

Compact Rotary Actuator

Rack & Pinion Style/Size: 10, 15, 20, 30, 40

Size

10: 17 mm

15: 20 mm

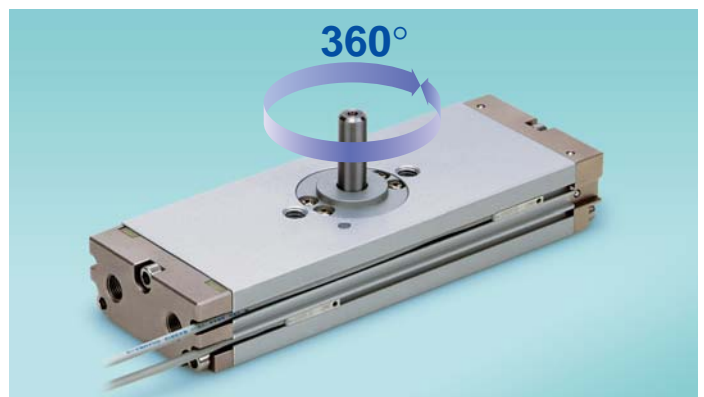
20: 29 mm

30: 33 mm

40: 37 mm

Series **CRQ2**

360° Rotation type
has been added.



Compact Rotary Actuator

Rack & Pinion Style/Size: 10, 15, 20, 30, 40

Built-in cushion

10, 15 : Rubber bumper
20, 30, 40 : Air cushion

Equipped with an angle adjusting mechanism ($\pm 5^\circ$)

Rotary actuator body serves as a flange.

360° type has been added to the series.

Piping can be installed from one end.

Series CRQ2

2 auto switches are mountable on the same side.
(Mountable on the both sides.)

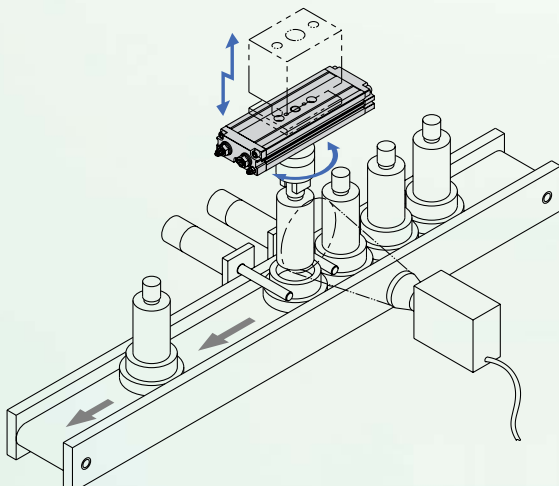
Mounting smaller auto switches prevents the auto switch from protruding above the body surface and realises space-savings.

Double piston style
Compact, with no backlash

Both single shaft and double shaft are available in all sizes.

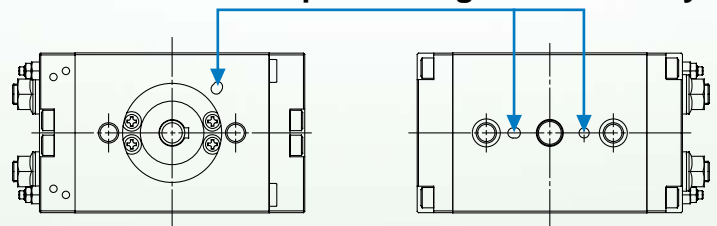
360° type application example

Complete external inspection of a work piece



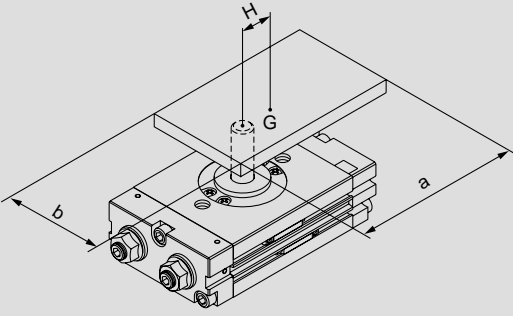
Centering is easy when mounting the main body.

Pin holes for positioning the main body



| Series | Size | Shaft type | Rotation | Cushion | |
|--------|------|----------------------|---|---------|-----|
| | | | | Rubber | Air |
| CRQ2 | 10 | • Single • Double | • 80° to 100° • 170° to 190° • 350° to 370° | ● | — |
| | 15 | | | ● | — |
| | 20 | | | — | ● |
| | 30 | | | — | ● |
| | 40 | | | — | ● |

Series CRQ2 Model Selection

| Selection Procedure | Formula | Selection Example |
|---|--|--|
| <p>1 Operating conditions</p> <p>Operating conditions are as follows:</p> | <ul style="list-style-type: none"> • Model used • Operating pressure • Mounting position • Load type <ul style="list-style-type: none"> Static load: T_s (N·m) Resistance load: T_f (N·m) Inertial load: T_a (N·m) • Load configuration • Rotation time t (s) • Rotation θ (rad) • Load mass m (kg) • Distance between central axis and centre of gravity H (m) |  <p>Rotary actuator: CDRQ2BS40-90, Pressure: 0.5 MPa Mounting position: Vertical, Type of load: Inertial load T_a Load configuration: 0.1 m x 0.06 m (Rectangular plate) Rotation time (t): 0.3 s, Rotation: $\frac{\pi}{2}$ rad (90°) Load mass (m): 0.4 kg Distance between central axis and centre of gravity (H): 0.04 m</p> |
| <p>2 Required torque</p> <p>Confirm the type of load as shown below, and select an actuator that satisfies the required torque.</p> <ul style="list-style-type: none"> • Static load: T_s • Resistance load: T_f Load type • Inertial load: T_a | <p>Effective torque $\geq T_s$ Effective torque $\geq (3 \text{ to } 5) \times T_f$ Effective torque $\geq 10 \times T_a$</p> <p>Effective torque</p> | <p>Inertial load $10 \times T_a = 10 \times I \times \dot{\omega}$ $= 10 \times 0.00109 \times (2 \times (\pi/2)/0.3^2)$ $= 0.380 \text{ N·m} < \text{Effective torque OK}$</p> <p>Note) I is obtained by substituting the value of inertia moment ⑤.</p> |
| <p>3 Rotation time</p> <p>Confirm that it is within the adjustable range of rotation time.</p> | <p>0.2 to 1.0 s/90°</p> | <p>0.3 s/90° OK</p> |
| <p>4 Allowable loads</p> <p>Confirm that the radial load, thrust load, and moment are within the allowable ranges.</p> | <p>Thrust load: $m \times 9.8 \leq \text{Allowable load}$</p> <p>Allowable load</p> | <p>$0.4 \times 9.8 = 3.92 \text{ N} < \text{Allowable load OK}$</p> |
| <p>5 Moment of inertia</p> <p>Find the load's moment of inertia "I" for the energy calculation.</p> | <p>$I = m \times (a^2 + b^2)/12 + m \times H^2$</p> <p>Moment of inertia</p> | <p>$I = 0.4 \times (0.10^2 + 0.06^2)/12 + 0.4 \times 0.04^2$ $= 0.00109 \text{ kg·m}^2$</p> |
| <p>6 Kinetic energy</p> <p>Confirm that the load's kinetic energy is within the allowable value.</p> | <p>$1/2 \times I \times \omega^2 \leq \text{Allowable energy}$ $\omega = 2 \theta/t$ (ω: Terminal angular velocity) θ: Rotation angle (rad) t: Rotation time (s)</p> <p>Allowable kinetic energy/Rotation time</p> | <p>$1/2 \times 0.00109 \times (2 \times (\pi/2)/0.3)^2$ $= 0.060 \text{ J} < \text{Allowable energy OK}$</p> |

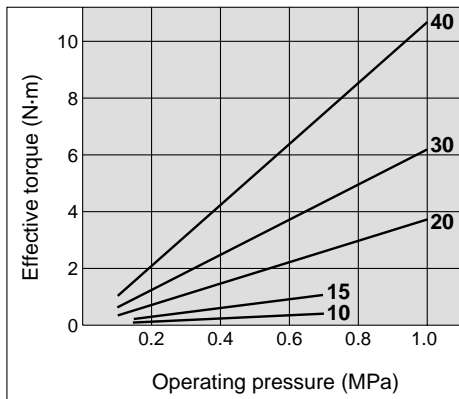
Series CRQ2

Effective Torque

Unit: N·m

| Size | Operating pressure (MPa) | | | | | | | | | | |
|------|--------------------------|------|------|------|------|------|------|------|------|------|------|
| | 0.10 | 0.15 | 0.20 | 0.30 | 0.40 | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 1.00 |
| 10 | — | 0.09 | 0.12 | 0.18 | 0.24 | 0.30 | 0.36 | 0.42 | — | — | — |
| 15 | — | 0.22 | 0.30 | 0.45 | 0.60 | 0.75 | 0.90 | 1.04 | — | — | — |
| 20 | 0.37 | 0.55 | 0.73 | 1.10 | 1.47 | 1.84 | 2.20 | 2.57 | 2.93 | 3.29 | 3.66 |
| 30 | 0.62 | 0.94 | 1.25 | 1.87 | 2.49 | 3.11 | 3.74 | 4.37 | 4.99 | 5.60 | 6.24 |
| 40 | 1.06 | 1.59 | 2.11 | 3.18 | 4.24 | 5.30 | 6.36 | 7.43 | 8.48 | 9.54 | 10.6 |

Note) The values of operating torque in the table above are representative values, and are not guaranteed. Make use of the values as a reference when ordering.

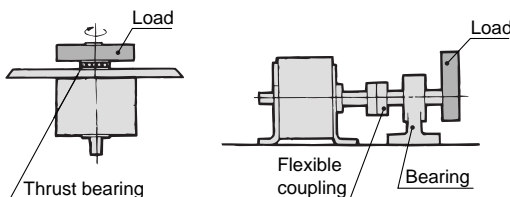


Allowable Load

Unit: N

| Size | Load direction | | |
|------|----------------|------|------|
| | Fsa | Fsb | Fr |
| 10 | 15.7 | 7.8 | 14.7 |
| 15 | 19.6 | 9.8 | 19.6 |
| 20 | 49 | 29.4 | 49 |
| 30 | 98 | 49 | 78 |
| 40 | 108 | 59 | 98 |

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 the operating conditions, a method such as that shown in the drawing below is recommended so that a direct load is not applied to the shaft.



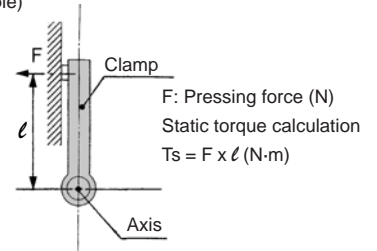
Load Type

● Static load: Ts

A load as represented by the clamp which requires pressing force only

(During examination if it is decided to consider the mass of the clamp itself in the drawing below, it should be regarded as an inertial load.)

(Example)



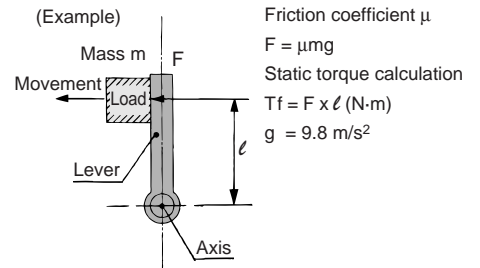
● Resistance load: Tf

A load that is affected by external forces such as friction or gravity

Since the object 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 $\geq (3 \text{ to } 5) T_f$

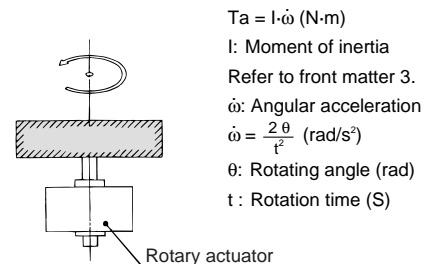
(Example)



● Inertial load: Ta

The load which must be rotated by the actuator. Since the object 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 $\geq S \cdot T_a$
(S is 10 times or more)



$$T_a = I \cdot \dot{\omega} \text{ (N·m)}$$

I: Moment of inertia

Refer to front matter 3.

