ROBO CYLINDER

ROBO Cylinder
RCS2 Actuator
Rod Type
Operation Manual

Seventh Edition

Ultra High-Thrust Rod Type, RA13R

IAI America, Inc.

ROBO CYLINDER

Please Read Before Use

Thank you for purchasing our product.

This Operation Manual describes all necessary info rmation to operate this product safely such as the operation procedure, structure and maintenance procedure.

Before operation, read this manual carefully and fully understand it to operate this product safely. The enclosed CD in this product package includes the Operation Manual for this product.
For the operation of this product, print out the necessary sections in the Operation Manual or display them using the personal computer.

After reading through this manual, keep this Operation Manual at hand so that the operator of this product can read it whenever 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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ROBO CYLINDER

CAUTION

Transporting the Unpacked Actuator

The table below lists the weights of this actuator.

Stroke	Weight
50 mm	33 kg
100 mm	34 kg
150 mm	35 kg
200 mm	36 kg

When transporting or installing the actuator, always work in a group of two or more to securely support the actuator body, and exercise due caution to prevent injury.

- Prohibited handling practices

Do not hold the rod when transporting the actuator.

Do not hold the motor cover when transporting the actuator.

ROBO CYLINDER

CAUTION

Reciprocating Operation in a Short Range

The oil film of the grease may get broken if a reciprocating operation is performed continuously at a distance of 30 mm or less. As a rough guideline, perform a reciprocating operation of five round-trips or so at a distance of 50 mm or more every 5,000 to 10,000 round-trips. The oil film will be restored.

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

Cautions for Handling the Load Cell Type (Optional)

1. The load cell type (optional) is for pressing only.
   Force control is not allowed in a pull direction.

2. The press count is 2 million times as a rough guideline of the operating life of a load cell.

3. With the load cell type (optional), a cable track and a flange cannot be selected simultaneously.

International Standards Compliances

This actuator complies with the following overseas standard.
Refer to Overseas Standard Compliance Manual (ME0287) for more detailed information.

RoHS	CE Marking
○	○

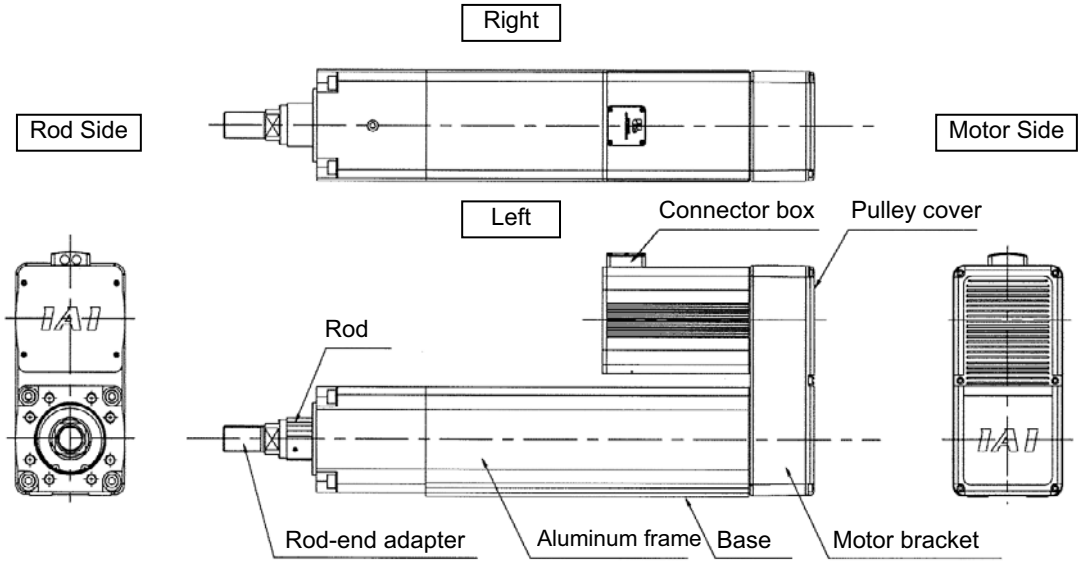
Table of Contents

1. Names of the Parts

The name of the actuator parts are indicated below.

In this manual, the left and right sides are indicated by looking at the actuator from the motor side in top view.

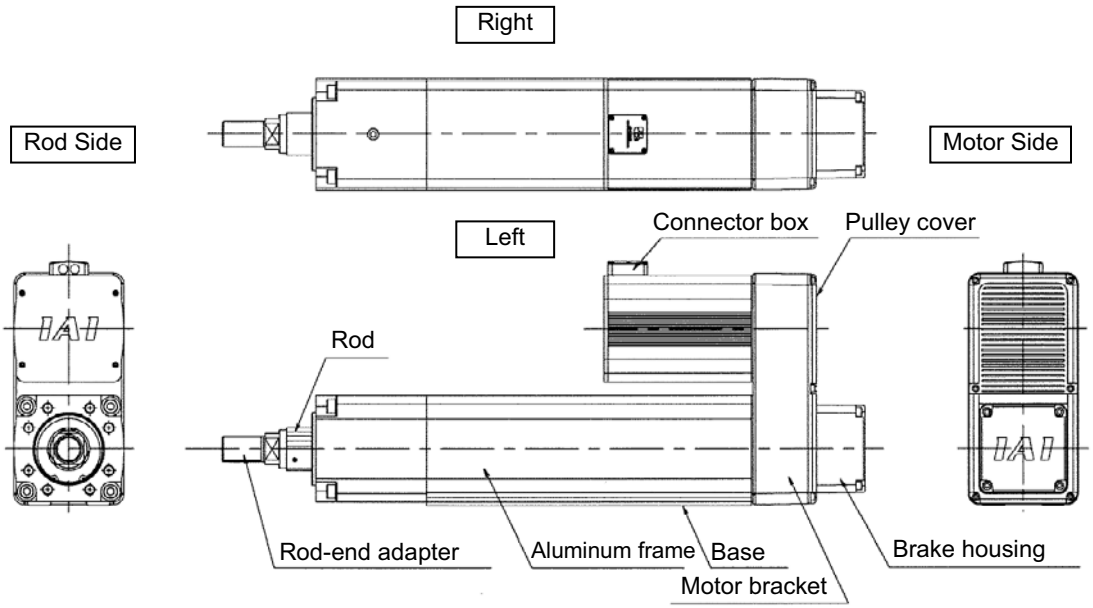
1.1 Standard Specification



* The motor-reversing direction varies depending on the specification of the delivered product.

Caution: Even if you specified a robot cable, the cable extending from the actuator is not a robot cable. Design an appropriate wiring layout so that this cable will not receive a flexing force. The robot cable specification applies to the extension cable.

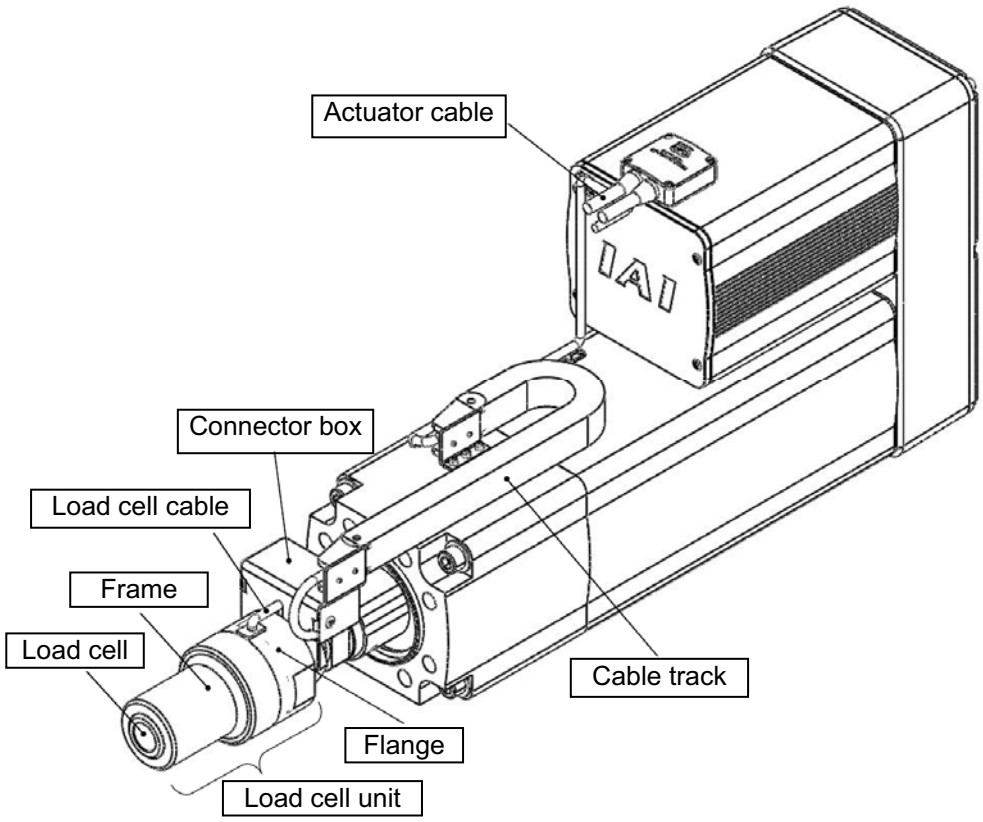
1.2 Brake Specification



* The motor-reversing direction varies depending on the specification of the delivered product.

Caution:	Even if you specified a robot cable, the cable extending from the actuator is not a robot cable. Design an appropriate wiring layout so that this cable will not receive a flexing force. The robot cable specification applies to the extension cable.

1.3 Load Cell Type (Optional)



2. Checking the Product

If based on a standard configuration, this product consists of the items listed below.

> ⚠ Caution: Check the packed items against the packing specification. Should you find a wrong model number or any missing item, please contact your IAI dealer or IAI.

2.1 Components

No.	Name	Model	Remarks
1	Actuator	Refer to “How to Read the Model Number Nameplate” and “How to Read the Model Number.”	
Accessories			
2	Motor/Encoder Cable *1		
3	Quick Step Guide		
4	Operation Manual (CD/DVD)		
5	Safety Guide		

*1 Supplied motor cables have different types such as brake specification, without brake specification and load cell type.

