



Operation Manual

PRODUCT NAME

Mini Rotary Actuator

MODEL / Series / Product Number

CRJ*05, 1

SMC Corporation

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Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of "Caution," "Warning" or "Danger." They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC)^{*1)}, and other safety regulations.

*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.

ISO 4413: Hydraulic fluid power -- General rules relating to systems.

IEC 60204-1: Safety of machinery -- Electrical equipment of machines .(Part 1: General requirements)

ISO 10218-1: Manipulating industrial robots -Safety.

etc.



Caution

Caution indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.



Warning

Warning indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.



Danger

Danger indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

Warning

1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results.

The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product.

This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

2. Only personnel with appropriate training should operate machinery and equipment.

The product specified here may become unsafe if handled incorrectly.

The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.

2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.

3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.

2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.

3. An application which could have negative effects on people, property, or animals requiring special safety analysis.

4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.



Safety Instructions

Caution

1. The product is provided for use in manufacturing industries.

The product herein described is basically provided for peaceful use in manufacturing industries.

If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.

If anything is unclear, contact your nearest sales branch.

Limited warranty and Disclaimer/Compliance Requirements

The product used is subject to the following “Limited warranty and Disclaimer” and “Compliance Requirements”.

Read and accept them before using the product.

Limited warranty and Disclaimer

1. The warranty period of the product is 1 year in service or 1.5 years after the product is delivered, whichever is first.

Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.

2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.

This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.

Compliance Requirements

1. The use of SMC products with production equipment for the manufacture of weapons of mass destruction (WMD) or any other weapon is strictly prohibited.

2. The exports of SMC products or technology from one country to another are governed by the relevant security laws and regulations of the countries involved in the transaction. Prior to the shipment of a SMC product to another country, assure that all local rules governing that export are known and followed.

Caution

SMC products are not intended for use as instruments for legal metrology.

Measurement instruments that SMC manufactures or sells have not been qualified by type approval tests relevant to the metrology (measurement) laws of each country.

Therefore, SMC products cannot be used for business or certification ordained by the metrology (measurement) laws of each country.

Warning

1. Confirm the specifications.

Products represented in this catalog are designed only for use in compressed air systems.

Do not operate at pressures or temperatures, etc., beyond the range of specifications, as this can cause damage or malfunction. (Refer to the specifications.)

Please contact SMC when using a fluid other than compressed air.

We do not guarantee against any damage if the product is used outside of the specification range.

2. If the operation involves load fluctuations, ascending/descending movements, or changes in friction resistance, make sure to provide safety measures.

Operating speed will increase, and bodily injury may occur, or damage to the machinery itself may occur.

3. If there is a chance that the product will pose a hazard to humans, install a protective cover.

If the moving portion of the product will pose a hazard to humans or will damage machinery or equipment, provide a construction that prevents direct contact with those areas.

4. Be certain that the secured portions will not loosen.

Be certain to adopt a reliable connecting method if the rotary actuator is used very frequently or if it is used in a location that is exposed to a large amount of vibrations.

5. There may be cases in which a speed reduction circuit or a shock absorber is required.

If the driven object moves at high speeds or is heavy, it will be unfeasible for only the rotary actuator's cushion to absorb the shock. Therefore, provide a speed-reduction circuit to reduce the rotary actuator's speed before the thrust is applied to the cushion, or an external shock absorber to dampen the shock. If these countermeasures are taken, make sure to take the rigidity of the mechanical equipment into consideration.

6. Consider the possibility of a reduction in the circuit air pressure caused by a power failure.

When a rotary actuator is used as clamping mechanism, there is a danger of workpiece dropping if there is a decrease in clamping force, due to a drop in circuit pressure caused by a power failure. Therefore, safety equipment should be installed to prevent damage to machinery and bodily injury.

7. Consider the possibility of power source related malfunctions that could occur.

For the machinery equipment that rely on power sources such as compressed air, electricity, or hydraulic pressure, adopt countermeasure to prevent the equipment from causing a hazard to humans or damage to the machinery and equipment in the event of malfunction.

8. If a speed controller is provided in the exhaust restrictor, implement a safety design taking the residual pressure into consideration.

If air pressure is applied to the air supply side without residual pressure in the exhaust side, the rotary table will operate at abnormally high speeds, which could pose a hazard to humans and damage the machinery and equipment.

9. Consider the behavior of the rotary actuator in the event of an emergency stop.

Devise a safe system so that if a person engages the emergency stop, or if a safety device is tripped during a system malfunction such as a power failure, the movement of the rotary actuator will not cause a hazard to humans or damage the equipment.

10. Consider the action of the rotary actuator when restarting after an emergency stop.

Devise a safe design so that the restarting of the rotary actuator will not pose a hazard to humans or damage the equipment. Install manually controlled equipment for safety when the rotary actuator has to be reset to the starting position.

11. Do not use the product as a shock absorber.

If an abnormal pressure or air leakage occurs, the rotary actuator's speed reduction capability could become severely affected, which could pose a hazard to humans and damage the machinery and equipment.

12. Select a speed within the product's allowable energy value.

If the product's kinetic energy of the load exceeds the allowable value, it could damage the product, and cause a hazard to humans and damage the machinery and equipment.

13. Provide a shock absorber if the kinetic energy that is applied to the product exceeds the allowable value.

If the product's kinetic energy exceeds the allowable value, it could damage the product, and cause a hazard to humans and damage the machinery or equipment.

14. Do not stop or hold the product at midpoint by keeping air pressure in the product. (Air balancers etc.)

For a product lacking an external stopping mechanism, if the directional control valve is closed to keep the air pressure in the product, in an attempt to stop the product at midpoint, it might not be possible to maintain that stopped position due to an air leakage. As a result, it could pose a hazard to humans and cause damage to machinery and/or equipment.

15. Do not use two or more rotary actuator with the aim of synchronized movement.

One of the rotary actuator may bear the load of operation, making synchronized movement impossible, and possibly leading to deformation of the equipment.

16. Do not use in a location where adverse effect could be occurred by the oozing of the lubricant to the exterior.

The lubricant coating the interior of the product may leak to the outside of the product from connecting parts of the rotary body, cover, etc.

17. Do not disassemble the product or make any modifications, including additional machining.

This may cause human injury and/or an accident.

18. Refer to the Auto Switches Precautions for using with an auto switch.

Caution

1. Do not use below the speed adjustment range specified for the product.

If the product is used below the specified speed adjustment range, it could cause the product to stick, slip, or the movement to stop.

2. Do not apply an external torque to the product that exceeds the rated output.

If an external force that exceeds the product's rated output is applied to the product, it could damage the product.

3. If it is necessary to provide repeatability of the rotation angle, directly stop the load externally.

Even with a product that is equipped with an angle adjuster, there are times when the initial rotation angle could change.

4. Do not use under hydraulic pressure.

The product will be damaged if it is used by applying hydraulic pressure.

5. Do not use in a places where there are many temperature fluctuations.

When using in lower temperature applications, use caution so that frost does not occur inside the cylinder or the piston rod.

Operation may be unstable.

6. Adjust the speed control in the environment in which it will be used in.

Speed adjustment may be changed if the environment is different.

Mounting

Warning

1. **Operation manual**

Install the product and operate it only after reading the operation manual carefully and understanding its contents. Also, keep the manual in a location where it can be referred to as necessary.

2. **Ensure sufficient space for maintenance activities.**

When installing the products, allow access for maintenance.

3. **Tighten threads with the proper tightening torque.**

When installing the products, follow the listed torque specifications.

4. **Before adjusting the angle by supplying air pressure, take appropriate measures to prevent the equipment from rotating unnecessarily.**

When an adjustment is performed under air pressure, the equipment could rotate and fall during the adjustment, depending on the mounted posture of the equipment. As a result, it could pose a hazard to humans and damage the machinery and equipment.

5. **Do not loosen the angle adjustment screw beyond the allowable adjustment range.**

The angle adjustment screw could fall out if it is loosened beyond its allowable adjustment range, which could pose a hazard to humans and damage the machinery and equipment.

6. **Do not place a magnetic object near the product.**

The auto switch is a magnetic sensing type. If a magnetic object is placed close to it, the rotary actuator could operate suddenly, which could pose a hazard to humans and damage the machinery and equipment.

7. **Do not perform additional machining to the product.**

Additional machining to the product can result in insufficient strength and cause damage to the product. This can lead to possible human injury and damage to the surrounding equipment.

8. **Do not enlarge the fixed throttle by modifying the pipe connectors.**

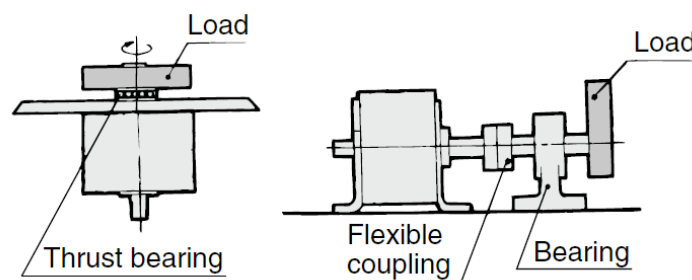
If the hole diameter is enlarged, the product's rotation speed will increase, causing the shock force to increase and damage to the product. As a result, it could pose a hazard to humans and damage the machinery and equipment.

9. **If shaft couplings are used, use those with angular freedom.**

If shaft couplings that lack angular freedom are used, they could scrape due to eccentricity, leading to equipment malfunction and product damage. As a result, it could pose a hazard to humans and damage the machinery and equipment.

10. **Do not apply to the shaft a load that exceeds the values given in a catalog.**

If a load that exceeds the allowable value is applied to the product, it could lead to equipment malfunction, a hazard to humans and damage to the machinery and equipment. Provided that a dynamic load is not generated, a load that is within the allowable radial / thrust load can be applied. However, applications in which the load is applied directly to the shaft should be avoided whenever possible. The methods such as those described below are recommended to prevent the load from being applied directly to the shaft in order to ensure a proper operating condition.