$\dot{\omega}$: Angular acceleration

$$\dot{\omega} = \frac{2\theta}{t^2} \text{ (rad/s}^2\text{)}$$

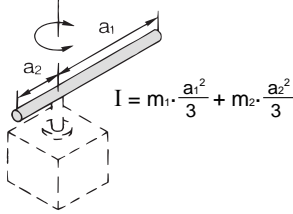
θ : Rotating angle (rad)

t: Rotation time (S)

Equation Table of Moment of Inertia (Calculation of moment of inertia I) I: Moment of inertia (kg·m²) m: Load weight (kg)

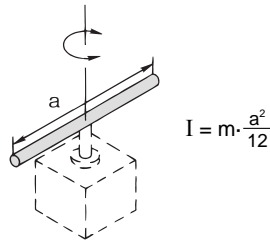
1. Thin shaft

Position of rotational axis:
Perpendicular to the shaft through one end



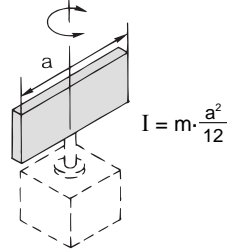
2. Thin shaft

Position of rotational axis:
Through the shaft's centre of gravity



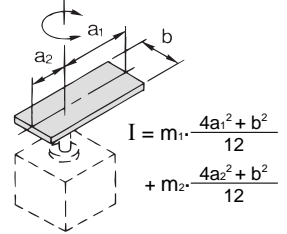
3. Thin rectangular plate (Rectangular parallelepiped)

Position of rotational axis:
Through the plate's centre of gravity



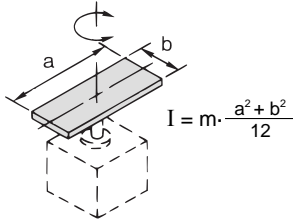
4. Thin rectangular plate (Rectangular parallelepiped)

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



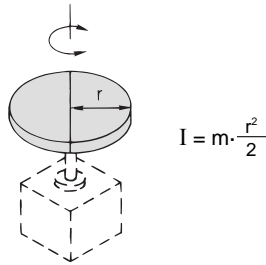
5. Thin rectangular plate (Rectangular parallelepiped)

Position of rotational axis: Through the centre of gravity and perpendicular to the plate (also the same in case of a thicker plate)



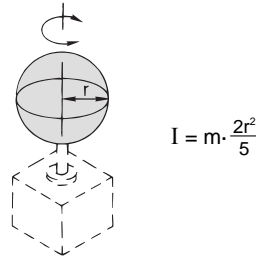
6. Column (Including thin round plate)

Position of rotational axis: Centre axis



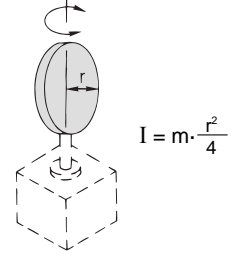
7. Solid sphere

Position of rotational axis:
Diameter

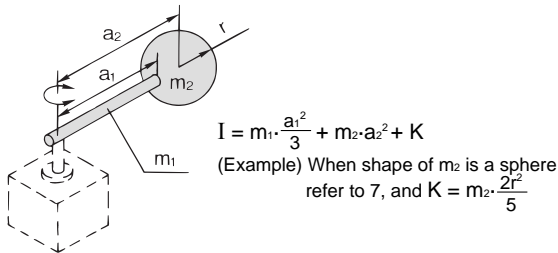


8. Thin round plate

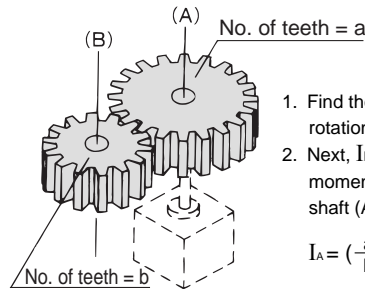
Position of rotational axis:
Diameter



9. Load at end of lever



10. Gear transmission



1. Find the moment of inertia I_B for the rotation of shaft (B).
2. Next, I_B is entered to find I_A the moment of inertia for the rotation of shaft (A) as

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

Kinetic Energy/Rotating Time

For a rotational movement, the kinetic energy of a load may damage the internal parts, even if the required torque for a load is small. Consider the moment of inertia and rotation time before selecting a model.

(For model selection, please refer to the moment of inertia and rotation time graph as shown on front matter 4.)

1. Allowable kinetic energy and rotation time adjustment range

Set the rotation time, within stable operational guidelines, using the adjustment range specification table as detailed below. When operating at low speeds which exceed the rotation time adjustment range, please use caution as it may result in sticking or malfunction.

| Size | Allowable kinetic energy | | | | Cushion angle | Stable operational rotation time adjustment range Rotation time (s/90°) |
|------|-------------------------------|---------------|-------------------|-------------------|---------------|--|
| | Allowable kinetic energy (mJ) | | | With air cushion* | | |
| | Without cushion | Rubber bumper | With air cushion* | | | |
| 10 | — | 0.25 | — | — | 0.2 to 0.7 | |
| 15 | — | 0.39 | — | — | 0.2 to 0.7 | |
| 20 | 25 | — | 120 | 40° | 0.2 to 1 | |
| 30 | 48 | — | 250 | 40° | 0.2 to 1 | |
| 40 | 81 | — | 400 | 40° | 0.2 to 1 | |

* Allowable kinetic energy for the bumper equipped type
Maximum absorbed energy under proper adjustment of the cushion needles.

2. Calculation of moment of inertia

Refer to above formula for moment of inertia, as this will vary, depending on a loads configuration.

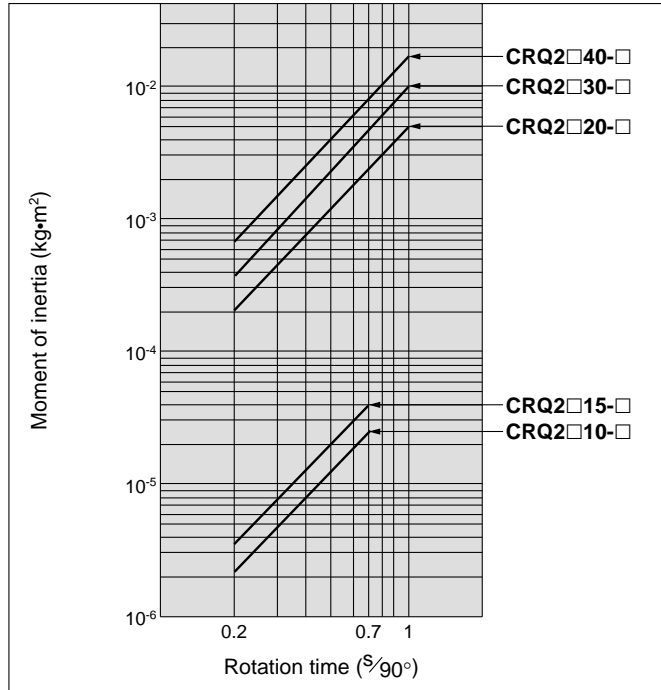
Series CRQ2

Kinetic Energy/Rotating Time

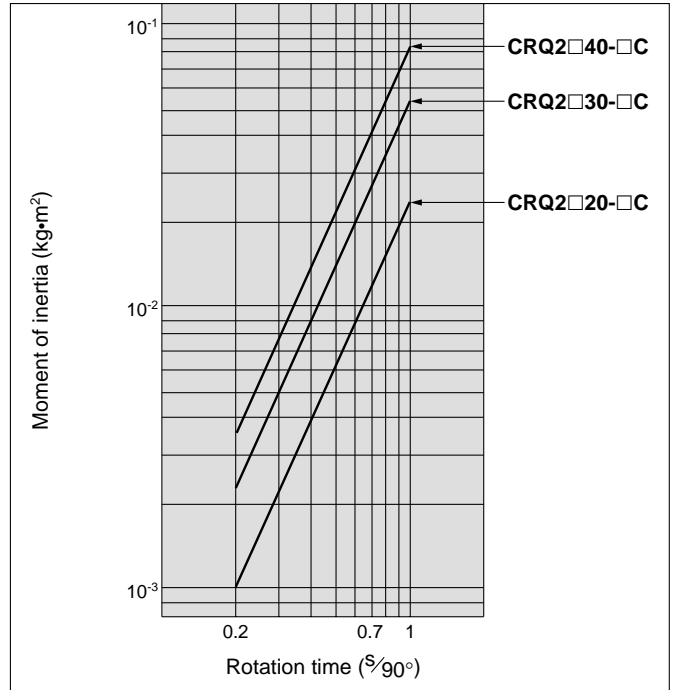
3. Model Selection

Select a model based on the moment of inertia and rotation time as shown graph below.

Without Cushion



With Cushion



Rotary Actuator Technical Data

Air Consumption

Air consumption is the volume of air which is expended by the rotary actuator's reciprocal operation inside the actuator and in the piping between the actuator and the switching valve, etc. This is necessary for selection of a compressor and for calculation of its running cost.

* The air consumption (Q_{CR}) required for one reciprocation of the rotary actuator alone is shown in the table below, and can be used to simplify the calculation.

Formulas

$$Q_{CR} = 2V \times \left(\frac{P + 0.1}{0.1}\right) \times 10^{-3}$$

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

$$Q_C = Q_{CR} + Q_{CP}$$

- Q_{CR} = Air consumption of rotary actuator [ℓ (ANR)]
- Q_{CP} = Air consumption of tubing or piping [ℓ (ANR)]
- V = Internal volume of rotary actuator [cm³]
- P = Operating pressure [MPa]
- ℓ = Length of piping [mm]
- a = Internal cross section of piping [mm²]
- Q_C = Air consumption required for one reciprocation of rotary actuator [ℓ (ANR)]

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

Formulas

$$Q_{C2} = Q_C \times n \times \text{Number of actuators} \times \text{Reserve factor}$$

- Q_{C2} = Compressor discharge flow rate [ℓ/min (ANR)]
- n = Actuator reciprocations per minute
- Reserve factor: 1.5 or greater

Internal Cross Section of Tubing and Steel Piping

| Nominal size | O.D. (mm) | I.D. (mm) | Internal cross section a (mm ²) |
|--------------|-----------|-----------|---|
| T□0425 | 4 | 2.5 | 4.9 |
| T□0604 | 6 | 4 | 12.6 |
| TU0805 | 8 | 5 | 19.6 |
| T□0806 | 8 | 6 | 28.3 |
| 1/8B | — | 6.5 | 33.2 |
| T□1075 | 10 | 7.5 | 44.2 |
| TU1208 | 12 | 8 | 50.3 |
| T□1209 | 12 | 9 | 63.6 |
| 1/4B | — | 9.2 | 66.5 |
| TS1612 | 16 | 12 | 113 |
| 3/8B | — | 12.7 | 127 |
| T□1613 | 16 | 13 | 133 |
| 1/2B | — | 16.1 | 204 |
| 3/4B | — | 21.6 | 366 |
| 1B | — | 27.6 | 598 |

Rack & Pinion Style: Series CRQ2

Air consumption of rotary actuator: Q_{CRℓ} (ANR)

| Size | Rotating angle (°) | Internal volume V (cm ³) | Operating pressure (MPa) | | | | | | | | | | |
|------|--------------------|--------------------------------------|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | | 0.1 | 0.15 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| 10 | 90 | 1.2 | — | 0.006 | 0.007 | 0.009 | 0.012 | 0.014 | 0.016 | 0.018 | — | — | — |
| | 180 | 2.2 | — | 0.011 | 0.013 | 0.018 | 0.022 | 0.026 | 0.031 | 0.035 | — | — | — |
| | 360 | 4.3 | — | 0.021 | 0.026 | 0.034 | 0.043 | 0.051 | 0.060 | 0.068 | — | — | — |
| 15 | 90 | 2.9 | — | 0.015 | 0.017 | 0.023 | 0.029 | 0.035 | 0.041 | 0.046 | — | — | — |
| | 180 | 5.5 | — | 0.028 | 0.033 | 0.044 | 0.055 | 0.066 | 0.077 | 0.088 | — | — | — |
| | 360 | 10.7 | — | 0.023 | 0.064 | 0.086 | 0.107 | 0.129 | 0.193 | 0.172 | — | — | — |
| 20 | 90 | 7.1 | 0.028 | 0.036 | 0.043 | 0.057 | 0.071 | 0.085 | 0.099 | 0.114 | 0.128 | 0.142 | 0.156 |
| | 180 | 13.5 | 0.054 | 0.068 | 0.081 | 0.108 | 0.135 | 0.162 | 0.189 | 0.216 | 0.243 | 0.270 | 0.297 |
| | 360 | 26.3 | 0.105 | 0.131 | 0.158 | 0.210 | 0.263 | 0.316 | 0.368 | 0.421 | 0.473 | 0.526 | 0.578 |
| 30 | 90 | 12.1 | 0.048 | 0.060 | 0.073 | 0.097 | 0.121 | 0.145 | 0.169 | 0.193 | 0.218 | 0.242 | 0.266 |
| | 180 | 23.0 | 0.092 | 0.115 | 0.138 | 0.184 | 0.230 | 0.276 | 0.322 | 0.368 | 0.413 | 0.459 | 0.505 |
| | 360 | 44.7 | 0.179 | 0.224 | 0.268 | 0.358 | 0.447 | 0.537 | 0.626 | 0.716 | 0.805 | 0.895 | 0.984 |
| 40 | 90 | 20.6 | 0.082 | 0.103 | 0.123 | 0.164 | 0.206 | 0.247 | 0.288 | 0.329 | 0.370 | 0.411 | 0.452 |
| | 180 | 39.1 | 0.156 | 0.195 | 0.234 | 0.313 | 0.391 | 0.469 | 0.547 | 0.625 | 0.703 | 0.781 | 0.859 |
| | 360 | 76.1 | 0.304 | 0.380 | 0.456 | 0.609 | 0.761 | 0.913 | 1.07 | 1.22 | 1.37 | 1.52 | 1.67 |

Compact Rotary Actuator Rack & Pinion Style Series CRQ2

How to Order

Without auto switch

CRQ2B S 20 90

With auto switch

CDRQ2B S 20 90 M9BW

Built-in magnet

Shaft type

| | |
|---|--------------|
| S | Single shaft |
| W | Double shaft |

Size

| |
|----|
| 10 |
| 15 |
| 20 |
| 30 |
| 40 |

Thread type

| Port type | | Size |
|-----------|----------|------------|
| - | M5 | 10, 15 |
| | Rc 1/8 | 20, 30, 40 |
| TF | G 1/8 | |
| TN | NPT 1/8 | |
| TT | NPTF 1/8 | |

Rotating angle

| | |
|-----|--------------|
| 90 | 80° to 100° |
| 180 | 170° to 190° |
| 360 | 350° to 370° |

Number of auto switches

| | |
|---|--------|
| - | 2 pcs. |
| S | 1 pc. |
| n | n pcs. |

Auto switch

| | |
|---|---------------------------------------|
| - | Without auto switch (Built-in magnet) |
|---|---------------------------------------|

* For the applicable auto switch model, refer to the table below.

