RoTARY ACTuATORS PISToN TYPE
RAR SERIES

CoNTENTS

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Caution
Before use, be sure to read the "Safety Precautions" on p. 57.
ROTARY ACTUATORS
RAT Series

Lightweight and Compact

■ High precision by using bearing.
■ Workpiece is easily mounted on the RAT table.

Two types are available for swing angle, **90° type** and **180° type**.

By adjusting threaded length of rubber stopper or shock absorber, ±5° adjustment at the end of the swing stroke is possible.

**90° type**

Application example

Pick up a workpiece by vacuum pad at the arm end, and rotate the arm to transfer.

Piping and adjusting swing angle are possible on one surface.

Piping and adjusting swing angle is possible on one surface throughout the product range. By using a vertical lead wire sensor switch, even lead wire can be run out in the same surface. (Except RAT5)

Piping connection is possible on 4 surfaces.

(One surface for RAT 5)

Piping direction can be selected for 4 surfaces. This enables easy piping in confined spaces or in workpiece installed condition. For the piping port location and swing direction, see p. 1250.
Four types of cushioning are possible.
The same mounting thread is used for both the rubber stopper and shock absorber. This allows for change of the rubber stopper to a shock absorber if required later on, or vice versa.

With rubber stopper on both sides
[Mounted at clockwise rotation end]

With shock absorber on left side
[Mounted at counterclockwise rotation end]

With shock absorber on both sides

With shock absorber on right side

Three types of torque, 0.5, 1.0, 3.0 N·m [0.4, 0.7, 2.2 ft·lbf] are available.

Locating hole on the table and bottom of the body are available.
Locating hole and mounting hole are common between 90° and 180° types. Dimensions of those are different in longitudinally only; consequently replacement between 90° type and 180° type is easy.
For details in dimensions, refer to p.1251 to 1254.

Embedded type sensor switch is available.
Sensor switch mounting grooves are available on 2 surfaces. For RAT5, they are available on 1 surface.

Note: At operating pressure 0.5MPa [73psi.], and nominal values.
Handling Instructions and Precautions

General precautions

Media
1. Use air for the media. For the use of any other media, consult us.
2. Air used for the rotary actuator should be clean air that contains no deteriorated compressor oil, etc. Install an air filter (filtration of a minimum 40 μm) near the rotary actuator or valve to remove collected liquid or dust. In addition, drain the air filter periodically.

Piping
1. Always thoroughly blow off (use compressed air) the tubing before connecting it to the rotary actuator. Entering metal chips, sealing tape, rust, etc., generated during piping work could result in air leaks or other defective operation.
2. When screwing in piping or fittings to the actuator, tighten to the appropriate tightening torque shown below.

<table>
<thead>
<tr>
<th>Connecting thread</th>
<th>Tightening torque N·cm [in·lbf]</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5×0.8</td>
<td>157 [13.9]</td>
</tr>
</tbody>
</table>

Lubrication
The product can be used without lubrication, if lubrication is required, use Turbine Oil Class 1 (ISO VG32) or equivalent. Avoid using spindle oil or machine oil.

Atmosphere
If using in locations subject to dripping water, dripping oil, etc., use a cover to protect the unit.

Start-up
When starting up operations of a device and the rotary actuator by supplying compressed air rapidly, it could not control the speed due to the construction of the rotary actuator, resulting in damage to the device and rotary actuator. When supplying compressed air to the device and rotary actuator where the air has been exhausted, always ensure that the table is in a secure position and cannot be moved further, paying attention to safety, and then apply air pressure from the connection port of not making move the table, first. For the piping port location and swing direction, see p.1250.

Mounting

1. Models with rubber stoppers on both sides can be freely mounted in any direction. If using models with shock absorbers (-SS2, -SSR, -SSL), however, avoid using with the shock absorbers mounted on top of the body. This position drastically reduces the shock absorbers’ operating life. When using with shock absorbers, locate the shock absorbers so that they are mounted on the bottom or side of the body.

Top
Shock absorbers on top

Bottom

Top
Shock absorbers on the side

Bottom

Top
Shock absorbers on the bottom

Bottom

Bottom

Bottom

2. The mounting surface should be always flat. Twisting or bending during the mounting could result in air leaks or improper operation.
3. Care should be taken that scratches or dents on the rotary actuator’s mounting surface may damage its flatness.
4. Take some locking measures when shocks or vibrations might loosen the bolts.
5. For workpiece mounting, female threads are available for installing the workpiece in place on the table. Always use bolts so that the screw length is less than the depth of the female thread. Use of longer bolts than the female thread will interfere with the angle adjusting bolt or shock absorber, and prevent them from working properly. When mounting the workpiece, tighten the bolts within the range of the tightening torque.
Workpiece Bolt for mounting workpiece in place

Angle adjusting bolt or shock absorber

RAT5 RAT10 RAT30
M5×0.7 7 [0.28] 1.37 [1.01]  
M6×1.0 8 [0.32] 4.80 [3.54]  

Caution: When using a bolt to mount the workpiece in place on the table, hold either the table or workpiece during the operation. Holding the body for tightening will apply excessive moment to the stopper, rubber stopper and shock absorber, resulting in a change of angle.

6. The rotary actuator RAT series can be mounted in either of the 2 ways shown below. When mounting, ensure that the tightening torque is within the range of allowable values.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Model} & \text{Thread size} & \text{Thread depth L mm [in.]} & \text{Maximum tightening torque N·m [ft·lbf]} \\
\hline
\text{RAT5} & \text{M5×0.7} & 7 [0.28] & 1.37 [1.01] \\
\text{RAT10} & \text{M6×1.0} & 8 [0.32] & 4.80 [3.54] \\
\text{RAT30} & \text{M8×1.25} & 12.0 [8.85] & \\
\hline
\end{array}
\]

Swing angle adjustment

1. The rotary actuator RAT series uses rubber stoppers or shock absorbers for angle adjustment, in the ranges shown on p.1250. For both clockwise and counterclockwise rotation, rotating the rubber stopper or shock absorber to the right (clockwise) will reduce the swing angle. After completing angle adjustment, tighten the nut and secure them in place.

2. Always follow the swing angle within the specified range for use. For the shock absorber, in particular, the angle between the load applying direction and the center line of the shock absorber exceeds the allowable angle variation, it could damage the product.

3. The rubber stopper or shock absorber are only temporarily tightened at shipping. For actual use, always tighten the nut to secure it in place.

4. When tightening the nut, ensure that the tightening torque is within the range shown below.

\[
\begin{array}{|c|c|c|}
\hline
\text{Model} & \text{Nut size} & \text{Maximum tightening torque N·m [ft·lbf]} \\
\hline
\text{RAT5} & \text{M8×0.75} & 2.45 [1.81] \\
\text{RAT10} & \text{M10×1.0} & 6.37 [4.70] \\
\hline
\end{array}
\]

Rubber stopper and shock absorber replacement instructions

Loosen and remove the mounting nut of the rubber stopper or shock absorber. Screw the new rubber stopper or shock absorber into the proper position, and then tighten the mounting nut and secure it in place. When tightening the nut, ensure that the tightening torque is within the range of setting values.

