Cat. No. I554-E1-01

OMRON

USER'S MANUAL

SMARTSTEP Junior

MECHATROLINK-II

MODELS R7D-ZN□-ML2

Servomotors/Servo Drivers

Thank you for choosing this SMARTSTEP Junior product.

This manual provides information on installation, wiring, switch setting, and troubleshooting for the SMARTSTEP Junior Servomotors and Servo Drivers.

■ Intended Audiences

This manual is intended for the following personnel, who must also have knowledge of electrical systems (an electrical engineer or the equivalent).

- Personnel in charge of installing FA systems
- Personnel in charge of designing FA systems
- Personnel in charge of managing FA systems and facilities

■ NOTICE

This manual contains information necessary for the operation of the SMARTSTEP Junior Servomotors and Servo Drivers. Please read this manual thoroughly and understand its contents before attempting to operate the product. Please keep this manual handy for future reference after reading it.

Be sure that this manual accompanies the product to its final user.

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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.

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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.

General Warnings

To ensure safe and proper use of SMARTSTEP Junior Servomotors and Servo Drivers, read the general warnings provided below along with the rest of this manual to gain sufficient knowledge of the devices, safety information, and precautions before actual use.

This OPERATION MANUAL is to be delivered to the actual end users of the products.

Please keep this manual close at hand for future reference.

The following conventions are used to indicate and classify precautions in this manual. Always heed the information provided with them. Failure to heed precautions can result in injury to people or damage to property.

⚠ **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.

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

⚠WARNING

⚠WARNING	Always connect the frame ground terminals of the Servo Driver and the Servomotor to a class-3 ground (to 100 Ω or less). Not connecting to a class-3 ground may result in electric shock.
⚠WARNING	Do not touch the inside of the Servo Driver. Doing so may result in electric shock.
⚠WARNING	Turn OFF the emergency stop input (STOP) whenever turning OFF the main circuit power supply. Even if the main circuit power supply is turned OFF, e.g., using an external emergency stop signal, the motor may continue to turn due to residual voltage, possibly resulting in injury or equipment damage.
⚠WARNING	Turn OFF the emergency stop input (STOP) whenever a Servo alarm occurs or a system emergency stop is executed. Otherwise, the motor may continue to turn due to residual voltage, possibly resulting in injury or equipment damage.
⚠WARNING	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.
⚠WARNING	Installation, operation, maintenance, or inspection must be performed by authorized personnel. Not doing so may result in electric shock or injury.
⚠WARNING	Wiring or inspection must not be performed for at least five minutes after turning OFF the power supply. Doing so may result in electric shock.
⚠WARNING	Do not damage, press, or put excessive stress or heavy objects on the cables. Doing so may result in electric shock.
⚠WARNING	Do not touch the rotating parts of the Servomotor in operation. Doing so may result in injury.
⚠WARNING	Do not modify the product. Doing so may result in injury or damage to the product.
⚠WARNING	Provide a stopping mechanism on the machine to ensure safety. The holding brake is not designed as a stopping mechanism for safety purposes.
⚠WARNING	Do not come close to the machine immediately after resetting momentary power interruption to avoid an unexpected restart. (Take appropriate measures to secure safety against an unexpected restart.) Doing so may result in injury.

⚠CAUTION

⚠ **Caution**	Use the Servomotors and Servo Drivers in a specified combination. Using them incorrectly 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 temperatures or humidity outside the range specified in the specifications. • Locations subject to condensation as the result of severe changes in temperature. • Locations subject to corrosive or flammable gases. • Locations subject to dust (especially iron dust) or salts. • Locations subject to shock or vibration. Locations subject to exposure to water, oil, or chemicals.
⚠ **Caution**	Do not touch the Servo Driver radiator, Servo Driver regeneration resistor, or Servomotor while the power is being supplied or soon after the power is turned OFF. Doing so may result in a skin burn due to the hot surface.

Storage and Transportation Precautions

⚠CAUTION

⚠ **Caution**	Do not hold the product by the cables or motor shaft while transporting it. Doing so may result in injury or malfunction.
⚠ **Caution**	Do not place any load exceeding the figure indicated on the product. Doing so may result in injury or malfunction.

Installation and Wiring Precautions

⚠CAUTION

⚠ **Caution**	Do not step on or place a heavy object on the product. Doing so may result in injury.
⚠ **Caution**	Do not cover the inlet or outlet ports and prevent any foreign objects from entering the product. Doing so may result in fire.
⚠ **Caution**	Be sure to install the product in the correct direction. Not doing so may result in malfunction.
⚠ **Caution**	Provide the specified clearances between the Servo Driver and the control panel or with other devices. Not doing so may result in fire or malfunction.
⚠ **Caution**	Do not apply any strong impact. Doing so may result in malfunction.
⚠ **Caution**	Be sure to wire correctly and securely. Not doing so may result in motor runaway, injury, or malfunction.
⚠ **Caution**	Be sure that all the mounting screws, terminal screws, and cable connector screws are tightened to the torque specified in the relevant manuals. Incorrect tightening torque may result in malfunction.
⚠ **Caution**	Use crimp terminals for wiring. Do not connect bare stranded wires directly to terminals. Connection of bare stranded wires may result in burning.
⚠ **Caution**	Always use the power supply voltage specified in the *User's Manual*. An incorrect voltage may result in malfunction or burning.
⚠ **Caution**	Take appropriate measures to ensure that the specified power with the rated voltage and frequency is supplied. Be particularly careful in places where the power supply is unstable. An incorrect power supply may result in malfunction.
⚠ **Caution**	Install external breakers and take other safety measures against short-circuiting in external wiring. Insufficient safety measures against short-circuiting may result in burning.
⚠ **Caution**	Take appropriate and sufficient countermeasures when installing systems in the following locations. Failure to do so may result in damage to the product. • Locations subject to static electricity or other forms of noise. • Locations subject to strong electromagnetic fields and magnetic fields. • Locations subject to possible exposure to radioactivity. • Locations close to power supplies.

Operation and Adjustment Precautions

⚠CAUTION

⚠Caution	Confirm that no adverse effects will occur in the system before performing the test operation. Not doing so may result in equipment damage.
⚠Caution	Check the newly set parameters and switches for proper execution before actually running them. Not doing so may result in equipment damage.
⚠Caution	Do not make any extreme adjustments or setting changes. Doing so may result in unstable operation and injury.
⚠Caution	Separate the Servomotor from the machine, check for proper operation, and then connect to the machine. Not doing so may cause injury.
⚠Caution	When an alarm occurs, remove the cause, reset the alarm after confirming safety, and then resume operation. Not doing so may result in injury.
⚠Caution	Do not use the built-in brake of the Servomotor for ordinary braking. Doing so may result in malfunction.
⚠Caution	Do not operate the Servomotor connected to a load that exceeds the applicable load moment of inertia. Doing so may result in malfunction.

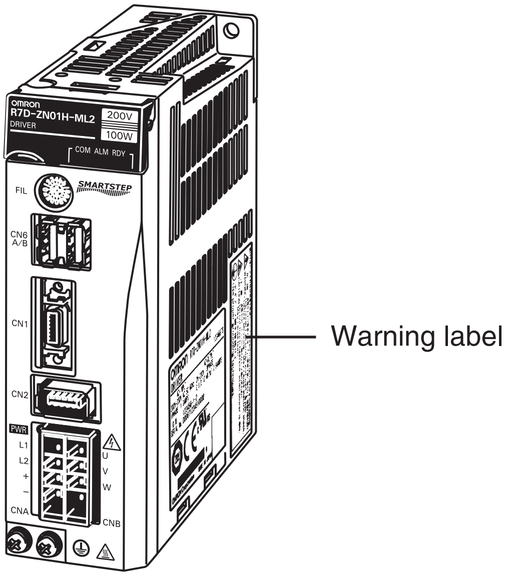
Maintenance and Inspection Precautions

⚠CAUTION

⚠Caution	Resume operation only after transferring to the new Unit the contents of the data required for operation. Not doing so may result in an unexpected operation.
⚠WARNING	Do not attempt to disassemble, repair, or modify any Units. Any attempt to do so may result in malfunction, fire, or electric shock.

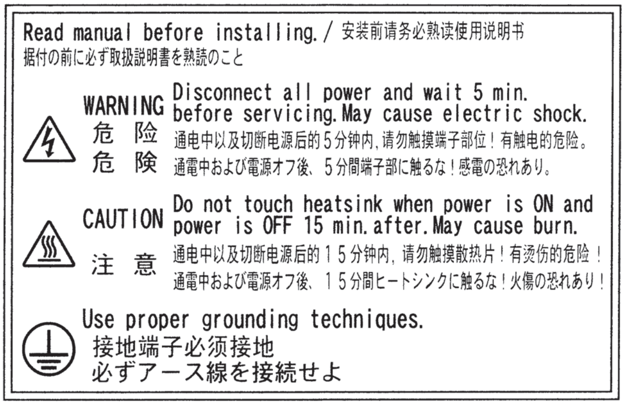
■ Warning Labels

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


omron
R7D-ZN01H-ML2
DRIVER
200V
100W
COM ALM RDY
FIL
SMARTSTEP
CN6 A/B
CN1
CN2
PWR
L1
L2
+
−
CNA
U
V
W
CNB
Warning label

Example from R7D-ZN01H-ML2

■ Warning Label Contents



Read manual before installing. / 安装前请务必熟读使用说明书
据付の前に必ず取扱説明書を熟読のこと

WARNING Disconnect all power and wait 5 min. before servicing. May cause electric shock.
危 险 通电中以及切断电源后的5分钟内,请勿触摸端子部位！有触电的危险。
危 険 通電中および電源オフ後、5分間端子部に触るな！感電の恐れあり。

CAUTION Do not touch heatsink when power is ON and power is OFF 15 min. after. May cause burn.
注 意 通电中以及切断电源后的１５分钟内，请勿触摸散热片！有烫伤的危险！
通電中および電源オフ後、１５分間ヒートシンクに触るな！火傷の恐れあり！

Use proper grounding techniques.
接地端子必须接地
必ずアース線を接続せよ

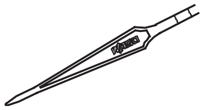
Items to Check When Unpacking

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

Item	Method
Has the correct product been delivered?	Check the model number on the nameplate on the side of the product.
Has the product been damaged in shipping?	Inspect the outside of the product and carefully check that there has been no damage during shipping.

- Accessories

1. Special screw driver for setting the rotary switch



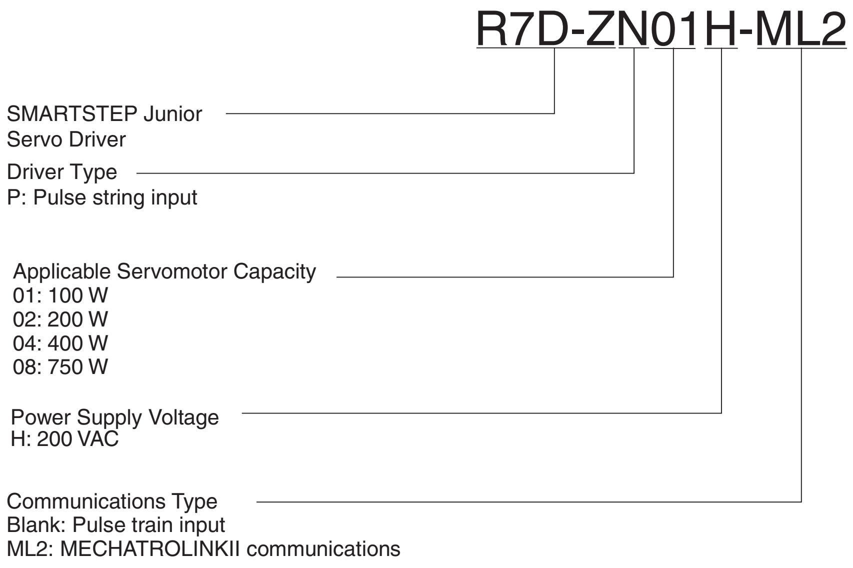
2. Safety Precautions document × 1

No connectors or mounting screws are provided. Obtain these separately.

If something is missing, the Servo Driver is damaged, or some other fault exists, please contact the point of purchase or your OMRON representative.

- Interpreting the Model Number

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



R7D-ZN01H-ML2

SMARTSTEP Junior
Servo Driver

Driver Type
P: Pulse string input

Applicable Servomotor Capacity
01: 100 W
02: 200 W
04: 400 W
08: 750 W

Power Supply Voltage
H: 200 VAC

Communications Type
Blank: Pulse train input
ML2: MECHATROLINKII communications

- Servo Driver and Servomotor Combinations

Rated output	**Servomotor**		**Servo Driver**	
	Without brake	**With brake**	**Pulse string input**	**MECHATROLINK-II communications**
100 W	R7M-Z10030-S1	R7M-Z10030-B S1	R7D-ZP01H	R7D-ZN01H-ML2
200 W	R7M-Z20030-S1	R7M-Z20030-B S1	R7D-ZP02H	R7D-ZN02H-ML2
400 W	R7M-Z40030-S1	R7M-Z40030-B S1	R7D-ZP04H	R7D-ZN04H-ML2
750 W	R7M-Z75030-S1	R7M-Z75030-B S1	R7D-ZP08H	R7D-ZN08H-ML2

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About this Manual

The contents of this manual is outlined in the following table. Use this table as a guide to read required information.

Chapter	Contents
Chapter 1 Features and System Configuration	Describes SMARTSTEP Junior features and components, as well as EC Directive and UL Standard compliance.
Chapter 2 Standard Models and Dimensions	Describes the models, external dimensions, and installation dimensions of the Servo Drivers, Servomotors, Decelerators, and accessories.
Chapter 3 Specifications	Provides general specifications, characteristics, connector specifications, and I/O circuit specifications for Servo Drivers, general specifications, characteristics, and Encoder specifications for Servomotors, and specifications for accessories.
Chapter 4 System Design	Describes installation conditions for Servo Drivers, Servomotors and Decelerators; wiring methods (including EMC-compliant wiring); calculation methods for regenerative energy; and the performance of External Regeneration Units and External Regeneration Resistors
Chapter 5 Operation	Describes operating procedures, setting methods for user parameters, the brake interlock function, and the interrupt feeding function.
Chapter 6 Troubleshooting	Describes items to check when troubles occur, troubleshooting with alarm codes, troubleshooting based on operating status, and periodic maintenance.
Appendix	Provides connection examples to OMRON Position Controllers and parameter lists.

Registered Trademark

- MECHATROLINK is a registered trademark of the MECHATROLINK Members Association.

Chapter 1

Features and System Configuration

1-1 Introduction
1-2 System Configuration
1-3 Nomenclature and Functions
1-4 System Block Diagrams
1-5 Applicable Standards

1-1 Introduction

1-1-1 Introduction

The SMARTSTEP Junior is available either with pulse-string input for position control or with built-in MECHATROLINK-II communications for reduced-wiring multi-axis control. It is easy to set up and start because it does not require the complex parameter settings and Servo adjustments that were required for previous Servos.

The SMARTSTEP Junior Servomotor and Servo Driver are easy-to-use, yet provide the responsiveness, high-speed, high-torque, and precision of traditional Servo systems.

This manual describes the SMARTSTEP Junior Servo Driver for MECHATROLINK-II communications. Servo Driver models with pulse-string input for position control are described in *the SMARTSTEP Junior User's Manual* (Cat. No. I553).

1-1-2 SMARTSTEP Junior Features

The SMARTSTEP Junior has the following features.

■ No Setup Parameters

No parameter settings are required for setup, so you can start using the Servo Driver immediately simply by removing it from the box and wiring it. If it is necessary to set the positioning resolution or reference pulse method, these settings can be set or changed easily with the rotary switches on the front of the Servo Driver.

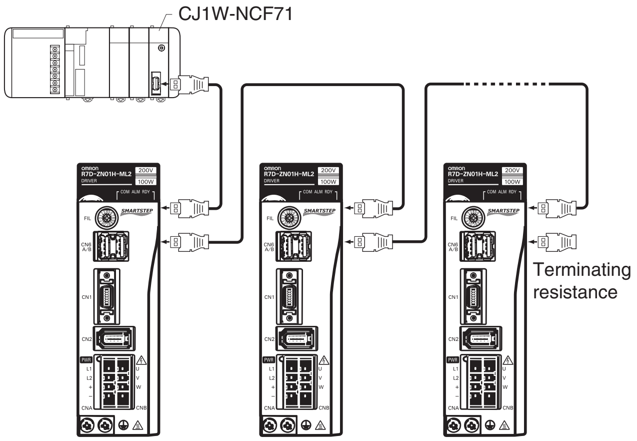
■ No Servo Adjustments Required

With the newest auto-tuning function, it isn't necessary to adjust the Servo Driver to achieve excellent responsiveness. Auto-tuning achieves excellent responsiveness while providing compatibility with a range of stepping motors. A Servomotor with moderate inertia is used to improve control system stability.

■ Reduced Wiring through Using MECHATROLINK-II CommunicationsÅiModels with MECHATROLINK-II Communications)

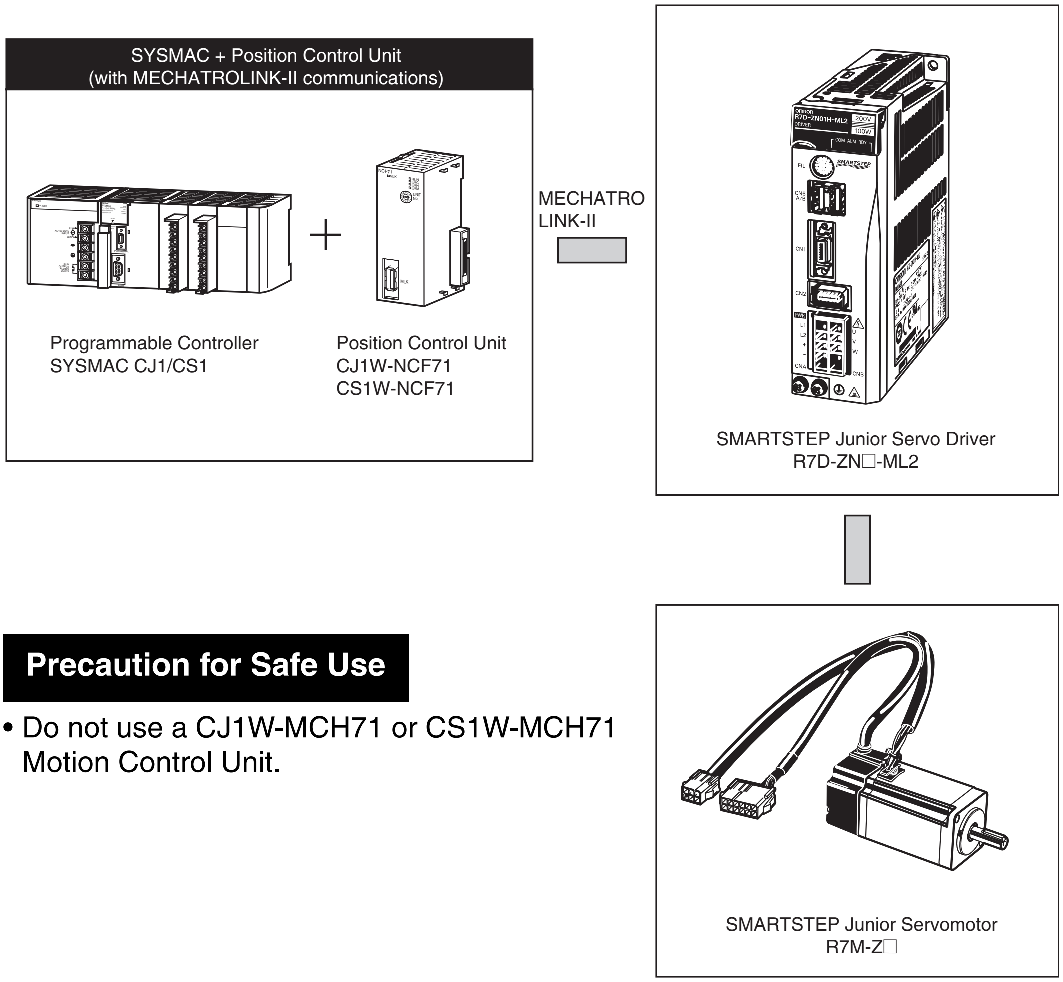
In combination with a MECHATROLINK-II-compatible Position Control Unit (CS1W-NCF71 or CJ1W-NCF71), the Servo Driver and the Controller can be connected with a single MECHATROLINK-II Cable.

Moreover, when wiring multiple Servo Drivers, connecting one Servo Driver to another by a single MECHATROLINK-II Cable makes it possible to greatly reduce the time involved in wiring without having to worry about wiring mistakes.


CJ1W-NCF71
R7D-ZN01H-ML2
Terminating
resistance

1-2 System Configuration

1-2-1 Basic Configuration


SYSMAC + Position Control Unit
(with MECHATROLINK-II communications)
Programmable Controller
SYSMAC CJ1/CS1
Position Control Unit
CJ1W-NCF71
CS1W-NCF71
MECHATRO
LINK-II
SMARTSTEP Junior Servo Driver
R7D-ZN□-ML2
SMARTSTEP Junior Servomotor
R7M-Z□

Precaution for Safe Use

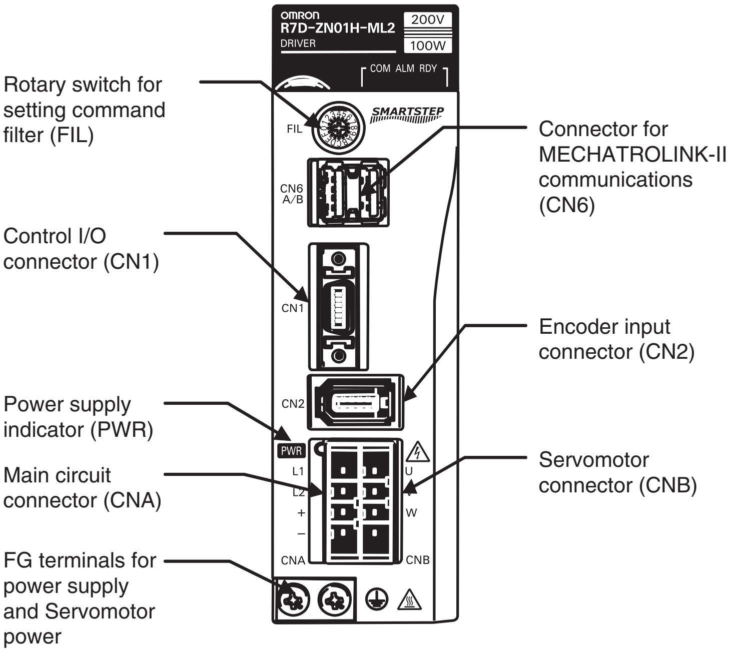
- Do not use a CJ1W-MCH71 or CS1W-MCH71 Motion Control Unit.

1-2-2 Application Restrictions

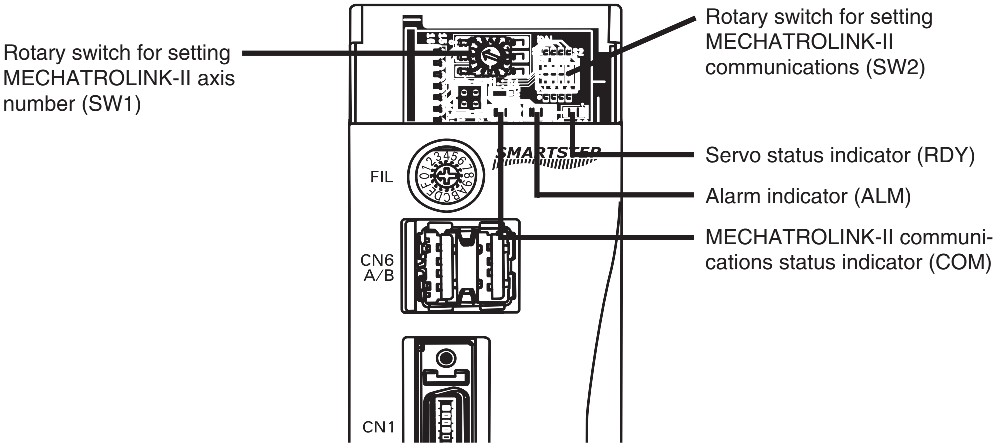
CS1W-NCF71/CJ1W-NCF71 functions		Applicability
Position control	Absolute movements	OK
	Relative movements	OK
	Interrupt feeding	OK
Speed control		Cannot be used.
Torque control		Cannot be used.
Other functions	Origin search	OK
	Jogging	OK
	Overrides	OK
	Present value preset	OK
	Stop functions	OK
	Backlash compensation	Cannot be used.

1-3 Nomenclature and Functions

1-3-1 Servo Driver Nomenclature


omron
R7D-ZN01H-ML2
DRIVER
200V
100W
COM ALM RDY
SMARTSTEP
FIL
CN6 A/B
CN1
CN2
PWR
L1
L2
+
−
U
W
CNA
CNB
Rotary switch for setting command filter (FIL)
Control I/O connector (CN1)
Power supply indicator (PWR)
Main circuit connector (CNA)
FG terminals for power supply and Servomotor power
Connector for MECHATROLINK-II communications (CN6)
Encoder input connector (CN2)
Servomotor connector (CNB)

With Top Cover Open


Rotary switch for setting MECHATROLINK-II axis number (SW1)
Rotary switch for setting MECHATROLINK-II communications (SW2)
SMARTSTEP
FIL
CN6 A/B
CN1
Servo status indicator (RDY)
Alarm indicator (ALM)
MECHATROLINK-II communications status indicator (COM)

1-3-2 Servo Driver Functions

■ Rotary Switch for Setting Command Filter (FIL)

This switch does not need to be set if the machine is not subject to vibration. (The switch is factory-set to 0.)

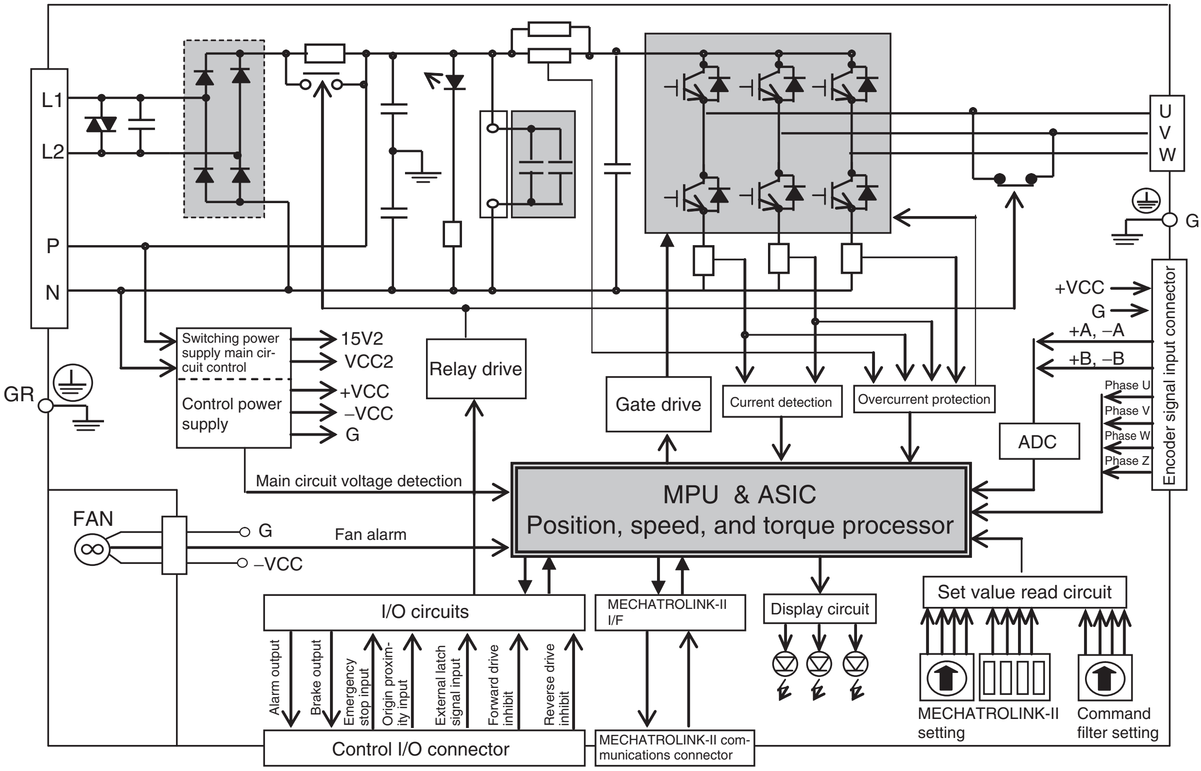
Filter setting (See note 1.)	Acceleration/deceleration time for STEP command (See note 2.)	Approx. time from end of command to end of positioning (settling time) (See note 3.)	Description
0	45 ms	100 to 200 ms	Smaller filter time constant (short positioning time)
1	50 ms	110 to 220 ms	↕
2	60 ms	130 to 260 ms	
3	65 ms	150 to 300 ms	
4	70 ms	170 to 340 ms	
5	80 ms	200 to 400 ms	Larger filter time constant (longer positioning time with little vibration)
6	85 ms	250 to 500 ms	
7	170 ms	500 to 1,000 ms	
8 to F	Do not set this switch to 8 to F.		

Note 1. Increase the value of the filter setting if there is vibration when starting or stopping.

Note 2. Use the acceleration/deceleration times as a guideline for determining the Servomotor capacity that can be driven when using STEP commands without commanded acceleration/deceleration.

Note 3. The settling time depends on the commanded acceleration/deceleration, the rigidity of the machine motor drive, the encoder resolution, and other factors.

1-4 System Block Diagrams


L1
L2
P
N
GR
U
V
W
GR
Switching power supply main circuit control
Control power supply
15V2
VCC2
+VCC
−VCC
G
Relay drive
Gate drive
Current detection
Overcurrent protection
+VCC
G
+A, −A
+B, −B
Phase U
Phase V
Phase W
Phase Z
Encoder signal input connector
ADC
Main circuit voltage detection
MPU & ASIC
Position, speed, and torque processor
FAN
G
−VCC
Fan alarm
I/O circuits
MECHATROLINK-II I/F
Display circuit
Set value read circuit
Alarm output
Brake output
Emergency stop input
Origin proximity input
External latch signal input
Forward drive inhibit
Reverse drive inhibit
Control I/O connector
MECHATROLINK-II communications connector
MECHATROLINK-II setting
Command filter setting

1-5 Applicable Standards

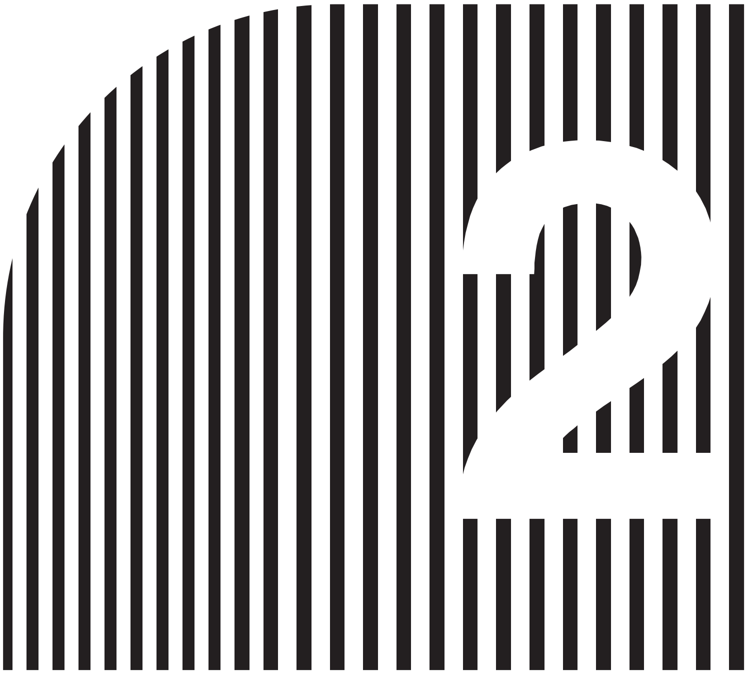
1-5-1 EC Directives

EC Directive	Product	Applicable standards	Comments
Low Voltage Directive	AC Servo Drivers	EN 50178	Safety requirements for electronic equipment for measurement, control, or laboratory use
	AC Servomotors	IEC 60034-1, -5, -8, and -9 EN 60034-1 and -9	Rotating electric machines
EMC Directive	AC Servo Drivers and AC Servomotors	EN 55011 Class A Group1	Limits and methods of measurement of radio disturbance of industrial, scientific, and medical radio-frequency equipment
		EN 61000-6-2	Electromagnetic compatibility (EMC): Immunity standard for industrial environments

Note To conform to EMC Directives, the Units must be installed under the conditions described in *4-2-6 Conforming to EMC Directives*.

1-5-2 UL and cUL Standards

Standard	Product	Applicable standards	File number	Comments
UL	AC Servo Drivers	UL 508C	E179149	Power Conversion Equipment
	AC Servomotors	UL 1004	E179189	Electric Motors
cUL	AC Servo Drivers	cUL C22.2 No.14	E179149	Industrial Control Equipment
	AC Servomotors	cUL C22.2 No.100	E179189	Motors and Generation Equipment



Chapter 2

Standard Models and Dimensions

2-1 Standard Models
2-2 External and Mounted Dimensions

2-1 Standard Models

2-1-1 Servo Drivers

Specifications		Model
With MECHATROLINK-II communications	100 W	R7D-ZN01H-ML2
	200 W	R7D-ZN02H-ML2
	400 W	R7D-ZN04H-ML2
	750 W	R7D-ZN08H-ML2

2-1-2 Servomotors

Specifications		Model
Without brake	100 W	R7M-Z10030-S1
	200 W	R7M-Z20030-S1
	400 W	R7M-Z40030-S1
	750 W	R7M-Z75030-S1
With brake	100 W	R7M-Z10030-BS1
	200 W	R7M-Z20030-BS1
	400 W	R7M-Z40030-BS1
	750 W	R7M-Z75030-BS1

2-1-3 Servo Driver-Servomotor Combinations

Rated output	Servomotor		Servo Driver
	Without brake	With brake	With MECHATROLINK-II communications
100 W	R7M-Z10030-S1	R7M-Z10030-BS1	R7D-ZN01H-ML2
200 W	R7M-Z20030-S1	R7M-Z20030-BS1	R7D-ZN02H-ML2
400 W	R7M-Z40030-S1	R7M-Z40030-BS1	R7D-ZN04H-ML2
750 W	R7M-Z75030-S1	R7M-Z75030-BS1	R7D-ZN08H-ML2

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

2-1-4 Decelerators (Straight Shaft with Key)

■ Backlash: 3 Arcminutes Max.

Specifications		Model
Motor capacity	**Gear ratio**	
100 W	1/5	R7G-VRSFPB05B100
	1/9	R7G-VRSFPB09B100
	1/15	R7G-VRSFPB15B100
	1/25	R7G-VRSFPB25C100
200 W	1/5	R7G-VRSFPB05B200
	1/9	R7G-VRSFPB09C400
	1/15	R7G-VRSFPB15C400
	1/25	R7G-VRSFPB25C200
400 W	1/5	R7G-VRSFPB05C400
	1/9	R7G-VRSFPB09C400
	1/15	R7G-VRSFPB15C400
	1/25	R7G-VRSFPB25D400
750 W	1/5	R7G-VRSFPB05C750
	1/9	R7G-VRSFPB09D750
	1/15	R7G-VRSFPB15D750
	1/25	R7G-VRSFPB25E750

■ Backlash: 45 Arcminutes Max.

