Document No.MSUB-OM00002-C

Operation Manual

PRODUCT NAME

Rotary Table

MODEL / Series / Product Number

MSUB1 to 20
MDSUB1 to 20

SMC Corporation

Contents

Safety Instructions

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

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

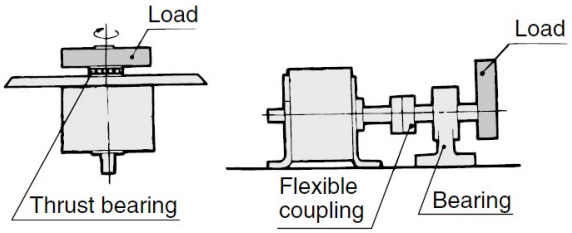
If the hole diameter is enlarged, the product's rotation speed will increase, causing the shock force to increase and damage to the product. As a result, it could pose a hazard to humans and damage the machinery and equipment.

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.

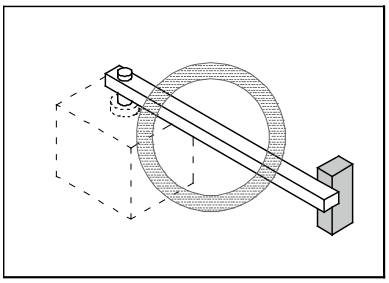
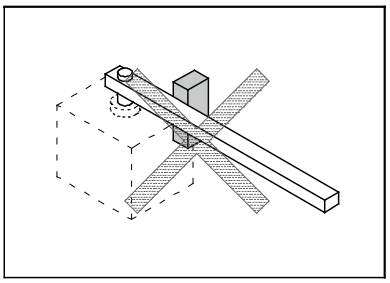
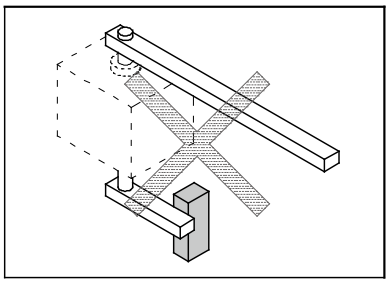
When rotational force from an external spring, etc., acts and generates negative pressure on the product's interior, breakage of the internal seal or acceleration of abrasion may occur.

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

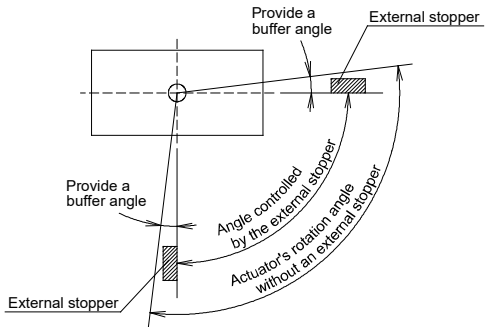
If the stopper is placed near the rotating table, the torque that is generated by the product itself will cause the reaction force which is directed to the stopper to be redirected and applied to the rotating table. This will lead to the breakage of the rotating table and bearing. As a result, it could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

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

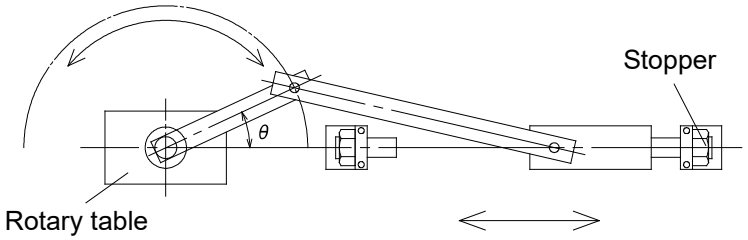
- Install external stoppers within the range of the rotating angle.
  Installing an external stopper at the maximum rotation angle may result in an inability to fully absorb the kinetic energy generated, and damage to equipment may occur.
- Angle adjustment is available for this product. When using an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



Precautions when Converting Rotational Motion to Linear Motion

When using a link mechanism, etc., to convert rotational motion to linear motion, and determining the operation end using the stopper on the linear motion end (see below), a small value for θ at the operation end may result in the torque of the rotary 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 θ at the operation end, to make sure the load generated does not exceed the allowable value for the product.



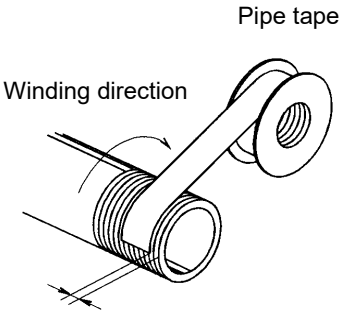
⚠Caution

1. **Do not use organic solvent to wipe the area of the name plate that shows the model.**
   It will erase what is indicated on the name plate.
2. **Do not hit the rotating 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.



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 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 dissemble, 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:

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

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.

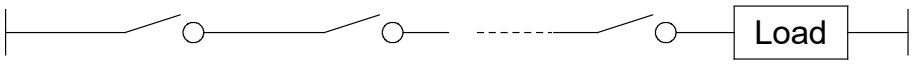
<Solid state>

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^2 or more for reed auto switches and 1000m/s^2 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.

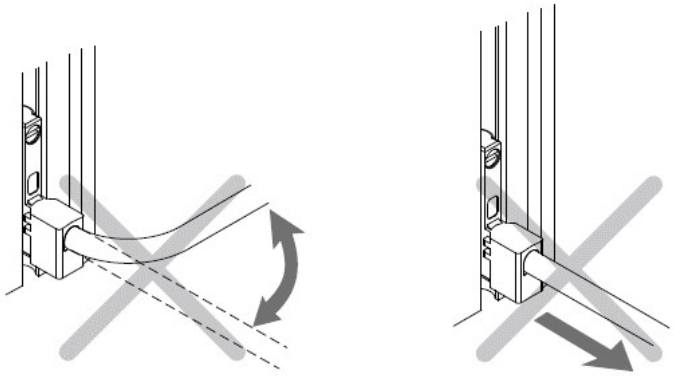
(Magnetic body, external magnetic field, proximal installation of rotary tables with built-in magnet and actuators, temperature change, other factors for magnetic force fluctuation during operation, etc.)

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 read 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^2 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 fre quency 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 is for the 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)

M S U B 20 – 90 S

Free mount type

Bearing type

B	Basic Type

Nominal size(Torque)

1	MSUB 1
3	MSUB 3
7	MSUB 7
20	MSUB 20

Connection port position

Nil	Side ported
E	Axial ported

Available with side ported only, when equipped with auto switch unit.

Vane

S	Single vane
D	Double vane

Rotating angle

Applications	Symbol	Rotating angle
Single vane	90	90°
	180	180°
Double vane	90	90°

Rotation adjustment range

Single vane: +/- 10° (+/- 5° at both stroke ends)

Double vane: +/- 5° (+/- 2.5° at both stroke ends)

Specifications

Table 1 Specifications

Model *2		MSUB1			MSUB3			MSUB7			MSUB20		
Vane		Single vane		Double vane	Single vane		Double vane	Single vane		Double vane	Single vane		Double vane
Rotating angle *1		90° +/-10°	180° +/- 10°	90° +/-5°	90° +/-10°	180° +/-10°	90° +/-5°	90° +/- 10°	180° +/- 10°	90° +/- 5°	90° +/-10°	180° +/-10°	90° +/-5°
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° *1)											
Allowable kinetic energy (J)	energy (J)	0.005			0.013			0.032			0.056		
Bearing		Bearing											
Port position		Side ported or axial ported											
Port size	Side ported	M3 x 0.5			M5 x 0.8								
	Axial ported	M3 x 0.5						M5 x 0.8					

*1) 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 sizes

Table 2*2 Correspondence to equivalent conventional free-mount type models

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

Product mass

Table 3 Mass (g)

Size	Rotating angle	Basic mass		Auto switch unit Note 1)
		Single vane	Double vane	
1	90	145	150	15
	180	140	-	
3	90	230	240	20
	180	225	-	
7	90	360	375	28
	180	355	-	
20	90	510	580	38
	180	505	-	

Note 1) Mass of the auto switch unit excluding the auto switch

Internal capacity

Table 4 Internal capacity of the rotary table

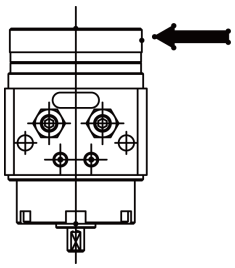
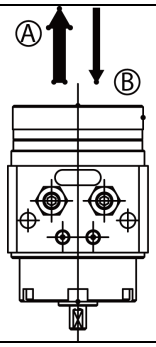
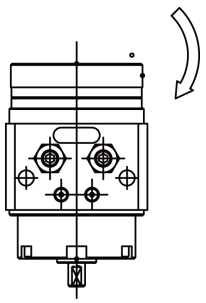
Vane type	Size	Rotating angle (°)	Internal capacity (cm^3)	
			Pressure supply to VA port	Pressure supply to VB port
Single vane	1	90	0.8	1.3
		180	1.3	1.3
	3	90	1.9	3.1
		180	3.1	3.1
	7	90	4.0	6.6
		180	6.6	6.6
	20	90	10.1	16.8
		180	16.8	16.8
Double vane	1	90	1.1	1.1
	3	90	2.7	2.7
	7	90	5.7	5.7
	20	90	14.5	14.5

Allowable Load to the table

Set the load and moment to be applied to the table within the allowable values shown in the table below.

