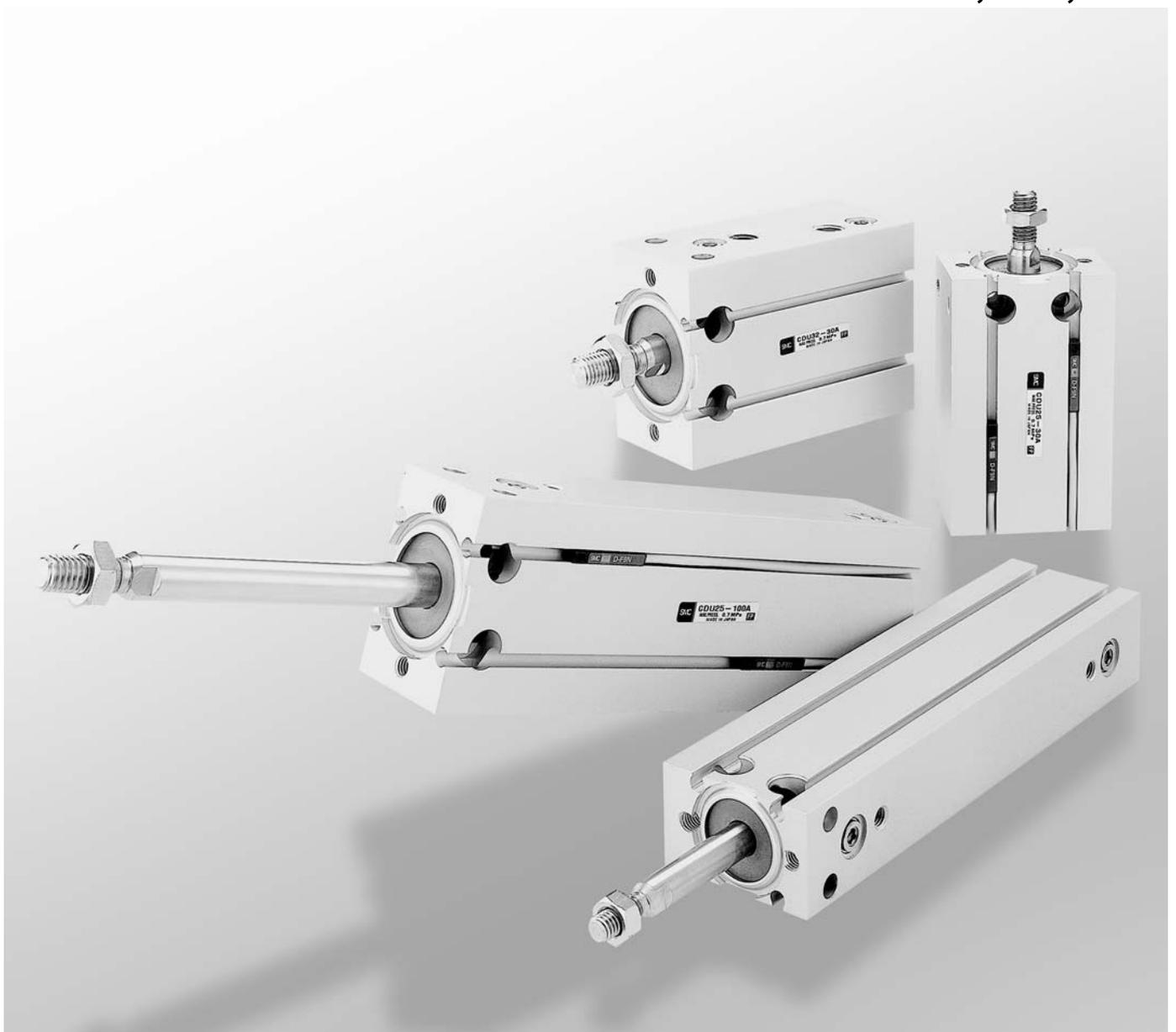


Free-Mounting Cylinder with Air Cushion

Series *CU*

Ø20, Ø25, Ø32



A unique air cushion mechanism has been added to our Series CU free-mounting cylinder.

Free-Mounting Cylinder with Air Cushion

Series CU

New air cushion mechanism

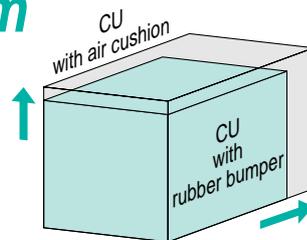


Free-mounting cylinder *Series CU* now employs an air cushion mechanism.

Extended dimensions (compared to the standard *CU* models) are hardly noticeable.

(with rubber bumper)

- Overall length: **+1.5 to 7mm**
- Overall height: **+0 to 2mm**
No air cushion protrusion!
- Overall width: not affected



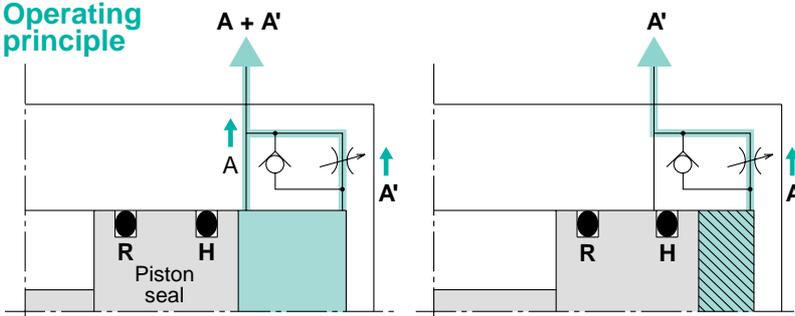
Bore size	Extended dimensions (mm)	
	Length	Height
ø20	7	2
ø25	1.5	0
ø32	4	0



Unique air cushion construction requires no cushion ring.

Elimination of the cushion ring used in conventional type air cushions has made it possible to reduce the overall length of the cylinder while retaining all the advantages of a compact profile.

Operating principle

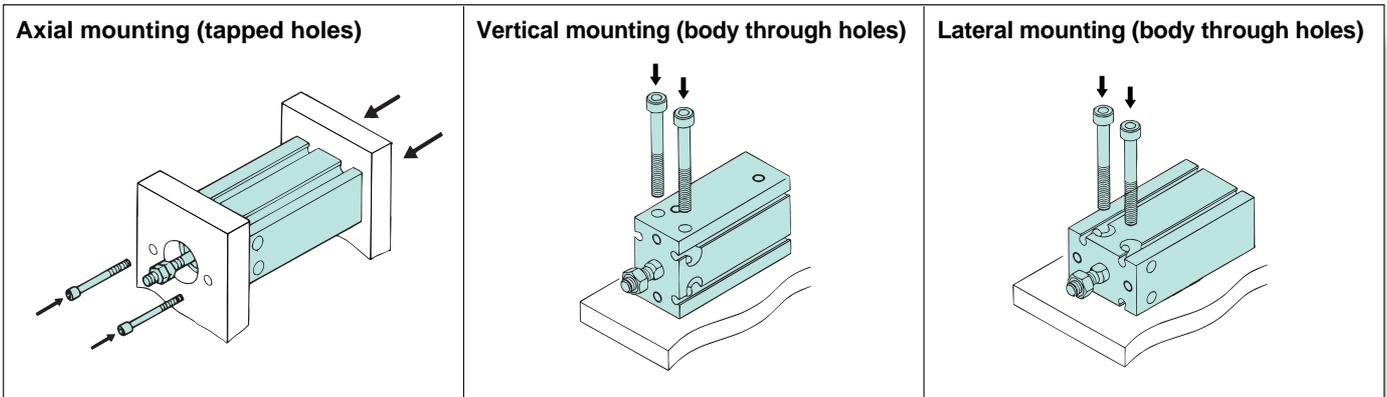


- ① When the piston is retracting, air is exhausted through both A and A' until piston seal H passes air passage A.
- ② After piston seal H has passed air passage A, air is exhausted only through A'. The section marked with slanted lines becomes a cushion chamber, and an air cushion effect is achieved.
- ③ When air is supplied for the piston extension, the check valve opens and the piston extends with no delay.

