Rotary Table/
Rack & Pinion Type

Size: 10, 20, 30, 50

Height

Max. **28%** reduction [1]

54 mm ➡ **39** mm

Reduced by 15 mm

39 mm

MSQ20A-M9BW

MAX.PRESS. 1.0MPa
MADE IN JAPAN | G | WW |

D-M9BW

Weight

Max. **28%** reduction [1]

940 g ➡ **680** g

[1] Compared with the existing model (MSQ20)

Enlarged center hole diameter for piping

∅**9** mm ➡ ∅**12** mm

Compared with the existing model (MSQ20)

MSQ Series

SMC®

CAT.ES20-256A

Rotary Table/Rack & Pinion Type *MSQ Series*

Compact and lightweight

Reduced Height
[mm]

Size	New MSQ (H₁)	MSQ (H₂)	Reduction rate [%]
10	**35.5**	47	24
20	**39**	54	28
30	**46**	57	19
50	**51.5**	66	22

Reduced Weight
[g]

Size	New MSQ	MSQ	Reduction rate [%]
10	**375**	500	25
20	**680**	940	28
30	**930**	1230	24
50	**1500**	1990	25

∗ For the MSQ□A

New MSQ   Existing MSQ series model

H₁   H₂

2 types of cushions are available.

Cushion pad
Reduces the metal noise that occurs when the piston stops

Internal shock absorber
The maximum allowable kinetic energy is up to 5 times higher than the cushion pad.

Size	Allowable kinetic energy [J]	
	Cushion pad	Internal shock absorber
10	0.007	0.039
20	0.025	0.116
30	0.048	0.116
50	0.081	0.294

Improved workability

The end ports and the angle adjustment mechanisms are located on the same surface.

End ports

Angle adjustment mechanism
(With cushion)

Side port
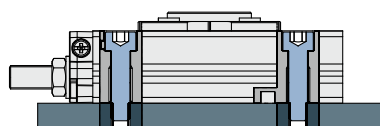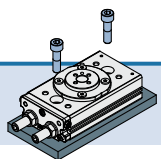(Same for the opposite side, With plug)
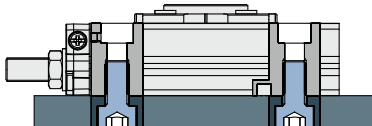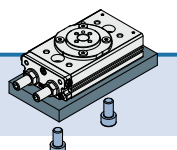
Internal shock absorber

3 types of mounting are possible.

Mounting dimensions are interchangeable with the existing MSQ series model. For mounting, refer to "Mounting" on page 25.
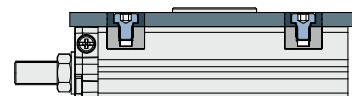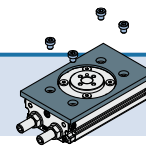
Top mounting (Through hole)
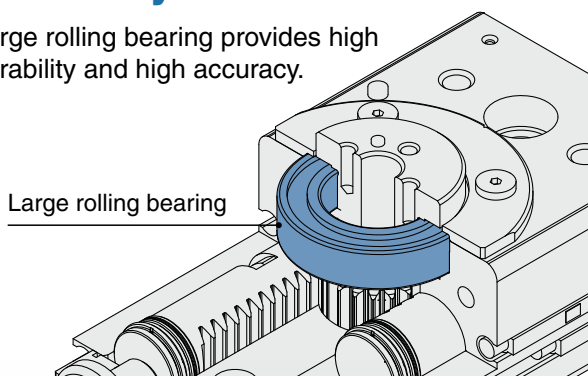
Bottom mounting (Body tapped)

Top mounting (Body tapped)

High durability and high accuracy

Large rolling bearing provides high durability and high accuracy.

Large rolling bearing

Enlarged center hole diameter for piping

[mm]

Size	New MSQ	MSQ
10	ø7	ø6
20	ø12	ø9
30	ø13	ø12
50	ø14	ø13

Center hole

Center hole

Piping, wiring

Mounting plate
(Provided by the customer)
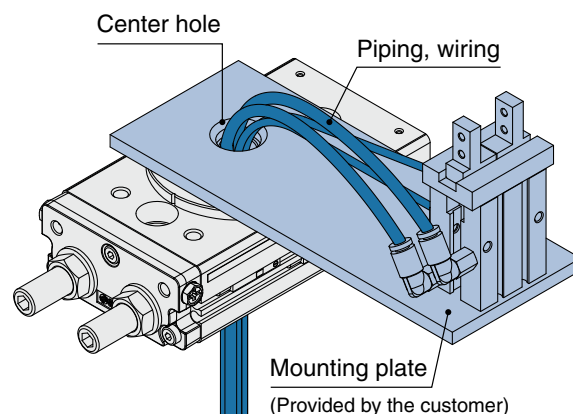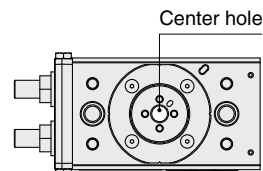
The adjustable rotation time range is expanded.

Can be used at lower speeds compared with the existing product
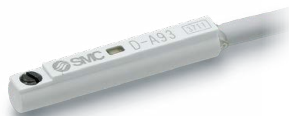
New **MSQ: 0.2 to 2.0 s/90°**

MSQ: 0.2 to 1.0 s/90°

∗ For the MSQ□A
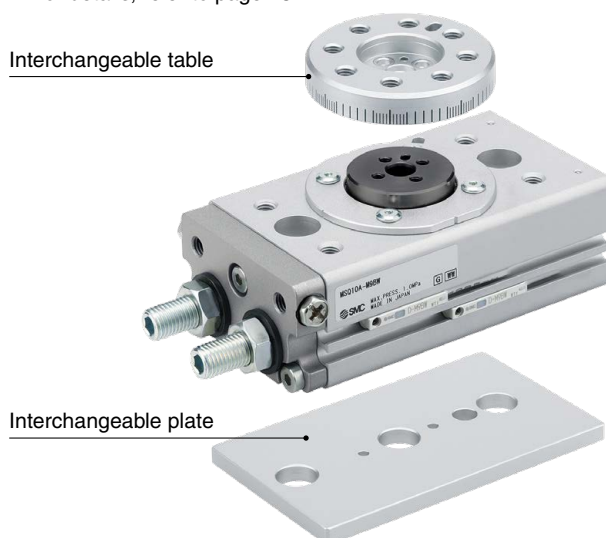
Interchangeable height tables and plates are available.
(Made to order)

The new product is only fully interchangeable with the existing product when the optional interchangeable plate and table are utilized.

∗ For details, refer to page 23.

Interchangeable table

Interchangeable plate

Compact auto switches are mountable.

Solid state auto switch
D-M9□

Reed auto switch
D-A9□

CONTENTS

Rotary Table/Rack & Pinion Type *MSQ* Series

● **Made to Order**

SMC

Rotary Actuator
Model Selection

CONTENTS

Rotary Actuator Model Selection

Selection Procedures	Note	Selection Example

◆ **List of Operating Conditions**

· Initially selected models
 · Operating pressure [MPa]
 · Mounting orientation
 · Load type
    Static load
    Resistance load
    Inertial load
 · Load dimensions [m]
 · Load mass [kg]
 · Rotation time [s]
 · Rotating angle [rad]
	Refer to page 10 for the load type.
	
	 The unit for the rotating angle is radian.
	 $180° = \pi$ rad
	 $90° = \pi/2$ rad
		
		 Initially selected model: MSQ30A
		 Operating pressure: 0.3 MPa
		 Mounting orientation: Vertical Load type: Inertial load
		 Rotation time: t = 1.5 s Rotating angle: $\theta = \pi$ rad (180°)

❶ Calculation of Moment of Inertia

Calculate the inertial moment of load. ⇒ p. 6	Loads are generated from multiple parts. The inertial moment of each load is calculated, and then totaled.	**Inertial moment of load 1: I_1** $I_1 = 0.4 \times \dfrac{0.15^2 + 0.05^2}{12} + 0.4 \times 0.05^2 = 0.001833$ **Inertial moment of load 2: I_2** $I_2 = 0.2 \times \dfrac{0.025^2}{2} + 0.2 \times 0.1^2 = 0.002063$ **Total inertial moment: I** $I = I_1 + I_2 = 0.003896$ [kg·m²]

❷ Calculation of Required Torque

Calculate the required torque for each load type and confirm whether the values fall in the effective torque range.
 	
 · Static load (Ts)
   Required torque T = Ts
 · Resistance load (Tf)
   Required torque T = Tf x (3 to 5)
 · Inertial load (Ta)
   Required torque T = Ta x 10
 ⇒ p. 10
	When the resistance load is rotated, the required torque calculated from the inertial load must be added.
	
	 Required torque T = Tf x (3 to 5) + Ta x 10
		Inertial load: Ta
		 $Ta = I \cdot \dot{\omega}$
		 $\dot{\omega} = \dfrac{2\theta}{t^2}$ [rad/s²]
		 Required torque: T
		 $T = Ta \times 10$
		 $= 0.003896 \times \dfrac{2 \times \pi}{1.5^2} \times 10 = 0.109$ [N·m]
		 0.109 N·m $<$ Effective torque OK

❸ Confirmation of Rotation Time

Confirm whether the time falls in the rotation time adjustment range. ⇒ p. 10	Consider the time after converted in the time per 90°. (1.0 s/180° is converted in 0.5 s/90°.)	$0.2 \leq t \leq 2.0$ **t = 0.75 s/90° OK**

❹ Calculation of Kinetic Energy

Calculate the kinetic energy of the load and confirm whether the energy is below the allowable range. Can confirm referring to the inertial moment and rotation time graph (p. 12) ⇒ p. 11	If the energy exceeds the allowable range, a suitable cushioning mechanism such as a shock absorber must be externally installed.	**Kinetic energy: E** $E = \dfrac{1}{2} \cdot I \cdot \omega^2$ $\omega = \dfrac{2 \cdot \theta}{t}$ $E = \dfrac{1}{2} \times 0.003896 \times \left(\dfrac{2 \times \pi}{1.5}\right)^2 = 0.03418$ [J] **0.03418 [J] $<$ Allowable energy OK**

❺ Confirmation of Allowable Load

Confirm whether the load applied to the product is within the allowable range. ⇒ p. 12	If the load exceeds the allowable range, a bearing or similar must be externally installed.	**Moment load: M** $M = 0.4 \times 9.8 \times 0.05 + 0.2 \times 9.8 \times 0.1$ $= 0.392$ [N·m] **0.392 [N·m] $<$ Allowable moment load OK**

❻ Calculation of Air Consumption and Required Air Flow Capacity

Air consumption and required air flow capacity are calculated when necessary. ⇒ p. 13		

SMC

1 Calculation of Moment of Inertia

The moment of inertia is a value indicating the inertia of a rotating body, and expresses the degree to which the body is difficult to rotate, or difficult to stop.
It is necessary to know the moment of inertia of the load in order to determine the value of required torque or kinetic energy when selecting a rotary actuator.
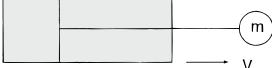
Moving the load with the actuator creates kinetic energy in the load. When stopping the moving load, it is necessary to absorb the kinetic energy of the load with a stopper or a shock absorber.
The kinetic energy of the load can be calculated using the formulas shown in **Fig. 1** (for linear motion) and **Fig. 2** (for rotation motion).

In the case of the kinetic energy for linear motion, the formula (1) shows that when the velocity **V** is constant, it is proportional to the mass **m**. In the case of rotation motion, the formula (2) shows that when the angular velocity ω is constant, it is proportional to the moment of inertia.
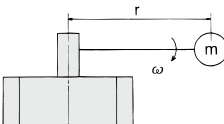
Linear motion

Fig. 1 Linear motion

$$E = \frac{1}{2} \cdot m \cdot V^2 \quad \cdots\cdots\cdots\cdots \ (1)$$

E : Kinetic energy
m : Load mass
V : Velocity

Rotation motion

Fig. 2 Rotation motion

$$E = \frac{1}{2} \cdot I \cdot \omega^2 = \frac{1}{2} \cdot m \cdot r^2 \cdot \omega^2 \quad \cdots\cdots\cdots \ (2)$$

E : Kinetic energy
I : Moment of inertia ($= m \cdot r^2$)
ω : Angular velocity
m : Mass
r : Radius of rotation

As the moment of inertia is proportional to the squares of the mass and the radius of rotation, even when the load mass is the same, the moment of inertia will be squared as the radius of rotation grows bigger. This will create greater kinetic energy, which may result in damage to the product.
When there is rotation motion, product selection should be based not on the load mass of the load, but on the moment of inertia.

Moment of Inertia Formula
The basic formula for obtaining a moment of inertia is shown below.

