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FS Actuator

Operating Manual

Fifth Edition







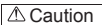

IAI America, Inc.

Safety Precautions (Please read before using the product.)

Before installing, operating, maintaining or inspecting this product, please peruse this operating manual as well as the operating manuals and other related documentations for all equipment and peripheral devices connected to this product in order to ensure the correct use of this product and connected equipment/devices. Those performing installation, operation, maintenance and inspection of the product must have sufficient knowledge of the relevant equipment and their safety. The precautions provided below are designed to help you use the product safely and avoid bodily injury and/or property damage.

In this operating manual, safety precautions 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.

It should be noted that the instructions under the  **Caution** and  **Note** headings may also lead to serious consequences, if unheeded, depending on the situation.

All instructions contained herein provide vital information for ensuring safety. Please read the contents carefully and handle the product with due caution.

Please keep this operating manual in a convenient place for quick reference whenever needed, and also make sure that the manual will get to the end-user.

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.
- 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.
- 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 product's protective functions (alarms) has actuated, turn off the power immediately. Continuing to use the product may result in injury due to product malfunction, or cause product breakdown or damage. After the power has been cut off, identify and remove the cause of the problem, and then reconnect the power.



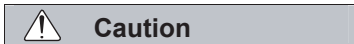
- Do not step on the product, use it as a footstool or place any object on it. You may slip and fall or the product may tip over or drop, resulting in injury. Malfunction, runaway product, etc., may also result due to product breakdown or damage.

[Maintenance, Inspection, Repair]

- Before commencing maintenance/inspection, servicing, replacement or any other work on the product, be sure to completely cut off the power supply to the product. Also take heed of the following precautions:
 1. Put up a sign bearing "WORK IN PROGRESS. DO NOT TURN ON POWER" or other warning statement to that effect, to prevent a bystander from accidentally turning on the power.
 2. If multiple operators work together to perform maintenance/inspection work, the operators should always give verbal cues to one another to ensure safety before turning on/off the power or moving any axis.

[Disposal]

- Do not throw the product into flames. The product may explode or toxic gases may generate.



[Installation]

- Do not use the product in a place exposed to direct sunlight (ultraviolet ray), dusty place or place where air contains salt or iron powder, humid place, or in any ambience where the product may come in contact with organic solvent, hydraulic oil containing phosphate ester, etc. If used in these places, the product may lose its function over a short period of time or suffer rapid performance deterioration, or the service life of the product may be reduced.
- Do not use the product in an area where it may come in contact with corrosive gases (sulfuric acid, hydrochloric acid, etc.). The product may lose its strength due to rust.
- Provide sufficient shielding measures if the product is used in any of the following places. If proper measures are not taken, the product may malfunction:
 1. Place where large current or strong magnetic field generates
 2. Place where arc discharge occurs due to welding work, etc.
 3. Place where noise generates due to electrostatic, etc.
 4. Place where the product may come in contact with radiation
- Do not install the product in a place subject to vibration or shock.
- Provide an emergency stop device in an easily accessible position so the device can be immediately actuated should danger occur during operation. Failure to do so may result in injury.
- Provide sufficient maintenance space when installing the product. If sufficient space is not available, daily inspection, maintenance and other necessary work cannot be carried out, resulting in system shutdown or product damage.
- When transporting or installing the product, support the product using a lift or suspension equipment or carry it with multiple operators working together, and exercise due caution to ensure safety.
- When installing the product, do not hold the moving parts or cables of the product. Doing so may result in injury.
- Use IAI's genuine cables to connect the actuator and controller. Also use IAI's genuine components for the actuator, controller, teaching pendant, etc.
- The brake mechanism is designed to prevent the slider from dropping upon turning off the power when the actuator is installed vertically. Do not use the brake mechanism as a safety brake.
- When installing, adjusting or carrying out any other work on the actuator, put up a sign bearing "WORK IN PROGRESS. DO NOT TURN ON POWER" or other warning statement to that effect, to prevent the product from being powered on accidentally. If the power is turned on accidentally, injury may result due to electric shock or sudden movement of the 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 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

[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

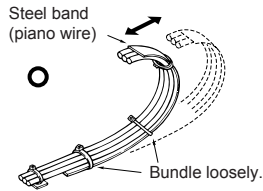
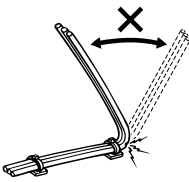
- IAI shall not be liable whatsoever for any loss or damage arising from a failure to observe the items specified in "Safety Precautions."



