



# Operation Manual

PRODUCT NAME

Rotary Table: High Precision Type

MODEL / Series / Product Number

MSUA1,3,7,20

**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)<sup>\*)</sup>, and other safety regulations.

\*) ISO 4414: Pneumatic fluid power - General rules and safety requirements for systems and their components  
ISO 4413: Hydraulic fluid power - General rules and safety requirements for systems and their components  
IEC 60204-1: Safety of machinery - Electrical equipment of machines - Part 1: General requirements  
ISO 10218-1: Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots  
etc.



## **Danger**

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



## **Warning**

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



## **Caution**

**Caution** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate 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. Our products cannot be used beyond their specifications. Our products are not developed, designed, and manufactured to be used under the following conditions or environments. Use under such conditions or environments is not covered.**

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.
2. Use for nuclear power, railways, aviation, space equipment, ships, vehicles, military application, equipment affecting human life, body, and property, fuel equipment, entertainment equipment, emergency shut-off circuits, press clutches, brake circuits, safety equipment, etc., and use for applications that do not conform to standard specifications such as catalogs and operation manuals.
3. Use for interlock circuits, except for use with double interlock such as installing a mechanical protection function in case of failure. Please periodically inspect the product to confirm that the product is operating properly.



# Safety Instructions

## Caution

We develop, design, and manufacture our products to be used for automatic control equipment, and provide them for peaceful use in manufacturing industries.

**Use in non-manufacturing industries is not covered.**

Products we manufacture and sell cannot be used for the purpose of transactions or certification specified in the Measurement Act.

The new Measurement Act prohibits use of any unit other than SI units in Japan.

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## 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.\*2)  
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.

**\*2) Vacuum pads are excluded from this 1 year warranty.**

A vacuum pad is a consumable part, so it is warranted for a year after it is delivered.

Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty

### 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.

# 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.)

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 table 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 table's cushion to absorb the shock. Therefore, provide a speed-reduction circuit to reduce the rotary table'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 table 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 table 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 table will not cause a hazard to humans or damage the equipment.

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

Devise a safe design so that the restarting of the rotary table will not pose a hazard to humans or damage the equipment. Install manually controlled equipment for safety when the rotary table 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 table's speed reduction capability could become severely affected, which could pose a hazard to humans and damage the machinery and equipment.

### 12. Ensure the load energy within the product's allowable energy value.

If the kinetic energy of the load exceeds the allowable value, it could damage the product, and cause a hazard to humans, or 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, or 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) Give consideration to the decline in strength**

caused by changes in the shaft shape.

Some shaft types, such as simple specials, may have shapes and dimensions that result in decreased strength when compared with standard models. Consider this carefully when using

**(16) Do not use two or more rotary actuators with the aim of synchronized movement.**

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

**(17) Do not use in a location where external leakage of lubricant could have an adverse effect.**

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.

**(18) Do not disassemble the product or make any modifications, including additional machining.**

This may cause human injury and/or an accident.

**(19) Refer to the Auto Switches Precautions when 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.

### **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 table 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.**

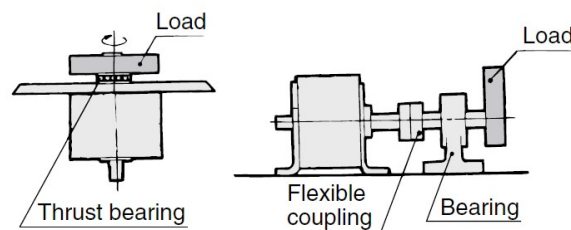
If the hole diameter is enlarged, the product's rotation speed will increase, causing the shock force to increase and damage to the product. As a result, it could pose a hazard to humans and damage the machinery and equipment.

#### **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, or 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.**

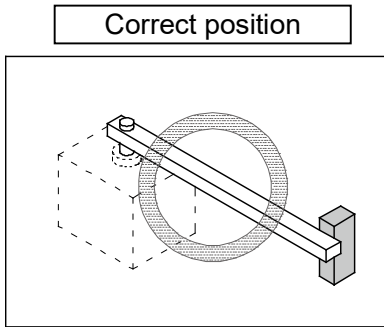
When rotational force from an external spring, etc., acts and generates negative pressure on the product's interior, breakage of the internal seal or acceleration of abrasion may occur.

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

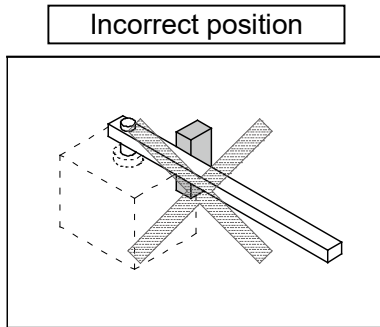
If the stopper is placed near the rotating table, the torque that is generated by the product itself will cause the reaction force which is directed to the stopper to be redirected and applied to the rotating table. This will lead to the breakage of the rotating table and bearing. As a result, it could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

**Precautions when Using External Stoppers**

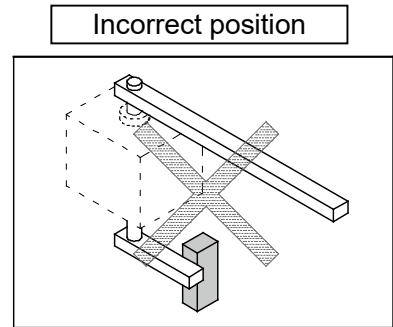
- Be sure to install external stoppers in the proper places. Installation in the wrong place can result in equipment breakage, which could damage other equipment or cause human injury.



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

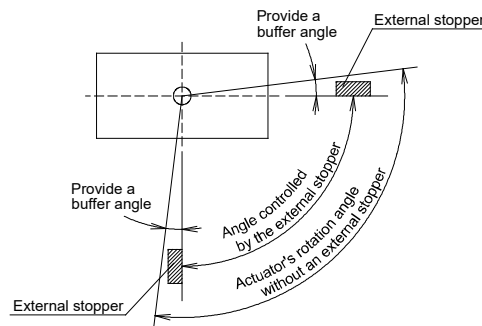


The external stopper becomes a fulcrum, resulting in the load's inertia force being applied to the table as a bending moment.



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.

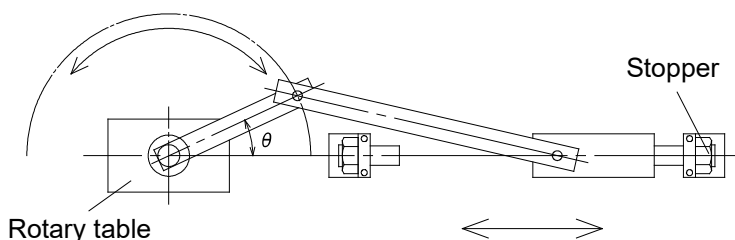
- Install external stoppers within the range of the rotating angle. Installing an external stopper at the maximum rotation angle may result in an inability to fully absorb the kinetic energy generated, and damage to equipment may occur.
- Angle adjustment is available for this product. When using an 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  $\theta$  at the operation end may result in the torque of the rotary table 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  $\theta$  at the operation end, to make sure the load generated does not exceed the allowable value for the product.





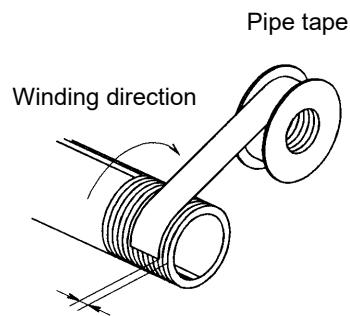
## Caution

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 table by securing the body or hit the body by securing the rotating table.**  
These actions could cause the table to bend or damage the bearing.
3. **Do not place your foot directly on the table or on the equipment that is coupled to the table.**  
Placing one's weight directly onto the rotating table could cause the rotating table 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 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.



Leave approx. 2 threads exposed

## Speed and Cushion 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**  
Use 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 that include organic solvents, salt, corrosive gases, etc., as it can cause damage or malfunction.

### **Caution**

1. **When low dew point 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. Install an air filter.**
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 tables. 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 table 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.  
Please refer to Table 13 on page 37 for where to apply grease and the grease to use.

# 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 problems by providing a mechanical protection function, or by 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.**

This may cause human injuries and accidents.

### **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:

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

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

When multiple auto switch rotary tables 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 table 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 table, 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 tables. 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 table mounting status or mounting bracket. Select an appropriate auto switch setting position where the auto switch does not interfere with the rotary table mounting bracket (trunnion or reinforcing ring) after checking it sufficiently.

## 8. Keep wiring as short as possible.

### <Reed>

As the length of the wiring to a load gets longer, the rush current at switching ON becomes greater, and this may shorten the product's life. (The switch will stay ON all the time.)

- 1) Use a contact protection box when the wire length is 5m or longer.
- 2) Even if an auto switch has a built-in contact protection circuit, when the wiring is more than 30m long, it is not able to adequately absorb the rush current and its life may be reduced. It is again necessary to connect a contact protection box in order to extend its life.

### <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.

### <Reed>

If a surge voltage is generated, the discharge occurs at the contact, possibly resulting in the shortening of product life.

If driving a load such as a relay that generates a surge voltage, use an auto switch with built-in contact protection circuit or use a contact protection box.

### <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.

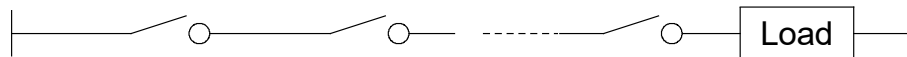
### <Reed>

- 1) Auto switch with an indicator light

- If auto switches are connected in series as shown below, take note that there will be a large voltage drop because of internal resistance in the light emitting diodes. (Refer to the internal voltage drop in the auto switch specifications.)

[The voltage drop will be "n" times larger when "n" auto switches are connected.]

Even though an auto switch operates normally, the load may not operate.



- In the same way, when operating under a specified voltage, although an auto switch may operate normally, the load may not operate. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

$$\text{Supply voltage} - \text{Internal voltage drop of auto switch} > \text{Minimum operating voltage of load}$$

- 2) If the internal resistance of a light emitting diode causes a problem, select an auto switch without an indicator light.

### <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, even if the auto switches operate correctly, 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.

### <Solid state / 2-wire type>

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

Operating current of load (OFF condition) > 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 (300m/s<sup>2</sup> or more for reed auto switches and 1000m/s<sup>2</sup> 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 table 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 tables 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 table 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 circuits, grounding faults, improper insulation between terminals, etc.) in the wiring, an over-current may flow in, causing the auto switch to break.

**2. Wire separately from power lines or highvoltage lines, avoiding parallel wiring or 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).

In addition, when using a commercially available checker, etc., to perform an acceptance inspection or check the operation of a 2-wire auto switch, be sure to confirm the wiring method of the checker beforehand and make sure to connect the terminal with a built-in load (IN, etc.) to the 0 V terminal. (Do not connect the power supply terminal and the ground terminal directly when in a non-load state.)