(Values exceeding the allowable range will cause excessive play, reduce accuracy, and shorten service life.)

Table 5 Allowable Load to the table

				
Size	Allowable radial load	Allowable thrust load		Allowable moment (N·m)
1	20	[A] 15	[B] 10	0.3
3	40	30	15	0.7
7	50	60	30	0.9
20	60	80	40	2.9

Rotation range of the table

When pressure is supplied to port A, the table rotates in the clockwise direction, and when pressure is supplied to port B, the table rotates in the counter-clockwise direction.

Angle adjustment is possible as shown in Fig. 1, using adjustment screws (A) and (B).

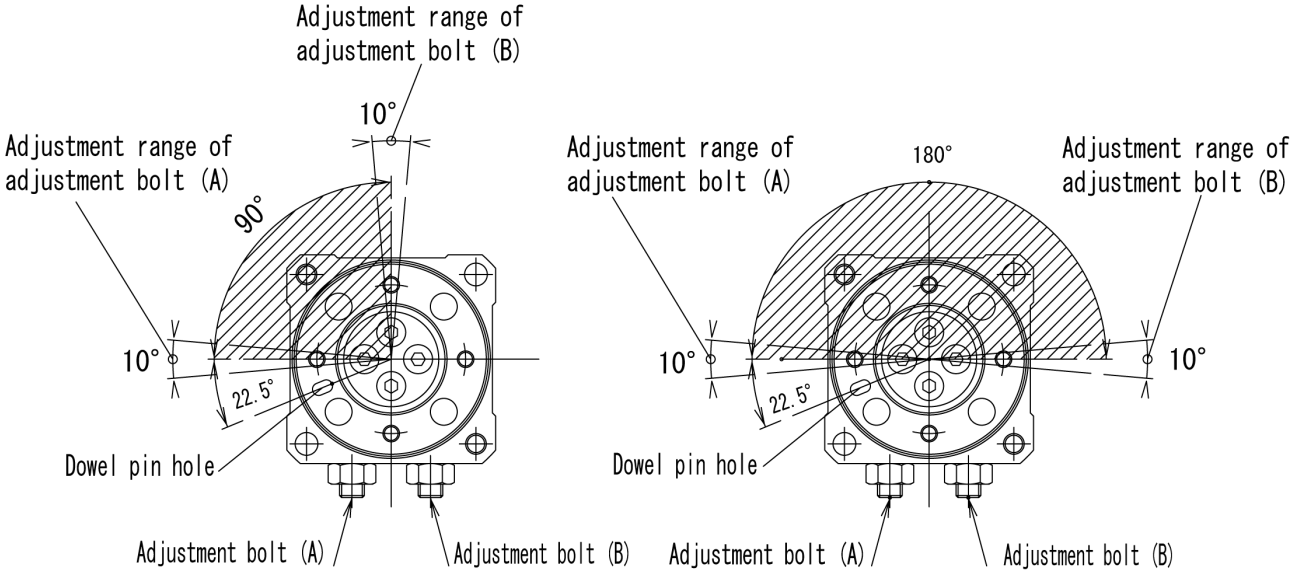
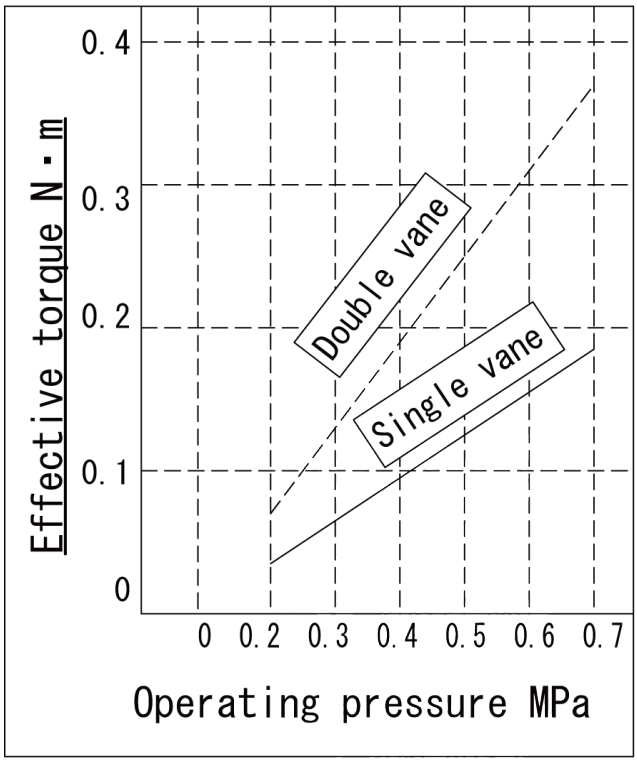