Reduced stroke end impact and noise: New standards to meet consumer demand.

Free-mounting

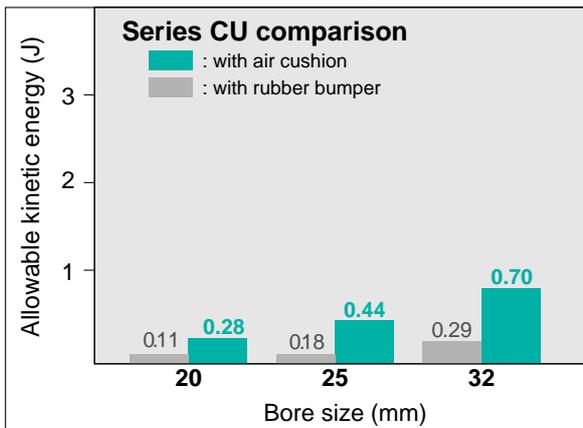
3 types of mounting orientations can be accommodated depending on the installation conditions.



Approximately 2.4 times of allowable kinetic energy

(Compared to the old Series CU with rubber bumper)

Improved allowable kinetic energy absorption.

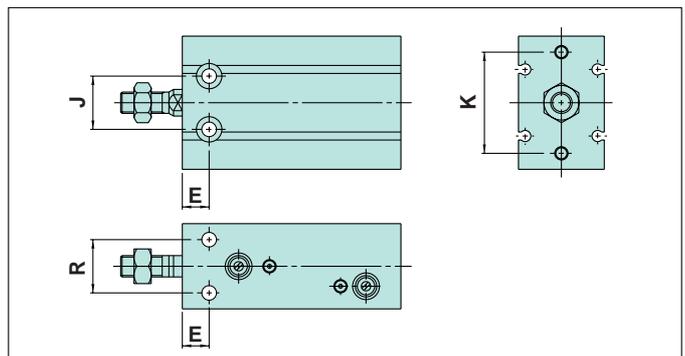


Improved sound insulation (Reduced impact noise at the stroke end)

- Noise reduction of more than 11dB is possible (compared to Series CU20 with rubber bumper).

Interchangeable mounting

Mounting dimensions (J, K, R, and E) are the same as the rubber bumper type Series CU.



Improved repeatability

When compared to rubber bumper type actuators, air cushion type cylinders are less likely to be affected by pressure fluctuations, and therefore better able to achieve a stable and smooth stroke.

Size variations

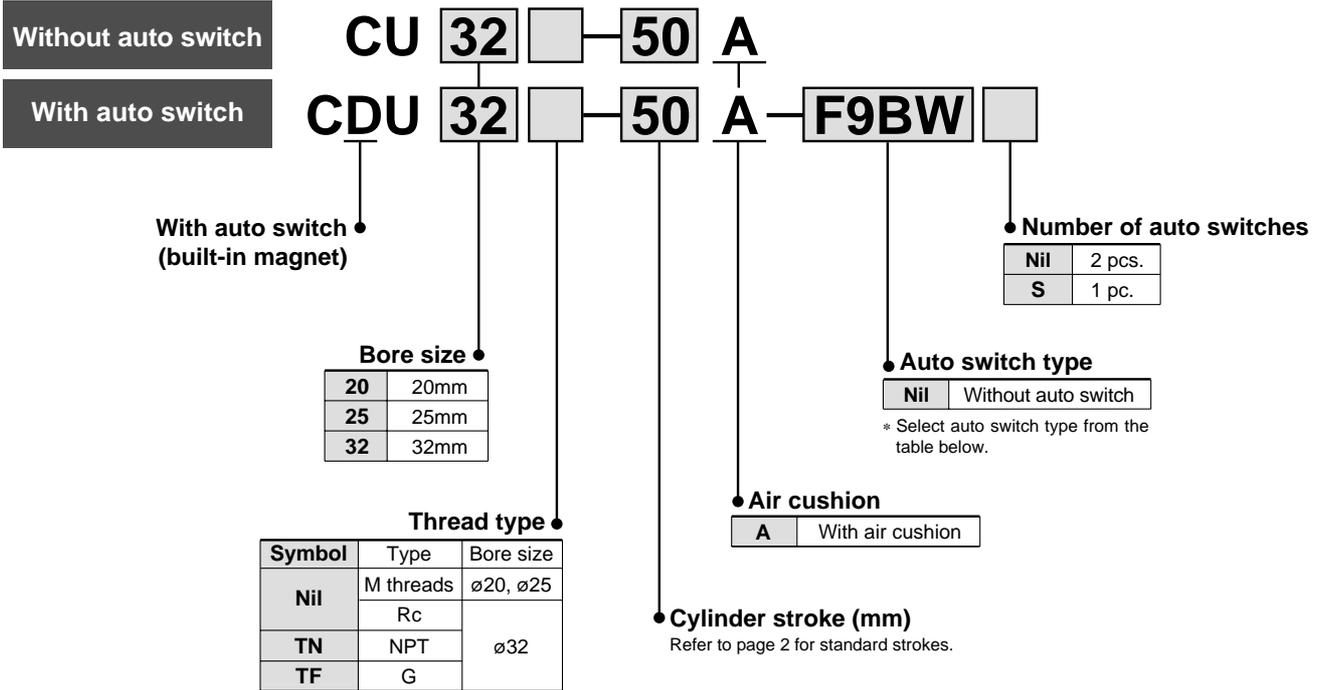
Model	Standard strokes									Auto switch
	20	30	40	50	60	70	80	90	100	
C(D)U20	●	●	●	●	●	●	●	●	●	<ul style="list-style-type: none"> • $\varnothing 20$ to $\varnothing 32$ • Direct mounting type auto switch
C(D)U25	●	●	●	●	●	●	●	●	●	
C(D)U32	●	●	●	●	●	●	●	●	●	

Free-Mounting Cylinder with Air Cushion

Series CU

∅20, ∅25, ∅32

How to Order



Auto switch specifications: Refer to pages 7 through 11 for detailed specifications of auto switch units.

Type	Special function	Electrical entry	Indicator light	Wiring (output)	Load voltage			Auto switch part no.		Lead wire length (m)*			Applicable load							
					DC	AC		Perpendicular	In-line	0.5 (Nil)	3 (L)	5 (Z)	IC circuit	Relay PLC						
Reed switch	—	Grommet	No	2-wire	24V	5V	100V	A90V	A90	●	●	—	IC circuit	Relay PLC						
			12V			100V	●								●	—				
			Yes	3-wire (NPN equiv.)	—	5V	—	A96V	A96	●	●	—	IC circuit	—						
Solid state switch	Diagnostic indication (2-colour display)	Grommet	Yes	3-wire (NPN)	24V	5V	—	F9NV	F9N	●	●	○	IC circuit	Relay PLC						
															3-wire (PNP)	12V	●	●	○	
															2-wire	12V	●	●	○	
															3-wire (NPN)	5V	●	●	○	IC circuit
															3-wire (PNP)					
															2-wire	12V	●	●	○	
															2-wire	12V	●	●	○	

* Lead wire length symbols: 0.5m Nil (Example) A93
 3m L A93L
 5m Z F9NWZ

Note) Solid state switches marked "○" are produced upon receipt of order.

