



Operation Manual

Product Name

Rotary Table

Model

MSUB1 to 20
MDSUB1 to 20

- Install and operate the product only after reading the Operation Manual carefully and understanding its contents.
- Specifically, read the safety instructions carefully.
- Keep this operation manual available whenever necessary.

SMC Corporation



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Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions are categorized into three groups, "Caution", "Warning" and "Danger" depending on the level of hazard and damage, and the degree of emergency. They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC)^{*1)} and other safety regulations.

- *1) ISO 4414: Pneumatic fluid power --General rules relating to systems
ISO 4413: Hydraulic fluid power -- General rules relating to systems
IEC 60204-1: SaAfeTy of machinery -- Electrical equipment of machines
(Part 1: General requirements)
ISO 10218-1992: Manipulating industrial robots -- Safety



Caution

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



Warning

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



Danger

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

Warning

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

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

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

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

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

The product specified here may become unsafe if handled incorrectly.

An operator who is appropriately trained and experienced must perform the assembly, operation and maintenance of machines or equipment.

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 dropping of driven objects or run-away of machinery/equipment have been confirmed.

Warning

- 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
- 3) Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.
- 4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.**
 - 1) Conditions and environments outside of the given specifications, or used outdoors or in a location exposed to direct sunlight.
 - 2) Installation of equipment in conjunction with atomic energy, railways, air navigation, space appliances, shipping, vehicles, military, medical equipment, combustion devices, recreation equipment, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or any other applications unsuitable for the standard specifications described in the product catalog.
 - 3) An application that could have negative effects on people, property, or animals, especially those applications requiring special safety analysis.
 - 4) Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation. Check the product regularly in order to confirm normal operation.

Caution

The product is provided for use in manufacturing industries.

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

If the product is being considered for use in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.

If anything is unclear, contact your nearest sales branch.

Limited Warranty and Disclaimer

/ Compliance Requirements

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

Read and accept them before using the product.

Limited warranty and Disclaimer

1. **The warranty period of the product is 1 year in service or 1.5 years after the product is delivered.**
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 SMC 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.**

Design precautions

Warning

1. Confirm the specifications

The product is designed for use only in compressed air systems.

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

Please contact SMC if using for other fluids than compressed air.

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

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

Failure to provide such measures could accelerate the movement, which may be hazardous to humans, machinery, and other equipment.

3. A protective cover is recommended to minimize the risk of personal injury.

If a driven object and moving parts of the product are in close proximity, personal injury may occur. Design the system to avoid contact with the human body.

4. Make sure that the secured portions will not loosen.

Be sure 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. A deceleration circuit or shock absorber etc., may be required.

When a driven object is operated at high speed or the load is heavy, the rotary table will not be sufficient to absorb the shock. Install a deceleration circuit to reduce the speed before cushioning, or install an external shock absorber to relieve the shock. In this case, confirm the rigidity of the equipment carefully.

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

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

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

For equipment that relies on power sourced such as compressed air, electricity, or hydraulic pressure, adopt countermeasures to prevent the equipment from causing a hazard to humans or damage to the equipment in the event of malfunction.

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

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

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

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

10. Consider the action when operation is restarted after an emergency stop or abnormal 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 actuator has to be reset to the starting position.

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

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

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

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

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

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

14. Do not stop or hold the product at midpoint by keeping air pressure in the product.

For a product without an external stopping mechanism, if a directional control valve is closed to keep the air pressure in the product, in an attempt to stop the product at midpoint, it might not be possible to maintain that stopped position due to an air leakage. As a result, it could pose a hazard to humans and cause damage to machinery and/or equipment.

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

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

16. Do not use in a location where 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.

17. Disassembly and modification prohibited

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

This may cause human injury and/or an accident.

18. Refer to the Auto Switches Common precautions when using with an auto switch.

Selection

Caution

1. Do not use below the 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 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 the product under hydraulic pressure.**
The product will be damaged if it is used by applying hydraulic pressure.
5. **Do not use in a location where there are many temperature fluctuations.**
When using in lower temperature applications, take care not to allow frost inside the cylinder.
Operation may be unstable.
6. **Perform speed adjustment in the environment in which the product is to be used.**
Speed adjustments may be necessary if the environmental conditions vary.

Mounting

Warning

1. **Operation Manual**

Install and operate only after reading the operation manual carefully and understanding the contents.
Keep the manual 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.**

Tighten the screws to the recommended torque when mounting the product.

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 adjustment bolt beyond the allowable adjustment range.**

The angle adjustment bolt 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 product could operate suddenly, which could pose a hazard to humans and damage the machinery and equipment.

7. **Do not make any alterations to this product.**

By modifying the product, its strength could be affected, which could cause the product to break. As a result, it could pose a hazard to humans and damage the machinery and equipment.

8. **Do not enlarge the fixed orifice at the piping port by additional machining.**

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

9. **If shaft couplings are to be 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 a load to the shaft that exceeds the values given in the catalog.**

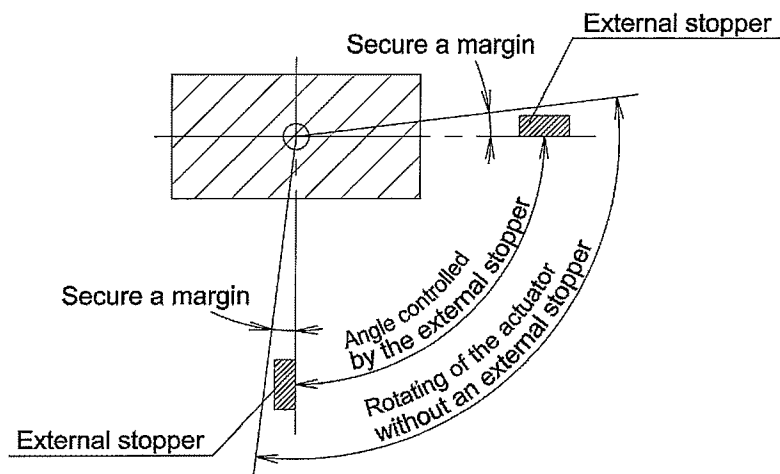
If a load that exceeds the allowable values is applied to the product, it could lead to equipment malfunction, a hazard to humans, and damage to the machinery and equipment.

11. **Place an external stopper in a position away from the rotating shaft.**

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

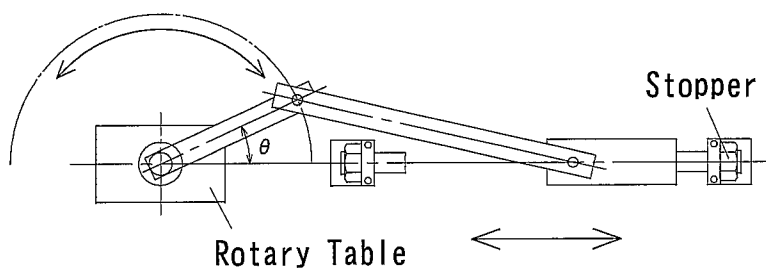
Precautions when Using External Stoppers

- Be sure to install external stoppers in the proper places.
Installation in the wrong place can result in equipment breakage, which could damage other equipment or cause human injury.
* Refer to page 12 for details.
- 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.



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 shaft, 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.



12. 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.

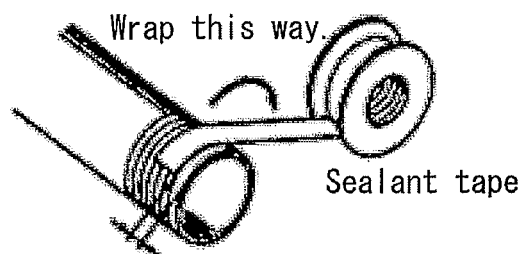
Caution

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 nameplate.
2. **Do not hit the output shaft by securing the body or hit the body by securing the output shaft.**
These actions may damage the output shaft or bearing.
When a load must be coupled to the output shaft, secure the output shaft.
3. **Do not place foot on the output shaft and the load mounted to the output shaft directly.**
Weighting the output shaft directly causes damage of the output shaft and bearing etc.
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.

Piping

Caution

1. Refer to the Fittings and Tubing Precautions (Best Pneumatics No.6) for handling one touch fittings.
2. **Preparation before piping**
Before piping is connected, flush thoroughly with air or wash to remove chips, cutting oil and other debris from inside the pipe.
3. **Sealant 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 sealant tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



Leave 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. **Fluids**
Please consult with SMC when using the product in applications other than compressed air.
2. **When there is a large amount of moisture**
Compressed air containing a large amount of condensate can cause malfunction of pneumatic equipment. An air dryer or water droplet separator should be installed upstream from filters.
3. **Draining control**
If condensate in the drain bowl is not emptied on a regular basis, the condensate will overflow and allow it to enter the compressed air lines. This will cause a 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.

