Doc. No. : MSUA−OM00002-A

Operation Manual

High Precision Rotary Table

MSUA1, 3, 7, 20

- Please read this operation manual throughout before installing and operating this product.
- Please read a description on safety instructions with special care.
- Please keep this operation manual with you so that you can read it whenever you need it.

SMC CORPORATION

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High Precision Rotary Table / Series MSUA

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Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard by labeling "Caution", "Warning" or "Danger". To ensure safety, be sure to observe ISO 4414, JIS 8370 and other safety practices.

⚠ Caution : Operator error could result in injury or equipment damage.

⚠ Warning: Operator error could result in serious injury or loss of life.

⚠ Danger: In extreme conditions, there is a possibility of serious injury or loss of life.

⚠ Warning

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

Since the products specified here are used in various operating conditions, their compatibility with the specific pneumatic system must be based on specifications or after analysis and/ or tests to meet your specific requirements.

② **Only trained personnel should operate pneumatically operated machinery and equipment.**

Compressed air can be dangerous if an operator is unfamiliar with it. Assembly, handling, or repair of pneumatic systems should be performed by trained and experienced operators.

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

1. Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.
2. When equipment is to be removed, confirm the safety process as mentioned above. Cut the supply pressure for the equipment and exhaust all residual compressed air in the system.
3. Before machinery/ equipment is re-started, take measures to prevent quick extensions of the cylinder piston rod etc. (Bleed air into the system gradually to create back-pressure.)

④ **Contact SMC if the product is to be used in an of the following conditions:**

1. Conditions and environments beyond the given specifications, or if product is used outdoors.
2. Installation on equipment in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverage, recreation equipment, emergency stop circuits, press applications, or safety equipment.
3. An application which has the possibility of having negative effects on people, property , or animals, requiring special safety analysis.

Precautions on Design

⚠ Warning

① **If the operation involves load fluctuations, ascending/descending movements, or changing 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.

② **If there is a chance that it will pose a hazard to humans, install a protective cover.**
If the moving portion of the product will pose a hazard to humans or damage the machinery of equipment, provide a construction that prevents direct contact with those areas.

③ **Make sure that the secured portions will not loosen.**
Be sure to adopt reliable connecting method if the rotary actuator is used very frequently or if it is used in a location that is exposed to large amount of vibrations.

④ **There may be cases in which a shock absorber is required.**
If the driven object moves at high speeds or has a large mass, shocks may exceed allowable kinetic energy value of the rotary actuator. Therefore, provide a external shock absorber to reduce the rotary actuator's speed before reaching the rotation end to dampen the shocks.
If these countermeasures are taken, make sure to take the rigidity of the mechanical equipment into consideration.

⑤ **Consider the possibility of a reduction in the circuit air pressure that could be caused by power outages.**
When the product is used for a clamping, if the circuit air pressure is reduced due to a power outage,
the clamping force could decrease, thus creating a hazardous situation in which the workpiece is released. Therefore, make sure to integrate safety features that will prevent hazards to humans or damage to the equipment.

⑥ **Consider the possibility of power source related malfunctions that could occur.**
On the pieces of equipment that relay on power sources such as compressed air, electricity or hydraulic pressure, adopt a countermeasure that will prevent these pieces of equipment from causing hazards to humans or damage to the equipment in the event of a malfunction in these power sources.

⑦ **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 actuator will operate at abnormally high speeds, which could pose a hazard to humans and damage the machinery and equipment.

⑧ **Consider the behavior of the rotary actuator in the event of an emergency stop.**
Devise a design that ensures safety so that if a person engages the emergency stop, or if safety device is tripped during a system malfunction such as a power outage, the halting of the machine will not cause the movement of the rotary actuator to pose a hazard to humans or damage the equipment.

⑨ **Consider the behavior of the rotary actuator when restarting after an emergency stop.**
Device a design that ensures safety so that the restarting of the rotary actuator will not pose a hazard to humans or damages the equipment.
If it is necessary to reset the rotary actuator to its starting position, make sure to provide a safe,

manually operated control device.

⑩ **Do not use the product as a shock absorber.**

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

Selection

⚠ Warning

① **Select a speed within the product's allowable kinetic energy value.**

If the product is used in a state in which the kinetic energy of the load exceeds the allowable value, it could damage the machinery and equipment.

② **Provide a shock absorber if the kinetic energy that is applied to the product exceeds the allowable value.**

If the product is used in a state in which the kinetic energy exceeds the allowable value, it could damage the products, which could pose a hazard to humans and damage the machinery and equipment.

③ Do not stop or hold the product at midpoint by keeping air pressure in the product.

With the product lacking an external stopping mechanism, if the directional control valve is closed to keep the air pressure in the product in and attempt to stop the product at mid point, 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 damage the machinery and equipment.

⚠ Caution

① **Do not operate the product in the low speed range below the speed adjustment range specified for the product.**

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

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

If an external force that exceeds the products 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 in which 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.

Mounting

⚠ **Warning**

① **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.

② **Do not loosen the angle adjustment screw beyond the allowable adjustment range.**

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

③ **Do not place a magnetic object near the product**

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

④ **Do not modify the product.**

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

⑤ **Do not enlarge the fixed throttle by modifying the pipe connectors .**

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

⑥ **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.

⚠ Caution

① Do not use organic solvent to wipe the area of the nameplate that shows the model.

It will erase what is indicated on the name plate.

Do not hit the table by securing the body or hit the body by securing the table.

These actions could damage the internal parts and the bearing. When a load must be coupled to the table, secure the table.

② Do not place your foot directly on a load coupled to the table.

Placing one's weight directly onto the table could cause the internal parts and the bearing become damaged.

Air Supply

⚠ Warning

① Use clean air.

Do not use compressed air that contains synthetic oil, salt, and corrosive gases in which chemicals and organic solvents are present, because it could cause equipment damage or malfunction.

⚠ Caution

① **Install an air filter.**

Install an air filter upstream, near the valve. Select an air filter with a filtration degree of 5 μm or finer.

② **Take appropriate measures to ensure air quality, such as by providing an after cooler, air dryer, or drain catch.**

Compressed air that contains a large amount of drainage could cause the rotary actuator or other types of pneumatic equipment to malfunction. Therefore , take appropriate measures to ensure air quality such as by providing an after cooler, air dryer, or drain catch .

③ **Ensure that the fluid and ambient temperature are within the specified range.**

If the fluid temperature is below 5℃, the moisture in the circuit could freeze, causing damage to the seals and leading to equipment malfunction. Therefore, take appropriate measures to prevent freezing. For detailed information regarding the quality of the compressed air described above, refer to SMC's "Air Cleaning Systems".

Environment

⚠ Warning

① Do not use the rotary actuator in an environment or location that poses the risk of corrosion. Refer to the respective construction diagram for details on the materials used in the rotary actuator.

② Do not use the rotary actuator in an area that contains a large amount of dust, or an area in which water or oil could be splashed on the rotary actuator.

Speed and Bumper 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

⚠ **Caution**

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

Maintenance

⚠ **Warning**

① **During maintenance inspection, do not disassemble the equipment with electrical power or an air supply applied.**

② **After the product has been disassembled for inspection, make sure to perform the appropriate functionality inspection.**
The product specifications cannot be met unless a functionality inspection is performed.

⚠ **Caution**

① **For lubrication, use the type of grease that is used for the respective product.**
The use of a non-designated lubricant could damage the seals.

Auto Switch Precautions

Design & Selection

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.

② Take precautions when multiple cylinders are used close together.

When multiple auto switch cylinders are used in close proximity, magnetic field interference may cause

the switches to malfunction. Maintain a minimum cylinder separation of 10mm.

③ 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 is again necessary to connect a contact protection box in order to extend its life. Please contact SMC in this case.

<Solid state switch>

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

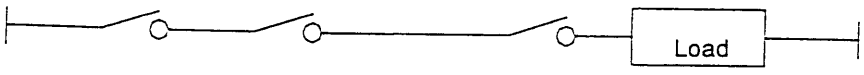
④ Take precautions for the internal voltage drop of the switch.

<Reed switch>

1) Switches with 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 diode. (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 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 minimum operating voltage of the load.

Supply voltage - Internal voltage drop of switch > Minimum operating voltage of load

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

<Solid state switch>

3) Generally, the internal voltage drop will be greater with a 2 wire solid state auto switch than with a reed switch. Take the same cautions as in 1).

Also, note that 12V DC relay is not applicable.

⑤ Watch for current leakage.

<Solid state switch>

With a 2 wire solid state auto switch, current (leakage) 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.

Do not use a load that generates surge voltage.

<Reed switch>

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

<Solid state switch>

Although, a zener diode for surge protection is connected at the output side of a solid state auto switch, damage may still occur if the surge is applied repeatedly. When a load such as a relay solenoid, which generates surge is directly driven, use a type of switch with a built-in surge absorbing element.

Cautions for use in interlock circuit

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

⑥ Ensure sufficient clearance for maintenance activities.

When designing an application, be sure to allow sufficient clearance for maintenance and inspections.

Mounting & Adjustment

⚠ **Warning**

① Do not drop or bump.

Do not drop, bump or apply excessive impacts (300m/s^2 or more for reed switches and 1000m/s^2 or more for solid state switches) with handling.

Although the body of the switch may not be damaged, the inside of the switch could be damaged and malfunction.

② Do not carry a rotary table by the auto switch lead wires.

Never carry a rotary table by its lead wires. This may not only break lead wires, but it may cause internal elements of the switch to be damaged by the stress.

③ Mount switches using the proper fastening torque.

When a switch is tightened beyond the range of fastening torque, the mounting screws, mounting bracket or switch may be damaged. On the other hand, tightening below the range of fastening torque may allow the switch to slip out of position.

④ Mount a switch at the center of the operating range.

Adjust the mounting position of an auto switch so that the piston stops at the center of the operating range (the range in which a switch is ON.) (The mounting position shown in a catalog indicates the optimum position at stoke end.) If mounted at the end of the operating range (around the borderline of ON and OFF), operation will be unstable.

Wiring

⚠ **Warning**

① Avoid repeatedly bending or stretching lead wires.

Broken lead wires will result from applying bending stress or tension in the lead wires.

② Be sure 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 switch will be instantly damaged because of excess current.

③ 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 a switch.

④ 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, including auto switches may malfunction due to noise from these other lines.

⑤ Do not allow short circuit of loads.

<Reed switch>

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

<Solid state switch>

All models of PNP output type 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 24V DC switch with indicator light has polarity. The brown lead wire or a terminal No.1 is (+), and the blue lead wire or a terminal No.2 is (-).