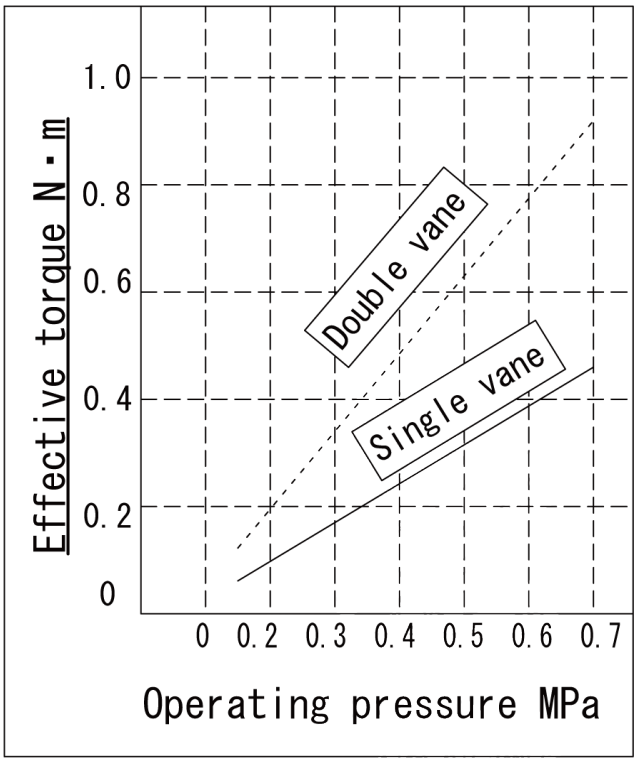
Fig. 1

Effective torque

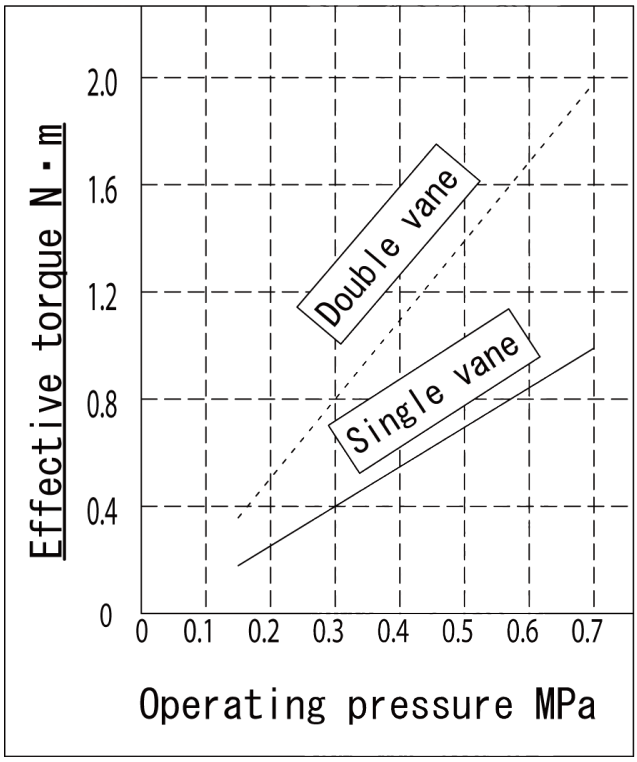
MSUB1



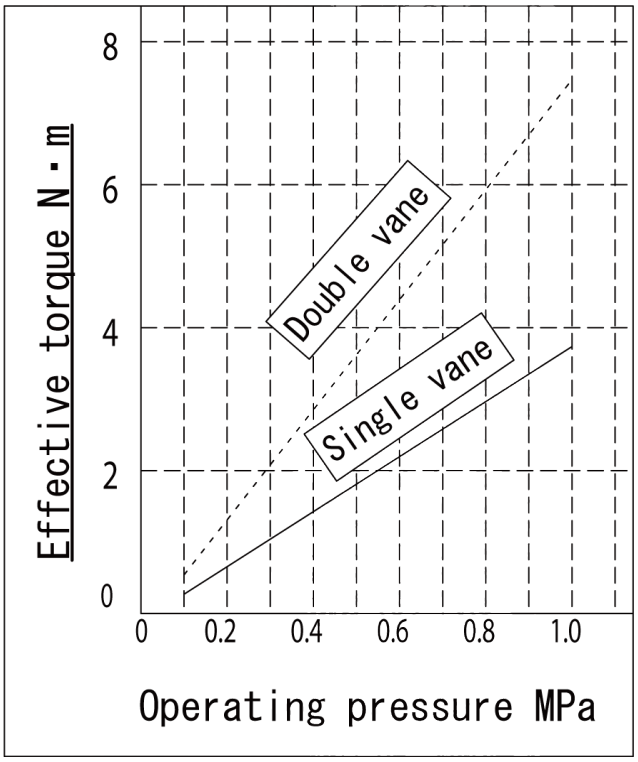
MSUB3



MSUB7

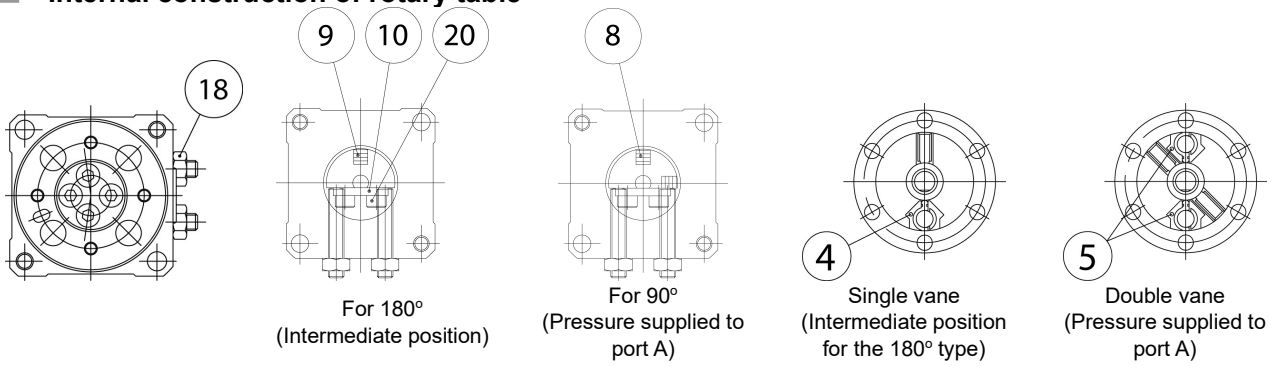


MSUB20

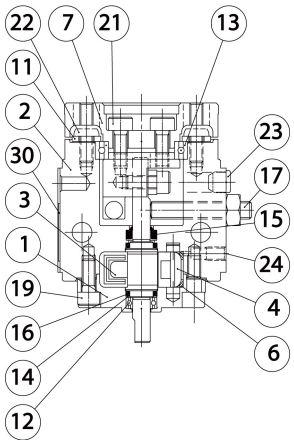


Internal Construction and Components

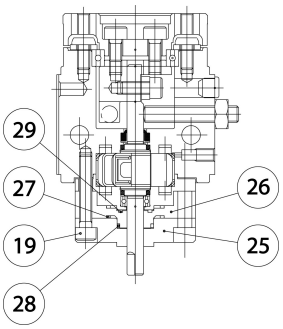
Internal construction of rotary table



Single vane: Size 1, 3, 7, 20



Double vane: Size 1



Double vane: Size 3, 7, 20

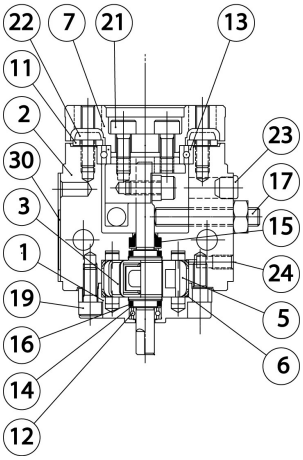


Table 6 Components

No.	Description	Material	Remarks
1	Body (A)	Aluminum alloy	Anodized
2	Body (B)	Aluminum alloy	Anodized
3	Vane shaft	Stainless steel (Carbon steel for MSUB20)	Single vane
		Carbon steel	Double vane
4	Stopper	Resin	Single vane
5	Stopper	Stainless steel	Double vane
6	Stopper seal	NBR	
7	Table	Aluminum alloy	Anodized Screen printing
8	Stopper lever (S)	Carbon steel	Heat treatment
9	Stopper lever (D)	Carbon steel	Heat treatment
10	Lever retainer	Carbon steel	
11	Ring collar	Carbon steel	
12	Bearing	High carbon chromium bearing steel	
13	Bearing	High carbon chromium bearing steel	
14	Back-up ring	Stainless steel	
15	Scraper	NBR	

No.	Description	Material	Remarks
16	O-ring	NBR	
17	Adjustment bolt	Carbon steel	Heat treatment
18	Hexagon nut	Carbon steel	
19	Hexagon socket head cap screw		
20	Hexagon socket head cap screw		
21	Hexagon socket head cap screw		
22	Button head screw		
23	Rubber cap	NBR	
24	Hexagon socket set screw		Only for SE type
25	Cover	Aluminum alloy	
26	Plate	Resin	
27	Gasket	NBR	
28	O-ring	NBR	
29	O-ring	NBR	
30	Label		

* The hexagon socket set screw (24) is used only for the SE type connection port.

* The components are not available individually.

Basic Circuit

Circuit configuration

The standard circuit for operating a rotary actuator with an air filter, regulator, solenoid valve and speed controller is shown in Fig. 2 below.

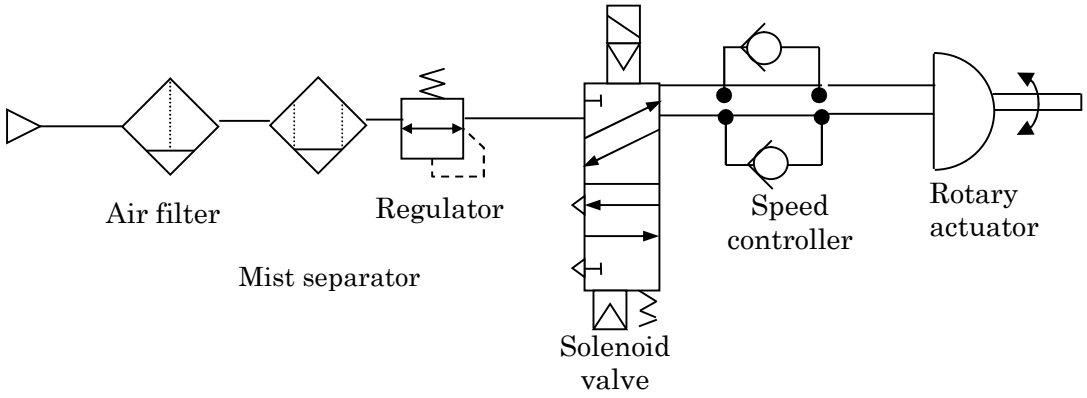


Fig. 2

Recommended models

Recommended models for the standard circuit in Figure 2 are shown in Table 7 below.

Table 7

Model	Solenoid valve (CV factor)	Speed controller	Tubing
MSUB1･3	0.05	AS∗-M3	ø 4 or ø 2.5
MSUB7･20	0.1 to 0.2	AS∗-M5	ø 4 or ø 2.5 ø 6 or ø 4

* The speed controllers must be used in a meter-out control.
(Do not use a speed controller for slow speed.)

Mounting

Mounting for flange application

L dimension when the unit is used as a flange is shown in the table below.
When a hexagon socket head cap screw which complies to JIS is used, the screw head can be installed into the groove of the actuator.

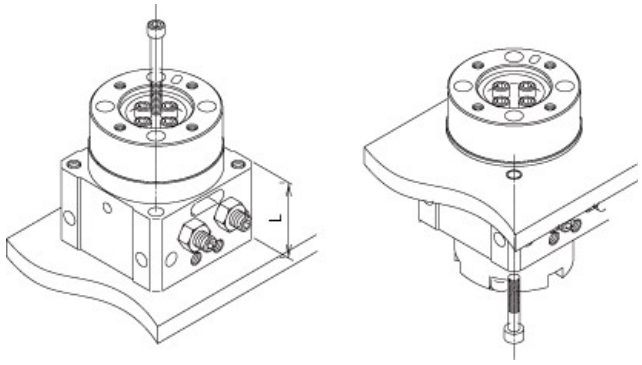


Fig. 3

Table 8

Axial mounting dimensions

Size	L	Screw
1	24	M4
3	26	M4
7	30.5	M5
20	34	M6

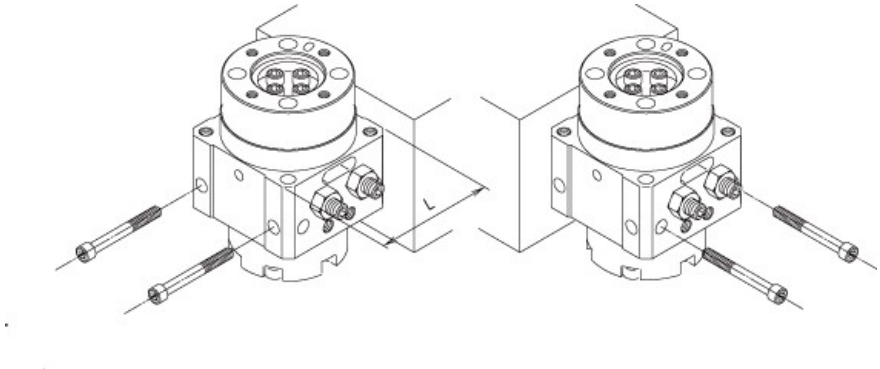


Fig. 4

Table 9

Side mounting dimensions

Size	L	Screw
1	38	M4
3	44	M4
7	50	M5
20	56	M6

Operating environment

⚠Warning

Do not use in environments where there is a danger of corrosion.
Refer to "Internal Construction and Components" on page 5 for materials used for the rotary actuator.