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

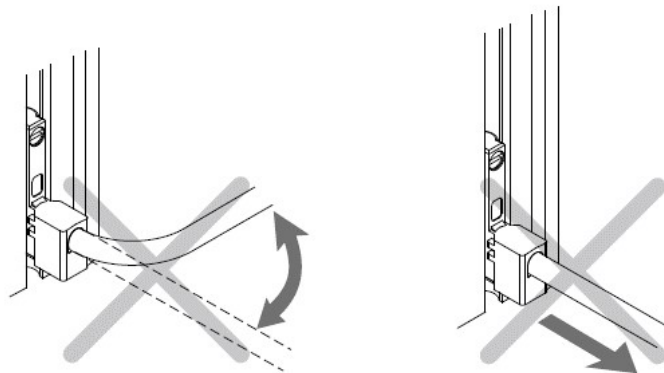
If the wiring work is performed with the power turned ON, this may cause electric shock, malfunction, or damage to the auto switch.

**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.

Keep the lead wire from moving, especially in the area where it connects with the auto switch.



**6. Do not allow short-circuit of loads.**

**<Reed>**

If the power is turned ON with a load in a short circuit condition, the auto switch will be instantly damaged because of excess current flow into the switch.

**<Solid state>**

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

Handle carefully as the auto switch may be damaged.

## 7. Avoid incorrect wiring.

### <Reed>

A 24 VDC auto switch with indicator light has polarity. The brown lead wire or terminal No.1 is (+), and the blue lead wire or terminal No.2 is (—).

[For D-97,(+) is on the no-displayed side,(-) is on the black line side.]

- 1) If connections are reversed, the auto switch will operate, but the light emitting diode will not light up. Also, take note that a current greater than that specified will damage the light emitting diode and it will no longer operate.

Applicable model: D-97, D-93A,D-R731\*,D-R732\*

### <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 remain 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.

## Operation Environment

### Warning

#### 1. Never use in an atmosphere with explosive gases.

Auto switches are not designed to prevent explosion. This may cause an explosion hazard.

### Caution

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

Auto switches will malfunction or magnets inside rotary actuators will become demagnetized.

#### 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, do not use auto switches in applications where they will be 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 with containing coolant, cleaning solvent, various oils or chemicals, even for a short period of time, this may adversely affect the auto switches, resulting improper insulation, malfunction due to the swelling of potting resin, or hardening of 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 environment where there is excessive impact shock.

### <Reed>

When excessive impact (300m/s<sup>2</sup> or more) is applied to a reed auto switch during operation, the contacts will malfunction and generate or cut off a signal momentarily (1ms or less). If further excessive impact is applied, the reed auto switch may break. Depending on the environment, a solid state auto switch may be required.



**6. 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, radio, etc.) that generates large surges or electromagnetic waves around cylinders or actuators with solid state auto switches, this may cause the circuit element inside the auto switch to break.

**7. Avoid the accumulation of iron waste or close contact with magnetic substances.**

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

**8. Do not use in direct sunlight.**

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

**10. Do not use in an area where surges are generated.**

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

**11. 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.**

## 12. 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 and inspection 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 if damage is discovered.

3) Confirm the detection setting position.

•Red light on 1-color indicator auto switch

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

•Confirm the green light and position of the 2-color indicator auto switch.

Confirm that the set position stops at the center of the appropriate operating range (green indication 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.

Some rotary actuators indicate a specific setting procedure for the auto switch. If so, set the mounting position according to the specific setting procedure.

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

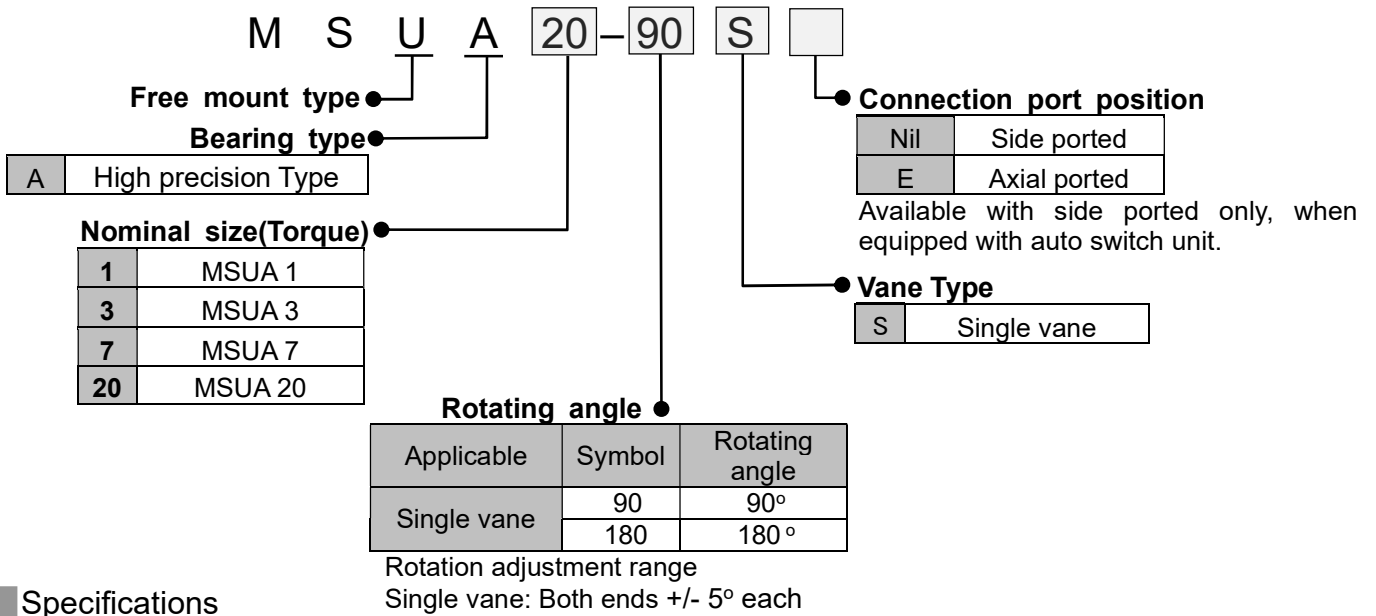
They could damage the surface of the body and erase the markings on the body. For heavy stains, use a cloth lightly dampened with diluted neutral detergent, then wipe up any residue with a dry

# Product Description

This operation manual explains “Vane type rotary table”.

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.

## How to order(Basic type)



## Specifications

Table 1. Specifications

Model	MSUA1		MSUA3		MSUA7		MSUA20	
Vane Type	Single vane							
Rotating angle *1)	90° +/- 10°	180° +/- 10°	90° +/- 10°	180° +/- 10°	90° +/- 10°	180° +/- 10°	90° +/- 10°	180° +/- 10°
Fluid	Air (Non-lube)							
Proof pressure	1.05 MPa						1.5 MPa	
Ambient and fluid temperature	5 to 60 °C							
Operating pressure range	0.2 to 0.7 MPa		0.15 to 0.7 MPa			0.15 to 1.0 MPa		
Rotation time adjustment range	0.07 to 0.3 sec/90°*2)							
Allowable kinetic energy (J)	0.065		0.017		0.042		0.073	
Bearing	Special bearing							
Port location	Side ported or top ported							
Port size	Side ported	M3 x 0.5		M5 x 0.8				
	Top ported	M3 x 0.5			M5 x 0.8			
Deflection accuracy	0.03 mm or less							

\*1) Single vane 90° can be adjusted to 90°±10°(both ends of rotation ±5° each)

Single vane 180° can be adjusted to 180°±10°(both ends of rotation ±5° each)

\*2) Operate within the speed adjustable range. Operation at a low speed outside of the speed adjustable limit may cause stick slip or operation failure.

## Equivalent size

Table 2. Correspondence to equivalent current free-mount types.

Rotary table		Free-mount rotary actuator
MSUA 1	→	CRBU2W10
MSUA 3	→	CRBU2W15
MSUA 7	→	CRBU2W20
MSUA 20	→	CRBU2W30

## Mass

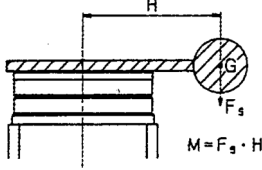
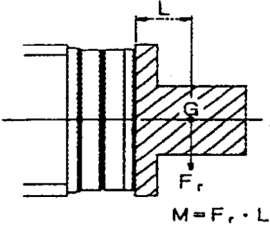
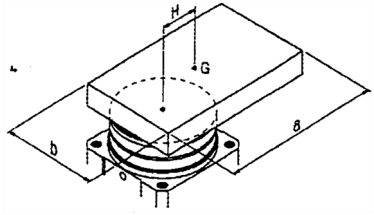
Table 3. Mass (g)

Size	Rotating angle	Basic mass	Auto switch unit <sup>Note)</sup>
		Single vane	
1	90°	162	15
	180°	161	
3	90°	262	20
	180°	260	
7	90°	440	28
	180°	436	
20	90°	675	38
	180°	671	

Note) Mass of the auto switch unit excluding the auto switch.

