Cat. No. I561-E2-01

# SmartStep 2 servo system

**Model:**
**R7D-BP_ servo drive**
**R88D-GP08H_ servo drive (750 W)**
**R88M-G_ servo motor**

# USER'S MANUAL

# Introduction

Thank you for choosing the SMARTSTEP 2 Series. This User's Manual describes installation/wiring methods and parameter setting procedures required for the operation of the SMARTSTEP 2 Series as well as troubleshooting and inspection methods.

## Intended Readers

This manual is intended for the following personnel.
Those with knowledge of electrical systems (a qualified electrical engineer or the equivalent) as follows:

- Personnel in charge of introducing FA equipment
- Personnel in charge of designing FA systems
- Personnel in charge of managing FA systems and facilities

## NOTICE

This manual contains information necessary to ensure safe and proper use of the SMARTSTEP 2 Series and its peripheral devices. Please read this manual thoroughly and understand its contents before using the products.
Please keep this manual handy for future reference.
Make sure this User's Manual is delivered to the actual end user of the products.

# Read and Understand this Manual

Please read and understand this manual before using the product. Please consult your OMRON representative if you have any questions or comments.

# Warranty and Limitations of Liability

## *WARRANTY*

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

## *LIMITATIONS OF LIABILITY*

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall the responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

# Application Considerations

## SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the products.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this manual.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCTS ARE PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

## PROGRAMMABLE PRODUCTS

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

# Disclaimers

## CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

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

## DIMENSIONS AND WEIGHTS

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

## *PERFORMANCE DATA*

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

## *ERRORS AND OMISSIONS*

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

# Precautions for Safe Use

- To ensure safe and proper use of the SMARTSTEP 2 Series and its peripheral devices, read the "Precautions for Safe Use" and the rest of the manual thoroughly to acquire sufficient knowledge of the devices, safety information, and precautions before using the products.
- Make sure this User's Manual is delivered to the actual end users of the products.
- Please keep this manual close at hand for future reference.

## Explanation of Signal Words

- The precautions indicated here provide important information for safety. Be sure to heed the information provided with the precautions.
- The following signal words are used to indicate and classify precautions in this manual.

| | |
|---|---|
| WARNING | 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. |

Failure to heed the precautions classified as "Caution" may also lead to serious results. Strictly heed these precautions.

## Safety Precautions

- This manual may include illustrations of the product with protective covers or shields removed in order to show the components of the product in detail. Make sure that these protective covers and shields are put in place as specified before using the product.
- Consult your OMRON representative when using the product after a long period of storage.

**WARNING**

| |
|---|
| Always connect the frame ground terminals of the Servo Drive and the Servomotor to 100 Ω or less. Not doing so may result in electric shock. |
| Do not touch the inside of the Servo Drive. Doing so may result in electric shock. |
| When turning OFF the main circuit power supply, turn OFF the RUN Command Input (RUN) at the same time. Residual voltage may cause the Servomotor to continue rotating and result in injury or equipment damage even if the main circuit power supply is turned OFF externally, e.g., with an emergency stop. |
| 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, maintenance, or inspection must be performed by authorized personnel only.<br>Not doing so may result in electric shock or injury. |
| Wiring or inspection must not be performed for at least 15 minutes after turning OFF the power supply.<br>Doing so may result in electric shock. |
| Do not damage, pull on, put excessive stress on, or put heavy objects on the cables.<br>Doing so may result in electric shock, stopping product operation, or burning. |
| Do not touch the rotating parts of the Servomotor during operation.<br>Doing so may result in injury. |
| Do not modify the product.<br>Doing so may result in injury or damage to the product. |
| Provide a stopping mechanism on the machine side to ensure safety.<br>*The holding brake is not designed as a stopping mechanism for safety purposes.<br>Not doing so may result in injury. |
| Provide an external emergency stopping mechanism that can stop operation and shut off the power supply immediately.<br>Not doing so may result in injury. |
| Do not come close to the machine immediately after resetting momentary power interruption to avoid danger due to an unexpected restart.<br>Doing so may result in injury.<br>Take precautions to secure safety in case of an unexpected restart. |
| Confirm safety after an earthquake has occurred.<br>Not doing so may result in electric shock, injury, or fire. |
| Do not use external force to drive the Servomotor.<br>Doing so may result in fire. |

## WARNING

Do not place any flammable materials near the Servomotor, Servo Drive, or Regeneration Resistor.
Doing so may result in fire.

Mount the Servomotor, Servo Drive, and Regeneration Resistor on metal or other non-flammable materials.
Not doing so may result in fire.

Do not turn ON/OFF the main power supply of the Servo Drive repeatedly at frequent intervals.
Doing so may result in product failure.

## Caution

Use the Servomotors and Servo Drives in a combination as specified in the manual.
Not doing so may result in fire or damage to the products.

Do not store or install the product in the following places. Doing so may result in fire, electric shock, or damage to the product.

- Locations subject to direct sunlight.
- Locations subject to ambient temperature exceeding the specified level.
- Locations subject to relative humidity exceeding the specified level.
- Locations subject to condensation due to temperature fluctuations.
- Locations subject to corrosive or flammable gases.
- Locations subject to dust (especially iron dust) or salt.
- Locations subject to exposure to water, oil, or chemicals.
- Locations subject to shock or vibration.

Do not touch the Servo Drive radiator, Regeneration Resistor, or Servomotor while the power is being supplied or for some time after the power is turned OFF.
Doing so may result in burn injuries.

### ■ Storage and Transportation Precautions

## Caution

Do not hold the product by the cables or motor shaft while transporting it.
Doing so may result in injury or malfunction.

Do not overly pile the products. (Follow the instructions on the product package.)
Doing so may result in injury or malfunction.

## ■ Installation and Wiring Precautions

### Caution

| |
|---|
| Do not step on or place a heavy object on the product.<br>Doing so may result in injury. |
| Do not cover the inlet/outlet ports and do not let any foreign objects enter the product.<br>Doing so may result in fire. |
| Be sure to install the product in the correct direction.<br>Not doing so may result in malfunction. |
| Keep the specified distance between the Servo Drive and the control panel or with other devices.<br>Not doing so may result in fire or malfunction. |
| Do not apply a strong impact on the Servomotor shaft or Servo Drive.<br>Doing so may result in malfunction. |
| Be sure to wire correctly and securely.<br>Not doing so may result in motor runaway, injury, or malfunction. |
| Be sure that all the mounting screws, terminal block screws, and cable connector screws are tightened securely.<br>Not doing so may result in malfunction. |
| Use crimp terminals for wiring.<br>Do not connect bare stranded wires directly to the protective ground terminal.<br>Doing so may result in fire. |
| Always use the power supply voltage specified in the User's Manual.<br>Not doing so may result in malfunction or burning. |
| Take appropriate measures to ensure that the specified power with the rated voltage and frequency is supplied. Use particular caution if the product is used in a place where a stable power supply cannot be provided.<br>Not doing so may result in equipment damage. |
| Install breakers and take other safety measures against short-circuiting of external wiring.<br>Not doing so may result in fire. |
| Take sufficient shielding measures when using the product in the following locations.<br>Not doing so may result in damage to the product.<br>• Locations subject to static electricity or other forms of noise.<br>• Locations subject to strong electromagnetic fields and magnetic fields.<br>• Locations subject to possible exposure to radioactivity.<br>• Locations close to power lines. |
| Connect an emergency stop shutoff relay in series with the brake control relay.<br>Not doing so may result in injury or product failure. |

## ■ Operation and Adjustment Precautions

### ⚠ Caution

| | |
|---|---|
| ⚠ | Confirm that no adverse effects will occur in the system before performing the test operation.<br>Not doing so may result in equipment damage. |
| ⚠ | Check that the newly set parameters function properly before the actual operation.<br>Not doing so may result in equipment damage. |
| ⚠ | Do not make any extreme adjustments or setting changes.<br>Doing so may result in injury. |
| ⚠ | Check for the proper operation of the Servomotor separately from the mechanical system before connecting it to the machine.<br>Not doing so may cause injury. |
| ⚠ | When an alarm occurs, remove the cause, reset the alarm after confirming safety, and then resume operation.<br>Not doing so may result in injury. |
| ⚠ | Do not use the built-in brake of the Servomotor for ordinary braking.<br>Doing so may result in malfunction. |
| ⚠ | Do not operate the Servomotor connected to a load that exceeds the applicable load inertia.<br>Doing so may result in malfunction. |

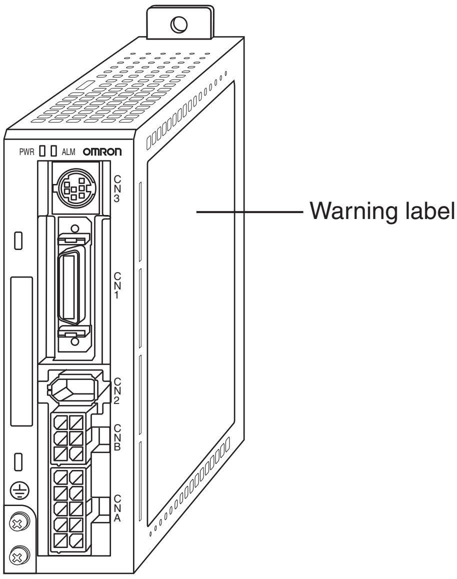
## ■ Maintenance and Inspection Precautions

### ⚠ Caution

| | |
|---|---|
| ⚠ | Resume operation only after transferring to the new Unit the contents of the data required for operation restart.<br>Not doing so may result in equipment damage. |
| | Do not dismantle or repair the product.<br>Doing so may result in electric shock or injury. |

## ■ Warning Label Position

Warning labels are located on the product as shown in the following illustration.
Be sure to follow the instructions given there.




(Example of R7D-BP01H)

## ■ Warning Label Contents


## ■ Disposing of the Product

- Dispose of the product as industrial waste.

# Items to Check When Unpacking

Check the following items after removing the product from the package.

- Has the correct product been delivered?
- Has the product been damaged in shipping?

## ■ Accessories Provided with Product

### Safety Precautions document × 1

- No connectors or mounting screws are provided. They have to be prepared by the user.
- Should you find any problems (missing parts, damage to the Servo Drive, etc.), please contact your local sales representative or OMRON sales office.

## ■ Understanding Model Numbers

### Servo Drive Models

The model number provides information such as the Servo Drive type, the applicable Servomotor capacity, and the power supply voltage.

R 7D-BP 01 H

SMARTSTEP 2
Servo Drive 50 - 400 W

Drive Type
P: Pulse-string input type

Applicable Servomotor Capacity
A5: 50 W
01: 100 W
02: 200 W
04: 400 W

Power Supply Voltage
L: 100 VAC
H: Single/Three-phase 200 VAC
HH: Single-phase 200 VAC

R 88D-GP08H

SMARTSTEP 2
Servo Drive 750 W *1

Drive Type
P: Pulse-string input type

Applicable Servomotor Capacity
08: 750 W

Power Supply Voltage
H: 230 VAC

*1: For the SmartStep 2 750W servo drive specifications, dimensions and operation please refer to the Appendix-2 at the end of this manual.

### Servomotor Models

The model number provides information such as the Servomotor type, Servomotor capacity, rated rotation speed, and options.

R 88 M-GP 10030 H-BOS2

G-Series Servomotor

Motor Type
- None: Cylinder type
- P: Flat type

Servomotor Capacity
- 050: 50 W
- 100: 100 W
- 200: 200 W
- 400: 400 W
- 750: 750 W *1

Rated Rotation Speed
- 30: 3000 r/min

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

Options
- None: Straight shaft
- B: With brake
- O: With oil seal
- S2: With key and tap

*1: For the SmartStep 2 750W servo motor specifications and dimensions please refer to the Appendix-2 at the end of this manual.

# About this Manual

This manual consists of the following chapters. Refer to this table and choose the required chapters of the manual.

| | | Overview |
|---|---|---|
| Chapter 1 | Features and System Configuration | Describes the features and names of parts of the product as well as the EC Directives and the UL standards. |
| Chapter 2 | Standard Models and Dimensions | Provides the model numbers, external and mounted dimensions for Servo Drives, Servomotors and peripheral devices. |
| Chapter 3 | Specifications | Provides the general specifications, performance specifications, connector specifications, and I/O circuit specifications for Servo Drives and the general specifications and performance specifications for Servomotors, as well as specifications for accessories such as encoders. |
| Chapter 4 | System Design | Describes the installation conditions for Servo Drives, Servomotors, EMC conforming wiring methods, calculations of regenerative energy, and performance information on the External Regeneration Resistor. |
| Chapter 5 | Operating Functions | Describes the electronic gear function and other operating functions as well as the parameter setting procedure. |
| Chapter 6 | Operation | Describes operating procedures and how to use the Parameter Unit. |
| Chapter 7 | Adjustment Functions | Describes realtime autotuning function, manual tuning and other procedures for gain adjustment. |
| Chapter 8 | Troubleshooting | Describes items to check for troubleshooting, error diagnoses using alarm displays and the countermeasures, error diagnoses based on the operation status and the countermeasures, and periodic maintenance. |
| Chapter 9 | Appendix-1 Connection Examples | Provides examples of connection with OMRON PLCs and Position Controllers. |
| Chapter 10 | Appendix-2 SMARTSTEP 2 750 W Model | Provides the specifications and operation of SMARTSTEP 2 750 W Model. |

# CONTENTS

# Chapter 1

# Features and System Configuration

# 1-1 Overview

## Overview of the SMARTSTEP 2 Series

The SMARTSTEP 2 Series is a series of pulse-string input type Servo Drives for position controlling and it has been designed to function for low-capacity positioning systems. In spite of the compact size, the SMARTSTEP 2 Series features realtime autotuning and adaptive filter functions that automatically perform complicated gain adjustments. A notch filter can also be automatically set to suppress machine vibration by reducing mechanical resonance during operation. The vibration control function of the SMARTSTEP 2 Series realizes stable stopping performance in a mechanism which vibrates because of the low rigidity of the load.

## Features of the SMARTSTEP 2 Series

The SMARTSTEP 2 Series has the following features.

### ■ Compact AC Servo Drives

Compared to the SMARTSTEP A Series, the SMARTSTEP 2 Series can reduce the installation space by 48% and the installation size by 39% in terms of volume. The AC Servo Drives of the SMARTSTEP 2 Series are equipped with newly developed functions for applications requiring more precise positioning.

### ■ Suppressing Vibration of Low-rigidity Mechanisms during Acceleration/Deceleration

The vibration control function can suppress vibration of low-rigidity mechanisms or devices whose ends tend to vibrate.

### ■ High-speed Positioning via Resonance Suppression Control

The realtime autotuning function automatically estimates the load inertia of the machine in realtime and sets the optimal gain. The adaptive filter automatically suppresses vibration caused by resonance.

### ■ Compatible with Command Pulse of 90° Phase Difference Inputs

In addition to conventional CW/CCW inputs (2 pulse inputs) and SIGN/PULS inputs (1 pulse input), the SMARTSTEP 2 supports 90° phase difference inputs. This makes it possible to input encoder output signals directly into the Servo Drive for simplified synchronization control.

### ■ A Wide Range of Pulse Setting Functions

A wide range of pulse setting functions, such as the command pulse multiplying, electronic gear, and encoder dividing, enable you to perform pulse settings suitable for your device or system.

### ■ Simplified Speed Control with Internal Speed Settings

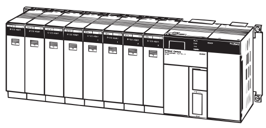
Four internal speed settings allow the speed to be easily switched by using external signals.

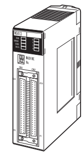
### ■ Encoder Dividing Output Function

The number of motor encoder pulses output by the Servo Drive can be freely set in the range of 1 to 2,500 pulses per rotation. A parameter can also be set to change the phase.

# 1-2 System Configuration

**SYSMAC PLC + Position Control Unit with pulse-string output**

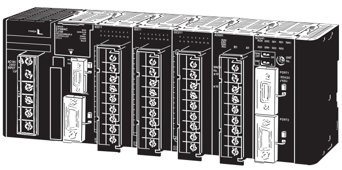




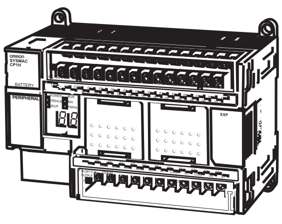
SYSMAC
CJ1/CS1/C-Series
Programmable Controller

Position Control Unit
CJ1 W-NC113/213/413
CJ1 W-NC133/233/433
CS1 W-NC113/213/413
CS1 W-NC133/233/433
C200H W-NC113/213/413

**SYSMAC PLC with pulse output functions**

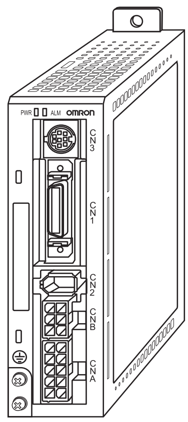


SYSMAC CJ1M

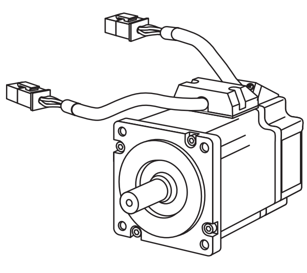


SYSMAC CP1H/CP1L

Pulse string




SMARTSTEP 2 Servo Drive
R7D-BP□



G-Series Servomotor
R88M-G□/-GP□

1

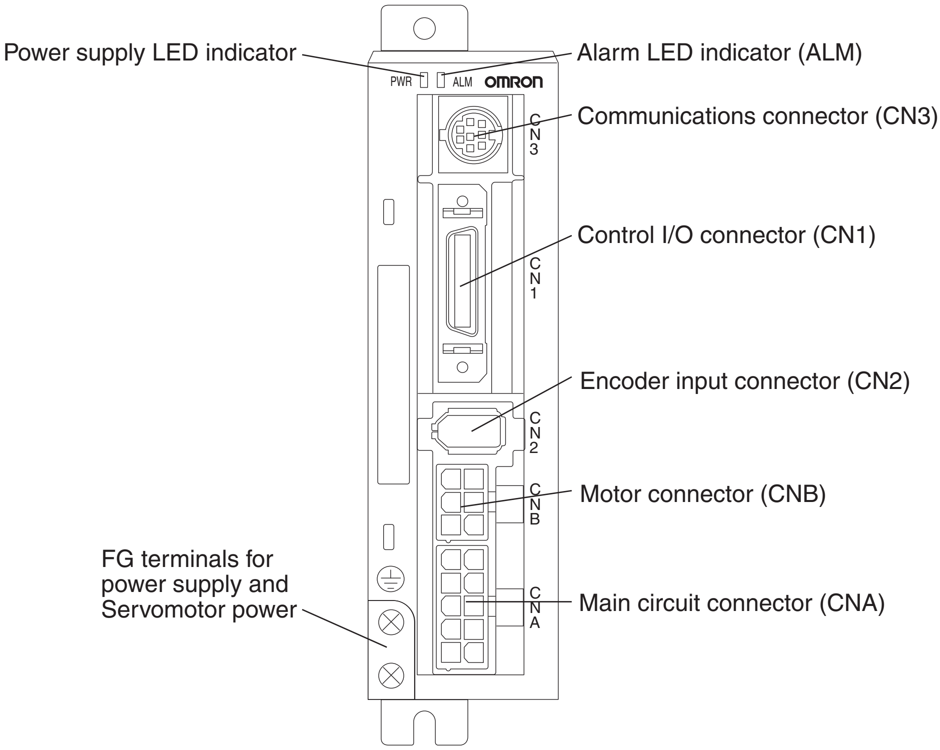
Features and System Configuration

1

Features and System Configuration

# 1-3 Names of Parts and Functions

## Servo Drive Part Names



## Servo Drive Functions

### ■ Power Supply LED Indicator (PWR)

| LED Indicator | Status |
|---|---|
| Lit green | Main power is ON. |
| Flashing orange at 1-second intervals | A warning has occurred (i.e., an overload, excessive regenerative energy, or fan speed error). |
| Lit red | An alarm has occurred. |

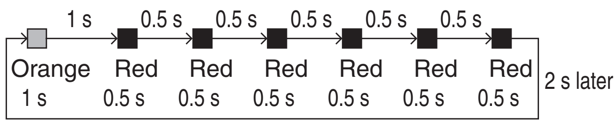
### ■ Alarm LED Indicator (ALM)

This indicator is lit when an alarm has occurred. The number of orange and red flashes indicate the alarm code. For details on the alarm code, refer to *Alarm List* on page 8-4.

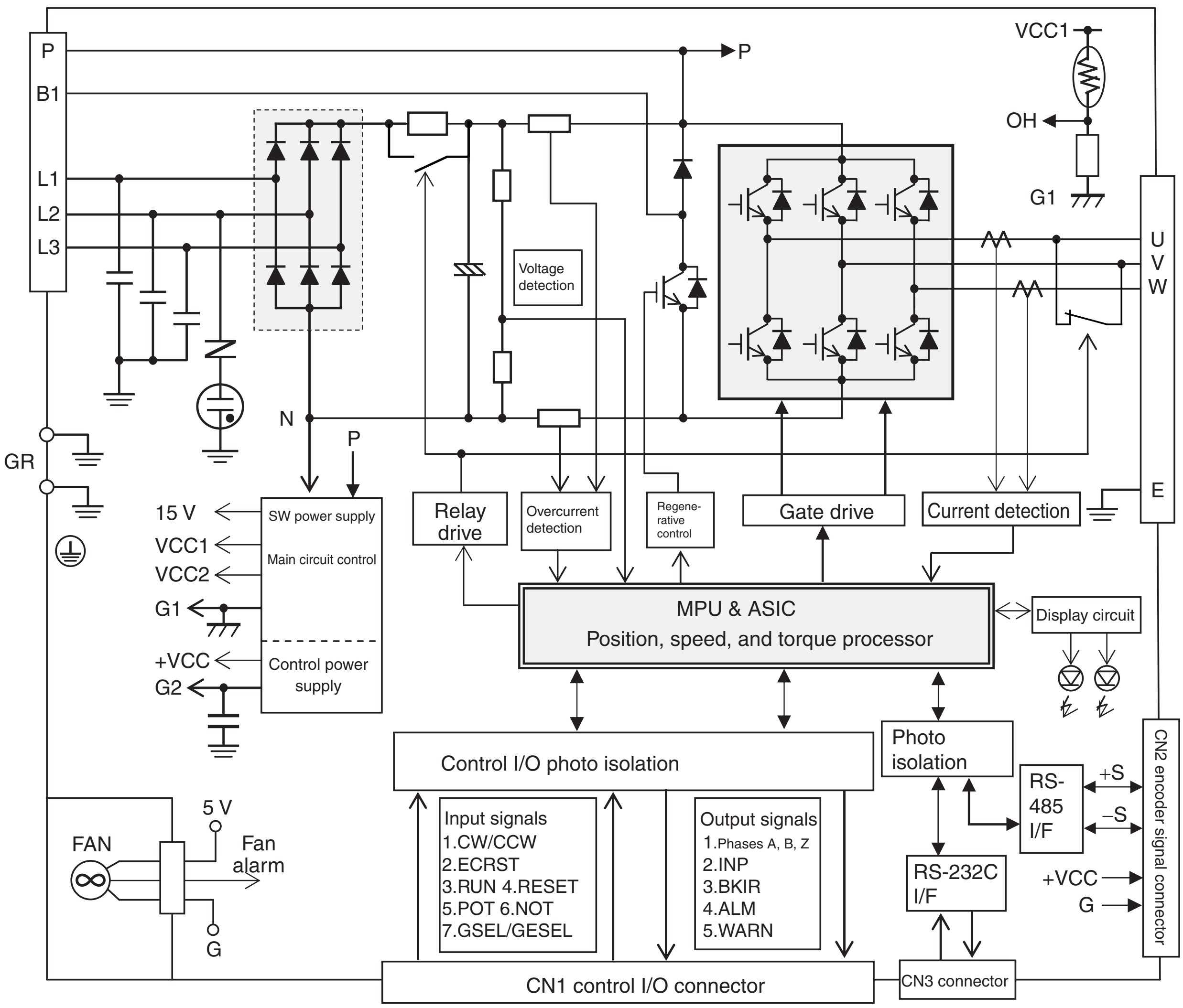
Example:

When an overload alarm (alarm code 16) has occurred and the Unit has stopped the indicator will flash 1 time in orange and 6 times in red.

Orange: 10s digit, Red: 1s digit



# 1-4 System Block Diagrams



# 1-5 Applicable Standards

## EC Directives

| EC Directive | Product | Applicable standards | Comments |
|---|---|---|---|
| Low Voltage Directive | AC Servo Drive | EN 50178 | Safety requirements for electronic equipment for measurement, control, or laboratory use |
| | AC Servomotor | IEC 60034-1 | Rotating electric machines |
| EMC Directive | AC Servo Drive and AC Servomotor | EN 55011 class A group1 | Radio disturbance limits and measurement methods of industrial, scientific, and medical radio-frequency equipment |
| | | EN 61000-6-2 | Electromagnetic compatibility (EMC): Immunity standard for industrial environments |

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

## UL Standards

| Standard | Product | Applicable standards | File number | Comments |
|---|---|---|---|---|
| UL Standard | AC Servo Drive | UL 508C | E179149 | Power conversion equipment |

# Chapter 2

# Standard Models and Dimensions

# 2-1 Standard Models



## Servo Drives

| Specifications | | Model |
|---|---|---|
| Single-phase 100 VAC | 50 W | R7D-BPA5L |
| | 100 W | R7D-BP01L |
| | 200 W | R7D-BP02L |
| Single-phase/three-phase 200 VAC | 50 W | R7D-BP01H |
| | 100 W | |
| | 400 W | R7D-BP04H |
| Single-phase 200 VAC | 200 W | R7D-BP02HH |
| Three-phase 200 VAC | 200 W | R7D-BP02H |

## Servomotors

### ■ 3,000-r/min Servomotors

| Specifications | | | Model | |
|---|---|---|---|---|
| | | | Straight shaft | Straight shaft with key and tap |
| Without brake | 100/200 V | 50 W | R88M-G05030H | R88M-G05030H-S2 |
| | 100 V | 100 W | R88M-G10030L | R88M-G10030L-S2 |
| | | 200 W | R88M-G20030L | R88M-G20030L-S2 |
| | 200 V | 100 W | R88M-G10030H | R88M-G10030H-S2 |
| | | 200 W | R88M-G20030H | R88M-G20030H-S2 |
| | | 400 W | R88M-G40030H | R88M-G40030H-S2 |
| With brake | 100/200 V | 50 W | R88M-G05030H-B | R88M-G05030H-BS2 |
| | 100 V | 100 W | R88M-G10030L-B | R88M-G10030L-BS2 |
| | | 200 W | R88M-G20030L-B | R88M-G20030L-BS2 |
| | 200 V | 100 W | R88M-G10030H-B | R88M-G10030H-BS2 |
| | | 200 W | R88M-G20030H-B | R88M-G20030H-BS2 |
| | | 400 W | R88M-G40030H-B | R88M-G40030H-BS2 |

Note Models with oil seals are also available.

### ■ 3,000-r/min Flat Servomotors

| Specifications | | | Model | |
|---|---|---|---|---|
| | | | Straight shaft | Straight shaft with key and tap |
| Without brake | 100 V | 100W | R88M-GP10030L | R88M-GP10030L-S2 |
| | | 200W | R88M-GP20030L | R88M-GP20030L-S2 |
| | 200 V | 100W | R88M-GP10030H | R88M-GP10030H-S2 |
| | | 200W | R88M-GP20030H | R88M-GP20030H-S2 |
| | | 400W | R88M-GP40030H | R88M-GP40030H-S2 |
| With brake | 100 V | 100W | R88M-GP10030L-B | R88M-GP10030L-BS2 |
| | | 200W | R88M-GP20030L-B | R88M-GP20030L-BS2 |
| | 200 V | 100W | R88M-GP10030H-B | R88M-GP10030H-BS2 |
| | | 200W | R88M-GP20030H-B | R88M-GP20030H-BS2 |
| | | 400W | R88M-GP40030H-B | R88M-GP40030H-BS2 |

Note Models with oil seals are also available.

## Parameter Unit

| Specifications | Model |
|---|---|
| Parameter Unit | R88A-PR02G |

## Servo Drive-Servomotor Combinations

Only the Servomotor and Servo Drive combinations listed here can be used. Do not use other combinations.

### ■ Single-phase 100-VAC Combinations

#### 3,000-r/min Servomotors

| Rated output | Servo Drive | Servomotor | |
|---|---|---|---|
| | Pulse-string input | Without brake | With brake |
| 50 W | R7D-BPA5L | R88M-G05030H-□ | R88M-G05030H-B□ |
| 100 W | R7D-BP01L | R88M-G10030L-□ | R88M-G10030L-B□ |
| 200 W | R7D-BP02L | R88M-G20030L-□ | R88M-G20030L-B□ |

#### 3,000-r/min Flat Servomotors

| Rated output | Servo Drive | Servomotor | |
|---|---|---|---|
| | Pulse-string input | Without brake | With brake |
| 100 W | R7D-BP01L | R88M-GP10030L-□ | R88M-GP10030L-B□ |
| 200 W | R7D-BP02L | R88M-GP20030L-□ | R88M-GP20030L-B□ |

## ■ Single-phase 200-VAC Combinations

### 3,000-r/min Servomotors

| Rated output | Servo Drive | Servomotor | |
|---|---|---|---|
| | Pulse-string input | Without brake | With brake |
| 50 W | R7D-BP01H | R88M-G05030H-☐ | R88M-G05030H-B☐ |
| 100 W | | R88M-G10030H-☐ | R88M-G10030H-B☐ |
| 200 W | R7D-BP02HH | R88M-G20030H-☐ | R88M-G20030H-B☐ |
| 400 W | R7D-BP04H | R88M-G40030H-☐ | R88M-G40030H-B☐ |

### 3,000-r/min Flat Servomotors

| Rated output | Servo Drive | Servomotor | |
|---|---|---|---|
| | Pulse-string input | Without brake | With brake |
| 100 W | R7D-BP01H | R88M-GP10030H-☐ | R88M-GP10030H-B☐ |
| 200 W | R7D-BP02HH | R88M-GP20030H-☐ | R88M-GP20030H-B☐ |
| 400 W | R7D-BP04H | R88M-GP40030H-☐ | R88M-GP40030H-B☐ |

## ■ Three-phase 200-VAC Combinations

### 3,000-r/min Servomotors

| Rated output | Servo Drive | Servomotor | |
|---|---|---|---|
| | Pulse-string input | Without brake | With brake |
| 50 W | R7D-BP01H | R88M-G05030H-☐ | R88M-G05030H-B☐ |
| 100 W | | R88M-G10030H-☐ | R88M-G10030H-B☐ |
| 200 W | R7D-BP02H | R88M-G20030H-☐ | R88M-G20030H-B☐ |
| 400 W | R7D-BP04H | R88M-G40030H-☐ | R88M-G40030H-B☐ |

### 3,000-r/min Flat Servomotors

| Rated output | Servo Drive | Servomotor | |
|---|---|---|---|
| | Pulse-string input | Without brake | With brake |
| 100 W | R7D-BP01H | R88M-GP10030H-☐ | R88M-GP10030H-B☐ |
| 200 W | R7D-BP02H | R88M-GP20030H-☐ | R88M-GP20030H-B☐ |
| 400 W | R7D-BP04H | R88M-GP40030H-☐ | R88M-GP40030H-B☐ |

**Note 1.** The standard models have a straight shaft.

**Note 2.** A model with a key and tap is indicated by adding “J” to the end of the model number (the suffix shown in the box).
Example: R88G-HPG11A05100BJ

## Accessories and Cables

### ■ Encoder Cables (for CN2)

| Specifications | | Model |
|---|---|---|
| Global Cables (Non-Flexible Cables) | 3 m | R88A-CRGB003C |
| | 5 m | R88A-CRGB005C |
| | 10 m | R88A-CRGB010C |
| | 15 m | R88A-CRGB015C |
| | 20 m | R88A-CRGB020C |
| Global Cables (Flexible Cables) | 3 m | R88A-CRGB003CR |
| | 5 m | R88A-CRGB005CR |
| | 10 m | R88A-CRGB010CR |
| | 15 m | R88A-CRGB015CR |
| | 20 m | R88A-CRGB020CR |
| European Cables (Flexible and Shielded Cables) | 1.5 m | R88A-CRGB001-5CR-E |
| | 3 m | R88A-CRGB003CR-E |
| | 5 m | R88A-CRGB005CR-E |
| | 10 m | R88A-CRGB010CR-E |
| | 15 m | R88A-CRGB015CR-E |
| | 20 m | R88A-CRGB020CR-E |

### ■ Servomotor Power Cables (for CNB)

| Specifications | | Model |
|---|---|---|
| Global Cables (Non-Flexible Cables) | 3 m | R7A-CAB003S |
| | 5 m | R7A-CAB005S |
| | 10 m | R7A-CAB010S |
| | 15 m | R7A-CAB015S |
| | 20 m | R7A-CAB020S |
| Global Cables (Flexible Cables) | 3 m | R7A-CAB003SR |
| | 5 m | R7A-CAB005SR |
| | 10 m | R7A-CAB010SR |
| | 15 m | R7A-CAB015SR |
| | 20 m | R7A-CAB020SR |
| European Cables (Flexible and Shielded Cables) | 1.5 m | R7A-CAB001-5SR-E |
| | 3 m | R7A-CAB003SR-E |
| | 5 m | R7A-CAB005SR-E |
| | 10 m | R7A-CAB010SR-E |
| | 15 m | R7A-CAB015SR-E |
| | 20 m | R7A-CAB020SR-E |

## ■ Brake Cables

| Specifications | | Model |
|---|---|---|
| Global Cables (Non-Flexible Cables) | 3 m | R88A-CAGA003B |
| | 5 m | R88A-CAGA005B |
| | 10 m | R88A-CAGA010B |
| | 15 m | R88A-CAGA015B |
| | 20 m | R88A-CAGA020B |
| Global Cables (Flexible Cables) | 3 m | R88A-CAGA003BR |
| | 5 m | R88A-CAGA005BR |
| | 10 m | R88A-CAGA010BR |
| | 15 m | R88A-CAGA015BR |
| | 20 m | R88A-CAGA020BR |
| European Cables (Flexible Cables) | 1.5 m | R88A-CAGA001-5BR-E |
| | 3 m | R88A-CAGA003BR-E |
| | 5 m | R88A-CAGA005BR-E |
| | 10 m | R88A-CAGA010BR-E |
| | 15 m | R88A-CAGA015BR-E |
| | 20 m | R88A-CAGA020BR-E |

## ■ Power Supply Cables

| Specifications | | Model |
|---|---|---|
| Power Supply Input Cable for Single-Phase Power (connectors attached) | 2 m | R7A-CLB002S2 |
| Power Supply Input Cable for Three-Phase Power (connectors attached) | 2 m | R7A-CLB002S3 |
| External Regeneration Resistor Connection Cable | 2 m | R7A-CLB002RG |

## ■ Personal Computer Monitor Cable

| Specifications | | Model |
|---|---|---|
| Personal Computer Monitor Cable | 2 m | R88A-CCG002P2 |

## ■ Connectors

| Specifications | Model |
|---|---|
| Main Circuit Connector (CNA) | R7A-CNB01P |
| Servomotor Connector (CNB) | R7A-CNB01A |
| Control I/O Connector (CN1) | R88A-CNW01C |
| Encoder Input Connector (CN2) | R88A-CNW01R |
| Servomotor Connector for Encoder Cable | R88A-CNG02R |
| Servomotor Connector for Servomotor Power Cable | R88A-CNG01A |
| Brake Cable Connector | R88A-CNG01B |

## ■ Servo Relay Units (for CN1)

| Specifications | | Model |
|---|---|---|
| Servo Relay Units | For CJ1W-NC133/-NC113<br>For CS1W-NC133/-NC113<br>For C200HW-NC113 | XW2B-20J6-1B |
| | For CJ1W-NC233/-NC433/-NC213/-NC413<br>For CS1W-NC233/-NC433/-NC213/-NC413<br>For C200HW-NC213/-NC413 | XW2B-40J6-2B |
| | For CJ1M-CPU21<br>For CJ1M-CPU22<br>For CJ1M-CPU23 | XW2B-20J6-8A |
| | | XW2B-40J6-9A<br>(for 2 axes) |
| | For FQM1-MMP22 | XW2B-80J7-12A |
| | For CQM1H-PLB21<br>For CQM1-CPU43-V1 | XW2B-20J6-3B |

## ■ Servo Relay Unit Cables for Servo Drives

| Specifications | | | Model |
|---|---|---|---|
| Servo Drive Cables | For Position Control Unit/CQM1<br>(XW2B-□J6-□B) | 1 m | XW2Z-100J-B29 |
| | | 2 m | XW2Z-200J-B29 |
| | For CJ1M<br>(XW2B-20J6-8A/XW2B-40J6-9A) | 1 m | XW2Z-100J-B32 |
| | | 2 m | XW2Z-200J-B32 |
| | For FQM1-MMP22<br>(XW2B-80J7-12A) | 1 m | XW2Z-100J-B30 |
| | | 2 m | XW2Z-200J-B30 |

## ■ Servo Relay Unit Cables for Position Control Units

| Specifications | | | | Model |
|---|---|---|---|---|
| Position Control Unit Cables | For CJ1W-NC133 | | 0.5 m | XW2Z-050J-A18 |
| | | | 1 m | XW2Z-100J-A18 |
| | For CJ1W-NC233/-NC433 | | 0.5 m | XW2Z-050J-A19 |
| | | | 1 m | XW2Z-100J-A19 |
| | For CS1W-NC133 | | 0.5 m | XW2Z-050J-A10 |
| | | | 1 m | XW2Z-100J-A10 |
| | For CS1W-NC233/-NC433 | | 0.5 m | XW2Z-050J-A11 |
| | | | 1 m | XW2Z-100J-A11 |
| | For CJ1W-NC113 | | 0.5 m | XW2Z-050J-A14 |
| | | | 1 m | XW2Z-100J-A14 |
| | For CJ1W-NC213/-NC413 | | 0.5 m | XW2Z-050J-A15 |
| | | | 1 m | XW2Z-100J-A15 |
| | For CS1W-NC113<br>For C200HW-NC113 | | 0.5 m | XW2Z-050J-A6 |
| | | | 1 m | XW2Z-100J-A6 |
| | For CS1W-NC213/-NC413<br>For C200HW-NC213/-NC413 | | 0.5 m | XW2Z-050J-A7 |
| | | | 1 m | XW2Z-100J-A7 |
| | For CJ1M-CPU21<br>For CJ1M-CPU22<br>For CJ1M-CPU23 | | 0.5 m | XW2Z-050J-A33 |
| | | | 1 m | XW2Z-100J-A33 |
| | For FQM1-MMP22 | General-purpose I/O Cables | 0.5 m | XW2Z-050J-A28 |
| | | | 1 m | XW2Z-100J-A28 |
| | | | 2 m | XW2Z-200J-A28 |
| | | Special I/O Cables | 0.5 m | XW2Z-050J-A30 |
| | | | 1 m | XW2Z-100J-A30 |
| | | | 2 m | XW2Z-200J-A30 |
| | For CQM1H-PLB21<br>For CQM1-CPU43-V1 | | 0.5 m | XW2Z-050J-A3 |
| | | | 1 m | XW2Z-100J-A3 |

## ■ Control Cables (for CN1)

| Specifications | | Model |
|---|---|---|
| Connector-Terminal Block Cables | 1 m | XW2Z-100J-B28 |
| | 2 m | XW2Z-200J-B28 |
| General-purpose Control Cables | 1 m | R7A-CPB001S |
| | 2 m | R7A-CPB002S |

## ■ Connector-Terminal Block Conversion Units

| Specifications | Model |
|---|---|
| M3 screws type | XW2B-34G4 |
| M3.5 screws type | XW2B-34G5 |
| M3 screws type | XW2D-34G6 |

## ■ External Regeneration Resistors

| Specifications | Model |
|---|---|
| Regeneration capacity: 70 W, 47 Ω | R88A-RR22047S |
| Regeneration capacity: 20 W, 100 Ω | R88A-RR080100S |
| Regeneration capacity: 20 W, 50 Ω | R88A-RR08050S |

## ■ Reactors

| Specifications | Applicable Servo Drive | Model |
|---|---|---|
| Single-phase 100 V | R7D-BPA5L | 3G3AX-DL2002 |
| | R7D-BP01L | 3G3AX-DL2004 |
| | R7D-BP02L | 3G3AX-DL2007 |
| Single-phase 200 V | R7D-BP01H | 3G3AX-DL2004 |
| | R7D-BP02HH | 3G3AX-DL2004 |
| | R7D-BP04H | 3G3AX-DL2007 |
| Three-phase 200 V | R7D-BP01H | 3G3AX-AL2025 |
| | R7D-BP02H | 3G3AX-AL2025 |
| | R7D-BP04H | 3G3AX-AL2025 |

## ■ DIN Rail Mounting Unit

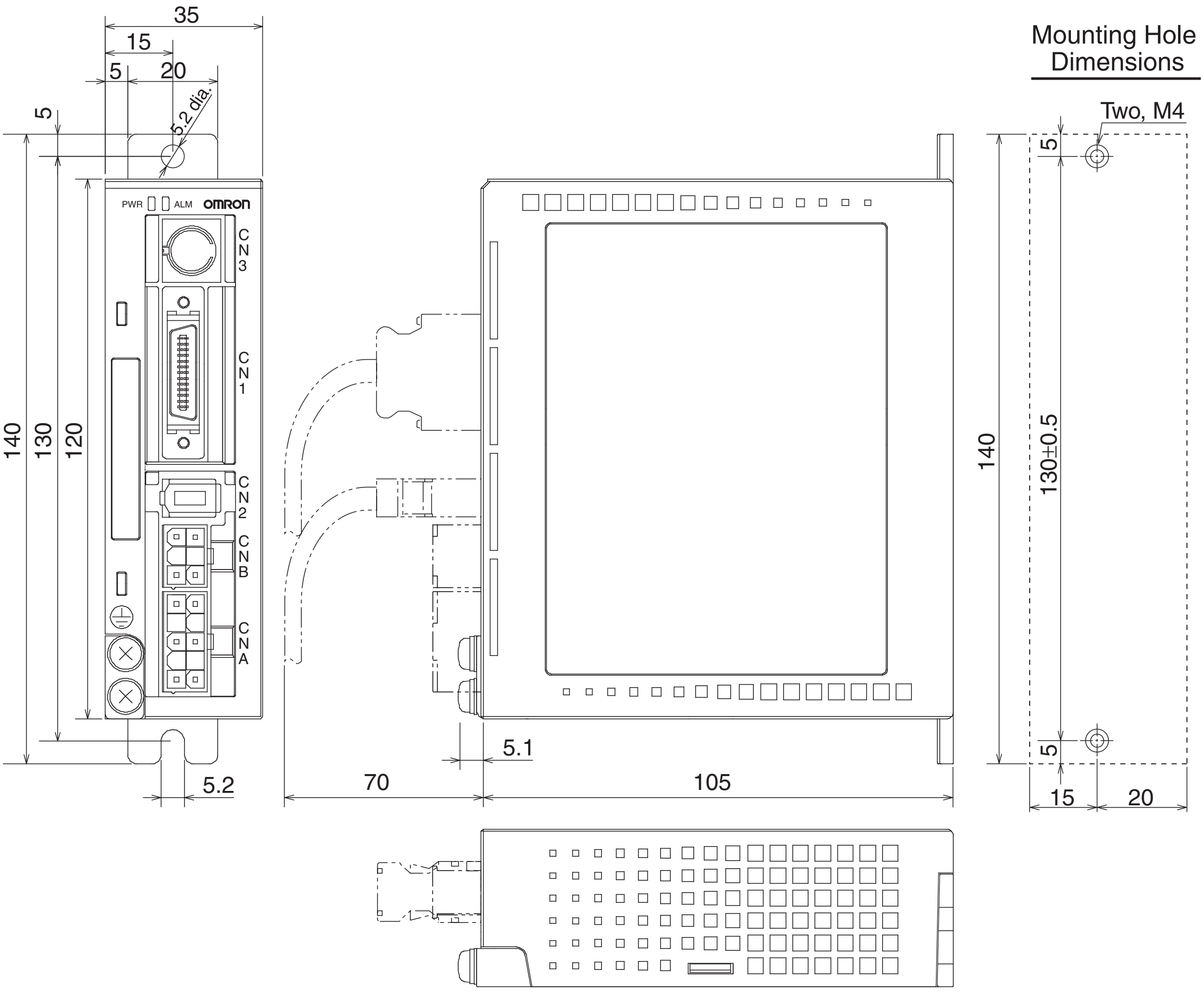
| Specifications | Model |
|---|---|
| DIN Rail Mounting Unit | R7A-DIN01B |

# 2-2 External and Mounted Dimensions

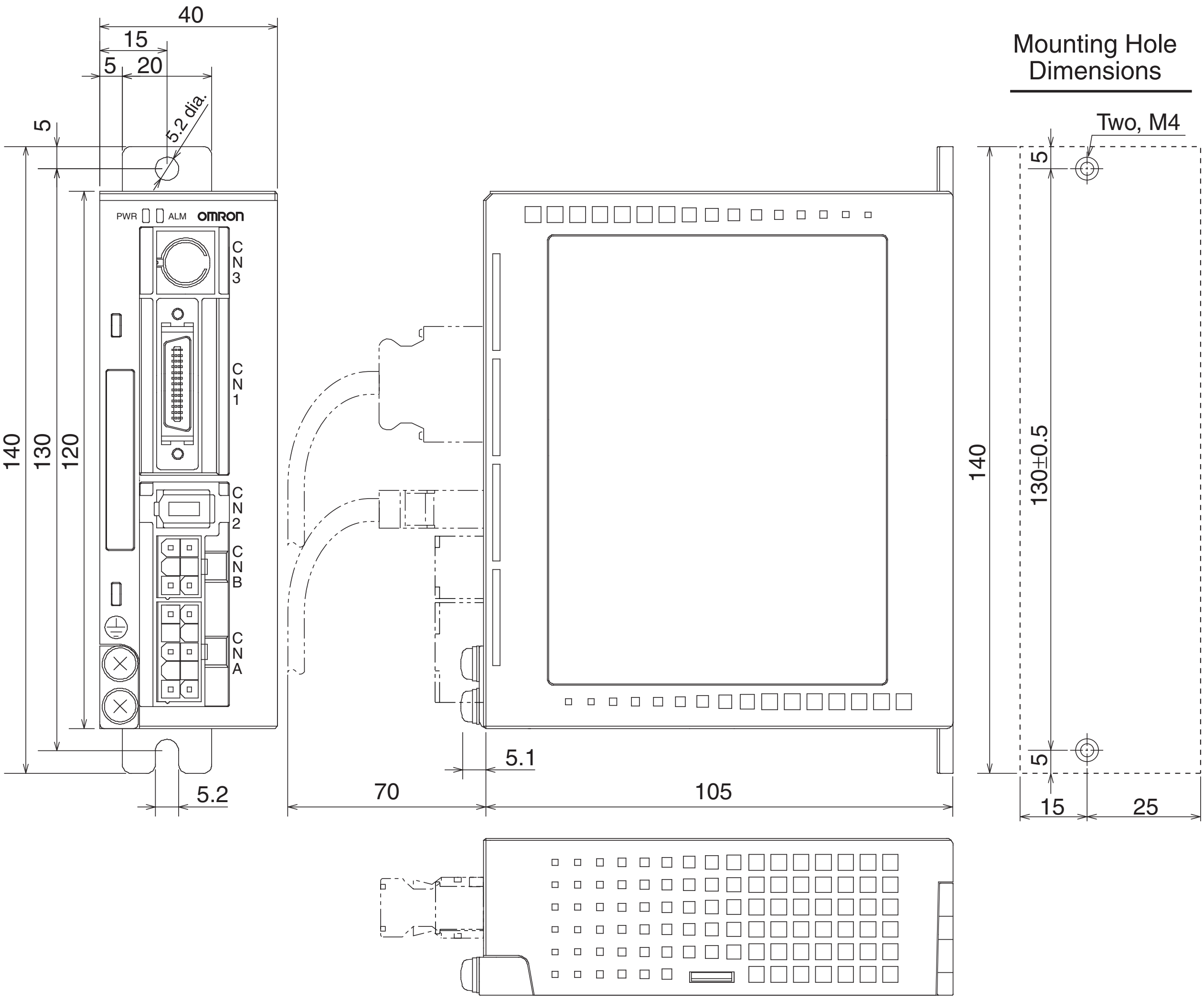


## Servo Drives

### ■ R7D-BPA5L/-BP01L/-BP01H/-BP02H (50 W/100 W/200 W)



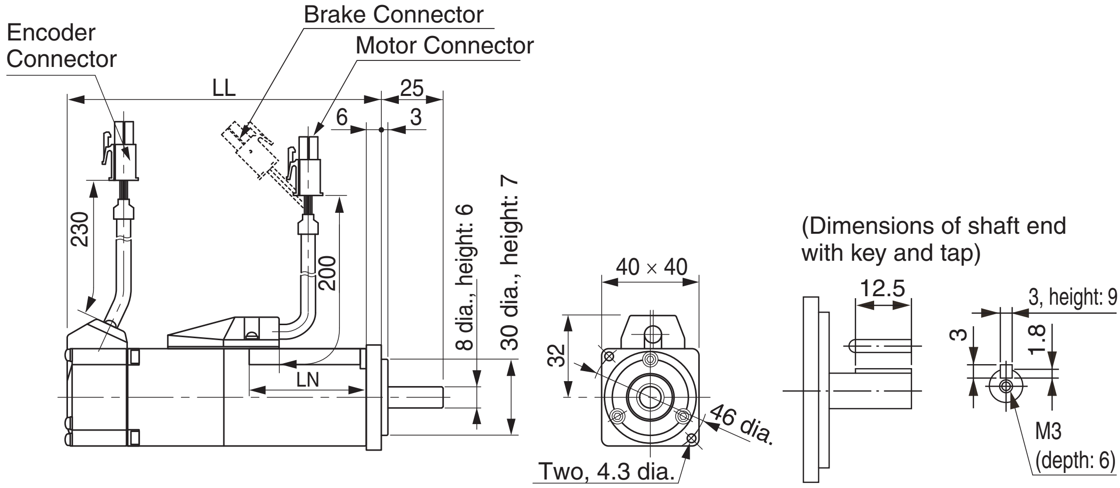
## ■ R7D-BP02L/-BP02HH/-BP04H (200 W/400 W)



## Servomotors

### ■ 3,000-r/min 50-/100-W Servomotors

**R88M-G05030H(-S2)/-G10030L(-S2)/-G10030H(-S2)
/-G05030H-B(S2)/-G10030L-B(S2)/-G10030H-B(S2)**




| Model | LL (mm) | LN (mm) |
|---|---|---|
| R88M-G05030H | 72 | 26.5 |
| R88M-G05030H-B *1 | 102 | 26.5 |
| R88M-G10030□ *2 | 92 | 46.5 |
| R88M-G10030□-B *1, *2 | 122 | 46.5 |

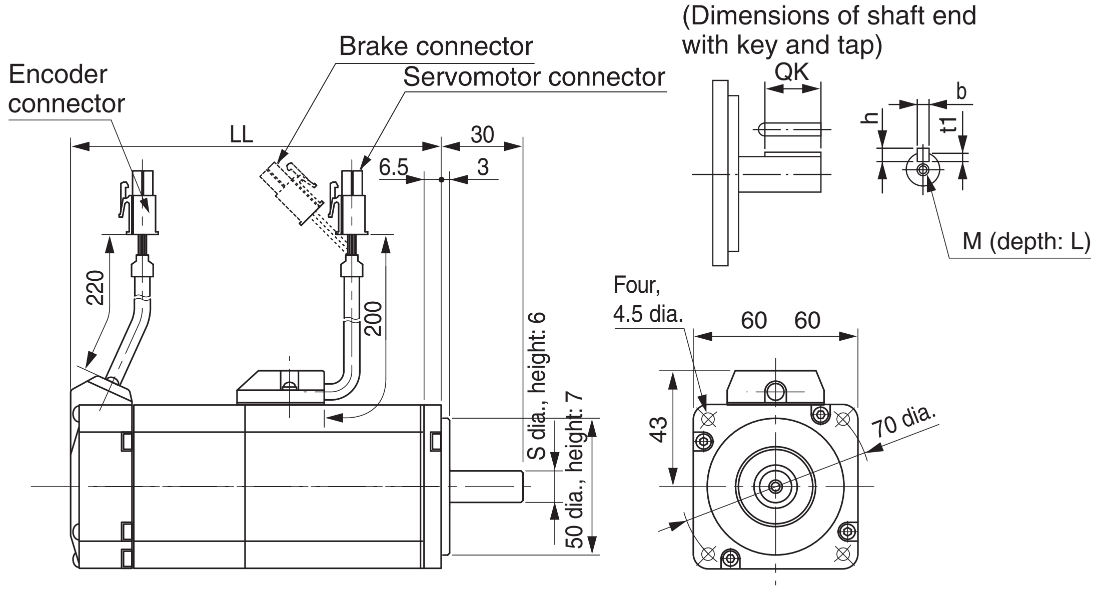
*1. This is the model number for the Servomotor with a brake.
*2. Put “L” or “H” in the place indicated by the box.

Note The standard models have a straight shaft. A model with a key and tap is indicated by adding “S2” to the end of the model number.

## ■ 3,000-r/min 200-/400-W Servomotors

### R88M-G20030L(-S2)/-G20030H(-S2)/-G40030H(-S2) /-G20030L-B(S2)/-G20030H-B(S2)/-G40030H-B(S2)





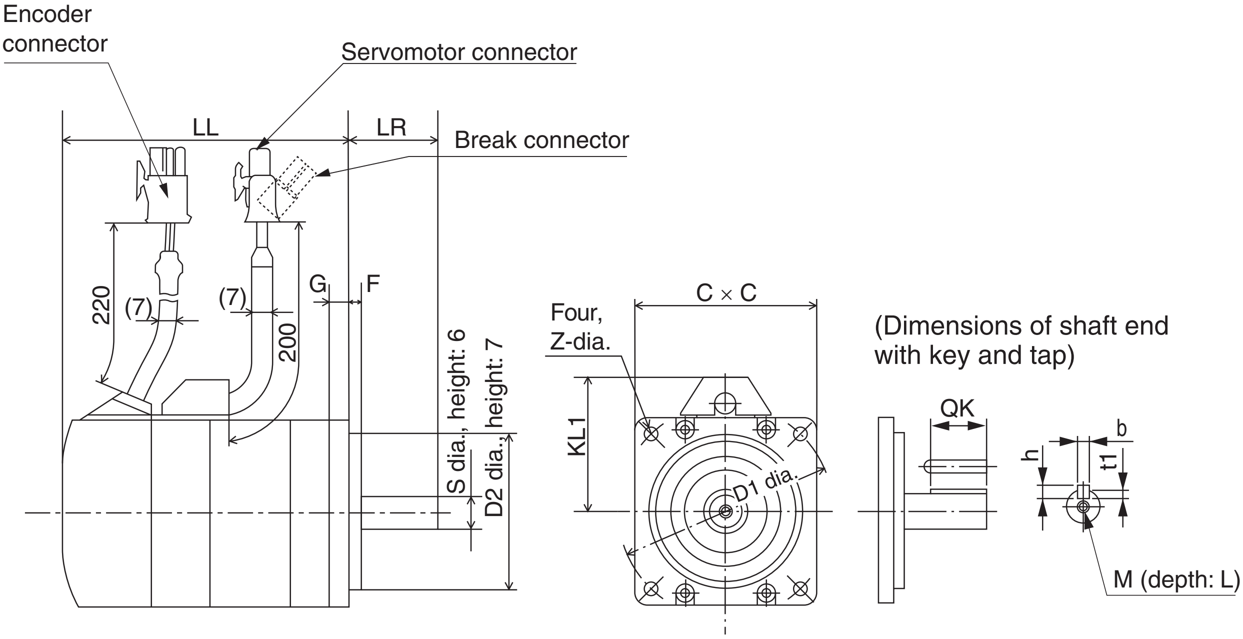

| Model | LL | S | Dimensions for models with key and tap *3 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | QK | b | h | t1 | M | L |
| | (mm) | (mm) | (mm) | | (mm) | (mm) | | (mm) |
| R88M-G20030□ *1 | 79.5 | 11 | 18 | 4h9 | 4 | 2.5 | M4 | 8 |
| R88M-G20030□-B *1,*2 | 116 | 11 | 18 | 4h9 | 4 | 2.5 | M4 | 8 |
| R88M-G40030H | 99 | 14 | 22.5 | 5h9 | 5 | 3 | M5 | 10 |
| R88M-G40030H-B *2 | 135.5 | 14 | 22.5 | 5h9 | 5 | 3 | M5 | 10 |

*1. Put “L” or “H” in the place indicated by the box.
*2 .This is the model number for the Servomotor with a brake.
*3. A model with a key and tap is indicated by adding “S2” to the end of the model number.

Note The standard models have a straight shaft.

## ■ 3,000-r/min 100-/200-/400-W Flat Servomotors

**R88M-GP10030L(-S2)/-GP10030H(-S2)/-GP20030L(-S2)/-GP20030H(-S2)/-GP40030H(-S2)**
**R88M-GP10030L-B(S2)/-GP10030H-B(S2)/-GP20030L-B(S2)/-GP20030H-B(S2)/-GP40030H-B(S2)**




| Model | LL | LR | S | D1 | D2 | C | F | G |
|---|---|---|---|---|---|---|---|---|
| | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) |
| R88M-GP10030□ *1 | 60.5 | 25 | 8 | 70 | 50 | 60 | 3 | 7 |
| R88M-GP10030□-B *1, *2 | 84.5 | 25 | 8 | 70 | 50 | 60 | 3 | 7 |
| R88M-GP20030□ *1 | 67.5 | 30 | 11 | 90 | 70 | 80 | 5 | 8 |
| R88M-GP20030□-B *1, *2 | 100 | 30 | 11 | 90 | 70 | 80 | 5 | 8 |
| R88M-GP40030H | 82.5 | 30 | 14 | 90 | 70 | 80 | 5 | 8 |
| R88M-GP40030H-B *2 | 115 | 30 | 14 | 90 | 70 | 80 | 5 | 8 |

| Model | KL1 | Z | Dimensions for models with key and tap*3 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | QK | b | h | t1 | M | L |
| | (mm) | (mm) | (mm) | | (mm) | (mm) | | (mm) |
| R88M-GP10030□ *1 | 43 | 4.5 | 12.5 | 3h9 | 3 | 1.8 | M3 | 6 |
| R88M-GP10030□-B *1,*2 | 43 | 4.5 | 12.5 | 3h9 | 3 | 1.8 | M3 | 6 |
| R88M-GP20030□ *1 | 53 | 5.5 | 18 | 4h9 | 4 | 2.5 | M4 | 8 |
| R88M-GP20030□-B *1,*2 | 53 | 5.5 | 18 | 4h9 | 4 | 2.5 | M4 | 8 |
| R88M-GP40030H | 53 | 5.5 | 22.5 | 5h9 | 5 | 3.0 | M5 | 10 |
| R88M-GP40030H-B *2 | 53 | 5.5 | 22.5 | 5h9 | 5 | 3.0 | M5 | 10 |

*1. Put “L” or “H” in the place indicated by the box.
*2. This is the model number for the Servomotor with a brake.
*3. A model with a key and tap is indicated by adding “S2” to the end of the model number.

Note The standard models have a straight shaft.

2

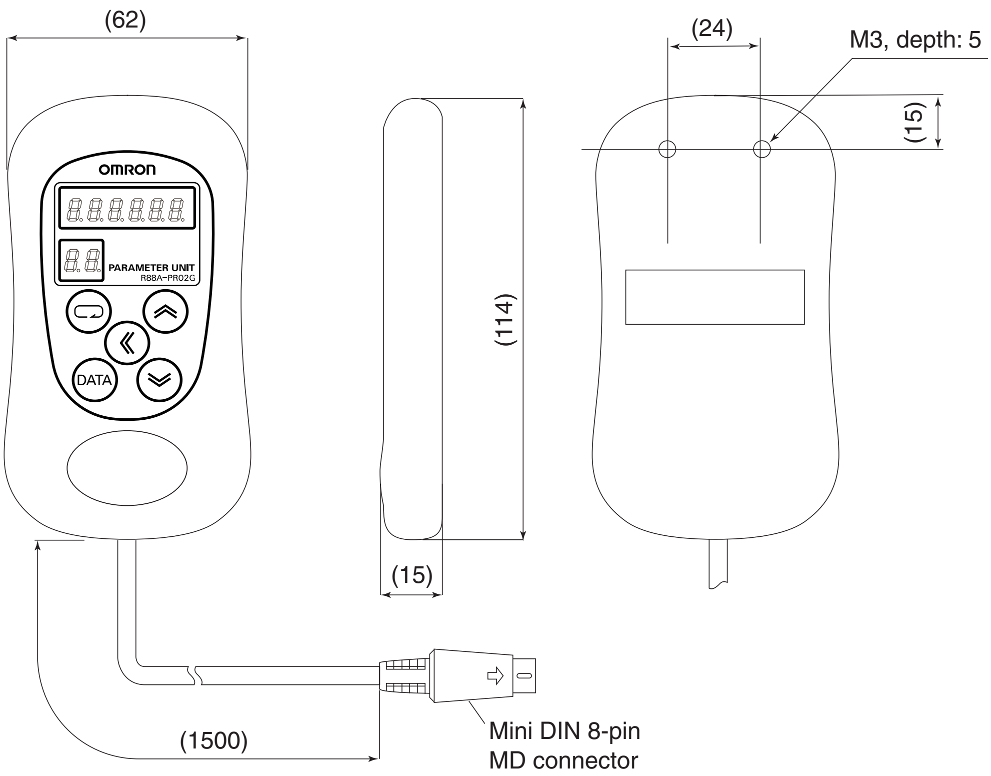
Standard Models and Dimensions

## Parameter Unit Dimensions

### ■ R88A-PR02G





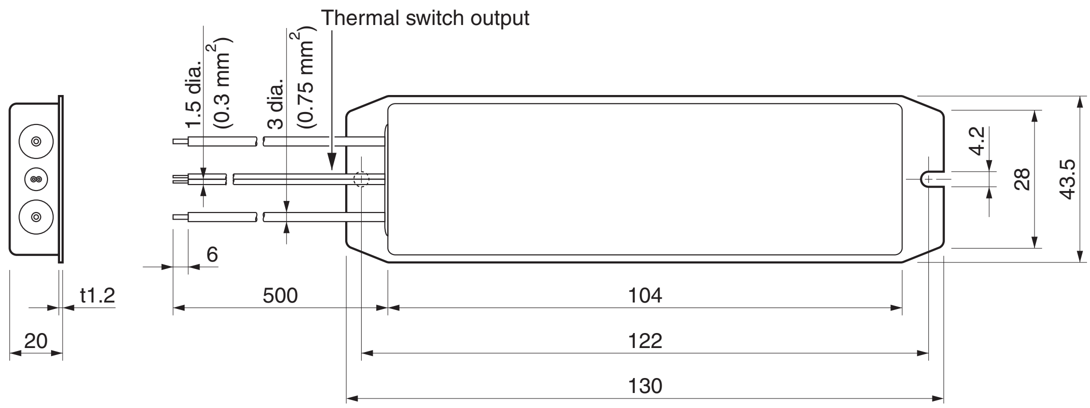



Note The standard models have a straight shaft. A model with a key and tap is indicated by adding “J” to the end of the model number (the suffix shown in the box).

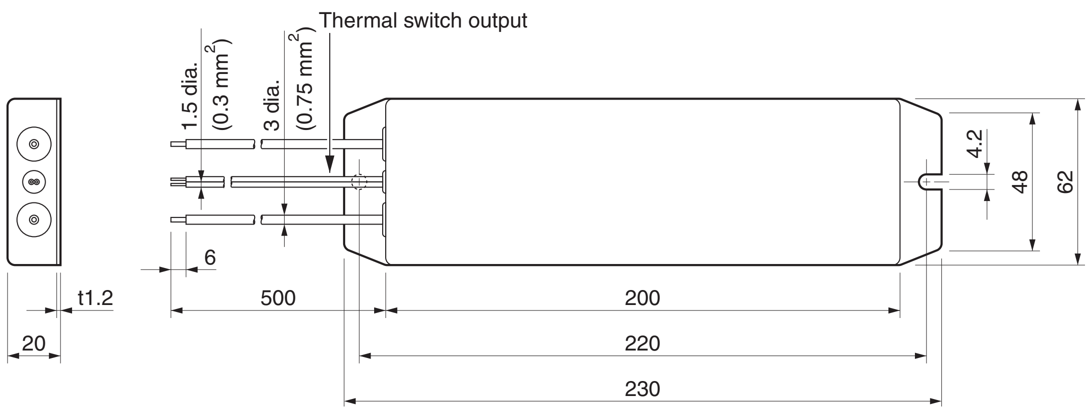
## External Regeneration Resistor Dimensions

### ■ External Regeneration Resistor

**R88A-RR08050S/R88A-RR080100S**

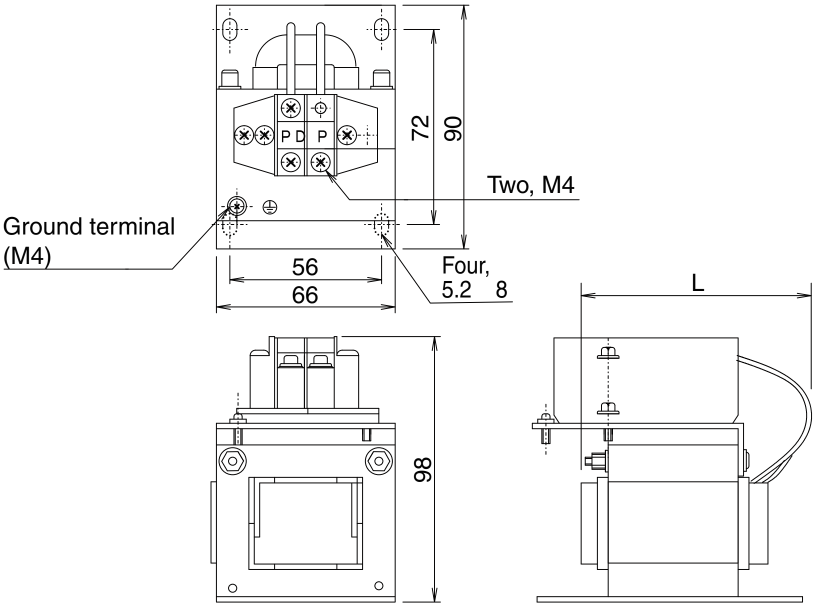



**R88A-RR22047S**



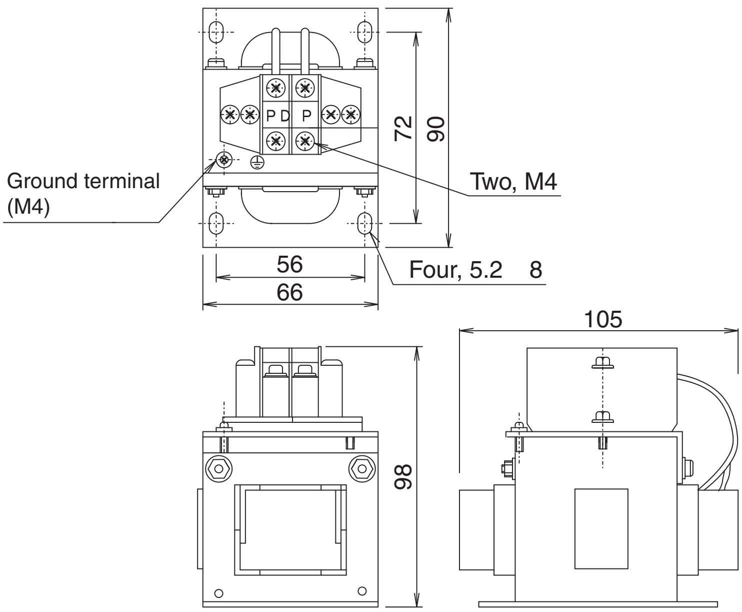
## Reactor Dimensions

### ■ 3G3AX-DL2002/-DL2004

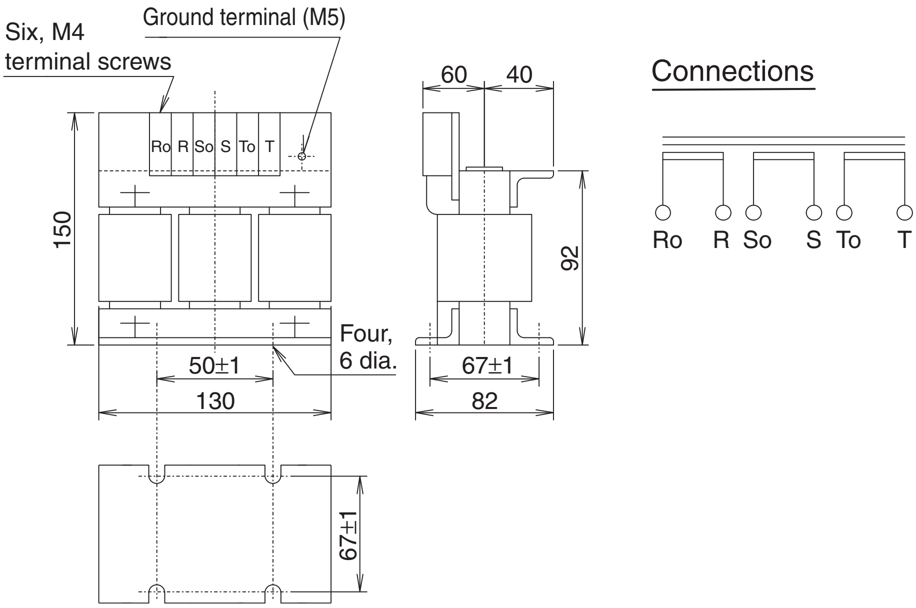



| Model | Dimension (mm) |
|---|---|
| | L |
| 3G3AX-DL2002 | 85 |
| 3G3AX-DL2004 | 95 |

### ■ 3G3AX-DL2007

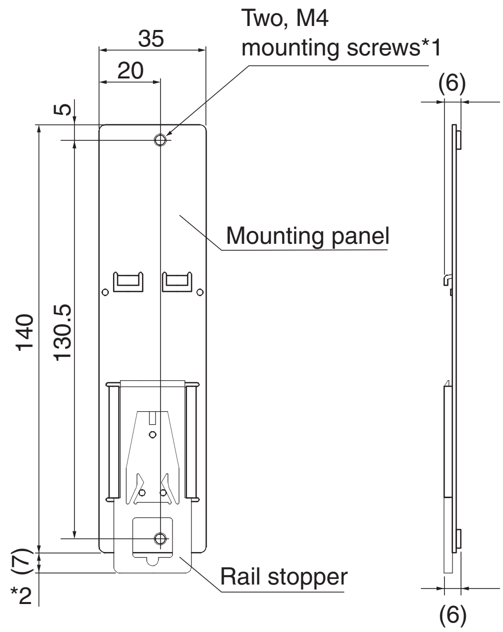


■ **3G3AX-AL2025**




# DIN Rail Mounting Unit Dimensions

**R7A-DIN01B**




*1. Two mounting screws (M4, length: 8) are included.
*2. When the rail stopper is extended, this dimension becomes 10 mm.

# Chapter 3

# Specifications

# 3-1 Servo Drive Specifications

Select the Servo Drive matching the Servomotor to be used.

## General Specifications

<table>
<tr><th colspan="3">Item</th><th>Specifications</th></tr>
<tr><td colspan="3">Ambient operating temperature<br>Ambient operating humidity</td><td>0 to 55°C, 90% RH max. (with no condensation)</td></tr>
<tr><td colspan="3">Ambient storage temperature<br>Ambient storage humidity</td><td>−20 to 65°C, 90% RH max. (with no condensation)</td></tr>
<tr><td colspan="3">Storage and operating atmosphere</td><td>No corrosive gasses, no dust, no iron dust, no exposure to moisture or cutting oil</td></tr>
<tr><td colspan="3">Vibration resistance</td><td>10 to 60 Hz; acceleration: 5.9 m/s$^2$ (0.6 G) max.</td></tr>
<tr><td colspan="3">Impact resistance</td><td>Acceleration of 19.6 m/s$^2$ max. 3 times each in X, Y, and Z directions.</td></tr>
<tr><td colspan="3">Insulation resistance</td><td>Between power supply/power line terminals and frame ground:<br>0.5 MΩ. min. (at 500 VDC)</td></tr>
<tr><td colspan="3">Dielectric strength</td><td>Between power supply/power line terminals and frame ground:<br>1,500 VAC for 1 min at 50/60 Hz<br>Between each control signal and frame ground: 500 VAC for 1 min</td></tr>
<tr><td colspan="3">Altitude</td><td>1,000 m above sea level max. (860 hp min.)</td></tr>
<tr><td colspan="3">Protective structure</td><td>Built into panel (IP10).</td></tr>
<tr><td rowspan="4">Interna-tional stan-dards</td><td rowspan="2">EC Direc-tives</td><td>EMC Directive</td><td>EN 55011 class A group 1<br>EN 61000-6-2</td></tr>
<tr><td>Low Voltage Directive</td><td>EN 50178</td></tr>
<tr><td colspan="2">UL standards</td><td>UL 508C</td></tr>
<tr><td colspan="2">cUL standards</td><td>cUL C22.2 No.14</td></tr>
</table>

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

**Note 2.** Depending on the operating conditions, some Servo Drive parts will require maintenance. Refer to *Servo Drive Service Life* on page 8-18 in the User’s Manual for details.

**Note 3.** The service life of the Servo Drive is 50,000 hours at an average ambient temperature of 40°C at 80% of the rated torque (excluding axial-flow fan).

**WARNING**

Never perform withstand-voltage or other megameter tests on the Servo Drive.

## Characteristics

### ■ Control Specifications

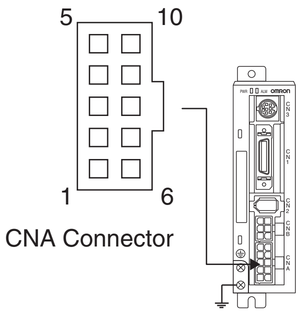
| Item | Servo Drive model | | |
|---|---|---|---|
| | R7D-BPA5L | R7D-BP01L | R7D-BP02L |
| Continuous output current (rms) | 1.0 A | 1.6 A | 2.5 A |
| Momentary maximum output current (rms) | 3.3 A | 5.1 A | 7.5 A |
| Power supply capacity | 0.16 KVA | 0.25 KVA | 0.42 KVA |
| Input power supply voltage (main circuit) | Single-phase 100 to 115 VAC (85 to 127 V), 50/60 Hz | | |
| Input power supply current (rms) (main circuit) | 1.4 A | 2.2 A | 3.7 A |
| Heat generated (main circuit) | 12 W | 16 W | 22 W |
| Control method | All-digital servo | | |
| Inverter method | IGBT-driven PWM method | | |
| PWM frequency | 12 kHz | | 6 kHz |
| Maximum response frequency (command pulses) | Line driver: 500 kpps, Open collector: 200 kpps | | |
| Weight | 0.35 kg | | 0.42 kg |
| Applicable motor capacity | 50 W | 100 W | 200 W |

| Item | Servo Drive model | | | |
|---|---|---|---|---|
| | R7D-BP01H | R7D-BP02HH | R7D-BP02H | R7D-BP04H |
| Continuous output current (rms) | 1.0 A | 1.6 A | 1.6 A | 2.5 A |
| Momentary maximum output current (rms) | 3.3 A | 4.9 A | 4.9 A | 7.8 A |
| Power supply capacity | 0.27 KVA (0.30 KVA)*1 | 0.35 KVA | 0.42 KVA | 0.69 KVA (0.77 KVA) *1 |
| Input power supply voltage (main circuit) | Both single-phase and three-phase 200 to 240 VAC (170 to 264 V), 50/60 Hz | | | |
| Input power supply current (rms) (main circuit) | 0.7 A (1.5 A) *1 | 1.6 A | 1.1 A | 1.8 A (3.5 A) *1 |
| Heat generated (main circuit) | 14 W | 16 W | 20 W | 26W |
| Control method | All-digital servo | | | |
| Inverter method | IGBT-driven PWM method | | | |
| PWM frequency | 12 kHz | | | 6 kHz |
| Maximum response frequency (command pulses) | Line driver: 500 kpps, Open collector: 200 kpps | | | |
| Weight | 0.35 kg | | 0.42 kg | |
| Applicable motor capacity | 100 W | 200 W | 200 W | 400 W |

*1. Values inside parentheses ( ) are for single-phase 200-V use.

## Main Circuit and Servomotor Connector Specifications (CNA and CNB)

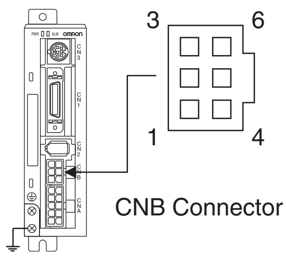
### ■ R7A-CNB01P Main Circuit Connector (CNA) Specifications




#### Main Circuit Connector (CNA) Pin Arrangement

| Symbol | Pin No. | Name | Function |
|---|---|---|---|
| L1 | 10 | Main circuit power supply input terminals | For three-phase 200 V, connect to L1 (pin 10), L2 (pin 8), and L3 (pin 6). For single-phase 100/200 V, connect to L1 (pin 10) and L3 (pin 6). |
| L2 | 8 | | |
| L3 | 6 | | |
| P | 5 | External Regeneration Resistor connection terminals | If regenerative energy is high, connect an External Regeneration Resistor. |
| B1 | 3 | | |
| FG | 1 | Frame ground | This is the ground terminal. Ground to 100 Ω or less. |

### ■ R7A-CNB01A Servomotor Connector (CNB) Specifications

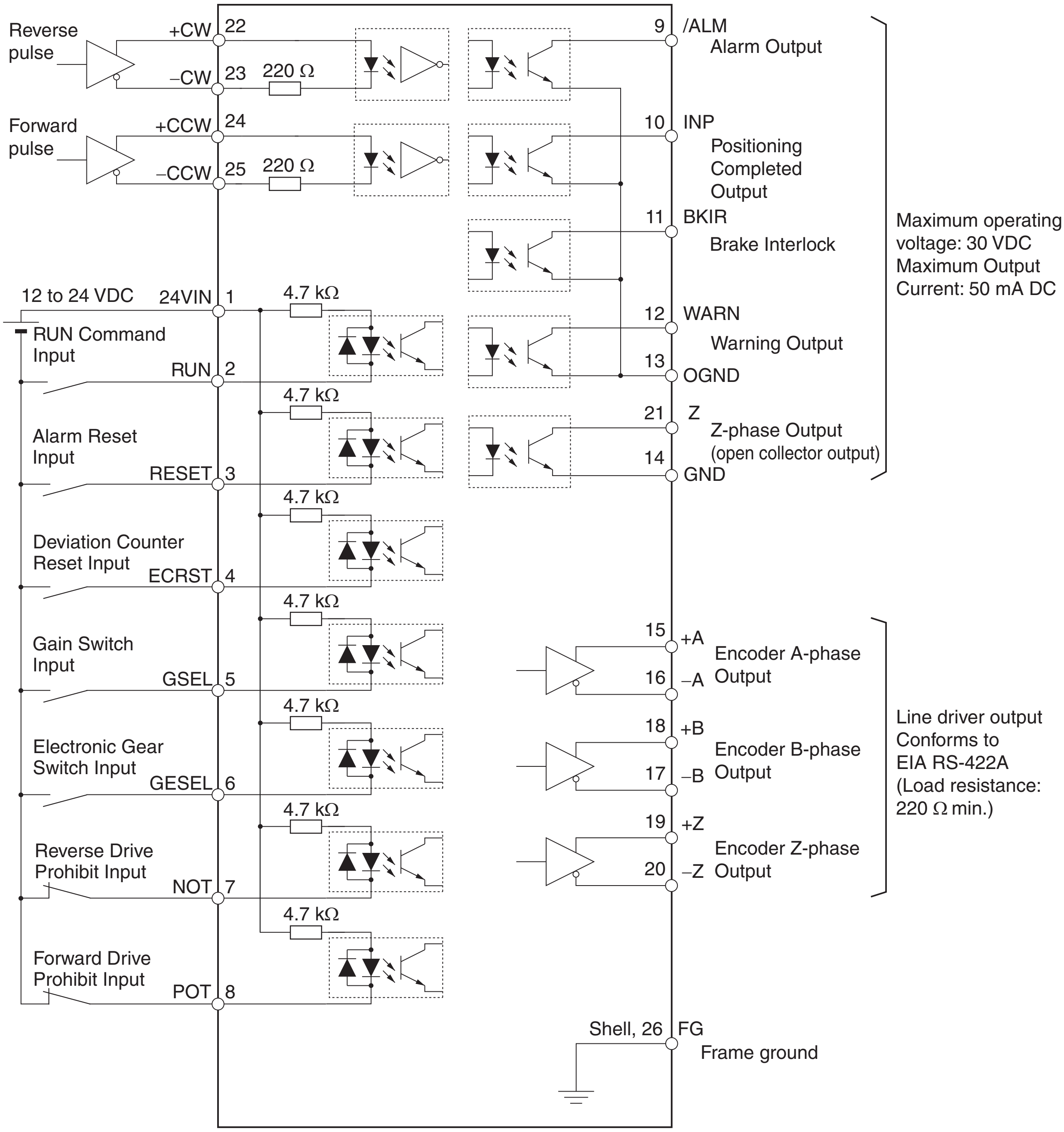



#### Servomotor Connector (CNB) Pin Arrangement

| Symbol | Pin No. | Name | Color | Function |
|---|---|---|---|---|
| U | 1 | Servomotor connection terminals | Red | These are the output terminals to the Servomotor. Be careful to wire them correctly. |
| V | 4 | | White | |
| W | 6 | | Blue | |
| ⏚ | 3 | Frame ground | Green/ Yellow | Connect the Servomotor FG terminals. |

# Control I/O Connector Specifications (CN1)

## ■ Control I/O Signal Connections and External Signal Processing




3

Specifications

## ■ Control I/O Signals

### Control Inputs (CN1)

| Pin No. | Signal name | Name | Function/Interface |
|---|---|---|---|
| 1 | +24VIN | DC power supply input for control | Power supply input terminal (12 to 24 VDC) for sequence input (pin 1). |
| 2 | RUN | RUN Command Input | ON: Servo ON (Starts power to Servomotor.) |
| 3 | RESET | Alarm Reset Input | ON: Servo alarm status is reset. *1<br>Must be ON for 120 ms min. |
| 4 | ECRST/ VSEL2 | Deviation Counter Reset Input or Internally Set Speed Selection 2 Input | Deviation Counter Reset Input in Position Control Mode (when Pn02 is set to 0 or 2).<br>ON: Pulse commands prohibited and deviation counter cleared. Must be ON for at least 2 ms. |
| | | | Internally set speed selection 2 in Internal Speed Control Mode (when Pn02 is set to 1).<br>ON: Internally Set Speed Selection 2 Input. |
| 5 | GSEL/ VZERO/ TLSEL | Gain Switch Input, Zero Speed Designation Input, or Torque Limit Switch Input | Gain Switch Input in Position Control Mode (when Pn02 is set to 0 or 2) when Zero Speed Designation/Torque Limit Switch (Pn06) is set to 0 or 1. |
| | | | Zero speed designation input in Internal Speed Control Mode (when Pn02 is set to 1).<br>OFF: Speed command is zero.<br>Input can also be disabled by the Zero Speed Designation/ Torque Limit Switch (Pn06) setting: Enabled: Pn06 = 1, Disabled: Pn06 = 0 |
| | | | Torque limit selection in both Position Control Mode and Internal Speed Control Mode when Zero Speed Designa-tion/Torque Limit Switch (Pn06) is set to 2.<br>OFF: Torque limit 1 enabled. (Pn70, 5E, 63)<br>ON: Torque limit 2 enabled. (Pn71, 72, 73) |
| 6 | GESEL/ VSEL1 | Electronic Gear Switch Input or Internally Set Speed Selection 1 Input | Electronic Gear Switch Input in Position Control Mode (when Pn02 is set to 0 or 2).*2<br>OFF: Electronic Gear Ratio Numerator 1 (Pn46)<br>ON: Electronic Gear Ratio Numerator 2 (Pn47) |
| | | | Internally set speed selection 1 in Internal Speed Control Mode (when Pn02 is set to 1).<br>ON: Internally set speed selection 1 is input. |
| 7 | NOT | Reverse Drive Prohibit Input | Reverse rotation overtravel input.<br>OFF: Prohibited, ON: Permitted |
| 8 | POT | Forward Drive Prohibit Input | Forward rotation overtravel input.<br>OFF: Prohibited, ON: Permitted |

*1. Some alarms cannot be cleared using this input. For details, refer to *8-2 Alarm Table*.

*2. Do not input command pulses for 10 ms before or after switching the electronic gear.

| Pin No. | Signal name | Name | Function/Interface |
|---|---|---|---|
| 22 | +CW/ PULS/FA | Reverse Pulses Input, Feed Pulses Input, or 90° Phase Difference Pulses (Phase A) | Input terminals for position command pulses.<br><br>Line-driver input:<br>Maximum response frequency: 500 kpps<br>Open-collector input:<br>Maximum response frequency: 200 kpps<br><br>Any of the following can be selected by using the Pn42 setting: forward and reverse pulses (CW/CCW); feed pulse and direction signal (PULS/SIGN); 90° phase difference (phase A/B) signals (FA/FB). |
| 23 | −CW/ PULS/FA | | |
| 24 | +CCW/ SIGN/FB | Forward Pulses, Direction Signal, or 90° Phase Difference Pulses (Phase B) | |
| 25 | −CCW/ SIGN/FB | | |





### Control Outputs (CN1)

| Pin No. | Signal name | Name | Function/Interface |
|---|---|---|---|
| 9 | /ALM | Alarm Output | When the Servo Drive generates an alarm, the output turns OFF. *1 |
| 10 | INP/TGON | Positioning Completed Output or Servomotor Rotation Speed Detection Output | Positioning completed output in Position Control Mode (when Pn02 is set to 0 or 2).<br>ON: The residual pulses for the deviation counter are within the setting for Positioning Completion Range (Pn60). |
| | | | Motor rotation detection output in Internal Speed Control Mode (when Pn02 is set to 1).<br>ON: The number of Servomotor rotations exceeds the value set for Servomotor Rotation Detection Speed (Pn62). |
| 11 | BKIR | Brake Interlock Output | Outputs the holding brake timing signals. Release the holding brake when this signal is ON. |
| 12 | WARN | Warning Output | The signal selected in the Warning Output Selection (Pn09) is output. |
| 13 | OGND | Output Ground Common | Ground common for sequence outputs (pins 9, 10, 11, and 12). |
| 14 | GND | Ground Common | Common for Encoder output and phase-Z output (pin 21). |
| 15 | +A | Encoder Phase-A Output | These signals output encoder pulses according to the Encoder Dividing Ratio Setting (Pn44).<br><br>This is the line-driver output (equivalent to RS-422). |
| 16 | −A | | |
| 17 | −B | Encoder Phase-B Output | |
| 18 | +B | | |
| 19 | +Z | Encoder Phase-Z Output | |
| 20 | −Z | | |
| 21 | Z | Phase-Z Output | Outputs the phase Z for the Encoder (1 pulse/rotation). This is the open-collector output. |

*1. This is OFF for approximately 2 seconds after turning ON the power.

**Note** An open-collector output interface is used for sequence outputs (maximum operating voltage: 30 VDC; maximum output current: 50 mA).

## ■ Control I/O Signal (CN1) Pin Arrangement

| Pin | Signal | Name |
|---|---|---|
| 1 | +24VIN | 12 to 24 VDC power supply input for control |
| 2 | RUN | RUN Command Input |
| 3 | RESET | Alarm Reset Input |
| 4 | ECRST/ VSEL2 | Deviation Counter Reset/ Internally Set Speed Selection 2 |
| 5 | GSEL/ VZERO/ TLSEL | Gain Switch/ Zero Speed Designation/ Torque Limit Switch |
| 6 | GESEL/ VSEL1 | Electronic Gear Switch/ Internally Set Speed Selection 1 |
| 7 | NOT | Reverse Drive Prohibit |
| 8 | POT | Forward Drive Prohibit Input |
| 9 | /ALM | Alarm Output |
| 10 | INP/ TGON | Positioning Completed/ Servomotor Rotation Speed Detection |
| 11 | BKIR | Brake Interlock Output |
| 12 | WARN | Warning Output |
| 13 | OGND | Output Ground Common |
| 14 | GND | Ground Common |
| 15 | +A | Encoder Phase-A + Output |
| 16 | –A | Encoder Phase-A – Output |
| 17 | –B | Encoder Phase-B – Output |
| 18 | +B | Encoder Phase-B + Output |
| 19 | +Z | Encoder Phase-Z + Output |
| 20 | –Z | Encoder Phase-Z – Output |
| 21 | Z | Phase-Z Output |
| 22 | +CW/ +PULS/ +FA | + Reverse Pulses/ + Feed Pulses/ + Phase-A |
| 23 | –CW/ –PULS/ –FA | – Reverse Pulses/ – Feed Pulses/ – Phase-A |
| 24 | +CCW/ +SIGN/ +FB | + Forward Pulses/ + Forward Pulse/ Reverse Pulse/ + Phase-B |
| 25 | –CCW/ –SIGN/ –FB | – Forward Pulses/ – Forward Pulse/ Reverse Pulse/ – Phase-B |
| 26 | FG | Frame ground |

## ■ CN1 Connectors (26 Pins)

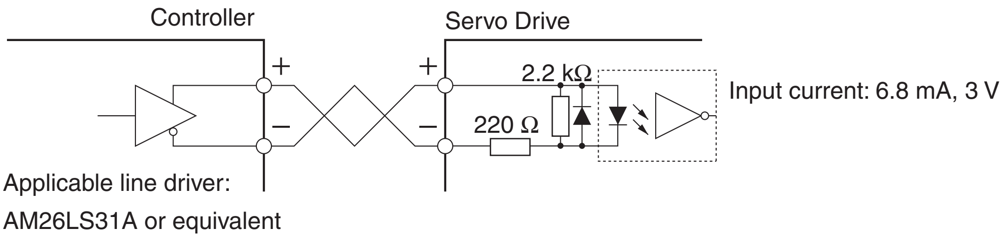
### Soldered Connectors

| Name | Model | Manufacturer |
|---|---|---|
| Servo Drive Connector | 5178238-4 | Tyco Electronics AMP |
| Cable plug | 10126-3000PE | Sumitomo 3M |
| Cable case (shell kit) | 10326-52A0-008 | |

## Control Input Circuits

### ■ Position Command Pulse Inputs

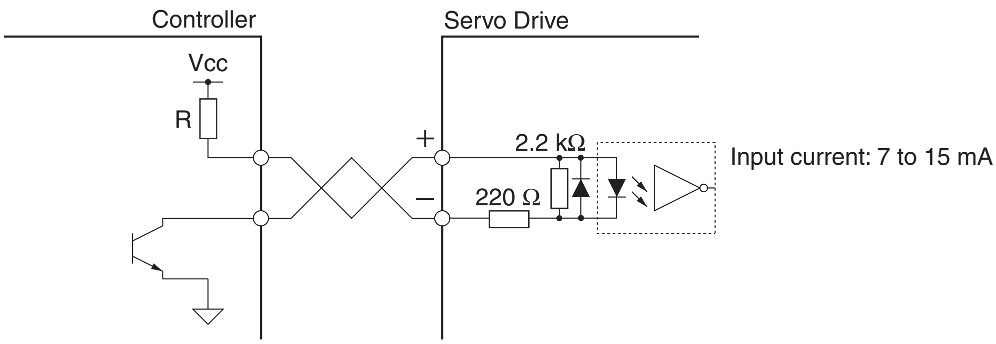
#### Line Driver Input




**Precautions for Correct Use**

- The twisted-pair cable should not exceed 10 m in length.

#### Open-collector Input



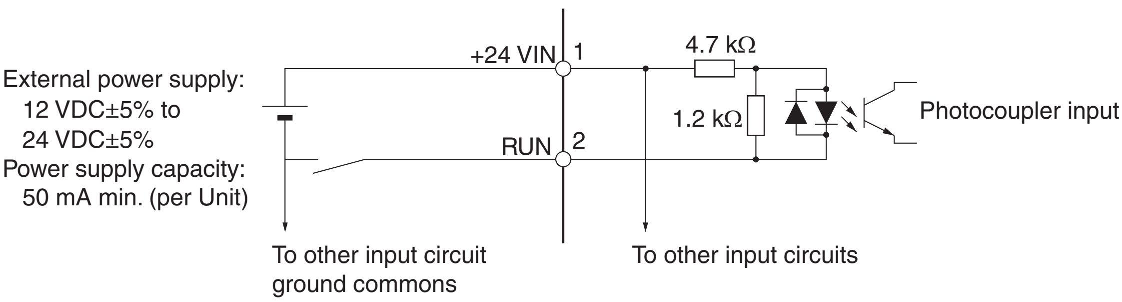

**Note** Select a value for resistance R so that the input current will be from 7 to 15 mA. Refer to the following table.

| Vcc | R |
|---|---|
| 24 V | 2 kΩ |
| 12 V | 1 kΩ |

**Precautions for Correct Use**

- The twisted-pair cable should not exceed 2 m in length.

### ■ Control Inputs




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

## Control Input Details

Details on the input pins for the CN1 connector are described here.

### ■ RUN Command Input (RUN)

Pin 2: RUN Command Input (RUN)

#### Function

- This input turns ON the power drive circuit for the main circuit of the Servo Drive. The Servomotor cannot operate without the input of this signal (i.e., servo-OFF status).
- The RUN Command Input is enabled approximately 2 seconds after the power supply is turned ON.
- After turning ON the RUN Command Input, wait for a minimum of 100 ms to lapse before inputting pulses or a speed command.



### ■ Alarm Reset Input

Pin 3: Alarm Reset Input (RESET)

#### Function

- Pin 3 is the external reset signal input for Servo Drive alarms. (The alarms are reset when this signal is input.)
- Eliminate the cause of the alarm before resuming operation. To prevent danger, turn OFF the RUN Command Input first, then input the alarm reset signal.
- Resetting is performed after the Alarm Reset Input is kept ON for 120 ms or longer.
- Some alarms cannot be cleared using the Alarm Reset Input. For details, refer to *8-2 Alarm Table*.

### ■ Deviation Counter Reset/Internally Set Speed Selection 2 Input

Pin 4: Deviation Counter Reset/Internally Set Speed Selection 2 Input (ECRST/VSEL2)

#### Function: Deviation Counter Reset

- Pin 4 is the Deviation Counter Reset Input (ECRST) in Position Control Mode (when Pn02 is set to 0 or 2).
- When the deviation counter reset signal turns ON, the value of the deviation counter will be reset and the position loop will be disabled.
- Input the reset signal for 2 ms minimum. The counter may not be reset if the signal is too short.

#### Function: Internally Set Speed Selection 2

- Pin 4 is the Internally Set Speed Selection 2 Input (VSEL2) in Internal Speed Control Mode (when Pn02 is set to 1).
- Four speeds can be selected by using pin 4 in combination with the Internally Set Speed Selection 1 Input (VSEL1).

## ■ Gain Switch/Zero Speed Designation/Torque Limit Switch Input

Pin 5: Gain Switch/Zero Speed Designation/Torque Limit Switch Input (GSEL/VZERO/TLSEL)

### Function: Gain Switch

- Pin 5 is the Gain Switch Input (GSEL) when Pn02 is set to 0 or 2 (Position Control Mode) and the Zero Speed Designation/Torque Limit Switch (Pn06) is set to anything other than 2.
- The Gain Switch Input (GSEL) switches between PI and P operation, or between gain 1 and gain 2.
- When the Gain Switch Input Operating Mode Selection (Pn30) is set to 0, this input switches between PI and P operation. When Pn30 is set to 1 and the Gain Switch Setting (Pn31) is set to 2, this input switches between gain 1 and gain 2.
- Gain 1 includes the Position Loop Gain (Pn10), Speed Loop Gain (Pn11), Speed Loop Integration Time Constant (Pn12), Speed Feedback Filter Time Constant (Pn13), and Torque Command Filter Time Constant (Pn14).
- Gain 2 includes the Position Loop Gain 2 (Pn18), Speed Loop Gain 2 (Pn19), Speed Loop Integration Time Constant 2 (Pn1A), Speed Feedback Filter Time Constant 2 (Pn1B), and Torque Command Filter Time Constant 2 (Pn1C).

### Function: Zero Speed Designation

- Pin 5 is the Zero Speed Designation Input (VZERO) when Pn02 is set to 1 (Internal Speed Control Mode) and the Zero Speed Designation/Torque Limit Switch (Pn06) is set to anything other than 2.
- When Zero Speed Designation Input (VZERO) is OFF, the speed command is zero. Turn ON the Zero Speed Designation Input (VZERO) for normal operation.
- Zero Speed Designation Input (VZERO) is enabled when the Zero Speed Designation/Torque Limit Switch (Pn06) is set to 1, and disabled when Pn06 is set to 0.

### Function: Torque Limit Switch

- Pin 5 is the Torque Limit Switch Input (TLSEL) in both Position Control Mode and Internal Speed Control Mode when the Zero Speed Designation/Torque Limit Switch (Pn06) is set to 2.
- This input switches the Overspeed Detection Level, Torque Limit, and Deviation Counter Overflow Level parameters.
- When the input is OFF, torque limit 1 (Pn70, Pn5E, Pn63) is enabled, and when the input is ON, torque limit 2 (Pn71, Pn72, Pn73) is enabled.

## ■ Electronic Gear Switch/Internally Set Speed Selection 1 Input

Pin 6: Electronic Gear Switch/Internally Set Speed Selection 1 Input (GESEL/VSEL1)

### Function: Electronic Gear Switch

- Pin 6 is the Electronic Gear Switch Input (GESEL) in Position Control Mode (when Pn02 is set to 0 or 2).
- The numerator setting for the electronic gear can be switched between Electronic Gear Ratio Numerator 1 and Electronic Gear Ratio Numerator 2.
- When the input is turned OFF, Electronic Gear Ratio Numerator 1 (Pn46) is enabled, and when the input is turned ON, Electronic Gear Ratio Numerator 2 (Pn47) is enabled.
- It takes 1 to 5 ms to switch the electronic gear after the Gear Switch input changes. Therefore, do not input a command pulse for 10-ms before and after switching.

### Function: Internally Set Speed Selection 1

- Pin 6 is the Internally Set Speed Selection 1 Input (VSEL1) in Internal Speed Control Mode (when Pn02 is set to 1).
- Four speeds can be selected by using pin 6 in combination with the Internally Set Speed Selection 2 Input (VSEL2).

## ■ Reverse Drive Prohibit/Forward Drive Prohibit Input



Pin 7: Reverse Drive Prohibit Input (NOT)
Pin 8: Forward Drive Prohibit Input (POT)

### Functions

- These inputs prohibit forward and reverse operation (overtravel).
- When an input is ON, operation is possible in that direction.
- These inputs can be disabled using the setting of Drive Prohibit Input Selection (Pn04).
- The motor will stop according to the setting of the Stop Selection for Drive Prohibition Input (Pn66).

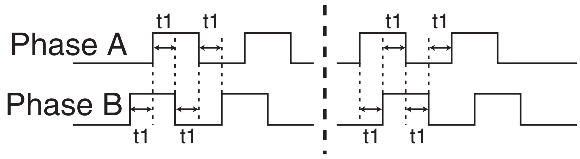
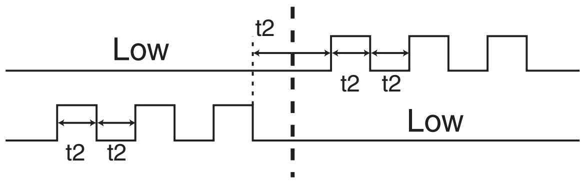
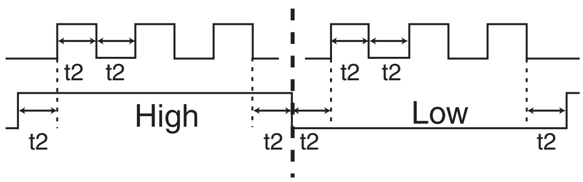


## ■ Reverse Pulse/Forward Pulse, Feed Pulse/Direction Signal, 90° Phase Difference Signal (Phase A/Phase B)

Pin 22: +Reverse Pulse (+CW), +Feed Pulse (+PULS), or +Phase A (+FA)
Pin 23: –Reverse Pulse (–CW), –Feed Pulse (–PULS), or –Phase A (–FA)
Pin 24: +Forward Pulse (+CCW), +Direction Signal (+SIGN), or +Phase B (+FB)
Pin 25: –Forward Pulse (–CCW), –Direction Signal (–SIGN), or –Phase B (–FB)

### Functions

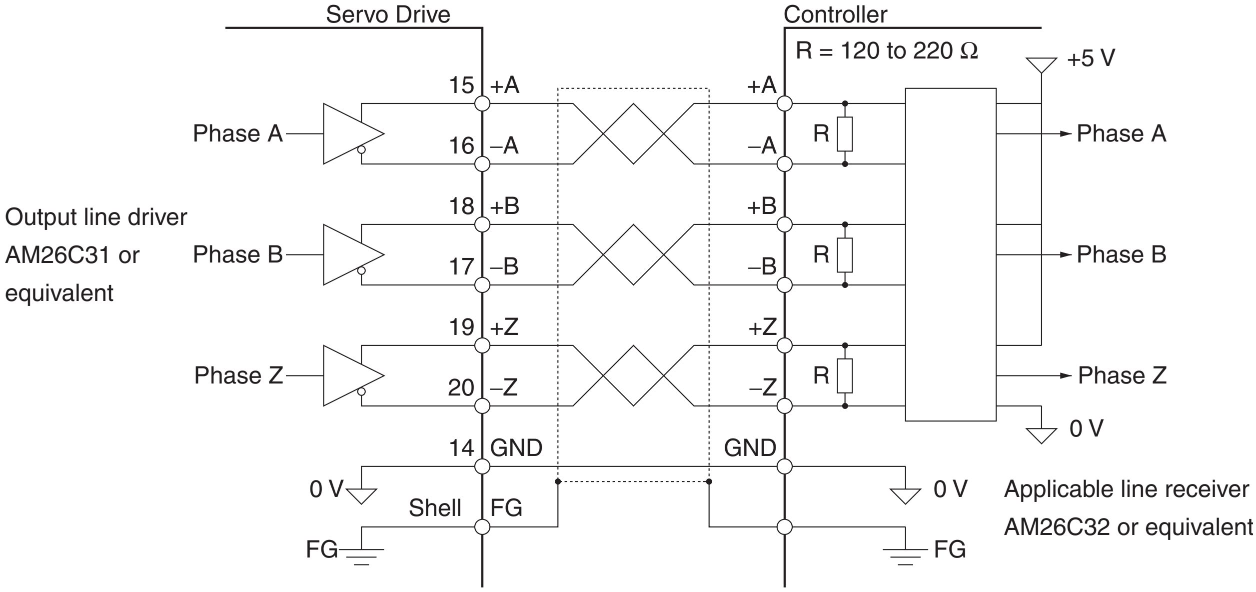
The functions of these signals depend on the setting of the Command Pulse Mode (Pn42).

| Setting | Command pulse mode | Input pins | Servomotor forward command | Servomotor reverse command |
|---|---|---|---|---|
| 0 or 2 | 90° phase difference signals | 22: +FA<br>23: –FA<br>24: +FB<br>25: –FB | <br>Line driver: t1 ≥ 2 μs<br>Open collector: t1 ≥ 5 μs | |
| 1 | Reverse pulse/forward pulse | 22: +CW<br>23: –CW<br>24: +CCW<br>25: –CCW | <br>Line driver: t2 ≥ 1 μs<br>Open collector: t2 ≥ 2.5 μs | |
| 3 | Feed pulse/direction signal | 22: +PULS<br>23: PULS<br>24: SIGN<br>25: –SIGN | <br>Line driver: t2 ≥ 1 μs<br>Open collector: t2 ≥ 2.5 μs | |

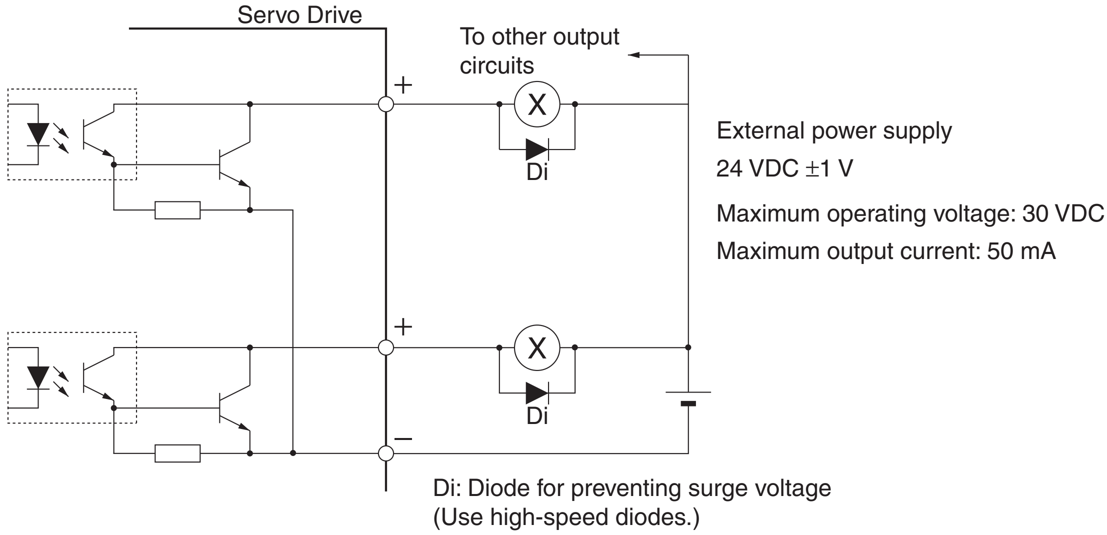
- If the photocoupler LED is turned ON, each signal will go high as shown above.

## Control Output Circuits

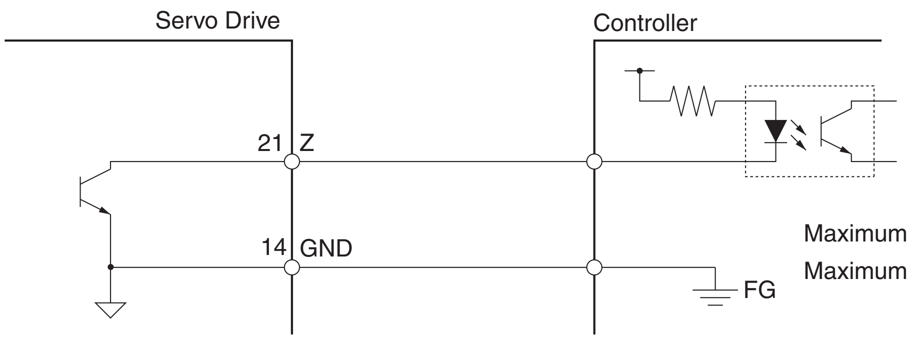
### ■ Position Feedback Output




### ■ Control/Alarm Outputs




### ■ Phase-Z Output (Open-collector Output)

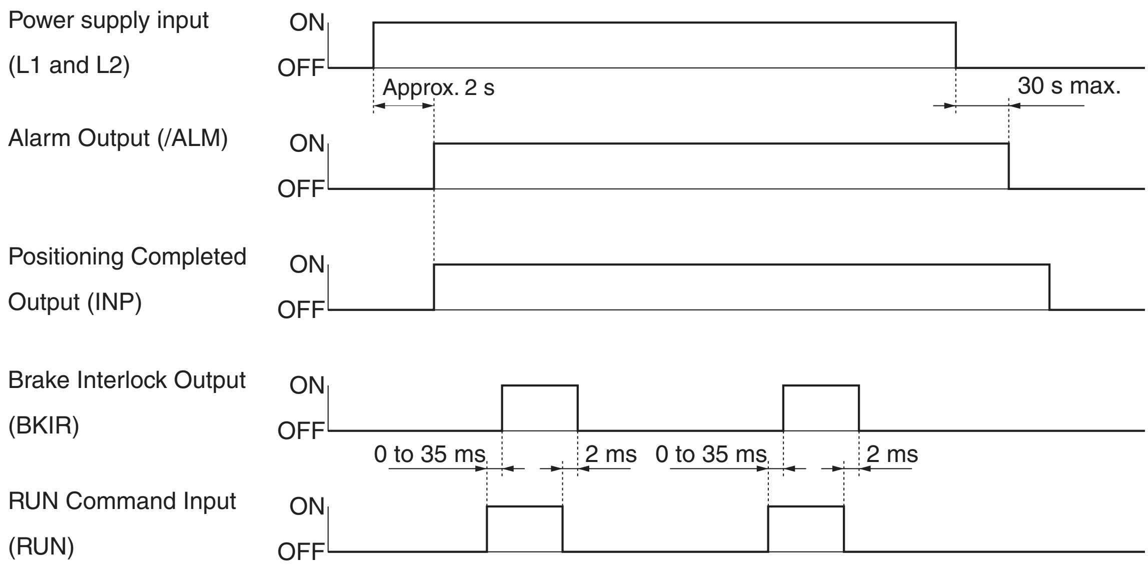



Maximum operating voltage: 30 VDC
Maximum output current: 50 mA

## Control Output Details

The details of the output pins for the CN1 connector are described as follows.

### ■ Control Output Sequence




### ■ Alarm Output

Pin 9: Alarm Output (/ALM)

#### Function

- The alarm output is turned OFF when the Servo Drive detects an error.
- This output is OFF at startup, but turns ON when the initial processing of the Servo Drive has been completed.

### ■ Positioning Completed Output/Servomotor Rotation Speed Detection Output

Pin 10: Positioning Completed Output/Servomotor Rotation Speed Detection Output (INP/TGON)

#### Function: Positioning Completed Output

- Pin 10 is the Positioning Completed Output (INP) in Position Control Mode (when Pn02 is set to 0 or 2).
- The INP signal turns ON when the number of accumulated pulses in the deviation counter is less than the Positioning Completion Range (Pn60).

#### Function: Servomotor Rotation Speed Detection Output

- Pin 10 is the Servomotor Rotation Speed Detection Output (TGON) in Internal Speed Control Mode (when Pn02 is set to 1).
- The TGON signal turns ON when the motor rotation speed exceeds the Rotation Speed for Servomotor Rotation Detection (Pn62).

## ■ Brake Interlock Output

Pin 11: Brake Interlock Output (BKIR)

### Function

- The external brake timing signal is output.
- This output is turned ON to release the external brake.



## ■ Warning Output

Pin 12: Warning Output (WARN)

### Function

- Pin 12 outputs the warning signal selected in the Warning Output Selection (Pn09).

## ■ Feedback Output

Pin 15: Encoder Phase A+ Output (+A)
Pin 16: Encoder Phase A– Output (–A)
Pin 17: Encoder Phase B– Output (–B)
Pin 18: Encoder Phase B+ Output (+B)
Pin 19: Encoder Phase Z+ Output (+Z)
Pin 20: Encoder Phase Z– Output (–Z)

### Function

- This signal outputs encoder pulses according to the Encoder Divider Setting (Pn44).
- Line-driver output (equivalent to RS-422).
- The output logic can be reversed with Encoder Output Direction Switch (Pn45).

## ■ Phase-Z Output

Pin 21: Phase-Z Output (Z)
Pin 14: Ground Common (GND)

### Function

- Pin 21 is the open-collector output for the phase-Z signal.
- The encoder phase Z is output.
- One pulse is output for each rotation.

## Encoder Connector Specifications (CN2)

| Pin No. | Signal name | Name | Function/Interface |
|---|---|---|---|
| 1 | E5V | Encoder power supply +5 V | Power supply output for the encoder 5 V, 70 mA |
| 2 | E0V | Encoder power supply GND | |
| 3 | NC | | Do not connect anything to these pins. |
| 4 | NC | | |
| 5 | S+ | Encoder + phase S I/O | RS-485 line-driver I/O |
| 6 | S− | Encoder − phase S I/O | |
| Shell | FG | Shield ground | Cable shield ground |





### ■ Connectors for CN2 (6 Pins)

| Name | Model | Maker |
|---|---|---|
| Servo Drive Connector | 53460-0629 | Molex Japan Co. |
| Cable Connector | 55100-0670 | |

# 3-2 Servomotor Specifications

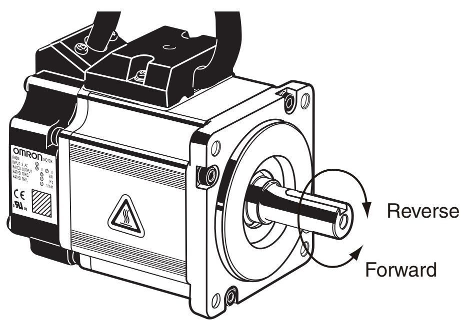
Select a Servomotor based on the mechanical system's load conditions and the installation environment. There are various options available on the Servomotors, such as models with brakes.

## General Specifications

| Item | | | Specifications |
|---|---|---|---|
| Ambient operating temperature<br>Ambient operating humidity | | | 0 to 40°C, 85% RH max. (with no condensation) |
| Ambient storage temperature<br>Ambient storage humidity | | | −20 to 65°C, 85% RH max. (with no condensation) |
| Storage and operating atmosphere | | | No corrosive gases |
| Vibration resistance | | | 49 m/s$^2$ max. in the X, Y, and Z directions |
| Impact resistance | | | Acceleration of 98 m/s$^2$ max. 3 times each in the X, Y, and Z directions |
| Insulation resistance | | | Between the power line terminals and FG: 20 MΩ min. (at 500 VDC) |
| Dielectric strength | | | Between the power line terminals and FG: 1,500 VAC for 1 min at 50/60 Hz |
| Operating position | | | All directions |
| Insulation grade | | | Type B |
| Structure | | | Totally-enclosed self-cooling |
| Protective structure | | | IP65 (excluding through-shaft parts and lead wire ends) |
| Vibration grade | | | V-15 |
| Mounting method | | | Flange-mounting |
| International standards | EC Directives | EMC Directive | EN 60034-1:2004 |
| | | Low Voltage Directive | IEC 60034-5:2001 |
| | UL standards | | UL 1004 File No. E179189 |
| | cUL standards | | cUL 22.2, No.100 |

### ■ Motor Rotation Directions

In this manual, the Servomotors rotation directions are defined as forward and reverse.
Viewed from the end of the motor's output shaft, counterclockwise (CCW) rotation is forward and clockwise (CW) rotation is reverse.



## Characteristics

### ■ 3,000-r/min Cylindrical Servomotors

| Item | | Unit | R88M-G05030H | R88M-G10030L | R88M-G20030L |
|---|---|---|---|---|---|
| Rated output *1 | | W | 50 | 100 | 200 |
| Rated torque *1 | | N·m | 0.16 | 0.32 | 0.64 |
| Rated rotation speed | | r/min | 3000 | | |
| Max. rotation speed | | r/min | 5000 | | |
| Max. momentary torque *1 | | N·m | 0.48 | 0.95 | 1.78 |
| Rated current *1 | | A(rms) | 1.1 | 1.7 | 2.5 |
| Max. momentary current *1 | | A(rms) | 3.4 | 5.1 | 7.6 |
| Rotor inertia | | $kg{\cdot}m^2$ | $2.5 \times 10^{-6}$ | $5.1 \times 10^{-6}$ | $1.4 \times 10^{-5}$ |
| Applicable load inertia | | --- | 30 times the rotor inertia max. *2 | | |
| Power rate *1 | | kW/s | 10.4 | 20.1 | 30.3 |
| Allowable radial load *3 | | N | 68 | 68 | 245 |
| Allowable thrust load *3 | | N | 58 | 58 | 98 |
| Weight | Without brake | kg | 0.3 | 0.5 | 0.8 |
| | With brake | kg | 0.5 | 0.7 | 1.3 |
| Radiation shield dimensions (material) | | --- | 100 × 80 × t10 (Al) | | 130 × 120 × t12 (Al) |
| Brake specifications | Brake inertia | $kg{\cdot}m^2$ | $2.0 \times 10^{-7}$ | $2.0 \times 10^{-7}$ | $1.8 \times 10^{-6}$ |
| | Excitation voltage *4 | V | 24 VDC ±10% | | |
| | Power consumption (at 20°C) | W | 7 | 7 | 9 |
| | Current consumption (at 20°C) | A | 0.30 | 0.30 | 0.36 |
| | Static friction torque | N·m | 0.29 min. | 0.29 min. | 1.27 min. |
| | Attraction time *5 | ms | 35 max. | 35 max. | 50 max. |
| | Release time *5 | ms | 20 max. | 20 max. | 15 max. |
| | Backlash | | ±1° max. | | |
| | Allowable work per braking operation | J | 39.2 | 39.2 | 137 |
| | Allowable total work | J | $4.9 \times 10^3$ | $4.9 \times 10^3$ | $44.1 \times 10^3$ |
| | Allowable angular acceleration | $rad/s^2$ | 30,000 max. (Speed of 2,800 r/min or more must not be changed in less than 10 ms) | | |
| | Brake life | --- | 10,000,000 operations | | |
| | Rating | --- | Continuous | | |

| Item | | Unit | R88M-G05030H | R88M-G10030H | R88M-G20030H | R88M-G40030H |
|---|---|---|---|---|---|---|
| Rated output *1 | | W | 50 | 100 | 200 | 400 |
| Rated torque *1 | | N·m | 0.16 | 0.32 | 0.64 | 1.3 |
| Rated rotation speed | | r/min | 3000 | | | |
| Max. rotation speed | | r/min | 5000 | | | |
| Max. momentary torque *1 | | N·m | 0.48 | 0.95 | 1.78 | 3.60 |
| Rated current *1 | | A(rms) | 1.1 | 1.1 | 1.6 | 2.6 |
| Max. momentary current *1 | | A(rms) | 3.4 | 3.4 | 4.9 | 7.9 |
| Rotor inertia | | $kg \cdot m^2$ | $2.5 \times 10^{-6}$ | $5.1 \times 10^{-6}$ | $1.4 \times 10^{-5}$ | $2.6 \times 10^{-5}$ |
| Applicable load inertia | | --- | 30 times the rotor inertia max. *2 | | | |
| Power rate*1 | | kW/s | 10.4 | 20.1 | 30.3 | 62.5 |
| Allowable radial load *3 | | N | 68 | 68 | 245 | 245 |
| Allowable thrust load *3 | | N | 58 | 58 | 98 | 98 |
| Weight | Without brake | kg | 0.3 | 0.5 | 0.8 | 1.2 |
| | With brake | kg | 0.5 | 0.7 | 1.3 | 1.7 |
| Radiation shield dimensions (material) | | --- | 100 × 80 × t10 (Al) | | 130 × 120 × t12 (Al) | |
| Brake specifications | Brake inertia | $kg \cdot m^2$ | $2.0 \times 10^{-7}$ | $2.0 \times 10^{-7}$ | $1.8 \times 10^{-6}$ | $7.5 \times 10^{-6}$ |
| | Excitation voltage *4 | V | 24 VDC ±10% | | | |
| | Power consumption (at 20°C) | W | 7 | 7 | 9 | 9 |
| | Current consumption (at 20°C) | A | 0.30 | 0.30 | 0.36 | 0.36 |
| | Static friction torque | N·m | 0.29 min. | 0.29 min. | 1.27 min. | 1.27 min. |
| | Attraction time *5 | ms | 35 max. | 35 max. | 50 max. | 50 max. |
| | Release time *5 | ms | 20 max. | 20 max. | 15 max. | 15 max. |
| | Backlash | | ±1° max. | | | |
| | Allowable work per braking operation | J | 39.2 | 39.2 | 137 | 196 |
| | Allowable total work | J | $4.9 \times 10^3$ | $4.9 \times 10^3$ | $44.1 \times 10^3$ | $147 \times 10^3$ |
| | Allowable angular acceleration | $rad/s^2$ | 30,000 max. (Speed of 2,800 r/min or more must not be stopped in less than 10 ms) | | | |
| | Brake life | --- | 10,000,000 operations | | | |
| | Rating | --- | Continuous | | | |

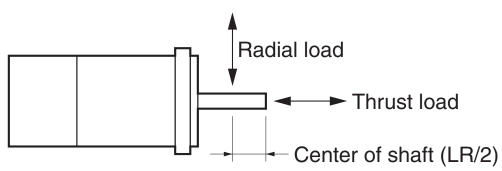
*1. These are the values when the Servomotor is combined with a Servo Drive at room temperature. The maximum momentary torque shown above indicates the standard value.

*2. For detailed information on the applicable load inertia, refer to *Applicable Load Inertia* on page 3-25.

*3. The allowable radial and thrust loads are the values determined for a service life of 20,000 hours at normal operating temperatures. The values are also for the locations shown in the following diagram.

*4. The brakes are non-excitation operation type. They are released when excitation voltage is applied.

*5. The operation time is the measured value (reference value) with a varistor installed as a surge suppressor.



## ■ 3,000-r/min Flat Servomotors

| Item | | Unit | R88M-GP10030L | R88M-GP20030L |
|---|---|---|---|---|
| Rated output *1 | | W | 100 | 200 |
| Rated torque *1 | | N·m | 0.32 | 0.64 |
| Rated rotation speed | | r/min | 3,000 | |
| Max. rotation speed | | r/min | 5,000 | |
| Max. momentary torque *1 | | N·m | 0.85 | 1.86 |
| Rated current *1 | | A(rms) | 1.6 | 2.5 |
| Max. momentary current *1 | | A(0-p) | 6.9 | 10.5 |
| Rotor inertia | | kg·m$^2$ | $9.0 \times 10^{-6}$ | $3.4 \times 10^{-5}$ |
| Applicable load inertia | | --- | 20 times the rotor inertia max.*2 | |
| Power rate *1 | | kW/s | 11.4 | 12.0 |
| Allowable radial load *3 | | N | 68 | 245 |
| Allowable thrust load *3 | | N | 58 | 98 |
| Weight | Without brake | kg | 0.65 | 1.3 |
| | With brake | kg | 0.90 | 2.0 |
| Radiation shield dimensions (material) | | --- | 130 × 120 × t10 (Al) | 170 × 160 × t12 (Al) |
| Brake specifications | Brake inertia | kg·m$^2$ | $3.0 \times 10^{-6}$ | $9.0 \times 10^{-6}$ |
| | Excitation voltage *4 | V | 24 VDC ±10% | |
| | Power consumption (at 20°C) | W | 7 | 10 |
| | Current consumption (at 20°C) | A | 0.29 | 0.41 |
| | Static friction torque | N·m | 0.29 min. | 1.27 min. |
| | Attraction time *5 | ms | 50 max. | 60 max. |
| | Release time *5 | ms | 15 max. | 15 max. |
| | Backlash | | ±1° max. | |
| | Allowable work per braking operation | J | 137 | 196 |
| | Allowable total work | J | $44.1 \times 10^3$ | $147 \times 10^3$ |
| | Allowable angular acceleration | rad/s$^2$ | 10,000 max. (Speed of 950 r/min or more must not be stopped in less than 10 ms) | |
| | Brake life | --- | 10,000,000 operations | |
| | Rating | --- | Continuous | |

| Item | | Unit | R88M-GP10030H | R88M-GP20030H | R88M-GP40030H |
|---|---|---|---|---|---|
| Rated output *1 | | W | 100 | 200 | 400 |
| Rated torque*1 | | N·m | 0.32 | 0.64 | 1.3 |
| Rated rotation speed | | r/min | 3000 | | |
| Max. rotation speed | | r/min | 5000 | | |
| Max. momentary torque*1 | | N·m | 0.90 | 1.82 | 3.60 |
| Rated current *1 | | A(rms) | 1.0 | 1.6 | 4.4 |
| Max. momentary current *1 | | A(0-p) | 4.3 | 6.8 | 18.6 |
| Rotor inertia | | $kg{\cdot}m^2$ | $9.0 \times 10^{-6}$ | $3.4 \times 10^{-5}$ | $6.4 \times 10^{-5}$ |
| Applicable load inertia | | --- | 20 times the rotor inertia max.*2 | | |
| Power rate*1 | | kW/s | 11.4 | 11.8 | 25.5 |
| Allowable radial load *3 | | N | 68 | 245 | 245 |
| Allowable thrust load*3 | | N | 58 | 98 | 98 |
| Weight | Without brake | kg | 0.7 | 1.3 | 1.8 |
| | With brake | kg | 0.9 | 2.0 | 2.5 |
| Radiation shield dimensions (material) | | --- | 130 × 120 × t10 (Al) | 170 × 160 × t12 (Al) | |
| Brake specifications | Brake inertia | $kg{\cdot}m^2$ | $3.0 \times 10^{-6}$ | $9.0 \times 10^{-6}$ | $9.0 \times 10^{-6}$ |
| | Excitation voltage *4 | V | 24 VDC ±10% | | |
| | Power consumption (at 20°C) | W | 7 | 10 | 10 |
| | Current consumption (at 20°C) | A | 0.29 | 0.41 | 0.41 |
| | Static friction torque | N·m | 0.29 min. | 1.27 min. | 1.27 min. |
| | Attraction time *5 | ms | 50 max. | 60 max. | 60 max. |
| | Release time*5 | ms | 15 max. | 15 max. | 15 max. |
| | Backlash | | ±1° max. | | |
| | Allowable work per braking operation | J | 137 | 196 | 196 |
| | Allowable total work | J | $44.1 \times 10^3$ | $147 \times 10^3$ | $147 \times 10^3$ |
| | Allowable angular acceleration | $rad/s^2$ | 10,000 max. (Speed of 950 r/min or more must not be stopped in less than 10 ms) | | |
| | Brake life | --- | 10,000,000 operations | | |
| | Rating | --- | Continuous | | |

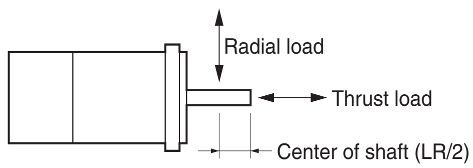
*1. These are the values when the Servomotor is combined with a Servo Drive at room temperature. The maximum momentary torque shown above indicates the standard value.