Specifications		Model
Motor capacity	**Gear ratio**	
100 W	1/5	R7G-RGSF05B100
	1/9	R7G-RGSF09B100
	1/15	R7G-RGSF15B100
200 W	1/5	R7G-RGSF05B200
	1/9	R7G-RGSF09C400
	1/15	R7G-RGSF15C400
400 W	1/5	R7G-RGSF05C400
	1/9	R7G-RGSF09C400
	1/15	R7G-RGSF15C400

2-1-5 Accessories and Cables

■ MECHATROLINK-II Cables and Terminating Resistance (for CN6)

● MECHATROLINK-II Cables

Specifications		Model
MECHATROLINK-II Cable	0.5 m	FNY-W6003-A5
	1 m	FNY-W6003-01
	3 m	FNY-W6003-03
	5 m	FNY-W6003-05
	10 m	FNY-W6003-10
	20 m	FNY-W6003-20
	30 m	FNY-W6003-30

● Terminating Resistance

Specifications	Model
MECHATROLINK-II Terminating Resistor	FNY-W6022

■ Control Cables (for CN1)

Specifications		Model
Cables for Connector Terminal Blocks	1 m	XW2Z-100J-B19
	2 m	XW2Z-200J-B19
General-purpose Control Cables	1 m	R7A-CPZ001S
	2 m	R7A-CPZ002S

■ Servomotor Power Cables (for CNB)

Specifications		Model
Power Cables for Servomotors without Brakes (connector attached)	3 m	R7A-CAZ003S
	5 m	R7A-CAZ005S
	10 m	R7A-CAZ010S
	15 m	R7A-CAZ015S
	20 m	R7A-CAZ020S
Cable Only (in 1-m increments)		R7A-CAZ001
Power Cables for Servomotors with Brakes (connector attached)	3 m	R7A-CAZ003B
	5 m	R7A-CAZ005B
	10 m	R7A-CAZ010B
	15 m	R7A-CAZ015B
	20 m	R7A-CAZ020B
Cable Only (in 1-m increments)		R7A-CAZ01B

■ Encoder Cables (for CN2)

Specifications		Model
Encoder Cables (connector attached)	3 m	R7A-CRZ003C
	5 m	R7A-CRZ005C
	10 m	R7A-CRZ010C
	15 m	R7A-CRZ015C
	20 m	R7A-CRZ020C
Cable Only (in 1-m increments)		R7A-CRZ001

■ Connectors

Specifications	Model
Main Circuit Connector (CNA) with Ejector Levers	R7A-CNZ01P
Servomotor Connector (CNB)	R7A-CNZ01A
Control Input Connector (CN1)	R7A-CNA01R
Encoder Input Connector (CN2)	R7A-CNZ01R
Servomotor Connector for Encoder Cable	R7A-CNZ02R
Servomotor Connector for Servomotor Power Cable	R7A-CNZ02A

■ Regeneration Resistance Unit

Specifications	Model
Regeneration current: 8 A Internal resistance: 50 Ω, 12 W	R88A-RG08UA

■ External Regeneration Resistor

Specifications	Model
Regeneration capacity: 70 W, 47 Ω	R88A-RR22047S

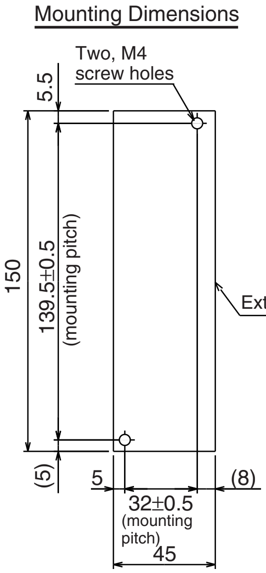
■ AC Reactors

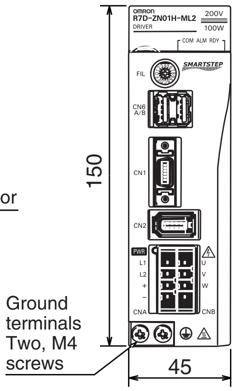
Specifications	Model
R7D-ZP01H/R7D-ZN01H-ML2	R88A-PX5052
R7D-ZP02H/R7D-ZN02H-ML2	R88A-PX5053
R7D-ZP04H/R7D-ZN04H-ML2	R88A-PX5054
R7D-ZP08H/R7D-ZN08H-ML2	R88A-PX5056

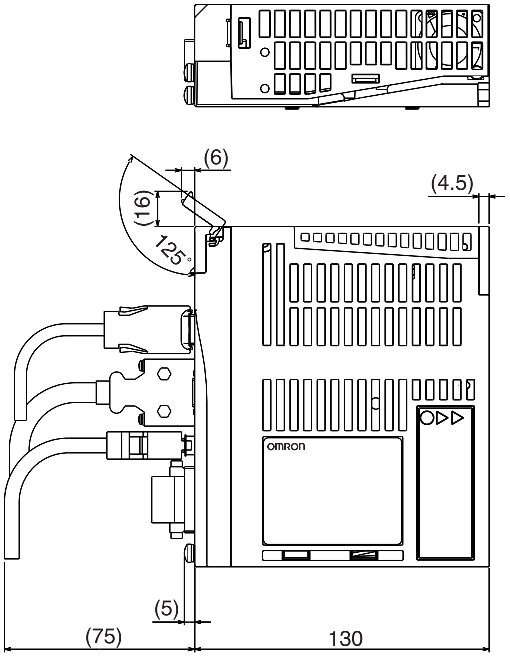
2-2 External and Mounted Dimensions

2-2-1 Servo Drivers

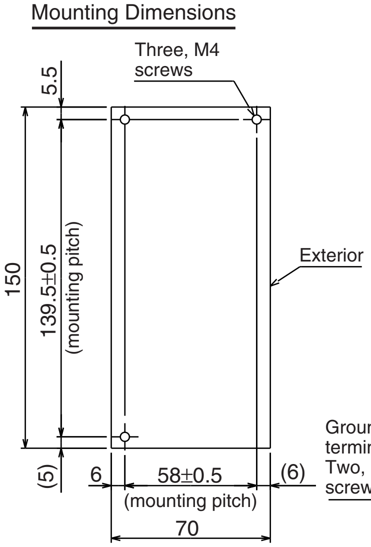
■ R7D-ZN01H-ML2/-ZN02H-ML2/-ZN04H-ML2 (100 W/200 W/400 W)

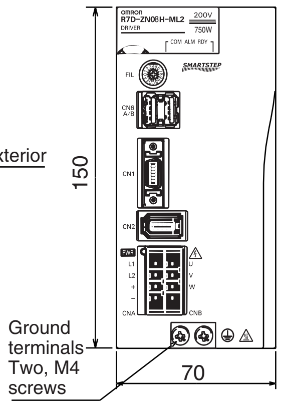

Mounting Dimensions
Two, M4 screw holes
5.5
150
139.5±0.5 (mounting pitch)
Exterior
(5)
5
(8)
32±0.5 (mounting pitch)
45

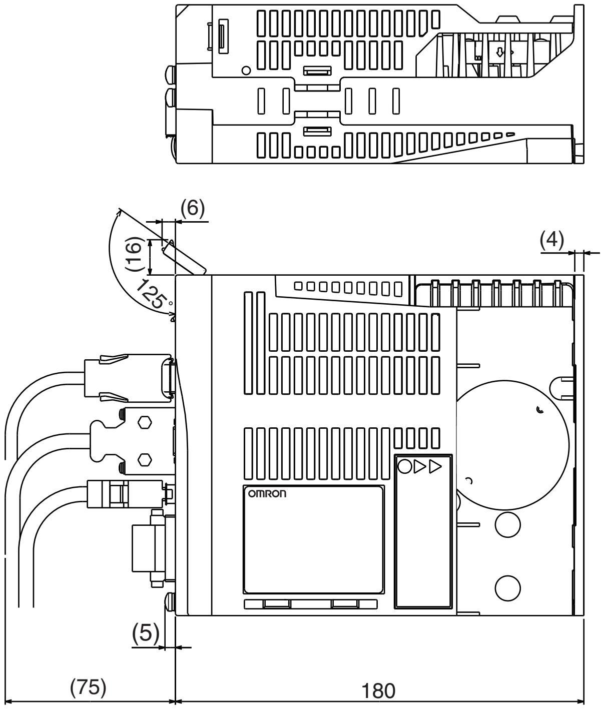

omron R7D-ZN01H-ML2 DRIVER 200V 100W
COM ALM RDY
SMARTSTEP
FIL
CN6 A/B
CN1
CN2
PWR
L1 L2 + −
U V W
CNA CNB
150
Ground terminals Two, M4 screws
45


(6)
(4.5)
(16)
125°
OMRON
(5)
(75)
130

■ R7D-ZN08H-ML2 (750 W)


Mounting Dimensions
Three, M4 screws
5.5
150
139.5±0.5 (mounting pitch)
Exterior
(5)
6
58±0.5 (mounting pitch)
(6)
70

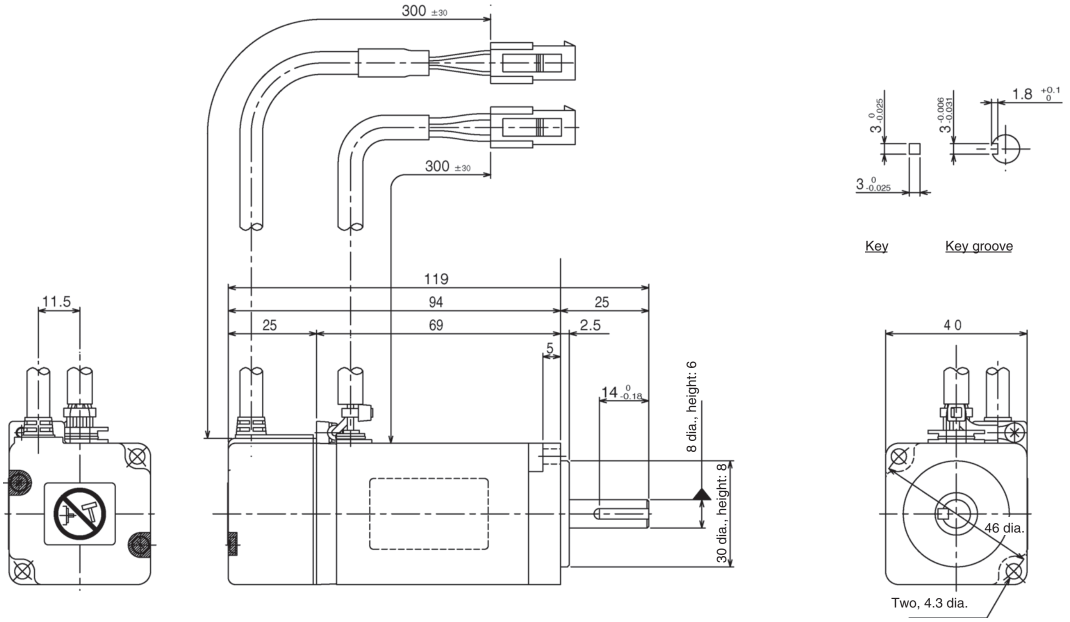

omron R7D-ZN08H-ML2 DRIVER 200V 750W
COM ALM RDY
SMARTSTEP
FIL
CN6 A/B
CN1
CN2
PWR
L1 L2 + −
U V W
CNA CNB
150
Ground terminals Two, M4 screws
70


(6)
(4)
(16)
125°
OMRON
(5)
(75)
180

2-2-2 Servomotors

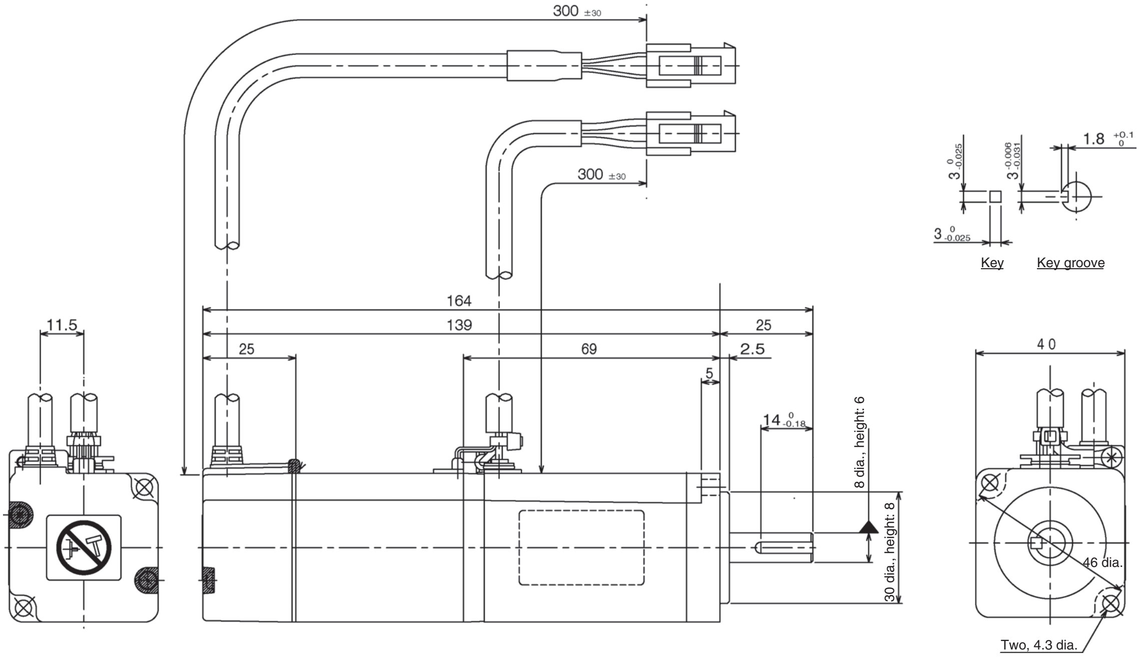
■ 100-W Servomotor without a Brake

R7M-Z10030-S1


300 ±30
300 ±30
1.8 +0.1 0
3 0 -0.025
3 -0.006 -0.031
3 0 -0.025
Key
Key groove
119
94
25
11.5
25
69
2.5
5
14 0 -0.18
8 dia., height: 6
30 dia., height: 8
40
46 dia.
Two, 4.3 dia.

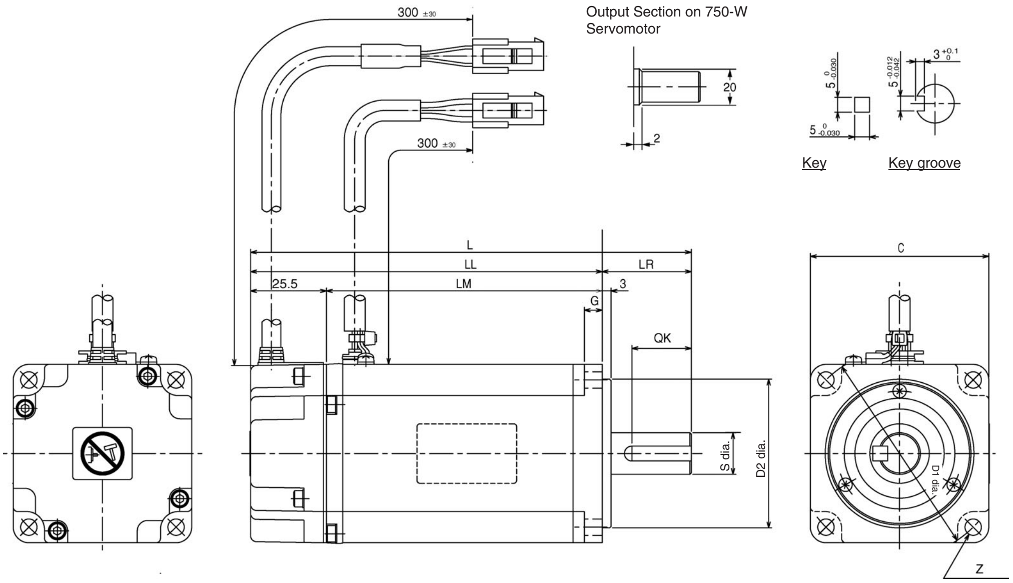
■ 100-W Servomotor with Brake

R7M-Z10030-BS1


300 ±30
300 ±30
1.8 +0.1 0
3 0 -0.025
3 -0.006 -0.031
3 0 -0.025
Key
Key groove
164
139
25
11.5
25
69
2.5
5
14 0 -0.18
8 dia., height: 6
30 dia., height: 8
40
46 dia.
Two, 4.3 dia.

■ 200-W/400-W/750-W Servomotors without Brakes

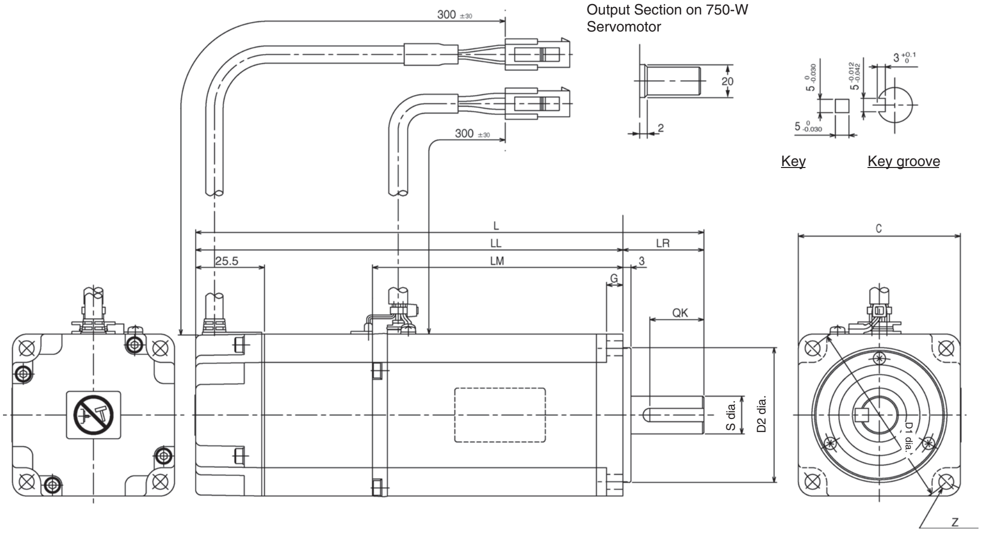
R7M-Z20030-S1/Z40030-S1/Z75030-S1


300 ±30
300 ±30
Output Section on 750-W Servomotor
20
2
5 $^{0}_{-0.030}$
5 $^{0}_{-0.030}$
5 $^{-0.012}_{-0.042}$
3 $^{+0.1}_{0}$
Key
Key groove
L
LL
LR
25.5
LM
3
G
QK
S dia.
D2 dia.
C
D1 dia.
Z

Model	L (mm)	LL (mm)	LM (mm)	LR (mm)	C (mm)	D1 (mm)	D2 (mm)	G (mm)	Z (mm)	S (mm)	QK (mm)
R7M-Z20030-S1	125.5	95.5	70	30	60	70	50h8	6	Four, 5.5 dia.	14h6	20
R7M-Z40030-S1	148.5	118.5	93	30	60	70	50h8	6	Four, 5.5 dia	14h6	20
R7M-Z75030-S1	173	133	107.5	40	80	90	70h8	8	Four, 7 dia	16h6	30

■ 200-W/400-W/750-W Servomotors with Brakes

R7M-Z20030-BS1/Z40030-BS1/Z75030-BS1


300 ±30
300 ±30
Output Section on 750-W Servomotor
20
2
5 0 -0.030
5 -0.012 -0.042
3 +0.1 0
5 0 -0.030
Key
Key groove
L
LL
LR
25.5
LM
3
G
QK
S dia.
D2 dia.
C
D1 dia.
Z

Model	L (mm)	LL (mm)	LM (mm)	LR (mm)	C (mm)	D1 (mm)	D2 (mm)	G (mm)	Z (mm)	S (mm)	QK (mm)
R7M-Z20030-BS1	165.5	135.5	70	30	60	70	50h8	6	Four, 5.5 dia.	14h6	20
R7M-Z40030-BS1	188.5	158.5	93	30	60	70	50h8	6	Four, 5.5 dia	14h6	20
R7M-Z75030-BS1	216	176	107.5	40	80	90	70h8	8	Four, 7 dia	16h6	30

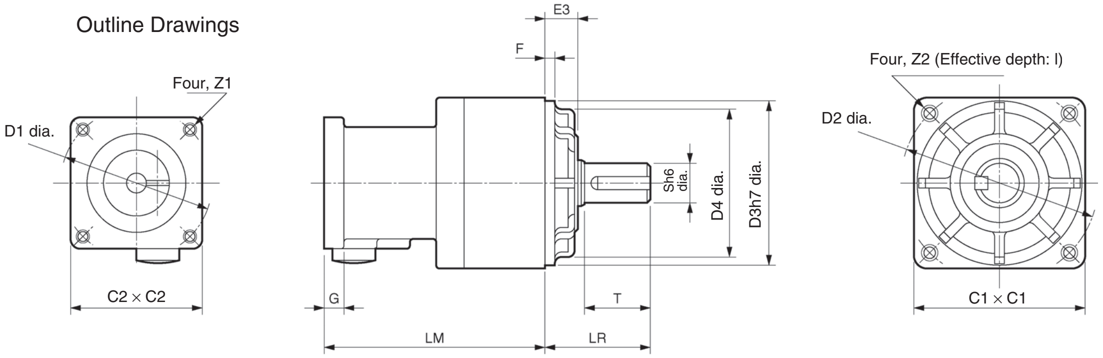
2-2-3 Decelerator Dimensions

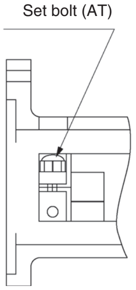
■ Backlash: 3 Arcminutes Max.

Model			Dimensions (mm)																		
			LM	LR	C1	C2	D1	D2	D3	D4	E3	F	G	S	T	Z1	Z2	AT (See note.)	l	Key dimensions			
																				QK	b	h	t1
100 W	1/5	R7G-VRSFPB05B100	67.5	32	52	40	46	60	50	45	10	3	6	12	20	M4	M5	M3	12	16	4	4	2.5
	1/9	R7G-VRSFPB09B100	67.5	32	52	40	46	60	50	45	10	3	6	12	20	M4	M5	M3	12	16	4	4	2.5
	1/15	R7G-VRSFPB15B100	78	32	52	40	46	60	50	45	10	3	6	12	20	M4	M5	M3	12	16	4	4	2.5
	1/25	R7G-VRSFPB25C100	92	50	78	40	46	90	70	62	17	3	6	19	30	M4	M6	M3	20	22	6	6	3.5
200 W	1/5	R7G-VRSFPB05B200	72.5	32	52	60	70	60	50	45	10	3	10	12	20	M5	M5	M4	12	16	4	4	2.5
	1/9	R7G-VRSFPB09C400	89.5	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
	1/15	R7G-VRSFPB15C400	100	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
	1/25	R7G-VRSFPB25C200	100	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
400 W	1/5	R7G-VRSFPB05C400	89.5	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
	1/9	R7G-VRSFPB09C400	89.5	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
	1/15	R7G-VRSFPB15C400	100	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
	1/25	R7G-VRSFPB25D400	104	61	98	60	70	115	90	75	18	5	8	24	40	M5	M8	M4	20	30	8	7	4
750 W	1/5	R7G-VRSFPB05C750	93.5	50	78	80	90	90	70	62	17	3	10	19	30	M6	M6	M4	20	22	6	6	3.5
	1/9	R7G-VRSFPB09D750	97.5	61	98	80	90	115	90	75	18	5	10	24	40	M6	M8	M4	20	30	8	7	4
	1/15	R7G-VRSFPB15D750	110	61	98	80	90	115	90	75	18	5	10	24	40	M6	M8	M4	20	30	8	7	4
	1/25	R7G-VRSFPB25E750	135	75	125	80	90	135	110	98	17	5	10	32	55	M6	M10	M4	20	45	10	8	5

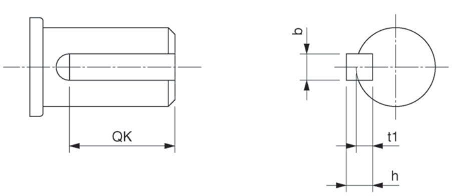
Note AT is the size of the set bolt.

Outline Drawings





Key dimensions

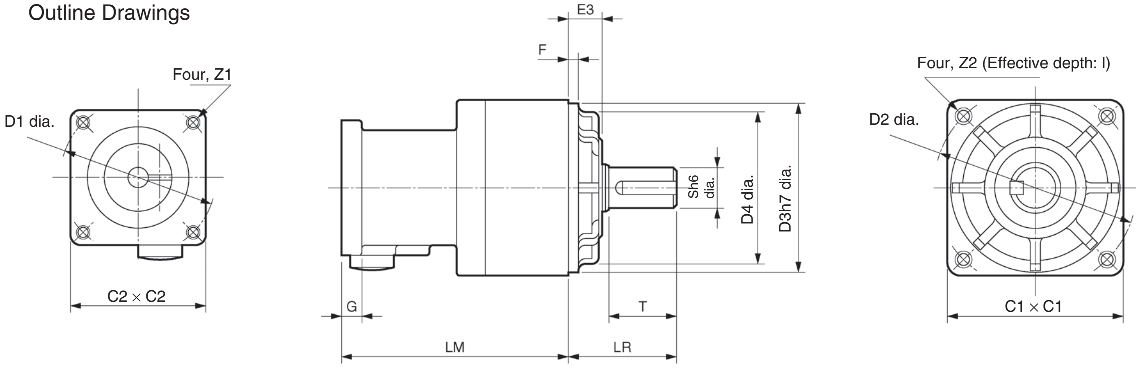


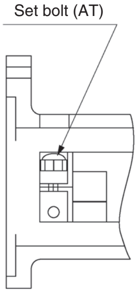
■ Backlash: 45 Arcminutes Max.

Model			Dimensions (mm)																			
			LM	LR	C1	C2	D1	D2	D3	D4	E3	F	G	S	T	Z1	Z2	AT (See note.)	l	Key dimensions			
																				QK	b	h	t1
100 W	1/5	R7G-RGSF05B100	67.5	32	52	40	46	60	50	45	10	3	6	12	20	M4	M5	M3	12	16	4	4	2.5
	1/9	R7G-RGSF09B100	67.5	32	52	40	46	60	50	45	10	3	6	12	20	M4	M5	M3	12	16	4	4	2.5
	1/15	R7G-RGSF15B100	78	32	52	40	46	60	50	45	10	3	6	12	20	M4	M5	M3	12	16	4	4	2.5
200 W	1/5	R7G-RGSF05B200	72.5	32	52	60	70	60	50	45	10	3	10	12	20	M5	M5	M4	12	16	4	4	2.5
	1/9	R7G-RGSF09C400	89.5	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
	1/15	R7G-RGSF15C400	100	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
400 W	1/5	R7G-RGSF05C400	89.5	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
	1/9	R7G-RGSF09C400	89.5	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5
	1/15	R7G-RGSF15C400	100	50	78	60	70	90	70	62	17	3	8	19	30	M5	M6	M4	20	22	6	6	3.5

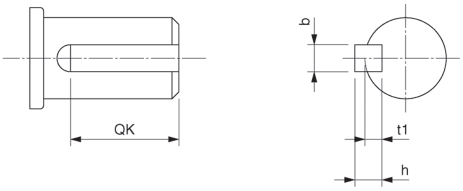
Note AT is the size of the set bolt.

Outline Drawings


Four, Z1
D1 dia.
C2 × C2
E3
F
Sh6 dia.
D4 dia.
D3h7 dia.
G
T
LM
LR
Four, Z2 (Effective depth: l)
D2 dia.
C1 × C1

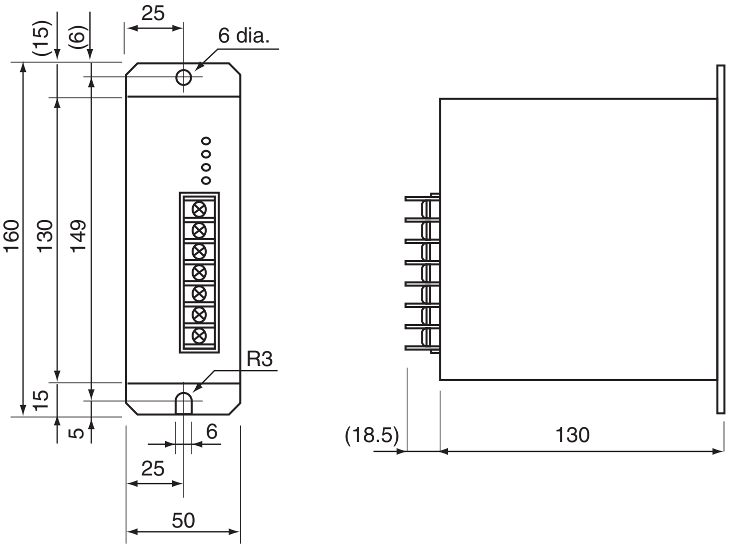


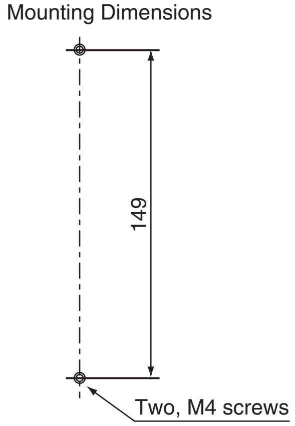
Key dimensions



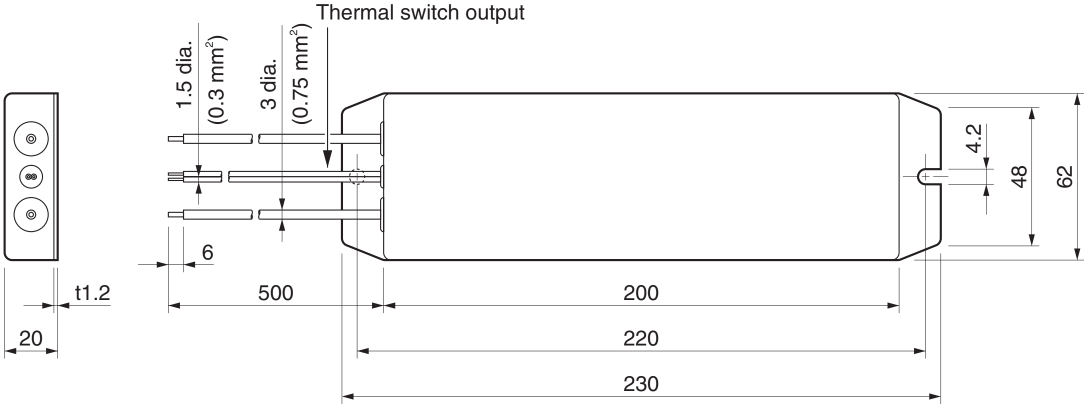
2-2-4 External Regeneration Unit and Resistor Dimensions

■ External Regeneration Unit

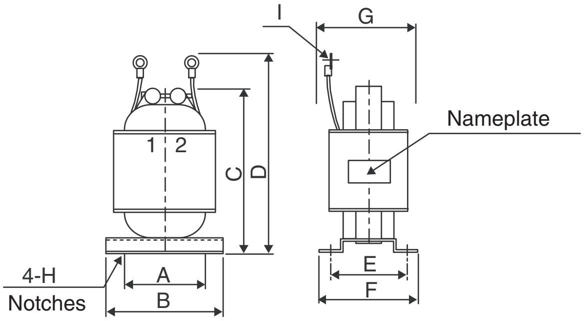

25
6 dia.
(15)
(6)
160
130
149
R3
15
5
6
25
50
(18.5)
130


Mounting Dimensions
149
Two, M4 screws

■ External Regeneration Resistor


Thermal switch output
1.5 dia.
(0.3 mm²)
3 dia.
(0.75 mm²)
4.2
48
62
6
t1.2
20
500
200
220
230

2-2-5 AC Reactor Dimensions


I
G
Nameplate
1
2
C
D
4-H
Notches
A
B
E
F

Model	Dimensions (mm)								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**Dia. H**	**Dia. I**
R88A-PX5052	35	52	80	95	30	40	45	4	4.3
R88A-PX5053	35	52	90	105	35	45	50	4	4.3
R88A-PX5054	35	52	80	95	30	40	45	4	4.5
R88A-PX5056	35	52	80	95	30	40	45	4	4.3

Chapter 3

Specifications

3-1 Servo Driver Specifications
3-2 Servomotor Specifications
3-3 Decelerator Specifications
3-4 Cable and Connector Specifications
3-5 External Regeneration Unit and External Regeneration Resistor
3-6 AC Reactors

3-1 Servo Driver Specifications

Select the Servo Driver in combination with the Servomotor being used. (For details, refer to *2-1-3 Servo Driver-Servomotor Combinations*.)

3-1-1 General Specifications

Item			Specifications
Ambient operating temperature			0 to 55°C
Ambient operating humidity			20 to 90% (with no condensation)
Ambient storage temperature			–20 to 70°C
Ambient storage humidity			90% max. (with no condensation)
Storage and operating atmosphere			No corrosive gasses, no dust, no iron dust, no exposure to moisture or cutting oil
Vibration resistance			10 to 55 Hz in X, Y, and Z directions with 0.1-mm double amplitude; acceleration: 4.9 m/s^2 max.
Impact resistance			Acceleration 19.6 m/s^2 max., in X, Y, and Z directions, three times
Insulation resistance			Between power supply/power line terminals and frame ground: 0.5 MΩ min. (at 500 V DC)
Dielectric strength			Between power supply/power line terminals and frame ground: 1,500 V AC for 1 min at 50/60 Hz Between each control signal and frame ground: 500 V AC for 1 min
Degree of protection			Built into panel (IP10).
International standards	EC Directives	EMC Directive	EN 55011 Class A Group 1 EN 61000-6-2
		Low Voltage Directive	EN 50178
	UL standards		UL 508C
	cUL standards		cUL C22.2 No.14

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 Driver parts will require maintenance. Refer to *6-5 Periodic Maintenance* for details.

Note 3. The service life of the Servo Driver 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 Driver.

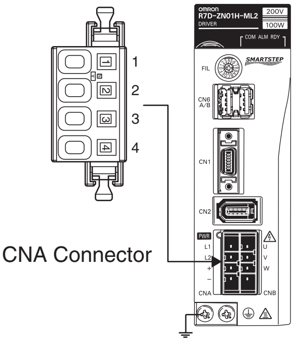
3-1-2 Characteristics

■ Control Specifications

Item		Servo Driver model (R7D-)			
		ZN01H-ML2	ZN02H-ML2	ZN04H-ML2	ZN08H-ML2
Input power supply voltage (For main circuit and control circuit)		Single-phase 200 to 230 VAC (170 to 253 V), 50/60 Hz			
Input power supply current (rms) (For main circuit and control circuit)		1.8 A	3.5 A	5.5 A	10 A
Heat generated	Main circuit	6 W	8 W	16 W	27 W
	Control circuit	9 W	9 W	9 W	9 W
Continuous output current (rms)		0.84 A	1.1 A	2.0 A	3.7 A
Momentary maximum output current (rms)		2.5 A	3.3 A	6.0 A	11.1 A
Control method		All-digital servo			
Inverter method		IGBT-driven PWM method			
Weight		1.0 kg			1.4 kg
Applicable motor capacity		100 W	200 W	400 W	750 W
Applicable Servomotors (R7M-)		Z10030-S1	Z20030-S1	Z40030-S1	Z75030-S1

3-1-3 Main Circuit and Servomotor Connector Specifications (CNA and CNB)

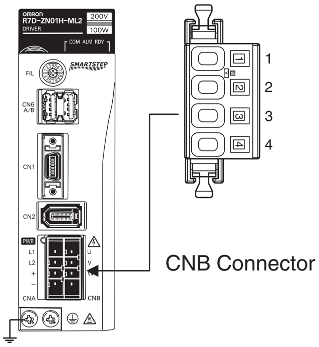
■ R7A-CNZ01P (CNA) Main Circuit Connector Specifications


1
2
3
4
CNA Connector
omron
R7D-ZN01H-ML2
DRIVER
200V
100W
COM ALM RDY
FIL
SMARTSTEP
CN6 A/B
CN1
CN2
PWR
L1
L2
+
−
CNA
U
V
W
CNB

● Main Circuit Connector (CNA) Pin Arrangement

Signal No.	Signal	Function	Condition
1	L1	Main circuits power supply input	Single-phase 200/230 V AC (170 to 253 V AC) 50/60 Hz
2	L2		
3	+	External Regeneration Unit connection terminals	If regenerative energy is high, connect an External Regeneration Unit between P and N.
4	–		
⏚	⏚	Frame ground	This is the ground terminal. Ground to a minimum of 100 Ω (class D, class 3).

■ R7A-CNZ01A (CNB) Servomotor Connector Specifications

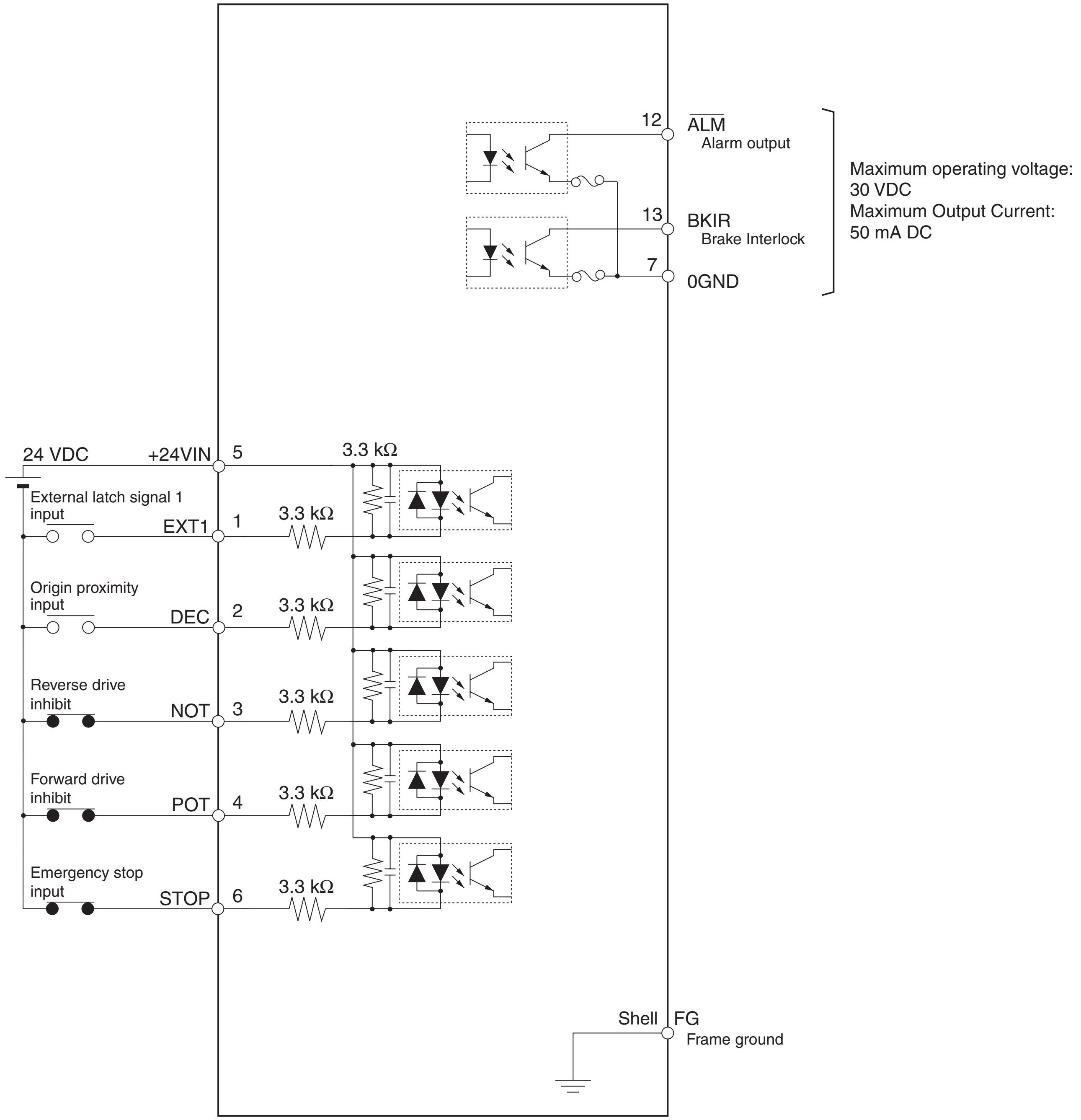

omron
R7D-ZN01H-ML2
DRIVER
200V
100W
COM ALM RDY
FIL
SMARTSTEP
CN6 A/B
CN1
CN2
PWR
L1
L2
+
−
CNA
U
V
W
CNB
1
2
3
4
CNB Connector

● Servomotor Connector (CNB) Pin Arrangement

Pin No.	Terminal label	Name	Function	
1	U	Servomotor connection Terminals	Red	These are the output terminals to the Servomotor. Be careful to wire them correctly.
2	V		White	
3	W		Blue	
4		---	Do not connect anything to this terminal.	
⏚	⏚	Frame ground	Green/Yellow	Connect the Servomotor FG terminal.