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

m: Mass
r : Radius of rotation
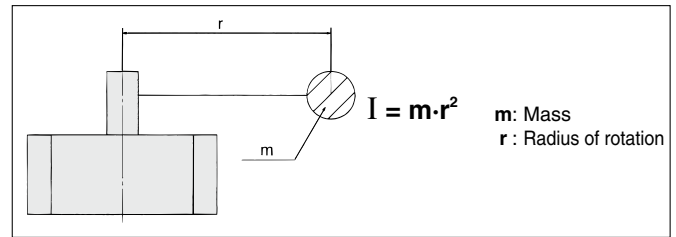
This formula represents the moment of inertia for the shaft with mass **m**, which is located at distance **r** from the shaft.
For actual loads, the values of the moment of inertia are calculated depending on configurations, as shown below.
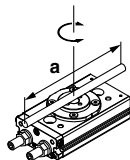
● Equation Table of Moment of Inertia

I: Moment of inertia **m**: Load mass

1. Thin shaft
Position of rotational axis: Perpendicular to the shaft through the center of gravity
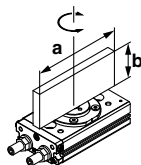
$$I = m \cdot \frac{a^2}{12}$$

2. Thin rectangular plate
Position of rotational axis: Parallel to side b and through the center of gravity
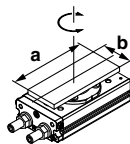
$$I = m \cdot \frac{a^2}{12}$$

3. Thin rectangular plate (Including rectangular parallelepiped)
Position of rotational axis: Perpendicular to the plate through the center of gravity
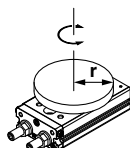
$$I = m \cdot \frac{a^2 + b^2}{12}$$

4. Round plate (Including column)
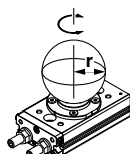Position of rotational axis: Through the center axis

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

5. Solid sphere
Position of rotational axis: Through the center of diameter

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

6. Thin round plate
Position of rotational axis: Through the center of diameter

$$I = m \cdot \frac{r^2}{4}$$
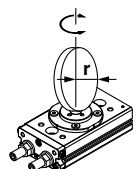
7. Cylinder
Position of rotational axis: Through the center of diameter and gravity

$$I = m \cdot \frac{3r^2 + a^2}{12}$$
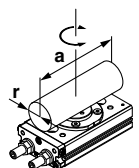
8. When the rotational axis and load center of gravity are not consistent

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

K: Moment of inertia around the load center of gravity

4. Round plate $K = m \cdot \frac{r^2}{2}$
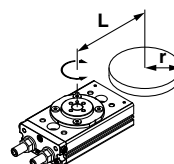
9. Gear transmission

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

2. I_B is converted to the moment of inertia I_A for the rotation of the shaft (A).

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

(B) (A) Gear = **a**

Gear = **b**

Rotary Actuator Model Selection

● Calculation Example of Moment of Inertia

■ If the shaft is located at a desired point of the load:

Example: ① If the load is the thin rectangular plate:
Obtain the center of gravity of the load as I_1, a provisional shaft.

$$I_1 = m \cdot \frac{a^2 + b^2}{12}$$

② Obtain the actual moment of inertia I_2 around the shaft, with the premise that the mass of the load itself is concentrated in the load's center of gravity point.

$$I_2 = m \cdot L^2$$

③ Obtain the actual moment of inertia I.

$$I = I_1 + I_2$$

$$\left(\begin{array}{l} \textbf{m}: \text{Load mass} \\ \textbf{L} : \text{Distance from the shaft to the load's center of gravity} \end{array}\right)$$
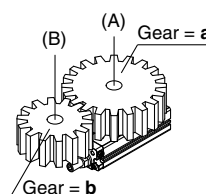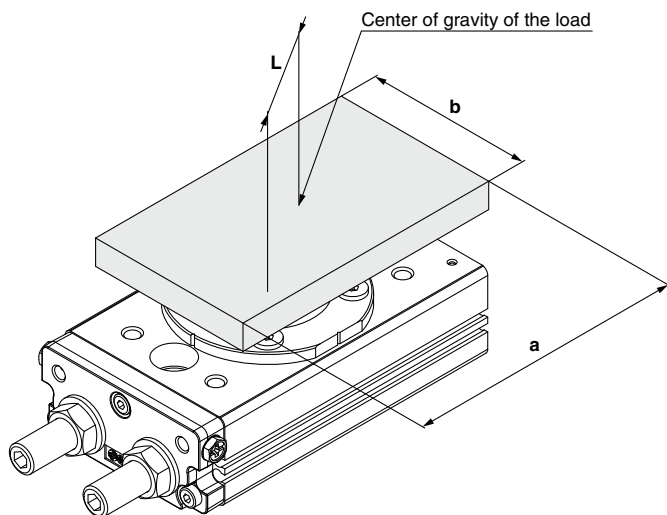
Center of gravity of the load

L

b

a

Calculation Example

a = 0.2 m, b = 0.1 m, L = 0.05 m, m = 1.5 kg

$I_1 = 1.5 \times \dfrac{0.2^2 + 0.1^2}{12} = 6.25 \times 10^{-3}$ kg·m²

$I_2 = 1.5 \times 0.05^2 = 3.75 \times 10^{-3}$ kg·m²

$I = (6.25 + 3.75) \times 10^{-3} = 0.01$ kg·m²

■ If the load is divided into multiple loads:

Example: ① If the load is divided into the 2 cylinders:
$$\left[\begin{array}{l} \text{The center of gravity of load 1 matches the shaft} \\ \text{The center of gravity of load 2 differs from the shaft} \end{array}\right]$$
Obtain the moment of inertia of load 1:

$$I_1 = m_1 \cdot \frac{r_1^2}{2}$$

② Obtain the moment of inertia of load 2:

$$I_2 = m_2 \cdot \frac{r_2^2}{2} + m_2 \cdot L^2$$

③ Obtain the actual moment of inertia I:

$$I = I_1 + I_2$$

$$\left(\begin{array}{l} \textbf{m}_1, \textbf{m}_2: \text{Mass of loads 1 and 2} \\ \textbf{r}_1, \textbf{r}_2: \text{Radius of loads 1 and 2} \\ \textbf{L}: \text{Distance from the shaft to the center of gravity of load 2} \end{array}\right)$$

Load 1: I_1

r1

L   r2

Load 2: I_2

Calculation Example

m1 = 2.5 kg, m2 = 0.5 kg, r1 = 0.1 m, r2 = 0.02 m, L = 0.08 m

$I_1 = 2.5 \times \dfrac{0.1^2}{2} = 1.25 \times 10^{-2}$ kg·m²

$I_2 = 0.5 \times \dfrac{0.02^2}{2} + 0.5 \times 0.08^2 = 0.33 \times 10^{-2}$ kg·m²

$I = (1.25 + 0.33) \times 10^{-2} = 1.58 \times 10^{-2}$ kg·m²

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■ If a lever is attached to the shaft and a cylinder and a gripper are mounted to the tip of the lever:

Lever: I_1
L
Cylinder: I_2
$\varnothing D$
b
a
Gripper: I_3
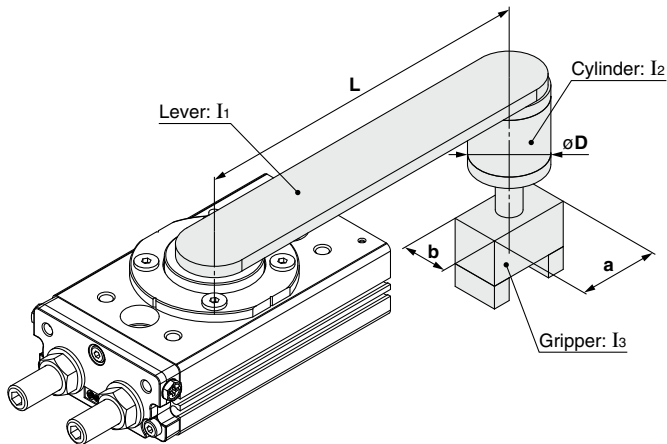
Example: ① Obtain the lever's moment of inertia:

$$I_1 = m_1 \cdot \frac{L^2}{3}$$

② Obtain the cylinder's moment of inertia:

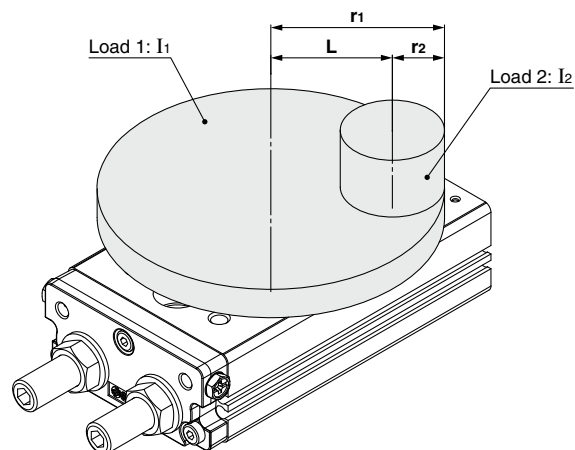$$I_2 = m_2 \cdot \frac{(D/2)^2}{2} + m_2 \cdot L^2$$

③ Obtain the gripper's moment of inertia:

$$I_3 = m_3 \cdot \frac{a^2 + b^2}{12} + m_3 \cdot L^2$$

④ Obtain the actual moment of inertia:

$$I = I_1 + I_2 + I_3$$

m_1: Mass of lever
m_2: Mass of cylinder
m_3: Mass of gripper

Calculation Example

L = 0.2 m, $\varnothing D$ = 0.06 m, a = 0.06 m, b = 0.03 m, m_1 = 0.5 kg, m_2 = 0.4 kg, m_3 = 0.2 kg
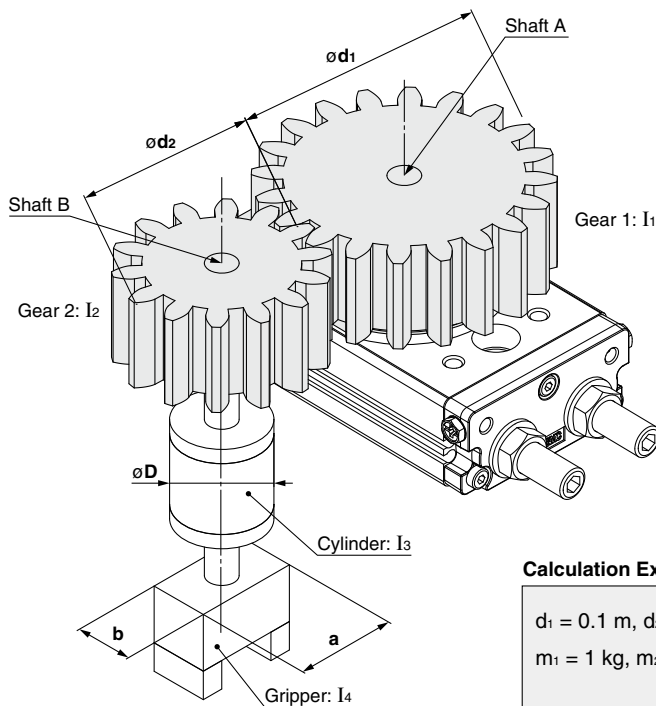
$$I_1 = 0.5 \times \frac{0.2^2}{3} = 0.67 \times 10^{-2} \quad \text{kg·m}^2$$

$$I_2 = 0.4 \times \frac{(0.06/2)^2}{2} + 0.4 \times 0.2^2 = 1.62 \times 10^{-2} \quad \text{kg·m}^2$$

$$I_3 = 0.2 \times \frac{0.06^2 + 0.03^2}{12} + 0.2 \times 0.2^2 = 0.81 \times 10^{-2} \quad \text{kg·m}^2$$

$$I = (0.67 + 1.62 + 0.81) \times 10^{-2} = 3.1 \times 10^{-2} \quad \text{kg·m}^2$$

■ If a load is rotated through the gears:

$\varnothing d_1$
$\varnothing d_2$
Shaft A
Shaft B
Gear 2: I_2
Gear 1: I_1
$\varnothing D$
Cylinder: I_3
b
a
Gripper: I_4

Example: ① Obtain the moment of inertia I_1 around shaft A:

$$I_1 = m_1 \cdot \frac{(d_1/2)^2}{2}$$

② Obtain moment of inertias I_2, I_3, and I_4 around shaft B:

$$I_2 = m_2 \cdot \frac{(d_2/2)^2}{2} \qquad I_3 = m_3 \cdot \frac{(D/2)^2}{2}$$

$$I_4 = m_4 \cdot \frac{a^2 + b^2}{12} \qquad I_B = I_2 + I_3 + I_4$$

③ Replace the moment of inertia I_B around shaft B with the moment of inertia I_A around shaft A.

$$I_A = (A/B)^2 \cdot I_B \qquad \text{[A/B: Ratio of the number of teeth]}$$

④ Obtain the actual moment of inertia:

$$I = I_1 + I_A$$

m_1: Mass of gear 1
m_2: Mass of gear 2
m_3: Mass of cylinder
m_4: Mass of gripper