* Auto switches are shipped together, (but not assembled).

Suffix symbol

| Symbol | Cushion | Size | | | | |
|--------|-----------------|------|----|----|----|----|
| | | 10 | 15 | 20 | 30 | 40 |
| - | Without cushion | — | — | ● | ● | ● |
| | Rubber bumper | ● | ● | — | — | — |
| C | Air cushion | — | — | ● | ● | ● |

Applicable Auto Switches/Refer to pages 9 to 13 for further information on auto switches.

| Type | Special function | Electrical entry | Indicator light | Wiring (Output) | Load voltage | | | Auto switch model | | Lead wire length (m)* | | | Applicable load | |
|--------------------|--|------------------|-----------------|---------------------|--------------|---------------|---------------|-------------------|------------|-----------------------|------------|-------|-----------------|------------|
| | | | | | DC | | AC | Perpendicular | In-line | 0.5 (Nil) | 3 (L) | 5 (Z) | | |
| | | | | | 24 V | 5 V, 12 V | 100 V or less | | | | | | | |
| Reed switch | — | Grommet | No | 2-wire | 24 V | 5 V, 12 V | 100 V or less | A90V | A90 | ● | ● | — | IC circuit | Relay, PLC |
| | | | Yes | 3-wire (NPN equiv.) | — | 5 V | — | A96V | A96 | ● | ● | — | | — |
| | | | | 2-wire | 24 V | 12 V | 100 V | A93V | A93 | ● | ● | — | — | Relay, PLC |
| Solid state switch | Diagnostic indication (2-colour) Water resistant (2-colour) | Grommet | Yes | 3-wire (NPN) | 24 V | 5 V, 12 V | — | M9NV | M9N | ● | ● | ○ | IC circuit | Relay, PLC |
| | | | | 3-wire (PNP) | | | | M9PV | M9P | ● | ● | ○ | | |
| | | | | 2-wire | | | | M9BV | M9B | ● | ● | ○ | — | |
| | | | | 3-wire (NPN) | 5 V, 12 V | M9NWV | M9NW | ● | ● | ○ | IC circuit | | | |
| | | | | 3-wire (PNP) | 5 V, 12 V | M9PWV | M9PW | ● | ● | ○ | — | | | |
| | | | | 2-wire | 12 V | M9B WV | M9B W | ● | ● | ○ | — | | | |
| | | | | | 12 V | — | M9BA** | — | ● | ○ | — | | | |

** Although it is possible to mount water resistant type auto switches, note that the rotary actuator itself is not of a water resistant construction.

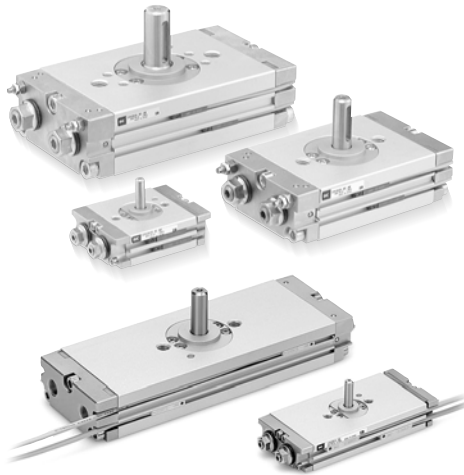
* Lead wire length symbols: 0.5 m Nil (Example) M9N

3 m L (Example) M9NL

5 m Z (Example) M9NZ

• Auto switches marked with "○" are made to order specification.

Specifications

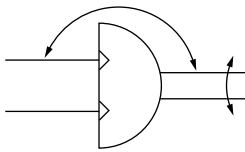


| Size | 10 | 15 | 20 | 30 | 40 |
|--------------------------------------|---|------|----------------------------------|-----|-----|
| Fluid | Air (Non-lube) | | | | |
| Max. operating pressure | 0.7 MPa | | 1 MPa | | |
| Min. operating pressure | 0.15 MPa | | 0.1 MPa | | |
| Ambient and fluid temperature | 0° to 60°C (No freezing) | | | | |
| Cushion | Rubber bumper | | Not attached, Air cushion | | |
| Angle adjustment | Rotation end $\pm 5^\circ$ | | | | |
| Rotation | 80° to 100°, 170° to 190°, 350° to 370° | | | | |
| Port size | M5 x 8 | | Rc 1/8, G 1/8, NPT 1/8, NPTF 1/8 | | |
| Output (N-m)* | 0.3 | 0.75 | 1.8 | 3.1 | 5.3 |

* Output for an operating pressure of 0.5 MPa. Refer to front matter 2 for further information.

Allowable Kinetic Energy and Rotation Time Adjustment Range

JIS Symbol



| Size | Allowable kinetic energy | | | | Stable operational rotation time adjustment range |
|-----------|-------------------------------|---------------|-------------------|---------------|---|
| | Allowable kinetic energy (mJ) | | | Cushion angle | |
| | Without cushion | Rubber bumper | With air cushion* | | Rotation time (s/90°) |
| 10 | — | 0.25 | — | — | 0.2 to 0.7 |
| 15 | — | 0.39 | — | — | 0.2 to 0.7 |
| 20 | 25 | — | 120 | 40° | 0.2 to 1 |
| 30 | 48 | — | 250 | 40° | 0.2 to 1 |
| 40 | 81 | — | 400 | 40° | 0.2 to 1 |

* Allowable kinetic energy for the bumper equipped type
Maximum absorbed energy under proper adjustment of the cushion needles.

If the rotary actuator is operated above the allowable kinetic energy value, damage may be caused to the internal parts and result in product failure. Please pay special attention to the kinetic energy levels when designing, adjusting and during operation to avoid exceeding the allowable limit.

Weight

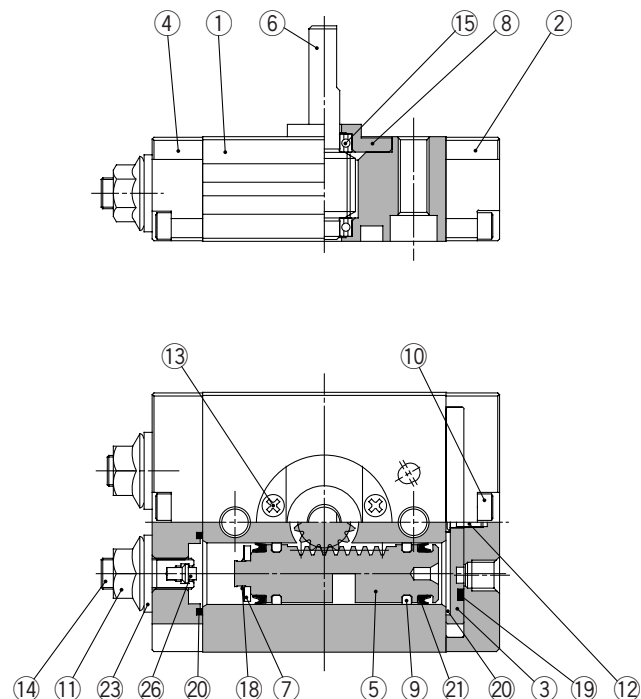
| Size | Standard weight* (g) | | |
|-----------|----------------------|------|------|
| | 90° | 180° | 360° |
| 10 | 120 | 150 | 200 |
| 15 | 220 | 270 | 380 |
| 20 | 600 | 700 | 1000 |
| 30 | 900 | 1100 | 1510 |
| 40 | 1400 | 1600 | 2280 |

* Excluding the weight of auto switch.

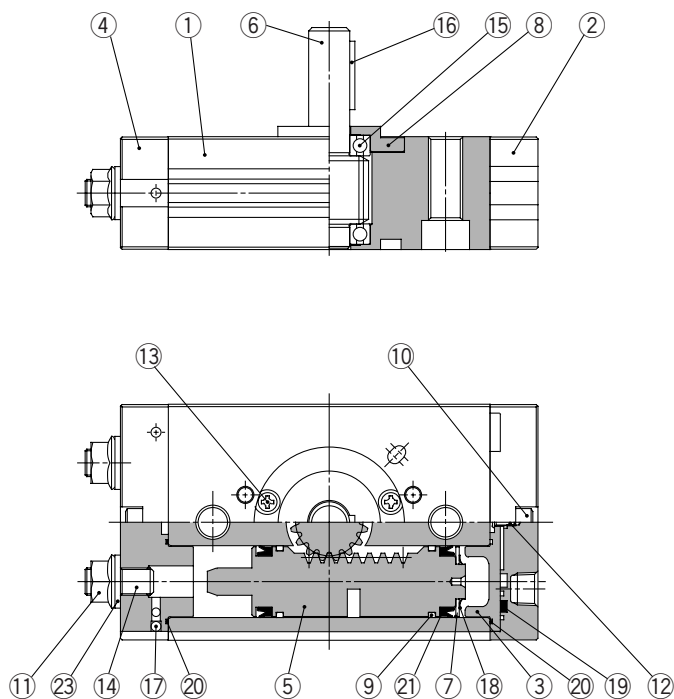
Series CRQ2

Construction

Basic type
Size 10/15



Basic type
Size 20/30/40



Component Parts

| No. | Description | Material |
|-----|--------------------------------------|----------------------------|
| 1 | Body | Aluminum alloy |
| 2 | Cover | Aluminum alloy |
| 3 | Plate | Aluminum alloy |
| 4 | End cover | Aluminum alloy |
| 5 | Piston | Stainless steel |
| 6 | Size: 10, 15 | Shaft |
| | Size: 20, 30, 40 | |
| 7 | Seal retainer | Aluminum alloy |
| 8 | Bearing retainer | Aluminum alloy |
| 9 | Wearing | Resin |
| 10 | Hexagon socket head cap screw | Stainless steel |
| 11 | Hexagon nut with flange | Steel wire |
| 12 | Cross recessed No. 0 screw | Steel wire |
| 13 | Size: 10, 15 | Cross recessed No. 0 screw |
| | Size: 20, 30, 40 | |
| | Cross recessed screw | Steel wire |

Component Parts

| No. | Description | Material | |
|-----|--------------------------------------|-------------------------------|-------------------|
| 14 | Hexagon socket head set screw | Chrome molybdenum steel | |
| 15 | Bearing | Bearing steel | |
| 16 | Size: 20, 30, 40 only | Parallel key | Carbon steel |
| 17 | Size: 20, 30, 40 only | Steel ball | Stainless steel |
| 18 | CS-type retaining ring | Stainless steel | |
| 19 | Seal | NBR | |
| 20 | Gasket | NBR | |
| 21 | Piston seal | NBR | |
| 22 | Size: 20, 30, 40 only with cushion | Cushion seal | Rubber material |
| 23 | Seal washer | NBR | |
| 24 | With auto switch only | Magnet | Magnetic material |
| 25 | Size: 20, 30, 40 with cushion only | Cushion valve assembly | |
| 26 | Size: 10,15 only | Cushion pad | Rubber material |

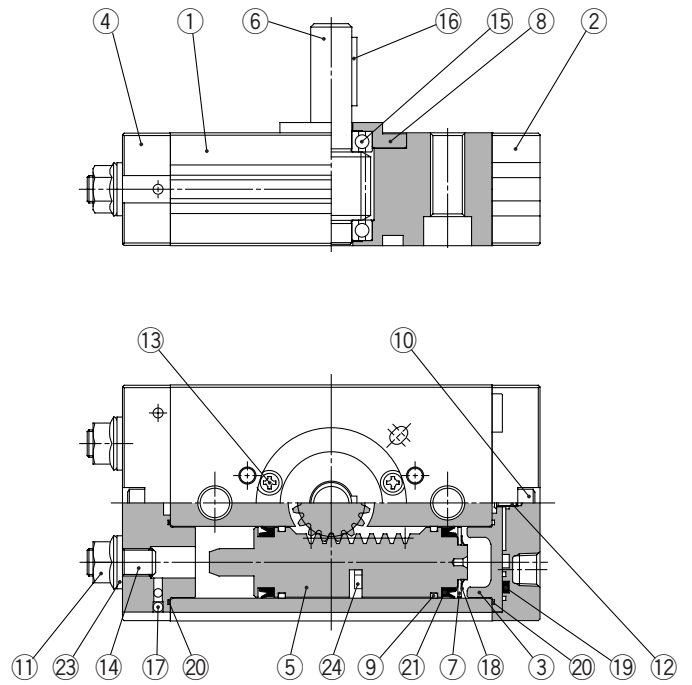
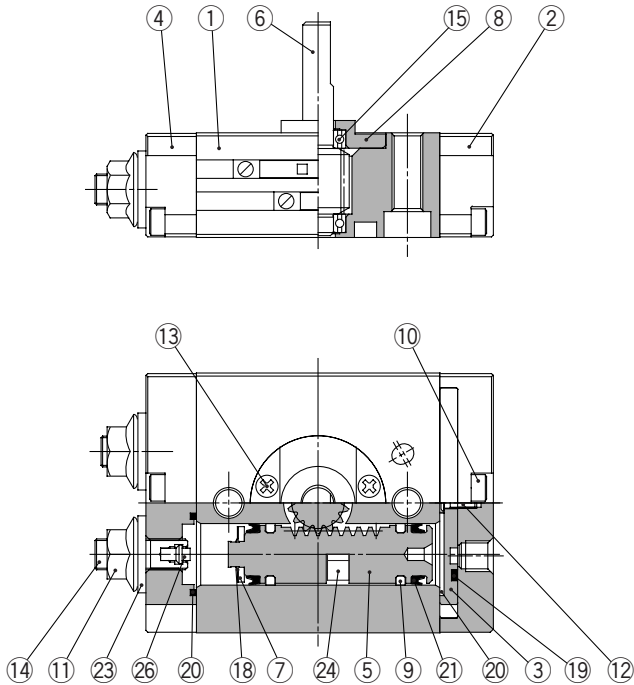
Replacement Parts

| Description | Part no. | | | | | Description |
|-------------|-----------|-----------|-----------|-----------|-----------|----------------|
| | 10 | 15 | 20 | 30 | 40 | |
| Seal kit | P473010-1 | P473020-1 | P473030-1 | P473040-1 | P473050-1 | 19, 20, 21, 23 |