# Precautions on model selection

## ⚠Caution

Model selection procedures	Calculation	Example
<p>① Operating conditions Pick up operating conditions considering mounting style.</p>  <p>Vertical mounting <math>M = F_s \cdot H</math></p>  <p>Horizontal mounting <math>M = F_r \cdot L</math></p>	<ul style="list-style-type: none"> <li>• Applicable model</li> <li>• Operating pressure</li> <li>• Mounting style</li> <li>• Load type                             <ul style="list-style-type: none"> <li><math>T_s(N \cdot m)</math></li> <li><math>T_f(N \cdot m)</math></li> <li><math>T_a(N \cdot m)</math></li> </ul> </li> <li>• Shape of load</li> <li>• Rotation time <math>t(s)</math></li> <li>• Rotation angle</li> <li>• Load weight <math>m(kg)</math></li> <li>• Distance between axial core <math>H(mm)</math></li> <li>• Mass point distance <math>L(mm)</math></li> </ul>	 <div style="border: 1px solid black; padding: 5px;"> <p>Rotary table : MSUA7-90S                      Pressure : 0.5MPa                      Mounting style : Vertical                      Type of load : Inertial load <math>T_a</math>                      Shape of load : 60mmX40mm (square plate)                      Rotation time <math>t</math> : 0.2 sec                      Rotation angle : <math>90^\circ</math>                      Load weight <math>m</math> : 0.15kg                      Distance between axial core <math>H</math> : 30mm</p> </div>
<p>② Required torque Confirm load conditions shown below, and select an actuator to satisfy required torque.</p> <ul style="list-style-type: none"> <li>• Static load : <math>T_s</math></li> <li>• Resistance load : <math>T_f</math></li> <li>• Inertial load : <math>T_a</math></li> </ul>	<p>Effective torque <math>\geq T_s</math>                      Effective torque <math>\geq (3 \sim 5) \cdot T_f</math>                      Effective torque <math>\geq 10 \cdot T_a</math></p> <p style="text-align: center;"><b>Date 1 and Graph 1</b></p>	<p>Inertial load  <math>10 \times T_a = 10 \times I \times \omega = 10 \times 0.0002 \times \pi / 0.2^2 = 0.157 N \cdot m</math> &lt; Effective torque OK                      Note: Substitute a numerical value of ⑤ moment of inertia for <math>I</math>.</p>
<p>③ Rotation time Confirm that it is within the adjustable rotation time.</p>	<p style="text-align: center;"><math>0.07 \sim 0.3s/90^\circ</math></p>	<p style="text-align: center;"><math>0.2s/90^\circ</math> OK</p>
<p>④ Allowable load Confirm that radial load thrust load and moment are within allowable range.</p>	<p>Thrust load : <math>m \times 9.8 \leq \text{Allowable load}</math>                      Moment : <math>m \times 9.8 \times H \leq \text{Allowable moment}</math>                      Allowable load <b>Table 7</b></p>	<p><math>0.15 \times 9.8 = 1.47N &lt; \text{Allowable load}</math> OK  <math>0.15 \times 9.8 \times 0.03 = 0.044N \cdot m</math>  <math>0.044N \cdot m &lt; \text{Allowable moment}</math> OK</p>
<p>⑤ Moment of inertia Find inertial moment of load to calculate energy. Find <math>I</math>.</p>	<p><math>I = m \times (a^2 + b^2) / 12 + m \times H^2</math>                      Moment of inertia <b>Date 2</b></p>	<p><math>I = 0.15 \times (0.06^2 + 0.04^2) / 12 + 0.15 \times 0.03^2 = 0.0002kg \cdot m^2</math></p>
<p>⑥ Kinetic energy Confirm that kinetic energy of load is within allowable range. Note) Moment inertia of table = <math>I_0</math></p>	<p><math>1/2 \times (I + I_0) \times \omega^2 \leq \text{Allowable energy}</math>  <math>\omega = 2\theta / t</math> (<math>\omega</math> : Terminal angular velocity)  <math>\theta</math> : Rotation angle (rad)  <math>t</math> : Rotation time (t)                      Allowable kinetic energy <b>Date 3</b></p>	<p><math>1/2 \times (0.0002 + 0.000028) \times (2 \times (\pi / 2) / 0.2)^2 = 0.028J &lt; \text{Allowable energy}</math>                      OK</p>

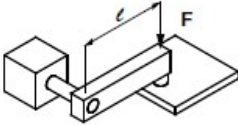
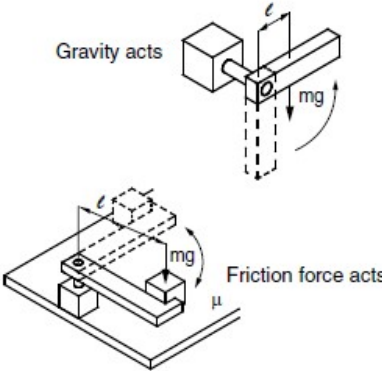
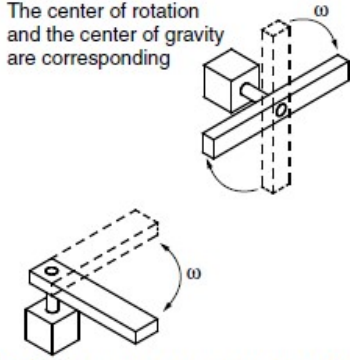
Date 1

Effective torque

Table 4. Effective torque table

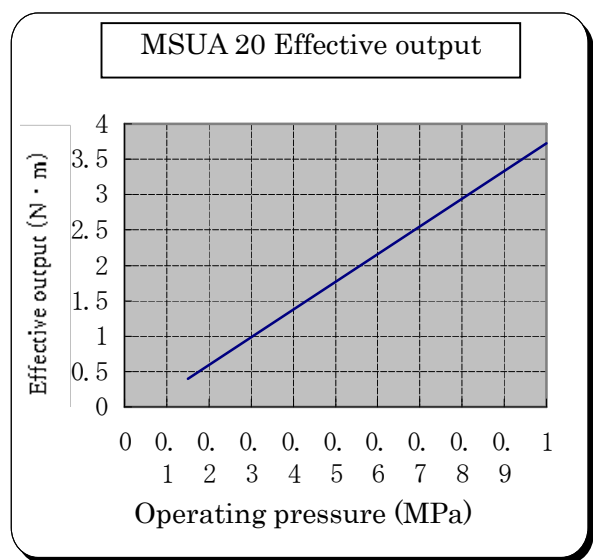
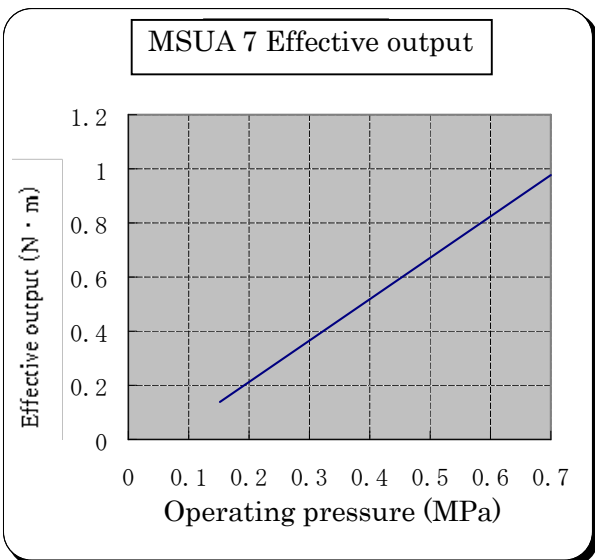
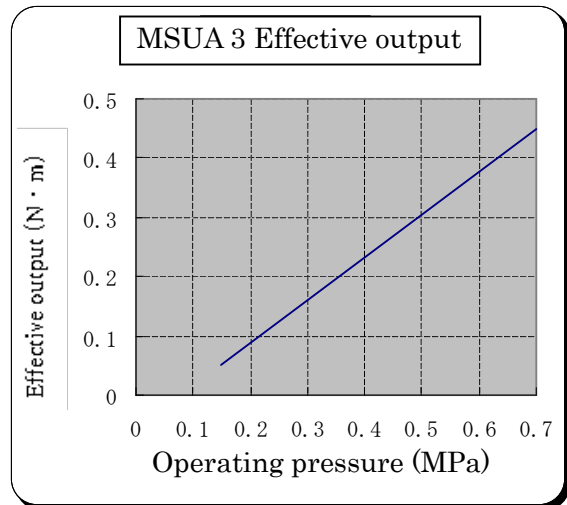
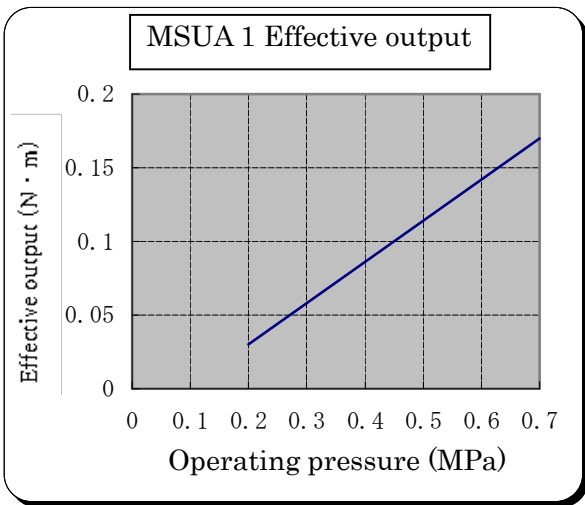
(N-m)

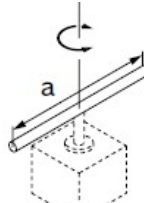
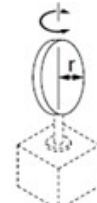
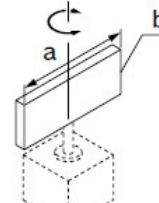
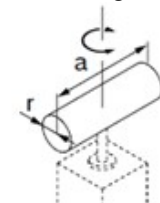
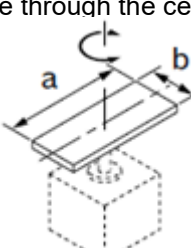
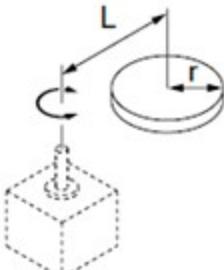
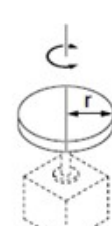
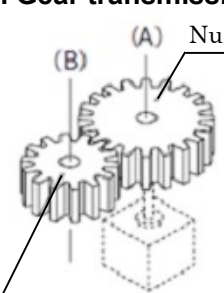
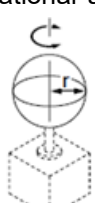
Size	Operating pressure (MPa)									
	0.15	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	—	0.03	0.06	0.09	0.11	0.14	0.17	—	—	—
3	0.05	0.09	0.16	0.23	0.31	0.38	0.45	—	—	—
7	0.14	0.21	0.37	0.52	0.69	0.83	0.98	—	—	—
20	0.40	0.58	0.99	1.38	1.78	2.19	2.58	2.99	3.39	3.73

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 <sup>2</sup> ) $l$ : Distance from the center of rotation to the gravity or friction force acting point (m) $\mu$ : Coefficient of friction	$T_a = I \cdot \dot{\omega} = I \cdot \frac{2\theta}{t^2}$ $T_a$ : Inertial load (N-m) $I$ : Moment of inertia (kg-m <sup>2</sup> ) $\dot{\omega}$ : Angular acceleration (rad/s <sup>2</sup> ) $\theta$ : Rotating angle (rad) $t$ : Rotation time (s)
Required torque $T = T_s$	Required torque $T = T_f \times (3 \text{ to } 5)$ <sup>Note 1)</sup>	Required torque $T = T_a \times 10$ <sup>Note 1)</sup>
<ul style="list-style-type: none"> <li>• 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.  <math>T = T_f \times (3 \text{ to } 5) + T_a \times 10</math> </li> <li>• 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.  <math>T = T_a \times 10</math> </li> </ul>		

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

# Graph 1



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

## Kinetic energy / Rotation time

### Date 3

In rotating movement, inertia of load may cause damage to interior parts even if the required torque of load is small. Select a model after considering moment of inertia of load, kinetic energy, and rotation time. (The graph of moment of inertia and rotation time is useful for selecting models.)

#### Allowable kinetic energy and adjustable range of rotation time

Table 5. Allowable kinetic energy and adjustable range of rotation time

Size	Allowable kinetic energy (J)	adjustable range of rotation time safe in operation (s/90°) *
MSAU 1	0.0065	0.07~0.3
MSAU 3	0.017	
MSAU 7	0.042	
MSAU 20	0.073	

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

#### 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 table is getting to have inertial force.

When the rotary table 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.

$$E = \frac{1}{2} \cdot (I + I_o) \cdot \omega^2$$

E: Kinetic energy [J]

I: Moment of inertia of load [kg · m<sup>2</sup>]

I<sub>o</sub>: Moment of inertia of load [kg · m<sup>2</sup>]

ω: Angular speed [rad/s]

The following table shows moment of inertia of table.