*2. For detailed information on the applicable load inertia, refer to *Applicable Load Inertia* on page 3-25.

*3. The allowable radial and thrust loads are the values determined for a service life of 20,000 hours at normal operating temperatures. The values are also for the locations shown in the following diagram.

*4. The brakes are non-excitation operation type. They are released when excitation voltage is applied.

*5. The operation time is the measured value (reference value) with a varistor installed as a surge suppressor.

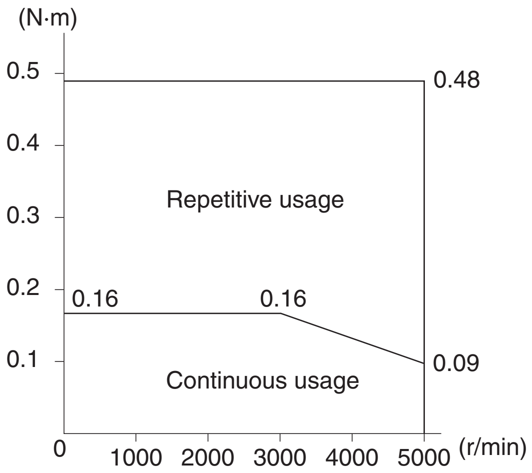


## ■ Torque and Rotation Speed Characteristics

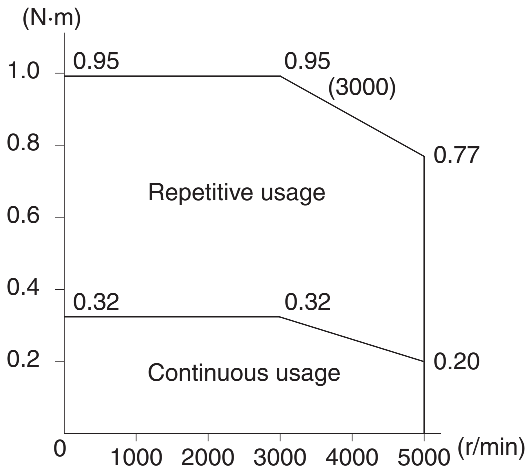
### 3,000-r/min Cylindrical Servomotors

The following graphs show the characteristics with a 3-m standard cable and a 100-VAC input.

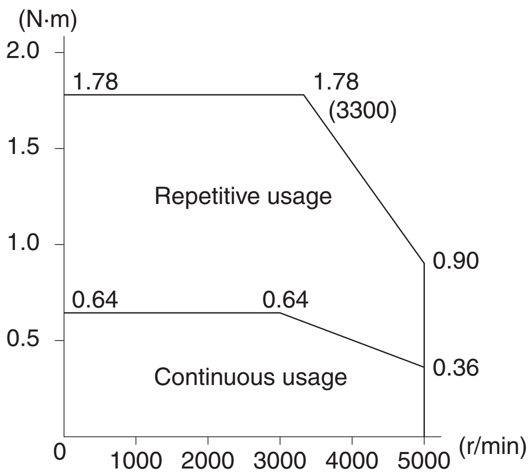
R88M-G05030H




R88M-G10030L

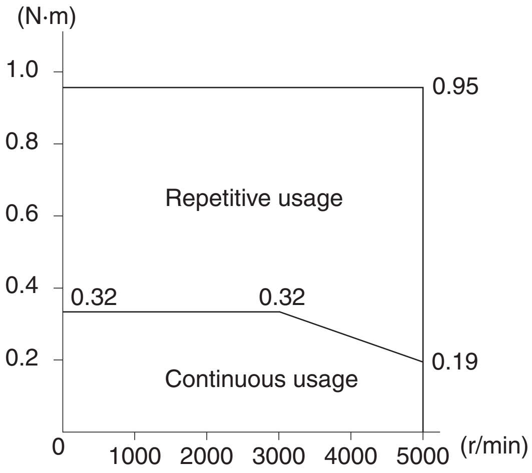



R88M-G20030L

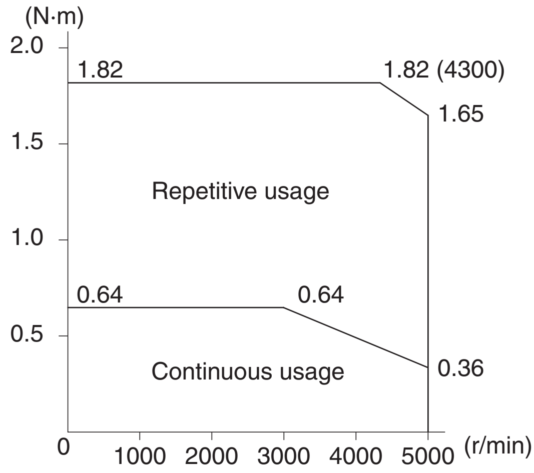


The following graphs show the characteristics with a 3-m standard cable and a 200-VAC input.

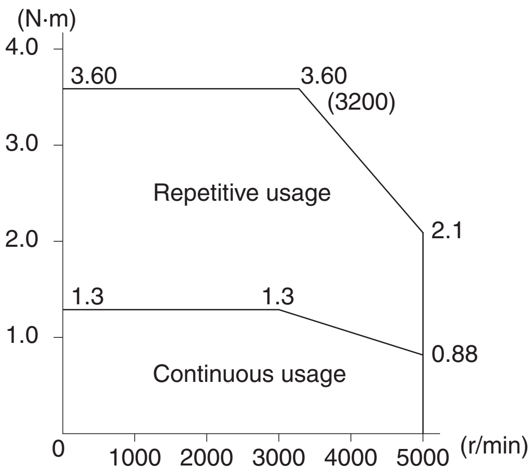
R88M-G10030H




R88M-G20030H



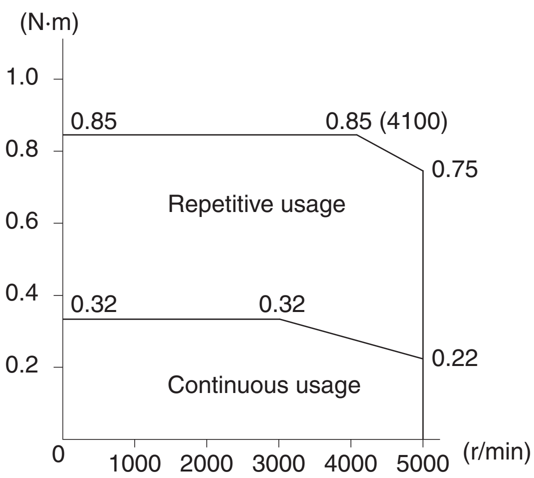

R88M-G40030H



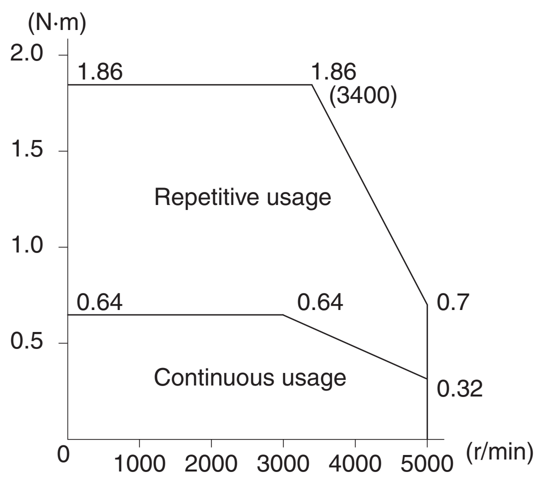

### 3,000-r/min Flat Servomotors

The following graphs show the characteristics with a 3-m standard cable and a 100-VAC input.

R88M-GP10030L

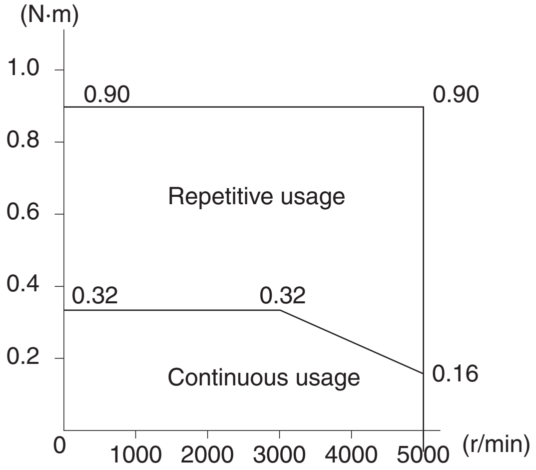



R88M-GP20030L

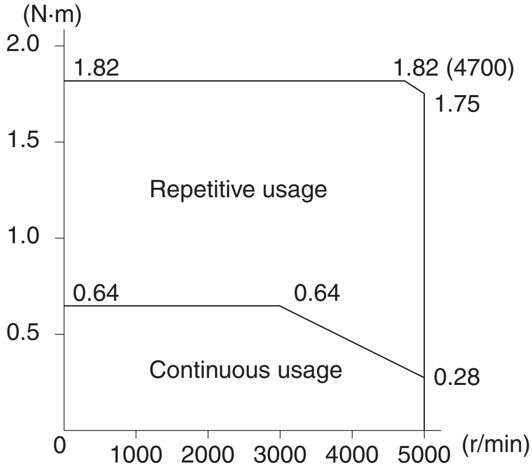


The following graphs show the characteristics with a 3-m standard cable and a 200-VAC input.

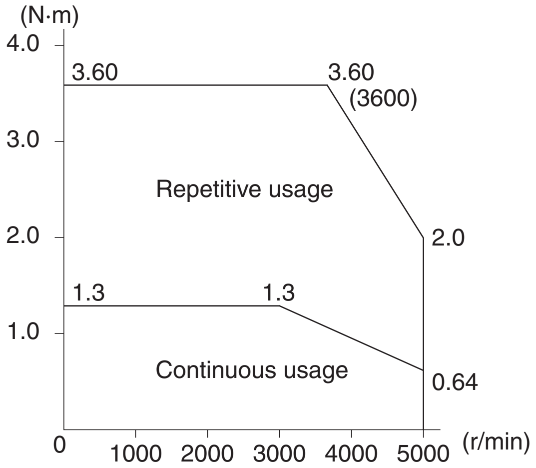
R88M-GP10030H




R88M-GP20030H




R88M-GP40030H

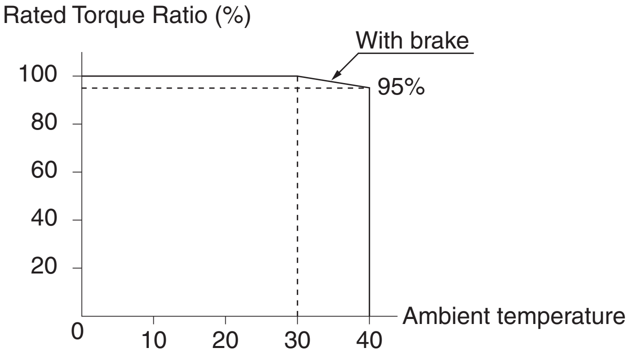



## ■ Temperature Characteristics of the Servomotor and Mechanical System

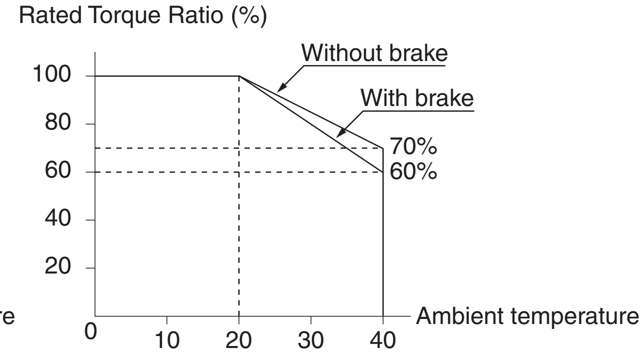
- G-Series Servomotors use rare earth magnets (neodymium-iron magnets).
- The temperature coefficient for these magnets is approximately −0.13%/°C. As the temperature drops, the Servomotor's maximum momentary torque increases, and as the temperature rises, the Servomotor's maximum momentary torque decreases.
- The maximum momentary torque rises by 4% at a normal temperature of 20°C compared to a temperature of −10°C. Conversely, the maximum momentary torque decreases about 8% when the magnet warms up to 80°C from the normal temperature of 20°C.
- An increase in load friction torque seemingly increases load inertia. Therefore, even if the Servo Drive gains are adjusted at a normal temperature, the Servomotor may not operate properly at low temperatures. Check to see whether there is optimal operation even at low temperatures.

| Precautions for Correct Use | • Use Cylindrical Servomotors in the ranges shown in the following graphs. Using outside of these ranges may cause the Servomotor to generate heat, which could result in encoder malfunction. |
|---|---|

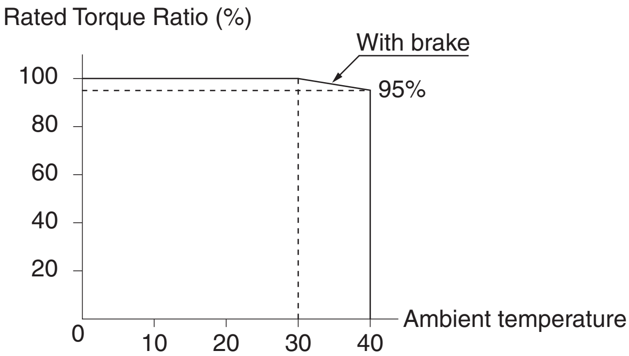
50 W (Without Oil Seal)



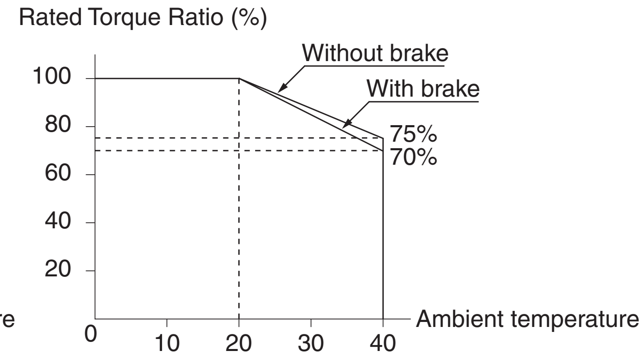

50 W (With Oil Seal)



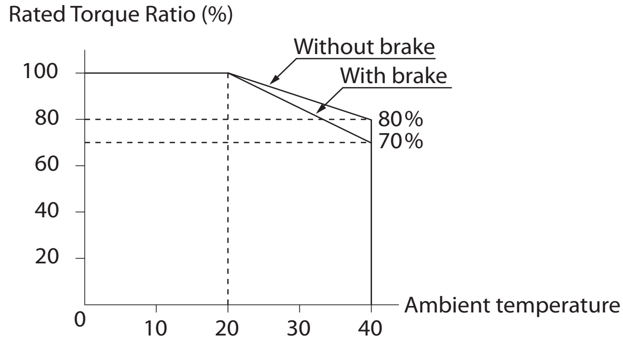

100 W (Without Oil Seal)



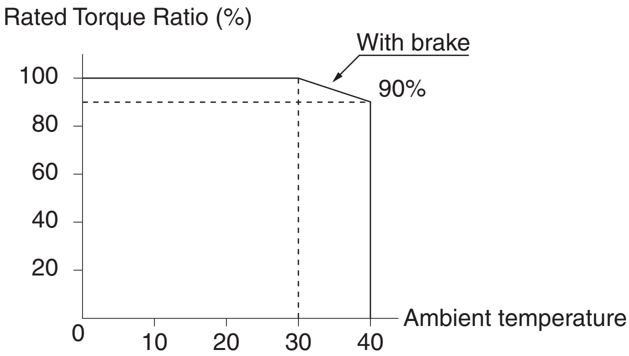

100 W (With Oil Seal)



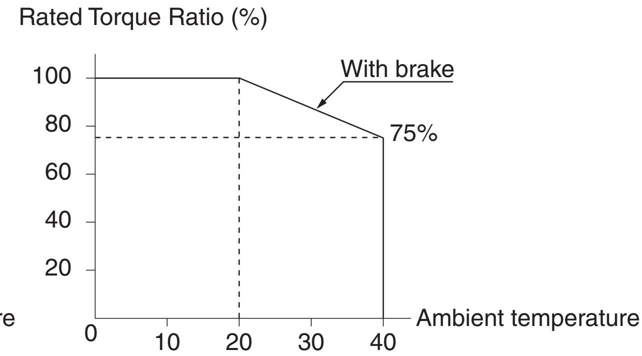
200 W (With Oil Seal)




400 W (Without Oil Seal)




400 W (With Oil Seal)




### ■ Applicable Load Inertia

- The drivable load inertia ratio (load inertia/rotor inertia) depends on the configuration and rigidity of the machine being driven. Machines with high rigidity can be operated with a large load inertia. Select the appropriate Servomotor and confirm the applicable load inertia.
- Frequently operating a dynamic brake with a large load inertia may burn the dynamic brake resistor. Do not turn ON/OFF the Servomotor frequently with the dynamic brake enabled.

## Encoder Specifications

| Item | Specifications |
|---|---|
| Encoder system | Optical encoder (incremental encoder) |
| No. of output pulses | Phases A and B: 2,500 pulses/rotation, Phase Z: 1 pulse/rotation |
| Power supply voltage | 5 V ±5% |
| Power supply current | 180 mA (max.) |
| Output signals | +S, −S |
| Output interface | EIA-RS-485 compliance |
| | Bidirectional serial communications data |

# 3-3 Cable and Connector Specifications



## Encoder Cable Specifications

These cables are used to connect the encoder between the Servo Drive and Servomotor. Encoder Cables with connectors for CN2 are available.

**Precautions for Correct Use**

- Use flexible cables for applications with moving parts.

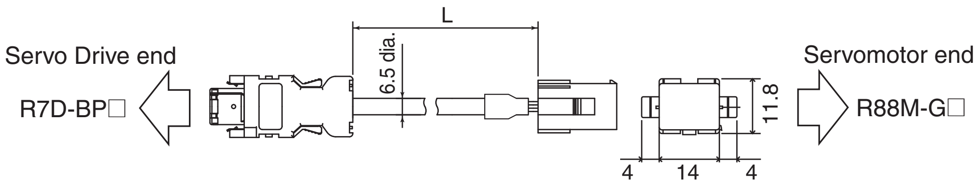
### ■ Global Cables for Encoders (Non-Flexible Cables)

#### Cable Models

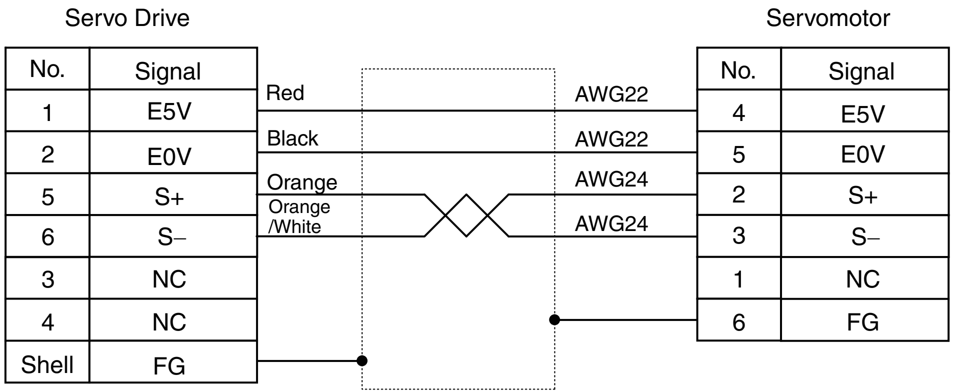
| Model | Length (L)*1 | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CRGB003C | 3 m | 6.5 dia. | Approx. 0.2 kg |
| R88A-CRGB005C | 5 m | | Approx. 0.3 kg |
| R88A-CRGB010C | 10 m | | Approx. 0.6 kg |
| R88A-CRGB015C | 15 m | | Approx. 0.9 kg |
| R88A-CRGB020C | 20 m | | Approx. 1.2 kg |

*1. The maximum distance between the Servo Drive and Servomotor is 20 m.

#### Connection Configuration and External Dimensions




#### Wiring




Servo Drive Connector
Connector pins:
50639-8028 (Molex Japan)
Connector case:
Crimp-type I/O Connector (Molex Japan)

Servomotor Connector
Connector pins:
170365-1 (Tyco Electronics AMP KK)
Connector case:
172160-1 (Tyco Electronics AMP KK)

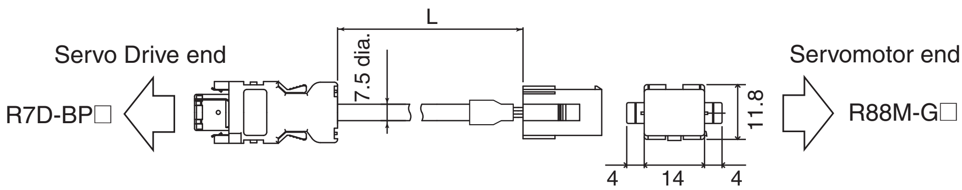
## ■ Global Cables for Encoders (Flexible Cables)

### Cable Models

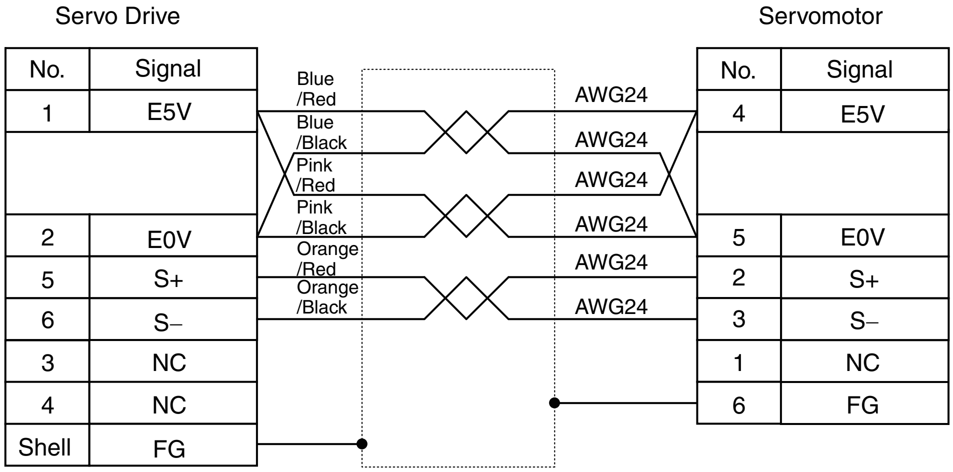
| Model | Length (L) *1 | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CRGB003CR | 3 m | 7.5 dia. | Approx. 0.2 kg |
| R88A-CRGB005CR | 5 m | | Approx. 0.4 kg |
| R88A-CRGB010CR | 10 m | | Approx. 0.8 kg |
| R88A-CRGB015CR | 15 m | | Approx. 1.1 kg |
| R88A-CRGB020CR | 20 m | | Approx. 1.5 kg |

*1. The maximum distance between the Servo Drive and Servomotor is 20 m.

### Connection Configuration and External Dimensions




### Wiring




Servo Drive Connector
Connector pins:
50639-8028 (Molex Japan)
Connector case:
Crimp-type I/O Connector (Molex Japan)

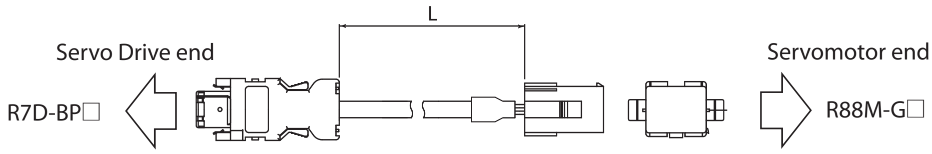
Servomotor Connector
Connector pins:
170365-1 (Tyco Electronics AMP KK)
Connector case:
172160-1 (Tyco Electronics AMP KK)

## ■ European Cables for Encoders (Flexible and Shielded Cables)

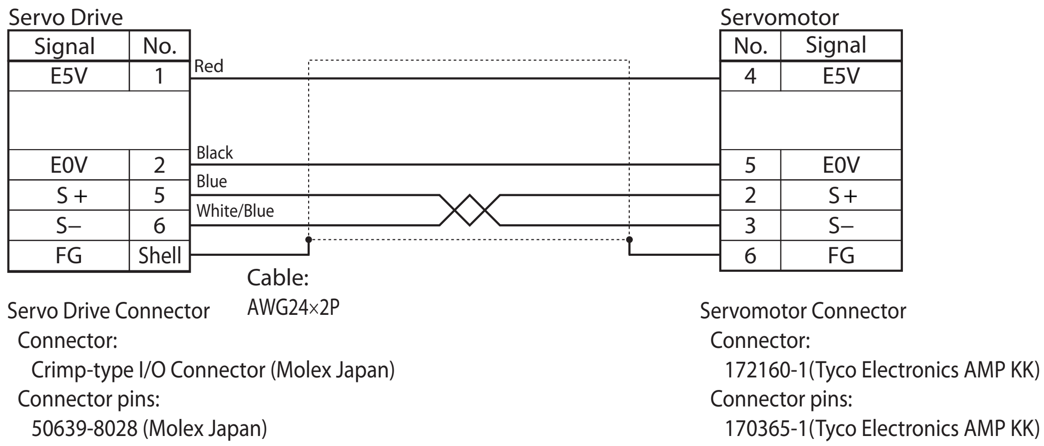
### Cable Models

| Model | Length (L) | Weight |
|---|---|---|
| R88A-CRGB001-5CR-E | 1.5 m | Approx. 0.1 kg |
| R88A-CRGB003CR-E | 3 m | Approx. 0.2 kg |
| R88A-CRGB005CR-E | 5 m | Approx. 0.4 kg |
| R88A-CRGB010CR-E | 10 m | Approx. 0.8 kg |
| R88A-CRGB015CR-E | 15 m | Approx. 1.1 kg |
| R88A-CRGB020CR-E | 20 m | Approx. 1.5 kg |

### Connection Configuration and External Dimensions




### Wiring



## Servomotor Power Cable Specifications

These are the cables connecting between the Servo Drive and Servomotor.
Servomotor Power Cables with connectors for the CNB are available.
When using Cables for a Servomotor with a brake, a Brake Cable is also required. Brake cables are also available as standard cables and robot cables.

| Precautions for Correct Use | • Use flexible cables for applications with moving parts. |
|---|---|

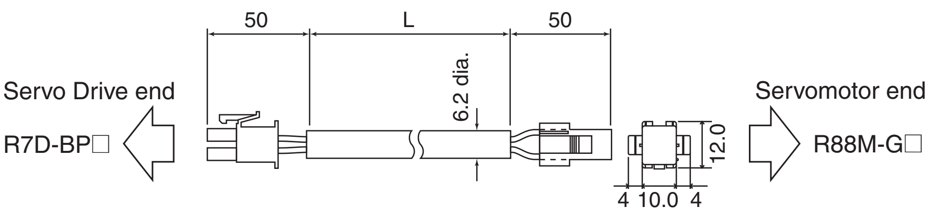
### ■ Global Cables for Servomotor Power (Non-Flexible Cables)

#### Cable Models

| Model | Length (L)[*1] | Outer diameter of sheath | Weight |
|---|---|---|---|
| R7A-CAB003S | 3 m | 6.2 dia. | Approx. 0.2 kg |
| R7A-CAB005S | 5 m | | Approx. 0.3 kg |
| R7A-CAB010S | 10 m | | Approx. 0.6 kg |
| R7A-CAB015S | 15 m | | Approx. 0.9 kg |
| R7A-CAB020S | 20 m | | Approx. 1.2 kg |

*1. The maximum distance between the Servo Drive and Servomotor is 20 m.

#### Connection Configuration and External Dimensions




#### Wiring

Servo Drive

| No. | Signal |
|---|---|
| 1 | Phase-U |
| 4 | Phase-V |
| 6 | Phase-W |
| 3 | FG |
| 2 | |
| 5 | |

Red
White
Blue
Green/Yellow
Cable: AWG20 × 4C UL2464

Servomotor

| No. | Signal |
|---|---|
| 1 | Phase-U |
| 2 | Phase-V |
| 3 | Phase-W |
| 4 | FG |

Servo Drive Connector

Connector pins:
5556PBTL (Molex Japan)
Connector case:
5557-06R-210 (Molex Japan)

Servomotor Connector

Connector pins:
170366-1 or 170362-1
(Tyco Electronics AMP KK)
Connector case:
172159-1 (Tyco Electronics AMP KK)

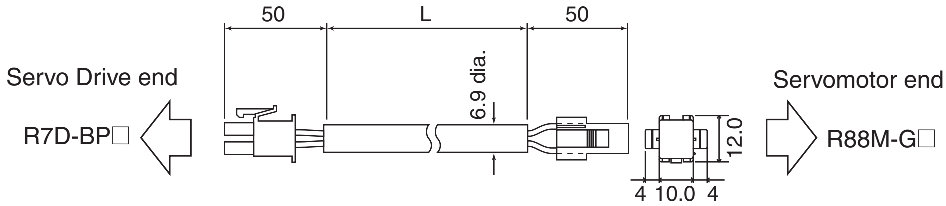
## ■ Global Cables for Servomotor Power (Flexible Cables)

### Cable Models

| Model | Length (L)[*1] | Outer diameter of sheath | Weight |
|---|---|---|---|
| R7A-CAB003SR | 3 m | 6.9 dia. | Approx. 0.2 kg |
| R7A-CAB005SR | 5 m | | Approx. 0.3 kg |
| R7A-CAB010SR | 10 m | | Approx. 0.7 kg |
| R7A-CAB015SR | 15 m | | Approx. 1.0 kg |
| R7A-CAB020SR | 20 m | | Approx. 1.3 kg |

*1. The maximum distance between the Servo Drive and Servomotor is 20 m.

### Connection Configuration and External Dimensions




### Wiring

| Servo Drive No. | Servo Drive Signal | Wire | Servomotor No. | Servomotor Signal |
|---|---|---|---|---|
| 1 | Phase-U | Red | 1 | Phase-U |
| 4 | Phase-V | White | 2 | Phase-V |
| 6 | Phase-W | Black | 3 | Phase-W |
| 3 | FG | Green/Yellow | 4 | FG |
| 2 | | | | |
| 5 | | | | |

Cable: AWG20 × 4C UL2464

Servo Drive Connector

Connector pins:
5556PBTL (Molex Japan)
Connector case:
5557-06R-210 (Molex Japan)

Servomotor Connector

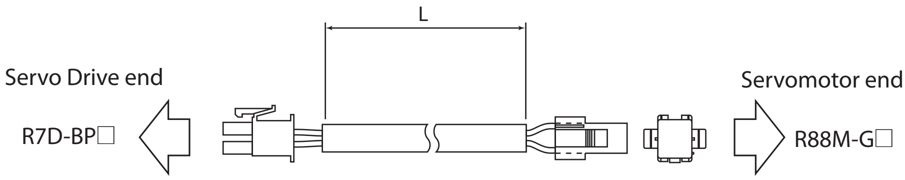
Connector pins:
170366-1 or 170362-1
(Tyco Electronics AMP KK)
Connector case:
172159-1 (Tyco Electronics AMP KK)

## ■ European Cables for Servomotor Power (Flexible and Shielded Cables)

### Cable Models

| Model | Length (L) | Weight |
|---|---|---|
| R7A-CAB001-5SR-E | 1.5 m | Approx. 0.1 kg |
| R7A-CAB003SR-E | 3 m | Approx. 0.2 kg |
| R7A-CAB005SR-E | 5 m | Approx. 0.3 kg |
| R7A-CAB010SR-E | 10 m | Approx. 0.7 kg |
| R7A-CAB015SR-E | 15 m | Approx. 1.0 kg |
| R7A-CAB020SR-E | 20 m | Approx. 1.3 kg |

### Connection Configuration and External Dimensions




### Wiring

Servo Drive

| No. | Signal |
|---|---|
| 1 | Phase-U |
| 4 | Phase-V |
| 6 | Phase-W |
| 3 | FG |
| 2 | |
| 5 | |

Cable: AWG20 × 4C UL2464

Red, White, Blue, Green/Yellow

Servomotor

| No. | Signal |
|---|---|
| 1 | Phase-U |
| 2 | Phase-V |
| 3 | Phase-W |
| 4 | FG |

Servo Drive Connector

Connector pins:
5556PBTL (Molex Japan)
Connector case:
5557-06R-210 (Molex Japan)

Servomotor Connector

Connector pins:
170366-1 or 170362-1
(Tyco Electronics AMP KK)
Connector case:
172159-1 (Tyco Electronics AMP KK)

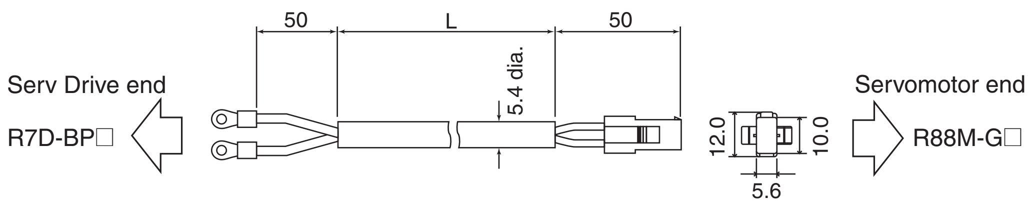
## ■ Global Cables for Brakes (Non-Flexible Cables)

### Cable Models

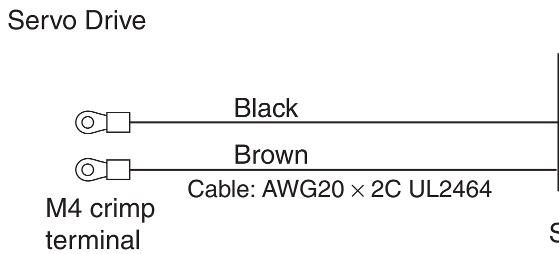
| Model | Length (L)*1 | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CAGA003B | 3 m | 5.4 dia. | Approx. 0.1 kg |
| R88A-CAGA005B | 5 m | | Approx. 0.2 kg |
| R88A-CAGA010B | 10 m | | Approx. 0.4 kg |
| R88A-CAGA015B | 15 m | | Approx. 0.6 kg |
| R88A-CAGA020B | 20 m | | Approx. 0.8 kg |

*1. The maximum distance between the Servo Drive and Servomotor is 20 m.

### Connection Configuration and External Dimensions




### Wiring




| No. | Signal |
|---|---|
| A | Brake |
| B | Brake |

Servomotor Connector
Connector pins:
170366-1 or 170362-1
(Tyco Electronics AMP KK)
Connector case:
172157-1
(Tyco Electronics AMP KK)

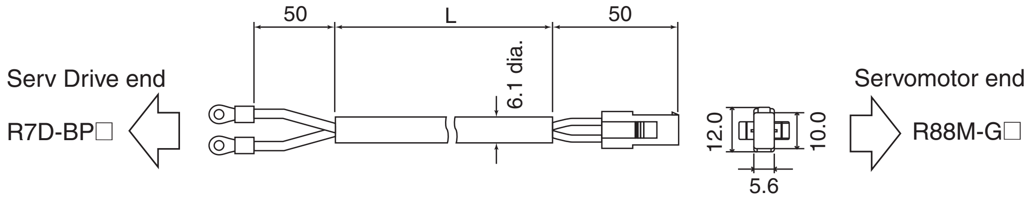
## ■ Global Cables for Brakes (Flexible Cables)

### Cable Models

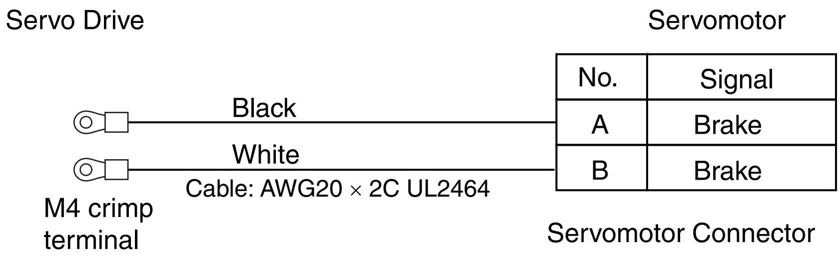
| Model | Length (L)*1 | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CAGA003BR | 3 m | 6.1 dia. | Approx. 0.1 kg |
| R88A-CAGA005BR | 5 m | | Approx. 0.2 kg |
| R88A-CAGA010BR | 10 m | | Approx. 0.4 kg |
| R88A-CAGA015BR | 15 m | | Approx. 0.7 kg |
| R88A-CAGA020BR | 20 m | | Approx. 0.9 kg |

*1. The maximum distance between the Servo Drive and Servomotor is 20 m.

### Connection Configuration and External Dimensions




### Wiring



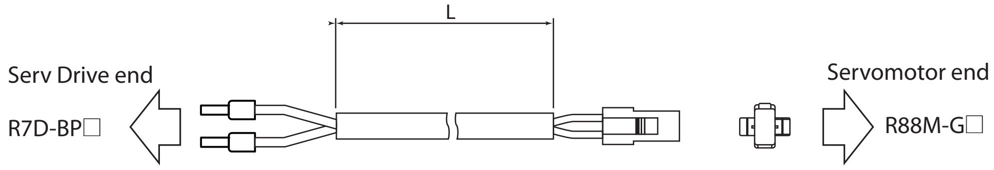

Servomotor Connector
Connector pins:
170366-1 or 170362-1
(Tyco Electronics AMP KK)
Connector case:
172157-1
(Tyco Electronics AMP KK)

## ■ European Cables for Brakes (Flexible Cables)

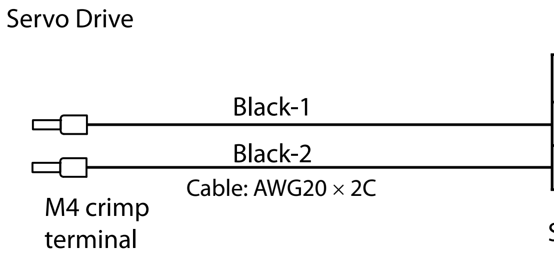
### Cable Models

| Model | Length (L) | Weight |
|---|---|---|
| R88A-CAGA001-5BR-E | 1.5 m | Approx. 0.1 kg |
| R88A-CAGA003BR-E | 3 m | Approx. 0.1 kg |
| R88A-CAGA005BR-E | 5 m | Approx. 0.2 kg |
| R88A-CAGA010BR-E | 10 m | Approx. 0.4 kg |
| R88A-CAGA015BR-E | 15 m | Approx. 0.7 kg |
| R88A-CAGA020BR-E | 20 m | Approx. 0.9 kg |

### Connection Configuration and External Dimensions




### Wiring




| No. | Signal |
|---|---|
| A | Brake |
| B | Brake |

Servomotor Connector
Connector pins:
170366-1 or 170362-1
(Tyco Electronics AMP KK)
Connector case:
172157-1
(Tyco Electronics AMP KK)

## Power Cable Specifications

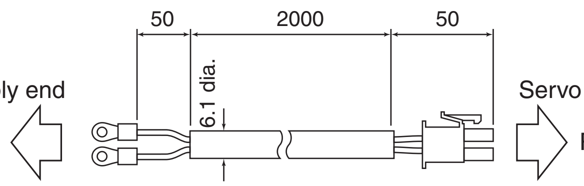
This is the Cable that supplies power to the Servo Drive.
Power Cables are available in two forms: single-phase and three-phase. Select the Cable matching the Servo Drive to be used.
When connecting an External Regeneration Resistor, use an External Regeneration Resistor Cable.

### ■ Single-phase Power Cable (with CNA Connector)

#### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R7A-CLB002S2 | 2 m | 6.1 dia. | Approx. 0.1 kg |

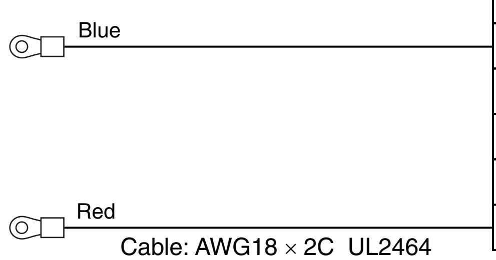
#### Connection Configuration and External Dimensions




#### Wiring

Power supply end

Servo Drive




| No. | Signal |
|---|---|
| 1 | FG |
| 2 | |
| 3 | B1 |
| 4 | |
| 5 | P |
| 6 | L3 |
| 7 | |
| 8 | L2 |
| 9 | |
| 10 | L1 |

Cable: AWG18 × 2C UL2464

M4 crimp terminal

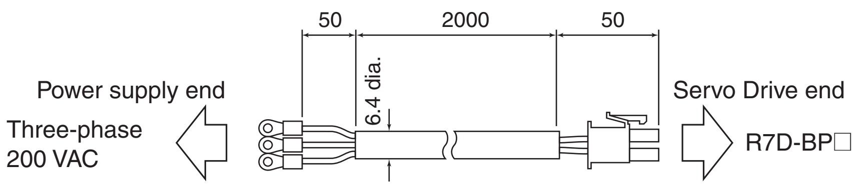
Servo Drive Connector
Connector pins:
5556PBTL (Molex Japan)
Connector case:
5557-10R-210 (Molex Japan)

## ■ Three-phase Power Cable (with CNA Connector)

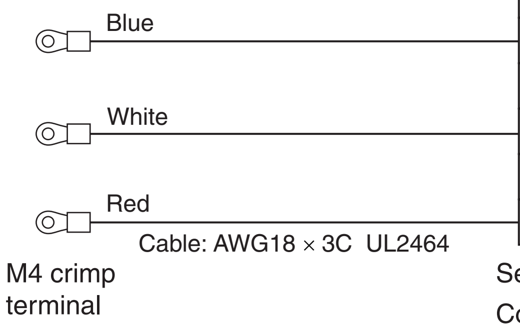
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R7A-CLB002S3 | 2 m | 6.4 dia. | Approx. 0.1 kg |

### Connection Configuration and External Dimensions




### Wiring




| No. | Signal |
|---|---|
| 1 | FG |
| 2 | |
| 3 | B1 |
| 4 | |
| 5 | P |
| 6 | L3 |
| 7 | |
| 8 | L2 |
| 9 | |
| 10 | L1 |

Servo Drive Connector

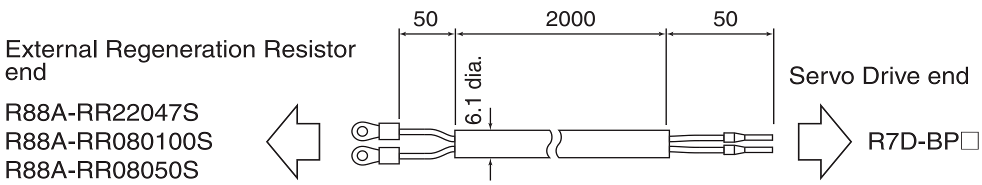
Connector pins:
5556PBTL (Molex Japan)
Connector case:
5557-10R-210 (Molex Japan)

## ■ External Regeneration Resistor Connection Cable (with Crimp Pins)

### Cable Models

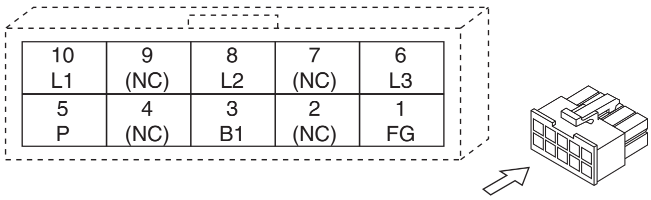
| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R7A-CLB002RG | 2 m | 6.1 dia. | Approx. 0.1 kg |

### Connection Configuration and External Dimensions




### Wiring

Insert into the P (pin 5) and B1 (pin 3) slots of the Main Circuit Connector (CNA).



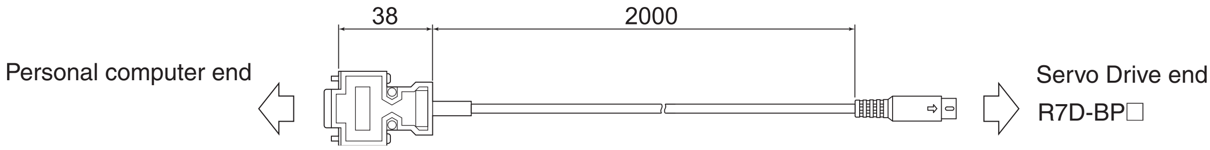
## Communications Cable Specifications

### ■ Personal Computer Monitor Cable

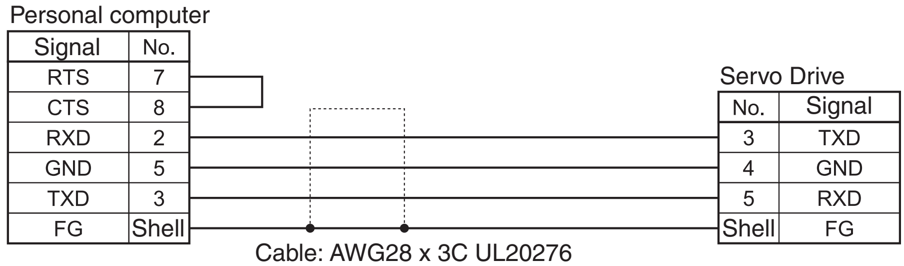
#### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CCG002P2 | 2 m | 4.2 dia. | Approx. 0.1 kg |

#### Connection Configuration and External Dimensions




#### Wiring




PC Connector
17JE-13090-02 (D8A) (DDK Ltd.)

**Precautions for Correct Use**

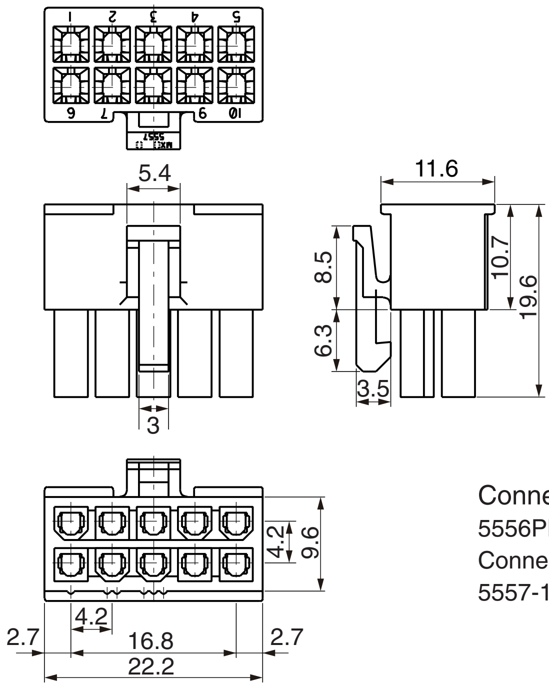
- Communications with the Host Device
  After confirming the startup of the Servo Drive, initiate communications with the host device.
  Note that irregular signals may be received from the host interface during startup. For this reason, take appropriate initialization measures such as clearing the receive buffer.

## Connector Specifications

### ■ Main Circuit Connector (R7A-CNB01P)

The Main Circuit Connector connects to the Servo Drive's Main Circuit Connector (CNA).

**Dimensions**

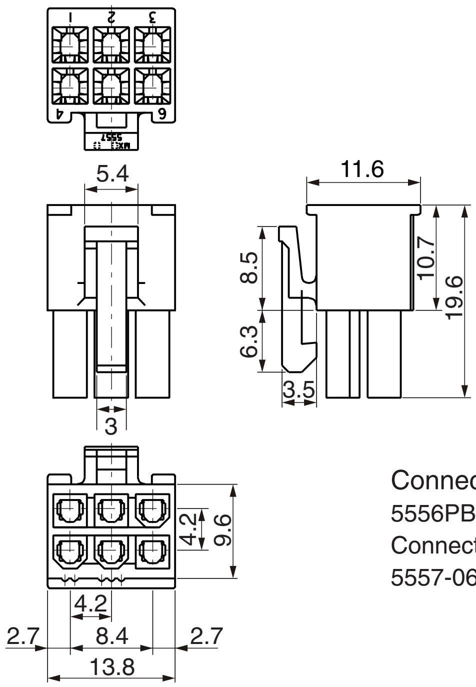



Connector pins:
5556PBTL (Molex Japan)
Connector case:
5557-10R-210 (Molex Japan)

## ■ Servomotor Connector (R7A-CNB01A)

The Servomotor Connector connects to the Servo Drive's Servomotor Connector (CNB).

### Dimensions

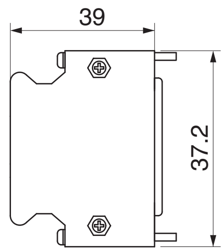



Connector pins:
5556PBTL (Molex Japan)
Connector case:
5557-06R-210 (Molex Japan)

## ■ Control I/O Connector (R88A-CNW01C)

This Connector connects to the Control I/O Connector (CN1) of the Servo Drive.
Use this Connector when preparing a control cable yourself.

### Dimensions




t = 14

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

3

Specifications

## ■ Encoder Connectors

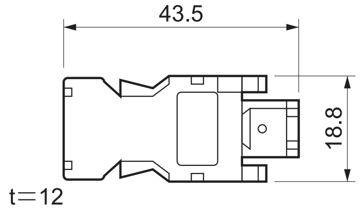
These Connectors are used for Encoder Cables.
Use them when preparing an encoder cable yourself.

### R88A-CNW01R (CN2 Servo Drive Connector)

This connector is soldering type.
Use the following cable.

- Applicable wire: AWG16 max.
- Insulating cover outer diameter: 2.1 mm max.
- Sheath outer diameter: 6.7±0.5 mm

Dimensions

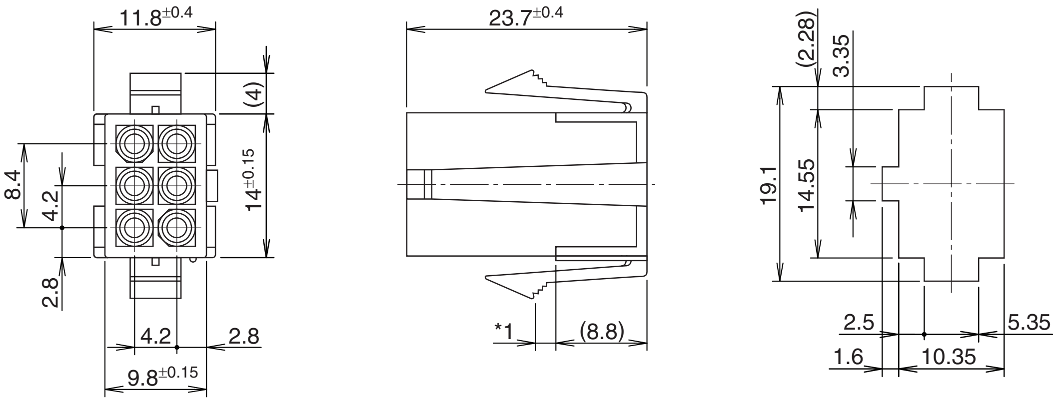



Connector plug:
55100-0670 (Molex Japan Co.)

### R88A-CNG02R (Servomotor Connector)

Use the following cable.

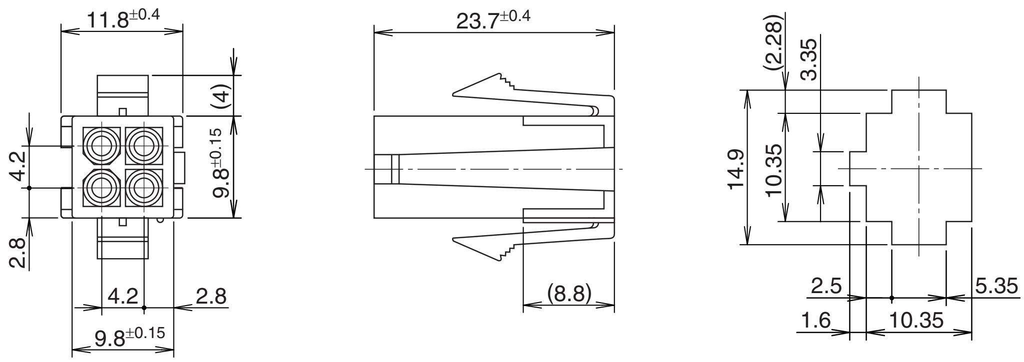
- Applicable wire: AWG22 max.
- Insulating cover outer diameter: 1.75 mm max.




- Connector housing: 172160-1 (Tyco Electronics AMP KK)
- Contact socket: 170365-1 (Tyco Electronics AMP KK)
- Applicable panel thickness: 0.8 to 2.0 mm

## ■ Power Cable Connector (R88A-CNG01A)

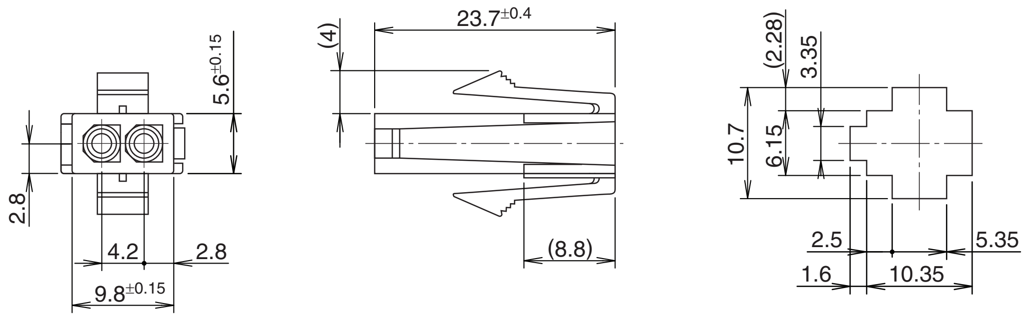
This Connector is used for Power Cables.
Use it when preparing a power cable yourself.




- Connector housing: 172159-1 (Tyco Electronics AMP KK)
- Contact socket: 170366-1 (Tyco Electronics AMP KK)
- Applicable panel thickness: 0.8 to 2.0 mm

## ■ Brake Cable Connector (R88A-CNG01B)

This Connector is used for brake cables.
Use it when preparing a brake cable yourself.




- Connector housing:172157-1 (Tyco Electronics AMP KK)
- Contact socket:170366-1 (Tyco Electronics AMP KK)
- Applicable panel thickness: 0.8 to 2.0 mm

## Control Cable Specifications

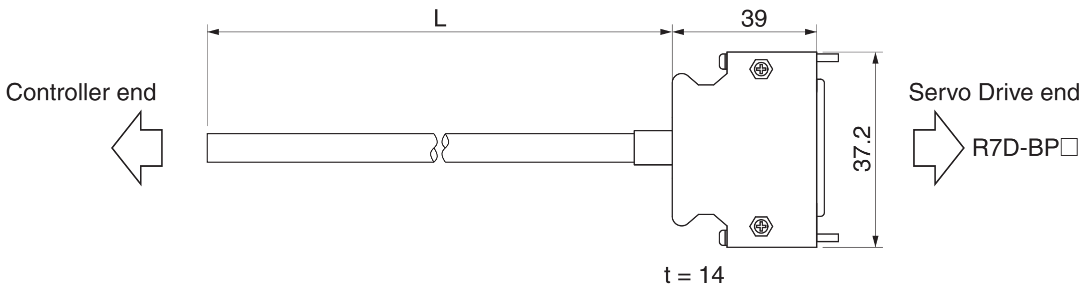
### ■ General-purpose Control Cables

A General-purpose Control Cable connects to the Servo Drive's Control I/O Connector (CN1). Do not wire the pins that have no signals allocated.

#### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R7A-CPB001S | 1 m | 9.5 dia. | Approx. 0.2 kg |
| R7A-CPB002S | 2 m | | Approx. 0.3 kg |

#### Connection Configuration and External Dimensions

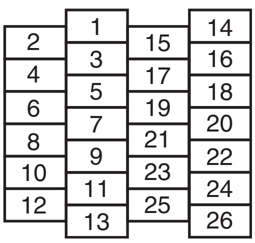


## Wiring

| No. | Wire color (mark color) | Signal |
|---|---|---|
| 1 | Orange (Red 1) | +24VIN |
| 2 | Orange (Black 1) | RUN |
| 3 | Gray (Red 1) | RESET |
| 4 | Gray (Black 1) | ECRST/VSEL2 |
| 5 | White (Red 1) | GSEL/VZERO/TLSEL |
| 6 | White (Black 1) | GESEL/VSEL1 |
| 7 | Yellow (Red 1) | NOT |
| 8 | Yellow (Black 1) | POT |
| 9 | Pink (Red 1) | /ALM |
| 10 | Pink (Black 1) | INP/TGON |
| 11 | Orange (Red 2) | BKIR |
| 12 | Orange (Black 2) | WARN |
| 13 | Gray (Red 2) | OGND |
| 14 | Gray (Black 2) | GND |
| 15 | White (Red 2) | +A |
| 16 | White (Black 2) | −A |
| 17 | Yellow (Black 2) | −B |
| 18 | Yellow (Red 2) | +B |
| 19 | Pink (Red 2) | +Z |
| 20 | Pink (Black 2) | −Z |
| 21 | Orange (Red 3) | Z |
| 22 | Gray (Red 3) | +CW/+PULS/+FA |
| 23 | Gray (Black 3) | −CW/−PULS/−FA |
| 24 | White (Red 3) | +CCW/+SIGN/+FB |
| 25 | White (Black 3) | −CCW/−SIGN/−FB |
| 26 | Orange (Black 3) | FG |

Connector plug: 10126-3000PE (Sumitomo 3M)
Connector case: 10326-52A0-008 (Sumitomo 3M)
Cable: AWG24 × 13P UL20276
Wires with the same wire color and number of marks form a twisted pair.

## Pin Arrangement



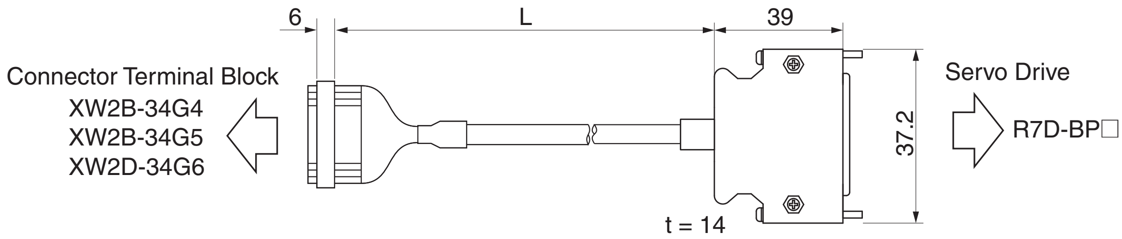
## ■ Connector Terminal Block Cables (XW2Z-□□□J-B28)

This Cable is for the Connector Terminal Block of the Servo Drive's Control I/O Connector (CN1).

### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-100J-B28 | 1 m | 9.1 dia. | Approx. 0.1 kg |
| XW2Z-200J-B28 | 2 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring

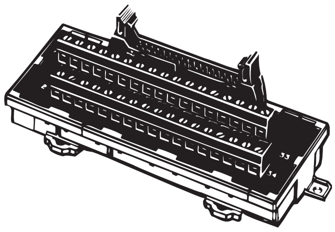
| Terminal Block Signal | Terminal Block No. | Connector No. | Servo Drive No. | Wire/mark color | Servo Drive Signal |
|---|---|---|---|---|---|
| +24VIN | 1 | 1 | 1 | Blue/Red (1) | +24VIN |
| RUN | 2 | 2 | 2 | Blue/Black (1) | RUN |
| RESET | 3 | 3 | 3 | Pink/Red (1) | RESET |
| ECRST/VSEL2 | 4 | 4 | 4 | Pink/Black (1) | ECRST/VSEL2 |
| GSEL/VZERO/TLSEL | 5 | 5 | 5 | Green/Red (1) | GSEL/VZERO/TLSEL |
| SESEL/VSEL1 | 6 | 6 | 6 | Green/Black (1) | SESEL/VSEL1 |
| NOT | 7 | 7 | 7 | Orange/Red (1) | NOT |
| POT | 8 | 8 | 8 | Orange/Black (1) | POT |
| /ALM | 9 | 9 | 9 | Gray/Red (1) | /ALM |
| INP/TGON | 10 | 10 | 10 | Gray/Black (1) | INP/TGON |
| BKIR | 11 | 11 | 11 | Blue/Red (2) | BKIR |
| WARN | 12 | 12 | 12 | Blue/Black (2) | WARN |
| OGND | 13 | 13 | 13 | Pink/Red (2) | OGND |
| GND | 14 | 14 | 14 | Pink/Black (2) | GND |
| +A | 15 | 15 | 15 | Green/Red (2) | +A |
| –A | 16 | 16 | 16 | Green/Black (2) | –A |
| –B | 17 | 17 | 17 | Orange/Red (2) | –B |
| +B | 18 | 18 | 18 | Orange/Black (2) | +B |
| +Z | 19 | 19 | 19 | Gray/Red (2) | +Z |
| –Z | 20 | 20 | 20 | Gray/Black (2) | –Z |
| +CW/+PULS/+FA | 22 | 22 | 22 | Blue/Red (3) | +CW/+PULS/+FA |
| –CW/–PULS/–FA | 23 | 23 | 23 | Blue/Black (3) | –CW/–PULS/–FA |
| +CCW/+SIGN/+FB | 24 | 24 | 24 | Pink/Red (3) | +CCW/+SIGN/+FB |
| –CCW/–SIGN/–FB | 25 | 25 | 25 | Pink/Black (3) | –CCW/–SIGN/–FB |
| Z | 21 | 21 | 21 | Green/Red (3) | Z |
| FG | 26 | 26 | 26 | Green/Black (3) | FG |
| | 27 | 27 | | | |
| | 28 | 28 | | | |
| | 29 | 29 | | | |
| | 30 | 30 | | | |
| | 31 | 31 | | | |
| | 32 | 32 | | | |
| | 33 | 33 | | | |
| | 34 | 34 | | | |

Terminal Block Connector
Connector socket: XG4M-3430
Strain relief: XG4T-3404
Cable
AWG28 × 13P UL2464
Servo Drive Connector
Connector plug: 10126-3000PE (Sumitomo 3M)
Connector case: 10326-52A0-008 (Sumitomo 3M)

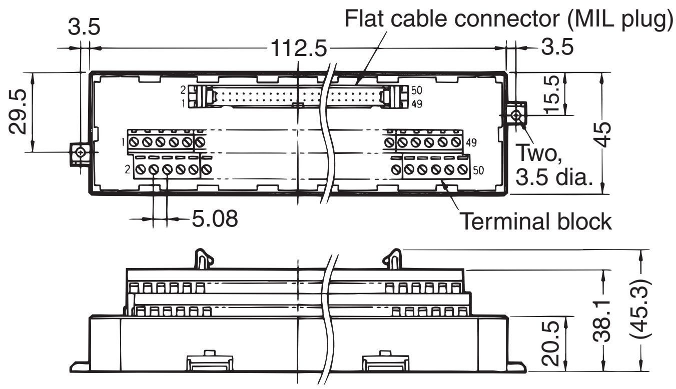
## ■ Connector-Terminal Block Conversion Unit

By using the Connector-Terminal Block Conversion Unit in combination with a Connector Terminal Block Cable (XW2Z-□J-B28), the Servo Drive's Control I/O Connector (CN1) can be converted to a terminal block.

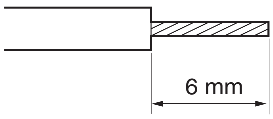
### XW2B-34G4 (M3 screw terminal block)



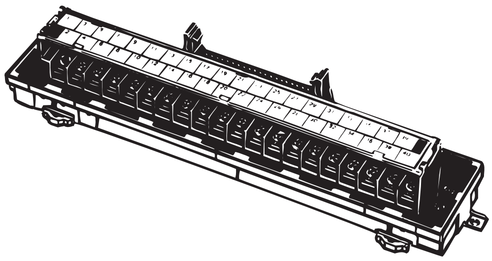
- Dimensions



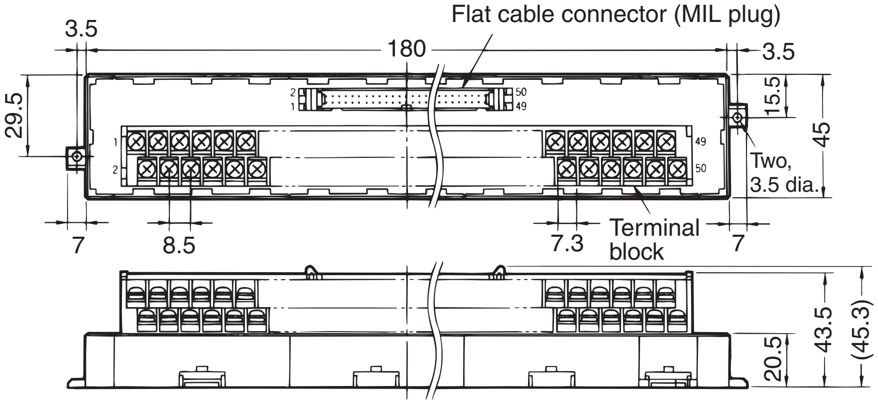

| | |
|---|---|
| **Precautions for Correct Use** | • Use 0.30 to 1.25 mm$^2$ wire (AWG22 to AWG16).<br>• The wire slot is 1.8 mm (height) × 2.5 mm (width).<br>• Strip the insulation from the end of the wire for 6 mm as shown below. |



### XW2B-34G5 (M3.5 screw terminal block)



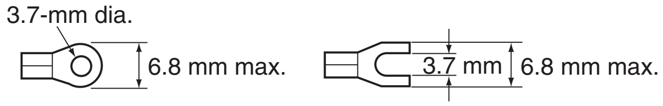
- Dimensions




| | |
|---|---|
| **Precautions for Correct Use** | • When using crimp terminals, use crimp terminals with the following dimensions.<br>• When connecting wires and crimp terminals to a Terminal Block, tighten them with a tightening torque of 0.59 N·m. |

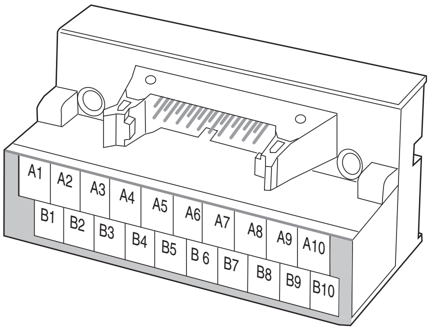
Round Crimp Terminals

Fork Terminals

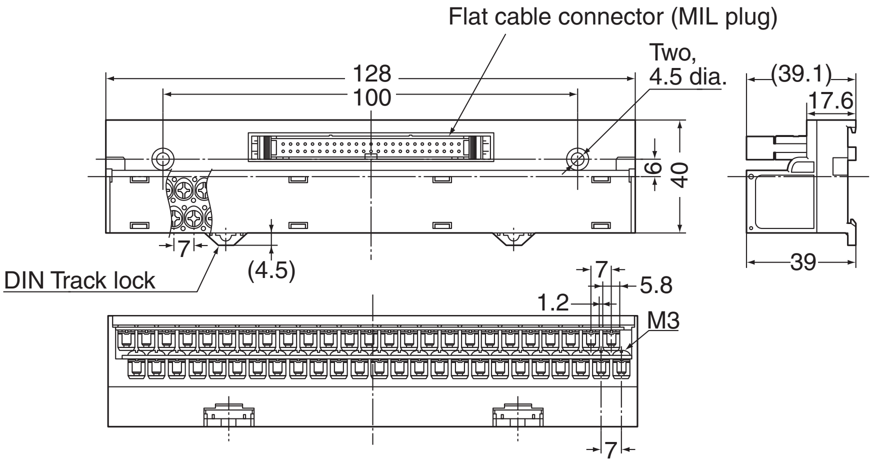



| Applicable Crimp Terminals | | Applicable Wires |
|---|---|---|
| Round Crimp Terminals | 1.25 to 3 | AWG22 to AWG16 (0.3 to 1.25 $mm^2$) |
| | 2 to 3.5 | AWG16 to AWG14 (1.25 to 2.0 $mm^2$) |
| Fork Terminals | 1.25Y to 3 | AWG22 to AWG16 (0.3 to 1.25 $mm^2$) |
| | 2 to 3.5 | AWG16 to AWG14 (1.25 to 2.0 $mm^2$) |

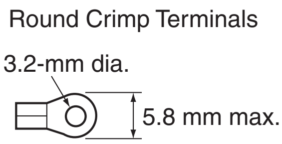
### XW2D-34G6 (M3 screw terminal block)

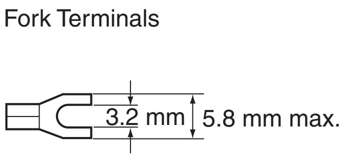



- Dimensions




| | |
|---|---|
| **Precautions for Correct Use** | - When using crimp terminals, use crimp terminals with the following dimensions.<br>- When connecting wires and crimp terminals to a Terminal Block, tighten them with a tightening torque of 0.7 N·m. |

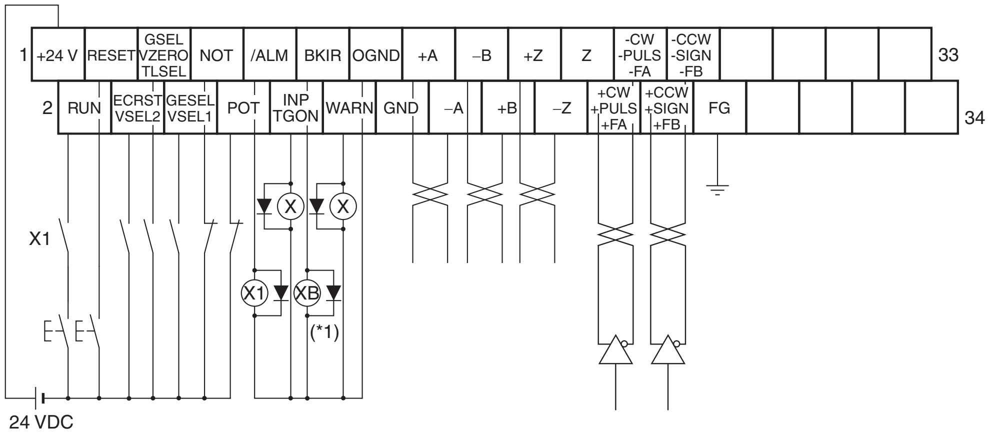



| Applicable Crimp Terminals | | Applicable Wires |
|---|---|---|
| Round Crimp Terminals | 1.25 to 3 | AWG22 to 16 ($0.3$ to $1.25\ mm^2$) |
| Fork Terminals | 1.25Y to 3 | AWG22 to 16 ($0.3$ to $1.25\ mm^2$) |

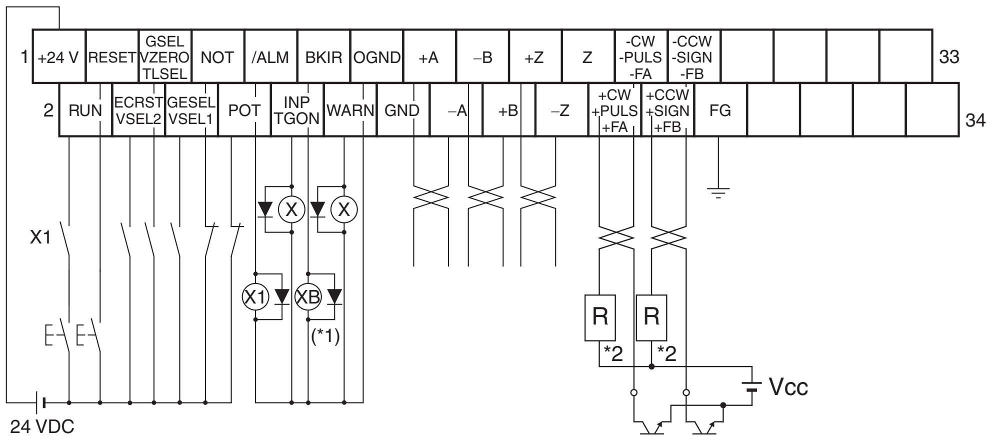
### Terminal Block Wiring Example (for XW2B-34G4, XW2B-34G5, and XW2D-34G6)

- Line-driver Connections




*1.The XB contacts are used to turn the electromagnetic brake ON and OFF.

- Open-collector Connections




*1. The XB contacts are used to turn the electromagnetic brake ON and OFF.

*2. Select a value for resistance R so that the input current will be from 7 to 15 mA. (Refer to the following table.)

| Vcc | R |
|---|---|
| 24 V | 2 kΩ |
| 12 V | 1 kΩ |

## Terminal Block Signal Names

| No. | Signal |
|---|---|
| 1 | +24VIN |
| 2 | RUN |
| 3 | RESET |
| 4 | ECRST/VSEL2 |
| 5 | GSEL/VZERO/TLSEL |
| 6 | SESEL/VSEL1 |
| 7 | NOT |
| 8 | POT |
| 9 | /ALM |
| 10 | INP/TGON |
| 11 | BKIR |
| 12 | WARN |
| 13 | OGND |
| 14 | GND |
| 15 | +A |
| 16 | −A |
| 17 | −B |
| 18 | +B |
| 19 | +Z |
| 20 | −Z |
| 21 | Z |
| 22 | +CW/+PULS/+FA |
| 23 | −CW/−PULS/−FA |
| 24 | +CCW/+SIGN/+FB |
| 25 | −CCW/−SIGN/−FB |
| 26 | FG |
| 27 | |
| 28 | |
| 29 | |
| 30 | |
| 31 | |
| 32 | |
| 33 | |
| 34 | |

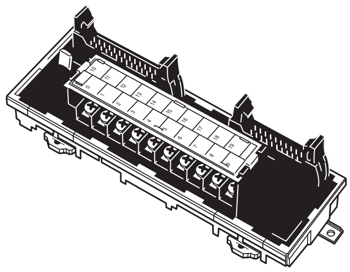
# 3-4 Servo Relay Units and Cable Specifications

This section provides the specifications for the Servo Relay Units and Cables used for connecting to Position Control Units for OMRON Programmable Controllers (SYSMAC). Select the models that match the Position Control Unit to be used. For details, refer to *Selecting Connecting Cables* on page 4-6.

## Servo Relay Units Specifications

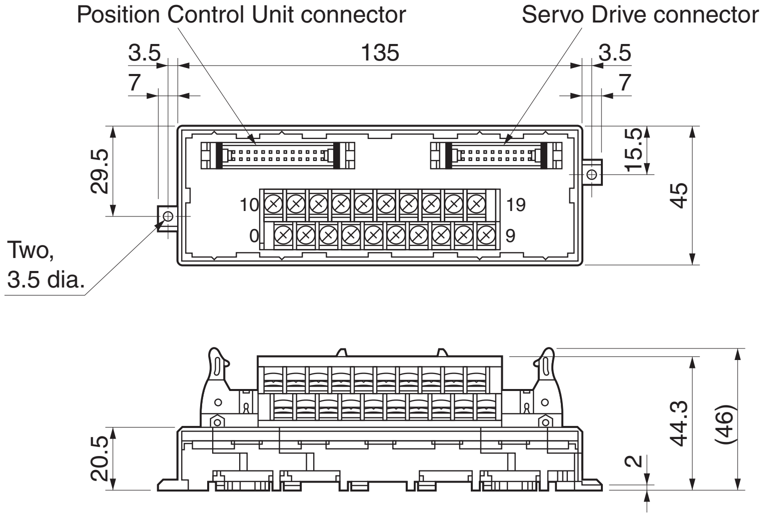
### ■ XW2B-20J6-1B

This Servo Relay Unit connects to the following OMRON Position Control Units.



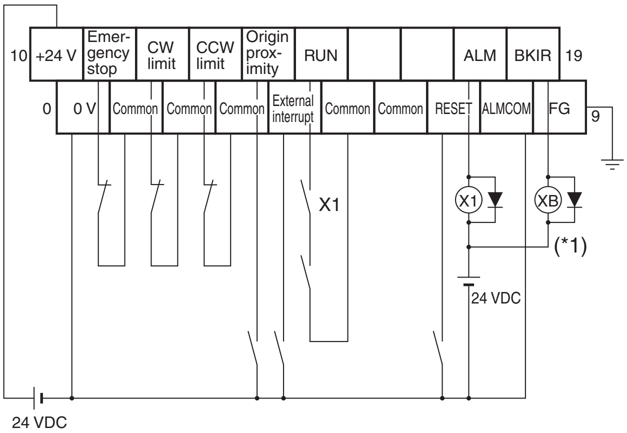
- CJ1W-NC113/-NC133
- CS1W-NC113/-NC133
- C200HW-NC113

#### Dimensions




- Terminal Block pitch: 7.62 mm

### Wiring




*1. The XB contacts are used to turn ON/OFF the electromagnetic brake.

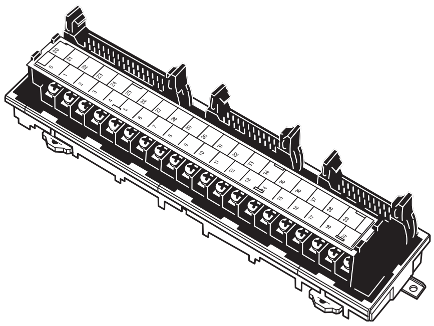
*2. Do not connect unused terminals.

*3. The 0 V terminal is internally connected to the common terminals.

*4. Applicable crimp terminal: R1.25-3 (round with open end).

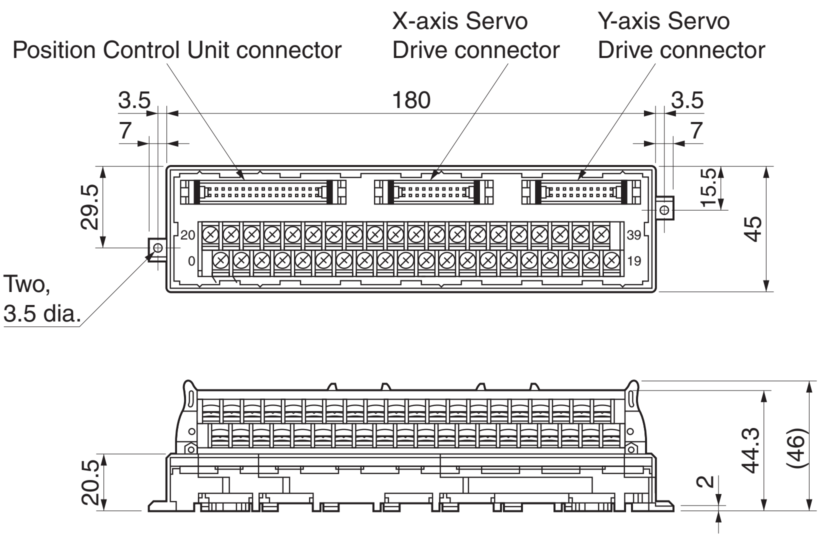
## ■ XW2B-40J6-2B

This Servo Relay Unit connects to the following OMRON Position Control Units.



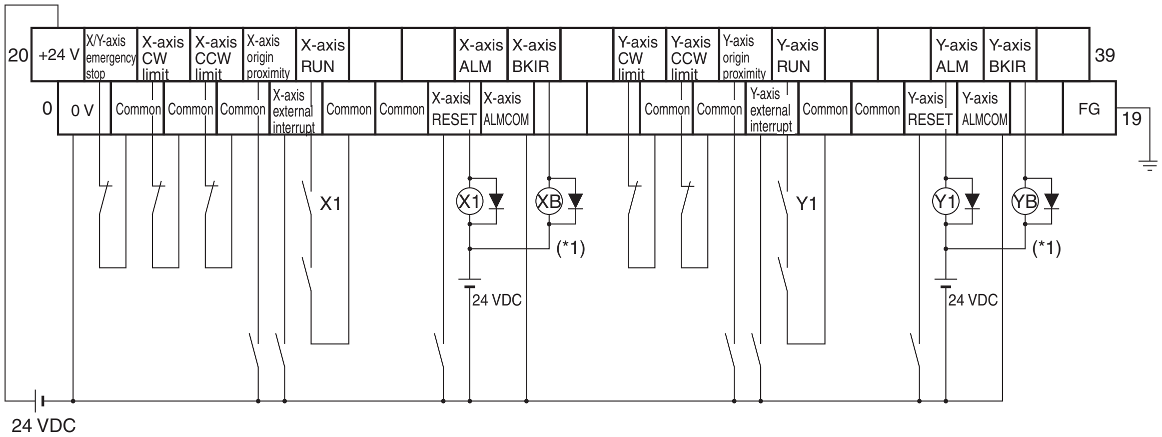
- CJ1W-NC213/-NC233/-NC413/-NC433
- CS1W-NC213/-NC233/-NC413/-NC433
- C200HW-NC213/-NC413

### Dimensions




- Terminal Block pitch: 7.62 mm

### Wiring




*1. The XB and YB contacts are used to turn ON/OFF the electromagnetic brake.

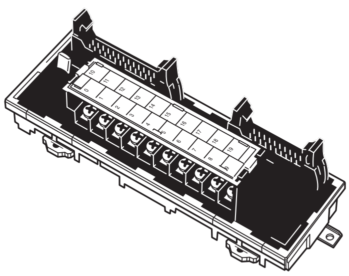
*2. Do not connect unused terminals.

*3. The 0 V terminal is internally connected to the common terminals.

*4. Applicable crimp terminal: R1.25-3 (round with open end).

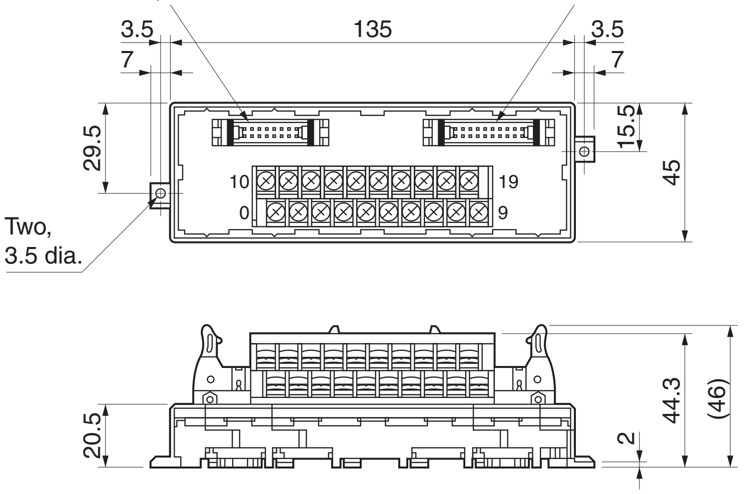
## ■ XW2B-20J6-3B

This Servo Relay Unit connects to the following OMRON Programmable Controllers.



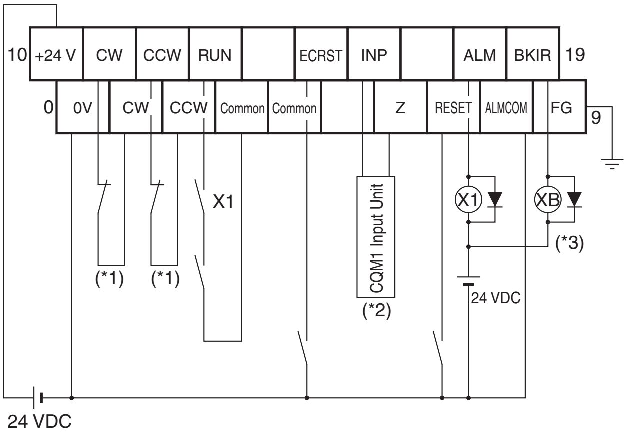
- CQM1H-PLB21
  (Pulse I/O Board for CQM1H-CPU51/CPU61)
- CQM1-CPU43-V1

### Dimensions




- Terminal Block pitch: 7.62 mm

### Wiring




*1. If this signal is input, the output pulse from the CQM1 will be input to the high-speed counter.

*2. Input this output signal to a CQM1 Input Unit.

*3. The XB contacts are used to turn ON/OFF the electromagnetic brake.

*4. The phase Z is an open collector.

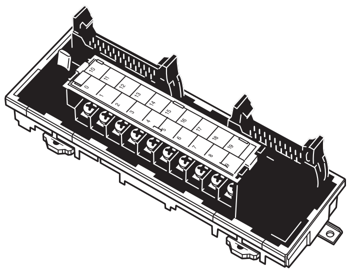
*5. Do not connect unused terminals.

*6. The 0 V terminal is internally connected to the common terminals.

*7. Applicable crimp terminal: R1.25-3 (round with open end).

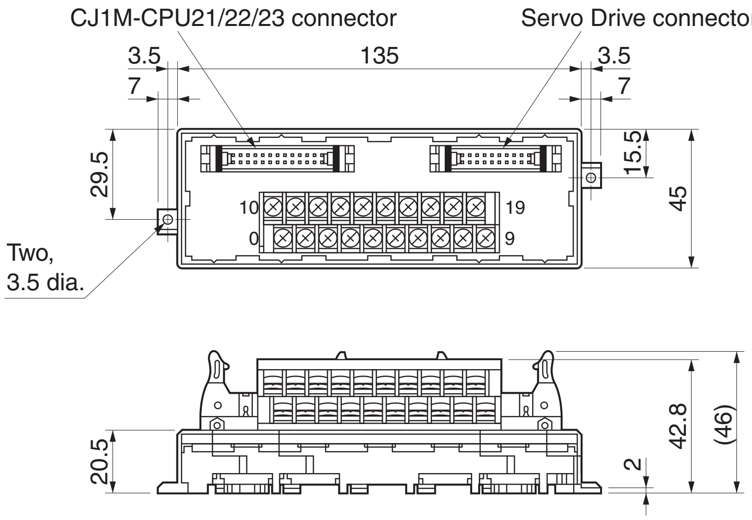
## ■ XW2B-20J6-8A

This Servo Relay Unit connects to the following OMRON Programmable Controllers.



- CJ1M-CPU21/-CPU22/-CPU23 (for 1 axis)

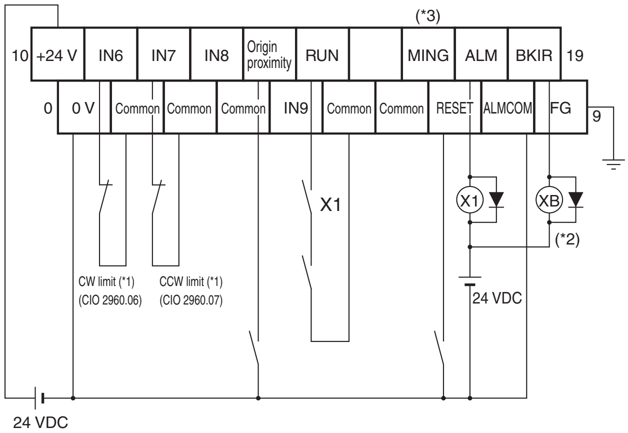
### Dimensions




♦ Terminal Block pitch: 7.62 mm

### Wiring

The Servo Drive phase-Z output signal is wired to the origin proximity signal in this Terminal Block.




*1. CW and CCW limit input signals can also be input through Input Units.
The bits for the CW/CCW limit inputs in the CJ1M are as follows: CW: A540.08, CCW: A540.09 for pulse output 0, and CW: A541.08, CCW: A541.09 for pulse output 1.
For example, the flag for the CW limit input (A540.08) can be controlled with an output from the ladder diagram using a bit allocated to the actual input (CIO 2960.06) on the Input Unit, as shown below.

Example:


*2. The XB contacts are used to turn ON/OFF the electromagnetic brake.

*3. Connection to the MING input terminal is invalid.

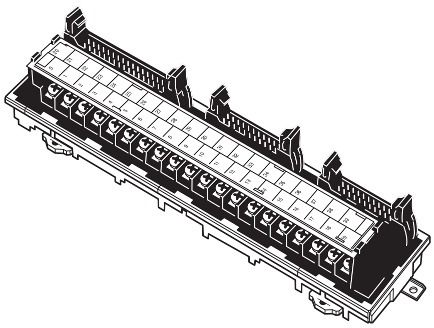
*4. Do not connect unused terminals.

*5. The 0 V terminal is internally connected to the common terminals.

*6. Applicable crimp terminal: R1.25-3 (round with open end).

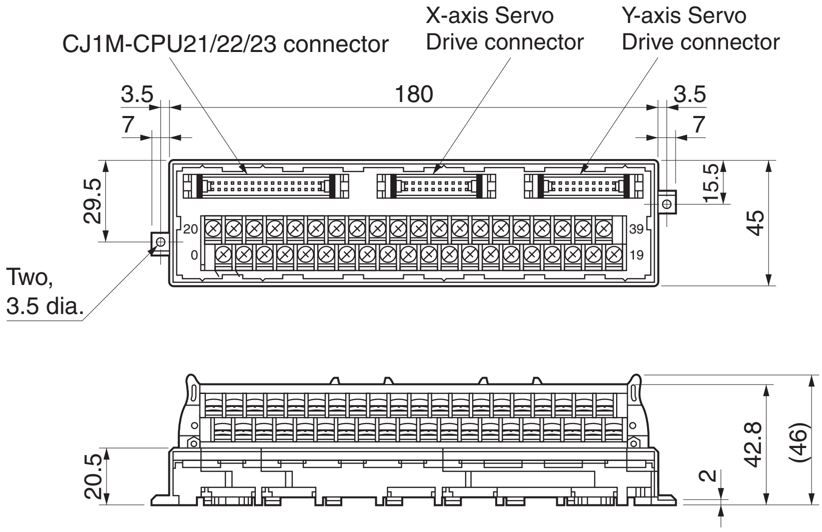
## ■ XW2B-40J6-9A

This Servo Relay Unit connects to the following OMRON Programmable Controllers.



- CJ1M-CPU21/-CPU22/-CPU23 (for 2 axes)

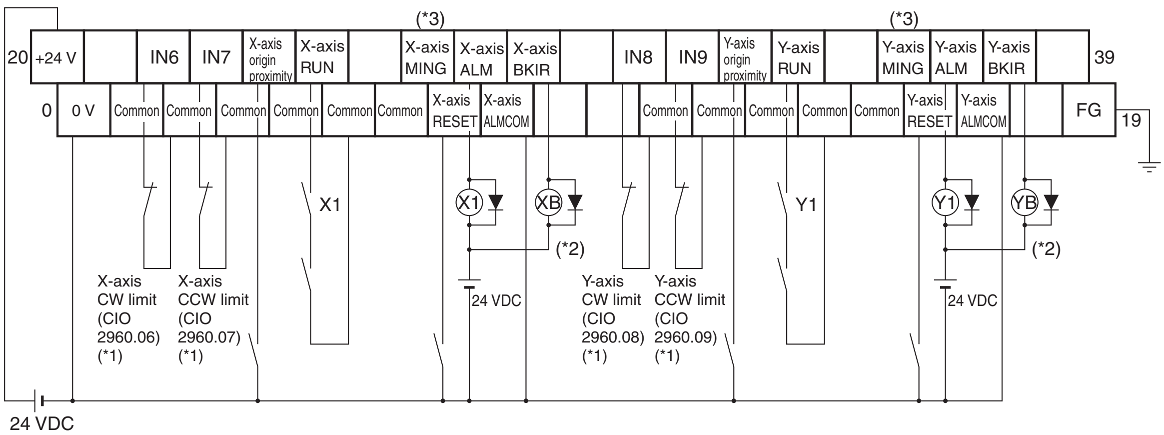
### Dimensions




- Terminal Block pitch: 7.62 mm

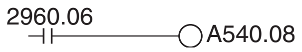
### Wiring

The Servo Drive phase-Z output signal is wired to the origin proximity signal in this Terminal Block.




*1. CW and CCW limit input signals can also be input through Input Units.
The bits for the CW/CCW limit inputs in the CJ1M are as follows: CW: A540.08, CCW: A540.09 for pulse output 0, and CW: A541.08, CCW: A541.09 for pulse output 1.
For example, the flag for the CW limit input (A540.08) can be controlled with an output from the ladder diagram using a bit allocated to the actual input (CIO 2960.06) on the Input Unit, as shown below.

Example:




*2. The XB and YB contacts are used to turn ON/OFF the electromagnetic brake.

*3. Connection to the MING input terminal is invalid.

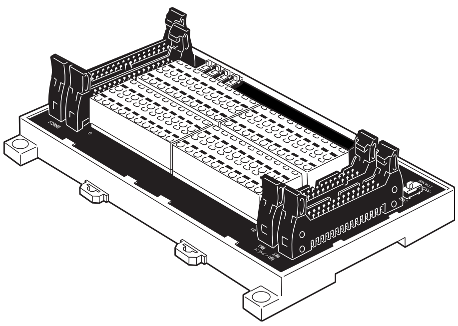
*4. Do not connect unused terminals.

*5. The 0 V terminal is internally connected to the common terminals.

*6. Applicable crimp terminal: R1.25-3 (round with open end).

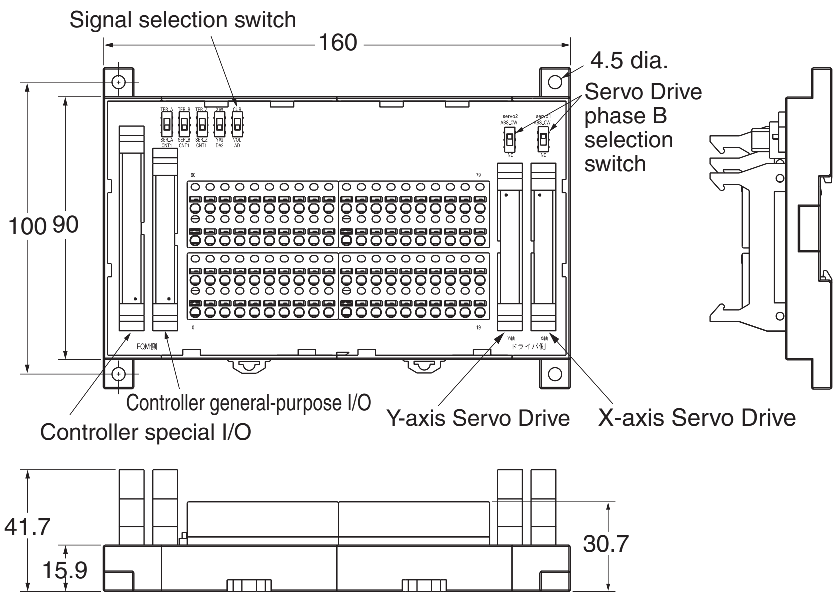
## ■ XW2B-80J7-12A

This Servo Relay Unit connects to the following OMRON Programmable Controller.

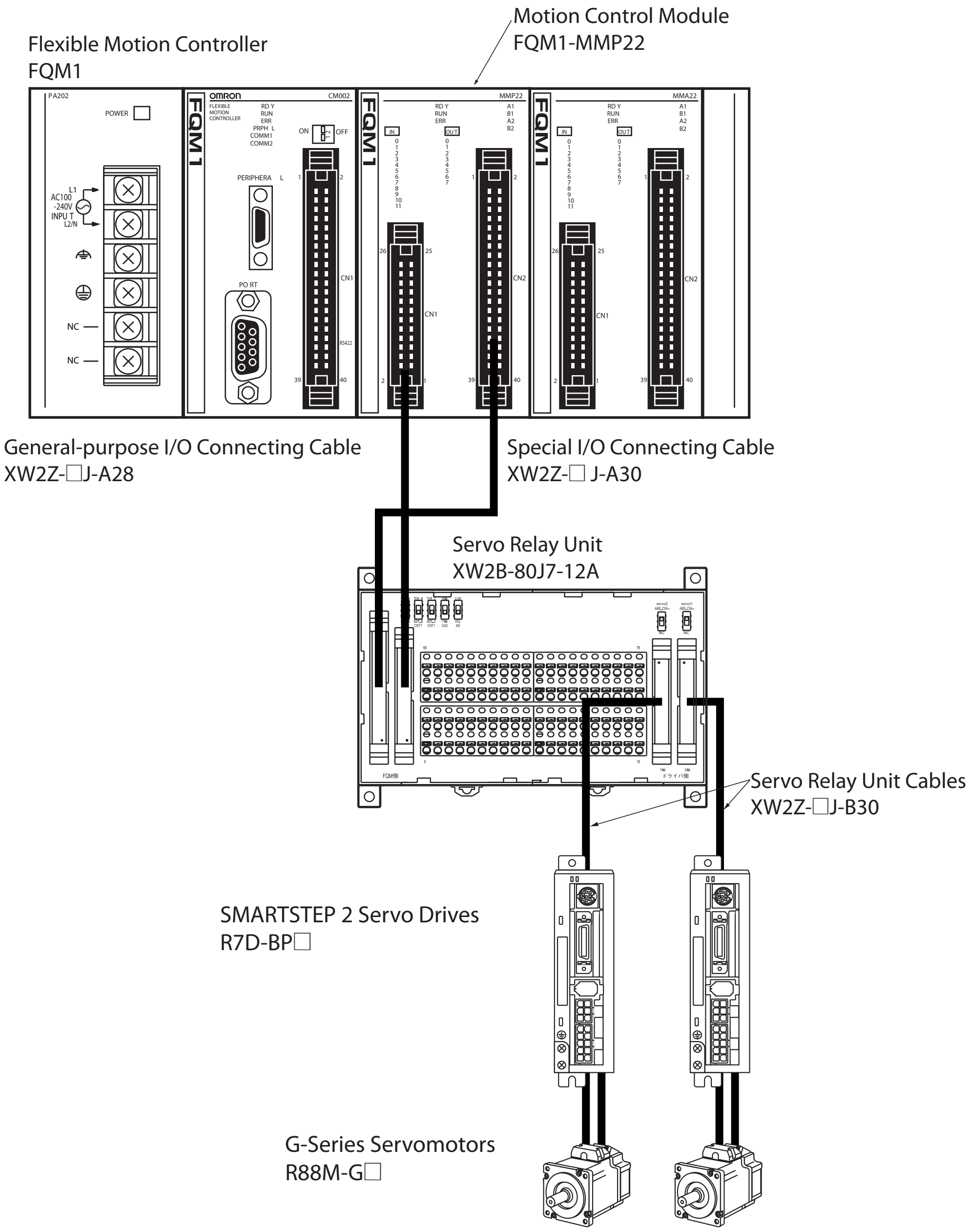


♦ FQM1-MMP22

### Dimensions

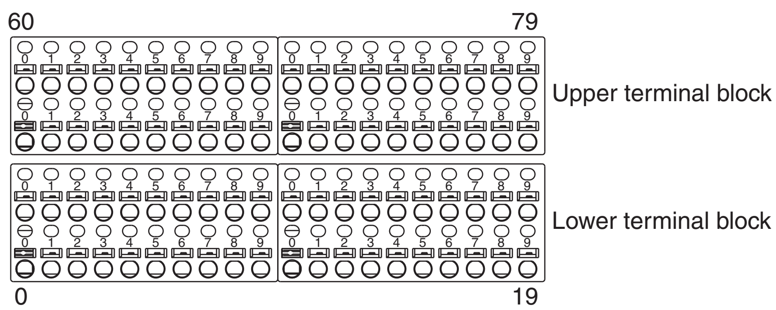


## System Configuration Example




## Terminal Block Connection

- The terminal block signal names are different depending on the Controller to be connected.
- A total of 80 terminals are provided (terminal numbers 0 to 79).
- Signal names and standard connections are listed in the following table.



### FQM1-MMP22 Signal Names

| No. | Signal name | No. | Signal name | No. | Signal name | No. | Signal name |
|---|---|---|---|---|---|---|---|
| 0 | 0 V | 20 | 24 V (*2) | 40 | 0 V | 60 | 5 V (*1) |
| 1 | 0 V | 21 | 24 V (*3) | 41 | Latch signal 1 common | 61 | Latch signal 1 input |
| 2 | Common (0 V) | 22 | IN0 | 42 | Latch signal 2 common | 62 | Latch signal 2 input |
| 3 | Common (0 V) | 23 | IN1 | 43 | Servo #1 phase A LD– | 63 | Servo #1 phase A LD+ |
| 4 | Common (0 V) | 24 | IN2 | 44 | Servo #1 phase B LD– | 64 | Servo #1 phase B LD+ |
| 5 | Common (0 V) | 25 | IN3 | 45 | Servo #1 phase Z LD– | 65 | Servo #1 phase Z LD+ |
| 6 | --- | 26 | --- | 46 | --- | 66 | --- |
| 7 | Servo #2 INP | 27 | Servo #2 ALM | 47 | Servo #1 INP | 67 | Servo #1 ALM |
| 8 | Common (0 V) | 28 | Servo #2 BKIR | 48 | Common (0 V) | 68 | Servo #1 BKIR |
| 9 | Common (0 V) | 29 | IN8 | 49 | Common (0 V) | 69 | IN4 |
| 10 | Common (0 V) | 30 | IN9 | 50 | Common (0 V) | 70 | IN5 |
| 11 | Common (0 V) | 31 | IN10 | 51 | Common (0 V) | 71 | IN6 |
| 12 | Common (0 V) | 32 | IN11 | 52 | Common (0 V) | 72 | IN7 |
| 13 | --- | 33 | --- | 53 | --- | 73 | --- |
| 14 | OUT4 | 34 | Servo #2 RUN | 54 | OUT0 | 74 | Servo #1 RUN |
| 15 | OUT5 | 35 | Servo #2 RESET | 55 | OUT1 | 75 | Servo #1 RESET |
| 16 | OUT6 | 36 | Servo #2 ECRST | 56 | OUT2 | 76 | Servo #1 ECRST |
| 17 | OUT7 | 37 | Servo #2 GSEL/TLSEL | 57 | OUT3 | 77 | Servo #1 GSEL/TLSEL |
| 18 | --- | 38 | --- | 58 | --- | 78 | --- |
| 19 | FG | 39 | FG | 59 | --- | 79 | --- |

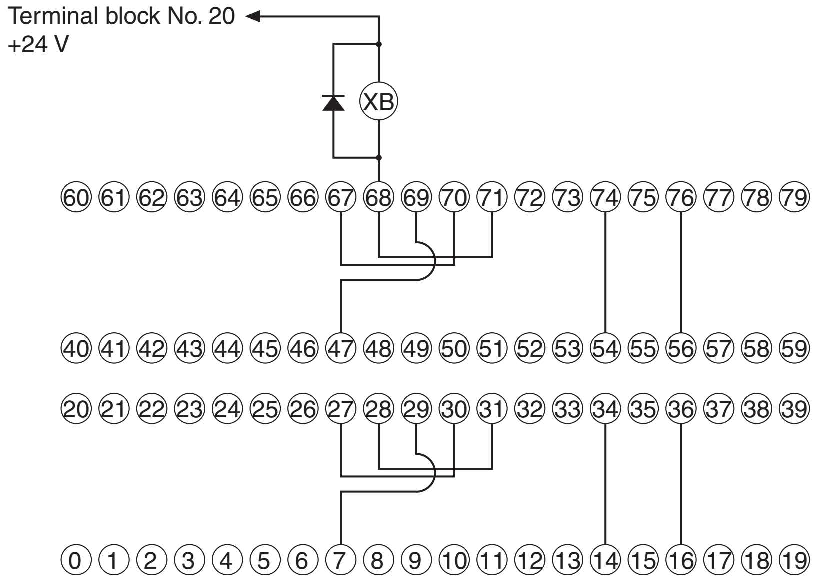
*1: Use as a power supply for FQM1-MMP22 pulse outputs, or for the SEN output for an Absolute Encoder Servo Drive.

*2: Use as a power supply for IN4 to IN11, OUT0 to OUT7, or Servo Drive control signals.

*3: Use as a power supply for IN0 to IN3 (interrupt inputs) or latch inputs.

### Wiring Example

| Servo Drive signals | | | FQM1 signals | | | |
|---|---|---|---|---|---|---|
| | #1 | #2 | For Servo Drive #1 | | For Servo Drive #2 | |
| RUN | 74 | 34 | 54 | OUT0 | 14 | OUT4 |
| ECRST | 76 | 36 | 56 | OUT2 | 16 | OUT6 |
| INP | 47 | 7 | 69 | IN4 | 29 | IN8 |
| /ALM | 67 | 27 | 70 | IN5 | 30 | IN9 |
| BKIR | 68 | 28 | 71 | IN6 | 31 | IN10 |



## Servo Drive-Servo Relay Unit Cable Specifications

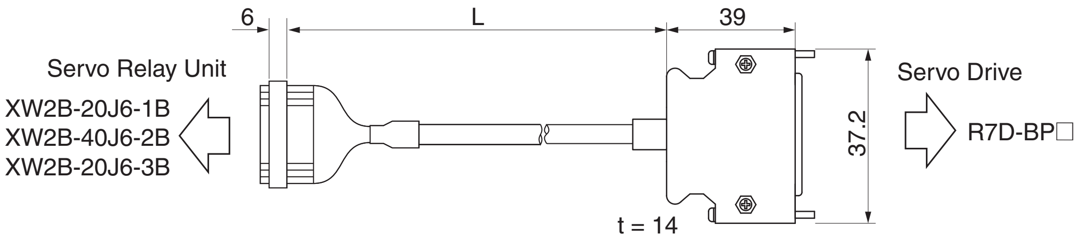
### ■ Servo Drive Cable (XW2Z-□J-B29)

This Cable connects the Servo Drive to a Servo Relay Unit (XW2B-20J6-1B/-3B, XW2B-40J6-2B).

#### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-100J-B29 | 1 m | 8.1 dia. | Approx. 0.1 kg |
| XW2Z-200J-B29 | 2 m | | Approx. 0.2 kg |

#### Connection Configuration and External Dimensions




#### Wiring

Servo Relay Unit

| Symbol | Wire/mark color | No. | Connector No. |
|---|---|---|---|
| +24VIN | Blue/Red (1) | 1 | 1 |
| 0GND | Blue/Black (1) | 2 | 2 |
| +CCW/+SIGN/+FB | Pink/Red (1) | 3 | 3 |
| –CCW/–SIGN/–FB | Pink/Black (1) | 4 | 4 |
| +CW/+PULS/+FA | Green/Red (1) | 5 | 5 |
| –CW/–PULS/–FA | Green/Black (1) | 6 | 6 |
| | | 7 | 7 |
| | | 8 | 8 |
| ECRST/VSEL2 | Orange/Black (1) | 9 | 9 |
| +Z | Gray/Red (1) | 10 | 10 |
| –Z | Gray/Black (1) | 11 | 11 |
| INP/TGON | Blue/Red (2) | 12 | 12 |
| RUN | Blue/Black (2) | 13 | 13 |
| | | 14 | 14 |
| GSEL/VZERO/TLSEL | Pink/Red (2) | 15 | 15 |
| RESET | Pink/Black (2) | 16 | 16 |
| BKIR | Green/Red (2) | 17 | 17 |
| /ALM | Green/Black (2) | 18 | 18 |
| | | 19 | 19 |
| Shield | Shield | 20 | 20 |

Servo Drive

| No. | Symbol |
|---|---|
| 1 | +24VIN |
| 13 | OGND |
| 24 | +CCW/+SIGN/+FB |
| 25 | –CCW/–SIGN/–FB |
| 22 | +CW/+PULS/+FA |
| 23 | –CW/–PULS/–FA |
| | |
| 4 | ECRST/VSEL2 |
| | |
| 19 | +Z |
| 20 | –Z |
| 10 | INP/TGON |
| 2 | RUN |
| | |
| 5 | GSEL/VZERO/TLSEL |
| 3 | RESET |
| 11 | BKIR |
| 9 | /ALM |
| | |
| 26 | FG |

Servo Relay Unit Connector
  Connector socket: XG4M-2030
  Strain relief: XG4T-2004
Cable
  AWG28 × 4P + AWG28 × 9C   UL2464
Servo Drive Connector
  Connector plug: 10126-3000PE (Sumitomo 3M)
  Connector case: 10326-52A0-008 (Sumitomo 3M)

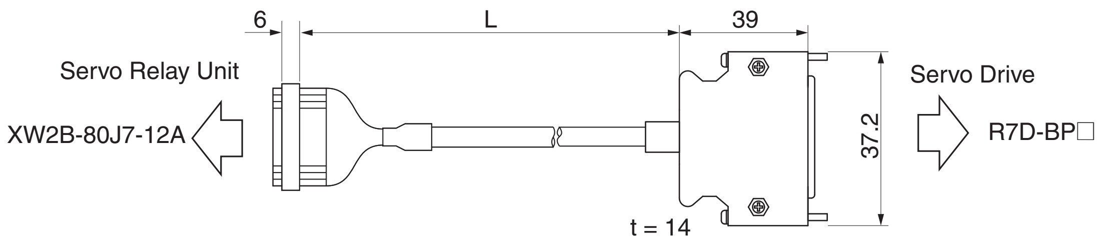
## ■ Servo Drive Cable (XW2Z-□J-B30)

This Cable connects the Servo Drive to a Servo Relay Unit (XW2B-80J7-12A). Use this Cable for the FQM1-MMP22.

### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-100J-B30 | 1 m | 9.1 dia. | Approx. 0.1 kg |
| XW2Z-200J-B30 | 2 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring

| Servo Relay Unit Symbol | Wire/mark color | No. | Connector No. | Servo Drive No. | Servo Drive Symbol |
|---|---|---|---|---|---|
| +24VIN | Blue/Red (1) | 1 | 1 | 1 | +24VIN |
| 0GND | Blue/Black (1) | 2 | 2 | 13 | OGND |
| +CCW/+SIGN/+FB | Pink/Red (1) | 3 | 3 | 24 | +CCW/+SIGN/+FB |
| –CCW/–SIGN/–FB | Pink/Black (1) | 4 | 4 | 25 | –CCW/–SIGN/–FB |
| +CW/+PULS/+FA | Green/Red (1) | 5 | 5 | 22 | +CW/+PULS/+FA |
| –CW/–PULS/–FA | Green/Black (1) | 6 | 6 | 23 | –CW/–PULS/–FA |
| | Orange/Red (1) | 7 | 7 | | |
| ECRST/VSEL2 | Orange/Black (1) | 8 | 8 | 4 | ECRST/VSEL2 |
| +Z | Gray/Red (1) | 9 | 9 | 19 | +Z |
| –Z | Gray/Black (1) | 10 | 10 | 20 | –Z |
| INP/TGON | Blue/Red (2) | 11 | 11 | 10 | INP/TGON |
| RUN | Blue/Black (2) | 12 | 12 | 2 | RUN |
| RESET | Pink/Red (2) | 15 | 15 | 3 | RESET |
| BKIR | Pink/Black (2) | 16 | 16 | 11 | BKIR |
| /ALM | Green/Red (2) | 17 | 17 | 9 | /ALM |
| +A | Orange/Red (2) | 21 | 21 | 15 | +A |
| –A | Orange/Black (2) | 22 | 22 | 16 | –A |
| +B | Gray/Red (2) | 23 | 23 | 18 | +B |
| –B | Gray/Black (2) | 24 | 24 | 17 | –B |
| GSEL/VZERO/TLSEL | Blue/Red (3) | 25 | 25 | 5 | GSEL/VZERO/TLSEL |
| Shield | Shield | 30 | 30 | 26 | FG |

Servo Relay Unit Connector
  Connector socket: XG4M-3030
  Strain relief: XG4T-3004
Cable
  AWG28 × 7P + AWG28 × 6C   UL2464
Servo Drive Connector
  Connector plug: 10126-3000PE (Sumitomo 3M)
  Connector case: 10326-52A0-008 (Sumitomo 3M)

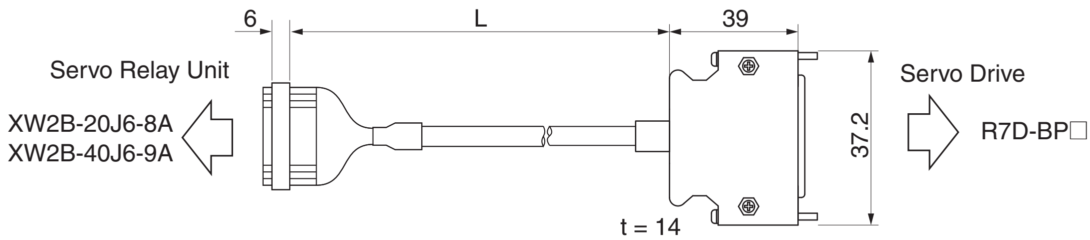
## ■ Servo Drive Cable (XW2Z-□J-B32)

This Cable connects the Servo Drive to a Servo Relay Unit (XW2B-20J6-8A, XW2B-40J6-9A).

### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-100J-B32 | 1 m | 8.1 dia. | Approx. 0.1 kg |
| XW2Z-200J-B32 | 2 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring

Servo Relay Unit / Connector / Servo Drive

| Symbol | Wire/mark color | No. | Connector No. | No. | Symbol |
|---|---|---|---|---|---|
| +24VIN | Blue/Red (1) | 1 | 1 | 1 | +24VIN |
| 0GND | Blue/Black (1) | 2 | 2 | 13 | OGND |
| +CCW/+SIGN/+FB | Pink/Red (1) | 3 | 3 | 24 | +CCW/+SIGN/+FB |
| −CCW/−SIGN/−FB | Pink/Black (1) | 4 | 4 | 25 | −CCW/−SIGN/−FB |
| +CW/+PULS/+FA | Green/Red (1) | 5 | 5 | 22 | +CW/+PULS/+FA |
| −CW/−PULS/−FA | Green/Black (1) | 6 | 6 | 23 | −CW/−PULS/−FA |
| | | 7 | 7 | | |
| | | 8 | 8 | 4 | ECRST/VSEL2 |
| | | 9 | 9 | | |
| +Z | Gray/Red (1) | 10 | 10 | 19 | +Z |
| −Z | Gray/Black (1) | 11 | 11 | 20 | −Z |
| INP/TGON | Blue/Red (2) | 12 | 12 | 10 | INP/TGON |
| RUN | Blue/Black (2) | 13 | 13 | 2 | RUN |
| ECRST/VSEL2 | Orange/Black (1) | 14 | 14 | | |
| GSEL/VZERO/TLSEL | Pink/Red (2) | 15 | 15 | 5 | GSEL/VZERO/TLSEL |
| RESET | Pink/Black (2) | 16 | 16 | 3 | RESET |
| BKIR | Green/Red (2) | 17 | 17 | 11 | BKIR |
| /ALM | Green/Black (2) | 18 | 18 | 9 | /ALM |
| | | 19 | 19 | | |
| Shield | Shield | 20 | 20 | 26 | FG |

Servo Relay Unit Connector
 Connector socket: XG4M-2030
 Strain relief: XG4T-2004
Cable
 AWG28 × 4P + AWG28 × 9C UL2464
Servo Drive Connector
 Connector plug: 10126-3000PE (Sumitomo 3M)
 Connector case: 10326-52A0-008 (Sumitomo 3M)

## Position Control Unit-Servo Relay Unit Cable Specifications

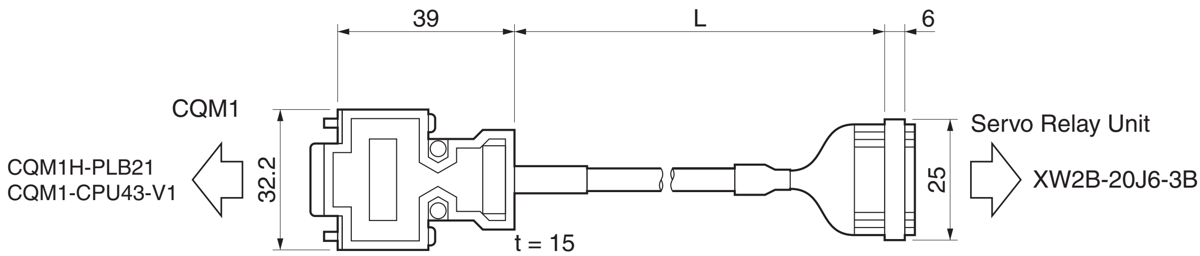
### ■ Position Control Unit Cable (XW2Z-□J-A3)

This Cable connects a Programmable Controller (CQM1H-PLB21, CQM1-CPU43-V1) to a Servo Relay Unit (XW2B-20J6-3B).

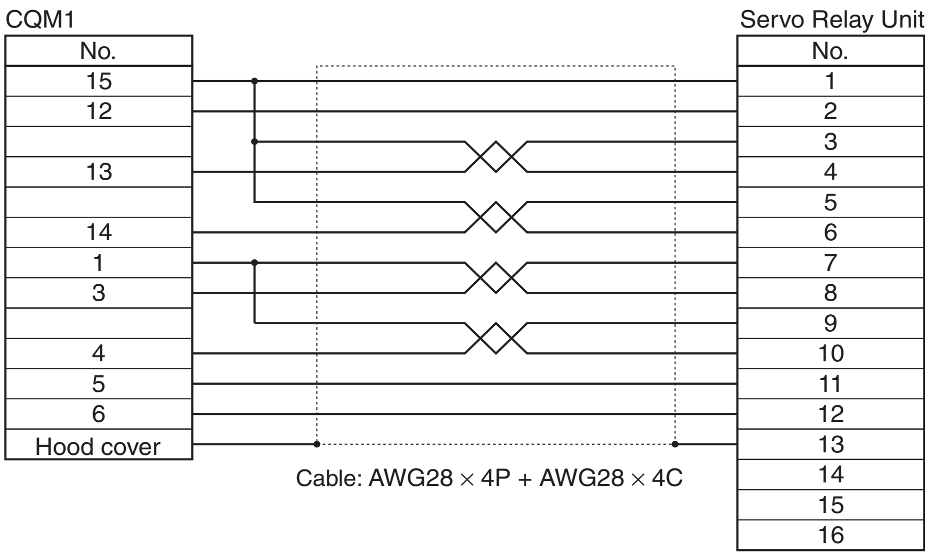
#### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A3 | 50 cm | 7.5 dia. | Approx. 0.1 kg |
| XW2Z-100J-A3 | 1 m | | Approx. 0.1 kg |

#### Connection Configuration and External Dimensions




#### Wiring




Cable: AWG28 × 4P + AWG28 × 4C

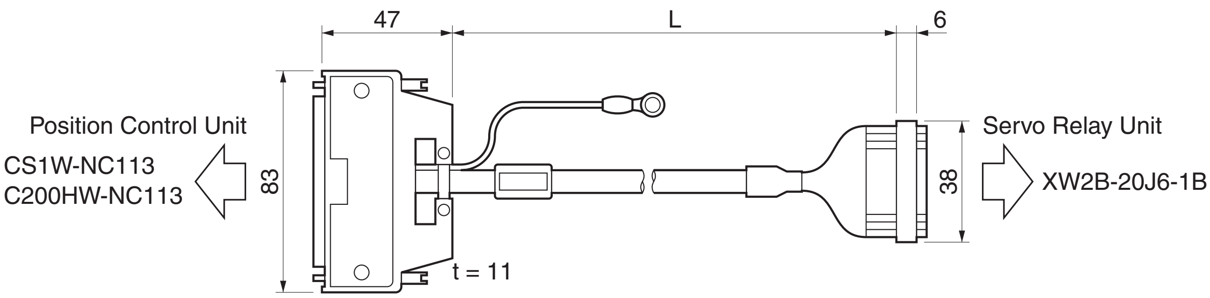
## ■ Position Control Unit Cable (XW2Z-□J-A6)

This Cable connects a Position Control Unit (CS1W-NC113, C200HW-NC113) to a Servo Relay Unit (XW2B-20J6-1B).

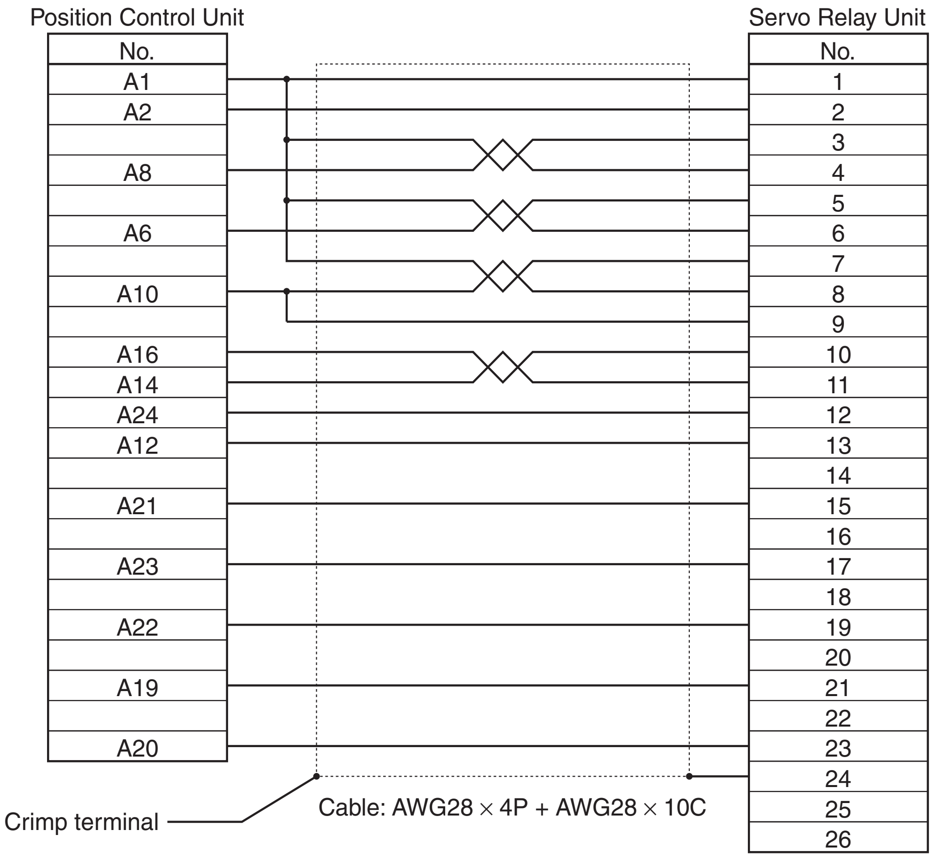
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A6 | 50 cm | 8.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A6 | 1 m | | Approx. 0.1 kg |

### Connection Configuration and External Dimensions




### Wiring



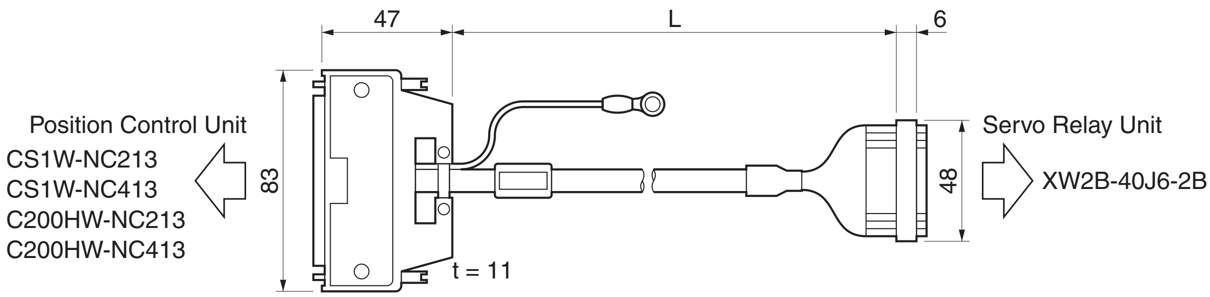
## ■ Position Control Unit Cable (XW2Z-□J-A7)

This Cable connects a Position Control Unit (CS1W-NC213/413, C200HW-NC213/413) to a Servo Relay Unit (XW2B-40J6-2B).

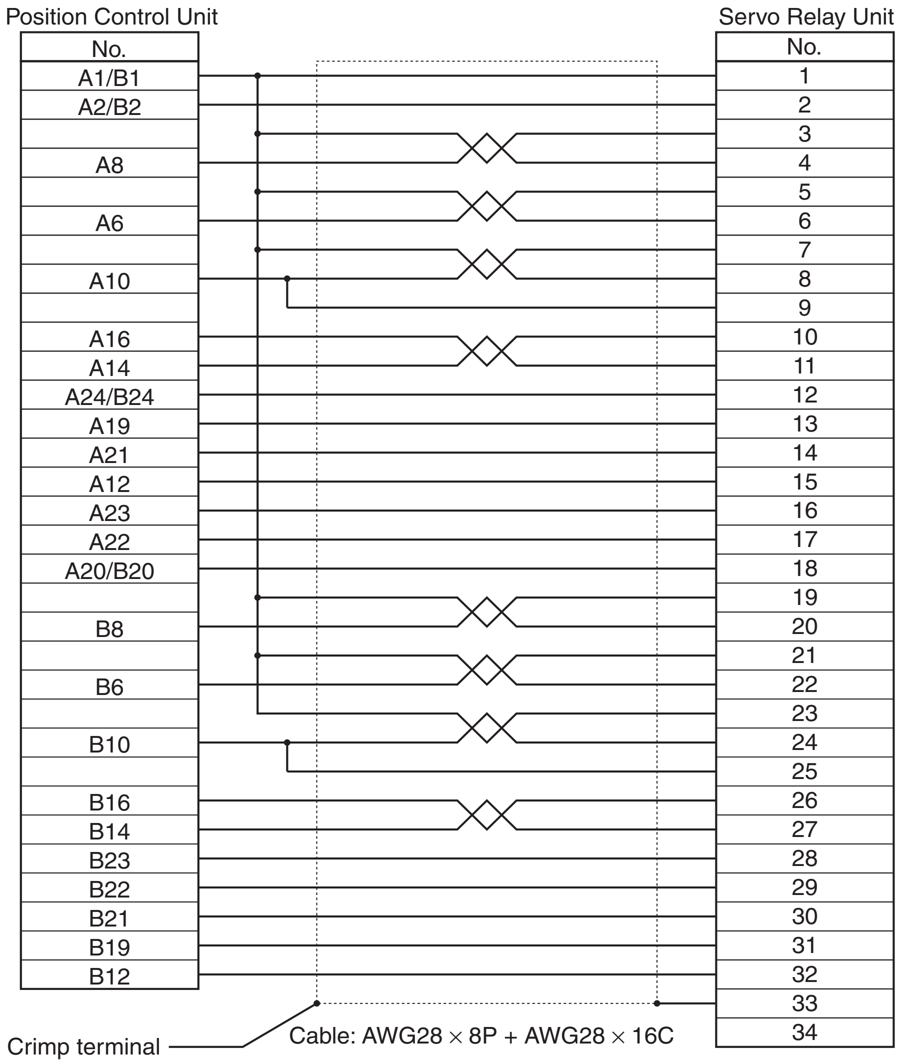
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A7 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A7 | 1 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring



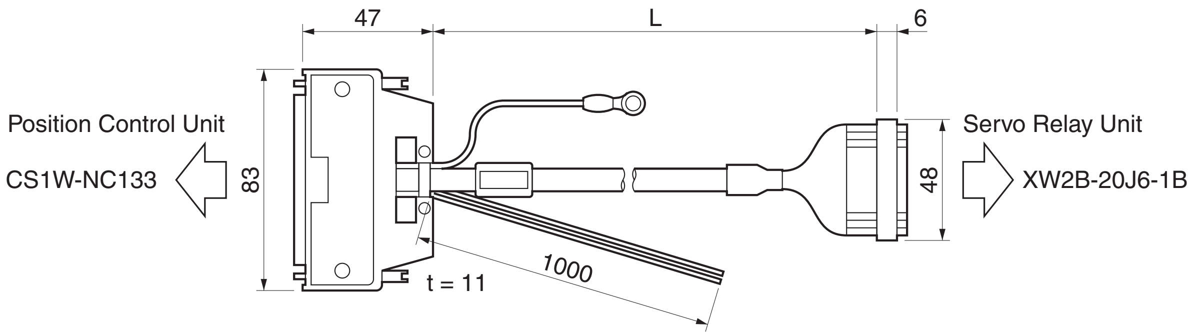
## ■ Position Control Unit Cable (XW2Z-□J-A10)

This Cable connects a Position Control Unit (CS1W-NC133) to a Servo Relay Unit (XW2B-20J6-1B).