3-1-4 Control I/O Specifications (CN1)

■ Control I/O Signal Connections and External Signal Processing


12
ALM
Alarm output
13
BKIR
Brake Interlock
7
0GND
Maximum operating voltage: 30 VDC
Maximum Output Current: 50 mA DC
24 VDC
+24VIN
5
3.3 kΩ
External latch signal 1 input
EXT1
1
3.3 kΩ
Origin proximity input
DEC
2
3.3 kΩ
Reverse drive inhibit
NOT
3
3.3 kΩ
Forward drive inhibit
POT
4
3.3 kΩ
Emergency stop input
STOP
6
3.3 kΩ
Shell
FG
Frame ground

■ Control I/O Signals

● CN1 Control Inputs

Pin No.	Signal name	Function	Function/Interface
1	EXT1	External latch signal 1 input	Functions as an origin signal during origin search, and as an interrupt signal during interrupt feeding.
2	DEC	Origin proximity input	Deceleration input during origin search
3	NOT	Reverse drive inhibit input	Reverse rotation overtravel input
4	POT	Forward drive inhibit input	Forward rotation overtravel input
5	+24VIN	+24-V power supply input for control DC	24-VDC power supply input terminal for sequence inputs (pin 6)
6	STOP	Emergency stop input	ON: Servo OFF (Stops power to Servomotor.)

● CN1 Control Outputs

Pin No.	Signal name	Function	Function/Interface
12	$\overline{\text{ALM}}$	Alarm output	When the Servo Driver generates an alarm, the output turns OFF. Note: OFF for approx. 2 s after the power is turned ON.
13	BKIR	Brake interlock output	Outputs the holding brake timing signals. Release the holding brake when this signal is ON.
7	0GND	Output ground common	Ground common for sequence outputs (pins 12 and 13).

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

■ CN1: Pin Arrangement

Pin No.	Signal name	Function	Pin No.	Signal name	Function
1	EXT1	External latch signal 1 input	8	---	---
2	DEC	Origin proximity input	9	---	---
3	NOT	Reverse drive inhibit input	10	---	---
4	POT	Forward drive inhibit input	11	---	---
5	+24VIN	+24-V power supply input for control DC	12	$\overline{\text{ALM}}$	Alarm output
6	STOP	Emergency stop input	13	BKIR	Brake interlock output
7	0GND	Output ground common	14	---	---

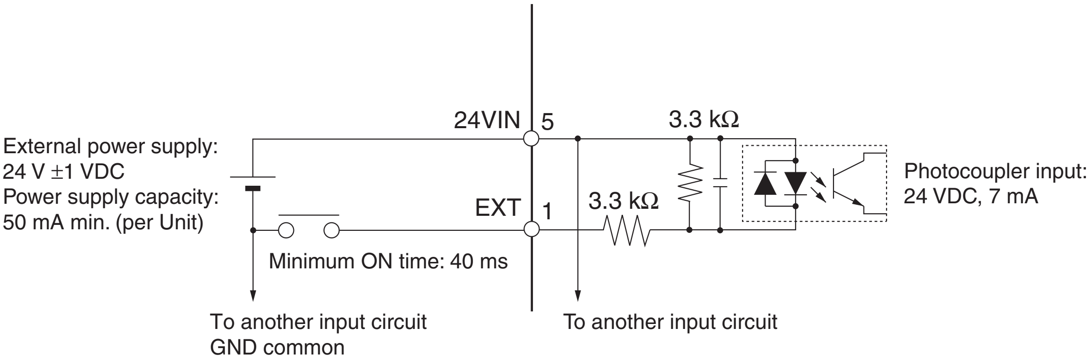
■ CN1 Connectors (14P)

Soldered Connectors

Name	Model	Manufacturer
Cable plug	10114-3000VE	Sumitomo 3M
Cable case (shell kit)	10314-52A0-008	

3-1-5 Control Input Circuits

■ Sequence Inputs


External power supply:
24 V ±1 VDC
Power supply capacity:
50 mA min. (per Unit)
24VIN
5
3.3 kΩ
EXT
1
3.3 kΩ
Photocoupler input:
24 VDC, 7 mA
Minimum ON time: 40 ms
To another input circuit
GND common
To another input circuit

Signal Levels
On level: Minimum (+24 VIN-11) V
OFF level: Maximum (+24 VIN-1) V

3-1-6 Control Input Details

The CN1 connector input pins are described in detail below.

■ External Latch Signal 1 Input (EXT1)

Pin 1: External latch signal 1 input (EXT1)

Functions

1. Function During Origin Search
    - Functions as an origin input signal during origin search.
    - Normally the encoder’s Z phase is used for origin inputs during an origin search, but this signal can be used when it is desirable to use an external sensor signal without using the Z phase.
2. Function During Interrupt Feeding Control
    - Functions as interrupt signal during interrupt feeding control.
    - When this signal turns ON during a positioning operation, positioning is executed from the signal input position for the specified final travel distance for external positioning.
    - When this signal does not turn ON during a positioning operation, the positioning specified first is executed.

■ Origin Proximity Input (DEC)

Pin 2: Origin proximity input (DEC)

Function

- This is the deceleration signal during origin search.

- When this signal turns ON while the Servomotor is moving at the origin search feed speed, the Servomotor decelerates to the origin search approach speed.
- After this signal turns OFF, at the first origin input signal the Servomotor decelerates to origin search creep speed and positioning is executed for the origin search final travel distance.
- After positioning is completed, that position becomes the origin.

■ Forward Drive Inhibit (POT) and Reverse Drive Inhibit (NOT)

Pin 4: Forward drive inhibit (POT)

Pin 3: Reverse drive inhibit (NOT)

Functions

- These two signals are the forward and reverse drive inhibit (overtravel) inputs.
- When they are input, driving is enabled in the respective rotation directions.
- When driving is inhibited, servo lock status goes into effect after deceleration to a stop.
- The maximum torque after deceleration to a stop is the maximum torque of the Servomotor.
- When driving is inhibited, the Servo Driver does not go into alarm status.

■ Emergency Stop Input (STOP)

Pin 6: Emergency stop input (STOP)

Function

- This input is used to forcibly turn the Servo OFF from an external sequences, e.g., in a host device.
- If this input turns OFF while the Servomotor is rotating, the Servomotor is decelerated to a stop using the dynamic brake. After stopping it will go into servo free status.
- When the emergency stop input (STOP) is turned ON while Servomotor power is ON, an emergency stop alarm (A.28) is generated.

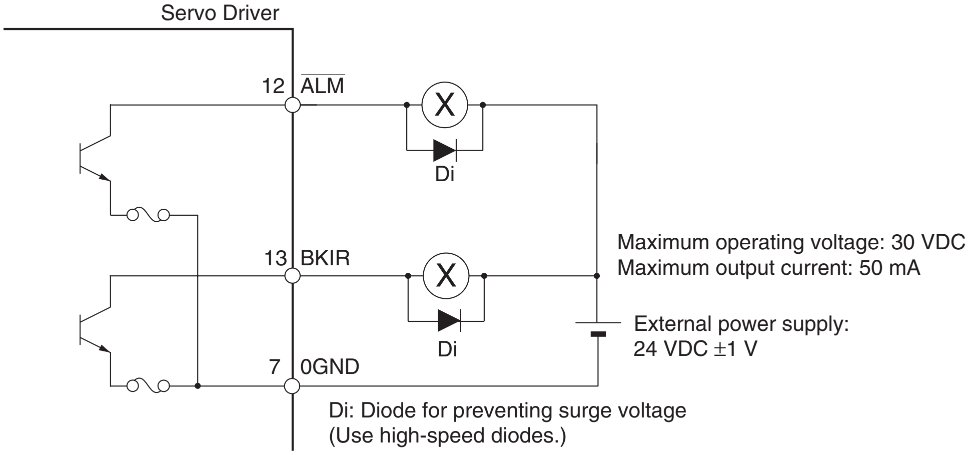
⚠WARNING

When turning OFF the main circuit power supply, turn OFF the emergency stop input (STOP) signal at the same time.

Even when the main circuit power supply is turned OFF by an external emergency stop, the Servomotor continues to rotate due to residual voltage. This can cause injury or damage to equipment.

3-1-7 Control Output Circuits

■ Sequence and Alarm Outputs


Servo Driver
12 $\overline{\text{ALM}}$
13 BKIR
7 0GND
X
X
Di
Di
External power supply:
24 VDC ±1 V

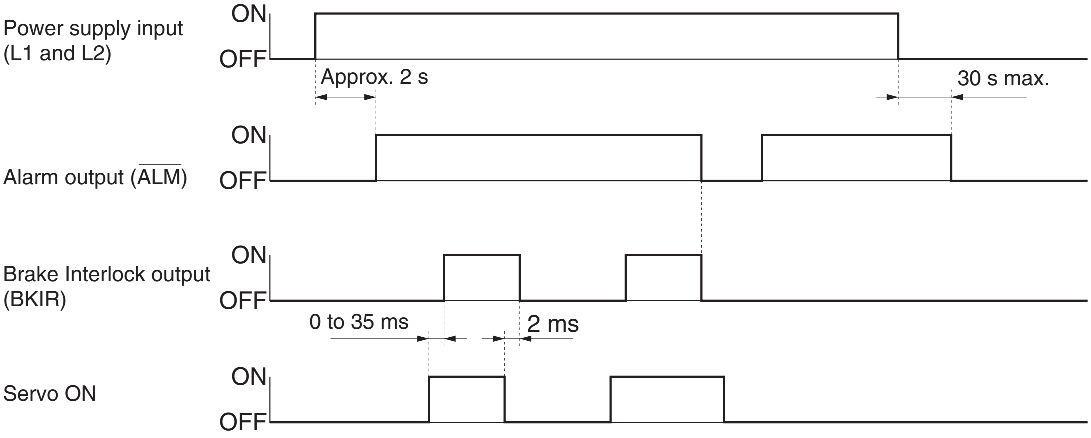
Maximum operating voltage: 30 VDC
Maximum output current: 50 mA

Di: Diode for preventing surge voltage
(Use high-speed diodes.)

3-1-8 Control Output Details

The CN1 connector output pins are described in detail below.

■ Control Output Sequence


Power supply input
(L1 and L2)
ON
OFF
Approx. 2 s
30 s max.
Alarm output ($\overline{\text{ALM}}$)
ON
OFF
Brake Interlock output
(BKIR)
ON
OFF
0 to 35 ms
2 ms
Servo ON
ON
OFF

■ Alarm Output ($\overline{\text{ALM}}$)

Pin No.12: Alarm Output ($\overline{\text{ALM}}$)

Function

- The alarm output is turned OFF when the Servo Driver detects an error.
- This output is OFF at startup and turns ON when the initial processing has been completed. (Approx. 2 s is required for initial processing.)

■ Brake Interlock Output (BKIR)

Pin No.13: Brake Interlock output (BKIR)

Function

- The external brake timing signal is output.

3-1-9 Encoder Connector Specifications (CN2)

Pin No.	Signal	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	Phase A+	Encoder phase +A input	Differential sine-wave input
4	Phase A–	Encoder phase –A input	
5	Phase B+	Encoder phase +B input	Differential cos-wave input
6	Phase B–	Encoder phase –B input	
7	Phase Z	Encoder phase Z input	Open collector input
8	Phase U	Pole sensor phase U input	Open collector input
9	Phase V	Pole sensor phase V input	Open collector input
10	Phase W	Pole sensor phase W input	Open collector input
Shell	FG	Shield ground	Cable shield ground

■ Connectors for CN2 (10-pin)

● Soldered Connector

Name	Model	Maker
Plug, Cable, and Cover Set	54599-1005	Molex Japan Co.
Plug Connector	51593-1011	

● Crimped (Solderless) Connector

Name	Model	Maker
Plug, Cable, and Cover Set	54559-1005	Molex Japan Co.
Plug Housing	51209-1001	
Crimp Terminal	59351-8187 (Loose wire)	
Crimping Tool	57401-5300	

3-1-10 MECHATROLINK-II Communications Specifications (CN6)

Item	Specifications
Communications specifications	MECHATROLINK-II
Baud rate	10 Mbps
Maximum transmission distance	50 m (See note.)
Minimum transmission distance between nodes	0.5 m
Transmission medium	2-core shielded twisted-pair cable
Number of connected nodes	30 max.
Topology	Bus
Transmission cycle	250 μs to 8 ms
Communications method	Master/Slave total synchronization method
Encoding method	Manchester encoding
Data length	Either 17 or 32 bytes can be selected.

Note This is the total length of cable connected between the devices. The maximum length will vary depending on the number of connected devices.

For details on the total cable length, refer to *3-4-1 MECHATROLINK-II Communications Cable Specifications*.

■ Communications Repeaters

The table below shows when a Communications Repeater is required or not required, depending on the number of MECHATROLINK-II devices connected and the maximum transmission distance.

● Communications Repeater Model Number

Name	Model
Communications Repeater	FNY-REP2000

● Communications Repeater Requirements

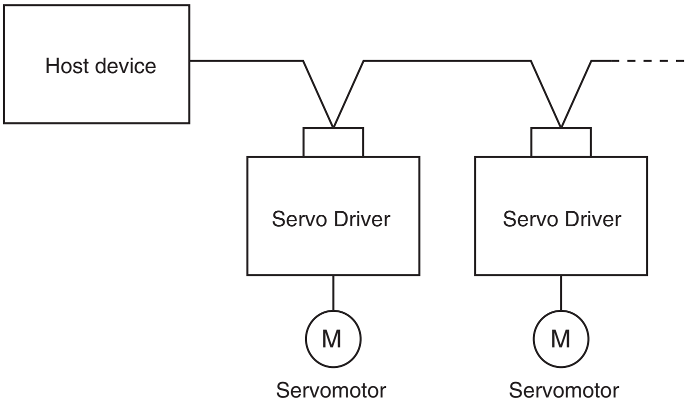
Number of connected devices	Maximum transmission distance	
	0 to 30 m	31 to 50 m
1 to 15	Repeater not required.	Repeater not required.
16	Repeater not required.	Repeater required.
17 to 30	Repeater required.	Repeater required.

■ System Configuration

The following diagram shows the basic system configuration.

Connection Example

CJ1W-NCF71 and CS1W-NCF71



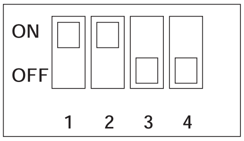
3-1-11 MECHATROLINK-II Communications Settings

This section describes the switch settings required for MECHATROLINK-II communications.

■ Communications Specifications

MECHATROLINK-II communications specifications are set using the DIP switch (SW2) for MECHATROLINK-II communications settings.The settings are shown in the following table. Changes to the settings go into effect after the power is turned ON.

Pin	Name	Setting	Contents	Factory setting
Pin 1	Reserved for system	ON	---	ON
Pin 2	Reserved for system	ON	---	ON
Pin 3	Axis No. setting	OFF	Axis No. 15 max.	OFF
		ON	Axis No. 16 min.	
Pin 4	Filter setting selection	OFF	Enables or disables the rotary switch for setting the command filter (FIL).	OFF



SW2 (factory settings)

■ Transmission Cycle

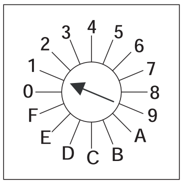
The following table shows the transfer times that can be used by the Servo Driver and the numbers of axes that can be connected.

	Transmission cycle (See note.)							
	0.5 ms	1.0 ms	1.5 ms	2.0 ms	2.5 ms	3.0 ms	3.5 ms	4.0 ms
Number of connectable axes	3	8	14	20	25	30	30	30

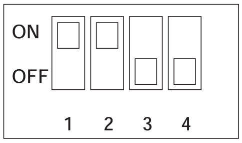
Note For details on settings, refer to the user's manual for the Position Controller with MECHATROLINK-II Communications.

■ Axis Number Setting

The axis number is set as shown below, using the rotary switch for setting the MECHATROLINK-II axis number (SW1) and the DIP switch for setting MECHATROLINK-II communications (SW2, pin 3).



SW1 (factory setting)



SW2 (factory settings)

SW2, pin 3	SW1	Axis No.	SW2, pin 3	SW1	Axis No.
OFF	0	Not valid	ON	0	16
	1	1		1	17
	2	2		2	18
	3	3		3	19
	4	4		4	20
	5	5		5	21
	6	6		6	22
	7	7		7	23
	8	8		8	24
	9	9		9	25
	A	10		A	26
	B	11		B	27
	C	12		C	28
	D	13		D	29
	E	14		E	30
	F	15		F	31

■ Filter Setting Selection

There are two methods for setting the command filter, as shown below. The selection is made using SW2 pin 4.

SW2, pin 4	Specifications
OFF	Set using the rotary switch for setting the command filter (FIL). (Factory setting)
ON	Set using PN00A. (Disables the rotary switch for setting the command filter.)

3-2 Servomotor Specifications

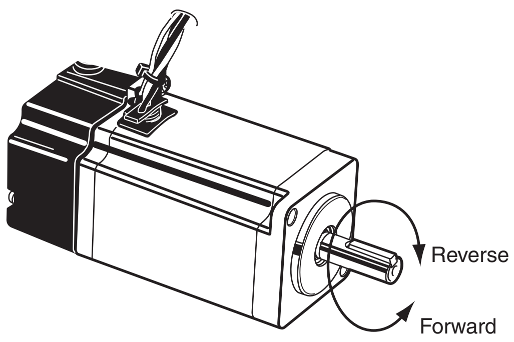
Select a Servomotor based on the mechanical system's load conditions and the installation environment. There are various options available on the Servomotors, such as brakes.

3-2-1 General Specifications

Item			Specifications
Ambient operating temperature			0 to 40°C
Ambient operating humidity			20% to 80% (with no condensation)
Ambient storage temperature			–20 to 60°C
Ambient storage humidity			20% to 80% (with no condensation)
Storage and operating atmosphere			No corrosive gases
Vibration resistance			10 to 2,500 Hz, with a 0.2-mm double amplitude or acceleration of 24.5 m/s^2 (whichever is smaller) in the X, Y, and Z directions
Impact resistance			98 m/s^2 max. (twice in vertical direction)
Insulation resistance			10 M min. at 500 VDC between the power terminals and FG terminal
Dielectric strength			1,500 VAC (50 or 60 Hz) for 1 minute between the power terminals and FG terminal
Operating position			Any direction
Insulation class			Type B
Construction			Totally-enclosed, self-cooling
Degree of protection			IP55 (excluding the through-shaft portion)
Vibration class			V-15
Mounting method			Flange-mounting
International standards	EC Directives	EMC Directive	EN 55011 Class A, Group1
			EN 61000-6-2
		Low Voltage Directive	IEC 60034-1, -5, -8, and -9 EN 60034-1 and -9
	UL standards		UL 1004
	cUL standards		cUL C22.2 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.



3-2-2 Characteristics

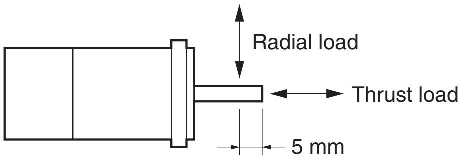
<table>
<tr><th colspan="2">Item</th><th>Unit</th><th>R7M-
Z10030-S1</th><th>R7M-
Z20030-S1</th><th>R7M-
Z40030-S1</th><th>R7M-
Z75030-S1</th></tr>
<tr><td colspan="2">Rated output (See note 1.)</td><td>W</td><td>100</td><td>200</td><td>400</td><td>750</td></tr>
<tr><td colspan="2">Rated torque (See note 1.)</td><td>N·m</td><td>0.318</td><td>0.637</td><td>1.27</td><td>2.39</td></tr>
<tr><td colspan="2">Rated rotation speed</td><td>r/min</td><td colspan="4">3,000</td></tr>
<tr><td colspan="2">Max. momentary speed</td><td>r/min</td><td colspan="4">4,500</td></tr>
<tr><td colspan="2">Max. momentary torque (See note 1.)</td><td>N·m</td><td>0.955</td><td>1.91</td><td>3.82</td><td>7.16</td></tr>
<tr><td colspan="2">Rated current (See note 1.)</td><td>A (rms)</td><td>0.84</td><td>1.1</td><td>2.0</td><td>3.7</td></tr>
<tr><td colspan="2">Max. momentary current (See note 1.)</td><td>A (rms)</td><td>2.5</td><td>3.3</td><td>6.0</td><td>11.1</td></tr>
<tr><td colspan="2">Power rate (See note 1.)</td><td>kW/s</td><td>16.0</td><td>12.3</td><td>26.7</td><td>38.1</td></tr>
<tr><td colspan="2">Allowable radial load (See notes 5 and 6.)</td><td>N</td><td>78</td><td>245</td><td>245</td><td>392</td></tr>
<tr><td colspan="2">Allowable thrust load (See note 5.)</td><td>N</td><td>54</td><td>74</td><td>74</td><td>147</td></tr>
<tr><td rowspan="2">Weight</td><td>Without brake</td><td>kg</td><td>0.5</td><td>0.9</td><td>1.3</td><td>2.6</td></tr>
<tr><td>With brake</td><td>kg</td><td>0.7</td><td>1.5</td><td>1.9</td><td>3.5</td></tr>
<tr><td colspan="3">Radiation shield dimensions (material)</td><td colspan="4">t6 × 250 × 250 (Al)</td></tr>
<tr><td rowspan="9">Brake specifications</td><td>Brake inertia</td><td>kg·m^2 (GD^2/4)</td><td>7.54×10^{-7}</td><td>6.4×10^{-6}</td><td>6.4×10^{-6}</td><td>1.71×10^{-5}</td></tr>
<tr><td>Excitation voltage (See note 3.)</td><td>V</td><td colspan="4">24 VDC ±10%</td></tr>
<tr><td>Power consumption (at 20°C)</td><td>W</td><td>6</td><td>7</td><td>7</td><td>7.7</td></tr>
<tr><td>Current consumption (at 20°C)</td><td>A</td><td>0.25</td><td>0.29</td><td>0.29</td><td>0.32</td></tr>
<tr><td>Static friction torque</td><td>N·m</td><td>0.318 min.</td><td>0.637 min.</td><td>1.27 min.</td><td>2.45 min.</td></tr>
<tr><td>Attraction time (See note 4.)</td><td>ms</td><td colspan="3">60 max.</td><td>80 max.</td></tr>
<tr><td>Release time (See note 4.)</td><td>ms</td><td>30 max.</td><td colspan="3">20 max.</td></tr>
<tr><td>Backlash</td><td>---</td><td colspan="4">1° max.</td></tr>
<tr><td>Rating</td><td>---</td><td colspan="4">Continuous</td></tr>
<tr><td rowspan="2">Applicable Servo Drivers (R7D-)</td><td colspan="2">Pulse-train models</td><td>ZP01H</td><td>ZP02H</td><td>ZP04H</td><td>ZP08H</td></tr>
<tr><td colspan="2">Models with MECHATROLINK-II communications</td><td>ZN01H-ML2</td><td>ZN02H-ML2</td><td>ZN04H-ML2</td><td>ZN08H-ML2</td></tr>
</table>

Note 1. These are the values when the Servomotor is combined with a Servo Driver and the armature winding temperature is 100°C. Other values are at normal conditions (20°C, 65%). The momentary maximum torque shown above indicates the standard value.

Note 2. This is the value without an accessory, such as an External Regeneration Unit.

Note 3. The brakes operate when the circuit is open (i.e., they are released when voltage is applied).

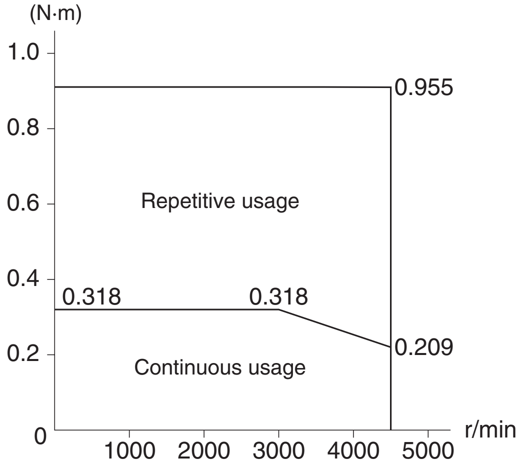
Note 4. The operation time is the measured value (reference value) with a varistor installed as a surge suppressor.



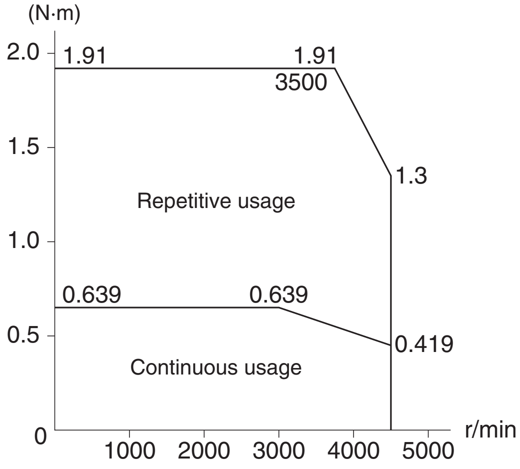
■ Torque and Rotation Speed Characteristics

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

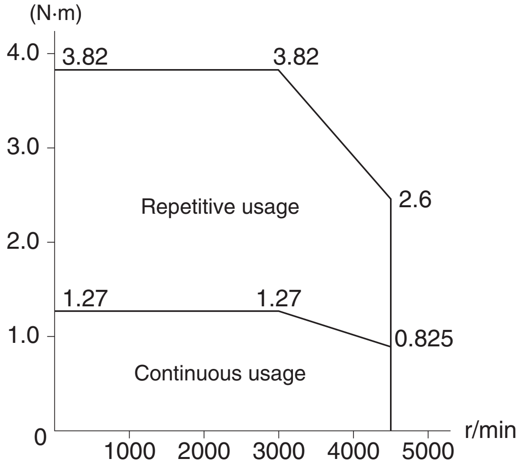
R7M-Z10030-S1



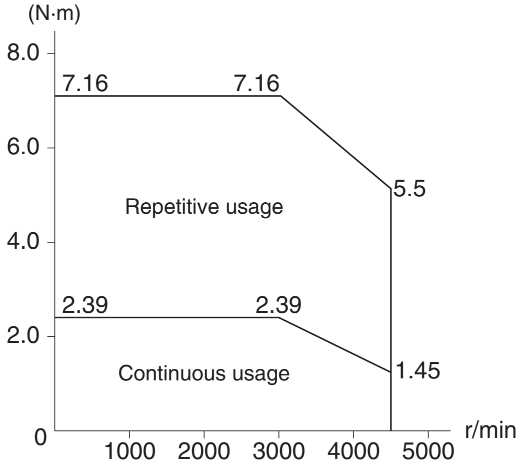
R7M-Z20030-S1



R7M-Z40030-S1



R7M-Z75030-S1



■ Temperature Characteristics of the Servomotor and Mechanical System

- SMARTSTEP Junior 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 is about 4% higher at –10°C compared to the normal temperature of 20°C. Conversely, the maximum momentary torque decreases about 8% when the Servomotor warms up to 80°C from the normal temperature of 20°C.
- 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. In particular, in systems that use a Decelerator, the load torque at low temperatures may be nearly twice the load torque at normal temperatures. Check with a current monitor to see whether there is overloading at low temperatures. Also check operation at high temperatures to see whether there is abnormal Servomotor overheating or alarms.
- An increase in load friction torque visibly increases load inertia. Therefore, even if the Servo Driver parameters are properly adjusted at a normal temperature, the Servomotor may not operate optimally at low temperatures. Check operation at low temperatures to see whether operation is optimal in those conditions, too.

3-2-3 Encoder Specifications

Item	Specification	
Encoder method	Optical encoder (incremental encoder)	
Number of output pulses	Phase A, B: 256 waves/revolution Phase Z: 1 pulse/revolution	
Power supply voltage	5 VDC 5%	
Power supply current	70 mA max.	
Output signals	+A, –A, +B, –B, Z, U, V, and W	
Output interface	+A, –A, +B, and –B	Sine wave voltage output
	Z, U, V, and W	Transistor output

3-3 Decelerator Specifications

The following Decelerators are available for use with SMARTSTEP Junior Servomotors. Select a Decelerator to match the Servomotor capacity.

3-3-1 Standard Models and Specifications

■ Backlash: 3 Arcminutes Max.

Model			Rated speed	Rated torque	Ratio	Maximum momentary speed	Maximum momentary torque	Decelerator inertia	Allowable radial load	Allowable thrust load	Weight
			r/min	N·m	%	r/min	N·m	kgm^2	N	N	kg
100 W	1/5	R7G-VRSFPB05B100	600	1.19	75	900	3.60	4.08×10^{-6}	392	196	0.55
	1/9	R7G-VRSFPB09B100	333	2.29	80	500	6.91	3.43×10^{-6}	441	220	0.55
	1/15	R7G-VRSFPB15B100	200	3.82	80	300	11.5	3.62×10^{-6}	588	294	0.7
	1/25	R7G-VRSFPB25C100	120	6.36	80	180	19.2	3.92×10^{-6}	1323	661	1.7
200 W	1/5	R7G-VRSFPB05B200	600	2.71	85	900	8.12	1.53×10^{-5}	392	196	0.72
	1/9	R7G-VRSFPB09C400	333	3.78	66	500	11.3	2.68×10^{-5}	931	465	1.7
	1/15	R7G-VRSFPB15C400	200	6.31	66	300	18.9	2.71×10^{-5}	1176	588	2.1
	1/25	R7G-VRSFPB25C200	120	11.1	70	180	33.4	2.67×10^{-5}	1323	661	2.1
400 W	1/5	R7G-VRSFPB05C400	600	5.40	85	900	16.2	3.22×10^{-5}	784	392	1.7
	1/9	R7G-VRSFPB09C400	333	9.49	83	500	28.5	2.68×10^{-5}	931	465	1.7
	1/15	R7G-VRSFPB15C400	200	15.8	83	300	47.6	2.71×10^{-5}	1176	588	2.1
	1/25	R7G-VRSFPB25D400	120	26.4	83	180	79.3	2.79×10^{-5}	1617	808	3.2
750 W	1/5	R7G-VRSFPB05C750	600	10.8	90	900	32.0	7.17×10^{-5}	784	392	2.1
	1/9	R7G-VRSFPB09D750	333	18.3	85	500	54.3	6.50×10^{-5}	1176	588	3.4
	1/15	R7G-VRSFPB15D750	200	30.5	85	300	90.5	7.09×10^{-5}	1372	686	3.8
	1/25	R7G-VRSFPB25E750	120	50.8	85	180	151	7.05×10^{-5}	2058	1029	7.2

Note 1. The Decelerator inertia is the Servomotor shaft conversion value.

Note 2. The enclosure rating for Servomotors with Decelerators is IP44.

Note 3. The allowable radial load is the value at the center of the shaft.

■ Backlash: 45 Arcminutes Max.

Model			Rated speed	Rated torque	Ratio	Maximum momentary speed	Maximum momentary torque	Decelerator inertia	Allowable radial load	Allowable thrust load	Weight
			r/min	N·m	%	r/min	N·m	kgm^2	N	N	kg
100 W	1/5	R7G-RGSF05B100	600	1.19	75	900	3.60	4.08×10^{-6}	392	196	0.55
	1/9	R7G-RGSF09B100	333	2.29	80	500	6.91	3.43×10^{-6}	441	220	0.55
	1/15	R7G-RGSF15B100	200	3.82	80	300	11.5	3.62×10^{-6}	588	294	0.7
200 W	1/5	R7G-RGSF05B200	600	2.71	85	900	8.12	1.53×10^{-5}	392	196	0.72
	1/9	R7G-RGSF09C400	333	3.78	66	500	11.3	2.68×10^{-5}	931	465	1.7
	1/15	R7G-RGSF15C400	200	6.31	66	300	18.9	2.71×10^{-5}	1176	588	2.1
400 W	1/5	R7G-RGSF05C400	600	5.40	85	900	16.2	3.22×10^{-5}	784	392	1.7
	1/9	R7G-RGSF09C400	333	9.49	83	500	28.5	2.68×10^{-5}	931	465	1.7
	1/15	R7G-RGSF15C400	200	15.8	83	300	47.6	2.71×10^{-5}	1176	588	2.1

Note 1. The Decelerator inertia is the Servomotor shaft conversion value.

Note 2. The enclosure rating for Servomotors with Decelerators is IP44.

Note 3. The allowable radial load is the value at the center of the shaft.

3-4 Cable and Connector Specifications

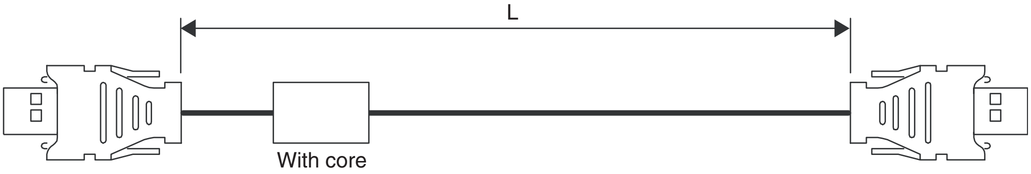
3-4-1 MECHATROLINK-II Communications Cable Specifications

MECHATROLINK-II Communications Cable is special cable for connecting a SMARTSTEP Junior Servo Driver and a Position Controller with MECHATROLINK-II Communications.

■ MECHATROLINK-II Communications Cable (with USB Connectors at Both Ends, With Core)

Model	Length (L)	Outer diameter of cable	Weight
0FNY-W6003-A5	0.5 m	5.1 dia.	Approx.0.10 kg
0FNY-W6003-01	1.0 m		Approx.0.11 kg
0FNY-W6003-03	3.0 m		Approx.0.17 kg
0FNY-W6003-05	5.0 m		Approx.0.23 kg
0FNY-W6003-10	10 m		Approx.0.38 kg
0FNY-W6003-20	20 m		Approx.0.68 kg
0FNY-W6003-30	30 m		Approx.0.97 kg

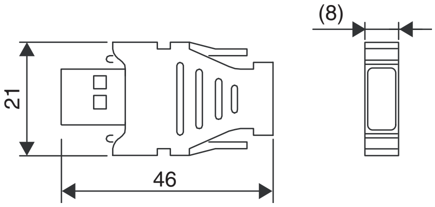
Dimensions



■ Terminating Resistor for MECHATROLINK-II

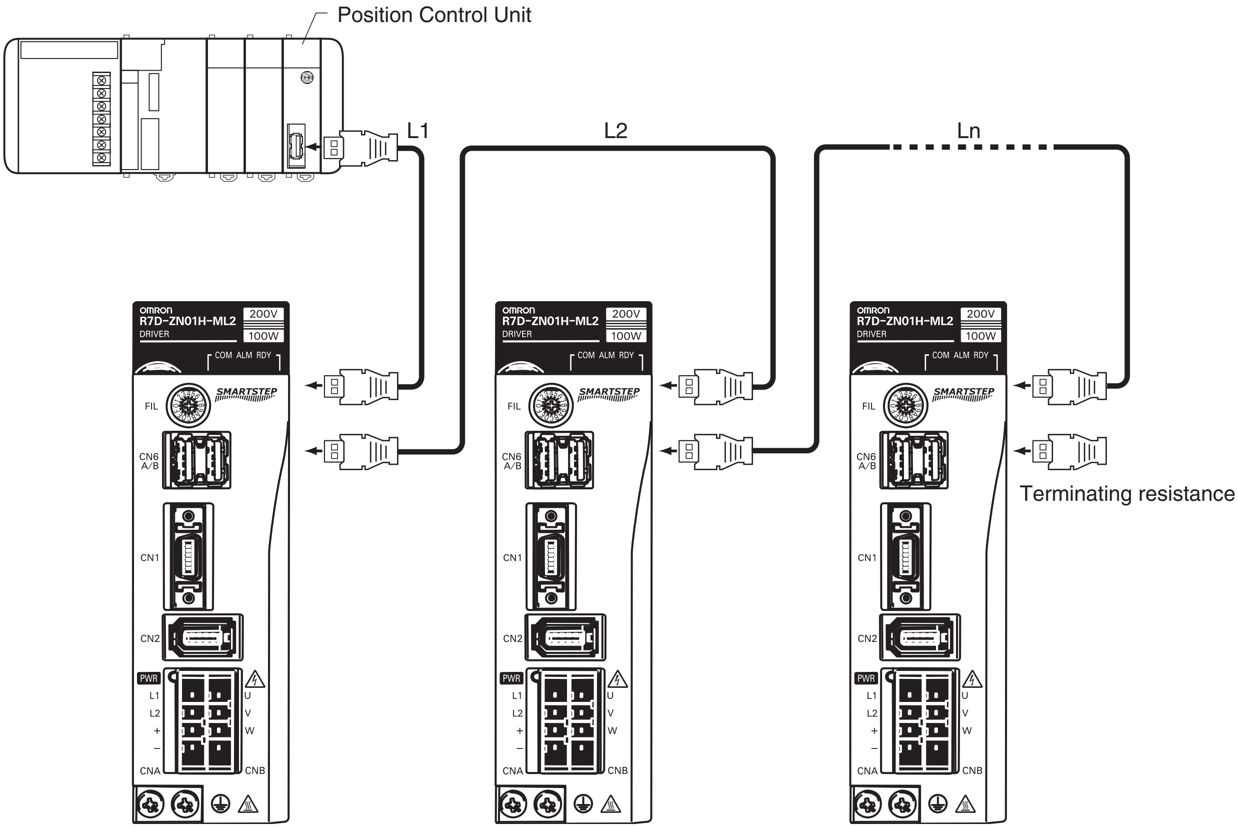
Model	FNY-W6022

Dimensions



■ MECHATROLINK-II Communications Connection Example

The following example diagram shows connections by MECHATROLINK-II Communications Cable between a Position Controller with MECHATROLINK-II Communications and Servo Drivers.