Table 6. Moment of inertia of table (kg · m<sup>2</sup>)

Size	Allowable kinetic energy (J)
MSAU 1	2.5x10 <sup>-6</sup>
MSAU 3	6.2x10 <sup>-6</sup>
MSAU 7	16.0x10 <sup>-5</sup>
MSAU 20	28.0x10 <sup>-5</sup>

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 ]

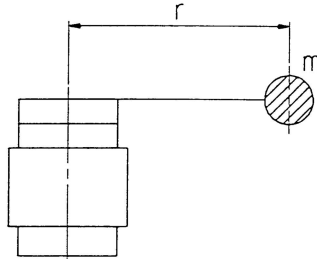


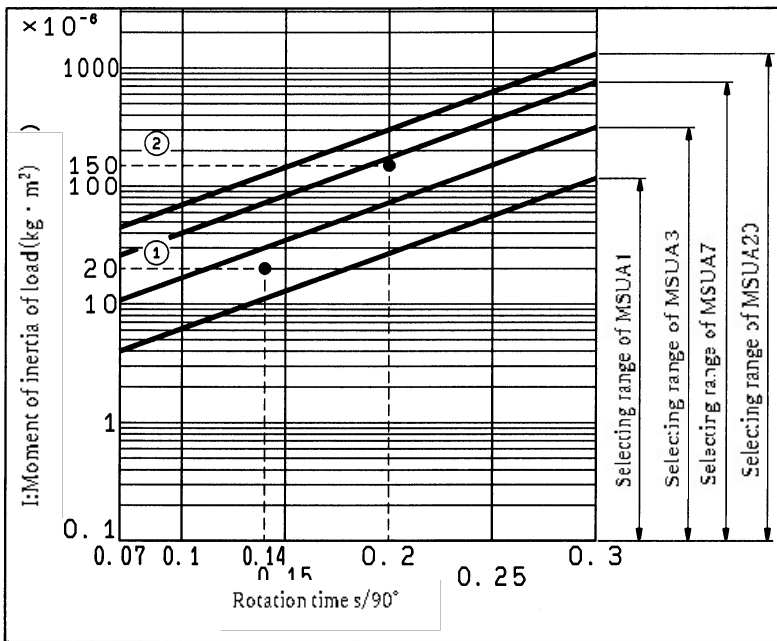
Fig. 1 Moment of inertia

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. Date 2 shows formulae to find moment of inertia of various shapes.

**Model selection**

Select a model by applying the calculated moment of inertia to the graph 2 below.

Graph 2. Moment of inertia – Rotation time



1. <How to read graph>  
 When  
 • Moment of inertia... 20 x 10<sup>-6</sup>  
 • Rotation time... 0.14s/90°, MSUA 3 or MSUA 7, 20 will be selected.

2. <Calculation example>  
 Shape of load: Column with a radius of 0.05m and weight of 0.12kg  
 Rotation time: 0.2s/90°

$$I = 0.12 \times \frac{0.05^2}{2} = 150 \times 10^{-6} \text{ kg} \cdot \text{m}^2$$

Based on the graph of moment of inertia and rotation time, find the intersection by extending a vertical axis (moment of inertia) 150 x 10<sup>-6</sup> kg · m<sup>2</sup> and horizontal axis (rotation time) 0.2s/90°. MSUA 7 or MSUA 20 is selected Because the intersection is within the Selecting range of MSUA 7.

# Setting

## Allowable Load

Load and moment applied to the table shall be set lower than the allowable value in the following table 7. (Operation out of the allowable value may influence life of the product such as excessive play and deterioration of accuracy.)

Table 7. Allowable load

Size	Allowable radial load(N)	Allowable thrust load(N)	Allowable moment (N·m)
1	20	15	0.3
3	40	30	0.7
7	50	60	0.9
20	60	80	2.9

## Table rotation range

Angle adjustment is possible as shown in the Fig. 2 below using adjustment bolts (A) and (B).

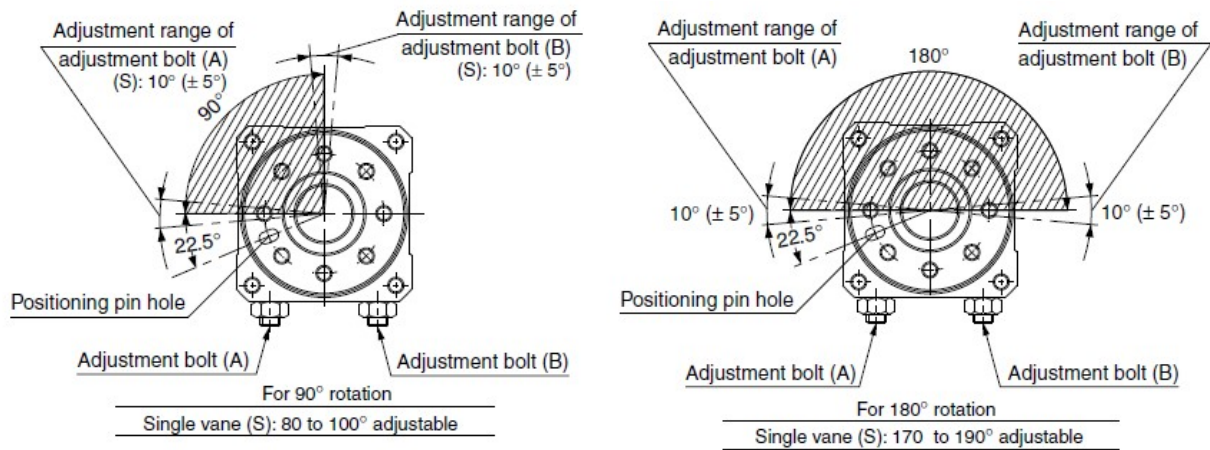


Fig.2

## ■ Calculation example of load condition

Example: MSUA7

Allowable thrust load; 60 N  
Allowable moment; 0.9 N·m

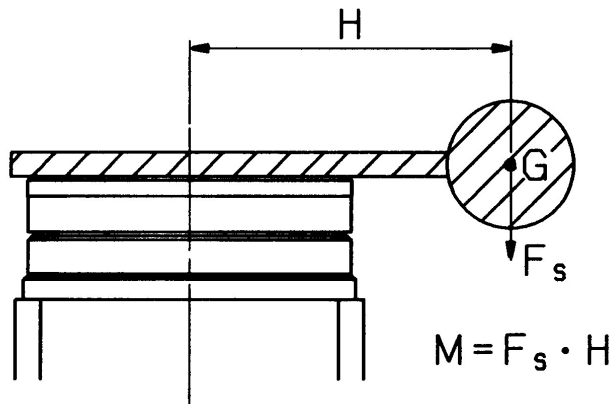


Fig.3

Assuming that load conditions in the Fig.3 are as follows.

$$H=0.1 \text{ m}$$

$$F_s=20 \text{ N}$$

If MSUA7 is selected under those conditions, thrust load of 20N will be within the allowable value of 60N, but moment will be  $20\text{N} \times 0.1\text{m} = 2\text{N} \cdot \text{m}$ , and it exceeds the allowable moment of  $0.9\text{N} \cdot \text{m}$ , so that it can not be used. In this case, selecting a large model should be considered.

## Using body as flange

High precision rotary table can be mounted from 5 directions, 2 axial directions and 3 body side directions.

### Axial direction mounting

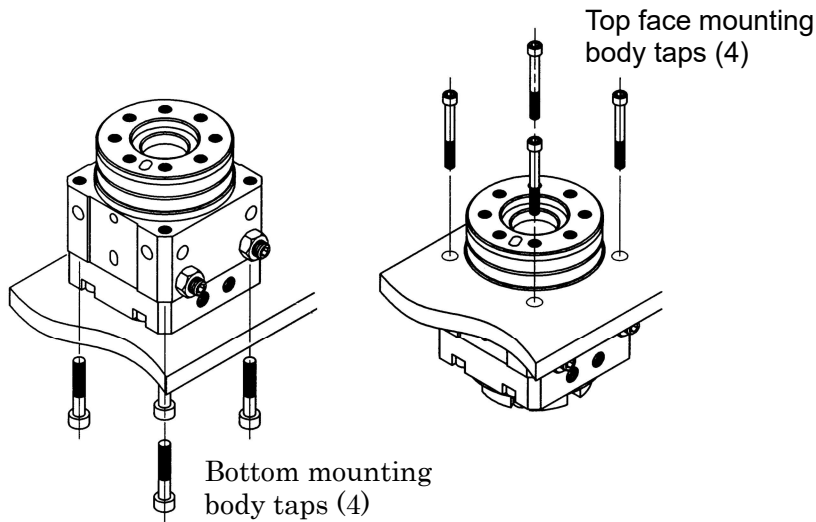
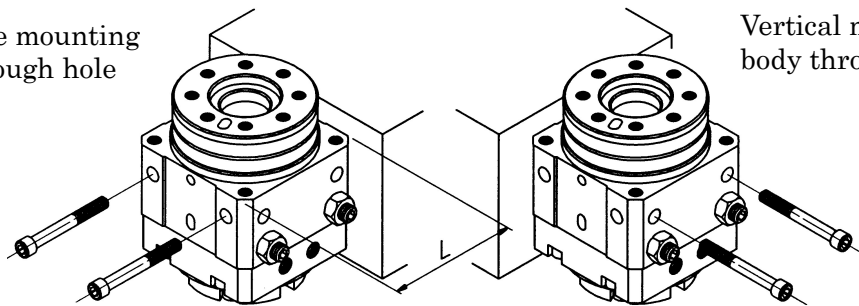


Table 8. Mounting dimension in axial

Size	Tap depth for the bottom mounting	Tap depth for the top mounting	Bolt
1	8	4	M4
3	8	7	M4
7	10	7	M5
20	11	7	M6

### Body side mounting body through hole



### Vertical mounting body through hole

Table 9. Mounting dimension in body side

Size	L	Bolt
1	38	M4
3	44	M4
7	50	M5
20	59	M6

## Piping

Fig. 4 and Table 10 show port position and size.

Table. 10 Port size

Size	Port size	
	Side ported	Axial ported
1	M3X0.5	
3	M5X0.8	M3X0.5
7	M5X0.8	
20	M5X0.8	

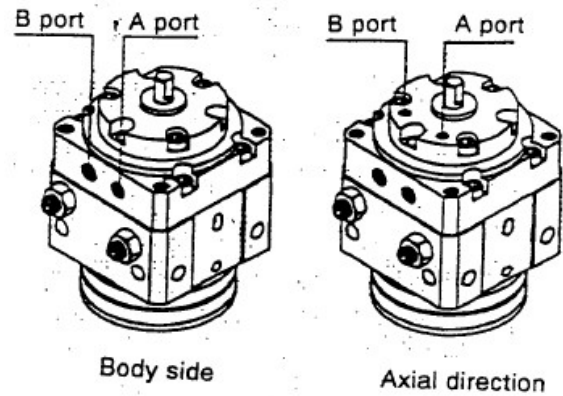


Fig. 4 Port position

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.