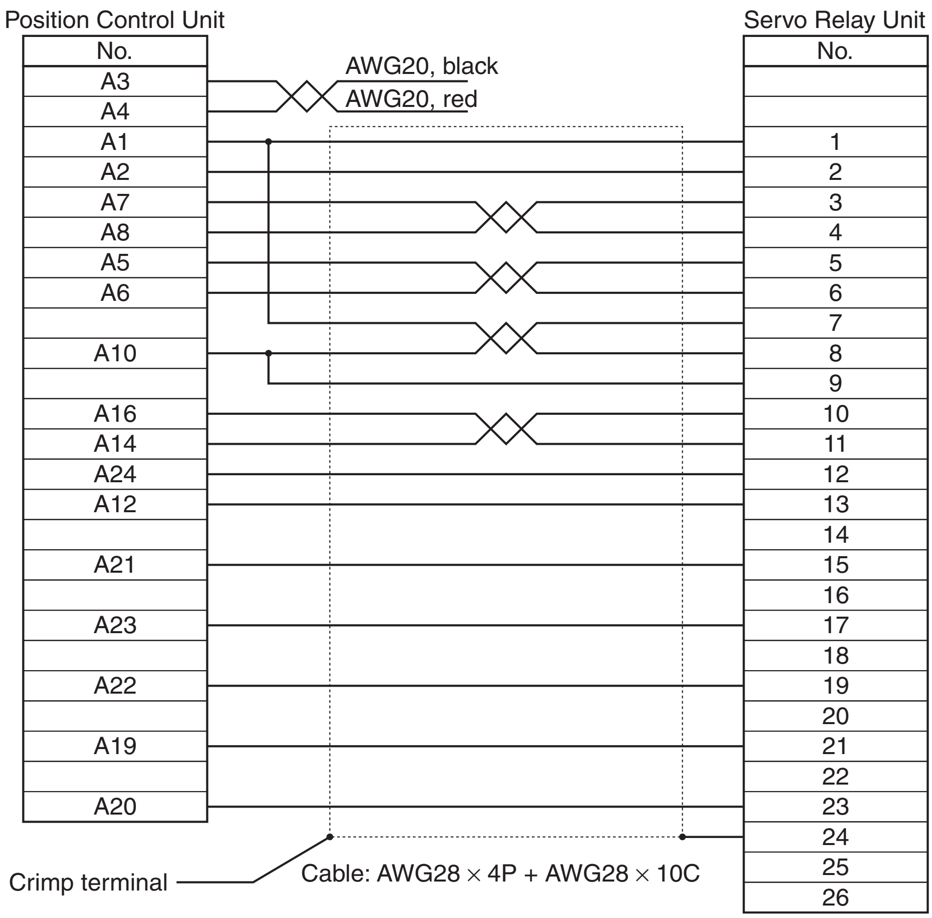
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A10 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A10 | 1 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring



## ■ Position Control Unit Cable (XW2Z-□J-A11)

This Cable connects a Position Control Unit (CS1W-NC233/433) to a Servo Relay Unit (XW2B-40J6-2B).

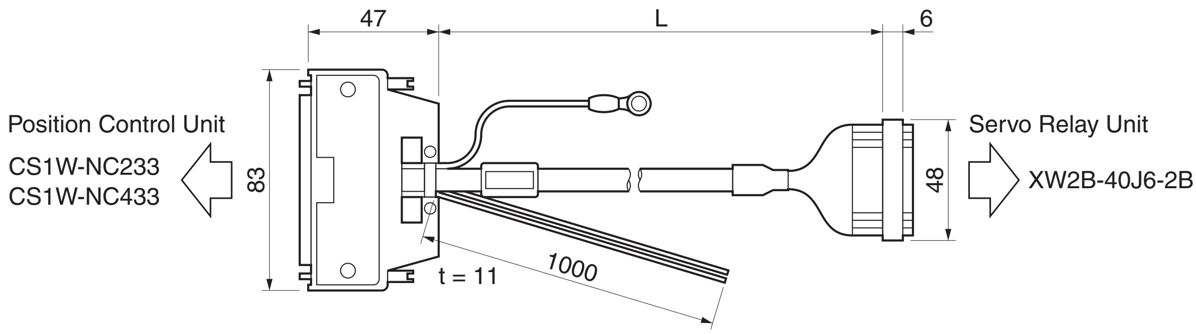
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A11 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A11 | 1 m | | Approx. 0.2 kg |

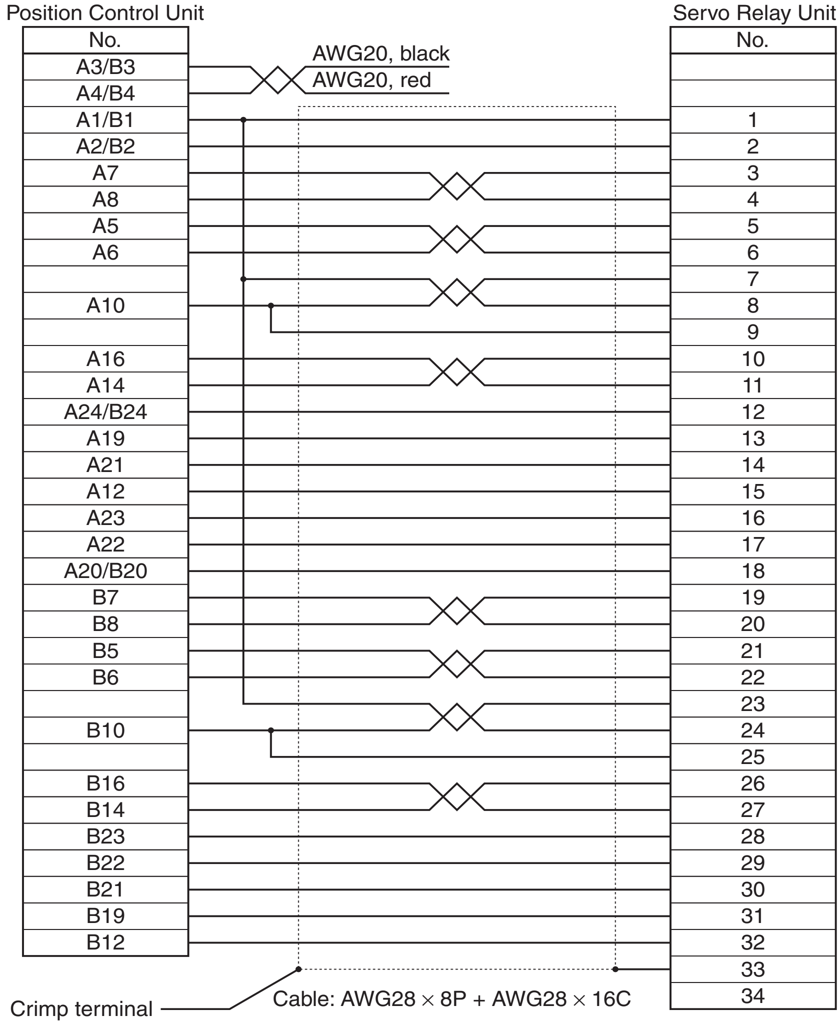




### Connection Configuration and External Dimensions




### Wiring



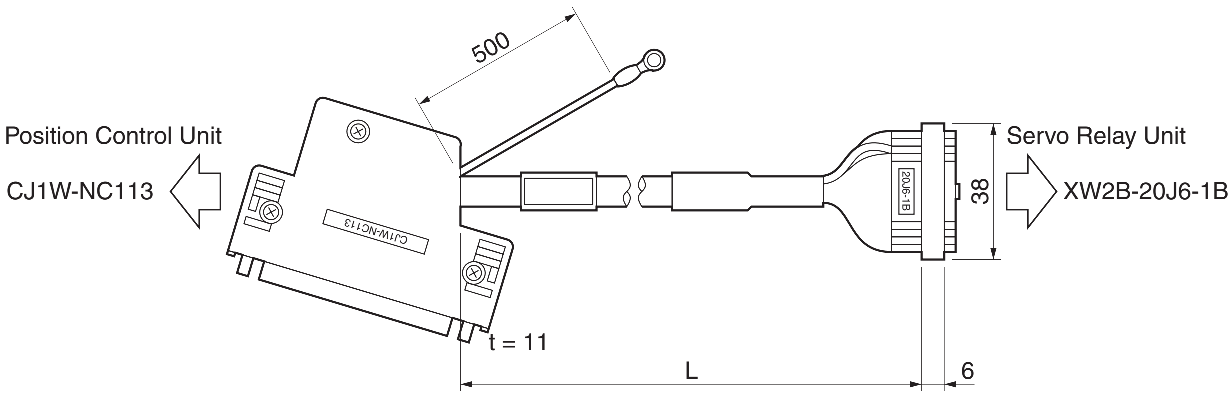
## ■ Position Control Unit Cable (XW2Z-□J-A14)

This Cable connects a Position Control Unit (CJ1W-NC113) to a Servo Relay Unit (XW2B-20J6-1B).

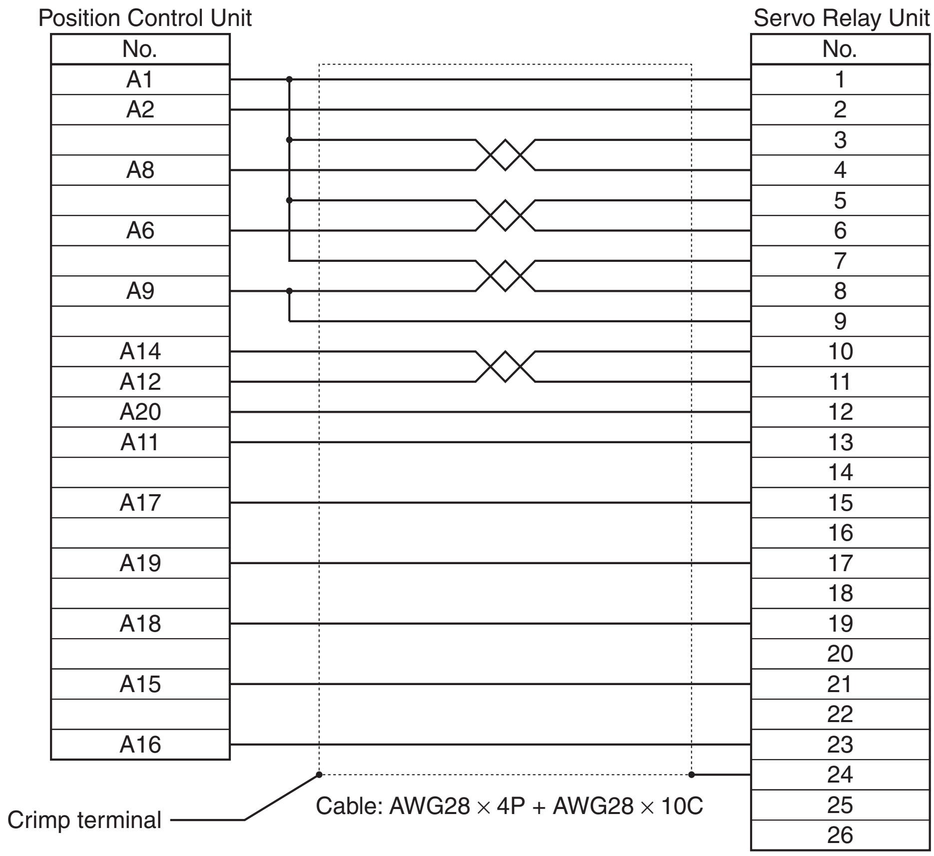
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A14 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A14 | 1 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring



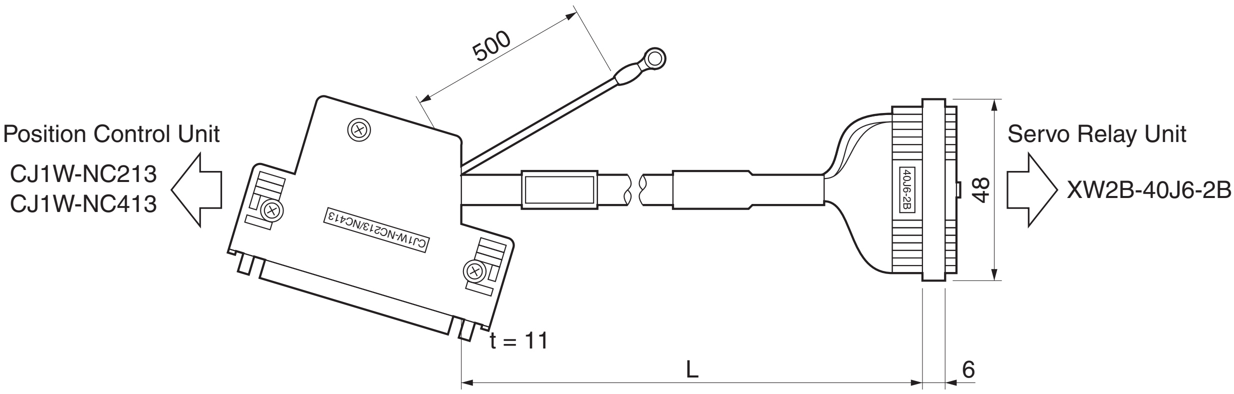
## ■ Position Control Unit Cable (XW2Z-□J-A15)

This Cable connects a Position Control Unit (CJ1W-NC213/413) to a Servo Relay Unit (XW2B-40J6-2B).

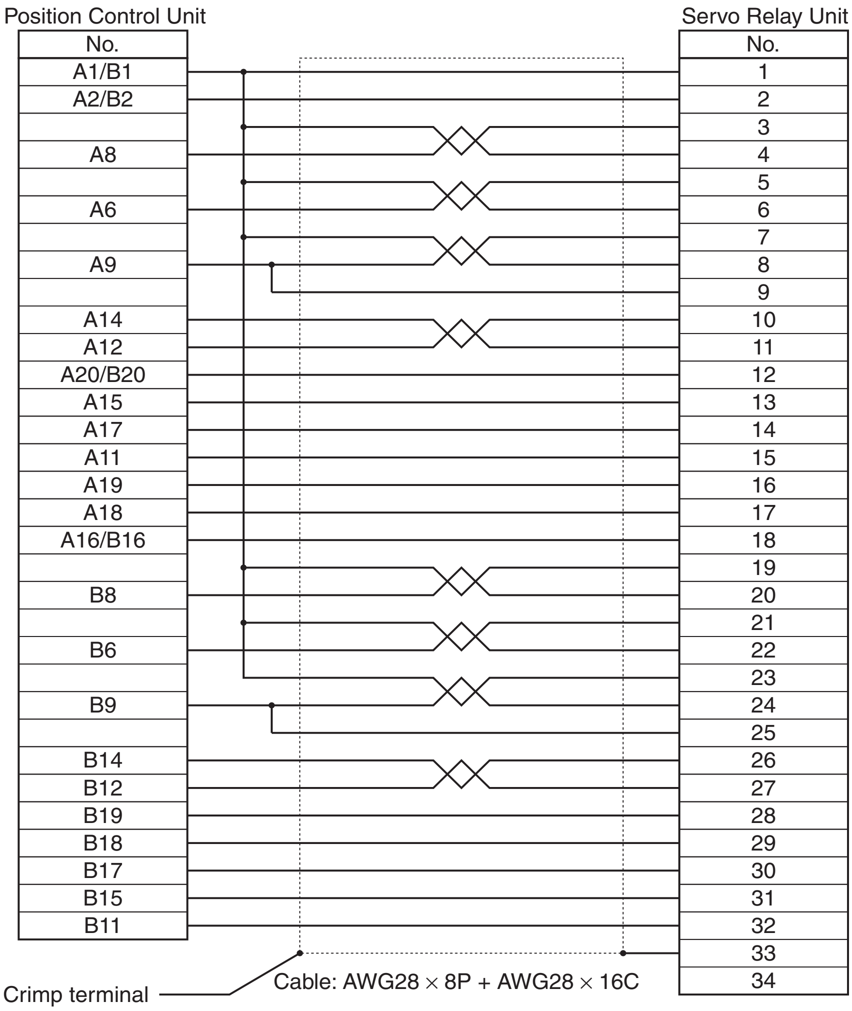
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A15 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A15 | 1 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring



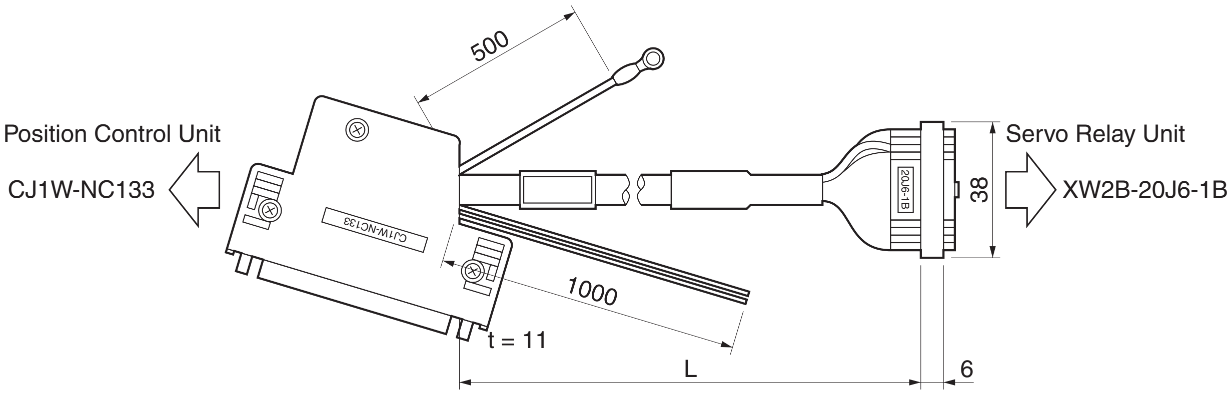
## ■ Position Control Unit Cable (XW2Z-□J-A18)

This Cable connects a Position Control Unit (CJ1W-NC133) to a Servo Relay Unit (XW2B-20J6-1B).

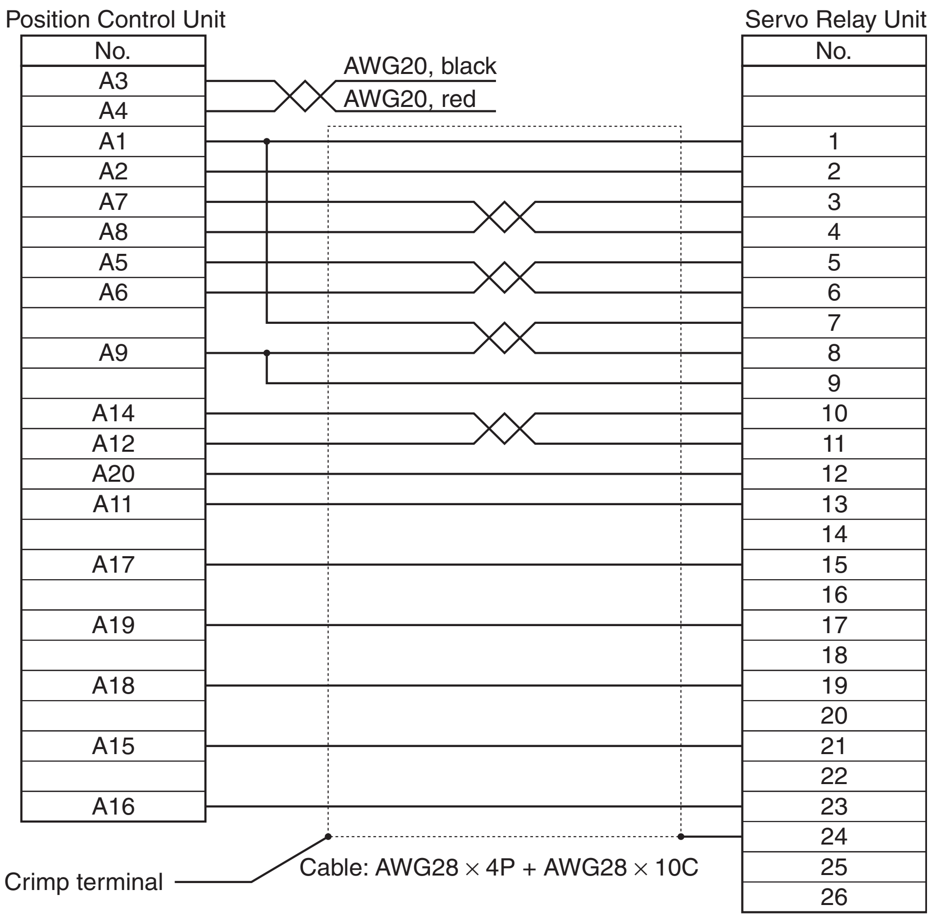
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A18 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A18 | 1 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring



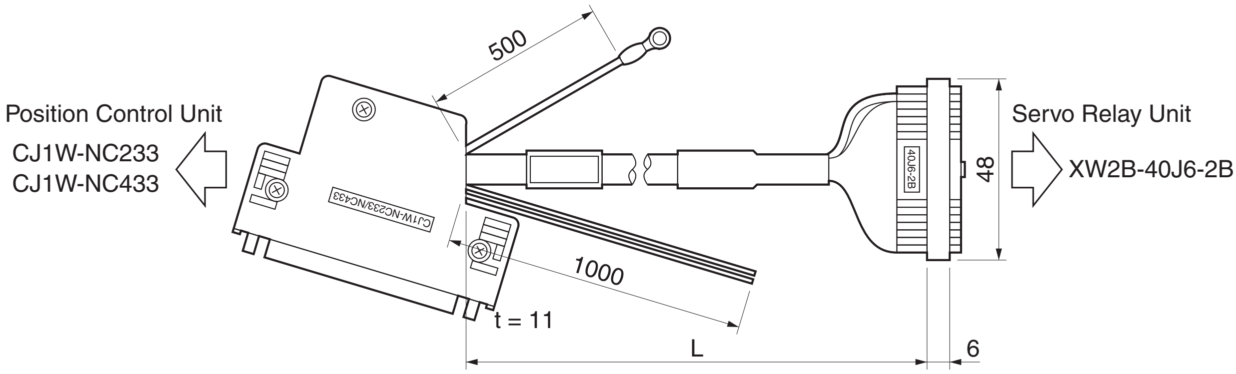
## ■ Position Control Unit Cable (XW2Z-□J-A19)

This Cable connects a Position Control Unit (CJ1W-NC233/433) to a Servo Relay Unit (XW2B-40J6-2B).

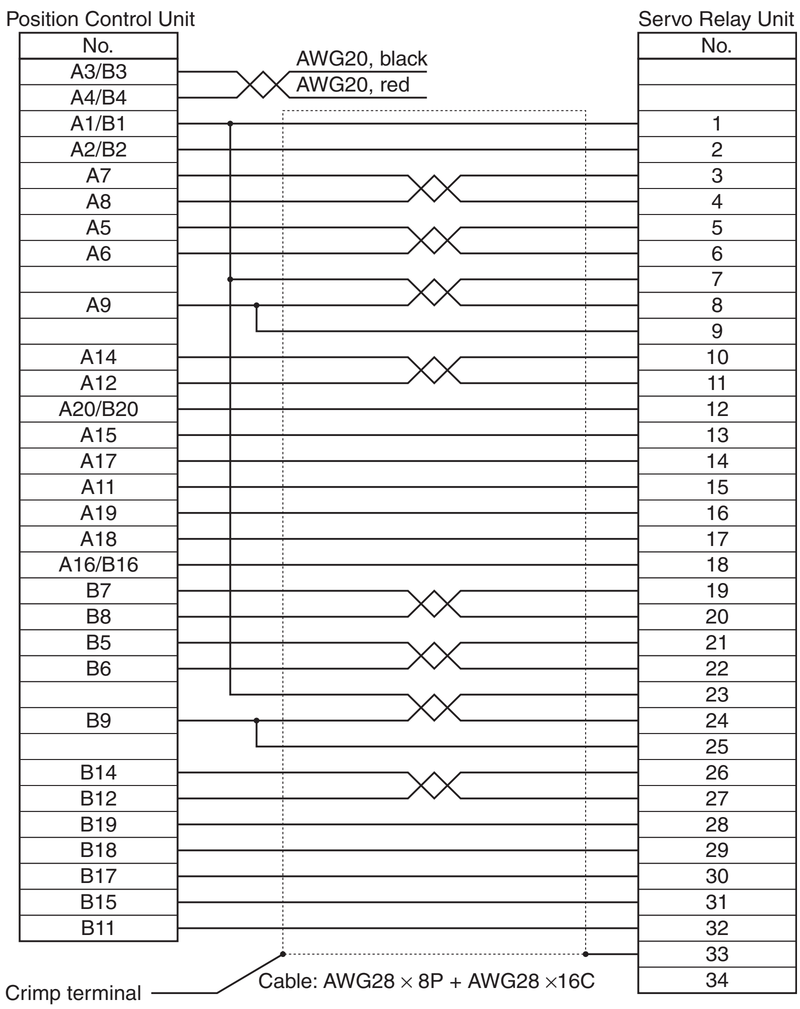
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A19 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A19 | 1 m | | Approx. 0.2 kg |

### Connection Configuration and External Dimensions




### Wiring



## ■ Position Control Unit Cable (XW2Z-□J-A33)

This Cable connects a Programmable Controller (CJ1M-CPU21/CPU22/CPU23) to a Servo Relay Unit (XW2B-20J6-8A, XW2B-40J6-9A).

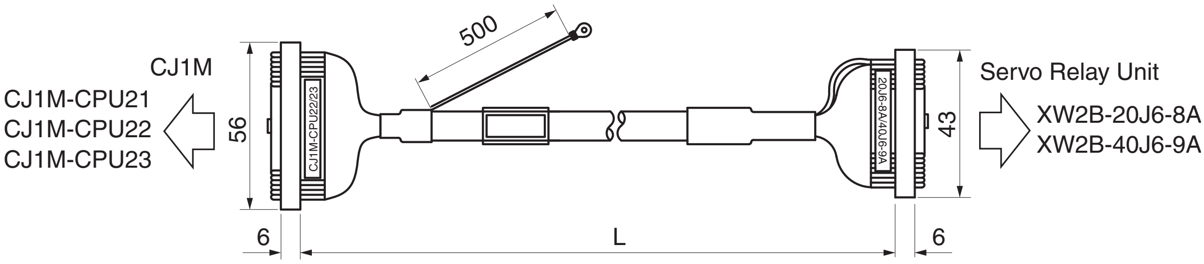
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A33 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A33 | 1 m | | Approx. 0.2 kg |

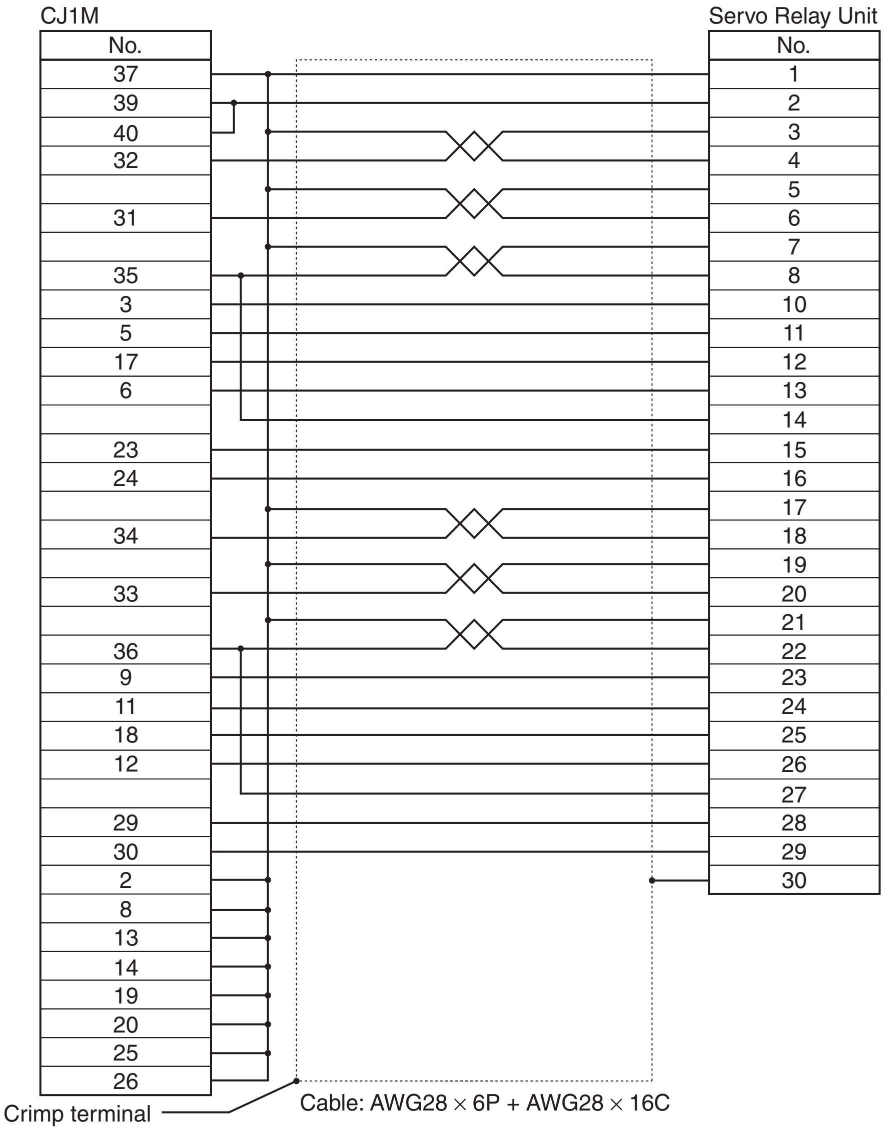
3



### Connection Configuration and External Dimensions




### Wiring



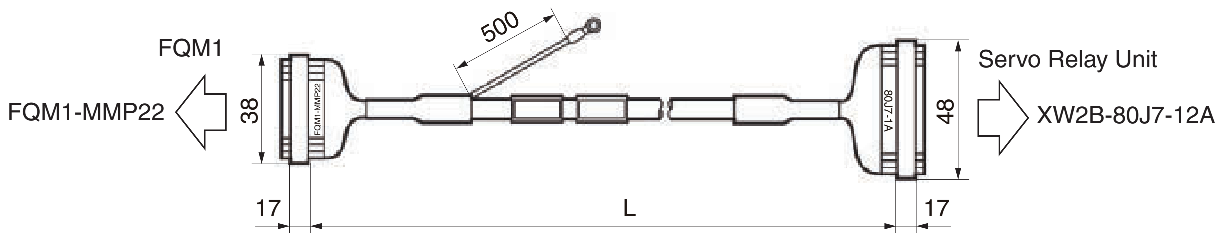
## ■ Position Control Unit Cable (XW2Z-□J-A28)

This Cable connects the general-purpose I/O connector of a Flexible Motion Controller (FQM1-MMP22) to a Servo Relay Unit (XW2B-80J7-12A).

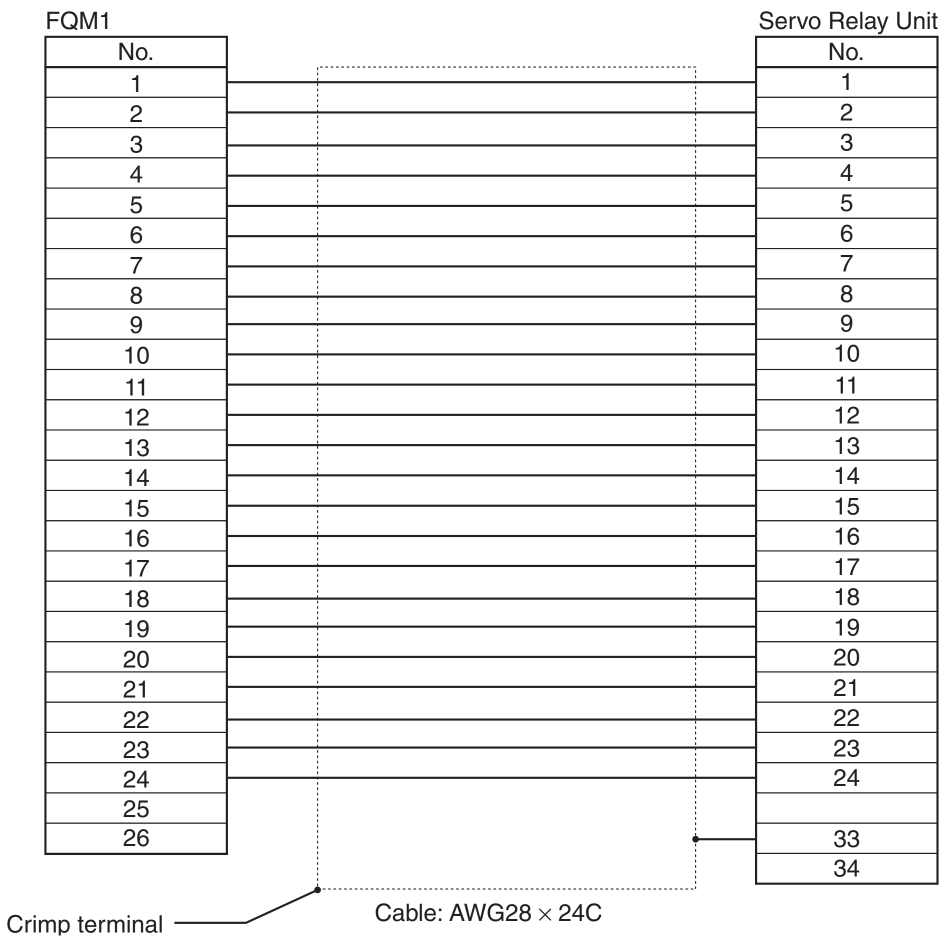
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A28 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A28 | 1 m | | Approx. 0.2 kg |
| XW2Z-200J-A28 | 2 m | | Approx. 0.3 kg |

### Connection Configuration and External Dimensions




### Wiring



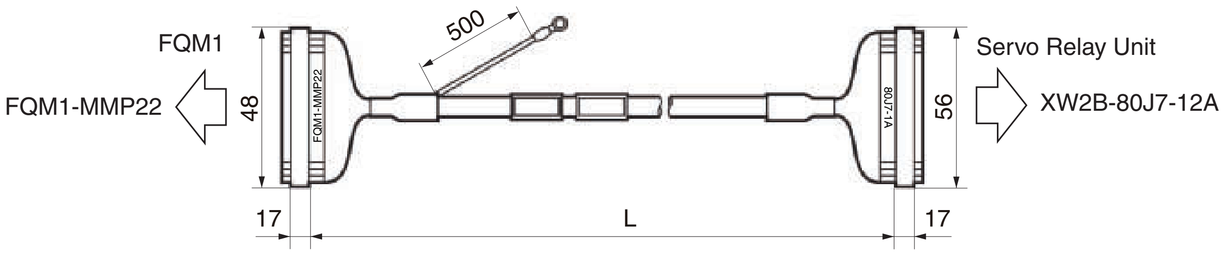
## ■ Position Control Unit Cable (XW2Z-□J-A30)

This Cable connects the special I/O connector of a Flexible Motion Controller (FQM1-MMP22) to a Servo Relay Unit (XW2B-80J7-12A).

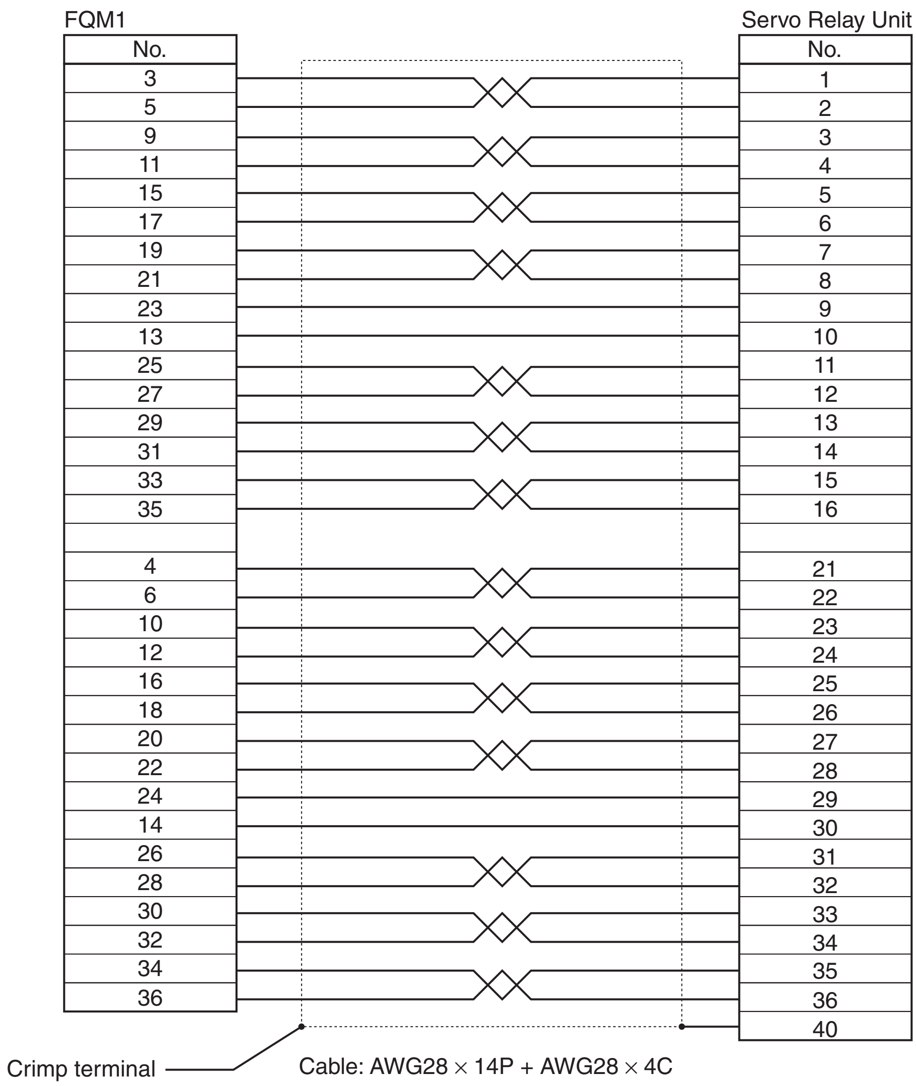
### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-050J-A30 | 50 cm | 10.0 dia. | Approx. 0.1 kg |
| XW2Z-100J-A30 | 1 m | | Approx. 0.2 kg |
| XW2Z-200J-A30 | 2 m | | Approx. 0.3 kg |

### Connection Configuration and External Dimensions




### Wiring



# 3-5 Parameter Unit Specifications

The Parameter Unit is required for parameter setting and monitoring for the Servo Drive.

## R88A-PR02G Hand-held Parameter Unit

### ■ General Specifications

| Item | Specifications |
|---|---|
| Operating ambient temperature<br>Operating ambient humidity | 0 to 55°C<br>90% RH max. (with no condensation) |
| Storage ambient temperature<br>Storage ambient humidity | −20 to 80°C<br>90% RH max. (with no condensation) |
| Operating and storage atmosphere | No corrosive gases |
| Vibration resistance | 5.9 m/s$^2$ max. |

### ■ Performance Specifications

| Item | | Specifications |
|---|---|---|
| Type | | Hand-held |
| Cable length | | 1.5 m |
| Connectors | | Mini DIN 8P MD connector |
| Display | | 7-segment LED |
| External dimensions | | 62 (W) × 114 (H) × 15 (D) mm |
| Weight | | Approx. 0.1 kg (including cable) |
| Communications specifications | Standard | RS-232 |
| | Communications method | Asynchronous (ASYNC) |
| | Baud rate | 9,600 bps |
| | Start bits | 1 bit |
| | Data | 8 bits |
| | Parity | None |
| | Stop bits | 1 bit |

# 3-6 External Regeneration Resistors Specifications

Refer to *4-4 Regenerative Energy Absorption* to ensure correct use of External Regeneration Resistors.

## ■ R88A-RR08050S/-RR080100S/-RR22047

| Model | Resis-tance | 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 250 × 250, Thickness: 3.0 | Operating temperature: 150°C±5%, NC contact, Rated output: 30 VDC, 50 mA max. |
| R88A-RR080100S | 100 Ω | 80 W | 20 W | Aluminum 250 × 250, Thickness: 3.0 | Operating temperature: 150°C±5%, NC contact, Rated output: 30 VDC, 50 mA max. |
| R88A-RR22047S | 47 Ω | 220 W | 70 W | Aluminum 350 × 350, Thickness: 3.0 | Operating temperature: 170°C±5%, NC contact, Rated output: 250 VAC, 0.2 A max. |

# 3-7 Reactor Specifications

A Reactor is connected to the Servo Drive as a harmonic current control measure. Select a model matching the Servo Drive to be used.



## ■ Specifications

| Reactor type | Specifications | | | |
|---|---|---|---|---|
| | Model | Rated current (A) | Inductance (mH) | Weight (kg) |
| Single-phase Reactors | 3G3AX-DL2002 | 1.6 A | 21.4 mH | 0.8 kg |
| | 3G3AX-DL2004 | 3.2 A | 10.7 mH | 1.0 kg |
| | 3G3AX-DL2007 | 6.1 A | 6.75 mH | 1.3 kg |
| Three-phase Reactor | 3G3AX-AL2025 | 10 A | 2.8 mH | 2.8 kg |

# 3-8 EMC Filter Specifications

## Specifications

| Applicable Servo Drive | Filter Model | Rated current | Leakage Current | Rated Voltage |
|---|---|---|---|---|
| R7D-BP01H | R7A-FIB104-RE | 4 A | 3.5 mA | 230 VAC |
| R7D-BP02HH | | | | |
| R7D-BP04H | | | | |

# Chapter 4

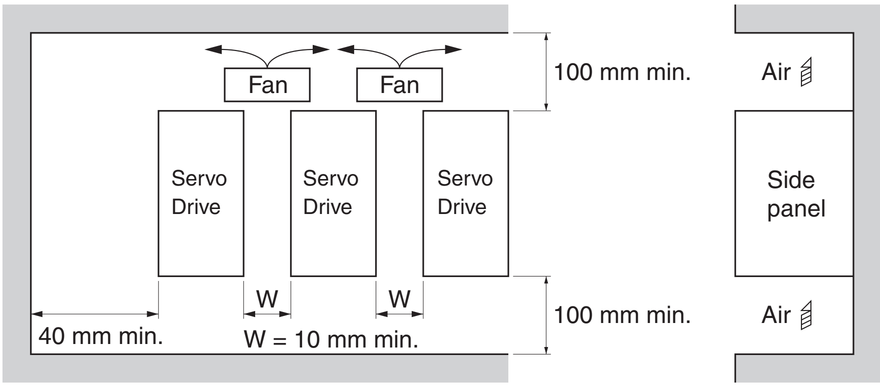
# System Design

# 4-1 Installation Conditions

## Servo Drives

### ■ Space around Drives

- Install Servo Drives according to the dimensions shown in the following illustration to ensure proper heat dispersion and convection inside the panel. Also if the Servo Drives are installed side by side, install a fan for air circulation to prevent uneven temperatures from developing inside the panel.




### ■ Mounting Direction

- Mount the Servo Drives in a direction (perpendicular) so that the model number can be seen properly.

### ■ Operating Environment

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

  Ambient operating temperature: 0 to 55°C (Take into account temperature rises in the individual Servo Drives themselves.)
  Ambient operating humidity: 90% RH max. (with no condensation)
  Atmosphere: No corrosive gases.

## ■ Ambient Temperature Control

- Servo Drives should be operated in environments in which there is minimal temperature rise to maintain a high level of reliability.
- Temperature rise in any Unit installed in a closed space, such as a control box, will cause the Servo Drive's ambient temperature to rise. Use a fan or air conditioner to prevent the Servo Drive's ambient temperature from exceeding 55°C.
- Servo Drive surface temperatures may rise to as much as 30°C above the ambient temperature. Use heat-resistant materials for wiring, and keep its distance from any devices or wiring that are sensitive to heat.
- The service life of a Servo Drive is determined by the temperature around the internal electrolytic capacitors. The service life of an electrolytic capacitor is affected by a drop in electrostatic capacity and an increase in internal resistance, which can result in overvoltage alarms, malfunctioning due to noise, and damage to individual elements.
- If a Servo Drive is operated at the ambient temperature of 55°C with the rated torque output and rated rotation speed, its service life is expected to be approximately 28,000 hours (excluding axial-flow fan). A drop of 10°C in the ambient temperature will double the expected service life.

## ■ Keeping Foreign Objects Out of Units

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

## Servomotors

### ■ Operating Environment

- The environment in which the Servomotor is operated must meet the following conditions. Operating the Servomotor outside of the following ranges may result in malfunction of the Servomotor.

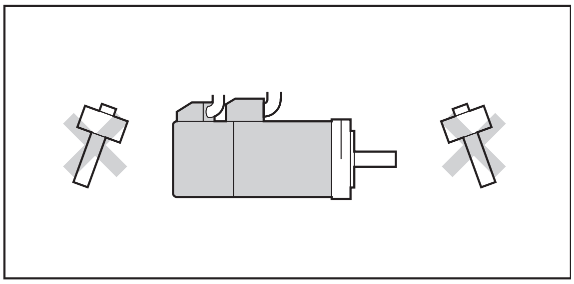
  Ambient operating temperature: 0 to 40°C
  Ambient operating humidity: 85% RH max. (with no condensation)
  Atmosphere: No corrosive gases.





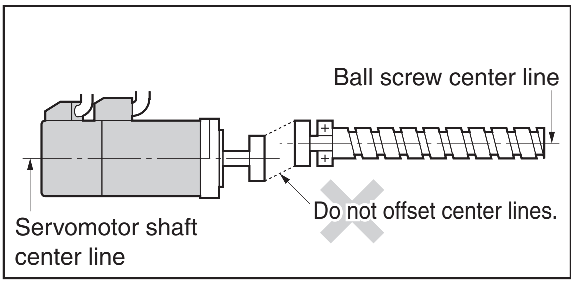
### ■ Impact and Load

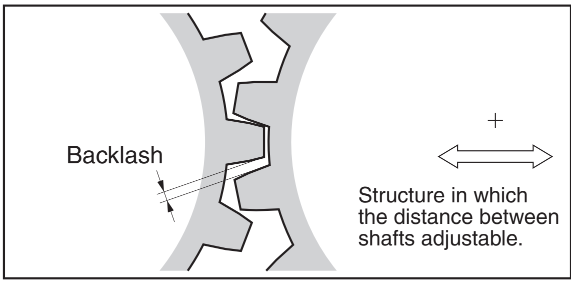
- The Servomotor is resistant to impacts of up to 98 m/s$^2$. Do not apply heavy impacts or loads during transportation, installation, or removal.
- When transporting, hold the Servomotor body itself, and do not hold the Encoder, Cable, or connector areas. Doing so may damage the Servomotor.
- Always use a pulley remover to remove pulleys, couplings, or other objects from the shaft.
- Secure cables so that there is no impact or load placed on the cable connector areas.

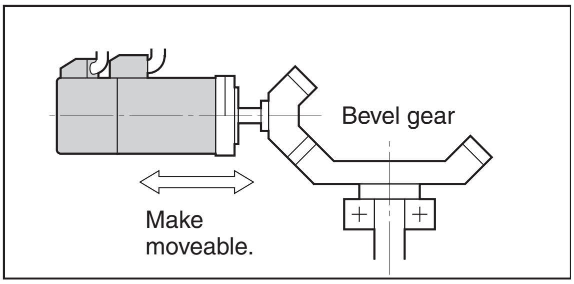


### ■ Connecting to Mechanical Systems

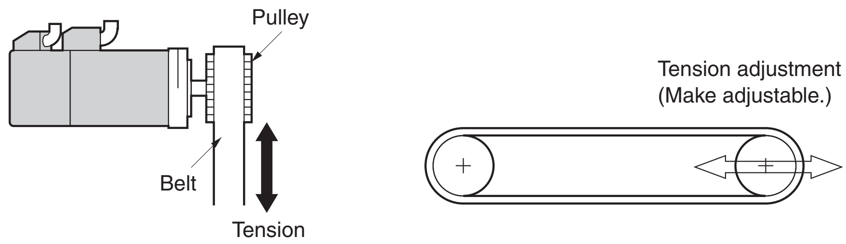
- The axial loads for Servomotors are specified in *Characteristics* on page 3-17. If an axial load greater than that specified is applied to a Servomotor, it will reduce the service life of the motor bearings and may break the motor shaft.
- When connecting to a load, use couplings that can sufficiently absorb mechanical eccentricity and declination.
- For spur gears, an extremely large radial load may be applied depending on the gear precision. Use spur gears with a high degree of precision (for example, JIS class 2: normal line pitch error of 6 μm max. for a pitch circle diameter of 50 mm).
- If the gear precision is not adequate, allow backlash to ensure that no radial load is placed on the motor shaft.
- Bevel gears will cause a load to be applied in the thrust direction depending on the structural precision, the gear precision, and temperature changes. Provide appropriate backlash or take other measures to ensure that a thrust load larger than the specified level is not applied.
- Do not put rubber packing on the flange surface. If the flange is mounted with rubber packing, the motor flange may crack under the tightening force.



- When connecting to a V-belt or timing belt, consult the maker for belt selection and tension.
- A radial load twice the belt tension will be placed on the motor shaft. Do not allow a radial load exceeding specifications to be placed on the motor shaft. If an excessive radial load is applied, the motor shaft and bearings may be damaged.
- Set up a structure so that the belt tension can be adjusted.








## Water and Drip Resistance

- The protective structure for the Servomotors is as follows:
  IP65 (except for through-shaft parts and cable outlets)

## Oil Seal Part Number

With G-Series Servomotors, an oil seal can be installed afterwards.
Refer to the installation instructions from NOK Corporation for information on installing the oil seal.
The following oil seals are not standard NOK products. Check with the manufacturer.
The expected service life of the oil seals is approximately 5,000 hours, but the actual life depends on the application conditions and environment.

| Motor model | Shaft diameter (mm) | Outer diameter (mm) | Width (mm) | Material (rubber) | NOK part number (SC type) |
|---|---|---|---|---|---|
| R88M-G05030H | 8.9 | 17 | 4 | A435 | BC6646-E0 |
| R88M-G10030L/H | 8.9 | 17 | 4 | A435 | BC6646-E0 |
| R88M-G20030L/H | 14 | 28 | 4 | A435 | BC5102-E1 |
| R88M-G40030H | 14 | 28 | 4 | A435 | BC5102-E1 |
| R88M-GP10030L/H | 8.9 | 22 | 4 | A435 | BC5101-E1 |
| R88M-GP20030L/H | 14 | 28 | 4 | A435 | BC5102-E1 |
| R88M-GP40030H | 14 | 28 | 4 | A435 | BC5102-E1 |

## Other Precautions

- Take measures to protect the shaft from corrosion.
  The shafts are coated with anti-corrosion oil when shipped, but anti-corrosion oil or grease should also be applied when connecting the shaft to a load.

**⚠ WARNING**

Do not apply commercial power directly to the Servomotor.
Doing so may result in fire.

Do not dismantle or repair the product.
Doing so may result in electric shock or injury.

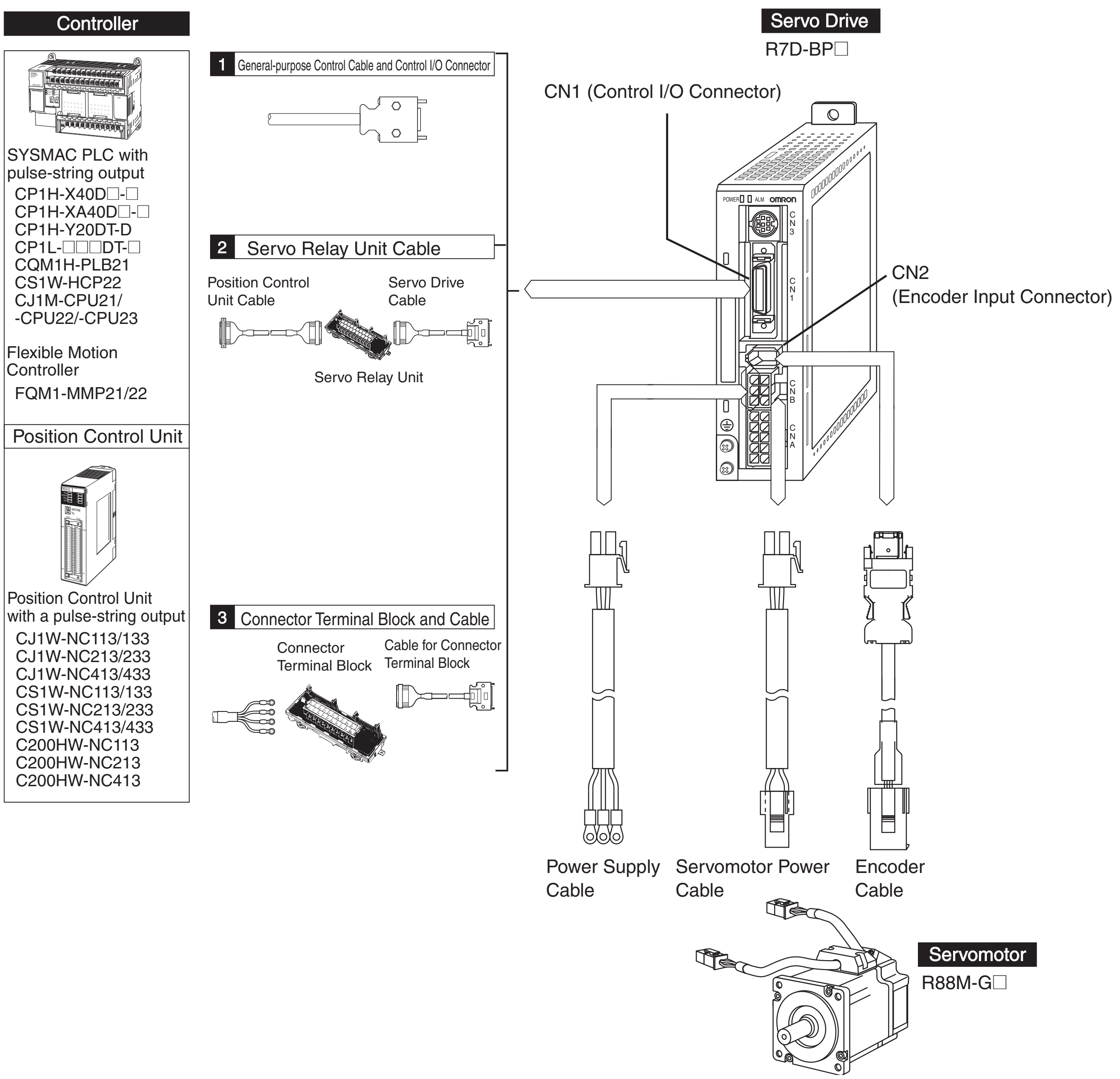
# 4-2 Wiring

## Connecting Cables

This section shows the types of connecting cables used in a SMARTSTEP 2 system.
A wide selection of cables are available when using Position Control Units for OMRON SYSMAC PLCs, making it easy to wire a servo system.



### ■ System Configuration



## Selecting Connecting Cables

### ■ Encoder Cables (CN2)

| Name | Model | Comments |
|---|---|---|
| Global Cables for Encoders (Non-Flexible Cables) | R88A-CRGB□□□C | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |
| Global Cables for Encoders (Flexible Cables) | R88A-CRGB□□□CR | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |
| European Cables for Encoders (Flexible and Shielded Cables) | R88A-CRGB□□□CR-E | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |

### ■ Servomotor Power Cables (CNB)

| Name | Model | Comments |
|---|---|---|
| Global Cables for Servomotor Power (Non-Flexible Cables) | R7A-CAB□□□S | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |
| Global Cables for Servomotor Power (Flexible Cables) | R7A-CAB□□□SR | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |
| European Cables for Servomotor Power (Flexible and Shielded Cables) | R88A-CAGA□□□SR-E | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |

### ■ Brake Cables

| Name | Model | Comments |
|---|---|---|
| Global Cables for Brakes (Non-Flexible Cables) | R88A-CAGA□□□B | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |
| Global Cables for Brakes (Flexible Cables) | R88A-CAGA□□□BR | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |
| European Cables for Brakes (Flexible Cables) | R88A-CAGA□□□BR-E | The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). |

## ■ Power Supply Cables (CNA)

| Name | Model | Comments |
|---|---|---|
| Cable for Single-phase Power Supply Input | R7A-CLB002S2 | Cable length: 2 m |
| Cable for Three-phase Power Supply Input | R7A-CLB002S3 | Cable length: 2 m |
| Cable for Connecting to External Regeneration Resistor | R7A-CLB002RG | Cable length: 2 m |

## ■ Servo Relay Units and Cables

Select the Servo Relay Unit and Cable according to the model of the Position Control Unit to be used.

<table>
<tr><th>Position Control Unit</th><th colspan="2">Position Control Unit Cable</th><th>Servo Relay Unit</th><th>Servo Drive Cable</th></tr>
<tr><td>CJ1W-NC133</td><td colspan="2">XW2Z-□□□J-A18</td><td>XW2B-20J6-1B</td><td rowspan="15">XW2Z-□□□J-B29</td></tr>
<tr><td>CJ1W-NC233</td><td colspan="2" rowspan="2">XW2Z-□□□J-A19</td><td rowspan="2">XW2B-40J6-2B</td></tr>
<tr><td>CJ1W-NC433</td></tr>
<tr><td>CS1W-NC133</td><td colspan="2">XW2Z-□□□J-A10</td><td>XW2B-20J6-1B</td></tr>
<tr><td>CS1W-NC233</td><td colspan="2" rowspan="2">XW2Z-□□□J-A11</td><td rowspan="2">XW2B-40J6-2B</td></tr>
<tr><td>CS1W-NC433</td></tr>
<tr><td>CJ1W-NC113</td><td colspan="2">XW2Z-□□□J-A14</td><td>XW2B-20J6-1B</td></tr>
<tr><td>CJ1W-NC213</td><td colspan="2" rowspan="2">XW2Z-□□□J-A15</td><td rowspan="2">XW2B-40J6-2B</td></tr>
<tr><td>CJ1W-NC413</td></tr>
<tr><td>CS1W-NC113</td><td colspan="2" rowspan="2">XW2Z-□□□J-A6</td><td rowspan="2">XW2B-20J6-1B</td></tr>
<tr><td>C200HW-NC113</td></tr>
<tr><td>CS1W-NC213</td><td colspan="2" rowspan="4">XW2Z-□□□J-A7</td><td rowspan="4">XW2B-40J6-2B</td></tr>
<tr><td>CS1W-NC413</td></tr>
<tr><td>C200HW-NC213</td></tr>
<tr><td>C200HW-NC413</td></tr>
<tr><td>CJ1M-CPU21</td><td colspan="2" rowspan="3">XW2Z-□□□J-A33</td><td rowspan="3">XW2B-20J6-8A<br>XW2B-40J6-9A<br>(for 2 axes)</td><td rowspan="3">XW2Z-□□□J-B32</td></tr>
<tr><td>CJ1M-CPU22</td></tr>
<tr><td>CJ1M-CPU23</td></tr>
<tr><td rowspan="2">FQM1-MMP22</td><td>General-purpose I/O Cable</td><td>XW2Z-□□□J-A28</td><td rowspan="2">XW2B-80J7-12A</td><td rowspan="2">XW2Z-□□□J-B30</td></tr>
<tr><td>Special I/O Cable</td><td>XW2Z-□□□J-A30</td></tr>
<tr><td>CQM1H-PLB21</td><td colspan="2" rowspan="2">XW2Z-□□□J-A3</td><td rowspan="2">XW2B-20J6-3B</td><td rowspan="2">XW2Z-□□□J-B29</td></tr>
<tr><td>CQM1-CPU43-V1</td></tr>
</table>

**Note 1.** The cable length is indicated in the boxes of the model number (□□□). Position Control Unit cables come in two lengths: 0.5 m and 1 m (some 2-m cables are also available). Servo Drive Cables also come in two lengths: 1 m and 2 m. For information on cable lengths, refer to *Accessories and Cables* on page 2-4.

**Note 2.** Two Servo Drive Cables are required if 2-axis control is performed using one Position Control Unit.

## ■ Connector-Terminal Block Conversion Units and Cables

These Conversion Units and Cables are used for connecting to Controllers for which no specific cable is available. The Cables and Connector-Terminal Block Unit convert the Servo Drive's control I/O Connector (CN1) signals to a terminal block.

| Name | Model | Comments |
|---|---|---|
| Connector-Terminal Block Conversion Unit | XW2B-34G4 | Terminal block with M3 screws |
| | XW2B-34G5 | Terminal block with M3.5 screws |
| | XW2D-34G6 | Terminal block with M3 screws |
| Connector-Terminal Block Cable | XW2Z-□□□J-B28 | This cable is used to connect a Connector-Terminal Block Conversion Unit. The cable length is indicated in the boxes of the model number (□□□). There are two cable lengths: 1 m and 2 m. Model number example for 1-m cable: XW2Z-100J-B28 |

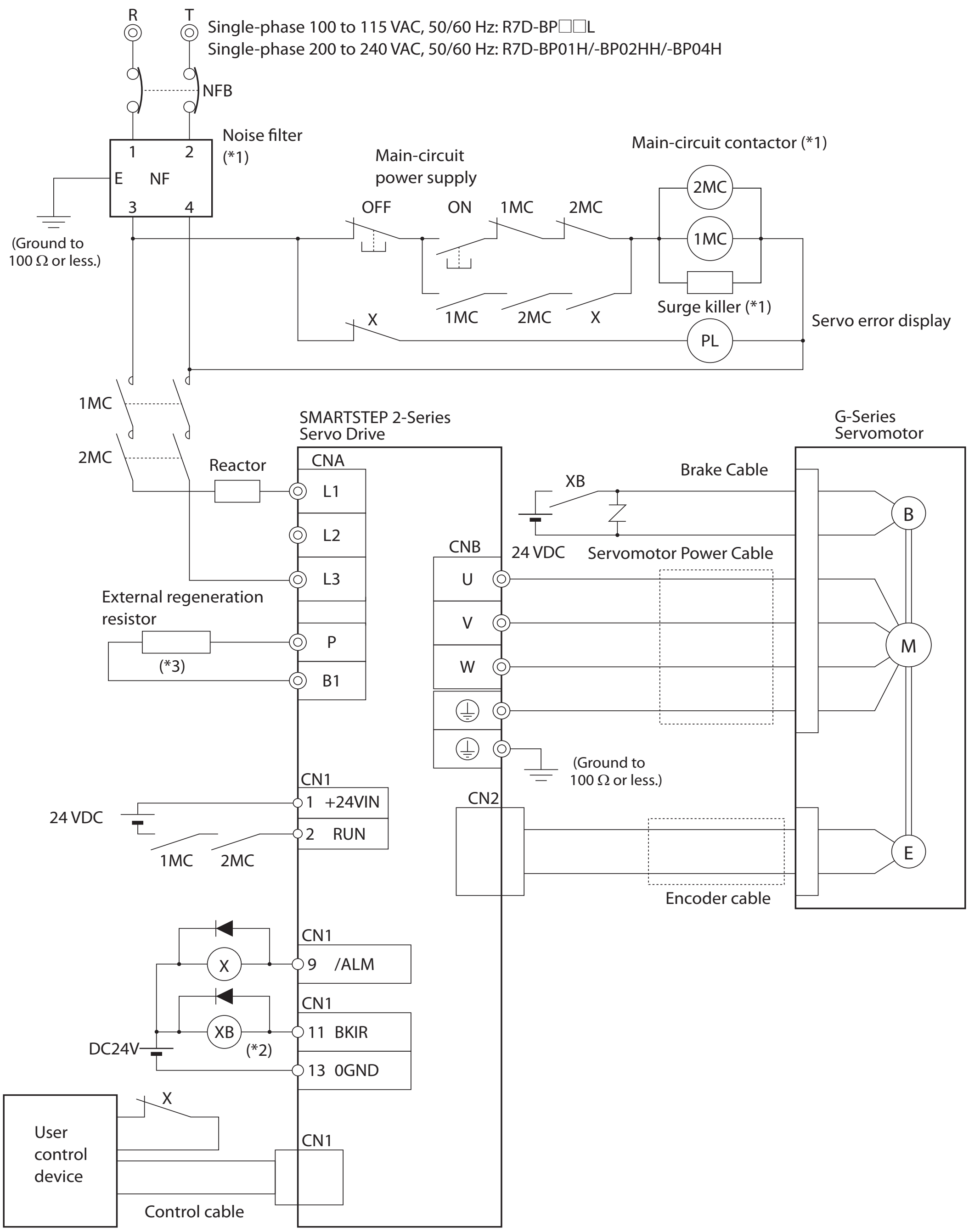
## ■ General-purpose Control Cables (CN1)

A General-purpose Control Cable is used to prepare a cable by yourself to connect to the Servo Drive’s Control I/O Connector (CN1).

| Name | Model | Comments |
|---|---|---|
| General-purpose Control Cable | R7A-CPB□□□S | One end of the cable has loose wires.<br>The □□□ digits in the model number indicate the cable length (1 m or 2 m).<br>Example model number for 1-m cable:<br>R7A-CPB001S |

## Peripheral Device Connection Examples

### ■ R7D-BPA5L/-BP01L/-BP02L/-BP01H/-BP02HH/-BP04H

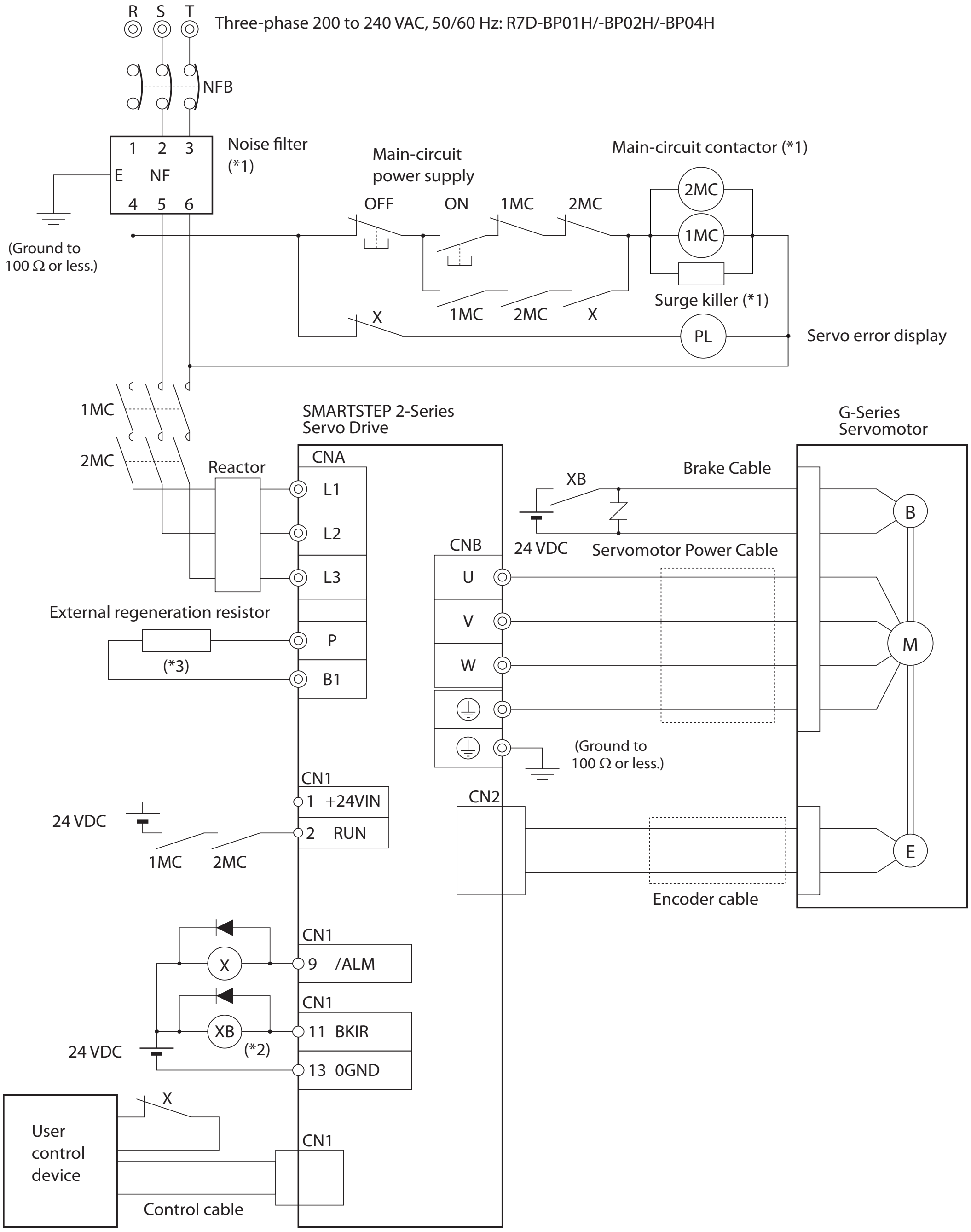



*1. Recommended products are listed in *4-3 Wiring Conforming to EMC Directives*.
*2. Recommended Relay: OMRON G7T Relay (24-VDC model)
*3. An External Regeneration Resistor can be connected.
Connect this resistor if the regenerative energy exceeds regeneration absorption capacity in the Servo Drive. (Refer to *Servo Drive Regenerative Energy Absorption Capacity* on page 4-30.).

**Note 1.** The dynamic brake operates when the main circuit power supply or the control circuit power supply is turned OFF.

Note 2. When turning OFF the main circuit power supply, turn OFF the RUN Command Input (RUN) signal at the same time.

## ■ R7D-BP01H/-BP02H/-BP04H




*1. Recommended products are listed in *4-3 Wiring Conforming to EMC Directives*.
*2. Recommended Relay: OMRON G7T Relay (24-VDC model)
*3. An External Regeneration Resistor can be connected.
Connect this resistor if the regenerative energy exceeds regeneration absorption capacity in the Servo Drive. (Refer to *Servo Drive Regenerative Energy Absorption Capacity* on page 4-30.)

**Note 1.** The dynamic brake operates when the main circuit power supply or the control circuit power supply is turned OFF.

Note 2. When turning OFF the main circuit power supply, turn OFF the RUN Command Input (RUN) signal at the same time.

4

System Design

## Main Circuit Wiring

When wiring a Terminal Block, use proper wire sizes, grounding systems, and take into account anti-noise characteristics.

### ■ Terminal Names and Functions

| Signal | Name | Function |
|---|---|---|
| L1 | Main circuit power supply input | Single-phase 100 to 115 VAC (85 to 126 VAC), 50/60 Hz<br>Single-phase/three-phase 200 to 230 VAC (170 to 264 VAC), 50/60 Hz |
| L2 | | |
| L3 | | |
| P | External regeneration resistor connection terminals | If regenerative energy is high, connect an External Regeneration Resistor. |
| B1 | | |
| ⏚ | Frame ground | This is the ground terminal. Ground to 100 Ω or less. |

### ■ Terminal Wire Sizes

| Item | | Unit | R7D-BPA5L | R7D-BP01L | R7D-BP02L |
|---|---|---|---|---|---|
| Power supply capacity | | kVA | 0.16 | 0.25 | 0.42 |
| Main circuit power supply input (L1, L2) | Rated current | A(rms) | 1.4 | 2.2 | 3.7 |
| | Wire size | | AWG18 | | |
| External Regeneration Resistor connection (+, −) | Wire size | | AWG18 | | |
| Servomotor connection terminal (U, V, W,⏚)*1 | Rated current | A(rms) | 1.0 | 1.6 | 2.5 |
| | Maximum momentary current | A(rms) | 3.3 | 5.1 | 7.5 |
| | Wire size | | AWG18 | | |
| Frame ground | Wire size | | AWG14 min. | | |
| | Screw size | --- | M4 | | |
| | Torque | N·m | 1.2 to 1.4 | | |
| No-fuse breaker or fuse capacity*2 | | A(rms) | 3 | 5 | 7 |

*1. Connect an OMRON Servomotor Power Cable to the Servomotor connection terminals.

*2. Use a no fuse breaker or a surge withstand fuse. The maximum inrush current is 20 A.

<table>
<tr><th colspan="2">Item</th><th>Unit</th><th>R7D-BP01H</th><th>R7D-BP02HH</th><th>R7D-BP02H</th><th>R7D-BP04H</th></tr>
<tr><td colspan="2">Power supply capacity</td><td>kVA</td><td>0.27<br>(0.3)*1</td><td>0.35</td><td>0.42</td><td>0.69<br>(0.77)*1</td></tr>
<tr><td rowspan="2">Main circuit power supply input (L1, L2)</td><td>Rated current</td><td>A(rms)</td><td>0.7<br>(1.5)*1</td><td>1.6</td><td>1.1</td><td>1.8<br>(3.5)*1</td></tr>
<tr><td>Wire size</td><td></td><td colspan="4">AWG18</td></tr>
<tr><td>External Regeneration Resistor connection (+, −)</td><td>Wire size</td><td></td><td colspan="4">AWG18</td></tr>
<tr><td rowspan="3">Servomotor connection terminal (U, V, W,⏚)*2</td><td>Rated current</td><td>A(rms)</td><td>1.0</td><td>1.6</td><td>1.6</td><td>2.5</td></tr>
<tr><td>Maximum momentary current</td><td>A(rms)</td><td>3.3</td><td>4.9</td><td>4.9</td><td>7.8</td></tr>
<tr><td>Wire size</td><td></td><td colspan="4">AWG18</td></tr>
<tr><td rowspan="3">Frame ground</td><td>Wire size</td><td></td><td colspan="4">AWG14 min.</td></tr>
<tr><td>Screw size</td><td>---</td><td colspan="4">M4</td></tr>
<tr><td>Torque</td><td>N·m</td><td colspan="4">1.2 to 1.4</td></tr>
<tr><td colspan="2">No-fuse breaker or fuse capacity*3</td><td>A(rms)</td><td colspan="2">3</td><td>2</td><td>5<br>(7)*1</td></tr>
</table>

*1. Values in parentheses ( ) are for using single-phase 200 V.

*2. Connect an OMRON Servomotor Power Cable to the Servomotor connection terminals.

*3. Use a no fuse breaker or a surge withstand fuse. The maximum inrush current is 20 A.

## ■ Wire Size and Allowable Current (Reference)

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

### 600-V Heat-resistant Vinyl Wire (HIV)

<table>
<tr><th rowspan="2">AWG size</th><th rowspan="2">Nominal cross-sectional area (mm²)</th><th rowspan="2">Configuration (wires/mm²)</th><th rowspan="2">Conductive resistance (Ω/km)</th><th colspan="3">Allowable current (A) for ambient temperature</th></tr>
<tr><th>30°C</th><th>40°C</th><th>50°C</th></tr>
<tr><td>20</td><td>0.5</td><td>19/0.18</td><td>39.5</td><td>6.6</td><td>5.6</td><td>4.5</td></tr>
<tr><td>---</td><td>0.75</td><td>30/0.18</td><td>26.0</td><td>8.8</td><td>7.0</td><td>5.5</td></tr>
<tr><td>18</td><td>0.9</td><td>37/0.18</td><td>24.4</td><td>9.0</td><td>7.7</td><td>6.0</td></tr>
<tr><td>16</td><td>1.25</td><td>50/0.18</td><td>15.6</td><td>12.0</td><td>11.0</td><td>8.5</td></tr>
<tr><td>14</td><td>2.0</td><td>7/0.6</td><td>9.53</td><td>23</td><td>20</td><td>16</td></tr>
</table>

# 4-3 Wiring Conforming to EMC Directives

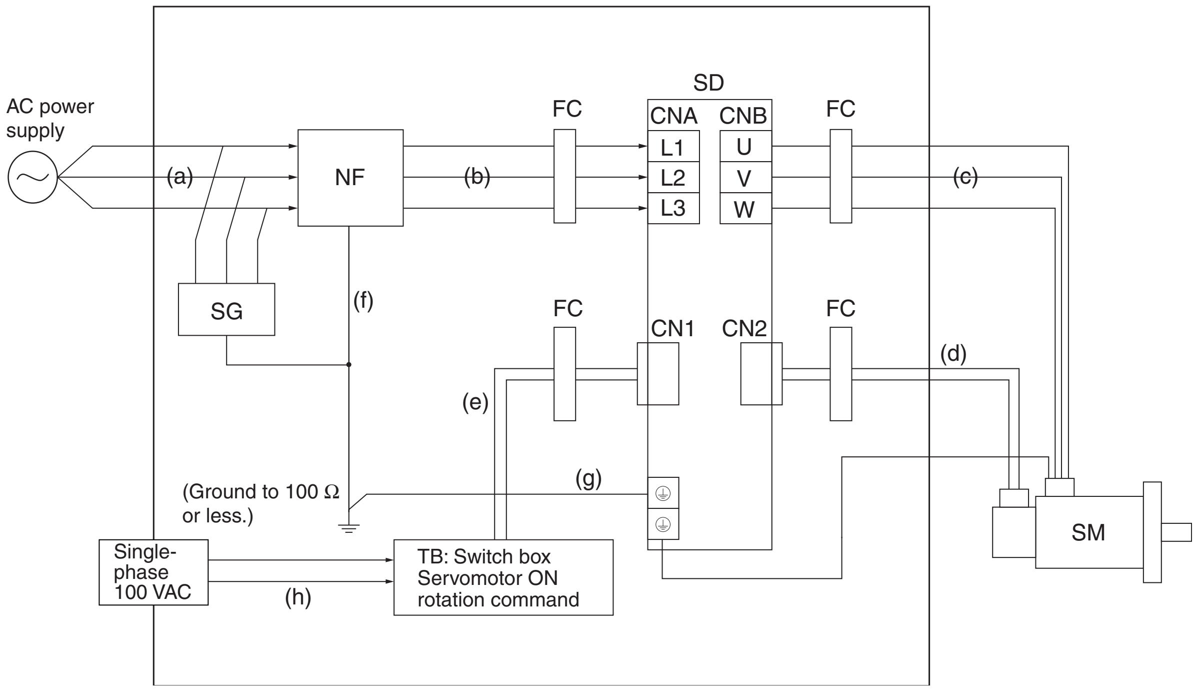
Conformance to the EMC Directives (EN55011 class A group 1 (EMI) and EN61000-6-2 (EMS)) can be ensured by wiring under the conditions described below. These conditions are for conformance of the SMARTSTEP-2 products to the EMC Directives.
EMC-related performance of these products, however, will vary depending on the configuration, wiring, and other conditions of the equipment in which the products are installed. The EMC conformance of the system as a whole must be confirmed by the customer.

The following are the requirements for EMC Directive conformance.

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



## Wiring Method




**Note** For models with a single-phase power supply input (R7D-BP□□L/-BP01H/BP02HH/-BP04H), the main input power supply terminals are L1 and L3.

- Ground the motor's frame to the machine ground when the motor is on a movable shaft.
- 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.
- No-fuse breakers, surge absorbers, and noise filters 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

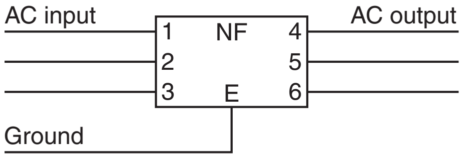
| Symbol | Name | Manufacturer | Model | Remarks |
|---|---|---|---|---|
| SG | Surge absorber | Okaya Electric Industries Co., Ltd. | RAV781BWZ-4 | Single-phase 100 VAC |
| | | | RAV781BXZ-4 | Three-phase 200 VAC |
| NF | Noise filter | Okaya Electric Industries Co., Ltd. | 3SUP-HQ10-ER-6 | Single-phase 100/200 VAC |
| SD | Servo Drive | OMRON Corp. | R7D-BP02L | Single-phase 100 VAC |
| | | | R7D-BP04H | Three-phase 200 VAC |
| SM | Servomotor | OMRON Corp. | R88M-G20030L | 100 VAC |
| | | | R88M-G40030H | 200 VAC |
| FC | Clamp core | TDK | ZACT305-1330 | |
| TB | Switch box | | | |

## ■ Cable Details

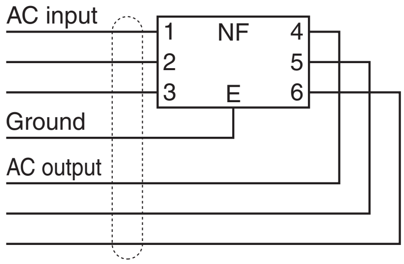
| Symbol | Supplies from | Connects to | Cable name | Length | Remarks | Shielded | Ferrite |
|---|---|---|---|---|---|---|---|
| (a) | AC power supply | Noise filter | Power supply line | 2 m | Single-phase 100 VAC | No | No |
| | | | | 3 m | Three-phase 200 VAC | No | No |
| (b) | Noise filter | Servo Drive | Power supply line | 2 m | --- | No | Yes |
| (c) | Servo Drive | Servomotor | Power cable | 20 m | --- | Yes | Yes |
| (d) | Servo Drive | Servomotor | Encoder cable | 20 m | --- | No | Yes |
| (e) | Switch box | Servo Drive | I/O cable | 1 m | --- | No | Yes |
| (f) | Frame ground | Noise filter | Frame ground line | 1.5 m | --- | No | No |
| (g) | Frame ground | Noise filter | Frame ground line | 1.5 m | --- | No | No |
| (h) | AC power supply | Switch box | Power supply line | 1.5 m | --- | No | No |

- 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.
- Wire the noise filter as shown at the left in the following illustration. The noise filter must be installed as close as possible to the entrance of the control box.

**Correct: Separate input and output**

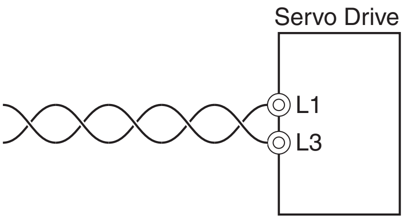



**Wrong: Noise not filtered effectively**

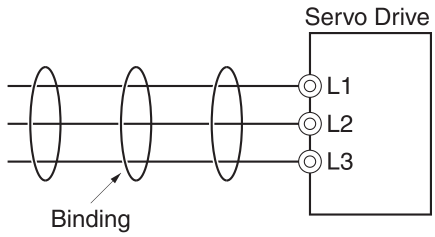



- Use twisted-pair cables for the power supply cables, or bind the cables.

**Correct: Properly twisted**




**Correct: Cables are bound.**




- Separate power supply cables and signal cables when wiring.

## Control Panel Structure

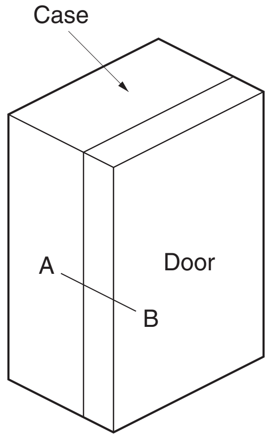
Openings in the control panel, such as holes for cables, operating panel mounting holes, and gaps around the door, may allow electromagnetic waves into the panel. To prevent this from occurring, observe the items described below when designing or selecting a control panel.

### ■ Case Structure

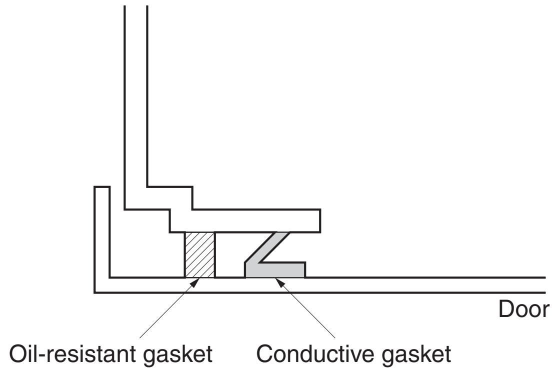
- Use a metal control panel with welded joints at the top, bottom, and sides so that the surfaces will be electrically conductive.
- If assembly is required, strip the paint off the joint areas (or mask them during painting), to make them electrically conductive.
- If gaps appear in the control box case when screws are tightened, make adjustments to prevent this from occurring.
- Do not leave any conductive part unconnected.
- Ground all Units within the case to the case itself.

## ■ Door Structure

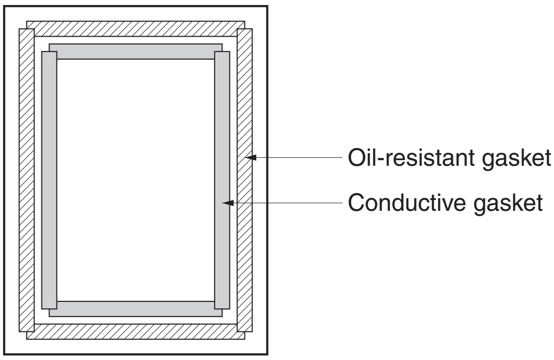
- Use a metal door.
- Use a water-draining structure where the door and case fit together, and leave no gaps. (Refer to the diagrams below.)
- Use a conductive gasket between the door and the case, as shown in the diagrams below. (Refer to the diagrams below.)
- Strip the paint off the sections of the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




Control panel




Cross-sectional view of A–B




Door (interior view)

## 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 conditions when selecting the components. For more details, contact the manufacturers directly.

### ■ No-fuse Breakers (NFB)

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



#### Maximum Input Current:

- The Servo Drive's maximum momentary output is approximately three times the rated output, and can be output for up to three seconds. Therefore, select a no-fuse breaker with an operating time of at least five seconds at 300% of the rated current. General-purpose and low-speed no-fuse breakers are generally suitable.
- Select a no-fuse-breaker with a rated current greater than the total effective load current of all the Servomotors. The rated current of the power supply input for each Servomotor is provided in *Main Circuit Wiring* on page 4-11.
- Add the current consumption of other controllers, and any other components, when selecting the NFB.

#### Inrush Current:

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

| Servo Drive model | Inrush current (A0-p) |
|---|---|
| | Main circuit power supply |
| R7D-BP Series | 20 |

## ■ Leakage Breakers

The leakage current for the Servomotor and Servo Drive combinations are given in the following table.

| R7D-BP Series | | Resistor + capacitor measurement | Clamp leak tester (measurement filter ON with HIOKI 3283) | |
|---|---|---|---|---|
| | | 5-m power cable | 5-m power cable | 20-m power cable |
| Servo Drive model | Specifications | Leakage current (mA) | Leakage current (mA) | Leakage current (mA) |
| R7D-BPA5L | Single-phase 100 V, 50 W | 0.48 | 0.08 | 0.13 |
| R7D-BP01L | Single-phase 100 V, 100 W | 0.59 | 0.09 | 0.13 |
| R7D-BP02L | Single-phase 100 V, 200 W | 0.50 | 0.10 | 0.15 |
| R7D-BP01H | Single/three-phase 200 V, 50 W | 0.91 | 0.25 | 0.37 |
| | Single/three-phase 200 V, 100 W | 1.18 | 0.18 | 0.29 |
| R7D-BP02HH | Single-phase 200 V, 200 W | 0.95 | 0.30 | 0.40 |
| R7D-BP02H | Three-phase 200 V, 200 W | 1.17 | 0.26 | 0.37 |
| R7D-BP04H | Single/three-phase 200 V, 400 W | 1.25 | 0.55 | 0.72 |

**Note 1.** The resistor plus capacitor measurement provides a guide to the leakage current level that may flow through people if the Servomotor and Servo Drive are not properly grounded. The actual value changes depending on the ambient temperature and humidity.

Note 2. The clamp leak tester measurement is the leakage current actually detected at the inverter and surge-resistant leakage breaker. Triple this value when using a general leakage breaker.

### Actual Selection

- The leakage breaker starts to detect leakage current from 50% of the rated leakage current, so provide a margin of two times.
- Also, a large amount of leakage current will flow from the noise filter. Leakage current form other Controllers should also be added to the total leakage current.
- To prevent incorrect operation due to inrush current, it is necessary to select a current value of ten times the total leakage current for uses other than surge resistance.
- Refer to the specifications from the relevant manufacturer for information on leakage breakers.

## ■ Surge Absorbers

- Use surge absorbers to absorb lightning surge voltage or abnormal voltage from power supply input lines.
- When selecting surge absorbers, take into account the varistor voltage, the allowable surge current, and the energy.
- For 200-VAC systems, use surge absorbers with a varistor voltage of 620 V.
- The surge absorbers shown in the following table are recommended.

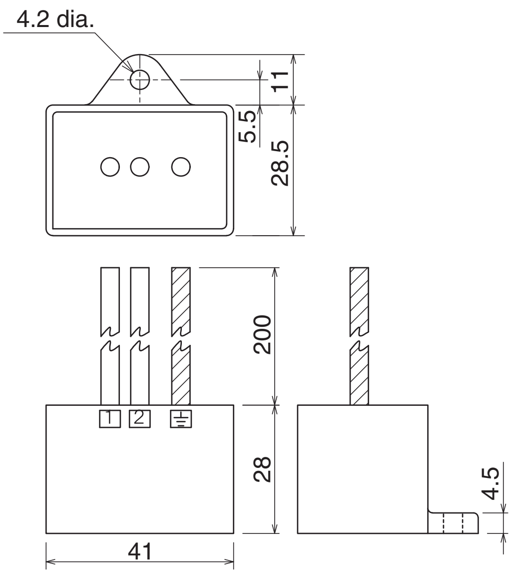
| Maker | Model | Max. limit voltage | Surge immunity | Type | Remarks |
|---|---|---|---|---|---|
| Okaya Electric Industries Co., Ltd. | R·A·V-781BWZ-4 | 700 V ±20% | 2500 A | Block | Single-phase 100/200 VAC |
| | R·A·V-781BXZ-4 | 700 V ±20% | 2500 A | | Three-phase 200 VAC |

**Note 1.** Refer to the manufacturers' documentation for operating details.

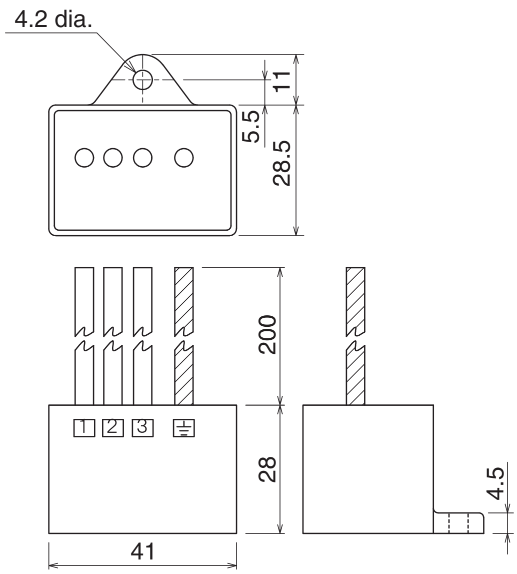
Note 2. The surge immunity is for a standard impulse current of 8/20 μs. If pulses are wide, either decrease the current or change to a larger-capacity surge absorber.

### Dimensions

Single-phase BWZ Series

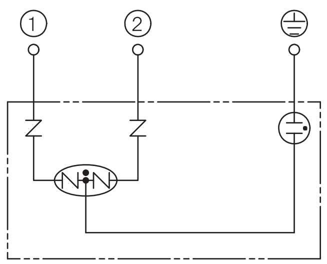



Three-phase BXZ Series

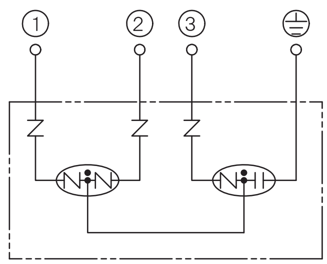



### Equalizing Circuits

Single-phase BWZ Series




Three-phase BXZ Series

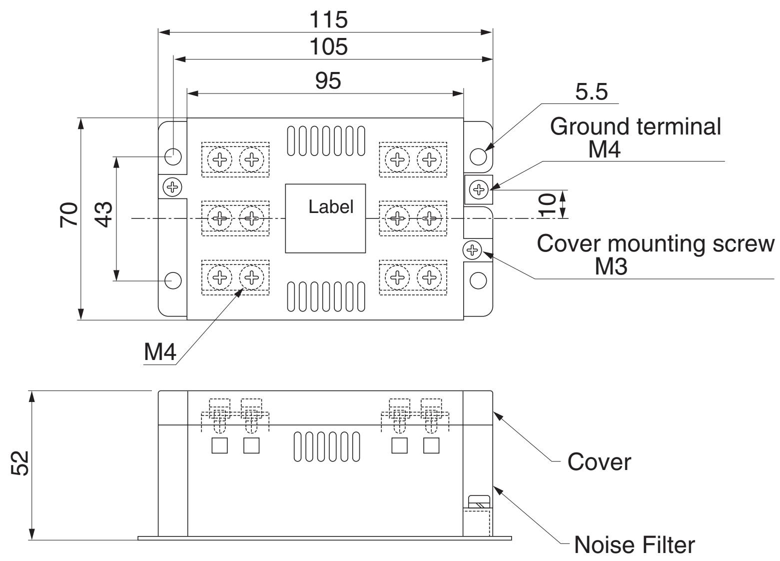


## ■ Noise Filter for the Power Supply Input

Use the following noise filter for the Servo Drive's power supply.

| Servo Drive model | Noise filter | | | | |
|---|---|---|---|---|---|
| | Model | Rated current | Rated voltage | Max. leakage current (60 Hz) | Maker |
| R7D-BP Series | 3SUP-HU10-ER-6 | 10 A | 230 VAC | 0.4 mA/phase | Okaya Electric Industries Co., Ltd. |

### Dimensions



## ■ Radio Noise Filters and Emission Noise Prevention Clamp Cores

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

| Model | Maker | Application |
|---|---|---|
| 3G3AX-ZCL2*1 | OMRON | Servo Drive output and power cable |
| ESD-R-47B*2 | NEC TOKIN | Servo Drive output and power cable |
| ZCAT3035-1330*3 | TDK | Encoder cable and I/O cable |

*1. Mainly used for 200/400 W. The maximum number of windings is three turns.

*2. Mainly used for 50/100 W. The maximum number of windings is two turns.

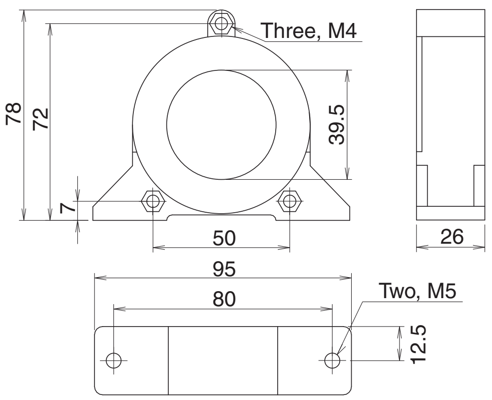
*3. Also used on the Servo Drive output power lines to comply with the EMC Directives. Only a clamp is used. This clamp can also be used to reduce noise current on a frame ground line.



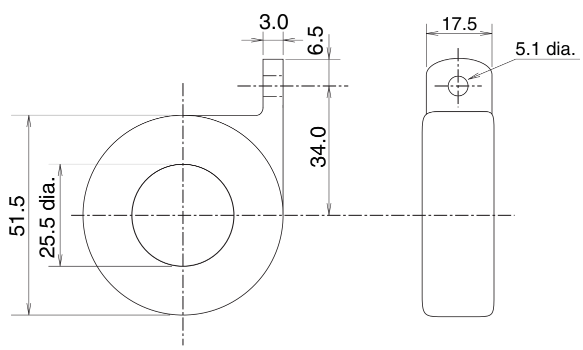


### Dimensions

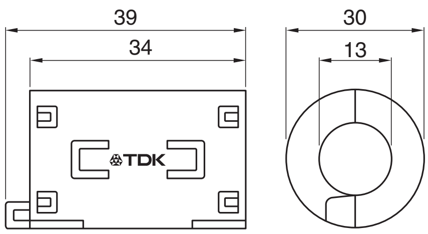
3G3AX-ZCL2




ESD-R-47B

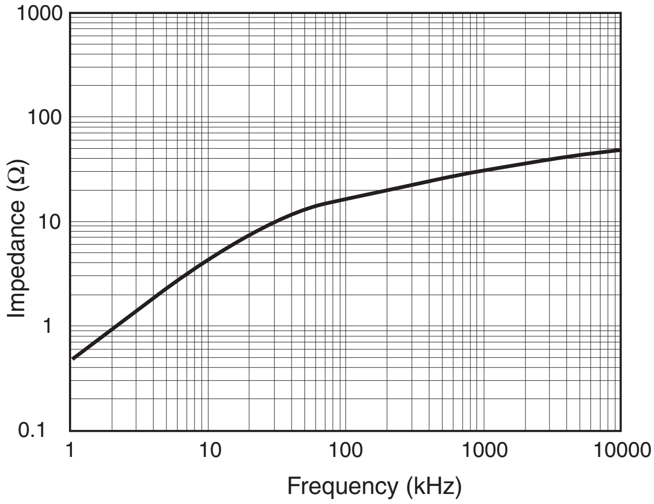



ZCAT 3035-1330

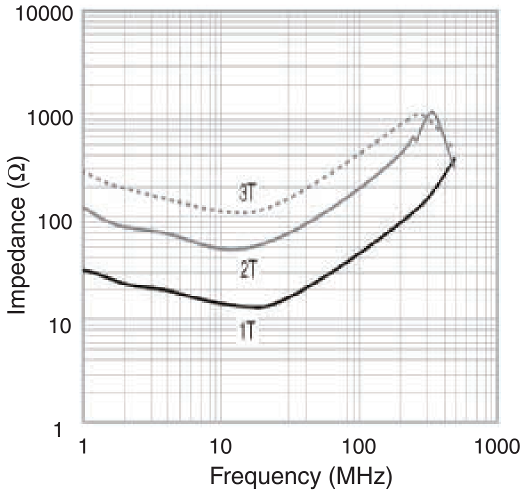


## Impedance Characteristics

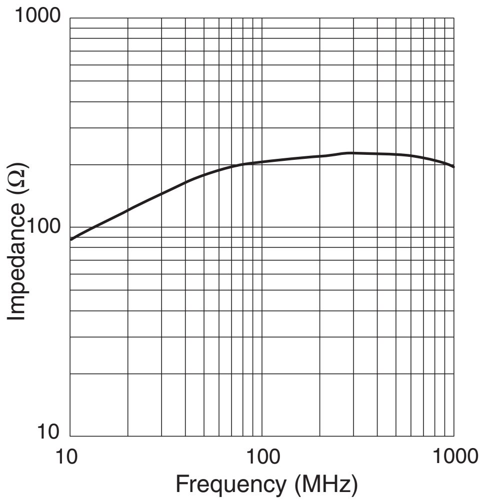
3G3AX-ZCL2




ESD-R-47B




ZCAT 3035-1330



## ■ 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 | Features | Recommended products |
|---|---|---|
| Diode | Diodes are used for relatively small loads when the reset time is not an issue, such as relays.<br>At power shutoff, the surge voltage is the lowest, but the reset time becomes longer.<br>Used for 24/48-VDC systems. | Use a fast-recovery diode with a short reverse recovery time<br>(e.g., RU2 of Sanken Electric Co., Ltd.). |
| Thyristor or varistor | Thyristors and varistors are used for loads when induction coils are large, as in electromagnetic brakes, solenoids, etc., and when reset time is an issue. The surge voltage at power shutoff is approximately 1.5 times the varistor voltage. | Select the varistor voltage as follows:<br>24 VDC system: Varistor V0 39 V<br>100 VDC system: Varistor V0 200 V<br>100 VAC system: Varistor V0 270 V<br>200 VAC system: Varistor V0 470 V |
| Capacitor + resistor | The capacitor and resistor dissipate and absorb the surge at power shutoff. The reset time can be shortened by selecting the appropriate capacitor and resistance values. | Okaya Electric Industries Co., Ltd.<br>XEB12002 0.2 μF - 120 Ω<br>XEB12003 0.3 μF - 120 Ω |

**Note** Thyristors and varistors are made by the following companies. Refer to manufacturers' documentation for details on these components.
Thyristors: Ishizuka Electronics Co.
Varistors: Ishizuka Electronics Co., Matsushita Electric Industrial Co.

## ■ Contactors

- Select contactors based on the circuit's inrush current and the maximum momentary phase current.
- The Servo Drive inrush current is covered in the preceding explanation of no-fuse breaker selection, and the maximum momentary phase current is approximately twice of the rated current.
- The following table shows the recommended contactors.

| Maker | Model | Rated current | Coil voltage |
|---|---|---|---|
| OMRON | J7L-09-22200 | 11 A | 200 VAC |
| | J7L-12-22200 | 13 A | 200 VAC |
| | J7L-18-22200 | 18 A | 200 VAC |
| | J7L-32-22200 | 26 A | 200 VAC |

## ■ Improving Encoder Cable Noise Resistance

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

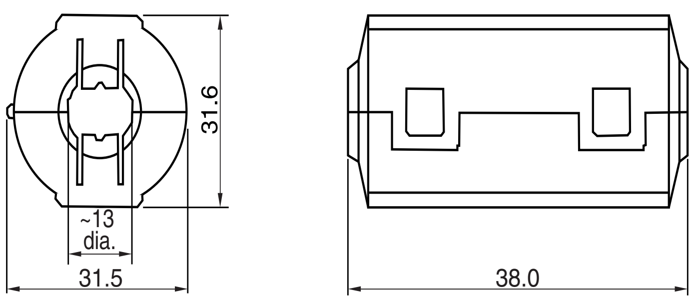
- Always use the specified Encoder Cables.
- If cables are joined midway, be sure to use connectors and do not remove more than 50 mm of the cable insulation. In addition, always use shielded cables.
- Do not coil cables. If cables are long and coiled, mutual induction and inductance will increase and cause malfunctions. Always use cables fully extended.
- When installing noise filters for Encoder Cables, use clamp filters.
- The following table shows the recommended clamp filters.

| Maker | Product name | Model | Specifications |
|---|---|---|---|
| NEC TOKIN | Clamp filter | ESD-SR-250 | For cable diameter up to 13 mm |
| TDK | Clamp filter | ZCAT3035-1330 | For cable diameter up to 13 mm |

- Do not place the Encoder Cable with the following cables in the same duct.
  Control Cables for brakes, solenoids, clutches, and valves.

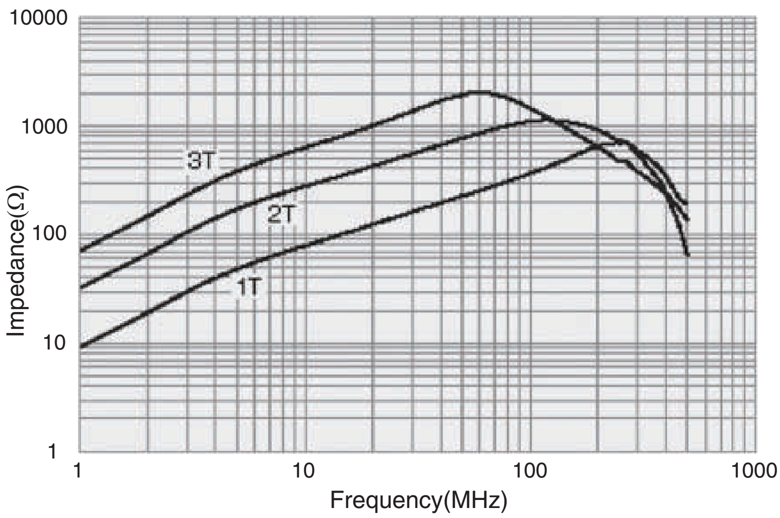
### Dimensions

ESD-SR-250




### Impedance Characteristics

ESD-SR-250




For information on the TDK clamp filter (ZCAT3035-1330), refer to *Radio Noise Filters and Emission Noise Prevention Clamp Cores* on page 4-21.

## ■ Improving Control I/O Signal Noise Resistance

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

- Use completely separate power supplies for the control power supply (especially 24 VDC) and for the external operation power supply. In particular, do not connect the two power supply ground wires.
- Install a noise filter on the primary side of the control power supply.
- If Servomotors with brakes are 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.
- Keep the power supply for pulse commands and deviation counter reset input lines separated from the control power supply as far apart as possible. In particular, do not connect the two power supply ground lines.
- We recommend using line drivers for the pulse command output.
- Always use twisted-pair shielded cable for the pulse command and deviation counter reset signal lines, and connect both ends of the shield to frame grounds.
- If the control power supply wiring is long, noise resistance can be improved by adding 1-μF laminated ceramic capacitors between the control power supply and ground at the Servo Drive input section or the controller output section.
- For open-collector specifications, keep the length of wires to within two meters.

## ■ Selecting Other Parts for Noise Resistance

This section explains the criteria for selecting other connection components required to improve noise resistance.
Understand each component's characteristics, such as its capacity, performance, and applicable conditions when selecting the components.
For more details, contact the manufacturers directly.

### Noise Filters for the Power Supply Input

- Use a noise filter to attenuate external noise and reduce noise emitted from the Servo Drive.
- Select a noise filter with a rated current that is at least two times greater than the effective load current (the rated current of the main circuit power supply input given in *Main Circuit Wiring* on page 4-11).

| Maker | Model | Rated current | Applicable standards | Remarks |
|---|---|---|---|---|
| NEC TOKIN | GT-2050 | 5 A | UL, CSA, VDE, TUV | Single-phase |
| | GT-2100 | 10 A | | |
| | GT-2150 | 15 A | | |
| | GT-2200 | 20 A | | |
| | HFP-2153 | 15 A | UL, CSA, TUV | Three-phase |
| | HFP-2303 | 30 A | | |
| Okaya Electric Industries Co., ltd. | SUP-EW5-ER-6 | 5 A | UL, cUL, SEMKO | Single-phase |
| | SUP-EW10-ER-6 | 10 A | | |
| | SUP-EW15-ER-6 | 15 A | | |
| | SUP-EW20-ER-6 | 20 A | | |
| | SUP-EW30-ER-6 | 30 A | | |
| | 3SUP-HU10-ER-6 | 10 A | | Three-phase |
| | 3SUP-HU20-ER-6 | 20 A | | |
| TDK | ZRCS2006-00S | 6 A | UL, CSA, NEMKO | Single-phase |
| | ZRCS2010-00S | 10 A | | |
| | ZRCS2020-00S | 20 A | | |
| | ZRCS2030-00S | 30 A | | |

**Note 1.** To attenuate noise at low frequencies below 200 kHz, use an isolation transformer and a noise filter.

Note 2. To attenuate noise at high frequencies over 30 MHz, use a ferrite core and a high-frequency noise filter with a feed through capacitor.

Note 3. If multiple Servo Drives are connected to a single noise filter, select a noise filter with a rated current at least two times the total rated current of all the Servo Drives.

### Noise Filters for Servomotor Output

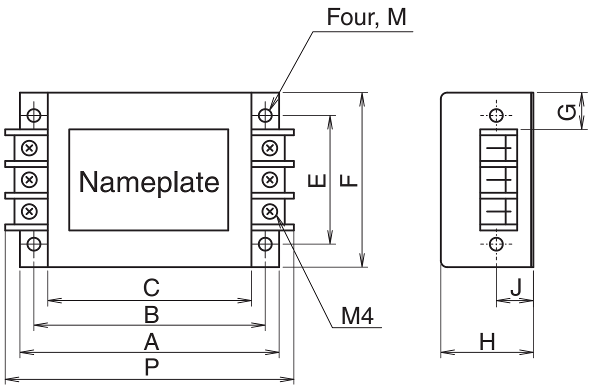
- Use noise filters without built-in capacitors on the Servomotor output lines.
- Select a noise filter with a rated current at least two times the Servo Drive's continuous output current.
- The following table shows the recommended noise filters for Servomotor output.

| Maker | Model | Rated current | Remarks |
|---|---|---|---|
| OMRON | 3G3AX-NF001 | 6 A | For inverter output |
| | 3G3AX-NF002 | 12 A | |

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

Note 2. Typical noise filters are made for power supply frequencies of 50/60 Hz. If these noise filters are connected to the PWM output of the Servo Drive, an extremely large (about 100 times larger) leakage current will flow through the noise filter's condenser and the Servo Drive could be damaged.

### Dimensions




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

### Measures against Brake Line Noise

- To reduce the noise from the brake line of the Servomotor, use a clamp filter of the same type used for the Encoder Cable.

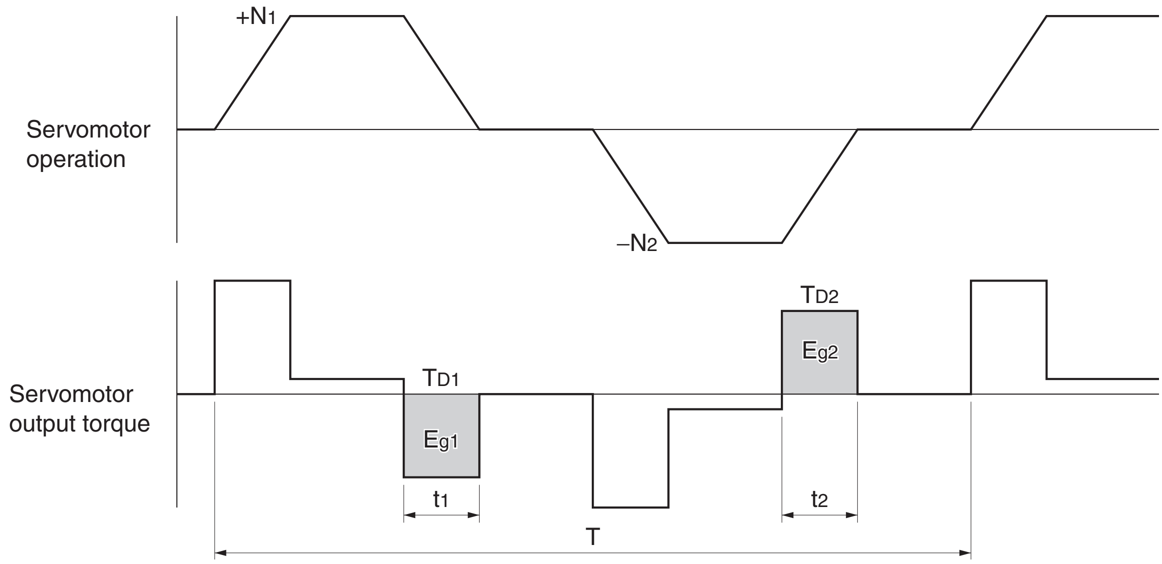
# 4-4 Regenerative Energy Absorption

The Servo Drives have internal regenerative energy absorption circuitry, which absorbs the regenerative energy produced during Servomotor deceleration and prevents the DC voltage from increasing. An overvoltage error occurs, however, if the amount of regenerative energy from the Servomotor is too large. In this case, measures must be taken to reduce the regenerative energy by changing operating patterns, or to increase the regenerative energy absorption capacity by connecting an External Regeneration Resistor.



## Calculating the Regenerative Energy

### ■ Horizontal Axis




**Note** In the output torque graph, acceleration in the positive direction is shown as positive, and acceleration in the negative direction is shown as negative.

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

$$E_{g1} = \frac{1}{2} * \frac{2\pi}{60} * N_1 * T_{D1} * t_1 \text{ [J]} = 0.0524 * N_1 * T_{D1} * t_1 \text{ [J]}$$

$$E_{g2} = \frac{1}{2} * \frac{2\pi}{60} * N_2 * T_{D2} * t_2 \text{ [J]} = 0.0524 * N_2 * T_{D2} * t_2 \text{ [J]}$$

$N_1$, $N_2$: Rotation speed at beginning of deceleration [r/min]
$T_{D1}$, $T_{D2}$: Deceleration torque [N·m]
$t_1$, $t_2$: Deceleration time [s]

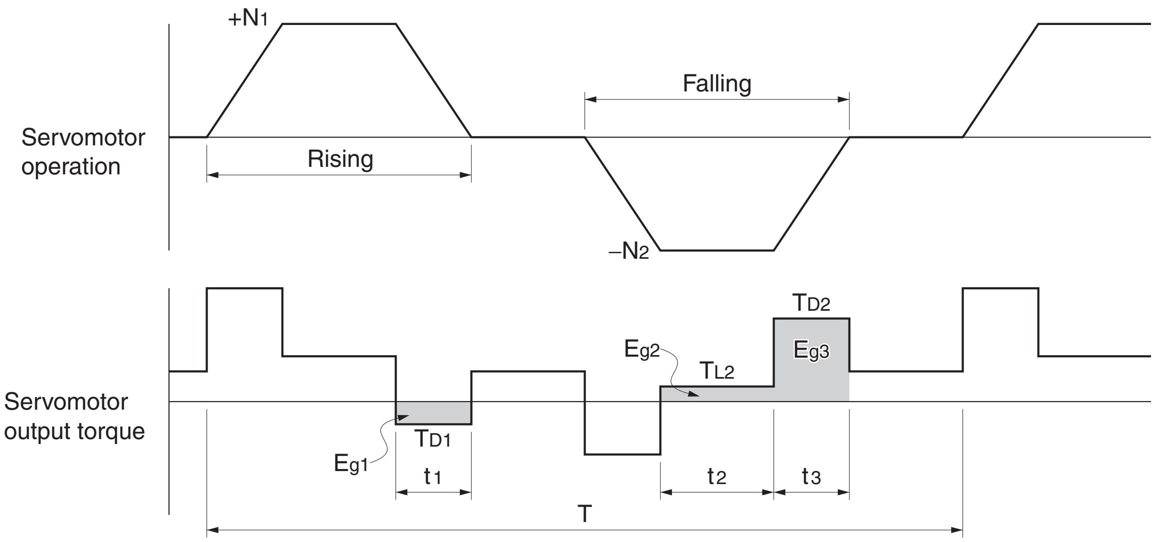
**Note** Due to the loss of winding resistance and PWM, the actual regenerative energy will be approximately 90% of the values derived from these equations.

• Average regeneration power (Pr): Regeneration power produced in one cycle of operation.

$P_r = (E_{g1} + E_{g2}) / T$ [W] T: Operation cycle [s]

- Since an internal capacitor absorbs regenerative energy, the value for $E_{g1}$ a $E_{g2}$ (unit: J) must be lower than the Servo Drive's regenerative energy absorption capacity. (For details, refer to *Servo Drive Regenerative Energy Absorption Capacity* on page 4-30.) If an External Regeneration Resistor is connected, be sure that the average regeneration power (Pr) does not exceed the External Regeneration Resistor's regenerative energy absorption capacity (12 W).

## ■ Vertical Axis




**Note** In the output torque graph, acceleration in the positive direction (rising) is shown as positive, and acceleration in the negative direction (falling) is shown as negative.

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

$$E_{g1} = \frac{1}{2} * \frac{2\pi}{60} * N_1 * T_{D1} * t_1 \ \ [J] \ =0.0524 * N_1 * T_{D1} * t_1 \ \ [J]$$

$$E_{g2} = \frac{2\pi}{60} * N_2 * T_{L2} * t_2 \ \ [J] = 0.105 * N_2 * T_{D2} * t_3 \ \ [J]$$

$$E_{g3} = \frac{1}{2} * \frac{2\pi}{60} * N_2 * T_{D2} * t_3 \ \ [J] \ =0.0524 * N_2 * T_{D2} * t_3 \ \ [J]$$

$N_1$, $N_2$: Rotation speed at beginning of deceleration [r/min]
$T_{D1}$, $T_{D2}$: Deceleration torque [N·m]
$T_{L2}$: Torque when falling [N·m]
$t_1$, $t_3$: Deceleration time [s]
$t_2$: Constant-velocity running time when falling [s]

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

- The average regeneration power (Pr): Regeneration power produced in one cycle of operation [W].

$$P_r = (E_{g1} + E_{g2} + E_{g2}) / T \ \ [W] \qquad T: \text{Operation cycle [s]}$$

- Since an internal capacitor absorbs regenerative energy, the value for $E_{g1}$ and ($E_{g2}$+ $E_{g3}$)(unit: J) must be lower than the Servo Drive's regenerative energy absorption capacity. (For details, refer to *Servo Drive Regenerative Energy Absorption Capacity*.)

## Servo Drive Regenerative Energy Absorption Capacity

The SMARTSTEP 2 Servo Drives absorb regenerative energy internally with built-in capacitors. If the regenerative energy is too large to be processed internally, an overvoltage error (AL12) occurs and operation cannot continue. The following table shows the regenerative energy (and amount of regeneration) that each Servo Drive can absorb.
If these values are exceeded, take the following measures.

- Add an External Regeneration Resistor.
- Reduce the operating rotation speed. (The amount of regeneration is proportional to the square of the rotation speed.)
- Lengthen the deceleration time (to decrease the regenerative energy produced per time unit).
- Lengthen the operation cycle, i.e., the cycle time (to decrease the average regeneration power).

| Servo Drive | Regenerative energy that can be absorbed by the internal capacitor | Minimum external regenerative resistance |
|---|---|---|
| | J | Ω |
| R7D-BPA5L<br>R7D-BP01L | 6 | 20 |
| R7D-BP02L | 12 | 20 |
| R7D-BP01H | 8 | 50 |
| R7D-BP02H<br>R7D-BP02HH | 16 | 35 |
| R7D-BP04H | 16 | 35 |



## Absorbing Regenerative Energy with an External Regeneration Resistor

If the regenerative energy exceeds the absorption capacity of the Servo Drive, connect an External Regeneration Resistor. Connect the External Regeneration Resistor to CNA pins 5 and 3 (between terminals P and B1) of the Servo Drive. Double-check the pin numbers when connecting the resistor because the Regeneration Resistor may be damaged by burning if connected to the wrong terminals. The External Regeneration Resistor will heat up to approximately 120°C. Do not place it near equipment or wiring that is easily affected by heat. Attach radiator plates suitable for the heat radiation conditions.

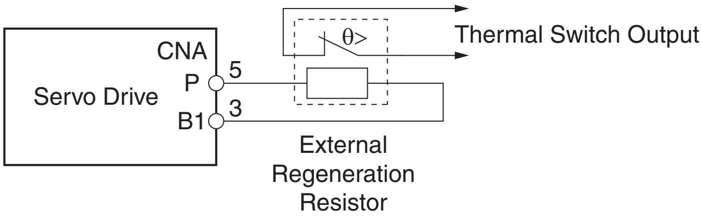
### ■ External Regeneration Resistor

#### Performance Specifications

| Model | Resistance | Nominal capacity | Regeneration absorption at 120°C | Heat radiation condition | Thermal switch output specifications |
|---|---|---|---|---|---|
| R88A-RR08050S | 50 Ω | 80 W | 20 W | Aluminum 250 × 250, Thickness: 3.0 | Operating temperature: 150°C ±5%<br>NC contact<br>Rated output: 30 VDC, 50 mA max. |
| R88A-RR080100S | 100 Ω | 80 W | 20 W | Aluminum 250 × 250, Thickness: 3.0 | Operating temperature: 150°C ±5%<br>NC contact<br>Rated output: 30 VDC, 50 mA max. |
| R88A-RR22047S | 47 Ω | 220 W | 70 W | Aluminum 350 × 350, Thickness: 3.0 | Operating temperature: 170°C ±5%<br>NC contact<br>Rated output: 250 VAC, 0.2 A max. |

### Wiring Method

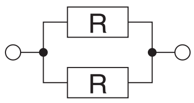
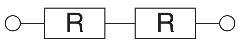
Connect the External Regeneration Resistor between terminals P and B1.




**Precautions for Correct Use**

- Connect the thermal switch output so that the power supply is shut OFF when the contacts open. Configure a sequence to shut OFF the power via the thermal output. Not doing so may cause the resistor to overheat, resulting in a fire or damage to the equipment.

### Combining External Regeneration Resistors

| Regeneration absorption capacity *1 | 20 W | 40 W | 70 W | 140 W |
|---|---|---|---|---|
| Model | R88A-RR08050S<br>R88A-RR080100S | R88A-RR08050S<br>R88A-RR080100S | R88A-RR22047S | R88A-RR22047S |
| Resistance *2 | 50 Ω/100 Ω | 25 Ω/50 Ω | 47 Ω | 94 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 of resistors with a resistance lower than the minimum external regenerative resistance of each Servo Drive. For information on the minimum external regenerative resistance, refer to *Servo Drive Regenerative Energy Absorption Capacity* on page 4-30.

# Chapter 5

# Operating Functions

# 5-1 Position Control



- Positioning can be performed according to the pulses input into the pulse-string inputs (CN1-22 to 25).
- The Servomotor rotates using the value of the pulse-string inputs multiplied by the value of the electronic gear (Pn46, Pn47, Pn4A, and Pn4B).
- SMARTSTEP2 Series Servo Drives have two position control modes: high-response position control and advanced position control. Select the mode better suited for your operational conditions.

## High-Response Position Control vs. Advanced Position Control

The two position control modes have the following differences.

| | Notch Filter 1 Frequency (Pn1D) | Vibration Frequency (Pn2B) | Realtime Autotuning Mode Selection (Pn21) | Adaptive Filter Table Number Display (Pn2F) |
|---|---|---|---|---|
| High-Response Position Control | Conditional | Conditional | Conditional | Disabled |
| Advanced Position Control | Enabled | Enabled | Enabled | Enabled |

- The Notch Filter 1 Frequency, Vibration Frequency, and Realtime Autotuning Mode Selection cannot be used at the same time in high-response position control mode. The parameter entered first will be given priority.

Example: When the Realtime Autotuning Mode Selection is set, the Servo Drive will be forcibly set to 1500 (disabled), even if the Notch Filter 1 Frequency is input.

- The adaptive filter will be disabled under high-response position control. To use the adaptive filter, select the advanced position control mode.

## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn02 | Control Mode Selection | Select a control mode for position control (setting: 0 or 2). | Page 5-33 |
| Pn42 | Command Pulse Mode | Set to match the command pulse form of the controller. | Page 5-49 |
| Pn46 | Electronic Gear Ratio Numerator 1 | Set the pulse rate for command pulses and Servomotor travel amount. $\dfrac{\text{Electronic Gear Ratio Numerator 1 (Pn46)} \times 2^{\text{Electronic Gear Ratio Numerator Exponent (Pn4A)}}}{\text{Electronic Gear Ratio Denominator (Pn4B)}}$ The maximum value of the calculated numerator is 2,621,440. | Page 5-50 |
| Pn4A | Electronic Gear Ratio Numerator Exponent | | |
| Pn4B | Electronic Gear Ratio Denominator | | |
| Pn60 | Positioning Completion Range | The Positioning Completed Output (INP) turns ON when the number of pulses in the deviation counter is equal to or less than the setting of this parameter. | Page 5-55 |

**Reference**

- The Control Mode Selection (Pn02) is set as follows.

| Setting | Control mode |
|---|---|
| 0 | High-Response Position Control |
| 1 | Internally Set Speed Control |
| 2 | Advanced Position Control |

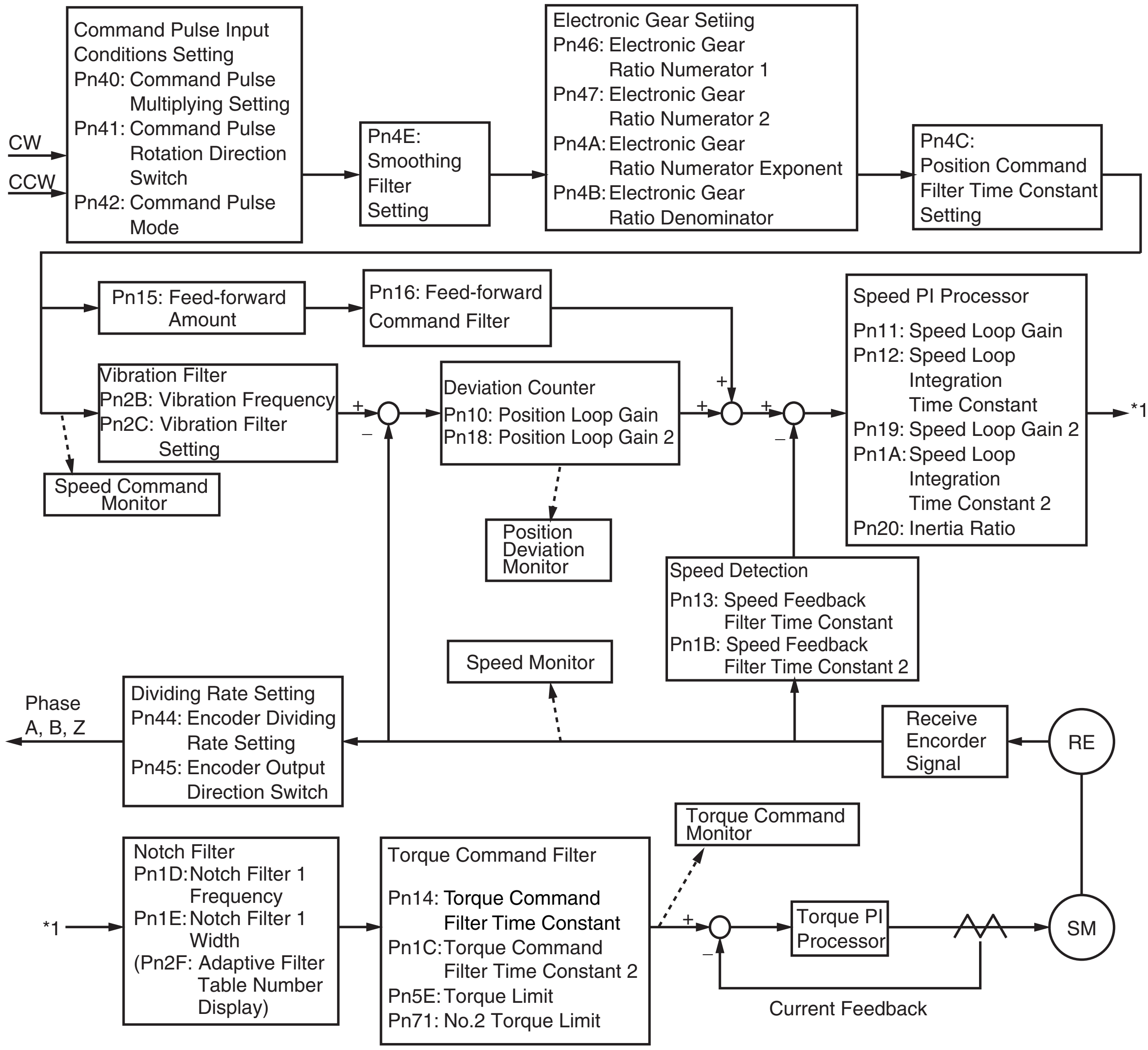
- To perform position control, select 0 (high-response position control) or 2 (advanced position control) for the control mode.

## Related Parameters

The main functions provided by the parameters related to position control are described in the following table.

| Function | Explanation | Reference |
|---|---|---|
| Gain Switching | The Gain Switching Input (GSEL) is used when the Zero Speed Designation/ Torque Limit Switch (Pn06) is set to a value other than 2. The Gain Switching Input is used to switch between PI and P operation or to switch between gain 1 and gain 2. | Page 5-13 |
| Torque Limit Switch | The Torque Limit Switch Input (TLSEL) is used when the Zero Speed Designation/Torque Limit Switch (Pn06) is set to 2. The following parameters are switched: Overspeed Detection Level, Torque Limit, and Deviation Counter Overflow Level. | Page 5-15 |
| Vibration Control | Vibration control can be used to reduce vibration when using a low-rigidity mechanism or equipment whose ends tend to vibrate. | Page 7-23 |
| Realtime Autotuning | Autotuning automatically estimates the load inertia of the machine in realtime and sets the optimal gain. The adaptive filter automatically suppresses vibration caused by resonance. | Page 7-3 |

## Parameter Block Diagram for Position Control Mode



# 5-2 Internally Set Speed Control

- The speed of the Servomotor can be controlled using the speeds set in the No. 1 to 4 Internal Speed Setting parameters.
- After the RUN Command Input (RUN) is turned ON and then the Zero Speed Designation Input (VZERO) is turned ON, the Servomotor will accelerate according to the Soft Start Acceleration Time (Pn58). When the Zero Speed Designation Input (VZERO) is turned OFF, the Servomotor will decelerate to a stop according to the Soft Start Deceleration Time (Pn59).
- Switching between the internally set speeds is controlled by the Internally Set Speed Selection 1 and 2 Inputs (VSEL1: CN1-6, VSEL2: CN1-4).





## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn02 | Control Mode Selection | Select the control mode for internally set speeds (setting: 1). | Page 5-33 |
| Pn06 | Zero-speed Designation/ Torque Limit Switch | Always enable the zero-speed designation when internally set speeds are used (setting: 1). | Page 5-34 |
| Pn53 | No. 1 Internal Speed Setting | Set the internally set speeds (r/min). The settings can be made from −20,000 to 20,000 r/min. Be sure to set the speeds within the allowable range of rotation speed of the Servomotor. | Page 5-53 |
| Pn54 | No. 2 Internal Speed Setting | | |
| Pn55 | No. 3 Internal Speed Setting | | |
| Pn56 | No. 4 Internal Speed Setting | | |
| Pn58 | Soft Start Acceleration Time | Set the acceleration time for Internally Set Speed Control. Set the time (setting × 2 ms) until 1,000 r/min is reached. | Page 5-53 |
| Pn59 | Soft Start Deceleration Time | Set the deceleration time for Internally Set Speed Control. Set the time (setting × 2 ms) until operation stops from 1,000 r/min. | |

## Related Parameters

The main functions provided by the parameters related to Internally Set Speed Control are described in the following table.

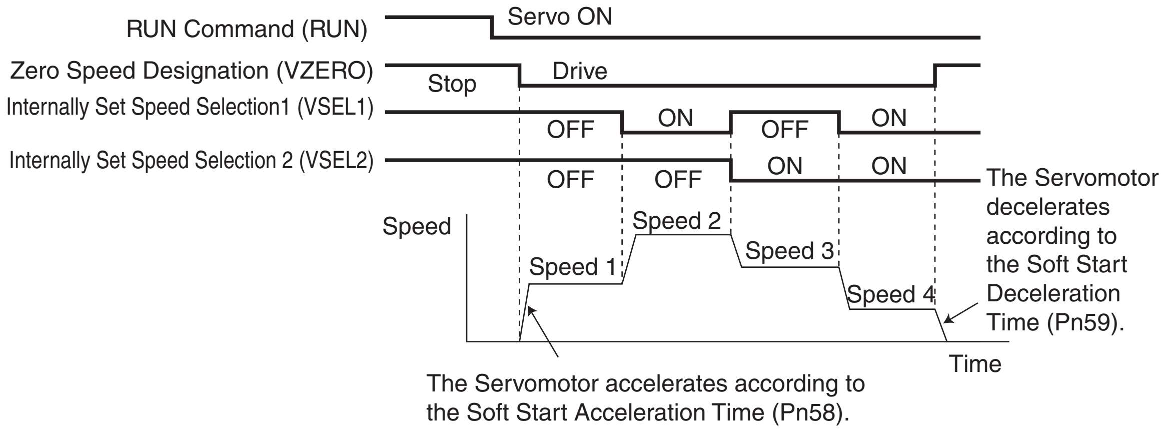
| Function | Explanation | Reference |
|---|---|---|
| Torque Limit Switch | The Torque Limit Switch Input (TLSEL) is used when the Zero Speed Designation/Torque Limit Switch (Pn06) is set to 2. The following parameters are switched: Overspeed Detection Level, Torque Limit, and Deviation Counter Overflow Level. | Page 5-15 |
| Zero Speed Detection | The Zero Speed Detection Signal will be output if the speed of the Servomotor falls below the setting of this parameter. The Warning Output Selection (Pn09) must be set to 1 to use this function. | Page 5-55 |
| Motor Rotation Detection | The Servomotor Rotation Speed Detection Output (TGON) will be output if the speed of the Servomotor exceeds the setting of this parameter. | Page 5-56 |

## Selecting the Internally Set Speeds

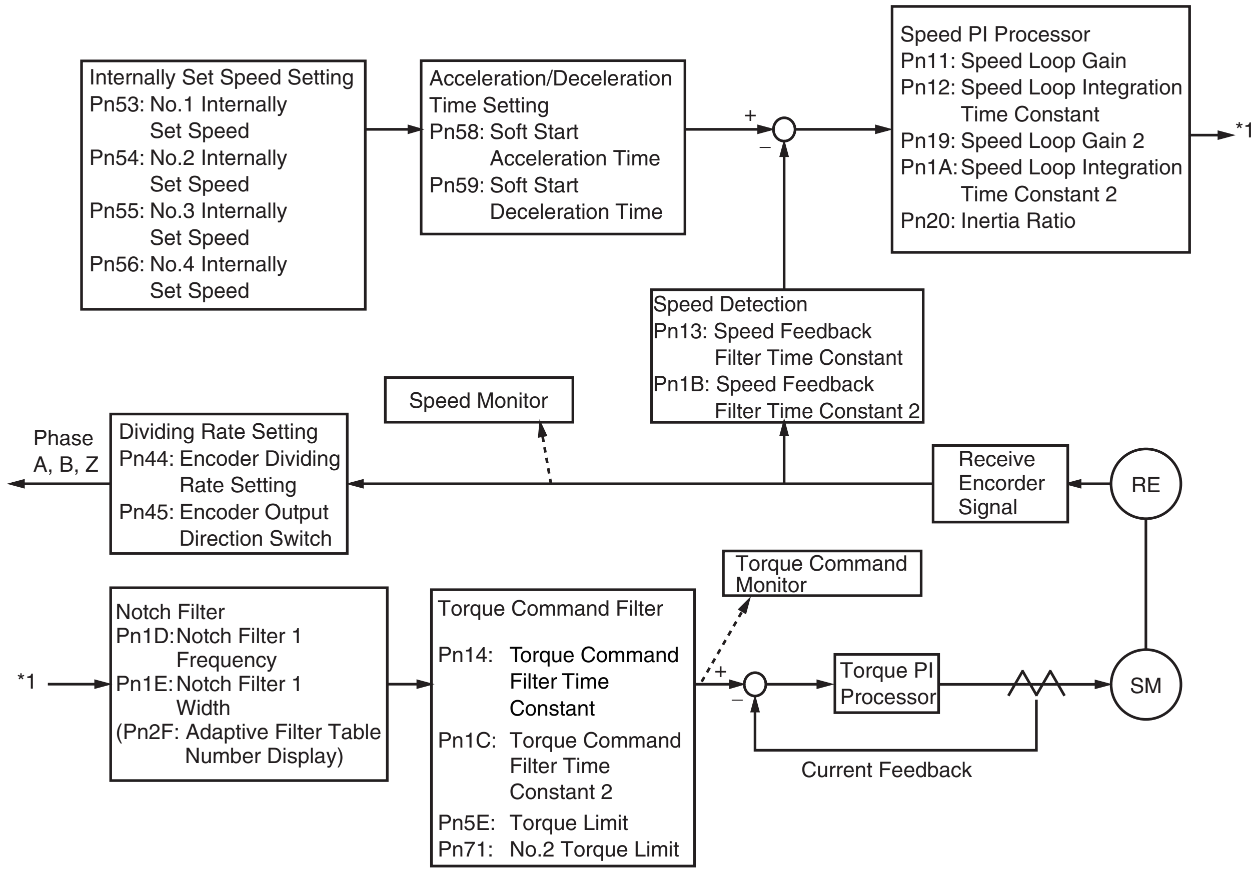
The four internally set speeds are switched by using the Internally Set Speed Selection 1 Input (VSEL1) and Internally Set Speed Selection 2 Input (VSEL2).

| Internally set speed | Internally Set Speed Selection 1 Input (VSEL1) (CN1-6) | Internally Set Speed Selection 2 Input (VSEL2) (CN1-4) |
|---|---|---|
| No. 1 Internally Set Speed (Pn53) | OFF | OFF |
| No. 2 Internally Set Speed (Pn54) | ON | OFF |
| No. 3 Internally Set Speed (Pn55) | OFF | ON |
| No. 4 Internally Set Speed (Pn56) | ON | ON |

## Operation



## Parameter Block Diagram for Internally Set Speed Control Mode



# 5-3 Forward and Reverse Drive Prohibit

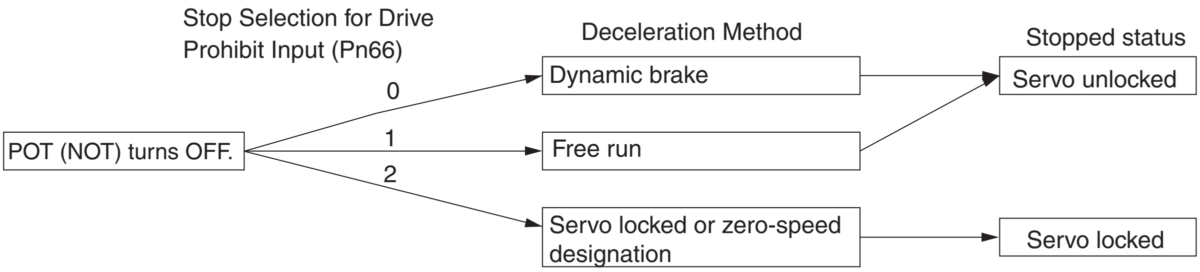
- When the Forward Drive Prohibit Input (POT: CN1-8) and Reverse Drive Prohibit Input (NOT: CN1-7) are turned OFF, the Servomotor will stop rotating.
- You can prevent the Servomotor from rotating beyond the device's travel range by connecting limit inputs.

## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn04 | Drive Prohibit Input Selection | Enable or disable the Forward/Reverse Drive Prohibit Inputs. | Page 5-33 |
| Pn66 | Stop Selection for Drive Prohibit Input | Set the operation for decelerating to a stop after the Forward/Reverse Drive Prohibit Input turns OFF. This parameter can be used to set whether to stop with the dynamic brake or free-running. | Page 5-57 |

## Operation

Stopping Methods When Forward/Reverse Drive Prohibit Is OFF.




While the Forward Drive Prohibit Input (POT) is OFF, the Servomotor cannot be driven in the forward direction, but it can be driven in the reverse direction. Conversely, while the Reverse Drive Prohibit Input (NOT) is OFF, the Servomotor cannot be driven in the reverse direction, but it can be driven in the forward direction.

# 5-4 Encoder Dividing

- The number of pulses can be set for the encoder signals output from the Servo Drive.
- The number of pulses per Servomotor rotation can be set within a range of 1 to 2,500 pulses/rotation.
- Use this function for the following applications:
- When using a controller with a low response frequency.
- When it is desirable to set a pulse rate that is easily divisible.

Example:
To use a resolution of 5 μm/pulse in a mechanical system in which one Servomotor rotation corresponds to a travel of 10 mm, set the encoder dividing rate to 2,000 pulses/rotation.

5

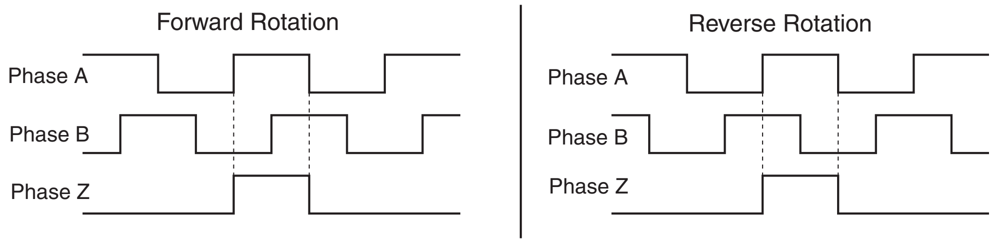
Operating Functions

## Parameters Requiring Setting

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn44 | Encoder Dividing Rate Setting | Set the number of encoder pulses to be output from the Servo Drive for each rotation. The default setting is 2,500 pulses/rotation.<br>The setting can be made from 1 to 16,384 pulses/rotation, but the setting will not be valid if it exceeds 2,500 pulses/rotation. Even if the dividing rate is changed, there will always be 1 pulse per rotation for phase Z. | Page 5-49 |
| Pn45 | Encoder Output Direction Switch | This parameter can be used to reverse the output phase of the encoder signal output from the Servo Drive. | Page 5-50 |

## Operation

The output phases of the encoder signal output from the Servo Drive are as shown below.



# 5-5 Electronic Gear

- The Servomotor can be rotated for the number of pulses obtained by multiplying the command pulses by the electronic gear ratio.
- This function is effective in the following cases:
  When fine-tuning the position and speed of two lines that are to be synchronous.
  When using a position controller with a low command pulse frequency.
  When you want to set the machine travel distance per pulse, to 0.01 mm for example.



## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn46 | Electronic Gear Ratio Numerator 1 *1 | Set the pulse rate for command pulses and Servomotor travel distance. $\dfrac{\text{Electronic Gear Ratio Numerator 1 (Pn46) or Electronic Gear Ratio Numerator 2 (Pn47)} \times 2^{\text{Electronic Gear Ratio Numerator Exponent (Pn4A)}}}{\text{Electronic Gear Ratio Denominator (Pn4B)}}$ The maximum value of the calculated numerator is 2,621,440. Any higher setting than this will be invalid, and the numerator will be 2,621,440. | Page 5-50 |
| Pn47 | Electronic Gear Ratio Numerator 2 *1 | | |
| Pn4A | Electronic Gear Ratio Numerator Exponent | | Page 5-51 |
| Pn4B | Electronic Gear Ratio Denominator | | |

*1. The Electronic Gear Switch Input (GESEL) is used to switch between Electronic Gear Ratio Numerator 1 (Pn46) and Electronic Gear Ratio Numerator 2 (Pn47).

## Operation

### Calculation Method

- The following equation shows the relation between the number of internal command pulses (F) after the electronic gear ratio multiplication and the number of command pulses (f) per Servomotor rotation.

$$F = f \times \frac{Pn46 \times 2^{Pn4A}}{Pn4B}$$

- The Servomotor has a 2,500 pulses/rotation encoder. Therefore, the number of internal command pulses (F) in the Servo Drive is 10,000 pulses/rotation (2,500 pulses/rotation $\times$ 4).
- Given the conditions above, the relation between the number of command pulses per Servomotor rotation (f) and the electronic gear ratio is as follows:

$$\frac{F}{f} = \frac{10000}{f} = \frac{Pn46 \times 2^{Pn4A}}{Pn4B} \left( = \frac{\text{Encoder resolution (by a factor of 4)}}{\text{Number of command pulses for Servomotor rotation}} \right)$$

### Calculation Examples

- To operate with 2,000 pulses/rotation:

$$\frac{10000\ (\text{Pn46}) \times 2^{0\ (\text{Pn4A})}}{2000\ (\text{Pn48})}$$

- To operate with 1,000 pulses/rotation:

$$\frac{10000\ (\text{Pn46}) \times 2^{0\ (\text{Pn4A})}}{1000\ (\text{Pn48})}$$

- Conversely, to increase the resolution per rotation and operate with 40,000 pulses/rotation:

$$\frac{10000\ (\text{Pn46}) \times 2^{0\ (\text{Pn4A})}}{40000\ (\text{Pn48})}$$

The setting ranges for Pn46, Pn47, and Pn4B, however, will be 1 to 10,000, so reduction to one of the following is required.

$$\frac{2500\ (\text{Pn46}) \times 2^{0\ (\text{Pn4A})}}{10000\ (\text{Pn48})} \quad \text{or} \quad \frac{1\ (\text{Pn46}) \times 2^{0\ (\text{Pn4A})}}{4\ (\text{Pn48})}$$

Make reductions so that the values fit into the setting ranges, as shown above.

## Related Parameter

The main function provided by the parameter related to electronic gears is given in the following table.

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn40 | Command Pulse Multiplying Setting | The command pulses are multiplied by a factor of 2 or 4 when using 90° phase difference signal inputs is selected as the input format for the command pulses in the Command Pulse Mode (Pn42). | Page 5-48 |

# 5-6 bBrake Interlock

You can set the Brake Interlock Signal (BKIR) timing to turn ON and OFF the electromagnetic brake.

**Precautions for Correct Use**

- The electromagnetic brake of a Servomotor with a brake is a non-excitation brake designed for holding. Set the parameter to first stop the Servomotor, and then turn OFF the power supply to the brake.
- If the brake is applied while the Servomotor is rotating, the brake disk may become damaged due to friction, leading to the Servomotor malfunction.

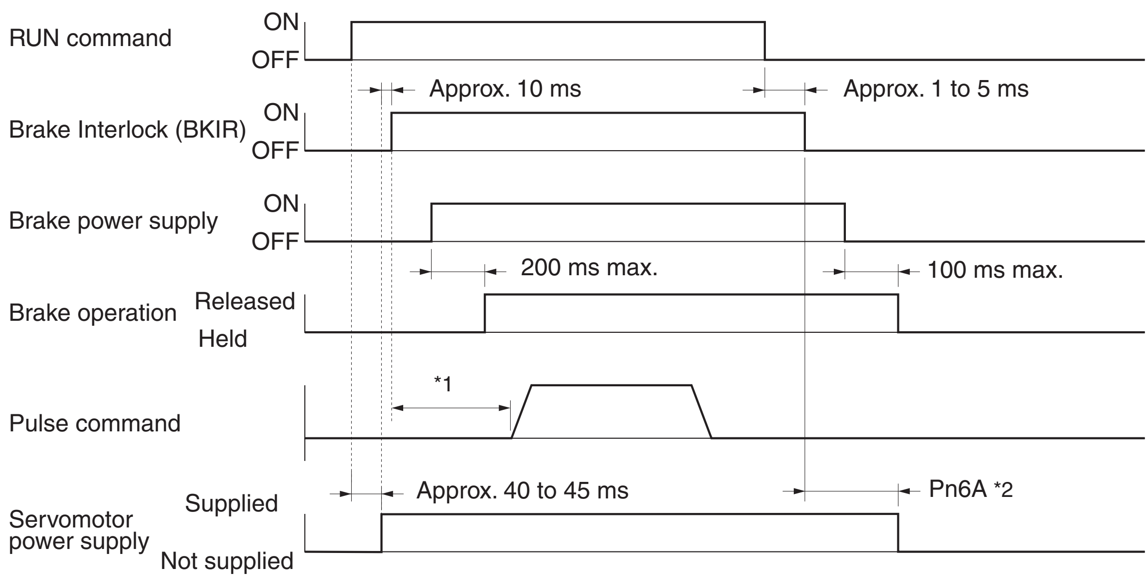


## Parameters Requiring Setting

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn6A | Brake Timing when Stopped | Use this parameter to set the output timing of the Brake Interlock Signal (BKIR) when the Servomotor is stopped. | Page 5-58 |
| Pn6B | Brake Timing during Operation | Use this parameter to set the output timing of the Brake Interlock Signal (BKIR) when the Servomotor is rotating. | Page 5-59 |

## Operation

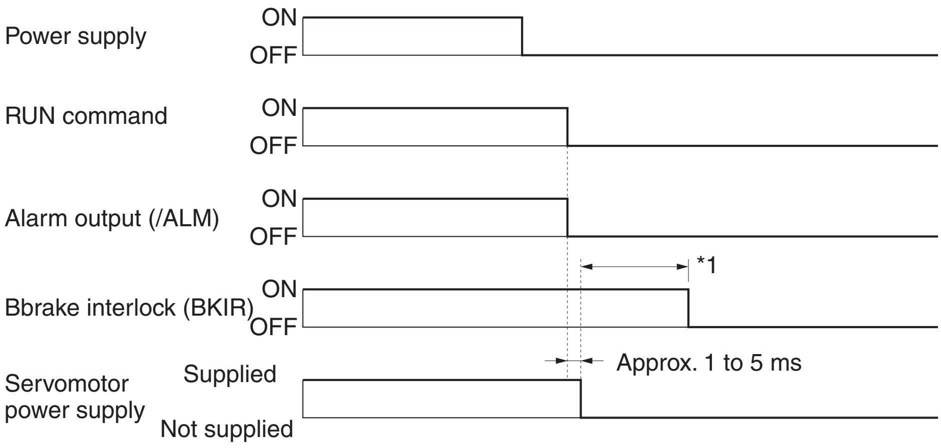
### ■ RUN Command Timing (When Servomotor Is Stopped)




*1. The time from turning ON the brake power supply to releasing the brake is 200 ms max. Provide a pulse command after the brake has been released, taking into account this delay.

*2. The time from turning OFF the brake power supply to the brake engaging is 100 ms max. If using the Servomotor on a vertical axis, take this delay into account and set the Brake Timing when Stopped (Pn6A) longer so that the Servomotor power is turned OFF after the brake has been held.

## ■ RUN Command, Errors, and Power Supply Timing (When Servomotor Is Rotating)




*1. This time is the shorter value of either the setting for the Brake Timing during Operation (Pn6B) or the time it takes until the Servomotor rotation speed drops to 30 r/min or lower. Depending on the holding time of the power supply, this time may be shorter than the value set in Pn6B.

# 5-7 Gain Switching

- In Position Control Mode, you can switch between PI (proportional and integral) operation and P (proportional) operation, or between gain 1 and gain 2.
- With PI/P operation switching, the repulsion to external forces applied to the load can be weakened by eliminating the integral of the speed deviation (i.e., the difference between the speed command and speed feedback).
- Gain 1/gain 2 switching is effective in the following cases:
  Reducing the gain to suppress vibration caused by changes in load inertia during operation.
  Reducing the gain to suppress vibration due to an increase in speed.
  Increasing responsiveness by increasing the gain during operation.
  Increasing servo lock rigidity by increasing the gain when stopping.
  Reducing the gain to suppress vibration when stopping.





## Parameters Requiring Setting

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn30 | Gain Switching Input Operating Mode Selection | Select whether to use PI/P operation switching or gain 1/gain 2 switching in Position Control Mode. | Page 5-44 |
| Pn31 | Gain Switch Setting | Select the condition for switching between gain 1 and gain 2. | Page 5-44 |
| Pn32 | Gain Switch Time *1 | Set the delay time from the moment the condition set in the Gain Switch Setting (Pn31) is not met until returning to gain 1. | Page 5-46 |
| Pn33 | Gain Switch Level Setting *1 | Set the judgment level for switching between gain 1 and gain 2. The unit for the setting depends on the condition set in the Gain Switch Setting (Pn31). | |
| Pn34 | Gain Switch Hysteresis Setting | Set the hysteresis width above and below the judgment level set in the Gain Switch Level Setting (Pn33). | |
| Pn35 | Position Loop Gain Switching Time | When switching between gain 1 and gain 2 is enabled, set the phased switching time only for the position loop gain at gain switching. | Page 5-47 |

*1. These settings are disabled when the Gain Switch Setting (Pn31) is set to always use gain1 or gain 2 or set to the Gain Switching Input (CN1-5).

## Related Parameters

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn10 | Position Loop Gain | Set the position control system responsiveness. The higher the setting, the shorter the positioning time. | Page 5-36 |
| Pn11 | Speed Loop Gain | Set the speed loop responsiveness. | Page 5-37 |
| Pn12 | Speed Loop Integration Time Constant | The integration constant is included in the speed loop. This parameter functions to quickly eliminate minor speed deviations after stopping. The lower the setting, the faster the action. | Page 5-37 |
| Pn13 | Speed Feedback Filter Time Constant | The encoder signal is converted to the speed signal via the low pass filter. Noise from the Servomotor can be reduced by increasing the setting. Normally set it to 4 or less. | Page 5-37 |
| Pn14 | Torque Command Filter Time Constant | Set to adjust the primary lag filter time constant for the torque command section. | Page 5-38 |
| Pn18 | Position Loop Gain 2 | These settings are for gain 2. These parameters function in the same way as the parameters described above. | Page 5-39 |
| Pn19 | Speed Loop Gain 2 | | Page 5-39 |
| Pn1A | Speed Loop Integration Time Constant 2 | | Page 5-39 |
| Pn1B | Speed Feedback Filter Time Constant 2 | | Page 5-39 |
| Pn1C | Torque Command Filter Time Constant 2 | | Page 5-39 |

# 5-8 Torque Limit

- This function limits the output torque of the Servomotor.
- This function is effective in the following cases:
  Pressing a moving part of a machine (such as a bending machine) against a workpiece with a constant force.
  Protecting the Servomotor and mechanical system from excessive force or torque.
- The Warning Output Selection (Pn09) can be set to output an alarm to the Warning Output (WARN) when the torque limit function is enabled.
- Two torque limits can be set and you can switch between them. To switch the torque limit setting, enable the Torque Limit Switch Input (TLSEL) in the Zero Speed Designation/Torque Limit Switch (Pn06).





## Parameters Requiring Setting

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn5E | Torque Limit *1 | Set the torque limit as a percentage of the maximum torque of the Servomotor. | Page 5-54 |
| Pn63 | Deviation Counter Overflow Level | Set the alarm detection level for deviation counter overflow. | Page 5-56 |
| Pn70 | Overspeed Detection Level Setting *2 | An overspeed alarm will occur if the Servomotor rotation speed exceeds the setting of this parameter. | Page 5-60 |

*1. Values exceeding the default setting cannot be set. The default setting depends on the combination of the Servomotor and Servo Drive.

*2. The Overspeed Detection Level Setting (Pn70) will function only when torque limit switching function is enabled.

## Related Parameters

The following parameters must be set to use torque limit switching function.

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn71 | No. 2 Torque Limit *1 | These parameters are set when using the No. 2 torque limit. These parameters function in the same way as the parameters described above. | Page 5-60 |
| Pn72 | No. 2 Deviation Counter Overflow Level | | |
| Pn73 | No. 2 Overspeed Detection Level Setting *2 | | |

*1. Values exceeding the default setting cannot be set. The default setting depends on the combination of Servomotor and Servo Drive.

*2. The No. 2 Overspeed Detection Level Setting (Pn73) will function only when torque limit switching function is enabled.

# 5-9 Overrun Limit

- The overrun limit function is enabled only in Position Control Mode.
- The overrun limit is used to stop operation via an alarm if the Servomotor's allowable operating range set in Overrun Limit Setting (Pn26) is exceeded.
- The overrun limit is effective in the following case:
  Preventing impact on the edges of the machine because of Servomotor oscillation.

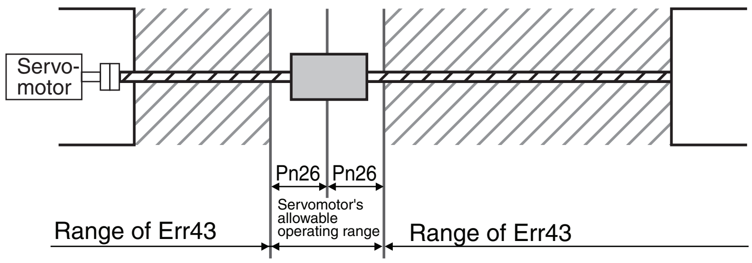
## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation | Reference |
|---|---|---|---|
| Pn26 | Overrun Limit Setting | Set the operating range for the Servomotor. The overrun limit is disabled if the setting is 0. | Page 5-41 |

## Operation

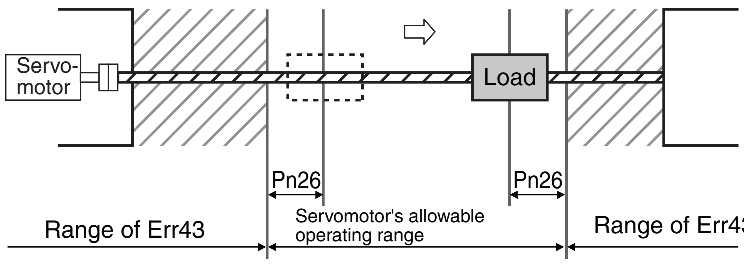
### ■ Servomotor Stopped (Servo Locked)

Since the Servomotor is stopped, the Servomotor's allowable operating range is within the travel distance set in the Overrun Limit Setting (Pn26) for both sides of the Servomotor stop position. If the load of the Servomotor enters the shaded area due to oscillation, an alarm will occur.




### ■ In Operation (Traveling)

When a position command is input, the Servomotor's allowable operating range will increase according to the position command. In the following figure, an alarm will occur if the load enters the setting range on the left side before travel and the setting range on the right side after travel due to oscillation or for other reason.



# 5-10 User Parameters

A Parameter Unit (R88A-PR02G) is required to set and change parameters. For information on operating procedures, refer to *6-3 Using the Parameter Unit*.
Set and check the user parameters in Parameter Setting Mode. Fully understand the parameter meanings and setting procedures before setting user parameters according to your system.
Some parameters are enabled by turning the power OFF and then ON again. When changing these parameters, turn OFF the power, check that the power LED indicator has gone OFF, and then turn ON the power again.

## Setting and Checking Parameters



### ■ Overview

Use the following procedure to set and check parameters.

**1. Display Parameter Setting Mode.**
When the power supply is turned ON, the item set for the Default Display (Pn01) will be displayed. Press the Data key to go to Monitor Mode. Then press the Mode key to go to Parameter Setting Mode.

**2. Set the parameter number.**
Press the Shift, Increment, and Decrement keys to set the parameter number.

**3. Display the parameter setting.**
Press the Data key to display the setting.

**4. Change the parameter setting.**
Press the Shift, Increment, and Decrement keys to change the displayed setting, and then press the Data key to enter the setting of the parameter.

**5. Save the changed setting to memory.**
Press the Mode key to go to the display of Parameter Write Mode and then press the Data key to move on to Parameter Write Mode. By pressing the Increment key for at least 5 s, the set data will be written in EEPROM.

**6. Exit Parameter Write Mode.**
Press the Data key to return to the display of Parameter Write Mode.

## ■ Operating Procedures

### 1. Displaying Parameter Setting Mode

| Key operation | Display example | Explanation |
|---|---|---|
| | r 0 | The item set for the Default Display (Pn01) is displayed. |
| DATA | Un_SPd. | Press the Data key to display Monitor Mode. |
| | Pn_r00. | Press the Mode key to display Parameter Setting Mode. |

### 2. Setting the Parameter Number

| Key operation | Display example | Explanation |
|---|---|---|
| | Pn_ 10. | Use the Shift, Increment, and Decrement keys to set the parameter number.<br>If the parameter number is too high, you can change the parameter number faster by using the Shift key to change the digit. The decimal point will flash for the digit that can be set. |

### 3. Displaying the Parameter Setting

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | 40. | Press the Data key to display the setting of the parameter. |

### 4. Changing the Parameter Setting

| Key operation | Display example | Explanation |
|---|---|---|
| | 100. | Use the Shift, Increment, and Decrement keys to change the setting. |
| DATA | 100. | Press the Data key to save the new setting. |

### 5. Saving the New Setting to Memory

| Key operation | Display example | Explanation |
|---|---|---|
| | EE_SEt | Press the Mode key to display Parameter Write Mode. |
| DATA | EEP -. | Press the Data key to move on to Parameter Write Mode. |
| | EEP --. | Press the Increment key for at least 5 s. |
| | ------. | The bar indicator will appear. |
| | StArt | Writing will start. (This display will appear only momentarily.) |
| | FiniSh. | This display indicates a normal completion. In addition to “Finish,” either rESEt. or Error. may be displayed. If rESEt. is displayed, writing has been completed normally, but some of the changed parameters will be enabled only after the power is turned ON again. Turn OFF the Servo Drive power supply and then turn it ON again. If Error. is displayed, there is a writing error. Write the data again. |

### 6. Returning to the Display of Parameter Write Mode

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | EE_SEt | Press the Data key to return to the display of Parameter Write Mode. |

## Parameter List

- Some parameters are enabled by turning the power OFF and then ON again. When changing these parameters, turn OFF the power, check that the power LED indicator has gone OFF, and then turn ON the power again.
- Do not make any settings for parameters marked "Not used."

### ■ Function Selection Parameters

| Pn No. | Parameter name | Setting | Explanation | Default setting | Unit | Setting range | Power OFF→ON |
|---|---|---|---|---|---|---|---|
| 00 | Unit No. Setting | Set the unit number. | | 1 | --- | 1 to 15 | Yes |
| 01 | Default Display | Select the data to display on the Parameter Unit when the power supply is turned ON. | | 1 | | 0 to 15 | Yes |
| | | 0 | Position deviation | | Pulses | | |
| | | 1 | Servomotor rotation speed | | r/min | | |
| | | 2 | Torque output | | % | | |
| | | 3 | Control mode | | --- | | |
| | | 4 | I/O signal status | | --- | | |
| | | 5 | Alarm display and history | | --- | | |
| | | 6 | Not used. | | --- | | |
| | | 7 | Warning display | | --- | | |
| | | 8 | Regeneration load ratio | | % | | |
| | | 9 | Overload load ratio | | % | | |
| | | 10 | Inertia ratio | | % | | |
| | | 11 | Total feedback pulses | | Pulses | | |
| | | 12 | Total command pulses | | Pulses | | |
| | | 13 | Not used. | | --- | | |
| | | 14 | Not used. | | --- | | |
| | | 15 | Automatic Servomotor recognition enabled/disabled display | | --- | | |
| 02 | Control Mode Selection | Set the control mode to be used. | | 2 | --- | 0 to 2 | Yes |
| | | 0 | High-response position control | | | | |
| | | 1 | Internally set speed control | | | | |
| | | 2 | Advanced position control | | | | |
| 03 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 04 | Drive Prohibit Input Selection | You can prevent the Servomotor from rotating beyond its operating range by connecting limit inputs. | | 1 | --- | 0 or 1 | Yes |
| | | 0 | Enabled | | | | |
| | | 1 | Disabled | | | | |
| 05 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |

| Pn No. | Parameter name | Setting | Explanation | Default setting | Unit | Setting range | Power OFF→ ON |
|---|---|---|---|---|---|---|---|
| 06 | Zero Speed Designation/ Torque Limit Switch | Select the function of the Zero Speed Designation Input (VZERO) and Torque Limit Switch Input (TLSEL). | | 1 | --- | 0 to 2 | Yes |
| | | 0 | Both inputs disabled. | | | | |
| | | 1 | Zero-speed designation enabled. | | | | |
| | | 2 | Torque limit switching enabled. | | | | |
| 07 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 08 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 09 | Warning Output Selection | Allocate the function of the Warning Output (WARN). | | 2 | --- | 0 to 6 | --- |
| | | 0 | Output while torque is being limited. | | | | |
| | | 1 | Output for zero speed detection. | | | | |
| | | 2 | Output for over regeneration, overload, or fan rotation speed error. | | | | |
| | | 3 | Output for over regeneration overload warning. | | | | |
| | | 4 | Output for overload warning. | | | | |
| | | 5 | Not used. | | | | |
| | | 6 | Output for fan rotation speed error alarm. | | | | |
| 0A | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 0B | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 0C | Not used. | (Do not change setting.) | | 2 | --- | --- | --- |
| 0D | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 0E | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 0F | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |

## ■ Servo Gain Parameters

| Pn No. | Parameter name | Explanation | Default setting | Unit | Setting range | Power OFF→ ON |
|---|---|---|---|---|---|---|
| 10 | Position Loop Gain *1 | Set to adjust the position control system responsiveness. | 40 | 1/s | 0 to 32767 | --- |
| 11 | Speed Loop Gain *1 | Set to adjust the speed loop responsiveness. | 60 | Hz | 1 to 3500 | --- |
| 12 | Speed Loop Integration Time Constant *1 | Set to adjust the speed loop integral time constant. | 20 | ms | 1 to 1000 | --- |
| 13 | Speed Feedback Filter Time Constant *1 | The encoder signal is converted to the speed signal via the low pass filter. | 0 | --- | 0 to 5 | --- |
| 14 | Torque Command Filter Time Constant *1 | Set to adjust the primary lag filter time constant for the torque command section. | 100 | 0.01 ms | 0 to 2500 | --- |
| 15 | Feed-forward Amount *1 | Set the position control feed-forward compensation value. | 300 | 0.1% | −2000 to 2000 | --- |
| 16 | Feed-forward Command Filter *1 | Set the position control feed-forward command filter. | 100 | 0.01 ms | 0 to 6400 | --- |
| 17 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 18 | Position Loop Gain 2 *1 | Set to adjust the position control system responsiveness. | 20 | 1/s | 0 to 32767 | --- |
| 19 | Speed Loop Gain 2 *1 | Set to adjust the speed loop responsiveness. | 80 | Hz | 1 to 3500 | --- |
| 1A | Speed Loop Integration Time Constant 2 *1 | Set to adjust the speed loop integral time constant. | 50 | ms | 1 to 1000 | --- |
| 1B | Speed Feedback Filter Time Constant 2 *1 | The encoder signal is converted to the speed signal via the low pass filter. | 0 | --- | 0 to 5 | --- |
| 1C | Torque Command Filter Time Constant 2 *1 | Set to adjust the primary lag filter time constant for the torque command section. | 100 | 0.01 ms | 0 to 2500 | --- |
| 1D | Notch Filter 1 Frequency | Set the notch frequency of the resonance suppression notch filter. | 1500 | Hz | 100 to 1500 | --- |
| 1E | Notch Filter 1 Width | Set the width to one of five levels for the resonance suppression notch filter. Normally, use the default setting. | 2 | --- | 0 to 4 | --- |
| 1F | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 20 | Inertia Ratio *1 | Set the ratio between the mechanical system inertia and the Servomotor rotor inertia. | 300 | % | 0 to 10000 | --- |

<table>
<thead>
<tr><th>Pn No.</th><th>Parameter name</th><th colspan="2">Explanation</th><th>Default setting</th><th>Unit</th><th>Setting range</th><th>Power OFF→ON</th></tr>
</thead>
<tbody>
<tr><td rowspan="9">21</td><td rowspan="9">Realtime Autotuning Mode Selection</td><td colspan="2">Set the operating mode for realtime autotuning.</td><td rowspan="9">0</td><td rowspan="9">---</td><td rowspan="9">0 to 7</td><td rowspan="9">---</td></tr>
<tr><td>0</td><td>Realtime autotuning is not used.<br>The adaptive filter is disabled.</td></tr>
<tr><td>1</td><td>Realtime autotuning is used. Use this setting if there are almost no changes in load inertia during operation.<br>The adaptive filter is enabled if Pn02 is set to 2.</td></tr>
<tr><td>2</td><td>Realtime autotuning is used. Use this setting if there are gradual changes in load inertia during operation.<br>The adaptive filter is enabled if Pn02 is set to 2.</td></tr>
<tr><td>3</td><td>Realtime autotuning is used. Use this setting if there are sudden changes in load inertia during operation.<br>The adaptive filter is enabled if Pn02 is set to 2.</td></tr>
<tr><td>4</td><td>Realtime autotuning is used. Use this setting if there are almost no changes in load inertia during operation.<br>The adaptive filter is disabled.</td></tr>
<tr><td>5</td><td>Realtime autotuning is used. Use this setting if there are gradual changes in load inertia during operation.<br>The adaptive filter is disabled.</td></tr>
<tr><td>6</td><td>Realtime autotuning is used. Use this setting if there are sudden changes in load inertia during operation.<br>The adaptive filter is disabled.</td></tr>
<tr><td>7</td><td>Realtime autotuning is not used.<br>The adaptive filter is enabled if Pn02 is set to 2.</td></tr>
<tr><td>22</td><td>Realtime Autotuning Machine Rigidity Selection</td><td colspan="2">Set the machine rigidity during realtime autotuning to one of 16 levels.<br>The higher the machine rigidity, the greater the setting needs to be. The higher the setting, the higher the responsiveness.</td><td>2</td><td>---</td><td>0 to 15</td><td>---</td></tr>
<tr><td>23</td><td>Not used.</td><td colspan="2">(Do not change setting.)</td><td>0</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>24</td><td>Not used.</td><td colspan="2">(Do not change setting.)</td><td>0</td><td>---</td><td>---</td><td>---</td></tr>
</tbody>
</table>

| Pn No. | Parameter name | Explanation | | Default setting | Unit | Setting range | Power OFF→ON |
|---|---|---|---|---|---|---|---|
| 25 | Autotuning Operation Setting | Set the operating pattern for autotuning. | | 0 | --- | 0 to 7 | --- |
| | | 0 | Rotation direction: CCW → CW, two rotations | | | | |
| | | 1 | Rotation direction: CW → CCW, two rotations | | | | |
| | | 2 | Rotation direction: CCW → CCW, two rotations | | | | |
| | | 3 | Rotation direction: CW → CW, two rotations | | | | |
| | | 4 | Rotation direction: CCW → CW, one rotation | | | | |
| | | 5 | Rotation direction: CW → CCW, one rotation | | | | |
| | | 6 | Rotation direction: CCW → CCW, one rotation | | | | |
| | | 7 | Rotation direction: CW → CW, one rotation | | | | |
| 26 | Overrun Limit Setting | Set the allowable operating range for the Servomotor. The overrun limit function is disabled if this parameter is set to 0. | | 10 | 0.1 rotation | 0 to 1000 | --- |
| 27 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 28 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 29 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 2A | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 2B | Vibration Frequency | Set the vibration frequency to suppress vibration at the end of the load. | | 0 | 0.1Hz | 0 to 5000 | --- |
| 2C | Vibration Filter Setting | Set the vibration filter to suppress vibration at the end of the load. | | 0 | 0.1Hz | −200 to 2500 | --- |
| 2D | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 2E | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 2F | Adaptive Filter Table Number Display *1 | Displays the table entry number corresponding to the frequency of the adaptive filter. This parameter is set automatically and cannot be changed if the adaptive filter is enabled (i.e., if the Realtime Autotuning Mode Selection (Pn21) is set to 1 to 3 or 7). | | 0 | --- | 0 to 64 | --- |
| 30 | Gain Switching Input Operating Mode Selection | Enable or disable gain switching. If gain switching is enabled, the setting of the Gain Switch Setting (Pn31) is used as the condition for switching between gain 1 and gain 2. | | 1 | --- | 0 or 1 | --- |
| | | 0 | Disabled. The gain set in Pn10 to Pn14 is used, and the Gain Switch Input (GSEL) will be used to switch between PI operation and P operation. | | | | |
| | | 1 | Enabled. The gain will be switched between gain 1 (Pn10 to Pn14) and gain 2 (Pn18 to Pn1C). | | | | |

5

Operating Functions

| Pn No. | Parameter name | Explanation | Default setting | Unit | Setting range | Power OFF→ ON |
|---|---|---|---|---|---|---|
| 31 | Gain Switch Setting | Select the condition for switching between gain 1 and gain 2 in one of the position control modes. The Gain Switching Input Operating Mode Selection(Pn30) must be set to 1 (enabled).<br>0: Always gain 1<br>1: Always gain 2<br>2: Switching using Gain Switch Input (GSEL)<br>3: Amount of change in torque command<br>4: Always gain 1<br>5: Command speed<br>6: Amount of position deviation<br>7: Command pulses received<br>8: Positioning Completed Signal (INP) OFF<br>9: Actual Servomotor speed<br>10: Combination of command pulse input and speed | 0 | --- | 0 to 10 | --- |
| 32 | Gain Switch Time *1 | This parameter is enabled when the Gain Switch Setting (Pn31) is set to 3, or 5 to 10. Set the delay time from the moment the condition set in the Gain Switch Setting (Pn31) is not met until returning to gain 1. | 30 | 166 μs | 0 to 10000 | --- |
| 33 | Gain Switch Level Setting *1 | This parameter is enabled when the Gain Switch Setting (Pn31) is set to 3, 5, 6, 9, or 10. Set the judgment level for switching between gain 1 and gain 2. The unit for the setting depends on the condition set in the Gain Switch Setting (Pn31). | 600 | --- | 0 to 20000 | --- |
| 34 | Gain Switch Hysteresis Setting *1 | Set the hysteresis width above and below the judgment level set in the Gain Switch Level Setting (Pn33). | 50 | --- | 0 to 20000 | --- |
| 35 | Position Loop Gain Switching Time *1 | When switching between gain 1 and gain 2 is enabled, set the phased switching time only for the position loop gain at gain switching. | 20 | 166 μs | 0 to 10000 | --- |
| 36 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 37 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 38 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 39 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 3A | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 3B | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 3C | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 3D | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 3E | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 3F | Not used. | (Do not change setting.) | 0 | --- | --- | --- |

*1. These parameters are automatically changed by executing realtime autotuning function. To set them manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

## ■ Position Control Parameters

| Pn No. | Parameter name | Explanation | Default setting | Unit | Setting range | Power OFF→ ON |
|---|---|---|---|---|---|---|
| 40 | Command Pulse Multiplying Setting | The command pulses are multiplied by a factor of 2 or 4 when using 90° phase difference signal inputs is selected as the input format for the command pulses in the Command Pulse Mode (Pn42).<br>1, 2: Multiply by 2.<br>3, 4: Multiply by 4. | 4 | --- | 1 to 4 | Yes |
| 41 | Command Pulse Rotation Direction Switch | Set the Servomotor rotation direction for the command pulse input.<br>0: The Servomotor rotates in the direction specified by the command pulse.<br>1, 2: The Servomotor rotates in the opposite direction from the direction specified by the command pulse.<br>3: The Servomotor rotates in the direction specified by the command pulse. | 0 | --- | 0 to 3 | Yes |
| 42 | Command Pulse Mode | Set the input format of the pulse sent as input commands to the Servo Drive from the position controller.<br>0: 90° phase difference (phases A and B) signal inputs<br>1: Forward pulse and reverse pulse inputs<br>2: 90° phase difference (phases A and B) signal inputs<br>3: Feed pulse input and forward/reverse signal | 1 | --- | 0 to 3 | Yes |
| 43 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 44 | Encoder Dividing Rate Setting | Set the number of encoder pulses to be output from the Servo Drive for each rotation.<br>The setting can be made from 1 to 16,384 pulses/rotation, but the setting will not be valid if it exceeds 2,500 pulses/rotation. | 2500 | Pulses | 1 to 16384 | Yes |
| 45 | Encoder Output Direction Switch | Set to reverse the logic of encoder pulses output from the Servo Drive.<br>0: Positive logic<br>1: Negative logic | 0 | --- | 0 or 1 | Yes |
| 46 | Electronic Gear Ratio Numerator 1 | Set the pulse rate for command pulses and Servomotor travel distance.<br>$\frac{\text{Electronic Gear Ratio Numerator 1 (Pn46) or Electronic Gear Ratio Numerator 2 (Pn47)} \times 2^{\text{Electronic Gear Ratio Numerator Exponent (Pn4A)}}}{\text{Electronic Gear Ratio Denominator (Pn4B)}}$ | 10000 | --- | 1 to 10000 | --- |
| 47 | Electronic Gear Ratio Numerator 2 | | 10000 | --- | 1 to 10000 | --- |
| 48 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 49 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |

| Pn No. | Parameter name | Explanation | Default setting | Unit | Setting range | Power OFF→ ON |
|---|---|---|---|---|---|---|
| 4A | Electronic Gear Ratio Numerator Exponent | Set the pulse rate for command pulses and Servomotor travel distance.<br>$$\frac{\text{Electronic Gear Ratio Numerator 1 (Pn46) or Electronic Gear Ratio Numerator 2 (Pn47)} \times 2^{\text{Electronic Gear Ratio Numerator Exponent (Pn4A)}}}{\text{Electronic Gear Ratio Denominator (Pn4B)}}$$ | 0 | --- | 0 to 17 | --- |
| 4B | Electronic Gear Ratio Denominator | | 2500 | --- | 1 to 10000 | --- |
| 4C | Position Command Filter Time Constant Setting | Set the time constant for the primary lag filter for the command pulse input.<br>If the parameter is set to 0, the filter will not function.<br>The larger the setting, the larger the time constant. | 0 | --- | 0 to 7 | --- |
| 4D | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 4E | Smoothing Filter Setting | Select the FIR filter time constant used for the command pulse input.<br>The larger the setting, the smoother the command pulses. | 0 | --- | 0 to 31 | Yes |
| 4F | Not used. | (Do not change setting.) | 0 | --- | --- | --- |

## ■ Internally Set Speed Control Parameters

| Pn No. | Parameter name | Explanation | Default setting | Unit | Setting range | Power OFF→ ON |
|---|---|---|---|---|---|---|
| 50 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 51 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 52 | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 53 | No. 1 Internally Set Speed | Set the No. 1 internally set rotation speed. | 100 | r/min | –20000 to 20000 | --- |
| 54 | No. 2 Internally Set Speed | Set the No. 2 internally set rotation speed. | 200 | r/min | –20000 to 20000 | --- |
| 55 | No. 3 Internally Set Speed | Set the No. 3 internally set rotation speed. | 300 | r/min | –20000 to 20000 | --- |
| 56 | No. 4 Internally Set Speed | Set the No. 4 internally set rotation speed. | 400 | r/min | –20000 to 20000 | --- |
| 57 | Jog Speed | Set the rotation speed for jogging. | 200 | r/min | 0 to 500 | --- |
| 58 | Soft Start Acceleration Time | Set the acceleration time for internally set speed control. Set the time (setting × 2 ms) required until 1,000 r/min is reached. | 0 | 2 ms | 0 to 5000 | --- |
| 59 | Soft Start Deceleration Time | Set the deceleration time for internally set speed control. Set the time (setting × 2 ms) required until operation stops from 1000 r/min. | 0 | 2 ms | 0 to 5000 | --- |
| 5A | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 5B | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 5C | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 5D | Not used. | (Do not change setting.) | 0 | --- | --- | --- |
| 5E | Torque Limit | Set the limit to the Servomotor's maximum torque. | 300 | % | 0 to 500 | --- |
| 5F | Not used. | (Do not change setting.) | 0 | --- | --- | --- |

## ■ Sequence Parameters

| Pn No. | Parameter name | Setting | Explanation | Default setting | Unit | Setting range | Power OFF→ON |
|---|---|---|---|---|---|---|---|
| 60 | Positioning Completion Range | | Set the range for the Positioning Completed Output (INP). | 25 | Pulses | 0 to 32767 | --- |
| 61 | Zero Speed Detection | | Set the rotation speed for the Warning Output for zero speed detection. | 20 | r/min | 0 to 20000 | --- |
| 62 | Rotation Speed for Servomotor Rotation Detection | | Set the rotation speed for the Servomotor Rotation Speed Detection Output (TGON) for Internally Set Speed Control. | 50 | r/min | 0 to 20000 | --- |
| 63 | Deviation Counter Overflow Level | | Set the detection level for the Deviation Counter Overflow Alarm. The alarm level is the setting value multiplied by 256 pulses. | 100 | × 256 pulses | 0 to 32767 | --- |
| 64 | Deviation Counter Overflow Alarm Disabled | | Enable or disable the Deviation Counter Overflow Alarm. | 0 | --- | 0 or 1 | --- |
| | | 0 | Deviation Counter Overflow Alarm enabled. | | | | |
| | | 1 | Deviation Counter Overflow Alarm disabled. | | | | |
| 65 | Not used. | | (Do not change setting.) | 0 | --- | --- | --- |
| 66 | Stop Selection for Drive Prohibit Input | | Set the operation used to decelerate to a stop after the Forward Drive Prohibit Input (POT) or Reverse Drive Prohibit Input (NOT) is turned ON. | 0 | --- | 0 to 2 | Yes |
| | | 0 | The torque in the drive prohibit direction is disabled, and the dynamic brake is activated. | | | | |
| | | 1 | The torque in the drive prohibit direction is disabled, and free-run deceleration is performed to stop. | | | | |
| | | 2 | A servo lock stop is used in position control, and a zero-speed designation stop is used in Internally Set Speed Control. | | | | |
| 67 | Not used. | | (Do not change setting.) | 0 | --- | --- | --- |
| 68 | Stop Selection at Alarm | | Set the operation to use during deceleration and after stopping when an alarm occurs. The deviation counter will be cleared when an alarm occurs. | 0 | --- | 0 to 3 | --- |
| | | 0 | During deceleration: Dynamic brake<br>After stopping: Dynamic brake | | | | |
| | | 1 | During deceleration: Free run<br>After stopping: Dynamic brake | | | | |
| | | 2 | During deceleration: Dynamic brake<br>After stopping: Servo free | | | | |
| | | 3 | During deceleration: Free run<br>After stopping: Servo free | | | | |

| Pn No. | Parameter name | Setting | Explanation | Default setting | Unit | Setting range | Power OFF→ ON |
|---|---|---|---|---|---|---|---|
| 69 | Stop Selection with Servo OFF | Set the operation to use during deceleration and after stopping and set the deviation counter status when the RUN Command Input (RUN) is turned OFF. | | 0 | --- | 0 to 7 | --- |
| | | 0 | During deceleration: Dynamic brake<br>After stopping: Dynamic brake<br>Deviation counter: Cleared | | | | |
| | | 1 | During deceleration: Free run<br>After stopping: Dynamic brake<br>Deviation counter: Cleared | | | | |
| | | 2 | During deceleration: Dynamic brake<br>After stopping: Servo free<br>Deviation counter: Cleared | | | | |
| | | 3 | During deceleration: Free run<br>After stopping: Servo free<br>Deviation counter: Cleared | | | | |
| | | 4 | During deceleration: Dynamic brake<br>After stopping: Dynamic brake<br>Deviation counter: Hold | | | | |
| | | 5 | During deceleration: Free run<br>After stopping: Dynamic brake<br>Deviation counter: Hold | | | | |
| | | 6 | During deceleration: Dynamic brake<br>After stopping: Servo free<br>Deviation counter: Hold | | | | |
| | | 7 | During deceleration: Free run<br>After stopping: Servo free<br>Deviation counter: Hold | | | | |
| 6A | Brake Timing When Stopped | When the Servomotor is stopped and the RUN Command Input (RUN) is turned OFF, the Brake Interlock Signal (BKIR) will turn OFF, and the Servomotor will turn OFF after the time set for this parameter elapses (i.e., setting × 2 ms). | | 10 | 2 ms | 0 to 100 | --- |
| 6B | Brake Timing during Operation | When the Servomotor is operating and the RUN Command Input (RUN) is turned OFF, the Servomotor will decelerate to reduce speed, and the Brake Interlock Signal (BKIR) will turn OFF after a set time (i.e., setting × 2 ms) has elapsed.<br>BKIR will also turn OFF if the speed drops to 30 r/min or lower before the set time elapses. | | 50 | 2 ms | 0 to 100 | --- |

| Pn No. | Parameter name | Setting | Explanation | Default setting | Unit | Setting range | Power OFF→ ON |
|---|---|---|---|---|---|---|---|
| 6C | Regeneration Resistor Selection | Set this parameter to 1 or 2 if an external generation resistor is mounted. | | 0 | --- | 0 to 3 | --- |
| | | 0 | The external regeneration processing circuit will not operate. Regenerative energy will be processed with the built-in capacitor. | | | | |
| | | 1 | An External Regeneration Resistor is used, and an External Regeneration Resistor overload alarm (alarm code 18) will occur when the resistance exceeds 10% of the operating limit. | | | | |
| | | 2 | An External Regeneration Resistor is used, but an External Regeneration Resistor overload alarm will not occur. | | | | |
| | | 3 | The external regeneration processing circuit will not operate. Regenerative energy will be processed with the built-in capacitor. | | | | |
| 6D | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 6E | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 6F | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 70 | Overspeed Detection Level Setting | Set the No. 1 overspeed detection level when torque limit switching is enabled in the Zero-speed Designation/Torque Limit Switch (Pn06). | | 0 | r/min | 0 to 6000 | --- |
| 71 | No. 2 Torque Limit | Set the No. 2 torque limit when torque limit switching is enabled in the Zero-speed Designation/ Torque Limit Switch (Pn06). | | 100 | % | 0 to 500 | --- |
| 72 | No. 2 Deviation Counter Overflow Level | Set the No. 2 deviation counter overflow level when torque limit switching is enabled in the Zero-speed Designation/Torque Limit Switch (Pn06). | | 100 | × 256 pulses | 1 to 32767 | --- |
| 73 | No. 2 Overspeed Detection Level Setting | Set the No. 2 overspeed detection level when torque limit switching is enabled in the Zero-speed Designation/Torque Limit Switch (Pn06). | | 0 | r/min | 0 to 6000 | --- |
| 74 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 75 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 76 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 77 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 78 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 79 | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 7A | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 7B | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 7C | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 7D | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 7E | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |
| 7F | Not used. | (Do not change setting.) | | 0 | --- | --- | --- |

## Parameter Details

This section describes the user parameters in detail. Be sure to fully understand the meanings of the parameters and change them properly.
Do not change settings of the parameters marked “Not used.”

### ■ Function Selection Parameters

| Pn00 | Unit No. Setting | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 15 | Unit | --- | Default setting | 1 | Power OFF → ON | Yes |

- Use this parameter to set the unit number.

| Pn01 | Default Display | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 15 | Unit | Refer to the following table. | Default setting | 1 | Power OFF → ON | Yes |

- Use this parameter to set the item to be displayed on the Parameter Unit when the power supply is turned ON.

#### Explanation of Settings

| Setting | Explanation | | Unit |
|---|---|---|---|
| 0 | Position deviation | Displays the number of accumulated pulses in the deviation counter. | Pulse |
| 1 | Servomotor rotation speed | Displays the Servomotor rotation speed. | r/min |
| 2 | Torque output | Displays the Servomotor output torque as a percentage of the rated torque output. | % |
| 3 | Control mode | Displays the control mode, i.e., position control or Internally Set Speed Control. | --- |
| 4 | I/O signal status | Displays the status of control input and output signals connected to CN1. | --- |
| 5 | Alarm display and history | Displays the 14 most recent alarms, including current alarms. | --- |
| 6 | Not used. | | --- |
| 7 | Warning display | Displays overload and over regeneration warnings. | --- |
| 8 | Regeneration load ratio | Displays the load ratio as a percentage of the regeneration overload alarm operation level. | % |
| 9 | Overload load ratio | Displays the load ratio as a percentage of the rated load. | % |
| 10 | Inertia ratio | Displays the inertia ratio. | % |
| 11 | Total feedback pulses | Displays the total number of pulses since the power supply was turned ON.<br><br>Press the Data key for 5 s or longer to reset the value. | Pulse |
| 12 | Total command pulses | | Pulse |
| 13 | Not used. | | --- |
| 14 | Not used. | | --- |
| 15 | Automatic Servomotor recognition display | Automatic Servomotor recognition is always enabled. | --- |

| Pn02 | Control Mode Selection | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 2 | Power OFF → ON | Yes |

- Set the control mode to be used.

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | High-response Position Control |
| 1 | Internally Set Speed Control |
| 2 | Advanced Position Control |

### Differences between High-response Position Control and Advanced Position Control

| | Notch Filter 1 Frequency (Pn1D) | Vibration Frequency (Pn2B) | Realtime Autotuning Mode Selection (Pn21) | Adaptive Filter Table Number Display(Pn2F) |
|---|---|---|---|---|
| High-response Position Control | Conditional | Conditional | Conditional | Disabled |
| Advanced Position Control | Enabled | Enabled | Enabled | Enabled |

- The Notch Filter 1 Frequency, Vibration Frequency, and Realtime Autotuning Mode Selection cannot be used at the same time in High-response Position Control Mode. The parameter entered first will be given priority.

Example:
When the Realtime Autotuning Mode Selection is set, the Servo Drive will be forcibly set to 1500 (disabled), even if the Notch Filter 1 Frequency is input.

- The adaptive filter is disabled in High-response Position Control Mode. To use the adaptive filter, use the Advanced Position Control Mode.

| Pn03 | Not used. (Do not change setting.) |
|---|---|

| Pn04 | Drive Prohibit Input Selection | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 1 | Power OFF → ON | Yes |

- Set whether to use the drive prohibit inputs.
- You can prevent the Servomotor from rotating beyond the device's operating range by connecting limit inputs.
- When only the Forward Drive Prohibit Input (POT) is turned ON, the Servomotor can operate in the forward direction, but cannot operate in the reverse direction.

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Drive prohibit inputs enabled.<br>When the Forward Drive Prohibit Input (POT) and the Reverse Drive Prohibit Input (NOT) are ON, the Servomotor can operate in the forward and reverse directions. |
| 1 | Drive prohibit inputs disabled.<br>Operation is possible regardless of the POT and NOT inputs. |

| Pn05 | Not used. (Do not change setting.) |
|---|---|

| Pn06 | Zero Speed Designation/Torque Limit Switch | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 1 | Power OFF → ON | Yes |

- Use this parameter to select whether to use the Zero Speed Designation Input (VZERO) or Torque Limit Switch Input (TLSEL) as the function of pin CN1-5.
- For Position Control Mode, 0 or 2 can be selected. For Internally Set Speed Control Mode, 1 or 2 can be selected.
- If 0 is selected in Position Control Mode, pin CN1-5 will be used as the Gain Switch Input (GSEL).
- If the Torque Limit Switch Input (TLSEL) is used, always set the following parameters: Overspeed Detection Level Setting (Pn70), No. 2 Torque Limit (Pn71), and No. 2 Overspeed Detection Level Setting (Pn73). If the Torque Limit Switch Input is used with the default settings, an overspeed alarm (alarm code 26) will occur.

### Explanation of Settings

| Setting | Explanation | |
|---|---|---|
| | Zero Speed Designation Input (VZERO) | Torque Limit Switch Input (TLSEL) |
| 0 | Disabled | Disabled |
| 1 | Enabled | Disabled |
| 2 | Disabled | Enabled |

| Pn07 | Not used. (Do not change setting.) |
|---|---|

| Pn08 | Not used. (Do not change setting.) |
|---|---|

| Pn09 | Warning Output Selection | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 6 | Unit | --- | Default setting | 2 | Power OFF → ON | --- |

- Set the function of the Warning Output (WARN).

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Output while torque is being limited. |
| 1 | Output for zero speed detection. |
| 2 | Output for regeneration, overload, or fan rotation speed alarm warning. |
| 3 | Output for regeneration warning. |
| 4 | Output for overload warning. |
| 5 | Not Used. |
| 6 | Output for fan rotation speed alarm warning. |

| | |
|---|---|
| Pn0A | Not used. (Do not change setting.) |
| Pn0B | Not used. (Do not change setting.) |
| Pn0C | Not used. (Do not change setting.) |
| Pn0D | Not used. (Do not change setting.) |
| Pn0E | Not used. (Do not change setting.) |
| Pn0F | Not used. (Do not change setting.) |

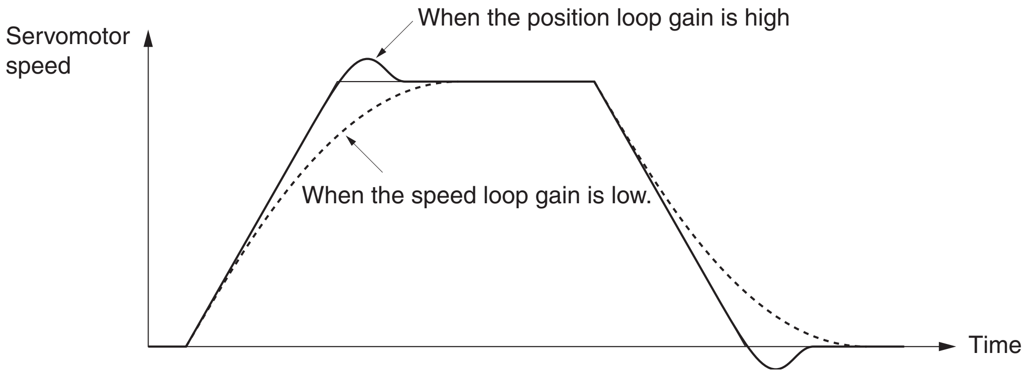
## ■ Gain Parameters

| Pn10 | Position Loop Gain | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 32767 | Unit | 1/s | Default setting | 40 | Power OFF → ON | --- |

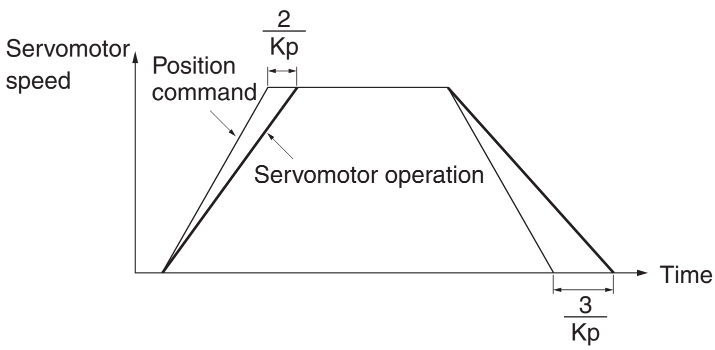
- Set this parameter to adjust the position loop response according to the mechanical rigidity.
- The responsiveness of the servo system is determined by the position loop gain. Servo systems with a high loop gain have a high response and can make positioning faster. To increase the position loop gain, you must improve mechanical rigidity and increase the specific oscillation frequency. The value should be 50 to 70 (1/s) for ordinary machine tools, 30 to 50 (1/s) for general-use and assembly machines, and 10 to 30 (1/s) for industrial robots. Since the default position loop gain is 40 (1/s), be sure to lower the setting for machines with low rigidity.
- Increasing the position loop gain in systems with low mechanical rigidity or systems with low specific oscillation frequencies may cause machine resonance, resulting in an overload alarm.
- If the position loop gain is low, you can shorten the positioning time by using feed forward.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.
- Position loop gain is generally calculated as follows:

$$\text{Position loop gain (Kp)} = \frac{\text{Command pulse frequency (pulses/s)}}{\text{Deviation counter accumulated pulses (pulses)}}\ \text{(1/s)}$$

When the position loop gain is changed, the response is as shown in the following diagram.



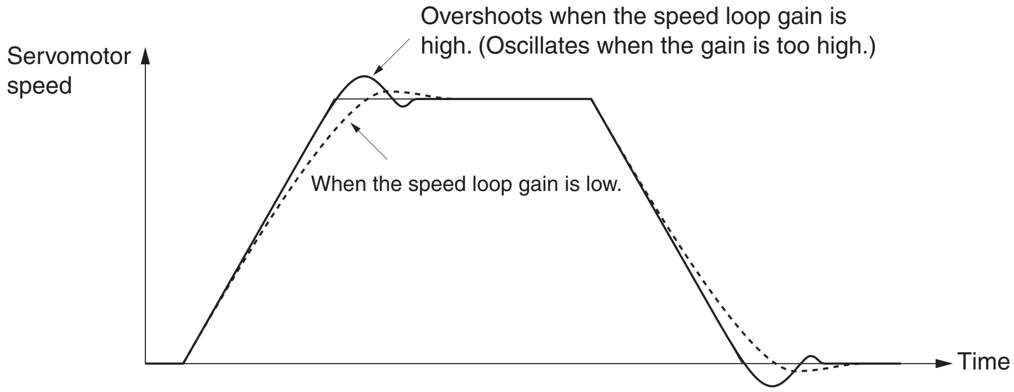

- If the speed loop gain and position loop gain are optimally set, the Servomotor operation for the command will be delayed 2/Kp at acceleration and delayed 3/Kp at deceleration.



| Pn11 | Speed Loop Gain | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 3500 | Unit | Hz | Default setting | 60 | Power OFF → ON | --- |

- This gain adjusts the speed loop response.
- Increase the gain to increase servo rigidity. Generally, the greater the inertia ratio, the higher the setting. If the gain is too high, it causes oscillation.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

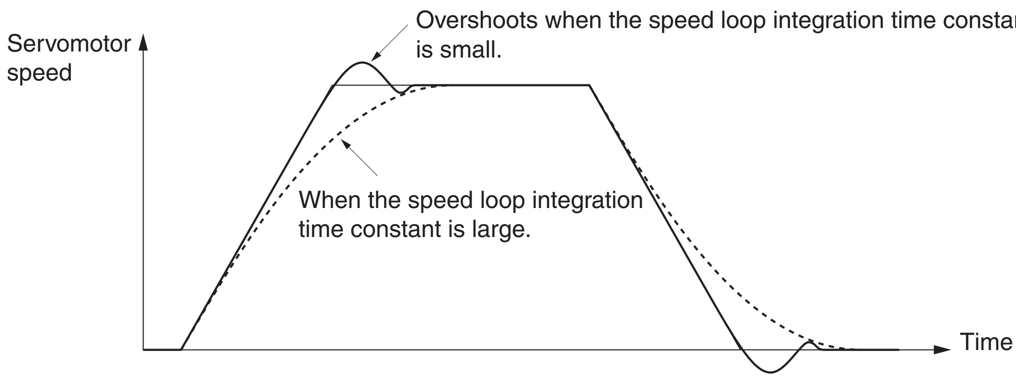
When the speed loop gain is changed, the response is as shown in the following diagram.




| Pn12 | Speed Loop Integration Time Constant | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 1000 | Unit | ms | Default setting | 20 | Power OFF → ON | --- |

- Set the speed loop integration time constant.
- The higher the setting, the lower the responsiveness and the lower the resiliency to external force. If the setting is too low, it causes oscillation.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

When the speed loop integration time constant is changed, the response is as shown in the following diagram.




| Pn13 | Speed Feedback Filter Time Constant | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 5 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- The encoder signal is converted to the speed signal via the low pass filter.
- The higher the setting, the higher the time constant and the lower the noise level generated by the Servomotor. Normally, use a setting of 4 or less.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

| Pn14 | Torque Command Filter Time Constant | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2500 | Unit | × 0.01 ms | Default setting | 100 | Power OFF → ON | --- |

- Set this parameter to adjust the primary lag filter time constant for the torque command.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

| Pn15 | Feed-forward Amount | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | −2000 to 2000 | Unit | × 0.1% | Default setting | 300 | Power OFF → ON | --- |

- Set the feed-forward compensation value during position control.
- When performing feed-forward compensation, the effective servo gain increases, improving responsiveness. There is almost no effect, however, on systems whose position loop gain is sufficiently high.
- Use this parameter to shorten positioning time.
- Setting a high value may result in machine vibration. Set the feed-forward amount for general machinery to 80% maximum. (Make adjustments while checking machine response.)
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

| Pn16 | Feed-forward Command Filter | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 6400 | Unit | × 0.01 ms | Default setting | 100 | Power OFF → ON | --- |

- Set the feed-forward (primary lag) command filter to use during position control.
- If the Positioning Completed Signal (INP) is interrupted (i.e., repeatedly turns ON and OFF) because of feed-forward compensation, and speed overshooting occurs, the problem may be solved by setting the primary lag filter.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

| Pn17 | Not used. (Do not change setting.) |
|---|---|

| Pn18 | Position Loop Gain 2 | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 32767 | Unit | 1/s | Default setting | 20 | Power OFF → ON | --- |

| Pn19 | Speed Loop Gain 2 | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 3500 | Unit | Hz | Default setting | 80 | Power OFF → ON | --- |

| Pn1A | Speed Loop Integration Time Constant 2 | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 1000 | Unit | ms | Default setting | 50 | Power OFF → ON | --- |

| Pn1B | Speed Feedback Filter Time Constant 2 | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 5 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

| Pn1C | Torque Command Filter Time Constant 2 | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2500 | Unit | × 0.01 ms | Default setting | 100 | Power OFF → ON | --- |

- These parameters are for the gain and time constants selected when gain switching is enabled in the Gain Switching Input Operating Mode Selection (Pn30).
- The gain is switched according to the condition set in the Gain Switch Setting (Pn31).
- If the mechanical system inertia changes greatly or if you want to change the responsiveness while the Servomotor is rotating and stopped, you can achieve the appropriate control by setting the gains and time constants beforehand for each condition, and switch between them according to the condition.
- These parameters are automatically changed by executing realtime autotuning function. To set them manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.
- Gain switching function is enabled only for position control. For Internally Set Speed Control, operation will be performed using gain 1 (Pn11, Pn12, Pn13, and Pn14).

| Pn1D | Notch Filter 1 Frequency | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 100 to 1500 | Unit | Hz | Default setting | 1500 | Power OFF → ON | --- |

- Set the notch frequency of the resonance suppression notch filter.
- Set this parameter to approximately 10% lower than the resonance frequency of the mechanical system.
- The notch filter function will be disabled if this parameter is set to 1500.

| Pn1E | Notch Filter 1 Width | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 4 | Unit | --- | Default setting | 2 | Power OFF → ON | --- |

- Set the width to one of five levels for the resonance suppression notch filter.
- Increasing the setting increases the width.
- Normally, use the default setting.

| Pn1F | Not used. (Do not change setting.) |
|---|---|

| Pn20 | Inertia Ratio | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10000 | Unit | % | Default setting | 300 | Power OFF → ON | --- |

- Set the mechanical system inertia (load inertia at the Servomotor shaft) as a percentage of the Servomotor rotor inertia.
- This parameter is automatically changed by executing autotuning.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.
- When realtime autotuning is performed, the estimated inertia ratio is saved in EEPROM every 30 minutes.
- If the inertia ratio is set correctly, the setting unit for Speed Loop Gain (Pn11) and Speed Loop Gain 2 (Pn19) will be Hz. If the Inertia Ratio (Pn20) is set larger than the actual value, the setting for speed loop gain will increase. If the inertia ratio is set smaller than the actual value, the setting for speed loop gain will decrease.

| Pn21 | Realtime Autotuning Mode Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 7 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- Set the operating mode for realtime autotuning.
- The higher the setting value is (e.g., 3 or 6), the faster the response is to a change in inertia during operation. Operation, however, may become unstable depending on the operating pattern. Normally, set the parameter to 1 or 4.
- To enable the adaptive filter, the Control Mode Selection (Pn02) must be set to 2 (advanced position control).
- The adaptive filter table entry number display will be reset to 0 if the adaptive filter is disabled.
- Changes to this parameter are enabled when the Servo status shifts from OFF to ON.
- The Notch Filter 1 Frequency (Pn1D) and Vibration Frequency (Pn2B) must be disabled if realtime autotuning function is used with the Control Mode Selection (Pn02) set to 0 (high-response position control).

### Explanation of Settings

| Setting | Realtime autotuning | Degree of change in load inertia during operation | Adaptive filter |
|---|---|---|---|
| 0 | Not used. | --- | Disabled |
| 1 | Used. | There is almost no change. | Enabled (Pn02 = 2) |
| 2 | | There are gradual change. | |
| 3 | | There are sudden changes. | |
| 4 | | There is almost no change. | Disabled |
| 5 | | There are gradual changes. | |
| 6 | | There are sudden changes. | |
| 7 | Not used. | --- | Enabled (Pn02 = 2) |

| Pn22 | Realtime Autotuning Machine Rigidity Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 15 | Unit | --- | Default setting | 2 | Power OFF → ON | --- |

- Set the machine rigidity to one of 16 levels for executing realtime autotuning.
- The greater the machine rigidity, the higher the setting. The higher the setting, the higher the responsiveness.
- If the setting is changed suddenly by a large amount, the gain will change rapidly, subjecting the machine to shock. Always start with a small value in the setting, and gradually increase the setting while monitoring machine operation.

| Pn23 | Not used. (Do not change setting.) |
|---|---|

| Pn24 | Not used. (Do not change setting.) |
|---|---|





| Pn25 | Autotuning Operation Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 7 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- Set the operating pattern for autotuning.

### Explanation of Settings

| Setting | Rotation direction | Number of rotations |
|---|---|---|
| 0 | CCW → CW | Two rotations |
| 1 | CW → CCW | |
| 2 | CCW → CCW | |
| 3 | CW → CW | |
| 4 | CCW → CW | One rotation |
| 5 | CW → CCW | |
| 6 | CCW → CCW | |
| 7 | CW → CW | |

| Pn26 | Overrun Limit Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 1000 | Unit | × 0.1 rotation | Default setting | 10 | Power OFF → ON | --- |

- Set the allowable operating range for the Servomotor.
- The overrun limit function is disabled if the setting is 0.
- For details, refer to *Overrun Limit* on page 5-16.

| Pn27 | Not used. (Do not change setting.) |
|---|---|

| Pn28 | Not used. (Do not change setting.) |
|---|---|

| Pn29 | Not used. (Do not change setting.) |
|---|---|

| Pn2A | Not used. (Do not change setting.) |
|---|---|

| Pn2B | Vibration Frequency | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 5000 | Unit | × 0.1 Hz | Default setting | 0 | Power OFF → ON | --- |

- Set vibration frequency for vibration control to suppress vibration at the end of the load.
- The minimum frequency that can be set is 100 (10.0 Hz). The parameter will be disabled if it is set to 0 to 99.
- The Notch Filter 1 Frequency (Pn1D) and Realtime Autotuning Mode Selection (Pn21) must be disabled if vibration control function is used with the Control Mode Selection (Pn02) set to 0 (high-response position control).
- For details, refer to *Vibration Control* on page 7-23.

| Pn2C | Vibration Filter Setting | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | –200 to 2500 | Unit | × 0.1 Hz | Default setting | 0 | Power OFF → ON | --- |

- Set the vibration filter for vibration control to suppress vibration at the end of the load.
- When the Vibration Frequency (Pn2B) is set, set a small value if torque saturation occurs and set a large value to achieve faster positioning.
- Normally, set the parameter to 0.
- For details, refer to *Vibration Control* on page 7-23.

| Pn2D | Not used. (Do not change setting.) |
|---|---|

| Pn2E | Not used. (Do not change setting.) |
|---|---|

| Pn2F | Adaptive Filter Table Number Display | | | | | Advanced position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 64 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- This parameter displays the table entry number corresponding to the frequency of the adaptive filter.
- This parameter is set automatically and cannot be changed if the adaptive filter is enabled in the Realtime Autotuning Mode Selection (Pn21).
- When the adaptive filter is enabled, data will be saved in EEPROM every 30 minutes. If the adaptive filter is enabled the next time the power supply is turned ON, adaptive operation will start with the data saved in the EEPROM as the default value.
- To reset the adaptive filter when operation is not normal, set the Realtime Autotuning Mode Selection (Pn21) to 0 or to between 4 and 6 and disable the filter, and enable it again.
- If the display for this parameter is 49 or higher, the adaptive filter may be automatically disabled depending on the Realtime Autotuning Machine Rigidity Selection (Pn22).





### Explanation of Settings

| Displayed value | Notch Filter 1 Frequency (Hz) |
|---|---|
| 0 | Disabled |
| 1 | Disabled |
| 2 | Disabled |
| 3 | Disabled |
| 4 | Disabled |
| 5 | 1482 |
| 6 | 1426 |
| 7 | 1372 |
| 8 | 1319 |
| 9 | 1269 |
| 10 | 1221 |
| 11 | 1174 |
| 12 | 1130 |
| 13 | 1087 |
| 14 | 1045 |
| 15 | 1005 |
| 16 | 967 |
| 17 | 930 |
| 18 | 895 |
| 19 | 861 |
| 20 | 828 |
| 21 | 796 |

| Displayed value | Notch Filter 1 Frequency (Hz) |
|---|---|
| 22 | 766 |
| 23 | 737 |
| 24 | 709 |
| 25 | 682 |
| 26 | 656 |
| 27 | 631 |
| 28 | 607 |
| 29 | 584 |
| 30 | 562 |
| 31 | 540 |
| 32 | 520 |
| 33 | 500 |
| 34 | 481 |
| 35 | 462 |
| 36 | 445 |
| 37 | 428 |
| 38 | 412 |
| 39 | 396 |
| 40 | 381 |
| 41 | 366 |
| 42 | 352 |
| 43 | 339 |

| Displayed value | Notch Filter 1 Frequency (Hz) |
|---|---|
| 44 | 326 |
| 45 | 314 |
| 46 | 302 |
| 47 | 290 |
| 48 | 279 |
| 49 | 269 (Disabled when Pn22 ≥ F) |
| 50 | 258 (Disabled when Pn22 ≥ F) |
| 51 | 248 (Disabled when Pn22 ≥ F) |
| 52 | 239 (Disabled when Pn22 ≥ F) |
| 53 | 230 (Disabled when Pn22 ≥ F) |
| 54 | 221 (Disabled when Pn22 ≥ E) |
| 55 | 213 (Disabled when Pn22 ≥ E) |
| 56 | 205 (Disabled when Pn22 ≥ E) |
| 57 | 197 (Disabled when Pn22 ≥ E) |
| 58 | 189 (Disabled when Pn22 ≥ E) |
| 59 | 182 (Disabled when Pn22 ≥ D) |
| 60 | Disabled |
| 61 | Disabled |
| 62 | Disabled |
| 63 | Disabled |
| 64 | Disabled |

| Pn30 | Gain Switching Input Operating Mode Selection | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 1 | Power OFF → ON | --- |

- Set this parameter to enable or disable gain switching.
- If gain switching is disabled, the gain switching input can be used to switch between PI operation and P operation.
- If gain switching is enabled, the setting of the Gain Switch Setting (Pn31) is used as the condition for switching between gain 1 and gain 2.

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Gain switching is disabled.<br>Gain 1 (Pn10 to Pn14) is used, and the Gain Switch Input (GSEL) will be used to switch between PI operation and P operation. |
| 1 | Gain switching is enabled.<br>The gain will be switched between gain 1 in (Pn10 to Pn14) and gain 2 (Pn18 to Pn1C). |

| Pn31 | Gain Switch Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

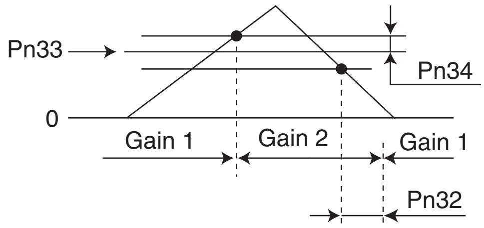
- Select the condition for switching between gain 1 and gain 2.
- The Gain Switch Input Operating Mode Selection (Pn30) must be set to 1 to enable gain switching.

### Explanation of Settings

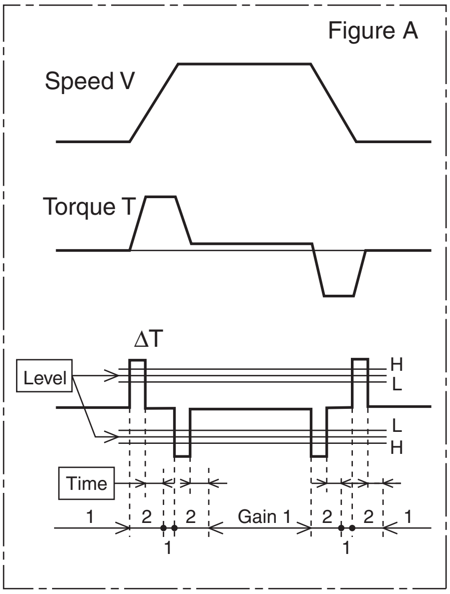
(○: Enabled, ×: Disabled)

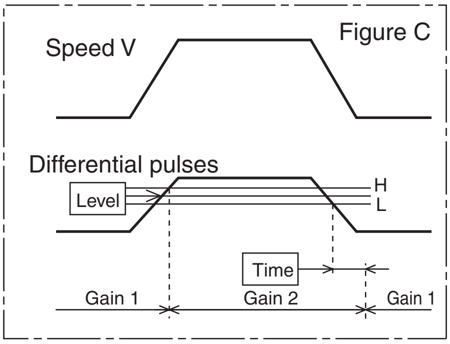
| Setting | Explanation | | | |
|---|---|---|---|---|
| | Gain switching conditions | Gain Switch Time (Pn32) *1 | Gain Switch Level Setting | Gain Switch Hysteresis Setting (Pn34) *2 |
| 0 | Always gain 1 (Pn10 to Pn14) | × | × | × |
| 1 | Always gain 2 (Pn18 to Pn1C) | × | × | × |
| 2 | Switching using Gain Switch Input (GSEL) for pin CN1-5. | × | × | × |
| 3 | Amount of change in torque command (Figure A) | ○ | ○ *3 (× 0.05%) | ○ *3) (× 0.05%) |
| 4 | Always gain 1 (Pn10 to Pn14) | × | × | × |
| 5 | Command speed (Figure B) | ○ | ○ (r/min) | ○ (r/min) |
| 6 | Amount of position deviation (Figure C) | ○ | ○ *4 (Pulse) | ○ *4 (Pulse) |
| 7 | Command pulses received (Figure D) | ○ | × | × |
| 8 | Positioning Completed Output (INP) OFF (Figure E) | ○ | × | × |
| 9 | Actual Servomotor speed (Figure B) | ○ | ○ (r/min) | ○ (r/min) |
| 10 | Combination of command pulse input and speed (Figure F) | ○ | ○ *5 (r/min) | ○ *5 (r/min) |

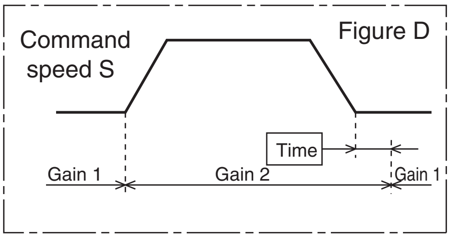
*1. The Gain Switch Time (Pn32) is used when returning from gain 2 to gain 1.
*2. The Gain Switch Hysteresis Setting (Pn34) is defined as shown in the following figure.

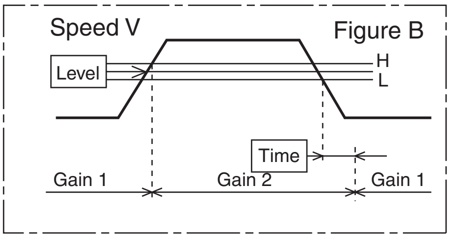


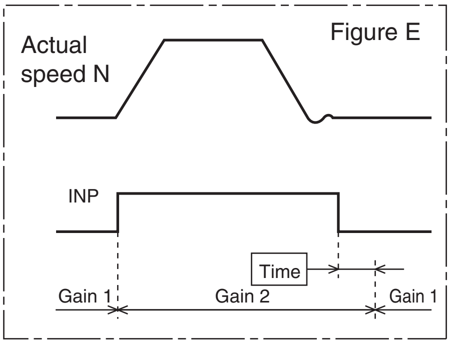

*3. The amount of change is the value within 166 μs.
Example: When the condition is a 10% change in torque in 166 μs, the set value is 200.
*4. This is the encoder resolution.
*5. The meanings of the Gain Switch Time, Gain Switch Level Setting, and Gain Switch Hysteresis Setting are different from normal if this parameter is set to 10. (Refer to Figure F.)

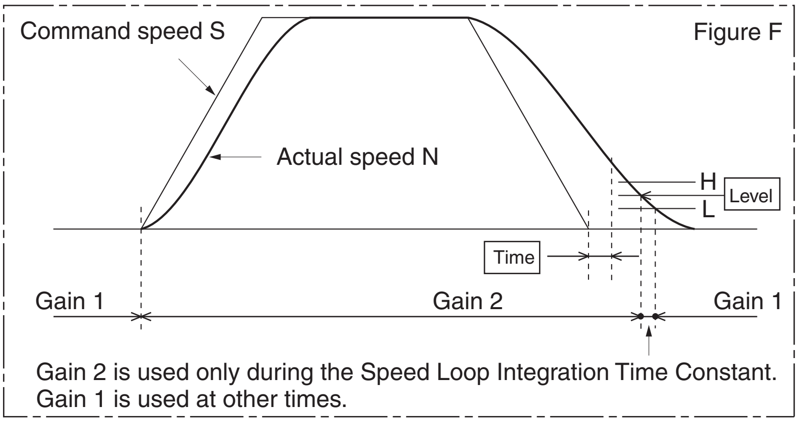


| Pn32 | Gain Switch Time | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10000 | Unit | × 166 μs | Default setting | 30 | Power OFF → ON | --- |

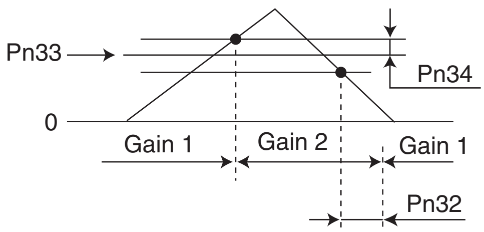
- This parameter is enabled when the Gain Switch Setting (Pn31) is set to 3, or 5 to 10. Set the delay time from the moment the condition set in the Gain Switch Setting (Pn31) is not met until returning to gain 1.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

| Pn33 | Gain Switch Level Setting | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 20000 | Unit | --- | Default setting | 600 | Power OFF → ON | --- |

- This parameter is enabled when the Gain Switch Setting (Pn31) is set to 3, 5, 6, 9, or 10. Set the judgment level for switching between gain 1 and gain 2.
- The unit for the setting depends on the condition set in the Gain Switch Setting (Pn31).
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

| Pn34 | Gain Switch Hysteresis Setting | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 20000 | Unit | --- | Default setting | 50 | Power OFF → ON | --- |

- Set the hysteresis width above and below the judgment level set in the Gain Switch Level Setting (Pn33).
- The Gain Switch Hysteresis Setting (Pn34) is defined as shown in the following figure.



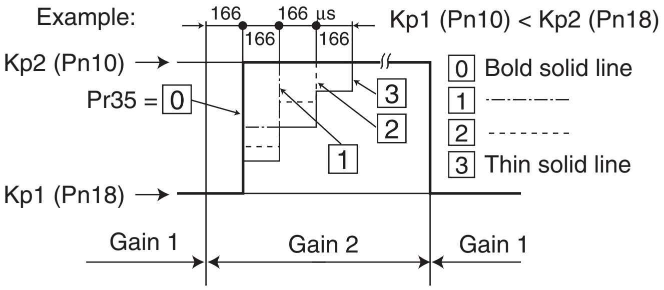

- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

5

Operating Functions

| Pn35 | Position Loop Gain Switching Time | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10000 | Unit | (Setting + 1) (× 166 μs) | Default setting | 20 | Power OFF → ON | --- |

- If the Gain Switching Input Operating Mode Selection (Pn30) is set to 1 (gain switching enabled), set the phased switching time only for position loop gain at gain switching.




- The switching time is set only when switching from a small position loop gain to a large position loop gain (Kp1 to Kp2). This is to reduce the shock to the machine due to sudden changes in the gain.
- Set a value smaller than the difference between Kp2 and Kp1.
- This parameter is automatically changed by executing realtime autotuning function. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.

| Pn36 | Not used. (Do not change setting.) |
|---|---|

| Pn37 | Not used. (Do not change setting.) |
|---|---|

| Pn38 | Not used. (Do not change setting.) |
|---|---|

| Pn39 | Not used. (Do not change setting.) |
|---|---|

| Pn3A | Not used. (Do not change setting.) |
|---|---|

| Pn3B | Not used. (Do not change setting.) |
|---|---|

| Pn3C | Not used. (Do not change setting.) |
|---|---|

| Pn3D | Not used. (Do not change setting.) |
|---|---|

| Pn3E | Not used. (Do not change setting.) |
|---|---|

| Pn3F | Not used. (Do not change setting.) |
|---|---|

## ■ Position Control Parameters

| Pn40 | Command Pulse Multiplying Setting | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 4 | Unit | --- | Default setting | 4 | Power OFF → ON | Yes |

- The command pulses are multiplied by a factor of 2 or 4 when 90° phase difference signal inputs are selected as the input format for the command pulses in the Command Pulse Mode (Pn42).

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 1 | Multiply the input pulses by 2. |
| 2 | |
| 3 | Multiply the input pulses by 4. |
| 4 | |

| Pn41 | Command Pulse Rotation Direction Switch | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 0 | Power OFF → ON | Yes |

- Set the Servomotor rotation direction used for the command pulse input.

### Explanation of Setting

| Setting | Explanation |
|---|---|
| 0 | The Servomotor rotates in the direction specified by the command pulse. |
| 1 | The Servomotor rotates in the opposite direction of the direction specified by the command pulse. |
| 2 | |
| 3 | The Servomotor rotates in the direction specified by the command pulse. |

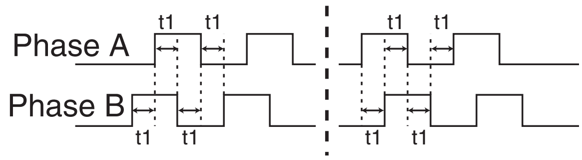
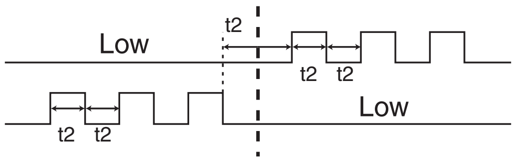
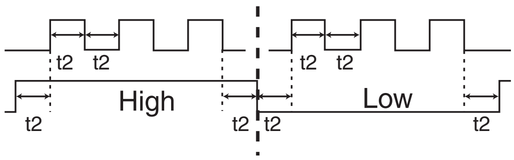
5

Operating Functions

| Pn42 | Command Pulse Mode | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 1 | Power OFF → ON | Yes |

- Set the input format of the pulse inputs sent as commands to the Servo Drive from the position controller.

### Explanation of Setting

| Setting | Command pulse mode | Servomotor forward command | Servomotor reverse command |
|---|---|---|---|
| 0 or 2 | 90° phase difference (phases A and B) signal inputs |   Line driver: t1 ≥ 2 µs<br>Open collector: t1 ≥ 5 µs | |
| 1 | Forward pulse and reverse pulse inputs |   Line driver: t2 ≥ 1 µs<br>Open collector: t2 ≥ 2.5 µs | |
| 3 | Feed pulse input and forward/reverse signal |   Line driver: t2 ≥ 1 µs<br>Open collector: t2 ≥ 2.5 µs | |

| Pn43 | Not used. (Do not change setting.) |
|---|---|

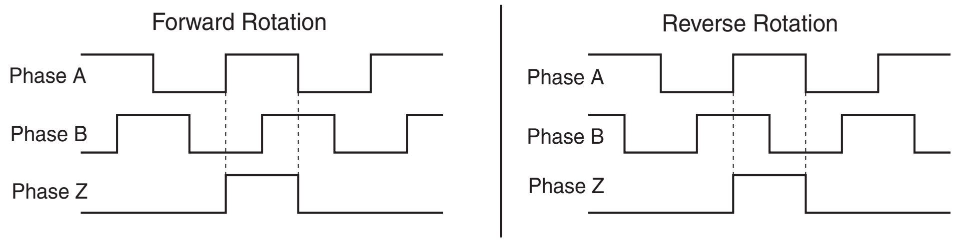
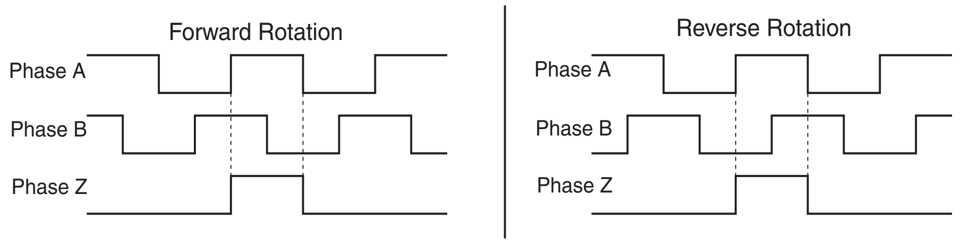
| Pn44 | Encoder Dividing Rate Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 16384 | Unit | Pulse | Default setting | 2500 | Power OFF → ON | Yes |

- Set the number of encoder pulses to be output from the Servo Drive for each rotation.
- The setting can be made from 1 to 16,384 pulses, but the setting will not be valid if it exceeds 2,500 pulses. (Any setting that exceeds the encoder resolution will be invalid.)
- Even if the dividing rate is changed, there will always be 1 pulse per rotation for phase Z.

| Pn45 | Encoder Output Direction Switch | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 0 | Power OFF → ON | Yes |

- This parameter can be used to reverse the logic of the encoder pulses output from the Servo Drive.
- Phase Z is synchronized with phase A. The logic of phase Z cannot be reversed.

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Positive logic<br> |
| 1 | Negative logic<br> |

| Pn46 | Electronic Gear Ratio Numerator 1 | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 10000 | Unit | --- | Default setting | 10000 | Power OFF → ON | --- |

| Pn47 | Electronic Gear Ratio Numerator 2 | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 10000 | Unit | --- | Default setting | 10000 | Power OFF → ON | --- |

- Set the pulse rate for command pulses and Servomotor travel distance along with Pn4A and Pn4B.

$$\frac{\begin{array}{c}\text{Electronic Gear Ratio Numerator 1 (Pn46)}\\ \text{or}\\ \text{Electronic Gear Ratio Numerator 2 (Pn47)}\end{array} \times 2^{\text{Electronic Gear Ratio Numerator Exponent (Pn4A)}}}{\text{Electronic Gear Ratio Denominator (Pn4B)}}$$

- For details, refer to *Electronic Gear* on page 5-9.

| Pn48 | Not used. (Do not change setting.) |
|---|---|

| Pn49 | Not used. (Do not change setting.) |
|---|---|

| Pn4A | Electronic Gear Ratio Numerator Exponent | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 17 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

| Pn4B | Electronic Gear Ratio Denominator | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 10000 | Unit | --- | Default setting | 2500 | Power OFF → ON | --- |

- Set the pulse rate for command pulses and Servomotor travel distance along with Pn46 and Pn47

$$\frac{\text{Electronic Gear Ratio Numerator 1 (Pn46) or Electronic Gear Ratio Numerator 2 (Pn47)} \times 2^{\text{Electronic Gear Ratio Numerator Exponent (Pn4A)}}}{\text{Electronic Gear Ratio Denominator (Pn4B)}}$$

- For details, refer to *Electronic Gear* on page 5-9.



| Pn4C | Position Command Filter Time Constant Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 7 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- Set the time constant for the primary lag filter for command pulse inputs.
- If the command pulses are erratic, the normal countermeasure is to reduce the stepping movement of the Servomotor.

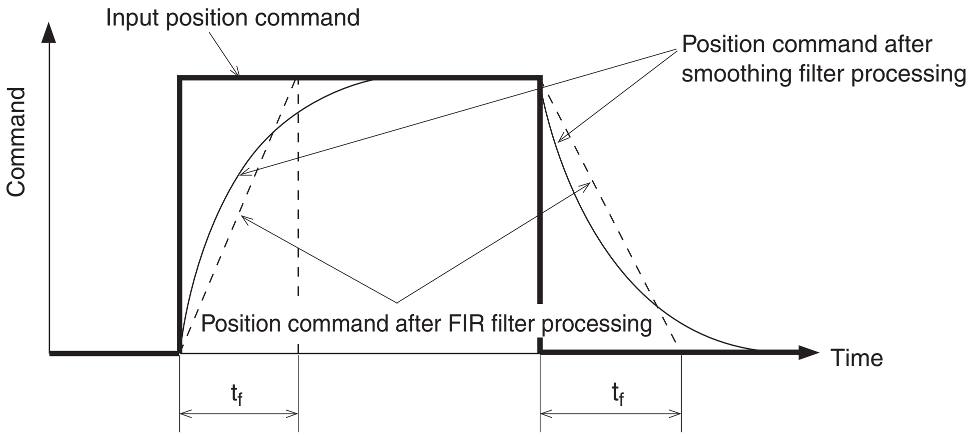
### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | No filter |
| 1 | Time constant: 0.2 ms |
| 2 | Time constant: 0.6 ms |
| 3 | Time constant: 1.3 ms |
| 4 | Time constant: 2.6 ms |
| 5 | Time constant: 5.3 ms |
| 6 | Time constant: 10.6 ms |
| 7 | Time constant: 21.2 ms |

| Pn4D | Not used. (Do not change setting.) |
|---|---|

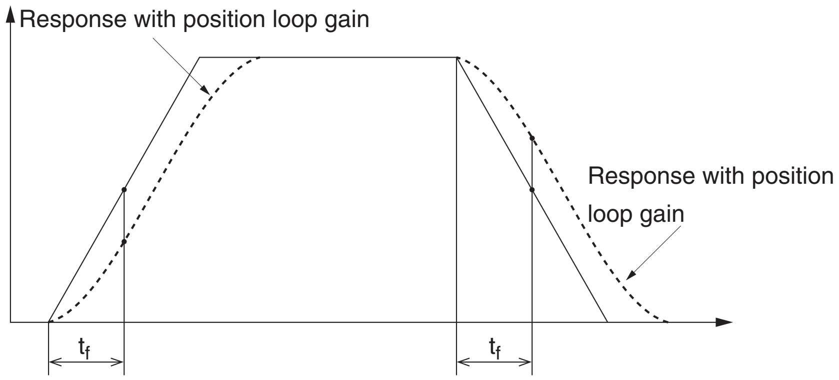
| Pn4E | Smoothing Filter Setting | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 31 | Unit | --- | Default setting | 0 | Power OFF → ON | Yes |

- Select the FIR filter time constant used for the command pulses (FIR: Finite impulse response).
- The higher the setting, the smoother the command pulses.




$t_f$ = (Pn4E + 1) × Control cycle

- Control Cycles with High-response Position Control (Pn02 = 0):
  Setting: 0, Cycle: (0 + 1) × 166 = 166 μs
  Setting: 1, Cycle: (1 + 1) × 166 = 332 μs
  Setting: 31, Cycle: (31 + 1) × 166 = 5312 μs
- Control Cycles with Advanced Position Control (Pn02 = 2):
  Setting: 0, Cycle: (0 + 1) × 333 = 333 μs
  Setting: 1, Cycle: (1 + 1) × 333 = 666 μs
  Setting: 31, Cycle: (31 + 1) × 333 = 10656 μs




| Pn4F | Not used. (Do not change setting.) |
|---|---|

## ■ Internally Set Speed Control Parameters

| | |
|---|---|
| Pn50 | Not used. (Do not change setting.) |

| | |
|---|---|
| Pn51 | Not used. (Do not change setting.) |

| | |
|---|---|
| Pn52 | Not used. (Do not change setting.) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pn53 | No. 1 Internally Set Speed | | | | | Internally set speed | |
| Setting range | −20000 to 20000 | Unit | r/min | Default setting | 100 | Power OFF → ON | --- |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pn54 | No. 2 Internally Set Speed | | | | | Internally set speed | |
| Setting range | −20000 to 20000 | Unit | r/min | Default setting | 200 | Power OFF → ON | --- |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pn55 | No. 3 Internally Set Speed | | | | | Internally set speed | |
| Setting range | −20000 to 20000 | Unit | r/min | Default setting | 300 | Power OFF → ON | --- |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pn56 | No. 4 Internally Set Speed | | | | | Internally set speed | |
| Setting range | −20000 to 20000 | Unit | r/min | Default setting | 400 | Power OFF → ON | --- |

- These speed settings are used for Internally Set Speed Control.
- Use internally set speeds No. 1 to No. 4 when Internally Set Speed Control is selected in the Control Mode Selection (Pn02).
- The sign of the setting indicates the direction of rotation. Settings with a plus sign (normally not indicated) are for the forward direction, and settings with minus sign are for the reverse direction.
- For details, refer to *Internally Set Speed Control* on page 5-4.

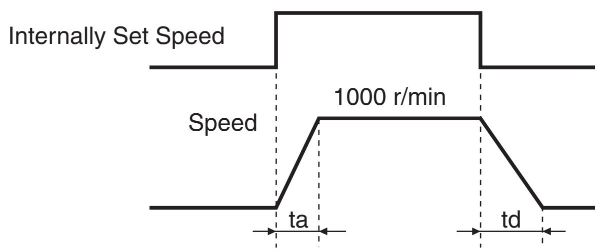
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pn57 | Jog Speed | | | | | All modes | |
| Setting range | 0 to 500 | Unit | r/min | Default setting | 200 | Power OFF → ON | --- |

- Use this parameter to set the speed for jog operation.
- For details, refer to *Auxiliary Function Mode* on page 6-18.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pn58 | Soft Start Acceleration Time | | | | | Internally set speed | |
| Setting range | 0 to 5000 | Unit | × 2 ms | Default setting | 0 | Power OFF → ON | --- |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pn59 | Soft Start Deceleration Time | | | | | Internally set speed | |
| Setting range | 0 to 5000 | Unit | × 2 ms | Default setting | 0 | Power OFF → ON | --- |

- Set the acceleration or deceleration time for Internally Set Speed Control.
- Set the time (setting × 2 ms) required until the Servomotor rotation speed reaches 1,000 r/min or until operation stops from 1,000 r/min.



| | |
|---|---|
| Pn5A | Not used. (Do not change setting.) |

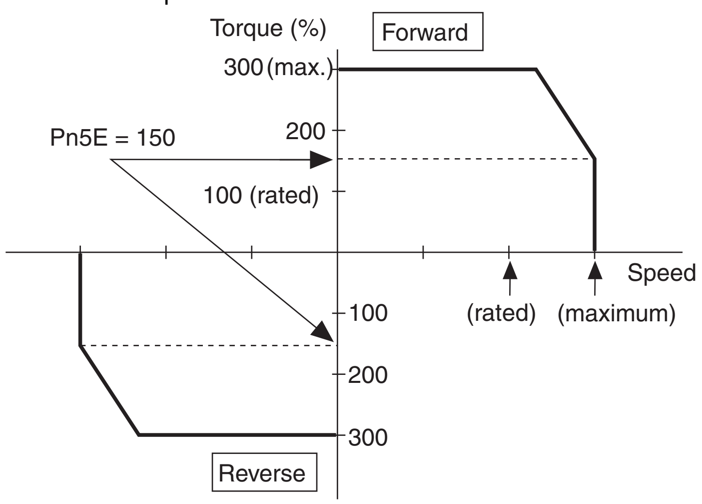
| | |
|---|---|
| Pn5B | Not used. (Do not change setting.) |

| | |
|---|---|
| Pn5C | Not used. (Do not change setting.) |

| | |
|---|---|
| Pn5D | Not used. (Do not change setting.) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pn5E | Torque Limit | | | | | | All modes |
| Setting range | 0 to 500 | Unit | % | Default setting | 300 | Power OFF → ON | --- |

- Set the limit for the maximum torque of the Servomotor.
- Normally, the Servomotor generates an instantaneous torque three times the rated value. Limit the maximum torque, however, if a torque of three times the rated value may cause problems with the strength of the mechanical system.
- Make the setting as a percentage of the rated torque.
  Example: Maximum torque limited to 150%




- Both the forward and the reverse torque are limited at the same time.
- This parameter will be used for No.1 torque control if the Zero Speed Designation/Torque Limit Switch (Pn06) is set to 2.
- The default setting depends on the combination of Servomotor and Servo Drive.
- Values exceeding the default setting cannot be set.
- Refer to *Torque Limit* on page 5-15.

| | |
|---|---|
| Pn5F | Not used. (Do not change setting.) |

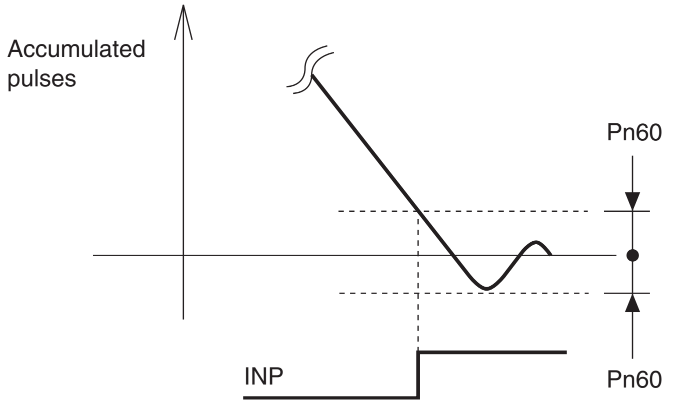
5

Operating Functions

## ■ Sequence Parameters

| Pn60 | Positioning Completion Range | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 32767 | Unit | Pulse | Default setting | 25 | Power OFF → ON | --- |

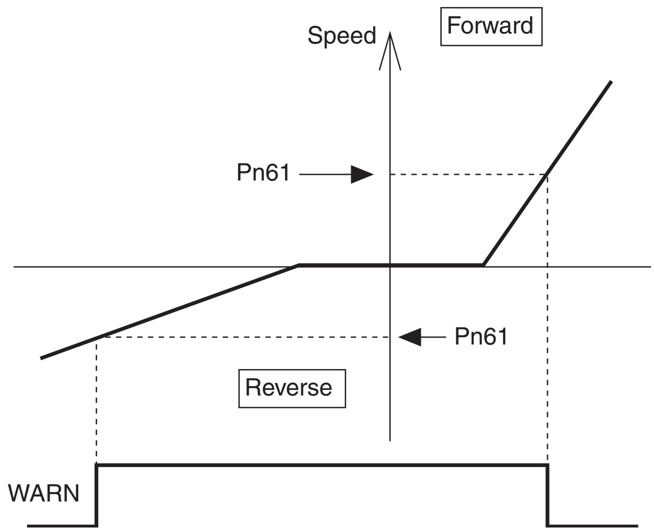
- Set the deviation counter value for the Positioning Completed Output (INP).
- The Positioning Completed Output (INP) turns ON when the accumulated pulses in the deviation counter fall below the setting of this parameter.




- The encoder resolution is 2,500 pulses/rotation, but in the Servo Drive it is regarded as 10,000 pulses/rotation (i.e., 2,500 pulses/rotation × 4).

| Pn61 | Zero Speed Detection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 20000 | Unit | r/min | Default setting | 20 | Power OFF → ON | --- |

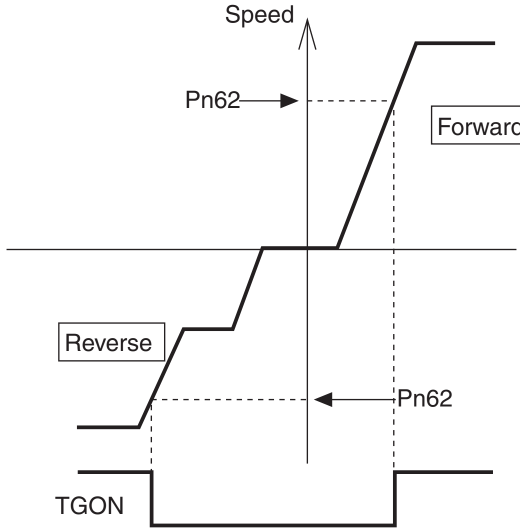
- Set the number of rotations for the warning output (zero speed detection output).
- The Warning Output Selection (Pn09) must be set to 1 to output zero speed detection.
- Zero speed detection will be output if the Servomotor speed falls below the set speed regardless of the direction of rotation.




- There is an hysteresis of 10 r/min, so set a value higher than 10.

| Pn62 | Rotation Speed for Servomotor Rotation Detection | | | | | Internally set speed | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 20000 | Unit | r/min | Default setting | 50 | Power OFF → ON | --- |

- Set the number of rotations for the Servomotor Rotation Speed Detection Output (TGON) during Internally Set Speed Control.
- The Servomotor Rotation Speed Detection Output (TGON) will turn ON if the Servomotor speed exceeds the set speed regardless of the direction of rotation.




- There is a hysteresis of 10 r/min, so set a value higher than 10.

| Pn63 | Deviation Counter Overflow Level | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 32767 | Unit | × 256 pulses | Default setting | 100 | Power OFF → ON | --- |

- Set the detection level for the deviation counter overflow alarm.
- The alarm level is the setting value multiplied by 256 pulses.

| Pn64 | Deviation Counter Overflow Alarm Disabled | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- The deviation counter overflow alarm can be disabled so that it does not occur.

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Enabled |
| 1 | Disabled |

| Pn65 | Not used. (Do not change setting.) |
|---|---|

| Pn66 | Stop Selection for Drive Prohibit Input | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 0 | Power OFF → ON | Yes |

- Set the operation to be used to decelerate to a stop after the Forward Drive Prohibit Input (POT) or Reverse Drive Prohibit Input (NOT) is turned ON.

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | The torque in the drive prohibit direction is disabled, and the dynamic brake is activated. |
| 1 | The torque in the drive prohibit direction is disabled, and free-run deceleration is performed to stop. |
| 2 | The servo lock stop is used in a Position Control Mode, and the zero speed designation stop is used in Internally Set Speed Control Mode. |

| Pn67 | Not used. (Do not change setting.) |
|---|---|

| Pn68 | Stop Selection at Alarm | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- Set the operating condition during deceleration and after stopping when an alarm occurs.
- The deviation counter will be cleared when an alarm occurs.

### Explanation of Settings

| Setting | Explanation | | |
|---|---|---|---|
| | During deceleration | After stopping | Deviation counter content |
| 0 | Dynamic brake | Dynamic brake | Clear |
| 1 | Free run | Dynamic brake | Clear |
| 2 | Dynamic brake | Servo free | Clear |
| 3 | Free run | Servo free | Clear |

| Pn69 | Stop Selection with Servo OFF | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 7 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- Set the operation during deceleration and after stopping as well as the deviation counter status when the RUN Command Input (RUN) turns OFF.

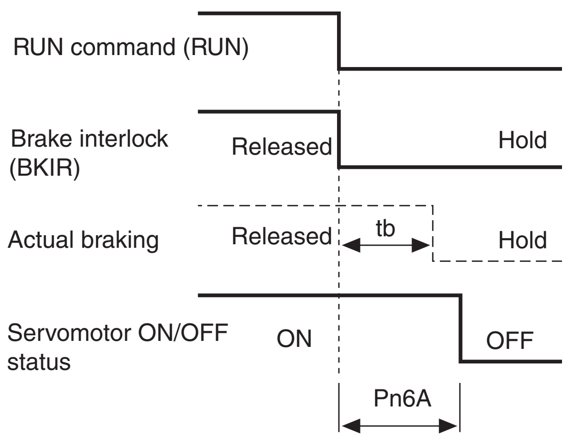
### Explanation of Settings

| Setting | Explanation | | |
|---|---|---|---|
| | During deceleration | After stopping | Deviation counter content |
| 0 | Dynamic brake | Dynamic brake | Clear |
| 1 | Free run | Dynamic brake | Clear |
| 2 | Dynamic brake | Servo free | Clear |
| 3 | Free run | Servo free | Clear |
| 4 | Dynamic brake | Dynamic brake | Hold |
| 5 | Free run | Dynamic brake | Hold |
| 6 | Dynamic brake | Servo free | Hold |
| 7 | Free run | Servo free | Hold |

**Reference**
- Dynamic Brake at Power OFF
  By default, the dynamic brake of the Servo Drive will be engaged when the main circuit power is turned OFF. For this reason, it feels slightly heavier to rotate the Servomotor shaft manually than in servo free status. To release the dynamic brake, disconnect the wirings (U, V, W) from the Servomotor. Be sure to reconnect these wirings before restoring the power.

| Pn6A | Brake Timing When Stopped | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 100 | Unit | × 2 ms | Default setting | 10 | Power OFF → ON | --- |

- When the RUN Command Input is turned OFF while the Servomotor is stopped, the Brake Interlock Signal (BKIR) will turn OFF, and the Servo will turn OFF after the time set for this parameter (setting × 2 ms) elapses.

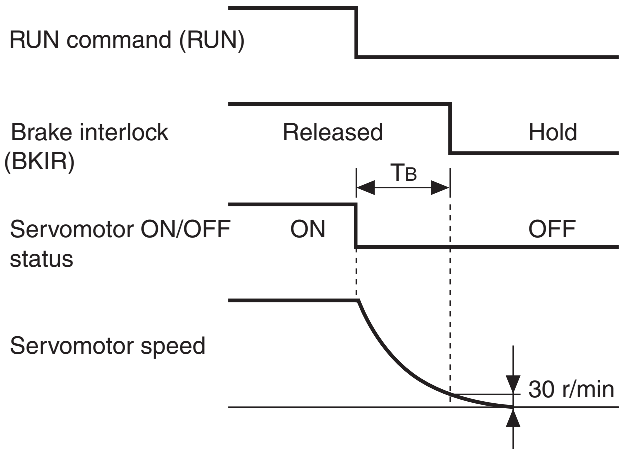



- Make the setting as follows to prevent the machine (workpiece) from moving or falling due to the delay in the brake operation (tb).

  Brake timing when stopped (setting × 2 ms) ≥ tb

| Pn6B | Brake Timing during Operation | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 100 | Unit | × 2 ms | Default setting | 50 | Power OFF → ON | --- |

- When the RUN Command Input is turned OFF while the Servomotor is operating, the Servomotor will decelerate, the number of rotations will drop, and the Brake Interlock Signal (BKIR) will turn OFF after the time set for this parameter has elapsed (setting × 2 ms).




- "TB" in the above figure is the brake timing during operation (setting × 2 ms) or the time required until the Servomotor rotation speed falls to 30 r/min or lower, whichever is shorter.

| Pn6C | Regeneration Resistor Selection | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 0 | Power OFF → ON | --- |

- Set whether to mount an External Regeneration Resistor.

### Explanation of Settings

| Setting | Explanation | |
|---|---|---|
| | Regeneration resistor used | Regeneration resistor overload alarm |
| 0 | Servo Drive built-in capacitor | The external regeneration processing circuit does not operate. Regenerative energy is processed with the built-in capacitor. |
| 1 | External Regeneration Resistor | An External Regeneration Resistor alarm (alarm code 18) will occur when the resistance exceeds 10% of the operating limit. |
| 2 | External Regeneration Resistor | The regeneration resistor overload alarm does not operate. |
| 3 | Servo Drive built-in capacitor | The external regeneration processing circuit does not operate. Regenerative energy is processed with the built-in capacitor. |

**Precautions for Safe Use**

- Always install a thermal fuse or other external protection when Pn6C is set to 2. Without protection for the External Regeneration Resistor, it may generate abnormal heat and result in burning.

| Pn6D | Not used. (Do not change setting.) |
|---|---|

| Pn6E | Not used. (Do not change setting.) |
|---|---|

| Pn6F | Not used. (Do not change setting.) |
|---|---|

| Pn70 | Overspeed Detection Level Setting | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 6000 | Unit | r/min | Default setting | 0 | Power OFF → ON | --- |

- Set the No. 1 overspeed detection level when torque limit switching is enabled in the setting of the Zero Speed Designation/Torque Limit Switch (Pn06).
- When the No. 1 torque limit is selected, an overspeed error will occur if the rotation speed of the Servomotor exceeds the setting.
- This parameter is disabled when torque limit switching is disabled.

| Pn71 | No. 2 Torque Limit | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 500 | Unit | % | Default setting | 100 | Power OFF → ON | --- |

- Set the No. 2 torque limit when torque limit switching is enabled in the setting of the Zero Speed Designation/Torque Limit Switch (Pn06).
- This parameter is disabled when torque limit switching is disabled.
- Refer to *Torque Limit* on page 5-54 for information on setting details.

| Pn72 | No. 2 Deviation Counter Overflow Level | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 32767 | Unit | × 256 pulse | Default setting | 100 | Power OFF → ON | --- |

- Set the No. 2 deviation counter overflow level when torque limit switching is enabled in the setting of the Zero Speed Designation/Torque Limit Switch (Pn06).
- This parameter is disabled when torque limit switching is disabled.
- Refer to *Deviation Counter Overflow Level* on page 5-56 for information on setting details

| Pn73 | No. 2 Overspeed Detection Level | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 6000 | Unit | r/min | Default setting | 0 | Power OFF → ON | --- |

- Set the No. 2 overspeed detection level when torque limit switching is enabled in the setting of the Zero Speed Designation/Torque Limit Switch (Pn06).
- When No. 2 torque limit is selected, an overspeed error will occur if the rotation speed of the Servomotor exceeds the setting.
- This parameter is disabled when torque limit switching is disabled.

| Pn74 | Not used. (Do not change setting.) |
|---|---|

to

| Pn7F | Not used. (Do not change setting.) |
|---|---|

# Chapter 6

# Operation

# 6-1 Operational Procedure

After installation and wiring, turn ON the power and check the operation of the Servomotor and Servo Drive. Then make the function settings as required according to the use of the Servomotor and Servo Drive. If the parameters are set incorrectly, there is a danger of the Servomotor operating in an unpredictable manner. Set the parameters according to the instructions in this manual.

| Item | Contents | Reference |
|---|---|---|
| Mounting and installation | Install the Servomotor and Servo Drive according to the installation conditions. (Do not connect the Servomotor to the mechanical system before checking the no-load operation.) | Chapter 4 Page 4-1 |
| ↓ | | |
| Wiring and connections | Connect the Servomotor and Servo Drive to the power supply and peripheral devices.<br>* Specified installation and wiring requirements must be satisfied, particularly for models conforming to the EC Directives. | Chapter 4 Page 4-5 |
| ↓ | | |
| Preparing for operation | Check the necessary items and then turn ON the power supply. Check with the display indications to see whether there are any internal errors in the Servo Drive. | Chapter 6 Page 6-2 |
| ↓ | | |
| Checking operation | Check the operation of the Servomotor and Servo Drive by performing jogging operations without a load. | Chapter 6 Page 6-4 |
| ↓ | | |
| Setting functions | Set the functions according to the operating conditions with the user parameters. | Chapter 5 Page 5-17 |
| ↓ | | |
| Trial operation | To enable the parameter settings, turn OFF the power first.<br>Connect the Servomotor to the mechanical system.<br>Turn ON the power, and check to see whether protective functions, such as the emergency stop and operational limits, work properly.<br>Check operation without a workpiece, or with dummy workpieces at low and high speed. (Operate using commands from a position controller.) | Chapter 6 Page 6-23 |
| ↓ | | |
| Adjustments | Manually adjust the gain if necessary. Further adjust the various functions to improve the control performance. | Chapter 7 |
| ↓ | | |
| Operation | Operation can now be started. If any problems should occur, refer to *Chapter 8 Troubleshooting*. | Chapter 8 |

# 6-2 Preparing for Operation

This section explains the procedure to prepare the mechanical system for trial operation after the installation and wiring of the Servomotor and Servo Drive are completed. It also explains the items that need to be checked before and after turning ON the power.

## Items to Check Before Turning ON the Power

### ■ Checking Power Supply Voltage

- Check to be sure that the power supply voltage is within the ranges shown below.
  R7D-BP□□L (Single-phase 100 VAC input)
  Main-circuit power supply: Single-phase 100/115 VAC (85 to 127 V) 50/60 Hz
  R7D-BP□□H (Single-phase/three-phase 200 VAC input)
  Main-circuit power supply: Single-phase/three-phase 200/240 VAC (170 to 264 V) 50/60 Hz
  R7D-BP□□HH (Single-phase 200 VAC input)
  Main-circuit power supply: Single-phase 200/240 VAC (170 to 264 V) 50/60 Hz

### ■ Checking Terminal Block Wiring

- The main-circuit power supply input lines (L1/L3 or L1/L2/L3) must be properly connected to the terminal block.
- The Servomotor's red (U), white (V), and blue (W) power lines and the green/yellow ground wire (⏚) must be properly connected to the terminal block.

