3-Position Rotary Table

Stop position adjustment range

- From centre: ±10°
- Rotation range: 0~95°

The desired position is adjustable to between 0 and 95° from the centered position to both the right and left hand sides.

Can be operated by a single valve.

Controllable with one 3-position solenoid valve.

Sorting work to the right and left hand sides

Series MSZ
Example of Stop Position Settings

Angle is adjustable as shown below. (CCW: Counterclockwise, C: Centre, CW: Clockwise)

Working Principle

This example uses a 3-position 5-port solenoid valve (pressure centre). When air is supplied to all ports after the solenoid valve is in a pressure-center position, the pistons for rotary operation do not have any thrust, as the pressure on both sides is equal, and the pistons for rotary operation move to the centre position due to the thrust of the pistons for centre stop. When all of the pistons (centre stop and rotary operation) are in contact with each other, the piston system stops.

A load can be mounted directly on the table.

A High-precision model is also available in addition to the basic model.

Features 1
Series **MSZ**  
Model Selection

### Model Selection Procedure

1. **Operating conditions**
   - Evaluate the operating conditions according to the mounting position.

2. **Required torque**
   - Confirm the type of load as shown below, and select an actuator that satisfies the required torque.
   - Load types:
     - Static load: \(T_s\) (N m)
     - Resistance load: \(T_f\) (N m)
     - Inertial load: \(T_a\) (N m)
   - Effective torque \(\geq T_s\)
   - Effective torque \(\geq (3 \text{ to } 5) \cdot T_f\)
   - Effective torque \(\geq 10 \cdot T_a\)

3. **Rotation time**
   - Confirm that it is within the adjustable range of rotation time.
   - 0.2 to 1.0 s / 90°
   - 0.3 s / 90° OK

4. **Allowable load**
   - Confirm that the radial load, thrust load and moment are within the allowable ranges.
   - Thrust load: \(m \times 9.8 \leq \text{Allowable load}\)
   - Moment: \(m \times 9.8 \times H \leq \text{Allowable moment}\)
   - Allowable load
   - Allowable moment

5. **Inertial moment**
   - Find the load’s inertial moment \(I\) for the energy calculation.
   - \(I = m x \left(\frac{a^2 + b^2}{12} + m x H^2\right)\)
   - Inertial moment
   - \(I = 0.4 x (0.10^2 + 0.06^2) / 12 + 0.4 x 0.04^2\)
   - \(I = 0.00109 \text{ kg m}^2\)

6. **Kinetic energy**
   - Confirm that the load’s kinetic energy is within the allowable value.
   - \(\frac{1}{2} \times I \times \omega^2 \leq \text{Allowable energy}\)
   - \(\omega = \frac{2 \pi}{t} \omega (\omega: \text{Terminal angular velocity})\)
   - \(\omega: \text{Rotation angle (rad)}\)
   - \(t: \text{Rotation time (s)}\)
   - Allowable kinetic energy/Rotation time
   - \(\frac{1}{2} \times 0.00109 \times (2 \times \left(\frac{r}{2}\right) / 0.3)^2\)
   - \(= 60 \text{ mJ} \leq \text{Allowable energy OK}\)

---

**Formula**

- Allowable energy \(\omega = \frac{2 \pi}{t} \omega\)
- \(\omega: \text{Terminal angular velocity}\)
- \(\omega: \text{Rotation angle (rad)}\)
- \(t: \text{Rotation time (s)}\)

**Selection Example**

- Rotary table: MSZB50A, Pressure: 0.5 MPa
- Mounting orientation: Vertical
- Load configuration: 0.1 m \(\times\) 0.06 m (Rectangular plate)
- Rotation time \(t\): 0.3 s, Rotation angle: 90°
- Load mass \(m\): 0.4 kg
- Distance between central axis and centre of gravity \(H\): 0.04 m

Note: \(I\) substitutes for the value for inertial moment.
Effective Torque

<table>
<thead>
<tr>
<th>Size</th>
<th>Operating direction</th>
<th>Operating pressure (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>End→Centre</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>Centre→End</td>
<td>0.29</td>
</tr>
<tr>
<td>20</td>
<td>End→Centre</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td>Centre→End</td>
<td>0.62</td>
</tr>
<tr>
<td>30</td>
<td>End→Centre</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>Centre→End</td>
<td>0.91</td>
</tr>
<tr>
<td>50</td>
<td>End→Centre</td>
<td>1.83</td>
</tr>
</tbody>
</table>

Unit: N·m

Load Type

**Static load:** A load as represented by the clamp which requires a pressing force only

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

**Inertial load:** A load that must be rotated by the actuator

Allowable Load

Do not allow the load and moment applied to the table to exceed the allowable values shown in the table below.

(Operational beyond the allowable values can cause adverse effects on the service life, such as play in the table and loss of accuracy.)

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable radial load (N)</th>
<th>Allowable thrust load (N)</th>
<th>Allowable moment (N·m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic type</td>
<td>High precision type</td>
<td>Basic type</td>
</tr>
<tr>
<td>10</td>
<td>78</td>
<td>86</td>
<td>74</td>
</tr>
<tr>
<td>20</td>
<td>147</td>
<td>166</td>
<td>137</td>
</tr>
<tr>
<td>30</td>
<td>196</td>
<td>233</td>
<td>197</td>
</tr>
<tr>
<td>50</td>
<td>314</td>
<td>378</td>
<td>296</td>
</tr>
</tbody>
</table>

Note) Effective torque values are representative values and not to be considered as guaranteed values. Torque changes depending on the rotating direction. Please refer to the figure below for the rotating directions.
Inertial Moment Formula (Calculation of Inertial Moment)

1. Find the inertial moment $\mathbf{\Theta}$ for the rotation of shaft (B).

2. Next, $\mathbf{\Theta}_B$ is entered to find $\mathbf{\Theta}_A$ the inertial moment for the rotation of shaft (A) as

$$\mathbf{\Theta}_A = \frac{a}{b} \cdot \mathbf{\Theta}_B$$

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.

Select models giving consideration to the load’s inertial moment and rotation time during operation.

(1) Allowable kinetic energy and rotation time adjustment range

From the table below, set the rotation time within the adjustment range for stable operation. Note that 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>10</td>
<td>7</td>
<td>0.2 to 1.0</td>
</tr>
<tr>
<td>20</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>81</td>
<td></td>
</tr>
</tbody>
</table>

(2) Inertial moment calculation

Since the formula for inertial moment differ depending on the configuration of the load, refer to the inertial moment calculation formula on this page.
Kinetic Energy/Rotation Time

(3) Model selection  Select models by applying the inertial moment and rotation time which have been found to the chart below.