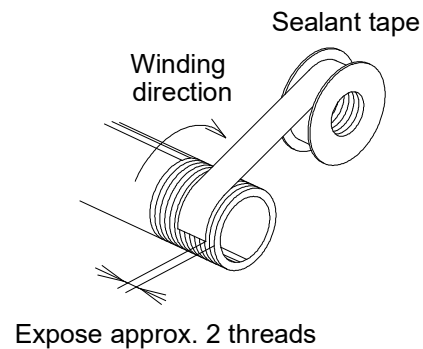


Fig. 5 Wrapping of pipe tape

## External stopper

When kinetic energy generated by load exceeds the allowable kinetic energy of the actuator, inertial force should be absorbed by providing a cushion system externally.

### Mounting position of external stopper

A shaft and a bearing may be damaged depending on a mounting position of an external stopper. Then it should be provided to the mass point or the place away from the actuator.

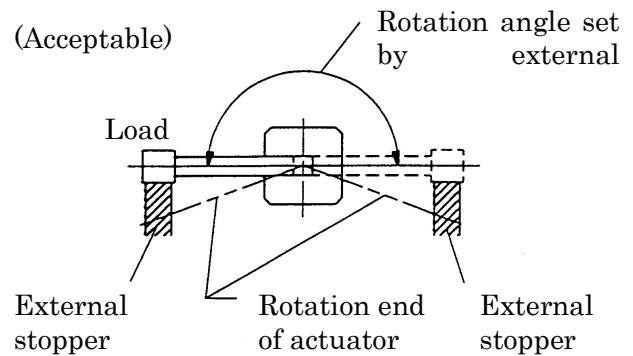


Fig. 6 Mounting position of external stopper (Correct)

When an external stopper is located near the actuator, the actuator becomes a fulcrum, and moment of inertia of load is applied to a rotation axis as bending moment, the product may be damaged.

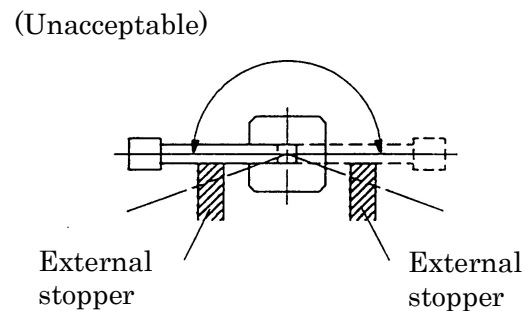


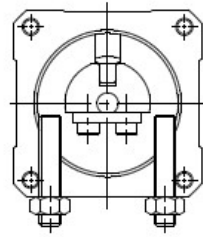
Fig. 7 Mounting position of external stopper (Incorrect)

### Precautions for using external stopper

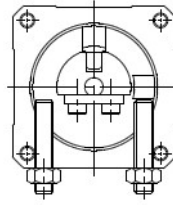
High precision rotary table / series MSUA has an angle adjusting system by an adjusting screw, so that setting of an adjusting bolt should be performed not to touch it to a stopper lever for using an external stopper.

# Internal construction and component parts

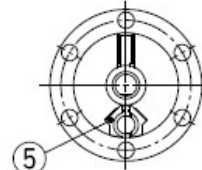
## Internal construction of rotary table



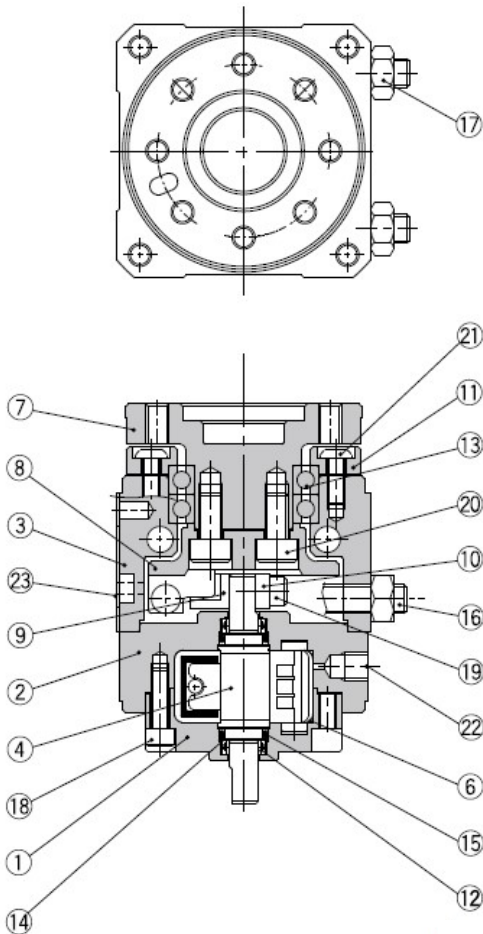
For 180°  
(Figure in the middle position)



For 90°  
(Figure with pressure to A port)



Single vane  
(Figure in the middle position for 180°)



No.	Description	Material	Note
1	Body (A)	Aluminum alloy	Anodized
2	Body (B)	Aluminum alloy	Anodized
3	Body (C)	Aluminum alloy	Anodized
4	Vane shaft	Stainless steel (MSUA20 is carbon steel)	Single vane
5	Stopper	Resin	Single vane
6	Stopper seal	NBR	
7	Table	Aluminum alloy	Anodized, Serigraph
8	Stopper lever	Carbon steel	Heat treatment, Electroless nickel plated
9	Stopper guide	Stainless steel	Nitriding
10	Lever retainer	Carbon steel	Zync Chromated
11	Bearing retainer	Aluminum alloy	Anodized
12	Bearing	High carbon chrome bearing steel	
13	Special bearing	High carbon chrome bearing steel	
14	Back-up ring	Stainless steel	
15	O-ring	NBR	
16	Adjustment bolt	Carbon steel	Heat treated
17	Hexagon nut	Carbon steel	
18	Hexagon socket head cap screw	Stainless steel	
19	Hexagon socket head cap screw	Stainless steel	
20	Hexagon socket head cap screw	Carbon steel	
21	Button bolt	Carbon steel	
22	Hexagon socket head cap screw	Stainless steel	SE type only
23	Label		

\*The hexagon socket head cap screw (22) is used only when the connection port is type SE.

# Rotary table with auto switch

Rotary table with auto switch has a magnet mounted to the vane shaft, and an auto switch is mounted on the exterior of the body to detect the rotation position (magnet position).

## How to order(with auto switch)

**With auto switch unit** M D S U A 20 - 90 S - T79 L

**With auto switch unit (Built-in magnet)**

**Nominal size (torque)**

1	MSUA 1
3	MSUA 3
7	MSUA 7
20	MSUA20

**Rotating angle**

Applicable	Symbol	Rotating angle
Single vane	90	90°
	180	180°

Rotation adjustment range  
Single vane: Both ends +/- 5° each

**Vane type**

S	Single vane
---	-------------

**Auto switch**

Nil	Without auto switch (built-in magnet)
-----	---------------------------------------

\* Refer to the table (12) for the applicable auto switch model.

**Number of auto switches**

S	1 pc. *
Nil	2 pcs. **

\* S (1 auto switch) is shipped with a right-hand auto switch.  
\*\* Nil (2 auto switches) is shipped with a right-hand and a left-hand switch.

**Electrical entry/Lead wire length**

Nil	Grommet/Lead wire: 0.5 m
L	Grommet/Lead wire: 3 m
Z	Grommet/Lead wire: 5 m
C	connector/Lead wire: 0.5 m
CL	connector/Lead wire: 3 m
CN	connector/Without lead wire

\* Applicable only with R73, R80 and T79 type connectors.  
\*\* Lead wire with connector Part No.  
D-LC05: Lead wire 0.5 m  
D-LC30: Lead wire 3m  
D-LC50: Lead wire 5m

## Applicable auto switches

Table. 11 Applicable auto switches

Applicable series	Auto switch model		Electrical entry	Indicator LED
MDSUA1, 3	Reed switch	D-90, 90A	Grommet/ 2-wire type	Without
		D-97, 93A		With
	Solid state switch	D-S99, S99V	Grommet/ 3-wire type (NPN)	With
		D-S9P, S9PV	Grommet/ 3-wire type (PNP)	
MDSUA7, 20	Reed switch	D-T99, T99V	Grommet/ 2-wire type	Without
		D-R73	Grommet/ 2-wire type	
		D-R73C	Connector/ 2-wire type	
		D-R80	Grommet/ 2-wire type	
	Solid state switch	D-R-80C	Connector/ 2-wire type	With
		D-S79	Grommet/ 3-wire type (NPN)	
		D-S7P	Grommet/ 3-wire type (PNP)	
		D-T79	Grommet/2-wire type	
		D-T79C	Connector/ 2-wire type	

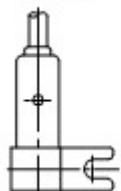
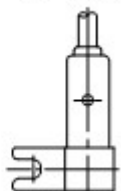
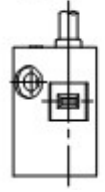
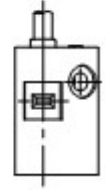


## Auto switch specification

Table. 12 Auto switch specification

Model	Auto switch model		Part No.		Applicable load	Load voltage	Max. load current and load current range	
	Right handed	Left handed	Perpendicular	In-line				
D-9	D-90		-	90	Relay PLC IC circuit	5, 12, 24 V AC/DC	50mA	
	D-90A		-	90A		5, 12, 24 V AC/DC	50mA	
	D-97		-	97		100V AC/DC	20mA	
	D-93A		-	93A	Relay PLC	5, 12, 24 V AC/DC	50mA	
D-R73	D-R731	D-R732	-	R73	Relay PLC	24 VDC	5 to 40mA	
						100 VAC	5 to 20mA	
	D-R731C	D-R732C	-	R73C		Relay PLC	24 VDC	5 to 40 mA
						24 VDC	5 to 40 mA	
D-R8	D-R801	D-R802	-	R80	Relay PLC IC circuit	24 V AC/DC or less	50mA	
						48V AC/DC	40mA	
						100V AC/DC	20mA	
	D-R801C	D-R802C	-	R80C	Relay PLC	24V AC/DC	50mA	
D-S7	D-S791	D-S792	-	S79	Relay PLC IC circuit	28 VDC or less	40mA or less	
	D-S7P1	D-S7P2	-	S7P		—	80mA or less	
D-S9	D-S991	D-S992	S99V	S99		28 VDC or less	40mA or less	
	D-S9P1	D-S9P2	S9PV	S9P		—	80mA or less	
D-T7	D-T791	D-T792	-	T79	Relay PLC	24 VDC (10 to 28 VDC)	5 to 40 mA	
	D-T791C	D-T792C	-	T79C				
D-T9	D-T991	D-T992	T99V	T99				