Mounting using the through holes on the body

Mounting using the female threads on the body

6. The rotary actuator RAT series can be mounted in either of the 2 ways shown below. When mounting, ensure that the tightening torque is within the range of allowable values.

\[
\begin{array}{|c|c|c|}
\hline
\text{Model} & \text{Mounting method} & \text{Thread size} & \text{Maximum tightening torque N·m [ft·lbf]} \\
\hline
\text{RAT5} & \text{Through hole} & \text{M5×0.8} & 2.84 [2.09] \\
\text{RAT10} & \text{Female thread} & \text{M6×1.0} & 4.80 [3.54] \\
\text{RAT30} & \text{Through hole} & \text{M6×1.0} & 4.80 [3.54] \\
\text{RAT30} & \text{Female thread} & \text{M8×1.25} & 12.0 [8.85] \\
\hline
\end{array}
\]

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2. Always follow the swing angle within the specified range for use. For the shock absorber, in particular, the angle between the load applying direction and the center line of the shock absorber exceeds the allowable angle variation, it could damage the product.

3. The rubber stopper or shock absorber are only temporarily tightened at shipping. For actual use, always tighten the nut to secure it in place.

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\[
\begin{array}{|c|c|c|}
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\hline
\end{array}
\]
Air Flow Rate and Air Consumption

Finding the air flow rate
(For selecting F.R.L., valves, etc.)

**RAT5**

\[
Q_1 = \frac{\pi D^2}{4} \times L \times \frac{60}{T} \times P^+ \times 14.696 \times \frac{1}{1728}
\]

**RAT10, 30**

\[
Q_1 = \frac{\pi D^2}{4} \times 2 \times L \times \frac{60}{T} \times P^+ \times 14.696 \times \frac{1}{1728}
\]

Finding the air consumption

**RAT5**

\[
Q_2 = \frac{\pi D^2}{4} \times L \times \frac{60}{T} \times P^+ \times 14.696 \times \frac{1}{1728}
\]

**RAT10, 30**

\[
Q_2 = \frac{\pi D^2}{4} \times 2 \times L \times \frac{60}{T} \times P^+ \times 14.696 \times \frac{1}{1728}
\]

Calculation of air flow rate and air consumption

The above graph shows the air consumption during 1 cycle of the rotary actuator. The actual air flow rate and consumption required can be found through the following calculations. Note that the calculations vary between "RAT5" and "RAT10/RAT30" due to the difference between single piston and double piston construction.

Air consumption for 1 cycle operation

<table>
<thead>
<tr>
<th>Model</th>
<th>Air pressure MPa [psi.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT5-90</td>
<td>0.2 [29] 0.3 [44] 0.4 [58] 0.5 [73] 0.6 [87] 0.7 [100]</td>
</tr>
<tr>
<td>RAT30-90</td>
<td>45.0 [2.746] 60.0 [3.661] 74.9 [4.571] 89.9 [5.486] 104.8 [6.395] 119.8 [7.311]</td>
</tr>
</tbody>
</table>

- Refer to p.54 for an explanation of ANR.

Cylinder bore and stroke

<table>
<thead>
<tr>
<th>Model</th>
<th>Cylinder bore</th>
<th>Cylinder stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT5-90</td>
<td>16 [0.630]</td>
<td>9.4 [0.370]</td>
</tr>
<tr>
<td>RAT5-180</td>
<td>16 [0.630]</td>
<td>18.8 [0.740]</td>
</tr>
<tr>
<td>RAT10-90</td>
<td>16 [0.630]</td>
<td>9.4 [0.370]</td>
</tr>
<tr>
<td>RAT10-180</td>
<td>16 [0.630]</td>
<td>18.8 [0.740]</td>
</tr>
<tr>
<td>RAT30-90</td>
<td>20 [0.787]</td>
<td>15.6 [0.650]</td>
</tr>
<tr>
<td>RAT30-180</td>
<td>20 [0.787]</td>
<td>33.0 [1.299]</td>
</tr>
</tbody>
</table>
### Handling Instructions and Precautions

#### Allowable Load

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>RAT5</th>
<th>RAT10</th>
<th>RAT30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable radial load Ws N [lbf]</td>
<td>30 [6.7]</td>
<td>80 [18.0]</td>
<td>200 [45.0]</td>
<td></td>
</tr>
<tr>
<td>Allowable moment M N·m [ft-lbf]</td>
<td>1.5 [1.1]</td>
<td>2.5 [1.8]</td>
<td>5.5 [4.1]</td>
<td></td>
</tr>
</tbody>
</table>

#### Table Displacement Caused by Moment

In the rotary actuator RAT series, mounting a plate and applying moment on it, and then measure the displacement at 100mm [3.94 in.] position from the rotation center.

![Diagram of moment and displacement](image)

#### Effective Torque

<table>
<thead>
<tr>
<th>Model</th>
<th>Air pressure MPa [psi.]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N·m [ft·lbf]</td>
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<tr>
<td>RAT5</td>
<td>0.2 [29] 0.25 [36] 0.3 [44] 0.35 [51] 0.4 [58]</td>
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<td>RAT10</td>
<td>0.12 [0.09] 0.17 [0.13] 0.22 [0.16] 0.27 [0.20] 0.32 [0.24]</td>
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<tr>
<td>RAT30</td>
<td>0.29 [0.21] 0.39 [0.29] 0.49 [0.36] 0.59 [0.44] 0.69 [0.51]</td>
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**Note:** The above values are actual measurement values, and are not guaranteed values.

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<tr>
<th>Air pressure MPa [psi.]</th>
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<tr>
<td>0.45 [65]</td>
<td>0.5 [73] 0.55 [80] 0.6 [87] 0.65 [94] 0.7 [102]</td>
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<td>0.37 [52]</td>
<td>0.42 [0.31] 0.47 [0.35] 0.52 [0.38] 0.57 [0.42] 0.62 [0.46]</td>
</tr>
<tr>
<td>0.79 [118]</td>
<td>0.89 [0.66] 0.99 [0.73] 1.09 [0.80] 1.19 [0.88] 1.29 [0.95]</td>
</tr>
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**Note:** The values of effective torque are calculated using the formula: $1\text{N·m} = 0.7376\text{ft·lbf}$

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Selection

Caution: For the load and swing time, follow the below “Model selection procedure” to select within the range of specified values. Moreover, about 80% of the allowable values is recommended to use in the application. By using these values, adverse effects on cylinders and guides can be a minimum.

1. Check the application conditions
   Check the following items:
   ① Swing angle (90° or 180°)
   ② Swing time (s)
   ③ Applied pressure (MPa)
   ④ Workpiece shape and materials
   ⑤ Mounting direction

2. Check the swing time
   Check the swing time in 1—② is within the swing time adjustment range in the specification.

<table>
<thead>
<tr>
<th>Angle</th>
<th>Swing time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90°</td>
<td>0.2~1.0</td>
</tr>
<tr>
<td>180°</td>
<td>0.4~2.0</td>
</tr>
</tbody>
</table>

Note: The swing time is obtained when using the rubber stopper with no load at 0.5MPa condition.

3. Select torque size (select model)
   Find the torque \( T_A \) required for rotating the workpiece.

\[
T_A = I \cdot \dot{\omega} \cdot K \quad \text{\( T_A \): Torque (N\cdotm)}
\]

\[
\dot{\omega} = \frac{2 \cdot \theta}{t^2} \quad \text{Use the formulas on p.1241~1244 to find.}
\]

\[
\theta : \text{Uniform angular acceleration (rad/s²)}
\]

\[
K : \text{Marginal coefficient 5}
\]

\[
\dot{\omega} : \text{Angular velocity (rad/s)}
\]

\[
\theta : \text{Swing angle (rad)}
\]

\[
t : \text{Swing time (s)}
\]

Select the model secures the required torque \( T_A \) by using the applied pressure checked in 2—⑤, from among the effective torque table or graph on p.1238.

4. Check kinetic energy
   If kinetic energy exceeds the allowable energy, the actuator could be damaged. Always select a model so that the energy lies within the allowable energy range. When the kinetic energy is large, use a model with shock absorber (-SS2, -SSR, or -SSL). For the allowable kinetic energy, see Table 1.