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

<Solid state switch>

1) If connections are reversed on a 2 wire type 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 line + and power supply line -) on a 3 wire type switch, the 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 switch will be damaged.

Environment

⚠ Warning

① Never use in an atmosphere with explosive gases.

The structure of auto switches is not intended to prevent explosion. However, never use in an atmosphere with an explosive gas since this may cause a serious explosion.

② Do not use in an area where a magnetic field is generated.

Auto switches will malfunction or magnets will become demagnetized. (Consult SMC regarding the availability of a magnetic field resistant auto switch.)

③ Do not use in an environment where the auto switch will be continually exposed to water.

Although switches satisfy the IEC standard IP67 structure (JIS C0920: anti-immersion structure) , do not use switches in applications where they are continually exposed to water splash or spray. Poor insulation or swelling of the potting resin inside switches may cause a malfunction.

④ Do not use in an environment with 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.

⑤ Do not use in an environment with temperature cycles.

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

⑥ Do not use in an environment where there is excessive impact shock.

<Reed switch>

When excessive impact (300m/s^2 or more) is applied to a reed switch during operation, the contact point will malfunction and generate or cut off a signal momentarily (1ms or less). Consult SMC regarding the need to use a solid state switch depending upon the environment.

⑦ Do not use in an area where surges are generated.

<Solid state switch>

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

⑧ Avoid accumulation of iron powder or close contact with magnetic substances.

When a large amount of ferrous powder such as machining chips or spatter is accumulated, or a magnetic substance (something attracted by a magnet) is brought into close proximity with a rotary table with auto switch, it may cause the auto switch to malfunction due to a loss of magnetic force.

Maintenance

⚠ Warning

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

1) Secure and tighten 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 switches or repair lead wires etc., if damage is discovered.

Others

⚠ Warning

① Consult SMC concerning water resistance, elasticity of lead wires, and usage at welding sites etc..

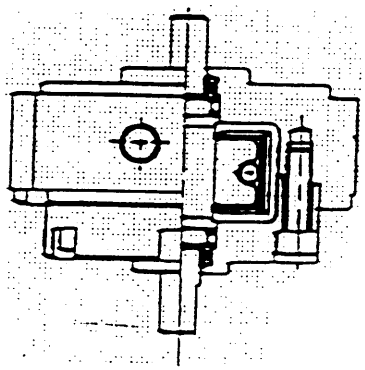
High Precision Rotary Table Precautions

Maintenance

⚠ **Warning**

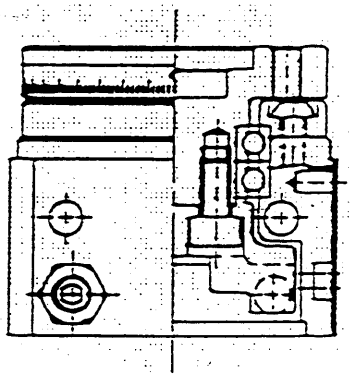
① If a table unit and a rotary unit are required for maintenance, order by the following unit part No.

Rotary Unit



Model	Unit Part No.
MSUA 1-※S	P402070-2A
MSUA 1-※SE	P402070-2B
MSUA 3-※S	P402090-2A
MSUA 3-※SE	P402090-2B
MSUA 7-※S	P402060-2A
MSUA 7-※SE	P402060-2B
MSUA 20-※S	P402080-2A
MSUA 20-※SE	P402080-2B

Table Unit

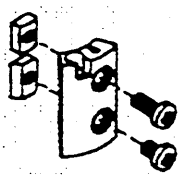
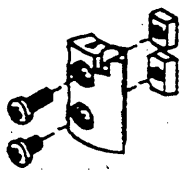
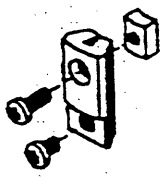


Model	Unit Part No.
MSUA 1-90※	P402070-3A
MSUA 1-180※	P402070-3B
MSUA 3-90※	P402090-3A
MSUA 3-180※	P402090-3B
MSUA 7-90※	P402060-3A
MSUA 7-180※	P402060-3B
MSUA 20-90※	P402080-3A
MSUA 20-180※	P402080-3B

※ Note that rotation angle can not be changed even if a rotary unit is changed.
For maintenance, specify a unit part No. in accordance with your model currently used.

② Switch Unit

Auto Switch Part No.	
Model	Part No.
MDSUA 1	P211070-1
MDSUA 3	P211090-1
MDSUA 7	P211060-1
MDSUA20	P211080-1

Auto Switch Block Unit		
MDSUA1,3		MDSUA7,20
Right hand	Left hand	Both directions
		
Part No. P211070-8	Part No.:P211070-9	Part No.: P211060-8

1. How to Order

1-1 How to Order

•Bearing
A: High precision

Free mount•

Standard　M S U A 20 - 90 S □

With auto switch　M D S U A 20 - 90 S □ - R73 L

Switch unit •

-	No switch unit
D	With switch unit

Nominal(torque) •

1	MSUA 1
3	MSUA 3
7	MSUA 7
20	MSUA20

Rotation angle•

Vane	Symbol	Rotation angle
Single vane	90	90°
	180	180°

Adjustment range of rotation angle

Single vane: Both end directions each ±5°

Vane style •

S	Single vane

Connecting port position•

-	Body side
E	Axial direction

Port position is only on the body side for switch unit attached style.

•Lead wire entry/length

-	Grommet/Lead wire 0.5m
L	Grommet/Lead wire 3m
C	Connector/Lead wire 0.5m
CL	Connector/Lead wire 3m
CN	Connector/No lead wire

*Connector type is applicable only to R73,R80 and T79.

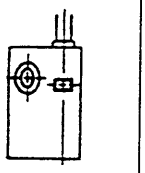
*Model Number of lead wire with connector:

D-LC05:Lead wire 0.5m

D-LC30:Lead wire 3m

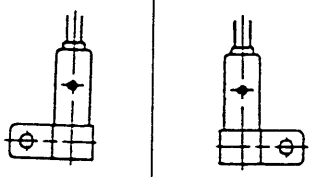
Classification of auto switch hanging way

For MDSUA1,3



Left-hand D-□992　Right-hand D-□991

For MDSUA7,20



Left-hand D- □□□2　Right-hand D- □□□1

Switch Unit Part No.

Model	Unit Part No.
MDSUA 1	P211070-1
MDSUA 3	P211090-1
MDSUA 7	P211060-1
MDSUA20	P211080-1

Auto Switch Block Unit Part No.

Model	Right-hand	Left-hand
MDSUA 1	P211070-8	P211070-9
MDSUA 3		
MDSUA 7	P211060-8	
MDSUA20		

Each auto switch unit is provided with one right-hand and one left-hand switch block unit. Same model as the auto switch unit and switch block unit of Series CRB1.

Applicable auto switch •

Symbol		Type of auto switch		
-		No auto switch	-	
For MDSUA 1, 3	90	D-90(2 switches)	Reed switch	
	90A	D-90A (2 switches)		
	97	D-97 (2 switches)		
	93A	D-93A (2 switches)		
	S99	D-S991,D-S992(1 for each)	Solid state switch	3 wire
	S99V	D-S99V1, D-S99V2 (1 for each)		
	S9P	D-S9P1,D-S9P2(1 for each)		
	S9PV	D-S9PV1,D-S9PV2 (1 for each)		
	T99	D-T991,D-T992(1 for each)		2 wire
	T99V	D-T99V1,D-T99V2 (1 for each)		
For NDSUA 7,20	※R73	D-R731,D-R732 (1 for each)	Reed switch	
	※R80	D-S801,D-R802 (1 for each)		
	S79	D-S791,D-S792(1 for each)	Solid state switch	3 wire
	S7P	D-S7P1,D-S7P2(1 for each)		
	※T79	D-T791,D-T792(1 for each)		2 wire

Example: MSUA20 single vane type

(Connecting port position on the side of body)

1. Standard type (no auto switch) rotation angle 90° port position body side, MSUA20-90S
2. With switch unit + Auto switch R73, rotation angle 180 ° port position body side MDSUA20-180S-R73

2. Specifications

2-1 Specifications

		MSUA1	MSUA3	MSUA7	MSUA20
Fluid		Air (No lubrication)			
Operating pressure range		0.2~0.7MPa	0.15MPa~0.7MPa		0.15~1.0MPa
Rotation angle		90°±10°, 180°±10°			
Ambient and fluid temperature		5~60℃			
Rotation time adjustable range Note1		0.07~0.3 sec/90°			
Shaft load	Allowable radial load	20N	40N	50N	60N
	Allowable thrust load	15N	30N	60N	80N
	Allowable moment	0.3N · m	0.7N · m	0.9N · m	2.9N · m
Bearing		Special bearing			
Port position		On the body side or in the axial direction			
Port size	Body side	M3 X 0.5	M5 X 0.8		
	Axial direction	M3 X 0.5		M5 X 0.8	
Allowable kinetic energy		0.065J	0.017J	0.042J	0.073J
Deflection accuracy Note 2		Within 0.03mm			

Note1) Lower speed our of the upper limit may cause sticking or stopping operation, so that use the product within the speed adjustable range.

Note 2) Deflection accuracy indicates that of the table surface for rotating.

