ROBO CYLINDER

RCP2
ROBO Cylinder Actuator
Belt-Drive Type
Operating Manual

BA6, BA6U, BA7, BA7U

First Edition

IAI
Quality and Innovation

IAI America, Inc.

Safety Precautions (Actuator)

Please read the information in “Safety Precautions” carefully before selecting a model and using the product.

The precautions described below are designed to help you use the product safely and avoid bodily injury and/or property damage.

Directions are classified as “danger,” “warning,” “caution” and “note,” according to the degree of risk.

⚠ Danger	Failure to observe the instruction will result in an imminent danger leading to death or serious injury.
⚠ Warning	Failure to observe the instruction may result in death or serious injury.
⚠ Caution	Failure to observe the instruction may result in injury or property damage.
ⓘ Note	The user should take heed of this information to ensure the proper use of the product, although failure to do so will not result in injury.

This product has been designed and manufactured as a component for use in general industrial machinery.

Devices must be selected and handled by a system designer, personnel in charge of the actual operation using the product or similar individual with sufficient knowledge and experience, who has read both the catalog and operation manual (particularly the “Safety Precautions” section). Mishandling of the product poses a risk.

Please read the operation manuals for all devices, including the main unit and controller.

It is the user’s responsibility to verify and determine the compatibility of this product with the user’s system, and to use them properly.

After reading the catalog, operation manual and other materials, be sure to keep them in a convenient place easily accessible to the personnel using this product.

When transferring or loaning this product to a third party, be sure to attach the catalog, operation manual and other materials in a conspicuous location on the product, so that the new owner or user can understand its safe and proper use.

The danger, warning and caution directions in this “Safety Precautions” do not cover every possible case. Please read the catalog and operation manual for the given device, particularly for descriptions unique to it, to ensure its safe and proper handling.

⚠ Danger

[General]

- Do not use this product for 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
  3. Important safety parts of machinery

  This product has not been planned or designed for applications requiring high levels of safety. Use of this product in such applications may jeopardize the safety of human life. The warranty covers only the product as it is delivered.

[Installation]

- Do not use this product in a place exposed to ignitable, inflammable or explosive substances. The product may ignite, burn or explode.
- When installing the product, be sure to securely support and affix it (including the work). Failure to do so may cause the product to tip over, drop or malfunction, resulting in injury.
- Avoid using the product in a place where the main unit or controller may come in contact with water or oil droplets.
- Never cut and/or reconnect the cables supplied with the product for the purpose of extending or shortening the cable length. Doing so may result in fire.

[Operation]

- Do not enter the machine's range of operation while the product is operating or standing by. The actuator may move suddenly, causing injury.
- If you are using a pace maker or other mechanical implant, do not come within one meter of the product. The strong magnetic field generated by the product may cause the pace maker, etc., to malfunction.
- Do not pour water onto the product. Spraying water over the product, washing it with water or using it in water may cause the product to malfunction, resulting in injury, electric shock, fire, etc.

[Maintenance, Inspection, Repair]

- Never modify the product. Unauthorized modification may cause the product to malfunction, resulting in injury, electric shock, fire, etc.
- Do not disassemble and reassemble the components relating to the basic structure of the product or its performance and function. Doing so may result in injury, electric shock, fire, etc.

⚠ Warning

[General]

- Do not use the product outside the specifications. Using the product outside the specifications may cause it to fail, stop functioning or sustain damage. It may also significantly reduce the service life of the product. In particular, observe the maximum loading capacity and speed.

[Installation]

- If the machine will stop in the case of system problem such as emergency stop or power failure, design a safety circuit or other device that will prevent equipment damage or injury.
- Be sure to provide Class D grounding for the controller and actuator (formerly Class 3 grounding: Grounding resistance at 100 Ω or less). Leakage current may cause electric shock or malfunction.
- Before supplying power to and operating the product, always check the operation area of the equipment to ensure safety. Supplying power to the product carelessly may cause electric shock or injury due to contact with the moving parts.
- Wire the product correctly by referring to the operation manual. Securely connect the cables and connectors so that they will not be disconnected or come loose. Failure to do so may cause the product to malfunction or cause fire.

[Operation]

- Before operating the moving parts of the product by hand (for the purpose of manual positioning, etc.), confirm that the servo is turned off (using the teaching pendant). Failure to observe this instruction may result in injury.
- The cables supplied with the product offer excellent flexibility, but they are not robot cables. If the cables are to be stored in a movable cable duct (cable bearer, etc.), use robot cables.
- Do not scratch the cables. Scratching, forcibly bending, pulling, winding, crushing with heavy object or pinching a cable may cause it to leak current or lose continuity, resulting in fire, electric shock, malfunction, etc.
- Turn off the power to the product in the event of power failure. Failure to do so may cause the product to suddenly start moving when the power is restored, thus resulting in injury or product damage.

- If the product is generating heat, smoke or a strange smell, turn off the power immediately. Continuing to use the product may result in product damage or fire.
- If noise or abnormally high vibration is detected, stop the operation immediately. Continuing to use the product may result in product damage, malfunction due to damage, runaway machine, etc.
- If any of the internal protective devices (alarms) of the product has actuated, turn off the power immediately. Continuing to use the product may result in product damage or injury due to malfunction. Once the power supply is cut off, investigate and remove the cause and then turn on the power again.
- Do not step on the product, use it as a footstool or place any object on it. You may lose your footing or the product may tip over, resulting in a fall and consequent injury, product damage, malfunction due to damage, runaway machine, etc.

[Maintenance, Inspection, Repair]

- Before conducting maintenance/inspection, parts replacement or other operations on the product, completely shut down the power supply. At this time, take the following measures:
  1. Display a sign that reads, “WORK IN PROGRESS. DO NOT TURN ON POWER” at a conspicuous place, in order to prevent a person other than the operator from accidentally turning on the power while the operation is working.
  2. When two or more operators are to perform maintenance/inspection together, always call out every time the power is turned on/off or an axis is moved in order to ensure safety.

[Disposal]

- Do not throw the product into fire. The product may burst or generate toxic gases.

⚠ Caution

[Installation]

- Do not use the product under direct sunlight (ultraviolet ray), in a place exposed to dust, salt or iron powder, in a humid place, or in an atmosphere of organic solvent, phosphate-ester machine oil, etc. The product may lose its function over a short period of time, or exhibit a sudden drop in performance or its service life may be significantly reduced.
- Do not use the product in an atmosphere of corrosive gases (sulfuric acid or hydrochloric acid). Rust may form and reduce the structural strength of the product.
- When using the product in any of the places specified below, provide a sufficient shield. Failure to do so may result in malfunction:
  1. Place where large current or high magnetic field is present
  2. Place where welding or other operations are performed that cause arc discharge
  3. Place subject to electrostatic noise
  4. Place with potential exposure to radiation
- Install the main unit and controller in a place subject to as little dust as possible. Installing them in a dusty place may result in malfunction.
- Do not install the product in a place subject to large vibration or impact (4.9 m/s^2 or more). Doing so may result in the malfunctioning of the product.
- Provide an emergency-stop device in a readily accessible position so the device can be actuated immediately upon occurrence of a dangerous situation during operation. Lack of such device in an appropriate position may result in injury.
- Provide sufficient maintenance space when installing the product. Routine inspection and maintenance cannot be performed without sufficient space, which will eventually cause the equipment to stop or the product to sustain damage.
- When transporting or installing the product, exercise due caution to prevent injury. For example, securely hold the product using a lift or support or engage multiple operators to carry the product.
- Do not hold the moving parts of the product or its cables during installation. It may result in injury.
- Always use IAI’s genuine cables for connection between the controller and the actuator. Also use IAI’s genuine products for the key component units such as the actuator, controller and teaching pendant.
- Before installing or adjusting the product or performing other operations on the product, display a sign that reads, “WORK IN PROGRESS. DO NOT TURN ON POWER.” If the power is turned on inadvertently, injury may result due to electric shock or sudden activation of an actuator.

[Operation]

- Turn on the power to individual equipment one by one, starting from the equipment at the highest level in the system hierarchy. Failure to do so may cause the product to start suddenly, resulting in injury or product damage.
- Do not insert a finger or object in the openings in the product. It may cause fire, electric shock or injury.
- Do not bring a floppy disk or other magnetic media within one meter of the product. The magnetic field generated by the magnet may destroy the data in the floppy disk, etc.
- Do not step on the product, use it as a footstool or place any object on it. It may cause scoring, dents or deformation of the driving part, resulting in product damage, unintended stopping due to damage, or performance drop.

[Maintenance, Inspection, Repair]

- Wear protective goggles when applying grease to the actuator. Failure to do so may result in eye inflammation due to spattered grease.

Note

[General]

- If you are planning to use the product under a condition or environment not specified in the catalogs or operation manual, or in an application requiring strict safety such as aircraft facility, combustion system, clean room, entertainment machine, safety device or other equipment having significant impact on human life or property, design operating ranges with ample margins from the ratings and design specifications or provide sufficient safety measures such as fail-safes. Whatever you do, always consult IAI's sales representatives.

[Installation]

- If the product is used in a vertical setup, be sure to use the vertical specification (with brake).
- Protection covers or other guards must be provided for the moving parts of the equipment to avoid direct contact with the operators.
- Do not configure a control circuit that will cause the work to drop in case of power failure. Configure a control circuit that will prevent the table or work from dropping when the power to the machine is cut off or an emergency stop is actuated.
- The following conditions must be met in order to improve the straightness of the table movement and ensure the smooth movement of the ball screw and linear guides:
  1. Flatness of the mounting surface must be within 0.05 mm.
  2. The mounting surface area must be large enough to ensure the rigidity of the actuator.

[Installation, Operation, Maintenance]

- When handling the product, wear protective gloves, protective goggles, safety shoes or other necessary gear to ensure safety.

[Maintenance, Inspection, Repair]

- When performing maintenance, apply the specified grease to the guides and ball screw. Pay special attention not to let fluoride grease mix with lithium grease. The machine may be damaged due to poor lubrication, increased resistance, etc.

[Disposal]

- When the product becomes no longer usable or necessary, dispose of it properly as an industrial waste.

Others

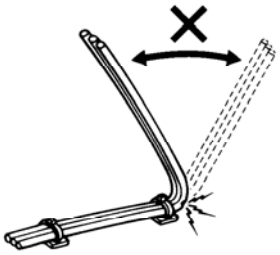
- IAI shall not be liable whatsoever for any loss or damage arising from a failure to observe the items specified in “Safety Precautions.”
- If you have any question regarding the product, please contact your nearest IAI sales office. The addresses and phone numbers of our sales offices are provided at the end of this operation manual.

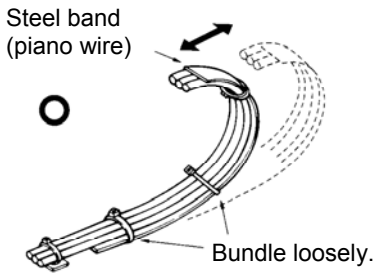
Prohibited Handling of Cables

When designing an application system using IAI's 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.

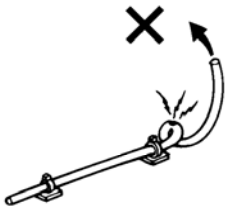
Ten Rules for Handling Cables (Must be Observed!)

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

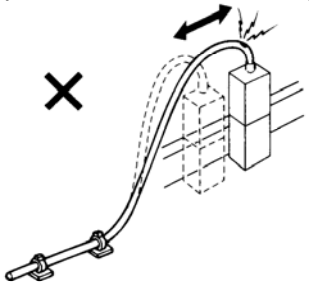




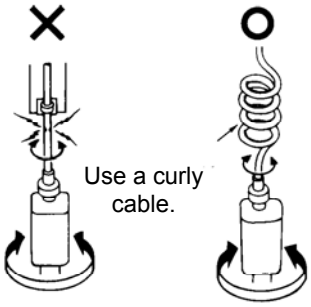
2. Do not let the cable bend, kink or twist.



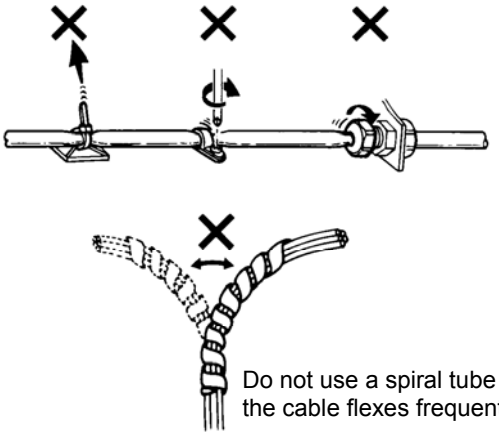
3. Do not pull the cable with a strong force.



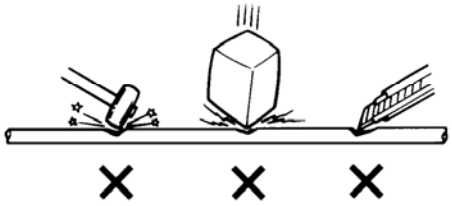
4. Do not let the cable receive a turning force at a single point.



