Rotary Actuators Piston Type

Flat Rotary Actuators

Koganei Brand
All Products Are RoHS Compliant

RAF
High precision, high rigidity, and lightweight

Uses cross roller bearings
Rotary Actuators Piston Type

Flat Rotary Actuators

Rotary actuator uses cross roller bearings to achieve high precision and rigidity

Six types of torque, 1.0, 2.0, 2.5, 3.0, 5.0, and 7.0 N·m (0.74, 1.48, 1.84, 2.21, 3.69, and 5.16 ft·lbf) Note (Nominal) are available.  Note: At operating pressure of 0.5 MPa [73 psi]

Uses cross roller bearings to achieve high precision and rigidity

Smooth operation from low to high speeds 0.2 to 7.0 s/90°

Workpiece can be mounted directly to bearing.

Additional parts for mounting are available. Can handle a variety of mounting formats.

Thin construction for installation in narrow spaces.

Large diameter hollow shaft makes piping and wiring easy.

Equipped with newly developed pressure-resistant shock absorber. Allows smooth control at the end of stroke.

Uses KSHK series linear orifice® pressure-resistant shock absorbers

“Linear orifice” is a registered trademark of Koganei Corporation.

Torque Variation

<table>
<thead>
<tr>
<th>Torque Value</th>
<th>Conversion Value</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 N·m</td>
<td>0.74 ft·lbf</td>
<td>RAF10-180</td>
</tr>
<tr>
<td>2.0 N·m</td>
<td>1.48 ft·lbf</td>
<td>RAF20-180</td>
</tr>
<tr>
<td>2.5 N·m</td>
<td>1.84 ft·lbf</td>
<td>RAF25-180</td>
</tr>
<tr>
<td>3.0 N·m</td>
<td>2.21 ft·lbf</td>
<td>RAF30-180</td>
</tr>
</tbody>
</table>
Before use, be sure to read the “Safety Precautions” on page 3.

**CAUTION**

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- Safety Precautions ..................................... 3
- Handling Instructions and Precautions ............. 5
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- Sensor Switches ....................................... 13

**Application example**

- Supply and remove workpieces
  - Sensors detect presence of workpieces
  - Press fitting
  - Supply/remove
  - Mounted to body by outer ring of cross roller bearing

- Manufacturing process for discs etc.

**Additional Parts**

- Locating pin for body P1-RAF
- Locating ring for bottom of body R-RAF
- Locating pin for cross roller bearing P2-RAF
- Spacer for cross roller bearing SP-RAF
- Shock absorber KSHK × 01

**Features**

Various mounting methods including body or outer ring mounting

Large diameter hollow shaft

Wiring and piping fit easily. Also, spacers (additional parts) makes mounting brackets simple.

Thin construction

Smooth operation from low to high speeds 0.2 to 7.0 s/90°

**Application example**

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**Application example**

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**Application example**

- Supply and remove workpieces
  - Sensors detect presence of workpieces
  - Press fitting
  - Mounted to body by outer ring of cross roller bearing

- Manufacturing process for discs etc.
Before selecting and using the products, please read all the Safety Precautions carefully to ensure proper product use. The Safety Precautions shown below are to help you use the product safely and correctly, and to prevent injury or damage to you, other people, and assets beforehand.

Follow the Safety Precautions for: ISO4414 (Pneumatic fluid power—Recommendations for the application of equipment to transmission and control systems), JIS B 8370 (Pneumatic system regulations)

The directions are ranked according to degree of potential danger or damage:

- **DANGER!** Expresses situations that can be clearly predicted as dangerous. If the noted danger is not avoided, it could result in death or serious injury. It could also result in damage or destruction of assets.
- **WARNING** Expresses situations that, while not immediately dangerous, could become dangerous. If the noted danger is not avoided, it could result in death or serious injury. It could also result in damage or destruction of assets.
- **CAUTION** Expresses situations that, while not immediately dangerous, could become dangerous. If the noted danger is not avoided, it could result in light or semi-serious injury. It could also result in damage or destruction of assets.
- **ATTENTION** While there is little chance of injury, this content refers to points that should be observed for appropriate use of the product.

- **This product was designed and manufactured as parts for use in General Industrial Machinery.**
- In the selection and handling of the equipment, the system designer or other person with fully adequate knowledge and experience should always read the Safety Precautions, Catalog, Owner’s Manual and other literature before commencing operation. Making mistakes in handling is dangerous.
- After reading the Owner’s Manual, Catalog, etc., always place them where they can be easily available for reference to users of this product.
- If transferring or lending the product to another person, always attach the Owner’s Manual, Catalog, etc., to the product where they are easily visible, to ensure that the new user can use the product safely and properly.
- The danger, warning, and caution items listed under these “Safety Precautions” do not cover all possible cases. Read the Catalog and Owner’s Manual carefully, and always keep safety first.

### Safety Precautions (Flat Rotary)

**DANGER**
- Do not use the product for the purposes listed below:
  1. Medical equipment related to maintenance or management of human lives or bodies.
  2. Machines or equipment designed for the purpose of moving or transporting people.
  3. Critical safety components in mechanical devices.

- This product has not been planned or designed for purposes that require advanced levels of safety. Using it in this way may result in loss of human life.
- Do not use the product in locations with or near dangerous substances such as flammable or ignitable substances. This product is not explosion-proof. It could ignite or burst into flames.
- When mounting the product and workpiece, always firmly support and secure them in place. Falling, dropping, or abnormal operation etc. of the product, may result in injury.
- Persons who use a pacemaker, etc., should keep a distance of at least one meter [3.28 ft] away from the product. There is a possibility that the pacemaker will malfunction due to the strong magnet built into the product.
- Never attempt to modify the product. It could result in abnormal operation leading to injury, electric shocks, fire, etc.
- Never attempt inappropriate disassembly, assembly, or repair of the product relating to basic construction, or to its performance or functions. It could result in injury, electric shocks, fire, etc.
- Do not splash water on the product. Spraying it with water, washing it, or using it under water could result in malfunction of the product leading to injury, electric shocks, fire, etc.
- While the product is in operation, avoid touching it with your hands or otherwise approaching too close. In addition, do not make any adjustments to the interior or to the attached mechanisms (sensor switch mounting location, disconnection of piping tubes or plugs, etc.). The actuator may move suddenly, possibly resulting in injury.
- When operating the product, always install speed controllers, and gradually loosen the needle valve from a choked state to adjust the increase in speed. Failure to make this adjustment could result in sudden movements, putting human lives at risk.

**WARNING**
- Do not use the product in excess of its specification range. Such use could result in product breakdowns, function stops, or damage. It could also drastically reduce the product’s operating life.
- Before supplying air or electricity to the device and before starting operation, always conduct a safety check of the area where the machine is operating. Unintentional supply of air or electricity could possibly result in electric shocks, or in injury caused by contact with moving parts.
- Do not touch the terminals and the miscellaneous switches, etc., while the device is turned on. There is a possibility of electric shocks and abnormal operation.
- Do not allow the product to be thrown into fire. The product could explode and/or release toxic gases.
- Do not sit on the product, place your foot on it, or place other objects on it. Dropping the product may result in injury, damage or breakage to the product resulting in abnormal, erratic, or runaway operation, etc.
- When conducting operations, such as maintenance, inspection, repair, or replacement on the product, always turn off the air supply completely and confirm that residual pressure inside the product or in piping connected to the product is zero before proceeding. In particular, be aware that residual air will still be in the air compressor or air storage tank. The actuator could abruptly move if residual air pressure remains inside the piping, causing injury.
- Do not use the actuator for equipment whose purpose is absorbing the shocks and vibrations of mechanical devices. It could break and possibly result in injury or in damage to mechanical devices.
- Avoid scratching the cords for the sensor switch lead wires, etc. Subjecting the cords to scratching, excessive bending, pulling, rolling up, placing them under heavy objects, or squeezing them between two objects may result in current leaks or defective continuity that lead to fires, electric shocks, or abnormal operation.
- Do not subject sensor switches to an external magnetic field during actuator operation. Untended movements could result in damage to the equipment or in personal injury.
Always observe the following items.

1. When using this product in pneumatic systems, always use genuine KOGANEI parts or compatible parts (recommended parts). When conducting maintenance and repairs, always use genuine KOGANEI parts or compatible parts (recommended parts). Always observe the required methods and procedures.

2. Never attempt inappropriate disassembly or assembly of the product relating to basic configurations, or its performance or functions.

Koganei is not responsible if these items are not properly observed.
Design and selection

1. **Check the specifications.**
   Read the specifications carefully to ensure correct use within the product’s specified voltage, current, temperature, and maximum impact. Otherwise, it could result in a breakdown or defective operation.

2. **Avoid mounting actuators in close proximity to each other.**
   Mounting two or more actuators with sensor switches in close proximity may result in erratic operation of the sensor switches due to magnetic field interference.

3. **Be careful of how long the sensor switch is ON when detecting the position in mid-stroke.**
   When setting the sensor switch at an intermediate position of the actuator stroke, be aware that it is possible that if the actuator’s speed is too fast during detection of piston travel, the sensor switch’s operation time will decrease and the load (programmable controller, etc.) may not activate.
   
   The maximum cylinder speed that can be detected is calculated using the formula below.

   \[
   V \text{[mm/s]} = \frac{\text{Sensor switch operating range [mm]}}{\text{Time required to activate load [ms]}} \times 1000
   \]

4. **Keep wiring as short as possible.**
   Lead wires for solid state sensor switches should be within 30 m [98 ft.] as stipulated by EN standards. For the reed sensor switch, if the lead wire is too long (10 m [33 ft.] or more), capacitive surges will shorten the operating life of the sensor switch. If long wiring is needed, install the protection circuit mentioned in the catalog.
   
   If the load is inductive or capacitive, also install the protection circuit mentioned in the catalog.

5. **Avoid repeated or excessive bending or pulling of lead wires.**
   Applying repeated bending stress or tension force on the lead wires could break them.

6. **Check for current leakage.**
   2-lead wire solid state sensor switches produce current leakage to activate their internal circuits and the current passes through the load even when turned-off. Ensure that they satisfy the following inequality:

   \[
   \text{Input off current of programmable controller} > \text{Leakage current}
   \]

   If the above inequality cannot be satisfied, select a 3-lead wire solid state sensor switch instead. Also note that parallel installation of a total of \( n \) sensor switches will multiply the amount of current leakage by \( n \) times.

**CAUTION**

1. **Check for sensor switch internal voltage drop.**
   Series connection of reed sensor switches with indicator lamps or 2-lead wire solid state sensor switches causes increasing internal voltage drop and the load may fail to activate. A total number of \( n \) sensor switches will lead to \( n \) times the internal voltage drop.
   
   Ensure that the system satisfies the following inequality:

   \[
   \text{Supply voltage} - \text{Internal voltage drop} \times n > \text{Minimum operating voltage for load}
   \]

   In relays with a rated voltage of less than 24VDC, check to see whether the above inequality is satisfied, even in the case of \( n = 1 \).

   If the above inequality cannot be satisfied, select a reed sensor switch without an indicator lamp.

2. **Do not use KOGANEI sensor switches with actuators from another company.**
   The sensor switches are designed for use with KOGANEI actuators only. Use with actuators from another company may lead to malfunction.