Caution

1. **If ultra dry air is used as a fluid, the lubrication characteristics of the equipment will deteriorate and this can affect the reliability (life) of the product. Contact SMC beforehand if using ultra dry air.**
2. **Install an air filter.**
Install an air filter upstream, near the valve. A filtration degree of 5µm or less should be selected.
3. **Therefore, take appropriate measures to ensure air quality, such as by providing an after cooler, water separator.**
Compressed air that contains a large amount of moisture can cause malfunction of pneumatic equipment such as rotary actuators. Therefore, take appropriate measures to ensure air quality, such as by providing an after cooler, water separator.
4. **Ensure that the fluid and ambient temperature are within the specified range.**
When operating at temperatures 5°C or lower, water in the circuit may freeze and cause breakage of seals or malfunction. Measures should be taken to prevent freezing.

Operating Environment

Warning

1. **Do not use in an atmosphere containing corrosive gases, chemicals, sea water, water, steam, or where there is direct contact with any of these.**
Refer to the construction diagram for details on the materials used in the rotary table.
2. **Do not use in direct sunlight.**
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.**
6. **Never use in an atmosphere with explosive gases.**
This rotary table does not have an explosion proof structure. Never use in an atmosphere containing explosive gas since this may cause a serious explosion.

Maintenance

Warning

1. **Maintenance should be performed according to the procedure indicated in the Operating 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 moisture 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 and/or equipment running away, etc. Cut the supply pressure and electric power and exhaust all compressed air from the system.

Turn off the power supply, stop the air supply and exhaust all compressed air from the system.

Caution

1. **For lubrication, use the designated grease for each specific product.**

The use of a non-designated lubricant could damage the seals.

Auto Switches Precautions

Design and selection

Warning

1. Confirm the specifications.

Read the specifications carefully and use this product appropriately. The product may be damaged or malfunction if it is used outside the range of specifications of current load, voltage, temperature or impact.

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

2. Cautions for use in an interlock circuit

When an auto switch is used in an interlock system which requires high reliability, provide a double interlock system, for example a mechanical protection system, for extra safety, or by also using another switch (sensor) together with the auto switch. Also, perform regular maintenance and confirm proper operation.

3. Do not make any modifications (including exchanging the printed circuit boards) to the product.

This may cause human injuries and accidents.

It may cause injury and/or an accident and will void the warranty.

Caution

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

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

2. Wiring should be kept as short as possible.

<Reed switch>

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) For an auto switch without a contact protection circuit, 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 will be necessary to connect a contact protection box, in order to extend the product life. Please consult with SMC.

<Solid state switch>

3) Although wire length should not affect switch function, use a wire 100m or shorter.

Even if the length is less than 100m, longer wiring makes it more likely to be affected by noise.

For long wire lengths, we recommend a ferrite core should be attached to both ends of the cable, to reduce noise.

A contact protection box (used for reed type auto switches) is not necessary for solid state switches, because of the type of switch construction.

3. Do not use a load which generates surge voltage.

If a surge voltage is generated, discharge may be generated at the switch contacts, which may reduce the product life.

When a load which generates a surge voltage is to be directly driven, operate such as a relay or solenoid, use an auto switch with built-in surge protection.

<Reed switch>

Use an auto switch with built-in contact protection circuit or use a contact protection box.

<Solid state switch>

Use a built-in surge absorbing element type device.

4. Take precautions when multiple actuators are used close together.

When using two or more rotary tables with auto switches in a close proximity in parallel, keep them at least 40mm apart.

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

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

5. Pay attention to the internal voltage drop of the switch.

<Reed switch>

1) Switches with an indicator light

- When auto switches are connected in series, as shown below, there will be a large voltage drop, due to the internal resistance of the LED. (Refer to 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 may operate normally, the load may not operate.



- Similarly, when operating below the specified voltage, although an auto switch may operate correctly, the load may not operate. Therefore, the formula below should be satisfied, after confirming the minimum operating voltage of the load.

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

2) If the internal resistance of an LED causes a problem, select a switch without an indicator light.

<Solid state switch, 2-wire type>

3) Generally, the internal voltage drop will be greater with a 2-wire solid state switch than with a reed switch.

Take the same precautions as in 1).

Note that a 12 VDC relay is not applicable.

6. Pay attention to leakage current.

<Solid state switch, 2-wire type>

With a 2 wire solid state switch, current (leakage current) flows to the load to operate the internal circuit even when the switch is in the OFF state.

$$\text{Current to operate load (OFF condition)} > \text{Leakage current}$$

If the criteria given in the above formula are not met, it will not reset correctly (stays ON).

Use a 3 wire switch if this specification will not be satisfied.

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

7. Reserve a space for maintenance.

Design the system allowing the required space for maintenance.

8. Use the rotary table and auto switch in proper combination.

The auto switch is pre-adjusted to operate properly for an auto-switch-capable SMC rotary table.

If the auto switch is mounted improperly, used for another brand of rotary table or used after changing the machine installation, the auto switch may not operate properly.

Mounting and Installation

Caution

- 1. Do not drop or bump.**
Do not drop, bump or apply excessive impact (300m/s^2 or more for Reed switches and 1000m/s^2 or more for solid state switches) while handling. Although the body of the switch may not be damaged, the inside of the switch could be damaged and cause a malfunction.
- 2. Observe the proper tightening torque for mounting an auto switch.**
If an auto switch is tightened beyond the specified tightening torque, the auto switch, mounting screws, or mounting bracket may be damaged.
On the other hand, tightening below the range of tightening torque may allow the auto switch to slip out of position.
- 3. Do not carry a rotary actuator by the auto switch lead wires.**
This may not break the lead wires, but it may cause internal elements of the auto switch to be damaged by the stress.
- 4. Fix the auto switch using the appropriate screws on the switch body. If other screws are used, the auto switch may be damaged.**
- 5. Auto switches should be mounted in the middle of the operation range.**
Auto switches should be set so that the magnet stops in the middle of the operation range (the range that it is ON). Mounting the auto switch close to the edge of the operating range can cause operation to be unstable.

Wiring

Caution

- 1. Confirm proper insulation of wiring.**
Be certain that there is no faulty wiring insulation (contact with other circuits, ground fault, improper insulation between terminals, etc.) Damage may occur due to excess current flow into the auto switch.
- 2. Do not wire with power lines or high voltage lines.**
Wire separately from power lines or high voltage lines, avoiding parallel wiring or wiring in the same conduit with these lines. Control circuits containing auto switches may malfunction due to noise from these other lines.
- 3. Avoid repeatedly bending or stretching lead wires.**
Broken lead wires will result if bending stresses or tensile forces are applied to the lead wires.
Stress and tensile forces applied to the connection between the lead wire and auto switch increases the possibility of disconnection. Fix the cable in the middle so that it is not movable in the area where it connects with the auto switch.
- 4. Be sure to connect the load before power is applied.**
<2 wire type>
If power is supplied when an auto switch is not connected to a load, the switch will be damaged due to excess current. The same applies if the brown wire (+, output) is directly connected to the (+) power supply terminal.
- 5. Do not allow short circuit of loads.**
<Reed switch>
If power is supplied with the load in a short circuit condition, the switch will be damaged due to excess current flow into the auto switch.
<Solid state switch>
All PNP output switches do not have built-in short circuit prevention circuits.
If loads are short circuited, the switches will be instantly damaged. Take special care to avoid reverse wiring with the brown power supply line and the black output line on 3 wire type switches.

6. Avoid incorrect wiring.

<Reed switch>

A 24 VDC switch with indicator light has polarity.

The brown wire or terminal No.1 is (+), and the blue wire or terminal No.2 is (-).

1) If connections are reversed, the auto switch will operate, however the LED will not turn ON.

Also, note that a current greater than that specified will damage the LED and it will no longer operate.

Applicable models

D-97, D-93A, D-R731*, and D-R732*

<Solid state switch>

1) If connections are reversed on a 2 wire type auto switch, the switch will not be damaged if protected by a protection circuit, but the switch will always stay in an ON state.

However, it is still necessary to avoid reversed connections, since the switch could be damaged by a load short circuit in this condition.

