In our pursuit of excellence in size and weight reduction, we proudly announce the release of the Series CRJ Mini-Rotary Actuator!
**Mini-Rotary Actuator Series CRJ**

Rack-and-Pinion Type/Size: 05, 1

**Compact**

- CRJ05: 32g (39g)
- CRJ1: 54g (67g)

**Light weight**

- CRJ05: 32g (39g)
- CRJ1: 54g (67g)

Flexible mounting

A new compact body design not only reduces overall space requirements, but also achieves space savings in wiring and piping. Ease in mounting is maximized thanks to the merits of the new compact body.

- **Free mount**

  - Speed controllers do not protrude from the top of the body.
  - Top mount
  - Bottom mount
  - Side mount

**Wiring and piping direction can be selected depending on mounting conditions.**

Mounting examples for auto switch and speed controller
Improved allowable load
Large roller bearing and large diameter output shaft add to overall compactness while ensuring high rigidity.

<table>
<thead>
<tr>
<th>Model</th>
<th>CRJ05</th>
<th>CRJ1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable load (N)</td>
<td>Fr 25 30</td>
<td></td>
</tr>
<tr>
<td>FS(a)</td>
<td>20 25</td>
<td></td>
</tr>
<tr>
<td>FS(b)</td>
<td>20 25</td>
<td></td>
</tr>
<tr>
<td>Output shaft size (mm)</td>
<td>ø5 ø6</td>
<td></td>
</tr>
</tbody>
</table>

With external stopper/Series CRJU
4 to 5 times allowable kinetic energy (Basic type compared to CRJB)

Variations

<table>
<thead>
<tr>
<th>Series</th>
<th>Rotation angle</th>
<th>Port location</th>
<th>Auto switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRJB05</td>
<td>90° 100° 180° 190°</td>
<td>Front port</td>
<td>D-F8</td>
</tr>
<tr>
<td>CRJB 1</td>
<td></td>
<td>Side port</td>
<td>D-F9</td>
</tr>
<tr>
<td>With external stopper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRJU05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRJU 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Series CRJ

## Model Selection

### Operating conditions
1. List all possible operating conditions according to the mounting position.

- Model used
- Operating pressure
- Mounting position
- Load type
  - Ts (N m)
  - Tf (N m)
  - Ta (N m)
- Load configuration
- Rotation time \( t \) (s)
- Rotation angle
- Load mass \( m \) (kg)
- Distance between central axis and center of gravity \( H \) (mm)

### Required torque
2. Confirm the type of load as shown below, and select an actuator that satisfies the required torque.

- Static load: Ts
- Resistance load: Tf
- Inertial load: Ta

**Load types**

#### Effective torque

- Effective torque \( \geq Ts \)
- Effective torque \( \geq (3 \text{ to } 5) \times Tf \)
- Effective torque \( \geq 10 \times Ta \)

**Effective torque**

#### Inertial load

\[
10 \times Ta = 10 \times \frac{I x \omega}{\theta} = 10 \times 1.57 \times 10^{-6} \times (2 \times \frac{\pi}{2} / 0.2)^2 = 0.0012N \cdot m < \text{Effective torque} \quad \text{OK}
\]

**Effective torque**

**Note:** \( I \) substitutes for \( \mathcal{I} \), the value for inertial moment.

### Rotation time
3. Confirm that it is within the rotation adjustment time range.

\( 0.1 \text{ to } 0.5s / 90^\circ \)

\( 0.2s / 90^\circ \) **OK**

### Allowable load
4. Confirm that the radial load, thrust load and moment are within the allowable ranges.

**Thrust load:** \( m \times 9.8 \leq \text{Allowable load} \)

\( (0.03 + 0.006) \times 9.8 = 0.35N < \text{Allowable load} \) **OK**

### Inertial moment
5. Find the load's inertial moment \( "I" \) for the energy calculation.

\[
I_1 = m \times (a^2 + b^2)/12 \\
I_2 = m \times (a^2 + b^2)/12 + m \times H^2 \\
I = I_1 + I_2
\]

**Inertial moment**

\[
I = 0.03 \times (0.02^2 + 0.01^2)/12 = 1.25 \times 10^{-5} \text{kg} \cdot \text{m}^2 \\
I = 0.006 \times (0.005^2 + 0.005^2)/12 = 0.006 \times 0.007^2 = 0.32 \times 10^{-5} \text{kg} \cdot \text{m}^2 \\
I = 1.25 \times 10^{-5} + 0.32 \times 10^{-6} = 1.57 \times 10^{-5} \text{kg} \cdot \text{m}^2
\]

### Kinetic energy
6. Confirm that the load’s kinetic energy is within the allowable value.

\[
\frac{1}{2} \times I \times \omega^2 \leq \text{Allowable energy} \\
\omega = \frac{2 \theta}{t} \quad (\theta: \text{Terminal angular velocity}) \\
t: \text{Rotation time (s)}
\]

**Allowable kinetic energy/Rotation time**

\[
\frac{1}{2} \times 1.57 \times 10^{-5} \times (2 \times (\pi/2)/0.2)^2 = 0.00019J = 0.19mJ < \text{Allowable energy} \quad \text{OK}
\]
Effective Torque

### Load Types

- **Static load: \( T_s \)**
  - **Definition for our purposes:** A load that requires pressing force only, as represented by the clamp.
  - If the mass of the clamp itself in the drawing below is considered in the calculations, it should be regarded as an inertial load.

- **Resistance load: \( T_f \)**
  - **Definition for our purposes:** A load that is affected by external forces such as friction or gravity. Since the purpose is to move the load, and speed adjustment is necessary, allow an extra margin of 3 to 5 times in the effective torque.
  - Actuator effective torque \( \geq (3 \text{ to } 5) \times T_f \)
  - If the mass of the lever itself in the drawing below is considered in the calculations, it should be regarded as an inertial load.

- **Inertial load:**
  - **Definition for our purposes:** The load that is actually rotated by the actuator. Since the purpose is to rotate the load, and speed adjustment is necessary, allow an extra margin of 10 times or more in the effective torque.
  - Actuator effective torque \( \geq S \times T_a \) (\( S \) is 10 times or more)

### Allowable Load

Set the load and moment applied to the shaft within the allowable values provided in the table below.
(Operation above the allowable values can cause adverse effects on service life, such as play in the shaft and loss of accuracy.)