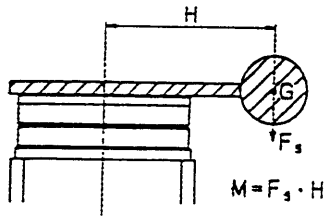
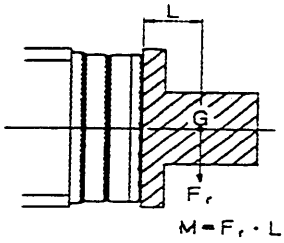
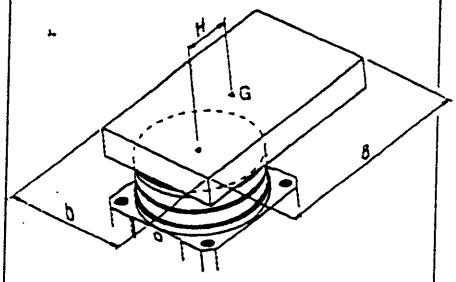
2-2. Weight

Unit: g

	Basic weight		Switch unit + 2 switches
	90°	180°	
MSUA 1	162	161	25
MSUA 3	261.5	259.5	30
MSUA 7	440	436	50
MSUA20	675	670.5	60

3. Precautions on Model Selection

⚠ Caution

Model Selection Procedures	Calculation	Example
① Operating Conditions Pick up operating conditions considering mounting style.  Vertical Mounting  Horizontal Mounting	• Applicable model • Operating pressure • Mounting style • Load condition Ts (n • m) Tf (n • m) Ta(n • m) • Shape of load • Rotation time t (s) • Rotation angle • Load weight m (kg) • Distance between axial core H (mm) • Mass point distance L (mm)	 Rotary Table; MSUA7-90S Pressure 0.5MPa Mounting Style: Vertical Type of Load: Inertial load Ta Shape of load: 60mmx 40 mm(square plate) Rotation time t: 0.2 sec Rotation angle: 90° ° Load weight m: 0.1 kg Distance between axial core : H:30m
② Required Torque Confirm load conditions shown below, and select an actuator to satisfy required torque. • Static load: Ts • Resistance load : Tf • Inertial load : Ta	Effective torque ≥ Ts Effective torque ≥ (3~5) • Tf Effective torque ≥ 10 • Ta Data 1 and Graph 1	Inertial Load $10xTa = 10x\ I \times \dot{\omega} = 10 \times 0.0002 \times \pi/0.2^2$ = 0.157N • m < Effective torque OK Note: Substitute a numerical value of ⑤ moment of Inertia for I.
③ Rotation Time Confirm that it is within the adjustable rotation time.	0.07 ~ 0.3 s/90°	0.2 s/ 90° OK
④ Allowable Load Confirm that radial load, thrust load and moment are within allowable range .	Thrust load : m x 9.8 ≤ Allowable load Moment : m x 9.8 x H ≤ Allowable moment Allowable moment Table 1	0.15 x 9.8 = 1.47N < Allowable load OK 0.15 x 9.8 X 0.03=0.044 N • m 0.044 N • m < Allowable moment OK
⑤ Inertial Moment Find inertial moment of load to calculate energy. Find I.	$I = m \times (a^2+b^2) / 12+M \times H^2$ Moment of Inertia Data 2	$I = 0.15X\ (0.06^2+0.04^2)/12+0.15X0.03^2$ = 0.0002 kg • m^2
⑥ Kinetic Energy Confirm that kinetic energy of load is within allowable range. Note) Moment Inertia of table = I_0	$1/2 \times (I + I_0) \times \omega\ 2 \leq$ Allowable energy $\omega = 2\ \theta / t$ (ω: Terminal angular velocity) θ :Rotation angle (rad) t::Rotation time (s) Allowable kinetic energy Data 3	$1/2x\ (0.0002+0.000028) \times (2X(\pi/2)/0.2)^2=0.028J$ < Allowable energy OK

Data 1

Effective Torque

Table.1 Effective Torque Unit: N · m

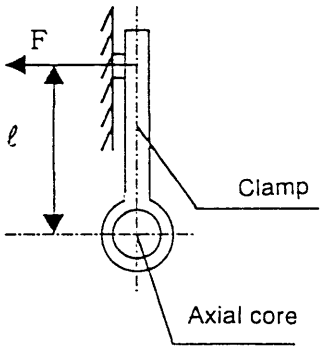
	Operating Pressure (MPa)										
	0.1	0.15	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
MSUA 1	-	-	0.03	0.06	0.09	0.11	0.14	0.17	-	-	-
MSUA 2	-	0.05	0.09	0.16	0.23	0.31	0.38	0.45	-	-	-
MSUA 7	-	0.14	0.21	0.37	0.52	0.69	0.83	0.98	-	-	-
MUSA 20	-	0.40	0.58	0.99	1.38	1.78	2.19	2.58	2.99	3.39	3.73

Load Condition

· Static load : Ts

A load that requires only the pressing force, as represented by a clamp.
(If the clamp itself in the graph is determined to be a mass object, consider the clamp as being an inertial moment,

(Example)

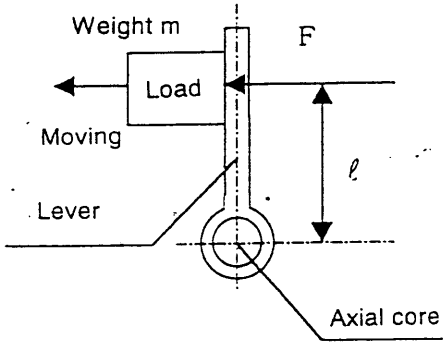


F: Pressing force
Calculation of static torque
Ts = Fx ℓ (N · m)

· Resistance Load: Tf

A load upon which external force act, such as friction force of gravity. Because its purpose is to move the load, and its speed must be adjusted, ensure a margin of over 3 to 5 times the effective torque.
*Actuator effective torque ≥ (3~5)Tf
(If the lever itself in the graph is determined to be a mass, consider the lever as being an inertial load.)

(Example)



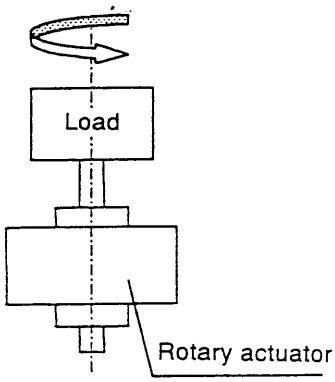
Friction factor μ
F = μ mg
Calculation of static torque
Ts = Fx ℓ (N · m)
g = 9.8 m/S²

· Inertial Load : Ta

A load that is required to be rotated by the actuator. Because its purpose is to rotate the load, and its speed must be adjusted, ensure a margin of over 10 times the effective torque.
* Effective torque for the actuator ≥ Sta
(S is 10 times as large or more)

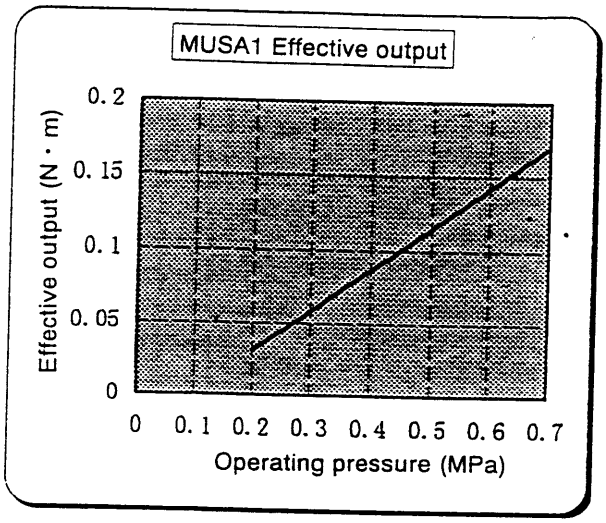
(Example)

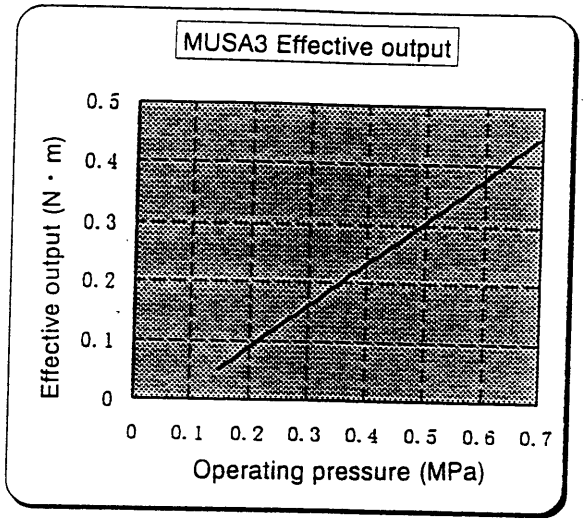
Calculation of accelerating torque

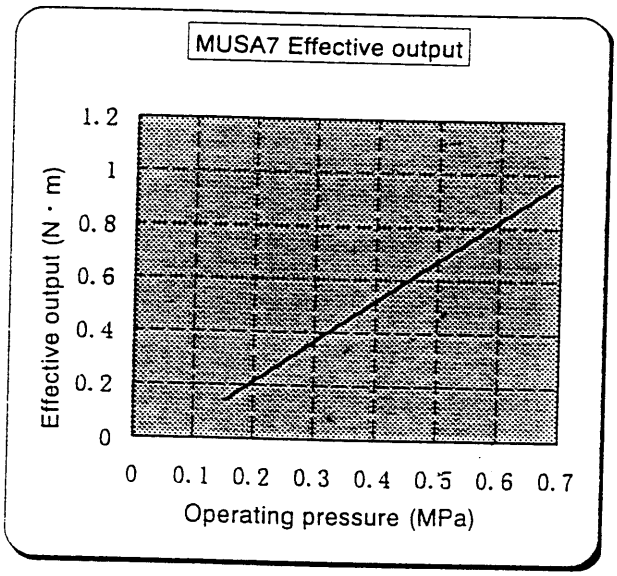


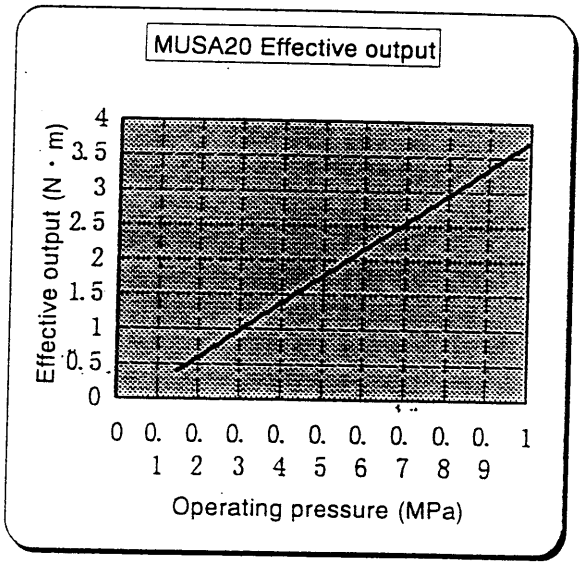
Ta = I · $\dot{\omega}$ (N · m)
I : Moment of Inertia
$\dot{\omega}$ = Angle acceleration
θ =Rotation angle (rad)
t = Rotation time (S)
$\dot{\omega} = \frac{2\theta}{t^2}$ (rad/S²)

Graph 1


MUSA1 Effective output
Effective output (N・m)
0.2
0.15
0.1
0.05
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
Operating pressure (MPa)


MUSA3 Effective output
Effective output (N・m)
0.5
0.4
0.3
0.2
0.1
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
Operating pressure (MPa)


MUSA7 Effective output
Effective output (N・m)
1.2
1
0.8
0.6
0.4
0.2
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
Operating pressure (MPa)

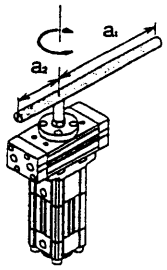

MUSA20 Effective output
Effective output (N・m)
4
3.5
3
2.5
2
1.5
1
0.5
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
Operating pressure (MPa)

Data 2

Moment of Inertia

Calculating a Moment of Inertia I (I: Moment of inertia kg•m² m: Weight of load kg)

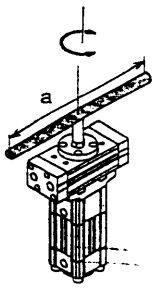
❶ Thin rod



Rotation of pivot: Passes through one end perpendicular to the rod.

$$I=m_1 \cdot \frac{a_1^2}{3} + m_2 \cdot \frac{a_2^2}{3}$$

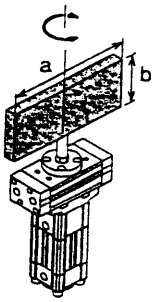
❷ Thin rod



Position of pivot: Passes through the center of gravity perpendicular to the rod.