Find the kinetic energy.

**With rubber stopper**

\[
E = \frac{1}{2} l \times I \times \omega^2 \quad \text{\( E \): Kinetic energy (J)}
\]

\[
\omega = \frac{2 \cdot \theta}{t} \quad \text{Use the formulas on p.1241~1244 to find.}
\]

\[
\omega : \text{Angular velocity (rad/s)}
\]

\[
\theta : \text{Swing angle (rad)}
\]

\[
t : \text{Swing time (s)}
\]

\[
E_a : \text{Allowable energy with rubber stopper}
\]

... See Table 1.

**Model selection procedure**

1. Check the application conditions
   Check the following items:
   ① Swing angle (90° or 180°)
   ② Swing time (s)
   ③ Applied pressure [psi.]
   ④ Workpiece shape and materials
   ⑤ Mounting direction

2. Check the swing time
   Check the swing time in 1—② is within the swing time adjustment range in the specification.

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<td>180°</td>
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</table>

Note: The swing time is obtained when using the rubber stopper with no load at 73psi condition.

3. Select torque size (select model)
   Find the torque \( T_A \) required for rotating the workpiece.

\[
T_A = l \cdot \dot{\omega} \cdot K \quad T_A : \text{Torque [ft-lbf]}
\]

\[
\dot{\omega} = \frac{2 \cdot \theta}{t^2} \quad \text{Use the formulas on p.1241~1244 to find.}
\]

\[
\theta : \text{Swing angle [rad/sec²]}
\]

\[
K : \text{Marginal coefficient 5}
\]

\[
\dot{\omega} : \text{Uniform angular acceleration [rad/sec²]}
\]

\[
I : \text{Mass moment of inertia [lbf-ft-sec²]}
\]

\[
t : \text{Swing time [sec.]} \]

Select the model secures the required torque \( T_A \) by using the applied pressure checked in 2—③, from among the effective torque table or graph on p.1238.

4. Check kinetic energy
   If kinetic energy exceeds the allowable energy, the actuator could be damaged. Always select a model so that the energy lies within the allowable energy range. When the kinetic energy is large, use a model with shock absorber (-SS2, -SSR, or -SSL). For the allowable kinetic energy, see Table 1.

Find the kinetic energy.

**With rubber stopper**

\[
E' = \frac{1}{2} l \cdot I \cdot \omega^2 \quad \text{\( E' \): Kinetic energy [ft-lbf]}
\]

\[
\omega = \frac{2 \cdot \theta}{t} \quad \text{Use the formulas on p.1241~1244 to find.}
\]

\[
\theta : \text{Swing angle [rad/sec]} \]

\[
I : \text{Mass moment of inertia [lbf-ft-sec²]}
\]

\[
t : \text{Swing time [sec.]} \]

\[
E'a : \text{Allowable energy with rubber stopper}
\]

... See Table 1.
With shock absorber

1. Find the equivalent mass \( m_1 \).
\[ m_1 = \frac{l}{R^2} \]

2. Find the equivalent mass \( m_2 \).
\[ m_2 = 2\frac{2TXL}{R^3 \times \omega^2} \]

3. Find the total mass \( m \).
\[ m = m_1 + m_2 \]

4. Find the impact velocity.
\[ V = R \times \omega \]

5. Find the kinetic energy.
\[ E = \frac{1}{2} X m \times V^2 \]

6. Judgement whether the unit is usable or not
The unit is usable if it satisfies both 4. Kinetic energy and 5. Load ratio.
\[ E < E_a \]
\[ \sum \text{Load ratio} \leq 1 \]

---

With shock absorber

1. Find the equivalent weight \( w_1 \).
\[ w_1 = \frac{l'}{R^2} \times 32.2 \]

2. Find the equivalent weight \( w_2 \).
\[ w_2 = 2\frac{2TXL'}{R^3 \times \omega^2} \]

3. Find the total weight \( w \).
\[ w = w_1 + w_2 \]

4. Find the impact velocity.
\[ V' = R' \times \omega \]

5. Find the kinetic energy.
\[ E' = \frac{1}{2} X \frac{w}{32.2} \times V'^2 \]

6. Judgement whether the unit is usable or not
The unit is usable if it satisfies both 4. Kinetic energy and 5. Load ratio.
\[ E' < E'a \]
\[ \sum \text{Load ratio} \leq 1 \]

---

**Table 1. Allowable energy \( E_a \)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Allowable energy with rubber stopper ((J))</th>
<th>Allowable energy with shock absorber ((J))</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT5</td>
<td>0.005</td>
<td>0.36</td>
</tr>
<tr>
<td>RAT10</td>
<td>0.008</td>
<td>0.53</td>
</tr>
<tr>
<td>RAT30</td>
<td>0.030</td>
<td>1.14</td>
</tr>
</tbody>
</table>

**Table 2.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Distance ( R ) from rotation center to impact point ((m))</th>
<th>Shock absorber stroke ( L ) ((m))</th>
<th>Shock absorber model</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT5</td>
<td>0.0175</td>
<td>0.005</td>
<td>KSHAR5×5-D</td>
</tr>
<tr>
<td>RAT10</td>
<td>0.0175</td>
<td>0.005</td>
<td>KSHAR5×5-E</td>
</tr>
<tr>
<td>RAT30</td>
<td>0.0220</td>
<td>0.008</td>
<td>KSHAR6×8-F</td>
</tr>
</tbody>
</table>

**Fig.1** \( R \): Distance from rotation center to impact point

**Fig.1** \( R' \): Distance from rotation center to impact point

---

**Table 3. Allowable load**

<table>
<thead>
<tr>
<th>Model</th>
<th>Thrust load ( W_s ) ((N))</th>
<th>Radial load ( W_r ) ((N))</th>
<th>Moment ( M ) ((N\cdot m))</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT5</td>
<td>50</td>
<td>30</td>
<td>1.5</td>
</tr>
<tr>
<td>RAT10</td>
<td>80</td>
<td>80</td>
<td>2.5</td>
</tr>
<tr>
<td>RAT30</td>
<td>200</td>
<td>200</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**Table 3. Allowable load**

<table>
<thead>
<tr>
<th>Model</th>
<th>Thrust load ( W_s ) ((lb))</th>
<th>Radial load ( W_r ) ((lb))</th>
<th>Moment ( M ) ((lb\cdot ft))</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT5</td>
<td>11.2</td>
<td>6.7</td>
<td>1.1</td>
</tr>
<tr>
<td>RAT10</td>
<td>18.0</td>
<td>18.0</td>
<td>1.8</td>
</tr>
<tr>
<td>RAT30</td>
<td>45.0</td>
<td>45.0</td>
<td>4.1</td>
</tr>
</tbody>
</table>
Diagram for calculating mass moment of inertia
[When the rotation axis passes through the workpiece]

● Disk

- Diameter  \( d \) (m)
- Mass  \( m \) (kg)
- Mass moment of inertia  \( I \) (kg\(\cdot\)m\(^2\))
  \[ I = \frac{md^2}{8} \]
- Rotating radius  \( \frac{d^2}{8} \)

- Diameter  \( d \) [ft.]
- Weight  \( w \) [lbf.]
- Mass moment of inertia  \( I' \) [lbf\(\cdot\)ft\(\cdot\)sec\(^2\)]
  \[ I' = \frac{wd^2}{8 \times 32.2} \]
- Rotating radius  \( \frac{d^2}{8} \)

Remark: No particular mounting direction.
For sliding use, see separate materials.