Position Control Unit
L1
L2
Ln
OMRON R7D-ZN01H-ML2 200V 100W DRIVER
COM ALM RDY
SMARTSTEP
FIL
CN6 A/B
CN1
CN2
PWR
L1
L2
+
−
U
V
W
CNA
CNB
Terminating resistance

Note 1. Use a minimum Cable length (L1, L2... Ln) of 0.5 m between the Servo Drivers.

Note 2. The total Cable length must be no more than 50 m. (L1 + L2 +... Ln ≤ 50 m)

3-4-2 Control Cable Specifications

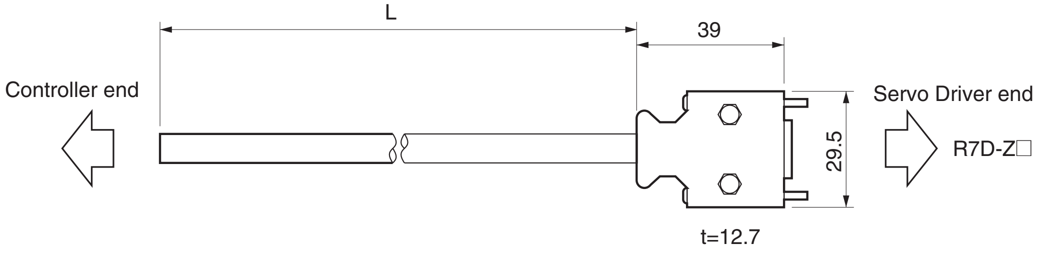
■ General-purpose Control Cables

A General-purpose Control Cable connects to the Servo Driver's Control I/O Connector (CN1). There is no connector on the controller end. Wire a connector to match the controller if you are connecting to a Position Control Unit and a compatible cable is not available or connecting to a controller manufactured by another company.

● Cable Models

Model	Length (L)	Outer diameter of cable	Weight
R7A-CPZ001S	1 m	5.6 dia.	Approx. 0.1 kg
R7A-CPZ002S	2 m		Approx. 0.2 kg

● Connection Configuration and Dimensions

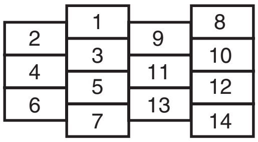


● Wiring

No.	Wire color/Mark color	Signal
1	Orange/Red (–)	EXT1
2	Orange/Black (–)	DEC
3	Gray/Red (–)	NOT
4	Gray/Black (–)	POT
5	White/Red (–)	+24VIN
6	Yellow/Black (–)	STOP
7	White/Black (–)	0GND
8	Pink/Red (–)	---
9	Pink/Black (–)	---
10	Orange/Red (—)	---
11	Orange/Black (––)	---
12	Gray/Red (—)	$\overline{\text{ALM}}$
13	Gray/Black (––)	BKIR
14	Yellow/Red (–)	---

Connector plug: 10114-3000VE (Sumitomo 3M)
Connector case: 10314-52A0-008 (Sumitomo 3M)
Cable: AWG24 × 7P UL20276
Wires with the same wire color and the same number of marks are a twisted pair.

● Connector Pin Arrangement



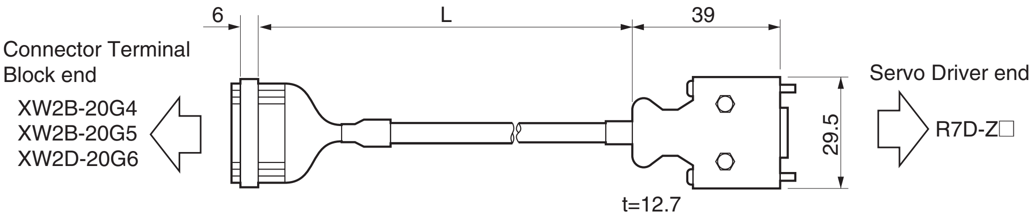
■ Connector Terminal Block Cable (XW2Z-□□□J-B19)

This is the Cable for the Connector Terminal Block for the Servo Driver's control I/O connector (CN1).

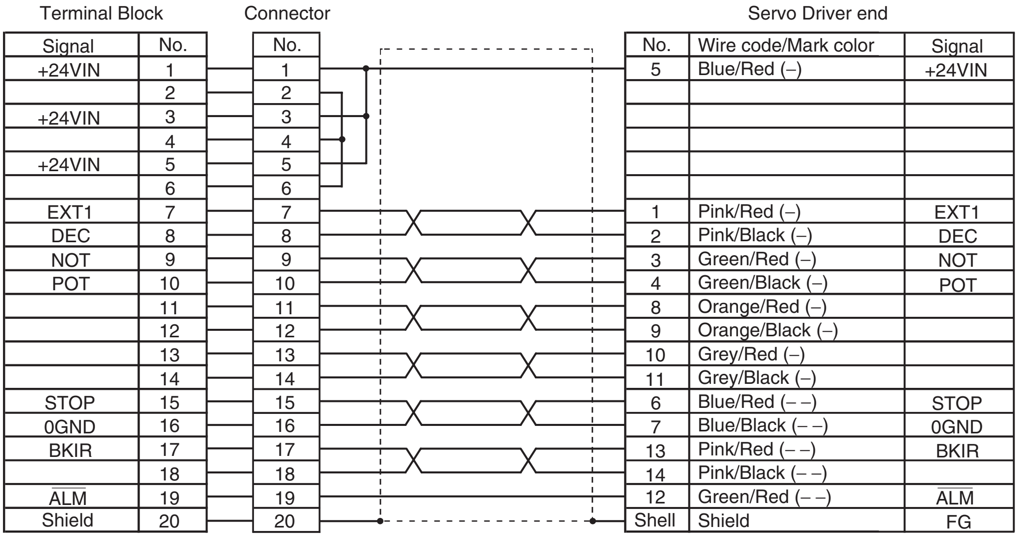
● Cable Models

Model	Length (L)	Outer diameter of cable	Weight
XW2Z-100J-B19	1 m	8 dia.	Approx. 0.1 kg
XW2Z-200J-B19	2 m		Approx. 0.2 kg

● Connection Configuration and Dimensions



● Wiring



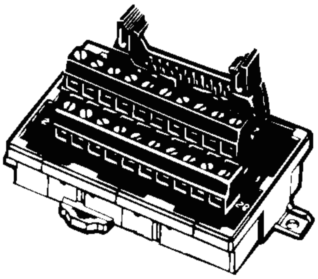
Terminal Block Signal	Terminal Block No.	Connector No.	Servo Driver end No.	Wire code/Mark color	Signal
+24VIN	1	1	5	Blue/Red (–)	+24VIN
	2	2			
+24VIN	3	3			
	4	4			
+24VIN	5	5			
	6	6			
EXT1	7	7	1	Pink/Red (–)	EXT1
DEC	8	8	2	Pink/Black (–)	DEC
NOT	9	9	3	Green/Red (–)	NOT
POT	10	10	4	Green/Black (–)	POT
	11	11	8	Orange/Red (–)	
	12	12	9	Orange/Black (–)	
	13	13	10	Grey/Red (–)	
	14	14	11	Grey/Black (–)	
STOP	15	15	6	Blue/Red (– –)	STOP
0GND	16	16	7	Blue/Black (– –)	0GND
BKIR	17	17	13	Pink/Red (– –)	BKIR
	18	18	14	Pink/Black (– –)	
$\overline{\text{ALM}}$	19	19	12	Green/Red (– –)	$\overline{\text{ALM}}$
Shield	20	20	Shell	Shield	FG

Connector at Connector Terminal Block
Connector Socket: XG4M-2030
Strain Relief: XG4T-5004
Cable
AWG28-10P UL20276
Connector at Servo Driver
Connector Plug: 10114-3000PE (Sumitomo 3M)
Connector Case: 10314-52A0-008 (Sumitomo 3M)

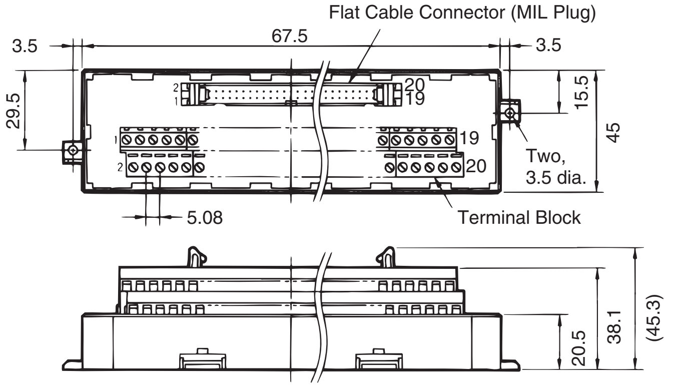
■ Connector Terminal Block Conversion Unit (XW2B-20G□)

The Servo Driver's control I/O connector (CN1) can be converted to a terminal block by using it in combination with Connector Terminal Block Cable (XW2Z-□J-B19).

● XW2B-20G4 (M3-screw Terminal Block)



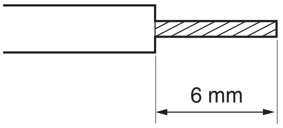
- Dimensions


Flat Cable Connector (MIL Plug)
3.5
67.5
3.5
29.5
15.5
45
2
1
20
19
1
2
19
20
Two,
3.5 dia.
5.08
Terminal Block
20.5
38.1
(45.3)

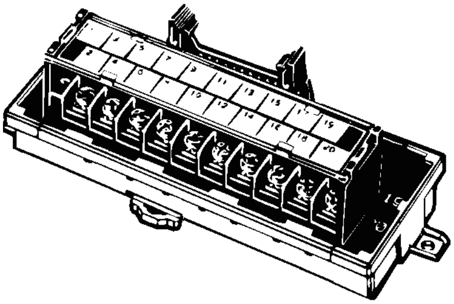
Note 1. Use power lines of 0.3 to 1.25 mm^2 (AWG22 to 16)

Note 2. The power line insertion opening is 1.8 mm (height) × 2.5 mm (width).

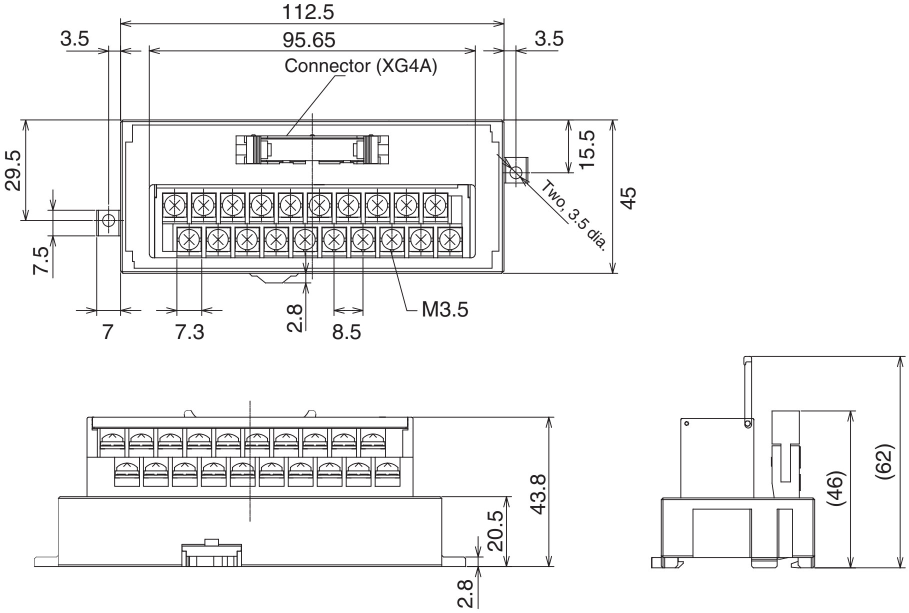
Note 3. As shown in the diagram below, peel back the power line insulation for 6 mm from the end.



● XW2B-20G5 (M3.5-screw Terminal Block)



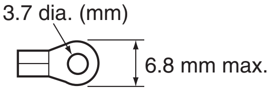
- Dimensions


112.5
3.5
95.65
3.5
Connector (XG4A)
29.5
15.5
45
Two, 3.5 dia.
7.5
7
7.3
2.8
8.5
M3.5
43.8
20.5
2.8
(46)
(62)

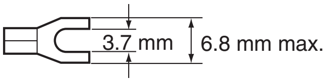
Note 1. When using crimp terminals, use the dimensions shown below.

Note 2. Mount power lines and crimp terminals to the terminal block at a torque of 0.59 N·m.

Round Crimp Terminal

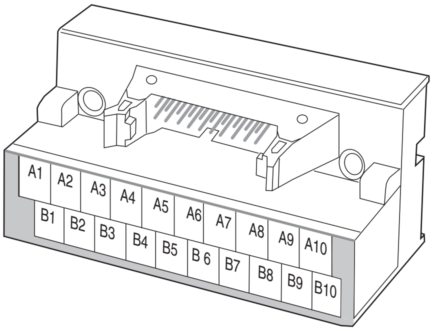

3.7 dia. (mm)
6.8 mm max.

Forked Crimp Terminal

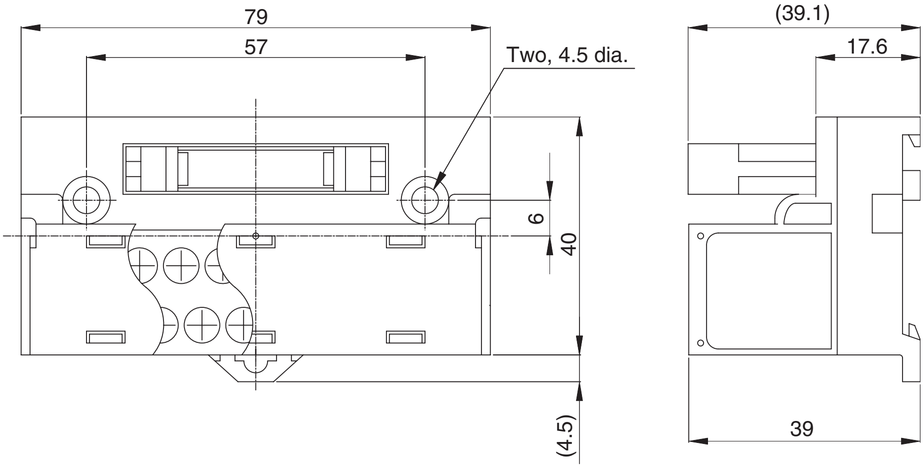

3.7 mm
6.8 mm max.

Applicable crimp terminals		Applicable power lines
Round 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)
Y 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-20G6 (M3-screw Terminal Block)

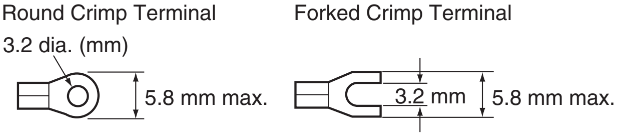

A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
B1
B2
B3
B4
B5
B 6
B7
B8
B9
B10

- Dimensions


79
57
Two, 4.5 dia.
6
40
(4.5)
(39.1)
17.6
39

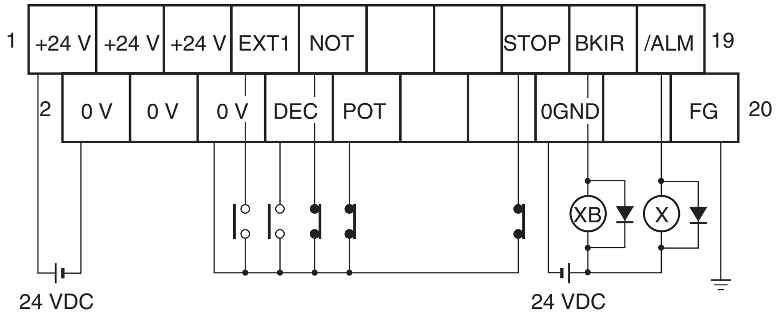
Note 1. When using crimp terminals, use the dimensions shown below.

Note 2. Mount power lines and crimp terminals to the terminal block at a torque of 0.7 N·m.


Round Crimp Terminal
3.2 dia. (mm)
5.8 mm max.
Forked Crimp Terminal
3.2 mm
5.8 mm max.

Applicable crimp terminals		Applicable power lines
Round terminals	1.25-3	AWG22-16 (0.3 to 1.25 mm^2)
Y terminals	1.25Y-3	AWG22-16 (0.3 to 1.25 mm^2)

● Terminal Block Wiring Example (XW2B-20G4, XW2B-20G5, and XW2D-20G6)


1
+24 V
+24 V
+24 V
EXT1
NOT
STOP
BKIR
/ALM
19
2
0 V
0 V
0 V
DEC
POT
0GND
FG
20
XB
X
24 VDC
24 VDC

Note 1. Use a maximum of 300 mA total for the 24-VDC inputs.

Note 2. Do not use inputs other than sensor inputs.

● Terminal Block Signal Names

Terminal Block

Signal	No.
+24VIN	1
	2
+24VIN	3
	4
+24VIN	5
	6
EXT1	7
DEC	8
NOT	9
POT	10
	11
	12
	13
	14
STOP	15
0GND	16
BKIR	17
	18
$\overline{\text{ALM}}$	19
Shield	20

3-4-3 Servomotor Power Cable Specifications

The Servomotor Cable supplies power between the Servo Driver and Servomotor. Servomotor Power Cables are available in two forms: Servomotor Power Cables with an attached CNB Connector and Servomotor Power Cables without a connector (Cable Only). Select the Cable to match the Servomotor being used.

Note When connecting to moving parts, use robot cable and make a custom cable.

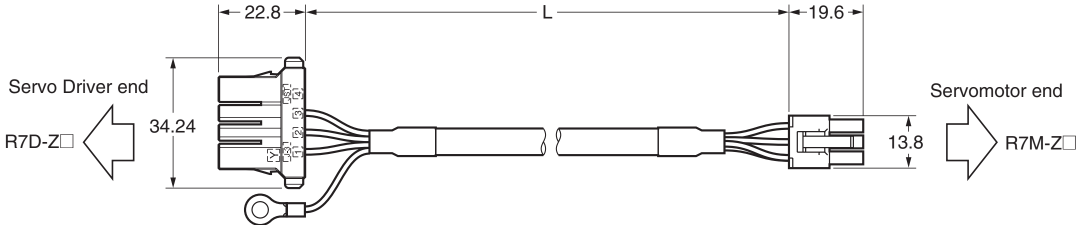
■ Power Cables with CNB Connector for Servomotors without Brakes

Cable Models

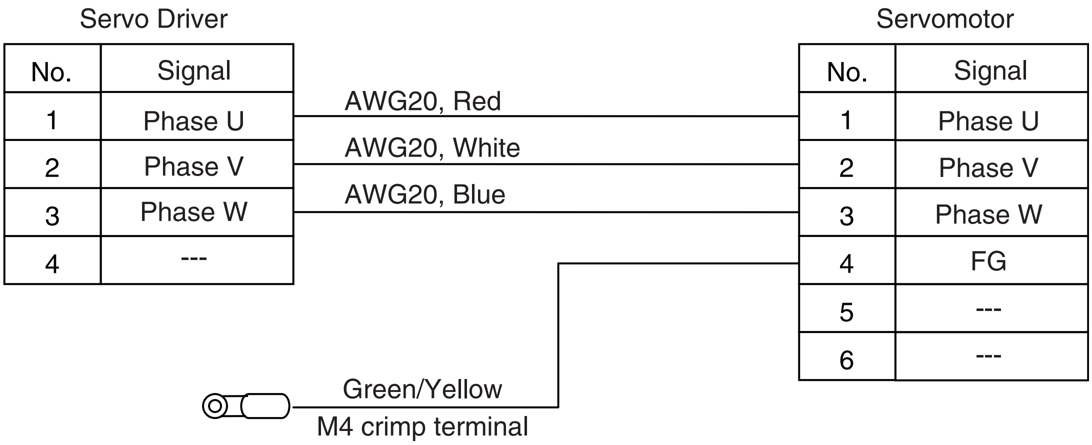
Model	Length (L) (See note.)	Outer diameter of cable	Weight
R7A-CAZ003S	3 m	7.4 dia.	Approx. 0.4 kg
R7A-CAZ005S	5 m		Approx. 0.8 kg
R7A-CAZ010S	10 m		Approx. 1.2 kg
R7A-CAZ015S	15 m		Approx. 1.6 kg
R7A-CAZ020S	20 m		Approx. 2.0 kg

Note The maximum distance between the Servo Driver and Servomotor is 20 meters.

● Connection Configuration and Dimensions



● Wiring



Servo Driver

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

Servomotor

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

Servo Driver Connector
Connector plug
04JFAT-SAYGF-N (JST Mfg. Co., Ltd.)

Servomotor Connector
Connector plug
5557-06R-210 (Molex Japan)
Connector case
5556TL (Molex Japan)

■ Power Cables without Connector (Loose Wires) for Servomotors without Brakes

● Cable Models

Model	Length (L) (See note 1.)	Outer diameter of cable	Weight
R7A-CAZ001	1 m (See note 2.)	7.4 dia.	Approx. 0.1 kg

Note 1. The maximum distance between the Servo Driver and Servomotor is 20 meters.

Note 2. Cables are sold in 1-m increments. It is cut to the specified length.

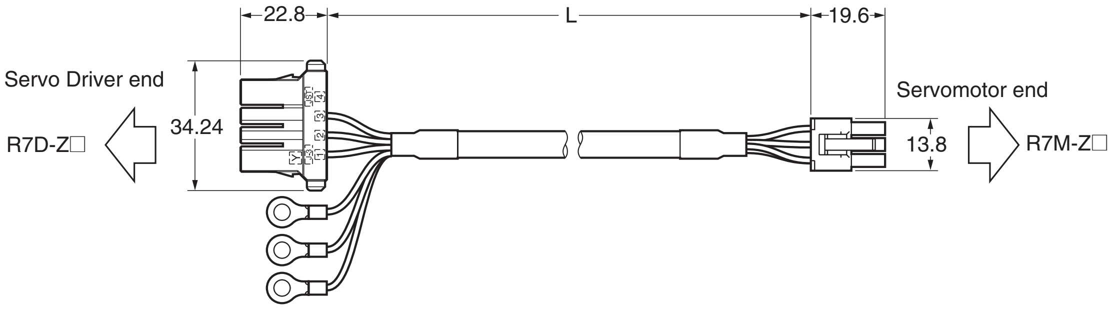
■ Power Cables with CNB Connector for Servomotors with Brakes

● Cable Models

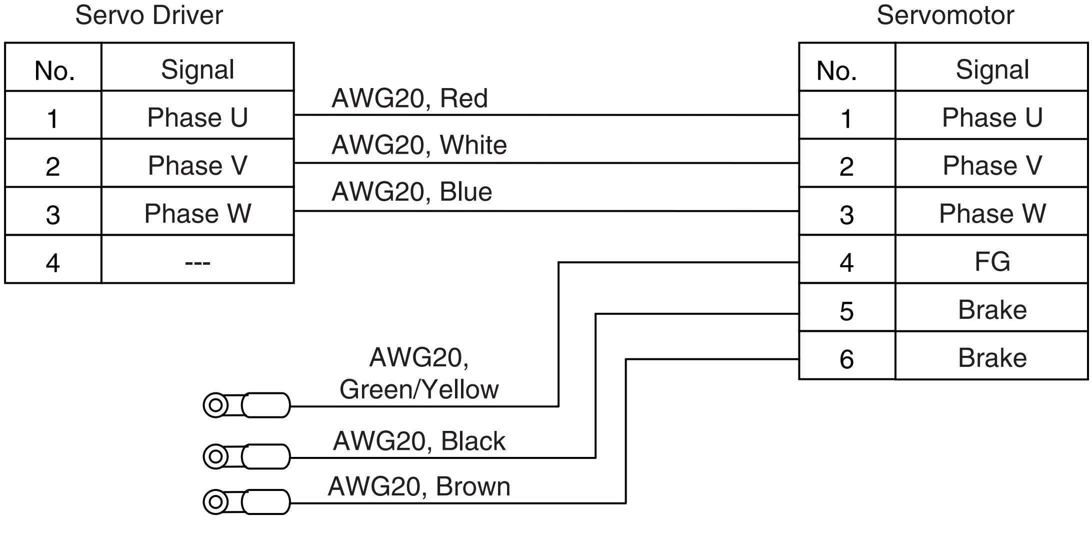
Model	Length (L) (See note.)	Outer diameter of cable	Weight
R7A-CAZ003B	3 m	7.4 dia.	Approx. 0.4 kg
R7A-CAZ005B	5 m		Approx. 0.8 kg
R7A-CAZ010B	10 m		Approx. 1.2 kg
R7A-CAZ015B	15 m		Approx. 1.6 kg
R7A-CAZ020B	20 m		Approx. 2.0 kg

Note The maximum distance between the Servo Driver and Servomotor is 20 meters.

● Connection Configuration and Dimensions


22.8
L
19.6
Servo Driver end
R7D-Z□
34.24
Servomotor end
13.8
R7M-Z□

● Wiring


AWG20, Red
AWG20, White
AWG20, Blue
AWG20, Green/Yellow
AWG20, Black
AWG20, Brown

Servo Driver

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

Servomotor

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

Servo Driver Connector:
Connector plug
04JFAT-SAYGF-N (JST Mfg. Co., Ltd.)

Servomotor Connector:
Connector plug
5557-06R-210 (Molex Japan)
Connector case
5556TL (Molex Japan)

■ Power Cables without Connectors (Loose Wires) for Servomotors with Brakes

Cable Models

Model	Length (L) (See note 1.)	Outer diameter of cable	Weight
R7A-CAZ01B	1 m (See note 2.)	7.4 dia.	Approx. 0.1 kg

Note 1. The maximum distance between the Servo Driver and Servomotor is 20 meters.

Note 2. Cables are sold in 1-m increments. It is cut to the specified length.

3-4-4 Encoder Cable Specifications

The Encoder Cable connects the encoder between the Servo Driver and Servomotor. Encoder Cables are available in two forms: Encoder Cables with an attached CN2 Connector and plain cable only.

Note When connecting to moving parts, use robot cable to make a custom cable.

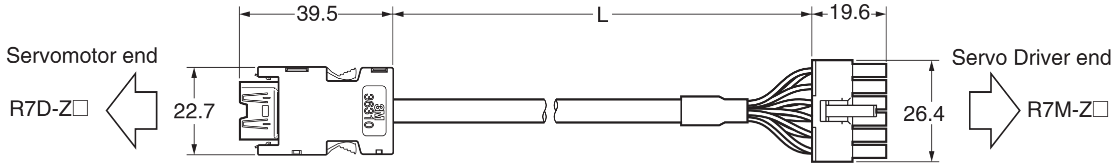
■ Encoder Cable (CN2 Connector Attached)

● Cable Models

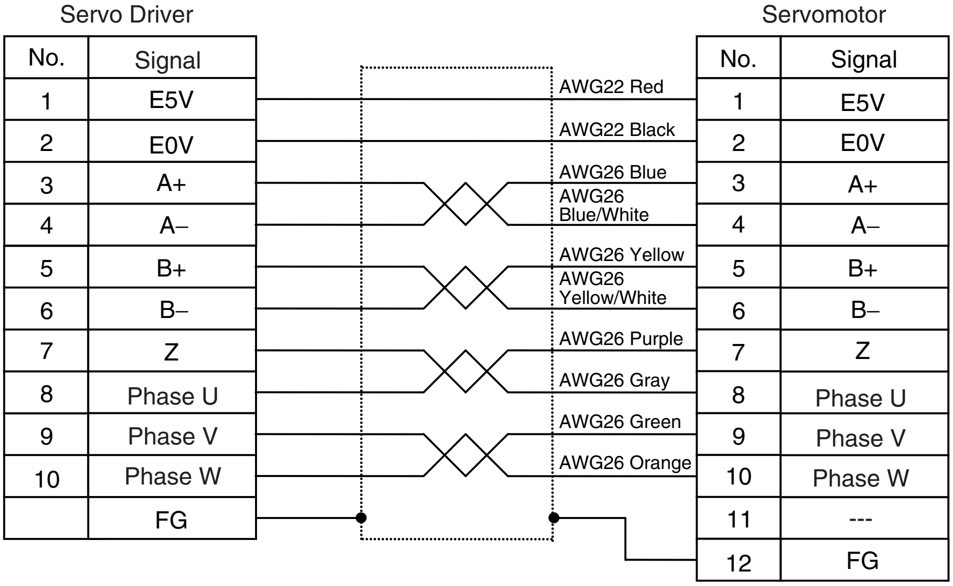
Model	Length (L) (See note.)	Outer diameter of cable	Weight
R7A-CRZ003C	3 m	7.1 dia.	Approx. 0.4 kg
R7A-CRZ005C	5 m		Approx. 0.8 kg
R7A- CRZ010C	10 m		Approx. 1.2 kg
R7A-CRZ015C	15 m		Approx. 1.6kg
R7A-CRZ020C	20 m		Approx. 2.0kg

Note The maximum distance between the Servo Driver and Servomotor is 20 meters.

● Connection Configuration and Dimensions



● Wiring


Servo Driver
No.
Signal
1
E5V
2
E0V
3
A+
4
A–
5
B+
6
B–
7
Z
8
Phase U
9
Phase V
10
Phase W
FG
AWG22 Red
AWG22 Black
AWG26 Blue
AWG26 Blue/White
AWG26 Yellow
AWG26 Yellow/White
AWG26 Purple
AWG26 Gray
AWG26 Green
AWG26 Orange
Servomotor
No.
Signal
1
E5V
2
E0V
3
A+
4
A–
5
B+
6
B–
7
Z
8
Phase U
9
Phase V
10
Phase W
11

12
FG

Servo Driver Connector:
Plug
54593-1019 □
Connector case
54599-1005 (JST Mfg. Co., Ltd.)

Servomotor Connector:
Connector plug
5557-12R-210 □
Connector case
5556T2L □□
(JST Mfg. Co., Ltd.)

■ Encoder Cable (Loose Wires Only)

● Cable Models

Model	Length (L) (See note 1.)	Outer diameter of cable	Weight
R7A-CRZ001	1 m (See note 2.)	7.1 dia.	Approx. 0.1 kg

Note 1. The maximum distance between the Servo Driver and Servomotor is 20 meters.

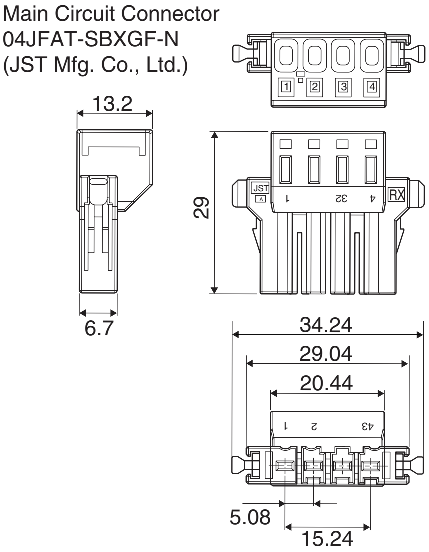
Note 2. Cable are sold in 1-m increments. It is cut to the specified length.

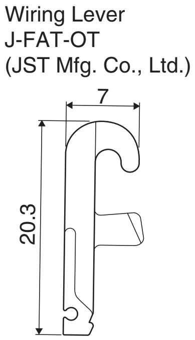
3-4-5 Connector Specifications

■ Main Circuit Connector (R7A-CNZ01P)

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

Dimensions

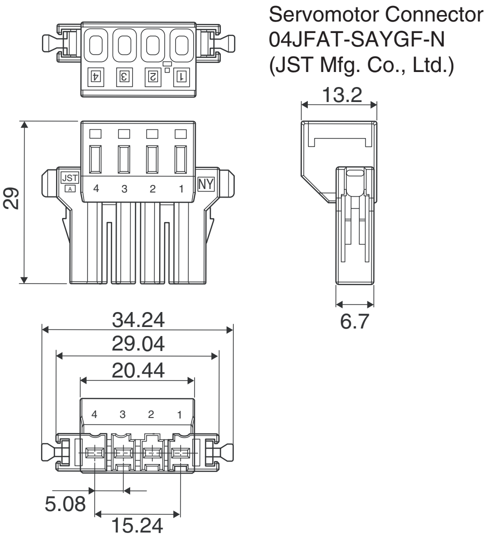

Main Circuit Connector
04JFAT-SBXGF-N
(JST Mfg. Co., Ltd.)
13.2
6.7
29
1
2
3
4
JST
RX
34.24
29.04
20.44
5.08
15.24


Wiring Lever
J-FAT-OT
(JST Mfg. Co., Ltd.)

■ Servomotor Connector (R7A-CNZ01A)

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

Dimensions


Servomotor Connector
04JFAT-SAYGF-N
(JST Mfg. Co., Ltd.)
13.2
6.7
29
4
3
2
1
JST
NY
34.24
29.04
20.44
5.08
15.24

3-5 External Regeneration Unit and External Regeneration Resistor

When using an External Regeneration Unit (R88A-RG08UA) or an External Regeneration Resistor (R88A-RR22047S), refer to *4-3 Regenerative Energy Absorption* to use them correctly.

3-5-1 External Regeneration Unit (R88A-RG08UA) Specifications

■ General Specifications

Item	Specifications
Ambient operating temperature	0 to 55°C
Ambient operating humidity	35% to 85% (with no condensation)
Ambient storage temperature	–10 to 75°C
Ambient storage humidity	35% to 85% (with no condensation)
Storage and operating atmosphere	No corrosive gasses
Vibration resistance	4.9 m/s^2 max.
Impact resistance	Acceleration 19.6 m/s^2 max.

Note The External Regeneration Unit does not conform to EC Directives.

■ Characteristics

Item	Specifications
Regeneration voltage	380 VDC
Regeneration current	8 A (DC)
Average internal regeneration power	12 W (internal resistance: 50 Ω, 60 W)
Externally connected regeneration resistance	47 Ω ±5%
Error detection functions	Regeneration resistance disconnection, Regeneration transistor failure, and overvoltage
Alarm output	Single-pole NC contact (open when protection function is operating), can handle 200 VAC.
Dimensions	55 × 160 × 130 mm (W × H × D)

■ LED Indicator Specifications

Item	Specifications
POWER	Lit when power is being supplied to the P and N terminals.
REGEN	Lit during regeneration operation.
ALARM-REGEN	Lit when the regeneration resistance is disconnected or the regeneration transistor failed.
ALARM-OV	Lit when there is an overvoltage.

● Error Detection Function

- If an error is detected, an alarm is output from the External Regeneration Unit. Set up a sequence so that the power to the Servo Driver (L1 and L2) is turned OFF when an alarm occurs.
- When an error is detected and the Servo Driver's power is turned OFF, the External Regeneration Unit will not reset normally unless the Servo Driver's power is OFF for 2 to 3 seconds. (The External Regeneration Unit will reset to its normal status after the Servo Driver's internal capacitors discharge completely and the voltage drops across terminals P and N.)

3-5-2 External Regeneration Resistor (R88A-RR22047S) Specifications

■ Specifications

Model	Resistance	Nominal capacity	Regenerative absorption with temperature rise of 120°C	Heat radiation	Thermal switch output specifications
R88A-RR22047S	47 Ω ± 5%	220 W	70 W	t1.0 × 350 × 350 (SPCC)	Operating temperature: 170°C ±5% NC contact Rated output: 3 A

3-6 AC Reactors

An AC Reactor can be connected to the Servo Driver to suppress harmonic currents. Select a model to match the Servo Driver being used.

■ Specifications

Servo Driver model	AC Reactor			
	Model	Rated current (A)	Inductance (mH)	Weight (kg)
R7D-ZP01H/ R7D-ZN01H-ML2	R88A-PX5052	1.0	45.0	Approx. 0.4
R7D-ZP02H/ R7D-ZN02H-ML2	R88A-PX5053	2.0	20.0	Approx. 0.6
R7D-ZP04H/ R7D-ZN04H-ML2	R88A-PX5054	3.0	5.0	Approx. 0.4
R7D-ZP08H/ R7D-ZN08H-ML2	R88A-PX5056	4.0	2.0	Approx. 0.4

Chapter 4

System Design

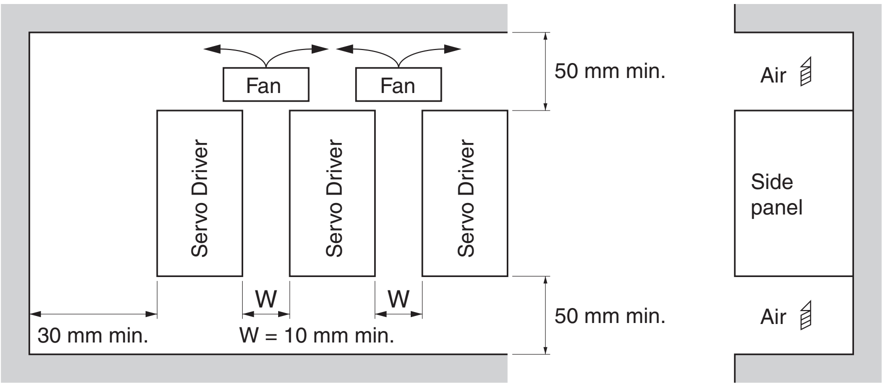
4-1 Installation Conditions
4-2 Wiring
4-3 Regenerative Energy Absorption

4-1 Installation Conditions

4-1-1 Servo Drivers

■ Space around Drivers

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



■ Mounting Direction

- Mount the Servo Drivers in a direction (perpendicular) such that the lettering for the model number, and so on, can be seen.

■ Operating Environment

- The environment in which Servo Drivers are operated must meet the following conditions. Servo Drivers may malfunction if operated under any other conditions.
  - Ambient operating temperature: 0 to 55°C (Take into account temperature rises in the individual Servo Drivers themselves.)
  - Ambient operating humidity: 20% to 90% (with no condensation)
  - Atmosphere: No corrosive gases.