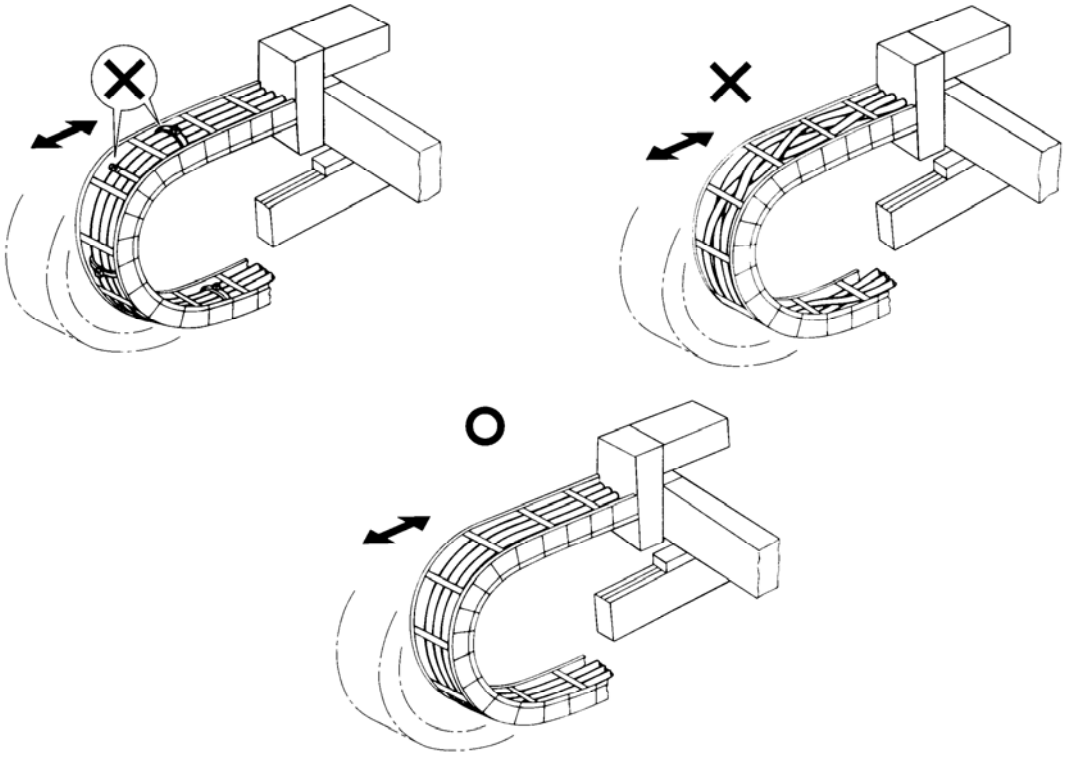
5. When fixing the cable, provide a moderate slack and do not tension it too tight.



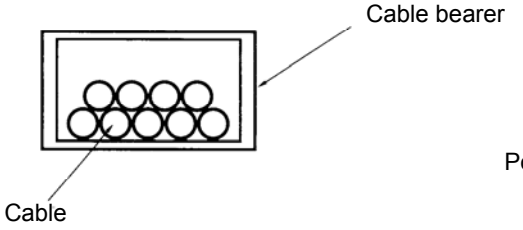
6. Do not pinch, drop a heavy object onto or cut the cable.



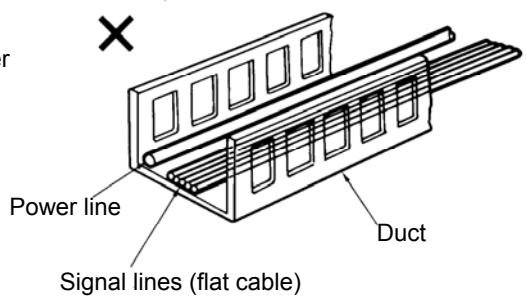
7. Do not let the cable get tangled or kinked in a cable bearer or flexible tube. When bundling the cable, keep a certain degree of flexibility (so that the cable will not become too taut when bent).



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

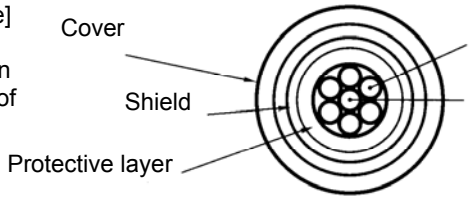


9. Do not lay signal lines together with circuit lines that create a strong electric field.



10. Always use a <u>robot cable</u> if the cable is likely to flex significantly.

[Standard structure of cable]
The standard structure of cable will vary depending on the manufacturer and type of cable.



★ Need for Robot Cables

A cable connected to a moving part of an actuator system will inevitably receive repeated bending loads at the base of the cable. As a result, the cores in the cable may break over time. To minimize the risk of cable breakage, we strongly recommend that a <u>robot cable</u> offering significantly higher flexibility be used in this type of application.

Caution:	The cable directly connected to the actuator is not robot cable even when ordered with robot cable option. When designing, please be sure not to give repeated bending loads to this cable. The robot cable is applicable only to the connecting cables.

Table of Contents

1. Foreword

Thank you for purchasing the ROBO Cylinder Actuator. This manual explains the structure, correct operation and maintenance of the ROBO Cylinder Actuator. Please read this manual carefully before using the actuator. For more complete information on operating the actuator, please refer to the controller operating manual.

2. Safety Precautions

2.1 Basic Operating Instructions

- Please do not attempt to use or operate the actuator in any manner not indicated in this manual or the controller manual.
- Please be sure to use only the cable provided by IAI to connect the actuator and controller.
- Please do not allow people within the moving range of the unit when it is in operation or when the power is ON since this is dangerous.

2.2 Maintenance and Inspection

- When doing maintenance and inspection work, always shut down the controller power first.
- When doing inspection, make sure that no one can inadvertently turn the power ON.
- Make sure that a sign indicating work in progress is clearly visible.
- If several persons are working, be sure to watch out for each other's safety. In particular, check before turning power ON or OFF and let others know if you are doing work involving axis movement.

(Note)
- The content of this manual is subject to change without notice for the purpose of improvement.
- This manual was created with utmost attention to accuracy. Should you find any error, however, or if you have any question, please contact IAI’s Sales Engineering or Technical Service Section.

3. Warranty

3.1 Warranty Period

Warranty period shall be either of the following periods whichever ends first:

- **18 months after shipment from our factory**
- **12 months after delivery to a specified location**
- **2500 hours of operation time**

3.2 Scope of Warranty

If a breakdown occurs within the period specified above and is due to the manufacturer's error, we will repair the unit at no cost. However, the following items are not covered by this warranty.

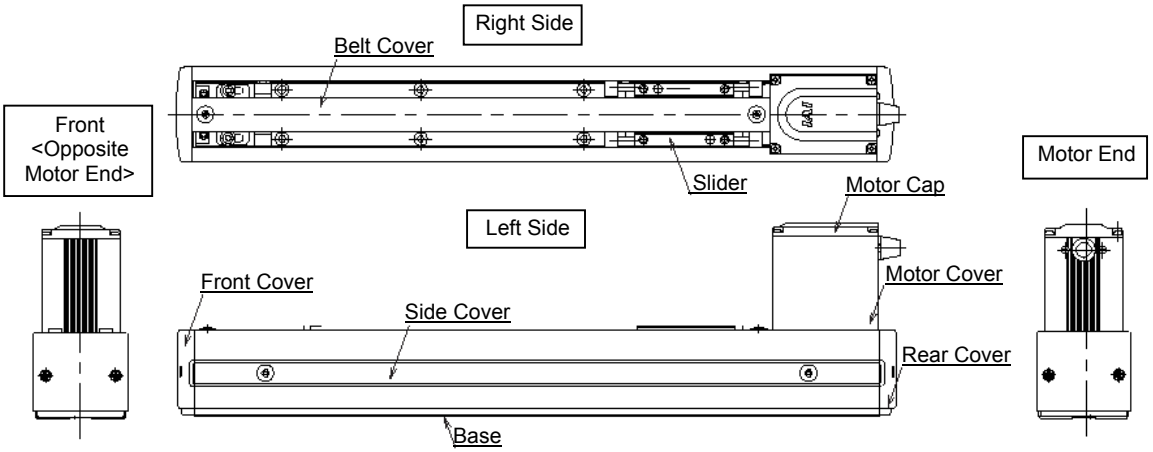
- Faded paint or other changes that occur naturally over time.
- Consumable components that wear out with use (timing belt, etc.).
- Unit seems to be noisy or similar impressions that do not affect machinery performance.
- Damage resulting from improper handling by the user or lack of proper maintenance.
- Any alterations made by other than IAI or its representatives.
- Breakdowns caused by using controllers made by other manufacturers.
- Any damages caused by fire and other natural disasters or accidents.

The warranty pertains to the purchased product itself and does not cover any damages that might arise from a breakdown of the supplied product.
Any repairs will be done at our factory. Even if the product is still covered under the warranty period, we will assess a separate charge for sending technicians to the customer's site.

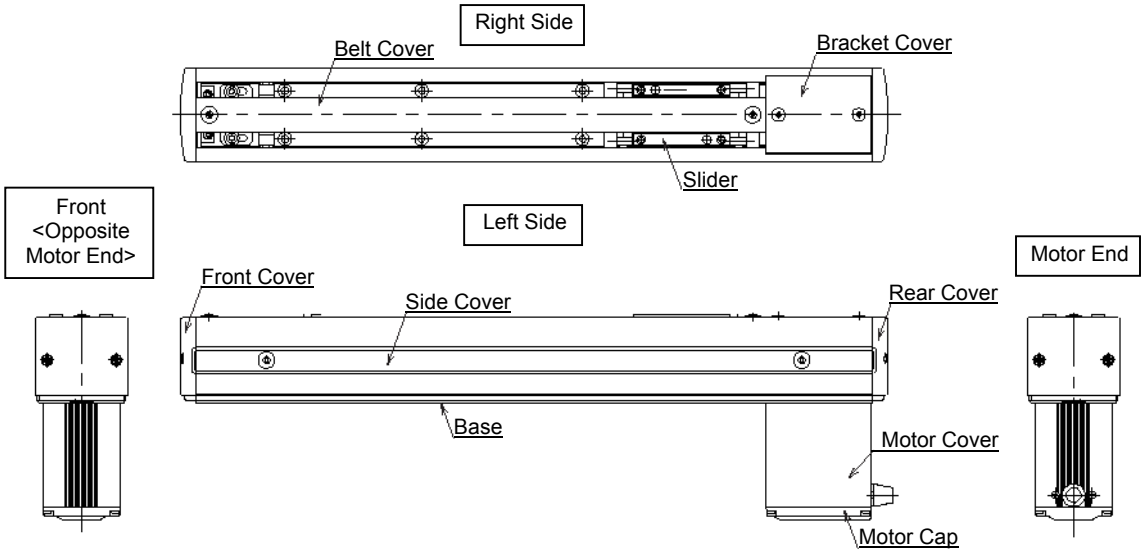
4. Names of the Parts

The left and right sides are indicated by looking at the actuator from the motor end with the actuator set down horizontally. Front end means the side opposite the motor end.

- BA6/BA7 (Motor on Top)



- BA6U/BA7U (Motor at Bottom)



5. Transporting and Handling

5.1 Handling the Actuator

Pay attention to the following instructions when transporting the actuator alone.

5.1.1 Handling the Packed Unit

Unless otherwise specified, each actuator (axis) is shipped individually.
Please take care that the shipping box is not dropped or subjected to strong impact during transport.

- The operator should not carry heavy shipping boxes by themselves.
- 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.

5.1.2 Handling the Actuator After It is Unpacked

Lift the actuator up by the base to remove it from the packing.

- When carrying the actuator, take care not to bump it. Take particular care with the front cover and motor cover.
- Do not exert excessive force on any part of the actuator.
- Be careful not to cause the cables to receive a tensile force.

* Please refer to Section 4 above for the names of the actuator parts.

5.2 Handling the Actuator Assembly

Pay attention to the following instructions when transporting an assembly of actuator axes.

5.2.1 Condition of Shipment from IAI (Assembled)

The actuators you have ordered are assembled at IAI, after which the assembly receives a shipping inspection and is shipped in an outer frame with skids.

The assembly is packed with the sliders securely affixed so that they will not move unexpectedly during transportation. In the case of a combined unit, the actuator ends are secured to prevent swinging due to external vibration.

- The package is not designed with special considerations for protection against impact due to dropping or collision, so please handle the package with care. Also, do not place any heavy object on the outer frame, as it is not strong enough to withstand loads.
- When suspending the package using ropes, etc., pass the ropes from underneath the reinforcement frames at the bottom of the skids. When lifting with a forklift, also place the forks underneath the skids.
- Set down the package carefully so as not to apply impact to the assembly or cause it to bounce.