Rotation Accuracy: Displacement Values at 180° (Reference values)

<table>
<thead>
<tr>
<th>Measuring plate</th>
<th>MSZA</th>
<th>MSZB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotating amount of table top</td>
<td>0.03</td>
<td>0.1</td>
</tr>
<tr>
<td>Rotating amount of table side</td>
<td>0.03</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Values in the table are actual values and not guaranteed values.
The following graphs show the displacement at point A, which is 100 mm away from the centre of rotation, where the load is applied.

**MSZ-10A**

Displacement (μm) vs. Load (N)

**MSZ-20A**

Displacement (μm) vs. Load (N)

**MSZ-30A**

Displacement (μm) vs. Load (N)

**MSZ-50A**

Displacement (μm) vs. Load (N)
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.

| QCR | Amount of air consumption of rotary actuator |
| QCP | Amount of air consumption of tube or piping |
| V  | Inner volume of the rotary table |
| P  | Operating pressure |
| L  | Length of piping |
| a  | Inner sectional area of piping |

Air consumption at each operating pressure calculated using formula (2).

Internal volume changes depending on the rotating direction (refer to the figure shown in the lower right). Because of this, to obtain the total air consumption, first calculate the air consumption of each stroke respectively by using formula (1), then add up each result.

The internal volume for each rotating direction and the air consumption at each operating pressure calculated using formula (1) are shown in the table below.

**[Calculation example]**

Size: 10  Operating pressure: 0.5 MPa  Inner sectional area of piping: 12.6 mm²
Length of piping: 1000mm  Stroke: Centre → Counterclockwise → Centre → Clockwise → Centre

Total air consumption, Q1, is obtained by adding up the air consumption of each stroke, which is shown in the table below.

Q1 = 0.019 + 0.040 + 0.019 + 0.040 = 0.118 (ANR)

Air consumed in the tubing is calculated using formula (2), as shown below.

Q2 = 12.6 x 1000 x 0.6 x 10⁻⁶ = 0.063 (ANR)

An entire stroke includes two rotations from end to centre where the air is consumed. Thus, the total air consumption Q of the rotary table and tubing is obtained as shown below.

Q = Q1 + Q2 = 0.244 (ANR)

**Internal Cross Section of Tubing and Steel Piping**

<table>
<thead>
<tr>
<th>Nominal</th>
<th>O.D. (mm)</th>
<th>I.D. (mm)</th>
<th>Internal cross section a (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:0604</td>
<td>6</td>
<td>4</td>
<td>12.6</td>
</tr>
<tr>
<td>TU 0805</td>
<td>8</td>
<td>5</td>
<td>19.6</td>
</tr>
<tr>
<td>T:0806</td>
<td>8</td>
<td>6</td>
<td>28.3</td>
</tr>
<tr>
<td>1/BB</td>
<td></td>
<td>6.5</td>
<td>33.2</td>
</tr>
<tr>
<td>T:1075</td>
<td>10</td>
<td>7.5</td>
<td>44.2</td>
</tr>
<tr>
<td>TU 1208</td>
<td>12</td>
<td>8</td>
<td>50.3</td>
</tr>
<tr>
<td>T:1209</td>
<td>12</td>
<td>9</td>
<td>63.6</td>
</tr>
<tr>
<td>3/8B</td>
<td></td>
<td>9.2</td>
<td>66.5</td>
</tr>
<tr>
<td>TS 1612</td>
<td>16</td>
<td>12</td>
<td>113</td>
</tr>
<tr>
<td>3/4B</td>
<td></td>
<td>13</td>
<td>133</td>
</tr>
<tr>
<td>1/2B</td>
<td></td>
<td>16.1</td>
<td>204</td>
</tr>
<tr>
<td>3/4B</td>
<td></td>
<td>21.6</td>
<td>366</td>
</tr>
<tr>
<td>1B</td>
<td></td>
<td>27.6</td>
<td>598</td>
</tr>
</tbody>
</table>

**Air Consumption**

<table>
<thead>
<tr>
<th>Size</th>
<th>Operating direction</th>
<th>Rotation</th>
<th>Inner volume (cm³)</th>
<th>Operating pressure (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>End→Centre</td>
<td>90°</td>
<td>6.69</td>
<td>0.20 0.027 0.033 0.040 0.047 0.054 0.060 0.067 0.074</td>
</tr>
<tr>
<td></td>
<td>Centre→End</td>
<td></td>
<td>3.11</td>
<td>0.009 0.012 0.016 0.019 0.022 0.025 0.028 0.031 0.034</td>
</tr>
<tr>
<td>20</td>
<td>End→Centre</td>
<td>90°</td>
<td>13.2</td>
<td>0.040 0.053 0.066 0.079 0.093 0.106 0.119 0.132 0.145</td>
</tr>
<tr>
<td></td>
<td>Centre→End</td>
<td></td>
<td>6.40</td>
<td>0.019 0.026 0.032 0.038 0.045 0.051 0.058 0.064 0.070</td>
</tr>
<tr>
<td>30</td>
<td>End→Centre</td>
<td>90°</td>
<td>20.0</td>
<td>0.060 0.080 0.100 0.120 0.140 0.160 0.180 0.200 0.220</td>
</tr>
<tr>
<td></td>
<td>Centre→End</td>
<td></td>
<td>9.52</td>
<td>0.029 0.038 0.048 0.057 0.067 0.076 0.086 0.095 0.105</td>
</tr>
<tr>
<td>50</td>
<td>End→Centre</td>
<td>90°</td>
<td>32.6</td>
<td>0.098 0.130 0.163 0.195 0.228 0.261 0.293 0.326 0.358</td>
</tr>
<tr>
<td></td>
<td>Centre→End</td>
<td></td>
<td>16.2</td>
<td>0.049 0.065 0.081 0.097 0.113 0.130 0.146 0.162 0.178</td>
</tr>
</tbody>
</table>

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

Formula

Qc2 = Qc x n x No. of actuators x Margin rate

Qc = Amount of exhaust air from a compressor  [l/min (ANR)]

n = Actuator oscillations per minute

Qc2 = Amount of exhaust air from a compressor  [l/min (ANR)]

Qc2 = Qc x n x No. of actuators x Margin rate

[Front matter 6]
3-Position Rotary Table
Series MSZ
Size: 10, 20, 30, 50

How to Order

- High precision type
  MSZA 10 A M9B
- Basic type
  MSZB 10 A M9B

Number of auto switches
- 2 pcs.
- n pcs.

