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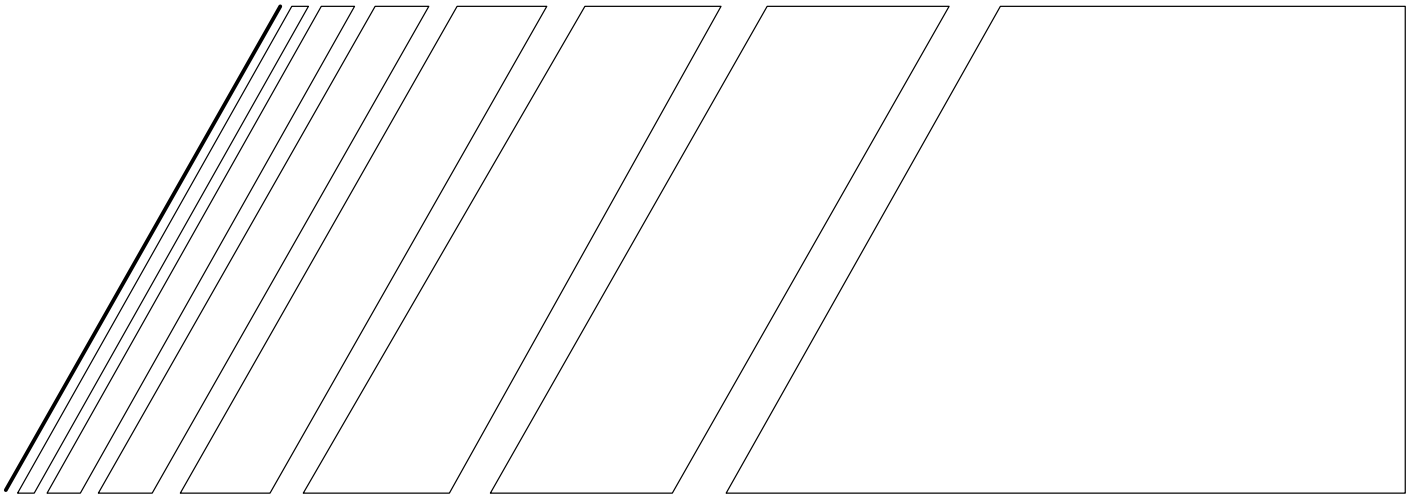
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OMRON



USER'S MANUAL

OMNUC U SERIES

MODELS R88M-U□
(AC Servo Motors)

MODELS R88D-UT□
(AC Servo Drivers)

AC SERVO MOTORS/DRIVERS (1 to 5 kW)

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Thank you for choosing this OMNUC U-series product. Proper use and handling of the product will ensure proper product performance, will length product life, and may prevent possible accidents.
Please read this manual thoroughly and handle and operate the product with care.

NOTICE

1. This manual describes the functions of the product and relations with other products. You should assume that anything not described in this manual is not possible.
2. Although care has been given in documenting the product, please contact your OMRON representative if you have any suggestions on improving this manual.
3. The product contains dangerous high voltages inside. Turn off the power and wait for at least five minutes to allow power to discharge before handling or working with the product. Never attempt to disassemble the product.
4. We recommend that you add the following precautions to any instruction manuals you prepare for the system into which the product is being installed.
   - Precautions on the dangers of high-voltage equipment.
   - Precautions on touching the terminals of the product even after power has been turned off. (These terminals are live even with the power turned off.)
5. Specifications and functions may be changed without notice in order to improve product performance.
6. Positive and negative rotation of AC Servo Motors described in this manual are defined as looking at the end of the output shaft of the motor as follows: counterclockwise rotation is positive and clockwise rotation is negative.
7. Do not perform withstand-voltage or other megameter tests on the product. Doing so may damage internal components.
8. Servo Motors and Servo Drivers have a finite service life. Be sure to keep replacement products on hand and to consider the operating environment and other conditions affecting the service life.
9. The OMNUC UT□ can control both incremental and absolute encoders. Differences in functions or specifications according to the encoder type are indicated in this manual. Be sure to check the model that is being used, and follow the relevant specifications.
   - Servo Motor with incremental encoder: R88M-U□□□30H-□/V-□S1
   - Servo Motor with absolute encoder: R88M-U□□□30T-□/V-□S1

Items to Check After Unpacking

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

- Has the correct product been delivered (i.e., the correct model number and specifications)?
- Has the product been damaged in shipping?
- Are any screws or bolts loose?

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Notice:

OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual.

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.

⚠DANGER Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠Caution Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

OMRON Product References

All OMRON products are capitalized in this manual. The word “Unit” is also capitalized when it refers to an OMRON product, regardless of whether or not it appears in the proper name of the product.

The abbreviation “Ch,” which appears in some displays and on some OMRON products, often means “word” and is abbreviated “Wd” in documentation in this sense.

The abbreviation “PC” means Programmable Controller and is not used as an abbreviation for anything else.

Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

Note Indicates information of particular interest for efficient and convenient operation of the product.

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No patent liability is assumed with respect to the use of the information contained herein. Moreover, because OMRON is constantly striving to improve its high-quality products, the information contained in this manual is subject to change without notice. Every precaution has been taken in the preparation of this manual. Nevertheless, OMRON assumes no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained in this publication.

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General Warnings

Observe the following warnings when using the OMNUC Servomotor and Servo Driver including Parameter Unit, Regenerative Unit, and peripheral devices.

This manual may include illustrations of the product with protective covers removed in order to describe the components of the product in detail. Make sure that these protective covers are on the product before use.

Consult your OMRON representative when using the product after a long period of storage.

⚠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 Do not remove the front cover, terminal covers, cables, Parameter Units, 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 be performed at least 5 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 under operation. Doing so may result in injury.

⚠WARNING Do not modify the product. Doing so may result in injury or damage to the product.

⚠Caution Use the Servomotors and Servo Drivers in a specified combination. Doing so may result in fire or damage to the products.

⚠Caution Do not store or install in the following places. Doing so may result in fire 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.

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⚠ **Caution** Do not touch the Servo Driver radiator 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** Do not hold by the cables or motor shaft while transporting the product. 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.

⚠ **Caution** Use the motor eye-bolts only for transporting the Motor. Using them for transporting the machinery may result in injury or malfunction.

Installation and Wiring Precautions

⚠ **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.

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⚠ **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** Provide an appropriate stopping device on the machine side to secure safety. (A holding brake is not a stopping device for securing safety.) Not doing so may result in injury.

⚠ **Caution** Provide an external emergency stopping device that allows an instantaneous stop of operation and power interruption. Not doing so may result in injury.

⚠ **Caution** Take appropriate and sufficient countermeasures when installing systems in the following locations:

- 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** Check the newly set parameters 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 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** Do not use the built-in brake of the Servomotor for ordinary braking. Doing so may result in malfunction.

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Maintenance and Inspection Precautions

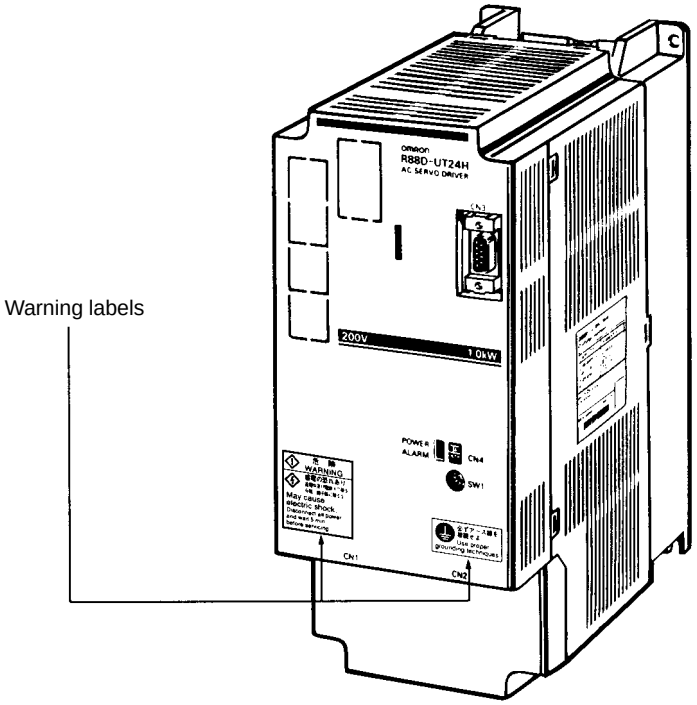
⚠ **WARNING** Do not attempt to disassemble, repair, or modify any Units. Any attempt to do so may result in malfunction, fire, or electric shock.

⚠ **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.

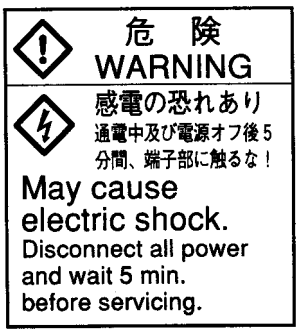
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Warning Labels

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



Warning Labels for Non-conforming Models



Warning label 1



Warning label 2

Warning Labels for Models Conforming to EC Directives



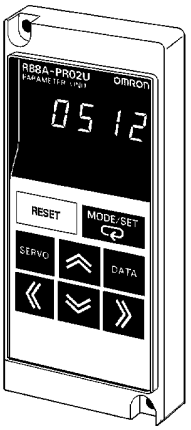
Warning label 1



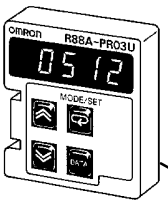
Warning label 2

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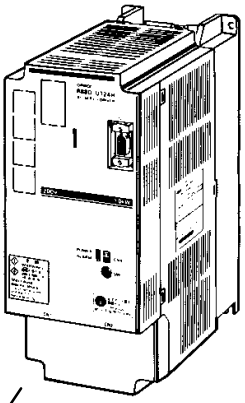
OMNUC U Series



Parameter Units



Operation Method
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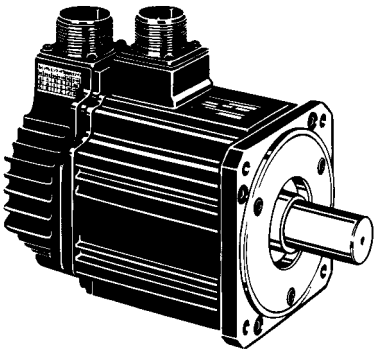


OMNUC U-series AC Servo Driver

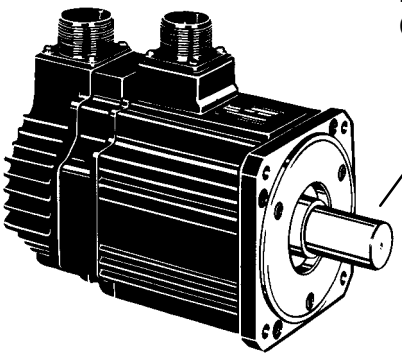
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Chapter 5: 5-1-3

Cable Specifications
Chapter 5: 5-3-2, 5-3-3

Motor Specifications
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OMNUC U-series AC Servomotor
(with incremental encoder)



OMNUC U-series AC Servomotor
(with absolute encoder)

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VISUAL INDEX

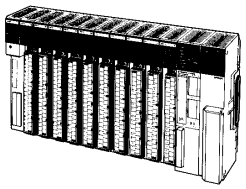
For users who wish to operate as quickly as possible.

⁎ The following portions of this manual provide the minimum information required for operation. Be sure you fully understand at least the information in these portions before attempting operation.

Chapter 2 System Design and Installation, and sections 3-1, 3-2, 3-3, and 3-4 of Chapter 3 Operation.

Instructions for jog operation using a Parameter Unit are provided in 3-4.

SYSMAC C/CV
Programmable Controller



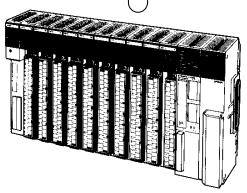


Position Control Unit
C500-NC222-E
Motion Control Units
CV500-MC221/421
C200H-MC221

Analog input

Pulse train input

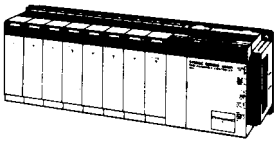
Controller Connecting Cable
Chapter 5: 5-3-1

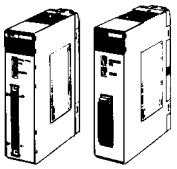




Position Control Units
3G2A5-NC111-EV1
C500-NC211

SYSMAC C/CV
Programmable Controller





Position Control Units
C200H-NC112
C200H-NC211
C200HW-NC113
C200HW-NC213
C200HW-NC413

SYSMAC C200HX/HG/HE
Programmable Controller

DIGITAL INNOVATION

OMNUC U is a series of fully digital AC servo drivers built on advanced OMRON software servo technology. It provides high performance, a sensitive man-machine interface, and economy.

Setting Functions	
❑ Using Parameter Unit:	Chapter 3, section 3-1-3
❑ Setting, checking setup parameters:	Chapter 3, section 3-3-1
❑ Important setup parameters:	Chapter 3, section 3-3-1
❑ Setting, checking user parameters	Chapter 3, section 3-3-2
❑ Important user parameters	Chapter 3, section 3-3-3

Adjustments and Troubleshooting	
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❑ Using monitor outputs:	Chapter 4, section 4-3
❑ Protections and diagnostic functions:	Chapter 4, section 4-4

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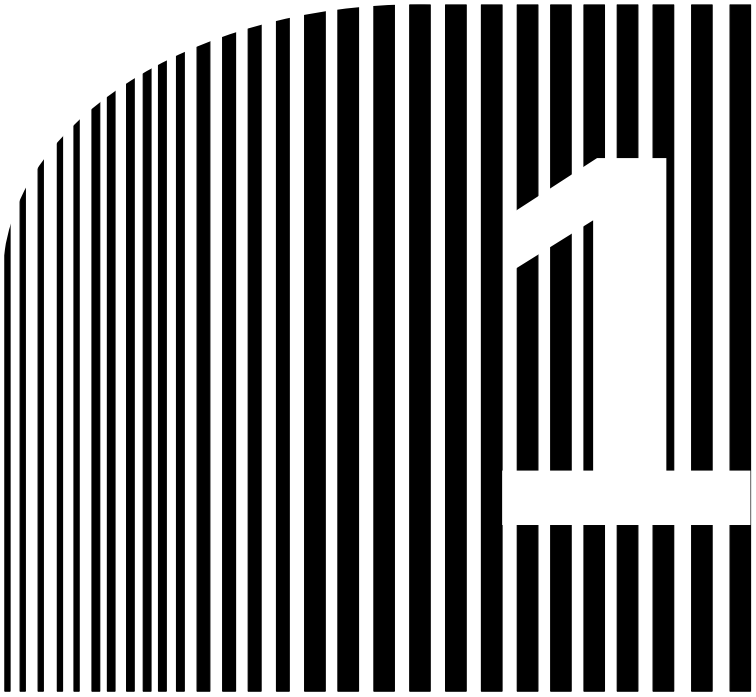
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Chapter 1

• Introduction •

1-1 Features
1-2 System Configuration
1-3 Servo Driver Nomenclature
1-4 Applicable Standards and Models

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1-1 Features

With their superior performance and fast response times, and an output capacity of up to 5 kW, these AC Servomotors and Servo Drivers have improved features of previous models.

■ Models Bearing the CE Marking and Complying with EC Directives

Servo Driver and Servomotor models satisfying the LVD (Low-voltage Directive) and EMC (electromagnetic compatibility) requirements of EC Directives are available. These models are the same as the U-series models in performance and function and help a customer's products equipped with these models satisfy EC Directives with ease.

■ Motor Output

A line of models with the following outputs is available.

■ Servo Drivers Requiring External Regenerative Resistors

Servomotor models connecting to external regenerative resistors and complying with EC Directives are available.

These Servomotor models are available for vertical shaft applications and other applications that generate high regenerative energy. For application details, refer to *3-6 Regenerative Energy Absorption*.

■ Model Number Legend

● Servo Drivers

R88D-UT□□□-□
1 2 3

Legend number	Item	Symbol (example)	Description
1	Maximum output current	24	Approx. 24 A
		40	Approx. 40 A
2	Applicable standard	H	Models not conforming to standards
		V	Models conforming to EC Directives
3	Regenerative resistor specifications	No indication	---
		RG	Models requiring external regenerative resistors (see note 1)

Note Although the R88D-UT110V has no indication for the regenerative resistor specifications, the model requires an external regenerative resistor.

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● Servomotors

R88M-U□□□30□-□□
1 2 3 4

3 and 4: Option Specifications

Legend number	Item	Symbol (example)	Description
1	Motor capacity	1K0	1.0 kW
		1K5	1.5 kW
2	Applicable standard/encoder type	H	Models not conforming to standards Incremental encoder
		T	Models not conforming to standards Absolute encoder
		V	Models conforming to EC Directives Incremental encoder
		X	Models conforming to EC Directives Absolute encoder
3	Brake specifications	No indication	Without brake
		B	With brake
4	Shaft shape	No indication	Straight shaft without key
		S1	Straight shaft with key (see note 1)

Note 10. Models conforming to EC Directives are available only for straight shafts with keys.

Note 11. For details about model numbers, refer to *6-3 OMNUC U-series Models*. For details about combinations of Servo Drivers and Servomotors, refer to *6-4 Combinations of Servo Drivers and Servomotors*.

■ Control Functions

Any one of the following 12 control modes can be selected in the parameter settings, thereby allowing various applications with a single Servo Driver.

Control mode		
Speed control (Analog command)		
Position control (Pulse train command)		[Factory setting]
Torque control (Analog command) [factory setting]		
Internal speed control settings		
Internal speed control settings	←→	Speed control (Analog command)
Internal speed control settings	←→	Position control (Pulse train command)
Internal speed control settings	←→	Torque control (Analog command)
Position control (Pulse train command)	←→	Speed control (Analog command)
Position control (Pulse train command)	←→	Torque control (Analog command)
Speed control (Analog command)	←→	Torque control (Analog command)
Speed control (Analog command)	←→	Position-lock stop
Position control (Pulse train command)	←→	Pulse prohibit

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■ Auto-tuning

The gain can be adjusted automatically when the responsiveness has been selected to match the rigidity of the mechanical system. The auto-tuning feature automatically finds the optimum adjustment to match the load, with no need for difficult operations.

■ Monitor

Displays the driver's operating status on the Parameter Unit.

The following items can be monitored: speed feedback, speed commands, torque commands, number of pulses from the U-phase edge, electrical angle, the internal status (bit display), command pulse speed, position deviation, and input pulse counter.

■ Jog Operation

Forward/Reverse motor operation can be controlled from the Parameter Unit. Rotational speed can be set in the parameters.

■ Automatic Adjustment of Control Offset (Speed Control and Torque Control)

The offsets of the speed command input and torque command input can be adjusted automatically.

■ Electronic Gear Function (Position Control)

This function turns the motor by the number of pulses obtained by applying the gear ratio to the number of command pulses. It can be effectively used in the following situations.

- When fine tuning positions and speeds while synchronizing two lines.
- When using a controller with a short command pulse frequency.
- When setting the mechanical movement per pulse to amounts such as 0.01 mm.

The electronic gear ratio is set by parameters (numerator: G1; denominator: G2). The setting range for G1 and G2 is 1 to 65,535, with 0.01 ◻ (G1/G2) ◻ 100.

■ Encoder Resolution Function

This function allows the encoder signal output from the driver to be set anywhere within the ranges shown below for incremental and absolute.

- [Incremental]: 16 to 4,096 pulses/revolution
- [Absolute]: 16 to 8,192 pulses/revolution

■ Software Start Function (Speed Control, Internal Speed Control Settings)

This function causes the motor to be started/stopped in the preset acceleration/deceleration times, allowing a simple position control system to be constructed without a Positioner or Host Controller.

The acceleration and deceleration times are set separately, and the setting range is 0 to 10 s for each.

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■ Pulse Smoothing Function (Position Control)

Applying acceleration and deceleration to command pulses enables tracking of high-frequency commands. The setting is the same for acceleration and deceleration times, and the range is 0 to 64 ms.

■ Reverse Mode

Forward/Reverse commands can be switched in the parameters, without changing the wiring to the motor or encoder.

■ Brake Interlock Output

Outputs a timing signal interlocked with the motor's ON/OFF status and rotational speed. The holding brake of a motor with a brake can be operated reliably.

■ Output Signal Selection Function

Any three output signals can be selected for output from among the following seven: Positioning completed, motor rotation detection, servo preparation completed, electrical current limit detection, brake interlock, overload warning, and overload alarm.

■ Overtravel Sequence

An overtravel sequence compatible with the system can be selected. There are three deceleration methods available: dynamic brake deceleration, free-run deceleration, and emergency-stop torque deceleration (parameter setting).

■ Feed-forward Function, Bias Function (Position Control)

These functions reduce the position control time.

- **Feed-forward Function**
  Reduces the position control time by reducing the number of pulses accumulated in the deviation counter.
- **Bias Function**
  Reduces the position control time by adding the bias revolutions to the speed control when the deviation counter value exceeds the position completion range.

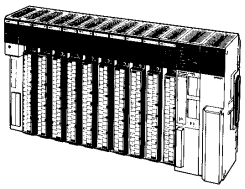
■ Personal Computer Monitor

The special Servodriver Communications Software allows parameter setting, speed and current monitoring, I/O monitoring, auto-tuning, and jog operations to be performed from a personal computer. It is also possible to perform multiple-axis communications that set the parameters and monitor operation of several drivers.

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1-2 System Configuration

Controller (Voltage Output Models)

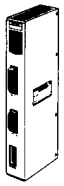


SYSMAC C/CV Programmable Controller

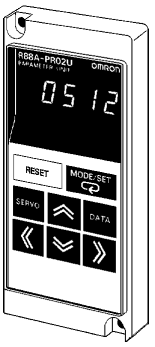
\+



Motion Control Unit
CV500-MC221/421
C200H-MC221

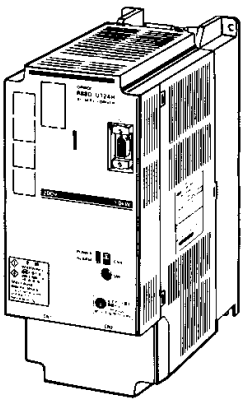


Position Control Unit
C500-NC222-E



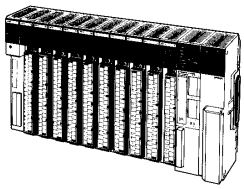


Parameter Units



OMNUC U-series AC Servo Driver

Controller (Pulse Train Output Models)

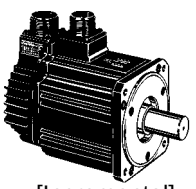


SYSMAC C/CV Programmable Controller

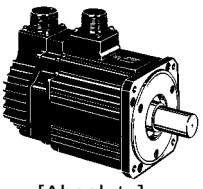
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Position Control Units
C500-NC111-EV1
C500-NC211
C200H-NC112
C200H-NC211
C200H-NC113
C200H-NC213
C200H-NC413



[Incremental]



[Absolute]

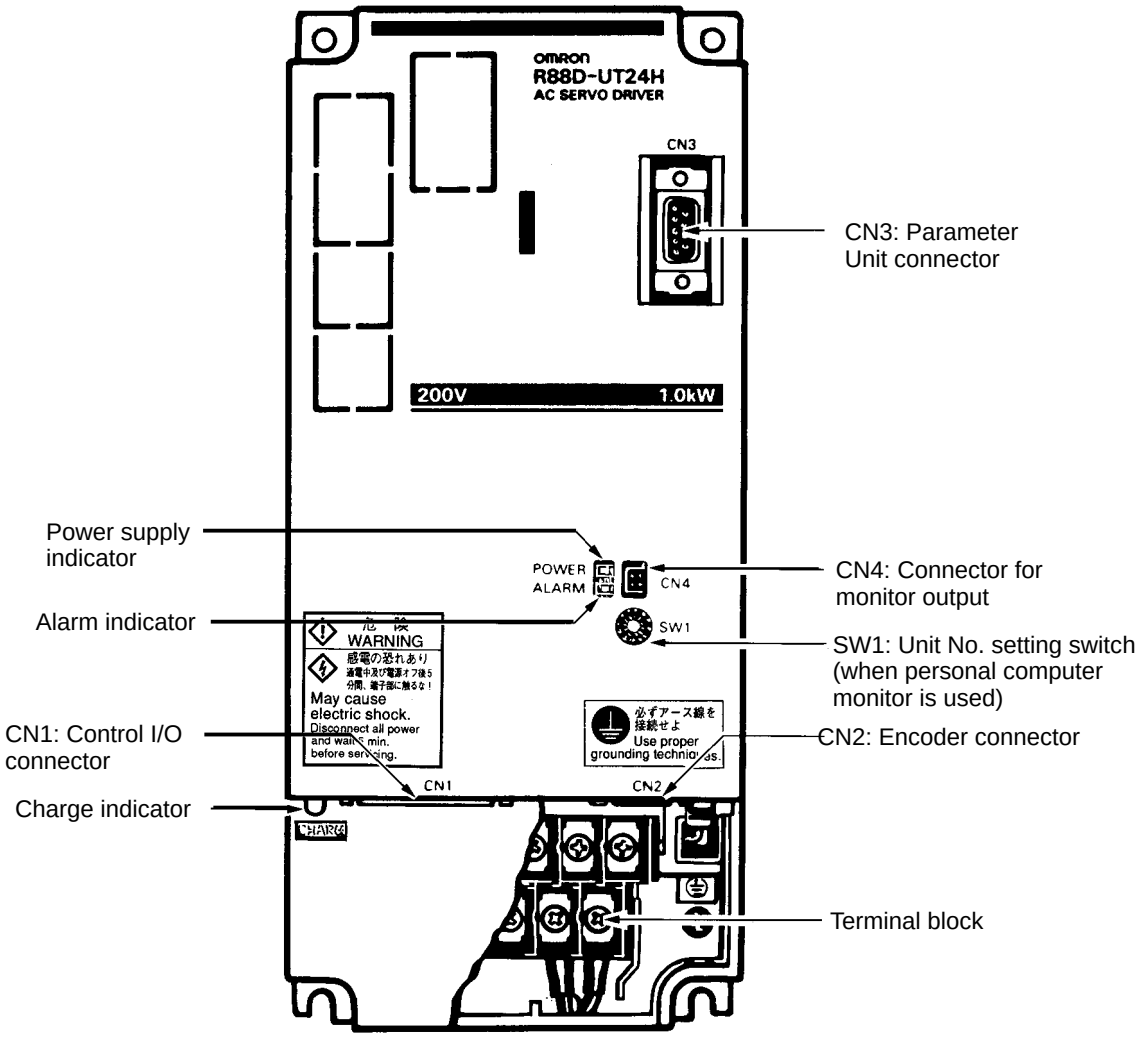
OMNUC U-series AC Servomotor

Note Motors with absolute encoders can be used in combination with CV500-MC221/421 or C200H-MC221 Motion Control Units.

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1-3 Servo Driver Nomenclature

■ Front View



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1-4 Applicable Standards and Models

■ Applicable Standards

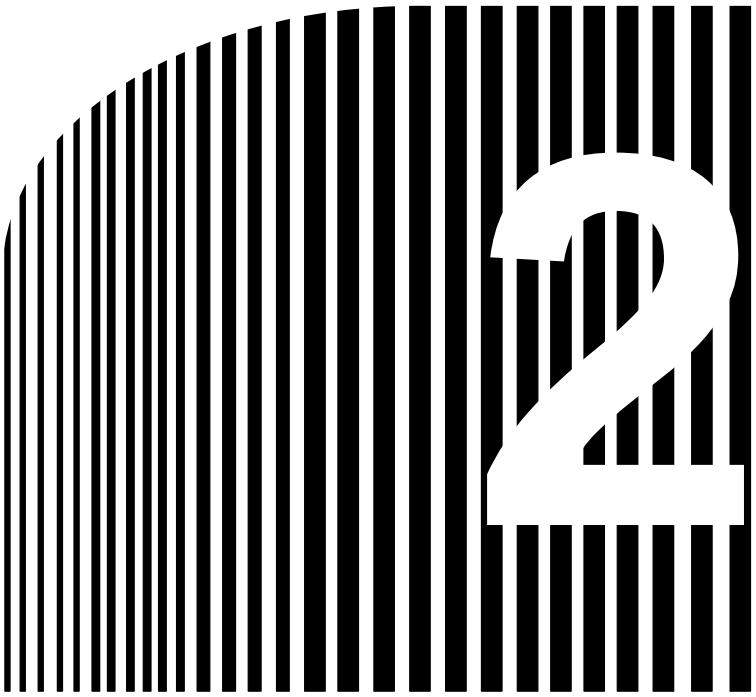
EC Directives	Product	Applicable standard	Remarks
Low voltage	AC Servo Driver	EN61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use.
	AC Servo Motor	IEC34-1, -5, -8, -9	Rotating electrical machines.
EMC	AC Servo Driver and AC Servomotor	EN55011 class A group 1	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific, and medical (ISM) radio-frequency equipment.
		EN50082-2	Electromagnetic compatibility generic immunity standard, Part 2 Industrial environment.

Note Installation under the conditions specified in *2-3-3Wiring Conditions Satisfying EMC Directives* is required to conform to EMC Directives.

■ Applicable Models

Supply voltage	Output	AC Servo Driver	AC Servomotor	
			Incremental Encoder	Absolute Encoder
200 VAC	1 kW	R88D-UT24V R88D-UT24V-RG	R88M-U1K030V-□S1	R88M-U1K030X-□S1
	1.5 kW	R88D-UT40V R88D-UT40V-RG	R88M-U1K530V-□S1	R88M-U1K530X-□S1
	2 kW	R88D-UT60V R88D-UT60V-RG	R88M-U2K030V-□S1	R88M-U2K030X-□S1
	3 kW	R88D-UT80V R88D-UT80V-RG	R88M-U3K030V-□S1	R88M-U3K030X-□S1
	4 kW	R88D-UT110V	R88M-U4K030V-□S1	R88M-U4K030X-□S1
	5 kW	R88D-UT110V	R88M-U5K030V-□S1	R88M-U5K030X-□S1

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Chapter 2

• System Design and Installation•

2-1 Installation

2-2 Wiring and Connections
(Models Not Conforming to Standards)

2-3 Wiring and Connections
(Models Conforming to EC Directives)

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Installation and Wiring Precautions

⚠ **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** Provide an appropriate stopping device on the machine side to secure safety. (A holding brake is not a stopping device for securing safety.) Not doing so may result in injury.

⚠ **Caution** Provide an external emergency stopping device that allows an instantaneous stop of operation and power interruption. Not doing so may result in injury.

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⚠ Caution Take appropriate and sufficient countermeasures when installing systems in the following locations:

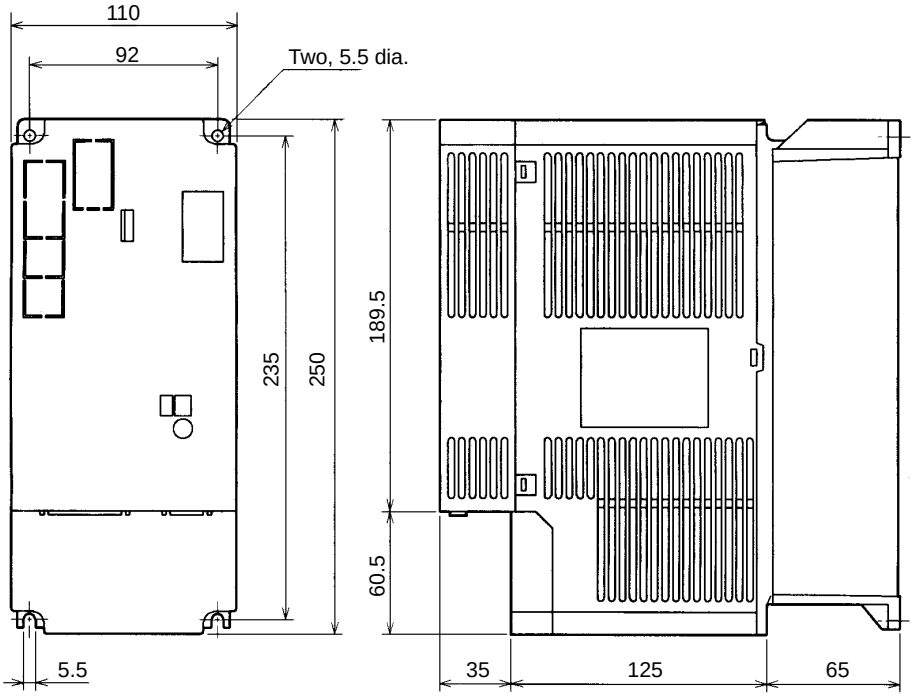
- Locations subject to static electricity or other forms of noise.
- Locations subject to strong electromagnetic fields and magnetic fields.
- Locations subject to possible exposure to radioactivity.
- Locations close to power supplies.

2-1 Installation

2-1-1 External Dimensions (Unit: mm)

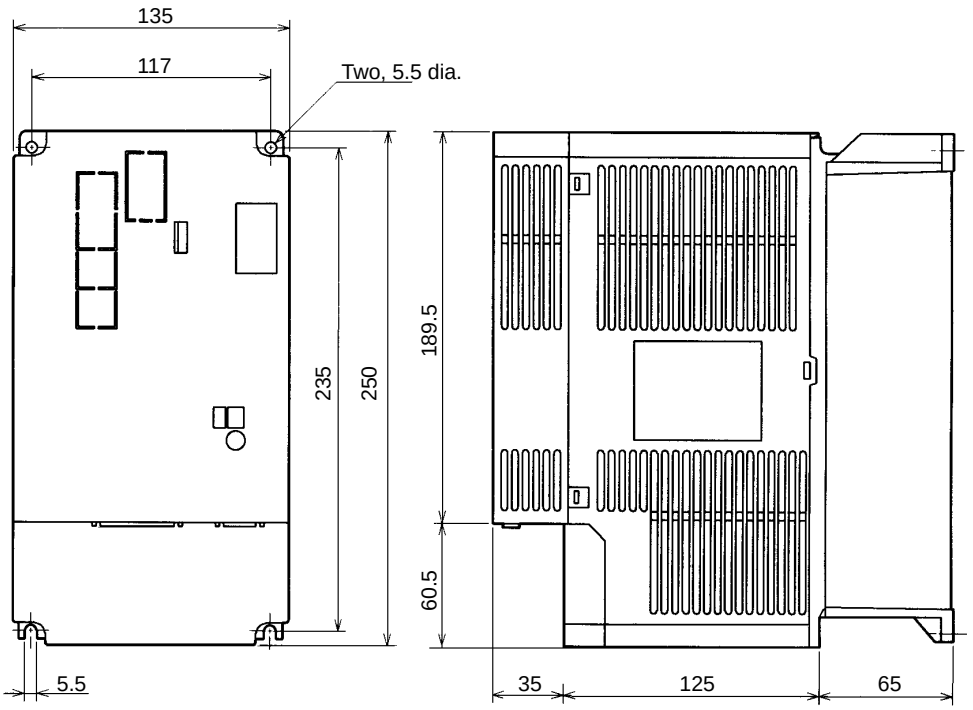
■ AC Servo Drivers

● 1.0-kW/1.5-kW Models:
R88D-UT24H/-UT40H, R88D-UT24V/-UT40V, R88D-UT24V-RG/-UT40V-RG

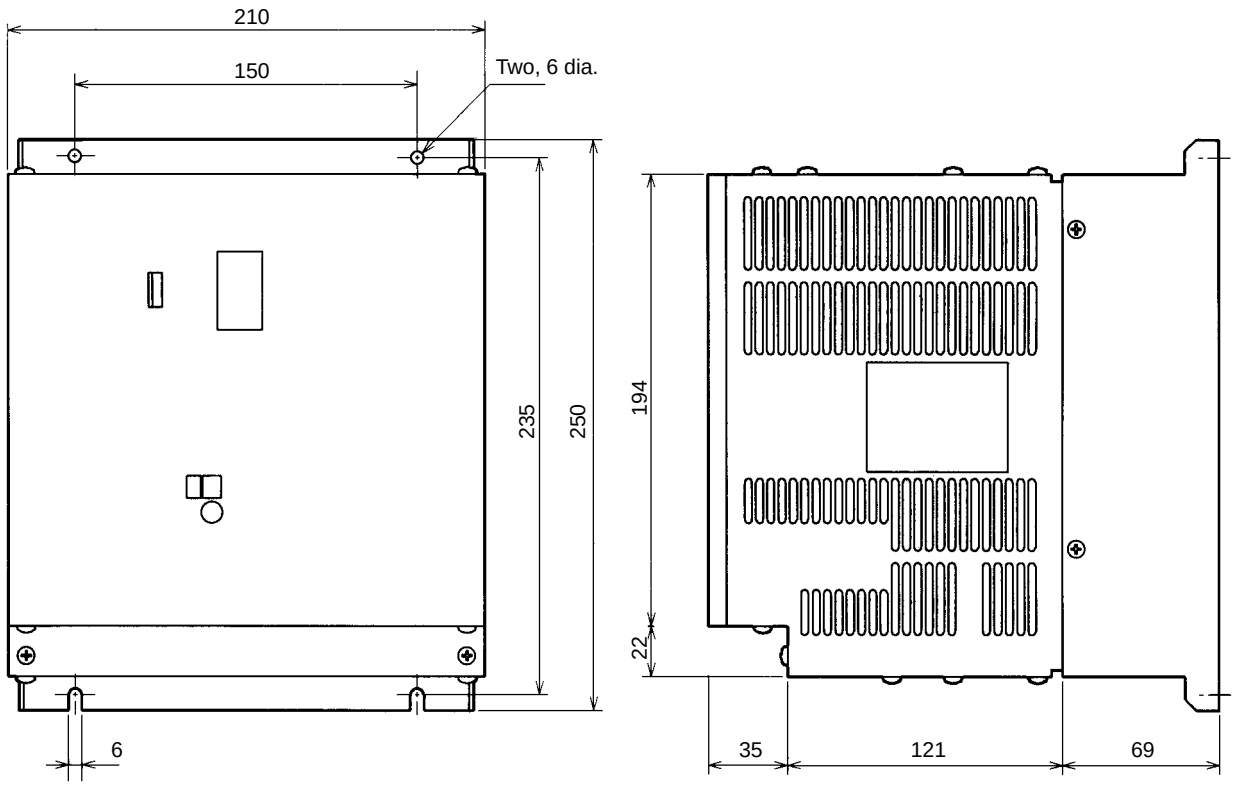


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- **2.0-kW/3.0-kW Models:**
  R88D-UT60H/-UT80H, R88D-UT60V/-UT80V, R88D-UT60V-RG/-UT80V-RG

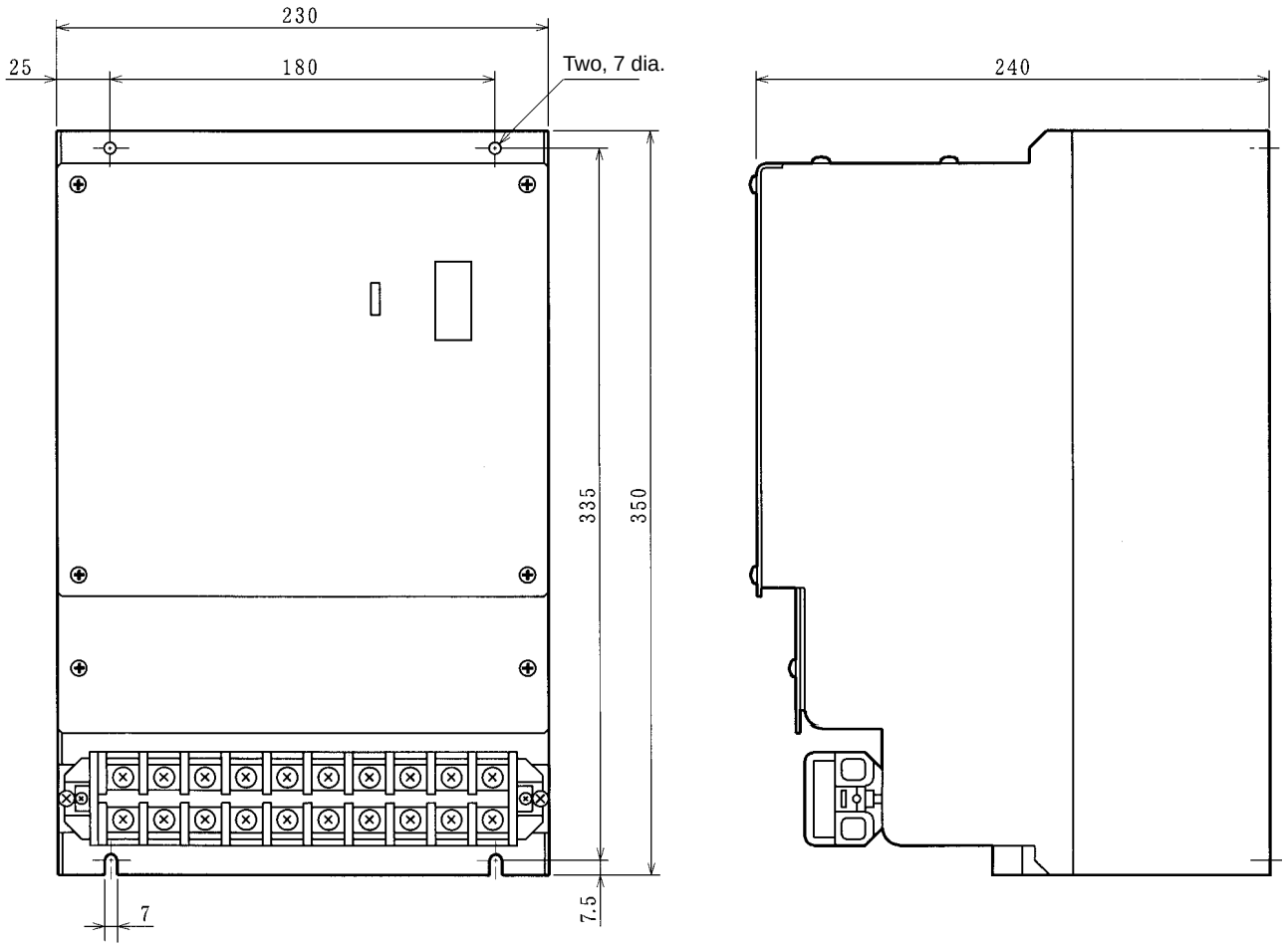


- **4.0-kW/5.0-kW Models:**
  R88D-UT110H/-UT120H



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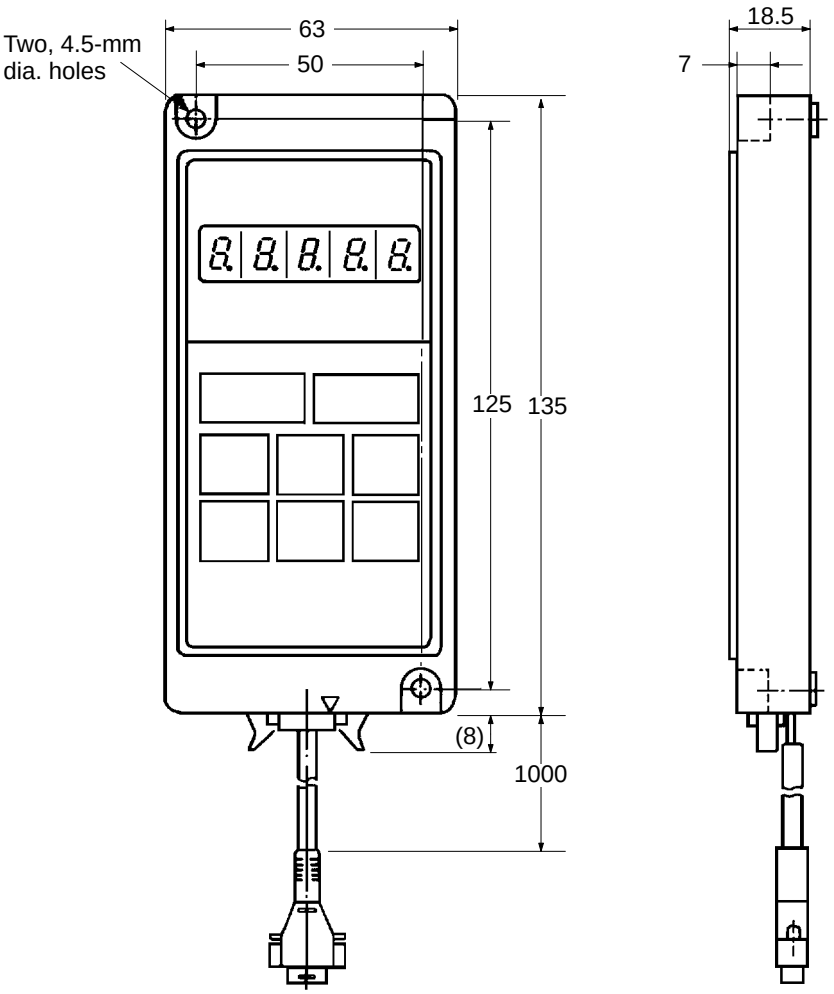
- **4.0-kW/5.0-kW Models:**
  R88D-UT110V



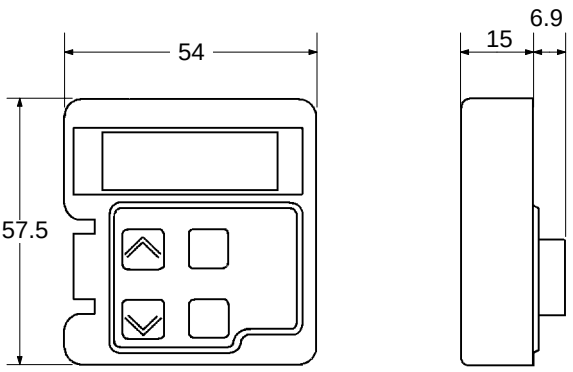
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■ Parameter Units

● R88A-PR02U



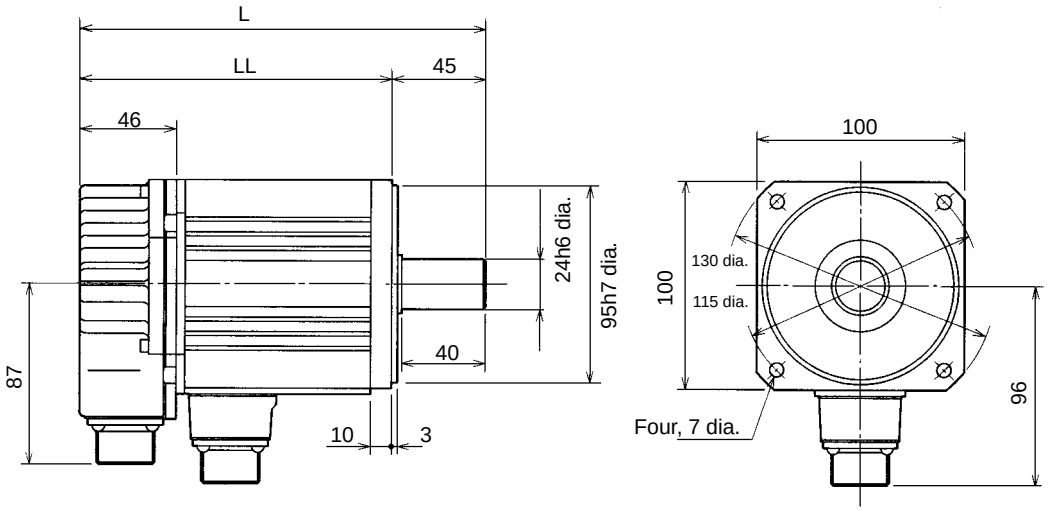
● R88A-PR03U



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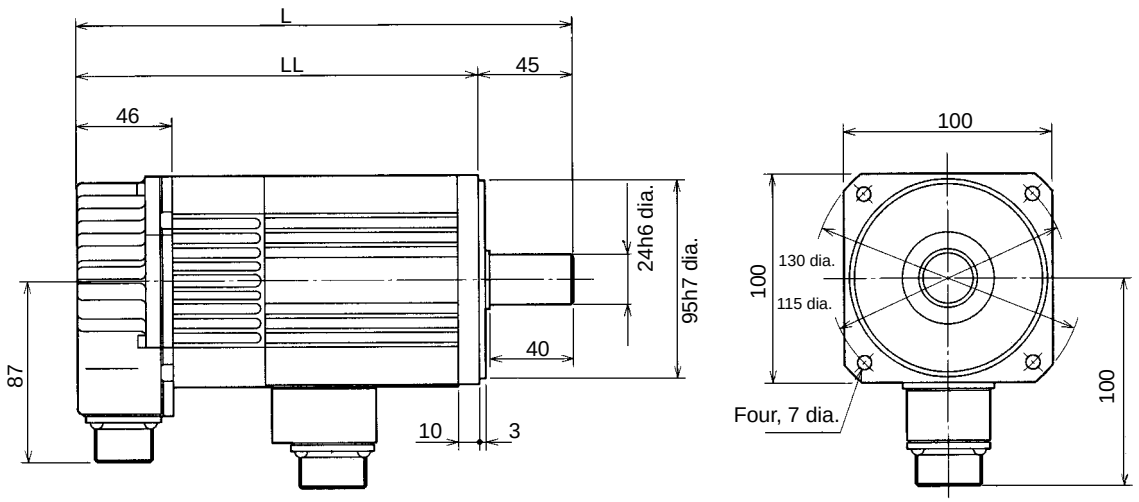
■ AC Servomotors (Incremental)

- **1.0-kW/1.5-kW/2.0-kW Standard Models:**
  R88M-U1K030H/-U1K530H/-U2K030H
  R88M-U1K030V-S1/-U1K530V-S1/-U2K030V-S1



Note The model number with the suffix “S1” indicates a straight-shaft motor with key. For dimensions of the key sections, refer to *Shaft Dimensions of Motors with Keys* on page 2-11.

- **1.0-kW/1.5-kW/2.0-kW Models with Brake:**
  R88M-U1K030H-B/-U1K530H-B/-U2K030H-B
  R88M-U1K030V-BS1/-U1K530V-BS1/-U2K030V-BS1



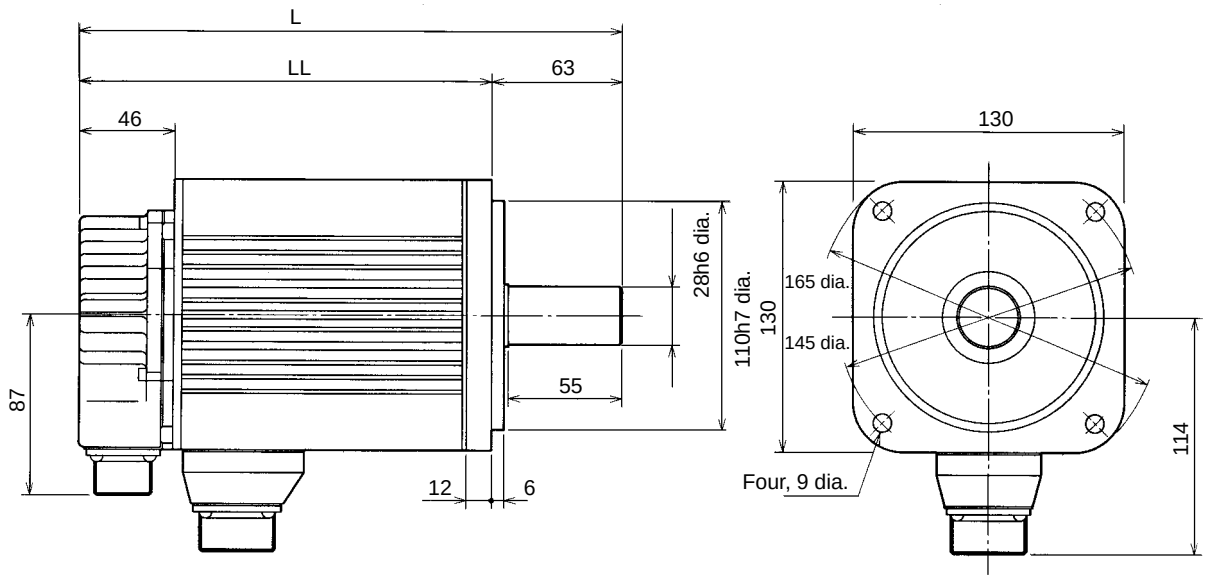
Note The model number with the suffix “S1” indicates a straight-shaft motor with key. For dimensions of the key sections, refer to *Shaft Dimensions of Motors with Keys* on page 2-11.

Standard Models		
Model	**L**	**LL**
R88M-U1K030□	194	149
R88M-U1K530□	220	175
R88M-U2K030□	243	198

Models with Brake		
Model	**L**	**LL**
R88M-U1K030□-B□	238	193
R88M-U1K530□-B□	264	219
R88M-U2K030□-B□	287	242

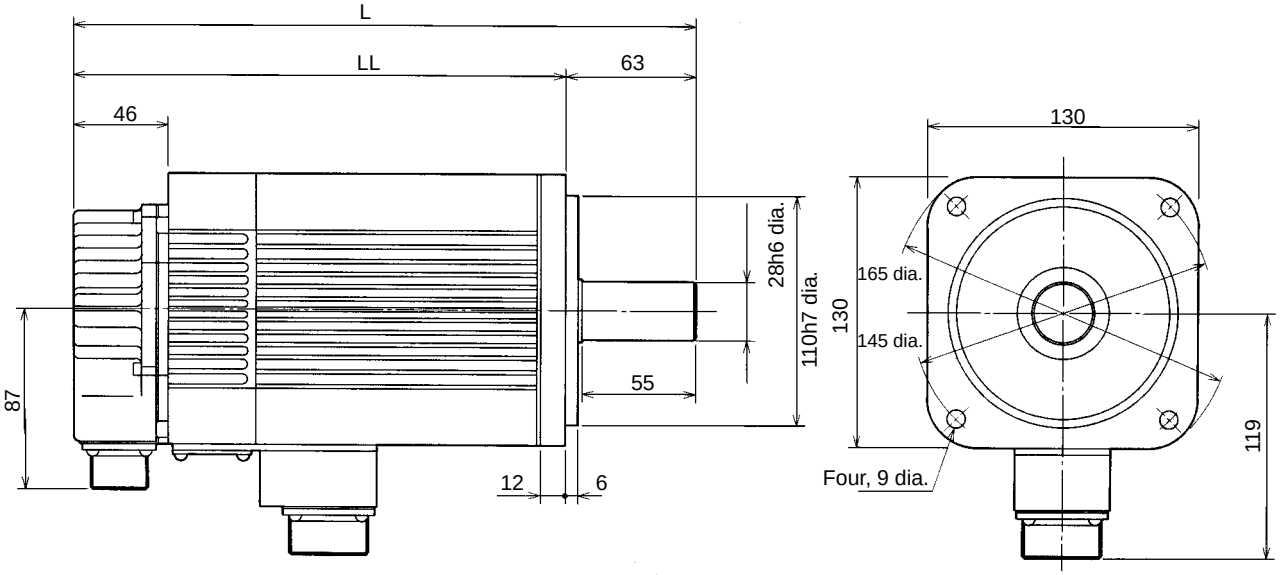
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- **3.0-kW/4.0-kW/5.0-kW Standard Models:**
  R88M-U3K030H/-U4K030H/-U5K030H
  R88M-U3K030V-S1/-U4K030V-S1/-U5K030V-S1



Note The model number with the suffix “S1” indicates a straight-shaft motor with key. For dimensions of the key sections, refer to *Shaft Dimensions of Motors with Keys* on page 2-11.

- **3.0-kW/4.0-kW/5.0-kW Models with Brake:**
  R88M-U3K030H-B/-U4K030H-B/-U5K030H-B
  R88M-U3K030V-BS1/-U4K030V-BS1/-U5K030V-BS1



Note The model number with the suffix “S1” indicates a straight-shaft motor with key. For dimensions of the key sections, refer to *Shaft Dimensions of Motors with Keys* on page 2-11.

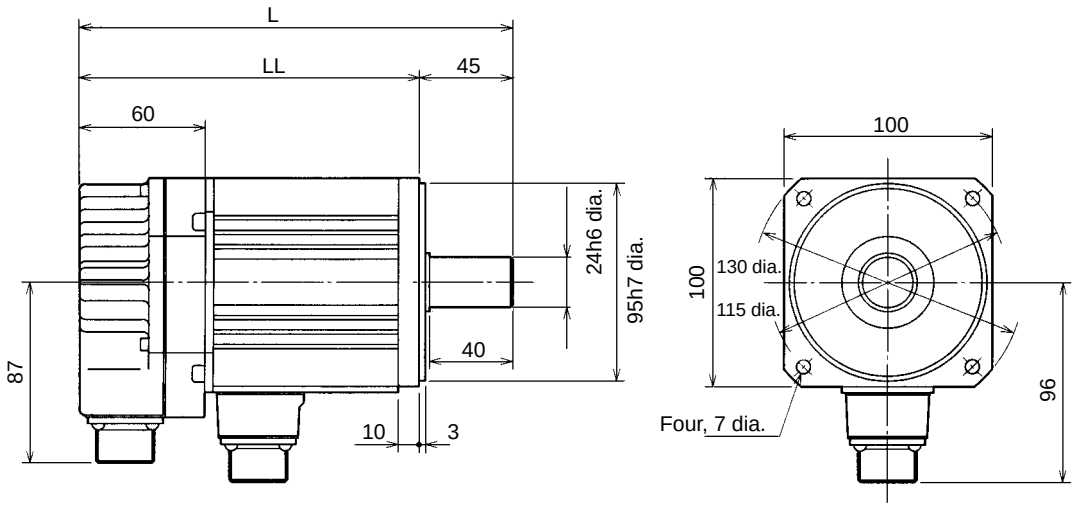
Standard Models		
Model	**L**	**LL**
R88M-U3K030□	262	199
R88M-U4K030□	299	236
R88M-U5K030□	339	276

Models with Brake		
Model	**L**	**LL**
R88M-U3K030□-B□	300	237
R88M-U4K030□-B□	337	274
R88M-U5K030□-B□	377	314

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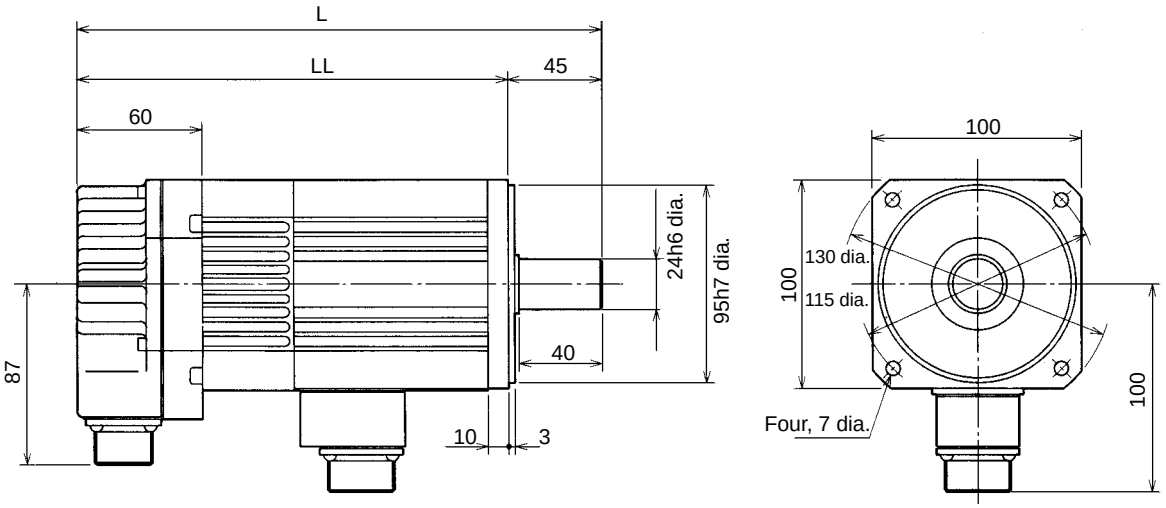
■ AC Servomotors (Absolute)

● 1.0-kW/1.5-kW/2.0-kW Standard Models:
R88M-U1K030T/-U1K530T/-U2K030T
R88M-U1K030X-S1/-U1K530X-S1/-U2K030X-S1



Note The model number with the suffix “S1” indicates a straight-shaft motor with key. For dimensions of the key sections, refer to *Shaft Dimensions of Motors with Keys* on page 2-11.

● 1.0-kW/1.5-kW/2.0-kW Models with Brake:
R88M-U1K030T-B/-U1K530T-B/-U2K030T-B
R88M-U1K030X-BS1/-U1K530X-BS1/-U2K030X-BS1



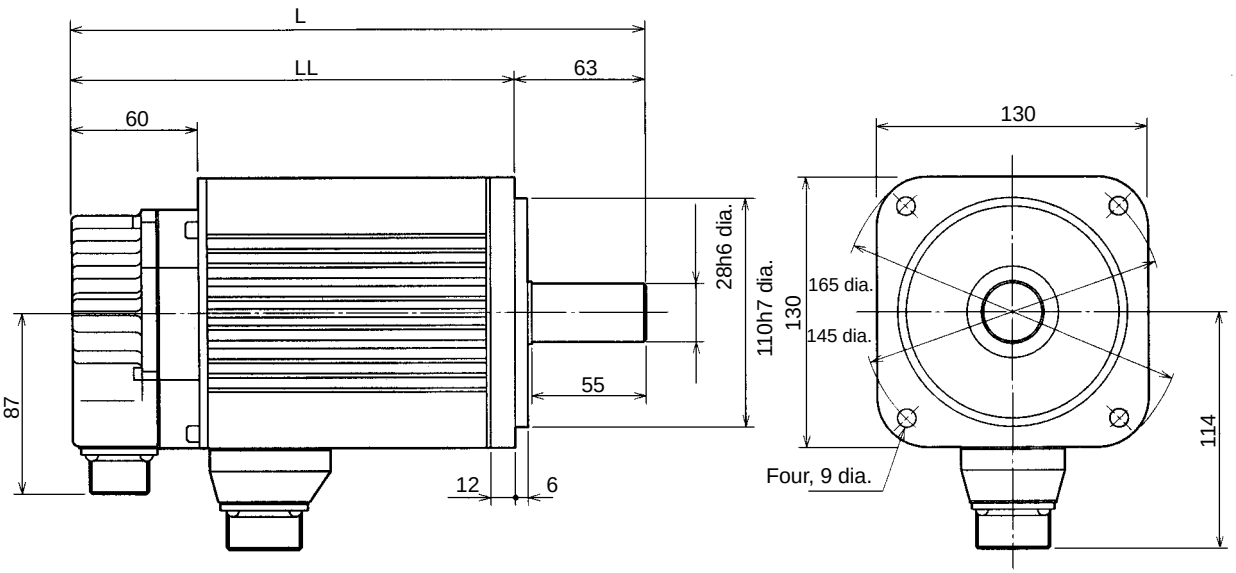
Note The model number with the suffix “S1” indicates a straight-shaft motor with key. For dimensions of the key sections, refer to *Shaft Dimensions of Motors with Keys* on page 2-11.

Standard Models		
Model	**L**	**LL**
R88M-U1K030□	208	163
R88M-U1K530□	234	189
R88M-U2K030□	257	212

Models with Brake		
Model	**L**	**LL**
R88M-U1K030□-B□	252	207
R88M-U1K530□-B□	278	233
R88M-U2K030□-B□	301	256

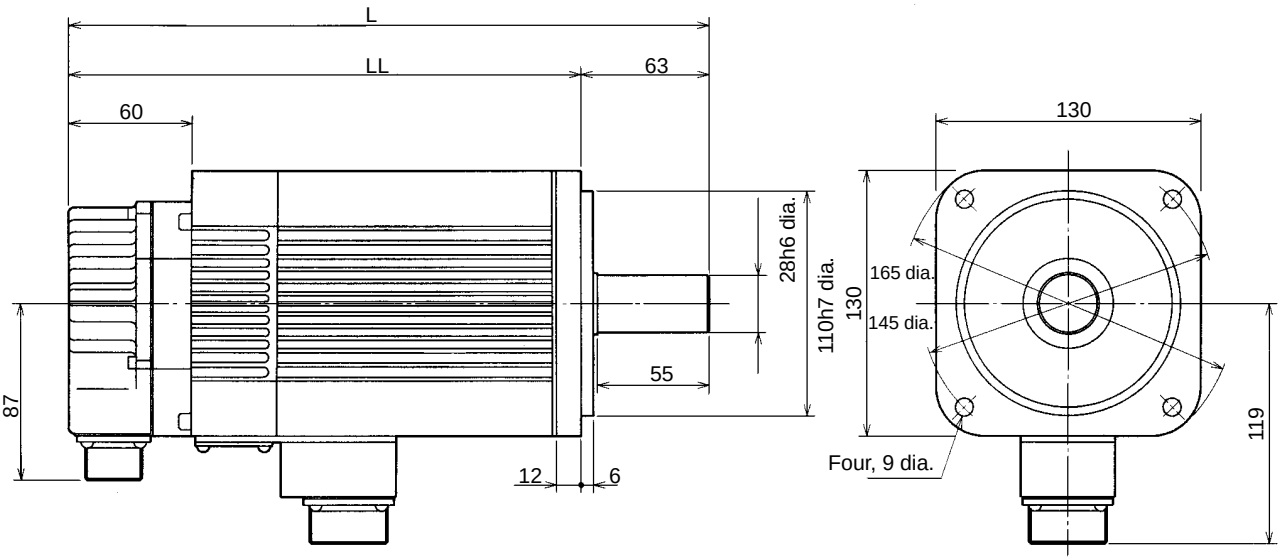
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- **3.0-kW/4.0-kW/5.0-kW Standard Models:**
  R88M-U3K030T/-U4K030T/-U5K030T
  R88M-U3K030X-S1/-U4K030X-S1/-U5K030X-S1



Note The model number with the suffix “S1” indicates a straight-shaft motors with key. For dimensions of the key sections, refer to *Shaft Dimensions of Motors with Keys* on page 2-11.

- **3.0-kW/4.0-kW/5.0-kW Models with Brake:**
  R88M-U3K030T-B/-U4K030T-B/-U5K030T-B
  R88M-U3K030X-BS1/-U4K030X-BS1/-U5K030X-BS1



Note The model number with the suffix “S1” indicates a straight-shaft motors with key. For dimensions of the key sections, refer to *Shaft Dimensions of Motors with Keys* on page 2-11.

Standard Models		
Model	**L**	**LL**
R88M-U3K030□	276	213
R88M-U4K030□	313	250
R88M-U5K030□	353	290

Models with Brake		
Model	**L**	**LL**
R88M-U3K030□-B□	314	251
R88M-U4K030□-B□	351	288
R88M-U5K030□-B□	391	328

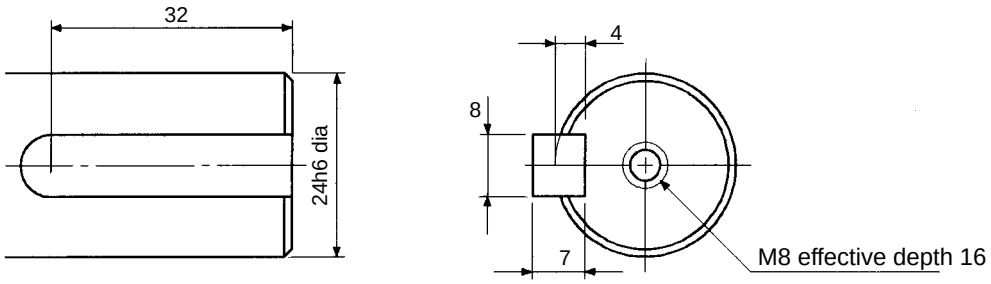
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■ Shaft Dimensions of Motors With Keys

Standard U-series AC Servomotors do not have keys on the shafts. The dimensions of motors with keys are shown below. Motors with keys are indicated by adding “-S1” to the end of the model number. Key slots are based on JIS B1301-1976.

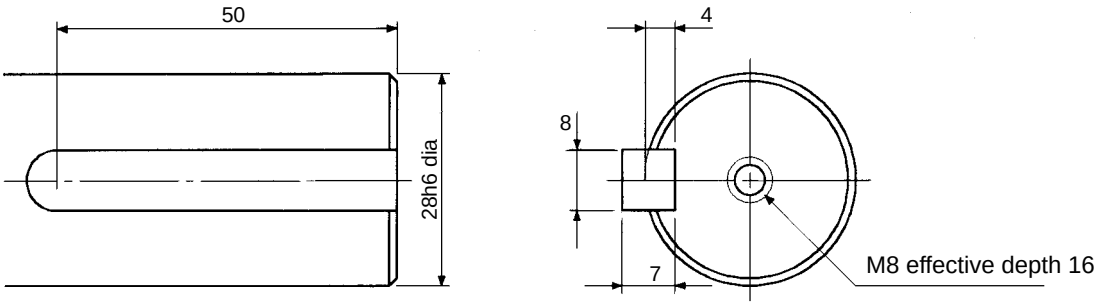
- **1.0-kW/1.5-kW/2.0-kW Models**

Without Brake: **R88M-U1K030□-S1**
R88M-U1K530□-S1
R88M-U2K030□-S1
With Brake: **R88M-U1K030□-BS1**
R88M-U1K530□-BS1
R88M-U2K030□-BS1



- **3.0-kW/4.0-kW/5.0-kW Models**

Without Brake: **R88M-U3K030□-S1**
R88M-U4K030□-S1
R88M-U5K030□-S1
With Brake: **R88M-U3K030□-BS1**
R88M-U4K030□-BS1
R88M-U5K030□-BS1



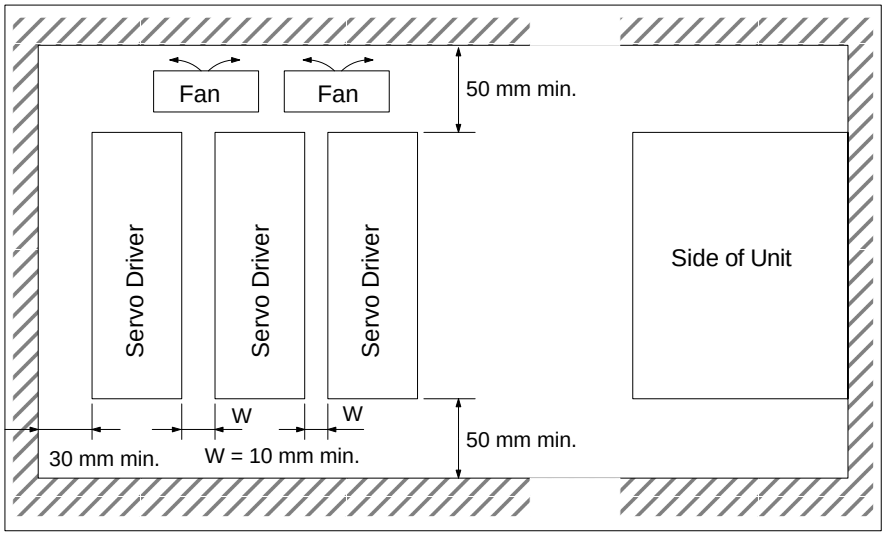
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2-1-2 Installation Conditions

■ AC 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 Servo Drivers are installed side by side to prevent uneven temperatures from developing inside the panel.
- Mount the Servo Drivers vertically (so that the model number and writing can be read).