■ Ambient Temperature

- Servo Drivers 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 Driver's ambient temperature to rise. Use a fan or air conditioner to prevent the Servo Driver's ambient temperature from exceeding 55°C.
- Servo Driver surface temperatures may rise to as much as 30°C above the ambient temperature. Use heat-resistant materials for wiring, and keep separate any devices or wiring that are sensitive to heat.

- The service life of a Servo Driver is largely determined by the temperature around the internal electrolytic capacitors. The service life of an electrolytic capacitor is affected by a drop in electrolytic volume and an increase in internal resistance, which can result in overvoltage alarms, malfunctioning due to noise, and damage to individual elements.
- If a Servo Driver is always operated at the maximum ambient temperature of 40°C and at 80% of the rated torque, then a service life of approximately 50,000 hours can be expected (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

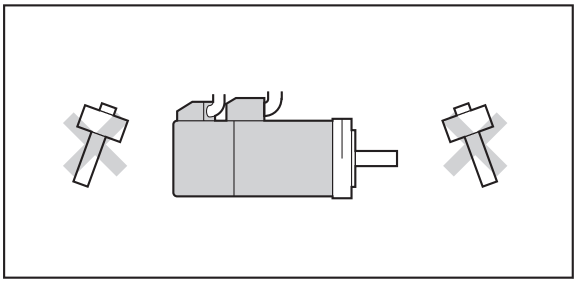
- Place a cover over the Units or take other preventative measures to prevent foreign objects, such as drill filings, from getting into the Units during installation. Be sure to remove the cover after installation is complete. If the cover is left on during operation, heat buildup may damage the Units.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

4-1-2 Servomotors

■ Operating Environment

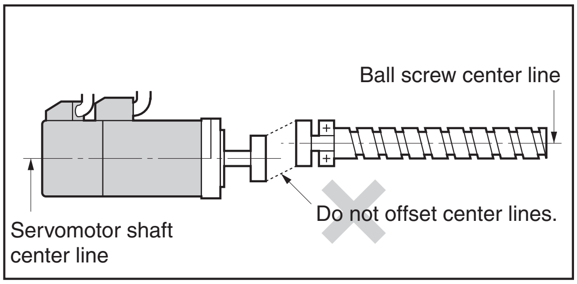
- The environment in which the Servomotor is operated must meet the following conditions. Operating the Servomotor outside of the following ranges may result in malfunction of the Servomotor.
  - Ambient operating temperature: 0 to +40°C
  - Ambient operating humidity: 20% to 80% (with no condensation)
  - Atmosphere: No corrosive gases.

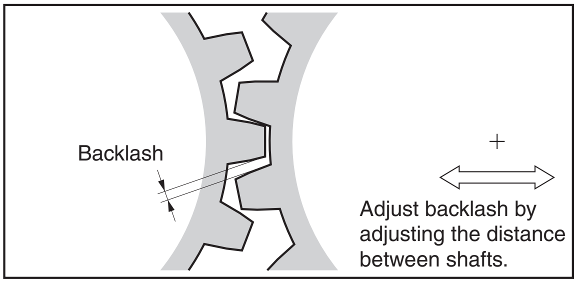
■ Impact and Load



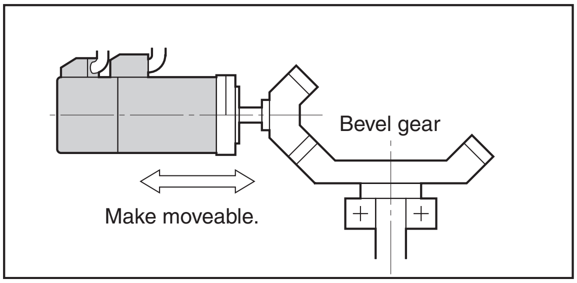
- The Servomotor is resistant to impacts of up to 98 m/s^2. Do not subject it to heavy impacts or loads during transport, installation, or removal.
- When transporting it, hold onto the Servomotor itself, and do not hold onto the encoder, cable, or connector areas. Holding onto weaker areas such as these can 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

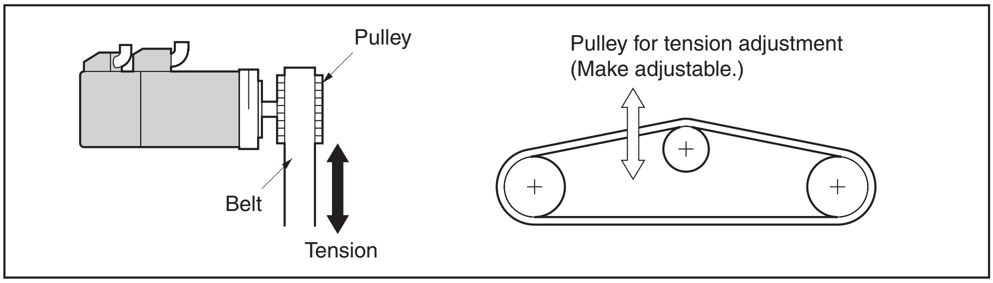




- The axial loads for Servomotors are specified in *3-2-2 Characteristics*. If an axial load greater than that specified is applied to a Servomotor, it will reduce the service life of the motor bearings and may damage the motor shaft.
- When connecting to a load, use couplings that can sufficiently absorb mechanical eccentricity and variation.
- For spur gears, an extremely large radial load may be applied depending on the gear precision. Use spur gears with a high degree of accuracy (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 no thrust load is applied which exceeds specifications.
- Do not put rubber packing on the flange surface.
- 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 due to belt tension. If an excessive radial load is applied, the motor shaft and bearings may be damaged.
- Set up a movable pulley between the motor axis and the load axis so that the belt tension can be adjusted.



■ Water and Drip Resistance

The enclosure ratings for the Servomotors are as follows:

IP55 (except for through-shaft parts and cable exit holes)

■ Other Precautions

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

⚠WARNING

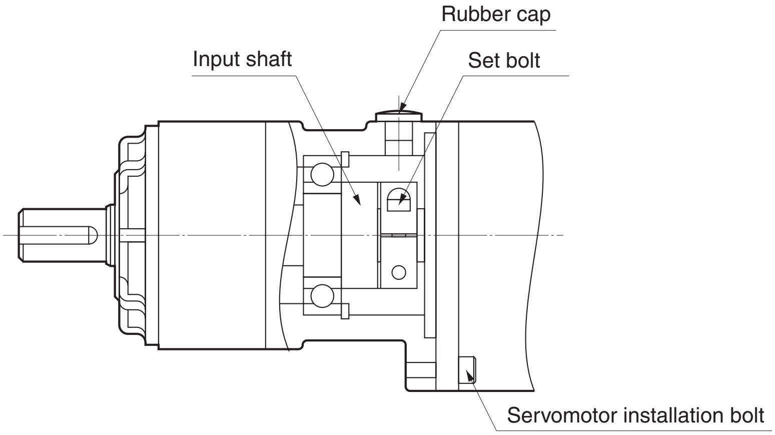
Do not apply commercial power directly to the Servomotor.
Applying commercial power directly will burn out the motor coils.

Do not attempt to disassemble, repair, or modify any Units. Any attempts to do so may result in electric shock or other injury.

4-1-3 Decelerators

■ Installing Decelerators

- Use only the specified combinations of Servomotors and Decelerators. (Refer to *3-3 Decelerator Specifications*.) The service life of the motor bearings may be shortened by using a combination that is not specified or a decelerator or servomotor from another company.
- The dimensions of the Servomotor mounting flange on the Decelerators differ for each Servomotor. Do not install Decelerators on a Servomotor other than the one specified.
- Use the following procedure when installing a Decelerator on the Servomotor.
- When installing the Servomotor, avoid the Servomotor shaft's key groove when installing the set bolt.



1. Remove the rubber cap and check that the set bolt is loose.
2. Insert the Servomotor shaft into the input shaft.
3. Tighten the Servomotor installation bolt to the torque specified in the following table.

Servomotor installation bolt	Tightening torque (N·m)
M4	2.9
M5	5.8
M6	9.8

4. Tighten the set bolt to the torque specified in the following table.

Set bolt	Tightening torque (N·m)
M3	1.0
M4	2.9

5. After tightening the set bolt, replace the rubber cap.

■ Using a Decelerator from Another Company (Reference Information)

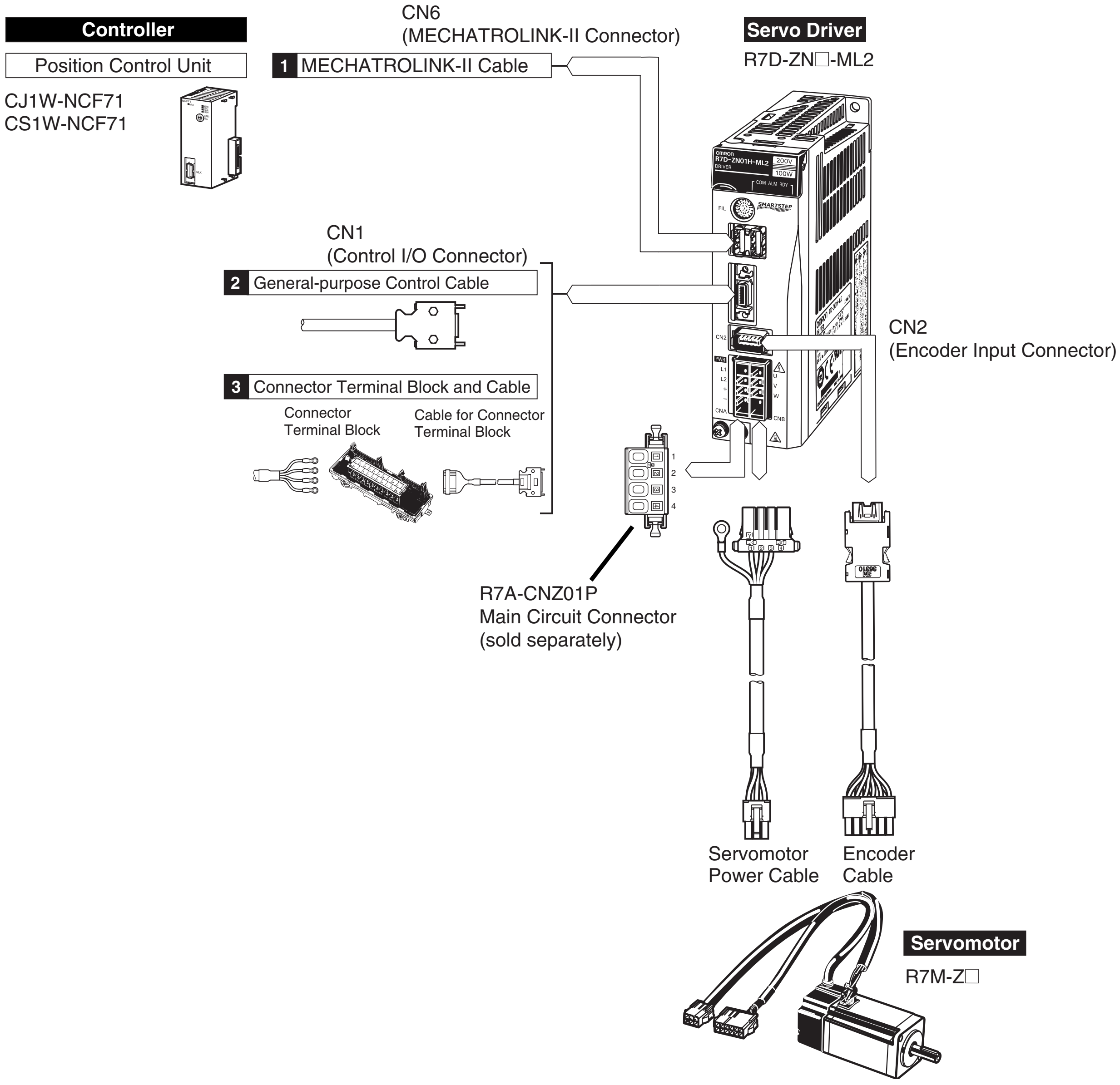
If the system configuration requires another company's decelerator to be used in combination with a SMARTSTEP Junior Servomotor, select the decelerator so that the load on the motor shaft (i.e., both the radial and thrust loads) is with the allowable values. (Refer to *3-2-2 Characteristics* under for details on the allowable loads for Servomotors.) Also, select the decelerator so that the allowable input speed and allowable input torque of the decelerator is not exceeded.

4-2 Wiring

4-2-1 Connecting Cables

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

■ System Configuration


Controller
Position Control Unit
CJ1W-NCF71
CS1W-NCF71
CN6
(MECHATROLINK-II Connector)
1 MECHATROLINK-II Cable
Servo Driver
R7D-ZN□-ML2
CN1
(Control I/O Connector)
2 General-purpose Control Cable
3 Connector Terminal Block and Cable
Connector Terminal Block
Cable for Connector Terminal Block
CN2
(Encoder Input Connector)
R7A-CNZ01P
Main Circuit Connector
(sold separately)
Servomotor Power Cable
Encoder Cable
Servomotor
R7M-Z□

4-2-2 Selecting Connecting Cables

■ MECHATROLINK-II Cable (CN6)

● Special Cable

Name	Model number	Comments
MECHATROLINK-II Cable	FNY-W6003-□□	Use special MECHATROLINK-II Cable to connect MECHATROLINK-II devices. The figures indicated by the boxes (□□) in the model number show the length of the Cable. The Cable is available in seven lengths (in meters): 0.5, 1, 3, 5, 10, 20, and 30.

● Terminating Resistance

Name	Model number	Comments
MECHATROLINK-II Terminating Resistor	FNY-W6022	Terminating resistance is required at the ends of MECHATROLINK-II communications.

■ General-purpose Control Cables

If you are connecting to a controller that does not have a standard cable available, use General-purpose Control Cable to assemble a cable to connect to the Servo Driver's Control I/O Connector (CN1).

Name	Model number	Comments
Cable for Connector Terminal Block	XW2Z-□□□J-B19	This is special cable for connecting to the Connector Terminal Block. The figures indicated by the boxes (□□□) in the model number show the length of the Cable. The Cable is available in two lengths: 1 m or 2 m. Example model number: XW2Z-100J-B19 (1 m)
General-purpose Control Cable	R7A-CPZ□□□S	This cable has a connector attached to connect to the Control I/O Connector (CN1). The □□□ digits in the model number indicate the cable length (either 1 m or 2 m). Example model number: R7A-CPZ001S (1 m)

■ Servomotor Power Cables (CNB)

There are two kinds of Servomotor Power Cables, one for Servomotors with a brake and another for Servomotors without a brake. Select the Cable to match the Servomotor being used.

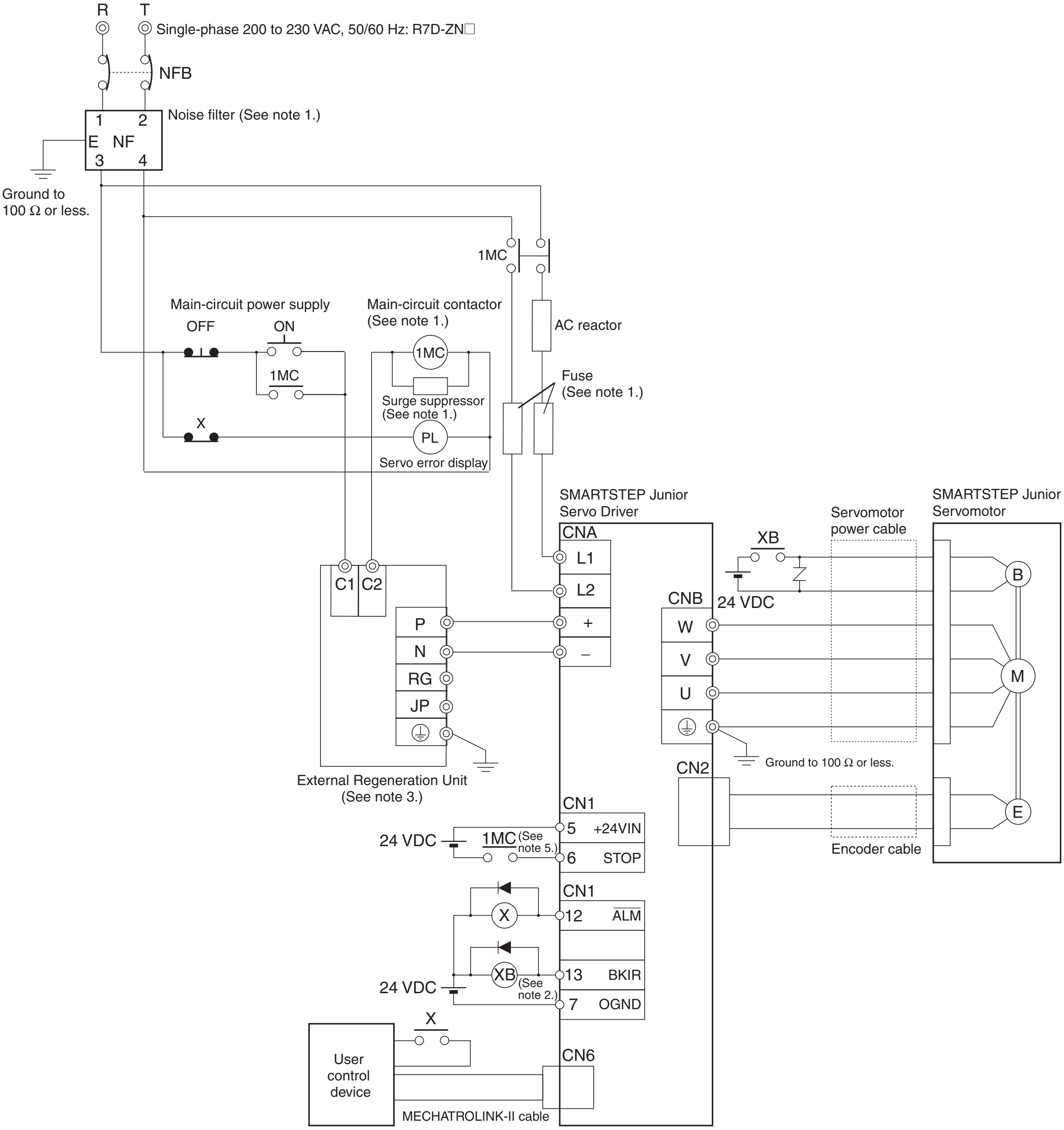
Specification	Model number	Comments
For a Servomotor without a brake	R7A-CAZ□□□S	The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). Example model number: R7A-CAZ003S (3 m cable for a Servomotor without a brake)
For a Servomotor with a brake	R7A-CAZ□□□B	

■ Encoder Cables (CN2)

Name	Model number	Comments
Encoder Cable	R7A-CRZ□□□C	The □□□ digits in the model number indicate the cable length (3 m, 5 m, 10 m, 15 m, or 20 m). Example model number: R7A-CRZ003C (3 m)

4-2-3 Peripheral Device Connection Examples

■ R7D-ZN01H-ML2/-ZN02H-ML2/-ZN04H-ML2/-ZN08H-ML2


R
T
Single-phase 200 to 230 VAC, 50/60 Hz: R7D-ZN□
NFB
Noise filter (See note 1.)
1 2
E NF
3 4
Ground to 100 Ω or less.
1MC
Main-circuit power supply
OFF
ON
1MC
X
Main-circuit contactor (See note 1.)
1MC
Surge suppressor (See note 1.)
PL
Servo error display
AC reactor
Fuse (See note 1.)
SMARTSTEP Junior Servo Driver
CNA
L1
L2
+
–
C1 C2
P
N
RG
JP
External Regeneration Unit (See note 3.)
CNB
W
V
U
XB
24 VDC
Servomotor power cable
SMARTSTEP Junior Servomotor
B
M
E
Ground to 100 Ω or less.
CN2
Encoder cable
CN1
5 +24VIN
6 STOP
24 VDC
1MC (See note 5.)
CN1
12 ALM
13 BKIR
7 OGND
X
XB (See note 2.)
24 VDC
X
User control device
CN6
MECHATROLINK-II cable

Note 1. Recommended products are listed in *4-2-6 Conforming to EMC Directives*.

Note 2. Recommended Relay: OMRON MY-series Relay (24-V model)

Note 3. An R88A-RR22047S External Regeneration Resistor can be connected to the External Regeneration Unit. Connect the R88A-RR22047S if the regenerative energy exceeds the regenerative absorption capacity of the External Regeneration Unit. (Refer to the External Regeneration Unit specifications in *3-5 External Regeneration Unit and External Regeneration Resistor*. Connect the External Regeneration Resistor so that the power supply is cut off when the thermal switch output opens. (Refer to *4-3-4 Absorbing Regenerative Energy with an External Regeneration Resistor*.)

Note 4. The dynamic brake will operate while the main circuit power supply or the control circuit power supply is OFF.

Note 5. When turning OFF the main-circuit power supply, turn off the emergency stop input (STOP) at the same time.

4-2-4 Wiring the Main Circuit and Servomotor Connections

When wiring a Terminal Block, use proper wire sizes, grounding systems, and anti-noise measures.

■ Terminal Block Names and Functions

Signal	Function	Condition	
L1	Main circuits power supply input	Single-phase 200/230 V AC (170 to 253 V AC) 50/60 Hz	
L2			
+	External regeneration resistance connection terminals	If regenerative energy is high, connect an External Regeneration Unit.	
–			
U	Servomotor connection terminals	Red	These are the terminals for outputs to the Servomotor. Be sure to wire these terminals correctly.
V		White	
W		Blue	
⏚		Green/Yellow	
⏚	Frame ground	This is the ground terminal. Ground to a minimum of 100 Ω (class D, class 3).	

■ Terminal Block Wire Sizes

Model (R7D-)			ZP01H ZN01H-ML2	ZP02H ZN02H-ML2	ZP04H ZN04H-ML2	ZP08H ZN08H-ML2
Item		Unit				
Power supply capacity		kVA	0.4	0.75	1.2	2.2
Main circuit power supply input (L1, L2)	Rated current	A (rms)	1.8	3.5	5.5	10
	Wire size	mm^2	1.25		2.0	
External Regeneration Unit connection terminals (+, –)	Wire size	mm^2	1.25 (Wiring length: 0.5 m max.)			
Servomotor connection terminal (U, V, W, ⏚) (See note.)	Rated current	A (rms)	0.84	1.1	2.0	3.7
	Maximum momentary current	A (rms)	2.5	3.3	6.0	11.1
	Wire size	mm^2	1.25 (Wiring length: 20 m max.)			
Frame ground	Wire size	mm^2	2.0 min.			
	Screw size	---	M4			
	Torque	N·m	1.2 to 1.4			
No-fuse breaker or fuse capacity		A (rms)	4		8	16

Note Connect an OMRON Servomotor Cable to the Servomotor connection terminals.

■ Wire Size and Allowable Current (Reference)

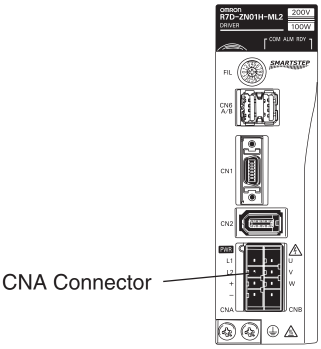
The following table shows the allowable current when there are three power supply wires. Use a current below these specified values.

● 600-V Heat-resistant Vinyl Wire (HIV) (Reference Values)

AWG size	Cross-sectional area (mm^2)	Configuration (wires/mm^2)	Conductive resistance (Ω/km)	Allowable current (A) for ambient temperature		
				30°C	40°C	50°C
20	0.5	19/0.18	39.5	6.6	5.6	4.5
---	0.75	30/0.18	26.0	8.8	7.0	5.5
18	0.9	37/0.18	24.4	9.0	7.7	6.0
16	1.25	50/0.18	15.6	12.0	11.0	8.5
14	2.0	7/0.6	9.53	23	20	16
12	3.5	7/0.8	5.41	33	29	24

■ Terminal Block Wiring Procedure

Spring-type connectors are used for SMARTSTEP Junior Servo Drivers. The procedure for wiring these is described below.



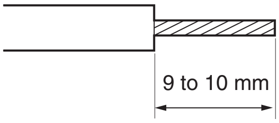
1. Remove the Terminal Block from the Servo Driver.

   The Terminal Block must be removed from the Servo Driver before being wired.

   The Servo Driver will be damaged if the wiring is done with the Terminal Block in place.

2. Strip the covering off the ends of the wires.

   Prepare wires of the right sizes, according to the table under *4-2-4 Wiring the Main Circuit and Servomotor Connections* above, and strip off 9 to 10 mm of the covering from the end of each wire.



3. Open the wire insertion slots in the Terminal Block

   There are two ways to open the wire insertion slots, as follows:

   - Pry the slot open using the lever that comes with the Servo Driver (as in Fig. A).
   - Insert a flat-blade screwdriver (end width: 2.5 to 3.0 mm) into the opening for Servo Driver installation, and press down firmly to open the slot (as in Fig. B).

Fig. A

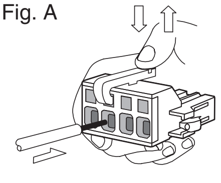
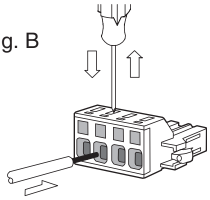


Fig. B



4. Insert the wire into the slot.

   With the slot held open, insert the end of the wire. Then let the slot close by releasing the pressure from the lever or the screwdriver.

5. Mount the Terminal Block to the Servo Driver.

   After all of the terminals have been wired, return the Terminal Block to its original position on the Servo Driver.

4-2-5 Selecting Connection Components

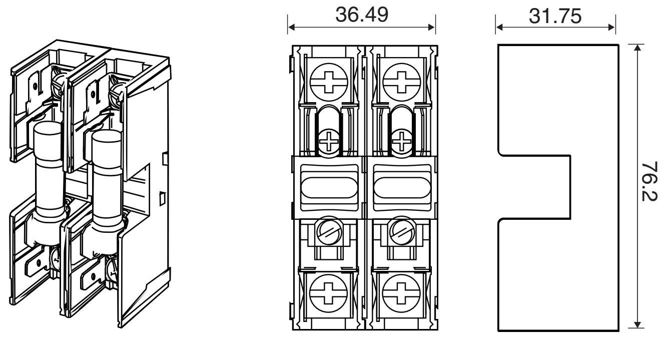
This section explains the criteria for selecting the connection components required to improve noise resistance. Review each component's characteristics, such as its capacity, performance, and applicable conditions when selecting the components. For more details, contact the manufacturers directly.

■ Fuses

- Always install fuses at each Servo Driver to prevent fire or burn damage.
- Two fuses are required per Servo Driver.
- We recommend the following fuses, based on the rated current, current at the maximum momentary torque, and inrush current when the power is turned ON.

Servo Driver			Fuse (Littelfuse, Inc.)			Fuse block (Littelfuse, Inc.)	
Model	**Capacity (W)**	**Momentary rating A (rms)**	**Model**	**Rating A**	**Inrush A_{0-P}**	**Model**	**Specifications**
R7D-ZP01H R7D-ZN01H-ML2	100	4	KLK015	15	30	L60030M-1C	Max. AC voltage: 600 V Max. rated current: 30 A Screw/Q.C. Terminals
R7D-ZP02H R7D-ZN02H-ML2	200	4					
R7D-ZP04H R7D-ZN04H-ML2	400	8					
R7D-ZP08H R7D-ZN08H-ML2	750	16	KLK030	30	60		

● Application Example



The diagram above shows two fuses mounted in a Servo Driver.

■ No-fuse Breakers (NFB)

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

● Maximum Input Current:

- The Servo Driver's maximum momentary output is approximately three times the rated output, and can be output for up to three seconds. Therefore, select no-fuse breakers with an operating time of at least five seconds at 300% of the rated maximum output. General-purpose and low-speed no-fuse breakers are generally suitable.
- The table under *4-2-4 Wiring the Main Circuit and Servomotor Connections* above shows the rated power supply input current for each Servomotor. Select a no-fuse-breaker with a rated current greater than the total effective load current (when multiple Servomotors are used).
- Add the current consumption of other controllers, and any other components, when selecting the NFB.

● Inrush Current:

- The following table lists the Servo Drivers' inrush currents.
- With low-speed no-fuse breakers, an inrush current 10 times the rated current flows for 0.02 second.
- When there is a simultaneous inrush for multiple Servo Drivers, select a no-fuse-breaker with a 20-ms allowable current greater than the total inrush current for those Servo Drivers, shown in the following table.

Servo Driver model	Inrush current ($A_{0\text{-}p}$)
	Main circuit power supply
R7D-ZP01H/-ZP02H/-ZP04H/ -ZN01H-ML2/-ZN02H-ML2/-ZN04H-ML2	30
R7D-ZP08H/-ZN08H-ML2	60

■ Surge Absorbers

- Use surge absorbers to absorb surges from power supply input lines due to lightning, abnormal voltages, etc.
- When selecting surge absorbers, take into account the varistor voltage, the amount of surge immunity, and the amount of energy resistance.
- For 200-V AC systems, use surge absorbers with a varistor voltage of 470 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-781BYZ-2	783 V	2,500 A	Block	Between power supply lines
	R_A_V-781BWZ-4	783 V	2,500 A		Between power supply line grounds

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.

■ Noise Filters for the Power Supply Input

Use the following noise filters for the Servo Driver's power supply.

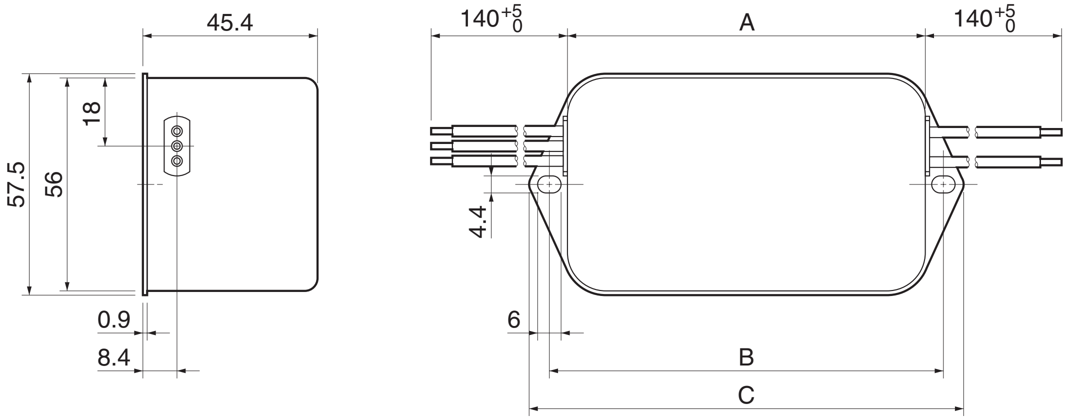
Servo Driver model	Noise filter				
	Model (See note.)	Rated current	Rated voltage	Leakage current (50 Hz)	Maker
R7D-ZP01H/-ZP02H/ -ZN01H-ML2/-ZN02H-ML2	FN2070-6/07	6 A	250 V	0.4 mA/phase	Schaffner
R7D-ZP04H/-ZN04H-ML2	FN2070-10/07	10 A	250 V	0.4 mA/phase	
R7D-ZP08H/-ZN08H-ML2	FN2070-16/07	16 A	250 V	0.4 mA/phase	

Note The last two digits of the noise filter model number indicate the type of terminal connection. The /07 models have lead wires, the /06 models have fast-on connections that can be soldered, and the /08 models have screw terminals. Select the appropriate version for your application. Contact the manufacturer (www.schaffner.com) for details.

Dimensions

The following diagram shows the dimensions of a noise filter with lead wires. Contact the manufacturer for dimensions of the noise filters with other connections.

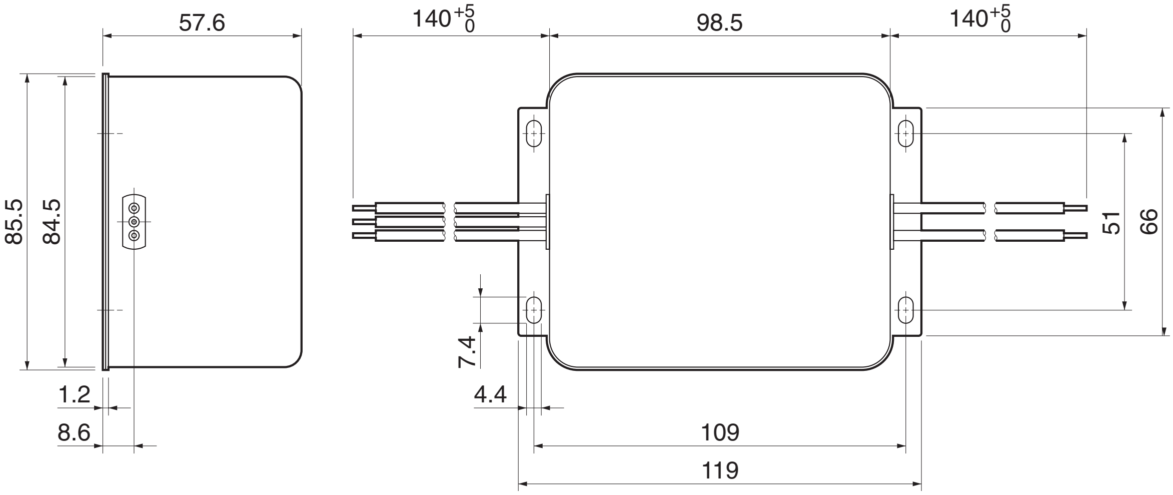
- Single-phase Input (Models FN2070-6/07 and FN2070-10/07)



Dimensions (mm)

Model	A	B	C
FN2070-6/07	94	103	113.6
FN2070-10/07	130.5	143	156

- Single-phase Input (Model FN2070-16/07)


57.6
140$^{+5}_{0}$
98.5
140$^{+5}_{0}$
85.5
84.5
51
66
7.4
4.4
1.2
8.6
109
119

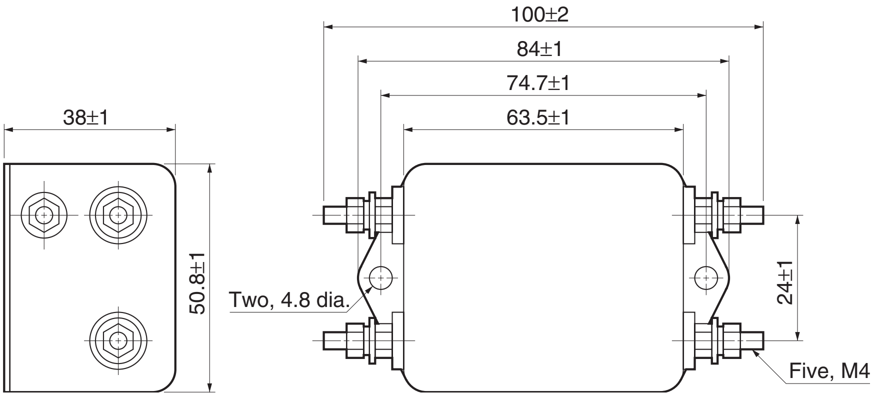
■ Noise Filter for the Brake Power Supply

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

Model	Rated current	Rated voltage	Leakage current	Maker
SUP-P5H-EPR	5 A	250 V	0.6 mA (at 250 Vrms, 60 Hz)	Okaya Electric Industries Co., Ltd.

Dimensions

- Noise Filter for the Brake Power Supply (SUP-P5H-EPR)


100±2
84±1
74.7±1
63.5±1
38±1
50.8±1
Two, 4.8 dia.
24±1
Five, M4

■ Surge Suppressors

- Install surge suppressors for loads that have induction coils, such as relays, solenoids, brakes, clutches, etc.
- The following table shows types of surge killers 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. The reset time is increased because the surge voltage is the lowest when power is cut off. Used for 24/48-V DC systems.	Use a fast-recovery diode with a short reverse recovery time. Example: Fuji Electric Co., ERA22-06
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 when power is cut off is approximately 1.5 times the varistor voltage.	Select the varistor voltage as follows: 24 VDC system: 39 V 100 VDC system: 200 V 100 VAC system: 270 V 200 VAC system: 470 V
Capacitor + resistor	The capacitor + resistor combination is used to absorb vibration in the surge when power is cut off. The reset time can be shortened by selecting the appropriate capacitance and resistance.	Okaya Electric Industries Co., Ltd. XEB120020.2 μF – 120 Ω XEB120030.3 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 current.
- The Servo Driver inrush current is covered in the preceding explanation of no-fuse breaker selection, and the maximum momentary current is approximately twice the rated current.
- The following table shows the recommended contactors.

Maker	Model number	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

■ Leakage Breakers

- Use leakage breakers designed for motors.
- Since switching takes place inside the Servo Drivers, harmonic current leaks from the armature of the motor. With leakage breakers designed for motors, harmonic current is not detected, preventing the breaker from operating due to leakage current.
- When selecting leakage breakers, remember to add the leakage current in devices besides the Servomotor that use the switching power supply, such as noise filters and inverters.
- For details on leakage breakers, refer to the manufacturer's catalog.
- The following table shows the Servomotor leakage current for each Servo Driver model.

Servo Driver model	Driver Leakage current (resistor/capacitor measurement) in the commercial power supply frequency range
R7D-ZP01H/-ZP02H/-ZP04H/ -ZN01H-ML2/-ZN02H-ML2/ -ZN04H-ML2	3 mA max.
R7D-ZP08H/-ZN08H-ML2	5 mA max.

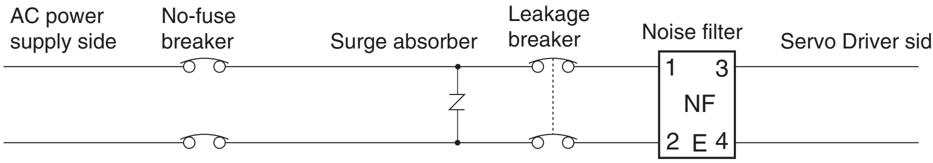
Note 1. The leakage current shown above is for Servomotor power cables less than 5 meters long. (The leakage current depends on the power cable length and the insulation.)