Installation and adjustment

1. **During actuator operation, do not subject sensor switches to an external magnetic field.**
   Unintended movements could result in damage to the equipment or in personal injury.

**CAUTION**

1. **Ensure a safe installation environment for the actuators with sensors.**
   Do not use the sensor switch in locations subject to large electrical currents or strong magnetic fields. It could result in erratic operation. In addition, do not use magnetized materials for the mounting bracket. Doing so may cause erratic operation.

2. **Install sensor switches in the center of their operating range.**
   Adjust the mounting position of a sensor switch so that the piston stops in the center of its operating range (the range while the sensor is ON). Operations will be unstable if mounted at the end of the operating range (at the boundary near ON and OFF). Also be aware that the operating range will vary with changes in temperature.

3. **Follow the tightening torque guidelines for mounting sensor switches.**
   Over-tightening beyond the allowed tightening torque may damage the mounting threads, mounting brackets, sensor switches and other components. However, insufficient tightening torque may cause the sensor switch position to change, resulting in unstable operation. Follow the instructions on p. 6 concerning the tightening torque.

4. **Do not carry the actuator by the sensor switch lead wires.**
   After mounting a sensor switch to an actuator, do not grab the lead wires to carry the actuator. It may not only break the lead wires, but it will apply stress to the interior of the sensor switch causing the internal electronic elements to break.

5. **Do not drop or bump sensor switches.**
   While handling sensor switches, do not subject them to excessive shock (294.2 m/s² [30G]) by hitting, dropping or bumping them. For reed sensor switches, the contact reed may be activated unintentionally, causing it to send or break signals suddenly. This may cause contact interval changes that will affect sensor switch sensitivity and result in erratic operation. Even if the sensor switch case is undamaged, the internal electronic elements of the sensor switch may be damaged resulting in erratic operations.
Handling Instructions and Precautions

General Precautions

Air supply
1. Use air as the medium. For the use of any other medium, consult KOGANEI.
2. Air used for the flat rotary actuator should be clean air that contains no degraded compressor oil, etc. Install an air filter (filtration of 40 µm or less) near the flat rotary actuator or valve to remove dust or accumulated liquid. Also drain the air filter periodically.

Piping
1. Before installing piping for the flat rotary actuator, always flush the tube completely by blowing compressed air through it. Machining chips, sealing tape, rust and other debris remaining from the piping work may result in air leaks and malfunctions.
2. When screwing pipes or fittings into the flat rotary actuator, use the appropriate tightening torque shown below:

<table>
<thead>
<tr>
<th>Connecting thread</th>
<th>Tightening torque N·m [ft·lbf.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5 x 0.8</td>
<td>1.0<del>1.5 [0.74</del>1.11]</td>
</tr>
<tr>
<td>Rc 1/8</td>
<td>7<del>9 [5.2</del>6.6]</td>
</tr>
</tbody>
</table>

Lubrication
Do not lubricate the flat rotary actuator. Doing so may reduce the operability of the flat rotary actuator, causing the physical properties of the materials used in the shock absorber to change or deteriorate, and may cause a reduction in functionality.

Atmosphere
Protect the actuator with a cover if it is being used where it may be splashed with water or oil.

When in use
Due to the way the flat rotary actuator is built, a sudden application of compressed air at initial operation may disable speed control resulting in damage to the equipment or the actuator. When applying pressure to flat rotary actuators and equipment that are not pressurized, make sure the table is turned all the way to one side and apply pressure through the piping connection port that does not move the table. See page 14 for information about port location and swing direction.

Or, if the mass moment of inertia of the workpiece is particularly large, use a 5-port, 3-position pressure center solenoid valve to start at the pressure center position. However, do not cause it to hold in a stop location. The location may shift due to air leaks etc.

Holding torque
When the internal rack contacts and stops against the shock absorber in the flat rotary actuator (double acting double piston type) with shock absorber, the holding torque at the swing end is half of the effective torque.
Handling Instructions and Precautions

**Mounting**

**Body mounting**

The flat rotary actuator can be mounted in the following four ways. Tighten mounting screws to a torque within the range limits.

1. **Mounting using the through holes on the body**

2. **Mounting by the bottom of the body**

3. **Mounting by the top of the body**

<table>
<thead>
<tr>
<th>Model</th>
<th>Screw size</th>
<th>Maximum tightening torque N·m [ft·lbf]</th>
<th>Screw size</th>
<th>Maximum tightening torque N·m [ft·lbf]</th>
<th>Screw size</th>
<th>Maximum tightening torque N·m [ft·lbf]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180</td>
<td>M5 × 0.8</td>
<td>3.0 [2.21]</td>
<td>M6 × 1</td>
<td>5.2 [3.84]</td>
<td>M4 × 0.7</td>
<td>1.5 [1.11]</td>
</tr>
<tr>
<td>RAF20-180</td>
<td>M6 × 1</td>
<td>5.2 [3.84]</td>
<td>M8 × 0.25</td>
<td>12.5 [9.22]</td>
<td>M5 × 0.8</td>
<td>3.0 [2.21]</td>
</tr>
<tr>
<td>RAF25-180</td>
<td>M8 × 1.25</td>
<td>12.5 [9.22]</td>
<td>M10 × 1.5</td>
<td>24.5 [18.07]</td>
<td>M6 × 1</td>
<td>5.2 [3.84]</td>
</tr>
<tr>
<td>RAF30-180</td>
<td>M8 × 1.25</td>
<td>12.5 [9.22]</td>
<td>M10 × 1.5</td>
<td>24.5 [18.07]</td>
<td>M6 × 1</td>
<td>5.2 [3.84]</td>
</tr>
<tr>
<td>RAF50-180</td>
<td>M8 × 1.25</td>
<td>12.5 [9.22]</td>
<td>M10 × 1.5</td>
<td>24.5 [18.07]</td>
<td>M6 × 1</td>
<td>5.2 [3.84]</td>
</tr>
<tr>
<td>RAF70-180</td>
<td>M8 × 1.25</td>
<td>12.5 [9.22]</td>
<td>M10 × 1.5</td>
<td>24.5 [18.07]</td>
<td>M6 × 1</td>
<td>5.2 [3.84]</td>
</tr>
</tbody>
</table>

When using the mounting holes in the outer ring of the cross roller bearings, be sure to use screws that are shorter than the thread depth. Screws that are longer than the thread depth will contact the inner parts, and cause defective operations and damage. Also, the inner and outer rings of the cross roller bearing are the same height, so there must be a difference in level when mounted and designed so the inner ring does not touch the plate mounted on the outer ring. The recommended dimensions are shown in the table above.
Handling instructions and precautions for shock absorbers

1. The shock absorber is temporarily tightened before shipping. Before using the actuator be sure to tighten the hexagon nuts and secure them in place.

2. When tightening hexagon nuts, ensure that the tightening force is within the maximum range. Tightening using excessive force may result in damage.

<table>
<thead>
<tr>
<th>Model</th>
<th>Maximum tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-SS2</td>
<td>6.5 [4.79]</td>
</tr>
<tr>
<td>RAF20-180-SS2</td>
<td>6.5 [4.79]</td>
</tr>
<tr>
<td>RAF25-180-SS2</td>
<td>12.0 [8.85]</td>
</tr>
<tr>
<td>RAF30-180-SS2</td>
<td>20.0 [14.75]</td>
</tr>
<tr>
<td>RAF50-180-SS2</td>
<td>25.0 [18.44]</td>
</tr>
<tr>
<td>RAF70-180-SS2</td>
<td>30.0 [22.13]</td>
</tr>
</tbody>
</table>

3. The screw on the rear end of the shock absorber should never be loosened or removed. Oil may leak out of the shock absorber leading to a loss of functionality and resulting in damage to the equipment and accidents.

4. Do not block the air path port on the rear end of the shock absorber. Doing so applies air pressure on the inside of the shock absorber leading to a loss of functionality and resulting in damage to the equipment and accidents.

5. Be sure to insert the KSHK18 × 9-01 seal washer in the orientation shown below. Inserting it in the opposite orientation causes air leaks. Also, keep the direction of motion to one direction. Moving it in the opposite direction damages the packing and causes air leaks.

Replacement procedure for the shock absorber

Before replacement, be sure to completely turn off the air supply, and check that the air pressure in the pipes and equipment is zero. Loosen the hexagon nut for the shock absorber and remove it. Screw in the new shock absorber into the correct position and then tighten it in place with the hexagon nut. Tighten the nut to within the maximum torque. Tightening using excessive torque may result in damage.

Replace shock absorbers only with those listed on page 2. Do not replace them with any other shock absorbers.

Swing angle adjustment using shock absorber

1. The flat rotary actuator uses shock absorbers that can be adjusted in the range of angles shown on page 2. For both clockwise and counterclockwise rotation, screwing in the shock absorber reduces the swing angle. Set the air pressure at the minimum 0.2 MPa [29 psi] when adjusting the swing angle. After completing angle adjustment, tighten the hexagon nuts and secure them in place.

2. Always use a swing angle within the specified range. The dimension L shown in the table below indicates the protrusion of the shock absorber at the maximum swing angle. Do not exceed the L dimension. Using an excessive L dimension will cause the rack inside to touch the side plate, causing defective operations.

<table>
<thead>
<tr>
<th>Model</th>
<th>Dimensions of shock absorber protrusion mm [in.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-SS2</td>
<td>32.1 [1.264]</td>
</tr>
<tr>
<td>RAF20-180-SS2</td>
<td>38.0 [1.496]</td>
</tr>
<tr>
<td>RAF25-180-SS2</td>
<td>45.8 [1.803]</td>
</tr>
<tr>
<td>RAF30-180-SS2</td>
<td>51.8 [2.039]</td>
</tr>
<tr>
<td>RAF50-180-SS2</td>
<td>53.9 [2.122]</td>
</tr>
<tr>
<td>RAF70-180-SS2</td>
<td>61.5 [2.421]</td>
</tr>
</tbody>
</table>

Precautions when there is no angle adjustment mechanism

When the actuator does not have an angle adjustment mechanism (no shock absorbers), be sure to install an external shock absorber or stopper mechanism so the rack does not hit the plug. Absolutely, do not loosen or remove the plug. Doing so may cause air leaks, defective operation, or the plug may fly out.
Workpiece mounting

When mounting the workpiece on the inner ring of the cross roller bearings, be sure to use screws that are shorter than the thread depth. Screws that are longer than the thread depth will contact the inner parts, and cause defective operations and damage. Also, the inner and outer rings of the cross roller bearing are the same height, so there must be a difference in level when mounted and designed so the inner ring does not touch the plate mounted on the outer ring. The recommended dimensions are shown in the table above.