● Operating Environment

Be sure that the environment in which Servo Drivers are operated meets the following conditions.

- Ambient operating temperature: 0°C to +55°C
- Ambient operating humidity: 20% to 85% (RH, 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 ambient temperature to rise inside the entire closed space. Use a fan or a air conditioner to prevent the ambient temperature of the Servo Driver from exceeding 55°C.
- Unit 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. A drop of 10°C in the ambient temperature will double the expected service life.

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● 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.

■ AC Servomotors

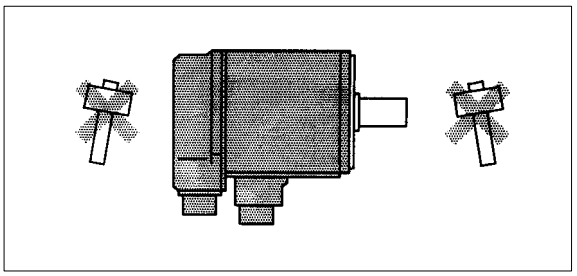
● Operating Environment

Be sure that the environment in which the Servomotor is operated meets the following conditions.

- Ambient operating temperature: 0°C to +40°C
- Ambient operating humidity: 20% to 80% (RH, with no condensation)
- Atmosphere: No corrosive gases.

● Impact and Load

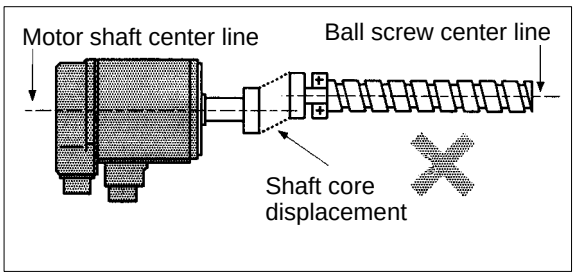
- The Servomotor is resistant to impacts of up to 98 m/s^2 (10 G). Do not subject it to heavy impacts or loads during transport, installation, or positioning. In addition, do not hold onto the encoder, cable, or connector areas when transporting it.
- Always use a pulley remover to remove pulleys, couplings, 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

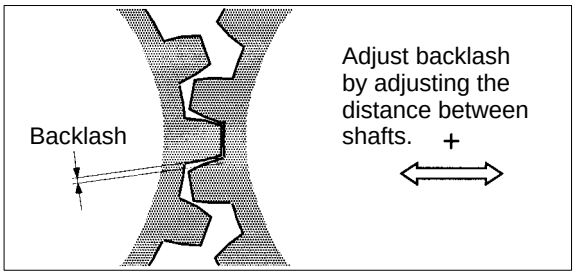
- The axial loads for Servomotors are specified in section 5-2-4. If an axial load greater than that specified is applied to a Servomotor, it will reduce the service life of the motor bearings and may damage the motor shaft. When connecting to a load, use couplings that can sufficiently absorb mechanical eccentricity and variation.



Recommended Coupling

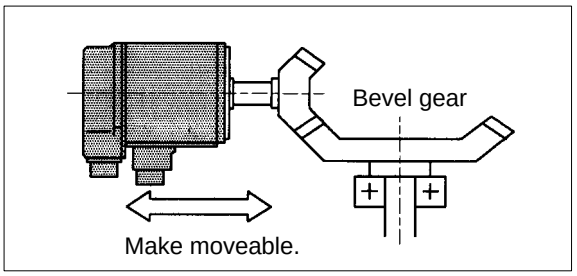
Name	Maker
Oldham coupling	Myghty Co., Ltd

- 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.

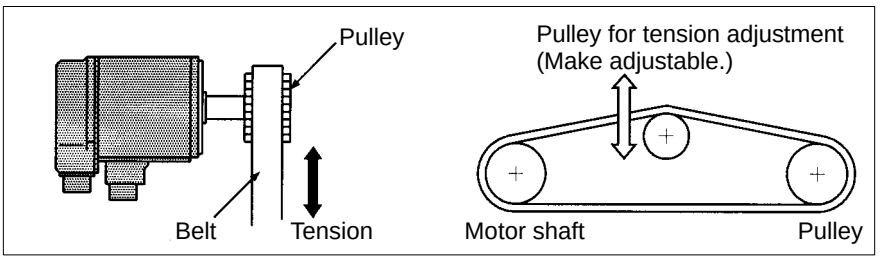


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- Bevel gears will cause a load to be applied in the thrust direction depending on the structural precision, the gear precision, and temperature changes. Provide appropriate backlash or take other measures to ensure that no thrust load is applied which exceeds specifications.



- Do not put rubber packing on the flange surface. If the flange is mounted with rubber packing, the motor flange may separate due to the tightening strength.
- 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 may be damaged. Set up the structure so that the radial load can be adjusted. A large radial load may also be applied as a result of belt vibration. Attach a brace and adjust Servo Driver gain so that belt vibration is minimized.



● Water and Drip Resistance

- The Servomotor is not of waterproof construction.

The Servomotor is provided with either of the following protection.

Models not complying with EC Directives: IP65 (excluding the shaft penetration areas)
Models complying with EC Directives: IP55 (including the shaft penetration areas)

The standard cable conforms to IP30. If the Power Cable or Encoder Cable is used in places wet with sprayed water, connect waterproof connectors to the Cable.
If the equipment incorporating the Servomotor must comply with EC Directives, connect the following connectors to the Power Cable and Encoder Cable.

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Recommended Connectors for Power Cables

	Motor model	Connector model	Cable clamp model	Maker
Without brake	R88M-U1K030□-□ R88M-U1K530□-□ R88M-U2K030□-□	Angled type CE05-8A18-10SD-B-BAS Straight type CE05-6A18-10SD-B-BSS	For sheath external diameter of 6.5 to 8.7 dia.: CE3057-10A-3 (D265) For sheath external diameter of 8.5 to 11 dia.: CE3057-10A-2 (D265) For sheath external diameter of 10.5 to 14.1 dia.: CE3057-10A-1 (D265)	DDK Ltd.
	R88M-U3K030□-□ R88M-U4K030□-□ R88M-U5K030□-□	Angled type JL04V-8A22-22SE-EB Straight type JL04V-6A22-22SE-EB	For sheath external diameter of 6.5 to 9.5 dia.: JL04-2022CK(09) For sheath external diameter of 9.5 to 13 dia.: JL04-2022CK(12) For sheath external diameter of 12.9 to 15.9 dia.: JL04-2022CK(14)	Japan Aviation Electronics Industry, Ltd. (JAE)
With brake	R88M-U1K030□-B□ R88M-U1K530□-B□ R88M-U2K030□-B□	Angled type JL04V-8A20-15SE-EB Straight type JL04V-6A20-15SE-EB	For sheath external diameter of 6.5 to 9.5 dia.: JL04-2022CK(09) For sheath external diameter of 9.5 to 13 dia.: JL04-2022CK(12) For sheath external diameter of 12.9 to 15.9 dia.: JL04-2022C K(14)	Japan Aviation Electronics Industry, Ltd. (JAE)
	R88M-U3K030□-B□ R88M-U4K030□-B□ R88M-U5K030□-B□	Angled type JL04V-8A24-10SE-EB Straight type JL04V-6A24-10SE-EB	For sheath external diameter of 9 to 12 dia.: JL04-2428CK(11) For sheath external diameter of 12 to 15 dia.: JL04-2428CK(14) For sheath external diameter of 15 to 18 dia.: JL04-2428CK(17) For sheath external diameter of 18 to 20 dia.: JL04-2428CK(20)	Japan Aviation Electronics Industry, Ltd. (JAE)

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Recommended Connector for Encoder Cables

Motor model	Connector model	Cable clamp model	Maker
All models	Angled type JA08A-20-29S-J1-EB Straight type JA06A-20-29S-J1-EB	For sheath external diameter of 6.5 to 9.5 dia.: JL04-2022CKE(09) For sheath external diameter of 9.5 to 13 dia.: JL04-2022CKE(12) For sheath external diameter of 12.9 to 16 dia.: JL04-2022CKE(14)	Japan Aviation Electronics Industry, Ltd. (JAE)

- If the Servomotor is used in an environment in which condensation occurs, water may enter inside of the encoder from the end surfaces of cables due to motor temperature changes. Either take measures to ensure that water cannot penetrate in this way, or use water-proof connectors. Even when machinery is not in use, water penetration can be avoided by taking measures, such as keeping the motor in servo-lock status, to minimize temperature changes.
- If machining oil with surfactants (e.g., coolant fluids) or their spray penetrate inside of the motor, insulation defects or short-circuiting may occur. Take measures to prevent machining oil penetration.

● Oil Seals

If the motor shaft is exposed to oil or grease, attach an oil seal to the motor shaft.

Oil seal model: SC30458 (NOK)

● Other Precautions

- Do not apply commercial power directly to the Servomotor. The Servomotors run on synchronous AC and use permanent magnets. Applying three-phase power will burn out the motor coils.
- 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.
- Absolutely do not remove the encoder cover or take the motor apart. The magnet and the encoder are aligned in the Servomotor. If they become misaligned, the motor will not operate.

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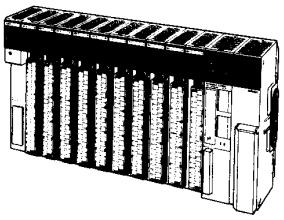
2-2 Wiring and Connections (Models Not Conforming to Standards)

2-2-1 Connecting OMRON Servo Controllers

Use general-purpose control cable (purchased separately) to connect U-series AC Servomotors and Servo Drivers to OMRON Servo Controllers.

■ Connecting SYSMAC C-Series Position Control Units

Programmable Controller

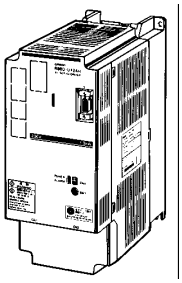


SYSMAC C/CV

Position Control Unit
C500-NC222-E (Analog output)
3G2A5-NC111-EV1 (Pulse train output)
C500-NC211 (Pulse train output)
C200H-NC112 (Pulse train output)
C200H-NC211 (Pulse train output)
C200HW-NC113 (Pulse train output)
C200HW-NC213 (Pulse train output)
C200HW-NC413 (Pulse train output)

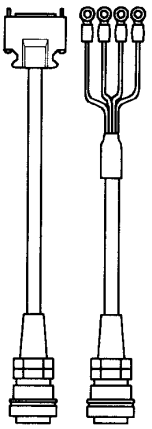


General-purpose Control Cable
R88A-CPUB□□□S

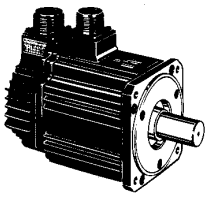


AC Servo Driver
R88D-UT□□H

Encoder Cable
R88A-CRUB□□□N



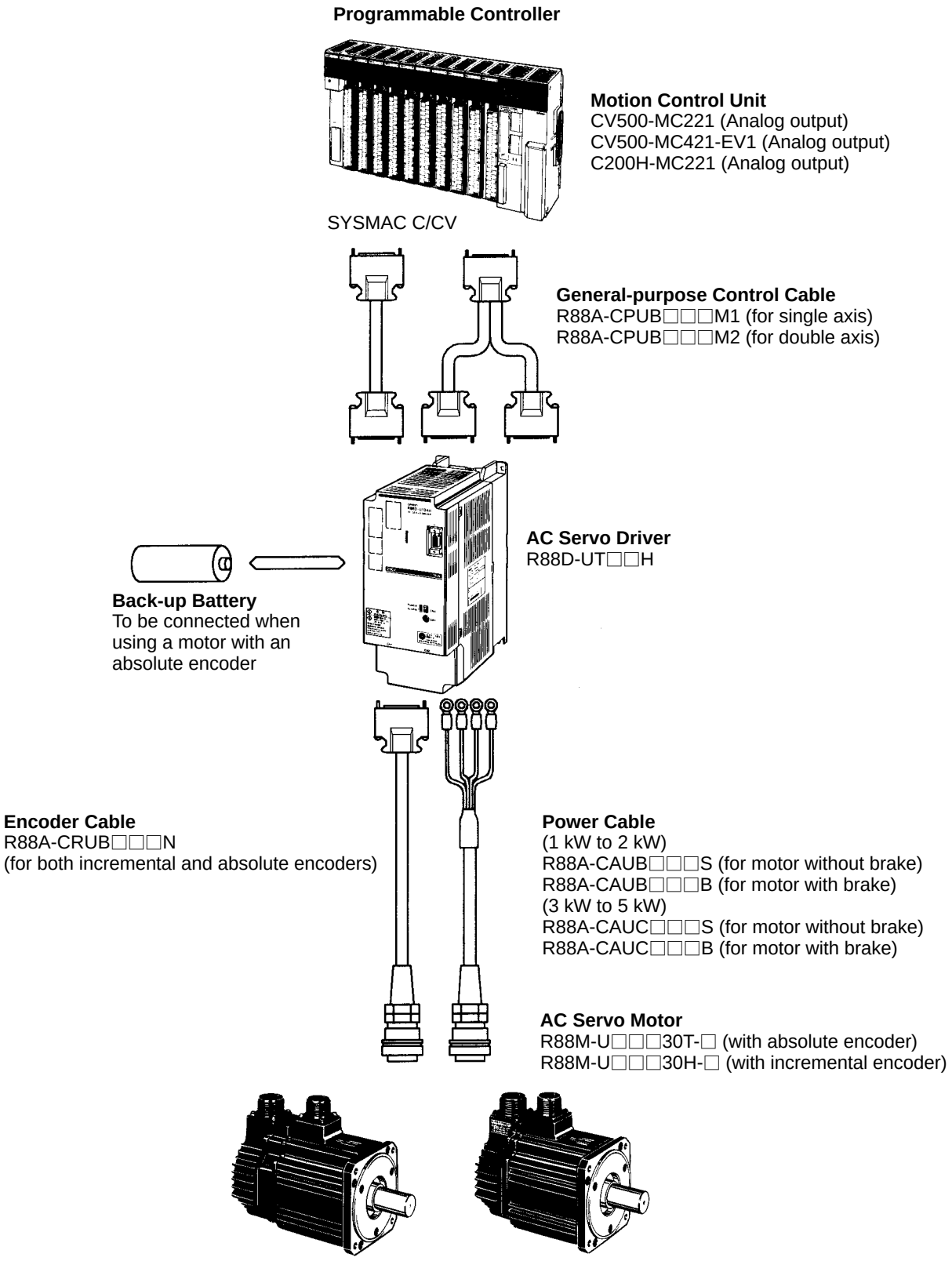
Power Cable
(1 kW to 2 kW)
R88A-CAUB□□□S (for motor without brake)
R88A-CAUB□□□B (for motor with brake)
(3 kW to 5 kW)
R88A-CAUC□□□S (for motor without brake)
R88A-CAUC□□□B (for motor with brake)



AC Servo Motor
R88M-U□□□30H-□ (with incremental encoder)

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■ Connecting to SYSMAC C/CV-series Motion Control Units



Note Refer to *Chapter 5 Specifications* for connector and cable specifications.

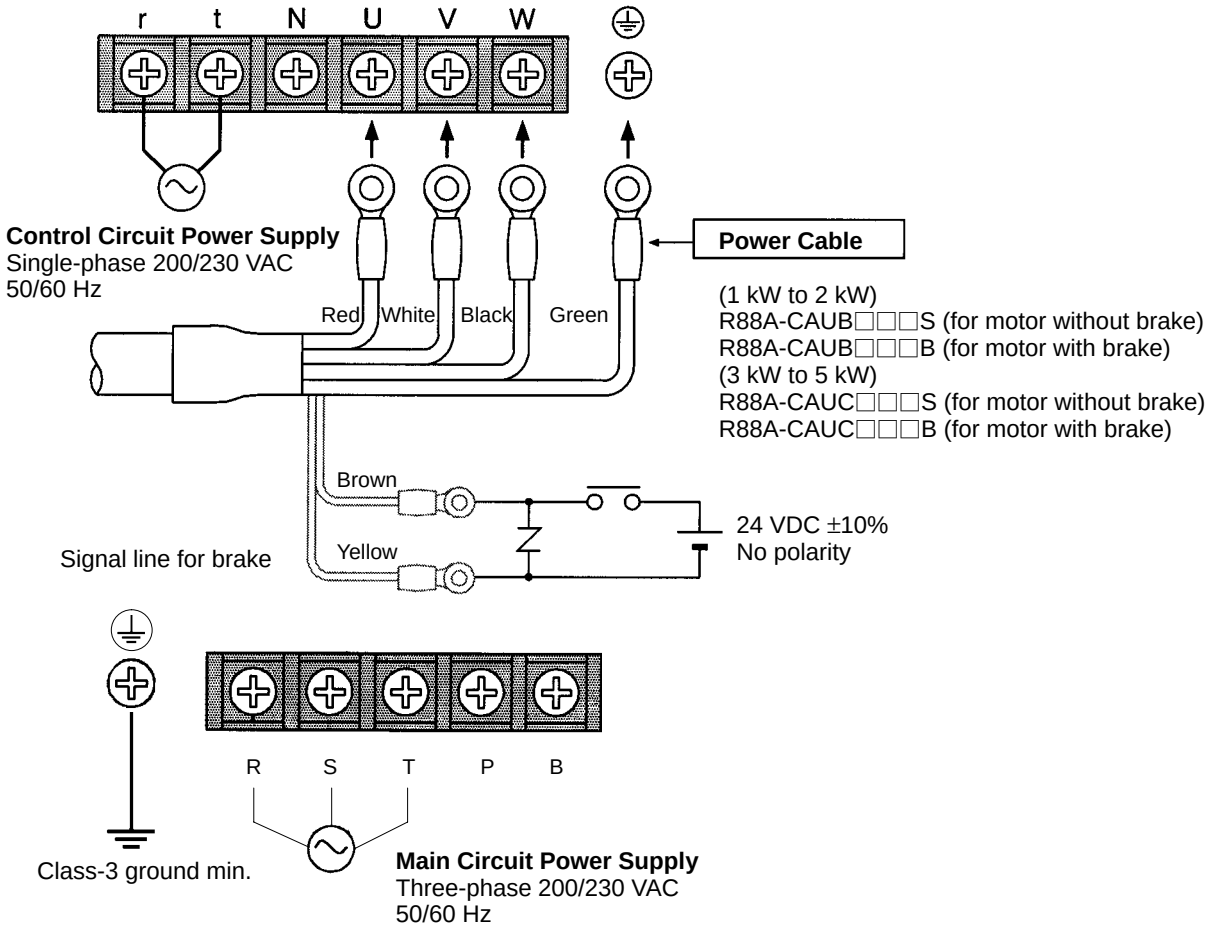
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2-2-2 Wiring Servo Drivers

Provide proper wire diameters, ground systems, and noise resistance when wiring terminal blocks.

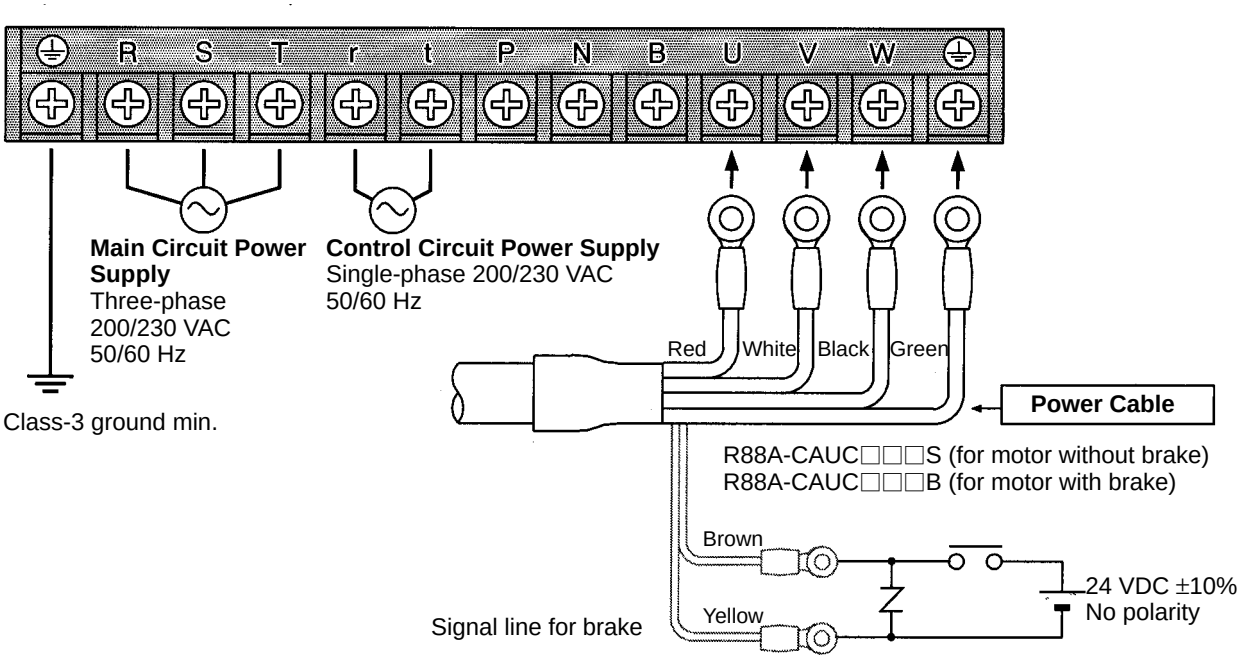
■ Wiring Terminal Blocks

• R88D-UT24H/UT40H/UT60H/UT80H



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- **R88D-UT110H/UT120H**



Terminal label	Name	Function	
⏚	Frame ground	This is the ground terminal. Ground to a class-3 ground (to 100 Ω or less) or better.	
R S T	Main circuit power supply input	Three-phase 200/230 VAC (170 to 253 V), 50/60 Hz	
r t	Control circuit power supply input	Single-phase 200/230 VAC (170 to 253 V), 50/60 Hz	
P B	Main circuit DC output (positive)	Do not connect anything to these terminals.	
N	Main circuit DC output (negative)		
U	Motor connection terminals	Red	These are the output terminals to the Servomotor. Be careful to wire them correctly.
V		White	
W		Black	
⏚	Frame ground	Green	

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■ Terminal Block Current and Wire Sizes

The following table shows the rated effective currents flowing to the Servo Driver and the sizes of the electrical wires.

Driver (Watts)		R88D-UT24H (1.0 kW)	R88D-UT40H (1.5 kW)	R88D-UT60H (2.0 kW)	R88D-UT80H (3.0 kW)	R88D-UT110 H (4.0 kW)	R88D-UT120 H (5.0 kW)
Main circuit power supply input (R, S, T)	Effective current	6.6 A	9.2 A	13.0 A	18.4 A	24.0 A	28.0 A
	Wire size	3.5 mm^2 or AWG 12 min.			5.5 mm^2 or AWG 10 min.		
Control circuit power supply input (r, t)	Effective current	0.25 A	0.25 A	0.25 A	0.25 A	0.25 A	0.25 A
	Wire size	1.25 mm^2 or AWG 16 min.					
Motor connection terminal (U, V, W)	Effective current	6.1 A	9.9 A	12.0 A	19.4 A	25.3 A	26.2 A
	Wire size	3.5 mm^2 or AWG 12			5.5 mm^2 or AWG 10 min.		
		Use OMRON standard cables.					
	Motor connector's applicable cable size	AWG 14 to AWG 12			AWG 10 to AWG 8		
Frame ground	Wire size	Use 2.0-mm^2 external ground wires. Use the same wire as used for the motor output.					
Terminal block screw size		M4					

■ Wire Sizes and Allowable Current

The following table shows allowable currents when there are three electrical wires. Use values equal to or lower than the specified values.

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

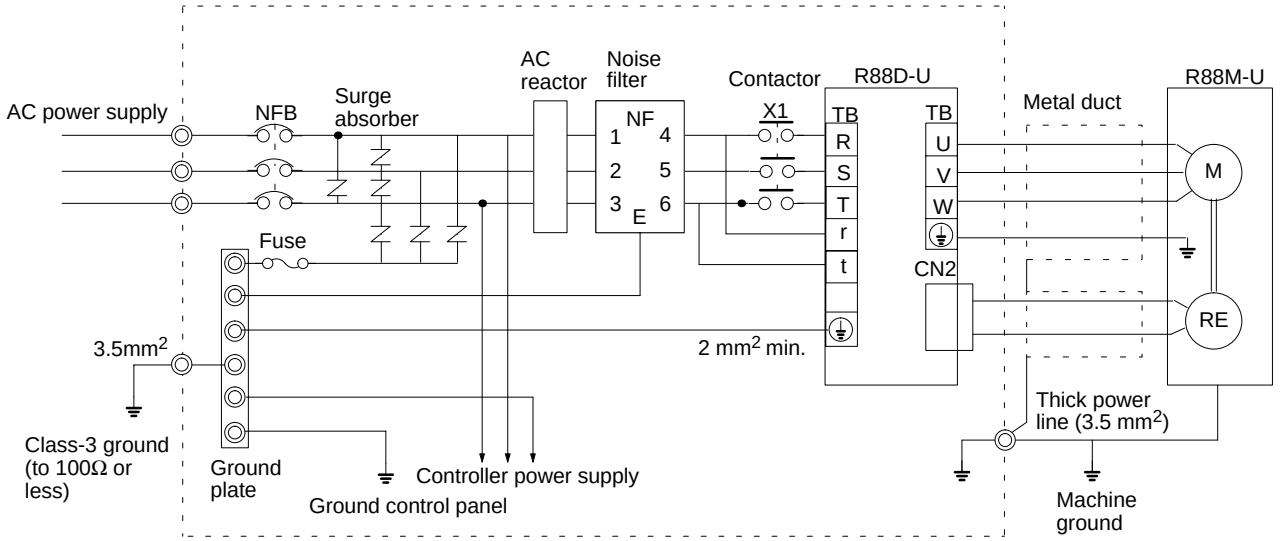
AWG size	Nominal cross-sectional area (mm^2)	Configuration (wires/mm^2)	Conductive resistance (Ω/km)	Allowable current (A) for ambient temperature		
				30°C	40°C	50°C
16	1.25	7/0.45	17.5	16	14	11
14	2.0	7/0.6	9.53	23	20	16
12	3.5	7/0.8	5.41	33	29	24
10	5.5	7/1.0	3.47	43	38	31
8	8.0	7/1.2	2.41	55	49	40
6	14.0	7/1.6	1.35	79	70	57

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2-2-3 Wiring for Noise Resistance

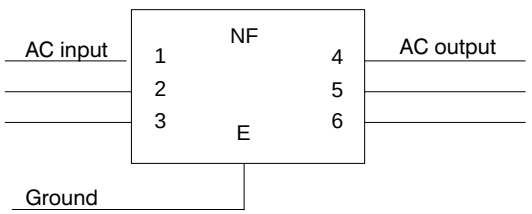
■ Wiring Method

Noise resistance will vary greatly depending on the wiring method used. Resistance to noise can be increased by paying attention to the items described below.

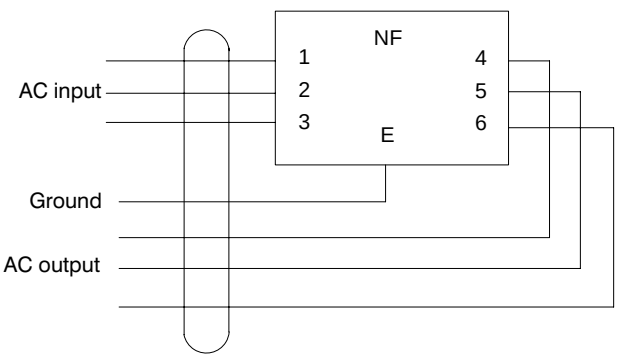


- Ground the motor's frame to the machine ground when the motor is on a movable shaft.
- Use a grounding plate for the frame ground for each Unit, as shown in the illustration, and ground to a single point.
- Use ground lines with a minimum thickness of 3.5 mm^2, and arrange the wiring so that the ground lines are as short as possible.
- 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.
- 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 means possible.
- 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 panel whenever possible.

Good: Separate input and output

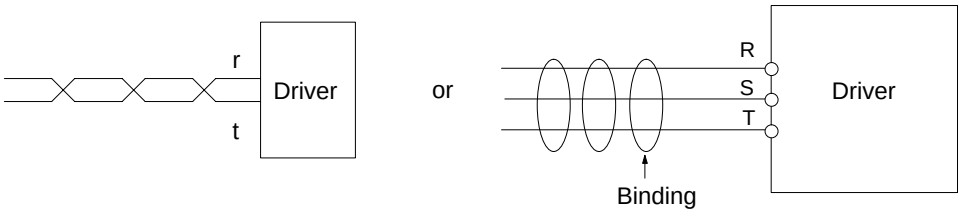


NO: Noise not filtered effectively



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



• Separate power supply cables and signal cables when wiring.

■ Selecting Components

● No-fuse Breakers (MCCB)

When selecting no-fuse breakers, take into consideration the maximum output current and the inrush current. The momentary maximum output for a servo system is approximately three times that of the rated output, and a maximum output of three seconds can be executed. 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. Refer to the table in *2-2-2 Terminal Block Wiring* for the power supply input currents for each motor, and then add the current consumption for the number of shafts, other controllers, etc., to make the selection.

The Servo Driver inrush current flows at a maximum of 50 A for 20 ms when 200 V is input. With low-speed no-fuse breakers, a inrush current 7 to 8 times the rated current flows for 0.1 second. When making the selection, take into consideration the entire inrush current for the system.

● 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. The surge absorbers shown in the following table are recommended.

Maker	Model	Varistor voltage	Max. limit voltage	Surge immunity	Energy resistance	Type
Matsushita Electric Parts	ERZC20EK471(W)	470 V	775 V	5,000 A	150 J	Block
	ERZC25EK471(W)	470 V	775 V	10,000 A	225 J	
	ERZC32EK471(W)	470 V	775 V	20,000 A	405 J	
Ishizuka Electronics Co.	Z25M471S	470 V	810 V	10,000A	235 J	Block
	Z33M471S	470 V	810 V	20,000 A	385 J	

Note 1. The (W) for the Matsushita models indicates that they are UL and CSA certified.

Note 2. Refer to manufacturers documentation for operating details.

Note 3. 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.

Note 4. The energy resistance is the value for 2 ms. It may not be possible to retard high-energy pulses at less than 700 V. In that case, absorb surges with an insulated transformer or reactor.

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● Noise Filters for Power Supply Input

Use a noise filter to attenuate extraneous noise and to diminish noise radiation from the Servo Driver. Select a noise filter with a load current of at least twice the rated current. The following table shows noise filters that reduce by 40 dB noise between 200 kHz and 30 MHz.

Type	Model	Rated current	Maker
Single-phase	GT-2050	5 A	Tokin
	ZAC2206-11	6 A	TDK
Three-phase	LF-315K	15 A	Tokin
	LF-325K	25 A	
	LF-335K	35 A	
	LF-380K	80 A	
	ZCW2210-01	10 A	TDK
	ZCW2220-01	20 A	
	ZCW2230-01	30 A	
	ZCW2240-01	40 A	
	ZACT2280-ME	80 A	

To attenuate noise at frequencies of 200 kHz or less, use an insulated transformer and a noise filter. For high frequencies of 30 MHz or more, use a ferrite core and a high-frequency noise filter with a through-type capacitor.

● Noise Filters for Motor Output

Use noise filters without built-in capacitors on the Servomotor output lines. Output lines cannot use the same noise filters as the power supply. The following table shows the noise filters that are recommended for motor output.

Maker	Model	Rated current	Remarks
Tokin	LF-310KA	10 A	Three-phase block noise filter
	LF-320KA	20 A	
	LF-350KA	50 A	

Note 1. The 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 3.3 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.

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● Surge Killers

Install surge killers 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 relatively small devices such as relays used for loads when reset time is not an issue. The reset time is increased because the surge voltage is the lowest when power is cut off. Used for 24/48-VDC systems.	Use a fast-recovery diode with a short reverse recovery time. Fuji Electric Co., ERB44-06 or equivalent
Thyristor or Varistor	Thyristor and varistor 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 that of the varistor.	Select varistor voltage as follows: 24-VDC system varistor: 39 V 100-VDC system varistor: 200 V 100-VAC system varistor: 270 V 200-VAC system varistor: 470 V
Capacitor + resistor	Use capacitors and resistors for vibration absorption of surge when power is cut off. The reset time can be shortened by proper selection of the capacitor or resistor.	Okaya Electric Ind. CR-50500 0.5 μF-50 Ω CRE-50500 0.5 μF-50 Ω S2-A-0 0.2 μF-500 Ω

Note Thyristors and varistors are made by the following companies. Refer to manufacturers documentation for operating details. Thyristors: Ishizuka Electronics Co.
Varistors: Ishizuka Electronics Co., Matsushita Electric Parts

● Contactors

When selecting contactors, take into consideration the circuit's inrush current and the momentary maximum current. The Servo Driver inrush current is 50 A, and the momentary maximum current is approximately twice the rated current. The following table shows the recommended contactors.

Maker	Model	Rated current	Coil voltage
OMRON	LC1D25106	26 A	200 VAC
	LC1D40116	35 A	
	LC1D50116	50 A	
	LC1D80116	80 A	
	LP1D25106	26 A	24 VDC
	LP1D40116	35 A	
	LP1D50116	50 A	
	LP1D80116	80 A	

● Leakage Breakers

Select leakage breakers designed for inverters.
Since switching takes place inside the Servo Drivers, high-frequency current leaks from the armature of the motor.
With inverter leakage breakers, high-frequency current is not detected, preventing the breaker from operating due to leakage current.

When selecting leakage breakers, remember to also add the leakage current from devices other than the Servomotor, such as machines using a switching power supply, noise filters, inverters, and so on. When selecting leakage breakers, refer to the manufacturer's catalog.

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The following table shows leakage current of each Servomotor.

Driver	Leakage current (direct measurement) (including high-frequency current)	Leakage current (resistor/capacitor measurement) (commercial power supply frequency range)
R88D-UT24H R88D-UT40H	50 mA	6 mA
R88D-UT60H R88D-UT80H	70 mA	7 mA
R88D-UT110H R88D-UT120H	90 mA	8 mA

Note 1. The above leakage current is for cases where motor power line length is less than 10 m. (It varies depending on the power line length and insulation.)

Note 2. The above leakage current is for normal temperature and humidity. (It varies depending on the temperature and humidity.)

● AC Reactor

The AC Reactor is used for suppressing harmonic currents. The AC Reactor suppresses sudden and quick changes in electric currents.
In September 1994, the Ministry of International Trade and Industry established guidelines for the suppression of harmonic waves emitted from home and general electric appliances. In compliance with the guidelines, appropriate measures are required to suppress the influence of harmonic waves on power supply lines.
Select a proper AC Reactor model according to the Servo Driver.

Specifications of Applicable Models

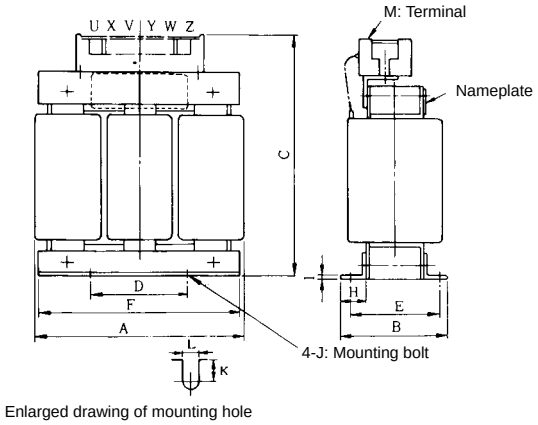
Servo Driver model	AC Reactor				
	Model	Rated current	Inductance	Loss	Weight
R88D-UT24H R88D-UT40H	3G3IV-PUZBAB10A1.1MH	10 A	1.1 mH	25 W	3 kg
R88D-UT60H	3G3IV-PUZBAB15A0.71MH	15 A	0.71 mH	30 W	3 kg
R88D-UT80H	3G3IV-PUZBAB20A0.53MH	20 A	0.53 mH	35 W	3 kg
R88D-UT110H R88D-UT120H	3G3IV-PUZBAB30A0.35MH	30 A	0.35 mH	45 W	3 kg

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Dimensions

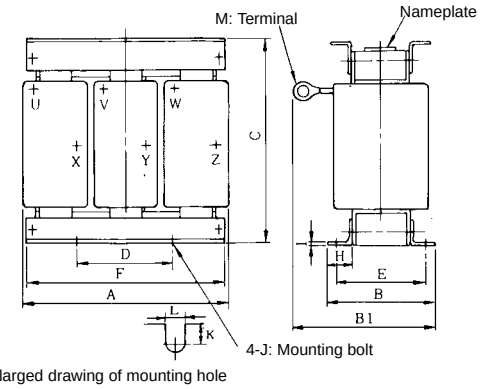
3G3IV-PUZBAB□	Drawing number of external dimensions	Dimension (mm)											
		A	B	B1	C	D	E	F	H	J	K	L	M
10A1.1MH	1	130	88	---	130	50	65	130	22	M6	11.5	7	M4
15A0.71MH		130	88	---	130	50	65	130	22	M6	11.5	7	M4
20A0.53MH	2	130	88	114	105	50	65	130	22	M6	11.5	7	M4
30A0.35MH		130	88	119	105	50	70	130	22	M6	9	7	M4

External Dimensions Drawing 1



Enlarged drawing of mounting hole

External Dimensions Drawing 2



Enlarged drawing of mounting hole

■ Improving Encoder Cable Noise Resistance

Signals from the encoder are either A, B, or S phase (Z phase). The frequency for A- or B-phase signals is either 307.2 kHz (if an incremental encoder is used) or 614.4 kHz (if an absolute encoder is used), while the transmission speed for S-phase signals is 1.23 Mbps. Follow the wiring methods outlined below to improve encoder noise resistance.

- Be sure to use dedicated encoder cables.
- If lines are interrupted in the middle, be sure to connect them with connectors, making sure that the cable insulation is not peeled off for more than 50 mm. In addition, be sure to use shielded wire.
- Do not coil cables. If cables are long and are coiled, mutual induction and inductance will increase and will cause malfunctions. Be sure to use cables fully extended.
- When installing noise filters for encoder cables, use clamp cables. The following table shows the recommended clamp filter models.

Maker	Name	Model
Tokin	EMI core	ESD-QR-25-1
TDK	Clamp filter	ZCAT2032-0930
		ZCAT3035-1330
		ZCAT2035-0930A

- Do not wire the encoder cable in the same duct as power cables and control cables for brakes, solenoids, clutches, and valves.

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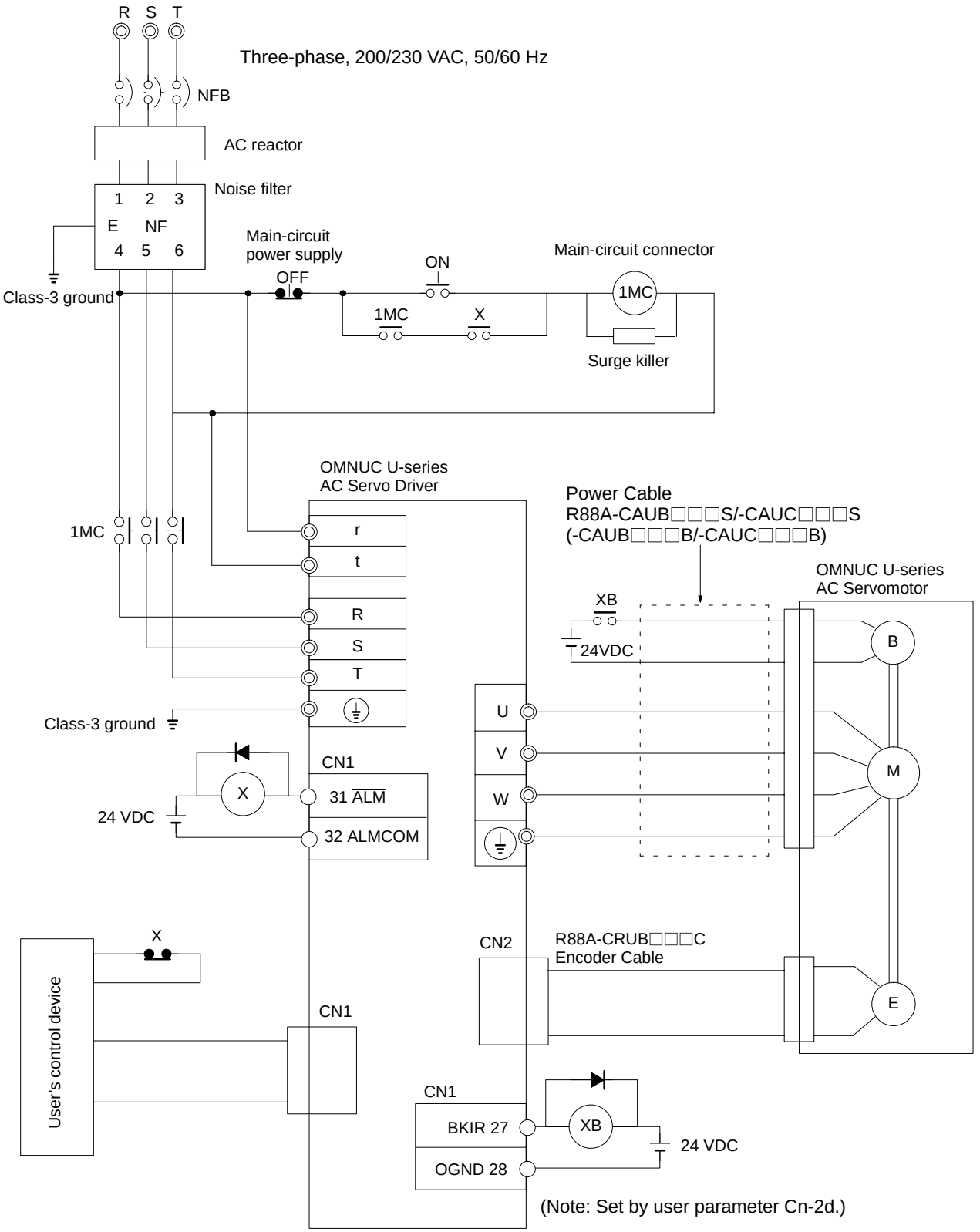
■ Improving Control I/O Signal Noise Resistance

Position can be affected if control I/O signals are 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, be careful not to connect two power supply ground wires. Install a noise filter on the primary side of the control power supply.
- As much as possible, keep the power supply for pulse command and deviation counter reset input lines separate from the control power supply. Be particularly careful not to connect the two power supply ground lines.
- It is recommended that a line driver be used for pulse command and deviation counter reset outputs.
- Be sure to use twisted-pair shielded wire for pulse command and deviation counter reset signal lines, and connect both ends of the wires to frame grounds.
- For speed and torque command input lines, be sure to use twisted-pair shielded cable, and connect both ends of the shield wire to ground.
- 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 and the controller output section.
- For encoder output (A, B, and Z phase) lines, be sure to use twisted-pair shielded cable, and connect both ends of the shield wire to ground.
- For open collector specifications, keep the length of wires to within one meter.

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2-2-4 Peripheral Device Connection Examples



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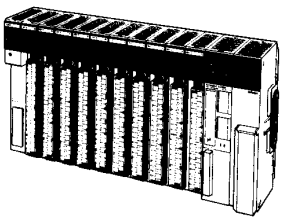
2-3 Wiring and Connections (Models Conforming to EC Directives)

2-3-1 Connecting OMRON Servo Controllers

Use general-purpose control cable (purchased separately) to connect U-series AC Servomotors and Servo Drivers to OMRON Servo Controllers.

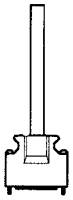
■ Connecting SYSMAC C-Series Position Control Units

Programmable Controller

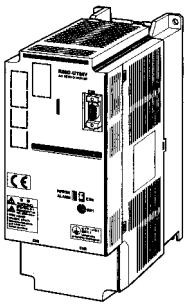


SYSMAC C/CV

Position Control Unit
C500-NC211 (Pulse train output)
C200HW-NC113 (Pulse train output)
C200HW-NC213 (Pulse train output)
C200HW-NC413 (Pulse train output)



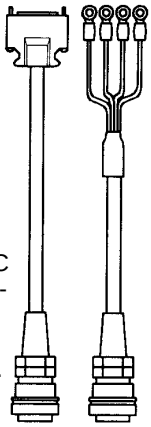
General-purpose Control Cable
R88A-CPUB□□□S



AC Servo Driver
R88D-UT□□V-□

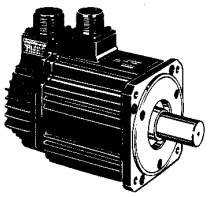
Encoder Cable
R88A-CRUB□□□N

The cable is of IP30 construction. If more protection is required or to conform to the EC Directives, use the recommended connectors. Refer to *2-1-2 Installation Conditions*.



Power Cable
(1 kW to 2 kW)
R88A-CAUB□□□S (for motor without brake)
R88A-CAUB□□□B (for motor with brake)
(3 kW to 5 kW)
R88A-CAUC□□□S (for motor without brake)
R88A-CAUC□□□B (for motor with brake)

The cable is of IP30 construction. If more protection is required or to conform to the EC Directives, use the recommended connectors. Refer to *2-1-2 Installation Conditions*.

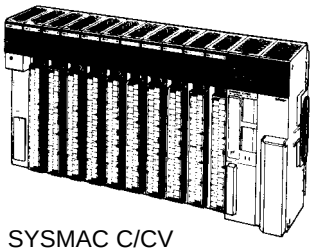


AC Servo Motor
R88M-U□□□30V-□S1 (with incremental encoder)

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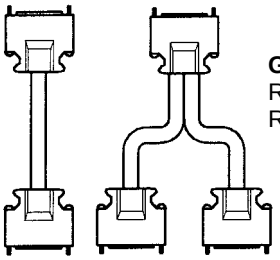
■ Connecting to SYSMAC C/CV-series Motion Control Units

Programmable Controller

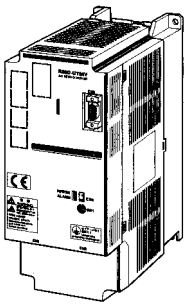


SYSMAC C/CV

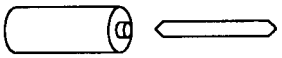
Motion Control Unit
CV500-MC221 (Analog output)
CV500-MC421-EV1 (Analog output)
C200H-MC221 (Analog output)



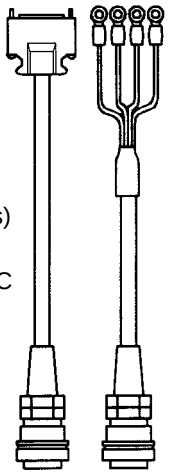
General-purpose Control Cable
R88A-CPUB□□□M1 (for single axis)
R88A-CPUB□□□M2 (for double axis)



AC Servo Driver
R88D-UT□□V-□



Back-up Battery
To be connected when using a motor with an absolute encoder



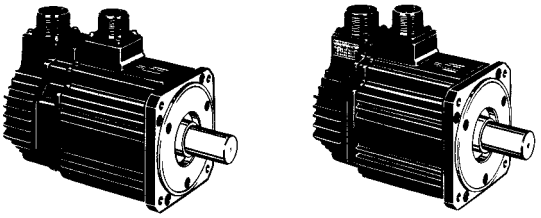
Power Cable
(1 kW to 2 kW)
R88A-CAUB□□□S (for motor without brake)
R88A-CAUB□□□B (for motor with brake)
(3 kW to 5 kW)
R88A-CAUC□□□S (for motor without brake)
R88A-CAUC□□□B (for motor with brake)

The cable is of IP30 construction. If more protection is required or to conform to the EC Directives, use the recommended connectors. Refer to *2-1-2 Installation Conditions*.

Encoder Cable
R88A-CRUB□□□N
(for both incremental and absolute encoders)

The cable is of IP30 construction. If more protection is required or to conform to the EC Directives, use the recommended connectors. Refer to *2-1-2 Installation Conditions*.

AC Servo Motor
R88M-U□□□30X-□S1 (with absolute encoder)
R88M-U□□□30V-□S1 (with incremental encoder)



Note Refer to *Chapter 5 Specifications* for connector and cable specifications.

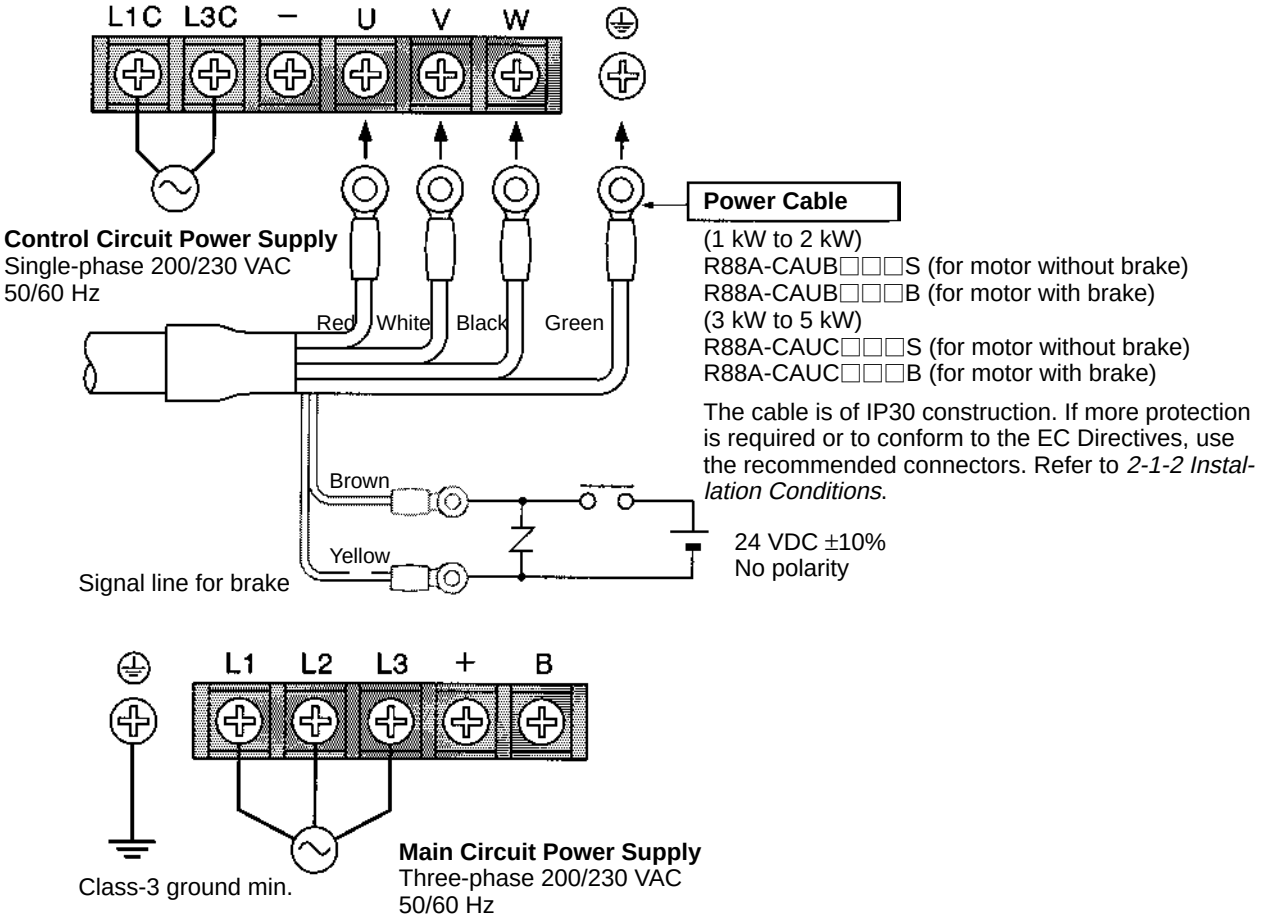
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2-3-2 Wiring Servo Drivers

Provide proper wire diameters, ground systems, and noise resistance when wiring terminal blocks.

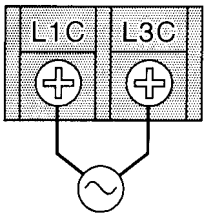
■ Wiring Terminal Blocks

- **R88D-UT24V-□/UT40V-□/UT60V-□/UT80V-□**

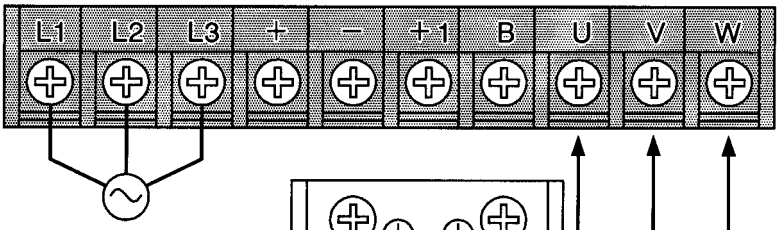


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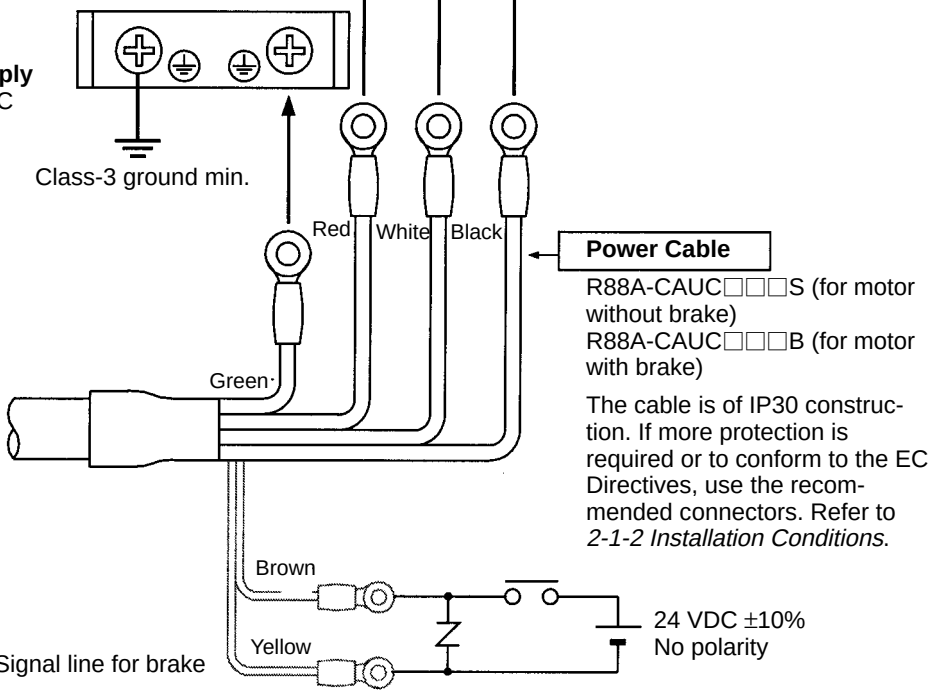
- **R88D-UT110V**



Control Circuit Power Supply
Single-phase 200/230 VAC
50/60 Hz



Main Circuit Power Supply
Three-phase 200/230 VAC
50/60 Hz



Power Cable

R88A-CAUC□□□S (for motor without brake)
R88A-CAUC□□□B (for motor with brake)

The cable is of IP30 construction. If more protection is required or to conform to the EC Directives, use the recommended connectors. Refer to *2-1-2 Installation Conditions*.

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Terminal label	Name	Function	
⏚	Frame ground	This is the ground terminal. Ground to a class-3 ground (to 100 Ω or less) or better.	
L1	Main circuit power supply input	Three-phase 200/230 VAC (170 to 253 V), 50/60 Hz	
L2			
L3			
L1C	Control circuit power supply input	Single-phase 200/230 VAC (170 to 253 V), 50/60 Hz	
L3C			
+ (+1)	Main circuit DC output (positive)	Be sure to connect a regenerative resistor (corresponding to the amount of regenerative energy) between the + and B terminals for the R88D-UT□V-RG and between the +1 and B terminals for the R88D-UT110V. Refer to *3-6-3 Absorption of Regenerative Energy with External Regenerative Resistors Connected to Models Complying with EC Directives* for details. Do not connect anything to these terminals of any other models.	
B			
–	Main circuit DC output (negative)		
U	Motor connection terminals	Red	These are the output terminals to the Servomotor. Be careful to wire them correctly.
V		White	
W		Black	
⏚	Frame ground	Green	

■ Terminal Block Current and Wire Sizes

The following table shows the rated effective currents flowing to the Servo Driver and the sizes of the electrical wires.

Driver (Watts)		R88D-UT24V-□ (1.0 kW)	R88D-UT40V-□ (1.5 kW)	R88D-UT60V-□ (2.0 kW)	R88D-UT80V-□ (3.0 kW)	R88D-UT110V (4.0 kW)	R88D-UT110V (5.0 kW)
Main circuit power supply input (L1, L2, L3)	Effective current	6.6 A	9.2 A	13.0 A	18.4 A	24.0 A	28.0 A
	Wire size	3.5 mm^2 or AWG 12 min.			5.5 mm^2 or AWG 10 min.		
Control circuit power supply input (L1C, L3C)	Effective current	0.25 A	0.25 A	0.25 A	0.25 A	0.25 A	0.25 A
	Wire size	1.25 mm^2 or AWG 16 min.					
Motor connection terminal (U, V, W)	Effective current	6.1 A	9.9 A	12.0 A	19.4 A	25.3 A	26.2 A
	Wire size	3.5 mm^2 or AWG 12			5.5 mm^2 or AWG 10 min.		
		Use OMRON standard cables.					
	Motor connector's applicable cable size	AWG 14 to AWG 12			AWG 10 to AWG 8		
Frame ground	Wire size	Use 2.0-mm^2 external ground wires. Use the same wire as used for the motor output.					
Terminal block screw size		M4					

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■ Wire Sizes and Allowable Current

The following table shows allowable currents when there are three electrical wires. Use values equal to or lower than the specified values.

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

AWG size	Nominal cross-sectional area (mm^2)	Configuration (wires/mm^2)	Conductive resistance (Ω/km)	Allowable current (A) for ambient temperature		
				30°C	40°C	50°C
16	1.25	7/0.45	17.5	16	14	11
14	2.0	7/0.6	9.53	23	20	16
12	3.5	7/0.8	5.41	33	29	24
10	5.5	7/1.0	3.47	43	38	31
8	8.0	7/1.2	2.41	55	49	40
6	14.0	7/1.6	1.35	79	70	57

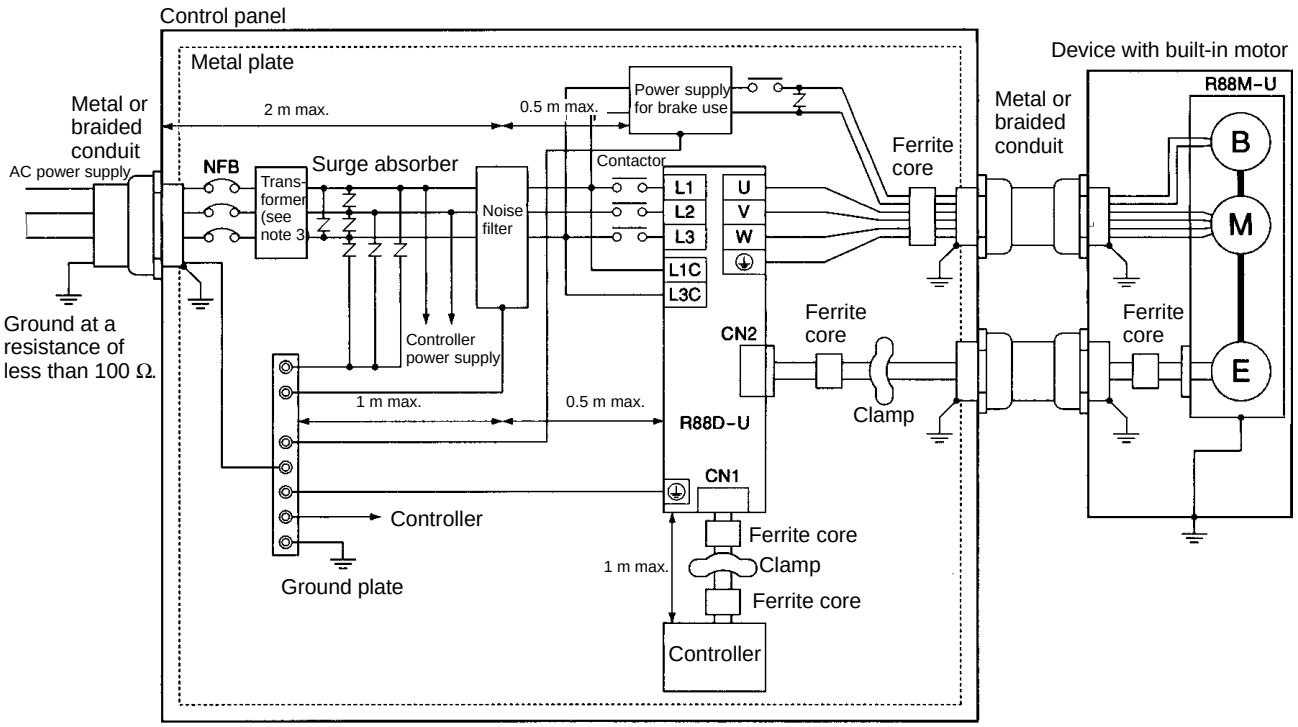
2-3-3 Wiring Conditions Satisfying EMC Directives

Models complying with EC Directives must abide by the following wiring conditions to satisfy EMC Directive EN55011 (EMI) Class A, group I and EN50082-2 requirements (EMS).
If the models cannot abide by the conditions because the models are built into equipment, the equipment must be completely examined to make sure that the equipment satisfies EC Directives.

- The Servo Driver must be mounted to a metal panel (i.e., a control panel).
- The power supply line must be connected to a noise filter and a surge absorber to protect the power supply lines from lightning or any other surge.
- The I/O signal and encoder signal lines must be constructed of cables with braided shield wire made of tin-coated annealed copper.
- Any cable from the control panel must be protected with a metal conduit or braided conduit.
- All cables with braided shield wire must be attached with ferrite cores and the shield wire must be grounded directly to the ground plate from the clamps.
- The power supply must be equipped with a transformer if the Servo Driver is a 4- or 5-kW model.

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■ Wiring Method



Note 1. The cables must be coiled around each ferrite core by 1.5 turns.

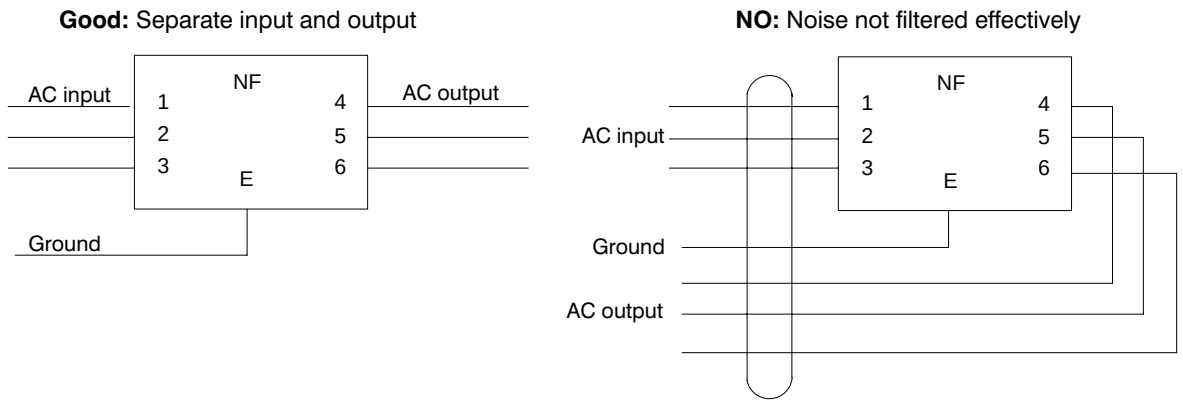
Note 2. At the clamp positions, the shield wire of the cables must be stripped and grounded directly to the ground plate.

Note 3. The power supply must be equipped with a transformer if the Servo Driver is a 4- or 5-kW model.

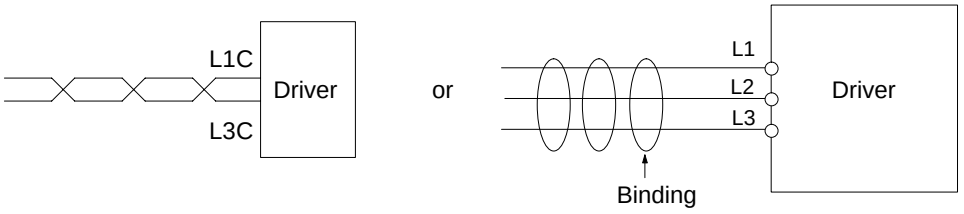
- Ground the motor's frame to the machine ground when the motor is on a movable shaft.
- Use a grounding plate for grounding the protective earth (PE) terminal of each Unit as shown in the illustration, and ground to a single point.
- Use ground lines with a minimum thickness of 3.5 mm^2, and arrange the wiring so that the ground lines are as short as possible.
- 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.
- 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 means possible.

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- 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 panel whenever possible.



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



- Separate power supply cables and signal cables when wiring.

■ Construction of Control Panel

The control panel will leak electromagnetic energy or permit the interior of the control panel to be affected by external electromagnetic fields if there is a space around any cable inlet or outlet, mounting hole, or door of the control panel. To prevent electromagnetic energy leakage from the control panel or external electromagnetic influence on the interior of the control panel, follow the instructions below before designing or selecting the control panel.

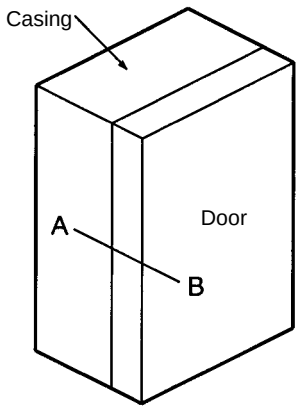
● Casing Construction

- The control panel must be made of metal plates, each of which must be connected by welding so that the plates will be all in contact together electrically.
- If the control panel is an assembly type consisting of metal plates connected to one another with screws, be sure to remove the surface paint coating of each joint portion so that the plates will be all in contact together electrically.
- Be sure to tighten the screws properly so that the metal plates will not be warped.
- Make sure that control panel has no part that is electrically isolated.
- All units mounted inside the control panel must be grounded to the control panel.

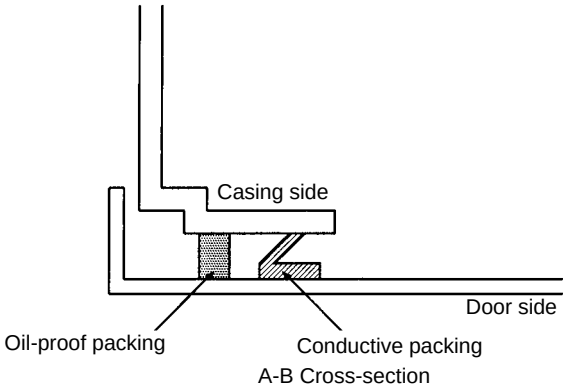
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● Door Construction

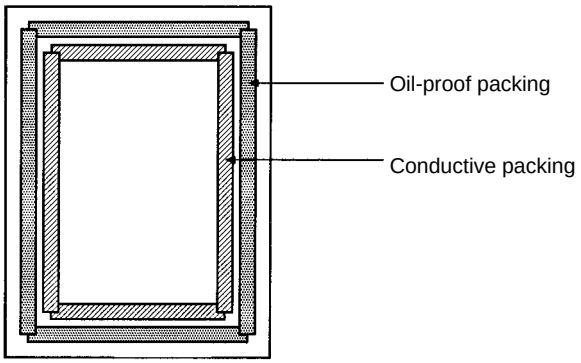
- The door must be made of metal.
- The space between the door and casing must be of watertight construction as shown below.
- Apply conductive packing to the space between the casing and door as shown below.
  Be sure to remove the surface paint coating of the portion of the casing and that of the door coming into contact with the conductive packing so that the door, conductive packing, and casing will be all in contact electrically.
- Be sure to tighten the screws properly so that the metal plates of the control panel will not be warped.



Control panel



A-B Cross-section



Door (inner side)

■ Selecting Components

This section describes standards to be considered when selecting components to be connected to reduce noise. Select components after reviewing characteristics such as capacities, performance, and application ranges. Recommended components are listed below for reference. For further details, consult the respective manufacturer.

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● No-fuse Breakers (MCCB)

When selecting no-fuse breakers, take into consideration the maximum input current and the inrush current. The momentary maximum output for a servo system is approximately three times that of the rated output, and a maximum output of three seconds can be executed. 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. Refer to the table in *2-2-2 Terminal Block Wiring* for the power supply input currents for each motor, and then add the current consumption for the number of shafts, other controllers, etc., to make the selection.

The Servo Driver inrush current flows at a maximum of 50 A for 20 ms when 200 V is input. With low-speed no-fuse breakers, a inrush current 7 to 8 times the rated current flows for 0.1 second. When making the selection, take into consideration the entire inrush current for the system.