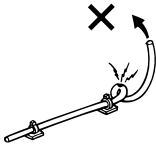
Prohibited Handling of Cables

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.

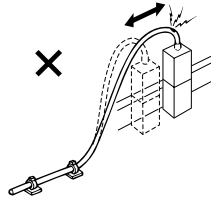
1. Do not let the cable flex at a single point.



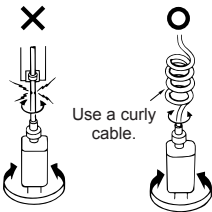
2. Do not let the cable bend, kink or twist.



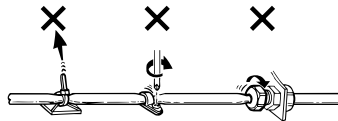
3. Do not pull the cable with a strong force.



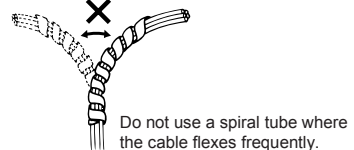
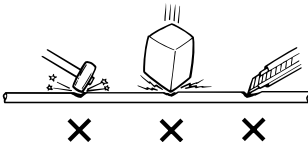
4. Do not let the cable receive a turning force at a single point.



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



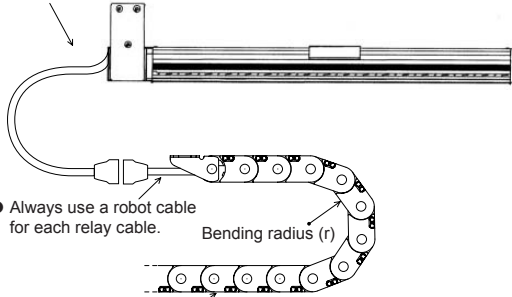
6. Do not pinch, drop a heavy object onto or cut the cable.





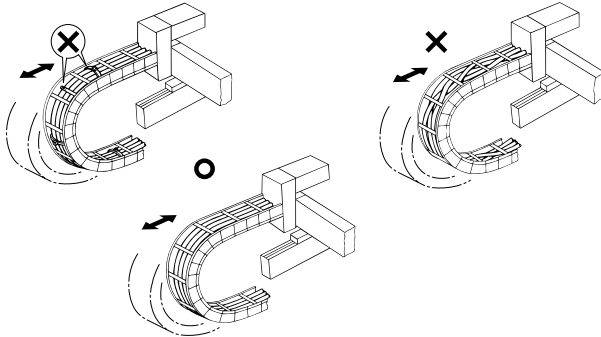
7. Notes on using cable bearers

- The supplied cables are not robot cables. Accordingly, never store the cables in a cable bearer.



- Use a cable bearer with a bending radius (r) of 50 mm or greater.

- 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).



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

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

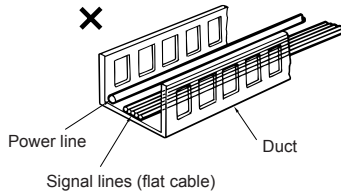
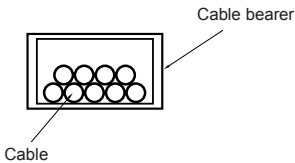




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1. Foreword

Thank you for purchasing the FS Actuator. This manual explains the structure, correct operation, assemble and maintenance of the FS 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)