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

Operating Environment

Warning

1. Never use in an atmosphere with explosive gases.

Auto switches are not designed with an explosion proof construction. Never use in an atmosphere containing explosive gas since this may cause a serious explosion.

Contact SMC for information regarding ATEX compliant products.

Caution

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

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

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

Although most auto switches satisfy the IEC standard IP67 construction (JIS C 0920: watertight construction), do not use in applications where continually exposed to water splash or spray. Poor insulation or swelling of the potting resin inside switches may cause malfunction.

3. Do not use the product in a place where the product could be splashed by oil or chemicals.

Consult SMC if auto switches will be used in an environment with coolant, cleaning solvent, various oils or chemicals. If auto switches are used under these conditions for even a short time, they may be adversely affected by improper insulation, malfunction due to swelling of the potting resin, or hardening of the lead wires.

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

Consult SMC if switches are used where there are temperature cycles other than normal temperature changes, as they may be adversely affected.

5. Do not use in an environment where there is excessive impact shock.

<Reed switch>

When excessive impact (300m/s² or more) is applied to a reed type auto switch during operation, the switch contacts may malfunction and generate or disconnect a signal momentarily (1 ms or less). Consult SMC regarding the need to use a solid state switch depending upon the environment.

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

<Solid state switch>

When there are units (solenoid lifter, high frequency induction furnace, motor, etc.) which generate a large amount of surge in the area around the rotary table with solid state switches, this may cause deterioration or damage to the switch. Avoid sources of surge generation and crossed lines.

7. Avoid accumulation of iron debris or close contact with magnetic substances.

When a large amount of ferrous debris such as machining chips or spatter is accumulated, or a magnetic substance is brought into close proximity with an auto switch table, it may cause the auto switch to malfunction due to a loss of the magnetic force inside the rotary table.

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

9. Do not use in direct sunlight.

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

Maintenance

⚠ Warning

1. 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 and/or equipment running away, etc. Cut the supply pressure and electric power and exhaust all compressed air from the system.

Turn off the power supply, stop the air supply and exhaust all compressed air from the system.

⚠ Caution

1. Perform the following maintenance regularly to avoid possible danger due to unexpected auto switch malfunction.

1) Securely tighten the auto switch mounting screws.

If the screws have become loose and the required mounting position has been lost, re-adjust the auto switch to the correct mounting position and re-tighten the screws.

2) Check that there is no damage to the lead wire.

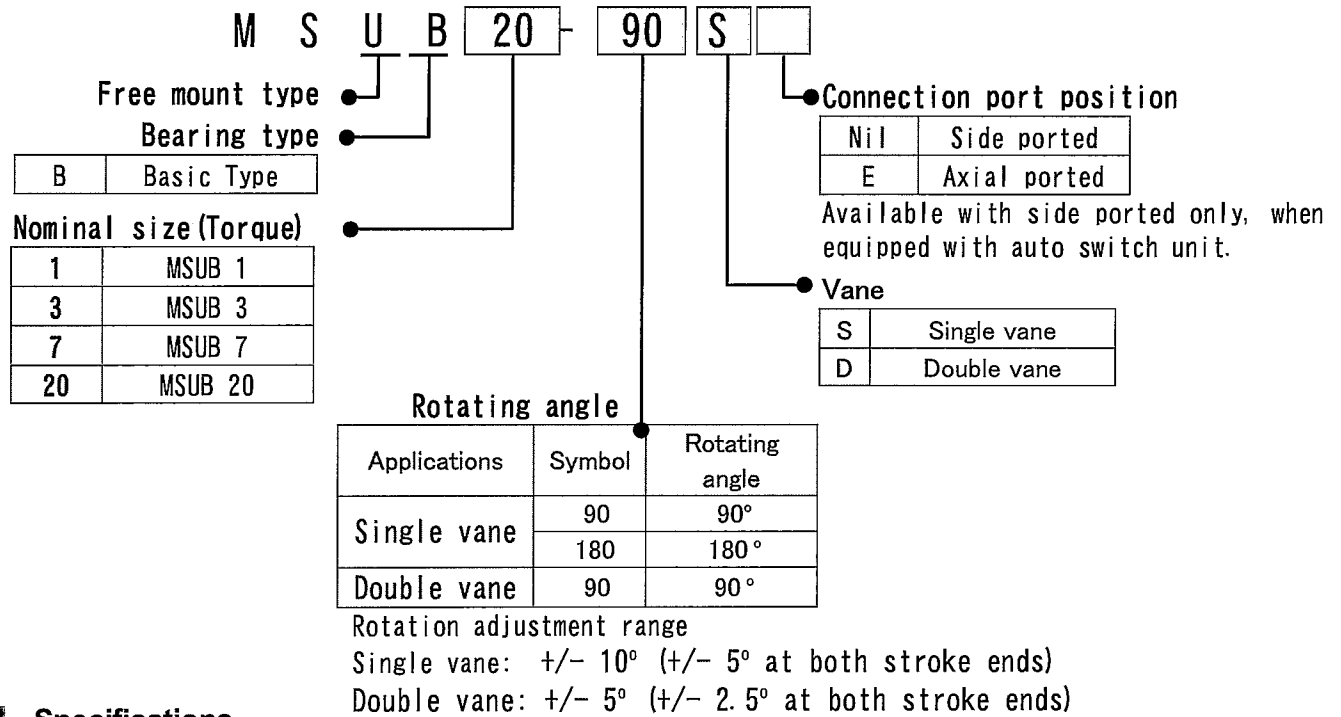
If damage to the lead wire is found, replace the auto switch, or repair the lead wire, to avoid faulty insulation.

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)



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	Double vane		
Rotating angle ^{*1}	90° ±10°	180° ±10°	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)	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 2² 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)
		[A]	[B]	
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).

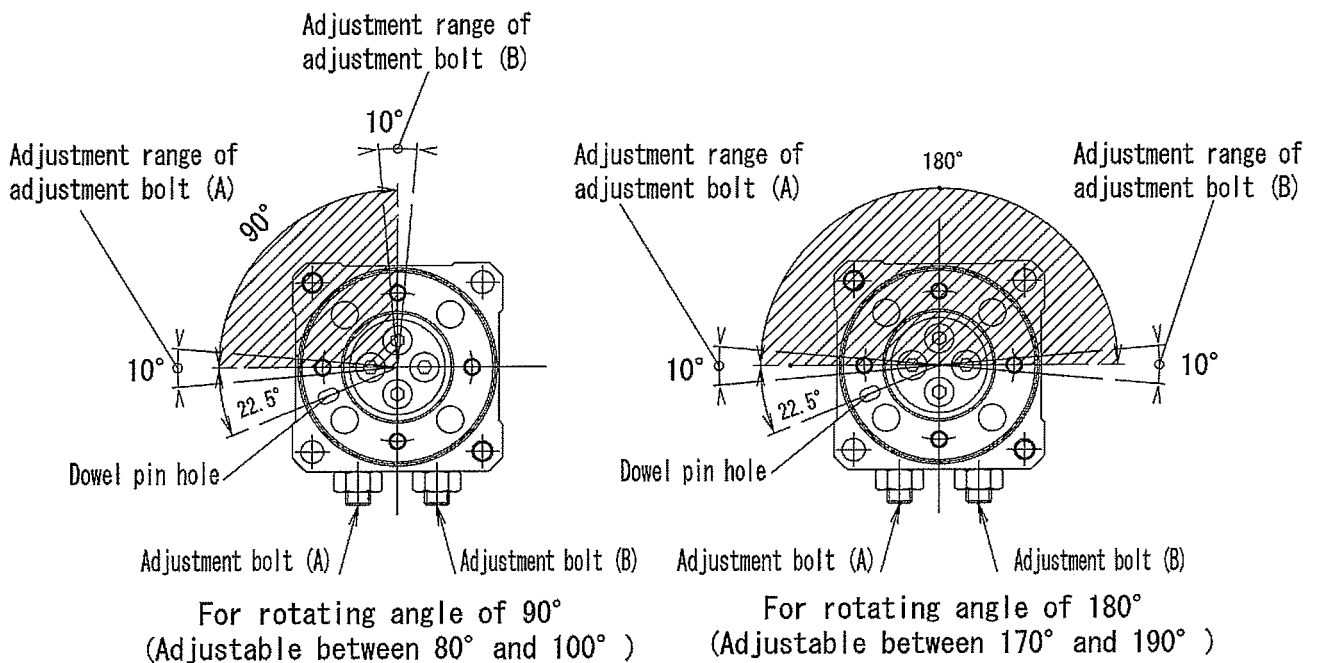
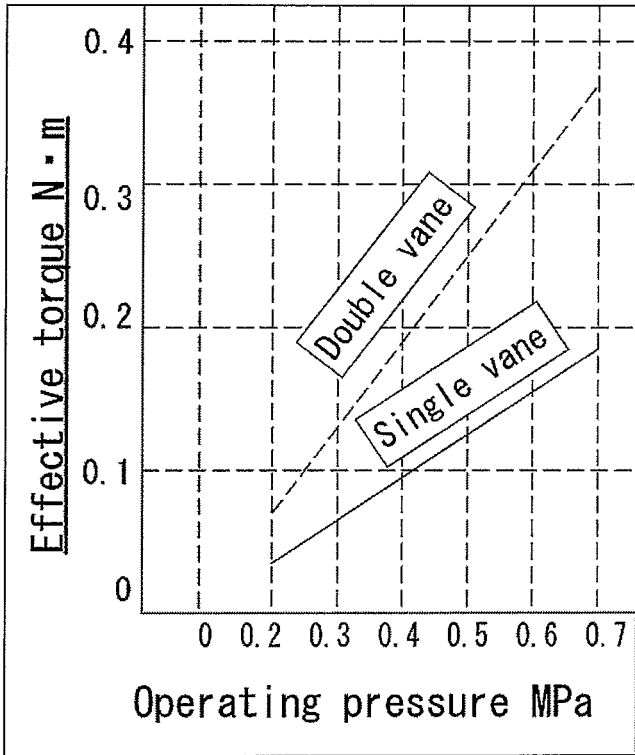