● 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 the 200-VAC series, use one with 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 Ind.	R.A.V-781BYZ-2	783 V	1,000 A	Block	Between power lines
	R.A.V-781BXZ-4	783 V	1,000 A		Between the power line and grounding

Note **1.** Refer to 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

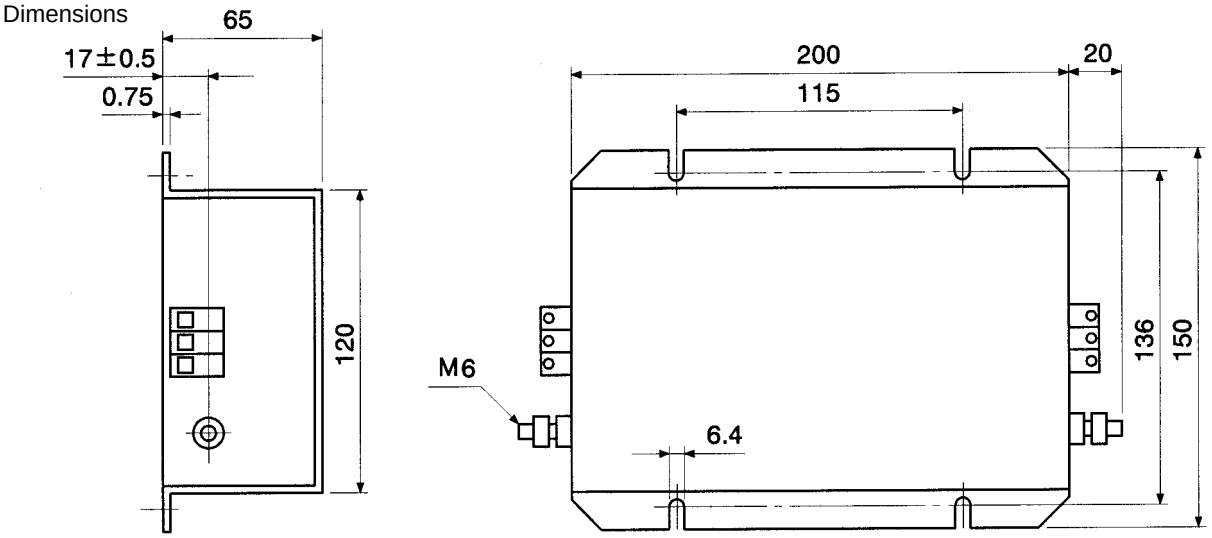
Apply one of the following Schaffner Noise Filters to the power supply for the Servo Driver.

Application	Model	Rated current (at 40 °C)	Rated voltage	Test voltage	Leakage current (at 400 V, 50 Hz max.) (See note)
1.0/1.5 kW	FN351-16/29	16 A	440 V	2,250 VDC for 2 seconds between the terminal and case 1,100 VDC for 2 seconds between the terminals	17.5 mA
2.0 kW	FN351-25/29	25 A			160 mA
3.0 kW	FN351-36/33	36 A			160 mA
4.0/5.0 kW	FN351-50-33	50 A			175 mA

Note The leakage current values shown in the table indicate those for star-connection (Y-connection) three-phase power supply. For the delta-connection (Δ-connection) power supply, the values may become larger than those shown in the table.

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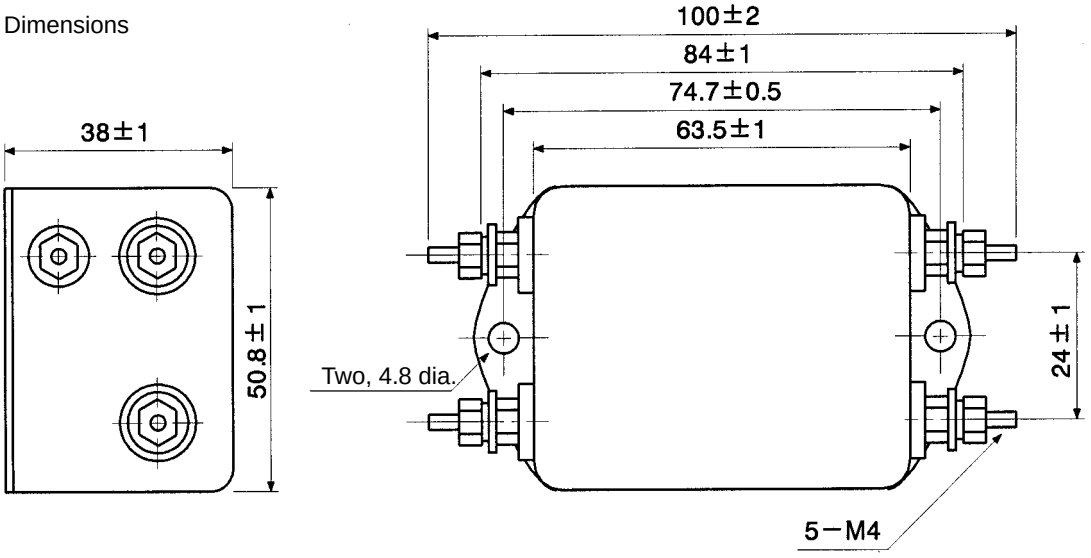
Dimensions



Use the following noise filter on the power supply for the brake. This filter is manufactured by Okaya Electric Ind.

Model	SUP-P5H-EPR-4
Rated current	5 A
Test voltage	Between terminals and case: 2,000 V rms, 50/60 Hz, 60 s Between terminals: 1,250 V rms, 50/60 Hz, 60 s
Insulation resistance	Between terminals and case: 6,000 MΩ min. (at 500 VDC)
Leakage current	0.6 mA (at 250 V rms 60 Hz)
Attenuation characteristics	Normal mode: 0.5 to 30 MHz Common mode: 0.2 to 30 MHz

Dimensions



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● Surge Killers

Install surge killers 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 relatively small devices such as relays used for loads when reset time is not an issue. The reset time is increased because the surge voltage is the lowest when power is cut off. Used for 24/48-VDC systems.	Use a fast-recovery diode with a short reverse recovery time. Fuji Electric Co., ERB44-06 or equivalent
Thyristor or Varistor	Thyristor and varistor 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 that of the varistor.	Select varistor voltage as follows: 24-VDC system varistor: 39 V 100-VDC system varistor: 200 V 100-VAC system varistor: 270 V 200-VAC system varistor: 470 V
Capacitor + resistor	Use capacitors and resistors for vibration absorption of surge when power is cut off. The reset time can be shortened by proper selection of the capacitor or resistor.	Okaya Electric Ind. CR-50500 0.5 μF-50 Ω CRE-50500 0.5 μF-50 Ω S2-A-0 0.2 μF-500 Ω

Note Thyristors and varistors are made by the following companies. Refer to manufacturers documentation for operating details. Thyristors: Ishizuka Electronics Co.
Varistors: Ishizuka Electronics Co., Matsushita Electric Parts

● Contactors

When selecting contactors, take into consideration the circuit's inrush current and the momentary maximum current. The Servo Driver inrush current is 50 A, and the momentary maximum current is approximately twice the rated current. The following table shows the recommended contactors.

Maker	Model	Rated current	Coil voltage
OMRON	LC1D25106	26 A	200 VAC
	LC1D40116	35 A	
	LC1D50116	50 A	
	LC1D80116	80 A	
	LP1D25106	26 A	24 VDC
	LP1D40116	35 A	
	LP1D50116	50 A	
	LP1D80116	80 A	

● Leakage Breakers

Select leakage breakers designed for inverters.
Since switching takes place inside the Servo Drivers, high-frequency current leaks from the armature of the motor.
With inverter leakage breakers, high-frequency current is not detected, preventing the breaker from operating due to leakage current.

When selecting leakage breakers, remember to also add the leakage current from devices other than the Servomotor, such as machines using a switching power supply, noise filters, inverters, and so on. When selecting leakage breakers, refer to the manufacturer's catalog.

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The following table shows leakage current of each Servomotor.

Driver	Leakage current (direct measurement) (including high-frequency current)	Leakage current (resistor/capacitor measurement) (commercial power supply frequency range)
R88D-UT24V-□ R88D-UT40V-□	50 mA	6 mA
R88D-UT60V-□ R88D-UT80V-□	70 mA	7 mA
R88D-UT110V	100 mA	12 mA

Note 1. The above leakage current is for cases where motor power line length is less than 10 m. (It varies depending on the power line length and insulation.)

Note 2. The above leakage current is for normal temperature and humidity. (It varies depending on the temperature and humidity.)

■ Improving Encoder Cable Noise Resistance

Signals from the encoder are either A, B, or S phase (Z phase). The frequency for A- or B-phase signals is either 307.2 kHz (if an incremental encoder is used) or 614.4 kHz (if an absolute encoder is used), while the transmission speed for S-phase signals is 1.23 Mbps. Follow the wiring methods outlined below to improve encoder noise resistance.

- Be sure to use dedicated encoder cables.
- If lines are interrupted in the middle, be sure to connect them with connectors, making sure that the cable insulation is not peeled off for more than 50 mm. In addition, be sure to use shielded wire.
- Do not coil cables. If cables are long and are coiled, mutual induction and inductance will increase and will cause malfunctions. Be sure to use cables fully extended.
- When installing noise filters for encoder cables, use clamp cables. The following table shows the recommended clamp filter models.

Maker	Name	Model
Tokin	EMI core	ESD-QR-25-1
TDK	Clamp filter	ZCAT2032-0930
		ZCAT3035-1330
		ZCAT2035-0930A

- Do not wire the encoder cable in the same duct as power cables and control cables for brakes, solenoids, clutches, and valves.

■ Improving Control I/O Signal Noise Resistance

Position can be affected if control I/O signals are influenced by noise. Follow the methods outlined below for the power supply and wiring.

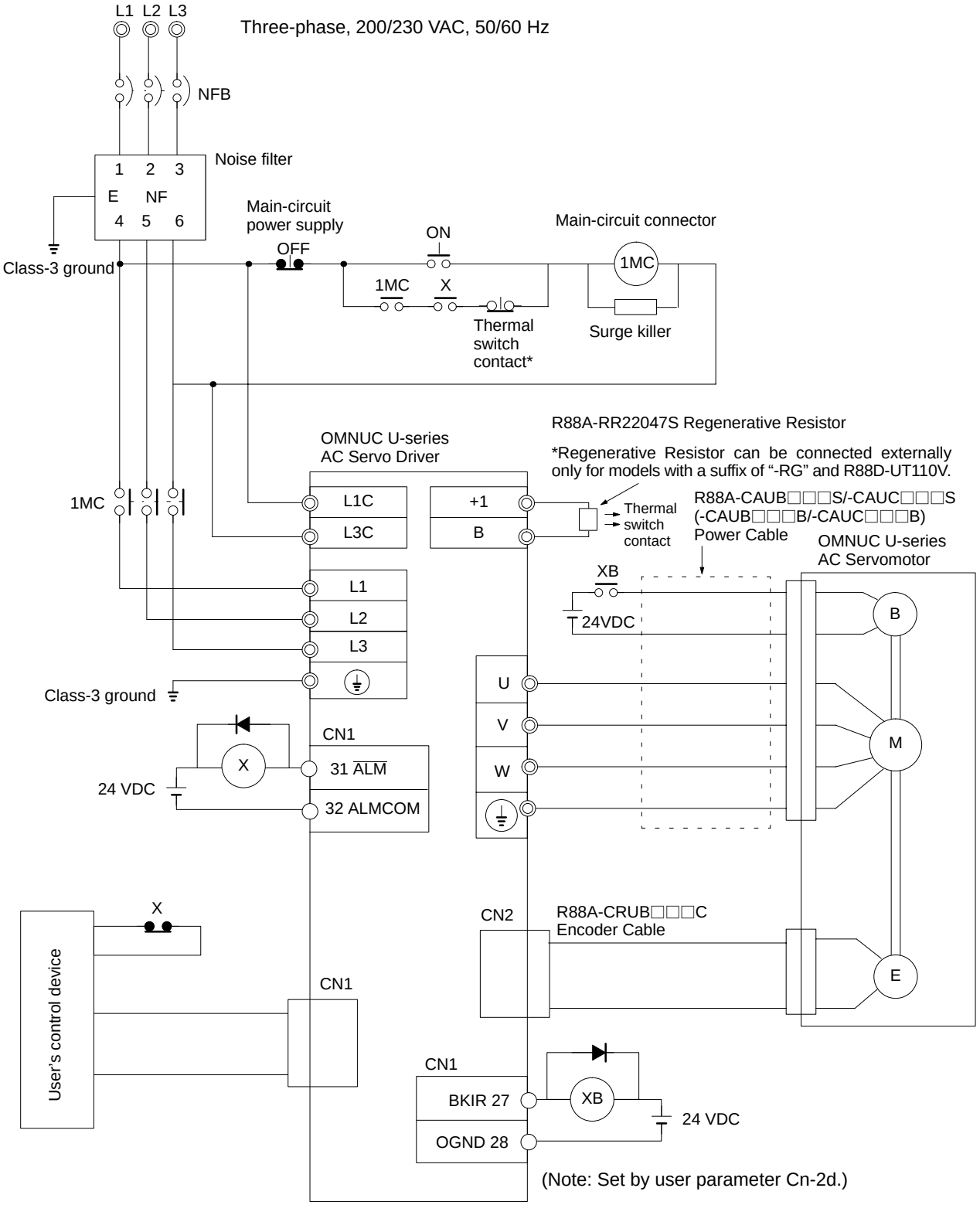
- Use completely separate power supplies for the control power supply (especially 24 VDC) and the external operation power supply. In particular, be careful not to connect two power supply ground wires. Install a noise filter on the primary side of the control power supply.
- As much as possible, keep the power supply for pulse command and deviation counter reset input lines separate from the control power supply. Be particularly careful not to connect the two power supply ground lines.

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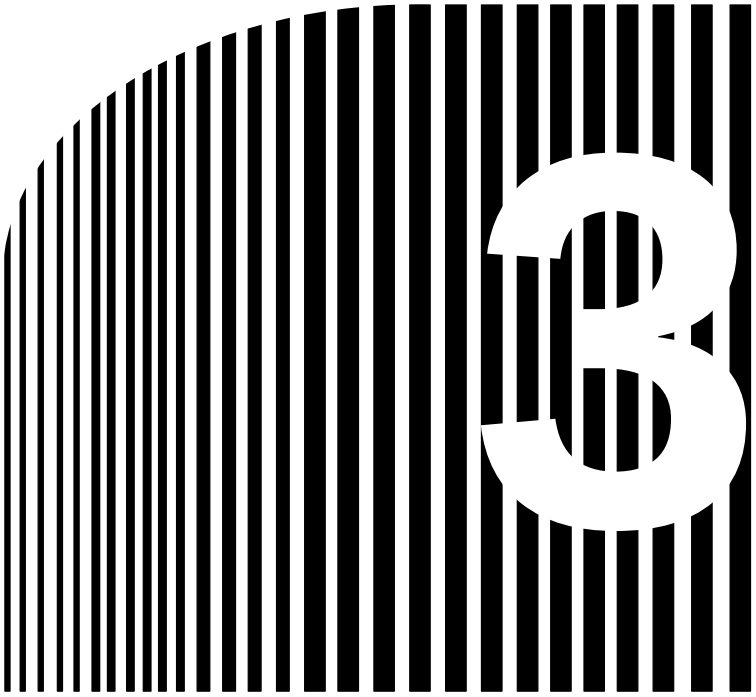
- It is recommended that a line driver be used for pulse command and deviation counter reset outputs.
- Be sure to use twisted-pair shielded wire for pulse command and deviation counter reset signal lines, and connect both ends of the wires to frame grounds.
- For speed and torque command input lines, be sure to use twisted-pair shielded cable, and connect both ends of the shield wire to ground.
- 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 and the controller output section.
- For encoder output (A, B, and Z phase) lines, be sure to use twisted-pair shielded cable, and connect both ends of the shield wire to ground.
- For open collector specifications, keep the length of wires to within one meter.

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2-3-4 Peripheral Device Connection Examples



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Chapter 3

• Operation •

3-1 Beginning Operation
3-2 System Check Mode (Cn-00)
3-3 Function Settings
3-4 Trial Operation
3-5 Making Adjustments
3-6 Regenerative Energy Absorption

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Operation and Adjustment Precautions

⚠ **Caution** Check the newly set parameters 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 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** Do not use the built-in brake of the Servomotor for ordinary braking. Doing so may result in malfunction.

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3-1 Beginning Operation

3-1-1 Operational Procedure

Before beginning operation, be sure to make the initial settings for the Servo Driver. Make function settings as required according to the use of the Servomotor.

■ Startup Procedure

1. Mounting and installation

   Install the Servomotor and Servo Driver according to the installation conditions: **Chapter 2, section 2-1.**

2. Wiring and connections

   Connect to power supply and peripheral devices. Specified installation and wiring requirements must be satisfied, particularly for models conforming to the EC Directives: **Chapter 2, sections 2-2 and 2-3.**

3. Turning on power supply

   Before turning on the power supply, check the necessary items. In order to make the initial settings, turn on an application power supply: **Chapter 3, section 3-1-2 and Chapter 4, section 4-1.**

4. Checking display status

   Check by means of the displays to see whether there are any internal errors in the Servo Driver: **Chapter 3, section 3-1-2**

5. Initial settings

   Make the settings for the operation setup parameters (initial settings): **Chapter 3, section 3-3-1.**

6. Function settings

   By means of the user parameters, set the functions according to the operating conditions: **Chapter 3, section 3-3-2.**

7. Trial operation

   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: **Chapter 3, section 3-4.**

8. Adjustments

   Execute auto-tuning. Manually adjust the gain as required: **Chapter 3, section 3-5.**

9. Operation

   Operation can now begin. If any trouble should occur, refer to Chapter 4 Application: **Chapter 4.**

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3-1-2 Turning On Power and Checking Displays

■ Items to Check Before Turning On Power

● Checking Power Supply Voltage

- Check to be sure that the power supply voltage is within the ranges shown below.

Main-circuit power supply: Three-phase 200/230 VAC (170 to 253 V) 50/60 Hz

Control-circuit power supply: Single-phase 200/230 VAC (170 to 253 V) 50/60 Hz

● Checking Terminal Block Wiring

- The main-circuit power supply inputs (R/S/T or L1/L2/L3) and the control-circuit power supply inputs (r/t or L1C/L3C) must be properly connected to the terminal block.
- The Servomotor's red (U), white (V), and black (W) power lines and the 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 power line connectors at the Servomotor must be securely connected.

● Checking the Encoder Connectors

- The encoder connectors (CN2) at the Servo Driver must be securely connected.
- The encoder connectors at the Servomotor must be securely connected.

● Checking the Control Connectors

- The control connectors must be securely connected.
- The operation command (RUN) must be OFF.

● Checking Parameter Unit Connections

- The Parameter Unit (R88A-PR02U or R88A-PR03U) must be securely connected to the CN3 connector.

■ Turning On Power

- First carry out the preliminary checks, and then turn on the control-circuit power supply. It makes no difference whether or not the main-circuit power supply is also turned on.

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■ Checking Displays

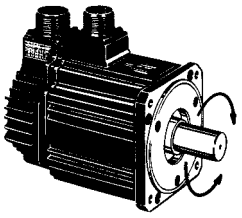
- When the power is turned on, one of the codes shown below will be displayed.

Normal (Base Block)	Error (Alarm Display)
-. bb	-. A.02

Note 1. "Baseblock" means that the Servomotor is not receiving power.

Note 2. The alarm code (the number shown in the alarm display) changes depending on the contents of the error.

- If the display is normal (i.e., no errors), use it as a monitor mode speed display. Manually turn the Servomotor shaft clockwise and counterclockwise, and check to be sure that it agrees with the positive and negative on the speed display. If it does not agree, then the encoder signal line may be wired incorrectly.



Reverse rotation

Forward rotation

Display example

0038 - - - Forward rotation

-0025 - - - Reverse rotation

Note To monitor the speed feedback value, press the MODE/SET Key and go into monitor mode Un-00. Then press the DATA Key.

- If there is an error, refer to *Chapter 4 Application* and take the necessary countermeasures.

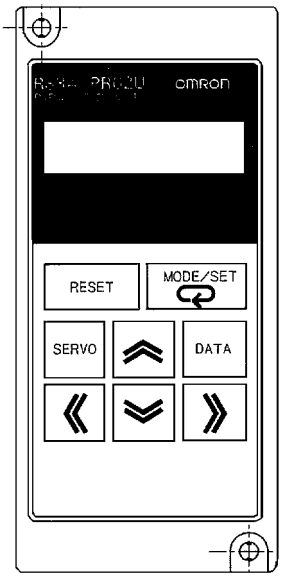
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3-1-3 Using Parameter Units

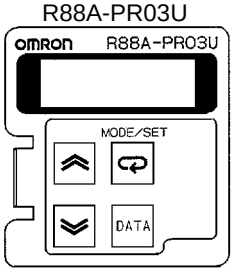
The key operations for the Handy-type R88A-PR02U and the Mounted-type R88A-PR03U vary depending on the functions used. The same settings and operations are possible with either Parameter Unit.

■ Parameter Unit Keys and Functions

Handy-type
R88A-PR02U



Mounted-type
R88A-PR03U



PR02U	PR03U	Function
RESET	∧ + ∨	Alarm reset
↩	↩	Mode switching Data memory
SERVO	DATA	Servo ON/OFF during jog operations
DATA	DATA	Switching between parameter display and data display; data memory
∧	∧	Increments parameter numbers and data values.
∨	∨	Decrements parameter numbers and data values.
≪		Left shift for operation digits
≫		Right shift for operation digits

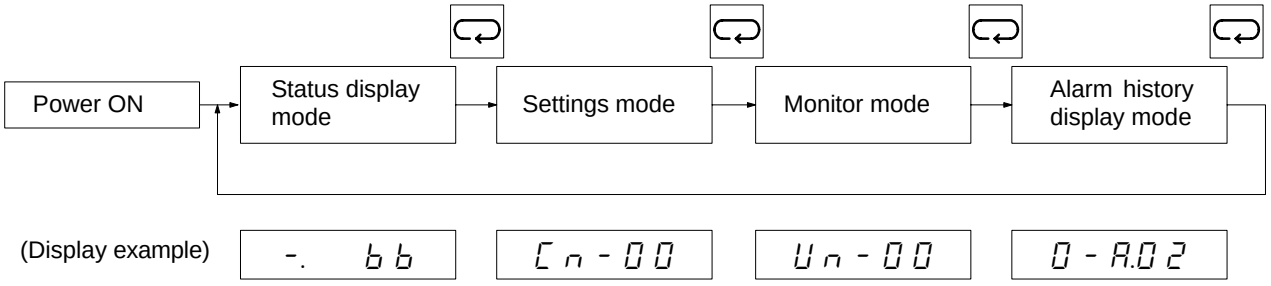
■ Modes

Mode	Function
Status display mode	Bit display: Control-circuit power supply ON display, main-circuit power supply ON display, baseblock, in position, speed conformity, rotation detection, command pulses being input, speed command being input, torque command being input, deviation counter reset signal being input Symbol display: Baseblock, operating, forward rotation prohibited, reverse rotation prohibited, alarm display
Settings mode	System check: Jog operations, command offset automatic adjustment, alarm history data clear, command offset manual adjustment, motor parameters check, auto-tuning Setting and checking setup parameters Setting and checking user parameters
Monitor mode	Speed feedback, speed commands, torque commands, number of pulses from U-phase, electrical angle, internal status bit display, command pulse speed display, position displacement, input pulse counter
Alarm history display mode	Displays contents of alarms that have been previously generated (up to a maximum of 10).

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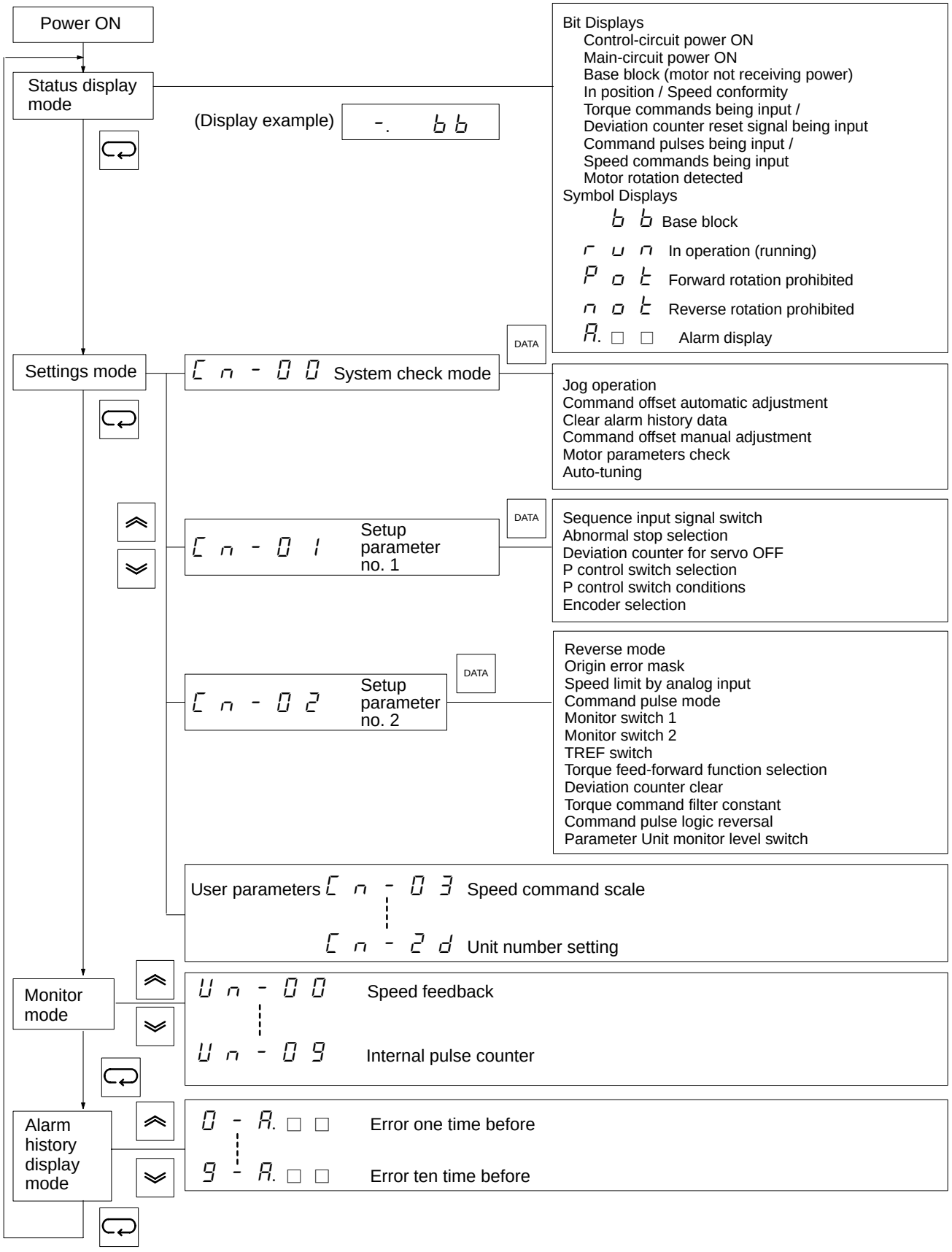
■ Changing Modes

To change modes, press the MODE/SET Key.



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■ Mode Changes and Display Contents



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3-2 System Check Mode (Cn-00)

The various kinds of system checks can be carried out by setting data for parameter Cn-00.

In system check mode, the following six kinds of checks can be carried out according to the data set for Cn-00. This chapter explains these checks only in a general way. For details, see the references noted in the table below.

Set value	Contents of check	Explanation	References
00	Jog operation	The motor can be operated by the Parameter Unit. The rotation speed is set by user parameter Cn-10 (jog speed).	Section 3-4
01	Command offset automatic adjustment	Automatically adjusts speed command and torque command input offset. Treat speed command and torque command inputs as 0 V.	Section 3-5-3
02	Alarm history data clear	Clears history data for alarms that were previously generated.	Section 4-4-1
03	Command offset manual adjustment	Speed command input offset is adjusted manually.	Section 3-5-3
04	Motor parameter check	Checks whether the Servo Driver and Servomotor are correctly aligned.	Section 4-2-4
05	Auto-tuning	Operates the motor and automatically adjusts the position loop gain, speed loop gain, and speed loop integration constant. The rotation speed is 1/2 of that set by the user parameter Cn-10 (jog speed).	Section 3-5-1

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3-3 Function Settings

3-3-1 Setting and Checking Setup Parameters (Cn-01, 02)

Setup parameters are parameters that are essential for starting up the system. They include I/O signal function changes, selection of processing for momentary stops and errors, control mode changes, and so on. Set them to match the user system.
Once the parameters have been set, they become effective when the power supply is turned on again after having been turned off. (Check to see that the LED display has gone off.)

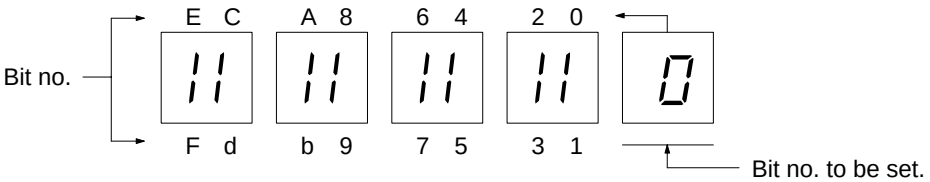
■ Displaying Setup Parameters

To display the contents of setup parameters, execute the following key operations.

- To go into settings mode (Cn-00), press the MODE/SET Key.
- To display the setup parameter number (Cn-01 or Cn-02), press the Up and Down keys.
- To display the contents of the setup parameter, press the DATA key.

■ Setting Setup Parameters

The contents of the setup parameters are displayed as follows:



In the leftmost four digits, 16 bits of information are displayed. In the rightmost digit, the bit number that can be set is displayed. It can be checked whether the bit information is “0” (not lit) or “1” (lit), according to the 7-segment LED vertical bar. To change the set value, first set the bit number in the rightmost digit, and then set the appropriate bit to “0” or “1.”

● Making Settings with Handy-type (R88A-PR02U)

1. Use the Right and Left Keys to display in the rightmost digit the bit number that is to be set.
2. Using the Up (or Down) Key, reverse the lit/not lit status of the appropriate bit number. For “lit,” set the bit number to “1.” For “not lit,” set it to “0.”
3. Repeat steps 1 and 2 above as required.
4. Save the data in memory by pressing the MODE/SET Key (or the DATA Key).
5. With this, the parameter setting operation is complete. Pressing the DATA Key at this point will bring back the parameter number display.
6. To go from the settings mode to the monitor mode, press the MODE/SET Key.

● Making Settings with Mounted-type (R88A-PR03U)

1. Use the Up and Down Keys to display in the rightmost digit the bit number that is to be set.
2. Using the MODE/SET Key, reverse the lit/not lit status of the appropriate bit number. For “lit,” set the bit number to “1.” For “not lit,” set it to “0.”
3. Repeat steps 1 and 2 above as required.
4. Save the data in memory by pressing the DATA Key.
5. With this, the parameter setting operation is complete. Pressing the DATA Key at this point will bring back the parameter number display.
6. To go from the settings mode to the monitor mode, press the MODE/SET Key.

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■ Setup Parameter Contents

● Setup Parameter No. 1 (Cn-01)

Item	Bit no.	Factory setting	Setting	Explanation
Sequence input signal switching	0	0	0	Servo turned ON or OFF by Run command (externally input).
			1	Servo always ON.
	1 [Absolute]	0	0	Enables sensor-on input (externally input).
			1	Automatically regards as high level internally, regardless of sensor-on input signal.
	2	1	0	Enables forward drive prohibit input (POT).
			1	Permits always-forward drive.
	3	1	0	Enables reverse drive prohibit input (NOT).
			1	Permits always-reverse drive.
	4	0	——	Not used.
	5	0	——	Not used.
Abnormal stop selection	6	1	0	Motor stopped by dynamic brake.
			1	Motor stopped with free run.
	7 (Note 1)	(Note 3)	0	Dynamic brake OFF after motor stopped.
			1	Dynamic brake ON after motor stopped.
	8	0	0	Method for stopping when over-travel occurs depends on bit no. 6 setting.
			1	When over-travel occurs, motor is stopped at the torque set by user parameter Cn-06 (emergency stop torque).
	9	0	0	When over-travel occurs, motor comes to deceleration stop and servo turns OFF.
			1	When over-travel occurs, motor comes to deceleration stop and position is locked.
Deviation counter for servo OFF	A	0	0	Deviation counter cleared when servo is OFF and alarm is generated.
			1	Deviation counter not cleared when servo is OFF and alarm is generated.
P control switch selection	b	1	0	Switch function enabled; follows bit nos. C, d.
			1	No switch function.
P control switch conditions	d, C (Note 4)	0, 0	0, 0	The torque command value (Cn-0C) is taken as the condition.
			0, 1	The speed command value (Cn-0d) is taken as the condition
			1, 0	The acceleration command value (Cn-0E) is taken as the condition.
			1, 1	The deviation pulse (Cn-0F) is taken as the condition.
Encoder selection	E [Absolute]	0	0	Incremental encoder
			1	Absolute encoder
	F	0	——	Not used.

Note 1. If set bit 6 to “1” and bit 8 to “0,” the dynamic brake relay will turn OFF after the Servomotor stops, regardless of the setting of bit no. 7.

Note 2. In the torque control mode, the method of stopping for errors depends on the setting of bit no. 6. The setting of bit no. 8 has no effect.

Note 3. The factory settings (i.e., the default settings) for Cn-01 bit no. 7 are as follows:

1: 1.0 kW and 1.5 kW motors

0: Motors of 2.0 kW and over.

The Cn-01 bit no. 7 setting is valid only for 1.0 kW and 1.5 kW motors.

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Note 4. With P control switch conditions, a change from PI control to P control is selected. This function is not valid for torque control.

Note 5. Do not change the settings of bit nos. 4, 5, and F of setup parameter no. 1 (Cn-01).

Note 6. These parameters become effective only after power is reset. Confirm that the indicators go out before turning power back on. (Check to see that the LED display has gone off.)

● Setup Parameter No. 2 (Cn-02)

Item	Bit no.	Factory setting	Setting	Explanation
Reverse rotation mode	0	0	0	CCW direction is taken upon "+" command. (See note 5.)
			1	CW direction is taken upon "+" command.
Origin error mask	1 [Absolute]	0	0	Origin errors are detected.
			1	Origin errors are not detected.
Speed limit by analog input (for torque control)	2	0	0	Disabled.
			1	Enabled.
Command pulse mode	5, 4, 3	0, 0, 1	0, 0, 0	Feed pulses / Forward/reverse signal
			0, 0, 1	Forward pulses / Reverse pulses
			0, 1, 0	90° phase difference (A/B phase) signal (x1)
			0, 1, 1	90° phase difference (A/B phase) signal (x2)
			1, 0, 0	90° phase difference (A/B phase) signal (x4)
Monitor switch 1	6	0	0	AM terminal is taken as current monitor output terminal.
			1	AM terminal is taken as speed command / command pulse speed monitor output terminal. (See note 3.)
Monitor switch 2	7	0	0	NM terminal is taken as speed monitor output terminal.
			1	NM terminal is taken as deviation counter monitor output terminal. (See note 4.)
TREF switch (for speed control)	8	0	0	Current limit is disabled by TREF.
			1	Current limit is enabled by TREF.
Torque feed-forward function selection (for speed control)	9	0	0	No torque feed-forward function.
			1	Torque feed-forward function enabled.
Deviation counter clear (for position control)	A	1	0	Deviation countered cleared by status (high level).
			1	Deviation countered cleared by differentiation (rising edge).
	b	0	——	Not used.
Torque command filter degree	C	0	0	Primary filter
			1	Secondary filter
Command pulse logic reversal (for position control)	d	0	0	Positive logic
			1	Negative logic
Parameter Unit monitor level switch (for position control)	E	0	0	Deviation monitor taken as x1 command units.
			1	Deviation monitor taken as x100 command units.
	F	0	——	Not used.

Note 1. Do not change the settings of bit nos. b and F of setup parameter no. 2 (Cn-02).

Note 2. Parameters other than bit nos. 6 and 7 of setup parameter no. 2 (Cn-02) become effective only after power is reset. Confirm that the indicators go out before turning power back on. (Check to see that the LED display has gone off.)

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Note 3. The function will vary depending on the control mode that is selected.

Position control:	Command pulse speed monitor (1 V/1,000 r/min)
Speed control:	Speed command monitor (1 V/1,000 r/min)
Torque control:	(Disabled: 0 V)

Note 4. The function will vary depending on the control mode that is selected.

Position control:	Deviation counter monitor (when 0.05 V/command unit: Cn-02 bit no. E = 0)
Speed control:	(Disabled: 0 V)
Torque control:	(Disabled: 0 V)

Note 5. CCW direction refers to counterclockwise rotation and CW direction refers to clockwise rotation when viewed from the motor output side.

● Important Setup Parameters (Cn-01 and Cn-02)

This section explains the particularly important setup parameters. If these parameters aren't set properly, the motor might not operate or might operate unpredictably. Set these parameters appropriately for the system being used.

Command Pulse Types (for Position Control, Cn-02 Bit Nos. 5, 4, and 3)

Set the command pulse mode for position control according to the pulse command configuration.

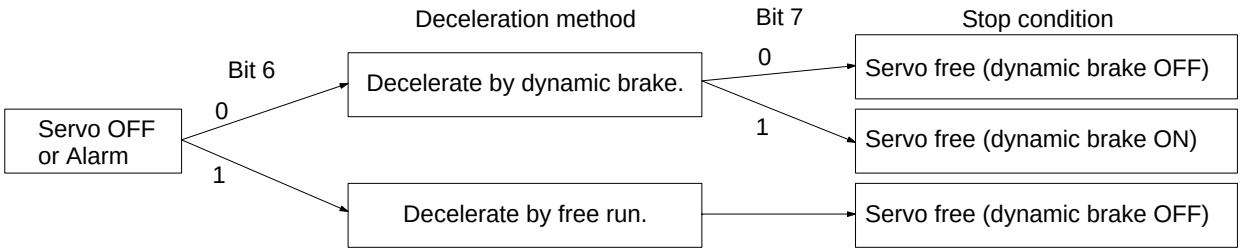
Command pulse mode (Cn-02 bit nos. 5, 4, 3)	Selected command pulse mode
0, 0, 0	Feed pulses (PULS) / Forward/reverse signal (SIGN)
0, 0, 1	Forward pulses (CCW) / Reverse pulses (CW) (Factory setting)
0, 1, 0	90° phase difference (A/B phase) signal (x1)
0, 1, 1	90° phase difference (A/B phase) signal (x2)
1, 0, 0	90° phase difference (A/B phase) signal (x4)

Note When a 90° phase difference signal is input, any of three types of multipliers can be selected: x1, x2, or x4. If x4 is selected, the input pulses will be multiplied by four, so the number of motor revolutions (speed, angle) will be four times that of x1.

Error Stop Processes

Bits 6, 7, 8, and 9 of Cn-01 specify how the motor will be stopped when the servo goes OFF (the run command is OFF), an alarm is generated, or overtravel occurs. The following diagrams show the function of these four bits:

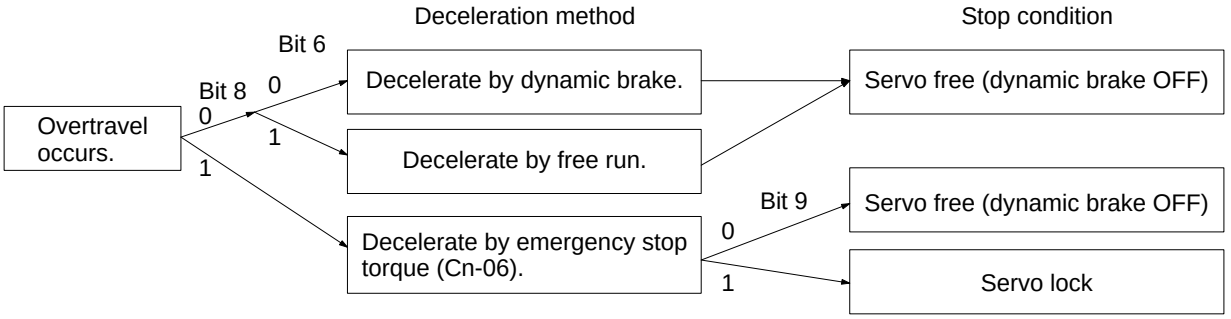
Stop Process for Servo OFF/Alarm



Note Bit no. 7 is not valid for motors of 2.0 kW or more. At the time of stopping, the dynamic brake turns OFF.

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Stop Process for Overtravel



Encoder Selection (Cn-01 Bit No. E)

Set this parameter according to the encoder for the Servo Motor that is used. The factory setting is for an incremental encoder (“0”). If an absolute encoder is to be used, set this parameter to “1.”

Encoder selection (Cn-01 bit no. E)	Selected encoder
0	Incremental encoder (factory setting)
1	Absolute encoder

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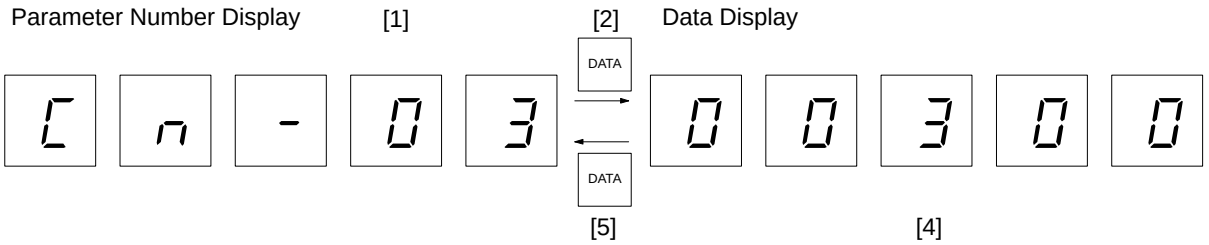
3-3-2 Setting and Checking User Parameters (Cn-03 to 2d)

Execute the user parameter settings in order as follows:

Go into settings mode	MODE/SET Key
Display the pertinent parameter number	Direction Keys (Handy-type) Up and Down Keys (Mounted-type)
Display the contents (data) of the parameter	DATA Key
Change the data	Direction Keys (Handy-type) Up and Down Keys (Mounted-type)
Save the data in memory	MODE/SET and DATA Keys

■ Checking User Parameters

The contents of a given user parameter can be checked by pressing the DATA Key while that parameter number is being displayed. Pressing the DATA Key again will bring back the parameter number display. (See the illustration below.)



■ Setting User Parameters

Use the following procedures to set user parameters.

● Making Settings with Handy-type (R88A-PR02U)

1. Use the Direction Keys to display the number of the parameter that is to be set.
   Using the Right and Left Keys, select the digit that is to be set. The digit for which the number can be changed will blink.
   With the Up and Down Keys, increment or decrement the number for that digit.
2. Press the DATA Key. The contents (data) of the pertinent parameter will be displayed.
3. Using the Direction Keys, set the data. The method is the same as for step 1 above.
4. Save the data in memory by pressing the MODE/SET Key (or the DATA Key).
5. Pressing the DATA Key again will bring back the parameter number display.
6. Repeat steps 1 through 5 above as required.

● Making Settings with Mounted-type (R88A-PR03U)

1. Use the Up and Down keys to display the number of the parameter that is to be set.
2. Press the DATA Key. The contents (data) of the pertinent parameter will be displayed.
3. Using the Up and Down Keys, set the data. If the keys are held down, the numbers will change 10 at a time. If the keys are held down even longer, the numbers will change 100 and then 1,000 at a time.
4. Save the data in memory by pressing the MODE/SET Key (or the DATA Key).
5. Pressing the DATA Key again will bring back the parameter number display.
6. Repeat steps 1 through 5 above as required.

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■ User Parameter Chart

PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-00	System check mode	---	---	---	Refer to system check mode explanation.
Cn-01	Setup parameter no. 1	---	---	---	Refer to setup parameter no. 1 explanation.
Cn-02	Setup parameter no. 2	---	---	---	Refer to setup parameter no. 2 explanation.
Cn-03	Speed command scale	300	(r/min)/V	10 to 2,000	Rotation speed setting per 1 V of speed command voltage.
Cn-04	Speed loop gain (See note 1.)	80	Hz	1 to 2,000	Adjusts speed loop response.
Cn-05	Speed loop integration constant	2,000	0.01 ms	200 to 51,200	Speed loop integration constant
Cn-06	Emergency stop torque	350	%	0 to 350	Deceleration torque when abnormality occurs (compared to rated torque).
Cn-07	Soft start acceleration time (Note 4)	0	ms	0 to 10,000	Acceleration time setting for software start.
Cn-08	Forward torque limit	350	%	0 to 350	Output torque for rotation in forward direction (compared to rated torque).
Cn-09	Reverse torque limit	350	%	0 to 350	Output torque for rotation in reverse direction (compared to rated torque).
Cn-0A	Encoder divider rate (See note 2.)	1,000	Pulses/ revolution	16 to 8,192 (Note 6)	Setting for number of output pulses from Servo Driver.
Cn-0b	Rotation speed for motor rotation detection	20	r/min	1 to 4,500	Setting for rotation speed for motor rotor detection output.
Cn-0C	P control switching (torque commands)	200	%	0 to 350	If a torque command exceeds this value, the mode switches from PI to P control.
Cn-0d	P control switching (speed commands)	0	r/min	0 to 4,500	If a speed command exceeds this value, the mode switches from PI to P control.
Cn-0E	P control switching (acceleration commands)	0	10 (r/min)/s	0 to 3,000	If an acceleration command exceeds this value, the mode switches from PI to P control.
Cn-0F	P control switching (deviation pulses)	10	Command	0 to 10,000	If the deviation pulses exceed this value, the mode switches from PI to P control.
Cn-10	Jog speed	500	r/min	0 to 4,500	Setting for manual rotation speed
Cn-11	Number of encoder pulses (Notes 2 and 5)	4,096	Pulses/ revolution	[INC]: 4,096 [ABS]: 8,192	Setting for number of pulses for encoder used.
Cn-12	Brake timing 1	0	10 ms	0 to 50	Delay time setting from brake command until servo turns off.
Cn-13	Torque command scale	30	0.1 V/rated torque	10 to 100	Sets gain for torque command input.
Cn-14	Speed limit	3,000	r/min	0 to 4,500	Sets speed limit value for torque control mode.

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PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-15	Brake command speed	100	r/min	0 to 4,500	Sets rotation speed for outputting brake commands.
Cn-16	Brake timing 2	50	10 ms	10 to 100	Waiting time from servo-off to brake command output.
Cn-17	Torque command filter time constant	4	100 µs	0 to 250	Setting for torque command filter time constant (6.4 to 398 Hz).
Cn-18	Forward rotation external current limit	100	%	0 to 350	Output torque for when forward rotation current limit is input (compared to rated torque).
Cn-19	Reverse rotation external current limit	100	%	0 to 350	Output torque for when reverse rotation current limit is input (compared to rated torque).
Cn-1A	Position loop gain	40	1/s	1 to 1,000	Adjusts the position loop response.
Cn-1b	Positioning completion range	3	Commands	0 to 250	Positioning completion signal output range setting
Cn-1C	Bias rotational speed	0	r/min	0 to 450	Position control bias setting
Cn-1d	Feed-forward amount	0	%	0 to 100	Position control feed-forward compensation value
Cn-1E	Deviation counter over level	1,024	x256 command	1 to 32,767	Setting for detection of deviation counter overrun
Cn-1F	No. 1 internal speed setting	100	r/min	0 to 4,500	Rotation speed, no. 1 internal setting
Cn-20	No. 2 internal speed setting	200	r/min	0 to 4,500	Rotation speed, no. 2 internal setting
Cn-21	No. 3 internal speed setting	300	r/min	0 to 4,500	Rotation speed, no. 3 internal setting
Cn-22	Speed conformity signal output width	10	r/min	0 to 100	Sets the allowable fluctuation width for the speed conformity signal.
Cn-23	Soft start deceleration time (Note 4)	0	ms	0 to 10,000	Sets the deceleration time for software starts.
Cn-24	Electronic gear ratio G1 (numerator) (Note 2)	4	---	0 to 65,535	Setting range: 0.01 □ G1/G2 □ 100
Cn-25	Electronic gear ratio G2 (denominator) (Note 2)	1	---	0 to 65,535	
Cn-26	Position command acceleration/deceleration constant	0	0.1 ms	0 to 640	Sets the pulse smoothing constant
Cn-27	Feed-forward command filter	0	0.1 ms	0 to 640	Feed-forward command filter setting
Cn-28	Compensation gain	0	---	0 to 100	Positioning time adjustment gain
Cn-29	Position lock rotation speed	10	r/min	0 to 4,500	Sets the position lock rotation speed.
Cn-2A	Motor selection (Note 2)	(Table 1)	---	0 to 255	Sets the applicable motor.
Cn-2b	Control mode selection (Note 2)	1	---	0 to 11	Sets the control mode. (Table 2)

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PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-2C	Encoder power supply voltage (Note 7)	52,500	0.1 mV	52,000 to 58,000	Changes the encoder power supply voltage.
Cn-2d	Output signal selection	210	---	110 to 666	Selects control output functions. (Table 3)

Note 1. Cn-04 (speed loop gain) is factory set for three times the load inertia. Therefore, if the load inertia is extremely small, some oscillation may occur. If it does, then lower Cn-04 to 20 or less.

Note 2. After the settings for Cn-0A (encoder divider rate), Cn-11 (number of encoder pulses), Cn-24 (electronic gear ratio G1), Cn-25 (electronic gear ratio G2), Cn-2A (motor selection), and Cn-2b (control mode selection) have been made, they become effective when the power is turned on again after having been cut off. (Check to see that the LED display has gone off.)

Note 3. Set all values within the specified ranges.

Note 4. Be sure to set both Cn-07 and Cn-23 when the software start function is used.

Note 5. The setting for Cn-11 (number of encoder pulses) is determined by the encoder that is used. If any settings other than the following are used, the motor may not operate properly.

[Incremental]: Cn-11 set value = 4,096
[Absolute]: Cn-11 set value = 8,192

Note 6. The upper limit for Cn-0A (encoder divider rate) is as follows:

[Incremental]: Cn-0A upper limit = 4,096
[Absolute]: Cn-0A upper limit = 8,192

⚠ **Caution** The Cn-2C (encoder power supply voltage) setting depends on the encoder cable length. The encoder may be damaged if the setting is wrong. Refer to the following table when making the setting.

Encoder	3 m	5 m	10 m	15 m	20 m
[Incremental]	52,500			54,000	55,500
[Absolute]	52,500			55,000	57,000

• Table 1: Cn-2A (Motor Selection)

⚠ **Caution** Check to be sure that these settings are made correctly. If they are set incorrectly, the motor may malfunction or suffer damage.

Driver model	Applicable motor model	Set value
R88D-UT24H	R88M-U1K030H-□/T-□	163
R88D-UT40H	R88M-U1K530H-□/T-□	164
R88D-UT60H	R88M-U2K030H-□/T-□	165
R88D-UT80H	R88M-U3K030H-□/T-□	166
R88D-UT110H	R88M-U4K030H-□/T-□	167
R88D-UT120H	R88M-U5K030H-□/T-□	168

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Driver model	Applicable motor model	Set value
R88D-UT24V-□	R88M-U1K030V-□S1/X-□S1	163
R88D-UT40V-□	R88M-U1K530V-□S1/X-□S1	164
R88D-UT60V-□	R88M-U2K030V-□S1/X-□S1	165
R88D-UT80V-□	R88M-U3K030V-□S1/X-□S1	166
R88D-UT110V	R88M-U4K030V-□S1/X-□S1	167
	R88M-U5K030V-□S1/X-□S1	168

Note The default setting of the R88D-UT110V is 4 kW (motor selection: “167”). When using a 5-kW motor, change the motor selection setting to “168.”

● Table 2: Cn-2b (Control Mode Selection)

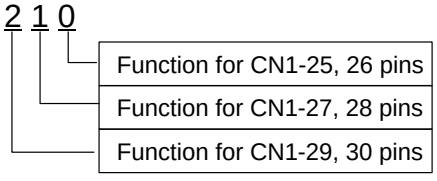
⚠ **Caution** Check to be sure that these settings are made correctly. If they are set incorrectly, the motor may malfunction.

Control mode			Set value
Speed control (Analog commands)			0
Position control (Pulse train commands)		[Factory setting]	1
Torque control (Analog commands)			2
Internally-set speed control			3
Internally-set speed control	←→	Speed control (Analog commands)	4
Internally-set speed control	←→	Position control (Pulse train commands)	5
Internally-set speed control	←→	Torque control (Analog commands)	6
Position control (Pulse train commands)	←→	Speed control (Analog commands)	7
Position control (Pulse train commands)	←→	Torque control (Analog commands)	8
Speed control (Analog commands)	←→	Torque control (Analog commands)	9
Speed control (Analog commands)	←→	Position lock prohibit	10
Position control (Pulse train commands)	←→	Pulse prohibit	11

● Table 3: Cn-2d (Output Signal Selection)

Any of the functions can be allocated to the three output terminals. The three digits of the set value correspond respectively to the output terminals. The setting “0” can be made only for the first digit (CN1-25, 26 pins).

Example Setting



Output signal function	Set value
In position (INP) / Speed compare (VCMP)	0
Motor rotation detection (TGON)	1
Servo ready (READY)	2
Current limit detection (CLIMT)	3
Brake interlock (BKIR)	4
Overload warning ($\overline{\text{OLWRN}}$)	5
Overload alarm ($\overline{\text{OLALM}}$)	6

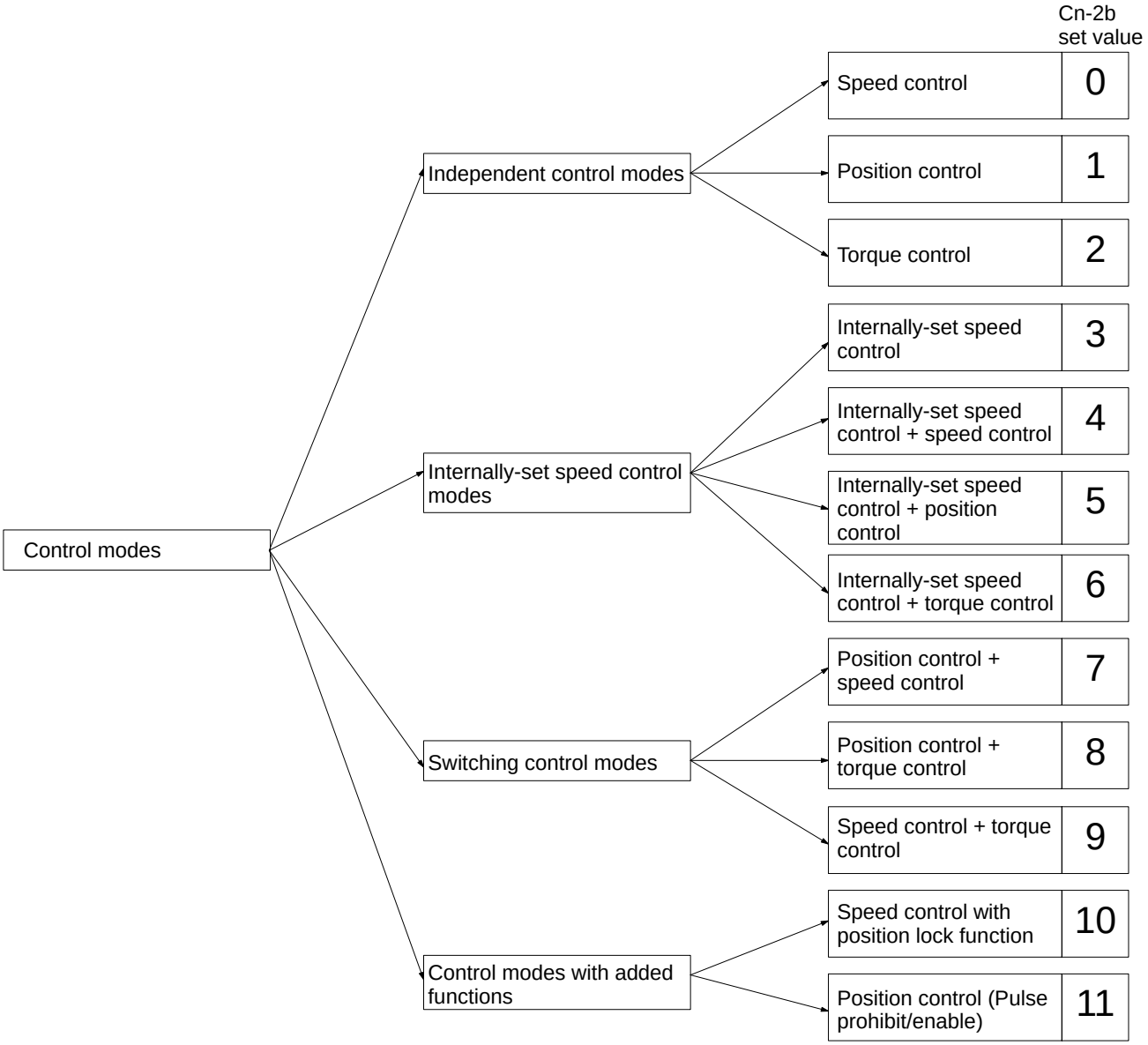
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3-3-3 Important User Parameters

This section explains the checks and settings that are required before using the Servomotor and Servo Driver. These parameters must be set correctly. If they are set incorrectly, the motor may fail to operate or may malfunction. Make the appropriate settings for the system that is being used.

■ Control Mode Settings

The control mode is set by user parameter Cn-2b.



■ Number of Encoder Pulses (Cn-11)

The number of pulses varies depending on the type of encoder that is connected. Match the settings to the encoder type. The factory settings are for an incremental encoder. Change the settings for these parameters if an absolute encoder is to be used. If the settings are not made correctly, the motor may malfunction.

PRM No.	Parameter name	Factory setting	Unit	Set value	Encoder type
Cn-11	Number of encoder pulses	4,096	Pulses/revolution	4,096	[Incremental]
				8,192	[Absolute]

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3-3-4 Setting Internal Speed Control

■ Function

- This function controls Servomotor speed using the speeds set in the parameters (No. 1, No. 2, and No. 3 internal speed settings).
- This function can be used in the speed control modes. (It can't be used with torque control.) Select the internal speed using the control inputs CN1-45 and 46 (speed selection commands 1 and 2) and specify the rotational direction using the CN1-41 (rotation direction command).
- When both speed selection commands 1 and 2 are OFF, the motor will decelerate to a stop in the software start deceleration time and then go into servo lock status. Depending on the parameter settings, it is possible to use pulse train inputs (for position control), speed command inputs (for speed control), and torque command inputs (for torque control) in this status.

■ User Parameter Settings

- Set user parameter Cn-02 (control mode selection) to any number from "3" to "6." When this bit is set to "1," the internal speed control settings function can be used and CN1-45, 46, and 41 have the following functions:

  Control inputs CN1-45 and 46: . . . . Speed selection commands 1 and 2 (SPD1 and SPD2)
  Control input CN1-41: . . . . . Rotation direction command (RDIR)

- The following table shows the combinations of speeds and directions that can be selected with these three control inputs.

CN1-45 SPD1	CN1-46 SPD2	CN1-41 RDIR	Internal speed setting, rotational direction
OFF	ON	OFF	No. 1 internal speed setting, forward
		ON	No. 1 internal speed setting, reverse
ON	ON	OFF	No. 2 internal speed setting, forward
		ON	No. 2 internal speed setting, reverse
ON	OFF	OFF	No. 3 internal speed setting, forward
		ON	No. 3 internal speed setting, reverse

● Internal Speed Control Settings Only: Control Mode Selection (Cn-2b = "3")

- Setting user parameter Cn-2b (control mode selection) to "3" specifies the "internal speed control settings only" mode.
- When both SPD1 and SPD2 are OFF, the motor will decelerate to a stop and then go into servo lock status with an internal speed command status of 0 r/min. (Position lock will not be in effect.)
- Speed command inputs, pulse train inputs, and torque command inputs cannot be received.

● Internal Speed Control Settings + Speed Control: Control Mode Selection (Cn-2b = "4")

- Setting user parameter Cn-2b (control mode selection) to "4" specifies the "internal speed control settings + speed control" mode.
- Speed control using internal speed settings and speed command inputs (REF) is possible in this control mode.
- Speed command inputs (REF) can be received from the point at which both SPD1 and SPD2 turn OFF.

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- **Internal Speed Control Settings + Position Control: Control Mode Selection (Cn-2b = "5")**
  - Setting user parameter Cn-2b (control mode selection) to "5" specifies the "internal speed control settings + position control" mode.
  - Speed control using internal speed settings and position control using pulse train inputs are possible in this control mode.
  - When both SPD1 and SPD2 are OFF, the motor will decelerate to a stop. When the positioning completion signal is output, the position lock is in effect and the system is ready to receive the pulse command input.
  - Pulse commands can be input after the positioning completion (INP) signal turns ON. Pulses input up until that point will be ignored. Likewise, when switching from position control to internally-set speeds, wait until the positioning completion (INP) signal turns ON before turning ON the speed selection command. If the speed selection command is turned ON during command pulse input, command pulse transmission and positioning will be ended before switching to internally-set speeds.

- **Internal Speed Control Settings + Torque Control: Control Mode Selection (Cn-2b = "6")**
  - Setting user parameter Cn-2b (control mode selection) to "6" specifies the "internal speed control settings + torque control" mode.
  - Speed control using internal speed settings and torque control using torque command inputs (TREF) are possible in this control mode.
  - Torque command inputs (TREF) can be received from the point at which both SPD1 and SPD2 turn OFF.

■ Other User Parameter Settings

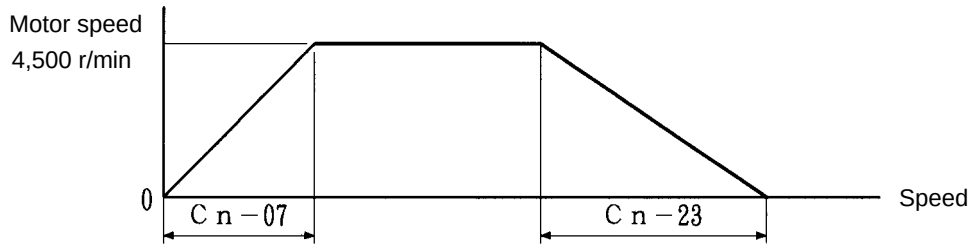
PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-07	Soft start acceleration time	0	ms	0 to 10,000	Sets the time for the motor to accelerate from 0 r/min to 4,500 r/min.
Cn-23	Soft start deceleration time	0	ms	0 to 10,000	Sets the time for the motor to decelerate from 4,500 r/min to 0 r/min.
Cn-26	Position command acceleration/deceleration constant	0	0.1 ms	0 to 640	Sets the constant for pulse smoothing.
Cn-14	Speed control	3,000	r/min	0 to 4,500	Sets the speed limit for the torque control mode.
Cn-1F	No. 1 internal speed setting	100	r/min	0 to 4,500	Sets the speed for when SPD1 is OFF and SPD2 is ON.
Cn-20	No. 2 internal speed setting	200	r/min	0 to 4,500	Sets the speed for when SPD1 is ON and SPD2 is ON.
Cn-21	No. 3 internal speed setting	300	r/min	0 to 4,500	Sets the speed for when SPD1 is ON and SPD2 is OFF.

Note **1.** The software start acceleration and deceleration times are effective on the internal speed settings and the speed command input (REF).

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Note 2. Acceleration and deceleration times are set at up to 4,500 r/min. The actual acceleration and deceleration times are found by means of the following formula:

$$\text{Actual acceleration (deceleration) time} = \frac{\text{Internally set speed (r/min)}}{\text{4,500 (r/min)}} \times \text{Soft start acceleration (deceleration) time}$$

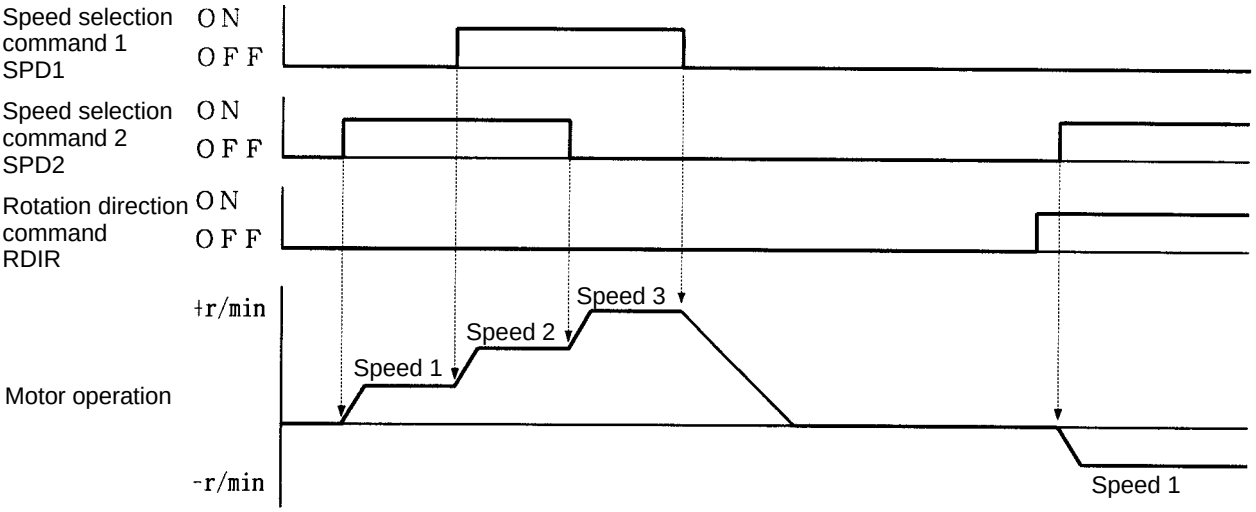


Note 3. The position command acceleration/deceleration constant is effective on pulse commands.

Note 4. The speed limit setting is effective only in torque control mode.

■ Operation Examples

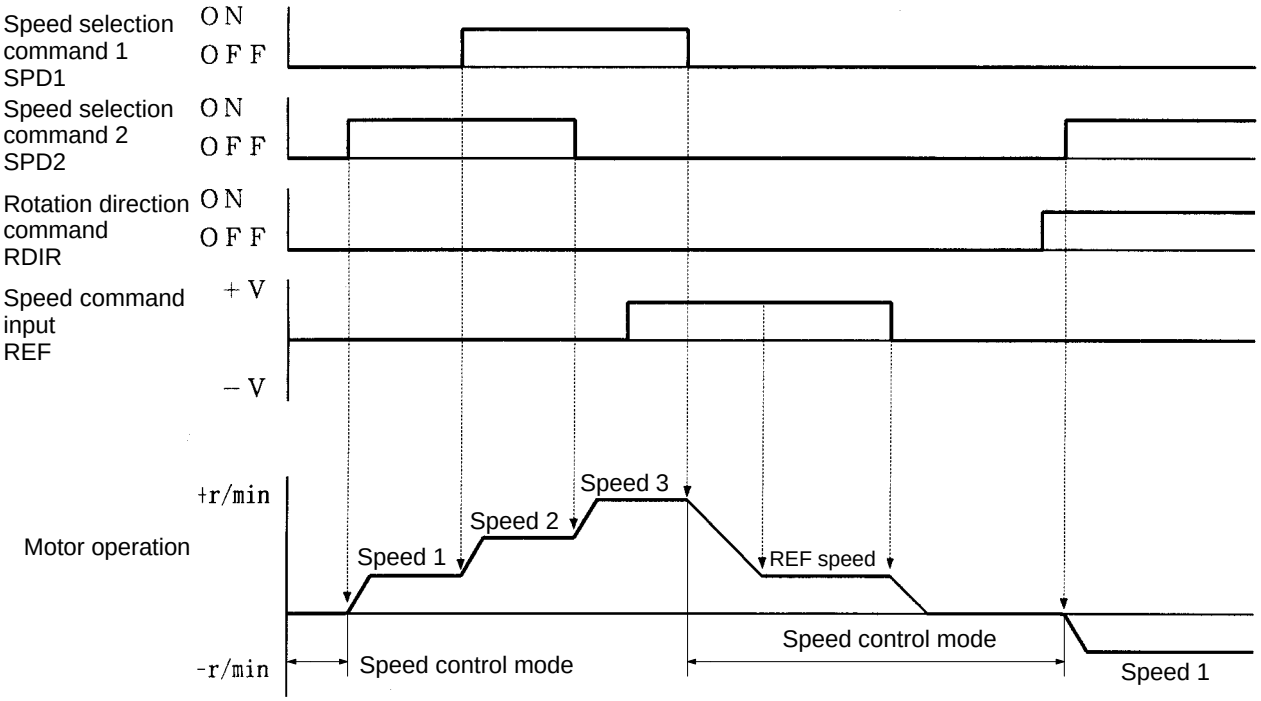
● Internal Speed Control Settings Only (Cn-2b = "3")



Note There is a maximum delay of 6 ms in reading the input signal.

