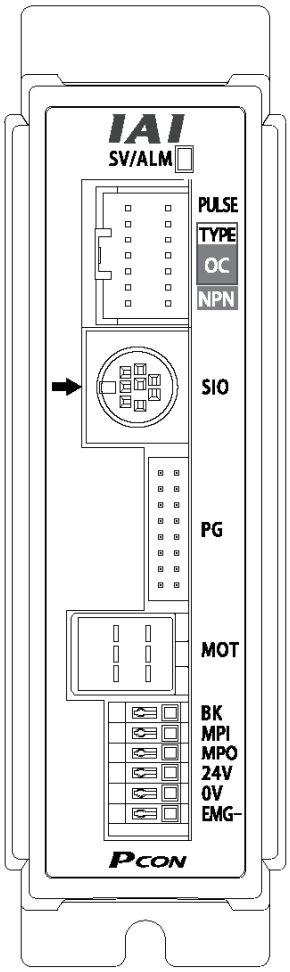
PCON

PCON-PL/PO Controller
Pulse-train Input Type

Operation Manual Seventeenth Edition



IAI America, Inc.

PCON

Please Read Before Use

Thank you for purchasing our product.

This Operation Manual explains the handling methods, structure and maintenance of this product, among others, providing the information you need to know to use the product safely.

Before using the product, be sure to read this manual and fully understand the contents explained herein to ensure safe use of the product.
The DVD that comes with the product contains operation manuals for IAI products.
When using the product, refer to the necessary portions of the applicable operation manual by printing them out or displaying them on a PC.

After reading the Operation Manual, keep it in a convenient place so that whoever is handling this product can reference it quickly when necessary.

[Important]

- This Operation Manual is original.
- The product cannot be operated in any way unless expressly specified in this Operation Manual. IAI shall assume no responsibility for the outcome of any operation not specified herein.
- Information contained in this Operation Manual is subject to change without notice for the purpose of product improvement.
- If you have any question or comment regarding the content of this manual, please contact the IAI sales office near you.
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PCON	CAUTION

1. Note

A rotary actuator of multi-rotational specification shall be used within a range where the equation below is satisfied. Also note that the maximum rotational angle is □9999 [deg] (maximum soft stroke limit).

$$\pm 2^{23} \geq \frac{\text{Maximum rotational angle [deg]}}{\text{Unit travel [deg/pulse]}}$$

- Maximum rotational angle : Set an appropriate angle based on the applicable conditions of use. (Max. -9999 to 9999 [deg])
- Unit travel : Travel per command pulse

Example) The RCP2-RTBL-I-28P-20-360-* is operated to cover the maximum rotational angle of 9999 [deg] at a unit travel of 0.05 [deg/pulse].

$$\pm 2^{23} \geq \frac{\text{Maximum rotational angle [deg]}}{\text{Unit travel [deg/pulse]}}$$

$$\pm 2^{23} \geq \frac{9999}{0.05}$$

$$\pm 2^{23} \geq 199980$$

Accordingly, this actuator can be operated in the condition given.

2. Applicable Models

Actuator	RCP2-RTBL-I-28P-20-360-*	Controller	PCON-PL/PO-28PI-*
	RCP2-RTBL-I-28P-30-360-*		
	RCP2-RTCL-I-28P-20-360-*		
	RCP2-RTCL-I-28P-30-360-*		

PCON	CAUTION

1. Usage Environment

PCON controllers can be used in an environment of pollution degree 2 or equivalent.

2. PC Software and Teaching Pendant Models

New functions have been added to the entire PCON controller series.
To support these new features, the communication protocol has been changed to the general Modbus (Modbus-compliant) mode. As a result, the existing PC software programs and teaching pendants compatible with RCP2 controllers can no longer be used.
If you are using this controller, use a compatible PC software program and/or teaching pendant selected from the following models.

	Model	Earliest supporting version	Remarks
PC software	RCM-101-***	V6.0.0.0	All are compatible with existing RCP2 controllers.
Teaching pendant	RCM-T	V2.00	
Simple teaching pendant	RCM-E	V2.00	
Data setting unit	RCM-P	V2.00	

3. Recommendation for Backing Up Latest Data

This product uses nonvolatile memory to store parameters. Normally the memory will retain the stored data even after the power is disconnected. However, the data may be lost if the nonvolatile memory becomes faulty.
We strongly recommend that the latest parameter data be backed up so that the data can be restored quickly when the controller must be replaced for a given reason.
The data can be backed up using the following methods:
[1] Save to a CD or DVD from the PC software.
[2] Create a parameter sheet and keep a written record of backup.

CE Marking

If a compliance with the CE Marking is required, please follow Overseas Standards Compliance Manual (ME0287) that is provided separately.

Table of Contents

Safety Guide

"Safety Guide" has been written to use the machine safely and so prevent personal injury or property damage beforehand. Make sure to read it before the operation of this product.

Safety Precautions for Our Products

The common safety precautions for the use of any of our robots in each operation.

No.	Operation Description	Description
1	Model Selection	● This product has not been planned and designed for the application where high level of safety is required, so the guarantee of the protection of human life is impossible. Accordingly, do not use it in any of the following applications. 1) Medical equipment used to maintain, control or otherwise affect human life or physical health. 2) Mechanisms and machinery designed for the purpose of moving or transporting people (For vehicle, railway facility or air navigation facility) 3) Important safety parts of machinery (Safety device, etc.) ● Do not use the product outside the specifications. Failure to do so may considerably shorten the life of the product. ● Do not use it in any of the following environments. 1) Location where there is any inflammable gas, inflammable object or explosive 2) Place with potential exposure to radiation 3) Location with the ambient temperature or relative humidity exceeding the specification range 4) Location where radiant heat is added from direct sunlight or other large heat source 5) Location where condensation occurs due to abrupt temperature changes 6) Location where there is any corrosive gas (sulfuric acid or hydrochloric acid) 7) Location exposed to significant amount of dust, salt or iron powder 8) Location subject to direct vibration or impact ● For an actuator used in vertical orientation, select a model which is equipped with a brake. If selecting a model with no brake, the moving part may drop when the power is turned OFF and may cause an accident such as an injury or damage on the work piece.

No.	Operation Description	Description
2	Transportation	● When carrying a heavy object, do the work with two or more persons or utilize equipment such as crane. ● When the work is carried out with 2 or more persons, make it clear who is to be the leader and who to be the follower(s) and communicate well with each other to ensure the safety of the workers. ● When in transportation, consider well about the positions to hold, weight and weight balance and pay special attention to the carried object so it would not get hit or dropped. ● Transport it using an appropriate transportation measure. The actuators available for transportation with a crane have eyebolts attached or there are tapped holes to attach bolts. Follow the instructions in the operation manual for each model. ● Do not step or sit on the package. ● Do not put any heavy thing that can deform the package, on it. ● When using a crane capable of 1t or more of weight, have an operator who has qualifications for crane operation and sling work. ● When using a crane or equivalent equipments, make sure not to hang a load that weighs more than the equipment's capability limit. ● Use a hook that is suitable for the load. Consider the safety factor of the hook in such factors as shear strength. ● Do not get on the load that is hung on a crane. ● Do not leave a load hung up with a crane. ● Do not stand under the load that is hung up with a crane.
3	Storage and Preservation	● The storage and preservation environment conforms to the installation environment. However, especially give consideration to the prevention of condensation. ● Store the products with a consideration not to fall them over or drop due to an act of God such as earthquake.
4	Installation and Start	(1) Installation of Robot Main Body and Controller, etc. ● Make sure to securely hold and fix the product (including the work part). A fall, drop or abnormal motion of the product may cause a damage or injury. Also, be equipped for a fall-over or drop due to an act of God such as earthquake. ● Do not get on or put anything on the product. Failure to do so may cause an accidental fall, injury or damage to the product due to a drop of anything, malfunction of the product, performance degradation, or shortening of its life. ● When using the product in any of the places specified below, provide a sufficient shield. 1) Location where electric noise is generated 2) Location where high electrical or magnetic field is present 3) Location with the mains or power lines passing nearby 4) Location where the product may come in contact with water, oil or chemical droplets

No.	Operation Description	Description
4	Installation and Start	(2) Cable Wiring ● Use our company's genuine cables for connecting between the actuator and controller, and for the teaching tool. ● Do not scratch on the cable. Do not bend it forcibly. Do not pull it. Do not coil it around. Do not insert it. Do not put any heavy thing on it. Failure to do so may cause a fire, electric shock or malfunction due to leakage or continuity error. ● Perform the wiring for the product, after turning OFF the power to the unit, so that there is no wiring error. ● When the direct current power (+24V) is connected, take the great care of the directions of positive and negative poles. If the connection direction is not correct, it might cause a fire, product breakdown or malfunction. ● Connect the cable connector securely so that there is no disconnection or looseness. Failure to do so may cause a fire, electric shock or malfunction of the product. ● Never cut and/or reconnect the cables supplied with the product for the purpose of extending or shortening the cable length. Failure to do so may cause the product to malfunction or cause fire.
		(3) Grounding ● The grounding operation should be performed to prevent an electric shock or electrostatic charge, enhance the noise-resistance ability and control the unnecessary electromagnetic radiation. ● For the ground terminal on the AC power cable of the controller and the grounding plate in the control panel, make sure to use a twisted pair cable with wire thickness 0.5mm^2 (AWG20 or equivalent) or more for grounding work. For security grounding, it is necessary to select an appropriate wire thickness suitable for the load. Perform wiring that satisfies the specifications (electrical equipment technical standards). ● Perform Class D Grounding (former Class 3 Grounding with ground resistance 100Ω or below).

No.	Operation Description	Description
4	Installation and Start	(4) Safety Measures ● When the work is carried out with 2 or more persons, make it clear who is to be the leader and who to be the follower(s) and communicate well with each other to ensure the safety of the workers. ● When the product is under operation or in the ready mode, take the safety measures (such as the installation of safety and protection fence) so that nobody can enter the area within the robot's movable range. When the robot under operation is touched, it may result in death or serious injury. ● Make sure to install the emergency stop circuit so that the unit can be stopped immediately in an emergency during the unit operation. ● Take the safety measure not to start up the unit only with the power turning ON. Failure to do so may start up the machine suddenly and cause an injury or damage to the product. ● Take the safety measure not to start up the machine only with the emergency stop cancellation or recovery after the power failure. Failure to do so may result in an electric shock or injury due to unexpected power input. ● When the installation or adjustment operation is to be performed, give clear warnings such as "Under Operation; Do not turn ON the power!" etc. Sudden power input may cause an electric shock or injury. ● Take the measure so that the work part is not dropped in power failure or emergency stop. ● Wear protection gloves, goggle or safety shoes, as necessary, to secure safety. ● Do not insert a finger or object in the openings in the product. Failure to do so may cause an injury, electric shock, damage to the product or fire. ● When releasing the brake on a vertically oriented actuator, exercise precaution not to pinch your hand or damage the work parts with the actuator dropped by gravity.
5	Teaching	● When the work is carried out with 2 or more persons, make it clear who is to be the leader and who to be the follower(s) and communicate well with each other to ensure the safety of the workers. ● Perform the teaching operation from outside the safety protection fence, if possible. In the case that the operation is to be performed unavoidably inside the safety protection fence, prepare the "Stipulations for the Operation" and make sure that all the workers acknowledge and understand them well. ● When the operation is to be performed inside the safety protection fence, the worker should have an emergency stop switch at hand with him so that the unit can be stopped any time in an emergency. ● When the operation is to be performed inside the safety protection fence, in addition to the workers, arrange a watchman so that the machine can be stopped any time in an emergency. Also, keep watch on the operation so that any third person can not operate the switches carelessly. ● Place a sign "Under Operation" at the position easy to see. ● When releasing the brake on a vertically oriented actuator, exercise precaution not to pinch your hand or damage the work parts with the actuator dropped by gravity. * Safety protection Fence : In the case that there is no safety protection fence, the movable range should be indicated.

No.	Operation Description	Description
6	Trial Operation	● When the work is carried out with 2 or more persons, make it clear who is to be the leader and who to be the follower(s) and communicate well with each other to ensure the safety of the workers. ● After the teaching or programming operation, perform the check operation one step by one step and then shift to the automatic operation. ● When the check operation is to be performed inside the safety protection fence, perform the check operation using the previously specified work procedure like the teaching operation. ● Make sure to perform the programmed operation check at the safety speed. Failure to do so may result in an accident due to unexpected motion caused by a program error, etc. ● Do not touch the terminal block or any of the various setting switches in the power ON mode. Failure to do so may result in an electric shock or malfunction.
7	Automatic Operation	● Check before starting the automatic operation or rebooting after operation stop that there is nobody in the safety protection fence. ● Before starting automatic operation, make sure that all peripheral equipment is in an automatic-operation-ready state and there is no alarm indication. ● Make sure to operate automatic operation start from outside of the safety protection fence. ● In the case that there is any abnormal heating, smoke, offensive smell, or abnormal noise in the product, immediately stop the machine and turn OFF the power switch. Failure to do so may result in a fire or damage to the product. ● When a power failure occurs, turn OFF the power switch. Failure to do so may cause an injury or damage to the product, due to a sudden motion of the product in the recovery operation from the power failure.

No.	Operation Description	Description
8	Maintenance and Inspection	● When the work is carried out with 2 or more persons, make it clear who is to be the leader and who to be the follower(s) and communicate well with each other to ensure the safety of the workers. ● Perform the work out of the safety protection fence, if possible. In the case that the operation is to be performed unavoidably inside the safety protection fence, prepare the “Stipulations for the Operation” and make sure that all the workers acknowledge and understand them well. ● When the work is to be performed inside the safety protection fence, basically turn OFF the power switch. ● When the operation is to be performed inside the safety protection fence, the worker should have an emergency stop switch at hand with him so that the unit can be stopped any time in an emergency. ● When the operation is to be performed inside the safety protection fence, in addition to the workers, arrange a watchman so that the machine can be stopped any time in an emergency. Also, keep watch on the operation so that any third person can not operate the switches carelessly. ● Place a sign “Under Operation” at the position easy to see. ● For the grease for the guide or ball screw, use appropriate grease according to the Operation Manual for each model. ● Do not perform the dielectric strength test. Failure to do so may result in a damage to the product. ● When releasing the brake on a vertically oriented actuator, exercise precaution not to pinch your hand or damage the work parts with the actuator dropped by gravity. ● The slider or rod may get misaligned OFF the stop position if the servo is turned OFF. Be careful not to get injured or damaged due to an unnecessary operation. ● Pay attention not to lose the cover or untightened screws, and make sure to put the product back to the original condition after maintenance and inspection works. Use in incomplete condition may cause damage to the product or an injury. * Safety protection Fence : In the case that there is no safety protection fence, the movable range should be indicated.
9	Modification and Dismantle	● Do not modify, disassemble, assemble or use of maintenance parts not specified based at your own discretion.
10	Disposal	● When the product becomes no longer usable or necessary, dispose of it properly as an industrial waste. ● When removing the actuator for disposal, pay attention to drop of components when detaching screws. ● Do not put the product in a fire when disposing of it. The product may burst or generate toxic gases.
11	Other	● Do not come close to the product or the harnesses if you are a person who requires a support of medical devices such as a pacemaker. Doing so may affect the performance of your medical device. ● See Overseas Specifications Compliance Manual to check whether complies if necessary. ● For the handling of actuators and controllers, follow the dedicated operation manual of each unit to ensure the safety.

Alert Indication

The safety precautions are divided into “Danger”, “Warning”, “Caution” and “Notice” according to the warning level, as follows, and described in the Operation Manual for each model.

Level	Degree of Danger and Damage	Symbol
Danger	This indicates an imminently hazardous situation which, if the product is not handled correctly, will result in death or serious injury.	 Danger
Warning	This indicates a potentially hazardous situation which, if the product is not handled correctly, could result in death or serious injury.	 Warning
Caution	This indicates a potentially hazardous situation which, if the product is not handled correctly, may result in minor injury or property damage.	 Caution
Notice	This indicates lower possibility for the injury, but should be kept to use this product properly.	 Notice

1. Overview

1.1 Introduction

This product is a pulse-train input controller used exclusively with RCP2 actuators.
It can control actuators using the positioning control function of the host controller (PLC).
This controller also provides power-saving functions to address the growing need for saving energy.
The key features and functions of this controller are summarized below.

■ Dedicated Homing Signal
This signal supports IAI's original homing operation based on push motion at the stroke end.
With this signal, homing can be performed automatically without having to program a complex sequence or using an external sensor, etc.

■ Brake Control Function
The electromagnetic brake power is supplied internally from the controller. However, 24 V must be supplied externally to forcibly release the brake when the servo is off.

■ Torque Limiting Function
This controller lets you limit torque using an external signal (set by a parameter). A signal is output when the specified torque is reached. This function enables push-motion operation, press-fit operation, etc.

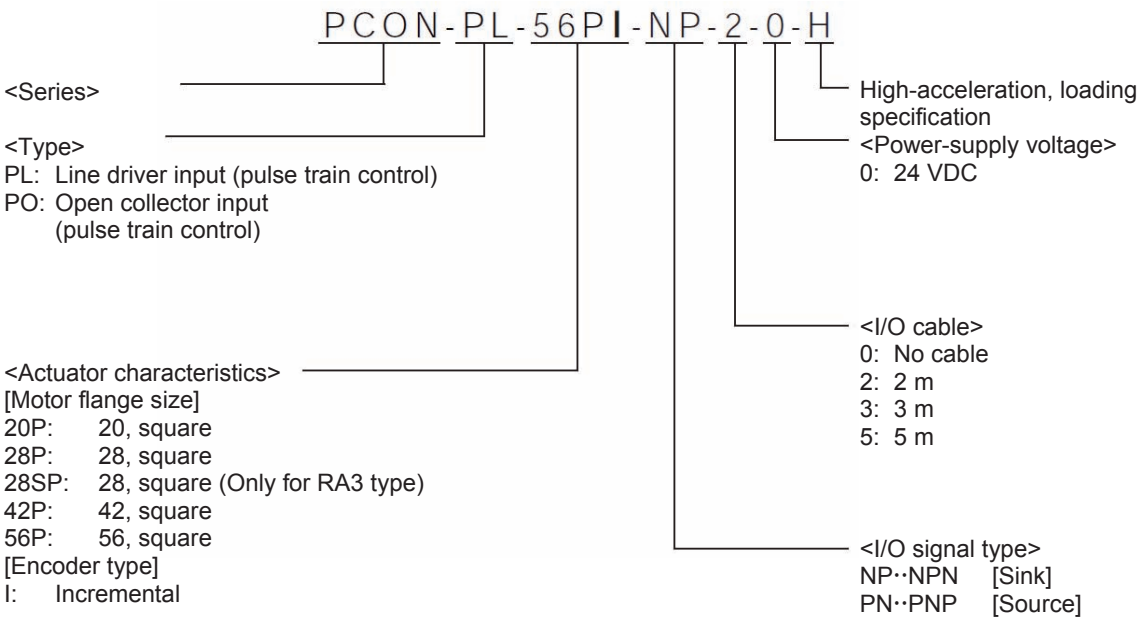
■ Full Servo Control Function
The holding current can be reduced via servo-control of the pulse motor.
Although the exact level of current reduction varies in accordance with the actuator type and load condition, normally the holding current drops to approx. one-half to one-fourth.

When actually starting your system or if you have encountered any problem, also refer to the manuals for the actuator, teaching pendant, PC software and/or any other component you are using, in addition to this manual.

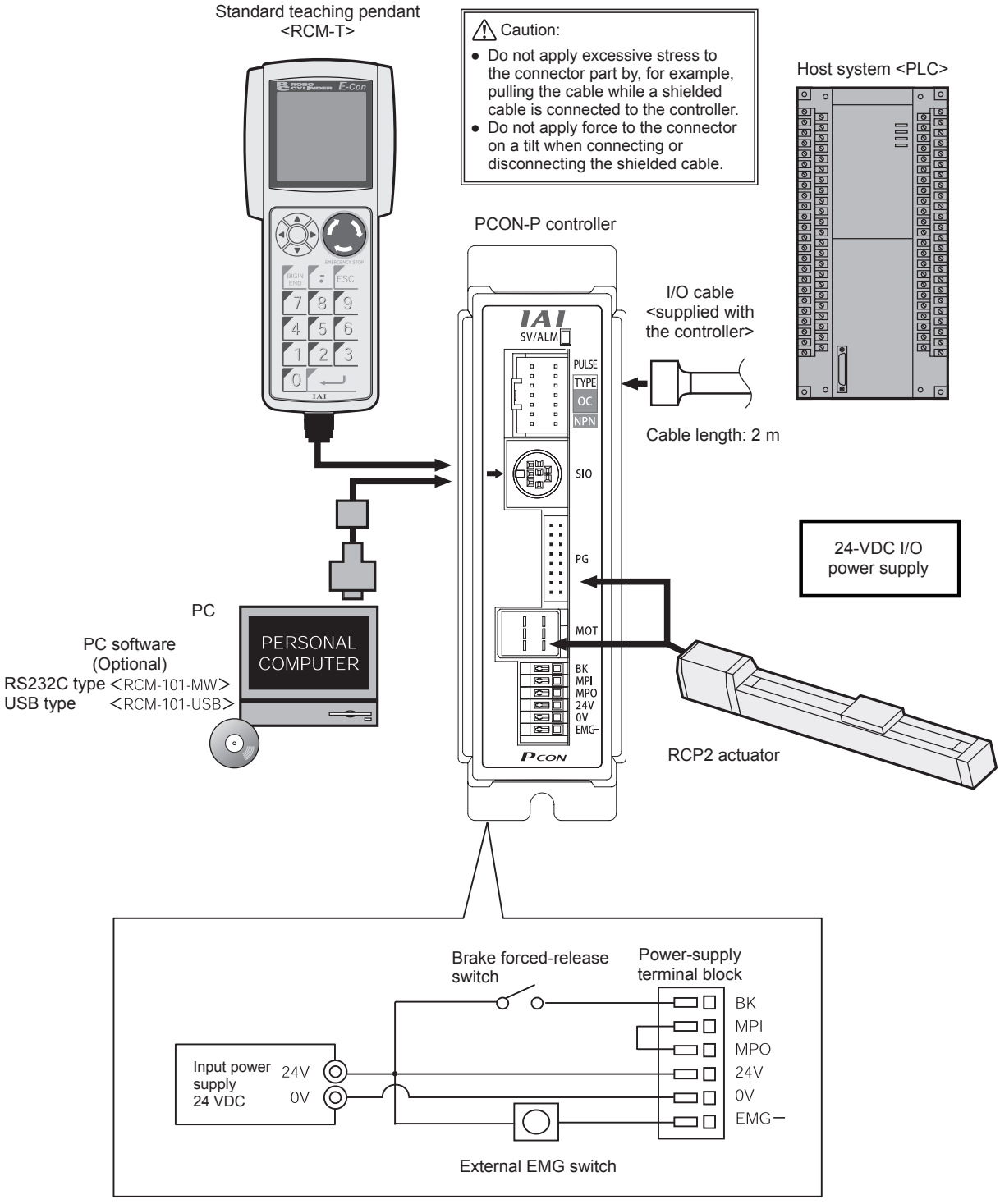
This manual does not cover all possible deviations from normal operations or unexpected phenomena such as complex signal changes resulting from critical timings. Therefore, the reader should assume that items not described in this manual are "not permitted," as a rule.

* This manual has been prepared with the utmost attention to ensure accuracy and completeness. However, there may still be inaccuracies and omissions. Should you find any inaccurate description or if you have any comment, please contact IAI.
Keep this manual in a convenient place so that you can easily reference it whenever necessary.

1.2 How to Read Model Name



1.3 System Configuration



⚠ Caution: The BK terminal need not be connected if the actuator has no brake.

1.4 Steps from Unpacking to Adjustment by Trial Operation

If you are using this controller for the first time, refer to the steps explained below and perform the specified tasks carefully by making sure you check all necessary items and connect all required cables.

1. Checking the items in the package

Should you find any of the following items missing or of a wrong model type, please contact your IAI sales agent.

- Controller
  PCON-PL/PO
- Actuator
- I/O shield cable
  CB-PACPU-PIO ***
- Motor cable
  CB-RCP2-MA ***
- Encoder cable
  CB-RCP2-PA ***
- Operation manual
- Teaching pendant <Options>
  RCM-T (standard)
  RCM-E (simple)
  RCM-P (data setting)
  CON-T (standard)
- PC software <Options>
  RS-232C type <RCM-101-MW>
  USB type <RCM-101-USB>
  (Includes attached cable)
- Touch-screen panel display
  RCM-PM-01

2. Installation

[1] Affix the actuator and install the robot hand → Refer to the operation manual for your actuator.
[2] Install the controller → Chapter 3, “Installation and Wiring”

3. Wiring/connection

- Wire the 24-V power supply.
- Wire the brake forced-release switch (if the actuator is equipped with a brake).
- Connect the grounding wire to ground.
- Wire the emergency stop circuit and motor drive power supply. → Chapter 3, “Installation and Wiring”
- Connect the motor cable and encoder cable.
- Connect the I/O shield cable.

4. Turning on the power and checking for alarms

Confirm first that the emergency stop circuit is not actuated, and then supply the 24-V power.
If the monitor LED [SV/ALM] on the front face of the controller illuminates in orange for 2 seconds and then turns off, the controller is normal. (The LED remains unlit when the servo is off.)
If the [SV/ALM] illuminates in red, it means that an alarm is present.
In this case, connect a PC or teaching pendant and check the nature of the alarm, and remove the cause by referring to Chapter 6, “Troubleshooting.”

5. Setting a mode

If you want to use the “standard type” PIO pattern, change the value of Parameter No. 25 to “1.”
→ Chapter 4, “Operation Using I/Os”

* The factory setting is to use the “standard type.”

6. Setting an electronic gear

Determine the unit travel distance of the actuator per one pulse in input command pulse train.

→ Chapter 4, “Setting Parameters Required for Operation”

7. Setting the command pulse-train input mode

Set a pulse-train input pattern for command pulse input (PP•/PP, NP•/NP).

→ Chapter 4, “Setting Parameters Required for Operation”

8. Checking the servo-on status

Confirm that the slider or rod is not contacting a mechanical end.
If the slider/rod is contacting a mechanical end, move the slider/rod in the opposite direction to provide a space in between.
If a brake is equipped, turn on the brake release switch to forcibly release the brake before moving the slider/rod.
At this time, be careful not to pinch your hand or damage the robot hand by the slider/rod, as the slider/rod may drop unexpectedly by its dead weight.
Turn servo on by operating the PC or the teaching pendant.
The actuator enters a servo lock mode. If the monitor LED [SV/ALM] on the front face of the controller illuminates in green, the controller is functioning normally.

9. Confirming the safety circuit operation

Confirm that the drive-signal cutoff circuit (or motor drive-power cutoff circuit) operates normally.

→ Chapter 3, “Installation and Wiring”

10. Adjustment by test operation

- Carry out operation check under the actual load using the host controller to check the operating characteristics. Adjust the parameters, if necessary.

→ Chapter 5, “Parameter Settings”

- Confirm that the entire system operates properly without presenting any abnormality.

1.5 Warranty

1.5.1 Warranty Period

One of the following periods, whichever is shorter:

- Elapse of 18 months after the shipment from IAI
- Elapse of 12 months after the delivery to the specified location

1.5.2 Scope of Warranty

Our products are covered by warranty when all of the following conditions are met. Faulty products covered by warranty will be replaced or repaired free of charge:

(1) The breakdown or problem in question pertains to our product as delivered by us or our authorized dealer.
(2) The breakdown or problem in question occurred during the warranty period.
(3) The breakdown or problem in question occurred while the product was in use for an appropriate purpose under the conditions and environment of use specified in the operation manual and catalog.
(4) The breakdown or problem in question was caused by a specification defect or problem, or by the poor quality of our product.

Note that breakdowns due to any of the following reasons are excluded from the scope of warranty:

[1] Anything other than our product
[2] Modification or repair performed by a party other than us (unless we have approved such modification or repair)
[3] Anything that could not be easily predicted with the level of science and technology available at the time of shipment from our company
[4] A natural disaster, man-made disaster, incident or accident for which we are not liable
[5] Natural fading of paint or other symptoms of aging
[6] Wear, depletion or other expected result of use
[7] Operation noise, vibration or other subjective sensation not affecting function or maintenance

Note that the warranty only covers our product as delivered and that any secondary loss arising from a breakdown of our product is excluded from the scope of warranty.

1.5.3 Honoring the Warranty

As a rule, the product must be brought to us for repair under warranty.

1.5.4 Limited Liability

[1] We shall assume no liability for any special damage, consequential loss or passive loss such as a loss of expected profit arising from or in connection with our product.
[2] We shall not be liable for any program or control method created by the customer to operate our product or for the result of such program or control method.

1.5.5 Conditions of Conformance with Applicable Standards/Regulations, Etc., and Applications

(1) If our product is combined with another product or any system, device, etc., used by the customer, the customer must first check the applicable standards, regulations and/or rules. The customer is also responsible for confirming that such combination with our product conforms to the applicable standards, etc. In such a case we will not be liable for the conformance of our product with the applicable standards, etc.

(2) Our product is for general industrial use. It is not intended or designed for the applications specified below, which require a high level of safety. Accordingly, as a rule our product cannot be used in these applications. Contact us if you must use our product for any of these applications:

[1] Medical equipment pertaining to maintenance or management of human life or health
[2] A mechanism or mechanical equipment intended to move or transport people (such as a vehicle, railway facility or aviation facility)
[3] Important safety parts of mechanical equipment (such as safety devices)
[4] Equipment used to handle cultural assets, art or other irreplaceable items

(3) Contact us at the earliest opportunity if our product is to be used in any condition or environment that differs from what is specified in the catalog or operation manual.

1.5.6 Other Items Excluded from Warranty

The price of the product delivered to you does not include expenses associated with programming, the dispatch of engineers, etc. Accordingly, a separate fee will be charged in the following cases even during the warranty period:

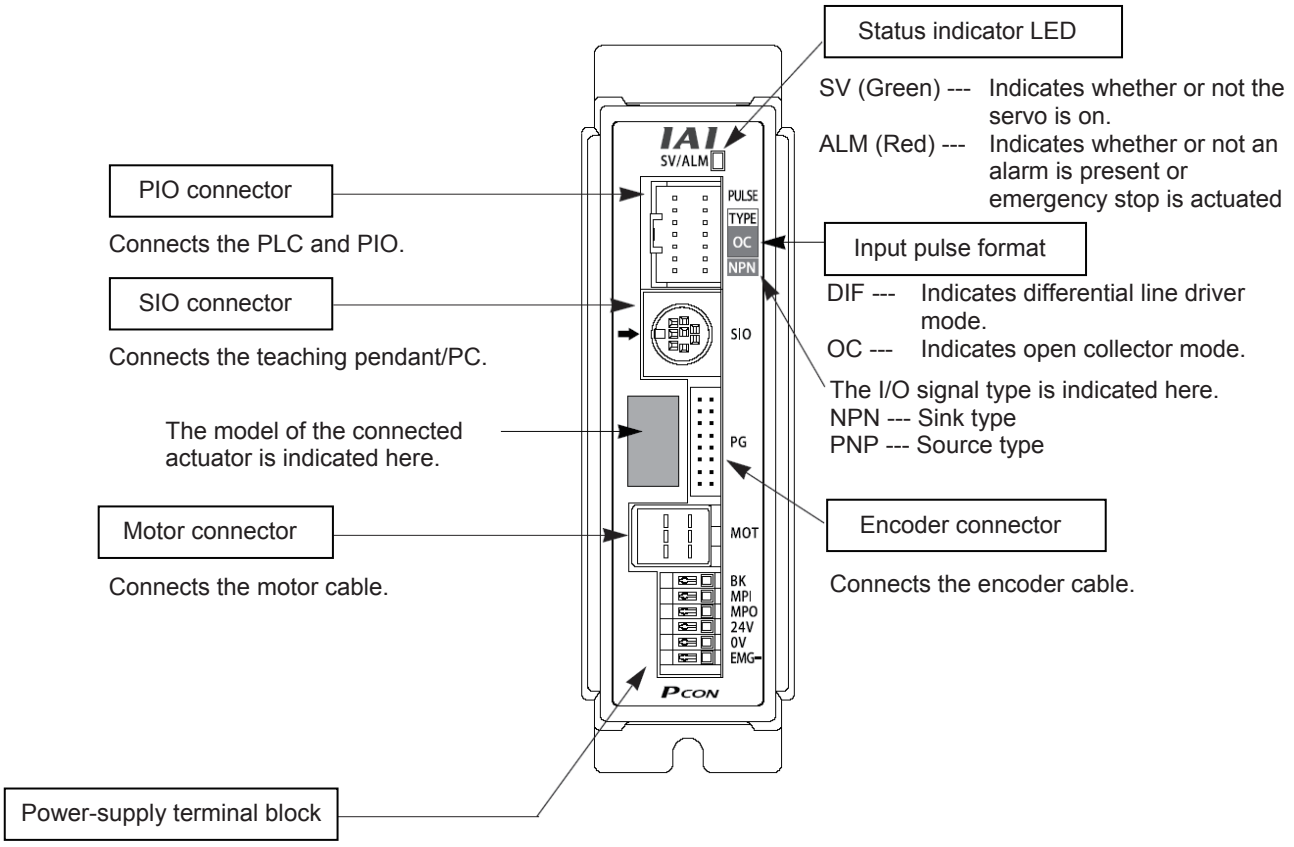
[1] Guidance for installation/adjustment and witnessing of test operation
[2] Maintenance and inspection
[3] Technical guidance and education on operating/wiring methods, etc.
[4] Technical guidance and education on programming and other items related to programs

2. Specifications

2.1 Basic Specifications

Specification item		Description
Model		PCON-PL/PO
Number of controlled axes		1 axis per unit
Power-supply voltage		24 VDC +10%/-10%
Power-supply current		2 A max.
Control method		Field-weakening vector control (patent pending)
Encoder resolution		800 P/rev
Function/performance	Control mode	Position control by pulse train input
	Maximum input pulse frequency	60 kpps max. (open collector) / 200 kpps max. (differential)
	Command pulse multiplier (Electronic gear: $\frac{A}{B}$)	$A, B = 1 \sim 4096$ $\frac{1}{50} < \frac{A}{B} < \frac{50}{1}$ (set by parameters)
	Positioning complete band	0.1 mm to 999.999 mm (set by parameters)
Power supply for I/O signal I/F		24 VDC ± 10% Some open collector output has a built-in pull-up resistor, but in such case, either remove the pull-up resistor or use a port that does not have a pull-up resistor.
LED indicator		SV (green) --- Whether or not the servo is on / ALM (red) --- Whether or not an alarm is present or emergency stop is actuated.
Serial communication		RS485, 1 channel (for teaching pendant/dedicated PC software)
Encoder interface		Incremental specification conforming to EIA RS-422A/423A
Forced release of electromagnetic brake		24 V is applied to the BK terminal on the power-supply terminal block.
Cable length		Actuator cable: 20 m or shorter I/O shield cable: 2 m or shorter (open collector) or 10 m or shorter (differential)
Dielectric strength		500 VDC 10 mΩ
Environment	Surrounding air temperature	0 to 40°C
	Surrounding humidity	85% RH or below (non-condensing)
	Surrounding environment	Refer to 3.1 Installation Environment
	Storage temperature	-10 to 65°C
	Storage humidity	90% RH or below (non-condensing)
	Vibration resistance	10 to 57 Hz in all X/Y/Z directions / Single amplitude: 0.035 mm (continuous), 0.075 mm (intermittent)
Protection class		Natural air cooling (IP20)
Weight		128 g or below
External dimensions		35 (W) x 120 (H) x 68 (D) mm