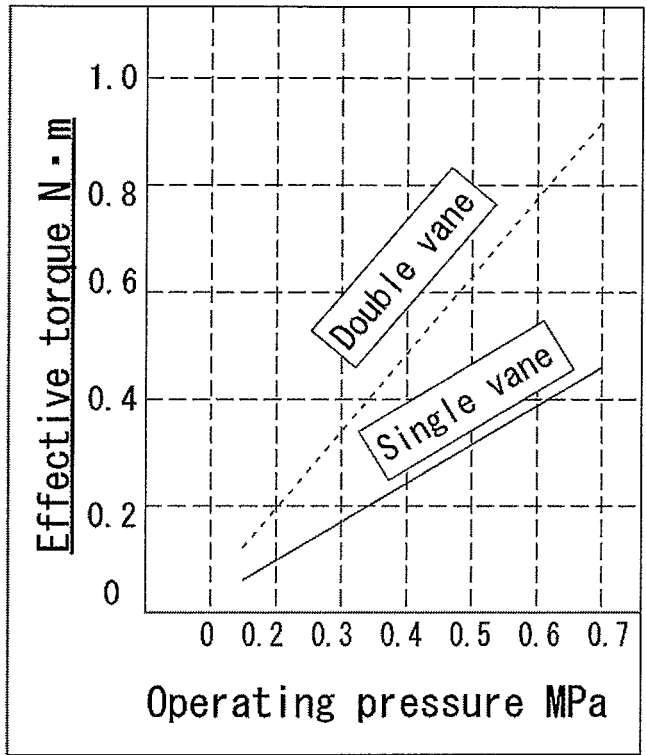
Fig. 1

Effective torque

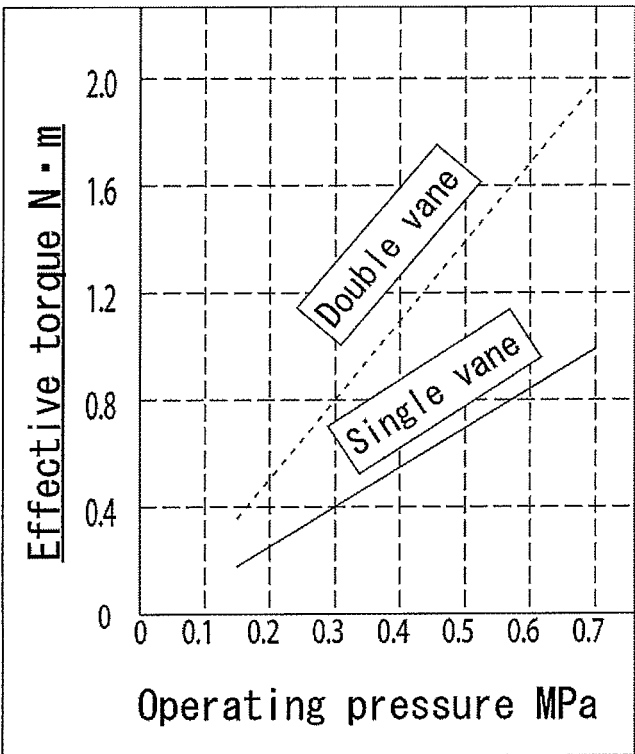
MSUB1



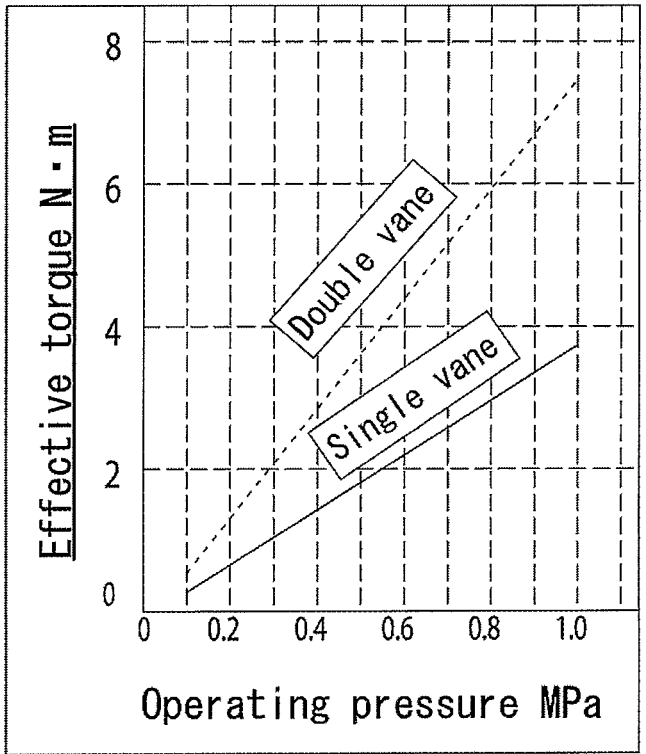
MSUB3



MSUB7

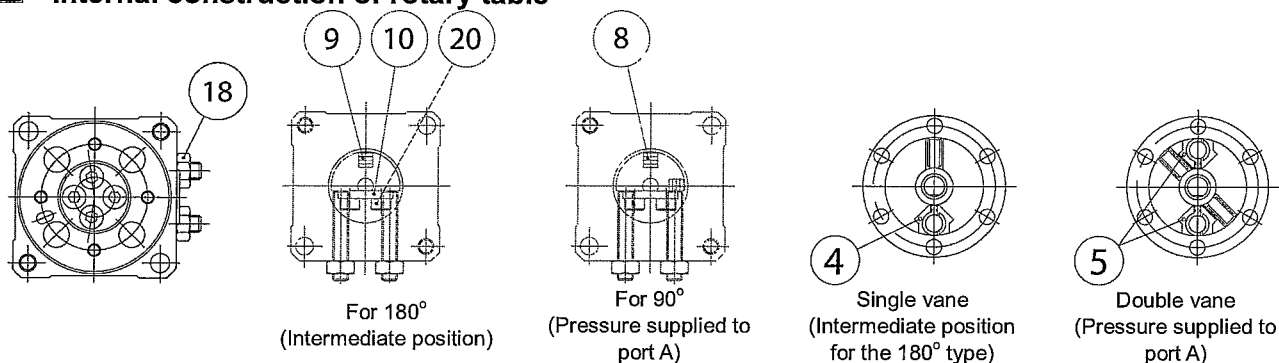


MSUB20

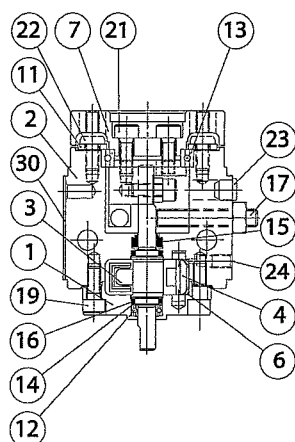


Internal Construction and Components

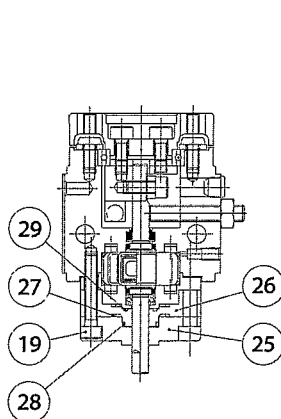
Internal construction of rotary table



Single vane: Size 1, 3, 7, 20



Double vane: Size 1



Double vane: Size 3, 7, 20

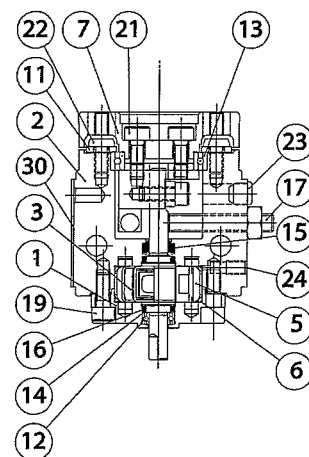


Table 6 Components

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.