11. **Do not use springs, etc., to add force in the rotational movement direction.**

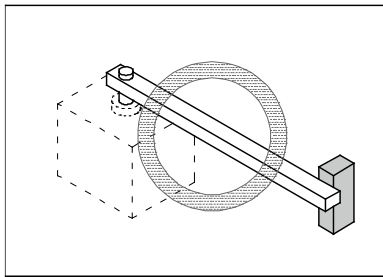
When rotational force from an external spring, etc., acts and generates negative pressure on the product's interior, breakage of the internal seal or acceleration of abrasion may occur.

12. Place an external stopper in a position that is away from the rotating shaft.

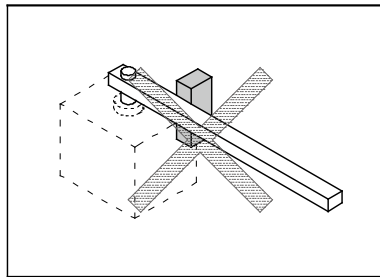
If the stopper is placed near the rotating shaft, the torque that is generated by the product itself will cause the reaction force which is directed to the stopper to be redirected and applied to the rotating shaft. This will lead to the breakage of the rotating shaft and bearing. As a result, it could pose a hazard to humans and damage the machinery and equipment.

Precautions when Using External Stoppers

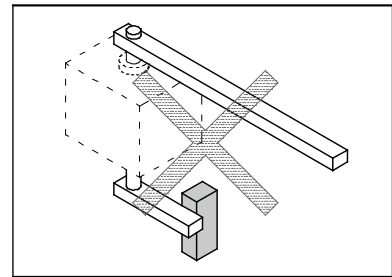
- Be sure to install external stoppers in the proper places. Installation in the wrong place can result in equipment breakage, which could damage other equipment or cause human injury.



Install the stopper at a sufficient distance from the rotating shaft.

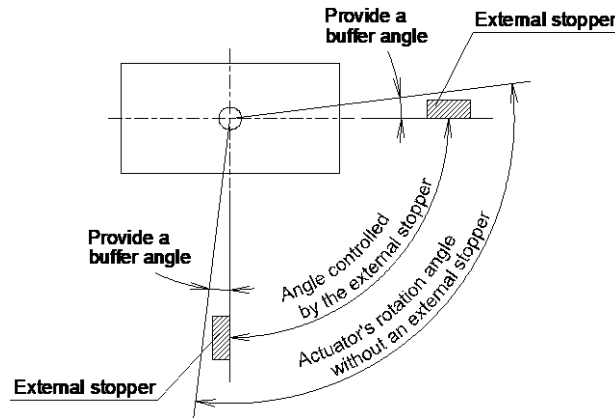


The external stopper becomes a fulcrum, resulting in the load's inertia force being applied to the table as a bending moment.



If an external stopper is installed on the opposite side of the load, the inertia force generated by the load is applied directly to the table.

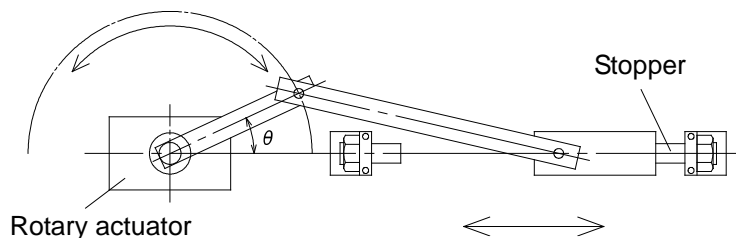
- Install external stoppers within the range of the rotating angle. Installing an external stopper at the maximum rotation angle may result in an inability to fully absorb the kinetic energy generated, and damage to equipment may occur.
- Angle adjustment is available for this product. When using an external stopper, set in a position so that that the adjusting bolt does not collide into the piston.



Precautions when Converting Rotational Motion to Linear Motion

When using a link mechanism, etc., to convert rotational motion to linear motion, and determining the operation end using the stopper on the linear motion end (see below), a small value for θ at the operation end may result in the torque of the rotary actuator causing excessive radial load to act on the output axle, and equipment breakage may occur.

Install a stopper on the rotation motion side, or increase the value of θ at the operation end, to make sure the load generated does not exceed the allowable value for the product.



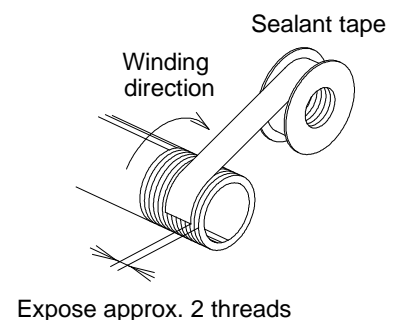
Caution

1. **Do not use organic solvent to wipe the area of the name plate that shows the model.**
It will erase what is indicated on the name plate.
2. **Do not hit the rotating shaft by securing the body or hit the body by securing the rotating shaft.**
These actions could cause the shaft to bend or damage the bearing. When a load must be coupled to the rotating shaft, secure the rotating shaft.
3. **Do not place your foot directly on the shaft or on the equipment that is coupled to the shaft.**
Placing one's weight directly onto the rotating shaft could cause the rotating shaft or the bearing to become damaged.
4. **If a product is equipped with an angle adjustment function, use it within the specified adjustment range.**
If the product is used outside the specified adjustment range, it could lead to equipment malfunction or product damage. Refer to the product specifications for details on the adjustment range of the products.
5. **A product with an angle adjustment screw is temporarily secured at an arbitrary position within the adjustable rotating range. Before using product, readjust it to a desired angle and tighten the screw firmly.**

Piping

Caution

1. **Refer to the Fittings and Tubing Precautions (Best Pneumatics No.7) for handling one touch fittings.**
2. **Preparation before piping**
Before piping is connected, it should be thoroughly blown out with air (flushing) or washed to remove chips, cutting oil and other debris from inside the pipe.
3. **Wrapping of pipe tape**
When screwing piping or fittings into ports, ensure that chips from the pipe threads or sealing material do not enter the piping. Also, if tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



Speed Adjustment

Warning

1. **To make a speed adjustment, gradually adjust starting from the low speed end.**
If the speed adjustment is performed from the high speed end, it could damage the product. As a result, it could pose a hazard to humans and damage the machinery and equipment.

Lubrication

Warning

1. This product should be used without lubrication. Although it will operate even if it is lubricated, it could lead to sticking or slipping.

Air Supply

Warning

1. **Type of fluids**

Please consult with SMC when using the product in applications other than compressed air.

2. **When there is a large amount of moisture**

Compressed air containing a large amount of moisture can cause malfunction of pneumatic equipment. An air dryer or water separator should be installed upstream from filters.

3. **Drain flushing**

If condensation in the drain bowl is not emptied on a regular basis, the bowl will overflow and allow the condensation to enter the compressed air lines. This may cause malfunction of pneumatic equipment. If the drain bowl is difficult to check and remove, installation of a drain bowl with an auto drain option is recommended.

4. **Use clean air.**

Do not use compressed air that contains chemicals, synthetic oils including organic solvents, salt or corrosive gases, etc., as it can cause damage or malfunction.

Caution

1. **When extremely dry air is used as the fluid, degradation of the lubrication properties inside the equipment may occur, resulting in reduced reliability (or reduced service life) of the equipment. Please consult with SMC.**

2. **Install an air filter.**

Install an air filter upstream near the valve. Select an air filter with a filtration size of 5µm or smaller.

3. **Take measures to ensure air quality, such as by installing an aftercooler, air dryer, or water separator.**

Compressed air that contains a large amount of moisture can cause malfunction of pneumatic equipment such as rotary actuator. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.

4. **Ensure that the fluid and ambient temperature are within the specified range.**

If the fluid temperature is 5°C or less, the moisture in the circuit could freeze, causing damage to the seals and equipment malfunction. Therefore, take appropriate measures to prevent freezing.

Operating Environment

Warning

1. **Do not use in an atmosphere having corrosive gases, chemicals, sea water, water, steam, or where there is direct contact with any of these.**
Refer to the construction for information on the rotary actuator material.
2. **Do not expose the product to direct sunlight for an extended period of time.**
3. **Do not use in a place subject to heavy vibration and/or shock.**
4. **Do not mount the product in locations where it is exposed to radiant heat.**
5. **Do not use in dusty locations or where water oil, etc., splash on the equipment.**

Maintenance

Warning

1. **Perform maintenance inspection according to the procedures indicated in the operation manual.**
If handled improperly, malfunction and damage of machinery or equipment may occur.
2. **Maintenance work**
If handled improperly, compressed air can be dangerous. Assembly, handling, repair and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.
3. **Drain flushing**
Remove drainage from air filters regularly.
4. **Removal of equipment, and supply/exhaust of compressed air**
When components are removed, first confirm that measures are in place to prevent workpieces from dropping, run-away equipment, etc. Then, cut off the supply pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.
When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent cylinders from sudden movement.

Caution

1. **For lubrication, use the designated grease for each specific product.**
The use of a non-designated lubricant could damage the seals.

Auto Switches Precautions

Design / Selection

Warning

1. **Confirm the specifications.**

If the product is used with excess load applied or beyond the specification range, this may cause the product to break or malfunction. We do not guarantee against any damage if the product is used outside of the specification range.

2. **Cautions for use in an interlock circuit**

When an auto switch is used for an interlock signal requiring high reliability, devise a double interlock system to avoid trouble by providing a mechanical protection function, or by also using another switch (sensor) together with the auto switch.

Also, perform regular maintenance and confirm proper operation.

3. **Do not attempt to disassemble, modify (including exchanging the printed circuit boards), or repair the product.**

An injury or failure can result.

Caution

1. **Pay attention to the length of time that a switch is ON at an intermediate stroke position.**

When an auto switch is placed at an intermediate position of the stroke and a load is driven, at the time the piston passes the auto switch will operate, but if the speed is too great the operating time will be shortened and the load may not operate properly.