2.2 Name and Function of Each Part of the Controller



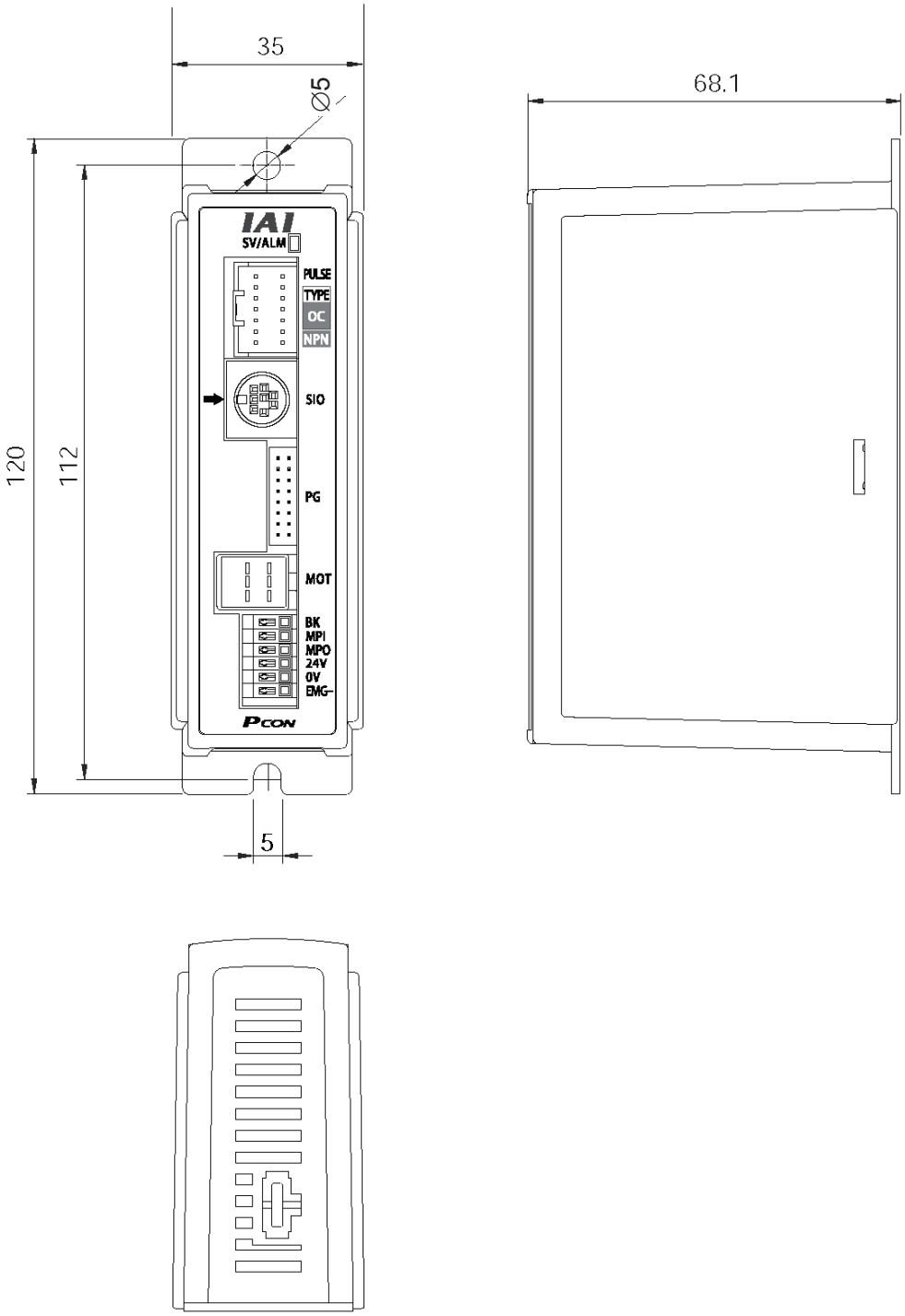
BK	Connection terminal for the brake forced-release switch to be used when the actuator is equipped with a brake. Connect the opposite side of the switch to 24 VDC.
MPI, MPO	Contacts for cutting off the motor drive power to achieve a safety level of safety category 1. MPI and MPO connect to the input side and output side of the motor power supply, respectively. (If these contacts are not used, connect them using a jumper cable. The controller is shipped with MPI and MPO connected by a jumper cable.)
24 V	Positive side of the 24-VDC input power supply.
0 V	Negative side of the 24-VDC input power supply.
EMG-	Connection terminal for the emergency stop circuit (for cutting of motor drive signals). A common ground is used, so connect the opposite side of the emergency stop switch (or contacts) to the positive side of the 24-VDC input power supply.

■ Model indication of the connected actuator type
The type, ball screw lead and stroke of the actuator are indicated. When connecting the cables, confirm that the actuator is of the correct specifications.
Example of indication:

RA4C ← The actuator type is RA4C.
L：5mm ← The ball screw lead is 5 mm.
ST：200 ← The stroke is 200 mm.

2.3 External Dimensions

An external view and dimensions of this product are shown below.



3. Installation and Wiring

Pay due attention to the environment where the controller is installed.

3.1 Installation Environment

This product is capable for use in the environment of pollution degree 2[*1] or equivalent.
*1 Pollution Degree 2 : Environment that may cause non-conductive pollution or transient conductive pollution by frost (IEC60664-1)

[1] Installation Environment

Do not use this product in the following environment.

- Location where the surrounding air temperature exceeds the range of 0 to 40°C
- Location where condensation occurs due to abrupt temperature changes
- Location where relative humidity exceeds 85%RH
- Location exposed to corrosive gases or combustible gases
- Location exposed to significant amount of dust, salt or iron powder
- Location subject to direct vibration or impact
- Location exposed to direct sunlight
- Location where the product may come in contact with water, oil or chemical droplets
- Environment that blocks the air vent [Refer to 3.3 Noise Elimination Measures and Grounding]

When using the product in any of the locations specified below, provide a sufficient shield.

- Location subject to electrostatic noise
- Location where high electrical or magnetic field is present
- Location with the mains or power lines passing nearby

[2] Storage and Preservation Environment

- Storage and preservation environment follows the installation environment. Especially, when the product is to be left for a long time, pay special attention to condensed water.
  Unless specially specified, moisture absorbency protection is not included in the package when the machine is delivered. In the case that the machine is to be stored in an environment where dew condensation is anticipated, take the condensation preventive measures from outside of the entire package, or directly after opening the package.

3.2 Supplied Voltage

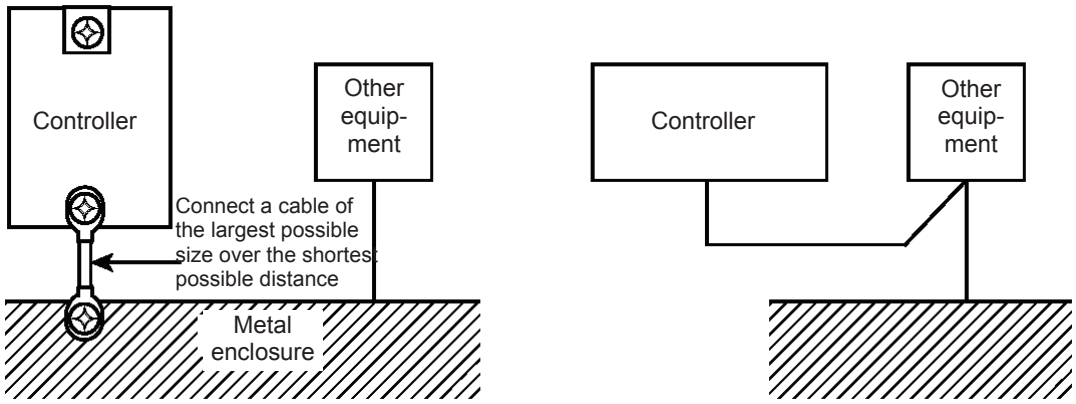
The controller takes a supplied voltage of 24 VDC ± 10%.
(Maximum power-supply current: 2 A)

3.3 Noise Elimination Measures and Grounding

The following explains the noise elimination measures that should be taken when using this controller.

(1) Wiring and power connection

[1] Provide dedicated class-D grounding using a grounding wire with a size of 2.0 to 5.5 mm^2 or larger.



Class-D grounding Good Avoid this pattern.

[2] Cautions on wiring method

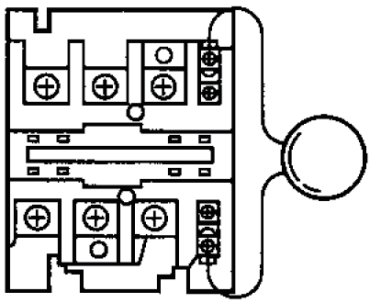
Use a twisted cable to connect the 24-VDC external power supply.
Separate the controller wiring from high-power lines of motive power circuits, etc. (Do not tie them together or place in the same cable duct.)
If you want to extend the motor or encoder cable beyond the length of the supplied cable, contact IAI.

(2) Noise sources and elimination

Noise generates from many sources, but the most common sources of noise you should consider when designing a system are solenoid valves, magnet switches and relays. Noise generation from these components can be prevented by the method explained below.

AC solenoid valves, magnet switches, relays

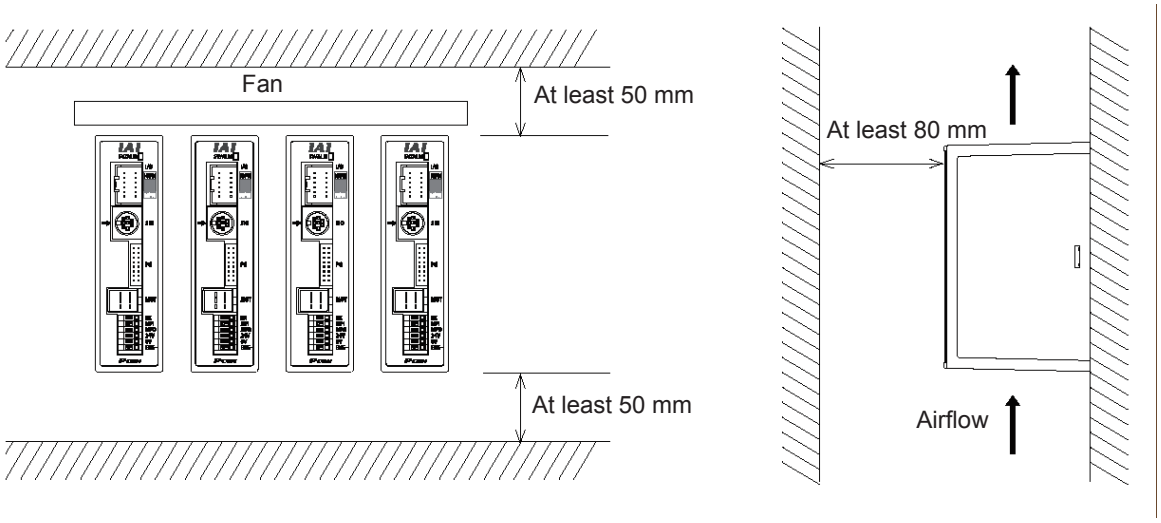
Method --- Install a surge absorber in parallel with the coil



← Point
Connect to each coil over the shortest possible wiring distance.
When a surge absorber is installed on the terminal block, etc., its noise elimination effect will decrease if the distance from the coil is long.

3.4 Heat Radiation and Installation

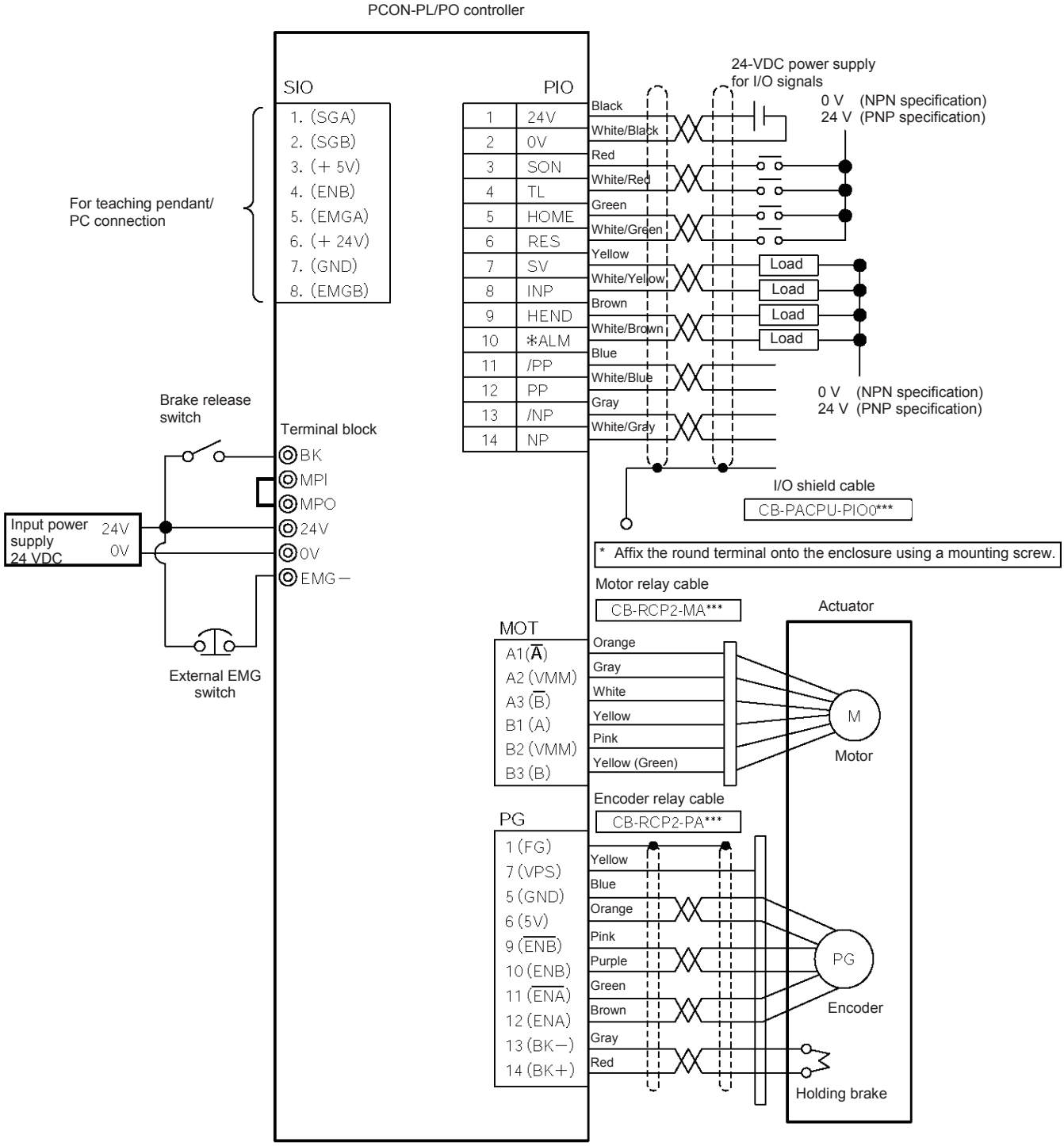
Design the control panel size, controller layout and cooling method so that the temperatures around the controller will always be kept to 40?C or below.
Mount the controller vertically on the wall, as shown below. Since cooling is provided by means of natural convection, follow this orientation and provide a minimum clearance of 50 mm above and below the controller to allow sufficient airflows to circulate.
If you are installing multiple controllers side by side, provide a fan on top of the controllers to agitate the airflows as an effective way to keep the surrounding temperatures constant.
Provide a minimum clearance of 80 mm between the front face of the controller and the wall (cover).



Regardless of whether you are installing one or more controllers, provide sufficient clearances around each controller to permit easy access for installation and removal of the controller.

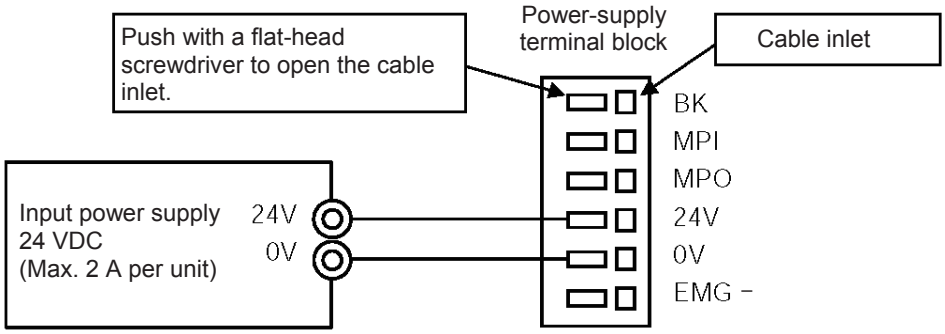
3.5 External Connection Diagram

An example of standard wiring is shown below.
The wire colors of the robot encoder relay cable are different from those of the standard encoder relay cable. Refer to 3.9.2, “Encoder Relay Cable.”

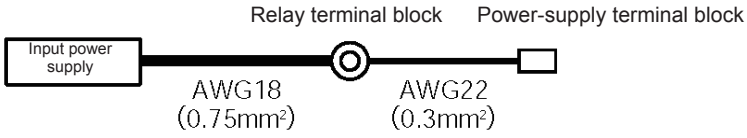
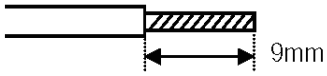


3.6 Wiring the Power Supply

Connect the positive side and negative side of the 24-VDC power supply to the 24-V terminal and N terminal on the power-supply terminal block, respectively.

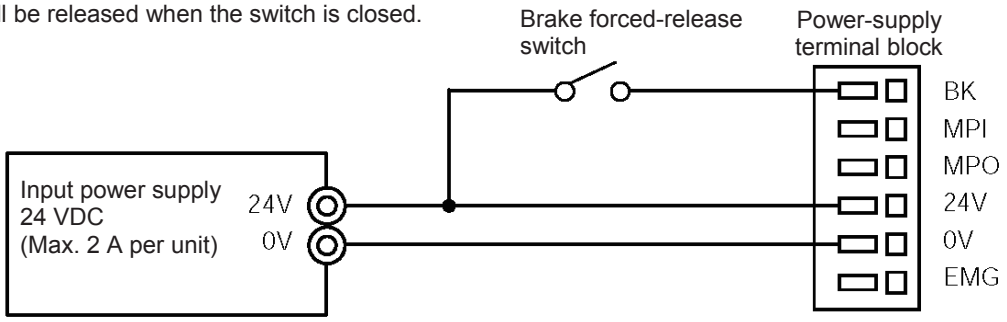


Use a wire satisfying the following specifications.

Item	Specification
Applicable wire	Twisted wire: AWG 22 (0.3 mm^2) (copper wire) (Note) Provide proper termination to prevent shorting due to contact with wire offcut. If the wiring path is long, provide a relay terminal block and connect the original wire to another wire of a different size. 
Temperature rating of insulation sheath	60°C or above
Length of bare wire	

3.7 Wiring the Brake Forced-release Switch

If the actuator is equipped with a brake, provide a forced-release switch to permit a reset means during startup adjustment or in case of emergency.
The customer must provide the switch (24 VDC, with a minimum contact capacity of 0.2 A).
Connect one side of the switch to the positive side of the 24-VDC power supply, and connect the other side to the BK terminal on the power-supply terminal block.
The brake will be released when the switch is closed.



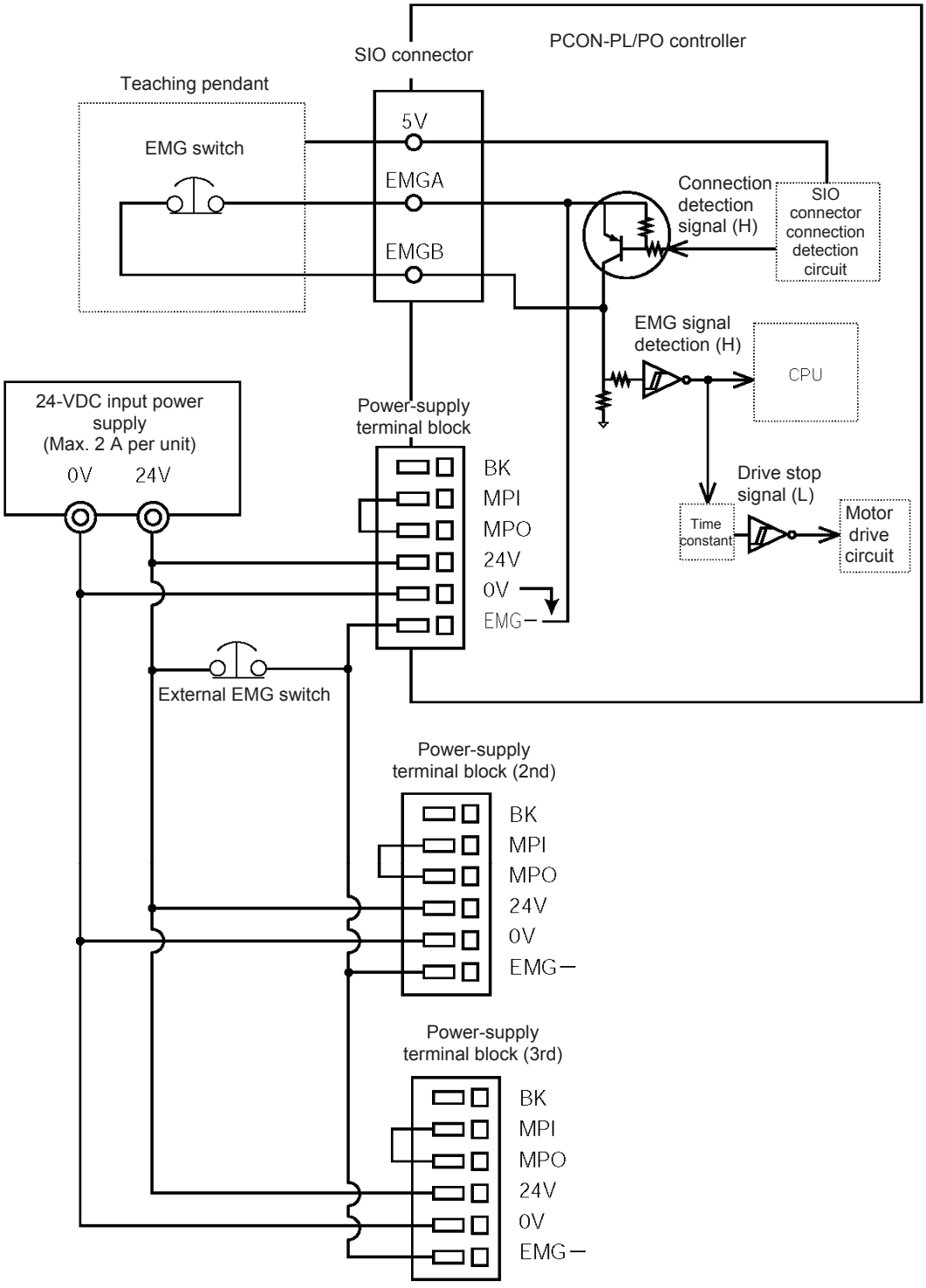
Danger: If the actuator is oriented vertically, exercise due caution when releasing the brake to prevent the slider/rod from dropping unexpectedly to pinch your hand or damage the robot hand or work.

3.8 Wiring the Emergency Stop Circuit

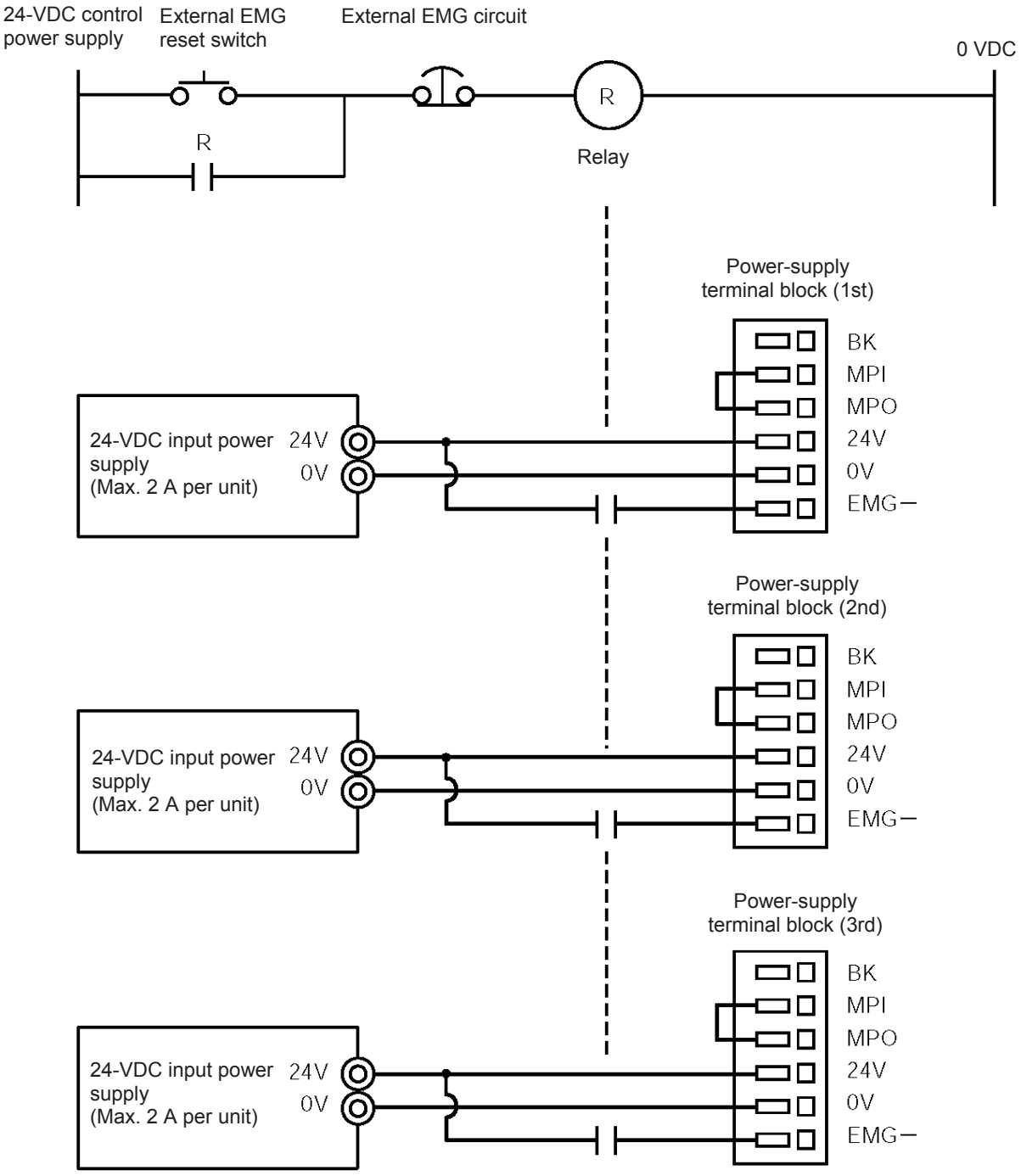
3.8.1 Cutting Off the Drive Signal (Standard)

Connect one side of the external EMG switch to the positive side of the 24-VDC power supply, and connect the other side to the BK terminal.

(Note) The EMG switch on the teaching pendant works only on the controller connected to the switch.



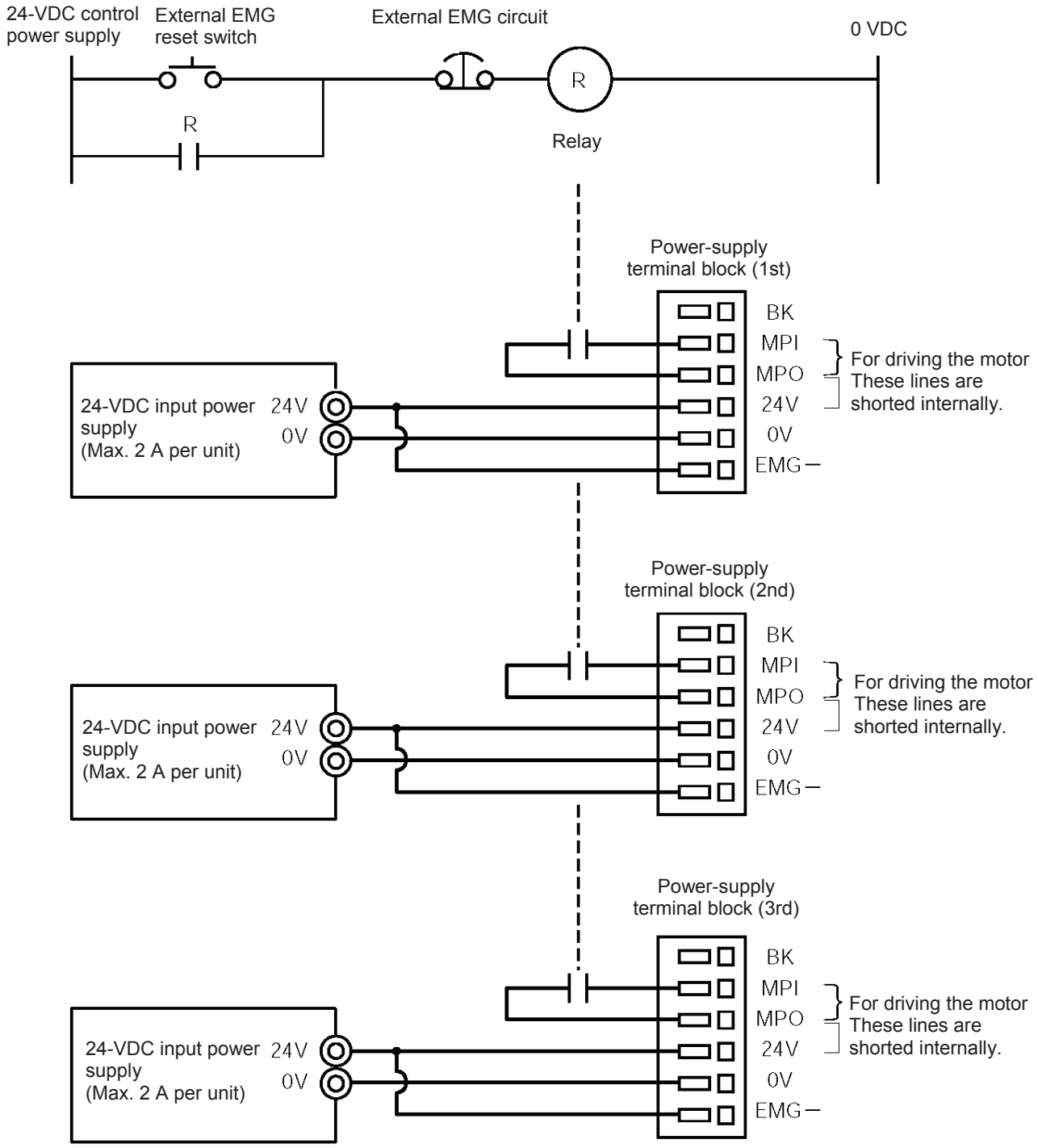
If a separate emergency stop circuit is provided to stop the entire system, or when multiple controllers are linked together and each controller has a different power supply, connect external EMG relay contacts.



3.8.2 Cutting Off the Motor Drive Power

If the motor drive power must be cut off in order to meet the required safety category of the entire system, connect external EMG relay contacts between the MPI terminal and MPO terminal.
Also connect the 24-V controller power supply to the EMG terminal.

(Note) The EMG switch on the teaching pendant cuts off the motor driver signal. It does not cut off the motor drive power.