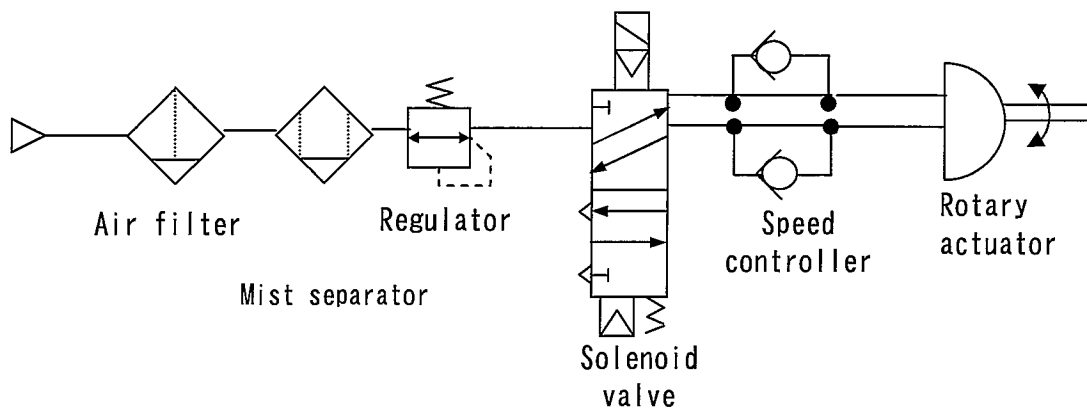


Fig. 2

■ 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.

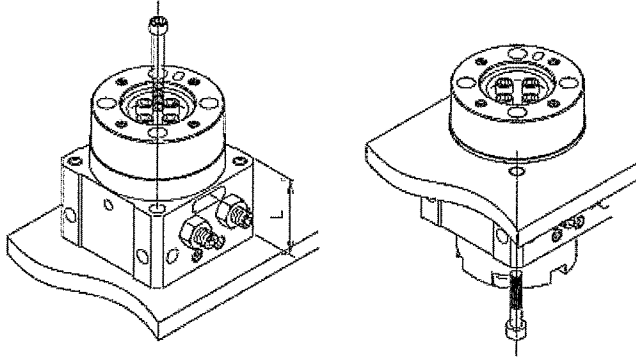


Fig. 3

Table 8

Axial mounting dimensions

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

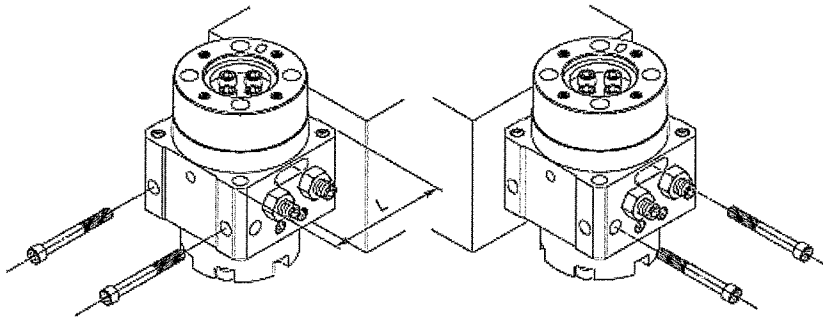


Fig. 4

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.

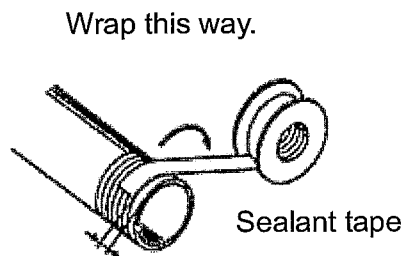
Therefore, take appropriate measures to ensure air quality, such as by providing an after cooler, air dryer, or water separator.

■ 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.**



Leave 2 threads exposed.

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.

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

E: Kinetic energy (J)

I: Moment of inertia ($\text{kg} \cdot \text{m}^2$)

I_o: Moment of inertia of Table ($\text{kg} \cdot \text{m}^2$)

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)

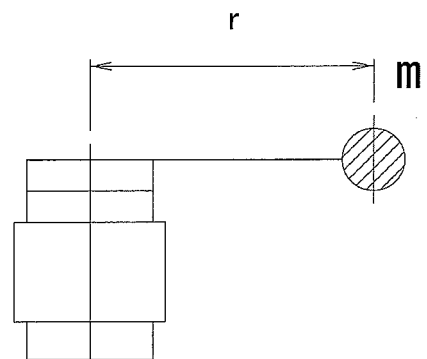


Fig. 6 Moment of inertia

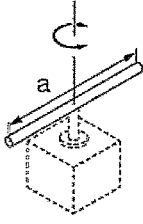
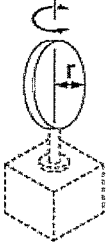
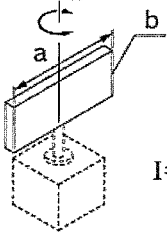
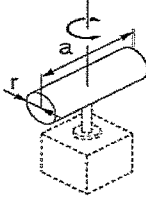
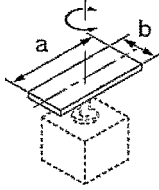
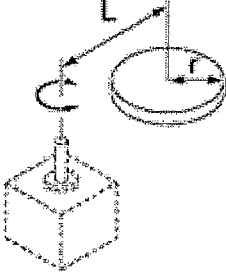
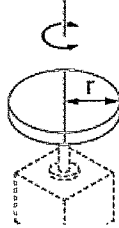
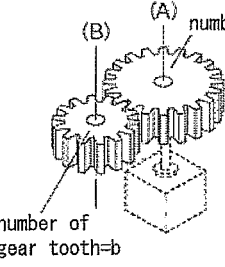
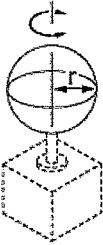
This represents the moment of inertia for a shaft with mass m, which is located at distance R from the shaft.

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·m²), m: Load weight (kg)

<p>1. Thin bar Rotating shaft position: Perpendicular to the bar and goes along the center of gravity</p>  $I = m \cdot \frac{a^2}{12}$	<p>6. Thin round disk Rotating shaft position: On the diameter</p>  $I = m \cdot \frac{r^2}{4}$
<p>2. Thin rectangular plate Rotating shaft position: Parallel to the side and goes along the center of gravity</p>  $I = m \cdot \frac{a^2}{12}$	<p>7. Cylinder Rotating shaft position: Goes along the diameter and the center of gravity</p>  $I = m \cdot \frac{3r^2 + a^2}{12}$
<p>3. Thin rectangular plate (including rectangular parallelepiped) Rotating shaft position: Perpendicular to the plate and goes along the center of gravity</p>  $I = m \cdot \frac{a^2 + b^2}{12}$	<p>8. When the rotating shaft and the center of gravity of the load are not consistent</p>  $I = K + m \cdot L^2$ <p>K: Moment of inertia around the center of gravity</p> <p>Of the load Disk</p> $K = m \cdot \frac{r^2}{2}$
<p>4. Round disk (including column) Rotating shaft position: Goes along the center of the shaft</p>  $I = m \cdot \frac{r^2}{2}$	<p>9. Gear transmission</p>  <p>number of gear tooth=a</p> <p>number of gear tooth=b</p> <ol style="list-style-type: none"> Find the moment of inertia IB for the rotation of shaft (B). IB is converted to the moment of inertia IA for the rotation of shaft (A). $I_A = \left(\frac{a}{b}\right)^2 \cdot I_B$
<p>5. Solid sphere Rotating shaft position: On the diameter</p>  $I = m \cdot \frac{2r^2}{5}$	

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° : $1/2 \pi$ Rad)
(180° : π Rad)

t: Rotation time sec

Kinetic energy E can be found with the formula below.