These auto switches have been changed
 Contact SMC or view www.smcworld.com

F9N	⇒	M9N	F9NV	⇒	M9NV
F9P	⇒	M9P	F9PV	⇒	M9PV
F9B	⇒	M9B	F9BV	⇒	M9BV



Specifications

Type	Pneumatic (non-lube) type
Fluid	Air
Proof pressure	1.0MPa
Maximum operating pressure	0.7MPa
Minimum operating pressure	0.08MPa
Ambient and fluid temperature	Without auto switch: -10°C to 70°C (with no freezing) With auto switch: -10°C to 60°C (with no freezing)
Rod end thread	Male threads
Rod end thread tolerance	JIS class 2
Stroke length tolerance	+1.0 0
Piston speed	50 to 500mm/s

Effective Cushion Length

Bore size (mm)	20	25	32
Effective cushion length (mm)	6.6	6.7	7.7

Standard Strokes

Bore sizes (mm)	Standard strokes (mm)
20, 25, 32	20, 30, 40, 50, 60, 70, 80, 90, 100

* Intermediate strokes are also available upon receipt of order. Contact SMC.
Minimum stroke length is 20mm.

Tightening torque: Refer to the below table for mounting Series CU.

Bore sizes (mm)	Hexagon socket head cap screw size (mm)	Proper tightening torque (N·m)
20, 25	M5	5.10 ±10%
32	M6	8.04 ±10%

Allowable kinetic energy

Refer to "Selection" on page 19 regarding allowable kinetic energy.

Theoretical Output



Unit: N

Bore size (mm)	Operating direction	Operating pressure (MPa)		
		0.3	0.5	0.7
20	OUT	94.2	157	220
	IN	79.2	132	185
25	OUT	147	246	344
	IN	124	206	288
32	OUT	241	402	563
	IN	207	346	454

Weights

Basic weight

Unit: g

Bore size (mm)	Standard stroke (mm)								
	20	30	40	50	60	70	80	90	100
20	186	208	230	252	274	296	318	340	362
25	289	323	357	391	425	459	493	527	561
32	464	512	560	608	656	704	752	800	848

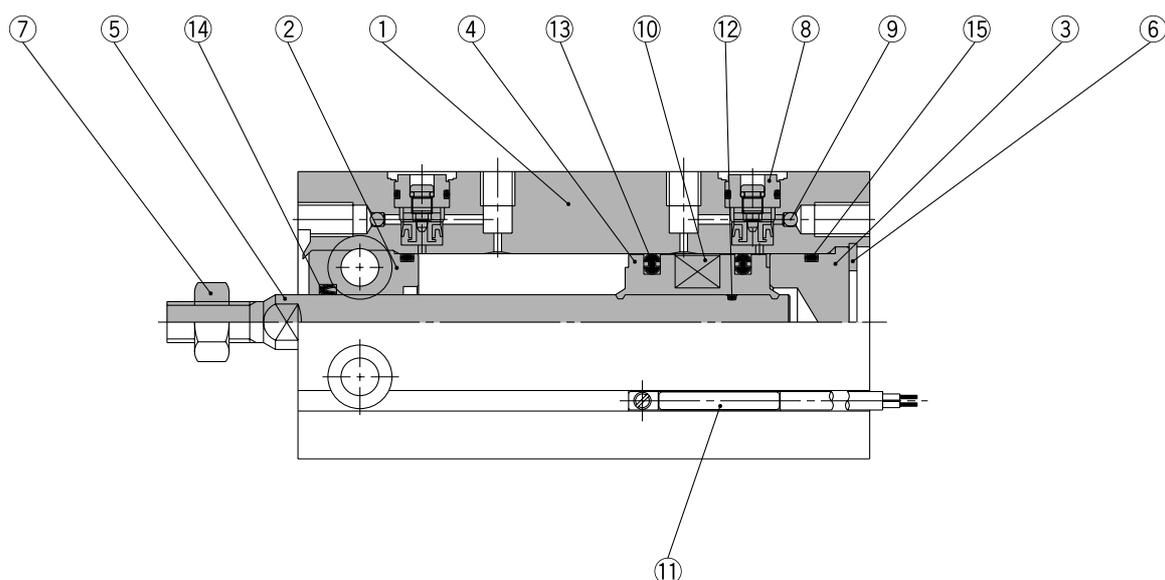
Additional weight

Unit: g

Bore size (mm)	Magnet
20	5
25	6
32	11

Series CU

Construction



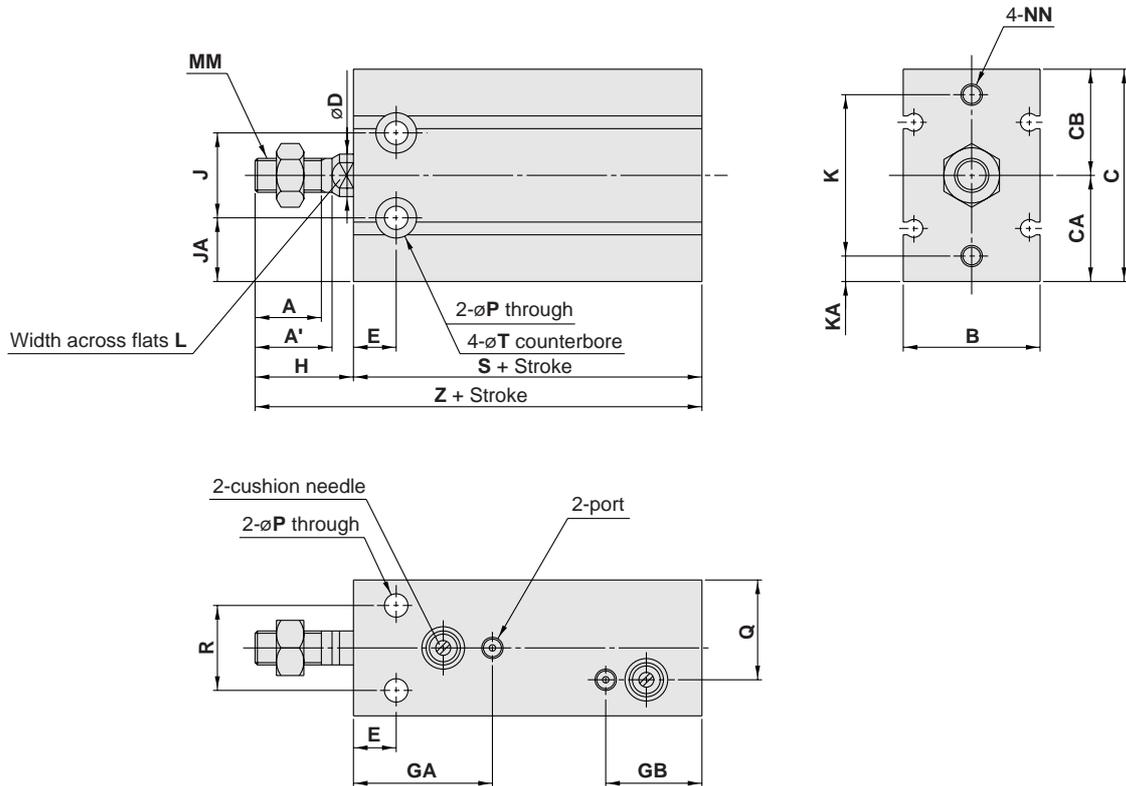
Parts list

No.	Description	Material	No. of pcs.	Note
1	Cylinder tube	Aluminum alloy	1	Hard anodized
2	Rod cover/Bearing	Aluminum alloy	1	Hard anodized
3	Head cover	Aluminum alloy	1	Clear chromated
4	Piston	Aluminum alloy	1	Chromated
5	Piston rod	Stainless steel	1	
6	Snap ring	Carbon tool steel	1	Phosphate coated
7	Rod end nut	Carbon steel	1	Nickel plated
8	Cushion needle assembly	—	(2)	
9	Steel ball	Carbon steel	2	
10	Magnet	Magnetic material	1	
11	Auto switch	—	(2)	D- $\frac{9}{16}$ type
12	Piston gasket	NBR	1	
13	Piston seal	NBR	2	
14	Rod seal	NBR	1	
15	Gasket	NBR	1	