3.9 Connecting the Actuator

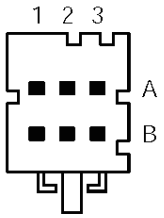
3.9.1 Motor Relay Cable

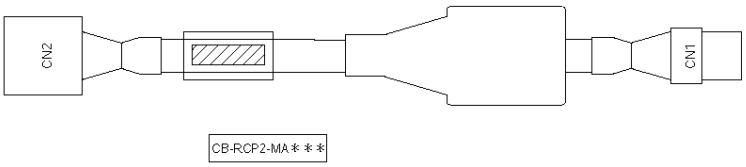
• Connect the motor relay cable to the MOT connector.
Signal table of controller-end connector (CN2)

Pin No.	Signal	Wire color	Description
A1	$\overline{A}$	Orange	Motor drive line (phase -A)
A2	VMM	Gray	Motor power line
A3	$\overline{B}$	White	Motor drive line (phase -B)
B1	A	Yellow	Motor drive line (phase +A)
B2	VMM	Pink	Motor power line
B3	B	Yellow (Green)	Motor drive line (phase +B)

Controller end

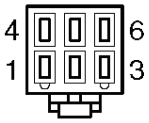
CN2 pin layout





Actuator end

CN1 pin layout



CN2

Cable color	Signal abbreviation	Pin No.
Orange	$\overline{A}$	A1
Gray	VMM	A2
White	$\overline{B}$	A3
Yellow	A	B1
Pink	VMM	B2
Yellow (Green)	B	B3

Housing: 1-1318119-3 (AMP)
Receptacle contact: 1318107-1

CN1

Pin No.	Signal abbreviation	Cable color
1	A	Yellow
2	VMM	Gray
3	$\overline{A}$	Orange
4	B	Yellow (Green)
5	VMM	Pink
6	$\overline{B}$	White

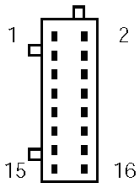
Housing: SLP-06V (J.S.T. Mfg.)
Socket contact: BSF-21T-P1.4

3.9.2 Encoder Relay Cable

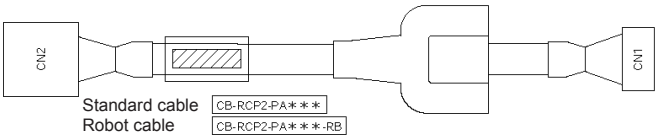
• Connect the encoder relay cable to the PG connector.
Signal table of controller-end connector (CN2)

Pin No.	Signal abbreviation	Description
1	F.G	Shielded wire
2	-	(Not used)
3	-	(Not used)
4	-	(Not used)
5	GND	Encoder power output
6	5V	
7	VPS	Encoder control signal output
8	-	(Reserved)
9	$\overline{ENB}$	Encoder differential signal phase-B input
10	ENB	
11	$\overline{ENA}$	Encoder differential signal phase-A input
12	ENA	
13	BK -	Brake power –
14	BK +	Brake power +
15	LS -	Home check sensor
16	LS +	

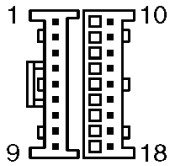
Controller end
CN2 pin layout



CN2



Actuator end
CN1 pin layout



Cable color		Signal abbreviation	Pin No.
Robot cable	Standard cable		
–	–	LS+	16
–	–	LS-	15
Purple	Red	BK+	14
White (vs.Purple)	Gray	BK-	13
Blue	Brown	ENA	12
White (vs. Blue)	Green	$\overline{ENA}$	11
Yellow	Purple	ENB	10
White (vs.Yellow)	Pink	$\overline{ENB}$	9
–	–	(Reserved)	8
Green	Yellow	VPS	7
Red	Orange	5V	6
White (vs. Red)	Blue	GND	5
–	–	–	4
–	–	–	3
–	–	–	2
Drain	Drain	F.G	1

Housing: PHDR-16VS (J.S.T. Mfg.)
Contact: SPHD-001T-P0.5

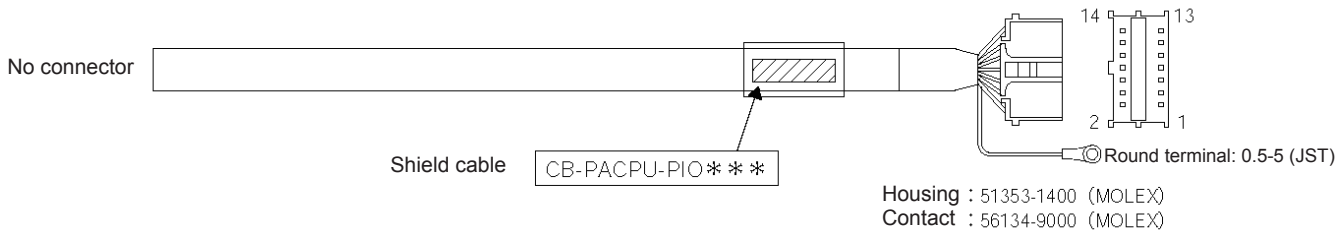
CN1

Pin No.	Signal abbreviation	Cable color	
		Standard cable	Robot cable
1	ENA	Brown	Blue
2	$\overline{ENA}$	Green	White (vs. Blue)
3	ENB	Purple	Yellow
4	$\overline{ENB}$	Pink	White (vs. Yellow)
5	–	–	–
6	–	–	–
7	–	–	–
8	–	–	–
9	GND	Blue	White (vs. Red)
10	5V	Orange	Red
11	VPS	Yellow	Green
12	–	–	–
13	–	–	–
14	–	–	–
15	–	–	–
16	BK+	Red	Purple
17	BK-	Gray	White (vs. Purple)
18	F.G	Drain	Drain

Housing: XMP-18V (J.S.T. Mfg.)
Contact: BXA-001T-P0.6
Retainer: XMS-09V

3.10 Connecting the I/O Shield Cable

Cable model: CB-PACPU-PIO***
(Note: *** indicates the cable length. (Example) 2 m: 020)

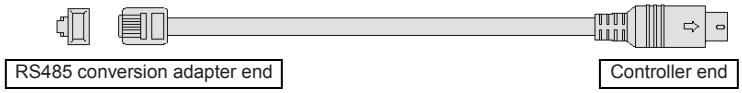


Pin No.	Color	Name	Remarks
1	Black	External 24 V	
2	White/Black	External ground	If the controller is used in the open collector mode, also use this pin for the COMMON signal for command pulses.
3	Red	SON	Servo-on signal
4	White/Red	TL	Torque-limit selection signal
5	Green	HOME	Homing signal
6	White/Green	RES/DCLR	Reset signal/deviation-counter clear signal
7	Yellow	SV	Servo-on output
8	White/Yellow	INP/TLR	Positioning complete signal/torque limit signal
9	Brown	HEND	Homing complete signal
10	White/Brown	*ALM	Alarm signal
11	Blue	Command pulse (/PP)	
12	White/Blue	Command pulse (PP)	Not connected if the controller is used in the open collector mode.
13	Gray	Command pulse (/NP)	
14	White/Gray	Command pulse (NP)	Not connected if the controller is used in the open collector mode.
-	-	FG	Shield (connected to the enclosure)

⚠ Caution:
- Do not apply excessive stress to the connector part by, for example, pulling the cable while a shielded cable is connected to the controller.
- Do not apply force to the connector on a tilt when connecting or disconnecting the shielded cable.

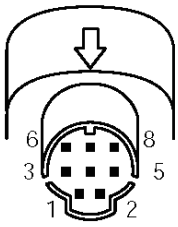
3.11 Connecting the Communication Cable

Connect the communication cable to the SIO connector.



CB-RCA-SIO＊＊＊

Pin layout of cable-end connector



Cable color	Signal abbreviation	Pin No.
Brown	5V	1
Yellow	SGA	2
Red	GND	3
Orange	SGB	4
Blue	GND	5
Green	5V	6

Shorting wire UL1004AWG28 (Black)

Not connected to the shield.

Pin No.	Signal abbreviation	Cable color
1	SGA	Yellow
2	SGB	Orange
3	5V	Brown/Green
4	ENB	—
5	EMGA	Black
6	24V	—
7	GND	Red/Blue
8	EMGB	Black
FG		Shield

4. Operation Using I/O Signals

This chapter explains the wire connections and operation timings you should know in order to perform positioning operation using a PLC with I/O signals. Two PIO patterns are available for you to choose from in accordance with your specific application.

PIO pattern	Setting (User Parameter No. 25)
Standard type (factory setting)	0
Push type	1

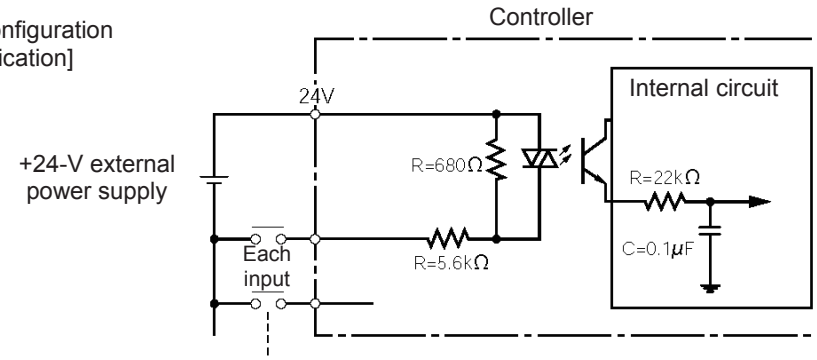
4.1 Interface Circuit

The standard interface circuit conforms to the NPN specification, but the PNP specification type is also available as an option.
To simplify wiring, a common power line is used for both the NPN specification and PNP specification. Accordingly you need not reverse the power connections when using the PNP specification.

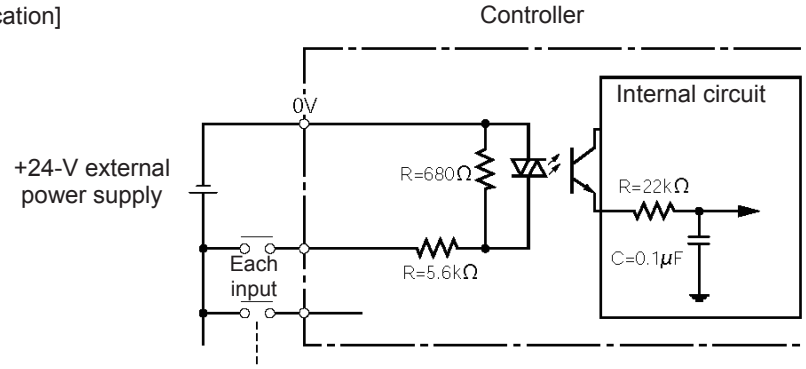
4.1.1 External Input Specifications

Item	Specification
Number of input points	4 points
Input voltage	24 VDC ± 10%
Input current	5 mA per circuit
Operating voltage	ON voltage: Min. 18 V (3.5 mA) OFF voltage: Max. 6 V (1 mA)
Leak current	Max. 1 mA per point
Insulation method	Photocoupler

Internal circuit configuration
[NPN specification]



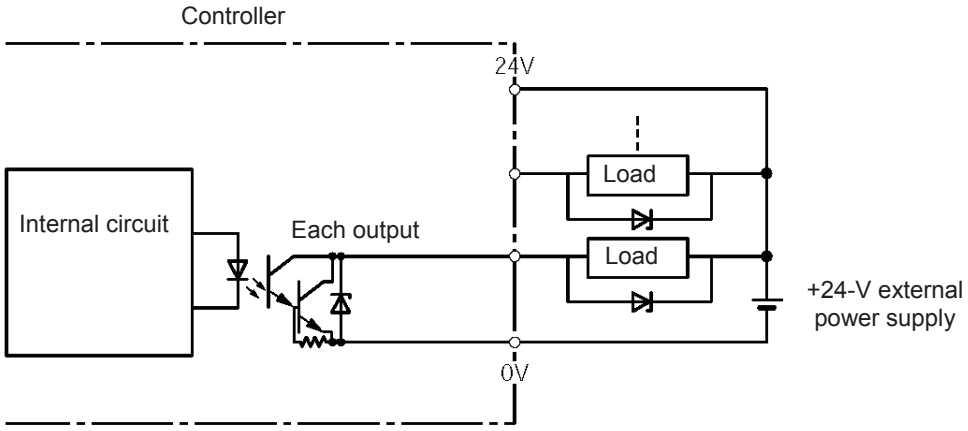
[PNP specification]



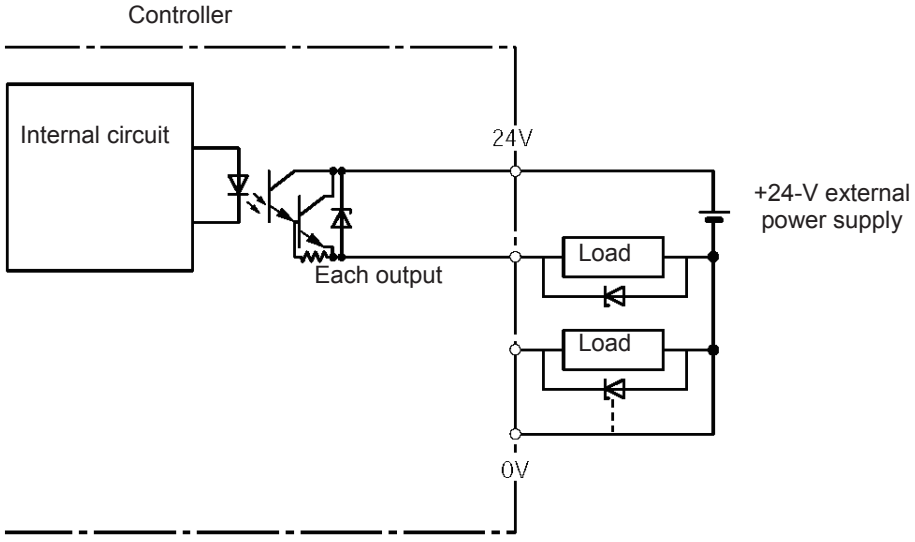
4.1.2 External Output Specifications

Item	Specification
Number of output points	4 points
Rated load voltage	24 VDC
Maximum current	50 mA per point
Residual voltage	Max. 2 V
Insulation method	Photocoupler

Internal circuit configuration
[NPN specification]

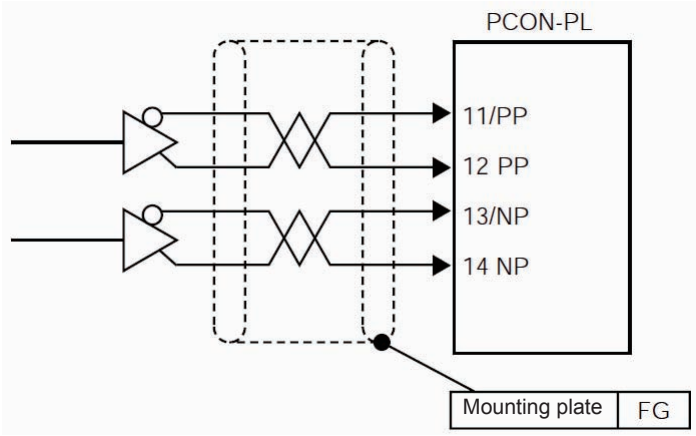


[PNP specification]



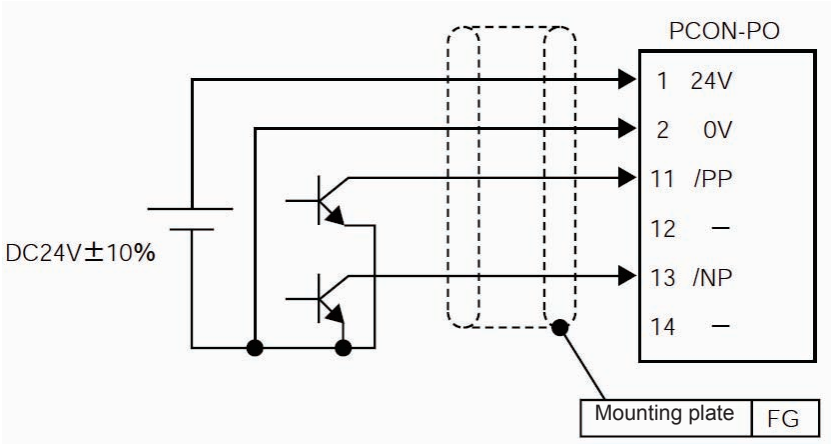
4.1.3 Command Pulse Train Input Specifications

[Input using a differential line driver]
Applicable line driver: 26C31 or equivalent



Note Always connect the shield of the twisted pair cable joined to the connector, to the mounting plate.

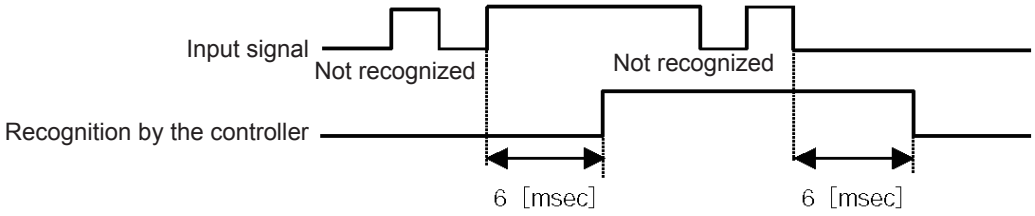
[Input using an open collector]



Note 1 Always connect the shield of the twisted pair cable joined to the connector, to the mounting plate.
Note 2 Some open collector outputs have built-in pull-up resistors, but in such case, either remove the pull-up resistor or use a port that does not have a pull-up resistor.
(Provide 24 V for pulse train input.)

4.1.4 Recognition of Input Signals

The input signals of this controller have an input time constant to prevent malfunction due to chattering, noise, etc. Each input signal is switched when the new signal state has continued for at least 6 msec.
In other words, when the input is switched from OFF to ON, the controller will recognize that the input signal is ON after 6 msec. The same applies when the input is switched from ON to OFF.
* Excluding command pulse input (PP•/PP, NP•/NP).



4.1.5 Notes on the ROBO Gripper

(1) Finger Operation

[1] Definition of position

With the two-finger type, the stroke specification indicates the total sum of travels by both fingers. In other words, the travel by one finger is one-half this stroke.

A position is specified as a travel by one finger from the home position toward the closing direction. Therefore, the maximum command value is 5 mm for the GRS type, and 7 mm for the GRM type.

[2] Definition of speed and acceleration

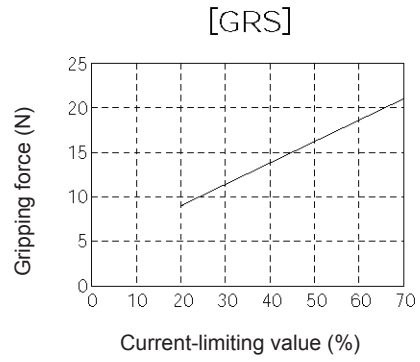
The command value applies to one finger.

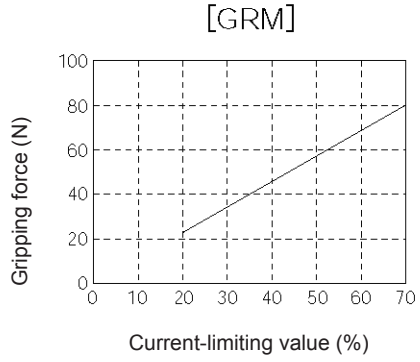
With the two-finger type, the relative speed and acceleration are double the command values, respectively.

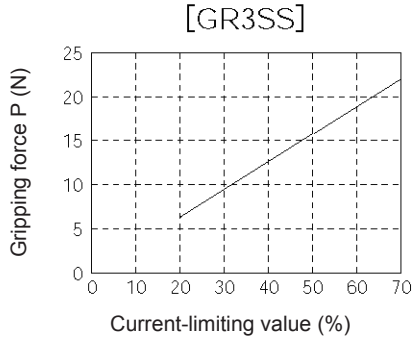
[3] Gripper operation mode

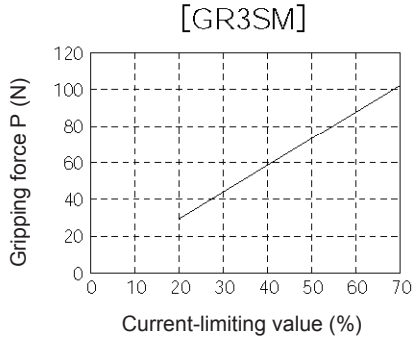
In applications where the work is to be gripped, be sure to use the “push-motion mode.”

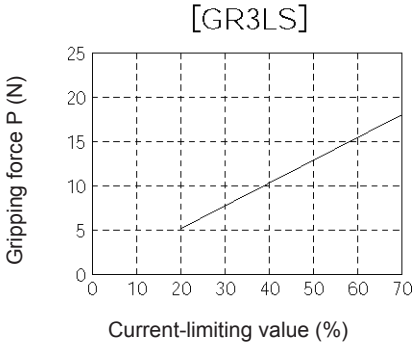
[Diagram of gripping force and current-limiting value]

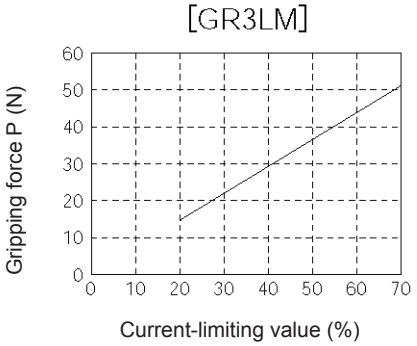








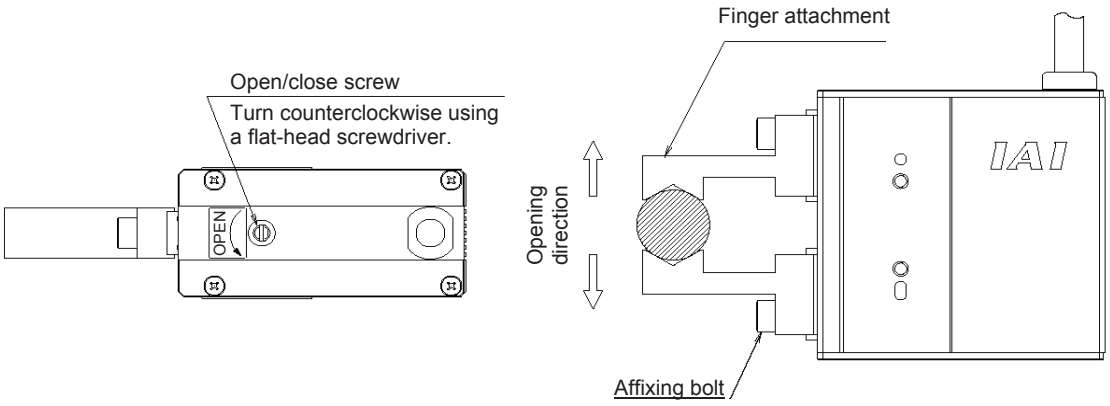




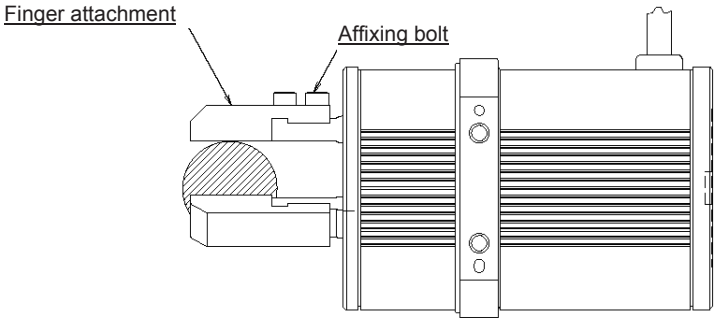
(2) Removing the gripped work

The ROBO Gripper is structured in such a way that even when the controller power is cut off, the work gripping force will still be maintained by a self-lock mechanism.
If you must remove the gripped work while the power is cut off, turn the open/close screw or remove one of the finger attachments to release the work.

[Two-finger type]
Turn the open/close screw or remove one of the finger attachments.



[Three-finger type]
Remove one of the finger attachments.



4.2 Standard Type

Choose the PIO pattern of this type if you wish to perform position control using pulse train input from a PLC.
Set User Parameter No. 25 (PIO pattern selection) to “0.” (This parameter has been set to the “standard type” prior to the shipment).

4.2.1 Explanation of I/O Signals

Pin No.	Signal	Name	Remarks
1	24 V	External 24 V	
2	0 V	External ground	If the controller is used in the open collector mode, also use this pin for the COMMON signal for command pulses as well as the 0V signal for the controller’s control power.
3	IN0	SON	Servo-on signal
4	IN1	TL	Torque-limit selection signal
5	IN2	HOME	Homing signal
6	IN3	RES	Reset signal
7	OUT0	SV	Servo-on output
8	OUT1	INP	Positioning complete signal
9	OUT2	HEND	Homing complete signal
10	OUT3	*ALM	Alarm signal
11	/PP	Command pulse	
12	PP	Command pulse	Not connected if the controller is used in the open collector mode.
13	/NP	Command pulse	
14	NP	Command pulse	Not connected if the controller is used in the open collector mode.

■ Servo-on Command Input (SON)
The servo remains on while this signal is ON.
The actuator can be operated while the SON signal is ON.
While this signal is OFF, the actuator does not operate even when the controller power is supplied.
If the SON signal is turned OFF while the actuator is operating, the actuator will decelerate at the forced-stop torque until it stops. After the actuator stops, the servo will turn off and the motor will enter a free-run state.
At this time, the function specified by the applicable parameter (electromagnetic brake) becomes active (provided that the actuator is equipped with a brake).
When the servo turns off, the deviation counter will be cleared if User Parameter No. 58 (Clear deviation at servo off/alarm stop) is set to “Enable.”

■ Reset Signal Input (RES)
This signal resets the alarms currently detected by the controller.
You can turn the RES signal ON to reset the alarms currently detected by the controller.

⚠ Caution: This signal cannot reset cold-start level alarms. Identify the cause of each alarm and remove the cause before restarting the controller.

■ Torque-limit Selection Signal (TL)
This signal limits the motor torque.
While this signal is ON, the actuator thrust (motor torque) is limited to the torque set in User Parameter No. 57 (Torque limit).

⚠ Caution: Excessive deviation (standing pulses) may generate while torque is limited (while the TL signal is ON) (for example, when the actuator receives load and is prevented from moving just like in push-motion operation).
If the TL signal is turned OFF in this condition, the controller will instantly start controlling the actuator at the maximum torque and the actuator may move suddenly or run out of control.

This signal can be disabled using User Parameter No. 61 (Torque-limit command input). Disable the TL signal if it is not used.

■ Homing Signal (HOME)
This command signal is used to perform homing automatically.
The homing command is processed at the leading edge (ON edge) of the HOME signal to cause the actuator to return to its home automatically.
When the homing is completed, the HEND (homing complete) output signal turns ON.
Program the host controller (PLC) so that its current-value register will be reset to the home (“0” will be input to the register) by the current-value preset function, etc., upon turning ON of the HOME signal.
* This signal is always enabled as long as the servo is on.
* Even after homing has been performed once, homing can be performed again by turning the HOME signal ON.

⚠ Caution:
- The HOME signal is given priority over pulse train commands. Even while the actuator is moving under a pulse train command, it will start moving to the home once the HOME signal is turned ON.
- The HOME signal is processed only at its leading edge (ON edge).
- If the SON signal turns OFF or an alarm is detected during homing, the homing operation will stop. If the servo turns off, the homing command will be cancelled even if the HOME signal is still ON. To perform homing again, turn the HOME signal OFF, and then turn it back ON.
- The actuator can be operated without using this function. If this function is not used, however, all management actions over position data will be left to the host controller.
  In this case, take necessary measures to prevent an over-stroke error, such as not sending pulse commands exceeding the effective stroke, or providing external limit switches or other devices for detecting stroke ends to forcibly stop the actuator upon detection of a stroke end.

■ Command Pulse Input

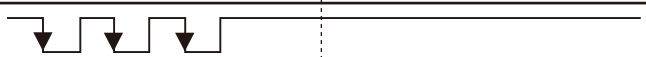
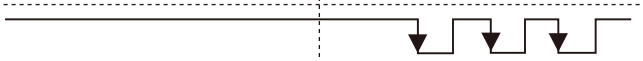
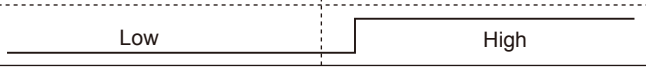
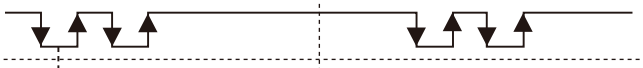
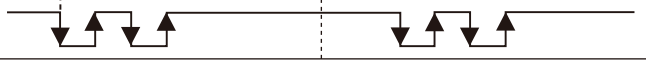
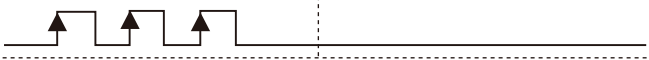
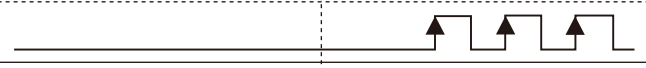
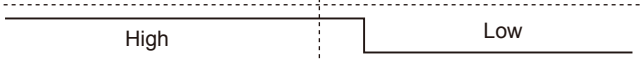
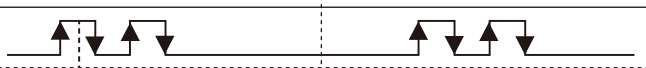
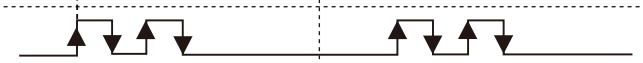
Command pulses can be input in the open collector mode (MAX 60 kpps) or differential line driver mode (MAX 200 kpps).

You can select a desired input pattern of command pulses from 90° phase-difference (phase-A/B x4) signal, pulse train + forward/reverse signal, and forward pulse/reverse pulse. The positive logic or negative logic can be selected for each of these patterns.

⚠ Caution:
- The actuator moves in the negative direction (the motor runs in the forward direction) when forward pulses are input, and moves in the positive direction (the motor runs in the reverse direction) when reverse pulses are input. (These directions are reversed if the actuator is of motor reversing type.)
- When determining the forward/reverse directions, pay attention to the host controller setting as well as the PP•/PP and NP•/NP connection.
- For actuator accelerations/decelerations, set values not exceeding the rated acceleration/deceleration of the actuator. (The rated acceleration/deceleration of each actuator is specified in the actuator's catalog.)

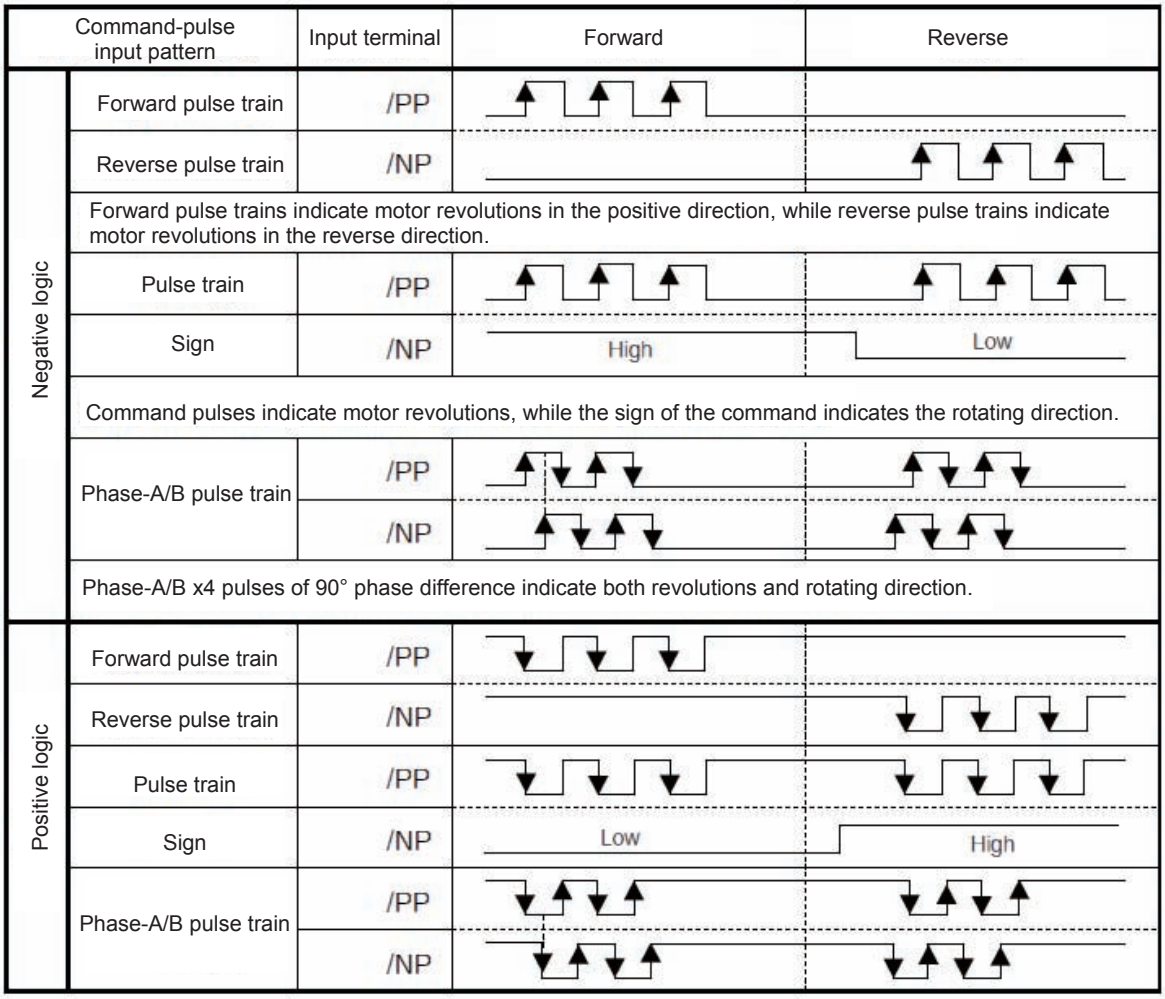
* The motor direction is determined based on CCW representing the forward direction when viewed from the load-end of the shaft.

- You can set one of six command pulse patterns in the command-pulse input mode.

Command-pulse input pattern		Input terminal	Forward	Reverse
Negative logic	Forward pulse train	PP・/PP		
	Reverse pulse train	NP・/NP		
	Forward pulse trains indicate motor revolutions in the positive direction, while reverse pulse trains indicate motor revolutions in the reverse direction.			
	Pulse train	PP・/PP		
	Sign	NP・/NP	 Low	High
	Command pulses indicate motor revolutions, while the sign of the command indicates the rotating direction.			
	Phase-A/B pulse train	PP・/PP		
		NP・/NP		
	Phase-A/B x4 pulses of 90° phase difference indicate both revolutions and rotating direction.			
Positive logic	Forward pulse train	PP・/PP		
	Reverse pulse train	NP・/NP		
	Pulse train	PP・/PP		
	Sign	NP・/NP	High	 Low
	Phase-A/B pulse train	PP・/PP		
		NP・/NP		

(Note) The figures shown above are an image when a command pulse input is made on the differential line driver. The pulse waveform reverses as shown in the next page when the pulse is input on the open collector.

Shown below is an image when a command pulse input is made on the open collector.



■ Positioning Complete Signal (INP)
This signal turns ON when the deviation in the deviation counter (standing pulses) is within the positioning band. It remains OFF while the servo is off.

⚠ Caution:
- This signal turns ON when the servo is turned on (to perform positioning at the present position).
- This signal turns ON simply due to accumulation of deviation (standing pulses). Therefore, setting an excessively wide positioning band in the applicable position control parameter will cause the INP signal to turn ON once the actuator enters the positioning band during low-speed operation (before positioning is completed).
- The INP signal is recognized even when the TL signal is ON.

■ Homing Complete Signal (HEND)
This signal turns ON after homing has completed and the coordinate system has been established.
It turns ON upon completion of homing initiated by the HOME signal or a command from the teaching pendant or PC software.
This signal turns OFF once the servo turns off. Perform homing again after the servo has turned off.

⚠ Caution:
- The software stroke limits set by the corresponding actuator parameters are effective only while this signal is ON.
- The actuator can be operated without using this function. In this case, however, take necessary measures, such as not sending pulse commands exceeding the effective stroke, or providing external limit switches for detecting stroke ends to forcibly stop the actuator upon detection of a stroke end.

■ Servo-on Output Signal (SV)
When the SON (servo-on) signal turns ON, the servo turns on. As the controller subsequently enters a ready state (where it can accept pulse train input) (the condition where the controller can accept pulse train input = pulse mode), this signal turns ON.
This signal turns OFF when the servo is turned off upon turning OFF of the SON signal.
This signal is linked to the LED (green light) on the front panel of the controller.

■ Alarm Signal (*ALM)
This signal turns OFF when the controller's protective circuit (function) has actuated following an alarm detection and the basic cutoff procedure has been implemented as a result.
The signal will turn ON if the RES (reset) signal is turned ON after the cause of the alarm has been removed (except when the alarm relates to a cold-start level error).
When an alarm is detected, a red LED light will illuminate on the front panel of the controller. A green LED remains on while the controller is operating normally.