Calculation Example

d_1 = 0.1 m, d_2 = 0.05 m, D = 0.04 m, a = 0.04 m, b = 0.02 m

m_1 = 1 kg, m_2 = 0.4 kg, m_3 = 0.5 kg, m_4 = 0.2 kg, Ratio of the number of teeth = 2

$$I_1 = 1 \times \frac{(0.1/2)^2}{2} = 1.25 \times 10^{-3} \text{ kg·m}^2$$

$$I_2 = 0.4 \times \frac{(0.05/2)^2}{2} = 0.13 \times 10^{-3} \text{ kg·m}^2$$

$$I_3 = 0.5 \times \frac{(0.04/2)^2}{2} = 0.1 \times 10^{-3} \text{ kg·m}^2$$

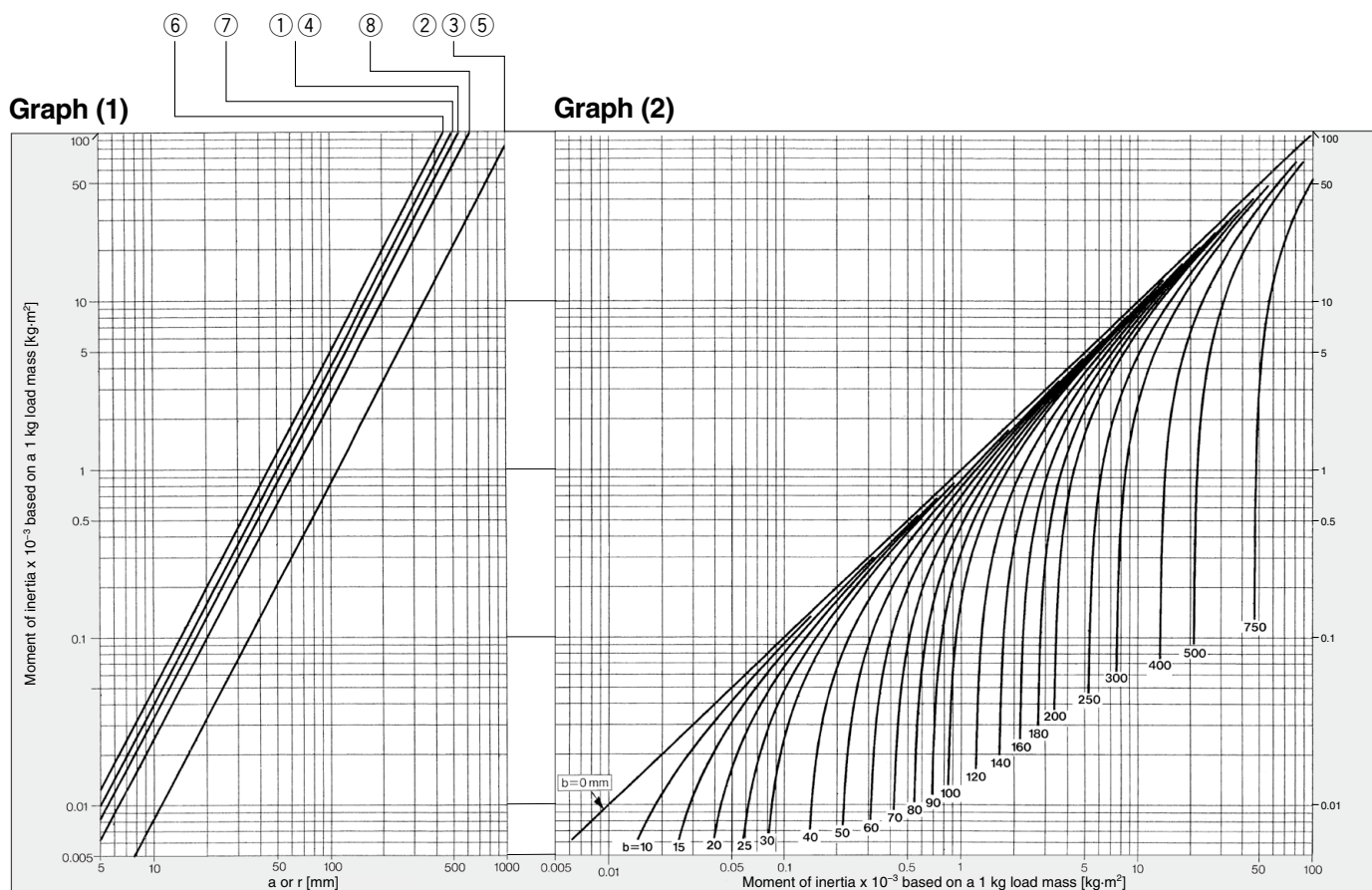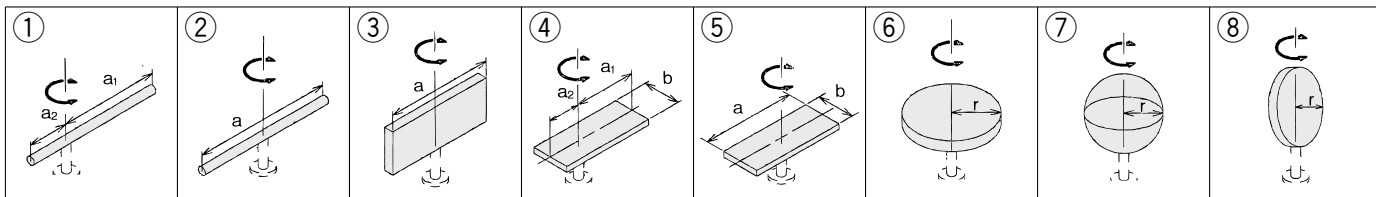$$I_4 = 0.2 \times \frac{0.04^2 + 0.02^2}{12} = 0.03 \times 10^{-3} \text{ kg·m}^2$$

$$I_B = (0.13 + 0.1 + 0.03) \times 10^{-3} = 0.26 \times 10^{-3} \text{ kg·m}^2$$

$$I_A = 2^2 \times 0.26 \times 10^{-3} = 1.04 \times 10^{-3} \text{ kg·m}^2$$

$$I = (1.25 + 1.04) \times 10^{-3} = 2.29 \times 10^{-3} \text{ kg·m}^2$$

Rotary Actuator **Model Selection**

●**Graph for Calculating the Moment of Inertia**

Graph (1)

Moment of inertia x 10^{-3} based on a 1 kg load mass [kg·m²]

a or r [mm]

Graph (2)

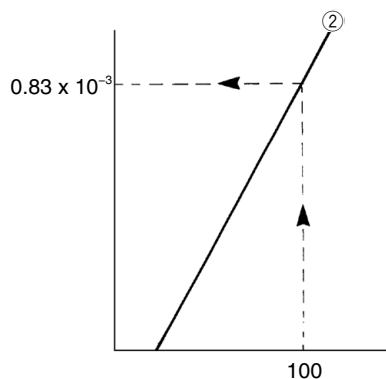Moment of inertia x 10^{-3} based on a 1 kg load mass [kg·m²]

How to read the graph: Only when the dimension of the load is "a" or "r"

[Example] When the load shape is ②, a = 100 mm, and the load mass is 0.1 kg

In Graph (1), the point at which the vertical line of a = 100 mm and the line of the load shape ② intersect indicates that the moment of inertia of the 1 kg mass is 0.83 x 10^{-3} kg·m².

Since the load mass is 0.1 kg, the actual moment of inertia is

0.83 x 10^{-3} x 0.1 = 0.083 x 10^{-3} kg·m²

(Note: If "a" is divided into "a₁a₂", the moment of inertia can be obtained by calculating them separately.)

How to read the graph: When the dimension of the load contains both "a" and "b"

[Example] When the load shape is ⑤, a = 100 mm, b = 100 mm, and the load mass is 0.5 kg

In Graph (1), obtain the point at which the vertical line of a = 100 mm and the line of the load shape ⑤ intersect. Move this intersection point to Graph (2), and the point at which it intersects with the curve of b = 100 mm indicates that the moment of inertia of the 1 kg mass is 1.7 x 10^{-3} kg·m².
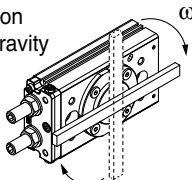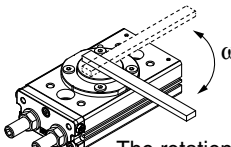
Since the load mass is 0.5 kg, the actual moment of inertia is

1.7 x 10^{-3} x 0.5 = 0.85 x 10^{-3} kg·m²

SMC
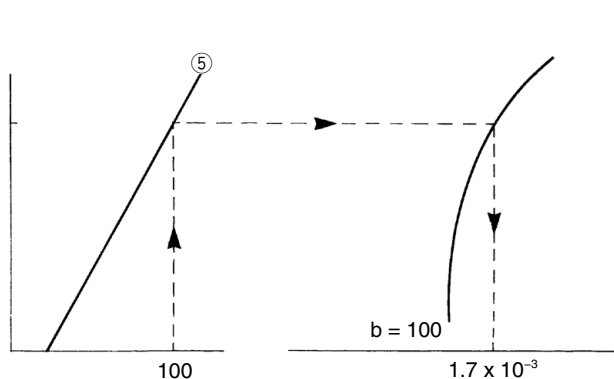
2 Calculation of Required Torque

● Load Type

The calculation method of required torque varies depending on the load type. Obtain the required torque referring to the table below.

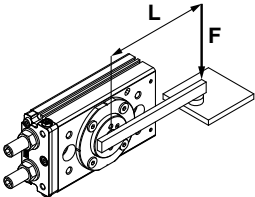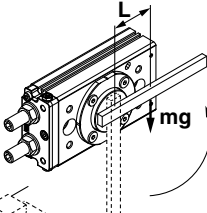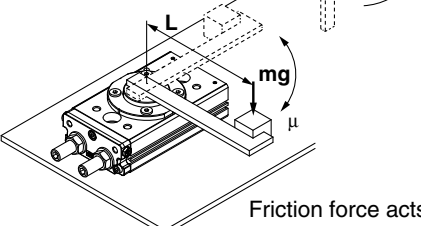| Load type		
Static load: Ts	**Resistance load: Tf**	**Inertial load: Ta**
When the pressing force is necessary (clamp, etc.)	When friction force or gravity is applied to the rotation direction	When the load with inertia is rotated
	 Gravity acts Friction force acts	 The center of rotation and the center of gravity are corresponding The rotational axis is vertical (up and down)

Ts = F·L
 	
Ts: Static load [N·m]
F : Clamp force [N]
L : Distance from the center of rotation to clamp [m]
	When gravity acts to the rotation direction
	   Tf = m·g·L
	When friction force acts to the rotation direction
	   Tf = μ·m·g·L
	
	Tf: Resistance load [N·m]
	m: Load mass [kg]
	g : Gravitational acceleration 9.8 [m/s^2]
	L : Distance from the center of rotation to the gravity or friction force acting point [m]
	μ : Coefficient of friction
		$\mathbf{Ta} = \mathrm{I}\cdot\dot{\omega} = \mathrm{I}\cdot\dfrac{2\theta}{t^2}$
		
		Ta: Inertial load [N·m]
		I : Moment of inertia [kg·m^2]
		$\dot{\omega}$: Angular acceleration [rad/s^2]
		θ : Rotating angle [rad]
		t : Rotation time [s]

Required torque **T** = **Ts**	Required torque **T** = **Tf** x (3 to 5)[*1]	Required torque **T** = **Ta** x 10[*1]

· Resistance loads → Gravity or friction applies in the rotation direction.
  Example 1) The axis of rotation is in a horizontal (lateral) direction, and the center of rotation and center of gravity of the load are not the same.
  Example 2) The load slips against the floor while rotating.
  ∗ The required torque equals the total of the resistance load and inertial load.
     T = **Tf** x (3 to 5) + **Ta** x 10
· Non-resistance loads → Gravity or friction does not apply in the rotation direction.
  Example 1) The axis of rotation is in a perpendicular (vertical) direction.
  Example 2) The axis of rotation is in a horizontal (lateral) direction, and the center of rotation and center of gravity of the load are the same.
  ∗ The required torque equals the inertial load only.
     T = **Ta** x 10

∗1 In order to adjust the velocity, it is necessary to have a margin of adjustment for **Tf** and **Ta**.

● Effective Torque

[N·m]

Size	Operating pressure [MPa]									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
10	0.18	0.36	0.53	0.71	0.89	1.07	1.25	1.42	1.60	1.78
20	0.37	0.73	1.10	1.47	1.84	2.20	2.57	2.93	3.29	3.66
30	0.55	1.09	1.64	2.18	2.73	3.19	3.82	4.37	4.91	5.45
50	0.93	1.85	2.78	3.71	4.64	5.57	6.50	7.43	8.35	9.28

3 Confirmation of Rotation Time

For stable operation, check that each product is used within the allowable rotation time range.
MSQ□A (Cushion pad): 0.2 to 2.0 s/90°   **MSQ□R** (Internal shock absorber): 0.2 to 0.7 s/90°

Rotary Actuator Model Selection

Kinetic energy is generated when the load rotates. Kinetic energy applies on the product at the operating end as inertial force, and may cause the product to damage. In order to avoid this, the value of allowable kinetic energy is determined for each product.
Find the kinetic energy of the load, and verify that it is within the allowable range for the product in use.

Kinetic Energy

Use the following formula to calculate the kinetic energy of the load.

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

E : Kinetic energy [J]
I : Moment of inertia [kg·m²]
ω: Angular velocity [rad/s]

⇒p. 12 Moment of inertia and rotation time

Angular Velocity

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

ω: Angular velocity [rad/s]
θ : Rotating angle [rad]
t : Rotation time [s]

To find the rotation time when kinetic energy is within the allowable range for the product, use the following formula.

When the angular velocity is $\omega = \frac{2\theta}{t}$

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

t : Rotation time [s]
I : Moment of inertia [kg·m²]
θ: Rotating angle [rad]
E: Allowable kinetic energy [J]

● Allowable Kinetic Energy and Rotation Time Adjustment Range

Table: Allowable Kinetic Energy and Rotation Time Adjustment Range

Size	Allowable kinetic energy [J]		Adjustable range of rotation time safe in operation [s/90°]	
	Cushion pad	Internal shock absorber	Cushion pad	Internal shock absorber
10	0.007	0.039	0.2 to 2.0	0.2 to 0.7
20	0.025	0.116		
30	0.048	0.116		
50	0.081	0.294		

Calculation Example

Load form: Round rod
Length of **a₁** part   : 0.12 m   Rotating angle: 90°
Length of **a₂** part   : 0.04 m   Rotation time : 0.9 $^s/_{90°}$
Mass of **a₁** part (= m₁): 0.09 kg
Mass of **a₂** part (= m₂): 0.03 kg
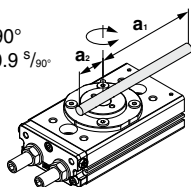
$$I = m_1 \cdot \frac{a_1^2}{3} + m_2 \cdot \frac{a_2^2}{3}$$

(Step 1) Find the angular velocity ω.

$$\omega = \frac{2\theta}{t} = \frac{2}{0.9}\left(\frac{\pi}{2}\right)$$
$$= 3.489 \text{ rad/s}$$

(Step 2) Find the moment of inertia I.

$$I = \frac{m_1 \cdot a_1^2}{3} + \frac{m_2 \cdot a_2^2}{3}$$
$$= \frac{0.09 \times 0.12^2}{3} + \frac{0.03 \times 0.04^2}{3}$$
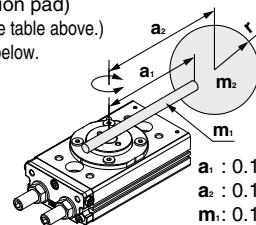$$= 4.48 \times 10^{-4} \text{ kg·m}^2$$

(Step 3) Find the kinetic energy E.

$$E = \frac{1}{2} \cdot I \cdot \omega^2 = \frac{1}{2} \times 4.48 \times 10^{-4} \times 3.489^2$$
$$= 0.00273 \text{ J}$$

Calculation Example

If the model to be used has been determined, obtain the threshold rotation time in which the rotary actuator can be used in accordance with the allowable kinetic energy of that model.
Model used   : MSQ50A (Cushion pad)
Allowable kinetic energy: 0.081 J (Refer to the table above.)
Load form   : Refer to the figure below.
Rotating angle   : 90°

$$I = m_1 \cdot \frac{a_1^2}{3} + m_2 \cdot a_2^2 + m_2 \cdot \frac{2r^2}{5}$$

a₁ : 0.12 m
a₂ : 0.15 m
m₁ : 0.1   kg
m₂ : 0.18 kg
r : 0.03 m

(Step 1) Find the moment of inertia.

$$I = \frac{m_1 \cdot a_1^2}{3} + m_2 \cdot a_2^2 + \frac{m_2 \cdot 2r^2}{5}$$
$$= \frac{0.1 \times 0.12^2}{3} + 0.18 \times 0.15^2 + \frac{0.18 \times 2 \times 0.03^2}{5}$$
$$= 4.6 \times 10^{-3} \text{ kg·m}^2$$

(Step 2) Find the rotation time.

$$t \geq \sqrt{\frac{2 \cdot I \cdot \theta^2}{E}} = \sqrt{\frac{2 \times 4.6 \times 10^{-3} \times (\pi/2)^2}{0.081}} = 0.53 \text{ s}$$

It is therefore evident that there will be no problem if it is used with a rotation time of less than 0.53 s. However, according to the table above, the maximum value of rotation time for stable operation is 2 s. Thus, the rotation time should be within the range of $0.53 \leq t \leq 2$.