Replacement parts: Seal kits

Bore size	Seal kit no.	Kit components
$\varnothing 20$	CU20A-PS	13, 14, and 15
$\varnothing 25$	CU25A-PS	
$\varnothing 32$	CU32A-PS	

Dimensions



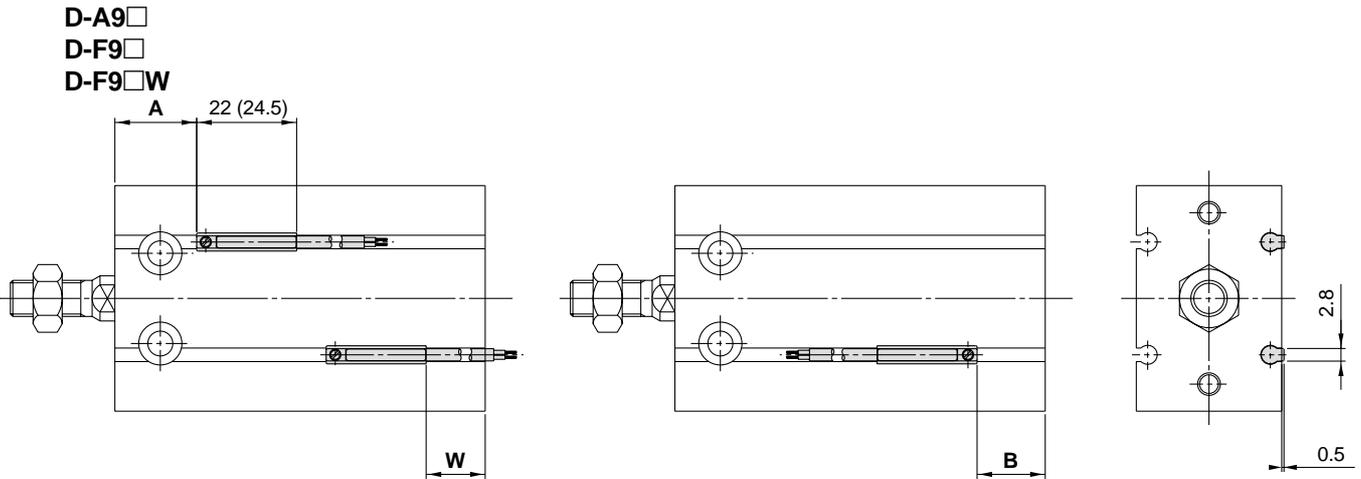
(mm)

Bore size (mm)	Port size	A	A'	B	C	CA	CB	D	E	GA	GB	H	J	JA
20	M5	12	14	26	42	20	22	8	9	29	27	19	16	12
25	M5	15.5	18	32	50	25	25	10	10	32.5	22.5	23	20	15
32	1/8	19.5	22	40	62	31	31	12	11	35	25	27	24	19

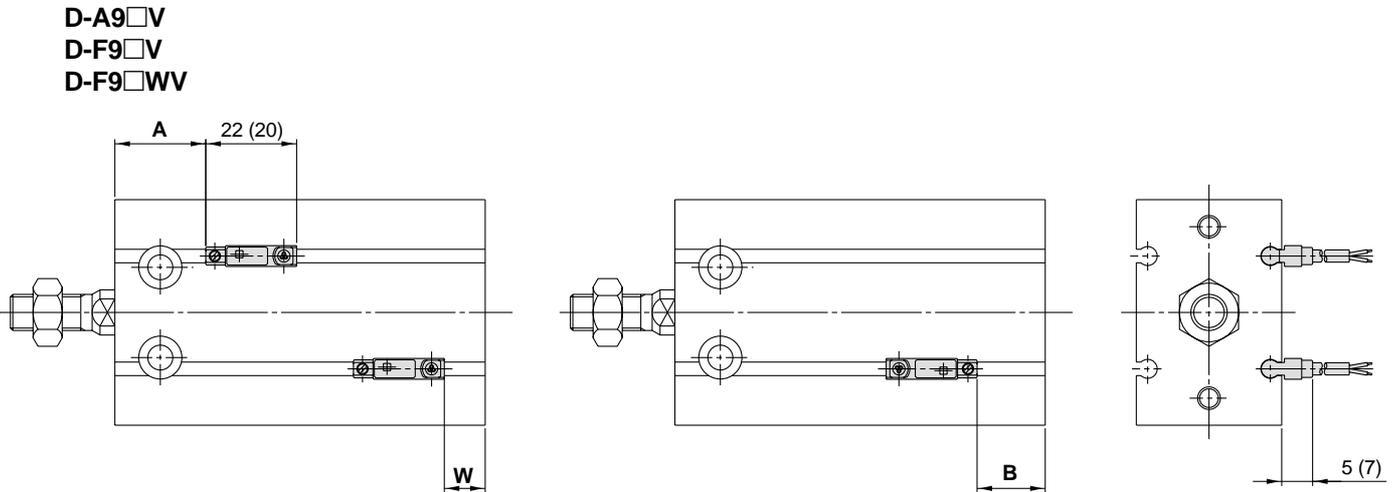
Bore size (mm)	K	KA	L	MM	NN	P	Q	R	T	S	Z	Standard strokes
20	30	5	5	M6	M5 with depth 8	5.5	13	16	9.3 with depth 8	53	72	20, 30, 40, 50, 60, 70, 80, 90, 100
25	38	6	6	M8	M5 with depth 8	5.5	23.5	20	9.3 with depth 9	51.5	74.5	
32	48	7	8	M10 x 1.25	M6 with depth 9	6.6	29	24	11 with depth 11.5	56	83	

Series CU

Auto Switch Proper Mounting Positions and Heights for Stroke End Detection



The dimension in () is for D-A93 type.



The dimension in () is for D-F9□V and D-F9□WV.

(mm)

Bore size (mm)	D-A9□, D-A9□V			D-F9□, D-F9□W			D-F9□V, D-F9□WV		
	A	B	W	A	B	W	A	B	W
20	18	15	13 (10.5)	22	19	9	22	19	11
25	20	11	9 (6.5)	24.5	15	5	24.5	15	7
32	22.5	13.5	11.5 (9)	26.5	17.5	7.5	26.5	17.5	9.5

* Values in () are dimensions for D-A93 type.