The maximum piston speed is:

$$V(\text{mm/s}) = \frac{\text{Auto switch operating range (mm)}}{\text{Load applied time (ms)}} \times 1000$$

2. **Take precautions when multiple rotary actuators are used close together.**

When multiple auto switch rotary actuators are used in close proximity, magnetic field interference may cause the auto switches to malfunction. Maintain a minimum cylinder separation of 40 mm. (When the allowable interval is specified for each cylinder series, use the indicated value.)

The auto switches may malfunction due to interference from the magnetic fields.

Use of a magnetic screen plate (MU-S025) or commercially available magnetic screen tape can reduce the interference of magnetic force.

3. **Ensure sufficient clearance for maintenance activities.**

When designing an application, be certain to allow sufficient clearance for maintenance.

4. **Do not mount rotary actuator with the auto switch on a footing.**

If work personnel gets on or puts the work personnel's foot on the footing accidentally, an excessive load is applied to the rotary actuator, causing the rotary table to break.

5. **Design the circuit so that any back-flow current does not flow in if a short-circuit trouble occurs or forced operation is performed to check the operation.**

If a back-flow current occurs, this may cause the switch to malfunction or break.

6. **When multiple auto switches are required.**

"n" indicates the number of auto switches which can be physically mounted on the rotary actuators. Detection intervals depends on the auto switch mounting structure and set position, therefore some required interval and set positions may not be available.

7. **Limitations on detectable position**

There are positions or surfaces (bottom surface of the foot bracket, etc.) where the auto switch cannot be mounted due to the physical interference depending on the rotary actuator mounting status or mounting bracket. Select an appropriate auto switch setting position where the auto switch does not interfere with the rotary actuator mounting bracket (trunnion or reinforcing ring) after checking it sufficiently.

8. Keep wiring as short as possible.

<Solid state>

Be sure to use a wire length 100m or less.

When the wire length is long, we recommend the ferrite core should be attached to the both ends of the cable to prevent excess noise. A contact protection box is not necessary for solid state switches due to the nature of this product construction.

9. Do not use a load that generates surge voltage.

<Solid state>

If driving a load such as a relay that generates a surge voltage, use a built-in surge absorbing element type device.

10. Pay attention to the internal voltage drop of the auto switch.

<Solid state>

Generally, the internal voltage drop of the solid state auto switch is larger than that of the reed auto switch. When the auto switches ("n" pcs.) are connected in series, the voltage drop is multiplied by "n".

In this case, the auto switches operate correctly, but the loads may not operate. Additionally, note that the 12 VDC relay does not apply to the auto switch.

11. Pay attention to leakage current.

<2-wire type>

Current (leakage current) flows to the load to operate the internal circuit even when in the OFF state.

$$\text{Operating current of load (OFF condition)} > \text{Leakage current}$$

If the criteria given in the above formula are not met, it will not reset correctly (stays ON). Use a 3-wire switch if this specification will not be satisfied.

Moreover, leakage current flow to the load will be "n" times larger when "n" auto switches are connected in parallel.

12. Output operation of the solid state auto switch is not stable for 50 [ms] after powered ON.

In the output operation immediately after powered ON or AND connection operation, the input device (PCL or relay, etc.) may judge the ON position as OFF output or the OFF position as ON output. So, please make the setting on the equipment so that the input judgement signal is set disabled for 50 [ms] immediately after powered ON or AND connection. When using SMC's AHC system (Auto Hand Changing System) Series MA, please also make this setting.

Mounting / Adjustment

Caution

1. Do not drop or bump.

Do not drop, bump or apply excessive impacts (1000m/s² or more for solid state auto switches) while handling. Although the body of the auto switch may not be damaged, the inside of the auto switch could be damaged and cause malfunction.

2. Observe the proper tightening torque for mounting an auto switch.

When an auto switch is tightened beyond the range of tightening torque, auto switch mounting screws, auto switch mounting brackets or auto switch may be damaged.

On the other hand, tightening below the range of tightening torque may allow the auto switch to slip out of position.

3. Do not carry a rotary actuator by the auto switch lead wires.

This may cause disconnection of the lead wire or the internal element to break.

4. Do not use screws other than the set screws installed on the auto switch body to secure the auto switch.

If using other screws, auto switch may be damaged.

5. Mount an auto switch at the center of the operating range.

In the case of 2-color display auto switch, mount it at the center of the green LED illuminating range.

Adjust the mounting position of the auto switch so that the piston stops at the center of the operating range. (The mounting position shown in the catalog indicates the optimum position at stroke end.)

If mounted at the end of the operating range (around the borderline of ON and OFF), operation will be unstable depending of the operating environment. Also there are some rotary tables with individual setting methods for auto switches. If so, mount it in accordance with the indicated method.

Even if 2-color indication solid state auto switches are fixed at a proper operating range (the green light lights up), the operation may become unstable depending on the installation environment or magnetic field disturbance.

(Magnetic body, external magnetic field, proximal installation of rotary actuator with built-in magnet and actuators, temperature change, other factors for magnetic force fluctuation during operation, etc.)

6. Check the actual actuation status and adjust the auto switch mounting position.

According to the installation environment, the rotary actuator may not operate even at its proper mounting position. Even when setting at a midpoint of the stroke, check the actuation status and make the adjustment in the same manner.

7. Be very careful when handling the auto switch mounting band, as it has a thin structure.

Wiring

Caution

1. Confirm proper insulation of wiring.

If there is any improper insulation (mixed contact with other circuit, grounding fault, or improper insulation between terminals, etc.) in the wiring, an over-current flows in, causing the auto switch to break.

2. Wire separately from power lines of high voltage lines, avoiding parallel wiring of wiring in the same conduit with these lines.

If an inrush current is generated, the noise may cause the auto switch to malfunction.

3. Be certain to connect the load before power is applied.

<2-wire type>

If the power is turned ON when an auto switch is not connected to a load, the auto switch will be instantly damaged because of excess current (short circuit).

It is the same as when the 2-wire brown lead wire (+, output) is directly connected to the (+) power supply terminal.

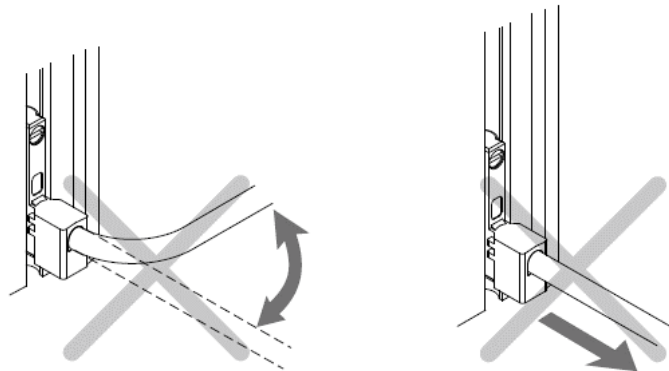
4. Carry out the wiring work after shutting down the power.

If the wiring work is performed with the power turned ON, this may cause electric shock, malfunction, or damage to the auto switch.

5. Avoid repeatedly bending or stretching lead wires.

Broken lead wires will result from repeatedly applying bending stress or stretching force to the lead wires.

Stress and tensile force applied to the connection between the lead wire and auto switch increases the possibility of disconnection.



6. Do not allow short-circuit of loads.

<Solid state>

PNP output type auto switches do not have built-in short circuit protection circuits.

Carefully handle as the auto switch may be damaged.

Take special care to avoid reverse wiring with the brown power supply line and the black output line on 3-wire type auto switches.

7. Avoid incorrect wiring.

<Solid state>

1) If connections are reversed on a 2-wire type auto switch, the auto switch will not be damaged if protected by a protection circuit, but the auto switch will always stay in an ON state. However, it is still necessary to avoid reversed connections, since the auto switch could be damaged by a load short circuit in this condition.

2) If connections are reversed (power supply line + and power supply line-) on a 3-wire type auto switch, the auto switch will be protected by a protection circuit. However, if the power supply line (+) is connected to the blue wire and the power supply line (-) is connected to the black wire, the auto switch will be damaged.

8. When the lead wire sheath is stripped, confirm the stripping direction. The insulator may be split or damaged depending on the direction. (D-M9□ only)



Recommended Tool

Description	Model
Wire stripper	D-M9N-SWY

* Stripper for a round cable (Ø2.0) can be used for a 2-wire type cable.



Operation Environment

Warning

1. Never use in an atmosphere with explosive gases.

The structure of auto switches is not intended to prevent explosion. This may lead to explosion hazard. Please contact SMC concerning ATEX compliant products.

Caution

1. Do not use in an area where a magnetic field is generated.

Auto switches will malfunction or magnets inside rotary actuator will become demagnetized. (Please consult with SMC if a magnetic field resistant auto switch can be used.)

2. Do not use in an environment where the auto switch will be continually exposed to water.

Although auto switches satisfy IEC standard IP67 construction expect some models (D-A3□, A44□, G39□, K39□, RNK, RPK) do not use auto switches in applications where continually exposed to water splash or spray. This may cause improper insulation or malfunction.

3. Do not use in an environment with oil or chemicals.

If auto switches are used in an environment containing coolant, cleaning solvent, various oils, or chemicals even for a short period of time, this may adversely affect the auto switches, resulting in improper insulation, malfunction due to swelling of the potting resin, or hardening of the lead wires.

4. Do not use in an environment with temperature cycles.

If temperature cycles other than normal temperature changes are applied, this may adversely affect the insides of the auto switches.

5. Do not use in an area where surges are generated.

<Solid state>

If there is an equipment unit (electromagnetic lifter, high-frequency induction furnace, motor, or radio, etc.) that generates large surges or electromagnetic waves around cylinders with solid state auto switches or actuators, this may cause the circuit element inside the auto switch to break.

6. Avoid accumulation of iron waste or close contact with magnetic substances.

If many iron particles, such as cutting chips or spatters accumulate around a cylinder with the auto switches or an actuator or if a magnetic substance (attracted by a magnet) is put close to a cylinder with the auto switch or an actuator, the magnetic force inside the cylinder or actuator loses, causing the auto switch to malfunction.

7. Please contact SMC concerning water resistance, elasticity of lead wires, usage at welding sites, etc.

8. Do not use in direct sunlight.

9. Do not mount the product in locations where it is exposed to radiant heat.

10. Take appropriate measures against the lightning surge on the equipment side as the auto switches do not have any lightning surge resistance specified in the CE marking.