● Stepped disk

- Diameter  \( d_1 \) (m),  \( d_2 \) (m)
- Mass  \( m_1 \) (kg),  \( m_2 \) (kg)
- Mass moment of inertia  \( I \) (kg\(\cdot\)m\(^2\))
  \[ I = \frac{1}{8} (m_1d_1^2 + m_2d_2^2) \]
- Rotating radius  \( \frac{d_1^2 + d_2^2}{8} \)

- Diameter  \( d_1 \) [ft.],  \( d_2 \) [ft.]
- Weight  \( w_1 \) [lbf.],  \( w_2 \) [lbf.]
- Mass moment of inertia  \( I' \) [lbf\(\cdot\)ft\(\cdot\)sec\(^2\)]
  \[ I' = \frac{1}{8 \times 32.2} \times (w_1d_1^2 + w_2d_2^2) \]
- Rotating radius  \( \frac{d_1^2 + d_2^2}{8} \)

Remark: The \( d_2 \) portion can be negligible when it is much smaller than the \( d_1 \) portion.

● Bar (rotation center is at the edge)

- Bar length  \( \ell \) (m)
- Mass  \( m \) (kg)
- Mass moment of inertia  \( I \) (kg\(\cdot\)m\(^2\))
  \[ I = \frac{m \ell^2}{3} \]
- Rotating radius  \( \frac{\ell^2}{3} \)

- Bar length  \( \ell \) [ft.]
- Weight  \( w \) [lbf.]
- Mass moment of inertia  \( I' \) [lbf\(\cdot\)ft\(\cdot\)sec\(^2\)]
  \[ I' = \frac{w \ell^2}{3 \times 32.2} \]
- Rotating radius  \( \frac{\ell^2}{3} \)

Remark: Mounting direction is horizontal.
If the mounting direction is vertical, the swing time will change.

● Slender rod

- Rod length  \( \ell_1 \) (m),  \( \ell_2 \) (m)
- Mass  \( m_1 \) (kg),  \( m_2 \) (kg)
- Mass moment of inertia  \( I \) (kg\(\cdot\)m\(^2\))
  \[ I = \frac{m_1 \ell_1^2}{3} + \frac{m_2 \ell_2^2}{3} \]
- Rotating radius  \( \frac{\ell_1^2 + \ell_2^2}{3} \)

- Rod length  \( \ell_1 \) [ft.],  \( \ell_2 \) [ft.]
- Weight  \( w_1 \) [lbf.],  \( w_2 \) [lbf.]
- Mass moment of inertia  \( I' \) [lbf\(\cdot\)ft\(\cdot\)sec\(^2\)]
  \[ I' = \frac{w_1 \ell_1^2}{3 \times 32.2} + \frac{w_2 \ell_2^2}{3 \times 32.2} \]
- Rotating radius  \( \frac{\ell_1^2 + \ell_2^2}{3} \)

Remark: Mounting direction is horizontal.
If the mounting direction is vertical, the swing time will change.
Bar (rotation center is through the center of gravity)

- **Bar length** \( \ell \) (m)
- **Mass** \( m \) (kg)
- **Mass moment of inertia** \( I \) (kg\( \cdot \)m\(^2\))
  \[ I = \frac{m \ell^2}{12} \]
- **Rotating radius**
  \[ \frac{\ell^2}{12} \]

Remark: No particular mounting direction.

---

Thin rectangular plate (rectangular solid)

- **Plate length** \( a_1 \) (m)
- **Length of side** \( b \) (m)
- **Mass** \( m_1 \) (kg)
- **Mass moment of inertia** \( I \) (kg\( \cdot \)m\(^2\))
  \[ I = \frac{m_1}{12} \left( 4a_1^2+b^2 \right) + \frac{m_2}{12} \left( 4a_2^2+b^2 \right) \]
- **Rotating radius**
  \[ \frac{\ell}{12} \]

Remark: Mounting direction is horizontal.
If the mounting direction is vertical, the swing time will change.

---

Rectangular parallelepiped

- **Length of sides** \( a \) (m)
- **Mass** \( m \) (kg)
- **Mass moment of inertia** \( I \) (kg\( \cdot \)m\(^2\))
  \[ I = \frac{m}{12} \left( a^2+b^2 \right) \]
- **Rotating radius**
  \[ \frac{a^2+b^2}{12} \]

Remark: No particular mounting direction.
For sliding use, see separate materials.
### Concentrated Load

- **Shape of concentrated load**
- **Distance to center of gravity of concentrated load** \( \ell_1 \) (m)
- **Length of arm** \( \ell_2 \) (m)
- **Mass of concentrated load** \( m_1 \) (kg)
- **Mass of arm** \( m_2 \) (kg)

\[
\dot{I} = m_2 k^2 + m_1 \ell_1^2 + \frac{m_2 \ell_2^2}{3}
\]

Rotating radius: \( k^2 \) is calculated according to shape of the concentrated load.

Remark: Mounting direction is horizontal. When \( m_2 \) is much smaller than \( m_1 \), calculate as \( m_2 = 0 \).

### Gear

**Equation for calculating the load \( J \):** with respect to rotary actuator axis when transmitted by gears

- **Gear**
- **Rotation actuator side**
  - Load side \( b \)
- **Inertia moment of load** \( N \cdot m \)

\[
l_a = \left( \frac{a}{b} \right)^2 l_b
\]

**Mass moment of inertia** \( [\text{kg} \cdot \text{m}^2] \)

**Mass moment of inertia of load with respect to rotary actuator axis**

Remark: If the shapes of the gears are too large, the mass moment of inertia of the gears must be also taken into consideration.
When the rotation axis is offset from the workpiece

**Rectangular parallelepiped**

- Length of side \( h \) (m)
- Distance from rotation axis to the center of load \( L \) (m)
- Mass \( m \) (kg)
- Mass moment of inertia \( I \) (kg\(\cdot\)m\(^2\))

\[
I = \frac{m h^2}{12} + mL^2
\]

**Hollow rectangular parallelepiped**

- Length of side \( h_1 \) (m), \( h_2 \) (m)
- Distance from rotation axis to the center of load \( L \) (m)
- Mass \( m \) (kg)
- Mass moment of inertia \( I \) (kg\(\cdot\)m\(^2\))

\[
I = \frac{m (h_2^2 + h_1^2)}{12} + mL^2
\]

**Circular cylinder**

- Diameter \( d \) (m)
- Distance from rotation axis to the center of load \( L \) (m)
- Mass \( m \) (kg)
- Mass moment of inertia \( I \) (kg\(\cdot\)m\(^2\))

\[
I = \frac{md^2}{16} + mL^2
\]

**Hollow circular cylinder**

- Diameter \( d_1 \) (m), \( d_2 \) (m)
- Distance from rotation axis to the center of load \( L \) (m)
- Mass \( m \) (kg)
- Mass moment of inertia \( I \) (kg\(\cdot\)m\(^2\))

\[
I = \frac{m (d_2^2 + d_1^2)}{16} + mL^2
\]

Remark: Same for cube.

Remark: Cross-section is square only.
1. Check application conditions
   ① Swing angle: 90°
   ② Swing time: 0.5 (s)
   ③ Applied pressure: 0.5 (MPa)
   ④ Workpiece shape: Shown in the above

Workpiece material
   Rectangular plate: Aluminum alloy (Specific gravity = 2.68 × 10³ kg/m³)
   Cube: Steel (Specific gravity = 7.85 × 10³ kg/m³)

Mounting direction: Horizontal

2. Check the swing time
   The swing time is 0.5 sec./90°, which is within the range of 0.2 ~ 1.0 sec./90°, and satisfactory.