## Auto switch orientation

<p>left handed switch D-0001</p> 	<p>right handed switch D-0002</p> 	<p>MDSUA 7/ 20</p> <p>One right handed switch and one left handed switch</p>
<p>D-0991</p> 	<p>D-0992</p> 	<p>MDSUA 1/ 3</p> <p>One right handed switch and one left handed switch</p>

Operating time:  
1.2 ms(Reed switch),  
1 ms or less(Solid state switch)

Shock resistance:  
300m/s<sup>2</sup> (Reed switch),  
1000m/s<sup>2</sup> (Solid state switch)

Ambient temperature:  
-10 to 60°C

Lead wire length:  
0.5m (standard)

■ Table positioning pin hole rotation range and auto switch mounting position

MSUA 1 · 3

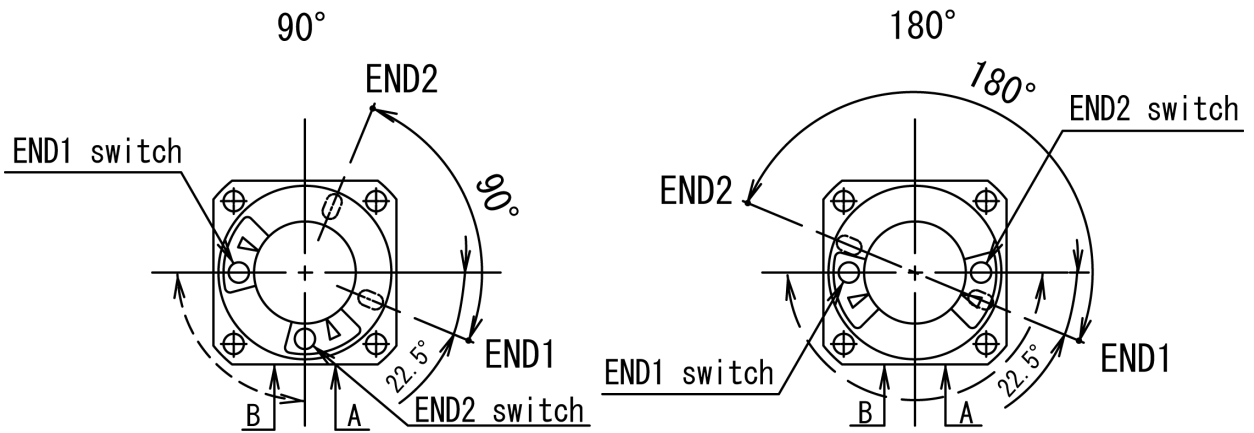


Fig.7

MSUA 7 · 20

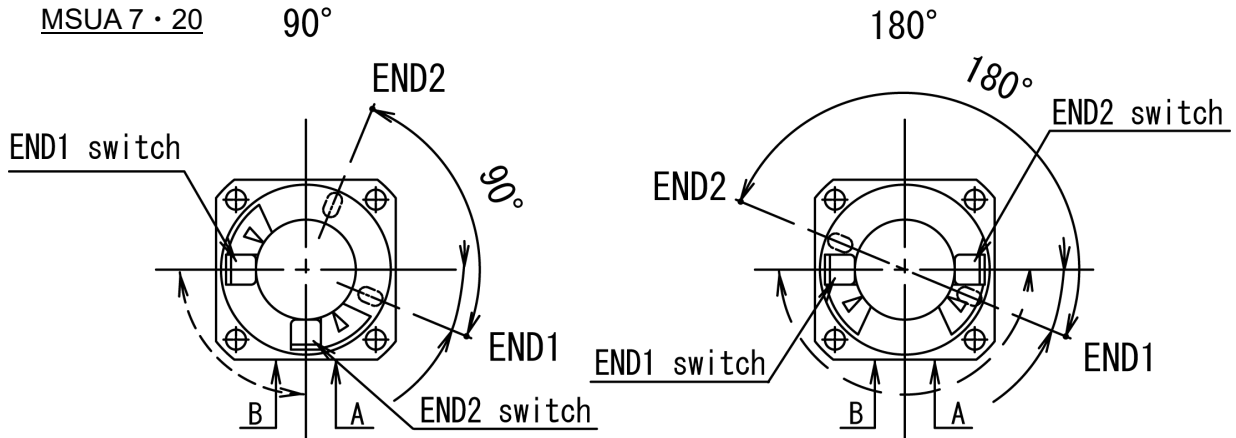


Fig.8

In the Fig.7 and Fig.8 that show the rotation range, the arrows on the solid line 90°(180°) indicate the rotation range of the positioning pin hole on the table surface. When the pin hole is at END1, the END1 auto switch operates, and when the pin hole is at END2, the END2 auto switch operates.

The arrows on the broken line indicate the rotation range of the internal magnet. The rotation range of each auto switch can be reduced by moving the END1 auto switch clockwise and the END2 auto switch counterclockwise.

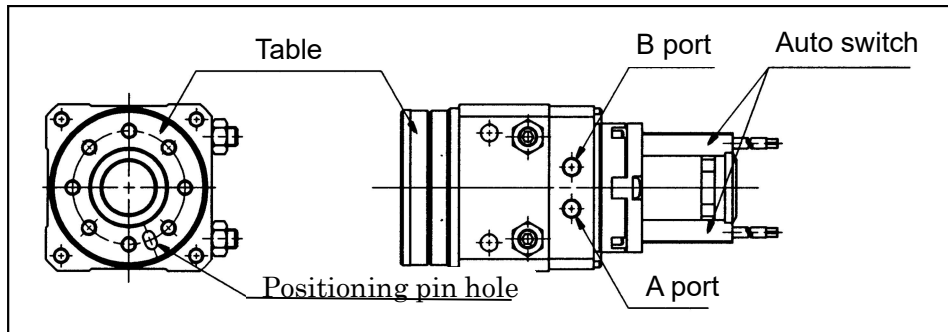


Fig.9

### ■ How to change the auto switch detecting position

When setting the detection position, loosen the cross recessed round head screw a bit and move the auto switch to the preferred position and then tighten again and fix it. At this time, if tightened too much, screw can become damaged and unable to fix position. Proper tightening torque: 0.4 to 0.6 [N·m]

When tightening the cross recessed round head screw, take care that the auto switch does not tilt.

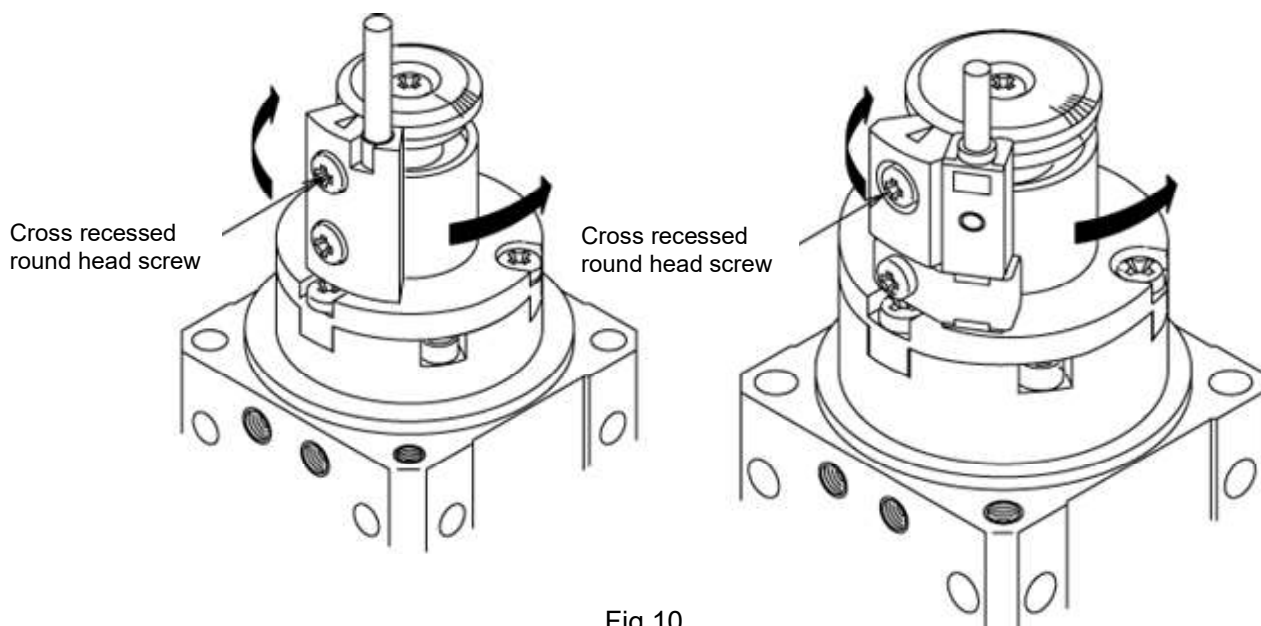


Fig.10

### ■ Auto switch operating angle and hysteresis angle

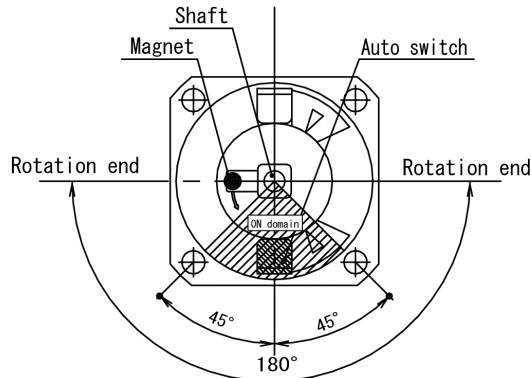
Table.13

Model	Operation angle	Hysteresis angle
MDSUA1,3	110°	10°
MDSUA7,20	90°	

## ■ Operating range and hysteresis of auto switch

[Example]

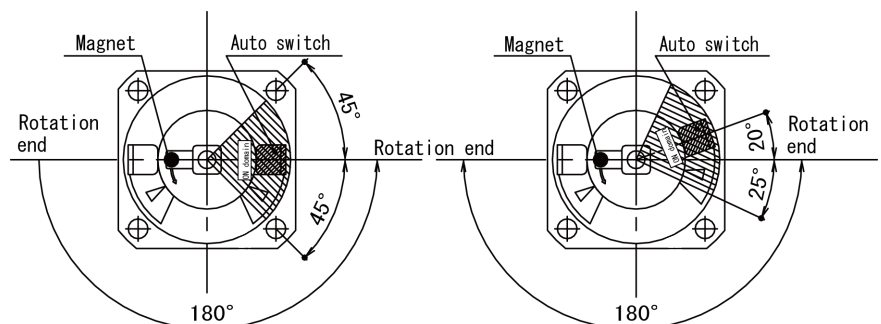
Rotary table:  $180^\circ$   
 Switch operating angle:  $90^\circ$   
 When the switch is mounted at the intermediate position of the rotation



As shown in the figure shown above, when the magnet rotates in the arrow direction along with the shaft rotation, the switch turns on when the magnet passes through the point A, and when it passes through the point B, the switch turns off. In this case, the ON area is  $90^\circ$ , i.e. switch rotation angle is  $90^\circ$ .