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

Size
- 10
- 20
- 30
- 50

With adjustment bolt

Applicable Auto Switch
Refer to pages 7 to 11 for detailed auto switch specification.

<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 model</th>
<th>Lead wire length (m)</th>
<th>Applicable load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reed switch</td>
<td>—</td>
<td>Grommet</td>
<td>No</td>
<td>2-wire</td>
<td>24 V</td>
<td>A90V</td>
<td>0.5 (Nil) 3 (L) 5 (Z)</td>
<td>Relay, PLC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3-wire</td>
<td>5 V</td>
<td>—</td>
<td>A96V</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-wire</td>
<td>24 V 12 V</td>
<td>100 V</td>
<td>A93V</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Solid state switch</td>
<td>—</td>
<td>Grommet</td>
<td>Yes</td>
<td>3-wire (NPN)</td>
<td>5 V 12 V</td>
<td>M9NV</td>
<td>—</td>
<td>Relay, PLC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2-wire</td>
<td>12 V</td>
<td>M99P</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-wire (NPN)</td>
<td>5 V 12 V</td>
<td>M9NW</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-wire (PNP)</td>
<td>5 V 12 V</td>
<td>M9PV</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2-wire</td>
<td>12 V</td>
<td>M9BV</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

** Although it is possible to attach a water resistant auto switch, this is not a water-resistant-type rotary table.

* Lead wire length symbols: 0.5 m — Nil (Example) M9N
  3 m — L (Example) M9NL
  5 m — Z (Example) M9NZ

* Auto switches marked with a "O" symbol are produced upon receipt of orders.
Specifications

<table>
<thead>
<tr>
<th>Size</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid</td>
<td>Air (non-lube)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. operating pressure</td>
<td>1MPa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. operating pressure</td>
<td>0.2 MPa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient and fluid temperature</td>
<td>0 to 60°C (with no freezing)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cushion</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotation angle adjustment range</td>
<td>0 to 190°</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centre position adjustment range</td>
<td>±10°</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port size</td>
<td>M5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Allowable Kinetic Energy and Rotation Time Adjustment Range

<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>10</td>
<td>7</td>
<td>0.2 to 1.0</td>
</tr>
<tr>
<td>20</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>81</td>
<td></td>
</tr>
</tbody>
</table>

If a kinetic energy exceeding the allowable value is applied to the product, it may be damaged and become unusable. Care should be taken in designing, adjusting and operating the system so that the kinetic energy will not exceed the allowable values.

Weight

<table>
<thead>
<tr>
<th>Size</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic type</td>
<td>730</td>
<td>1350</td>
<td>1730</td>
<td>2660</td>
</tr>
<tr>
<td>High precision type</td>
<td>760</td>
<td>1450</td>
<td>1850</td>
<td>2820</td>
</tr>
</tbody>
</table>

Note) Excluding the weight of the auto switches.

Piping and speed control

1) A single 3-position pressure centre solenoid valve or two 3-port solenoid valves can be used. (Refer to Figures 1 or 2.)
2) A meter-out type speed controller is used for ports A and B and a meter-in type speed controller is used for ports C and D. (Figures 1 and 2 show the state at which pressure is applied to ports B and D.)

3) Figure 3 shows the operational direction and Table 1 shows the pressure port and active speed controller for each operation.

Table 1 Pressure port and active speed controller

<table>
<thead>
<tr>
<th>Operating</th>
<th>Pressure port</th>
<th>Speed controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clockwise-1</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Clockwise-2</td>
<td>●</td>
<td>—</td>
</tr>
<tr>
<td>Counterclockwise-1</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Counterclockwise-2</td>
<td>—</td>
<td>●</td>
</tr>
</tbody>
</table>

Note) Excluding the weight of the auto switches.
Angle Adjustment

1) Stop positions are adjusted with the adjusting bolts shown in Figure 4.
   ① Adjusting bolts “a” and “b” are used for adjusting the rotation ends. Adjusting bolts “c” and “d” are used for adjusting the centre position.
   ② Figure 5 shows the angle ranges that can be adjusted with each adjusting bolt.

2) Angle adjustment
   Supply air when adjusting the angle (a low pressure of approx. 0.2 MPa is recommended).
   ① First adjust both rotation end positions.
     · Apply pressure to ports A and C and to adjust adjusting bolt “b”.
     · Apply pressure to ports B and D and to adjust adjusting bolt “a”.
     · Lock the bolts with the fixing nuts after adjustment.
   ② Next, apply pressure to ports A to D to adjust the centre position.
     · Loosen the fixing nuts for adjusting bolts “c” and “d”.
     · Tighten adjusting bolts “c” and “d” until they are almost hidden completely behind the fixing nuts (the table can be rotated manually).
     · Follow the appropriate procedure (R or L) shown in Table 2.

Table 2  Centre position adjustment

<table>
<thead>
<tr>
<th></th>
<th>R: Clockwise adjustment</th>
<th>L: Counterclockwise adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manually rotate the table counterclockwise until resistance is felt.</td>
<td>Manually rotate the table clockwise until resistance is felt.</td>
</tr>
<tr>
<td>2</td>
<td>Rotate the table clockwise when adjusting bolt “d” is loosened. Set it to the desired position.</td>
<td>Rotate the table counterclockwise when adjusting bolt “c” is loosened. Set it to the desired position.</td>
</tr>
<tr>
<td>3</td>
<td>Loosen adjusting bolt “c” until resistance is felt. (Make sure that there is no rotation backlash in the table.)</td>
<td>Loosen adjusting bolt “d” until resistance is felt. (Make sure that there is no rotation backlash in the table.)</td>
</tr>
<tr>
<td>4</td>
<td>Tighten both adjusting bolts “c” and “d” by approx. 45°. Note 1</td>
<td>Tighten both adjusting bolts “c” and “d” by approx. 45°. Note 1</td>
</tr>
<tr>
<td>5</td>
<td>Lock adjusting bolts “c” and “d” with fixing nuts. Note 2</td>
<td>Lock adjusting bolts “c” and “d” with fixing nuts. Note 2</td>
</tr>
</tbody>
</table>

Note 1) Since the position of the adjusting bolt can shift with the changing of screw clearance when tightening the fixing nuts.
Note 2) If the table has a rotation backlash after tightening the nut, readjust it.