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable radial load ( F_r ) (N)</th>
<th>Allowable thrust load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( F_s(a) )</td>
<td>( F_s(b) )</td>
</tr>
<tr>
<td>05</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>30</td>
<td>25</td>
</tr>
</tbody>
</table>
1. Thin shaft  
   Position of rotational axis: Perpendicular to the shaft anywhere along its length

\[ I = m_1 \times \frac{a_1^3}{3} + m_2 \times \frac{a_2^3}{3} \]

2. Thin shaft  
   Position of rotational axis: Through the shaft’s center of gravity

\[ I = m \times \frac{a^3}{12} \]

3. Thin rectangular plate (rectangular parallelepiped)  
   Position of rotational axis: Through the plate’s center of gravity

\[ I = m \times \frac{a_1^3}{12} \]

4. Thin rectangular plate (rectangular parallelepiped)  
   Position of rotational axis: Perpendicular to the plate through one end (also the same in the case of a thicker plate)

\[ I = m_1 \times \frac{4a_1^2 + b^2}{12} + m_2 \times \frac{4a_2^2 + b^2}{12} \]

5. Thin rectangular plate (rectangular parallelepiped)  
   Position of rotational axis: Through the center of gravity and perpendicular to the plate (also the same in the case of a thicker plate)

\[ I = m \times \frac{a^2 + b^2}{12} \]

6. Cylinder (including thin round plate)  
   Position of rotational axis: Through the plate’s central axis

\[ I = m \times \frac{r^3}{2} \]

7. Solid sphere  
   Position of rotational axis: Through the sphere’s diameter

\[ I = m \times \frac{2r^2}{5} \]

8. Thin round plate  
   Position of rotational axis: Through the plate’s diameter

\[ I = m \times \frac{1}{4} r^2 \]

9. Load at the end of lever  
   Position of rotational axis: Perpendicular to the plate through one end (also the same in the case of a thicker plate)

\[ I = m \times \frac{a^2}{3} + m_2 \times a_2^2 + K \]

(Example) When the shape of \( m_2 \) is a sphere, refer to 7 above. \( K = m_2 \times \frac{2r^2}{5} \)

10. Gear transmission  

Number of teeth = \( a \)  
1. Find the inertial moment \( I_B \) for the rotation of shaft (B).  
2. Next, \( I_B \) is entered to find the inertial moment \( I_A \) for the rotation of shaft (A) as

\[ I_A = -\left( \frac{a}{b} \right)^2 \times I_B \]
Kinetic Energy/Rotation Time

Even in cases where the torque required for rotation of the load is small, damage to internal parts may result from the inertial force of the load.

Take into account the load's inertial moment and rotation time during operation when making your model selection. (The inertial moment and rotation time charts can be used for your convenience in making model selections.)

1. Allowable kinetic energy and rotation time adjustment range

From the table below, set the rotation time within the proper adjustment range for stable operation. Note that slow speed operation exceeding the rotation time adjustment range, may lead to sticking or stopping of operation.

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable kinetic energy (mJ)</th>
<th>Rotation time adjustment range for stable operation (s/90°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>CRJB05 0.25</td>
<td>0.1 to 0.5</td>
</tr>
<tr>
<td></td>
<td>CRJU05 1.0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CRJB 1 0.40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRJU 1 2.0</td>
<td></td>
</tr>
</tbody>
</table>

2. Inertial moment calculation

Since the formulas for inertial moment differ depending on the configuration of the load, refer to the inertial moment calculation formulas on the preceding page.

3. Model selection

Select models by applying the inertial moment and rotation time that you have calculated to the chart below.

1. How to read the chart:
   - Inertial moment .......... $1 \times 10^{-5}$ kg m²
   - Rotation time ............. 0.5s/90°

   CRJB05 is selected in this case.

2. Calculation example:

   Load configuration: A cylinder of radius 0.05m and mass 0.04kg
   Rotation time: 0.4s/90°
   \[
   I = 0.04 \times 0.05^2 / 2 = 5 \times 10^{-4} \text{ kg m}^2
   \]

   In the inertial moment and rotation time chart, find the intersection of the lines extended from the points corresponding to $5 \times 10^{-4}$ kg m² on the vertical axis (inertial moment) and 0.4s/90° on the horizontal axis (rotation time).

   Since the resulting intersection point falls within the CRJU1 selection range, CRJU1 may be selected.
Mini-Rotary Actuator

Air Consumption

Air consumption is the volume of air that is expended by the Mini-Rotary Actuator’s reciprocal operation inside the actuator and in the piping between the actuator and the switching valve. It is required for selection of a compressor and for calculation of its running cost.

The air consumption \( (Q_{CR}) \) required for one reciprocation of a single Mini-Rotary Actuator alone is shown in the table below, and can be used to simplify the calculation.

Formulas

\[
Q_{CR} = 2V \times \left( \frac{P + 0.1}{0.1} \right) \times 10^{-3} \\
Q_{CP} = 2 \times a \times l \times \frac{P}{0.1} \times 10^{-6} \\
Q_c = Q_{CR} + Q_{CP}
\]

When selecting a compressor, it is necessary to choose one that has sufficient reserve for the total downstream air consumption of all pneumatic actuators. This is affected by factors such as leakage in piping, consumption by drain valves and pilot valves, and reduction of air volume due to temperature drops.

Formula

\[
Q_{C2} = Q_c \times n \times \text{Number of actuators} \times \text{Reserve factor}
\]

\(Q_{C2}\) = Compressor discharge flow rate

\(n\) = Actuator reciprocations per minute

Internal cross section of tubing and steel piping

<table>
<thead>
<tr>
<th>Nominal size</th>
<th>O.D. (mm)</th>
<th>I.D. (mm)</th>
<th>Internal cross section (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T 0425</td>
<td>4</td>
<td>2.5</td>
<td>4.9</td>
</tr>
<tr>
<td>T 0608</td>
<td>6</td>
<td>4.0</td>
<td>12.6</td>
</tr>
<tr>
<td>TU 0806</td>
<td>8</td>
<td>5.0</td>
<td>19.6</td>
</tr>
<tr>
<td>1/8B</td>
<td></td>
<td>6.5</td>
<td>33.2</td>
</tr>
<tr>
<td>TU 1075</td>
<td>10</td>
<td>7.5</td>
<td>44.2</td>
</tr>
<tr>
<td>TU 1208</td>
<td>12</td>
<td>8.0</td>
<td>50.3</td>
</tr>
<tr>
<td>TU 1209</td>
<td>12</td>
<td>9.0</td>
<td>63.6</td>
</tr>
<tr>
<td>1/4B</td>
<td></td>
<td>9.2</td>
<td>66.5</td>
</tr>
<tr>
<td>TS 1612</td>
<td>16</td>
<td>12.0</td>
<td>113.0</td>
</tr>
<tr>
<td>3/8B</td>
<td></td>
<td>12.7</td>
<td>127.0</td>
</tr>
<tr>
<td>T 1613</td>
<td>16</td>
<td>13.0</td>
<td>133.0</td>
</tr>
<tr>
<td>1/2B</td>
<td></td>
<td>16.1</td>
<td>204.0</td>
</tr>
<tr>
<td>3/4B</td>
<td></td>
<td>21.6</td>
<td>366.0</td>
</tr>
<tr>
<td>1B</td>
<td></td>
<td>27.8</td>
<td>598.0</td>
</tr>
</tbody>
</table>

Air Consumption

<table>
<thead>
<tr>
<th>Size</th>
<th>Rotation</th>
<th>Internal volume (cm³)</th>
<th>0.15</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>90°</td>
<td>0.15</td>
<td>0.00074</td>
<td>0.00089</td>
<td>0.0012</td>
<td>0.0015</td>
<td>0.0018</td>
<td>0.0021</td>
<td>0.0024</td>
</tr>
<tr>
<td></td>
<td>180°</td>
<td>0.31</td>
<td>0.0015</td>
<td>0.0018</td>
<td>0.0025</td>
<td>0.0031</td>
<td>0.0037</td>
<td>0.0043</td>
<td>0.0049</td>
</tr>
<tr>
<td>1</td>
<td>90°</td>
<td>0.33</td>
<td>0.0016</td>
<td>0.0020</td>
<td>0.0026</td>
<td>0.0033</td>
<td>0.0039</td>
<td>0.0046</td>
<td>0.0052</td>
</tr>
<tr>
<td></td>
<td>180°</td>
<td>0.66</td>
<td>0.0033</td>
<td>0.0039</td>
<td>0.0052</td>
<td>0.0065</td>
<td>0.0078</td>
<td>0.0091</td>
<td>0.0100</td>
</tr>
</tbody>
</table>
Mini-Rotary Actuator
Series CRJ

How to Order

CRJ B 05 - 90 E - F9B S

CRJ U 05 - 90 E - F9B S

Number of auto switches
Nil 2 pcs.
S 1 pc.

