



ROBO Cylinder RCP3 Actuator Rod Type Operating Manual

Fourth Edition

Motor coupling types	[Slim Small ROBO Cylinders] RA2AC/RA2BC
Motor reversing types	[Slim Small ROBO Cylinders] RA2AR/RA2BR

IAI America, Inc.

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.

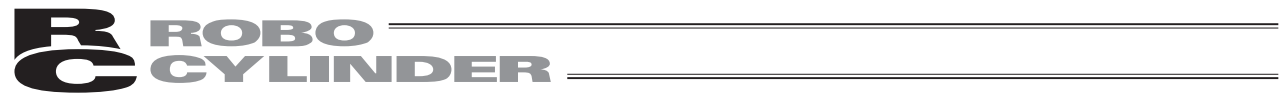
The CD or DVD that comes with the product contains operation manuals for IAI products.

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.
- Using or copying all or part of this Operation Manual without permission is prohibited.
- The company names, names of products and trademarks of each company shown in the sentences are registered trademarks.



CE Marking

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

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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	<ul style="list-style-type: none">• 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.<ol style="list-style-type: none">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.<ol style="list-style-type: none">1) Location where there is any inflammable gas, inflammable object or explosive2) Place with potential exposure to radiation3) Location with the ambient temperature or relative humidity exceeding the specification range4) Location where radiant heat is added from direct sunlight or other large heat source5) Location where condensation occurs due to abrupt temperature changes6) Location where there is any corrosive gas (sulfuric acid or hydrochloric acid)7) Location exposed to significant amount of dust, salt or iron powder8) 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<p>(1) Installation of Robot Main Body and Controller, etc.</p> <ul style="list-style-type: none"> • 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. <ol style="list-style-type: none"> 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	<p>(2) Cable Wiring</p> <ul style="list-style-type: none"> ● 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. <p>(3) Grounding</p> <ul style="list-style-type: none"> ● 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 0.5mm² (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	<p>(4) Safety Measures</p> <ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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. <p>* Safety protection Fence : In the case that there is no safety protection fence, the movable range should be indicated.</p>

No.	Operation Description	Description
6	Trial Operation	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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. <p>Use in incomplete condition may cause damage to the product or an injury.</p> <p>* Safety protection Fence : In the case that there is no safety protection fence, the movable range should be indicated.</p>
9	Modification and Dismantle	<ul style="list-style-type: none"> • Do not modify, disassemble, assemble or use of maintenance parts not specified based at your own discretion.
10	Disposal	<ul style="list-style-type: none"> • 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. <p>The product may burst or generate toxic gases.</p>
11	Other	<ul style="list-style-type: none"> • 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

Handling Precautions

1. Do Not Set Speed and Acceleration/Deceleration Higher Than the Rated Values.

Do not set speed and acceleration/deceleration higher than the rated values. It causes vibration, failure, or shortening of life. If acceleration/deceleration higher than the rated value is set, creeping phenomenon or coupling slide may occur.

2. Do Not Apply External Force on the Rod from Directions Other Than the Rod Traveling Direction.

Do not apply external force (radial load) on the rod from directions other than the rod traveling direction. If force in the perpendicular or rotating direction is applied on the rod, the actuator may be damaged or malfunction.

If external force from directions other than the traveling direction is applied, mount external guide or similar.

3. Oil Film of Grease May Run Out If Short-distance Reciprocating Operation is Performed.

When performing continuous reciprocating operation of a distance of 30 mm or shorter, oil film of grease may run out. To recover oil film, perform approximately five cycles of a distance of 50 mm or longer, every 5,000 to 10,000 cycles, as a guideline

4. Make sure to attach the Horizontal Articulated Robot properly by following this operation manual.

Using the product with the Horizontal Articulated Robot not being certainly retained or affixed may cause abnormal noise, vibration, malfunction or shorten the product life.

5. Transportation

5.1 Handling a Single Actuator

Please adhere to the following when handling a single actuator.

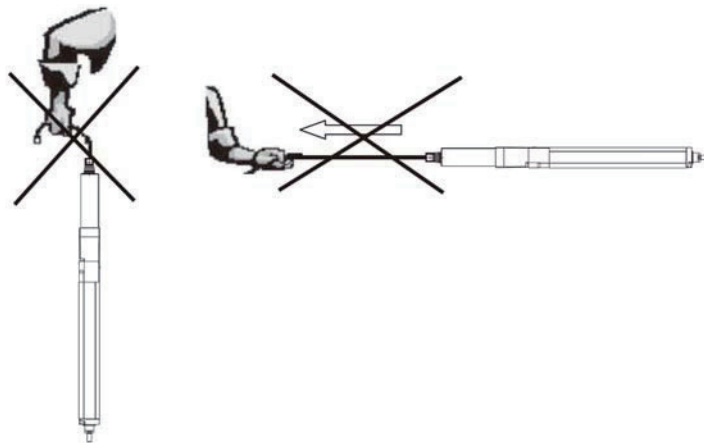
5.1.1 Handling the Packed Unit

Unless otherwise specified, the actuator is shipped with each axis packaged separately.

- Do not damage or drop. The package is not applied with any special treatment that enables it to resist an impact caused by a drop or crash.
- Transport a heavy package with at least more than two operators. Consider an appropriate method for transportation.
- Keep the unit in horizontal orientation when placing it on the ground or transporting. Follow the instruction if there is any for the packaging condition.
- Do not step or sit on the package.
- Do not put any load that may cause a deformation or breakage of the package.

5.1.2 Handling the Actuator After Unpacking

- Do not carry an actuator by a cable or attempt to move it by pulling the cable.



- Hold the body base when transporting the actuator.
- Be careful not to bump the actuator into anything when moving it.
- Do not apply an excessive force to each part of the actuator. In particular, prevent the motor unit and rear bracket from receiving an unnecessary force.

Supplement) For the names of each part of the actuator, refer to 1, "Part Names".

5.2 Handling the Actuator Assembly

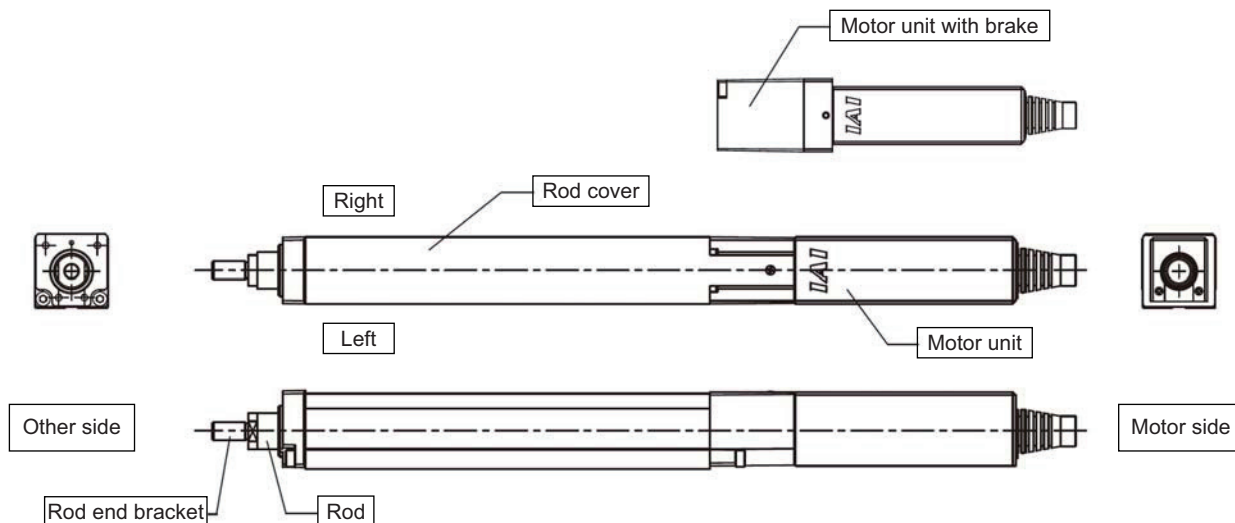
- When carrying the actuator, exercise caution not to bump it against nearby objects or structures.
- Secure the sliders to prevent sudden movement during transport.
- If any end of the actuator is overhanging, secure it properly to avoid significant movement due to external vibration.
- When transporting the assembly without the ends of the actuators fastened, do not subject the assembly to an impact of 0.3 G or more.
- When suspending the mechanical equipment (system) with ropes, avoid applying force to actuator, connector box, etc. Also, avoid the cables being pinched or caused an excessive deformation.

1. Part Names

The names of the actuator parts are indicated below.

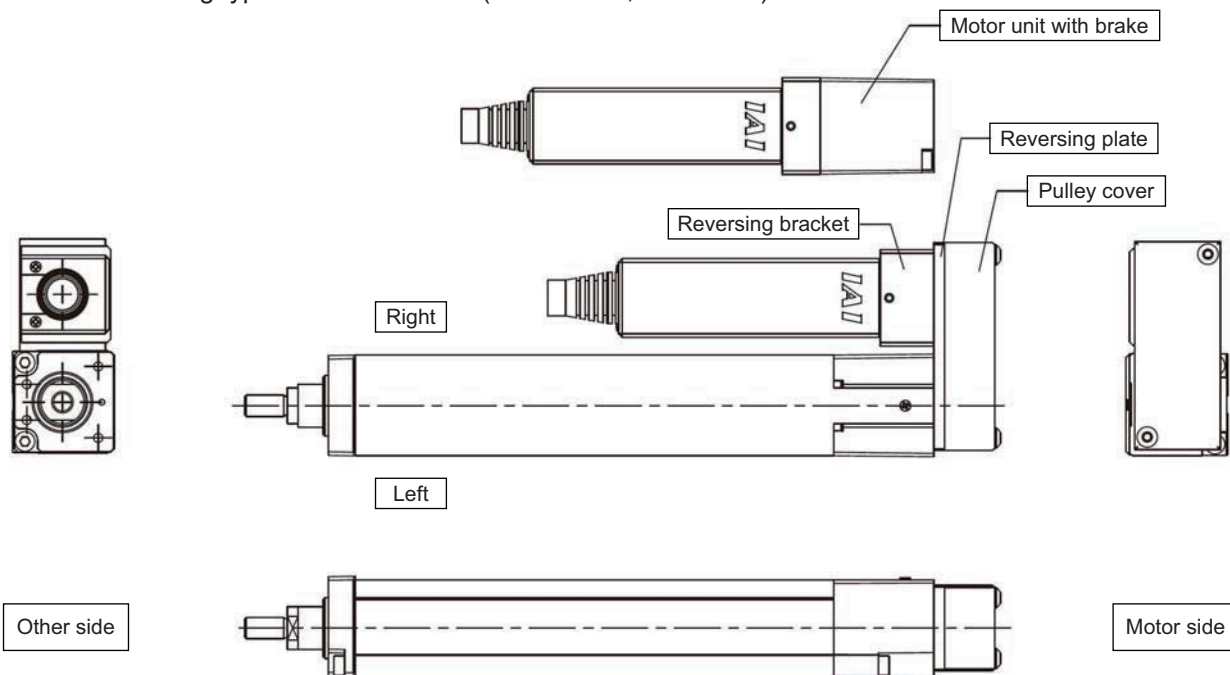
In this manual, the right and left are determined by viewing the actuator from the top and from the motor side.