Never use this product in dusty locations or where water, oil, etc., splash on the equipment.

Air supply

⚠Caution

1. The air supplied to the rotary table should be filtered by SMC's air filter and regulated to the specified set pressure by SMC's AR series regulator.
2. **This is a non-lube type actuator. Never supply lubricant oil.**
3. If lubricant is supplied to the actuator, the grease inside the actuator will be washed away, and this may cause operation failure.
   Compressed air containing a large amount of condensate can cause malfunction of the rotary table. Therefore, take appropriate measures to ensure air quality, such as by providing an after cooler, air dryer, or water separator.

Piping

⚠Caution

Preparation before piping

1. Before piping, perform air blow (flushing) or cleaning inside of the piping to eliminate any cutting chips, cutting oil, dust, etc.
2. When attaching piping or fittings to the ports, ensure that chips from the pipe threads or sealing material do not enter the piping.
   Also, if sealant tape is used, **leave 1.5 to 2 thread ridges exposed at the end of the threads.**

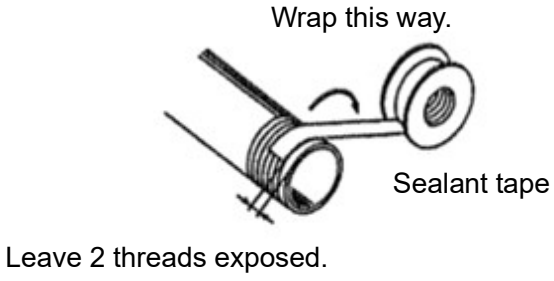


Fig. 5

Settings of Rotation Time

Even if the torque that is required by the load in the rotation movement is small, the shaft or the internal parts could become damaged depending on the inertia of the load. Therefore, select an appropriate model for your application by taking the load's moment of inertia, kinetic energy, and rotation time into consideration.

Moment of inertia

Moment of inertia is the tendency of a still object to resist rotation, or, conversely, the tendency of a rotating object to resist stopping.

When the actuator moves an object (load), inertia (kinetic energy) is generated in the object.

The rotary table stops at the rotation end, but due to inertia, a large shock (kinetic energy) is applied to the rotary table.

The kinetic energy can be calculated using the formula below.

$$E = \frac{1}{2} \times (I + Io) \times \omega^2$$

E: Kinetic energy (J)
I: Moment of inertia (kg·m^2)
Io: Moment of inertia of Table (kg·m^2)
ω: Angular speed (rad/s)

There is a threshold of kinetic energy that a rotary actuator allows. Therefore, by finding the moment of inertia, it is possible to find the threshold value of the rotation time.

The basic formula for finding the moment of inertia is shown below.

The Moment of inertia can be found using the formula shown below.

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

m: Load weight (kg)
R: Center of gravity of load and distance of rotational axis (m)

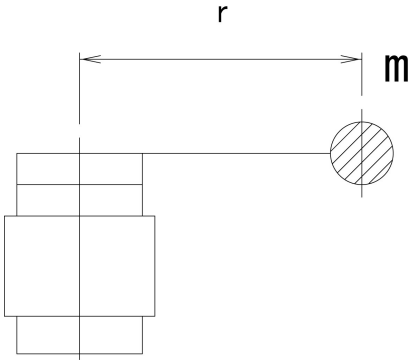


Fig. 6 Moment of inertia

This represents the moment of inertia for a shaft with mass m, which is located at distance R from the shaft.

The formula for finding the moment of inertia depends on the shape of the object.

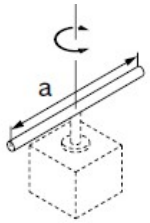
A table of formula for calculating moment of inertia is shown on the following page.

Calculation formulas for moment of inertia

I: Moment of inertia (kg-m^2), m: Load weight (kg)

1. Thin bar

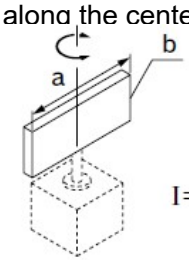
Rotating shaft position: Perpendicular to the bar and goes along the center of gravity



$$I = m \cdot \frac{a^2}{12}$$

2. Thin rectangular plate

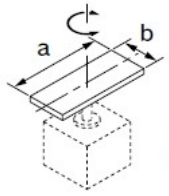
Rotating shaft position: Parallel to the side and goes along the center of gravity



$$I = m \cdot \frac{a^2}{12}$$

3.Thin rectangular plate (including rectangular parallelepiped)

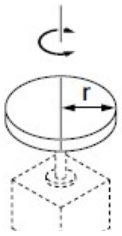
Rotating shaft position: Perpendicular to the plate and goes along the center of gravity



$$I = m \cdot \frac{a^2+b^2}{12}$$

4. Round disk (including column)

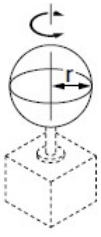
Rotating shaft position: Goes along the center of the shaft



$$I = m \cdot \frac{r^2}{2}$$

5. Solid sphere

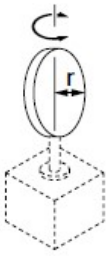
Rotating shaft position: On the diameter



$$I = m \cdot \frac{2r^2}{5}$$

6. Thin round disk

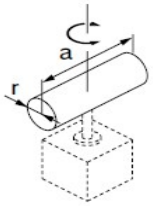
Rotating shaft position: On the diameter



$$I = m \cdot \frac{r^2}{4}$$

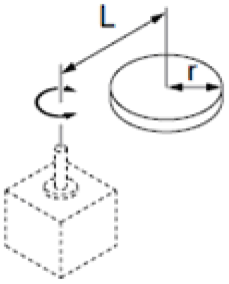
7. Cylinder

Rotating shaft position: Goes along the diameter and the center of gravity



$$I = m \cdot \frac{3r^2+a^2}{12}$$

8. When the rotating shaft and the center of gravity of the load are not consistent



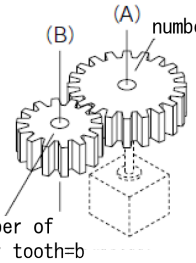
$I = K + m \cdot L^2$

K: Moment of inertia around the center of gravity

Of the load Disk

$K = m \cdot \frac{r^2}{2}$

9. Gear transmission



(1). Find the moment of inertia IB for the rotation of shaft (B).

(2). IB is converted to the moment of inertia IA for the rotation of shaft (A).

$I_A = (\frac{a}{b})^2 \cdot I_B$

SMC

Kinetic energy

Allowable kinetic energy of MSUB series is shown in Table 10.
The angular speed ω at the rotation ends can be found using the formula below.

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

θ: Rotating angle Rad
(90° : 1/2π Rad)
(180° : π Rad)
t: Rotation time sec

Table 10 Allowable kinetic energy

Size	Allowable kinetic energy (J)
1	0.005
3	0.013
7	0.032
20	0.056

Table 11 Additional value of moment of inertia : Io

Size	Moment of inertia of Table (kg·m²)
1	2.5×10^{-6}
3	6.2×10^{-6}
7	1.6×10^{-5}
20	2.8×10^{-5}

Kinetic energy E can be found with the formula below.

$$E = \frac{1}{2} \times (I + Io) \times \omega^2$$

Therefore, the rotation time of the rotary actuator is:

$$t \geq \sqrt{\frac{2 \times (I + Io) \times \theta^2}{E}}$$

E: Allowable kinetic energy J
θ: Rotating angle rad
I: Moment of inertia kg·m²
Io: Moment of inertia of Table kg·m²

Refer to Table 1 for the rotation time adjustment range of each size.

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

$$\omega = \dot{\omega} \times t \quad \cdots\cdots(1)$$

$$\theta = \int \dot{\omega} t \, dt = \frac{1}{2} \dot{\omega} t^2 + C \quad \cdots\cdots(2)$$ C: Integration constant

When t = 0, rotation angle θ = 0, so is C = 0.

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

Therefore,

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

External stopper

If the kinetic energy generated by the load exceeds the threshold value of the rotary table, an external dampening function must be provided to absorb the energy.