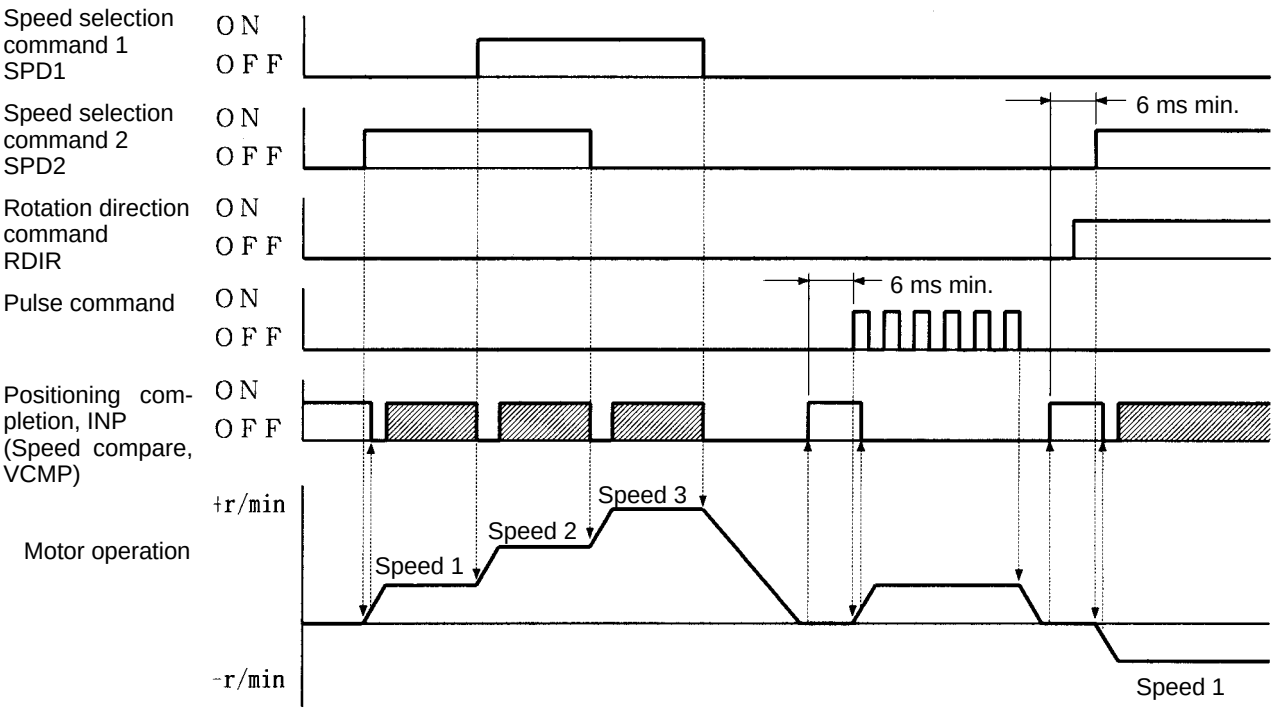
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● Internal Speed Control Settings + Speed Control (Cn-2b = “4”)



Note When the control mode is “internal speed control settings + speed control,” operation follows the speed command input (REF) immediately after SPD1 and SPD2 are both OFF (although there is a delay of up to 6 ms in reading the input signal). There is no need to wait until the servo-lock operates.

● Internal Speed Control Settings + Position Control (Cn-2b = “5”)

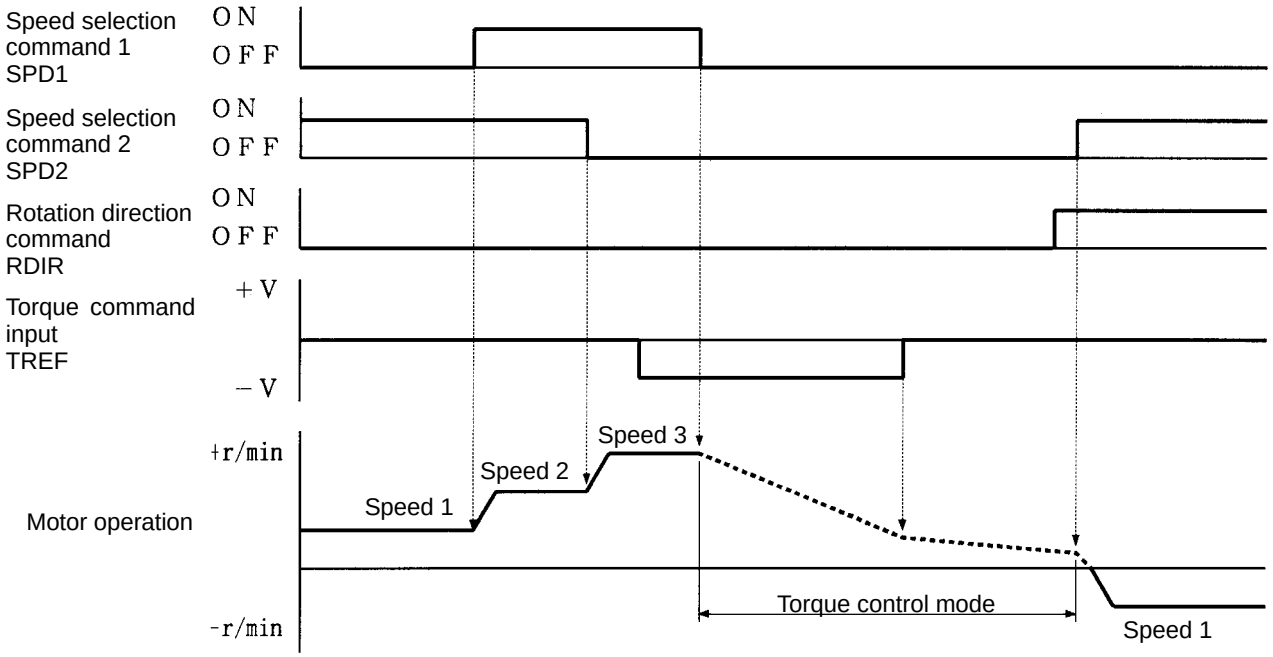


Note **1.** There is a maximum delay of 6 ms in reading the input signal.

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Note 2. The shaded areas in the time chart for the positioning completion signal indicate the places where the signal is turned ON as the speed compare (VCMP) signal. (The meaning of the signal differs according to the control mode.)

- **Internal Speed Control Settings + Torque Control (Cn-2b = "6")**



Note 1. When the control mode is "internal speed control settings + torque control," operation follows the torque command input (TREF) immediately after SPD1 and SPD2 are both OFF (although there is a delay of up to 6 ms in reading the input signal).

Note 2. Motor operation with torque control varies according to the motor load conditions (e.g., friction, external power, inertia).

Note 3. When motor servo-lock is required, set any of the internal speed settings to "0 r/min" and select that speed with speed selection commands 1 and 2.

3-3-5 Switching Control Mode

■ Function

This function controls the motor by switching between two control modes by means of external inputs. The control mode switching is executed at control input terminal CN1-41 (control mode switching).

■ User Parameter Settings

Set "7," "8," or "9" for user parameter Cn-2b (control mode selection). This setting causes control input terminal CN1-41 to become a control mode switching terminal (TVSEL). The following tables show the control modes.

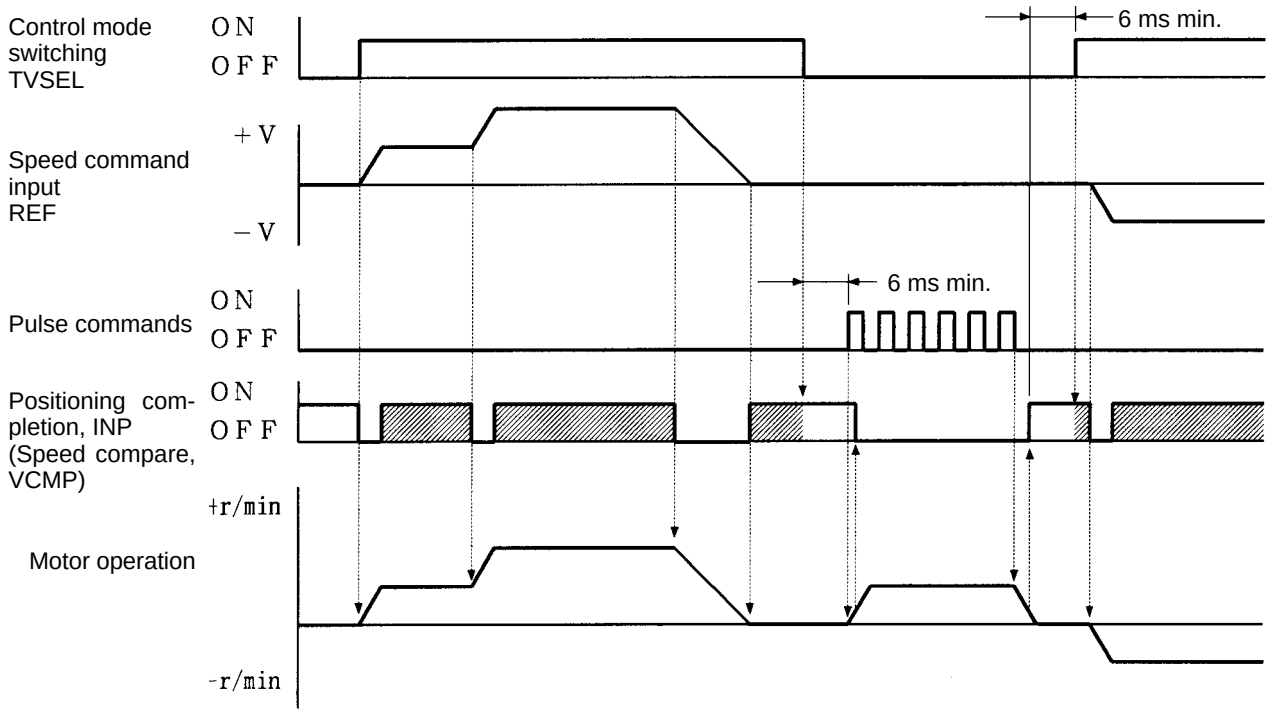
Control mode	Set value
Position control (Pulse train command) ←→ Speed control (Analog command)	7
Position control (Pulse train command) ←→ Torque control (Analog command)	8
Speed control (Analog command) ←→ Speed control (Analog command)	9

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Set value	Selected Control Mode	
	CN1-41: OFF	CN1-41: ON
7	Position control	Speed control
8	Position control	Torque control
9	Torque control	Speed control

■ Operation

● Position and Speed Control Switching Example (Cn-2b = "7")



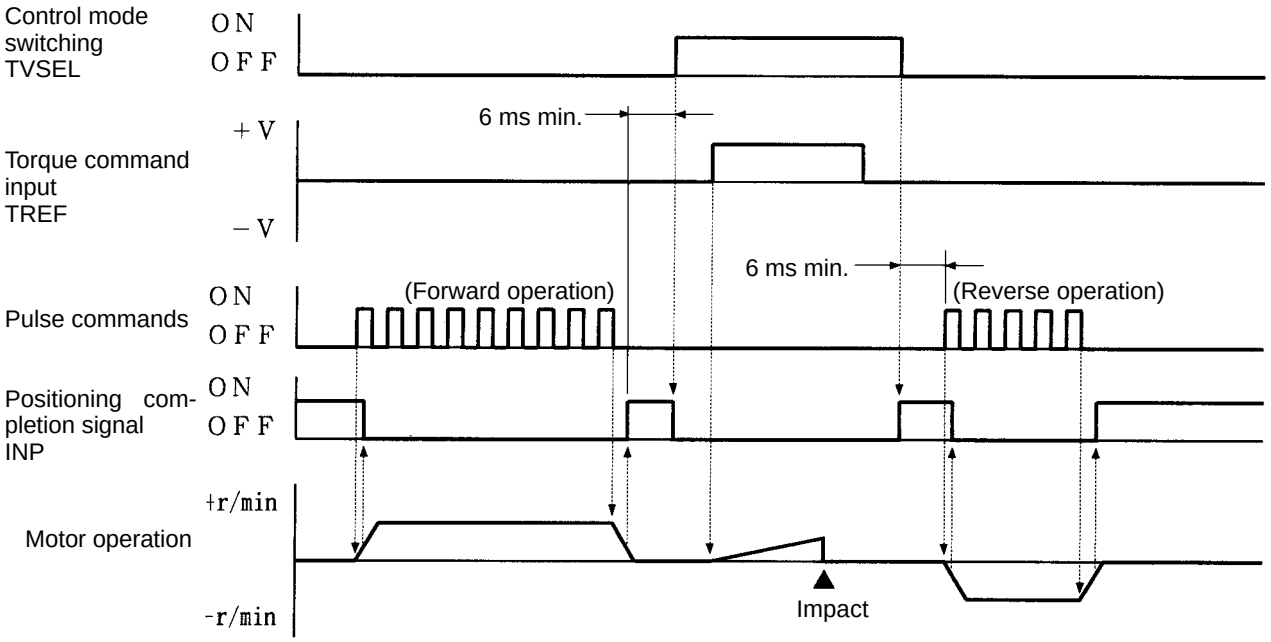
Note 1. There is a maximum delay of 6 ms in reading the input signal.

Note 2. When switching from speed control to position control, input the pulse command after the control mode switching (TVSEL) has turned OFF, the positioning completion (INP) signal has turned ON, and 6 ms has elapsed. The pulses will be ignored until the positioning completion (INP) signal has turned ON.

Note 3. The shaded areas in the time chart for the positioning completion signal indicate the places where the signal is turned ON as the speed compare (VCMP) signal. (The meaning of the signal differs according to the control mode.)

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● Position and Torque Control Switching Example (Cn-2b = “8”)

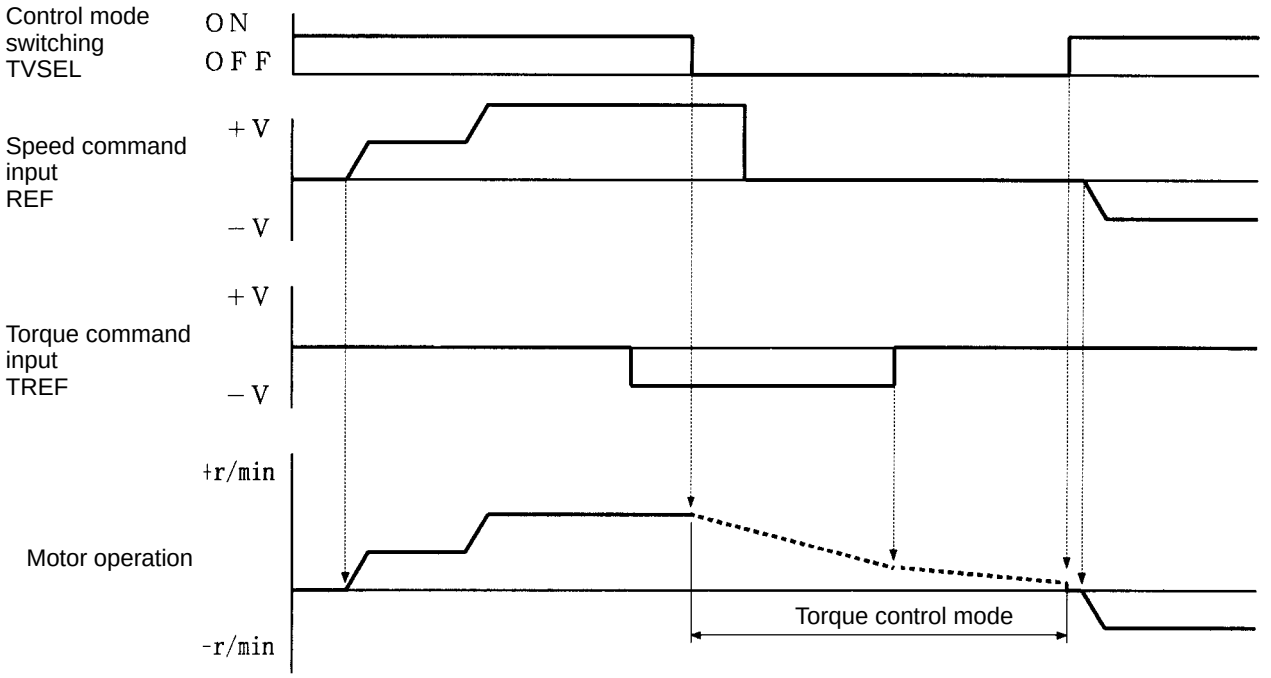


Note 1. This time chart shows an example of torque thrust.

Note 2. There is a maximum delay of 6 ms in reading the input signal.

Note 3. When switching from torque control to position control, input the pulse command after the control mode switching (TVSEL) has turned OFF, the positioning completion (INP) signal has turned ON, and 6 ms has elapsed. The pulses will be ignored until the positioning completion (INP) signal has turned ON.

● Speed and Torque Control Switching Example (Cn-2b = “9”)



Note 1. There is a maximum delay of 6 ms in reading the input signal.

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Note 2. Motor operation with torque control varies according to the motor load conditions (e.g., friction, external power, inertia).

3-3-6 Software Start Function

■ Function

- This function starts and stops the Servomotor according to the acceleration and deceleration times that have been set.
- The acceleration curve is trapezoidal. Acceleration and deceleration can be set independently.
- Use software start processing for speed command inputs (or internal speed settings) to minimize impact at the time of acceleration and deceleration.
- This function is effective for simple positioning and when changing speeds.
- Set the parameters as shown in the following table.

PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-07	Soft start acceleration time	0	ms	0 to 10,000	Sets the time for the motor to accelerate from 0 r/min to 4,500 r/min.
Cn-23	Soft start deceleration time	0	ms	0 to 10,000	Sets the time for the motor to decelerate from 4,500 r/min to 0 r/min.
Cn-29	Position lock rotation speed	10	r/min	0 to 4,500	Setting for the rotation speed to cause position lock.
Cn-1A	Position loop gain	40	1/s	1 to 500	Adjusts position loop response.

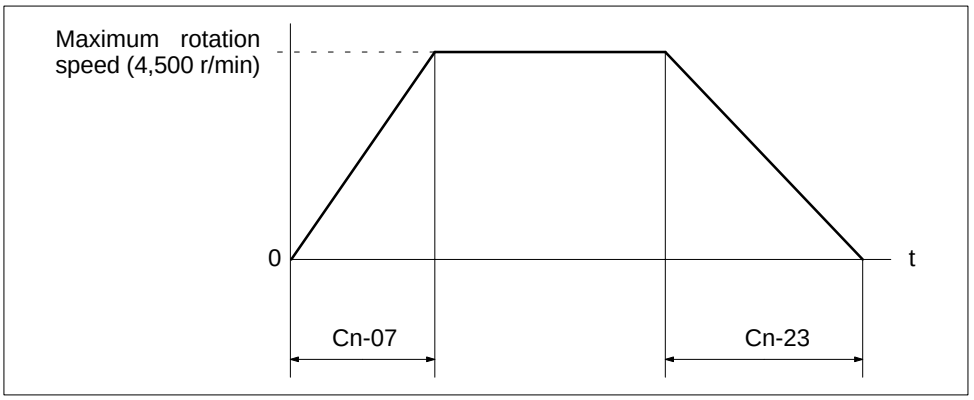
Note 1. The software start acceleration and deceleration times are effective on the internal speed settings and the speed command input (REF). This has no effect on the pulse command.

Note 2. The position lock rotation speed setting is valid only for speed control.

Note 3. The position loop gain adjusts the servo-lock force during position-lock.

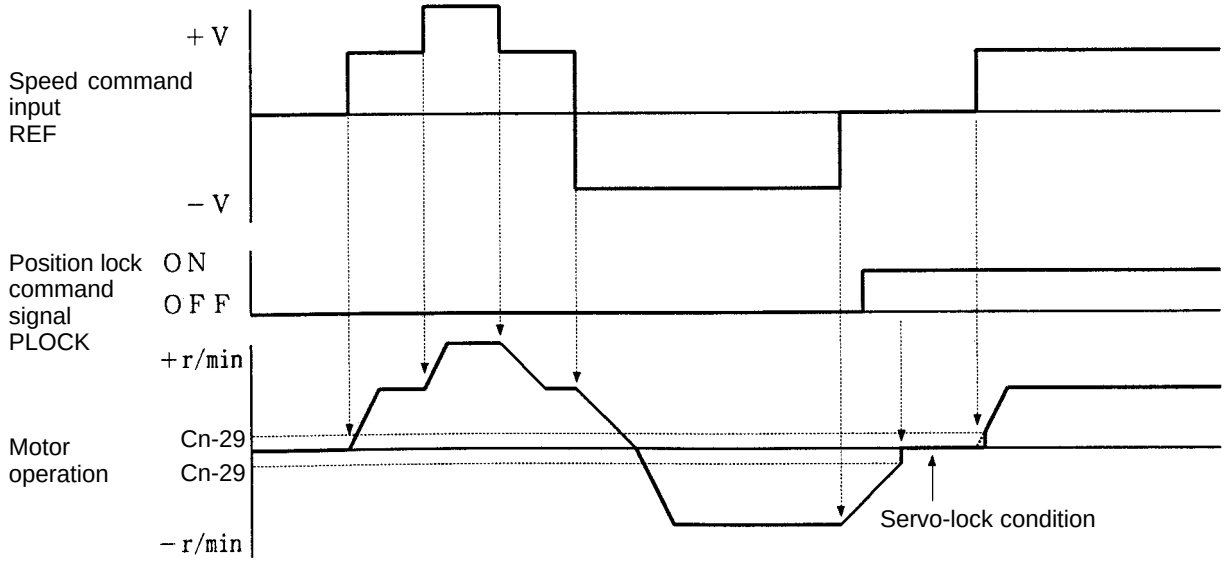
Note 4. Acceleration and deceleration times are set at up to 4,500 r/min. The actual acceleration and deceleration times are found by means of the following formula:

$$\text{Actual acceleration (deceleration) time} = \frac{\text{Internally set speed (r/min)}}{\text{4,500 (r/min)}} \times \text{Soft start acceleration (deceleration) time}$$



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■ Timing Chart



Note 1. Select “speed control with position lock” as the control mode (i.e., set “10” for Cn-2b) when controlling the position lock with an external signal. (Refer to *3-3-3 Important User Parameters* for details.)

Note 2. The Unit will go into servo-lock if the position lock signal (PLOCK) is ON and the number of motor rotations falls below the position lock rotations set in Cn-29. The motor will revolve when the internal speed command exceeds the position lock rotations.

3-3-7 Electronic Gear Function (Position Control)

■ Function

With this function, the motor will revolve for the number of pulses derived by applying the electronic gear ratio to command pulses. The function is effective in the following types of situations:

- Fine adjustments of positions and speeds when synchronizing two lines.
- When using a positioner with a low command pulse frequency.
- When setting a value such as 0.01 mm for the amount of mechanical movement per pulse.

■ User Parameter Settings [Incremental]

- The gear ratio utilizes G1 and G2 for user parameters Cn-24 and Cn-25, and is defined by G1/G2.

$$\text{Target number of pulses} = \text{Number of command pulses} \times \frac{G1}{G2}$$

PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-24	Electronic gear ratio G1 (numerator)	4	___	1 to 65,535	Setting range: 0.01 ◻ G1/G2 ◻ 100
Cn-25	Electronic gear ratio G2 (denominator)	1	___	1 to 65,535	

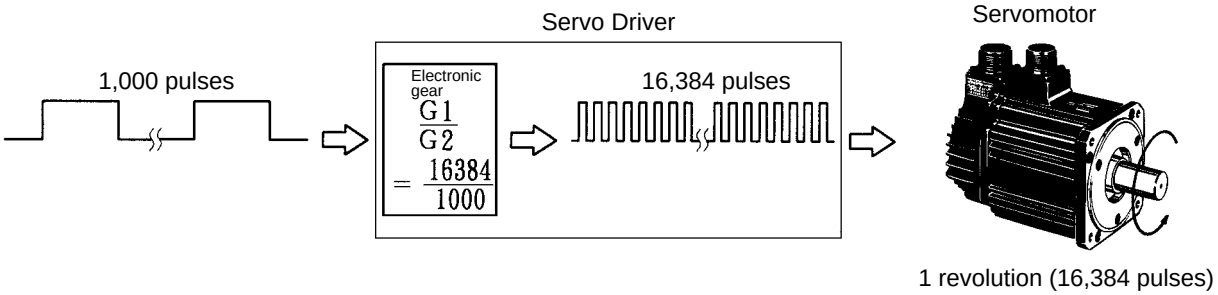
Note The electronic gear setting becomes effective when the power is turned on again after having been cut off. (Check to see that the LED display has gone off.)

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- When G1/G2 = 1, the motor makes one revolution with a 16,384-pulse command. (The driver operates with an internal multiplication factor of 4.
- With the factory setting, the motor makes one revolution when 4,096 pulses are input.
- A single pulse for position deviation (deviation counter) display or positioning completion range becomes a single input pulse.

■ Operation Example [Incremental]

In this example, G1/G2 is set to16,384/1,000, and operation is the same as for a Servomotor of 1,000 (pulses/revolution).



3-3-8 Encoder Dividing Function [Incremental]

■ Function

- With this function, any number of pulses can be set for encoder signals output from the Servo Driver.
- The number of pulses per Servomotor revolution can be set within a range of 16 to 4,096.
- Use this function for the following applications:
  When connecting to a positioner with a low response frequency.
  When it is desirable to set a pulse rate that is easily understandable.
  (For example, in a mechanical system in which a single Servomotor revolution corresponds to a movement of 10 mm, if the resolution is 5 μm/pulse, set the encoder dividing rate to 2,000 (pulses/revolution).
- Set the parameters as shown in the following table.

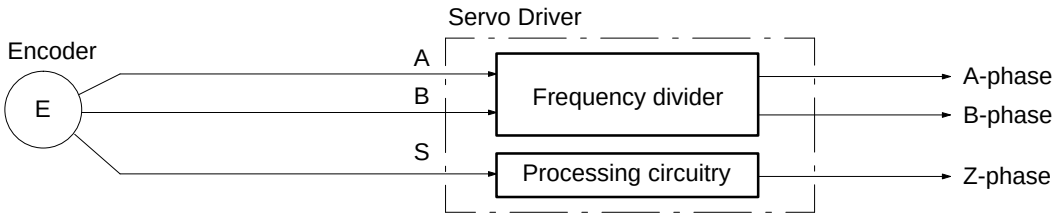
PRM No.	Parameter name	Factory setting	Setting range	Explanation
Cn-0A	Encoder divider rate	1,000 pulses/revolution	16 to 4,096 pulses/revolution	Setting for number of output pulses from Servo Driver.
Cn-11	Number of encoder pulses	4,096 pulses/revolution	4,096 pulses/revolution	(Do not change the setting.)

Note Theses parameters become effective when the power is turned on again after having been cut off. (Check to see that the LED display has gone off.)

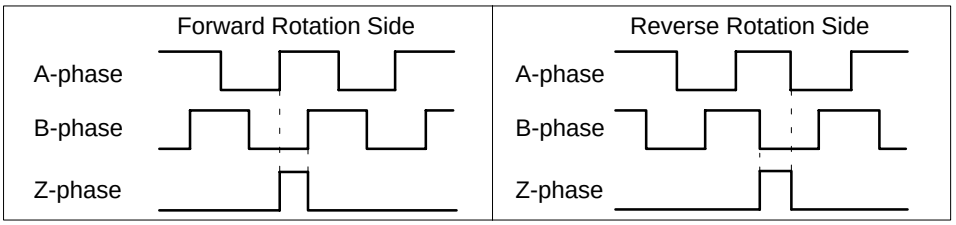
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■ Operation

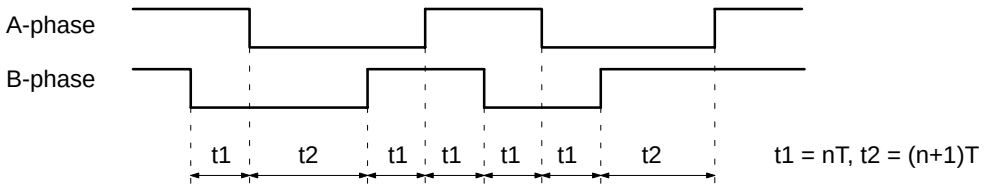
- Incremental pulses are output from the Servo Driver through a frequency divider.



- The output phases of the encoder signal output from the Servo Driver are as shown below (when divider rate Cn-0A = 4,096).

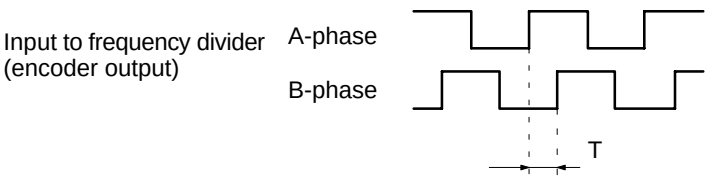


Note When the encoder divider rate is set to other than 4,096, 2,048, 1,024,..., the phase difference for phases A and B is not 90°, but scatters for time T. (See the diagram below.)



In this diagram, T represents the time between phase A and phase B, and n is an integer that satisfies the following formula (with digits below the decimal point discarded).

n = 4,096/encoder divider rate



3-3-9 Encoder Dividing Function (Absolute)

■ Function

- With this function, any number of pulses can be set for encoder signals output from the Servo Driver.
- The number of pulses per Servomotor revolution can be set within a range of 16 to 8,192.
- Use this function for the following applications:
  When connecting to a positioner with a low response frequency.
  When it is desirable to set a pulse rate that is easily understandable.

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(For example, in a mechanical system in which a single Servomotor revolution corresponds to a movement of 10 mm, if the resolution is 5 μm/pulse, set the encoder dividing rate to 2,000 (pulses/revolution).

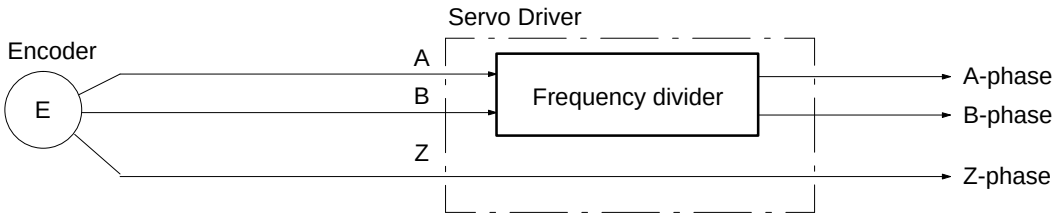
- Set the parameters as shown in the following table.

PRM No.	Parameter name	Factory setting	Setting range	Explanation
Cn-0A	Encoder divider rate	1,000 pulses/revolution	16 to 8,192 pulses/revolution	Setting for number of output pulses from Servo Driver.
Cn-11	Number of encoder pulses	4,096 pulses/revolution	8,192 pulses/revolution	(Be sure to change the setting to "8,192.")

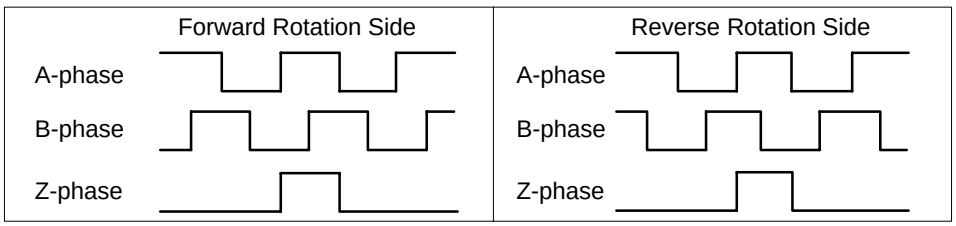
Note Theses parameters become effective when the power is turned on again after having been cut off. (Check to see that the LED display has gone off.)

■ Operation

- Incremental pulses are output from the Servo Driver through a frequency divider.

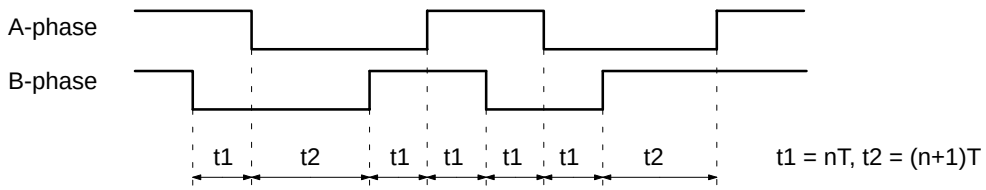


- The output phases of the encoder signal output from the Servo Driver are as shown below (when divider rate Cn-0A = 8,192).



The Z-phase is synchronized with the A-phase, but its pulse width may become shorter than that of the A-phase.

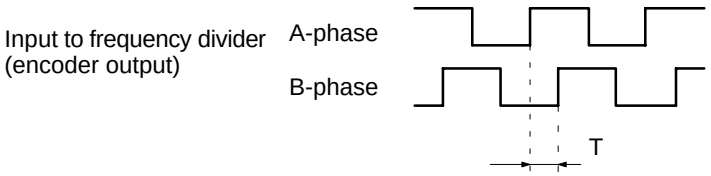
Note When the encoder divider rate is set to other than 8,192, 4,096, 2,048,..., the phase difference for phases A and B is not 90°, but scatters for time T. (See the diagram below.)



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In this diagram, T represents the time between phase A and phase B, and n is an integer that satisfies the following formula (with digits below the decimal point discarded).

n = 8,192/encoder divider rate



3-3-10 Bias Function (Position Control)

■ Function

- The bias function shortens positioning time by adding bias revolutions to speed commands.
- If the residual pulses in the deviation counter exceed the positioning completion range (Cn-1b), the bias rotational speed (Cn-1C) is added to the speed command until the pulses are within the positioning completion range.
- Set the parameters as shown in the following table.

PRM No.	Parameter name	Factory setting	Setting range	Explanation
Cn-1b	Positioning completion range	3 command units	1 to 250 command units	Sets range for positioning completion signal output.
Cn-1C	Bias rotational speed	0 r/min	0 to 450 r/min	Sets position control bias.

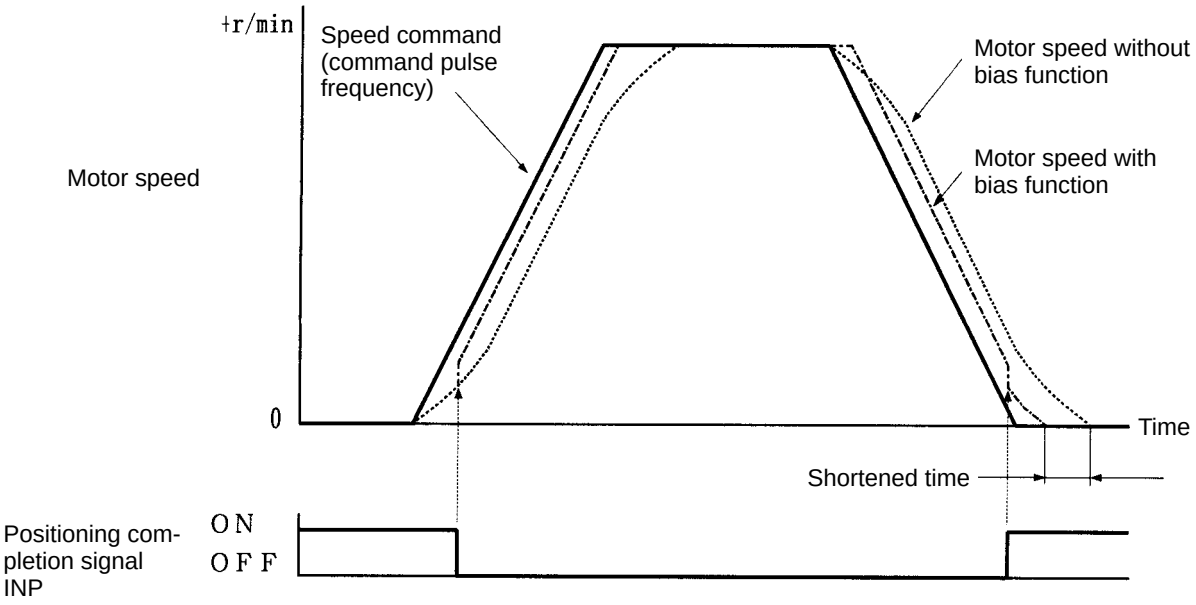
Note 1. When not using the bias function, set the bias rotational speed to 0 r/min.

Note 2. If the bias rotational speed is set too high, it will cause motor operation to be unstable. The optimum setting depends on the load, the gain, and the positioning completion range, so adjust the setting while observing the motor response. (Begin with a bias setting of “0,” and gradually increase it.)

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■ Operation Example

- In this example, the bias rotational speed (Cn-1C) is added to the deviation counter output (speed command) when the residual pulses in the deviation counter exceed the positioning completion range (Cn-1b). This continues until the residual pulses in the deviation counter are within the positioning completion range, and then it stops.
- For the internal processing block configuration, refer to the position loop block diagram in *3-5-2 Manually Adjusting Gain (Position Control)*.



3-3-11 Torque Limit Function (Position Control, Speed Control, Torque Control)

■ Function

- The torque limit function limits the Servomotor's output torque; it can be used with position control, speed control, and torque control.
- This function can be used to protect the Servomotor and machine system by preventing excessive force or torque on the machine system when the machine (moving part) pushes against the workpiece with a steady force, such as in a bending machine.
- There are three methods that can be used to limit the torque:

1. Limit the steady force applied during normal operation with user parameters Cn-08 (forward torque limit) and Cn-09 (reverse torque limit).
2. Limit operation with external signals connected to pins CN1-45 (PCL: forward current limit input) and CN1-46 (NCL: reverse current limit input). Set user parameters Cn-18 (forward rotation external current limit) and Cn-19 (reverse rotation external current limit).
3. Limit operation with analog voltage by using TREF (torque command input) as the analog current limit input.

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■ Parameter Settings

● Method 1: Limiting the Force Applied During Operation

• User Parameter Settings

PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-08	Forward torque limit	Maximum torque	% of rated torque	0 to maximum torque	This parameter sets the output torque limit for the forward direction (as a percentage of the rated torque).
Cn-09	Reverse torque limit	Maximum torque	% of rated torque	0 to maximum torque	This parameter sets the output torque limit for the reverse direction (as a percentage of the rated torque).

Note 1. This method is effective with speed control, internal speed control settings, and torque control.

Note 2. Set these parameters to the maximum torque (the factory setting) when the torque limit function isn't being used.

● Method 2: Limiting Operation with External Signals

• Control Mode Selection (Cn-02 = 0 to 2, 7 to 11)

Set the control mode selection (Cn-2b) to a control mode other than internally-set speed control (3 to 6).

With this setting, control input terminal CN1-45 will be PCL (forward current limit input), CN1-46 will be NCL (reverse current limit input), and it will be possible to use the external current limit function.

• User Parameter Settings

PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-18	Forward rotation external current limit	100	% of rated torque	0 to maximum torque	This parameter sets the limit when PCL is ON.
Cn-19	Reverse rotation external current limit				This parameter sets the limit when NCL is ON.

● Method 3: Limiting Operation with Analog Voltage

• Setup Parameter Settings (Bit 8 of Cn-02 = 1)

Set bit 8 of Cn-02 (the TREF switch) to "1." When bit 8 is "1," terminals CN1-9 and CN1-10 (TREF and AGND) become analog current limit input terminals. The current limit value can be calculated from the following equation:

Current limit value = (absolute value of voltage applied to TREF) × (torque command scale)

The polarity of the analog voltage is irrelevant and the same current limit value is used for forward and reverse.

• User Parameter Settings

PRM No.	Parameter name	Factory setting	Units	Setting range	Explanation
Cn-13	Torque command scale	30	0.1 V/rated torque	10 to 100	This parameter sets the gain for the torque command input.

Note 1. This method is useful when controlling torque in multiple stages.

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Note 2. This method is effective with speed control and torque control.

Note 3. This method can't be used when the torque feed-forward function is being used (i.e., when bit 9 of Cn-02 is set to "1.")

3-3-12 Speed Limit Function (Torque Control)

■ Function

- This function limits motor rotation speed when torque control is used. It sets a limit so that the motor rotation speed does not exceed the maximum speed of the mechanical system.
- Outside of the speed limit range, a torque in proportion to the difference with the speed limit value is generated to slow down the motor rotation speed. In such cases the number of motor rotations does not necessarily match the speed limit value. (The number of motor rotations varies depending the load.)
- There are two methods that can be used for limiting the speed:

1. Apply a constant fixed speed limit for torque control, by means of user parameter Cn-14 (speed limit).
2. Limit the speed by means of analog voltage. Use REF (speed command input) as an analog speed limit input.

■ Parameter Settings

● Applying a Constant Fixed Speed Limit for Torque Control

- User Parameter Settings

PRM No.	Parameter name	Factory setting	Units	Setting range	Explanation
Cn-14	Speed limit	3,000	r/min	0 to 4,500	This parameter sets the speed limit value for torque control.

● Limiting the Speed with Analog Voltage

- Set bit no. 2 of setup parameter Cn-02 to "1." When bit no. 2 is "1," terminals CN1-5 and CN1-6 (REF and AGND) become analog speed limit input terminals. The speed limit value can be calculated from the following equation:

  Speed limit value = (absolute value of voltage applied to REF) × (speed command scale)

- If the voltage is positive, this becomes the speed limit value for both the forward and reverse directions. (If the voltage is negative, this is regarded as a limit value of 0 r/min.
- User Parameter Settings

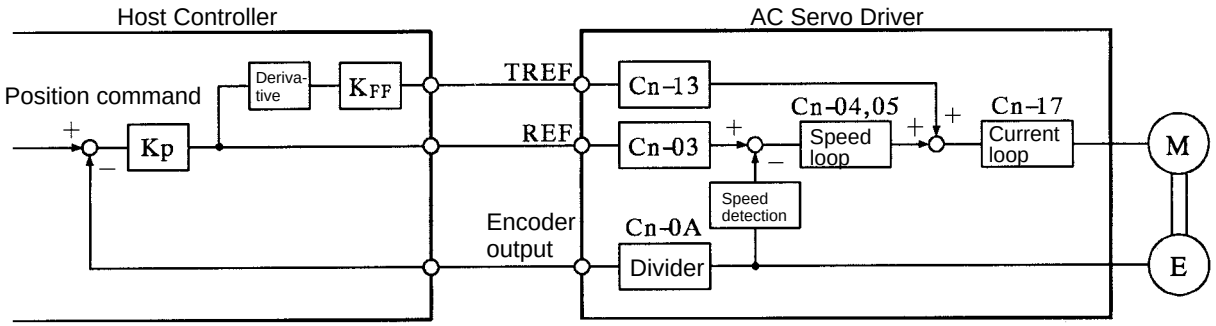
PRM No.	Parameter name	Factory setting	Units	Setting range	Explanation
Cn-03	Speed command scale	300	(r/min)/V	10 to 2,000	This parameter sets the number of rotations per speed command volt.

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3-3-13 Torque Feed-forward Function (Speed Control)

■ Function

- The torque feed-forward function reduces the acceleration time by adding the value of the torque command input (TREF) to the current loop; it can be used with speed control.
- Normally a derivative value is generated in the Controller and this value is input to TREF.
- Overshooting will occur if the feed-forward amount (the voltage input to TREF) is too high, so adjust user parameter Cn-13 (the torque command scale) as required.
- The following figure shows a block diagram when the torque feed-forward function is used.



■ Parameter Settings

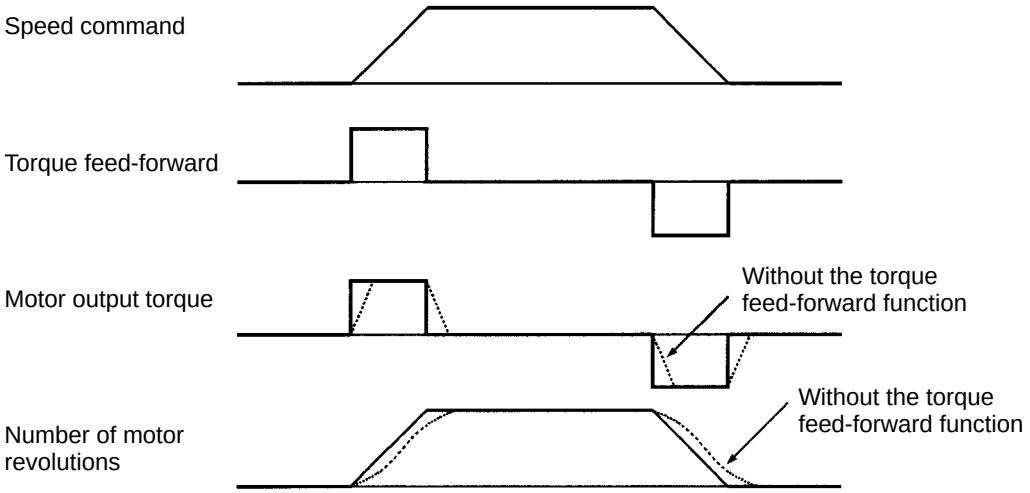
- Setup Parameter Settings (Bit 9 of Cn-02 = 1)

  Set bit 9 of Cn-02 (the torque feed-forward switch) to "1." When bit 9 is "1," terminals CN-9 and CN-10 (TREF and AGND) become the torque feed-forward input terminals.

- User Parameter Settings

PRM No.	Parameter name	Factory setting	Units	Setting range	Explanation
Cn-13	Torque command scale	30	0.1 V/rated torque	10 to 100	This parameter sets the gain for the torque command input.

■ Operation



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Note 1. If torque feed-forward is input when the motor's rotational speed is fixed, the rotational speed won't match the speed command. Design the Controller's circuit so that torque feed-forward is applied only when the motor is accelerating or decelerating.

Note 2. A torque will be generated that accelerates the motor in the forward direction if torque feed-forward is applied with a positive (+) voltage. Be sure that the polarity is correct because errors such as reverse motor rotation or oscillation will occur if the feed-forward is applied with a polarity opposing the acceleration direction.

3-3-14 Brake Interlock (for Motors With Brakes)

U-series AC Servo Drivers have a brake interlock signal (BKIR) to control the magnetic brake. In addition, they have a built-in dynamic brake circuit.

■ Magnetic Brakes

The magnetic brakes for Servomotors with brakes are specialized holding brakes with non-magnetized operation. Therefore set the parameters so that the brake power supply is turned off after the Servomotor stops. If the brake is applied while the Servomotor is operating, the brake will suffer abnormal wear or even damage, and will quickly become defective.

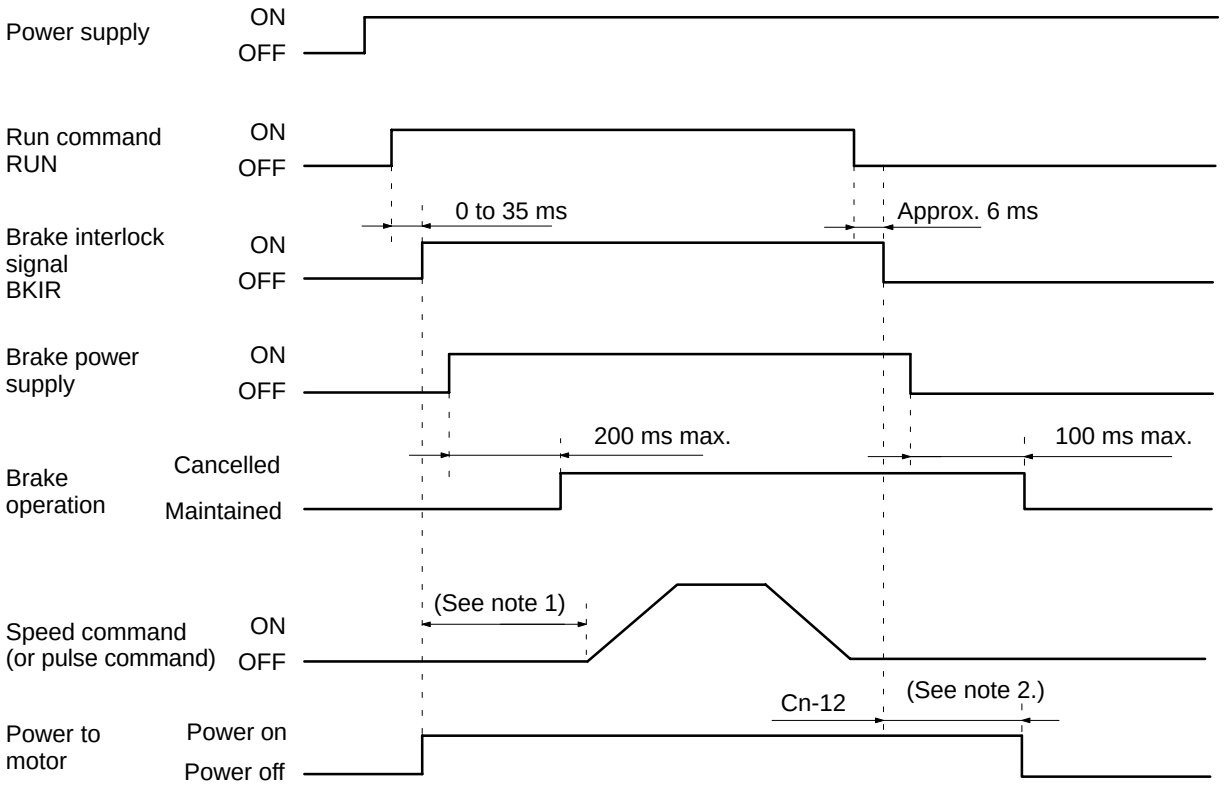
For wiring methods, refer to *2-2-4 Peripheral Device Connection Examples*.

● Parameters to be Set

PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-12	Brake timing 1	0	10 ms	0 to 50	Delay time setting from brake command until servo turns off.
Cn-15	Brake command speed	100	r/min	0 to 4,500	Sets rotation speed for outputting brake commands.
Cn-16	Brake timing 2	50	10 ms	10 to 100	Waiting time from servo-off to brake command output.

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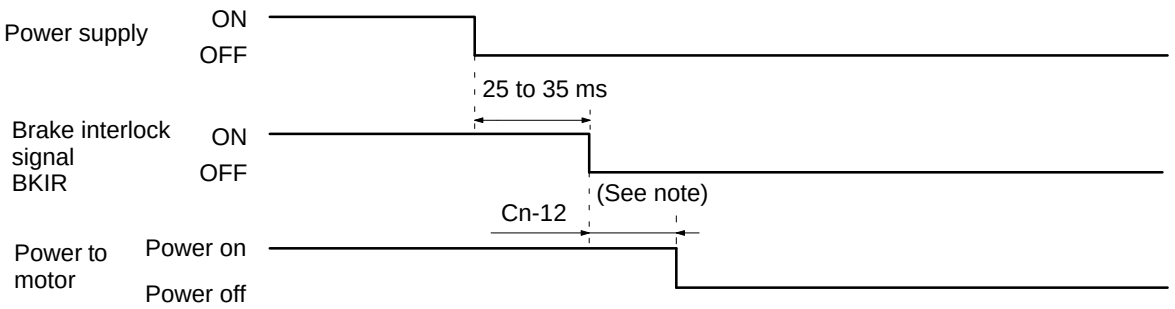
● Timing for Run Command (RUN) <When Servomotor is Stopped>



Note 1. It takes up to 200 ms for the brake to be cleared after the brake power supply has been turned on. Taking this delay into account, have the speed command (or pulse command) be given after the brake has been cleared.

Note 2. It takes up to 100 ms for the brake to be held after the brake power supply has been turned off. When using it for the vertical shaft, take this delay into account and set brake timing 1 (Cn-12) so that the Servomotor will not receive power until after the brake is held.

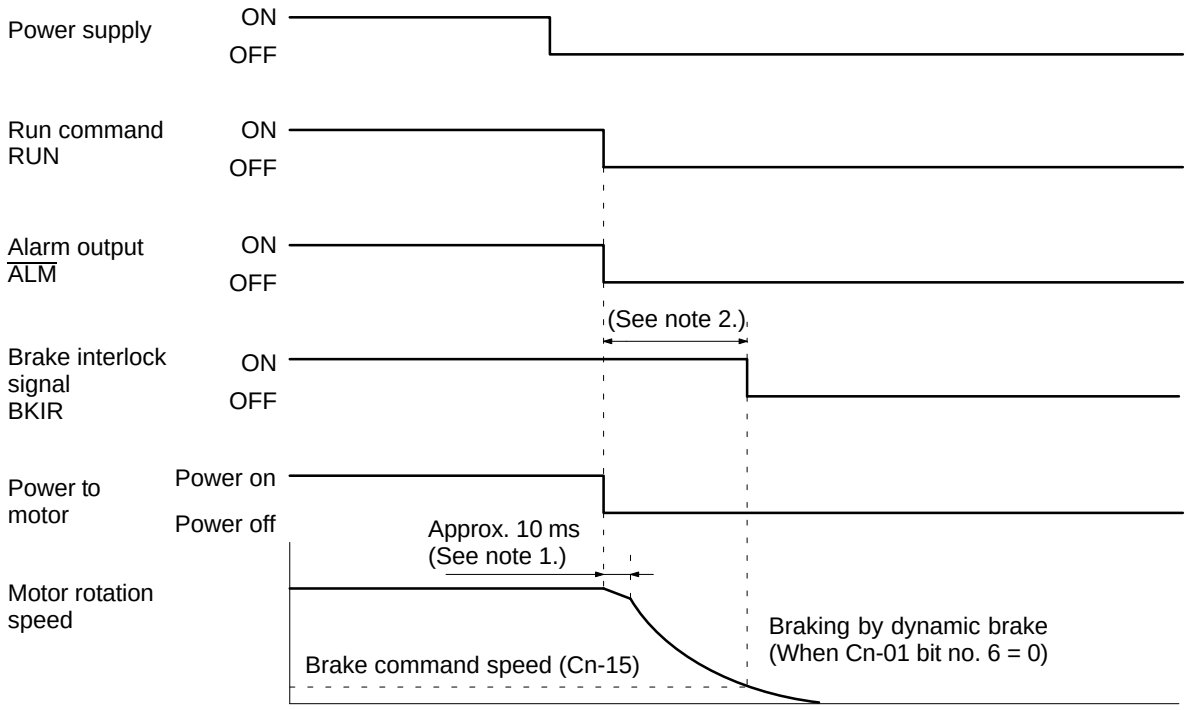
● Timing for Power Supply <When Servomotor is Stopped>



Note It takes up to 100 ms for the brake to be held after the brake power supply has been turned off. When using it for the vertical shaft, take this delay into account and set brake timing 1 (Cn-12) so that the Servomotor will not receive power until after the brake is held.

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- **Timing for Run Command (RUN), Errors, Power Supply <When Servomotor is Stopped>**



Note 1. For the approximately 10 ms it takes from when the power to the Servomotor turns off until the dynamic brake operates, the Servomotor rotates by momentum.

Note 2. If the Servomotor rotation speed falls below the speed set for the brake command speed (Cn-15), or if the time set for brake timing 2 (Cn-16) elapses after the Servomotor stops receiving power, the brake interlock signal (BKIR) will turn OFF.

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3-4 Trial Operation

After the wiring is complete and the parameter settings have been made, conduct a trial operation. Follow he procedure outlined below, to be prepared for unlikely events such as motor runaway.

■ Preparation for Trial Operation

- Do not connect a load (i.e., the mechanical system) to the Servomotor.
- Cut off the run command (RUN) so that the Servomotor can be stopped at any time.

■ Actual Trial Operation

(1) Powering Up

- With the run command (RUN) OFF, apply an AC voltage.
- After internal initialization, the mode will be the status display mode.
- Set the speed loop gain (Cn-04) to 20 or less. (Match the gain with no load.)

(2) Turning ON the Run command Input

- Turn ON the run command input. The Servomotor will go into servo-ON status.

(3) Low Speed Operation by the Servomotor Alone

- Give a speed command, or carry out the following check with a jogging operation.
  Is the direction of Servomotor rotation correct?
  Are there any abnormal sounds or vibration?
  Is anything abnormal occurring?
- If anything abnormal occurs, refer to *Chapter 4 Application* and apply the appropriate countermeasures.

(4) Low Speed Operation With a Load Connected

- After the low speed operation by the Servomotor alone is completed, connect a load (i.e., connect to the mechanical system). Make the connections securely, with no loose screws.
- Operate at low speed, and check the following items.
  Is the emergency stop operating correctly?
  Are the limit switches operating correctly?
  Is the operating direction of the machinery correct?
  Are the operating sequences correct?
  Are there any abnormal sounds or vibration?
  Is anything abnormal occurring?
- If anything abnormal occurs, refer to *Chapter 4 Application* and apply the appropriate countermeasures.

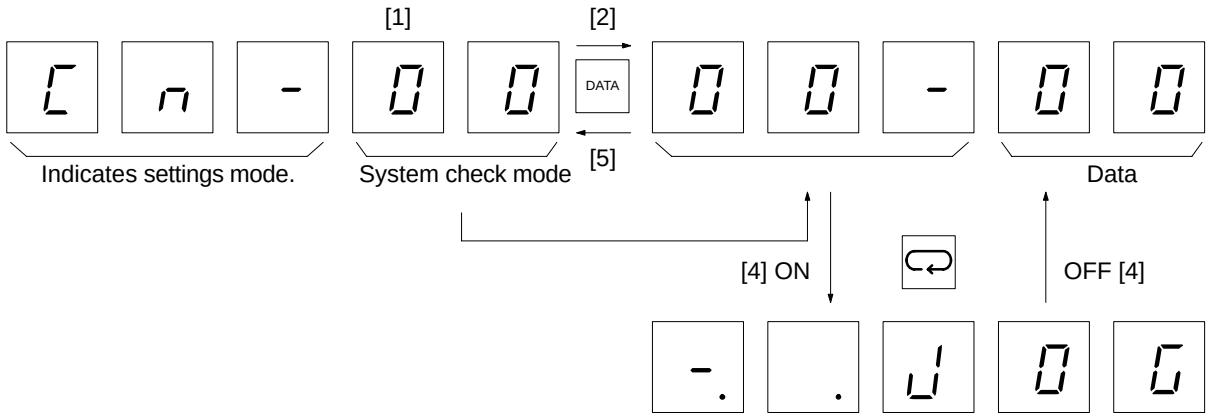
(5) Operation Under Actual Load Conditions

- After adjusting the gain (refer to *Section 3-5*), operate the Servomotor in a regular pattern and check the following items.
  Is the speed correct? (Use the speed display.)
  Is the load torque roughly equivalent to the measured value? (Use the torque command display.)
  Are the positioning points correct?
  When an operation is repeated, is there any discrepancy in positioning?
  Are there any abnormal sounds or vibration?
  Is either the Servomotor or the Servo Driver abnormally overheating?
  Is anything abnormal occurring?
- If anything abnormal occurs, refer to *Chapter 4 Application* and apply the appropriate countermeasures.

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■ Jog Operations

Jog operations rotate the Servomotor in a forward or reverse direction using the Parameter Unit. Jog operations are made possible when system check mode Cn-00 is set to “00.” The items in parentheses in the following explanation indicate operations using the Handy-type Parameter Unit.



1. Using the Up and Down (and Right and Left) Keys, set parameter number “00.” (System check mode)
2. Press the DATA Key to display the Cn-00 data.
3. Using the Up and Down (and Right and Left) Keys, set data “00.” (Jog operation)
4. Using the MODE/SET Key, turn ON and OFF the jog operation from the Parameter Unit. With the jog operation ON, operation by the Parameter Unit is enabled. For the run operation, refer to “Operation Method” below.
5. Press the DATA Key to return to the parameter number display.
6. Press the MODE/SET Key to move from settings mode to monitor mode.

● Operation Method

1. With the DATA (SERVO) Key, turn the servo ON and OFF.
2. With the servo ON, press the Up Key to rotate the Servomotor forward.
3. With the servo ON, press the Down Key to rotate the Servomotor in reverse.

● Parameters to be Set (User Parameter Cn-10)

The rotational speed during jog operation can be set with user parameter Cn-10, as shown in the following table.

PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-10	Jog speed	500	r/min	0 to 4,500	Speed setting for jog operation

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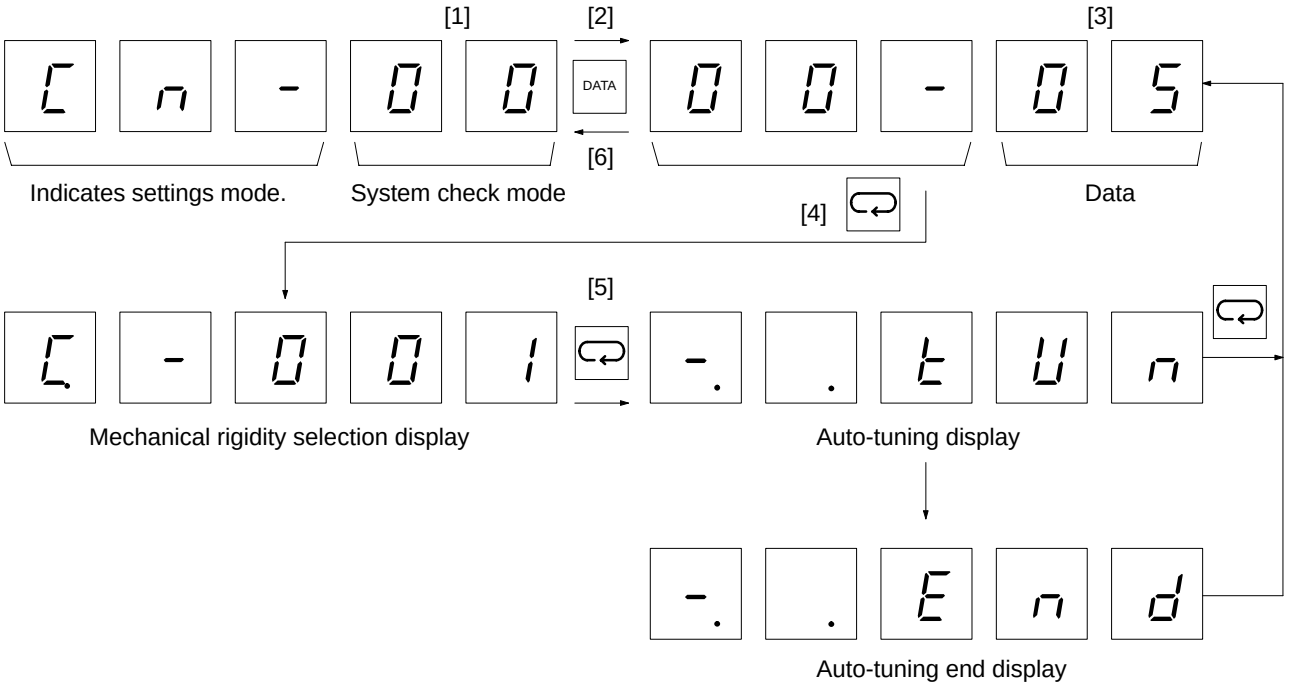
3-5 Making Adjustments

3-5-1 Auto-tuning

Auto-tuning rotates the Servomotor with a load connected (mechanical system), and automatically adjusts the position loop gain, the speed loop gain, and the speed loop integration time constant. When adjustments cannot be made by auto-tuning, refer to *3-5-2 Manually Adjusting Gain*.

■ Executing Auto-tuning

Auto-tuning is made possible when the system check mode Cn-00 is set to “05.” The items in parentheses in the following explanation indicate operations using the Handy-type Parameter Unit.



1. Using the Up and Down (and Right and Left) Keys, set parameter number “00.” (System check mode)
2. Press the DATA Key to display the Cn-00 data.
3. Using the Up and Down (and Right and Left) Keys, set data “05.” (Auto-tuning)
4. Press the MODE/SET Key to display the mechanical rigidity selection. (Refer to *Selecting Mechanical Rigidity* below.)
5. Press the MODE/SET Key to change to the auto-tuning display. (Refer to the following “Auto-tuning Procedure.”)
6. Press the DATA Key to return to the parameter number display.
7. Press the MODE/SET Key to move from settings mode to monitor mode.

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● Selecting Mechanical Rigidity

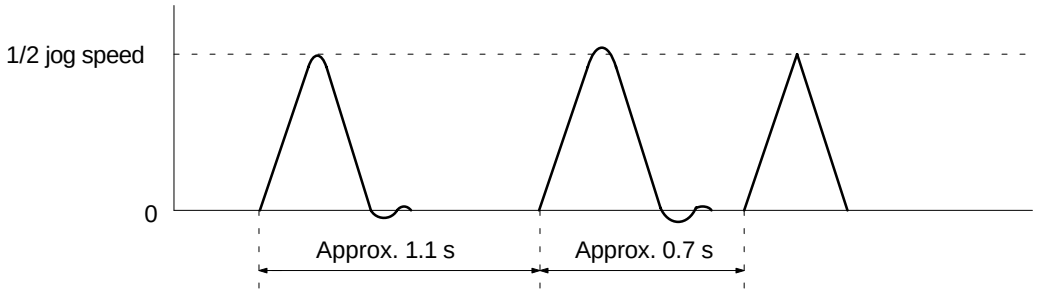
Select the set value to match the rigidity of the mechanical system.

Response	Set value	Position loop gain (1/s)	Representative applications
Low	001	16	Articulated robots, harmonic drives, chain drives, belt drives, rack and pinion drives, etc.
	002	28	
Medium	003	40	XY tables, Cartesian-coordinate robots, general-purpose machinery, etc.
High	004	56	Ball screws (direct coupling), feeders, etc.
	005	78	
	006	108	
	007	130	

Note The response will rise according to a rise in the rigidity of the mechanical system.

● Auto-tuning Procedure

1. With the DATA (SERVO) Key, turn the servo ON and OFF.
2. While pressing the Up Key, operate the Servomotor three times in the forward direction and adjust the gain. The auto-tuning will not be complete until the Servomotor has been operated at least three times. If the auto-tuning is not complete after three times, then repeat the operation while holding down the Up Key. The Servomotor rotation speed should be approximately 1/2 that of the jog speed (Cn-10).



3. While pressing the Down Key, adjust the gain in the same way for the reverse direction.
4. By executing step 2 or step 3, the user parameter position loop gain (Cn-1A), speed loop gain (Cn-04), and speed loop integration time constant (Cn-05) will be adjusted automatically. These values will not be changed, however, until the auto-tuning operation has been completed.
5. When the auto-tuning operation is complete, "-. End" will be displayed at the Parameter Unit (while the Up and Down Keys are being pressed). When the Up and Down Keys are released, "00-05" will again be displayed.
6. If the auto-tuning operation is still not complete even after being executed many times, or if you wish to abort the operation, press the MODE/SET Key. After the MODE/SET Key is pressed, "00-05" will again be displayed.

Note 1. If the auto-tuning operation is not completed, or if there is an inadequate response for the gain that is adjusted by auto-tuning, refer to *3-5-2 Manually Adjusting Gain* and adjust the gain manually.

Note 2. The auto-tuning will not be complete until the Servomotor has been operated at least three times, so pay sufficient attention to the operating range of the machinery. If auto-tuning cannot be executed within the operating range of the machinery, then adjust the gain manually.

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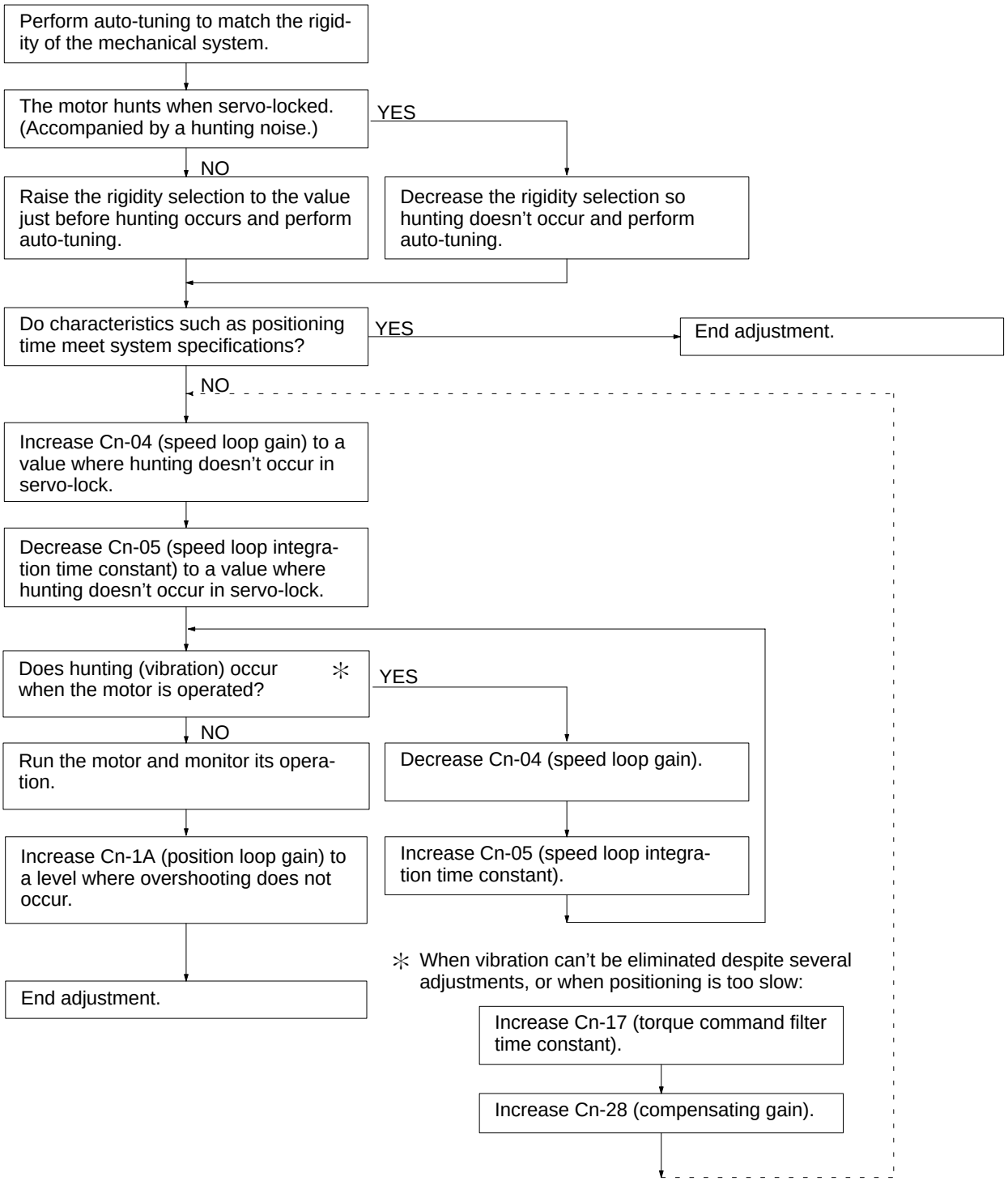
3-5-2 Manually Adjusting Gain

There are eleven kinds of parameters for adjusting Servomotor response. For situations in which the factory settings or the settings derived from auto-tuning alone do not provide adequate characteristics, the settings can be adjusted manually.