After unpacking, handle the actuator assembly correctly by observing the instructions given below.

5.2.2 Handling after Assembly with Peripheral Equipment

When transporting the actuators that have been assembled with peripheral equipment either at IAI or on your site, observe the instructions given below.

- Secure each slider to prevent unexpected movement during transportation.
- If any actuator end is protruding, secure it to prevent swinging due to external vibration.
- If the actuator ends are not secured, do not apply any impact force exceeding 0.3 G during transportation.
- When suspending the actuator-assembled peripheral equipment using ropes, etc., make sure the ropes do not contact the actuators directly.
- Pass the ropes over appropriate cushion materials, and make sure the loads from the ropes will be received by the base of each actuator.
- Secure the end of the Y-axis using a separate rope to maintain the axis in a stable horizontal position. At this time, be careful not to apply loads on the screw cover.
- Be careful not to allow the brackets, covers and connector box of each actuator to receive loads. Also protect the cables from pinching or excessive deformation.

6. Operating and Storage Environment

6.1 Operating Environment

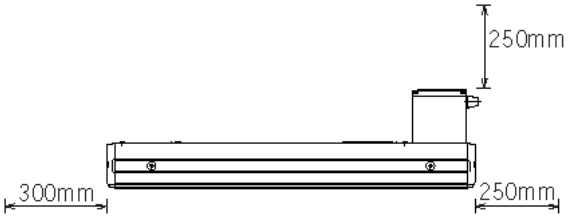
The actuator should be set up in an environment that meets the following criteria:

- Avoid direct sunlight.
- Avoid radiant heat from strong heat sources such as a furnace.
- Ambient 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 unit should not be subject to vibrations greater than 0.3 G.
- Avoid extreme electromagnetic waves, ultraviolet rays and radiation.
- This product is not intended to be used in a chemical environment.

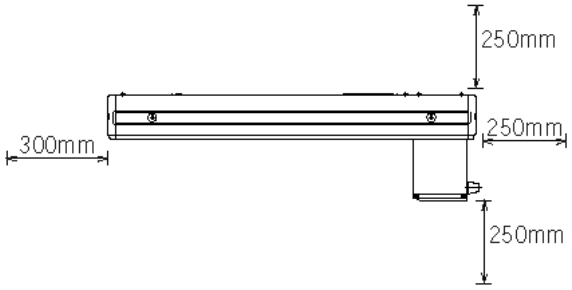
In general, the environment should be one in which an operator can work without protective gear.

Work space needed for maintenance/inspection

[Motor on Top]



[Motor at Bottom]



6.2 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.

7. Installation

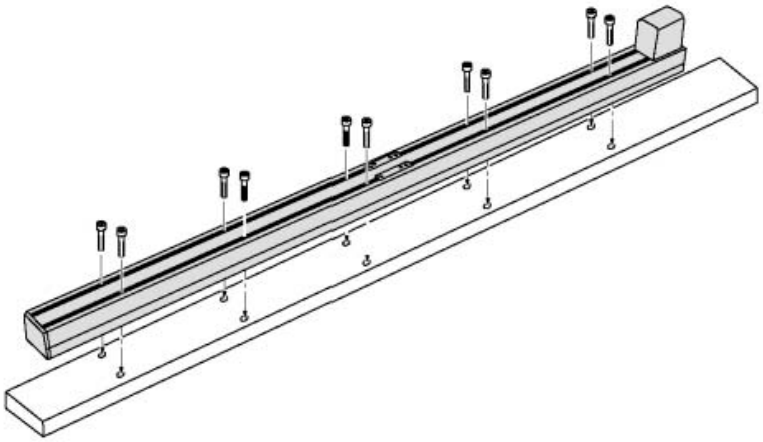
This chapter explains how to install the actuator in a single-axis setup.

7.1 Installing the Main Body

The actuator base has mounting holes. Affix the actuator with M4 hexagon socket-head bolts using these holes. Use of high strength bolts of ISO-10.9 or higher is recommended.

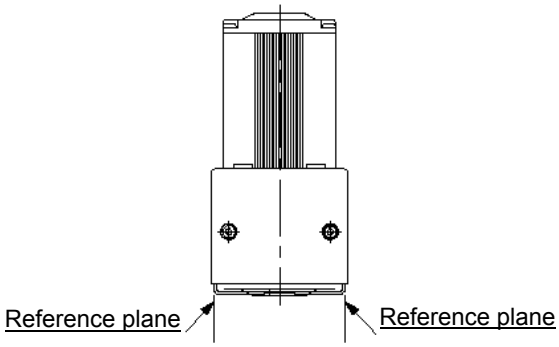
The length of mounting bolts varies depending on the material of the machine frame.
- Steel frame: M4 x 10
- Aluminum frame: M4 x 15

Tightening torque: 2.3 N·m (0.23 kgf·m)



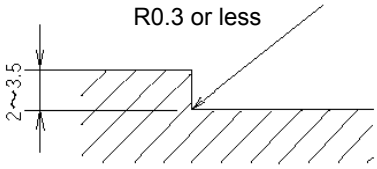
7.2 Mounting Surface

- The mounting table should have sufficient rigidity to suppress vibration.
- The surface where the actuator will be mounted should be machined or be equally level and the flatness tolerance between the actuator and the table should be within 0.05 mm.
- Provide enough space around the actuator to permit maintenance work to be done.
- The slider traveling plane is the reference plane for the actuator base and the lower surface. When traveling precision is required, use this as the reference plane for mounting.



Caution:	As shown above, the side faces of the base provide the reference planes for slider travel. When precision is required, use these surfaces as the reference planes for mounting.

When using the base as the reference planes for mounting the actuator to the machine frame, follow the machining dimensions shown below.



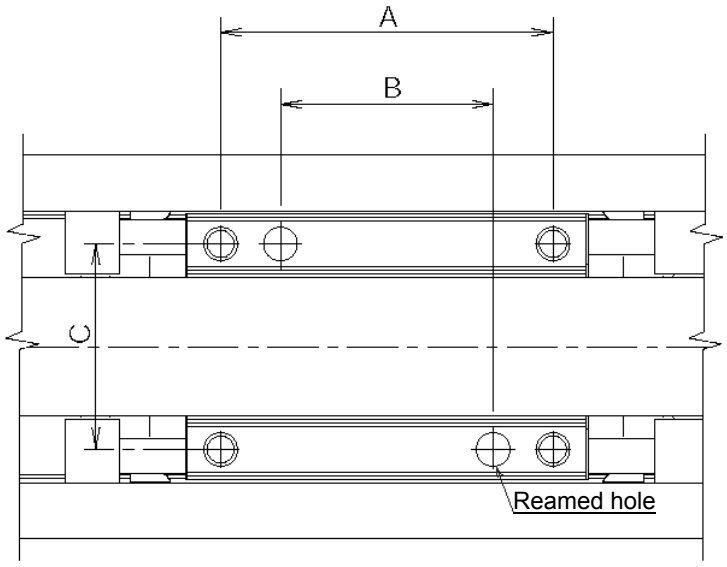
7.3 Installing the Load to the Slider

- Tapped holes are provided on the slider for installing the load.
- In case of moving actuator instead of slider, use the same tapped holes on the slider.
- Please use two reamed holes on the slider when repeatability of mounting and dismounting is required. When fine adjustment of the squareness is necessary, use only one reamed hole to allow adjustment.

Sizes and depths of tapped holes and reamed holes on slider

Model	Tap size	Depth of thread	A	B	C	Hole size	Hole depth
BA6/BA6U	M5	10 mm	50 mm	32 mm	31 mm	ϕ 5 H10	10 mm
BA7/BA7U	M5	10 mm	65 mm	47 mm	40 mm	ϕ 5 H10	10 mm

The tightening torque is as follows.
- When the bolt-bearing surface is steel: 7.5 N·m (0.77 kgf·m)
- When the bolt-bearing surface is aluminum: 4.3 N·m (0.44 kgf·m)



8. 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 cables supplied with the actuator offer excellent flexibility, but they are not robot cables. If the cables are to be stored in a movable cable duct (cable bearer, etc.), use robot cables.

For cable modification, please contact your IAI sales representative.

9. Load on the Actuator

- Do not exceed the load shown in the load specification column.
  Please make note of the slider moment, allowable overhang length and the load weight.

- The body of the base warps easily when the actuator is used as the Y-axis in an X-Y overhang setup.
  In this case, use the actuator so that the Ma and Mc moments are kept to one-half the allowable moment or less (see the figure below).

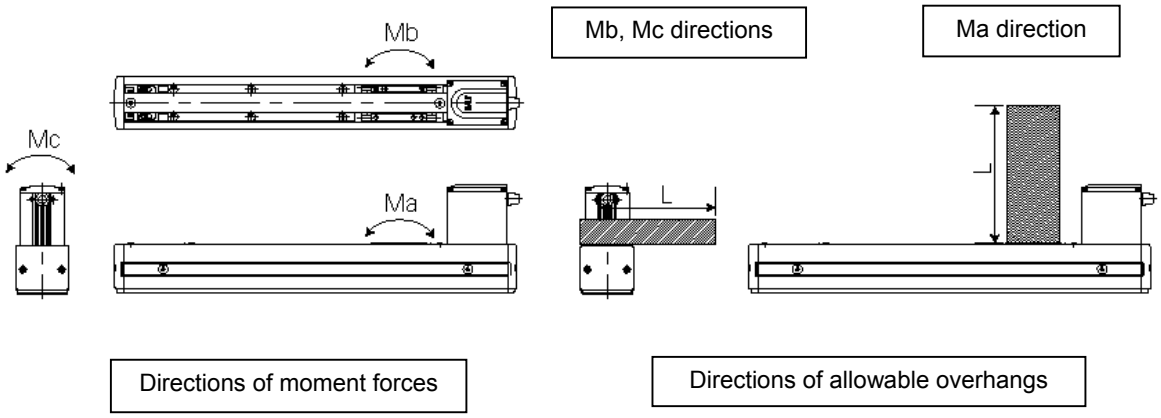
Allowable load moments

Model	Ma	Mb	Mc
BA6/BA6U	8.9 N·m (0.91 kgf·m)	12.7 N·m (1.29 kgf·m)	18.6 N·m (1.9 kgf·m)
BA7/BA7U	13.8 N·m (1.41 kgf·m)	19.7 N·m (2.01 kgf·m)	29.0 N·m (2.96 kgf·m)

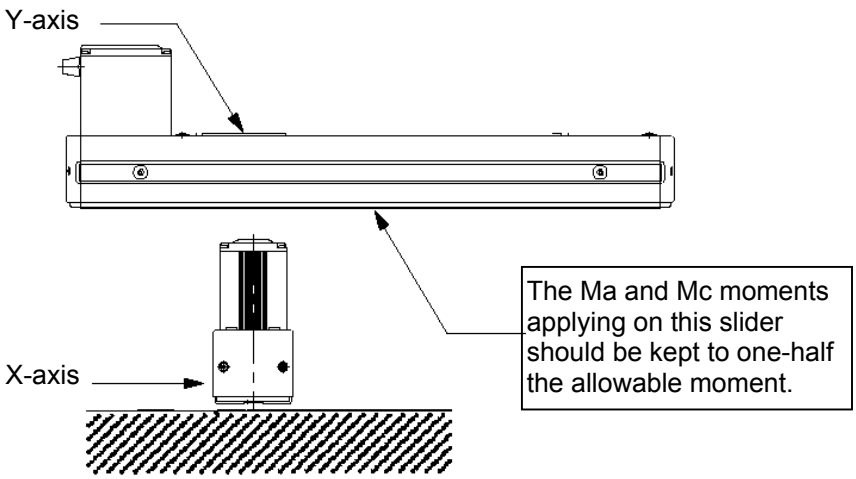
Allowable overhang lengths

Model	Ma direction	Mb direction	Mc direction
BA6/BA6U	150 mm or less	150 mm or less	150 mm or less
BA7/BA7U	150 mm or less	150 mm or less	150 mm or less

- The allowable overhang lengths are based on a configuration where the center of gravity of the load mounted on the actuator corresponds to the center of the overhang length.



Note) Allowing the actuator to receive an excessive load moment will shorten the service life of the guides. If the allowable overhang length is exceeded, vibration may generate or the service life of the guides may be reduced.


Y-axis
X-axis
The Ma and Mc moments applying on this slider should be kept to one-half the allowable moment.

10. Maintenance

10.1 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	Check interior	Grease supply	Belt loosening
Start of operation	○			
After 1 month of operation	○			
After 6 months of operation	○	○		
After 1 year of operation	○	○	○	○
Every 6 months thereafter	○			
Every 1 year	○	○	○	○

10.2 Visual Inspection of the Machine Exterior

Check the following items when carrying out visual inspection.

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

10.3 Cleaning

- Clean the exterior as needed.
- Wipe off dirt with a soft cloth.
- Do not use strong compressed air on the actuator as this may force dust into the crevices.
- Do not use petroleum-based solvent on plastic parts or painted surfaces.
- If the unit is badly soiled, apply a neutral detergent or alcohol to a soft cloth, and wipe gently.