Maintenance

Warning

1. Removal of equipment, and supply/exhaust of compressed air.

Before any machinery or equipment is removed, first ensure that the appropriate measures are in place to prevent the fall or erratic movement of driven objects and equipment, then cut off the electric power and reduce the pressure in the system to zero. Only then should you proceed with the removal of any machinery and equipment.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent rotary tables from moving suddenly.

2. Do not touch a terminal during energizing.

Touching a terminal during energizing may cause electric shock, malfunction, or auto switch breakage.

Caution

1. Perform the following maintenance periodically in order to prevent possible danger due to unexpected auto switch malfunction.

1) Secure and tighten auto switch mounting screws.

If screws become loose or the mounting position is dislocated, retighten them after readjusting the mounting position.

2) Confirm that there is no damage to lead wires.

To prevent faulty insulation, replace auto switches or repair lead wires, etc., if damage is discovered.

3) Confirm the detection setting position.

• Red light of 1-color display auto switch

Confirm that the set position stops at the center of the operating range (red display area).

• Conform the green light and position of the 2-color display auto switch.

Conform that the set position stops at the center of the appropriate operating range (green display area). If stopped with the red LED lit, the operation may become unstable due to effects of the equipment environment or external disturbance. So, set the mounting position at the center of the appropriate operating range again.

2. Do not use solvents such as benzene, thinner etc. to clean the product.

They could damage the surface of the body and erase the markings on the body. For heavy stains, use a cloth lightly dampened with diluted neutral detergent, then wipe up any residue with a dry cloth.

Outline

This operation manual explains “Rack and Pinion Type Mini Rotary actuator”.
When using the product, load (moment of inertia), rotation time and other factors have to be considered.
So, confirm the specification of the product prior to use.

Specifications

Table 1. Specifications

Size	05		1	
	Basic type	With external stopper	Basic type	With external stopper
Fluid	Air(Non-lube)			
Maximum operating pressure	0.7 MPa			
Minimum operating pressure	0.15 MPa			
Ambient and fluid temperature	0~60°C (No freezing)			
Rotation angle	90 ₀ ^{+8°} , 100 ₀ ^{+10°} 180 ₀ ^{+8°} , 190 ₀ ^{+10°}	90°, 180°	90 ₀ ^{+8°} , 100 ₀ ^{+10°} 180 ₀ ^{+8°} , 190 ₀ ^{+10°}	90°, 180°
Angle adjustment range	—	Each rotation end ±5°	—	Each rotation end ±5°
Cylinder bore size	φ 6		φ 8	
Port size	M3X0.5			

Table 2. Allowable kinetic energy and adjustable range of rotation time

Size			Allowable kinetic energy (mJ)	adjustable range of rotation time safe in operation (s/90°) *
05	Basic type	CRJB05	0.25	0.1~0.5
	With external stopper	CRJU05	1.0	
1	Basic type	CRJB1	0.40	
	With external stopper	CRJU1	2.0	

* Operation at speed lower than the adjustable range of rotation time may cause stick slip phenomenon
Or operation stop.

Mass

Table 3. Mass (g)

Size		Model No.	Mass*
Basic type	05	CRJB05-90	32
		CRJB05-100	
		CRJB05-180	39
		CRJB05-190	
	1	CRJB 1-90	54
		CRJB 1-100	
		CRJB 1-180	67
		CRJB 1-190	
With external stopper	05	CRJU05-90	47
		CRJU05-180	53
	1	CRJU1-90	70
		CRJU1-180	81

*Mass of auto switch is not included.

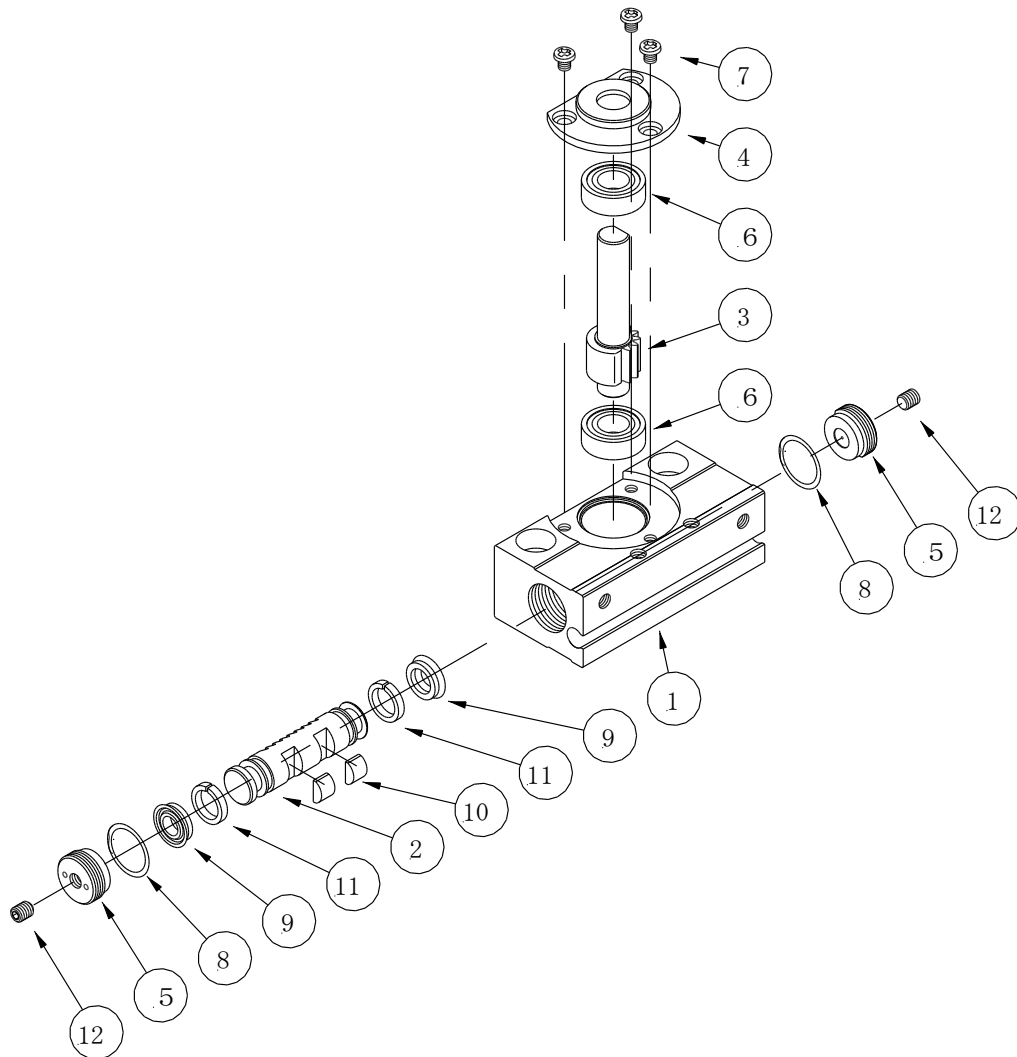
Effective torque

Table 4. Effective torque table (N·m)

Size	Operating pressure(MPa)						
	0.15	0.2	0.3	0.4	0.5	0.6	0.7
05	0.013	0.017	0.026	0.034	0.042	0.050	0.059
1	0.029	0.038	0.057	0.076	0.095	0.11	0.13

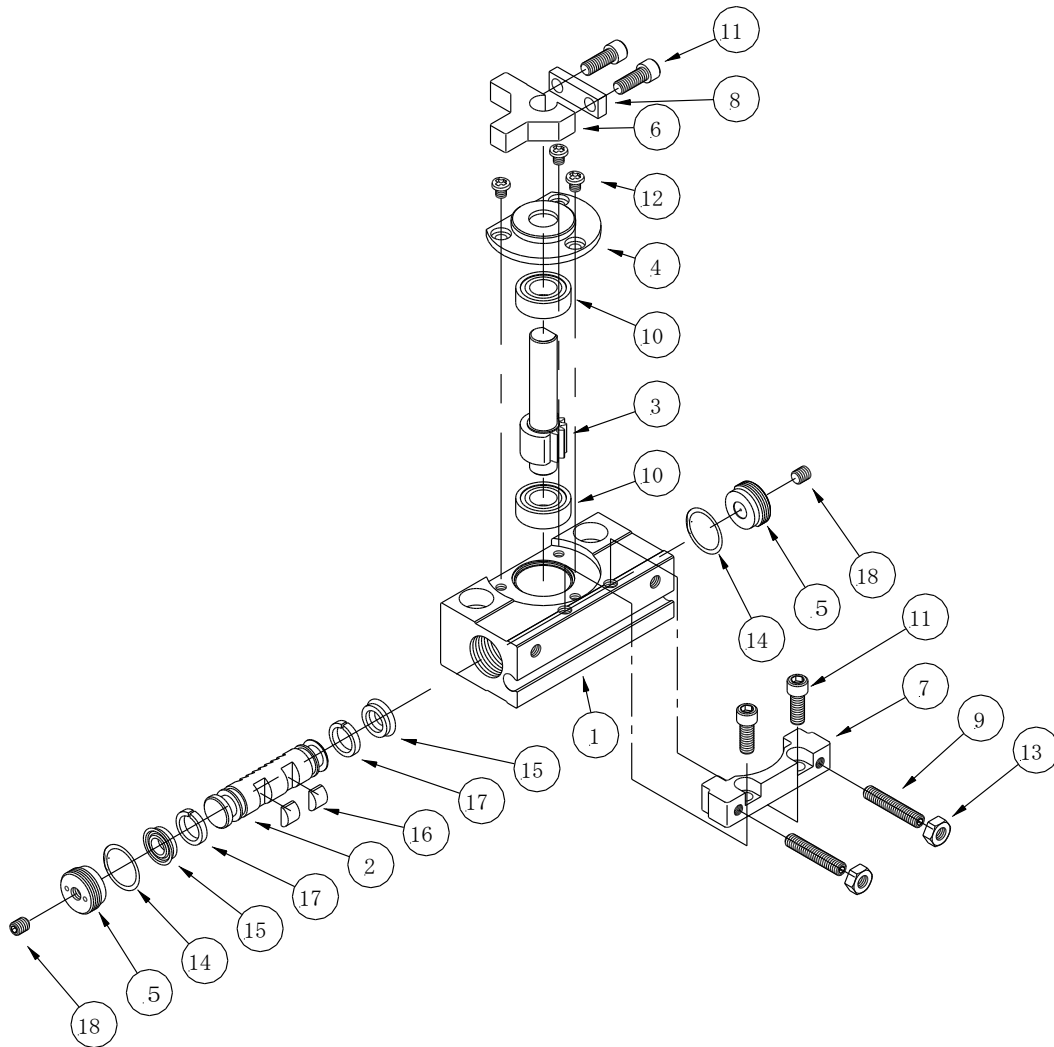
Internal structure and parts description