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

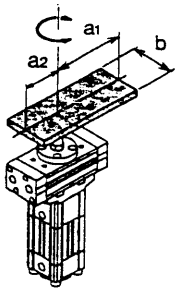
❸ Thin rectangular plate (rectangular parallel piped)



Position of pivot: Passes through the center of gravity, parallel to side b.

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

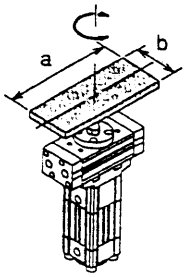
❹ Thin rectangular plate (rectangular parallel piped)



Position of pivot: Passes through one end perpendicular to the plate.

$$I=m_1 \cdot \frac{4a_1^2+b^2}{12} + m_2 \cdot \frac{4a_2^2+b^2}{12}$$

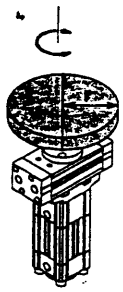
❺ Thin rectangular plate (rectangular parallel piped)



Position of pivot: Passes through the center of gravity perpendicular to the plate. (Similar to thick rectangular plate)

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

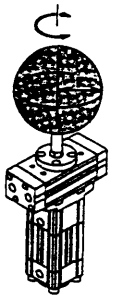
❻ Column (inclusive of thin disk)



Position of pivot: Axis

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

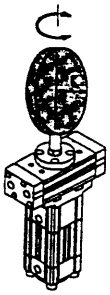
❼ Solid globe



Position of pivot: Diameter

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

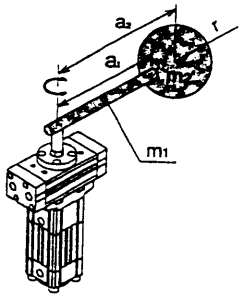
❽ Thin disk



Position of pivot: Diameter

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

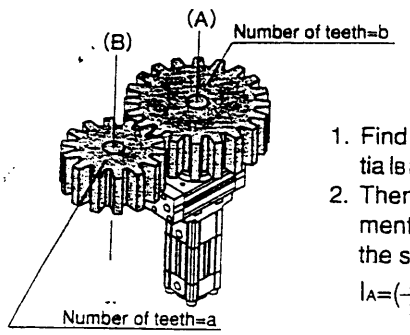
❾ If load is in the end of lever



$$I=m_1 \cdot \frac{a_1^2}{3} + m_2 \cdot a_2^2 + K$$

(Example)
When W_2 is spherical,
$K=m_2 \cdot \frac{2r^2}{5}$ according to ❼.

❿ Propagation of gear



1. Find the moment of inertia I_B around the shaft (B).
2. Then replace the moment of inertia I_B around the shaft (A) by I_A.

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

Data 3

Kinetic Energy / Rotation Time

Allowable Kinetic Energy

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

① Allowable kinetic energy and rotation time adjustable range

Set operationally stable rotation time within the adjustable range according to the table below.

Note that operation out of the lower speed range whose upper limit is 0.3 S/90° may cause sticking or stopping operation.

Size	Allowable kinetic energy J	Operationally stable adjustable rotation time S/90°
MSUA 1	0.0065	0.07~0.3
MSUA 3	0.017	
MSUA 7	0.042	
MSUA20	0.073	

② Allowable kinetic energy and rotation time adjustable range

When an object is moved by a rotary table, the object generate inertial force. When the rotary table is stopped at the stroke end, strong impact force (kinetic energy) is applied to the rotary table since the object has inertial force.

Kinetic energy at that time

$E = \frac{1}{2} \cdot (I + I_0) \cdot \varpi^2$

E: Kinetic energy J

I: Inertial moment of load $kg \cdot m^2$

I_0: Inertial moment of table $kg \cdot m^2$

ϖ: Angular velocity rad/s

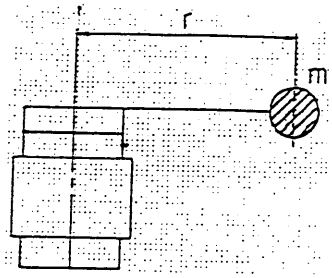
The following table shows moment of inertial of the table.

Moment of Inertial of Table Unit: $kg \cdot m^2$

Size	I_0
MSUA 1	2.5×10^{-6}
MSUA 3	6.2×10^{-6}
MSUA 7	16.0×10^{-6}
MSUA 20	28.0×10^{-6}

As allowable kinetic energy for the rotary table is limited, the limit value of rotation time can be found by calculating moment of inertia.

Moment of inertia indicates difficulty in rotation an object, in other words, difficulty in stopping a rotating object, and they are defined by size, shape and weight of an object.



The following is how to calculate moment of inertia.

The basic formula of moment of inertia is,

$I = m \cdot r^2$ m : Weight *kg*

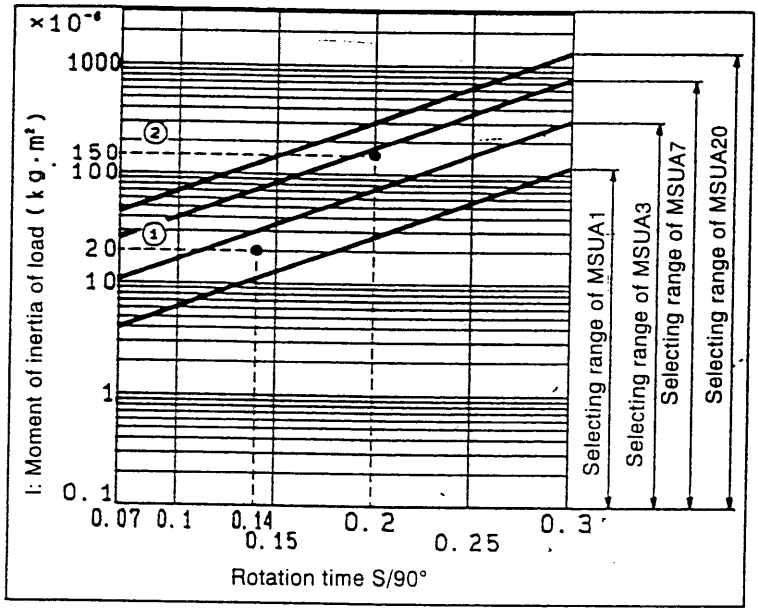
This is moment of inertia for a rotation axis of an object whose distance from the rotation axis is r and weight is m.

Different formulae are used depending on shapes of objects. Data 2 shows formulae to find moment of inertia of various shapes.

③ Model selection

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

Graph 2 Moment of Inertia - Rotation Time



1. <How to read graph>

When

- Moment of inertia ··· 20×10^{-6}
- Rotation time ··· 0.14S/90° ,

MSUA3 or MSUA7, 20 will be selected.

2. <Calculation Example>

shape of load : Column with a radius of 0.05m and weight of 0.12kg

Rotation time: 0.2 S/90°

$I = 0.12 \times \frac{0.05^2}{2} = 150 \times 10^{-6}$ kg · m²

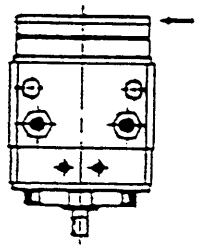
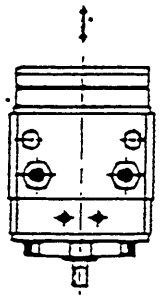
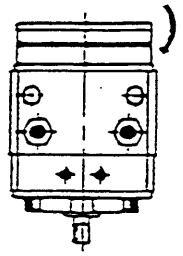
Based on the graph of moment of inertial and rotation time, find the intersection by extending a vertical axis (moment of inertial) 150×10^{-6} kg · m² and horizontal axis (rotation time) 0.2S/90° . MSUA7 or MSUA20 is selected because the intersection is within the selecting range of MSUA7.

4. Setting

4-1 Limitation of Load Applied to Table

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

Table 1

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

4-2 Rotation Range of Table

Rotation angle can be changed as shown in the figure below by adjusting the adjusting screws (A) and (B).

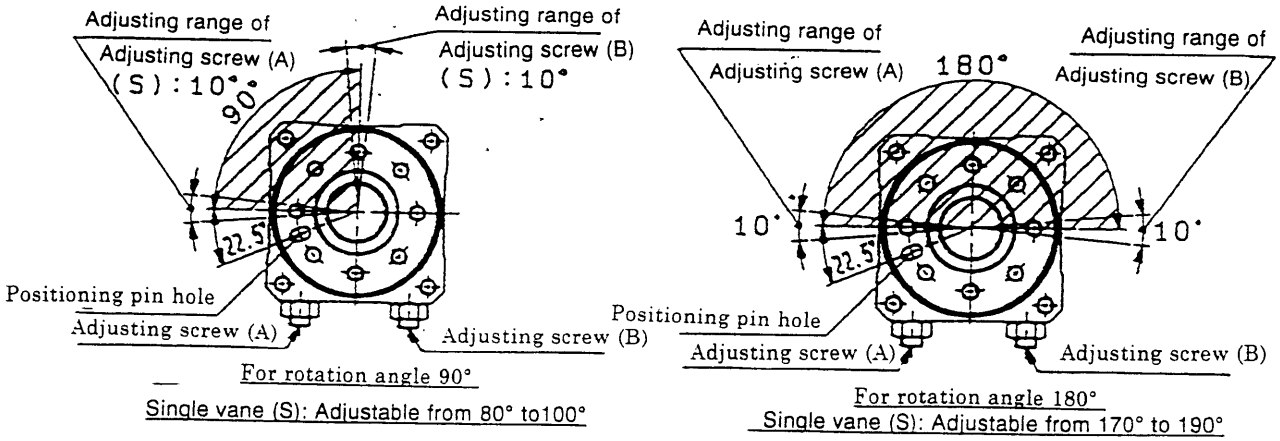


Figure 1 Rotation Range of Table

4-3 Calculation Example of Load Condition

Example : MSUA 7	Allowable thrust load ・・60N Allowable moment ・・0.9 N・m

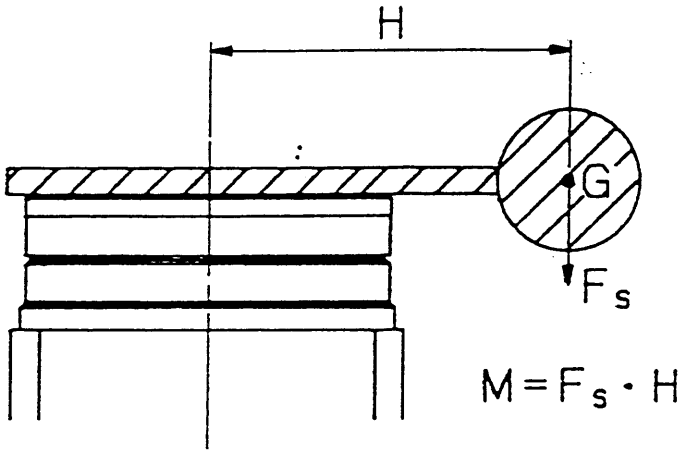


Figure 2

Assuming that load conditions in the figure 2 are as follows.