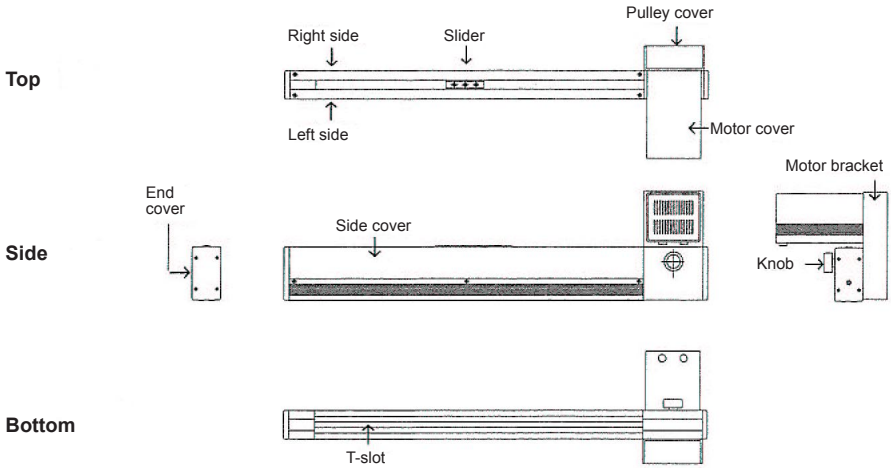
- The content of this manual is subject to change without notice for the purpose of improvement.
- This manual was created with utmost attention to accuracy. Should you find any error, however, or if you have any question, please contact IAI's Sales Engineering or Technical Service Section.



3. Names of the Parts

The name of the actuator parts are indicated below.

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





4. Transporting • Handling

4.1 Handling of the Single Unit

4.1.1 Handling of the Packed Unit

Unless there are special instructions, the actuator is shipped with each axis packed separately. Please take care that the shipping carton is not dropped or subjected to strong impact during transport.

- The operator should not carry heavy shipping boxes by himself.
- If the shipping carton is left standing, it should be in a horizontal position.
- Do not climb on top of the shipping carton.
- Do not place heavy objects on top of the shipping carton.

4.1.2 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 motor bracket and motor cover.
- Do not exert excessive force on any part of the actuator. Take particular care with the connector and cable.

* Please refer to Section 3 regarding the names of the actuator parts.



4.2 Handling of the Assembled Unit

When the actuator is carried with all the axes installed, follow the instructions below.

4.2.1 Shipping of the Assembled Unit from Our Company

For the specified machine, after it is assembled in our company, the delivery inspection is performed and the machine is packed with the outer frame nailed onto the skid. The carton is fixed so that the slider does not move unexpectedly during the transportation. For the combined actuator unit, it is fixed so that the pointed end does not swing greatly due to the external vibration.

- There is no special accommodation for this carton to endure the impact due to drop or bump. Therefore, take the greatest care in handling it. Because the outer frame can not stand the load on it, do not put any heavy thing on it.
- When it is suspended using a rope, support it from the reinforced frame under the skid. When it is lifted using the forklift, lift it also from the skid bottom.
- When it is lowered, handle it so that no impact is given or it does not bounce.

After it is unpacked, handle it following the instructions below.

4.2.2 Handling of the Assembled Unit with Peripheral Equipment

When the machine is transported after it is assembled in and shipped from our company, or assembled in your company, handle it following the instructions below.

- Fix the machine, in particular, at the position around the slider so that the slider does not move unexpectedly.
- Fix the machine so that the projected end does not swing greatly due to the external vibration.
- In the transportation of this machine without fixing the pointed end, do not give any impact of 0.3G or more.
- When it is suspended using a rope, arrange the rope so that it does not touch the machine body directly. Arrange it so that the load of the rope is given to the base body for the X-axis through the appropriate buffer material. At that time, take care not to give the load onto the side cover.
- Take care not to give the load onto the bracket, the cover or connector box on each section in the main machine. Also, make sure that the cable is not caught or deformed forcibly.



5. Installation and Storage Environments

5.1 Installation 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.
- 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 0.3G.
- Avoid surroundings with extreme electromagnetic waves, ultraviolet rays and radiation.

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

5.2 Storage environment

The storage environment is basically the same as the operating environment but if unit is to be stored for a long period of time, be especially careful that condensation does not form.

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 packing 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.



6. Installation

We'll describe the installation process using a single axis unit.