3. Select by the torque
   Firstly calculate the mass moment of inertia.

   rectangular plate
   \[
   m_1 = 0.05 \times (0.12 - 0.025) \times 0.01 \times 2.68 \times 10^3 = 0.127 \text{ (kg)}
   \]
   \[
   m_2 = 0.05 \times 0.025 \times 0.01 \times 2.68 \times 10^3 = 0.034 \text{ (kg)}
   \]
   \[
   I_1 = \frac{0.127}{12} \left( 4 \times (0.12 - 0.025)^2 + 0.05^2 \right) + \frac{0.034}{12} \left( 4 \times 0.025^2 + 0.05^2 \right)
   = 0.42 \times 10^{-3} \text{ (kg m²)}
   \]
   Cube
   \[
   m_2 = 0.05 \times 0.05 \times 0.05 \times 7.85 \times 10^3 = 0.981 \text{ (kg)}
   \]
   \[
   I_2 = \frac{0.981 \times 0.05^2}{12} + 0.981 \times 0.07^2
   = 5.01 \times 10^{-3} \text{ (kg m²)}
   \]

From ① and ②, the total mass moment of inertia \( I \) is
   \[
   I = I_1 + I_2
   = 0.42 \times 10^{-3} + 5.01 \times 10^{-3}
   = 5.43 \times 10^{-3} \text{ (kg m²)}
   \]

According to the given conditions, \( \theta = 90°, t = 0.5 \text{ (s)} \)
   Therefore, the uniform angular acceleration \( \dot{\omega} \) is
   \[
   \dot{\omega} = 2 \times 1.57 \frac{\text{rad}}{\text{s}^2} = 12.56 \text{ (rad/s²)}
   \]
   From ③ and ④, the required torque \( T_A \) is
   \[
   T_A = 5.43 \times 10^{-3} \times 12.56 \times 5
   = 0.341 \text{ (N m)}
   \]
   From the Effective Torque Table (graph) on p.1238, select a
   model where the torque is more than 0.341 \( \text{ (N m)} \) at 0.5 MPa.

RAT5-90
4. Check kinetic energy
With rubber stopper
According to the given conditions, $\theta=90^\circ$, $t=0.5$ (s) therefore,
$$\omega = \frac{2 \times 1.57}{0.5} = 6.28 \text{ (rad/s)} \cdots (1)$$

From (1), kinetic energy $E$ is
$$E = \frac{1}{2} \times 5.43 \times 10^{-3} \times 6.28^2 = 0.107 \text{ (J)} \cdots (2)$$

0.107 > 0.005, which means the rubber stopper is not sufficient. Therefore, recalculate a case with shock absorber.

With shock absorber
$$m_1 = \frac{5.43 \times 10^{-3}}{0.0175} = 0.31 \text{ (kg)} \cdots (3)$$
$$m_2 = \frac{2 \times 0.42 \times 0.005}{0.0175 \times 6.28^2} = 5.23 \text{ (kg)} \cdots (4)$$

From (3) and (4), $m = 0.31 + 5.23 = 5.54 \text{ (kg)} \cdots (5)$
$$V = 0.0175 \times 6.28 = 0.110 \cdots (6)$$

From (5) and (6), find the kinetic energy.
$$E = \frac{1}{2} \times 37.60 \times 0.110^2 = 0.227 \text{ (J)}$$

0.227 < 0.36, which means there is no problem in the application with shock absorber.

5. Check load ratio
[Tug load]
The total mass is
$$0.034 + 0.127 + 0.981 = 1.142 \text{ (kg)}$$
Therefore,
$$W_S = 1.142 \times 9.8 = 11.192 \text{ (N)} \cdots (1)$$

[Radial load]
Since no radial load is applied,
$$W_R = 0 \text{ (N)} \cdots (2)$$

[Moment]
The moment $M_1$ by the rectangular plate is
$$M_1 = (0.034 + 0.127) \times 9.8 \times \left( \frac{12}{2} - 0.025 \right) = 0.555 \text{ (N\cdot m)} \cdots (3)$$

The moment $M_2$ by the cube is
$$M_2 = 0.981 \times 9.8 \times 0.07 = 0.673 \text{ (N\cdot m)} \cdots (4)$$

From (3) and (4), the total moment is
$$M = 0.555 + 0.673 = 1.23 \text{ (N\cdot m)} \cdots (5)$$

From (1), (2), and (5), find the load ratio
$$\frac{W_S}{W_{S\text{MAX}}} + \frac{W_R}{W_{R\text{MAX}}} + \frac{M}{M_{\text{MAX}}} = \frac{11.192}{50} + \frac{0}{30} + \frac{0.728}{1.5} = 0.71 \leq 1.0$$

the load ratio is less than 1.0, and satisfactory.

6. Check the unit specifications
Selection of [RAT5-90-SS2] satisfies both the kinetic energy and load ratio requirements.
## RAT Series

### Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>RAT5</th>
<th>RAT10</th>
<th>RAT30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation type</td>
<td>Double acting single piston type (rack and pinion construction)</td>
<td>Double acting double piston type (rack and pinion construction)</td>
<td></td>
</tr>
<tr>
<td>Effective torque&lt;sup&gt;Note 1&lt;/sup&gt; N·m [ft·lbf]</td>
<td>0.42 [0.31]</td>
<td>0.89 [0.66]</td>
<td>2.87 [2.12]</td>
</tr>
<tr>
<td>Media</td>
<td>Air</td>
<td>Air</td>
<td>Air</td>
</tr>
<tr>
<td>Operating pressure range MPa [psi.]</td>
<td>0.2<del>0.7 [29</del>102]</td>
<td>1.05 [152]</td>
<td></td>
</tr>
<tr>
<td>Proof pressure MPa [psi.]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range°C [°F]</td>
<td>0<del>60 [32</del>140]</td>
<td>90<del>180 °C [194</del>356 °F]</td>
<td></td>
</tr>
<tr>
<td>Cushion</td>
<td>With rubber stopper</td>
<td>Rubber bumper</td>
<td>Shock absorber</td>
</tr>
<tr>
<td>with shock absorber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swing angle range</td>
<td>90° type</td>
<td>90° type</td>
<td>90° type</td>
</tr>
<tr>
<td>180° type</td>
<td>−5°~95°</td>
<td>−5°~185°</td>
<td>−5°~185°</td>
</tr>
<tr>
<td>Swing angle adjustment range&lt;sup&gt;Note 2&lt;/sup&gt; 90° type</td>
<td>Clockwise rotation end: ±5° referred to 0° position/Counterclockwise rotation end: ±5° referred to 90° position</td>
<td>Clockwise rotation end: ±5° referred to 0° position/Counterclockwise rotation end: ±5° referred to 90° position</td>
<td></td>
</tr>
<tr>
<td>Swing time adjustment range&lt;sup&gt;Note 3&lt;/sup&gt; s/90°</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All allowable energy J [ft·lbf]</td>
<td>0.005 [0.004]</td>
<td>0.008 [0.006]</td>
<td>0.03 [0.022]</td>
</tr>
<tr>
<td>with shock absorber</td>
<td>0.36 [0.27]</td>
<td>0.53 [0.39]</td>
<td>1.14 [0.841]</td>
</tr>
<tr>
<td>All allowable moment N·m [ft·lbf]</td>
<td>1.5 [0.33]</td>
<td>2.5 [0.5]</td>
<td>5.5 [1.1]</td>
</tr>
<tr>
<td>Lubrication</td>
<td>Not required (If lubrication is required, use Turbine Oil Class 1 [ISO VG32] or equivalent.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port size</td>
<td>M5×0.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>Note 1</sup> Effective torque is the value when the pressure is 0.5 MPa [73 psi].
<sup>Note 2</sup> For the swing end position, see p.1250.
<sup>Note 3</sup> The swing time adjustment range is the value by using the rubber stopper option, with no load at air pressure of 0.5 MPa [73 psi].