CRJB05~1



12	Hexagon socket head set screw	2	
11	Wear ring	2	
10	Magnet	2	
9	Piston seal	2	
8	O-ring	2	
7	Round head no. 0 Philips screw	3	
6	Bearing	2	
5	Cover	2	
4	Bearing retainer	1	
3	Shaft	1	
2	Piston	1	
1	Body	1	
No	Description	Qty.	Note

CRJU05~1



18	Hexagon socket head set screw	2	
17	Wear ring	2	
16	Magnet	2	
15	Piston seal	2	
14	O-ring	2	
13	Hexagon nut	2	
12	Round head no. 0 Philips screw	3	
11	Hexagon socket head cap screw	4	
10	Bearing	2	
9	Hexagon socket head set screw	2	
8	Stopper retainer	1	
7	Holder	1	
6	Stopper	1	
5	Cover	2	
4	Bearing retainer	1	
3	Shaft	1	
2	Piston	1	
1	Body	1	
No	Description	Qty.	Note

Basic circuit for using rotary actuator

Circuit structure

The basic circuit for operating the rotary actuator using an air filter, regulator, solenoid valve and speed controller is shown in Fig. (1) below.

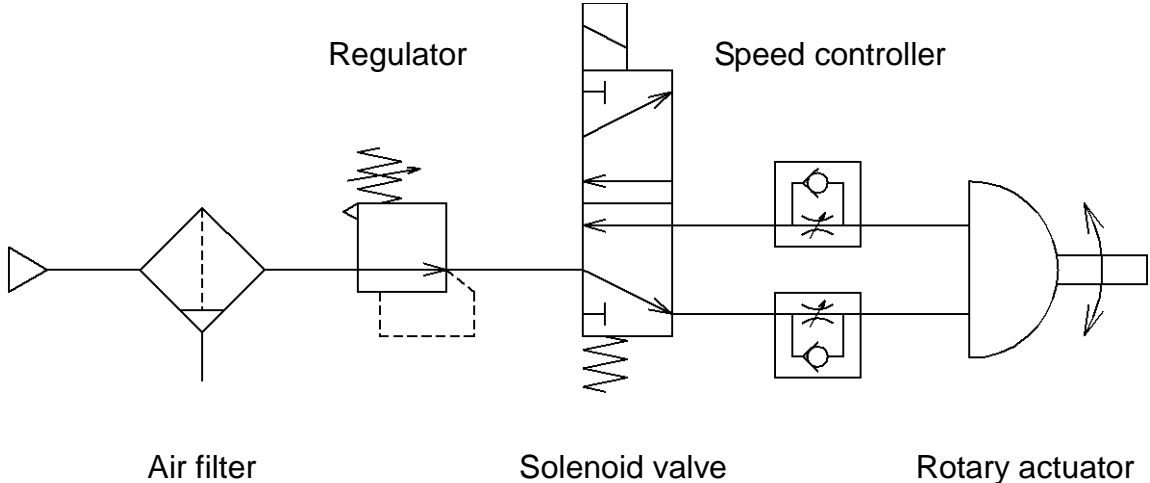


Fig.1 Basic circuit

Mounting

Load restrictions

Provided that a dynamic load is not generated, a load in the axial direction can be applied up to the value that is indicated in the table (5) below. However, applications in which the load is applied directly to the shaft should be avoided as much as possible.

Table 5. Allowable shaft load

Size	Allowable radial load F_r (N)	Allowable thrust load (N)	
		F_s (a)	F_s (b)
0.5	2.5	2.0	2.0
1	3.0	2.5	2.5

The methods such as those described below are recommended to prevent the load from being applied directly to the shaft in order to ensure a proper operating condition.

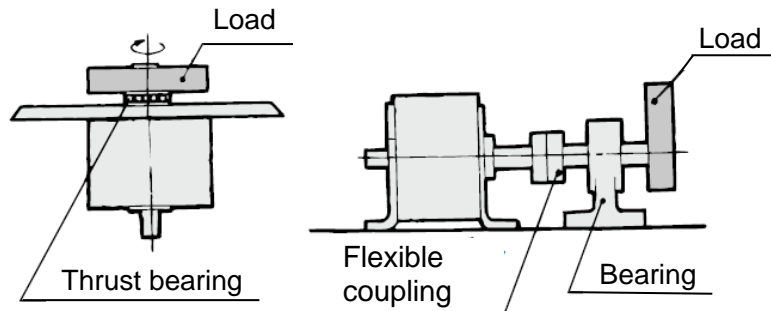


Fig. 2 Bearing

Operation of shaft couplings

As in Fig. (3), alignment of the rotary actuator and the mating axis is necessary when the rotary actuator is used with its axis lengthened. If misaligned, the axis is applied with excessive bend moment. Under this condition, stable operation is not available which lead to cause the damage of axis. In this case, flexible fitting (flexible joint specified by JIS) becomes necessary.

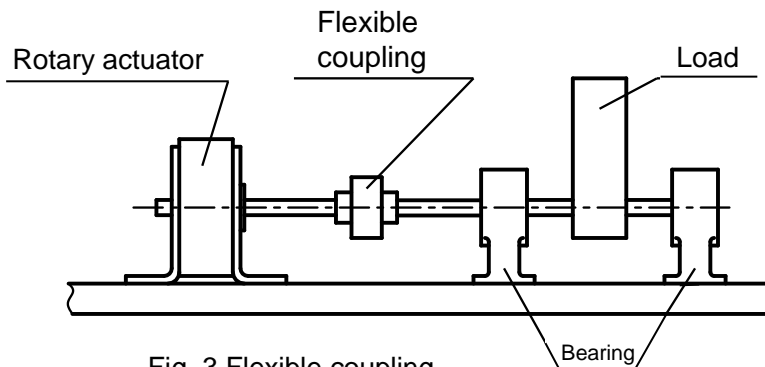
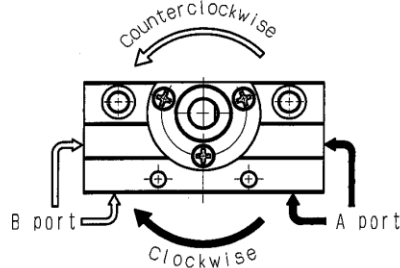


Fig. 3 Flexible coupling

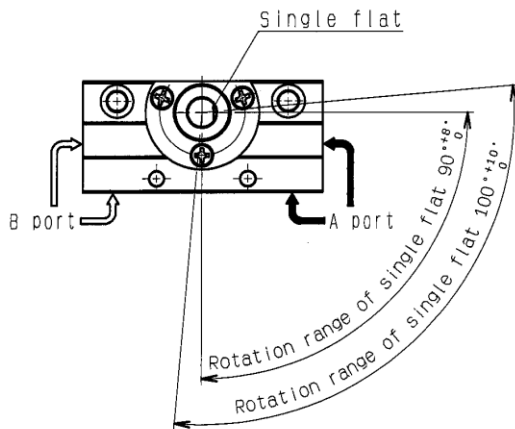
Rotating Direction and Rotating Angle

- The shaft turns clockwise when the A port is pressurized, and counterclockwise when the B port is pressurized.
- For actuators with external stopper, the rotation end can be set within the range shown in the drawing by adjusting the stopper bolt.

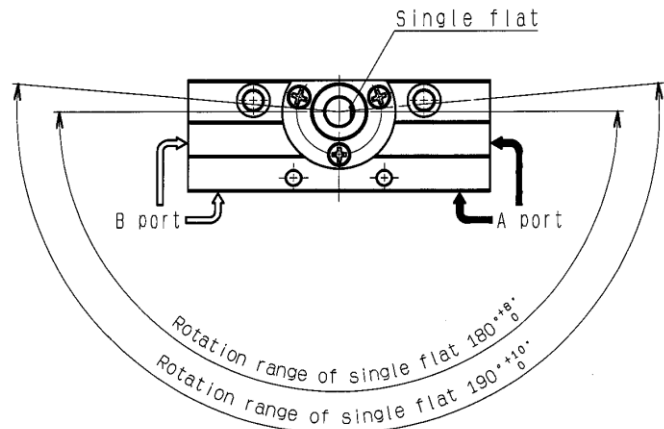


Basic type

For 90° and 100°

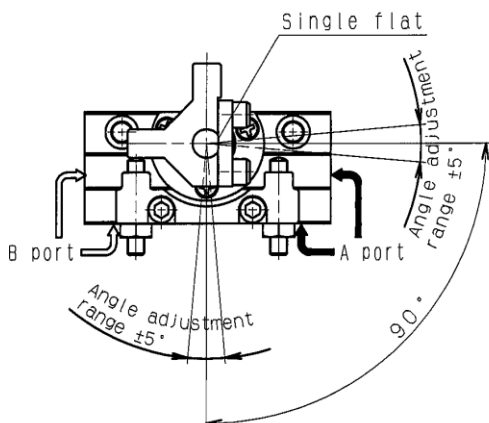


For 180° and 190°

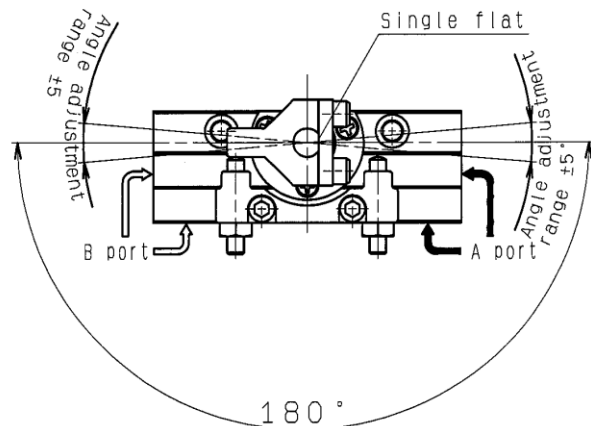


With external stopper

For 90°



For 180°



Note)

- The drawings show the rotation range for the shaft's single flat.
- The single flat position in the drawings shows the counterclockwise Rotation end when the rotation angle is adjusted to 90° and 180° .