Recommended dimensions for locating ring

<table>
<thead>
<tr>
<th>Model</th>
<th>Locating ring model</th>
<th>φ A</th>
<th>φ B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-</td>
<td>R-RAF10</td>
<td>13H7</td>
<td>0.51181 [0.020]</td>
<td>17 [0.669]</td>
</tr>
<tr>
<td>RAF20-180-</td>
<td>R-RAF20</td>
<td>17H7</td>
<td>0.69629 [0.028]</td>
<td>21 [0.827]</td>
</tr>
<tr>
<td>RAF25-180-</td>
<td>R-RAF25</td>
<td>19H7</td>
<td>0.74893 [0.030]</td>
<td>23 [0.906]</td>
</tr>
<tr>
<td>RAF30-180-</td>
<td>R-RAF30</td>
<td>23H7</td>
<td>0.90551 [0.034]</td>
<td>27 [1.063]</td>
</tr>
<tr>
<td>RAF50-180-</td>
<td>R-RAF50</td>
<td>50H7</td>
<td>1.02362 [0.040]</td>
<td>30 [1.181]</td>
</tr>
<tr>
<td>RAF70-180-</td>
<td>R-RAF70</td>
<td>26H7</td>
<td>0.90551 [0.034]</td>
<td>30 [1.181]</td>
</tr>
</tbody>
</table>

Air flow rate and air consumption

Air consumption for 1 cycle

<table>
<thead>
<tr>
<th>Model</th>
<th>Air pressure MPa [psi]</th>
<th>cm³/cycle [in.³/cycle] (ANR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-</td>
<td>0.2 [29]</td>
<td>0.3 [44]</td>
</tr>
<tr>
<td>RAF20-180-</td>
<td>37.1 [2624]</td>
<td>49.4 [3015]</td>
</tr>
<tr>
<td>RAF30-180-</td>
<td>94.0 [5736]</td>
<td>125.1 [7634]</td>
</tr>
<tr>
<td>RAF50-180-</td>
<td>142.5 [6696]</td>
<td>189.8 [11582]</td>
</tr>
<tr>
<td>RAF70-180-</td>
<td>184.9 [11283]</td>
<td>246.3 [15030]</td>
</tr>
</tbody>
</table>

1 cm³/cycle = 0.061024 in.³/cycle
1 MPa = 145 psi
Calculation of air flow rate and air consumption

The graph on the previous page shows the air consumption during 1 cycle of the flat rotary actuator used in a 180° swing angle. The actual air flow rate and consumption required can be found through the following calculations.

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

\[ Q_1 = \frac{\pi D^2}{4} \times L \times \frac{60}{t} \times \frac{P + 0.1013}{0.1013} \times 10^{-6} \]

**Finding the air consumption**

\[ Q_2 = \frac{\pi D^2}{4} \times 2 \times L \times 2 \times n \times \frac{P + 0.1013}{0.1013} \times 10^{-6} \]

Q₁ : Air flow rate required for the cylinder ℓ /min (ANR)
Q₂ : Cylinder air consumption ℓ /min (ANR)
D : Cylinder bore inner diameter (bore size) mm
L : Cylinder stroke mm
n : Number of cylinder reciprocations per minute cycles/min
P : Operating pressure MPa

**Bore size and stroke** mm [in.]

<table>
<thead>
<tr>
<th>Model</th>
<th>Cylinder bore size</th>
<th>Cylinder stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180</td>
<td>12 [0.472]</td>
<td>27.6 [1.087]</td>
</tr>
<tr>
<td>RAF20-180</td>
<td>16 [0.630]</td>
<td>34.5 [1.358]</td>
</tr>
<tr>
<td>RAF25-180</td>
<td>16 [0.630]</td>
<td>39.3 [1.547]</td>
</tr>
<tr>
<td>RAF30-180</td>
<td>18 [0.709]</td>
<td>47.1 [1.854]</td>
</tr>
<tr>
<td>RAF50-180</td>
<td>20 [0.787]</td>
<td>49.5 [1.949]</td>
</tr>
<tr>
<td>RAF70-180</td>
<td>22 [0.866]</td>
<td>56.5 [2.224]</td>
</tr>
</tbody>
</table>

**Static load rating for the cross roller bearing alone**

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>RAF10</th>
<th>RAF20</th>
<th>RAF25</th>
<th>RAF30</th>
<th>RAF50</th>
<th>RAF70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrust load</td>
<td>8700</td>
<td>12380</td>
<td>20720</td>
<td>24090</td>
<td>25680</td>
<td>47500</td>
<td></td>
</tr>
<tr>
<td>Ws [N lbf.]</td>
<td>[956]</td>
<td>[2783]</td>
<td>[4658]</td>
<td>[5415]</td>
<td>[5773]</td>
<td>[10678]</td>
<td></td>
</tr>
<tr>
<td>Radial load</td>
<td>3830</td>
<td>5450</td>
<td>9120</td>
<td>10600</td>
<td>11300</td>
<td>20900</td>
<td></td>
</tr>
<tr>
<td>Wr [N lbf.]</td>
<td>[861]</td>
<td>[1225]</td>
<td>[2050]</td>
<td>[2383]</td>
<td>[2540]</td>
<td>[4698]</td>
<td></td>
</tr>
<tr>
<td>Moment</td>
<td>65</td>
<td>110</td>
<td>212</td>
<td>272</td>
<td>319</td>
<td>668</td>
<td></td>
</tr>
<tr>
<td>N·m [ft·lbf.]</td>
<td>[47.9]</td>
<td>[81.1]</td>
<td>[156.4]</td>
<td>[200.6]</td>
<td>[235.3]</td>
<td>[492.7]</td>
<td></td>
</tr>
</tbody>
</table>

Note: Apply 1/30th or less of the static load rating listed above during use. For details see “Selection” on page 10.
Handling Instructions and Precautions

● Displacement of inner ring of cross roller bearing due to moment (by load)
  Measured at a position 100 mm [3.94 in.] from the rotation center, with a load applied to a plate mounted on the flat rotary actuator.

Note: The above values are actual measured values, and are not guaranteed values.

---

● Deflection: Displacement of inner ring of cross roller bearing due to 180° swing

<table>
<thead>
<tr>
<th>Model</th>
<th>Top surface deflection [mm [in.]]</th>
<th>Inside surface deflection [mm [in.]]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-˘</td>
<td>0.015</td>
<td>0.015</td>
</tr>
<tr>
<td>RAF20-180-˘</td>
<td>0.00059</td>
<td>0.00059</td>
</tr>
<tr>
<td>RAF25-180-˘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAF30-180-˘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAF50-180-˘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAF70-180-˘</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The above values are initial values, and are not guaranteed values.

● Parallelism of cross roller bearing

<table>
<thead>
<tr>
<th>Model</th>
<th>Parallelism A [mm [in.]]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-˘</td>
<td>0.030[+mm]</td>
</tr>
<tr>
<td>RAF20-180-˘</td>
<td></td>
</tr>
<tr>
<td>RAF25-180-˘</td>
<td></td>
</tr>
<tr>
<td>RAF30-180-˘</td>
<td></td>
</tr>
<tr>
<td>RAF50-180-˘</td>
<td></td>
</tr>
<tr>
<td>RAF70-180-˘</td>
<td></td>
</tr>
</tbody>
</table>

Note: The above values are actual measured values, and are not guaranteed values.

---

Displacement of inside surface of cross roller bearing

Displacement of top surface of cross roller bearing

1 N·m = 0.7376 ft·lbf

Note: The above values are actual measured values, and are not guaranteed values.
How to select a model

1. Check operating conditions
   ① Swing angle
   ② Swing time (s)  
   ③ Applied pressure (MPa)  
   (Reference — Aluminum alloy: Specific gravity = 2.68×10^3 kg/m^3
   Steel: Specific gravity = 7.85×10^3 kg/m^3)  
   ④ Load shape and materials
   ⑤ Mounting direction

2. Check swing time
   Check that the swing time in 1-④ is within the swing time adjustment range in the specification.
   Swing time: 0.2~7.0 s/90°
   Note: The swing time is obtained with no load at 0.5 MPa.

3. Select torque size
   Find the torque $T_A$ required for rotating the workpiece.
   \[ T_A = l \cdot \omega \cdot K \]
   \[ \omega = \frac{2 \theta}{t^2} \]
   \[ \theta : \text{Swing angle (rad)} \]
   \[ 90° \sim 1.57 \text{rad} \]
   \[ 180° \sim 3.14 \text{rad} \]
   \[ t : \text{Swing time (s)} \]

   Use the applied pressure checked in 1-③ to select an actuator that has the necessary torque $T_A$ from the effective torque tables or graphs on page 10.

4. Check mass moment of inertia in relation to swing time (when using a shock absorber)
   Select an actuator from the “Mass moment of inertia in relation to swing time limits” graphs.
   ■ When swing angle is adjusted to 30°~90° during use
     Refer to page 11 for the graphs for 90° swing angles.
   ■ When swing angle is adjusted to 91°~180° during use
     Refer to page 12 for the graphs for 180° swing angles.

How to select a model

1. Check operating conditions
   ① Swing angle
   ② Swing time [sec.]
   ③ Applied pressure [psi]
   ④ Load shape and materials
   (Reference — Aluminum alloy: Specific gravity = 167 lbf./ft.³
   Steel: Specific gravity = 490 lbf./ft.³)
   ⑤ Mounting direction

2. Check swing time
   Check that the swing time in 1-② is within the swing time adjustment range in the specification.
   Swing time: 0.2~7.0 sec./90°
   Note: The swing time is obtained with no load at 73 psi.

3. Select torque size
   Find the torque $T_A$ required for rotating the workpiece.
   \[ T_A = l \cdot \omega \cdot K \]
   \[ \omega = \frac{2 \theta}{t^2} \]
   \[ \theta : \text{Swing angle [rad.]} \]
   \[ 90° \sim 1.57 \text{rad.} \]
   \[ 180° \sim 3.14 \text{rad.} \]
   \[ t : \text{Swing time [sec.]} \]

   Use the applied pressure checked in 1-③ to select an actuator that has the necessary torque $T_A$ from the effective torque tables or graphs on page 10.

4. Check mass moment of inertia in relation to swing time (when using a shock absorber)
   Select an actuator from the “Mass moment of inertia in relation to swing time limits” graphs.
   ■ When swing angle is adjusted to 30°~90° during use
     Refer to page 11 for the graphs for 90° swing angles.
   ■ When swing angle is adjusted to 91°~180° during use
     Refer to page 12 for the graphs for 180° swing angles.
5. Check load ratio
Check that the loads do not exceed 1/30th of the static load rating on each cross roller bearing. Also, check that the total load ratio does not exceed 1/30th of the static load rating on each cross roller bearing. Refer to page 10 for static load ratings for each cross roller bearing.

\[
\frac{W_S}{W_S\text{ MAX}} \leq \frac{1}{30} \\
\frac{W_R}{W_R\text{ MAX}} \leq \frac{1}{30} \\
\frac{M}{M\text{ MAX}} \leq \frac{1}{30} \\
\frac{W_S}{W_S\text{ MAX}} + \frac{W_R}{W_R\text{ MAX}} + \frac{M}{M\text{ MAX}} \leq \frac{1}{30}
\]

Precautions for mass moment of inertia in relation to swing time limits

1: The values in the “Mass moment of inertia in relation to swing time limits” graphs are not guaranteed values. The values were measured using a shock absorber with average shock absorbing capacity. Shock absorbing capacity varied within tolerances of shock absorber parts. In addition, shock absorbing capacity and characteristics varied due to operating temperature. This causes the swing time to vary, so allow for leeway for actual usage.
2: The times in the “Mass moment of inertia in relation to swing time limits” graphs include shock absorber shock absorbing times.
3: Rebound phenomenon may occur even though it is within the range of the “Mass moment of inertia in relation to swing time limits” graphs. Use a speed controller to control the speed so rebound phenomenon does not occur.
4: The graphs on page 19 and 20 are based on data for a load (mass moment of inertia) applied to the top of a horizontally mounted actuator.