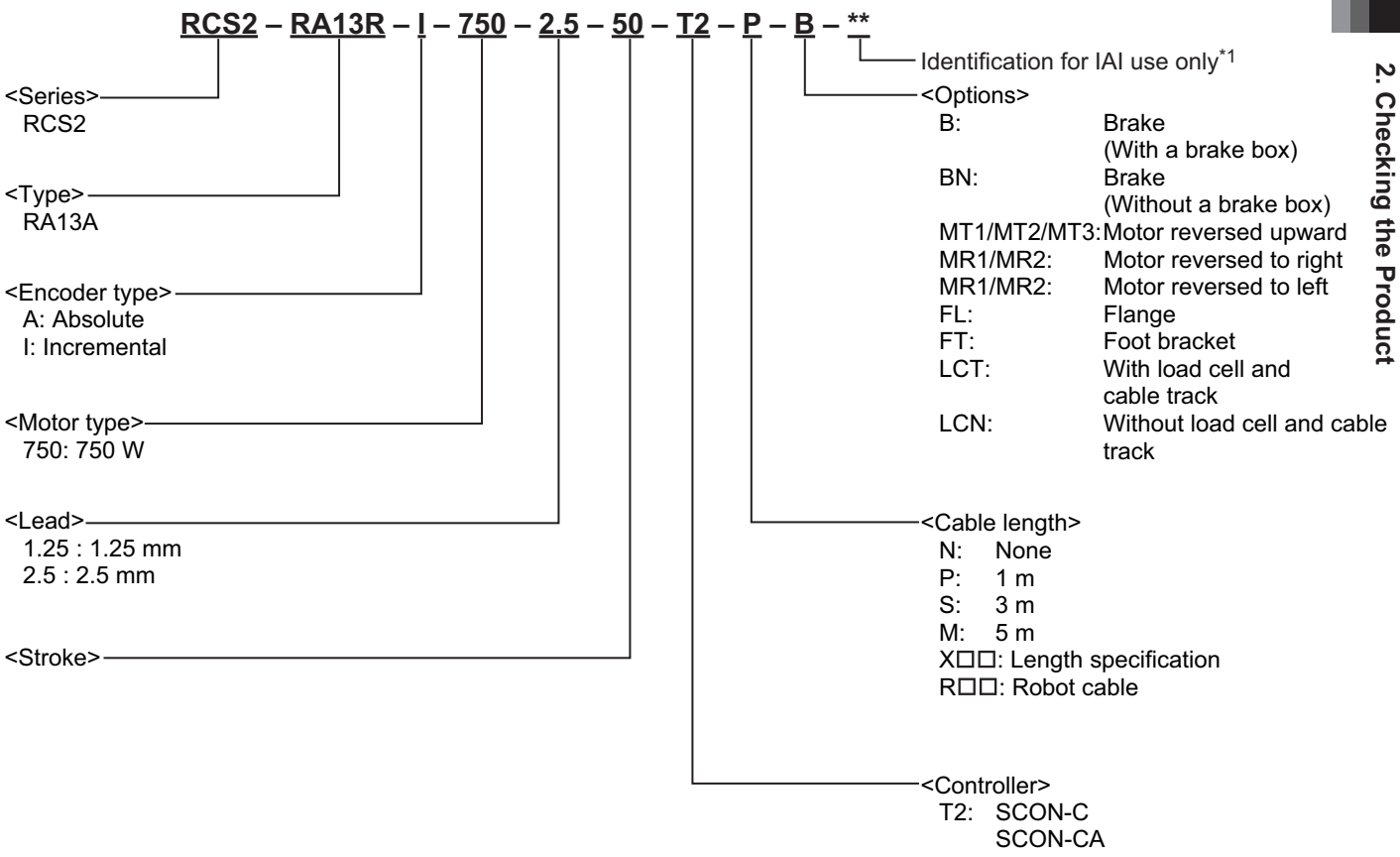
2.2 Operation Manuals for Controllers Supported by This Product

(1) SCON controller

No.	Name	Control No.
1	Operation Manual for SCON Controller	ME0161
2	Operation Manual for SCON-CA Controller	ME0243
3	Operation Manual for PC Software IA-101-X-MW/IA-101-X-USBMW	ME0155
4	Operation Manual for Teaching Pendant CON-T/TG	ME0178
5	Operation Manual for Teaching Pendant RCM-T/TD	ME0173
6	Operation Manual for Simple Teaching Pendant RCM-E RCM-PT	ME0174
7	Operation Manual for Data Setter RCM-P	ME0175
8	Operation Manual for Touch Panel Display RCM-PM-01	ME0182
9	Operation Manual for DeviceNet	ME0124
10	Operation Manual for CC-Link	ME0123
11	Operation Manual for PROFIBUS	ME0153

2.3 How to Read Model Number Nameplate

2.4 How to Read the Model Number



*1 This may be displayed for the manufacturing reason.
(This is not to indicate the manufacturing model code.)

3. Transporting and Handling

3.1 Handling the Unassembled Actuator

3.1.1 Handling the Packed Unit

Unless otherwise specified, each single-axis actuator is packed and shipped individually. When transporting the packed actuator, exercise due caution to avoid dropping the box or hitting it against an object, structure, etc.

- Heavy shipping boxes should be carried by two or more persons.
- If the shipping box is left standing, it should be in a horizontal position.
- Do not climb on top of the shipping box.
- Do not place heavy objects on top of the shipping box.

3.1.2 Handling the Actuator After It is Unpacked

The table below lists the weights of this actuator.

Stroke	Weight
50 mm	33 kg
100 mm	34 kg
150 mm	35 kg
200 mm	36 kg

When transporting or installing the actuator, always work in a group of two or more to securely support the actuator body, and exercise due caution to prevent injury.

- When carrying the actuator, exercise care not to hit it against an object, structure, etc. Pay particular attention to the motor unit and pulley case.
- Do not exert an excessive force on any part of the actuator.
- Do not pull any of the cables.

Supplement) Refer to 1, “Names of the Parts” for the name of each actuator part.

● Prohibited handling practices

Do not hold the rod when transporting the actuator.

Do not hold the motor cover when transporting the actuator.

3.2 Handling the Assembled Actuator

Take heed of the following precautions when transporting the actuator after each axis has been assembled.

3.2.1 Preassembled Actuator

If specified, IAI assembles the mechanical components at our factory, conducts a shipping inspection on the assembly, and ships the assembled actuator by packing it with skid plates bolted to the exterior frame. The rod is secured to prevent sudden movement during transport. If the actuator is of combination type, the extremities are also secured to prevent excessive swinging caused by external vibration.

- The above packing specification does not reflect special considerations for protection against impact resulting from dropping or bumping the box. Handle the box carefully. The outer frame is not designed to withstand loads from the above, so do not place heavy objects on the frame.
- If the box is suspended using ropes, etc., pass the ropes around the reinforcement frame at the bottom face of skid plates. Similarly when lifting the actuator with a forklift, place the forks below the skid plates.
- Set down the box carefully to prevent application of impact or bouncing of the box upon landing.

Once the actuator is unpacked, handle the actuator by observing the instructions below.

3.2.2 Handling the Actuator Assembled with Peripherals

When transporting the unpacked machine preassembled at IAI or customer-assembled machine, take heed of the following handling precautions:

- Secure the rod to prevent sudden movement during transport.
- If the actuator has any overhung extremity, properly secure the extremity to prevent excessive swinging caused by external force.
- If the actuator must be transported with its extremities not secured, make sure the actuator does not receive impact loads greater than 0.3 G.
- When suspending the actuator/peripherals using ropes, etc., do not allow the ropes to contact the actuator directly.
- When passing ropes, guide them around the base by inserting an appropriate buffer material between the rope and base.
- Exercise caution not to apply loads on the brackets, covers and connector box. Also protect the cables against pinching or excessive deformation.

4. Operating and Storage Environment

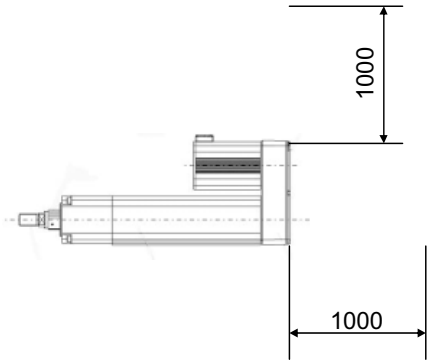
4.1 Operating Environment

The actuator should be set up in an environment which meets the following criteria:

- Avoid direct sunlight.
- Avoid radiant heat from strong heat sources such as a furnace.
- Surrounding air temperature should be 0 ~ 40°C.
- The humidity should be less than 85% and there should be no condensation.
- Avoid exposure to corrosive or combustible gases.
- The area should have very little dust and be suitable for normal assembly operations.
- Avoid exposure to oil mist or fluids using in cutting.
- The actuator should not be subject to vibration or shock.
- The actuator should not be subject to significant levels of electromagnetic waves, ultraviolet rays or radiation.
- This product is not designed for use in a chemical environment.

In general, the environment should be one in which an operator can work without protective gear.

Work space required for maintenance/inspection
Provide the work space specified below if you want to replace the motor, belt, etc., without removing the actuator.



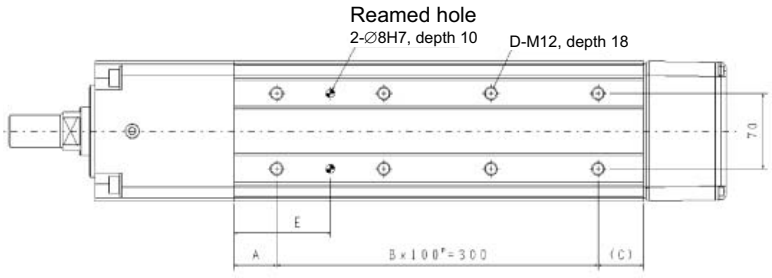
4.2 Storage Environment

The storage environment should be similar to the operating environment. In addition, you must take precautions against condensation if the unit is to be stored for a long period of time. Unless there are special instructions, we do not include moisture absorption agents when shipping the unit. If you are storing the unit where condensation might occur, then you must treat the entire package or treat the unit itself after it is unpacked to prevent condensation. The unit can withstand up to 60°C during a short storage interval but only up to 50°C if the storage period is longer than one month.

5. Installation

5.1 Installing the Main Body

(1) Using the tapped holes in the back of the base

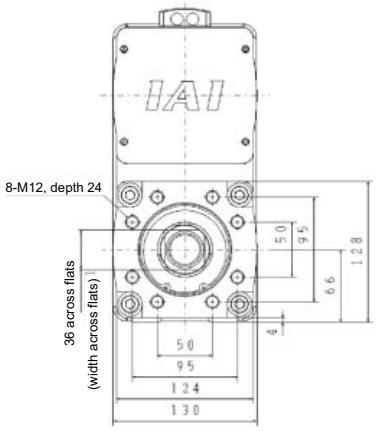


Tap size	Maximum thread length
M12	18 mm

Stroke	A	B	C	D	E
50	90	40	2	42.5	6
100	115	65	2	67.5	6
150	90	40	3	42.5	8
200	115	65	3	67.5	8

Tapped holes are provided in the back of the base for mounting. You can use these tapped holes to install the actuator. The maximum thread length of base mounting screws is specified above. Make sure the bolt ends do not project through the holes.
There are also reamed positioning holes, which can be used if necessary.