$H = 0.1m$

$F_s = 20\ N$

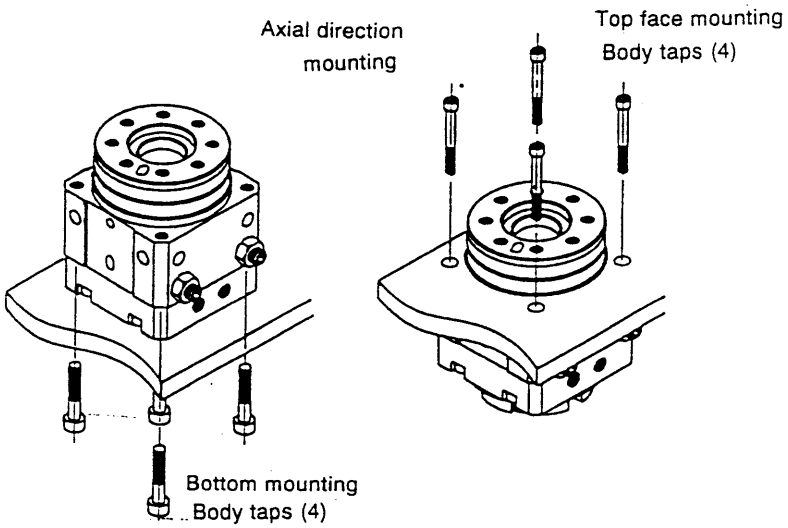
If MSUA7 is selected under those conditions, thrust load of 20N will be within the allowable value of 60N, but moment will be 20N x 0.1m = 2N・m, and it exceeds the allowable moment of 0.9 N・m, so that it can not be used. In this case, selecting a larger model should be considered.

4-4 Using Body as Flange

This High Precision Rotary Table can be mounted from 5 directions, 2 axial directions and 3 body side directions.

Table 2 Mounting Dimensions in Axial Directions

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



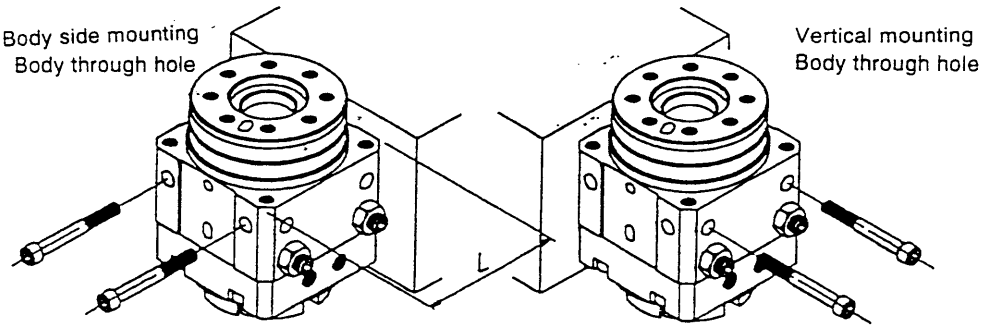


Table 3 Mounting Dimensions in Body Side

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

4-5 Piping

Port positions and sizes are shown in Figure 3 and Table 4.

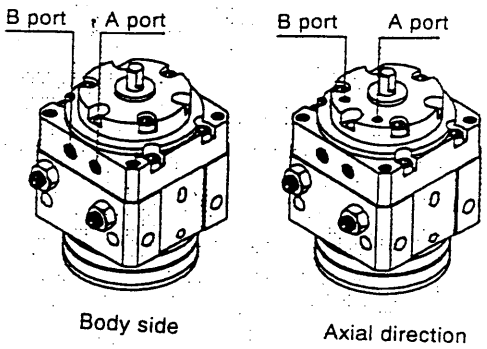


Figure 3 Port Position

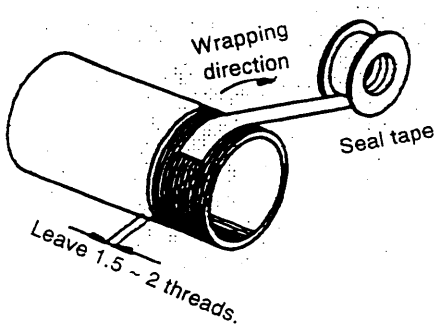
Table 4 Port Size

Model	Port Size	
	Body side	Axial direction
MSUA 1	M3 x 0.5	
MSUA 3	M5 x 0.8	M3 x 0.5
MSUA 7	M5 x 0.8	
MSUA 20	M5 x 0.8	

Perform the following precautions for connecting piping.

a) Dust and scale in piping before a filter can be removed by a filter, but those after a filter can not be removed and may enter in a solenoid valve and a cylinder, so that malfunction will occur or life will be shortened. Therefore, be sure to flush piping thoroughly before connecting.

b) When piping and fittings are screwed in, take care to prevent contamination by chips and sealant.
When wrapped with seal tape, leave 1.5 ~ 2 threads uncovered on the pipe end.



5. External Stopper

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

5-1 Mounting Position of External Stopper

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

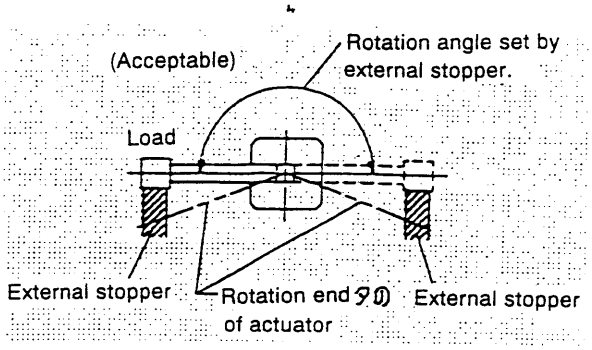


Figure 4 Mounting Position of External Stopper (Correct)

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

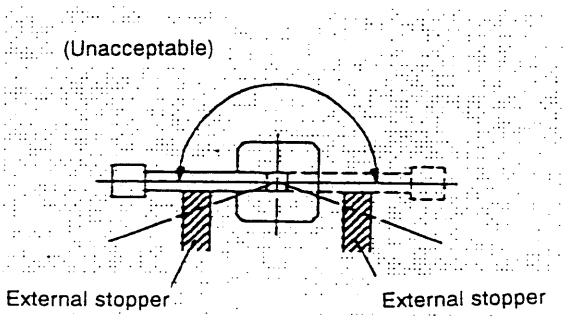
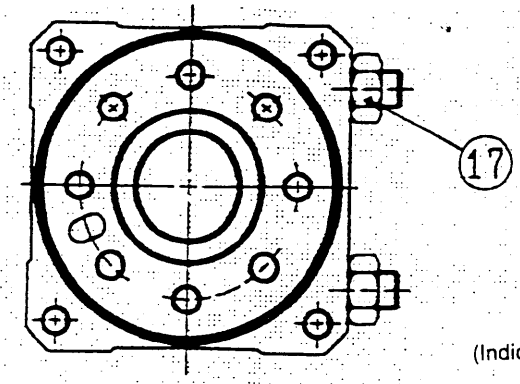


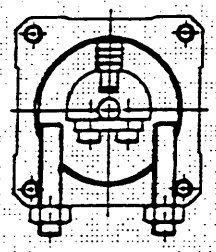
Figure 5 Mounting Position of External Stopper (Incorrect)

5-2 Precautions for Using External Stopper

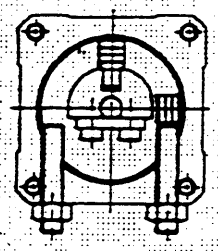
High Precision Rotary Table / Series MUSA has an angle adjusting system by an adjusting screw, so that setting of an adjusting bolt should be performed not to touch it to a stopper lever for using an external stopper.

6. Construction & Parts List

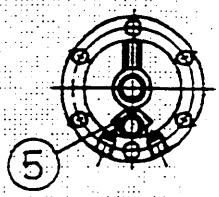




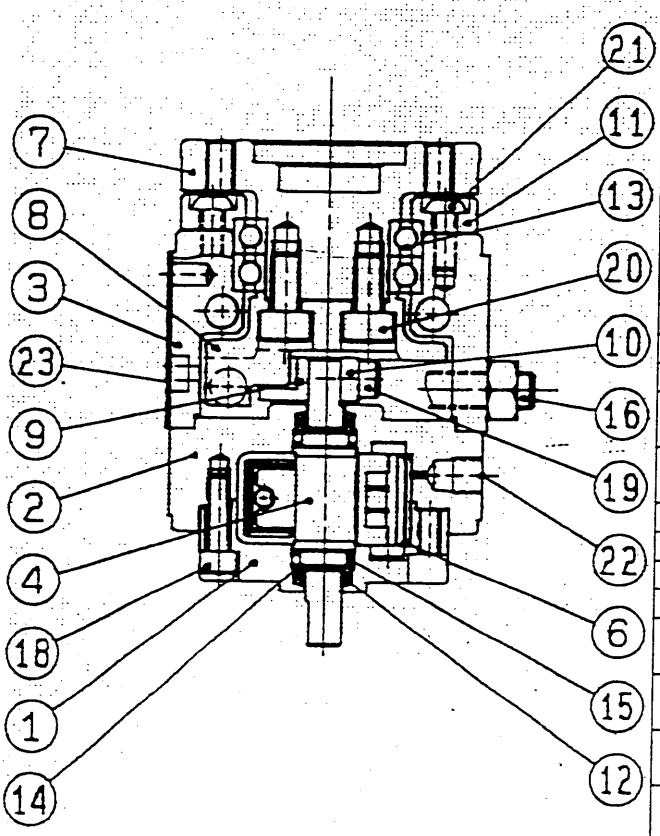
For 180°
(Indicate intermediate position)