Note 2. The leakage current shown above is for normal temperature and humidity. (The leakage current depends on the temperature and humidity.)

- The following table shows the recommended leakage breakers. (Conform to UL/CSA and CE standards.)

Maker	Model number	Rated current	Sensitive current
Fuji Electric Corp.	EG33CM/30-30MA-CE	30 A	30 mA
	EG33CM/30-100MA-CE	30 A	100 mA

Leakage Breaker Connection Example



■ Radio Noise Filters

- Use a radio noise filter to reduce the Servo Driver's PWM noise.
- The following table shows some available radio noise filters.

Maker	Model number
FDK Corporation	RN603620M
	RN80UD
Hitachi Metals	FT-3KMF6045GB
	FT-3KMS10085GB
	FT-1KMF6045GB

■ 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 connect them with connectors and do not remove more than 50 mm of the cable insulation. In addition, always use shielded cable.
- Do not coil cables. If cables are long and are coiled, mutual induction and inductance will increase and will cause malfunctions. Always use cables fully extended.
- When installing noise filters for Encoder Cables, use clamp filters.
- The following table shows the recommended ferrite-core clamp filter models.

Maker	Product name	Model number	Specifications
NEC TOKIN	Clamp-type EMI Core	ESD-SR-250	For cable diameter up to 13 mm
TDK	Clamp Filters for Cable	ZCAT2032-0930	For cable diameter up to 9 mm
		ZCAT3035-1330	For cable diameter up to 13 mm
		ZCAT2035-0930A	For cable diameter up to 9 mm

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

■ 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. Follow the methods outlined below for the power supply and wiring.

- Use completely separate power supplies for the control power supply (especially 24 VDC) and the external operation power supply. In particular, do not connect the two power supply ground wires.
- Install a noise filter on the primary side of the control power supply.
- If Servomotors with brakes are being used, do not use the same 24-VDC power supply for both the brakes and the control I/O. Also, do not connect the ground wires. Connecting the ground wires may cause I/O signal errors.
- 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 Driver input section or the Controller output section.

■ Selecting Other Parts for Noise Resistance

This section explains the criteria for selecting other connection components required to improve noise resistance. Review 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 Driver.
- 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 shown in the table under *4-2-4 Wiring the Main Circuit and Servomotor Connections* above).

Maker	Model number	Rated current	Applicable standards
NEC TOKIN	GT-2050	5 A	UL, CSA, VDE, and TUV
	GT-2100	10 A	
	GT-2150	15 A	
	GT-2200	20 A	
Soshin Electric Company	HF2005A-UP	5 A	UL and TUV
	HF2010A-UP	10 A	
	HF2015A-UP	15 A	
	HF2020A-UP	20 A	
	HF2030A-UP	30 A	
TDK	ZRCS2006-00S	6 A	UL, CSA, and NEMKO
	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 through-type capacitor.

Note 3. If multiple Servo Drivers are being 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 Drivers.

● 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 Driver’s continuous output current.
- The following table shows the noise filters that are recommended for Servomotor output.

Maker	Model number	Rated current	Applicable standards	Remarks
NEC TOKIN	LF-310KA	10 A	UL	For inverter output
	LF-320KA	20 A		
Soshin Electric Company	CC3005C-AZ	5 A	---	For inverter output
	CC3010C-AZ	10 A		
	CC3015C-AZ	15 A		

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

Note 2. Typical noise filters are used with power supply frequencies of 50/60 Hz. If these noise filters are connected to outputs of 11.7 kHz (the Servo Driver’s PWM frequency), a very large (about 100 times larger) leakage current will flow through the noise filter’s condenser and the Servo Driver could be damaged.

4-2-6 Conforming to EMC Directives

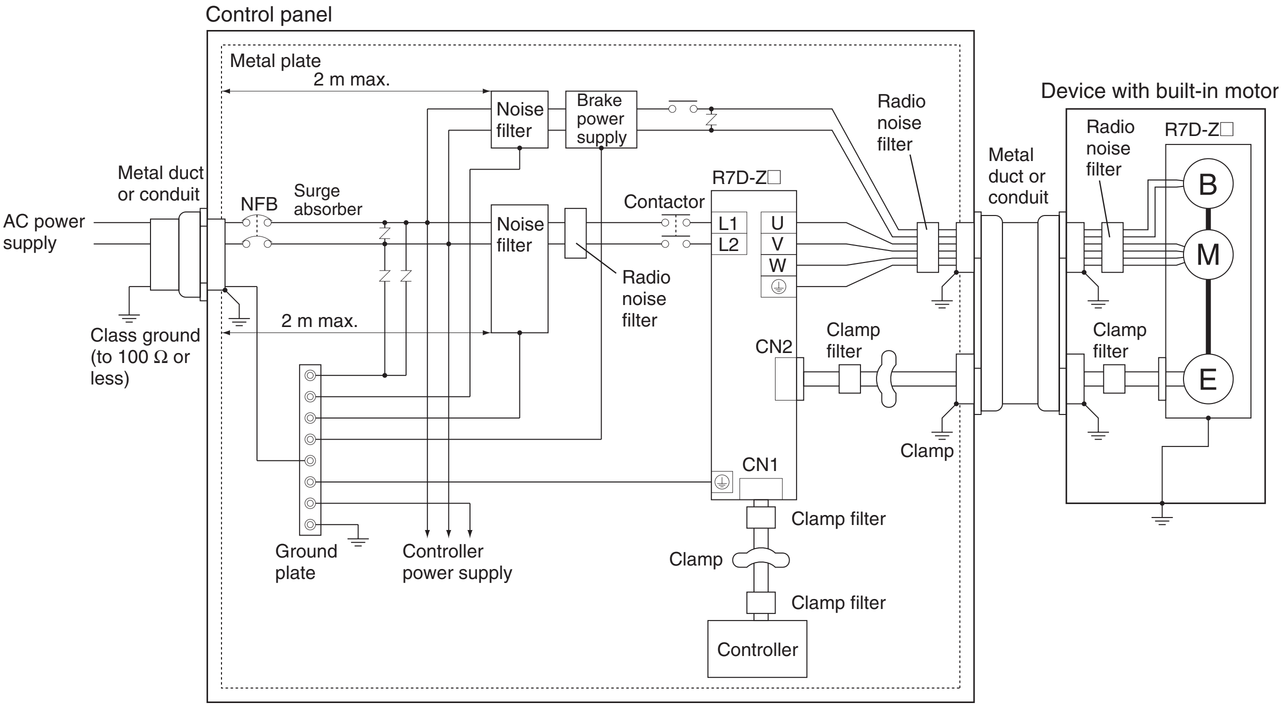
Conformance to EMC Directives (EN55011 class A group 1 (EMI) and EN61000-6-2 EMS)) can be ensured by wiring under the conditions described below. These conditions are for conformance of SMARTSTEP Junior products to EMC Directives.

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 customer must, therefore, perform final checks to confirm that devices and the overall installation conform to EMC Directives.

The following conditions must be met to conform to EMC Directives.

- The Servo Driver 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 all power supply lines.
- Shielded cables must be used for all I/O signal lines and encoder lines. (Use tin-plated, soft copper wires for the shield weaving.)
- All cables leaving the control panel must be wired in metal ducts or conduits with blades. (The 30-cm power cable, encoder cable, and connector do not have to be inserted in metal ducts or conduits.)
- Clamp filters must be installed on cables with braided shields, and the shield must be directly grounded to a ground plate.

■ Wiring Method

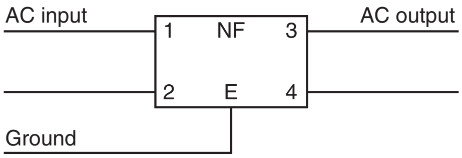

Control panel
Metal plate
2 m max.
Noise filter
Brake power supply
Radio noise filter
Device with built-in motor
Radio noise filter
R7D-Z□
Metal duct or conduit
R7D-Z□
Metal duct or conduit
NFB
Surge absorber
Contactor
AC power supply
Noise filter
L1
L2
U
V
W
B
M
Radio noise filter
2 m max.
Class ground (to 100 Ω or less)
CN2
Clamp filter
Clamp filter
E
Clamp
CN1
Clamp filter
Ground plate
Controller power supply
Clamp
Clamp filter
Controller

Note 1. Make 1.5 turns for the ferrite core's cable winding.

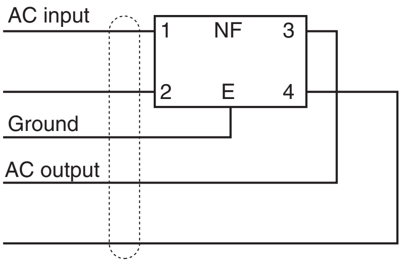
Note 2. Peel the insulation off the cable at the clamp, and directly connect the shield to the metal plate.

- Ground the motor's frame to the machine ground when the motor is on a movable shaft.
- Use a grounding 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 (NF) should be positioned near the input terminal block (ground plate), and I/O lines should be isolated and wired using the shortest distance possible.
- 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 and 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 should be installed at the entrance to the control box whenever possible.

Correct: Separate input and output

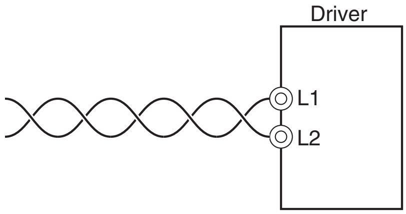


Wrong: Noise not filtered effectively

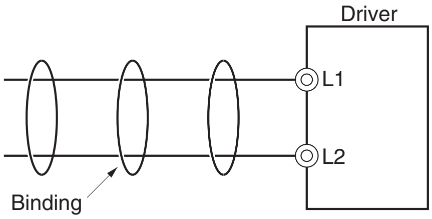


- Use twisted-pair cables for the power supply cables whenever possible, or bind the cables.

Correct: Properly twisted



Correct: Cables are bound.



- Separate power supply cables and signal cables when wiring.

■ Control Panel Construction

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 recommendations described below when designing or selecting a control panel.

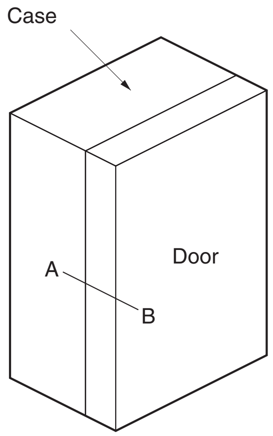
● Case Structure

- Use a metal control panel with welded joints at the top, bottom, and sides so that the surfaces will be electrically conductive.
- During assembly, strip the paint off of 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.

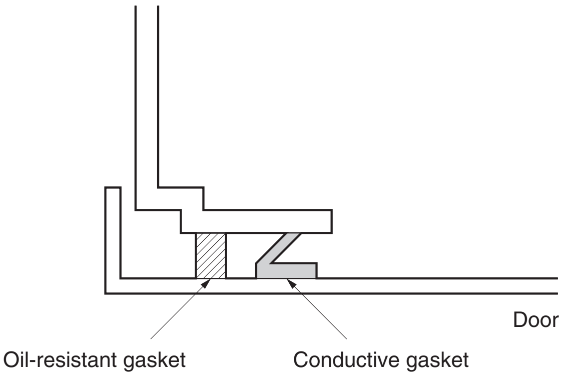
- Do not leave any conductive part unconnected.
- Ground all Units within the case to the case itself.

● Door Structure

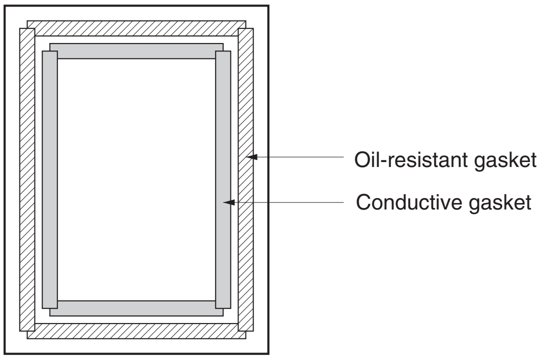
- Use a door that is made of metal.
- Use a water-draining structure where the door and case fit together, and leave no gaps. (Refer to the diagrams below.)
- Use a conductive gasket between the door and the case, as shown in the diagrams below. (Refer to the diagrams below.) Strip the paint off of the 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.
- Gaps may open between case panels when screws are tightened. Be sure that no gaps appear when tightening down screws.


Case
A
Door
B

Control panel


Door
Oil-resistant gasket
Conductive gasket

Cross-sectional view of A-B


Oil-resistant gasket
Conductive gasket

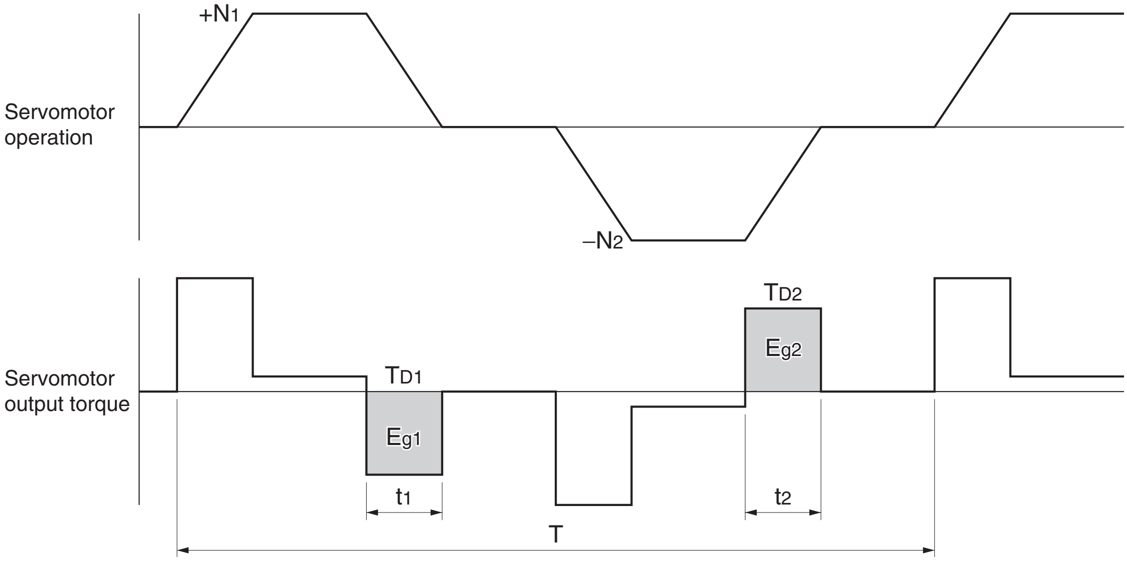
Door (interior view)

4-3 Regenerative Energy Absorption

The Servo Drivers 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 is generated, however, if the amount of regenerative energy from the Servomotor is too large. If this occurs, measures must be taken to reduce the regenerative energy produced by changing operating patterns, or to increase the regenerative energy absorption capacity by connecting external regeneration resistance.

4-3-1 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 There is some loss due to winding resistance, so the actual regenerative energy will be approximately 90% of the values derived from these equations.

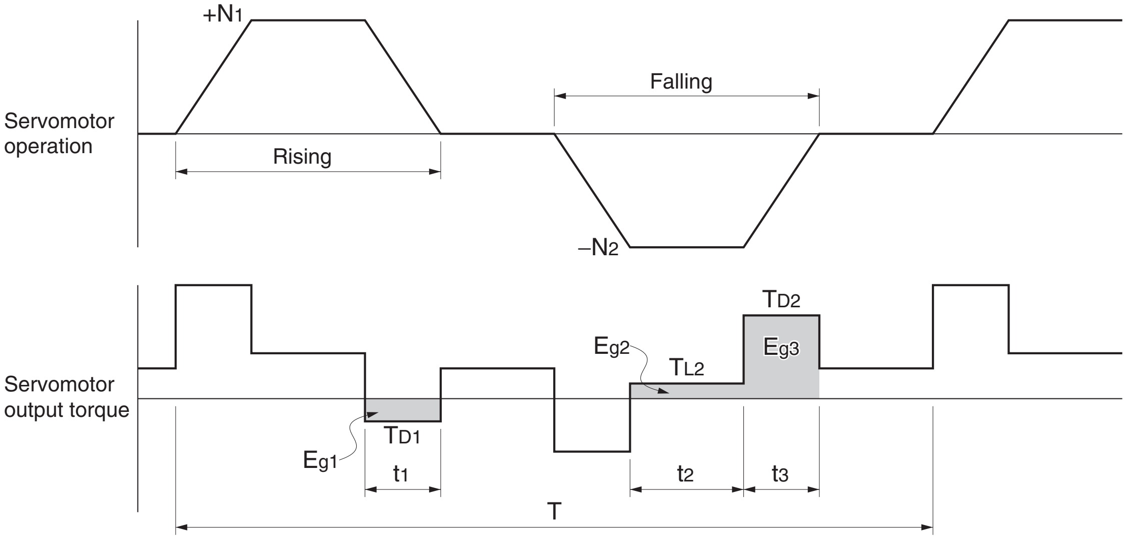
- The average regeneration power (Pr) is the power consumed by regeneration resistance in one cycle of operation.

$$P_r = (E_{g1} + E_{g2}) / T \text{ [W]}$$

T: Operation cycle [s]

- Since there is an internal capacitor to absorb regenerative energy, the value for Eg1 and Eg2 (unit: J) must be lower than the Servo Driver's regenerative energy absorption capacity. (The capacity varies depending on the model. For details, refer to *4-3-2 Servo Driver Regenerative Energy Absorption Capacity* below.
  If an external External Regeneration Unit is connected, be sure that the average regeneration power (Pr) does not exceed the external External Regeneration Unit'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.

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

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

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

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 travel time when falling [s]

Note There is some loss due to winding resistance, so the actual regenerative energy will be approximately 90% of the values derived from these equations.

- The average regeneration power (Pr) is the power consumed by regeneration resistance in one cycle of operation.

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

T: Operation cycle [s]

- Since there is an internal capacitor to absorb regenerative energy, the value for Eg1 and $E_{g2} + E_{g3}$ (unit: J) must be lower than the Servo Driver's regenerative energy absorption capacity. (The capacity varies depending on the model. For details, refer to *4-3-2 Servo Driver Regenerative Energy Absorption Capacity* below.
  If an External Regeneration Unit is connected, be sure that the average regeneration power (Pr) does not exceed the External Regeneration Unit's regenerative energy absorption capacity (12 W).

4-3-2 Servo Driver Regenerative Energy Absorption Capacity

The SMARTSTEP Junior Servo Drivers absorb regenerative energy internally with built-in capacitors. If the regenerative energy is too large to be processed internally, an overvoltage error is generated and operation cannot continue.

The following table shows the regenerative energy (and amount of regeneration) that each Servo Driver can absorb. If these values are exceeded, take the following measures.

- Connect an External Regeneration Unit (to increase the regeneration processing capacity).
- 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 regenerative power).

Servo Driver	Regenerative energy that can be absorbed by the internal capacitor	Allowance when decelerating to stop from 3,000 r/min	
		Load inertia	Rotor inertia ratio
	J	$\text{kg}\cdot\text{m}^2$	Multiple
R7D-ZP01H/ R7D-ZN01H-ML2	13	6.0×10^{-5}	9.5
R7D-ZP02H/ R7D-ZN02H-ML2	19	3.0×10^{-4}	9.1
R7D-ZP04H/ R7D-ZN04H-ML2	28	5.0×10^{-4}	8.3
R7D-ZP08H/ R7D-ZN08H-ML2	59	1.0×10^{-3}	6.7

4-3-3 Absorbing Regenerative Energy with an External Regeneration Unit

Connect an External Regeneration Unit if the amount of regeneration exceeds the capacity of the Servo Driver alone. Connect the P and N terminals of the External Regeneration Unit to the + and – terminals respectively of the main-circuit connector (CNA) at the Servo Driver. (Refer to *4-2-3 Peripheral Device Connection Examples*.)

Double-check the terminal names when connecting the External Regeneration Unit. The Unit can be damaged if the terminals are connected incorrectly. (The External Regeneration Unit does not conform to EC Directives.)

■ External Regeneration Unit

External Regeneration Resistor Models

Model	Regeneration voltage	Regeneration current	Internal average regenerative power	Externally connected regenerative resistance
R88A-RG08UA	380 V_{DC}	8 A_{DC}	12 W (Internal resistance: 50 Ω - 60 W)	47 Ω ± 5%

For detailed specifications, refer to *3-5-1 External Regeneration Unit (R88A-RG08UA) Specifications*.

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

If the regenerative energy exceeds the absorption capacity of the R88A-RG08UA External Regeneration Unit, connect an External Regeneration Resistor.

To connect an External Regeneration Resistor, remove the shorting bar between the RG-JP terminals and connect the resistor between the P-RG terminals.

Double-check the terminal names when connecting the Resistor. The External Regeneration Unit can be damaged if the Resistor is connected to the wrong terminals. (The External Regeneration Unit does not conform to EC Directives.)

The External Regeneration Resistor can reach a temperature of approximately 120°C, so install it at a distance from heat-sensitive devices and wiring. In addition, install a heat-radiating heat sink to cool the resistor if necessary.

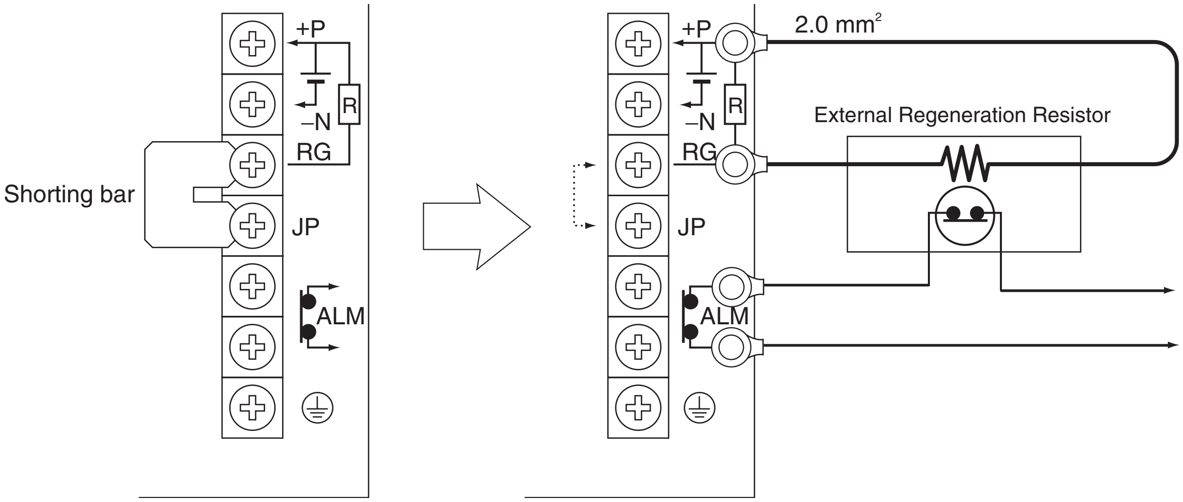
■ External Regeneration Resistor

● External Regeneration Resistor Models

Model	Resistance	Nominal capacity	Regeneration absorption at 120°C	Heat radiation	Thermal switch output specifications
R88A-RR22047S	47 Ω ± 5%	220 W	70 W	t1.0 × 350 × 350 (SPCC)	Operating temperature: 170°C ± 5% NC contact Rated output: 3A

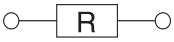
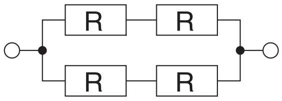
● Wiring Method

When installing an External Regeneration Resistor, remove the shorting bar between the RG-JP terminals and connect the resistor between the P-RG terminals.

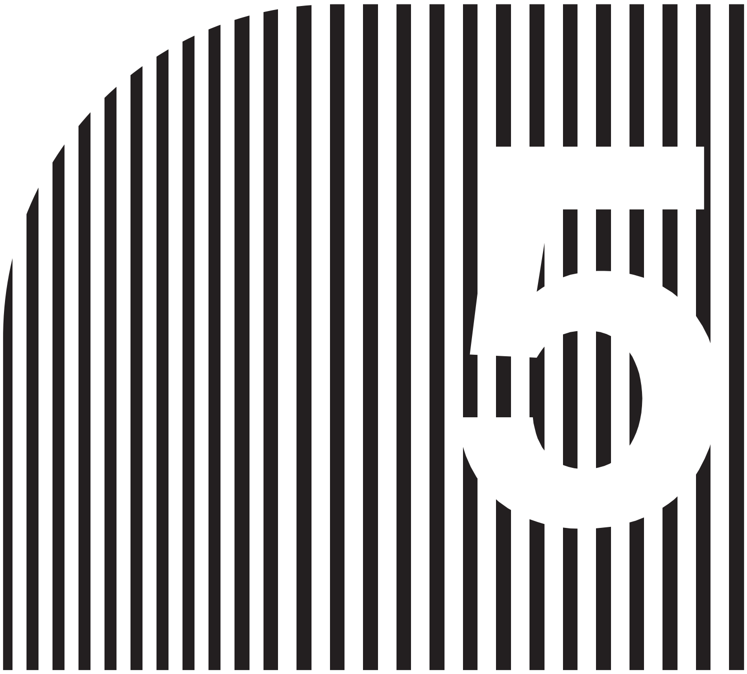


Note Connect the thermal switch output just like the External Regeneration Unit's ALM output, so that the power supply will be shut off when the contact opens. If a sequence is not added to cut off the power with this output, the Resistor may overheat.

● Combining External Regeneration Resistors

Resistor configurations (See note.)	Regeneration absorption capacity	
	70 W	280 W
		

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



Chapter 5

Operation

5-1 Operational Procedure
5-2 Switch Settings
5-3 Preparing for Operation
5-4 User Parameters
5-5 Trial Operation
5-6 Operating Functions

5-1 Operational Procedure

After mounting and wiring, connect a power supply and check the operation of the Servomotor and Servo Driver.

If the parameter settings are incorrect, the Servomotor may operate in dangerous and unexpected ways. Be careful to make the settings correctly according to the procedures described in this manual.

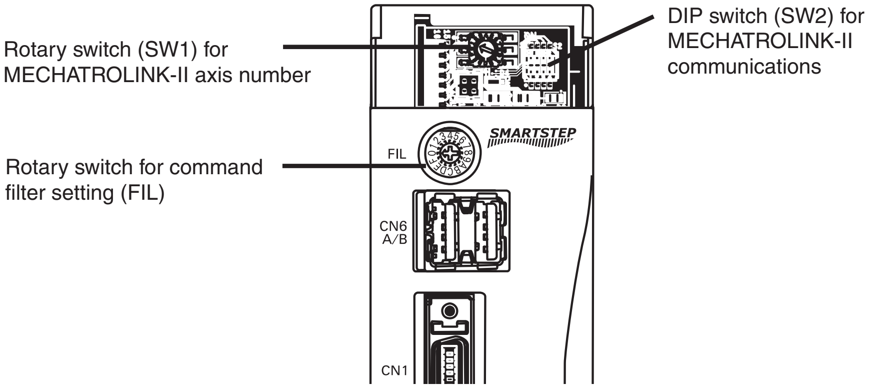
Item	Description	Section
Mounting and installation	Install the Servomotor and Servo Driver according to the installation conditions. (Do not connect the Servomotor to the mechanical system before checking the no-load operation.)	*4-1 Installation Conditions*
	↓	
Wiring and connections	Connect to power supply and peripheral devices. Note: Specified installation and wiring requirements must be satisfied, particularly for models conforming to the EC Directives.	*4-2 Wiring*
	↓	
Switch settings	Make sure that the power supply is turned OFF, and set the Servo Driver's front panel switches.	*5-2 Switch Settings*
	↓	
Preparing for operation	After checking the necessary items, turn ON the Unit's power supply. Check to see whether there are any internal errors in the Servo Driver.	*5-3 Preparing for Operation*
	↓	
Function settings	Set the functions with the user parameters, according to the application.	*5-4 User Parameters*
	↓	
Trial operation	First turn the power OFF and then ON again to enable the parameters that have been set. Then check Servomotor operation with no load. Next turn OFF the power again and connect the Servomotor to the mechanical system. Turn ON the power, and check to see whether protective functions such as emergency stop and operational limits are working reliably. Check operation at both low speed and high speed, with either no workpiece or a dummy workpiece. (Execute the operations using commands from the host controller.)	*5-5 Trial Operation*
	↓	
Adjustments	Adjust the command filter setting as required.	*5-2 Switch Settings* and *5-4 User Parameters*
	↓	
Operation	Operation can now begin. If any trouble should occur, refer to *Chapter 6 Troubleshooting*.	*Chapter 6 Troubleshooting*

5-2 Switch Settings

With SMARTSTEP Junior Servo Drivers, the settings required for MECHATROLINK-II communications can be made simply by setting the front panel switches under the cover. Command filter settings can also be made using the rotary switch on the front panel. Set the switches according to the system configuration.

5-2-1 Switch Names

With Top Cover Open


Rotary switch (SW1) for MECHATROLINK-II axis number
Rotary switch for command filter setting (FIL)
DIP switch (SW2) for MECHATROLINK-II communications
SMARTSTEP
FIL
CN6 A/B
CN1

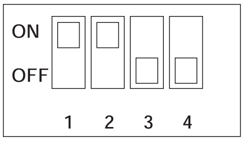
5-2-2 Switch Functions

■ Communications Specifications

MECHATROLINK-II communications specifications are set using the DIP switch (SW2).

The settings are shown in the following table. Changes to the settings are enabled by turning the power OFF and then ON again.

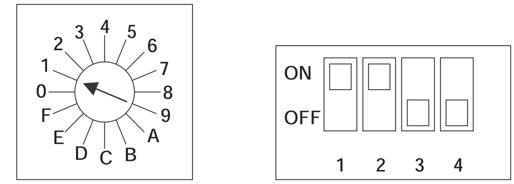
Pin	Name	Setting	Contents	Factory setting
Pin 1	Reserved for system.	ON	---	ON
Pin 2	Reserved for system.	ON	---	ON
Pin 3	Axis No. setting	OFF	Axis No. 15 max.	OFF
		ON	Axis No. 16 min.	
Pin 4	Filter selection	OFF	Enables or disables the rotary switch for setting the command filter.	OFF



SW2 (factory settings)

■ Setting the Axis Number

Set the axis number as shown in the following table, using the rotary switch for setting the MECHATROLINK-II axis number (SW1) and the DIP switch for setting MECHATROLINK-II communications (SW2, pin 3).



SW1 (factory settings) SW2 (factory settings)

SW2, pin 3	SW1	Axis No.	SW2, pin 3	SW1	Axis No.
OFF	0	Disabled	ON	0	16
	1	1		1	17
	2	2		2	18
	3	3		3	19
	4	4		4	20
	5	5		5	21
	6	6		6	22
	7	7		7	23
	8	8		8	24
	9	9		9	25
	A	10		A	26
	B	11		B	27
	C	12		C	28
	D	13		D	29
	E	14		E	30
	F	15		F	31

■ Selecting the Filter Setting

There are two methods for setting the command filter, as shown below. The selection is made using SW2 pin 4.

SW2, pin 4	Specifications
OFF	Set using the rotary switch for setting the command filter (FIL). (Factory setting)
ON	Set using PN00A. (Disable the rotary switch for setting the command filter.)

■ Rotary Switch for Command Filter Setting (FIL)

This switch does not need to be set if the machine is not subject to vibration. (The switch is factory-set to 0.)

Filter setting (See note 1.)	Acceleration/deceleration time for STEP command (See note 3.)	Approx. time from end of command to end of positioning (settling time) (See note 2.)	Description
0	45 ms	100 to 200 ms	Smaller filter time constant (short positioning time) ↕ Larger filter time constant (longer positioning time with little vibration)
1	50 ms	110 to 220 ms	
2	60 ms	130 to 260 ms	
3	65 ms	150 to 300 ms	
4	70 ms	170 to 340 ms	
5	80 ms	200 to 400 ms	
6	85 ms	250 to 500 ms	
7	170 ms	500 to 1000 ms	
8 to F	Do not set this switch to 8 to F.		

Note 1. Increase the value of the filter setting if there is vibration when starting or stopping.

Note 2. The settling time depends on the commanded acceleration/deceleration, the rigidity of the machine motor drive, the encoder resolution, and other factors.

Note 3. Use the acceleration/deceleration times as a guideline for determining the Servomotor capacity that can be driven when using STEP commands without command acceleration/deceleration.

5-3 Preparing for Operation

This section explains the procedure following installation, wiring, and switch setting of the Servomotor and Servo Driver, to prepare the mechanical system for trial operation.

It explains what you need to check both before and after turning ON the power.

5-3-1 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-ZN☐☐H-ML2 (Single-phase 200-V AC input)
  Main-circuit power supply: Single-phase 200/230 V AC (170 to 253 V) 50/60 Hz

● Checking Terminal Block Wiring

- The main-circuit power supply inputs (L1/L2) must be properly connected to the terminal block.
- The Servomotor's red (U), white (V), and blue (W) power lines and the yellow/green ground wire (⏚) must be properly connected to the terminal block.

● Checking the Servomotor

- There should be no load on the Servomotor. (Do not connect to the mechanical system.)
- The Servomotor's power lines and Servomotor Power Cable must be connected securely.
- The Encoder Cable must be securely connected to the Encoder Connector (CN2) at the Servo Driver.
- The Encoder Cable must be securely connected to the Encoder Connector at the Servomotor.

● Checking the Control Connectors

- The Control Cable must be securely connected to the I/O Control Connector (CN1).
- The reverse drive prohibit (NOT), forward drive prohibit (POT), and emergency stop (STOP) inputs must be input properly.

● Checking the MECHATROLINK-II Connections

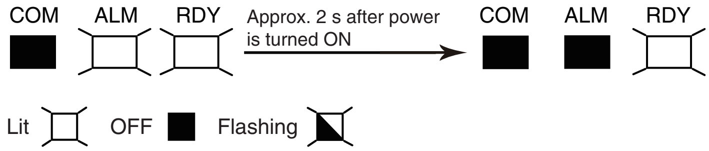
- The MECHATROLINK-II cable most be securely connected to the MECHATROLINK-II connector at the host controller.
- The MECHATROLINK-II Cable most be securely connected to the MECHATROLINK-II Connector (CN6) at the Servo Driver.
- The terminating resistance must be securely connected at the end Servo Drivers.

5-3-2 Turning ON Power

- First carry out the preliminary checks, and then turn ON the main circuit power supply.
- The ALM output 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).

5-3-3 Checking Displays

- When the power is turned ON, check that the alarm indicator (ALM) and the Servo indicator (RDY) light. After approximately two seconds, check that the ALM indicator turns OFF and that only the REF indicator remains lit.



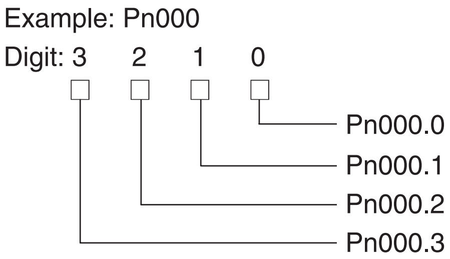
- If the indicators do not light as described above, or if the alarm indicator (ALM) remains lit, refer to *Chapter 6 Troubleshooting* and correct the error.

5-4 User Parameters

This section describes the user parameters that must be set and checked before using the Servomotor or Servo Driver. If these parameters are not set correctly, it may cause faulty Servomotor operation. Set the parameters to match the system.

■ User Parameter Precautions

- Some parameters require that the power be turned OFF and then back ON before changes to the settings will go into effect. (This is shown individually for each parameter below.) After changing the settings for those parameters, turn OFF the power (checking to be sure that the PWR indicator has turned OFF) and then turn it back ON again.
- Parameters for which digits must be set individually have their particular digits indicated by adding a decimal point and an extra digit after the parameter number. For example, digit No. 0 of Pn000 is indicated by “Pn000.0.”



- Do not set parameters or digits which are indicated as not used.

5-4-1 Changing the Servomotor Direction of Rotation

The SMARTSTEP Junior Servo Driver is provided with a reverse rotation mode for reversing the direction of Servomotor rotation without having to change the Servomotor wiring.

The forward direction is the counterclockwise (CCW) direction as seen from the Servomotor load side. (Refer to *3-2 Servomotor Specifications*.)

■ Reverse Rotation (Pn000.0)

Pn000.0	Reverse rotation						
Setting range	0, 1	Unit	---	Factory setting	0	Restart to enable	Yes

- This parameter reverses the Servomotor direction of rotation.
- The polarity of Servomotor data such as feedback positions and feedback speeds is not changed.
- When 0 is set, a forward command rotates the Servomotor in the forward (CCW) direction, and when 1 is set a forward command rotates the Servomotor in the reverse (CW) direction.

5-4-2 Setting the Command Filter

The command filter does not need to be set if the machine is not subject to vibration, but set it as troubleshooting for problems such as overshooting.
There are two methods for setting the command filter, and the method using Pn00A is covered here. The other method is to use the rotary switch for command filter setting (FIL) on the front of the Servo Driver. For information on that method, refer to *5-2-2 Switch Functions*.

■ Command Filter Setting (Pn00A)

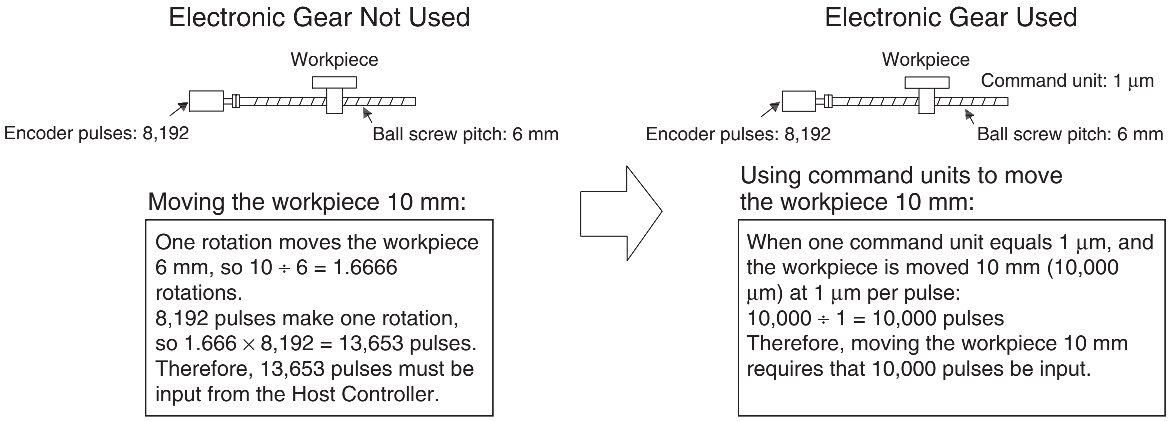
Pn00A	Command filter setting						
Setting range	0000H to 0000FH	Unit	---	Factory setting	0000H	Restart to enable	---

- The setting method is the same as for the rotary switch for command filter setting (FIL).
- Do not set 8 (0008H) to F (000FH).