Using a body as a flange

Mini rotary actuator can be mounted from 3 directions, 2 shaft directions and 1 side direction.

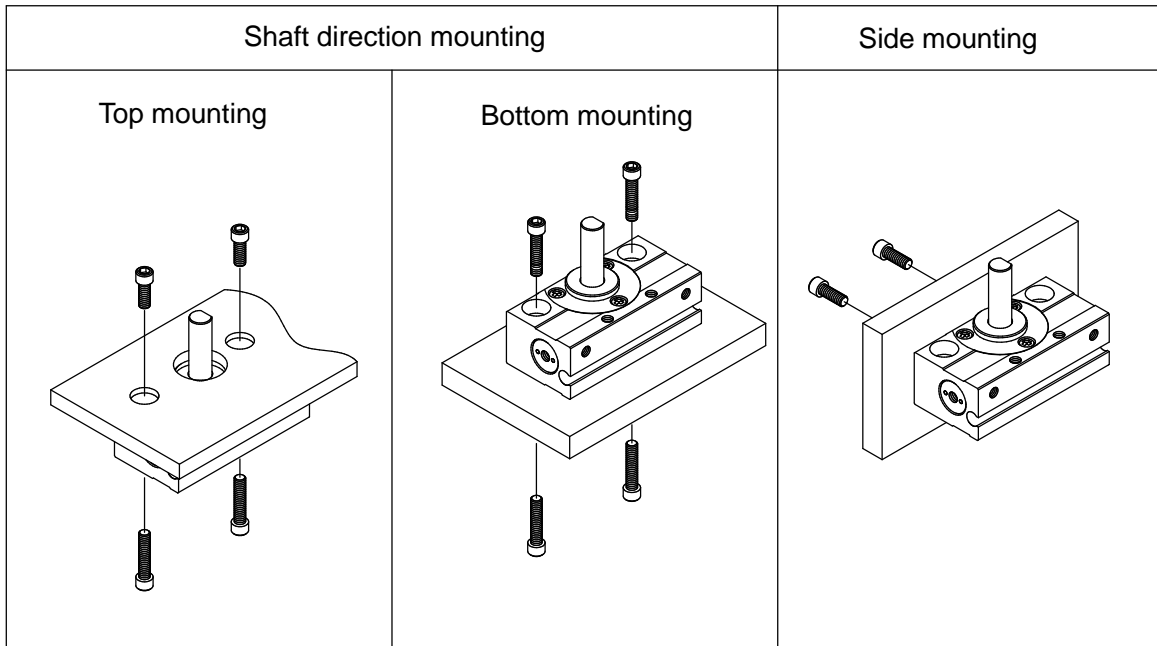


Table 6. Mounting dimension in shaft direction

Size	Bolt	
	Body tap	Body through hole
05	M4X0.7	M3
1	M5X0.8	M4

Table 7. Mounting dimension on side face

Size	Bolt	Tap depth
05	M4X0.7	5
1	M5X0.8	6

Piping

Fig. (4) and Table (8) show port position and size.

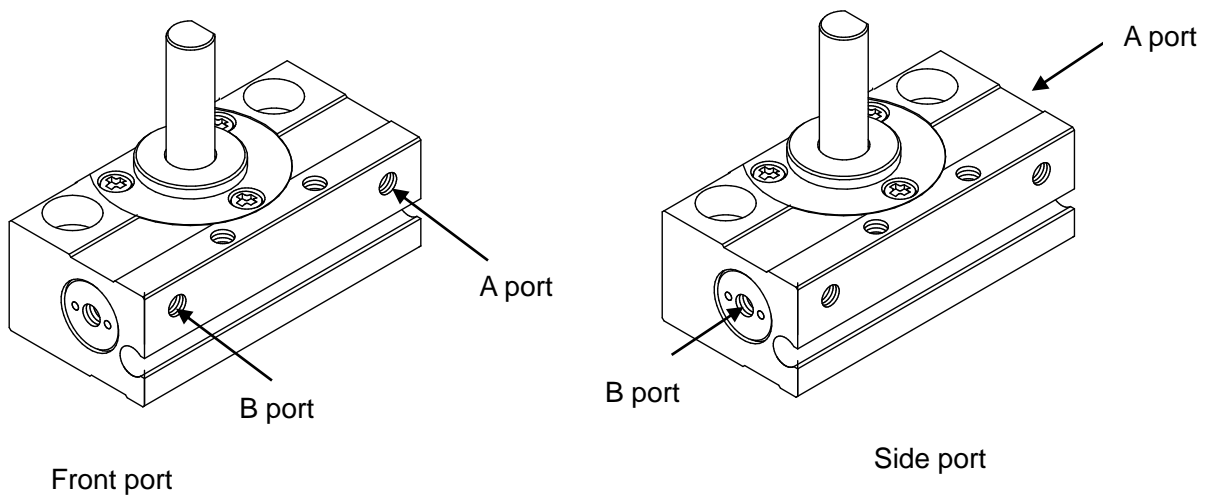


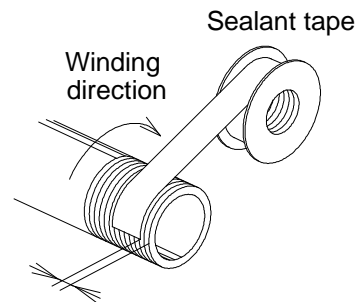
Fig.4 Port position

Table 8. Port size

Size	Port size	
	Front port	Side port
05	M3X0.5	
1		

Preparation before piping.

- a) Before piping is connected, it should be thoroughly blown out with air to remove dust and scale from inside the pipe. Dust and scale on the inlet side of the filter can be removed, but those on the outlet side cannot be removed, so they can enter the solenoid valve or rotary table, which causes malfunction or shortens product life.
- b) When screwing piping or fittings into ports, ensure that chips from the pipe threads or sealing material do not enter the piping. Also, if pipe tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



Expose approx. 2 threads

Fig. 5 Wrapping of pipe tape

■ Air supply

Air supplied to the rotary actuator shall be cleaned by the filter. CRJ series is lubrication free.

Setting of rotation time

It is necessary to calculate the inertial load and kinetic energy in the application prior to setting the speed of the actuator. The inertial load generated in the application may be high even if the torque required in the application is low, this may lead to damage to the internal components of the actuator.

Moment of inertia

The moment of inertia indicates how hard it is to rotate an object, and also how hard it is to stop the object once it is rotating.

An object started by the rotary actuator is getting to have inertial force.

When the rotary actuator stops at the stroke end, the actuator will receive a big impact (kinetic energy) due to the inertial force.

Please refer below for calculation of kinetic energy.

$$E = \frac{1}{2} \cdot I \cdot \omega^2$$

E: Kinetic energy [J]

I: Moment of inertia [$kg \cdot m^2$]

ω : Angular speed [rad/s]

Allowable kinetic energy for the rotary actuator is limited. The limit of rotation time is obtained by calculating the moment of inertia.

Please refer below to calculate the moment of inertia.

Basic moment of inertia

$$I = m \cdot r^2$$

m : Weight [kg]

r : Center of gravity of load and distance of rotational axis [m]

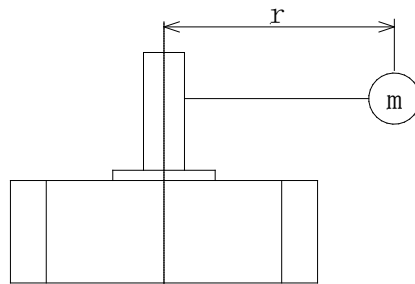


Fig. 6 Moment of inertia

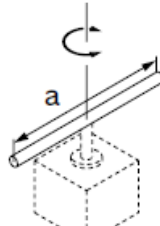
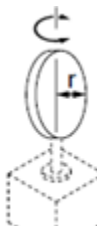
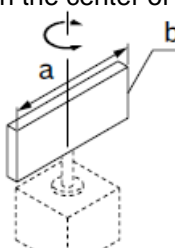
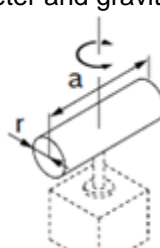
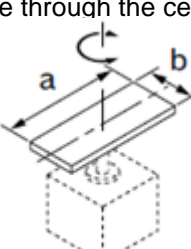
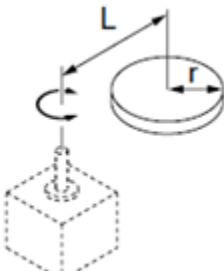
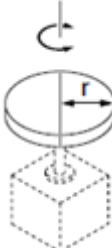
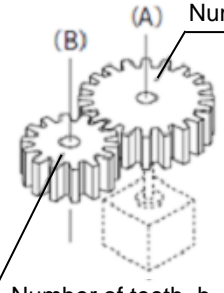
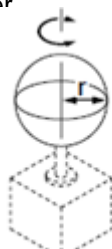
This shows moment of inertia of "m (weight)" at "r" distance from the axis of rotation.

The calculation for the moment of inertia depends on the shape of the object.

Please refer the table on the next page for the moment of inertia calculations.