For 90°
(Indicate that port A is pressurized)



Single Vane



	Description	Material	Note
1	Body (A)	Aluminum alloy	Light gray color
2	Body (B)	Aluminum alloy	Light gray color
3	Body (C)	Aluminum alloy	Light gray color
4	Vane shaft	1~7: Stainless steel 20: Carbon steel	Rubber lining
5	Stopper	Resin	
6	Stopper packing	NBR	
7	Table	Aluminum alloy	Light gray color
8	Stopper lever	Carbon steel	2 types, for 90° & 180°
9	Stopper guide	Stainless steel	
10	Lever retainer	Carbon steel	
11	Bearing retainer	Aluminum alloy	Light gray color
12	Bearing	Hard carbon chrome bearing steel	
13	Special bearing	Hard carbon chrome bearing steel	
14	Back-up ring	Stainless steel	
15	O ring	NBR	
16	Adjusting screw	Carbon steel	
17	Hexagon nut	Carbon steel	
18	Hexagon socket head cap screw	Stainless steel	
19	Hexagon socket head cap screw	Stainless steel	
20	Hexagon socket head cap screw	Carbon steel	
21	Hexagon button bolt	Carbon steel	
22	Hexagon socket set screw	Stainless steel	Only SE type
23	Name plate		

* Plug (22) is used when a connection port is SE type.

7. Rotary Table with Auto Switch

Rotary Table with Auto Switch is the product which mounts an auto switch to detect rotating position of the table on the outside of the body.

7-1 Auto Switch Specifications

Table 7 Applicable Auto Switch

Applicable series	Auto switch model		Lead wire entry	Indicator light
MDSUA1 MDSUA3	Reed switch	D-90, 90A	Grommet/ 2 wire	-
		D-97, 93A		Available
	Solid state switch	D-S99, S99V	Grommet / 3 wire	
		D-S9P,S9PV	Grommet / 3 wire PNP	
		D-T99,T99V	Grommet / 2 wire	
MDSUA7 MDSUA20	Reed switch	D-R73	Grommet/ 2 wire	Available
		D-R80	Connector/ 2 wire	-
	Solid state switch	D-S79	Grommet / 3 wire	Available
		D-S7P	Grommet /3 wire PNP	
		D-T79	Grommet / 2 wire Connector/ 2 wire	

Table 8 Auto Switch Part Number / Specifications

Model	Auto switch model		Applicable load	Load voltage	Max. load current and load current range
	Right hand mounting	Left hand mounting			
D-9	D-90		Relay, IC circuit, PLC	24V AC DC or less	50 mA
	D-90A			24V AC DC or less	50 mA
				100V AC DC	20 mA
	D-97		Relay, PLC	24V DC	5~40mA
	D-93A			24V DC	5~40mA
				100V AC	5~20mA
D-R7	D-R731	D-R732	Relay, PLC	24V DC	5~40mA
				100V AC	5~20mA
D-R8	D-R801	D-R802	Relay, IC circuit, PLC	24V AC DC or less	50mA
				48V AC DC	40mA
				100V AC DC	20mA
D-S7	D-S791	D-S792	Relay, IC circuit, PLC	28V AC DC or less	40mA or less
D-S7P	D-S7P1	D-S7P2		-	80mA or less
D-S9	D-S991 D-S99V1	D-S992 D-S99V2	Relay, IC circuit, PLC	28V DC or less	40mA or less
D-S9P	D-9P1 D-S9PV1	D-29P2 D-S9PV2		-	80mA or less
D-7T	D-T791	D-T792	24V DC relay, PLC	24V DC	5~150mA
D-T9	D-T991 D-T99V1	D-T992 D-T99V2	24V DC relay, PLC	24V DC	5~40mA

Response time: 1.2 ms <Reed switch>, 1ms or less <Solid state switch>

Operating pressure range: 5~60°C Lead wire length: 0.5m (Standard)

Shock resistance: 300m/S^2 <Reed switch>, 1000m/S^2 <Solid state switch>

7-2 Rotation Range of Table Surface Positioning Pin Hole and Auto Switch Mounting Position

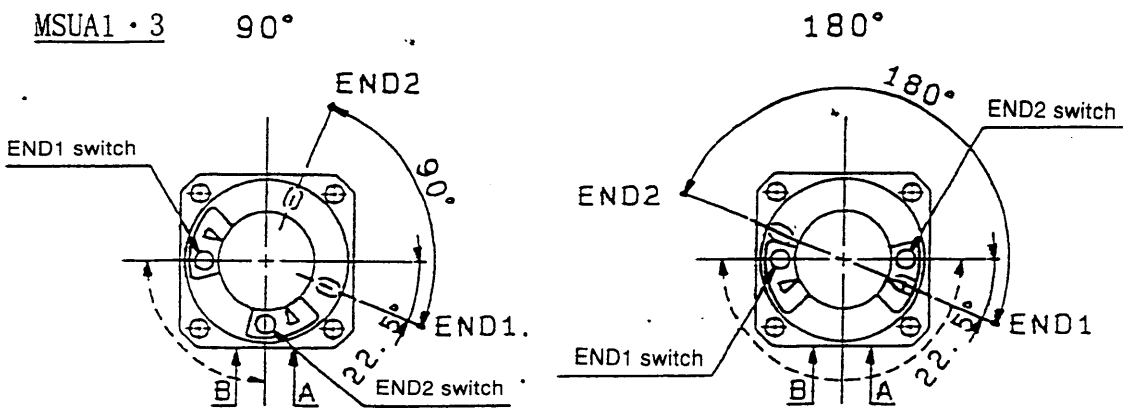


Figure 6

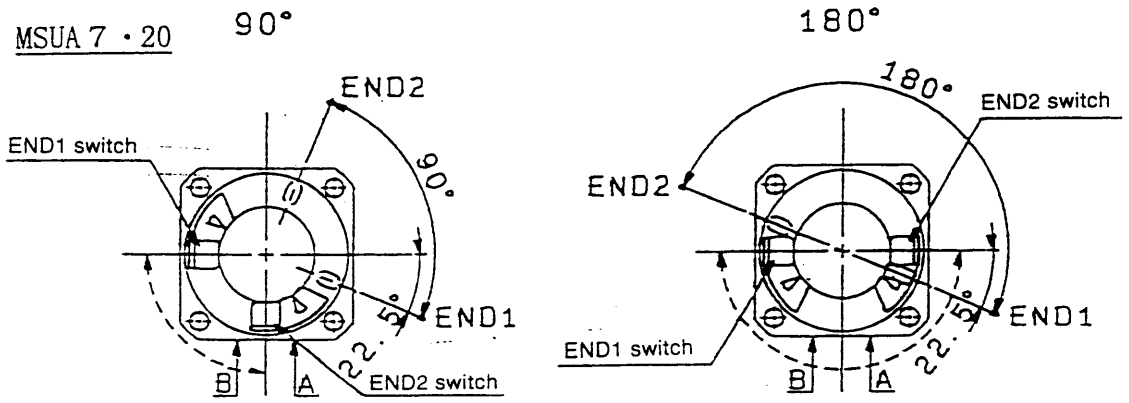


Figure 7

In the figures 6 and 7 that indicate the rotating range, the arrows of the solid line 90° (180°) indicate the rotating range of the positioning pin hole on the table top. If the pin hole is at END1, the END1 switch activates, and if the pin hole is at END2, the END2 switch activates.

The broken line arrows indicate the built-in magnet's rotating range. By shifting END1 switch clockwise,
or END2 switch counterclockwise, rotation angle of respective switch can be decreased.

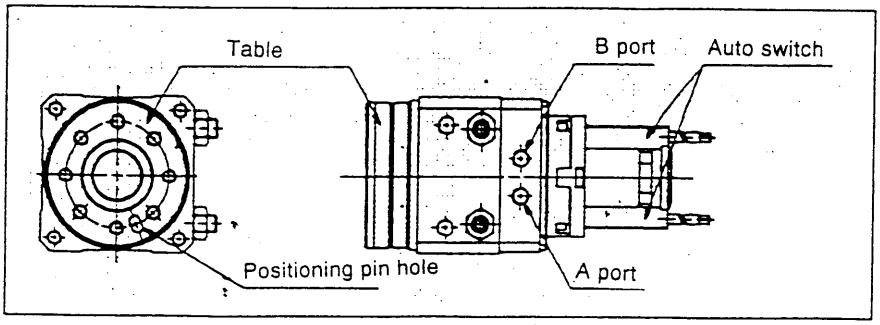


Figure 8

7-3 How to Move Auto Switch Detecting Position

To set the detection position, slightly loosen the set screw, move the switch to the designed position, and secure the switch in place by tightening the set screw. The set screw should be tightened to approximately 0.5 N · m. If it is tightened excessively, the threads could be stripped and the set screw will no longer be able to secure the switch.