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● Moment of Inertia and Rotation Time

How to read the graph

Example 1) When there are constraints for the moment of inertia of load and rotation time. From Graphs (3) and (4), to operate at the load moment of inertia 1×10^{-3} kg·m^2 and at the rotation time setting of 0.3 ^{S}/$_{90°}$, the models will be MSQ50A and MSQ20 to 50R.

Example 2) When there are constraints for the moment of inertia of load, but not for rotation time. From Graphs (3) and (4), to operate at the load moment of inertia 1×10^{-2} kg·m^2:
MSQ50A will be 0.8 to 2 ^{S}/$_{90°}$.
MSQ50R will be 0.4 to 0.7 ^{S}/$_{90°}$.

[Remarks] As for the rotation times in Graphs (3) and (4), the lines in the graph indicate the adjustable speed ranges. If the speed is adjusted towards the low-speed end beyond the range of the line, it could cause the actuator to stick.
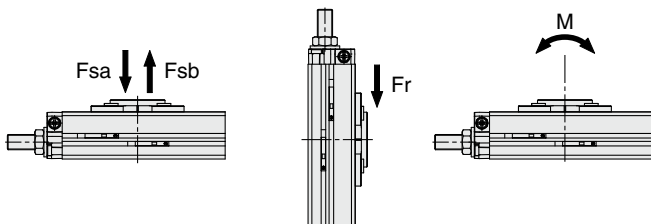
Graph (3) Cushion Pad
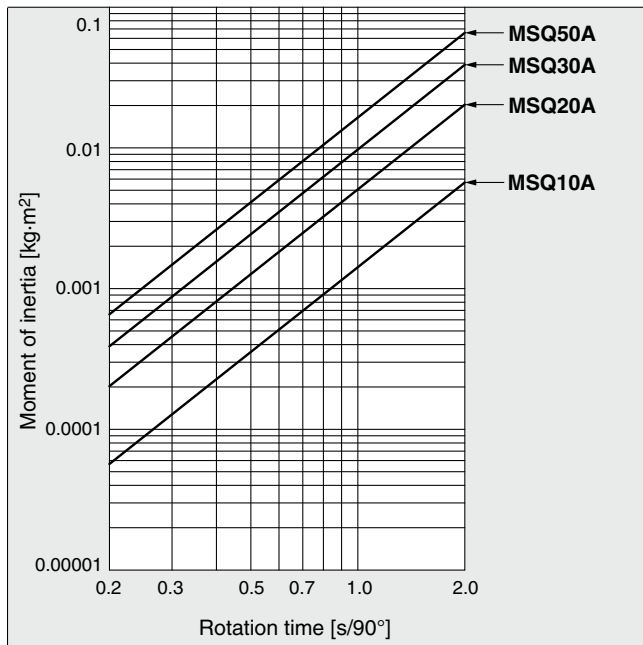
Graph (4) Internal Shock Absorber
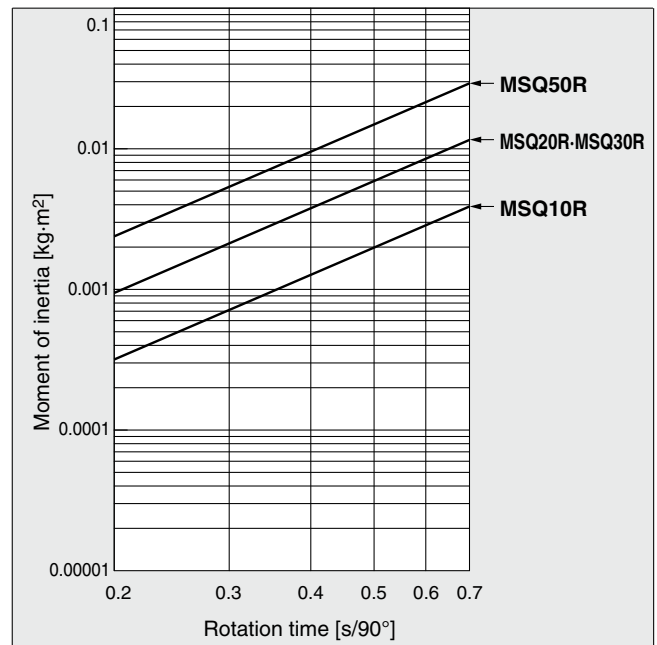
5 Confirmation of Allowable Load

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

Size	Load direction			
	Fsa [N]	Fsb [N]	Fr [N]	M [N·m]
10	78	74	78	2.4
20	137	137	147	4.0
30	363	197	196	5.3
50	451	296	314	9.7

Rotary Actuator Model Selection

6 Calculation of Air Consumption and Required Air Flow Capacity

Air consumption is the volume of air which is expended by the rotary actuator's reciprocal operation inside the actuator and in the piping between the actuator and the switching valve, etc. This is necessary for selection of a compressor and for calculation of its running cost. Required air volume is the air volume necessary to make a rotary actuator operate at a required speed. It requires calculation when selecting the upstream piping diameter from the switching valve and air line equipment.

* For the air consumption calculation graph, refer to Graphs (5) and (6) on page 14.

① Air consumption volume

Formula

$$Q_{CR} = V \times \left(\frac{P + 0.1}{0.1} \right) \times 10^{-3} \quad \cdots \cdots \cdots \cdots \cdots (1)$$

$$Q_{CP} = 2 \times a \times L \times \left(\frac{P}{0.1} \right) \times 10^{-6} \quad \cdots \cdots \cdots (2)$$

$$Q_C = Q_{CR} + Q_{CP} \quad \cdots \cdots \cdots \cdots \cdots \cdots \cdots (3)$$

Q_{CR}	= Amount of air consumption of rotary actuator	[L (ANR)]
Q_{CP}	= Amount of air consumption of tube or piping	[L (ANR)]
V	= Inner volume of the rotary actuator (1 cycle)	[cm³]
P	= Operating pressure	[MPa]
L	= Length of piping	[mm]
a	= Inner sectional area of piping	[mm²]
Q_C	= Amount of air consumption required for one cycle of the rotary actuator	[L (ANR)]

To select a compressor, it is important to select one that has plenty of margin to accommodate the total air volume that is consumed by the pneumatic actuators that are located downstream. The total air consumption volume is affected by the leakage in the tube, the consumption in the drain valves and pilot valves, as well as by the reduction in air volume due to reduced temperature.

Formula

$$Q_{C2} = Q_C \times n \times \text{No. of actuators} \times \text{Safety factor} \cdots (4)$$

Q_{C2}	= Amount of air from a compressor	[L/min (ANR)]
n	= Actuator reciprocations per minute	

Safety factor: From 1.5

② Required air flow capacity

Formula

$$Q_r = \left\{ \frac{V}{2} \times \left(\frac{P + 0.1}{0.1} \right) \times 10^{-3} + a \times L \times \left(\frac{P}{0.1} \right) \times 10^{-6} \right\} \times \frac{60}{t} \cdots (5)$$

Q_r	= Consumed air volume for rotary actuator	[L/min (ANR)]
V	= Inner volume of the rotary actuator (1 cycle)	[cm³]
P	= Operating pressure	[MPa]
L	= Length of piping	[mm]
a	= Inner sectional area of piping	[mm²]
t	= Total time for rotation	[S]

Internal Cross Section of Tubing and Steel Tube

Nominal	O.D. [mm]	I.D. [mm]	Internal cross section a [mm²]
T☐ 0425	4	2.5	4.9
T☐ 0604	6	4	12.6
TU 0805	8	5	19.6
T☐ 0806	8	6	28.3

SMC

● **Air Consumption Calculation Graph**

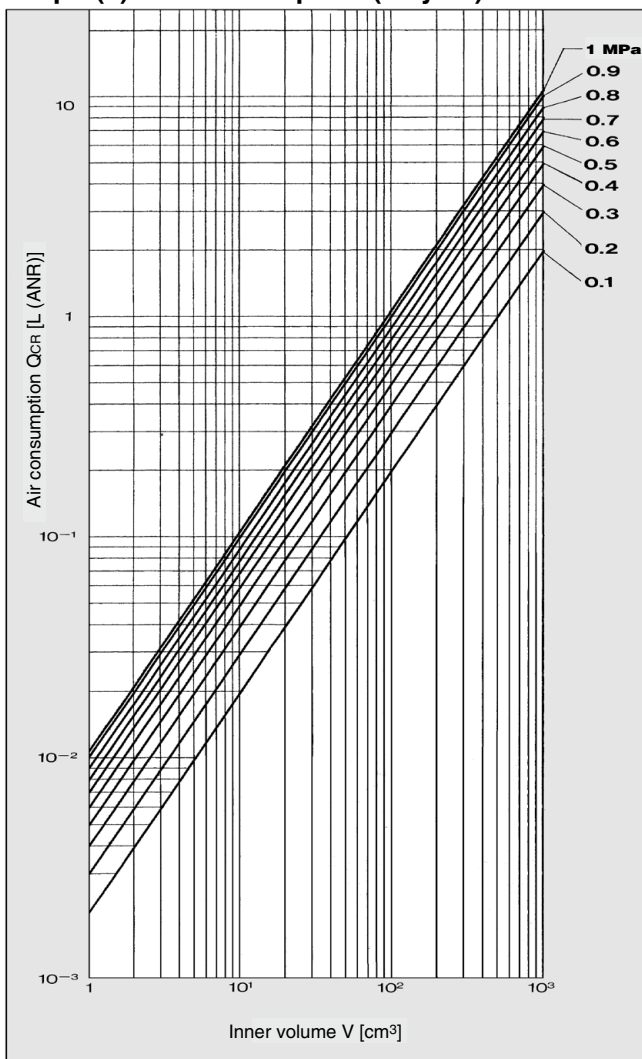| Step 1 | Using Graph (5), air consumption volume of the rotary actuator is obtained. From the point of intersection between the inner volume and the operating pressure (slanted line) and then looking to the side (left side) direction, the air consumption volume for 1 cycle operation of a rotary actuator is obtained. |

| Step 2 | **Using Graph (6), the air consumption volume for 1 cycle operation of tubing or steel tube is obtained.**
(1) First determine the point of intersection between the operating pressure (slanted line) and the piping length, and then go up the vertical line perpendicularly from there.
(2) From the point of intersection of an operating piping tube inside diameter (slanted line), then look to the side (left or right) to obtain the required air consumption volume for piping. |

| Step 3 | **Total air consumption volume per minute is obtained as follows:**
(Air consumption volume of a rotary actuator [unit: L (ANR)] + Tubing or steel tube's air consumption volume) x Cycle times per minute x Number of rotary actuators = Total air consumption volume |

Inner Volume   1 cycle [cm³]

Size	Rotating angle
	190°
10	15.6
20	30.8
30	47.4
50	76.0

Example) When 10 units of an MSQ30A are used at a pressure of 0.5 MPa, what is the air consumption of their 5 cycles per minute? (Piping between the actuator and switching valve is a tube with an inside diameter of 6 mm and length of 2 m.)
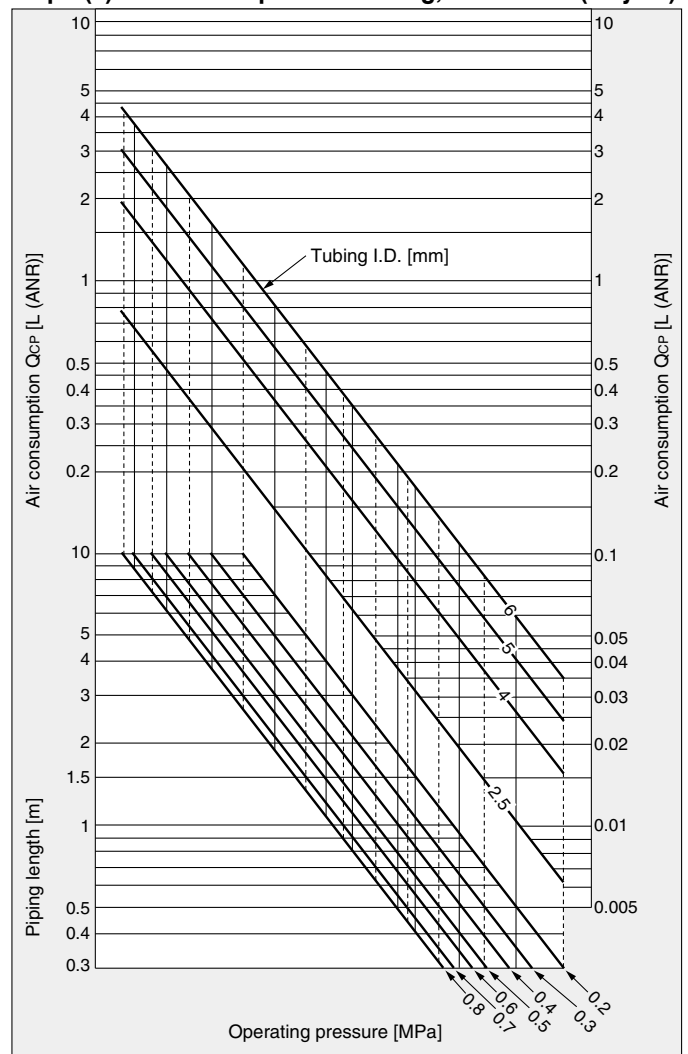
1. Operating pressure 0.5 MPa → Inner volume of MSQ30A 47.4 cm³
   → Air consumption volume 0.25 L (ANR)
2. Operating pressure 0.5 MPa→ Piping length 2 m → Inside diameter 6 mm → Air consumption volume 0.56 L (ANR)
3. Total air consumption volume = (0.25 + 0.56) x 5 x 10 = 40.5 L/min (ANR)

Graph (5) Air Consumption (1 cycle)

Graph (6) Air Consumption of Tubing, Steel Tube (1 cycle)

∗ "Piping length" indicates the length of steel tube or tubing which connects rotary actuator and switching valves (solenoid valves, etc.).
∗ Refer to page 13 for the size of tubing and steel tube (inside diameter and outside diameter).