- “Motor coupling type” RA2AC/RA2BC (Lead screw, ball screw)



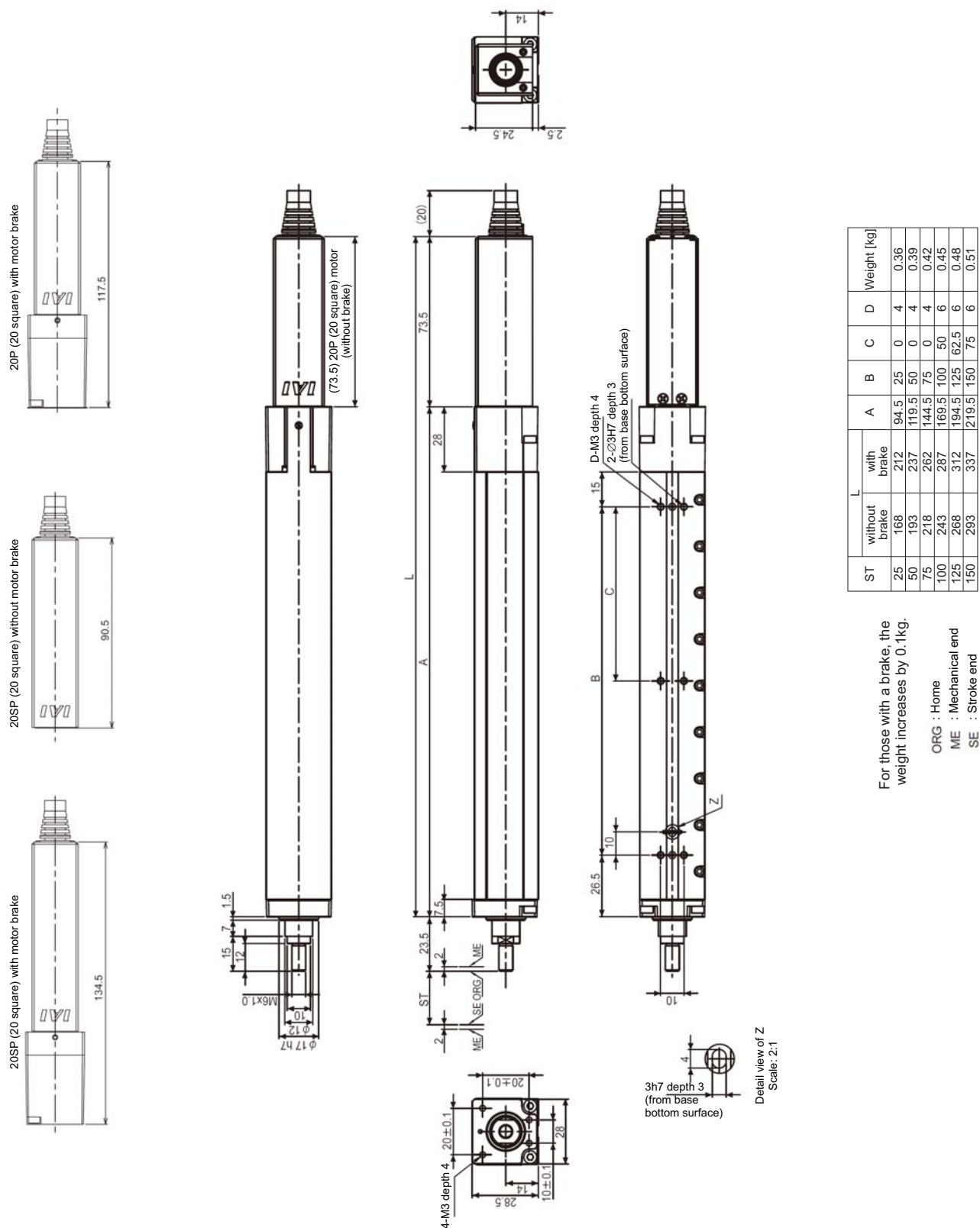
* Refer to 2, “External Dimensions” for details.

- “Motor reversing type” RA2AR/RA2BR (Lead screw, ball screw)

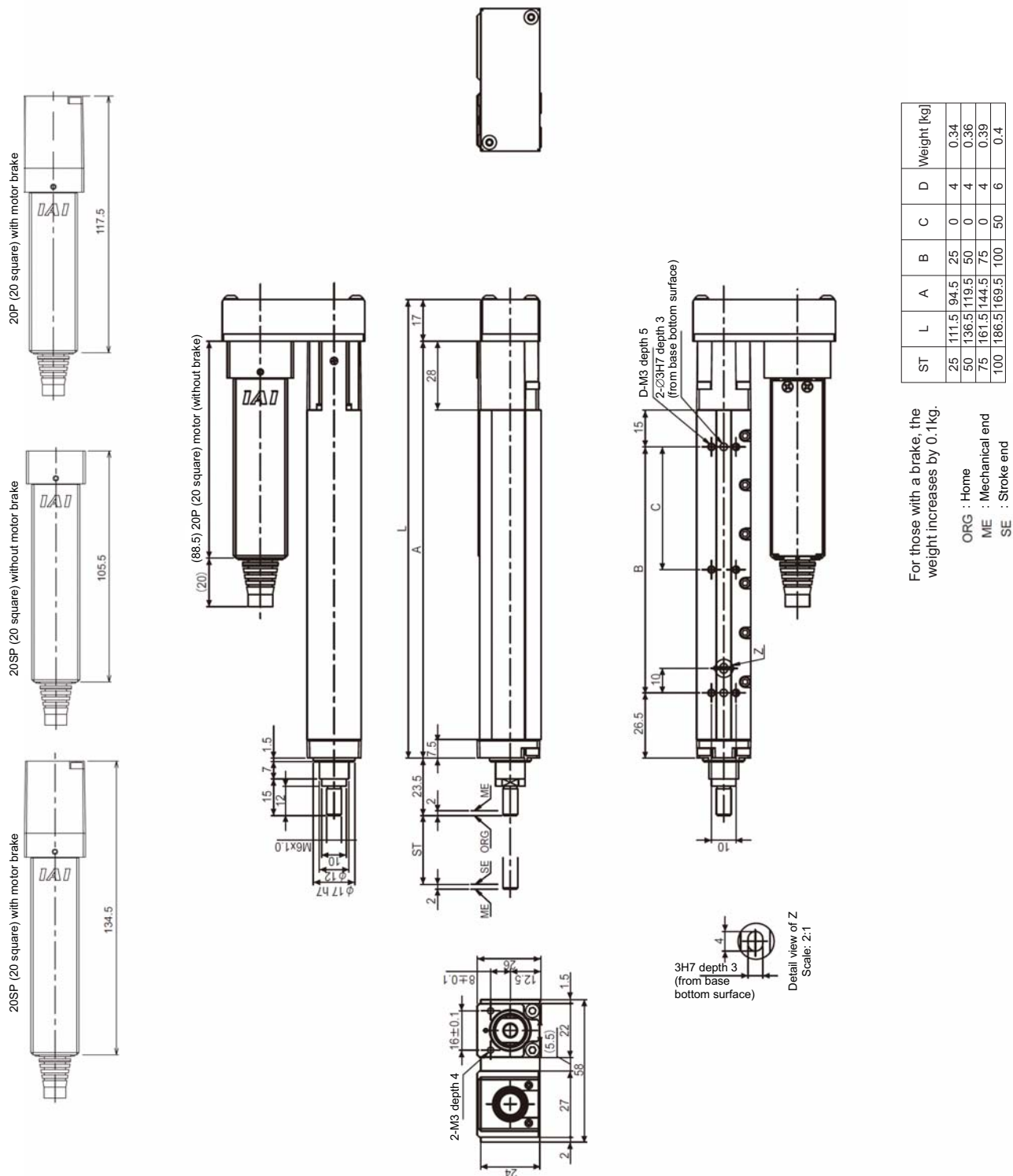


* Refer to 2, “External Dimensions” for details.

2.2 RCP3-RA2BC (Lead Screw, Ball Screw)



2.3 RCP3-RA2AR, Reversing to Right (Lead Screw, Ball Screw)



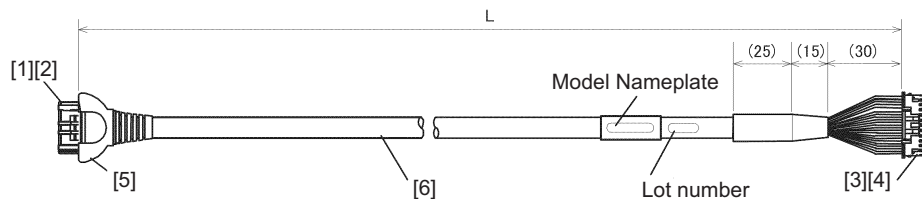
ORG : Home
ME : Mechanical end
SE : Stroke end

3. Cable Drawings

3.1 PMEC, PSEP Controller Cables

Integrated motor/encoder cable
(CB-APSEP-MPA***)

*** indicates the cable length (L). Up to 20 m can be specified.
Example) 080 = 8 m



No.	Item	Model number	Manufacturer
1	Housing	D-1100D 1-1827863-1 (black, 2.0-mm pitch, 22 poles)	AMP
2	Contact	D-1 1827570-2 (AWG 22 to 18, 1.08 to 1.6 Ø)	
3	Housing	PADP-24V-1-S (white, 2.0-mm pitch, 24 poles)	JST
4	Contact	SPND-001T-C0.5 (AWG 26 to 22, 1.0 to 1.5 Ø)	
5	Coupler cover	TMS-4ZB008	TATSUTA ELECTRIC WIRE & CABLE
6	ZUL2854-OHFRPCVVSW	25AWG x 6P + 25AWG x 2C + 22AWG x 6C, TS08V0350	TATSUTA ELECTRIC WIRE & CABLE

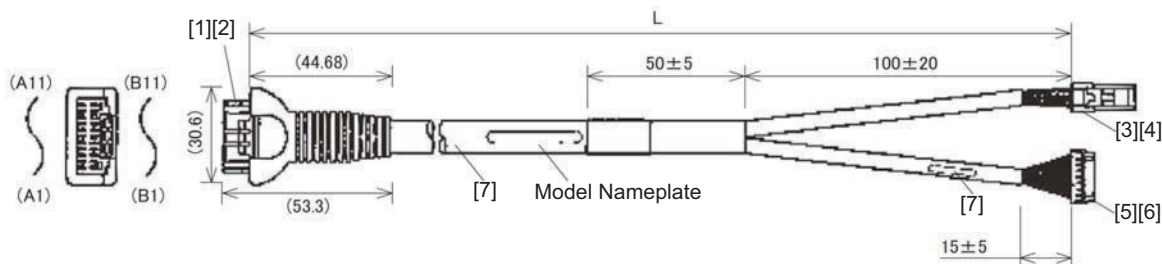
Terminal number on actuator side Wiring diagram [PCON] (ACON) Terminal number on controller side

A1	Black [Φ A] (U)	1
B1	White [VMM] (V)	2
A2	Brown [Φ / A] (W)	5
B2	Green [Φ B] (-)	3
A3	Yellow [VMM] (-)	4
B3	Red [Φ / B] (-)	6
A4	Orange [LS+] (BK+)	7
B4	Gray [LS-] (BK-)	8
A6	White [-] (A+)	11
B6	Yellow [-] (A-)	12
A7	Red [A+] (B+)	13
B7	Green [A-] (B-)	14
A8	Black [B+] (Z+)	15
B8	Brown [B-] (Z-)	16
A5	Black [BK+] (LS+)	9
B5	Brown [BK-] (LS-)	10
A9	Green [GND _{LS}] (GND _{LS})	20
B9	Red [VPS] (VPS)	18
A10	White [VCC] (VCC)	17
B10	Yellow [GND] (GND)	19
A11	NC	21
B11	Shield [FG] (FG)	24
	NC	22
	NC	23

3.2 PCON Controller Cable

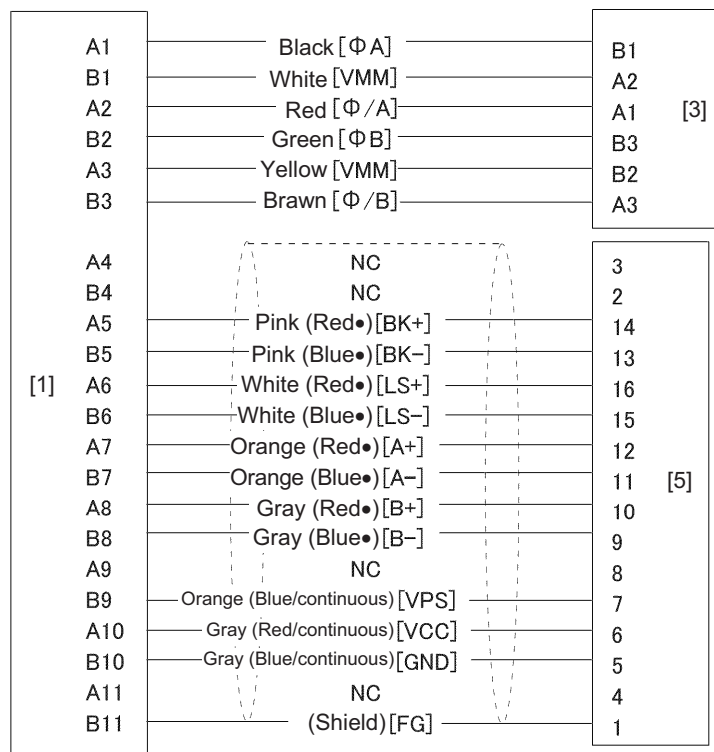
RCA3 Integrated motor/encoder cable
(CB-PCS-MPA***)