Auto switch type
Nil Without auto switch (built-in magnet)

Select applicable auto switches from the table below.

Applicable auto switches/
Refer to pages 7 through 11 for detailed auto switch specifications.

<table>
<thead>
<tr>
<th>Type</th>
<th>Special function</th>
<th>Electrical entry</th>
<th>Indicator light</th>
<th>Wiring (output)</th>
<th>Load voltage</th>
<th>Auto switch part no.</th>
<th>Lead wire length (m)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid state switch</td>
<td>-</td>
<td>Grommet</td>
<td>Yes</td>
<td>3-wire (NPN)</td>
<td>24V 12V</td>
<td>F9N</td>
<td>F9N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-wire (PNP)</td>
<td></td>
<td>F9P</td>
<td>F9P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2-wire</td>
<td></td>
<td>F8P</td>
<td>F8P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-wire (PNP)</td>
<td></td>
<td>F9B</td>
<td>F9B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-wire (PNP)</td>
<td></td>
<td>F8B</td>
<td>F8B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2-wire</td>
<td></td>
<td>F9NW</td>
<td>F9NW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2-wire</td>
<td></td>
<td>F9PW</td>
<td>F9PW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2-wire</td>
<td></td>
<td>F9BW</td>
<td>F9BW</td>
</tr>
</tbody>
</table>

* Lead wire length symbols: 0.5m ..... Nil (Example) F9N
   3m ...... L (Example) F9NL
   5m ...... Z (Example) F9NWZ

* Auto switches marked "/L50263" are produced upon receipt of order.
### Specifications

<table>
<thead>
<tr>
<th>Size/Type</th>
<th>Fluid</th>
<th>Max. operating pressure</th>
<th>Min. operating pressure</th>
<th>Ambient and fluid temperature</th>
<th>Rotation angle</th>
<th>Cylinder bore size</th>
<th>Port size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Air (non-lube)</td>
<td>0.7MPa</td>
<td>0.15MPa</td>
<td>0° to 60°C (with no freezing)</td>
<td>90°, 100°, 180°, 190°</td>
<td>M3 x 0.5</td>
<td></td>
</tr>
<tr>
<td>With external stopper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Angle adjustment range
- ±5° at each rotation end

#### Cylinder bore size
- 6 mm
- 8 mm

Note: Above values do not include auto switch weights.

### Allowable Kinetic Energy and Rotation Time Adjustment Range

<table>
<thead>
<tr>
<th>Size/Type</th>
<th>Allowable kinetic energy (mJ)</th>
<th>Rotation time adjustment range for stable operation (s/90°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>CRJB05 0.25</td>
<td>0.1 to 0.5</td>
</tr>
<tr>
<td>With external stopper CRJU05 1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CRJB 1 0.40</td>
<td>0.1 to 0.5</td>
</tr>
<tr>
<td>With external stopper CRJU 1 2.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Weights

<table>
<thead>
<tr>
<th>Type/Size</th>
<th>Model</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>CRJB05-90</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>CRJB05-100</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>CRJB05-180</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRJB05-190</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CRJB 1-90</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>CRJB 1-100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRJB 1-180</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>CRJB 1-190</td>
<td></td>
</tr>
<tr>
<td>With external stopper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>CRJU05-90</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>CRJU05-180</td>
<td>53</td>
</tr>
<tr>
<td>1</td>
<td>CRJU 1-90</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>CRJU 1-180</td>
<td>81</td>
</tr>
</tbody>
</table>

Note: Above values do not include auto switch weights.

Note) If optimum accuracy of the rotation angle is required, select an actuator with external stopper.
Rotating Direction and Rotation Angle

- The shaft turns clockwise when the A port is pressurized, and counterclockwise when the B port is pressurized.
- For actuators with external stopper, the rotation end can be set within the ranges shown in the drawing by adjusting the stopper bolt.

Basic type

For 90° and 100°

For 180° and 190°

With external stopper

For 90°

For 180°

Note) • The drawings show the rotation range for the shaft’s single flat.
• The single flat position in the drawings shows the counterclockwise rotation end when the rotation angle is adjusted to 90° and 180°.
Construction

Basic type/CRJB

With external stopper/CRJU

Parts list

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Body</td>
<td>Aluminum alloy</td>
</tr>
<tr>
<td>2</td>
<td>Piston</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>3</td>
<td>Shaft</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>4</td>
<td>Bearing retainer</td>
<td>Aluminum alloy</td>
</tr>
<tr>
<td>5</td>
<td>Cover</td>
<td>Aluminum alloy</td>
</tr>
<tr>
<td>6</td>
<td>Bearing</td>
<td>Bearing steel</td>
</tr>
<tr>
<td>7</td>
<td>Piston seal</td>
<td>NBR</td>
</tr>
<tr>
<td>8</td>
<td>O-ring</td>
<td>NBR</td>
</tr>
<tr>
<td>9</td>
<td>Wear ring</td>
<td>Resin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Magnet</td>
<td>Magnetic material</td>
</tr>
<tr>
<td>11</td>
<td>Round head no. 0 Phillips screw</td>
<td>Steel wire</td>
</tr>
<tr>
<td>12</td>
<td>Hexagon socket head set screw</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>13</td>
<td>Stopper</td>
<td>Chrome molybdenum steel</td>
</tr>
<tr>
<td>14</td>
<td>Holder</td>
<td>Aluminum alloy</td>
</tr>
<tr>
<td>15</td>
<td>Stopper retainer</td>
<td>Steel</td>
</tr>
<tr>
<td>16</td>
<td>Hexagon socket head set screw</td>
<td>Steel wire</td>
</tr>
<tr>
<td>17</td>
<td>Hexagon nut</td>
<td>Steel wire</td>
</tr>
<tr>
<td>18</td>
<td>Hexagon socket head cap screw</td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>

* The mounting position of hexagon socket head set screws (no. 12) varies depending on the connecting port position.*
**Dimensions/Size 0.5, 1**

**Basic type/CRJB**

![Diagram of basic type/CRJB](image)

- **2-JC depth JD**
- **2-J through JA**
- **depth of counter bore JB** (opposite side, same location)
- **2-M3 x 0.5 depth 4**
- **2-M3 x 0.5** (For side port, use hexagon socket head set screw)

Note 1: This dimension is for the actuator with D-F9 type auto switch (not including the 2-color indication type).