### Shock Absorber Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>KSHAR5×5-D</th>
<th>KSHAR5×5-E</th>
<th>KSHARE6×8-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable model</td>
<td>RAT5</td>
<td>RAT10</td>
<td>RAT30</td>
</tr>
<tr>
<td>Maximum absorption J [ft·lbf]</td>
<td>1.0 [0.7]</td>
<td>2.0 [1.5]</td>
<td>3.0 [2.2]</td>
</tr>
<tr>
<td>Absorption stroke mm [in.]</td>
<td>5 [0.20]</td>
<td>8 [0.31]</td>
<td></td>
</tr>
<tr>
<td>Maximum operating frequency cycle/min</td>
<td>60</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Angle variation</td>
<td>8° or less</td>
<td>12° or less</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range °C [°F]</td>
<td>0<del>60 [32</del>140]</td>
<td>120 [4.7]</td>
<td></td>
</tr>
</tbody>
</table>

**Caution:** Even if applications are within the shock absorber absorption range, follow also within the rotary actuator RAT series swing time adjustment and allowable energy range.

**Remarks:**
1. Do not loosen or remove the small screw on the rear end of the shock absorber. The oil inside will leak out which will fail the function of the shock absorber.
2. The life of the shock absorber may vary from the rotary actuator RAT series depending on its operating conditions.
Order Codes

**RAT**

---

**Number of sensor switches**
1: With 1 sensor switch
2: With 2 sensor switches
n: With n switches

**Lead wire length**
A: 1000mm [39 in.]
B: 3000mm [118 in.]

**Sensor switch**
Blank: No sensor switch
ZE101: Reed switch type, without indicator lamp
ZE102: Reed switch type, with indicator lamp
ZE201: Reed switch type, without indicator lamp
ZE202: Reed switch type, with indicator lamp
ZE135: 2-lead wires solid state type, with indicator lamp
ZE155: 3-lead wires solid state type, with indicator lamp
ZE235: 2-lead wires solid state type, with indicator lamp
ZE255: 3-lead wires solid state type, with indicator lamp

For details of sensor switches, see p.1544.

**Angle adjustment**
Blank: With rubber stopper on both sides
SS2: With shock absorber on both sides
SSR: With shock absorber on right side (Clockwise rotation end side)
SSL: With shock absorber on left side (Counterclockwise rotation end side)

**Swing angle**
90°: 90°
180°: 180°

**Nominal torque**
5: 0.42N·m [0.31ft-lbf]
10: 0.89N·m [0.66ft-lbf]
30: 2.87N·m [2.12ft-lbf]

**Mass**

<table>
<thead>
<tr>
<th>Model</th>
<th>Mass (g/oz.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT5-90</td>
<td>285[10.05]</td>
</tr>
<tr>
<td>RAT5-90-SS2</td>
<td>285[10.05]</td>
</tr>
<tr>
<td>RAT5-90-SSR(L)</td>
<td>285[10.05]</td>
</tr>
<tr>
<td>RAT5-180</td>
<td>340[11.99]</td>
</tr>
<tr>
<td>RAT5-180-SS2</td>
<td>340[11.99]</td>
</tr>
<tr>
<td>RAT5-180-SSR(L)</td>
<td>340[11.99]</td>
</tr>
<tr>
<td>RAT10-90</td>
<td>350[12.35]</td>
</tr>
<tr>
<td>RAT10-90-SS2</td>
<td>350[12.35]</td>
</tr>
<tr>
<td>RAT10-90-SSR(L)</td>
<td>350[12.35]</td>
</tr>
<tr>
<td>RAT10-180</td>
<td>420[14.81]</td>
</tr>
<tr>
<td>RAT10-180-SS2</td>
<td>420[14.81]</td>
</tr>
<tr>
<td>RAT10-180-SSR(L)</td>
<td>420[14.81]</td>
</tr>
<tr>
<td>RAT30-90</td>
<td>690[24.34]</td>
</tr>
<tr>
<td>RAT30-90-SS2</td>
<td>694[24.48]</td>
</tr>
<tr>
<td>RAT30-90-SSR(L)</td>
<td>692[24.41]</td>
</tr>
<tr>
<td>RAT30-180</td>
<td>855[30.16]</td>
</tr>
<tr>
<td>RAT30-180-SS2</td>
<td>859[30.30]</td>
</tr>
<tr>
<td>RAT30-180-SSR(L)</td>
<td>857[30.23]</td>
</tr>
<tr>
<td>CRK588</td>
<td>10[0.35]</td>
</tr>
<tr>
<td>CRK589</td>
<td>20[0.71]</td>
</tr>
<tr>
<td>KSHAR5×5-D</td>
<td>10[0.35]</td>
</tr>
<tr>
<td>KSHAR5×5-E</td>
<td>10[0.35]</td>
</tr>
<tr>
<td>KSHAR6×8-F</td>
<td>22[0.78]</td>
</tr>
</tbody>
</table>

**Remark:** The shock absorber or rubber stopper comes as a set consisting of its body and 1 mounting nut.

**Additional Parts**

- **Rubber stopper**
  CRK
  588: For RAT5- and RAT10-
  589: For RAT30-

- **Shock absorber**
  KSHAR
  5×5-D: For RAT5-
  5×5-E: For RAT10-
  6×8-F: For RAT30-

---

**Basic model**
Rotary actuator RAT series

**Notes:**
1. Standard, with magnet type.
2. The opposite side of the shock absorber (SSR or SSL) comes with the rubber stopper.
3. In the vertical lead wire type, the lead wire protrudes the sensor switch at right angles.

**For details of sensor switches, see p.1544.
### Inner Construction

#### RAT5

![Diagram of RAT5](image)

#### RAT10, RAT30

![Diagram of RAT10, RAT30](image)

### Major Parts and Materials

#### RAT5

<table>
<thead>
<tr>
<th>No.</th>
<th>Parts</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Body</td>
<td>Aluminum alloy (anodized)</td>
</tr>
<tr>
<td>2</td>
<td>Piston seal</td>
<td>Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>3</td>
<td>Table</td>
<td>Aluminum alloy (anodized)</td>
</tr>
<tr>
<td>4</td>
<td>Table holding screw</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>5</td>
<td>Stopper</td>
<td>Special steel</td>
</tr>
<tr>
<td>6</td>
<td>Adjusting bolt</td>
<td>Steel (nickel plated)</td>
</tr>
<tr>
<td>7</td>
<td>Rack</td>
<td>Plastic</td>
</tr>
<tr>
<td>8</td>
<td>Spur gear</td>
<td>Steel</td>
</tr>
<tr>
<td>9</td>
<td>Bearing</td>
<td>Steel</td>
</tr>
<tr>
<td>10</td>
<td>Bearing</td>
<td>Steel</td>
</tr>
<tr>
<td>11</td>
<td>Spring pin</td>
<td>Steel</td>
</tr>
<tr>
<td>12</td>
<td>O-ring</td>
<td>Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>13</td>
<td>O-ring</td>
<td>Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>14</td>
<td>Snap ring</td>
<td>Steel (nickel plated)</td>
</tr>
<tr>
<td>15</td>
<td>Washer</td>
<td>Steel</td>
</tr>
<tr>
<td>16</td>
<td>Hexagon nut</td>
<td>Mild steel (zinc plated)</td>
</tr>
<tr>
<td>17</td>
<td>Piston</td>
<td>Plastic</td>
</tr>
<tr>
<td>18</td>
<td>Magnet</td>
<td>Plastic magnet</td>
</tr>
<tr>
<td>19</td>
<td>Magnet holder</td>
<td>Plastic</td>
</tr>
<tr>
<td>20</td>
<td>End plate</td>
<td>Plastic</td>
</tr>
<tr>
<td>21</td>
<td>Bumper</td>
<td>Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>22</td>
<td>Shock absorber</td>
<td>—</td>
</tr>
</tbody>
</table>