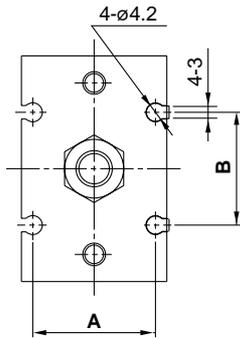
Operating Range

(mm)

Switch types	Bore size		
	20	25	32
D-A9□, D-A9□V	11	12.5	14
D-F9□, D-F9□V	6.5	7	7
D-F9□W, D-F9□WV			

* Values in this table include hysteresis and are to be used as a guide only. They do not guarantee an actual fixed range (expect approximately ±30% dispersion). Values may vary greatly depending on the operating environment.

Auto Switch Rail Position

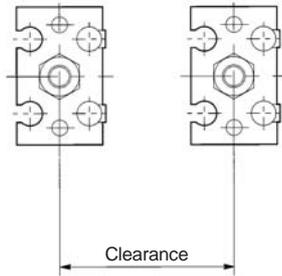


Bore size (mm)	A	B
20	21	23
25	27	25
32	35	27

(mm)

Caution – Proximity Installation

When free-mounting cylinders equipped with D-A9□ or D-F9□ type auto switches are used, be sure to provide an extra clearance in addition to what is suggested in the table at right. If the distance between two cylinders is less than the noted value, auto switches may malfunction. When for some reason you cannot avoid installing cylinders closer than the required clearance, install a steel plate or magnetic shield plate (MU-SO25) on the side of the cylinder facing the auto switches to shield them. (Contact SMC for details.) Auto switches may malfunction if a shielding plate is not used.



Bore size (mm)	Mounting clearance (mm)
20	40
25	46
32	56

Series CU

Auto Switch Specifications

Auto Switch Common Specifications

Type	Reed switch	Solid state switch
Leakage current	None	3-wire: 100 μ A or less; 2-wire: 0.8mA or less
Operating time	1.2ms	1ms or less
Impact resistance	30G/s ²	100G/s ²
Insulation resistance	50M Ω or more at 500VDC (between lead wire and case)	
Withstand voltage	1500VAC for 1 minute (between lead wire and case)	1000VAC for 1 minute (between lead wire and case)
Ambient temperature	-10° to 60°C	
Enclosure	IEC529 standard IP67, JIS C0920 watertight construction	

Lead Wire Length

Lead wire length indication

(Example) D-F9P **L**

Lead wire length

Nil	0.5m
L	3m
Z	5m

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

(Example) D-F9PL- **61**

Flexible wire specification

Contact Protection Box: CD-P11, CD-P12

<Applicable switch types>

D-A9□, D-A9□V

The above auto switches do not have built-in contact protection circuits.

A contact protection box should be used in any of the following conditions, otherwise, the life of the contacts may be reduced (They may stay on continuously):

1. Operated load is an induction load.
2. The length of wiring to the load is 5m or more.
3. The load voltage is 100VAC or 200VAC.

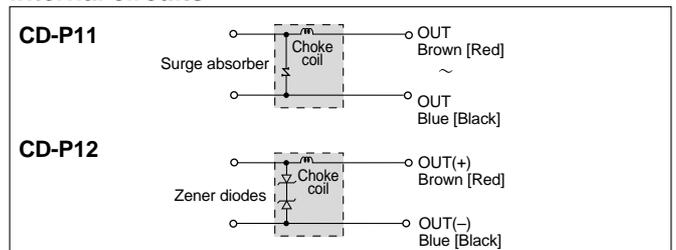
Specifications

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

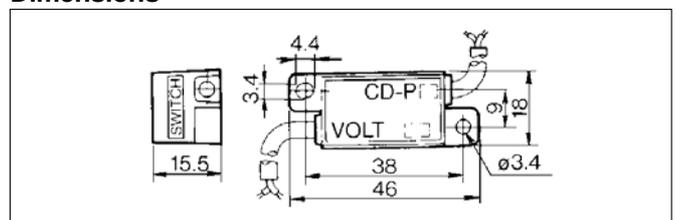
* Lead wire length — Switch connection side: 0.5m
Load connection side: 0.5m



Internal circuits



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.

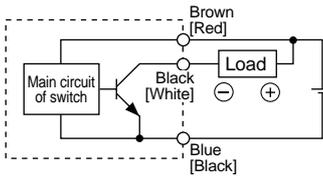
The switch unit should be kept as close as possible to the contact protection box with a lead wire that is no more than 1 meter in length.

Series CU

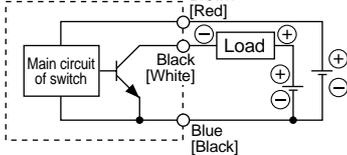
Auto Switch Connections and Examples

Basic Wiring

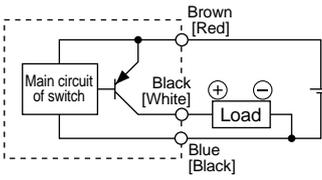
Solid state 3-wire, NPN



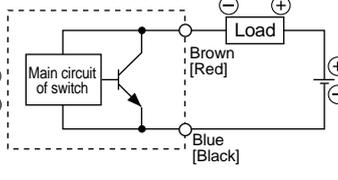
(Power supplies for switch and load are separate.)



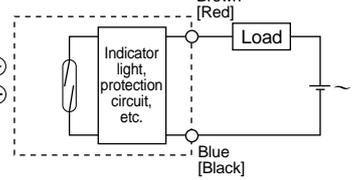
Solid state 3-wire, PNP



2-wire <Solid state>



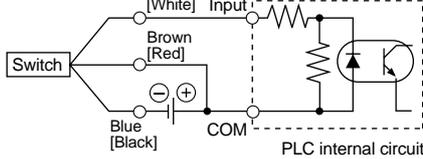
2-wire <Reed switch>



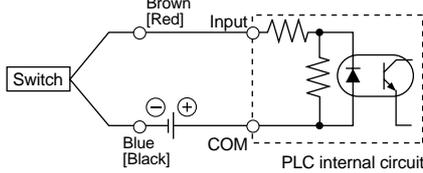
Examples of Connection to PLC

Sink input specifications

3-wire, NPN

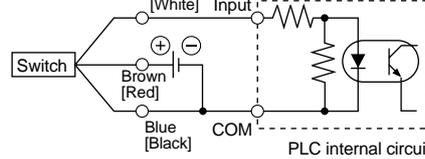


2-wire

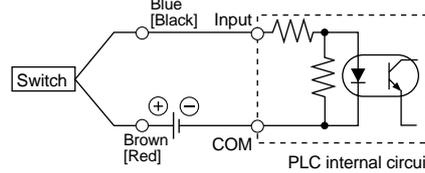


Source input specifications

3-wire, PNP



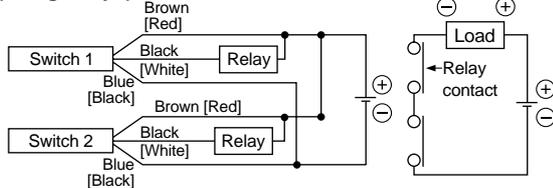
2-wire



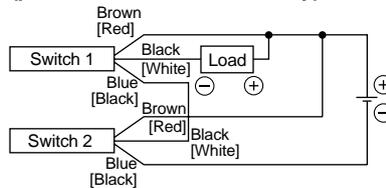
The connection method will vary depending on the applicable PLC input specifications.