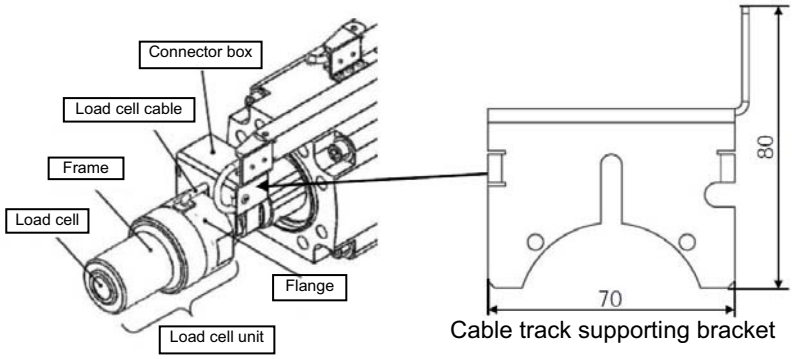
(2) Using the tapped holes on the rod side

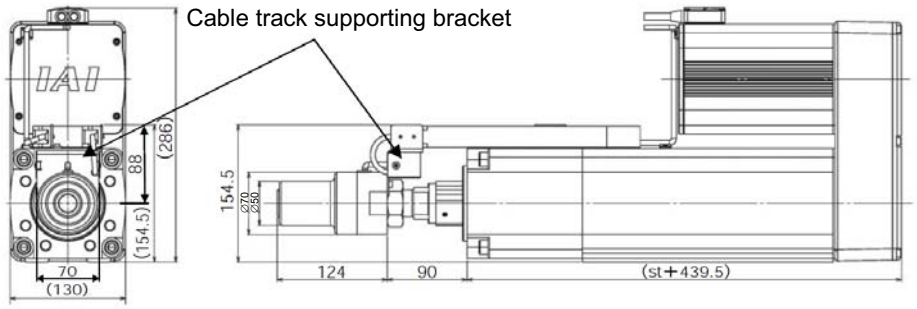


Tap size	Maximum thread length
M12	24 mm

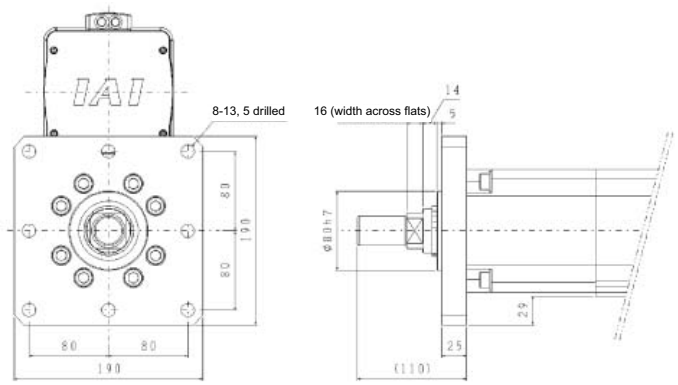
Tapped holes are provided on the rod side for mounting. You can use these tapped holes to install the actuator. The maximum thread length of rod mounting screws is specified above. Make sure the bolt ends do not project through the holes.

[Cautions when installing the load cell type (optional)]
A cable track supporting bracket is attached to the load cell type (optional) as shown in the figure below, and moves with the rod.
When installing it vertically using the taps on the rod side, take measures, such as creating holes on the installation board, based on the dimensions below so that the cable track supporting bracket does not interfere.



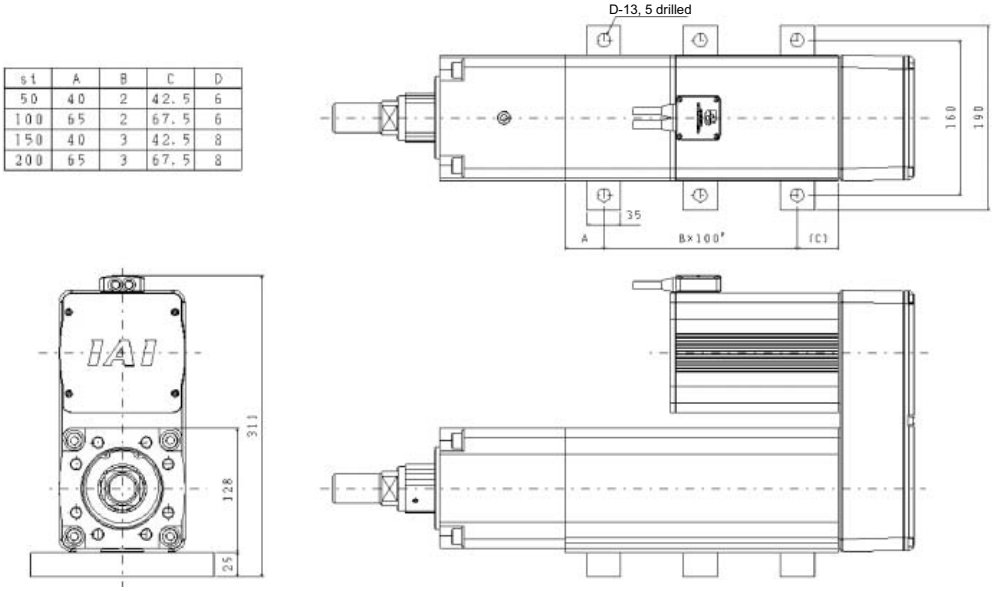


(3) Using a flange (optional) with screws
An optional flange is available. You can use this flange to install the actuator.



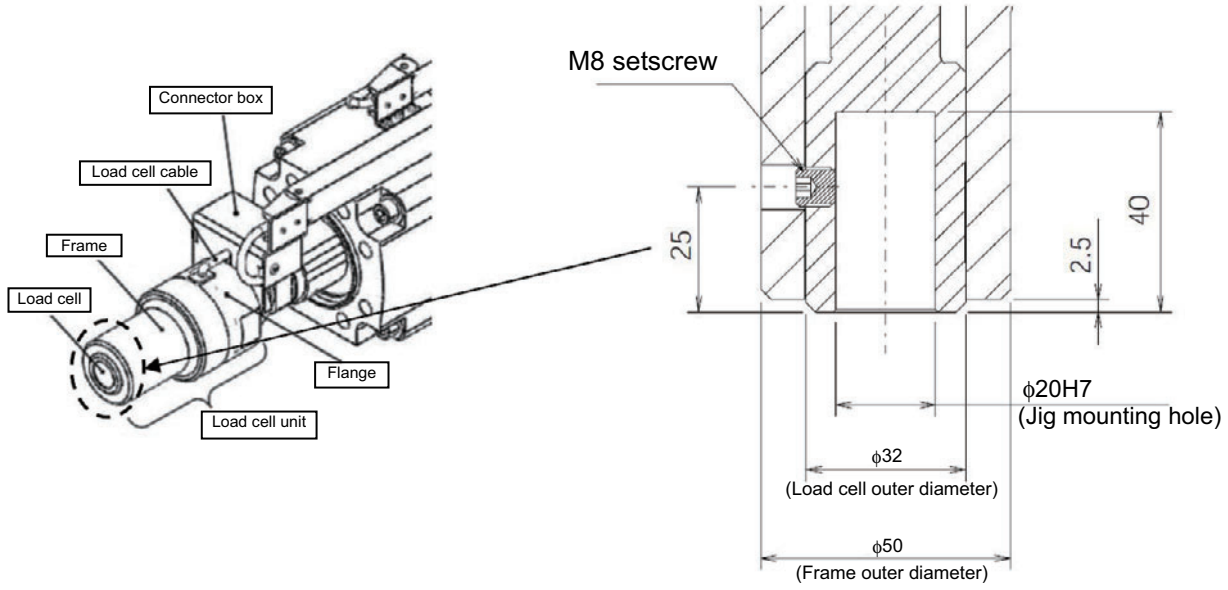
(4) Using foot brackets (optional)
Optional foot brackets are available. You can use these brackets to install the actuator.

st	A	B	C	D
50	40	2	42.5	6
100	65	2	67.5	6
150	40	3	42.5	8
200	65	3	67.5	8



5.2 Installation of the End of the Load Cell Type (Optional)

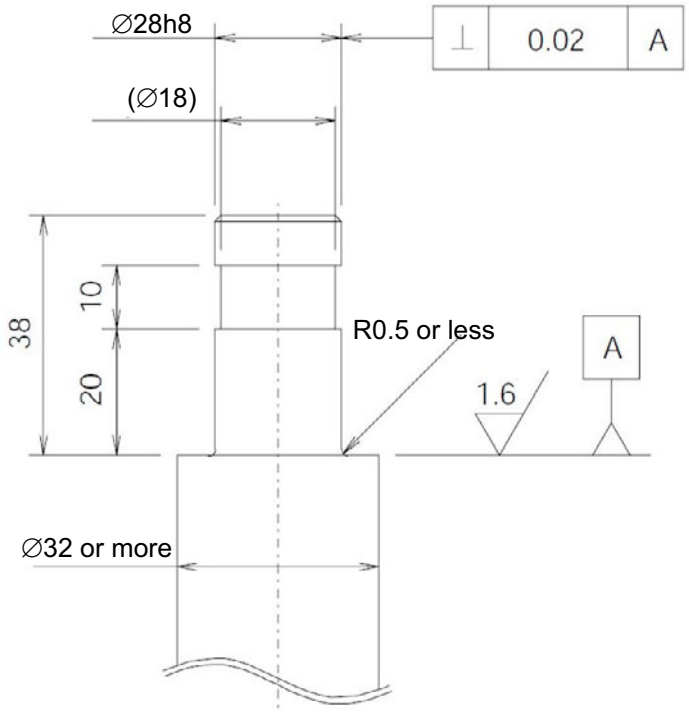
If you create a tool with its tip in the dimensions as shown in the next page, stick it to the ϕ20 fixing hole, and it can be attached on the end of the loadcell tip.
Affix the jig using the M8 screw.
The weight of the object attached on the tip should be 10kg or less.



⚠ Caution:
- Pay careful attention when attaching a jig so that no impact or offset load is applied to the load cell and its surrounding parts.
  The load cell may break down.
- Force cannot be received inside the load cell.
  Make sure that the end of the jig does not protrude through to the inside of the load cell.
  The load cell may break down.
- Use a lightweight jig as it gets affixed only with an M8 screw.
- When attaching a jig in a horizontal installation, make sure that no moment load is applied to the load cell.

[Reference dimensions of the load cell side where a jig is to be attached]

The following are reference dimensions of the load cell side where a jig is to be attached.



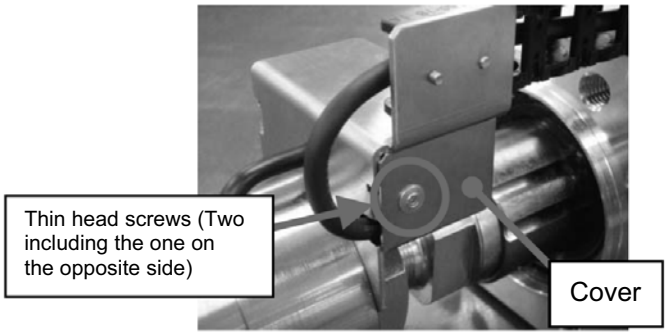
Dimensions of the load cell side where a jig is to be attached

5.3 Front Side Installation of the Load Cell Type (Optional)

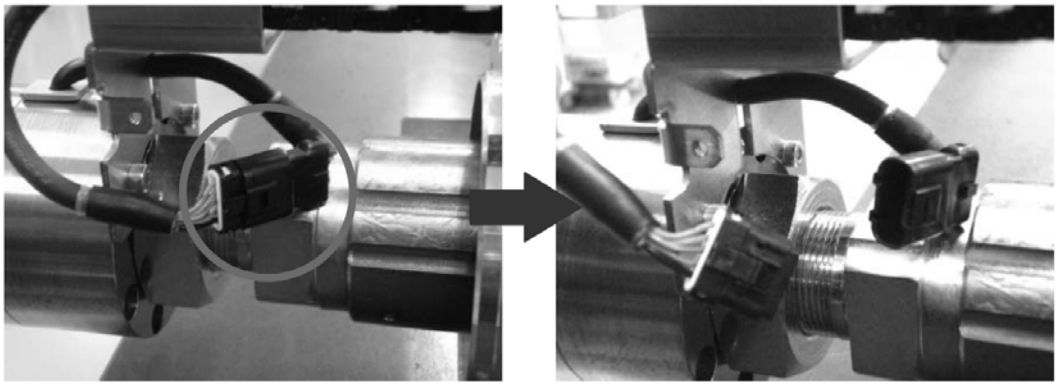
When installing the actuator on the front side, the cable track that is used to wire cables for the load cell needs to be removed temporarily.