#### RAT10, RAT30

<table>
<thead>
<tr>
<th>No.</th>
<th>Parts</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Body</td>
<td>Aluminum alloy (anodized)</td>
</tr>
<tr>
<td>2</td>
<td>Piston seal</td>
<td>Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>3</td>
<td>Table</td>
<td>Aluminum alloy (anodized)</td>
</tr>
<tr>
<td>4</td>
<td>Table holding screw</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>5</td>
<td>Stopper</td>
<td>Special steel</td>
</tr>
<tr>
<td>6</td>
<td>Adjusting bolt</td>
<td>Steel (nickel plated)</td>
</tr>
<tr>
<td>7</td>
<td>Rack</td>
<td>Plastic</td>
</tr>
<tr>
<td>8</td>
<td>Bearing</td>
<td>Steel</td>
</tr>
<tr>
<td>9</td>
<td>Bearing</td>
<td>Steel</td>
</tr>
<tr>
<td>10</td>
<td>Plug</td>
<td>Mild steel (nickel plated)</td>
</tr>
<tr>
<td>11</td>
<td>Steel ball</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>12</td>
<td>Seal</td>
<td>Mild steel + Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>13</td>
<td>O-ring</td>
<td>Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>14</td>
<td>O-ring</td>
<td>Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>15</td>
<td>Snap ring</td>
<td>Steel (nickel plated)</td>
</tr>
<tr>
<td>16</td>
<td>Washer</td>
<td>Steel</td>
</tr>
<tr>
<td>17</td>
<td>Hexagon nut</td>
<td>Mild steel (zinc plated)</td>
</tr>
<tr>
<td>18</td>
<td>Piston</td>
<td>Plastic</td>
</tr>
<tr>
<td>19</td>
<td>Magnet</td>
<td>Plastic magnet</td>
</tr>
<tr>
<td>20</td>
<td>Magnet holder</td>
<td>Plastic</td>
</tr>
<tr>
<td>21</td>
<td>End plate</td>
<td>Plastic</td>
</tr>
<tr>
<td>22</td>
<td>Bumper</td>
<td>Synthetic rubber (NBR)</td>
</tr>
<tr>
<td>23</td>
<td>Shock absorber</td>
<td>—</td>
</tr>
</tbody>
</table>
Swing Angle Range and Swing Direction

**90° type**

- **Angle adjustment range**: ±5° by adjusting bolt C (shock absorber C)

**180° type**

- **Angle adjustment range**: ±5° by adjusting bolt D (shock absorber D)

Piping Port Location and Swing Direction

**RAT5**

The table swings in clockwise rotation when air is supplied to connection port A, and in counterclockwise rotation when air is supplied to connection port B. (The other surfaces do not have connection ports.)

**RAT10, 30**

The table swings in clockwise rotation when air is supplied to connection port A, C, E or G, and in counterclockwise rotation when air is supplied to connection port B, D, F or H. Note that connection ports C, D, E, F, G and H are plugged at shipping.
**Dimensions (mm)**

**RAT5-90**

![Diagram of RAT5-90]

Remark: The drawings show when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).

**Dimensions of Shock Absorber (mm)**

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>KSHAR5×5-D</td>
<td>M8×0.75</td>
<td>5</td>
<td>46</td>
<td>31</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>1.2</td>
<td>2</td>
<td>10</td>
<td>11.5</td>
<td>10</td>
</tr>
<tr>
<td>KSHAR5×5-E</td>
<td>M8×0.75</td>
<td>5</td>
<td>46</td>
<td>31</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>1.2</td>
<td>2</td>
<td>10</td>
<td>11.5</td>
<td>10</td>
</tr>
<tr>
<td>KSHAR6×8-F</td>
<td>M10×1</td>
<td>8</td>
<td>61</td>
<td>45</td>
<td>8</td>
<td>4</td>
<td>5</td>
<td>9</td>
<td>2</td>
<td>3</td>
<td>12</td>
<td>13.9</td>
<td>8</td>
</tr>
</tbody>
</table>

Note: Do not screw the bolt deeper than the thread depth.

For mounting a workpiece on the table, see the Handling Instructions and Precautions, “Mounting,” on p.1235.
RAT5-180

Remark: The drawings show when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).

Note: Do not screw the bolt deeper than the thread depth.
For mounting a workpiece on the table, see the Handling Instructions and Precautions, "Mounting," on p.1235.
Dimensions (mm)

**RAT10-90**
**RAT30-90**

<table>
<thead>
<tr>
<th>Model Code</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>P</th>
<th>Q</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT10</td>
<td>53</td>
<td>10.5</td>
<td>35</td>
<td>50</td>
<td>64</td>
<td>76</td>
<td>M4×0.7 Depth7</td>
<td>35</td>
<td>14H7 (teflon) Depth6</td>
<td>6</td>
<td>28</td>
<td>34</td>
<td>43</td>
<td>48</td>
<td>49</td>
<td>53</td>
</tr>
<tr>
<td>RAT30</td>
<td>63</td>
<td>11.5</td>
<td>44</td>
<td>60</td>
<td>72</td>
<td>102</td>
<td>M6×1 Depth8</td>
<td>44</td>
<td>18H7 (teflon) Depth12</td>
<td>6</td>
<td>35</td>
<td>41</td>
<td>54</td>
<td>60</td>
<td>59</td>
<td>84</td>
</tr>
</tbody>
</table>

**RAT10-90-SS2**
**RAT30-90-SS2**

**RAT10-90-SSL**
**RAT30-90-SSL**

**RAT10-90-SSR**
**RAT30-90-SSR**

**Remark:** The drawings show when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).

**Note:** Do not screw the bolt deeper than the thread depth.

For mounting a workpiece on the table, see the Handling Instructions and Precautions, "Mounting," on p.1235.
RAT10-180
RAT30-180

M5×0.8 Connection port
(Counterclockwise rotation side, plug supplied)

M5×0.8 Connection port
(Clockwise rotation side, plug supplied)

Remark: The drawings show when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).

RAT10-180-SS2
RAT30-180-SS2

RAT10-180-SSL
RAT30-180-SSL

Note: Do not screw the bolt deeper than the thread depth.

For mounting a workpiece on the table, see the Handling Instructions and Precautions, “Mounting,” on p.1235.