Adjusting angle per rotation of angle adjusting screw

<table>
<thead>
<tr>
<th>size</th>
<th>Adjusting bolt a, b (End position adjustment)</th>
<th>Adjusting bolt c, d (Centre position adjustment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>$10.2^\circ$</td>
<td>$5.1^\circ$</td>
</tr>
<tr>
<td>20</td>
<td>$9.0^\circ$</td>
<td>$3.6^\circ$</td>
</tr>
<tr>
<td>30</td>
<td>$8.2^\circ$</td>
<td>$3.3^\circ$</td>
</tr>
<tr>
<td>50</td>
<td>$8.2^\circ$</td>
<td>$4.1^\circ$</td>
</tr>
</tbody>
</table>

A piping, speed control, and angle adjustment manual is attached to the product.
### Component Parts

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Material</th>
<th>No.</th>
<th>Description</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Body</td>
<td>Aluminium alloy</td>
<td>24</td>
<td>Basic type</td>
<td>Deep groove ball bearing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>High precision type</td>
<td>Angular contact ball bearing</td>
</tr>
<tr>
<td>2</td>
<td>Cover</td>
<td>Aluminium alloy</td>
<td>25</td>
<td>Bushing</td>
<td>SPCC</td>
</tr>
<tr>
<td>3</td>
<td>Plate</td>
<td>Aluminium alloy</td>
<td>26</td>
<td>Bushing</td>
<td>SPCC</td>
</tr>
<tr>
<td>4</td>
<td>Seal</td>
<td>NBR</td>
<td>27</td>
<td>Seal washer</td>
<td>NBR</td>
</tr>
<tr>
<td>5</td>
<td>Piston</td>
<td>Stainless steel</td>
<td>28</td>
<td>Piston seal</td>
<td>NBR</td>
</tr>
<tr>
<td>6</td>
<td>Pinion</td>
<td>Chrome molybdenum steel</td>
<td>29</td>
<td>Piston seal</td>
<td>NBR</td>
</tr>
<tr>
<td>7</td>
<td>Seal retainer</td>
<td>Aluminium alloy</td>
<td>30</td>
<td>Rod seal</td>
<td>NBR</td>
</tr>
<tr>
<td>8</td>
<td>Gasket (for cover)</td>
<td>NBR</td>
<td>31</td>
<td>Gasket</td>
<td>NBR</td>
</tr>
<tr>
<td>9</td>
<td>Table</td>
<td>Aluminium alloy</td>
<td>32</td>
<td>O-ring</td>
<td>NBR</td>
</tr>
<tr>
<td>10</td>
<td>Bearing retainer</td>
<td>Aluminium alloy</td>
<td>33</td>
<td>O-ring</td>
<td>NBR</td>
</tr>
<tr>
<td>11</td>
<td>End cover (A)</td>
<td>Aluminium alloy</td>
<td>34</td>
<td>O-ring</td>
<td>NBR</td>
</tr>
<tr>
<td>12</td>
<td>End cover (B)</td>
<td>Aluminium alloy</td>
<td>35</td>
<td>Compact hexagon nut</td>
<td>Steel wire</td>
</tr>
<tr>
<td>13</td>
<td>Cylinder tube (A)</td>
<td>Aluminium alloy</td>
<td>36</td>
<td>Hexagon nut</td>
<td>Steel wire</td>
</tr>
<tr>
<td>14</td>
<td>Cylinder tube (B)</td>
<td>Aluminium alloy</td>
<td>37</td>
<td>Hexagon socket head set bolt</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>15</td>
<td>Tube cover (A)</td>
<td>Aluminium alloy</td>
<td>38</td>
<td>Hexagon socket head set bolt</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>16</td>
<td>Tube cover (B)</td>
<td>Aluminium alloy</td>
<td>39</td>
<td>Hexagon socket head set bolt</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>17</td>
<td>Sub piston (R)</td>
<td>Carbon steel</td>
<td>40</td>
<td>Round head phillips screw</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>18</td>
<td>Sub piston (F)</td>
<td>Carbon steel</td>
<td></td>
<td>Size: 10</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>19</td>
<td>Adjustment bolt (R)</td>
<td>Carbon steel</td>
<td></td>
<td>Size: 20, 30, 50</td>
<td>Low head cap screw</td>
</tr>
<tr>
<td>20</td>
<td>Adjustment bolt (F)</td>
<td>Carbon steel</td>
<td></td>
<td>Low head cap screw</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>21</td>
<td>Magnet</td>
<td>Magnetic material</td>
<td>41</td>
<td>Round head phillips screw No.0</td>
<td>Steel wire</td>
</tr>
<tr>
<td>22</td>
<td>Wear ring</td>
<td>Resin</td>
<td>42</td>
<td>CS type snap ring</td>
<td>Spring steel</td>
</tr>
<tr>
<td>23</td>
<td>Deep groove ball bearing</td>
<td>Bearing steel</td>
<td>43</td>
<td>Parallel pin</td>
<td>Carbon steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>44</td>
<td>Steel ball</td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>
The position table shows the counterclockwise end when adjusted the rotation angle to 180°.
Proper Auto Switch Mounting Position

The appropriate mounting position of the centre position detection switch is between dimensions A and B, as shown above. However, since the auto switch turns on in the range of the operating angle (θm), when one auto switch is used for detecting the centre position, the switch turns on long before reaching the centre position, as shown in the left figure below. To avoid this, use two switches (as shown in the right figure below) so that the rotation may be detected from both the clockwise rotation end to the centre position and from the counterclockwise rotation end to the centre position.

<table>
<thead>
<tr>
<th>Size</th>
<th>Rotation</th>
<th>A</th>
<th>B</th>
<th>Operating angle θm</th>
<th>Hysteresis angle</th>
<th>A</th>
<th>B</th>
<th>Operating angle θm</th>
<th>Hysteresis angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>190°</td>
<td>27</td>
<td>45</td>
<td>90°</td>
<td>10°</td>
<td>31</td>
<td>49</td>
<td>90°</td>
<td>10°</td>
</tr>
<tr>
<td>20</td>
<td>190°</td>
<td>35</td>
<td>62</td>
<td>80°</td>
<td>10°</td>
<td>39</td>
<td>66</td>
<td>80°</td>
<td>10°</td>
</tr>
<tr>
<td>30</td>
<td>190°</td>
<td>39</td>
<td>68</td>
<td>65°</td>
<td>10°</td>
<td>43</td>
<td>72</td>
<td>65°</td>
<td>10°</td>
</tr>
<tr>
<td>50</td>
<td>190°</td>
<td>49</td>
<td>83</td>
<td>50°</td>
<td>10°</td>
<td>53</td>
<td>87</td>
<td>50°</td>
<td>10°</td>
</tr>
</tbody>
</table>

Operating angle θm: Value of the operating range Lm of a single auto switch when converted to an axial rotation angle.
Hysteresis angle: Value of the auto switch hysteresis when converted to an angle.