*** indicates the cable length (L). Up to 10 m can be specified.
Example) 080 = 8 m



No.	Item	Model number	Manufacturer
[1]	Receptacle housing	D-1100D 1-1827863-1	AMP
[2]	Receptacle contact	D-1 1827570-2	AMP
[3]	Socket	D2100D 1-1318119-3	Hirose
[4]	Socket contact	D-2 1318105-1	Hirose
[5]	Housing	PHDR-16VS	JST
[6]	Contact	SPHD-001T-P0.5	JST
[7]	UL2854-VVSWKA	TS06V1200 (25AWG x 7P + 22AWG x 6C)	TATSUTA ELECTRIC WIRE & CABLE

Terminal number on actuator side Wiring diagram [Serial] Terminal number on controller side



4. Options

4.1 Brake Type

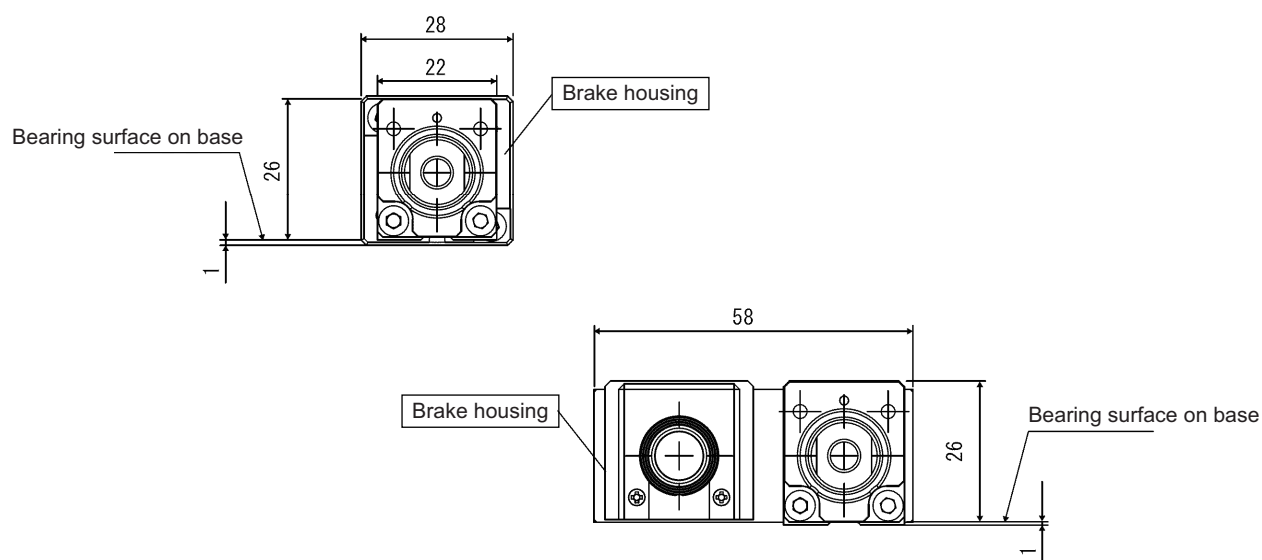
The brake is a mechanism designed to prevent the slider from dropping on a vertically installed actuator when the power or servo is turned off.

Use the brake to prevent the installed work part, etc., from being damaged due to the falling rod.

(Notes on installation)

With the RA2AC and RA2BC, the brake project from the bearing surface by 1 mm.

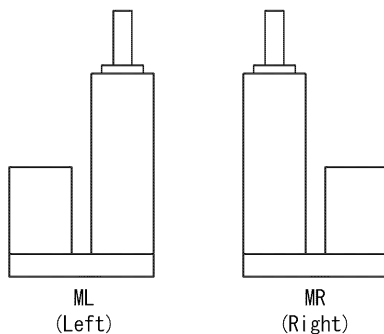
When using a base surface for installation, a measure to raise the unit using a foot bracket, etc. is required.



4.2 Motor Reversing to Left, Motor Reversing to Right

The motor reversing direction can be specified for the motor reversing types RA2AR and RA2BR.

“ML” indicates reversing to the left, while “MR” indicates reversing to the right, as viewed from the motor side.



5. Checking after Unpacking

After unpacking, check the product condition and the included items.

5.1 Included Items

No.	Item	Model number	Remarks
1	Actuator	Refer to "How to Read Model Nameplate" and "How to Read Model Number."	
Accessories			
2	RCP3 integrated motor/ encoder cable	CB-APSEP-MPA□□□: PSEP type	
		CB-PCS-MPA□□□: PCON, PSEL type	
3	First Step Guide		
4	Operating Manual		
5	Safety Guide		

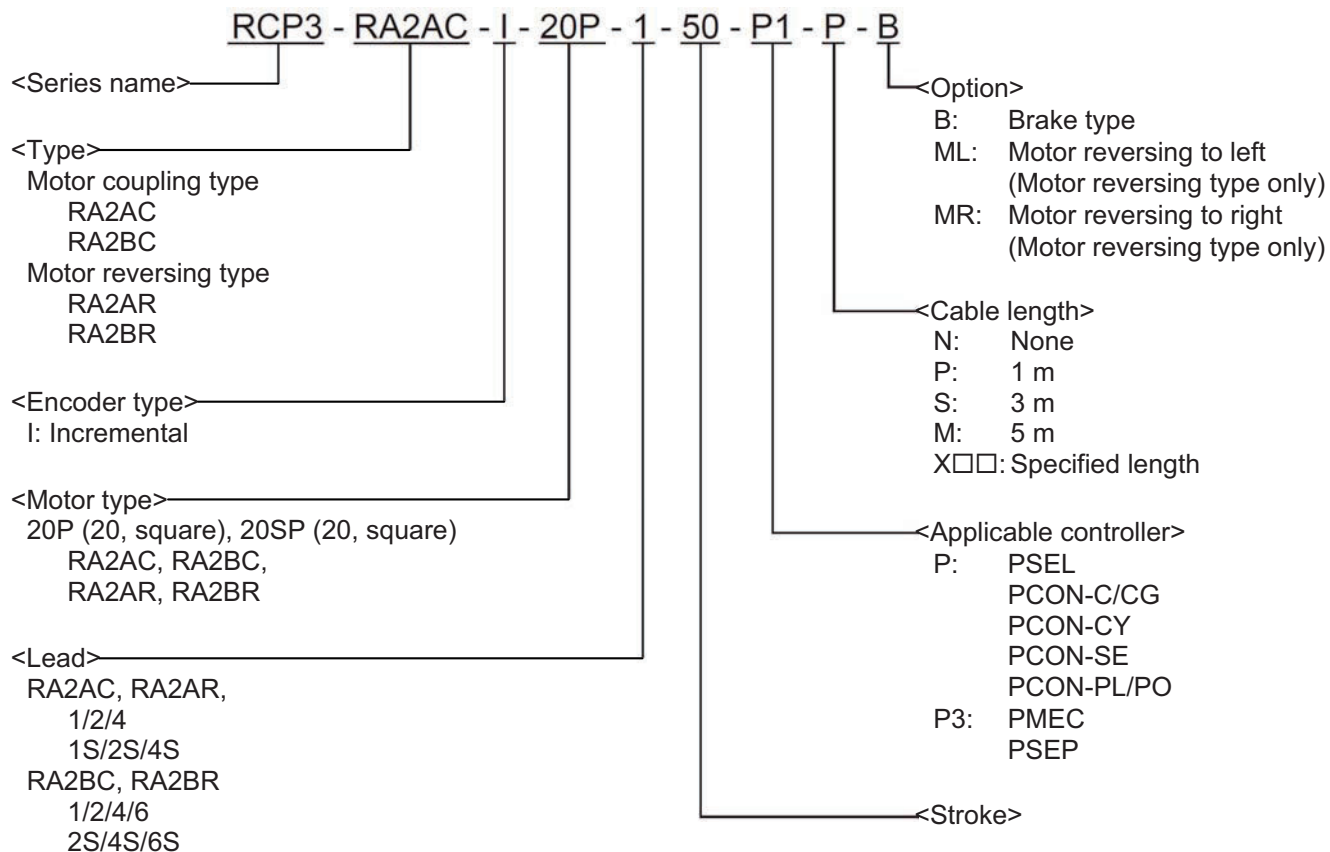
5.2 Operation Manuals Relating to This Product

No.	Name	Control No.
1	Operation Manual for PSEL Controller	MJ0172
2	Operation Manual for PCON-C/CG/CF Controller	MJ0170
3	Operation Manual for PCON-CY Controller	MJ0156
4	Operation Manual for PCON-SE Controller	MJ0163
5	Operation Manual for PCON-PL/PO Controller	MJ0164
6	MEC Controller Operation Manual	MJ0245
7	Operation Manual for ASEP/PSEP Controller	MJ0216
8	PC Software IA-101-X-MW/IA-101-X-USBMW Operation Manual	MJ0154
9	Operation Manual for PC Software RCM-101MW/RCM-101-USB	MJ0155
10	MEC PC Software Operation Manual	MJ0248
11	Teaching Pendant SEL-T/TD Operation Manual	MJ0183
12	Operation Manual for Teaching Pendant CON-T/TG	MJ0178
13	Touch Panel Teaching CON-PT/PD/PG Operation Manual	MJ0227
14	Touch Panel Teaching SEP-PT Operation Manual	MJ0217
15	Operation Manual for Simple Teaching Pendant RCM-E	MJ0174
16	Operation Manual for Data Setter RCM-P	MJ0175
17	Operation Manual for Touch Panel Display RCM-PM-01	MJ0182

5.3 How to Read Model Nameplate

Model	→	MODEL RCP3-RA2AC-I-20P-1-50-P1-P
Serial number	→	SERIAL No.600090255 MADE IN JAPAN

5.4 How to Read Model Number



6. Specifications

Item		RA2AC (Lead screw) RA2AR (Lead screw)		
Lead	mm	1	2	4
Maximum speed ^{(*)1}	mm/sec	50	100	200
Stroke	mm	25 to 100 (in 25 steps)		
Maximum thrust	N	36	18	9
Maximum loading capacity ^{(*)2}	Horizontal	kg	1	0.5
	Vertical	kg	0.5	0.25
Positioning repeatability ^{(*)3}	mm	±0.05		
Lost motion ^{(*)3}	mm	0.3		
Number of encoder pulses ^{(*)4}	Pulse	800		

*1 The maximum speed may not be reached depending on the stroke.

*2 The acceleration/deceleration is assumed to be 0.2 G in both horizontal and vertical applications.

*3 The default value.

*4 The number of pulses input in the controller

Item		RA2AC (Ball screw) RA2AR (Ball screw)					
		20P (20, square) motor			20SP (20, square) motor		
Lead	mm	1	2	4	1	2	4
Maximum speed ^{(*)1}	mm/sec	50	100	200	50	100	200
Stroke	mm	25 to 100 (in 25 steps)			25 to 150 (in 25 steps)		
Maximum thrust	N	72	36	18	132	66	33
Maximum loading capacity ^{(*)2}	Horizontal	kg	2	1	0.5	4	2
	Vertical	kg	0.75	0.375	0.2	1.25	0.625
Positioning repeatability ^{(*)3}	mm	±0.02			±0.02		
Lost motion ^{(*)3}	mm	0.1			0.1		
Number of encoder pulses ^{(*)4}	Pulse	800			800		

*1 The maximum speed may not be reached depending on the stroke.

*2 The acceleration/deceleration is assumed to be 0.3 G in horizontal application and 0.2 G in vertical application.

*3 The default value.