[Procedure]
Be sure to cut off the power supply when performing this operation.

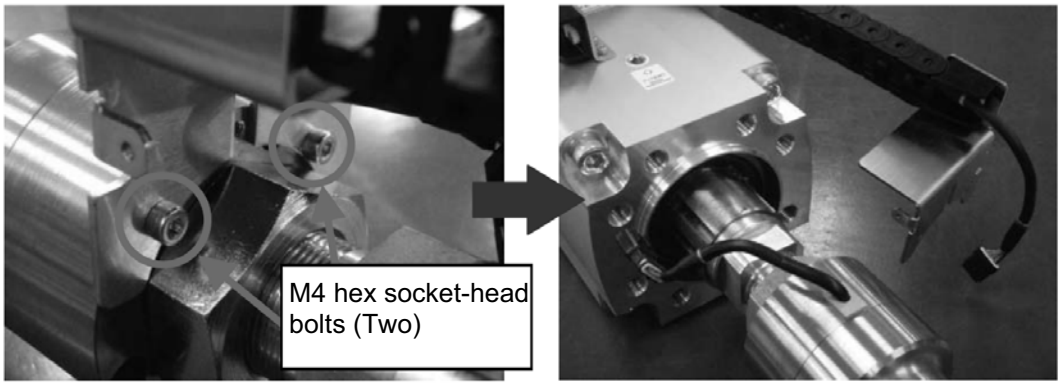
[1] Remove the M3 thin head screws and remove the cover.



[2] Remove the connector to which the cables are connected.



[3] Remove the M4 hex socket-head bolts and remove the cable track from the load cell.



[4] Attach the cable track based on the procedure on the previous page in the reverse order.
Be careful so that no impact or offset load is applied to the load cell and its surrounding parts.
When connecting the connector, pay attention to the connector direction, and connect it securely until it clicks.
Be careful not to pinch any cables when attaching the cover.

6. Wiring Cable

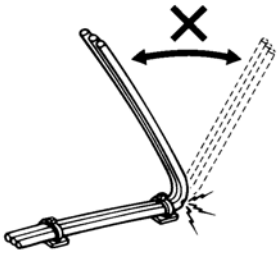
- In an application where the cable cannot be anchored, try to place the cable so that it sags only under its own weight or use self-standing type cable as large radial wire duct to limit the load on the cable.
- Never cut and/or reconnect the cables supplied with the product for the purpose of extending or shortening the cable length.
- The standard cable provides excellent flexibility, but it is not a robot cable. Use a robot cable if the cable is to be stored in a moving cable duct (cable track, etc.).
- For the load cell type (optional) with no cable track, you are responsible for taking care of the cables from the load cell.

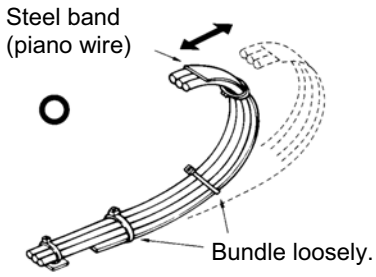
For cable modification, please contact IAI.

Prohibited Handling of Cables

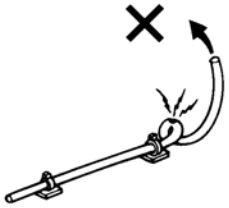
When designing an application system using IAI actuators and controllers, incorrect wiring or connection of each cable may cause unexpected problems such as a disconnected cable or poor contact, or even a runaway system. This section explains prohibited handling of cables. Read the information carefully to connect the cables properly.

1. Do not let the cable flex at a single point.

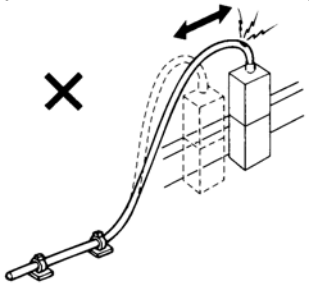




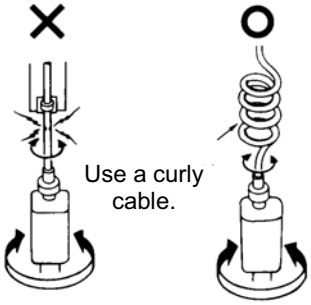
2. Do not let the cable bend, kink or twist.



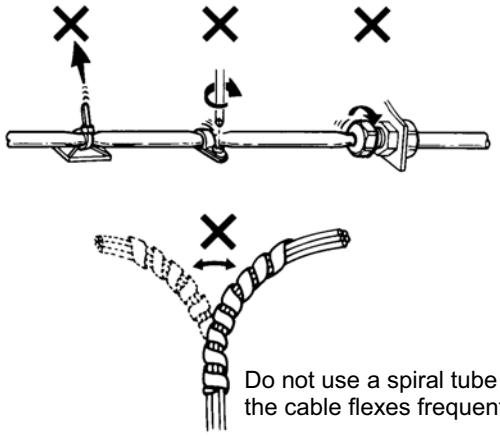
3. Do not pull the cable with a strong force.



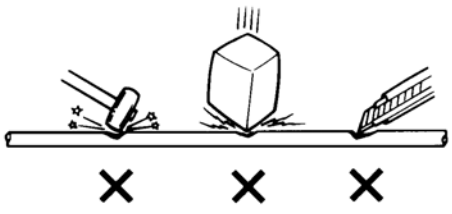
4. Do not let the cable receive a turning force at a single point.



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

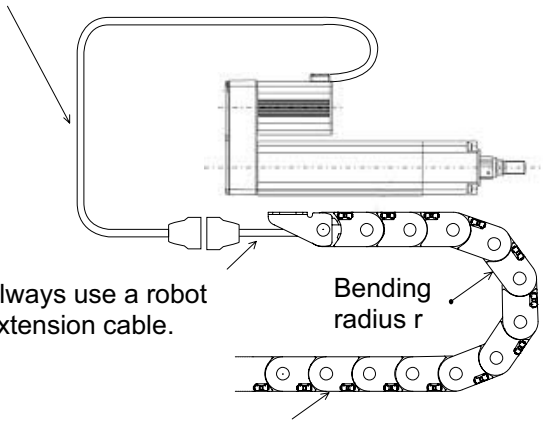


6. Do not pinch, drop a heavy object onto or cut the cable.



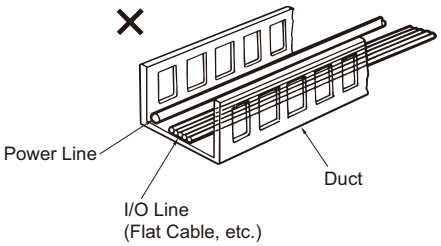
7. Cautions for use of a cable track

- The supplied cable is not a robot cable, so never store it in a cable track.



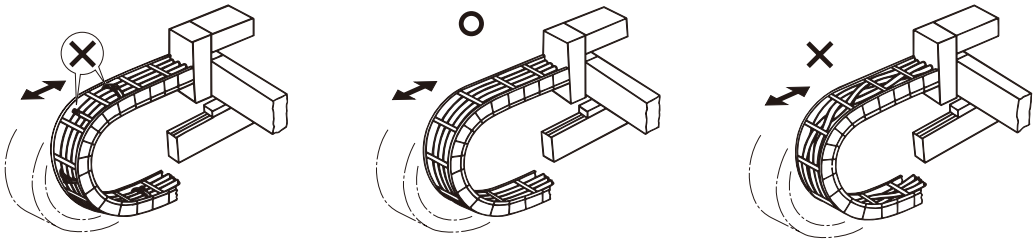
- Always use a robot extension cable.
- If a cable track is used, select one with a bending radius r of at least 50 mm.

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



Follow the instructions below when using a cable track.

- If there is an indication to the cable for the space factor in a cable track, refer to the wiring instruction given by the supplier when storing the cable in the cable track.
- Avoid the cables to get twined or twisted in the cable track, and also to have the cables move freely and do not tie them up. (Avoid tension being applied when the cables are bent.)
  Do not pile up cables. It may cause faster abrasion of the sheaths or cable breakage.

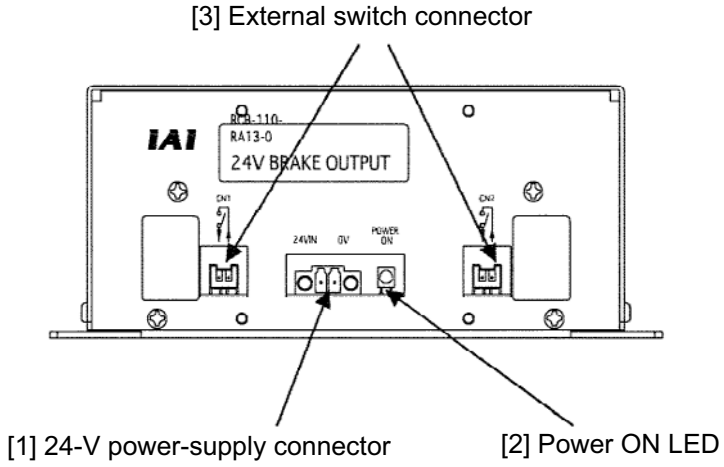


7. Installing the External Brake Connection Box for the Brake Specification

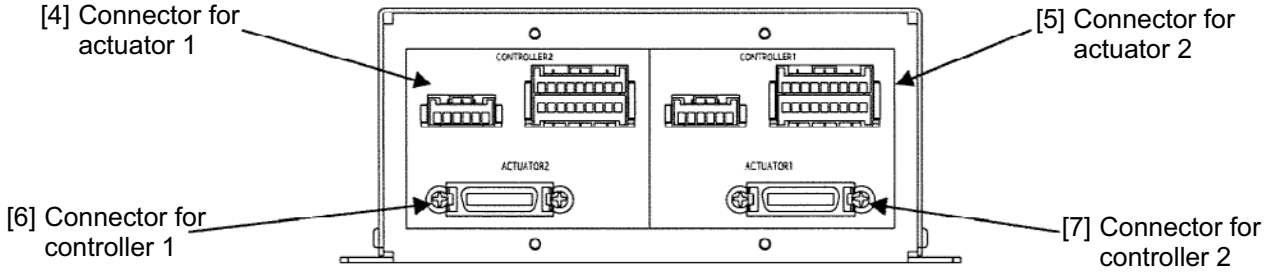
If the actuator is equipped with a brake, an external brake connection box must be installed.

- External brake connection box Model: RCB-110-RA13-0

[Front view]



[Rear view]

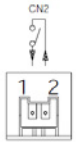


[1] 24-V power-supply connector
This connector is used to supply 24-V power to the external brake box.

Matching cable	AWG28 to 16	
Terminal	24 V	+24-V power supply input
	0 V	GND

[2] Power ON LED
The LED turns on when a +24-V power is supplied to the external brake box.