**With external stopper/CRJU**

![Diagram of with external stopper/CRJU](image)

- **2-M3 x 0.5 (opposite side, same location)**
- **(For front port, use hexagon socket head set screw)**

Note 2: For the 180° specification, the slated line area do not exist.

Note 3: The maximum dimensions that appear are those measured at the maximum rotation angle settings: 100° and 190°.

---

**Table of Dimensions**

<table>
<thead>
<tr>
<th>Size</th>
<th>Rotation angle</th>
<th>A</th>
<th>BA</th>
<th>BB</th>
<th>BC</th>
<th>BD</th>
<th>BE</th>
<th>BG</th>
<th>BH</th>
<th>BI</th>
<th>CA</th>
<th>CB</th>
<th>D</th>
<th>DD</th>
<th>J</th>
<th>JA</th>
<th>JB</th>
<th>JC</th>
<th>JD</th>
<th>H</th>
<th>N</th>
<th>Q</th>
<th>S</th>
<th>SD</th>
<th>UU</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRJB05</td>
<td>90° 180°</td>
<td>19.5</td>
<td>30</td>
<td>32.4</td>
<td>43.4</td>
<td>9.5</td>
<td>11</td>
<td>6.5</td>
<td>3.5</td>
<td>17.1</td>
<td>20</td>
<td>7</td>
<td>21.5</td>
<td>5.5</td>
<td>27</td>
<td>5g6</td>
<td>10h9</td>
<td>M4 x 0.7</td>
<td>5.8</td>
<td>3.5</td>
<td>M4 x 0.7</td>
<td>5</td>
<td>14.5</td>
<td>13.5</td>
<td>13.5</td>
<td>4.3</td>
</tr>
<tr>
<td>CRJB 1</td>
<td>90° 180°</td>
<td>23.5</td>
<td>35</td>
<td>37.4</td>
<td>50.4</td>
<td>12.5</td>
<td>14</td>
<td>9</td>
<td>4.5</td>
<td>21.1</td>
<td>22</td>
<td>8.5</td>
<td>24</td>
<td>30.5</td>
<td>7.5</td>
<td>6g6</td>
<td>14h9</td>
<td>M5 x 0.8</td>
<td>7.5</td>
<td>4.5</td>
<td>M5 x 0.8</td>
<td>6</td>
<td>15.5</td>
<td>13.5</td>
<td>16.5</td>
<td>48</td>
</tr>
</tbody>
</table>

---

**Note 1:** This dimension is for the actuator with D-F9 type auto switch (not including the 2-color indication type).

**Note 2:** For the 180° specification, the slated line area do not exist.

**Note 3:** The maximum dimensions that appear are those measured at the maximum rotation angle settings: 100° and 190°.
**Auto Switch/Proper Mounting Position at Rotation End**

<table>
<thead>
<tr>
<th>Size</th>
<th>Rotation</th>
<th>D-F9 auto switch</th>
<th>D-F8 auto switch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Rotation range (°m)</td>
<td>Actuation range</td>
</tr>
<tr>
<td>05</td>
<td>90°</td>
<td>20.5</td>
<td>40°</td>
</tr>
<tr>
<td></td>
<td>180°</td>
<td>23.2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>90°</td>
<td>22.4</td>
<td>30°</td>
</tr>
<tr>
<td></td>
<td>180°</td>
<td>25.6</td>
<td></td>
</tr>
</tbody>
</table>

Rotation range (°m): Value of the operating range Lm of a single auto switch converted to an axial rotation range.

Actuation range: Value of auto switch hysteresis converted to an angle.
### Auto Switch Common Specifications

<table>
<thead>
<tr>
<th>Type</th>
<th>Solid state switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating time</td>
<td>1ms or less</td>
</tr>
<tr>
<td>Impact resistance</td>
<td>1000m/s²</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>50MΩ or more at 500VDC (between lead wire and case)</td>
</tr>
<tr>
<td>Withstand voltage</td>
<td>1000VAC for 1min.</td>
</tr>
<tr>
<td>(between lead wire and case)</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>–10° to 60°C</td>
</tr>
<tr>
<td>Enclosure</td>
<td>IEC529 standard IP67</td>
</tr>
<tr>
<td></td>
<td>JISC0920 watertight construction</td>
</tr>
</tbody>
</table>

#### Lead Wire Lengths

**Indication of lead wire length**

**Example**

<table>
<thead>
<tr>
<th>Lead wire length</th>
<th>0.5m</th>
<th>3m</th>
<th>5m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D-F9P L</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1) Lead wire length Z: Auto switch applicable to 5m length.

Solid state switches: All models are produced upon receipt of order.

Note 2) The standard lead wire length is 3m for water resistant 2-color indication solid state switches. (0.5m is not available.)

Note 3) For solid state with flexible wire specification, enter "–61" after the lead wire length.

#### Lead Wire Color Changes

Lead wire colors of SMC auto switches have been changed in order to meet standard IEC947-5-2 for production beginning September, 1996 and thereafter, as shown in the tables below.

Take special care regarding wire polarity during the time that the old colors still coexist with the new colors.

**2-wire**

<table>
<thead>
<tr>
<th></th>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) Output</td>
<td>Red</td>
<td>Brown</td>
</tr>
<tr>
<td>(-) Output</td>
<td>Black</td>
<td>Blue</td>
</tr>
</tbody>
</table>

**3-wire**

<table>
<thead>
<tr>
<th></th>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) Power supply</td>
<td>Red</td>
<td>Brown</td>
</tr>
<tr>
<td>GND Power supply</td>
<td>Black</td>
<td>Blue</td>
</tr>
<tr>
<td>Output</td>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>Diagnostic output</td>
<td>Yellow</td>
<td>Orange</td>
</tr>
</tbody>
</table>

**Solid state with diagnostic output**

<table>
<thead>
<tr>
<th></th>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) Power supply</td>
<td>Red</td>
<td>Brown</td>
</tr>
<tr>
<td>GND Power supply</td>
<td>Black</td>
<td>Blue</td>
</tr>
<tr>
<td>Output</td>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>Diagnostic output</td>
<td>Yellow</td>
<td>Orange</td>
</tr>
</tbody>
</table>

**Solid state with latch type diagnostic output**

<table>
<thead>
<tr>
<th></th>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) Power supply</td>
<td>Red</td>
<td>Brown</td>
</tr>
<tr>
<td>GND Power supply</td>
<td>Black</td>
<td>Blue</td>
</tr>
<tr>
<td>Output</td>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>Diagnostic output</td>
<td>Yellow</td>
<td>Orange</td>
</tr>
</tbody>
</table>
Basic Wiring

Solid state 3-wire, NPN

Solid state 3-wire, PNP

2-wire

Examples of Connection to PLC

Sink input specifications

3-wire, NPN

Source input specifications

3-wire, PNP

The connection method will vary depending on the applicable PLC input specifications. Connect accordingly.