*4 The number of pulses input in the controller

Item		RA2BC (Lead screw) RA2BR (Lead screw)		
Lead	mm	2	4	6
Maximum speed ^{(*)1}	mm/sec	100	200	300
Stroke	mm	25 to 150 (in 25 steps)		
Maximum thrust	N	18	9	6
Maximum loading capacity ^{(*)2}	Horizontal	kg	1	0.5
	Vertical	kg	0.5	0.25
Positioning repeatability ^{(*)3}	mm	±0.05		
Lost motion ^{(*)3}	mm	0.3		
Number of encoder pulses ^{(*)4}	Pulse	800		

*1 The maximum speed may not be reached depending on the stroke.

*2 The acceleration/deceleration is assumed to be 0.2 G in both horizontal and vertical applications.

*3 The default value.

*4 The number of pulses input in the controller

Item		RA2BC (Ball screw) RA2BR (Ball screw)							
		20P (20, square) motor				20SP (20, square) motor			
Lead	mm	1	2	4	6	1	2	4	6
Maximum speed ^{(*)1}	mm/sec	50	100	200	300	50	100	200	300
Stroke	mm	25 to 150 (in 25 steps)				25 to 100 (in 25 steps)			
Maximum thrust	N	72	36	18	9	132	66	33	22
Maximum loading capacity ^{(*)2}	Horizontal	kg	4	2	1	0.5	8	4	2
	Vertical	kg	1.5	0.75	0.375	0.2	2.5	1.25	0.625
Positioning repeatability ^{(*)3}	mm	±0.02				±0.02			
Lost motion ^{(*)3}	mm	0.1				0.1			
Number of encoder pulses ^{(*)4}	Pulse	800				800			

*1 The maximum speed may not be reached depending on the stroke.

*2 The acceleration/deceleration is assumed to be 0.3 G in horizontal application and 0.2 G in vertical application.

*3 The default value.

*4 The number of pulses input in the controller

7. Operation

7.1 Operational Conditions for Positioning Operation

By following the procedures below, check whether the operation is available.

[1] Operation

Check the operational conditions [1] to [5].

[1] Load installation orientation (horizontal, upright, vertical)

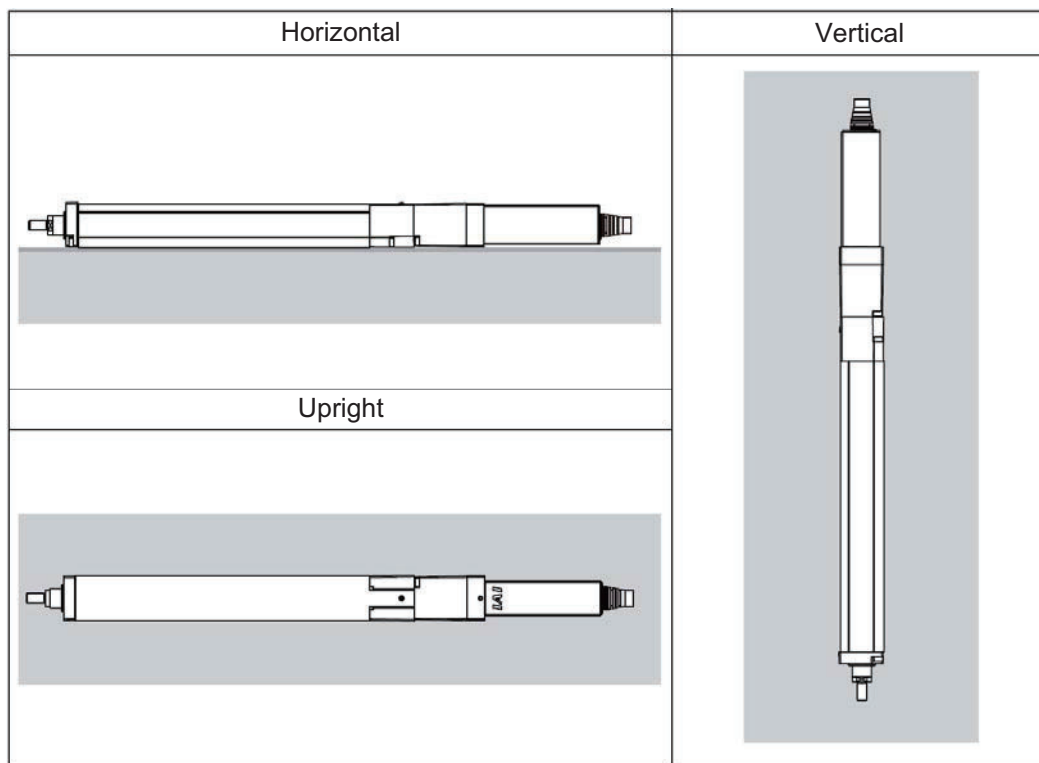
[2] Stroke L (mm)

[3] Maximum speed V (mm/s)

[4] Acceleration a (G)

[5] Loading capacity W (kg)

Installation orientation



[2] Stroke, maximum speed, acceleration

Check whether the operation is available by [2] stroke, [3] maximum speed and [4] acceleration.

Table 1

Installation Orientation	Model	Lead (mm)	Acceleration (G)	Max Speed (mm/s)	Stroke (mm)
Horizontal Upright Vertical	RA2AC RA2AR (Lead screw)	1	0.2	50	25, 50, 75, 100
		2	0.2	100	
		4	0.2	200	
	RA2BC RA2BR (Lead screw)	2	0.2	100	25, 50, 75, 100, 125, 150
		4	0.2	200	
		6	0.2	300	
Horizontal Upright	RA2AC RA2AR (Ball screw)	1	0.3	50	25, 50, 75, 100
		2	0.3	100	
		4	0.3	200	
	RA2BC RA2BR (Ball screw)	1	0.3	50	25, 50, 75, 100, 125, 150
		2	0.3	100	
		4	0.3	200	
		6	0.3	300	
Vertical	RA2AC RA2AR (Ball screw)	1	0.2	50	25, 50, 75, 100
		2	0.2	100	
		4	0.2	200	
	RA2BC RA2BR (Ball screw)	1	0.2	50	25, 50, 75, 100, 125, 150
		2	0.2	100	
		4	0.2	200	
		6	0.2	300	

How to decide: [2] Desired stroke \leq model stroke

[3] Desired speed \leq maximum speed for selected stroke

[4] Desired acceleration \leq 0.2 G

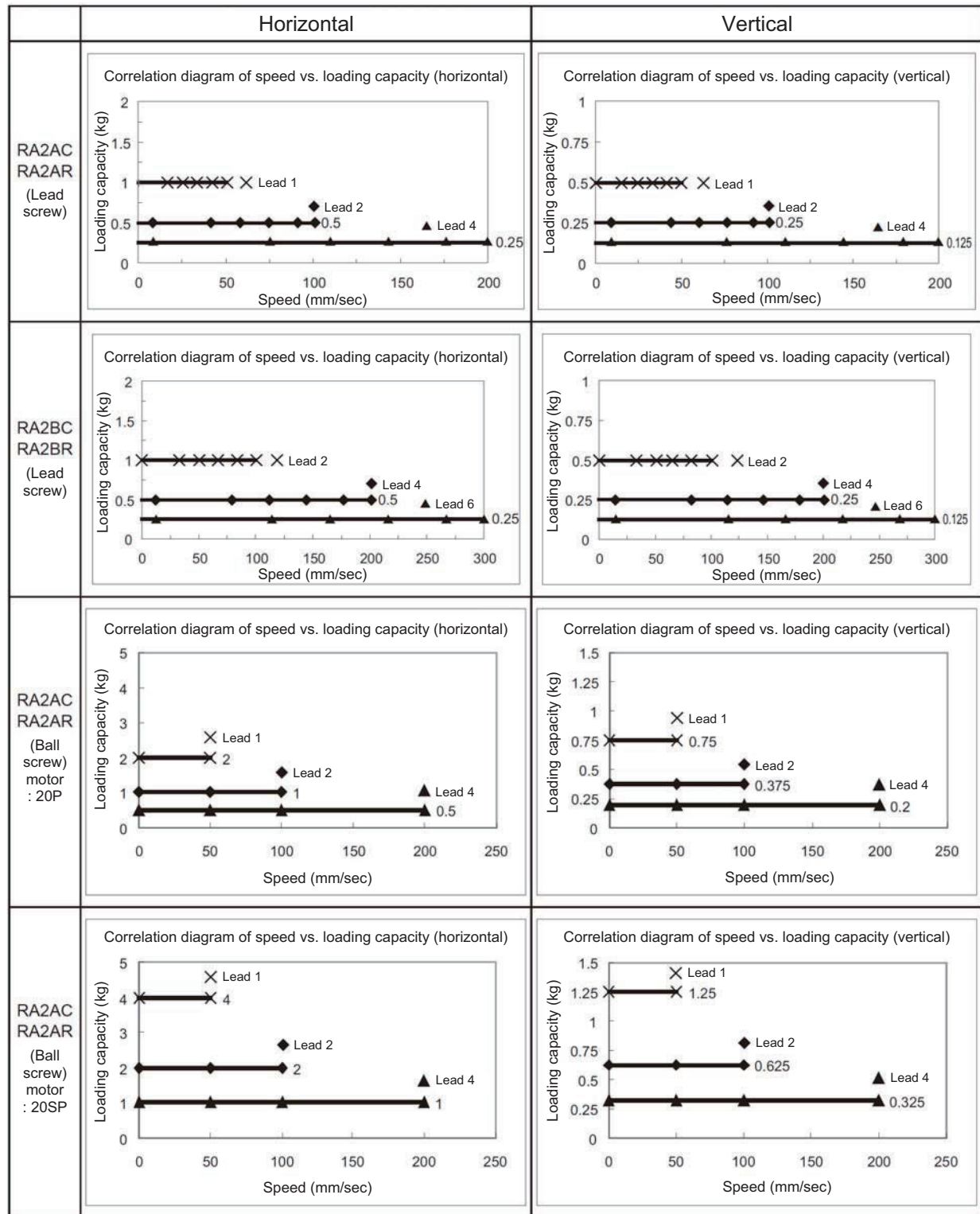
[3] Maximum speed, loading mass

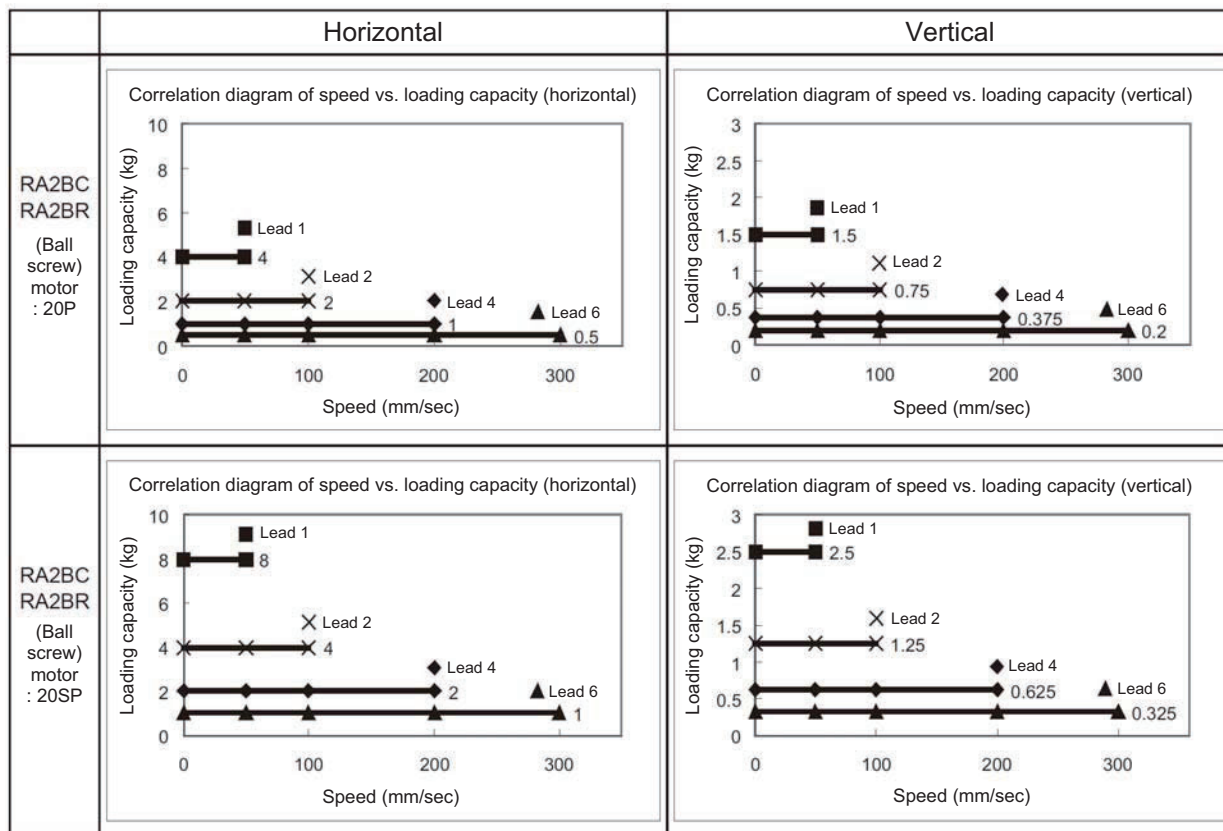
Check whether the operation is available by [3] maximum speed and [5] loading capacity.