[Example]

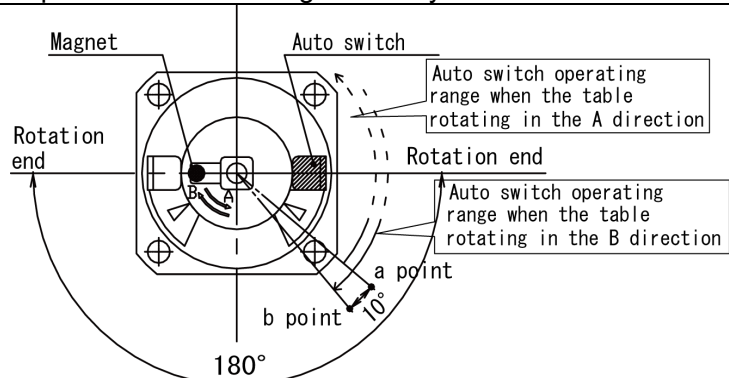
Rotary table:  $180^\circ$   
 Switch operating angle:  $90^\circ$   
 When the switch is mounted at the rotation end



As shown in the left figure above, when the magnet rotates in the arrow direction, the switch turns on at the position where 45 degrees away from the the rotation end where the switch is mounted. If the switch is moved by 20 degrees as shown in the right figure above, it will be possible to turn on the switch at the position where 25 degrees away from the rotation end.

[Example]

Rotary table:  $180^\circ$   
 Switch hysteresis angle:  $10^\circ$

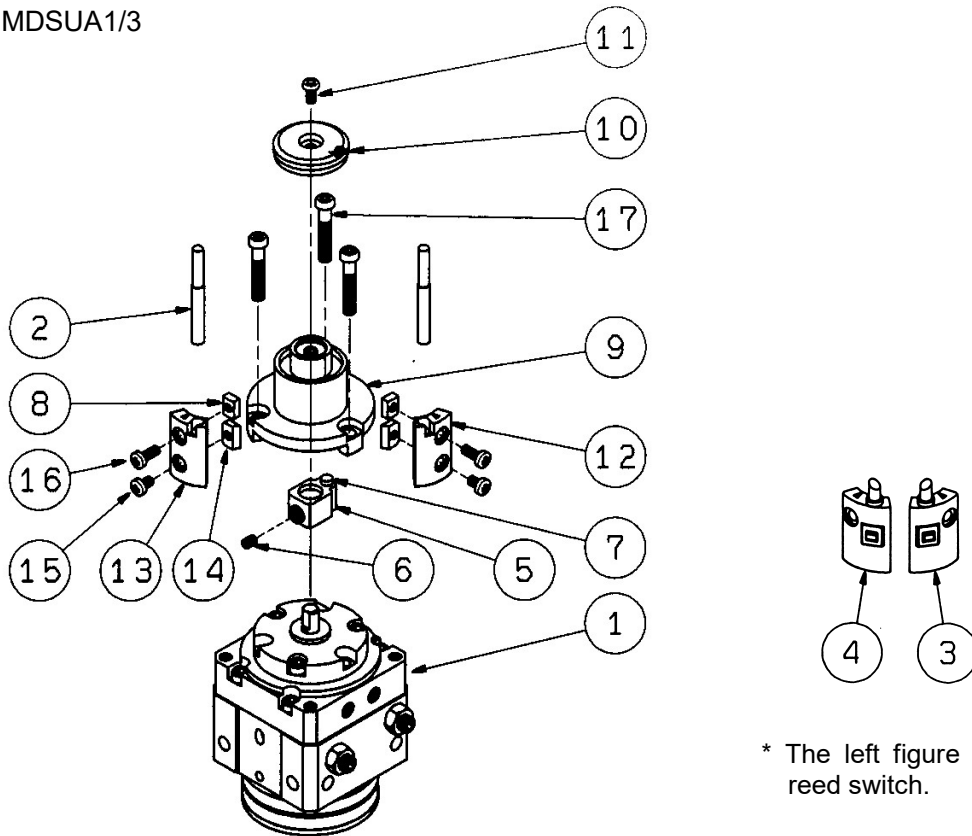


As shown in the figure above, when the magnet rotates in the A direction, the switch turns on at point a. On the contrary, when the magnet rotates in the B direction, the switch turns off at point b. At this time, the 10 degrees of hysteresis between point a and b is the hysteresis angle.

# Internal construction and component parts

## Internal construction of rotary table with auto switch

MDSUA1/3



\* The left figure shows the product with reed switch.

Fig.11 Component parts of MSUA1/3 switch

No.	Description	Material
1	Rotary table body	
2	Reed auto switch	
3	Solid state auto switch (Right handed)	
4	Solid state auto switch (Left handed)	
5	Magnet lever	Resin
6	Hexagon socket head set screw	Stainless steel
7	Magnet	
8	Holding block	Stainless steel
9	Cover (A)	Resin
10	Cover (B)	Resin
11	Cross recessed round-head screw	Stainless steel
12	Switch block (A)	Resin
13	Switch block (B)	Resin
14	Holding block (B)	Aluminum alloy
15	Cross recessed round-head screw	Stainless steel
16	Cross recessed round-head screw	Stainless steel
17	Cross recessed round-head screw	Stainless steel

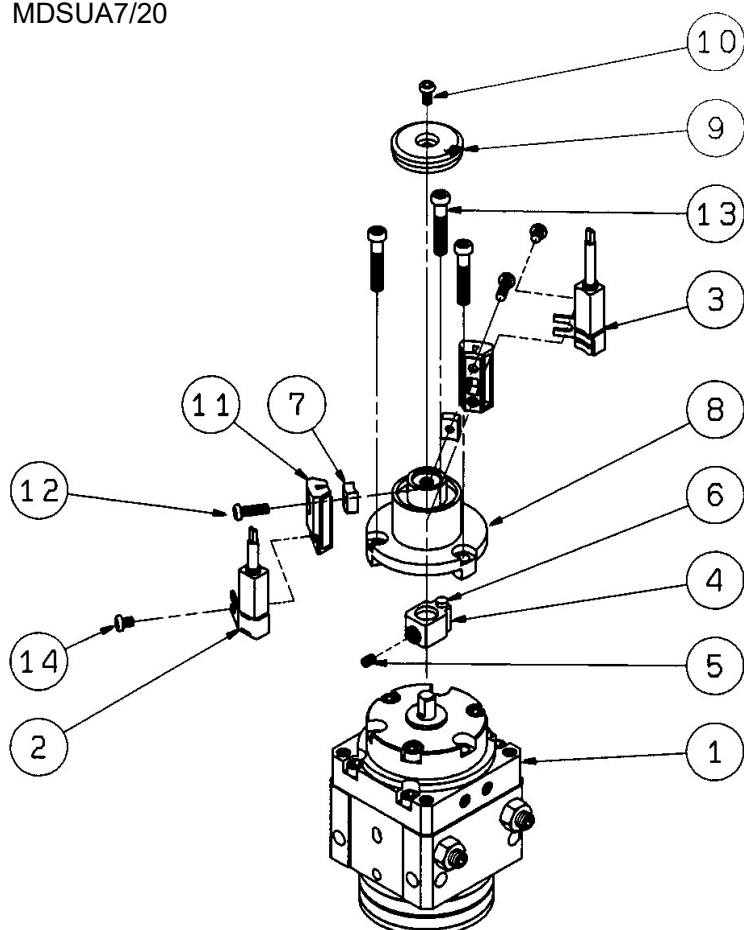
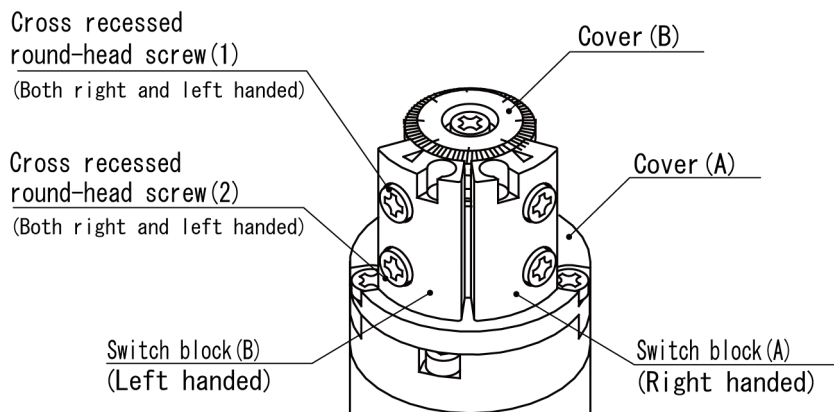


Fig.12 Component parts of MSUA7/20 switch unit

No.	Description	Material
1	Rotary table body	
2	Auto switch (Right handed)	
3	Auto switch (Left handed)	
4	Magnet lever	Resin
5	Hexagon socket head set screw	Stainless steel
6	Magnet	
7	Holding block	Stainless steel
8	Cover (A)	Resin
9	Cover (B)	Resin
10	Cross recessed round-head screw	Stainless steel
11	Switch block	Resin
12	Cross recessed round-head screw	Stainless steel
13	Cross recessed round-head screw	Stainless steel
14	Cross recessed round-head screw	Stainless steel

## ■ MDSUA1/3 auto switch mounting

### External view and descriptions of auto switch unit



#### Solid state auto switch

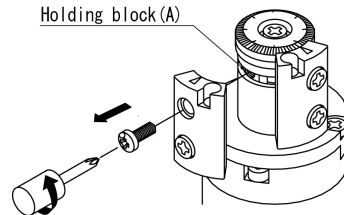
<Applicable auto switches>

**3-wire type: D-S99(V), D-S9P(V)**

**2-wire type: D-T99(V)**

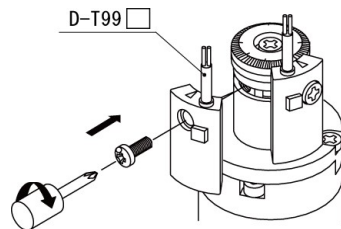
##### 1. Removal of the switch block

Remove the cross recessed round head screw (1) and remove the switch block.



##### 2. Mounting of the solid state switch

Hold the solid state switch with the cross recessed round head screw (1) and the holding block (A).



\* Appropriate tightening torque: 0.4 to 0.6 (N·m)

\* Holding block (A) moves along the groove. Move it to the mounting position before mounting the switch.  
- Adjust the switch sensing position by the cross recessed round head screw (1) before operating the product.