Connection Examples for AND (Series) and OR (Parallel)

3-wire

AND connection for NPN output (using relays)

AND connection for NPN output (performed with switches only)

OR connection for NPN output

2-wire, with 2-switch AND connection

2-wire, with 2-switch OR connection

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

Load voltage at OFF = Leakage current x 2 pcs. x Load impedance
Example: Load impedance is 3kΩ. Leakage current from switch is 1mA.
Auto Switch Specifications

<table>
<thead>
<tr>
<th>D-F8N</th>
<th>D-F8P</th>
<th>D-F8B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto switch part no.</td>
<td>D-F8N</td>
<td>D-F8P</td>
</tr>
<tr>
<td>Electrical entry direction</td>
<td>Perpendicular</td>
<td>Perpendicular</td>
</tr>
<tr>
<td>Wiring</td>
<td>3-wire</td>
<td>2-wire</td>
</tr>
<tr>
<td>Output</td>
<td>NPN type</td>
<td>PNP type</td>
</tr>
<tr>
<td>Applicable load</td>
<td>IC circuit, 24VDC relay, PLC</td>
<td>24VDC relay, PLC</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>5, 12, 24VDC (4.5 to 28VDC)</td>
<td>—</td>
</tr>
<tr>
<td>Current consumption</td>
<td>10mA or less</td>
<td>—</td>
</tr>
<tr>
<td>Load voltage</td>
<td>28VDC or less</td>
<td>—</td>
</tr>
<tr>
<td>Load current</td>
<td>40mA or less</td>
<td>80mA or less</td>
</tr>
<tr>
<td>Internal voltage drop</td>
<td>1.5V or less (0.8V or less at a load current of 10mA)</td>
<td>0.8V or less</td>
</tr>
<tr>
<td>Leakage current</td>
<td>100μA or less at 24VDC</td>
<td>0.8mA or less at 24VDC</td>
</tr>
<tr>
<td>Indicator light</td>
<td>Red LED lights up when ON</td>
<td></td>
</tr>
</tbody>
</table>

*Lead wires — Heavy duty oil resistant vinyl cord, ø2.7, 0.5m (standard)
D-F8N, D-F8P 0.15mm² x 3-wire (Brown, Black, Blue [Red, White, Black])
D-F8B 0.18mm² x 2-wire (Brown, Blue [Red, Black])
*Refer to page 7 for auto switch common specifications and lead wire length options.

Auto Switch Weights

<table>
<thead>
<tr>
<th>Model</th>
<th>D-F8N</th>
<th>D-F8P</th>
<th>D-F8B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead wire length 0.5m</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead wire length 3m</td>
<td>32</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Auto Switch Dimensions

D-F8N, D-F8P, D-F8B

---

Auto switch internal circuits

Lead wire colors inside [ ] are those prior to conformity with IEC standard.

**D-F8N**

- DC (+) Brown [Red]
- OUT Black [White]
- DC (−) Blue [Black]

**D-F8P**

- DC (+) Brown [Red]
- OUT Black [White]
- DC (−) Blue [Black]

**D-F8B**

- OUT (+) Brown [Red]
- OUT (−) Blue [Black]

---

Grommet

---

Solid State Auto Switches/Direct Mount Type

D-F8N, D-F8P, D-F8B
Solid State Auto Switches/Direct Mount Type
D-F9N, D-F9P, D-F9B

Auto Switch Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>D-F9N</th>
<th>D-F9P</th>
<th>D-F9B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto switch part no.</td>
<td>D-F9N</td>
<td>D-F9P</td>
<td>D-F9B</td>
</tr>
<tr>
<td>Electrical entry direction</td>
<td>In-line</td>
<td>In-line</td>
<td>In-line</td>
</tr>
<tr>
<td>Wiring</td>
<td>3-wire</td>
<td>2-wire</td>
<td>—</td>
</tr>
<tr>
<td>Output</td>
<td>NPN type</td>
<td>PNP type</td>
<td>—</td>
</tr>
<tr>
<td>Applicable load</td>
<td>IC circuit, Relay, PLC</td>
<td>24VDC relay, PLC</td>
<td>—</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>5, 12, 24VDC (4.5 to 28VDC)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Current consumption</td>
<td>10mA or less</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Load voltage</td>
<td>28VDC or less</td>
<td>—</td>
<td>24VDC (10 to 28VDC)</td>
</tr>
<tr>
<td>Load current</td>
<td>40mA or less</td>
<td>80mA or less</td>
<td>5 to 40mA</td>
</tr>
<tr>
<td>Internal voltage drop</td>
<td>1.5V or less (0.8V or less at a load current of 10mA)</td>
<td>0.8V or less</td>
<td>4V or less</td>
</tr>
<tr>
<td>Leakage current</td>
<td>100µA or less at 24VDC</td>
<td>0.8mA or less</td>
<td>—</td>
</tr>
<tr>
<td>Indicator light</td>
<td>Red LED lights up when ON</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

* Lead wires — Heavy duty oil resistant vinyl cord, ø2.7, 0.5m (standard)
  D-F9N, D-F9P  0.15mm² x 3-wire (Brown, Black, Blue [Red, White, Black])
  D-F9B  0.18mm² x 2-wire (Brown, Blue [Red, Black])
* Refer to page 7 for auto switch common specifications and lead wire length options.

Auto Switch Weights

<table>
<thead>
<tr>
<th>Model</th>
<th>D-F9N</th>
<th>D-F9P</th>
<th>D-F9B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead wire length 0.5m</td>
<td>7</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Lead wire length 3m</td>
<td>37</td>
<td>37</td>
<td>31</td>
</tr>
</tbody>
</table>

Auto Switch Dimensions

D-F9N, D-F9P, D-F9B
2-Color Indication Solid State Auto Switches
Direct Mount Type
D-F9NW, D-F9PW, D-F9BW

Auto Switch Specifications

<table>
<thead>
<tr>
<th></th>
<th>D-F9NW</th>
<th>D-F9PW</th>
<th>D-F9BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto switch part no.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical entry direction</td>
<td>In-line</td>
<td>In-line</td>
<td>In-line</td>
</tr>
<tr>
<td>Wiring</td>
<td>3-wire</td>
<td></td>
<td>2-wire</td>
</tr>
<tr>
<td>Output</td>
<td>NPN type</td>
<td>PNP type</td>
<td>—</td>
</tr>
<tr>
<td>Applicable load</td>
<td>IC circuit, Relay IC, PLC</td>
<td>24VDC relay, PLC</td>
<td>—</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>5, 12, 24VDC (4.5 to 28VDC)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Current consumption</td>
<td>10mA or less</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Load voltage</td>
<td>28VDC or less</td>
<td>—</td>
<td>24VDC (10 to 28VDC)</td>
</tr>
<tr>
<td>Load current</td>
<td>0.4mA or less</td>
<td>80mA or less</td>
<td>5 to 40mA</td>
</tr>
<tr>
<td>Internal voltage drop</td>
<td>(0.8V or less at a load current of 10mA)</td>
<td>0.8V or less</td>
<td>4V or less</td>
</tr>
<tr>
<td>Leakage current</td>
<td>100μA or less at 24VDC</td>
<td>0.8mA or less</td>
<td></td>
</tr>
</tbody>
</table>

Indication light
- Actuated position: Red LED lights up
- Optimum operating position: Green LED lights up

Auto Switch Weights

<table>
<thead>
<tr>
<th></th>
<th>Unit: g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>D-F9NW</td>
</tr>
<tr>
<td>Lead wire length 0.5m</td>
<td>7</td>
</tr>
<tr>
<td>Lead wire length 3m</td>
<td>34</td>
</tr>
</tbody>
</table>

Auto Switch Dimensions

D-F9NW, D-F9PW, D-F9BW

Auto switch internal circuits
Lead wire colors inside [ ] are those prior to conformity with IEC standard.