- Pulse motor (RCP3) (Graph 1)

How to decide: You can use any model that has a [3] maximum speed and [4] loading mass that exceeds your usage range.

Graphs 1 Pulse motor (RCP3)





7.2 Operational Conditions for Pressing Operation

7.2.1 RA2AC, RA2AR, RA2BC, RA2BR (Lead Screw)

[1] Operation

Check the operational condition of pressing force F (N).

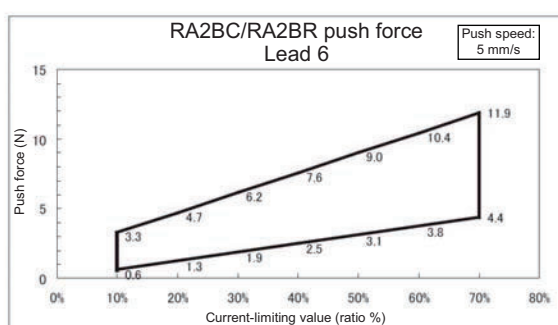
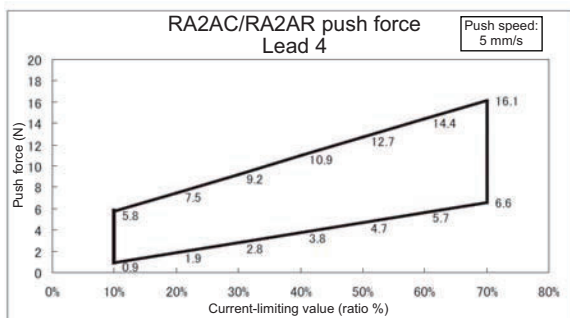
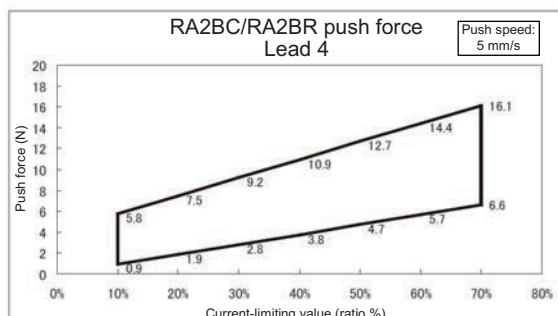
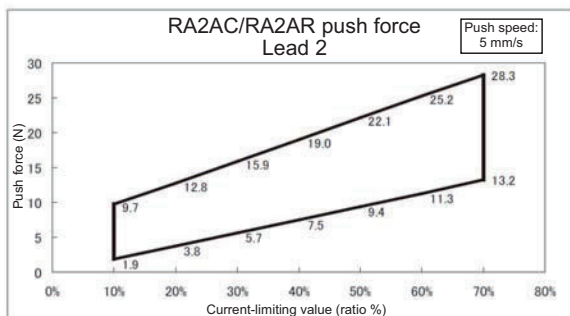
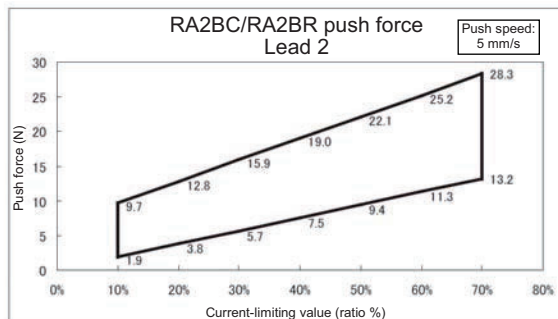
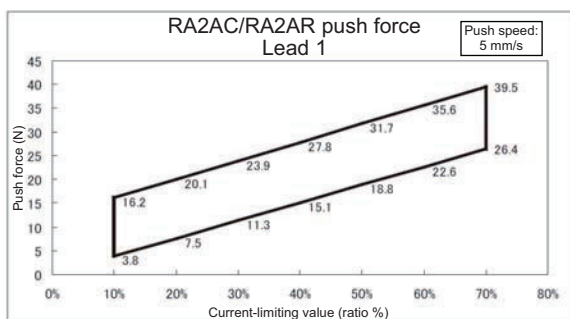
* For push & hold operations, movement speed is set at 5 mm/s.

[2] Push force

Check whether the operation is available by pressing force.

(The graphs provide some margin by considering a drop in lead screw efficiency over time.)

How to decide: The operation is available as long as the pressing force is in the ranges shown in the graphs.



7.2.2 RA2AC, RA2AR, RA2BC, RA2BR (Ball Screw)

[1] Operation

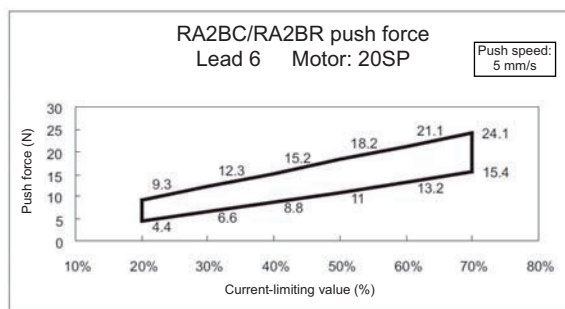
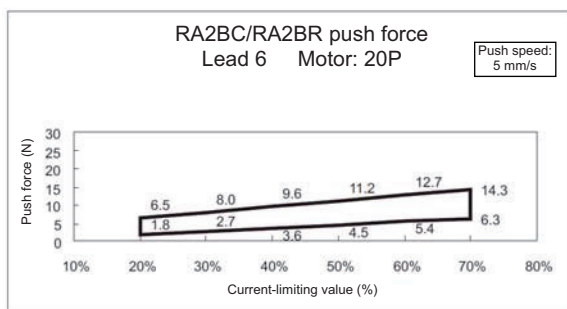
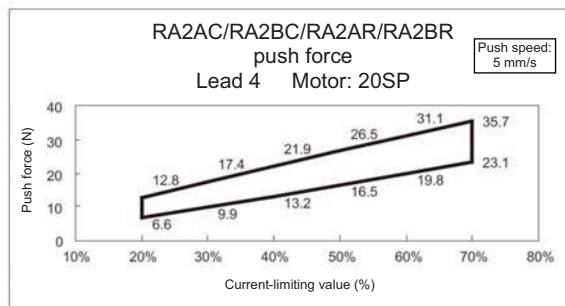
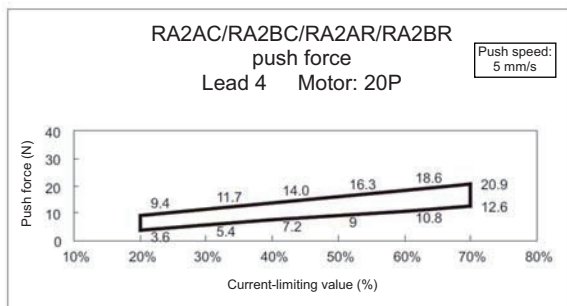
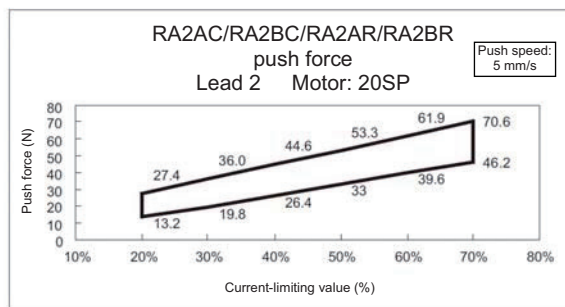
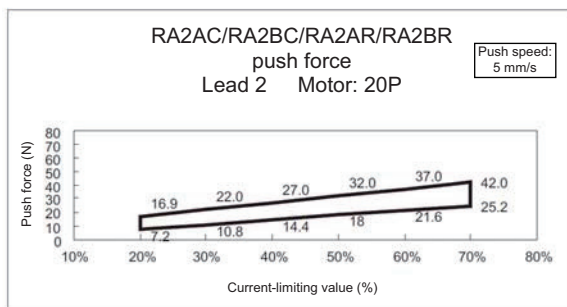
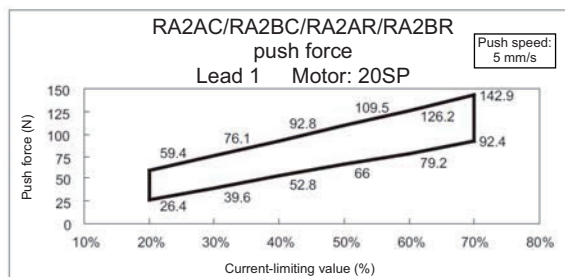
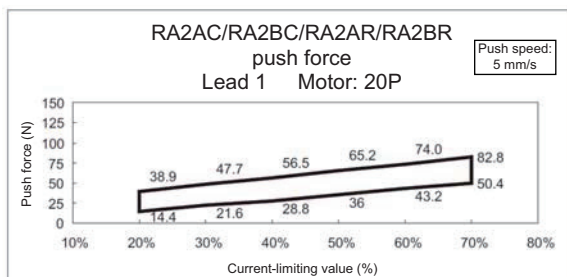
Check the operational condition of pressing force F (N).

* For push & hold operations, movement speed is set at 5 mm/s.

[2] Push force

Check whether the operation is available by pressing force.

How to decide: The operation is available as long as the pressing force is in the ranges shown in the graphs.



8. Installation Environment and Storage Environment

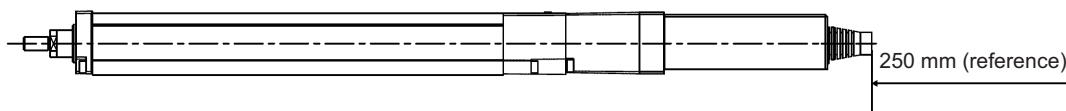
8.1 Installation Environment

Install the actuator in an environment meeting the following conditions:

- Is a normal environment for assembly work where there is not much dust.
(If the actuator is used in an environment where dust is floating in air, the life of the actuator will become significantly shortened.)
- Not exposed to direct sunlight
- The machine does not receive radiated heat from large heat sources such as heat treatment furnaces.
- Surrounding air temperature of 0 to 40°C
- Humidity of 85% or below, non-condensing
- Not subject to corrosive or flammable gases
- Not subject to oil mist or cutting fluid
- Not subject to impact or vibration
- Not subject to significant electromagnetic waves, ultraviolet light or radiation
- This product is not designed to provide chemical resistance.

In general, the environment shall be one where the operator can work without wearing protective gears.

Open space required for maintenance inspection



8.2 Storage/Preservation Environment

The storage/preservation environment conforms to the installation environment. If the robot is to be stored/preserved for a prolonged period of time, be sure the robot will not be exposed to condensation. Unless otherwise specified, desiccant is not placed in the carton when shipped. If the robot is to be stored/preserved in an environment subject to condensation, provide preventive measures from over the carton or directly to the robot after unpacking.

The maximum storage/preservation temperature is 60°C for a short storage period. If the robot is to be stored/preserved for more than a month, the temperature should not exceed 50°C.