10.4 Interior Inspection

After turning off the power, remove the side covers and belt cover to conduct visual checks.
Check the following items during interior inspection.

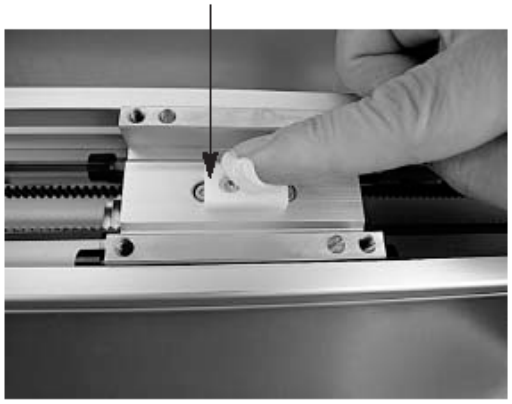
Body	Loose mounting bolts?
Guides	Lubrication appropriate? Soiling?
Drive belt	Scratches? Loose?
Backside of belt cover	Lubrication appropriate?

The side covers and belt cover can be removed using an Allen wrench of 2 mm across flats.

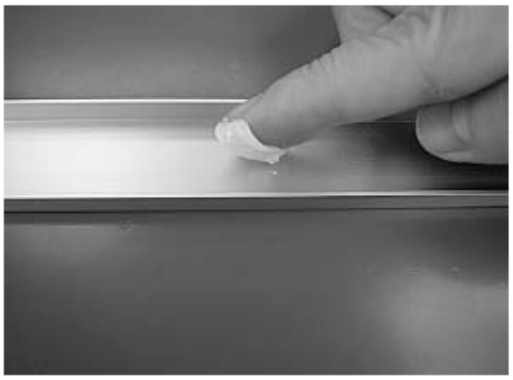
Make a visual check of the interior to see if there is any dust or foreign matter in the unit and also check the lubrication condition. Even if the grease you see around the parts is brown, the lubrication is fine as long as the traveling surface appears shiny.
If the grease becomes dirty and dull or if the grease has worn away due to extended operating time, lubricate the parts after cleaning them.
For details on how to check the drive belt, refer to the check items listed in 10.7.

- Checking the lubrication of the backside of the belt cover
  Check the lubrication condition of the backside of the belt cover and the belt-cover support (made of resin) at the center of the slider to make sure the frictional resistance between the slider and belt cover is minimized and the slider can move smoothly.
  If lubrication is not enough, apply grease.
  Grease: Kyodo Yushi's Multemp LRL3 or equivalent

Belt-cover support



Backside of belt cover



10.5 Internal Cleaning

- Wipe off dirt with a soft cloth.
- Do not use strong compressed air on the actuator as this may force dust into the crevices.
- Do not use petroleum-based solvent, neutral detergent or alcohol on the belt.

Caution:	Do not use flushing oil, molybdenum grease or anti-rust lubricant. When grease is soiled with large amounts of foreign substances, wipe off the dirty grease and then apply new grease.

10.6 Lubricating the Guides

10.6.1 What Grease to Use on the Guides

Lithium grease No. 2 is used on the guides.
The following grease is applied when we ship the unit.

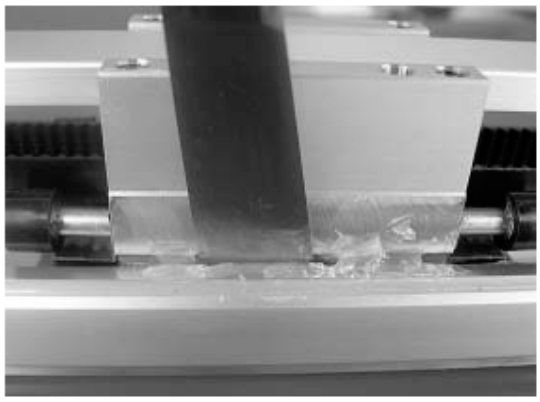
Idemitsu Kosan	Daphne Eponex Grease No.2

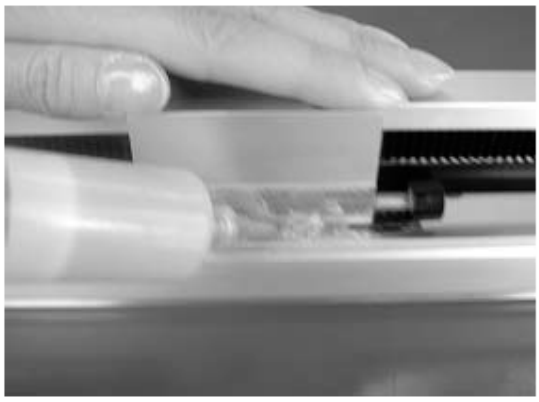
Other companies also sell a grease similar to this. If ordering from another maker, give the name of this product and request something comparable. Comparable products include the following:

Showa Shell Oil	Albania Grease No. 2
Mobil Oil	Mobilux 2

10.6.2 How to Apply Grease

1) Remove the side covers on both sides.
2) When greasing the guide, use a spatula or grease applicator to squeeze or inject grease into the space between the slider and base, and then move the slider back and forth several times to let the grease spread evenly. Remove excess grease.





3) Follow the same steps to apply grease on the other guide.
4) Install the side covers.

10.7 Drive Belt

10.7.1 Inspecting the Belt

Remove the side covers and visually inspect the belt.
Durability of the drive belt is affected significantly by the operating condition, and there is no standard guideline as to when the belt should be replaced.
Generally, the belt is designed to withstand several million cycles of flexing loads.
As a practical guideline, replace the drive belt when any of the conditions listed below is observed:

- The teeth and end faces of the belt have worn significantly.
- The belt has swollen due to deposits of oil, etc.
- Cracks and other damages are found on the teeth or back of the belt.
- The belt has broken.

10.7.2 Applicable Belt

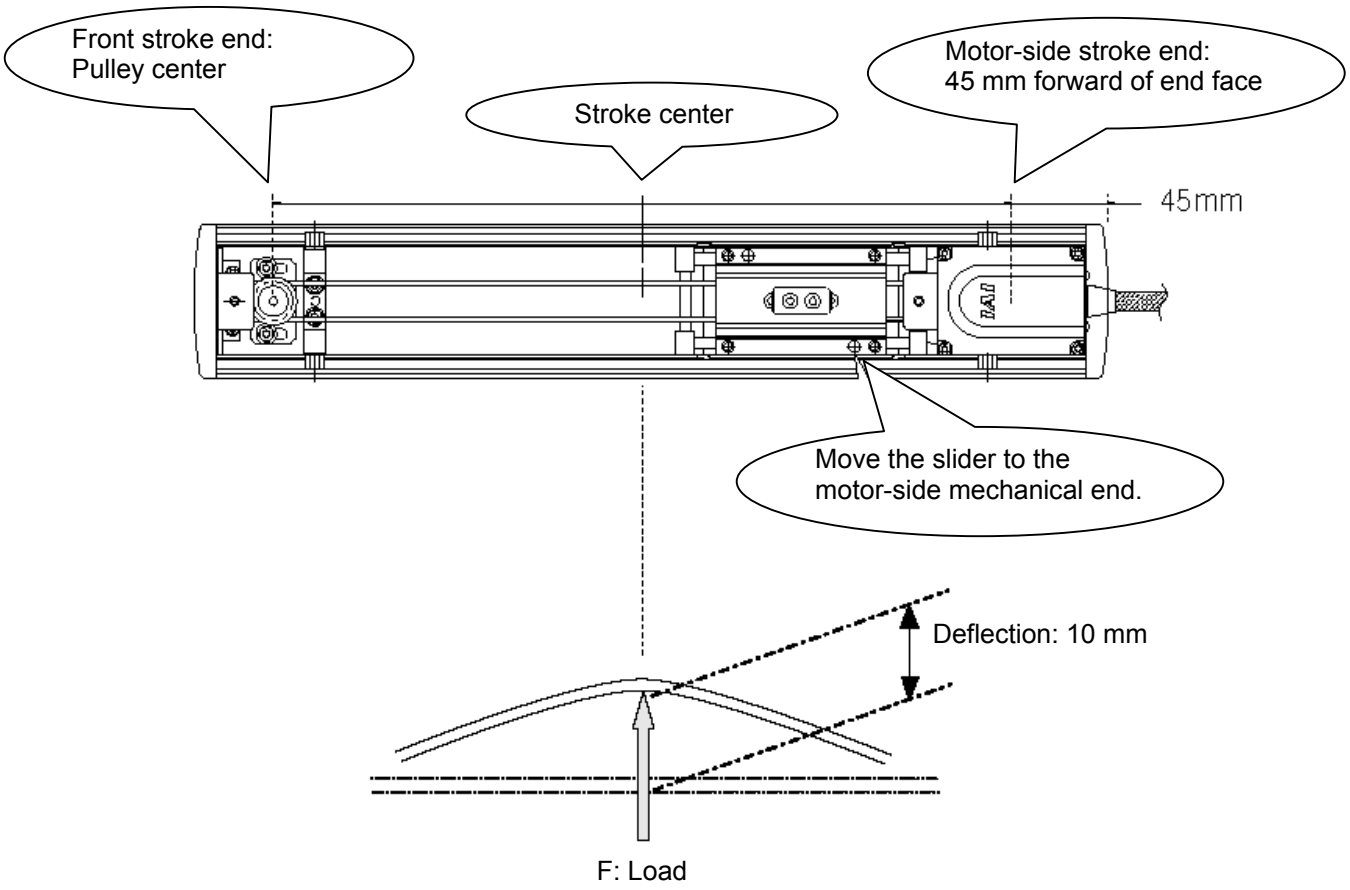
Manufacturer:	Mitsuboshi Belting	
Model number, material:	Long Belt OTG100S3M, 10 mm wide:	Urethane specification

10.7.3 Checking and Adjusting the Belt Tension

[Checking the Tension]
As a guideline, belt tension is evaluated by the load needed to deflect the belt by 10 mm when the belt is pushed near the stroke center.
The table below lists the appropriate loads needed to achieve a 10-mm deflection on each belt used at different strokes.
If the measured load is less than the applicable value by approx. 20% or more, the belt is loose and its tension must be adjusted.

Appropriate loads to achieve 10-mm deflection

Model	**Top: Stroke (mm)** **Bottom: Load (kgf)**												
BA6 BA6U	500	550	600	650	700	750	800	850	900	950	1000	–	–
	0.32	0.31	0.31	0.30	0.35	0.35	0.34	0.34	0.40	0.40	0.39	–	–
BA7 BA7U	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200
	0.37	0.36	0.35	0.35	0.41	0.40	0.40	0.39	0.39	0.45	0.45	0.44	0.44



[Adjusting the Tension]
Adjust the tension using the affixing bolts in the pulley bracket on the counter-motor side.

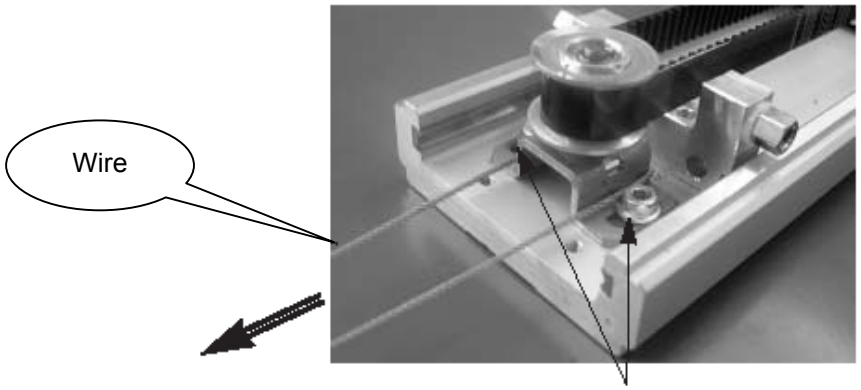
[1] Move the slider to the motor-side mechanical end.

[2] Loosen the affixing bolts (using an Allen wrench of 3 mm across flats).

[3] Guide a wire around the bracket and pull the wire uniformly from both ends using tension gauges.

[4] With the wire pulled to a specified tension from both ends, tighten the affixing bolts carefully by making sure the bracket does not deform. The appropriate tension varies depending on the stroke.

Model	Tension		
BA6 / BA6U	Stroke: 500 to 650 mm	Stroke: 700 to 850 mm	Stroke: 900 to 1000 mm
	6 kgf	8 kgf	10 kgf
BA7 / BA7U	Stroke: 600 to 750 mm	Stroke: 800 to 950 mm	Stroke: 1000 to 1200 mm
	8 kgf	10 kgf	12 kgf



Pull both ends uniformly using tension gauges by making sure the pulley bracket does not deform.

M4 hexagon socket-head bolts for adjustment
Tightening torque: 360 N·cm (36.7 kgf·cm)

(Note) The user must provide an appropriate wire available on the market.