⚠ Caution:
- Identify the cause of each alarm and remove the cause before restarting the controller.
  You can check alarm codes using the teaching pendant or PC software. The controller can store data of up to 16 most recent alarms. This alarm history data will be retained even after the power is cut off.
  Each alarm record is displayed with the time it was generated, so you can check which alarm occurred when.
- For details on alarm history, refer to 6.3, "Alarms, Causes and Actions."

4.2.2 Setting Parameters Required for Operation

The following parameters must always be set prior to every operation.
(These parameters are all you need to set to perform operations that only involve positioning.)

(1) Electronic gear

User Parameter Nos. 65 and 66 (Electronic gear numerator and denominator)

Name	Symbol	Unit	Input range	Default (reference)
Electronic gear numerator	CNUM	-	1 to 4096	200
Electronic gear denominator	CDEN	-	1 to 4096	15

These parameters are used to determine the unit travel distance of the actuator per one pulse in input command pulse train.
Unit travel distance of linear-motion axis = Minimum travel unit (1, 0.1, 0.01 mm, etc.)/pulse
Unit travel distance of rotational axis = Minimum travel unit (1, 0.1, 0.01 deg, etc.)/pulse

■ Calculation Formula for Electronic Gear

Linear-motion axis

$$\frac{\text{Electronic gear numerator (CNUM)}}{\text{Electronic gear denominator (CDEN)}} = \frac{\text{Encoder pulses (Pulse/rev)}}{\text{Ball screw lead length (mm/rev)}} \times \text{Unit travel distance (mm/Pulse)}$$

Rotational axis

$$\frac{\text{Electronic gear numerator (CNUM)}}{\text{Electronic gear denominator (CDEN)}} = \frac{\text{Encoder pulses (Pulse/rev)}}{\text{360 (deg/rev) x Gear ratio of rotational axis}} \times \text{Unit travel distance (deg/Pulse)}$$

Reference

The actuator speed is calculated as follows:
Speed = Unit travel distance x Input pulse frequency (Hz)
Take note that if the unit travel distance is too small, the actuator may not be able to reach the maximum speed.

Table of encoder pulses and lead lengths for different models

Actuator type(s)	Encoder pulses (Pulse/rev)	Lead length
SA5C/SA6C/SA7C/SS7C/SS8C SA5R/SA6R/SA7R/SS7R/SS8R RA2C/RA3C/RA4C/RA6C RGS4C/RGS6C/RGD3C/RGD4C/RGD6C	800	Check the lead length shown on the controller front panel
BA6/BA6U/BA7/BA7U	800	54
GRS	800	1
GRM	800	1.1
GR3LS/GR3LM	800	12
GR3SS	800	2.5
GR3SM	800	3
RTB (Gear ratio 1/20)/ RTC (Gear ratio 1/20)	800	18
RTB (Gear ratio 1/30)/ RTC (Gear ratio 1/30)	800	12

■ Calculation Example

Operate an actuator with a ball screw lead of 6 mm equipped with an encoder of 800 pulses/rev, at a unit travel distance to 0.1 mm (1/10).

* Encoder pulses are 800 pulses/rev for all RCP2 models.

$$\frac{\text{Electronic gear numerator (CNUM)}}{\text{Electronic gear denominator (CDEN)}} = \frac{\text{Encoder pulses (Pulse/rev)}}{\text{Ball screw lead length (mm/rev)}} \times \text{Unit travel distance (mm/Pulse)}$$

$$= \frac{800}{6} \times \frac{1}{10} = \frac{40}{3}$$

The electronic gear numerator (CNUM) and electronic gear denominator (CDEN) are 40 and 3, respectively. Based on these settings, the travel distance per one pulse in input command pulse train is calculated as 0.1 mm.

⚠ Caution:

- Set both the electronic gear numerator (CNUM) and electronic gear denominator (CDEN) as integers not exceeding 4,096, by reducing them as much as possible with a common divisor.
  Also, CNUM and CDEN must satisfy the relational expression specified below.

$$2^{31} \geq \frac{\text{Stroke length (mm)}}{\text{Ball screw lead length (mm/rev)}} \times \text{Encoder pulses (Pulse)} \times \text{(CNUM)}$$

$$2^{31} \geq \frac{\text{Stroke length (mm)}}{\text{Ball screw lead length (mm/rev)}} \times \text{Encoder pulses (Pulse)} \times \text{(CDEM)}$$

- Do not set a minimum travel unit smaller than the encoder resolution.

$$\text{Encoder resolution for linear-motion axis (mm/Pulse)} = \frac{\text{Ball screw lead length (mm/rev)}}{\text{Encoder pulses (Pulse/rev)}}$$

$$\text{Encoder resolution for rotational axis (deg/Pulse)} = \frac{\text{300 (deg/rev) x Gear ratio of rotational axis}}{\text{Encoder pulses (Pulse/rev)}}$$

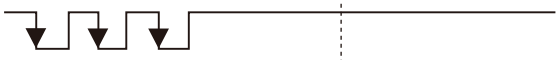
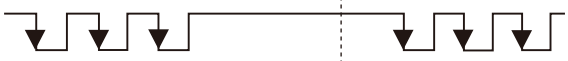
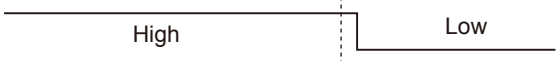
The actuator will not move unless enough command pulses accumulate to reach or exceed the encoder resolution.

(2) Command Pulse Mode

User Parameter No. 63 (Command-pulse input mode)

Name	Symbol	Unit	Input range	Default (reference)
Command-pulse input mode	MOD	-	0 to 2	1

Set a pulse-train input pattern for command pulse input (PP•/PP, NP•/NP).
* The setting of positive logic or negative logic is explained in (3), “Input Polarity in the Command Pulse Mode.”

Command-pulse input pattern		Input terminal	Forward	Reverse	Setting
Negative logic	Forward pulse train	PP・/PP			2
	Reverse pulse train	NP・/NP			
	Forward pulse trains indicate motor revolutions in the positive direction, while reverse pulse trains indicate motor revolutions in the reverse direction.				
	Pulse train	PP・/PP			1
	Sign	NP・/NP			
	Command pulses indicate motor revolutions, while the sign of the command indicates the rotating direction.				
	Phase-A/B pulse train	PP・/PP			0
		NP・/NP			
	Phase-A/B x4 pulses of 90° phase difference indicate both revolutions and rotating direction.				
Positive logic	Forward pulse train	PP・/PP			2
	Reverse pulse train	NP・/NP			
	Pulse train	PP・/PP			1
	Sign	NP・/NP			
	Phase-A/B pulse train	PP・/PP			0
		NP・/NP			

(Note) The figures shown above are an image when a command pulse input is made on the differential line driver.
The pulse waveform reverses when the pulse is input on the open collector.
[Refer to 4.2.1 Command Pulse Input]

(3) Input Polarity in the Command Pulse Mode

User Parameter No. 64 (Polarity in command-pulse input mode)

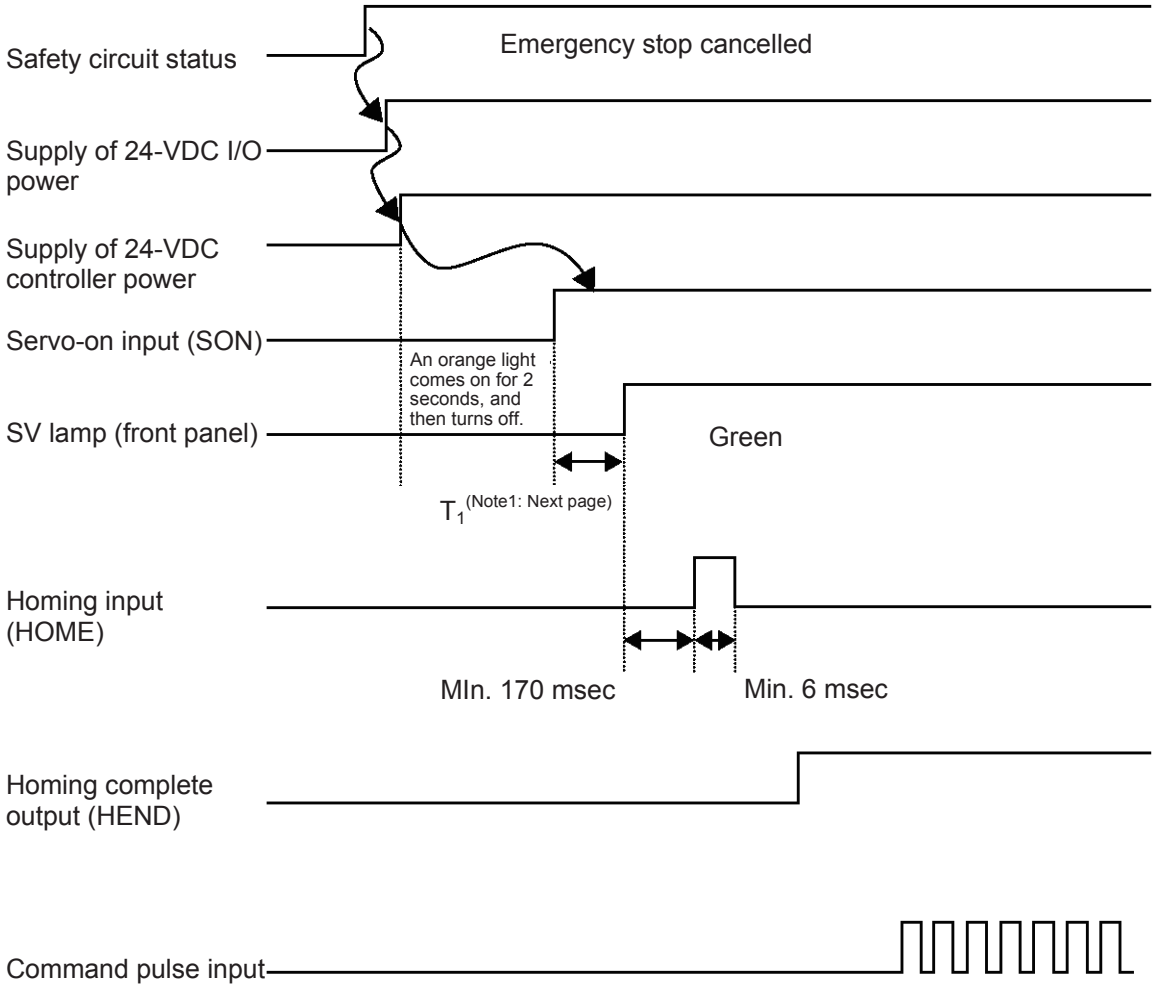
Name	Symbol	Unit	Input range	Default (reference)
Polarity in command-pulse input mode	POLE	-	0 to 1	0

Setting
Positive logic: 0
Negative logic: 1

Warning: Since the drive motor is a pulse motor, the excited phase is detected when the servo is turned on for the first time after turning on the power.
Therefore, one condition for the servo to turn on is that the actuator can move once the servo is turned on.
If the slider or rod is contacting a mechanical end or the work is contacting any peripheral equipment, the excited phase may not be detected correctly and an erroneous movement or excitation detection error may occur.
In this case, move the actuator manually to an appropriate position before turning the servo on.
If the actuator is equipped with a brake, the brake must be forcibly released by turning on the brake release switch. At this time, be careful not to pinch your hand or damage the robot hand or work by the slider/rod, as the slider/rod may drop unexpectedly by its dead weight. If the actuator cannot be moved by hand, you can change Parameter No. 28 (Direction of excited phase signal detection). Before changing this parameter, contact IAI.

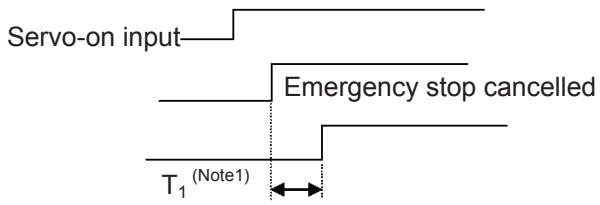
4.2.3 Timings after Power On

- Steps from Initial Startup to Actuator Adjustment
  [1] Confirm that the slider or rod is not contacting a mechanical end or that the work is not contacting any peripheral equipment.
  [2] Cancel the emergency stop or connect the motor drive power.
  [3] Supply the 24-VDC I/O power: PIO connector pins 1 and 2.
  [4] Supply the 24-VDC controller power: 24-V and 0-V terminals on the power-supply terminal block.
  [5] Set the minimum required parameters. Refer to 4.2.2, “Setting Parameters Required for Operation.”
  Reference To temporarily disable the servo-on input because the PLC is not yet ready to accept the input, change the value of Parameter No. 21 (Servo-on input disable selection) to “1.”
  [6] Input a servo-on signal from the PLC (if the servo-on input is enabled).
  [7] Input a homing signal from the PLC.
  [8] Input position command pulses from the PLC.



* If Parameter No. 21 (Servo-on input disable selection) is set to “1,” a servo-on signal need not be input.

⚠ Caution: In the “Emergency stop actuated → Turn on the power → Servo-on input → Cancel the emergency stop” sequence, the servo will turn on up to T_1 (Note 1) sec after the emergency stop is cancelled.



(Note 1) T1: Excited-pole detection time = 0.2 to 12 sec
Normally the detection of excited pole completes in approx. 0.2 sec, although the exact time varies from one actuator to another due to individual differences and also depending on the load condition. If the detection of excited pole has failed, the excited-pole detection operation will be continued for up to 12 sec.

4.3 Push Type

Use the PIO pattern of this type if you wish to perform position control and push-motion operation using pulse train input from a PLC.
Set User Parameter No. 25 (PIO pattern selection) to “1.”

4.3.1 Explanation of I/O Signals

Pin No.	Signal	Name	Remarks
1	24 V	External 24 V	
2	0 V	External ground	If the controller is used in the open collector mode, also use this pin for the COMMON signal for command pulses as well as the 0V signal for the controller’s control power.
3	IN0	SON	Servo-on signal
4	IN1	TL	Torque-limit selection signal
5	IN2	HOME	Homing signal
6	IN3	RES	Reset signal/deviation-counter clear signal
7	OUT0	SV	Servo-on output
8	OUT1	INP	Positioning complete signal/torque limit signal
9	OUT2	HEND	Homing complete signal
10	OUT3	*ALM	Alarm signal
11	/PP	Command pulse	
12	PP	Command pulse	Not connected if the controller is used in the open collector mode.
13	/NP	Command pulse	
14	NP	Command pulse	Not connected if the controller is used in the open collector mode.

■ Servo-on Command Input (SON)
The servo remains on while this signal is ON.
The actuator can be operated while the SON signal is ON.
While this signal is OFF, the actuator does not operate even when the controller power is supplied.
If the SON signal is turned OFF while the actuator is operating, the actuator will decelerate at the forced-stop torque until it stops. After the actuator stops, the servo will turn off and the motor will enter a free-run state.
If the actuator is equipped with a brake, the function specified by the applicable parameter (electromagnetic brake) is activated.
When the servo turns off, the deviation counter will be cleared (if User Parameter No. 58 Clear deviation at servo off/alarm stop is set to “Enable.”)

■ Reset Signal Input (RES)
This signal resets the alarms currently detected by the controller.
You can turn the RES signal ON to reset the alarms currently detected by the controller.

> ⚠ Caution: This signal cannot reset cold-start level alarms. Identify the cause of each alarm and remove the cause before restarting the controller.

■ Deviation-counter Clear Signal (DCLR)
While the TL signal is ON, the RES signal functions as the deviation-counter clear signal (DCLR).
The deviation counter is cleared continuously while this signal is ON.
Upon completion of push-motion operation, you can clear the deviation counter by inputting this signal.

■ Torque-limit Selection Signal (TL)
This signal limits the motor torque.
While this signal is ON, the actuator thrust (motor torque) is limited to the torque set in User Parameter No. 57 (Torque limit).

⚠ Caution:
- Do not turn the TL signal OFF while it is ON.
- If the TL signal is turned OFF in this condition, the controller will instantly start controlling the actuator at the maximum torque and the actuator may move suddenly or run out of control.

This signal can be disabled using User Parameter No. 61 (Torque-limit command input). Disable the TL signal if it is not used.

■ Homing Signal (HOME)
This command signal is used to perform homing automatically.
When the HOME signal is turned ON, the command will be processed at the leading edge (ON edge) of the signal and the actuator will return to its home automatically.
When the homing is completed, the HEND (homing complete) output signal turns ON.
Program the host controller (PLC) so that its current-value register will be reset to the home ("0" will be input to the register) by the current-value preset function, etc., upon turning ON of the HOME signal.
* This signal is always enabled as long as the servo is on.
* Even after homing has been performed once, homing can be performed again by turning the HOME signal ON.

⚠ Caution:
- The HOME signal is given priority over pulse train commands. Even while the actuator is moving under a pulse train command, it will start moving to the home once the HOME signal is turned ON.
- The HOME signal is processed only at its leading edge (ON edge).
- If the SON signal turns OFF or an alarm is detected during homing, the homing operation will stop. If the servo turns OFF , the homing command will be cancelled even if the HOME signal is still ON. To perform homing again, turn the HOME signal OFF, and then turn it back ON.
- The actuator can be operated without using this function. If this function is not used, however, all management actions over position data will be left to the host controller.

  In this case, take necessary measures to prevent an over-stroke error, such as not sending pulse commands exceeding the effective stroke, or providing external limit switches or other devices for detecting stroke ends to forcibly stop the actuator upon detection of a stroke end.

■ Command Pulse Input

Command pulses can be input in the open collector mode (MAX 60 kpps) or differential line driver mode (MAX 200 kpps).

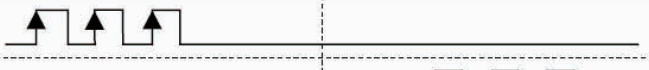
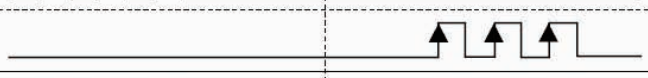
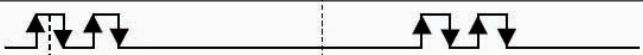
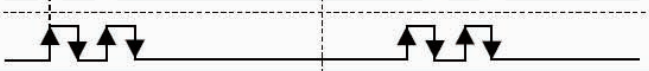
You can select a desired input pattern of command pulses from 90° phase-difference (phase-A/B x4) signal, pulse train + forward/reverse signal, and forward pulse/reverse pulse. The positive logic or negative logic can be selected for each of these patterns.

⚠ Caution:

- The actuator moves in the negative direction (the motor runs in the forward direction) when forward pulses are input, and moves in the positive direction (the motor runs in the reverse direction) when reverse pulses are input. (These directions are reversed if the actuator is of motor reversing type.)
- When determining the forward/reverse directions, pay attention to the host controller setting as well as the PP•/PP and NP•/NP connection.
- For actuator accelerations/decelerations, set values not exceeding the rated acceleration/deceleration of the actuator. (The rated acceleration/deceleration of each actuator is specified in the actuator's catalog.)

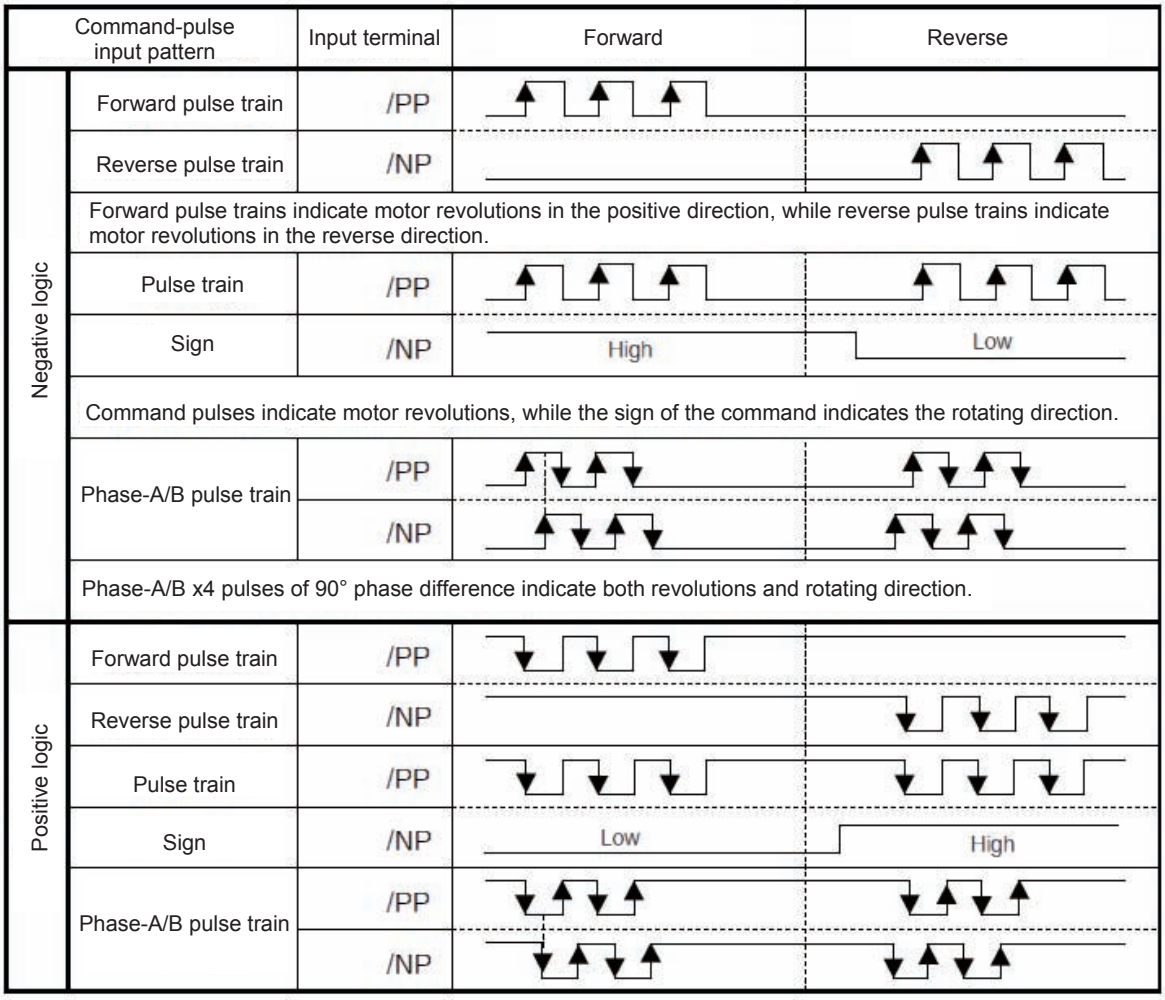
* The motor direction is determined based on CCW representing the forward direction when viewed from the load-end of the shaft.

- You can set one of six command pulse patterns in the command-pulse input mode.

	Command-pulse input pattern	Input terminal	Forward	Reverse
Negative logic	Forward pulse train	PP • /PP		
	Reverse pulse train	NP • /NP		
	Forward pulse trains indicate motor revolutions in the positive direction, while reverse pulse trains indicate motor revolutions in the reverse direction.			
	Pulse train	PP • /PP		
	Sign	NP • /NP	Low	High
	Command pulses indicate motor revolutions, while the sign of the command indicates the rotating direction.			
	Phase-A/B pulse train	PP • /PP		
		NP • /NP		
	Phase-A/B x4 pulses of 90° phase difference indicate both revolutions and rotating direction.			
Positive logic	Forward pulse train	PP • /PP		
	Reverse pulse train	NP • /NP		
	Pulse train	PP • /PP		
	Sign	NP • /NP	High	Low
	Phase-A/B pulse train	PP • /PP		
		NP • /NP		

(Note) The figures shown above are an image when a command pulse input is made on the differential line driver. The pulse waveform reverses as shown in the next page when the pulse is input on the open collector.

Shown below is an image when a command pulse input is made on the open collector.



■ Positioning Complete Signal (INP)
This signal turns ON when the deviation in the deviation counter (standing pulses) is within the positioning band. It remains OFF while the servo is off.

⚠ Caution:
- This signal turns ON when the servo is turned on (to perform positioning at the present position).
- This signal turns ON simply due to accumulation of deviation (standing pulses). Therefore, setting an excessively wide positioning band in the applicable position control parameter will cause the INP signal to turn ON once the actuator enters the positioning band during low-speed operation (before positioning is completed).

■ Torque Limiting Signal (TLR)
This signal turns ON when the specified torque limit is reached in the torque limiting mode.
While the TL (torque-limit selection) signal is ON, this signal will turn ON if the actuator thrust (motor torque) reaches the torque limit set by the torque limit parameter.
This signal will turn OFF once the motor torque drops to below the specified limit.

■ Homing Complete Signal (HEND)
This signal turns ON after homing has completed and the coordinate system has been established.
It turns ON upon completion of homing initiated by the HOME signal or a command from the teaching pendant or PC software.
This signal turns OFF once the servo turns off. Perform homing again after the servo has turned off.

⚠ Caution:
- The software stroke limits set by the corresponding actuator parameters are effective only while this signal is ON.
- The actuator can be operated without using this function. In this case, however, take necessary measures, such as not sending pulse commands exceeding the effective stroke, or providing external limit switches for detecting stroke ends to forcibly stop the actuator upon detection of a stroke end.

■ Servo-on Output Signal (SV)
When the SON (servo-on) signal turns ON, the servo turns on. As the controller subsequently enters a ready state (where it can accept pulse train input) (the condition where the controller can accept pulse train input = pulse mode), this signal turns ON.
This signal turns OFF when the servo is turned off upon turning OFF of the SON signal.
This signal is linked to the LED (green light) on the front panel of the controller.

■ Alarm Signal (*ALM)
This signal turns OFF when the controller's protective circuit (function) has actuated following an alarm detection and the basic cutoff procedure has been implemented as a result.
The signal will turn ON if the RES (reset) signal is turned ON after the cause of the alarm has been removed (except when the alarm relates to a cold-start level error).
When an alarm is detected, a red LED light will illuminate on the front panel of the controller. A green LED remains on while the controller is operating normally.

⚠ Caution:
- Identify the cause of each alarm and remove the cause before restarting the controller.
  You can check alarm codes using the teaching pendant or PC software. The controller can store data of up to 16 most recent alarms. This alarm history data will be retained even after the power is cut off.
  Each alarm record is displayed with the time it was generated, so you can check which alarm occurred when.
- For details on alarm history, refer to 6.3, "Alarms, Causes and Actions."

4.3.2 Setting Parameters Required for Operation

The following parameters must always be set prior to every operation.
(These parameters are all you need to set to perform operations that only involve positioning.)

(1) Electronic gear

User Parameter Nos. 65 and 66 (Electronic gear numerator and denominator)

Name	Symbol	Unit	Input range	Default (reference)
Electronic gear numerator	CNUM	-	1 to 4096	200
Electronic gear denominator	CDEN	-	1 to 4096	15

These parameters are used to determine the unit travel distance of the actuator per one pulse in input command pulse train.
Unit travel distance of linear-motion axis = Minimum travel unit (1, 0.1, 0.01 mm, etc.)/pulse
Unit travel distance of rotational axis = Minimum travel unit (1, 0.1, 0.01 deg, etc.)/pulse

■ Calculation Formula for Electronic Gear

Linear-motion axis

$$\frac{\text{Electronic gear numerator (CNUM)}}{\text{Electronic gear denominator (CDEN)}} = \frac{\text{Encoder pulses (Pulse/rev)}}{\text{Ball screw lead length (mm/rev)}} \times \text{Unit travel distance (mm/Pulse)}$$

Rotational axis

$$\frac{\text{Electronic gear numerator (CNUM)}}{\text{Electronic gear denominator (CDEN)}} = \frac{\text{Encoder pulses (Pulse/rev)}}{\text{360 (deg/rev) x Gear ratio of rotational axis}} \times \text{Unit travel distance (deg/Pulse)}$$

Reference

The actuator speed is calculated as follows:
Speed = Unit travel distance x Input pulse frequency (Hz)
Take note that if the unit travel distance is too small, the actuator may not be able to reach the maximum speed.

Table of encoder pulses and lead lengths for different models

Actuator type(s)	Encoder pulses (Pulse/rev)	Lead length
SA5C/SA6C/SA7C/SS7C/SS8C SA5R/SA6R/SA7R/SS7R/SS8R RA2C/RA3C/RA4C/RA6C RGS4C/RGS6C/RGD3C/RGD4C/RGD6C	800	Check the lead length shown on the controller front panel
BA6/BA6U/BA7/BA7U	800	54
GRS	800	1
GRM	800	1.1
GR3LS/GR3LM	800	12
GR3SS	800	2.5
GR3SM	800	3
RTB (Gear ratio 1/20)/ RTC (Gear ratio 1/20)	800	18
RTB (Gear ratio 1/30)/ RTC (Gear ratio 1/30)	800	12

■ Calculation Example

Operate an actuator with a ball screw lead of 6 mm equipped with an encoder of 800 pulses/rev, at a unit travel distance to 0.1 mm (1/10).

* Encoder pulses are 800 pulses/rev for all RCP2 models.

$$\frac{\text{Electronic gear numerator (CNUM)}}{\text{Electronic gear denominator (CDEN)}} = \frac{\text{Encoder pulses (Pulse/rev)}}{\text{Ball screw lead length (mm/rev)}} \times \text{Unit travel distance (mm/Pulse)}$$

$$= \frac{800}{6} \times \frac{1}{10} = \frac{40}{3}$$

The electronic gear numerator (CNUM) and electronic gear denominator (CDEN) are 40 and 3, respectively. Based on these settings, the travel distance per one pulse in input command pulse train is calculated as 0.1 mm.

⚠ Caution:

- Set both the electronic gear numerator (CNUM) and electronic gear denominator (CDEN) as integers not exceeding 4,096, by reducing them as much as possible with a common divisor.
  Also, CNUM and CDEN must satisfy the relational expression specified below.

$$2^{31} \geq \frac{\text{Stroke length (mm)}}{\text{Ball screw lead length (mm/rev)}} \times \text{Encoder pulses (Pulse)} \times \text{(CNUM)}$$

$$2^{31} \geq \frac{\text{Stroke length (mm)}}{\text{Ball screw lead length (mm/rev)}} \times \text{Encoder pulses (Pulse)} \times \text{(CDEM)}$$

- Do not set a minimum travel unit smaller than the encoder resolution.

$$\text{Encoder resolution for linear-motion axis (mm/Pulse)} = \frac{\text{Ball screw lead length (mm/rev)}}{\text{Encoder pulses (Pulse/rev)}}$$

$$\text{Encoder resolution for rotational axis (deg/Pulse)} = \frac{\text{300 (deg/rev) x Gear ratio of rotational axis}}{\text{Encoder pulses (Pulse/rev)}}$$

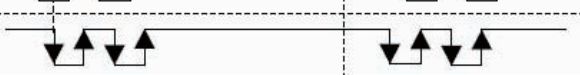
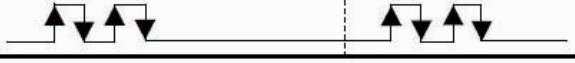
The actuator will not move unless enough command pulses accumulate to reach or exceed the encoder resolution.

(2) Command Pulse Mode

User Parameter No. 63 (Command-pulse input mode)

Name	Symbol	Unit	Input range	Default (reference)
Command-pulse input mode	MOD	-	0 to 2	1

Set a pulse-train input pattern for command pulse input (PP•/PP, NP•/NP).
* The setting of positive logic or negative logic is explained in (3), “Input Polarity in the Command Pulse Mode.”

	Command-pulse input pattern	Input terminal	Forward	Reverse	Setting
Negative logic	Forward pulse train	PP • /PP			2
	Reverse pulse train	NP • /NP			
	Forward pulse trains indicate motor revolutions in the positive direction, while reverse pulse trains indicate motor revolutions in the reverse direction.				
	Pulse train	PP • /PP			1
	Sign	NP • /NP	Low	High	
	Command pulses indicate motor revolutions, while the sign of the command indicates the rotating direction.				
	Phase-A/B pulse train	PP • /PP			0
		NP • /NP			
	Phase-A/B x4 pulses of 90° phase difference indicate both revolutions and rotating direction.				
Positive logic	Forward pulse train	PP • /PP			2
	Reverse pulse train	NP • /NP			
	Pulse train	PP • /PP			1
	Sign	NP • /NP	High	Low	
	Phase-A/B pulse train	PP • /PP			0
		NP • /NP			

(Note) The figures shown above are an image when a command pulse input is made on the differential line driver.
The pulse waveform reverses when the pulse is input on the open collector.
[Refer to 4.3.1 Command Pulse Input]

(3) Input Polarity in the Command Pulse Mode

User Parameter No. 64 (Polarity in command-pulse input mode)

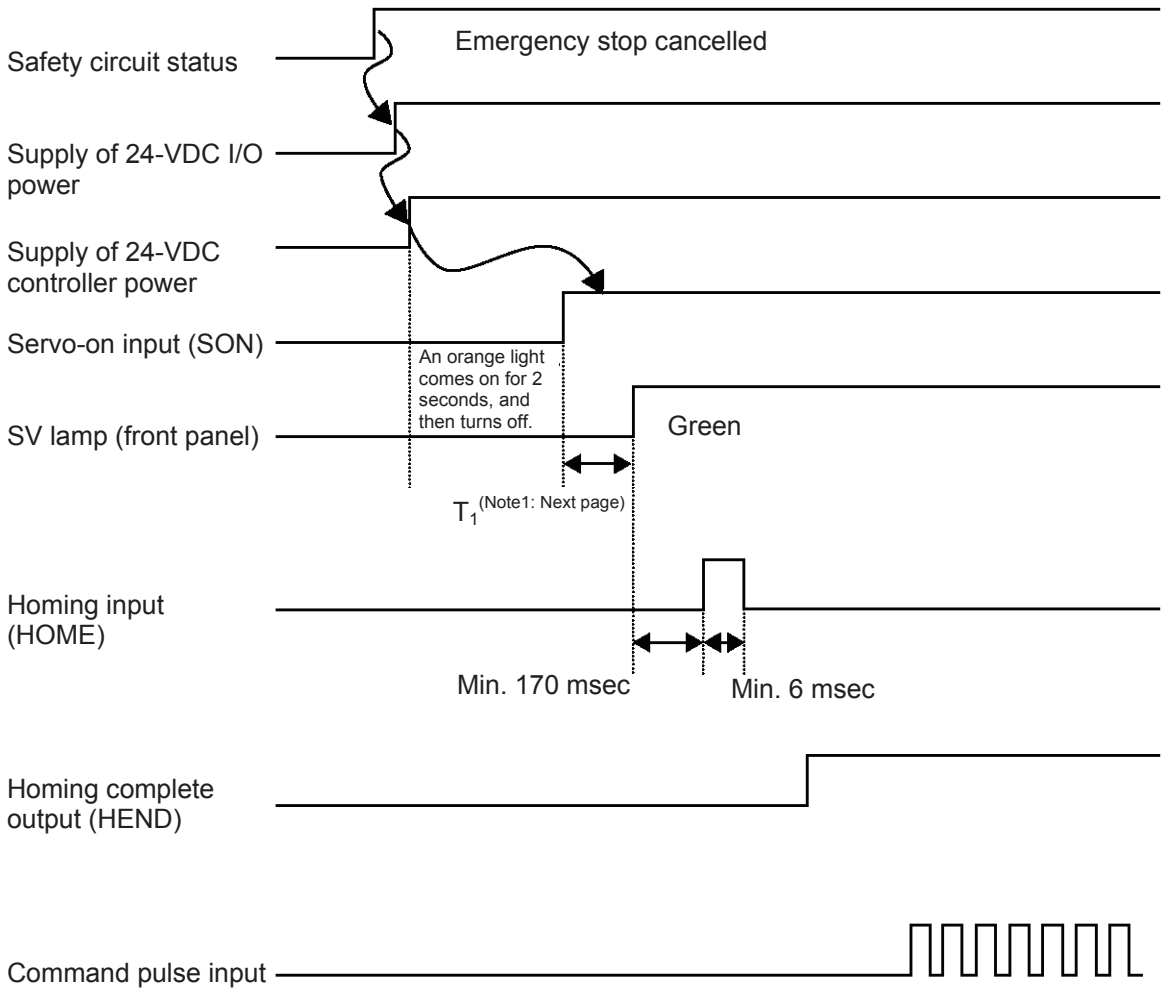
Name	Symbol	Unit	Input range	Default (reference)
Polarity in command-pulse input mode	POLE	-	0 to 1	0

Setting
Positive logic: 0
Negative logic: 1

Warning: Since the drive motor is a pulse motor, the excited phase is detected when the servo is turned on for the first time after turning on the power.
Therefore, one condition for the servo to turn on is that the actuator can move once the servo is turned on.
If the slider or rod is contacting a mechanical end or the work is contacting any peripheral equipment, the excited phase may not be detected correctly and an erroneous movement or excitation detection error may occur.
In this case, move the actuator manually to an appropriate position before turning the servo on.
If the actuator is equipped with a brake, the brake must be forcibly released by turning on the brake release switch. At this time, be careful not to pinch your hand or damage the robot hand or work by the slider/rod, as the slider/rod may drop unexpectedly by its dead weight. If the actuator cannot be moved by hand, you can change Parameter No. 28 (Direction of excited phase signal detection). Before changing this parameter, contact IAI.