■ Gain Adjustment Flowchart

● For Position Control (Pulse Train Input)

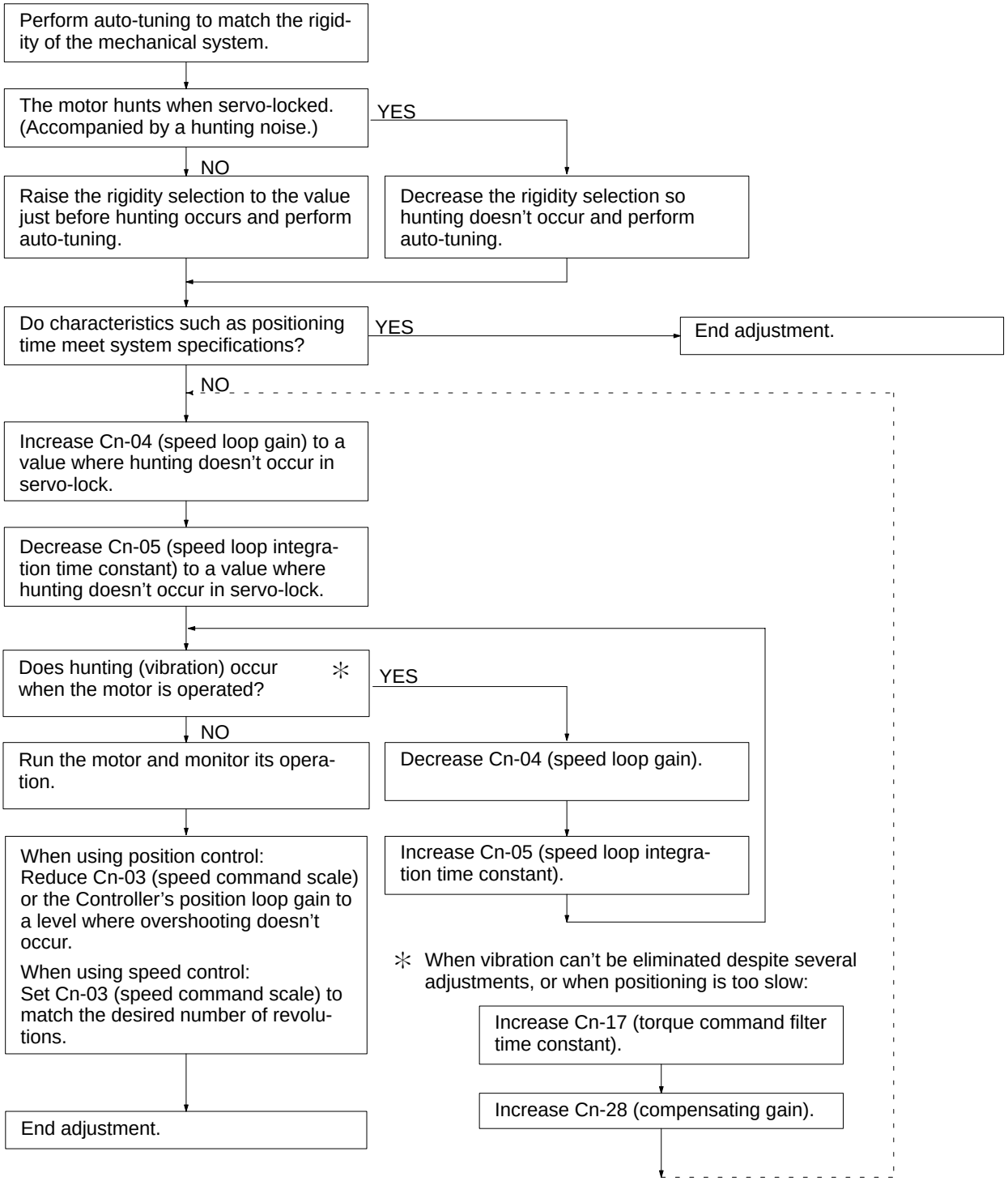
Adjustment procedures for position control are shown in the following flowchart.



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● For Speed Control (Analog Input)

Adjustment procedures for speed control are shown in the following flowchart.



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■ Adjustment Parameters

The user parameters for making adjustments are shown in the following table. The symbols following each parameter name indicate which control modes that particular parameter can be used for. (P: Position control; S: Speed control; T: Torque control)

PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-04	Speed loop gain (P, S)	80	Hz	1 to 2,000	Adjusts the speed loop response. As this is made higher, the servo rigidity is strengthened. The greater the inertia rate, the higher this is set. If it is set too high, oscillation will occur. (See the illustration following this table.)
Cn-05	Speed loop integration time constant (P, S)	2,000	0.01 ms	200 to 51,200	Speed loop integration time constant. As this is made longer, the response is shortened and the resiliency toward external force is weakened. If it is set too short, vibration will occur. (See the illustration following this table.)
Cn-17	Torque command filter time constant (P, S, T)	4	0.1 ms	0 to 250	Sets torque command filter time constant. Make this large in order to reduce oscillation and vibration due to machinery resonance frequency. The filter characteristics are switched by the torque command filter degree (bit no. C of Cn-02).
Cn-1A	Position loop gain (P, S)	40	l/s	1 to 1,000	For speed control, this function is valid only when position-lock function is used. For position lock, use it for servo-lock adjustment. Servo system responsiveness is determined by position loop gain. When position loop gain is high, responsiveness increases and positioning can be speeded up. In order to increase position loop gain, it is necessary to increase mechanical rigidity and thereby increase the natural frequency (oscillation). In general, the setting range is 50 to 70 (l/s) for construction machinery, 30 to 50 (l/s) for general-purpose and assembly equipment, and 10 to 30 (l/s) for industrial robots. The factory setting is 40 (l/s), so it should be reduced for systems with low mechanical rigidity. If position loop gain is increased for a system with low mechanical rigidity, or with low natural frequency, resonance will occur and an overload alarm will be generated. If position loop gain is low, positioning time can be shortened by using feed-forward or the bias function. (For more detail, see the illustration following this table.)

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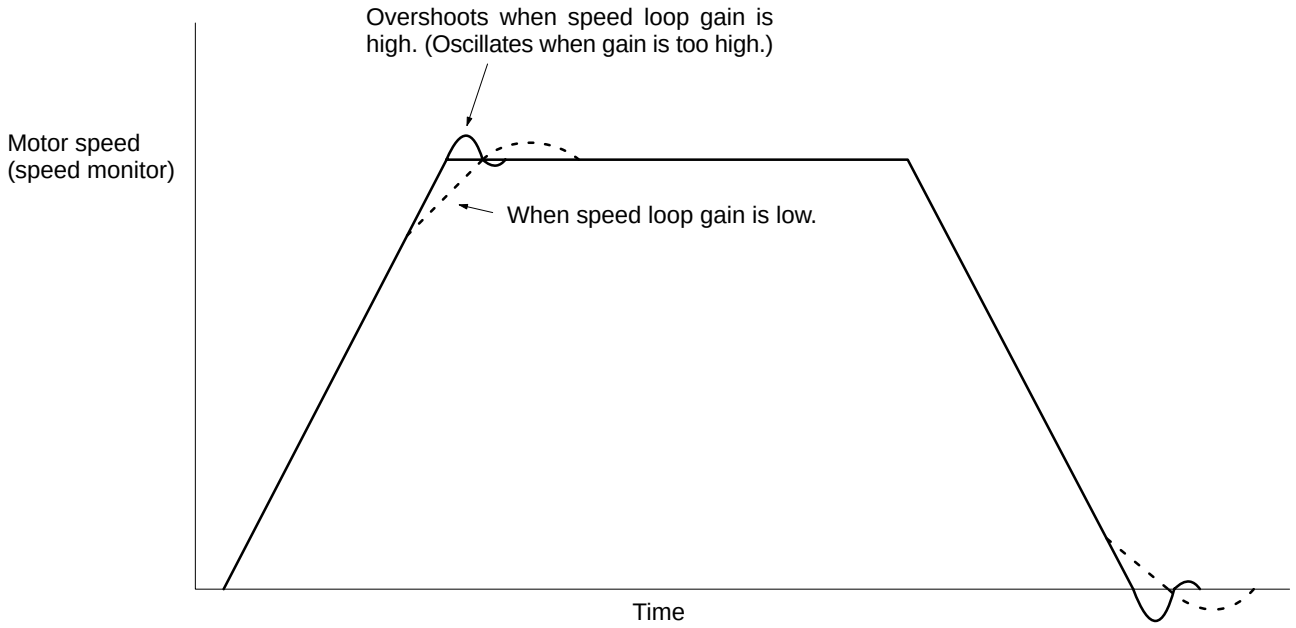
PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-1b	Positioning completion range (P)	3	Command	0 to 250	Sets the positioning completion range with input command pulses. (The settings are ordinarily based on the precision required by the machine.) positioning completion outputs smaller than required are slower. **Caution:** If this setting is too high, when there are few residual pulses the positioning completion output may turn ON while the motor is still rotating at low speed.
Cn-1C	Bias rotational speed (P)	0	r/min	0 to 450	Used to shorten positioning time. The higher this parameter is set, the more the positioning time is shortened. If it is set too high, however, operation will be unstable. Gradually increase the setting from 0 r/min while observing the response.
Cn-1d	Feed-forward (P)	0	%	0 to 100	Effective when position loop gain is small, i.e., less then 25 (1/s), but ineffective when it is large. Setting this parameter too high will increase overshooting. The feed-forward amount is added directly to the speed loop, bypassing the deviation counter and thereby speeding up the response (when load system is not slowed by command). Before adjusting the feed-forward amount, check to be sure that the position loop has been completely adjusted and that the speed loop is operating with stability. Start from 0% and increase the setting gradually. If the feed-forward amount is set too high, speed commands become like sawtooth waves and abnormal noises occur. Be careful when setting this parameter so that the positioning completion signal doesn't repeat the ON/OFF cycle and speed overshooting doesn't occur.
Cn-1E	Deviation counter overrun level (P)	1,024	x 256 command units	1 to 32,767	The residual pulses in the deviation counter are equivalent to the command pulse frequency divided by the position loop gain. Divide this value by 256 to set a further allowance.
Cn-26	Position command acceleration/deceleration constant (P)	0	0.1 ms	0 to 640	Sets the pulse smoothing time constant. The motor accelerates and decelerates according to this setting even when position command pulses are input in steps. This is the position command software start function. The acceleration time is the same as the deceleration time. Set this parameter to 0 ms when using a positioner with an acceleration/deceleration function.

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PRM No.	Parameter name	Factory setting	Unit	Setting range	Explanation
Cn-27	Feed-forward command filter (P)	0	0.1 ms	0 to 640	Sets the filter so that the feed-forward amount is not added suddenly when position command pulses are input in steps.
Cn-28	Compensating gain (P, S)	0	---	0 to 100	Decreases the speed loop gain by the set value when a large torque is output due to acceleration, deceleration, etc. Increasing the set value reduces motor oscillation, and positioning time can be shortened. If the set value is too large, a follow-up delay will occur for acceleration and deceleration.

● Adjusting Speed Loop Gain (Cn-04)

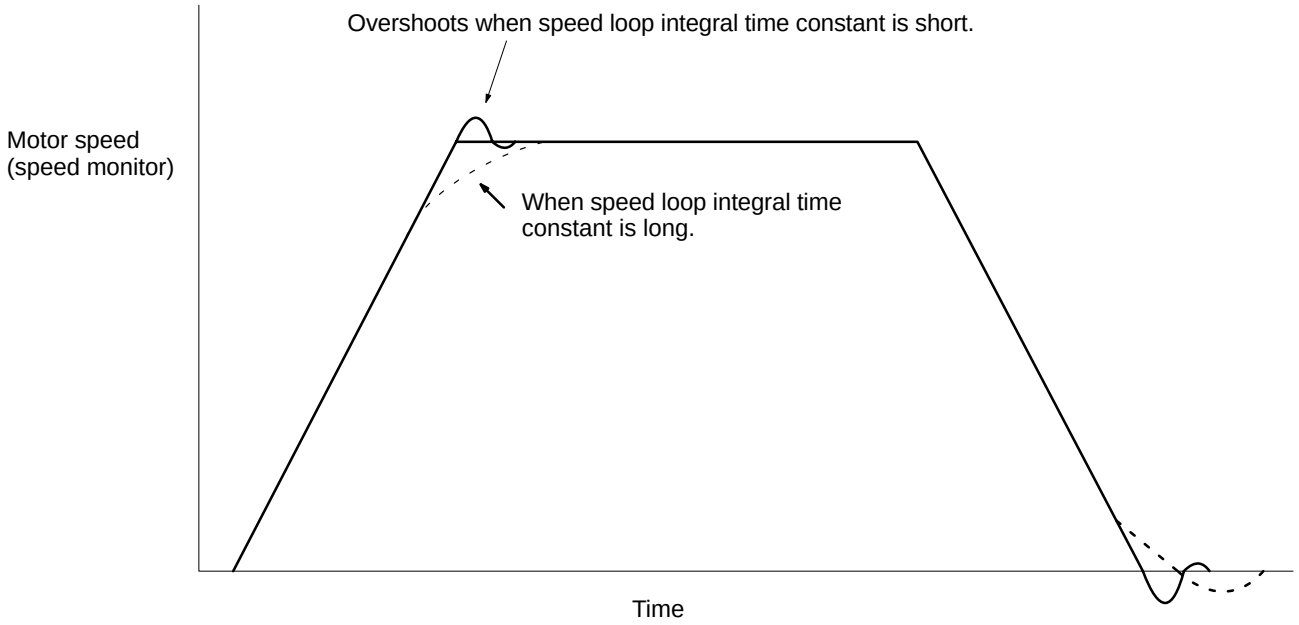
When the speed loop gain is manipulated, the response is as shown in the diagram below.



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● Adjusting the Speed Loop Integration Time Constant (Cn-05)

When the speed loop integration time constant is manipulated, the response is as shown in the diagram below.

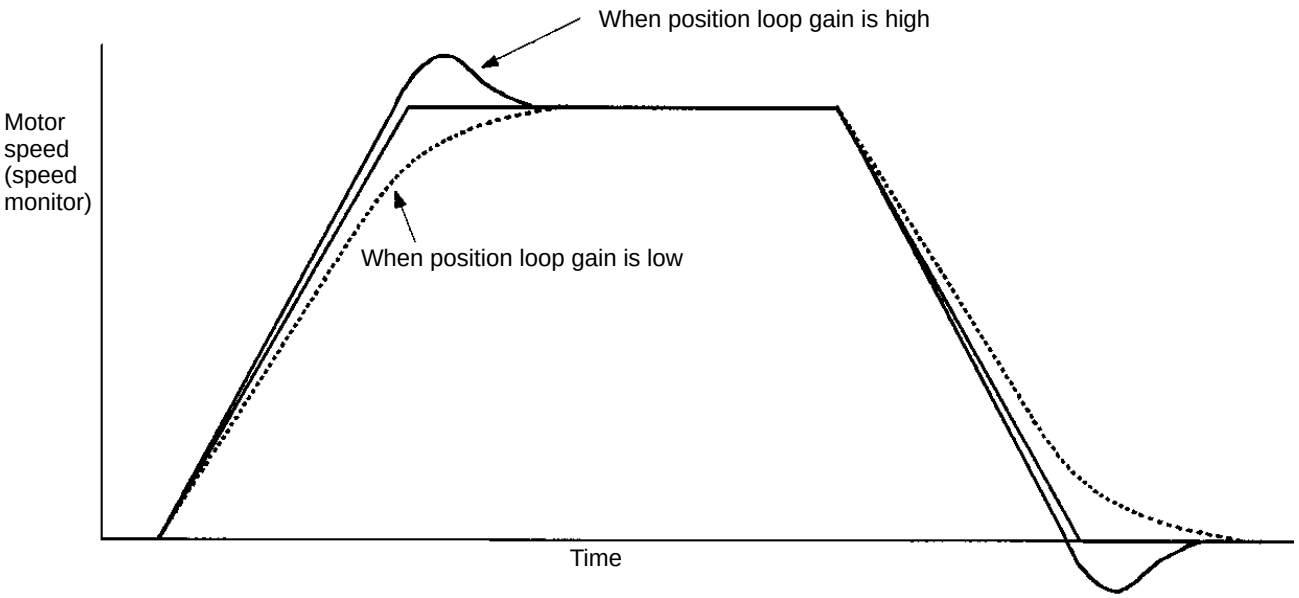


● Position Loop Gain (Cn-1A)

Position loop gain is generally expressed as follows:

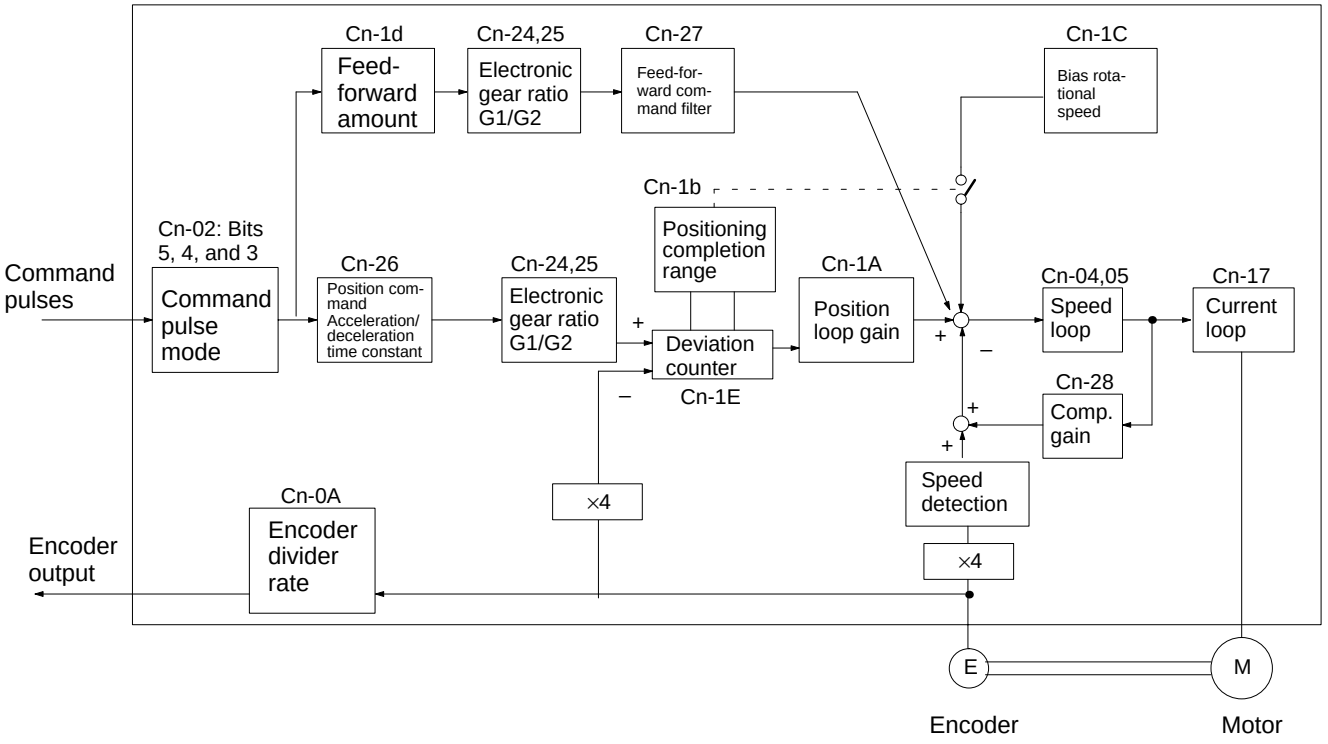
$$\text{Position loop gain (Kp)} = \frac{\text{Command pulse frequency (pulses/s)}}{\text{Deviation counter residual pulses (pulses)}} \quad (1/s)$$

When the position loop gain is manipulated, the response is as shown in the diagram below.



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■ Position Loop Block Diagram (Reference)



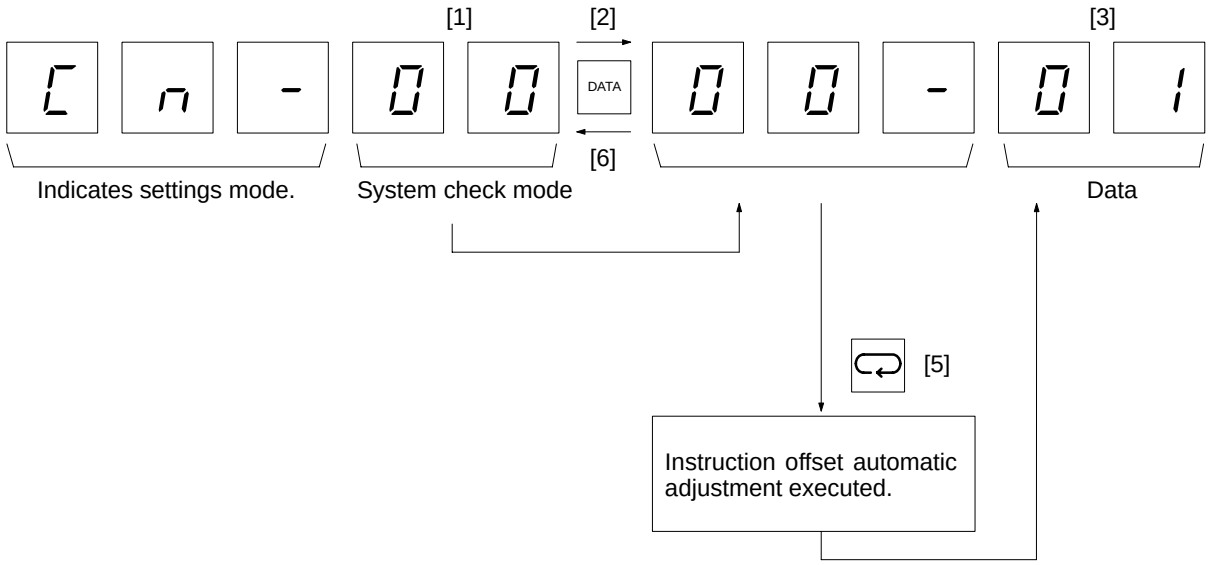
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3-5-3 Adjusting Command Offset

Use the following procedure to adjust the analog voltage offsets for the speed command and torque command.
Command offset can be adjusted either automatically or manually.
The torque command's offset can't be adjusted manually, so adjust it automatically.

■ Adjusting Instruction Offset Automatically

Automatic adjustment of command offset is made possible when the system check mode Cn-00 is set to "01." The items in parentheses in the following explanation indicate operations using the Handy-type Parameter Unit.

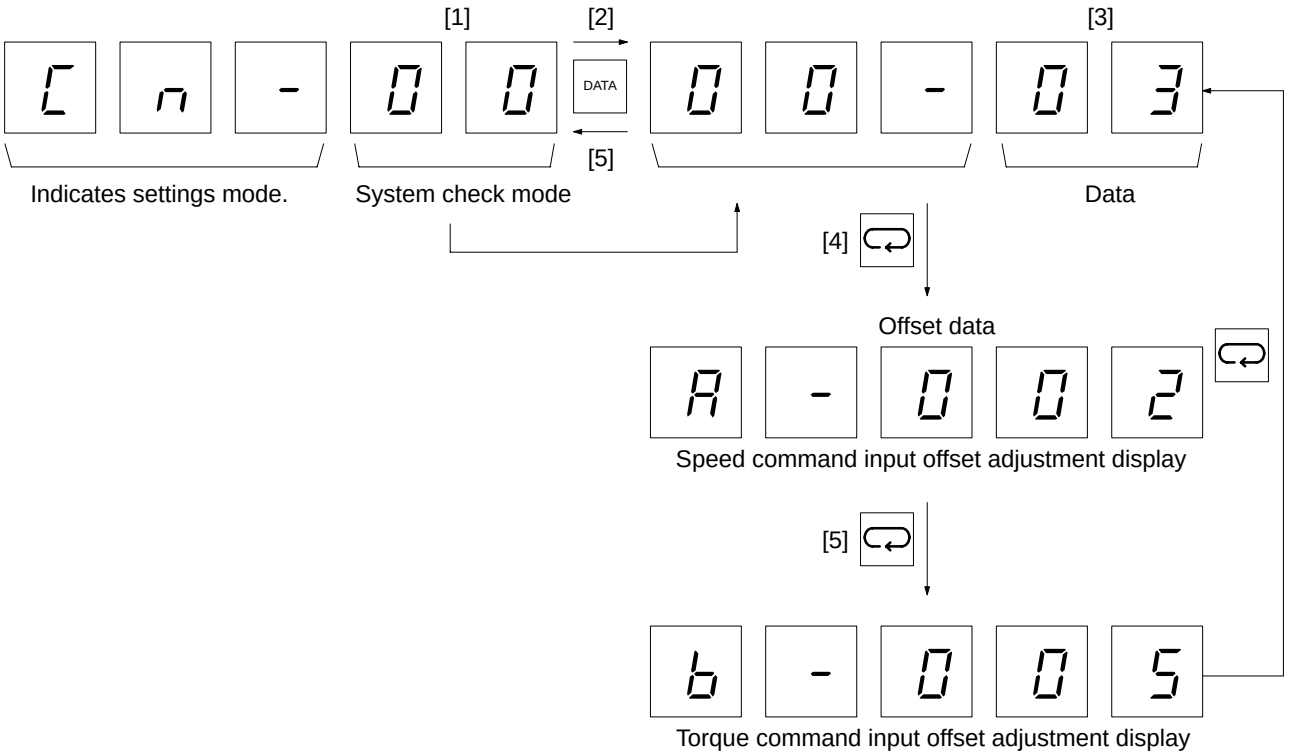


1. Using the Up and Down (and Right and Left) Keys, set parameter number "00." (System check mode)
2. Press the DATA Key to display the Cn-00 data.
3. Using the Up and Down (and Right and Left) Keys, set data "01." (Instruction offset automatic adjustment)
4. Input the voltage required to set the speed command input (REF) and the torque command input (TREF) to zero rotation speed and zero output torque respectively. (Normally 0 V.)
5. Press the MODE/SET Key to automatically adjust the command offset.
6. Press the DATA Key to return to the parameter number display.
7. Press the MODE/SET Key to move from settings mode to monitor mode.

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■ Adjusting Instruction Offset Manually

Manual adjustment of command offset is made possible when the system check mode Cn-00 is set to “03.” The items in parentheses in the following explanation indicate operations using the Handy-type Parameter Unit.



1. Using the Up and Down (and Right and Left) Keys, set parameter number “00.” (System check mode)
2. Press the DATA Key to display the Cn-00 data.
3. Using the Up and Down (and Right and Left) Keys, set data “03.” (Instruction offset manual adjustment)
4. Press the MODE/SET Key to change to the manual adjustment display. Refer to “Instruction Offset Manual Adjustment Method” below.
5. Press the DATA Key to return to the parameter number display.
6. Press the MODE/SET Key to move from settings mode to monitor mode.

● Instruction Offset Manual Adjustment Method

Input the voltage required to set the speed command input (REF) to zero rotation speed. (Normally 0 V.)

1. While the Up Key is being pressed, an offset is added in the forward direction.
2. While the Down Key is being pressed, an offset is added in the reverse direction.
3. Press the MODE/SET Key to save the offset data to memory and return to the data display.

Note When the offset data display indicates zero, it is not necessarily the optimal adjustment. For speed control, make the offset adjustment determination based on Servomotor movement; for position control, make the determination based on the amount of accumulated pulses in the deviation counter.

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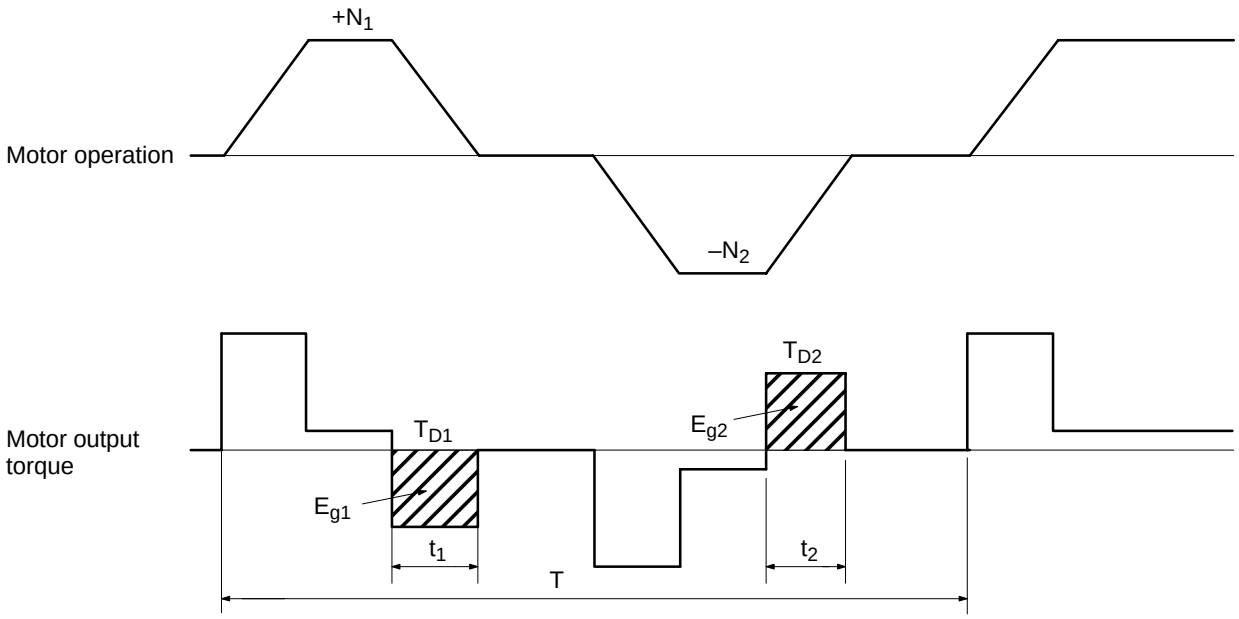
3-6 Regenerative Energy Absorption

3-6-1 Calculating Regenerative Energy

Regenerative energy produced at times such as Servomotor deceleration is absorbed by the Servo Driver's internal capacitors, thereby preventing an increase in DC voltage. If the regenerative energy from the Servomotor becomes too large, however, an over-voltage error will occur. In such cases, it is necessary to reduce the regenerative energy by taking an action such as changing operation patterns.

Regenerative energy is produced when the direction of Servomotor rotation or output torque is reversed. The methods for calculating regenerative energy for the horizontal and vertical shafts are explained below.

■ Horizontal Axle



Note In the output torque graph, acceleration in the positive side (rising) is shown as positive, and acceleration in the negative side (falling) is shown as negative.
The regenerative energy for each section can be found by means of the following formulas:

$E_{g1} = 1/2 \bullet N_1 \bullet T_{D1} \bullet t_1 \bullet 1.027 \times 10^{-2}$ [J]
$E_{g2} = 1/2 \bullet N_2 \bullet T_{D2} \bullet t_2 \bullet 1.027 \times 10^{-2}$ [J]

N_1, N_2:	Rotation speed at beginning of deceleration [r/min]
T_{D1}, T_{D2}:	Deceleration torque [kgf • cm]
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 figure derived by the formula.

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To find the regenerative processing capacity, it is necessary to calculate the average regenerative power.

1. Energy (E_g) consumed by regenerative resistance:
   The regenerative energy that cannot be absorbed by the Servo Driver's internal capacitors is consumed by regenerative resistance. This energy can be found by means of the following formula:

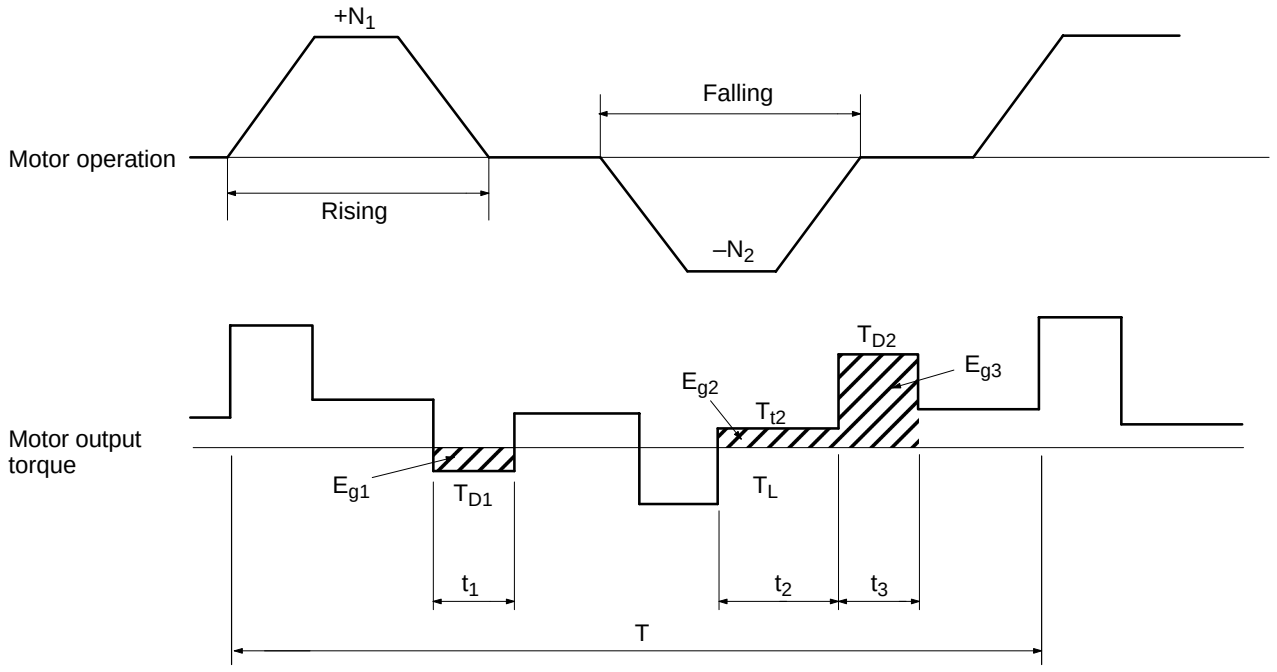
   $E_g = (E_{g1} - E_c) + (E_{g2} - E_c)$ [J]

   E_c is the regenerative energy absorbed by the capacitors. (This value varies according to the model.)
   If either ($E_{g1} - E_c$) or ($E_{g2} - E_c$) is less than zero, calculate as if it were zero.
2. Average regeneration amount (P_r):
   Power consumed by regenerative resistance in one cycle of operation (unit: W):

   $P_r = E_g/T$ [W]
   T: Operation cycle [s]

This average regeneration amount must be no more than the average regenerative amount for the Servo Driver.

■ Vertical Axle



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 for each section can be found by means of the following formulas:

$E_{g1} = 1/2 \bullet N_1 \bullet T_{D1} \bullet t_1 \bullet 1.027 \times 10^{-2}$ [J]
$E_{g2} = N_2 \bullet T_{L2} \bullet t_2 \bullet 1.027 \times 10^{-2}$ [J]
$E_{g3} = 1/2 \bullet N_2 \bullet T_{D2} \bullet t_3 \bullet 1.027 \times 10^{-2}$ [J]

N_1, N_2: Rotation speed at beginning of deceleration [r/min]
T_{L2}: Torque when declining [kgf • cm]

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T_{D1}, T_{D2}: Deceleration torque [kgf • cm]
t_1, t_3: Deceleration time [s]
t_2: Travel time equivalent to torque when declining [s]

Note There is some loss due to winding resistance, so the actual regenerative energy will be approximately 90% of the figure derived by the formula.

To find the regenerative processing capacity, it is necessary to calculate the average regenerative power.

1. Energy (E_g) consumed by regenerative resistance:
   The regenerative energy that cannot be absorbed by the Servo Driver's internal capacitors is consumed by regenerative resistance. This energy can be found by means of the following formula:

   $E_g = (E_{g1} – E_c) + (E_{g2} + E_{g3} – E_c)$ [J]

   E_c is the regenerative energy absorbed by the capacitors. (This value varies according to the model.)
   If either ($E_{g1} – E_c$) or ($E_{g2} + E_{g3} – E_c$) is less than zero, calculate as if it were zero.
2. Average regeneration amount (P_r):
   Power consumed by regenerative resistance in one cycle of operation (unit: W):

   $P_r = E_g/T$ [W]
   T: Operation cycle [s]

This average regeneration amount must be no more than the average regenerative amount for the Servo Driver.

3-6-2 Servo Driver Absorbable Regenerative Energy

■ Regenerative Energy Absorbed Internally

The Servo Driver absorbs regenerative energy by means of an internal capacitor. If there is more regenerative energy than can be absorbed by the capacitor, an overvoltage error will be generated and operation cannot continue. The amounts of regenerative energy that can be absorbed by the various Servo Drivers alone are shown in the tables below. If regenerative energy exceeding these values is produced, take the following measures.

- Lower the operating rotation speed. (The regenerative energy is proportional to the square of the rotation speed.)
- Lengthen the deceleration time. (Reduce the amount of regenerative energy per unit time.)
- Lengthen the operating cycle (i.e., the cycle time). (Reduce the average regenerative power.)

Servo Driver model	Absorptive regeneration energy E_c (J)	Average absorbable regenerative energy (W)
R88D-UT24H/V	24.3	28
R88D-UT40H/V	24.3	28
R88D-UT60H/V	64.3	28
R88D-UT80H/V	64.3	28
R88D-UT110H	107	56
R88D-UT120H	107	56

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Servo Driver model requiring external regenerative resistor	Absorptive regeneration energy E_C (J)
R88D-UT24V-RG	24.3
R88D-UT40V-RG	24.3
R88D-UT60V-RG	64.3
R88D-UT80V-RG	64.3
R88D-UT110V	119

Note 1. The Servo Drivers requiring external regenerative resistors do no have built-in regenerative resistors. Be sure to install Regenerative Resistors that correspond to the amount of regenerative energy.

Note 2. The input voltage is the value at 200 VAC. As the input voltage is increased, the amount of regenerative energy that can be absorbed is decreased.

3-6-3 Absorption of Regenerative Energy with External Regenerative Resistors Connected to Models Complying with EC Directives

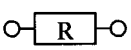
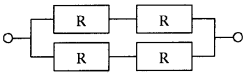
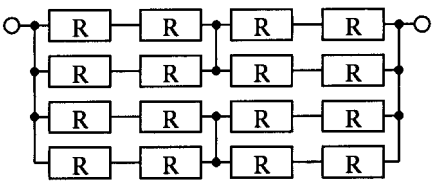
If there is excessive regenerative energy that cannot be absorbed by the Servo Driver, use a Servo Driver model to which external regenerative resistors can be connected. An appropriate number of external regenerative resistors must be connected between the + and B terminals of the Servo Driver. Do not connect external regenerative resistors to any other terminals of the Servo Driver, otherwise the Servo Driver may be damaged. The temperature of the external regenerative resistors rises by approximately 120°C. Be sure to keep them away from any device or wiring that may be affected by heat. Be sure to attach proper heat sinks to the external regenerative resistors before use.

■ External Regenerative Resistor

● Model

Model	Resistance	Nominal capacity	Absorption of regenerative energy at 120°C temperature rise	Heat radiating condition	Thermal switch output specification
R88A-RR22047S	47Ω±5%	220 W	70 W	t1.0 x □350 (SPCC)	Operating temperature: 170°C

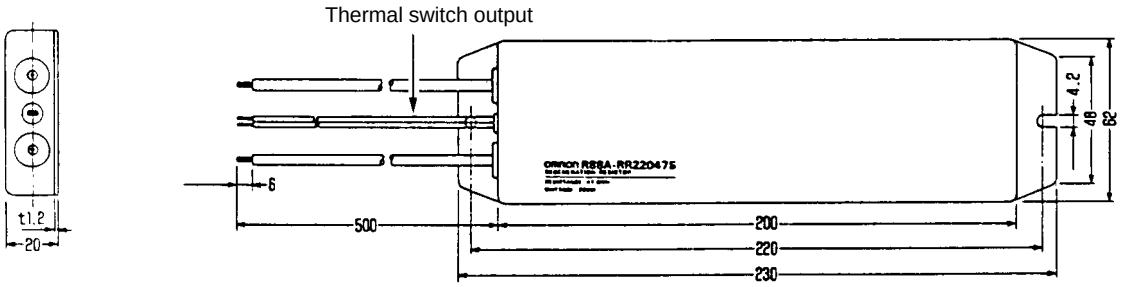
● Combinations of External Regenerative Resistors

	Regenerative absorption capacity		
	70 W	280 W	1120 W
Combination			

Note Make sure to combine external regenerative resistors so that their regeneration absorbing capacity exceeds the average regenerative power (Pr).

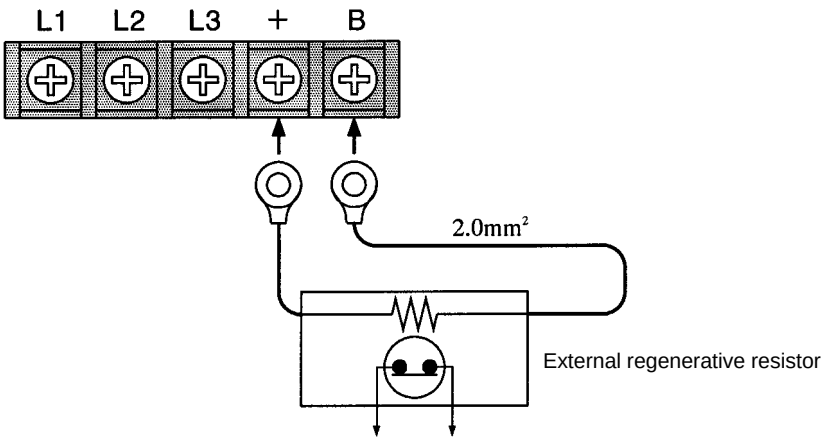
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● **Dimensions**



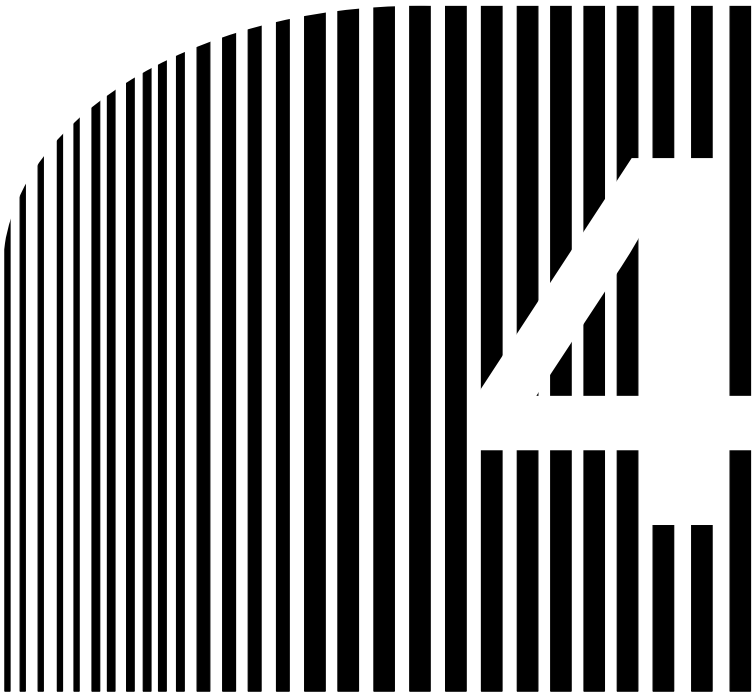
■ Wiring of External Regenerative Resistor

The external regenerative resistor must be connected between + and B terminals (or between +1 and B terminals for the R88D-UT110V).



Note Like the ALM output of the Regeneration Unit, the power source of thermal switch output should turn power off when the contact is open. Refer to *2-3-4 Peripheral Device Connection Examples*.

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Chapter 4

• Application •

4-1 Absolute Encoder Setup and Battery Changes
4-2 Using Displays
4-3 Using Monitor Output
4-4 Protective and Diagnostic Functions
4-5 Periodic Maintenance

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Operation and Adjustment Precautions

⚠ **Caution** Check the newly set parameters 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 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** Do not use the built-in brake of the Servomotor for ordinary braking. Doing so may result in malfunction.

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4-1 Absolute Encoder Setup and Battery Changes

This section explains how to carry out the setup procedure and change the battery for an absolute encoder.

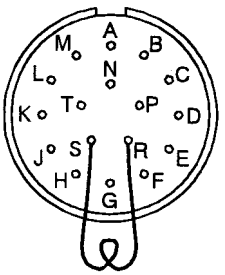
4-1-1 Absolute Encoder Setup [Absolute]

The setup procedure is required when the mechanical rotation data is set to “0” at the time of Servomotor trial operation, or when the absolute encoder is left for more than two days without a battery connected. (If it is left for more than two days without a battery connected, the internal capacitor voltage drops and internal components may not operate properly.)

■ Setup Procedure

Be sure to follow this procedure carefully. Any mistakes in carrying out this procedure could result in faulty operation.

1. Resetting Data
   Connect (short-circuit) the encoder connector terminals R and S (at the Servomotor) for at least two minutes. (Refer to the illustration on the right.) Then remove the connecting line and check to be sure that there is a maximum voltage of 0.4 V between R and S (with the S terminal as the ground). If the voltage between the terminals is more than 0.4 V, reconnect the line between them.



2. Turning On Power to the Servo Driver
   Be sure to wire the Servo Driver and the Servomotor properly. Connect the battery to supply battery power to the encoder and wait for several seconds. Then turn on the power to the Servo Driver.
3. Inputting the SEN Signal (CN1-4)
   Turn ON the SEN signal. When the SEN signal is turned ON, a +5-V power supply will be provided to the encoder.
   As long as there is no error, the setup procedure is complete at this point. If alarm A.00 is generated, repeat the procedure beginning with step 1.

Note When removing encoder connectors, leave the power on for at least 30 minutes with the SEN signal ON. If there is to be no battery connected, the data for the amount of rotation will be retained for two days.

● Setup Precautions

Note **1.** When connecting to the CV500-MC221/421 or C200H-MC221, carry out the setup close to the mechanical origin.

Note **2.** An error will be generated if the absolute data exceeds +32,767 pulses when making the initial settings for the CV500-MC221/421 or C200H-MC221.

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4-1-2 Replacing Batteries [Absolute]

■ Lithium Batteries

Be sure to use a battery so that position data will be retained even in case of a power interruption for the absolute encoder. The following batteries are recommended.

Maker	Model	Voltage	Electrical capacity	Remarks
Toshiba Corp.	ER6V	3.6 V	2,000 mA • h	One/Servo Driver Service life: Approx. 10 years
Hitachi Maxell, Ltd.	ER6	3.6 V	2,050 mA • h	One/Servo Driver Service life: Approx. 10 years
OMRON (made by Hitachi Maxell, Ltd.)	C500-BAT08 (ER17/33)	3.6 V	1,650 mA • h	One/Servo Driver Service life: Approx. 7 years

Note If the Servo Driver's internal power supply is turned OFF, the battery voltage will not be monitored. Be careful to ensure that the voltage does not fall below 2.8 V. If required, install a battery voltage drop detection circuit or monitor in the system.

■ Battery Replacement Method

The following procedure can be used to replace the battery without losing the encoder's rotation data.

1. Turn on the power to the Servo Driver and turn ON the SEN signal, and leave them for at least 30 minutes to charge the encoder's internal capacitors.
2. Replace the battery. Connect the battery between the Servo Driver's control I/O connector (CN1) pin nos. 21 and 22.

   21: BAT Backup battery + input (Connect a 2.8- to 4.5-VDC battery.)
   22: BATGND Backup battery – input (ground for backup battery)

   The battery can be replaced with the power either turned on or off.

Note **1.** After step number 1 above has been implemented, the encoder will operate properly for two days even with the battery removed.

Note **2.** When replacing the battery, be careful not to short-circuit across the battery's plus and minus terminals.

Note **3.** When cutting battery lead lines, cut plus and minus lines separately. If they are cut simultaneously, they may short circuit and cause sparks.

Note **4.** Dispose batteries according to the specified methods. Never throw the battery into a fire, otherwise it may explode.

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4-2 Using Displays

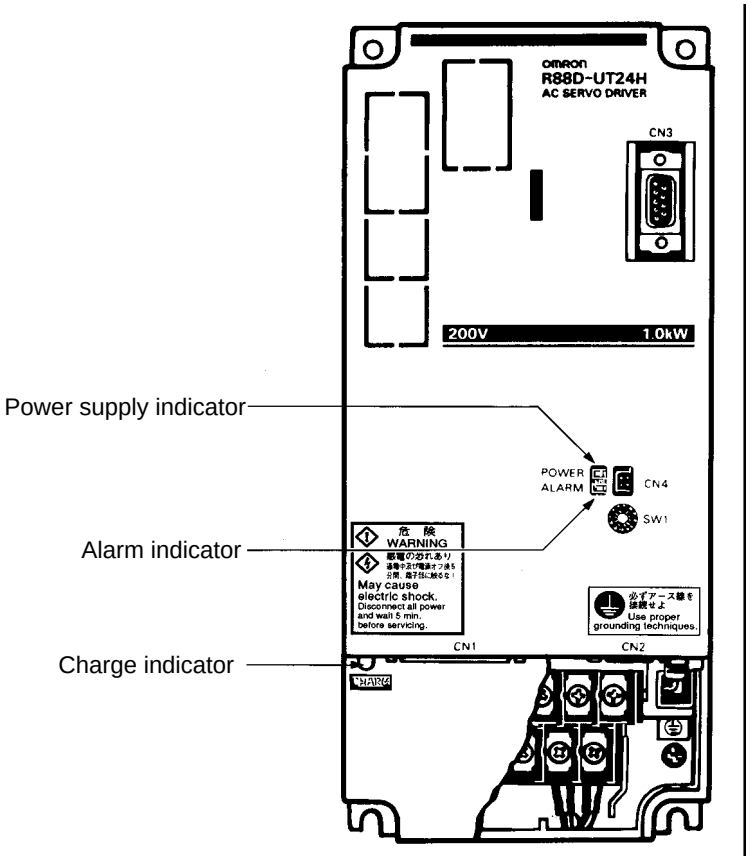
OMRON U-series AC Servomotors have unique servo software that enables quantitative monitoring in real time, on digital displays, of changes in a variety of characteristics. Use these displays for checking the various characteristics during operation.

4-2-1 Display Functions

■ Servo Driver Displays

There are three LED indicators on the Servo Driver itself. One is for the power supply, one is for alarms, and the other is a charge indicator.

Symbol	Name	Color	Function
POWER	Power supply indicator	Green	Lit when control power supply is normal.
ALARM	Alarm indicator	Red	Lit when error occurs.
CHARGE	Charge indicator	Red	Lit when main-circuit power supply is charging.



● Charge Indicator (CHARGE) Function

The charge indicator lights when the voltage is added to the main-circuit power supply capacitors in the Servo Driver.

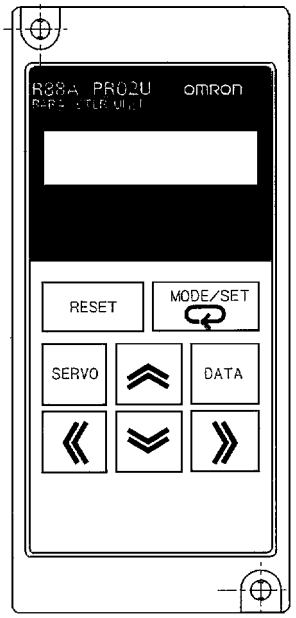
⚠ **Caution** Even after the AC power supply has been interrupted, the charge lamp remains lit to indicate that voltage is remaining. Wait until this indicator turns off before touching the terminal block for inspection or any other purpose. Touching the terminal block while this indicator is lit can result in electrical shock.

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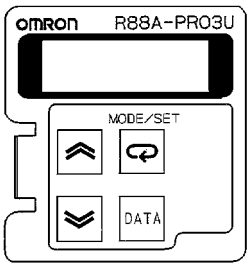
■ Parameter Unit Displays

When a Parameter Unit is connected, monitoring can be conducted by means of a 5-digit 7-segment LED.

R88A-PR02U Handy Type



R88A-PR03U Mounted Type



■ Parameter Unit Key Functions

The contents displayed by the Parameter Unit can be changed by key operations.

Handy type R88A-PR02U	Mounted type R88A-PR03U	Function
RESET	∧ + ∨	Alarm reset
↩	↩	Mode switching; data memory
SERVO	DATA	Servo ON/OFF during jog operations
DATA	DATA	Switching between parameter display and data display; data memory
∧	∧	Increments parameter numbers and data values.
∨	∨	Decrements parameter numbers and data values.
≪		Left shift for operation digits
≫		Right shift for operation digits

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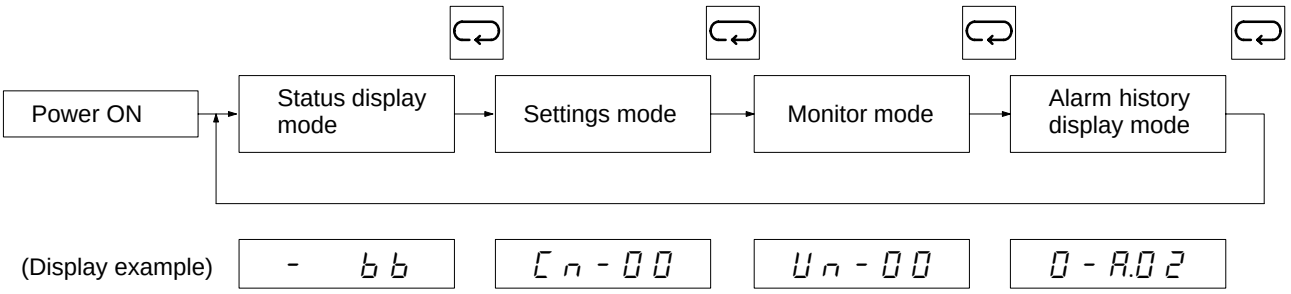
■ Types of Modes

There are four types of modes for Parameter Unit displays. The functions in each mode are shown in the following table.

Mode	Function
Status display mode	Bit display: Control-circuit power supply ON display, main-circuit power supply ON display, base block, positioning completion/speed conformity, rotation detection, inputting command pulses / inputting speed command, inputting torque command / inputting deviation counter reset signal Symbol display: Base block, operating, forward rotation prohibited, reverse rotation prohibited, alarm display
Settings mode	System check: Jog operations, command offset automatic adjustment, alarm history data clear, command offset manual adjustment, motor parameters check, auto-tuning Setting and checking setup parameters Setting and checking user parameters
Monitor mode	Speed feedback, speed commands, torque commands, number of pulses from U-phase, electrical angle, internal status bit display, command pulse speed display, position deviation, input pulse counter
Alarm history display mode	Displays contents of alarms that have been previously generated (up to a maximum of 10).

■ Changing the Mode

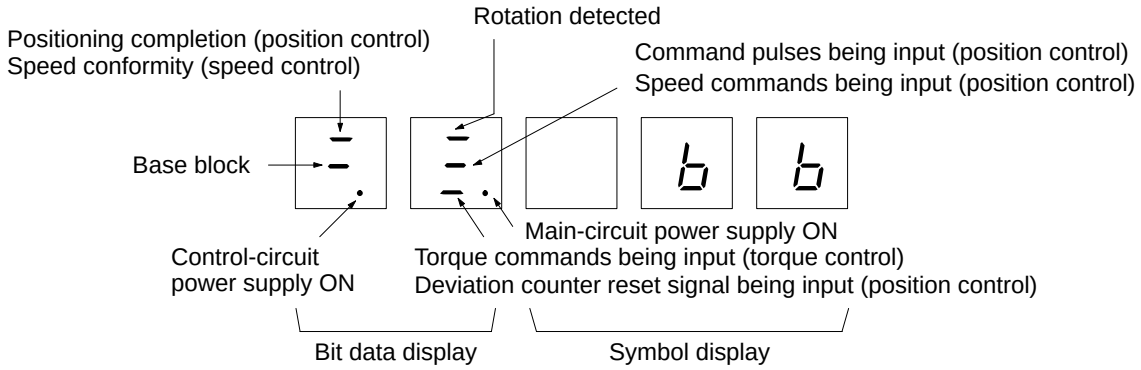
Use the MODE/SET Key to change from one mode to another.



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4-2-2 Status Display Mode

The status display mode is entered when powering up or by means of the MODE/SET Key. In the status display mode, Servo Driver status is displayed in two ways: bit data and symbols. These displays are shown in the following illustration.



■ Bit Data Display Contents

Bit data	Contents
Control-circuit power supply ON	Lit when Servo Driver control-circuit power supply is ON.
Main-circuit power supply ON	Lit when Servo Driver main-circuit power supply is ON.
Base block	Lit during base block (no power to motor); dimmed when servo is ON.
Positioning completion	Lit when the residual pulses in the deviation counter fall below the positioning completion range set for Cn-1b.
Speed conformity	Lit when the motor rotation speed is within the range of (speed command value ± [Cn-22 set value]).
Rotation detection	Lit when the motor rotation speed is equal to or greater than the rotation speed for motor rotation detection (Cn-0b).
Inputting command pulses	Lit when command pulses are being input.
Inputting speed command	Lit when a speed command input meets the rotation speed for motor rotation detection (Cn-0b).
Inputting torque command	Lit when a torque command at least 10% of the rated torque is input.
Inputting deviation counter reset signal	Lit when the deviation counter reset signal is being input.

■ Symbol Display Contents

Symbol display	Contents
bb	Base block (no power to motor)
run	Operating
Pot	Forward rotation prohibited
not	Reverse rotation prohibited
A.□□	Alarm display (Refer to alarm table.)

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4-2-3 Monitor Mode

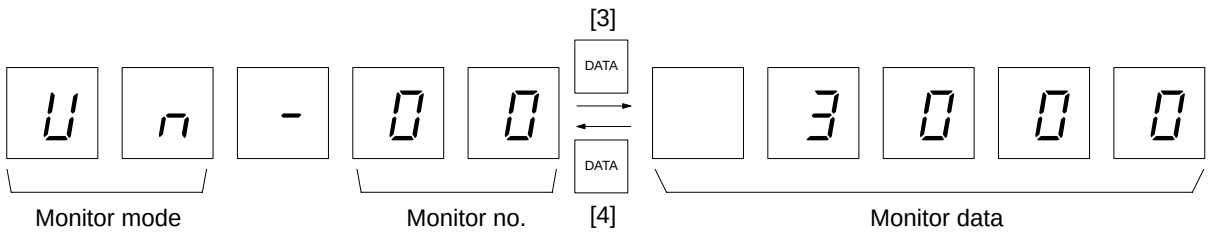
■ Types of Monitoring

In monitor mode, ten types of monitoring can be carried out.

Monitor no.	Monitor contents	Unit	Explanation
00	Speed feedback	r/min	Displays actual rotation speed of motor.
01	Speed command	r/min	Displays command to speed loop. (The display is “0” for position control by pulse train input.)
02	Torque command	%	The command to the current loop is displayed as 100% of the rated torque.
03	Number of pulses from U-phase edge	Pulses	The number of pulses from the U-phase edge is displayed in units of encoder resolution. (There is an uncertainty of about ±5 pulses.) Incremental: Displays pulse number with 1/4 turn being 4,096 pulses. Absolute: Displays pulse number with one turn being 32,768 pulses.
04	Electrical angle	Degrees	Displays the electrical angle of the motor.
05	Internal status bit display 1	---	Displays Servo Driver internal information as either lit or not lit.
06	Internal status bit display 2		
07	Command pulse speed display	r/min	Calculates and displays command pulse frequency in r/min.
08	Position deviation (deviation counter)	Command	Displays residual pulses in deviation counter by command units (input pulse standard).
09	Input pulse counter	Command	Counts and displays input pulses.

■ Operation in Monitor Mode

In order to conduct monitoring, first go into monitor mode and then set the monitor number and press the DATA Key. The items in parentheses in the following explanation indicate operations using the Handy-type Parameter Unit.

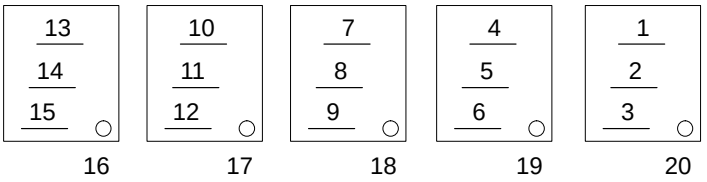


1. Press the MODE/SET Key to go into monitor mode.
2. Using the Up and Down (and Right and Left) Keys, set the monitor number.
3. Press the DATA Key to display the monitor data.
4. Press the DATA Key to return to the monitor number display.
5. Press the MODE/SET Key to move from monitor mode to alarm history display mode.

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■ Internal Status Bit Display (Un-05, Un-06)

Internal status is displayed by 7-segment bit lighting. The bit number allocation is shown in the following diagram.



Monitor no.	Bit no.	Symbol	Contents
Un-05	1	ALM	Lit when alarm is generated.
	2	DBON	Lit during dynamic brake operation.
	3	DIR	Lit when in reverse rotation mode (when Cn-02 bit no. 0 = 1).
	4	TGON	Lit when the motor rotation speed is equal to or greater than the rotation speed for motor rotation detection (Cn-0b).
	5	INP	Lit when residual pulses in the deviation counter are no more than the setting of Cn-1b (positioning completion range).
		VCMP	Lit when the motor rotation speed reaches the speed command value ± the Cn-22 set value.
	6	PCON	Lit when the speed control loop is in P control.
	7	PCL/SPD1	Lit when forward rotation current limit / speed selection command 1 (CN1-45) is ON.
	8	NCL/SPD2	Lit when reverse rotation current limit / speed selection command 2 (CN1-46) is ON.
	9	SVON	Lit when motor is receiving power.
	10	A	Encoder A phase (Lit when there is a signal)
	11	B	Encoder B phase (Lit when there is a signal)
	12	Z	Encoder Z phase (Lit when there is a signal)
	13	PU	Poll sensor U phase [Incremental]
	14	PV	Poll sensor V phase [Incremental]
	15	PW	Poll sensor W phase [Incremental]
	16	RUN	Lit when run command is ON.
	17	MING/PLOCK TVSEL/RDIR/ IPG	Lit when CN1-41 is ON. (Input signal functions change according to parameter settings.)
	18	POT	Lit when forward drive prohibit input is ON.
	19	NOT	Lit when reverse drive prohibit input is ON.
	20	SEN	Lit when the sensor-on signal is ON. [Absolute]

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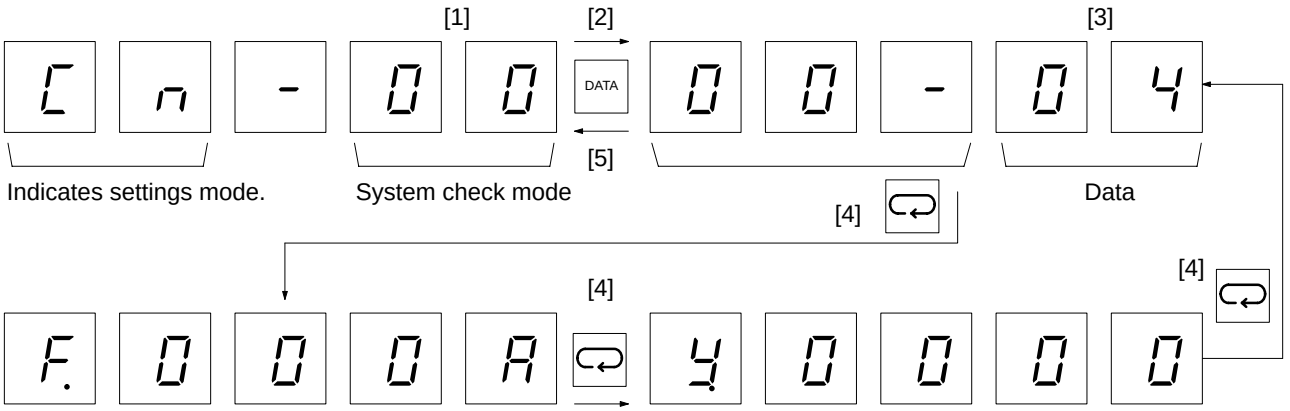
Monitor no.	Bit no.	Symbol	Contents
Un-06	1	CW	Lit during CW command pulse input.
	2	CCW	Lit during CCW command pulse input.
	3	ECRST	Lit when the deviation counter reset input is ON.
	4	CLIMT	Lit when commands to the current loop are limited by the torque limit (Cn-08, 09, Cn-18, 19 or TREF).
	5	BKIR	Lit when external brake interlock output is ON.
	6	$\overline{\text{OLWRN}}$	Turns off when at least 20% of overload detection level is reached.
	7	PON	Lit while Servo Driver's main-circuit power supply is on.
	8	READY	Lit if an error occurs after main-circuit power supply is turned on.
	9 to 20		(Not used.)

4-2-4 Checking Servomotor Parameters

Servomotor parameters can be checked when system check mode Cn-00 is set to "04." Servomotor parameters are the Servomotor specifications that can be controlled by that Servo Driver. They are not the specifications of the Servomotor that is connected. Use this to check whether the Servo Driver and Servomotor combination is suitable.

■ Servomotor Parameter Checking Operation

The items in parentheses in the following explanation indicate operations using the Handy-type Parameter Unit.



1. Using the Up and Down (and Right and Left) Keys, set parameter number "00." (System check mode)
2. Press the DATA Key to display the Cn-00 data.
3. Using the Up and Down (and Right and Left) Keys, set data "04." (Servomotor parameter check)
4. Press the MODE/SET Key to check the Servomotor parameters in order.
5. Press the DATA Key to return to the parameter number display.
6. Press the MODE/SET Key to move from settings mode to monitor mode.

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■ Parameter Display Contents

● Servomotor Parameters



Motor capacity
0A: 1.0 kW
0F: 1.5 kW
14: 2.0 kW
1E: 3.0 kW
2C: 4.0 kW
2C: 5.0 kW

Motor type 00: 200-V type

● Particular Specifications

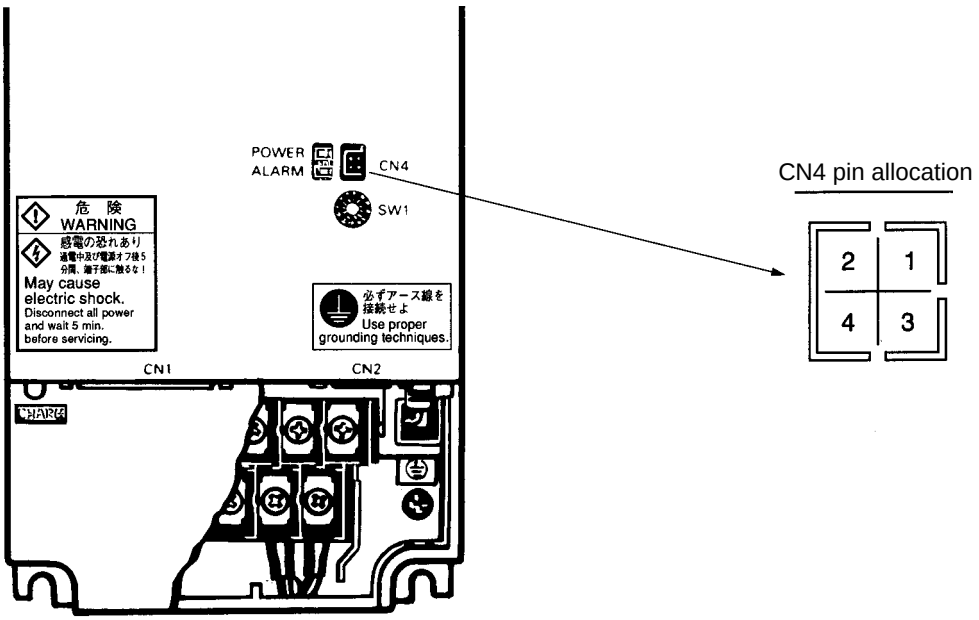


User specifications number (hexadecimal display)

4-3 Using Monitor Output

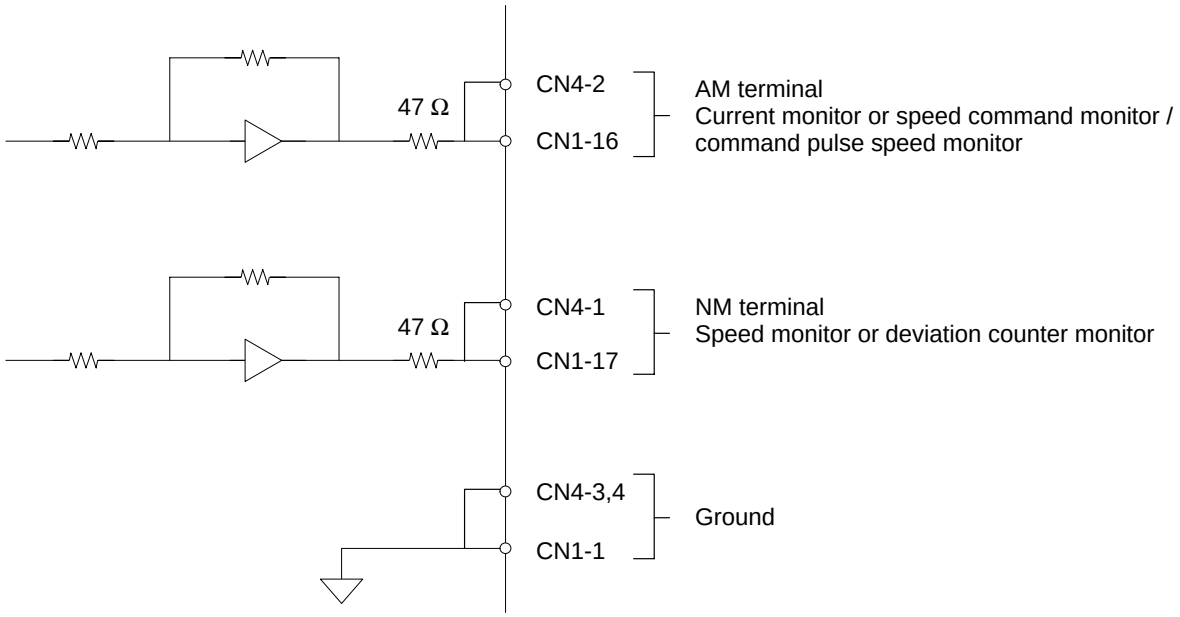
The Servo Driver outputs, in analog, according to parameter settings, a voltage proportional to the Servomotor rotation speed, motor current, speed command value, and deviation counter amount. The monitor voltage is output from the monitor output connector (CN4) and from pin nos. 16 and 17 of the control I/O connector (CN1). This function can be used in situations such as making fine gain adjustments or when a meter is attached to the control panel.