D-F9NW

D-F9PW

D-F9BW

Indicator light/Display method
These safety instructions are intended to prevent a hazardous situation and/or equipment damage. These instructions indicate the level of potential hazard by a label of "Caution", "Warning" or "Danger". To ensure safety, be sure to observe ISO 4414 Note 1), JIS B 8370 Note 2) and other safety practices.

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

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

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

---

Warning

1. The compatibility of pneumatic equipment is the responsibility of the person who designs the pneumatic system or decides its specifications.
   Since the products specified here are used in various operating conditions, their compatibility with the specific pneumatic system must be based on specifications or after analysis and/or tests to meet your specific requirements.

2. Only trained personnel should operate pneumatically operated machinery and equipment.
   Compressed air can be dangerous if handled incorrectly. Assembly, handling or repair of pneumatic systems should be performed by trained and experienced operators.

3. Do not service machinery/equipment or attempt to remove components until safety is confirmed.
   1. Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.
   2. When equipment is to be removed, confirm the safety process as mentioned above. Cut the supply pressure for this equipment and exhaust all residual compressed air in the system.
   3. Before machinery/equipment is restarted, take measures to prevent shooting-out of cylinder piston rod, etc. (Bleed air into the system gradually to create back pressure.)

4. Contact SMC if the product is to be used in any of the following conditions:
   1. Conditions and environments beyond the given specifications, or if product is used outdoors.
   2. Installation on equipment in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverages, recreation equipment, emergency stop circuits, press applications, or safety equipment.
   3. An application which has the possibility of having negative effects on people, property, or animals, and therefore requires special safety analysis.
### Warning

1. **In cases of load variations, lifting/lowering operations or changes in frictional resistance, employ a safety design which allows for these factors.**
   
   Increases in operating speed can cause human injury as well as damage to equipment and machinery.

2. **A protective cover is recommended to minimize the risk of human injury.**
   
   If driven objects and moving parts of the product pose a danger of human injury or equipment damage, design the structure to avoid contact with that area.

3. **Make secure connections so that stationary parts and connecting parts do not become loose.**
   
   Particularly when operation frequency is high or a rotary actuator is used in a location with excessive vibration, employ a secure method of connection.

4. **A deceleration circuit or shock absorber may be required.**
   
   When a driven object is operated at high speed or the load is heavy, it is hard to absorb the impact. Therefore, install a deceleration circuit or an external shock absorber to relieve the impact. In this case, the rigidity of the machinery and equipment should also be examined.

5. **Consider a possible drop in operating pressure due to a power outage.**
   
   When the actuator is used as a clamping mechanism, there is a danger of work pieces dropping out of it if there is a decrease in clamping force due to a drop in circuit pressure caused by a power outage. Therefore, safety equipment should be installed to prevent human injury or damage to machinery and equipment.

6. **Consider a possible loss of power supply.**
   
   Measures should be taken to protect against human injury and equipment damage in the event that there is a loss of power to equipment controlled by air pressure, electricity or hydraulics.

7. **When a meter-out speed controller is used, employ a safety design which takes into account residual pressure.**
   
   If the air supply side is pressurized when there is no residual pressure on the exhaust side, operation will be abnormally fast and this can cause human injury as well as damage to equipment and machinery.

8. **Consider emergency stops.**
   
   Design so that human injury and/or damage to machinery and equipment will not be caused by operation of a rotary actuator when machinery is stopped by a manual emergency stop or by a safety device under abnormal conditions, such as a power outage.

9. **Consider the action when operation is restarted after an emergency stop or abnormal stop.**
   
   Design machinery so that human injury or equipment damage will not occur upon restart of operation. In the case that the rotary actuator needs to be reset at the starting position, install safe manual control equipment.

### Design

10. **Do not use the product as a shock absorbing mechanism.**

    If abnormal pressure or leakage occurs, there may be a drastic loss of deceleration effectiveness, with the accompanying risk of human injury as well as damage to equipment and machinery.

### Selection

1. **Keep the speed setting within the product’s allowable energy value.**
   
   Operating with the kinetic energy of the load exceeding the allowable value can cause damage to the product, leading to human injury as well as damage to equipment and machinery.

2. **Provide a shock absorbing mechanism when kinetic energy applied to the product exceeds the allowable value.**
   
   Operation exceeding the allowable kinetic energy can cause damage to the product and lead to human injury and damage to equipment and machinery.

3. **Do not perform stops or holding operations by containing air pressure inside the product.**
   
   If intermediate stops are performed by containing air with a directional control valve when the product does not have an external stopping mechanism, the stopping position may not hold due to leakage. This can cause human injury and damage to equipment and machinery.

### Caution

1. **Do not operate the product at low speeds that are below the prescribed speed adjustment range.**
   
   If operated at low speeds below the speed adjustment range, this may cause sticking and slipping or stopping of operation.

2. **Do not apply external torque that exceeds the product’s rated output.**
   
   If external force is applied that exceeds the product’s rated output, the product can be damaged.

3. **When repeated accuracy of the rotation angle is required, the load should be directly stopped externally.**
   
   The initial rotation angle may vary even in products equipped with angle adjustment.

4. **Avoid operation on hydraulic systems.**
   
   Operation on hydraulic systems can cause damage to the product.
Warning

1. When angle adjustment is performed while applying pressure, make advance preparations to keep equipment from rotating any more than necessary.
When adjustment is performed with pressure applied, there is the possibility that the equipment will rotate and fall out during adjustment depending on its mounting orientation. This can cause human injury and damage to equipment and machinery.

2. Do not loosen the angle adjustment screw above the adjustment range.
If the angle adjustment screw is loosened past the adjustment range, it may come out causing human injury and damage to equipment and machinery.

3. Do not allow external magnetism close to the product.
Since the auto switches used are types sensitive to magnetism, external magnetism in close proximity to the product can cause malfunction leading to human injury and damage to equipment and machinery.

4. Do not perform additional machining on the product.
Additional machining of the product can adversely affect product strength and cause damage to the product leading to human injury and damage to equipment and machinery.

5. Do not enlarge the fixed orifice on the piping port by reworking.
If the bore is enlarged, rotation speed and impact force will increase. This can cause damage to the product leading to human injury and damage to equipment and machinery.

6. When using a shaft coupling, use one with a sufficient degree of freedom.
If a shaft coupling that does not have a sufficient degree of freedom is used, twisting will occur due to eccentricity. This can cause a malfunction and product damage leading to human injury and damage to equipment and machinery.