Mounting position of external stopper

Mount an external stopper at just below the center of gravity of the load, or at the position as far as possible from the rotary table. Depending on the mounting position of the external stopper, the shaft and/or the bearing may be damaged.

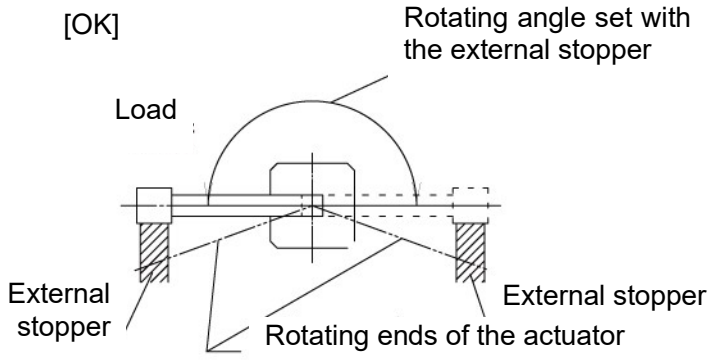


Fig. 7 Correct mounting position of the external stopper

When the external stopper is installed close to the rotary table, the external stopper will be the fulcrum and the inertial force of the load will be applied to the rotating shaft as a bending moment, and this has a bad influence to the product.

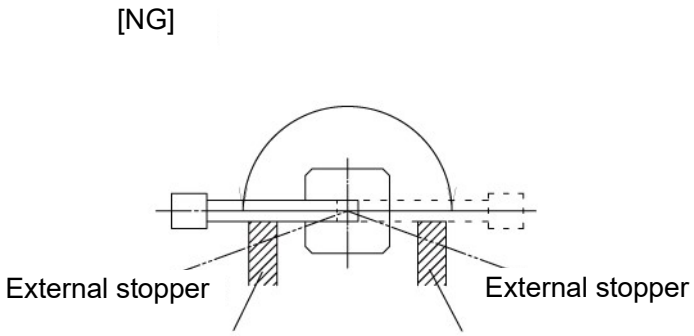


Fig. 8 Incorrect mounting position of the external stopper

Precautions when Using External Stoppers

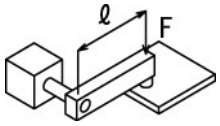
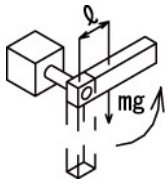
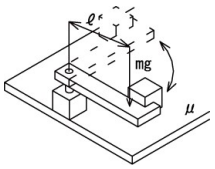
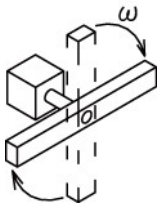
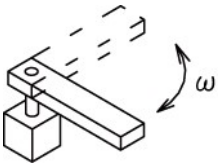
Angle adjustment is available for MSU series rotary table. When using an external stopper, set in a position so that that the adjusting screw does not collide into the stopper lever.

Install the external stopper on the table side. Do not install it to the shaft on the auto switch side.

Calculation of Necessary Torque

Load type

Table12　The calculation method for the torque required varies depending on the load type.

Load type		
Static load: Ts	**Resistance load: Tf**	**Inertial load: TA**
When only a pushing force is necessary (e.g. clamping)	When gravity or friction force acts in the rotating direction	When rotating a load which has inertia
	<Gravity acts>   <Friction force acts>	<Rotation center matches the center of gravity of the load>   <Rotation shaft is in the perpendicular direction>
Ts＝F･ℓ Ts: Static load (N･m) F: Clamping force (N) ℓ: Distance from the rotation center to the clamping position (m)	When gravity acts in the rotating direction Tf＝m･g･ℓ When friction force acts in the rotating direction Tf=μ･m･g･ℓ Tf: Resistance load (N･m) m: Load weight (kg) g: Gravitational acceleration 9.8 (m/s^2) ℓ : Distance from the center of rotation to the point of action of gravity or friction force (m) μ: Coefficient of friction	$Ta = (I + Io) \cdot \dot{\omega} = (I + Io) \cdot \frac{2\theta}{t^2}$ TA: Inertial load (Nm) I: Moment of inertia (kg･m^2) Io: Moment of inertia of table (kg･m^2) $\dot{\omega}$: Angular speed (Rad/s^2) θ: Rotating angle (Rad) t: Rotation time (sec)
Necessary torque T=Ts	Necessary torque T=Tfx(3 to 5) Note 1)	Necessary torque T=TAx10 Note 1)

Resistance load: Gravity and/or frictional force act in the rotating direction.
Example 1) The rotating shaft is in the horizontal direction, and the rotation center does not match the center of gravity of the load.
Example 2) The load slides on the floor while rotating.
* Necessary torque is the total of the resistance load and inertial load.
T=Tfx(3 to 5)+TAx10

Load which is not a resistance load: Gravity and/or frictional force does not act in the rotating direction.
Example 1) Rotating shaft is in the perpendicular direction
Example 2) The rotating shaft is in the horizontal direction, and the rotation center matches the center of gravity of the load.
* Only the inertial load is necessary.
T=TAx10

Note 1) Some margin needs to be given to the torque by multiplying some factors by Tf/TA.

Rotary Table with Auto Switch

Rotary actuator 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 B** **20** - **90** **S** - **T79** **L** **[ ]**

With auto switch unit (Magnet built-in)

Nominal (torque)

1	MSUB 1
3	MSUB 3
7	MSUB 7
20	MSUB20

Rotating angle

Vane type	Symbol	Rotating angle
Single vane	90	90°
	180	180°
Double vane	90	90°

Adjusting range of the rotating angle
Single vane: +/- 5° at both stroke ends
Double vane: +/- 2.5° at both stroke ends

Vane

S	Single vane
D	Double vane

Auto switch

Nil	Without auto switch (magnet built-in)

* For auto switch part numbers, refer to Table 14 *3 on page 15.

Number of mounted auto switch

S	1 pc. *
Nil	2 pcs. **

* A right handed auto switch will be shipped together with the product, but not assembled.
* A right handed auto switch and a left handed auto switch will be shipped together with the product, but not assembled.

Number of mounted auto switch

Nil	grommet/ lead wire 0.5-meter
L	grommet/lead wire 3-meter
C	connector/ lead wire 0.5-meter
CL	connector/ lead wire 3-meter
CN	connector/ Withoutlead wire

* Connector type is applicable only to R73, R80 and T79.
** Lead wire with connector
Part No.
D-LC05: 0.5-meter lead wire
D-LC30: 3-meter lead wire
D-LC50: 5-meter lead wire

Applicable auto switches

Table 13 Applicable auto switches

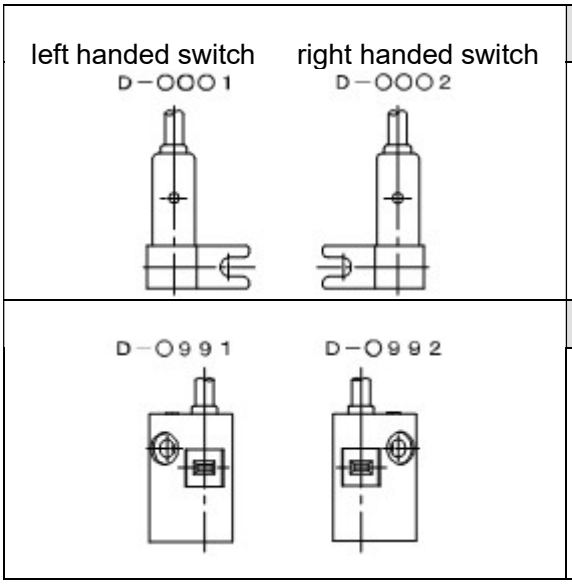
Applicable series	Auto switch model		Electrical entry	Indicator LED
MDSUB1, 3	Reed switch	D-90, 90A	Grommet/ 2-wire type	Without
		D-97, 93A		With
	Solid state switch	D-S99, S99V	Grommet/ 3-wire type (NPN)	With
		D-S9P, S9PV	Grommet/ 3-wire type (PNP)	
		D-T99, T99V	Grommet/ 2-wire type	
MDSUB7, 20	Reed switch	D-R73	Grommet/ 2-wire type	With
		D-R80	Connector/ 2-wire type	Without
	Solid state switch	D-S79	Grommet/ 3-wire type (NPN)	With
		D-S7P	Grommet/ 3-wire type (PNP)	
		D-T79	Grommet/2-wire type, Connector/ 2-wire type	