■ Analog Monitor Output Terminals (Front of the Servo Driver)



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■ Monitor Output Circuit



■ Setup Parameter Settings

Analog monitor output contents can be selected by means of bit nos. 6 and 7 of setup parameter no. 2 (Cn-02). The settings are shown in the following table.

Item	Bit no.	Factory setting	Setting	Explanation
Monitor switch 1	6	0	0	Takes AM (CN1-16 and CN4-2) analog monitor output as current monitor output.
			1	Takes AM (CN1-16 and CN4-2) analog monitor output as speed command monitor output (for speed control) or command pulse speed monitor output (for position control). Not valid for torque control (i.e., set to 0 V).
Monitor switch 2	7	0	0	Takes NM (CN1-17 and CN4-1) analog monitor output as speed monitor output.
			1	Takes NM (CN1-17 and CN4-1) analog monitor output as deviation counter monitor output. Not valid for speed or torque control (i.e., set to 0 V).
Parameter Unit monitor switch level	E	0	0	Takes deviation monitor as x1 command units.
			1	Takes deviation monitor as x100 command units.

Note 1. When the Parameter Unit's monitor switch level (bit no. E of Cn-02) is set to "1" (x100 command units), the deviation counter monitor output becomes 0.05 V / (x100 command units).

Note 2. When the Parameter Unit's monitor switch level (bit no. E of Cn-02) setting is changed, the change does not go into effect until the power has been turned off and then on again. (Check to be sure that the LED indicator has turned off.)

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■ Monitor Output Specifications

Speed monitor Speed command monitor Command pulse speed monitor	With 0 V as center, voltage output at 1 V/(1000 r/min) ratio. Forward rotation: (–) voltage; reverse rotation: (+) voltage Output accuracy: approximately ±10%
Current monitor	With 0 V as center, voltage output at 2 V/(rated torque) ratio. Forward acceleration: (–) voltage; reverse acceleration: (+) voltage Output accuracy: approximately ±10%
Deviation counter monitor	With 0 V as center, voltage output at 0.05 V/(command unit: Cn-02, bit no. E) ratio. When the deviation counter value is positive, a negative voltage is output, while a positive voltage is output when the value is negative. Output accuracy: approximately ±10%

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4-4 Protective and Diagnostic Functions

4-4-1 Alarm Displays and Alarm Code Outputs

The Servo Driver has the error detection functions shown below. When an error is detected, the alarm output ($\overline{\text{ALM}}$) and the alarm code output (ALO1-3) are output, the Servo Driver's internal power drive circuit is turned off, and the alarm is displayed.

■ Alarm Table

Display	Alarm code			Alarm $\overline{\text{ALM}}$	Error detection function	Detection contents; cause of error
	ALO1	ALO2	ALO3			
A.00	OFF	OFF	OFF	OFF	Absolute data error [Absolute]	Absolute data error at time of SEN signal input detected.
A.02	OFF	OFF	OFF	OFF	Parameter corruption	The checksum for the parameters read from the EEP-ROM does not match.
A.04	OFF	OFF	OFF	OFF	Parameter setting error	Incorrect parameter setting.
A.10	ON	OFF	OFF	OFF	Overcurrent	Overcurrent detected.
A.30	ON	ON	OFF	OFF	Regeneration error	Regeneration circuit damaged due to large amount of regenerative energy.
A.31	ON	ON	OFF	OFF	Deviation counter over	Deviation counter residual pulses exceeded level set for Cn-1E.
A.40	OFF	OFF	ON	OFF	Overvoltage or insufficient voltage	Main circuit DC voltage outside of the allowable range (150 to 420 VDC).
A.51	ON	OFF	ON	OFF	Over speed	Detected at 4,950 r/min.
A.71	ON	ON	ON	OFF	Overload	Detected at reverse limit characteristics when 135% of the rated torque was exceeded.
A.72	ON	ON	ON	OFF	Overload	Detected at reverse limit characteristics for 120% to 135% of the rated torque.
A.80	OFF	OFF	OFF	OFF	Encoder error [Absolute]	Error detected in the number of feedback pulses during one revolution.
A.A1	ON	ON	ON	OFF	Radiation shield overheating	Abnormal temperature rise detected in radiation shield.
A.b1	OFF	OFF	OFF	OFF	Command input reading error	The A/D end signal was not output from the A/D converter within a fixed time.
A.C1	ON	OFF	ON	OFF	Runaway detected.	Faulty power or encoder wiring.
A.C2	ON	OFF	ON	OFF	Phase error detected.	Connector not properly connected. Encoder not properly wired.
A.C3	ON	OFF	ON	OFF	Encoder A or B phase wire disconnection.	Either Phase A or Phase B signal was disconnected or short circuited.
A.C4	ON	OFF	ON	OFF	Encoder S phase wire disconnection.	Encoder S phase (Z phase) was disconnected or short circuited.
A.F1	OFF	ON	OFF	OFF	Missing phase detected.	Main-circuit power supply missing phase or disconnection detected.
A.99	OFF	OFF	OFF	ON	Alarm reset power supply turned on.	This is history data only, and is not an alarm.

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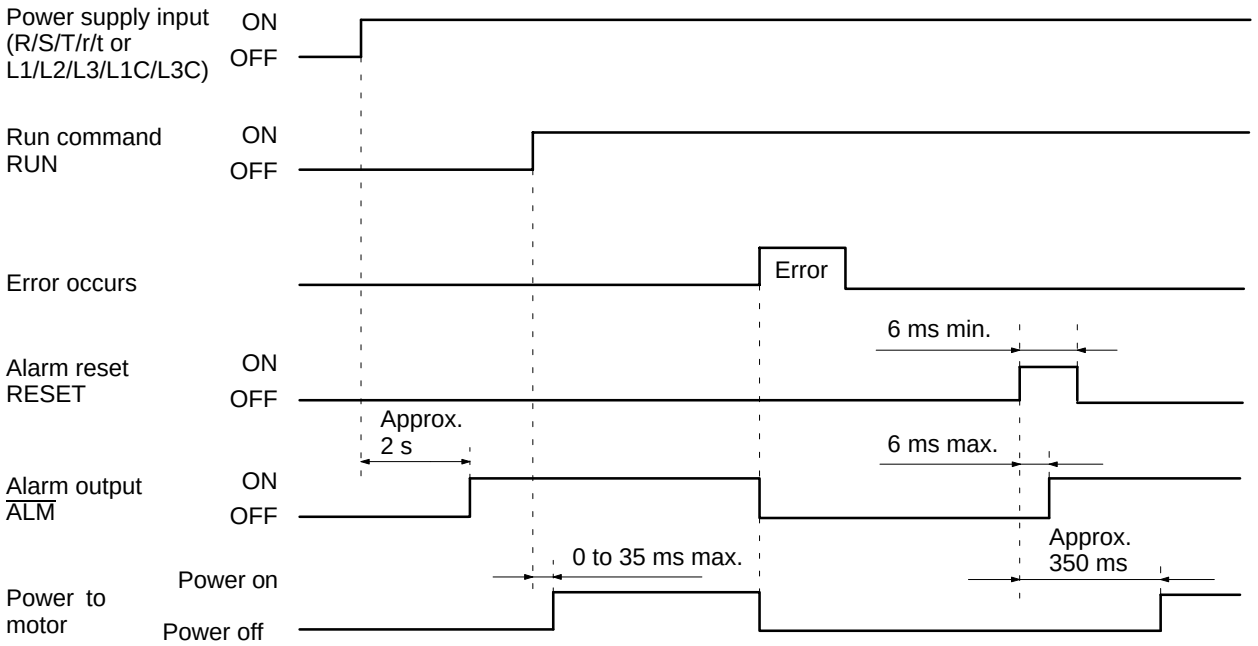
Display	Alarm code			Alarm $\overline{\text{ALM}}$	Error detection function	Detection contents; cause of error
	ALO1	ALO2	ALO3			
CPF00	OFF	OFF	OFF	OFF	Parameter Unit transmission error 1	Data could not be transmitted after the power supply was turned on. (It no longer exists in the alarm history.)
CPF01	---	---	---	---	Parameter Unit transmission error 2	Transmission timeout error (It no longer exists in the alarm history.)

Note "---" means indefinite.

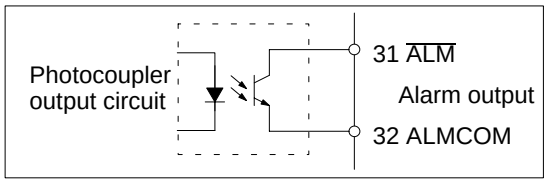
■ Alarm Output

This section explains the timing of alarm outputs when the power is turned on and when alarms occur, and it explains how to clear the alarms.

● Timing Chart



● Alarm Output Circuit



Output specifications: 30 V, 50 mA max.
When normal: Output transistor ON
For alarm: Output transistor OFF

● Clearing Alarms

- Any of the following three methods can be used to clear an alarm.

  Turn ON the alarm reset signal (RESET).
  Power up again. (An overcurrent error (A.10) can't be cleared just by powering up again.)
  Use the Parameter Unit reset operation.

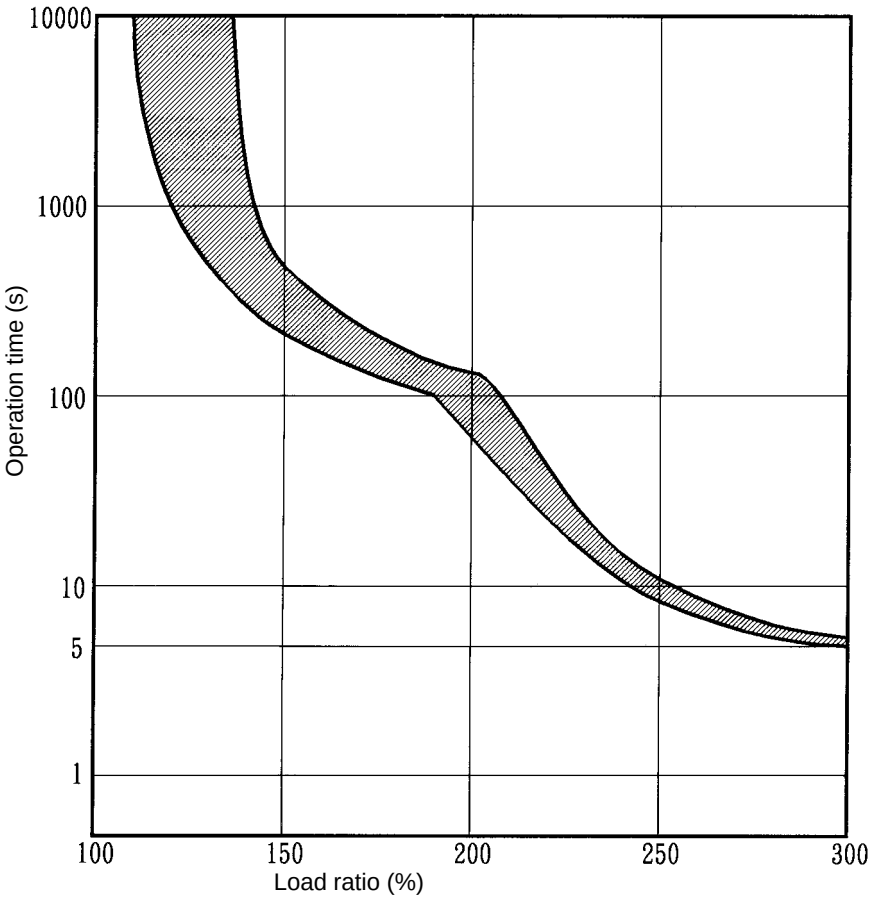
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⚠ **Caution** If an alarm is cleared while the run command (RUN) is ON, operation will begin immediately after the alarm is cleared, which could be dangerous. Turn the run command off before clearing alarms.
When the run command is ON and bit 0 of setup parameter Cn-01 is set to “1” (Servo always ON), be sure that it is safe to resume operation before clearing an alarm.

■ Overload Characteristics (Electron Thermal Characteristics)

An overload protection function (electron thermal) is built into the Servo Driver to protect against Servo Driver or Servomotor overload. If an overload (A.71 to A.72) does occur, first clear 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 too soon, the Servomotor coil may be damaged.

Overload characteristics are shown in the following table. If, for example, a current of three times the Servomotor’s rated current flows continuously, it will be detected after approximately three seconds.



Note The load ratio is calculated in relation to the Servomotor’s rated current.

$$\text{Load ratio (\%)} = \frac{\text{Servomotor current}}{\text{Servomotor rated current}} \times 100$$

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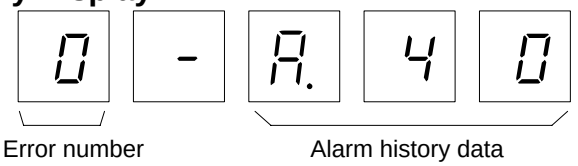
■ Alarm History Display Mode

The Servo Driver stores the history of the 10 most recent alarms that have been generated. The alarm history can be displayed by going into the alarm history display mode and using the Up and Down Keys.

● Alarm History Display Contents

- A maximum of 10 items of alarm history data can be saved.
- The alarm history data item “A.99” is saved when an alarm is reset or when power is reset.

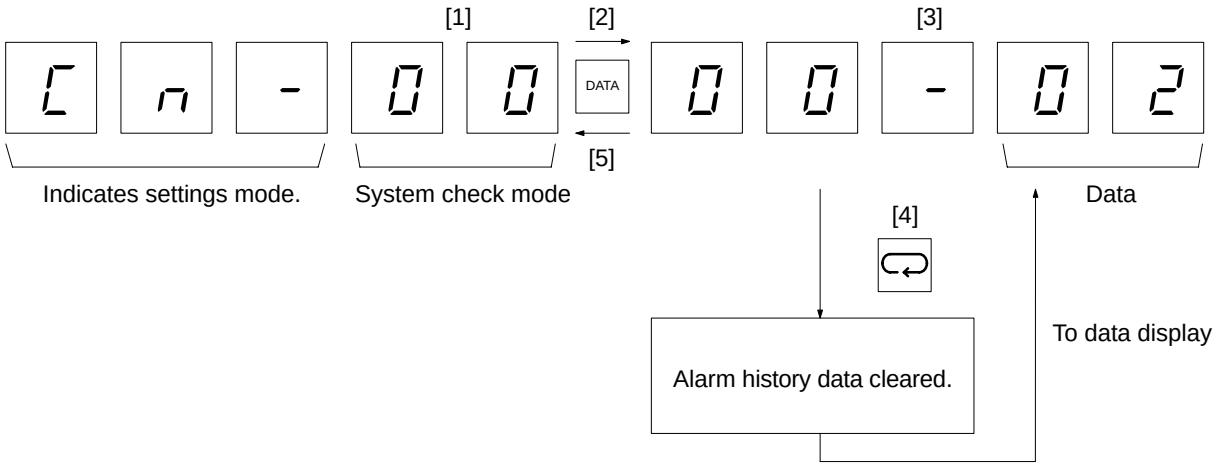
● Using the Alarm History Display



1. Press the MODE/SET Key to go to the alarm history display mode.
2. Use the Up and Down Keys to go up and down through the error occurrence numbers and display the corresponding alarm history data. (The larger the error occurrence number, the less recent the alarm is.)
3. Press the MODE/SET Key to move from alarm history display mode to status display mode.

■ Clearing Alarm History Data

Alarm history data initialization is executed in the system check mode. The items in parentheses in the following explanation indicate operations using the Handy-type Parameter Unit.



1. Using the Up and Down (and Right and Left) Keys, set parameter number “00.” (System check mode)
2. Press the DATA Key to display the Cn-00 data.
3. Using the Up and Down (and Right and Left) Keys, set data “02.” (Clear alarm history data)
4. Press the MODE/SET Key to clear the alarm history data.
5. Press the DATA Key to return to the parameter number display.
6. Press the MODE/SET Key to move from settings mode to monitor mode.

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4-4-2 Troubleshooting

When an error occurs, check the error contents by means of the operating status and alarm display, investigate the cause and apply the appropriate countermeasures.

■ Error Diagnosis by Means of Operating Status

Symptom	Probable cause	Items to check	Countermeasures	Control mode
The power supply indicator (POWER) does not light even when the power supply is turned on.	Power supply lines are incorrectly wired.	• Check the power supply voltage. • Check the power supply lines.	• Correct the power supply. • Correct the wiring.	Common
The motor does not operate even when a command is given. (No alarm is output.)	The RUN signal is OFF (when Cn-01 bit no. 0 is “0”).	Check the RUN signal’s ON and OFF by means of the monitor mode.	• Input the RUN signal. • Correct the wiring.	Common
	The correspondence between the Servo Driver and the Servomotor is incorrect.	Check the models.	Combine models that correspond correctly.	Common
	The POT and NOT signals are OFF (when Cn-01 bit nos. 2 and 3 are “0”).	Check whether POT and NOT are displayed in status display mode.	• Turn ON the POT and NOT signals. • If POT and NOT are not being used, set Cn-01 bit nos. 2 and 3 to “1.”	Common
	The control mode is not right.	Check the control mode selection (Cn-2b).	Set the control mode to match the command type.	Common
	The deviation counter reset input (ECRST) is ON.	With monitor mode, check the ON/OFF status of the deviation counter reset signal.	• Turn OFF the ECRST signal. • Correct the wiring.	Position
	An error occurred with the RESET signal ON.	Check the RESET signal’s ON and OFF by means of the monitor mode.	Turn the RESET signal OFF and take measures according to the alarm display.	Common
	The command pulse mode (bit nos. 3, 4, 5 of Cn-02) is setting is incorrect.	Check the Controller’s command pulse type and the Servo Driver’s command pulse mode.	Set the mode to match the Controller’s command pulse type.	Position
	The speed command (REF) voltage is 0 V.	• Check the speed command by means of the monitor mode. • Check the speed command voltage.	Correct the wiring.	Speed
	The PLOCK signal is ON.	Check the PLOCK signal by means of the monitor mode (internal status bit).	• Turn the PLOCK signal OFF. • Check the Cn-29 value.	Speed
The motor operates momentarily, but then it does not operate.	The setting for the number of encoder pulses is incorrect.	Check the value of Cn-11.	Inc.: Set Cn-11 to “4096.” Abs.: Set Cn-11 to “8192.”	Common
	The Servomotor power lines or encoder lines are wired incorrectly.	Check the Servomotor power line U, V, and W phases, and the encoder line wiring.	Correct the wiring.	Common

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Symptom	Probable cause	Items to check	Countermeasures	Control mode
Servomotor operation is unstable.	The Servomotor power lines or encoder lines are wired incorrectly.	Check the Servomotor power line U, V, and W phases, and the encoder line wiring.	Correct the wiring.	Common
	The bias function setting is incorrect.		Adjust the bias rotational speed and the positioning completion range.	Position
	The polarity of the speed command (REF) input is wrong.	Check the speed command input wiring.	Correct the wiring.	Speed
	There are eccentricities or looseness in the coupling connecting the Servomotor shaft and the mechanical system, or there are load torque fluctuations according to how the pulley gears are engaging.	• Check the machinery. • Try operating the Servomotor without a load.	Adjust the machinery.	Common
	Gain is wrong.		• Use auto-tuning. • Adjust the gain manually.	Common
Servomotor is overheating.	The ambient temperature is too high.	Check to be sure that the ambient temperature around the Servomotor is no higher than 40°C.	Lower the ambient temperature to 40°C or lower. (Use a cooler or fan.)	Common
	Ventilation is obstructed.	Check to see whether anything is blocking ventilation.	Ensure adequate ventilation.	Common
	There is an overload.	Check the torque command value by means of monitor mode.	• Lighten the load. • Change to a larger capacity Servomotor.	Common
	The correspondence between the Servo Driver and the Servomotor is incorrect.	Check the models.	Combine models that correspond correctly.	Common
There are unusual noises.	The machinery is vibrating.	Inspect the machinery to see whether there are any foreign objects in the movable parts, or whether there is any damage, deformation, or looseness.	Fix any problems causing vibration.	Common
	The speed loop gain adjustment is insufficient.		• Use auto-tuning. • Adjust the gain manually (speed loop gain).	Position Speed
Vibration is occurring at the same frequency as the applicable power supply.	Inductive noise is occurring.	• Check to see whether the Servo Driver control signal lines are too long. • Check to see whether control signal lines and power supply lines are too close to each other.	• Shorten the control signal lines. • Separate control signal lines from power supply lines. • Use a low-impedance power supply for control signals.	Common
The Servomotor operates even when speed command is for 0 V.	The speed command voltage and the speed command input section are offset.	Check the speed command voltage.	• Adjust the speed command offset. • Use speed control mode with position lock function. (Control mode selection: Cn-2b = 10)	Speed

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■ Error Diagnosis by Means of Alarm Display (Parameter Unit)

Alarm display	Error content	Condition when error occurred	Probable cause	Countermeasures
A.00	Absolute data error [Absolute]	Occurred when SEN signal turned ON.	Absolute encoder malfunction	• Turn ON SEN signal again. • Execute setup for absolute encoder.
			Faulty wiring of absolute encoder	Correct the wiring.
A.02	Parameter corruption	Occurred when power was turned on.	Internal memory error	Replace Servo Driver.
A.04	Parameter setting error	Occurred when power was turned on.	A user parameter was set to a value outside of the setting range previously.	Change the user parameter setting so it is within the setting range.
			Control board defective.	Replace Servo Driver.
A.10	Overcurrent	Occurred when power was turned on.	Control board defective.	Replace Servo Driver.
		Occurred when Servo was turned on.	• Current feedback circuit error • Main circuit transistor module error	Replace Servo Driver.
			Servomotor power line is short-circuited or grounded.	• Correct the power line short-circuiting or grounding. • Measure the insulation resistance at the Servomotor itself. If there is short-circuiting, replace the Servomotor.
			There is faulty wiring at the U, V, or W phase, or the GR.	Correct the wiring.
			Servomotor coil are damaged.	Measure the winding resistance. If the coil are damaged, replace the Servomotor.
A.30	Regeneration error	Occurred during operation.	Regeneration circuit component error	Replace Servo Driver.
A.31	Deviation counter over	Occurred when Servomotor did not operate even when command pulse train was input.	Servomotor power line or encoder line malfunction	Correct the wiring.
			Mechanical lock is in effect.	If the Servomotor shaft is locked, unlock it.
		Occurred during high-speed rotation.	Servomotor power line or encoder line malfunction	Correct the wiring.
		Occurred during long command pulse input.	Gain adjustment is insufficient.	Adjust the gain.
			Acceleration is too sudden.	Lengthen the acceleration time.
			Load is too large.	• Lighten the load. • Select another Servomotor.

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Alarm display	Error content	Condition when error occurred	Probable cause	Countermeasures
A.40	Overvoltage; Insufficient voltage	Occurred when power was turned on.	The main-circuit power supply voltage is outside of the allowable range.	• The main-circuit power supply voltage must be 170 to 253 VAC.
		Occurred during Servomotor deceleration.	The load inertia is too large.	• Lengthen the deceleration time. • Select another Servomotor.
			The main-circuit power supply voltage has exceeded the allowable range.	Lower the voltage to within the allowable range.
		Occurred while lowering (vertical shaft)	Gravity torque is too large.	• Add a counterbalance to the machine, and reduce the gravity torque. • Reduce the lowering speed.
A.51	Overspeeding	High-speed rotation occurred when command was input.	The rotation speed exceeded 4,950 r/min due to overshooting.	• Adjust the gain. • Lower the maximum speed of the command.
			Encoder is wired incorrectly.	Correct the wiring.
A.71	Overload	Occurred during operation.	Operating at more than 135% of the rated torque. (Effective torque)	• If the Servomotor shaft is locked, unlock it. • If Servomotor power lines are incorrectly wired, correct them. • Lighten the load. • Lengthen the acceleration time. • Adjust the gain.
			Power supply voltage has dropped.	Check the power supply voltage and raise it to within the allowable range.
A.72	Overload	Occurred during operation.	Operating at 120% to 135% of the rated torque. (Effective torque)	• Lighten the load. • Lengthen the acceleration time. • Adjust the gain.
			Power supply voltage has dropped.	Check the power supply voltage and raise it to within the allowable range.
A.80	Encoder error [Absolute]	Occurred during operation.	Absolute encoder faulty wiring or poor contact.	Correct the wiring.
			Pulse counter malfunction	Turn OFF the SEN signal and input the alarm reset. Then turn ON the SEN signal again.
A.A1	Overheating	Occurred during operation. If reset is executed after waiting for a time, operation resumes.	The ambient temperature for the Servo Driver is higher than 55°C.	Bring the ambient temperature for the Servo Driver down to 55°C or lower.
			The load torque is too high.	• Lighten the load. • Lengthen the acceleration time. • Select another Servomotor.

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Alarm display	Error content	Condition when error occurred	Probable cause	Countermeasures
A.b1	Command input reading error	Occurred during operation.	Malfunctioning of the command input reading area.	Reset and then run again.
			Damage at the command input reading area.	Replace Servo Driver.
A.C1	Runaway detected	Some movement occurred at the beginning of operation.	• Encoder lines wired incorrectly. • Servomotor power lines wired incorrectly.	Correct the wiring.
A.C2	Phase error detected	Some movement occurred at the beginning of operation.	• Encoder lines wired incorrectly. • Connector contact faulty.	• Correct the wiring. • Insert connectors correctly.
		Occurred when power was turned on.	• Incorrect setting on bit E of parameter Cn-01.	• Set bit E of Cn-01 to 0 when the incremental encoder is in use. • Set bit E of Cn-01 to 1 when the absolute encoder is in use.
A.C3	Encoder A, B phase lines disconnected.	Some movement occurred at the beginning of operation.	• Encoder lines disconnected. • Connector contact faulty.	• Correct any disconnected lines. • Insert connectors correctly.
			Encoder lines wired incorrectly.	Correct the wiring.
		Occurred when power was turned on.	Incorrect setting on bit E of parameter Cn-01.	• Set bit E of Cn-01 to 0 when the incremental encoder is in use. • Set bit E of Cn-01 to 1 when the absolute encoder is in use.
A.C4	Encoder S phase lines disconnected.	Some movement occurred at the beginning of operation.	• Encoder lines disconnected. • Connector contact faulty.	• Correct any disconnected lines. • Insert connectors correctly.
			Encoder lines wired incorrectly.	Correct the wiring.
		Occurred when power was turned on.	Incorrect setting on bit E of parameter Cn-01.	• Set bit E of Cn-01 to 0 when the incremental encoder is in use. • Set bit E of Cn-01 to 1 when the absolute encoder is in use.
A.F1	Missing phase	Occurred when Servo was turned ON.	• Main-circuit power supply is not on. • Main-circuit power supply has missing phase or disconnected line.	Check the main-circuit power supply wiring.
CPF00	Parameter Unit transmission error 1	Occurred when power was turned on.	Servo Driver defective.	Replace Servo Driver.
CPF01	Parameter Unit transmission error 2	Occurred while the Parameter Unit was being used.	Internal element is malfunctioning.	Reset and then run again.
			Internal element is damaged.	Replace Servo Driver.

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4-5 Periodic Maintenance

Maintenance and Inspection Precautions

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

⚠ **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.

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. In order to ensure proper long-term operation of Servomotors and Drivers, periodic inspection and part replacement is required according to the life of the components.

The periodic maintenance cycle depends on the installation environment and application conditions of the Servomotor or Driver. Recommended maintenance times are listed below for Servomotors and Drivers. Use these are reference in determining actual maintenance schedules.

■ Servomotors

- Recommended Periodic Maintenance
  Bearings: 20,000 hours

  Application Conditions: Ambient motor operating temperature of 40°C, within allowable shaft load, rated operation (rated torque and r/m), installed as described in 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 motor is used under a shaft load exceeding the allowable limit, the motor shaft can break, the bearings can burn out, and other problems can occur.

■ Servo Drivers

- Recommended Periodic Maintenance

  Aluminum analytical capacitors: 50,000 hours, at an ambient Servo Driver operating temperature of 40°C, rated operation (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% RH.

- When using the Servo Driver under the continuous operation mode, cool the Servo Driver with fans and air conditioners to maintain an ambient operating temperature below 40°C.

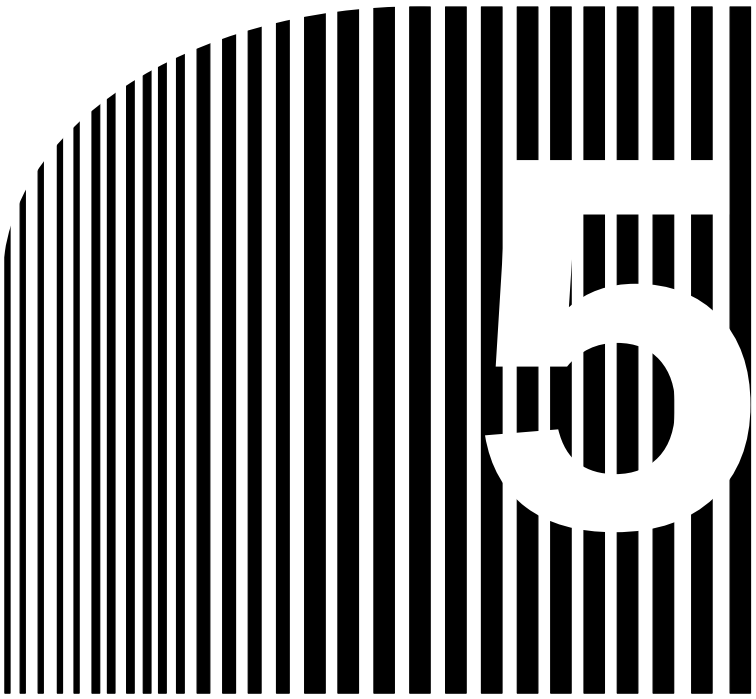
- The life of aluminum analytical capacitors is greatly affected by the ambient operating temperature. Generally speaking, an increase of 10°C in the ambient operating temperature will reduce capacitor

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life by 50%. We recommend that ambient operating temperature be lowered and the power supply time be reduced as much as possible to lengthen the maintenance times for Servo Drivers.

- 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. Please consult with OMRON to determine whether or not components need to be replaced.

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Chapter 5

• Specifications •

5-1 Servo Driver Specifications
5-2 Servomotor Specifications
5-3 Cable Specifications
5-4 Parameter Unit Specifications

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5-1 Servo Driver Specifications

5-1-1 General Specifications

Item	Specifications
Operating ambient temperature	0°C to 55°C
Operating ambient humidity	20% to 85% RH (with no condensation)
Storage ambient temperature	–20°C to 85°C
Storage ambient humidity	20% to 85% RH (with no condensation)
Storage and operating atmosphere	No corrosive gasses.
Vibration resistance	10 to 55 Hz in X, Y, and Z directions with 0.10-mm double amplitude; acceleration: 4.9 m/s^2 {0.5 G} max.; time coefficient: 8 min; 4 sweeps
Impact resistance	Acceleration 19.6 m/s^2 {2 G} max., in X, Y, and Z directions, three times
Insulation resistance	Between power line terminals and case: 1 MΩ min. (at 500 VDC)
Dielectric strength	Between power line terminals and case: 1,500 VAC for 1 min (20 mA max.) at 50/60 Hz
Protective structure	Built into panel.

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

Note 2. Absolutely do not conduct a withstand voltage test with a megger tester on the Servo driver. If such tests are conducted, internal elements may be damaged.

Note 3. Depending on the operating conditions, some Servo Driver parts will require maintenance. Refer to *4-5 Periodic Maintenance* for details.

Note 4. 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.

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5-1-2 Performance Specifications

● Performance Specifications (Models Not Conforming to Standards)

Item			R88D-UT24H	R88D-UT40H	R88D-UT60H	R88D-UT80H	R88D-UT110H	R88D-UT120H
Continuous output current (0-P)			8.6 A	14.0 A	17.0A	27.4 A	35.8 A	37.0 A
Momentary maximum output current (0-P)			24 A	40 A	59 A	79 A	108 A	119 A
Input power supply	Main circuits		Three-phase 200/230 VAC (170 to 253 V) 50/60 Hz					
	Control circuits		Single-phase 200/230 VAC (170 to 253 V) 50/60 Hz					
Control method			All-digital servo					
Speed feedback	[Incremental]		Optical incremental encoder, 4,096 pulses/revolution					
	[Absolute]		Optical absolute encoder, 8,192 pulses/revolution					
Applicable load inertia			Maximum of 10 times motor's rotor inertia					
Inverter method			PWM method based on IGBT					
PWM frequency			3.3 kHz					
Applicable Servomotor	(R88M-)	[Incremental]	U1K030H	U1K530H	U2K030H	U3K030H	U4K030H	U5K030H
		[Absolute]	U1K030T	U1K530T	U2K030T	U3K030T	U4K030T	U5K030T
Applicable Servomotor wattage			1.0 kW	1.5 kW	2.0 kW	3.0 kW	4.0 kW	5.0 kW
Weight			Approx. 4.0 kg		Approx. 5.0 kg		Approx. 8.0 kg	
Heating value	Main circuits		55 W	80 W	120 W	170 W	250 W	260 W
	Control circuits		20 W			22 W	24 W	
Capacity for analog inputs	Speed control range		1:5,000					
	Load fluctuation rate		0.01% at 0% to 100% (at rated rotation speed)					
	Voltage fluctuation rate		0% at input voltage of 170 to 253 VAC					
	Temperature fluctuation rate		±0.1% max. at 0 to +50°C					
	Frequency characteristics		250 Hz (at the same load as the rotor inertia)					
	Acceleration time setting		0 to 10 s (acceleration and deceleration set separately)					
Capacity for pulse train inputs	Maximum frequency		200 kpps					
	Position loop gain		1 to 1,000 (1/s)					
	Electronic gear ratio		Setting range: 0.01 □ (G1, G2) □ 100 (G1, G2 = 1 to 65,535)					
	Positioning range		0 to 250 (command unit)					
	Feed-forward compensation		0% to 100% of speed command amount (pulse frequency)					
	Bias setting		0 to 450 (r/min)					
	Position acceleration constant setting		0 to 64 (ms) (same setting for acceleration and deceleration)					

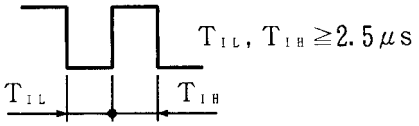
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● Control Specifications (Models Conforming to EC Directives)

Item			R88D-UT24V-°	R88D-UT40V-°	R88D-UT60V-°	R88D-UT80V-°	R88D-UT110V	
Continuous output current (0-P)			8.6 A	14.0 A	17.0A	27.4 A	37.0 A	
Momentary maximum output current (0-P)			24 A	40 A	59 A	79 A	119 A	
Input power supply	Main circuits		Three-phase 200/230 VAC (170 to 253 V) 50/60 Hz					
	Control circuits		Single-phase 200/230 VAC (170 to 253 V) 50/60 Hz					
Control method			All-digital servo					
Speed feedback	[Incremental]		Optical incremental encoder, 4,096 pulses/revolution					
	[Absolute]		Optical absolute encoder, 8,192 pulses/revolution					
Applicable load inertia			Maximum of 10 times motor's rotor inertia					
Inverter method			PWM method based on IGBT					
PWM frequency			3.3 kHz					
Applicable Servomotor	(R88M-)	[Incremental]	U1K030V	U1K530V	U2K030V	U3K030V	U4K030V	U5K030V
		[Absolute]	U1K030X	U1K530X	U2K030X	U3K030X	U4K030X	U5K030X
Applicable Servomotor wattage			1.0 kW	1.5 kW	2.0 kW	3.0 kW	4.0 kW	5.0 kW
Weight			Approx. 4.0 kg		Approx. 5.0 kg		Approx. 15.0 kg	
Heating value	Main circuits		55 W	80 W	120 W	170 W	260 W	
	Control circuits		20 W			22 W	24 W	
Capacity for analog inputs	Speed control range		1:5,000					
	Load fluctuation rate		0.01% at 0% to 100% (at rated rotation speed)					
	Voltage fluctuation rate		0% at input voltage of 170 to 253 VAC					
	Temperature fluctuation rate		±0.1% max. at 0 to +50°C					
	Frequency characteristics		250 Hz (at the same load as the rotor inertia)					
	Acceleration time setting		0 to 10 s (acceleration and deceleration set separately)					
Capacity for pulse train inputs	Maximum frequency		200 kpps					
	Position loop gain		1 to 1,000 (1/s)					
	Electronic gear ratio		Setting range: 0.01 □ (G1, G2) □ 100 (G1, G2 = 1 to 65,535)					
	Positioning range		0 to 250 (command unit)					
	Feed-forward compensation		0% to 100% of speed command amount (pulse frequency)					
	Bias setting		0 to 450 (r/min)					
	Position acceleration constant setting		0 to 64 (ms) (same setting for acceleration and deceleration)					

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● I/O Signals (Common to Models Not Conforming to Standards and those Conforming to EC Directives)

Signals		Specifications
Input signals	Speed command voltage	±2 to 10 VDC / rated rotation speed (set via parameter) (motor forward rotation by +voltage) Input impedance: Approx. 30 kΩ; circuit time constant: Approx. 47 μs
	Torque command voltage	±1 to 10 VDC / rated torque (set via parameter) (motor forward torque by +voltage) Input impedance: Approx. 30 kΩ; circuit time constant: Approx. 47 μs
	Position command pulse	TTL, line-driver input; photoisolation; input current: 6 mA at 3 V One of the following set via parameter: Feed pulse, forward/reverse signal, Forward pulse, reverse pulse, or 90• phase difference (A/B phase) signal. Input pulse width must be as shown in diagram. 
	Error counter reset input	TTL, line-driver input; photoisolation; input current: 6 mA at 3 V
	Sensor ON signal input (absolute)	1 mA at 5 VDC, TTL input, current to encoder on high level
	Sequence input	24-VDC, 5-mA photocoupler input, external power supply: 24±1 VDC, 50 mA min. Run command, (gain deceleration, position lock command, control mode switch, direction command, pulse prohibit), forward/reverse current limit, (speed command 1, 2), forward/reverse drive prohibit, alarm reset Signals within parentheses can be set via parameters.
Output signals	Position feedback output	A-, B-, Z-phase line driver output (EIA RS-422A) A-phase and B-phase (dividing rate setting): 16 to 4,096 pulses/revolution A-phase and B-phase (dividing rate setting): 16 to 8,192 pulses/revolution Z-phase: 1 pulse/revolution
	Speed monitor output	1 V/1,000 r/min
	Current monitor output	2 V/rated torque
	Sequence output	Open collector output, 30 VDC, 50 mA Alarm output, (speed conformity/positioning completion, motor rotation detection, servo ready, current limit detection, brake interlock, overload warning, overload alarm) Open collector output, 30 VDC, 20 mA Alarm code output Signals within parentheses can be set via parameters.

● Protective Functions (Common to Models Not Conforming to Standards and those Conforming to EC Directives)

Signals	Specifications
Dynamic brake stopping	Operates when the power supply turns off, a servo alarm is generated, an overrun occurs, or the servo turns off.
Other protective functions	Absolute data error (absolute), parameter destruction, parameter setting error, overcurrent, regenerative error, error counter overflow, overvoltage, undervoltage, overspeeding, overload, encoder errors (absolute), heating plate overheating, command input read error, overrun prevention, position misdetection, encoder A/B phase break, encode S phase break, out-of-phase detection, Parameter Unit transmission error

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5-1-3 I/O Specifications

● Terminal Block Specifications (Models Not Conforming to Standards)

Signal	Function	Condition	
⏚	Frame ground	This is the ground terminal. Ground to a maximum of 100 Ω (class-3).	
R S T	Main circuits power supply input	Three-phase 200/230 VAC (170 to 253 VAC) 50/60 Hz	
r t	Control circuits power supply input	Single-phase 200/230 VAC (170 to 253 VAC) 50/60 Hz	
P B N	Main circuit DC output (Forward) (Reverse)	Do not connect anything to these terminals	
U	Servomotor U-phase output	Red	These are the terminals for outputs to the Servomotor. Be sure to wire these terminals correctly.
V	Servomotor V-phase output	White	
W	Servomotor W-phase output	Black	
⏚	Frame ground	Green	

● Terminal Block Specifications (Models Conforming to EC Directives)

Signal	Function	Condition	
⏚	Frame ground	This is the ground terminal. Ground to a maximum of 100 Ω (class-3).	
L1 L2 L3	Main circuits power supply input	Three-phase 200/230 VAC (170 to 253 VAC) 50/60 Hz	
L1C L3C	Control circuits power supply input	Single-phase 200/230 VAC (170 to 253 VAC) 50/60 Hz	
+ (+1) B –	Main circuit DC output (Forward) (Reverse)	Be sure to connect a regenerative resistor (corresponding to the amount of regenerative energy) between the + and B terminals for the R88D-UT° V-RG and between the +1 and B terminals for the R88D-UT110V. Refer to 3-6-3 *Absorption of Regenerative Energy with External Regenerative Resistors Connected to Models Complying with EC Directives* for details.	
U	Servomotor U-phase output	Red	These are the terminals for outputs to the Servomotor. Be sure to wire these terminals correctly.
V	Servomotor V-phase output	White	
W	Servomotor W-phase output	Black	
⏚	Frame ground	Green	

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• CN1 Control I/O Specifications (Common to Models Not Conforming to Standards and those Conforming to EC Directives)

⁎CN1 Control Inputs

Pin No.	Signal name	Function	Contents	Command mode
5	REF	Speed command input	±2 to ±10 V / rated revolution Changeable by means of user parameter Cn-03 speed command scale.	Speed Torque
6	AGND	Speed command input ground		
9	TREF	Torque command input	±1 to ±10 V / rated torque Changeable by means of user parameter Cn-13 torque command scale.	Speed Torque
10	AGND	Torque command input ground		
3 13 18	PCOM	Open collector command power supply	Used to use an open-collector output for CW, CCW, and ECRST signals. Connect + inputs to the terminals and connect – inputs to open-collector output terminals.	Position
7	+PULS/ CW/A	Feed pulse, reverse pulse, or 90• phase difference pulse (A phase)	Line-driver input: 6 mA at 3 V Open-collector input: 15 mA at 5 V Switch via bits 3, 4, and 5 of setup parameter Cn-02. Maximum response frequency: 200 kpps	Position
8	–PULS/ CW/A			
11	+SIGN/ CCW/B	Forward/reverse signal, forward pulse, or 90• phase difference pulse (B phase)		
12	–SIGN/ CCW/B			
14	–ECRST	Error counter reset	Line-driver input: 6 mA at 3 V Open-collector input: 15 mA at 5 V Error counter cleared on ON signal Switch between status signal (high level) and differential signal (rising edge) via bit A of setup parameter Cn-02.	Position
15	+ECRST			
40	RUN	Run command input	ON: Servo ON, when setup parameter Cn-01 bit no. 0 = 0. When setup parameter Cn-01 bit no. 0 = 1, this signal is not used. (Automatically set to Servo ON.)	All

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Pin No.	Signal name	Function	Contents	Command mode
41	MING	Gain deceleration input	When user parameter CN-2b = 0 or 1, and SPD1 and SPD2 are both OFF and parameter Cn-2b = 3, 4, or 5, then ON: Decrease speed loop gain	Position Speed
	TVSEL	Control mode switch input	When user parameter Cn-2b = 7, 8, or 9, then ON: Change control mode	Switch control mode
	PLOCK	Position lock command input	When user parameter Cn-2b = 10, then ON: position lock goes in effect if the motor rotation speed is no more than the position lock rotation speed (Cn-29).	Position lock speed
	IPG	Pulse disable input	When user parameter Cn-2b = 11, then ON: Command pulse inputs are ignored and the motor stops.	Position (pulse disabled)
	RDIR	Rotation direction command inputs	When user parameter Cn-2b = 3, 4, 5, or 6 and an internal set speed is selected, this is the rotation direction command for internal speed settings 1 to 3. (OFF: Forward rotation, ON: Reverse rotation)	Internal setting Speed control
42	POT	Forward drive prohibit input	Forward rotation overtravel input (OFF when prohibited). When setup parameter Cn-01 bit no. 2 = 1, this signal is not used.	All
43	NOT	Reverse drive prohibit input	Reverse rotation overtravel input (OFF when prohibited). When setup parameter Cn-01 bit no. 3 = 1, this signal is not used.	All
44	RESET	Alarm reset input	ON: Servo alarm status is reset.	All
45	PCL/ SPD1	Forward rotation current limit input / Speed selection command 1 input	Forward/reverse rotation current limit (PCL/NCL) when user parameter Cn-2b = 0, 1, 2, 7, 8, 9, 10, or 11 (ON: Current limit) Internal setting speed (Cn-1F, 20, 21) selector switch when user parameter Cn-2b = 3, 4, 5, or 6	All
46	NCL/ SPD2	Reverse rotation current limit input / Speed selection command 2 input		
47	+24VIN	+24-V power supply input for control DC	Power supply for pin nos. 40, 41, 42, 43, 44, 45, and 46; +24-V input	All
4	SEN	Sensor ON input	ON: 5-V power supplies to absolute encoder [absolute] The signal is not used when setup parameter Cn-01 bit no. 1 = 1.	Speed
2	SENGND	Sensor ON input ground		
21	BAT	Backup battery + input	Backup battery connector terminals for power interruption for absolute encoder [absolute]	Speed
22	BATGND	Backup battery – input		

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⁎CN1 Control Outputs

Pin No.	Signal name	Function	Contents	Command mode
1	GND	Ground common	Ground for the encoder output, alarm code, and monitor output	All
16	AM	Current monitor	Voltage is output centered on 0 V according to the following ratio: 2 V/(rated torque) Forward acceleration is negative, reverse acceleration is positive. Output accuracy is approximately ±10%	All
17	NM	Speed monitor	Voltage is output centered on 0 V according to the following ratio: 1 V/(1,000 r/min) Forward is negative, reverse is positive. Output accuracy is approximately ±10%	All
19	+Z	Encoder Z-phase + output	Encoder Z-phase output (1 pulse/revolution). Line driver output (conforming to RS-422A).	All
20	–Z	Encoder Z-phase – output		
23	P12	Built-in command power supply	Power supply for speed commands and torque commands. Can be used for speed and torque commands by connecting an external variable resistor.	Speed Torque
24	N12			
The function of the following pairs of signals is set in user parameter CN-2d (output signal selection); 25 (+) and 26 (–), 27 (+) and 28 (–), 29 (+) and 30 (–)				
25 to 30	VCMP	Speed conformity output	Output (ON) when the Servomotor speed error is within the speed conformity signal output range (Cn-22).	Speed
	INP	Positioning completion output	Output (ON) when the position error is within the positioning completion range (Cn-1b).	Position
	TGON	Servomotor rotation detection output	Output (ON) if the Servomotor rotation speed exceeds the value set for the Servomotor rotation detection speed (Cn-0b).	All
	READY	Servo ready output	Output (ON) if no errors are discovered after powering the main circuits.	All
	CLIMT	Current limit detection output	The CLIMT signal will turned ON in any of the following 3 cases: • The output torque reaches the value set for the torque limit (Cn-08, -09) • The forward/reverse rotation current limit (PCL/NCL) is ON and the output torque reaches the external current limit set in Cn-18 or Cn-19.	All
			• The output torque reaches the analog current limit input (TREF). (When Cn-02 bit no. 8 = 1)	Speed
	BKIR	Brake interlock output	Outputs external brake interlock signal according to setting in Cn-12, 15, and 16.	All
	$\overline{\text{OLWRN}}$	Overload warning output	Goes OFF when the effective torque exceeds 20% of the overload detection level.	All
	$\overline{\text{OLALM}}$	Overload alarm output	Goes OFF when an overload is detected. Goes ON when the alarm reset is input.	All

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Pin No.	Signal name	Function	Contents	Command mode
31	$\overline{\text{ALM}}$	Alarm output	When an alarm is generated for the Servo Driver, the output is OFF. Open collector output (50 mA, 30 VDC max.)	All
32	ALMCOM	Alarm output ground		
33	+A	Encoder A-phase + output	Outputs encoder pulses divided according to user parameter Cn-0A. Line driver output (conforming to RS-422A).	All
34	–A	Encoder A-phase – output		
35	–B	Encoder B-phase – output	Outputs encoder pulses divided according to user parameter Cn-0A. Line driver output (conforming to RS-422A).	All
36	+B	Encoder B-phase + output		
37	ALO1	Alarm code output 1	When an alarm is generated for the Servo Driver, the contents of the alarm are output in 3-bit code. Open collector output: 30 VDC, 20 mA max.	All
38	ALO2	Alarm code output 2		
39	ALO3	Alarm code output 3		
50	FG (see note 2)	Frame ground	Ground terminal for shield wire of cable and FG line.	——

Note 1. Do not connect pins no. 48 and 49.

Note 2. Pin No. 50 is open for models conforming to the EC Directives. Connect the cable shield to the connector case and ground it directly using a clamp.

⁎CN1 Connectors Used (50P)

Receptacle at Servo Driver	10250-52A2JL	(Sumitomo 3M)
Soldered plug at cable side	10150-3000VE	(Sumitomo 3M)
Case at cable side	10350-52A0-008	(Sumitomo 3M)

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⁎Pin Arrangement

1	GND	Encoder output alarm code ground
2	SENGND	Sensor ON input ground [absolute]
3	PCOM	Open-collector command power
4	SEN	Sensor ON input [absolute]
5	REF	Speed command input
6	AGND	Speed command input ground
7	+PULS /+CW/+A	+ feed pulse, + reverse pulse, + A phase
8	–PULS /–CW/–A	– feed pulse, – reverse pulse, – A phase
9	TREF	Torque command input
10	AGND	Torque command input ground
11	+SIGN /+CCW/+B	+ forward/reverse signal, + forward pulse, + B phase
12	–SIGN /–CCW /–B	– forward/reverse signal, – forward pulse, – B phase.
13	PCOM	Open-collector command power
14	–ECRST	– error counter reset
15	+ECRST	+ error counter reset
16	AM	Current monitor (see note 2)
17	NM	Speed monitor (see note 2)
18	PCOM	Open-collector command power
19	+Z	Encoder Z-phase + output
20	–Z	Encoder Z-phase – output
21	BAT	Backup battery + input [absolute]
22	BATGND	Backup battery – input [absolute]
23	P12	Built-in command power supply
24	N12	Built-in command power supply
25	+INP	Positioning completion output (see note 1)
26	–INP	Positioning completion output ground (see note 1)
27	+TGON	Motor rotation detection output (see note 1)
28	–TGON	Motor rotation detection output ground (see note 1)
29	+READY	Servo ready output (see note 1)
30	–READY	Servo ready output ground (see note 1)
31	$\overline{\text{ALM}}$	Alarm output
32	ALMCOM	Alarm output ground
33	+A	Encoder A-phase + output
34	–A	Encoder A-phase – output
35	–B	Encoder B-phase – output
36	+B	Encoder B-phase + output
37	AL01	Alarm code output 1
38	AL02	Alarm code output 2
39	AL03	Alarm code output 3
40	RUN	Run command input
41	MING /PLOCK /TVSEL /IPG /RDIR	Gain deceleration, position lock, control mode, pulse disable, rotation direction
42	POT	Forward rotation drive prohibit input
43	NOT	Reverse rotation drive prohibit input
44	RESET	Alarm reset input
45	PCL /SPD1	Forward current limit/speed selection command 1
46	NCL /SPD2	Reverse current limit/speed selection command 1
47	+24VIN	Control DC +24-V input
48		
49		
50	FG	Frame ground (see note 3)

Note 1. The output terminal function of CN1 pins 25 through 30 are set in user parameter Cn-2d (output signal selection). The output signals shown above are the factory settings.

- ■Positioning completion (INP: position control)/speed conformity (VCMP: speed control)
- ■Motor rotation detection (TGON)
- ■ Servo ready (READY)
- ■Current limit detection (CLIMT)
- ■ Break interlock (BKIR)
- ■Overload warning ($\overline{\text{OLWRN}}$)
- ■ Overload alarm ($\overline{\text{OLARM}}$)

Of these, positioning completion (INP: position control)/speed conformity (VCMP: speed control) can be set for CN1 pints 25 and 26 only.

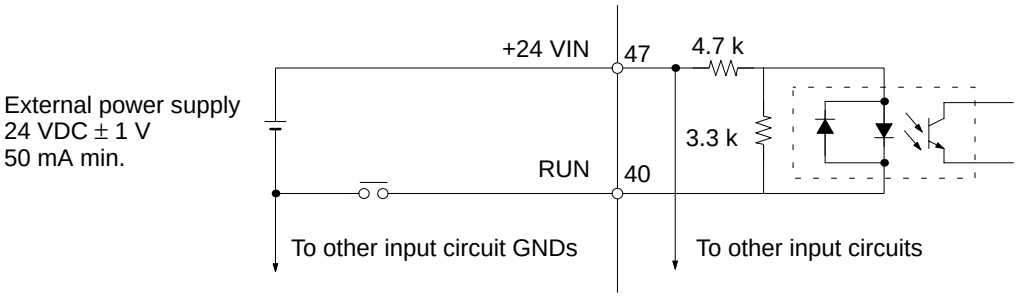
Note 2. The content of the monitor output for the AM and NM terminals can be changed via setup parameter Cn-02 bits 6 and 7.

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Note **3.** Pin No. 50 is open for models conforming to the EC Directives. Connect the cable shield to the connector case and ground it directly using a clamp.

● Control Input Interface

The input circuit for the control I/O connector (CN1) is as shown in the following diagram.



⁎Run Command (40: RUN)

This is the input that turns on the power drive circuit for the main circuit of the Servo Driver. If this signal is not input (i.e., servo-off status), the Servomotor cannot operate. Depending on the setting of setup parameter Cn-01, bit no. 0, this signal can be bypassed. In that case, the servo will be turned on after the power is turned on.

⁎Gain Reduction, Position Lock Command, Control Mode Switch, Rotation Direction Command, Pulse Disable (41: MING/PLOCK/TVSEL/RDIR/IPG)

This input signal switches among the following five kinds of signals according to the settings of user parameter Cn-2b.

- **Gain Reduction (41: MING; User Parameter Cn-2b = 0 (speed control) or 1 (position control), or user parameter Cn-2b = 3, 4, or 5 and SPD1 and SPD2 (speed selection commands 1 and 2) are both OFF)**

  Input this signal to lower the loop gain for the control loop, and to weaken servo rigidity (repellant force with respect to external force). If position control is executed without including a position loop, there may be some position deviation due to temperature drift from a device such as the A/D converter. In such a case, if a gain reduction is input, the loop gain of the speed loop will be lowered and the amount of drift will be decreased. If there is static friction torque on the load (5% or more of the rated torque), the Servomotor will completely stop.

  In addition, if a position loop is included, when parts are inserted after positioning, the insertion operation is made easier because the repellant force with respect to external force is weakened by the inputting of this signal. This cannot be used for the vertical shaft where a gravity load is applied, because position deviation will occur.

- **Position Lock Command (41: PLOCK; User Parameter Cn-2b = 10 (position lock speed control))**

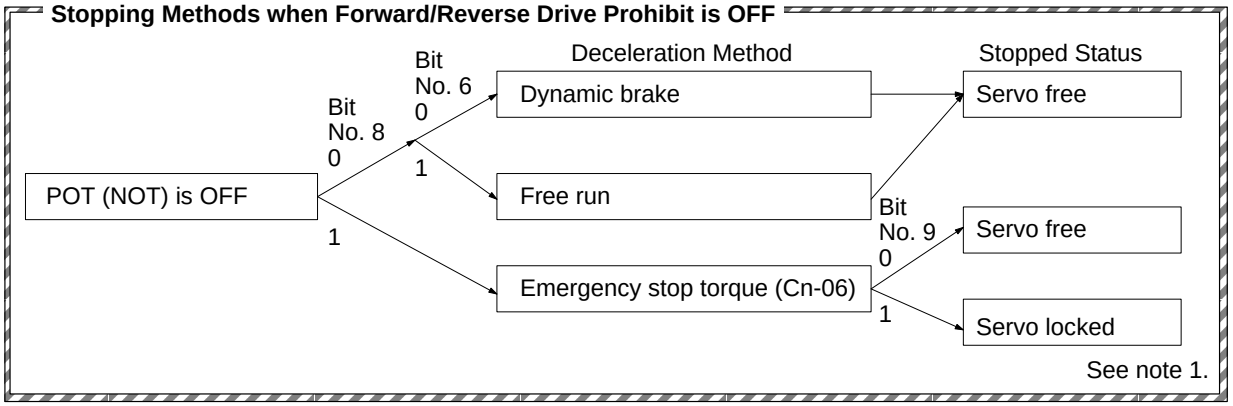
  If position control is executed without including a position loop, there may be some position deviation due to temperature drift from a device such as the A/D converter. In such a case, if this signal is input, when the Servomotor rotation speed is less than the rotation speed set for the position lock rotation speed (user parameter Cn-29), the mode changes from speed control mode to position control mode. The Servomotor goes into position lock status and completely stops. This function can be used even for the vertical shaft where a gravity load is applied.

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- **Control Mode Switch (41: TVSEL; User Parameter Cn-2b = 7, 8, or 9 (change control mode))**
  If user parameter Cn-2b is 7 (position control + speed control), the mode is switched between position control and speed control (ON: speed control).
  If user parameter Cn-2b is 8 (position control + torque control), the mode is switched between position control and torque control (ON: torque control).
  If user parameter Cn-2b is 9 (speed control + torque control), the mode is switched between speed control and torque control (ON: speed control).
- **Rotation Direction Command (41: RDIR; User Parameter Cn-2b = 3, 4, 5, or 6 and either SPD1 or SPD2 is ON for internally set speed)**
  This signal becomes the rotation direction change command for when operation is carried out at the internally set speed (no. 1 through no. 3 internally set speeds). When this signal is not input, the rotation direction is forward; when it is input, the direction is reverse.
- **Pulse Disable (41: IPG; User Parameter Cn-2b = 11 (position control, pulse disabled)**
  Command pulse inputs are disabled. The motor will stop when this signal goes ON and the position will be locked.

⁎Forward/Reverse Drive Prohibit (42 POT: forward drive prohibit, Cn-01 bit 2 = 0; 43 NOT: reverse drive prohibit, Cn-01 bit 3 = 0))

These two signals are the inputs for forward and reverse drive prohibit (overtravel). When they are input, driving is possible in the respective direction. When driving is prohibited, movement will stop according to the settings of bits nos. 6, 8, and 9 of setup parameter no. 1 (Cn-01). Alarm status will not be generated at the Driver. When drive prohibit is not used, clear the function by connecting the respective signal to the external power supply +24-V GND or setting setup parameter Cn-01, bit nos. 2, 3 = 1,1.



Note 1. The position loop will not operate for position control when stopping in this mode.

Note 2. When torque control is being used, the stop method is determined by the status of bit 6. (The status of bit 8 is irrelevant.)

⁎Forward/Reverse Rotation Current Limit [45, 46: (PCL/SPD1), (NCL/SPD2)]

These input signals switch between the forward/reverse current limit and the speed selection command signal for the internally set speed, depending on the setting of user parameter Cn-2b.

- **Forward/Reverse Rotation Current Limit (45, 46: PCL, NCL; user parameter Cn-2b = 0, 1, 2, 7, 8, 9, 10, or 11)**
  These input signals are the forward rotation current limit and the reverse rotation current limit, and they limit the current to the Servomotor. The current limit values can be set for the respective directions by means of user parameters Cn-18 and 19. The set values can be set for up to the maximum output current as 100% of the rated output current.

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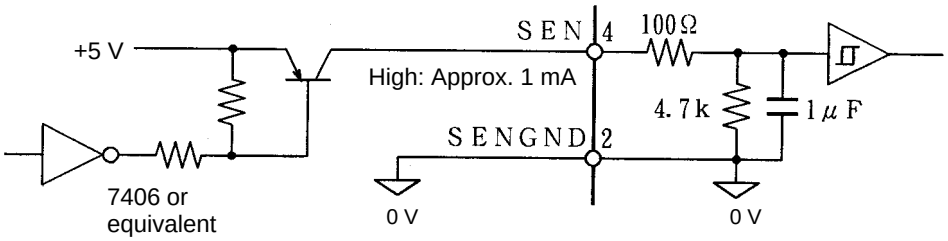
- **Speed Selection Command (45, 46: SPD1, SPD2; user parameter Cn-2b = 3, 4, 5, or 6)**
  These input signals are the speed selection command 1 and the speed selection command 2. Depending on the combination of signals, the Servomotor speed can be controlled according to the internally set speeds, nos. 1 through 3, which are set in user parameter Cn-1F, 20, 21. At that time, the CN1-41 pin becomes the rotation direction command (RDIR).

⁎Alarm Reset (44: RESET)

This is the external reset signal input for the servo alarm. Remove the cause of the alarm and then restart operation. In order to prevent danger, either set the speed command to 0 V or turn OFF the run command before inputting the reset signal.

⁎Sensor ON Input (4: SEN) [Absolute]
Sensor ON Input Ground (2: SENGND) [Absolute]

The SEN signal input circuit is shown below.

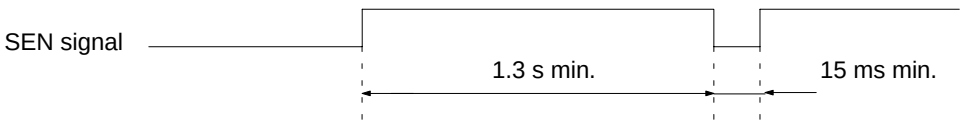


- A PNP transistor is recommended.
- Signal Levels High: 4 V min.
  Low: 0.7 V max.

When the SEN signal turns ON (low to high), 5 V is supplied to the absolute encoder. When power is not supplied to the motor (Run command input OFF) and the SEN signal is turned OFF (high to low), the 5 V to the absolute encoder is cut off.

The SEN signal is ignored while power is supplied to the motor even if it is turned OFF.

Power cannot be supplied to the motor even if the Run command is received unless the SEN signal is ON. Power will also not be supplied to the motor between t6he time that the SEN signal turns ON and the encoder achieves normal operation even if the Run command is received. Do not turn ON the SEN signal for at least 3 s after turning on the power supply. Refer to the chart below to turn the SEN signal ON, OFF, and ON again.



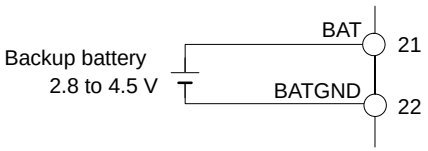
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⁎Backup Battery + Input (21: BAT) [Absolute]
Backup Battery – Input (22: BATGND) [Absolute]

These are the connection terminals for a backup battery for power interruption to the absolute encoder. The battery voltage is 2.8 to 4.5 V.

A backup battery is not supplied with the motor or driver. Purchase a battery separately.

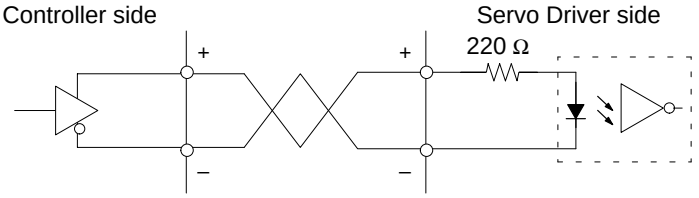
Connect the battery as shown in the following diagram.



● Command Pulse and Error Counter Reset Interface

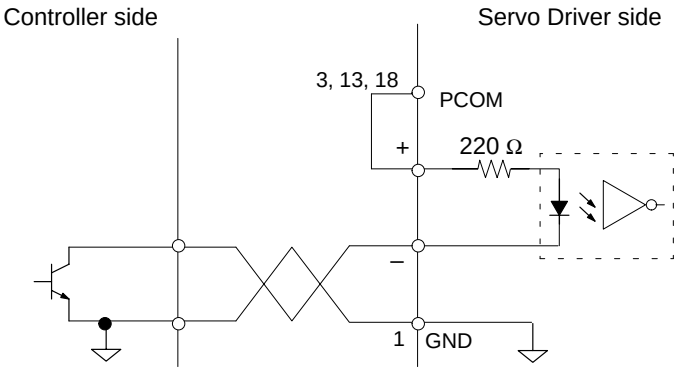
The input circuits for the control connector's (CN1) command pulses and error counter reset are shown in the following diagrams.

Line Driver Inputs



Applicable driver: AM26L S31A
or equivalent

Open Collector Inputs



⁎+ Error Counter Reset (15: +ECRST)
– Error Counter Reset (14: –ECRST)

The content of the error counter will be reset when the error counter reset signal turns ON and the position loop will stop operating.

Input the reset signal for 20 μs minimum. The counter will not be reset if the signal is too short.

Cn-02 bit no. A can be used to set either a status signal (high) or a differential signal (rising edge).

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⁎+ Feed Pulse, Reverse Pulse, 90• Phase Difference Pulse A Phase (7: +PULS/+CW/+A)
– Feed Pulse, Reverse Pulse, 90• Phase Difference Pulse A Phase (8: –PULS/–CW/–A)
+ Forward/Reverse Signal, Forward Pulse, 90• Phase Difference Pulse B Phase (11: +SIGN/+CCW/+B)
– Forward/Reverse Signal, Forward Pulse, 90• Phase Difference Pulse B Phase (12: –SIGN/–CCW/–B)

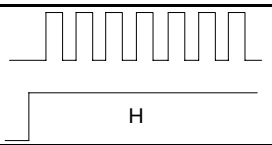
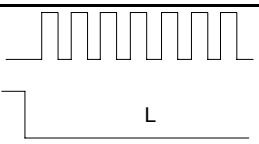
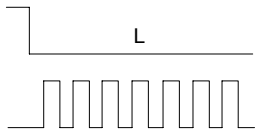
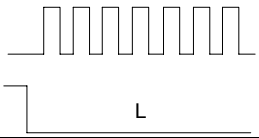
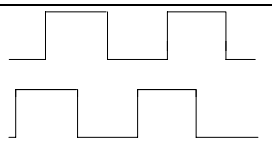
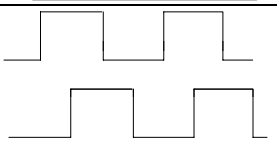
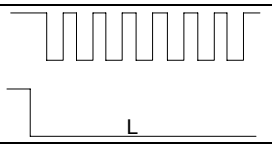
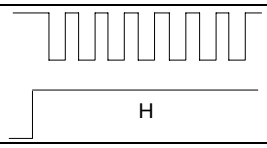
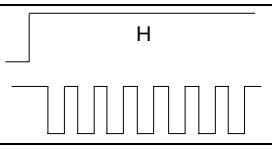
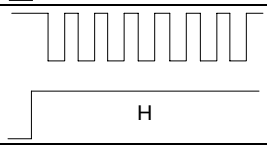
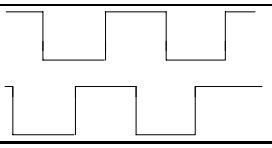
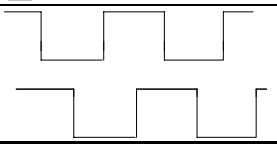
The function of these signals depends on the command pulse mode and the command pulse logic.