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

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 : I_o

Size	Moment of inertia of Table (kg·m ²)
1	2.5×10^{-6}
3	6.2×10^{-6}
7	1.6×10^{-5}
20	2.8×10^{-5}

Therefore, the rotation time of the rotary actuator is:

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

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

$$\omega = \dot{\omega} \times t \text{-----(1)}$$

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

When $t = 0$, rotation angle $\theta = 0$, 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.

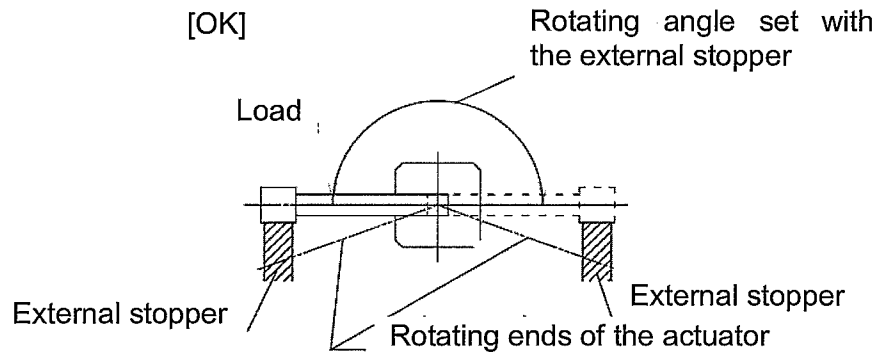


Fig. 7 Correct mounting position of the external stopper

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.

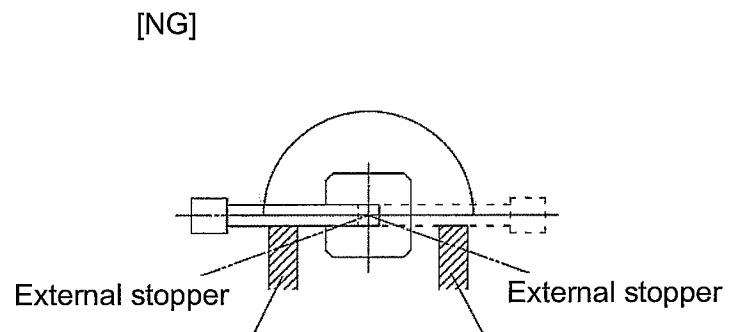


Fig. 8 Incorrect mounting position of the external stopper

■ Precautions when Using External Stoppers

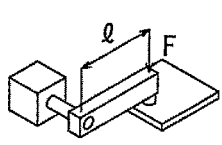
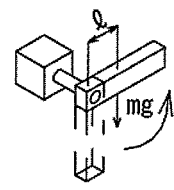
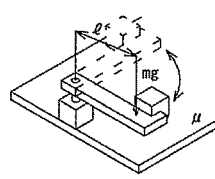
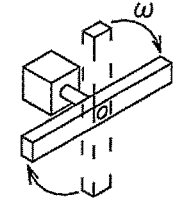
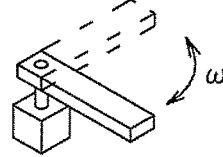
Angle adjustment is available for MSU series rotary table. When using an external stopper, set in a position so that that the adjusting screw does not collide into the stopper lever.

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
	<p><Gravity acts></p>  <p><Friction force acts></p> 	<p><Rotation center matches the center of gravity of the load></p>  <p><Rotation shaft is in the perpendicular direction></p> 
$T_s = F \cdot l$ 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 $T_f = m \cdot g \cdot l$ When friction force acts in the rotating direction $T_f = \mu \cdot m \cdot g \cdot l$ 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	$T_a = (I + I_o) \cdot \omega = (I + I_o) \cdot \frac{2\theta}{t^2}$ TA: Inertial load (Nm) I: Moment of inertia (kg·m ²) I _o : Moment of inertia of table (kg·m ²) ω: 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. $T = T_f \times (3 \text{ to } 5) + T_A \times 10$ 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. $T = T_A \times 10$ 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/ Without lead 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

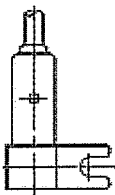
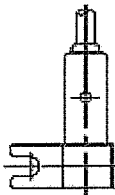
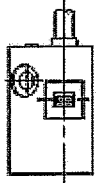
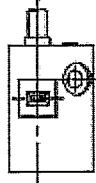
Applicable series	Auto switch model	Electrical entry	Indicator LED	
MDSUB1, 3	Reed switch	D-90, 90A	Without	
		D-97, 93A	With	
	Solid state switch	D-S99, S99V	Grommet/ 3-wire type (NPN)	With
		D-S9P, S9PV	Grommet/ 3-wire type (PNP)	
MDSUB7, 20	Reed switch	D-R73	With	
		D-R80	Without	
	Solid state switch	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
	D-97		-	97	IC circuit	100V AC/DC	20mA
	D-93A		-	93A	Relay Sequence controller	24 VDC	5 to 20mA
						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
	D-R731C	D-R732C	-	R73C	Relay Sequence controller	100 VAC	5 to 20mA
D-R8	D-R801	D-R802	-	R80	Relay Sequence controller IC circuit	24 V AC/DC or less	50mA
						48V AC/DC	40mA
	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

<p>left handed switch D-0001</p> 	<p>right handed switch D-0002</p> 	<p>MDSUB 7/ 20</p> <p>One right handed switch and one left handed switch</p>	<p>Operating time: 1.2 ms</p> <p>Shock resistance: 300m/s² (Reed switch), 1000m/s² (Solid state switch)</p> <p>Operating temperature range: 5 to 60°C</p>
<p>D-0991</p> 	<p>D-0992</p> 	<p>MDSUB1/ 3</p> <p>One right handed switch and one left handed switch</p>	<p>Lead wire length: 0.5m (standard)</p>

Internal Construction and Components

Construction of the rotary table with auto switch

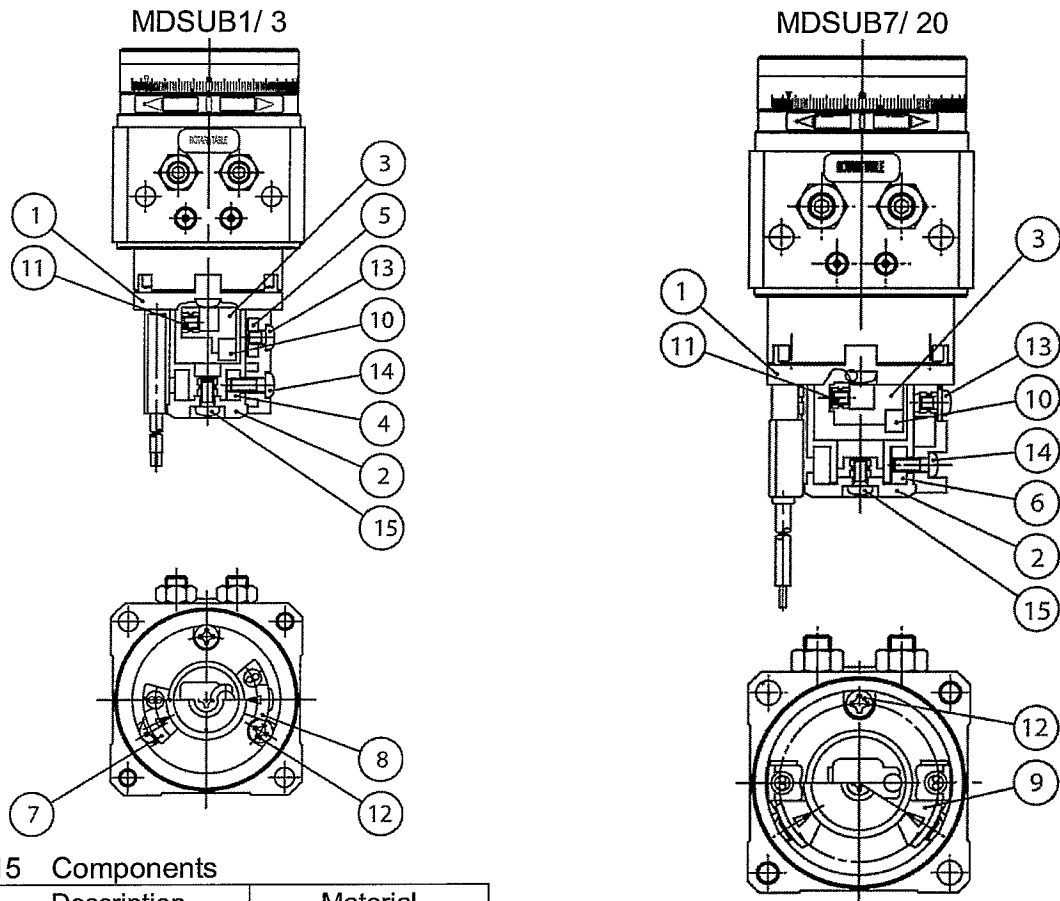
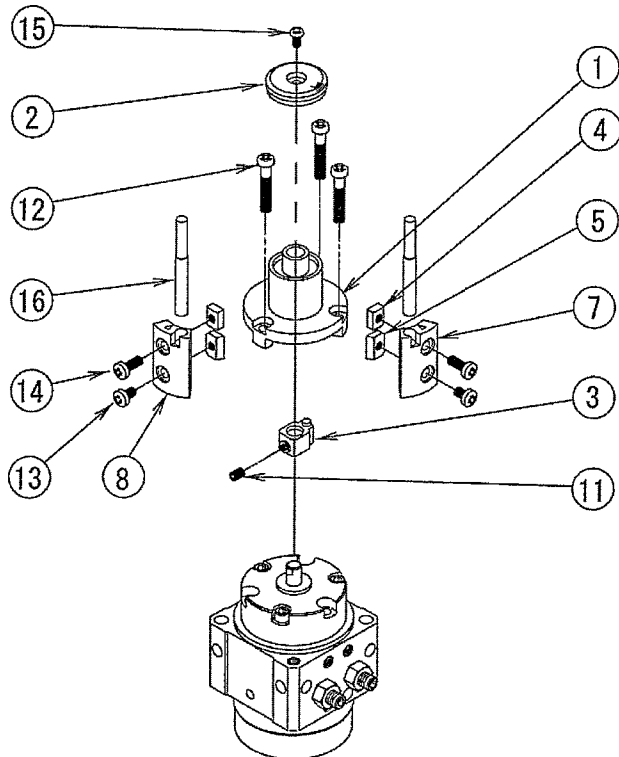