### ■ Checking the Servomotor

- There should be no load on the Servomotor. (Do not connect the mechanical system.)
- The Servomotor’s power lines and the power cables are securely connected.
- The Encoder Cable must be securely connected to the Encoder Connector (CN2) at the Servo Drive.
- The Encoder Cable must be securely connected to the Encoder Connector at the Servomotor.

### ■ Checking the I/O Control Connectors

- The Control Cable must be securely connected to the I/O Control Connector (CN1).
- The RUN Command Input (RUN) must be OFF.

### ■ Checking Parameter Unit Connections

- The Parameter Unit (R88A-PR02G) must be securely connected to the CN3 connector.

## Turning ON Power

- After checking the above items, turn ON the main circuit power supply.
- The alarm output (ALM) will take approximately 2 seconds to turn ON after the power has been turned ON. Do not attempt to detect an alarm using the Host Controller during this time (when power is being supplied with the Host Controller connected).

## Checking Displays

- After turning ON the power, confirm that the Servo Drive's power supply LED indicator (PWR) is lit green.
- When the power is turned ON, one of the following will appear on the Parameter Unit display.

| Normal | Error (alarm display) |
|---|---|
| r 0 | Err. 14 |

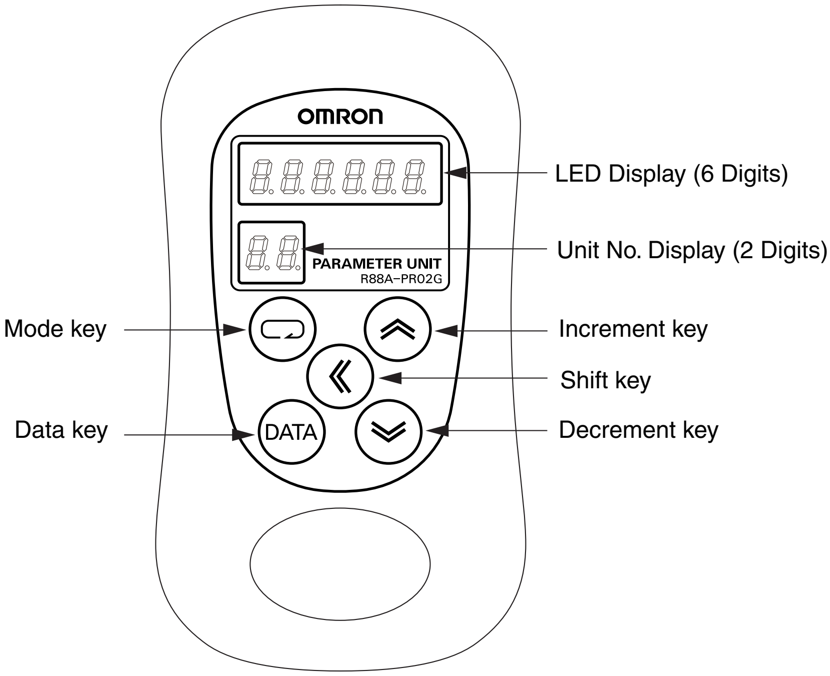
If Servo Drive is normal, the item set for Default Display (Pn01) will appear on the display.
If there is an error, an alarm code will appear. The number shown (an alarm code) depends on the cause of the error.

# 6-3 Using the Parameter Unit

This section describes the basic operation of the Parameter Unit, the jog operation with just the Servomotor and Servo Drive, and the Parameter Unit's copy function.

## Names of Parts and Functions

### ■ Parameter Unit Names

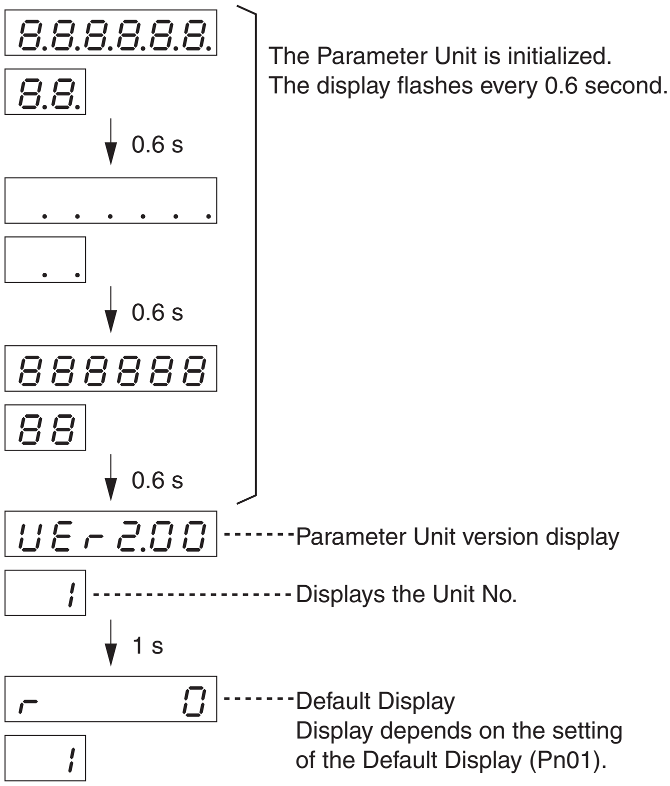



### ■ Parameter Unit Functions

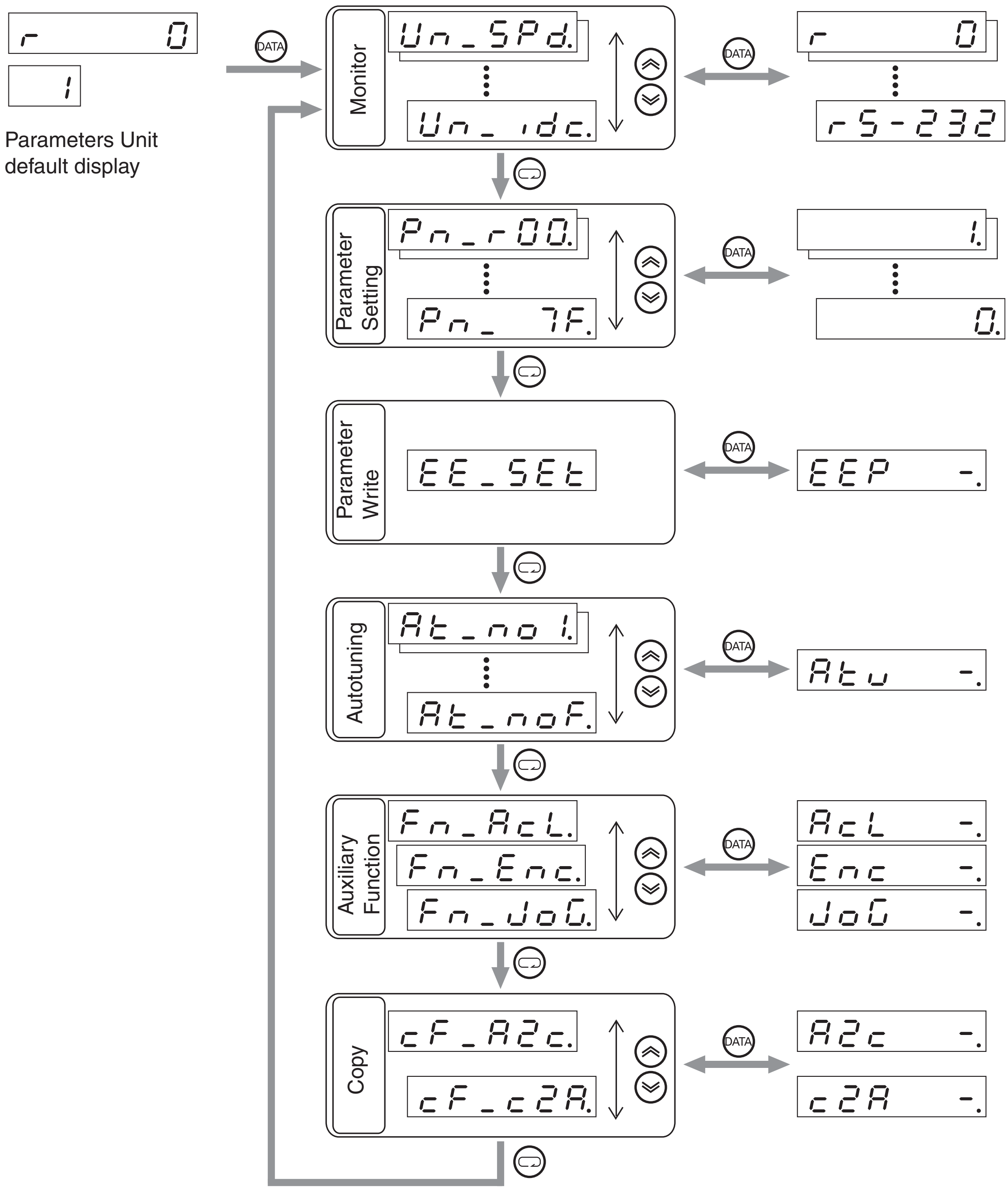
| Name | Function |
|---|---|
| LED Display | Displays the parameters and data settings. |
| Unit No. Display | Displays the Unit No. set in Unit No. Setting (Pn00).<br>Displays the parameter number in Parameter Setting Mode. |
| Mode key | Switches among the six modes. |
| Data key | Switches between the parameter and setting displays, saves data settings. |
| Increment key | Increases the parameter number or set value. |
| Decrement key | Decreases the parameter number or set value. |
| Shift key | Shifts the digit to the left. |

## Display When Power Is Turned ON

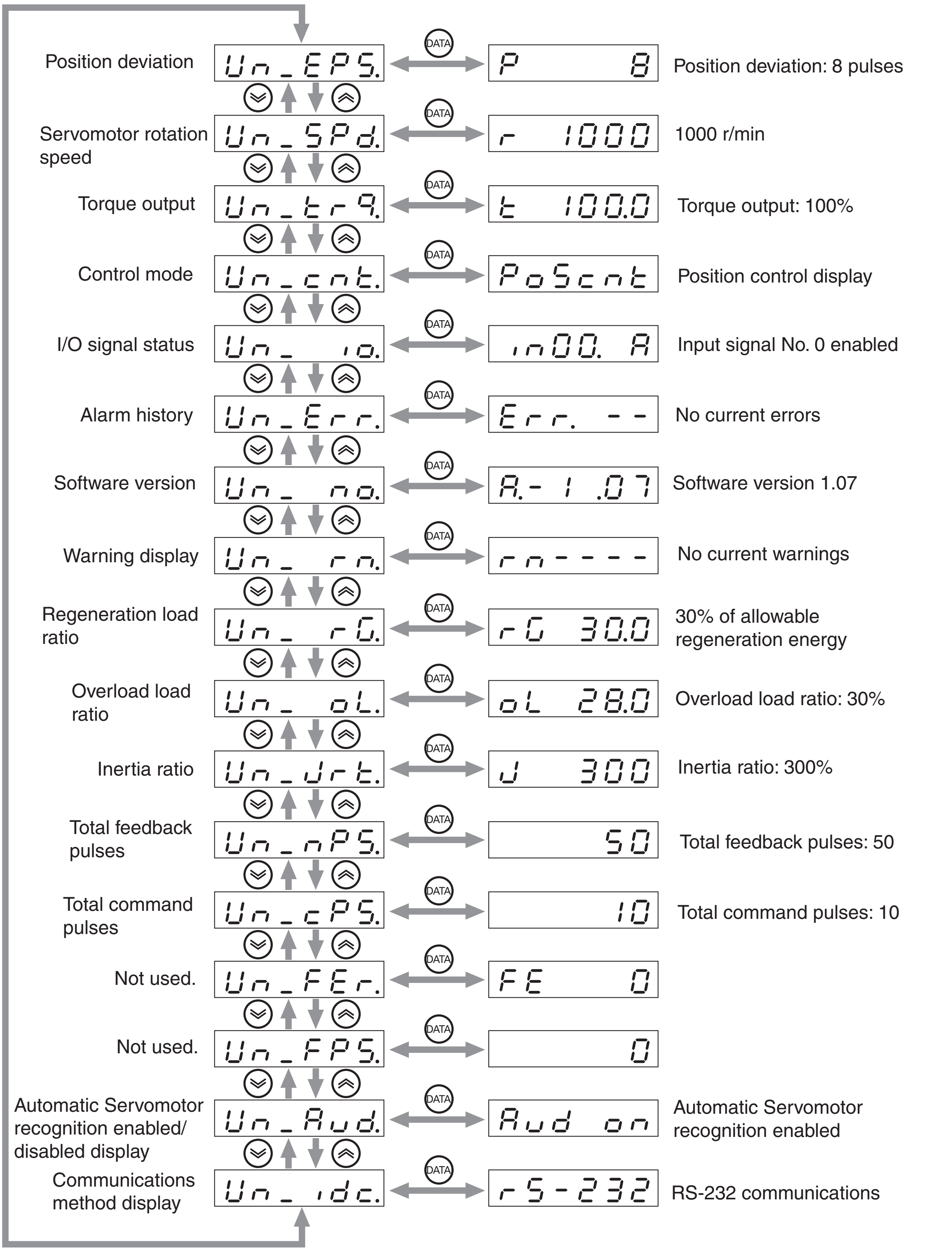
Turn ON the power with the Parameter Unit connected to the Servo Drive, or connect the Parameter Unit to the Servo Drive with Servo Drive power already turned ON. Then the following indications appear on the display.



## Changing the Mode



## Monitor Mode




- The Servomotor rotation speed will be displayed the first time the power is turned ON after purchase. To change the initial display when the power is turned ON, change the setting of the Default Display (Pn01). For details, refer to the description of the Default Display (Pn01) on page 5-32.

## ■ Position Deviation

`P          8`

- Displays the number of accumulated pulses in the deviation counter (unit: pulse).
- Accumulated pulses during reverse rotation are displayed with "-".

## ■ Servomotor Rotation Speed

`r    1000`

- Displays the Servomotor rotation speed (unit: r/min).
- Rotation speeds during reverse rotation are displayed with "-".

## ■ Torque Output

`t    100.0`

- Displays the percentage of Servomotor torque output.
- When the rated toque output for the Servomotor is used, "100%" is displayed.
- Torque outputs during reverse rotation are displayed with "-".

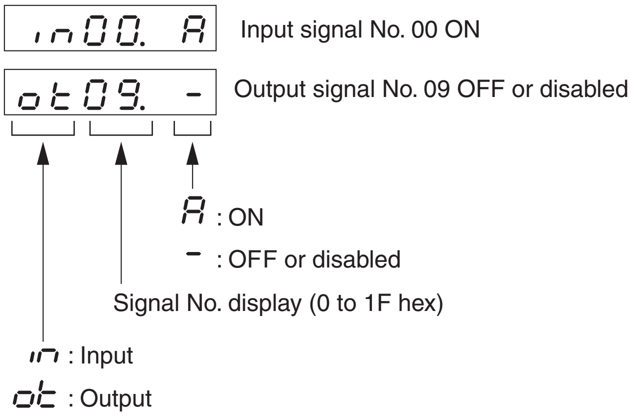
## ■ Control Mode

`PoScnt` Position Control Mode

`SPdcnt` Internally Set Speed Control Mode

- Displays whether the position control or internally set speed control is being used.
- The High-response Position Control Mode and Advanced Position Control Mode are displayed as Position Control Modes.

## ■ I/O Signal Status




- Displays the status of the control input and output signals connected to CN1.

### Input Signals

<table>
<tr><th colspan="4">CN1</th><th rowspan="2">Function</th></tr>
<tr><th>Signal No.</th><th>Symbol</th><th>Name</th><th>Pin No.</th></tr>
<tr><td>00</td><td>RUN</td><td>RUN Command</td><td>2</td><td>If the RUN signal turns ON, a Servo lock occurs, and A is displayed.</td></tr>
<tr><td>01</td><td>RESET</td><td>Alarm Reset</td><td>3</td><td>If the RESET signal turns ON, the alarm is reset, and A is displayed.</td></tr>
<tr><td>02</td><td>NOT</td><td>Reverse Drive Prohibit</td><td>7</td><td rowspan="2">If the Drive Prohibit Input Selection (Pn04) is set to disable the prohibit inputs (setting 1), "-" is displayed.<br>If Pn04 is set to enable the prohibit inputs (setting 0), the Servomotor stops and A is displayed when the POT signal turns OFF.</td></tr>
<tr><td>03</td><td>POT</td><td>Forward Drive Prohibit</td><td>8</td></tr>
<tr><td>04</td><td colspan="4">Not used.</td></tr>
<tr><td>05</td><td>VZERO</td><td>Zero Speed Designation</td><td>5</td><td>The Servomotor stops and A is displayed if this signal turns OFF when the Zero Speed Designation/Torque Limit Switch (Pn06) is set to 1.</td></tr>
<tr><td>06</td><td>GESEL</td><td>Electronic Gear Switch</td><td>6</td><td>If the GESEL signal turns ON, the Electronic Gear Ratio Numerator 2 is enabled, and A is displayed.</td></tr>
<tr><td>07 to 08</td><td colspan="4">Not used.</td></tr>
<tr><td>09</td><td>GSEL</td><td>Gain Switch</td><td>5</td><td>When the Gain Switching Input Operating Mode Selection (Pn30) is set to 0 and the GSEL signal turns OFF, PI operation is enabled and "-" is displayed.</td></tr>
<tr><td>0A</td><td>ECRST</td><td>Deviation Counter Reset</td><td>4</td><td>Used to reset the deviation counter.<br>When the ECRST signal turns ON, A is displayed.</td></tr>
<tr><td>0B</td><td colspan="4">Not used.</td></tr>
<tr><td>0C</td><td>VSEL1</td><td>Internally Set Speed Selection 1</td><td>6</td><td rowspan="2">When VSEL1 and VSEL2 are ON, A is displayed.</td></tr>
<tr><td>0D</td><td>VSEL2</td><td>Internally Set Speed Selection 2</td><td>4</td></tr>
<tr><td>0E to 1F</td><td colspan="4">Not used.</td></tr>
</table>

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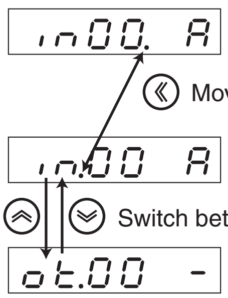
### Output Signals

| CN1 | | | | Function |
|---|---|---|---|---|
| Signal No. | Symbol | Name | Pin No. | |
| 00 | Not used. | | | |
| 01 | /ALM | Alarm | 9 | If an alarm occurs, the /ALM signal turns OFF, and A is displayed. |
| 02 | INP | Positioning Completed | 10 | When a workpiece is positioned within the setting range, the Positioning Completion Range (Pn60), INP turns ON and A is displayed. |
| 03 | BKIR | Brake Interlock | 11 | The output transistor for the electromagnetic brake signal turns ON, and A is displayed. |
| 04 | --- | Zero Speed Detection | 12 | When the Warning Output Selection (Pn09) is set to 1, and Zero Speed Detection output turns ON, A is displayed. |
| 05 | --- | Torque Limiting | 12 | When the Warning Output Selection (Pn09) is set to 0, and Torque Limiting output turns ON, A is displayed. |
| 06 to 08 | Not used. | | | |
| 09 | TGON | Servomotor Rotation Speed Detection | 10 | When the actual motor speed exceeds the Rotation Speed for Servomotor Rotation Detection (Pn62), TGON turns ON and A is displayed. |
| 0A to 1F | Not used. | | | |

### Switching between Input Signals and Output Signals




If the decimal point is at the right of the signal number, the signal number can be changed.

Move the flashing decimal point with the Shift key.

If the decimal point is at the right of the input/output indication, you can switch between inputs and outputs.

Switch between inputs and outputs with the Increment/Decrement keys.

The following procedure can also be used to switch between input and output.



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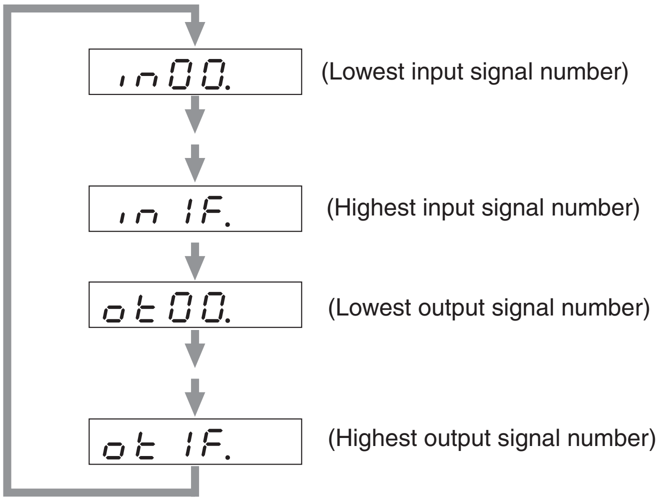
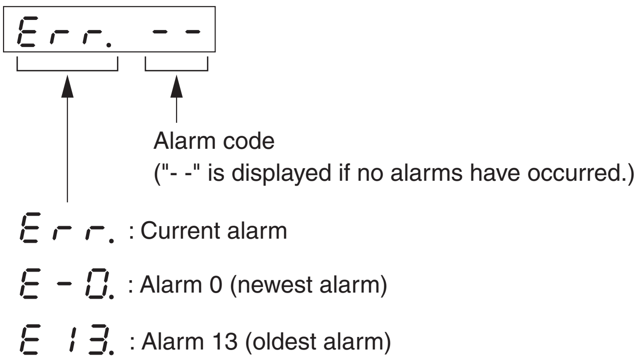
Press the Increment or Decrement key to select the signal number to be monitored.




## ■ Alarm History




- Up to 14 alarms, including the current one, can be viewed in the alarm history.
- The display will flash when an alarm occurs.
- If an alarm that is recorded in the history occurs, the alarm code for the current alarm and for alarm 0 will be the same.

### Alarm Codes and Meanings

| Alarm codes | Meaning |
|---|---|
| 11 | Power supply undervoltage |
| 12 | Overvoltage |
| 14 | Overcurrent |
| 15 | Built-in resistor overheat |
| 16 | Overload |
| 18 | Regeneration overload |
| 21 | Encoder disconnection detection |
| 23 | Encoder data error |
| 24 | Deviation counter overflow |
| 26 | Overspeed |
| 27 | Electronic gear setting error |

| Alarm codes | Meaning |
|---|---|
| 29 | Deviation counter overflow |
| 34 | Overrun limit error |
| 36 | Parameter error |
| 37 | Parameter corruption |
| 38 | Drive prohibit input error |
| 48 | Encoder phase Z error |
| 49 | Encoder CS signal error |
| 95 | Servomotor non-conformity |
| 96 | LSI setting error |
| Others | Other errors |

**Note** The following alarms are not recorded in the history.
11: Power supply undervoltage
36: Parameter error
37: Parameter corruption
38: Drive prohibit input error
95: Servomotor non-conformity
96: LSI setting error

## ■ Software Version

`A.- 1 .07`

- Displays the software version of the Servo Drive.

## ■ Warning Display

`rn----`

–: No warning, A: Warning

Overload: 85% or more of the alarm level for overload.

Over-regeneration: 85% or more of the alarm level for regeneration overload.
The alarm level will be 10% of the operating ratio of the regeneration resistance if the Regeneration Resistance Selection (Pn6C) is set to 1.

Not used.

## ■ Regeneration Load Ratio

`rG 80.0`

- Displays the load ratio as a percentage of the detection level for the regeneration load.

## ■ Overload Load Ratio

`oL 28.0`

- Displays the percentage of the load ratio as a percentage of the rated load.

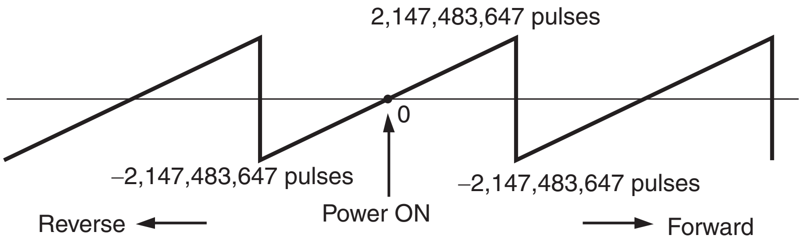
## ■ Inertia Ratio

`J 100` Displays the inertia ratio as a percentage.

## ■ Total Feedback Pulses/Total Command Pulses

`100`

- Displays the total number of pulses after the power supply is turned ON.
- The display will overflow as shown in the following figure.




- Use the Shift key to switch the display between the upper and lower digits of the total number of pulses.

| Upper digits | | Lower digits |
|---|---|---|
| `H-2147` | ↔ | `483647` |

- When the Data key is pressed for 5 s or longer, the total number of pulses will be reset, and the display will return to 0.

## ■ Automatic Servomotor Recognition

`Aud on` Automatic recognition enabled (Always this indication is displayed)

## Parameter Setting Mode

### 1. Displaying Parameter Setting Mode

| Key operation | Display example | Explanation |
|---|---|---|
| | r 0 | The item set for the Default Display (Pn01) is displayed. |
| DATA | Un_SPd. | Press the Data key to display Monitor Mode. |
| | Pn_r00. | Press the Mode key to display Parameter Setting Mode. |

### 2. Setting the Parameter Number

| Key operation | Display example | Explanation |
|---|---|---|
| « ∧ ∨ | Pn_ 10. | Use the Shift, Increment, and Decrement keys to set the parameter number.<br>If the parameter number is large, the setting can be made more quickly by using the Shift key to change the digit that is being set.<br>The decimal point will flash for the digit that can be set. |

### 3. Displaying the Parameter Setting

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | 40. | Press the Data key to display the setting. |

### 4. Changing the Parameter Setting

| Key operation | Display example | Explanation |
|---|---|---|
| « ∧ ∨ | 100. | Use the Shift, Increment, and Decrement keys to change the setting.<br>The decimal point will flash for the digit that can be changed. |
| DATA | 100. | Press the Data key to save the new setting. |

### 5. Returning to the Display of Parameter Setting Mode

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | Pn_ 10. | Press the Data key to return to the Parameter Setting Mode Display. |

**Precautions for Correct Use**

- Some parameters will be displayed with an “r” before the number when the Parameter Setting Mode is displayed. To enable the settings that have been changed for these parameters, you must turn the power supply OFF and ON after saving the parameters in EEPROM.
- Once the setting for a parameter is saved, the new setting will be used for control. Make changes little by little, not widely when setting the parameters (in particular, the speed loop gain, position loop gain, etc.) which can affect the motor operation greatly.
- For details on parameters, refer to *Parameter Details* on page 5-32.

## Parameter Write Mode

Settings changed in the Parameter Setting Mode must be saved in EEPROM. To do so, the following procedure must be performed.

### 1. Saving Changed Settings

| Key operation | Display example | Explanation |
|---|---|---|
| (Mode key) | EE_SEt | Press the Mode key to display Parameter Write Mode. |
| DATA | EEP - | Press the Data key to enter Parameter Write Mode. |
| (Increment key) | EEP - - | Press and hold the Increment key for at least 5 s. |
| | - - - - - - | The bar indicator will increase. |
| | StArt | Writing will start. (This display will appear only momentarily.) |
| | FiniSh. | This display indicates a normal completion. In addition to “Finish,” either rESEt or Error may be displayed.<br>If rESEt is displayed, writing has been completed normally, but some of the changed parameters will be enabled only after the power is turned ON again. Turn OFF the Servo Drive power supply and then turn it ON again.<br>If Error is displayed, there is a writing error. Write the data again. |

### 2. Returning to the Display of Parameter Write Mode

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | EE_SEt | Press the Data key to return to the Parameter Write Mode Display. |

**Precautions for Correct Use**

- If a writing error occurs, write the data again. If a writing error continues to occur, there may be a fault in the Servo Drive.
- Do not turn OFF the power supply while writing in EEPROM. Incorrect data may be written if the power supply is turned OFF. If the power supply is turned OFF, perform the settings again for all parameters, and write the data again.
- Do not disconnect the Parameter Unit from the Servo Drive during the time from writing start (“Start”) to writing completion (“Finish” or “Reset”). If the Parameter Unit is disconnected, repeat the procedure from the beginning.

## Autotuning Mode

For details on autotuning, refer to *7-3 Autotuning*. This section describes only the operating procedure.

### 1. Displaying Autotuning Mode

| Key operation | Display example | Explanation |
|---|---|---|
| | r 0 | The item set for the Default Display (Pn01) is displayed. |
| DATA | Un_SPd. | Press the Data key to display Monitor Mode. |
| | At_no 1. | Press the Mode key three times to display Autotuning Mode. |

### 2. Executing Autotuning

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | Atu -. | Press the Data key to enter Autotuning Mode. |
| | Atu - -. | Press and hold the Increment key until "Start" is displayed.<br>The bar indicator will increase when the key is pressed for 5 s or longer. |
| | - - - - - -. | The bar indicator will increase. |
| | StArt | The Servomotor will start, and autotuning will begin. |
| | FiniSh. | This display indicates a normal completion.<br>If Error. is displayed, a tuning error has occurred. |

### 3. Returning to the Display of Autotuning Mode

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | At_no 1. | Press the Data key to return to the Autotuning Mode Display. |

**Precautions for Correct Use**

- Do not remove the Parameter Unit from the Servo Drive during the time from Start to Finish. If the Parameter Unit is removed during autotuning, repeat the procedure from the beginning.
- Always save each gain value changed with autotuning in EEPROM so that the data is not lost when the power is turned OFF.
- If an autotuning error occurs, the values for each gain will return to the value before executing autotuning.

## Auxiliary Function Mode

The Auxiliary Function Mode includes the alarm reset and jog operation.

### Displaying Auxiliary Function Mode

| Key operation | Display example | Explanation |
|---|---|---|
| | r 0 | The items set for the Default Display (Pn01) is displayed. |
| DATA | Un_SPd. | Press the Data key to display Monitor Mode. |
| | Fn_AcL. | Press the Mode key four times to display Auxiliary Function Mode. |

## ■ Alarm Reset

### 1. Executing Alarm Reset

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | AcL -. | Press the Data key to enter Alarm Reset Mode. |
| | AcL --. | Press and hold the Increment key until "Start" is displayed.<br>The bar indicator will increase when the key is pressed for 5 s or longer. |
| | ------. | The bar indicator will increase. |
| | StArt | Alarm reset will start. |
| | Finish. | This display indicates a normal completion.<br>If Error. is displayed, an alarm has not been reset. Reset the power supply to clear the error. |

### 2. Returning to the Display of Auxiliary Function Mode

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | Fn_AcL. | Press the Data key to return to the Auxiliary Function Mode Display. |

## ■ Jog Operation

### 1. Executing Jog Operation

| Key operation | Display example | Explanation |
|---|---|---|
| | Fn_JoG. | Press the Increment key to display the Jog Operation Mode on the alarm reset display in Auxiliary Function Mode. |
| DATA | JoG -. | Press the Data key to enter Jog Operation Mode. |
| | JoG --. | Press and hold the Increment key until “Ready” is displayed.<br>The bar indicator will increase when the key is pressed for 5 s or longer. |
| | ------. | The bar indicator will increase. |
| | rEAdy . | This completes preparations for jog operation. |
| | rEAdy. | Press and hold the Shift key until “Sev_on” is displayed.<br>The decimal point will move to the left when the key is pressed for 3 s or longer. |
| | r.EAdy | |
| | SrU_on | The Servo will turn ON. |
| | SrU_on | Forward operation will be performed while the Increment key is pressed, and reverse operation will be performed while the Decrement key is pressed.<br>The Servomotor will stop when the key is released. The rotation speed set for Jog Speed (Pn57) will be used for jogging. |

### 2. Returning to the Display of Auxiliary Function Mode

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | Fn_JoG. | Press the Data key to return to the Auxiliary Function Mode Display.<br>The servo lock is released. The system is now in servo free status. |

## Copy Mode

In Copy Mode, user parameters set in the Servo Drive can be copied to the Parameter Unit, and user parameters stored in the Parameter Unit can be copied to the Servo Drive.
This function can be used to easily set the same user parameters for more than one Servo Drive.

### ■ Copying from the Servo Drive to the Parameter Unit

#### 1. Displaying Copy Mode

| Key operation | Display example | Explanation |
|---|---|---|
| | r 0 | The item set for the Default Display (Pn01) is displayed. |
| DATA | Un_SPd. | Press the Data key to display Monitor Mode. |
| | cF_A2c. | Press the Mode key five times to display Copy Mode. |

#### 2. Executing Copying

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | A2c -. | Press the Data key to enter Copy Mode. |
| | A2c --. | Press and hold the Increment key until “EEPCLR” is displayed.<br>The bar indicator will increase when the key is pressed for 3 s or longer. |
| | ------. | The bar indicator will increase. |
| | EEPcLr<br>-- | Initialization of the EEPROM in the Parameter Unit will start. |
| | Finish. | This display indicates a normal completion. |

#### 3. Returning to the Display of Copy Mode

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | cF_A2c. | Press the Data key to return to the Copy Mode Display. |

**Precautions for Correct Use**

- If “Error” is displayed before completion, repeat the procedure from the beginning. Press the Data key to clear the error.
- Do not disconnect the Parameter Unit from the Servo Drive while copying is being performed. If the Parameter Unit is disconnected, reconnect it and repeat the procedure from the beginning.
- If an error is repeatedly displayed, the following are the possible causes: cable disconnection, connector contact failure, incorrect operation due to noise, or EEPROM fault in the Parameter Unit.

## ■ Copying from the Parameter Unit to the Servo Drive

### 1. Displaying Copy Mode

| Key operation | Display example | Explanation |
|---|---|---|
| | r 0 | The item set for the Default Display (Pn01) is displayed. |
| DATA | Un_SPd. | Press the Data key to display Monitor Mode. |
|  | cF_A2c. | Press the Mode key five times to display Copy Mode. |
|  | cF_c2A. | Press the Increment key to switch to the copy display for copying from the Parameter Unit to the Servo Drive. |

### 2. Checking the Servo Drive Model Code

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | c2A -. | Press the Data key to enter Copy Mode. |
|  | c2A - -. | Press and hold the Increment key until "EEP_CH" is displayed.<br>"DIFFER" will be displayed if a different model code is entered.<br>The bar indicator will increase when the key is pressed for 3 s or longer. |
| | - - - - - -. | The bar indicator will increase.<br>The Servo Drive model code is being checked. If a different model code has been entered, refer to *3. Different Model Codes* below to perform the procedure.<br>If the model codes match, the display will proceed to the display in *4. Executing Copying*. |

### 3. Different Model Codes

| Key operation | Display example | Explanation |
|---|---|---|
|  | d iFFEr. | The decimal point will move to the left when the Shift key is pressed for 3 s or longer. |
| | d iFFE.r | The model codes are being matched.<br>Press the Data key to cancel copying before completion. |
| | d iFFEr | |

### 4. Executing Copying

| Key operation | Display example | Explanation |
|---|---|---|
| | EEP_ch<br>- - | Writing user parameters in EEPROM of the Servo Drive will start. |
| | F in iSh. | This display indicates a normal completion. |

### 5. Returning to the Display of Copy Mode

| Key operation | Display example | Explanation |
|---|---|---|
| DATA | cF_c2A. | Press the Data key to return to the Copy Mode Display. |

**Precautions for Correct Use**

- If “Error” is displayed before completion, repeat the procedure from the beginning.
- Press the Data key to clear the error.
- If an error is repeatedly displayed, the following are the possible causes: cable disconnection, connector contact failure, incorrect operation due to noise, or EEPROM fault in the Parameter Unit.
- Do not disconnect the Parameter Unit from the Servo Drive while copying is being performed.
  If the Parameter Unit is disconnected, incorrect data may be written and the data may be corrupted. Copy the user parameters again from the source Servo Drive to the Parameter Unit, and then copy the user parameters from the Parameter Unit to the other Servo Drive.

# 6-4 Trial Operation

When you have finished installation, wiring, Servomotor/Servo Drive jog operation, and user parameter setting, perform trial operation.
The main purpose of trial operation is to confirm that the servo system operates electrically correctly. Make sure that the host position controller and all peripheral devices are connected, and turn ON the power. Then perform trial operation at low speed to confirm the operation. Next, perform actual run patterns to confirm that the system works properly.

**Precautions for Correct Use**

- If an error occurs during the trial operation, refer to *Chapter 8 Troubleshooting* to eliminate the cause. Then ensure safety and resume operation.
- If the machine vibrates when starting or stopping, refer to *Chapter 7 Adjustment Functions* and perform the gain adjustment first.



## Preparation for Trial Operation

### ■ Turning OFF the Power

Some parameters are enabled by turning OFF the power and turning it ON again. First turn OFF the main circuit power.

### ■ Preparing for Turning OFF the Servomotor

In order that the Servomotor can be immediately turned OFF if an abnormality occurs in the machine, set up the system so that the power and the RUN Command Input can be turned OFF.

## Trial Operation

**1. Operating without a Load**

- Turn ON the power to the main circuit and peripheral devices, and then turn ON the RUN Command Input.
- Check that the Servomotor is in Servo ON status.
- Send the command to start the Servomotor from the host position controller, and check that the Servomotor operates properly according to the command. (Check that the Servomotor is rotating in the correct direction and the rotation speed and amount of rotation are as specified by the command.)

**2. Mechanical System Connection**

- Turn OFF the power.
- Firmly connect the Servomotor shaft to the load (i.e., the mechanical system). Tighten screws and make sure they are not loose.
- Turn ON the power.

**3. Low-speed Operation with Actual Load Connected**

- Send a low speed command from the host position controller to start the Servomotor. (The definition of “low speed” depends on the mechanical system, but a rough estimate is 1/10 to 1/5 of normal operating speed.)
- Check the following items.
  a) Are the emergency stop and over load switch operating correctly?
  b) Is the operating direction of the machine correct?

c) Are the operating sequences correct?
d) Are there any abnormal sounds or vibration?
If vibration occurs when starting or stopping the machine, refer to *Chapter 7 Adjustment Functions*, and adjust the gain.
e) Is any error (or alarm) generated?
If anything abnormal occurs, refer to *Chapter 8 Troubleshooting* and take the appropriate countermeasures.

### 4. Regular Pattern Operation

- Operate the Servomotor in a regular pattern and check the following items.

a) Is the operating speed correct?
b) Is the load torque almost equivalent to the measured value?
c) Are the positioning points correct?
d) When an operation is repeated, is there any discrepancy in positioning?
e) Are there any abnormal sounds or vibration?
If vibration occurs when starting or stopping the machine, refer to *Chapter 7 Adjustment Functions*, and adjust the gain.
f) Is the Servomotor or the Servo Drive abnormally overheating?
g) Is any error (or alarm) generated?
If anything abnormal occurs, refer to *Chapter 8 Troubleshooting* and take the appropriate countermeasures.

### 5. Trial Operation Completed

Performing the above completes the trial operation. Next, adjust the gain to improve control performance.

# Chapter 7

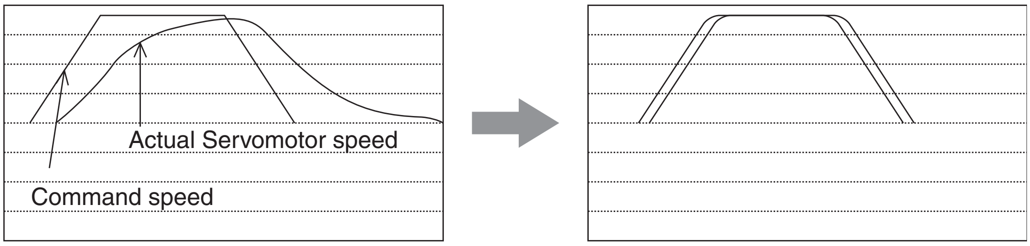
# Adjustment Functions

# 7-1 Gain Adjustment

SMARTSTEP 2-Series Servo Drive has realtime autotuning and autotuning functions.
With these functions, gain adjustments can be made easily even by those who use a servo system for the first time. If autotuning cannot be used, use manual tuning.

## Purpose of the Gain Adjustment

The Servomotor must operate in response to commands from the Servo Drive with minimal time delay and maximum reliability. The gain is adjusted to make the Servomotor operation follow the commands as strictly as possible to the operations specified by the commands, and to maximize the performance of the mechanical system.




## Gain Adjustment Methods

The SMARTSTEP 2-Series Servo Drive has three gain adjustment methods: realtime autotuning, autotuning, and manual tuning.

### ■ Realtime Autotuning

- Realtime autotuning estimates the load inertia of the mechanical system in realtime, and automatically sets the optimal gain according to the estimated result.
- Realtime autotuning includes the adaptive filter function that estimates the resonance frequency from the vibrating component in the motor speed, and automatically sets the notch filter coefficient to suppress the resonance point vibration.

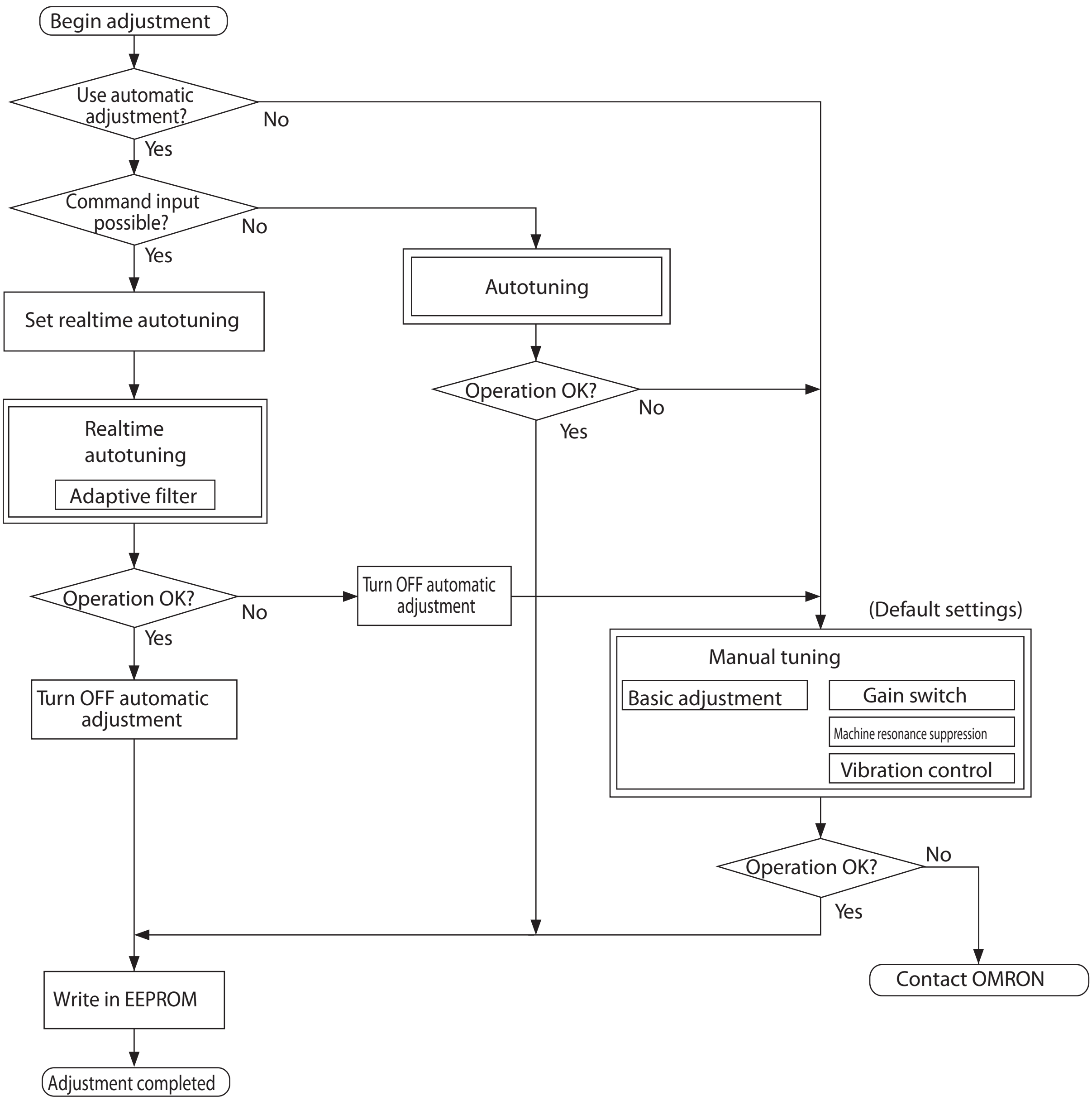
### ■ Autotuning

- Autotuning operates the Servomotor according to the operating pattern set in the Autotuning Operation Setting (Pn25), estimates the load inertia through the torque required, and automatically sets the optimal gain.

### ■ Manual Tuning

- Use manual tuning when autotuning cannot be performed due to the restrictions of the operating pattern or load conditions, or when maximum responsiveness needs to be obtained for individual loads.
  The default setting is for manual tuning.

## Gain Adjustment Procedure




**Reference** **Gain Adjustment and Machine Rigidity**

- The specific vibration (resonance frequency) of the mechanical system has a large impact on the gain adjustment. The servo system responsiveness cannot be set high for machines with a low resonance frequency (low machine rigidity).
- Check the following items to increase mechanical system rigidity.
  Lay the foundation firmly and set up a machine so that it does not wobble.
  Use a Decelerator with minimal backlash.
  Use couplings of a type with high rigidity and designed for servo systems.
  Use a wide timing belt, and use a tension within the allowable axial load for the Servomotor.

# 7-2 Realtime Autotuning

Realtime autotuning estimates the load inertia of the machine in realtime, and automatically sets the optimal gain according to the estimated load inertia. The adaptive filter automatically suppresses vibration caused by resonance. In the default settings realtime autotuning is disabled. Refer to the following procedures to enable realtime autotuning.

**Precautions for Correct Use**

- Realtime autotuning may not function properly under the conditions described in the following table. If realtime autotuning does not function properly, use autotuning or manual tuning.

| | Conditions under which realtime autotuning does not function properly |
|---|---|
| Load inertia | • If the load inertia is less than 3 times the rotor inertia.<br>• If the load inertia is more than 20 times the rotor inertia.<br>• If the load inertia changes quickly, i.e., in less than 10 seconds. |
| Load | • If the machine rigidity is extremely low.<br>• If there is backlash or play in the system.<br>• If the static friction torque is greater than the dynamic friction torque. |
| Operating pattern | • If the Servomotor is continuously run at a low speed below 100 r/min.<br>• If the acceleration/deceleration is gradual at less than 2000 r/min in 1 s.<br>• For abrupt operations, e.g., if the speed or acceleration condition is met in less than 40 ms.<br>• If the acceleration/deceleration torque is unbalanced and smaller compared to the viscous friction torque. |

## Realtime Autotuning Setting Method

### 1. Stopping the Servomotor

- Turn OFF the RUN Command Input (RUN) to the Servomotor. The Servomotor will stop.

### 2. Realtime Autotuning Mode Selection (Pn21)

Pn21 Setting

| Setting | Realtime Autotuning | Degree of change in load inertia during operation | Adaptive filter |
|---|---|---|---|
| 0 | Not used | --- | Disabled |
| 1 | Used | Almost no change in load inertia | Enabled (Pn02 = 2) |
| 2 | | Gradual changes in load inertia | |
| 3 | | Sudden changes in load inertia | |
| 4 | | Almost no change in load inertia | Disabled |
| 5 | | Gradual changes in load inertia | |
| 6 | | Sudden changes in load inertia | |
| 7 | Not used | --- | Enabled (Pn02 = 2) |

- When the degree of load inertia change is high, set the value to 3 or 6.
- Enable the adaptive filter if the load inertia change is affected by resonance.

### 3. Normal Operation

- Turn ON the RUN Command Input (RUN) and run the machine as usual.

### 4. Machine Rigidity Selection

- To increase responsiveness, gradually increase the setting of the Realtime Autotuning Machine Rigidity Selection (Pn22).
- If the machine produces an unusual noise or resonates, lower the setting.

### 5. Saving Gain Adjustment Values

- To save the gain setting, change to Parameter Write Mode and save the parameters in EEPROM. (For operation details, refer to *Parameter Write Mode* on page 6-16.)

| **Precautions for Correct Use** | • The setting of the Realtime Autotuning Mode Selection is changed when the Unit power is turned ON, or when the RUN Command Input (RUN) is turned ON.<br>• To disable realtime autotuning, set Pn21 to 0, and then turn OFF the RUN Command Input (RUN) and turn if ON again. |
|---|---|

## Operating Procedures

| | |
|---|---|
| Insert the connector of the Parameter Unit into CN2 of the Servo Drive, and then turn ON the power to the Servo Drive. | r 0 |

### Setting Parameter Pn21

| | |
|---|---|
| Press the Data key. | Un_SPd |
| Press the Mode key. | Pn_ 00. |
| Press the Increment or Decrement key to select the parameter to be set. (In this case, select Pn21.) | Pn_ 21. |
| Press the Data key. | 1. |
| Press the Increment or Decrement key to change the setting. | |
| Press the Data key. | Pn_ 21. |

### Setting Parameter Pn22

| | |
|---|---|
| Press the Increment key to set the parameter number to Pn22. | Pn_ 22. |
| Press the Data key. | 4 |
| Press the Increment key to increase the setting. | (Default setting) |
| Press the Decrement key to decrease the setting. | |
| Press the Data key. | |

### Writing in EEPROM

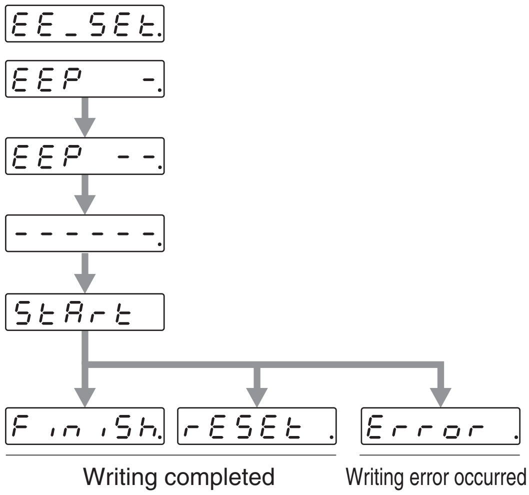
Press the Mode key.

Press the Data key.

Press the Increment key for at least 5 s.
The bars will increase as shown in the diagram on the right.

Writing will start.
("Start" will be displayed momentarily.)

Writing completed.




After writing has been completed, return to the display for Parameter Write Mode.



## Adaptive Filter

The adaptive filter will be enabled if the Control Mode Selection (Pn02) is set to advanced position control (setting of 2) and the Realtime Autotuning Mode Selection (Pn21) is set to 1 to 3 or 7.

The adaptive filter estimates the resonance frequency from the vibration component in the motor speed during operation, eliminates the resonance component from the torque command by automatically setting the notch filter coefficient, and suppresses the resonance point vibration.

**Precautions for Correct Use**

- The adaptive filter may not function properly under the conditions described in the following table. In that case, use manual tuning with Notch Filter 1 Frequency (Pn1D) and Notch Filter 1 Width (Pn1E) as a countermeasure for resonance. (For details on the notch filter, refer to *Machine Resonance Control* on page 7-21.)

| | Conditions under which the adaptive filter does not function properly |
|---|---|
| Resonance points | • If the resonance frequency is 300 Hz or less.<br>• If the resonance peak or control gain is low, and the Servomotor speed is not affected by it.<br>• If there are multiple resonance points. |
| Load | • If the Servomotor speed with high frequency components varies due to backlash or other non-linear elements. |
| Operating pattern | • If the acceleration/deceleration suddenly changes i.e., 3000 r/min or more in 0.1 s. |

## Automatically Set Parameters

When realtime autotuning is enabled, the following parameters will be set automatically. Parameters that are set automatically cannot be changed manually.

| Parameter No. (Pn No.) | Parameter name |
|---|---|
| 10 | Position Loop Gain |
| 11 | Speed Loop Gain |
| 12 | Speed Loop Integration Time Constant |
| 13 | Speed Feedback Filter Time Constant |
| 14 | Torque Command Filter Time Constant |
| 18 | Position Loop Gain 2 |
| 19 | Speed Loop Gain 2 |
| 1A | Speed Loop Integration Time Constant 2 |
| 1B | Speed Feedback Filter Time Constant 2 |
| 1C | Torque Command Filter Time Constant 2 |
| 20 | Inertia Ratio |
| 2F | Adaptive Filter Table Number Display |

The following parameters are set automatically. (The settings will not change even if realtime autotuning is executed.)

| (Pn No.) | Parameter name | Set value |
|---|---|---|
| 15 | Feed-forward Amount | 300 |
| 16 | Feed-forward Command Filter | 50 |
| 30 | Gain Switching Input Operating Mode Selection | 1 |
| 31 | Gain Switch Setting | 10 |
| 32 | Gain Switch Time | 30 |
| 33 | Gain Switch Level Setting | 50 |
| 34 | Gain Switch Hysteresis Setting | 33 |
| 35 | Position Loop Gain Switching Time | 20 |

**Precautions for Correct Use**

- An unusual noise or resonance may occur right after turning ON the first RUN Command Input (RUN) after the power ON, or when the setting of the Realtime Autotuning Machine Rigidity Selection (Pn22) is increased. Usually, the noise or resonance may continue until the load inertia is estimated, or the adaptive filter stabilizes. If the unusual noise or resonance stops immediately, there is no problem. However, if the unusual noise or resonance occurs for more than three reciprocating operations, perform the following measures in any order you can.

(1) Save the parameter settings when the machine operated normally to EEPROM.

(2) Decrease the setting of the Realtime Autotuning Machine Rigidity Selection (Pn22).

(3) Set the Realtime Autotuning Mode Selection (Pn21) to 0 to disable the adaptive filter. Then, enable realtime autotuning again. (Refer to *Disabling Realtime Autotuning* on page 7-13 for information on inertia estimation, resetting adaptive operations, and disabling realtime autotuning.)

(4) Set Notch Filter 1 Frequency (Pn1D) and Notch Filter 1 Width (Pn1E) manually. (For information on notch filters, refer to *Machine Resonance Control* on page 7-21.)

- After an unusual noise or resonance occurred, the setting of the Inertia Ratio (Pn20) or Adaptive Filter Table Number Display (Pn2F) may have been changed to an extreme value. Perform the above measures as well.
- Among the realtime autotuning results, the Inertia Ratio (Pn20) and Adaptive Filter Table Number Display (Pn2F) parameters are automatically saved to EEPROM every 30 minutes. Realtime autotuning will use this data as the default settings when the power is turned ON.

# 7-3 Autotuning

Autotuning operates the Servomotor according to command patterns created automatically in the Servo Drive, estimates the load inertia from the required torque and automatically sets the optimal gain.

**Precautions for Correct Use**

- Autotuning may not function properly under the conditions described in the following table. If autotuning does not function properly, use manual tuning.

| | Conditions under which autotuning does not function properly |
|---|---|
| Load inertia | • If the load inertia is less than 3 times the rotor inertia.<br>• If the load inertia is more than 20 times the rotor inertia.<br>• If the load inertia changes. |
| Load | • If the machine rigidity is extremely low.<br>• If there is backlash or play in the system.<br>• If the static friction torque is greater than the dynamic friction torque. |

- A tuning error will occur if the servo turns OFF (e.g., the RUN Command Input (RUN) turns OFF), or a deviation counter reset occurs (e.g., the Deviation Counter Reset (ECRST)) during the autotuning.
- If the load inertia cannot be estimated during autotuning, the setting of each gain cannot be changed and remains the same as before autotuning.
- When autotuning is being executed, the Servomotor output torque will reach the maximum output torque set in the Torque Limit (Pn5E).
- When autotuning is being executed, the Forward Drive Prohibit Input and Reverse Drive Prohibit Input will be ignored.

**Precautions for Safe Use**

- If the Servomotor oscillates, immediately cut off the power, or turn OFF the RUN Command Input (RUN). Then, return each gain to the default setting.

## Autotuning Setting Method

### 1. Setting the Operating Pattern

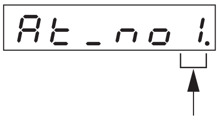
- Set the operating pattern using the Autotuning Operation Setting (Pn25).
- The operating pattern set in Pn25 will repeat in a maximum of five cycles. Starting with the third cycle, the acceleration level will double every cycle.
- Depending on the load, the operating pattern does not repeat in five cycles when operation is completed, or the acceleration does not change. In either case, this is not an error.

### 2. Moving the Load

- Move the load to the position where there's no problem if the Servomotor operates according to the setting in Pn25. The Servomotor will rotate once or twice in both forward and reverse depending on the settings.

### 3. Moving to the Autotuning Mode Display

- For information on moving to the Autotuning Mode Display, refer to *Autotuning Mode* on page 6-17.

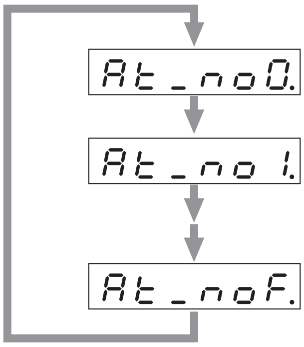



Autotuning Mode Display

Machine rigidity No.

### 4. Selecting Machine Rigidity

- Press the Increment or Decrement key to select the machine rigidity number.




Lowest machine rigidity

Highest machine rigidity

- The machine rigidity number sets the machine rigidity, and can be set to a value from 0 to F hex.
- The greater the machine rigidity, the higher the machine rigidity number is. The higher the machine rigidity is set, the higher the gain can be set.
- Under normal conditions, set the machine rigidity gradually from a low level in autotuning. Set the value in a range where an unusual noise, oscillation, and vibration do not occur.

**Reference** **Machine Rigidity Number Setting by Machine Drive System**

| Drive system | Machine rigidity No. |
|---|---|
| Ball screw direct coupling | 6 to C |
| Ball screw + timing belt | 4 to A |
| Timing belt | 2 to 8 |
| Gear, rack and pinion drive | 2 to 8 |
| Machine with low rigidity, etc. | 0 to 4 |

Machine rigidity numbers D to F can be used for machines with no resonance, high rigidity, and a low inertia ratio.

### 5. Moving to Autotuning Mode

- After setting the machine rigidity, press the Data key to move to Autotuning Mode. (For details, refer to *Autotuning Mode* on page 6-17.)


Autotuning Mode

### 6. Turning ON the Servo

- Turn ON the RUN Command Input (RUN). The Servo will turn ON.

### 7. Executing Autotuning

- Press and hold the Increment key until  is displayed. (For details, refer to *Autotuning Mode* on page 6-17.)
- The Servomotor will rotate and autotuning will begin. The operating pattern depends on the Autotuning Operation Setting (Pn25). If Pn25 is set to 0, the Servomotor will rotate two times in

both forward and reverse for approximately 15 seconds. This will be repeated up to 5 cycles. It is not an error if the Servomotor stops before cycling 5 times.

- Repeat step 4 (Selecting Machine Rigidity) to step 7 (Executing Autotuning) until satisfactory responsiveness can be obtained.

### 8. Saving the Gain Settings

- When system responsiveness is satisfactory, move to Parameter Write Mode and save the settings in EEPROM so they will not be lost. (For details on operations, refer to *Parameter Write Mode* on page 6-16.)
- To save the new settings, move to Parameter Write Mode and save the parameters in EEPROM.

**Precautions for Correct Use**

- Execute autotuning when a load is connected. If autotuning is executed without a load (i.e., Servomotor/Servo Drive only) the Inertia Ratio (Pn20) will be 0.
- A tuning error will occur if any of the following conditions occur while autotuning is being executed.

(1) If an error occurs. If the Servo is turned OFF, e.g., the RUN Command Input (RUN) is turned OFF. If the deviation counter is reset, e.g., using the Deviation Counter Reset Input (ECRST). If auto tuning is executed near a limit sensor.

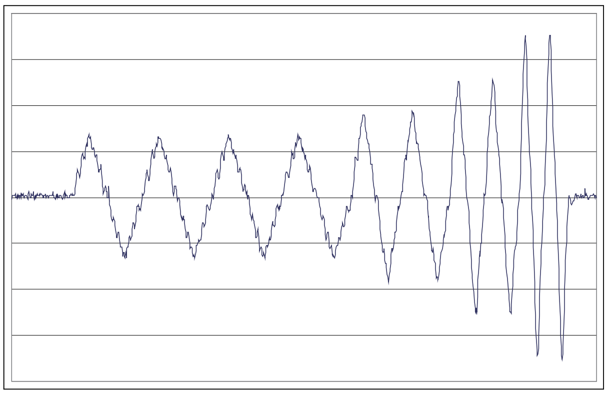
(2) If the inertia or load is too large and the output torque becomes saturated.

(3) If oscillation occurs and tuning cannot be performed correctly.

- If a tuning error occurs, the setting of each gain parameter will return to the value before tuning was executed. Except for times when an error occurs, the Servomotor will not stop.
- Depending on the load, the Error. message does not appear and oscillation may occur.

## Autotuning Operation Waveform

The following figure illustrates how the operation waveform will appear when autotuning is executed. The waveform will be distorted immediately after the execution, but will gradually smooth out.



## Automatically Set Parameters

The following parameters will be set automatically according to the autotuning machine rigidity number selected.

| Pn No. | Parameter name | Machine Rigidity No. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 10 | Position Loop Gain | 27 | 32 | 39 | 48 | 63 | 72 | 90 | 108 |
| 11 | Speed Loop Gain | 15 | 18 | 22 | 27 | 35 | 40 | 50 | 60 |
| 12 | Speed Loop Integration Time Constant | 37 | 31 | 25 | 21 | 16 | 14 | 12 | 11 |
| 13 | Speed Feedback Filter Time Constant | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Torque Command Filter Time Constant | 152 | 126 | 103 | 84 | 65 | 57 | 45 | 38 |
| 18 | Position Loop Gain 2 | 31 | 38 | 46 | 57 | 73 | 84 | 105 | 126 |
| 19 | Speed Loop Gain 2 | 15 | 18 | 22 | 27 | 35 | 40 | 50 | 60 |
| 1A | Speed Loop Integration Time Constant 2 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| 1B | Speed Feedback Filter Time Constant 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1C | Torque Command Filter Time Constant 2 | 152 | 126 | 103 | 84 | 65 | 57 | 45 | 38 |
| 20 | Inertia Ratio | Estimated load inertia ratio | | | | | | | |

| Pn No. | Parameter name | Machine Rigidity No. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 8 | 9 | A | B | C | D | E | F |
| 10 | Position Loop Gain | 135 | 162 | 206 | 251 | 305 | 377 | 449 | 557 |
| 11 | Speed Loop Gain | 75 | 90 | 115 | 140 | 170 | 210 | 250 | 310 |
| 12 | Speed Loop Integration Time Constant | 9 | 8 | 7 | 6 | 5 | 4 | 4 | 3 |
| 13 | Speed Feedback Filter Time Constant | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Torque Command Filter Time Constant | 30 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| 18 | Position Loop Gain 2 | 157 | 188 | 241 | 293 | 356 | 440 | 524 | 649 |
| 19 | Speed Loop Gain 2 | 75 | 90 | 115 | 140 | 170 | 210 | 250 | 310 |
| 1A | Speed Loop Integration Time Constant 2 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| 1B | Speed Feedback Filter Time Constant 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1C | Torque Command Filter Time Constant 2 | 30 | 25 | 20 | 16 | 13 | 11 | 10 | 10 |
| 20 | Inertia Ratio | Estimated load inertia ratio | | | | | | | |

**Reference** ♦ The parameter default values are set according to the machine rigidity number. The parameter settings are automatically changed when autotuning is executed.

The following parameters are set automatically. (The settings will not be changed even if realtime autotuning is executed.)

| Pn No. | Parameter name | Machine Rigidity No. |
|---|---|---|
| | | 0 to F |
| 15 | Feed-forward Amount | 300 |
| 16 | Feed-forward Command Filter | 50 |
| 30 | Gain Switching Input Operating Mode Selection | 1 |
| 31 | Gain Switch Setting | 10 |
| 32 | Gain Switch Time | 30 |
| 33 | Gain Switch Level Setting | 50 |
| 34 | Gain Switch Hysteresis Setting | 33 |
| 35 | Position Loop Gain Switching Time | 20 |

- Regardless of the machine rigidity number, the settings cannot be changed.

# 7-4 Disabling the Automatic Gain Adjustment Function

This section explains how to disable realtime autotuning and the adaptive filter. These functions are enabled by default.

**Precautions for Correct Use**

- When disabling the automatic adjustment function, the RUN Command Input (RUN) must be turned OFF.

## Disabling Realtime Autotuning

By setting the Realtime Autotuning Mode Selection (Pn21) to 0 or 7, the automatic estimation of the Inertia Ratio (Pn20) will stop and realtime autotuning will be disabled.

However, the estimated results of the Inertia Ratio (Pn20) will remain. If the Pn20 value is obviously incorrect, perform autotuning or set the calculated value manually after disabling realtime autotuning.

**Precautions for Correct Use**

- To enable the Realtime Autotuning Mode Selection (Pn21), turn OFF the RUN Command Input (RUN), and then turn it back ON.

## Disabling the Adaptive Filter

Setting the Realtime Autotuning Mode Selection (Pn21) to 0 or 4 to 6 will disable the adaptive filter which automatically adjusts for load resonance. If the properly functioning adaptive filter is disabled, the effect of the suppressed resonance may appear, and noise and vibration may occur. Disable the adaptive filter only after manually setting the Notch Filter 1 Frequency (Pn1D) based on the displayed value of the Adaptive Filter Table Number Display (Pn2F).

| Displayed value | Notch Filter 1 Frequency (Hz) | Displayed value | Notch Filter 1 Frequency (Hz) | Displayed value | Notch Filter 1 Frequency (Hz) |
|---|---|---|---|---|---|
| 0 | Disabled | 22 | 766 | 44 | 326 |
| 1 | Disabled | 23 | 737 | 45 | 314 |
| 2 | Disabled | 24 | 709 | 46 | 302 |
| 3 | Disabled | 25 | 682 | 47 | 290 |
| 4 | Disabled | 26 | 656 | 48 | 279 |
| 5 | 1482 | 27 | 631 | 49 | 269 (Disabled when Pn22 ≥ F) |
| 6 | 1426 | 28 | 607 | 50 | 258 (Disabled when Pn22 ≥ F) |
| 7 | 1372 | 29 | 584 | 51 | 248 (Disabled when Pn22 ≥ F) |
| 8 | 1319 | 30 | 562 | 52 | 239 (Disabled when Pn22 ≥ F) |
| 9 | 1269 | 31 | 540 | 53 | 230 (Disabled when Pn22 ≥ F) |
| 10 | 1221 | 32 | 520 | 54 | 221 (Disabled when Pn22 ≥ E) |
| 11 | 1174 | 33 | 500 | 55 | 213 (Disabled when Pn22 ≥ E) |
| 12 | 1130 | 34 | 481 | 56 | 205 (Disabled when Pn22 ≥ E) |
| 13 | 1087 | 35 | 462 | 57 | 197 (Disabled when Pn22 ≥ E) |
| 14 | 1045 | 36 | 445 | 58 | 189 (Disabled when Pn22 ≥ E) |
| 15 | 1005 | 37 | 428 | 59 | 182 (Disabled when Pn22 ≥ D) |
| 16 | 967 | 38 | 412 | 60 | Disabled |
| 17 | 930 | 39 | 396 | 61 | Disabled |
| 18 | 895 | 40 | 381 | 62 | Disabled |
| 19 | 861 | 41 | 366 | 63 | Disabled |
| 20 | 828 | 42 | 352 | 64 | Disabled |
| 21 | 796 | 43 | 339 | | |

- When the Adaptive Filter Table Number Display (Pn2F) is greater than 49, the Realtime Autotuning Machine Rigidity Selection (Pn22) may have automatically disabled the adaptive filter. In this case, the Notch Filter 1 Frequency (Pn1D) does not need to be set.

# 7-5 Manual Tuning

Use manual tuning to adjust the gain when adjustments cannot be made properly with autotuning (described in the previous section) due to load conditions or other restrictions, or when loads that have been adjusted with autotuning need to be readjusted individually to achieve optimal response and stability.

This section explains manual tuning, which is used to manually adjust the gain.

## Function Differences in Control Modes

The following table shows the adjustment ranges of manual tuning for each control mode.

| Pn02 setting | Control Mode | Basic adjustment | Gain switch | Torque filter | Notch filter | Vibration control switch |
|---|---|---|---|---|---|---|
| 0 | High-response Position Control | Supported. | Supported. | Supported. | Supported (See note.)*1 | Supported (See note.)*1 |
| 1 | Internally Set speed Control | Supported. | Supported. | Supported. | Supported. | Not supported. |
| 2 | Advanced Position Control | Supported. | Supported. | Supported. | Supported. | Supported. |

*1. The notch filter and vibration control cannot be used at the same time in High-response Position Control. The parameter entered first will be given priority.

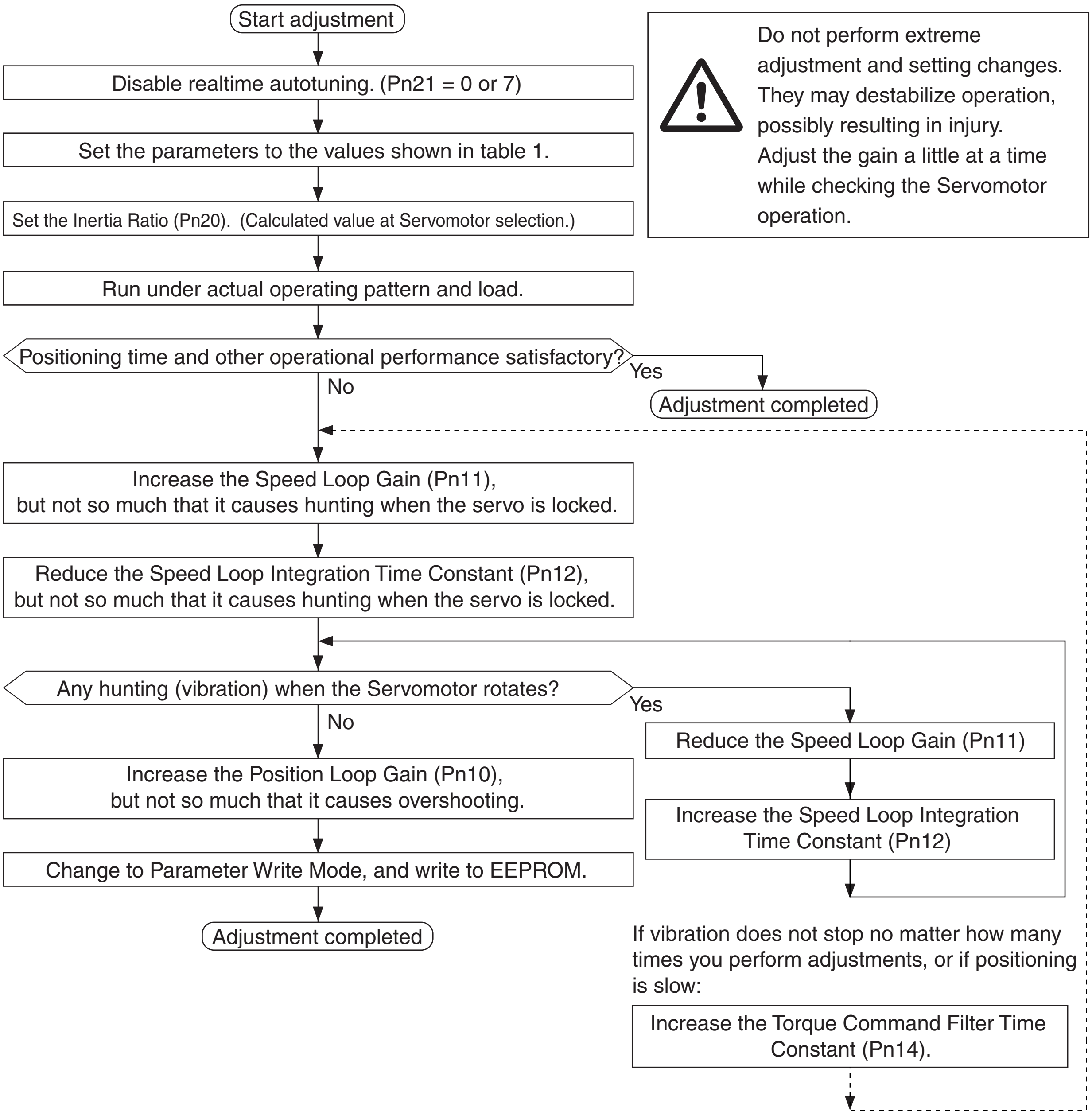
Example:

When vibration control is set, the Servo Drive will be forcibly set to 1500 (disabled), even if the Notch Filter 1 Frequency (Pn1D) is input.

## Basic Adjustment Procedures

### ■ Adjustment in Position Control Mode

> ⚠ Do not perform extreme adjustment and setting changes. They may destabilize operation, possibly resulting in injury. Adjust the gain a little at a time while checking the Servomotor operation.



## ■ Adjustment in Internally Set Speed Control Mode

The following parameters are adjustable: Speed Loop Gain (Pn11 and Pn19), Speed Loop Integration Time Constant (Pn12 and Pn1A), and Torque Command Filter Time Constant (Pn14 and Pn1C).

Do not perform extreme adjustment and setting changes. They may destabilize operation, possibly resulting in injury.
Adjust the gain a little at a time while checking the Servomotor operation.

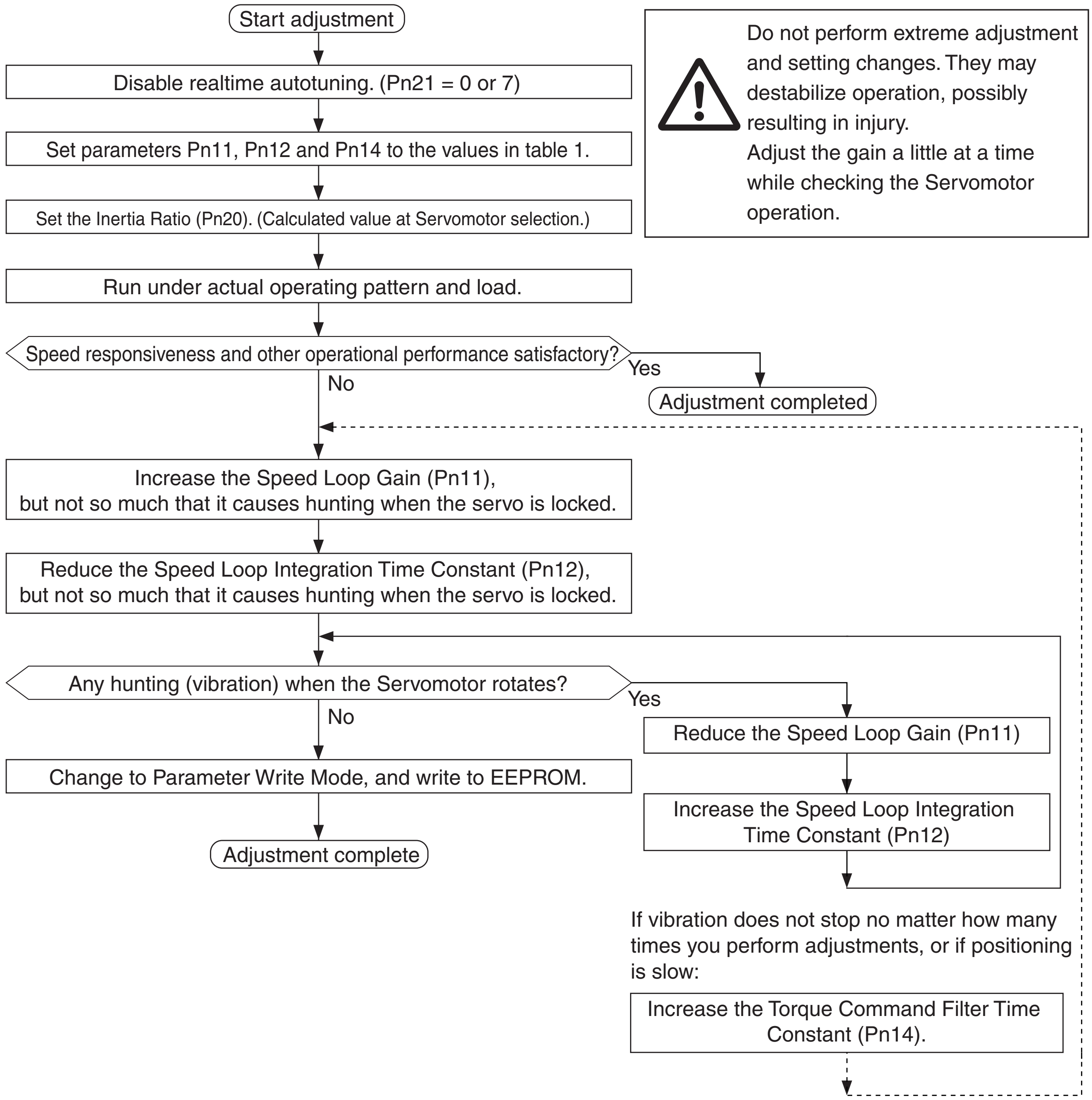


Table 1 :Parameter Adjustment Guidelines

| Pn No. | Parameter name | Guideline |
|---|---|---|
| 10 | Position Loop Gain | 27 |
| 11 | Speed Loop Gain | 15 |
| 12 | Speed Loop Integration Time Constant | 37 |
| 13 | Speed Feedback Filter Time Constant | 0 |
| 14 | Torque Command Filter Time Constant | 152 |
| 15 | Feed-forward Amount | 0 |
| 16 | Feed-forward Command Filter | 0 |
| 18 | Position Loop Gain 2 | 27 |
| 19 | Speed Loop Gain 2 | 15 |
| 1A | Speed Loop Integration Time Constant 2 | 37 |
| 1B | Speed Feedback Filter Time Constant 2 | 0 |
| 1C | Torque Command Filter Time Constant 2 | 152 |
| 1D | Notch Filter 1 Frequency | 1500 |
| 1E | Notch Filter 1 Width | 2 |
| 20 | Inertia Ratio | *1 |

*1. Input the Inertia Ratio (Pn20). The inertia ratio can be measured with autotuning or set to a calculated value. When the inertia ratio is unknown, set 300 in Pn20.

## Gain Switching Function

With manual tuning, gain 1 and gain 2 can be set manually. For example, the gain can be switched according to the following conditions.

- To increase responsiveness by increasing the gain during operation.
- To increase servo lock rigidity by increasing the gain when operation is stopped.
- To switch to an optimal gain according to the Operating Mode.
- To reduce the gain to suppress vibration when operation is stopped.

The function of switching from gain 1 to gain 2 can be used in a variety of applications.

### ■ Explanation of Settings

To use the gain switching function, the Gain Switching Input Operating Mode Selection (Pn30) and Gain Switch Setting (Pn31) parameters must be set. For details on parameter settings, refer to *Parameter Details* on page 5-32.

#### Gain Switching Input Operating Mode Selection (Pn30)

Set Pn30 to 1 to enable the gain switching function.

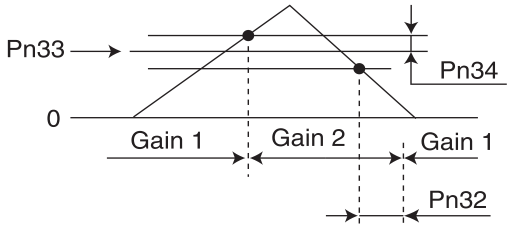
#### Gain Switch Setting (Pn31)

Gain switching can be used by first enabling the gain switching function and then setting the switching conditions for gain 1 and gain 2 with Gain Switch Setting (Pn31).

| Pn31 setting | Explanation | | | |
|---|---|---|---|---|
| | Gain switch condition | Gain Switch Time (Pn32) *1 | Gain Switch Level Setting (Pn33) | Gain Switch Hysteresis Setting (Pn34) *2 |
| 0 | Always gain 1 (Pn10 to Pn14) | Disabled | Disabled | Disabled |
| 1 | Always gain 2 (Pn18 to Pn1C) | Disabled | Disabled | Disabled |
| 2 | Switching using Gain Switch Input (GSEL) at pin CN1-5 | Disabled | Disabled | Disabled |
| 3 | Amount of change in torque command (Figure A) | Enabled | Enabled *3 (× 0.05%) | Enabled *3 (× 0.05%) |
| 4 | Always gain 1 (Pn10 to Pn14) | Disabled | Disabled | Disabled |
| 5 | Command speed (Figure B) | Enabled | Enabled (r/min) | Enabled (r/min) |
| 6 | Amount of position deviation (Figure C) | Enabled | Enabled *4 (pulse) | Enabled *4 (pulse) |
| 7 | Command pulses received (Figure D) | Enabled | Disabled | Disabled |
| 8 | Positioning Completed Signal (INP) OFF (Figure E) | Enabled | Disabled | Disabled |
| 9 | Actual Servomotor speed (Figure B) | Enabled | Enabled (r/min) | Enabled (r/min) |
| 10 | Combination of command pulse input and speed (Figure F) | Enabled | Enabled *5 (r/min) | Enabled *5 (r/min) |

*1. The Gain Switch Time (Pn32) is used when switching from gain 2 to gain 1.

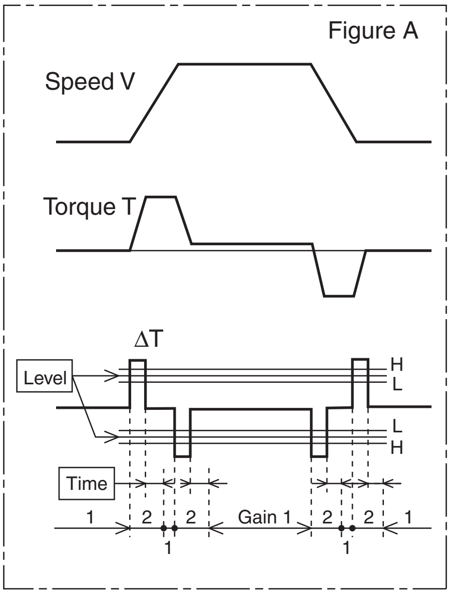
*2. The Gain Switch Hysteresis Setting (Pn34) is defined as shown in the following figure.

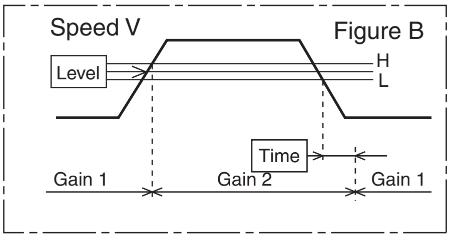


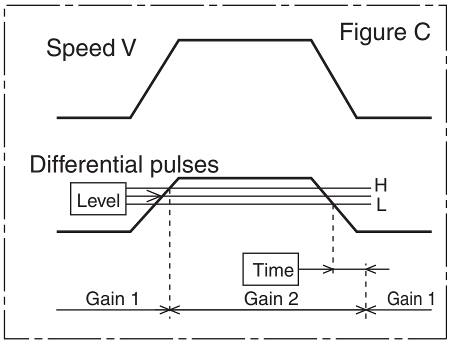

*3. The amount of change is the value within 166 μs.
Example: When the condition is a 10% change in torque in 166 μs, the set value is 200.

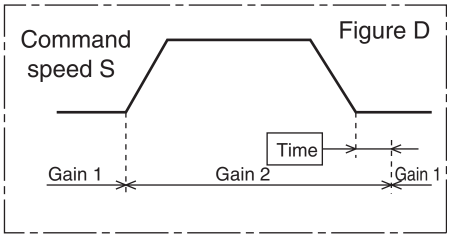
*4. This is the encoder resolution value.

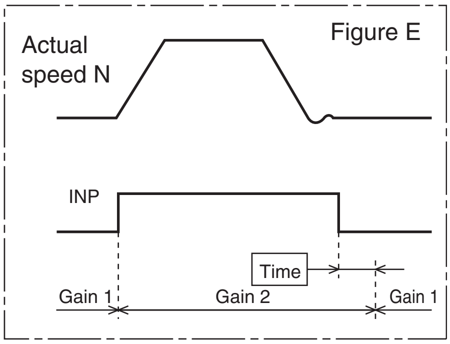
*5. The meanings of the Gain Switch Time, Gain Switch Level Setting, and Gain Switch Hysteresis Setting are different from normal if this parameter is set to 10. (Refer to Figure F.)

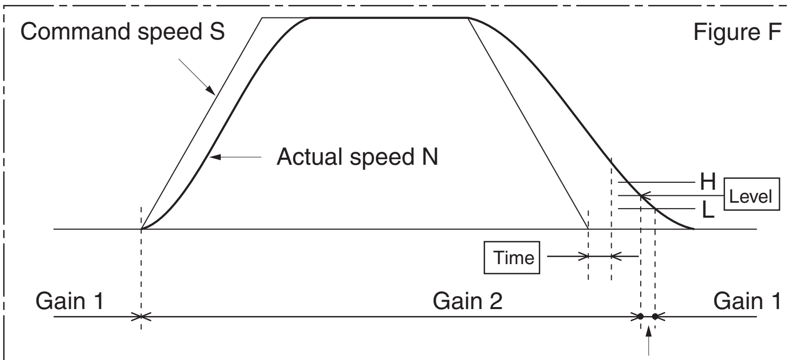



Gain 2 is used only during the Speed Loop Integration Time Constant.
Gain 1 is used at other times.

## Machine Resonance Control

When machine rigidity is low, shaft torsion may cause resonance, leading to vibration or noise, thus not allowing the gain to be set high. In this case, the resonance can be suppressed by using the two filter types.

### ■ Torque Command Filter Time Constant (Pn14, Pn1C)

The filter time constant is set to attenuate the resonance frequency. The cut-off frequency can be calculated using the following equation.

Cut-off frequency (Hz) $fc = \dfrac{1}{2\pi T} = \dfrac{1}{2\pi \times \text{Parameter setting} \times 10^{-5}}$

### ■ Notch Filter

#### Adaptive Filter (Pn21, Pn2F)

By using the adaptive filter, the Servo Drive can suppress vibration of loads with various resonance points for each machinery, which conventional notch filters or torque command filters were unable to cope with. Enable the adaptive filter by selecting advanced position control (2) for the Control Mode Selection (Pn02) and setting the Realtime Autotuning Mode Selection (Pn21) to 1 to 3 or 7.

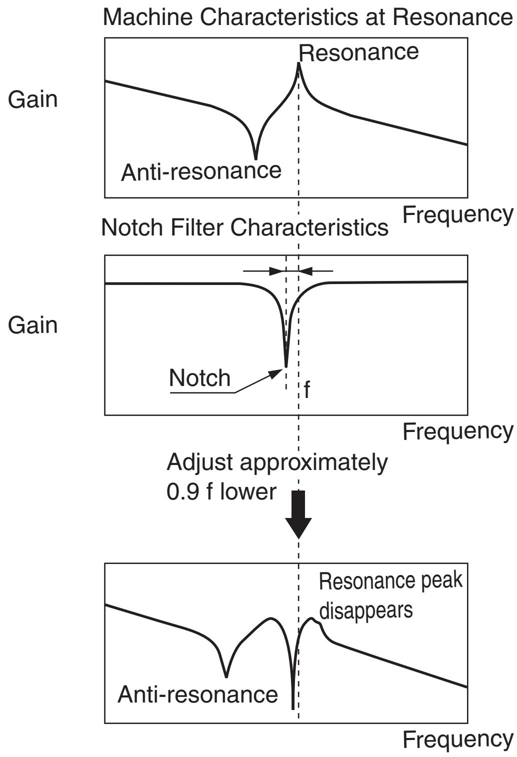
| Pn No. | Parameter name | Explanation |
|---|---|---|
| 21 | Realtime Autotuning Mode Selection | The adaptive filter is enabled when this parameter is set to 1 to 3, or 7. |
| 2F | Adaptive Filter Table Number Display | Displays the table entry number corresponding to the frequency of the adaptive filter.*1<br>The setting of this parameter cannot be changed. |

*1. For information on table entry numbers and frequency, refer to *Disabling the Adaptive Filter* on page 7-14.

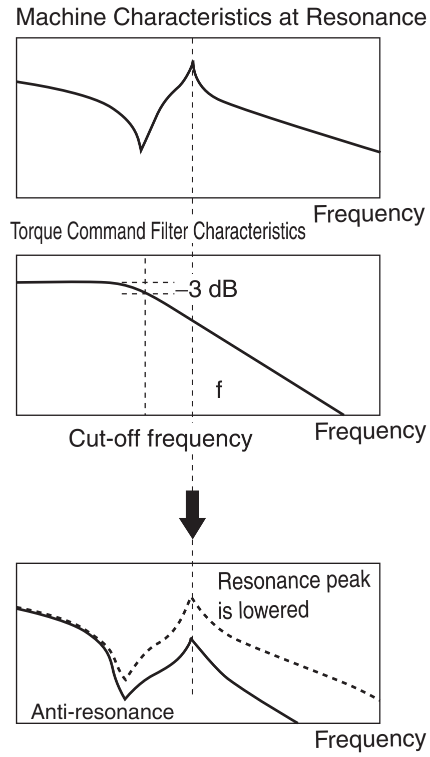
#### Notch Filter 1 (Pn1D, Pn1E)

Adjust the notch frequency of the notch filter according to the machine resonance frequency.

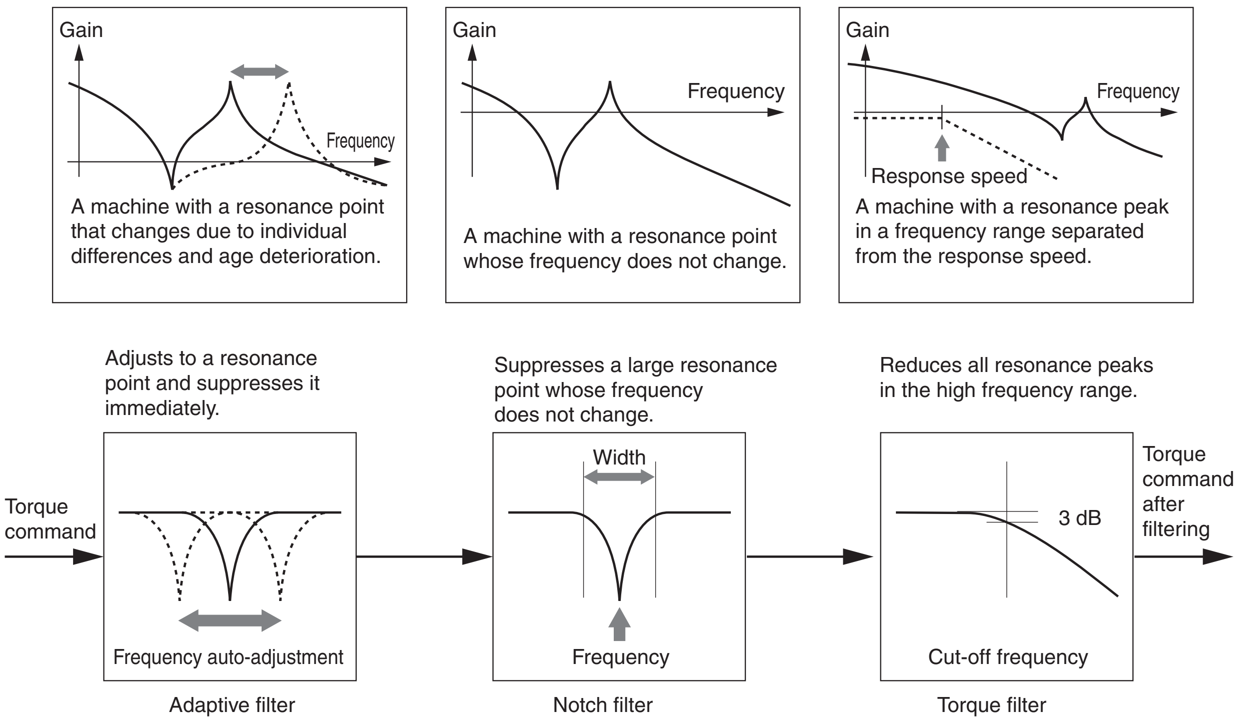
Notch Filter Function




Torque Command Filter Function

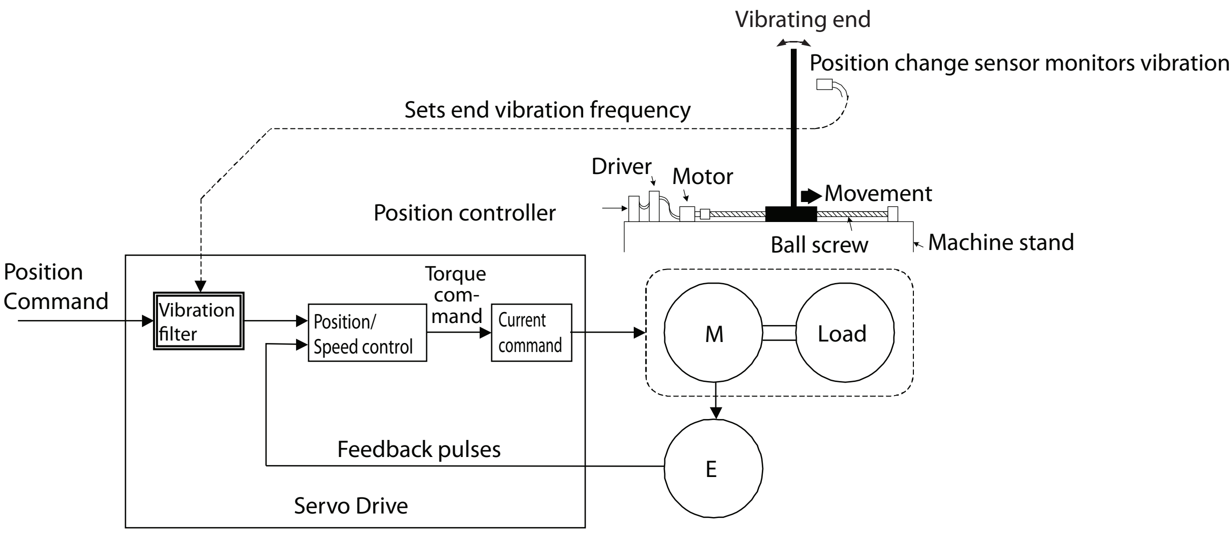



Example of an Adaptive Machine



## Vibration Control

When the machine end vibrates, vibration control removes the vibration frequency component from the command and suppresses vibration.




**Precautions for Correct Use**

- The following conditions must be met to use vibration control.

| | Conditions under which vibration control operates |
|---|---|
| Control Mode | • The Position Control Mode must be used.<br>• If the Control Mode Selection (Pn02) is set to 0, realtime autotuning and notch filter 1 must be disabled in High-Response Position Control.<br>• If the Control Mode Selection (Pn02) is set to 2, Advanced Position Control Mode is used. |

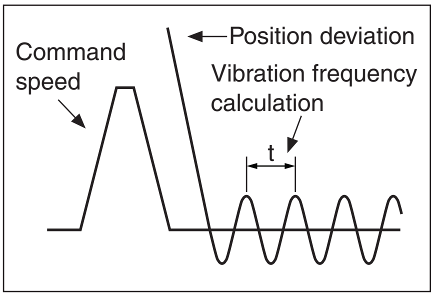
- Stop operation before changing parameters.
- Under the following conditions, vibration control may not operate properly or may have no effect.

| | Conditions under which the effect of vibration control is inhibited |
|---|---|
| Load | • When forces other than commands, such as external forces, cause vibration.<br>• When the difference between the resonance frequency and anti-resonance frequency is large.<br>• When the vibration frequency is large (more than 100 Hz). |

## ■ Operating Procedure

### 1. Setting the Vibration Frequency (Pn2B)

Measure the vibration frequency at the end of the machine. If the end vibration can be measured directly using a laser displacement sensor, read the vibration frequency (Hz) from the measured waveform and set it in the Vibration Frequency (Pn2B). If no measurement device is available, use the CX-Drive waveform graphic function, and read the residual vibration frequency (Hz) from the position deviation waveform as shown in the following figure. The set values from 0 to 99 are invalid.



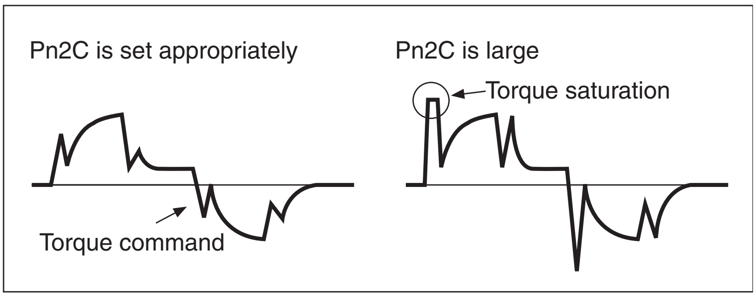

Measure the distance between the residual peaks (t), and calculate the vibration frequency (Hz) using the following formula.

$$f\ (\mathrm{Hz}) = \frac{1}{t\ (\mathrm{s})}$$

### 2. Setting the Vibration Filter (Pn2C)

First, set the Vibration Filter Setting (Pn2C) to 0. The settling time can be reduced by setting a large value, however, torque ripple will increase at the command change point as shown in the following figure.

Set in a range that will not cause torque saturation under actual operation conditions. The effects of vibration suppression will be lost if torque saturation occurs.



# Chapter 8

# Troubleshooting

# 8-1 Error Processing

This section explains preliminary checks required to determine the cause of problems that might occur and cautions for the problems.

## Preliminary Checks When a Problem Occurs

This section explains the preliminary checks and analytical tools required to determine the cause of problems that might occur.

### ■ Checking the Power Supply Voltage

- Check the voltage at the power supply input terminals.
  Main-circuit Power Supply Input Terminals (L1, (L2), L3)
    R7D-BP□□L: Single-phase 100 to 115 VAC (85 to 127 V), 50/60 Hz
    R7D-BP02HH: Single-phase 200 to 240 VAC (170 to 264 V), 50/60 Hz
    R7D-BP□□H: Single-phase/three-phase 200 to 240 VAC (170 to 264 V), 50/60 Hz
    R7D-BP02H: Three-phase 200 to 240 VAC (170 to 264 V), 50/60 Hz
  If the voltage is outside of this range, there is a risk of operation failure. Be sure to supply the power correctly.
- Check the voltage for the sequence input power supply:
  Within the range of 11 to 25 VDC (+24 VIN terminal (pin CN1-1)).
  If the voltage is outside of this range, there is a risk of operation failure. Be sure to supply the power correctly.



### ■ Checking Whether an Alarm Has Occurred

Check the alarm LED indicator on the front of the Servo Drive to see whether an alarm has occurred, or check the alarm code on the Parameter Unit.

#### When an alarm has occurred:

- Check the status of the alarm LED indicator (ALM) and evaluate the problem based on the alarm indicated.
- Check the alarm code and perform analysis based on the alarm code information.

#### When an alarm has not occurred:

Make an analysis according to the problem.

**Note** In either case, refer to *8-3 Troubleshooting* for details.

## Precautions When Troubleshooting

When checking and verifying I/O after a problem has occurred, the Servomotor/Servo Drive may suddenly start to operate or stop, so always use the following precautions.
You should assume that anything not described in this manual is not possible with this product.

### ■ Precautions

- Disconnect the cable before checking for wire breakage. Even 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 Servomotor may run away, or an error may occur. Be sure to disconnect the Servomotor from the mechanical system before checking the encoder signal.
- When performing tests, first check that there are no persons in the vicinity or inside the equipment, and that the equipment will not be damaged even if the Servomotor runs away. Before performing the tests, verify that you can immediately stop the machine using an emergency stop even if the Servomotor runs away.

## Replacing the Servomotor and Servo Drive

Use the following procedure to replace the Servomotor or Servo Drive.

### ■ Replacing the Servomotor

**1. Replace the Servomotor.**

**2. Perform machine origin position alignment (for position control).**

- When the Servomotor is replaced, the Servomotor's origin position (phase Z) may deviate, so origin alignment must be performed.
- Refer to the Position Controller's operation manual for details on performing origin alignment.

### ■ Replacing the Servo Drive

**1. Copy the parameters.**

- Use the copy function of the Parameter Unit to copy all the parameter settings to the Parameter Unit. Alternatively, use the Parameter Unit to display all the parameter settings and write them down.

**2. Replace the Servo Drive.**

**3. Set the parameters.**

- Use the copy function of the Parameter Unit to transfer all the saved parameters to the Servo Drive. Alternatively, use the Parameter Unit to set all the parameters.

# 8-2 Alarm Table

If the Servo Drive detects an error, the Alarm Output (ALM) will turn ON, the power drive circuit will turn OFF, and the alarm code will be displayed. If a warning is detected (torque limit imposed, zero speed detection, over regeneration, overload, or fan rotation speed error), the Warning Output (WARN) will turn ON, and the warning will be displayed. (Operation will continue.)

**Precautions for Correct Use**

- The Warning Output is output only for warnings set in the Warning Output Selection (Pn09).
- Refer to *Error Diagnosis Using the Displayed Alarm Codes* on page 8-6 for alarm countermeasures.
- Reset the alarm using one of the following methods. Be sure to remove the cause of the alarm before resetting.
  Turn ON the Alarm Reset Input (RESET).
  Turn OFF the power supply, then turn it ON again.
  Perform the Alarm Reset operation on the Parameter Unit.
  The following alarms can only be reset by turning OFF the power supply, then turning it ON again: 14, 15, 18, 21, 23, 36, 37, 48, 49, 95, and 96.
- If you reset an alarm while the RUN Command (RUN) is turned ON, the Servo Drive will start operation as soon as the alarm is reset, which is dangerous. Be sure to turn OFF the RUN Command (RUN) before resetting the alarm.
  If the RUN Command (RUN) is always ON, ensure safety thoroughly before resetting the alarm.



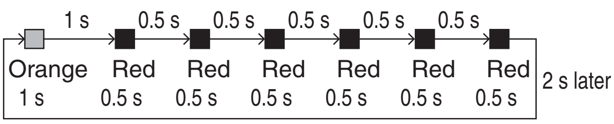
## Alarm Indicator on the Servo Drive

The alarm LED indicator on the front of the Servo Drive lights up if an error is detected. The indicator shows the alarm code by the number of orange and red flashes.

Example:

When an overload alarm (alarm code 16) has occurred and the Unit has stopped, the indicator will flash 1 time in orange and 6 times in red.

Orange: 10s digit, Red: 1s digit



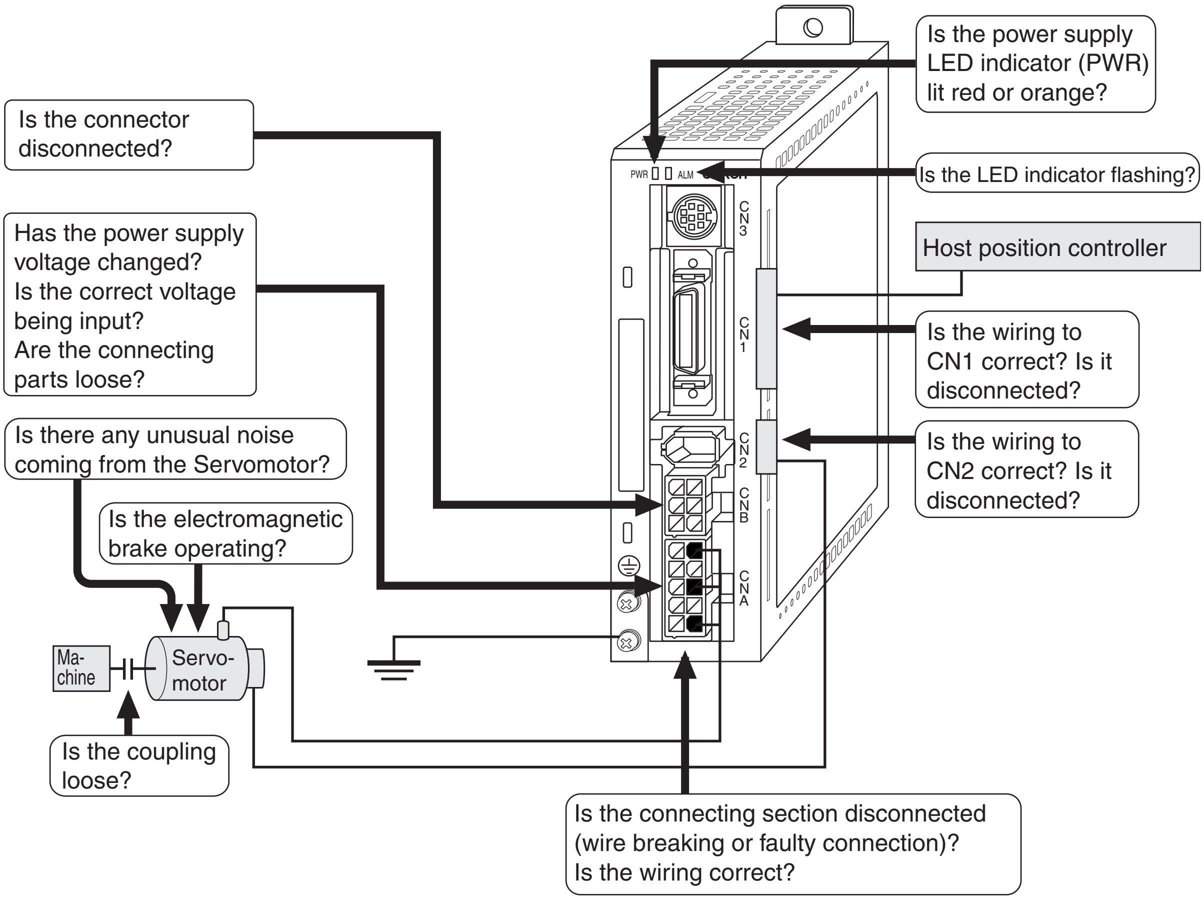
## Alarm List

| Alarm code | Error detection function | Detection details and cause of error | Alarm reset possible |
|---|---|---|---|
| 11 | Power supply undervoltage | The DC voltage of the main circuit fell below the specified value while the RUN Command Input was ON. | Yes |
| 12 | Overvoltage | The DC voltage of the main circuit is abnormally high. | Yes |
| 14 | Overcurrent | Overcurrent flowed to the IGBT. Servomotor power line ground fault or short circuit. | No |
| 15 | Built-in resistor overheat | The resistor in the Servo Drive is abnormally overheating. | No |
| 16 | Overload | Operation was performed with torque significantly exceeding the rated level for several seconds to several tens of seconds. | Yes |
| 18 | Regeneration overload | The regeneration energy exceeded the processing capacity of the regeneration resistor. | No |
| 21 | Encoder disconnection detected | The encoder wiring is disconnected. | No |
| 23 | Encoder data error | Data from the encoder is abnormal. | No |
| 24 | Deviation counter overflow | The number of accumulated pulses in the deviation counter exceeded the setting in the Deviation Counter Overflow Level (Pn63). | Yes |
| 26 | Overspeed | The Servomotor exceeded the maximum number of rotations.<br>If the torque limit function was used, the Servomotor's rotation speed exceeded the settings in the Overspeed Detection Level Setting (Pn70 and Pn73). | Yes |
| 27 | Electronic gear setting error | The setting in Electronic Gear Ratio Numerator 1 (Pn46) or Electronic Gear Ratio Numerator 2 (Pn47) is not appropriate. | Yes |
| 29 | Deviation counter overflow | The number of accumulated pulses for the deviation counter exceeded 134,217,728. | Yes |
| 34 | Overrun limit error | The Servomotor exceeded the allowable operating range set in the Overrun Limit Setting (Pn26). | Yes |
| 36 | Parameter error | Data in the parameter saving area was corrupted when data was read from the EEPROM at power ON. | No |
| 37 | Parameter corruption | The checksum didn't match when data was read from the EEPROM at power on. | No |
| 38 | Drive prohibit input error | The forward drive prohibit and reverse drive prohibit inputs are both turned OFF. | Yes |
| 48 | Encoder phase Z error | A phase-Z pulse was not detected regularly. | No |
| 49 | Encoder CS signal error | A logic error of the CS signal was detected. | No |
| 95 | Servomotor non-conformity | The combination of the Servomotor and Servo Drive is not appropriate.<br>The encoder was not connected when the power supply was turned ON. | No |
| 96 | LSI setting error | Excessive noise caused the LSI setting not to be completed properly. | No |
| Others | Other errors | The Servo Drive's self-diagnosis function detected an error in the Servo Drive. | No |

# 8-3 Troubleshooting

If an error occurs in the machine, determine the error conditions from the alarm indicator and operating status, identify the cause of the error, and take appropriate countermeasures.

## Points to Check




8

Troubleshooting

## Error Diagnosis Using the Displayed Alarm Codes

| Alarm code | Error | Status when error occurs | Cause | Countermeasure |
|---|---|---|---|---|
| 11 | Power supply undervoltage | Occurs when the Servo Drive is turned ON. | • The power supply voltage is low.<br>• Momentary power interruption occurred.<br>• Power supply capacity is insufficient.<br>• The power supply voltage drops because the main power supply is OFF.<br>• The main power supply is not input. | • Increase the power supply capacity.<br>• Change the power supply.<br>• Turn ON the power supply. |
| | | | • Power supply capacity is insufficient. | • Increase the power supply capacity. |
| | | | • Phase loss. | • Connect the phases (L1, L2, L3) of the power supply voltage correctly.<br>• For single-phase, connect to L1 and L3 correctly. |
| | | | • The main circuit power supply part is damaged.<br>• Control PCB error. | • Replace the Servo Drive. |
| 12 | Overvoltage | Occurs when power supply is turned ON. | • Main circuit power supply voltage is outside the allowable range. | • Change the main circuit power supply voltage to within the allowable range. |
| | | Occurs when the Servomotor is decelerating. | • Load inertia is too large. | • Calculate the regenerative energy, and connect an External Regeneration Resistor with the required regeneration absorption capacity.<br>• Extend the deceleration time. |
| | | | • Main circuit power supply voltage is outside the allowable range. | • Change main circuit power supply voltage to within the allowable range. |
| | | Occurs during descent (vertical axis). | • Gravitational torque is too large. | • Add a counterbalance to the machine to lower gravitational torque.<br>• Slow the descent speed.<br>• Calculate the regenerative energy, and connect an External Regeneration Resistor with the required regeneration absorption capacity. |

| Alarm code | Error | Status when error occurs | Cause | Countermeasure |
|---|---|---|---|---|
| 14 | Overcurrent | Occurs when the Servo Drive is turned ON. | • Control PCB error | • Replace the Servo Drive. |
| | | | • Servomotor power line is short-circuited or ground-faulted between phases. | • Repair the short-circuited or ground-faulted wire.<br>• Measure the insulation resistance at the Servomotor and, if there is a short-circuit, replace the Servomotor. |
| | | | • Miswiring between phase U, V, or W and ground. | • Correct the wiring. |
| | | | • Servomotor winding is burned out. | • Measure the wire wound resistance, and if the winding is burned out, replace the Servomotor. |
| | | | • The relay for the dynamic brake has been consequently welded. | • Do not frequently input the RUN Command Input.<br>• Do not operate the system by turning the Servo Drive ON and OFF. |
| | | | • Servomotor non-conformity | • Use a Servomotor that is appropriate for use with the Servo Drive. |
| | | | • The pulse input timing is too fast. | • Wait 100 ms min. before inputting pulses after turning ON the RUN Command Input (RUN). |
| | | | • The resistor in the Servo Drive is abnormally overheating. | • Reduce the ambient temperature of the Servo Drive to 55°C or lower.<br>• If the relay does not click when the power supply is turned ON, replace the Servo Drive. |
| 16 | Overload | Occurs when the Servo Drive is turned ON. | • There is an error in the Servomotor wiring (e.g., the wiring or the contacts are faulty). | • Wire the Servomotor Power Cable correctly. |
| | | | • The electromagnetic brake is ON. | • Reset the brake. |
| | | | • The Servo Drive is faulty. | • Replace the Servo Drive. |
| | | Occurs during operation. | • The actual torque exceeds the rated torque.<br>• The starting torque exceeds the maximum torque. | • Review the load conditions and operating conditions.<br>• Review the Servomotor capacity. |
| | | | • An unusual noise oscillation or vibration is caused by faulty gain adjustment. | • Adjust the gain correctly. |
| | | | • The Servo Drive is faulty. | • Replace the Servo Drive. |

| Alarm code | Error | Status when error occurs | Cause | Countermeasure |
|---|---|---|---|---|
| 18 | Regeneration overload | Occurs when the Servomotor is decelerating. | • Load inertia is too large. | • Calculate the regenerative energy, and connect an External Regeneration Resistor with the required regeneration absorption capacity.<br>• Extend the deceleration time. |
| | | | • The deceleration time is too short.<br>• The Servomotor rotation speed is too high. | • Reduce the Servomotor rotation speed.<br>• Extend the deceleration time.<br>• Calculate the regenerative energy, and connect an External Regeneration Resistor with the required regeneration absorption capacity. |
| | | | • The operating limit of the External Regeneration Resistor is limited to 10%. | • Set Pn6C to 2.<br>For details, refer to *Parameter Details* on page 5-32. |
| | | Occurs during descent (vertical axis). | • Gravitational torque is too large. | • Add a counterbalance to the machine to lower gravitational torque.<br>• Slow the descent speed.<br>• Calculate the regenerative energy, and connect an External Regeneration Resistor with the required regeneration absorption capacity. |
| | | | • The operating limit of the External Regeneration Resistor is limited to 10%. | • Set Pn6C to 2.<br>For details, refer to *Parameter Details* on page 5-32. |
| 21 | Encoder disconnection detected | Occurs during operation. | • The encoder is disconnected.<br>• Connector contacts are faulty. | • Fix the locations that are disconnected.<br>• Correct the wiring. |
| | | | • The encoder wiring is incorrect. | • Correct the wiring. |
| | | | • The encoder is damaged. | • Replace the Servomotor. |
| | | | • The Servo Drive is faulty. | • Replace the Servo Drive. |
| | | | • The Servomotor is mechanically being held. | • If the Servomotor shaft is being held by external force, release it. |

| Alarm code | Error | Status when error occurs | Cause | Countermeasure |
|---|---|---|---|---|
| 23 | Encoder data error | Occurs when the power supply is turned ON or during operation. | • The encoder signal wiring is incorrect. | • Correct the wiring. |
| | | | • Noise on the encoder wiring causes incorrect operation. | • Take measures against noise on the encoder wiring. |
| | | | • The power supply voltage for the encoder has dropped (especially when the cable is long.) | • Provide the required encoder power supply voltage (5 VDC±5%). |
| 24 | Deviation counter overflow | Occurs when the Servomotor does not rotate even when command pulses are input. | • The Servomotor power wiring or the encoder wiring is incorrect. | • Correct the wiring. |
| | | | • The Servomotor is mechanically being held. | • If the Servomotor shaft is held by external force, release it.<br>• Release the electromagnetic brake. |
| | | | • Control PCB error. | • Replace the Servo Drive. |
| | | Occurs during high-speed rotation. | • The Servomotor power wiring or the encoder wiring is incorrect. | • Correct the wiring. |
| | | Occurs when long command pulses are given. | • Gain adjustment is insufficient. | • Adjust the gain. |
| | | | • The acceleration and deceleration are too rapid. | • Extend the acceleration and deceleration times. |
| | | | • The load is too large. | • Reduce the load.<br>• Select a suitable Servomotor. |
| | | Occurs during operation. | • The setting for the Deviation Counter Overflow Level (Pn63) was exceeded. | • Increase the setting of Pn63.<br>• Slow the rotation speed.<br>• Reduce the load.<br>• Extend the acceleration and deceleration times. |
| 26 | Overspeed | Occurs during high-speed rotation. | • The speed command input is too large. | • Set the command pulse frequency to 500 kpps max. |
| | | | • The setting for the Electronic Gear Ratio Numerator (Pn46 or Pn47) is not appropriate. | • Set Pn46 and Pn47 so that the command pulse frequency is 500 kpps max. |
| | | | • The maximum number of rotations is exceeded due to overshooting. | • Adjust the gain.<br>• Reduce the maximum command speed. |
| | | | • The encoder wiring is incorrect. | • Correct the wiring. |
| | | Occurs when torque limit switching is used. | • The Overspeed Detection Level Setting (Pn70) or No. 2 Overspeed Detection Level Setting (Pn73) has been exceeded. | • If torque limit switching is used, correctly set the allowable operating speed for Pn70 and Pn73. |

| Alarm code | Error | Status when error occurs | Cause | Countermeasure |
|---|---|---|---|---|
| 27 | Electronic gear setting error | Occurs when command pulses are given. | • The setting for the Electronic Gear Ratio Numerator (Pn46 or Pn47) is not appropriate. | • Set Pn46 and Pn47 so that the command pulse frequency is 500 kpps max. |
| 29 | Deviation counter overflow | Occurs when the Servomotor does not rotate even if command pulses are input. | • The Servomotor power wiring or the encoder wiring is incorrect. | • Correct the wiring. |
| | | | • The Servomotor is mechanically being held. | • If the Servomotor shaft is held by external force, release it.<br>• Release the electromagnetic brake. |
| | | | • Control PCB error | • Replace the Servo Drive. |
| | | Occurs during high-speed rotation. | • The Servomotor power wiring or the encoder wiring is incorrect. | • Correct the wiring. |
| | | Occurs when long command pulses are given. | • Gain adjustment is insufficient. | • Adjust the gain. |
| | | | • The acceleration and deceleration are too rapid. | • Extend the acceleration and deceleration times. |
| | | | • The load is too large. | • Reduce the load.<br>• Select a suitable Servomotor. |
| 34 | Overrun limit error | Occurs during operation. | • The Overrun Limit Setting (Pn26) is exceeded during operation. | • Adjust the gain.<br>• Increase the setting for Pn26.<br>• Set Pn26 to 0 to disable the function. |
| 36 | Parameter error | Occurs when the power supply is turned ON. | • There are errors in the parameters that were read. | • Reset all parameters. |
| | | | • The Servo Drive is faulty. | • Replace the Servo Drive. |
| 37 | Parameter corruption | Occurs when the power supply is turned ON. | • The parameters that were read are corrupt. | • Replace the Servo Drive. |
| 38 | Drive prohibit input error | Occurs when the Servo is turned ON or during operation. | • The Forward Drive Prohibit Input (POT) and Reverse Drive Prohibit Input (NOT) were both OFF at the same time. | • Correct the wiring.<br>• Replace the limit sensor.<br>• Check whether the power supply for control is input correctly.<br>• Check whether the setting for Drive Prohibit Input Selection (Pn04) is correct. |
| 48 | Encoder phase Z error | Occurs during operation. | • A phase-Z pulse from the encoder was not detected regularly. | • Replace the Servomotor. |
| 49 | Encoder CS signal error | Occurs during operation. | • A logic error of the CS signal from the encoder was detected. | • Replace the Servomotor. |

| Alarm code | Error | Status when error occurs | Cause | Countermeasure |
|---|---|---|---|---|
| 95 | Servomotor non-conformity | Occurs when the power supply is turned ON. | • The Servomotor and Servo Drive combination is incorrect. | • Use a correct combination. |
| | | | • The encoder wiring is disconnected. | • Wire the encoder.<br>• Fix the locations that are disconnected. |
| 96 | LSI setting error | | • Incorrect operation due to noise. | • Take measures against noise. |
| Others | Other errors | --- | • The Servo Drive's self-diagnosis function detected an error in the Servo Drive. | • Turn OFF the power supply and turn it ON again.<br>• Replace the Servomotor or Servo Drive. |

## Error Diagnosis Using the Operating Status

| Symptom | Probable cause | Items to check | Countermeasures |
|---|---|---|---|
| The power LED indicator (PWR) does not light when the power supply is turned ON. | The power supply cable is wired incorrectly. | Check whether the power supply input is within the allowed voltage range. | Supply the correct voltage. |
| | | Check whether the power supply input is wired correctly. | Correct the wiring. |
| The Servomotor does not rotate even if commands are input from the Controller. | The RUN Command Input is OFF. | Check whether the RUN signal is ON or OFF in monitor mode. | • Turn ON the RUN Command Input.<br>• Correct the wiring. |
| | The Forward Drive Prohibit Input (POT) and Reverse Drive Prohibit Input (NOT) are OFF. | Check whether the POT input and NOT input are ON or OFF in monitor mode. | • Turn ON the POT and NOT inputs.<br>• If the POT and NOT inputs are not used, disabled them. |
| | The control mode is not correct. | Check the Control Mode Selection (Pn02). | Set the control mode to match the command type. |
| | The Deviation Counter Reset Input (ECRST) is ON. | Check whether the ECRST Input is ON or OFF in monitor mode. | • Turn the ECRST Input OFF.<br>• Correct the wiring. |
| | The Command Pulse Mode (Pn42) setting is incorrect. | Check the Controller's command pulse type and the Servo Drive's command pulse type. | Set the Servo Drive's pulse type to match the Controller's command pulse type. |
| | The Zero Speed Designation Input (VZERO) is OFF. | Check whether the VZERO Input is ON or OFF in monitor mode. | • Turn ON the VZERO Input.<br>• Correct the wiring. |
| | The internally set speeds are not set. | Check the settings for Pn53 to Pn56. | Set the desired speeds. |
| | The Torque Limit (Pn5E) is set to 0. | Check the setting for Pn5E. | Return the setting to the default. |
| | The Servomotor Power Cable is wired incorrectly. | Check the wiring. | Wire correctly. |
| | The Encoder Cable is wired incorrectly. | | |
| | The control I/O connector (CN1) is wired incorrectly. | Check the command pulse's wiring. | Wire correctly. |
| | | Check the command pulse type. | Set the Servo Drive's pulse type to match the Controller's command pulse type. |
| | | Check the command pulse's voltage. | Connect a resistor that matches the voltage. |
| | The power supply is not ON. | Check whether the power supply is ON and check the PWR LED indicator. | Turn ON the power supply. |
| | | Check the voltage across the power supply terminals. | Wire the power supply's ON circuit correctly. |
| | The CW Input and CCW Input are ON at the same time. | Check the command pulse's wiring. | • Input the pulse signal either to the CW Input or CCW Input.<br>• Always turn OFF the terminal that is not input to. |
| | Servo Drive is faulty. | --- | Replace the Servo Drive. |

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Troubleshooting

| Symptom | Probable cause | Items to check | Countermeasures |
|---|---|---|---|
| The Servomotor operates momentarily, but it does not operate after that. | The Servomotor Power Cable is wired incorrectly. | Check the wiring of the Servomotor Power Cable's phases U, V, and W. | Wire correctly. |
| | The Encoder Cable is wired incorrectly. | Check the Encoder Cable's wiring. | Wire correctly. |
| The Servomotor rotates without a command. | The command pulse input is incorrect. | Check the command pulse type. | Set the command pulse input appropriately. |
| | | Check the command pulse's voltage. | Connect a resistor that matches the voltage. |
| | The Servo Drive is faulty. | --- | Replace the Servo Drive. |
| The Servomotor rotates in the opposite direction from the command. | The CW input and CCW input are connected reversely. | Check the Controller's command pulse type and the Servo Drive's command pulse type. | Connect the CW pulse signal to the CW Input and the CCW pulse signal to the CCW Input. |
| Servomotor rotation is unstable. | The Servomotor Power Cable or Encoder Cable is wired incorrectly. | Check the wiring of the Servomotor Power Cable's phases U, V, and W and check the Encoder Cable's wiring. | Wire correctly. |
| | The coupling system between the Servomotor shaft and the mechanical system has eccentricity and declination, loose screws, or the torque is fluctuating due to engagement between pulleys or gears. | Check the mechanical system's coupling section. | Review and adjust the machine. |
| | | Try rotating the Servomotor without a load. (Disconnect it from the mechanical system.) | |
| | The load's moment of inertia exceeds the Servo Drive's allowable value. | Try rotating the Servomotor without a load. (Disconnect it from the mechanical system.) | • Reduce the load.<br>• Replace it with the Servomotor and Servo Drive with higher capacity. |
| | The pulse signal line's connections failure. | Check the pulse signal wiring at the Controller and Servo Drive. | Wire correctly. |
| | | Check the Controller's command pulse type and the Servo Drive's command pulse type. | Set the Servo Drive's pulse type to match the Controller's command pulse type. |
| | The gain doesn't match. | --- | • Use autotuning.<br>• Perform manual tuning. |
| | The CN1 input signal is chattering. | Check the RUN Command Input (RUN), Deviation Counter Reset Input (ECRST), Zero Speed Designation Input (VZERO), Internally set Speed Selection 1, 2 (VSEL1, VSEL2). | Correct the wiring so that there is no chattering. |
| The Servomotor is overheating. | The ambient temperature is too high. | Check that the ambient temperature around the Servomotor is below 40°C. | Lower the ambient temperature to 40°C or less. (Use a cooler or fan.) |
| | Ventilation is obstructed. | Check to see whether anything is blocking ventilation. | Improve ventilation. |
| | The Servomotor is overloaded. | Try rotating the Servomotor without a load. (Disconnect it from the mechanical system.) | • Reduce the load.<br>• Replace the Servomotor and Servo Drive with a Servomotor and Servo Drive with higher capacities. |
| | The Servomotor is rotating with vibration. | | |

| Symptom | Probable cause | Items to check | Countermeasures |
|---|---|---|---|
| The holding brake is ineffective. | Power is supplied to the holding brake. | Check whether power is supplied to the holding brake. | Configure a circuit that cuts power to the holding brake when the motor stops and the load is held by the holding brake. |
| The Servomotor doesn't stop or is hard to stop even if the RUN Command Input (RUN) is turned OFF while the Servomotor is rotating. | The load inertia is too large. | Check the following:<br>• Is the load too large?<br>• Is the Servomotor speed too high? | Re-evaluate the load conditions and replace the Servomotor/Servo Drive with an appropriate model if necessary. |
| | The stop circuit failed. | --- | Replace the Servo Drive. |
| The Servomotor is producing unusual noises or the machine is vibrating. (Continued on next page.) | There are problems with the machine's installation. | Check whether the Servomotor's mounting screws are loose. | Tighten the mounting screws. |
| | | Check whether the axes are misaligned in the mechanical coupling system. | Align the mechanical couplings. |
| | | Check whether the coupling is unbalanced. | Adjust the coupling's balance. |
| | There is a problem with the bearings. | Check for noise or vibration around the bearings. | Contact your OMRON representative. |
| | The gain is doesn't match. | --- | • Use autotuning.<br>• Perform manual tuning. |
| | The Speed Feedback Filter Time Constant (Pn13) is wrong. | Check the setting of Pn13. | Return the setting to 4 (default) or increase the setting. |
| | Noise is entering the Control I/O Cable because the cable does not meet specifications. | Check that the cable wire is a twisted-pair wire or shielded twisted-pair cable with wires of at least 0.08 $mm^2$. | Use the Control I/O Cable that meets specifications. |
| | Noise is entering the Control I/O Cable because the cable is longer than the specified length. | Check the length of the Control I/O Cable. | Shorten the Control I/O Cable to 3 m or less. |
| | Noise is entering the cable because the Encoder Cable does not meet specifications. | Check that the cable wires are twisted-pair wires or shielded twisted-pair wires that are at least 0.12 $mm^2$. | Use the Encoder Cable that meets specifications. |
| | Noise is entering the Encoder Cable because the cable is longer than the specified length. | Check the length of the Encoder Cable. | Shorten the Encoder Cable to 20 m or less. |
| | Noise is entering the signal wires because the Encoder Cable is stuck or the sheath is damaged. | Check whether the Encoder Cable is damaged. | Correct the Encoder Cable's pathway to prevent damage. |
| | Too much noise is entering the Encoder Cable. | Check whether the Encoder Cable is tied up in a bundle with or too close to high current lines. | Lay the Encoder Cable in a way surges are not applied. |

| Symptom | Probable cause | Items to check | Countermeasures |
|---|---|---|---|
| The Servomotor is producing unusual noises or the machine is vibrating. (Continued from previous page.) | The FG's potential is fluctuating due to devices near the Servomotor, such as a welding machine. | Check for grounding problems (failure to ground or incomplete grounding) at devices such as a welding machine near the Servomotor. | Ground the equipment properly and prevent currents from flowing to the encoder FG. |
| | Errors are being caused by excessive vibration or shock on the encoder. | There are problems with mechanical vibration or motor installation (such as the mounting surface precision, attachment, or axial misalignment). | Reduce the mechanical vibration or correct the Servomotor's installation. |
| | The machine and the Servomotor are resonating. | Check whether the machine is resonating. | • Readjust the Torque Command Filter Time Constant.<br>• If there is resonance, set the Notch Filter 1 Frequency (Pn1D) and Notch Filter 1 Width (Pn1E). |
| Vibration is occurring at the same frequency as the power supply. | Inductive noise is occurring. | Check whether the Servo Drive control signal lines are too long. | Shorten the control signal lines. |
| | | Check whether control signal lines and power supply lines are bundled together. | • Separate control signal lines from power supply lines.<br>• Use a low-impedance power supply for control signals. |
| The position is misaligned. (Position misalignment occurs without an alarm being output.) | There is an error in the coupling of the mechanical system and the Servomotor. | Check whether the coupling of the mechanical system and the Servomotor is misaligned. | Couple the mechanical system and the Servomotor correctly. |
| | Noise is entering the Deviation Counter Reset Input (ECRST). | Check whether the control signal lines and power supply lines are bundled together. | Take measures against noise, such as separating the control signal lines and power lines. |
| | The gain is does not match. | --- | • Use autotuning.<br>• Perform manual tuning. |
| | The load inertia is too large. | Check the following:<br>• Check whether the load is too large.<br>• Check whether the rotation speed of the Servomotor is too high. | • Adjust the gain.<br>• Review the load conditions, and replace the Servomotor and Servo Drive with appropriate models. |

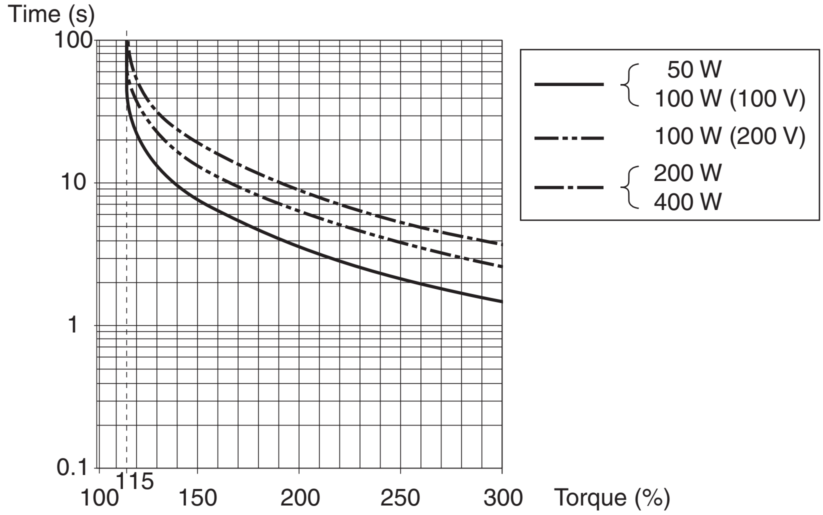
# 8-4 Overload Characteristics (Electronic Thermal Function)

An overload protection (electronic thermal) function is built into the Servo Drive to protect the Servo Drive and Servomotor from overloading.
If an overload does occur, eliminate the cause of the error and then wait at least one minute for the Servomotor temperature to drop before turning on the power again.
If the power is turned ON again repeatedly at short intervals, the Servomotor windings may burn out.