5-4-3 Setting the Electronic Gear

The electronic gear function sets the amount of movement per pulse for command pulses from the host controller. A single command pulse from the host controller is called a command unit.

When the electronic gear is used, the host controller position and speed can be set without paying attention to the deceleration rate of the machine or the number of encoder pulses.



Electronic Gear Not Used

Moving the workpiece 10 mm:

One rotation moves the workpiece 6 mm, so 10 ÷ 6 = 1.6666 rotations.
8,192 pulses make one rotation, so 1.666 × 8,192 = 13,653 pulses.
Therefore, 13,653 pulses must be input from the Host Controller.

Electronic Gear Used

Using command units to move the workpiece 10 mm:

When one command unit equals 1 µm, and the workpiece is moved 10 mm (10,000 µm) at 1 µm per pulse:
10,000 ÷ 1 = 10,000 pulses
Therefore, moving the workpiece 10 mm requires that 10,000 pulses be input.

■ Setting the Electronic Gear Ratio

Pn20E	Electronic gear ratio G1 (numerator)						
Setting range	1 to 1073747824	Unit	---	Factory setting	1	Restart to enable	Yes

Pn210	Electronic gear ratio G2 (denominator)						
Setting range	1 to 1073747824	Unit	---	Factory setting	1	Restart to enable	Yes

- Set in the following range: 0.01 ≤ Electronic gear ratio (G1/G2) ≤ 100
- When G1/G2 =1, inputting 8,192 pulses generates one Servomotor rotation.
- The electronic gear function is useful in the following situations:

  When fine-tuning positions and speeds for two synchronized lines.

  When setting, for example, 0.001 mm for the amount of machine travel per pulse.

  When it is necessary to minimize the effect of pi (π).

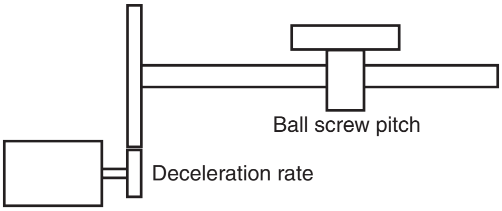
■ Setting Method

Use the following procedure to calculate the electronic gear ratio (G1/G2) and to set it in the user parameters (Pn20E and Pn210).

1. Check the machine specifications.

   The following items are related to the electronic gear ratio.

   - Deceleration rate
   - Ball screw pitch
   - Pulley diameter, etc.



   - For this calculation example, it is assumed that the pulley deceleration rate is 1/2 and that the pulley pitch is 5 mm.

2. Check the encoder resolution for the Servomotor.

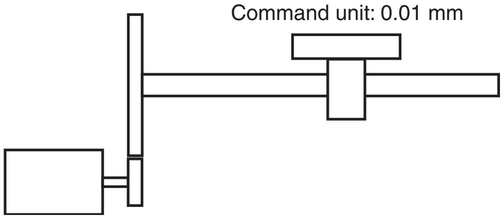
Servomotor model	Encoder resolution
R7M-Z☐	8,192 (pulses/rotation)

3. Determine the command unit.

   - The command unit is positioning data that specifies the load travel per command pulse. The pulse rate is calculated according to the mechanical system and the encoder resolution. The pulse rate is determined first, and then the electronic gear ratio is set to achieve the desired command unit.
   - Units such as the following can be used for the command unit.
     Examples: 0.01 mm, 0.0001 mm, 0.1°, 0.1 inch, etc.

- Take factors such as the machine specifications and positioning accuracy into account when determining the command unit
- For this calculation example, it is assumed that the command unit is 0.01 mm.

When table movement is specified in increments of 0.01 mm



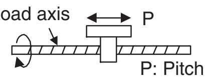
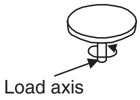
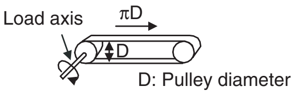
4. Find the amount of load travel per load axis rotation, in command units.

$$\text{Load travel per load axis rotation} = \frac{\text{Amount of travel when the load axis is rotated once}}{\text{Command unit}}$$

- In this calculation example, it is assumed that the ball screw pitch is 5 mm and the command unit is 0.01 mm. Therefore the calculation becomes:

$$\frac{5}{0.01} = 500$$

- In this calculation example the amount of travel per load axis rotation was calculated using a ball screw as an example. For other mechanical systems, refer to the following descriptions when doing the calculation.

Ball screw	Turntable	Belt drive
 $\text{Amount of travel per load axis rotation} = \frac{P}{\text{Command unit}}$	 $\text{Amount of travel per load axis rotation} = \frac{360^\circ}{\text{Command unit}}$	 $\text{Amount of travel per load axis rotation} = \frac{\pi D}{\text{Command unit}}$

5. Find the electronic gear ratio (G1/G2).

- If the Servomotor axis and load axis deceleration rate is n/m (if the load axis rotates n times when the Servomotor axis rotates m times):

$$\text{Electronic gear ratio}\left(\frac{G1}{G2}\right) = \frac{8192}{\text{Travel per load axis rotation}} \times \frac{m}{n}$$

In this example the pulley deceleration rate is assumed to be 1/2. Therefore:

$$\text{Electronic gear ratio}\left(\frac{G1}{G2}\right) = \frac{8192}{500} \times \frac{2}{1} = \frac{16384}{500} = \frac{4096}{125}$$

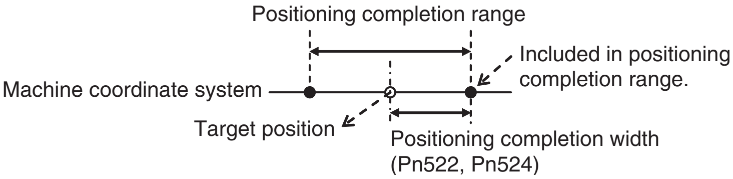
- Check to make sure that the following condition is satisfied: 0.01 ≤ Electronic gear ratio (G1/G2) ≤ 100. If the electronic gear ratio is outside of this range, the Servo Driver will not operate correctly. In that case, change either the machine configuration or the command unit.

6. Set the values in the user parameters.
   - The electronic gear ratio (G1/G2) is reduced as shown above, and so that both G1 and G2 are integers smaller than 1,073,741,824, and then the values are set in the user parameters. Set G1 in Pn20E, and G2 in Pn210.
   - The results in this example are 4,096 for G1 and 125 for G2, and they are set respectively in user parameters Pn20E and Pn210.

This completes the setting of the electronic gear.

5-4-4 Setting the Positioning Completion Width

The positioning completion width provides a width for the output signal for the target position, i.e., for the positioning completed signal. As the positioning completion width is increased, the positioning completed signal is output farther before the target position, but the Servomotor will continue to operate until the target position is reached. There is thus no problem with controlling stopping.


Positioning completion range
Included in positioning completion range.
Machine coordinate system
Target position
Positioning completion width (Pn522, Pn524)

■ Positioning Completion Width 1 (Pn522)

Pn522	Positioning completion width 1						
Setting range	0 to 1073741824	Unit	Command unit	Factory setting	10	Restart to enable	---

- Set the deviation counter value for outputting positioning completion width 1.
- The output turns ON when the deviation counter residual pulses fall below the set value.

■ Positioning Completion Width 2 (Pn524)

Pn524	Positioning completion width 2						
Setting range	0 to 1073741824	Unit	Command unit	Factory setting	100	Restart to enable	---

- Set the deviation counter value for outputting positioning completion width 2.
- The output turns ON when the deviation counter residual pulses fall below the set value.
- For example, this parameter can be used for purposes such as shortening processing time by using positioning completion output 2 as a near-coincidence signal to prepare for the next sequence before positioning completion output 1 turns ON. In this case, set a greater value for Pn524 than for Pn522.

5-4-5 Setting Software Limits

When the machine's movable parts enter a software limit area, positioning is forcibly stopped in the same way as for drive prohibit (overtravel). Servomotor operation is stopped by setting the speed reference at the Servo Driver to zero.

■ Software Limit Function (Pn801.0)

Pn801.0	Function selection application 6 (software limit switch) - Software limit function						
Setting range	0 to 3	Unit	---	Factory setting	3	Restart to enable	---

Set Values

Set value	Function
0	Software limits enabled
1	Forward software limit disabled
2	Reverse software limit disabled
3	Both software limits disabled

- Specify whether software limits are to be enabled or disabled. The software limit function settings are made in the following parameters.
- The origin be established in order for software limits to be enabled. (The CJ1W-NCF71 or CS1W-NCF71 No-origin Flag must be OFF.) If the origin is not established, the software limits will not go into effect even when positioning is out of the software limit range.
- When using the CJ1W-NCF71 or CS1W-NCF71, set 000☐H for Pn801. (Enter a number from 0 to 3 for ☐.)

■ Forward Software Limit (Pn804)

Pn804	Forward software limit						
Setting range	–1073741823 to 1073741823	Unit	Command unit	Factory setting	1073741823	Restart to enable	---

- Set the software limit in the positive (+) direction.
- The area is set according to the direction, so be sure to set the reverse software limit to a value lower than the forward software limit.

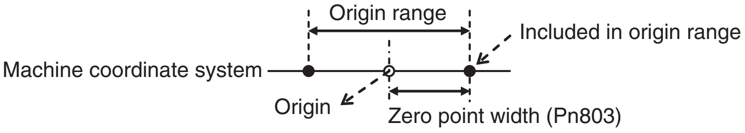
■ Reverse Software Limit (Pn806)

Pn806	Reverse software limit						
Setting range	–1073741823 to 1073741823	Unit	Command unit	Factory setting	–1073741823	Restart to enable	---

- Set the software limit in the negative (–) direction.
- The area is set according to the direction, so be sure to set the reverse software limit to a value lower than the forward software limit.

5-4-6 Setting the Zero Point Width

Like the positioning completion width, this function can be used to set the width for output signals for the origin. It can be set separately from the positioning completion signal.



■ Zero Point Width (Pn803)

Pn803	Zero point width						
Setting range	0 to 250	Unit	Command unit	Factory setting	10	Restart to enable	---

- Set the zero point (ZPOINT) width.
- Zero point (ZPOINT) is enabled when the origin is established (when the No-origin Flag is OFF). It cannot be used when the origin is not established.

5-4-7 Setting Acceleration and Deceleration

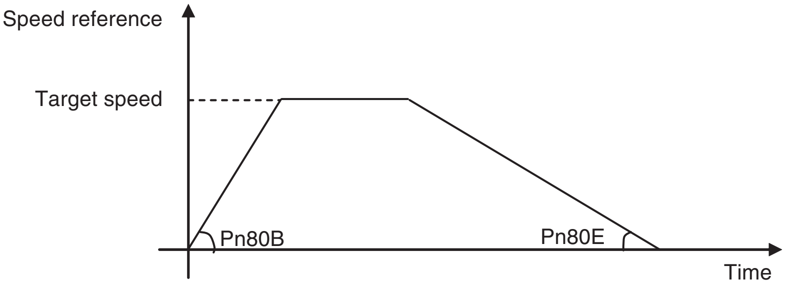
Set the acceleration and deceleration for PTP positioning control. Stop the axes before changing the settings. (The settings can be changed when the host controller's Busy Flag is OFF.)

■ Linear Acceleration Constant (Pn80B)

Pn80B	Linear acceleration constant						
Setting range	1 to 65535	Unit	×10,000 command unit/s^2	Factory setting	100	Restart to enable	---

■ Linear Deceleration Constant (Pn80E)

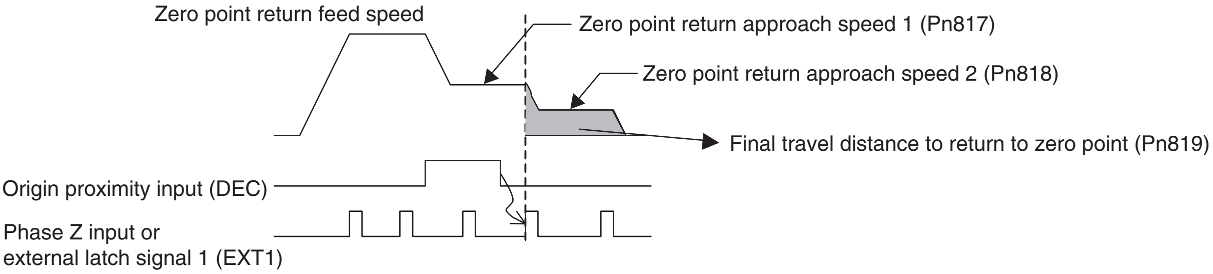
Pn80E	Linear deceleration constant						
Setting range	1 to 65535	Unit	×10,000 command unit/s^2	Factory setting	100	Restart to enable	---



5-4-8 Setting Origin Search

The origin search function operates the Servomotor to establish the origin based on the limit input signal, origin proximity input signal, and the origin input signal. When the origin is established by executing origin search, the present position is cleared to 0.

■ Operation Overview


Zero point return feed speed
Zero point return approach speed 1 (Pn817)
Zero point return approach speed 2 (Pn818)
Final travel distance to return to zero point (Pn819)
Origin proximity input (DEC)
Phase Z input or
external latch signal 1 (EXT1)

■ Origin Search Direction (Pn816.0)

Pn816.0	Zero point return direction						
Setting range	0, 1	Unit	---	Factory setting	---	Restart to enable	---

Set Values

Set value	Function
0	Forward rotation
1	Reverse rotation

- Set the speed for after the origin proximity input (DEC) signal turns ON during an origin search.

■ Origin Search Approach Speed (Pn817)

Pn817	Zero point return approach speed 1						
Setting range	1 to 65,535	Unit	×100 command unit/s	Factory setting	50	Restart to enable	---

- Set the speed for after the origin proximity input (DEC) signal turns ON during an origin search.

■ Origin Search Creep Speed (Pn818)

Pn818	Zero point return approach speed 2						
Setting range	1 to 65,535	Unit	×100 command unit/s	Factory setting	5	Restart to enable	---

- Set the speed for finding the origin after the origin proximity input (DEC) signal turns from ON to OFF during an origin search.

■ Origin Position Offset (Pn819)

Pn819	Final travel distance to return to zero point						
Setting range	–1,073,741,823 to 1,073,741,823	Unit	1 command unit	Factory setting	100	Restart to enable	---

- Set the distance from the phase Z input signal or external latch signal 1 (EXT1) input position until the origin during an origin search.
- If the origin position offset (Pn819) is in the opposite direction of the origin search, or if the distance is too short, positioning will decelerate to a stop and then rotate in the opposite direction.

5-5 Trial Operation

Once mounting, wiring, switch setting, and connecting a power supply have been finished and normal status has been confirmed, perform trial operation. The main purpose of trial operation is to confirm that the servo system is operating correctly electrically. First no-load operation and then loaded operation is checked.

Note If an error occurs during the trial operation, refer to *Chapter 6 Troubleshooting* to eliminate the cause. Then check for safety, reset the alarm, and then retry the trial operation.

5-5-1 Preparing for Trial Operation

■ Switch Settings

After turning OFF the power supply, set the following switches.

- Set the DIP switch (SW2) for MECHATROLINK-II communications and the rotary switch (SW1) for the MECHATROLINK-II axis number to the same settings as the host controller.
- Set the command filter rotary switch (FIL) to 0.

■ Turning OFF the Servomotor

Set up the system so that the power and the RUN command can be turned OFF so that the Servomotor can be immediately turned OFF if an abnormality occurs in the system.

5-5-2 Trial Operation

1. No-load Operation
    - Turn ON the power supply to the control circuits, main circuits, and peripheral devices.
    - Turn ON (close the circuits for) the emergency stop input (STOP), the forward drive prohibit input (POT), and the reverse drive prohibit input (NOT).
    - Check that Servomotor is ON.
    - Send a command from the host controller to rotate the Servomotor and confirm that Servomotor rotation direction is correct and that the rotation speed and rotation amount match the command that was sent.
2. Power OFF, Mechanical Device Connection, Power ON
    - Turn OFF the power supply.
    - Connect the mechanical device to the Servomotor shaft.
    - Turn ON the power supply.
3. Loaded Low-speed Operation
    - Send a low-speed command from the host controller to rotate the Servomotor. (The definition of low speed varies depending on the mechanical system, but a rough estimate is 1/10 to 1/5 of the normal operating speed.)

- Check the following items.
  - a) Are the emergency stop (STOP), the forward drive prohibit (POT), and the reverse drive prohibit (NOT) operating correctly?
  - b) Is the operating direction of the machinery correct?
  - c) Are the operating sequences correct?
  - d) Are there any abnormal sounds or vibration? If the machine vibrates when starting or stopping, refer to *5-2-2 Switch Functions* and adjust the command filter rotary switch (FIL).
  - e) Is any error (or alarm) generated? (If anything abnormal occurs, refer to *Chapter 6 Troubleshooting* and apply the appropriate countermeasures.)

4. Operation under Actual Conditions
   - Operate the Servomotor in a regular pattern and check the following items.
     - a) Is the operating speed correct?
     - b) Is the load torque roughly 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 the machine vibrates when starting or stopping, refer to *5-2-2 Switch Functions* and adjust the command filter rotary switch (FIL).
     - f) Is either the Servomotor or the Servo Driver abnormally overheating?
     - g) Is any error (or alarm) generated? If anything abnormal occurs, refer to *Chapter 6 Troubleshooting* and apply the appropriate countermeasures.)
5. Completing the Trial Operation

   Performing the above procedures completes the trial operation.

5-6 Operating Functions

5-6-1 Brake Interlock

■ Precautions When Using the Electromagnetic Brake

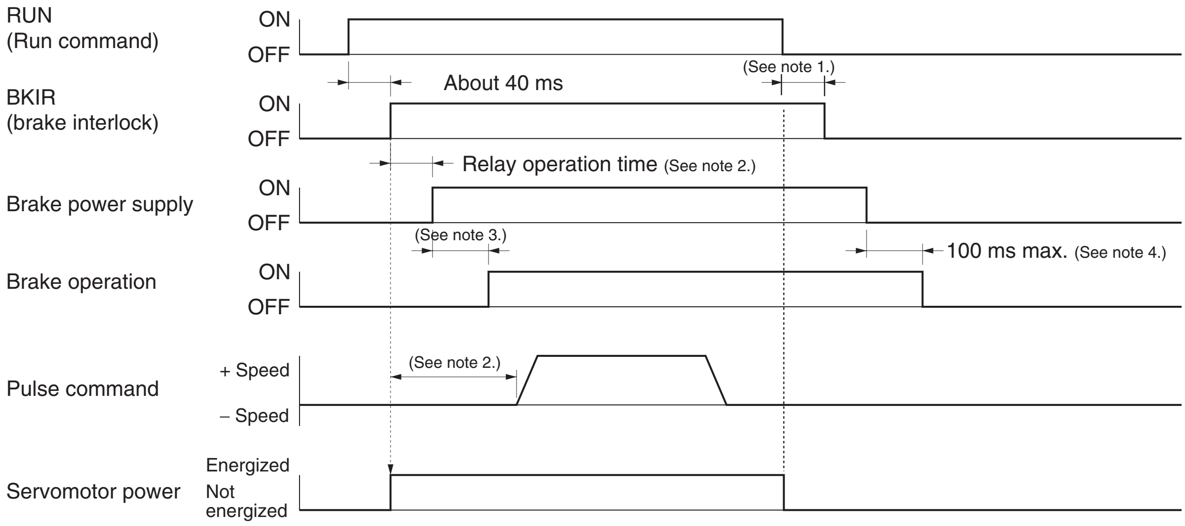
The electromagnetic brake of a Servomotor with a brake is a non-excitation brake especially for holding. First stop the Servomotor and then turn OFF the brake power supply. If the brake is applied while the Servomotor is operating, the brake disk may become damaged or malfunction due to friction, causing damage to the Servomotor.

■ Function

Output the BKIR (brake interlock) signal, which turns the electromagnetic brake ON and OFF.

■ Operation

Servo ON Timing (When Servomotor Is Stopped)


RUN
(Run command)
ON
OFF
About 40 ms
(See note 1.)
BKIR
(brake interlock)
ON
OFF
Relay operation time (See note 2.)
Brake power supply
ON
OFF
(See note 3.)
100 ms max. (See note 4.)
Brake operation
ON
OFF
Pulse command
+ Speed
– Speed
(See note 2.)
Servomotor power
Energized
Not energized

Note 1. Refer to the stop sequence on the following page (Servo OFF and Error Timing when Servomotor is Rotating).

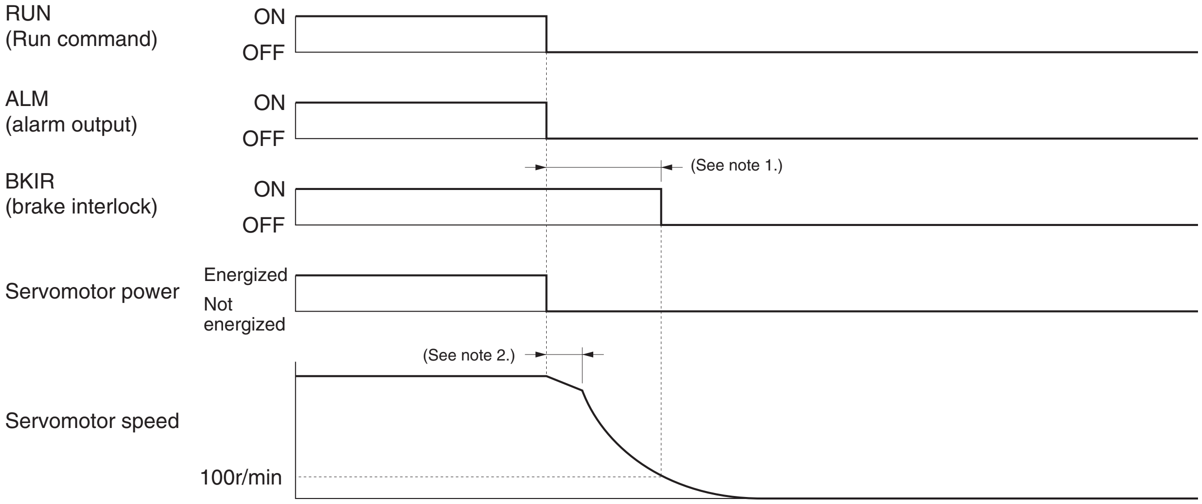
Note 2. The timechart above shows the time it takes from Servo ON until the brake is released. Take this delay into account when sending the RUN command, so that the RUN command is sent after the brake has been released. There is also a delay between a change in the BKIR (brake interlock) signal and the brake power switching, so check the relay response time.

Note 3. The time from turning ON the brake power supply to the brake being released depends on the Servomotor being used. The following table shows the delay for each model.

Model	Delay
R7M-Z10030-B	60 ms max.
R7M-Z20030-B	
R7M-Z40030-B	
R7M-Z75030-B	80 ms max.

Note 4. The maximum time from turning OFF the brake power supply to the brake engaging is 100 ms. The brake's operation time depends on the type of surge suppressor installed on the brake.

Servo OFF and Error Timing (When Servomotor Is Rotating)


RUN
(Run command)
ON
OFF
ALM
(alarm output)
ON
OFF
(See note 1.)
BKIR
(brake interlock)
ON
OFF
Servomotor power
Energized
Not energized
(See note 2.)
Servomotor speed
100r/min

Note 1. The BKIR (brake interlock) signal will be turned OFF if the Servomotor rotation speed falls below 100 r/min after 130 ms has elapsed since the Servo turned OFF, or if 500 ms has elapsed since the Servo turned OFF.

Note 2. The Servomotor will continue to rotate due to momentum for about 6 ms after the Servomotor de-energizes until the dynamic brake operates.

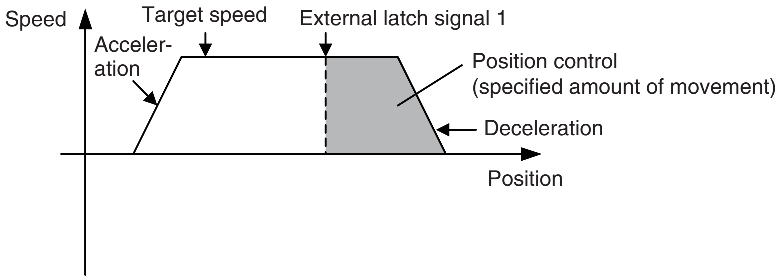
Note 3. Be careful, because the dynamic brake will not operate if the Servo turns OFF with the Servomotor rotation speed at 100 r/min or less.

5-6-2 Interrupt Feeding Control

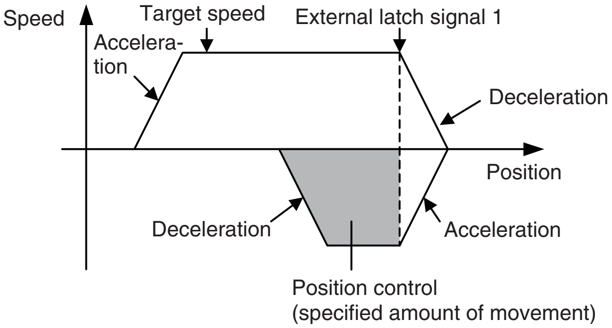
Interrupt feeding control is used for positioning by a fixed amount in the direction of travel or in the reverse direction, separately from the position command value, when external latch signal 1 (EXT1) is input for an axis during a positioning operation. Positioning for the fixed amount of movement is executed at the speed in effect when external latch signal 1 is input. If external latch signal 1 is not input, positioning is executed to the specified target position using the position command value.

■ Operation Overview

Specified Amount of Movement in Direction of Travel

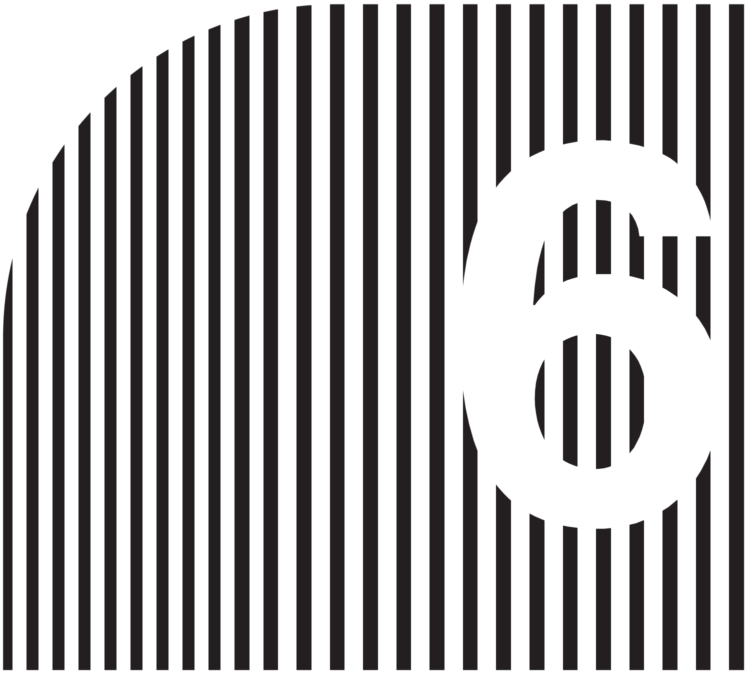

Speed
Target speed
External latch signal 1
Acceler-ation
Position control
(specified amount of movement)
Deceleration
Position

Specified Amount of Movement in the Reverse Direction


Speed
Target speed
External latch signal 1
Accelera-
tion
Deceleration
Position
Deceleration
Acceleration
Position control
(specified amount of movement)

■ Final Travel Distance for Interrupt Feeding (Pn814)

Pn814	Final travel distance for interrupt feeding						
Setting range	–1,073,741,823 to 1,073,741,823	Unit	1 command unit	Factory setting	100	Restart to enable	---



Chapter 6

Troubleshooting

6-1 Error Processing

6-2 Alarm Table

6-3 Troubleshooting

6-4 Overload Characteristics (Electronic Thermal Function)

6-5 Periodic Maintenance

6-1 Error Processing

6-1-1 Preliminary Checks when a Problem Occurs

This section explains the preliminary checks and analytical tools required to determine the cause of a problem if one occurs.

■ Checking the Power Supply Voltage

- Check the voltage at the power supply input terminals.
  Main-circuit Power Supply Input Terminals (L1, L2)
  Single-phase 200/230 V AC (170 to 253 V) 50/60 Hz
  If the voltage is outside of this range, there is a risk of incorrect operation, so be sure that the power supply is correct.
- Check the voltage of the sequence input power supply and verify that the +24 VIN Terminal (pin CN1-5) is within the allowed range of 23 to 25 VDC. If the voltage is outside of this range, there is a risk of malfunction, so be sure that the power supply is correct.

■ Checking Whether an Alarm Has Occurred

Refer to *6-3 Troubleshooting* in the following situations.

- When an alarm has occurred:
  Check the status of the alarm indicators (A.□□) and evaluate the problem based on the alarm indicated.
- When an alarm has not occurred:
  Evaluate the problem with the error information.

6-1-2 Precautions When Troubleshooting

When checking and verifying I/O after a problem has occurred, the Servo Driver may suddenly start to operate or suddenly stop, so always take the following precautions. In addition, never attempt operations that are not specified in this manual.

■ Precautions

- Disconnect any cables before checking whether they are broken or damaged. Even if you have checked the conduction of the wiring, there is a risk of conduction due to the return circuit.
- If the encoder signal is lost, the Servomotor may overrun, or an error may be generated. Be sure that the Servomotor is disconnected from the mechanical system before checking the encoder signal.
- When performing tests, first check that there are no personnel in the vicinity of the mechanical equipment, and that the equipment will not be damaged even if the Servomotor overruns. Before performing the tests, verify that you can immediately stop the machine using an emergency stop even if the Servomotor overruns.

■ Checking the Alarm Code at the Controller

With CJ1W-NCF71 and CS1W-NCF71 Position Control Units, alarm codes at the Servo Driver are stored at the Controller as follows:

● Alarm Codes at the Controller

Alarm codes for alarms that occur at the Servo Driver are stored at the Controller as 40□□ hex. The alarm code is displayed in the □□ digits. For example, alarm code 40B3 hex would be stored at the Controller for a current detection error (A.b3).

● Controller Storage Area

Controller	Storage variable, memory area name	Stored data
Position Control Unit CJ1W-NCF71 CS1W-NCF71	Input area for individual axis operation, axis error code	Stored as error codes for errors that occur at each axis.

Note For details on system variables and memory areas, refer to the user's manual for the particular Position Controller.

6-1-3 Replacing the Servomotor and Servo Driver

Use the following procedure to replace the Servomotor or Servo Driver.

■ Replacing the Servomotor

1. Replace the Servomotor.
2. Establish the mechanical origin (for position control).
   - When the Servomotor is replaced, the Servomotor's origin position (Z-phase) may become incorrect, so the origin must be established.
   - Refer to the Position Controller's manual for details on establishing the origin.

■ Replacing the Servo Driver

1. Copy the parameters.
   - Use the CX-Process Tool at the personal computer to transfer all of the user parameters in the Servo Driver to the personal computer or host controller, and save the parameters there.
2. Replace the Servo Driver.
3. Set the parameters.
   - Transfer all the saved user parameters to the Servo Driver.

6-2 Alarm Table

If the Servo Driver detects an error, ALM (alarm output) will be output, the power drive circuit in the Servo Driver will be turned OFF, and the alarm code will be displayed.

- Refer to *6-3-1 Error Diagnosis Using the Alarm Indicators* for details on appropriate alarm countermeasures.
- Read the alarm code from the host controller. For information on checking alarm codes when using an OMRON Controller, refer to *6-1-2 Precautions When Troubleshooting*.
- An alarm can be cleared either by (a) turning the power OFF and then back ON, or by (b) inputting an error reset signal from the host controller. The following alarms, however, can only be cleared by turning the power OFF and then back ON: A.02, A.04, A.05, A.10, A.7A, A.b3, A.bF, A.C2, A.C5, A.C9, A.d6, and A.E0.
- When an alarm occurs, the Servo Driver stops the Servomotor by the following methods:
  a) DB stop: Stops the Servomotor rapidly using the dynamic brake.
  b) Zero speed stop: Stops the Servomotor by setting the speed reference at the Servo Driver to zero.

■ Alarms

Alarm code	Error detection function	Detected error or cause of error	Stopping method	Alarm reset
A.02	Parameter error	Error in internal Servo Driver parameter data	DB stop	No
A.03	Main circuit detection error	Error in main circuit detection values	DB stop	Yes
A.04	Parameter setting error	A user parameter value is set out of range.	DB stop	No
A.05	Unsupported Servo Driver alarm	Servo Driver error	DB stop	No
A.10	Overcurrent	Overcurrent flowed to the IGBT, or the Servo Driver heat sink overheated.	DB stop	No
A.28	Emergency stop	An emergency stop was input during Servomotor operation.	DB stop	Yes
A.40	Overvoltage	The main-circuit DC voltage is abnormally high.	DB stop	Yes
A.41	Undervoltage	The Servo Driver power was turned back ON before it was completely turned OFF.	Zero speed stop	Yes
A.51	Overspeed	The Servomotor speed is abnormally high.	DB stop	Yes
A.71	Overload (Momentary maximum load)	Operated for several seconds at a torque greatly exceeding the rated load.	Zero speed stop	Yes
A.72	Overload (Continuous maximum load)	Continuously operated at a torque exceeding the rated load.	DB stop	Yes
A.73	Dynamic brake overload	The Servomotor did not stop even when three or more seconds elapsed after the Servo turned OFF.	DB stop	Yes
A.7A	Board overheating error	The Servo Driver internally overheated, or the built-in cooling fan stopped.	Zero speed stop	No
A.b3	Current detection error	The Servomotor's current detector failed, or the Servomotor power line became disconnected.	DB stop	No

Alarm code	Error detection function	Detected error or cause of error	Stopping method	Alarm reset
A.b6	MECHATROLINK-II communications LSI error	Error in MECHATROLINK-II communications LSI	DB stop	No
A.bF	System alarm	The Servo Driver is faulty.	DB stop	No
A.C1	Runaway prevention detection	Servomotor has run out of control.	DB stop	Yes
A.C2	Phase detection error	A Servomotor magnetic pole signal was incorrectly detected.	DB stop	No
A.C5	Magnetic pole detection error	A Servomotor magnetic pole signal was incorrectly detected.	DB stop	No
A.C9	Encoder signal error	Error in encoder output signal amplitude	DB stop	No
A.d0	Excessive following error	There is excessive residual following error.	DB stop	Yes
A.E0	MECHATROLINK-II internal synchronization error 1	Error in synchronization between MECHATROLINK-II communications and Servo Driver	Zero speed stop	No
A.EA	MECHATROLINK-II internal synchronization error 2	Error in synchronization between MECHATROLINK-II communications and Servo Driver	Zero speed stop	Yes
A.ED	MECHATROLINK-II internal command error	Servo Driver internal command error	Zero speed stop	Yes
A.E4	MECHATROLINK-II transfer cycle setting error	Error in transfer cycle setting for MECHATROLINK-II communications	Zero speed stop	Yes
A.E5	MECHATROLINK-II synchronization error	Synchronization error in MECHATROLINK-II communications	Zero speed stop	Yes
A.E6	MECHATROLINK-II communications error	A communications error occurred during MECHATROLINK-II communications, or the transfer cycle fluctuated.	Zero speed stop	Yes

■ Warnings

Warning code	Error detection function	Description
A.91	Overload warning	This warning is displayed before an overload alarm (A.71 or A.72) occurs. If operation continues in the same way, an alarm may occur.
A.94	MECHATROLINK-II data setting warning	The user parameter data was out of range, or incorrect data was detected.
A.96	MECHATROLINK-II communications error warning	A communications error occurred during MECHATROLINK-II communications.

6-3 Troubleshooting

If an error occurs in the machinery, determine the error conditions from the alarm indicators and operating status, identify the cause of the error, and take appropriate countermeasures.

6-3-1 Error Diagnosis Using the Alarm Indicators

Alarm code	Error	Status when error occurs	Probable cause	Countermeasures
A.02	Parameter error	Occurs when the power is turned ON.	The power was interrupted while the user parameters were being set.	Contact an OMRON representative.
			The number of user parameter write operations is over the upper limit.	Replace the Servo Driver.
			The Servo Driver is faulty.	
A.03	Main circuit detection error	Occurs when the power is turned ON or during operation.	The Servo Driver is faulty.	Replace the Servo Driver.
A.04	Parameter setting error	Occurs when the power is turned ON.	A user parameter value is set out of range.	Set the value within the setting range.
			The electronic gear ratio is set out of range.	Set the electronic gear ratio within the following range: 0.01 ≤ Electronic gear ratio (Pn20E/Pn210) ≤ 100
			The Servo Driver is faulty.	Replace the Servo Driver.
A.05	Unsupported Servo Driver alarm	Occurs when the power is turned ON.	The Servo Driver is faulty.	Replace the Servo Driver.