Calculation formulae for moment of inertia

I: Moment of inertia [kg · m²] m: Load mass [kg]

<p>1. Thin shaft Position of rotational axis: Perpendicular to the shaft through the center of gravity</p>  $I = m \cdot \frac{a^2}{12}$	<p>6. Thin round plate Position of rotational axis: Through the center of diameter</p>  $I = m \cdot \frac{r^2}{4}$
<p>2. Thin rectangular plate Position of rotational axis: Parallel side b and through the center of gravity</p>  $I = m \cdot \frac{a^2}{12}$	<p>7. Cylinder Position of rotational axis: Through the center of diameter and gravity</p>  $I = m \cdot \frac{3r^2 + a^2}{12}$
<p>3. Thin rectangular plate (Including Rectangular parallelepiped) Position of rotational axis: Perpendicular to the plate through the center of gravity</p>  $I = m \cdot \frac{a^2 + b^2}{12}$	<p>8. When the rotational axis and load center of gravity are not consistent</p>  <p>$I = K + m \cdot L^2$ K: Moment of inertia around the load center of gravity</p> <p>4.Round plate $K = m \cdot \frac{r^2}{2}$</p>
<p>4. Round plate (Including column) Position of rotational axis: Through the center axis</p>  $I = m \cdot \frac{r^2}{2}$	<p>9. Gear transmission</p>  <p>Number of teeth=a Number of teeth=b</p> <ol style="list-style-type: none"> 1. Find the moment of inertia I_B for the rotation of shaft (B). 2. I_B is converted to the rotation of the shaft (A). $I_A = \left(\frac{a}{b}\right)^2 \cdot I_B$
<p>5. Solid sphere Position of rotational axis: Through the center of diameter</p>  $I = m \cdot \frac{2r^2}{5}$	

Kinetic energy

Table (9) shows the allowable kinetic energy of the rotary actuator.

The end angular speed ω is obtained by:

$$\omega = \frac{2\theta}{t}$$

θ : Rotation angle [rad]

t : Rotation time [s]

Kinetic energy E is obtained by:

$$E = \frac{1}{2} \times I \times \omega^2$$

Table 9. Allowable kinetic energy (J)

Model		Allowable kinetic energy (mJ)
Basic type	CRJB05	0.25
With external stopper	CRJU05	1.0
Basic type	CRJB1	0.40
Basic type	CRJU1	2.0

Therefore, the rotary table rotation time is:

$$t \geq \sqrt{\frac{2 \times I \times \theta^2}{E}}$$

E: Allowable kinetic energy [J]

θ : Rotation range [rad]

I: Moment of inertia [kg · m²]

During uniform acceleration, the angular acceleration ω after t seconds can be found as follows.

$$\omega = \dot{\omega} \cdot t \quad \dots (1)$$

$$\theta = \dot{\omega} dt = \frac{1}{2} \dot{\omega} t^2 + C \quad \dots (2)$$

When $t = 0$, rotation angle $\theta = 0$, so the integration constant is $C = 0$.

$$\theta = \frac{1}{2} \dot{\omega} t^2 = \frac{1}{2} \omega t$$

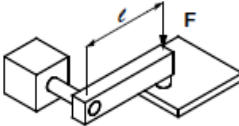
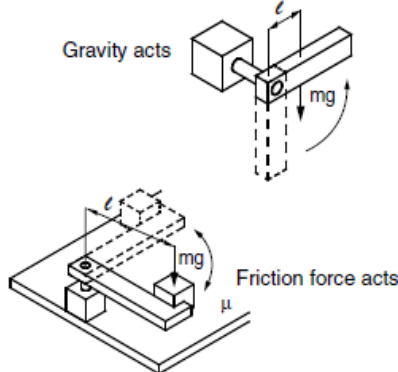
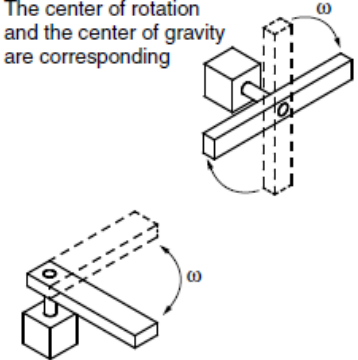
thus,

$$\omega = \frac{2\theta}{t}$$

Calculation of required torque

Load type

The calculation method required torque varies depending on the load type.

Load type		
Static load: T_s	Resistance load: T_f	Inertial load: T_a
When the pressing force is necessary (clamp, etc.)	When friction force or gravity is applied to the rotation direction	When the load with inertia is rotated
		
$T_s = F \cdot l$ T_s : Static load (N·m) F : Clamp force (N) l : Distance from the center of rotation to clamp (m)	When gravity acts to the rotation direction $T_f = m \cdot g \cdot l$ When friction force acts to the rotation direction $T_f = \mu \cdot m \cdot g \cdot l$ T_f : Resistance load (N·m) m : Mass of load (kg) g : Gravitational acceleration 9.8 (m/s ²) l : Distance from the center of rotation to the gravity or friction force acting point (m) μ : Coefficient of friction	$T_a = I \cdot \ddot{\omega} = I \cdot \frac{2\theta}{t^2}$ T_a : Inertial load (N·m) I : Moment of inertia (kg·m ²) $\ddot{\omega}$: Angular acceleration (rad/s ²) θ : Rotating angle (rad) t : Rotation time (s)
Required torque $T = T_s$	Required torque $T = T_f \times (3 \text{ to } 5)$ <small>Note 1)</small>	Required torque $T = T_a \times 10$ <small>Note 1)</small>
<ul style="list-style-type: none"> Resistance loads → Gravity or friction applies in the rotation direction. Example 1) The axis of rotation is in a horizontal (lateral) direction, and the center of rotation and center of gravity of the load are not the same. Example 2) The load slips against the floor while rotating. *The necessary torque equals the total of the resistance load and inertial load. $T = T_f \times (3 \text{ to } 5) + T_a \times 10$ Non-resistance loads → Gravity or friction does not apply in the rotation direction. Example 1) The axis of rotation is in a perpendicular (vertical) direction. Example 2) The axis of rotation is in a horizontal (lateral) direction, and the center of rotation and center of gravity of the load are the same. *The necessary torque equals the inertial load only. $T = T_a \times 10$ 		

Note 1) In order to adjust the velocity, it is necessary to have a margin of adjustment for T_f and T_a .

Auto switch type for rotary actuator

The rotary actuator has a magnet mounted on its piston and an auto switch on the outside of the body to detect the piston position (single flat and key groove position). Rotary actuator have a short piston stroke, so detection should be done at the stroke end.

Auto switch specification

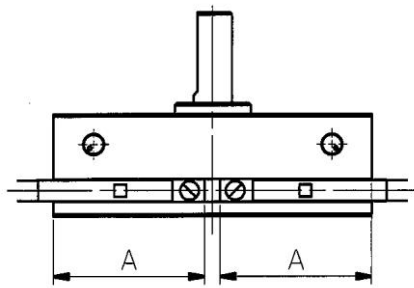
Table 10. Solid state auto switch specification

Auto switch Model no.	Output	Power voltage	Current consumption	Load voltage	Load current	Internal voltage drop	Current leakage	Applicable load
D-M9N D-M9NV D-M9NW D-M9NWV	NPN Type	DC5·12·24V (4.5to 28V)	10mA or less	DC28V or less	40mA or less	At 10mA 0.8V or less At 40mA 2V or less	100μA or less at DC24V	Relay PLC IC circuit
D-M9P D-M9PV D-M9PW D-M9PWV	PNP type			—				
D-M9B D-M9BV D-M9BW D-M9BWV	—	—	—	DC24V (DC10 to 28V)	2.5 to 40mA	4V or less	0.8mA or less	DC24V Relay PLC

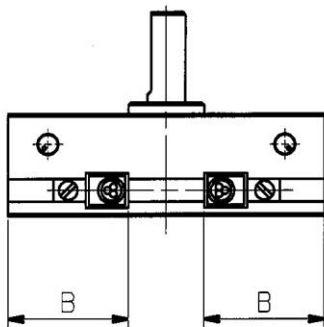
Auto switch Model no.	Output	Power voltage	Current consumption	Load voltage	Load current	Internal voltage drop	Current leakage	Applicable load
D-F8N	NPN Type	DC5·12·24V (4.5to 28V)	10mA or less	DC28V or less	40mA or less	1.5V or less	100μA or less at DC24V	DC24V Relay PLC IC circuit
D-F8P	PNP type			—	80mA or less	0.8V or less		
D-F8B	—	—	—	DC24V (DC10 to 28V)	2.5 to 40mA	4V or less	0.8mA or less at DC24V	DC24V Relay PLC

- Isolation resistance — 50MΩ or more at DC500VM (between lead wire and case)
- Withstand voltage— AC1000V for 1 minute (between lead wire and case)
- Operating time — 1ms or less
- Ambient temperature — -10 to 60°C
- Shock resistance — 1000m/s²
- Enclosure — Standard: IEC60529, watertight: IP67(JISC0920)

■ Proper auto switch mounting position and operating range



For D-M9



For D-F8

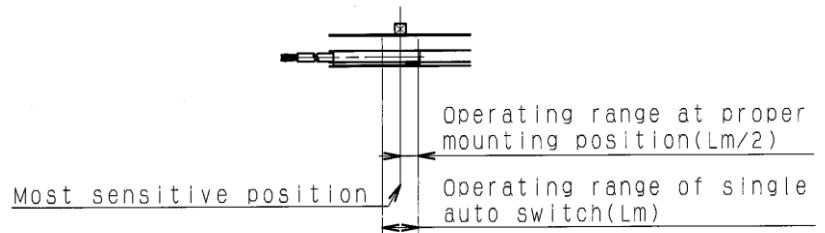


Fig.8 operating range of auto switch

Fig.7 Proper auto switch mounting position

Table 11. Auto Switch Rotation range / Actuation / most sensitive position

Size	Rotating angle	D-M9 auto switch			D-F8 auto switch		
		A (mm)	Operation angle θ_m	Hysteresis angle	B (mm)	Operation angle θ_m	Hysteresis angle
05	90	20.5	46°	10°	16.5	20°	10°
	180	23.2			19.2		
1	90	22.4	41°	10°	18.4	15°	10°
	180	25.6			21.6		

Operating angle θ_m : Value of the operating range “Lm” of a single auto switch converted to an axial rotating angle.