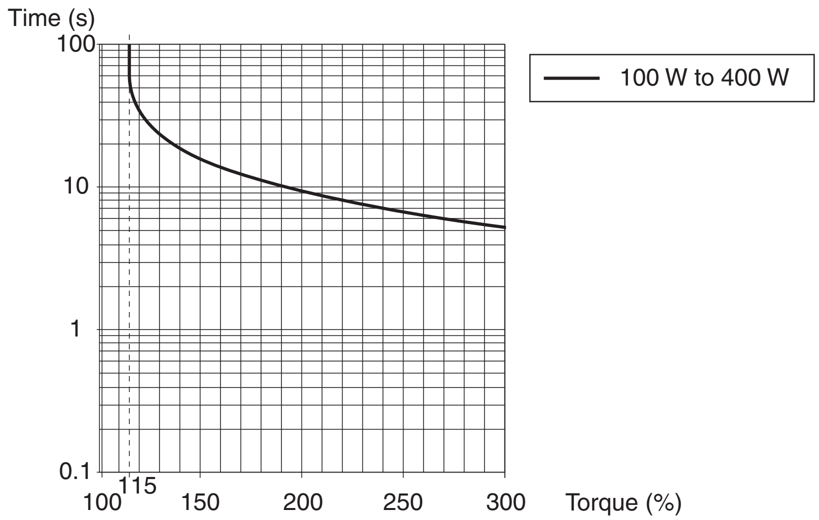
## Overload Characteristics Graphs

The following graphs show the characteristics of the load rate and electronic thermal operating time.

### ■ R88M-G (Cylindrical Servomotor)




### ■ R88M-GP (Flat Servomotor)

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Troubleshooting

# 8-5 Periodic Maintenance

The Servomotor and Servo Drive contain many components and will function fully only when each of the individual components operates properly.
Some of the electrical and mechanical components require maintenance depending on application conditions. Periodic inspection and part replacement are necessary to ensure the proper long-term operation of the Servomotor and Servo Drive. (quotes 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 Servomotor and Servo Drive.
Recommended maintenance times are listed below for reference in determining actual maintenance schedules.

**Caution**

Resume operation only after transferring all data required for operation to the new Unit.
Not doing so may result in damage to the product.

Do not dismantle or repair the product.
Doing so may result in electric shock or injury.



## Servomotor Service Life

The service life for components is listed below.

- Bearings: 20,000 hours
- Oil seal: 5,000 hours
- Encoder: 30,000 hours

These values presume an ambient Servomotor operating temperature of 40°C, shaft loads within the allowable range, rated operation (rated torque and rated r/min), and install as described in this manual.

- The oil seal can be replaced.
- If timing pulleys are belt driven, the radial loads during operation (rotation) are as twice as the static loads. Consult with the belt and pulley manufacturers and adjust designs and system settings so that the Servomotor's allowable shaft load is not exceeded even during operation. If a Servomotor is used under a shaft load exceeding the allowable limit, the Servomotor shaft may break and the bearings may burn out.

## Servo Drive Service Life

The service life of the Servo Drive is provided below.
Consult with your OMRON representative to determine whether or not components need to be replaced.

- Aluminum electrolytic capacitors: 50,000 hours, at an ambient Servo Drive operating temperature of 40°C, 80% of the rated operation output (rated torque), installed as described in this manual.
- Axial fan: 30,000 hours, at an ambient Servo Drive operating temperature of 40°C and an ambient humidity of 65% RH.
- When using the Servo Drive in continuous operation, use a fan or air conditioner to maintain an ambient operating temperature of 40°C or lower.
- We recommend that the ambient operating temperature be lowered and the power ON time be reduced as much as possible to lengthen the service life of the Servo Drive.
- The service life of aluminum electrolytic capacitors is greatly affected by the ambient operating temperature. Generally, an increase of 10°C in the ambient operating temperature will reduce the capacitor life by 50%.
- Aluminum electrolytic capacitors deteriorate even if the Servo Drive is stored with no power supplied. If the Servo Drive is not used for a long time, we recommend a periodic inspection and part replacement in five years.
- If the Servomotor or Servo Drive is not used for a long time, or if they are used under conditions worse than those described above, a periodic inspection of five years is recommended.

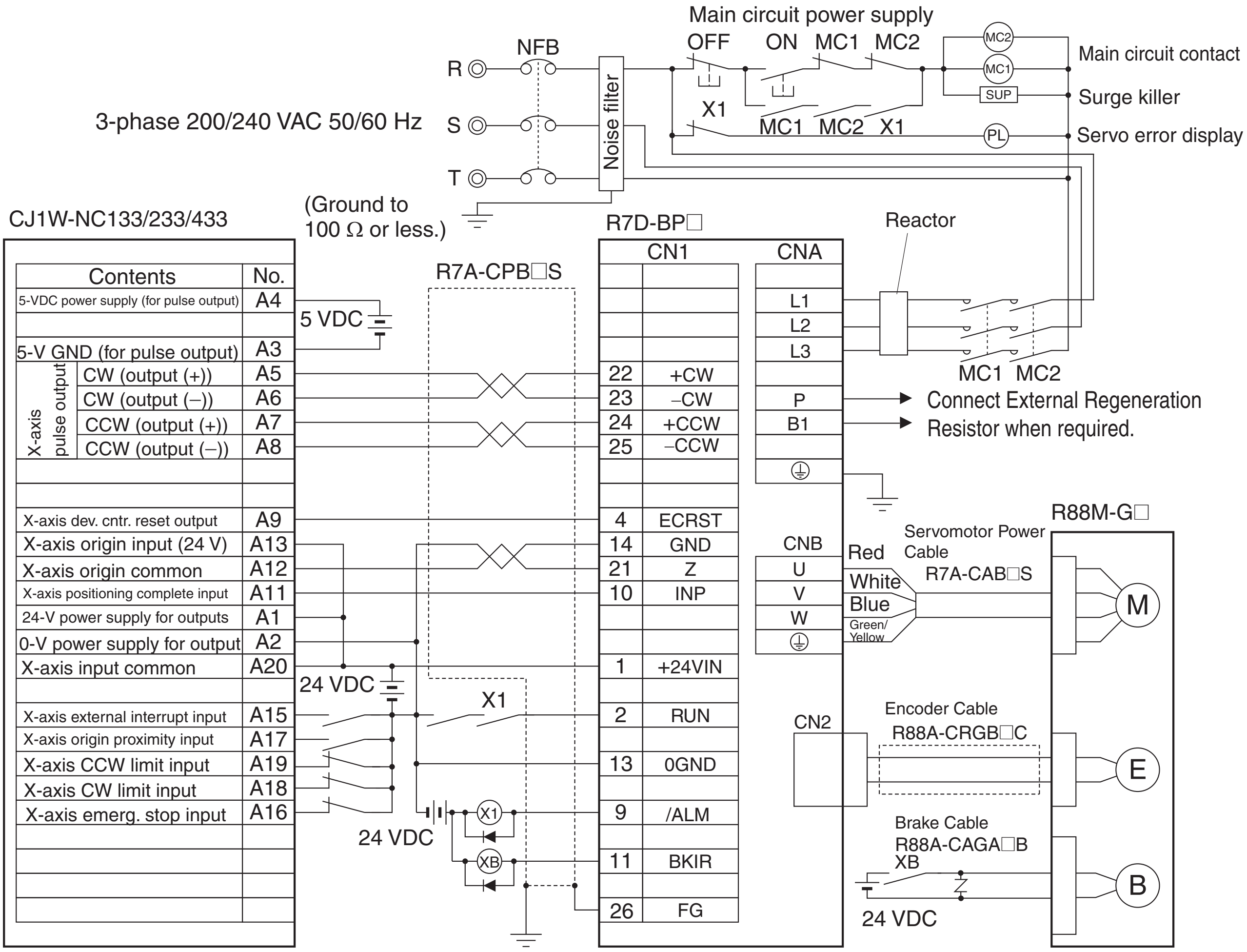
# Chapter 9

# Appendix-1

## Connection Examples

# 9-1 Connection Examples

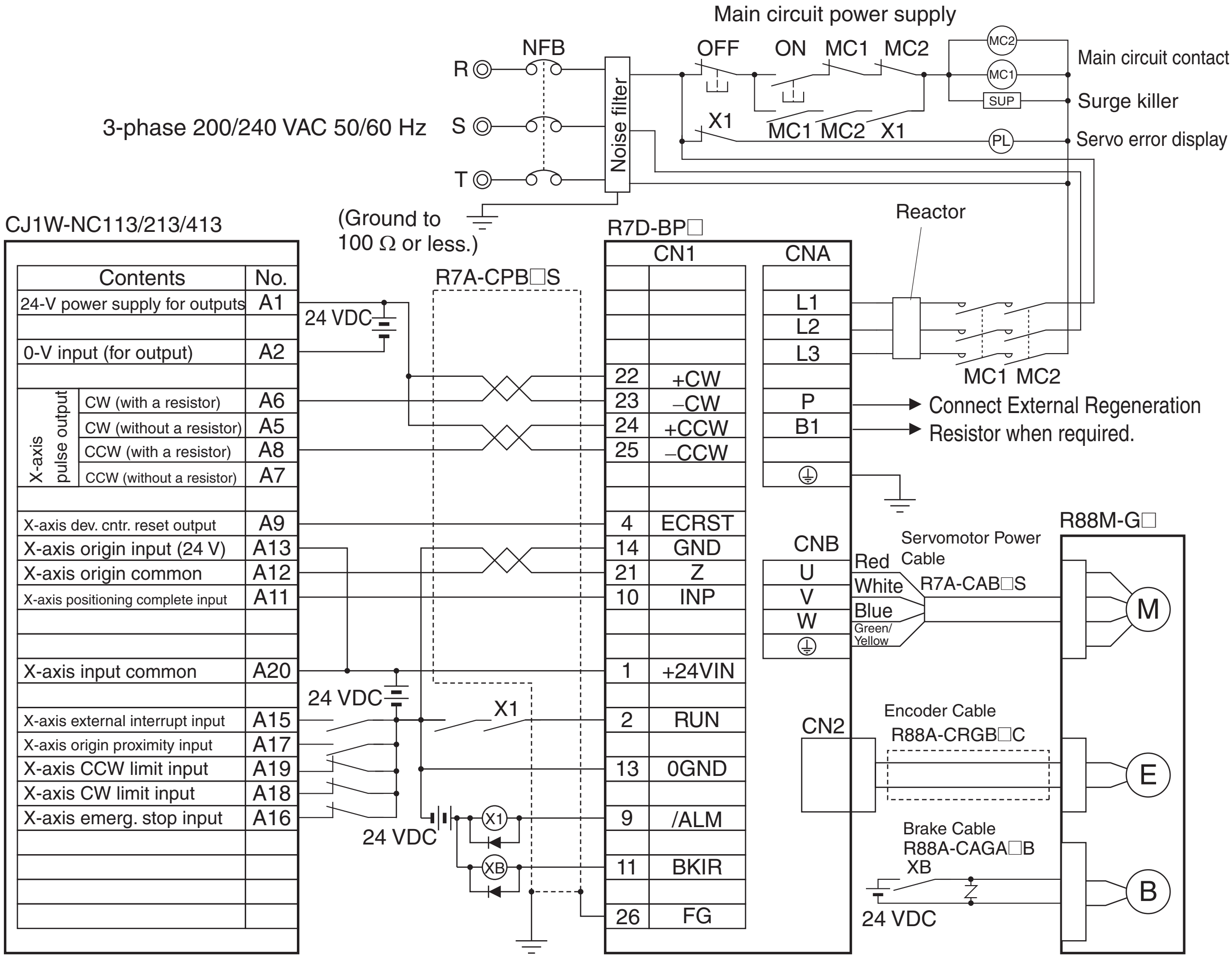
## ■ Connection Example 1: Connecting to SYSMAC CJ1W-NC133/233/433 Position Control Units




**Precautions for Correct Use**

- Incorrect signal wiring can cause damage to Units and the Servo Drive.
- Leave unused signal lines open and do not wire them.
- Use mode 2 for origin search.
- Use the 5-VDC power supply for the command pulse inputs as a dedicated power supply.
- Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.
- Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent

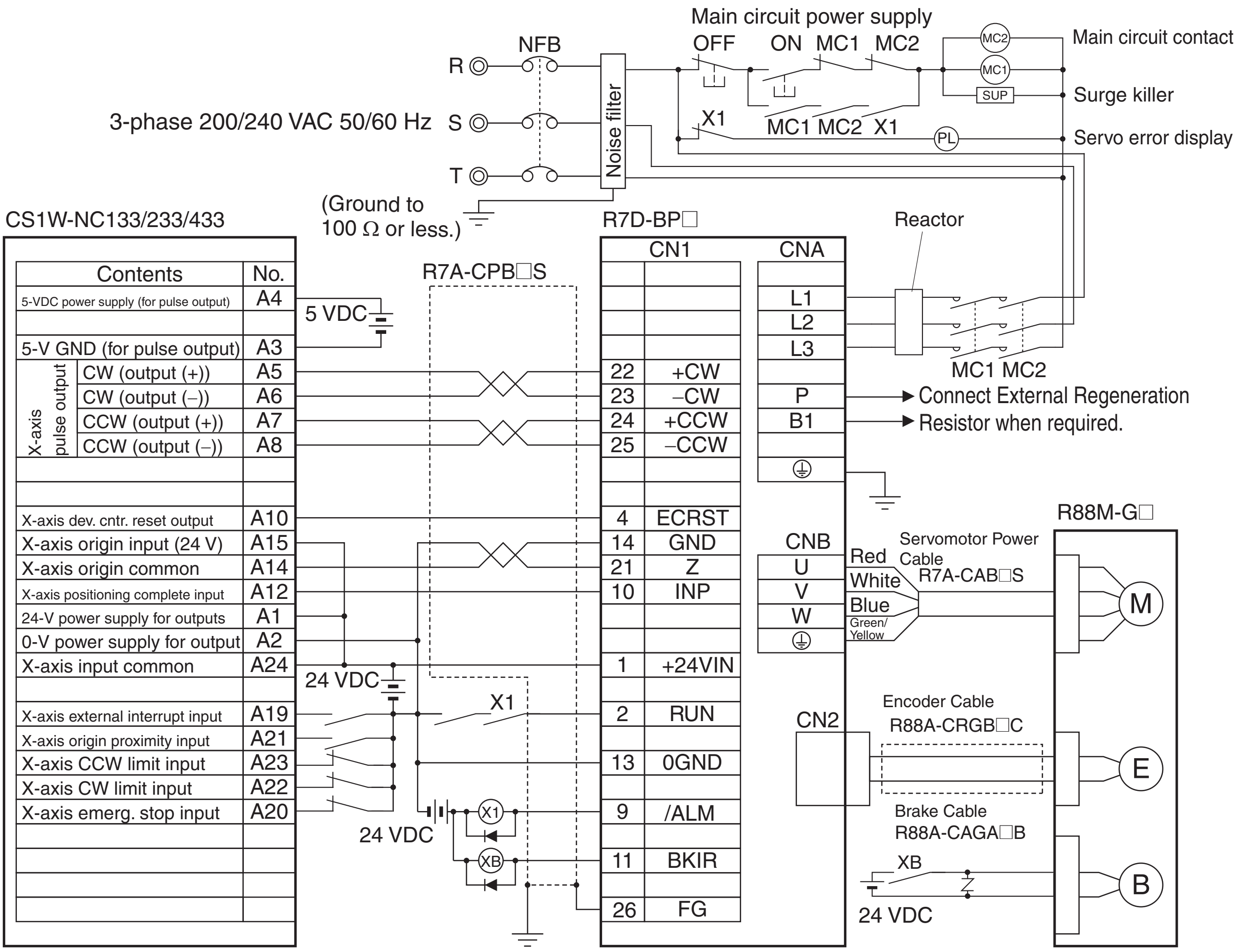
## ■ Connection Example 2: Connecting to SYSMAC CJ1W-NC113/213/413 Position Control Units




**Precautions for Correct Use**

- Incorrect signal wiring can cause damage to Units and the Servo Drive.
- Leave unused signal lines open and do not wire them.
- Use mode 2 for origin search.
- Use the 24-VDC power supply for the command pulse inputs as a dedicated power supply.
- Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.
- Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent

## ■ Connection Example 3: Connecting to SYSMAC CS1W-NC133/233/433 Position Control Units

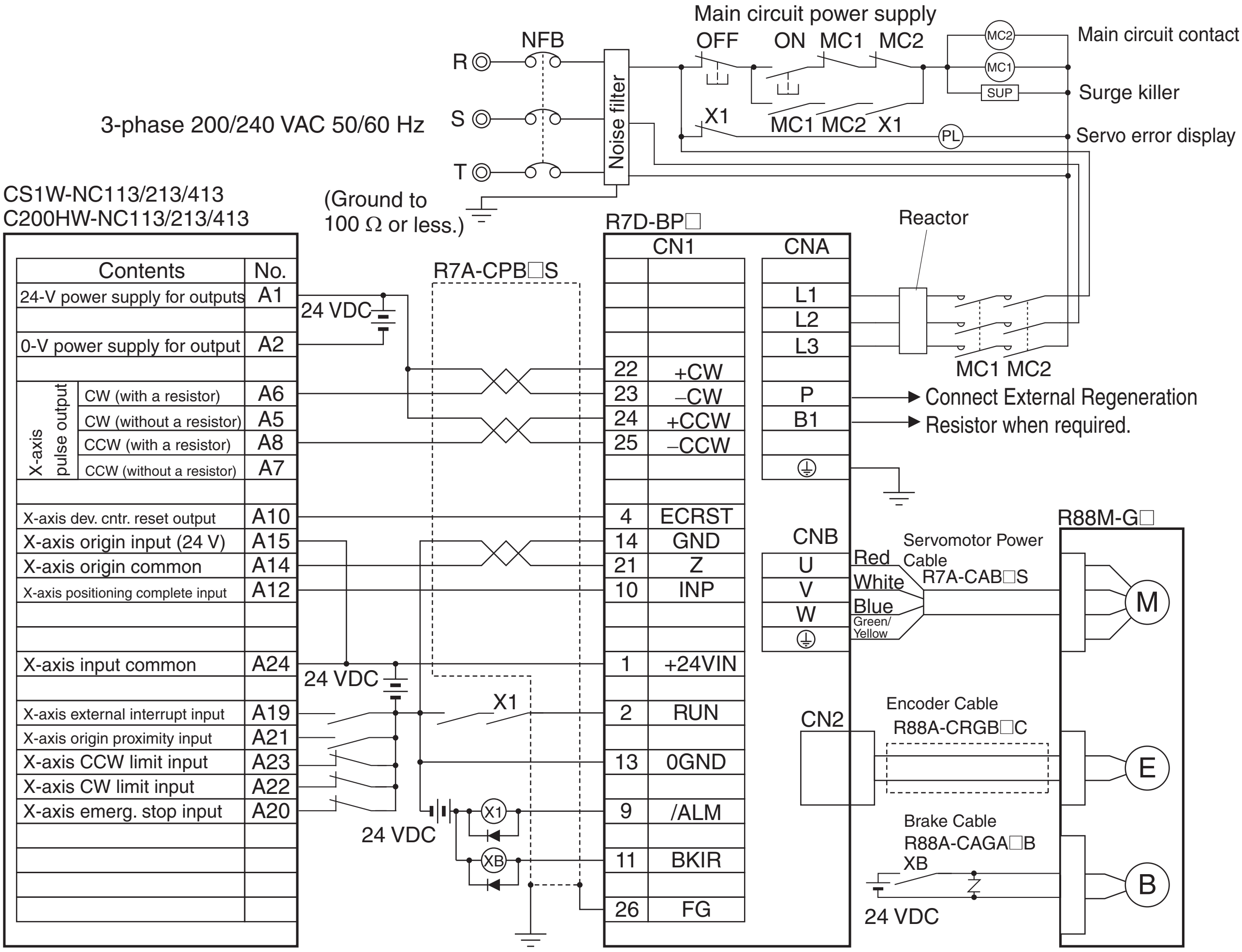



| Precautions for Correct Use | |
|---|---|

**Precautions for Correct Use**

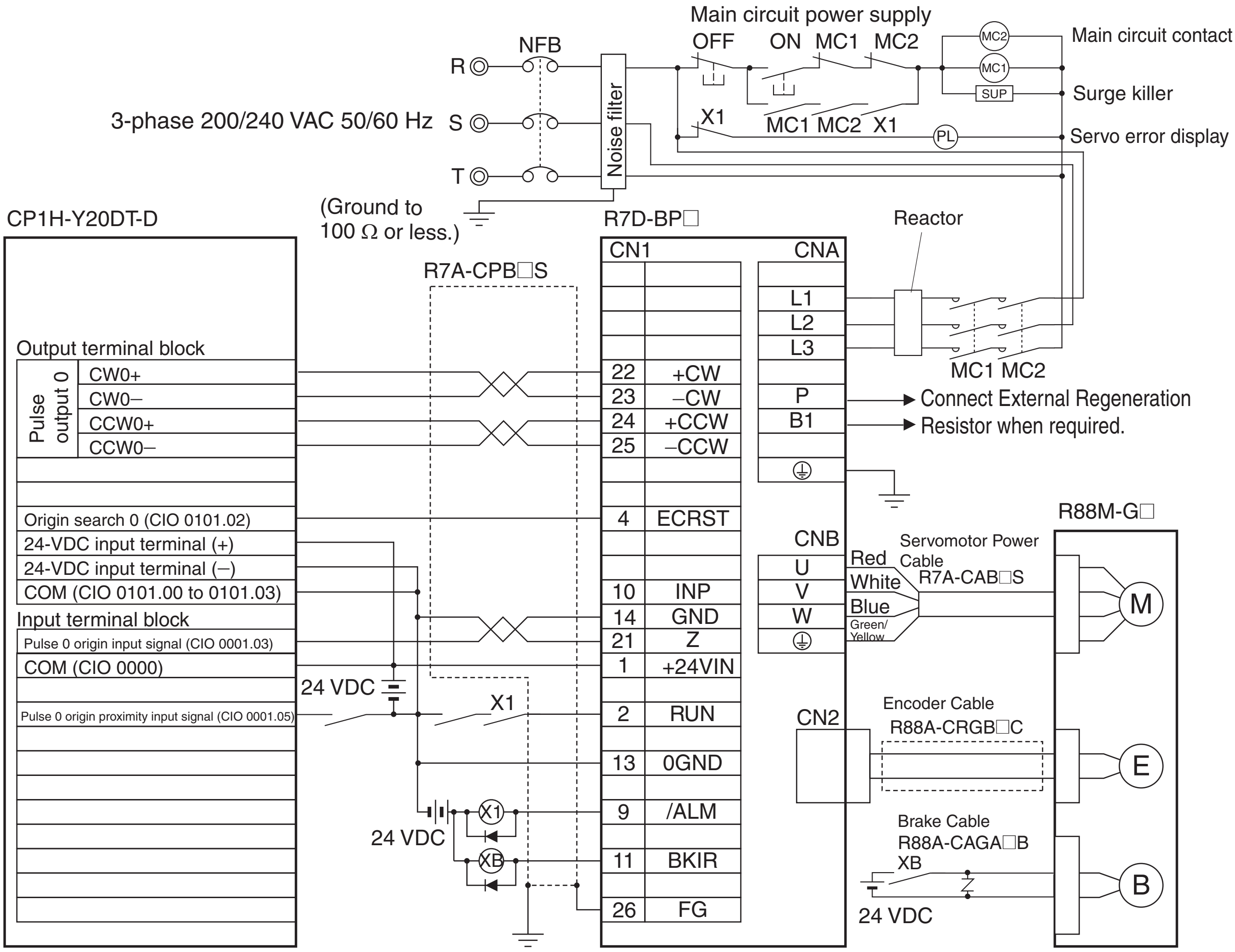
- Incorrect signal wiring can cause damage to Units and the Servo Drive.
- Leave unused signal lines open and do not wire them.
- Use mode 2 for origin search.
- Use the 5-VDC power supply for the command pulse inputs as a dedicated power supply.
- Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.
- Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent

## ■ Connection Example 4: Connecting to SYSMAC CS1W-NC113/213/413, C200HW-NC113/213/413 Position Control Units




| | |
|---|---|
| **Precautions for Correct Use** | • Incorrect signal wiring can cause damage to Units and the Servo Drive.<br>• Leave unused signal lines open and do not wire them.<br>• Use mode 2 for origin search.<br>• Use the 24-VDC power supply for the command pulse inputs as a dedicated power supply.<br>• Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.<br>• Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent |

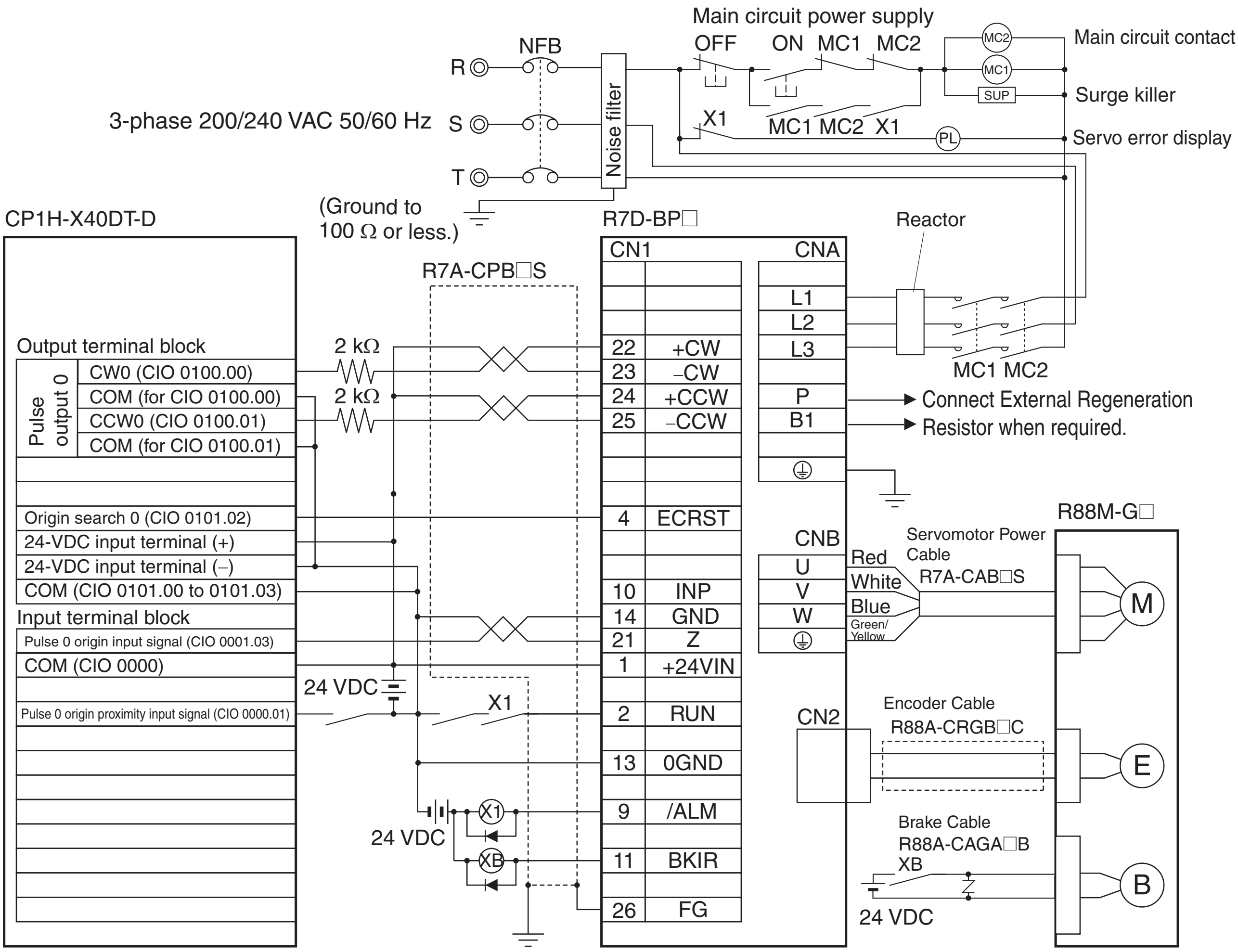
## ■ Connection Example 5: Connecting to SYSMAC CP1H-Y20DT-D




**Precautions for Correct Use**

- Incorrect signal wiring can cause damage to Units and the Servo Drive.
- Leave unused signal lines open and do not wire them.
- Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.
- Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent

## ■ Connection Example 6: Connecting to SYSMAC CP1H-X40DT-D/CP1L-□□□DT-□




| Precautions for Correct Use | |
|---|---|

- Incorrect signal wiring can cause damage to Units and the Servo Drive.
- Leave unused signal lines open and do not wire them.
- Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.
- Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent

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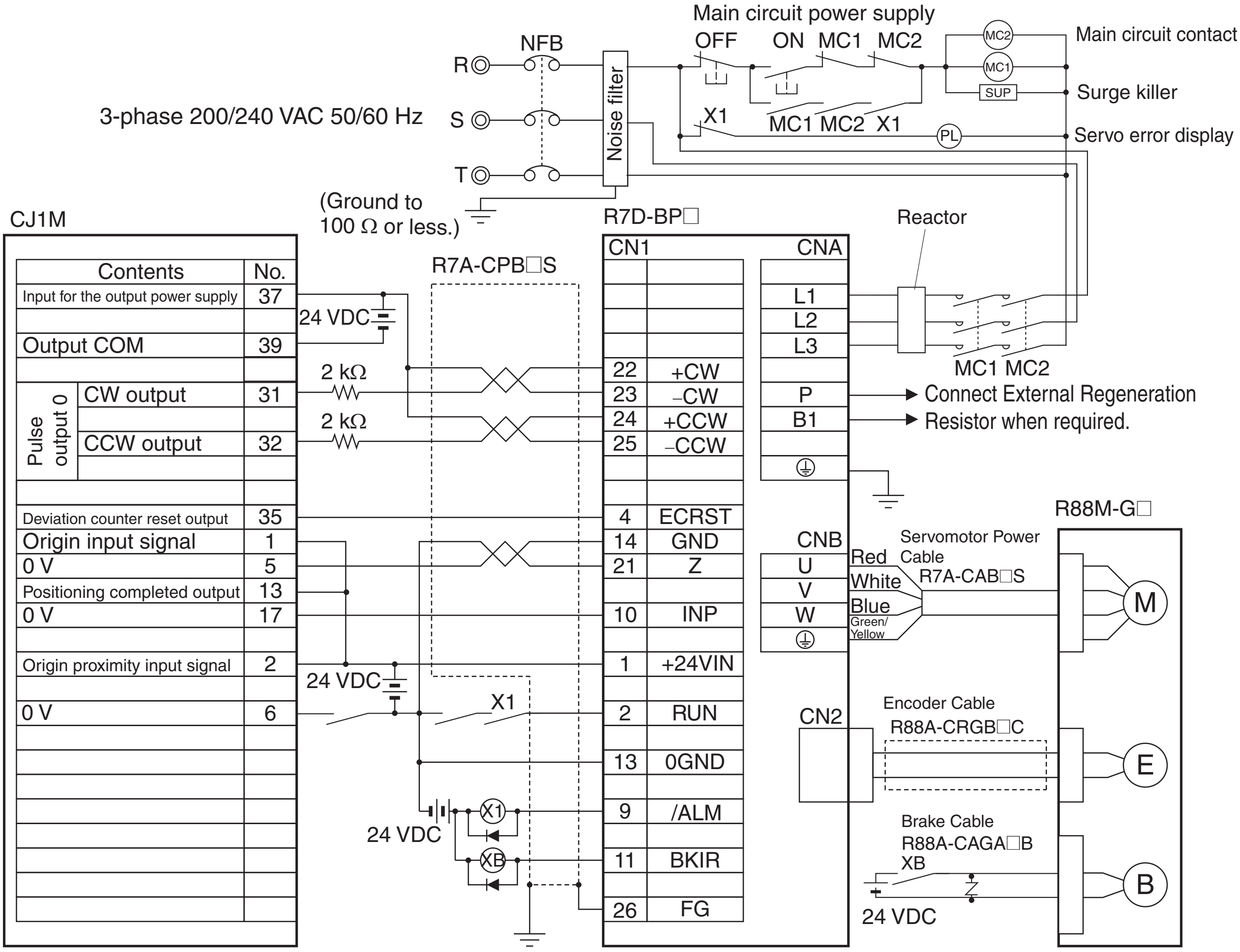
Appendix-1

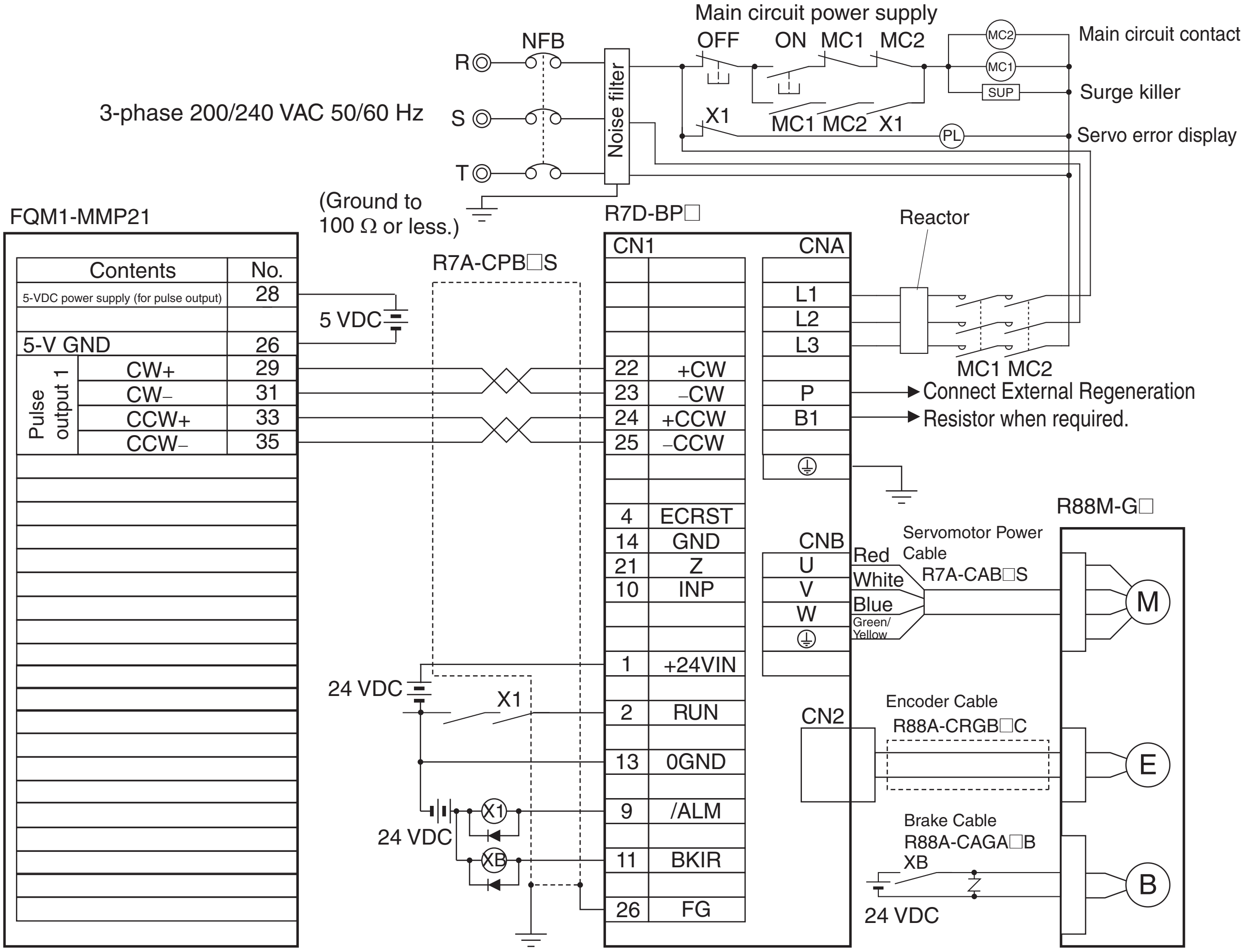
## ■ Connection Example 7: Connecting to SYSMAC CJ1M




**Precautions for Correct Use**

- Incorrect signal wiring can cause damage to Units and the Servo Drive.
- Leave unused signal lines open and do not wire them.
- Use mode 2 for origin search.
- Use the 24-VDC power supply for the command pulse inputs as a dedicated power supply.
- Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.
- Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent

## ■ Connection Example 8: Connecting to FQM1-MMP21 Flexible Motion Controller

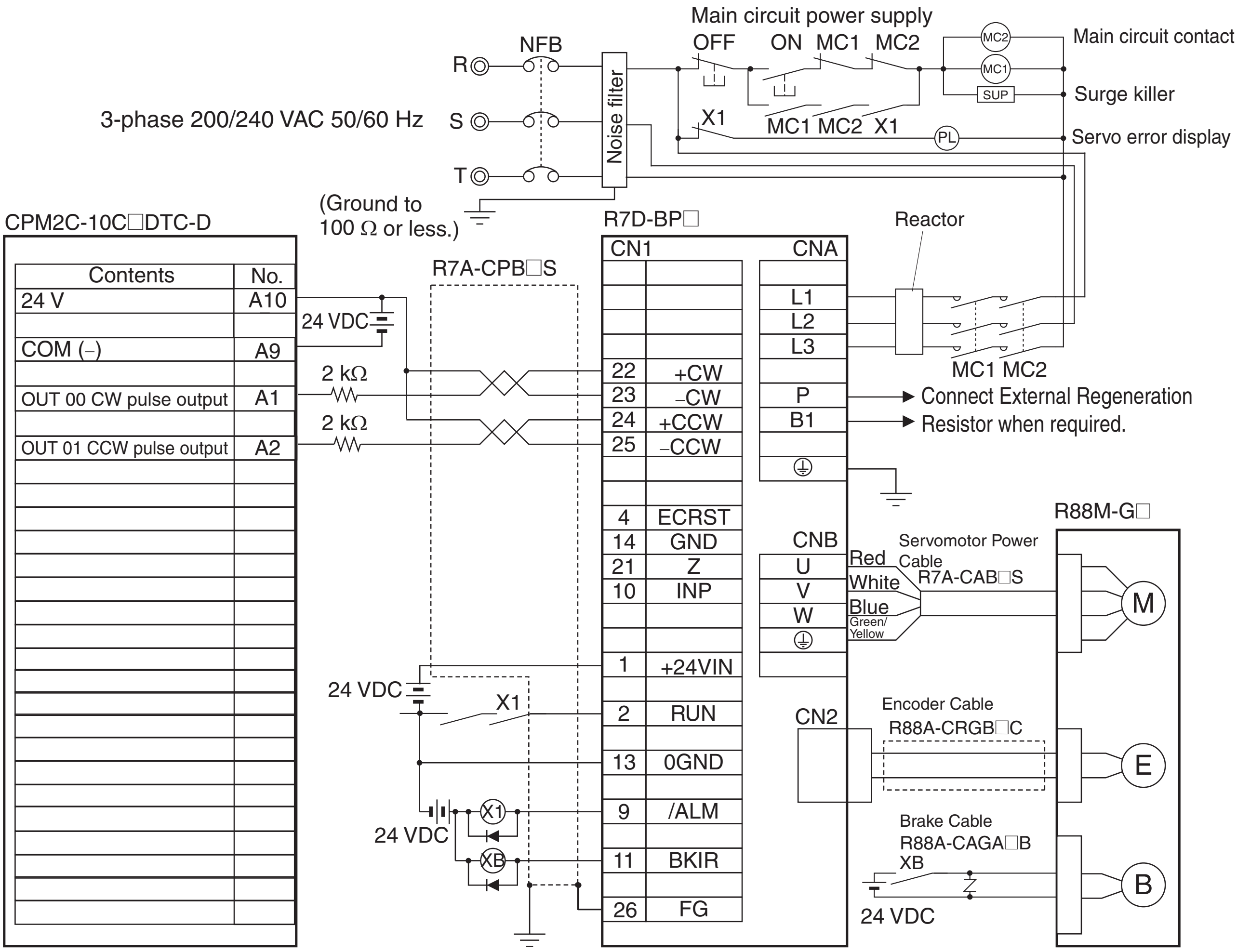



**Precautions for Correct Use**

- Incorrect signal wiring can cause damage to Units and the Servo Drive.
- Leave unused signal lines open and do not wire them.
- Use the 24-VDC power supply for the command pulse inputs as a dedicated power supply.
- Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.
- Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent

## ■ Connection Example 9: Connecting to SYSMAC CPM2C

CPU Unit with 10 inputs and outputs
An example of a transistor output (sink model).




**Precautions for Correct Use**

- Incorrect signal wiring can cause damage to Units and the Servo Drive.
- Leave unused signal lines open and do not wire them.
- Use the 24-VDC power supply for the command pulse inputs as a dedicated power supply.
- Do not share the power supply for brakes (24 VDC) with the 24-VDC power supply for controls.
- Recommended surge absorption diode: RU2 (Sanken Electric) or the equivalent

# Chapter 10

# Appendix-2

## SMARTSTEP 2 750 W Model

# 10-1 Features and System Configuration

## 10-1-1 Overview

### Overview of the SMARTSTEP 2 750 W Model

The SMARTSTEP 2 750 W Model is a pulse input Servo Drive for Position Control. Servomotors with 2,500-pulse incremental encoders are available as standard models.
The SMARTSTEP 2 750 W Model features realtime autotuning and adaptative filter functions that automatically perform complicated gain adjustments. A notch filter can also be automatically set to suppress machine vibration by reducing mechanical resonance during operation. The vibration control function of the SMARTSTEP 2 750 W Model realizes stable stopping performance in a mechanism which vibrates beacuse of the low rigidity of the load.

### Features of the SMARTSTEP 2 750 W Model

The SMARTSTEP 2 750 W Model has the following features.

#### ■ High-speed Response

The SMARTSTEP 2 750 W Model AC Servomotors and Servo Drives have achieved high-speed response capabilities exceeding OMRON's W-Series models, with a high response frequency of 1 KHz (compared to 400 Hz for the W Series).

#### ■ Suppressing Vibration of Low-rigidity Mechanisms during Acceleration/ Deceleration

The vibration control function suppresses vibration of low-rigidity mechanisms or devices whose ends tend to vibrate. Two vibration filters are provided to enable switching the vibration frequency automatically according to the direction of rotation and also via an external signal. In addition, the settings can be made easily merely by just setting the vibration frequency and filter values, and you are assured of stable operation even if the settings are inappropiate.

#### ■ High-speed Positioning via Resonance Suppression Control

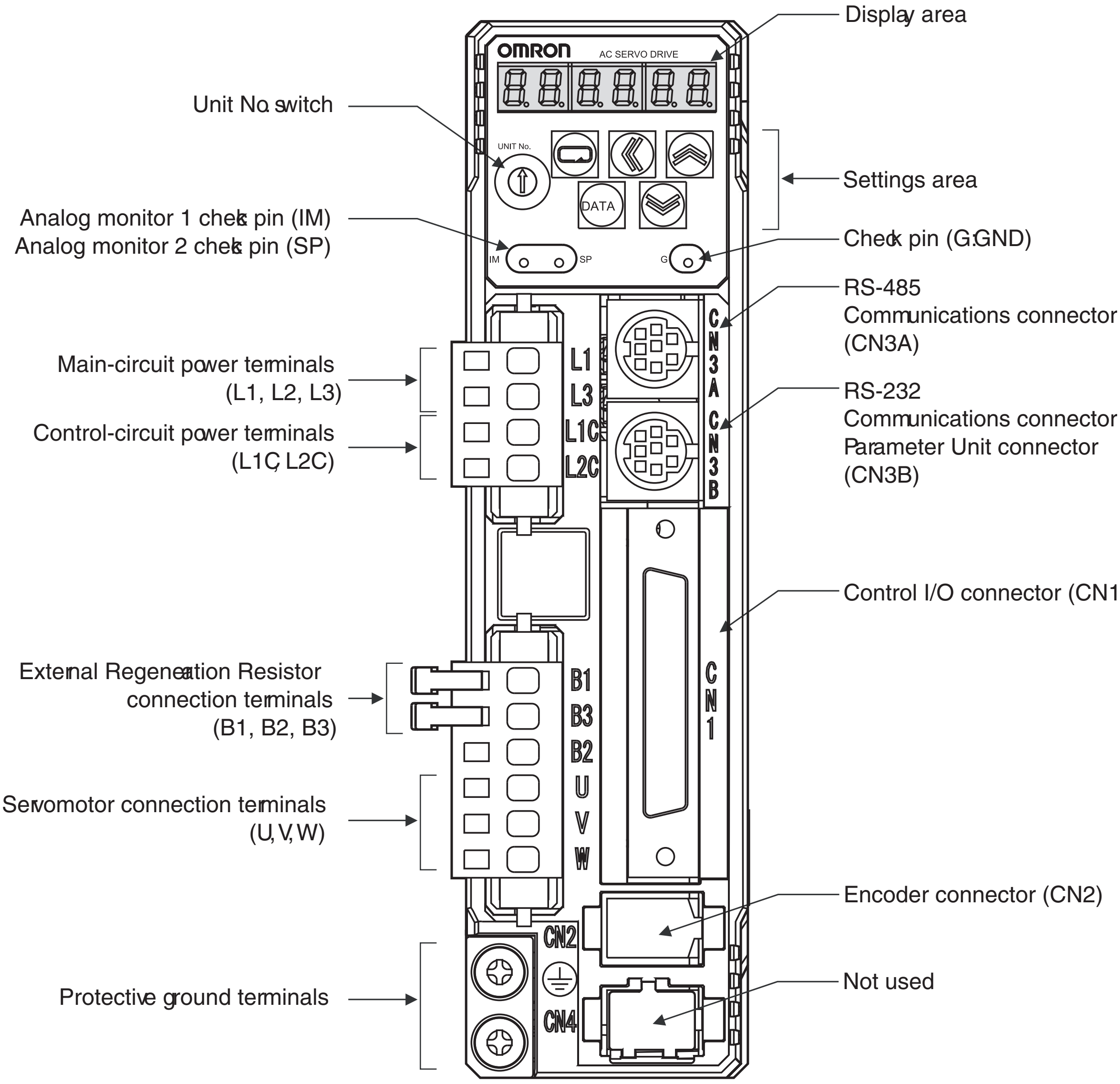
The realtime autotuning function automatically estimates the load inertia of the machine in realtime and sets the optimal gain. The adaptive filter automatically suppresses vibration caused by resonance. Also, two independent notch filters make it possible to reduce vibration of a mechanism with multiple resonance frequencies.

#### ■ Simplified Speed Control with Internal Speed Settings

Eight internal speed settings allow you to change the speed easily by using external signals.

# 10-1-2 Names of Parts and Functions

## Servo Drive Part Names



## Servo Drive Functions

### ■ Display Area

A 6-digit 7-segment LED display shows the Servo Drive status, alarm codes, parameters, and other information.

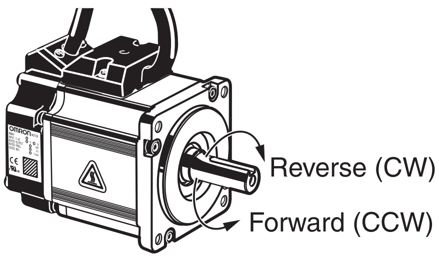
### ■ Check Pins (IM, SP, and G)

The actual Servomotor speed, command speed, torque, and number of accumulated pulses can be measured based on the analog voltage level by using an oscilloscope. The type of signal to output and the output voltage level are set in the SP Selection (Pn07) and IM Selection (Pn08) parameters.

### ■ Unit No. Switch

The Servo Drive number in serial communications is set to a value from 0 to F. This number is used to identify which Servo Drive the computer is accessing in RS-232/485 communications between multiple Servo Drives and a computer.

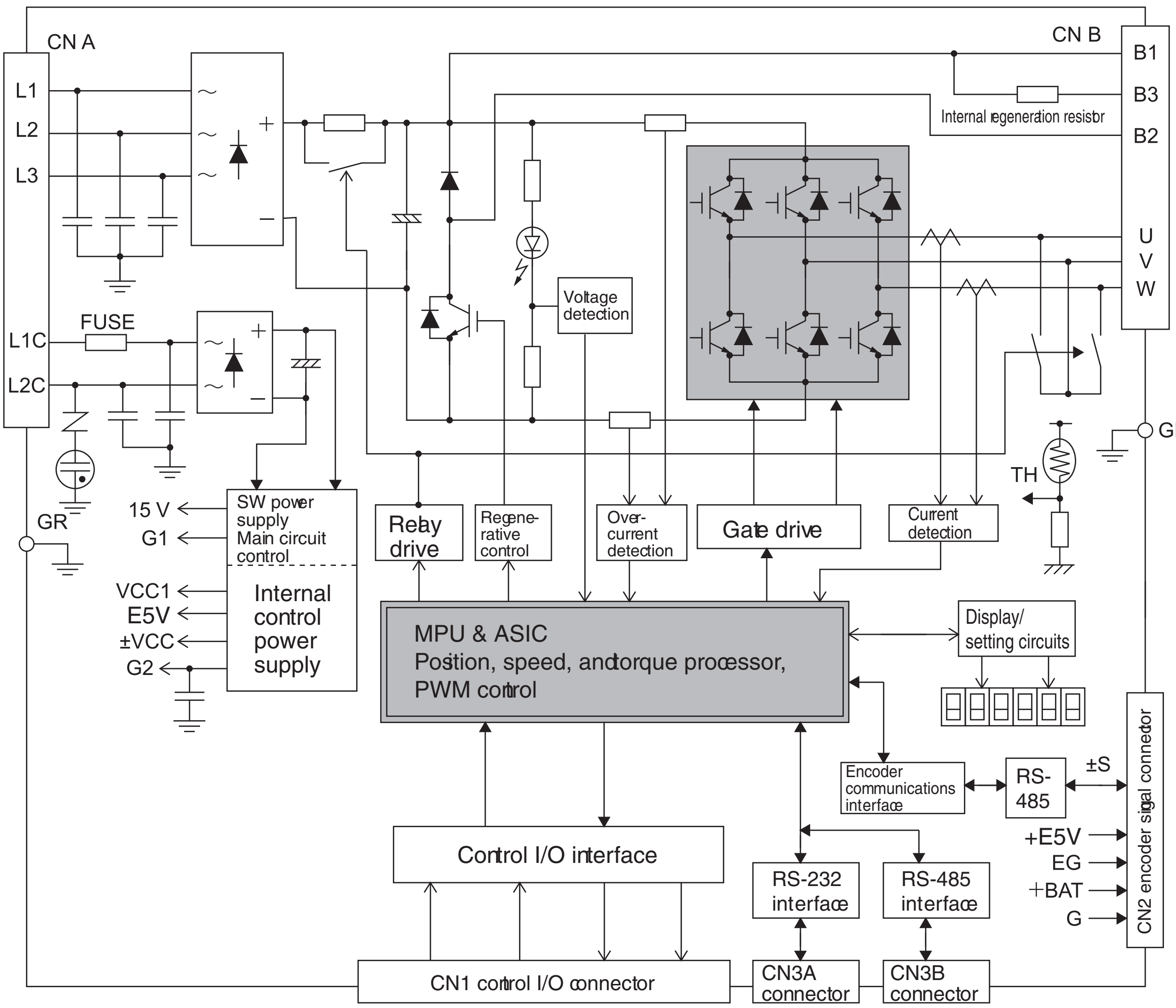
## Forward and Reverse Motor Rotation




When the motor output shaft is viewed from the end, counterclockwise (CCW) rotation is forward and clockwise (CW) rotation is reverse.

## 10-1-3 System Block Diagrams

### R88D-GP08H



# 10-1-4 Applicable Standards

## EC Directives

| EC Directive | Product | Applicable standards | Comments |
|---|---|---|---|
| Low Voltage Directive | AC Servo Drive | EN 50178 | Safety requirements for electrical equipment for measurement, control, or laboratory use |
| | AC Servomotor | IEC 60034-1/-5 | Rotating electrical machines |
| EMC Directive | AC Servo Drive and AC Servomotor | EN 55011 Class A Group1 | Limits of radio disturbance and measurement methods for industrial, scientific, and medical radio-frequency equipment |
| | | EN 61000-6-2 | Electromagnetic compatibility (EMC) Immunity standard for industrial environments |
| | | IEC 61000-4-2 | Electrostatic discharge immunity testing |
| | | IEC 61000-4-3 | Radio frequency radiation field immunity testing |
| | | IEC 61000-4-4 | Electrical fast transient burst immunity testing |
| | | IEC 61000-4-5 | Lightning surge immunity testing |
| | | IEC 61000-4-6 | High-frequency conduction immunity testing |
| | | IEC 61000-4-11 | Momentary power interruption immunity testing |

## UL and CSA Standards

| Standard | Product | Applicable standards | File number | Comments |
|---|---|---|---|---|
| UL standard | AC Servo Drive | UL 508C | E179149 | Power conversion equipment |
| | AC Servomotor | UL1004 | E179189 | Electric motor |
| CSA standard | AC Servomotors | CSA22.2 No.100 | E179189 | Motor and generator |

# 10-2 Standard Models and Dimensions

## 10-2-1 Standard Models

### Servo Drive-Servomotor Combination

The table in this section show the possible combination of SMARTSTEP 2 750 W Model Servo Drive and Servomotor. The Servomotor and Servo Drive can only be used in the listed combinations. The box (-□) at the end of the model number is for options.

#### ■ 3,000-r/min Servomotor and Servo Drive

| Voltage | Rated output | Servo Drive | Servomotor | |
|---|---|---|---|---|
| | | Pulse-string input | Without brake | With brake |
| Single-phase/three-phase 200 VAC | 750 W | R88D-GP08H | R88M-G75030H-□ | R88M-G75030H-B□ |

### Accessories and Cables

#### ■ Encoder Cables

| Specifications | | Model |
|---|---|---|
| Encoder cable R88M-G75030H-□ | 1.5 m | R88A-CRGB001-5CR-E |
| | 3 m | R88A-CRGB003CR-E |
| | 5 m | R88A-CRGB005CR-E |
| | 10 m | R88A-CRGB010CR-E |
| | 15 m | R88A-CRGB015CR-E |
| | 20 m | R88A-CRGB020CR-E |

#### ■ Servomotor Power Cables

| Specifications | | Model |
|---|---|---|
| For 750 W servomotors without brake R88M-G75030H-□-S2<br>For servomotors with brake, a separate cable (R88A-CAGA□BR-E) is needed | 1.5 m | R88A-CAGA001-5SR-E |
| | 3 m | R88A-CAGA003SR-E |
| | 5 m | R88A-CAGA005SR-E |
| | 10 m | R88A-CAGA010SR-E |
| | 15 m | R88A-CAGA015SR-E |
| | 20 m | R88A-CAGA020SR-E |

## ■ Brake Cables

| Specifications | | Model |
|---|---|---|
| Brake cable only<br>For R88M-G75030H-BS2 servomotors | 1.5 m | R88A-CAGA001-5BR-E |
| | 3 m | R88A-CAGA003BR-E |
| | 5 m | R88A-CAGA005BR-E |
| | 10 m | R88A-CAGA010BR-E |
| | 15 m | R88A-CAGA015BR-E |
| | 20 m | R88A-CAGA020BR-E |

## ■ Computer Cable

| Specifications | | Model |
|---|---|---|
| Computer cable RS232 | 2 m | R88A-CCG002P2 |

## ■ Connectors

| Specifications | Model |
|---|---|
| I/O connector kit -50 pins- (for CN1) | R88A-CNU11C |
| Power cable connector (motor side) | R88A-CNG01A |
| Encoder connector (Servo drive side CN2) | R88A-CNW01R |
| Incremental encoder cable connector (motor side) | R88A-CNG02R |

## ■ Reactor

| Specifications | Model |
|---|---|
| R88D-GP08H | 3G3AX-AL2025 |

## ■ External Regeneration Resistors

| Regenerative resistor unit model | Specifications |
|---|---|
| R88A-RR08050S | 50 Ω, 80 W |
| R88A-RR080100S | 100 Ω, 80 W |
| R88A-RR22047S | 47 Ω, 220 W |
| R88A-RR50020S | 20 Ω, 500 W |

## ■ Control Cables (for CN1)

| Description | Connecto to | | Model |
|---|---|---|---|
| Control cable<br>(line-driver output for 1 axis) | Position control units (high speed type)<br>CJ1W-NC234<br>CJ1W-NC434 | 1 m | XW2Z-100J-G9 |
| | | 5 m | XW2Z-500J-G9 |
| | | 10 m | XW2Z-10MJ-G9 |
| Control cable<br>(open-collector output for 1 axis) | Position control units (high speed type)<br>CJ1W-NC214<br>CJ1W-NC414 | 1 m | XW2Z-100J-G13 |
| | | 3 m | XW2Z-300J-G13 |
| Control cable<br>(line-driver output for 2 axis) | Position control units (high speed type)<br>CJ1W-NC234<br>CJ1W-NC434 | 1 m | XW2Z-100J-G1 |
| | | 5 m | XW2Z-500J-G1 |
| | | 10 m | XW2Z-10MJ-G1 |
| Control cable<br>(open-collector output for 2 axis) | Position control units (high speed type)<br>CJ1W-NC214<br>CJ1W-NC414 | 1 m | XW2Z-100J-G5 |
| | | 3 m | XW2Z-300J-G5 |

| Description | Connecto to | | Model |
|---|---|---|---|
| Terminal block cable for external signals (for input common, forward/reverse run prohibited inputs, emergency stop input, origin proximity input and interrupt input) | Position control units (high speed type)<br>CJ1W-NC234<br>CJ1W-NC434<br>CJ1W-NC214<br>CJ1W-NC414 | 0.5 m | XW2Z-C50X |
| | | 1 m | XW2Z-100X |
| | | 2 m | XW2Z-200X |
| Terminal block for external signals (M3 screw, pin terminals) | | 3 m | XW2Z-300X |
| | | 5 m | XW2Z-500X |
| Terminal block ext. signals (M3.5 screw, fork/round terminals) | | 10 m | XW2Z-010X |
| | | - | XW2B-20G4 |
| Terminal block ext. signals (M3 screw, fork/round terminals) | | - | XW2B-20G5 |
| | | - | XW2B-20G6 |
| Cable from servo relay unit to servo drive | CS1W-NC1□3, CJ1W-NC1□3, C200HW-NC113/213/413, CS1W-NC2□3/4□3, CJ1W-NC2□3/4□3 or CQM1H-PLB21 | 1 m | XW2Z-100J-B25 |
| | | 2 m | XW2Z-200J-B25 |
| | CJ1M-CPU21/22/23 | 1 m | XW2Z-100J-B31 |
| | | 2 m | XW2Z-200J-B31 |
| Servo relay unit | CS1W-NC1□3, CJ1W-NC1□3 or C200HW-NC113 position control unit | - | XW2B-20J6-1B (1 axis) |
| | CS1W-NC2□3/4□3, CJ1W-NC2□3/4□3 or C200HW-NC213/413 position control unit | - | XW2B-40J6-2B (2 axes) |
| | CQM1H-PLB21 | - | XW2B-20J6-3B (1 axis) |
| | CJ1M-CPU21/22/23 | - | XW2B-20J6-8A (1 axis) |
| | | | XW2B-40J6-9A (2 axes) |
| Position control unit connecting cable | CQM1H-PLB21 | 0.5 m | XW2Z-050J-A3 |
| | | 1 m | XW2Z-100J-A3 |
| | CS1W-NC113 or C200HW-NC113 | 0.5 m | XW2Z-050J-A6 |
| | | 1 m | XW2Z-100J-A6 |
| | CS1W-NC213/413 or C200HW-NC213/413 | 0.5 m | XW2Z-050J-A7 |
| | | 1 m | XW2Z-100J-A7 |
| | CS1W-NC133 | 0.5 m | XW2Z-050J-A10 |
| | | 1 m | XW2Z-100J-A10 |
| | CS1W-NC233/433 | 0.5 m | XW2Z-050J-A11 |
| | | 1 m | XW2Z-100J-A11 |
| | CJ1W-NC113 | 0.5 m | XW2Z-050J-A14 |
| | | 1 m | XW2Z-100J-A14 |
| | CJ1W-NC213/413 | 0.5 m | XW2Z-050J-A15 |
| | | 1 m | XW2Z-100J-A15 |
| | CJ1W-NC133 | 0.5 m | XW2Z-050J-A18 |
| | | 1 m | XW2Z-100J-A18 |
| | CJ1W-NC233/433 | 0.5 m | XW2Z-050J-A19 |
| | | 1 m | XW2Z-100J-A19 |
| | CJ1M-CPU21/22/23 | 0.5 m | XW2Z-050J-A33 |
| | | 1 m | XW2Z-100J-A33 |

| Description | Connecto to | | Model |
|---|---|---|---|
| General purpose cable | For general purpose controllers | 1 m | R88A-CPG001S |
| | | 2 m | R88A-CPG002S |
| Terminal block cable | For general purpose controllers | 1 m | XW2Z-100J-B24 |
| | | 2 m | XW2Z-200J-B24 |
| Terminal block (M3 screw and for pin terminals) | | - | XW2B-50G4 |
| Terminal block (M3.5 screw and for fork/ round terminals) | | - | XW2B-50G5 |
| Terminal block (M3 screw and for fork/ round terminals) | | - | XW2D-50G6 |

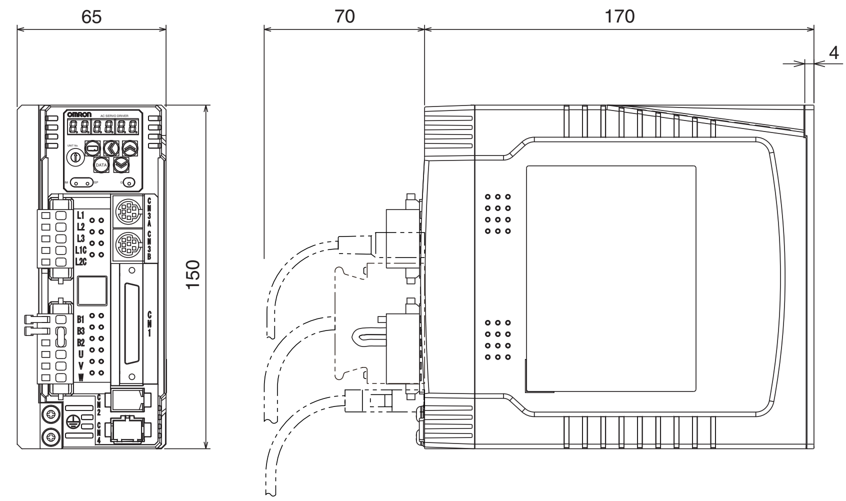
# 10-2-2 External and Mounting Hole Dimensions

## Servo Drive

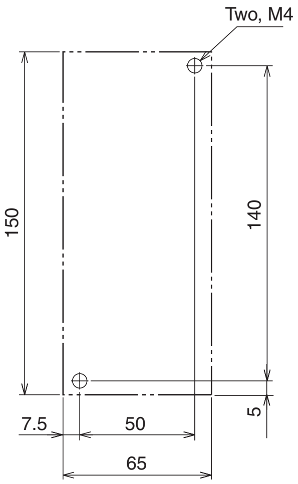
### ■ Single-phase/Three-phase 200 VAC: R88D-GP08H (750 W)

#### Wall Mounting

External Dimensions

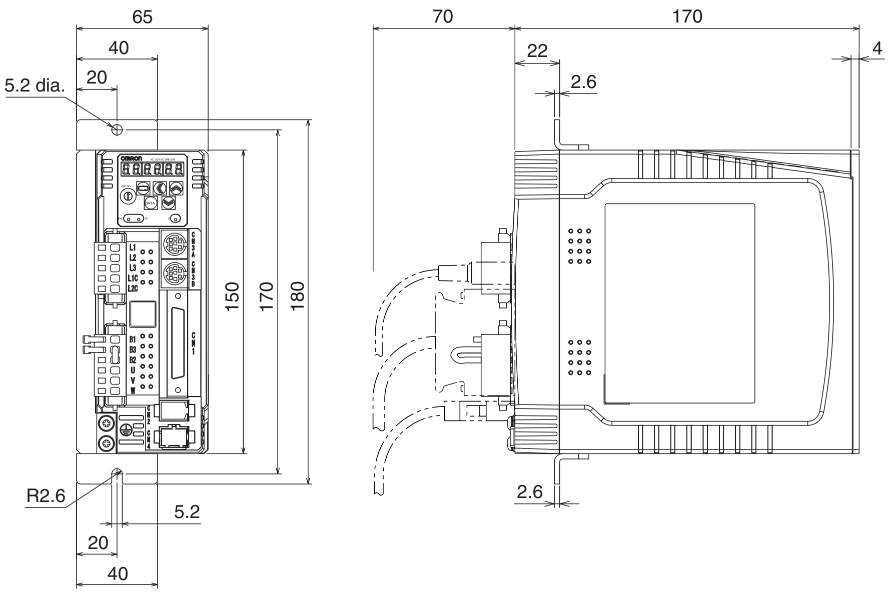



Mounting Hole Dimensions

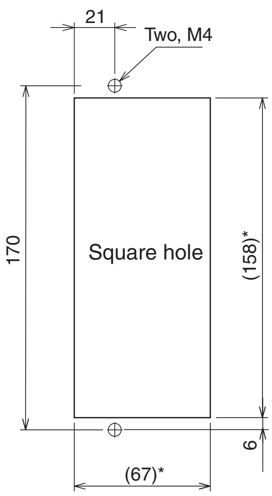



#### Front Panel Mounting (Using Mounting Brackets)

External Dimensions




Mounting Hole Dimensions (Reference)




Dimensions for front panel mounting are references values that provide leeway.

* The dimensions of the square hole are reference values.

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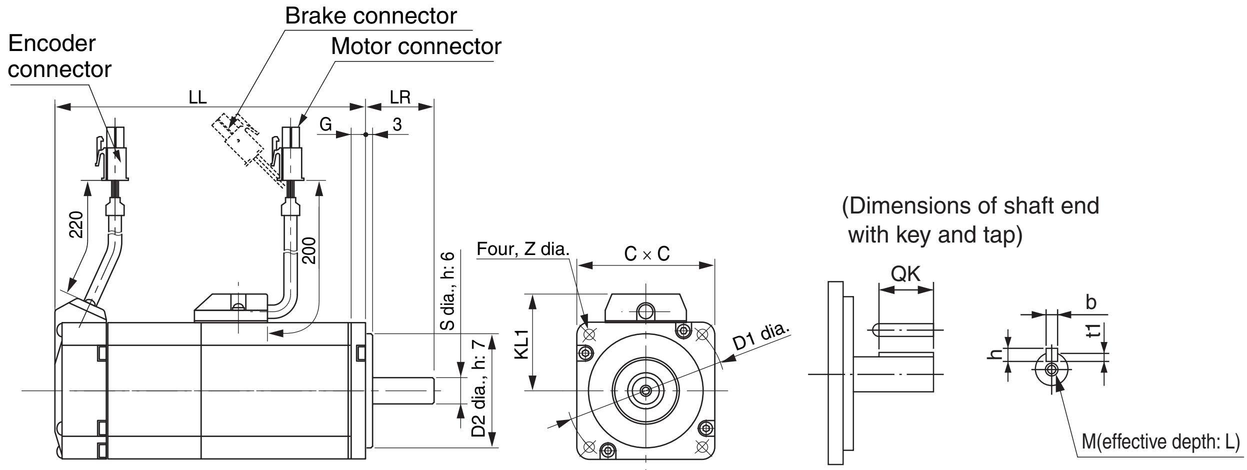
Appendix-2

## Servomotor

### ■ 3,000-r/min Servomotor

**750W**

R88M-G75030H(-S2)/-G75030H-B(S2) **INC**




| Model | Dimensions (mm) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LL | LR | S | D1 | D2 | C | G | KL1 | Z | QK | b | h | M | t1 | L |
| R88M-G75030□ | 112.2 | 35 | 19 | 90 | 70 | 80 | 8 | 53 | 6 | 22 | 6h9 | 6 | M5 | 3.5 | 10 |
| R88M-G75030□-B□ | 149.2 | 35 | 19 | 90 | 70 | 80 | 8 | 53 | 6 | 22 | 6h9 | 6 | M5 | 3.5 | 10 |

**Note** The standard models have a straight shaft. Models with a key and tap are indicated with “S2” at the end of the model number.

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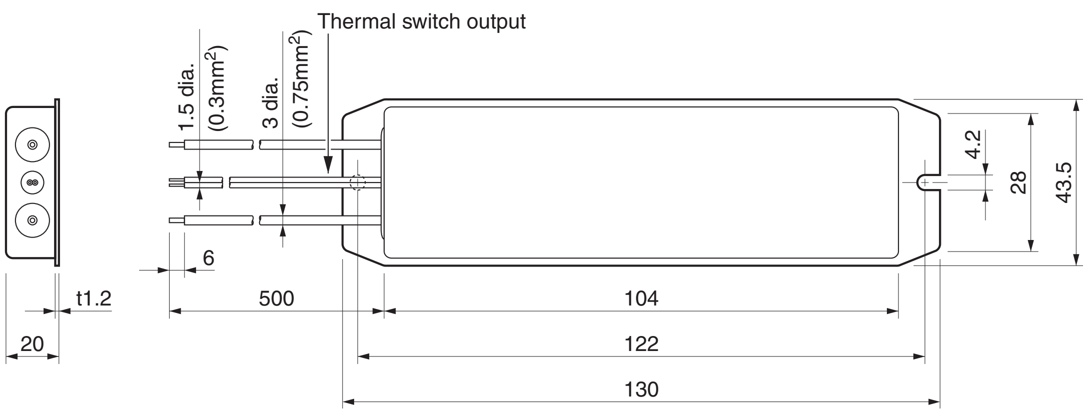
Appendix-2

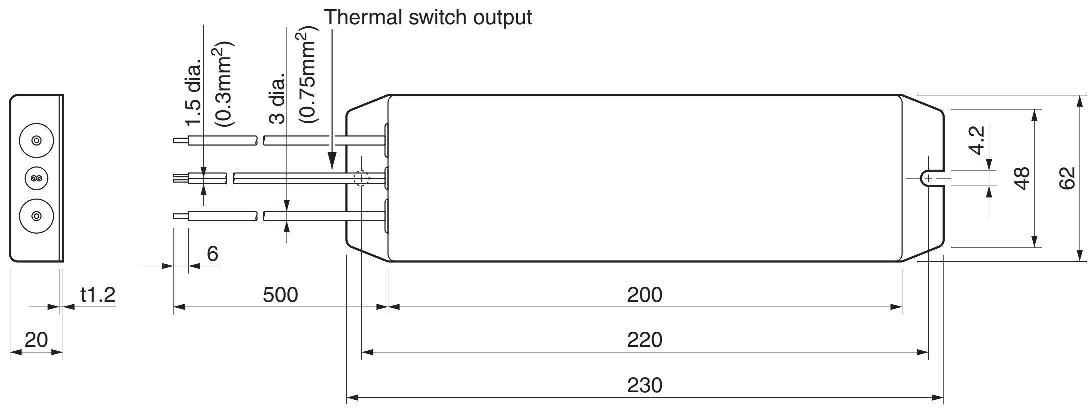
## External Regeneration Resistor Dimensions

### ■ External Regeneration Resistor

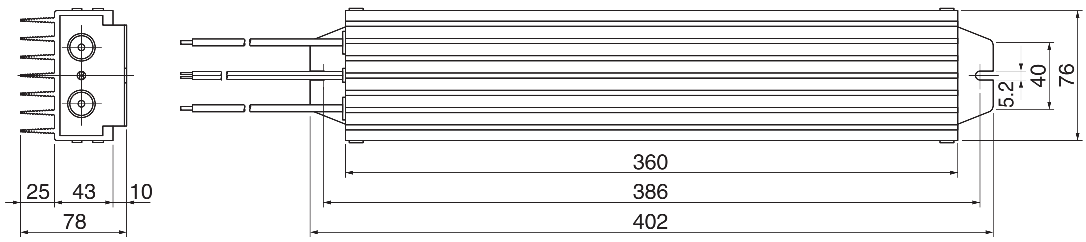
**R88A-RR08050S/-RR080100S**



**R88A-RR22047S**

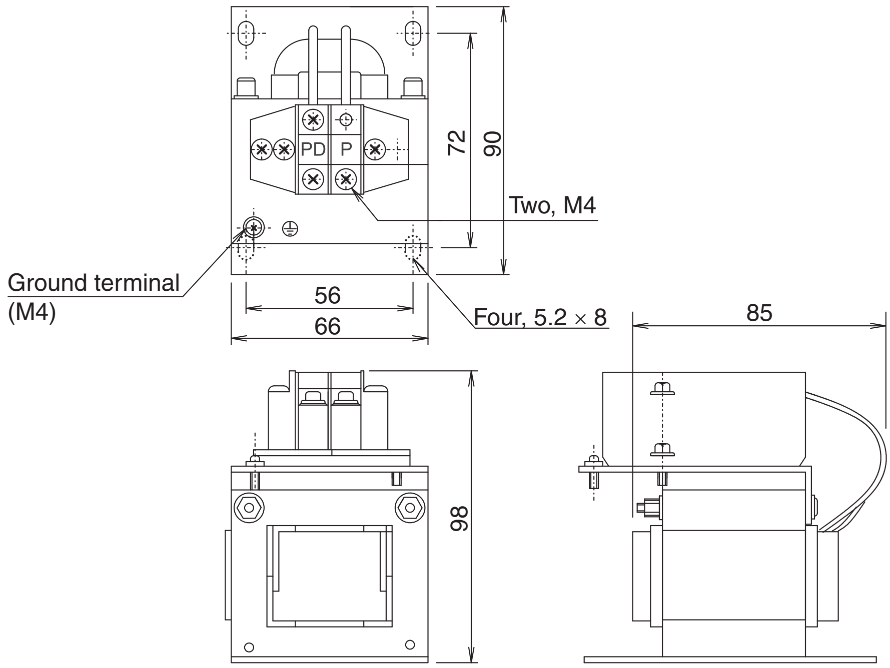



**R88A-RR50020S**

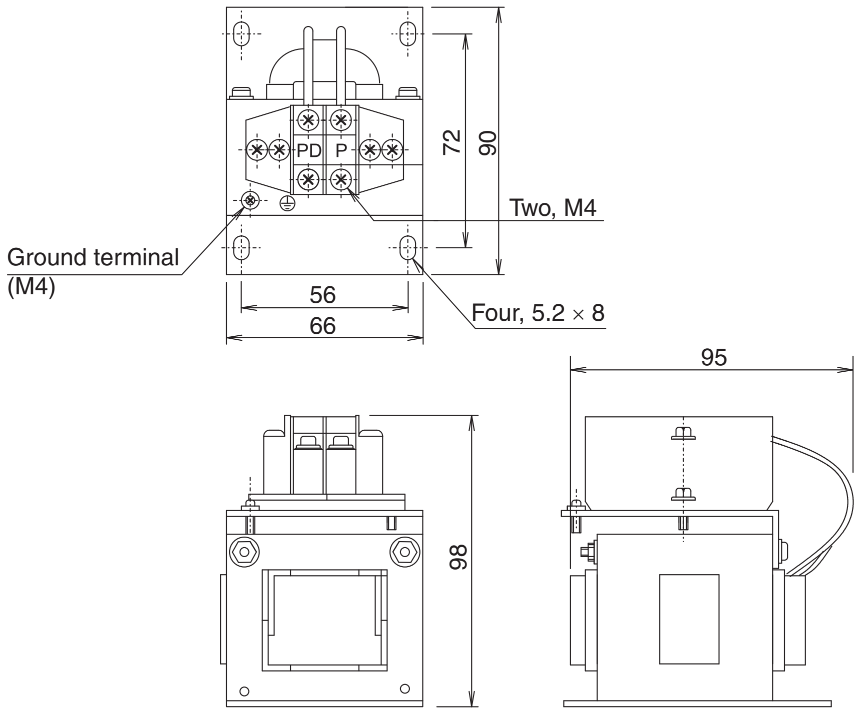


## Reactor Dimensions

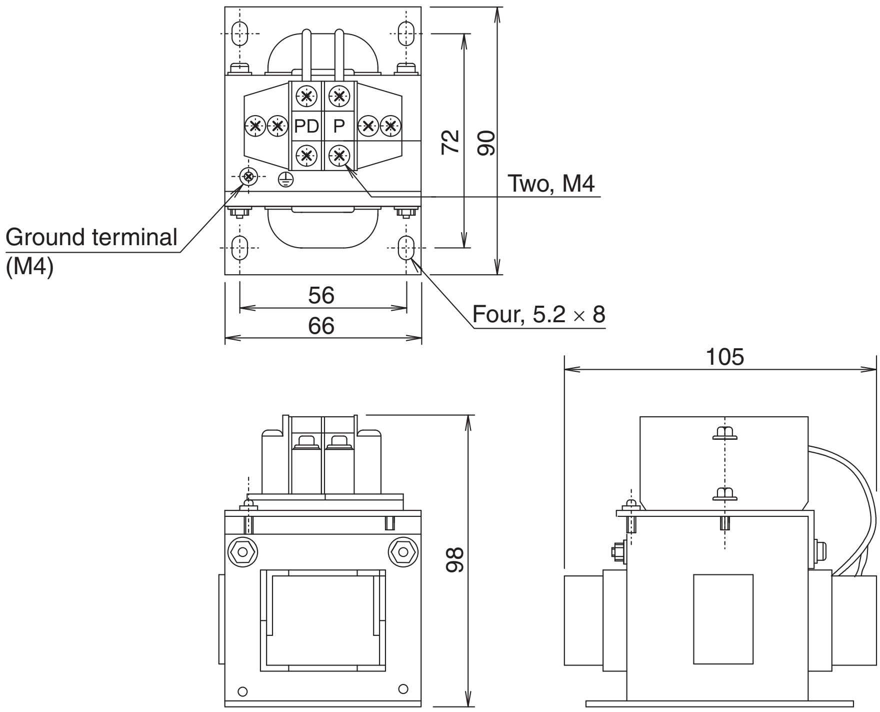
### ■ 3G3AX-DL2002



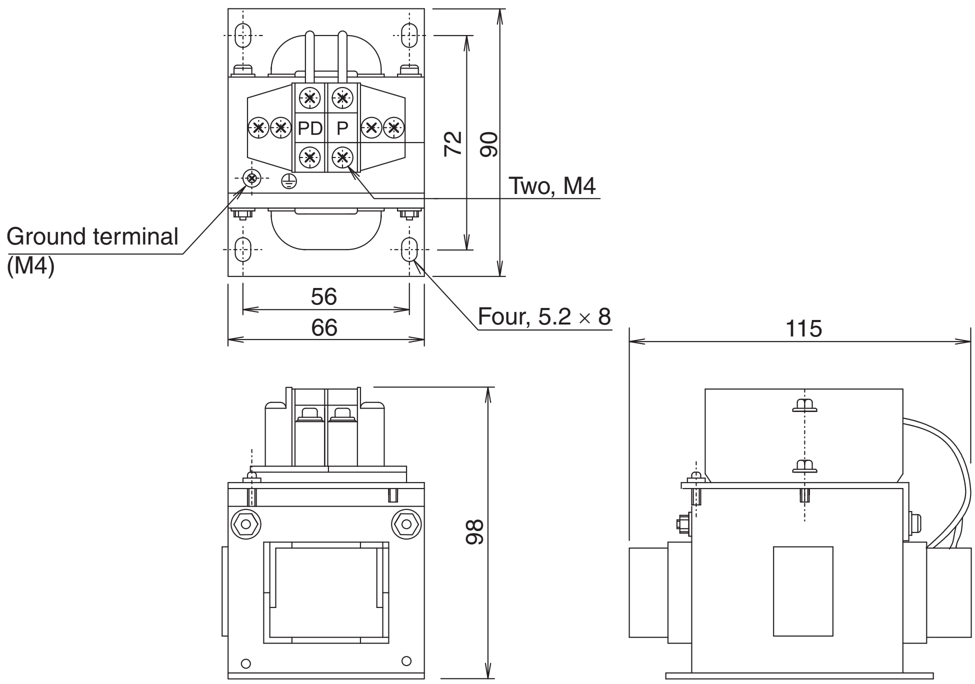

### ■ 3G3AX-DL2004



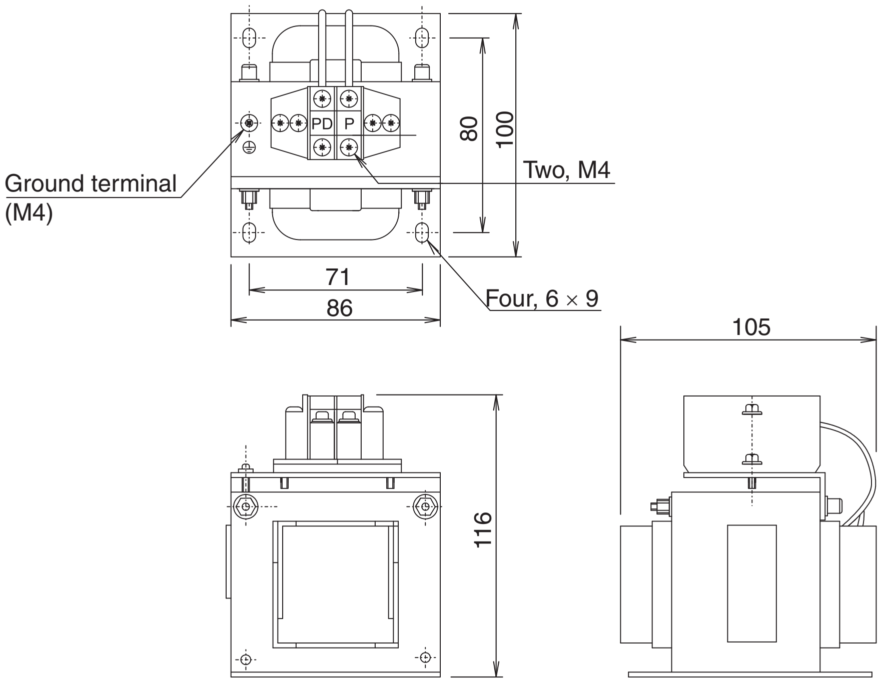
## ■ 3G3AX-DL2007



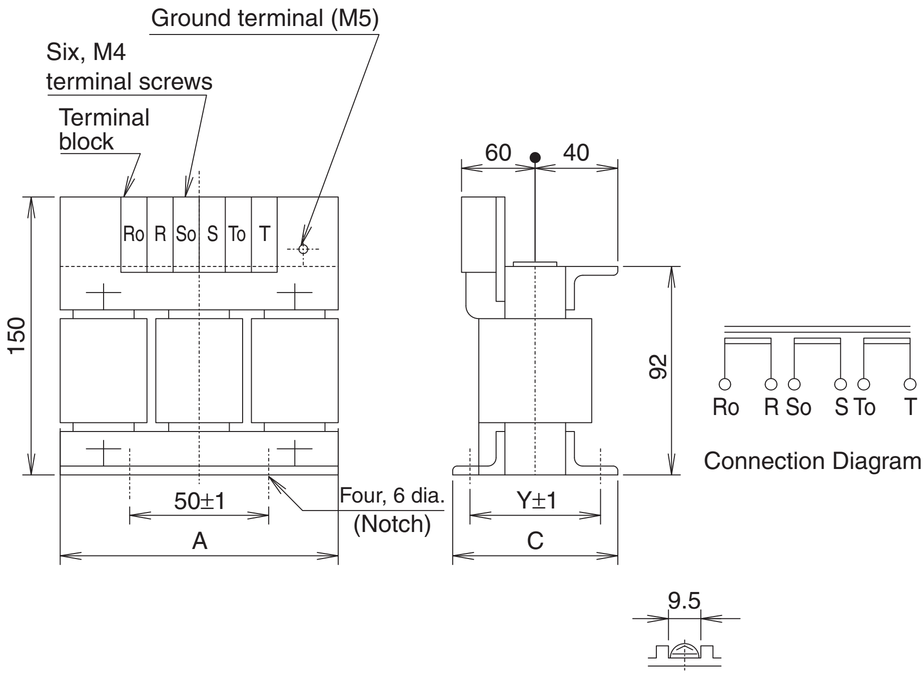

## ■ 3G3AX-DL2015



## ■ 3G3AX-DL2022




## ■ 3G3AX-AL2025/-AL2055




| Model | Dimensions (mm) | | |
|---|---|---|---|
| | A | C | Y |
| 3G3AX-AL2025 | 130 | 82 | 67 |
| 3G3AX-AL2055 | 140 | 98 | 75 |

# 10-3 Specifications

## 10-3-1 Servo Drive Specifications

### Characteristics

| Item | | | R88D-GP08H |
|---|---|---|---|
| Continuous output current (rms) | | | 4.0 A |
| Momentary maximum output current (rms) | | | 14.1 A |
| Input power supply | Main circuit | Power supply capacity | 1.3 KVA |
| | | Power supply voltage | Single-phase or three-phase 200 to 240 VAC (170 to 264 V) 50/60 Hz |
| | | Rated current | 5.0 |
| | Control circuit | Power supply voltage | Single-phase 200 to 240 VAC (170 to 264 V), 50/60 Hz |
| | | Rated current | 0.05 A |
| Heat generated | Main circuit | | 38.7 W |
| | Control circuit | | 4.3 W |
| PWM frequency | | | 6.0 KHz |
| Weight | | | Approx. 1.5 kg |
| Maximum applicable motor capacity | | | 750 W |
| Applicable Servomotors | 3,000-r/min Servomotors | INC | G75030H |
| Control method | | | All-digital servo |
| Inverter method | | | IGBT-driven PWM method |

## Main Circuit and Servomotor Connections

When wiring the main circuit, use proper wire sizes, grounding systems, and anti-noise measures.

### ■ R88D-GP08H

#### Main Circuit Connector Specifications (CNA)

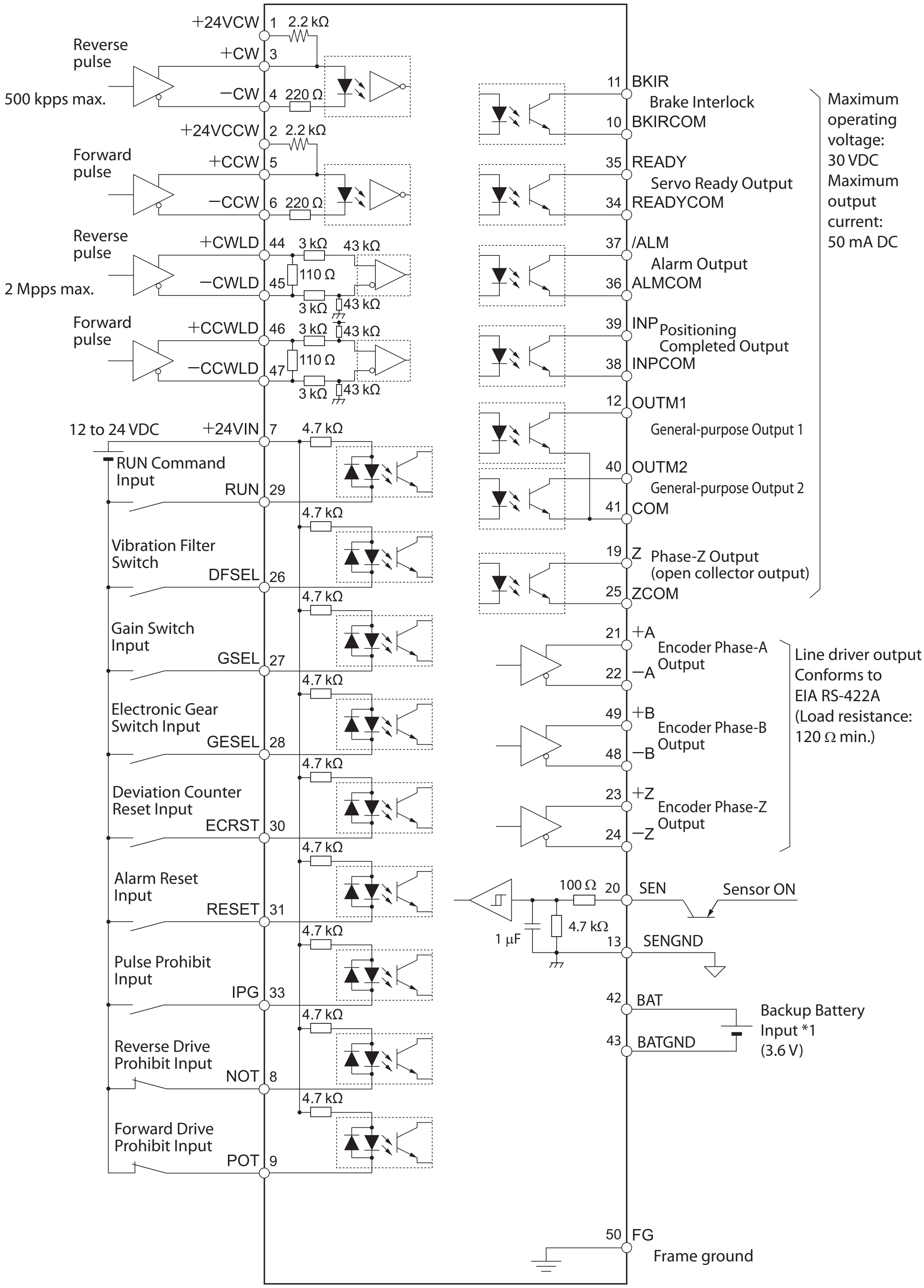
| Symbol | Name | Function |
|---|---|---|
| L1 | Main circuit power supply input | R88D-GP08H (750W): Single-phase 200 to 240 VAC (170 to 264 V), 50/60 Hz<br>R88D-GP08H (750W): Three-phase 200 to 240 VAC (170 to 264 V), 50/60 Hz |
| L2 | | |
| L3 | | |
| L1C | Control circuit power supply input | R88D-GP08H: Single-phase 200 to 240 VAC (170 to 264 V) 50/60 Hz |
| L2C | | |

#### Servomotor Connector Specifications (CNB)

| Symbol | Name | Function | |
|---|---|---|---|
| B1 | External Regeneration Resistor connection terminals | 750 W: Normally B2 and B3 are connected. If there is high regenerative energy, remove the short-circuit bar between B2 and B3 and connect an External Regeneration Resistor between B1 and B2. | |
| B2 | | | |
| B3 | | | |
| U | Servomotor connection terminals | Red | These are the output terminals to the Servomotor.<br>Be sure to wire them correctly. |
| V | | White | |
| W | | Blue | |
| ⏚ | | Green/ Yellow | |
| ⏚ | Frame ground | This is the ground terminal. Ground to a 100 Ω or less. | |

# Control I/O Connector Specifications (CN1)

## ■ Control I/O Signal Connections




*1. Use only when an absolute encoder. If a backup battery is connected, an encoder cable with a battery is not required.

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Appendix-2

## ■ Control I/O Signals

### CN1 Control Inputs

| Pin No. | Symbol | Name | Function/Interface | Control mode |
|---|---|---|---|---|
| 1 | +24VCW | 24-V Open-collector Input for Command Pulse | Input terminals for position command pulses.<br>These are selected by setting the Command Pulse Input Selection (Pn40) to 0.<br>Line-Driver input:<br>Maximum response frequency: 500 kpps<br>Open-collector input:<br>Maximum response frequency: 200 kpps<br>Any of the following can be selected by using the Pn42 setting: reverse and forward pulses (CW/CCW), feed pulse and direction signal (PULS/SIGN), 90° phase difference (phase A/B) signals (FA/FB). | Position |
| 2 | +24VCCW | 24-V Open-collector Input for Command Pulse | | |
| 3 | +CW/ PULS/FA | Reverse Pulses Input/ Feed Pulses Input, or 90° Phase Difference Pulse Input (Phase A) | | |
| 4 | −CW/ PULS/FA | | | |
| 5 | +CCW/ SIGN/FB | Forward Pulse Input/ Direction Signal, or 90° Phase Difference Pulse Input (Phase B) | | |
| 6 | −CCW/ SIGN/FB | | | |
| 7 | +24VIN | 12 to 24-VDC Power Supply Input | Power supply input terminal (+12 to 24 VDC) for sequence inputs. | All |
| 8 | NOT | Reverse Drive Prohibit Input | Reverse rotation overtravel input.<br>OFF: Prohibited, ON: Permitted | All |
| 9 | POT | Forward Drive Prohibit Input | Forward rotation overtravel input.<br>OFF: Prohibited, ON: Permitted | All |
| 20 | SEN | Sensor ON Input | ON: Initial incremental pulses are sent. | All |
| 13 | SENGND | | | |
| 26 | VZERO | Zero Speed Designation Input | When the Zero Speed Designation/Speed Command Direction Switch (Pn06) is set to 0, Zero Speed Designation Input is disabled.<br>When the Zero Speed Designation/Speed Command Direction Switch (Pn06) is set to 1, Zero Speed Designation Input is enabled.<br>OFF: Speed Command is regarded as 0.<br>ON: Normal operation. | Internally Speed |
| | DFSEL | Vibration Filter Switch | Vibration filter switch input when the Vibration Filter Selection (Pn24) is set to 1.<br>OFF: Vibration filter 1 (Pn2B, Pn2C) enabled.<br>ON: Vibration filter 2 (Pn2D, Pn2E) enabled. | Position |
| 27 | GSEL | Gain Switch | Gain switch input when the Torque Limit Selection (Pn03) is set to 0 to 2.<br>If the Gain Switching Input Operating Mode Selection (Pn30) is set to 0:<br>OFF: PI (Proportional/Integral) operation<br>ON: P (Proportional) operation<br>When the Gain Switching Input Operating Mode Selection (Pn30) is set to 1, switches between Gain 1 and Gain 2. The selected Gain will differ depending on the settings for Pn31 and Pn36. | All |
| | TLSEL | Torque Limit Switch | Torque limit switch input when the Torque Limit Selection (Pn03) is set to 3.<br>OFF: No. 1 Torque Limit (Pn5E) enabled.<br>ON: No. 2 Torque Limit (Pn5F) enabled. | All |

| Pin No. | Symbol | Name | Function/Interface | Control mode |
|---|---|---|---|---|
| 28 | GESEL | Electronic Gear Switch | Electronic gear switch input. [*1]<br>OFF: Electronic Gear Ratio Numerator 1 (Pn48)<br>ON: Electronic Gear Ratio Numerator 2 (Pn49) | Position |
| | VSEL3 | Internally Set Speed Selection 3 | Internally set speed selection 3.<br>ON: Internally set speed selection 3 is input. | Internally Speed |
| 29 | RUN | RUN Command | ON: Servo ON (Starts power to Servomotor.) [*2] | All |
| 30 | ECRST | Deviation Counter Reset Input | Deviation counter reset input. [*3]<br>ON: The deviation counter is reset (i.e., cleared). | Position |
| | VSEL2 | Internally Set Speed Selection 2 | Internally set speed selection 2.<br>ON: Internally set speed selection 2 is input. | Internally Speed |
| 31 | RESET | Alarm Reset Input | ON: Servo alarm status is reset. [*4]<br>Must be ON for 120 ms min. | All |
| 33 | IPG | Pulse Prohibit Input | Pulse prohibit input (IPG) when the Command Pulse Prohibited Input (Pn43) is set to 0.<br>OFF: The command pulse is ignored. | Position |
| | VSEL1 | Internally Set Speed Selection 1 | Internally set speed selection 1.<br>ON: Internally set speed selection 1 is input. | Internally Speed |
| 44 | +CWLD | Reverse Pulse (input for line driver only) | Position command pulse input when the Command Pulse Input Selection (Pn40) is set to 1.<br>Line-driver input:<br>Maximum response frequency: 2 Mpps<br>Any of the following can be selected by using the Pn42 setting: reverse and forward pulses (CW/CCW), feed pulse and direction signal (PULS/SIGN), 90° phase difference (phase A/B) signals (FA/FB). | Position |
| 45 | −CWLD | | | |
| 46 | +CCWLD | Forward Pulse (input for line driver only) | | |
| 47 | −CCWLD | | | |

*1. Do not input a command pulse within 10 ms before and after switching.

*2. Dynamic brake operation and deviation counter clear can be selected using the Stop Selection with Servo OFF (Pn69).

*3. Must be ON for 2 ms min.

*4. The deviation counter is cleared when the alarm is reset. Some alarms cannot be reset with this input.

## ■ CN1 Control Outputs

| Pin No. | Symbol | Name | Function/Interface | Control mode |
|---|---|---|---|---|
| 10 | BKIRCOM | Brake Interlock Output | Outputs holding brake timing signals. Releases the holding brake when ON. | All |
| 11 | BKIR | | | |
| 12 | OUTM1 | General-purpose Output 1 | Used according to the setting of the General-purpose Output 1 Selection (Pn0A). | All |
| 19 | Z | Phase-Z Output (open collector) | Outputs the encoder phase-Z signal (1 pulse/ revolution). Open-collector output. | All |
| 25 | ZCOM | Phase-Z Output (open collector) common | | |
| 21 | +A | Encoder Phase-A + Output | Outputs encoder pulses according to the Encoder Dividing Rate Setting (Pn44 and Pn45). This is the line-driver output (equivalent to RS-422). | All |
| 22 | –A | Encoder Phase-A – Output | | |
| 48 | –B | Encoder Phase-B – Output | | |
| 49 | +B | Encoder Phase-B + Output | | |
| 23 | +Z | Encoder Phase-Z + Output | | |
| 24 | –Z | Encoder Phase-Z – Output | | |
| 35 | READY | Servo Ready Output | Output signal to indicate that power can be supplied to the Servo Drive. ON if no errors are found after the power is supplied to the main circuit. | All |
| 34 | READYCOM | | | |
| 37 | /ALM | Alarm Output | The output is OFF when an alarm is generated for the Servo Drive. | All |
| 36 | ALMCOM | | | |
| 39 | INP | Positioning Completed Output | The accumulated pulses in the deviation counter are within the setting for Positioning Completion Range (Pn60). | Position |
| 38 | INPCOM | | | |
| 39 | TGON | Servomotor Rotation Speed Detection Output | The number of Servomotor rotations exceeds the value set for Rotation Speed for Motor Rotation Detection (Pn62). | Internally Speed |
| 38 | TGONCOM | | | |
| 40 | OUTM2 | General-purpose Output 2 | Used according to the setting of the General-purpose Output 2 Selection (Pn09). | All |
| 41 | COM | General-purpose Output Common | Ground common for sequence outputs. | All |
| Shell | FG | Frame Ground | Connected to the ground terminal inside the Servo Drive. | All |

## ■ CN1 Pin Arrangement

| Pin | Signal | Name |
|---|---|---|
| 2 | +24VCCW | 24-V Open-collector Input for Command Pulse |
| 4 | –CW/ -PULS/-FA | Reverse Pulses Input/ Feed Pulses Input, or 90° Phase Difference Pulse Input (Phase A) |
| 6 | –CCW/ –SIGN/–FB | Forward Pulses/ Direction Signal, or 90° Phase Difference Pulse Input (Phase B) |
| 8 | NOT | Reverse Drive Prohibit Input |
| 10 | BKIRCOM | Brake Interlock Output |
| 12 | OUTM1 | General-purpose Output 1 |
| 14 | Reserved | * |
| 16 | Reserved | * |
| 18 | Reserved | * |
| 20 | SEN | Sensor ON Input |
| 22 | –A | Encoder Phase-A Output |
| 24 | –Z | Encoder Phase-Z Output |

| Pin | Signal | Name |
|---|---|---|
| 1 | +24VCW | 24-V Open-collector Input for Command Pulse |
| 3 | +CW/ +PULS/+FA | Reverse Pulses Input/ Feed Pulses Input, or 90° Phase Difference Pulse Input (Phase A) |
| 5 | +CCW/ +SIGN/+FB | Forward Pulses/ Direction Signal, or 90° Phase Difference Pulse Input (Phase B) |
| 7 | +24VIN | 12 to 24-VDC Power Supply Input |
| 9 | POT | Forward Drive Prohibit Input |
| 11 | BKIR | Brake Interlock Output |
| 13 | SENGND | Ground Common |
| 15 | Reserved | * |
| 17 | Reserved | * |
| 19 | Z | Phase-Z Output (open collector) |
| 21 | +A | Encoder Phase-A + Output |
| 23 | +Z | Encoder Phase-Z + Output |
| 25 | ZCOM | Phase-Z Output (open collector) Common |

| Pin | Signal | Name |
|---|---|---|
| 27 | GSEL/TLSEL | Gain Switch/ Torque Limit Switch |
| 29 | RUN | RUN Command |
| 31 | RESET | Alarm Reset Input |
| 33 | IPG/VSEL1 | Pulse Prohibit Input/Internally Set Speed Selection 1 |
| 35 | READY | Servo Ready Output |
| 37 | /ALM | Alarm Output |
| 39 | INP/TGON | Positioning Completed Output/Servomotor Rotation Speed Detection Output |
| 41 | COM | General-purpose Output Common |
| 43 | BATGND | Absolute Encoder Backup Battery Input |
| 45 | –CWLD | Reverse Pulse (input for line driver only) |
| 47 | –CCWLD | Forward Pulse (input for line driver only) |
| 49 | +B | Encoder Phase-B + Output |

| Pin | Signal | Name |
|---|---|---|
| 26 | VZERO/ DFSEL | Zero Speed Designation Input/Vibration Filter Switch |
| 28 | GESEL/ VSEL3 | Electronic Gear Switch/ Internally Set Speed Selection 3 |
| 30 | ECRST/VSEL2 | Deviation Counter Reset/Internally Set Speed Selection 2 |
| 32 | Reserved | * |
| 34 | READYCOM | Servo Ready Output |
| 36 | ALMCOM | Alarm Output |
| 38 | INPCOM/ TGONCOM | Positioning Completed Output/Servomotor Rotation Speed Detection Output Common |
| 40 | OUTM2 | General-purpose Output 2 |
| 42 | BAT | Absolute Encoder Backup Battery Input |
| 44 | +CWLD | Reverse Pulse (input for line driver only) |
| 46 | +CCWLD | Forward Pulse (input for line driver only) |
| 48 | –B | Encoder Phase-B – Output |
| 50 | Reserved | * |

**Note** Do not connect anything to unused pins (*).

## ■ CN1 Connectors (50 Pins)

| Name | Model | Manufacturer |
|---|---|---|
| Servo Drive Connector | 52986-3679 | Molex Japan |
| Cable Plug | 10150-3000PE | Sumitomo 3M |
| Cable Case (Shell Kit) | 10350-52A0-008 | |

## ■ Control Input Functions

### - Reverse Drive Prohibit Input (NOT) and Forward Drive Prohibit Input (POT)

Pin 8: Reverse Drive Prohibit Input (NOT)
Pin 9: Forward Drive Prohibit Input (POT)

#### Functions

- These inputs are used to prohibit driving in the forward and reverse directions.
- If the Drive Prohibit Input Selection (Pn04) is set to 1, both inputs will be disabled.
- The Stop Selection for Drive Prohibition Input (Pn66) changes the operation when these inputs are enabled.

### - RUN Command Input (RUN)

Pin 29: RUN Command Input (RUN)

#### Functions

- This input turns ON the power drive circuit for the main circuit of the Servo Drive. If this signal is not input (i.e., servo-OFF status), the Servomotor cannot operate.

### - Deviation Counter Reset Input (ECRST)

Pin 30: Deviation Counter Reset Input (ECRST)

#### Functions

- Position Control Mode
  The value of the deviation counter will be reset when the deviation counter reset input turns ON.
  The condition for resetting is selected in the Deviation Counter Reset Condition Setting (Pn4E).
  The pulse width of the Deviation Counter Reset Signal must be at least 1 ms.





### - Alarm Reset Input (RESET)

Pin 31: Alarm Reset Input (RESET)

#### Functions

- Pin 31 is the external reset signal for Servo Drive alarms. (The alarms are reset when this signal is input.)
- The alarm status is reset when RESET is connected to the 24-V power supply ground for +24VIN for 120 ms or longer.
- The deviation counter is also reset when alarms are reset.
- Eliminate the cause of the alarm before resuming operation. To prevent danger, turn OFF the RUN Command Input first, then input the alarm reset signal.

### - Pulse Prohibit Input (IPG) and Internally Set Speed Selection 1 (VSEL1)

Pin 33: Pulse Prohibit Input (IPG) / Internally Set Speed Selection 1 (VSEL1)

#### Functions

- Position Control Mode
  Pin 33 is the Pulse Prohibit Input.
  When the input is OFF, inputting command pulses will be disabled.
  The Pulse Prohibit Input can be disabled by setting the Command Pulse Prohibited Input (Pn43).

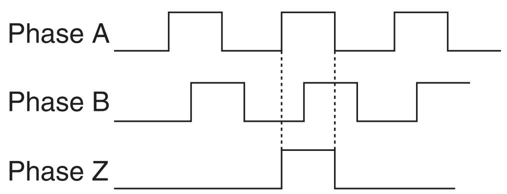
## ■ Control Output Functions

### - Encoder Outputs (Phases A, B, and Z)

Pin 21: +A, 22: –A, 48: –B, 49: +B, 23: +Z, 24: –Z

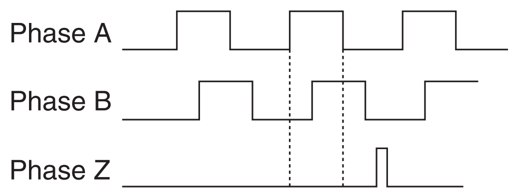
#### Functions

- Pin 21 outputs the phase-A, phase-B, and phase-Z encoder signals for the Servomotor.
- The encoder outputs conform to the RS-422 communication method.
- The dividing ratio is set in the Encoder Divider Numerator Setting (Pn44) and the Encoder Divider Denominator Setting (Pn45).
- The logical relation of phase B to the phase-A pulse is set in the Encoder Output Direction Switch (Pn46).
- The ground for the output circuit line driver is connected to the signal ground (GND). It is not isolated.
- The maximum output frequency is 4 Mpps (after multiplying by 4). The output frequency equals the Servomotor encoder resolution × (Pn44/Pn45) × 4 × Servomotor rotation speed (r/min) ÷ 60
- The output phases are shown below. (They are the same for both incremental and absolute encoders.)



Synched

- If the Servomotor encoder resolution × (Pn44/Pn45) is a multiple of 4, phases Z and A are synchronized.



Not synched

- In cases except for the one on the left, phases A and Z are not synchronized.

### - Brake Interlock Output (BKIR)

Pin 11: Brake Interlock Output (BKIR)

#### Functions

Pin 11 outputs an external brake timing signal according to the settings of the Brake Timing When Stopped (Pn6A) and Brake Timing During Operation (Pn6B).

### - Servo Ready Output (READY)

Pin 35: Servo Ready Output (READY)

#### Functions

- This output signal indicates that the Servo Drive is turned ON and ready to start operation.

This output will turn ON if no errors occur after the main circuit power supply is turned ON.

### - Alarm Output (/ALM)

Pin 37: Alarm Output (/ALM)

#### Functions

- The alarm output is turned OFF when the Servo Drive detects an error.
- This output is OFF at power-ON, but turns ON when the Servo Drive's initial processing has been completed.

### - Positioning Completed Output (INP) or Servomotor Rotation Speed Detection Output (TGON)

Pin 39: Positioning Completed Output (INP) or Servomotor Rotation Speed Detection Output (TGON)

#### Functions

- Position Control Mode
  The INP signal turns ON when the number of accumulated pulses in the deviation counter is less than the Positioning Completion Range (Pn60). The output condition is set in the Positioning Completion Condition Setting (Pn63).
- Internal Speed Mode

The TGON signal turns ON when the speed of the Servomotor exceeds the setting of the Rotation Speed for Motor Rotation Detection (Pn62).

## Encoder Connector Specifications (CN2)

| Pin No. | Symbol | Name | Function/Interface |
|---|---|---|---|
| 1 | E5V | Encoder power supply +5 V | Power supply output for the encoder 5.2 V, 180 mA |
| 2 | E0V | Encoder power supply GND | |
| 3 | BAT+ | Battery + | Backup power supply output for the absolute encoder.<br>3.6 V, 100 μA for operation during power interruption, 265 μA for power interruption timer, and 3.6 μA when power is supplied to Servo Drive |
| 4 | BAT− | Battery − | |
| 5 | PS+ | Encoder +phase S input | Line-driver input (corresponding with the EIA RS-485 communications method) |
| 6 | PS− | Encoder −phaseS input | |
| Shell | FG | Shield ground | Cable shield ground |

### Connectors for CN2 (6 Pins)

| Name | Model | Manufacturer |
|---|---|---|
| Servo Drive Connector | 53460-0629 | Molex Japan Co. |
| Cable Connector | 55100-0670 | |

# 10-3-2 Servomotor Specifications

## ■ 3,000-r/min Servomotor

| Item | | Unit (Model (R88M-)) | 200 VAC G75030H |
|---|---|---|---|
| Rated output t *1 | | W | 750 |
| Rated torque *1 | | N·m | 2.4 |
| Rated rotation speed | | r/min | 3000 |
| Max. momentary rotation speed | | r/min | 4500 |
| Max. momentary torque *1 | | N·m | 7.05 |
| Rated current *1 | | A (rms) | 4 |
| Max. momentary current *1 | | A (rms) | 12.1 |
| Rotor inertia | | $kg\cdot m^2$ ($GD^2/4$) | $8.7 \times 10^{-5}$ |
| Applicable load inertia | | --- | 20 times the rotor inertia max. *2 |
| Torque constant *1 | | N·m/A | 0.64 |
| Power rate *1 | | kW/s | 66 |
| Mechanical time constant | | ms | 0.45 |
| Electrical time constant | | ms | 4.6 |
| Allowable radial load *3 | | N | 392 |
| Allowable thrust load *3 | | N | 147 |
| Weight | Without brake | kg | Approx. 2.3 |
| | With brake | kg | Approx. 3.1 |
| Radiation shield dimensions (material) | | | $170 \times 160 \times$ t12 (Al) |
| Applicable Servo Drives (R88D-) | | | GP08H |
| Brake specifications | Brake inertia | $kg\cdot m^2$ ($GD^2/4$) | $7.5 \times 10^{-6}$ |
| | Excitation voltage *4 | V | 24VDC ±5% |
| | Power consumption (at 20°C) | W | 10 |
| | Current consumption (at 20°C) | A | 0.42 |
| | Static friction torque | N·m | 2.45 min. |
| | Attraction time *5 | ms | 70 max. |
| | Release time *5 | ms | 20 max. |
| | Backlash | --- | 1º (reference value) |
| | Allowable work per braking | J | 196 |
| | Allowable total work | J | $147 \times 10^3$ |
| | Allowable angular acceleration | $rad/s^2$ | 30,000 max. (Speed of 2,800 r/min or more must not be changed in less than 10ms) |
| | Brake life | --- | 10,000,000 operations |
| | Rating | --- | Continuous |
| | Insulation grade | --- | Type B |

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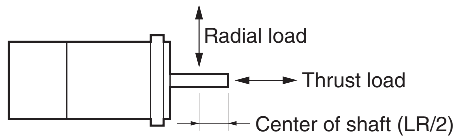
Appendix-2

*1. These are the values when the Servomotor is combined with a Servo Drive at room temperature (20°C, 65%). The maximum momentary torque indicates the standard value.

*2. Applicable Load Inertia:
- The operable load inertia ratio (load inertia/rotor inertia) depends on the mechanical configuration and its rigidity. For a machine with high rigidity, operation is possible even with high load inertia. Select an appropriate motor and confirm that operation is possible.
- If the dynamic brake is activated frequently with high load inertia, the dynamic brake resistor may burn. Do not repeatedly turn the Servomotor ON and OFF while the dynamic brake is enabled.

*3. The allowable radial and thrust loads are the values determined for a service life of 20,000 hours at normal operating temperatures. The allowable radial loads are applied as shown in the following diagram.




*4. This is an OFF brake. (It is reset when excitation voltage is applied).

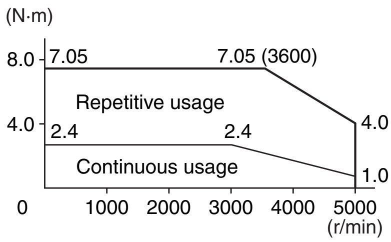
*5. The operation time is the value (reference value) measured with a surge suppressor (CR50500 manufactured by Okaya Electric Industries Co., Ltd.).

### Torque-Rotational Speed Characteristics for 3,000-r/min Servomotor

- 3,000-r/min Servomotor with 200-VAC Power Input

The following graph show the characteristics with a 3-m standard cable and a 200-VAC input.

♦ R88M-G75030H (750 W)




## ■ Temperature Characteristics of the Servomotor and Mechanical System

- SMARTSTEP 2 750 W Model AC Servomotors use rare earth magnets (neodymium-iron magnets). The temperature coefficient for these magnets is approximately –0.13%/°C. As the temperature drops, the Servomotor's maximum momentary torque increases, and as the temperature rises, the Servomotor's maximum momentary torque decreases.
- The maximum momentary torque rises by 4% at a normal temperature of 20°C compared to a temperature of −10°C. Conversely, the maximum momentary torque decreases about 8% when the magnet warms up to 80°C from the normal temperature.
- Generally, when the temperature drops in a mechanical system, the friction torque and the load torque increase. For that reason, overloading may occur at low temperatures.
- An increase in load friction torque seemingly increases load inertia. Therefore, even if the Servo Drive gains are adjusted at a normal temperature, the Servomotor may not operate properly at low temperatures. Check to see whether there is optimal operation even at low temperatures.

# 10-3-3 Cable and Connector Specifications

## European Cables

### ■ European Encoder Cable Specifications (Flexible and Shielded Cables)

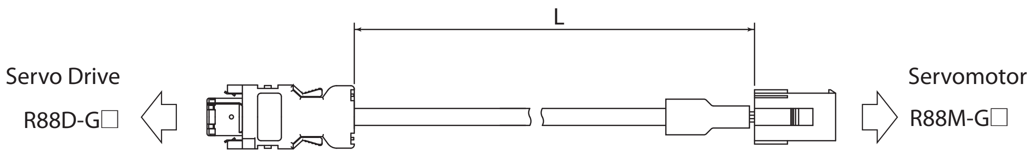
**R88A-CRGB□CR-E**

**Cable Models**

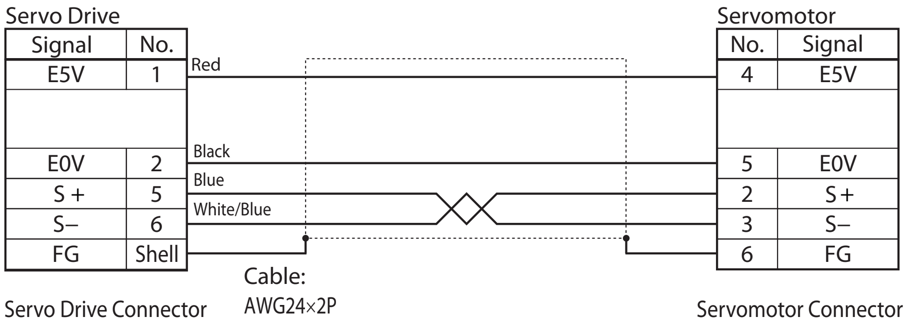
For incremental encoders: 3,000-r/min Servomotors of 750 W.

| Model | Length (L) |
|---|---|
| R88A-GRGB001-5CR-E | 1.5 m |
| R88A-CRGB003CR-E | 3 m |
| R88A-CRGB005CR-E | 5 m |
| R88A-CRGB010CR-E | 10 m |
| R88A-CRGB015CR-E | 15 m |
| R88A-CRGB020CR-E | 20 m |

**Connection Configuration and Dimensions**




**Wiring**




Servo Drive Connector
Connector:
Crimp-type I/O Connector (Molex Japan)
Connector pins:
50639-8028 (Molex Japan)

Servomotor Connector
Connector:
172160-1(Tyco Electronics AMP KK)
Connector pins:
170365-1(Tyco Electronics AMP KK)

## ■ European Power Cable for Servomotors without Brakes (Flexible and Shielded Cables)

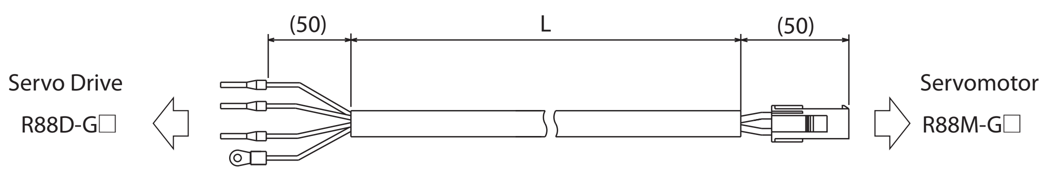
### R88A-CAGA□SR-E

**Cable Models**

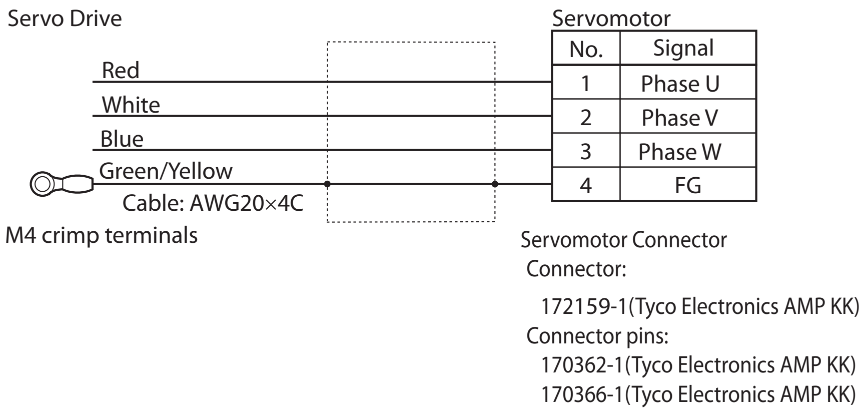
For 3,000-r/min Servomotors of 750 W.

| Model | Length (L) |
|---|---|
| R88A-CAGA001-5SR-E | 1.5 m |
| R88A-CAGA003SR-E | 3 m |
| R88A-CAGA005SR-E | 5 m |
| R88A-CAGA010SR-E | 10 m |
| R88A-CAGA015SR-E | 15 m |
| R88A-CAGA020SR-E | 20 m |

**Connection Configuration and Dimensions**




**Wiring**



## ■ European Brake Cable (Flexible Cables)

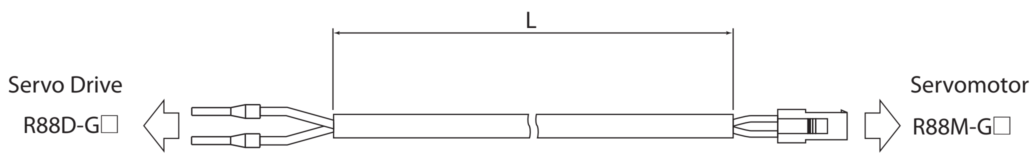
### R88A-CAGA□BR-E

**Cable Models**

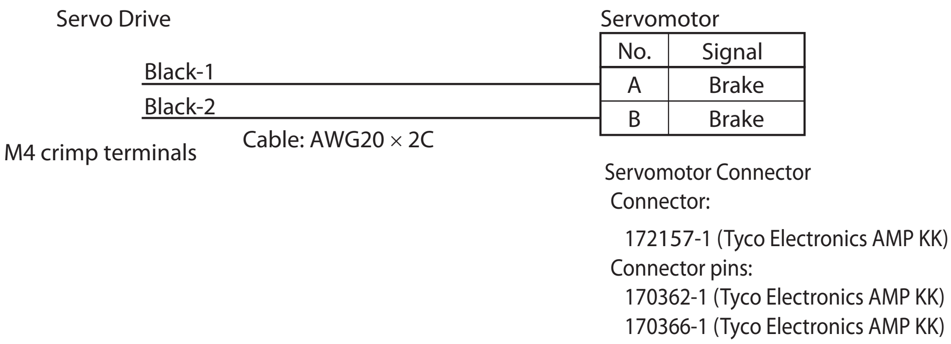
For 3,000-r/min Servomotors of 750 W.

| Model | Length (L) |
|---|---|
| R88-CAGA001-5BR-E | 1.5 m |
| R88A-CAGA003BR-E | 3 m |
| R88A-CAGA005BR-E | 5 m |
| R88A-CAGA010BR-E | 10 m |
| R88A-CAGA015BR-E | 15 m |
| R88A-CAGA020BR-E | 20 m |

**Connection Configuration and Dimensions**




**Wiring**



## Global Cables

### ■ Encoder Cables (Non-Flexible Cables)

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CRGB003C | 3 m | 6.5 dia. | Approx. 0.2 kg |
| R88A-CRGB005C | 5 m | | Approx. 0.3 kg |
| R88A-CRGB010C | 10 m | | Approx. 0.6 kg |
| R88A-CRGB015C | 15 m | | Approx. 0.9 kg |
| R88A-CRGB020C | 20 m | | Approx. 1.2 kg |
| R88A-CRGB030C | 30 m | 6.8 dia. | Approx. 2.4 kg |
| R88A-CRGB040C | 40 m | | Approx. 3.2 kg |
| R88A-CRGB050C | 50 m | | Approx. 4.0 kg |

### ■ Encoder Cables (Flexible Cables)

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CRGB003CR | 3 m | 7.5 dia. | Approx. 0.2 kg |
| R88A-CRGB005CR | 5 m | | Approx. 0.4 kg |
| R88A-CRGB010CR | 10 m | | Approx. 0.8 kg |
| R88A-CRGB015CR | 15 m | | Approx. 1.1 kg |
| R88A-CRGB020CR | 20 m | | Approx. 1.5 kg |
| R88A-CRGB030CR | 30 m | 8.2 dia. | Approx. 2.8 kg |
| R88A-CRGB040CR | 40 m | | Approx. 3.7 kg |
| R88A-CRGB050CR | 50 m | | Approx. 4.6 kg |

### ■ Power Cables for Servomotors (Non-Flexible Cables)

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CAGA003S | 3 m | 6.2 dia. | Approx. 0.2 kg |
| R88A-CAGA005S | 5 m | | Approx. 0.3 kg |
| R88A-CAGA010S | 10 m | | Approx. 0.6 kg |
| R88A-CAGA015S | 15 m | | Approx. 0.9 kg |
| R88A-CAGA020S | 20 m | | Approx. 1.2 kg |
| R88A-CAGA030S | 30 m | | Approx. 1.8 kg |
| R88A-CAGA040S | 40 m | | Approx. 2.4 kg |
| R88A-CAGA050S | 50 m | | Approx. 3.0 kg |

## ■ Power Cables for Servomotors (Flexible Cables)

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CAGA003SR | 3 m | 6.9 dia. | Approx. 0.2 kg |
| R88A-CAGA005SR | 5 m | | Approx. 0.3 kg |
| R88A-CAGA010SR | 10 m | | Approx. 0.7 kg |
| R88A-CAGA015SR | 15 m | | Approx. 1.0 kg |
| R88A-CAGA020SR | 20 m | | Approx. 1.3 kg |
| R88A-CAGA030SR | 30 m | | Approx. 1.9 kg |
| R88A-CAGA040SR | 40 m | | Approx. 2.6 kg |
| R88A-CAGA050SR | 50 m | | Approx. 3.2 kg |

## ■ Brake Cables (Non-Flexible Cables)

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CAGA003B | 3 m | 5.4 dia. | Approx. 0.1 kg |
| R88A-CAGA005B | 5 m | | Approx. 0.2 kg |
| R88A-CAGA010B | 10 m | | Approx. 0.4 kg |
| R88A-CAGA015B | 15 m | | Approx. 0.6 kg |
| R88A-CAGA020B | 20 m | | Approx. 0.8 kg |
| R88A-CAGA030B | 30 m | | Approx. 1.2 kg |
| R88A-CAGA040B | 40 m | | Approx. 1.6 kg |
| R88A-CAGA050B | 50 m | | Approx. 2.1 kg |

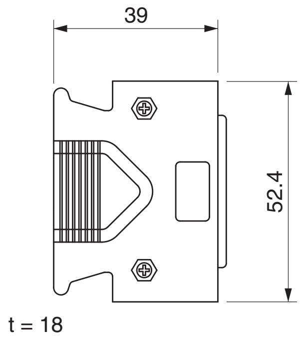
## ■ Brake Cables (Flexible Cables)

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CAGA003BR | 3 m | 6.1 dia. | Approx. 0.1 kg |
| R88A-CAGA005BR | 5 m | | Approx. 0.2 kg |
| R88A-CAGA010BR | 10 m | | Approx. 0.4 kg |
| R88A-CAGA015BR | 15 m | | Approx. 0.7 kg |
| R88A-CAGA020BR | 20 m | | Approx. 0.9 kg |
| R88A-CAGA030BR | 30 m | | Approx. 1.3 kg |
| R88A-CAGA040BR | 40 m | | Approx. 1.8 kg |
| R88A-CAGA050BR | 50 m | | Approx. 2.2 kg |

## ■ Control I/O Connector (R88A-CNU11C)

This connector connects to the control I/O connector (CN1) on the Servo Drive.
Use this connector when preparing a control cable yourself.