Detection of the Center Position

The appropriate mounting position of the centre position detection switch is between dimensions A and B, as shown above. However, since the auto switch turns on in the range of the operating angle (θm), when one auto switch is used for detecting the centre position, the switch turns on long before reaching the centre position, as shown in the left figure below. To avoid this, use two switches (as shown in the right figure below) so that the rotation may be detected from both the clockwise rotation end to the centre position and from the counterclockwise rotation end to the centre position.
Auto Switch Common Specifications

<table>
<thead>
<tr>
<th>Type</th>
<th>Reed switch</th>
<th>Solid state switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leakage current</td>
<td>None</td>
<td>3-wire: 100 μA or less, 2-wire: 0.8 mA or less</td>
</tr>
<tr>
<td>Operating time</td>
<td>1.2 ms</td>
<td>1 ms or less</td>
</tr>
<tr>
<td>Impact resistance</td>
<td>300 m/s²</td>
<td>1000 m/s²</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>50 MΩ or more at 500 V DC Mega (between lead wire and case)</td>
<td>500 V DC (between lead wire and case)</td>
</tr>
<tr>
<td>Withstand voltage</td>
<td>1000 V AC for 1 min. (between lead wire and case)</td>
<td>1000 V AC for 1 min. (between lead wire and case)</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>–10 to 60°C</td>
<td>–10 to 60°C</td>
</tr>
<tr>
<td>Enclosure</td>
<td>IEC529 standard IP67, watertight (JIS C 0920)</td>
<td>-</td>
</tr>
</tbody>
</table>

Lead Wire Length

Lead wire length indication (Example) D-M9P[L]

<table>
<thead>
<tr>
<th>Lead wire length</th>
<th>0.5 m</th>
<th>3 m</th>
<th>5 m</th>
</tr>
</thead>
</table>

Note 1) Lead wire length Z: 5 m applicable auto switches
Solid state switch: All types are produced upon receipt of order.
Note 2) For solid state switches with flexible wire specification, add "-61" at the end of the lead wire length.

(Example) D-M9PV[L-61]

Flexible specification

Contact Protection Box/CD-P11, CD-P12

<Applicable switch type>
D-A9 and D-A9CV type switches do not have internal contact protection circuits.
(1) The operated load is an induction load.
(2) The length of wiring to the load is 5 m or more.
(3) The load voltage is 100 VAC.
A contact protection box should be used in any of the above situations. Otherwise the lifetime of the contact may be shortened.

Specifications

<table>
<thead>
<tr>
<th>Part No.</th>
<th>CD-P11</th>
<th>CD-P12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load voltage</td>
<td>100 V AC</td>
<td>200 V AC</td>
</tr>
<tr>
<td>Max. load current</td>
<td>25 mA</td>
<td>12.5 mA</td>
</tr>
</tbody>
</table>

Contact Protection Box/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. The switch unit should be kept as close as possible to the contact protection box with a lead wire that is no more than 1 metre in length.
Auto Switch Connections and Examples

Basic Wiring

### Solid state 3-wire, NPN

![3-wire NPN diagram]

- **Switch main circuit:** Brown, Black, Blue
- **Load:** Brown, Blue

### Solid state 3-wire, PNP

![3-wire PNP diagram]

- **Switch main circuit:** Brown, Black, Blue
- **Load:** Brown, Blue

### 2-wire (Solid state)

- **Switch main circuit:** Brown, Blue
- **Load:** Brown, Blue

### 2-wire (Reed)

- **Indicator light, protection circuit, etc.:** Brown, Blue

Examples of Connection to PLC

#### Sink input specifications

**3-wire, NPN**

- **Switch main circuit:** Brown, Black, Blue
- **Load:** Brown, Blue

**2-wire**

- **Switch main circuit:** Brown, Blue
- **Load:** Brown, Blue

#### Source input specifications

**3-wire, PNP**

- **Switch main circuit:** Brown, Black, Blue
- **Load:** Brown, Blue

**2-wire**

- **Switch main circuit:** Brown, Blue
- **Load:** Brown, Blue

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

#### 3-wire

**AND connection for NPN output (using relays)**

- **Switch 1:** Brown, Black, Blue
- **Switch 2:** Brown, Black, Blue
- **Load:** Brown, Blue

**OR connection for NPN output**

- **Switch 1:** Brown, Black, Blue
- **Switch 2:** Brown, Black, Blue
- **Load:** Brown, Blue

#### 2-wire

**AND connection for NPN output (performed with switches only)**

- **Switch 1:** Brown, Black, Blue
- **Switch 2:** Brown, Black, Blue
- **Load:** Brown, Blue

**OR connection for NPN output**

- **Switch 1:** Brown, Black, Blue
- **Switch 2:** Brown, Black, Blue
- **Load:** Brown, Blue

The indicator lights will light up when both switches are turned ON.

**2-wire with 2 switches AND connection**

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

**2-wire with 2 switches OR connection**

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

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

Load voltage at ON = Power supply voltage
Residual voltage \times 2 pcs.

= 24 V – 4 V \times 2 pcs.