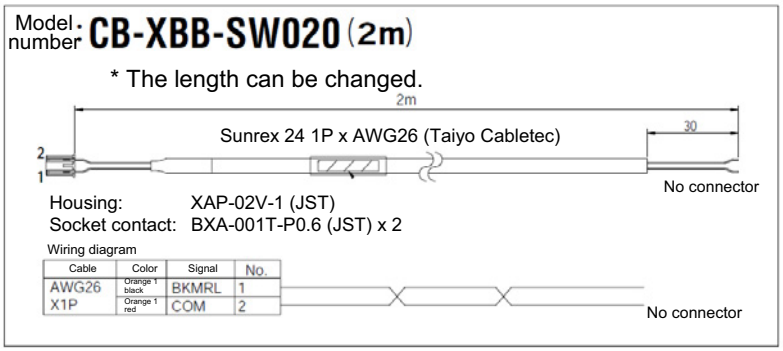
[3] External switch connector
Connect a switch to the external switch connector and short circuit pins 1 and 2 to forcibly release the brake.



Cable-side connector	XAP-02V-1 (Contact BXA-001T-P0.6) (Japan Solderless Terminal)		
Terminal	1	BKMRL	Brake release switch input
	2	COM	Power supply output for brake release switch input

* A brake release switch cable is available as an option to connect the switch and an external switch connector.

Brake release switch cable (Optional)



[4] Actuator 1 connector, [5] Actuator 2 connector
These connectors are used to connect the encoder cables on the actuator side.

[6] Controller 1 connector, [7] Controller 2 connector
These connectors are used to connect the encoder cables on the controller side.

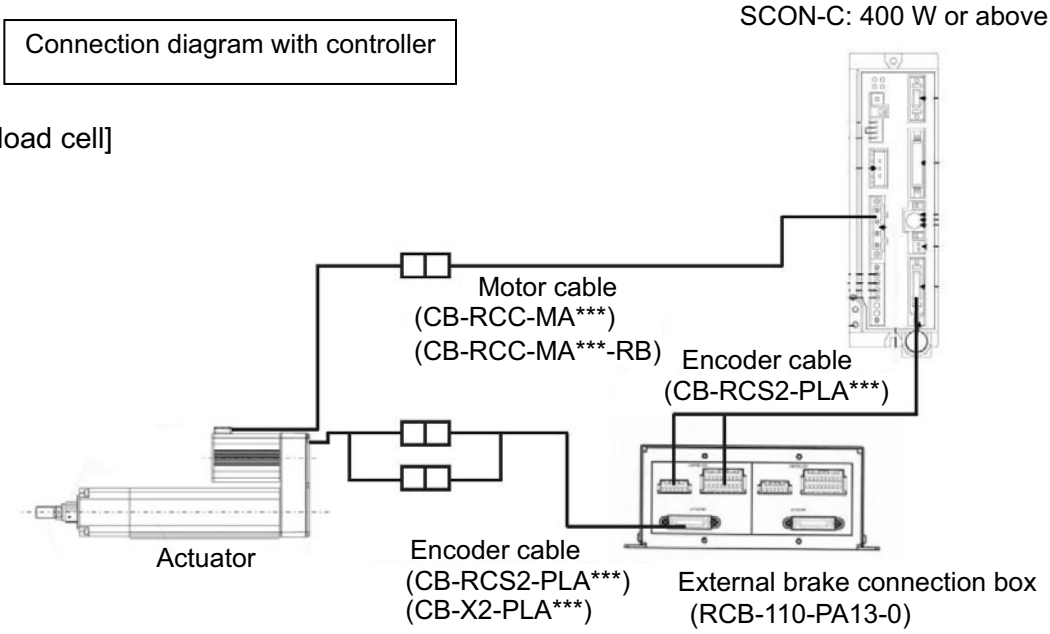
(1) Wiring and starting the external brake connection box

[1] An example of connection with a SCON controller is explained.
Connect the cables according to the example.
In this example, the connectors for actuator 1 and controller 1 are used. It is also possible to use the connectors for actuator 2 and controller 2.

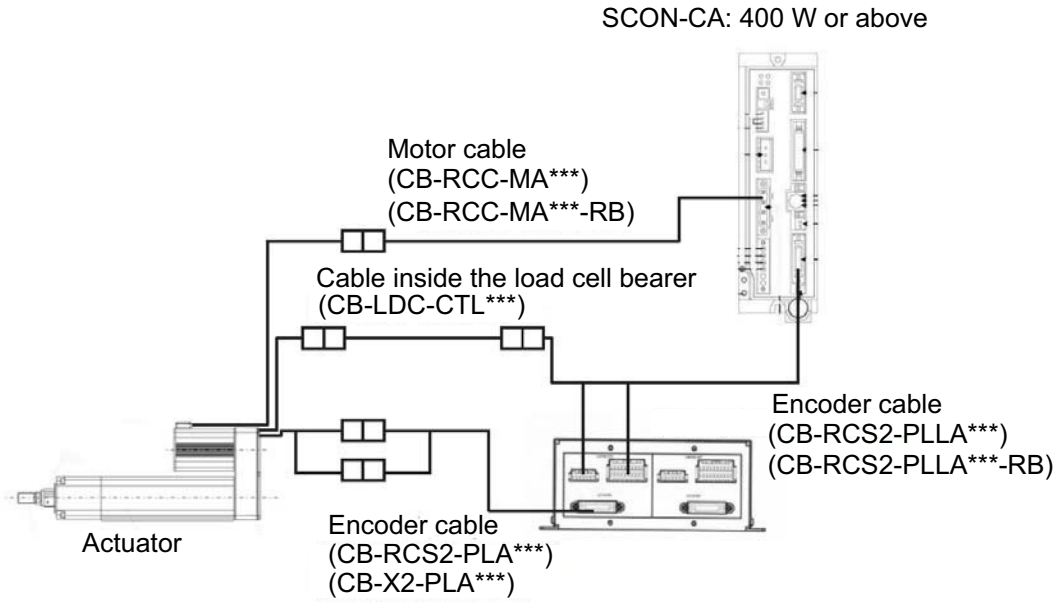
[2] Connect a +24-V power supply to the 24-V power-supply connector on the external brake connection box and input +24-V power. The external brake connection box can be used.

Connection diagram with controller

[No load cell]



[Load cell type (Optional)]



8. Specifications

8.1 Maximum Speed

A maximum speed is specified for this product to prevent resonance of the ball screw shaft while conforming to the speed limit of the motor. Refer to the table below to find the maximum speed of your actuator and operate the actuator at speeds not exceeding the maximum level.

Maximum speed limits

Type	Stroke	Maximum speed
Lead 2.5 (1t)	50 mm	85 mm/sec
	100 mm	120 mm/sec
	150 mm, 200 mm	125 mm/sec
Lead 1.25 (2t)	50 mm, 100 mm, 150 mm, 200 mm	62 mm/sec

⚠ Caution: If the actuator is used at speeds beyond the maximum level, noise may increase or vibration may generate due to resonance of the ball screw shaft, and such increased noise or vibration may consequently reduce the service life of the product.
If each actuator is used independently, write a program conforming to the maximum speed of the actuator (refer to the table above). If multiple actuators are used in a synchronized operation, write a program conforming to the lowest of the maximum speeds applicable to all synchronized actuators.
In either way, always check the maximum speed of each applicable actuator when writing a program.

8.2 Loadcell (Option)

Item		Specification
Loadcell System		Strain Gauge
Rated Capacity		20000N
Allowable Overload		200%R.C* An alarm occurs if: Pressing force exceeds 150% of R.C*. Tensile force exceeds 25% of R.C*.
Lordcell Accuracy		±1%R.C*
Temperature drift	Zero	±0.2%R.C* /10°C
	Output	±0.1%R.C* /10°C
Ambient temperature range		0 to 40°C
Dielectric strength voltage		50V DC

* R.C : Rated Capacity

(Note) The product life of the loadcell is 2000000 cycles of pressing operation.

(Note) The frequency of calibration for loadcell differs depending on the condition of use (such as frequency of pressing operation, pressing force, ambient temperature and so on).
Please contact IAI for the frequency reference of calibration.
Refer to 11.5 Removing and Iinstalling a Load Cell for how to detach and attach the loadcell when passing to the calibration.

9. Load Applied to the Actuator

- Make sure the actuator will not receive a load exceeding the value specified in the catalog.
- This actuator can receive a load on its rod.

Use the actuator correctly by observing the condition specified below:

$M + T \leq 120$ (N•m)

Load moment $M = mg \times L_2$

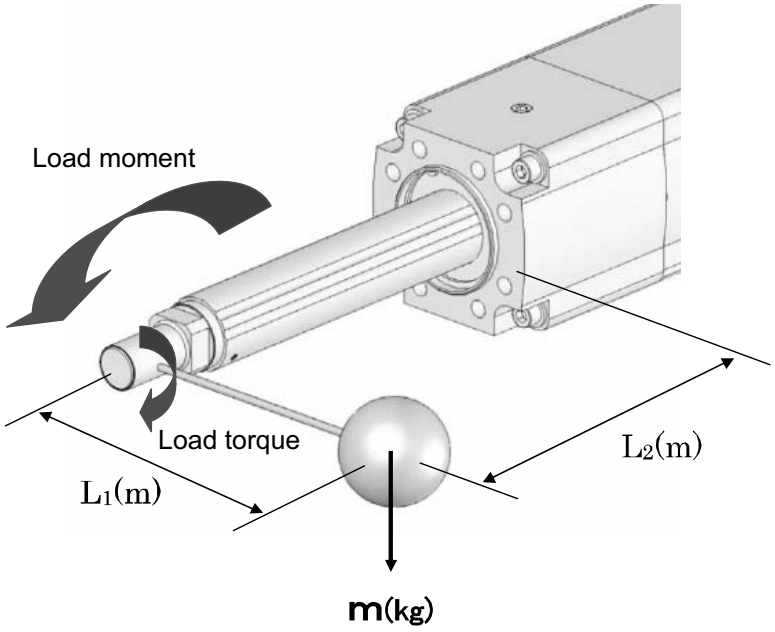
Load torque $T = mg \times L_1$

g: Gravitational acceleration = 9.8

L_1: Distance from the rod center to the work part's center of gravity

L_2: Distance from the actuator mounting surface to the work part's center of gravity + 0.07

If these conditions are not satisfied, make necessary adjustments, such as installing an external guide, so that no load is applied to the rod.



- Do not allow the rod to receive any load torque exceeding the value calculated above.
  * Doing so may damage the internal parts of the actuator.

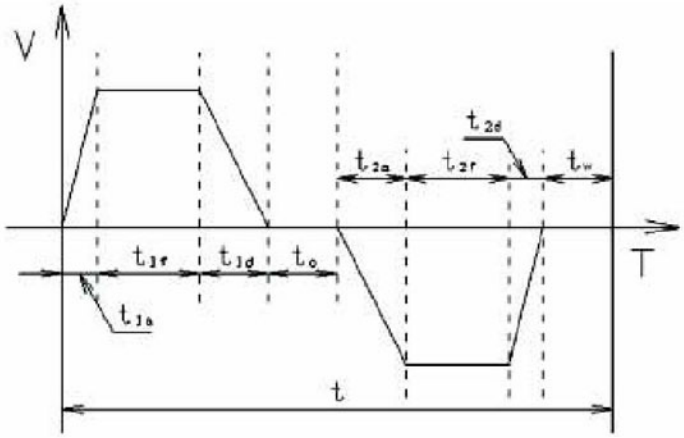
When tightening the nut at the end of the rod, hold the rod using a monkey wrench, etc.