### Dimensions




Connector plug:
10150-3000PE (Sumitomo 3M)
Connector case:
10350-52A0-008 (Sumitomo 3M)

## ■ Motion Control Unit Cables (R88A-CPG□M□)

Use this cable to connect to the Motion Control Units in OMRON SYSMAC Programmable Controllers. Cables are available for either one axis or two axes.
The following Motion Control Units can be used.
CS1W-MC221/421(-V1)

### Cable Models

- Cables for One Axis

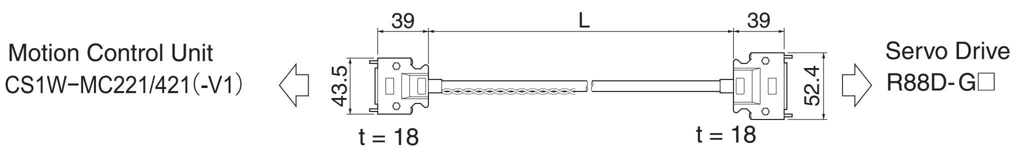
| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CPG001M1 | 1 m | 8.3 dia. | Approx. 0.2 kg |
| R88A-CPG002M1 | 2 m | | Approx. 0.3 kg |
| R88A-CPG003M1 | 3 m | | Approx. 0.4 kg |
| R88A-CPG005M1 | 5 m | | Approx. 0.6 kg |

- Cables for Two Axes

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CPG001M2 | 1 m | 8.3 dia. | Approx. 0.3 kg |
| R88A-CPG002M2 | 2 m | | Approx. 0.5 kg |
| R88A-CPG003M2 | 3 m | | Approx. 0.7 kg |
| R88A-CPG005M2 | 5 m | | Approx. 1.0 kg |

### Connection Configuration and Dimensions

- Cables for One Axis



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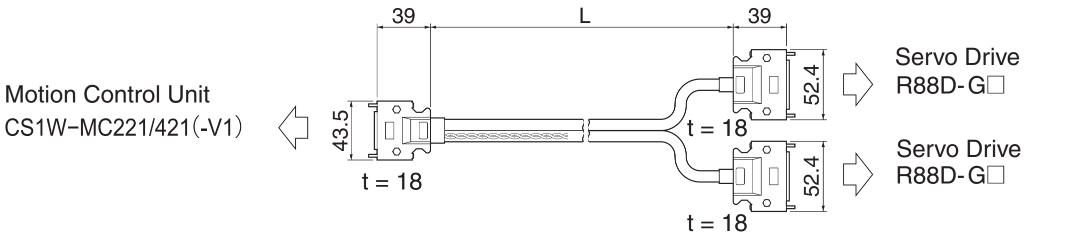
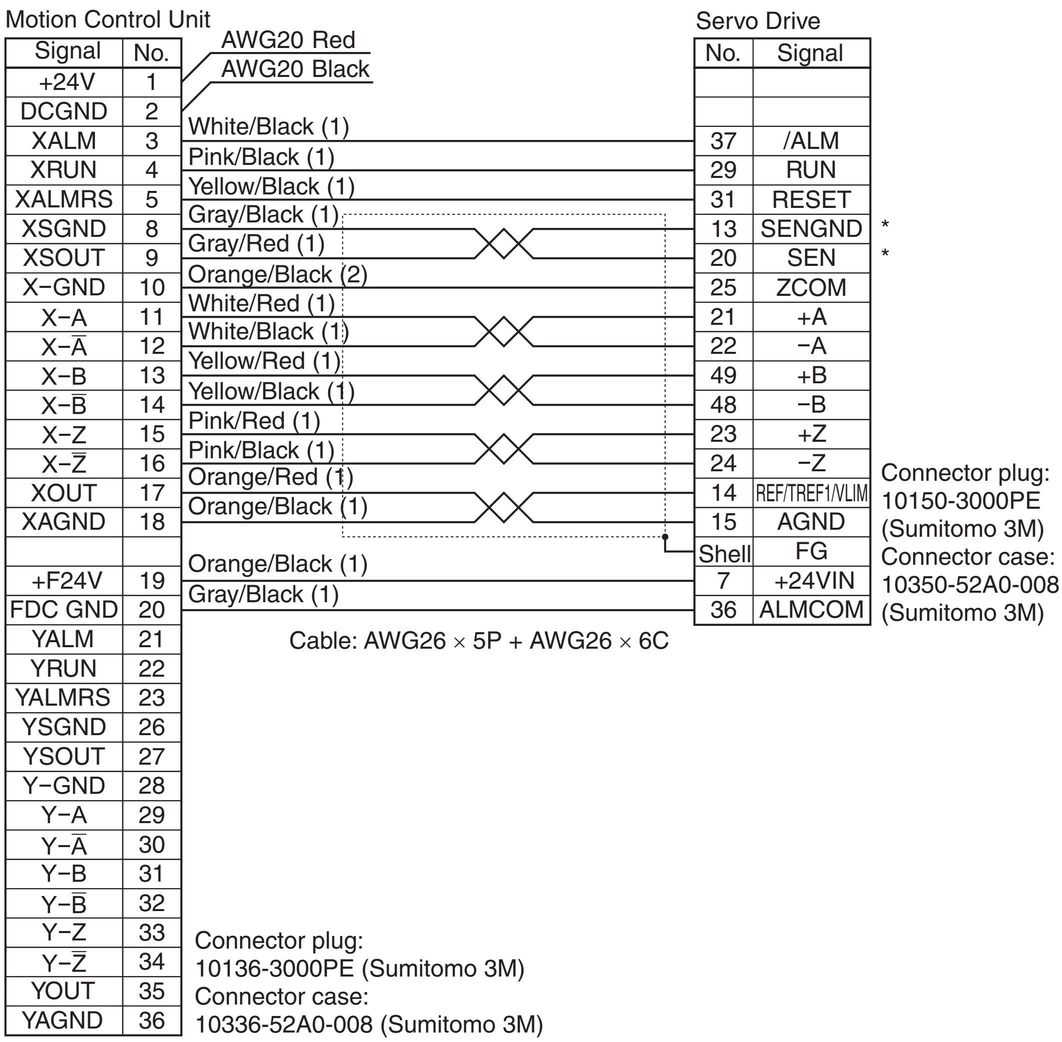
Appendix-2

• Cables for Two Axes



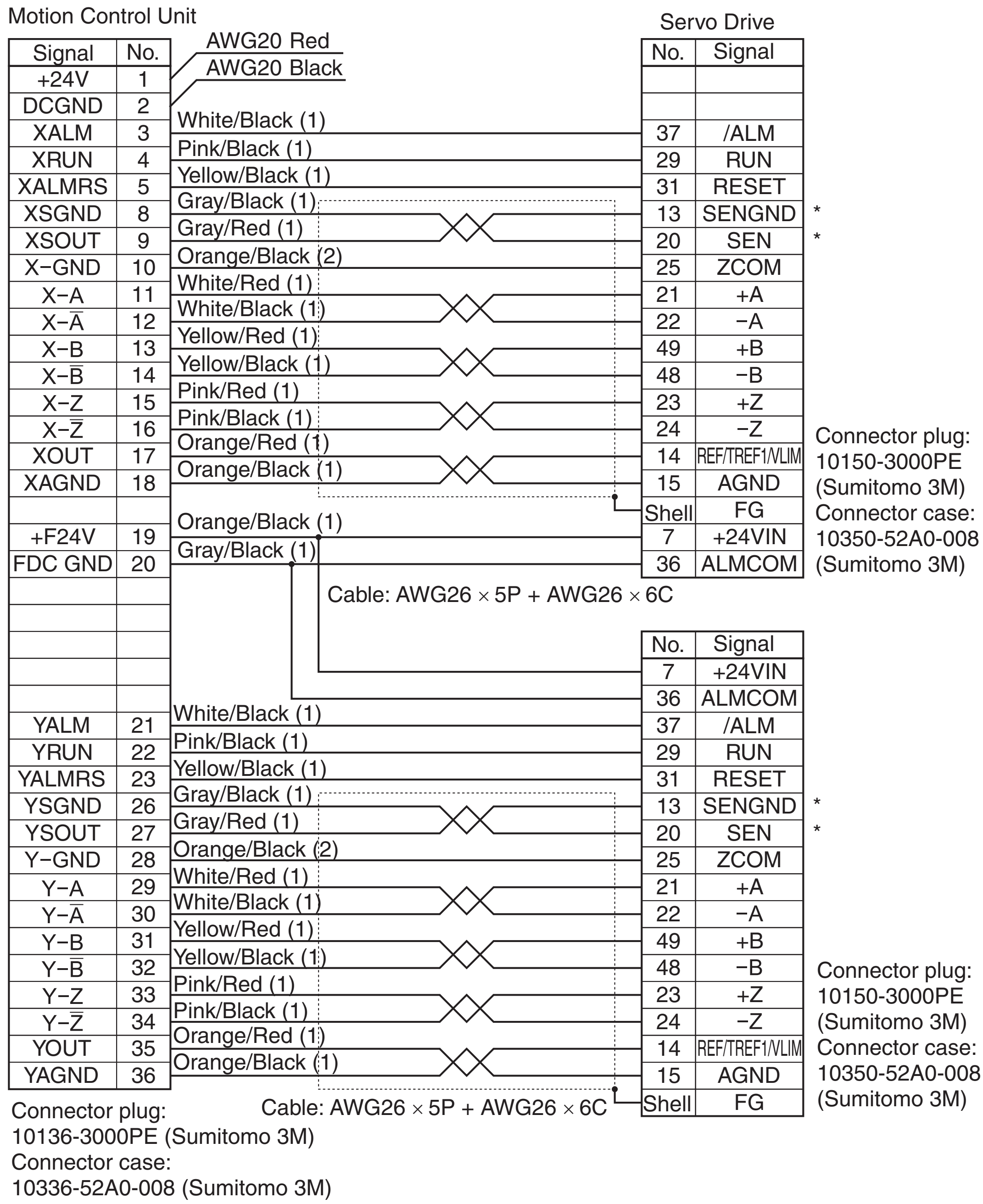

## Wiring

• Cables for One Axis




• The Motion Control Unit signals are the DRVX and DRVY connector signals. For the DRVZ and DRVU connectors, X and Y are indicated as Z and U, respectively.
• Pins marked with asterisks are for absolute encoders.
• Connect 24 VDC to the two lines (red and black) extending from the Motion Control Unit connector (red: +24 V, black: −).

- Cables for Two Axes




- The Motion Control Unit signals are the DRVX and DRVY connector signals. For the DRVZ and DRVU connectors, X and Y are indicated as Z and U, respectively.
- Pins marked with asterisks are for absolute encoders.

Connect 24 VDC to the two lines (red and black) extending from the Motion Control Unit connector (red: +24 V, black: −).

## ■ General-purpose Control Cables (R88A-CPG□S)

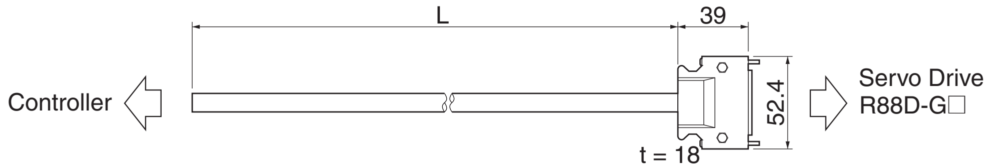
A General-purpose Control Cable connects to the Servo Drive's control I/O connector (CN1). The connector for the controller is not provided. When connecting to a Position Control Unit which doesn't have a specified cable or connecting to another company's controller, prepare wiring suited for the controller to be connected.

- When connecting to a controller which doesn't have a specified cable, either use a General-purpose Control Cable or a Connector Terminal Block Cable and a Connector Terminal Block.

### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| R88A-CPG001S | 1 m | 12.8 dia. | Approx. 0.3 kg |
| R88A-CPG002S | 2 m | | Approx. 0.6 kg |

### Connection Configuration and Dimensions



### Wiring

| No. | Wire/mark color | Signal | No. | Wire/mark color | Signal |
|---|---|---|---|---|---|
| 1 | Orange/Red (1) | +24VCW | 27 | Pink/Black (3) | GSEL/TLSEL |
| 2 | Orange/Black (1) | +24VCCW | 28 | White/Black (3) | GESEL/VSEL3 |
| 3 | Gray/Red (1) | +CW/+PULS/+FA | 29 | Yellow/Red (3) | RUN |
| 4 | Gray/Black (1) | −CW/−PULS/−FA | 30 | Pink/Red (3) | ECRST/VSEL2 |
| 5 | White/Red (1) | +CCW/+SIGN/+FB | 31 | Yellow/Black (3) | RESET |
| 6 | White/Black (1) | −CCW/−SIGN/−FB | 32 | Gray/Black (4) | TVSEL |
| 7 | Yellow/Red (1) | +24VIN | 33 | Orange/Red (4) | IPG/VSEL1 |
| 8 | Pink/Red (1) | NOT | 34 | White/Red (4) | READYCOM |
| 9 | Pink/Black (1) | POT | 35 | White/Black (4) | READY |
| 10 | Orange/Red (2) | BKIRCOM | 36 | Yellow/Red (4) | ALMCOM |
| 11 | Orange/Black (2) | BKIR | 37 | Yellow/Black (4) | /ALM |
| 12 | Yellow/Black (1) | OUTM1 | 38 | Pink/Red (4) | INPCOM/TGONCOM |
| 13 | Gray/Black (2) | GND | 39 | Pink/Black (4) | INP/TGON |
| 14 | White/Red (2) | REF/TREF1/VLIM | 40 | Gray/Red (4) | OUTM2 |
| 15 | White/Black (2) | AGND | 41 | Orange/Black (4) | COM |
| 16 | Yellow/Red (2) | PCL/TREF2 | 42 | Gray/Red (5) | BAT |
| 17 | Yellow/Black (2), Pink/Black (2) | AGND | 43 | Gray/Black (5) | BATGND |
| 18 | Pink/Red (2) | NCL | 44 | White/Red (5) | +CWLD |
| 19 | Orange/Red (5) | Z | 45 | White/Black (5) | −CWLD |
| 20 | Gray/Red (2) | SEN | 46 | Yellow/Red (5) | +CCWLD |
| 21 | Orange/Red (3) | +A | 47 | Yellow/Black (5) | −CCWLD |
| 22 | Orange/Black (3) | −A | 48 | Pink/Black (5) | −B |
| 23 | Gray/Red (3) | +Z | 49 | Pink/Red (5) | +B |
| 24 | Gray/Black (3) | −Z | 50 | --- | --- |
| 25 | Orange/Black (5) | ZCOM | Shell | --- | FG |
| 26 | White /Red (3) | VZERO/DFSEL/ PNSEL | | | |

Connector plug: 10150-3000PE (Sumitomo 3M)
Connector case: 10350-52A0-008 (Sumitomo 3M)
Cable: AWG24 × 25P UL20276

- Wires with the same wire color and the same number of marks form a twisted pair.
  Example: An orange/red (1) wire and orange/black (1) wire form are a twisted pair.

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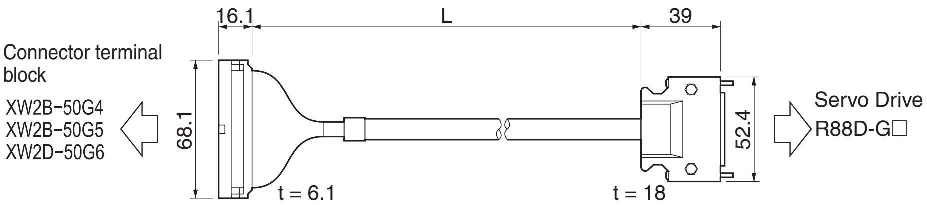
## ■ Connector Terminal Block Cables (XW2Z-□J-B24)

This Cable is for the connector terminal block of the Servo Drive's control I/O connector (CN1). All of the pins in the control I/O connector (CN1) can be converted to terminals on the terminal block.

### Cable Models

| Model | Length (L) | Outer diameter of sheath | Weight |
|---|---|---|---|
| XW2Z-100J-B24 | 1 m | 11.2 dia. | Approx. 0.2 kg |
| XW2Z-200J-B24 | 2 m | | Approx. 0.4 kg |

### Connection Configuration and Dimensions




| Terminal block No. | Connector No. | Servo Drive No. | Wire/mark color | Signal |
|---|---|---|---|---|
| 1 | 1 | 1 | Blue/Red (1) | +24VCW |
| 2 | 2 | 2 | Blue/Black (1) | +24VCCW |
| 3 | 3 | 3 | Pink/Red (1) | +CW/+PULS/+FA |
| 4 | 4 | 4 | Pink/Black (1) | CW/ PULS/–FA |
| 5 | 5 | 5 | Green/Red (1) | +CCW/+SIGN/+FB |
| 6 | 6 | 6 | Green/Black (1) | CCW/ SIGN/–FB |
| 7 | 7 | 7 | Orange/Red (1) | +24VIN |
| 8 | 8 | 8 | Gray/Red (1) | NOT |
| 9 | 9 | 9 | Gray/Black (1) | POT |
| 10 | 10 | 10 | Blue/Red (2) | BKIRCOM |
| 11 | 11 | 11 | Blue/Black (2) | BKIR |
| 13 | 13 | 13 | Pink/Red (2) | SENGND |
| 20 | 20 | 20 | Pink/Black (2) | SEN |
| 14 | 14 | 14 | Green/Red (2) | REF/TREF1/VLIM |
| 15 | 15 | 15 | Green/Black (2) | AGND |
| 16 | 16 | 16 | Orange/Red (2) | PCL/TREF2 |
| 17 | 17 | 17 | Orange/Black (2) | AGND |
| 18 | 18 | 18 | Gray/Red (2) | NCL |
| 12 | 12 | 12 | Gray/Black (2) | OUTM1 |
| 19 | 19 | 19 | Blue/Red (3) | Z |
| 25 | 25 | 25 | Blue/Black (3) | ZCOM |
| 21 | 21 | 21 | Pink/Red (3) | +A |
| 22 | 22 | 22 | Pink/Black (3) | A |
| 23 | 23 | 23 | Green/Red (3) | +Z |
| 24 | 24 | 24 | Green/Black (3) | Z |
| 26 | 26 | 26 | Orange/Red (3) | VZERO/DFSEL/PNSEL |
| 27 | 27 | 27 | Orange/Black (3) | GSEL/TLSEL |
| 28 | 28 | 28 | Gray/Red (3) | GESEL/VSEL3 |
| 29 | 29 | 29 | Gray/Black (3) | RUN |
| 30 | 30 | 30 | Blue/Red (4) | ECRST/VSEL2 |
| 31 | 31 | 31 | Blue/Black (4) | RESET |
| 32 | 32 | 32 | Pink/Red (4) | TVSEL |
| 33 | 33 | 33 | Pink/Black (4) | IPG/VSEL1 |
| 34 | 34 | 34 | Green/Red (4) | READYCOM |
| 35 | 35 | 35 | Green/Black (4) | READY |
| 36 | 36 | 36 | Orange/Red (4) | ALMCOM |
| 37 | 37 | 37 | Orange/Black (4) | /ALM |
| 38 | 38 | 38 | Gray/Red (4) | INPCOM/TGONCOM |
| 39 | 39 | 39 | Gray/Black (4) | INP/TGON |
| 40 | 40 | 40 | Blue/Red (5) | OUTM2 |
| 41 | 41 | 41 | Blue/Black (5) | COM |
| 42 | 42 | 42 | Pink/Red (5) | BAT |
| 43 | 43 | 43 | Pink/Black (5) | BATGND |
| 44 | 44 | 44 | Green/Red (5) | +CWLD |
| 45 | 45 | 45 | Green/Black (5) | CWLD |
| 46 | 46 | 46 | Orange/Red (5) | +CCWLD |
| 47 | 47 | 47 | Orange/Black (5) | CCWLD |
| 48 | 48 | 48 | Gray/Red (5) | B |
| 49 | 49 | 49 | Gray/Black (5) | +B |
| 50 | 50 | 50 | Orange/Black (1) | – |
| | | Shell | | FG |

Wires with the same wire color and the same number of marks form a twisted pair.

Example:
A yellow/black (1) wire and pink/black (1) wire form a twisted pair.

Servo Drive Connector
Connector plug:
10150-3000PE (Sumitomo 3M)
Connector case:
10350-52A0-008 (Sumitomo 3M)

Terminal Block Connector
Connector socket: XG4M-5030 (OMRON)
Strain relief: XG4T-5004 (OMRON)

Cable
AWG28 × 25P UL2464

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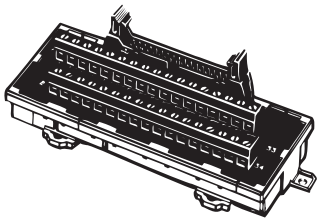
Appendix-2

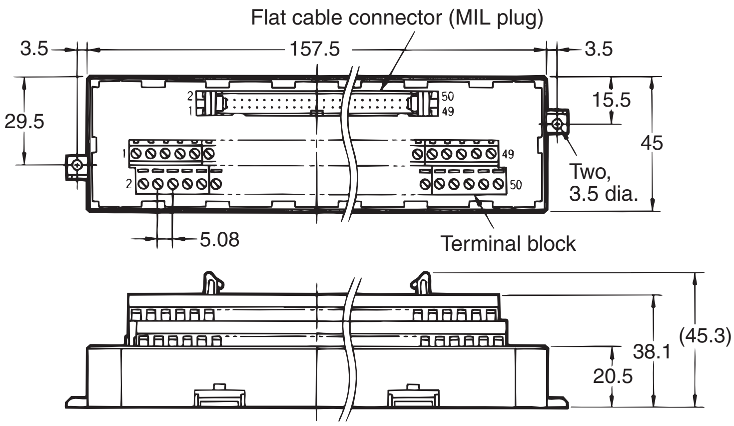
## ■ Connector-Terminal Block Conversion Unit

The Connector-Terminal Block Conversion Unit can be used along with a Connector Terminal Block Cable (XW2Z-□J-B24) to convert the Servo Drive's control I/O connector (CN1) to a terminal block.

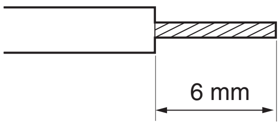
### XW2B-50G4 (M3 screw terminal block)



• Dimensions




| Precautions for Correct Use | |
|---|---|
| | • Use 0.30 to 1.25 mm$^2$ wire (AWG22 to AWG16).<br>• The wire inlet is 1.8 mm (height) × 2.5 mm (width).<br>• Strip the insulation from the end of the wire for 6 mm as shown below. |

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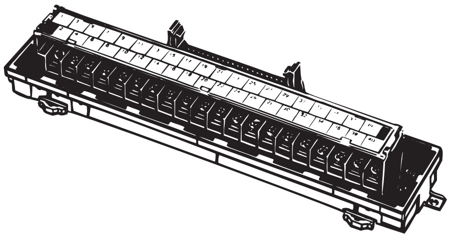
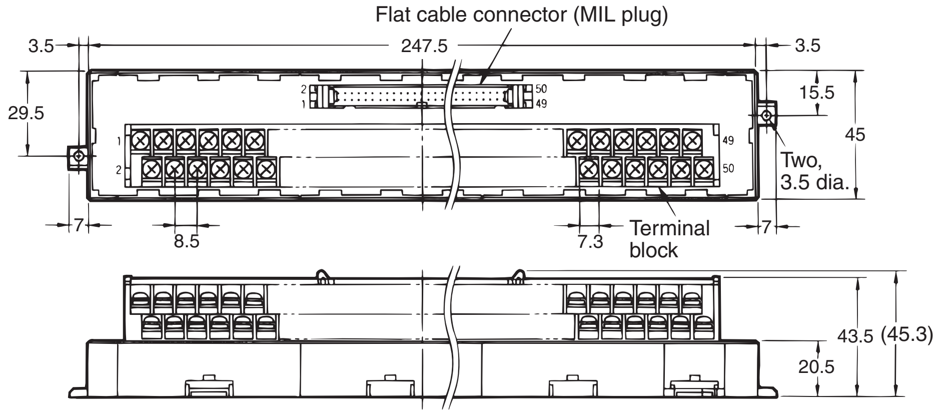
Appendix-2

### XW2B-50G5 (M3.5 Screw Terminal Block)



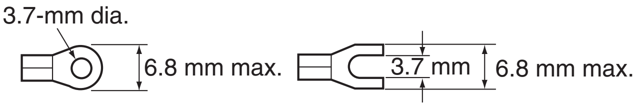
• Dimensions




**Precautions for Correct Use**

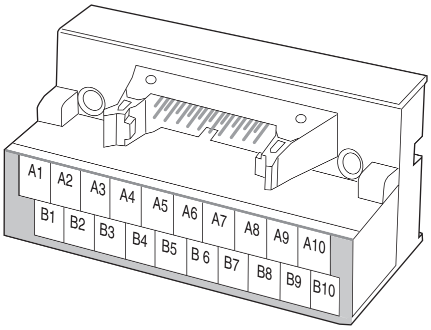
- When using crimp terminals, use crimp terminals with the following dimensions.
- When connecting wires and crimp terminals to a terminal block, tighten them with a tightening torque of 0.59 N·m.

Round Crimp Terminals　　Fork Terminals

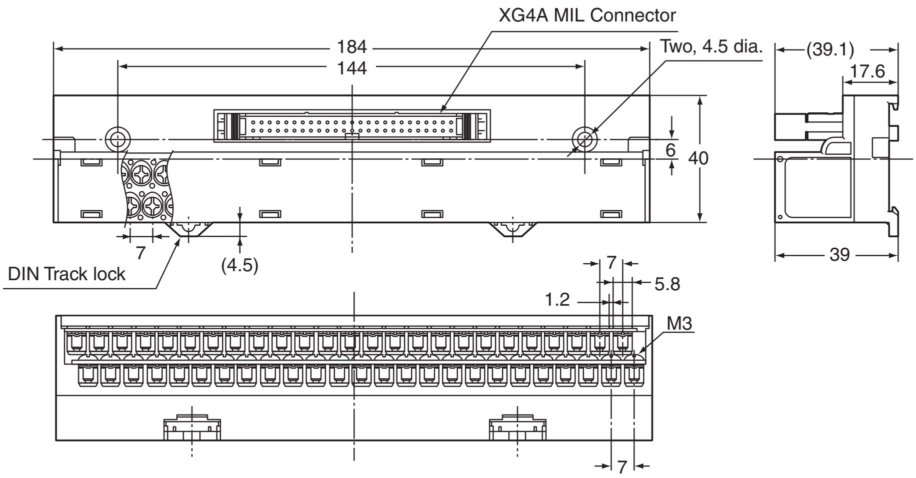



| Applicable Crimp Terminals | | Applicable Wires |
|---|---|---|
| Round Crimp Terminals | 1.25-3 | AWG22-16 (0.3 to 1.25 mm$^2$) |
| | 2-3.5 | AWG16-14 (1.25 to 2.0 mm$^2$) |
| Fork Terminals | 1.25Y-3 | AWG22-16 (0.3 to 1.25 mm$^2$) |
| | 2-3.5 | AWG16-14 (1.25 to 2.0 mm$^2$) |

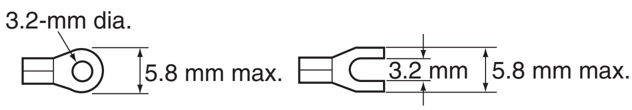
### XW2D-50G6 (M3 Screw Terminal Block)




- Dimensions




| | |
|---|---|
| **Precautions for Correct Use** | • When using crimp terminals, use crimp terminals with the following dimensions.<br>• When connecting wires and crimp terminals to a terminal block, tighten them with a tightening torque of 0.7 N·m. |




| Applicable Crimp Terminals | | Applicable Wires |
|---|---|---|
| Round Crimp Terminals | 1.25-3 | AWG22-16 (0.3 to 1.25 mm$^2$) |
| Fork Terminals | 1.25Y-3 | AWG22-16 (0.3 to 1.25 mm$^2$) |

# 10-4 System Design

## 10-4-1 Servo Drive Specifications

### ■ Oil Seal

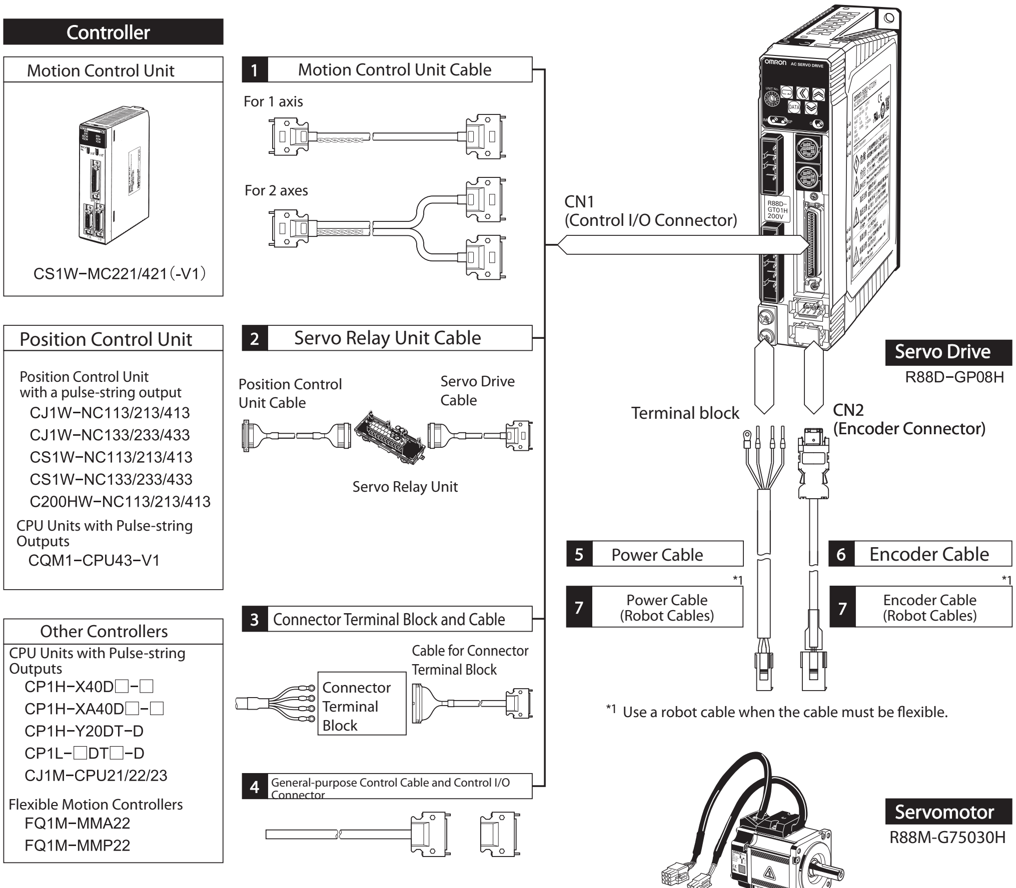
| Motor model | Shaft diameter (mm) | Outer diameter (mm) | Width (mm) |
|---|---|---|---|
| R88M-G75030□ | 19.8 | 30 | 4 |

## 10-4-2 Wiring

### Connecting Cables

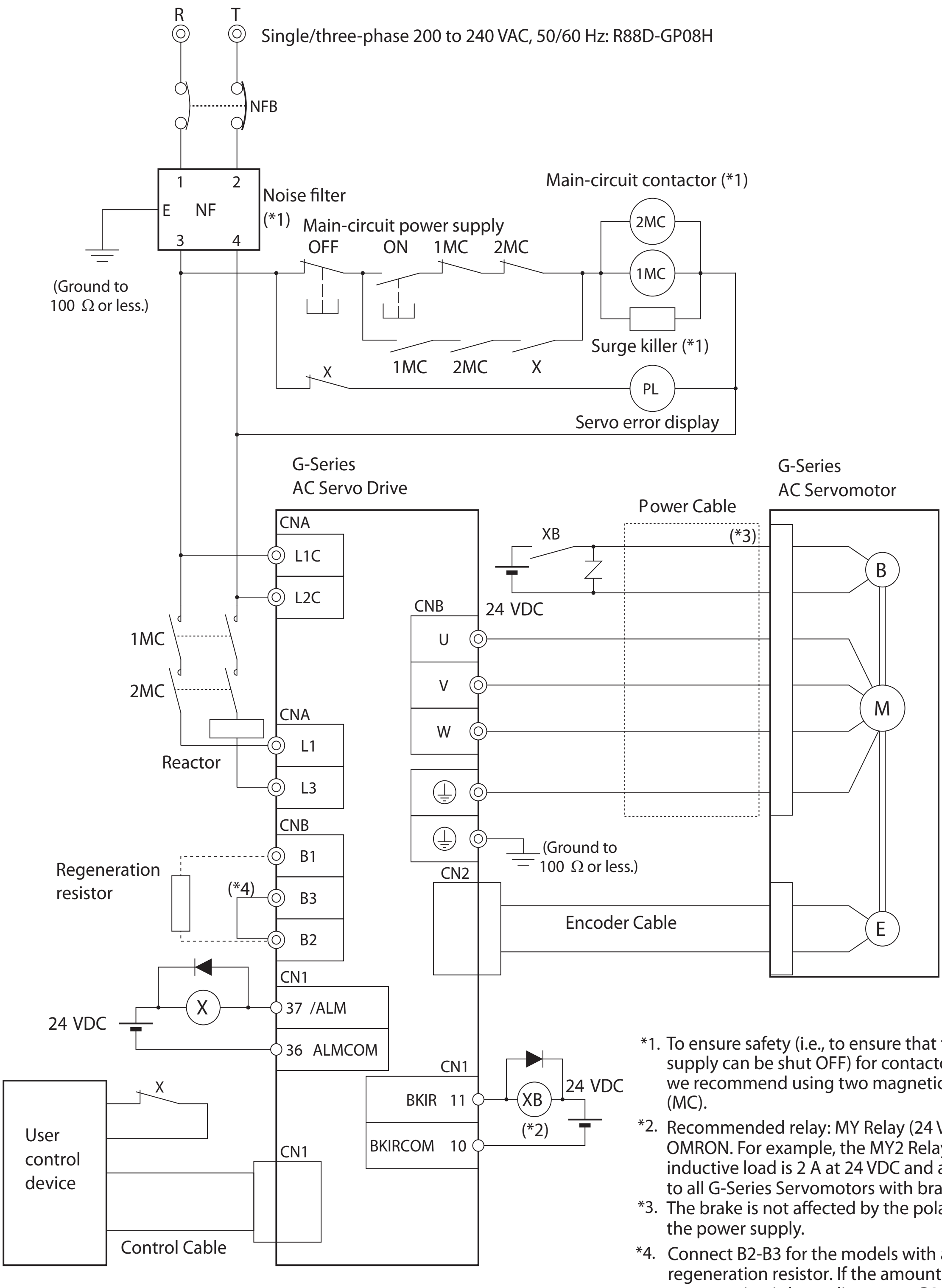
■ This section shows the types of connecting cables used in an SMARTSTEP 2 750 W Model servo system. A wide selection of cables are available when configuring a servo system with an OMRON SYSMAC Motion Control Unit or Position Unit, which makes wiring easy.

### ■ System Configuration



## Peripheral Device Connection Examples

### ■ R88D-GP08H




*1. To ensure safety (i.e., to ensure that the power supply can be shut OFF) for contactor welding, we recommend using two magnetic contactors (MC).

*2. Recommended relay: MY Relay (24 V), by OMRON. For example, the MY2 Relay's rated inductive load is 2 A at 24 VDC and applicable to all G-Series Servomotors with brakes.

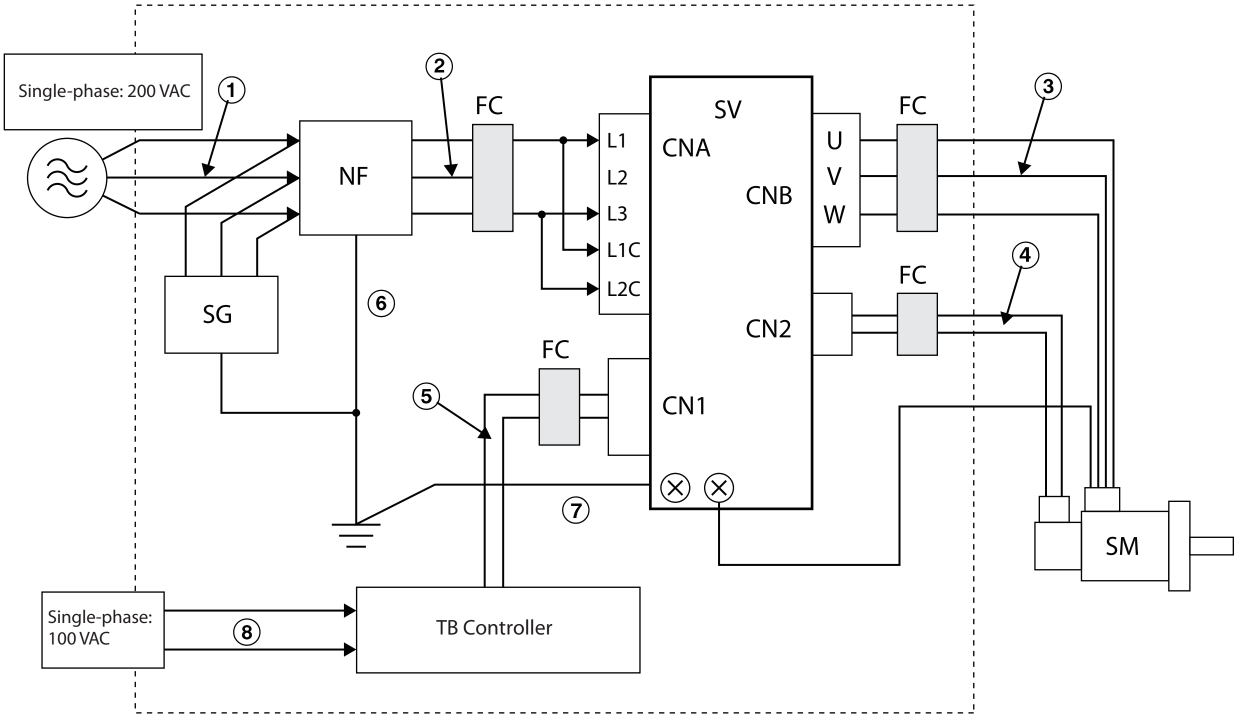
*3. The brake is not affected by the polarity of the power supply.

*4. Connect B2-B3 for the models with a built-in regeneration resistor. If the amount of regeneration is large,disconnect B2-B3 and connect an External Regeneration Resistor to B1-B2.

# 10-4-3 Wiring Conforming to EMC Directives

## Wiring Method

### R88D-GP08H




*1. The main circuit power supply input terminals are L1 and L3.

- Ground the motor's frame to the machine ground when the motor is on a movable shaft.
- 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.
- No-fuse breakers, surge absorbers, and noise filters should be positioned near the input terminal block (ground plate), and I/O lines should be separated and wired at the shortest distance.

## ■ Noise Filter for Power Supply Input

| Servo Drive model | Noise Filter | | | | |
|---|---|---|---|---|---|
| | Model | Rated current | Phases | Maximum leakage current (60 Hz) | Manufacturer |
| R88D-GP08H | 3SUP-HQ10-ER-6 | 10 A | Three | 3.5 mA (at 500 VAC) | Okaya Electric Industries Co., Ltd. |

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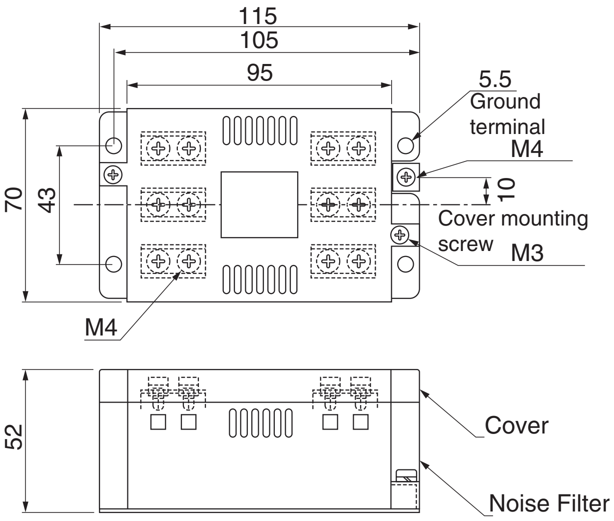
Appendix-2

## ■ No-fuse Breakers (NFB)

| Servo Drive model | Inrush current (Ao-p) | |
|---|---|---|
| | Main circuit power supply | Control circuit power supply |
| R88D-GP08H | 60 | 28 |

## ■ Noise Filter for the Power Supply Input

| Servo Drive model | Noise Filter | | | |
|---|---|---|---|---|
| | Model | Rated current | Maximum leakage current (60 Hz) | Manufacturer |
| R88D-GP08H | 3SUP-HQ10-ER-6 | 10 A | 3.5 mA (at 500 VAC) | Okaya Electric Industries Co., Ltd. |




## ■ 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. |

## ■ Contactors

| Manufacturer | Model | Rated current | Coil voltage |
|---|---|---|---|
| OMRON | J7L-09-22200 | 11 A | 200 VAC |
| | J7L-12-22200 | 13 A | 200 VAC |
| | J7L-18-22200 | 18 A | 200 VAC |
| | J7L-32-22200 | 26 A | 200 VAC |
| | J7L-40-22200 | 35 A | 200 VAC |
| | J7L-50-22200 | 50 A | 200 VAC |
| | J7L-65-22200 | 65 A | 200 VAC |
| | J7L-75-22200 | 75 A | 200 VAC |

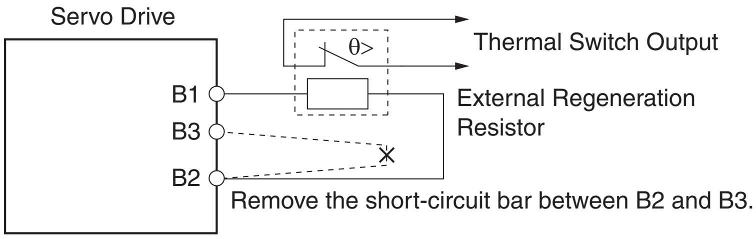
## ■ Reactors to Reduce Harmonic Current

| Servo Drive | Reactor Specifications | | |
|---|---|---|---|
| | Model number | Rated current | Inductance |
| R88D-GP08H | 3G3AX-DL2015 | 9.3 A | 3.51 mH |
| R88D-GP08H | 3G3AX-AL2025 | 10.0 A | 2.8 mH |

# Connecting an External Regeneration Resistor

## ■ R88D-GP08H

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.

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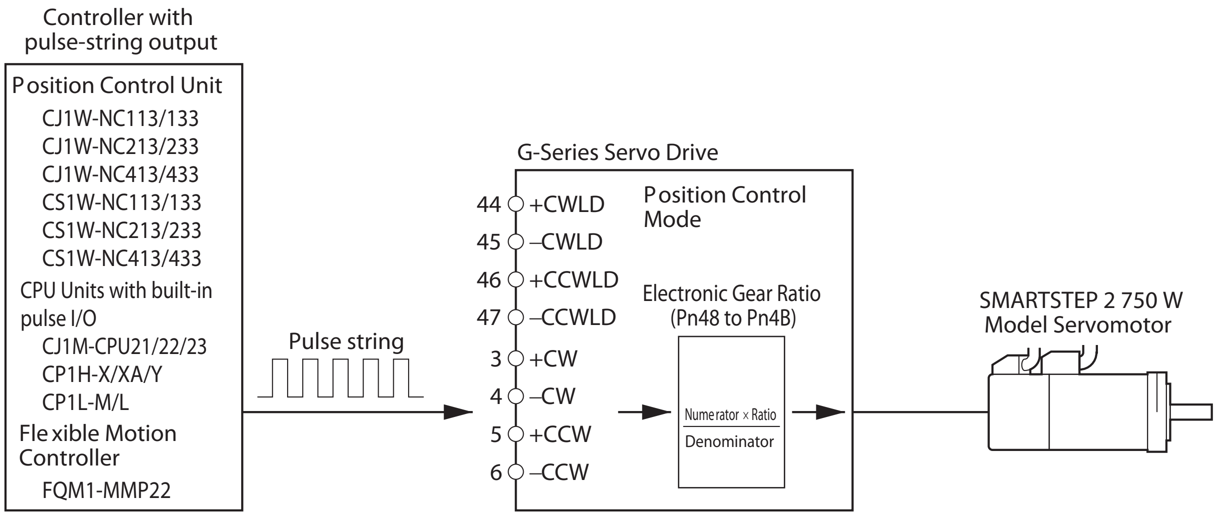
Appendix-2

# 10-5 Operating Functions

## 10-5-1 Position Control

### Function

- Perform control using the pulse-string input from CN1 pins 3 to 6.
- The Servomotor rotates using the value of the pulse-string input multiplied by the Electronic Gear Ratio (Pn48 to Pn4B).




### Parameters Requiring Settings

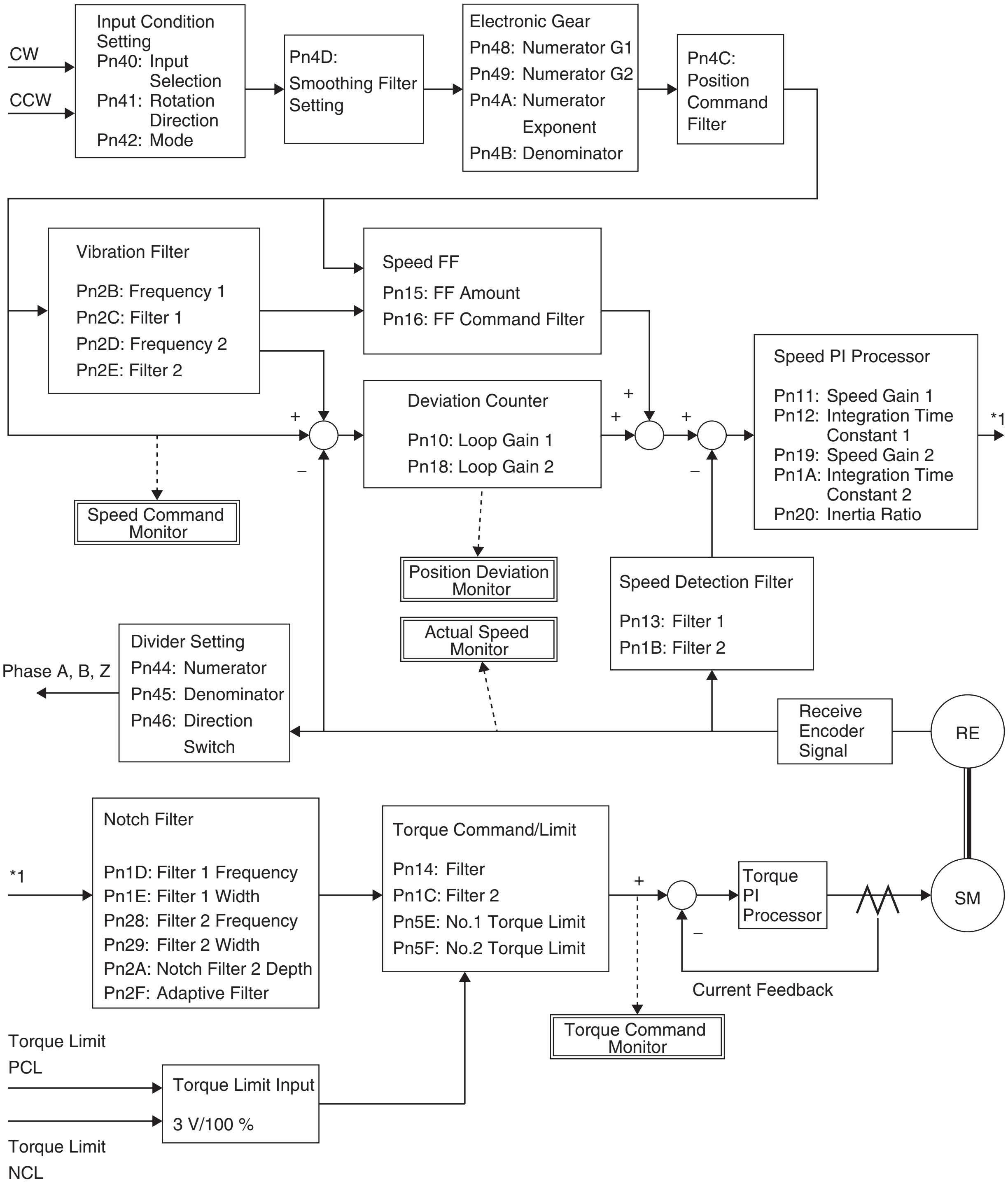
| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn02 | Control Mode Selection | Select the control mode for position control (setting: 0 to 6). |
| Pn40 | Command Pulse Input Selection | Select using a photocoupler input or a line-driver input as the command pulse input. |
| Pn41 | Command Pulse Rotation Direction Switch | Set to match the command pulse form of the controller. |
| Pn42 | Command Pulse Mode | |
| Pn48 to Pn4B | Electronic Gear Ratio | Set the pulse rate for command pulses and Servomotor travel amount. |

## Related Functions

- The main functions related to position control are as follows:

| Function | Explanation |
|---|---|
| Position command filter function | Sets the soft start for the command pulse. |
| Feed-forward function | Adds the command pulse differential to the speed loop to reduce the positioning time. |
| Torque limit function | Limits the Servomotor's torque output. |

## Parameter Block Diagram for Position Control Mode



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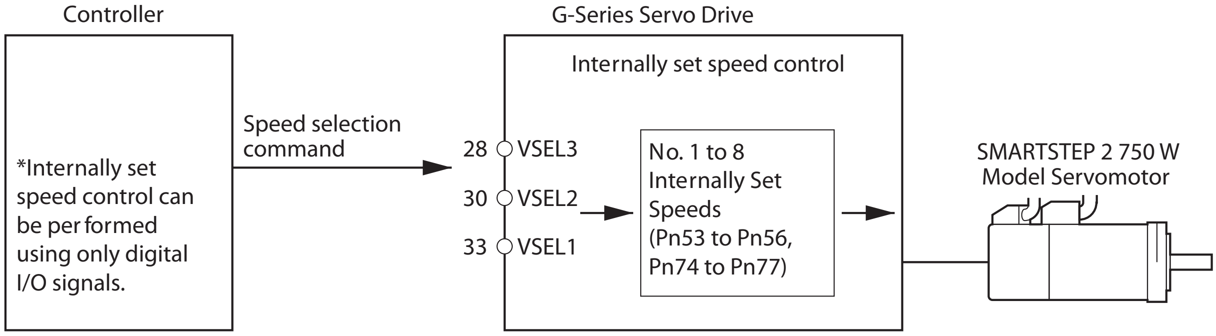
# 10-5-2 Internally Set Speed Control

## Function

- Performs Servomotor speed control using the speeds set in the No. 1 to 8 Internally Set Speeds.
- Select the internally set speed using the Internally Set Speed Selection 1 to 3 of the control input terminals (VSEL1: CN1 pin 33, VSEL2: CN1 pin 30, VSEL3: CN1 pin 28).




## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn02 | Control Mode Selection | Select the control mode for internally set speeds (setting: 1). |
| Pn05 | Command Speed Selection | Make a setting to use the internally set speeds (setting: 1, 2, or 3). |
| Pn53 | No. 1 Internally Set Speed | Set the internally set speeds (r/min). The settings can be made from −20,000 to 20,000 r/min. Be sure to set the speeds within the allowable range of rotation speed of the Servomotor. |
| Pn54 | No. 2 Internally Set Speed | |
| Pn55 | No. 3 Internally Set Speed | |
| Pn56 | No. 4 Internally Set Speed | |
| Pn74 | No. 5 Internally Set Speed | |
| Pn75 | No. 6 Internally Set Speed | |
| Pn76 | No. 7 Internally Set Speed | |
| Pn77 | No. 8 Internally Set Speed | |
| Pn58 | Soft Start Acceleration Time | Set the acceleration time for internally set speed control. Set the time (setting × 2 ms) until 1,000 r/min is reached. |
| Pn59 | Soft Start Deceleration Time | Set the deceleration time for internally set speed control. Set the time (setting × 2 ms) until 1,000 r/min is reached. |
| Pn5A | S-curve Acceleration/ Deceleration Time Setting | Set the S-curve time width (setting × 2 ms) centered on the inflection points for acceleration and deceleration. |

### ■ Selecting the Internally Set Speeds

The following tables show the internally set speeds that are set with VSEL1, VSEL2, and VSEL3 (Internally Set Speed Selection 1, 2, and 3 Inputs).

**Pn05 = 1**

| No. | VSEL1 | VSEL2 | VSEL3 | Set speed |
|---|---|---|---|---|
| 0 | OFF | OFF | OFF | Pn53 |
| 1 | ON | OFF | OFF | Pn54 |
| 2 | OFF | ON | OFF | Pn55 |
| 3 | ON | ON | OFF | Pn56 |
| 4 | OFF | OFF | ON | Pn53 |
| 5 | ON | OFF | ON | Pn54 |
| 6 | OFF | ON | ON | Pn55 |
| 7 | ON | ON | ON | Pn56 |

**Pn05 = 2**

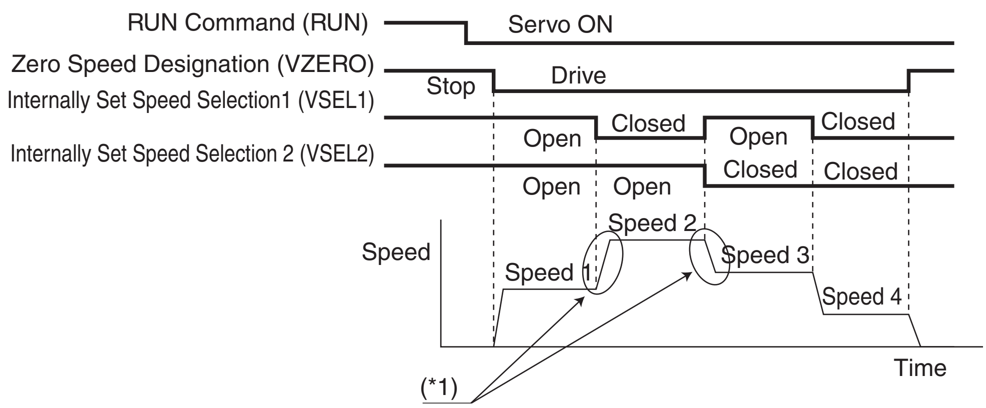
Reserved.

**Pn05 = 3**

| No. | VSEL1 | VSEL2 | VSEL3 | Set speed |
|---|---|---|---|---|
| 0 | OFF | OFF | OFF | Pn53 |
| 1 | ON | OFF | OFF | Pn54 |
| 2 | OFF | ON | OFF | Pn55 |
| 3 | ON | ON | OFF | Pn56 |
| 4 | OFF | OFF | ON | Pn74 |
| 5 | ON | OFF | ON | Pn75 |
| 6 | OFF | ON | ON | Pn76 |
| 7 | ON | ON | ON | Pn77 |

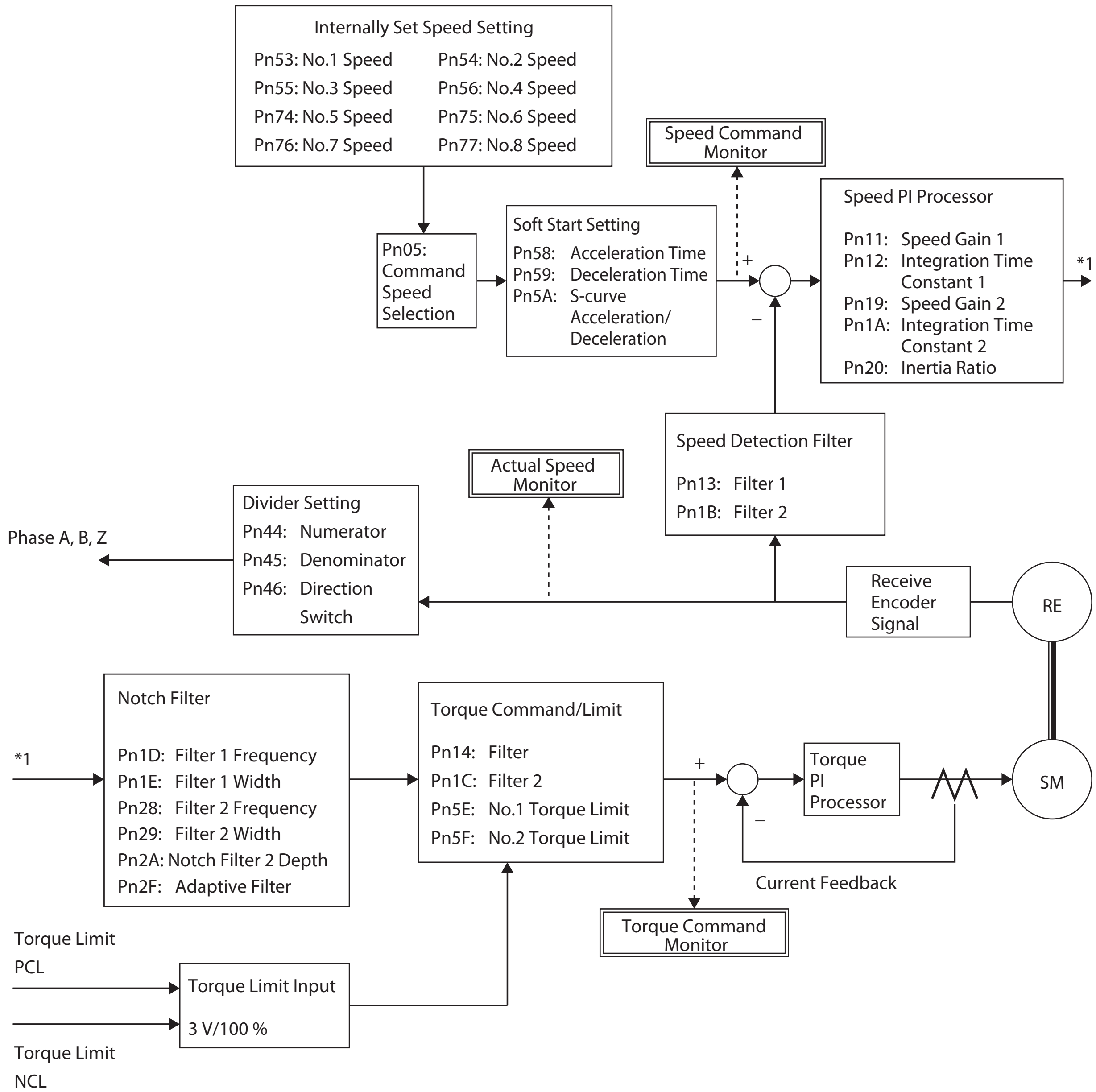
## ■ Operation Example

- Internally Set Speed Control with Four Speed Changes When Pn05 = 1




*1.The acceleration time, deceleration time, and S-curve acceleration/deceleration time can be set using parameters (Pn58, Pn59, and Pn5A).

## Parameter Block Diagram for Internal Set Speed Control Mode



# 10-5-3 Forward and Reverse Drive Prohibit

## Function

- When the Forward Drive Prohibit Input (POT: CN1 pin 9) and Reverse Drive Prohibit Input (NOT: CN1 pin 8) are turned OFF, the Servomotor will stop rotating.
- You can stop the Servomotor from rotating beyond the device's operating range by connecting limit inputs.

## Parameters Requiring Settings

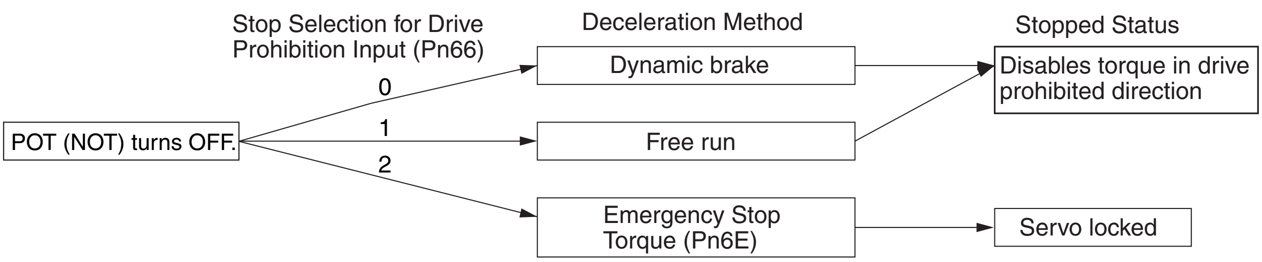
| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn04 | Drive Prohibit Input Selection | Enable or disable the Forward/Reverse Drive Prohibit Inputs. |
| Pn66 | Stop Selection for Drive Prohibition Input | Set the operation for decelerating to a stop after the Forward/Reverse Drive Prohibit Input turns OFF. Set whether to use the dynamic brake to stop or free-running. |





## Operation

Stopping Methods When Forward/Reverse Drive Prohibit Is OFF




While the Forward Drive Prohibit Input (POT) is OFF, the Servomotor cannot be driven in the forward direction, but it can be driven in the reverse direction. Conversely, while the Reverse Drive Prohibit Input (NOT) is OFF, the Servomotor cannot be driven in the reverse direction, but it can be driven in the forward direction.

With a vertical axis, there is a risk that the load may drop when drive is prohibited by the drive prohibit input. To prevent this, it is recommended that the deceleration method be set to use emergency stop torque in the Drive Prohibit Input Stop Selection parameter (Pn066), and that stopping in the servo-lock state be set (set value: 2).

# 10-5-4 Encoder Dividing

## Function

- The number of pulses can be set for the encoder signals output from the Servo Drive.

## Parameters Requiring Settings

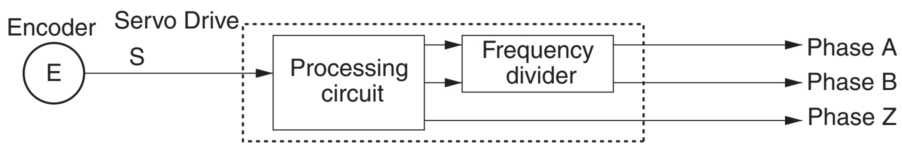
| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn44 | Encoder Divider Numerator Setting | Set the number of pulses to be output in combination with the Encoder Divider Denominator Setting (Pn45). |
| Pn45 | Encoder Divider Denominator Setting | Set the number of pulses to be output in combination with the Encoder Divider Numerator Setting (Pn44). |
| Pn46 | Encoder Output Direction Switch | Set the phase-B logic and output source for the pulse output (CN1 −B: pin 48, CN1 +B: pin 49) |



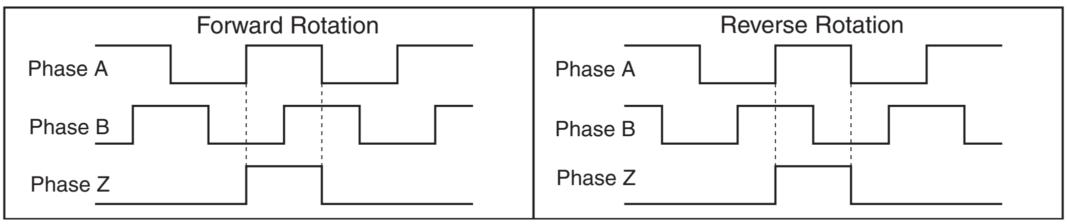


## Operation

- Incremental pulses are output from the Servo Drive through a frequency divider.




- The output phases of the encoder signal output from the Servo Drive are as shown below.



# 10-5-5 Electronic Gear

## Function

- The Servomotor can be rotated for the number of pulses obtained by multiplying the command pulses by the electronic gear ratio.
- This function is effective under the following conditions:
  - When fine-tuning the position and speed of two lines that are to be synchronous.
  - When using a position controller with a low command pulse frequency.
  - When you want to set the machine travel distance per pulse, to 0.01 mm for example.

## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn48 | Electronic Gear Ratio Numerator 1 *1 | Set the pulse rate for command pulses and Servomotor travel distance.<br>$$\frac{\begin{matrix}\text{Electronic Gear Ratio Numerator 1 (Pn48)}\\ \text{or}\\ \text{Electronic Gear Ratio Numerator 2 (Pn49)}\end{matrix} \times 2^{\text{Electronic Gear Ratio Numerator Exponent (Pn4A)}}}{\text{Electronic Gear Ratio Denominator (Pn4B)}}$$ |
| Pn49 | Electronic Gear Ratio Numerator 2 *1 | |
| Pn4A | Electronic Gear Ratio Numerator Exponent | |
| Pn4B | Electronic Gear Ratio Denominator | The upper limit of the gear ratio numerator is determined by the following formulas.<br>• Electronic Gear Ratio Numerator 1<br>Pn48 $\times$ 2 $^{Pn4A}$ $\leq$ 4,194,304/(Pn4D+1)<br>• Electronic Gear Ratio Numerator 2<br>Pn49 $\times$ 2 $^{Pn4A}$ $\leq$ 4,194,304/(Pn4D+1)<br><br>Pn48: Electronic Gear Ratio Numerator 1<br>Pn49: Electronic Gear Ratio Numerator 2<br>Pn4A: Electronic Gear Ratio Numerator Exponent<br>Pn4D: Smoothing Filter Setting<br><br>Any higher setting will be invalid, and the numerator will be 4,194,304/(Pn4D+1). If the numerator is 0, the encoder resolution will be automatically set to the value of the numerator and the number of command pulses per rotation can be set in Pn4B. |

*1. The Electronic Gear Switch Input (GESEL) is used to switch between Electronic Gear Ratio Numerator 1 (Pn48) and Electronic Gear Ratio Numerator 2 (Pn49).

## Operation

### Calculation Method

The following equation shows the relation between the number of internal command pulses (F) multiplied by the electronic gear ratio and the number of command pulses (f) per Servomotor rotation.

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$$F = f \times \frac{Pn46 \times 2^{Pn4A}}{Pn4B}$$

- When an encoder with a resolution of 2,500 pulses/rotation is used, the number of internal command pulses (F) in the Servo Drive will be 10,000 pulses/rotation (2,500 pulses/rotation × 4).
- Given the conditions above, the relation between the number of command pulses per Servomotor rotation (f) and the electronic gear ratio is as follows:

$$\frac{F}{f} = \frac{10000}{f} = \frac{Pn48 \times 2^{Pn4A}}{Pn4B}$$

### Calculation Examples (For a 2,500 pulses/rotation encoder)

- Make the following settings to operate with 2,000 pulses/rotation.

$$\frac{10000\ (Pn48) \times 2^{0\ (Pn4A)}}{2000\ (Pn4B)}$$

- Similarly, make the following settings to operate with 1,000 pulses/rotation.

$$\frac{10000\ (Pn48) \times 2^{0\ (Pn4A)}}{1000\ (Pn4B)}$$

- Conversely, make the following settings to increase the resolution per rotation and operate with 40,000 pulses/rotation.

$$\frac{10000}{40000} = \frac{2500\ (Pn48) \times 2^{0\ (Pn4A)}}{10000\ (Pn4B)}$$

The setting ranges for Pn48, Pn49, and Pn4B are from 1 to 10,000, so reduction is required in the settings.

### Calculation Example (For a 17-bit encoder)

- Use the following setting to operate at 5,000 pulses/rotation:

$$\frac{1\ (Pn48) \times 2^{17\ (Pn4A)}}{5000\ (Pn4B)}$$

## Related Parameter

The main function provided by the parameter related to the electronic gear is given in the following table.

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn40 | Command Pulse Input Selection | The command pulses are multiplied by a factor of 2 or 4 when using 90° phase difference signal inputs is selected as the input format for the command pulse in the Command Pulse Mode (Pn42). |

# 10-5-6 Overrun Limit

## Function

- The Servomotor can be stopped with an alarm for an overrun limit error (alarm code 34) if the Servomotor exceeds the allowable operating range set in the Overrun Limit Setting (Pn26) with respect to the position command input.
- This can be used to prevent impact on the edges of the machine because of Servomotor oscillation.

## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn26 | Overrun Limit Setting | Set the Servomotor's allowable operating range for the position command input range.<br>An overrun limit error (alarm code 34) will occur if the set value is exceeded. |

## Operating Conditions

- The overrun limit will operate under the following conditions.

| | Conditions under which the overrun limit will operate |
|---|---|
| Operating mode | Position Control Mode is used.<br>Pn02 = 0: Position control |
| Others | ⬩1.The servo is ON.<br>⬩2.The Overrun Limit Setting (Pn26) is not 0.<br>⬩3.The allowable operating range for both forward and reverse is within 2147483647 after the position command input range is cleared to zero.<br>If the condition 1 above is not met, the Overrun Limit Setting will be disabled until the conditions for clearing the position command input range are satisfied, as described below.<br>If the conditions 1 and 2 above are not met, the position command input range will be cleared to zero. |

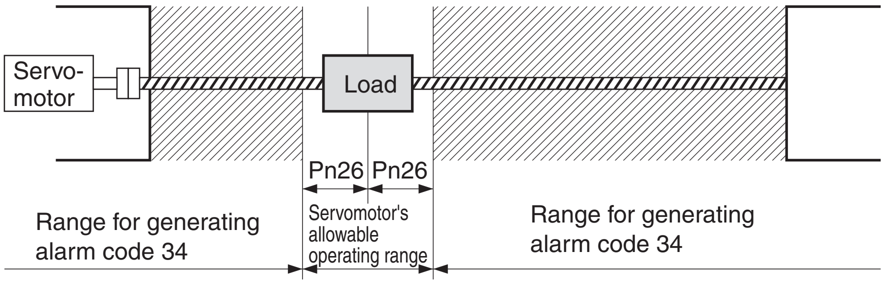
Conditions for Clearing the Position Command Input Range
The position command input range will be cleared to zero under the following conditions.

- The power supply is turned ON.
- The position deviation is cleared. (The deviation counter clearing is enabled and drive prohibit input is enabled by setting the Stop Selection for Drive Prohibition Input (Pn66) to 2.)
- Normal Mode Autotuning starts or ends.

## Operating Examples

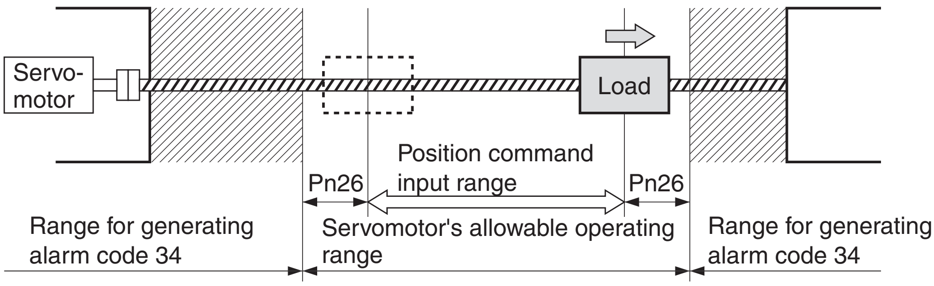
### ■ No Position Command Input (Servo ON)

No position command is input, and so the Servomotor's allowable operating range for both sides will be the range of the travel distance set in Pn26. An overrun limit error will occur if the load enters the range for generating alarm code 34 (range of slanted lines) due to oscillation.



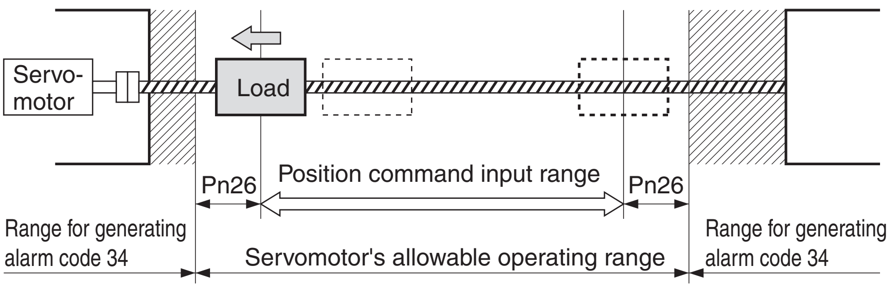

### ■ Right Side Operation (Servo ON)

When the position command to the right is input, the Servomotor's allowable operating range will increase by the input position command and will be the range with the rotations set in Pn26 added on both sides of the position command input range.




### ■ Left Side Operation (Servo ON)

When the position command to the left is input, the position command input range will further increase.



# 10-5-7 Brake Interlock

## Precautions for Using the Electromagnetic Brake

- The electromagnetic brake on a Servomotor with a brake is a nonexcitation brake designed for holding. Set the parameter to first stop the Servomotor, and then turn OFF the power supply to the brake.
- If the brake is applied while the Servomotor is rotating, the brake disk may become damaged due to friction, damaging the Servomotor.

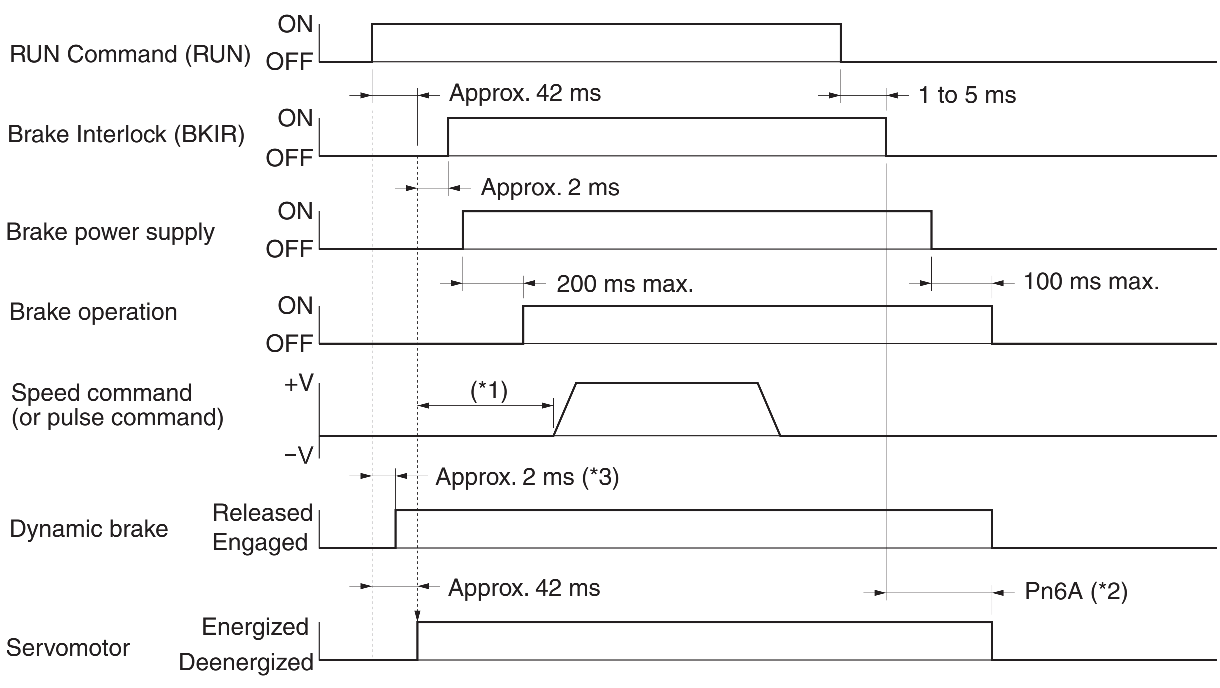
## Function

- You can set the Brake Interlock Output (BKIR) timing to turn ON and OFF the electromagnetic brake.

## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn6A | Brake Timing when Stopped | Use this parameter to set the output timing of the Brake Interlock Output (BKIR).<br>Pn6A: Delay time setting from BKIR OFF until servo OFF.<br>Pn6B: Wait time setting from servo OFF until BKIR OFF. |
| Pn6B | Brake Timing during Operation | |

### ■ RUN Command Timing (When Servomotor Is Stopped)



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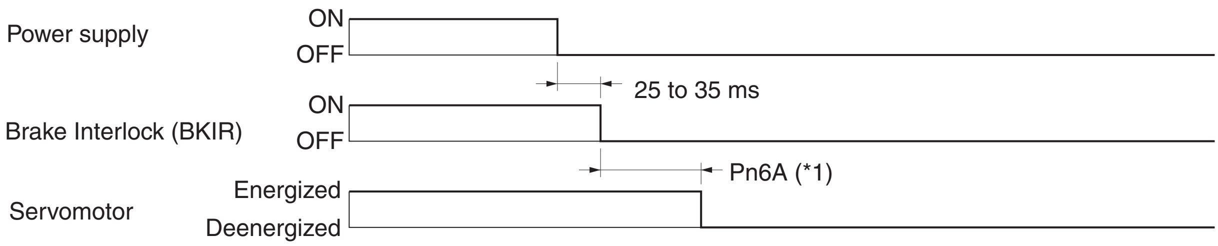
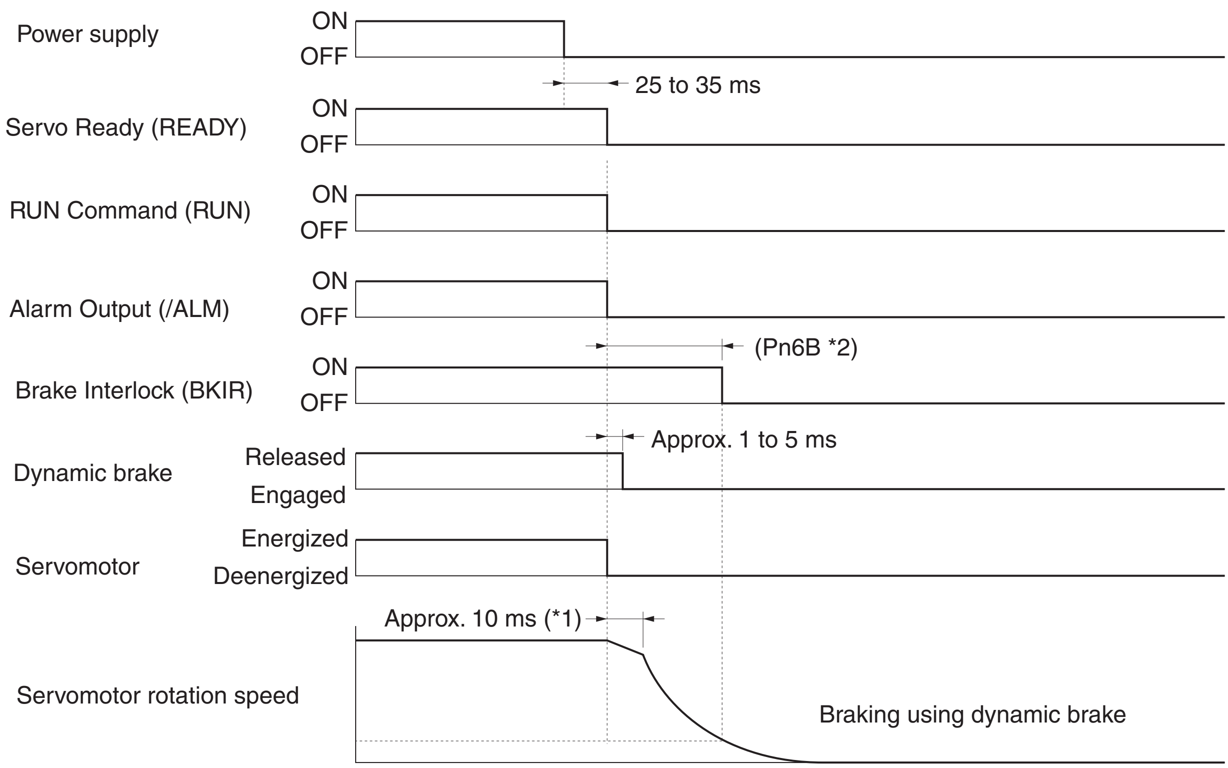
*1. The time from turning ON the brake power supply to the brake being released is 200 ms max. Take this delay into account and be sure the brake has been released before providing a speed command (pulse command).
*2. The time from turning OFF the brake power supply to the brake engaging is 100 ms max. If using the Servomotor on a vertical axis, take this delay into account and set the Brake Timing when Stopped (Pn6A) so that the Servomotor is deenergized after the brake has engaged.
*3. The Servo ON status will not occur until the Servomotor drops to 30 r/min or less.

## ■ Power Supply OFF Timing (When Servomotor Is Stopped)



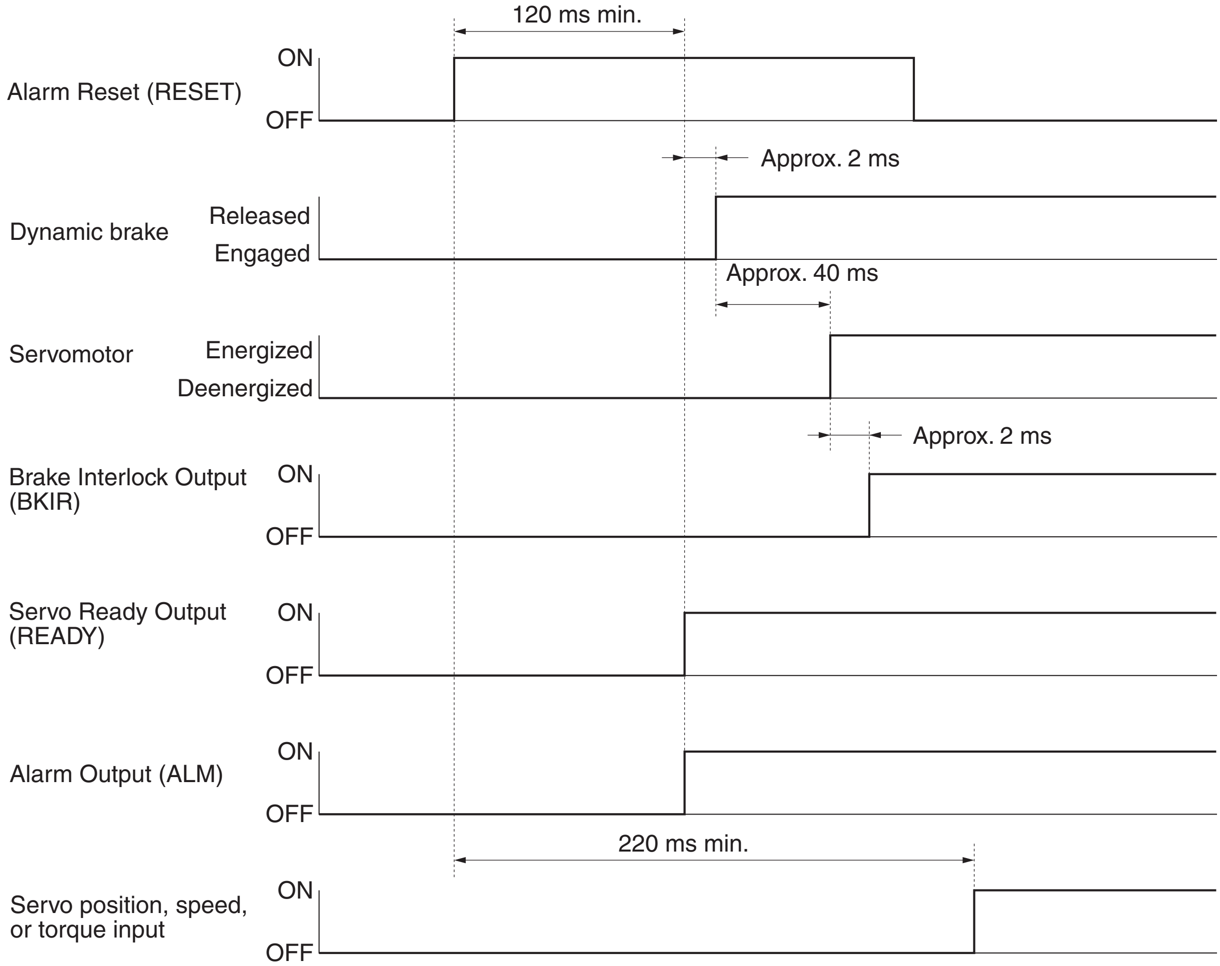

*1. The time from turning OFF the brake power supply to the brake engaging is 100 ms max. If using the Servomotor on a vertical axis, take this delay into account and set the Brake Timing when Stopped (Pn6A) so that the Servomotor is deenergized after the brake has engaged.

## ■ RUN Command, Errors, and Power Supply OFF Timing (When Servomotor Is Rotating)




*1. After the Servomotor is deenergized, it will rotate by inertia for approximately 10 ms until the dynamic brake operates.
*2. The Brake Interlock (BKIR) signal will turn OFF when the Servomotor's rotation speed is 30 r/min. or lower, or the time set in the Brake Timing during Operation (Pn6B) has elapsed.

## ■ Alarm Clear (When Servo Is ON)



# 10-5-8 Gain Switching

## Function

- This function switches the speed loop and position loop gain. Enabled when Pn30 is set to 1 and Pn31 is not set to 1, 2, or 4, or when Pn36 is not set to 0 or 1 under Speed Control.
- If GSEL (gain switching) signal is not input, perform control using the Speed Loop Gain (Pn11), Speed Loop Integration Time Constant (Pn12), and Position Loop Gain (Pn10). If GSEL is input, perform control using the Speed Loop Gain 2 (Pn19), Speed Loop Integration Time Constant 2 (Pn1A), and Position Loop Gain 2 (Pn18).
- If the mechanical system inertia fluctuates too much, or if you want different responsiveness during operation and stoppage, you can perform applicable control using gain switching.
- If realtime autotuning is not effective (under the conditions shown below), the gain switching function will be useful.
  - When the load inertia fluctuates in 200 ms or less.
  - When rotation speed does not exceed 500 r/min., or output torque does not exceed 50% of the rated torque.
  - When external force is constantly applied, as with a vertical axis.

**Note** When No. 2 gain has been selected (i.e., GSEL ON), realtime autotuning will not operate normally. If using the gain switching function, set the Realtime Autotuning Mode Selection (Pn21) to 0 (not used).

## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn18 | Position Loop Gain 2 | Set the responsiveness of the position control system when gain 2 is selected. |
| Pn19 | Speed Loop Gain 2 | Set the responsiveness of the speed loop when gain 2 is selected. |
| Pn1A | Speed Loop Integration Time Constant 2 | Set the integration time constant of the speed loop when gain 2 is selected. |
| Pn30 | Gain Switching Input Operating Mode Selection | Set switching between PI and P operation for speed control or switching between gain 1 and gain 2. This parameter can be set if 0 to 2 is set for the Torque Limit Selection (Pn03) (setting: 1). |
| Pn31 | Control Gain Switch 1 Setting | If 1 is set for the Gain Switching Input Operating Mode Selection (Pn30), set the switching conditions for gain 1 and gain 2 (setting: 0). If a composite mode is set, the setting of this parameter is valid when the first control mode is used. |

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# 10-5-9 Torque Limit

## Function

- The torque output by the Servomotor can be limited.
- This function is effective in the following cases: Pressing a moving part of a machine (such as a bending machine) against a workpiece with constant force and protecting the Servomotor and mechanical system from excessive force or torque.
- The torque limit method depends on the setting of Pn03.

## Parameters Requiring Settings

### Pn03 = 0

Reserved.

### Pn03 = 1

Torque is limited during operation to a constant torque (parameter settings). For both forward and reverse operation, use Pn5E to limit the maximum torque.

### Pn03 = 2

Torque is limited during operation to a constant torque (parameter settings). To limit the maximum torque, use Pn5E for forward operation, and Pn5F for reverse operation.

### Pn03 = 3

Use Pn5E to limit the maximum torque when pin 27 is OFF, and use Pn5F when pin 27 is ON.

# 10-5-10 Soft Start

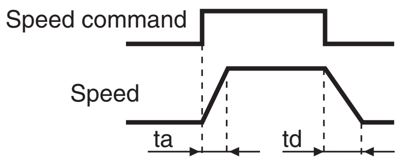
## Function

- This function accelerates and decelerates the Servomotor in the set acceleration and deceleration times.
- You can set the acceleration and deceleration independently of each other using the trapezoidal acceleration and deceleration curve.
- The soft start processes speed command input (REF) or internally set speed control switching to reduce impact during acceleration and deceleration.
- This function is effective for simple positioning and speed switching operations.
- Do not use this function for a position controller with an acceleration/deceleration function.

## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn58 | Soft Start Acceleration Time | Set the time using the following formula.<br>Setting = Acceleration time (setting × 2 ms) from 0 r/min to 1,000 r/min. |
| Pn59 | Soft Start Deceleration Time | Set the time using the following formula.<br>Setting = Deceleration time (setting × 2 ms) from 1,000 r/min to 0 r/min. |

- If the soft start function is not used, set this parameter to 0 (default setting).
- The actual acceleration and deceleration time is as follows:




ta = Pn58 × 2 ms/(1000 r/min)

td = Pn59 × 2 ms/(1000 r/min)

# 10-5-11 Position Command Filter

## Function

- Perform soft start processing for the command pulses using the selected filter to gently accelerate and decelerate.
- Select the filter characteristics using the Position Command Filter Time Constant Setting (Pn4C).
- This function is effective in the following cases:
  - There is no acceleration/deceleration function in the command pulse (controller).
  - The command pulse frequency changes abruptly, causing the machinery to vibrate during acceleration and deceleration.
  - The electronic gear setting is high (G1/G2 ≥ 10)

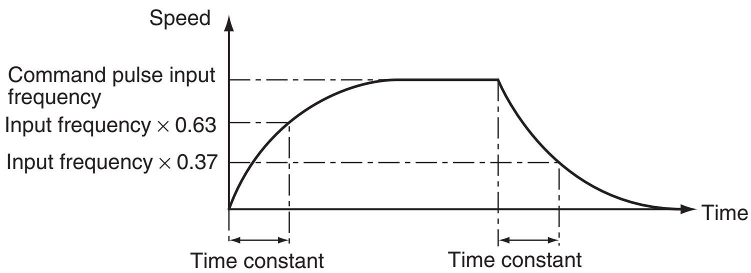
## Parameters Requiring Settings

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn4C | Position Command Filter Time Constant Setting | This is a first-order lag filter for the command pulse input section. If the command pulses change abruptly, this filter can be used to reduce the stepping movement of the Servomotor.<br>The larger the setting, the larger the time constant (setting range: 0 to 7). |

## Operation Example

- The characteristics for each filter are shown below.
- Servomotor acceleration and deceleration are delayed further than the characteristics shown below due to position loop gain.
  Acceleration: 2/Kp (s); Deceleration: 3/Kp (s); Kp: Position loop gain

### ■ Primary Filter




**Note** The time constant will be as follows according to the setting of Pn4C.

| Pn4C | Time constant (ms) |
|---|---|
| 0 | Disabled |
| 1 | 0.2 |
| 2 | 0.6 |
| 3 | 1.3 |
| 4 | 2.6 |
| 5 | 5.3 |
| 6 | 10.6 |
| 7 | 21.2 |

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# 10-5-12 User Parameters

Set and check the user parameters in Parameter Setting Mode. Fully understand what the parameters mean and the setting procedures, and set the parameters according to the control system.
Some parameters are enabled by turning the power OFF and then ON again. After changing these parameters, turn OFF the power, confirm that the power indicator has gone OFF, and then turn ON the power again.

## Setting and Checking Parameters

### ■ Overview

Use the following procedure to set or check parameters.

- Go to Parameter Setting Mode. Press the Data key, and then press the Mode key once.
- Set the parameter number (Pn□□) using the Increment and Decrement keys.
- Display the parameter setting by pressing the Data key.
- Change the parameter setting using the Increment, Decrement, and Shift keys.
- Save the changed setting to memory and return to the parameter number display by pressing the Data key.

### ■ Operating Procedures

#### Displaying Parameter Setting Mode

| PR02G keys | Front panel keys | Display example | Explanation |
|---|---|---|---|
| | | r 0 | The default display is displayed. |
| DATA | DATA | Un_SPd. | Press the Data key to display Monitor Mode. |
| | | Pn_r00. | Press the Mode key to display Parameter Setting Mode. |

#### Setting the Parameter Number

| PR02G keys | Front panel keys | Display example | Explanation |
|---|---|---|---|
| | | Pn_ 07. | Set the number of the parameter to be set or checked. |

### Displaying Parameter Settings

| PR02G keys | Front panel keys | Display example | Explanation |
|---|---|---|---|
| | | Pn_ 07. | The parameter number will be displayed. |
| DATA | DATA | 3. | Press the Data key. The setting of the parameter will be displayed. |

### Changing Parameter Settings

- The following operation is not required if you are only checking a parameter setting.

| PR02G keys | Front panel keys | Display example | Explanation |
|---|---|---|---|
| | | 3. | The present setting will be displayed. |
| ⋀ ⋁ ≪ | ⋀ ⋁ ≪ | 5. | Use the Shift, Increment, and Decrement keys to change the setting.<br>The Shift key is used to change the digit. |

### Saving the New Setting to Memory and Returning to the Parameter Number Display

- The following operation is not required if you are only checking a parameter setting.

| PR02G keys | Front panel keys | Display example | Explanation |
|---|---|---|---|
| DATA | DATA | 5. | Press the Data key. The new parameter setting will be saved and the parameter number will be displayed again. |

## Parameters Details

- This section provides an explanation for all parameters.
  Be sure to fully understand the meanings of parameters before making changes to the parameter settings.

### ■ Function Selection Parameters (Pn00 to Pn0F)

| Pn00 | Unit No. Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 15 | Unit | --- | Default setting | 1 | Power OFF→ON | Yes |

- If communications with a computer or other host controller are used by multiple Units via RS-232 or RS-485, it is necessary to identify which Unit the host is accessing. With this parameter, the unit number can be confirmed using alphanumeric characters.
- The unit number is determined by the unit number switch setting on the front panel when the power supply is turned ON. This number is the unit number when using serial communications.
- The setting of this parameter has no effect on Servomotor operation.
- The setting of this parameter can be changed only by using the unit number switch on the front panel.

| Pn01 | Default Display | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 17 | Unit | --- | Default setting | 1 | Power OFF→ON | Yes |

#### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Position deviation |
| 1 | Servomotor rotation speed |
| 2 | Torque output |
| 3 | Control mode |
| 4 | I/O signal status |
| 5 | Alarm code and history |
| 6 | Software version |
| 7 | Warning display |
| 8 | Regeneration load ratio |
| 9 | Overload load ratio |
| 10 | Inertia ratio |
| 11 | Total feedback pulses |
| 12 | Total command pulses |
| 13 | Reserved |
| 14 | Reserved |
| 15 | Automatic Servomotor recognition display |
| 16 | Reserved |
| 17 | Reason for no rotation |

- Select the data to be displayed on the 7-segment display on the front panel after the power supply is turned ON.

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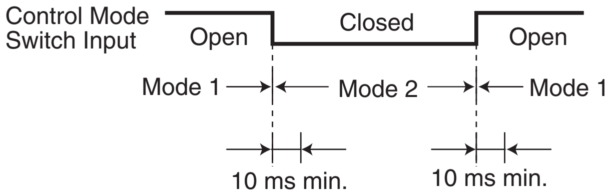
Appendix-2

| **Pn02** | Control Mode Selection | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 6 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Position Control Mode (pulse-string command) |
| 1 | Internal Speed Mode |
| 2 | Reserved |
| 3 | Reserved |
| 4 | Reserved |
| 5 | Reserved |
| 6 | Reserved |

- Use this parameter to set the control mode.
- Do not input a command within 10 ms before or after switching.




| **Pn03** | Torque Limit Selection | | | | | Position Speed | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 1 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Reserved. |
| 1 | Use Pn5E as the limit value for forward and reverse operation. |
| 2 | Use Pn5E as the limit value for forward operation and Pn5F as the limit value for reverse operation. |
| 3 | Use Pn5E as the value when the GSEL/TLSEL input is open and use Pn5F as the value when the GSEL/TLSEL input is closed. |

- Use this parameter to set the torque limit method for forward and reverse operation.
- If this parameter is set to 0, the torque limit input for forward and reverse operation will be limited by the No.1 Torque Limit (Pn5E).
- When using torque control, the No.1 Torque Limit (Pn5E) will be the limit value for forward and reverse operation regardless of the setting of this parameter.

| Pn04 | Drive Prohibit Input Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 1 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Forward Drive Prohibit Input and Reverse Drive Prohibit Input enabled. |
| 1 | Forward Drive Prohibit Input and Reverse Drive Prohibit Input disabled. |
| 2 | Forward Drive Prohibit Input and Reverse Drive Prohibit Input enabled. |

- Install limit switches at both ends of the axis to prohibit the Servomotor from traveling in the direction specified by the switch. This can be used to prevent the workpiece from traveling too far and thus prevent damage to the machine.
- Operation will be as follows if 0 is set.
  - Connection between Forward Drive Prohibit Input (POT: CN1 pin 9) and COM closed: Forward limit switch not operating and status normal.
  - Connection between Forward Drive Prohibit Input (POT: CN1 pin 9) and COM open: Forward drive prohibited and reverse drive permitted.
  - Connection between Reverse Drive Prohibit Input (NOT: CN1 pin 8) and COM closed: Reverse limit switch not operating and status normal.
  - Connection between Reverse Drive Prohibit Input (NOT: CN1 pin 8) and COM open: Reverse drive prohibited and forward drive permitted.
- If this parameter is set to 0, the Servomotor will decelerate and stop according to the sequence set in the Stop Selection for Drive Prohibition Input (Pn66).
- If this parameter is set to 0 and the forward and reverse prohibit inputs are both open, an error will be detected in the Servo Drive, and a drive prohibit input error (alarm code 38) will occur.
- If this parameter is set to 2, a drive prohibit input error (alarm code 38) will occur when the connection between either the forward or reverse prohibit input and COM is open.
- If a limit switch above the workpiece is turned OFF when using a vertical axis, the upward torque will be eliminated, and there may be repeated vertical movement of the workpiece. If this occurs, set the Stop Selection for Drive Prohibition Input (Pn66) to 2 or limit operation using the host controller rather than using this parameter.

| Pn05 | Command Speed Selection | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Reserved. |
| 1 | No. 1 Internally Set Speed to No. 4 Internally Set Speed (Pn53 to Pn56) |
| 2 | Reserved. |
| 3 | No. 1 Internally Set Speed to No. 8 Internally Set Speed (Pn53 to Pn56 and Pn74 to Pn77) |

- Use this parameter to select the speed command when using speed control. The Servo Drives has internally set speeds that can be used to easily achieve speed control by using contact inputs.

| Pn06 | Zero Speed Designation/Speed Command Direction Switch | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | The zero-speed designation input will be ignored, and a zero-speed designation will not be detected. |
| 1 | The zero-speed designation input will be enabled, and the speed command will be assumed to be zero when the connection between the input and common is open. |
| 2 | Speed mode: Use as the speed command sign. The rotation direction is forward when the connection between the input and common is open and reverse when the connection between the input and common is closed. |

- Use this parameter to set the function of the Zero-speed Designation Input (VZERO: CN1 pin 26).

| Pn07 | SP Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 9 | Unit | --- | Default setting | 3 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Actual Servomotor speed: 6 V/47 r/min |
| 1 | Actual Servomotor speed: 6 V/188 r/min |
| 2 | Actual Servomotor speed: 6 V/750 r/min |
| 3 | Actual Servomotor speed: 6 V/3000 r/min |
| 4 | Actual Servomotor speed: 1.5 V/3000 r/min |
| 5 | Command speed: 6 V/47 r/min |
| 6 | Command speed: 6 V/188 r/min |
| 7 | Command speed: 6 V/750 r/min |
| 8 | Command speed: 6 V/3000 r/min |
| 9 | Command speed: 1.5 V/3000 r/min |

| Pn08 | IM Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 12 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Torque command: 3 V/rated (100%) torque |
| 1 | Position deviation: 3 V/31 pulses |
| 2 | Position deviation: 3 V/125 pulses |
| 3 | Position deviation: 3 V/500 pulses |
| 4 | Position deviation: 3 V/2000 pulses |
| 5 | Position deviation: 3 V/8000 pulses |
| 6 | Reserved |
| 7 | Reserved |
| 8 | Reserved |
| 9 | Reserved |
| 10 | Reserved |
| 11 | Torque command: 3 V/200% torque |
| 12 | Torque command: 3 V/400% torque |





| Pn09 | General-purpose Output 2 Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 8 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Output during torque limit |
| 1 | Zero speed detection output |
| 2 | Any warning |
| 3 | Over regeneration warning output |
| 4 | Overload warning output |
| 5 | Battery warning output |
| 6 | Fan lock warning output |
| 7 | Reserved |
| 8 | Speed conformity output |

- Use this parameter to assign the function of General-purpose Output 2 (OUTM2: CN1 pin 40).

| Pn0A | General-purpose Output 1 Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 8 | Unit | --- | Default setting | 1 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Output during torque limit |
| 1 | Zero speed detection output |
| 2 | Any warning |
| 3 | Over regeneration warning output |
| 4 | Overload warning output |
| 5 | Battery warning output |
| 6 | Fan lock warning output |
| 7 | Reserved |
| 8 | Speed conformity output |

- Use this parameter to assign the function of General-purpose Output 1 (OUTM1: CN1 pin 12).

| Pn0B | Operation Switch When Using Absolute Encoder | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Use as absolute encoder. |
| 1 | Use as incremental encoder. |
| 2 | Use as absolute encoder but ignore multi-turn counter overflow. |

- Use this parameter to set the operating method for the 17-bit absolute encoder.
- The setting of this parameter is disabled if a 5-core 2,500-pulse/revolution incremental encoder is used.

| Pn0C | RS-232 Baud Rate Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 5 | Unit | --- | Default setting | 2 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | 2,400 bps |
| 1 | 4,800 bps |
| 2 | 9,600 bps |
| 3 | 19,200 bps |
| 4 | 38,400 bps |
| 5 | 57,600 bps |

- Use this parameter to select the baud rate for RS-232 communications.
- Baud rate error: ±0.5%.

| Pn0D | RS-485 Baud Rate Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 5 | Unit | --- | Default setting | 2 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | 2,400 bps |
| 1 | 4,800 bps |
| 2 | 9,600 bps |
| 3 | 19,200 bps |
| 4 | 38,400 bps |
| 5 | 57,600 bps |

- Use this parameter to select the baud rate for RS-485 communications.
- Baud rate error: ±0.5%.

| Pn0E | Front Key Protection Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 1 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | All enabled |
| 1 | Limited to Monitor Mode |

- Front panel key operations can be limited to Monitor Mode. This function can be used to prevent unintended changes to parameters because of incorrect key operations.
- Even if this parameter is set to 1, parameters can be changed by using communications.
- Use communications to return this parameter to 0.

| Pn0F | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

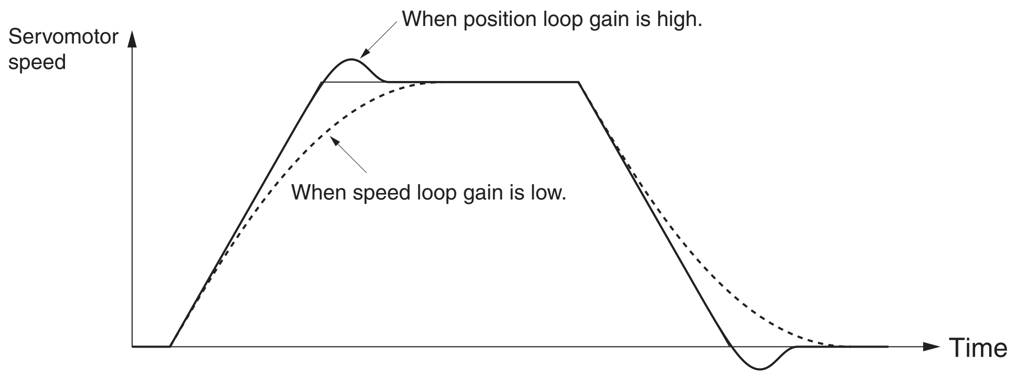
## ■ Gain Parameters (Pn10 to Pn3D)

| Pn10 | Position Loop Gain | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3000 | Unit | 1/s | Default setting | 40 | Power OFF→ON | --- |

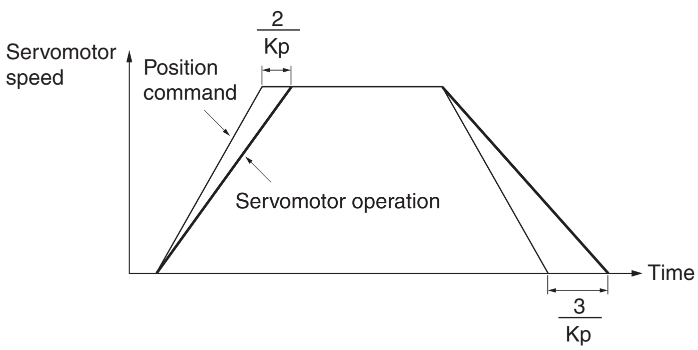
- Use this parameter to adjust the position loop response to suit the mechanical rigidity.
- The responsiveness of the servo system is determined by the position loop gain. Servo systems with a high loop gain have a high responsiveness and fast positioning. To increase the position loop gain, you must improve mechanical rigidity and increase the specific oscillation frequency. This should be 50 to 70 (1/s) for ordinary machine tools, 30 to 50 (1/s) for general-use and assembly machines, and 10 to 30 (1/s) for industrial robots. The default position loop gain is 40 (1/s), so be sure to lower the setting for machines with low rigidity.
- Increasing the position loop gain in systems with low mechanical rigidity or systems with low specific oscillation frequencies may cause machine resonance, resulting in an overload alarm.
- If the position loop gain is low, you can shorten the positioning time using feed forward.
- This parameter is automatically changed by executing realtime autotuning. To set it manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.
  Position loop gain is generally expressed as follows:

$$\text{Position loop gain (Kp)} = \frac{\text{Command pulse frequency (pulses/s)}}{\text{Deviation counter accumulated pulses (pulses)}} \text{ (1/s)}$$

When the position loop gain is changed, the response is as shown in the following diagram.



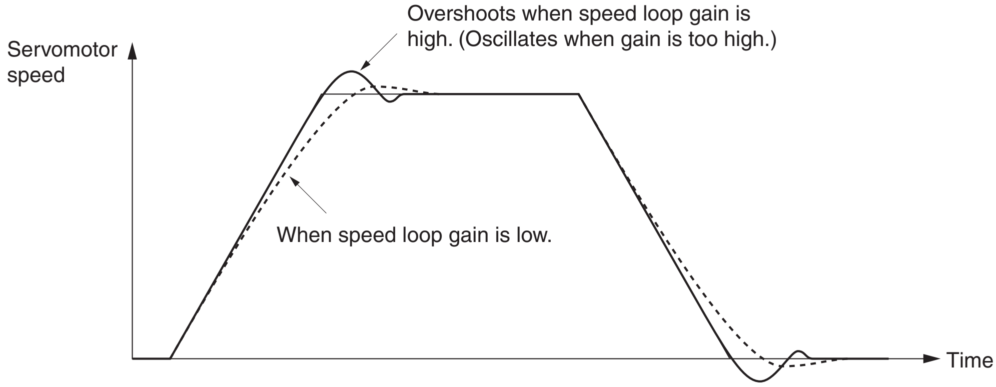

- If the speed loop gain and position loop gain are optimally set, the Servomotor operation for the command will be delayed 2/Kp at acceleration and delayed 3/Kp at deceleration.



| Pn11 | Speed Loop Gain | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 3500 | Unit | Hz | Default setting | 50 | Power OFF→ON | --- |

- Use this parameter to determine 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 the Speed Loop Gain too high, however, may result in oscillation.
- The setting unit for Pn11 will be Hz if the Inertia Ratio (Pn20) is set correctly.

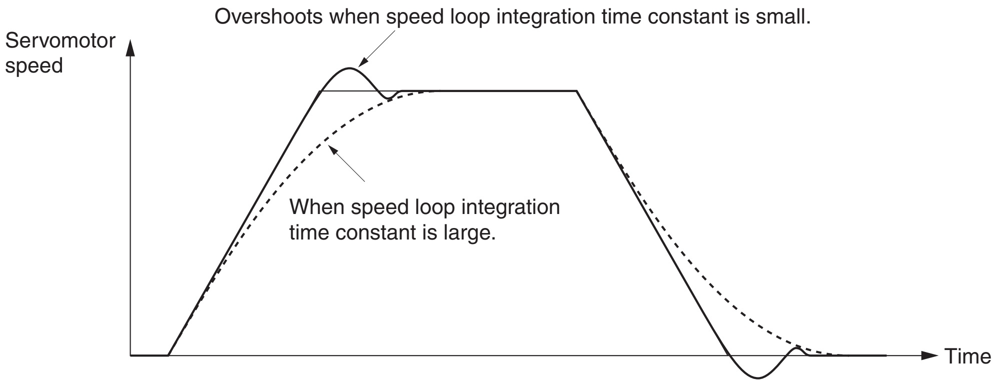
When the speed loop gain is changed, the response is as shown in the following diagram.




| Pn12 | Speed Loop Integration Time Constant | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 1000 | Unit | ms | Default setting | 20 | Power OFF→ON | --- |

- Use this parameter to set the speed loop integration time constant.
- The smaller the setting, the faster the deviation will come close to 0 when stopping. If 1000 is set, the integral will be ineffective.

When the speed loop integration time constant is changed, the response is as shown in the following diagram.



| Pn13 | Speed Feedback Filter Time Constant | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 5 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the time constant for the low-pass filter (LPF) after speed detection to one of six value (0 to 5).
- Increasing the setting increases the time constant and decreases the noise generated by the Servomotor. Responsiveness, however, also decreases.
- Normally, use the default setting.

| Pn14 | Torque Command Filter Time Constant | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2500 | Unit | 0.01ms | Default setting | 80 | Power OFF→ON | --- |

- Use this parameter to set the time constant for the first-order lag filter inserted into the torque command.
- This parameter may be effective in suppressing oscillation due to torsion resonance.

| Pn15 | Speed Feed-forward Amount | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | −2000 to 2000 | Unit | 0.10% | Default setting | 300 | Power OFF→ON | --- |

- Use this parameter to set the feed-forward amount in Position Control Mode.
- Increasing the setting decreases the position deviation and increases the responsiveness. Overshooting, however, will occur more easily.

| Pn16 | Feed-forward Command Filter | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 6400 | Unit | 0.01ms | Default setting | 100 | Power OFF→ON | --- |

- Use this parameter to set the time constant for the first-order lag filter inserted into the feed-forward.
- Setting the Feed-forward Command Filter may improve operation if speed overshooting occurs or the noise during operation is large when the feed forward is set high.

| Pn17 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn18 | Position Loop Gain 2 | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3000 | Unit | 1/s | Default setting | 20 | Power OFF→ON | --- |

- Use this parameter to set the responsiveness of the position control system for the second position loop.

| Pn19 | Speed Loop Gain 2 | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 3500 | Unit | Hz | Default setting | 80 | Power OFF→ON | --- |

- Use this parameter to set the responsiveness of the second speed loop.

| Pn1A | Speed Loop Integration Time Constant 2 | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 1000 | Unit | ms | Default setting | 50 | Power OFF→ON | --- |

- Use this parameter to set the second speed loop integration time constant.

| Pn1B | Speed Feedback Filter Time Constant 2 | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 5 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the second speed feedback filter time constant.

| Pn1C | Torque Command Filter Time Constant 2 | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2500 | Unit | 0.01 ms | Default setting | 100 | Power OFF→ON | --- |

- Use this parameter to set the second torque command filter time constant.
- The parameters from Pn18 to Pn1C are the gain and time constants to be selected when gain switching is enabled in the Gain Switching Input Operating Mode Selection (Pn30).
- The gain is switched according to the condition set in the Control Gain Switch 1 Setting (Pn31).
- If the mechanical system inertia changes greatly or if you want to change the responsiveness when the Servomotor is rotating and when it is being stopped, you can achieve the appropriate control by setting the gains and time constants beforehand for each of these conditions, and switch them according to the condition.
- These parameters are automatically changed by executing realtime autotuning. To set them manually, set the Realtime Autotuning Mode Selection (Pn21) to 0.
- Gain switching is enabled only for position control.



| Pn1D | Notch Filter 1 Frequency | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 100 to 1500 | Unit | Hz | Default setting | 1500 | Power OFF→ON | --- |

- Use this parameter to set the frequency of notch filter 1 for resonance suppression.
- The notch filter function will be disabled if this parameter is set to 1500.

| Pn1E | Notch Filter 1 Width | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 4 | Unit | --- | Default setting | 2 | Power OFF→ON | --- |

- Use this parameter to set the width of notch filter 1 for resonance suppression to one of 5 levels.
- Increasing the setting increases the notch width. Normally, use the default setting.

| Pn1F | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn20 | Inertia Ratio | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10000 | Unit | % | Default setting | 300 | Power OFF→ON | --- |

- Use this parameter to set the load inertia as a percentage of the Servomotor rotor inertia.
- Pn20 = (Load inertia ÷ Rotor inertia) × 100%
- When normal mode autotuning is executed, the load inertia will be automatically estimated after the specified operation, and this parameter will be updated with the result.
- When realtime autotuning is enabled, the inertia ratio is continuously estimated and saved in EEPROM every 30 min.
- If the inertia ratio is set correctly, the setting unit for the Speed Loop Gain (Pn11) and Speed Loop Gain 2 (Pn19) will be Hz.
- If the Inertia Ratio (Pn20) is set larger than the actual value, the setting for speed loop gain will increase. If the inertia ratio is set smaller than the actual value, the setting for speed loop gain will decrease.

| Pn21 | Realtime Autotuning Mode Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 7 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Realtime autotuning is disabled. |
| 1 | Normal mode: There is almost no change. |
| 2 | Normal mode: There are gradual changes. |
| 3 | Normal mode: There are sudden changes. |
| 4 | Vertical axis mode: There is almost no change. |
| 5 | Vertical axis mode: There are gradual changes. |
| 6 | Vertical axis mode: There are sudden changes. |
| 7 | No gain switching: There is almost no change. |

- Use this parameter to set the operating mode for realtime autotuning.
- The higher the value that is set (e.g., 3 or 6), the faster the response is for a change in inertia during operation. Operation, however, may be unstable depending on the operating pattern. Normally, set the parameter to 1 or 4.
- Use a setting of 4 to 6 if a vertical axis is used.
- Use setting 7 if vibration is caused by gain switching.

| Pn22 | Realtime Autotuning Machine Rigidity Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 15 | Unit | --- | Default setting | 2 | Power OFF→ON | --- |

- Use this parameter to set the machine rigidity to one of 16 levels when realtime autotuning is enabled.

Low ← Machine rigidity → High

Low ← Servo gain → High

| Pn22 | 0·1 - - - - - - - - - - - - - - - E·F |
|---|---|

Low ← Responsiveness → High

If the setting is changed suddenly by a large amount, the gain will change rapidly, subjecting the machine to shock. Always start by making small changes in the setting, and gradually increase the setting while monitoring machine operation.

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Appendix-2

| Pn23 | Adaptive Filter Selection | | | | | | Position Speed |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Adaptive filter disabled. |
| 1 | Adaptive filter enabled. |
| 2 | Hold (The adaptive filter frequency when the setting was changed to 2 will be held.) |

- Use this parameter to set the operation of the adaptive filter.
- The Adaptive Filter Table Number Display (Pn2F) will be reset to 0 when the adaptive filter is disabled.
- The adaptive filter is normally disabled in the torque control mode.

| Pn24 | Vibration Filter Selection | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | No switching. (Both filter 1 and filter 2 are enabled.) |
| 1 | Filter 1 or filter 2 can be selected using vibration filter switching (DFSEL).<br>•DFSEL open: Vibration filter 1 (Pn2B and Pn2C) is selected.<br>•DFSEL closed: Vibration filter 2 (Pn2D and Pn2E) is selected. |
| 2 | Switching with position command direction.<br>•Forward: Vibration filter 1 (Pn2B and Pn2C) is selected.<br>• Reverse: Vibration filter 2 (Pn2D and Pn2E) is selected. |

| Pn25 | Autotuning Operation Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 7 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Rotation direction | Number of rotations |
|---|---|---|
| 0 | Forward to reverse | Two rotations |
| 1 | Reverse to forward | |
| 2 | Forward to forward | |
| 3 | Reverse to reverse | |
| 4 | Forward to reverse | One rotation |
| 5 | Reverse to forward | |
| 6 | Forward to forward | |
| 7 | Reverse to reverse | |

Set the operating pattern for normal mode autotuning.

| Pn26 | Overrun Limit Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 1000 | Unit | 0.1 revolution | Default setting | 10 | Power OFF→ON | --- |

- Use this parameter to set the Servomotor's allowable operating range for the position command input range.
- An overrun limit error (alarm code 34) will occur if the setting is exceeded.
- The function will be disabled if the setting is 0.

| Pn27 | Instantaneous Speed Observer Setting | | | | | | Position Speed |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 1 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Disabled |
| 1 | Enabled |

- The instantaneous speed observer can both increase the responsiveness and reduce vibration at stopping by improving the speed detection accuracy for devices with high rigidity.
- The Inertia Ratio (Pn20) must be set correctly.
- The Instantaneous Speed Observer Setting (Pn27) will be 0 (disabled) if the Realtime Autotuning Mode Selection (Pn21) is not set to 0 (enabled).

| Pn28 | Notch Filter 2 Frequency | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 100 to 1500 | Unit | Hz | Default setting | 1500 | Power OFF→ON | --- |

- Use this parameter to set the notch frequency of notch filter 2 for resonance suppression.
- The notch filter will be disabled if the setting is 1500.

| Pn29 | Notch Filter 2 Width | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 4 | Unit | --- | Default setting | 2 | Power OFF→ON | --- |

- Use this parameter to set the notch width of notch filter 2 for resonance suppression.
- Increasing the setting will increase the notch width. Normally, use the default setting.

| Pn2A | Notch Filter 2 Depth | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 99 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the notch depth of notch filter 2 for resonance suppression.
- Increasing the setting will decrease the notch depth and the phase lag.

| Pn2B | Vibration Frequency 1 | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2000 | Unit | 0.1 Hz | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set vibration frequency 1 for vibration control to suppress vibration at the end of the load.
- Measure the frequency at the end of the load and make the setting in units of 0.1 Hz.
- Setting frequency: 10.0 to 200.0 Hz. The function will be disabled if the setting is 0 to 9.9 Hz.

| Pn2C | Vibration Filter 1 Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | −200 to 2000 | Unit | 0.1 Hz | Default setting | 0 | Power OFF→ON | --- |

- First set the Vibration Frequency 1 (Pn2B). Then reduce the setting of Pn2C if torque saturation occurs or increase the setting of Pn2C to increase operation speed. Normally, use a setting of 0.
- Other than the setting range, the following restriction also applies: 10.0 Hz – Pn2B ≤ Pn2C ≤ Pn2B.

| Pn2D | Vibration Frequency 2 | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2000 | Unit | 0.1 Hz | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the vibration frequency 2 for vibration control to suppress vibration at the end of the load.
- Measure the frequency at the end of the load and make the setting in units of 0.1 Hz.
- Setting frequency: 10.0 to 200.0 Hz. The function will be disabled if the setting is 0 to 9.9 Hz.

| Pn2E | Vibration Filter 2 Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | −200 to 2000 | Unit | 0.1 Hz | Default setting | 0 | Power OFF→ON | --- |

- First set the Vibration Frequency 2 (Pn2D). Then reduce the setting of Pn2E if torque saturation occurs or increase the setting of Pn2E to increase operation speed. Normally, use a setting of 0.
- Other than the setting range, the following restriction also applies: 10.0 Hz – Pn2D ≤ Pn2E ≤ Pn2D.

| Pn2F | Adaptive Filter Table Number Display | | | | | Position Speed | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 64 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

## Explanation of Settings

| Displayed value | Notch Filter 1 Frequency (Hz) | Displayed value | Notch Filter 1 Frequency (Hz) | Displayed value | Notch Filter 1 Frequency (Hz) |
|---|---|---|---|---|---|
| 0 | Disabled | 22 | 766 | 44 | 326 |
| 1 | Disabled | 23 | 737 | 45 | 314 |
| 2 | Disabled | 24 | 709 | 46 | 302 |
| 3 | Disabled | 25 | 682 | 47 | 290 |
| 4 | Disabled | 26 | 656 | 48 | 279 |
| 5 | 1482 | 27 | 631 | 49 | 269 (Disabled when Pn22 ≥ F) |
| 6 | 1426 | 28 | 607 | 50 | 258 (Disabled when Pn22 ≥ F) |
| 7 | 1372 | 29 | 584 | 51 | 248 (Disabled when Pn22 ≥ F) |
| 8 | 1319 | 30 | 562 | 52 | 239 (Disabled when Pn22 ≥ F) |
| 9 | 1269 | 31 | 540 | 53 | 230 (Disabled when Pn22 ≥ F) |
| 10 | 1221 | 32 | 520 | 54 | 221 (Disabled when Pn22 ≥ E) |
| 11 | 1174 | 33 | 500 | 55 | 213 (Disabled when Pn22 ≥ E) |
| 12 | 1130 | 34 | 481 | 56 | 205 (Disabled when Pn22 ≥ E) |
| 13 | 1087 | 35 | 462 | 57 | 197 (Disabled when Pn22 ≥ E) |
| 14 | 1045 | 36 | 445 | 58 | 189 (Disabled when Pn22 ≥ E) |
| 15 | 1005 | 37 | 428 | 59 | 182 (Disabled when Pn22 ≥ D) |
| 16 | 967 | 38 | 412 | 60 | Disabled |
| 17 | 930 | 39 | 396 | 61 | Disabled |
| 18 | 895 | 40 | 381 | 62 | Disabled |
| 19 | 861 | 41 | 366 | 63 | Disabled |
| 20 | 828 | 42 | 352 | 64 | Disabled |
| 21 | 796 | 43 | 339 | | |

- This parameter displays the table entry number corresponding to the frequency of the adaptive filter.
- This parameter is set automatically and cannot be changed if the adaptive filter is enabled (if the Adaptive Filter Selection (Pn23) is not 0).
- When the adaptive filter is enabled, data will be saved in EEPROM every 30 min. If the adaptive filter is enabled the next time the power supply is turned ON, adaptive operation will start with the data saved in EEPROM as the default value.
  - To clear this parameter and reset the adaptive operation, disable the adaptive filter by setting the Adaptive Filter Selection (Pn23) to 0, and then enable it again.

| Pn30 | Gain Switching Input Operating Mode Selection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 1 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Gain 1 (PI/P switching enabled) |
| 1 | Gain 1/gain 2 switching enabled |

- Use this parameter to select whether to switch between PI and P operation or to switch between gain 1 and gain 2 in Speed Control Mode.
- PI/P operation switching is performed using gain switching (GSEL: CN1 pin 27). PI is not changed, however, if the Torque Limit Selection (Pn03) is set to 3.

| Gain input | Speed loop operation |
|---|---|
| COM open | PI operation |
| COM connection | P operation |

| Pn31 | Control Gain Switch 1 Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

Position Control Mode (○: Enabled, ×: Disabled)

| Setting | Explanation | | | |
|---|---|---|---|---|
| | Gain switching conditions | Gain Switch 1 Time (Pn32) *1 | Gain Switch 1 Level Setting (Pn33) | Gain Switch 1 Hysteresis Setting (Pn34) *2 |
| 0 | Always gain 1 (Pn10 to Pn14) | × | × | × |
| 1 | Always gain 2 (Pn18 to Pn1C) | × | × | × |
| 2 | Switching using Gain Switch Input (GSEL) for CN1 pin 27 | × | × | × |
| 3 | Amount of change in torque command (Figure A) | ○ | ○ *3 (× 0.05%) | ○ *3 (× 0.05%) |
| 4 | Always gain 1 (Pn10 to Pn14) | × | × | × |
| 5 | Command speed (Figure B) | ○ | ○ (r/min) | ○ (r/min) |
| 6 | Amount of position deviation (Figure C) | ○ | ○ *4 (Pulse) | ○ *4 (Pulse) |
| 7 | Command pulses received (Figure D) | ○ | × | × |
| 8 | Positioning Completed Signal (INP) OFF (Figure E) | ○ | × | × |
| 9 | Actual Servomotor speed (Figure B) | ○ | ○ (r/min) | ○ (r/min) |
| 10 | Combination of command pulse input and speed (Figure F) | ○ | ○ *5 (r/min) | ○ *5 (r/min) |

Speed Control Mode

| Setting | Explanation | | | |
|---|---|---|---|---|
| | Gain switching conditions | Gain Switch Time (Pn32, 37) *1 | Gain Switch Level Setting (Pn33, 38) | Gain Switch Hysteresis Setting (Pn34, 39) *2 |
| 0 | Always gain 1 (Pn10 to Pn14) | × | × | × |
| 1 | Always gain 2 (Pn18 to Pn1C) | × | × | × |
| 2 | Switching using Gain Switch Input (GSEL) for CN1 pin 27 | × | × | × |
| 3 | Amount of change in torque command (Figure A) | ○ | ○ *3 (0.05%/166 μs) | ○ *3 (0.05%/166 μs) |
| 4 | Amount of change in speed command (Figure B) | ○ | ○ *5 (10 r/min/s) | ○ *5 (10 r/min/s) |
| 5 | Command speed (Figure C) | ○ | ○ (r/min) | ○ (r/min) |

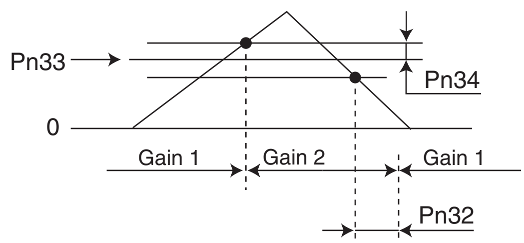
Torque Control Mode

| Setting | Explanation | | | |
|---|---|---|---|---|
| | Gain switching conditions | Gain Switch Time (Pn32, 37) *1 | Gain Switch Level Setting (Pn33, 38) | Gain Switch Hysteresis Setting (Pn34, 39) *2 |
| 0 | Always gain 1 (Pn10 to Pn14) | × | × | × |
| 1 | Always gain 2 (Pn18 to Pn1C) | × | × | × |
| 2 | Switching using Gain Switch Input (GSEL) for CN1 pin 27 | × | × | × |
| 3 | Amount of change in torque command (Figure A) | ○ | ○ *3 (0.05%/166 μs) | ○ *3 (0.05%/166 μs) |

- Use this parameter to select the conditions for switching between gain 1 and gain 2 when the Gain Switching Input Operation Mode Selection (Pn30) is set to 1.
- The gain is always gain 1 regardless of the gain input if the Control Gain Switch 1 Setting (Pn31) is 2 and the Torque Limit Selection (Pn03) is 3.