Construction

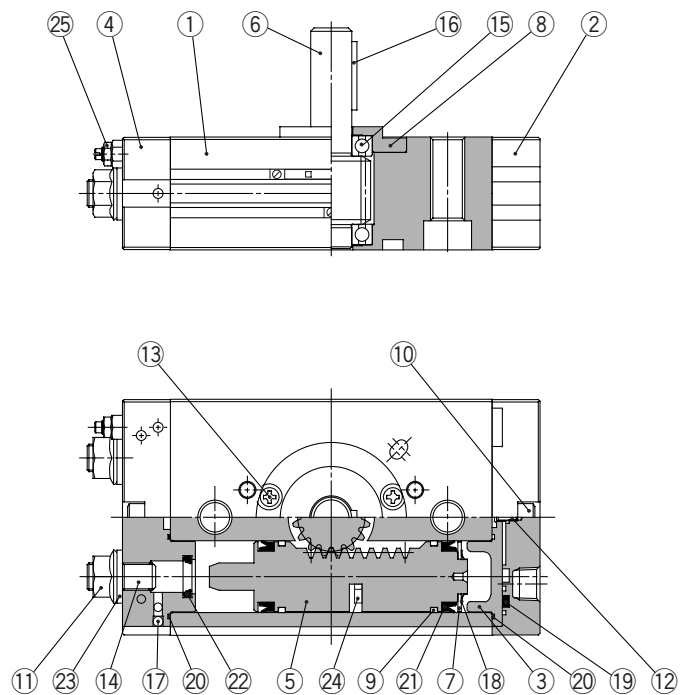
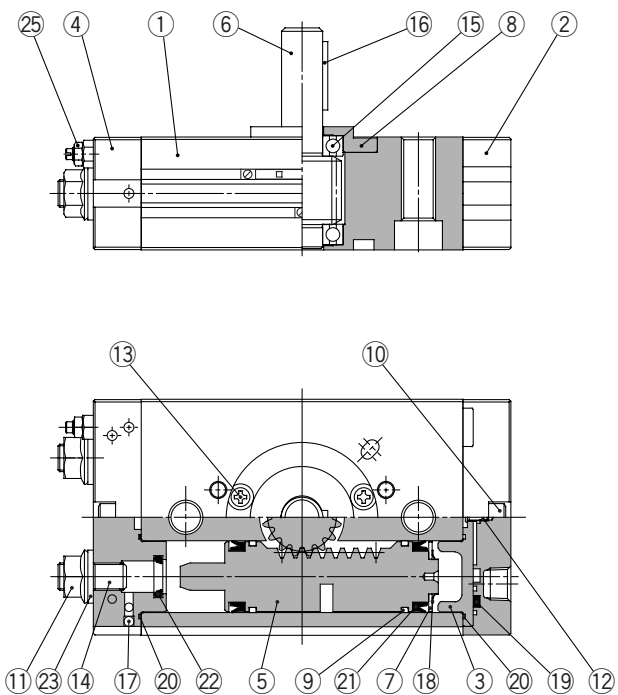
With auto switch
Size 10/15

With auto switch
Size 20/30/40



With cushion
Size 20/30/40

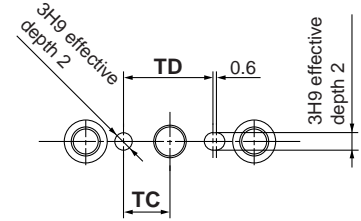
With auto switch and cushion
Size 20/30/40



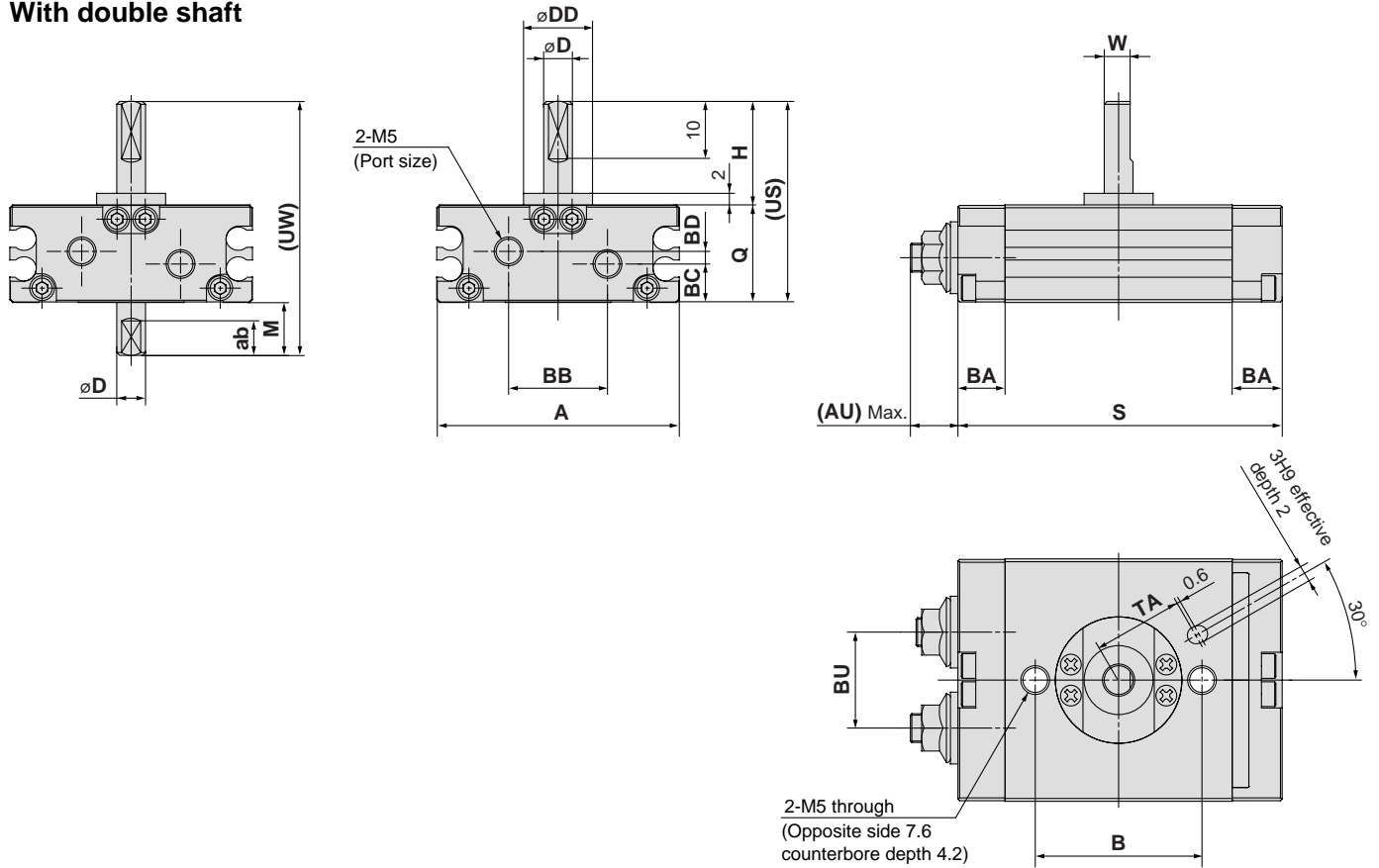
Series CRQ2

Dimensions

Size 10/15



With double shaft



| Size | Rotating angle | A | AU* | B | BA | BB | BC | BD | BU | D (g6) | DD (h9) | H |
|------|-----------------|----|-------|----|-----|------|------|-----|------|--------|---------|----|
| 10 | 90°, 180°, 360° | 42 | (8.5) | 29 | 8.5 | 17 | 6.7 | 2.2 | 16.7 | 5 | 12 | 18 |
| 15 | 90°, 180°, 360° | 53 | (9.5) | 31 | 9 | 26.4 | 10.6 | — | 23.1 | 6 | 14 | 20 |

| Size | Rotating angle | W | Q | S | US | UW | ab | M | TA | TC | TD |
|------|----------------|-----|----|-----|----|----|----|----|------|----|------|
| 10 | 90° | 4.5 | 17 | 56 | 35 | 44 | 6 | 9 | 15.5 | 8 | 15.4 |
| | 180° | | | 69 | | | | | | | |
| | 360° | | | 97 | | | | | | | |
| 15 | 90° | 5.5 | 20 | 65 | 40 | 50 | 7 | 10 | 16 | 9 | 17.6 |
| | 180° | | | 82 | | | | | | | |
| | 360° | | | 116 | | | | | | | |

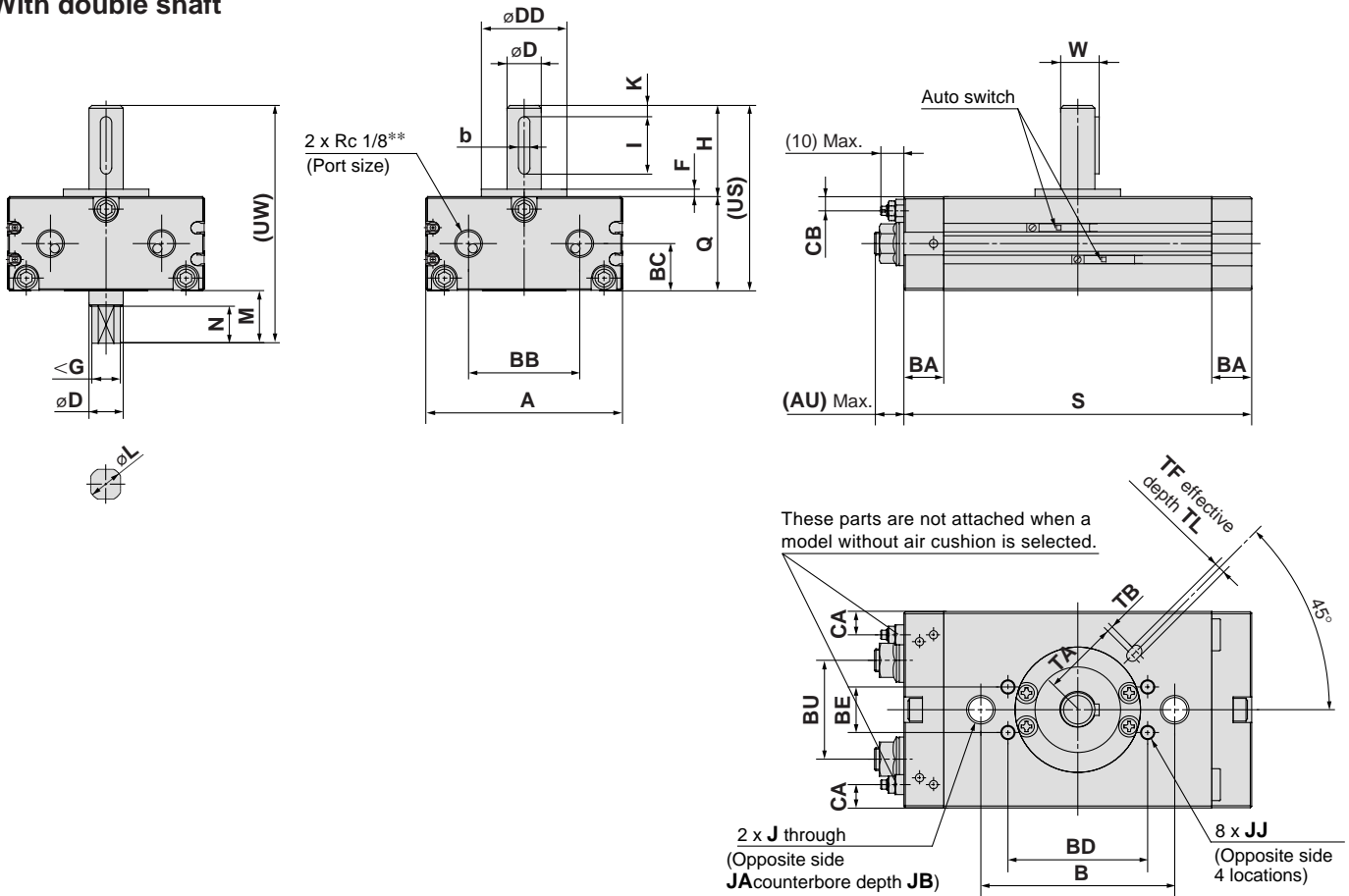
* AU dimension is not the dimension at the time of shipment, since this dimension is for adjustable parts.