Alarm code	Error	Status when error occurs	Probable cause	Countermeasures
A.10	Overcurrent	Occurs when the power is turned ON or during operation.	The connection between the U, V, or W phases and the ground terminal is faulty.	Check and correct the wiring.
			The ground wire is linked to another terminal.	
			Short-circuiting is occurring between the U, V, or W phases for the Servomotor main-circuit cable and a ground.	Repair or replace the Servomotor main-circuit cable. Caution: Before turning ON the power again, be sure to verify that there are no short-circuits or interconnected lines.
			The Regeneration Unit wiring is incorrect.	Check and correct the wiring.
			Short-circuiting is occurring between the Servo Driver U, V, or W phases and a ground.	Replace the Servo Driver.
			Short-circuiting is occurring between the Servomotor U, V, or W phases and the ground, or between the Servomotor U, V, and W phases.	Replace the Servomotor.
			The load is too large and exceeds the regeneration absorption capacity.	Re-evaluate the load and the operating conditions.
			There is a problem with the Servo Driver installation, such as direction, Spacing between Units, or ambient temperature.	Lower the ambient temperature for the Servo Driver to 55°C or below.
			The Servomotor is operating at over the rated output.	Lighten the load.
			The Servomotor and Servo Driver combination is not correct.	Combine the Servomotor and Servo Driver correctly.
			The Servo Driver is faulty.	Replace the Servo Driver.
			Servomotor failure	Replace the Servomotor.

Alarm code	Error	Status when error occurs	Probable cause	Countermeasures
A.28	Emergency stop	Occurs when a servo-lock command is executed from the host controller.	The emergency stop signal is not wired.	Wire the emergency stop signal.
		Occurs during Servomotor operation.	The emergency stop signal was input.	Correct the emergency stop signal operation sequence.
			The emergency stop signal operated incorrectly.	Check and correct the wiring.
A.40	Overvoltage	Occurs when the power is turned ON.	The AC power supply voltage is over 290 V.	Keep the AC power supply voltage within the normal range.
			The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs during Servomotor operation.	A large voltage chance occurred in the AC power supply.	Keep the AC power supply voltage within the normal range.
			Servomotor speed is high and there is large load inertia. (Regeneration capacity is insufficient.)	Check Regeneration Unit and External Regeneration Resistor use. Re-evaluate the load and operating conditions.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.41	Undervoltage	Occurs when the power is turned ON.	The Servo Driver power was turned back ON before it was completely turned OFF.	Wait until the RDY indicator has turned OFF before turning the power back ON again.
			Power is momentarily interrupted.	Use the alarm reset to restart operation.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.51	Overspeed	Occurs when the power is turned ON.	The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs when Servomotor operation started, or during high-speed operation.	The U, V, and W phases at the Servomotor are wired incorrectly.	Check and correct the Servomotor wiring.
			Encoder wiring is incorrect.	Check and correct the encoder wiring.
			Noise infiltrated the Encoder Cable and caused improper operation.	Take measures against noise in the encoder wiring.
			The position command input is too large.	Reduce the command value.
			The Servo Driver is faulty.	Replace the Servo Driver.

Alarm code	Error	Status when error occurs	Probable cause	Countermeasures
A.71	Overload (Momentary maximum load)	Occurs when the power is turned ON.	The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs during Servomotor operation.	The effective torque exceeds the rated torque, or the starting torque exceeds the maximum torque.	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.72	Overload (Continuous maximum load)	Occurs when the servo is turned ON.	Servomotor wiring error (Faulty wiring or connections)	Wire the Servomotor main-circuit cable correctly.
			Encoder wiring error (Faulty wiring or connections)	Wire the encoder correctly.
			The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs when a command is input, without the Servomotor rotating.	Servomotor wiring error (Faulty wiring or connections)	Wire the Servomotor main-circuit cable correctly.
			Encoder wiring error (Faulty wiring or connections)	Wire the encoder correctly.
			The starting torque exceeds the maximum torque.	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
			The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs during Servomotor operation.	The effective torque exceeds the rated torque, or the starting torque exceeds the maximum torque.	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.73	Dynamic brake overload	Occurs when the servo is turned OFF during Servomotor operation.	The Servomotor is being rotated by external force.	Re-evaluate the load and operating conditions.
			The Servo Driver is faulty.	Replace the Servo Driver.

Alarm code	Error	Status when error occurs	Probable cause	Countermeasures
A.7A	Board overheating error	Occurs when the power is turned ON.	The overload alarm is being reset when the power is turned OFF, and is operating repeatedly.	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
			The built-in cooling fan in the Servo Driver has stopped.	Replace the cooling fan.
			Cooling fan ventilation is obstructed by dirt, or foreign objects have gotten inside.	Inspect the cooling fan.
			The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs during Servomotor operation.	The torque is greater than the rated torque.	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
			The overload alarm is being reset when the power is turned OFF, and is operating repeatedly.	
			The ambient temperature for the Servo Driver is above 55°C.	Lower the ambient temperature for the Servo Driver to 55°C or below.
			There is a problem with the Servo Driver installation, such as direction or Spacing between Units. (Is there heat radiation at the mounting panel or heat from the surroundings?)	Modify the installation conditions so that the ambient temperature for the Servo Driver is 55°C or below.
			The built-in cooling fan in the Servo Driver has stopped.	Replace the cooling fan.
			Cooling fan ventilation is blocked by dirt, or foreign objects have gotten inside.	Inspect the cooling fan.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.b3	Current detection error	Occurs when the servo is turned ON.	The Servomotor's main-circuit cable is disconnected.	Fix the Servomotor's main-circuit cable.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.b6	MECHATROLINK-II communications LSI error	Occurs when the power is turned ON.	Error in MECHATROLINK-II communications LSI	Replace the Servo Driver.

Alarm code	Error	Status when error occurs	Probable cause	Countermeasures
A.bF	System alarm	Occurs when the power is turned ON or during operation.	The Servo Driver is faulty.	Replace the Servo Driver.
A.C1	Runaway prevention detection	Occurs when the power is turned ON.	The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs when the servo is turned ON or during command input.	The U, V, and W phases at the Servomotor are wired incorrectly.	Check and correct the Servomotor wiring.
			The encoder is faulty.	Replace the Servomotor.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.C2 A.C5 A.C9	Phase detection error Magnetic pole detection error Encoder signal error	Occurs when the power is turned ON or during operation.	Encoder wiring error (Faulty wiring or connections)	Wire the encoder correctly.
			Noise is entering the Encoder Cable because it does not meet specifications.	Use an Encoder Cable with twisted-pair wires or shielded twisted-pair wires of at least 0.12 mm^2.
			Noise is entering the Encoder Cable because it is too long.	Use an Encoder Cable no more than 20 m in length.
			The Encoder Cable is faulty.	Replace the Encoder Cable.
			The encoder is faulty.	Replace the encoder.
			The Servo Driver is faulty.	Replace the Servo Driver.

Alarm code	Error	Status when error occurs	Probable cause	Countermeasures
A.d0	Excessive following error	Occurs when the power is turned ON.	The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs during high-speed operation.	Connection is faulty for a U, V, or W phases at the Servomotor main-circuit cable.	Wire the cable correctly.
			Encoder wiring error (Faulty wiring or connections)	Wire the encoder correctly.
			The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs regardless of position commands, and without the Servomotor rotating.	Connection is faulty for a U, V, or W phases at the Servomotor main-circuit cable.	Wire the cable correctly.
			The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs when operation is normal but the command is long.	A position command input was too large.	Reduce the command value.
			The Servomotor specifications do not match the load conditions (e.g., torque, inertia).	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
A.E0 A.EA	MECHATROLINK-II internal synchronization error	Occurs at the start of or during MECHATROLINK-II communications.	With a MECHATROLINK-II connection established, communications with the host controller were aborted and then started again.	Turn the power OFF and back ON again. Alternatively, close the communications connection with the host controller and set up the communications again.
			The MECHATROLINK-II wiring is incorrect.	Wire the MECHATROLINK-II Communications Cable correctly. Wire the terminating resistance correctly.
			A MECHATROLINK-II data reception error occurred due to noise.	Implement measures against noise, such as modifying the MECHATROLINK-II Communications Cable and FG wiring, and installing a ferrite core in the MECHATROLINK-II Communications Cable.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.ED	MECHATROLINK-II internal command error	Occurs at the start of or during MECHATROLINK-II communications.	The Servo Driver is faulty.	Replace the Servo Driver.

Alarm code	Error	Status when error occurs	Probable cause	Countermeasures
A.E4	MECHATROLINK-II transfer cycle setting error	Occurs at the start of MECHATROLINK-II communications.	The MECHATROLINK-II transfer cycle setting is out of the specified range.	Set an appropriate value for the MECHATROLINK-II transfer cycle setting at the host controller.
A.E5	MECHATROLINK-II synchronization error	Occurs at the start of or during MECHATROLINK-II communications.	The MECHATROLINK-II communications data WDT that is updated by the host controller is not being normally updated.	Make sure that the host controller WDT data is properly updated.
A.E6	MECHATROLINK-II communications error	Occurs at the start of or during MECHATROLINK-II communications.	With a MECHATROLINK-II connection established, communications with the host controller were aborted and then started again.	Turn the power OFF and back ON again. Alternatively, close the communications connection with the host controller and set up the communications again.
			The MECHATROLINK-II wiring is incorrect.	Wire the MECHATROLINK-II Communications Cable correctly. Wire the terminating resistance correctly.
			A MECHATROLINK-II data reception error occurred due to noise.	Implement measures against noise, such as modifying the MECHATROLINK-II Communications Cable and FG wiring, and installing a ferrite core in the MECHATROLINK-II Communications Cable.
			The Servo Driver is faulty.	Replace the Servo Driver.

6-3-2 Error Diagnosis Using the Warning Indicators

Warning code	Warning	Status when warning occurs	Probably cause	Countermeasures
A.91	Overload warning (displayed before an overload alarm (A.71 or A.72) occurs)	Occurs when the servo is turned ON.	Servomotor wiring error (Faulty wiring or connections)	Wire the Servomotor main-circuit cable correctly.
			Encoder wiring error (Faulty wiring or connections)	Wire the Encoder Cable correctly.
			The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs during a command input without the Servomotor rotating.	Servomotor wiring error (Faulty wiring or connections)	Wire the Servomotor main-circuit cable correctly.
			Encoder wiring error (Faulty wiring or connections)	Wire the Encoder Cable correctly.
			The starting torque exceeds the maximum torque.	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
			The Servo Driver is faulty.	Replace the Servo Driver.
		Occurs during Servomotor operation.	The effective torque exceeds the rated torque.	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
			The ambient temperature for the Servo Driver is above 55°C.	Keep the ambient temperature for the Servo Driver at 55°C or below.
			The Servo Driver is faulty.	Replace the Servo Driver.
A.94	MECHATROLINK-II data setting warning	Occurs when a MECHATROLINK-II command is sent.	An unusable parameter data number was set.	Set the user parameter numbers correctly.
			A value outside of the setting range was set in the user parameters.	Set the value in the setting range.
A.96	MECHATROLINK-II communications error warning	Occurs at the start of or during MECHATROLINK-II communications.	The MECHATROLINK-II wiring is incorrect.	Wire the MECHATROLINK-II Communications Cable correctly. Wire the terminating resistance correctly.
			A MECHATROLINK-II data reception error occurred due to noise.	Implement measures against noise, such as modifying the MECHATROLINK-II Communications Cable and FG wiring, and installing a ferrite core in the MECHATROLINK-II Communications Cable.

6-3-3 Error Diagnosis Using the Operating Status

Problem	Probable cause	Items to check	Countermeasures
The power indicator (PWR) does not light when the power is turned ON.	The power supply cable is wired incorrectly.	Check whether the power supply input is within the allowed voltage range.	Input the correct power supply voltage.
		Check whether the power supply input is wired correctly.	Wire correctly.
	The External Regeneration Unit is wired incorrectly.	Check whether the connection to the External Regeneration Unit is wired correctly.	Wire correctly.
The Servomotor does not start.	The I/O (CN1) wiring is incorrect.	Check the CN1 connector and the wiring.	Wire the CN1 connector correctly.
	Servomotor or encoder wiring is disconnected.	Check the wiring.	Connect the wiring.
	There is an overload.	Try operating the Servomotor with no load.	Either reduce the load or use a Servomotor with a greater capacity.
	The Servo-ON command is not being sent.	Check the host controller commands.	Send a Servo-ON command.
	The emergency stop input (STOP), forward drive prohibit (POT), and reverse drive prohibit (NOT) signals are remaining OFF.	Check the STOP, POT, and NOT signals.	Turn ON the STOP, POT, and NOT signals.
	The power is not ON.	Check the PWR indicator to see if the power is ON.	Turn ON the power.
		Check the voltage between the power supply terminals.	Wire the power-ON circuit correctly.
	The Servo Driver is faulty.	The Servo Driver PCB is faulty.	Replace the Servo Driver.
The Servomotor operates momentarily but then it does not operate.	The Servomotor is wired incorrectly.	Check the Servomotor wiring.	Wire the Servomotor correctly.
	The encoder is wired incorrectly.	Check the encoder wiring.	Wire the encoder correctly.
Servomotor rotation speed is unstable.	The wiring to the Servomotor is faulty.	Check the wiring of the Servomotor Power Cable (U, V, and W phases) and check whether the encoder connector is stable.	Tighten any looseness in the terminals and connectors.
	The coupling between the Servomotor shaft and the mechanical system has eccentricities or looseness.	Check the mechanical system's coupling section.	Review and adjust the machinery.
		Try operating the Servomotor with no load.	
	The load inertia exceeds the allowable value for the Servo Driver.	Try operating the Servomotor with no load.	Either reduce the load or use a Servomotor with a greater capacity.
The Servomotor rotates without a command.	The Servo Driver is faulty.	The Servo Driver PCB is faulty.	Replace the Servo Driver.

Problem	Probable cause	Items to check	Countermeasures
The Servomotor is overheating.	The ambient temperature is too high.	Check to see whether the ambient temperature is below 40°C.	Lower the ambient temperature to 40°C or below. (Use a cooler or fan.)
	The ventilation is obstructed.	Check to see whether anything is blocking the ventilation.	Improve the ventilation.
	The Servomotor has an overload.	Try operating the Servomotor with no load.	Either reduce the load or use a Servomotor with a greater capacity.
The Servomotor holding brake does not operate.	Power is being supplied to the holding brake.	Check to see whether power is being supplied to the holding brake.	Configure a circuit that cuts power to the holding brake when the motor stops and the load will be held by the holding brake.
The servo is turned OFF while the Servomotor is rotating, but the Servomotor does not stop or is hard to stop.	The load inertia is too large.	Check the following: Is the load too large? Is the Servomotor speed too high?	Re-evaluate the load and operating conditions. Re-evaluate the Servomotor capacity.
	The stop circuit is faulty.	---	Replace the Servo Driver.
The emergency stop (STOP) does not operate.	The external emergency stop input switch is faulty or wired incorrectly.	Check the switch and the wiring.	Replace the switch or wire it correctly.
	The parameter for the emergency stop input signal (STOP) is set to disable the emergency stop.	Check the setting for user parameter Pn515.2.	Change the setting for user parameter Pn515.2.
	The Servo Driver is faulty.	The Servo Driver PCB is faulty.	Replace the Servo Driver.

Problem	Probable cause	Items to check	Countermeasures
The Servomotor is making unusual noises or the machinery is vibrating.	There is a problem with the installation of the machinery.	Check whether Servomotor mounting screws are loose.	Tighten the mounting screws.
		Check for misalignment in the couplings.	Align the couplings.
		Check whether the couplings are unbalanced.	Balance the couplings.
	There is a problem with the bearings.	Check for noise or vibration around the bearings.	Contact an OMRON representative.
	There is a vibration source in another machine.	Inspect the machinery to see whether any foreign objects may have gotten inside, and look for any damage, deformation or looseness.	Correct any problems.
	Noise is infiltrating the Encoder Cable because it does not meet specifications.	Check whether the Encoder Cable wires are twisted-pair wires or shielded twisted-pair wires of at least 0.12 mm^2.	Use Encoder Cable that meets the specifications.
	Noise is infiltrating the Encoder Cable because it is too long.	Check the length of the Encoder Cable.	Use Encoder Cable no more than 20 m in length.
	Noise is infiltrating the signal wires because the Encoder Cable is damaged or the sheath is cut.	Check the Encoder Cable for any damage.	Correct the Encoder Cable pathway to prevent damage.
	Too much noise is reaching the Encoder Cable.	Check whether the Encoder Cable is too close to high-current lines.	Install the Encoder Cable where it will not be subject to surges.
	The FG potential is fluctuating due to devices such as welding machines near the Servomotor.	Check for ground problems (loss of ground or incomplete ground) at equipment such as welding machines 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 at the encoder.	There are problems with mechanical vibration or Servomotor installation (such as mounting surface, attachment, or axial offset).	Reduce the mechanical vibration or correct the Servomotor installation.
	The filter setting is not suitable.	Check the setting on the command filter setting rotary switch (FIL).	Increase the value set on the command filter setting rotary switch (FIL).

Problem	Probable cause	Items to check	Countermeasures
Overtravel (Travel outside of the zone specified by the host controller)	The forward or reverse drive prohibit input signals (POT/NOT) is not changing. (POT (CN1-4) or NOT (CN1-3) is high.)	Is the input signal external power supply voltage (+24 V) correct?	Input the correct voltage (+24 V).
		Is the operating status of the overtravel limit switch correct?	Make sure the overtravel limit switch is operating correctly.
		Is the wiring to the overtravel limit switch correct?	Wire the switch correctly.
	The forward or reverse drive prohibit input signals (POT/NOT) is not operating correctly. (The POT or NOT signal sometimes changes.)	Is the input signal external power supply voltage (+24 V) fluctuating?	Eliminate fluctuation in the external power supply voltage (+24 V).
		Is the operation of the overtravel limit switch unstable?	Stabilize the operation of the overtravel limit switch.
		Is the overtravel limit switch wiring correct? (Is there cable damage? Are the screws tight?)	Correct the wiring to the overtravel limit switch.
	The forward or reverse drive prohibit input signals (POT/NOT) parameters are set to always enable driving.	Check the POT signal selection (Pn50A.3).	Change the setting of user parameter Pn50A.3
		Check the NOT signal selection (Pn50B.0).	Change the setting of user parameter Pn50B.0
	The position of the overtravel limit switch is unsuitable.	Check whether the position of the overtravel limit switch is too close for the amount of inertia.	Correct the position of the overtravel limit switch.
	Noise is infiltrating the Encoder Cable because it does not meet specifications.	Check whether the Encoder Cable wires are twisted-pair wires or shielded twisted-pair wires of at least 0.12 mm^2.	Use Encoder Cable that meets the specifications.
	Noise is infiltrating the Encoder Cable because it is too long.	Check the length of the Encoder Cable.	Use Encoder Cable no more than 20 m in length.
	Noise is infiltrating the signal wires because the Encoder Cable is damaged or the sheath is cut.	Check the Encoder Cable for any damage.	Correct the Encoder Cable pathway to prevent damage.
	Too much noise is reaching the Encoder Cable.	Check whether the Encoder Cable is too close to high-current lines.	Install the Encoder Cable where it will not be subject to surges.
	The FG potential is fluctuating due to devices such as welding machines near the Servomotor.	Check for ground problems (loss of ground or incomplete ground) at equipment such as welding machines near the Servomotor.	Ground the equipment properly and prevent currents from flowing to the encoder FG.
	Servo Driver feedback pulses are being miscounted due to noise.	Check whether noise is infiltrating signal lines from the encoder.	Implement noise countermeasures in the encoder wiring.
	Errors are being caused by excessive vibration or shock at the encoder.	There are problems with mechanical vibration or Servomotor installation (such as mounting surface, attachment, or axial offset).	Reduce the mechanical vibration or correct the Servomotor installation.

Problem	Probable cause	Items to check	Countermeasures
	The encoder is faulty.	Check whether the encoder is faulty.	Replace the Servomotor.
	The Servo Driver is faulty.	Check whether the Servo Driver PCB is faulty.	Replace the Servo Driver.
Position deviation (The position is not correct, but no alarm is output.)	There is a problem with the coupling between the machine and the Servomotor.	Check whether there is slippage in the coupling section between the machine and the Servomotor.	Correct the coupling.
	The encoder is faulty. (Pulses are not changing.)	Check whether the encoder is faulty.	Replace the Servomotor.

6-4 Overload Characteristics (Electronic Thermal Function)

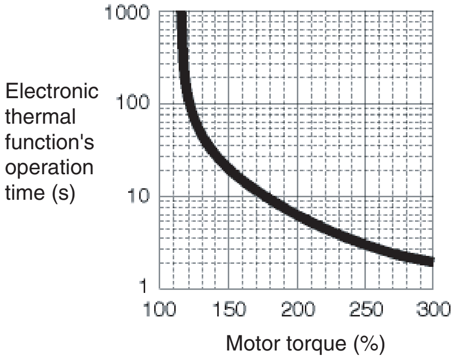
An overload protection (electronic thermal) function is built into the Servo Driver to protect against Servo Driver and Servomotor from overloading. If an overload does occur, first eliminate the cause of the error and then wait at least one minute for the Servomotor temperature to drop before turning on the power again. If the power is turned ON again repeatedly at short intervals, the Servomotor windings may burn out.

The overload characteristics are for a Servomotor with an aluminum heat sink (250 × 250 × 6 mm) mounted and an ambient temperature of 40°C, so use the Servomotor under these conditions.

6-4-1 Overload Characteristics Graphs

The following graphs show the characteristics of the load rate and electronic thermal function’s operation time.

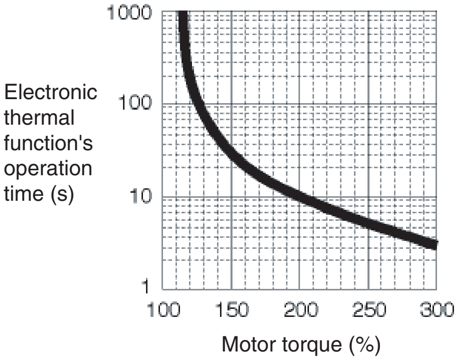
■ R7M-Z10030-S1 Servo Motor (100 W)



Note 1. The motor torque (%) indicates the percentage of the rated torque that is applied.

Note 2. For example, if the motor torque is 300% of the rated torque, an overload alarm will be generated after about 2 seconds when an R7M-Z10030-S1 is being used.

■ R7M-Z20030-S1/-Z40030-S1/-Z75030-S1 Servo Motors (200 W to 750 W)



Note 1. The motor torque (%) indicates the percentage of the rated torque that is applied.

Note 2. For example, if the motor torque is 300% of the rated torque, an overload alarm will be generated after about 3 seconds.

6-5 Periodic Maintenance

Servomotors and Servo Drivers contain many components and will operate properly only when each of the individual components is operating properly. Some of the electrical and mechanical components require maintenance depending on application conditions. Periodic inspection and part replacement are necessary to ensure proper long-term operation of Servomotors and Servo Drivers.

The periodic maintenance cycle depends on the installation environment and application conditions of the Servomotor or Servo Driver. Recommended maintenance times are listed below for Servomotors and Servo Drivers. Use these 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 an unexpected operation.

🛇 Do not attempt to disassemble, repair, or modify any Units. Any attempt to do so may result in malfunction, fire, or electric shock.

6-5-1 Servomotor Maintenance

The recommended periodic maintenance schedule is listed below.

- Bearings: 20,000 hours
- Decelerator: 20,000 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 proper installation as described in the *Operation Manual*.

- The radial loads during operation (rotation) on timing pulleys and other components contacting belts is twice the still load. Consult with the belt and pulley manufacturers and adjust designs and system settings so that the 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 can break, the bearings can burn out, and other problems can occur.
- When requesting repairs or investigations, separate the Servomotors and Decelerators, and make separate requests for each product.

6-5-2 Servo Driver Maintenance

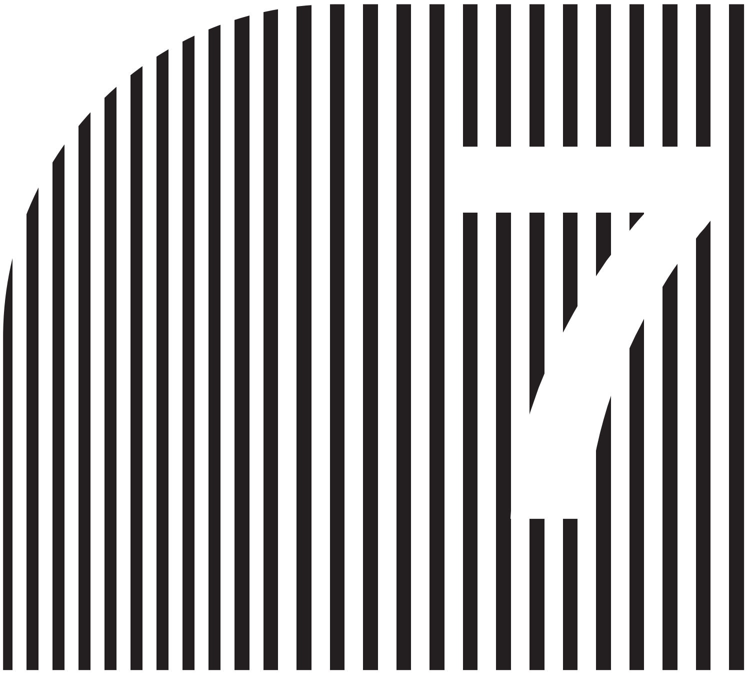
The recommended periodic maintenance schedule is listed in the following table. Please consult with your OMRON representative to determine whether or not components need to be replaced.

Aluminum electrolytic capacitors	50,000 hours, at an ambient Servo Driver operating temperature of 40°C, 80% of the rated operation output (rated torque), installed as described in operation manual.
Axle fan	30,000 hours, at an ambient Servo Driver operating temperature of 40°C and an ambient humidity of 65%.

- When using the Servo Driver in continuous operation, use fans or air conditioners to maintain an ambient operating temperature below 40°C.
- We recommend that ambient operating temperature and the power ON time be reduced as much as possible to lengthen the maintenance intervals for Servo Drivers.
- The life of aluminum electrolytic capacitors is greatly affected by the ambient operating temperature. Generally speaking, an increase of 10°C in the ambient operating temperature will reduce capacitor life by 50%.
- The aluminum electrolytic capacitors deteriorate even when the Servo Driver is stored with no power supplied. If the Servo Driver is not used for a long time, we recommend a periodic inspection and part replacement schedule of five years.
- If the Servomotor or Servo Driver is not to be used for a long time, or if they are to be used under conditions worse than those described above, a periodic inspection schedule of five years is recommended.

6-5-3 Replacing the Cooling Fan

Please contact your OMRON representative regarding cooling fan replacement.



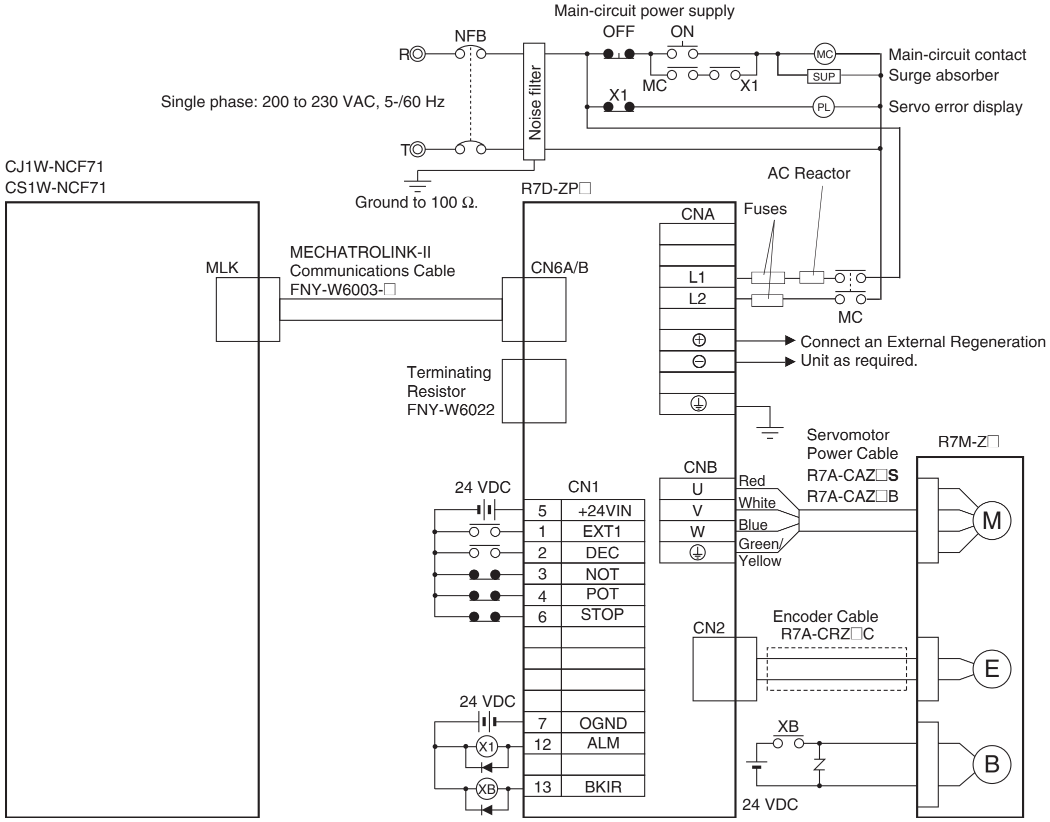
Chapter 7

Appendix

7-1 Connection Example
7-2 Parameter Tables
7-3 Position Data Range

7-1 Connection Example

■ Connecting to SYSMAC CJ1W-NCF71 or CS1W-NCF71


Main-circuit power supply
OFF
ON
NFB
R
T
Single phase: 200 to 230 VAC, 5-/60 Hz
Noise filter
MC
X1
X1
MC
SUP
PL
Main-circuit contact
Surge absorber
Servo error display
Ground to 100 Ω.
CJ1W-NCF71
CS1W-NCF71
MLK
MECHATROLINK-II
Communications Cable
FNY-W6003-□
R7D-ZP□
CN6A/B
Terminating
Resistor
FNY-W6022
CNA
L1
L2
⊕
⊖
Fuses
AC Reactor
MC
Connect an External Regeneration
Unit as required.
Servomotor
Power Cable
R7A-CAZ□S
R7A-CAZ□B
R7M-Z□
CNB
U
V
W
Red
White
Blue
Green/
Yellow
M
24 VDC
CN1
5 +24VIN
1 EXT1
2 DEC
3 NOT
4 POT
6 STOP
CN2
Encoder Cable
R7A-CRZ□C
E
24 VDC
7 OGND
12 ALM
13 BKIR
X1
XB
XB
24 VDC
B

Note 1. Be careful to wire the signals correctly. Incorrect wiring can cause damage to the Unit and the Servo Driver.

Note 2. Do not wire unused signal lines, but leave them open.

Note 3. For the surge-absorbing diode, the ERA22-06 (by Fuji Electric) or equivalent is recommended.

Note 4. Do not use the brake power supply (24 VDC) for the control 24-VDC power supply.

Note 5. When turning the main-circuit power supply OFF, turn OFF the emergency stop input (STOP) signal at the same time. Refer to *4-2-3 Peripheral Device Connection Examples* for information on wiring.

7-2 Parameter Tables

■ Function Selection Parameters (from Pn000)

PRM. No.	Parameter name	Description				Factory setting	Unit	Setting range	Reset to enable
		Digit No.	Name	Setting	Explanation				
Pn000	Function selection basic switches	0	Reverse rotation	0	CCW rotation with positive command	0010	---	---	---
				1	CW rotation with positive command				
		1	Not used.	1	(Do not change the setting.)				
		2 3	Not used.	0	(Do not change the setting.)				
Pn00A	Command filter setting (See note.)	Set when there is a problem such as over-shooting.				0000H	---	0000H to 000FH	---

Note The setting method is the same as with the command filter setting rotary switch (FIL).

■ Position Control Parameters (from Pn200)

PRM. No.	Parameter name	Description	Factory setting	Unit	Setting range	Restart to enable
Pn20E	Electronic gear ratio G1 (Numerator)	Sets the pulse rate for the command pulses and Servomotor travel distance. $0.01 \leq$ Pn20E/Pn210 ≤ 100	1	---	1 to 1,073,741,824	Yes
Pn210	Electronic gear ratio G2 (Denominator)		1	---	1 to 1,073,741,824	Yes

■ Speed Control Parameters

PRM. No.	Parameter name	Description	Factory setting	Unit	Setting range	Restart to enable
Pn304	Jog speed	Sets the rotation speed for jog operation.	500	r/min	0 to 10,000	---

■ Sequence Parameters (from Pn500)

PRM. No.	Parameter name	Description				Factory setting	Unit	Setting range	Restart to enable
		Digit No.	Name	Setting	Explanation				
Pn50A	Input signal selection 1	0	Not used.	1	(Do not change the setting.)	2881H	---	---	Yes
		1	Not used.	8	(Do not change the setting.)				
		2							
		3	POT signal allocation	2	Forward drive is enabled by turning ON (low) the CN1 to 4 input signals.				
				8	Always disabled.				
Pn50B	Input signal selection 2	0	NOT signal allocation	3	Reverse drive is enabled by turning ON (low) the CN1 to 3 input signals.	8883H	---	---	Yes
				8	Always disabled.				
		1 to 3	Not used.	8	(Do not change the setting.)				
Pn515	Input signal selection 7	0	Not used.	8	(Do not change the setting.)	8488H	---	---	Yes
		1							
		2	STOP signal allocation	4	Emergency stop is enabled by turning OFF the CN1 to 6 input signals.				
				8	Always disabled.				
		3	Not used.	8	(Do not change the setting.)				
Pn522	Positioning completion width 1	Sets the positioning completion output 1 width.				10	1 command unit	0 to 1,073,741,824	---
Pn524	Positioning completion width 2	Sets the positioning completion output 2 width.				100	1 command unit	1 to 1,073,741,824	---

■ Other Parameters (from Pn800)

PRM. No.	Parameter name	Description				Factory setting	Unit	Setting range	Restart to enable
		Digit No.	Name	Set-ting	Explanation				
Pn800	Communications control	0	Not used.	0	(Do not change the setting.)	0040H	---	---	---
		1	Warning check mask	0	Normal				
				1	Ignore data setting warning (A.94).				
				2	Ignore command warning (A.95).				
				3	Ignore A.94 and A.95.				
				4	Ignore communications warning (A.96).				
				5	Ignore A.94 and A.96.				
				6	Ignore A.95 and A.96.				
				7	Ignore A.94, A.95, and A.96.				
		2	Not used.	0	(Do not change the setting.)				
		3							
Pn801	Function selection application 6 (Software LS)	0	Software limit function	0	Software limit enabled.	0003H	---	---	---
				1	Forward software limit disabled.				
				2	Reverse software limit disabled.				
				3	Forward and reverse software limits disabled.				
		1 to 3	Not used.	0	(Do not change the setting.)				
Pn803	Zero point width	Sets the origin position output range.				10	1 command unit	0 to 250	---

PRM. No.	Parameter name	Description				Factory setting	Unit	Setting range	Restart to enable
		Digit No.	Name	Setting	Explanation				
Pn804	Forward software limit	Sets the software limit in the forward direction.				1,073,741,823	1 command unit	−1,073,741,823 to 1,073,741,823	---
Pn806	Reverse software limit	Sets the software limit in the reverse direction.				−1,073,741,823	1 command unit	−1,073,741,823 to 1,073,741,823	---
Pn80B	Linear acceleration constant	Sets the acceleration.				100	×10,000 Command units/s^2	1 to 65,535	---
Pn80E	Linear deceleration constant	Sets the deceleration.				100	×10,000 Command units/s^2	1 to 65,535	---
Pn814	Final travel distance for external positioning	Sets the distance from the interrupt signal (EXT1) input position during interrupt feeding. (See note.)				100	1 command unit	−1,073,741,823 to 1,073,741,823	---

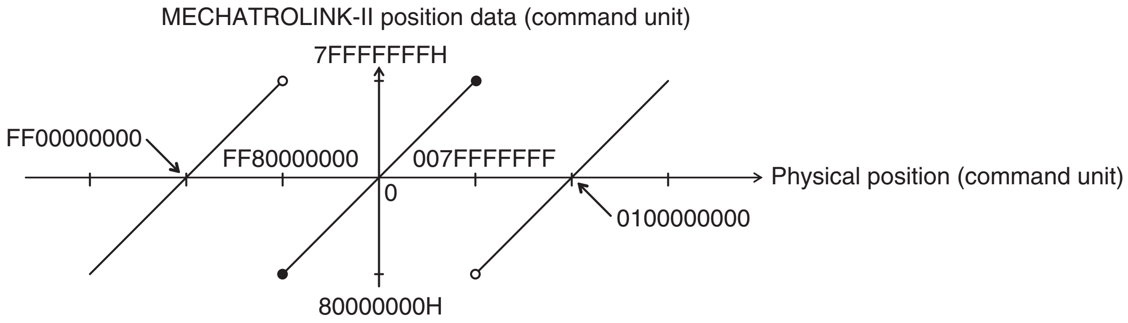
Note In the negative direction, or when the distance is short, the rotation is reversed after decelerating to a stop.

PRM. No.	Parameter name	Description				Factory setting	Unit	Setting range	Restart to enable
Pn816	Zero point return mode settings	0	Zero point return direction	0	Forward direction	0000H	---	---	---
				1	Reverse direction				
		1 to 3	Not used.	0	(Do not change the setting.)				
Pn817	Zero point return approach speed 1	Sets the speed for after the origin proximity input signal turns ON during an origin search.				50	×100 Command units/s	0 to 65,535	---
Pn818	Zero point return approach speed 2	Sets the speed for finding the origin after the origin proximity input signal turns ON and OFF during an origin search.				5	×100 Command units/s	0 to 65,535	---
Pn819	Final travel distance to return to zero point	Sets the distance from the phase-Z signal or external latch signal 1 (EXT1) input position to the origin during an origin search. (See note.)				100	1 command unit	−1,073,741,823 to 1,073,741,823	---

Note In the origin search or reverse direction, or when the distance is short, the rotation is reversed after decelerating to a stop.

7-3 Position Data Range

The position data length handled by MECHATROLINK-II is four bytes. Limitless operation beyond this length is as shown in the following diagram.


MECHATROLINK-II position data (command unit)
7FFFFFFFH
FF00000000
FF80000000
007FFFFFFF
Physical position (command unit)
0
0100000000
80000000H

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