#### Reed auto switch

<Applicable auto switches>

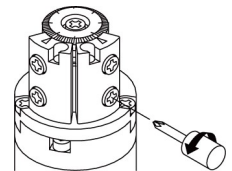
**D-97, D-93A (with indicator light)**

**D-90, D-90A (without indicator light)**

##### 1. Preparation

Loosen the cross recessed round head screw (2). (2 to 3 rotations)

\* The screw is tentatively fixed for shipment.

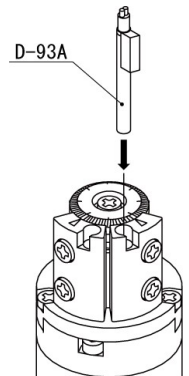


##### 2. Mounting of the Reed switch

Insert the Reed switch into the switch block port until it touches the end.

\* D-97 and D-93A type switches need to be inserted in the direction shown in the right Fig.

\* D-90 and D-90A are round shaped switches. Mounting direction is not specified for them.

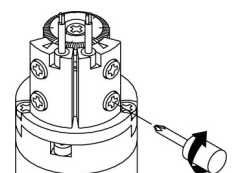


##### 3. Holding the Reed switch

Tighten the cross recessed round head screw (2) to fix the Reed switch in place.

Appropriate tightening torque: 0.4 to 0.6 (N·m)

Adjust the switch sensing position by the cross recessed round head screw (1) before operating the product.



# Maintenance and Inspection

In case a rotary unit and table unit are required for maintenance, order with the unit part numbers shown below.

## Maintenance unit

### Rotary unit

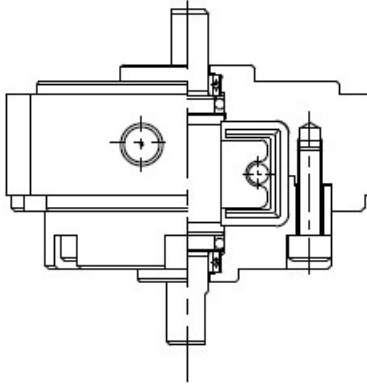


Table. 14

Model	Unit part no.
MSUA1-*S	P402070-2A
MSUA1-*SE	P402070-2B
MSUA3-*S	P402090-2A
MSUA3-*SE	P402090-2B
MSUA7-*S	P402060-2A
MSUA7-*SE	P402060-2B
MSUA20-*S	P402080-2A
MSUA20-*SE	P402080-2B

### Table unit

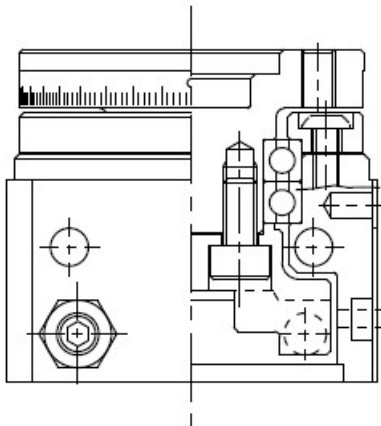


Table. 15

Model	Unit part no.
MSUA1-90*	P402070-3A
MSUA1-180*	P402070-3B
MSUA3-90*	P402090-3A
MSUA3-180*	P402090-3B
MSUA7-90*	P402060-3A
MSUA7-180*	P402060-3B
MSUA20-90*	P402080-3A
MSUA20-180*	P402080-3B

\*None that the rotation angle should not be changed even though the rotary unit has been changed.

For maintenance, order units with a part number suitable for the model being used.

Table. 16 Auto switch unit

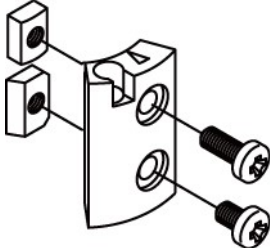
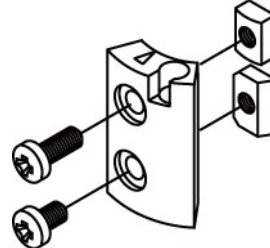
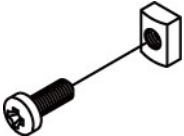
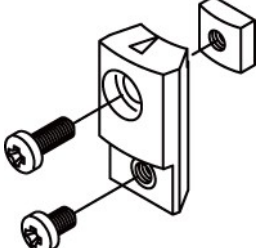
Model	Auto switch unit part no.
M(D)SUA1	P211070-1
M(D)SUA3	P211090-1
M(D)SUA7	P211060-1
M(D)SUA20	P211080-1

\*The auto switch unit can be retrofitted on a rotary actuator.

Auto switches should be ordered separately since they are not included.



Table. 17 Auto switch block unit

MDSUA1/3		MDSUA7/20	
For reed auto switch		For solid state auto switch	Combination of reed and solid state auto switch
Right handed	Left handed	Combination right and left handed	Combination right and left handed
			
Part No: P211070-8	Part No: P211070-9	Part No: P211070-13	Part No: P211060-8

\* The auto switch block unit is included in the auto switch unit.

\* Auto switch block unit shows the necessary assembly for mounting 1 piece of auto switch to the auto switch unit.

\* Individual part cannot be shipped.

### How to replace table unit

#### 【Disassembling】

- (1) Remove a hexagon socket head cap screw ④.

#### 【Reassembling】

- (1) Tighten a rotary unit and a table unit with a hexagon socket head cap screw ④.

### How to replace rotary unit

#### 【Disassembling】

- (1) Remove a hexagon socket head cap screw ④.
- (2) Loosen a hexagon socket head cap screw ③.
- (3) Remove a stopper guide ①.

#### 【Reassembling】

- (1) Fit a lever retainer ② to a shaft chamfered face, and mount a stopper guide ①.  
At that time, make clearance of around 0.5mm between a stopper guide and a rotary unit.
- (2) Tighten a hexagon socket head cap screw ③.  
At that time, take care not to tighten a lever Retainer and shaft chamfering surface unevenly.
- (3) Tighten table unit and a rotary unit with a hexagon socket head cap screw ④.

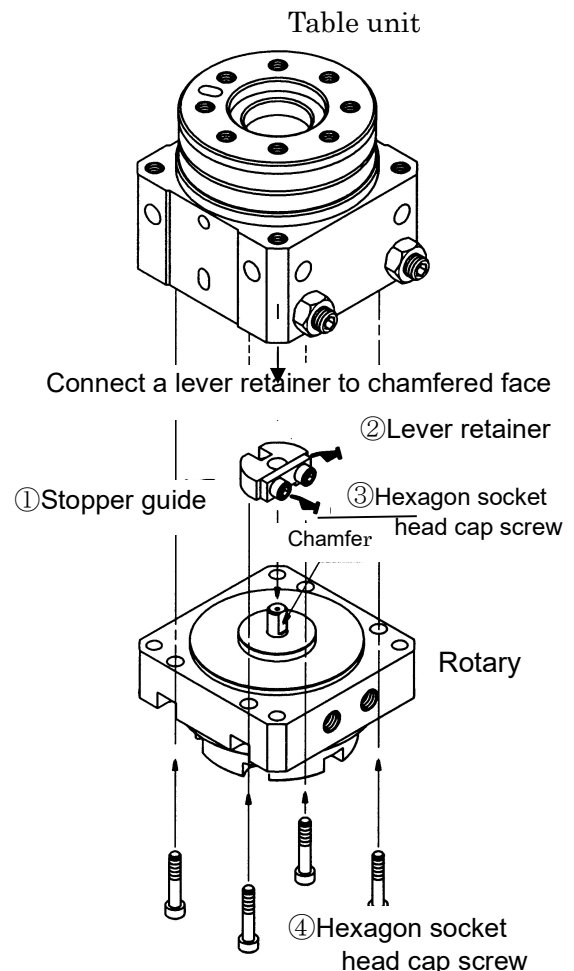


Fig.13 How to replace rotary unit

Table. 18

Model	Screw torque N · m	
	③	④
MSUA1	0.8~1.2	0.8~1.2
MSUA3	0.8~1.2	0.8~1.2
MSUA7	2~3.4	2~3.4
MSUA20	4~6	4~6

〈Note〉 None that the product whose inside of the rotary unit and table unit can not be guaranteed.

## ■ Periodic inspection

Periodic inspection is necessary for optimum use.

### (1) Inspection point

- ① Loosening of an adjusting bolt fixed by a nut
- ② Loosening of a hexagon socket head cap screw fixing a body
- ③ Loosening of a mounting base of an actuator
- ④ Checking rotating operation
- ⑤ Checking rotation angle and rotating position
- ⑥ External and internal leak
- ⑦ Checking ON and OFF operation of switch

Check the above points and if a failure is found, retighten screws, replace parts or repair the product.

### (2) Inspection interval

In order to use the high precision rotary table/series MSUA in optimum condition, please inspect it once or twice a year.

## Troubleshooting

Problem	Possible cause	Solution
Rotary table does not move or rotation is unstable.	Adjustment of rotation speed does not satisfy its range to stabilize operation.	Operate the actuator within the speed adjusting range to stabilize operation specified in the catalog.
	Sealing failure or increase of internal resistance due to operation outside of the operating temperature range.	Operate the product within the operating temperature range. (If seal is damaged, a rotary unit may be replaced.)
	Increase of internal leak because of damaging seals by foreign matter and drainage.	Replace with a new rotary unit.
	Insufficient air supply	Check if air flow supplied to the port is sufficient or not.
	Insufficient air pressure	Check if pressure supplied to the port is the set pressure.
	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).
Extreme rotating angle changes.	Excess load torque	Load torque shall be within the specified range.
	Internal parts are broken.	Replace the rotary table with the new one. After that, take the measures below. 1) Calculate the kinetic energy applied to the rotary table and adjust the load and rotation speed to make the value within the allowable kinetic energy. 2) Mount an external shock absorber to absorb the impact force. In this case, adjust an adjusting bolt not to touch a stopper lever, and decide the rotation end by an external stopper.
Air leakage from the table	The seal is worn out.	Replace with a new rotary table or rotary unit.
Internal leakage (Increase of leakage due to durability is excluded.)	Damage to the seals due to foreign matter or drainage.	Replace with a new rotary unit. Prevent any foreign matter and drainage from entering the product.
	Sealing failure due to operation outside of the operating temperature range.	Replace with a new rotary unit. Operate the product within the operating temperature range.

Problem	Possible cause	Solution
Insufficient rotating angle	MSUA series has an angle adjustment mechanism. The adjustment bolt for angle adjustment is set at a smaller angle than required.	Set the adjustment bolt correctly. Excessive loosening of the adjustment bolt will remove the stop side of the stopper lever from the adjustment bolt. Adjust it within the adjusting range.
The auto switch does not operate or operates incorrectly.	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.

Precautions for the troubleshooting table

1. Causes of the operation failure due to product life are not shown in the troubleshooting table.

Revision history
A: Change to SI unit
B: Corrected to the latest format
C: Corrected to "Safety Precautions"

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Note: Specifications are subject to change without prior notice and any obligation on the part of the manufacturer.  
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