S: Upper 90°, Middle 180°, Lower 360°

Dimensions

Size 20/30/40

With double shaft



(mm)

| Size | Rotating angle | A | AU* | B | BA | BB | BC | BD | BE | BU | CA | CB | D (g6) | DD (h9) | F | H | J | JA | JB |
|------|-----------------|----|------|----|----|----|------|----|----|------|-----|-----|-----------|------------|-----|----|-----|----|-----|
| 20 | 90°, 180°, 360° | 63 | (11) | 50 | 14 | 34 | 14.5 | — | — | 30.4 | 7 | 4.7 | 10 | 25 | 2.5 | 30 | M8 | 11 | 6.5 |
| 30 | 90°, 180°, 360° | 69 | (11) | 68 | 14 | 39 | 16.5 | 49 | 16 | 34.7 | 8.1 | 4.9 | 12 | 30 | 3 | 32 | M10 | 14 | 8.5 |
| 40 | 90°, 180°, 360° | 78 | (13) | 76 | 16 | 47 | 18.5 | 55 | 16 | 40.4 | 8.3 | 5.2 | 15 | 32 | 3 | 36 | M10 | 14 | 8.6 |

| Size | Rotating angle | JJ | K | Q | S | W | Keyway dimensions | | US | TA | TB | TC | TD | TF (H9) | TG (H9) | TL | UW | G | M | N | L |
|------|----------------|---------------|---|----|-----|------|---------------------------------|----|----|------|----|------|------|------------|------------|-----|----|---------------------------------|----|----|-----------------------------------|
| | | | | | | | b | l | | | | | | | | | | | | | |
| 20 | 90° | — | 3 | 29 | 104 | 11.5 | 4 ⁰ _{-0.03} | 20 | 59 | 24.5 | 1 | 13.5 | 27 | 4 | 4 | 2.5 | 74 | 8 ⁰ _{-0.1} | 15 | 11 | 9.6 ⁰ _{-0.1} |
| | 180° | | | | 130 | | | | | | | | | | | | | | | | |
| | 360° | | | | 180 | | | | | | | | | | | | | | | | |
| 30 | 90° | M5 depth 6 | 4 | 33 | 122 | 13.5 | 4 ⁰ _{-0.03} | 20 | 65 | 27 | 2 | 19 | 36 | 4 | 4 | 2.5 | 83 | 10 ⁰ _{-0.1} | 18 | 13 | 11.4 ⁰ _{-0.1} |
| | 180° | | | | 153 | | | | | | | | | | | | | | | | |
| | 360° | | | | 216 | | | | | | | | | | | | | | | | |
| 40 | 90° | M6 depth 7 | 5 | 37 | 139 | 17 | 5 ⁰ _{-0.03} | 25 | 73 | 32.5 | 2 | 20 | 39.5 | 5 | 5 | 3.5 | 93 | 11 ⁰ _{-0.1} | 20 | 15 | 14 ⁰ _{-0.1} |
| | 180° | | | | 177 | | | | | | | | | | | | | | | | |
| | 360° | | | | 253 | | | | | | | | | | | | | | | | |

* AU dimension is not the dimension at the time of shipment, since this dimension is for adjustable parts.

** In addition to Rc 1/8, G 1/8, NPT 1/8, NPTF 1/8 are also available.

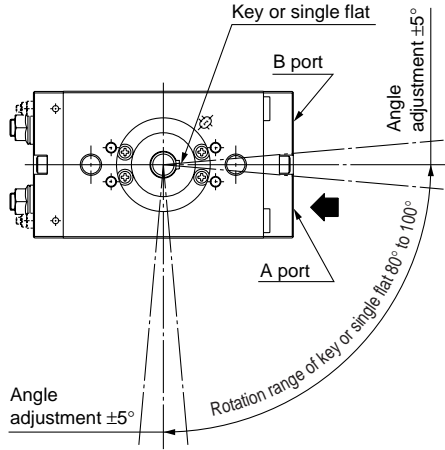
S: Upper 90°, Middle 180°, Lower 360°

Series CRQ2

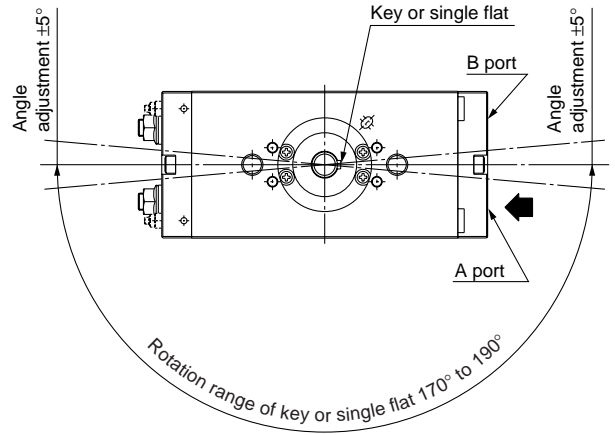
Rotation Range

When pressurised from the port indicated by the arrow, the shaft will rotate in a clockwise direction.

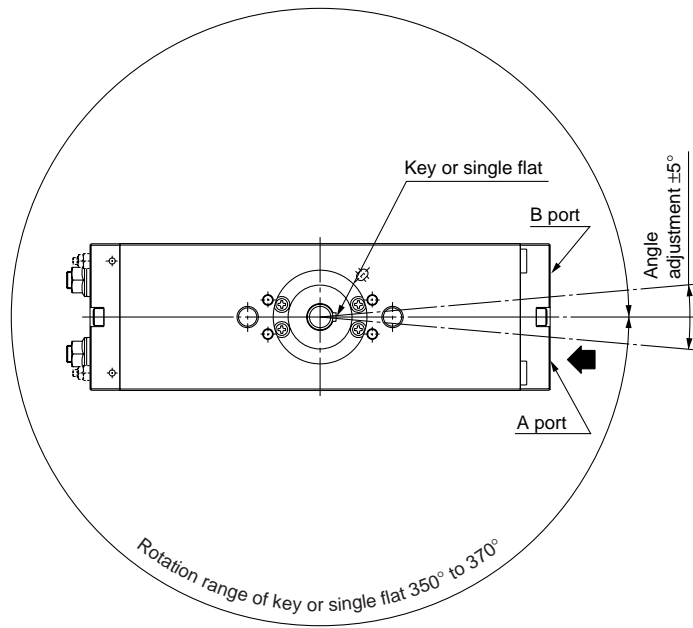
Rotating angle: 90°



Rotating angle: 180°

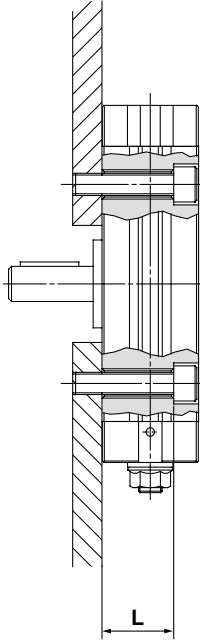


Rotating angle: 360°



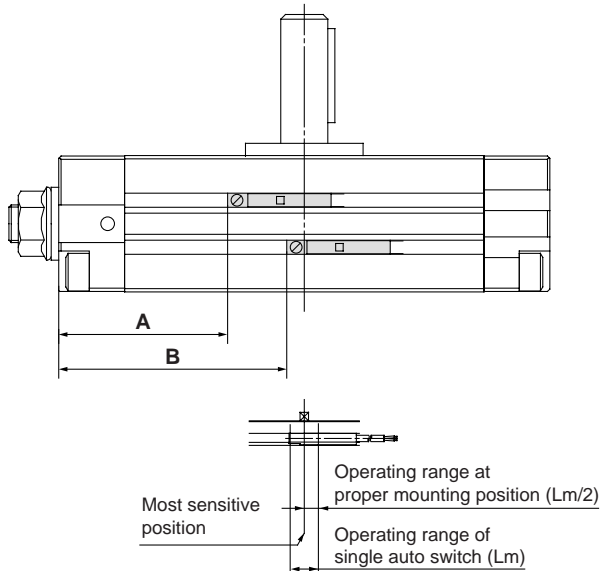
Unit Used as Flange Mount

The L dimensions of this unit are shown in the table below. When a hexagon socket head cap bolt of the JIS standard is used, the head of the bolt will recess into the counter bore of the actuator.



| Size | L | Screw |
|------|------|-------|
| 10 | 13 | M4 |
| 15 | 16 | M4 |
| 20 | 22.5 | M6 |
| 30 | 24.5 | M8 |
| 40 | 28.5 | M8 |

Auto Switch Proper Mounting Position at Rotation End



| Size | Rotating angle | Reed switch | | | | Solid state switch | | | |
|------|----------------|-------------|-------|-----------------------|------------------|--------------------|-------|-----------------------|------------------|
| | | A | B | Operating angle (θ m) | Hysteresis angle | A | B | Operating angle (θ m) | Hysteresis angle |
| 10 | 90° | 15 | 21.5 | 63° | 12° | 19 | 25.5 | 75° | 3° |
| | 180° | 18 | 31 | | | 22 | 35 | | |
| | 360° | 25 | 52.5 | | | 29 | 56.5 | | |
| 15 | 90° | 18.5 | 27 | 52° | 9° | 22.5 | 31 | 69° | 3° |
| | 180° | 22.5 | 39.5 | | | 26.5 | 43.5 | | |
| | 360° | 30.5 | 64.5 | | | 34.5 | 68.5 | | |
| 20 | 90° | 36 | 48.5 | 41° | 9° | 40 | 52.5 | 56° | 4° |
| | 180° | 42 | 67.5 | | | 46 | 71.5 | | |
| | 360° | 55.5 | 106 | | | 59.5 | 110 | | |
| 30 | 90° | 43 | 59 | 32° | 7° | 47 | 63 | 43° | 3° |
| | 180° | 51 | 82 | | | 55 | 86 | | |
| | 360° | 62 | 125.5 | | | 66 | 129.5 | | |
| 40 | 90° | 50 | 69 | 24° | 5° | 54 | 73 | 36° | 4° |
| | 180° | 59.5 | 97.5 | | | 63.5 | 101.5 | | |
| | 360° | 72.5 | 152 | | | 76.5 | 156 | | |

Operating angle θ m: The value of the individual switch's movement range Lm as represented by an angle.

Hysteresis angle: Value of the switch's hysteresis as represented by an angle.

Series CRQ2

Auto Switch Specifications

Auto Switch Common Specifications

| Type | Reed switch | Solid state switch |
|-----------------------|--|---|
| Leakage current | None | 3-wire: 100 μA or less 2-wire: 0.8 mA or less |
| Operating time | 1.2 ms | 1 ms or less |
| Impact resistance | 300 m/s ² | 1000 m/s ² |
| Insulation resistance | 50 MΩ or more at 500 Mega VDC (between lead wire and case) | |
| Withstand voltage | 1000 VAC for 1 minute (between lead wire and case) | |
| Ambient temperature | -10 to 60°C | |
| Enclosure | IEC529 standard IP67, JIS C 0920 waterproof construction | |

Lead Wire Length

Lead wire length indication

(Example) **D-M9P****L**

Lead wire length

| | |
|---|-------|
| - | 0.5 m |
| L | 3 m |
| Z | 5 m |

Note 1) Applicable auto switch with 5 m lead wire "Z"

Solid state switch: Manufactured upon receipt of order as standard.

Note 2) To designate solid state switches with flexible specifications, add "-61" after the lead wire length.

(Example) **D-M9PVL-61**

Flexible specification

Contact Protection Boxes: CD-P11, CD-P12

<Applicable switch model>

D-A9/A9□V

The auto switches below do not have a built-in contact protection circuit. Therefore, please use a contact protection box with the switch for any of the following cases:

- ① Where the operation load is an inductive load.
- ② Where the wiring length to load is greater than 5 m.
- ③ Where the load voltage is 100 VAC.

The contact life may be shortened. (Due to permanent energising conditions.)

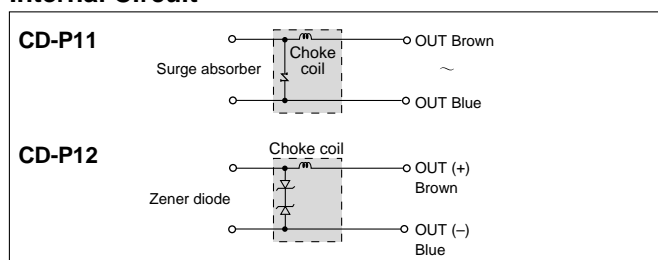
Specifications

| Part no. | CD-P11 | | CD-P12 |
|----------------------|---------|---------|--------|
| Load voltage | 100 VAC | 200 VAC | 24 VDC |
| Maximum load current | 25 mA | 12.5 mA | 50 mA |

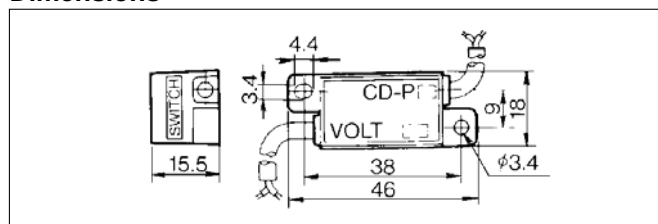
* Lead wire length — Switch connection side 0.5 m
Load connection side 0.5 m



Internal Circuit



Dimensions



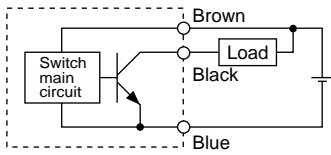
Connection

To connect a switch unit to a contact protection box, connect the lead wire from the side of the contact protection box marked SWITCH to the lead wire coming out of the switch unit. Keep the switch as close as possible to the contact protection box, with a lead wire length of no more than 1 metre.