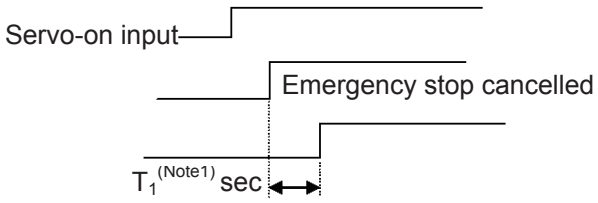
4.3.3 Timings after Power On

- Steps from Initial Startup to Actuator Adjustment
  [1] Confirm that the slider or rod is not contacting a mechanical end or that the work is not contacting any peripheral equipment.
  [2] Cancel the emergency stop or connect the motor drive power.
  [3] Supply the 24-VDC I/O power: PIO connector pins 1 and 2.
  [4] Supply the 24-VDC controller power: 24-V and 0-V terminals on the power-supply terminal block.
  [5] Set the minimum required parameters. Refer to 4.2.2, “Setting Parameters Required for Operation.”
  Reference To temporarily disable the servo-on input because the PLC is not yet ready to accept the input, change the value of Parameter No. 21 (Servo-on input disable selection) to “1.”
  [6] Input a servo-on signal from the PLC (if the servo-on input is enabled).
  [7] Input a homing signal from the PLC.
  [8] Input position command pulses from the PLC.



* If Parameter No. 21 (Servo-on input disable selection) is set to “1,” a servo-on signal need not be input.

⚠ Caution: In the “Emergency stop actuated → Turn on the power → Servo-on input → Cancel the emergency stop” sequence, the servo will turn on up to 170 msec after the emergency stop is cancelled.



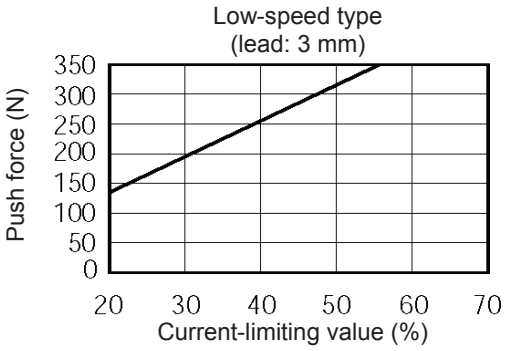
(Note 1) T1: Excited-pole detection time = 0.2 to 12 sec
Normally the detection of excited pole completes in approx. 0.2 sec, although the exact time varies from one actuator to another due to individual differences and also depending on the load condition. If the detection of excited pole has failed, the excited-pole detection operation will be continued for up to 12 sec.

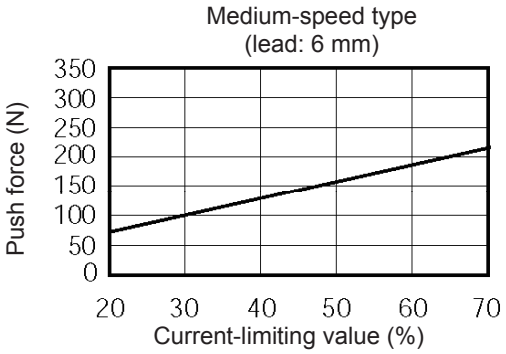
4.3.4 Correlation Diagram of Current-limiting Value and Push Force for Each Actuator

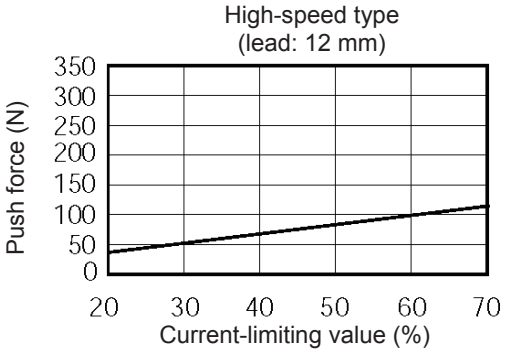
The correlation diagram of current-limiting value [%] and push force [N] is shown below for each actuator.

- Slider Type

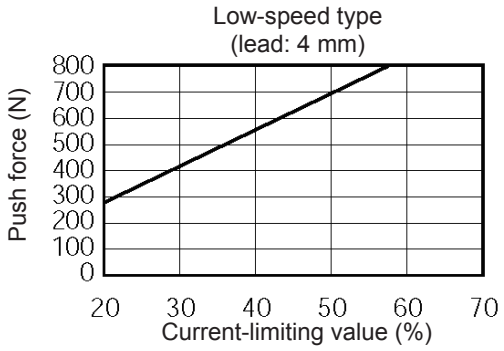
(1) SA5C/SA6C/SS7C type

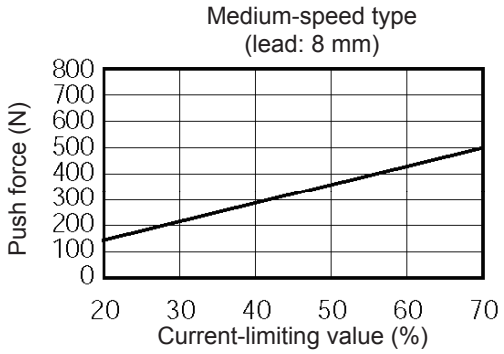


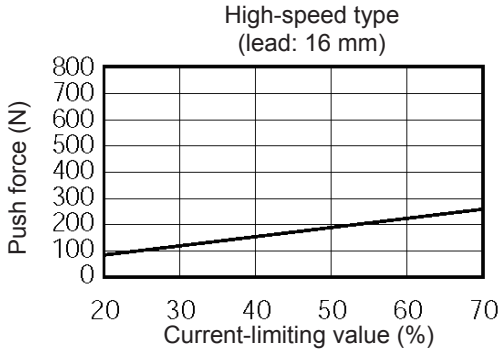




(2) SA7C type



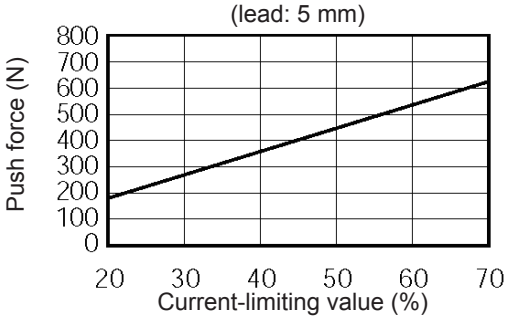




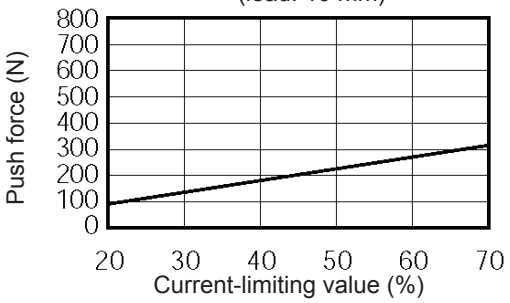
⚠ Caution:	Accuracy of push force while the actuator is standing still is not guaranteed. The above figures should be used for reference purposes only. Take note that if the push force is too small, the actuator may malfunction during push-motion operation due to slide resistance, etc. The maximum current-limiting values are as shown in the graphs above. The minimum current-limiting values should be at least 20%.

(3) SS8C type

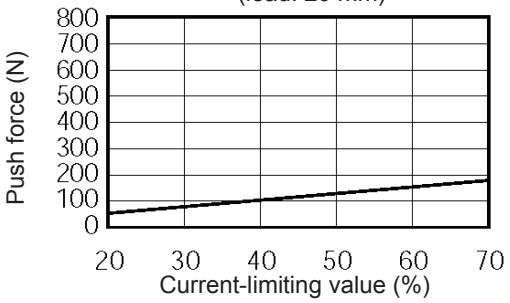
Low-speed type
(lead: 5 mm)



Medium-speed type
(lead: 10 mm)



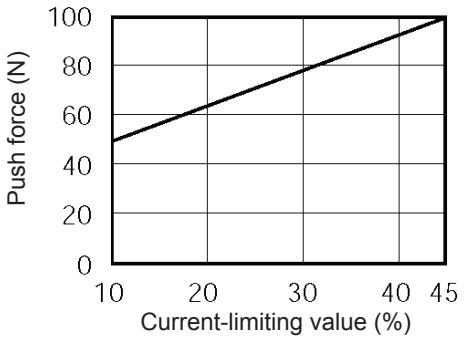
High-speed type
(lead: 20 mm)



⚠ Caution: Accuracy of push force while the actuator is standing still is not guaranteed. The above figures should be used for reference purposes only.
Take note that if the push force is too small, the actuator may malfunction during push-motion operation due to slide resistance, etc.
The maximum current-limiting values are as shown in the graphs above. The minimum current-limiting values should be at least 20%.

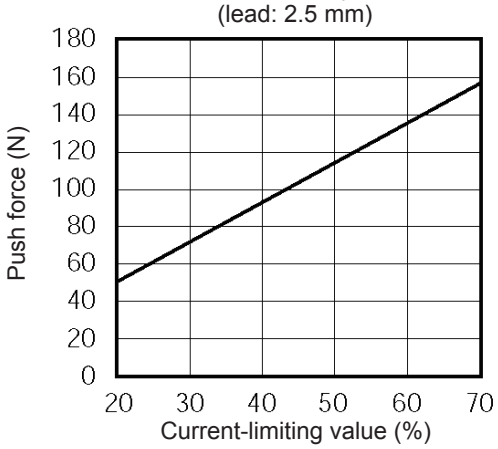
- Rod Type

(1) RA2C type

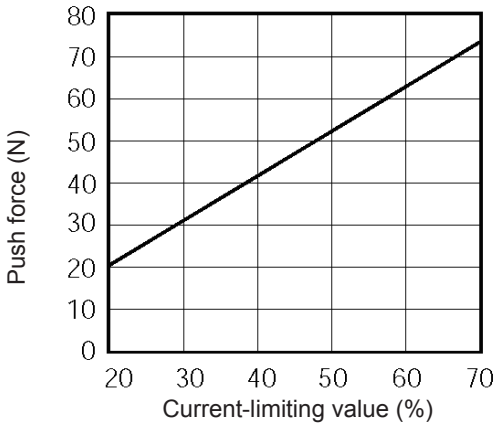


(2) RA3C type

Low-speed type
(lead: 2.5 mm)

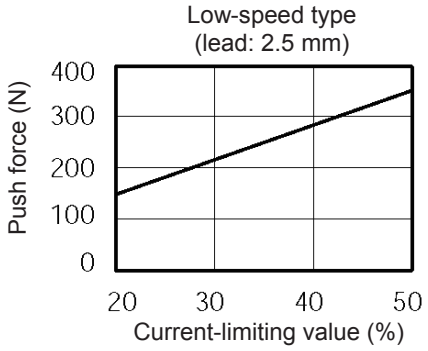


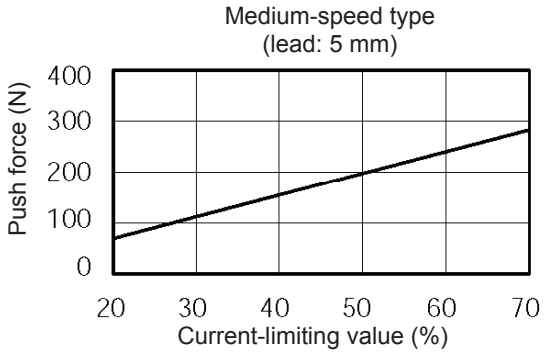
Medium-speed type
(lead: 5 mm)

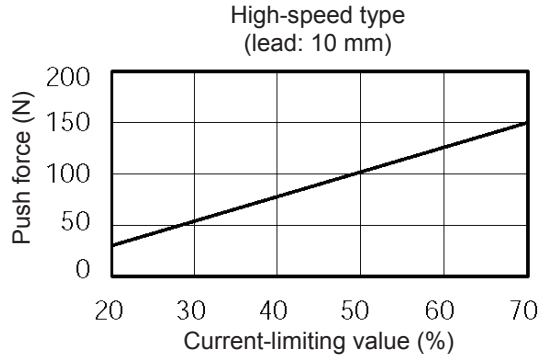


⚠ Caution:	Accuracy of push force while the actuator is standing still is not guaranteed. The above figures should be used for reference purposes only. Take note that if the push force is too small, the actuator may malfunction during push-motion operation due to slide resistance, etc. The maximum current-limiting values are as shown in the graphs above. The minimum current-limiting values should be at least 20%.

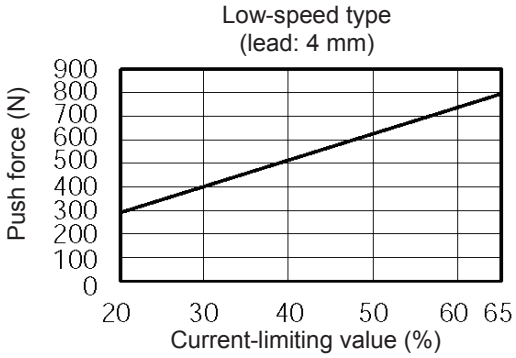
(3) RA4C type

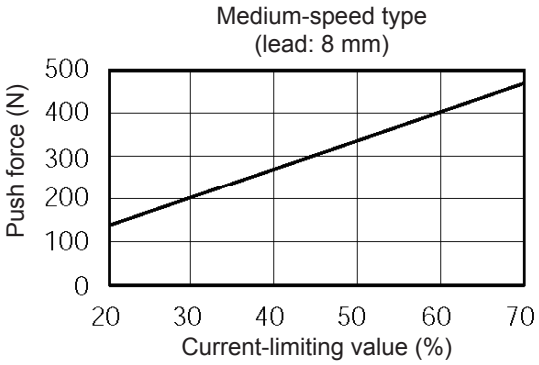


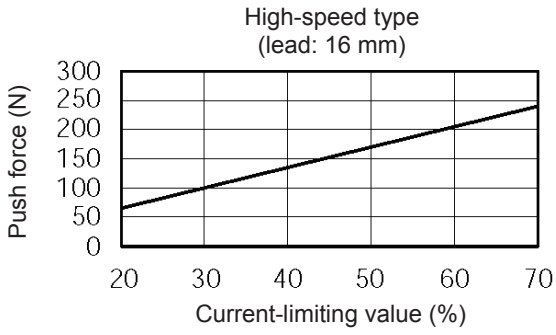




(4) RA6C type







⚠ Caution:	Accuracy of push force while the actuator is standing still is not guaranteed. The above figures should be used for reference purposes only. Take note that if the push force is too small, the actuator may malfunction during push-motion operation due to slide resistance, etc. The maximum current-limiting values are as shown in the graphs above. The minimum current-limiting values should be at least 20%.

5. Parameter Settings

5.1 Parameter List

The parameters are classified into the following four types depending on their function:
Types:

a: Parameter relating to actuator stroke range
b: Parameter relating to actuator operating characteristics
c: Parameter relating to external interface
d: Servo gain adjustment

No.	Type	Symbol	Name	Unit	Factory default
3	a	LIMM	Soft limit + side	mm	Effective length of the actuator
4	a	LIML	Soft limit – side	mm	Effective length of the actuator
5	a	ORG	Home direction [0: Reverse / 1: Forward]	-	(As specified at the time of order)
7	d	PLGO	Servo gain number	-	6
9	b	ACMD	Default acceleration/deceleration	G	Set individually in accordance with the actuator characteristics.
10	b	INP	Default positioning band (in-position)	mm	Set individually in accordance with the actuator characteristics.
12	b	SPOW	Current-limiting value at standstill after positioning	%	Set individually in accordance with the actuator characteristics.
13	b	ODPW	Current-limiting value during homing	%	Set individually in accordance with the actuator characteristics.
16	c	BRSL	SIO communication speed	bps	38400
17	c	RTIM	Minimum delay time for slave transmitter activation	msec	5
18	b	LS	Home sensor input polarity	-	Set individually in accordance with the actuator characteristics.
21	c	SOM	Servo-on input [0: Enable / 1: Disable]		0
22	a	OFST	Home offset	mm	Set individually in accordance with the actuator characteristics.
25	c	IOPN	PIO pattern selection	-	0 [Standard type]
28	b	PHSP	Default direction of excited phase signal detection [0: Reverse / 1: Forward]		0
29	b	PHSP	Excited phase signal detection time	msec	10
31	d	VLPG	Speed loop proportional gain	-	Set individually in accordance with the actuator characteristics.
32	d	VLPT	Speed loop integral gain	-	Set individually in accordance with the actuator characteristics.
33	d	TRQF	Torque filter time constant	-	Set individually in accordance with the actuator characteristics.
35	b	SAFV	Safety speed	mm/sec	100
40	b	HOME	Enable function [0: Enable / 1: Disable]	-	0 [Enable]
42	b	ENBL	Home check sensor input polarity	-	1 [Disable]
43	c	HMC	Silent interval multiplication factor	-	Set individually in accordance with the actuator characteristics.
45	b	SIVM	Speed override	-	0 [Multiplication factor disabled]
53	b	HSTP	Default standstill mode	-	0 [Complete stop]
57	b	TQLM	Torque limit	%	70
58	c	SDCR	Clear deviation at servo off/alarm stop [0: Disable / 1: Enable]	-	1 [Enable]
59	b	FSTP	Monitor error while limiting torque [0: Disable / 1: Enable]	-	1 [Enable]
60	c	DCLR	Deviation-counter clear input [0: Enable / 1: Disable]	-	0 [Enable]
61	c	TL	Torque-limit command input [0: Enable / 1: Disable]	-	0 [Enable]
62	b	CPR	Pulse count direction [0: Forward / 1: Reverse]	-	Set individually in accordance with the actuator characteristics.
63	c	MOD	Command-pulse input mode	-	1 [Pulse train + sign]
64	c	POLE	Polarity in command-pulse input mode [0: Positive / 1: Negative]	-	0 [Positive logic]
65	b	CNUM	Electronic gear numerator	-	200 [Numerator of command pulse multiplier]
66	b	CDEN	Electronic gear denominator	-	15 [Denominator of command pulse multiplier]
77	B	LEAD	Ball screw lead length	mm	Set individually in accordance with the actuator characteristics.

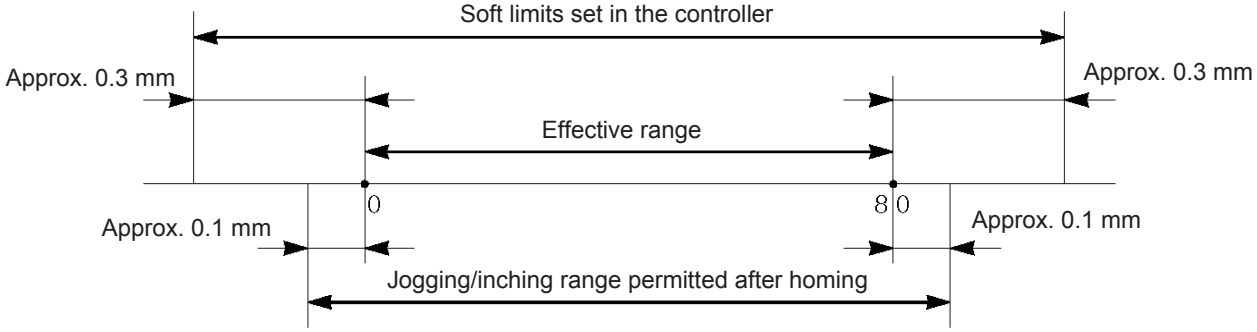
5.2 Detail Explanation of Parameters

If you have changed any parameter, be sure to restart the controller via a software reset or reconnect the controller power.

5.2.1 Parameters Relating to Actuator Stroke Range

- Soft Limits (No.3 LIMM) (No.4 LIML)

Set the + soft limit in parameter No. 3 and – soft limit in parameter No. 4.
Both parameters have been set to the effective actuator length at the factory. Change the parameter settings if necessary, such as when an obstacle is present and collision between the actuator and obstacle must be prevented or when the actuator must be operated beyond the effective length.
Exercise due caution when setting these parameters, as wrong settings will cause collision with the mechanical end.
The minimum setting unit is 0.01 mm.
(Note) To change these parameters, set values corresponding to positions that are 0.3 mm wider than the desired effective range.
Example) Set the effective range to between 0 and 80 mm
Parameter No. 3 (+ side): 80.3
Parameter No. 4 (– side): -0.3



- Home Direction (No.5 ORG)

If not specified by the user, the home direction is set to the motor side before shipment.
If you must change the home direction after the actuator has been assembled to your equipment, change the setting of parameter No. 5.
Also change the parameters for home offset, soft limits and default direction of excited phase signal detection, if necessary.

⚠ Caution: Rod-type actuators do not permit reversing of the home direction.
Note that if the home direction is reversed, all the entered position data will be cleared.

- Home Offset (No.22 OFST)

Parameter No. 22 has been set to an optimal value at the factory so that the distance from the mechanical end to home will remain constant.
The minimum setting unit is 0.01 mm.
This parameter can be adjusted in the following conditions:

[1] Align the actuator's home with the mechanical home on the equipment after the actuator has been assembled to the equipment.
[2] Set the home position again after reversing the factory-set home direction.
[3] Correct the minor position deviation that has generated after the actuator was replaced.

⚠ Caution: If you have changed the home offset, the soft limit parameters must also be reviewed.

5.2.2 Parameters Relating to Actuator Operating Characteristics

● Default Acceleration/Deceleration (No.9 ACMD)

The factory setting is the rated acceleration/deceleration of the actuator.
This value will be the acceleration/deceleration value during jog operation from the teaching pendant or PC software.
To decrease the default acceleration/deceleration from the rated acceleration/deceleration, change the value set in Parameter No. 9.

● Default Positioning Band (In-position) (No.10 INP)

Factory setting for parameter No. 10 is 0.01 mm.
This value is used for evaluating positioning completion. With a pulse-train input type, the positioning complete signal (INP) turns ON when the deviation in the deviation counter (standing pulses) is within the range indicated by this parameter.
Increasing this value may cause output of positioning complete signal (INP) even though the actuator is still moving.

⚠ Caution:	For the positioning band, set the value greater than that of the encoder resolution. Setting it smaller may cause a servo error.

● Current-limiting Value during Homing (No.13 ODPW)

Before shipment, this parameter is set to a current level appropriate for the standard specification of the actuator.
Increasing this parameter value increases the homing torque.
This parameter need not be changed in normal conditions of use. However, if the actuator is used in vertical orientation and the slide resistance increases due to the affixing method, load condition, etc., homing may complete before the correct position. In this case, the value set in Parameter No. 13 must be increased. (As a guide, the setting should not exceed 75%.)

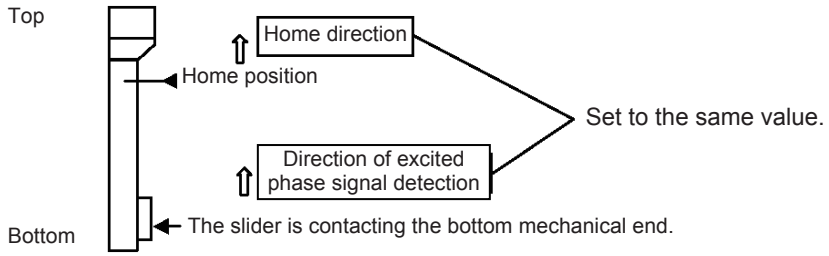
● Current-limiting Value at Standstill after Positioning (No.12 SPOW)

Before shipment, this parameter is set to a current level appropriate for the standard specification of the actuator.
Increasing this parameter value increases the holding torque.
This parameter need not be changed in normal conditions of use. If the actuator receives large external force while standing still, however, hunting will occur. In this case, the value set in Parameter No. 12 must be increased. (As a guide, the setting should not exceed 50%.)

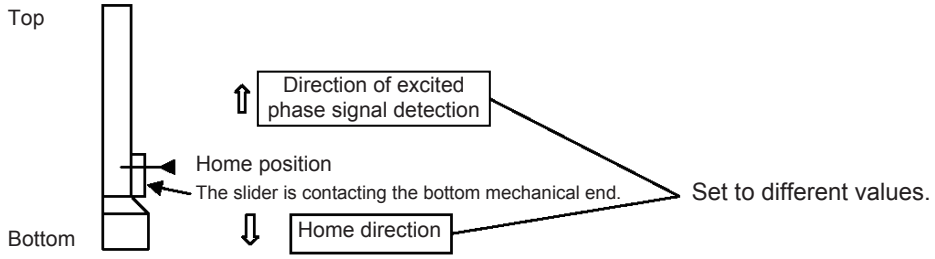
● Default Direction of Excited Phase Signal Detection (No.28 PHSP)

The excited phase is detected when the servo is turned on for the first time after turning on the power. This parameter defines the direction of this detection.
This parameter need not be changed in normal conditions of use. However, if the actuator is contacting a mechanical end or any obstacle when the power is turned on and cannot be moved by hand, change the direction of detection to one in which the motor can be driven easily.
To do this, set the value of Parameter No. 28 to either “0” or “1.” If the direction of detection is to be the same as the home direction, specify the same value currently set in Parameter No. 5, “Home direction.”
To set the direction opposite to the home direction, specify the value different from the one currently set in Parameter No. 5, “Home direction.”

(Example 1) The power is turned on when the slider is contacting the bottom mechanical end in a configuration where the motor is positioned at the top.



(Example 2) The power is turned on when the slider is contacting the bottom mechanical end in a configuration where the motor is positioned at the bottom.



● Excited Phase Signal Detection Time (No.29 PHSP)

The excited phase is detected when the servo is turned on for the first time after turning on the power. This parameter defines the time of this detection.
Before shipment, this parameter is set to a detection time appropriate for the standard specification of the actuator, and thus the setting need not be changed in normal conditions of use.
Should an excitation detection error or abnormal operation occur when the servo is turned on for the first time after turning on the power, you can try changing the detection time set in Parameter No. 29 as a possible countermeasure.
Before changing this parameter, contact IAI.

● Safety Speed (No.35 SAFV)

This parameter defines the feed speed during jog operation from the teaching pendant or PC software.
The factory setting is “100” [mm/sec].
To change the speed, set an optimal value in Parameter No. 35.
Since the maximum speed is limited to 250 mm/sec, set the safety speed to below this level.
* This parameter is invalid during pulse train control.

● Default Standstill Mode (No.53 HSTP)

This parameter defines the power-saving mode to be applied when the standby time while the servo is on is long after power on.
In Parameter No. 53, define whether or not to implement power-saving.

	Setting
All power-saving modes are disabled	0
Full servo control mode	4

The factory setting is “0” [Disable].

Full servo control mode

The pulse motor is servo-controlled to reduce the holding current.
Although the specific level of current reduction varies in accordance with the actuator model, load condition, etc., generally the holding current drops to around a half to one-fourth.
The servo remains on, so position deviation does not occur.
The actual holding current can be checked in the current monitor screen of the PC software.

● Enable Function (No.42 ENBL)

Parameter No. 42 is used to set whether to enable or disable the enable function accompanying the teaching pendant.

	Setting
Enable (Use)	0
Disable (Do not use)	1

The factory setting is “1” [Disable].

● Torque Limit (No.57 TQLM)

Parameter No. 57 is used to set torque limit value upon Torque-limit Selection Signal (TL) input.
Setting unit: %
Upper limit of the setting range will be 70% of the rated value.

● Monitor Error White Limitation Torque (No.59 FSTP)

Parameter No. 59 is used to set whether to enable or disable error monitoring when deviation pulse exceeds the internal parameter setting during torque limiting (while TL signal is ON).

	Setting
Disable (Do not monitor)	0
Enable (Monitor)	1

The factory setting is “1” [Enable].

● Pulse Count Direction (No.62 CPR)

Parameter No. 62 is used to set the rotational direction of the motor for command pulse.

	Setting
Pulse count direction forward	0
Pulse count direction reverse	1

Factory setting will be based on the individual characteristics of the actuator.

- Electronic Gear (No.65 CNUM) (No.66 CDEN)

Parameters No. 65 and 66 are used to set the electronic gear's numerator and denominator.

	Setting
Electronic gear numerator	200
Electronic gear denominator	15

This parameter is used to determine the unit travel distance of the actuator for a single pulse in the input pulse train.
Unit travel distance of linear-motion axis = Minimum travel unit (1, 0.1, 0.01 mm, etc.)/pulse
Unit travel distance of rotational axis = Minimum travel unit (1, 0.1, 0.01 deg, etc.)/pulse

5.2.3 Parameters Relating to External Interface

- PIO Pattern Selection (No.25 IOPN)

Parameter No. 25 is used to select a desired PIO operation pattern.
This is a basic operation parameter, so be sure to set it at the beginning.

Setting of Parameter No. 25	Features of PIO pattern
0	Standard type Use the PIO pattern of this type if you wish to perform position control using pulse train input from a PLC.
1	Push type Use the PIO pattern of this type if you wish to perform position control and push-motion control using pulse train input from a PLC.

The factory setting is “0” [Standard type].

- Servo-on Input Disable Selection (No.21 SON)

Parameter No. 21 is used to set whether enable or disable the servo-on input signal.

	Setting
Enable (Use)	0
Disable (Do not use)	1

The factory setting is “0” [Enable].

- SIO Communication Speed (No.16 BRSL)

This parameter is not used with this controller. It applies to controllers of serial communication type.
If this parameter is set, it sets the communication speed to be used when the controller implements serial communication control via the PLC’s communication module.
Set Parameter No. 16 to a value appropriate for the specification of the communication module.
9600, 19200, 38400 or 115200 bps can be selected as the communication speed.
The factory setting is “38400” bps.

- Minimum Delay Time for Slave Transmitter Activation (No.17 RTIM)

This parameter is not used with this controller. It applies to controllers of serial communication type.
If this parameter is set, it defines the minimum delay before the controller’s transmitter is activated following the completion of command reception, when the controller implements serial communication control via the PLC’s communication module.
The factory setting is “5” msec. If the communication module specification exceeds 5 msec, set the required time in Parameter No. 17.

- Silent Interval Multiplication Factor (No.45 SIVM)

This parameter is not used with this controller. It applies to RS485 serial communication commands.
If this parameter is set, it defines the multiplication factor of silent interval time to be used for delimiter judgment in the RTU mode.
The factory setting is the communication time corresponding to 3.5 characters in accordance with the Modbus specification.
This parameter need not be changed in normal conditions of use where the actuator is operated using a PC or teaching pendant.
If the character sending interval exceeds the silent interval because the scan time of the PLC is not ideal, however, you can extend the silent interval time through Parameter No. 45.
The minimum setting unit is 1 (times), and the input range is 0 to 10. If “0” is set, it means that the silent interval multiplication factor is disabled.

- Home Return Input (No.40 HOME)

Parameter No. 40 is used to set whether to enable or disable the home return input signal.

	Setting
Enable (Use)	0
Disable (Do not use)	1

The factory setting is “0” [Enable].

- Clear Deviation at Servo Off and Alarm Stop (No.58 SDCR)

Parameter No. 58 is used to set whether to enable or disable deviation clearing upon servo OFF and alarm stop.

	Setting
Enable (Do not clear)	0
Disable (Clear)	1

The factory setting is “1” [Enable].

- Deviation-counter Clear Input (No.60 DCLR)

Parameter No. 60 is used to set whether to enable or disable the deviation-counter clear input.

	Setting
Enable (Use)	0
Disable (Do not use)	1

The factory setting is “0” [Enable].

- Torque-limit Command Input (No.61TL)

Parameter No. 61 is used to set whether to enable or disable the torque-limit command input.

	Setting
Enable (Use)	0
Disable (Do not use)	1

The factory setting is “0” [Enable].

● Polarity in Command-pulse Input Mode (No.64 POLE)

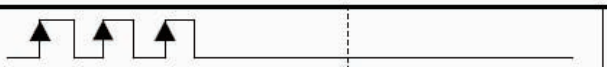
Parameter No. 64 is used to set the polarity of command-pulse input.

	Setting
Positive logic	0
Negative logic	1

The factory setting is “0” [Positive logic].

● Command-pulse Input Mode (No.63 MOD)

Parameter No. 63 is used to set the 6 types of command pulse formats.

	Command-pulse input pattern	Input terminal	Forward	Reverse	Setting
Negative logic	Forward pulse train	PP • /PP			2
	Reverse pulse train	NP • /NP			
	Forward pulse trains indicate motor revolutions in the positive direction, while reverse pulse trains indicate motor revolutions in the reverse direction.				
	Pulse train	PP • /PP			1
	Sign	NP • /NP	Low	High	
	Command pulses indicate motor revolutions, while the sign of the command indicates the rotating direction.				
	Phase-A/B pulse train	PP • /PP			0
		NP • /NP			
	Phase-A/B x4 pulses of 90° phase difference indicate both revolutions and rotating direction.				
Positive logic	Forward pulse train	PP • /PP			2
	Reverse pulse train	NP • /NP			
	Pulse train	PP • /PP			1
	Sign	NP • /NP	High	Low	
	Phase-A/B pulse train	PP • /PP			0
		NP • /NP			

(Note) The figures shown above are an image when a command pulse input is made on the differential line driver.
The pulse waveform reverses when the pulse is input on the open collector. [Refer to 4.2.1 Command Pulse Input]

The factory setting is 1 [pulse train + sign].