Precautions for mass moment of inertia in relation to swing time limits

1: The values in the “Mass moment of inertia in relation to swing time limits” graphs are not guaranteed values. The values were measured using a shock absorber with average shock absorbing capacity. Shock absorbing capacity varied within tolerances of shock absorber parts. In addition, shock absorbing capacity and characteristics varied due to operating temperature. This causes the swing time to vary, so allow for leeway for actual usage.
2: The times in the “Mass moment of inertia in relation to swing time limits” graphs include shock absorber shock absorbing times.
3: Rebound phenomenon may occur even though it is within the range of the “Mass moment of inertia in relation to swing time limits” graphs. Use a speed controller to control the speed so rebound phenomenon does not occur.
4: The graphs on page 19 and 20 are based on data for a load (mass moment of inertia) applied to the top of a horizontally mounted actuator.
Mass moment of inertia calculation diagrams

When the rotation axis passes through the workpiece

**Disk**

- **Diameter**  \( d \) (m)
- **Mass**  \( m \) (kg)
- **Mass moment of inertia**  \( I = \frac{md^2}{8} \)
- **Turning radius**  \( \frac{d^2}{8} \)

- **Diameter**  \( d \) [ft.]
- **Weight**  \( w \) [lbf.]
- **Mass moment of inertia**  \( I' = \frac{wd^2}{8 \times 32.2} \)
- **Turning 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**  \( I = \frac{m_1 d_1^2 + m_2 d_2^2}{8} \)
- **Turning 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**  \( I' = \frac{(w_1 d_1^2 + w_2 d_2^2)}{8 \times 32.2} \)
- **Turning 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**  \( I = \frac{m \ell^2}{3} \)
- **Turning radius**  \( \frac{\ell^2}{3} \)

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

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

**Slender rod**

- **Bar length**  \( \ell_1 \) (m), \( \ell_2 \) (m)
- **Mass**  \( m_1 \) (kg), \( m_2 \) (kg)
- **Mass moment of inertia**  \( I = \frac{m_1 \ell_1^2 + m_2 \ell_2^2}{3} \)
- **Turning radius**  \( \frac{\ell_1^2 + \ell_2^2}{3} \)

- **Bar length**  \( \ell_1 \) [ft.], \( \ell_2 \) [ft.]
- **Weight**  \( w_1 \) [lbf.], \( w_2 \) [lbf.]
- **Mass moment of inertia**  \( I' = \frac{w_1 \ell_1^2 + w_2 \ell_2^2}{3 \times 32.2} \)
- **Turning 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**  \( I = \frac{m \ell^2}{12} \)
- **Turning radius**  \( \frac{\ell^2}{12} \)

- **Bar length**  \( \ell \) [ft.]
- **Weight**  \( w \) [lbf.]
- **Mass moment of inertia**  \( I' = \frac{w \ell^2}{12 \times 32.2} \)
- **Turning radius**  \( \frac{\ell^2}{12} \)

Remark: No particular mounting direction.
●Thin rectangular plate (rectangular solid)

![Diagram of thin rectangular plate]

- **Length of plate** $a_1$ (m)
- **Length of side** $b$ (m)
- **Mass** $m_1$ (kg)
- **Mass moment of inertia** $I_1$ (kg·m²)

$$I_1 = \frac{m_1}{12} (4a_1^2 + b^2) + \frac{m_2}{12} (4a_2^2 + b^2)$$

- **Turning radius**
  $$R = \left(\frac{4a_1^2 + b^2}{4a_2^2 + b^2}\right)^{1/2}$$

- **Concentrated load**
  - **Shape of concentrated load**
  - **Distance to center of gravity of concentrated load** $R_1$ (m)
  - **Length of arm** $R_2$ (m)
  - **Mass of concentrated load** $m_1$ (kg)
  - **Mass of arm** $m_2$ (kg)

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

![Diagram of thin rectangular plate with load]

- **Load**
  - **Shape of load**
  - **Distance to center of gravity of load**
  - **Length of arm** $R_2$ (m)
  - **Mass of load** $m_1$ (kg)
  - **Mass of arm** $m_2$ (kg)

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

*Equations for calculating the load $J_1$ with respect to the rotary actuator axis when transmitted by gears*

- **Gear**
  - **Rotary side** $a$
  - **Load side** $b$
  - **Inertia moment of load** $J$ (N·m)
  - **Mass moment of inertia** $I_1$ (kg·m²)

$$I_1 = \frac{a}{b} l_b$$

- **Turning radius**
  $$R = \left(\frac{4a_1^2 + b^2}{4a_2^2 + b^2}\right)^{1/2}$$

**Remark**: Mounting direction is horizontal.
If the shapes of the gears are too large, the mass moment of inertia of the gears must be also taken into consideration.
### Rectangular parallelepiped

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of side</td>
<td>$h$ (m)</td>
</tr>
<tr>
<td>Distance from rotation axis</td>
<td>$L$ (m)</td>
</tr>
<tr>
<td>Mass</td>
<td>$m$ (kg)</td>
</tr>
</tbody>
</table>

Moment of Inertia $I = \frac{mh^2}{12} + mL^2$

### Hollow rectangular parallelepiped

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of side</td>
<td>$h$ (m)</td>
</tr>
<tr>
<td>Distance from rotation axis</td>
<td>$L$ (m)</td>
</tr>
<tr>
<td>Mass</td>
<td>$m$ (kg)</td>
</tr>
</tbody>
</table>

Moment of Inertia $I = \frac{m}{12} (h_x^2 + h_y^2) + mL^2$

### Circular cylinder

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>$d$ (m)</td>
</tr>
<tr>
<td>Distance from rotation axis</td>
<td>$L$ (m)</td>
</tr>
<tr>
<td>Mass</td>
<td>$m$ (kg)</td>
</tr>
</tbody>
</table>

Moment of Inertia $I = \frac{md^2}{16} + mL^2$

### Hollow circular cylinder

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>$d_1$ (m)</td>
</tr>
<tr>
<td>Diameter</td>
<td>$d_2$ (m)</td>
</tr>
<tr>
<td>Mass</td>
<td>$m$ (kg)</td>
</tr>
<tr>
<td>Distance from rotation axis</td>
<td>$L$ (m)</td>
</tr>
</tbody>
</table>

Moment of Inertia $I = \frac{m}{16} (d_2^2 + d_1^2) + mL^2$

### Remark

- Same for cube.
- Cross section is square only.

---

**[When the rotation axis is offset from the workpiece]**

### Remark

- Same for cube.
Calculation example

1. Check operating conditions
   1. Swing angle $\theta$ : 3.14 (rad)→180°
   2. Swing time $t$ : 1.5 (s)
   3. Applied pressure $P$ : 0.5 (MPa)
   4. Load shape Disk
      Diameter $d$ : 0.2 (m)
      Mass $m$ : 10 (kg)

2. Check swing time
   The swing time is expressed as 0.75 s/90° for 90°, which is within the range of 0.2 - 7.0 s/90°, and satisfactory.

3. Select by the torque
   Find the mass moment of inertia $I$.
   
   $I = \frac{md^2}{8} = \frac{10 \times 0.2^2}{8} = 0.05 \text{ (kg} \cdot \text{m}^2\text{)} \ldots (1)$

   Find the uniform angular acceleration $\dot{\omega}$.
   
   $\dot{\omega} = \frac{2 \theta}{t^2} = \frac{2 \times 3.14}{1.5^2} = 2.79 \text{ (rad/s}^2\text{)} \ldots (2)$

   From (1) and (2), the necessary torque $T_{x}$ is
   
   $T_{x} = I \dot{\omega} K = 0.05 \times 2.79 \times 5 = 0.698 \text{ (N} \cdot \text{m)} \ldots (3)$

   From the Effective Torque Table (graph) on page 10, select a model where the torque is more than (3) 0.698 (N·m) at 0.5 MPa.

   That is, RAF10 ~ RAF70.

4. Check mass moment of inertia in relation to swing time
   Use the graph on page 13 "Mass moment of inertia in relation to swing time limits (swing angle 180°)" to select an actuator with a swing angle for the following conditions.

   ■ Conditions
   Applied pressure: 0.5 (MPa)
   Mass moment of inertia $I$: 0.05 (kg·m²)
   Swing time: 1.5 (s)/180°

   For RAF10
   Cannot be used because it is below the curve.

   For RAF20
   Can be used because it is above the curve, but there is little leeway.

   For RAF25
   Can be used because it is above the curve. There is approximately 0.5 (s) of leeway.

   Select RAF25 because there is little leeway when using the RAF20.
5. Check load ratio

[Thrust load]

\[ W_s = 10 \times 9.8 = 98 \text{ (N)} \]

[Radial load]

Because radial load is not applied

\[ W_r = 0 \text{ (N)} \]

[Moment]

Because moment is not applied

\[ M = 0 \text{ (N-m)} \]

The load ratios of each load and moment are:

\[ \frac{W_s}{W_s \text{ MAX}} = \frac{98}{20720} < \frac{1}{30} \neq 0.033 \]

\[ \frac{W_r}{W_r \text{ MAX}} = \frac{0}{9120} < \frac{1}{30} \neq 0.033 \]

\[ \frac{M}{M \text{ MAX}} = \frac{0}{212} < \frac{1}{30} \neq 0.033 \]

So, it is satisfactory.

Total load ratio

\[ \text{Total load ratio} = \frac{W_s}{W_s \text{ MAX}} + \frac{W_r}{W_r \text{ MAX}} + \frac{M}{M \text{ MAX}} \]

\[ = \frac{98}{20720} + \frac{0}{9120} + \frac{0}{212} \]

\[ = 0.005 < \frac{1}{30} \neq 0.033 \]

Total load ratio is below 0.033, so it is satisfactory.

6. Check the unit specifications

RAF25-180-SS2 satisfies operating conditions if selected.

5. Check load ratio

[Thrust load]

\[ W_s = 22.05 \text{ [lbf.]} \]

[Radial load]

Because radial load is not applied

\[ W_r = 0 \text{ (N)} \]

[Moment]

Because moment is not applied

\[ M = 0 \text{ [ft.-lbf.]} \]

The load ratios of each load and moment are:

\[ \frac{W_s}{W_s \text{ MAX}} = \frac{22.05}{4658} = 0.0047 < \frac{1}{30} \neq 0.033 \]

\[ \frac{W_r}{W_r \text{ MAX}} = \frac{0}{2050} < \frac{1}{30} \neq 0.033 \]

\[ \frac{M}{M \text{ MAX}} = \frac{0}{156.4} < \frac{1}{30} \neq 0.033 \]

So, it is satisfactory.

Total load ratio

\[ \text{Total load ratio} = \frac{W_s}{W_s \text{ MAX}} + \frac{W_r}{W_r \text{ MAX}} + \frac{M}{M \text{ MAX}} \]

\[ = \frac{22.05}{4658} + \frac{0}{2050} + \frac{0}{156.4} \]

\[ = 0.0047 < \frac{1}{30} \neq 0.033 \]

Total load ratio is below 0.033, so it is satisfactory.

6. Check the unit specifications

RAF25-180-SS2 satisfies operating conditions if selected.
Selection

Mass moment of inertia in relation to swing time limits

Swing angle (90°)

Can be used in the range that is above the curve in the graph. Be sure to refer to “Precautions for mass moment of inertia in relation to swing time limits” on page 13 when making a selection.