= 16 V

Example: Power supply voltage is 24 V DC
Voltage decline in switch is 4 V

Load voltage at OFF = Leakage current \times 2 pcs. \times Load impedance

= 1 mA \times 2 pcs. \times 3 k\Omega

= 6 V

Example: Load impedance is 3 k\Omega
Leakage current from switch is 1 mA
Reed Switch: Direct Mounting Style
D-A90(V)/D-A93(V)/D-A96(V)

Auto Switch Specifications

PLC: Programmable Logic Controller

D-A90/D-A90V (Without indicator light)

<table>
<thead>
<tr>
<th>Auto switch part no.</th>
<th>D-A90/D-A90V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable load</td>
<td>IC circuit, Relay, PLC</td>
</tr>
<tr>
<td>Load voltage</td>
<td>24 V AC/DC or less</td>
</tr>
<tr>
<td>Max. load current</td>
<td>50 mA</td>
</tr>
<tr>
<td>Contact protection circuit</td>
<td>None</td>
</tr>
<tr>
<td>Internal resistance</td>
<td>1 Ω or less (including lead wire length of 3 m)</td>
</tr>
</tbody>
</table>

D-A93/D-A93V/D-A96/D-A96V (With indicator light)

<table>
<thead>
<tr>
<th>Auto switch part no.</th>
<th>D-A93/D-A93V</th>
<th>D-A96/D-A96V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable load</td>
<td>Relay, PLC</td>
<td></td>
</tr>
<tr>
<td>Load voltage</td>
<td>24 V DC 100 V AC</td>
<td></td>
</tr>
<tr>
<td>Load current range</td>
<td>5 to 40 mA</td>
<td></td>
</tr>
<tr>
<td>Contact protection circuit</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Internal voltage drop</td>
<td>D-A93 — 2.4 V or less (to 20 mA)/3 V or less (to 40 mA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D-A93 V — 2.7 V or less</td>
<td></td>
</tr>
<tr>
<td>Indicator light</td>
<td>Red LED lights when ON</td>
<td></td>
</tr>
</tbody>
</table>

Note 1) Refer to page 7 for reed switch common specifications.

Note 2) Refer to page 7 for lead wire lengths.

Note 3) Load current range and max. load current

IC circuit, Relay, PLC

24 V AC/DC or less
50 mA
None
1 Ω or less (including lead wire length of 3 m)

48 V AC/DC or less
40 mA

100 V AC/DC or less
20 mA

Relay, PLC

24 V DC
5 to 40 mA
None

D-A93 — 2.4 V or less (to 20 mA)/3 V or less (to 40 mA)

D-A93 V — 2.7 V or less

100 V AC
5 to 20 mA

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.

Please use the auto switch with a contact protection box any of the above mentioned cases.
(For details about the contact protection box, refer to page 7.)

Weight

<table>
<thead>
<tr>
<th>Model</th>
<th>D-A90</th>
<th>D-A90V</th>
<th>D-A93</th>
<th>D-A93V</th>
<th>D-A96</th>
<th>D-A96V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead wire length: 0.5 m</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Lead wire length: 3 m</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>41</td>
<td>41</td>
</tr>
</tbody>
</table>

Dimensions

<table>
<thead>
<tr>
<th>D-A90/D-A93/D-A96</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC (+) Brown</td>
</tr>
<tr>
<td>DC (-) Black</td>
</tr>
<tr>
<td>Slotted set screw</td>
</tr>
</tbody>
</table>

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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.

Please use the auto switch with a contact protection box any of the above mentioned cases.
(For details about the contact protection box, refer to page 7.)

Auto Switch Internal Circuit

D-A90(V)

| Reed switch |
| Contact protection box |
| CD-P11 |
| CD-P12 |
| OUT (+) Brown |
| OUT (-) Blue |

D-A93(V)

| Reed switch |
| Contact protection box |
| Zener diode |
| CD-P11 |
| CD-P12 |
| OUT (+) Brown |
| OUT (-) Blue |

D-A96(V)

| Reed switch |
| Reverse current protection diode |
| DC (+) Brown |
| DC (-) Black |

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.

Please use the auto switch with a contact protection box any of the above mentioned cases.
(For details about the contact protection box, refer to page 7.)

Grommet Electrical entry: 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.

Lead wires

D-A90(V)/D-A90(V) — Oilproof vinyl heavy-duty cord: ø2.7, 0.18 mm² x 2 cores (Brown, Blue), 0.5 m

D-A96(V) — Oilproof vinyl heavy-duty cord: ø2.7, 0.15 mm² x 3 cores (Brown, Black, Blue), 0.5 m

Note 1) Refer to page 7 for reed switch common specifications.

Note 2) Refer to page 7 for lead wire lengths.

Weight

Unit: g

<table>
<thead>
<tr>
<th>Model</th>
<th>D-A90</th>
<th>D-A90V</th>
<th>D-A93</th>
<th>D-A93V</th>
<th>D-A96</th>
<th>D-A96V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead wire length: 0.5 m</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Lead wire length: 3 m</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>41</td>
<td>41</td>
</tr>
</tbody>
</table>

Dimensions

Unit: mm

D-A90/D-A93/D-A96

DC power supply

Indicator light

D-A90 type comes without indicator light

D-A90V/D-A93V/D-A96V

Indicator light

D-A90 type comes without indicator light

Note) (1): dimensions for D-A93.
**Solid State Switch: Direct Mounting Style**  
**D-M9N(V)/D-M9P(V)/D-M9B(V)**

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

**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-M9N(V)**

```
     |       |
---|---|
DI! | OUT |
     |     |
```

**D-M9P(V)**

```
     |       |
---|---|
DI(+) | OUT |
     |     |
```

**D-M9B(V)**

```
     |       |
---|---|
DI(+) | OUT |
     |     |
```

**Auto Switch Specifications**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical entry direction</td>
<td>In-line</td>
<td>Perpendicular</td>
<td>In-line</td>
<td>Perpendicular</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Wiring type</td>
<td>—</td>
<td>3-wire</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2-wire</td>
</tr>
<tr>
<td>Output type</td>
<td>—</td>
<td>NPN</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>PNP</td>
</tr>
<tr>
<td>Applicable load</td>
<td>—</td>
<td>IC circuit, Relay, PLC</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>24 V DC relay, PLC</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>—</td>
<td>5, 12, 24 V DC (4.5 to 28 V)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Current consumption</td>
<td>—</td>
<td>10 mA or less</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Load voltage</td>
<td>28 V DC or less</td>
<td>—</td>
<td>24 V DC (10 to 28 V DC)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Load current</td>
<td>—</td>
<td>40 mA or less</td>
<td>2.5 to 40 mA</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Internal voltage drop</td>
<td>—</td>
<td>0.8 V or less</td>
<td>4 V or less</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Leakage current</td>
<td>—</td>
<td>100 μA or less at 24 V DC</td>
<td>0.8 mA or less</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Indicator light</td>
<td>Red LED lights when ON.</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Lead wires**
- Oilproof vinyl heavy-duty cord: ø2.7 x 3.2 ellipse, 0.15 mm².
- 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 7 for auto switch common specifications.
**Note 2)** Refer to page 7 for lead wire lengths.