10.7.4 Replacing the Belt

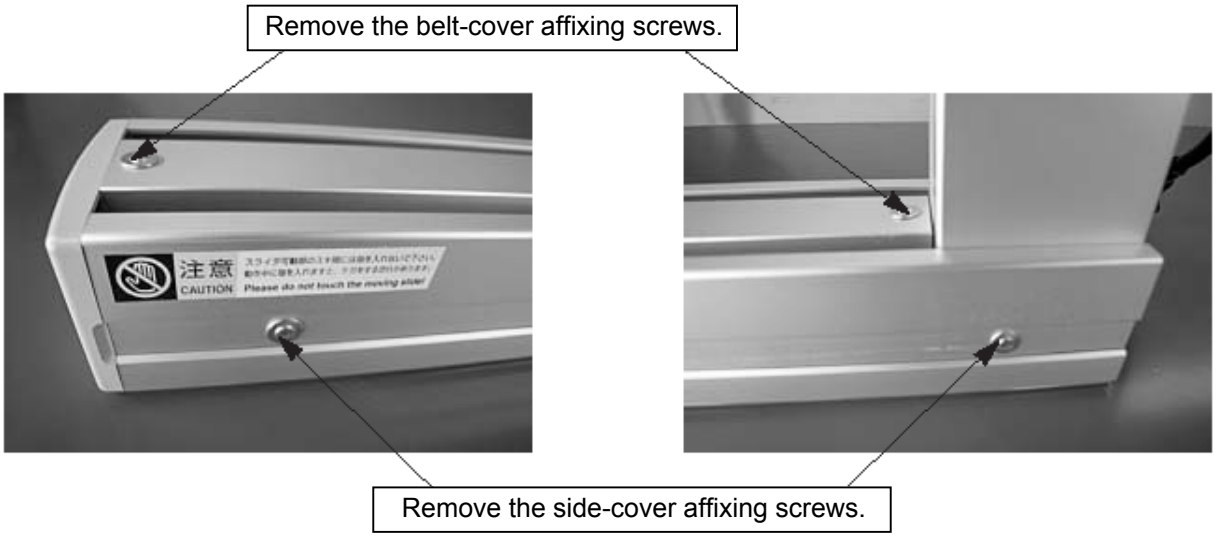
[Items Required for Replacement]

- Replacement drive belt
- Tension adjustment wire (provide a commercially available wire like the one shown in the photograph at right)
- Phillips screwdriver set and Allen wrench set
- Tension gauge (capable of applying a tensile load of 12 kgf or more)
- Grease (Kyodo Yushi's Multemp LRL3 or equivalent)

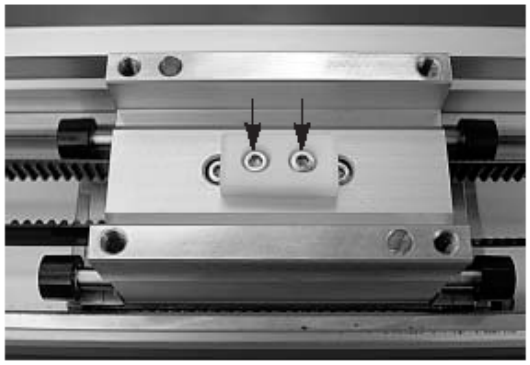
[Procedure]

1) Remove the load from the slider.
2) Remove the belt cover and one of the side covers (using an Allen wrench of 2 mm across flats).

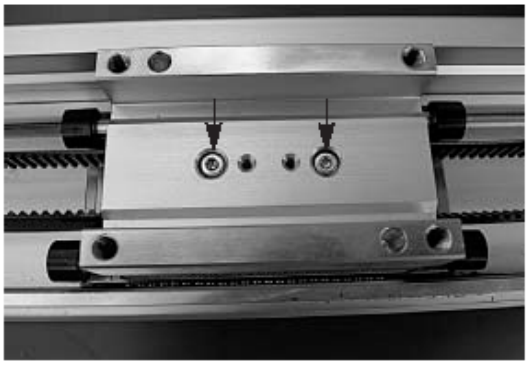
[Counter-motor side] [Motor side]



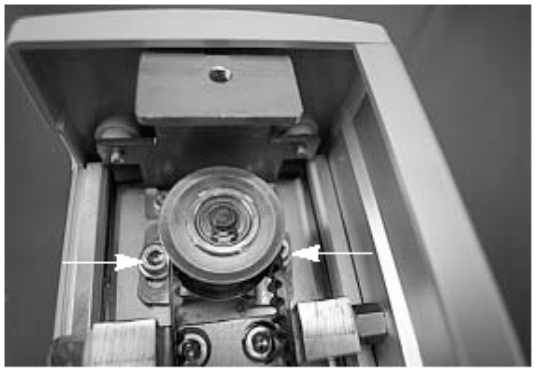
3) Remove the belt-cover support (resin) (using an Allen wrench of 2.5 mm across flats). Wipe off grease attached on the support.



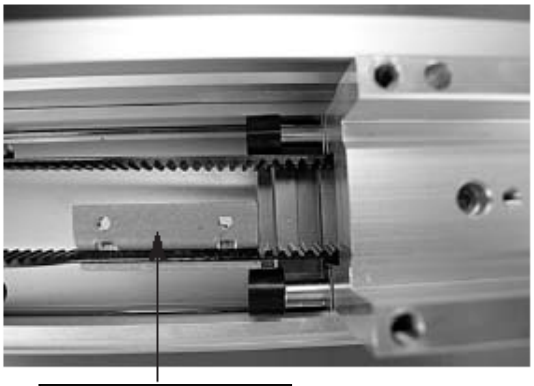
4) Remove the belt-holder affixing bolts (using an Allen wrench of 2.5 mm across flats).



5) Loosen the tension adjustment bolts (using an Allen wrench of 3 mm across flats). If the bolts are not readily accessible, remove the other side cover.

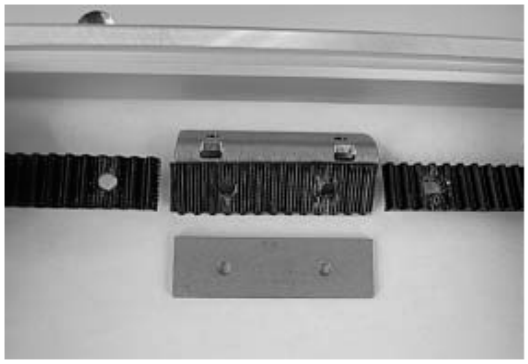


6) Move the slider to expose the belt holder.

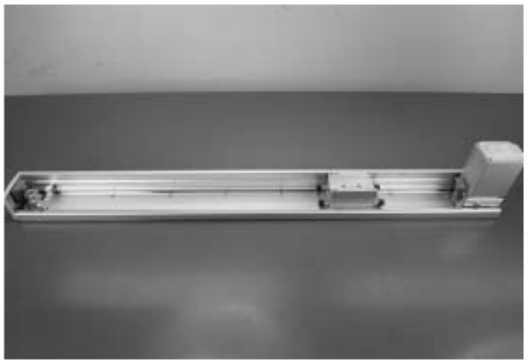


7) Separate the belt and pull it out of the actuator.
[1] Remove the belt-affixing bolts (using an Allen wrench of 2.5 mm across flats).

[2] Removed belt



[3] Actuator without belt



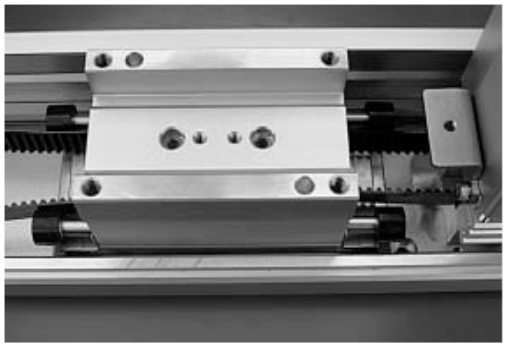
8) Remove the rear cover (using an Allen wrench of 2.5 mm across flats).

9) Remove the front-cover affixing bracket (using an Allen wrench of 2.5 mm across flats).

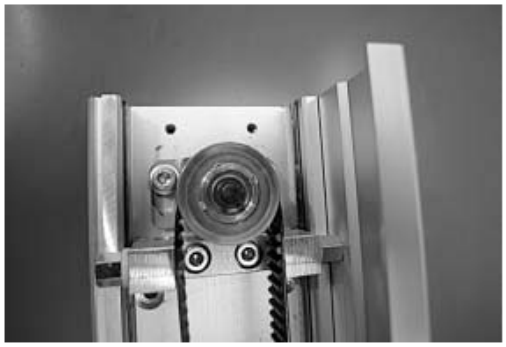
10) Install a new belt by guiding it around the pulleys.

[1] Insert the belt from the spaces provided on both sides of the motor-side pulley.

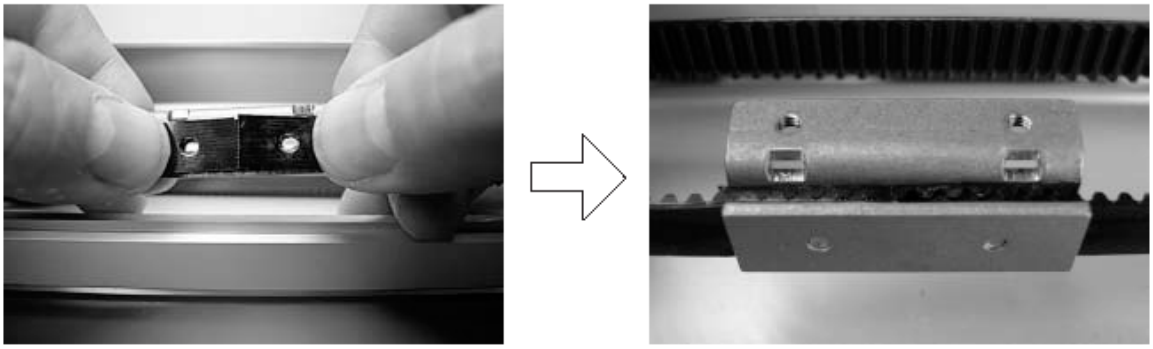
[2] Guide the belt through the slider.



[3] Guide the belt around the counter-motor side pulley (front side).

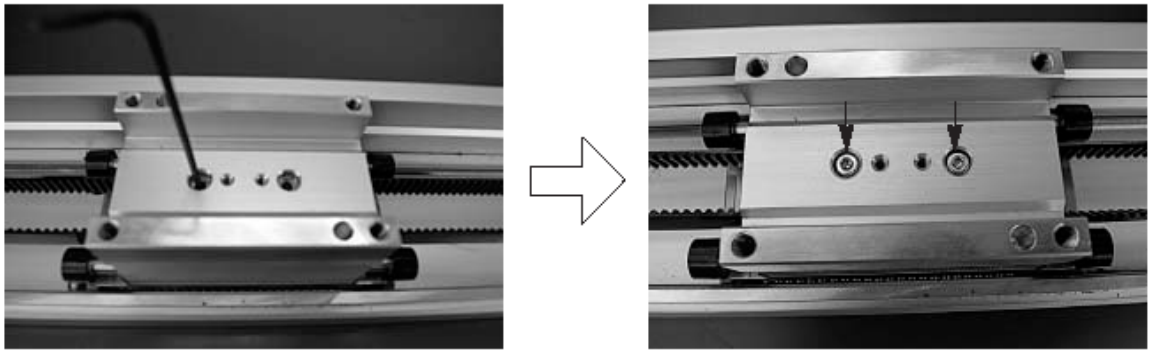


11) Affix the belt to the belt holder.
Align the belt teeth on the belt holder with the teeth on the drive belt, and tighten the bolts (M3 x 6).



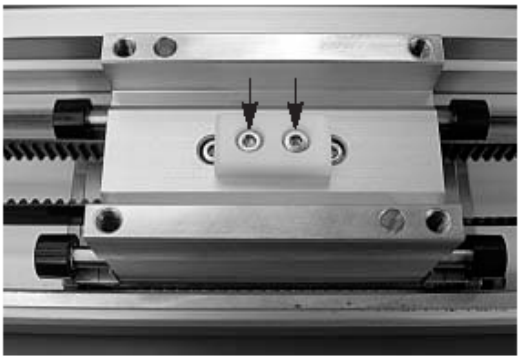
Tightening torque: 154 N·cm (15.7 kgf·cm)

12) Move the slider to a position where it aligns with the mounting holes in the belt holder, and tighten the bolts (BA6: M3 x 6 / BA7: M3 x 12).