7. Do not apply loads to the shaft exceeding the values shown on features 4.
If loads exceeding the allowable values are applied to the product, this can cause malfunction and product damage leading to human injury and damage to equipment and machinery.
A load up to the allowable radial/thrust load can be applied provided that a dynamic load is not generated. However, applications which apply a load directly to the shaft should be avoided whenever possible. In order to further improve operating conditions, methods such as shown in the drawings below are recommended so that a direct load is not applied to the shaft.

8. Attach external stoppers away from the axis of rotation.
If the stopper is installed close to the axis of rotation, the reactive force operating on the stopper due to torque generated by the product itself will be applied to the shaft. This can cause damage to the shaft and bearing, leading to human injury and damage to equipment and machinery.

Precautions when using external stoppers
When the kinetic energy generated by the load exceeds the limit value of the actuator, an external shock absorbing mechanism must be provided to absorb the energy. The correct method for mounting external stoppers is explained in the figure below.

Caution

1. Do not secure the body and strike the shaft, or secure the shaft and strike the body.
This can bend the shaft and cause damage to the bearing. When installing a load on the shaft, secure the shaft.

2. Do not step directly on the shaft or on any equipment installed on the shaft.
Stepping directly on the shaft can cause damage to the shaft and bearing.

3. Operate products equipped with the angle adjustment function within the prescribed adjustment range.
Operation outside the adjustment range can cause malfunction and product damage. Refer to product specifications for the adjustment range of each product.
Air Supply

⚠️ Warning
1. Use clean air.
   Do not use compressed air which contains chemicals, synthetic oils containing organic solvents, salt, or corrosive gases as this can cause damage or malfunctions.

⚠️ Caution
1. Install air filters.
   Install air filters at the upstream side of valves. The rated filtration should be 5µm or finer.
2. Install an after-cooler, air dryer or water separator (SMC Drain Catch).
   Compressed air that includes excessive drainage may cause malfunction of rotary actuators and other pneumatic equipment. To prevent this, install an after-cooler air dryer or water separator.
3. Use the product within the specified range of fluid and ambient temperature.
   Take measures to prevent freezing, since moisture in circuits may freeze at, or below 5°C and this can cause damage to seals and lead to malfunctions.

Refer to SMC’s “Air Cleaning Equipment” catalog for further details on compressed air quality.

Speed Adjustment

⚠️ Warning
1. Perform speed adjustment gradually from the low speed side.
   Speed adjustment from the high speed side can cause product damage leading to human injury and damage to equipment and machinery.

⚠️ Caution
1. When operating at high speed with a large load weight, a large amount of energy is applied to the actuator and can cause damage. Refer to the model selection procedure on features page 3 to find the proper operating time.
2. Do not machine the fixed orifice of the port to enlarge its size. If the fixed orifice size is enlarged, the actuator operating speed and impact force will increase and cause damage.

Lubrication

⚠️ Caution
1. Use this product without lubrication.
   This product is lubricated with grease at the factory, and further lubrication will result in a failure to meet the product's specifications.

Maintenance

⚠️ Warning
1. Maintenance should be performed according to the procedure indicated in the instruction manual. Improper handling can cause damage and malfunction of equipment and machinery.
2. During maintenance, do not disassemble while the electric power and supply air are turned ON.
3. Conduct suitable function tests after the product has been disassembled for maintenance.
   Failure to test functions can result in the product's inability to operate according to specifications.

⚠️ Caution
1. For lubrication, use the grease specified for each product.
   Use of a lubricant other than the specified grease can cause damage to seals and other components.
**Warning**

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

2. **Take precautions when actuators are used close together.**
   When two or more auto switch actuators are lined up in close proximity to each other, magnetic field interference may cause the switches to malfunction. Maintain a minimum actuator separation of 40mm. (When the allowable separation is indicated for each actuator series, use the specified value.)

3. **Monitor the length of time that a switch is ON at an intermediate stroke position.**
   When an auto switch is placed at an intermediate position of the stroke and a load is driven at the time the piston passes, the auto switch will operate, but if the speed is too great the operating time will be shortened and the load may not move properly. The maximum detectable piston speed is:
   \[ V(\text{mm/s}) = \frac{\text{Auto switch operating range (mm)}}{\text{Load operating time (ms)}} \times 1000 \]

4. **Keep wiring as short as possible.**
   <Solid state switch>
   1) Although wire length should not affect switch function, use wiring that is 100m or shorter.

5. **Monitor the internal voltage drop of the switch.**
   <Solid state switch>
   1) Generally, the internal voltage drop will be greater with a 2-wire solid state auto switch than with a reed switch.
      • If auto switches are connected in series as shown below, take note that there will be a large voltage drop. (Refer to internal voltage drop in the auto switch specifications.)
      [The voltage drop will be “n” times larger when “n” auto switches are connected.]
      Even though an auto switch operates normally, the load may not move.

      ![Diagram of auto switch and load](https://via.placeholder.com/150)

      • Similarly, when operating below a specified voltage, it is possible that the load may be ineffective even though the auto switch function is normal. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

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

      Also, note that a 12VDC relay is not applicable.

**Warning**

6. **Be careful of leakage current.**
   <Solid state switch>
   With a 2-wire solid state auto switch, current (leakage current) flows to the load to operate the internal circuit even when in the OFF state.

   \[ \text{Operating current of load (OFF condition)} > \text{Leakage current} \]

   If the condition given in the above formula is not met, it will not reset correctly (stays ON). Use a 3-wire switch if this specification cannot be satisfied.
   Moreover, leakage current flow to the load will be “n” times larger when “n” auto switches are connected in parallel.

7. **Do not use a load that generates surge voltage.**
   <Solid state switch>
   Although a zener diode for surge protection is connected at the output side of a solid state auto switch, damage may still occur if the surge is applied repeatedly. When a load, such as a relay or solenoid, which generates surge is directly driven, use a type of switch with a built-in surge absorbing element.

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

9. **Ensure sufficient clearance for maintenance activities.**
   When designing an application, be sure to allow sufficient clearance for maintenance and inspections.
Warning

1. Do not drop or bump.
   Do not drop, bump or apply excessive impacts (1000m/s² or more for solid state switches) while handling. Although the external body of the switch (switch case) may not be damaged, the inside of the switch could be damaged and cause a malfunction.

2. Do not carry a cylinder by the auto switch lead wires.
   Never carry a cylinder table by its lead wires, as this may not only cause broken lead wires, but it may cause internal elements of the switch to be damaged by the stress.

3. Mount switches using the proper tightening torque.
   When a switch is tightened beyond the range of tightening torque, the mounting screws, mounting bracket or switch may be damaged. On the other hand, tightening below the range of tightening torque may cause the switch to slip out of position.

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

Warning

5. Do not allow short circuit of loads.
   <Solid state switch>
   Model D-F9□(V), F9□□W(V) and all models of PNP output type switches do not have built-in short circuit protection circuits. As in the case of reed switches, if loads are short circuited, the switches will be instantly damaged.
   Take special care to avoid reverse wiring with the brown [red] power supply line and the black [white] output line on 3-wire type switches.