Rotary Table/Rack & Pinion Type
MSQ Series
Size: 10, 20, 30, 50

How to Order

Basic type   MSQ 10 A – M9BW ☐ ☐ – ☐

Size
10	
20	
30	
50	

A	Cushion pad	
R	Internal shock absorber	

Auto switch

Nil	Without auto switch (Built-in magnet)

∗ For applicable auto switches, refer to the table below.

Made to order
For details, refer to the next page.

Port type

End port type		Size
Nil	M5	10, 20
Nil	Rc1/8	
-XF	G1/8	30, 50
-XN	NPT1/8	

∗ Side ports are all M5.
  For details, refer to the specifications on page 16.

Number of auto switches

Nil	2
S	1
n	n

Applicable Auto Switches/Refer to the **Web Catalog** for further information on auto switches.

Type	Special function	Electrical entry	Indicator light	Wiring (Output)	Load voltage DC	Load voltage AC	Auto switch model Perpendicular	Auto switch model In-line	Lead wire length [m] 0.5 (Nil)	1 (M)	3 (L)	5 (Z)	Pre-wired connector	Applicable load
Solid state auto switch	—	Grommet	Yes	3-wire (NPN)	5 V, 12 V	—	M9NV	M9N	●	●	●	○	○	IC circuit	Relay, PLC
				3-wire (PNP)	5 V, 12 V		M9PV	M9P	●	●	●	○	○	IC circuit	
				2-wire	12 V		M9BV	M9B	●	●	●	○	○	—	
	Diagnostic indication (2-color indicator)			3-wire (NPN)	5 V, 12 V		M9NWV	M9NW	●	●	●	○	○	IC circuit	
				3-wire (PNP) 24 V	5 V, 12 V		M9PWV	M9PW	●	●	●	○	○	IC circuit	
				2-wire	12 V		M9BWV	M9BW	●	●	●	○	○	—	
	Water resistant (2-color indicator)			3-wire (NPN)	5 V, 12 V		M9NAV∗1	M9NA∗1	○	○	●	○	○	IC circuit	
				3-wire (PNP)	5 V, 12 V		M9PAV∗1	M9PA∗1	○	○	●	○	○	IC circuit	
				2-wire	12 V		M9BAV∗1	M9BA∗1	○	○	●	○	○	—	
Reed auto switch	—	Grommet	Yes	3-wire (NPN equiv.)	—	5 V	A96V	A96	●	—	●	—	—	IC circuit	—
			No	2-wire	24 V	12 V	100 V	A93V∗2	A93	●	●	●	●	—	Relay, PLC
						100 V or less	A90V	A90	●	—	●	—	—	IC circuit	

∗1 Although it is possible to mount water-resistant type auto switches, note that the rotary actuator itself is not of water-resistant construction.
∗2 The 1 m lead wire is only applicable to the D-A93.

∗ Lead wire length symbols: 0.5 m ········· Nil   (Example) M9NW
                                      1 m ········· M   (Example) M9NWM
                                      3 m ········· L   (Example) M9NWL
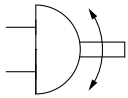   5 m ········· Z   (Example) M9NWZ

∗ Solid state auto switches marked with "○" are produced upon receipt of order.

∗ Auto switches are shipped together with the product but do not come assembled.

SMC

Symbol

Symbol	Specifications
A	With interchangeable table and plate
B	With interchangeable table
C	With interchangeable plate

· Auto Switch Proper Mounting Position
 (at Rotation End Detection)

Specifications

Size		10	20	30	50
Fluid		Air (Non-lube)			
Max. operating pressure	Cushion pad	1 MPa			
	Internal shock absorber	0.6 MPa*1			
Min. operating pressure		0.1 MPa			
Ambient and fluid temperatures		0 to 60°C (No freezing)			
Cushion	Cushion pad	Rubber bumper			
	Internal shock absorber	Shock absorber			
	Shock absorber model	RBA0805-X692	RBA1006-X692		RBA1411-X692
Angle adjustment range*2		0 to 190°*3			
Max. rotating angle*2		190°			
Cylinder bore size		ø13	ø16	ø20	ø22
Port size	End port	M5 x 0.8		Rc1/8, G1/8, NPT1/8	
	Side port	M5 x 0.8			

∗1 The maximum operating pressure of the actuator is restricted by the maximum allowable thrust of the shock absorber.
∗2 For details, refer to page 17.
∗3 Be careful if the rotating angle of a type with internal shock absorber is set below the value in the table below, the piston stroke will be smaller than the shock absorber's effective stroke, resulting in decreased energy absorption ability.

Size	10	20	30	50
Minimum rotating angle that will not allow decrease of energy absorption ability	40°	35°	35°	47°
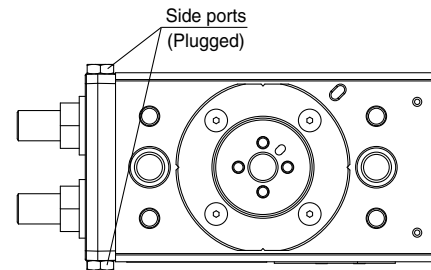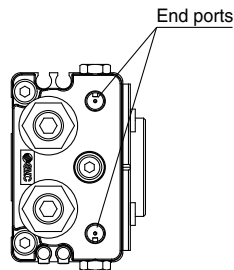
End ports

Side ports (Plugged)

Allowable Kinetic Energy and Rotation Time Adjustment Range

Size	Allowable kinetic energy [J]*1		Adjustable range of rotation time safe in operation [s/90°]	
	Cushion pad	Internal shock absorber	Cushion pad	Internal shock absorber*2
10	0.007	0.039	0.2 to 2.0	0.2 to 0.7
20	0.025	0.116		
30	0.048	0.116		
50	0.081	0.294		

∗1 If operated where the kinetic energy exceeds the allowable value, this may cause damage to the internal parts and result in product failure. Please pay special attention to the kinetic energy levels when designing and during operation to avoid exceeding the allowable limit.
∗2 When the rotation time of the type with an internal shock absorber is set longer than the time shown in the table above, energy absorption of the shock absorber greatly decreases.

Weight

[g]

| Size		10	20	30	50
Basic type	Cushion pad	375	680	930	1500
	Internal shock absorber	440	795	1130	1810

∗ Values above do not include auto switch weight.
∗ For made-to-order options, add the weight in the table below to the weight of the base model.

[g]

| Size	10	20	30	50
With interchangeable table and plate	70	160	120	220
With interchangeable table	30	60	80	130
With interchangeable plate	40	100	40	90

Rotation Direction and Rotating Angle

· The rotary table turns in the counterclockwise direction where the A port is pressurized, and in the clockwise direction when the B port is pressurized. (Please note that the rotation direction is different from the existing MSQ.)
· By adjusting the adjustment bolt, the rotation end can be set within the ranges shown in the drawing.
· The rotating angle can also be set on a type with internal shock absorber.
· Refer to page 24 for the tightening torques for setting the rotating angle.
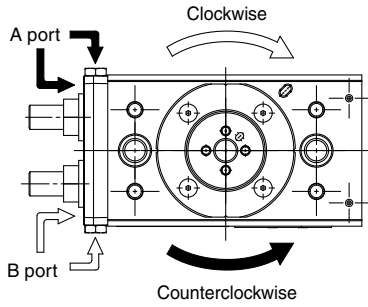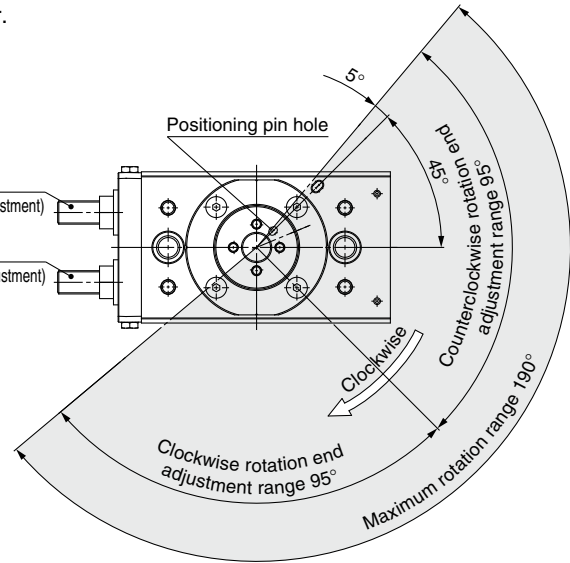
**Rotation Direction and Rotating Angle
(Cushion pad, Internal shock absorber)**

Size	Adjustment angle per rotation of adjustment bolt
10	8.0°
20	5.7°
30	5.7°
50	6.4°

Rotating Angle Range Examples

· Various rotation ranges are possible as shown in the drawings below using adjustment bolts A and B.
  (The drawings also show the rotation ranges of the positioning pin hole.)
· The rotating angle can also be set on a type with internal shock absorber.

190° (Maximum) Rotation

180° Rotation

90° Rotation

90° Rotation

90° Rotation

SMC
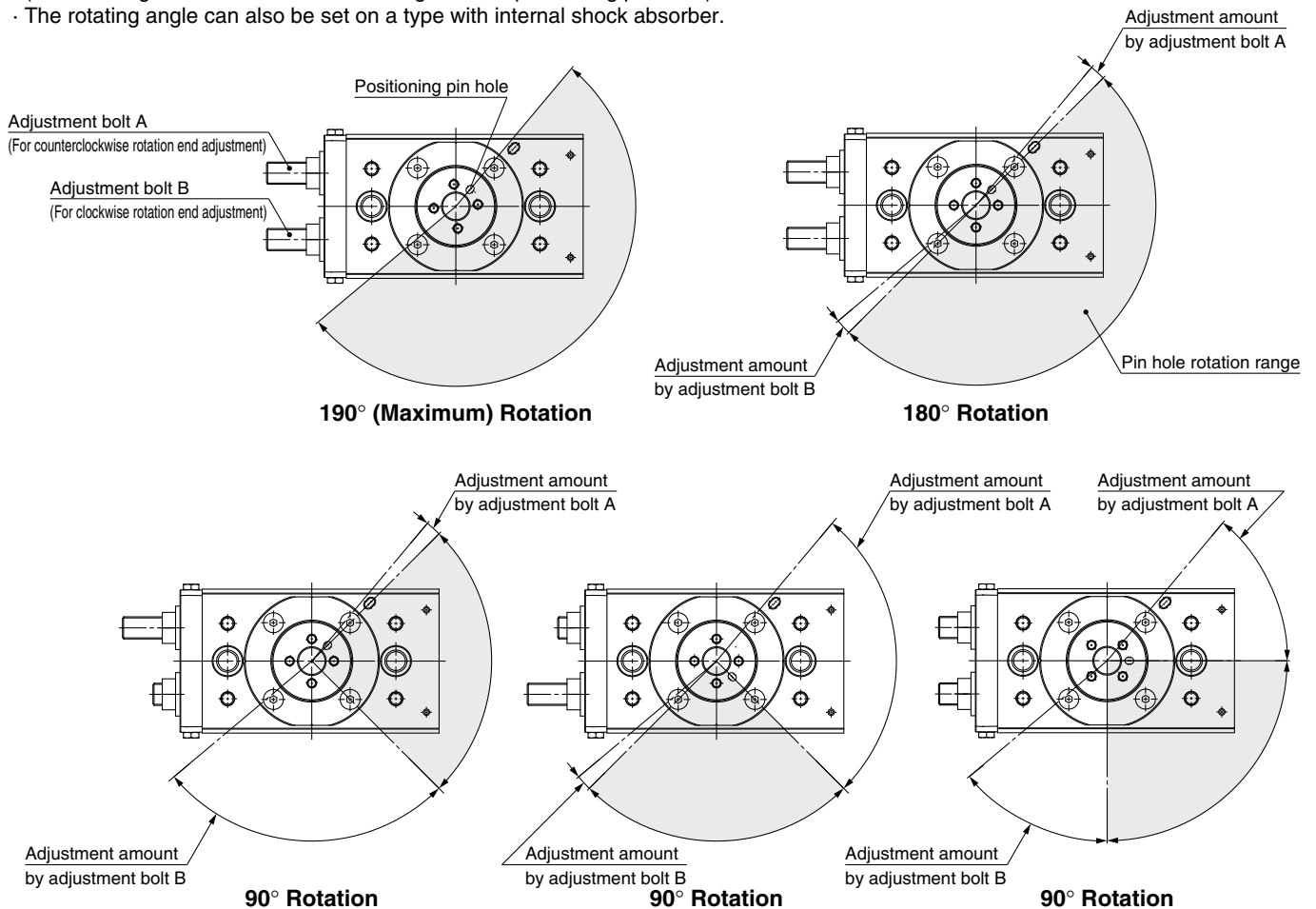
Table Displacement (Reference values)

· The following graphs show the displacement at point A, which is 100 mm apart from the center of rotation, where the load is applied.