RAF10

RAF20

RAF25

RAF30

RAF50

RAF70

1 MPa = 145 psi  
1 kg m² = 0.7375 lbf. ft. sec.²
Mass moment of inertia in relation to swing time limits

Swing angle (180°)

Can be used in the range that is above the curve in the graph. Be sure to refer to “Precautions for mass moment of inertia in relation to swing time limits” on page 13 when making a selection.

1 MPa = 145 psi    1 kgm² = 0.7375 lbf·ft·sec²
Specifications

**Flat Rotary Actuators**

### Symbol

#### Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>RAF10-180-♦</th>
<th>RAF20-180-♦</th>
<th>RAF25-180-♦</th>
<th>RAF30-180-♦</th>
<th>RAF50-180-♦</th>
<th>RAF70-180-♦</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating type</td>
<td>Double acting double piston type (Rack and pinion type)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective torque (at 0.5 MPa [73 psi])</td>
<td>0.96 [0.708]</td>
<td>2.13 [1.571]</td>
<td>2.34 [1.726]</td>
<td>3.57 [2.633]</td>
<td>4.70 [3.467]</td>
<td>6.65 [4.905]</td>
</tr>
<tr>
<td>Medium</td>
<td>Air</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating pressure range MPa [psi]</td>
<td>0.2<del>0.7 [29</del>102]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proof pressure MPa [psi]</td>
<td>1.05 [152]</td>
<td></td>
<td></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></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cushion</td>
<td>With shock absorber</td>
<td>Shock absorber</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swing angle range</td>
<td>Clockwise rotation end: -5°~110°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swing angle adjustment range</td>
<td>1° or less</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight [g [oz.]]</td>
<td>65 [47.9]</td>
<td>110 [81.1]</td>
<td>212 [156.4]</td>
<td>272 [200.6]</td>
<td>319 [235.3]</td>
<td>668 [49.27]</td>
</tr>
</tbody>
</table>

**Shock absorber specifications**

<table>
<thead>
<tr>
<th>Applicable models</th>
<th>RAF10</th>
<th>RAF20</th>
<th>RAF25</th>
<th>RAF30</th>
<th>RAF50</th>
<th>RAF70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum absorption</td>
<td>0.4 [0.30]</td>
<td>0.8 [0.59]</td>
<td>1 [0.74]</td>
<td>1.6 [1.18]</td>
<td>2.5 [1.84]</td>
<td>5 [3.7]</td>
</tr>
<tr>
<td>Absorption stroke</td>
<td>5 [0.20]</td>
<td>6 [0.24]</td>
<td>7 [0.28]</td>
<td>8 [0.32]</td>
<td>9 [0.36]</td>
<td>10 [0.39]</td>
</tr>
<tr>
<td>Max. operating frequency</td>
<td>30 cycle/min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle variation</td>
<td>1° or less</td>
<td>3° or less</td>
<td></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></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

1. Actual measured values, and are not guaranteed values.
2. When the actuator does not have shock absorbers, be sure to install an external shock absorber or stopper mechanism so the rack does not hit the plug.
3. The life of a shock absorber may vary from the flat rotary actuator series depending on the operating conditions.
4. Swing time at midpoint where shock absorbers do not affect operation, with no load at air pressure of 0.5 MPa [73 psi].
5. Apply 1/30th or less of the static load rating of the bearing during usage.
RAF 180 - -

**Basic model**
Flat rotary actuator

**Angle adjustment mechanism**
Blank: None (plugs on both sides)
SS2: Shock absorbers on both sides

**Sensor switch model**

- **Blank**: No sensor switch
- **ZE135**: 2-lead wire solid state type. Horizontal lead wire, 28VDC
- **ZE155**: 3-lead wire solid state type with NPN output. Horizontal lead wire, 4.5V-28VDC
- **ZE235**: 2-lead wire solid state type. Vertical lead wire, 28VDC
- **ZE255**: 3-lead wire solid state type with NPN output. Vertical lead wire, 4.5V-28VDC
- **ZE175**: 3-lead wire solid state type with PNP output. Vertical lead wire, 28VDC
- **ZE275**: 3-lead wire solid state type with PNP output. Vertical lead wire, 4.5V-28VDC
- **ZE101**: Reed switch type. Horizontal lead wire, 28VDC, 85-115VAC
- **ZE102**: Reed switch type with indicator. Horizontal lead wire, 28VDC, 85-115VAC
- **ZE201**: Reed switch type. Vertical lead wire, 28VDC, 85-115VAC
- **ZE202**: Reed switch type with indicator. Vertical lead wire, 28VDC, 85-115VAC

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

**Nominal torque**
- 10: 0.96 N·m [0.708 ft·lbf.]
- 20: 2.13 N·m [1.571 ft·lbf.]
- 25: 2.34 N·m [1.726 ft·lbf.]
- 30: 3.57 N·m [2.633 ft·lbf.]
- 50: 4.70 N·m [3.467 ft·lbf.]
- 70: 6.65 N·m [4.905 ft·lbf.]

**Swing angle**
180°

**Additional parts**

- **Locating pin for body**
P1-RAF

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1020</td>
<td>For RAF10, 20</td>
</tr>
<tr>
<td>2530</td>
<td>For RAF25, 30</td>
</tr>
<tr>
<td>5070</td>
<td>For RAF50, 70</td>
</tr>
</tbody>
</table>

- **Locating ring for bottom of body**
R-RAF

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>For RAF10</td>
</tr>
<tr>
<td>20</td>
<td>For RAF20</td>
</tr>
<tr>
<td>25</td>
<td>For RAF25</td>
</tr>
<tr>
<td>30</td>
<td>For RAF30</td>
</tr>
<tr>
<td>50</td>
<td>For RAF50</td>
</tr>
<tr>
<td>70</td>
<td>For RAF70</td>
</tr>
</tbody>
</table>

- **Locating pin for cross roller bearing**
P2-RAF

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1020</td>
<td>For RAF10, 20</td>
</tr>
<tr>
<td>2530</td>
<td>For RAF25, 30</td>
</tr>
<tr>
<td>5070</td>
<td>For RAF50, 70</td>
</tr>
</tbody>
</table>

- **Spacer for cross roller bearing**
SP-RAF

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>For RAF10</td>
</tr>
<tr>
<td>20</td>
<td>For RAF20</td>
</tr>
<tr>
<td>25</td>
<td>For RAF25</td>
</tr>
<tr>
<td>30</td>
<td>For RAF30</td>
</tr>
<tr>
<td>50</td>
<td>For RAF50</td>
</tr>
<tr>
<td>70</td>
<td>For RAF70</td>
</tr>
</tbody>
</table>

**Lead wire length**

- **A**: 1000 mm [39 in.]
- **B**: 3000 mm [118 in.]
- **G**: 300 mm [11.8 in.] with M8 connector, only for the ZE175 and ZE275

**Order Codes**

- **P1-RAF**
- **R-RAF**
- **P2-RAF**
- **SP-RAF**
- **MK** - **KSHK**

**Note 1**: The flat rotary actuator comes with magnets as standard.

**Note 2**: When using reed switch type, be careful of allowable swing time.

See page #4 for details.

**Additional Notes**

- **Remark**: If you do not need seal washers and hexagon nuts, write - NN at the end of the order code above.

- **Shock absorber (seal washer, hexagon nut included)**
  - KSHK10 x 5-01 (For RAF10)
  - KSHK12 x 6-01 (For RAF20)
  - KSHK14 x 7-01 (For RAF25)
  - KSHK16 x 8-01 (For RAF30)
  - KSHK18 x 9-01 (For RAF50)
  - KSHK20 x 10-01 (For RAF70)

**Seal washer and hexagon nut for shock absorber**

- MK - KSHK

**Thread size**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>10</td>
<td>M10 x 1</td>
</tr>
<tr>
<td>12</td>
<td>M12 x 1</td>
</tr>
<tr>
<td>14</td>
<td>M14 x 1.5</td>
</tr>
<tr>
<td>15</td>
<td>M16 x 1.5</td>
</tr>
<tr>
<td>18</td>
<td>M18 x 1.5</td>
</tr>
<tr>
<td>20</td>
<td>M20 x 1.5</td>
</tr>
</tbody>
</table>

**Parts**

1: Seal washer
2: Hexagon nut
3: Seal washer and hexagon nut
## Inner Construction

- **With shock absorber**
- **Without angle adjustment mechanism**
  (plug on both sides)

Diagrams are RAF20-180-SS2

### Major parts and materials

<table>
<thead>
<tr>
<th>No.</th>
<th>Parts</th>
<th>RAF10</th>
<th>RAF20</th>
<th>RAF25</th>
<th>RAF30</th>
<th>RAF50</th>
<th>RAF70</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Body</td>
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<td></td>
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</tr>
<tr>
<td>2</td>
<td>Pinion</td>
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<td></td>
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<td></td>
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<td>6</td>
<td>Side plate A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Side plate B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Cross roller bearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>Rack</td>
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</tr>
<tr>
<td>10</td>
<td>Striker</td>
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<td>11</td>
<td>Pin</td>
<td></td>
<td></td>
<td>Special steel</td>
<td>Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Steel ball</td>
<td></td>
<td></td>
<td>Stainless steel</td>
<td>Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>O-ring</td>
<td></td>
<td></td>
<td>Synthetic rubber (NBR)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>O-ring</td>
<td></td>
<td></td>
<td>Synthetic rubber (NBR)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Screw</td>
<td></td>
<td></td>
<td>Steel (black oxide finish)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Screw</td>
<td></td>
<td></td>
<td>Stainless steel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Screw</td>
<td></td>
<td></td>
<td>Steel (nickel plated)</td>
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<tr>
<td>18</td>
<td>Seal washer</td>
<td>Mild steel + synthetic rubber (NBR)</td>
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<tr>
<td>19</td>
<td>Hexagon nut</td>
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<td></td>
<td>Stainless steel</td>
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<tr>
<td>20</td>
<td>Shock absorber</td>
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<td></td>
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<tr>
<td>21</td>
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<tr>
<td>22</td>
<td>O-ring</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Synthetic rubber (NBR)</td>
</tr>
</tbody>
</table>
Swing angle range and swing direction

Note: It is possible to adjust the swing angle by how far the shock absorber is screwed in, but adjust it so the swing angle is 30° or more. The swing angle for one rotation of shock absorber is shown below.

<table>
<thead>
<tr>
<th>Model</th>
<th>Shock absorber thread size A</th>
<th>Angle adjustment by one rotation of shock absorber (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-SS2</td>
<td>M10 x 1</td>
<td>6.5°</td>
</tr>
<tr>
<td>RAF20-180-SS2</td>
<td>M12 x 1</td>
<td>5.2°</td>
</tr>
<tr>
<td>RAF25-180-SS2</td>
<td>M14 x 1.5</td>
<td>6.9°</td>
</tr>
<tr>
<td>RAF30-180-SS2</td>
<td>M16 x 1.5</td>
<td>5.7°</td>
</tr>
<tr>
<td>RAF50-180-SS2</td>
<td>M18 x 1.5</td>
<td>5.5°</td>
</tr>
<tr>
<td>RAF70-180-SS2</td>
<td>M20 x 1.5</td>
<td>4.8°</td>
</tr>
</tbody>
</table>

Note: Values vary due to tolerances of parts. Use them as guidelines.