<table>
<thead>
<tr>
<th>Model Code</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>P</th>
<th>Q</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT10</td>
<td>53</td>
<td>10.5</td>
<td>35</td>
<td>50</td>
<td>64</td>
<td>96</td>
<td>M4×0.7 Depth7</td>
<td>35</td>
<td>14H7 (10g9) Depth6</td>
<td>6</td>
<td>28</td>
<td>34</td>
<td>43</td>
<td>48</td>
<td>49</td>
<td>75</td>
</tr>
<tr>
<td>RAT30</td>
<td>63</td>
<td>11.5</td>
<td>44</td>
<td>60</td>
<td>72</td>
<td>135</td>
<td>M6×1 Depth8</td>
<td>44</td>
<td>18H7 (10g9) Depth12</td>
<td>6</td>
<td>35</td>
<td>41</td>
<td>54</td>
<td>60</td>
<td>59</td>
<td>117</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model Code</th>
<th>Code</th>
<th>S</th>
<th>T</th>
<th>U</th>
<th>V</th>
<th>W</th>
<th>Y</th>
<th>Z</th>
<th>AA</th>
<th>AB</th>
<th>AC</th>
<th>AD</th>
<th>AE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT10</td>
<td></td>
<td>M6×1 Depth9 Drilled hole diameter φ 5.2 through hole</td>
<td>40</td>
<td>39</td>
<td>M8×0.75</td>
<td>6</td>
<td>28</td>
<td>36.5</td>
<td>28</td>
<td>6</td>
<td>75</td>
<td>20</td>
<td>KSHARS X5-E</td>
</tr>
<tr>
<td>RAT30</td>
<td></td>
<td>M8×1.25 Depth12 Drilled hole diameter φ 6.6 through hole</td>
<td>48</td>
<td>50</td>
<td>M10×1</td>
<td>6</td>
<td>35</td>
<td>46.5</td>
<td>35</td>
<td>6</td>
<td>117</td>
<td>27</td>
<td>KSHAR6X8-F</td>
</tr>
</tbody>
</table>
## Order Codes

<table>
<thead>
<tr>
<th>Series</th>
<th>Lead wire length</th>
<th>Sensor switch</th>
<th>Voltage</th>
<th>Lead wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT</td>
<td>A — 1000mm [39in.]</td>
<td>ZE135 — Solid state type with indicator lamp</td>
<td>DC10~28V</td>
<td>Horizontal lead wire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZE235 — Solid state type with indicator lamp</td>
<td>DC10~28V</td>
<td>Vertical lead wire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZE101 — Reed switch type without indicator lamp</td>
<td>DC5~28V</td>
<td>Horizontal lead wire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZE201 — Reed switch type without indicator lamp</td>
<td>DC5~28V</td>
<td>Vertical lead wire</td>
</tr>
<tr>
<td></td>
<td>B — 3000mm [118in.]</td>
<td>ZE155 — Solid state type with indicator lamp</td>
<td>DC4.5~28V</td>
<td>Horizontal lead wire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZE255 — Solid state type with indicator lamp</td>
<td>DC4.5~28V</td>
<td>Vertical lead wire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZE102 — Reed switch type with indicator lamp</td>
<td>DC10~28V</td>
<td>Horizontal lead wire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZE202 — Reed switch type with indicator lamp</td>
<td>DC10~28V</td>
<td>Vertical lead wire</td>
</tr>
</tbody>
</table>

For details of sensor switches, see p.1544.
Moving Sensor Switch

- Loosening the mounting screw allows the sensor switch to be moved along the switch mounting groove on the rotary actuator.
- Tighten the mounting screw with a tightening torque of 0.1~0.2N·m [0.9~1.8in·lb].

When Mounting the Actuators with Sensor Switches in Close Proximity

When mounting the actuators in close proximity, use them at the values shown in the table below, or larger.

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT5</td>
<td>70 [2.76]</td>
<td>10 [0.039]</td>
</tr>
<tr>
<td>RAT10</td>
<td>80 [3.15]</td>
<td>17 [0.67]</td>
</tr>
<tr>
<td>RAT30</td>
<td>90 [3.54]</td>
<td>20 [0.79]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Solid State Type</th>
<th>mm [in.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating range: $R$</td>
<td>2.0<del>6.0 [0.079</del>2.36]</td>
<td></td>
</tr>
<tr>
<td>Response differential: $C$</td>
<td>1.0 or less [0.039 or less]</td>
<td></td>
</tr>
<tr>
<td>Maximum sensing location</td>
<td>6 [0.24]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Reed Switch Type</th>
<th>mm [in.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating range: $R$</td>
<td>5.5<del>9.5 [0.217</del>0.374]</td>
<td></td>
</tr>
<tr>
<td>Response differential: $C$</td>
<td>1.5 or less [0.059 or less]</td>
<td></td>
</tr>
<tr>
<td>Maximum sensing location</td>
<td>10 [0.394]</td>
<td></td>
</tr>
</tbody>
</table>

Sensor Switch Operating Range, Response Differential, and Maximum Sensing Location

- **Operating range**: $R$
  The distance the piston travels in one direction, while the switch is in the ON position.

- **Response Differential**: $C$
  The distance between the point where the piston turns the switch ON and the point where the switch is turned OFF as the piston travels in the opposite direction.

<table>
<thead>
<tr>
<th>Item</th>
<th>Solid state type</th>
<th>mm [in.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating range: $R$</td>
<td>2.0<del>6.0 [0.079</del>2.36]</td>
<td></td>
</tr>
<tr>
<td>Response differential: $C$</td>
<td>1.0 or less [0.039 or less]</td>
<td></td>
</tr>
<tr>
<td>Maximum sensing location</td>
<td>6 [0.24]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Reed switch type</th>
<th>mm [in.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating range: $R$</td>
<td>5.5<del>9.5 [0.217</del>0.374]</td>
<td></td>
</tr>
<tr>
<td>Response differential: $C$</td>
<td>1.5 or less [0.059 or less]</td>
<td></td>
</tr>
<tr>
<td>Maximum sensing location</td>
<td>10 [0.394]</td>
<td></td>
</tr>
</tbody>
</table>
Mounting Location of Swing End Detection Sensor Switch

RAT5-90/180

RAT10-90/180
RAT30-90/180

Solid State Type (ZE135, ZE155, ZE235, ZE255)

<table>
<thead>
<tr>
<th></th>
<th>90° specification</th>
<th>180° specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>30.3 [1.193]</td>
<td>40.3 [1.587]</td>
</tr>
<tr>
<td>B</td>
<td>39.7 [1.563]</td>
<td>59.1 [2.327]</td>
</tr>
<tr>
<td>C</td>
<td>33.7 [1.327]</td>
<td>43.7 [1.720]</td>
</tr>
<tr>
<td>D</td>
<td>24.3 [0.967]</td>
<td>24.9 [0.980]</td>
</tr>
<tr>
<td>E</td>
<td>24.3 [0.967]</td>
<td>24.9 [0.980]</td>
</tr>
<tr>
<td>F</td>
<td>33.7 [1.327]</td>
<td>43.7 [1.720]</td>
</tr>
<tr>
<td>G</td>
<td>30.3 [1.193]</td>
<td>40.3 [1.587]</td>
</tr>
<tr>
<td>H</td>
<td>24.3 [0.967]</td>
<td>24.9 [0.980]</td>
</tr>
</tbody>
</table>

Reed Switch Type (ZE101, ZE102, ZE201, ZE202)

<table>
<thead>
<tr>
<th></th>
<th>90° specification</th>
<th>180° specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>26.3 [1.035]</td>
<td>36.3 [1.429]</td>
</tr>
<tr>
<td>B</td>
<td>35.7 [1.406]</td>
<td>55.1 [2.169]</td>
</tr>
<tr>
<td>C</td>
<td>29.7 [1.169]</td>
<td>39.7 [1.563]</td>
</tr>
<tr>
<td>D</td>
<td>20.3 [0.799]</td>
<td>20.9 [0.823]</td>
</tr>
<tr>
<td>E</td>
<td>20.3 [0.799]</td>
<td>20.9 [0.823]</td>
</tr>
<tr>
<td>F</td>
<td>29.7 [1.169]</td>
<td>39.7 [1.563]</td>
</tr>
<tr>
<td>G</td>
<td>26.3 [1.035]</td>
<td>36.3 [1.429]</td>
</tr>
<tr>
<td>H</td>
<td>20.3 [0.799]</td>
<td>20.9 [0.823]</td>
</tr>
</tbody>
</table>

Remark: For the table’s 0°, 90° and 180° locations, see p.1250.