Without interchangeable table

With interchangeable table

Interchangeable table
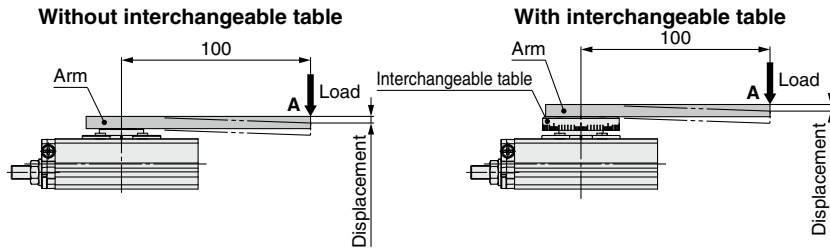
Size 10
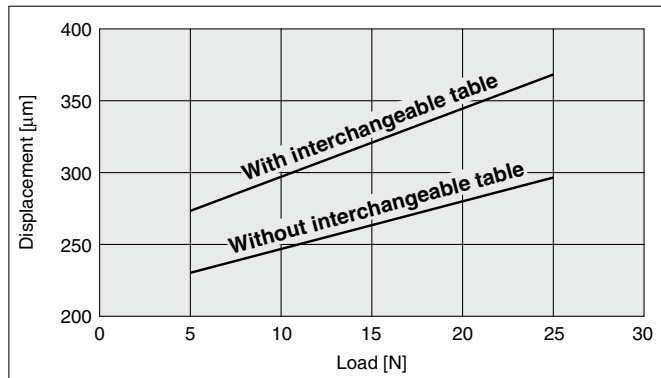
Size 20
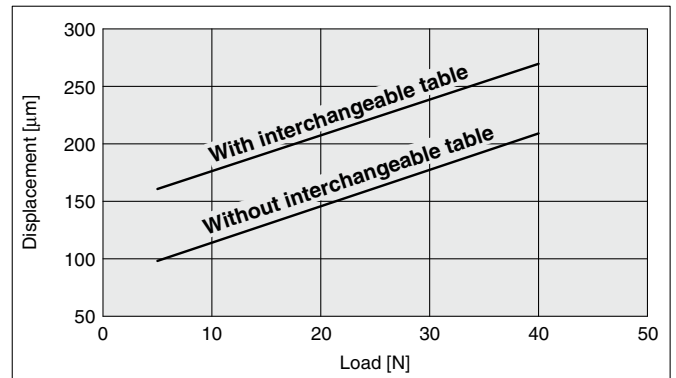
Size 30
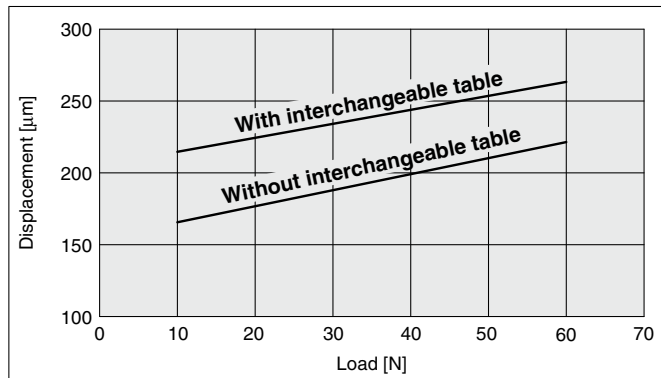
Size 50
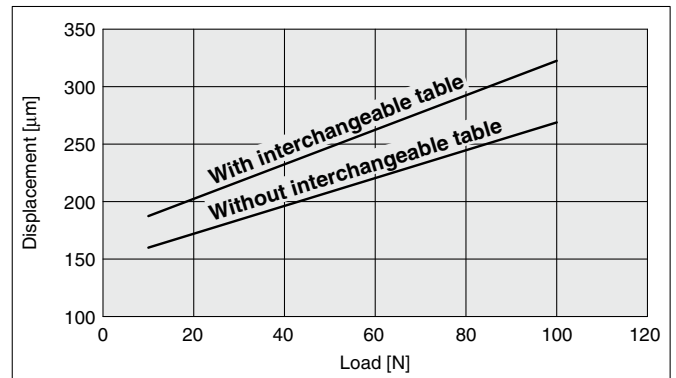
Working Principle
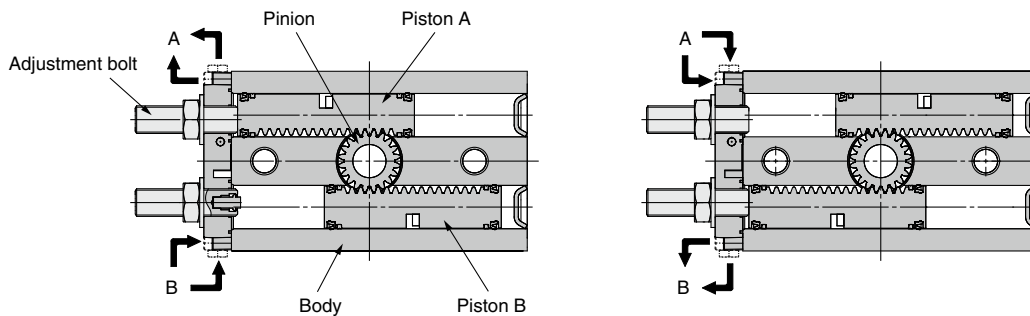
1. It consists of a rack that slides in 2 parallel cylinders, 2 pistons that are integrated with the rack, and a pinion.
2. The air that is supplied from port B pushes the left side of piston A; at the same time, it passes through the air passage of the body, pushing the right side of piston B, thus creating in the shaft an amount of torque that is equivalent to 2 pistons.
3. The air in the exhaust chamber discharges via port A and rotates clockwise.
4. The pinion stops when piston B comes in contact with the adjustment bolt and stops.
5. Similarly, when air is supplied from port A, it rotates counterclockwise.

MSQ *Series*

Construction

MSQ☐R
(With internal shock absorber)
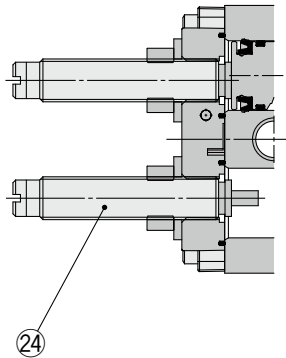
MSQ☐A
(Cushion pad)
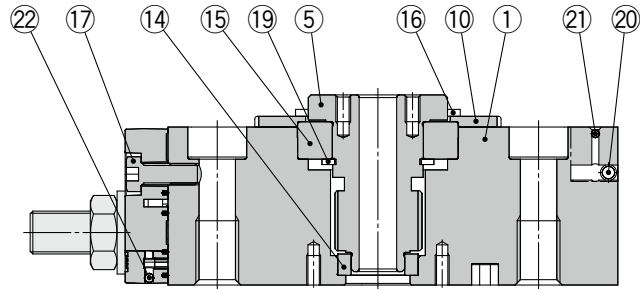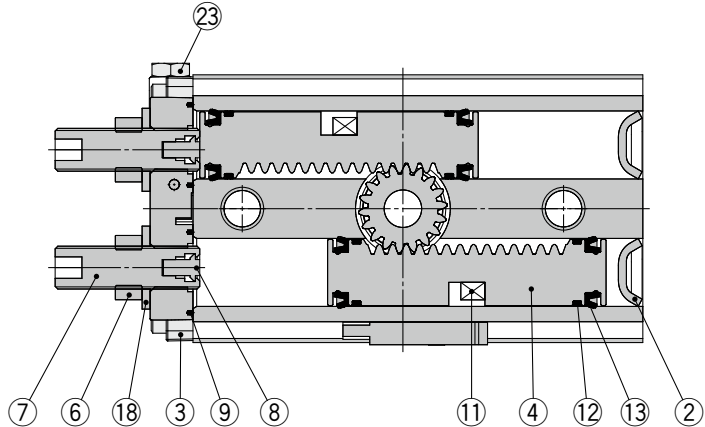
Component Parts

No.	Description		Material	Note
1	**Body**		Aluminum alloy	Anodized
2	**Head cap**		Aluminum alloy	Anodized
3	**End cover**		Aluminum alloy	Painted
4	**Piston**	With cushion pad	Aluminum alloy	Anodized
		With internal shock absorber	Stainless steel	
5	**Table pinion**		Chrome molybdenum steel	
6	**Compact hexagon nut**		Steel wire	Chromated
7	**Adjustment bolt**		Chrome molybdenum steel	Chromated
8	**Cushion pad**		Rubber material	
9	**Gasket**		NBR	
10	**Bearing retainer**		Aluminum alloy	Anodized
11	**Magnet**		—	
12	**Wear ring**		Resin	
13	**Piston seal**		NBR	
14	**Bearing**		Bearing steel	
15	**Bearing**		Bearing steel	
16	**Hexagon socket super thin head cap screw**		Steel wire	Chromated
17	**Hexagon socket thin head cap screw**		Steel wire	Chromated
18	**Seal washer**		Steel wire + NBR	
19	**Round type S retaining ring**		Steel wire	Phosphate coated
20	**Steel ball**		Stainless steel	
21	**Steel ball**		Stainless steel	
22	**Steel ball**		Stainless steel	
23	**M5 plug assembly**		Steel wire	Nickel plating
24	**Shock absorber**		—	

Replacement Parts

Size	Part no.	Contents
		Description (Qty.)
10	P891010-5	⑨ Gasket (1)
20	P891020-5	⑫ Wear ring (4)
30	P891030-5	⑬ Piston seal (4)
50	P891040-5	⑱ Seal washer (2)

A grease pack (10 g) is included. Order with the following part number when only the grease pack is needed.
Grease pack part number: GR-L-010 (10 g)

SMC

Dimensions: Sizes 10, 20, 30, 50

Basic type/MSQ□^A_R
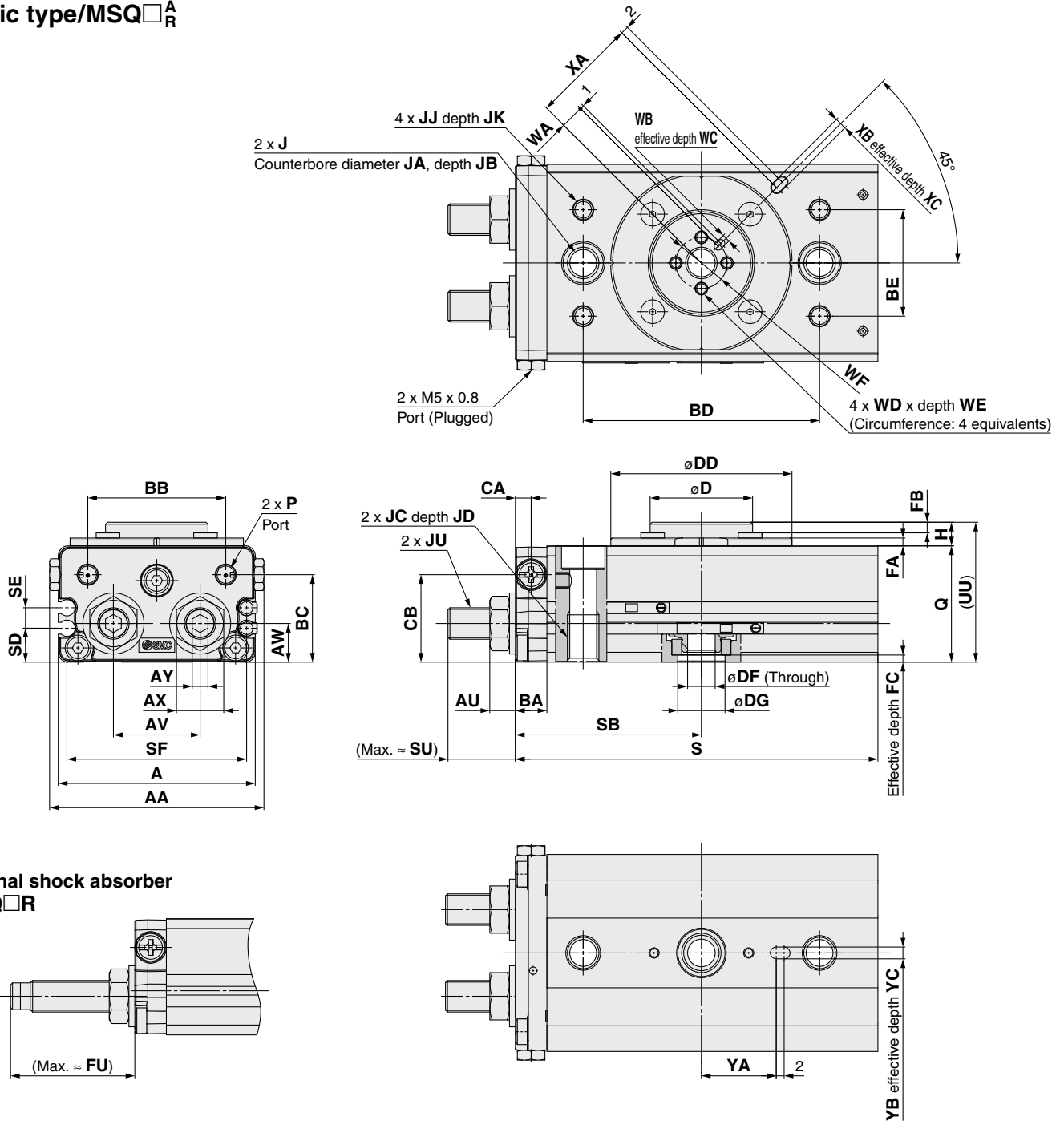
Internal shock absorber MSQ□R