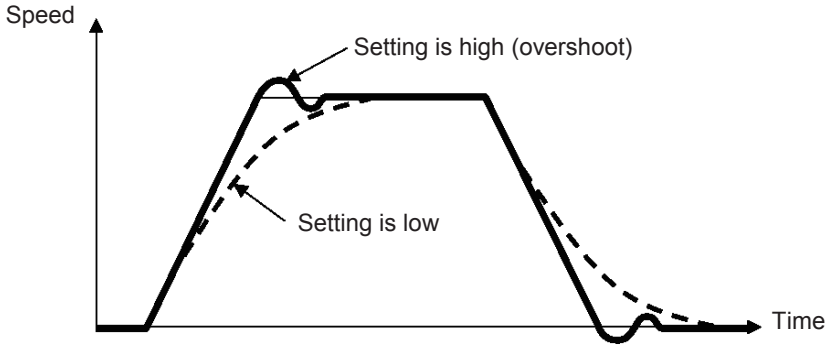
5.2.4 Servo Gain Adjustment

Since the servo has been adjusted at the factory in accordance with the standard specification of the actuator, the servo gain need not be changed in normal conditions of use.
However, vibration or noise may occur depending on how the actuator is affixed, specific load condition, and so on, and therefore the parameters relating to servo adjustment are disclosed to allow the customer to take quick actions should adjustment become necessary.
Particularly with custom models (whose ball screw lead or stroke is longer than the that of the standard model), vibration/noise may occur due to external conditions.
In this case, the parameters shown below must be changed. Contact IAI for details.

- Servo Gain Number (No.7 PLGO)

Parameter number	Unit	Input range	Default
7	5 rad/sec	0 to 31	6

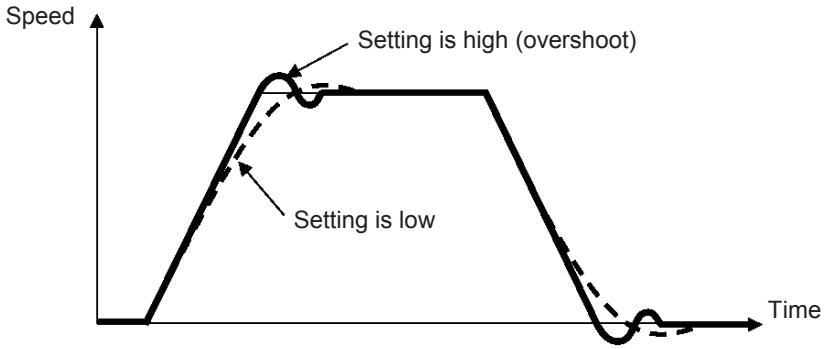
This parameter determines the level of response with respect to a position control loop.
Increasing the setting improves compliance with the position command.
However, increasing the setting too much increases the tendency of the actuator to overshoot.
If the setting is low, compliance with the position command drops and the positioning time increases as a result.



- Speed Loop Proportional Gain (No.31 VLPG)

Parameter number	Unit	Input range	Default
31	---	1 to 27661	Set individually in accordance with the actuator characteristics.

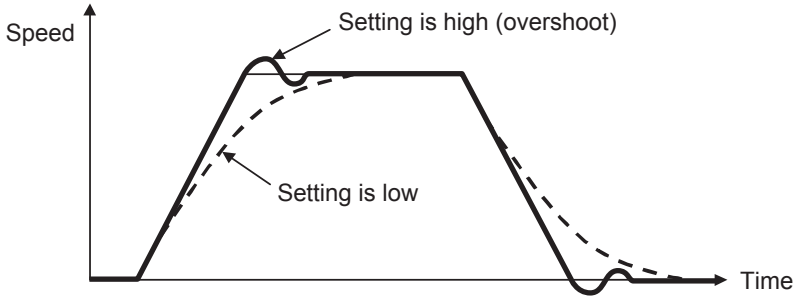
This parameter determines the level of response with respect to a speed control loop.
Increasing the setting improves compliance with the speed command (i.e., servo rigidity increases).
The greater the load inertia, the higher the setting should be.
However, increasing the setting too much increases the tendency of the actuator to overshoot or oscillate, resulting in increased mechanical vibration.



- Speed Loop Integral Gain (No.32 VLPT)

Parameter number	Unit	Input range	Default
32	---	1 to 217270	Set individually in accordance with the actuator characteristics.

This parameter determines the level of response with respect to a speed control loop.
Decreasing the setting results in lower response to the speed command and decreases the reactive force upon load change. If the setting is too low, compliance with the position command drops and the positioning time increases as a result.
Increasing the setting too much increases the tendency of the actuator to overshoot or oscillate, resulting in increased mechanical vibration.



- Torque Filter Time Constant (No.33 TROF)

Parameter number	Unit	Input range	Default
33	---	1 to 2500	Set individually in accordance with the actuator characteristics.

This parameter determines the filter time constant applicable to the torque command.
If the mechanical resonance frequency is equal to or lower than the servo loop response frequency, the motor will vibrate.
This mechanical resonance can be suppressed by increasing the setting of this parameter.
It should be noted, however, that increasing the setting too much may affect the stability of the control system.

6. Troubleshooting

6.1 What to Do When A Problem Occurs

If you encountered a problem, follow the steps below to conduct the specified checks to gather information needed to implement quick recovery and prevent recurrence of the problem.

a. Check the status indicator lamps
   SV (green) --- The servo is on.
   ALM (red) --- An alarm is present or emergency stop has been actuated, or the motor drive power is cut off.
b. Check the host controller for abnormality.
c. Check the voltage of the 24-VDC main power supply.
d. Check the voltage of the 24-VDC power supply for I/O signals.
e. Check for alarms.
   Check the details of each alarm on the PC or teaching pendant.
f. Check the cables for miswiring, disconnection and pinching.
   Before checking the continuity of cables, turn off the power (to prevent a runaway actuator) and disconnect all wirings (to prevent the power from being supplied unexpectedly due to a sneak path).
g. Check the I/O signals.
h. Check the noise elimination measure (ground connection, surge killer installation, etc.).
i. Identify how the problem occurred and the operating condition when the problem occurred.
j. Check the serial numbers of the controller and actuator.
k. Analyze the cause.
l. Take an action.

Before contacting IAI, please check the items in a through j above. Provide the information to our technical staff.

(Reference) Changes in indicators and *ALM output signal in each status

	Servo off	Servo on	Emergency stop actuated	Motor drive power cut off
SV (lamp)	Unlit	Lit	Unlit	Unlit
ALM (lamp)	Unlit	Unlit	Lit	Lit
*ALM (signal)	OFF	OFF	ON	ON

(Note 2) The *ALM output signal is a contact-b signal.
After the power is input, these signals remain ON while the controller is normal. They turn OFF when the power is cut off.
These signals cannot be used for providing a contact-b interlock when the power is not supplied to the controller.

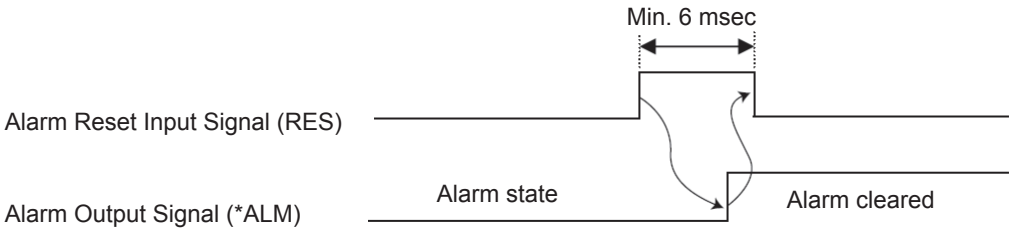
6.2 Alarm Level Classification

The alarms are classified into three levels based on the corresponding symptoms.

Alarm level	ALM lamp	*ALM signal	Condition at occurrence of alarm	How to reset
Operation cancellation	Lit	Output	The actuator decelerates to a stop, and then the servo turns off.	Input alarm reset signal (RES) from PLC. Execute reset using the PC/teaching pendant.
Cold start	Lit	Output	The actuator decelerates to a stop, and then the servo turns off.	Reconnect the power.

(Note) *The ALM output signal is contact-b.
After turning the power ON, the signal turns ON while normal, and turns OFF upon alarm generation.
The signal is OFF during the power cutoff but it cannot be used as a contact-b interlock.

■ Canceling the Operation Cancellation Level
Input alarm reset signal (RES) for at least 6 msec.
Then, the *ALM signal returns to ON, so after confirming that it is turned ON, turn the RES signal OFF.



⚠ Note: Whatever the alarm, always investigate the cause of the alarm and remove the cause before resetting the alarm. If the cause of the alarm cannot be removed, or when the alarm cannot be reset even after the cause has been removed, please contact IAI.
If the same error occurs again after a reset, the cause of the alarm still exists.

6.3 Alarms, Causes and Actions

(1) Operation Cancellation Alarms

Code	Error	Cause/action
0A1	Parameter data error	Cause: The parameter data does not meet the specified input range. (Example) This alarm generates when a pair of values clearly has an inappropriate magnitude relationship, such as when the soft limit + setting is 200.3 mm, while the soft limit – setting is 300 mm. Action: Change the settings to appropriate values.
0BA	Home sensor not yet detected	This alarm indicates that the actuator equipped with a home check sensor did not complete homing successfully. Cause: [1] The work contacted peripheral equipment during the homing. [2] The slide resistance of the actuator is large in some areas. [3] The home check sensor is not installed properly, or the sensor is faulty or its circuit is open. Action: If the work is not contacting any peripheral equipment, [2] and [3] are suspected. Contact IAI.
0BE	Homing timeout	Cause: After the start of homing, homing does not complete after elapse of the time set by the manufacturer' s parameter. (This alarm does not generate during normal operation.) Action: As one possible cause, the controller and actuator combination may be incorrect. Contact IAI.
0C0	Excessive actual speed	Cause: The motor speed exceeds the maximum speed set by the manufacturer' s parameter. This alarm does not generate during normal operation, but it may occur if the load decreased before a servo error was detected and the motor speed has increased as a result. This condition occurs due to the following reasons: [1] The slide resistance of the actuator is large in some areas. [2] The load increased due to momentary application of external force. Action: Check the assembly condition of mechanical parts for any abnormality. If the actuator itself is suspected as the cause, contact IAI.
0C1	Servo error	This alarm indicates that after the acceptance of the move command, the motor could not operate for 2 seconds or more before the actuator reached the target position. Cause: [1] The connector of the motor relay cable is loose or its circuit is open. [2] If the actuator is equipped with a brake, the brake cannot be released. [3] The load increased due to application of external force. [4] The sliding resistance of the actuator itself is high. [5] The positioning band setting is smaller than the encoder resolution. Action: [1] Check the wiring condition of the motor relay cable. [2] Check the wiring condition of the brake cable, and also turn on/off the brake release switch to check if "click" sound is heard. [3] Check the assembly condition of mechanical parts for any abnormality. [4] If the load is normal, cut off the power and move the actuator by hand to check the slide resistance. If the actuator itself is suspected as the cause, contact IAI. [5] Set the positioning band value greater than that of the encoder resolution.

Code	Error	Cause/action
0C9	Excessive motor power-supply voltage	This alarm indicates that the voltage of the motor power supply is excessive (24 V + 20%: 28.8 V or above). Cause: [1] The voltage of the 24-V input power supply is high. [2] Faulty part in the controller Action: Check the input power-supply voltage. If the voltage is normal, contact IAI.
0CA	Overheat	This alarm indicates that the temperature around the power transistor in the controller is excessive (95°C or above). Cause: [1] High surrounding temperature [2] Defective part in the controller Action: [1] Lower the temperature around the controller. If the condition in [1] is not applicable, contact IAI.
0CC	Excessive control power-supply voltage	This alarm indicates that the voltage of the 24-V input power supply is excessive (24 V + 20%: 28.8 V or above). Cause: [1] The voltage of the 24-V input power supply is high. [2] Faulty part in the controller Action: Check the input power-supply voltage. If the voltage is normal, contact IAI.
0CE	Low control power-supply voltage	This alarm indicates that the voltage of the 24-V input power supply is low (24 V – 20%: 19.2 V or below). Cause: [1] The voltage of the 24-V input power supply is low. [2] Faulty part in the controller Action: Check the input power-supply voltage. If the voltage is normal, contact IAI.
0D8	Deviation overflow	The position deviation counter has overflowed. Cause: [1] The speed dropped while the actuator was moving due to external force, etc. [2] Unstable excitation detection operation after the power was turned on Action: [1] Check the load condition, such as whether the work is contacting any peripheral equipment or the brake is released, and remove the cause of the identified problem. [2] Overload condition is suspected, so check the load. Reconnect the power, and then perform homing.
0D9	Software limit exceeded error	Cause: [1] When installation was vertical and the target location was close to the software limit, software limit was exceeded due to overshoot if load was large or deceleration setting was large [2] The servo ON operation was attempted after moving outside the software limit range in the servo-OFF state. Action: [1] Set the deceleration curve that prevents overshooting upon stopping. [2] Perform the servo-ON operation after returning to the software limit range.

(2) Cold Start Alarms

Code	Error	Cause/action
0B8	Excitation detection error	This controller detects the excited phase when the servo is turned on for the first time after turning on the power. This alarm indicates that the specified encoder signal level cannot be detected after 100 ms of excitation. Cause: [1] The connector of the motor relay cable is loose or its circuit is open. [2] If the actuator is equipped with a brake, the brake cannot be released. [3] The load increased due to application of external force. [4] The power was turned on when the actuator was contacting a mechanical end. [5] The sliding resistance of the actuator itself is high. Action: [1] Check the wiring condition of the motor relay cable. [2] Check the wiring condition of the brake cable, and also turn on/off the brake release switch to check if “click” sound is heard. [3] Check the assembly condition of mechanical parts for any abnormality. [4] Move the actuator away from the mechanical end, and then turn on the power again. [5] If the load is normal, cut off the power and move the actuator by hand to check the slide resistance. If the actuator itself is suspected as the cause, contact IAI.
0E8	Open phase A/B detected	Encoder signals cannot be detected correctly. Cause: [1] The connector of the encoder relay cable is loose or its circuit is open. [2] The connector of the supplied actuator cable is loose or its circuit is open. Action: Check the connection condition of the encoder relay cable and perform continuity check. If no abnormality is found, contact IAI. If [3] is suspected, connect the encoder relay cable connector first, and then connect the battery connector. If [4] is suspected, check the model name of each encoder relay cable and connect the correct relay cable to each actuator. Model name of cable for high-thrust rod type: CB-RFA-PA*** Model name of cable for other actuator types: CB-RCP2-PA***
0E9	Open phase A detected	
0EA	Open phase B detected	
0F4	Inconsistent PCB	This controller uses a different motor drive circuit depending on the motor capacity, and therefore the installed printed circuit board (PCB) is also different with each controller. During the initialization after starting, the controller checks if the motor type set by the manufacturer’s parameter matches the actual PCB installed. This alarm indicates that the two do not match. Cause: The parameter may not be entered correctly or the PCB may not be assembled correctly. Action: If you have encountered this error, contact IAI.

Code	Error	Cause/action
0F5	Nonvolatile memory verification error after write	When data has been written to the nonvolatile memory, the written data is read and compared (verified) against the written data for confirmation. This alarm indicates that the read data does not match the written data. Cause: [1] Faulty nonvolatile memory [2] The memory has been rewritten more than 100,000 times. (The nominal life of the nonvolatile memory is 100,000 rewrite operations.) Action: If the problem still persists after the power has been reconnected, contact IAI.
0F6	Nonvolatile memory timeout after write	This alarm indicates that no response was received within the specified time after writing data to the nonvolatile memory. Cause: [1] Faulty nonvolatile memory [2] The memory has been rewritten more than 100,000 times. (The nominal life of the nonvolatile memory is 100,000 rewrite operations.) Action: If the problem still persists after the power has been reconnected, contact IAI.
0F8	Damaged nonvolatile memory	Abnormal data was detected in the nonvolatile memory check after starting. Cause: [1] Faulty nonvolatile memory [2] The memory has been rewritten more than 100,000 times. (The nominal life of the nonvolatile memory is 100,000 rewrite operations.) Action: If the problem still persists after the power has been reconnected, contact IAI.
0FA	CPU error	The CPU is not operating correctly. Cause: [1] Faulty CPU [2] Malfunction due to noise Action: If the problem still persists after the power has been reconnected, contact IAI.

(3) Non-Alarm

Code	Error	Cause/action
FFF	Power-ON log	This is not an error. (Controller power up detection)

6.4 Messages Displayed during Teaching Pendant Operation

This section explains the warning messages that may be displayed while operating the teaching pendant or PC software.

Code	Message	Description
112	Input data error	An inappropriate value was input as a user parameter setting. (Example) "9601" was input as the serial communication speed by mistake. Input an appropriate value again.
113 114	Input value too small Input value too large	The input value is under the setting range. The input value is over the setting range. Input an appropriate value again by referring to the actuator specifications and parameter list.
115	Homing not yet complete	The current position was written before homing was complete. Perform homing first.
116	Last position data available	Data was stored in the last position fields when an attempt was made to add data to the position table. Clear or delete the data for the last position.
117	No movement data	No target position is set under the selected position number. Input a target position first.
11E	Inconsistent data pair	The magnitude relationship of a pair of data is inappropriate. (Example) The same value is set in both the + and – soft limit parameters. Input appropriate values again.
11F	Absolute value too small	The minimum travel toward a target position is determined by the lead of the drive system and encoder resolution. This message indicates that the input target position is less than this minimum travel. (Example) If the lead is 20 mm, the encoder resolution is 800 pulses and therefore the minimum travel is calculated as 0.025 mm/pulse (20 / 800). If 0.02 mm is input as the target position, this message will be displayed.
121	Push search end over	The final position in push-motion operation exceeds a soft limit. No harm is done as long as the actuator contacts the work. If it misses the work, however, the actuator will reach the soft limit and this message will be displayed. Change either the target position or positioning band.
122	Multiple axes connected at assignment	An axis number was assigned when multiple axes were connected. Always assign an axis number when only one axis is connected.
180 181 182	Axis number change OK Controller initialization OK Home change all clear	This is an operation check message. (It does not indicate misoperation or error.)
201	Emergency stop	An emergency stop status was detected. (This is not an error.)
20A	Servo OFF during movement	The servo ON signal (SON) was turned OFF by the PLC while the actuator was moving. As a result, the servo turned OFF and the actuator stopped.

Code	Message	Description
20C	CSTR-ON during movement	The start signal (CSTR) was turned ON from the PLC while the actuator was moving, resulting in redundant move commands.
20D	STOP-OFF during movement	The pause signal (*STP) was turned OFF from the PLC while the actuator was moving, disabling the actuator movement.
20E	Soft limit over	A soft limit was reached.
20F	Missed work detected	The actuator passed the work without contacting it in push-motion operation. Review the work condition as well as the target position/positioning band settings.
210	HOME-ON during movement	The homing signal (HOME) was turned ON from the PLC while the actuator was moving, resulting in redundant move commands.
211	JOG-ON during movement	The jog signal (JOG) was turned ON from the PLC while the actuator was moving, resulting in redundant move commands.
301 302 304 305 306 308 30A 30B	Overrun error (M) Framing error (M) SCIR-QUE OV (M) SCIS-QUE OV (M) R-BF OV Response timeout (M) Packet R-QUE OV Packet S-QUE OV	An error occurred in serial communication with the controller. Cause: [1] Garbage data due to noise [2] Duplicate slave numbers when multiple actuators are controlled via serial communication Action: [1] Revise the wiring, equipment layout, etc., to eliminate noise. [2] Change the slave numbers to eliminate duplication. If the message persists, please contact IAI.
307	Memory command denied	A command was denied in serial communication with the controller.
309	Write address error	An indeterminable write address error occurred in serial communication with the controller. These messages do not generate during normal operation. Should either of them occur, record the entire error list before turning off the power. The recorded error list will help us identify the cause of the problem. Also contact IAI.
30C	No connected axis	The controller axis number cannot be recognized. Cause: [1] The controller is not operating properly. [2] Only the communication line of the supplied cable (SGA/SGB) is open. [3] If the SIO converter is used, the link cable is not connected although the converter is receiving 24 V. [4] When multiple controllers are linked, the ADRS switch is set to the same number by mistake on two or more controllers. Action: [1] Check if the RDY LED on the controller is lit. If this LED is not lit, the controller is faulty. [2] If you have a spare teaching pendant, change to the spare teaching pendant. Or, switch to the PC software mode and see if the message will disappear. [3] Connect all pairs of converter and controller using link cables, and then supply the power. [4] Set each ADRS switch to a unique number. If the message persists, please contact IAI.

6.5 Common Problems and Recommended Actions

- I/O Signals Cannot Be Sent or Received to/from the PLC.

  Cause: [1] The 24-V I/O power supply is connected in reverse polarities.
  (In this case, input circuits are not affected, but output circuits will be damaged.)
  [2] If an output circuit presents this problem, electrical current exceeding the maximum current flowed due to a large load and a circuit component was damaged.
  [3] Poor contact at the connector or relay terminal block on the PLC side.
  [4] The female pins on the flat cable connector are bent outward, thus causing contact failure with the male pins on the controller connector.

  Action: Check the connection condition of the power supply and connector, as well as the load on the output side.
  If [1] or [2] is suspected, the controller must be replaced. If [4] is likely, the flat cable must be replaced. Either way, contact IAI.

⚠ Caution: When checking the continuity of the shield cable, exercise due caution not to bend the female pins on the connector outward. It may cause contact failure, resulting in malfunction.

- The ALM Lamp Illuminates after the Power Is Turned On.

  (An alarm is present, emergency stop is actuated, or the motor power is cut off.)
  * If the ALM output signal is OFF, an alarm is present. Connect a PC or teaching pendant to check the nature of the error and remove the cause.
  * If the ALM output signal is ON, the emergency stop circuit is actuated.

  Check the following items:
  [1] Is the emergency stop switch on the operation panel pressed by mistake? Is the necessary interlock canceled?
  [2] Is the emergency stop switch on the teaching pendant pressed by mistake?
  [3] Is Parameter No. 42 (Enable Function) set to enabled by mistake after connecting a teaching pendant that does not support the enable switch?
  [4] If multiple controllers are linked together, are they wired correctly?

- After Turning On the Power, the SV Lamp Does Not Illuminate upon Servo-on Signal Input.

  (The Servo Does Not Turn On.)
  Cause: [1] I/O shield cable contact failure
  [2] Faulty controller
  Check the servo-on signal (SON) in the I/O monitor screen on the PC or teaching pendant.
  If the signal is input, the controller may be faulty. Contact IAI.

- The Actuator does not Operate when a Pulse Train is Input.
  Cause: [1] The I/O I/F signal issued with the pulse train is invalid.
  [2] The command-pulse train pattern is not set properly in the parameters.
  Action: [1] Check the input signal.
  [2] Check User Parameter No. 63 (Command-pulse input mode) and No. 64 (Polarity in command-pulse input mode).

⚠ Caution:	With certain third-party host controllers, the positive and negative logic settings of pulse train patterns are opposite to those of IAI's controllers. Reverse the positive and negative logic settings to see if the problem is resolved.

- With an Actuator Installed in Vertical Orientation, Noise Generates during Downward Movement.
  Cause: The load exceeds the rated load capacity.
  Action: [1] Decrease the speed.
  [2] Decrease the value set in User Parameter No. 7 (Servo gain number). As a guide, do not decrease the setting to below 3.

- Vibration Occurs when the Actuator Is at Standstill.
  Cause: The slider is receiving external force.
  Action: If external force cannot be removed, increase the value set in User Parameter No. 12 (Current-limiting value at standstill after positioning).
  Increasing the setting of this parameter increases the holding torque. As a guide, keep the current limiting value to 70% or below.

- Stopped Position Sometime Deviates from the Home Position or Target Position.
  Cause: [1] Encoder waveforms are disturbed due to noise.
  [2] If the actuator is of rod type, non-rotational error increased due to application of rotational moment to the rod.
  Action: [1] Check if the grounding is provided correctly, and also check for any equipment that may be generating noise.
  [2] Depending on the condition, the actuator may have to be replaced. Contact IAI.

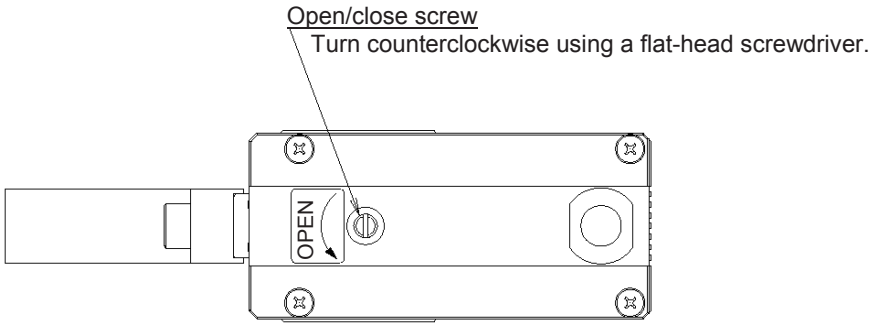
- The Actuator Moves Only a Half, or as Much as Twice, the Specified Travel.
  Cause: [1] The controller and actuator combination is incorrect.
  [2] The ball screw lead varies according to the actuator type. If the actuator is not combined with an appropriate controller, the travel and speed will change.
  [3] Wrong electronic gear setting
  [4] Pre-shipment setting error at IAI

  Action: [1] If multiple actuators of different types are used, check the label on each actuator or use other means to see if they are connected to correct controllers.
  [2] Recalculate for electronic gear.
  [3] Contact IAI.

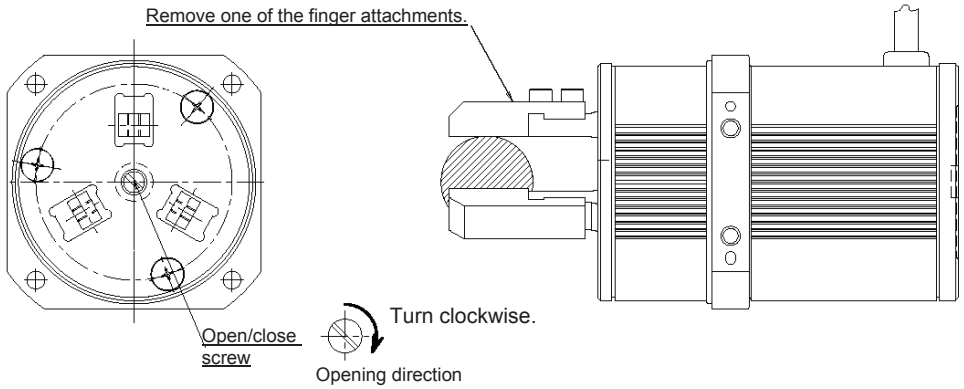
- A Servo Error Occurred while the ROBO Gripper Was Moving.
  Cause: The work was not positioned properly and a finger attachment contacted the work in the positioning mode.
  Action: Consider how much the work deviates and adjust the start position of push-motion operation, as well as the thickness of the finger attachment (including buffer material), so that the work can be clamped properly in the push-motion mode.
  Before resetting the error, be sure to turn the open/close screw and loosen the finger attachments first, because the feed mechanism may be locked.

⚠ Caution:	If the alarm is reset when the servo-on signal is disabled or while the servo-on signal is ON, the servo will turn on. Turning the open/close screw in this condition only results in the screw returning to the original position, and the feed mechanism remains locked. Therefore, the alarm will generate again the next time a move command is issued.

[Two-finger type]



[Three-finger type]
Remove one of the finger attachments and take out the work, and then turn the open/close screw clockwise.



- The Actuator Malfunctions when the Servo Is Turned On after Turning On the Power.

  Cause: Excited phase detection is not performed properly when the servo is turned on, because one of the following conditions exists when the power was turned on:
  [1] The slider or rod was contacting a mechanical end.
  [2] The work was pushed by a strong external force.

  Action: [1] Check if the slider or rod is not contacting a mechanical end. If the slider/rod is contacting a mechanical end, separate the slider/rod from the mechanical end.
  If it is equipped with a brake, turn the power ON to force release the brake before moving.
  At this time, be careful not to pinch your hand or damage the robot hand or work by the slider/rod, as the slider/rod may drop unexpectedly by its dead weight.
  If the actuator cannot be moved by hand, one measure is to check the direction of excited phase signal detection and change the direction of detection as necessary. If you wish to change the direction, contact IAI beforehand.
  For details, refer to the applicable parameter explained in 6.2.2, “Parameters Relating to Actuator Operating Characteristics.”
  [2] Check if the work is not contacting any peripheral equipment.
  If the work is contacting peripheral equipment, separate the work from the equipment by providing a minimum clearance of 1 mm in between.
  If neither [1] nor [2] applies, contact IAI.

* Appendix

List of Specifications of Connectable Actuators

The specifications included in this specification list are limited to those needed to set operating conditions and parameters. For other detailed specifications, refer to the catalog or operation manual for your actuator.

⚠ Caution

- The push force is based on the rated push speed (factory setting) indicated in the list, and provides only a guideline.
- Make sure the actual push force is equal to or greater than the minimum push force. If not, the push force will not stabilize.
- Do not change the setting of push speed (parameter No. 34). If you must change the push speed, consult IAI.
- If, among the operating conditions, the positioning speed is set to a value equal to or smaller than the push speed, the push speed will become the set speed and the specified push force will not generate.

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP2 (rod type)	RA2C	Ball screw	800	1	Horizontal/ vertical	1.25	25	0.05	50	100	3
	RA3C	Ball screw	800	5	Horizontal/ vertical	6.25	187	0.2	21	73.5	20
				2.5	Horizontal/ vertical	3.12	114		50	156.8	
	RGD3C	Ball screw	800	5	Horizontal/ vertical	6.25	187	0.2	21	73.5	20
				2.5	Horizontal	3.12	114		50	156.8	
					Vertical		93				
	RA4C	Ball screw	800	10	Horizontal/ vertical	12.5	458 (at to 250st) 350 (at 300st)	0.2	30	150	20
				5	Horizontal/ vertical	6.25	250 (at 50 to 200st) 237 (at 250st) 175 (at 300st)		75	284	
				2.5	Horizontal	3.12	125 (at 50 to 200st) 118 (at 250st) 87 (at 300st)		150	358	
					Vertical		114				
	RGS4C	Ball screw	800	10	Horizontal/ vertical	12.5	458 (at to 250st) 350 (at 300st)	0.2	30	150	20
				5	Horizontal/ vertical	6.25	250 (at 50 to 200st) 237 (at 250st) 175 (at 300st)		75	284	
				2.5	Horizontal	3.12	125 (at 50 to 200st) 118 (at 250st) 87 (at 300st)		150	358	
					Vertical		114				

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP2 (rod type)	RGD4C	Ball screw	800	10	Horizontal/ vertical	12.5	458 (at to 250st) 350 (at 300st)	0.2	30	150	20
				5	Horizontal/ vertical	6.25	250 (at 50 to 200st) 237 (at 250st) 175 (at 300st)		75	284	
				2.5	Horizontal	3.12	125 (at 50 to 200st) 118 (at 250st) 87 (at 300st)		150	358	
					Vertical		114				
	RA6C	Ball screw	800	16	Horizontal	20	450	0.2	75	240	20
					Vertical		400				
				8	Horizontal/ vertical	10	210		130	470	
				4	Horizontal/ vertical	5	130		300	800	
	RGS6C	Ball screw	800	16	Horizontal	20	450	0.2	75	240	20
					Vertical		400				
				8	Horizontal/ vertical	10	210		130	470	
				4	Horizontal/ vertical	5	130		300	800	
	RGD6C	Ball screw	800	16	Horizontal	20	450	0.2	75	240	20
					Vertical		400				
				8	Horizontal/ vertical	10	210		130	470	
				4	Horizontal/ vertical	5	130		300	800	
	SRA4R	Ball screw	800	5	Horizontal/ vertical	6.25	250	0.3	26	90	20
				2.5	Horizontal	3.12	124	0.2	50	170	
					Vertical		125				
	SRGS4R	Ball screw	800	5	Horizontal/ vertical	6.25	250	0.3	26	90	20
				2.5	Horizontal	3.12	124	0.2	50	170	
					Vertical		125				
	SRGD4R	Ball screw	800	5	Horizontal/ vertical	6.25	250	0.3	26	90	20
				2.5	Horizontal	3.12	124	0.2	50	170	
					Vertical		125				

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP2 (slider type)	SA5C	Ball screw	800	20	Horizontal	25	380 (at 50st) 540 (at 100st) 660 (at 150st) 770 (at 200st) 860 (at 250st) 940 (at 300st) 1000 (at 350 to 550st) 980 (at 600st) 850 (at 650st) 740 (at 700st) 650 (at 750st) 580 (at 800st)	0.7	11	39	20
					Vertical		380 (at 50st) 540 (at 100st) 660 (at 150st) 770 (at 200st) 800 (at 250 to 600st) 740 (at 700st) 650 (at 750st) 580 (at 800st)	0.2			
				12	Horizontal	15	300 (at 50st) 460 (at 100st) 600 (at 150 to 550st) 540 (at 600st) 460 (at 650st) 400 (at 700st) 360 (at 750st) 300 (at 800st)	0.7	40	115	
					Vertical			0.3			
				6	Horizontal	7.5	295 (at 50st) 300 (at 100 to 550st) 270 (at 600st) 230 (at 650st) 200 (at 700st) 180 (at 750st) 150 (at 800st)	0.7	70	210	
					Vertical			0.3			
				3	Horizontal	3.75	150 (at to 550st) 135 (at 600st) 115 (at 650st) 100 (at 700st) 90 (at 750st) 75 (at 800st)	0.7	140	330	
					Vertical			0.3			
	SA5R	Ball screw	800	12	Horizontal	15	300 (at 50st) 460 (at 100st) 600 (at 150 to 550st) 540 (at 600st) 460 (at 650st) 400 (at 700st) 360 (at 750st) 300 (at 800st)	0.3	–	–	–
					Vertical			0.2			
				6	Horizontal	7.5	295 (at 50st) 300 (at 100 to 550st) 270 (at 600st) 230 (at 650st) 200 (at 700st) 180 (at 750st) 150 (at 800st)	0.3	–	–	–
					Vertical			0.2			
				3	Horizontal	3.75	150 (at to 550st) 135 (at 600st) 115 (at 650st) 100 (at 700st) 90 (at 750st) 75 (at 800st)	0.2	–	–	–
					Vertical			0.2			