6.1 Mounting the actuator

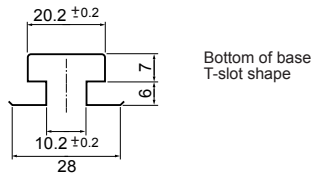
- There is a T-slot at the bottom of the base. Mount the actuator using this T-slot and the T nuts that come with the actuator. (Please see drawing below).

6.2 Attaching the payload to the slider

- There are M-8 tapped holes in the slider where you can affix the payload. The mounting procedure is basically the same as for the actuator.

6.3 Mounting Surface

- The mounting table should have sufficient rigidity to avoid generating 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 0.05mm.
- Provide enough space around the actuator to permit maintenance work to be done.



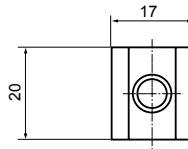


6.4 Mounting Procedure

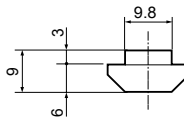
- The bolts for mounting the actuator should be of a dimension suitable for the mounting holes and slot.
- Use hexagonal bolts for the actuator mounting holes.
- We recommend high strength bolts of ISO-10.9 or higher.
- Make sure the bolt and screw engagement length following value or greater:
Steel screw → same length as the nominal diameter
Aluminum screw → twice as long as the nominal diameter
- When attaching the base to a mounting table, use washers made for high strength bolt if the bolts is M8 or larger or if the bearing surface is made of aluminum. A washer is not necessary for M6 or smaller bolts. Do not use a common spring washer.
- The recommended screw torque is given below.

Screw Nominal Diameter	Screw Torque
M6	7N•m (0.7 kgf•m)
M8	26N•m (2.6 kgf•m)

- Use the T-nuts provided by IAI. (Please see drawing below).
- If you require more than the number included, additional nuts are available for purchase.
- When mounting the actuator, select a bolt length so that the tip of the bolt does not touch the bottom of the T-slot.
- If you are purchasing brackets with the actuator, please use the bolts, nuts and washers that come with brackets.



Shape of T-nut





7. Connecting the Controller

The wiring using a single axis cable is described here.

7.1 Standard Cabling

Unless otherwise specified, we attach a 3m or 5m single axis cable to the actuator when we ship the unit, Please attach the cable end connector directly to the controller.

- Although we use cable that is resistant to bending fatigue, it is not robot cable.
Please avoid housing the cable in a wire duct with a small bending radius (we recommend R90 or larger).
- In an application where the cable cannot be anchored, try to place the cable where it will sag only under its own weight or use self-standing cable hose as large radius wire duct to limit the load on the cable.
- Do not cut the cable to lengthen, shorten, or reconnect it.

If you wish to alter the cable, please consult with IAI before doing so.

8. Actuator Load

- Do not exceed the load shown in the load specification column.
In particular, please note the slider moment, allowable overhang length and the load weight.
- The base can warp when you use the actuator with the Y-axis overhanging. Please use the actuator so that the Ma and Mc moments are less than 1/2 of the rated value.



9. Homing

9.1 Principle of Homing Operation

The IA performs homing in the following manner.

- (1) The moving direction for the homing command is set by the parameter.
- (2) The software senses the mechanical end during homing.
- (3) The axis reverses direction when it reaches the mechanical end and the place where the Z phase signal is detected becomes the reference point.
- (4) The axis travels further by an offset amount defined by the parameter and this position becomes home.

* The number of motor revolutions from the time the axis hits the stopper until the Z phase signal is generated is adjusted at the time the unit is shipped.



10. Inspection

10.1 Inspection check points and timing

Please perform inspection checks according to the following timetable.

Running time is assumed to be 8 hours per day. If you run the system continuously day and night, then shorten the maintenance interval accordingly.

	Visual Inspection	Internal Check	Lubrication
Operation start	<input type="radio"/>		
After 1 month of operation	<input type="radio"/>		
After 6 months of operation	<input type="radio"/>	<input type="radio"/>	
After 1 year of operation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Semiannually thereafter	<input type="radio"/>		
Annually thereafter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10.2 Visual inspection of the actuator exterior

Check the following when doing the visual inspection.