Port location and swing direction

Inner ring of cross roller bearing rotates clockwise when air is supplied to port A, and rotates counterclockwise when air is supplied to port B.

Remark: The diagram shows when air is supplied to connection port A on the clockwise rotation side, and the inner ring of the cross roller bearing has completed the rotation in the clockwise direction (0° location).
Dimensions mm [in.]

**RAF10-180-SS2 (with shock absorbers)**

1. **Dimensions**

   - **KSHK20**
   - **KSHK18**
   - **KSHK16**
   - **KSHK14**
   - **KSHK12**
   - **KSHK10**

2. **Shock absorber dimensions**

   - **RAF10-180**

3. **Note:** Do not insert screws beyond the thread depth. Be sure to see “Mounting” under Handling Instructions and Precautions on page 1 when mounting the body or workpiece.

4. **Remark:** The diagrams show when air is supplied to connection port A on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location). See page 1 for information about swing direction.

**RAF10-180 (without angle adjustment mechanism)**

- **Dimensions**
- **Note:** Do not block the air path port.

**Shock absorber dimensions** mm [in.]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>KSHK10 × 5-01</td>
<td>48.1</td>
<td>1.890</td>
<td>0.197</td>
<td>43.1</td>
<td>0.693</td>
<td>5</td>
<td>0.197</td>
<td>6</td>
<td>0.236</td>
<td>17</td>
<td>0.669</td>
<td>19.6</td>
</tr>
<tr>
<td>KSHK12 × 6-01</td>
<td>55.2</td>
<td>2.165</td>
<td>0.236</td>
<td>49.1</td>
<td>0.929</td>
<td>5</td>
<td>0.197</td>
<td>7</td>
<td>0.276</td>
<td>19</td>
<td>0.748</td>
<td>21.9</td>
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<tr>
<td>KSHK14 × 7-01</td>
<td>66.3</td>
<td>2.598</td>
<td>0.276</td>
<td>59.2</td>
<td>2.323</td>
<td>5</td>
<td>0.197</td>
<td>8</td>
<td>0.315</td>
<td>22</td>
<td>0.866</td>
<td>25.4</td>
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<tr>
<td>KSHK16 × 8-01</td>
<td>73.4</td>
<td>2.874</td>
<td>0.315</td>
<td>65.2</td>
<td>2.559</td>
<td>5</td>
<td>0.197</td>
<td>10</td>
<td>0.394</td>
<td>24</td>
<td>0.945</td>
<td>27.7</td>
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<tr>
<td>KSHK18 × 9-01</td>
<td>79.5</td>
<td>3.110</td>
<td>0.354</td>
<td>70.2</td>
<td>2.756</td>
<td>5</td>
<td>0.197</td>
<td>11</td>
<td>0.433</td>
<td>27</td>
<td>1.063</td>
<td>31.2</td>
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<tr>
<td>KSHK20 × 10-01</td>
<td>88.6</td>
<td>3.465</td>
<td>0.394</td>
<td>76.3</td>
<td>3.071</td>
<td>5</td>
<td>0.197</td>
<td>12</td>
<td>0.472</td>
<td>30</td>
<td>1.181</td>
<td>34.6</td>
</tr>
</tbody>
</table>
Remark: The diagrams show when air is supplied to connection port A on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location). See page 4 for information about swing direction.

Note: Do not insert screws beyond the thread depth. Be sure to see “Mounting” under Handling Instructions and Precautions on page 1 when mounting the body or workpiece.
Dimensions mm [in.]

**RAF25-180-SS2 (with shock absorbers)**

- **Dimensions:**
  - $\phi 1.5$ [0.059] (inner diameter of outer ring)
  - $\phi 1.614$ (outer diameter of inner ring)
  - $0.0012$ [0.0005] (for locating, only this screw is silver)
  - $0.03$ [0.0012]

**Remark:** The diagrams show when air is supplied to connection port A on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location). See page 4 for information about swing direction.

**RAF25-180 (without angle adjustment mechanism)**

- **Dimensions:**
  - $2.260$ [0.089] through hole $\phi 1.417$ [0.056]
  - $0.079$ [0.0031]

**Note:** Do not insert screws beyond the thread depth. Be sure to see "Mounting" under Handling Instructions and Precautions on page 6 when mounting the body or workpiece.
With shock absorbers
RAF30-180-SS2
RAF50-180-SS2
RAF70-180-SS2

Dimensions mm [in.]

Remark: The diagrams show when air is supplied to connection port A on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location). See page 4 for information about swing direction.

Model | A | B | C | D | E | F | G | H | J | K
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
RAF30-180-SS2 | 98 | 60 | 5 | 56 | 82 | 47.5 | 8 | 6.6 | 13 | 0.512
 | 3.858 | (2.362) | [0.1969] | [0.3302] | [0.283] | [0.1870] | [0.3079] | [0.256] | [0.343] | [0.1592]
RAF50-180-SS2 | 110 | 68 | 6 | 61.5 | 90 | 51 | 9.5 | 8.6 | 15 | 0.591
 | 4.331 | (2.671) | [0.2362] | [0.2336] | [0.3543] | [0.208] | [0.387] | [0.339] | [0.551] | [0.228]
RAF70-180-SS2 | 123 | 73 | 6 | 61.5 | 100 | 72 | 9.5 | 8.6 | 17 | 0.665
 | 4.724 | (2.874) | [0.2362] | [0.2336] | [0.3537] | [0.2835] | [0.387] | [0.339] | [0.551] | [0.228]

Model | L | M | N | O | P | Q | R | S | T | U | V
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
RAF30-180-SS2 | 7 | 0.276 | M5×0.8 Depth 8 [0.315] | M5×0.7 Depth 8 [0.315] | P.C.D.34 | 1.339 | P.C.D.34 | 1.339 | M5×0.7 Depth 8 [0.315] | P.C.D.69 | 2.717 | 40 | 24 | 16 | 0.650 | KSHK16×8-01 | M5×1.25 Depth 12 [0.472]
RAF50-180-SS2 | 0.276 | M6×1 Depth 9 [0.354] | M5×0.8 Depth 10 [0.394] | M5×0.7 Depth 10 [0.394] | P.C.D.38 | 1.496 | P.C.D.38 | 1.496 | M5×0.8 Depth 10 [0.394] | P.C.D.75 | 2.953 | 44 | 27 | 18 | 0.700 | KSHK18×9-01 | M10×1.5 Depth 15 [0.591]
RAF70-180-SS2 | 8 | 0.215 | M6×1 Depth 9 [0.354] | M5×0.8 Depth 11 [0.433] | P.C.D.42 | 1.654 | P.C.D.42 | 1.654 | M5×0.8 Depth 11 [0.433] | P.C.D.85 | 3.346 | 50 | 30 | 18 | 0.700 | KSHK20×10-01 | M10×1.5 Depth 15 [0.591]

Model | W | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AK | AL | AM | AN
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
RAF30-180-SS2 | φ8 | 0.3306 | φ23 | 0.9055 | φ0.23 | TH | φ19 | 0.748 | through hole | φ23 | 0.9055 | φ0.23 | TH | 10 | 44 | 1.732 | 10 | 12 | 12 | 156 | 12 | 156 | 21 | 0.827 | 0.433 | 1.102
RAF50-180-SS2 | φ0.4644 | φ0.9843 | φ0.25 | TH | 12 | 38 | 50 | φ19 | 0.748 | through hole | φ23 | 0.9055 | φ0.23 | TH | 11 | 13 | 15 | 162 | 15 | 162 | 23 | 0.512 | 1.181
RAF70-180-SS2 | φ8 | 0.3306 | φ29 | 1.1417 | φ0.29 | TH | φ22 | 0.866 | through hole | φ26 | 1.0236 | φ0.26 | TH | 12 | 14 | 15 | 184 | 15 | 184 | 23 | 0.827 | 0.512 | 1.181

Without angle adjustment mechanism
RAF30-180
RAF50-180
RAF70-180

Note: Do not insert screws beyond the thread depth. Be sure to see “Mounting” under Handling Instructions and Precautions on page 4 when mounting the body or workpiece.
### Additional parts dimensions \( \text{mm [in.]} \)

#### Locating pin for body

![Diagram of locating pin for body]

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Mass [g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1-RAF1020</td>
<td>8</td>
<td>4g6</td>
<td>3</td>
<td>5</td>
<td>3g6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>[0.316]</td>
<td>[0.15748]</td>
<td>[0.118]</td>
<td>[0.11811]</td>
<td>[0.0008]</td>
<td>[0.04]</td>
</tr>
<tr>
<td>P1-RAF2530</td>
<td>10</td>
<td>5g6</td>
<td>4</td>
<td>6</td>
<td>4g6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>[0.384]</td>
<td>[0.19685]</td>
<td>[0.157]</td>
<td>[0.15748]</td>
<td>[0.0008]</td>
<td>[0.07]</td>
</tr>
<tr>
<td>P1-RAF5070</td>
<td>12</td>
<td>6g6</td>
<td>5</td>
<td>7</td>
<td>5g6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>[0.472]</td>
<td>[0.23622]</td>
<td>[0.197]</td>
<td>[0.19685]</td>
<td>[0.0008]</td>
<td>[0.11]</td>
</tr>
</tbody>
</table>

#### Locating pin for cross roller bearing

![Diagram of locating pin for cross roller bearing]

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Mass [g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2-RAF1020</td>
<td>9.6</td>
<td>1.6</td>
<td>6.5g6</td>
<td>3g6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>[0.378]</td>
<td>[0.063]</td>
<td>[0.25591]</td>
<td>[0.11811]</td>
<td>[0.04]</td>
</tr>
<tr>
<td>P2-RAF2530</td>
<td>9.8</td>
<td>1.8</td>
<td>8g6</td>
<td>4g6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>[0.386]</td>
<td>[0.071]</td>
<td>[0.31496]</td>
<td>[0.15748]</td>
<td>[0.07]</td>
</tr>
<tr>
<td>P2-RAF5070</td>
<td>10</td>
<td>2</td>
<td>9.5g6</td>
<td>5g6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>[0.394]</td>
<td>[0.079]</td>
<td>[0.37402]</td>
<td>[0.19685]</td>
<td>[0.11]</td>
</tr>
</tbody>
</table>

#### Locating ring for bottom of body

![Diagram of locating ring for bottom of body]

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Mass [g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-RAF10</td>
<td>13g6</td>
<td>10</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>[0.51181]</td>
<td>[0.066929]</td>
<td>[0.512]</td>
<td>[0.0787]</td>
</tr>
<tr>
<td>R-RAF20</td>
<td>17g6</td>
<td>13</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>[0.51181]</td>
<td>[0.066929]</td>
<td>[0.512]</td>
<td>[0.0787]</td>
</tr>
<tr>
<td>R-RAF25</td>
<td>19g6</td>
<td>15</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>[0.51181]</td>
<td>[0.066929]</td>
<td>[0.512]</td>
<td>[0.0787]</td>
</tr>
<tr>
<td>R-RAF30</td>
<td>23g6</td>
<td>19</td>
<td>26</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>[0.90551]</td>
<td>[0.0787]</td>
<td>[1.024]</td>
<td>[0.144]</td>
</tr>
<tr>
<td>R-RAF50</td>
<td>23g6</td>
<td>19</td>
<td>26</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>[0.90551]</td>
<td>[0.0787]</td>
<td>[1.024]</td>
<td>[0.144]</td>
</tr>
<tr>
<td>R-RAF70</td>
<td>26g6</td>
<td>22</td>
<td>29</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>[1.02362]</td>
<td>[0.0866]</td>
<td>[1.142]</td>
<td>[0.046]</td>
</tr>
</tbody>
</table>