10. Selection Conditions

The following three conditions must be met before the ultra high-thrust actuator can be used:

Condition [1] The push time does not exceed the specified time.
Condition [2] The thrust for continuous operation does not exceed the rated thrust of the ultra high-thrust actuator throughout the cycle.
Condition [3] Push-motion operation is performed only once per cycle.

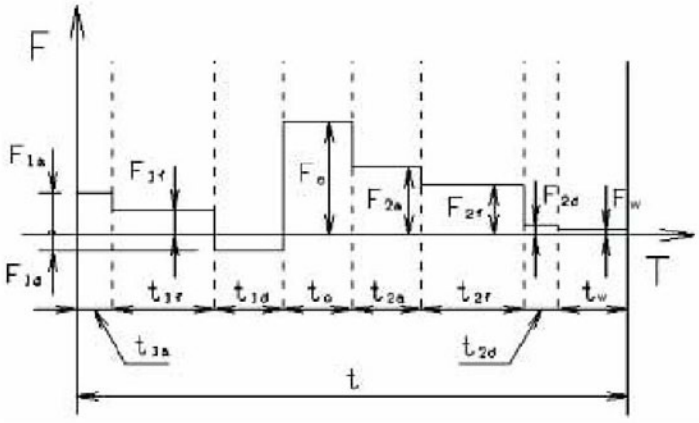
Each condition is explained by using a trapezoid operation pattern as an example.



In the graph on the left:

t	:	Operation time per cycle (sec)
t 1a、t 2a	:	Acceleration time (sec)
t 1f、t 2f	:	Traveling time at constant speed (sec)
t 1d、t 2d	:	Deceleration time (sec)
t O	:	Push time (sec)
t w	:	Standby time (sec)

The above operation pattern is expressed differently when the thrust is represented by the vertical axis, as shown below.



In the graph on the left:

F1a、F2a	:	Thrust required for acceleration (N)
F1f、F2f	:	Thrust required at constant speed (N)
F1d、F2d	:	Thrust required for deceleration (N)
FO	:	Push force (N)
Fw	:	Thrust required during standby (N)

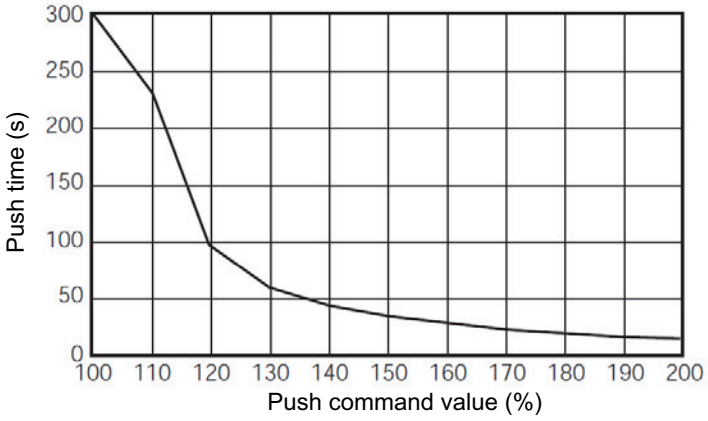
10.1 Selection Procedure

The following explains the procedure to select an actuator for vertical application.

Condition [1]
A maximum push time is specified for each push command value, as shown in the table below. Find the maximum push time for each command by referring to this table, and make sure the push time does not exceed the specified duration. Take note that a failure to adhere to this table may result in actuator problems.

Push command value (%)	Maximum push time (s)
79 or less	(Continuous push allowed)
80～100	300
110	230
120	95
130	58
140	43
150	33
160	27
170	21
180	18
190	15
200	13

[Push Time]



Condition [2] Thrust for continuous operation

Confirm that the thrust for continuous operation Ft, calculated by considering the load and duty, does not exceed the rated thrust of the ultra high-thrust actuator throughout the cycle. Here, remember that **push motion operation should not be performed more than once per cycle**.

$$F_t = \sqrt{\frac{F_{1a}^{\,2} \cdot t_{1a} + F_{1f}^{\,2} \cdot t_{1f} + F_{1d}^{\,2} \cdot t_{1d} + F_o^{\,2} \cdot t_o + F_{2a}^{\,2} \cdot t_{2a} + F_{2f}^{\,2} \cdot t_{2f} + F_{2d}^{\,2} \cdot t_{2d} + F_w^{\,2} \cdot t_w}{t}}$$

Here, Fa/Fd represents the force required for acceleration/deceleration and changes according to the operating direction. Calculate the value using the formulas below:

Horizontal application (both acceleration and deceleration)	$F_a = F_d = (M+m) \times d$
Accelerate in downward motion in vertical application	$F_{1a} = (M+m) \times 9.8 - (M+m) \times d$
Move at a constant speed in downward motion in vertical application	$F_{1f} = (M+m) \times 9.8 + \alpha$ (*1)
Decelerate in downward motion in vertical application	$F_{1d} = (M+m) \times 9.8 + (M+m) \times d$
Accelerate in upward motion in vertical application	$F_{2a} = (M+m) \times 9.8 + (M+m) \times d$
Move at a constant speed in upward motion in vertical application	$F_{2f} = (M+m) \times 9.8 + \alpha$ (*1)
Decelerate in upward motion in vertical application	$F_{2d} = (M+m) \times 9.8 - (M+m) \times d$
Stand by in vertical application	$F_w = (M+m) \times 9.8$

*1: If an external guide or other similar component is installed, the traveling resistance must be considered.

M: Mass of moving part (kg)
m: Loaded mass (kg)
d: Commanded acceleration/deceleration (m/s^2)

Mass of moving part: 9 kg

If the calculated thrust for continuous operation Ft is smaller than the rated thrust, the actuator can be operated.

Rated thrust of a ultra high-thrust actuator with 2.5 (1t) lead: 5100 N

Rated thrust of a ultra high-thrust actuator with 1.25 (2t) lead: 10200 N

The actuator can be operated under operating conditions where both conditions [1] and [2] are satisfied. If either condition cannot be satisfied, take an appropriate countermeasure such as decreasing the push-motion operation time or increasing the standby time to lower the duty.

10.2 Exercise

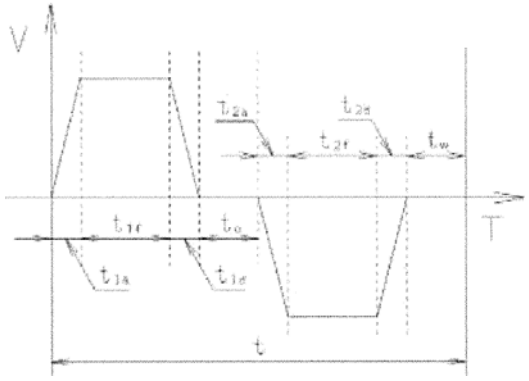
Let's check if a selected actuator supports a given operation pattern by using the selection procedure explained above.

★ Operating conditions

- Model: Ultra high-thrust actuator with 1.25 (2t) lead
- Mounting position: Vertical
- Speed: 62 mm/s
- Acceleration/deceleration: 98 mm/s^2 (0.01 G)
- Travel distance: 50 mm
- Loaded mass: 100 kg
- Push command value: 200% (2000 kgf)
- Push time: 3 s
- Standby time: 2 s
- Move 50 mm downward, perform push-motion operation, move 50 mm upward, and stand by for 2 sec. The operating conditions for upward and downward movements are the same.

* 1 G = 9.8 m/s^2

The graph on the right illustrates the above operation pattern.



Now, calculate the necessary values by following the selection procedure.

Condition [1] Check the push-motion operation time.
From Table 1 on p. 15, the push time is 3 seconds as opposed to the maximum push time of 13 seconds corresponding to the push command value of 200%. Accordingly, the push time condition is satisfied.

Condition [2] Calculate the thrust for continuous operation.
Assign the above operation pattern to the aforementioned formula to calculate thrust for continuous operation.

$$F_t = \sqrt{\frac{F_{1a}^{\ 2} \cdot t_{1a} + F_{1f}^{\ 2} \cdot t_{1f} + F_{1d}^{\ 2} \cdot t_{1d} + F_o^{\ 2} \cdot t_o + F_{2a}^{\ 2} \cdot t_{2a} + F_{2f}^{\ 2} \cdot t_{2f} + F_{2d}^{\ 2} \cdot t_{2d} + F_w^{\ 2} \cdot t_w}{t}}$$

Here,
F_{1a}, F_{2d} = (M + m) x 9.8 - (M + m) x d = 1058 N
F_{1f}, F_{2f} = (M + m) x 9.8 = 1068N
F_{1d}, F_{2a} = (M + m) x 9.8 + (M + m) x d = 1079 N
F_0 = Push command value 200% (2000 kgf) = 19600 N
F_w = (M + m) x 9.8 = 1068N
$t_{1a} = t_{2a} = t_{1d} = t_{2d}$ = Speed 62 mm/s ÷ Acceleration/deceleration 98 mm/s^2 = 0.632 s
$t_{1f} = t_{2f}$ = (Travel distance 50 mm – (Travel distance during acceleration 19.60 mm + Travel distance during deceleration 19.60 mm)) ÷ Speed 62 mm/s = 0.174 s
Travel distance during acceleration (deceleration) = Acceleration (deceleration) rate 98 mm/s^2 x (Acceleration (deceleration) time ($t_{1a, 2a, 1d, 2d}$) 0.632 s)^2 ÷ 2 = 19.60 mm
t_o = 3s, t_w = 2 s, t = 7.88 s

From the above, the following result is obtained:
F_w = 12113 N
Since this is greater than the rated thrust of 10200 N specified for the ultra high-thrust actuator with 1.25 (2t) lead, the actuator cannot be operated based on this operation pattern.

Now, the standby time is increased (duty is lowered) as a countermeasure.
In this example, calculations are repeated by assuming t_1 = 6.12 s (t = 12 s). This time, the following result is obtained:
F_w = 9814 N
The actuator can be operated.

11. Maintenance

11.1 Maintenance Schedule

Perform maintenance work according to the schedule below.
The schedule is set assuming eight hours of operation a day. When the operation time is long such as 24-hour operation, shorten the maintenance intervals as needed.

	Visual inspection	Grease supply	
Start of operation	○		
After 1 month of operation	○		
After 3 months of operation	○	○ (Rod (ball spline) slide surface)	*1
Every 3 months thereafter	○	○ (Rod (ball spline) slide surface)	*1
After 3 years of operation or 5000 km travel distance	○		
Every 1 year thereafter	○		

*1 Apply the grease to the rod (ball spline) slide surface when dry surface is observed at the start of operation or every three months of operation.

11.2 Visual Inspection of the Machine Exterior

Check the following when doing the visual inspection.

Body	Loose mounting bolts?
Cables	Damage to cables or connection to connector box?
General	Unusual noise or vibrations?