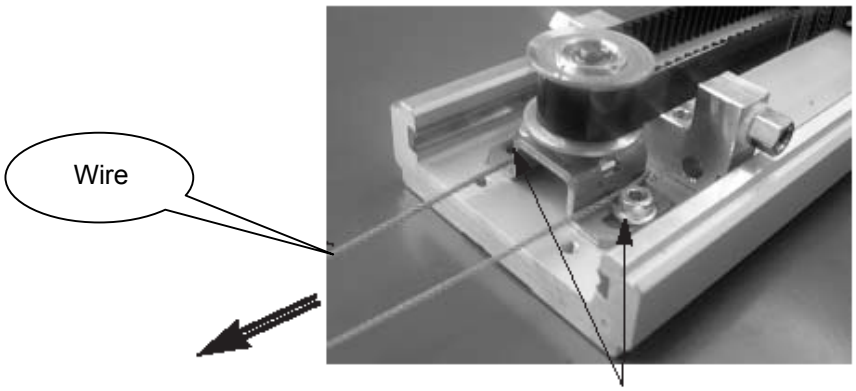
Tightening torque: 83 N·cm (8.5 kgf·cm)

13) Affix the belt-cover support (resin) using the bolts (M3 x 6).



14) Adjust the belt to the specified tension.
Move the slider to the motor-side mechanical end, guide a wire around the counter-motor side pulley bracket, and then pull the wire uniformly from both ends using tension gauges.
With the wire pulled to a specified tension from both ends, tighten the adjustment bolts.
(Refer to the table below to find the tension appropriate for your actuator and the stroke.)
When the tension has been adjusted, remove the wire.

Model	Tension		
BA6 / BA6U	Stroke: 500 to 650 mm	Stroke: 700 to 850 mm	Stroke: 900 to 1000 mm
	6 kgf	8 kgf	10 kgf
BA7 / BA7U	Stroke: 600 to 750 mm	Stroke: 800 to 950 mm	Stroke: 1000 to 1200 mm
	8 kgf	10 kgf	12 kgf

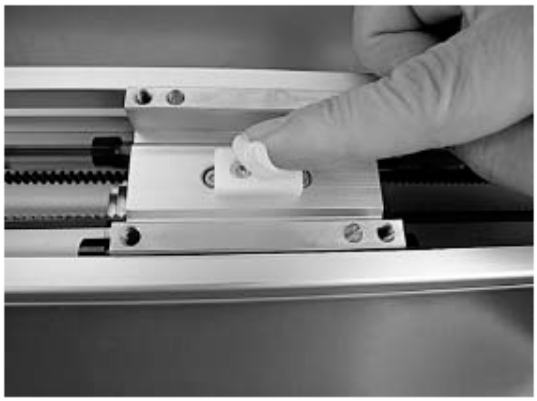


Pull both ends uniformly using tension gauges by making sure the pulley bracket does not deform.

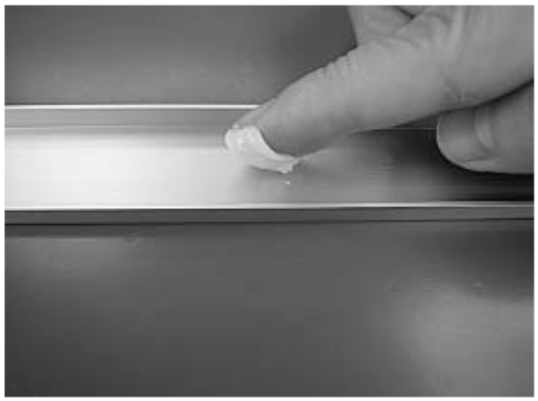
M4 hexagon socket-head bolts for adjustment
Tightening torque: 360 N·cm (36.7 kgf·cm)

15) Apply grease on the belt-cover support and the backside of the belt cover.
Grease: Kyodo Yushi's Multemp LRL3 or equivalent

[Belt-cover support]

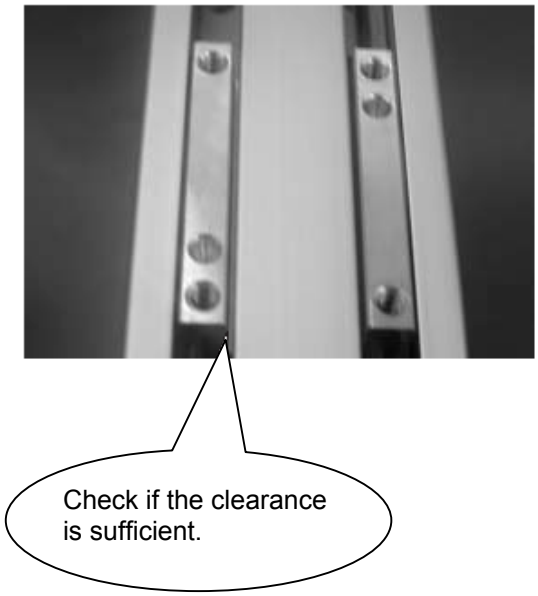


[Backside of side cover]



16) Install the side cover (thin-head screw M4 x 6, 2 pcs), front cover (hexagon socket-head bolt M3 x 8, 2 pcs) and rear cover (hexagon socket-head bolt M3 x 8, 2 pcs).
If the motor is installed at the bottom of the actuator, also install the bracket cover (thin-head screw M3 x 4, 2 pcs).

17) Install the belt cover using the thin-head screws (M4 x 6, 2 pcs). Move the slider back and forth over the entire stroke to make sure it does not contact the belt cover.



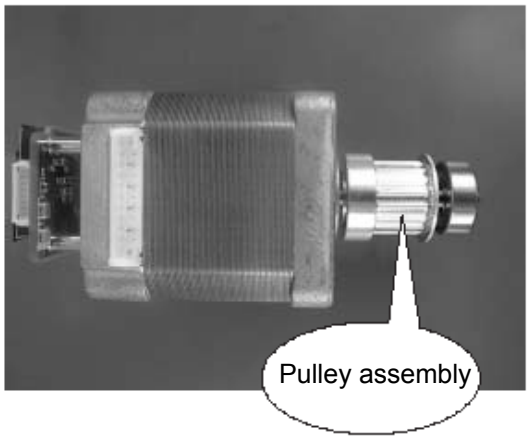
10.8 Replacing the Motor

10.8.1 BA6/BA7 (Motor on Top)

[Items Required for Replacement]

- Replacement motor (with the motor shaft preassembled with a pulley assembly: see photograph [1])
- Tension adjustment wire (provide a commercially available wire like the one shown in photograph [2])
- Phillips screwdriver set and Allen wrench set
- Tension gauge (capable of applying a tensile load of 12 kgf or more)
- Grease (Kyodo Yushi's Multemp LRL3 or equivalent)

[Photograph [1]]

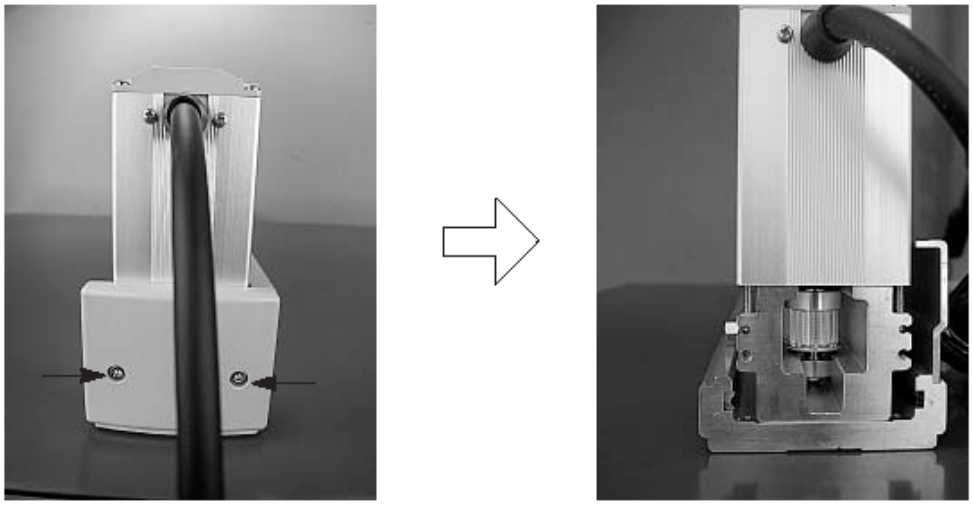


[Photograph [2]]

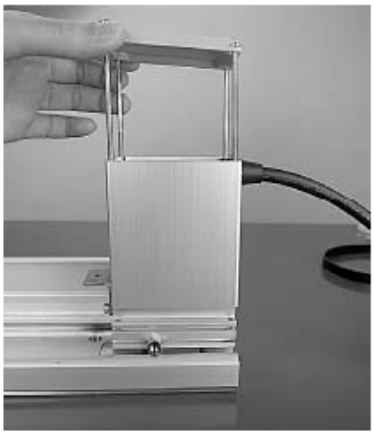
[Procedure]

1) First, remove the drive belt.
   Remove the load from the slider and follow steps 1) to 7) in 10.7.4, "Replacing the Belt," to remove the belt.

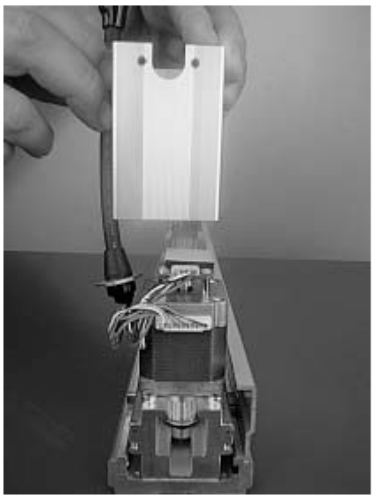
2) Remove the rear cover
   (using an Allen wrench of 2.5 mm across flats).



3) Loosen the four pan-head screws affixing the motor cap, and pull out the motor cap.

4) Remove the two pan-head screws affixing the cable-mounting plate, and separate the plate from the motor cover.

5) Pull out the encoder connector.

6) Pull out the motor connector.

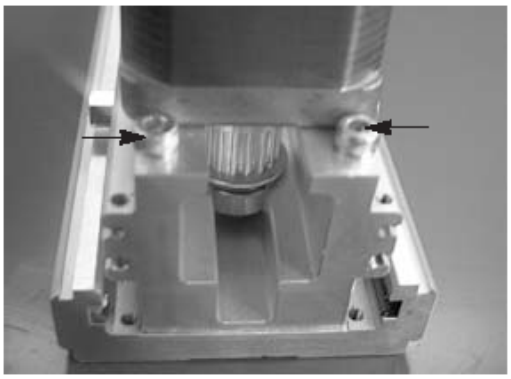
Caution:	When applying the force, do not touch the encoder directly.

7) Remove the other side cover.

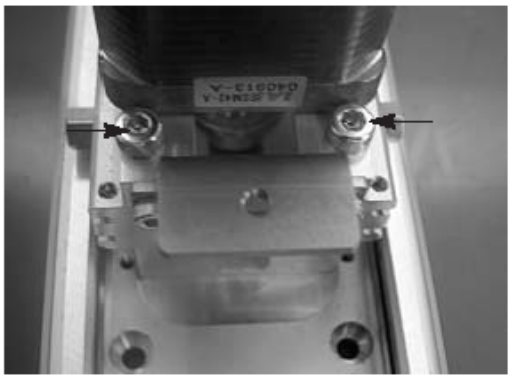
8) Remove the motor bracket.

[1] Remove the affixing bolts (M4 x 45, 4 pcs) using an Allen wrench of 3 mm across flats.

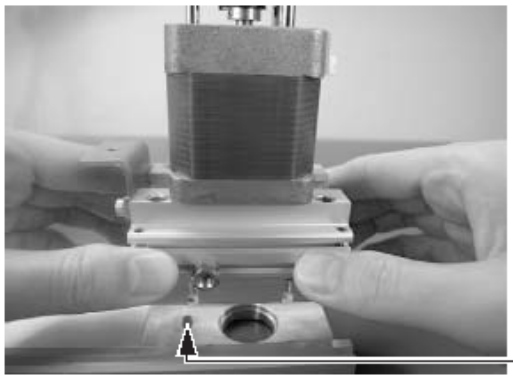
[Rear-cover side]



[Slider side]



[2] Pull out the motor bracket by hand.

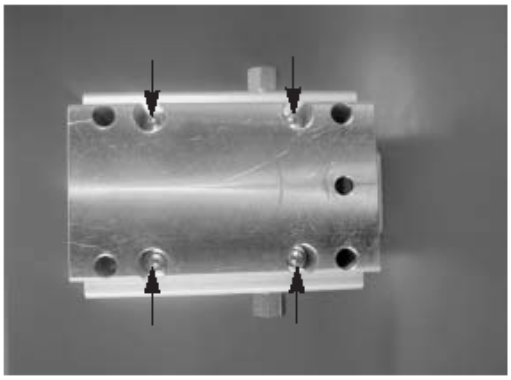


Caution: A parallel pin is pressed into the base. If the motor bracket does not come off easily, slowly turn the motor bracket by hand and pull it out.

Parallel pin

9) Remove the motor from the motor bracket.

- Remove the affixing bolts (M3 x 28, 4 pcs) using an Allen wrench of 2.5 mm across flats.