Auto switch specification

Table 14 Auto switch specifications

Model	Auto switch model		Part No.*3		Application	Load voltage	Max. load current and load current range
	Right handed	Left handed	Perpendicular entry	Horizontal entry			
D-9	D-90		-	90	Relay	24V AC/DC or less	50mA
	D-90A		-	90A	Sequence controller	24 V AC/DC or less	50mA
					IC circuit	100V AC/DC	20mA
	D-97		-	97	Relay Sequence controller	24 VDC	5 to 20mA
	D-93A		-	93A		24 VDC	5 to 40mA
						100 VAC	5 to 40mA
D-R73	D-R731	D-R732	-	R73	Relay Sequence controller	24 VDC	5 to 40mA
						100 VAC	5 to 20mA
	D-R731C	D-R732C	-	R73C	Relay Sequence controller	24 VDC	5 to 40 mA
D-R8	D-R801	D-R802	-	R80	Relay	24 V AC/DC or less	50mA
					Sequence controller	48V AC/DC	40mA
					IC circuit	100V AC/DC	20mA
	D-R801C	D-R802C	-	R80C	Relay Sequence controller	24V AC/DC or less	50mA
D-S7	D-S791	D-S792	-	S79	Relay Sequence controller IC circuit	5, 12, 24 VDC	40mA or less
	D-S7P1	D-S7P2	-	S7P			
D-S9	D-S991	D-S992	S99V	S99			
	D-S9P1	D-S9P2	S9PV	S9P			
D-T7	D-T791	D-T792	-	T79	Relay Sequence controller	5, 12, 24 VDC	40mA or less
	D-T791C	D-T792C	-	T79C			
D-T9	D-T991	D-T992	T99V	T99			

Auto switch orientation



MDSUB 7/ 20
One right handed switch and one left handed switch

MDSUB1/ 3
One right handed switch and one left handed switch

Operating time: 1.2 ms

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

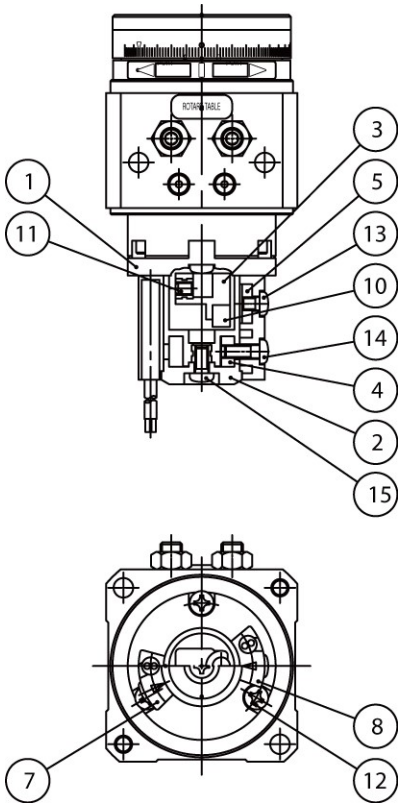
Operating temperature range:
5 to 60°C

Lead wire length:
0.5m (standard)

Internal Construction and Components

Construction of the rotary table with auto switch

MDSUB1/ 3



MDSUB7/ 20

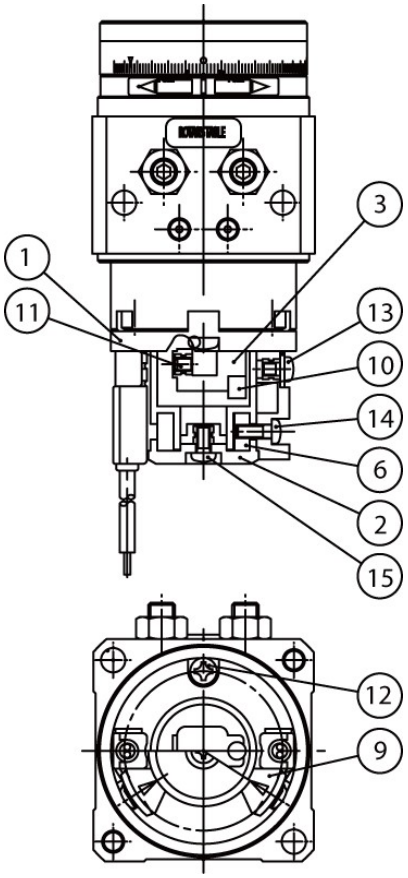


Table 15 Components

No.	Description	Material
1	Cover (A)	Resin
2	Cover (B)	Resin
3	Magnet lever	Resin
4	Holding block (A)	Stainless steel
5	Holding block (B)	Aluminum alloy
6	Holding block	Stainless steel
7	Switch block (A)	Resin
8	Switch block (B)	Resin
9	Switch block	Resin
10	Magnet	-
11	Hexagon socket head set screw	Stainless steel
12	Cross recessed round-head screw	Stainless steel
13	Cross recessed round-head screw	Stainless steel
14	Cross recessed round-head screw	Stainless steel
15	Cross recessed round-head screw	Stainless steel

Internal Construction and Parts

MDSUB1/ 3

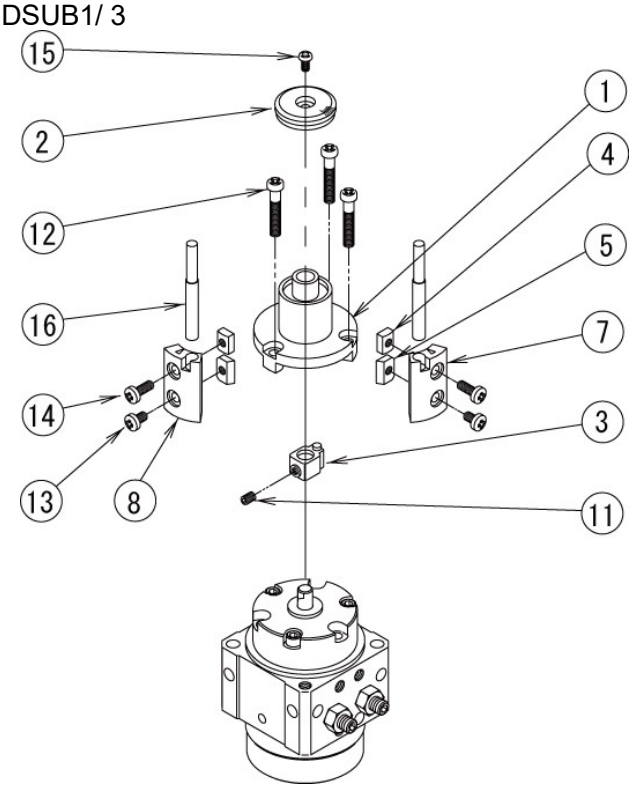


Table 16 MDSUB1/ 3

No.	Description	Material
1	Cover (A)	Resin
2	Cover (B)	Resin
3	Magnet lever	Resin
4	Holding block (A)	Aluminum alloy
5	Holding block (B)	Aluminum alloy
7	Switch block (A)	Resin
8	Switch block (B)	Resin
11	Hexagon socket head set screw	Stainless steel
12	Cross recessed round-head screw	Stainless steel
13	Cross recessed round-head screw	Stainless steel
14	Cross recessed round-head screw	Stainless steel
15	Cross recessed round-head screw	Stainless steel
16	Auto switch	

* Two pieces of the cross recessed head screws (12) are used for MDSUB1.

* The left figure shows the product with Reed switch. Please refer to page 18 for the product with solid state switch.

MDSUB7/20

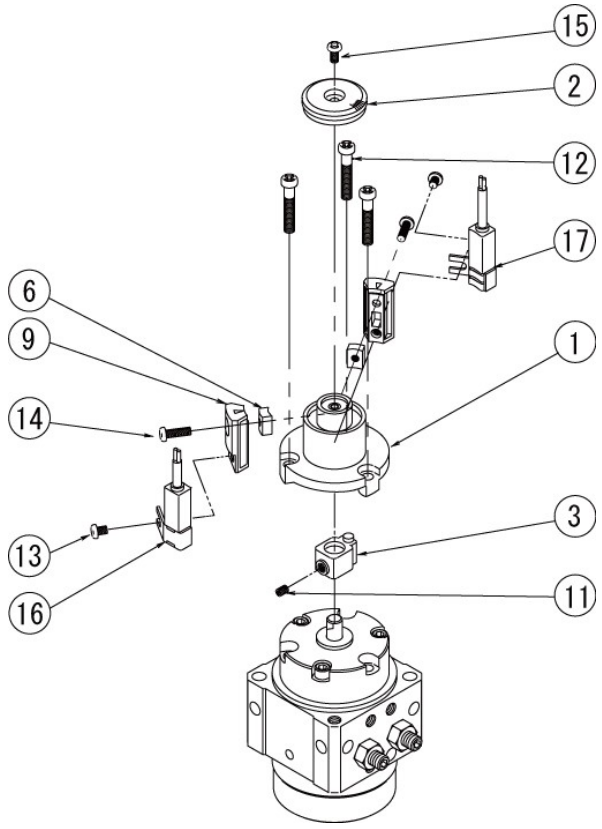
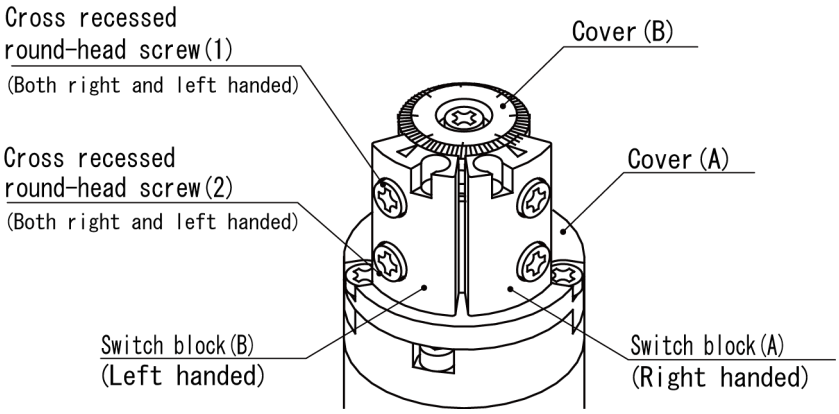