#### Spacer for cross roller bearing

**SP-RAF10** (Mass 18 g [0.63 oz])

![Diagram of SP-RAF10]

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Mass [g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-RAF20</td>
<td>27</td>
<td>3.4</td>
<td>18g6</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>[1.063]</td>
<td>[0.134]</td>
<td>[0.70866]</td>
<td>[0.512]</td>
<td>[1.437]</td>
</tr>
<tr>
<td>SP-RAF25</td>
<td>30</td>
<td>4.5</td>
<td>19g6</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>[1.181]</td>
<td>[0.177]</td>
<td>[0.74803]</td>
<td>[0.591]</td>
<td>[1.594]</td>
</tr>
<tr>
<td>SP-RAF30</td>
<td>34</td>
<td>4.5</td>
<td>23g6</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>[1.339]</td>
<td>[0.177]</td>
<td>[0.90551]</td>
<td>[0.748]</td>
<td>[1.850]</td>
</tr>
<tr>
<td>SP-RAF50</td>
<td>38</td>
<td>5.5</td>
<td>25g6</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>[1.496]</td>
<td>[0.217]</td>
<td>[0.98425]</td>
<td>[0.748]</td>
<td>[1.988]</td>
</tr>
<tr>
<td>SP-RAF70</td>
<td>42</td>
<td>5.5</td>
<td>29g6</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>[1.654]</td>
<td>[0.217]</td>
<td>[1.14173]</td>
<td>[0.866]</td>
<td>[2.244]</td>
</tr>
</tbody>
</table>
### Specifications

#### Solid state type

<table>
<thead>
<tr>
<th>Item</th>
<th>ZE135</th>
<th>ZE155</th>
<th>ZE235</th>
<th>ZE255</th>
<th>ZE175</th>
<th>ZE275</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wiring type</strong></td>
<td>2-lead</td>
<td>3-lead with NPN output</td>
<td>2-lead</td>
<td>3-lead with NPN output</td>
<td>3-lead with PNP output</td>
<td></td>
</tr>
<tr>
<td><strong>Lead wire direction</strong></td>
<td>Horizontal</td>
<td>—</td>
<td>Vertical</td>
<td>—</td>
<td>Horizontal</td>
<td>Vertical</td>
</tr>
<tr>
<td><strong>Power supply voltage</strong></td>
<td>10~28 VDC</td>
<td>—</td>
<td>10~28 VDC</td>
<td>—</td>
<td>4.5~28 VDC</td>
<td>—</td>
</tr>
<tr>
<td><strong>Load current</strong></td>
<td>50 mA MAX.</td>
<td>—</td>
<td>50 mA MAX.</td>
<td>—</td>
<td>50 mA MAX.</td>
<td>—</td>
</tr>
<tr>
<td><strong>Consumption current</strong></td>
<td>—</td>
<td>—</td>
<td>8 mA MAX. (24 VDC)</td>
<td>—</td>
<td>10 mA MAX. (24 VDC)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Internal voltage drop</strong></td>
<td>0.1 V MAX. (at load current of DC 40 mA)</td>
<td>—</td>
<td>0.1 V MAX. (at load current of DC 40 mA)</td>
<td>—</td>
<td>20 mA MAX.</td>
<td>—</td>
</tr>
<tr>
<td><strong>Response time</strong></td>
<td>1 ms MAX</td>
<td>—</td>
<td>1 ms MAX</td>
<td>—</td>
<td>1 ms MAX</td>
<td>—</td>
</tr>
<tr>
<td><strong>Insulation resistance</strong></td>
<td>100 MΩ</td>
<td>—</td>
<td>100 MΩ</td>
<td>—</td>
<td>100 MΩ</td>
<td>—</td>
</tr>
<tr>
<td><strong>Dielectric strength</strong></td>
<td>500 VAC (50/60 Hz) in 1 minute</td>
<td>—</td>
<td>500 VAC (50/60 Hz) in 1 minute</td>
<td>—</td>
<td>500 VAC (50/60 Hz) in 1 minute</td>
<td>—</td>
</tr>
<tr>
<td><strong>Shock resistance</strong></td>
<td>294.2 m/s² (300 G) (non-repeated)</td>
<td>—</td>
<td>294.2 m/s² (300 G) (non-repeated)</td>
<td>—</td>
<td>294.2 m/s² (300 G) (non-repeated)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Vibration resistance</strong></td>
<td>88.3 m/s² (9G) (total amplitude of 1.5 mm [0.059 in.], 10~55 Hz)</td>
<td>—</td>
<td>88.3 m/s² (9G) (total amplitude of 1.5 mm [0.059 in.], 10~55 Hz)</td>
<td>—</td>
<td>88.3 m/s² (9G) (total amplitude of 1.5 mm [0.059 in.], 10~55 Hz)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Environmental protection</strong></td>
<td>IEC IP67, JIS C0920 (watertight type)</td>
<td>—</td>
<td>IEC IP67, JIS C0920 (watertight type)</td>
<td>—</td>
<td>IEC IP67, JIS C0920 (watertight type)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Operating indicator</strong></td>
<td>When ON, Red LED indicator lights up</td>
<td>—</td>
<td>When ON, Red LED indicator lights up</td>
<td>—</td>
<td>When ON, Red LED indicator lights up</td>
<td>—</td>
</tr>
<tr>
<td><strong>Lead wire</strong></td>
<td>2-lead (brown and blue)</td>
<td>—</td>
<td>2-lead (brown and blue)</td>
<td>—</td>
<td>2-lead (brown and blue)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
<td>0°C<del>60°C (32°F</del>140°F)</td>
<td>—</td>
<td>0°C<del>60°C (32°F</del>140°F)</td>
<td>—</td>
<td>0°C<del>60°C (32°F</del>140°F)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>15 g [0.53 oz.]</td>
<td>—</td>
<td>15 g [0.53 oz.]</td>
<td>—</td>
<td>15 g [0.53 oz.]</td>
<td>—</td>
</tr>
</tbody>
</table>

*1: Internal voltage drop changes with the load current.

#### Reed switch type

<table>
<thead>
<tr>
<th>Item</th>
<th>ZE101</th>
<th>ZE102</th>
<th>ZE201</th>
<th>ZE202</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wiring type</strong></td>
<td>2-lead</td>
<td>—</td>
<td>3-lead</td>
<td>—</td>
</tr>
<tr>
<td><strong>Lead wire direction</strong></td>
<td>Horizontal</td>
<td>—</td>
<td>Vertical</td>
<td>—</td>
</tr>
<tr>
<td><strong>Load voltage</strong></td>
<td>5~28 VDC</td>
<td>10~28 VDC</td>
<td>5~28 VDC</td>
<td>5~28 VDC</td>
</tr>
<tr>
<td><strong>Load current</strong></td>
<td>40 mA MAX.</td>
<td>20 mA MAX.</td>
<td>5~20 mA</td>
<td>20 mA MAX.</td>
</tr>
<tr>
<td><strong>Internal voltage drop</strong></td>
<td>0.1 V MAX. (at load current of DC 40 mA)</td>
<td>—</td>
<td>0.1 V MAX. (at load current of DC 40 mA)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Response time</strong></td>
<td>1 ms MAX</td>
<td>—</td>
<td>1 ms MAX</td>
<td>—</td>
</tr>
<tr>
<td><strong>Insulation resistance</strong></td>
<td>100 MΩ</td>
<td>—</td>
<td>100 MΩ</td>
<td>—</td>
</tr>
<tr>
<td><strong>Dielectric strength</strong></td>
<td>1500 VAC (50/60 Hz) in 1 minute</td>
<td>—</td>
<td>1500 VAC (50/60 Hz) in 1 minute</td>
<td>—</td>
</tr>
<tr>
<td><strong>Shock resistance</strong></td>
<td>294.2 m/s² (300 G) (non-repeated)</td>
<td>—</td>
<td>294.2 m/s² (300 G) (non-repeated)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Vibration resistance</strong></td>
<td>88.3 m/s² (9G) (total amplitude of 1.5 mm [0.059 in.], 10~55 Hz), resonance frequency 2750 ± 250 Hz</td>
<td>—</td>
<td>88.3 m/s² (9G) (total amplitude of 1.5 mm [0.059 in.], 10~55 Hz), resonance frequency 2750 ± 250 Hz</td>
<td>—</td>
</tr>
<tr>
<td><strong>Environmental protection</strong></td>
<td>IP67 (IEC standard), JIS C0920 (watertight type)</td>
<td>—</td>
<td>IP67 (IEC standard), JIS C0920 (watertight type)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Operating indicator</strong></td>
<td>None</td>
<td>When ON, Red LED indicator lights up</td>
<td>None</td>
<td>When ON, Red LED indicator lights up</td>
</tr>
<tr>
<td><strong>Lead wire</strong></td>
<td>PCCV 0.2 SQ × 2 (brown, blue and black)</td>
<td>—</td>
<td>PCCV 0.2 SQ × 2 (brown, blue and black)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
<td>0°C<del>60°C (32°F</del>140°F)</td>
<td>—</td>
<td>0°C<del>60°C (32°F</del>140°F)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>15 g [0.53 oz.]</td>
<td>—</td>
<td>15 g [0.53 oz.]</td>
<td>—</td>
</tr>
</tbody>
</table>

*1: Internal voltage drop changes with the load current.

---

*2: According to KOGANEI test standards.

*3: Lead wire length: A: 1000 mm [39 in.], B: 3000 mm [118 in.], G: 300 mm [11.8 in.] with M8 connector only for the ZE175 and ZE275.
Order codes for sensor switches only

- RAF

Series RAF: Flat rotary actuator

Lead wire length
A: 1000 mm [39 in.]
B: 3000 mm [118 in.]
G: 300 mm [11.8 in.] with M8 connector, only for the ZE175 and ZE275

Sensor switch model
ZE135: Solid state type, 2-lead wire with indicator 10~28VDC
ZE155: Solid state type, 3-lead wire with PNP output with indicator 4.5~28VDC
ZE175: Solid state type, 3-lead wire with PNP output with indicator 4.5~28VDC
ZE235: Solid state type, 2-lead wire with indicator 10~28VDC
ZE255: Solid state type, 3-lead wire with PNP output with indicator 4.5~28VDC
ZE275: Solid state type, 3-lead wire with PNP output with indicator 4.5~28VDC
ZE101: Reed switch type, without indicator 5~28VDC Horizontal lead wire
ZE102: Reed switch type, with indicator 10~28VDC Horizontal lead wire
ZE201: Reed switch type, without indicator 5~28VDC Vertical lead wire
ZE202: Reed switch type, with indicator 10~28VDC Vertical lead wire

Inner circuit diagrams

- Solid State Type

ZE135, ZE235: LED indicator
Switching main circuit
Brown (+)
Blue (−) (External wiring)
Zener diode (for surge protection)
Load
10~28VDC

ZE175, ZE275: LED indicator
Switching main circuit
Brown (1+)
Black (4) (External wiring)
Diode (for reverse current protection)
Zener diode (for surge protection)
Load
4.5~28VDC

- Reed Switch Type

ZE101, ZE201: Brown (+)
ZE102, ZE202: Brown (+)

Sensor switch dimensions mm [in.]