**Weight**

<table>
<thead>
<tr>
<th>Auto switch part no.</th>
<th>D-M9N(V)</th>
<th>D-M9P(V)</th>
<th>D-M9B(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead wire length (m)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>0.5</td>
<td>8</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
<td>41</td>
<td>38</td>
</tr>
<tr>
<td>5</td>
<td>68</td>
<td>68</td>
<td>63</td>
</tr>
</tbody>
</table>

**Dimensions**

<table>
<thead>
<tr>
<th>Auto switch part no.</th>
<th>D-M9N(V)</th>
<th>D-M9P(V)</th>
<th>D-M9B(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead wire length (m)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>0.5</td>
<td>8</td>
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<td>7</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
<td>41</td>
<td>38</td>
</tr>
<tr>
<td>5</td>
<td>68</td>
<td>68</td>
<td>63</td>
</tr>
</tbody>
</table>

**Note 1)** Refer to page 7 for auto switch common specifications.
**Note 2)** Refer to page 7 for lead wire lengths.

**Note 3)** Refer to page 7 for dimensions.

**PLC: Programmable Logic Controller**

For details about certified products conforming to international standards, visit us at www.smaworld.com.
2-colour Indication Type, Solid State Switch: Direct Mounting Style
D-M9NW(V)/D-M9PW(V)/D-M9BW(V)

Grommet

Auto Switch Specifications

Auto Switch Internal Circuit

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

Auto Switch Specifications

PLC: Programmable Logic Controller

D-M9NW(V)/D-M9PW(V)/D-M9BW(V) (With indicator light)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical entry direction</td>
<td>In-line</td>
<td>Perpendicular</td>
<td>In-line</td>
<td>Perpendicular</td>
<td>In-line</td>
<td>Perpendicular</td>
</tr>
<tr>
<td>Wiring type</td>
<td>3-wire</td>
<td>PNP</td>
<td>NPN</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Output type</td>
<td>NPN</td>
<td>3-wire</td>
<td>PNP</td>
<td>NPN</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Applicable load</td>
<td>IC circuit, Relay, PLC</td>
<td>24 V DC relay, PLC</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>5, 12, 24 V DC (4.5 to 28 VDC)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Current consumption</td>
<td>10 mA or less</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Load voltage</td>
<td>28 V DC or less</td>
<td>—</td>
<td>24 V DC (10 to 28 V DC)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Load current</td>
<td>40 mA or less</td>
<td>80 mA or less</td>
<td>5 to 40 mA</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Internal voltage drop</td>
<td>1.5 V or less (0.6 V or less at 10 mA load current)</td>
<td>0.8 V or less</td>
<td>4 V or less</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Leakage current</td>
<td>100 μA or less at 24 V DC</td>
<td>0.8 mA or less</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Indicator light</td>
<td>Operating position ———— Red LED lights up</td>
<td>Operating position ———— Green LED lights up</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Weight

<table>
<thead>
<tr>
<th>Auto switch part no.</th>
<th>D-M9NW(V)</th>
<th>D-M9PW(V)</th>
<th>D-M9BW(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead wire length (m)</td>
<td>0.5 7</td>
<td>7 7</td>
<td>7 7</td>
</tr>
<tr>
<td>3 34</td>
<td>34 32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 56</td>
<td>56 52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dimensions

<table>
<thead>
<tr>
<th>D-M9NW(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting screw M2.5 x 4L</td>
</tr>
<tr>
<td>Slotted set screw</td>
</tr>
<tr>
<td>Indicator light</td>
</tr>
<tr>
<td>Most sensitive position</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D-M9NWV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting screw M2.5 x 4L</td>
</tr>
<tr>
<td>Slotted set screw</td>
</tr>
<tr>
<td>Indicator light</td>
</tr>
<tr>
<td>Most sensitive position</td>
</tr>
</tbody>
</table>
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, JIS B 8370 and other safety practices.

### Explanation of the Labels

<table>
<thead>
<tr>
<th>Labels</th>
<th>Explanation of the labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danger</td>
<td>In extreme conditions, there is a possible result of serious injury or loss of life.</td>
</tr>
<tr>
<td>Warning</td>
<td>Operator error could result in serious injury or loss of life.</td>
</tr>
<tr>
<td>Caution</td>
<td>Operator error could result in injury or equipment damage.</td>
</tr>
</tbody>
</table>

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 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 after analysis and/or tests to meet your 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 item 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. (Trained operators should understand JIS B 8370 “General Rules for Pneumatic Equipment” and other safety regulations.)

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 driven objects have been confirmed.
   2. When equipment is removed, confirm the safety process as mentioned above, turn off the supply pressure for this equipment, exhaust all residual compressed air and release all energy (liquid pressure, spring, condenser and gravity) in the system.
   3. Before machinery/equipment is restarted, take measures to prevent shooting-out of cylinder piston rod, etc.

4. **Take measures for safety and contact SMC if the product is to be used in any of the following conditions and atmosphere:**

   1. Conditions and environments beyond the given specifications, or if product is used outdoors or with direct sun lights.
   2. Installation on equipment in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverages, recreation equipment, emergency stop circuits, clutch/brake circuit for press, 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 earthquake 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 its employees shall be exempted from liability for any incidental damage that is caused by the use or the inability to use this product (loss of business interests, business interruptions, etc.).**

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.**
Design and 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 switches>
   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) For an auto switch without a contact protection circuit, 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>
   3) Although wire length should not affect switch function, use a wire that is 100 m or shorter.

3. Do not use a load that generates surge voltage. If a surge voltage is generated, 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 a surge is applied repeatedly. When directly driving a load which generates surge, such as a relay or solenoid valve, 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 safeguard against malfunctions by providing a mechanical protection function, or by using an additional switch (sensor) together with the auto switch. Also perform periodic inspection and confirm proper operation.

5. Do not disassemble the product or make any modifications, including additional machining.

⚠️ Caution

1. Take precautions when multiple cylinders 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 separation of 40 mm. (When the allowable interval is specified for each series, use the indicated value.)

2. Take precautions for 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.
      • 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.
      \[
      \text{Supply voltage} - \text{Internal voltage drop of switch} > \text{Minimum operating voltage of load}
      \]
   <Solid state switch>
   3) Generally, the internal voltage drop will be great with a 2-wire solid state auto switch. Also, note that a 12 V DC 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.
   \[
   \text{Current to operate load} \rightarrow \text{Leakage current (OFF condition)}
   \]
   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.