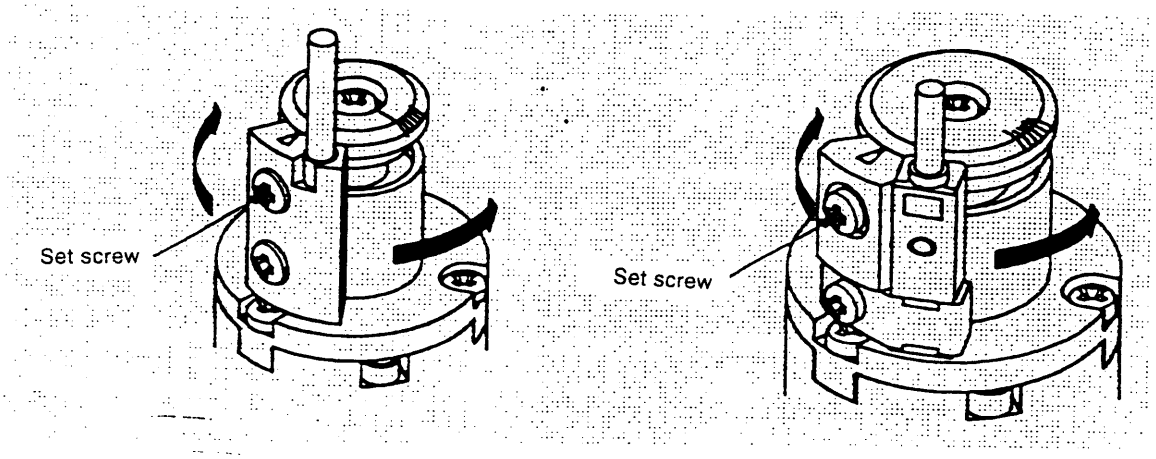


Figure 8

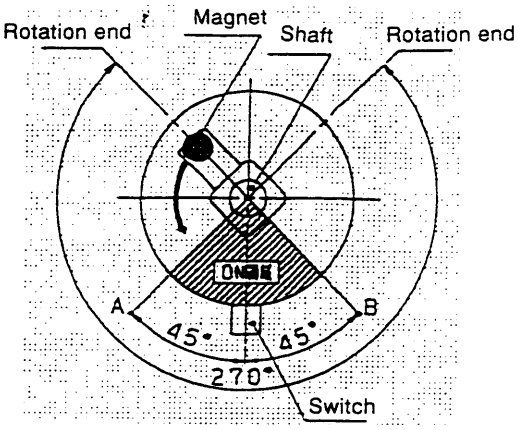
7-4 Rotation Angle and Hysteresis of Auto Switch

Table 9

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

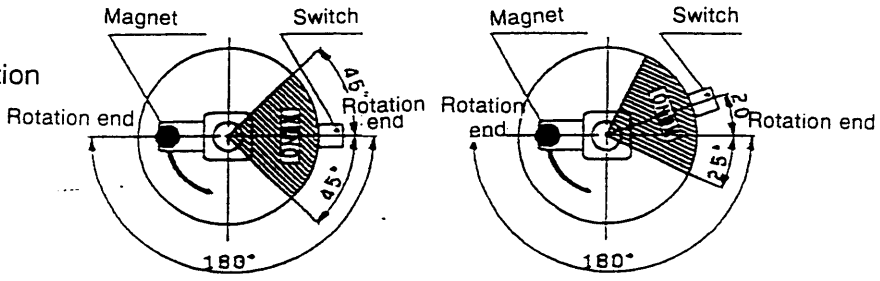
7-5 Explanation of Rotation Angle and Hysteresis

(Example)
Rotary actuator: 270°
Switch rotation angle: 90°
The switch is mounted on the intermediate position of rotation.



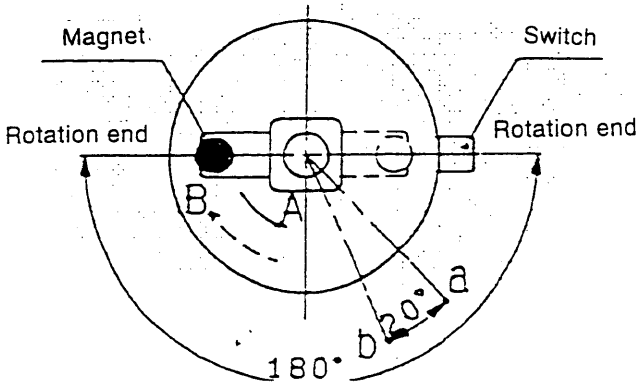
In the above figure, when the magnet moves to the arrow direction in accordance with the shaft rotation, the switch is turned off at the position where the magnet passes A point, and turned off at the position where it passes B point. In this case, the ON area is 90°, that is, rotation angle of the switch is 90°.

(Example)
Rotary actuator: 180°
Switch rotation angle: 90°
The switch is mounted on the rotation end.



In the above figure (a), when the magnet moves to the arrow direction, the switch is turned on 45° before the rotation end where the switch is mounted. If the switch is slid 20° as shown in the figure (b), the position where the switch is turned on can be changed 25° before the rotation end.

(Example)
Rotary actuator: 180°
Switch hysteresis: 20°



In the above figure, when the magnet A is moved to the A direction (the solid line), the switch is turned on at a point . When the magnet is reversed and moved to the B direction (the broken line), the switch is turned off at b point. At that time, hysteresis of a and b points is 20°.

7-6 Construction

1) Component Parts of MDSUA1 · 3

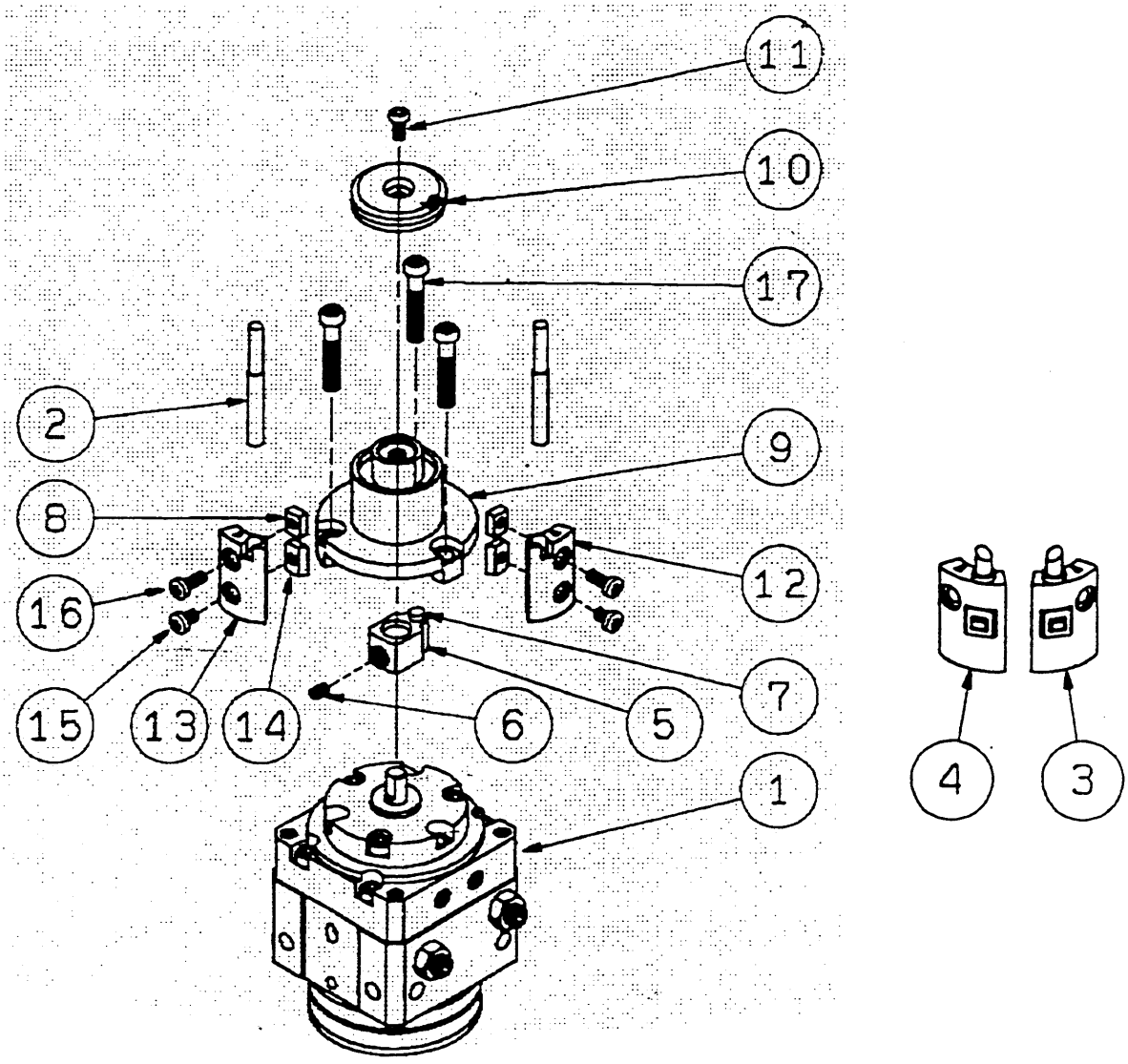


Figure 9 Component Parts of MSUA1 · 3 Switch Unit

No.	Description	Q'ty	No.	Description	Q'ty
1	Body	1	10	Cover (B)	1
2	Reed switch	2	11	Cross recessed head machine screw	1
3	Solid state switch (Right hand mounting)	1	12	Switch block (A)	1
4	Solid state switch (Left hand mounting)	1	13	Switch block (B)	1
5	Magnet lever	1	14	Fixing block (B)	2
6	Hexagon socket set screw	1	15	Cross recessed head machine screw	2
7	Magnet	1	16	Cross recessed head machine screw	2
8	Fixing block (A)	2	17	Cross recessed head machine screw	1:2
9	Cover (A)	1			3:3