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP2 (slider type)	SA6C	Ball screw	800	20	Horizontal	25	380 (at 50st) 540 (at 100st) 660 (at 150st) 770 (at 200st) 860 (at 250st) 940 (at 300st) 1000 (at 350 to 550st) 980 (at 600st) 850 (at 650st) 740 (at 700st) 650 (at 750st) 580 (at 800st)	0.7	11	39	20
					Vertical		380 (at 50st) 540 (at 100st) 660 (at 150st) 770 (at 200st) 800 (at 250 to 600st) 740 (at 700st) 650 (at 750st) 580 (at 800st)	0.2			
				12	Horizontal	15	300 (at 50st) 460 (at 100st) 600 (at 150 to 550st) 540 (at 600st) 460 (at 650st) 400 (at 700st) 360 (at 750st) 300 (at 800st)	0.7	40	115	
					Vertical			0.3			
				6	Horizontal	7.5	295 (at 50st) 300 (at 100 to 550st) 270 (at 600st) 230 (at 650st) 200 (at 700st) 180 (at 750st) 150 (at 800st)	0.7	70	210	
					Vertical			0.3			
				3	Horizontal	3.75	150 (at to 550st) 135 (at 600st) 115 (at 650st) 100 (at 700st) 90 (at 750st) 75 (at 800st)	0.7	140	330	
					Vertical			0.3			
	SA6R	Ball screw	800	12	Horizontal	15	300 (at 50st) 460 (at 100st) 600 (at 150 to 550st) 540 (at 600st) 460 (at 650st) 400 (at 700st) 360 (at 750st) 300 (at 800st)	0.3	–	–	–
					Vertical			0.2			
				6	Horizontal	7.5	295 (at 50st) 300 (at 100 to 550st) 270 (at 600st) 230 (at 650st) 200 (at 700st) 180 (at 750st) 150 (at 800st)	0.3	–	–	–
					Vertical			0.2			
				3	Horizontal	3.75	150 (at to 550st) 135 (at 600st) 115 (at 650st) 100 (at 700st) 90 (at 750st) 75 (at 800st)	0.2	–	–	–
					Vertical			0.2			

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP2 (slider type)	SA7C	Ball screw	800	16	Horizontal	20	380 (at 50st) 470 (at 100st) 533 (at 150 to 750st) 480 (at 800st)	0.3	90	250	20
					Vertical			0.2			
				8	Horizontal	10	266 (at 50 to 700st) 240 (at 800st)	0.3	150	500	
					Vertical			0.2			
				4	Horizontal	5	133 (at 50 to 700st) 120 (at 800st)	0.2	280	800	
					Vertical			0.2			
	SA7R	Ball screw	800	16	Horizontal	20	380 (at 50st) 470 (at 100st) 533 (at 150 to 750st) 480 (at 800st)	0.3	–	–	–
					Vertical		400	0.2			
				8	Horizontal	10	266 (at 50 to 700st) 240 (at 800st)	0.3	–	–	–
					Vertical			0.2			
				4	Horizontal	5	133 (at 50 to 700st) 120 (at 800st)	0.2	–	–	–
					Vertical			0.2			
	SS7C	Ball screw	800	12	Horizontal	15	600 (at 50 to 500st) 470 (at 600st)	0.3	40	120	20
					Vertical			0.2			
				6	Horizontal	7.5	300 (at 50 to 500st) 230 (at 600st)	0.3	75	220	
					Vertical			0.2			
				3	Horizontal	3.75	150 (at 50 to 500st) 115 (at 600st)	0.2	140	350	
					Vertical			0.2			
	SS7R	Ball screw	800	12	Horizontal	15	600 (at 50 to 500st) 470 (at 600st)	0.3	–	–	–
					Vertical		440 (at 50 to 500st) 440 (at 600st)	0.2			
				6	Horizontal	7.5	250 (at 50 to 500st) 230 (at 600st)	0.3	–	–	–
					Vertical			0.2			
				3	Horizontal	3.75	105 (at 50 to 500st) 105 (at 600st)	0.2	–	–	–
					Vertical			0.2			
	SS8C	Ball screw	800	20	Horizontal	25	666 (at 50 to 800st) 625 (at to 900st) 515 (at to 1000st)	0.3	50	180	20
					Vertical		600 (at 50 to 800st) 600 (at to 900st) 515 (at to 1000st)	0.2			
				10	Horizontal	12.5	333 (at 50 to 800st) 310 (at to 900st) 255 (at to 1000st)	0.3	95	320	
					Vertical		300 (at 50 to 800st) 300 (at to 900st) 255 (at to 1000st)	0.2			
				5	Horizontal	6.25	165 (at 50 to 800st) 155 (at to 900st) 125 (at to 1000st)	0.2	180	630	
					Vertical		150 (at 50 to 800st) 150 (at to 900st) 125 (at to 1000st)	0.2			

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP2 (slider type)	SS8R	Ball screw	800	20	Horizontal	25	600 (at 50 to 800st) 600 (at to 900st) 515 (at to 1000st)	0.3	–	–	–
					Vertical		333 (at 50 to 800st) 333 (at to 900st) 333 (at to 1000st)	0.2			
				10	Horizontal	12.5	300 (at 50 to 800st) 300 (at to 900st) 255 (at to 1000st)	0.3	–	–	–
					Vertical		250 (at 50 to 800st) 250 (at to 900st) 250 (at to 1000st)	0.2			
				5	Horizontal	6.25	160 (at 50 to 800st) 155 (at to 900st) 125 (at to 1000st)	0.2	–	–	–
					Vertical		140 (at 50 to 800st) 140 (at to 900st) 140 (at to 1000st)	0.2			
	HS8C	Ball screw	800	30	Horizontal	37.5	1200 (at 50 to 800st) 1000 (at to 900st) 800 (at to 1000st)	0.3	–	–	–
					Vertical		750 (at 50 to 800st) 750 (at to 900st) 750 (at to 1000st)	0.2			
	HS8R	Ball screw	800	30	Horizontal	37.5	1200 (at 50 to 800st) 1000 (at to 900st) 800 (at to 1000st)	0.3	–	–	–
					Vertical		750 (at 50 to 800st) 750 (at to 900st) 750 (at to 1000st)	0.2			
RCP2 (belt type)	BA6/ BA6U	Belt	800	Equivalent to 54	Horizontal	67.5	1000	0.5	–	–	–
	BA7/ BA7U	Belt	800	Equivalent to 54	Horizontal	67.5	1500	0.5	–	–	–
RCP2 (gripper type)	GRSS	–	800	1.57	–	1.96	78	–	4	14	20
	GRLS	–	800	12	–	15 (deg/s)	600 (deg/s)	–	1.8	6.4	5 (deg/s)
	GRS	–	800	1	–	1.25	33.3	–	9	21	5
	GRM	–	800	1.1	–	1.37	36.7	–	23	80	5
	GRST	–	800	1.05	–	1.31	34	–	15	40	5
		–	800	2.27	–	2.83	75	–	7.5	20	5
	GR3LS	–	800	12	–	15	200	–	5	18	5 (deg/s)
	GR3LM	–	800	12	–	15	200	–	15	51	5 (deg/s)
	GR3SS	–	800	2.5	–	3.12	40	–	7	22	5
	GR3SM	–	800	3	–	3.75	50	–	30	102	5
	GRHM	–	800	2	–	2.5	100	–	25	125	5
	GRHB	–	800	2	–	2.5	100	–	60	200	5

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP2 (rotary type)	RTBS	–	800	Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
		–		Gear ratio: 1/45	–	10 (deg/s)	266 (deg/s)	–	–	–	–
	RTBSL	–	800	Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
		–		Gear ratio: 1/45	–	10 (deg/s)	266 (deg/s)	–	–	–	–
	RTCS	–	800	Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
		–		Gear ratio: 1/45	–	10 (deg/s)	266 (deg/s)	–	–	–	–
	RTCSL	–	800	Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
		–		Gear ratio: 1/45	–	10 (deg/s)	266 (deg/s)	–	–	–	–
	RTB	–	800	Gear ratio: 1/20	–	22.5 (deg/s)	600 (deg/s)	–	–	–	–
		–		Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
	RTBL	–	800	Gear ratio: 1/20	–	22.5 (deg/s)	600 (deg/s)	–	–	–	–
		–		Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
	RTC	–	800	Gear ratio: 1/20	–	22.5 (deg/s)	600 (deg/s)	–	–	–	–
		–		Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
	RTCL	–	800	Gear ratio: 1/20	–	22.5 (deg/s)	600 (deg/s)	–	–	–	–
		–		Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
	RTBB	–	800	Gear ratio: 1/20	–	22.5 (deg/s)	600 (deg/s)	–	–	–	–
		–		Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
	RTBBL	–	800	Gear ratio: 1/20	–	22.5 (deg/s)	600 (deg/s)	–	–	–	–
		–		Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
	RTCB	–	800	Gear ratio: 1/20	–	22.5 (deg/s)	600 (deg/s)	–	–	–	–
		–		Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–
	RTCBL	–	800	Gear ratio: 1/20	–	22.5 (deg/s)	600 (deg/s)	–	–	–	–
		–		Gear ratio: 1/30	–	15 (deg/s)	400 (deg/s)	–	–	–	–

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP3 (rod type)	RA2AC	Lead screw	800	4	Horizontal/ vertical	5	180 (at 25st) 200 (at 50 to 100st)	0.2	0.9	16.1	5
				2		2.5	100		1.9	28.3	
				1		1.25	50		3.8	39.5	
	RA2BC	Lead screw	800	6	Horizontal/ vertical	7.5	180 (at 25st) 280 (at 50st) 300 (at 75 to 150st)	0.2	0.6	11.9	5
				4		5	180 (at 25st) 200 (at 50 to 150st)		0.9	16.1	
				2		2.5	100		1.9	28.3	
	RA2AR	Lead screw	800	4	Horizontal/ vertical	5	180 (at 25st) 200 (at 50 to 150st)	0.2	0.9	16.1	5
				2		2.5	100		1.9	28.3	
				1		1.25	50		3.8	39.5	
	RA2BR	Lead screw	800	6	Horizontal/ vertical	7.5	180 (at 25st) 280 (at 50st) 300 (at 75 to 150st)	0.2	0.6	11.9	5
				4		5	180 (at 25st) 200 (at 50 to 150st)		0.9	16.1	
				2		2.5	100		1.9	28.3	
RCP3 (slider type)	SA2AC	Lead screw	800	4	Horizontal	5	180 (at 25st) 200 (at 50 to 100st)	0.2	–	–	–
				2		2.5	100				
				1		1.25	50				
	SA2BC	Lead screw	800	6	Horizontal	7.5	180 (at 25st) 280 (at 50st) 300 (at 75 to 150st)	0.2	–	–	–
				4		5	180 (at 25st) 200 (at 50 to 150st)				
				2		2.5	100				
	SA2AR	Lead screw	800	4	Horizontal	5	180 (at 25st) 200 (at 50 to 100st)	0.2	–	–	–
				2		2.5	100				
				1		1.25	50				
	SA2BR	Lead screw	800	6	Horizontal	7.5	180 (at 25st) 280 (at 50st) 300 (at 75 to 150st)	0.2	–	–	–
				4		5	180 (at 25st) 200 (at 50 to 150st)				
				2		2.5	100				
	SA3C	Ball screw	800	6	Horizontal	7.5	300	0.3	9	15	20
					Vertical			0.2			
				4	Horizontal	5	200	0.3	14	22	
					Vertical			0.2			
				2	Horizontal	2.5	100	0.2	27	44	
					Vertical			0.2			
	SA3R	Ball screw	800	6	Horizontal	7.5	300	0.3	9	15	–
					Vertical			0.2			
				4	Horizontal	5	200	0.3	14	22	
					Vertical			0.2			
				2	Horizontal	2.5	100	0.2	27	44	
					Vertical			0.2			

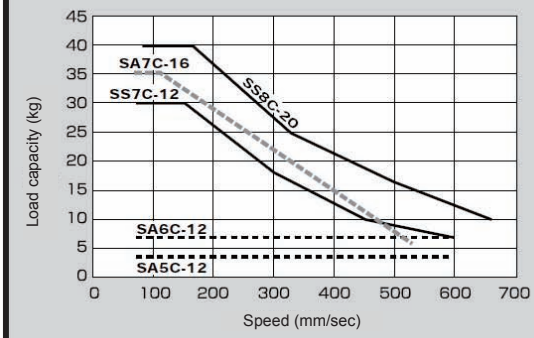
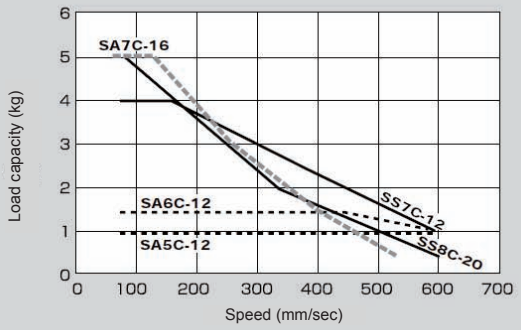
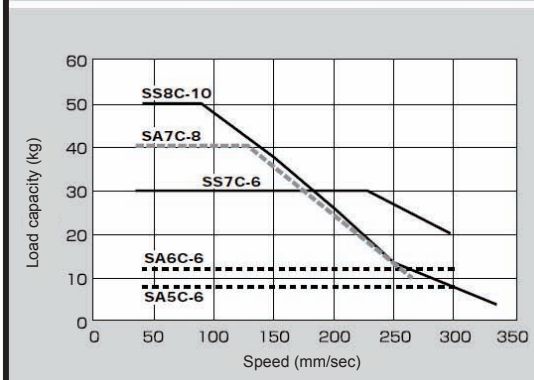
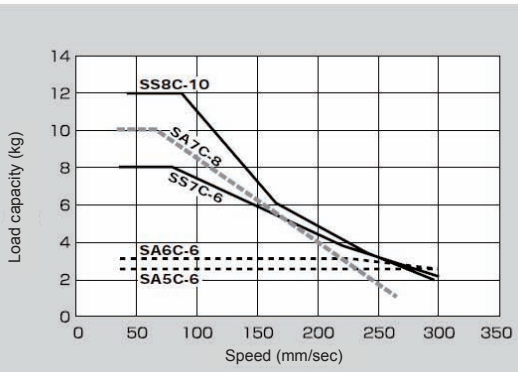
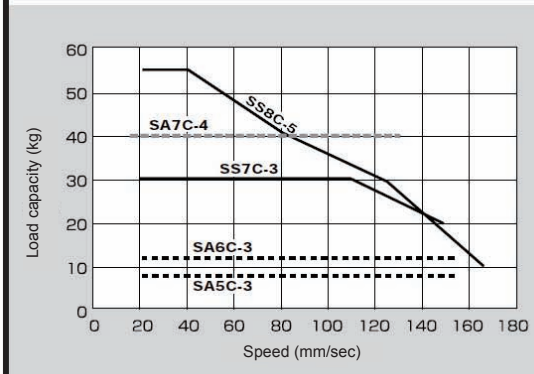
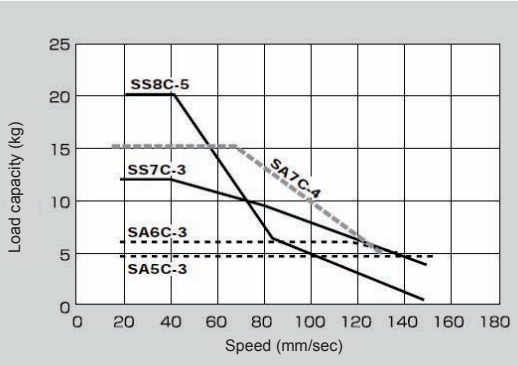
Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP3 (slider type)	SA4C	Ball screw	800	10	Horizontal	12.5	380 (at 50st) 500 (at 100st to 500st)	0.7	20	34	20
					Vertical			0.3			
				5	Horizontal	6.25	250	0.7	40	68	
					Vertical			0.3			
				2.5	Horizontal	3.12	125	0.7	82	136	
					Vertical			0.3			
	SA4R	Ball screw	800	10	Horizontal	12.5	380 (at 50st) 500 (at 100st to 500st)	0.3	20	34	–
					Vertical			0.2			
				5	Horizontal	6.25	250	0.3	40	68	
					Vertical			0.2			
				2.5	Horizontal	3.12	125	0.2	82	136	
					Vertical			0.2			
	SA5C	Ball screw	800	20	Horizontal	25	380 (at 50st) 540 (at 100st) 660 (at 150st) 770 (at 200st) 860 (at 250st) 940 (at 300st) 1000 (at 350 to 600st) 910 (at 650st) 790 (at 700st) 690 (at 750st) 610 (at 800st)	0.7	17	28	20
					Vertical		380 (at 50st) 540 (at 100st) 660 (at 150st) 770 (at 200st) 800 (at 250 to 650st) 790 (at 700st) 690 (at 750st) 610 (at 800st)	0.2			
				12	Horizontal	15	380 (at 50st) 540 (at 100st) 600 (at 150st to 550st) 570 (at 600st) 490 (at 650st) 425 (at 700st) 370 (at 750st) 330 (at 800st)	0.7	28	47	
					Vertical			0.3			
				6	Horizontal	7.5	300 (at 50st to 550st) 285 (at 600st) 245 (at 650st) 210 (at 700st) 185 (at 750st) 165 (at 800st)	0.7	57	95	
					Vertical			0.3			
				3	Horizontal	3.75	150 (at 50st to 550st) 140 (at 600st) 120 (at 650st) 105 (at 700st) 90 (at 750st) 80 (at 800st)	0.7	113	189	
					Vertical			0.3			

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP3 (slider type)	SA5R	Ball screw	800	12	Horizontal	15	380 (at 50st) 540 (at 100st) 600 (at 150st to 550st) 570 (at 600st) 490 (at 650st) 425 (at 700st) 370 (at 750st) 330 (at 800st)	0.3	30	47	20
					Vertical			0.2			
				6	Horizontal	7.5	300 (at 50st to 550st) 285 (at 600st) 245 (at 650st) 210 (at 700st) 185 (at 750st) 165 (at 800st)	0.3	58	95	
					Vertical			0.2			
				3	Horizontal	3.75	150 (at 50st to 550st) 140 (at 600st) 120 (at 650st) 105 (at 700st) 90 (at 750st) 80 (at 800st)	0.2	112	189	
					Vertical			0.2			
	SA6C	Ball screw	800	20	Horizontal	25	380 (at 50st) 540 (at 100st) 660 (at 150st) 770 (at 200st) 860 (at 250st) 940 (at 300st) 1000 (at 350 to 600st) 910 (at 650st) 790 (at 700st) 690 (at 750st) 610 (at 800st)	0.7	17	28	20
					Vertical		380 (at 50st) 540 (at 100st) 660 (at 150st) 770 (at 200st) 800 (at 250 to 650st) 790 (at 700st) 690 (at 750st) 610 (at 800st)	0.2			
				12	Horizontal	15	380 (at 50st) 540 (at 100st) 600 (at 150st to 550st) 570 (at 600st) 490 (at 650st) 425 (at 700st) 370 (at 750st) 330 (at 800st)	0.7	28	47	
					Vertical			0.3			
				6	Horizontal	7.5	300 (at 50st to 550st) 285 (at 600st) 245 (at 650st) 210 (at 700st) 185 (at 750st) 165 (at 800st)	0.7	57	95	
					Vertical			0.3			
				3	Horizontal	3.75	150 (at 50st to 550st) 140 (at 600st) 120 (at 650st) 105 (at 700st) 90 (at 750st) 80 (at 800st)	0.7	113	189	
					Vertical			0.3			

Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP3 (slider type)	SA6R	Ball screw	800	12	Horizontal	15	380 (at 50st) 540 (at 100st) 600 (at 150st to 550st) 570 (at 600st) 490 (at 650st) 425 (at 700st) 370 (at 750st) 330 (at 800st)	0.3	30	47	20
					Vertical			0.2			
				6	Horizontal	7.5	300 (at 50st to 550st) 285 (at 600st) 245 (at 650st) 210 (at 700st) 185 (at 750st) 165 (at 800st)	0.3	58	95	
					Vertical			0.2			
				3	Horizontal	3.75	150 (at 50st to 550st) 140 (at 600st) 120 (at 650st) 105 (at 700st) 90 (at 750st) 80 (at 800st)	0.2	112	189	
					Vertical			0.2			
RCP3 (table type)	TA3C	Ball screw	800	6	Horizontal	7.5	300	0.3	5.4	9	20
					Vertical		200	0.2			
				4	Horizontal	5	200	0.3	8.4	14	
					Vertical		133	0.2			
				2	Horizontal	2.5	100	0.2	16.8	28	
					Vertical		67	0.2			
	TA3R	Ball screw	800	6	Horizontal	7.5	300	0.3	5.4	9	20
					Vertical		200	0.2			
				4	Horizontal	5	200	0.3	8.4	14	
					Vertical		133	0.2			
				2	Horizontal	2.5	100	0.2	16.8	28	
					Vertical		67	0.2			
	TA4C	Ball screw	800	6	Horizontal	7.5	300	0.3	9	15	20
					Vertical			0.2			
				4	Horizontal	5	200	0.3	13.2	22	
					Vertical			0.2			
				2	Horizontal	2.5	100	0.2	26.4	44	
					Vertical			0.2			
	TA4R	Ball screw	800	6	Horizontal	7.5	300	0.3	9	15	20
					Vertical			0.2			
				4	Horizontal	5	200	0.3	13.2	22	
					Vertical			0.2			
				2	Horizontal	2.5	100	0.2	26.4	44	
					Vertical			0.2			
	TA5C	Ball screw	800	10	Horizontal	12.5	465	0.3	20	34	20
					Vertical		400	0.2			
				5	Horizontal	6.25	250	0.3	40	68	
					Vertical			0.2			
				2.5	Horizontal	3.12	125	0.2	82	136	
					Vertical			0.2			
	TA5R	Ball screw	800	10	Horizontal	12.5	465	0.3	20	34	20
					Vertical		400	0.2			
				5	Horizontal	6.25	250	0.3	40	68	
					Vertical			0.2			
				2.5	Horizontal	3.12	125	0.2	82	136	
					Vertical			0.2			

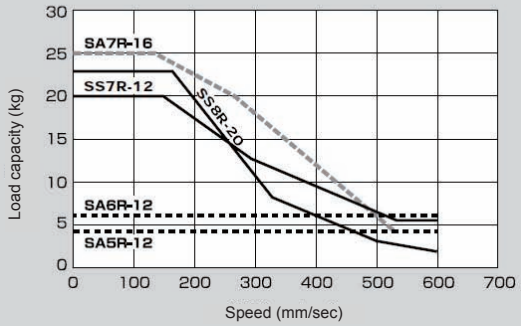
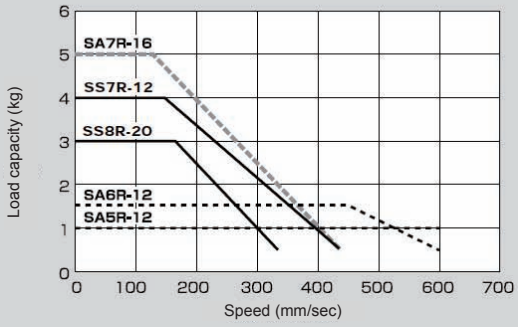
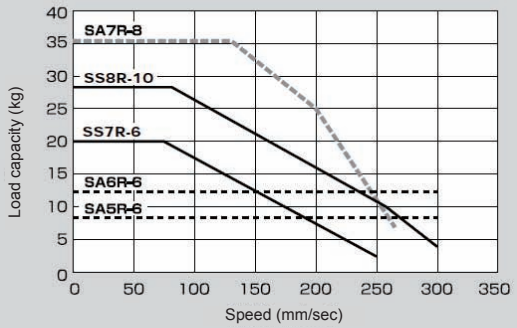
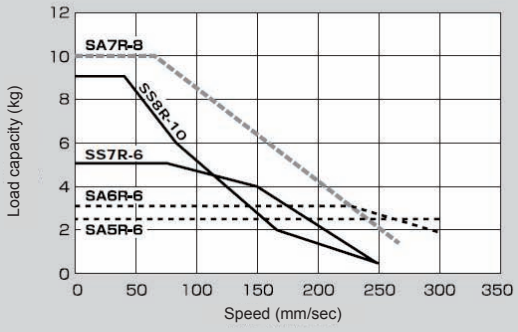
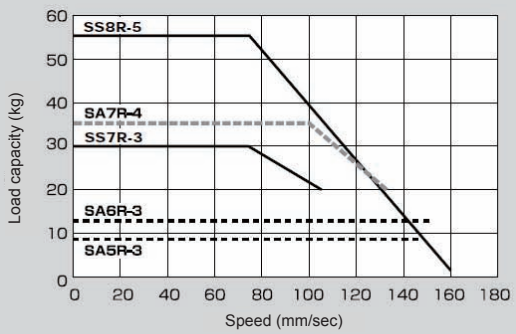
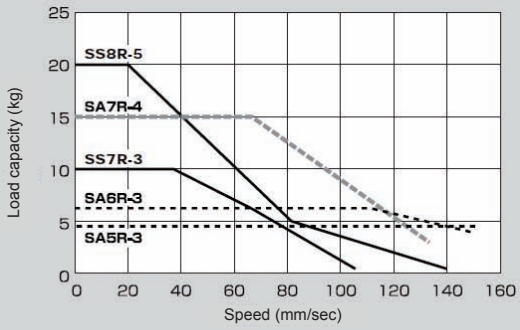
Actuator series	Type	Feed screw	No. of encoder pulses	Lead [mm]	Mounting direction	Minimum speed [mm/s]	Maximum speed [mm/s]	Maximum acceleration/ deceleration [G]	Minimum push force [N]	Maximum push force [N]	Rated push speed [mm/s]
RCP3 (table type)	TA6C	Ball screw	800	12	Horizontal	15	560	0.3	30	47	20
					Vertical		500	0.2			
				6	Horizontal	7.5	300	0.3	58	95	
					Vertical			0.2			
				3	Horizontal	3.75	150	0.2	112	189	
					Vertical			0.2			
	TA6R	Ball screw	800	12	Horizontal	15	560	0.3	30	47	20
					Vertical		500	0.2			
				6	Horizontal	7.5	300	0.3	58	95	
					Vertical			0.2			
				3	Horizontal	3.75	150	0.2	112	189	
					Vertical			0.2			
	TA7C	Ball screw	800	12	Horizontal	15	600	0.3	30	47	20
					Vertical		580	0.2			
				6	Horizontal	7.5	300	0.3	58	95	
					Vertical			0.2			
				3	Horizontal	3.75	150	0.2	112	189	
					Vertical			0.2			
	TA7R	Ball screw	800	12	Horizontal	15	600	0.3	30	47	20
					Vertical		580	0.2			
				6	Horizontal	7.5	300	0.3	58	95	
					Vertical			0.2			
				3	Horizontal	3.75	150	0.2	112	189	
					Vertical			0.2			

Correlation diagram of speed and load capacity for the slider type (motor-straight type)

	Horizontal installation	Vertical installation
High-speed type		
Medium-speed type		
Low-speed type		

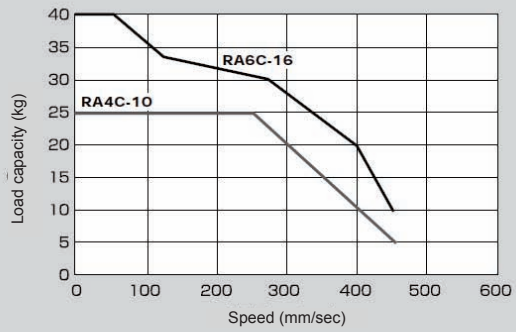
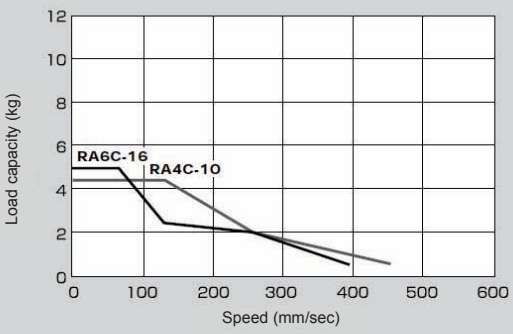
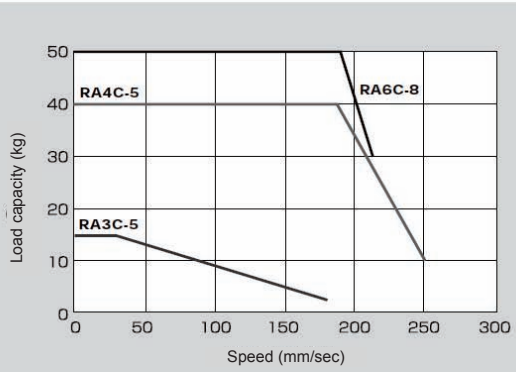
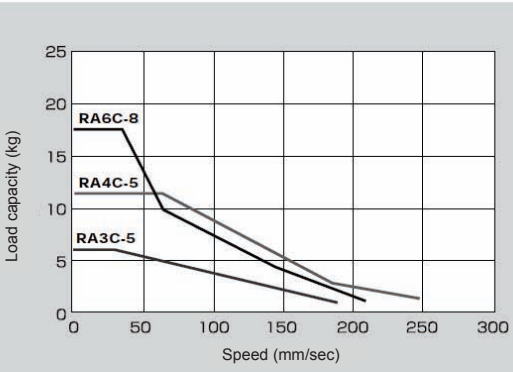
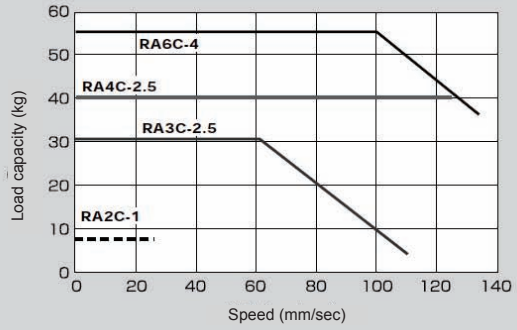
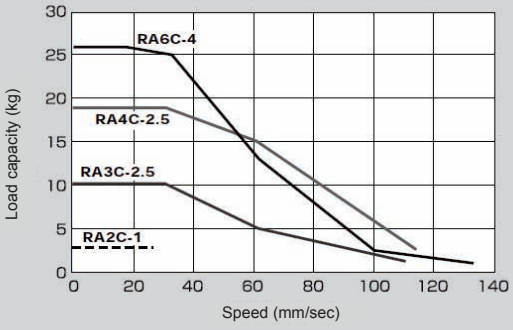
(Note) In the above graphs, the number after the type code indicates the lead.

Correlation diagram of speed and load capacity for the slider type (motor-reversing type)

	Horizontal installation	Vertical installation
High-speed type		
Medium-speed type		
Low-speed type		

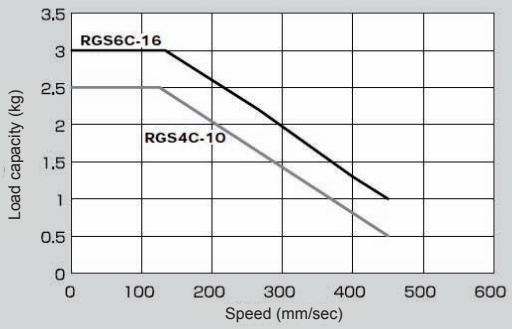
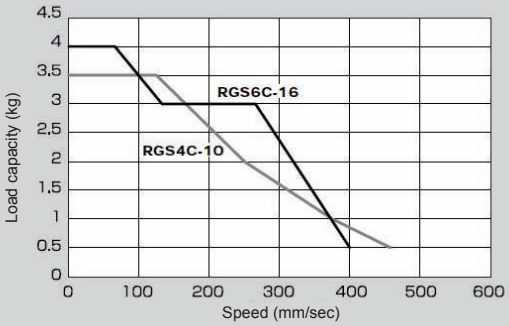
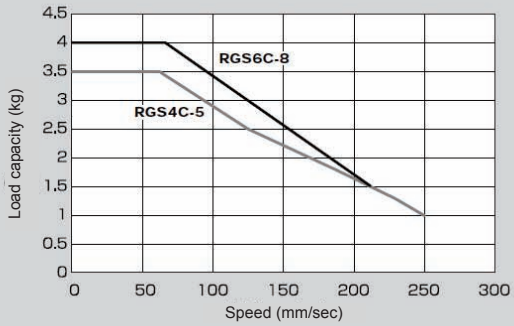
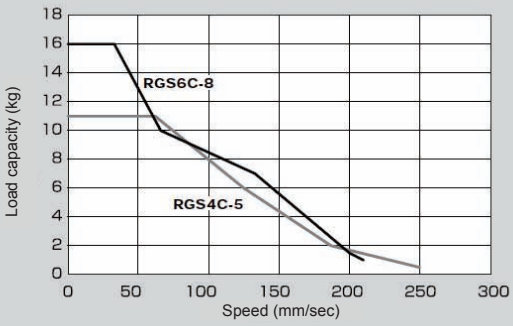
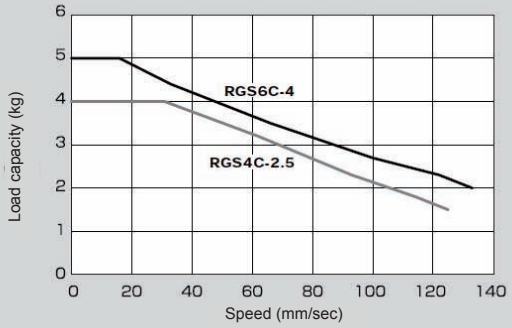
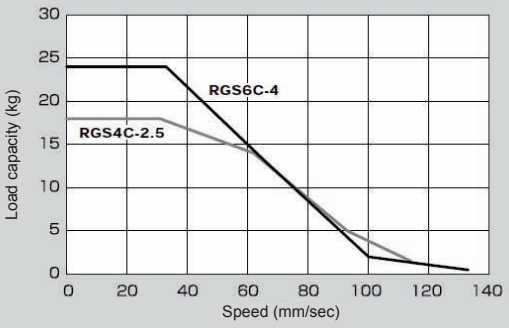
(Note) In the above graphs, the number after the type code indicates the lead.