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

3-wire AND connection for NPN output (using relays)

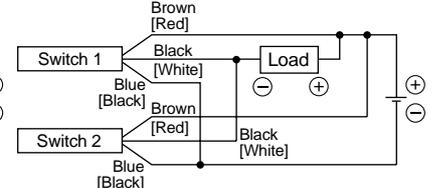


AND connection for NPN output (performed with switches only)

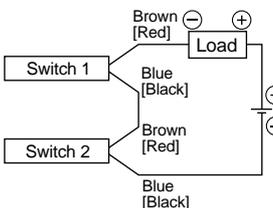


The indicator lights will light up when both switches are turned ON.

OR connection for NPN output



2-wire with 2-switch AND connection

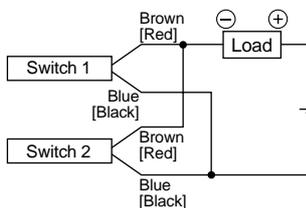


When two switches are connected in series, a load may malfunction because the load voltage will decline when in the ON state. The indicator lights will light up if both of the switches are in the ON state.

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

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

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 grow dim or not light up because of the dispersion and reduction of the current flowing to the switches.

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

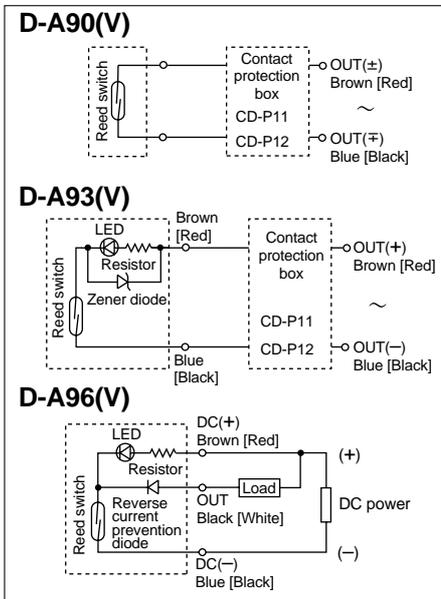
Example: Load impedance is 3kΩ
Leakage current from switch is 1mA

Reed Switches: Direct Mounting Type

D-A90(V), D-A93(V), D-A96(V)



Internal circuits



Specifications

Auto switch part no.	D-A90	D-A90V	D-A93	D-A93V	D-A96	D-A96V
Electrical entry direction	In-line	Perpendicular	In-line	Perpendicular	In-line	Perpendicular
Wiring type	2-wire			3-wire		
Applicable load	IC circuit, Relay, PLC		Relay, PLC		IC circuit	
Load voltage / Load current range and Max. load current	24V ^{AC} _{DC} or less/50mA 48V ^{AC} _{DC} or less/40mA 100V ^{AC} _{DC} or less/20mA		24VDC/5 to 40mA 100VAC/5 to 20mA		4 to 8VDC/20mA	
Contact protection circuit	None					
Internal resistance / Internal voltage drop	1Ω or less (includes 3m lead wire length)		2.4V or less (to 20mA) 3V or less (to 40mA)		2.7V or less 0.8V or less	
Indicator light	None		Red LED lights when ON			

- **Lead wire** Oil proof heavy duty vinyl cord: $\phi 2.7$, 0.5m
 D-A90(V), D-A93(V): 0.18mm² x 2 cores (Brown, Blue [Red, Black])
 D-A96(V): 0.15mm² x 3 cores (Brown, Black, Blue [Red, White, Black])

Note) Refer to page 7 for auto switch common specifications and lead wire length.

Weights

(g)

Auto switch part no.	D-A90	D-A90V	D-A93	D-A93V	D-A96	D-A96V
Lead wire length: 0.5m	7	7	6	7	8	8
Lead wire length: 3m	35	35	30	35	41	41

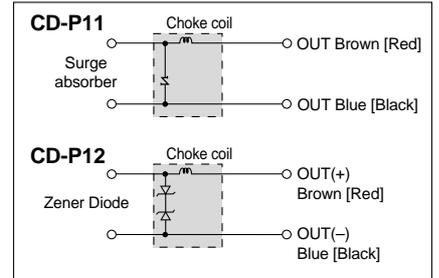
Contact Protection Box

Type D-A9 switches do not have built-in contact protection circuits. Use a contact protection box with an induction load, when lead wires are 5 meters or longer, or with 100VAC.

Part no.	Voltage	Lead wire length
CD-P11	100VAC	Switch connection side: 0.5m
CD-P12	24VDC	Load connection side: 0.5m

Since D-A90(V) type switches have no particular specified voltage below 100VAC, select a switch type based on the voltage being used.

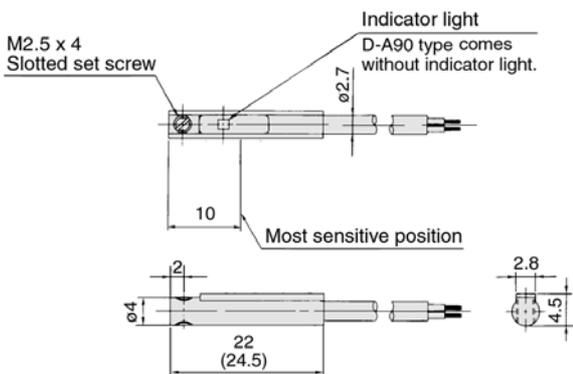
Contact protection box internal circuits



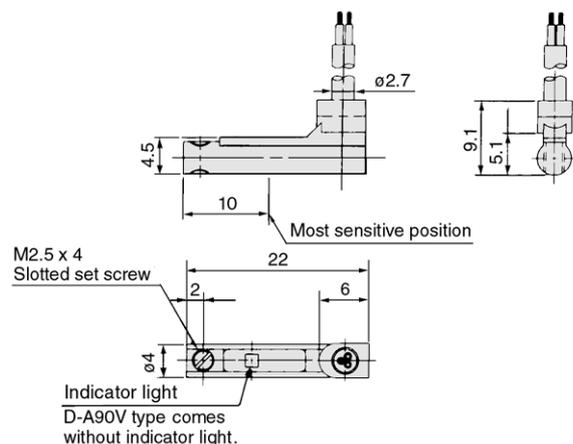
Dimensions

D-A9□

D-A9□V



The dimension inside () is for D-A93.



Solid State Switches: Direct Mounting Type

D-F9N(V), D-F9P(V), D-F9B(V)

Grommet



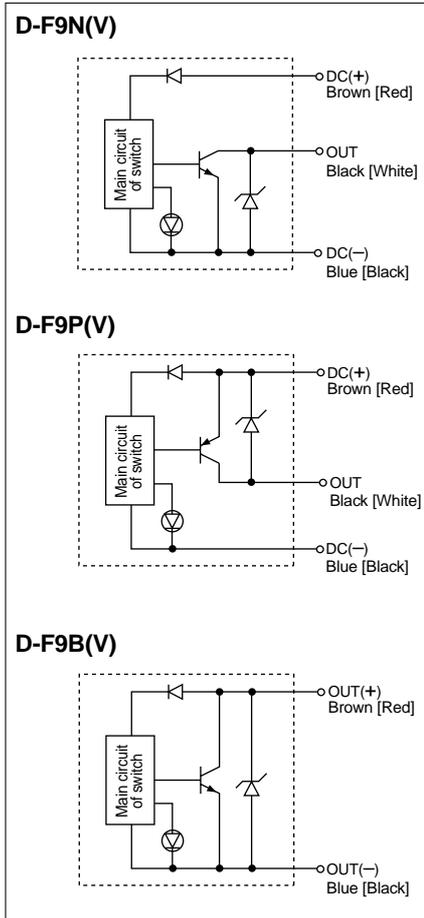
Specifications

D-F9□, D-F9□V (with indicator light)						
Auto switch part no.	D-F9N	D-F9NV	D-F9P	D-F9PV	D-F9B	D-F9BV
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				24VDC relay, PLC	
Power supply voltage	5, 12, 24VDC (4.5 to 28V)				—	
Current consumption	10mA or less				—	
Load voltage	28VDC or less		—		24VDC (10 to 28VDC)	
Load current	40mA or less		80mA or less		5 to 40mA	
Internal voltage drop	1.5V or less (0.8V or less at 10mA load current)		0.8V or less		4V or less	
Leakage current	100μA or less at 24VDC				0.8mA or less	
Indicator light	Red LED lights when ON					

- **Lead wire** Oil proof heavy duty vinyl cord: $\phi 2.7$, 0.5m
 D-F9N(V), D-F9P(V): 0.18mm² x 3 cores (Brown, Black, Blue [Red, White, Black])
 D-F9B(V): 0.15mm² x 2 cores (Brown, Blue [Red, Black])

Note) Refer to page 7 for auto switch common specifications and lead wire length.