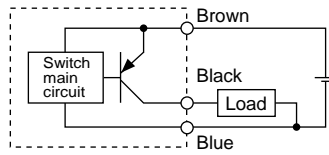
Series CRQ2 Auto Switch Connections and Examples

Basic Wiring

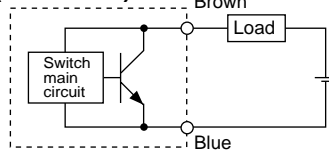
Solid state 3-wire, NPN



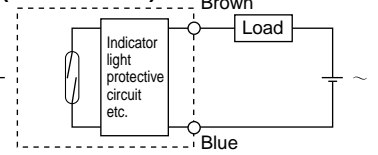
Solid state 3-wire, PNP



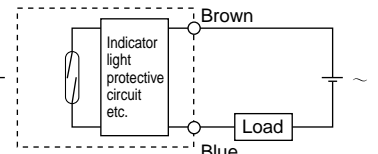
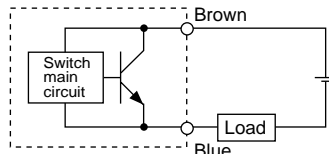
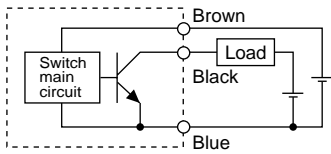
2-wire (Solid state)



2-wire (Reed switch)

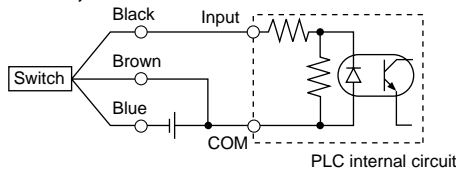


(Power supplies for switch and load are separate.)

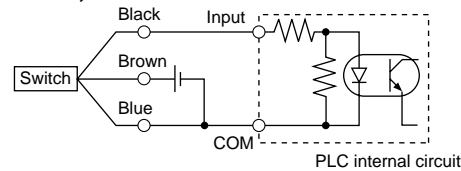


Example of Connection to PLC (Programmable Logic Controller)

• Sink input specifications 3-wire, NPN

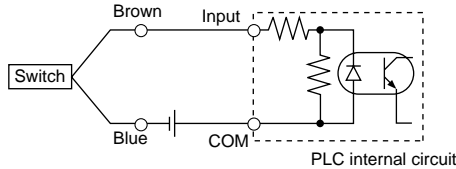


• Source input specifications 3-wire, PNP

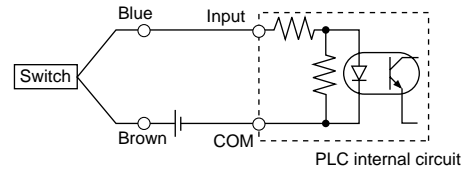


Connect according to the applicable PLC input specifications, since the connection method will vary depending on the PLC input specifications.

2-wire



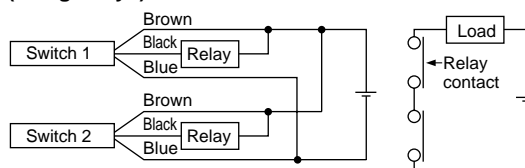
2-wire



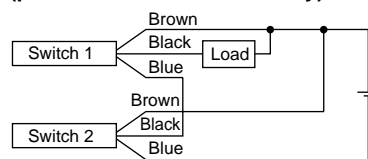
Example of AND (Serial) and OR (Parallel) Connection

• 3-wire

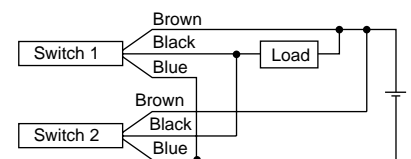
AND connection for NPN output (using relays)



AND connection for NPN output (performed with switches only)

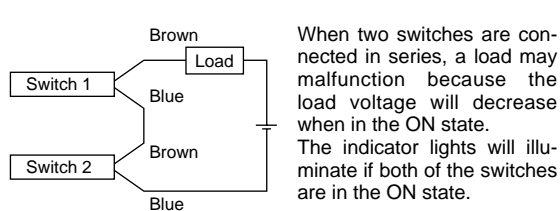


OR connection for NPN output



The indicator lights will illuminate when both switches are turned ON.

2-wire with 2-switch AND connection

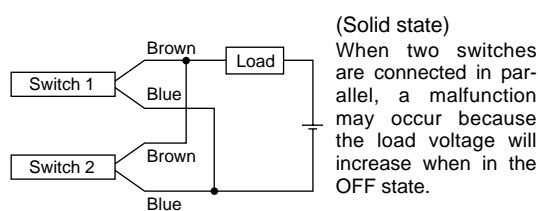


When two switches are connected in series, a load may malfunction because the load voltage will decrease when in the ON state. The indicator lights will illuminate if both of the switches are in the ON state.

$$\begin{aligned} \text{Load voltage at ON} &= \text{Power supply} - \text{Residual voltage} \times 2 \text{ pcs.} \\ &= 24 \text{ V} - 4 \text{ V} \times 2 \text{ pcs.} \\ &= 16 \text{ V} \end{aligned}$$

Example: Power supply is 24 VDC.
Internal voltage drop in switch is 4 V.

2-wire with 2-switch OR connection



(Solid state)

When two switches are connected in parallel, a malfunction may occur because the load voltage will increase when in the OFF state.

(Reed switch)

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

$$\begin{aligned} \text{Load voltage at OFF} &= \text{Leakage current} \times 2 \text{ pcs.} \\ &\quad \times \text{Load impedance} \\ &= 1 \text{ mA} \times 2 \text{ pcs.} \times 3 \text{ k}\Omega \\ &= 6 \text{ V} \end{aligned}$$

Example: Load impedance is 3 kΩ.
Leakage current from switch is 1 mA.

Reed Switch: Direct Mounting Style D-A90(V)/D-A93(V)/D-A96(V)

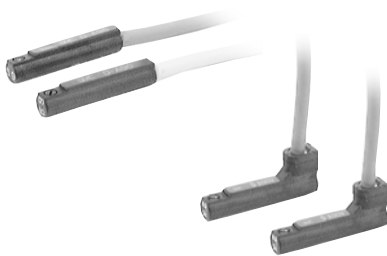


For details about certified products conforming to international standards, visit us at www.smcworld.com.

Auto Switch Specifications

PLC: Programmable Logic Controller

Grommet
Electrical entry direction: In-line



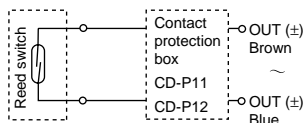
Caution

Operating Precautions

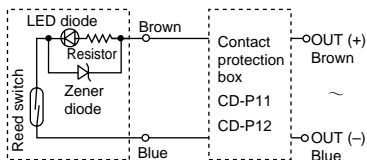
Fix the switch with the existing screw installed on the switch body. The switch may be damaged if a screw other than the one supplied, is used.

Auto Switch Internal Circuit

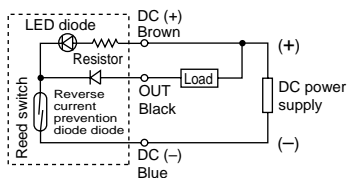
D-A90V



D-A93V



D-A96V



- Note) ① In a case where the operation load is an inductive load.
② In a case where the wiring load is greater than 5 m.
③ In a case where the load voltage is 100 VAC.

Use the auto switch with a contact protection box in any of the above mentioned cases. (For details about the contact protection box, refer to page 9.)

| D-A90/D-A90V (Without indicator light) | | | |
|--|---|--------------------|---------------------|
| Auto switch part no. | D-A90/D-A90V | | |
| Applicable load | IC circuit, Relay, PLC | | |
| Load voltage | 24 V AC/DC or less | 48 V AC/DC or less | 100 V AC/DC or less |
| Maximum load current | 50 mA | 40 mA | 20 mA |
| Contact protection circuit | None | | |
| Internal resistance | 1 Ω or less (including lead wire length of 3 m) | | |
| D-A93/D-A93V/D-A96/D-A96V (With indicator light) | | | |
| Auto switch part no. | D-A93/D-A93V | | D-A96/D-A96V |
| Applicable load | Relay, PLC | | IC circuit |
| Load voltage | 24 VDC | 100 VAC | 4 to 8 VDC |
| Load current range and max. load current | 5 to 40 mA | 5 to 20 mA | 20 mA |
| Contact protection circuit | None | | |
| Internal voltage drop | D-A93 — 2.4 V or less (to 20 mA)/3 V or less (to 40 mA) D-A93V — 2.7 V or less | | 0.8 V or less |
| Indicator light | Red LED illuminates when ON. | | |

Lead wires

D-A90(V)/D-A93(V) — Oilproof heavy-duty vinyl cable: $\phi 2.7$, 0.18 mm² x 2 cores (Brown, Blue), 0.5 m
D-A96(V) — Oilproof heavy-duty vinyl cable: $\phi 2.7$, 0.15 mm² x 3 cores (Brown, Black, Blue), 0.5 m

Note 1) Refer to page 9 for reed switch common specifications.

Note 2) Refer to page 9 for lead wire lengths.

Weight

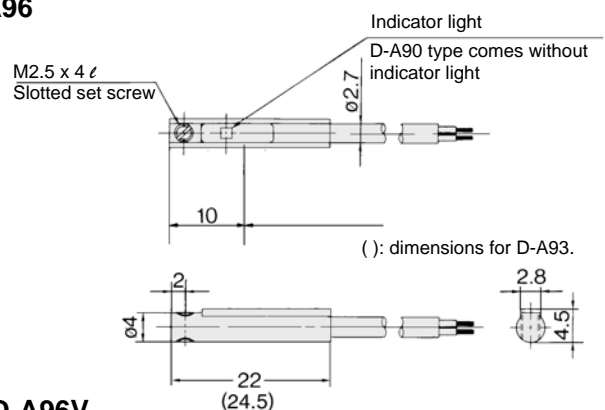
Unit: g

| Model | D-A90 | D-A90V | D-A93 | D-A93V | D-A96 | D-A96V |
|------------------------|-------|--------|-------|--------|-------|--------|
| Lead wire length 0.5 m | 6 | 6 | 6 | 6 | 8 | 8 |
| Lead wire length 3 m | 30 | 30 | 30 | 30 | 41 | 41 |

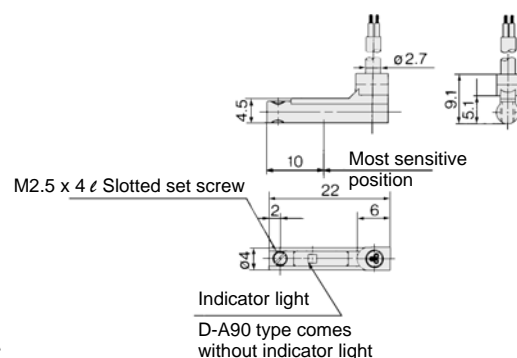
Dimensions

Unit: mm

D-A90/D-A93/D-A96



D-A90V/D-A93V/D-A96V



Solid State Switch: Direct Mounting Style D-M9N(V)/D-M9P(V)/D-M9B(V) C €



For details about certified products conforming to international standards, visit us at www.smcworld.com.

Auto Switch Specifications

PLC: Programmable Logic Controller

| D-M9□/D-M9□V (With indicator light) | | | | | | |
|-------------------------------------|------------------------------|---------------|---------|---------------|-----------------------|---------------|
| Auto switch part no. | D-M9N | D-M9NV | D-M9P | D-M9PV | D-M9B | D-M9BV |
| Electrical entry direction | In-line | Perpendicular | In-line | Perpendicular | In-line | Perpendicular |
| Wiring type | 3-wire | | | | 2-wire | |
| Output type | NPN | | PNP | | — | |
| Applicable load | IC circuit, Relay, PLC | | | | 24 VDC relay, PLC | |
| Power supply voltage | 5, 12, 24 VDC (4.5 to 28 V) | | | | — | |
| Current consumption | 10 mA or less | | | | — | |
| Load voltage | 28 VDC or less | | — | | 24 VDC (10 to 28 VDC) | |
| Load current | 40 mA or less | | | | 2.5 to 40 mA | |
| Internal voltage drop | 0.8 V or less | | | | 4 V or less | |
| Leakage current | 100 μA or less at 24 VDC | | | | 0.8 mA or less | |
| Indicator light | Red LED illuminates when ON. | | | | | |

Grommet

- 2-wire load current is reduced (2.5 to 40 mA)
- Lead free
- UL certified (style 2844) lead cable is used.



Lead wires

- Oilproof heavy-duty vinyl cable: $\varnothing 2.7 \times 3.2$ ellipse
- D-M9B(V) 0.15 mm² x 2 cores
- D-M9N(V), D-M9P(V) 0.15 mm² x 3 cores

Note 1) Refer to page 9 for solid state switch common specifications.

Note 2) Refer to page 9 for lead wire lengths.