9. Installation

The actuator mounting surface should be machined or otherwise processed to a smooth surface of equivalent precision.

9.1 Installation of Actuator

This actuator contains installation tap holes which allow it to be secured from the rear.

(Note that tap hole size depends on model. Please see 2, "External Dimensions.")

The actuator also contains reamed holes for use with positioning pins.


Tap size and maximum screw-in depth	Applicable bolt	Tightening torque		Reamed hole (mm)
		Bolt bearing surface is steel	Bolt bearing surface is aluminum	
M3, depth 5	M3	1.54 N-m (0.16 kgf-m)	0.83 N-m (0.085 kgf-m)	Ø2H7, depth 3 from base surface

Tightening screws

- Use hexagonal socket bolts for the male threads used to install the base.
- Use of high-tension bolts meeting at least ISO-10.9 is recommended.
- Ensure at least the applicable value specified below for the effective engagement length between the bolt and female thread:

Female thread is made of steel material → Same length as the nominal diameter

If female screws are made of aluminum → Maximum screw-in depth

 **Caution:** Select bolt length carefully. Using a bolt with inappropriate length can damage tap holes, result in insecure installation of actuator, interfere with the operation of the drive section, reduce the precision of the device, and cause unexpected accidents.

9.2 Installation Surface

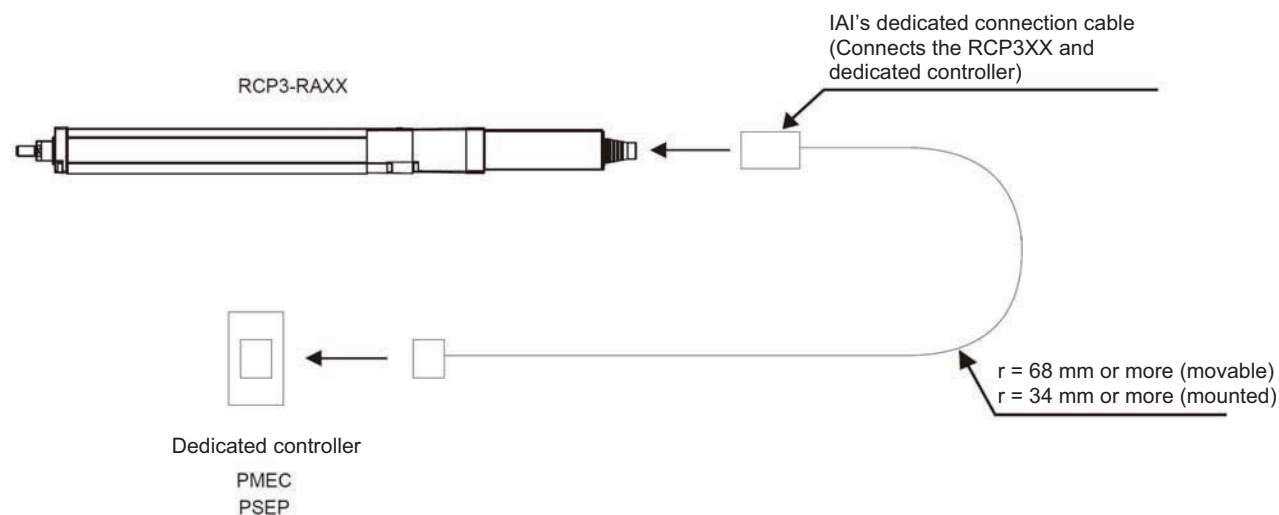
- Mount on a strong, rigid structure to prevent vibration.
- The actuator mounting surface should be machined or otherwise processed to a smooth surface of equivalent precision, within ± 0.05 mm/m.
- Provide adequate space around the device to allow for future maintenance.

10. Connection with Controller

Use IAI's dedicated controller. For the connection cable between this actuator and the controller, use IAI's connection cable.

This chapter explains the wiring method based on single-axis use.

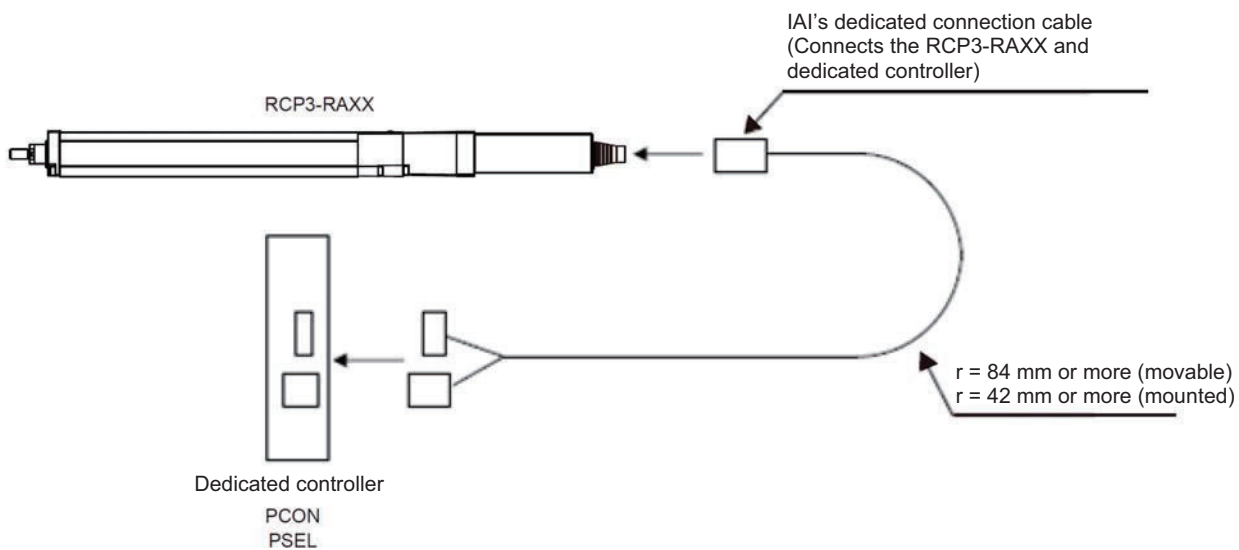
If you wish to change the cable, consult IAI.



Dedicated connection cable
Pulse motor cable: CB-APSEP-MPA***

*) *** indicates the cable length. Up to 20 m can be specified.

Example) 080 = 8 m

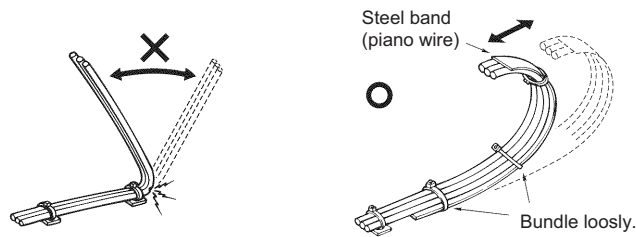


Dedicated connection cable
Pulse motor cable: CB-PCS-MPA***

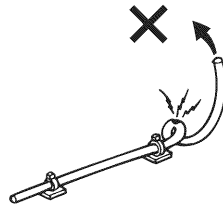
*) *** indicates the cable length. Up to 20 m can be specified.
Example) 080 = 8 m

The prohibited items relating to cable wiring are explained below.

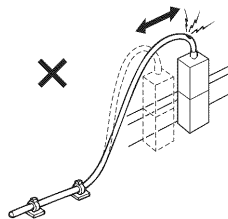
- Do not cut and reconnect the cable for extension or shorten the cable.
- If the cable cannot be secured, reduce the load on the cable by allowing it to deflect only by the weight of the cable or wire it in a self-standing cable hose, etc., having a large radius.
- Prevent the cable from bending at the same point.



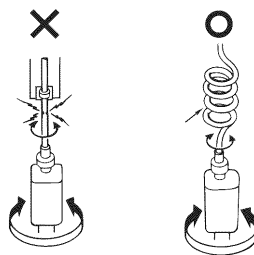
- Do not let the cable bend, kink or twist.



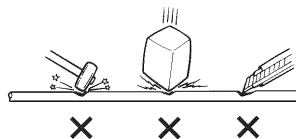
- Do not pull the cable with a strong force.



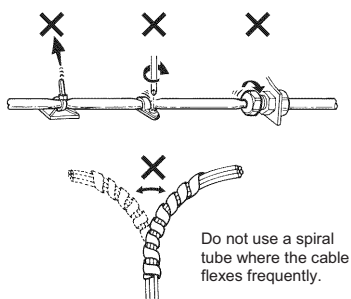
- Do not let the cable receive a turning force at a single point.



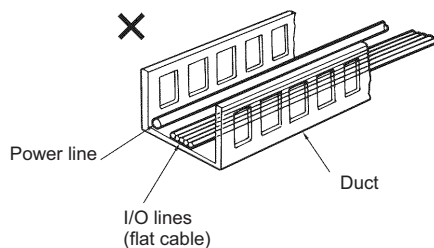
- Do not pinch, drop a heavy object onto or cut the cable.



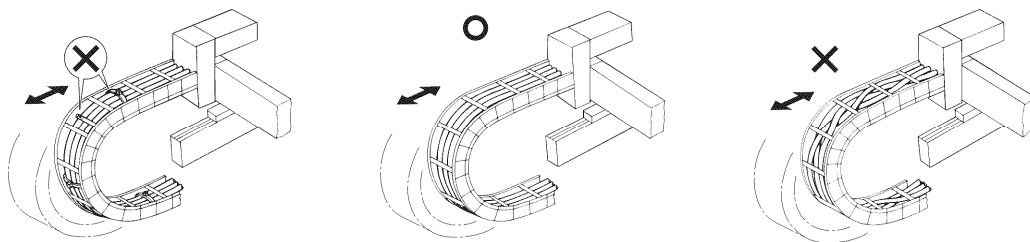
- When fixing the cable, provide a moderate slack and do not tension it too tight.



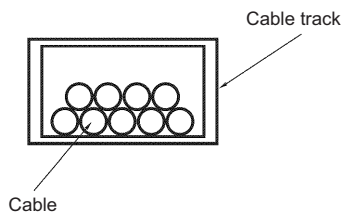
- Separate the I/O and communication lines from the power and drive lines. Do not wire them together in the same duct.



- Pay attention to the following points when using a cable track.
- Do not let the cable get tangled or kinked in a cable track or flexible tube. When bundling the cable, keep a certain degree of flexibility (so that the cable will not become too taut when bent).



- Do not cause the cables to occupy more than 60% of the space in the cable track.



Warning

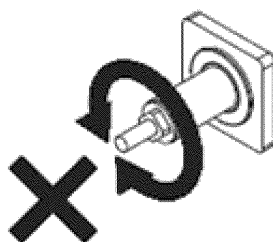
- Always turn off the controller power before connecting/disconnecting cables. If cables are connected/disconnected while the power is still supplied, the actuator may malfunction and a serious injury or equipment damage may occur.
- Loose connectors may cause the actuator to malfunction and create a dangerous situation. Be sure to confirm that all connectors are securely connected.

11. Notes on Operation

11.1 Loads Received by the Actuator

11.1.1 Loads applied to RA2AC, RA2AR, RA2BC and RA2BR actuators

- Align the shaft center of the rod with the moving direction of the load.
- Application of a lateral load may cause actuator damage or malfunction.
- If the rod receives a lateral load, provide a guide, etc., in the moving direction of the load.
- Do not apply a rotational torque to the rod. If the rod receives a rotational torque, actuator damage or malfunction may occur.



(Caution)

When installing the load, clamp the width across flats to prevent the rod from turning.

11.1.2 External force in thrust directions

- Do not apply an excessive external force to the rod.
With low-lead types, the rod will not move even when an external force is applied.
If an excessive external force is applied, the nut may be damaged.
To move the rod, use the jog function or turn the slit on the shaft end using a screwdriver, etc.
- Be careful not to apply in thrust directions any external force or impact load exceeding the allowable value. If an external force or impact load exceeding the allowable value is applied, the internal parts may be damaged.