Hysteresis angle : Value of auto switch hysteresis converted to an angle.

Note) The values given in the table above are representative values, not meant to be guaranteed. In the actual setting, adjust the value after confirming the auto switch performance.

■ Cautions on mini rotary actuator with auto switch

If a size 05 actuator with auto switch is being used, keep the magnetic body away at least 2mm or more from the bottom of the actuator.

If the magnetic body comes closer than 2mm, malfunction of the auto switch may occur due to the magnetic force drop.

*When using the bottom face for mounting, a non-magnetic spacer (such as aluminum) is required as shown below.

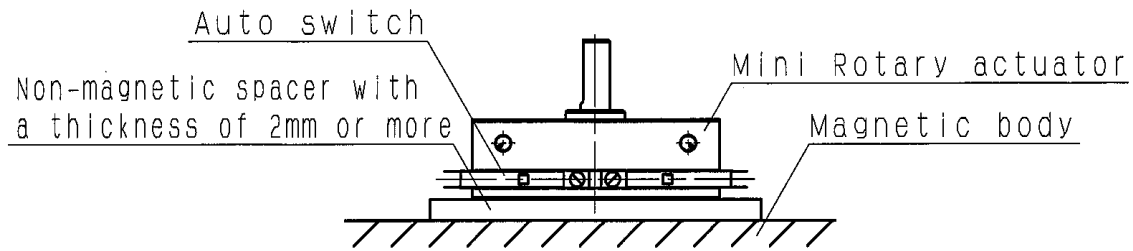


Fig.9

Maintenance and Inspection

Periodic inspection is necessary for optimum use. Generally, annual inspection is recommended for the mini rotary actuator. Even if no problem is found, seal parts replacement is recommended every three years. It is highly possible that the actuator is operated out of specification when the components like shaft, piston, bearing are broken. Please revise the operating condition. In this case, please return the broken actuator to SMC to repair.

Periodic inspection

Check the following for periodic inspection

- (1) Check actuator mounting table for looseness
- (2) Check actuator for rotating operation
- (3) Check actuator for rotation angle and rotation position
- (4) External / internal leakage
- (5) Check stopper bolt fixed with nut for looseness
- (6) Switch ON / OFF operation

If any items are found during the inspection that require repairing or tightening, either tighten the loose components or the product to repair.

《caution》 Special tools are necessary to disassemble this product.
Please contact us when maintenance is necessary.

External stopper assembly procedure

Order external stopper unit with the unit part numbers shown below.

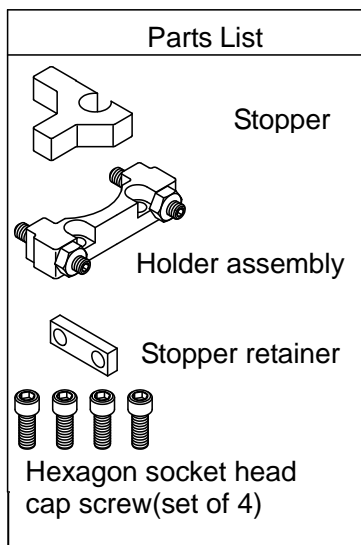
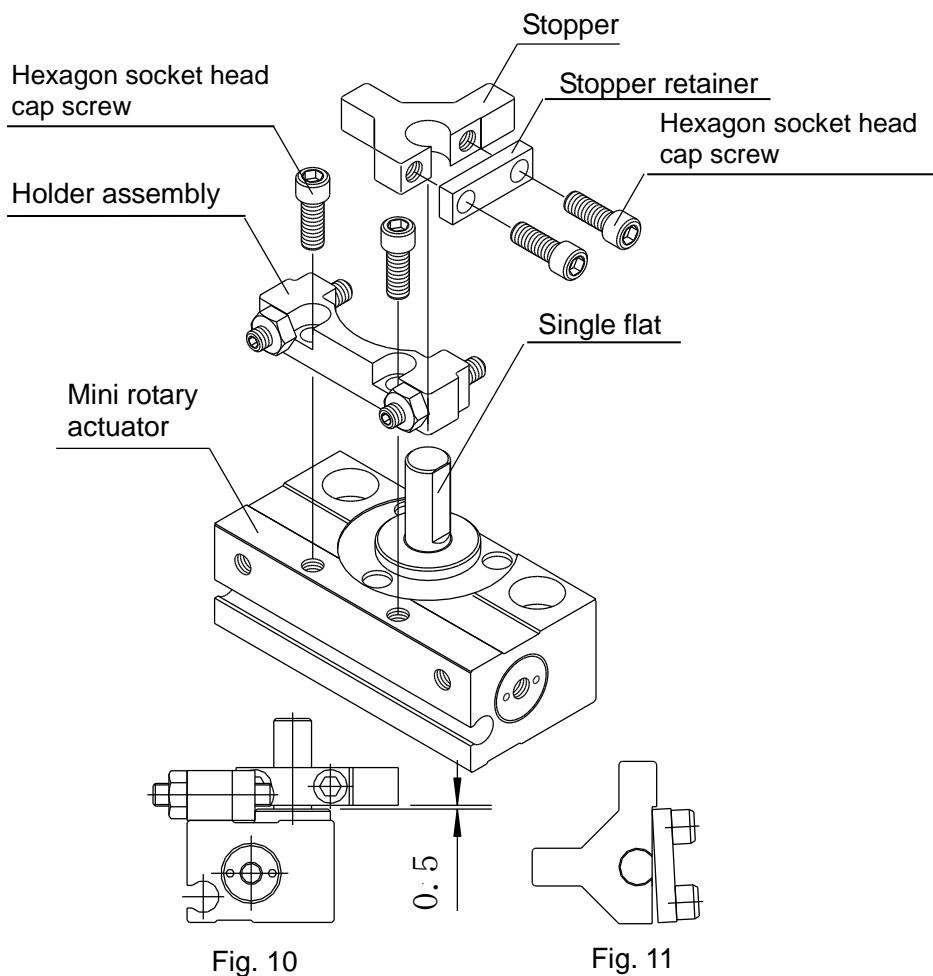


Table 12.

Model	Unit part no.
CRJU05-90	P531010-1
CRJU05-180	P531010-2
CRJU1-90	P531020-1
CRJU1-180	P531020-2

Note 1) External stopper units for 180° cannot be applied to the 90° Mini rotary actuators.

Note 2) When using external stoppers for 90°, use Mini rotary actuators with a rotation range of 100°, and for 180°, Use actuators with a rotation range of 190°.



- ① Assemble the stopper retainer to the stopper temporarily.
 Then place the stopper retainer in the single flat position and tighten with hexagon socket head cap screws. Leave a space of approximately 0.5mm between the stopper and the Mini rotary actuator, as shown in Fig. (10).
 Tighten the hexagon socket head cap screws evenly so that the stopper retainer is not unevenly tightened as in Fig. (11).
 ▼ Furthermore, take precautions to avoid applying excessive force to the shaft when tightening.
- ② Tighten the holder assembly with hexagon socket head cap screws.

Table 13. Tightening torque

	Tightening torque(N·m)
Hexagon socket head cap screw	0.8 to 1.2

Troubleshooting

Problem	Possible cause	Solution
Rotary actuator does not move	Supply pressure is not applied correctly.	Correctly set the regulator at the supply pressure side.
	The directional switching valve (such as a solenoid valve) does not switch.	Correctly apply a signal to the directional switching valve (such as a solenoid valve).
	Air leakage from piping.	Inspect the piping and stop the leakage.
	The restrictor in the port is clogged.	Clean the restrictor. Take the following countermeasures: (1) Blow air through the piping again. (2) Inspect the air filter.
Operation is not smooth. (stick-slip)	The load has some friction.	Reduce the friction resistance.
	Actuator axis and mating axis not aligned.	Align the two centers or use a flexible fitting.
	Insufficient output due to a low supply pressure.	To obtain stable operation, adjust the supply pressure to make the load ratio appropriate.
	Speed controller is restricted too much.	Adjust the speed controller so that the rotating marks will be in the adjusting range.
Extreme rotating angle changes.	Internal parts are broken.	Replace the rotary actuator with the new one. After that, take the measures below. (1) Calculate the kinetic energy applied to the rotary actuator and adjust the load and rotation speed to make the value within the allowable kinetic energy. (2) Mount an external stopper or shock absorber to absorb the impact force. In this case, provide a buffer angle to the stroke of the actuator(Use 100° actuator in the case of 90° stroke.) and touch it to an external stopper or the shock absorber surely.

Problem	Possible cause	Solution
Air leakage from the Shaft.	Piston seal is worn out.	Contact SMC for repair. After that, take the measures below. (1)Inspect the air filter, do blow air through the piping.
The pinion gear is broken.	Excessive kinetic energy was applied to the rotary actuator.	Replace the rotary actuator with the new one. After that, take the measures below. (1)Calculate the kinetic energy applied to the rotary actuator and adjust the load and rotation speed to make the value within the allowable kinetic energy. (2)Mount an external stopper or shock absorber to absorb the impact force. In this case, provide a buffer angle to the stroke of the actuator(Use 100° actuator in the case of 90° stroke.) and touch it to an external stopper or the shock absorber surely.
Insufficient rotating Angle.	There is no margin on rotation angle of actuator, hence rotation range of actuator is unsymmetrical with respect to external stopper.	Remove the external stopper and confirm the all rotations range of the actuator, and install external stopper in correct position. When external stopper is used, it is recommended to use 100° for 90° and 190° for 180° .
The auto switch will not operate or operates incorrectly.	The auto switch is mounted in an inappropriate position.	Mount the auto switch in the correct position.
	Effect of an external magnetic field.	Check that there is no strong magnetic field present.
	Trouble with the electrical circuit	Check that there is no trouble with the electrical circuit.
	Trouble with the electrical specification	Check there is no trouble with the electrical specification.

Revision history
A:Corrected to the latest format

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