Weight

Unit: g

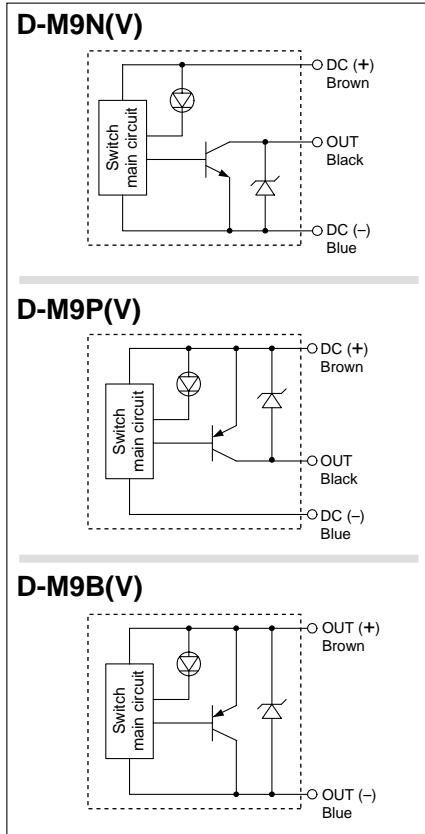
| Auto switch part no. | D-M9N(V) | D-M9P(V) | D-M9B(V) | |
|----------------------|----------|----------|----------|----|
| Lead wire length (m) | 0.5 | 8 | 8 | 7 |
| | 3 | 41 | 41 | 38 |
| | 5 | 68 | 68 | 63 |

Caution

Operating Precautions

Fix the switch with the existing screw installed on the switch body. The switch may be damaged if a screw other than the one supplied, is used.

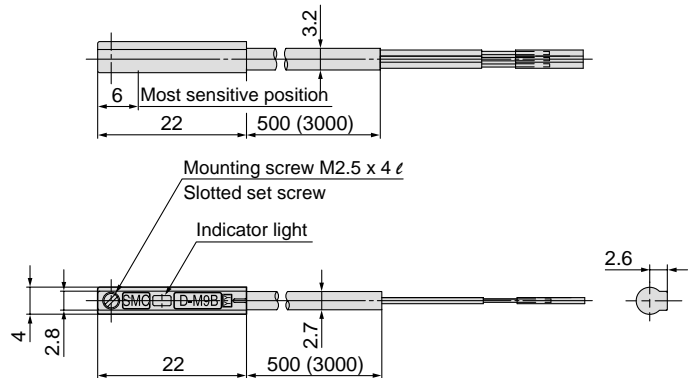
Auto Switch Internal Circuit



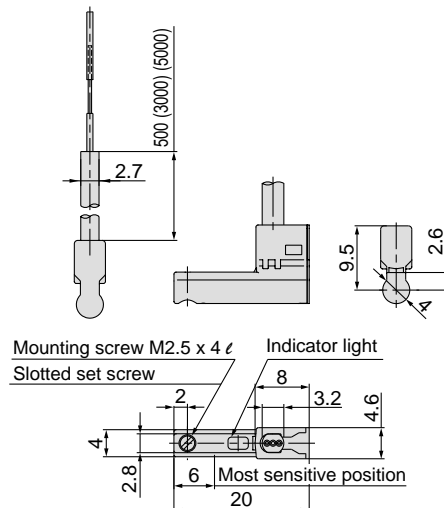
Dimensions

Unit: mm

D-M9□



D-M9□V



2-colour Indication, Solid State Switch: Direct Mounting Style

D-M9NW(V)/D-M9PW(V)/D-M9BW(V)



ALMOTION



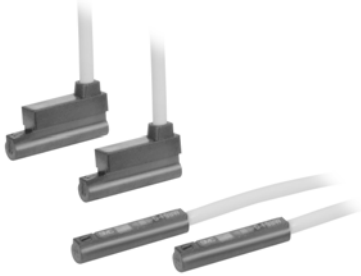
For details about certified products conforming to international standards, visit us at www.smcworld.com.

Auto Switch Specifications

PLC: Programmable Logic Controller

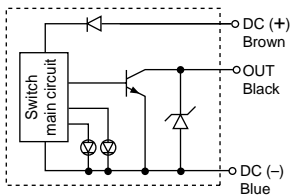
| D-M9□W/D-M9□W(V) (With indicator light) | | | | | | |
|---|--|---------------|---------------|---------------|-----------------------|---------------|
| Auto switch part no. | D-M9NW | D-M9NWV | D-M9PW | D-M9PWV | D-M9BW | D-M9BWV |
| Electrical entry direction | In-line | Perpendicular | In-line | Perpendicular | In-line | Perpendicular |
| Wiring type | 3-wire | | | 2-wire | | |
| Output type | NPN | | PNP | | — | |
| Applicable load | IC circuit, Relay IC, PLC | | | | 24 VDC relay, PLC | |
| Power supply voltage | 5, 12, 24 VDC (4.5 to 28 VDC) | | | | — | |
| Current consumption | 10 mA or less | | | | — | |
| Load voltage | 28 VDC or less | | — | | 24 VDC (10 to 28 VDC) | |
| Load current | 40 mA or less | | 80 mA or less | | 5 to 40 mA | |
| Internal voltage drop | 1.5 V or less (0.8 V or less at 10 mA load current) | | 0.8 V or less | | 4 V or less | |
| Leakage current | 100 μA or less at 24 VDC | | | | 0.8 mA or less | |
| Indicator light | Operating position Red LED illuminates. Optimum operating position Green LED illuminates. | | | | | |

Grommet

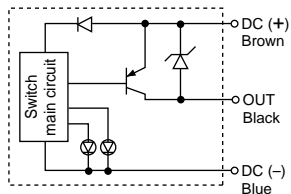


Auto Switch Internal Circuit

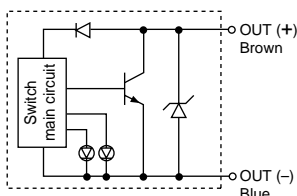
D-M9NW(V)



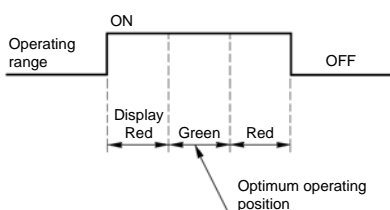
D-M9PW(V)



D-M9BW(V)



Indicator light/Display method



Lead wires

Oilproof heavy-duty vinyl cable: $\phi 2.7$, 0.15 mm² x 3 cores (Brown, Black, Blue), 0.18 mm² x 2 cores (Brown, Blue), 0.5 m

Note 1) Refer to page 9 for solid state switch common specifications.

Note 2) Refer to page 9 for lead wire lengths.

Weight

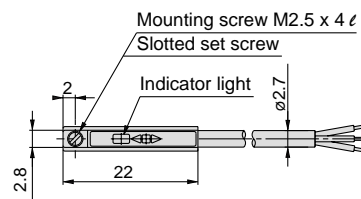
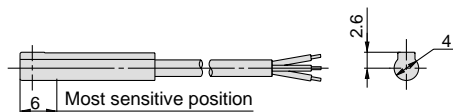
Unit: g

| Auto switch part no. | D-M9NW(V) | D-M9PW(V) | D-M9BW(V) |
|----------------------|-----------|-----------|-----------|
| Lead wire length (m) | 0.5 | 7 | 7 |
| | 3 | 34 | 34 |
| | 5 | 56 | 56 |

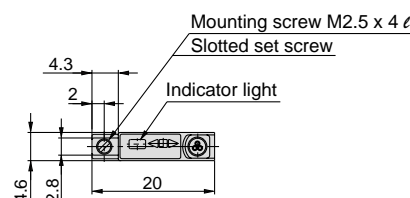
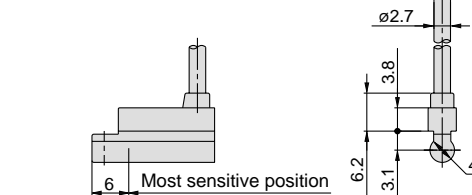
Dimensions

Unit: mm

D-M9□W



D-M9□WV





Series CRQ2 Safety Instructions

These safety instructions are intended to prevent a hazardous situation and/or equipment damage. These instructions indicate the level of potential hazard by labels 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.

■ Explanation of the Labels

| Labels | Explanation of the labels |
|----------------|---|
| Danger | In extreme conditions, there is a possible result of serious injury or loss of life. |
| Warning | Operator error could result in serious injury or loss of life. |
| Caution | Operator error could result in injury ^{Note 3)} or equipment damage ^{Note 4)} . |

Note 1) ISO 4414: Pneumatic fluid power – General rules relating to systems

Note 2) JIS B 8370: General Rules for Pneumatic Equipment

Note 3) Injury indicates light wounds, burns and electrical shocks that do not require hospitalisation or hospital visits for long-term medical treatment.

Note 4) Equipment damage refers to extensive damage to the equipment and surrounding devices.

■ Selection/Handling/Applications

1. The compatibility of the 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 for the specific pneumatic system must be based on specifications or post analysis and/or tests to meet the specific requirements. The expected performance and safety assurance are the responsibility of the person who has determined the compatibility of the system. This person should continuously review the suitability of all items specified, referring to the latest catalogue information with a view to giving due consideration to any possibility of equipment failure when configuring a system.

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. (Understanding JIS B 8370 General Rules for Pneumatic Equipment, and other safety rules are included.)

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 once measures to prevent falling or runaway of the driver objects have been confirmed.
2. When equipment is removed, confirm that safety process as mentioned above. Turn off the supply pressure for this equipment and exhaust all residual compressed air in the system, and release all the energy (liquid pressure, spring, condenser, gravity).
3. Before machinery/equipment is restarted, take measures to prevent quick extension of a cylinder piston rod, etc.

4. Contact SMC if the product will 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, clutch and brake circuits in press applications, or safety equipment.
3. An application which has the possibility of having negative effects on people, property, or animals, requiring special safety analysis.
4. If the products are used in an interlock circuit, prepare a double interlock style circuit with a mechanical protection function for the prevention of a breakdown. And, examine the devices periodically if they function normally or not.

■ Exemption from Liability

1. SMC, its officers and employees shall be exempted from liability for any loss or damage arising out of earthquakes or fire, action by a third person, accidents, customer error with or without intention, product misuse, and any other damages caused by abnormal operating conditions.

2. SMC, its officers and employees shall be exempted from liability for any direct or indirect loss or damage, including consequential loss or damage, loss of profits, or loss of chance, claims, demands, proceedings, costs, expenses, awards, judgments and any other liability whatsoever including legal costs and expenses, which may be suffered or incurred, whether in tort (including negligence), contract, breach of statutory duty, equity or otherwise.

3. SMC is exempted from liability for any damages caused by operations not contained in the catalogues and/or instruction manuals, and operations outside of the specification range.

4. SMC is exempted from liability for any loss or damage whatsoever caused by malfunctions of its products when combined with other devices or software.



Series CRQ2 Auto Switch Precautions 1

Be sure to read this before handling.

Design & Selection

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 of current load, voltage, temperature or impact. We do not guarantee any damage in any case the product is used outside of the specification range.

2. Keep wiring as short as possible.

<Reed switch>

As the length of the wiring to a load gets longer, the rush current at switching ON becomes greater, and this may shorten the product's life. (The switch will stay ON all the time.)

- 1) Use a contact protection box when the wire length is 5 m or longer.
- 2) Even if an auto switch has a built-in contact protection circuit, when the wiring is more than 30 m long, it is not able to adequately absorb the rush current and its life may be reduced. It is again necessary to connect a contact protection box in order to extend its life. Please contact SMC in this case.

<Solid state switch>

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

3. Do not use a load that generates surge voltage. If a surge voltage is generated, the discharge occurs at the contact, possibly resulting in the shortening of product life.

<Reed switch>

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

<Solid state switch>

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

4. 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.

5. Do not make any modifications to the product.

Do not take the product apart. It may cause human injuries and accidents.

Caution

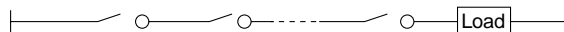
1. Use caution when multiple actuators are used and close to each other.

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 cylinder separation of 40 mm. (When the allowable interval is specified for each cylinder series, use the indicated value.)

2. Take note of the internal voltage drop of the switch.

<Reed switch>

- 1) Switches with an indicator light (Except D-A96, A96V)
 - If auto switches are connected in series as shown below, take note that there will be a large voltage drop because of internal resistance in the light emitting diodes. (Refer to internal voltage drop in the auto switch specifications.) [The voltage drop will be "n" times larger when "n" auto switches are connected.] Even though an auto switch operates normally, the load may not operate.



- In the same way, when operating under a specified voltage, although an auto switch may operate normally, the load may not operate. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

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

- 2) If the internal resistance of a light emitting diode causes a problem, select a switch without an indicator light (Model D-A90, A90V).

<Solid state switch>

- 3) Generally, the internal voltage drop will be greater with a 2-wire solid state auto switch than with a reed switch. Take the same precautions as in 1). Also, note that a 12 VDC relay is not applicable.

3. Pay attention to 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 criteria given in the above formula are not met, it will not reset correctly (stays ON). Use a 3-wire switch if this specification will not be satisfied.

Moreover, leakage current flow to the load will be "n" times larger when "n" auto switches are connected in parallel.

4. Ensure sufficient clearance for maintenance activities.

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



Series CRQ2 Auto Switch Precautions 2

Be sure to read this before handling.

Mounting & Adjustment

⚠ Warning

1. Instruction manual

Install the products and operate them only after reading the instruction manual carefully and understanding its contents. Also keep the manual where it can be referred to as necessary.

2. Do not drop or bump.

Do not drop, bump or apply excessive impacts (300 m/s² or more for reed switches and 1000 m/s² or more for solid state switches) while handling. Although the body of the switch may not be damaged, the inside of the switch could be damaged and cause a malfunction.