- After the motor has been removed

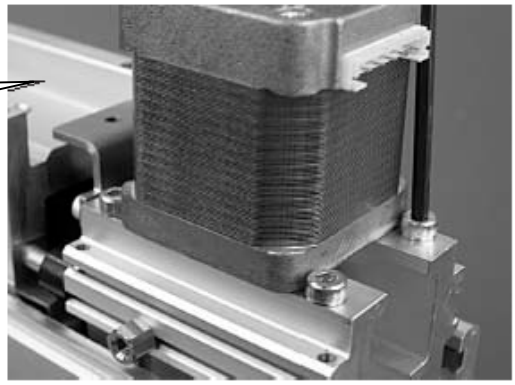
10) Install a new motor to the motor bracket.

When installing the motor, be careful not to damage the bearing at the tip of the motor shaft.

Tightening torque: 90 N·cm (9.2 kgf·cm)

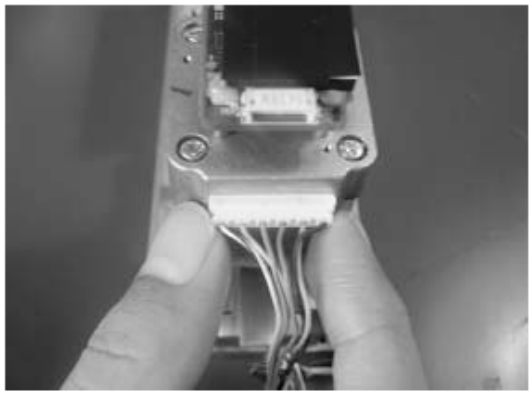
11) Affix the motor bracket on the base.
Tighten the affixing bolts (M4 x 45, 4 pcs) using an Allen wrench of 3 mm across flats.

Securely tighten the bolts with the slider firmly pressed against the motor bracket.

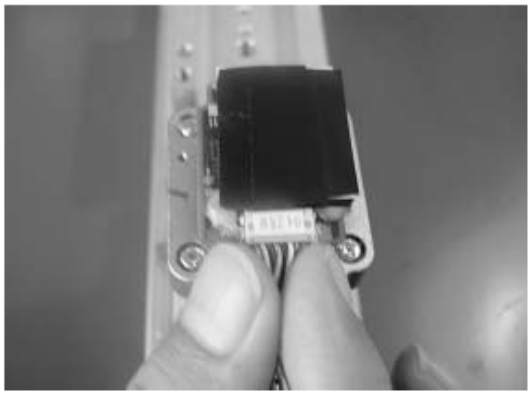


Tightening torque: 176 N·cm (18 kgf·cm)

12) Plug in the motor connector.

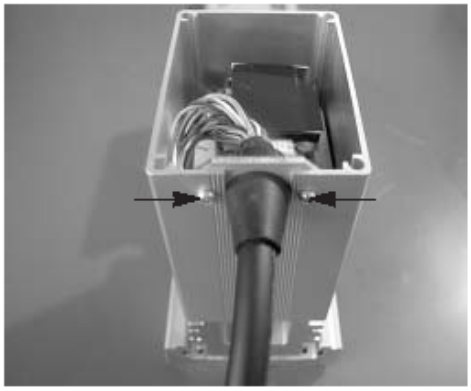


13) Plug in the encoder connector.

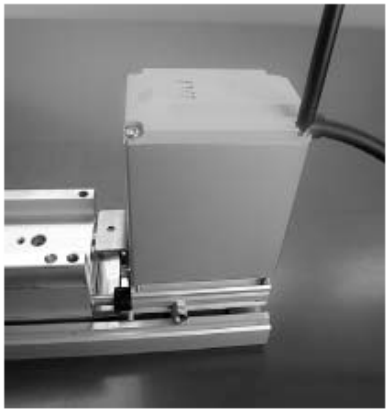


Caution: When applying the force, do not touch the encoder directly.

14) Store the cables into the motor cover and affix the cable-mounting plate using the pan-head screws (M2.6 x 5, 2 pcs)



15) Tighten the motor cap and motor cover together using the pan-head screws (4 pcs). Applicable screws (BA6: M3 x 80 / BA7: M3 x 90)



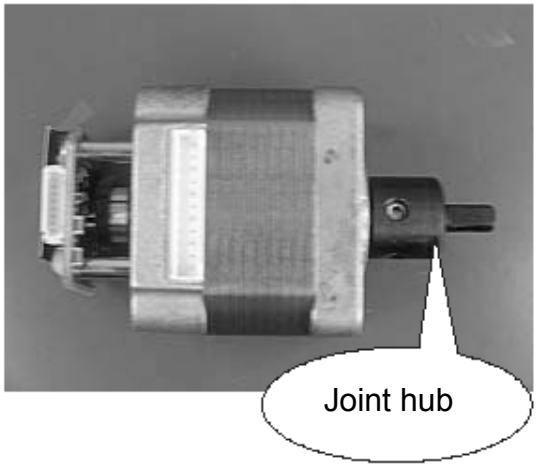
16) Install the drive belt, adjust it to the specified tension, and then install the covers. Follow steps 9) to 17) in 10.7.4, “Replacing the Belt.”

10.8.2 BA6U/BA7U (Motor at Bottom)

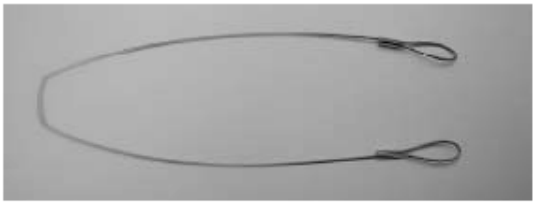
[Items Required for Replacement]

- Replacement motor (with the motor shaft preassembled with a joint hub: see photograph [1])
- Tension adjustment wire (provide a commercially available wire like the one shown in photograph [2])
- Setscrew (M4 x 5, flat-tip, precoated)
- Setscrew (M4 x 5, recessed-tip, precoated)
- 1.5-mm thick spacer (or thickness gauge)
- Phillips screwdriver set and Allen wrench set
- Tension gauge (capable of applying a tensile load of 12 kgf or more)
- Grease (Kyodo Yushi's Multemp LRL3 or equivalent)
- Hot gun (used if the setscrews do not come off)

[Photograph [1]]



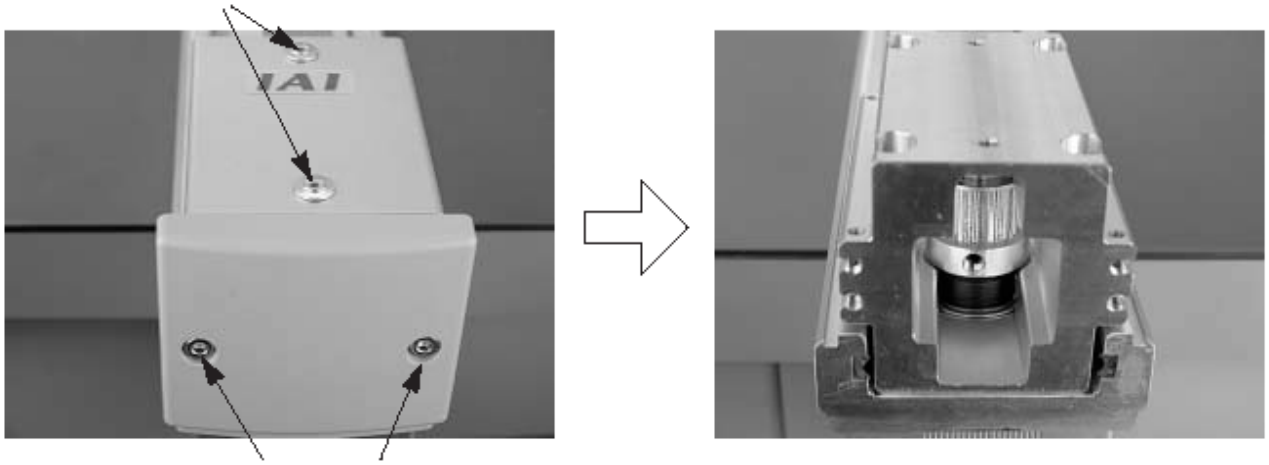
[Photograph [2]]



[Procedure]

1) First, remove the drive belt.
   Remove the load from the slider and follow steps 1) to 7) in 10.7.4, "Replacing the Belt," to remove the belt.

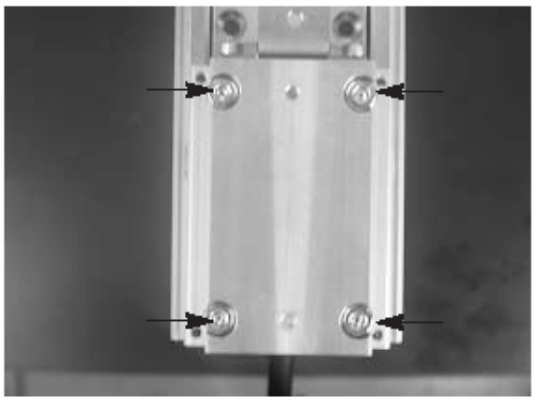
2) Remove the bracket and rear cover.
   Use an Allen wrench of 1.5 mm across flats.



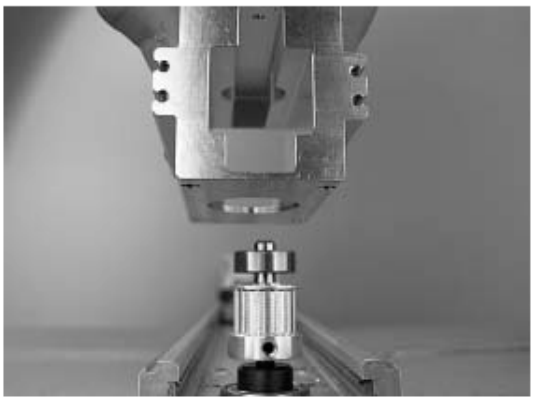
Use an Allen wrench of 2.5 mm across flats.

3) Remove the motor bracket.

[1] Remove the affixing bolts (M4 x 45, 4 pcs) using an Allen wrench of 3 mm across flats.



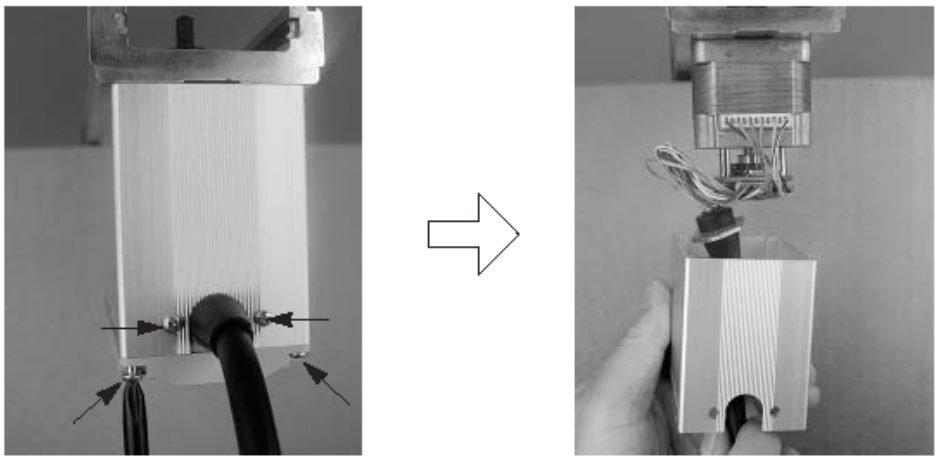
[2] Pull out the motor bracket by hand.



4) Remove the two setscrews (M4 x 5, precoated) affixing the pulley assembly (using an Allen wrench of 2 mm across flats), and pull out the pulley assembly.
If the setscrews do not come off, use a hot gun to heat the adhesive attached at the screw tips.

Caution: Remove the setscrews carefully so as not to misplace the set pieces.

5) Remove the four pan-head screws affixing the motor cap and two pan-head screws affixing the cable-mounting plate, and separate the motor cap and cable-mounting plate from the motor cover.



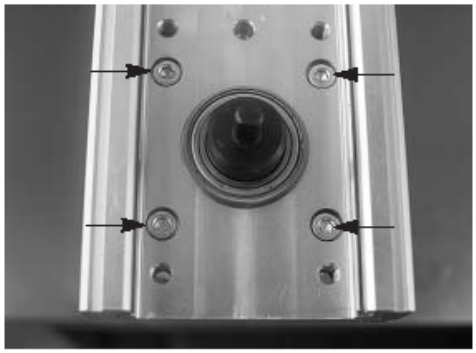
6) Pull out the motor connector.

7) Pull out the encoder connector.

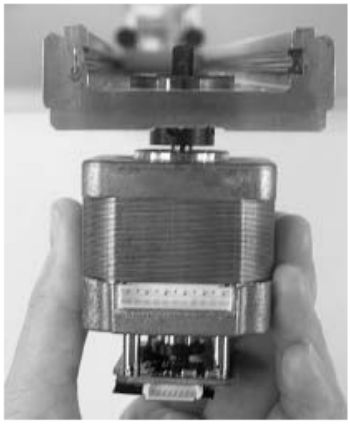
Caution:	When applying the force, do not touch the encoder directly.