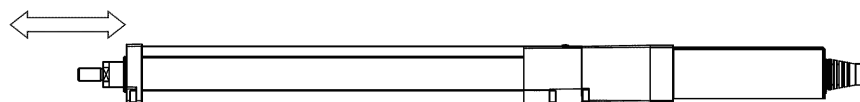
<External Force in Thrust Directions>

Allowable external force in thrust directions

The external force in thrust direction must not exceed the maximum push force for each model.

Type	L	M	H
RA2A	39.5 N	28.3 N	16.1 N
RA2B	28.3 N	16.1 N	11.9 N

Thrust directions



12. Life

12.1 Life of Actuator Using Ball Screws

The life of actuator using ball screws is set to 5,000 km (guideline), assuming it is operated with the maximum loading capacity and maximum acceleration/deceleration.

12.2 Life of Actuator Using Slide-screws

The lead-screw type actuator uses a lead screw and its nut wears over time.

A reference for product life is presented based on the wear amount of the nut.

The positioning precision of this product, such as lost motion, will drop as the wear of the nut progresses.

(Reference product life)

Horizontal application 10 million back-and-forth operations

Vertical application 5 million back-and-forth operations

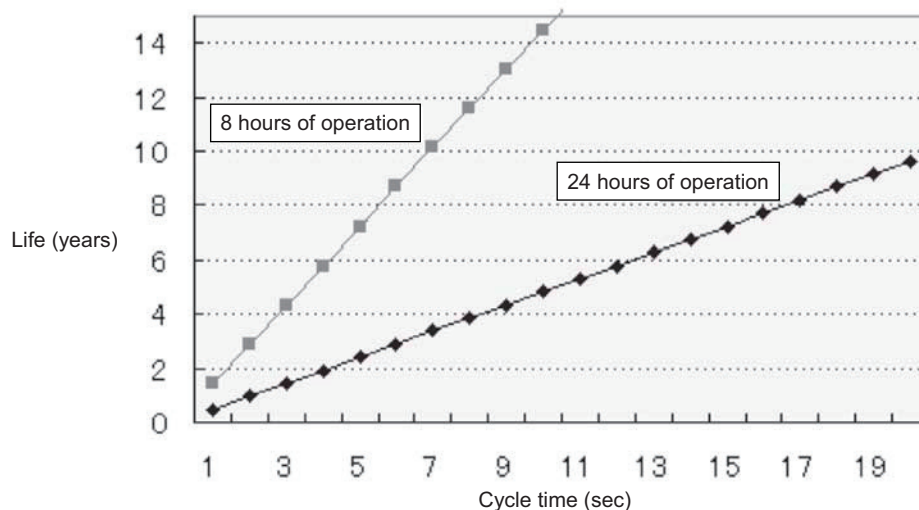
12.2.1 Relationship of Cycle Time and Product Life

(1) Horizontal application

The graph below shows the relationship between the cycle time for one back-and-forth operation and the life of the product in a horizontal application (product life: 10 million back-and-forth operations).

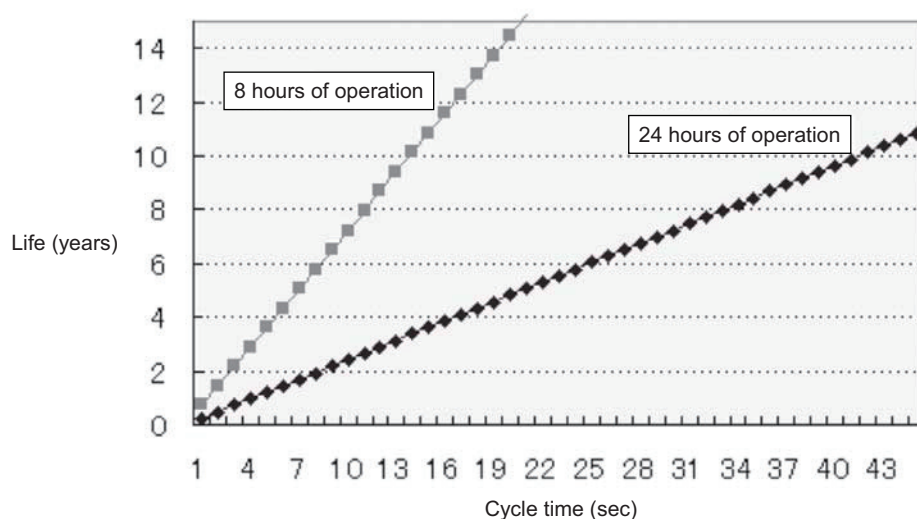
The lines based on 8 hours of operation and 24 hours operations a day, for 240 days a year, are shown.

Use this graph as a reference when determining the product life.



(2) Vertical application

The graph below shows the relationship between the cycle time for one back-and-forth operation and the life of the product in a vertical application (product life: 50 million back-and-forth operations). The lines based on 8 hours of operation and 24 hours operations a day, for 240 days a year, are shown. Use this graph as a reference when determining the product life.



13. Maintenance and Inspection

13.1 Inspection Items and Schedule

Perform maintenance and inspection at the schedule specified below.

This schedule assumes 8 hours of operation a day.

If the actuator is operated continuously day and night or at a higher utilization rate, shorten the inspection intervals according to the situation.

	Visual inspection of exterior	Inspection of interior	Greasing
Startup inspection	○		
1 month after startup	○		
3 months after startup	○	○	
6 months after startup	○	○	○
Every 6 months thereafter	○	○	○

*1 Continuous back and forth operation within a distance less than 30mm may cause wear of grease.

It is recommended to have 5 rounds of back and forth operation in a distance more than 50mm after every 5,000 to 10,000 rounds of the short distance operation. (Conduct back and forth operation in full stroke distance for ROBO Cylinder with its stroke less than 50mm.) A layer of the grease will recover.

13.2 Visual Inspection of Exterior

In the visual inspection of exterior, check the following items.

Actuator	Loose actuator mounting bolts, etc.
Cables	Scratches, connection at connectors
Overall	Abnormal noise, vibration

If the actuator is fixed vertically, grease on the guide may drip depending on the environment. In this case, clean the dirtied areas and add grease.

13.3 Cleaning

- Clean exterior surfaces as necessary.
- Use a soft cloth to wipe away dirt and buildup.
- Do not blow too hard with compressed air as it may cause dust to get in through the gaps.
- Do not use oil-based solvents as they can harm lacquered and painted surfaces.
- To remove severe buildup, wipe gently with a soft cloth soaked in a neutral detergent or alcohol.

13.4 Inspection of Interior

Inspect the interior with the power turned off.

Remove the rod cover.

When inspecting the interior, check the items specified below.

Main unit	Loose actuator mounting bolts, other loose items
Guide section	Lubrication, buildup

Visually inspect the interior of the equipment. Check whether dust or other foreign matter has gotten inside and check the lubrication state.

The lubrication may have turned brown. This is not a problem as long as the travel surfaces shine as though they are wet.

If the grease is mixed with dust and dirty or has no shiny appearance, or if the grease has lost its efficacy due to prolonged use, use a soft cloth, etc., to gently wipe the sliding parts of the lead guide and detent and then replenish grease.

13.5 Internal Cleaning

- Use a soft cloth to wipe away dirt and buildup.
- Do not blow too hard with compressed air as it may cause dust to get in through the gaps.
- Do not use oil-based solvents, neutral detergent or alcohol.

13.6 Greasing

13.6.1 Applicable Grease

[Lead screw type]

The lead screw product has been shipped with synthetic poly- α olefin grease applied to both the lead screw and lead guide.

IAI uses the following grease in our plant.

Location	Manufacturer	Model number
Lead screw/lead guide	Sumico Lubricant Co., Ltd.	Sumitec 308

Equivalent greases are also available from other manufacturers, but exercise caution when selecting the grease because the life of the product may be affected.



Warning

Never use anything other than synthetic poly- α olefin grease. Mixing poly- α grease with other grease not only reduces the performance of the grease, it may even cause damage to the actuator.

[Ball screw type]

The ball screw product has been shipped with lithium-based grease applied to the ball screw and poly- α olefin grease applied to the lead guide.

IAI uses the following grease in our plant.

Location	Manufacturer	Model number
Ball screw	Idemitsu Kosan Co., Ltd.	Daphne Eponex Grease No. 2
Lead guide	Sumico Lubricant Co., Ltd.	Sumitec 308



Warning

- Never use anything other than synthetic poly- α olefin grease. Mixing poly- α grease with other grease not only reduces the performance of the grease, it may even cause damage to the actuator.
- Never use fluorine-based grease. Mixing fluorine-based grease with lithium-based grease not only reduces the performance of the grease, it may even cause damage to the actuator.

13.6.2 How to Apply Grease

For the guide, use a grease syringe to apply grease between the rod and base (guide-piece retention groove) and then move the rod back and forth to spread the grease evenly.

For the lead screw, pull out the rod and clean the lead screw, and apply grease manually and then move the rod back and forth to spread the grease evenly.

(Caution) When moving the rod back and forth, do not move the rod directly by hand, but operate it using the jog function, etc.



Caution

- In case the grease got into your eye, immediately go to see the doctor to get an appropriate care.
- After finishing the grease supply work, wash your hands carefully with water and soap to rinse the grease off.

13.7 Belt

13.7.1 Inspection of Belt

When inspecting the belt, remove the pulley cover and check the condition visually.

Although the durability of the belt is affected significantly by the operating conditions, generally the belt has a flex life of several million times.

As a reference on when to replace the belt, replace the belt if any of the following conditions is observed:

- Significant wear of the teeth or end face of the belt
- Swelling of the belt due to attached oil, etc.
- Cracking or other damage to the belt teeth or back
- Breaking of the belt

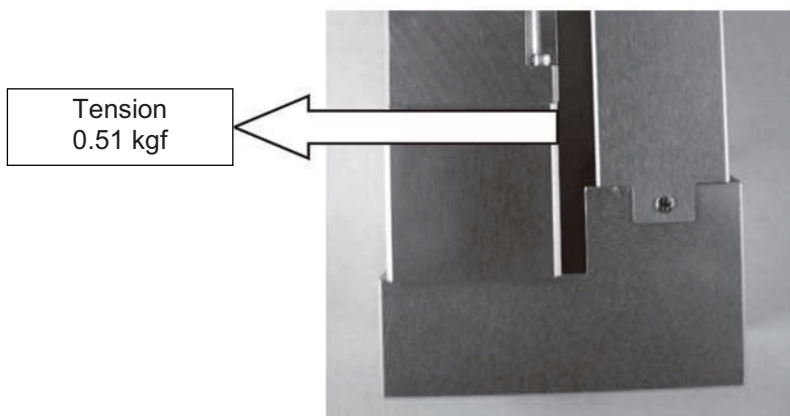
13.7.2 Applicable Belt

Manufacturer: Mitsuboshi Belting Ltd.

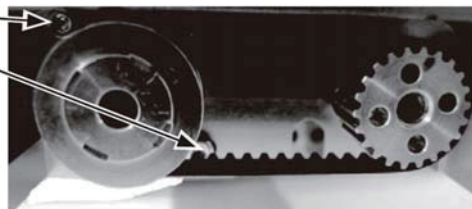
Belt model number (type)
40S2M104G (clean rubber type)

13.7.3 Adjustment of Belt Tension

Remove the pulley cover, loosen the tension adjustment bolts (2 locations), and then move the motor to the left as shown below to tension the belt. When the adjustment is finished, tighten the tension adjustment bolts.



Tension adjustment bolts	
Nominal thread size	Tightening torque
M3	0.83 N-m (0.085 kgf-m)



13.8 Motor Replacement (Pulse Motor: RCP3)

* Refer to 13.9 for the reversing types.