Table 15 Components

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



MDSUB7/20

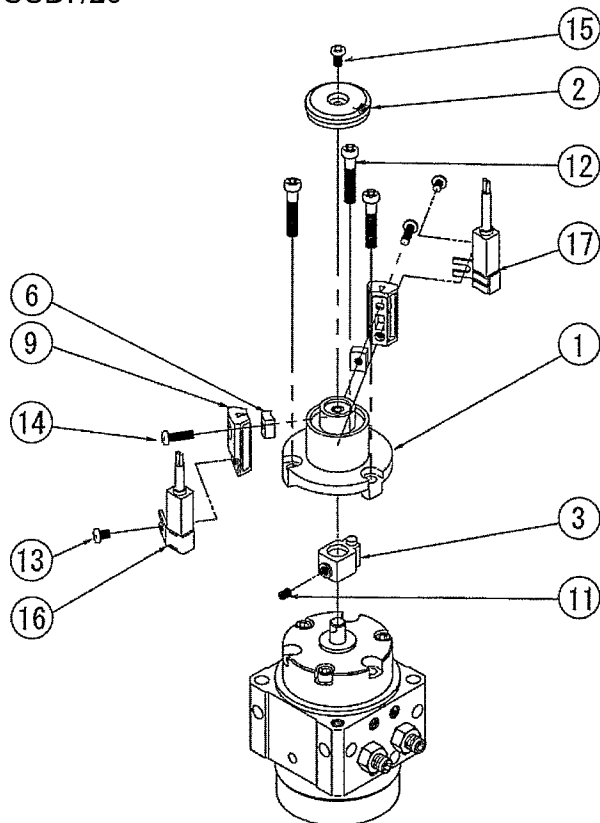


Table 16 MDSUB1/3

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.

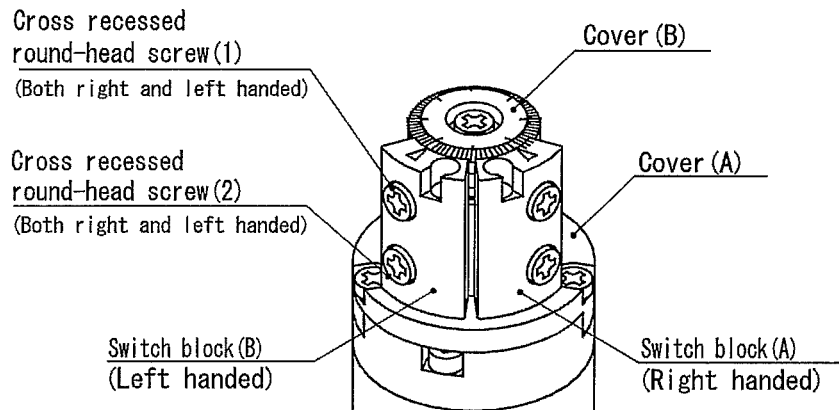
* The left figure shows the product with Reed switch. Please refer to page 18 for the product with solid state switch.

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

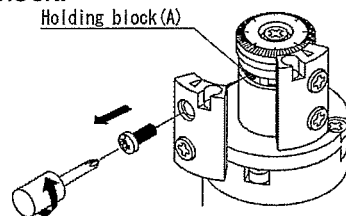
<Applicable auto switches>

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

2-wire type: D-T99(V)

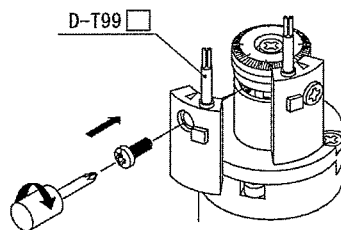
1. Removal of the switch block

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

Reed switch

<Applicable auto switches>

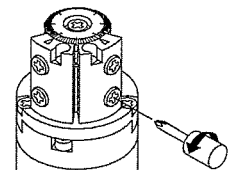
D-97, D-93A (with indicator light)

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.

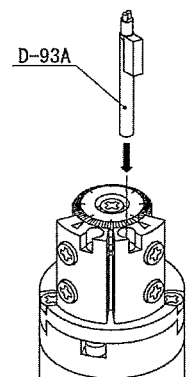


2. Mounting of the Reed switch

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.

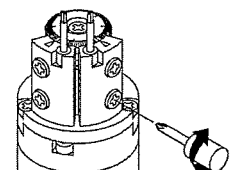


3. Holding the Reed switch

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 sensing 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.