Internal circuits



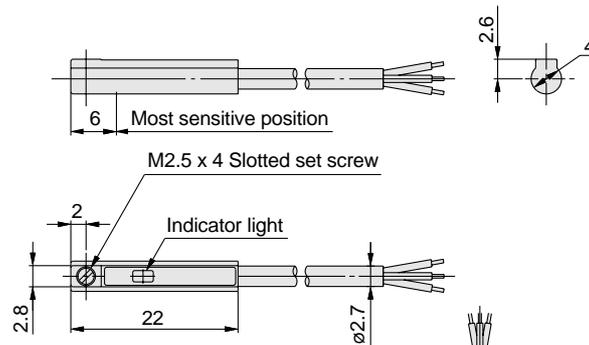
Weights

(g)

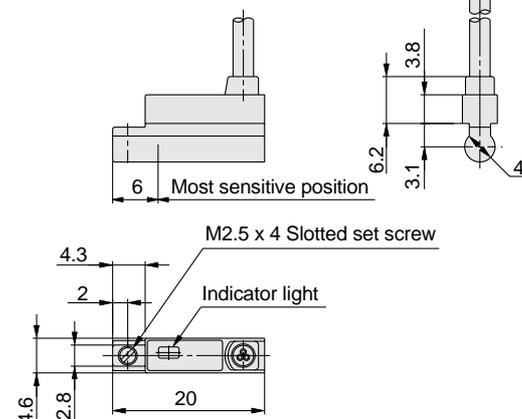
Auto switch part no.	D-F9N(V)	D-F9P(V)	D-F9B(V)
Lead wire length (m)	0.5	7	7
	3	37	37
	5	61	61

Dimensions

D-F9□



D-F9□V



Solid State Switches: Direct Mounting Type

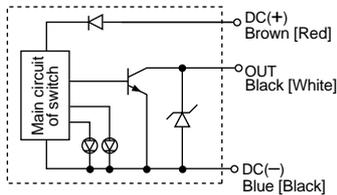
D-F9NW(V), D-F9PW(V), D-F9BW(V)

Grommet

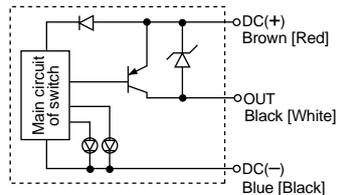


Internal circuits

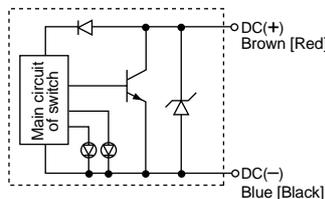
D-F9NW(V)



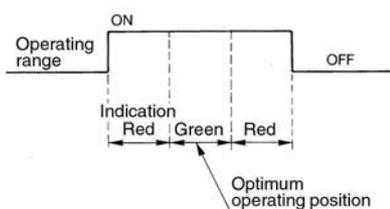
D-F9PW(V)



D-F9BW(V)



Indicator light



Specifications

D-F9□W, D-F9□WV (with indicator light)						
Auto switch part no.	D-F9NW	D-F9NWV	D-F9PW	D-F9PWV	D-F9BW	D-F9BWV
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				24VDC relay, PLC	
Power supply voltage	5, 12, 24VDC (4.5 to 28VDC)				—	
Current consumption	10mA or less				—	
Load voltage	28VDC or less		—		24VDC (10 to 28VDC)	
Load current	40mA or less		80mA or less		5 to 40mA	
Internal voltage drop	0.8V or less at 10mA load current 1.5V or less		0.8V or less		4V or less	
Leakage current	100μA or less at 24VDC				0.8mA or less	
Indicator light	Operating position Red LED lights up Optimum operating position ... Green LED lights up					

- Lead wire Oil proof heavy duty vinyl cord: $\phi 2.7$, 0.5m
D-F9NW(V), D-F9PW(V): 0.18mm² x 3 cores (Brown, Black, Blue [Red, White, Black])
D-F9BW(V): 0.15mm² x 2 cores (Brown, Blue [Red, Black])

Note) Refer to page 7 for auto switch common specifications and lead wire length.

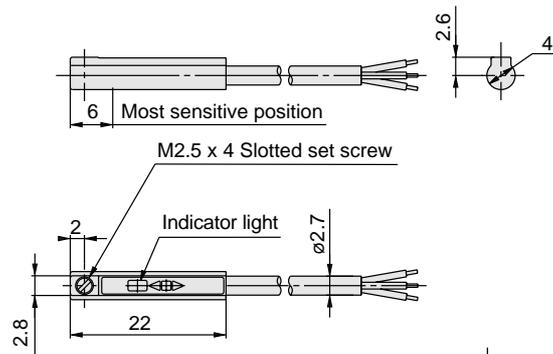
Weights

(g)

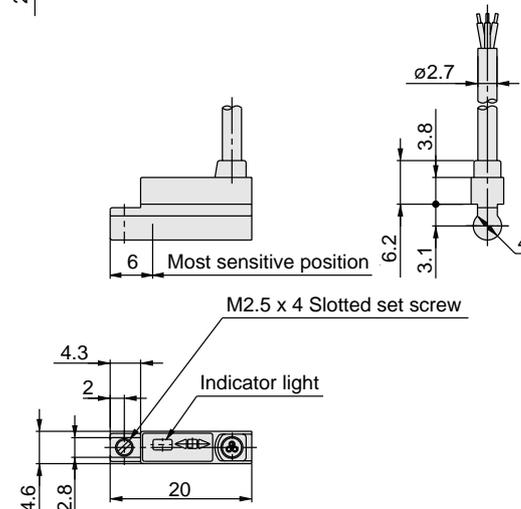
Auto switch part no.	D-F9NW(V)	D-F9PW(V)	D-F9BW(V)
Lead wire length (m)	0.5	7	7
	3	34	34
	5	56	56

Dimensions

D-F9□W



D-F9□WV





Series CU

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 a label of "**Caution**", "**Warning**", or "**Danger**". To ensure safety, be sure to observe ISO 4414 Note 1), JIS B 8370 Note 2) and other safety practices.

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

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

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

Note 1) ISO 4414: Pneumatic fluid power – Recommendations for the application of equipment to transmission and control systems.

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

⚠ Warning

1. The compatibility of pneumatic equipment is the responsibility of the person who designs the pneumatic system or decides its specifications.

Since the products specified here are used in various operating conditions, their compatibility with the specific pneumatic system must be based on specifications or after analysis and/or tests to meet your specific requirements.