4. Ensure sufficient clearance for maintenance activities.
   When designing an application, be sure to allow sufficient clearance for maintenance and inspections.
## Mounting and 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 (300m/s² or greater for reed switches and 1000m/s² or greater 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 tightening torque.**
   When a switch is tightened above the torque specification, the mounting screws, or switch may be damaged. On the other hand, tightening below the torque specification 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 positions shown in the catalogue indicate the optimum position at the stroke end.) If mounted at the end of the operating range (around the borderline of ON and OFF), operation will be unstable.

   **<D-M9>**
   When the D-M9 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, please 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 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 the 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 (such as 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 in conjunction 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 lines.

### Caution

1. **Avoid repeatedly bending or stretching lead wires.**
   Broken lead wires will result from repeatedly 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>**
   D-M9□, D-M9□W(V) and all models of PNP output type switches do not have built-in short circuit protection 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 brown [red] power supply line and the black [white] output line on 3-wire type switches.
Series MSZ
Auto Switch Precautions 3
Be sure to read before handling.

⚠️ Caution

4. Avoid incorrect wiring.
   <Reed switch>
   A 24 VDC switch with indicator light has polarity. The brown [red] lead wire is (+), and the blue [black] lead wire is (–).
   1) If connections are reversed, the switch will still operate, but the light emitting diode will not light up.
   Also note that a current greater than the maximum specified one will damage the light emitting diode and make it inoperable.
   Applicable models: D-A93, 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□, 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

<table>
<thead>
<tr>
<th>Model name</th>
<th>Model no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire stripper</td>
<td>D-M9N-SWY</td>
</tr>
</tbody>
</table>

* 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 the auto switch 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.
   The auto switch will malfunction or the magnets inside of an actuator will become demagnetised if used in such an environment.

3. Do not use in an environment where the auto switch will be continually exposed to water.
   The switch satisfies the IEC standard IP67 construction (JIS C 0920: watertight construction). Nevertheless, it should not be used in applications where it is continually exposed to water splash or spray. This may cause deterioration of the insulation or swelling of the potting resin inside switch causing a malfunction.

4. Do not use in an environment with oil or chemicals.
   Consult with SMC if the auto switch will be used in an environment with coolant, cleaning solvent, various oils or chemicals. If the auto switch is used under these conditions for even a short time, it may be adversely effected by a deterioration of the insulation, a 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 the switch is used where there are temperature cycles other than normal temperature changes, as they may adversely affected the switch 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 may malfunction and generate a signal momentarily (1 ms or less) or cut off. Consult with SMC regarding the need to use a solid state switch in a specific environment.

7. Do not use in an area where surges are generated.
   <Solid state switch>
   When there are units (such as solenoid type lifters, high frequency induction furnaces, motors, etc.) that generate a large amount of surge in the area around an actuator with a solid state auto switch, their proximity or pressure may cause deterioration or damage to the internal circuit of the switch. Avoid sources of surge generation and crossed lines.
**Auto Switch Precautions**

**Series MSZ**

Be sure to read before handling.

### Operating Environment

**Caution**

1. **Avoid accumulation of iron debris or close contact with magnetic substances.**
   
   When a large accumulated amount of ferrous waste such as machining chips or welding spatter, or a magnetic substance (something attracted by a magnet) is brought into close proximity to an actuator with auto switches, this may cause the auto switches to malfunction due to a loss of the magnetic force inside the actuator.

2. **Contact SMC for the water resistance ability, the elasticity ability of the lead wire, and the welding site etc.**

3. **Do not expose the product to direct sunlight for an extended period of time.**

4. **Do not use 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 the lead wires.
      - To prevent faulty insulation, replace switches or repair lead wires, etc., if damage is discovered.
   3) Confirm that the green light on the 2-colour display type switch lights up.
      - Confirm that the green LED is ON when stopped at the set position. If the red LED is ON, when stopped at the set position, the mounting position is not appropriate. Readjust the mounting position until the green LED lights up.

2. **Perform the maintenance procedures outlined in the instruction manual.**
   
   If the maintenance procedures are performed improperly, malfunction or damage to the machinery or equipment may occur.

3. **Removal of equipment, and supply/exhaust of compressed air.**
   
   When an equipment is serviced, first confirm that measures are in place to prevent workpieces from dropping run-away equipment, etc. Then cut the supply pressure and power, and exhaust all compressed air from the system using the residual pressure release function.
   
   When the equipment is operated after remounting or replacement, first confirm that measures are in place to prevent lurching of actuators, etc. Then confirm that the equipment is operating normally.
Operation which requires no stop at the centre position

**Caution**

1. End-to-end operation without stopping at the centre position includes situations such as decelerating or pausing around the centre position. Avoid use for applications in which speed change is a problem during end-to-end operation since the product may stop for max. 0.1s during high-speed rotation (0.2s/90) and for max. 0.5s during low-speed rotation (1s/90).

Breathing hole

**Caution**

1. The breathing holes located on the intermediate stopping part repeatedly absorb and release air. Care should be taken not to block the holes when mounting the product.

Mounting

**Caution**

1. Although any mounting direction is available with this product, when the gravity acting on the load acts in the direction of table rotation (e.g. the centre of gravity for the load and the rotation centre are not aligned when the rotation shaft is horizontal), stable rotation speed cannot be obtained.

In particular, since a meter-in speed controller controls the operation of rotating from the end to centre position, when the operating direction is the same as the direction the gravity acts on, then gravitational acceleration cannot be controlled, this may cause bouncing when it stops.

Backlash in the table at the centre position

**Caution**

1. Backlash in the table in the rotating direction can be controlled by adjusting the centre position properly. However, backlash (about 0.1) may occur as the rotation speed increases. If this causes any problems during operation, readjust the centre position.

Behaviour in the power-off condition

**Caution**

1. When a pressure-centre (PAB) type 3-position solenoid valve is used, the table as well as the solenoid valve return to the centre position when the power is cut due to blackouts, etc.

If the return position must be at a particular rotation end, either counterclockwise or clockwise when a blackout occurs, use two 3-port solenoid valves as shown below. Please refer to the table below for the solenoid valve type to be used.

<table>
<thead>
<tr>
<th>Reset position</th>
<th>Valve1</th>
<th>Valve2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counter clockwise rotation end</td>
<td>Normally closed</td>
<td>Normally open</td>
</tr>
<tr>
<td>Clockwise rotation end</td>
<td>Normally open</td>
<td>Normally closed</td>
</tr>
</tbody>
</table>

If the stopped position must be held when the power is cut, use two 5-port double solenoid valves as shown below. (Plug the port, A or B, that is not being used.)
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