11.3 Cleaning

- Clean the exterior as needed.
- Wipe off dirt with a soft cloth.
- Do not use strong compressed air on the actuator, as it may force dust into the crevices.
- Do not use petroleum-based solvents, as they may damage resin or coated surfaces.
- If the unit is badly soiled, apply a neutral detergent or alcohol to a soft cloth and wipe lightly.

11.4 Greasing the Rod (Ball Spline)

(1) Applicable grease

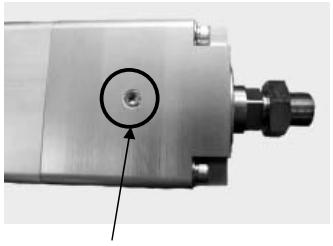
Showa Shell Sekiyu	Albania EP Grease 2

⚠ Warning: Never use fluorine grease. Fluorine grease chemically reacts with lithium grease to cause damage on the machine.

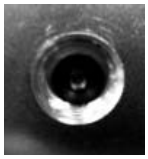
(2) How to apply grease

Before applying grease, turn off the actuator power.

1) Use an Allen wrench of 6 mm across flats to remove the tapered plug with hexagonal hole installed at the grease feed port. When the tapered plug has been removed, the grease nipple appears.



Tapered plug with hexagonal hole installed at grease feed port



Grease nipple

2) Insert the grease gun into the grease nipple and add grease.
* Use a grease gun corresponding to the diameter of the grease nipple.

Nipple diameter
∅4

3) After a sufficient amount of grease has been added, close the grease feed port with the tapered plug with hexagonal hole.

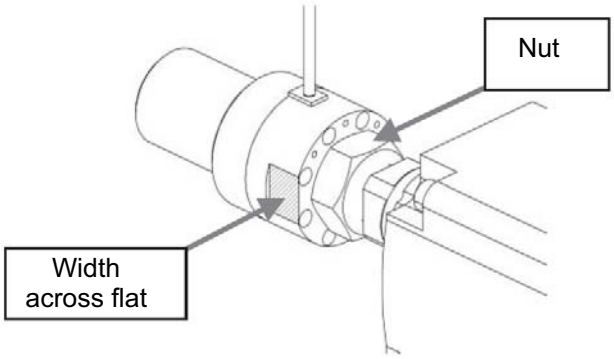
4) Turn on the controller power and retract/extend the rod repeatedly via jogging motion, etc., to spread the grease evenly over the entire surface.

11.5 Procedure of removing and Installing a Load Cell

The loadcell unit needs to be returned when a calibration is required on the loadcell.
Also, if there is an abnormality with the loadcell performance, such as the end of the operating life or a breakdown of the loadcell, the loadcell unit needs to be returned for repair or replacement with a new unit in some cases.
In such a case, detach the loadcell with the following steps.
Put back the loadcell after the calibration, repair or replacement with a new unit.

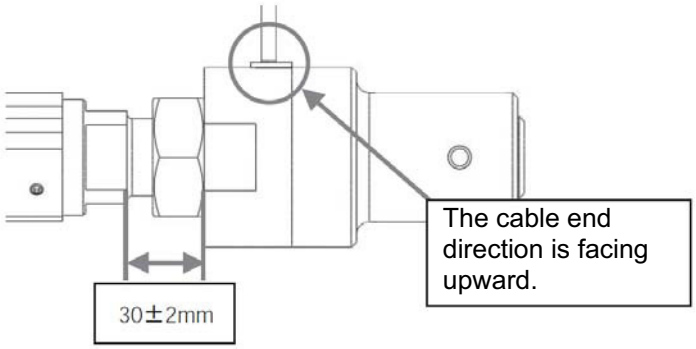
(1) Steps for Detaching
Be sure to cut off the power supply when performing this operation.

[1] First, remove the cable track. For information about cable track removal, refer to “5.3 Front Side Installation of the Load Cell Type (Optional).”
[2] Hold the width across flats of the flange with a tool to loosen the nut, and remove the load cell unit.



(2) Steps for Attaching

[1] Slowly screw in the load cell unit into the screw part at the end of the actuator. When the unit hits the bottom at 20 mm or so, loosen it until it reaches the position where the flange cable exit direction is facing upward. At this time, make sure that the dimensions of the flange end surface and width across flats of the actuator end screw part are set to 30 ±2 mm.



⚠ Caution: There is an electronic circuit board mounted in the loadcell unit, which is the precision instrument. Handle it with a special care and screw it in slowly.
Screwing it in forcefully may cause damage on the electronic circuit board.

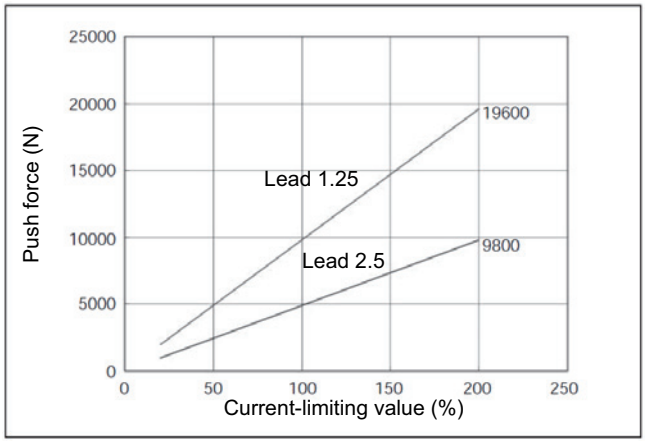
[2] Once the load cell unit position is determined, securely hold the width across flats of the flange and tighten a nut.
* Nut tightening torque: 340 N•m

[3] Finally, install the cable track. For information about cable track installation, refer to “5.3 Front Side Installation of the Load Cell Type (Optional).”

12. Relationship of Load and Weight

12.1 When the Load Cell Type (Optional) is Not Used

The push force to be applied during push-motion operation can be changed freely by changing the current-limiting value on the controller.
Specify the push force setting (%) based on the following graph as a guide line.



⚠ Caution: This diagram of push force and current-limiting value is provided as a reference.
Actual values may vary slightly from the diagram.
Keep the current-limiting value at 20% or above, because any lower setting may cause the push force to fluctuate.
The traveling speed is fixed to 10 mm/s during push-motion operation.
This diagram assumes a push speed of 10 mm/s. Take note that the push force may decrease when a different push speed is used.
Depending on the operating conditions, the push force may also decrease when the motor temperature rises.

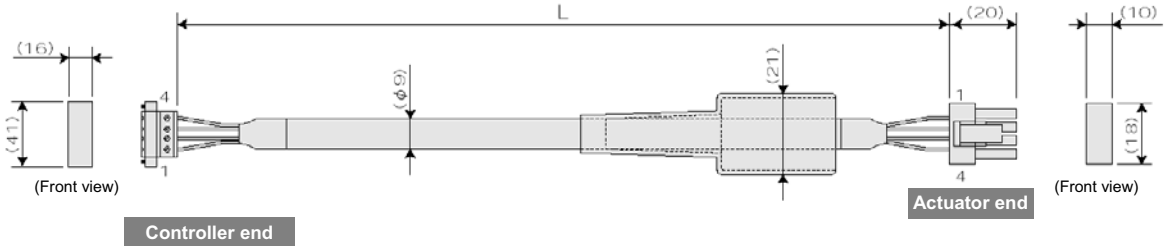
12.2 When Using the Load Cell Type (Optional)

When using the load cell type (optional), specify the push force as a percentage of the force control base thrust*1. Up to 200% can be specified.
The minimum setting is 20% for the 1.25 lead and 40% for the 2.5 lead.
(Example) 7350 N with a 2.5 lead at a setting of 150%
*1 Force control base thrust: Conversion thrust in a motor rated output during a force control
This is equivalent to a setting of 100% push force.

Lead	Force control base thrust [N]
1.25	9800
2.5	4900

13. Cable Drawings

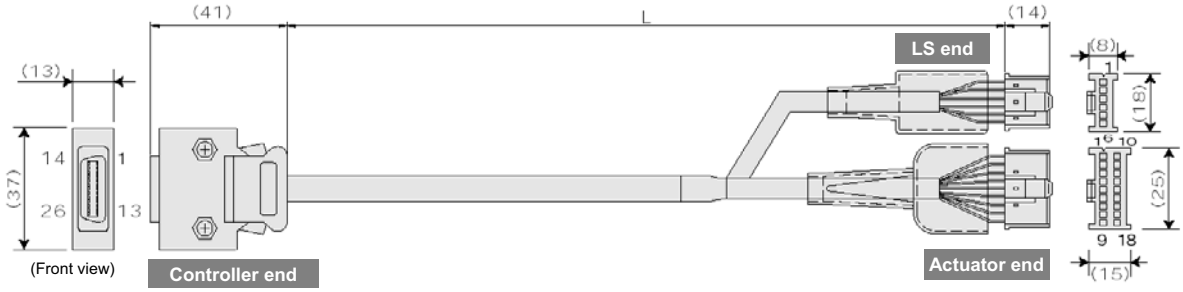
[1] Motor cable/motor robot cable
Model: CB-RCC-MA*** /CB-RCC-MA***-RB



Wire size	Color	Signal	No.
0.75sq	Green	PE	1
	Red	U	2
	White	V	3
	Black	W	4

No.	Signal	Color	Wire size
1	U	Red	0.75sq (crimped)
2	V	White	
3	W	Black	
4	PE	Green	

[2] Encoder cable/encoder robot cable
Model: CB-RCS2-PLA*** /CB-X2-PLA***



Wire size	Color	Signal	No.
AWG26 (soldered)	—	—	10
	—	—	11
	White/orange	E24V	12
	White/green	OV	13
	Brown/blue	LS	26
	Brown/yellow	CLEEP	25
	Brown/red	OT	24
	Brown/black	RSV	23
	—	—	9
	—	—	18
	—	—	19
	White/blue	A+	1
	White/yellow	A—	2
	White/red	B+	3
	White/black	B—	4
	White/purple	Z+	5
	White/gray	Z—	6
	Orange	SRD+	7
	Green	SRD—	8
	Purple	BAT+	14
	Gray	BAT—	15
	Red	VCC	16
	Black	GND	17
	Blue	BKR—	20
	Yellow	BKR+	21
	—	—	22

Clamp the shield to the hood.