[Items required for replacing the stainless sheet]

- Replacement motor unit

Model number	
Without Brake	With Brake
RCP3-MU00A	RCP3-MU00A-B

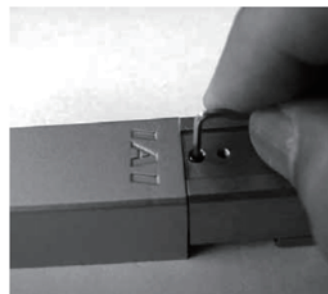
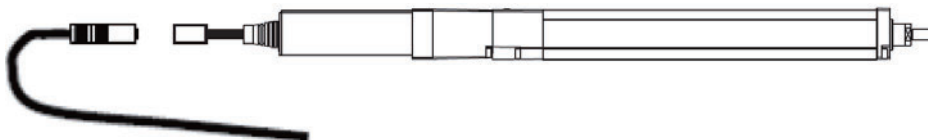


- Hex wrench set

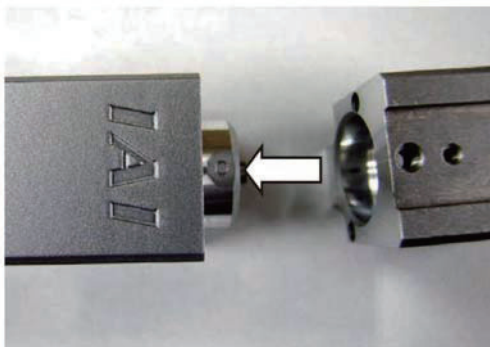
[Procedure]

- [1] Remove the cable connecting the actuator and controller and the motor unit cable.
Remove the cross-recessed socket screws on the cover to expose the screws affixing the motor.
Remove the affixing screws using a hex wrench of 2 mm across flats.

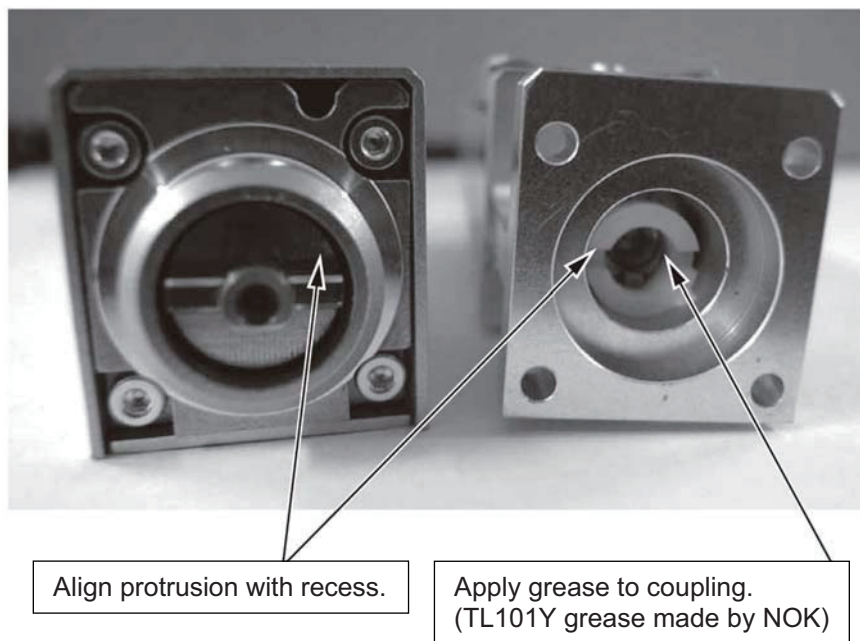
Disconnect the cable.



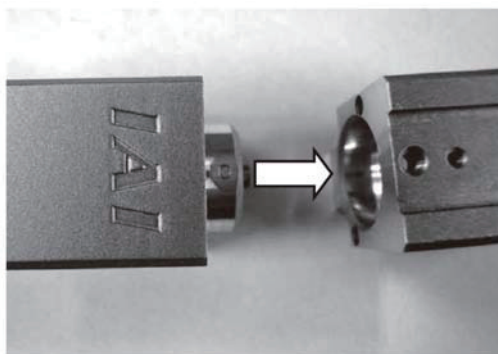
- [2] Detach the motor unit.



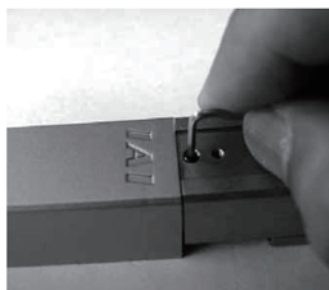
[3] Align the actuator side and replacement motor unit side projection section and the slit orientation.



[4] Install the replacement motor by fitting the protrusion of one unit in the recess of the other.



[5] Secure the affixing screws using a hex wrench of 2 mm across flats. Install the cover and tighten the cross-recessed socket screws.

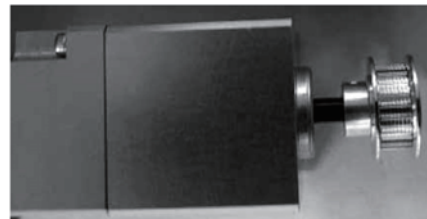


13.9 Replacement of Belt and Motor for Reversing Type (Pulse Motor: RCP3)

[Items required for replacement]

- Replacement motor unit of reversing type

Model number	
Without brake	With brake
RCP3-MU00B	RCP3-MU00B-B



- Belt

Manufacturer: Mitsubishi Belting Ltd.

Belt model number (type)
40S2M104G (clean rubber type)

- Tension gauge
- Hex wrench set

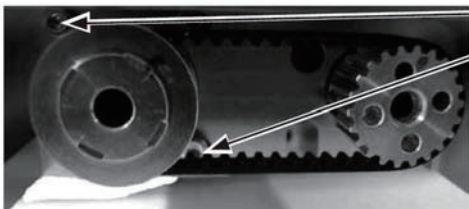
[Procedure]

- [1] Remove the pulley cover.
Remove the mounting screws (2 pcs).



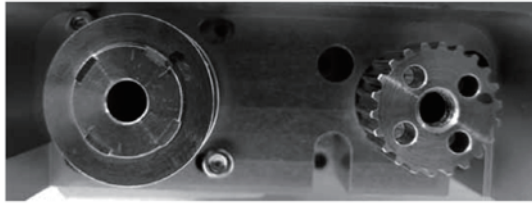
Mounting screw	
Nominal thread size	Applicable Allen wrench
M3	2.5 mm across flats

- [2] Loosen the tension adjustment bolts (2 pcs) and slack the belt.

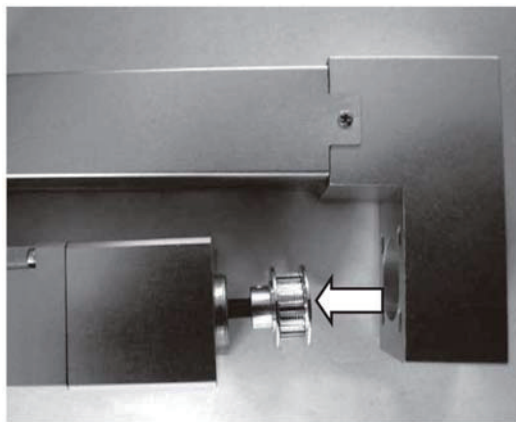


Tension adjustment bolt	
Nominal thread size	Applicable hex wrench
M3	2.5 mm across flats

[3] Remove the belt from the pulleys. When replacing the belt, proceed to step [6].

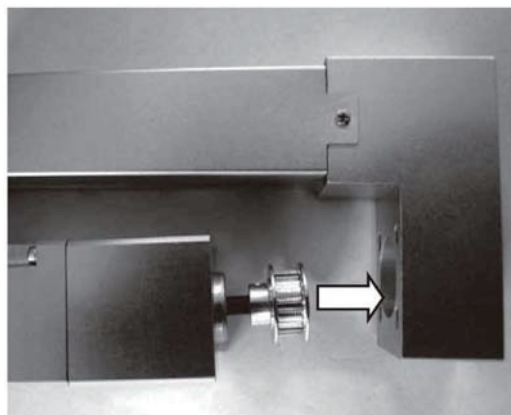


[4] Remove the tension adjustment bolts and pull out the motor unit.

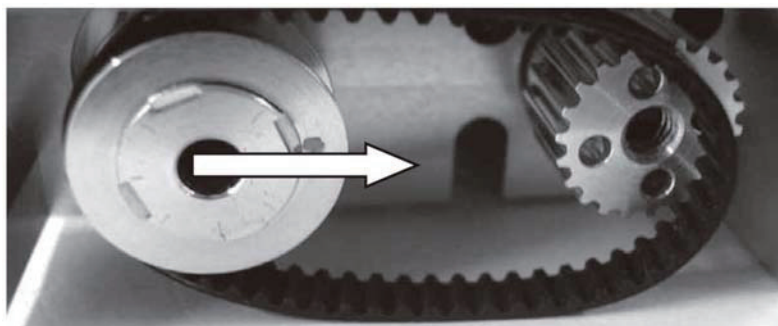


[5] Install the replacement motor unit.

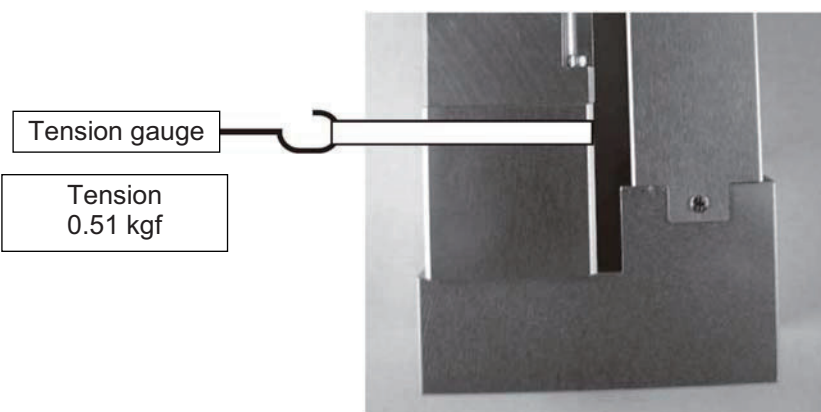
As shown below, install the motor unit so that its specified surface faces the actuator base. Use the tension adjustment bolts to loosely secure the motor unit.



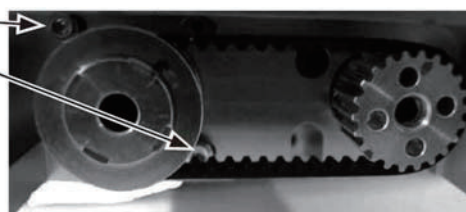
- [6] Move the motor unit in the direction of the arrow shown below, and then install the belt. When replacing the belt, install the replacement belt.



- [7] Pass around the base of the unit a strong string (or long tie band) that has been looped into a ring shape, and pull the ring with a tension gauge. After confirming that the tension gauge is indicating the specified tension, tighten the tension adjustment bolts uniformly.



Tension adjustment bolts	
Nominal thread size	Tightening torque
M3	0.83 N-m (0.085 kgf-m)



- [8] Install the pulley cover.



14 Warranty

14.1 Warranty Period

One of the following periods, whichever is shorter:

- 18 months after shipment from our company
- 12 months after delivery to the specified location

14.2 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 of problem in question was caused by a specification defect or problem, or by a quality issue with 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.

14.3 Honoring the Warranty

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

14.4 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.

14.5 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.

14.6 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

Change History

Revision Date	Description of Revision
May 2009	First edition
April 2010	Second edition A page for CE Marking added
July 2011	Third edition <p>Added “Handling Precautions” on page 8.</p> <p>Contents changed in 4. Transportation in pages 9 to 10</p> <p>Added ball screw type for the external dimensions on pages 13 to 16</p> <p>Added ball screw type and 20SP (20 square) motor specification to How to Read Model Number on page 21</p> <p>Added ball screw type and 20SP (20 square) motor specification to the specification on pages 22 to 23</p> <p>Added ball screw type and 20SP (20 square) motor specification to the maximum loading capacity on pages 22 to 23</p> <p>Added the maximum speed and loading mass graphs of ball screw type on pages 26 to 27</p> <p>Added ball screw grease to the grease used on page 43</p> <p>Added the warranty period of ball screw type to Warranty on page 50</p> <p>Contents changed in 14. Warranty in pages 50 to 51</p>
March 2012	Fourth edition <p>Contents added and changed in Safety Guide in pages 1 to 7</p> <p>Note “Make sure to attach the actuator properly by following this operation manual.” added in Caution in Handling in page 8</p> <p>Weight added to appearance drawing on pages 13 to 16</p> <p>Warning notes added such as in case the grease got into your eye, immediately go to see the doctor for an appropriate care in page 43</p> <p>Contents changed in 14. Warranty in pages 50 to 51</p>



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