Table 17 MDSUB7/20

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

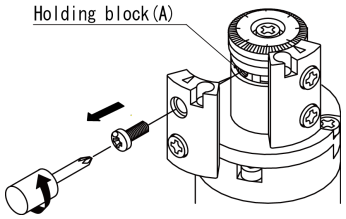
MDSUB1/3 Auto switch mounting instructions

Auto switch unit/ Appearance and Parts descriptions

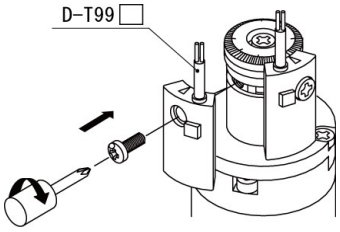


Solid state switch
<Applicable auto switches>
3-wire type: D-S99(V), D-S9P(V)
2-wire type: D-T99(V)

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).

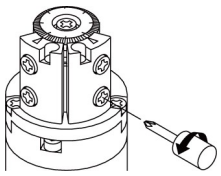


* Appropriate tightening torque: 0.4 to 0.6 (N·m)

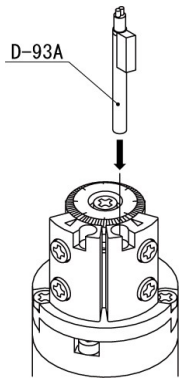
* Holding block (A) moves along the groove. Move it to the mounting position before mounting the switch.
- Adjust the switch sensoring position by the cross recessed round head screw (1) before operating the product.

Reed switch
<Applicable auto switches>
D-97, D-93A (with indicator light)
D-90, D-90A (without indicator light)

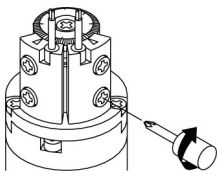
1. Preparation
Loosen the cross recessed round head screw (2). (2 to 3 rotations)
* The screw is tentatively fixed for shipment.



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 sensoring position by the cross recessed round head screw (1) before operating the product.

How to move the switch detecting position

When setting the detection position, loosen the holding screw to move the switch, and fix it at the required position by tightening the holding screw again. When doing it, if the set screw is tightened strongly, it will be broken and it will not be able to fix the screw, so keep the tightening torque to approximately 0.5 Nm.

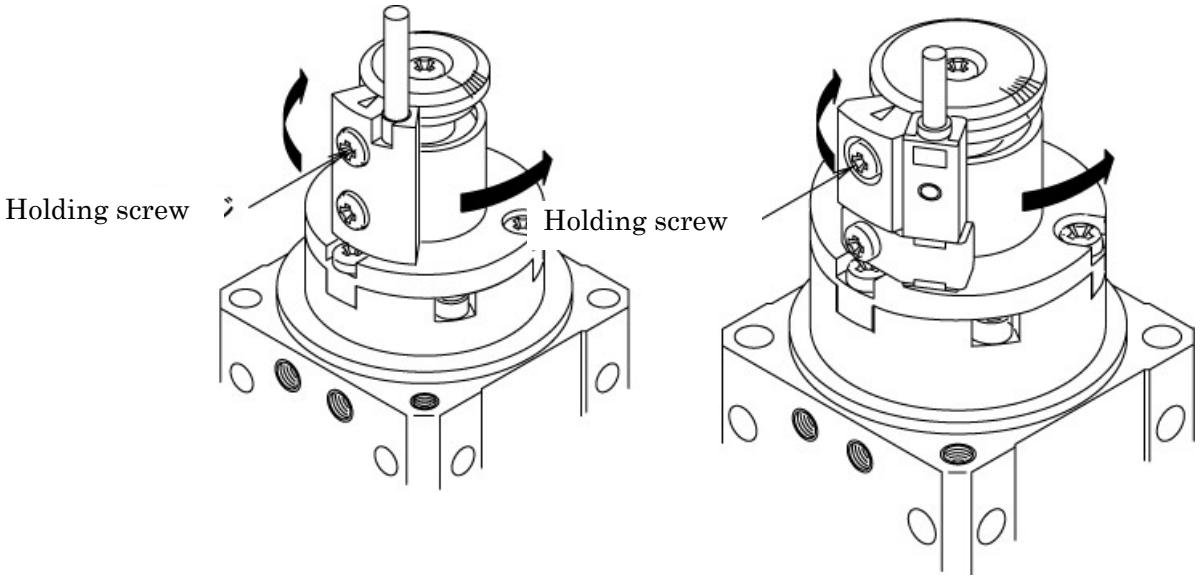


Fig. 9

Table 18 Operation angle and hysteresis angle of auto switch

Size	Reed switch		Solid state switch	
	Operation angle	Hysteresis angle	Operation angle	Hysteresis angle
1	110°	10°	110°	10°
3	110°	10°	110°	10°
7	90°	10°	90°	10°
20	90°	10°	90°	10°

Rotation range of the table dowel pin hole and auto switch mounting position

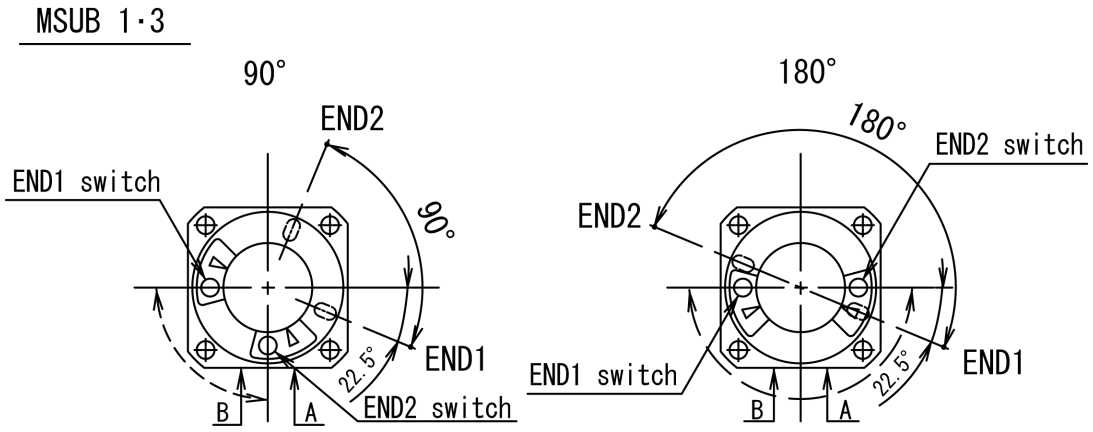


Fig. 10

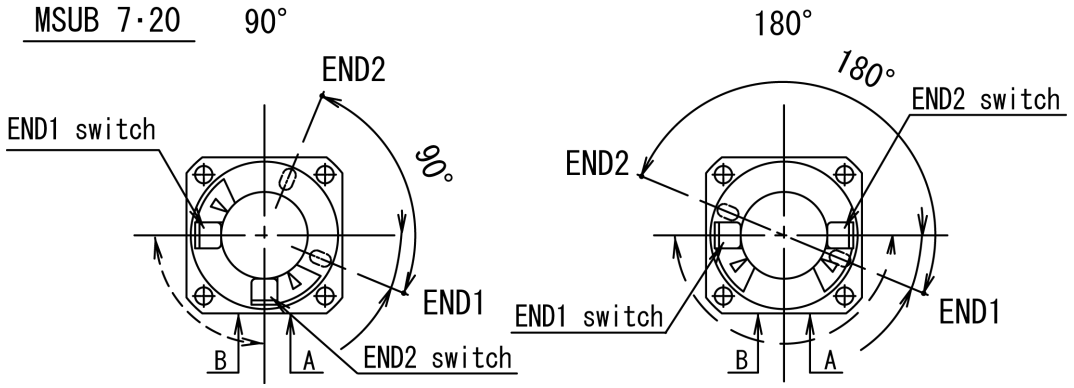


Fig. 11

- In Fig. 9 and Fig. 10, the solid line arrows of the angle 90 degrees and 180 degrees show the rotation range of the dowel pin hole on the table. When the dowel pin hole is at END1, the END1 switch operates and when the dowel pin hole is at END2, the END2 switch operates.
- The broken line shows the rotation range of the built-in magnet. The operation angle of the switch becomes smaller, when the END1 switch is moved clockwise and the END 2 switch is moved counterclockwise.