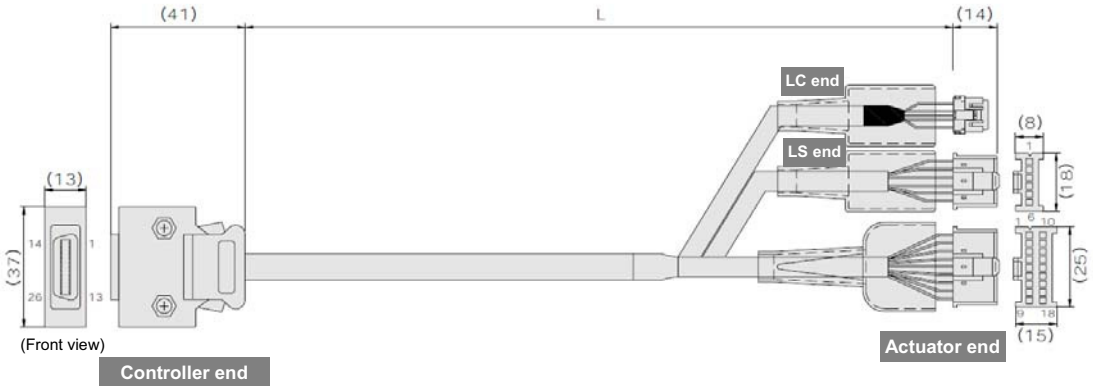
No.	Signal	Color	Wire size
1	E24V	White/blue	AWG26 (crimped)
2	OV	White/yellow	
3	LS	White/red	
4	CLEEP	White/black	
5	OT	White/purple	
6	RSV	White/gray	

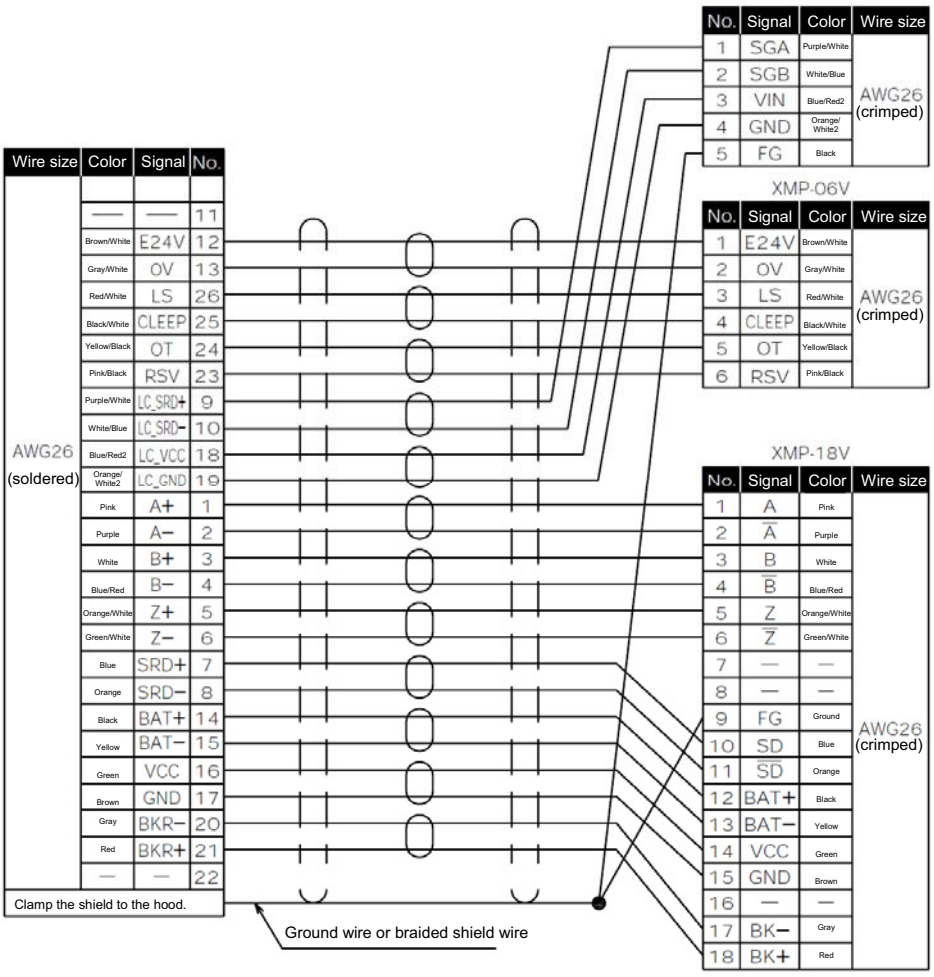
No.	Signal	Color	Wire size
1	A	White/blue	AWG26 (crimped)
2	A	White/yellow	
3	B	White/red	
4	B	White/black	
5	Z	White/purple	
6	Z	White/gray	
7	—	—	
8	—	—	
9	FG	Ground	
10	SD	Orange	
11	SD	Green	
12	BAT+	Purple	
13	BAT—	Gray	
14	VCC	Red	
15	GND	Black	
16	—	—	
17	BK—	Blue	
18	BK+	Yellow	

Ground wire or braided shield wire

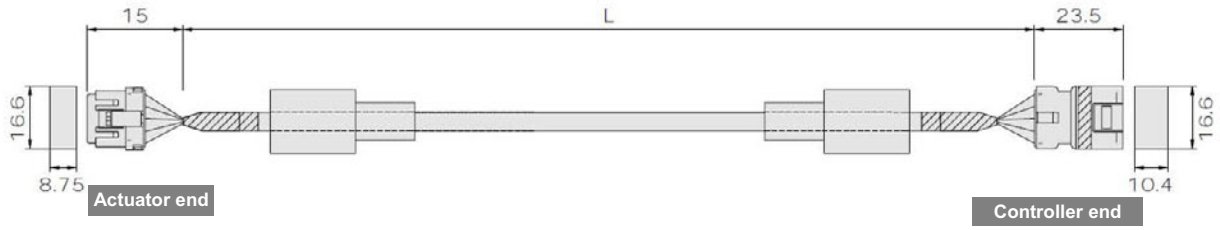
("White/blue" in the "Color" field indicates that the cable is white and the insulator is blue.)

[3] Use encoder cable / load cell type (optional)
Model number: CB-RCS2-PLLA*** /CB-RCS2-PLLA***-RB





[4] Use a cable inside the load cell bearer / load cell type (optional)
Model number: CB-LDC-CTL***

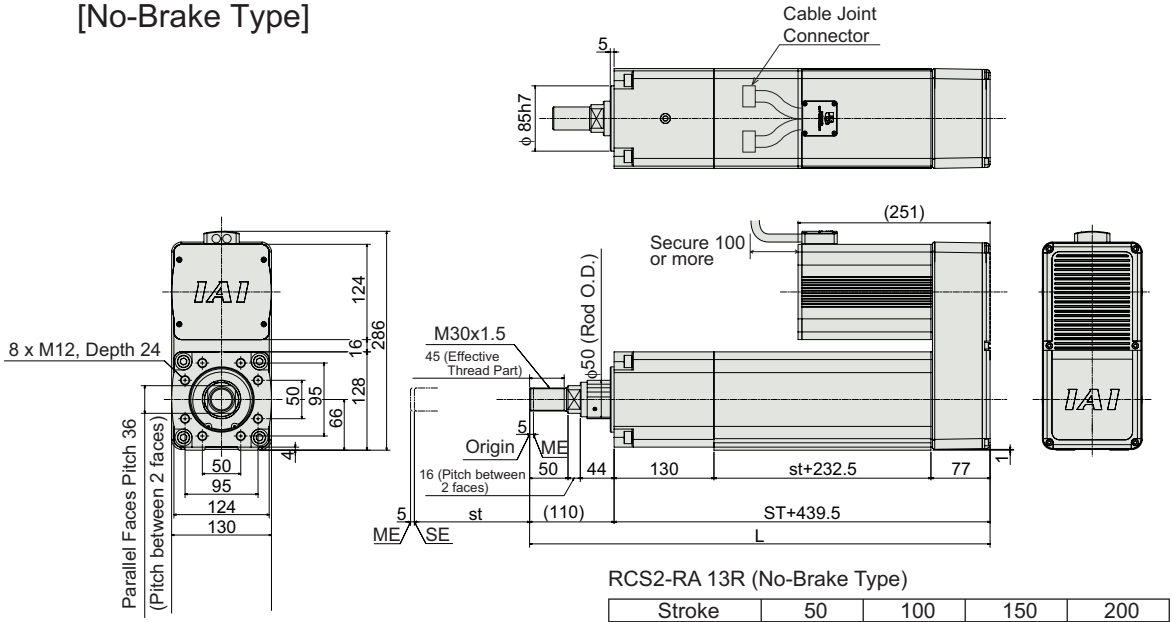


No.	Signal	Color
1	SGA	Blue
2	SGB	Orange
3	VIN	Green
4	GND	Brown
5	FG	Shield

No.	Signal	Color
1	SGA	Blue
2	SGB	Orange
3	VIN	Green
4	GND	Brown
5	FG	Shield

14. External Dimensions

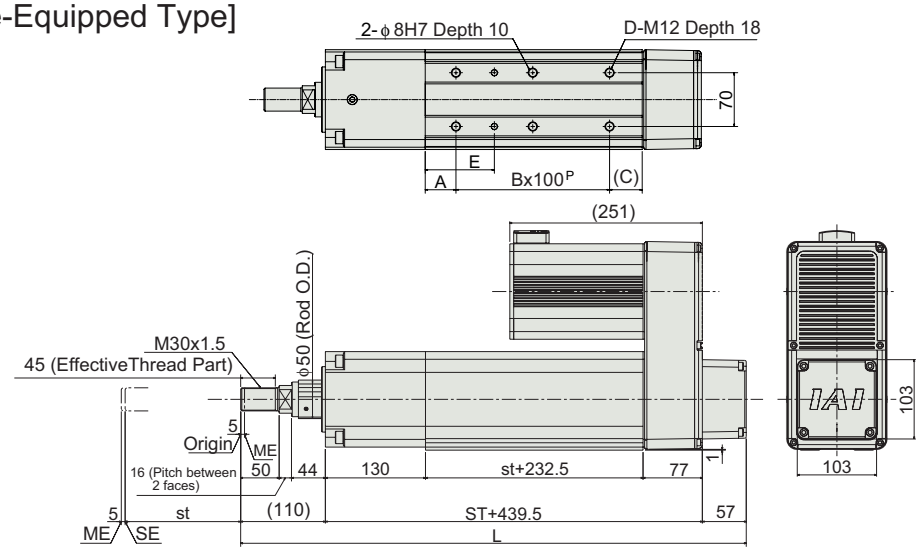
[No-Brake Type]



RCS2-RA 13R (No-Brake Type)

Stroke	50	100	150	200
L	599.5	649.5	699.5	749.5
A	40	65	40	65
B	2	2	3	3
C	42.5	67.5	42.5	67.5
D	6	6	8	8
E	90	116	90	115
Weight [kg]	33	34	35	36

[Brake-Equipped Type]



RCS2-RA 13R (Brake-Equipped Type)

Stroke	50	100	150	200
L	656.5	706.5	756.5	806.5
A	40	65	40	65
B	2	2	3	3
C	42.5	67.5	42.5	67.5
D	6	6	8	8
E	90	115	90	115
Weight [kg]	35	36	37	38

15. Warranty

15.1 Warranty Period

One of the following periods, whichever is shorter:
- 18 months after shipment from IAI
- 12 months after delivery to the location specified by the user
- 2,500 hours after start of operation

15.2 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.

15.3 Honoring the Warranty

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

15.4 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.

15.5 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.

15.6 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

16. Change History

Revision Date	Description of Revision
November 2011	Fourth edition — Contents changed in Safety Guide Caution notes added for when working with two or more persons Added the load cell type (optional) contents.
February 2012	Fifth edition — Table for Pg. 34 Lead 1.25 4900 → 9800 Lead 2.5 9800 → 4900
September 2012	Sixth edition — Additions and Changes made in Safety Guide contents International Standards Compliances added “14. External Dimensions” added in Pg. 38
November 2013	Seventh edition — Pg. 23 Note added to contact IAI for frequency reference of loadcell calibration Pg. 32 Steps divided into “Steps to Detach and Steps to Attach”

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