2) Component Parts of MDSUA7 · 20

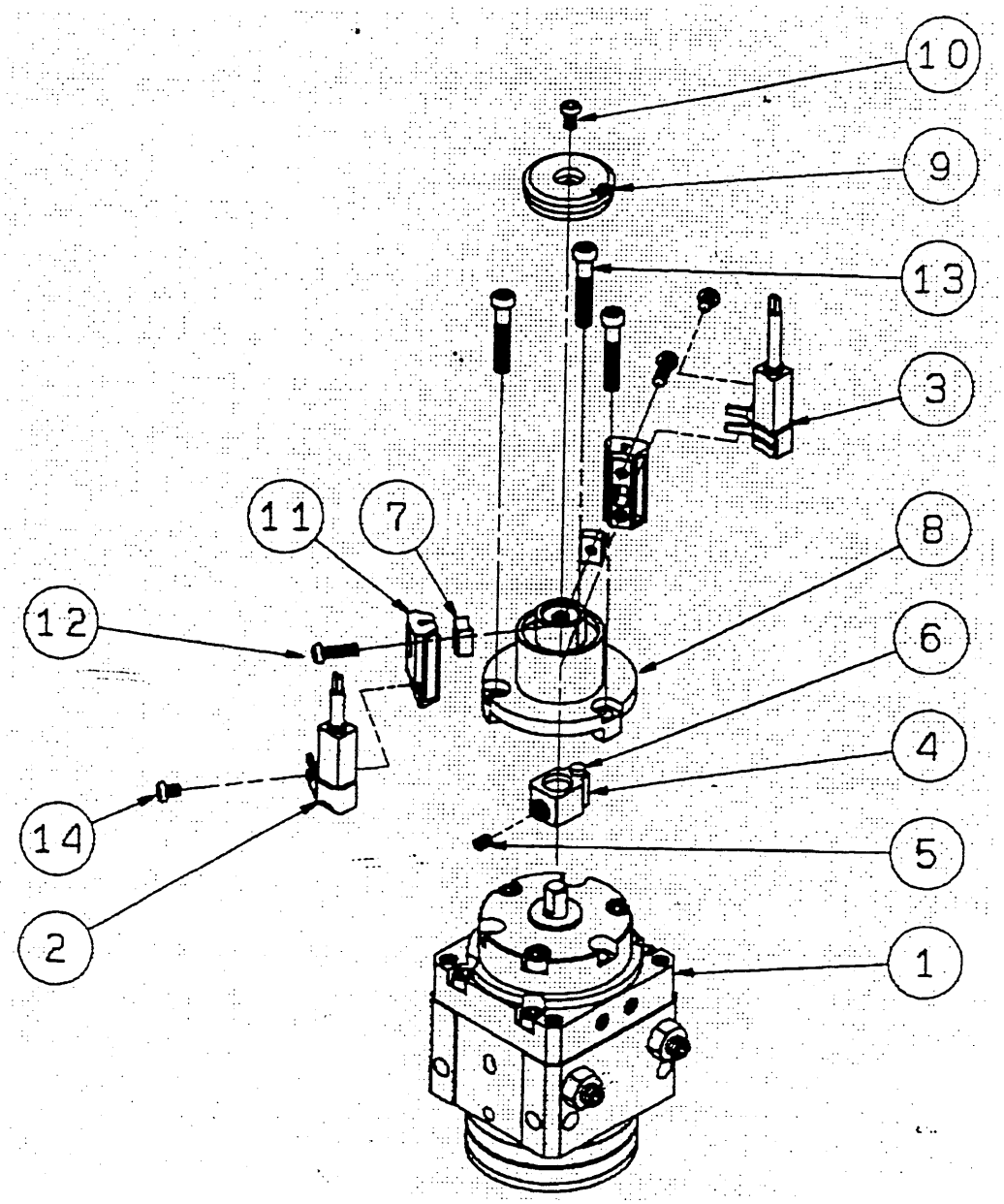
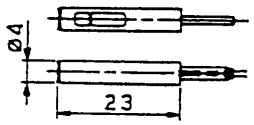


Figure 10 Component Parts of MSUA7 · 20 Switch Unit

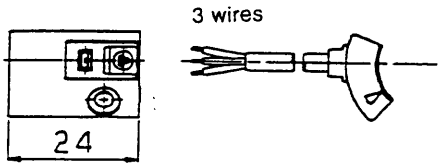
No.	Description	Q'ty	No.	Description	Q'ty
1	Body	1	8	Cover (A)	1
2	Auto switch (Right hand mounting)	1	9	Cover (B)	1
3	Auto switch (Left hand mounting)	1	10	Cross recessed head machine screw	1
4	Magnet lever	1	11	Switch block	2
5	Hexagon socket set screw	1	12	Cross recessed head machine screw	2
6	Magnet	1	13	Cross recessed head machine screw	2
7	Fixing block	2	14	Cross recessed head machine screw	2

7-7 Appearance

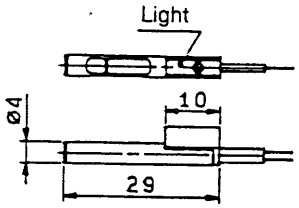
(D-90), (90A)



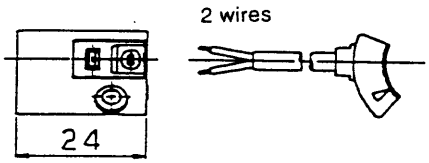
(D-S99V), (D-S9PV)



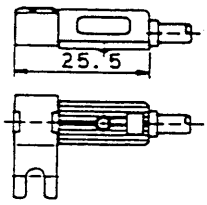
(D-97), (D-93A)



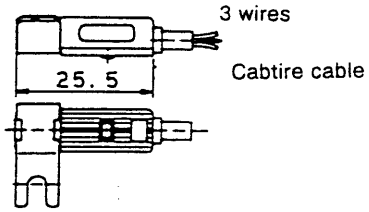
(D-T99V)



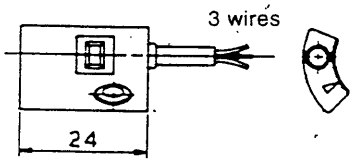
(D-R73), (D-R80)



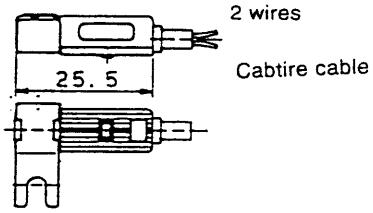
(D-S79), (D-S7P)



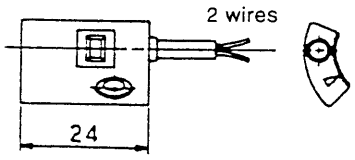
(D-S99), (D-S9P)



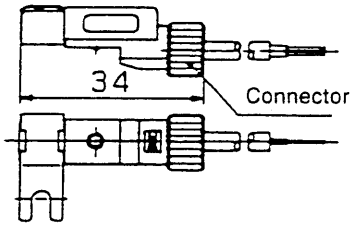
(D-T79)



(D-T99)



(D-R73CN), (D-R80CN), (D-T79CN)



8. Maintenance

When a rotary unit and a table unit are replaced, follow the procedures below.

8-1 How to Replace Table Unit

[Disassembling]

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

[Reassembling]

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

8-2 How to Replace Rotary Unit

[Disassembling]

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

[Reassembling]

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

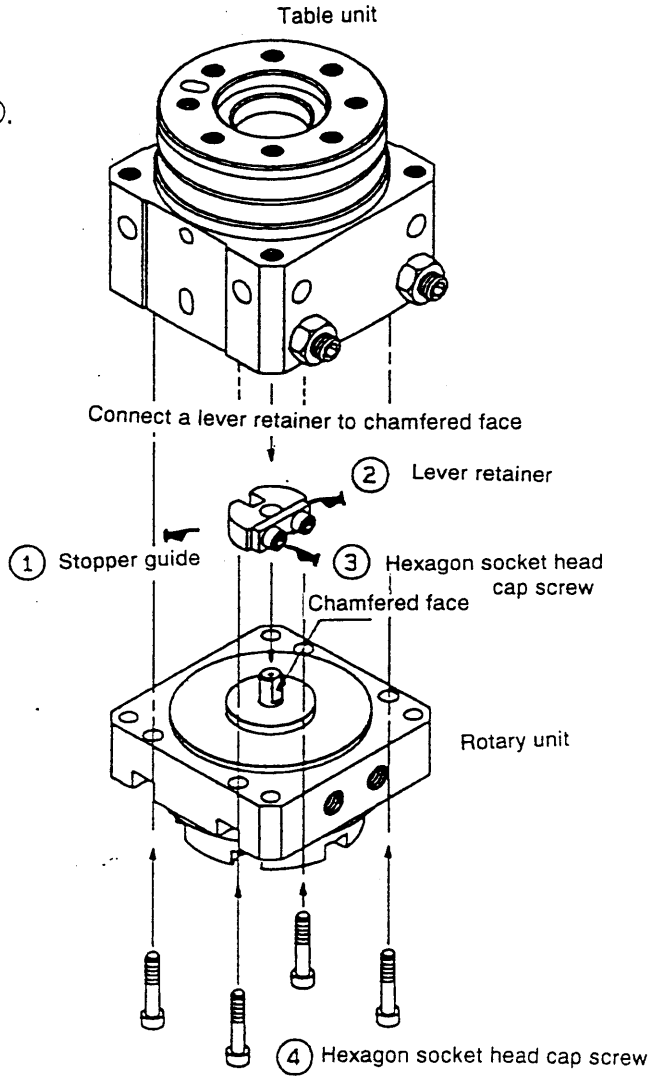


Figure 10 How to Replace Rotary Unit

Model	Screw torque N・m	
	③	④
MSUA 1	0.8~1.2	0.8~1.2
MSUA 3	0.8~1.2	0.8~1.2
MSUA 7	2~3.4	2~3.4
MSUA20	4~6	4~6

<Note> Note that the product whose inside of the rotary unit and table unit can not be guaranteed.

8-3 Maintenance

Periodical inspection is required to operate an actuator under the best condition.

(1) Points of Maintenance

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

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

(2) Period of Maintenance

Maintenance should be performed 1 to 2 times per year to operate High Precision Rotary Table / Series MSUA.

9 Troubleshooting

Contents of Failure	Cause	Countermeasures
The actuator can not operate or rotation is unstable.	Adjustment of rotation speed does not meet its range to stabilize operation.	Operate the actuator within the speed adjusting range to stabilize operation specified in the catalog.
	Failure of internal packing seal or increase of internal resistance due to operation out of the operating temperature range	Operate the actuator within the operating temperature range. (If packing seal is damaged, a rotary unit may be replaced.)
	Increase of internal leak because of damaging packing by foreign matter and different kind of oil	Replace a rotary unit.
	Insufficient air supply	Check if air flow supplied to the port is sufficient or not.
	Insufficient air pressure	Check if pressure supplied to the port is the set pressure.
	A directional control valve (solenoid valve) does not switch.	Make a signal to a directional control valve (solenoid valve) correctly.
	Excess load torque	Load torque shall be within the specified range.
Rotation angle changes extremely.	Internal parts are damaged.	Replace with a new actuator and take following procedures. 1) Calculate kinetic energy applied to the actuator and adjust a speed controller to obtain appropriate rotation time. 2) Install a shock absorber externally to absorb impact force. In this case, adjust an adjusting screw not to touch a stopper lever, and decide the rotation end by an external stopper.
Air leaks from the table part.	A packing on the sealing part has worn out.	Change to a new actuator or a rotary unit.
Internal leak (Increase of leak due to durability is excluded.)	Damage of packing due to foreign matter and different kind of oil.	Change a rotary unit. Avoid contamination by foreign matter and different kind of oil.
	Packing seal failure due to operation out of operating temperature range.	Change a rotary unit. Operate within the operating temperature range.

Contents of Failure	Cause	Countermeasures
Insufficient rotation angle	Series MSUA have angle adjusting system. An angle adjusting screw is adjusted less than the required rotation angle.	Adjust the adjusting bolt to the proper position. * If the bolt is loosened too much, the stop face of the stopper lever will be out of the screw, so that adjust the screw gradually.
An auto switch does not operate or malfunctions.	Influence by external magnetic field	Check that there is no strong magnetic force around the product.
	Problem of electric circuit	Check that there is no problem of electric circuit.
	Problem of electric specifications	Check that there is no problem of voltage and current.

Precautions for the list of troubleshooting.

1. Life time is excluded from the column of cause.
2. If causes other than described in the list are found, disassembling investigation may be required, so that please consult us.