*1. The Gain Switch 1 Time (Pn32) is used when returning from gain 2 to gain 1.

*2. The Gain Switch 1 Hysteresis Setting (Pn34) is defined as shown in the following figure.




*3. The amount of change is the value within 166 μs.

Example: When the condition is a 10% change in torque in 166 μs, the set value is 200.

*4. This is the encoder resolution.

*5. The meanings of the Gain Switch Time, Gain Switch Level Setting, and Gain Switch Hysteresis Setting are different from normal if this parameter is set to 10. (Refer to Figure F.)

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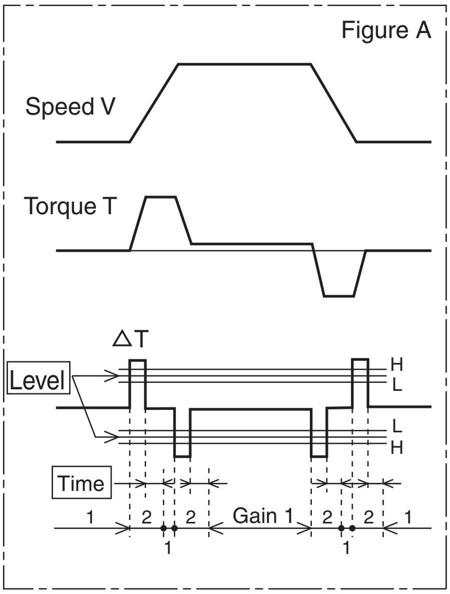
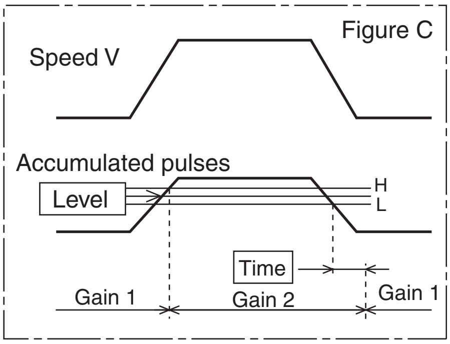
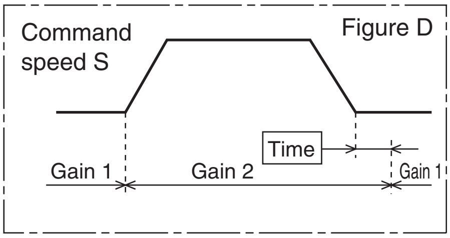
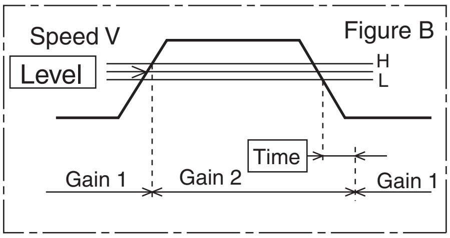
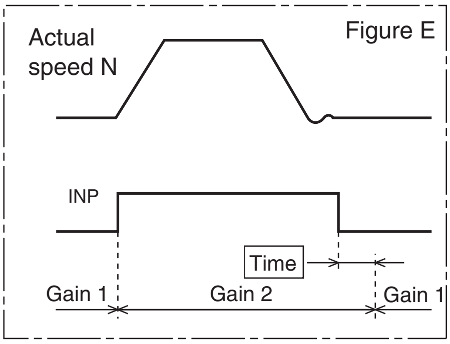
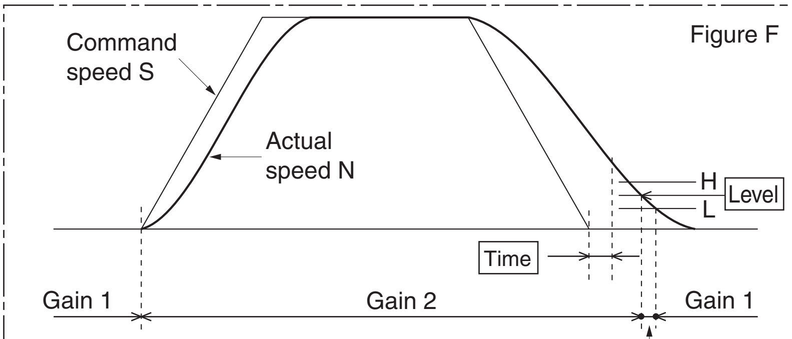



Gain 2 is used only during the Speed Loop Integration Time Constant.
Gain 1 is used at other times.

| Pn32 | Gain Switch 1 Time | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10000 | Unit | × 166 µs | Default setting | 30 | Power OFF→ON | --- |

- For Position Control Mode, use this parameter to set the delay time when returning from gain 2 to gain 1 if the Control Gain Switch 1 Setting (Pn31) is 3 or 5 to 10.
- For Speed Control Mode, use this parameter to set the delay time when returning from gain 2 to gain 1 if the Control Gain Switch 1 Setting (Pn31) is 3 to 5.

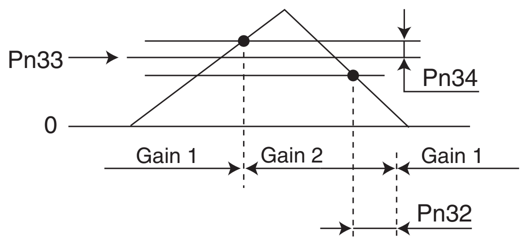
For Torque Control Mode, use this parameter to set the delay time when returning from gain 2 to gain 1 if the Control Gain Switch 1 Setting (Pn31) is 3.

| Pn33 | Gain Switch 1 Level Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 20000 | Unit | --- | Default setting | 600 | Power OFF→ON | --- |

- For Position Control Mode, use this parameter to set the judgment level for switching between gain 1 and gain 2. If the Control Gain Switch 1 Setting (Pn31) is set to 3, 5, 6, 9, or 10, Pn33 is enabled. The unit depends on the Control Gain Switch 1 Setting (Pn31).
- For Speed Control Mode, use this parameter to set the judgment level for switching between gain 1 and gain 2. If the Control Gain Switch 1 Setting (Pn31) is set to 3 to 5. Pn33 is enabled. The unit depends on the Control Gain Switch 1 Setting (Pn31).
- For Torque Control Mode, use this parameter to set the judgment level for switching between gain 1 and gain 2. If the Control Gain Switch 1 Setting (Pn31) is set to 3, Pn33 is enabled. The unit depends on the Control Gain Switch 1 Setting (Pn31).

| Pn34 | Gain Switch 1 Hysteresis Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 20000 | Unit | --- | Default setting | 50 | Power OFF→ON | --- |

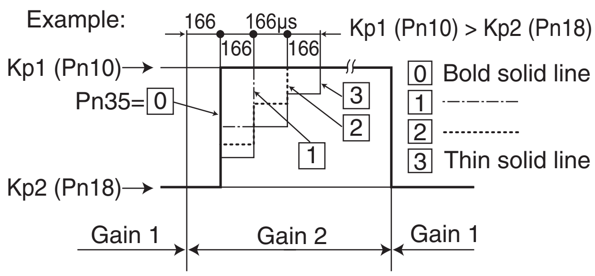
- Use this parameter to set the hysteresis width for the judgment level set in the Gain Switch 1 Level Setting (Pn33). The unit depends on the Control Gain Switch 1 Setting (Pn31). The following shows the definitions for the Gain Switch 1 Time (Pn32), Gain Switch 1 Level Setting (Pn33), and Gain Switch 1 Hysteresis Setting (Pn34).




- The settings for the Gain Switch 1 Level Setting (Pn33) and the Gain Switch 1 Hysteresis Setting (Pn34) are effective as absolute values (positive/negative).

| Pn35 | Position Loop Gain Switching Time | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10000 | Unit | × 166 μs | Default setting | 20 | Power OFF→ON | --- |

- When switching between gain 1 and gain 2 is enabled, set the phased switching time only for position loop gain at gain switching.

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| Pn36 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn37 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn38 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn39 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn3A | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn3B | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn3C | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn3D | Jog Speed | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 500 | Unit | r/min | Default setting | 200 | Power OFF→ON | --- |

- Use this parameter to set the speed for jog operation.

| Pn3E | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn3F | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

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## ■ Position Control Parameters (Pn40 to Pn4E)

| Pn40 | Command Pulse Input Selection | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Photocoupler input (+PULS: CN1 pin 3, –PULS: CN1 pin 4, +SIGN: CN1 pin 5, –SIGN: CN1 pin 6) |
| 1 | Line driver input (+CWLD: CN1 pin 44, –CWLD: CN1 pin 45, +CCWLD: CN1 pin 46, –CCWLD: CN1 pin 47) |

- Use this parameter to select whether to use photocoupler or line-driver input for the command pulse input.

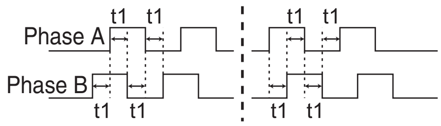
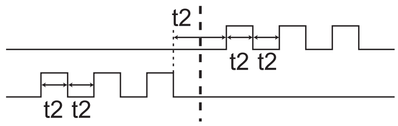
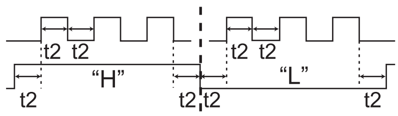
| Pn41 | Command Pulse Rotation Direction Switch | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | The Servomotor rotates in the direction specified by the command pulse. |
| 1 | The Servomotor rotates in the opposite direction from the direction specified by the command pulse. |

| Pn42 | Command Pulse Mode | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 1 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Command pulse mode | Servomotor forward command | Servomotor reverse command |
|---|---|---|---|
| 0 or 2 | 90° phase difference (phases A and B) signal inputs | <br><br>Line driver: t1 ≥ 2 µs<br>Open collector: t1 ≥ 5 µs | |
| 1 | Reverse pulse and forward pulse inputs | <br><br>Line driver: t2 ≥ 1 µs<br>Open collector: t2 ≥ 2.5 µs | |
| 3 | Feed pulse input and forward/reverse signal input | <br><br>Line driver: t2 ≥ 1 µs<br>Open collector: t2 ≥ 2.5 µs | |

- Use this parameter to set the form of the pulse inputs sent as commands to the Servo Drive from the position controller.

| Pn43 | Command Pulse Prohibited Input | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 1 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Enabled |
| 1 | Disabled |

- Use this parameter to enable or disable the Pulse Prohibit Input (IPG: CN1 pin 33).
- Command pulse inputs will be prohibited when the connection between the IPG input and COM is open.
- Set this parameter to 1 when the IPG input is not used. This will eliminate the necessity to externally connect the IPG input (CN1 pin 33) and COM (CN1 pin 41).

| **Pn44** | Encoder Divider Numerator Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 32767 | Unit | --- | Default setting | 2500 | Power OFF→ON | Yes |

| **Pn45** | Encoder Divider Denominator Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 32767 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

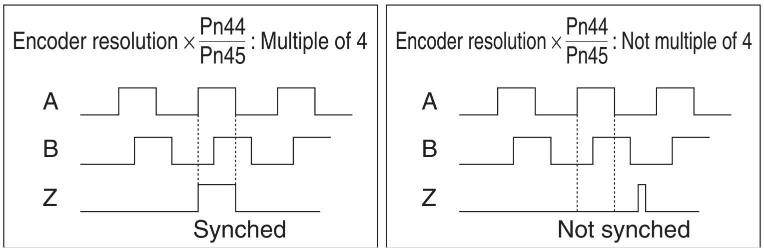
- Use this parameter to set the number of encoder pulses output from the pulse outputs (+A: CN1 pin 21, –A: CN1 pin 22, –B: CN1 pin 48, +B: CN1 pin 49)
- If the Encoder Divider Denominator Setting (Pn45) is 0, the number of output pulses for one Servomotor rotation can be set for A and B using the Encoder Divider Numerator Setting (Pn44). The resolution of the pulse output after multiplication by 4 will be as follows:

$$\text{Pulse output resolution per rotation} = \text{Encoder Divider Numerator Setting (Pn44)} \times 4$$

- If the Encoder Divider Denominator Setting (Pn45) is not 0, the pulse output resolution per rotation can be set using the following encoder divider equation.

$$\text{Pulse output resolution per rotation} = \frac{\text{Pn44 (Encoder Divider Numerator Setting)}}{\text{Pn45 (Encoder Divider Denominator Setting)}} \times \text{Encoder resolution}$$

- The encoder resolution for a 17-bit absolute encoder is 131,072 pulses/rotation and a 2,500-pulse/rotation, 5-core incremental encoder is 10,000 pulses/rotation.
- The pulse output resolution per rotation will never exceed the encoder resolution. (If the above settings are used, the pulse output resolution per rotation will be equal to the encoder resolution.)
- One phase-Z signal is output for each rotation of the Servomotor.
- If the value from the above equation is a multiple of 4, phases Z and A are synchronized. In all other cases, the output width of phase Z will coincide with the encoder resolution, so phases A and Z will not be synchronized.

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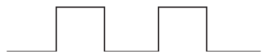
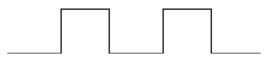
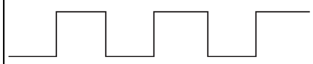
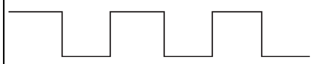
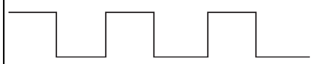
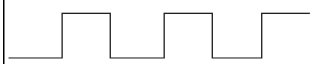
| Pn46 | Encoder Output Direction Switch | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 3 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

| Setting | Phase | Forward motor operation | Reverse motor operation |
|---|---|---|---|
| --- | Phase A |  |  |
| 0, 2 | Non-inverted phase B |  |  |
| 1, 3 | Inverted phase B |  |  |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Phase–B output: Not inverted, Output source: Encoder position |
| 1 | Phase–B output: Inverted, Output source: Encoder position |
| 2 | Phase-B output: Not inverted, Output source: External scale position |
| 3 | Phase-B output: Inversed, Output source: External scale position |

- Use this parameter to set the phase–B logic for pulse output (–B: CN1 pin 48, +B: CN1 pin 49).
- This parameter can be used to invert the output direction of the phase–B pulse to reverse the relation of the phase–B pulse to the phase-A pulse.

| Pn47 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

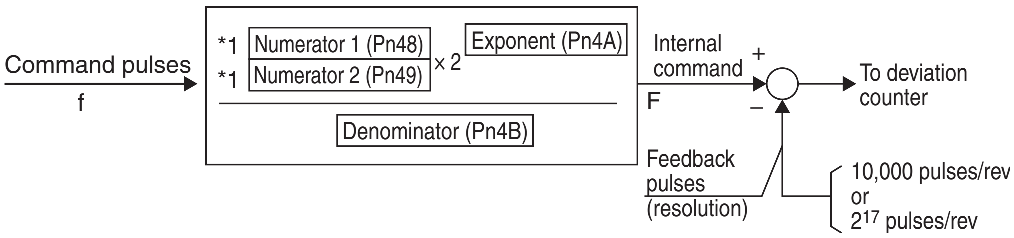
| Pn48 | Electronic Gear Ratio Numerator 1 | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10000 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

| Pn49 | Electronic Gear Ratio Numerator 2 | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 10000 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

| Pn4A | Electronic Gear Ratio Numerator Exponent | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 17 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

| Pn4B | Electronic Gear Ratio Denominator | | | | | Position | |
|---|---|---|---|---|---|---|---|
| Setting range | 1 to 10000 | Unit | --- | Default setting | 10000 | Power OFF→ON | --- |

- Use these parameters to set the electronic gear.
- The electronic gear can be used for the following:
  - To set the amount of Servomotor rotation or movement per input command pulse.
  - To increase the nominal command pulse frequency by using a multiplier when the desired Servomotor speed cannot be achieved due to the limited pulse oscillation capability of the host controller.
- Electronic Gear Block Diagram




*1. Numerator 1 or Numerator 2 is selected using the Electronic Gear Switch Input (GESEL: CN1 pin 28).

| | |
|---|---|
| GESEL input open | Numerator 1 (Pn48) selected. |
| GESEL input connected to COM | Numerator 2 (Pn49) selected. |

- The gear ratio is set using the following equations.

  If the numerator equals 0, the following value is set automatically.

  Numerator ((Pn48 or Pn49) $\times$ $2^{\text{Pn4A}}$) = Encoder resolution

  In this case, the number of command pulses per revolution can be set in Pn4B.

$$\text{Electronic gear ratio} = \frac{\text{Encoder resolution}}{\text{Number of command pulses per Servomotor rotation (Pn4B)}}$$

  If the numerator does not equal 0, the gear ratio is as follows:

$$\text{Electronic gear ratio} = \frac{\text{Electronic gear ratio numerator (Pn48 or Pn49)} \times 2^{\text{Electronic gear ratio numerator exponent (Pn4A)}}}{\text{Electronic gear ratio denominator (Pn4B)}}$$

The upper limit of the calculated numerator ((Pn48 or Pn49) $\times$ $2^{\text{Pn4A}}$) is 4,194,304/ (Pn4D setting + 1).

| Pn4C | Position Command Filter Time Constant Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 7 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

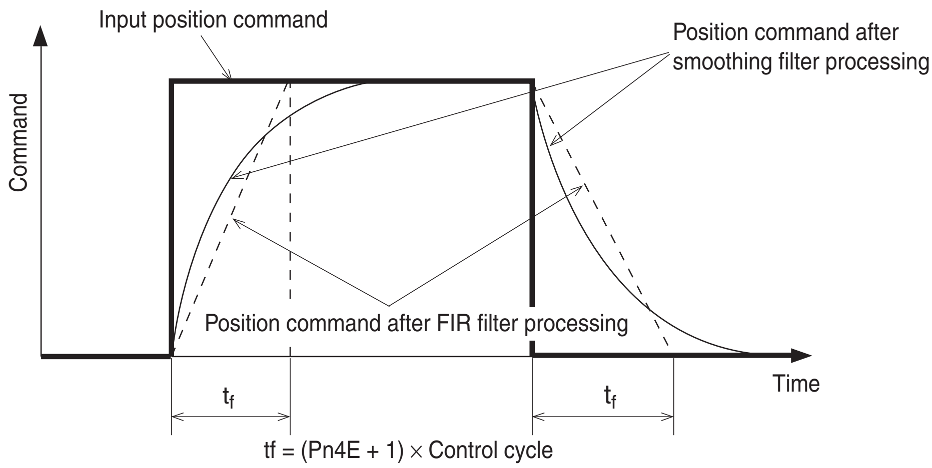
## Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | No filter |
| 1 | Time constant: 0.2 ms |
| 2 | Time constant: 0.6 ms |
| 3 | Time constant: 1.3 ms |
| 4 | Time constant: 2.6 ms |
| 5 | Time constant: 5.3 ms |
| 6 | Time constant: 10.6 ms |
| 7 | Time constant: 21.2 ms |

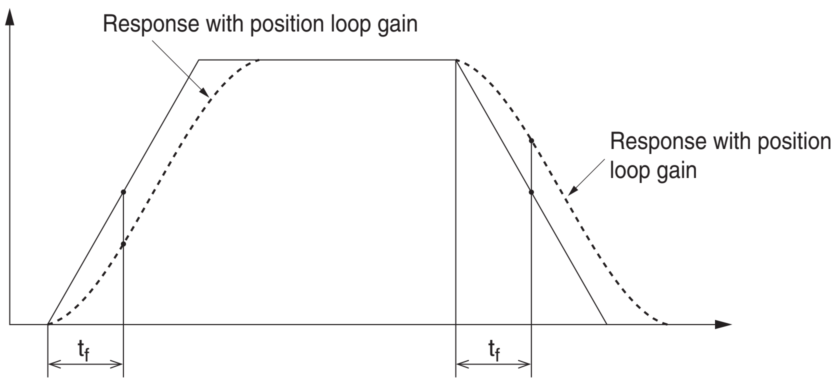
- The position command filter is the first-order lag filter for the command pulse input.
- The time constant of the position command filter can be set to one of eight values.
- The position command filter can be used for the following:
  - If the command pulses change abruptly, the filter can be used to reduce the stepping movement of the Servomotor.
  - The following are examples of when the command pulses can change abruptly:
    The electronic gear setting is high (10 times or higher).
    The command pulse frequency is low.

| Pn4D | Smoothing Filter Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 31 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

- Use this parameter to select the FIR filter time constant used for the command pulses (FIR: Finite impulse response).
- The higher the setting, the smoother the command pulses.



- If the setting is 0, the control cycle will be (0 + 1) × 166 = 166 μs.
  If the setting is 1, the control cycle will be (1 + 1) × 166 = 332 μs.
  Likewise, if the setting is 31, the control cycle will be (31 + 1) × 166 = 5,312 μs.



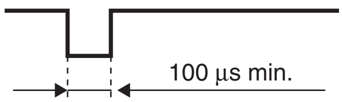

| Pn4E | Deviation Counter Reset Condition Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 1 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Clears the deviation counter when the signal is closed for 100 μs or longer. |
| 1 | Clears the deviation counter on the falling edge of the signal (open and then closed for 100 μs or longer). |
| 2 | Disabled |

- If Pn4E is set to 0, the minimum time width of the ECRST signal will be as follows:

ECRST (pin 30)




| Pn4F | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

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Appendix-2

## ■ Speed and Torque Control Parameters (Pn50 and Higher)

| Pn50 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn51 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn52 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn53 | No. 1 Internally Set Speed | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | –20000 to 20000 | Unit | r/min | Default setting | 100 | Power OFF→ON | --- |

| Pn54 | No. 2 Internally Set Speed | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | –20000 to 20000 | Unit | r/min | Default setting | 200 | Power OFF→ON | --- |

| Pn55 | No. 3 Internally Set Speed | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | –20000 to 20000 | Unit | r/min | Default setting | 300 | Power OFF→ON | --- |

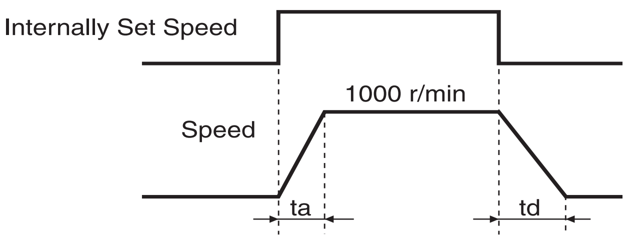
| Pn56 | No. 4 Internally Set Speed | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | –20000 to 20000 | Unit | r/min | Default setting | 50 | Power OFF→ON | --- |

| Pn57 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn58 | Soft Start Acceleration Time | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 5000 | Unit | 2 ms/ (1000 r/min) | Default setting | 0 | Power OFF→ON | --- |

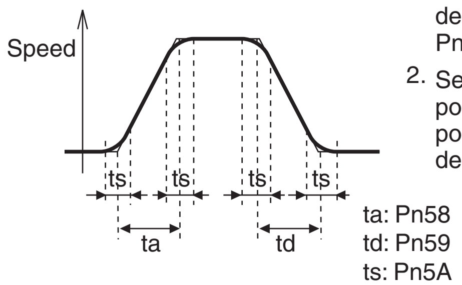
| Pn59 | Soft Start Deceleration Time | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 5000 | Unit | 2 ms/ (1000 r/min) | Default setting | 0 | Power OFF→ON | --- |

- A soft start can be set when inputting speed commands of stepping movement or when using internally set speed.
- Do not set acceleration and deceleration times when using the Servo Drive in combination with an external position loop. (Set both Pn58 and Pn59 to 0.)



| Pn5A | S-curve Acceleration/Deceleration Time Setting | | | | | Speed | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 500 | Unit | 2 ms | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the pseudo-S-curve acceleration/deceleration value to add to the speed command to enable smooth operation. This parameter is useful for applications where impact may occur due to a large change in acceleration or deceleration when starting or stopping with linear acceleration or deceleration.




1. Set the linear acceleration and deceleration times in Pn58 and Pn59.
2. Set the time width for the S-curve portion centered on the inflection points for acceleration and deceleration in Pn5A (unit: 2 ms).

Set as follows:

$$\frac{ta}{2} > ts \quad \text{and} \quad \frac{td}{2} > ts$$

| Pn5B | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

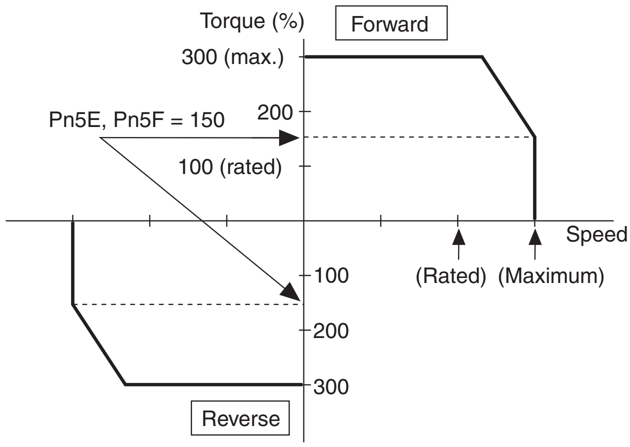
| Pn5C | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn5D | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn5E | No. 1 Torque Limit | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 500 | Unit | % | Default setting | 300 | Power OFF→ON | --- |

| Pn5F | No. 2 Torque Limit | | | | | Position Speed | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 500 | Unit | % | Default setting | 100 | Power OFF→ON | --- |

- Use these parameters to set the limit value for the output torque (Pn5E: No. 1 Torque Limit, Pn5F: No. 2 Torque Limit) of the Servomotor.
- The maximum torque in the forward and reverse directions is limited in Torque Control Mode, and the settings of the Torque Limit Selection (Pn03) and No. 2 Torque Limit (Pn5F) are ignored.
- Make the settings as a percentage of the rated torque.
  Example: Maximum torque is limited to 150%



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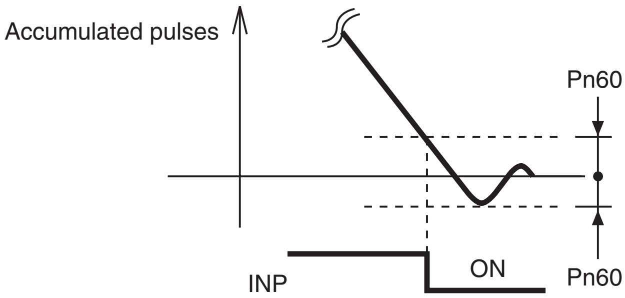
Appendix-2

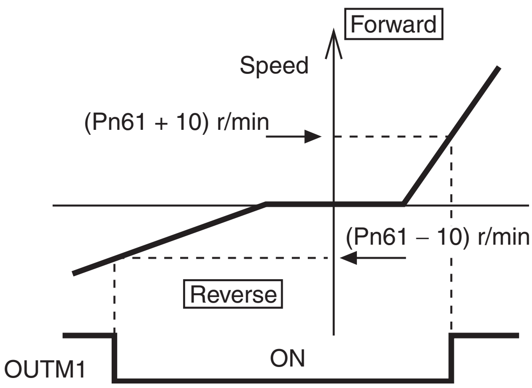
| Pn60 | Positioning Completion Range | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 32767 | Unit | Pulse | Default setting | 25 | Power OFF→ON | --- |

- Use this parameter in combination with the Positioning Completion Condition Setting (Pn63) to set the timing to output the Positioning Completed Output (INP: CN1 pin 39). The Positioning Completed Output (INP) will turn ON when command pulse input is completed, the Servomotor (workpiece) movement stops, and the number of the accumulated pulses in the deviation counter is less than the setting of this parameter.
- For position control, set the number of encoder pulses.
- The basic unit for accumulated pulses is the encoder resolution. The encoder resolutions are as follows:
  - 17-bit encoder: $2^{17}$ = 131,072
  - 2,500-pulse/revolution encoder: 4 × 2500 = 10000
- If this parameter is set to a very small value, the time required for the INP signal to turn ON will increase and the output may chatter. The setting of the Positioning Completion Range does not affect the precision of the final position.



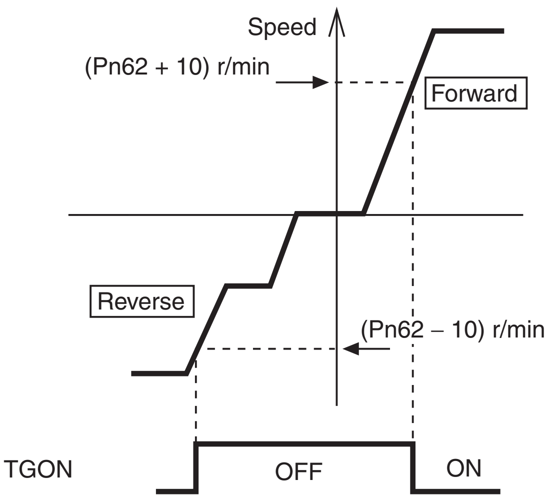

| Pn61 | Zero Speed Detection | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 10 to 20000 | Unit | r/min | Default setting | 20 | Power OFF→ON | --- |

- Use this parameter to set the rotation speed threshold at which to output a zero speed detection output or speed coincidence output from the general-purpose output (OUTM1: CN1 pin 12 or OUTM2: CN1 pin 40).
- If a speed detection output is assigned, an output will be made when the speed of the motor is lower than the value set for this parameter.
- If a speed coincidence output is assigned, an output will be made when difference between the speed command and the speed of the motor is lower than the value set for this parameter.
- The setting of this parameter is valid for both forward and reverse operation regardless of the Servomotor rotation direction. This setting has a hysteresis of 10 r/min.



| Pn62 | Rotation Speed for Motor Rotation Detection | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | 10 to 20000 | Unit | r/min | Default setting | 50 | Power OFF→ON | --- |

- Use this parameter to set the rotation speed (r/min) at which to output the Servomotor Rotation Detection Output (TGON: CN1 pin 39, TGONCOM: CN1 pin 38).
- The Servomotor Rotation Detection Output (TGON) will turn ON when the Servomotor speed exceeds the setting of this parameter.
- The setting of this parameter is valid for both forward and reverse operation regardless of the Servomotor direction. This setting has a hysteresis of 10 r/min.




| Pn63 | Positioning Completion Condition Setting | | | | | | Position |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Positioning completion output turns ON when the position deviation is within the Positioning Completion Range (Pn60). |
| 1 | Positioning completion output turns ON when the position deviation is within the Positioning Completion Range (Pn60) and there is no position command. |
| 2 | Positioning completion output turns ON when the zero speed detection signal is ON, the position deviation is within the Positioning Completion Range (Pn60), and there is no position command. |
| 3 | Positioning completion output turns ON when the position deviation is within the Positioning Completion Range (Pn60) and there is no position command. The ON status will be maintained until the next position command is received. |

- Use this parameter in combination with the Positioning Completion Range (Pn60) to set the operation for Positioning Completed Output (INP: CN1 pin 39).

| Pn64 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn65 | Undervoltage Alarm Selection | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 or 1 | Unit | --- | Default setting | 1 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | When the main power supply is interrupted during Servo ON status, a main power supply undervoltage alarm (alarm code 13) does not occur and the Servo OFF status is entered. When the main power supply turns ON again, the Servo ON status is reset. |
| 1 | When the main power supply is interrupted during Servo ON status, an error occurs for a main power supply undervoltage (alarm code 13). |

- Use this parameter to select whether to activate the main power supply undervoltage function (alarm code 13) if the main power supply is interrupted for the Momentary Hold Time (Pn6D).
- If the Momentary Hold Time (Pn6D) is set to 1,000, Pn65 is disabled.
- If the setting of Momentary Hold Time (Pn6D) is too long and the voltage between P and N in the main power supply converter drops below the specified value before a main power supply interruption is detected, a main power supply undervoltage (alarm code 13) will occur regardless of the setting of Pn65.

| Pn66 | Stop Selection for Drive Prohibition Input | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 2 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | During deceleration: The dynamic brake is activated. After stopping: The torque command in the drive prohibit direction is set to 0. Deviation counter contents: Held |
| 1 | During deceleration: The torque command in the drive prohibit direction is set to 0. After stopping: The torque command in the drive prohibit direction is set to 0. Deviation counter contents: Held |
| 2 | During deceleration: An emergency stop is performed. After stopping: The servo is locked. Deviation counter contents: Cleared before and after deceleration. |

- Use this parameter to set the drive conditions during deceleration or after stopping after the Forward Drive Prohibit Input (POT: CN1 pin 9) or Reverse Drive Prohibit Input (NOT: CN1 pin 8) is enabled.
- If this parameter is set to 2, the Emergency Stop Torque (Pn6E) will be used to limit the torque during deceleration.
- With a vertical axis, there is a risk that the load may drop when drive is prohibited by the drive prohibit input. To prevent this, it is recommended that the deceleration method be set to use emergency stop torque in the Drive Prohibit Input Stop Selection parameter (Pn66), and that stopping in the servo-lock state be set (set value: 2).

| Pn67 | Stop Selection with Main Power OFF | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 9 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation | | |
|---|---|---|---|
| | During deceleration | After stopping | Deviation counter |
| 0 | Dynamic brake | Dynamic brake | Cleared |
| 1 | Free run | Dynamic brake | Cleared |
| 2 | Dynamic brake | Servo free | Cleared |
| 3 | Free run | Servo free | Cleared |
| 4 | Dynamic brake | Dynamic brake | Held |
| 5 | Free run | Dynamic brake | Held |
| 6 | Dynamic brake | Servo free | Held |
| 7 | Free run | Servo free | Held |
| 8 | Emergency stop | Dynamic brake | Cleared |
| 9 | Emergency stop | Servo free | Cleared |

- Use this parameter to set the operation to be performed after the main power supply is shut off if the Undervoltage Alarm Selection (Pn65) is set to 0.
  - Operation during deceleration and after stopping
  - Clearing the deviation counter
- If this parameter is set to 8 or 9, the Emergency Stop Torque (Pn6E) will be used to limit the torque during deceleration.

| Pn68 | Stop Selection for Alarm Generation | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

### Explanation of Settings

| Setting | Explanation | | |
|---|---|---|---|
| | During deceleration | After stopping | Deviation counter |
| 0 | Dynamic brake | Dynamic brake | Held |
| 1 | Free run | Dynamic brake | Held |
| 2 | Dynamic brake | Servo free | Held |
| 3 | Free run | Servo free | Held |

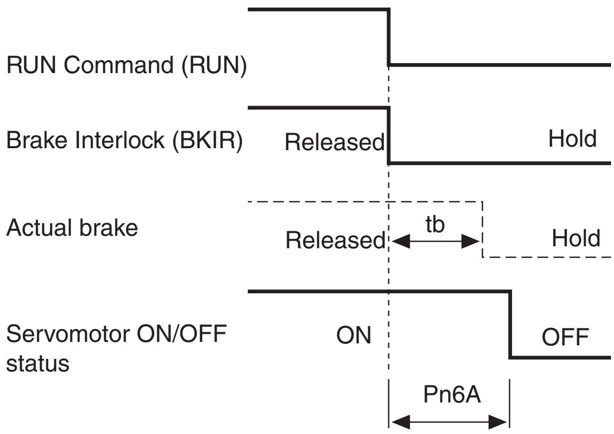
- Use this parameter to set the operation to be performed after stopping or during deceleration when any protective function of the Servo Drive operates and an error occurs.
- The deviation counter is cleared when an alarm is cleared.

| Pn69 | Stop Selection with Servo OFF | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 9 | Unit | --- | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the operation to be performed after Servo OFF status is entered (i.e., after RUN (CN1 pin 29) changes from ON to OFF).
  - Operation during deceleration and after stopping
  - Clearing the deviation counter
- The relations between set values, operation, and deviation counter processing for this parameter are the same as for the Stop Selection with Main Power OFF (Pn67).

| Pn6A | Brake Timing When Stopped | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 100 | Unit | 2 ms | Default setting | 10 | Power OFF→ON | --- |

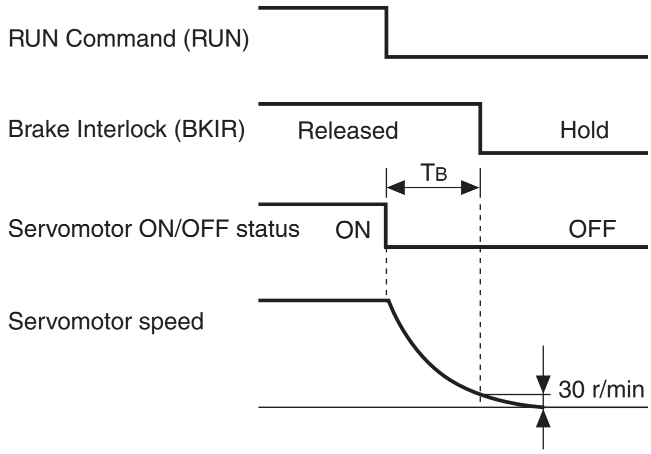
- Use this parameter to set the brake timing from when the Brake Interlock Output (BKIRCOM: CN1 pin 10, BKIR: CN1 pin 11) turns OFF (i.e., braking held) until the Servomotor is deenergized (servo free) when Servo OFF status is entered while the Servomotor is stopped.
- When the RUN Command Input is turned OFF while the Servomotor is stopped, the Brake Interlock Signal (BKIR) will turn OFF, and the Servo will turn OFF after the time set for this parameter (setting × 2 ms) elapses.




- Make the setting as follows to prevent the machine (workpiece) from moving or falling due to the delay in the brake operation (tb).
  Brake timing when stopped (setting × 2 ms) ≥ tb

| Pn6B | Brake Timing during Operation | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 100 | Unit | 2 ms | Default setting | 50 | Power OFF→ON | --- |

- Use this parameter to set the brake timing from when the RUN Command Input (RUN: CN1 pin 29) is detected to be OFF until the Brake Interlock Output (BKIRCOM: CN1 pin 10, BKIR: CN1 pin 11) turns OFF when Servo OFF status is entered while the Servomotor is operating.
  When the RUN Command Input is turned OFF while the Servomotor is operating, the Servomotor will decelerate reducing the number of rotations, and the Brake Interlock Signal (BKIR) will turn OFF after the time set for this parameter has elapsed (setting × 2 ms).




"TB" in the above figure is the brake timing during operation (setting × 2 ms) or the time until the speed of the Servomotor falls to 30 r/min or lower, whichever is shorter.

| Pn6C | Regeneration Resistor Selection | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 3 | Unit | --- | Default setting | 0 | Power OFF→ON | Yes |

### Explanation of Settings

| Setting | Explanation |
|---|---|
| 0 | Regeneration resistor used: Built-in resistor<br>The regeneration processing circuit will operate and the regeneration overload (alarm code 18) will operate according to the internal resistor (with approximately 1% duty). |
| 1 | Regeneration resistor used: External resistor<br>The regeneration processing circuit will operate, and regeneration overload (alarm code 18) will cause a trip when the operating rate of the regeneration resistor exceeds 10%. |
| 2 | Regeneration resistor used: External resistor<br>The regeneration processing circuit will operate, but regeneration overload (alarm code 18) will not. |
| 3 | Regeneration resistor used: None<br>The regeneration processing circuit and regeneration overload (alarm code 18) will not operate, and all regenerative energy will be processed by the built-in capacitor. |

- Do not touch the External Regeneration Resistor. It can be very hot and may cause burns.
- Always provide a temperature fuse or other protective measure when using an External Regeneration Resistor. Regardless of whether the regeneration overload is enabled or disabled, the External Regeneration Resistor can become extremely hot and may cause burning.
- Set this parameter depending on whether the built-in regeneration resistor is used, or the built-in regeneration resistor is disconnected and an External Regeneration Resistor is connected. (The External Regeneration Resistor is connected between B1 and B2.)
- To use the built-in regeneration resistor, always set this parameter to 0.

| Pn6D | Momentary Hold Time | | | | | All modes | |
|---|---|---|---|---|---|---|---|
| Setting range | 35 to 1000 | Unit | 2 ms | Default setting | 35 | Power OFF→ON | Yes |

- Use this parameter to set the amount of time required until shutoff is detected if the main power supply remains shut off.
- The main power OFF detection will be disabled if this parameter is set to 1000.

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Appendix-2

| Pn6E | Emergency Stop Torque | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 500 | Unit | % | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the torque limit for the following cases.
  - Drive prohibit deceleration with the Stop Selection for Drive Prohibition Input (Pn66) set to 2.
  - Deceleration with the Stop Selection with Main Power OFF (Pn67) set to 8 or 9.
  - Deceleration with the Stop Selection with Servo OFF (Pn69) set to 8 or 9.
- The normal torque limit will be used if this parameter is set to 0.

| Pn6F | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn70 | Deviation Counter Overflow Level | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 32767 | Unit | 256 × resolution | Default setting | 100 | Power OFF→ON | --- |

- Use this parameter to set the deviation counter overflow level.
- The set value is calculated using the following formula.
  Set value = Deviation counter overflow detection pulses [pulses]/256
- If the positioning loop gain is small and the setting of this parameter is too small, a deviation counter overflow (alarm code 24) may be detected even during normal operation.
- Deviation counter overflow (alarm code 24) will not be detected if this parameter is set to 0.

| Pn71 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn72 | Overload Detection Level Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 500 | Unit | % | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the overload detection level.
- The overload detection level will be 115% if this parameter is set to 0.
- This parameter should normally be set to 0. The setting should be changed only when it is necessary to reduce the overload detection level.
- The setting of this parameter is limited to 115% of the Servomotor rating.

| Pn73 | Overspeed Detection Level Setting | | | | | | All modes |
|---|---|---|---|---|---|---|---|
| Setting range | 0 to 20000 | Unit | r/min | Default setting | 0 | Power OFF→ON | --- |

- Use this parameter to set the overspeed detection level.
- The overspeed detection level will be 1.2 times the maximum Servomotor rotation speed if this parameter is set to 0.
- This parameter should normally be set to 0. The setting should be changed only when it is necessary to reduce the overspeed detection level.
- The setting of this parameter is limited to 1.2 times the maximum Servomotor rotation speed.
- The detection margin of error for the setting is ±3 r/min for a 7-core absolute encoder and ±36 r/min for a 5-core incremental encoder.

| Pn74 | No. 5 Internally Set Speed | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | –20000 to 20000 | Unit | r/min | Default setting | 500 | Power OFF→ON | --- |

| Pn75 | No. 6 Internally Set Speed | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | –20000 to 20000 | Unit | r/min | Default setting | 600 | Power OFF→ON | --- |

| Pn76 | No. 7 Internally Set Speed | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | –20000 to 20000 | Unit | r/min | Default setting | 700 | Power OFF→ON | --- |

| Pn77 | No. 8 Internally Set Speed | | | | | | Speed |
|---|---|---|---|---|---|---|---|
| Setting range | –20000 to 20000 | Unit | r/min | Default setting | 800 | Power OFF→ON | --- |

| Pn78 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn79 | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn7A | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn7B | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn7C | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn7D | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn7E | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

| Pn7F | Reserved | | | | | | |
|---|---|---|---|---|---|---|---|
| Setting range | --- | Unit | --- | Default setting | --- | Power OFF→ON | --- |

# 10-6 Trial Operation

## Preparation for Trial Operation

### ■ Checks before Trial Operation

Check the following items before starting trial operation.

#### Wiring

- Make sure that all wiring is correct, especially 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.

#### Motor Installation

- Make sure that the Servomotor has been securely installed.

#### Disconnection from Mechanical System

- If necessary, make sure that the Servomotor has been disconnected from the mechanical system.

#### Brake

- Make sure that the brake has been released.



## Trial Operation in Position Control Mode

1. **Connect connector CN1.**
2. **Input power (12 to 24 VDC) for the control signals (+24VIN, COM).**
3. **Turn ON the power supply to the Servo Drive.**
4. **Confirm that the parameters are set to the standard settings.**
5. **Set the outputs from the host device to agree with the Command Pulse Mode (Pn42).**
6. **Write the parameters to EEPROM and then turn OFF the power supply and turn it ON again.**
7. **Connect the RUN Command Input (RUN: CN1 pin 29) to COM (CN1 pin 41).**
   **Servo ON status will be entered and the Servomotor will be activated.**
8. **Input a low-frequency pulse signal from the host device to start low-speed operation.**
9. **Check the Servomotor rotation speed in Monitor Mode.**
   Check to see if the Servomotor is rotating at the specified speed and to see if the Servomotor stops when the command pulses are stopped.

# 10-7 Adjustment Functions

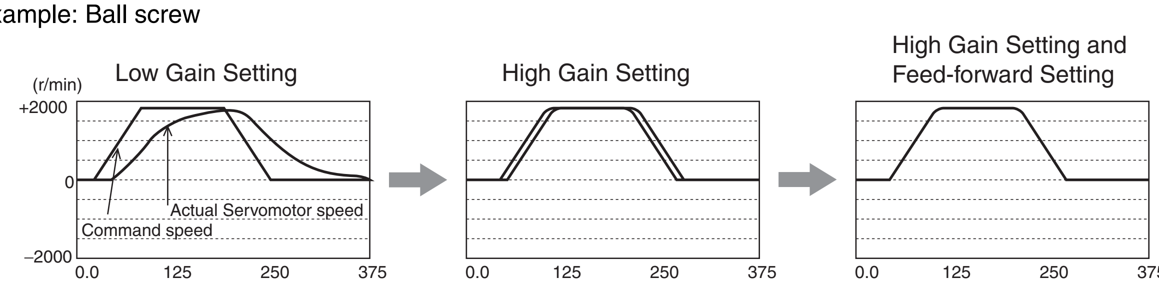
## 10-7-1 Gain Adjustment

SMARTSTEP 2 750 W Model Servo Drive provide realtime autotuning and normal mode autotuning functions. With these functions, gain adjustments can be made easily even by those who use a servo system for the first time. If you cannot obtain desired responsiveness with autotuning, use manual tuning.

### Purpose of the Gain Adjustment

The Servomotor must operate 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 Servomotor as close as possible to the operations specified by the commands, and to maximize the performance of the machine.

Example: Ball screw




| | Low Gain Setting | High Gain Setting | High Gain Setting and Feed-forward Setting |
|---|---|---|---|
| Position Loop Gain: | 20 | 70 | 100 |
| Speed Loop Gain: | 40 | 50 | 80 |
| Speed Loop Integration Time Constant: | 50 | 30 | 20 |
| Speed feed-forward | 0 | 0 | 500 |
| Inertia Ratio: | 300 | 300 | 300 |

## Gain Adjustment Methods

| Function | | | Explanation |
|---|---|---|---|
| Automatic adjustment | Realtime autotuning | | Realtime autotuning estimates the load inertia of the mechanical system in realtime and automatically sets the optimal gain according to the estimated load inertia. |
| | | Fit gain function | The fit gain function automatically searches for the appropriate rigidity setting by repeating input of an operation with a specified pattern to automatically make the rigidity setting for realtime autotuning when position control is performed. |
| | Adaptive filter | | The adaptive filter reduces resonance point vibration by estimating the resonance frequency from the vibration component that appears in the Servomotor speed during actual operation and automatically sets the coefficient of the notch filter, which removes the resonance component from the torque command. |
| | Normal Mode Autotuning | | Normal mode autotuning automatically sets the appropriate gain by operating the Servomotor with the command pattern automatically generated by the Servo Drive and estimating the load inertia from the torque required at that time. |
| | Automatic gain adjustment reset | | This function disables the default settings for realtime autotuning and the adaptive filter. |
| Manual adjustment | Manual tuning (basic) | | Manual tuning is performed if autotuning cannot be executed due to restrictions on the control mode or load conditions or if ensuring the maximum responsiveness to match each load is required. |
| | | Basic procedure | Position control mode adjustment |
| | | | Speed control mode adjustment |
| | | | Torque control mode adjustment |
| | | Gain switching | Gain switching can be used with internal data or external signals to perform such actions as reducing vibration at stopping, shortening stabilization time, and improving command follow-up. |
| | | Machine resonance suppression | It is sometimes not possible to set the gain high because of vibration or sound due to resonance caused by shaft contortion when the machine rigidity is low. In these cases, two types of filters can be used to suppress resonance. |
| | | Automatic gain setting | This function initializes control parameters and gain switching parameters to settings that match the normal mode autotuning rigidity parameters before manual tuning is performed. |
| | Manual tuning (application) | | The following application functions can be used to further improve performance if the specifications cannot be satisfied using basic adjustment. |
| | | Instantaneous speed observer | The instantaneous speed observer both increases responsiveness and reduces vibration at stopping by estimating the Servomotor speed using a load model and improving the speed detection accuracy. |
| | | Vibration control | Vibration control reduces vibration by removing the vibration frequency component from the command when the end of mechanisms or devices vibrates. |

**Note 1.** Take sufficient care for safety.

**Note 2.** If oscillation occurs (e.g., abnormal sound or vibration), immediately turn OFF the power supply or let the servo OFF status occur.

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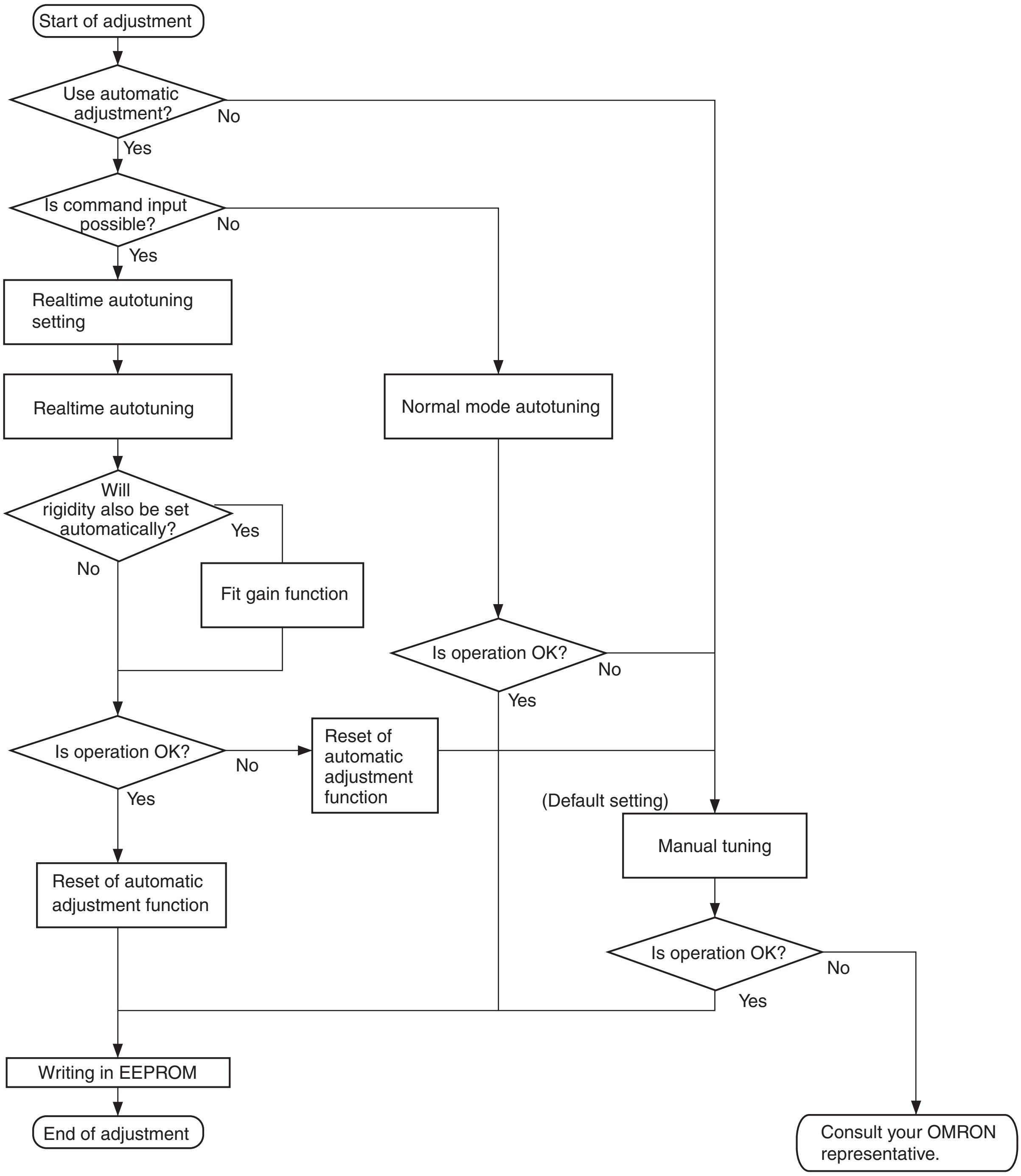
Appendix-2

## Gain Adjustment Procedure




### ■ Gain Adjustment and Machine Rigidity

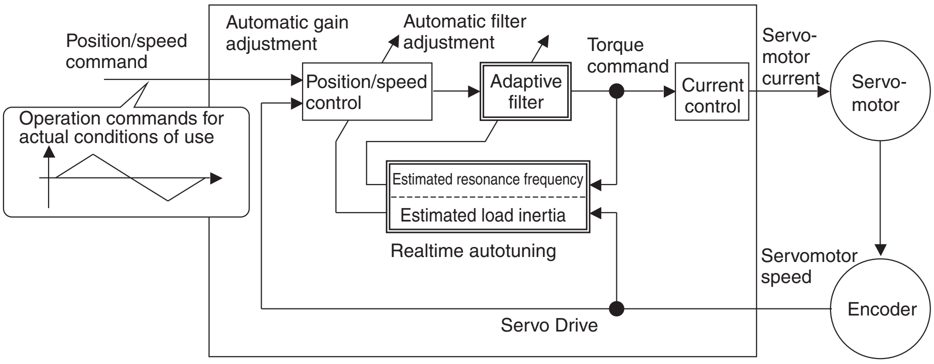
Do the following to increase the machine rigidity:

- Install the machine on a secure base so that it does not wobble.
- Use couplings that have a high rigidity, and that are designed for servo systems.
- Use a wide timing belt, and use a tension within the allowable axial load for the Servomotor.
- Use gears with small backlash.

  The specific vibration (resonance frequency) of the mechanical system has a large impact on the gain adjustment. The servo system responsiveness cannot be set high for machines with a low resonance frequency (low machine rigidity).

## 10-7-2 Realtime Autotuning

Realtime autotuning estimates the load inertia of the machine in realtime, and automatically sets the optimal gain according to the estimated load inertia.




**Precautions for Correct Use**

- Realtime autotuning may not function properly under the conditions described in the following table. If realtime autotuning does not function properly, use normal mode autotuning or manual tuning.

| | Conditions under which realtime autotuning does not function properly |
|---|---|
| Load inertia | • If the load inertia is too small or too large compared with the rotor inertia (i.e., less than 3 times, more than 20 times, or more than the applicable load inertia ratio).<br>• If the load inertia changes quickly, i.e., in less than 10 seconds. |
| Load | • If the machine rigidity is extremely low.<br>• If there is backlash or play in the system. |
| Operating pattern | • If the speed is continuously run at a low speed below 100 r/min.<br>• If the acceleration/deceleration gradually changes at less than 2,000 r/min in 1 s.<br>• If the acceleration/deceleration torque is too small compared with the unbalanced load and the viscous friction torque.<br>• If a speed of 100 r/min or an acceleration/deceleration of 2,000 r/min/s does not continue for at least 50 ms. |

**1. Stop the Servomotor (i.e., turn the servo OFF).**

**2. Set the Realtime Autotuning Mode Selection (Pn21) to 1 to 7.**

The default setting is 1.

| Setting | Realtime Autotuning | Degree of change in load inertia during operation |
|---|---|---|
| 0 | Not used | --- |
| 1 | Normal mode | No change in load inertia |
| 2 | | Gradual changes in load inertia |
| 3 | | Sudden changes in load inertia |
| 4 | Vertical axis mode | No change in load inertia |
| 5 | | Gradual changes in load inertia |
| 6 | | Sudden changes in load inertia |
| 7 | No gain switching mode | No change in load inertia |

When the degree of load inertia change is high, set the value to 3 or 6.
Use a setting of 4 to 6 when the vertical axis is used.
Use setting 7 if vibration occurs due to gain switching.

**3. Set the Realtime Autotuning Machine Rigidity Selection (Pn22) to 0 or a low value.**

**4. Turn the servo ON, and operate the machine as normally.**

**5. To increase system responsiveness, gradually increase the setting of the Realtime Autotuning Machine Rigidity Selection (Pn22).**

If the machine produces unusual noise or oscillation, return the Realtime Autotuning Machine Rigidity Selection to a low value (e.g., 0 to 3) immediately.

**6. Write data to the EEPROM if the results are to be saved.**

## Operating Procedure

| | |
|---|---|
| Insert the Parameter Unit connector into CN3B of the Servo Drive and turn ON the Servo Drive power supply. | r 0 |
| **Setting Parameter Pn21** | |
| Press the DATA key. | Un_SPd |
| Press the key. | Pn_ 00. |
| Select the number of the parameter to be set by using the and keys. | Pn_ 21. |
| (Pn21 is selected in this example.) | |
| Press the DATA key. | 1. |
| Change the value by using the and keys. | |
| Press the DATA key. | Pn_ 21. |
| **Setting Parameter Pn22** | |
| Select Pn22 by using the key. | Pn_ 22. |
| Press the DATA key. | 4 (Default setting) |
| Increase the value by using the key. | |
| Decrease the value by using the key. | |
| Press the DATA key. | |
| **Writing to EEPROM** | |
| Press the key. | EE_SEt. |
| Press the DATA key. | EEP -. |
| The bars as shown in the figure on the right will increase when the key is pressed down for approx. 5 s. | EEP --. → ------. |
| Writing will start (momentary display). | StArt |
| End | FiniSh. / rESEt . (Writing completed.) — Error . (Writing error occurred.) |



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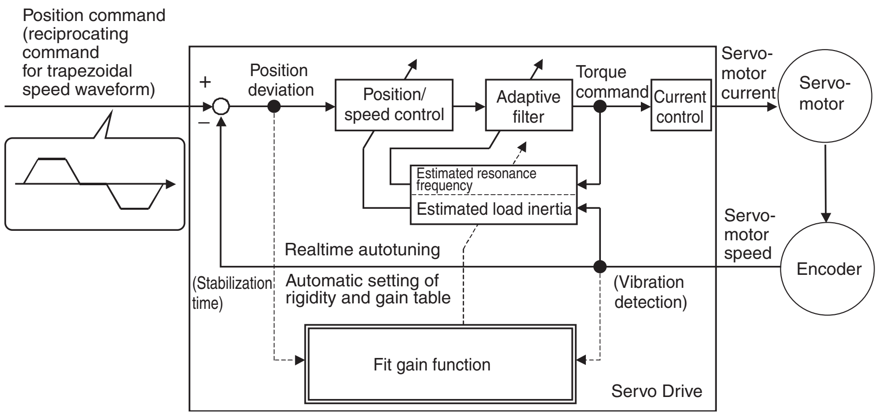
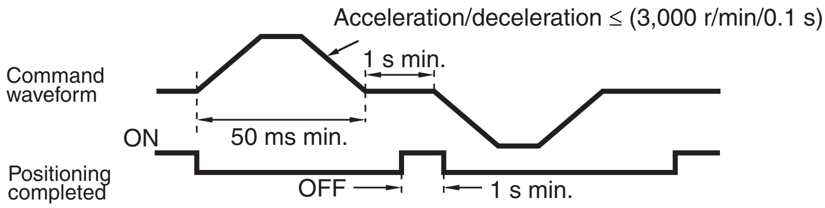
Appendix-2

## Filt Gain Function

SMARTSTEP 2 750 W Model include a fit gain function that automatically sets the rigidity to match the device when realtime autotuning is used at position control. A fully automatic search is performed for the optimal rigidity setting by repeating a specified reciprocating operation with position control.




| **Precautions for Correct Use** | • To be applicable, this function must satisfy the following conditions in addition to the conditions for realtime autotuning. |
|---|---|

| | Conditions under which the fit gain functions properly |
|---|---|
| Realtime autotuning operation | • The realtime autotuning operates normally.<br>• The Servo is ON.<br>• Pn21= 1 to 6. (Operation is not possible if Pn21 is 0 or 7.) |
| Adaptive filter | • The adaptive filter is enabled.<br>Pn23 = 1: Enabled |
| Control mode | • The control mode is position control.<br>Pn02 = 0: Position control |
| Operating pattern | • The position command is for reciprocating operation.<br>• The time per position command is at least 50 ms.<br>• The minimum frequency for the position command is 1 kpps.<br> |

• In addition to the precautions for realtime autotuning, be aware of the following conditions under which operation may not be performed correctly. If that occurs, use normal realtime autotuning.

| | Conditions under which the fit gain does not function properly |
|---|---|
| Operating pattern | • One position command is too short, i.e., less than two revolutions.<br>• Positioning is not completed after the position command is completed and before the next position command starts.<br>• The acceleration/deceleration is sudden, i.e., 3,000 r/min/0.1 s. |

Before starting the fit gain function, make the following settings using the fit gain window on the front panel, parameter setting mode, the Parameter Unit, or CX-Drive.

| Parameter | Setting | Remarks |
|---|---|---|
| Realtime Autotuning Mode Selection (Pn21) | Make one of the following settings.<br>1: Normal mode (almost no change)<br>2: Normal mode (gradual change)<br>3: Normal mode (sudden change)<br>4: Vertical axis mode (almost no change)<br>5: Vertical axis mode (gradual change)<br>6: Vertical axis mode (sudden change) | The parameters at the left can also be set using the execution display in the fit gain window on the front panel. |
| Realtime Autotuning Machine Rigidity Selection (Pn22) | 0: Realtime rigidity No. 0 | |
| Adaptive Filter Selection (Pn23) | 1: Enabled | |
| Positioning Completion Range (Pn60) | 17-bit encoder: 20 pulses min.<br>2,500 P/r encoder: 10 pulses min. | |

## ■ Operating Procedure

**1. Set the front panel display to the execution display of the fit gain window.**

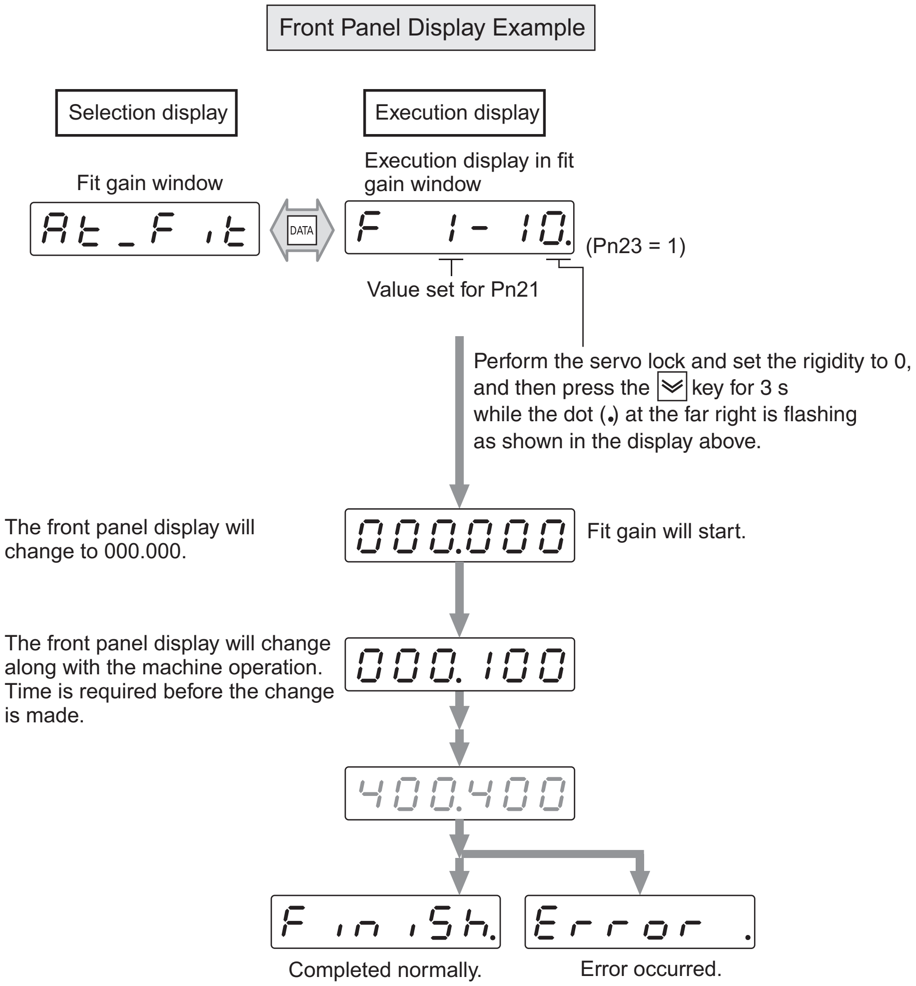
**2. With the dot at the far right flashing, decrease the rigidity to 0, and press the Decrement key on the front panel for 3 s min. to start the fit gain function.**

**3. Input a position command that satisfies the operating pattern conditions.**

If the fit gain is completed normally, Finish will be displayed, and Error will be displayed if it is completed with an error. (The Error display can be cleared using the keys.)

- Time is required for the change to be made for fit gain operation. It may take approximately 2 or 3 min. depending on the equipment configuration, which may require up to approximately 50 reciprocating operations. Normally, the fit gain will be completed when the optimal realtime rigidity number is found.
- Error will be displayed in the following cases.
  - The INP signal becomes unstable, or a realtime rigidity number without small vibration is not found.
  - The keys on the front panel are used while fit gain is operating or the applicable conditions are not satisfied.

## ■ Operating Procedure

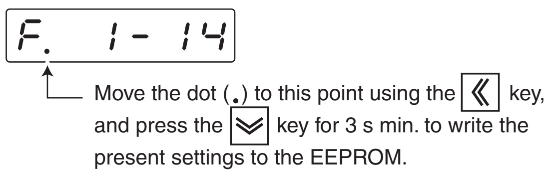







## ■ Fit Gain Results

If fit gain is completed normally, [Finish display] will be displayed, and [Error display] will be displayed if it is completed with an error. To apply the results obtained from fit gain after resetting the power supply, write the data to the EEPROM. (Refer to the following description.)



## ■ Automatically Set Parameters

The following parameters are set automatically.

| Parameter No. | Parameter name |
|---|---|
| Pn10 | Position Loop Gain |
| Pn11 | Speed Loop Gain |
| Pn12 | Speed Loop Integration Time Constant |
| Pn13 | Speed Feedback Filter Time Constant |
| Pn14 | Torque Command Filter Time Constant |
| Pn18 | Position Loop Gain 2 |
| Pn19 | Speed Loop Gain 2 |
| Pn1A | Speed Loop Integration Time Constant 2 |
| Pn1B | Speed Feedback Filter Time Constant 2 |
| Pn1C | Torque Command Filter Time Constant 2 |
| Pn20 | Inertia Ratio |
| Pn22 | Realtime Autotuning Machine Rigidity Selection |

The following parameters are set automatically. (The settings will not change even if realtime autotuning is executed.)

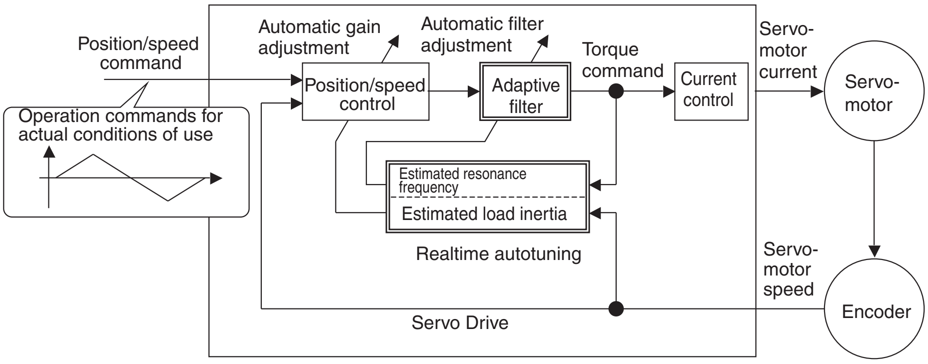
| Parameter No. | Parameter name | Set value |
|---|---|---|
| Pn15 | Speed Feed-forward Amount | 300 |
| Pn16 | Feed-forward Command Filter | 50 |
| Pn27 | Instantaneous Speed Observer Setting | 0 |
| Pn30 | Gain Switching Input Operating Mode Selection | 1 |
| Pn31 | Control Gain Switch 1 Setting | 10 |
| Pn32 | Gain Switch 1 Time | 30 |
| Pn33 | Gain Switch 1 Level Setting | 50 |
| Pn34 | Gain Switch 1 Hysteresis Setting | 33 |
| Pn35 | Position Loop Gain Switching Time | 20 |

**Precautions for Correct Use**

- Some degree of noise or vibration may occur during fit gain operation, but this is normally not a problem because the gain is lowered automatically. If the noise or vibration continues, however, press any key on the front panel to cancel the fit gain operation.

## Adaptive Filter

The adaptive filter reduces resonance point vibration by estimating the resonance frequency from the vibration component that appears in the Servomotor speed during actual operation, and automatically sets the coefficient of the notch filter. This removes the resonance component from the torque command.




**Precautions for Correct Use**

- The adaptive filter operates under the following conditions.

| | Conditions under which the adaptive filter operates |
|---|---|
| Control mode | • The control mode is not torque control. |

- The adaptive filter may not operate correctly under the following conditions. If it does not, take measures against resonance by following the manual adjustment procedure using Notch Filter 1 (Pn1D/1E) or Notch Filter 2 (Pn28 to 2A).
- Adaptive filter may not operate correctly under the following conditions.

| | Conditions under which the adaptive filter does not function properly |
|---|---|
| Resonance points | • If the resonance frequency is 300 Hz or lower.<br>• If the resonance peak or control gain is low, and the Servomotor speed is not affected by it.<br>• If there are multiple points of resonance. |
| Load | • If the Servomotor speed with high-frequency components changes due to backlash or other non-linear elements. |
| Command pattern | • If the acceleration/deceleration suddenly changes, i.e. 3,000 r/min or more in 0.1 s. |

### ■ Operating Procedure

**1. Set the Adaptive Filter Selection (Pn23) to 1.**

The adaptive filter will be enabled.

| Setting | Adaptive filter | Adaptive operation |
|---|---|---|
| 0 | Disabled | --- |
| 1 | Enabled | Yes |
| 2 | | Yes (hold) |

Set the Adaptive Filter Selection to 2 if the resonance point may not have changed when the adaptive operation is completed (i.e., Pn2F does not change).

**2. Write the data to the EEPROM if the results are to be saved.**

**Precautions for Correct Use**

- An unusual noise or vibration may occur until the adaptive filter stabilizes after startup, immediately after the first servo ON, or when the Realtime Autotuning Machine Rigidity Selection (Pn22) is increased, but this is not a problem if it disappears right away. If the unusual noise or vibration, however, continues for three or more reciprocating operations, take one or more of the following measures.
  - Write the parameters used during normal operation to the EEPROM.
  - Lower the Realtime Autotuning Machine Rigidity Selection (Pn22).
  - Disable the adaptive filter by setting the Adaptive Filter Selection (Pn23) to 0 (resetting the inertia estimation and the adaptive operation).
  - Manually set the notch filter.
- Once unusual noise or vibration occurs, the Adaptive Filter Table Number Display (Pn2F) may have changed to an extreme value. In this case, also take the measures described above.
- The Adaptive Filter Table Number Display (Pn2F) is written to the EEPROM every 30 minutes, and when the power supply is turned OFF and turned ON again, this data is used as the initial values for the adaptive operation.
- The adaptive filter is normally disabled when torque control is performed.

## Automatically Set Parameters

The following parameters are set automatically.

| Parameter No. | Parameter name |
|---|---|
| Pn10 | Position Loop Gain |
| Pn11 | Speed Loop Gain |
| Pn12 | Speed Loop Integration Time Constant |
| Pn13 | Speed Feedback Filter Time Constant |
| Pn14 | Torque Command Filter Time Constant |
| Pn18 | Position Loop Gain 2 |
| Pn19 | Speed Loop Gain 2 |
| Pn1A | Speed Loop Integration Time Constant 2 |
| Pn1B | Speed Feedback Filter Time Constant 2 |
| Pn1C | Torque Command Filter Time Constant 2 |
| Pn20 | Inertia Ratio |

The settings for the following parameters are automatically set and cannot be changed. (The settings will not change even if realtime autotuning is executed.)

| Parameter No. | Parameter name | Set value |
|---|---|---|
| Pn15 | Speed Feed-forward Amount | 300 |
| Pn16 | Feed-forward Command Filter | 50 |
| Pn27 | Instantaneous Speed Observer Setting | 0 |
| Pn30 | Gain Switching Input Operating Mode Selection | 1 |
| Pn31 | Control Gain Switch 1 Setting | 10 |
| Pn32 | Gain Switch 1 Time | 30 |
| Pn33 | Gain Switch 1 Level Setting | 50 |
| Pn34 | Gain Switch 1 Hysteresis Setting | 33 |
| Pn35 | Position Loop Gain Switching Time | 20 |

**Note 1.** Parameters that are automatically set cannot be changed if realtime autotuning is enabled.

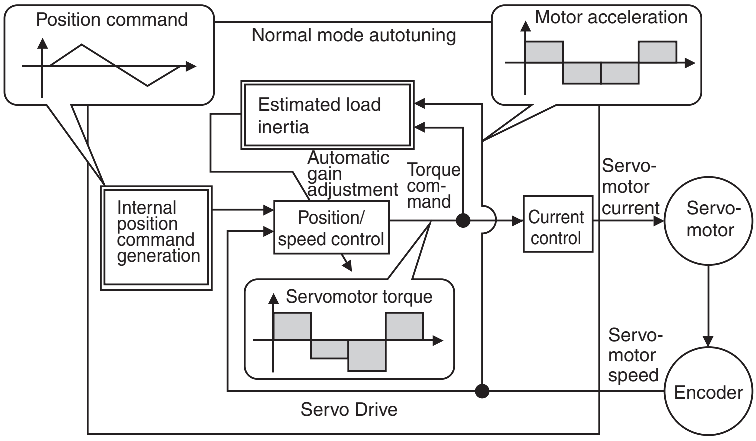
**Note 2.** Pn31 is 10 when position control is used and the Realtime Autotuning Mode Selection (Pn21) is set to 1 to 6. Otherwise, it is 0.

**Precautions for Correct Use**

- Unusual noise or vibration may occur until the load inertia is estimated or the adaptive filter stabilizes after startup, immediately after the first servo turns ON, or when the Realtime Autotuning Machine Rigidity Selection (Pn22) is increased. This is not a problem if it disappears right away. If the unusual noise or vibration, however, continues for three or more reciprocating operations, take the following measures in any order you can.
  - Write the parameters used during normal operation to the EEPROM.
  - Lower the Realtime Autotuning Machine Rigidity Selection (Pn22).
  - Manually set the notch filter.
- Once unusual noise or vibration occurs, the Inertia Ratio (Pn20) may have changed to an extreme value. In this case, also take the measures described above.
- Out of the results of realtime autotuning, the Inertia Ratio (Pn20) is automatically saved to the EEPROM every 30 minutes. Realtime autotuning will use this saved data as the default value when the power is turned OFF and turned ON again.
- The Instantaneous Speed Observer Setting (Pn27) will automatically be disabled (0) if realtime autotuning is enabled.

# 10-7-3 Normal Mode Autotuning

Normal mode autotuning operates the Servomotor according to command patterns automatically created in the Servo Drive, then estimates the load inertia based on the torque required at that time and automatically sets the appropriate gain.




**Precautions for Correct Use**

• Normal mode autotuning operates under the following conditions.

| | Conditions under which normal mode autotuning operates |
|---|---|
| Control mode | All control modes can be used. |
| Others | • The servo is ON.<br>• The deviation counter reset signal is not input. |

**Note** Set the Torque Limit Selection (Pn03) to 1. Operation may be incorrect if the setting is not 1.

• Normal mode autotuning may not function properly under the conditions described in the following table. If normal mode autotuning does not function properly, use manual tuning.

| | Conditions under which normal mode autotuning does not function properly |
|---|---|
| Load inertia | • If the load inertia is too small or too large compared with the rotor inertia (i.e., less than 3 times, more than 20 times, or more than the applicable load inertia ratio).<br>• If the load inertia changes. |
| Load | • If the machine rigidity is extremely low.<br>• If there is backlash or play in the system. |

**Note 1.** A tuning error will occur if an error occurs, the servo turns OFF, the main power supply is turned OFF, drive prohibit is enabled, or a deviation counter reset occurs while normal mode autotuning is in operation.

**Note 2.** If normal mode autotuning is executed, and the load inertia cannot be estimated, the gain will remain the same as it was before normal mode autotuning.

**Note 3.** When normal mode autotuning is being executed, the Servomotor output torque can be output to the maximum set in the No. 1 Torque Limit (Pn5E) parameter.

**Note 4.** Take sufficient care to ensure safety. If vibration occurs, immediately turn OFF the power supply or the servo and return the gain to the default by using the parameter settings.

## ■ Normal Mode Autotuning Operation

- Normal mode autotuning sets the responsiveness with the machine rigidity number.

### Machine Rigidity Numbers

The degree of rigidity for the machine used is set to a number from 0 to F. The higher the rigidity of the machine, the higher the rigidity number and gain that can be set. Normally, start with a low rigidity number, increase the number in sequence while repeating normal mode autotuning, and stop before oscillation, unusual noise, or vibration occurs.

- The operating pattern set in the Autotuning Operation Setting (Pn25) is repeated for up to five cycles. The operating acceleration doubles each cycle starting with the third cycle. Depending on the load, operation may end before completing five cycles or the operating acceleration may not change. This is not an error.

## Normal Mode Autotuning Setting Method

1. **Set the operating pattern using the Autotuning Operation Setting (Pn25) parameter.**
2. **Move the load to a safe position even if the Servomotor performs the operating pattern set in Pn25.**
3. **Prohibit the command.**
4. **Turn the servo ON.**
5. **Start normal mode autotuning.**
   Start normal mode autotuning from the front panel or by using CX-Drive.
6. **Adjust the machine rigidity for the desired responsiveness at a level where vibration does not occur.**
7. **If there are no problems with the results, write the data to the EEPROM.**

## Automatically Set Parameters

### Normal Mode Autotuning

| Parameter No. | Parameter name | Rigidity No. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
| Pn10 | Position Loop Gain | 12 | 32 | 39 | 48 | 63 | 72 | 90 | 108 | 135 | 162 | 206 | 251 | 305 | 377 | 449 | 557 |
| Pn11 | Speed Loop Gain | 9 | 18 | 22 | 27 | 35 | 40 | 50 | 60 | 75 | 90 | 115 | 140 | 170 | 210 | 250 | 310 |
| Pn12 | Speed Loop Integration Time Constant | 62 | 31 | 25 | 21 | 16 | 14 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 4 | 4 | 3 |
| Pn13 | Speed Feedback Filter Time Constant | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pn14 | Torque Command Filter Time Constant *2 | 253 | 126 | 103 | 84 | 65 | 57 | 45 | 38 | 30 | 25 | 20 | 16 | 13 | 11 | 10 | 10 |
| Pn15 | Speed Feed-forward Amount | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |
| Pn16 | Feed-forward Command Filter | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Pn18 | Position Loop Gain 2 | 19 | 38 | 46 | 57 | 73 | 84 | 105 | 126 | 157 | 188 | 241 | 293 | 356 | 440 | 524 | 649 |
| Pn19 | Speed Loop Gain 2 | 9 | 18 | 22 | 27 | 35 | 40 | 50 | 60 | 75 | 90 | 115 | 140 | 1170 | 210 | 250 | 310 |
| Pn1A | Speed Loop Integration Time Constant 2 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 |
| Pn1B | Speed Feedback Filter Time Constant 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pn1C | Torque Command Filter Time Constant 2 *2 | 253 | 126 | 103 | 84 | 65 | 57 | 45 | 38 | 30 | 25 | 20 | 16 | 13 | 11 | 10 | 10 |
| Pn20 | Inertia Ratio | Estimated load inertia ratio | | | | | | | | | | | | | | | |
| Pn27 | Instantaneous Speed Observer Setting | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pn30 | Gain Switching Input Operating Mode Selection | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Pn31 | Control Gain Switch 1 Setting *1 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Pn32 | Gain Switch 1 Time | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Pn33 | Gain Switch 1 Level Setting | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Pn34 | Gain Switch 1 Hysteresis Setting | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Pn35 | Position Loop Gain Switching Time | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

- The parameters Pn15, Pn16, Pn1A, Pn30, and Pn32 to Pn36 are set to fixed values. For normal mode autotuning, the default rigidity is 2.

*1. The value is 10 for position control and 0 for speed and torque control.

*2. The lower limit is set to 10 if a 17-bit encoder is used and to 25 if a 2,500-pulse/revolution encoder is used.

## ■ Front Panel Operating Procedure

### 1. Switch to the Normal Mode Autotuning from the Monitor Mode.

Press the Data key and then press the Mode key three times to change the mode.

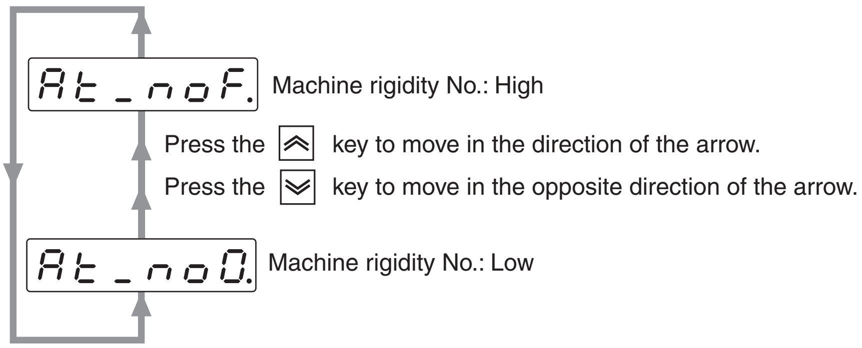
r 0 Servomotor rotation speed display (default display)

### 2. Input the machine rigidity number using the Increment and Decrement keys.

Cannot be set to 0 when using the Parameter Unit.

At_no0.

Machine rigidity No.




| Drive system | Machine rigidity No. |
|---|---|
| Ball screw direct coupling | 6 to C |
| Ball screw and timing belt | 4 to A |
| Timing belt | 2 to 8 |
| Gears, rack and pinion drives | 2 to 8 |
| Machines with low rigidity, etc. | 0 to 4 |

**3. Press the Data key to enter the Monitor/Run Mode.**

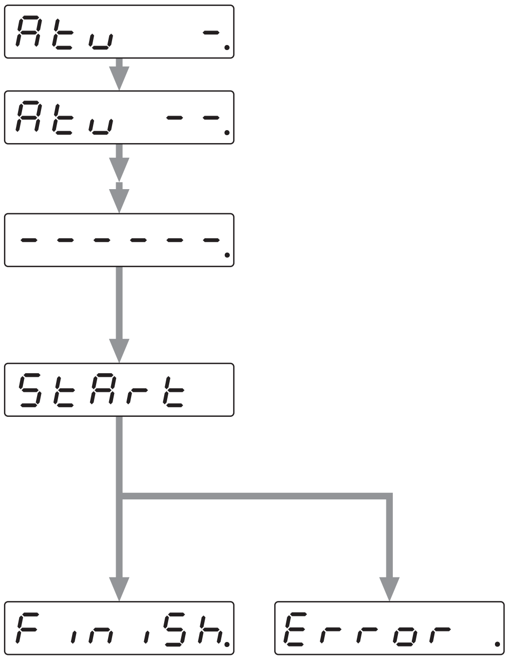
**4. Press and hold the Increment key until the display changes to StArt.**

The Servo will be ON for pin 29 of connector CN1.

**5. Press the Increment key for approx. 3 s.**

The bar indicator will increase as shown in the following figure.

The Servomotor will start to rotate.
For a period of approximately 15 s, the Servomotor will make two revolutions in the forward/reverse direction, which will comprise one cycle and will be repeated up to five times. There is no problem if operation ends before five cycles have been completed.




Tuning completed normally. Tuning error occurred.



**6. Write the data to the EEPROM so that the gain values are not lost when the power supply is shut off.**

- Do not perform normal mode autotuning with the Servomotor or Servo Drive alone. The Inertia Ratio (Pn20) will become 0.



### Precautions for Correct Use

| Problem | Likely cause | Countermeasures |
|---|---|---|
| An error is displayed. | An alarm has occurred, the servo is OFF, or the deviation counter is reset. | • Do not operate the Servomotor near the Limit Switches or Origin Proximity Sensor.<br>• Turn the servo ON.<br>• Release the deviation counter reset. |
| Values for Pn10 or other parameters related to gain are the same as before execution. | The load inertia cannot be estimated. | • Lower Pn10 to 10 and Pn11 to 50, and then execute again.<br>• Make the adjustment manually. (Input the calculated load inertia.) |
| The Servomotor does not rotate. | The ECRST (pin 30) of CN1 is input. | • Turn OFF the ECRST (pin 30) of CN1. |

# 10-7-4 Disabling the Automatic Gain Adjustment Function

This section provides precautions for disabling realtime autotuning and the adaptive filter. These functions are enabled by default.

**Precautions for Correct Use**

- When disabling the automatic adjustment function, the RUN Command Input (RUN) must be turned OFF.

## Disabling Realtime Autotuning

By setting the Realtime Autotuning Mode Selection (Pn21) to 0, the automatic estimation of the Inertia Ratio (Pn20) will stop, and realtime autotuning will be disabled.
However, the estimated Inertia Ratio (Pn20) will remain. If the Pn20 value is obviously incorrect, perform normal mode autotuning or calculate and set the appropriate value manually.

**Precautions for Correct Use**

- To enable the Realtime Autotuning Mode Selection (Pn21), turn OFF the RUN Command Input (RUN), and then turn it back ON.

## Disabling the Adaptative Filter

| Pn2F | Notch Filter 1 Frequency (Hz) |
|---|---|
| 0 | (Disabled) |
| 1 | (Disabled) |
| 2 | (Disabled) |
| 3 | (Disabled) |
| 4 | (Disabled) |
| 5 | 1482 |
| 6 | 1426 |
| 7 | 1372 |
| 8 | 1319 |
| 9 | 1269 |
| 10 | 1221 |
| 11 | 1174 |
| 12 | 1130 |
| 13 | 1087 |
| 14 | 1045 |
| 15 | 1005 |
| 16 | 967 |
| 17 | 930 |
| 18 | 895 |
| 19 | 861 |
| 20 | 828 |
| 21 | 796 |

| Pn2F | Notch Filter 1 Frequency (Hz) |
|---|---|
| 22 | 766 |
| 23 | 737 |
| 24 | 709 |
| 25 | 682 |
| 26 | 656 |
| 27 | 631 |
| 28 | 607 |
| 29 | 584 |
| 30 | 562 |
| 31 | 540 |
| 32 | 520 |
| 33 | 500 |
| 34 | 481 |
| 35 | 462 |
| 36 | 445 |
| 37 | 428 |
| 38 | 412 |
| 39 | 396 |
| 40 | 381 |
| 41 | 366 |
| 42 | 352 |
| 43 | 339 |

| Pn2F | Notch Filter 1 Frequency (Hz) |
|---|---|
| 44 | 326 |
| 45 | 314 |
| 46 | 302 |
| 47 | 290 |
| 48 | 279 |
| 49 | 269 (Disabled when Pn22 ≥ F) |
| 50 | 258 (Disabled when Pn22 ≥ F) |
| 51 | 248 (Disabled when Pn22 ≥ F) |
| 52 | 239 (Disabled when Pn22 ≥ F) |
| 53 | 230 (Disabled when Pn22 ≥ F) |
| 54 | 221 (Disabled when Pn22 ≥ E) |
| 55 | 213 (Disabled when Pn22 ≥ E) |
| 56 | 205 (Disabled when Pn22 ≥ E) |
| 57 | 197 (Disabled when Pn22 ≥ E) |
| 58 | 189 (Disabled when Pn22 ≥ E) |
| 59 | 182 (Disabled when Pn22 ≥ D) |
| 60 | (Disabled) |
| 61 | (Disabled) |
| 62 | (Disabled) |
| 63 | (Disabled) |
| 64 | (Disabled) |

# 10-7-5 Manual Tuning

## Basic Settings

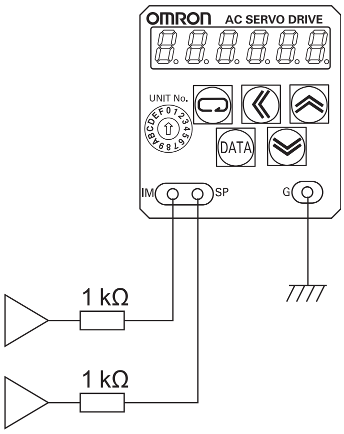
As described before, the SMARTSTEP 2 750 W Model Servo Drives have an autotuning function. Depending on load conditions or other restrictions, however, readjustment may be required if the gain cannot be properly adjusted when autotuning is performed or the optimum responsiveness or stability is required to match each load. This section describes how to perform manual tuning for each control mode and function.

### ■ Before Manual Setting

The front panel or the Parameter Unit can be used to adjust the Servomotor (machine) while monitoring the operation or noise, but more reliable adjustment can be performed quickly by using waveform monitoring with the data tracing function of CX-Drive or by measuring the analog voltage waveform with the monitor function.

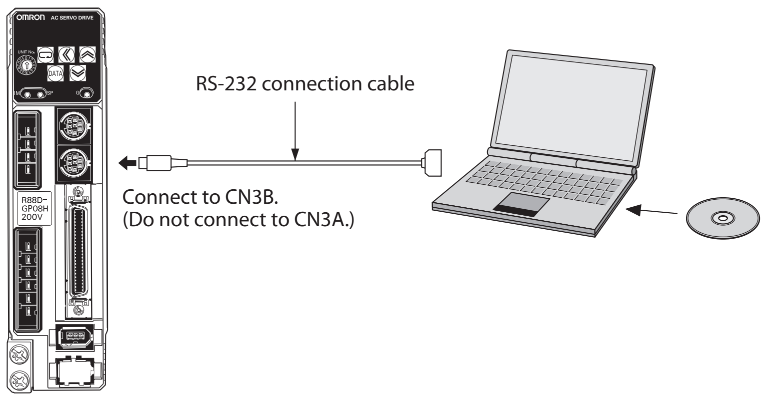
#### Analog Monitor Output

The actual Servomotor speed, command speed, torque, and number of accumulated pulses can be measured in the analog voltage level using an oscilloscope or other device. Set the type of signal to be output and the output voltage level by setting the SP Selection (Pn07) and IM Selection (Pn08).



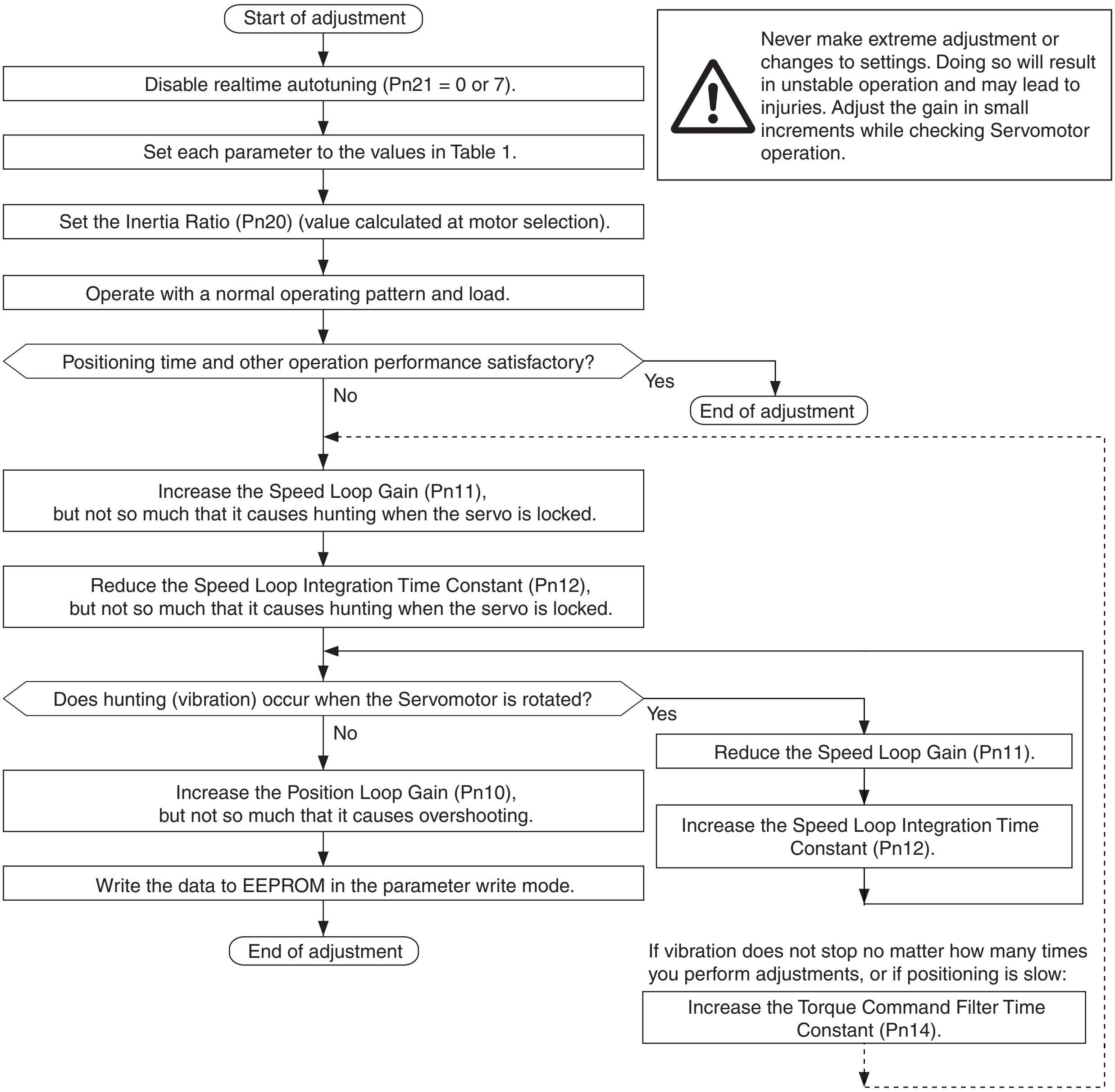

#### CX-Drive Data Tracing

Commands to the Servomotor and Servomotor operation (e.g., speed, torque commands, and position deviation) can be displayed on a computer as waveforms. Refer to the *CX-Drive Operation Manual* (Cat. No. W453).



## ■ Position Control Mode Adjustment

Use the following procedure to make adjustments in position control for the SMARTSTEP 2 750 W Model.




Set the following parameters.

Table 1: Parameter Adjustment Values

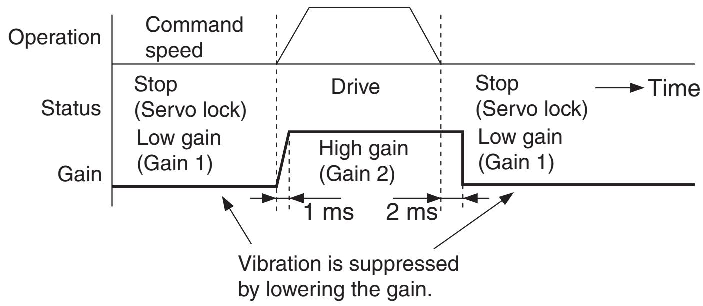
| Parameter No. | Parameter name | Guideline |
|---|---|---|
| Pn10 | Position Loop Gain | 30 |
| Pn11 | Speed Loop Gain | 50 |
| Pn12 | Speed Loop Integration Time Constant | 40 |
| Pn13 | Speed Feedback Filter Time Constant | 0 |
| Pn14 | Torque Command Filter Time Constant | 160 |
| Pn15 | Speed Feed-forward Amount | 0 |
| Pn16 | Feed-forward Command Filter | 0 |
| Pn18 | Position Loop Gain 2 | 30 |
| Pn19 | Speed Loop Gain 2 | 50 |
| Pn1A | Speed Loop Integration Time Constant 2 | 40 |
| Pn1B | Speed Feedback Filter Time Constant 2 | 0 |
| Pn1C | Torque Command Filter Time Constant 2 | 160 |
| Pn1D | Notch Filter 1 Frequency | 1500 |
| Pn1E | Notch Filter 1 Width | 2 |
| Pn20 | Inertia Ratio | *1 |

*1.Input the Inertia Ratio (Pn20). The inertia ratio can be measured with normal mode autotuning or set to a calculated value. When the inertia ratio is unknown, enter 300 as the inertia ratio.

## Gain Switching Function

With manual tuning, Gain 1 and Gain 2 can be set manually. The gain can be switched according to the operation.

Switching from Gain 1 to Gain 2 can be used for the following applications.
- To increase responsiveness by increasing the gain during operation.
- To increase servo lock rigidity by increasing the gain when operation is stopped.
- To switch to an optimal gain according to the operating mode.
- To reduce the gain to suppress vibration when operation is stopped.




### Application Example

The example is for a case where noise is a problem when the Servomotor is stopped (servo lock), and the noise is reduced by switching to a lower gain setting after the Servomotor has stopped.

| Parameter No. | Parameter name | Perform manual tuning without gain switching. → | Set Gain 2 (Pn18 to Pn1C) to the same values as Gain 1 (Pn10 to Pn14). → | Set gain switching conditions (Pn30 to Pn35). → | Adjust Pn11 and Pn14 (for Gain 1) when stopped. |
|---|---|---|---|---|---|
| Pn10 | Position Loop Gain | 60 | | | |
| Pn11 | Speed Loop Gain | 50 | | | 30 |
| Pn12 | Speed Loop Integration Time Constant | 16 | | | |
| Pn13 | Speed Feedback Filter Time Constant | 0 | | | |
| Pn14 | Torque Command Filter Time Constant | 50 | | | 85 |
| Pn15 | Speed Feed-forward Amount | 300 | | | |
| Pn16 | Feed-forward Command Filter | 50 | | | |
| Pn18 | Position Loop Gain 2 | | 60 | | |
| Pn19 | Speed Loop Gain 2 | | 50 | | |
| Pn1A | Speed Loop Integration Time Constant 2 | | 16 | | |
| Pn1B | Speed Feedback Filter Time Constant 2 | | 0 | | |
| Pn1C | Torque Command Filter Time Constant 2 | | 60 | | |

| Parameter No. | Name | Perform manual tuning without gain switching. | Set Gain 2 (Pn18 to Pn1C) to the same values as Gain 1 (Pn10 to Pn14). | Set gain switching conditions (Pn30 to Pn35). | Adjust Pn11 and Pn14 (for Gain 1) when stopped. |
|---|---|---|---|---|---|
| Pn20 | Inertia Ratio | • Enter the value for load calculation if already known.<br>• Perform normal mode auto-tuning and measure the inertia ratio.<br>• The default is 300. | | | |
| Pn30 | Gain Switching Input Operating Mode Selection | 0 | | 1 | |
| Pn31 | Control Gain Switch 1 Setting | | | 7 | |
| Pn32 | Gain Switch 1 Time | | | 30 | |
| Pn33 | Gain Switch 1 Level Setting | | | 0 | |
| Pn34 | Gain Switch 1 Hysteresis Setting | | | 0 | |
| Pn35 | Position Loop Gain Switching Time | | | 0 | |





## ■ Setting Gain Switching Conditions

### Position Control Mode (○: Relevant parameter enabled, ---: Disabled)

| Gain Switch Setting | | | Setting parameters for position control mode | | |
|---|---|---|---|---|---|
| Pn31 | Conditions for switching to gain 2 | Figure | Gain Switch Time *1 | Gain Switch Level Setting | Gain Switch Hysteresis Setting *2 |
| | | | Pn32 | Pn33 | Pn34 |
| 0 | Always gain 1 | --- | --- | --- | --- |
| 1 | Always gain 2 | --- | --- | --- | --- |
| 2 | Switching using Gain Switch Input (GSEL) | --- | --- | --- | --- |
| 3 | Amount of change in torque command | --- | ○ | ○ *3 (0.05%/166 µs) | ○ *3 (0.05%/166 µs) |
| 4 | Always gain 1 | A | --- | --- | --- |
| 5 | Command speed | --- | ○ | ○ (r/min) | ○ (r/min) |
| 6 | Amount of position deviation | C | ○ | ○ *4 (pulse) | ○ *4 (pulse) |
| 7 | Command pulses received | D | ○ | --- | --- |
| 8 | Positioning Completed Output | F | ○ | --- | --- |
| 9 | Actual Servomotor speed | C | ○ | ○ (r/min) | ○ (r/min) |
| 10 | Combination of command pulse input and speed | G | ○ | ○ (r/min) *6 | ○ (r/min) *6 |

## Machine Resonance Control

When machine rigidity is low, shaft torsion may cause resonance, leading to vibration or noise, thus not allowing the gain to be set to a high value. In this case, the resonance can be suppressed by using the two filter types.

### Torque Command Filter (Pn14, Pn1C)

The filter time constant is set to attenuate the resonance frequency. The cut-off frequency can be calculated using the following equation.

$$\text{Cut-off frequency (Hz) fc} = \frac{1}{2\pi T} = \frac{1}{2\pi \times \text{parameter setting} \times 10^{-5}}$$

### Notch Filter

• Adaptive Filter (Pn23, Pn2F)

The SMARTSTEP 2 750 W Model Servo Drive use an adaptive filter to control vibration for loads that are difficult to handle with the previous notch filters and torque filters, such as when each device has a different resonance point. The adaptive filter is enabled by setting the Adaptive Filter Selection (Pn23) to 1.

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn23 | Adaptive Filter Selection | 1: The adaptive filter is enabled. |
| Pn2F | Adaptive Filter Table Number Display | Displays the table number corresponding to the frequency for the adaptive filter.<br>The setting of this parameter cannot be changed. |

• Notch Filters 1 and 2 (Pn1D, Pn1E, Pn28, Pn29, and Pn2A)

The SMARTSTEP 2 750 W Model Servo Drive provide two normal notch filters. Notch Filter 1 can be used to adjust the frequency and width, and Notch Filter 2 can be used to adjust frequency, width, and depth with parameters.

| Parameter No. | Parameter name | Explanation |
|---|---|---|
| Pn1D | Notch Filter 1 Frequency | Set 10% lower. |
| Pn1E | Notch Filter 1 Width | Set according to the characteristics of the resonance points. |
| Pn28 | Notch Filter 2 Frequency | Set 10% lower. |
| Pn29 | Notch Filter 2 Width | Set according to the characteristics of the resonance points. |
| Pn2A | Notch Filter 2 Depth | |

## Automatic Gain Setting

Automatic gain setting initializes the control parameters and the gain switching parameters to gain settings for normal mode autotuning to match the rigidity before manual tuning is performed.

**Precautions for Correct Use**

- Stop operation before making changes when executing the automatic gain setting function.

### ■ Operating Procedure

Refer to *Front Panel Display Example* on page 113.

**1. Stop operation.**

**2. Start the automatic gain setting function in the fit gain window on the front panel.**

If the fit gain is completed normally, `Finish.` will be displayed, and `Error.` will be displayed if it is completed with an error. (The display can be cleared using the keys.)

**3. Write data to the EEPROM if the results are to be saved.**

### ■ Automatically Set Parameters

The following parameters are set automatically.

| Parameter No. | Parameter name |
|---|---|
| Pn10 | Position Loop Gain |
| Pn11 | Speed Loop Gain |
| Pn12 | Speed Loop Integration Time Constant |
| Pn13 | Speed Feedback Filter Time Constant |
| Pn14 | Torque Command Filter Time Constant |
| Pn18 | Position Loop Gain 2 |
| Pn19 | Speed Loop Gain 2 |
| Pn1A | Speed Loop Integration Time Constant 2 |
| Pn1B | Speed Feedback Filter Time Constant 2 |
| Pn1C | Torque Command Filter Time Constant 2 |

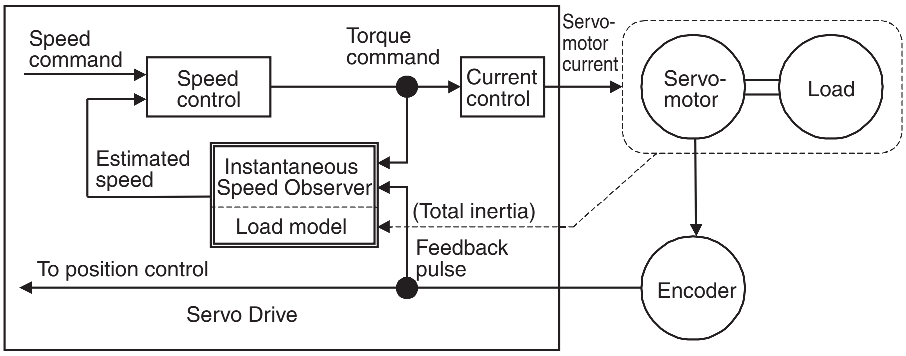
Settings for the following parameters are set automatically.

| Parameter No. | Parameter name | Set value |
|---|---|---|
| Pn15 | Speed Feed-forward Amount | 300 |
| Pn16 | Feed-forward Command Filter | 50 |
| Pn27 | Instantaneous Speed Observer Setting | 0 |
| Pn30 | Gain Switching Input Operating Mode Selection | 1 |
| Pn31 | Control Gain Switch 1 Setting | 10 *1 |
| Pn32 | Gain Switch 1 Time | 30 |
| Pn33 | Gain Switch 1 Level Setting | 50 |
| Pn34 | Gain Switch 1 Hysteresis Setting | 33 |
| Pn35 | Position Loop Gain Switching Time | 20 |

*1. The setting is 10 for position control and 0 for speed and torque control.

## Instantaneous Speed Observer

The instantaneous speed observer improves speed detection accuracy, increases responsiveness, and reduces vibration at stopping by estimating the Servomotor speed using a load model.




**Precautions for Correct Use**

- The instantaneous speed observer cannot be used unless the following conditions are satisfied.

| | Conditions under which the instantaneous speed observer operates |
|---|---|
| Control mode | • Position control or speed control is used.<br>Pn02 = 0: Position control<br>Pn02 = 1: Internal Speed control |
| Encoder | • A 7-core absolute encoder is used. |

- The instantaneous speed observer may not function properly or the effect may not be apparent under the following conditions.

| | Conditions under which the instantaneous speed observer does not function properly |
|---|---|
| Load | • If the margin of error with the actual device is too large for the inertia load of the Servomotor and load combined.<br>Example : If there is a large resonance point at the frequency of 300 Hz or lower.<br>: There is a non-linear element, such as large backlash.<br>• If the load inertia changes.<br>• If a large disturbance torque with high-frequency elements is applied. |
| Others | • If the stabilization range for positioning is extremely small. |

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Appendix-2

## ■ Operating Procedure

**1. Set the Inertia Ratio (Pn20).**

Set the inertia ratio as correctly as possible.

- Use the Pn20 setting if the Inertia Ratio (Pn20) is found using realtime autotuning that can be used in normal position control.
- Input the calculated value if it is already known by load calculation.
- If the inertia ratio is not known, perform normal mode autotuning and measure the inertia.

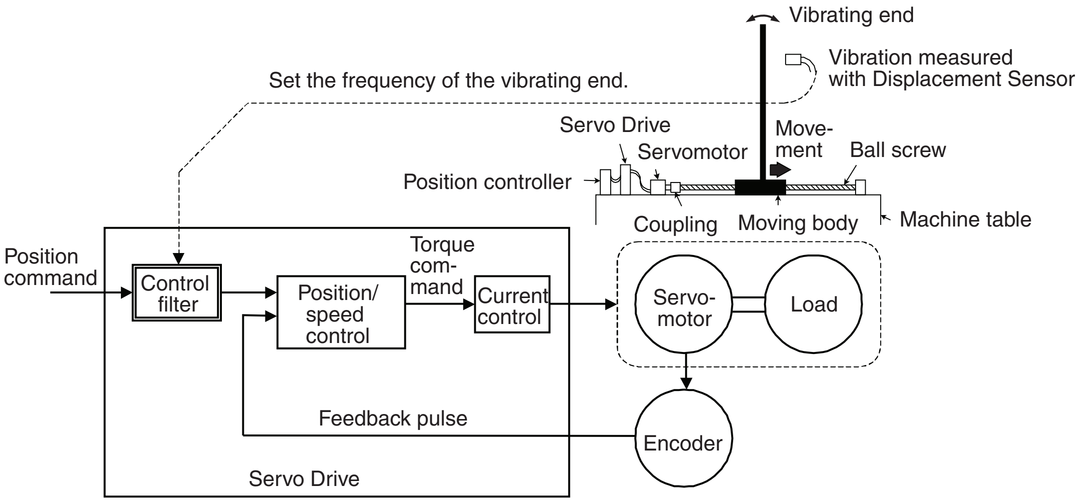
**2. Perform adjustments for normal position control.**

**3. Set the Instantaneous Speed Observer Setting (Pn27).**

- Set the Instantaneous Speed Observer Setting (Pn27) to 1. The speed detection method will switch to Instantaneous Speed Observer.
- If the change in torque waveform or the operation noise is large, return the setting to 0 and check the precautions above as well as the Inertia Ratio (Pn20) again.
- If the change in torque waveform or the operation noise is small, make small adjustments in the Inertia Ratio (Pn20) to find the setting that makes the smallest change while monitoring the position deviation waveform and the actual speed waveform. If the Position Loop Gain or Speed Loop Gain is changed, the optimal setting for the Inertia Ratio (Pn20) may have changed, so set it again by making small adjustments.

## Vibration Control

When the machine end vibrates, vibration control removes the vibration frequency from the commands, reducing vibration.




**Precautions for Correct Use**

• The following conditions must be met to use vibration control.

| | Conditions under which vibration control operates |
|---|---|
| Control Mode | • The Position Control Mode must be used.<br>Pn02 = 0: Position control |

• Stop operation before changing the parameters or switching with DFSEL/PNSEL.

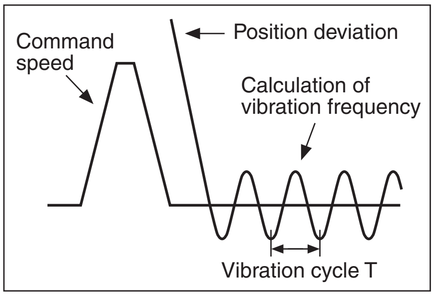
• Under the following conditions, vibration control may not operate properly or may have no effect.

| | Conditions under which the effect of vibration control is inhibited |
|---|---|
| Load | • If forces other than commands, such as external forces, cause vibration.<br>• If the ratio of the resonance frequency to anti-resonance frequency is large.<br>• If the vibration frequency is outside the range of 10.0 to 200.0 Hz. |

## ■ Operating Procedure

### 1. Setting the Vibration Frequency (Frequency 1: Pn2B, Frequency 2: Pn2D)

Measure the vibration frequency at the end of the machine. When the end vibration can be measured directly using a laser displacement sensor, read the vibration frequency f (Hz) from the waveform measurement and set it as the Vibration Frequency (Pn2B, Pn2D). If no measurement device is available, use CX-Drive data tracing function, and read the residual vibration frequency (Hz) from the position deviation waveform as shown in the following figure.




- The following gives the vibration frequency in the figure.

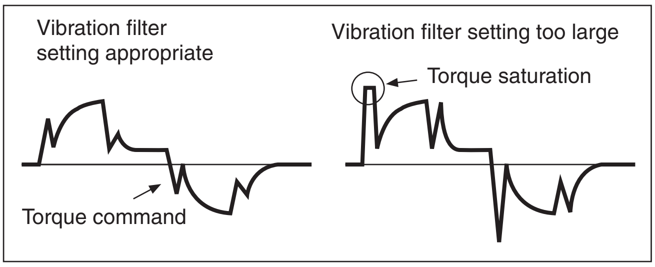
$$f\ (\text{Hz}) = \frac{1}{T(s)}$$

(Pn2B, Pn2D) = 10 × f

- Example:
  When the vibration cycle is 100 ms and 20 ms, the vibration frequency is 10 Hz and 40 Hz, therefore set Pn2B = 100, Pn2D = 400.

### 2. Setting the Vibration Filter (Filter 1: Pn2C, Filter 2: Pn2E)

First, set the Vibration Filter (Pn2C, Pn2E) to 0. The stabilization time can be reduced by setting a large value; however, torque ripple will increase at the command change point as shown in the following figure. Set a range that will not cause torque saturation under actual operation conditions. The effects of vibration suppression will be lost if torque saturation occurs.




- The vibration filter setting is restricted by the following equation.
  10.0 Hz – Vibration frequency ≤ Vibration filter setting ≤ Vibration frequency

### 3. Set the Vibration Filter Selection (Pn24).

Vibration filters 1 and 2 can be switched according to the conditions of the machine vibration.

| Pn24 | Switching mode |
|---|---|
| 0 | No switching (1 and 2 both enabled) |
| 1 | Switching with DFSEL/PNSEL input<br>Open: Vibration filter 1<br>Closed: Vibration filter 2 |
| 2 | Switching with command direction<br>Forward operation: Vibration filter 1<br>Reverse operation: Vibration filter 2 |

# 10-8 Troubleshooting

## 10-8-1 Alarm Table

If the Servo Drive detects an error, the Alarm Output (ALM) will turn ON, the power drive circuit in the Servo Drive will turn OFF, and the alarm code will be displayed

**Precautions for Correct Use**

- Reset the alarm using one of the following methods. Remove the cause of the alarm first.
  - Turn ON the Alarm Reset Input (RESET).
  - Turn OFF the power supply, then turn it ON again.
  - Reset the alarm on the Parameter Unit.

Note, however, that some alarms can only be cleared by recycling the power (turn ON → OFF → ON).

- If you clear an alarm while the RUN Command Input (RUN) is turned ON, the Servo Drive will start operation as soon as the alarm is cleared, which is dangerous. Be sure to turn OFF the RUN Command Input (RUN) before clearing the alarm. If the RUN Command Input (RUN) is always ON, first check safety sufficiently before clearing the alarm.

### ■ Alarms

Only shows the alarm codes that are different than in the previous sections. For the other alarm codes refer to Chapter 8-Troubleshooting.

| Alarm code | Error detection function | Detection details and cause of error | Alarm reset possible |
|---|---|---|---|
| 13 | Main power supply undervoltage | The DC voltage of the main circuit is low. | Yes |
| 24 | Deviation counter overflow | The number of accumulated pulses in the deviation counter exceeded the setting for the Deviation Counter Overflow Level (Pn70). | Yes |
| 26 | Overspeed | The Servomotor exceeded the maximum number of rotations. | Yes |
| 27 | Electronic gear setting error | The setting for the electronic gear ratio (Pn48 to 4B) is not appropriate. | Yes |
| 45 | Multi-turn counter error | Incremental encoder phase-AB signal error was detected. | No |
| 49 | Encoder PS signal error | A logic error was detected in the PS signal. | No |

# 10-8-2 Troubleshooting

## Error Diagnosis Using the Displayed Alarm Codes

| Alarm code | Error | Status when error occurs | Cause | Countermeasure |
|---|---|---|---|---|
| 13 | Main power supply undervoltage | Occurs when the Servo Drive is turned ON. | • The power supply voltage is low.<br>• Momentary power interruption occurred.<br>• Power supply capacity is insufficient.<br>• The power supply voltage is reduced beacuse the main power supply is OFF.<br>• The main power supply is not input. | • Check the power supply capacity.<br>• Change the power supply.<br>• Turn ON the power supply.<br>• Extend the Momentary Hold Time (Pn6D). |
| | | Occurs when power supply is turned ON. | • Phase loss. | • Correctly connect the phases of the power supply voltage. |
| | | | | • Correctly connect the single phase. |
| | | | • The main circuit power supply is damaged.<br>• Control PCB error. | • Replace the Servo Drive. |
| 24 | Deviation counter overflow (Continued on next page) | Occurs when the Servomotor does not rotate even when command pulses are input. | • The Servomotor power wiring or the encoder wiring is incorrect. | • Correct the wiring. |
| | | | • The Servomotor is mechanically being held. | • If the Servomotor shaft is held by external force, release it.<br>• Release the electromagnetic brake. |
| | | | • Control PCB error. | • Replace the Servo Drive. |
| | | Occurs during high-speed rotation. | • The Servomotor power wiring or the encoder wiring is incorrect. | • Correct the wiring. |
| | | Occurs when a long string of command pulses is given. | • Gain adjustment is insufficient. | • Adjust the gain |
| | | | • The acceleration and deceleration rapid. | • Extend the acceleration and deceleration times. |
| | | | • The load is too large. | • Reduce the load.<br>• Select a suitable Servomotor. |

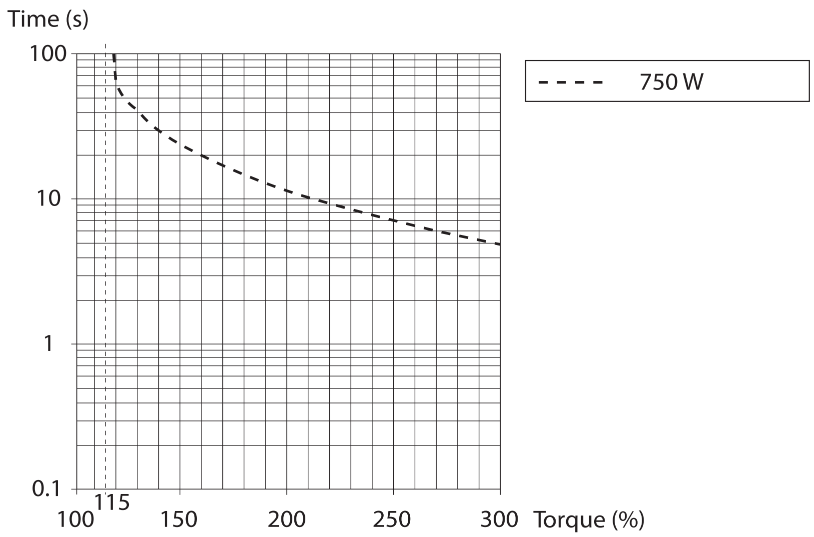
| Alarm code | Error | Status when error occurs | Cause | Countermeasure |
|---|---|---|---|---|
| 24 | Deviation counter overflow (Continued from previous page) | Occurs during operation. | • The setting for the Deviation Counter Overflow Level (Pn70) was exceeded. | • Increase the setting of Pn70.<br>• Reduce the rotation speed.<br>• Lighten the load.<br>• Extend the acceleration and deceleration time. |
| 26 | Overspeed | Occurs during high-speed rotation. | • The speed command input is too large. | • Set the command pulse frequency to 500 kpps max. |
| | | | • The setting for the Electronic Gear Ratio Numerator (Pn48 or Pn49) is not appropiate. | • Set Pn48 and Pn49 so that the command pulse frequency is 500 kpps max. |
| | | | • The maximum number of rotations is exceeded due to overshooting. | • Adjust the gain.<br>• Reduce the maximum command speed. |
| | | | • The encoder wiring is incorrect. | • Correct the wiring. |
| | | Occurs when torque limit switching is used. | • The Overspeed Detection Level Setting (Pn73) has ben exceeded. | • If torque limit switching is used, correctly set the allowable operating speed for Pn73. |
| 27 | Electronic gear setting error | Occurs when command signal is input or command is input. | • The setting for the Electronic Gear Ratio Numerator (Pn48 to Pn49) is not appropiate. | • Set Pn48 and Pn49 so that the command pulse frequency is 500 kpps max. |
| 45 | Multi-turn counter error | Occurs when the power supply is turned ON. | • The encoder is faulty. | • Replace the Servomotor. |
| 49 | Encoder PS signal error | Occurs during operation. | • A logic error was detected in the PS signal from the encoder. | • Replace the Servomotor. |

# 10-8-3 Overload Characteristics (Electronic Thermal Function)

An overload protection (electronic thermal) function is built into the Servo Drive to protect the Servo Drive and Servomotor from overloading.
If an overload does occur, first eliminate the cause of the error and then wait at least one minute for the Servomotor temperature to drop before turning ON the power again.
If the power is turned ON again repeatedly at short intervals, the Servomotor windings may burn out.

## Overload Characteristics Graph

The following graph show the characteristics of the load rate and electronic thermal function's operation time.




When the torque command = 0, and a constant torque command is continuously applied after three or more times the overload time constant has elapsed, the overload time t [s] will be:
t [s] = – Overload time constant [s] × $\log_e$ (1 – Overload level [%] / Torque command [%]) $^2$

(The overload time constant [s] depends on the Servomotor. The standard overload level is 115%.)

**Precautions for Correct Use**

- Overload (alarm code 16) cannot be reset for approximately 10 seconds after its occurrence.

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Appendix-2

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# Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers of the manual.

Cat. No. I561-E2-01

Revision code

The following table outlines the changes made to the manual during each revision. Page numbers refer to the previous version.

| Revision code | Date | Revised content |
|---|---|---|
| 01 | Dec 2011 | 750 W Servo Drive included. |

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Note: Specifications subject to change without notice.

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