- **Command Pulse Mode (Cn-02 bits 5, 4, 3)**

  Cn-02 bits 5, 4, 3 = 0, 0, 0: Feed pulse and direction signal (factory setting)
  Cn-02 bits 5, 4, 3 = 0, 0, 1: Forward pulse and reverse pulse
  Cn-02 bits 5, 4, 3 = 0, 1, 0: 90• Phase Difference (phases A/B) (1 multiplier)
  Cn-02 bits 5, 4, 3 = 0, 1, 1: 90• Phase Difference (phases A/B) (2 multiplier)
  Cn-02 bits 5, 4, 3 = 1, 0, 0: 90• Phase Difference (phases A/B) (4 multiplier)

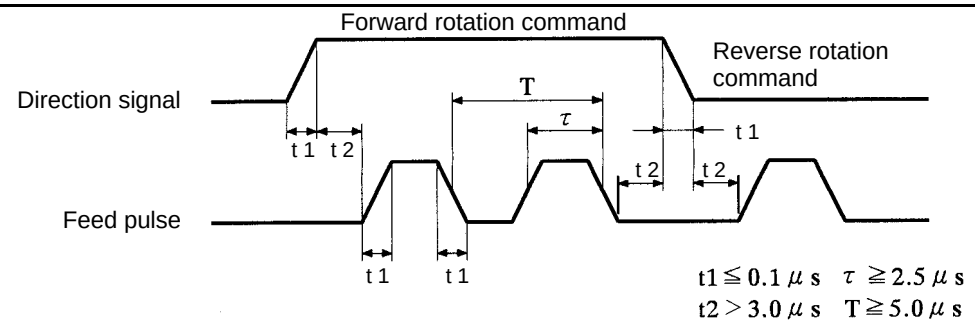
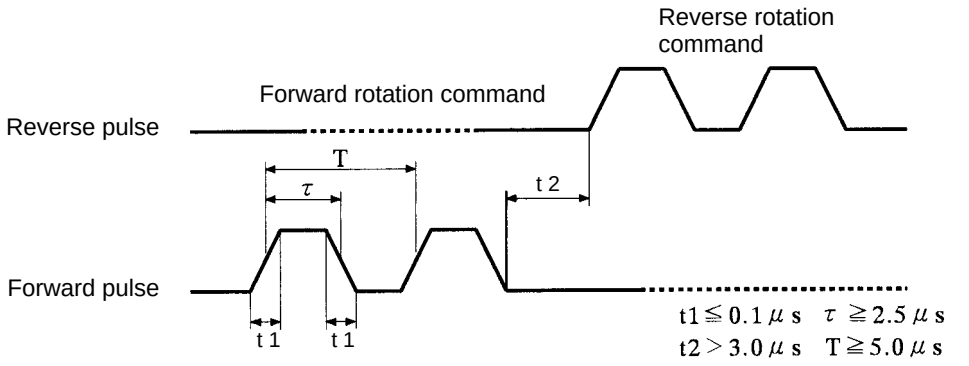
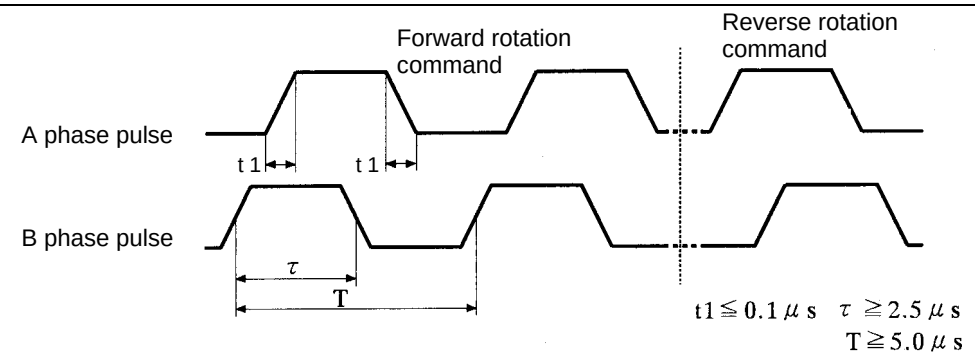
- **Command Pulse Logic (Cn-02 bit d)**

  Cn-02 bit d = 0: Positive logic; Bit d = 1: Negative logic

Logic	Cn-02 bit 5	4	3	Input multiplier	Command pulse mode	Input pins	Motor forward command	Motor reverse command
Positive	0	0	0	——	Feed pulse and direction signal	7: +PULS 8: –PULS 11: +SIGN 12: –SIGN		
	0	0	1	——	Reverse pulse and forward pulse	7: +CW 8: –CW 11: +CCW 12: –CCW		
	0	1	0	X1	90• phase difference signals	7: +A 8: –A 11: +B 12: –B		
	0	1	1	X2				
	1	0	0	X4				
Negative	0	0	0	——	Feed pulse and direction signal	7: +PULS 8: –PULS 11: +SIGN 12: –SIGN		
	0	0	1	——	Reverse pulse and forward pulse	7: +CW 8: –CW 11: +CCW 12: –CCW		
	0	1	0	X1	90• phase difference signals	7: +A 8: –A 11: +B 12: –B		
	0	1	1	X2				
	1	0	0	X4				

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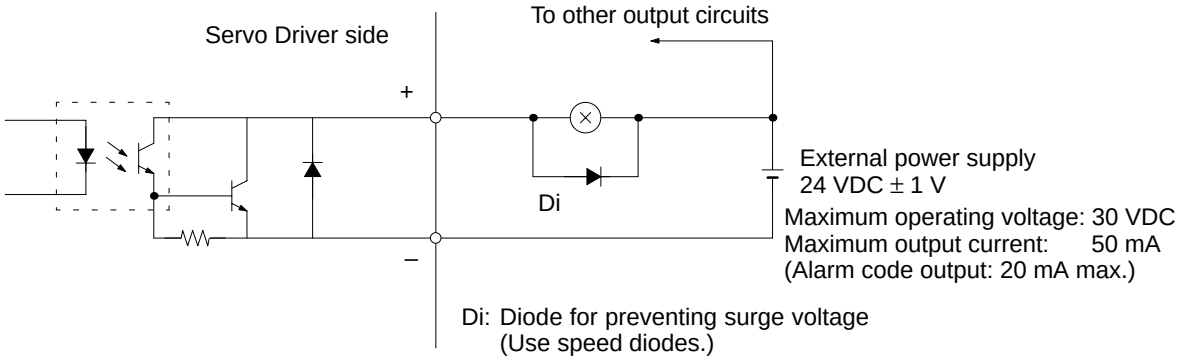
• **Command Pulse Timing** (Although the following wave forms are for positive logic, conditions are the same for negative logic.)

Command pulse mode	Timing
Feed pulse and direction signal Maximum input frequency: 200 kpps	
Reverse pulse and forward pulse Maximum input frequency: 200 kpps	
90• phase difference signals (A-/B-phase pulse) Maximum input frequency: 200 kpps	

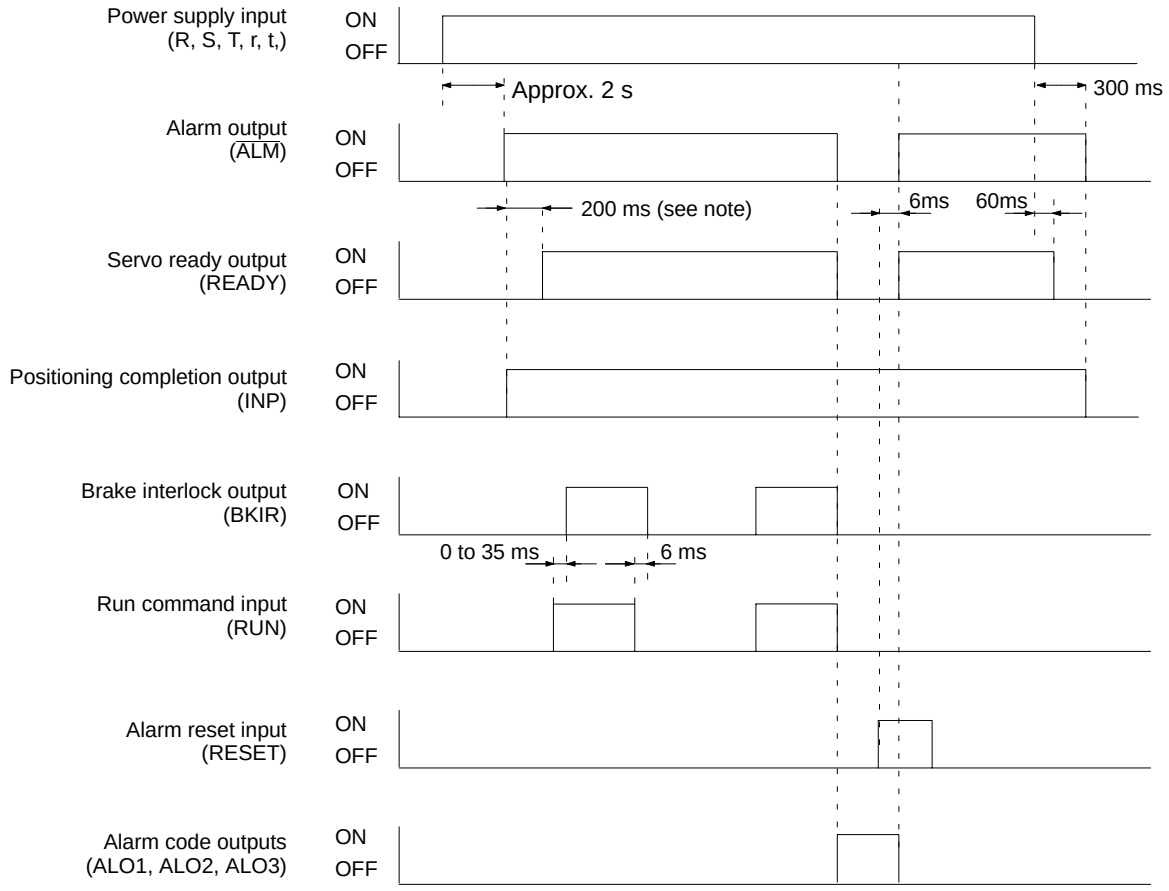
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● Control Output Interface

The output circuit for the control I/O connector (CN1) is as shown in the following diagram.



⁎Control Output Sequence



Note This signal will remain ON for approximately 250 ms after input of the SEN signal when using an absolute encoder.

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⁎+ Speed Conformity (25/27/29: +VCMP), Positioning completion (25/27/29: +INP), Motor Rotation Detection (25/27/29: +TGON), Current Limit Detection (25/27/29: +CLIMT), Brake Interlock (25/27/29: +BKIR), Overload Warning (25/27/29: +$\overline{\text{OLWRN}}$), Overload Alarm (25/27/29: +$\overline{\text{OLARM}}$)

– Speed Conformity (26/28/30: –VCMP), Positioning completion (26/28/30: –INP), Motor Rotation Detection (26/28/30: –TGON), Current Limit Detection (26/28/30: –CLIMT), Brake Interlock (26/28/30: –BKIR), Overload Warning (26/28/30: –$\overline{\text{OLWRN}}$), Overload Alarm (26/28/30: –$\overline{\text{OLARM}}$)

The function of the above three pairs of output terminals is determined by the setting of user parameter Cn-2d. Any of the available functions can be set to any of the terminal pairs. Each digit in the setting corresponds to one of the output terminal pairs. A setting of 0 is allowed only for the first digit (CN1 pins 25 and 26).

Set Value: 2 1 0

- 0: Setting of function for CN1-25, -26
- 1: Setting of function for CN1-27, -28
- 2: Setting of function for CN1-29, -30

Output signal function	Set value
Positioning completion (INP)/Speed conformity (VCMP)	0
Motor rotation detection (TGON)	1
Servo ready (READY)	2
Current Limit Detection (CLIMT)	3
Brake Interlock (BKIR)	4
Overload Warning (OLWRN)	5
Overload Alarm (OLARM)	6

- **Speed Conformity (Speed Control Mode)**
  This is output when the speed difference between the speed command and the rotation speed is equal to or less than the value set for the speed conformity signal output range (user parameter Cn-22). For example, if the speed command is for 3,000 r/min and the set value is for 50 r/min, it is output in the range from 2,950 to 3,050 r/min.
- **Positioning completion (Position Control Mode)**
  This is output when the pulse count in the error counter is equal to or less than the positioning completion range (Cn-1b). If the command speed is low speed and the positioning completion range is large, the positioning completion output will remain ON.
- **Motor Rotation Detection**
  Outputs when the motor rotation speed equals or exceeds the value set for user parameter Cn-0b (rotation speed for motor rotation detection).
- **Servo Ready**
  This signal is output if no errors are detected after powering up the main circuits.
- **Current Limit Detection**
  The CLIMT signal will turned ON in any of the following 3 cases:
  - The output torque reaches the limit value set in user parameter Cn-08 or Cn-09 (the forward and reverse rotation torque limits).
  - The forward/reverse rotation current limit (PCL/NCL) is ON and the output torque reaches the limit value set in user parameter Cn-18 or Cn-19.

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■The output torque is limited by the analog voltage input through TREF when Cn-02 bit no. 8 = 1 (speed control mode only).

- **Brake Interlock**
  This signal outputs an external brake timing signal according to the setting of Cn-12, -15, and -16. Refer to *3-3-14 Brake Interlock* for details.
- **Overload Warning**
  This signal goes OFF when the effective torque exceeds 20% of the overload detection level.
- **Overload Alarm**
  This signal goes OFF when an overload is detected. The signal will go ON when the alarm reset is input.

⁎Alarm Output (31: $\overline{\text{ALM}}$)
Alarm Output Ground (32: ALMCOM)

When the Servo Driver detects an error, outputs are turned OFF. At that time, an alarm code (see below) is output according to the contents of the error. This output is OFF at the time of powering up, and turns ON when the power-up processing is completed.

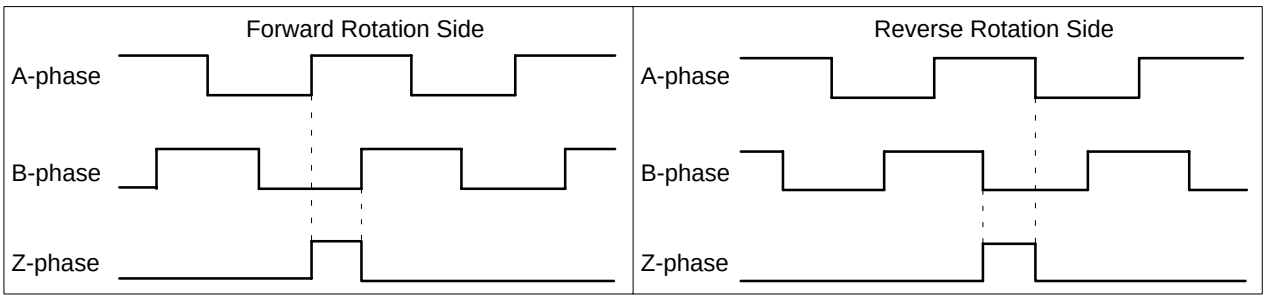
⁎Alarm Code Outputs 1 to 3 (37, 38, 39: ALO1 to ALO3)

When a Servo Driver error is generated, the contents of the error are output in 3-bit code. The alarm code output ground common is CN1 pin 1 or 2. For details, refer to *4-4-1 Alarm Displays and Alarm Code Outputs*.

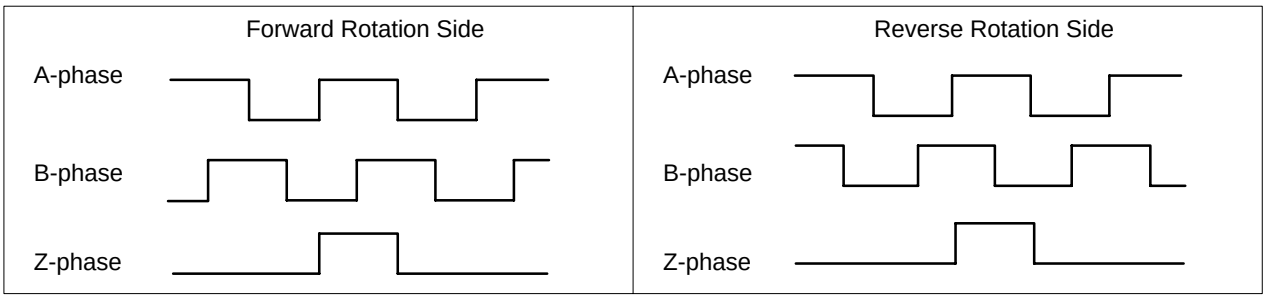
⁎Encoder A-, B-, and Z-phase Outputs (33, 34: +A, -A; 36, 35: +B, -B; 19, 20: +Z, -Z)

Servomotor encoder signals are output as divided phase-difference pulses according to the user parameter encoder divider rate setting (Cn-0A). The output form is line driver output, and conforms to EIA-RS-422A. Receive with a line driver or high-speed photocoupler.

- **Output Phase (When Encoder Divider Rate Setting is 4,096) [Incremental]**



- **Output Phase (When Encoder Divider Rate Setting is 8,192) [Absolute]**



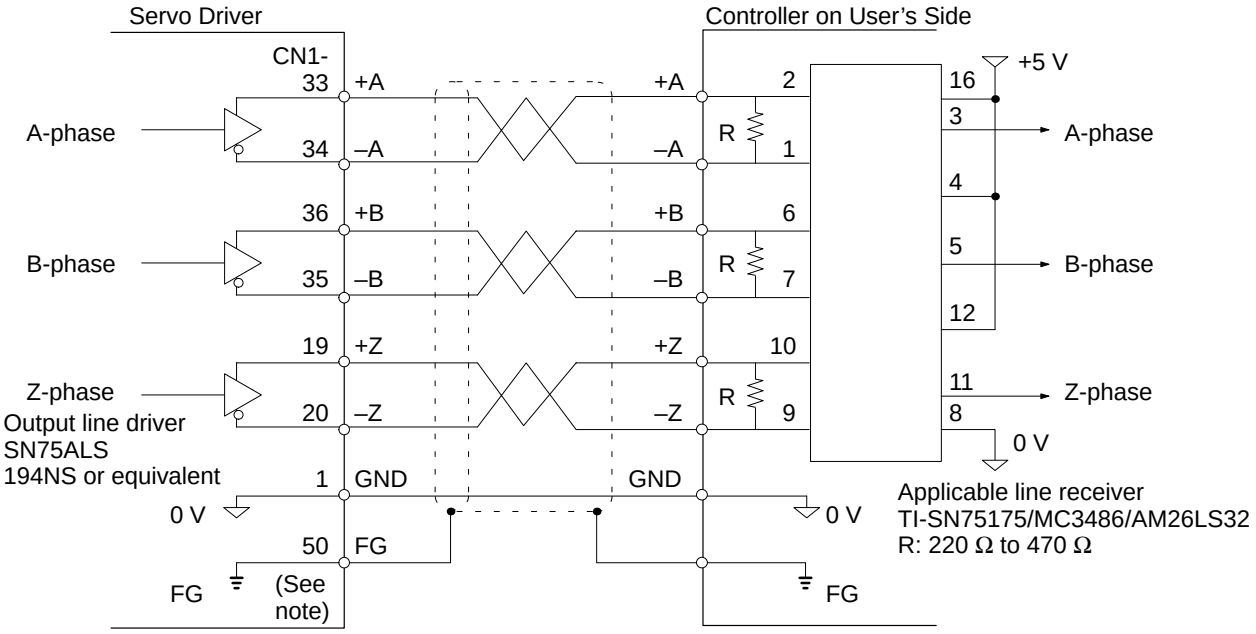
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Note 1. The Z and A phases are synced, but the pulse width can be shorter than phase A.

Note 2. Absolute data is first output from phase A as serial data when the SEN signal goes ON (low to high) and then it is output as the initial incremental pulses A and B (90• phase difference pulse). Finally, the same output operation as for a normal incremental corder (90• phase difference pulse) is carried out.

Note 3. The normal incremental encoder signals (phases A and B) are output approximately 400 ms after the SEN signal is input.

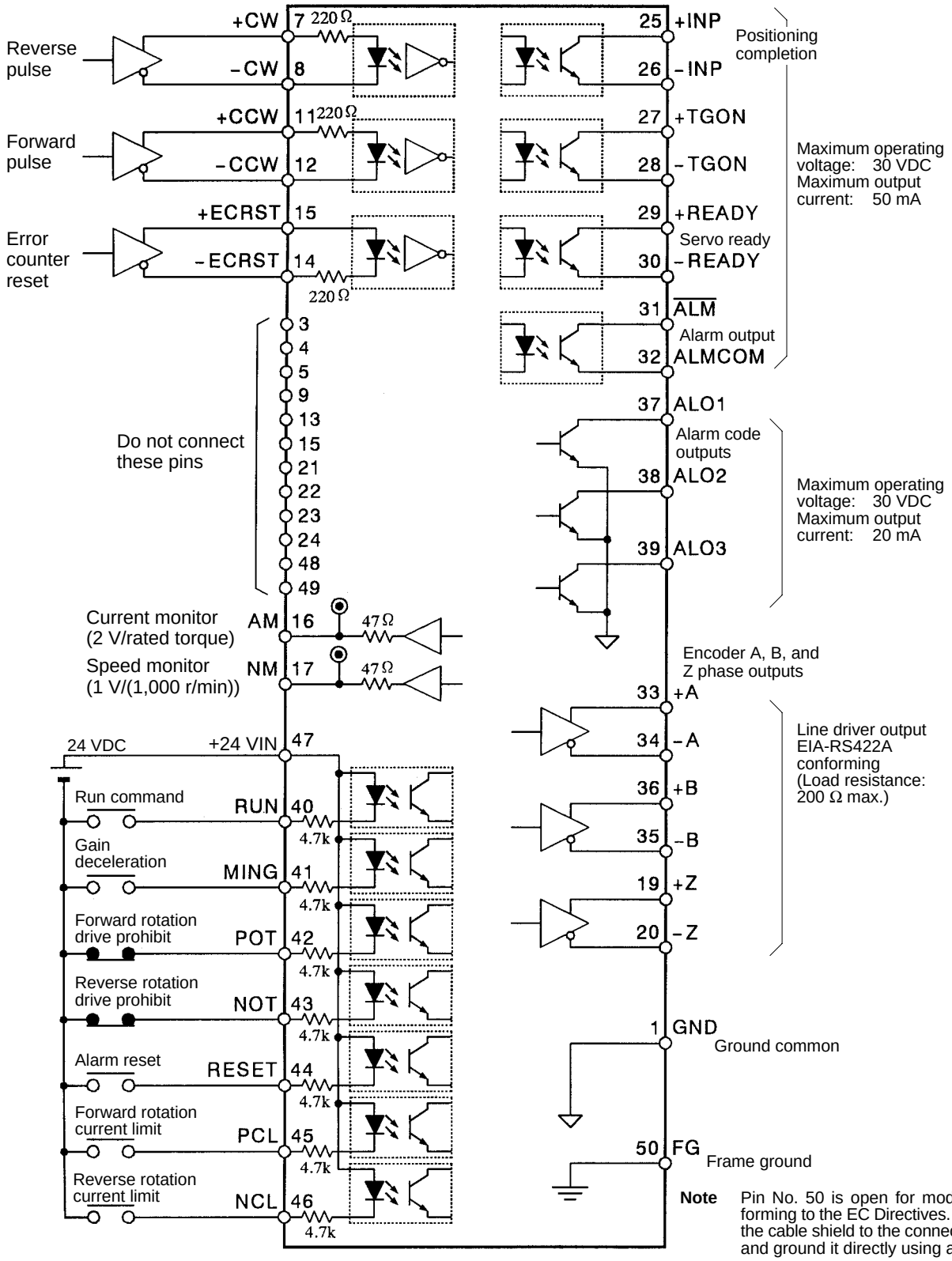
- **Output Circuit and Receiving Circuit [Incremental]**



Note Pin No. 50 is open for models conforming to the EC Directives. Connect the cable shield to the connector case and ground it directly using a clamp.

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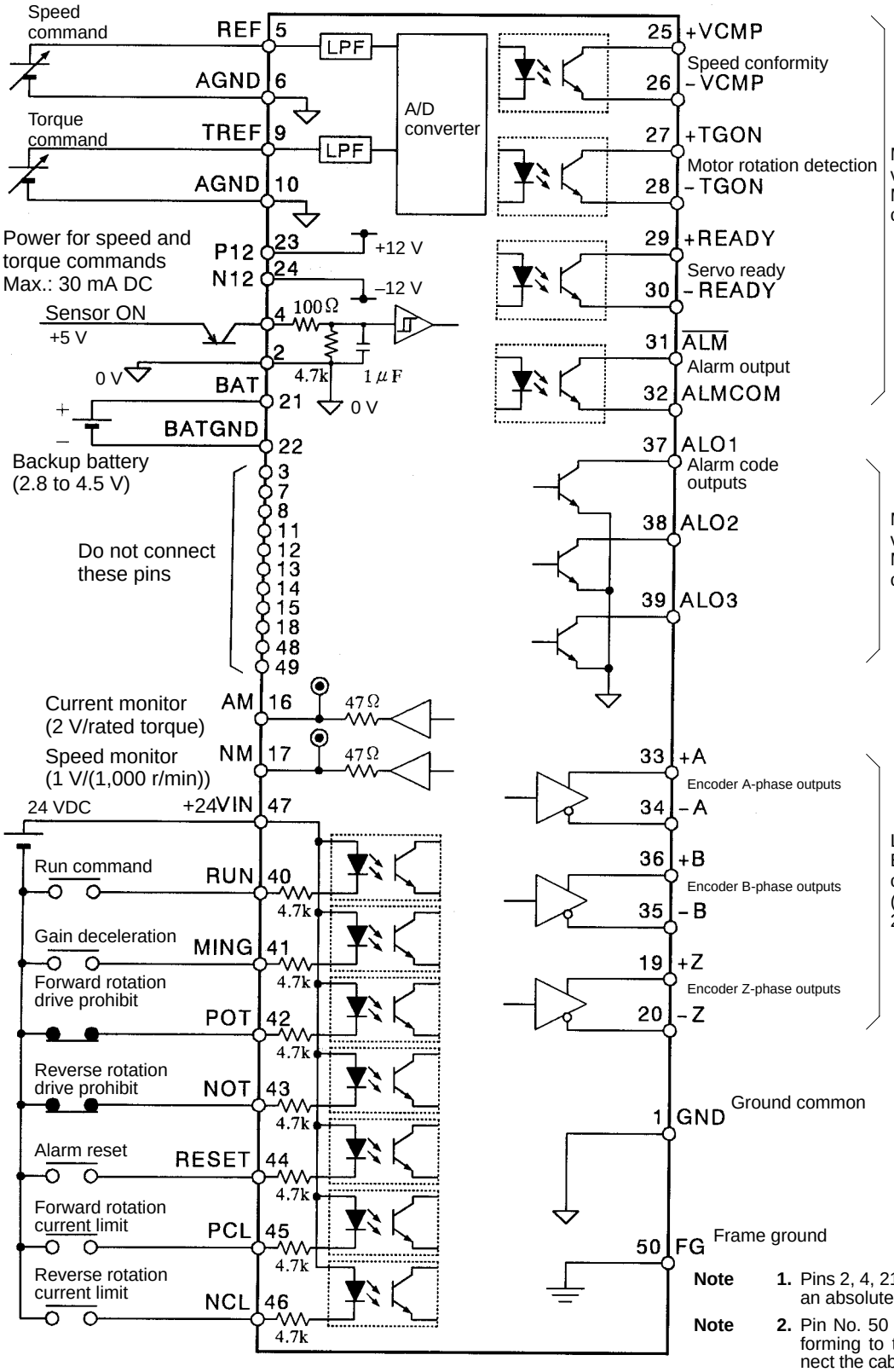
● Control I/O Signal Connections and External Signal Processing for Positioning Control



Note Pin No. 50 is open for models conforming to the EC Directives. Connect the cable shield to the connector case and ground it directly using a clamp.

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● Control I/O Signal Connections and External Signal Processing for Speed Control



Note **1.** Pins 2, 4, 21, and 22 are for use with an absolute encoder.

Note **2.** Pin No. 50 is open for models conforming to the EC Directives. Connect the cable shield to the connector case and ground it directly using a clamp.

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● CN2: Encoder Input Specifications

Pin No.	Signal name	Function	Interface
1, 2, 3	E0V	Encoder power supply GND	Power supply outlet for encoder: 5 V, 400 mA
4, 5, 6	E5V	Encoder power supply +5 V	
7	DIR	Rotation direction switch input	Connects to GND when reverse rotation is executed by + input.
8, 9	NC	Not used	Do not connect.
10, 11	NC	Not used	Do not connect.
12	BAT+	Battery + (see note 1)	Backup power output for encoder 10 μA, 3.6 V (backup, rotation stopped)
13	BAT–	Battery – (see note 1)	
14	S+ (Z+)	Encoder + S- (Z-) phase input (see note 2)	Line driver input (conforming to EIA-RS422A) (Input impedance: 220 Ω)
15	S– (Z–)	Encoder – S- (Z-) phase input (see note 2)	
16	A+	Encoder + A-phase input	Line driver input (conforming to EIA-RS422A) (Input impedance: 220 Ω)
17	A–	Encoder – A-phase input	
18	B+	Encoder + B-phase input	Line driver input (conforming to EIA-RS422A) (Input impedance: 220 Ω)
19	B–	Encoder – B-phase input	
20	FG	Shielded ground (see note 3)	Cable shielded ground

Note 1. These terminals are for an absolute encoder.

Note 2. Incremental encoders use the S phase; absolute encoders, the Z phase.

Note 3. Pin No. 20 is open for models conforming to the EC Directives. Connect the cable shield to the connector case and ground it directly using a clamp.

⁎Connectors Used (20P)

Receptacle at Servo Driver	10220-52A2JL	(Sumitomo 3M)
Soldered plug at cable side	10120-3000VE	(Sumitomo 3M)
Case at cable side	10320-52A0-008	(Sumitomo 3M)

⁎Pin Arrangement

2	E0V	Encoder power supply GND	1	E0V	Encoder power supply GND	12	BAT+	Battery + (see note)	11	NC	
4	E5V	Encoder power supply +5 V	3	E0V	Encoder power supply GND	14	S+ (Z+)	Encoder + S- (Z-) phase input	13	BAT–	Battery – (see note)
6	E5V	Encoder power supply +5 V	5	E5V	Encoder power supply +5 V	16	A+	Encoder + A-phase input	15	S– (Z–)	Encoder – S- (Z-) phase input
8	NC		7	DIR	Rotation direction switch input	18	B+	Encoder + B-phase input	17	A–	Encoder – A-phase input
10	NC		9	NC		20	FG	Frame ground	19	B–	Encoder – B-phase input

(See note 2.)

Note 1. The battery pins are for an absolute encoder.

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Note 2. Pin No. 20 is open for models conforming to the EC Directives. Connect the cable shield to the connector case and ground it directly using a clamp.

⁎Rotation Direction Change (7: DIR)

To set up the mechanical configuration so that a + voltage input causes reverse rotation instead of forward rotation, this terminal can be connected to the GND terminal for any of pins 1 through 3. This function carries out the same operation by means of setting setup parameter Cn-02 bit no. 0 to "1." Use this to prevent runaway when replacing the Servo Driver.

When the rotation direction is changed, the encoder A-phase and B-phase output phases are also changed. The following example is for speed control: When not set (factory setting), + voltage is for forward (CCW) rotation and A-phase advance; when set, + voltage if for reverse (CW) rotation and A-phase advance (and – voltage is for forward rotation and B-phase advance). Therefore wiring changes are unnecessary for encoder signals to the positioner.

⁎Encoder Pulse Input Signals (A-, B-, S-phase (incremental), Z-phase (absolute))

Inputs signals output from the Servomotor encoder. In S-phase, servo sensor U-, V-, W-, and Z-phase are transmitted according to A- and B-phase logic.

⁎Encoder Power Supply + 5-V Output and Ground (1, 2, 3: E0V; 4, 5, 6: E5V)

Outputs +5.2 ±0.1 V as the power supply for the Servomotor encoder. The encoder power supply cannot be used for other purposes.

● CN3: Parameter Unit Input Specifications

Pin No.	Signal name	Function	I/O interface
1	TXD+	Transmission data +	This is data transmitted to a Parameter Unit (or a personal computer).
2	TXD–	Transmission data –	
3	RXD+	Reception data +	This is data received from a Parameter Unit (or a personal computer).
4	RXD–	Reception data –	
5	PRMU	Unit switching	This is the switching terminal for a Parameter Unit or personal computer. If the pin is open, it is for a personal computer. If connected to +5V, it is for a Parameter Unit.
6	RT1	Termination resistance enabled/disabled	This is the termination resistance terminal for the line receiver. For 1-to-1 communications or for the final Servo Driver, short-circuit RT1-RT2.
7	RT2		
8	+5V	+5 V output	This is the +5 V output to the Parameter Unit.
9	GND	Ground	

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⁎Pin Arrangement

1	TXD+	Transmission data +
2	TXD–	Transmission data –
3	RXD+	Reception data +
4	RXD–	Reception data –
5	PRMU	Unit switching

6	RT1	Termination resistance on/off
7	RT2	
8	+5V	+5-V output
9	GND	Ground

⁎Connectors Used (D-sub Connector, 9P)

Socket at Servo Driver 17LE-13090-27 (D2BC) (DDK)
Soldered plug at cable side 17JE-23090-02 (D1) (DDK) (XM2A-0901 (OMRON))
Cover at cable side 17JE-09H-15 (DDK) (XM2S-0912 (OMRON))

● CN4: Monitor Output Connector Specifications

Function	I/O interface
Speed monitor Speed command monitor Command pulse speed monitor	Voltage output with a ratio of 1 V/(1,000 r/min), centered at 0 V. (–) voltage is forward, (+) voltage is reverse, and output accuracy is about ±10%.
Current monitor	Voltage output with a ratio of 2 V / (rated torque), centered at 0 V. (–) voltage is output during forward acceleration and positive voltage during reverse acceleration. Output accuracy is about ±10%.
Error counter monitor	Voltage output with a ratio of 0.05 V/(command unit: Cn-o2 bit E), centered at 0 V. (–) voltage is a positive count, (+) voltage is a negative count, and output accuracy is about ±10%.

⁎Connectors Used (4P)

Pin header at Servo Driver	DF11-4DP-2DS	(Hirose Electric)
Socket at cable side	DF11-4DS-2C	(Hirose Electric)
Socket crimp-type terminal at cable side	DF11-2428 SC	(Hirose Electric)

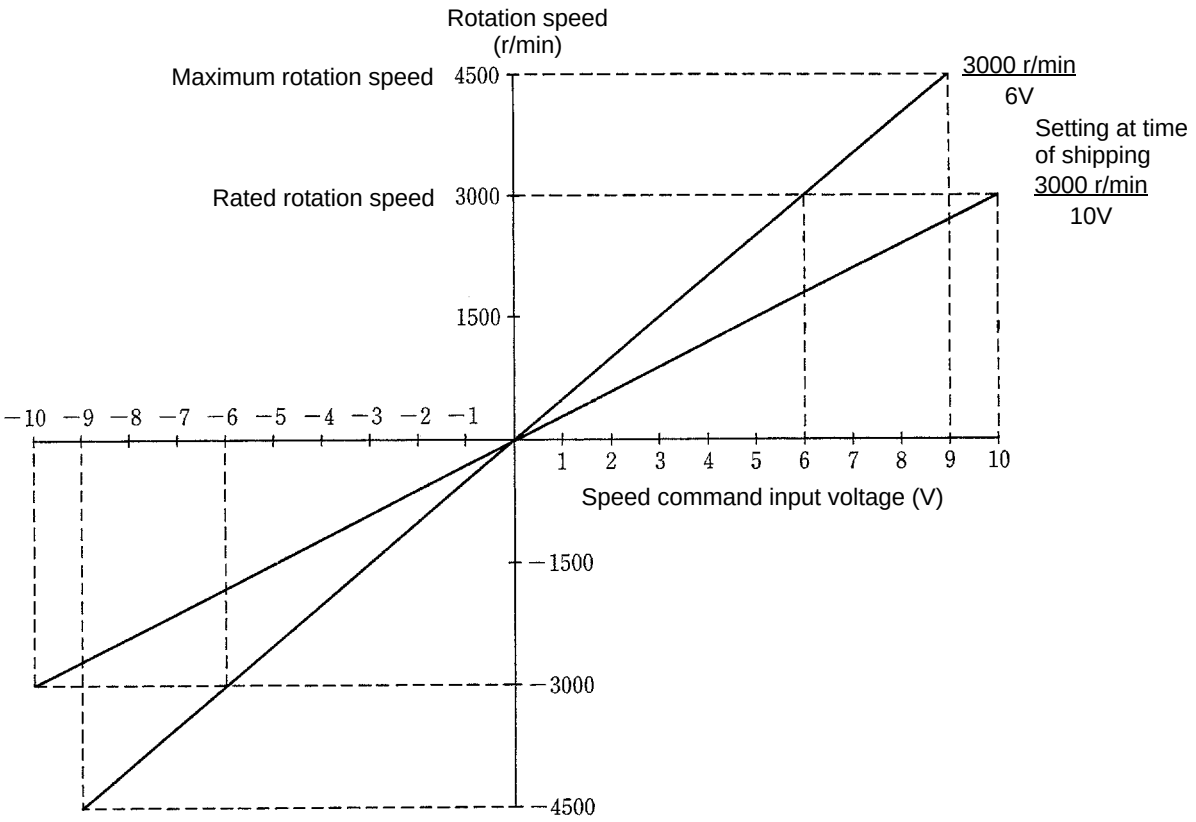
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5-1-4 Explanation of User Parameters

Refer to *3-3-2 Setting and Checking User Parameters (Cn-03 to 2d)* for a table of user parameters.

⁎Speed Command Scale: Cn-03 (Speed, Torque)

This is a constant for adjusting the motor rotation speed for the speed command input. The adjustable range is 10 to 2,000 (r/min/V). The factory setting is for 300 (r/min/V), with an input voltage of 10 V at 3,000 r/min.



When a position control loop is formed for a speed command type, this speed command scale becomes the position loop gain.

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⁎Speed Loop Gain: Cn-04 (Position, Speed)

This is the proportional gain for the speed controller. The adjustable range is 1 to 2,000 Hz (the response frequency when equivalent inertia is used). As the number is increased, the gain is increased.

The factory setting is for 80 (Hz). Using the factory setting for the Servomotor alone or with a small load inertia will cause vibration to occur, so set the value to a maximum of 20 (Hz) for operation.

⁎Speed Loop Integration Time Constant: Cn-05 (Position, Speed)

This is the integration time for the speed controller. The adjustable range is 200 to 51,200 (0.01 ms), and it is factory set to 2,000. As the number is increased, the gain is increased.

⁎Emergency Stop Torque: Cn-06 (Position, Speed)

When setup parameter Cn-01 bit no. 8 = 1, this sets the braking torque for over-travel stopping (forward/reverse drive prohibit input operation). The setting range is 0% to 350% of maximum torque (a percentage of the braking torque as 100% of the Servomotor rated torque). The factory setting is for 350% of the maximum torque.

⁎Software Start Acceleration Time: Cn-07 (Speed)
Software Start Deceleration Time: Cn-23 (Speed)

The Servomotor rotation acceleration time from 0 r/min to 4,500 r/min is set in Cn-07, and the deceleration time from 4,500 r/min to 0 r/min is set in Cn-23. The factory setting is for 0 (ms).

Set to 0 (ms) when positioning is controlled by connecting a positioner with an acceleration function or when the speed control mode is not being used.

Set both the acceleration and deceleration times when using these functions.

⁎Forward Rotation Torque Control: Cn-08 (Position, Speed, Torque)
Reverse Rotation Torque Control: Cn-09 (Position, Speed, Torque)

The Servomotor output torque control value for forward rotation is sen in Cn-08, and the value for reverse rotation is set in Cn-09. The setting range is 0% to 350% of the maximum torque, and the factory setting is for 350% of the maximum torque.

⁎Encoder Dividing Rate Setting: Cn-0A (Position, Speed, Torque)

The number of pulses detected (A- and B-pulses) per encoder revolution is converted to the number of pulses set for this parameter and output from the Servo Driver. The setting range is 16 to 8,192 pulses/revolution, and the factory setting is for 1,000 (pulses/revolution).

The upper limit of the setting range is 4,096 for incremental encoders and 8,192 for absolute encoders.

⁎Rotation Speed for Servomotor Rotation Detection: Cn-0b (Position, Speed, Torque)

This sets the rotation speed for detecting whether or not the Servomotor is rotating. The setting range is 1 to 4,500 r/min. When motor rotation detection has been set for the output signal switch (Cn-2d = 1), the Servomotor rotation detection output (TGON) is turned ON if the Servomotor rotational speed meets or exceeds this set value. The factory setting is for 20 (r/min).

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⁎P Control Switching (Torque Command): Cn-0C (Position, Speed)
P Control Switching (Speed Command): Cn-0d (Position, Speed)
P Control Switching (Acceleration Command): Cn-0E (Position, Speed)
P Control Switching (Error Pulse): Cn-0F (Position)

These set the various points for switching the speed controller from PI control to P control in order to moderate excessive characteristics when an operation such as acceleration or deceleration is executed accompanied by output saturation of the controller. These parameters are enabled by setting the P control switching selection (Cn-01 bit b) to 1. The selections are made by setting the setup parameter Cn-01 bit nos. d and C.

P Control Switching (Torque Command) is set between 0% and 350% as a percentage of the rated torque. The factory setting is 200%.

P Control Switching (Speed Command) is set between 0 and 4,500 r/min. The factory setting is 0.

P Control Switching (Acceleration Command) is set between 0 and 3,000 in units of 10 (r/min)/s. The factory setting is 0.

P Control Switching (error pulse) is set between 0 and 10,000 in command units. The factory setting is 10.

⁎Jog Speed: Cn-10 (Position, Speed, Torque)

This sets the speed for manual operation. The setting range is 0 to 4,500 r/min. During manual operation, operating commands are given from the Parameter Unit. The factory setting is for 500 (r/min).

⁎Number of Encoder Pulses: Cn-11 (Position, Speed, Torque)

This sets the number of pulses per revolution of a connected encoder. The setting is either 4,096 for an incremental encoder or 8,192 for an absolute encoder. The Servomotor might not operate correctly if any other values are used. The factory setting is for 4,096 (pulses/revolution).

⁎Brake Timing 1: Cn-12 (Position, Speed, Torque)
Brake Command Speed: Cn-15 (Position, Speed, Torque)
Brake Timing 2: Cn-16 (Position, Speed, Torque)

These parameters set the output timing for the brake interlock signal (BKIR), which turns the electromagnetic brake ON and OFF. The settings are enabled when the brake interlock is set in the output signal selection (Cn-2d = 4).

Brake timing 1 is a parameter for Servomotors with brakes, and it sets the delay time from the time of brake interlock output (BKIR) until the servo turns off. The setting range is 0 to 50 (× 10 ms), and the factory setting is for 0 (× 10 ms).

When setting the brake timing, the time when the servo turns off until the brake interlock is set to off is set as the holding time.

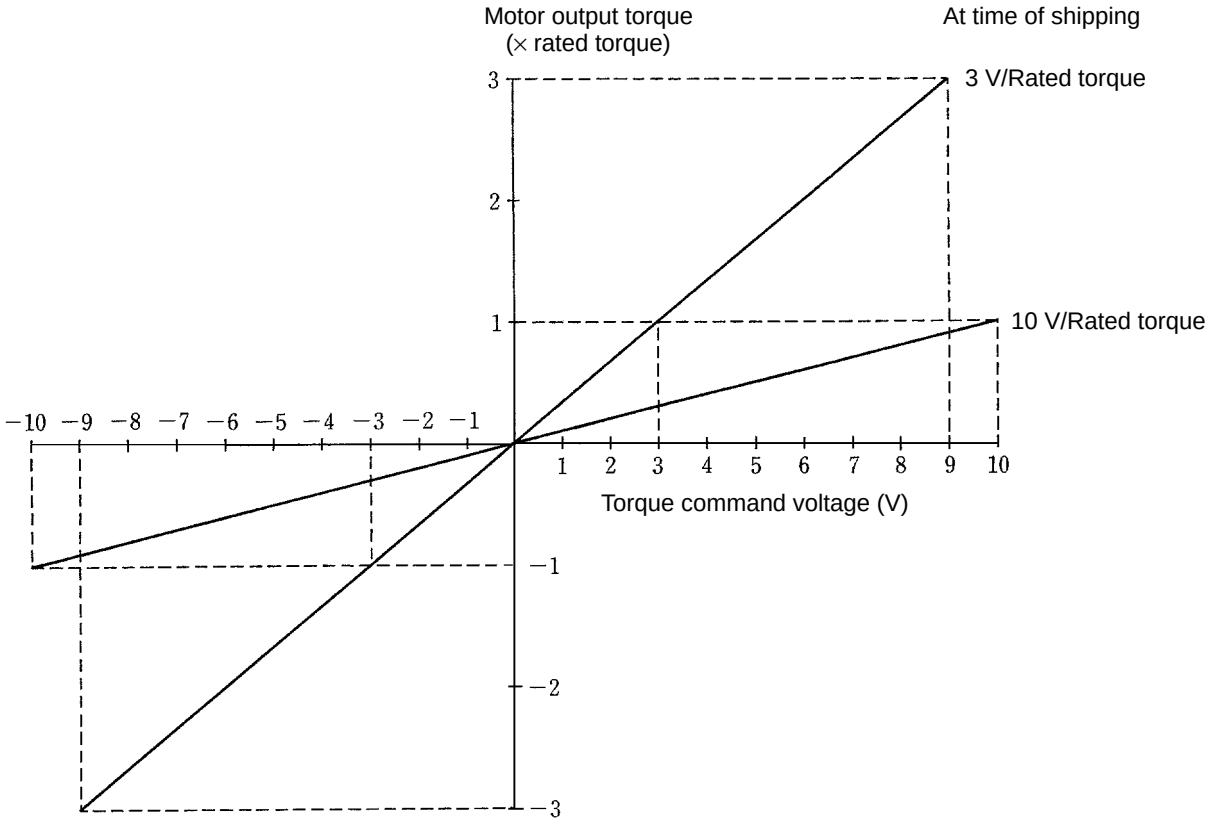
If the run command turns off, a servo error occurs, or the main-circuit power supply turns off during operation of a Servomotor with a brake, the dynamic brake comes on (setup parameter Cn-01 bit no. 6 = 0) and Servomotor rotation speed is decreased. When the speed drops to the level of the value set for the brake command speed (Cn-15), the brake interlock output (BKIR) turns OFF.

Even if the speed does not drop to the level of the value set for the brake command speed (Cn-15), the brake interlock output (BKIR) turns OFF after the time set for brake timing 2 has elapsed. (This time setting is made for the purpose of preventing damage to machinery or the Servomotor holding brake.) The setting range is 10 to 100 (× 10 ms), and the factory setting is for 50 (× 10 ms).

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⁎Torque Command Scale: Cn-13 (Speed, Torque)

This sets the input voltage per rated torque for the torque command scale (TREF: CN1-1). The setting range is 10 to 100 (× 0.1 V/rated torque), and the factory setting is 30 (× 0.1 V/rated torque, for a setting of 3 V/rated torque).



⁎Speed Limit: Cn-14 (Torque)

This limits the Servomotor rotation speed for the torque control mode and is valid in torque control mode only. The setting range is 0 to 4,500 (r/min), and the factory setting is for 3,000 (r/min).

⁎Torque Command Filter Time Constant: Cn-17 (Position, Speed, Torque)

This sets the low-pass filter time constant for the torque command. The setting range is 0 to 250 (× 100 μs), and the factory setting is 4 (× 100 μs).

The relationship between the filter time constant and the cut-off frequency can be found by means of the following formula:

fc (Hz) = 1 / ($2\Pi T$) : T= Filter time constant

If T= 400 (μs), fc will be approximately 400 (Hz).

When the characteristic vibration of the machinery is within the response frequency of the servo loop, Servomotor vibration will occur. In order to prevent this sympathetic vibration based on the characteristic vibration of the machinery, set the torque filter time constant to a value that will eliminate the vibration (i.e., set it to a high value).

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⁎Forward Rotation External Current Limit: Cn-18 (Position, Speed, Torque)
Reverse Rotation External Current Limit: Cn-19 (Position, Speed, Torque)

These set the Servomotor output torque limits for the forward and reverse directions. The are valid when when the forward/reverse current limits (PCL/NCL) are input. This function can't be used when the control mode is "internal speed control settings." The setting range is 0% to 350% of the maximum torque, and the factory setting is for the 100 (%).

⁎Position Loop Gain: Cn-1A (Position, Speed)

It is valid for position control and position lock status. The setting range is 1 to 1,000 (1/s), and the factory setting is 40 (1/s). Set to between 50 and 70 for general NC machine tools, to between 30 and 50 for general-purpose machine assembly machines, and to between 10 and 30 for industrial robots. If the position loop gain is set too high for systems with low machine hardness or for systems with low inherit vibrations, machine resonance can result, causing an overload alarm.

⁎Positioning Completion Range: Cn-1b (Position)

This sets the error counter value for outputting the positioning completion signal (INP). The positioning completion output will be ON when the error counter is at or below this value.

The setting range is 0 to 250 in command units and the factory setting is 3.

⁎Bias Rotational Speed: Cn-1C (Position)

This is the position control bias setting. It can be used according to the load conditions to reduce the positioning time.

The setting range is 0 to 450 in r/min and the factory setting is 0.

⁎Feed-forward Amount: Cn-1d (Position)

This is the compensation value for position control feed-forward. Positioning time is reduced by adding the differential of the command pulse to the speed command.

The setting range is 0% to 100% and the factory setting is 0%.

⁎Deviation Counter Over Level: Cn-1E (Position)

This is the setting for detection level for deviation counter overrun. A servo alarm will be generated if the error counter exceeds this value.

The setting range is 1 to 32,767 in x256 command units and the factory setting is 1,024.

⁎No. 1 Internal Speed Setting: Cn-1F (Factory Setting: 100 r/min) (Speed)
No. 2 Internal Speed Setting: Cn-20 (Factory Setting: 200 r/min) (Speed)
No. 3 Internal Speed Setting: Cn-21 (Factory Setting: 200 r/min) (Speed)

Make these settings to control speeds by means of internal settings. The setting range is 0 to 4,500 (r/min). For details, refer to *3-3-4 Setting Internal Speed Control*.

⁎Speed Conformity Signal Output Range: Cn-22 (Speed)

When the absolute value of the difference between the speed command and the Servomotor rotation speed (the speed deviation) is equal to or less than the set value, the speed conformity output (VCMP) turns ON. This parameter is valid in the speed control mode when the speed conformity output is set for the output signal selection. (Cn-2d = 0)

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If the speed command is for 2,000 (r/min) and the speed conformity signal output range is 100 (r/min), then the speed conformity output (VCMP) turns ON when the Servomotor rotation speed is between 1,900 (r/min) and 2,100 (r/min). The setting range is 0 to 100 (r/min), and the factory setting is for 10 (r/min).

⁎Electronic Gear Ratio G1 (Numerator): Cn-24 (Position)
Electronic Gear Ratio G2 (Denominator): Cn-25 (Position)

The motor will rotate via the pulse obtained by multiplying the command pulses by the electronic gear ratio G1/G2. The setting ranges for G1 and G2 are 1 to 65,535, but (1/100) (G1/G2) 100. The factory setting is 4/1, meaning that the motor will rotate once for each 4,096 pulses.

⁎Position Command Acceleration/Deceleration Constant: Cn-26 (Position)

This parameter can be used to perform smoothing processing on the command pulses to rotate the motor. This can be effective in the following cases.

- There is no acceleration or deceleration in the command pulses.
- The frequency of the command pulses varies rapidly.
- The electronic gear ratio is large (G1/G2／ 10)

The setting range is 0 to 640 in 0.1 ms units and the factory setting is 0.

⁎Feed-forward Command Filter: Cn-27 (Position)

This setting is for a low pass filter to prevent feed-forward amounts from being rapidly added. Overshooting can be prevented by using this setting when the command pulse frequency varies rapidly.

The setting range is 0 to 640 in 0.1 ms units and the factory setting is 0.

⁎Compensating Gain: Cn-28 (Position, Speed)

When outputting a large torque (during acceleration, deceleration, etc.), the speed loop gain is decreased based on this setting. Motor vibration can be reduced by increasing this setting; also, the positioning time can be reduced because the speed loop gain can be set to a higher value.

If this setting is too high, follow-up delays can occur during acceleration and deceleration. The setting range is 0 to 100, and the factory setting is 0.

⁎Rotation Speed for Position Lock: Cn-29 (Speed)

This sets the rotation speed for position locks, and is enabled when the control mode selection (Cn-2b) is set to 10 (position lock speed control). If the motor reaches or falls below the set speed when the position lock command input (PLOCK) is ON, the system will be changed from speed control to position control and the motor will servo-lock. The position lock force is adjusted via the position loop gain (Cn-1A).

The setting range is 0 to 4,500 r/min and the factory setting is 10.

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⁎Motor Selection: Cn-2A (Position, Speed, Torque)

This sets the applicable motor. The setting is determined for the output capacity of each servomotor. Confirm that the setting is appropriate for the servomotor being used. If the wrong value is used, operation will be unstable and the motor may be damaged. The setting range is between 0 and 255, and the factory setting is for an appropriate motor for each driver.

Driver model	Applicable motor model	Set value
R88D-UT24H	R88M-U1K030H-° /T-°	163
R88D-UT40H	R88M-U1K530H-° /T-°	164
R88D-UT60H	R88M-U2K030H-° /T-°	165
R88D-UT80H	R88M-U3K030H-° /T-°	166
R88D-UT110H	R88M-U4K030H-° /T-°	167
R88D-UT120H	R88M-U5K030H-° /T-°	168

Driver model	Applicable motor model	Set value
R88D-UT24V-°	R88M-U1K030V-° S1/X-° S1	163
R88D-UT40V-°	R88M-U1K530V-° S1/X-° S1	164
R88D-UT60V-°	R88M-U2K030V-° S1/X-° S1	165
R88D-UT80V-°	R88M-U3K030V-° S1/X-° S1	166
R88D-UT110V	R88M-U4K030V-° S1/X-° S1	167
	R88M-U5K030V-° S1/X-° S1	168

Note The default setting of the R88D-UT110V is 4 kW (motor selection: “167”). When using a 5-kW motor, change the motor selection setting to “168.”

⁎Control Mode Selection: Cn-2b (Position, Speed, Torque)

This sets the control mode to speed control, position control, torque control, etc. The motor may operate unexpectedly if the wrong mode is set. Be sure to check the setting.

The setting range is between 0 to 11, and the factory setting is 1 (Position control (Pulse train commands))

Control mode			Set value
Speed control (Analog commands)			0
Position control (Pulse train commands) [Factory setting]			1
Torque control (Analog commands)			2
Internally-set speed control			3
Internally-set speed control	←→	Speed control (Analog commands)	4
Internally-set speed control	←→	Position control (Pulse train commands)	5
Internally-set speed control	←→	Torque control (Analog commands)	6
Position control (Pulse train commands)	←→	Speed control (Analog commands)	7
Position control (Pulse train commands)	←→	Torque control (Analog commands)	8
Speed control (Analog commands)	←→	Torque control (Analog commands)	9
Speed control (Analog commands)	←→	Position lock prohibit	10
Position control (Pulse train commands)	←→	Pulse prohibit	11

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⁎Encoder Power Supply Voltage: Cn-2C (Position, Speed, Torque)

This sets the encoder power supply voltage. The Cn-2C (encoder power supply voltage) setting depends on the encoder cable length. The encoder may be damaged if the setting is wrong. Refer to the following table when making the setting.

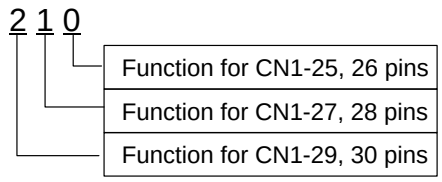
Encoder	3 m	5 m	10 m	15 m	20 m
[Incremental]	52,500			54,000	55,500
[Absolute]	52,500			55,000	57,000

The setting range is from 52,000 to 58,000 in mV units, and the factory setting is 52,500.

⁎Output Signal Selection: Cn-2d (Position, Speed, Torque)

This selects control output functions for CN1 pins 25 to 30. Each digit in the setting corresponds to one output terminal pair. A setting of 0 is allowed only for the first digit (CN1 pins 25 and 26).

Example Setting



Output signal function	Set value
In position (INP) / speed conformity (VCMP)	0
Motor rotation detection (TGON)	1
Servo ready (READY)	2
Current limit detection (CLIMT)	3
Brake interlock (BKIR)	4
Overload warning ($\overline{\text{OLWRN}}$)	5
Overload alarm ($\overline{\text{OLALM}}$)	6

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5-2 Servomotor Specifications

5-2-1 General Specifications

Item	Specifications
Operating ambient temperature	0°C to 40°C
Operating ambient humidity	20% to 80% RH (with no condensation)
Storage ambient temperature	–20°C to 60°C
Storage ambient humidity	20% to 80% RH (with no condensation)
Storage and operating atmosphere	No corrosive gasses.
Vibration resistance	10 to 150 Hz in X, Y, and Z directions with 0.2-mm double amplitude; acceleration: 24.5 m/s^2 {2.5 G} max.; time coefficient: 8 min; 4 sweeps (see note 1)
Impact resistance	Acceleration 98 m/s^2 {10 G} max., in X, Y, and Z directions, three times
Insulation resistance	Between power line terminals and case: 10 MΩ min. (500 VDC megger)
Dielectric strength	Between power line terminals and case: 1,500 VAC for 1 min (10 mA max.) at 50/60 Hz (JEC 2121)
Run position	All directions
Insulation grade	Type F (JIS C4004)
Structure	Totally-enclosed self-cooling
Protective structure	Models not conforming to standards: IP-65 (IEC 34-5) (Excluding through-shaft portion. The connector used on the standard cable is IP-30). (see note 2) Models conforming to EC Directives: IP-55 (IEC 34-5) (Including through-shaft portion. The connector used on the standard cable is IP-30). Cannot be used in environment with water-soluble cutting fluids. (see note 2)
Vibration grade	V-15 (JEC2121)
Mounting method	Flange-mounting

Note 1. Vibration may be amplified due to sympathetic resonance of machinery, so use the Servomotor Driver under conditions which will not exceed 19.6 m/s^2 {2 G} over a long period of time.

Note 2. Water-proof connectors must be used on the power and encoder cables when used in environments subject to direct contact with water. Refer to *2-1-2 Installation Conditions* for the recommended connectors.

Note 3. The Servomotors cannot be used in misty environments.

Note 4. The above items reflect individual evaluation testing. The results may differ under compounded conditions.

5-2-2 Performance Specifications

Item	Unit	R88M -U1K030°	R88M -U1K530°	R88M -U2K030°	R88M -U3K030°	R88M -U4K030°	R88M -U5K030°
Rated output*	W	1,000	1,500	2,000	3,000	4,000	5,000
Rated torque*	kgf■cm	32.4	48.7	65.0	97.4	129	161
	N■m	3.18	4.77	6.36	9.55	12.6	15.8

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Item	Unit	R88M -U1K030°	R88M -U1K530°	R88M -U2K030°	R88M -U3K030°	R88M -U4K030°	R88M -U5K030°
Rated rotation speed	r/min	3,000	3,000	3,000	3,000	3,000	3,000
Momentary maximum rotation speed	r/min	4,500	4,500	4,500	4,500	4,500	4,500
Momentary maximum torque*	kgf■cm	97.2	146	195	279	375	453
	N■m	9.54	14.3	19.1	27.4	36.8	44.4
Momentary maximum/ rated current ratio	%	279	283	350	289	304	320
Rated current*	A (rms)	6.1	9.9	12.0	19.4	25.3	26.2
Momentary maximum current*	A (rms)	17	28	42	56	77	84
Rotor inertia	kgf■cm■s^2	1.78×10^{-3}	2.52×10^{-3}	3.26×10^{-3}	7.14×10^{-3}	9.80×10^{-3}	12.6×10^{-3}
	kg■m^2 (GD^2/4)	1.74×10^{-4}	2.47×10^{-4}	3.19×10^{-4}	7.00×10^{-4}	9.60×10^{-4}	12.3×10^{-4}
Torque constant*	kgf■cm/A	6.1	5.5	5.3	5.5	5.2	5.8
	N■m/A	0.59	0.54	0.52	0.54	0.51	0.57
Induced voltage constant*	mV/ (r/min)	22.2	20.0	19.5	20.0	19.3	21.2
Power rate*	kW/s	57.9	92.2	103	137	156	171
Mechanical time constant	ms	0.9	0.7	0.6	0.6	0.6	0.6
Winding resistance	Ω	0.67	0.31	0.19	0.10	0.063	0.057
Winding impedance	mH	4.75	2.40	1.57	1.31	0.89	0.84
Electrical time constant	ms	7.1	7.7	8.3	14.0	14.1	14.7
Weight [incremental]	kg	Approx. 4.6	Approx. 5.8	Approx. 7.0	Approx. 11	Approx. 14	Approx. 17
Weight [absolute]	kg	Approx. 5.0	Approx. 6.2	Approx. 7.4	Approx. 11.5	Approx. 14.5	Approx. 17.5
Corresponding Servo Driver (R88D-)		UT24H UT24V-°	UT40H UT40V-°	UT60H UT60V-°	UT80H UT80H-°	UT110H UT110V	UT120H UT110V

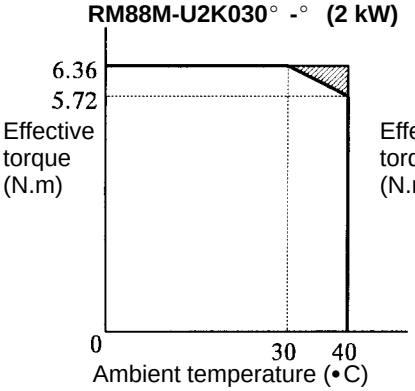
Note 1. *The values for items marked by asterisks are the values at an armature winding temperature of 100°C, combined with the Servo Driver. Other values are at normal conditions (20°C, 65%). The momentary maximum torque shown above indicates a standard value.

Note 2. When an AC Servomotor is continuously operated at the rated conditions, a heat radiation plate equivalent to an rectangular aluminum plate of t20 × 400 mm is required at the Servomotor flange mounting area. (This is for horizontal mounting, with nothing around the Servomotor and no interference from heat convection currents.)

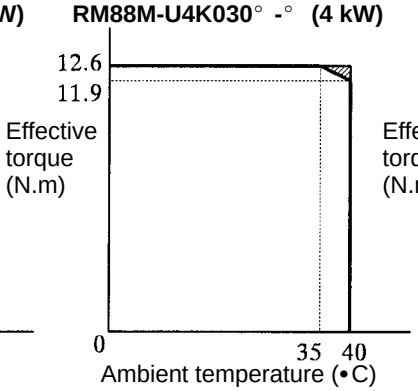
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Caution Do not use 2-kW, 4-kW, or 5-kW servomotors within the shaded portions of the following diagrams. If the servomotor is used in these regions, the motor may heat, causing the encoder to malfunction.

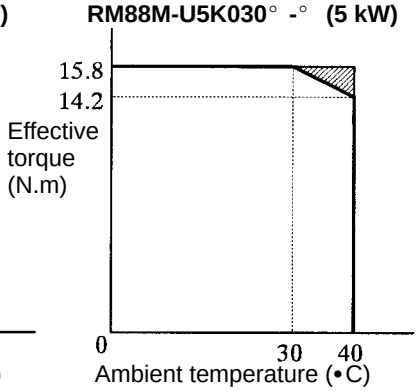
RM88M-U2K030° -° (2 kW)



RM88M-U4K030° -° (4 kW)



RM88M-U5K030° -° (5 kW)



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● Specifications for Servomotors with Magnetic Brakes

The magnetic brakes installed in Servomotors with brakes are status-holding brakes with non-magnetized operation. The magnetic brake is released when a magnetic current (24 VDC) is applied. The magnetic brake is not meant to be used for braking. Using it for braking will damage it. During Servomotor operation, be sure to release the magnetic brake by applying a magnetic voltage. The specifications for Servomotors with brakes are similar to those for Servomotors without brakes, so except for inertia and weight, the various constants are all the same.
Note: The inertia for magnetic brakes is the load inertia.

⁎Specifications for AC Servomotors With Brakes

Item	Unit	R88M -U1K030° -B	R88M -U1K530° -B	R88M -U2K030° -B	R88M -U3K030° -B	R88M -U4K030° -B	R88M -U5K030° -B
Rotor inertia	kgf■cm■s^2	1.78×10^{-3}	2.52×10^{-3}	3.26×10^{-3}	7.14×10^{-3}	9.80×10^{-3}	12.6×10^{-3}
	kg■m^2 (GD^2/4)	1.74×10^{-4}	2.47×10^{-4}	3.19×10^{-4}	7.00×10^{-4}	9.60×10^{-4}	12.3×10^{-4}
Brake inertia	kgf■cm■s^2	0.22×10^{-3}			2.1×10^{-3}		
	kg■m^2 (GD^2/4)	0.22×10^{-4}			2.1×10^{-4}		
Total inertia	kgf■cm■s^2	2.00×10^{-3}	2.74×10^{-3}	3.48×10^{-3}	9.24×10^{-3}	11.9×10^{-3}	14.7×10^{-3}
	kg■m^2 (GD^2/4)	1.96×10^{-4}	2.69×10^{-4}	3.41×10^{-4}	9.10×10^{-4}	11.7×10^{-4}	14.4×10^{-4}
Weight [incremental]	kg	Approx. 6.0	Approx. 7.5	Approx. 8.5	Approx. 14	Approx. 17	Approx. 20
Weight [absolute]	kg	Approx. 6.5	Approx. 8.0	Approx. 9.0	Approx. 14.5	Approx. 17.5	Approx. 20.5
Excitation voltage	V	24 VDC ±10% (No polarity)					
Power consumption	W (at 20°C)	7			9.8		
Current consumption	A (at 20°C)	0.29			0.41		
Static friction torque	kgf■cm	80 min.			200 min.		
	N■m	7.8 min.			20 min.		
Absorption time (see note 1)	ms	(180 max.)			(180 max.)		
Release time (see note 1)	ms	(100 max.)			(100 max.)		
Backlash	---	(±0.5°)					
Rating	---	Continuous					
Insulation grade	---	Type F (brake only)					

Note 1. The operation time measurement is the measured value with a surge killer (CR50500, by Okaya Electric Industrial Co.) installed.

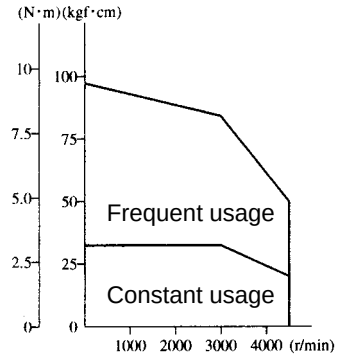
Note 2. The items in parentheses are reference values.

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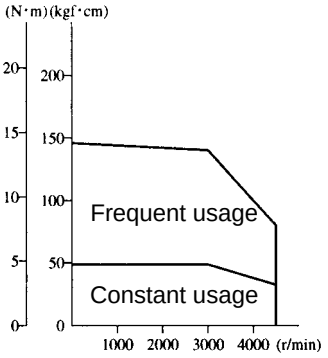
5-2-3 Torque and Rotation Speed Characteristics

The following graphs show characteristics for various combinations of drivers with an armature winding temperature of 100•C (with 3-m standard cable and 200-VAC input).

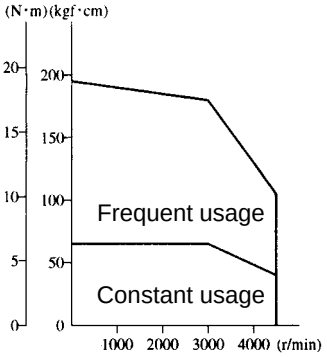
R88M-U1K030H-° /-U1K030T-°
R88M-U1K030V-° S1/-U1K030X-° S1



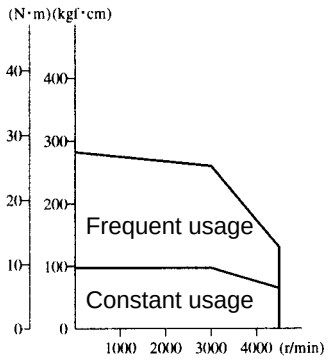
R88M-U1K530H-° /-U1K530T-°
R88M-U1K530V-° S1/-U1K530X-° S1



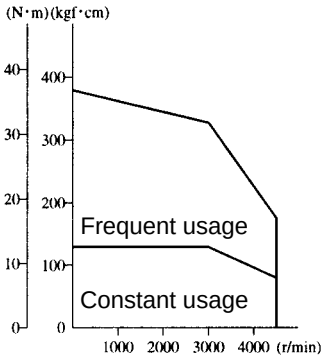
R88M-U2K030H-° /-U2K030T-°
R88M-U2K030V-° S1/-U2K030X-° S1



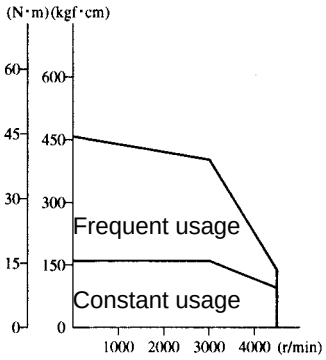
R88M-U3K030H-° /-U3K030T-°
R88M-U3K030V-° S1/-U3K030X-° S1



R88M-U4K030H-° /-U4K030T-°
R88M-U4K030V-° S1/-U4K030X-° S1



R88M-U5K030H-° /-U5K030T-°
R88M-U5K030V-° S1/-U5K030X-° S1



• Servomotor and Mechanical System Temperature Characteristics

- U-series AC Servomotors use rare earth magnets (neodymium–iron magnets). The temperature coefficient for these magnets is approximately -0.13%/°C. As the temperature drops, the Servomotor's momentary maximum torque increases, and as the temperature rises the Servomotor's momentary maximum torque decreases. When the normal temperature of 20°C and –10°C are compared, the momentary maximum torque increases by approximately 4%. Conversely, when the magnet warms up to 80°C from the normal temperature of 20°C, the momentary maximum torque decreases by approximately 8%.
- Generally, in a mechanical system, when the temperature drops the friction torque increases and the load torque becomes larger. For that reason, overloading may occur at low temperatures. In particular, in systems which use deceleration devices, the load torque at low temperatures may be nearly twice the load torque at normal temperatures. Check with a current monitor to see whether overloading is occurring at low temperatures, and how much the load torque is. Likewise, check to see whether there abnormal Servomotor overheating or alarms are occurring at high temperatures.
- An increase in load friction torque visibly increases load inertia. Therefore, even if the Servo Driver parameters are adjusted at a normal temperature, there may not be optimal operation at low temperatures. Check to see whether there is optimal operation at low temperatures too.

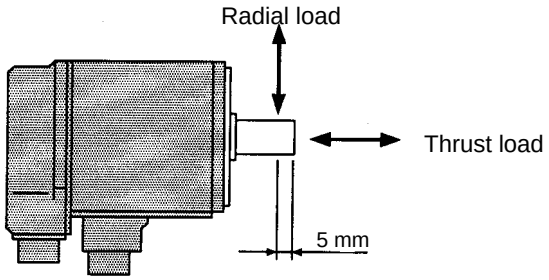
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5-2-4 Allowable Loads on Servomotor Shafts

The allowable loads on Servomotor shafts are shown in the following table. Operate the Servomotor at no more than the allowable radial and thrust loads. At the time of assembly, assemble the Servomotor at no more than the momentary maximum radial and thrust loads (static pressure).

Servomotor	Momentary allowable radial load (static pressure)		Momentary allowable thrust load (static pressure)		Allowable radial load		Allowable thrust load	
	kgf	N	kgf	N	kgf	N	kgf	N
R88M-U1K030° -°	160	1,570	60	590	70	680	20	190
R88M-U1K530° -°	160	1,570	60	590	70	680	20	190
R88M-U2K030° -°	160	1,570	60	590	70	680	20	190
R88M-U3K030° -°	160	1,570	120	1,170	100	980	40	390
R88M-U4K030° -°	160	1,570	120	1,170	120	1,170	40	390
R88M-U5K030° -°	160	1,570	120	1,170	120	1,170	40	390

Note 1. The allowable radial load is the value at a point 5 mm from the end of the shaft.



Note 2. The allowable radial and thrust loads are values determined with a service life of 20,000 hours taken as a criteria.

Note 3. Absolutely do not impact the Servomotor or the output shaft by striking them with an implement such as a hammer. Doing so will damage the Servomotor and encoder bearings.