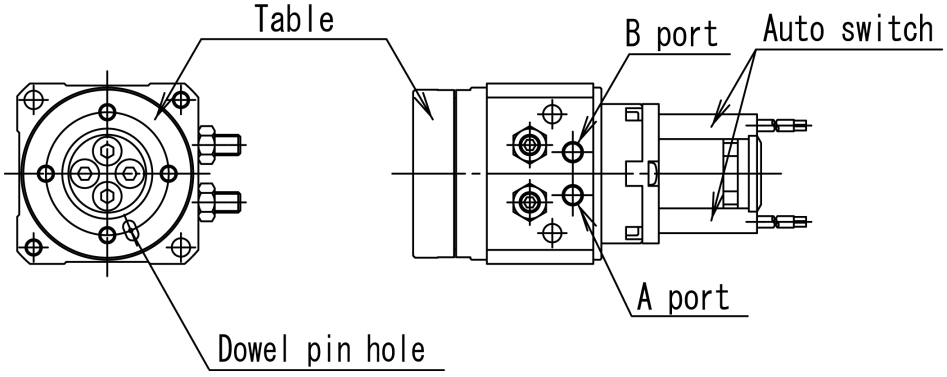
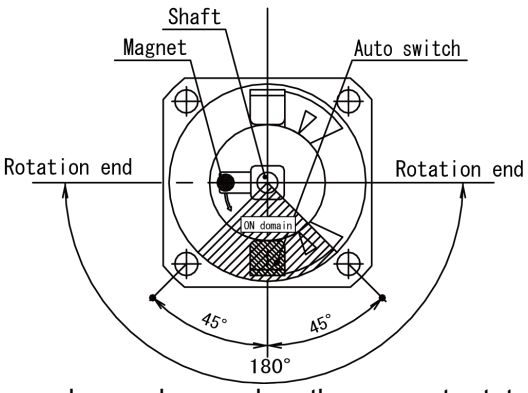


Fig. 12

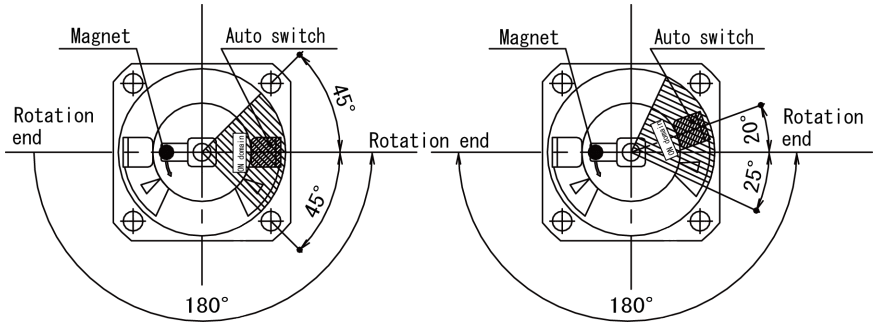
Operation angle and hysteresis angle of auto switch

[Example]
Rotary table: 180°
Switch operating angle: 90°
When the switch is mounted at the intermediate position of the rotation



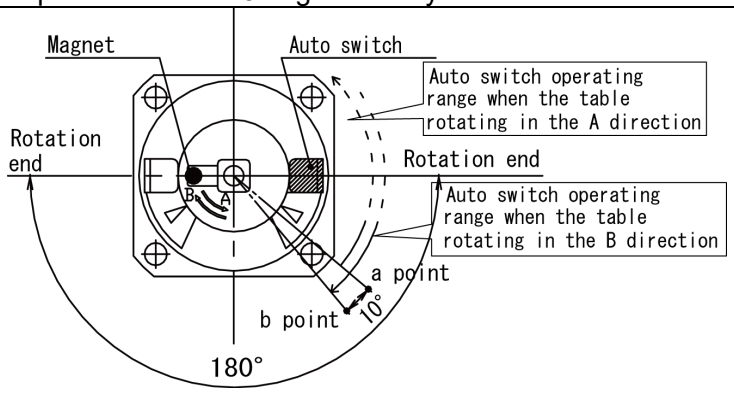
As shown in the figure shown above, when the magnet rotates in the arrow direction along with the shaft rotation, the switch turns on when the magnet passes through the point A, and when it passes through the point B, the switch turns off. In this case, the ON area is 90°, i.e. switch rotation angle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

[Example]
Rotary table: 180°
Switch operating angle: 90°
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°
Switch hysteresis angle: 10°



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.

Maintenance and Inspection

In order to use the rotary table in an optimal condition, it is necessary to perform maintenance depending on the operating conditions regularly. It is preferable to perform maintenance of the rotary table once a year in general, and it is strongly recommended that maintenance and repair are performed every three years. Note that if mechanical components such as vane shaft, bearing, etc. are damaged, they are likely to have been used outside of the specification of the rotary table, so review the operating conditions. In that case, be sure to ask your SMC representatives to repair the rotary table.

Regular inspection

The regular inspection should be performed on the following items.

(1) Looseness of the bolt used for fixing the rotary table
(2) Looseness of the mounting frame of the rotary table
(3) Operating condition
(4) External air leakage

If any items are found by the inspection that require repairing, tighten any loose parts.

Repair

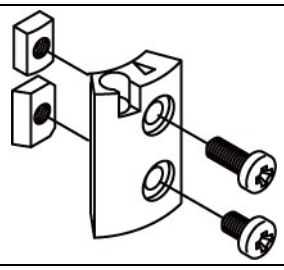
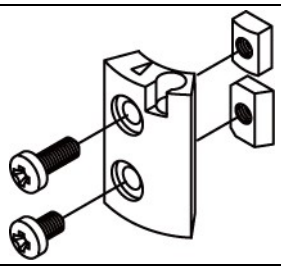
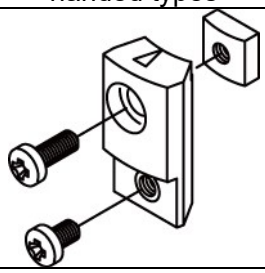
It is prohibited to disassemble the basic parts of this product. Please contact SMC for repair.
To replace the auto switch unit, use the units of the applicable size.
Part numbers are shown in Table 19 and Table 20 below respectively.

Table 19 Auto switch unit

Model	Part number
M(D)SUB1	P211070-1
M(D)SUB3	P211090-1
M(D)SUB7	P211060-1
M(D)SUB20	P211080-1

* Refer to Table 14 on page 16 for components. Auto switches are not included in the auto switch unit. It is necessary to place an order for auto switches separately.

Table 20 Auto switch block unit

MDSUB1/3			
For Reed switch		For solid state switch	For both Reed switch and solid state switch
For right handed type	For left handed type	Both for right and left handed types	Both for right and left handed types
			
Part No: P211070-8	Part No: P211070-9	Part No: P211070-13	Part No: P211060-8

* Auto switch block unit is included in the auto switch unit.
* Auto switch block unit is an assembly that is required to mount one auto switch to the auto switch unit.

Troubleshooting

Problem	Possible cause	Countermeasure
Rotary table does not move.	Supply pressure is not applied correctly.	Correctly set the regulator at the supply pressure side.
	The directional switching valve (such as a solenoid valve) does not switch.	Correctly apply a signal to the directional switching valve (such as a solenoid valve).
	Air leakage from piping	Inspect the piping and stop the leakage.
The table does not operate smoothly (e.g.stick-slip operation).	The load has some friction.	Reduce the friction resistance.
	The rotation table and the item used with it are not aligned.	Align the two centers or use a flexible fitting.
	Insufficient output due to a low supply pressure.	To obtain stable operation, adjust the supply pressure to make the load ratio appropriate.
	Speed controller is restricted too much.	The speed adjustment range of the rotary table is decided by size, so adjust the speed controller again.
Extreme rotating angle changes	Internal parts are broken.	Replace with a new rotary table. After that, take the measures below. 1. Calculate the kinetic energy applied to the rotary table, and adjust the load and rotating speed so that the kinetic energy will be within the allowable range. 2. Mount an external shock absorber to absorb the impact force. 3. Mount an external stopper to prevent the impact force from being applied to the rotary table. The adjusting screw inside the product
Play with the table		

Air leakage from the table		must be adjusted in the position that it does not touch the stopper lever. 4. Check the load that is applied to the product, and modify the load to be within the allowable load range.
Problem	Possible cause	Countermeasure
Air leakage from the short shaft or the table	The seal is worn out.	Replace with a new rotary table.
Insufficient rotating angle	MSU series had an angle adjusting 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 will not operate or operates incorrectly.	The auto switch is mounted in an inappropriate position.	Mount the auto switch in the correct position.
	Effect of an external magnetic field	Check that there is no strong magnetic field present.
	Trouble with the electrical circuit	Check that there is no trouble with the electrical circuit.
	Trouble with the electrical specification	Check that there is no trouble with the electrical specification.

- Note for the troubleshooting table
  1. Possible causes related to the product service life are excluded from the table.

Revision history
A: Change to SI unit B: Double vane added C: Correction to "Safety Precautions"

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