6. Avoid incorrect wiring.
   <Solid state switch>
   1) If connections are reversed on a 2-wire type switch, the switch will not be damaged if protected by a protection circuit, but the switch will be in a normally ON state. However, it is still necessary to avoid reversed connections, since the switch could be damaged by a load short circuit in this condition.
   2) If connections are reversed [(+ power supply line and (-) power supply line] on a 3-wire type switch, the switch will be protected by a protection circuit. However, if the (+) power supply line is connected to the blue [black] wire and the (-) power supply line is connected to the black [white] wire, the switch will be damaged.

Wiring

1. Avoid repeatedly bending or stretching lead wires.
   Broken lead wires will result from installation or applications that repeatedly apply bending stress or stretching force to the lead wires.

2. Be sure to connect the load before power is applied.
   <2-wire type>
   If the power is turned ON when an auto switch is not connected to a load, the switch will be instantly damaged because of excess current.

3. Confirm proper insulation of wiring.
   Be certain that there is no faulty wiring insulation (such as contact with other circuits, ground fault, improper insulation between terminals). Damage may occur due to excess current flow into a switch.

4. Do not wire with power lines or high voltage lines.
   Wire separately from power lines or high voltage lines, avoiding parallel wiring or wiring in the same conduit with these lines. Control circuits containing auto switches may malfunction due to noise from these other lines.

* Lead wire color changes
   Lead wire colors of SMC switches have been changed in order to meet NECA Standard 0402 for production beginning September, 1996 and thereafter. Please refer to the tables provided. Special care should be taken regarding wire polarity during the time that the old colors still coexist with the new colors.
Operating Environment

⚠️ Warning
1. Never use in an atmosphere of explosive gases.

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

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

Auto switches will malfunction or magnets inside actuators will become demagnetized under these usage conditions. Consult SMC regarding the availability of a magnetic field resistant auto switch.

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

Although most switches, except for some models, satisfy IEC standard IP67 construction (JIS C 0920: watertight construction), they should not be used in applications where they might be continually exposed to water splash or spray. Poor insulation or swelling of the potting resin inside switches may cause malfunction.

4. Do not use in an environment with oil or chemicals.

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

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

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

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

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

<Solid state switch>

When there are units (solenoid type lifter, high frequency induction furnace, motor, etc.) that generate a large amount of surge in the area around actuators with solid state auto switches, this may cause deterioration or damage to the internal circuit elements of the switches. Avoid sources of surge generation and crossed lines.

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

When a large amount of ferrous waste such as machining chips or welding spatter is accumulated, or a magnetic substance (something attracted by a magnet) is brought into close proximity of actuators with auto switches, it may cause the auto switches to malfunction due to a loss of the magnetic force inside the cylinder.

Maintenance

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

1) Securely tighten switch mounting screws

If screws become loose or displaced from their mounting position, retighten them after readjusting the mounting position.

2) Confirm that there is no damage to lead wires.

To prevent faulty insulation, replace switches or repair lead wires, if damage is discovered.

3) Confirm that the green light on the 2-color indicator type switch lights up.

Confirm that the GREEN LED is ON and the actuator is stopped when it is at the set position. If the RED LED is ON, and the actuator is stopped the mounting position is not appropriate. Readjust the mounting position until the GREEN LED lights up.

Other

⚠️ Warning
1. Consult SMC concerning water resistance, elasticity of lead wires and usage at welding sites.
**Series CRJ/Specific Product Precautions**

Be sure to read before handling. Refer to pages 12 through 18 for safety precautions, rotary actuator precautions and auto switch precautions.

---

### Rotation Angle Adjustment

**Caution**

As a standard feature, the actuator with external stopper is equipped with a rotation angle adjustment screw that can be used to adjust the angle of rotation.

<table>
<thead>
<tr>
<th>Size</th>
<th>Angle adjustment per single rotation of angle adjustment screw</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>2.3°</td>
</tr>
<tr>
<td>1</td>
<td>2.3°</td>
</tr>
</tbody>
</table>

The rotation adjustment range for the actuator with external stopper is ±5° at each rotation end. Please note that adjusting beyond this range may cause product malfunction.

### Mounting of Speed Controller and Fittings

**Caution**

The M3 x 0.5 piping port is used. In case the speed controller or fittings are directly connected, use the series listed below.

- Speed controller
  - AS121F/Elbow type
  - AS131F/Universal type
- One-touch fitting
  - One-touch mini Series KJ
- Reducer bushing Series M3

### Auto Switch Mounting

**Caution**

If a size 05 actuator with auto switch is being used, keep the magnetic body away at least 2mm or more from the bottom of the actuator.

If the magnetic body comes closer than 2mm, malfunction of the auto switch may occur due to the magnetic force drop.

* When using the bottom face for mounting, a non-magnetic spacer (such as aluminum) is required as shown below.

### Maintenance

**Caution**

This product requires special tools; therefore, it cannot be disassembled for maintenance.

---

### External Stopper Unit

**Caution**

Order external stopper unit with the unit part numbers shown below.

<table>
<thead>
<tr>
<th>Component parts</th>
<th>Model</th>
<th>Unit part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stopper</td>
<td>CRJU05-</td>
<td>P531010-1</td>
</tr>
<tr>
<td>Stopper holder</td>
<td>CRJU05-</td>
<td>P531010-2</td>
</tr>
<tr>
<td>Stopper holder</td>
<td>CRJU 1-</td>
<td>P531020-1</td>
</tr>
<tr>
<td>Stopper holder</td>
<td>CRJU 1-</td>
<td>P531020-2</td>
</tr>
</tbody>
</table>

Note 1) External stopper units for 180° cannot be applied to the 90° Mini-Rotary Actuators.

Note 2) When using external stoppers for 90°, use Mini-Rotary Actuators with a rotation range of 100°, and for 180°, use actuators with a rotation range of 190°.

**External Stopper Assembly Procedure**

- Actuators with external stopper (Model CRJU) come already assembled; therefore, the following procedure is not required.

**Caution**

Assemble the stopper retainer to the stopper temporarily. Then place the stopper retainer in the single flat position and tighten with hexagon socket head cap screws.

Leave a space of approximately 0.5mm between the stopper and the Mini-Rotary Actuator, as shown in Figure 1.

Tighten the hexagon socket head cap screws evenly so that the stopper retainer is not unevenly tightened as in Figure 2.

Furthermore, take precautions to avoid applying excessive force to the shaft when tightening.

**Maintenance**

<table>
<thead>
<tr>
<th>Hexagon socket head cap screws</th>
<th>Tightening torque N.m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexagon socket head cap screws</td>
<td>0.8 to 1.2</td>
</tr>
</tbody>
</table>

---

1. Assemble the stopper retainer to the stopper temporarily. Then place the stopper retainer in the single flat position and tighten with hexagon socket head cap screws.
2. Leave a space of approximately 0.5mm between the stopper and the Mini-Rotary Actuator, as shown in Figure 1.
3. Tighten the hexagon socket head cap screws evenly so that the stopper retainer is not unevenly tightened as in Figure 2.
4. Furthermore, take precautions to avoid applying excessive force to the shaft when tightening.