Actuator	Any loose mounting bolts?
Cables	Any damage, loose connection to connector?
General	Unusual noise or vibration?



10.3 Cleaning

- Clean the exterior surfaces from time to time.
- Wipe off dirt with a soft cloth.
- Do not spray compressed air on the actuator which might force dust into the crevices.
- Do not use petroleum-based solvents as they damage plastic parts and painted surfaces.
- If the unit gets badly soiled, apply a neutral detergent or alcohol to a soft cloth and wipe lightly.

10.4 Internal inspection

Turn the power OFF, remove the side cover and do a visual check of the inside.

Confirm the inside condition with visual check.

Check to see if there is any dust or foreign objects inside the unit, and check the lubrication and condition of the timing belt.

- Even if the grease is a brown color, the lubrication is fine as long as the travelling surface appears to be wet.
Check to see if there is any damage to the timing belt such as cracks in the teeth or in the section behind the teeth.
Note: The timing belt may generate a black powder. This is due to friction and is not unusual.
- The side cover can be removed with a hexagonal wrench.

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.

After you finish inspection, tighten the mounting screws for side cover. The screw torque should be for a cross-recessed head machine screw.

10.5 Cleaning the inside

- Use a soft cloth to wipe off dirt on the inside.
- Do not use compressed air to spray away dust since this may force the dust into the crevices.
- Do not use petroleum-based solvents, neutral detergents or alcohol.



10.6 Grease Replenishment for the Guide

10.6.1 What grease to use

Use lithium grease No. 2.

When we ship the unit, we use 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 lubricate

- (1) Remove the side cover.
- (2) With a grease gun, squirt grease into the grease nipple in the LM block to which the slider is attached.
- (3) Insert enough grease so that some of it leaks out of the other side of the LM block.
- (4) Repeat this procedure for the other grease nipples on the LM block.
- (5) Move the slider back and forth several times by hand.
- (6) After this, wipe away the excess grease from the LM block.
- (7) Replace the side cover.



11. Warranty

11.1 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

11.2 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 (stainless sheet, 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.

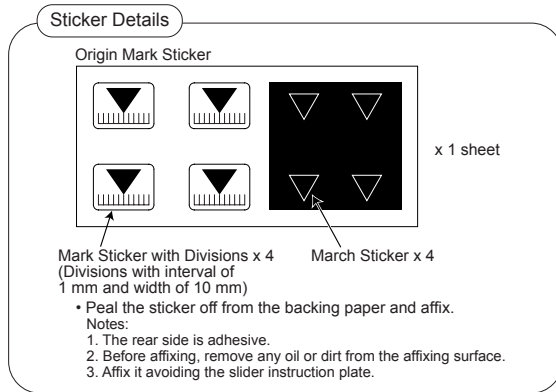
Any repairs will be done at our factory. Even if the product is still covered under the warranty period, we will assess a separate charge for sending technicians to the customer's site.



12. Appendix

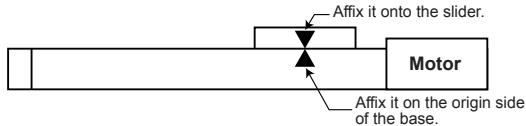
How to Use the Origin Marks

Use this mark by means of affixing to the product as the guide for the origin direction of the actuator, as occasion demands.

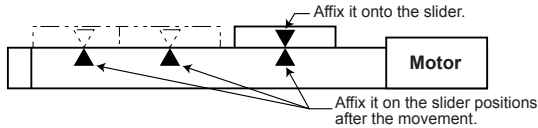


Use Examples

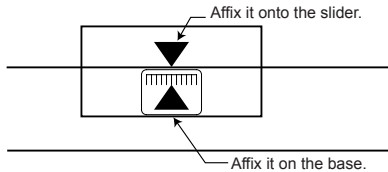
1) Affixing it as the guide for the origin direction of the actuator



2) Affixing it as the guide of the slider positions after movement



3) Affixing it as the guide for the deviation check



Affix two stickers each onto the slider and base while they are stopped at their origin positions.



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