- Horizontal lead wire

Solid state (ZE135, ZE155, ZE175)
M2.5 slotted head setscrew
Indicator
Max. sensing location
(A = A-1000 [39], B = 3000 [118])

Solid state (ZE175G)
M2.5 slotted head setscrew
Indicator
Max. sensing location
(300 [11.8])

Reed switch type (ZE101, ZE102)
M2.5 slotted head setscrew
Indicator
Max. sensing location
(4) (OUT)
Connector pin location

Note: Not available with the ZE101.
Wiring instructions for the solid state sensor switches

2-lead wire type

- **Basic connection**
  - Sensor switch<br>  - Load<br>  - 10~28VDC

- **Connecting with relays**
  - AND (series) connection and OR (parallel) connection
    - Sensor switch<br>    - Load<br>    - Relay contact

- **Connecting with a solenoid valve**
  - (+) Brown<br>  - (-) Blue

- **Connecting with a programmable controller**
  - (+) Brown<br>  - (-) Blue<br>  - COM

3-lead wire type (ZE275G)

- **Basic connection**
  - Sensor switch<br>  - Load<br>  - 4.5~28VDC

- **Connecting with relays**
  - AND (series) connection and OR (parallel) connection
    - Sensor switch<br>    - Load<br>    - Relay contact

- **Connecting with a solenoid valve**
  - (+) Brown<br>  - (-) Blue

- **Connecting with a programmable controller**
  - (+) Brown<br>  - (-) Blue<br>  - COM

3-lead wire with PNP output type

- **Basic connection**
  - Sensor switch<br>  - Load<br>  - 4.5~28VDC

- **Connecting with relays**
  - AND (series) connection and OR (parallel) connection
    - Sensor switch<br>    - Load<br>    - Relay contact

- **Connecting with a solenoid valve**
  - (+) Brown<br>  - (-) Blue

- **Connecting with a programmable controller**
  - (+) Brown<br>  - (-) Blue<br>  - COM

Note: Not available with the ZE201.

- **Solid state (ZE235, ZE255, ZE275)**
  - 3-lead wire with NPN output type
    - Sensor switch<br>    - Load<br>    - 4.5~28VDC
  - **Connecting with relays**
    - AND (series) connection and OR (parallel) connection
      - Sensor switch<br      - Load<br      - Relay contact

- **Connecting with a solenoid valve**
  - (+) Brown<br  - (-) Blue

- **Connecting with a programmable controller**
  - (+) Brown<br  - (-) Blue<br  - COM

Note: Not available with the ZE201.

- **Reed switch type (ZE201, ZE202)**
  - Sensor switch<br  - Load<br  - 4.5~28VDC
  - **Connecting with relays**
    - AND (series) connection and OR (parallel) connection
      - Sensor switch<br      - Load<br      - Relay contact

- **Connecting with a solenoid valve**
  - (+) Brown<br  - (-) Blue

- **Connecting with a programmable controller**
  - (+) Brown<br  - (-) Blue<br  - COM

Note: Not available with the ZE201.

1. Connect the lead wires according to their color. Incorrect wiring will cause damage to the sensor switch since there is no overcurrent protection.
2. The use of a surge protection diode is recommended for the inductive load such as electromagnetic relays.
3. Avoid the use of AND (series) connections because the circuit voltage will drop in proportion to the number of sensor switches.
4. When using an OR (parallel) connection, it is possible to connect sensor switch outputs directly (ex: connecting corresponding black lead wires). Be aware of load return errors since current leakage increases with the number of sensor switches.
5. Because the sensor switches are magnetically sensitive, avoid using them in locations subject to strong external magnetic fields or bringing them in close proximity to power lines and areas where large electric currents are present. In addition, do not use magnetized materials for the mounting bracket. Doing so may cause erratic operation.
6. Do not excessively pull on or bend the lead wires.
7. Avoid using the switches in environments where chemicals or gas are present.
8. Consult us for use in environments subject to water or oil.
Contact protection for reed switch type sensor switch

In order to use the reed switch type sensor switch safely, take the contact protection measures listed below.

- **For connecting an inductive load (electromagnetic relay etc.)**
  - **For capacitative surges**
    - (When the lead wire length exceeds 10 m [32.80 ft])

Moving sensor switch

- Loosening the screw allows the sensor switch to be moved along the switch mounting groove of the flat rotary actuator.
- The tightening torque for the screws is 0.1 N·m~0.2 N·m [0.9 in·lb~1.8 in·lb].

When mounting the cylinders with sensor switches in close proximity

When mounting flat rotary actuators with sensor switches in close proximity or side by side, install them using a value greater than those shown in the table below.

Sensor switch operating range, response differential, and maximum sensing location

- **Operating range:** \( R \)
  - The distance the rack travels in one direction, while the sensor switch is ON.
- **Response differential:** \( C \)
  - The distance between the rack where the rack turns the switch ON and the point where the switch is turned OFF as the rack travels in the opposite direction.
- **Solid state type**
  - Operating range: \( 2.0~6.0 \) [0.079~0.236]
  - Response differential: \( 1.0 \) [0.039] or less
  - Maximum sensing location \( = 6 \) [0.236]

- **Reed switch type**
  - Operating range: \( 4.5~8.5 \) [0.177~0.335]
  - Response differential: \( 1.5 \) [0.059] or less
  - Maximum sensing location \( = 10 \) [0.394]

Remark: The values in the table above are reference values.
Note: The value from the opposite end to the lead wire.
Swinging end detection sensor switch allowable swing time

Use a solid state sensor switch for low speed applications. The allowable swing time when using a reed switch type sensor switch are shown below.

<table>
<thead>
<tr>
<th>Model</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-0</td>
<td>0.2~0.4</td>
</tr>
<tr>
<td>RAF20-180-0</td>
<td>0.2~0.5</td>
</tr>
<tr>
<td>RAF25-180-0</td>
<td>0.2~0.6</td>
</tr>
<tr>
<td>RAF30-180-0</td>
<td>0.2~0.7</td>
</tr>
<tr>
<td>RAF50-180-0</td>
<td>0.2~0.8</td>
</tr>
<tr>
<td>RAF70-180-0</td>
<td>0.2~0.9</td>
</tr>
</tbody>
</table>

---

**Solid state type (ZE135, ZE155, ZE175, ZE235, ZE255, ZE275)** (mm [in.])

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-0</td>
<td>41.1 [1.618]</td>
<td>68.9 [2.713]</td>
<td>68.9 [2.713]</td>
<td>41.1 [1.618]</td>
</tr>
<tr>
<td>RAF20-180-0</td>
<td>48.7 [1.917]</td>
<td>83.3 [3.280]</td>
<td>83.3 [3.280]</td>
<td>48.7 [1.917]</td>
</tr>
<tr>
<td>RAF25-180-0</td>
<td>53.4 [2.102]</td>
<td>92.6 [3.646]</td>
<td>92.6 [3.646]</td>
<td>53.4 [2.102]</td>
</tr>
<tr>
<td>RAF50-180-0</td>
<td>65.3 [2.571]</td>
<td>114.7 [4.516]</td>
<td>114.7 [4.516]</td>
<td>65.3 [2.571]</td>
</tr>
<tr>
<td>RAF70-180-0</td>
<td>72.7 [2.862]</td>
<td>129.3 [5.091]</td>
<td>129.3 [5.091]</td>
<td>72.7 [2.862]</td>
</tr>
</tbody>
</table>

**Reed switch type (ZE101, ZE102, ZE201, ZE202)** (mm [in.])

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF10-180-0</td>
<td>37.1 [1.461]</td>
<td>64.9 [2.555]</td>
<td>64.9 [2.555]</td>
<td>37.1 [1.461]</td>
</tr>
<tr>
<td>RAF20-180-0</td>
<td>44.7 [1.760]</td>
<td>79.3 [3.122]</td>
<td>79.3 [3.122]</td>
<td>44.7 [1.760]</td>
</tr>
<tr>
<td>RAF25-180-0</td>
<td>49.4 [1.945]</td>
<td>88.6 [3.488]</td>
<td>88.6 [3.488]</td>
<td>49.4 [1.945]</td>
</tr>
<tr>
<td>RAF30-180-0</td>
<td>56.5 [2.224]</td>
<td>103.5 [4.075]</td>
<td>103.5 [4.075]</td>
<td>56.5 [2.224]</td>
</tr>
<tr>
<td>RAF50-180-0</td>
<td>61.3 [2.413]</td>
<td>110.7 [4.358]</td>
<td>110.7 [4.358]</td>
<td>61.3 [2.413]</td>
</tr>
<tr>
<td>RAF70-180-0</td>
<td>68.7 [2.705]</td>
<td>125.3 [4.933]</td>
<td>125.3 [4.933]</td>
<td>68.7 [2.705]</td>
</tr>
</tbody>
</table>

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Note: Be aware that, for horizontal lead wire types as shown in the following diagram, the lead wire protrudes from the side of the body if the sensor switch's lead wire is run from the shock absorber side. If there is a possibility of the lead wire coming into contact with anything where it protrudes, use a design that allows the lead wires to come out on the piping side.

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Reed switch type sensor switch allowable swing time

Use a solid state sensor switch for low speed applications. The allowable swing time when using a reed switch type sensor switch are shown below.

<table>
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<tr>
<th>Model</th>
<th>Time</th>
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<tr>
<td>RAF25-180-0</td>
<td>0.2~0.6</td>
</tr>
<tr>
<td>RAF30-180-0</td>
<td>0.2~0.7</td>
</tr>
<tr>
<td>RAF50-180-0</td>
<td>0.2~0.8</td>
</tr>
<tr>
<td>RAF70-180-0</td>
<td>0.2~0.9</td>
</tr>
</tbody>
</table>
Limited Warranty

KOGANEI CORP. warrants its products to be free from defects in material and workmanship subject to the following provisions.

Warranty Period
The warranty period is 180 days from the date of delivery.

Koganei Responsibility
If a defect in material or workmanship is found during the warranty period, KOGANEI CORP. will replace any part proved defective under normal use free of charge and will provide the service necessary to replace such a part.

Limitations
- This warranty is in lieu of all other warranties, expressed or implied, and is limited to the original cost of the product and shall not include any transportation fee, the cost of installation or any liability for direct, indirect or consequential damage or delay resulting from the defects.
- KOGANEI CORP. shall in no way be liable or responsible for injuries or damage to persons or property arising out of the use or operation of the manufacturer’s product.
- This warranty shall be void if the engineered safety devices are removed, made inoperative or not periodically checked for proper functioning.
- Any operation beyond the rated capacity, any improper use or application, or any improper installation of the product, or any substitution upon it with parts not furnished or approved by KOGANEI CORP., shall void this warranty.
- This warranty covers only such items supplied by KOGANEI CORP. The products of other manufacturers are covered only by such warranties made by those original manufacturers, even though such items may have been included as the components.

The specifications are subject to change without notice.

ISO 9001 / ISO 14001

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