8) Remove the motor.

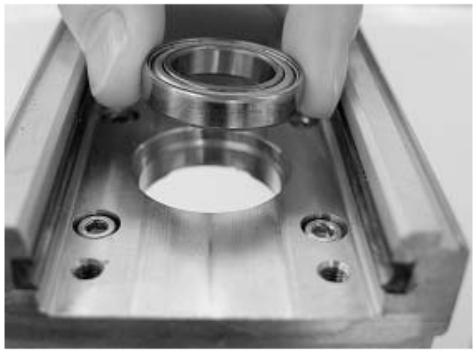
[1] Remove the affixing bolts (M3 x 8, 4 pcs) using an Allen wrench of 2.5 mm across flats.



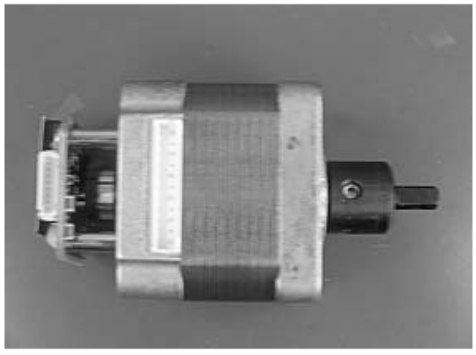
[2] Pull out the motor downward by slightly tilting it to right and left.



[3] Pull out the bearing by hand.

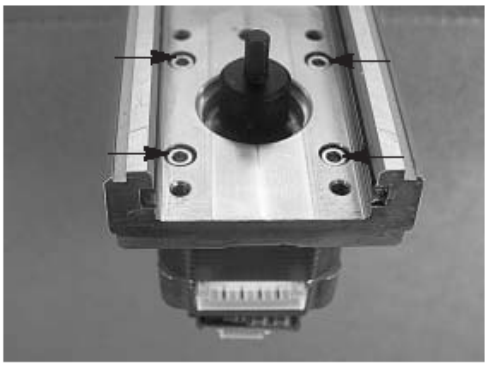


[4] After the motor has been removed

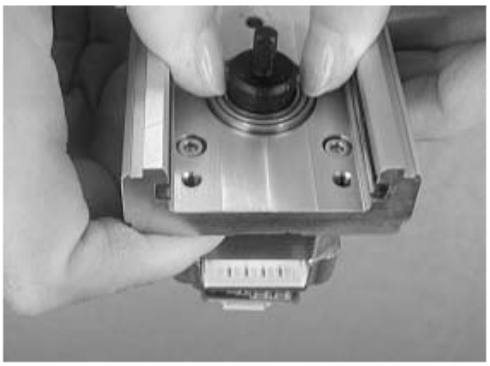


9) Install a new motor on the base and insert the bearing.

[1] Tighten the affixing bolts (M3 x 8, 4 pcs) using an Allen wrench of 2.5 mm across flats.

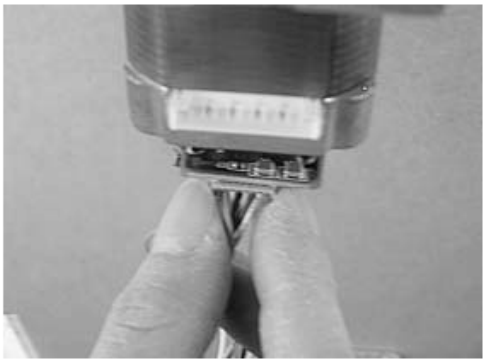


[2] Insert the bearing by hand.



Tightening torque: 90 N·cm (9.2 kgf·cm)

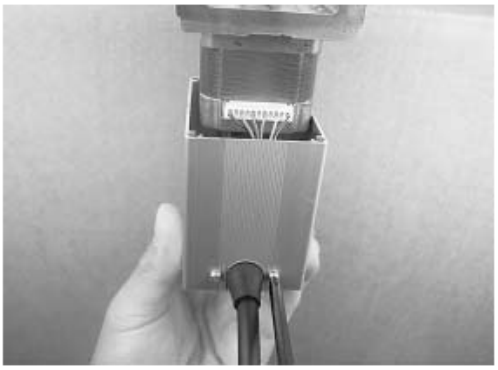
10) Plug in the encoder connector.



11) Plug in the motor connector.

Caution: When applying the force, do not touch the encoder directly.

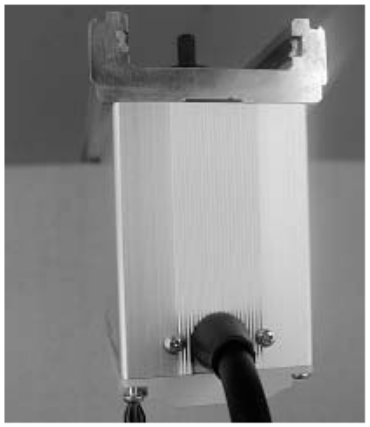
12) Store the cables into the motor cover and affix the cable-mounting plate using the pan-head screws (M2.6 x 5, 2 pcs).



13) Tighten the motor cap and motor cover together using the pan-head screws (4 pcs).

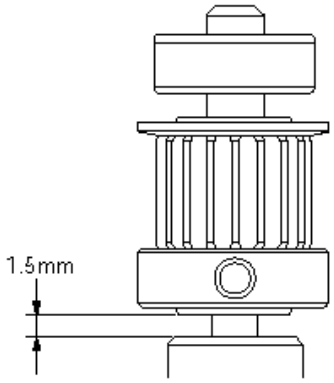
Applicable screws

(BA6U: M3 x 73/BA7U: M3 x 85)

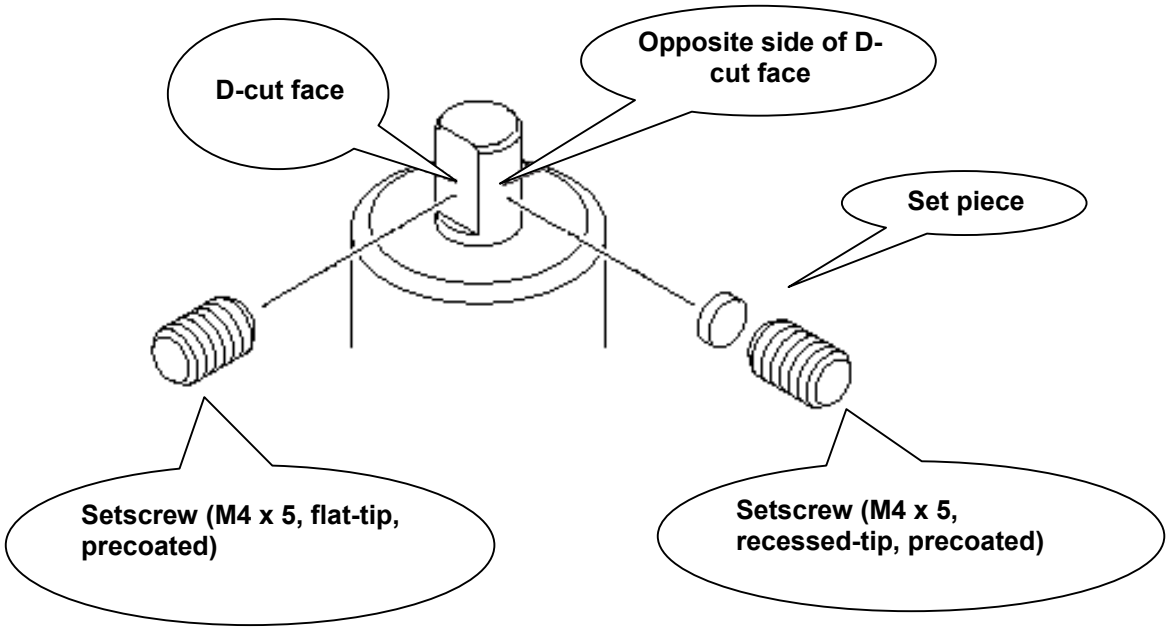


14) Affix the pulley assembly to the joint hub.

[1] Provide a 1.5-mm clearance between the joint hub and pulley assembly.



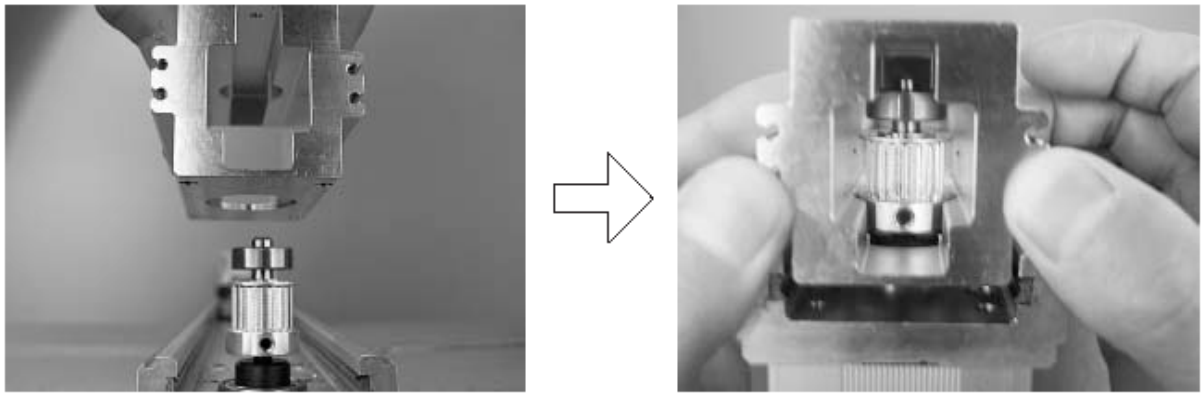
[2] Install new setscrews at two locations and tighten the screws (using an Allen wrench of 2 mm across flats).



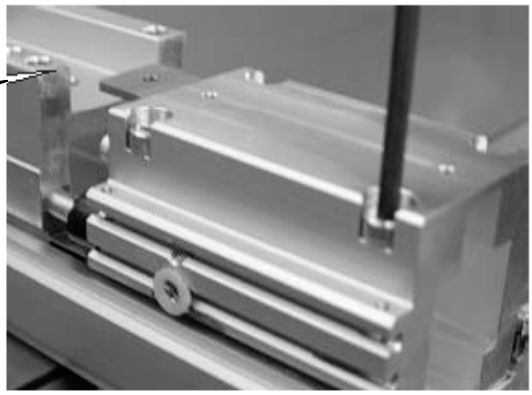
Caution: Always use new setscrews with a new motor.

15) Install the motor bracket.

[1] Align the motor bracket with the pilot section of the bearing and insert the bracket carefully so as not to damage the outer periphery of the bearing.



[2] Tighten the affixing bolts (M4 x 45, 4 pcs) using an Allen wrench of 3 mm across flats.



Securely tighten the bolts with the slider firmly pressed against the motor bracket.

Tightening torque: 176 N·cm (18 kgf·cm)

16) Install the drive belt, adjust it to the specified tension, and then install the covers. Follow steps 9) to 17) in 10.7.4, “Replacing the Belt.”

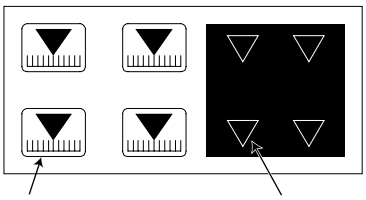
Appendix

Appendix How to use the origin mark

- Please affix these marks to the actuator as origin markers as needed.

Contents of sticker

Origin mark sticker



x 1 sheet

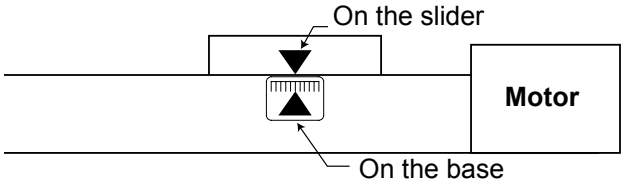
Origin mark scale x 4 Origin mark x 4
(Scale: 1 mm graduation mark, 10 mm width)

- Peel off the marks from the base sheet.

Note 1. Every mark has sticky back.
2. Remove smear and stain from the surface.
3. Avoid label or nameplate as a marking location.

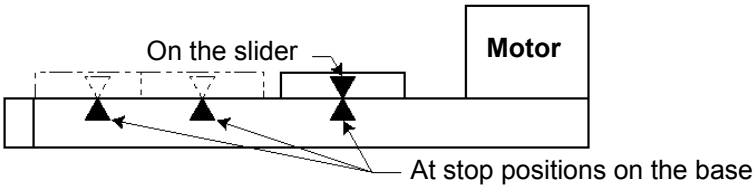
Example of Use

[1] Used as origin position



- Place the marks when the actuator is stopped at origin position.

[2] Used as stop positions



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