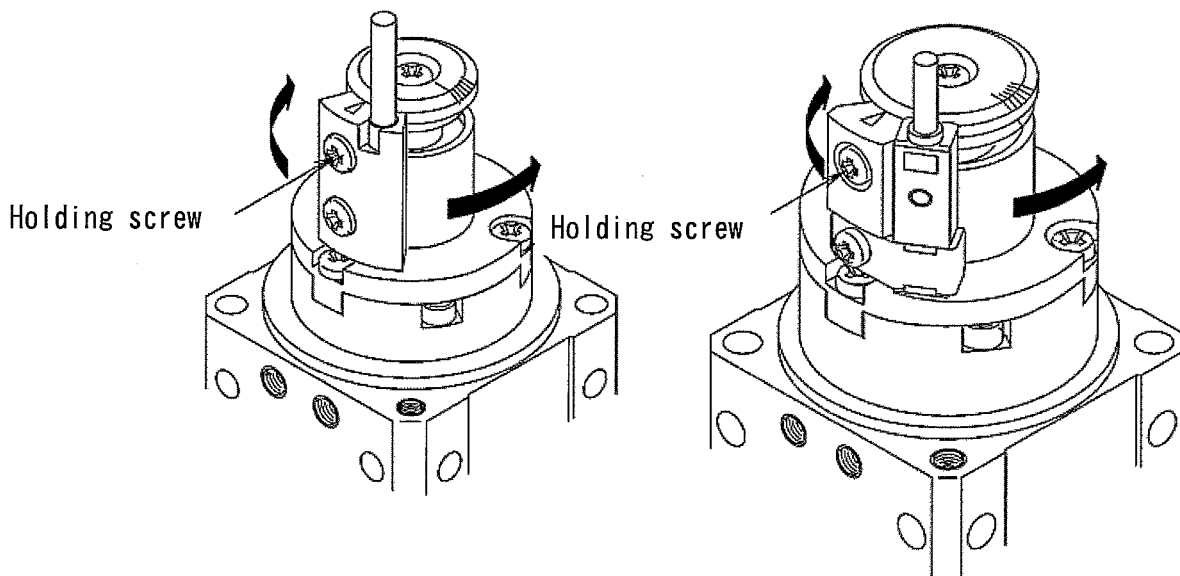


Fig. 9

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

MSUB 1-3

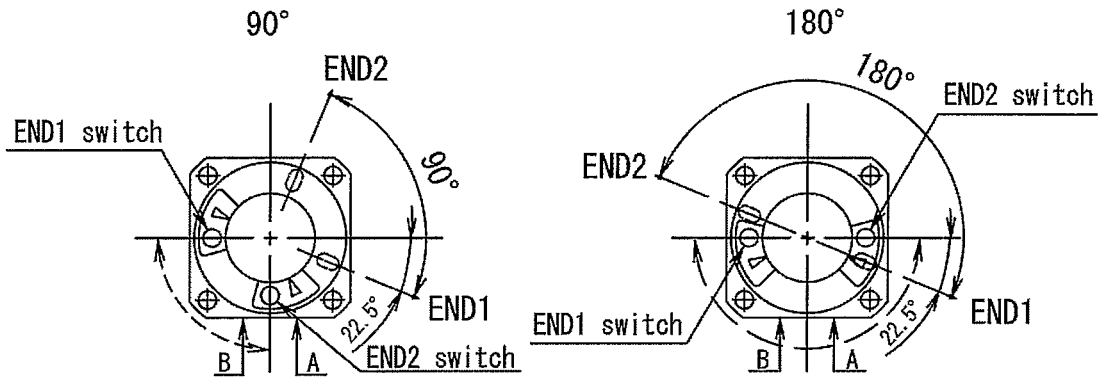


Fig. 10

MSUB 7-20

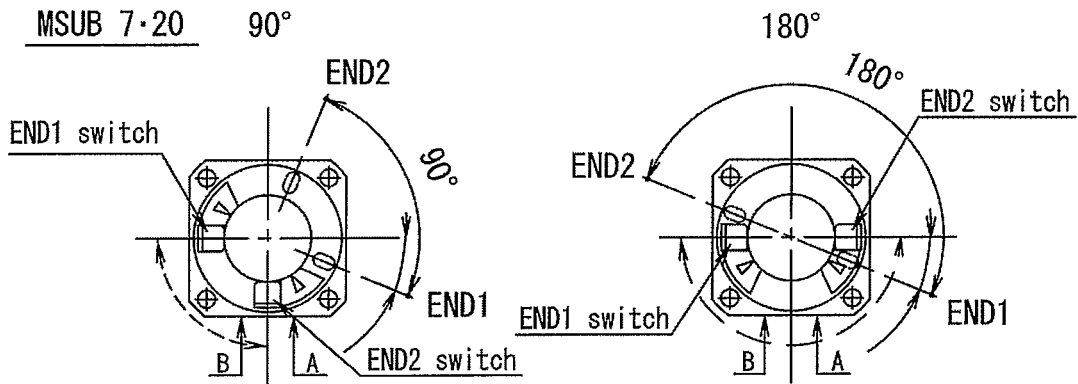


Fig. 11

- 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.

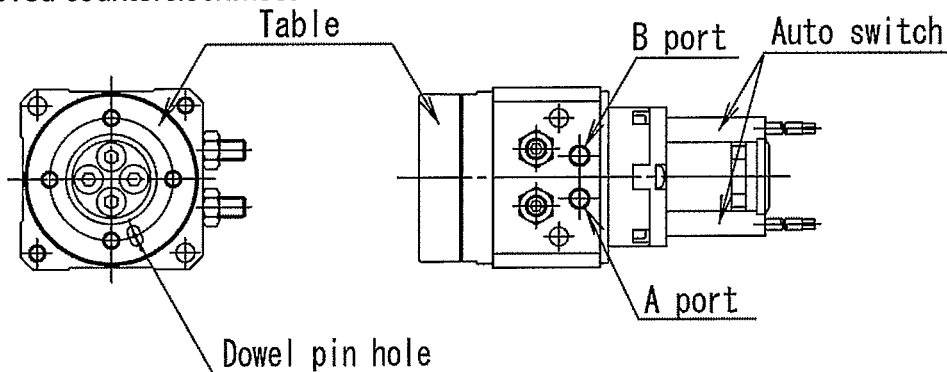
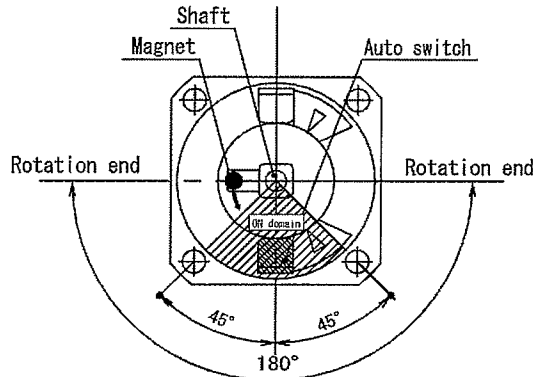


Fig. 12

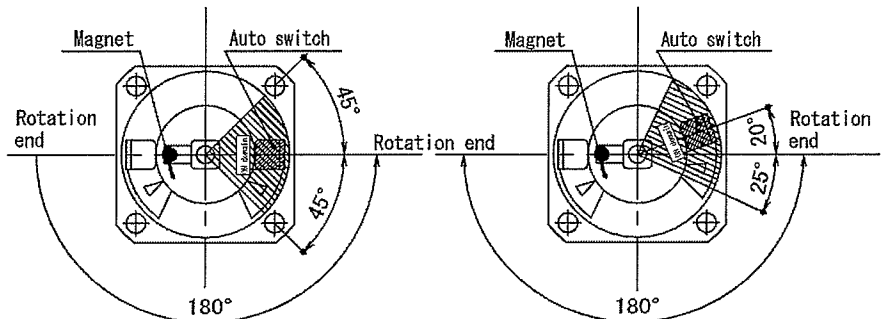
■ Operation angle and hysteresis angle of auto switch

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



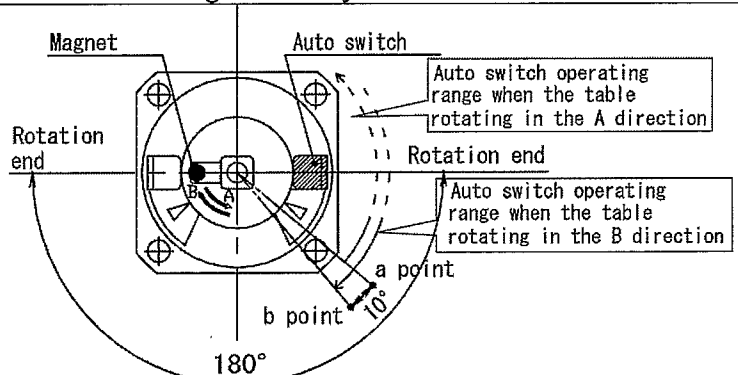
As shown in the figure shown above, when the magnet rotates in the arrow direction along with the shaft rotation, the switch turns on when the magnet passes through the point A, and when it passes through the point B, the switch turns off. In this case, the ON area is 90°, i.e. switch rotation angle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

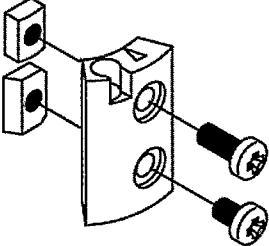
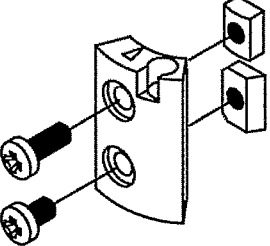
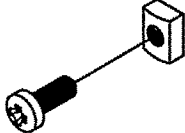
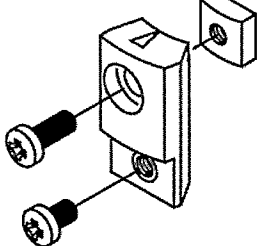
It is prohibited to disassemble the basic parts of this product. Please contact SMC for repair. To replace the auto switch unit, use the units of the applicable size. Part numbers are shown in Table 19 and Table 20 below respectively.

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.
Play with the table		<ol style="list-style-type: none"> 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.
Air leakage from the table		<p>The adjusting screw inside the product must be adjusted in the position that it does not touch the stopper lever.</p> <ol style="list-style-type: none"> 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

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