[mm]
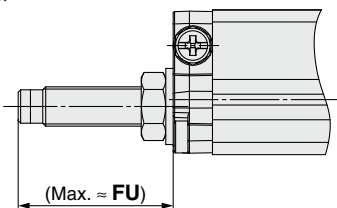
Size	AA	A	AU	AV	AW	AX	AY	BA	BB	BC	BD	BE	CA	CB	D	DD	DF	DG	FA	FB	FC	FU	H	J	JA	JB	JC	JD
10	54.4	50	6.6	22	9.8	12	4	8	35	22.2	60	27	4	22.2	26h9	46h9	7	12H9	2	2.7	1.3	32	6	6.8	11	6	M8 x 1.25	12
20	69.4	65	7.6	30	11.1	14	5	10	50.2	23.6	76	34	5	23.6	36h9	61h9	12	20H9	4	2.5	1.3	36	8	8.6	14	8.5	M10 x 1.5	15
30	74.4	70	7.6	36.5	13.8	14	5	12	49	30	84	37	6	31	41h9	67h9	13	20H9	4	2.5	2.3	34	8	8.6	14	8.5	M10 x 1.5	15
50	84.4	80	10	42	17.5	19	6	12	62	35	100	50	6	35	46h9	77h9	14	21H9	4.5	2.5	2.7	54	8.5	10.5	18	10.5	M12 x 1.75	18

[mm]

Size	JJ	JK	JU	P	Q	S	SB	SD	SE	SF	SU*1	UU	WA	WB	WC	WD	WE	WF	XA	XB	XC	YA	YB	YC
10	M5 x 0.8	6	M8 x 1	M5 x 0.8	29.5	92	47.2	8.6	5.2	45.6	18	35.5	6	2H9	2.5	M3 x 0.5	5	13	27	3H9	3.5	19	3H9	3.5
20	M6 x 1	6	M10 x 1	M5 x 0.8	31	117	59.9	10.1	5.2	59.4	26	39	9.5	3H9	3.5	M4 x 0.7	7	20	36	4H9	4.5	24	4H9	4.5
30	M6 x 1	6	M10 x 1	Rc1/8*2	38	127	65.3	10.5	14	65	24	46	10.5	4H9	3.5	M5 x 0.8	9	22	39	4H9	4.5	28	4H9	4.5
50	M8 x 1.25	8	M14 x 1.5	Rc1/8*2	43	152	77.7	11.3	16	75	34	51.5	11.5	4H9	3.5	M6 x 1	10	24	45	5H9	5.5	33	5H9	5.5

*1 SU dimension is not the dimension at the time of shipment, since its dimension is for adjustment parts.
*2 In addition to Rc1/8, G1/8 and NPT1/8 are also available.

Auto Switch Mounting

Auto Switch Proper Mounting Position (at Rotation End Detection)

Adjustment bolt

Adjustment bolt

Magnet

Operating range at proper mounting position (Lm/2)

Most sensitive position

Operating range of single auto switch Lm
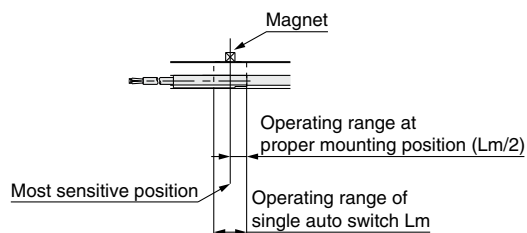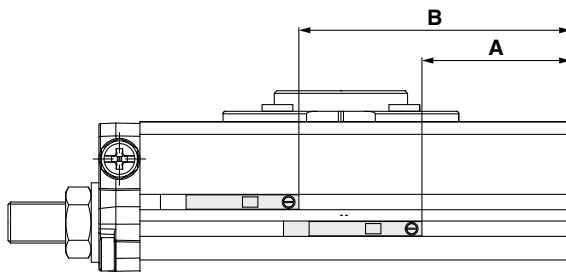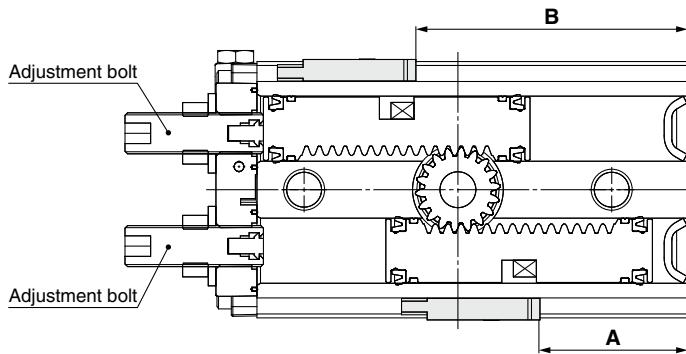
[mm]

Size	Rotating angle	Solid state auto switch				Reed auto switch			
		D-M9☐(V), D-M9☐W(V)				D-A9☐, D-A9☐V			
		A	B	Operating angle θ m	Hysteresis angle	A	B	Operating angle θ m	Hysteresis angle
10	180°	26 to 29	49 to 51	27°	3°	22 to 25	45 to 47	50°	4°
20	180°	34 to 37	66 to 68	21°	2°	30 to 33	62 to 64	42°	4°
30	180°	39 to 41	70 to 73	24°	2°	35 to 37	66 to 69	44°	4°
50	180°	46 to 48	88 to 91	19°	2°	42 to 44	84 to 87	31°	3°

Operating angle θ m: Value of the operating range Lm of a single auto switch converted to an axial rotating angle
Hysteresis angle : Value of auto switch hysteresis converted to an angle
∗ · Since the figures in the table above are provided as a guideline only, they cannot be guaranteed. Adjust the auto switch after confirming the operating conditions in the actual setting.
 · The values in the table above are the positions when the adjustment bolts (shock absorbers) are tightened in the same amount and adjusted to 180°.
 · For the tightening torque of the set screw of the auto switch, refer to the operation manual of each auto switch.

SMC

Prior to Use
Auto Switch Connections and Examples

Sink Input Specifications

3-wire, NPN

Auto switch — Brown — Input
Black
Blue — COM
(PLC internal circuit)

2-wire

Auto switch — Brown — Input
Blue — COM
(PLC internal circuit)
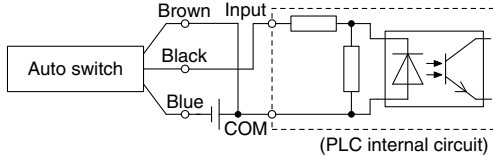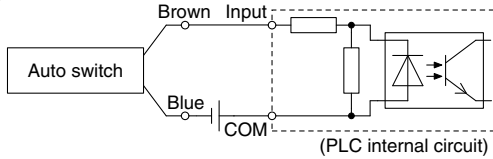
Source Input Specifications

3-wire, PNP

Auto switch — Brown — Input
Black
Blue
COM
(PLC internal circuit)

2-wire

Auto switch — Brown — COM
Blue
Input
(PLC internal circuit)
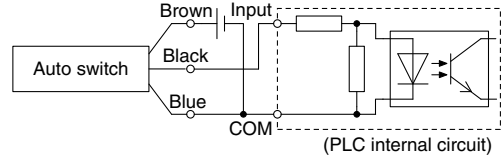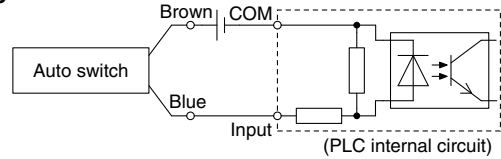
Connect according to the applicable PLC input specifications, as the connection method will vary depending on the PLC input specifications.

Examples of AND (Series) and OR (Parallel) Connections

∗ When using solid state auto switches, ensure the application is set up so the signals for the first 50 ms are invalid. Depending on the operating environment, the product may not operate properly.

3-wire AND connection for NPN output
(Using relays)
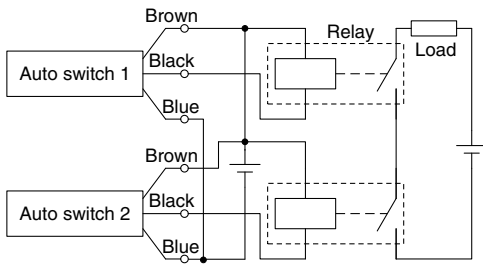
Auto switch 1 — Brown / Black / Blue — Relay — Load
Auto switch 2 — Brown / Black / Blue

(Performed with auto switches only)

Auto switch 1 — Brown / Black Load / Blue
Auto switch 2 — Brown / Black / Blue

3-wire OR connection for NPN output

Auto switch 1 — Brown / Black Load / Blue
Auto switch 2 — Brown / Black / Blue
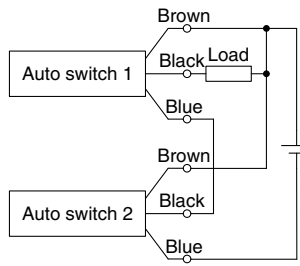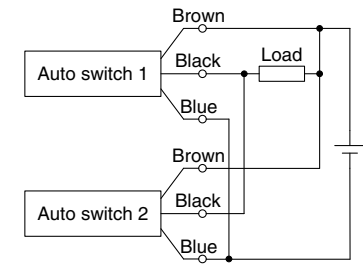
3-wire AND connection for PNP output
(Using relays)
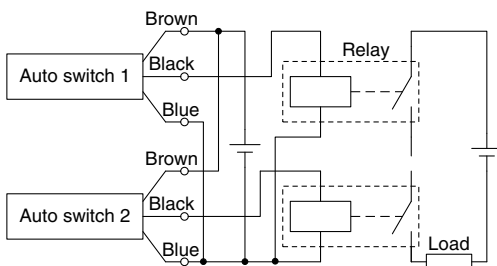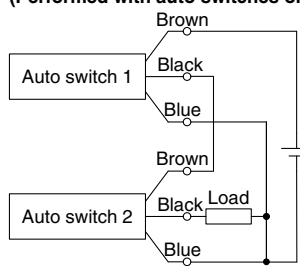
Auto switch 1 — Brown / Black / Blue — Relay
Auto switch 2 — Brown / Black / Blue — Load

(Performed with auto switches only)

Auto switch 1 — Brown / Black / Blue
Auto switch 2 — Brown / Black Load / Blue

3-wire OR connection for PNP output

Auto switch 1 — Brown / Black / Blue
Auto switch 2 — Brown / Black Load / Blue

2-wire AND connection

Auto switch 1 — Brown — Load / Blue
Auto switch 2 — Brown / Blue
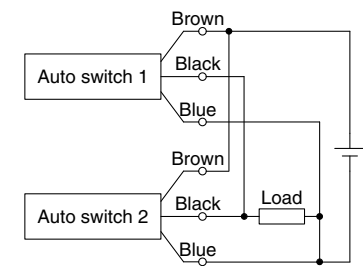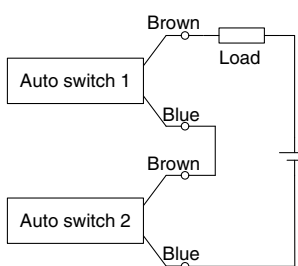
When two auto switches are connected in series, a load may malfunction because the load voltage will decline when in the ON state.
The indicator lights will light up when both of the auto switches are in the ON state. Auto switches with a load voltage less than 20 V cannot be used. Please contact SMC if using AND connection for a heat-resistant solid state auto switch or a trimmer switch.

Example) Load voltage at ON
Power supply voltage: 24 VDC
Internal voltage drop: 4 V
Load voltage at ON = Power supply voltage –
  Internal voltage drop x 2 pcs.
  = 24 V – 4 V x 2 pcs.
  = 16 V

2-wire OR connection

Auto switch 1 — Brown — Load / Blue
Auto switch 2 — Brown / Blue
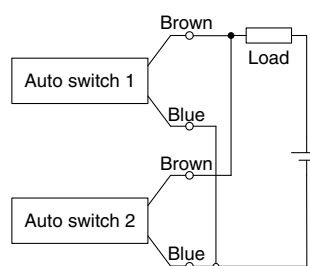
(Solid state)
When two auto switches are connected in parallel, malfunction may occur because the load voltage will increase when in the OFF state.

(Reed)
Because there is no current leakage, the load voltage will not increase when turned OFF. However, depending on the number of auto switches in the ON state, the indicator lights may sometimes grow dim or not light up, due to the dispersion and reduction of the current flowing to the auto switches.

Example) Load voltage at OFF
Leakage current: 1 mA
Load impedance: 3 kΩ
Load voltage at OFF = Leakage current x 2 pcs. x
  Load impedance
  = 1 mA x 2 pcs. x 3 kΩ
  = 6 V

SMC

22

Made to Order

Please contact SMC for detailed dimensions, specifications, and delivery times.

Made to Order

1 With Interchangeable Table and Plate

-A, -B, -C

How to Order

| Standard model no. | – | **A** |

● **Made to order**

A	With interchangeable table and plate
B	With interchangeable table
C	With interchangeable plate

∗ Interchangeable tables and plates can be ordered separately. For details, refer to the tables below.

∗ The interchangeable table and plate are assembled before shipment.

∗ Mounting diagram of the interchangeable table and plate Dimensions other than those shown below are the same as those of the basic type. Refer to page 20.