Note 4. The service life of bearing grease is 20,000 hours at a Servomotor ambient temperature of 40°C, and under the rated operating conditions.

Note 5. Make sure that the radial load is within the allowable range when there is a radial load applied. If the Servomotor is operated at more than the allowable radial load, the shaft may suffer damage due to fatigue.

Note 6. Applying an excessive load even once can damage the bearings and eventually cause a breakdown.

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5-2-5 Encoder Specifications

Item	Standards	
Encoder method	Optical encoder	
	Incremental encoder	Absolute encoder
Number of output pulses	A, B phase: 4,096 pulses/revolution Z phase: 1 pulse/revolution	A, B phase: 8,192 pulses/revolution Z phase: 1 pulse/revolution
Maximum rotational speed	——	±99,999 rotations
Power supply voltage	5 VDC±5%	
Power supply current	DC, 350 mA (for load resistance of 220 Ω)	DC, 400 mA (for load resistance of 220 Ω)
Applicable battery voltage	——	3.6 VDC
Battery current consumption	——	10 µA (3.0 V; when stopped)
Phase characteristics	90° ±36°	
Phase relationship	For rotation in the CW direction, A phase is advanced by 90° compared to B phase.	
Maximum rotation speed	4,500 r/min	
Maximum response frequency	307.2 kHz	614.4 kHz
Output signals	+A, –A, +B, –B, +S, –S	+A, –A, +B, –B, +Z, –Z
Output impedance	Conforming to EIA RS-422A. Output based on MC3487 or equivalent.	Conforming to EIA RS-422A. Output based on SN75158 or equivalent.
Serial communications data	Z phase, poll sensor, U, V, W phase	——
Serial communications method	Combination communications method based on A, B, and S phases.	——
Absolute value communications data	——	Rotation amount data Absolute position data within one rotation (output only when power is supplied)

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5-3 Cable Specifications

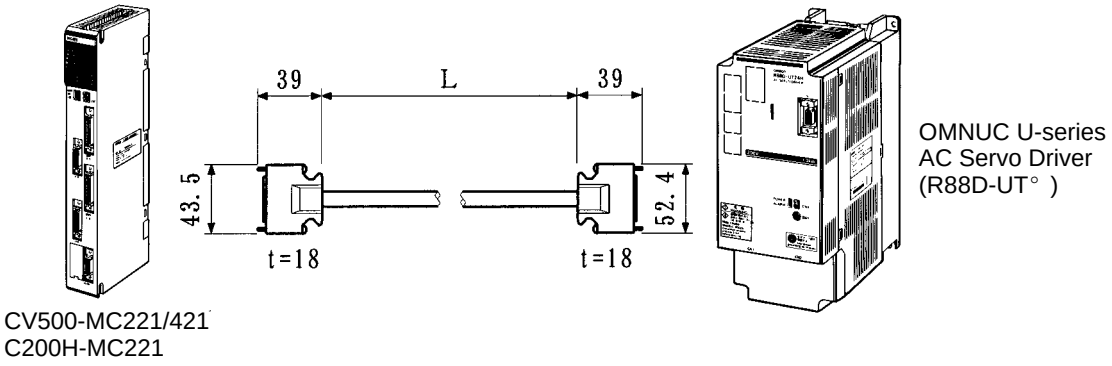
5-3-1 Controller Connecting Cable

● Connecting Cables for CV500-MC221/421/C200H-MC221

⁎Types of Cable

Number of axes	Model	Length (L)	Outer diameter of sheath
1	R88A-CPUB001M1	1 m	8.3 dia.
	R88A-CPUB002M1	2 m	
2	R88A-CPUB001M2	1 m	8.3 dia.
	R88A-CPUB002M2	2 m	

⁎Connection Configuration (For 1 Axis)

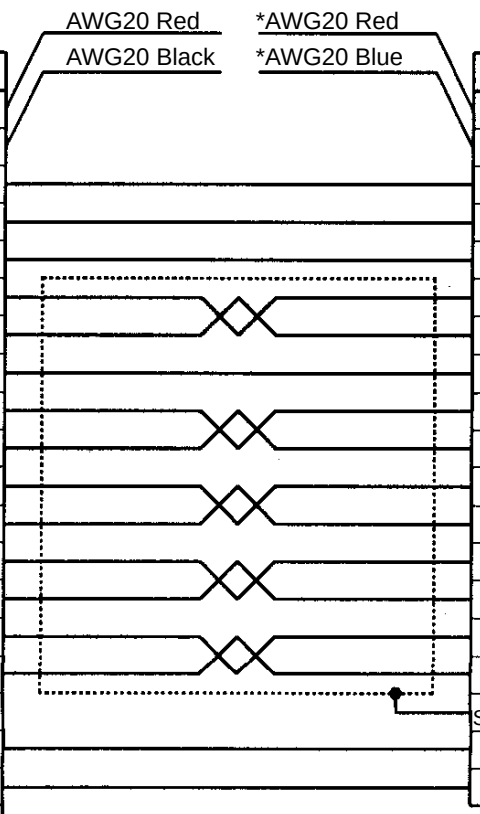


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⁎Wiring (For 1 Axis)

CV500-MC221/MC421
C200H-MC221

Signal	Insulation color/Marking color/Marking	No.
+24V		1
DCGND		2
XALM	White/Black –	3
XRUN	Pink/Black –	4
XALMRS	Yellow/Black –	5
XSGND	Gray/Black –	8
XSOUT	Gray/Red –	9
X−GND	Orange/Black – –	10
X−A	White/Red –	11
X−$\overline{A}$	White/Black –	12
X−B	Yellow/Red –	13
X−$\overline{B}$	Yellow/Black –	14
X−Z	Pink/Red –	15
X−$\overline{Z}$	Pink/Black –	16
XOUT	Orange/Red –	17
XAGND	Orange/Black –	18
+F24V	Orange/Black –	19
FDC GND	Gray/Black –	20
YALM		21
YRUN		22
YALMRS		23
YSGND		26
YSOUT		27
Y−GND		28
Y−A		29
Y−$\overline{A}$		30
Y−B		31
Y−$\overline{B}$		32
Y−Z		33
Y−$\overline{Z}$		34
YOUT		35
YAGND		36



OMNUC U-series
AC Servo Driver

No.	Signal	
21	BAT	*
22	BATGND	*
31	ALM	
40	RUN	
44	RESET	
2	SENGND	*
4	SEN	*
1	EGND	
33	+A	
34	−A	
36	+B	
35	−B	
19	+Z	
20	−Z	
5	REF	
6	AGND	
Shell	FG	
47	+24VIN	
32	ALMCOM	

Connector plug:
10150-3000VE (Sumitomo 3M)
Connector case:
10350-52A0-008 (Sumitomo 3M)

Connector plug:
10136-3000VE (Sumitomo 3M)
Connector case:
10336-52A0-008 (Sumitomo 3M)

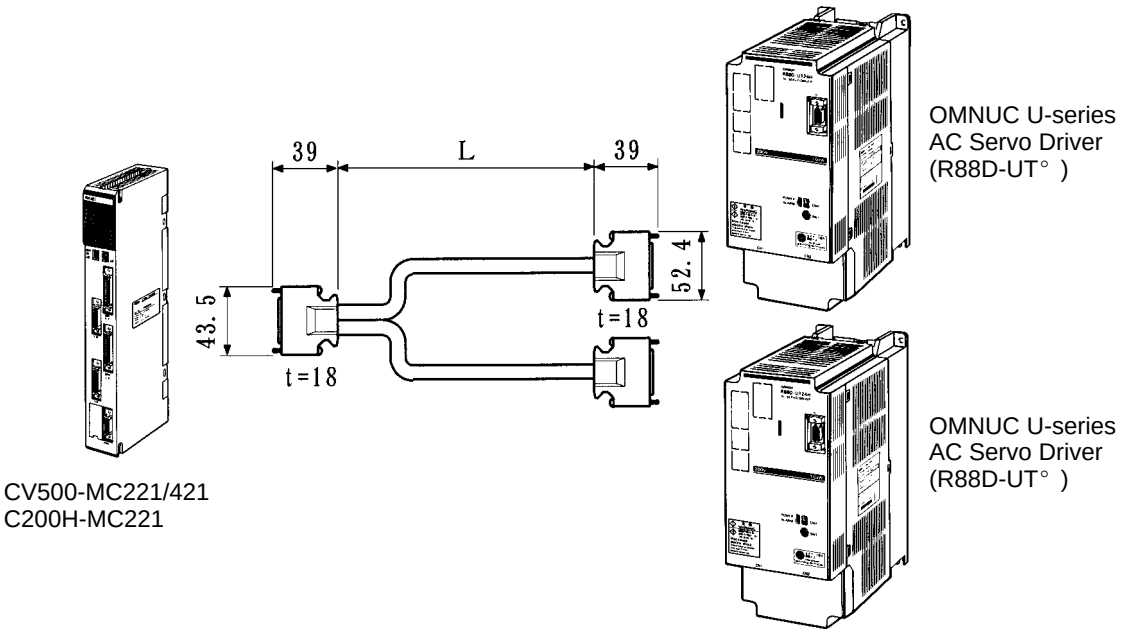
Note 1. The Controller's symbols are the DRVX-Y connector's symbols. In a DRVZ-U connector, X → Z and Y → U.

Note 2. The terminals and wires marked with asterisks are used with Absolute Encoders.

Note 3. Supply 24 VDC to the two wires (black and red) that are taken out from the Controller's connector. (Red is + and black is –.)

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⁎Connection Configuration (For 2 Axes)



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⁎Wiring (For 2 Axes)

CV500-MC221/MC421
C200H-MC221

Signal	Insulation color/Marking color/Marking	No.
+24V		1
DCGND		2
XALM	White/Black –	3
XRUN	Pink/Black –	4
XALMRS	Yellow/Black –	5
XSGND	Gray/Black –	8
XSOUT	Gray/Red –	9
X−GND	Orange/Black – –	10
X−A	White/Red –	11
X−$\overline{A}$	White/Black –	12
X−B	Yellow/Red –	13
X−$\overline{B}$	Yellow/Black –	14
X−Z	Pink/Red –	15
X−$\overline{Z}$	Pink/Black –	16
XOUT	Orange/Red –	17
XAGND	Orange/Black –	18
+F24V	Orange/Black –	19
FDC GND	Gray/Black –	20
YALM	White/Black –	21
YRUN	Pink/Black –	22
YALMRS	Yellow/Black –	23
YSGND	Gray/Black –	26
YSOUT	Gray/Red –	27
Y−GND	Orange/Black – –	28
Y−A	White/Red –	29
Y−$\overline{A}$	White/Black –	30
Y−B	Yellow/Red –	31
Y−$\overline{B}$	Yellow/Black –	32
Y−Z	Pink/Red –	33
Y−$\overline{Z}$	Pink/Black –	34
YOUT	Orange/Red –	35
YAGND	Orange/Black –	36

Connector plug:
10136-3000VE (Sumitomo 3M)

Connector case:
10336-52A0-008 (Sumitomo 3M)

AWG20 Red
AWG20 Black

*AWG20 Red
*AWG20 Blue

OMNUC U-series
AC Servo Driver

No.	Signal	
21	BAT	*
22	BATGND	*
31	$\overline{ALM}$	
40	RUN	
44	RESET	
2	SENGND	*
4	SEN	*
1	EGND	
33	+A	
34	−A	
36	+B	
35	−B	
19	+Z	
20	−Z	
5	REF	
6	AGND	
Shell	FG	
47	+24VIN	
32	ALMCOM	

No.	Signal	
47	+24VIN	
32	ALMCOM	
31	$\overline{ALM}$	
40	RUN	
44	RESET	
2	SENGND	*
4	SEN	*
1	EGND	
33	+A	
34	−A	
36	+B	
35	−B	
19	+Z	
20	−Z	
5	REF	
6	AGND	
Shell	FG	
21	BAT	*
22	BATGND	*

*AWG20 Red
*AWG20 Blue

Connector plug: 10150-3000VE (Sumitomo 3M)
Connector case: 10350-52A0-008 (Sumitomo 3M)

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Note 1. The Controller's symbols are the DRVX-Y connector's symbols. In a DRVZ-U connector, X → Z and Y → U.

Note 2. The terminals and wires marked with asterisks are used with Absolute Encoders.

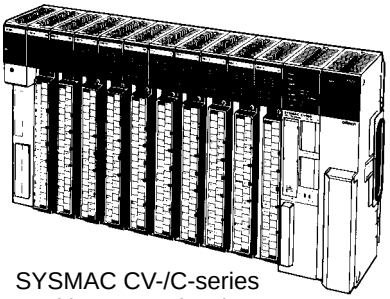
Note 3. Supply 24 VDC to the two wires (black and red) that are taken out from the Controller's connector. (Red is + and black is –.)

● General-purpose Control Cable

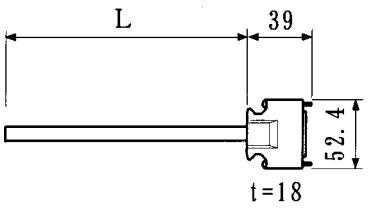
⁎Types of Cable

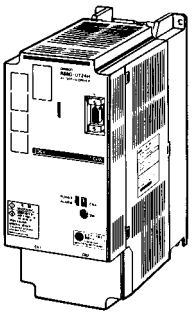
Model	Length (L)	Outer diameter of sheath
R88A-CPUB001S	1 m	9.9 dia.
R88A-CPUB002S	2 m	

⁎Connection Configuration



SYSMAC CV-/C-series
Position Control Unit





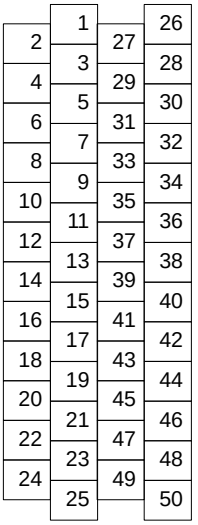
OMNUC U-Series
AC Servomotor Driver
(R88D-UT°)

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⁎Wiring

No.	Insulation color	Dot mark	Dot mark color	Signal name	
				Analog	Pulse
1	Yellow	– – –	Black	EGND	EGND
2				(GND)	(GND)
3					PCOM
4				(SEN)	(SEN)
5	Orange	–	Red	REF	
6	Orange	–	Black	AGND	
7	Light gray	–	Red		+CW
8	Light gray	–	Black		–CW
9	White	–	Red	TREF	
10	White	–	Black	AGND	
11	Yellow	–	Red		+CCW
12	Yellow	–	Black		–CCW
13					PCOM
14	Pink	–	Black		–ECRST
15	Pink	–	Red		+ECRST
16				AM	AM
17				NM	NM
18					PCOM
19	Light gray	– –	Red	+Z	+Z
20	Light gray	– –	Black	–Z	–Z
21				(BAT)	(BAT)
22				(BATGND)	(BATGND)
23				P12	P12
24				N12	N12
25	Orange	– –	Red	+VCMP	+INP
26	Orange	– –	Black	–VCMP	–INP
27	White	– –	Red	+TGON	+TGON
28	White	– –	Black	–TGON	–TGON
29	Yellow	– –	Red	+READY	+READY
30	Yellow	– –	Black	–READY	–READY
31	Pink	– –	Red	$\overline{\text{ALM}}$	$\overline{\text{ALM}}$
32	Pink	– –	Black	ALMCOM	ALMCOM
33	Orange	– – –	Red	+A	+A
34	Orange	– – –	Black	–A	–A
35	Light gray	– – –	Black	–B	–B
36	Light gray	– – –	Red	+B	+B
37	White	– – –	Red	ALO1	ALO1
38	White	– – –	Black	ALO2	ALO2
39	Yellow	– – –	Red	ALO3	ALO3
40	Pink	– – –	Red	RUN	RUN
41	Pink	– – –	Black	MING	MING
42	Orange	– – – –	Red	POT	POT

Connector Pin Arrangement



Connector plug model:
10150-3000VE (Sumitomo 3M)
Connector case model:
10350-52A0-008 (Sumitomo 3M)

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No.	Insulation color	Dot mark	Dot mark color	Signal name	
				Analog	Pulse
43	Orange	– – – –	Black	NOT	NOT
44	Light gray	– – – –	Black	RESET	RESET
45	White	– – – –	Red	PCL	PCL
46	White	– – – –	Black	NCL	NCL
47	Light gray	– – – –	Red	+24VIN	+24VIN
48					
49					
50	Shield			FG	FG

Cable: AWG24X18P

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5-3-2 Encoder Cable

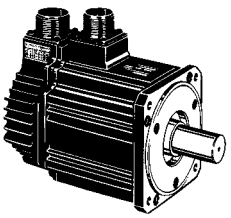
Use the recommended connectors shown in *2-1-2 Installation Conditions* to conform to the EC Directives.

⁎Types of Cable

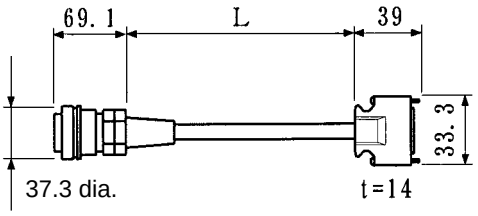
Model	Length (L)	Outer diameter of sheath
R88A-CRUB003N	3 m	10.3 dia.
R88A-CRUB005N	5 m	
R88A-CRUB010N	10 m	
R88A-CRUB015N	15 m	
R88A-CRUB020N	20 m	

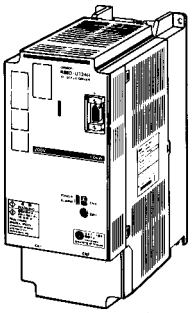
(Up to a maximum of 20 m between the Servomotor and the Servo Driver.)

⁎Connection Configuration



OMNUC U-Series AC Servomotor
(R88M-U°°°　30° -°)

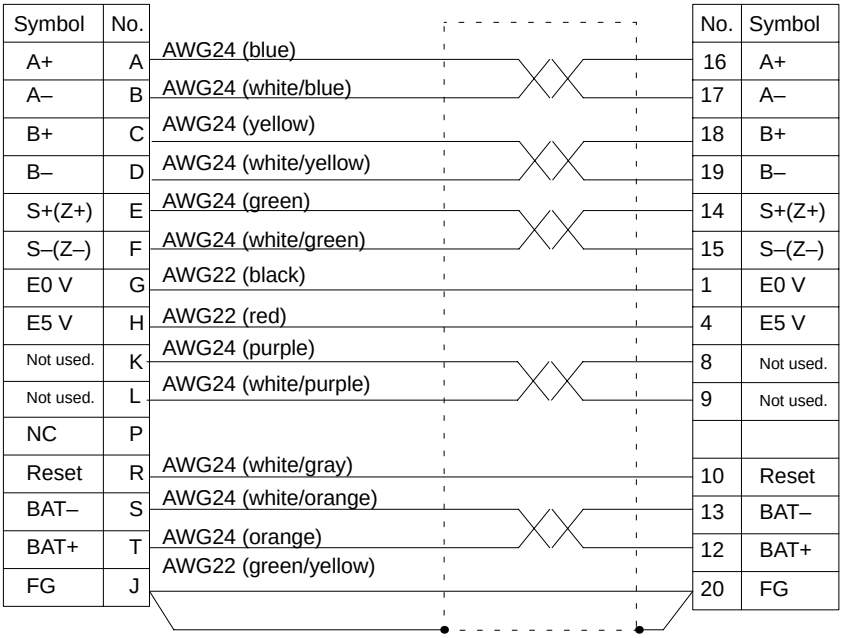




OMNUC U-Series
AC Servomotor Driver
(R88D-UT°)

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⁎Wiring



Cable: AWG22 × 3C + AWG24 × 6P

<For Cable>
Connector plug model: MS3106B20-29S (DDK)
Cable clamp model: MS3057-12A (DDK)
Contact plug model: 10120-3000VE (Sumitomo 3M)
Contact case model: 10320-52A0-008 (Sumitomo 3M)

<For Motor>
Receptacle model: MS3102A20-29P (DDK)

5-3-3 Power Cables

Use the recommended connectors shown in *2-1-2 Installation Conditions* to conform to the EC Directives.

● Power Cables for Servomotors Without Brakes (1.0 to 2.0 kW)

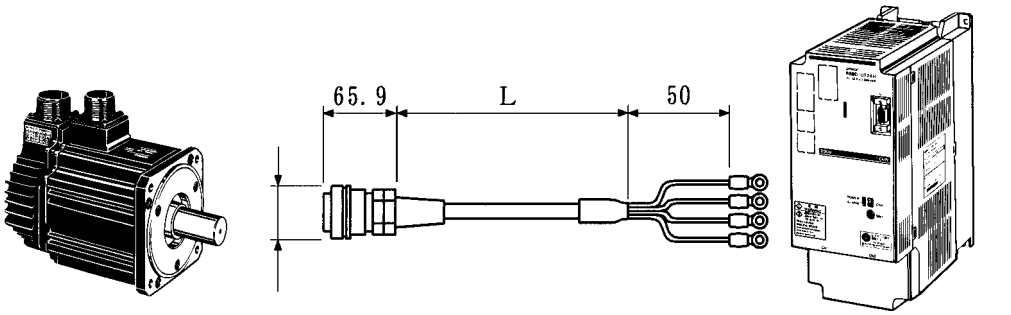
⁎Types of Cable

Model	Length (L)	Outer diameter of sheath
R88A-CAUB003S	3 m	14 dia.
R88A-CAUB005S	5 m	
R88A-CAUB010S	10 m	
R88A-CAUB015S	15 m	
R88A-CAUB020S	20 m	

(Up to a maximum of 20 m between the Servomotor and the Servo Driver.)

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⁎Connection Configuration



OMNUC U-Series AC Servomotor
(R88M-U°°° 30° -°)

OMNUC U-Series
AC Servomotor Driver
(R88D-UT°)

⁎Wiring

Symbol	No.
U-phase	A
V-phase	B
W-phase	C
GR	D

Red
White
Black
Green

Cable: AWG12 × 4C Crimp-style terminal: V5.5–4

<For Cable>
Connector plug model: MS3106B18-10S (DDK)
Cable clamp model: MS3057-10A (DDK)

<For Motor>
Receptacle model: MS3102A18-10P (DDK)

● Power Cables for Servomotors Without Brakes (3.0 to 5.0 kW)

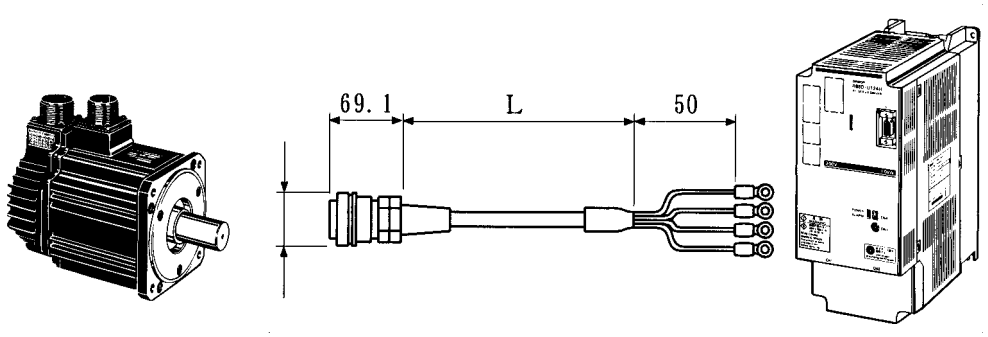
⁎Types of Cable

Model	Length (L)	Outer diameter of sheath
R88A-CAUC003S	3 m	16.5 dia.
R88A-CAUC005S	5 m	
R88A-CAUC010S	10 m	
R88A-CAUC015S	15 m	
R88A-CAUC020S	20 m	

(Up to a maximum of 20 m between the Servomotor and the Servo Driver.)

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⁎Connection Configuration

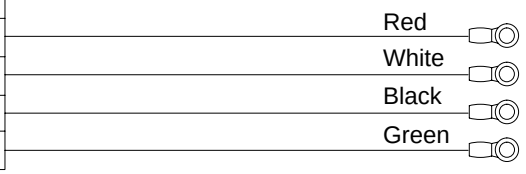


OMNUC U-Series AC Servomotor
(R88M-U°°° 30°-°)

OMNUC U-Series
AC Servomotor Driver
(R88D-UT°)

⁎Wiring

Symbol	No.
U-phase	A
V-phase	B
W-phase	C
GR	D



Cable: AWG10 × 4C Crimp-style terminal: V5.5–4

<For Cable>
Connector plug model: MS3106B22-22S (DDK)
Cable clamp model: MS3057-12A (DDK)

<For Motor>
Receptacle model: MS3102A22-22P (DDK)

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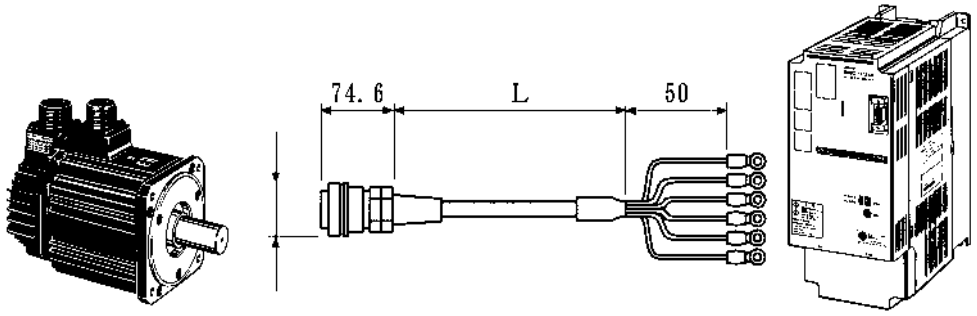
● Power Cable for Servomotors With Brakes (1.0 to 2.0 kW)

⁎Types of Cable

Model	Length (L)	Outer diameter of sheath
R88A-CAUB003B	3 m	16.5 dia.
R88A-CAUB005B	5 m	
R88A-CAUB010B	10 m	
R88A-CAUB015B	15 m	
R88A-CAUB020B	20 m	

(Up to a maximum of 20 m between the Servomotor and the Servo Driver.)

⁎Connection Configuration



OMNUC U-Series AC Servomotor
(R88M-U°°°　30°-B-°)

OMNUC U-Series
AC Servomotor Driver
(R88D-UT°)

⁎Wiring

Symbol	No.
U-phase	A
V-phase	B
W-phase	C
GR	D
Brake	E
Brake	F



Cable: AWG12 × 6C　　Crimp-style terminal: V5.5–4

<For Cable>
Connector plug model: MS3106B20-15S (DDK)
Cable clamp model: MS3057-12A (DDK)

<For Motor>
Receptacle model: MS3102A20-15P (DDK)

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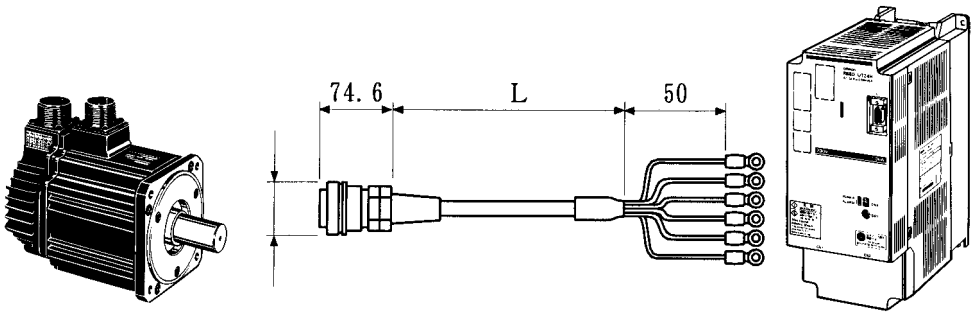
● Power Cable for Servomotors With Brakes (3.0 to 5.0 kW)

⁎Types of Cable

Model	Length (L)	Outer diameter of sheath
R88A-CAUC003B	3 m	20 dia.
R88A-CAUC005B	5 m	
R88A-CAUC010B	10 m	
R88A-CAUC015B	15 m	
R88A-CAUC020B	20 m	

(Up to a maximum of 20 m between the Servomotor and the Servo Driver.)

⁎Connection Configuration



OMNUC U-Series AC Servomotor
(R88M-U°°°　30° -B-°)

OMNUC U-Series
AC Servomotor Driver
(R88D-UT°)

⁎Wiring

Symbol	No.
U-phase	A
V-phase	B
W-phase	C
GR	D
Brake	E
Brake	F

Red
White
Black
Green
Brown
Yellow

Cable: AWG10 × 6C　　Crimp-style terminal: V5.5–4

<For Cable>
Connector plug model: MS3106B24-10S (DDK)
Cable clamp model: MS3057-16A (DDK)

<For Motor>
Receptacle model: MS3102A24-10P (DDK)

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5-4 Parameter Unit Specifications

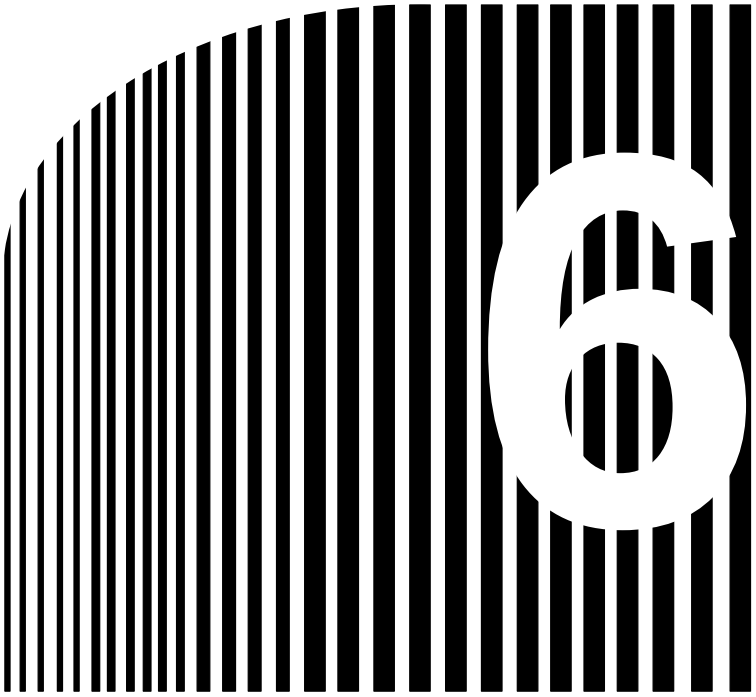
● General Specifications

Item	Standards
Operating ambient temperature	0°C to 55°C
Storage ambient temperature	–10°C to 75°C
Operating ambient humidity	35% to 85% RH (with no condensation)
Storage ambient humidity	35% to 85% RH (with no condensation)
Storage and operating atmosphere	No corrosive gasses.
Vibration resistance	0.5 G {4.9 m/s^2} max.
Impact resistance	Acceleration 2 G {19.6 m/s^2} max.

● Performance Specifications

Model		R88A-PR02U		R88A-PR03U
Type		Handy type		Mounted type
Accessory cable		1,000 mm		(Connected by connectors.)
Connectors		7910-7500SC (10 pins)		D-sub connector (9 pins)
Display		7-segment LED, 5 digits		
External dimensions		63 × 135 × 18.5 (W × H × D)		54 × 57.5 × 15 (W × H × D)
Communications specifications	Standard	RS-232C		RS-422A
	Communications method	Asynchronous (ASYNC)		
	Baud rate	2,400 bps		
	Start bits	1 bit		
	Data	8 bits		
	Parity	None		
	Stop bits	1 bit		
Errors detected by Parameter Unit		Display	CPF00	Cannot transmit even after 5 seconds have elapses since power supply was turned on.
			CPF01	A BCC error or faulty reception data has occurred for five consecutive times, or a time overrun (1 s) has occurred for three consecutive times.

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Chapter 6

• Appendix •

6-1 Connection Examples

6-2 Encoder Divider Rate for Servo Controllers

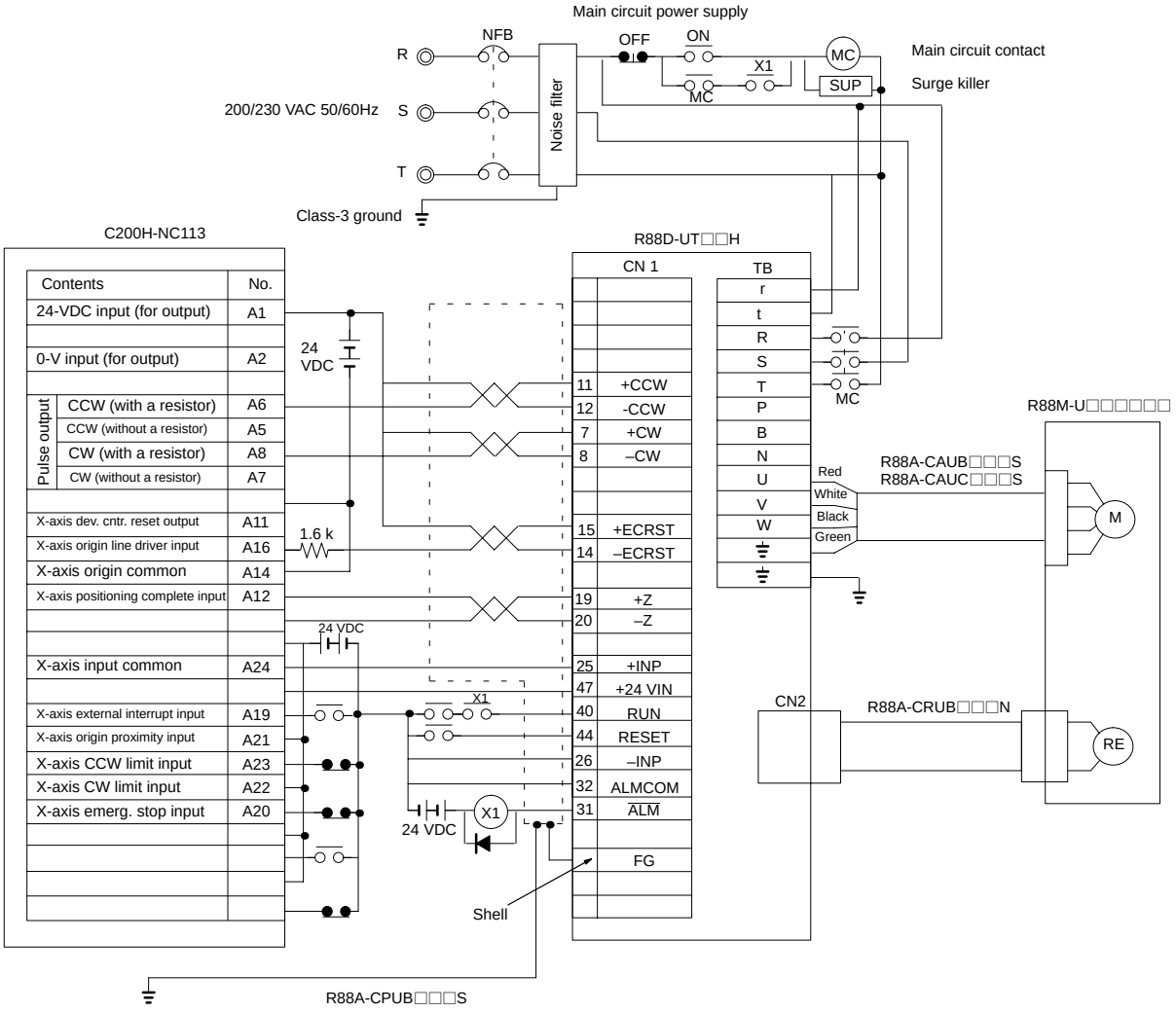
6-3 OMNUC U-series Standard Models

6-4 Combinations of Servo Drivers and Servomotors

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6-1 Connection Examples

■ Connection Example 1: Connecting to SYSMAC C200HW-NC113 Position Control Units



Note 1. Incorrect signal wiring can cause damage to Units and the Servo Driver.

Note 2. Leave unused signal lines open and do not wire them.

Note 3. Use mode 2 for origin search.

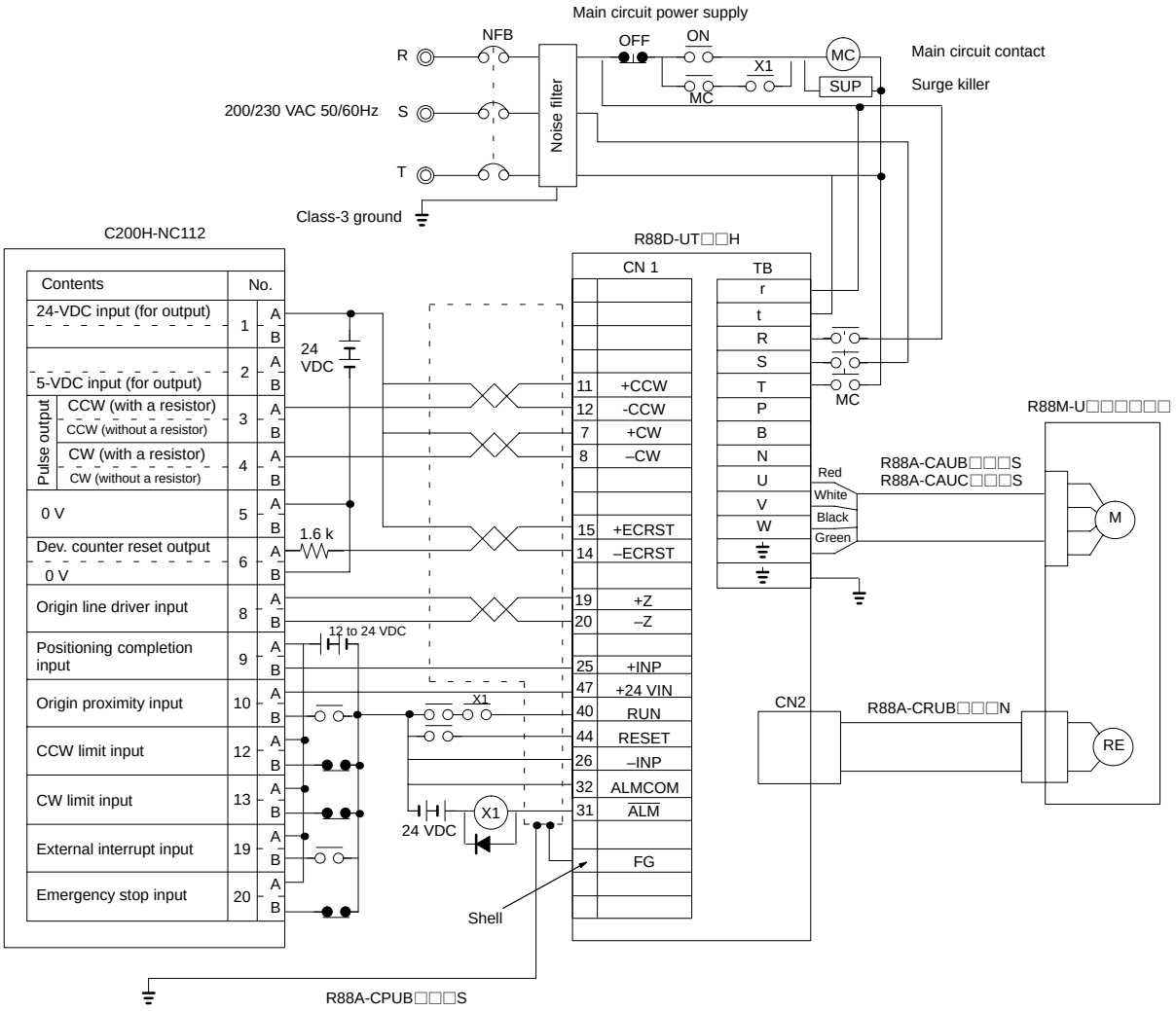
Note 4. Use the 24-VDC power supply for command pulse signals as a dedicated power supply.

Note 5. The diode recommended for surge absorption is the ERB44-02 (Fuji Electric).

Note 6. Use the RUN signal to set whether the Servo can be turned ON/OFF.

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■ Connection Example 2: Connecting to SYSMAC C200H-NC112 Position Control Units



Note 1. Incorrect signal wiring can cause damage to Units and the Servo Driver.

Note 2. Leave unused signal lines open and do not wire them.

Note 3. Use mode 2 for origin search.

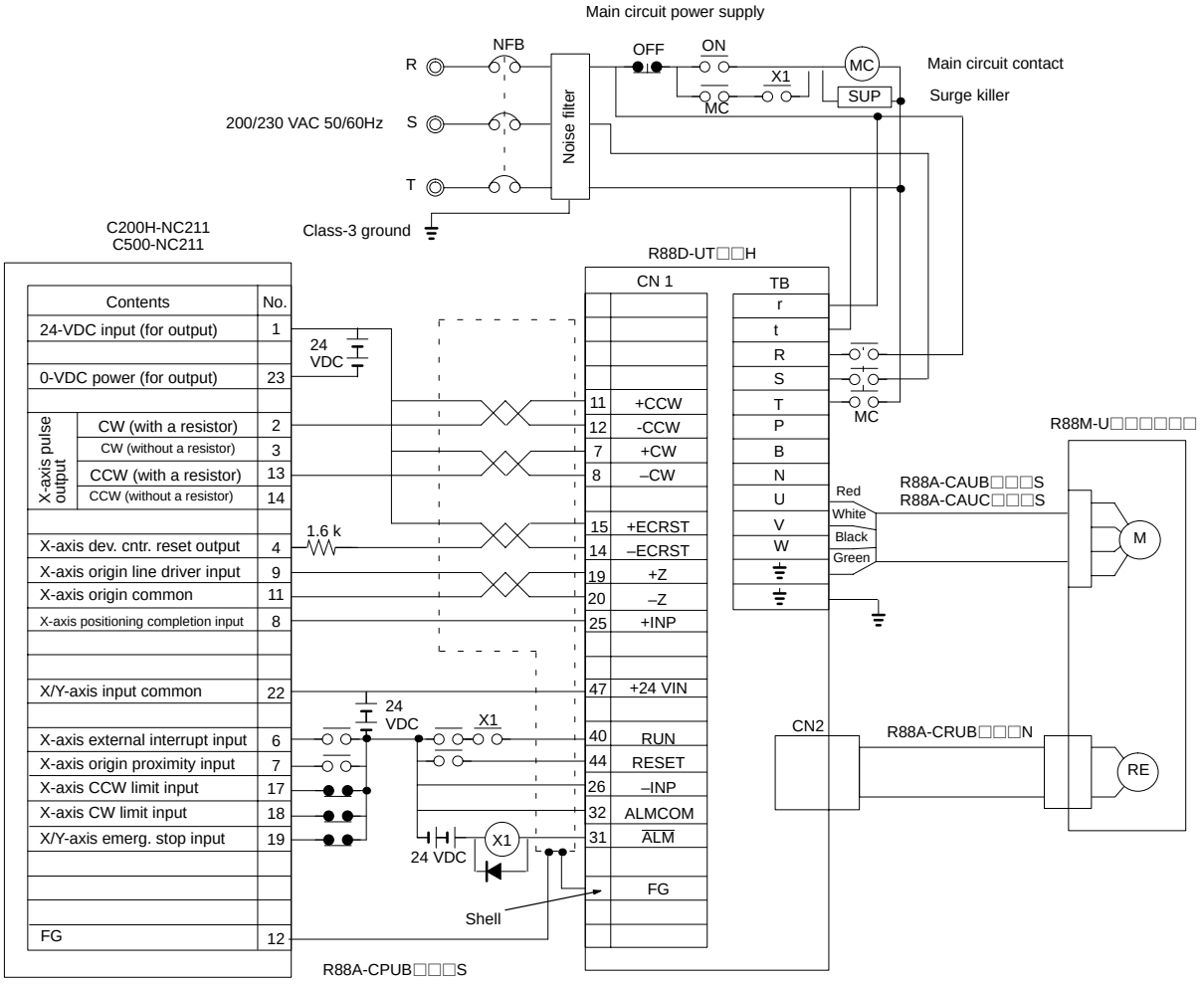
Note 4. Use the 24-VDC power supply for command pulse signals as a dedicated power supply.

Note 5. The diode recommended for surge absorption is the ERB44-02 (Fuji Electric).

Note 6. Use the RUN signal to set whether the Servo can be turned ON/OFF.

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■ Connection Example 3: Connecting to SYSMAC C200H-NC211/C500-NC211 Position Control Units



Note 1. Incorrect signal wiring can cause damage to Units and the Servo Driver.

Note 2. Leave unused signal lines open and do not wire them.

Note 3. Use mode 2 for origin search.

Note 4. Use the 24-VDC power supply for command pulse signals as a dedicated power supply.

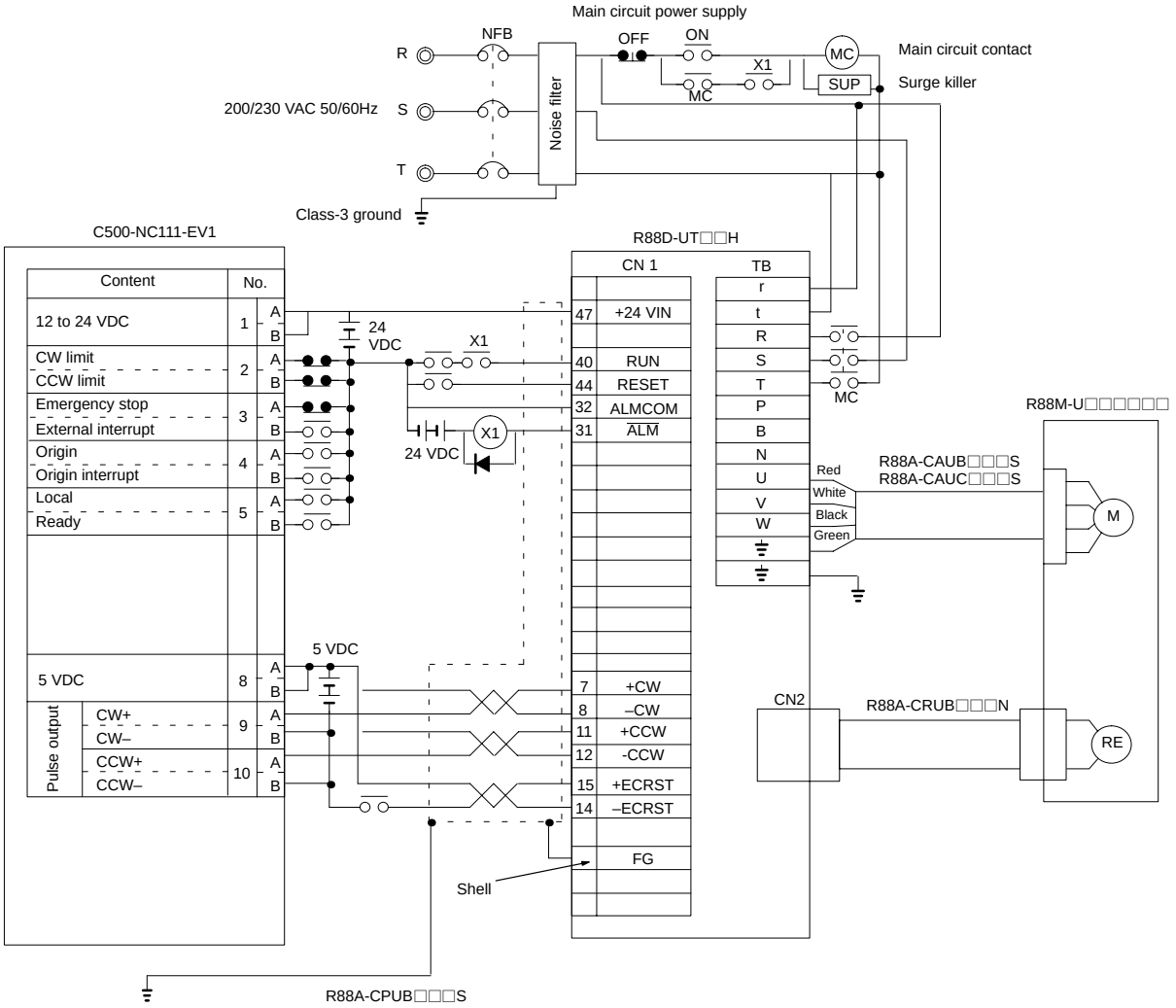
Note 5. The diode recommended for surge absorption is the ERB44-02 (Fuji Electric).

Note 6. This wiring diagram is for the X axis only. If the other axis is to be used, connect to the Servo Driver in the same way.

Note 7. Use the RUN signal to set whether the Servo can be turned ON/OFF.

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■ Connection Example 4: Connecting to SYSMAC C200H-NC111-EV1 Position Control Units



Note 1. Incorrect signal wiring can cause damage to Units and the Servo Driver.

Note 2. Leave unused signal lines open and do not wire them.

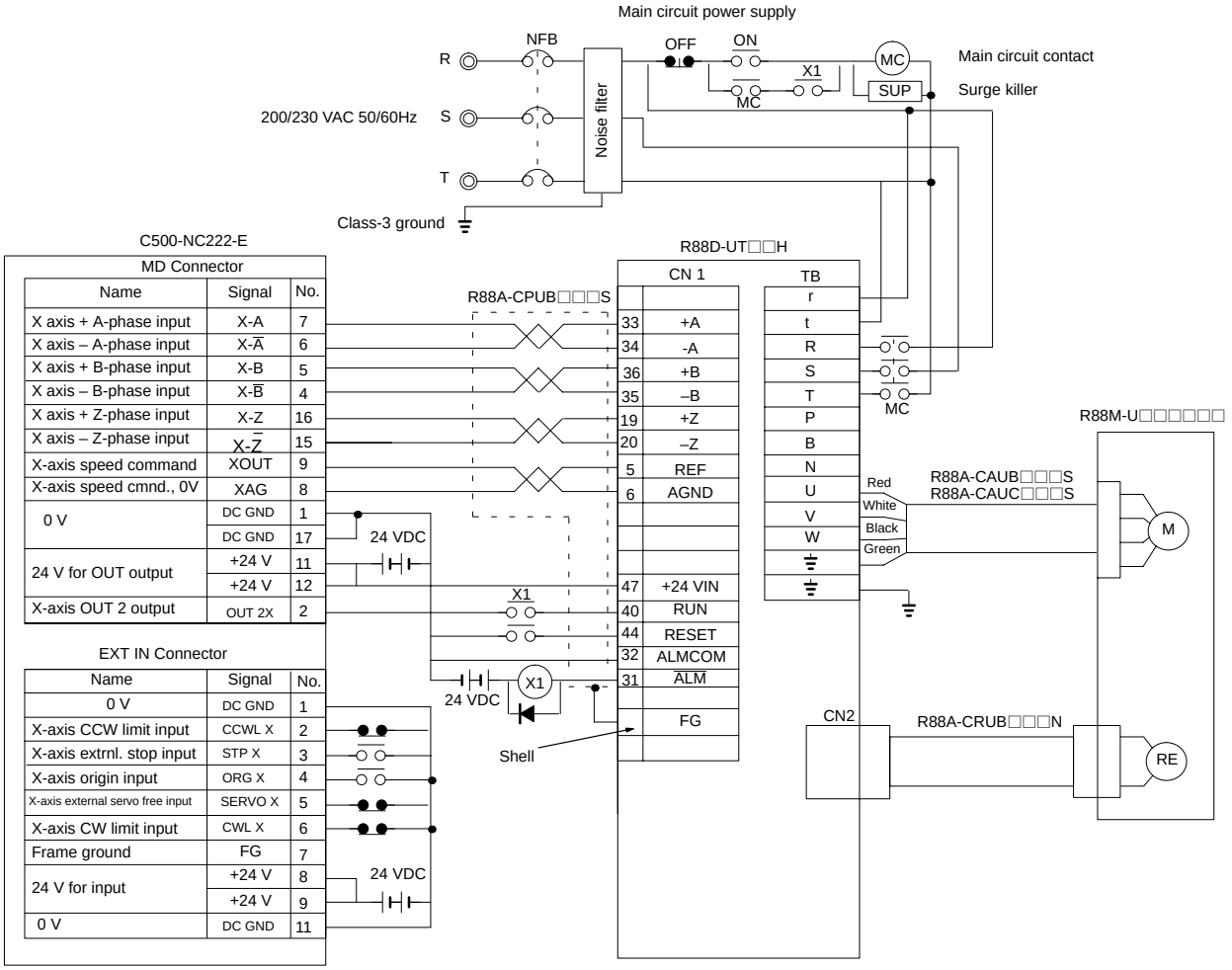
Note 3. The diode recommended for surge absorption is the ERB44-02 (Fuji Electric).

Note 4. When an NC111-EV1 Position Control Unit is used, the origin search is executed by means of the origin and origin proximity. Establish the origin and origin proximity with respect to the mechanical system. Pulses remain accumulated in the Servo Driver's deviation counter even after the Position Control Unit has completed the origin search and stopped pulses. This causes the Servomotor to move for the amount of residual pulses before stopping, thereby causing origin displacement. In order to minimize this, set the origin search low speed as low as possible.

Note 5. Use the RUN signal to set whether the Servo can be turned ON/OFF.

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■ Connection Example 5: Connecting to SYSMAC C200H-NC222-E Position Control Units



Note 1. Incorrect signal wiring can cause damage to Units and the Servo Driver.

Note 2. Leave unused signal lines open and do not wire them.

Note 3. The diode recommended for surge absorption is the ERB44-02 (Fuji Electric).

Note 4. This wiring diagram is an example of X-axis wiring only. For two-axis control, the external input and Driver wiring must be connected for the Y axis in the same way.

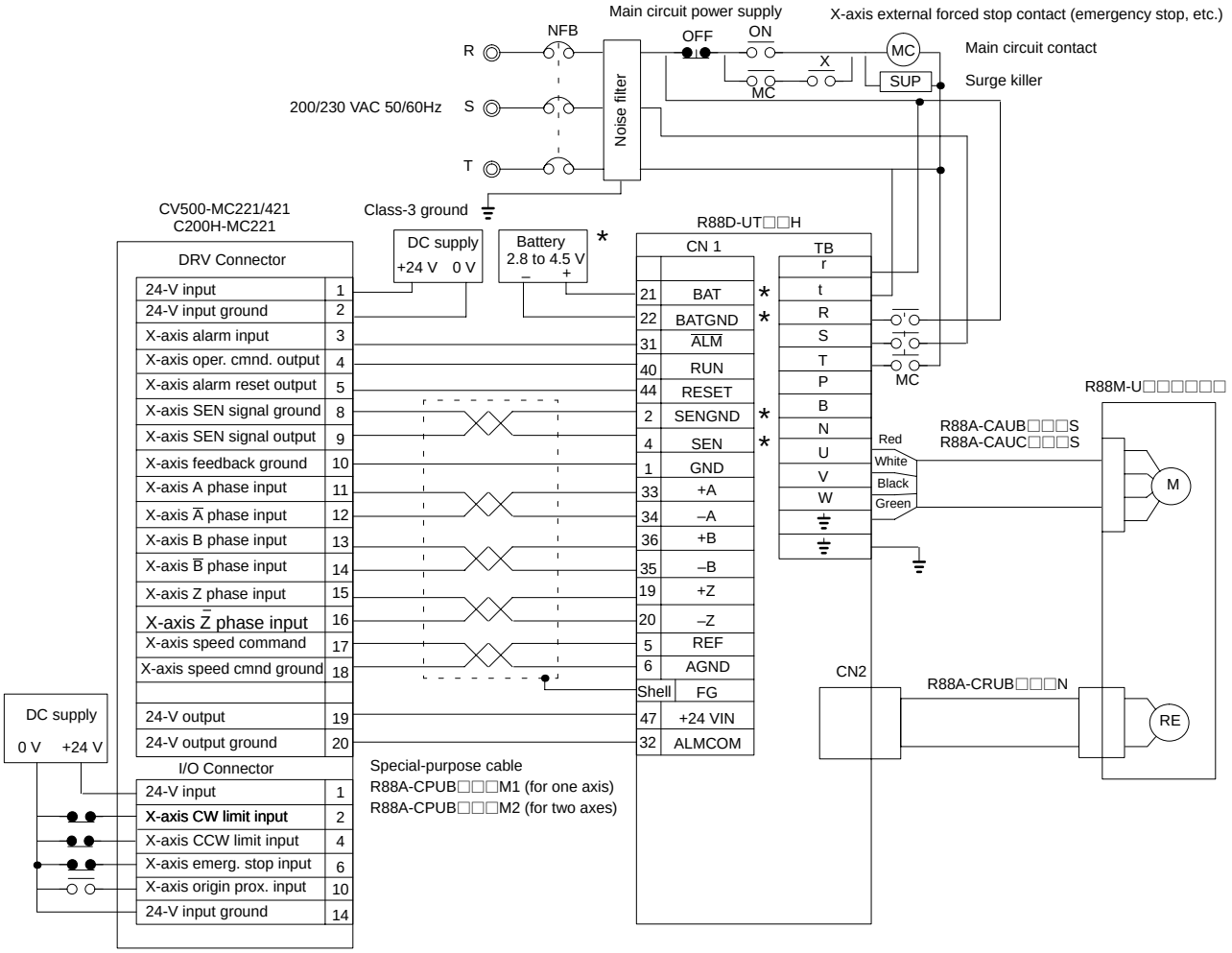
Note 5. External output 2 (OUT 2X) can be turned ON and OFF with external servo-free input, at which time external output 2 of the C500-NC222-E's address numbers 420 (X axis) and 820 (Y axis) must be set to 1 (turned OFF at the time of servo free).

Note 6. When the C500-NC222-E is used in NC221 mode, external servo-free input works as emergency stop input. Therefore external output 2 cannot be used as a RUN signal. Input a RUN signal from other I/O terminals.

Note 7. Use the RUN signal to set whether the Servo can be turned ON/OFF.

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■ Connection Example 6: Connecting to SYSMAC C500-MC221/421/C200H-MC221 Control Units



Note 1. Incorrect signal wiring can cause damage to Units and the Servo Driver.

Note 2. Leave unused signal lines open and do not wire them.

Note 3. Connect the terminals and wiring marked by asterisks (*) when using an absolute encoder.

Note 4. This wiring diagram is for the X axis only. If the other axis is to be used, connect to the Servo Driver in the same way.

Note 5. Be sure to short (in the connector) any unused NC input terminals in the CV500-221/421-E's I/O connector.

Note 6. Use the RUN signal to set whether the Servo can be turned ON/OFF.

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6-2 Encoder Divider Rate for Servo Controllers

Encoder output pulses for OMNUC U-Series AC Servo Drivers can be set within a range of 16 to 4,096 pulses/revolution by setting the encoder divider rate. Depending on the Controller's encoder input maximum response frequency limits, however, the maximum numbers of revolutions are limited as shown in the following table. In this table, the divider rates are shown in the top line above the multipliers. ("MC" indicates CV-500-MC221/421 Motion Control Units, and "NC" indicates C500-NC222-E Position Control Units.

■ Encoder Divider Rates (Cn-0A) and Maximum Numbers of Rotations

	2,048 to 1,366			**1,365 to 1,025**			**1,024 to 819**			**$\frac{4096}{n}$ □ Cn-0A > $\frac{4096}{n+1}$**		
	4	**2**	**1**	**4**	**2**	**1**	**4**	**2**	**1**	**4**	**2**	**1**
C500-NC222-E	4,500			4,500			4,500			2,490 x n		
CV500-MC221/ MC421 C200H-MC221	2,196	4,394	4,500	3,294	4,500		4,392	4,500		1,098 x n	2,197 x n	

Note 1. "n" represents a number from 1 to 256.

Note 2. The numbers in this table indicate the maximum number of revolutions (r/min) that can be used in combination with Servo Controllers.

Note 3. The upper limit for the maximum number of revolutions is 4,500 r/min.

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6-3 OMNUC U-series Standard Models

■ Models Not Conforming to Any Standards

• Servomotors with Incremental Encoders

Specification			Model
Straight shafts without key	Standard (without brake)	1.0 kW	R88M-U1K030H
		1.5 kW	R88M-U1K530H
		2.0 kW	R88M-U2K030H
		3.0 kW	R88M-U3K030H
		4.0 kW	R88M-U4K030H
		5.0 kW	R88M-U5K030H
	With brake	1.0 kW	R88M-U1K030H-B
		1.5 kW	R88M-U1K530H-B
		2.0 kW	R88M-U2K030H-B
		3.0 kW	R88M-U3K030H-B
		4.0 kW	R88M-U4K030H-B
		5.0 kW	R88M-U5K030H-B
Straight shafts with key	Standard (without brake)	1.0 kW	R88M-U1K030H-S1
		1.5 kW	R88M-U1K530H-S1
		2.0 kW	R88M-U2K030H-S1
		3.0 kW	R88M-U3K030H-S1
		4.0 kW	R88M-U4K030H-S1
		5.0 kW	R88M-U5K030H-S1
	With brake	1.0 kW	R88M-U1K030H-BS1
		1.5 kW	R88M-U1K530H-BS1
		2.0 kW	R88M-U2K030H-BS1
		3.0 kW	R88M-U3K030H-BS1
		4.0 kW	R88M-U4K030H-BS1
		5.0 kW	R88M-U5K030H-BS1

• Servomotors with Absolute Encoders

Specification			Model
Straight shafts without key	Standard (without brake)	1.0 kW	R88M-U1K030T
		1.5 kW	R88M-U1K530T
		2.0 kW	R88M-U2K030T
		3.0 kW	R88M-U3K030T
		4.0 kW	R88M-U4K030T
		5.0 kW	R88M-U5K030T
	With brake	1.0 kW	R88M-U1K030T-B
		1.5 kW	R88M-U1K530T-B
		2.0 kW	R88M-U2K030T-B
		3.0 kW	R88M-U3K030T-B
		4.0 kW	R88M-U4K030T-B
		5.0 kW	R88M-U5K030T-B

• Servo Drivers

Specification		Model
Common to analog and pulse train inputs Common to incremental and absolute encoders	1.0 kW	R88D-UT24H
	1.5 kW	R88D-UT40H
	2.0 kW	R88D-UT60H
	3.0 kW	R88D-UT80H
	4.0 kW	R88D-UT110H
	5.0 kW	R88D-UT120H

• Parameter Units

Specification	Model
Handy type	R88A-PR02U
Mounted type	R88A-PR03U

• Encoder Cables

Specification		Model
Common to incremental and absolute encoders with connectors at both ends	3 m	R88A-CRUB003N
	5 m	R88A-CRUB005N
	10 m	R88A-CRUB010N
	15 m	R88A-CRUB015N
	20 m	R88A-CRUB020N

• Power Cables (1.0 to 2.0 kW)

Specification		Model
For standard motors (without brake) with connector at one end	3 m	R88A-CAUB003S
	5 m	R88A-CAUB005S
	10 m	R88A-CAUB010S
	15 m	R88A-CAUB015S
	20 m	R88A-CAUB020S
For motors with brake and with connector at one end	3 m	R88A-CAUB003B
	5 m	R88A-CAUB005B
	10 m	R88A-CAUB010B
	15 m	R88A-CAUB015B
	20 m	R88A-CAUB020B

• Power Cables (3.0 to 5.0 kW)

Specification		Model
For standard motors (without brake) with connector at one end	3 m	R88A-CAUC003S
	5 m	R88A-CAUC005S
	10 m	R88A-CAUC010S
	15 m	R88A-CAUC015S
	20 m	R88A-CAUC020S
For motors with brake and with connector at one end	3 m	R88A-CAUC003B
	5 m	R88A-CAUC005B
	10 m	R88A-CAUC010B
	15 m	R88A-CAUC015B
	20 m	R88A-CAUC020B

• Dedicated Control Cables

Specification			Model
For CV500-MC221 /421 and C200H-MC221 with connectors at both ends	1 axis	1 m	R88A-CPUB001M1
		2 m	R88A-CPUB002M1
	2 axes	1 m	R88A-CPUB001M2
		2 m	R88A-CPUB002M2

• General-purpose Control Cables

Specification		Model
For general-purpose controllers with connector at one end	1 m	R88A-CPUB001S
	2 m	R88A-CPUB002S

• Control Cable Connector

Specification	Model
Half-pitch 50P (Sumitomo 3M)	R88A-CNU11C

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■ Models Conforming to EC Directives

• Servomotors with Incremental Encoders

Specification			Model
Straight shafts with key	Standard (without brake)	1.0 kW	R88M-U1K030V-S1
		1.5 kW	R88M-U1K530V-S1
		2.0 kW	R88M-U2K030V-S1
		3.0 kW	R88M-U3K030V-S1
		4.0 kW	R88M-U4K030V-S1
		5.0 kW	R88M-U5K030V-S1
	With brake	1.0 kW	R88M-U1K030V-BS1
		1.5 kW	R88M-U1K530V-BS1
		2.0 kW	R88M-U2K030V-BS1
		3.0 kW	R88M-U3K030V-BS1
		4.0 kW	R88M-U4K030V-BS1
		5.0 kW	R88M-U5K030V-BS1

• Servomotors with Absolute Encoders

Specification			Model
Straight shafts with key	Standard (without brake)	1.0 kW	R88M-U1K030X-S1
		1.5 kW	R88M-U1K530X-S1
		2.0 kW	R88M-U2K030X-S1
		3.0 kW	R88M-U3K030X-S1
		4.0 kW	R88M-U4K030X-S1
		5.0 kW	R88M-U5K030X-S1
	With brake	1.0 kW	R88M-U1K030X-BS1
		1.5 kW	R88M-U1K530X-BS1
		2.0 kW	R88M-U2K030X-BS1
		3.0 kW	R88M-U3K030X-BS1
		4.0 kW	R88M-U4K030X-BS1
		5.0 kW	R88M-U5K030X-BS1

• Servo Drivers

Specification		Model
Common to analog and pulse train inputs Common to incremental and absolute encoders	1.0 kW	R88D-UT24V
	1.5 kW	R88D-UT40V
	2.0 kW	R88D-UT60V
	3.0 kW	R88D-UT80V
	4.0 kW	R88D-UT110V
	5.0 kW	

• Servo Drivers
(Requiring External Regenerative Resistors)

Specification		Model
Common to analog and pulse train inputs Common to incremental and absolute encoders	1.0 kW	R88D-UT24V-RG
	1.5 kW	R88D-UT40V-RG
	2.0 kW	R88D-UT60V-RG
	3.0 kW	R88D-UT80V-RG

Note For the R88D-UT□V-RG and R88D-UT110V, be sure to install External Regenerative Resistors that correspond to the amount of regenerative energy.

• External Regenerative Resistor

Specification	Model
70 W	R88A-RR22047S

• Parameter Units

Specification	Model
Handy type	R88A-PR02U
Mounted type	R88A-PR03U

• Encoder Cables

Specification		Model
Common to incremental and absolute encoders with connectors at both ends	3 m	R88A-CRUB003N
	5 m	R88A-CRUB005N
	10 m	R88A-CRUB010N
	15 m	R88A-CRUB015N
	20 m	R88A-CRUB020N

• Power Cables (1.0 to 2.0 kW)

Specification		Model
For standard motors (without brake) with connector at one end	3 m	R88A-CAUB003S
	5 m	R88A-CAUB005S
	10 m	R88A-CAUB010S
	15 m	R88A-CAUB015S
	20 m	R88A-CAUB020S
For motors with brake and with connector at one end	3 m	R88A-CAUB003B
	5 m	R88A-CAUB005B
	10 m	R88A-CAUB010B
	15 m	R88A-CAUB015B
	20 m	R88A-CAUB020B

• Power Cables (3.0 to 5.0 kW)

Specification		Model
For standard motors (without brake) with connector at one end	3 m	R88A-CAUC003S
	5 m	R88A-CAUC005S
	10 m	R88A-CAUC010S
	15 m	R88A-CAUC015S
	20 m	R88A-CAUC020S
For motors with brake and with connector at one end	3 m	R88A-CAUC003B
	5 m	R88A-CAUC005B
	10 m	R88A-CAUC010B
	15 m	R88A-CAUC015B
	20 m	R88A-CAUC020B

• Dedicated Control Cables

Specification			Model
For CV500-MC221/421 and C200H-MC221 with connectors at both ends	1 axis	1 m	R88A-CPUB001M1
		2 m	R88A-CPUB002M1
	2 axes	1 m	R88A-CPUB001M2
		2 m	R88A-CPUB002M2

• General-purpose Control Cables

Specification		Model
For general-purpose controllers with connector at one end	1 m	R88A-CPUB001S
	2 m	R88A-CPUB002S

• Control Cable Connector

Specification	Model
Half-pitch 50P (Sumitomo 3M)	R88A-CNU11C

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6-4 Combinations of Servo Drivers and Servomotors

■ Models Not Conforming to Any Standards

Servo Drivers	Servomotors		Motor Capacity
	With Incremental Encoders	With Absolute Encoders	
R88D-UT24H	R88M-U1K030H-□	R88M-U1K030T-□	1 kW
R88D-UT40H	R88M-U1K530H-□	R88M-U1K530T-□	1.5 kW
R88D-UT60H	R88M-U2K030H-□	R88M-U2K030T-□	2 kW
R88D-UT80H	R88M-U3K030H-□	R88M-U3K030T-□	3 kW
R88D-UT110H	R88M-U4K030H-□	R88M-U4K030T-□	4 kW
R88D-UT120H	R88M-U5K030H-□	R88M-U5K030T-□	5 kW

■ Models Conforming to EC Directives

Servo Drivers	Servomotors		Motor Capacity
	With Incremental Encoders	With Absolute Encoders	
R88D-UT24V-□	R88M-U1K030V-□S1	R88M-U1K030X-□S1	1 kW
R88D-UT40V-□	R88M-U1K530V-□S1	R88M-U1K530X-□S1	1.5 kW
R88D-UT60V-□	R88M-U2K030V-□S1	R88M-U2K030X-□S1	2 kW
R88D-UT80V-□	R88M-U3K030V-□S1	R88M-U3K030X-□S1	3 kW
R88D-UT110V	R88M-U4K030V-□S1	R88M-U4K030X-□S1	4 kW
	R88M-U5K030V-□S1	R88M-U5K030X-□S1	5 kW

Note The default setting of the R88D-UT110V is 4 kW (motor selection: “167”). When using a 5-kW motor, change the motor selection setting to “168.”

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