3. Mount switches using the proper fastening torque.

When a switch is tightened beyond the range of fastening torque, the mounting screws, mounting bracket or switch may be damaged. On the other hand, tightening below the range of fastening torque may allow the switch to slip out of position. (Refer to switch mounting for each series regarding switch mounting, moving, and fastening torque, etc.)

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

Adjust the mounting position of an auto switch so that the piston stops at the centre of the operating range (the range in which a switch is ON).

(The mounting position shown in a catalog indicates the optimum position at stroke end.) If mounted at the end of the operating range (around the borderline of ON and OFF), operation will be unstable.

<D-M9□(V)>

When the D-M9□(V) auto switch is used to replace old series auto switch, it may not activate depending on operating condition because of its shorter operating range.

Such as

- Application where the stop position of actuator may vary and exceed the operating range of the auto switch, for example, pushing, pressing, clamping operation, etc.
- Application where the auto switch is used for detecting an intermediate stop position of the actuator. (In this case the detecting time will be reduced.)

In these applications, set the auto switch to the centre of the required detecting range.

5. Securing the space for maintenance

When installing the products, please allow access for maintenance.

⚠ Caution

1. Do not carry an actuator by the auto switch lead wires.

Never carry a cylinder (actuator) by its lead wires. This may not only cause broken lead wires, but it may cause internal elements of the switch to be damaged by the stress.

2. Fix the switch with appropriate screw installed on the switch body. If using other screws, switch may be damaged.

Wiring

⚠ Warning

1. Confirm proper insulation of wiring.

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

2. Do not wire with power lines or high voltage lines.

Wire separately from power lines or high voltage lines, avoiding parallel wiring or wiring in the same conduit with these lines. Control circuits, including auto switches, may malfunction due to noise from these other lines.

⚠ Caution

1. Avoid repeatedly bending or stretching lead wires.

Broken lead wires will result from applying 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. Do not allow short circuit of loads.

<Reed switch>

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

<Solid state switch>

Model D-M9□(V), M9□W(V) and all models of PNP output type switches do not have built-in short circuit prevention circuits. If loads are short circuited, the switches will be instantly damaged, as in the case of reed switches.

Take special care to avoid reverse wiring with the power supply line (brown) and the output line (black) on 3-wire type switches.



Series CRQ2 Auto Switch Precautions 3

Be sure to read this before handling.

Wiring

⚠ Caution

4. Avoid incorrect wiring.

<Reed switch>

A 24 VDC switch with indicator light has polarity. The brown lead wire or the first terminal are (+) and the blue lead wire or the second terminal are (-).

1) If connections are reversed, a switch will operate, however, the light emitting diode will not light up.

Also note that a current greater than that specified will damage a light emitting diode and it will no longer operate.

Applicable models:

D-A93, D-A93V

<Solid state switch>

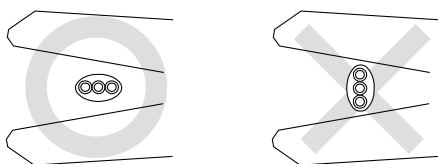
1) If connections are reversed on a 2-wire type switch, the switch will not be damaged if protected by a protection circuit, but the switch will always stay in an ON state. However, it is still necessary to avoid reversed connections, since the switch could be damaged by a load short circuit in this condition.

2) If connections are reversed (power supply line + and power supply line -) on a 3-wire type switch, the switch will be protected by a protection circuit. However, if the power supply line (+) is connected to the blue wire and the power supply line (-) is connected to the black wire, the switch will be damaged.

<D-M9□(V), F6□>

D-M9□(V) does not have built-in short circuit protection circuit. Be aware that if the power supply connection is reversed (e.g. (+) power supply wire and (-) power supply wire connection is reversed), the switch will be damaged.

5. When the cable sheath is stripped, confirm the stripping direction. The insulator may be split or damaged depending on the direction. (D-M9□(V) only)



Recommended Tool

| Model name | Model no. |
|---------------|-----------|
| Wire stripper | D-M9N-SWY |

* Stripper for a round cable (ø2.0) can be used for a 2-wire type cable.

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 demagnetised.

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

Although switches, satisfy IEC standard IP67 construction (JIS C 0920: watertight construction), do not use switches in applications where 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 with SMC if auto switches will be used in an environment with coolant, cleaning solvent, various oils or chemicals. If auto switches are used under these conditions for even a short time, they may be adversely affected by improper insulation, malfunction due to swelling of the potting resin, or hardening of the lead wires.

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

Consult with 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.

<Reed switch>

When excessive impact (300 m/s² or more) is applied to a reed switch during operation, the contact point will malfunction and generate or cut off a signal momentarily (1 ms or less). Consult with SMC regarding the need to use a solid state switch depending upon the environment.

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

<Solid state switch>

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



Series CRQ2 Auto Switch Precautions 4

Be sure to read this before handling.

Operating Environment

⚠ Caution

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

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

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

3. Do not use in direct sunlight.

4. Do not mount the product in locations where it is exposed to radiant heat.

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 the mounting position is dislocated, retighten them after readjusting the mounting position.
- 2) Confirm that there is no damage to lead wires.
To prevent faulty insulation, replace switches or repair lead wires, etc., if damage is discovered.
- 3) Confirm the lighting of the green light on the 2-colour indicator type switch.
Confirm that the green LED is on when stopped at the established position. If the red LED is on, the mounting position is not appropriate. Readjust the mounting position until the green LED lights up.

2. Maintenance procedures are outlined in the operation manual.

Not following proper procedures could cause the product to malfunction and could lead to damage to the equipment or machine.

3. Removal of equipment, and supply/exhaust of compressed air

Before any machinery or equipment is removed, first ensure that the appropriate measures are in place to prevent the fall or erratic movement of driven objects and equipment, then cut off the electric power and reduce the pressure in the system to zero. Only then should you proceed with the removal of any machinery and equipment.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent actuators from sudden movement.



EUROPEAN SUBSIDIARIES:



Austria

SMC Pneumatik GmbH (Austria).
Girakstrasse 8, A-2100 Korneuburg
Phone: +43 2262-62280, Fax: +43 2262-62285
E-mail: office@smc.at
http://www.smc.at



France

SMC Pneumatique, S.A.
1, Boulevard de Strasbourg, Parc Gustave Eiffel
Bussy Saint Georges F-77607 Marne La Vallée Cedex 3
Phone: +33 (0)1-6476 1000, Fax: +33 (0)1-6476 1010
E-mail: contact@smc-france.fr
http://www.smc-france.fr



Netherlands

SMC Pneumatics BV
De Ruyterkade 120, NL-1011 AB Amsterdam
Phone: +31 (0)20-5318888, Fax: +31 (0)20-5318880
E-mail: info@smcpneumatics.nl
http://www.smcneumatics.nl



Spain

SMC España, S.A.
Zuazobidea 14, 01015 Vitoria
Phone: +34 945-184 100, Fax: +34 945-184 124
E-mail: post@smc.smces.es
http://www.smces.es



Belgium

SMC Pneumatics N.V./S.A.
Nijverheidsstraat 20, B-2160 Wommelgem
Phone: +32 (0)3-355-1464, Fax: +32 (0)3-355-1466
E-mail: post@smcpneumatics.be
http://www.smcneumatics.be



Germany

SMC Pneumatik GmbH
Boschring 13-15, D-63329 Egelsbach
Phone: +49 (0)6103-4020, Fax: +49 (0)6103-402139
E-mail: info@smc-pneumatik.de
http://www.smc-pneumatik.de



Norway

SMC Pneumatics Norway A/S
Vollsveien 13 C, Granfos Næringspark N-1366 Lysaker
Tel: +47 67 12 90 20, Fax: +47 67 12 90 21
E-mail: post@smc-norge.no
http://www.smc-norge.no



Sweden

SMC Pneumatics Sweden AB
Ekhagsvägen 29-31, S-141 71 Huddinge
Phone: +46 (0)8-603 12 00, Fax: +46 (0)8-603 12 90
E-mail: post@smcpneumatics.se
http://www.smc.nu



Bulgaria

SMC Industrial Automation Bulgaria EOOD
16 klement Ohridski Blvd., fl.13 BG-1756 Sofia
Phone: +359 2 9744492, Fax: +359 2 9744519
E-mail: office@smc.bg
http://www.smc.bg



Greece

S. Parianopoulos S.A.
7, Konstantinoupoleos Street, GR-11855 Athens
Phone: +30 (0)1-3426076, Fax: +30 (0)1-3455578
E-mail: parianos@hol.gr
http://www.smceu.com



Poland

SMC Industrial Automation Polska Sp.z.o.o.
ul. Konstruktorska 11A, PL-02-673 Warszawa,
Phone: +48 22 548 5085, Fax: +48 22 548 5087
E-mail: office@smc.pl
http://www.smceu.com



Switzerland

SMC Pneumatik AG
Dorfstrasse 7, CH-8484 Weisslingen
Phone: +41 (0)52-396-3131, Fax: +41 (0)52-396-3191
E-mail: info@smc.ch
http://www.smc.ch



Croatia

SMC Industrijska automatika d.o.o.
Cromerec 12, 10000 ZAGREB
Phone: +385 1 377 66 74, Fax: +385 1 377 66 74
E-mail: office@smc.hr
http://www.smceu.com



Hungary

SMC Hungary Ipari Automatizálási Kft.
Budafoki út 107-113, H-1117 Budapest
Phone: +36 1 371 1343, Fax: +36 1 371 1344
E-mail: office@smc-automation.hu
http://www.smc-automation.hu



Portugal

SMC Sucursal Portugal, S.A.
Rua de Engº Ferreira Dias 452, 4100-246 Porto
Phone: +351 22-610-89-22, Fax: +351 22-610-89-36
E-mail: postpt@smc.smces.es
http://www.smces.es



Turkey

Entek Pnömatik San. ve Tic Ltd. Sti.
Perpa Tic. Merkezi Kat: 11 No: 1625, TR-80270 Okmeydanı Istanbul
Phone: +90 (0)212-221-1512, Fax: +90 (0)212-221-1519
E-mail: smc-entek@entek.com.tr
http://www.entek.com.tr



Czech Republic

SMC Industrial Automation CZ s.r.o.
Hudcova 78a, CZ-61200 Brno
Phone: +420 5 414 24611, Fax: +420 5 412 18034
E-mail: office@smc.cz
http://www.smc.cz



Ireland

SMC Pneumatics (Ireland) Ltd.
2002 Citywest Business Campus, Naas Road, Saggart, Co. Dublin
Phone: +353 (0)1-403 9000, Fax: +353 (0)1-464-0500
E-mail: sales@smcpneumatics.ie
http://www.smcneumatics.ie



Romania

SMC Romania srl
Str Frunzei 29, Sector 2, Bucharest
Phone: +40 213205111, Fax: +40 213261489
E-mail: smcromania@smcromania.ro
http://www.smcromania.ro



UK

SMC Pneumatics (UK) Ltd
Vincet Avenue, Crownhill, Milton Keynes, MK8 0AN
Phone: +44 (0)800 1382930 Fax: +44 (0)1908-555064
E-mail: sales@smcpneumatics.co.uk
http://www.smcneumatics.co.uk



Denmark

SMC Pneumatik A/S
Knudsminde 4B, DK-8300 Odder
Phone: +45 70252900, Fax: +45 70252901
E-mail: smc@smc-pneumatik.dk
http://www.smc.dk.com



Italy

SMC Italia S.p.A
Via Garibaldi 62, I-20061Carugate, (Milano)
Phone: +39 (0)2-92711, Fax: +39 (0)2-9271365
E-mail: mailbox@smcitalia.it
http://www.smcitalia.it



Russia

SMC Pneumatik LLC.
4B Sverdlovskaja nab, St. Petersburg 195009
Phone: +812 718 5445, Fax: +812 718 5449
E-mail: info@smc-pneumatik.ru
http://www.smc-pneumatik.ru



Estonia

SMC Pneumatics Estonia OÜ
Laki 12-101, 106 21 Tallinn
Phone: +372 (0)6 593540, Fax: +372 (0)6 593541
E-mail: smc@smcpneumatics.ee
http://www.smcneumatics.ee



Latvia

SMC Pneumatics Latvia SIA
Smerļa 1-705, Rīga LV-1006, Latvia
Phone: +371 781-77-00, Fax: +371 781-77-01
E-mail: info@smclv.lv
http://www.smclv.lv



Slovakia

SMC Priemyselná Automatizácia, s.r.o.
Námestie Martina Benku 10, SK-81107 Bratislava
Phone: +421 2 444 56725, Fax: +421 2 444 56028
E-mail: office@smc.sk
http://www.smc.sk



Finland

SMC Pneumatics Finland OY
PL72, Tiistinniityntie 4, SF-02031 ESPOO
Phone: +358 207 513513, Fax: +358 207 513595
E-mail: smcfi@smc.fi
http://www.smc.fi



Lithuania

SMC Pneumatics Lietuva, UAB
Savanoriu pr. 180, LT-01354 Vilnius, Lithuania
Phone: +370 5 264 81 26, Fax: +370 5 264 81 26



Slovenia

SMC industrijska Avtomatika d.o.o.
Grajski trg 15, SLO-8360 Zuzemberk
Phone: +386 738 85240 Fax: +386 738 85249
E-mail: office@smc-ind-avtom.si
http://www.smc-ind-avtom.si



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