B With interchangeable table

Hexagon socket head cap screw
Interchangeable table
Parallel pin (Built into the interchangeable table)

A With interchangeable table and plate

Interchangeable table

Interchangeable plate

C With interchangeable plate

Interchangeable plate
Cross recessed head machine screw for precision instruments

Dimensions

8 x **WH** depth **WI**
(Circumference: 8 equivalents)

XE effective depth XF

XD

2

22.5

WG

øDD
øDI
øDH
Effective depth 1.7

Interchangeable table

FD
HA
HB
UV

BF
BG
SG

AB

Interchangeable plate

SA

(S)

[mm]

Size	AB	SG	BF	BG	DD	DH	DI	FD	HA	HB
10	49	14.3	26.7	26.7	46h9	20H9	45h9	8	13	4.5
20	64	17.1	29.6	29.6	61h9	28H9	60h9	10	17	6
30	69	15.8	32	33	67h9	32H9	65h9	10	17	2
50	79	20.5	38	38	77h9	35H9	75h9	12.5	20	3

[mm]

Size	S	SA	UV	WG	WH	WI	XD	XE	XF
10	92	83	47	32	M5 x 0.8	8	15	3H9	3.5
20	117	106	54	43	M6 x 1	10	20.5	4H9	4.5
30	127	114	57	48	M6 x 1	10	23	4H9	4.5
50	152	139	66	55	M8 x 1.25	12.5	26.5	5H9	5.5

Part No. of Interchangeable Parts

With Interchangeable Table and Plate

Size	Part no.	Contents
		Description (Qty.)
10	P891010-50	· Interchangeable table (1)
20	P891020-50	· Parallel pin (1)
30	P891030-50	· Hexagon socket head cap screw (4) · Interchangeable plate (1)
50	P891040-50	· Cross recessed head machine screw for precision instruments (2)

With Interchangeable Plate

Size	Part no.	Contents
		Description (Qty.)
10	P891010-52	· Interchangeable plate (1)
20	P891020-52	· Cross recessed head machine screw for precision instruments (2)
30	P891030-52	
50	P891040-52	

With Interchangeable Table

Size	Part no.	Contents
		Description (Qty.)
10	P891010-51	· Interchangeable table (1)
20	P891020-51	· Parallel pin (1)
30	P891030-51	· Hexagon socket head cap screw (4)
50	P891040-51	

∗ Cushion pad type products (MSQ☐A) in which the piston material has been changed to stainless steel the same as the existing product are also available separately.

∗ Refer to page 24 for the tightening torque of the interchangeable parts.

SMC

MSQ *Series*
Specific Product Precautions 1

Be sure to read this before handling the products. Refer to the back cover for safety instructions. For rotary actuator and auto switch precautions, refer to the "Handling Precautions for SMC Products" and the "Operation Manual" on the SMC website.

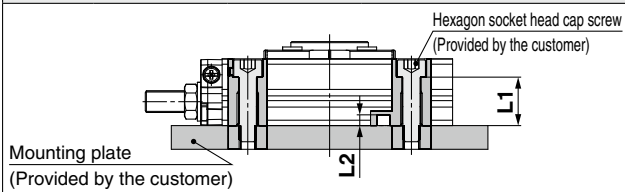## Speed Adjustment

⚠Warning

1. To make a speed adjustment, gradually adjust starting from the low speed end.

If the speed adjustment is performed from the high speed end, it could damage the product. As a result, it could pose a hazard to humans or damage the machinery and equipment.

⚠Caution

1. When operating at high speed with a large load weight, a large amount of energy is applied to the actuator and can cause damage. Calculate a correct operation time by referencing the model selection procedure on page 4.

2. Do not machine the fixed orifice of the port to enlarge its size. If the fixed orifice size is enlarged, the actuator operating speed and impact force will increase and cause damage.

Lubrication

⚠Caution

1. Use the product without lubrication.

This product is lubricated with grease at the factory, and further lubrication will result in a failure to meet the product's specifications.

Effective Torque

⚠Caution

1. The effective torque at the end of the rotation is half the effective torque generated during rotation. This is because one of the pistons of the double rack mechanism determines the angle by coming into contact with an adjustment bolt or a shock absorber at the rotation end.

Rotating Angle Adjustment

⚠Caution

1. As a standard feature, the rotary table is equipped with an angle adjustment mechanism (adjustment bolt or shock absorber) that can be used to adjust the rotating angle. Refer to page 17 for the rotation direction, rotating angle, and rotating angle range examples.

2. It might be difficult to adjust the angle using a tool due to the installation condition of the product.
If a special tool is required, refer to the operation manual.
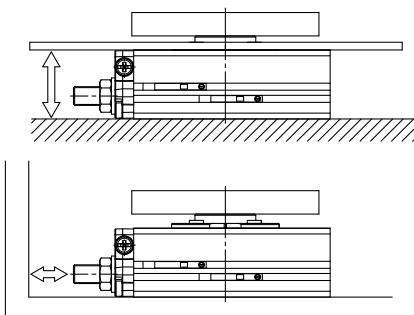
Tightening Torque

1. Tighten the adjustment bolt or the hexagon nut for setting the shock absorber with the tightening torque shown in the table below.

Hexagon nut for setting the adjustment bolt or shock absorber

Adjustment bolt or shock absorber
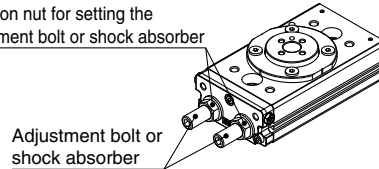
Size	Proper tightening torque [N·m]
10	1.00 to 1.67
20	1.88 to 3.14
30	
50	6.48 to 10.8

2. Tighten the screw for setting the interchangeable table and plate with the tightening torque shown in the table below.

Interchangeable table

Hexagon socket head cap screw

Interchangeable plate

Cross recessed head machine screw for precision instruments
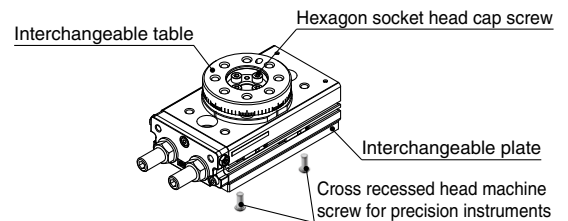
Size	Proper tightening torque [N·m]	
	Screw for setting interchangeable table	Screw for setting interchangeable plate
10	1.1 to 3.1	
20	2.9 to 4.9	
30	4.9 to 6.9	0.4 to 0.5
50	7.4 to 9.8	

∗ Refer to the operation manual for assembly procedures.

Mounting

⚠Caution

1. Keep away from objects which are influenced by magnets.

Since this product has a built-in magnet, do not allow close contact with magnetic disks, cards, or tapes. Data may be erased.

Magnet sensing area
(Same for the opposite side)
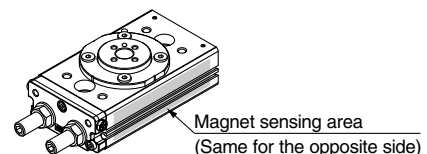
2. When using the center hole for piping, take care that the tube O.D., auto switch lead wire, etc., do not contact the mounting plate.

Piping, wiring

Center hole

Mounting plate
(Provided by the customer)
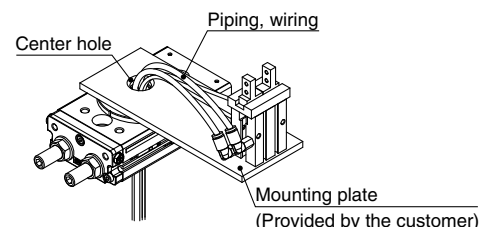
MSQ Series
Specific Product Precautions 2

Be sure to read this before handling the products. Refer to the back cover for safety instructions. For rotary actuator and auto switch precautions, refer to the "Handling Precautions for SMC Products" and the "Operation Manual" on the SMC website.

Mounting

⚠Caution

3. When mounting the body, use screws of the appropriate length.

● **Basic type**

● **With interchangeable plate**

Interchangeable plate

1. Top mounting (Through hole)

Hexagon socket head cap screw (Provided by the customer)

Mounting plate (Provided by the customer)

Size	L1		L2	
	Screw	Length [mm]	Pin [mm]	Effective depth [mm]
10	M6 x 1	23.5	ø3	3.5
20	M8 x 1.25	22.5	ø4	4.5
30	M8 x 1.25	29.5	ø4	4.5
50	M10 x 1.5	32.5	ø5	5.5

2. Bottom mounting (Body tapped)

Mounting plate (Provided by the customer)

Hexagon socket head cap screw (Provided by the customer)
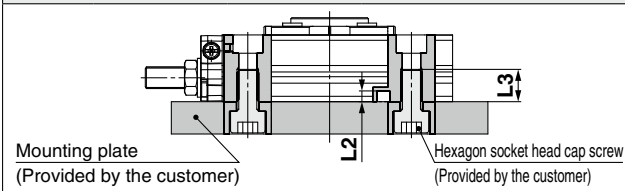
Size	L2		L3	
	Pin [mm]	Effective depth [mm]	Screw	Max. screw-in depth [mm]
10	ø3	3.5	M8 x 1.25	12
20	ø4	4.5	M10 x 1.5	15
30	ø4	4.5	M10 x 1.5	15
50	ø5	5.5	M12 x 1.75	18

3. Top mounting (Body tapped)

Hexagon socket thin head cap screw (Provided by the customer)

Mounting plate (Provided by the customer)
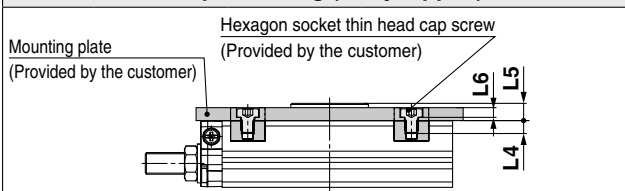
Size	L4		L5	L6
	Screw	Max. screw-in depth [mm]	Height [mm]	Counterbore depth [mm]
10	M5 x 0.8	6	6	3.9
20	M6 x 1	6	8	4.5
30	M6 x 1	6	8	4.5
50	M8 x 1.25	8	8.5	5.6

4. Top mounting (Through hole)

Hexagon socket head cap screw (Provided by the customer)

Interchangeable plate

Mounting plate (Provided by the customer)
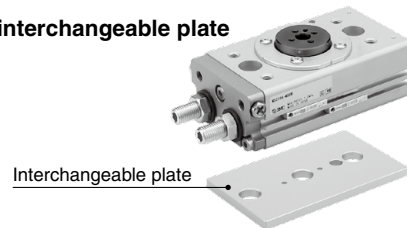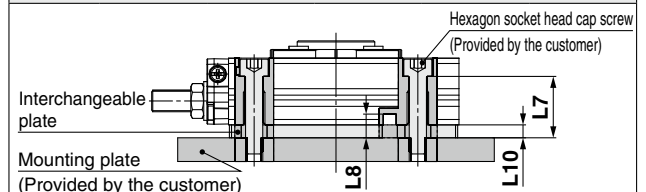
Size	L7		L8	L10
	Screw	Length [mm]	Pin [mm]	Depth*1 [mm]	Plate thickness [mm]
10	M6 x 1	28	ø3	8	4.5
20	M8 x 1.25	28.5	ø4	10.5	6
30	M8 x 1.25	31.5	ø4	6.5	2
50	M10 x 1.5	35.5	ø5	8.5	3

*1 The effective depth of the pin is the depth obtained by subtracting the plate thickness (L10) from the L8 depth.

* Refer to page 24 for the tightening torque of the interchangeable parts.

5. Bottom mounting (Body tapped)

Interchangeable plate

Mounting plate (Provided by the customer)

Hexagon socket head cap screw (Provided by the customer)
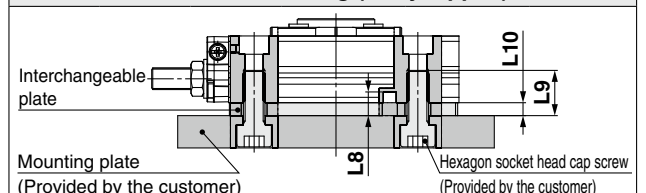
Size	L8		L9	L10
	Pin [mm]	Depth*1 [mm]	Screw	Max. screw-in depth [mm]	Plate thickness [mm]
10	ø3	8	M8 x 1.25	16.5	4.5
20	ø4	10.5	M10 x 1.5	21	6
30	ø4	6.5	M10 x 1.5	17	2
50	ø5	8.5	M12 x 1.75	21	3

*1 The effective depth of the pin is the depth obtained by subtracting the plate thickness (L10) from the L8 depth.

* Refer to page 24 for the tightening torque of the interchangeable parts.

SMC

MSQ Series
Specific Product Precautions 3

Be sure to read this before handling the products. Refer to the back cover for safety instructions. For rotary actuator and auto switch precautions, refer to the "Handling Precautions for SMC Products" and the "Operation Manual" on the SMC website.

Shock Absorber

⚠Caution

1. Never rotate the bottom screw of the shock absorber. (It is not an adjustment screw.) This may cause oil leakage.

Bottom screw cannot be rotated
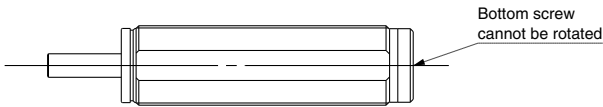
2. Products with shock absorber are not designed to smooth stop but to absorb the kinetic energy of the load. If the load has to be stopped smoothly, a shock absorber of the optimum size meeting the operating conditions must be installed external to the equipment.

3. Shock absorbers are consumable parts.

When a decrease in energy absorption capacity is noticed, it must be replaced.

With internal shock absorber

Size	Shock absorber model
10	RBA0805-X692
20	RBA1006-X692
30	
50	RBA1411-X692

Service Life and Replacement Period of Shock Absorber

⚠Caution

1. Allowable operation time under the specifications set in this catalog is 1 million.

∗ Specified service life (suitable replacement period) is the value at room temperature (20 to 25°C). The period may vary depending on the temperature and other conditions. In some cases the absorber may need to be replaced before the allowable operation time above.