Correlation diagram of speed and load capacity for the standard rod type

	Horizontal installation (Note 1)	Vertical installation
High-speed type		
Medium-speed type		
Low-speed type		

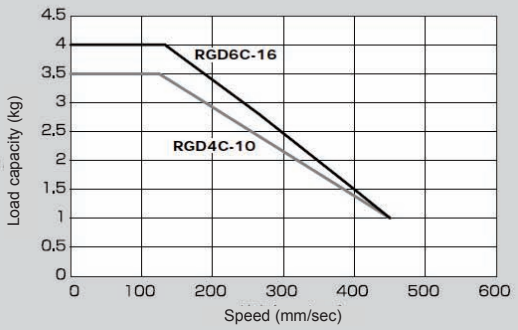
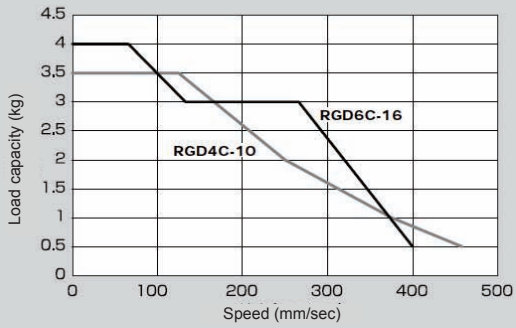
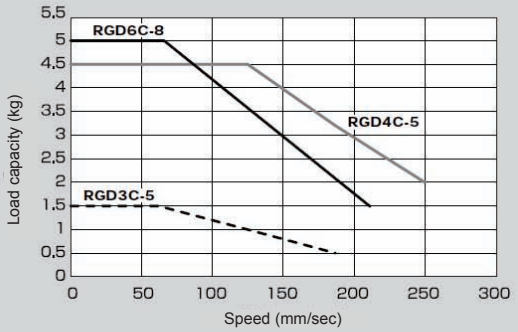
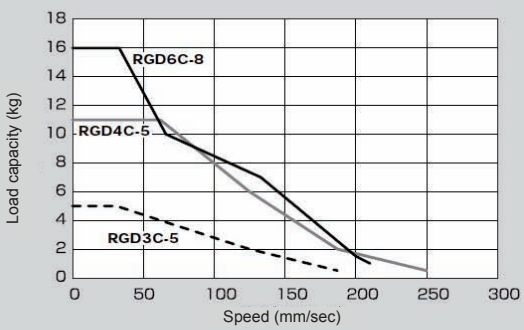
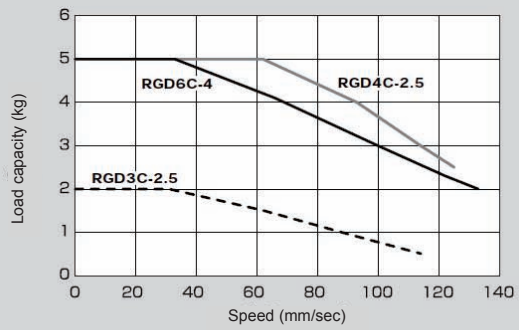
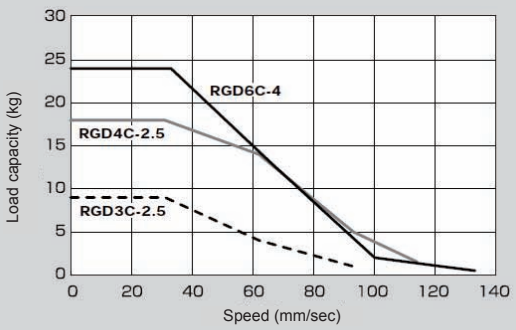
(Note) In the above graphs, the number after the type code indicates the lead.
(Note 1) The figures for horizontal installation assume use of an external guide.

Correlation diagram of speed and load capacity for the single-guide type

	Horizontal installation	Vertical installation
High-speed type		
Medium-speed type		
Low-speed type		

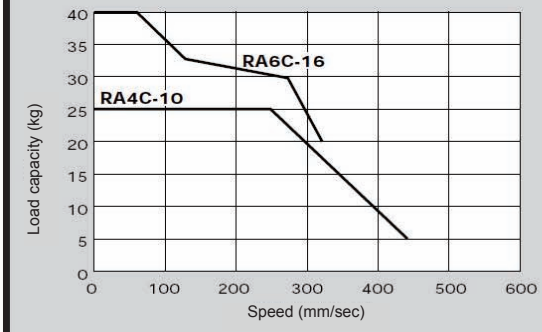
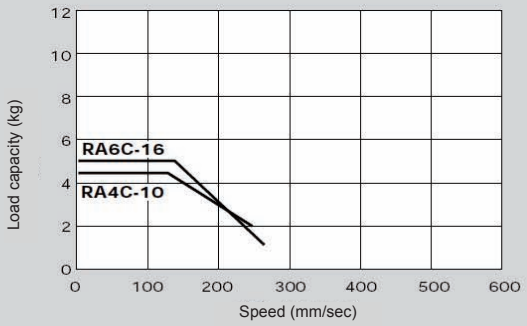
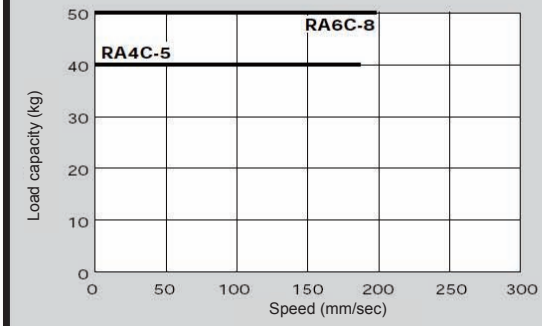
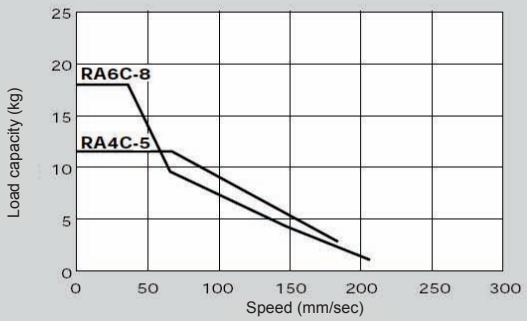
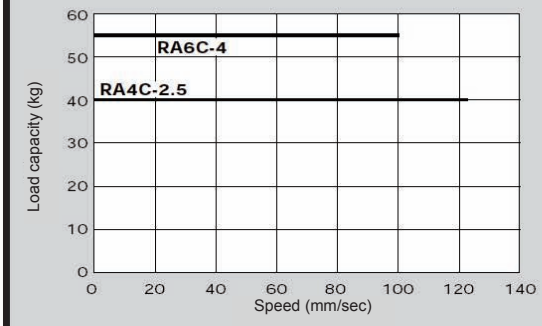
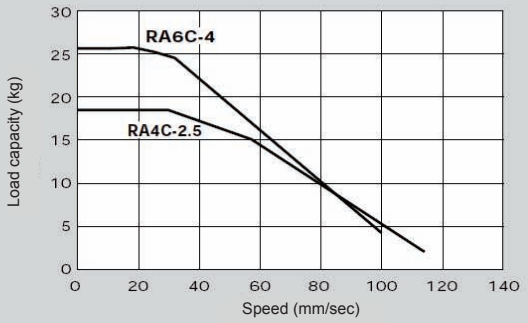
(Note) In the above graphs, the number after the type code indicates the lead.

Correlation diagram of speed and load capacity for the double-guide type

	Horizontal installation	Vertical installation
High-speed type		
Medium-speed type		
Low-speed type		

(Note) In the above graphs, the number after the type code indicates the lead.

Correlation diagram of speed and load capacity for the dustproof/splash-proof type

	Horizontal installation (Note 1)	Vertical installation (Note 2)
High-speed type		
Medium-speed type		
Low-speed type		

(Note) In the above graphs, the number after the type code indicates the lead.
(Note 1) The figures for horizontal installation assume use of an external guide.
(Note 2) Use of the actuator at the maximum load capacity corresponding to the applicable speed may cause vibration/overshooting. Select an appropriate model that provides an allowance of approx. 70%.

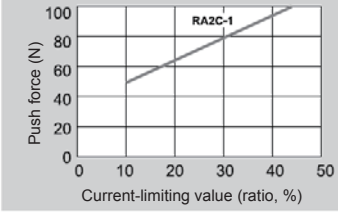
Push Force and Current-limiting Value

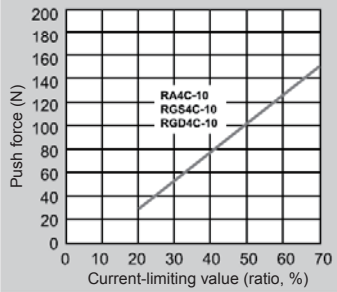
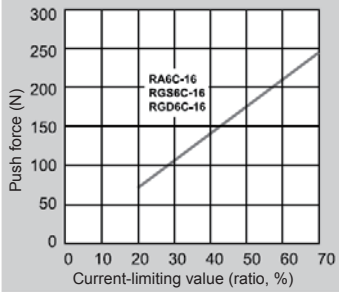
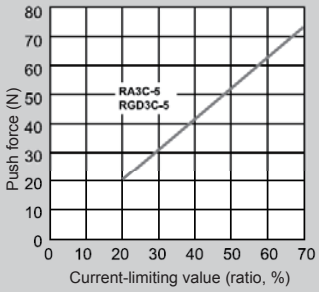
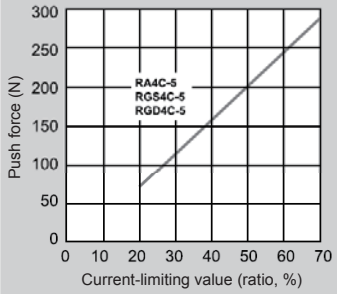
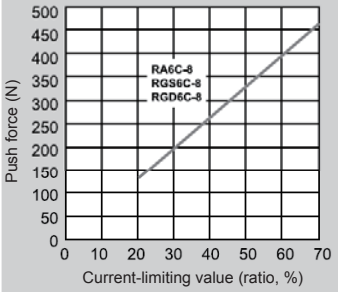
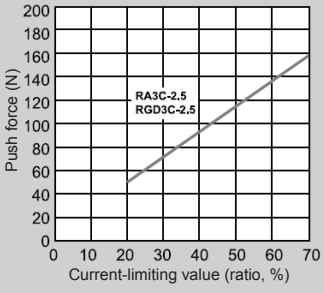
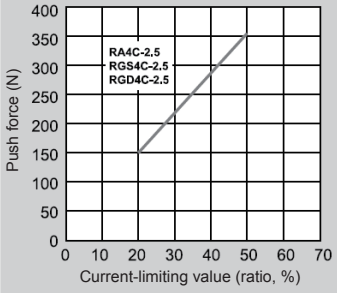
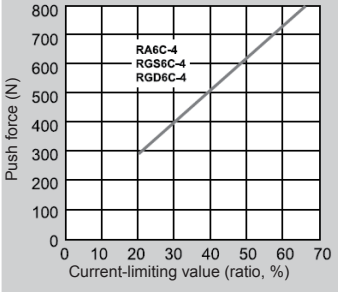
⚠ Caution

- The relationship of push force and current-limiting value is based on the rated push speed (factory setting) and provides only a guideline.
- Make sure the actual push force is equal to or greater than the minimum push force. If not, the push force will not stabilize.
- Do not change the setting of push speed (parameter No. 7). If you must change the push speed, consult IAI.
- If, among the operating conditions, the positioning speed is set to a value equal to or smaller than the push speed, the push speed will become the set speed and the specified push force will not generate.

RCP2 Series — Rod Type

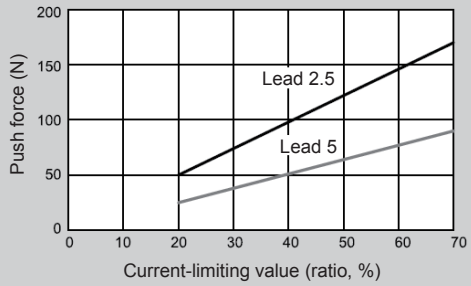
RA2C Type



	RA3C/RGD3C	RA4C/RGS4C/RGD4C	RA6C/RGS6C/RGD6C
High-speed type			
Medium-speed type			
Low-speed type			

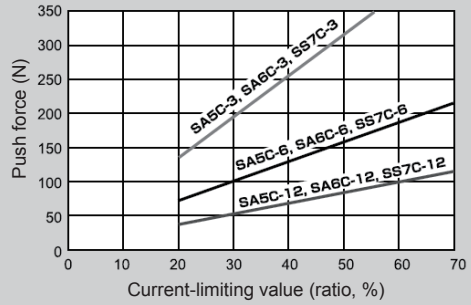
RCP2 Series **Short Type**

SRA4R/SRGS4R/SRGD4R

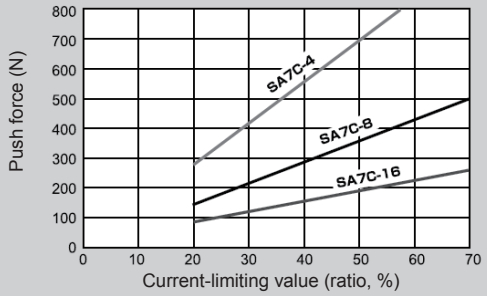


RCP2 Series **Slider Type**

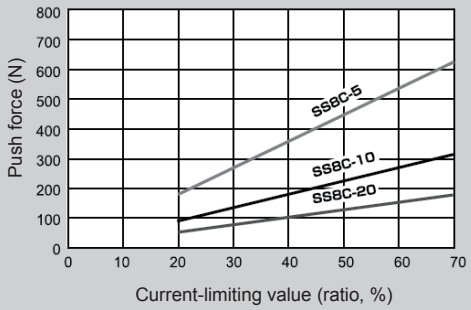
SA5C/SA6C/SS7C Type



SA7C Type

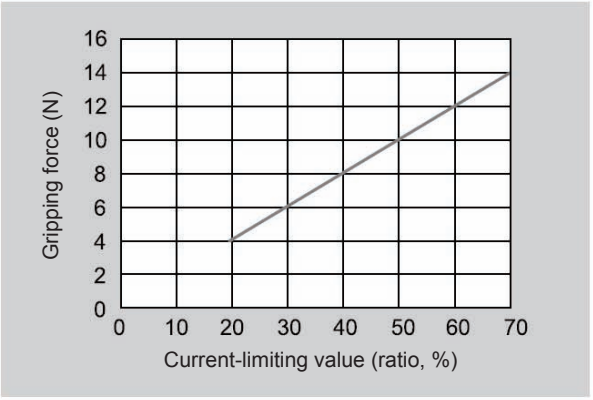


SS8C Type

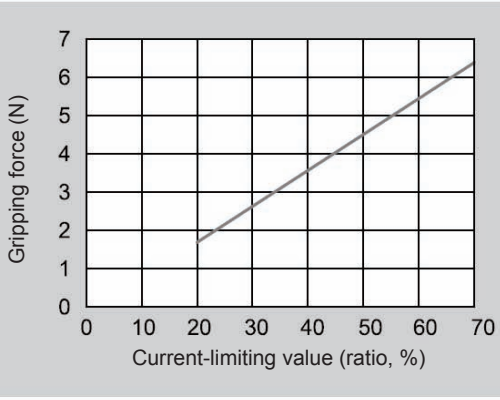


RCP2 Series **Gripper**

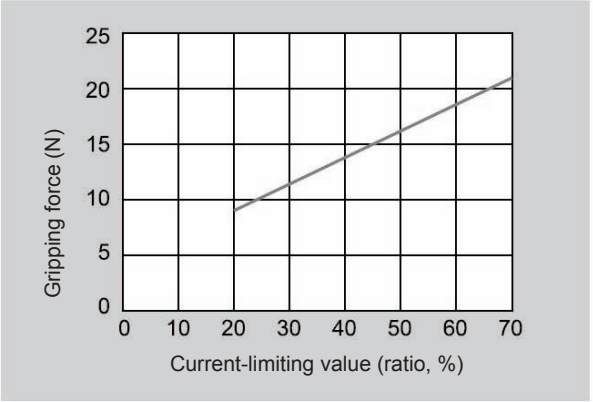
GRSS



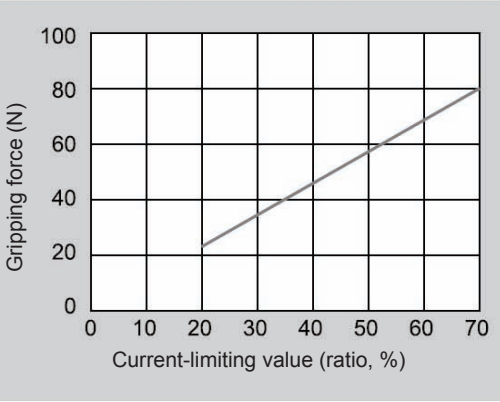
GRLS



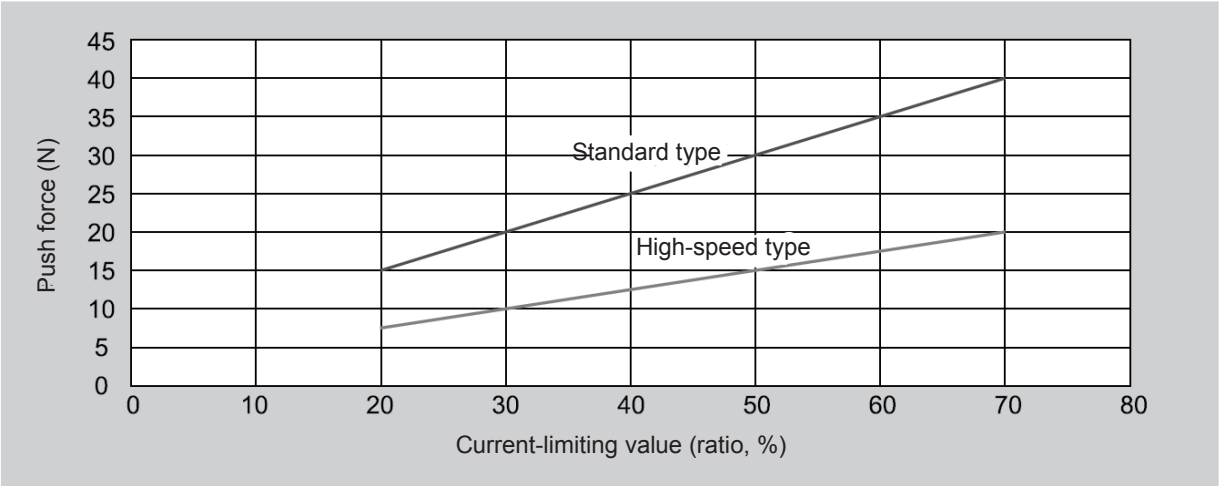
GRS



GRM

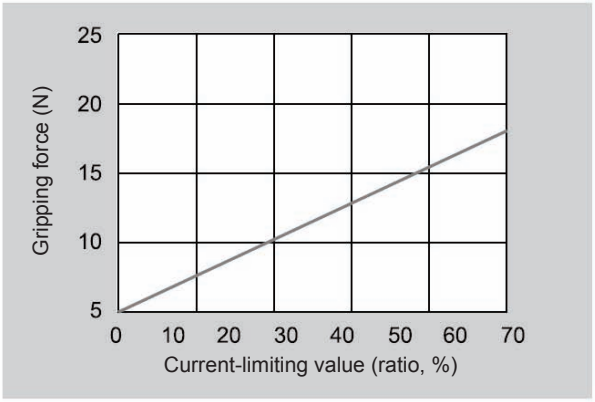


GRST

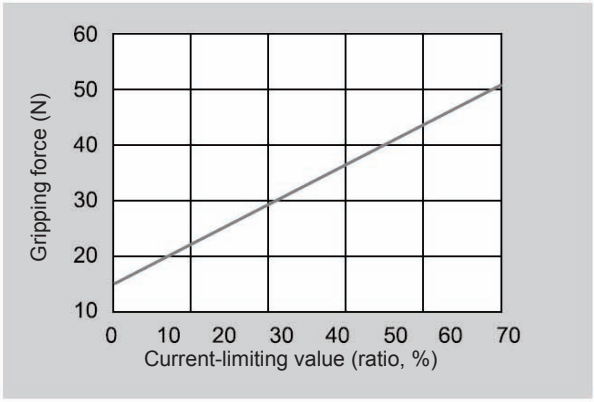


RCP2 Series | 3-finger Gripper

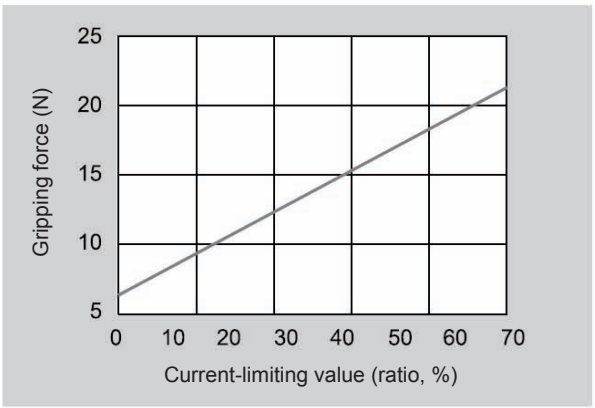
GR3LS



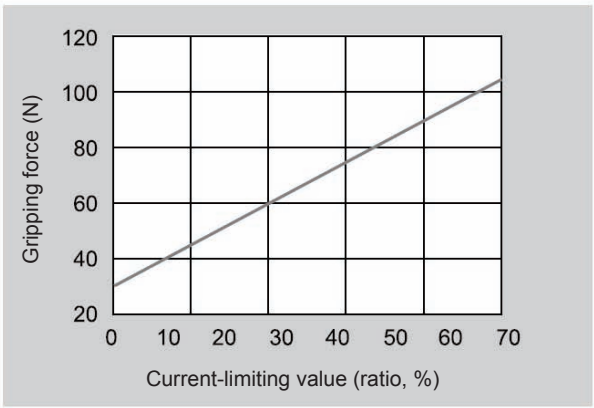
GR3LM



GR3SS

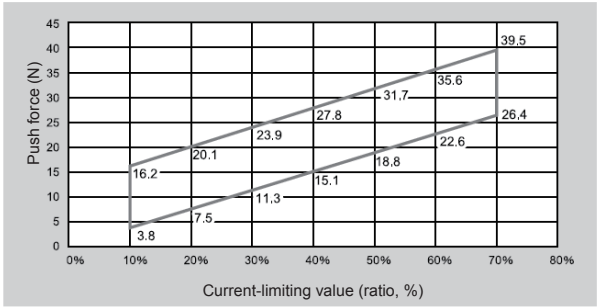


GR3SM

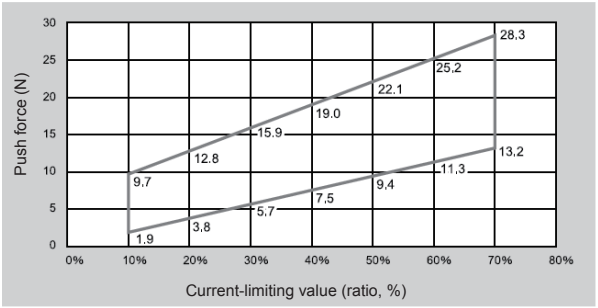


RCP3 Series **Slim, Compact Rod Type**

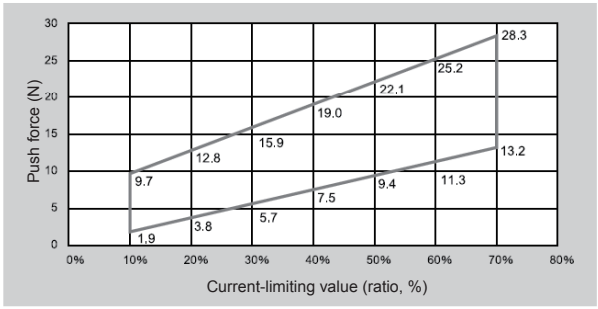
RA2AC/RA2AR Lead 1



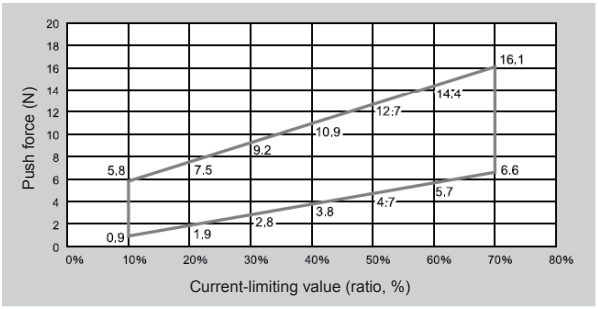
RA2BC/RA2BR Lead 2



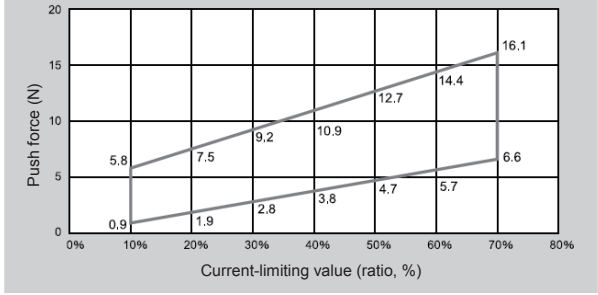
RA2AC/RA2AR Lead 2



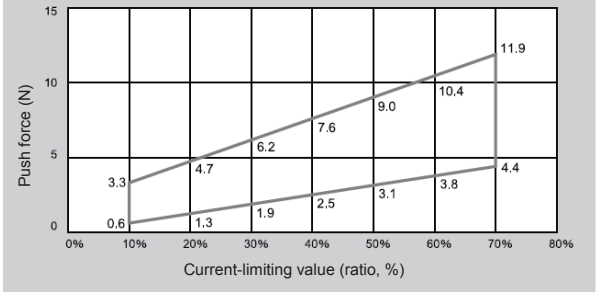
RA2BC/RA2BR Lead 4



RA2AC/RA2AR Lead 4

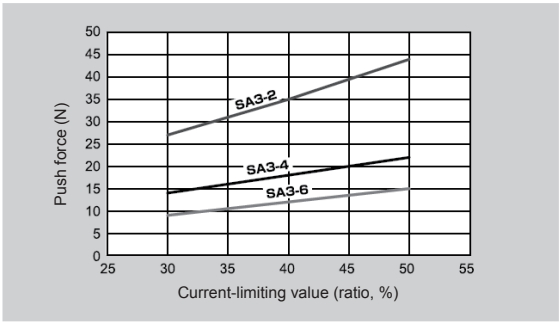


RA2BC/RA2BR Lead 6

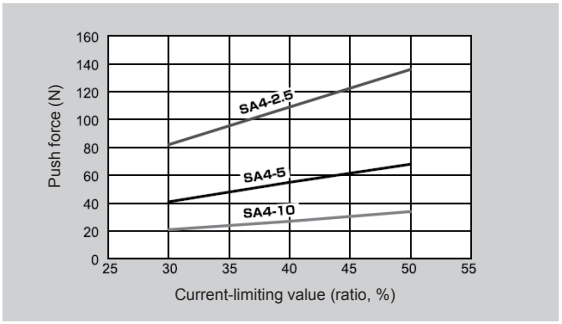


RCP3 Series Slider Type

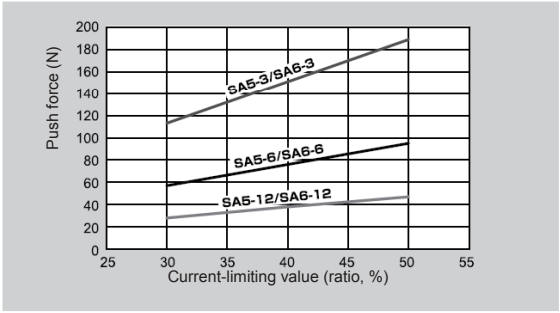
SA3C Type



SA4C Type

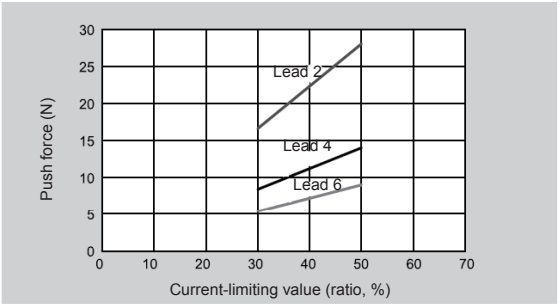


SA5C/SA6C Type

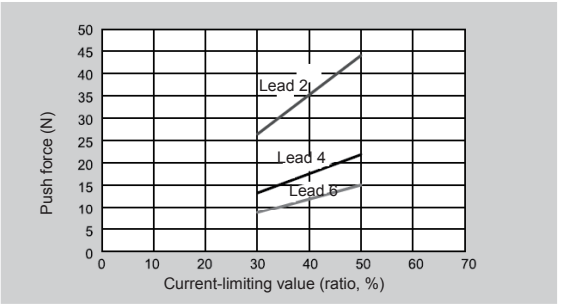


RCP3 Series Slim, Compact Table Type

TA3C/TA3R Type

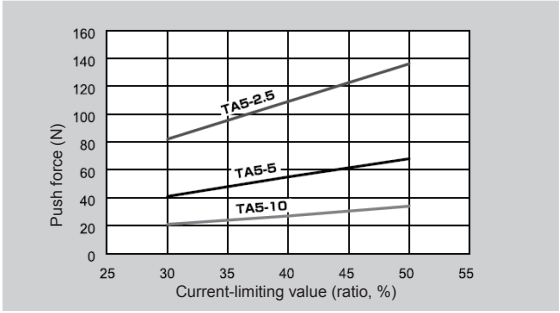


TA4C/TA4R Type

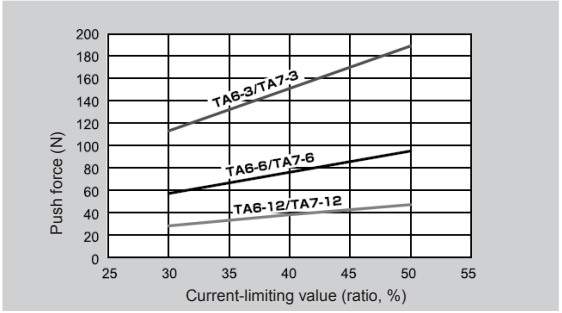


RCP3 Series Table Type

TA5C Type

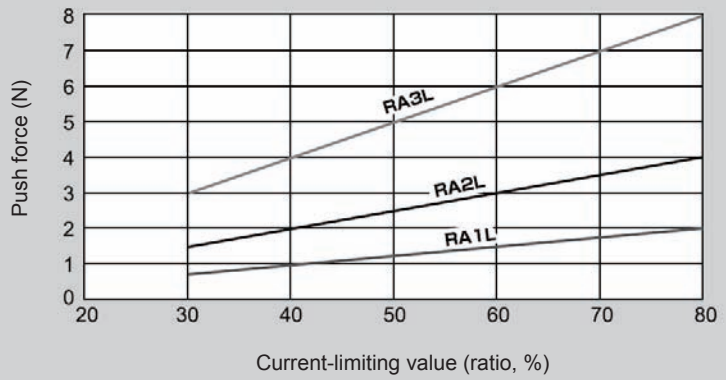


TA6C/TA7C Type



RCL Series | Micro-cylinder

RA1L/RA2L/RA3L



Parameter Record

Recorded date: _____

Types: a: Parameter relating to actuator stroke range
b: Parameter relating to actuator operating characteristics
c: Parameter relating to external interface
d: Servo gain adjustment

No.	Type	Symbol	Name	Unit	Factory default
3	a	LIMM	Soft limit + side	mm	
4	a	LIML	Soft limit – side	mm	
5	a	ORG	Home direction [0: Reverse / 1: Forward]	-	
7	d	PLGO	Servo gain number	-	
9	b	ACMD	Default acceleration/deceleration	G	
10	b	INP	Default positioning band (in-position)	mm	
12	b	SPOW	Current-limiting value at standstill after positioning	%	
13	b	ODPW	Current-limiting value during homing	%	
16	c	BRSL	SIO communication speed	bps	
17	c	RTIM	Minimum delay time for slave transmitter activation	msec	
18	B	LS	Power sensor input polarity	-	
21	c	SOM	Servo-on input [0: Enable / 1: Disable]		
22	a	OFST	Home offset	mm	
25	c	IOPN	PIO pattern selection	-	
28	b	PHSP	Default direction of excited phase signal detection [0: Reverse / 1: Forward]		
29	b	PHSP	Excited phase signal detection time	msec	
31	d	VLPG	Speed loop proportional gain	-	
32	d	VLPT	Speed loop integral gain	-	
33	d	TRQF	Torque filter time constant	-	
35	b	SAFV	Safety speed	mm/sec	
40	b	HOME	Enable function [0: Enable / 1: Disable]	-	
42	b	ENBL	Home check sensor input polarity	-	
43	c	HMC	Silent interval multiplication factor	-	
45	b	SIVM	Speed override	-	
53	b	HSTP	Default standstill mode	-	
57	b	TQLM	Torque limit	%	
58	c	SDCR	Clear deviation at servo off/alarm stop [0: Disable / 1: Enable]	-	
59	b	FSTP	Monitor error while limiting torque [0: Disable / 1: Enable]	-	
60	c	DCLR	Deviation-counter clear input [0: Enable / 1: Disable]	-	
61	c	TL	Torque-limit command input [0: Enable / 1: Disable]	-	
62	b	CPR	Pulse count direction [0: Forward / 1: Reverse]	-	
63	c	MOD	Command-pulse input mode	-	
64	c	POLE	Polarity in command-pulse input mode [0: Positive / 1: Negative]	-	
65	b	CNUM	Electronic gear numerator	-	
66	b	CDEN	Electronic gear denominator	-	
77	B	LRAD	Ball screw lead length	mm	

Change History

Revision Date	Description of Revision
	First edition
	Second edition
	Third edition
2007.06	Fourth edition
	Fifth edition
2009.12	Fifth I edition • Added “About CE Marking”.
2010.02	Sixth edition • Operation Manual Catalog No. changed
2010.03	Seventh edition • “Please Read Before Use” added after top page • “H: High-acceleration loading specification” added to model name in P.2
2010.04	Eighth edition • “Precautions for Safety” in Pg. 1 to 7, before Table of Contents, deleted and swapped to “Safety Guide” after Table of Contents • “List of Specifications of Applicable Actuators” in Appendix in P.87 swapped with “List of Specifications of Connectable Actuators” • “Push Force and Current-limiting Value” added to Appendix in P.101
	Ninth edition • Skipped
2010.09	Tenth edition • Note added regarding CE Marking at the beginning • Table of encoder pulses and lead lengths in P.42 and 53 moved to last pages and note added asking to refer to these pages • Examples of Electronic gear ratio calculations added in P.43 and 54 • Correction made to explanations of excited phase signal detection time in P.46 and 47 • Correction made to explanations of excited phase signal detection time in P.57 and 58 • Notes related to “Push Force and Current-limiting Value” moved to last pages • 0C8 error added in P.75 • Correction made to referable parameter numbers in caution note in P.83 and 97
2011.01	Eleventh edition • Correction made in “Speed loop integral gain” in P.74
2011.04	Twelfth edition • Swapped over the page for CE Marking

Revision Date	Description of Revision
2011.07	Thirteenth edition • Contents changed in 1.5 Warranty in P.14 to P.15 • Caution note added regarding positioning band setting in P.66 and P.77 • Contents changed and added in Appendix: List of Specifications of Connectable Actuators.
2012.05	Fourteenth edition • “Explanation for UL Compliance” added before Contents • Contents added and changed in Safety Guide • 3.1 Installation Environment revised
2012.07	Fifteenth edition • Contents changed in UL
2013.01	Sixteenth edition • Contents deleted in UL
2014.05	Seventeenth edition • Image added for input pulse image on open collector • Note added in P. 11 and P. 29

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