2. Only trained personnel should operate pneumatically operated machinery and equipment.

Compressed air can be dangerous if an operator is unfamiliar with it. Assembly, handling or repair of pneumatic systems should be performed by trained and experienced operators.

3. Do not service machinery/equipment or attempt to remove components until safety is confirmed.

1. Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.

2. When equipment is to be removed, confirm the safety process as mentioned above. Cut the supply pressure for this equipment and exhaust all residual compressed air in the system.

3. Before machinery/equipment is restarted, take measures to prevent shooting-out of cylinder piston rod, etc. (Bleed air into the system gradually to create back pressure.)

4. Contact SMC if the product is to be used in any of the following conditions:

1. Conditions and environments beyond the given specifications, or if product is used outdoors.

2. Installation on equipment in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverages, recreation equipment, emergency stop circuits, press applications, or safety equipment.

3. An application which has the possibility of having negative effects on people, property, or animals, requiring special safety analysis.



Series CU

Actuator Precautions 1

Be sure to read before handling.

Design

Warning

1. **There is a danger of sudden or erratic action by cylinders if sliding parts of machinery are twisted and changes in forces occur.**

In such cases, bodily injury may occur, e.g., by catching hands or feet in the machinery, or damage to the machinery itself may occur. Therefore, the machinery should be adjusted to operate smoothly and designed to prevent such dangers.

2. **A protective cover is recommended to minimize the risk of personal injury.**

If a driven object and moving parts of a cylinder pose a serious danger of bodily injury, design the structure to avoid contact with the human body.

3. **Securely tighten all stationary parts and connected parts so that they will not become loose.**

Especially when a cylinder operates with high frequency or is installed where there is a lot of vibration, ensure that all parts remain secure.

4. **A deceleration circuit or shock absorber may be required.**

When a driven object is operated at high speed or the load is heavy, a cylinder's cushion will not be sufficient to absorb the impact. Install a deceleration circuit to reduce the speed before cushioning, or install an external shock absorber to relieve the impact. In this case, the rigidity of the machinery should also be examined.

5. **Take into account a possible drop in operating pressure due to a power outage.**

When a cylinder is used as a clamping mechanism, there is a danger of work pieces dropping if there is a decrease in clamping force due to a drop in circuit pressure caused by a power outage. Therefore, safety equipment should be installed to prevent damage to machinery and bodily injury. Suspension mechanisms and lifting devices also require drop prevention measures.

6. **Take into account a possible loss of power source.**

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

7. **Design circuitry to prevent sudden lurching of driven objects.**

Take special care when a cylinder is operated by an exhaust center type directional control valve or when it is starting up after residual pressure is exhausted from the circuit. The piston and its driven object will lurch at high speed if pressure is applied to one side of the cylinder because of the absence of air pressure inside the cylinder. Therefore, equipment should be selected and circuits designed to prevent sudden lurching because of the danger of bodily injury, particularly to limbs, and/or damage to equipment when this occurs.

8. **Take into account emergency stops.**

Design the system so that bodily injury and/or damage to machinery and equipment will not occur when machinery is stopped by a manual emergency stop or a safety device triggered by abnormal conditions.

Design

Warning

9. **Consider the action when operation is restarted after an emergency stop or an abnormal stop.**

Design machinery so that bodily injury or equipment damage will not occur upon restart of operation.

When the cylinder has to be reset at the starting position, install safe manual control equipment.

Selection

Warning

1. **Confirm the specifications.**

The products featured in this catalog are designed for use in industrial compressed air systems. If the products are used in conditions where pressure and/or temperature are outside the range of specifications, damage and/or malfunctions may occur. Do not use in these conditions. (Refer to specifications.)

Consult with SMC if fluid other than compressed air to be used.

2. **Intermediate stops**

When intermediate stopping of a cylinder piston is performed with a 3-position closed center type directional control valve, it is difficult to achieve stopping positions as accurately and precisely as with hydraulic pressure due to the compressibility of air.

Furthermore, since valves and cylinders are not guaranteed for zero air leakage, it may not be possible to hold a stopped position for an extended period of time. Contact SMC in case it is necessary to hold a stopped position for an extended period.

Caution

1. **Operate within the limits of the maximum usable stroke.**

The piston rod will be damaged if operated beyond the maximum stroke. Operate within the standard stroke range.

2. **Operate the piston in such a way that collision damage will not occur at the stroke end.**

3. **Use a speed controller to adjust the cylinder drive speed, gradually increasing from a low speed to the desired speed setting.**



Series CU

Actuator Precautions 2

Be sure to read before handling.

Mounting

⚠ Caution

1. **Be certain to align the rod center of the piston axis with the load and direction of movement when connecting.**

When a cylinder is not properly aligned, the rod and tube may be twisted. This can cause wear on areas such as the inner tube surface, bushings, rod surface, seals, and cause damage to these areas.

2. **When an external guide is used, connect the piston rod end and the load in such a way that there is no interference at any point within the stroke.**
3. **Do not scratch or gouge the cylinder tube or the sliding parts of the piston rod by striking or grasping them with other objects.**

Cylinder bores are manufactured to precise tolerances, so that even a slight deformation may cause faulty operation. Also, scratches or gouges in the piston rod may lead to damaged seals and cause air leakage.

4. **Prevent the sticking (through friction) of rotating parts.**

Prevent the sticking of rotating parts (pins etc.) by applying grease.

5. **Do not use until you can verify that equipment can operate properly.**

Following mounting, repairs, or conversions, verify correct mounting by conducting suitable function and leakage tests after piping and power connections have been made.

6. **Instruction manual**

The product should be mounted and operated after thoroughly reading the manual and understanding its contents.

Keep the instruction manual where it can be readily referred to as needed.

Piping

⚠ Caution

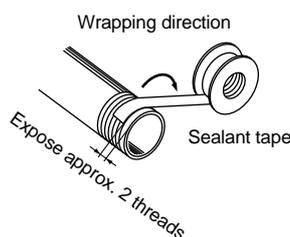
1. **Preparation before piping**

Before piping is connected, it should be thoroughly flushed out with air or water to remove chips, cutting oil, and other debris.

2. **Wrapping of sealant tape**

When screwing together pipes and fittings, be certain that chips from the pipe threads and sealing material do not get inside the piping.

Also, when sealant tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



Cushion

⚠ Caution

1. **Readjust using the cushion needle.**

Cushion needles are fully closed at the time of shipment. When the cylinder is put into service, the cushion needles should be readjusted based on factors such as the size of the load and the operating speed. When the cushion needles are turned clockwise, restriction of the air flow becomes greater and thus the cushion effect also increases.

2. **Do not operate with the cushion needles fully closed.**
3. **Adjust the cushion needles by gradually opening from the closed condition to a desired cushion speed.**

Lubrication

⚠ Caution

1. **Lubrication of non-lube type cylinder**

The cylinder is lubricated for life at the factory and can be used without any further lubrication.

However, in the event that the cylinder is lubricated additionally, be sure to use class 1 turbine oil (with no additives) ISO VG32.

Stopping lubrication later may lead to malfunctions because the new lubricant will cancel out the original lubricant. Therefore, lubrication must be continued once it has been started.

Air Supply

⚠ Warning

1. **Use clean air.**

Do not use compressed air containing chemicals, synthetic oils containing organic solvents, salt, or corrosive gases, as this can cause damage or malfunctions.

⚠ Caution

1. **Install air filters.**

Install air filters at the inlet side of valves. The filtration degree should be 5 μ m or finer.

2. **Install an after-cooler, air dryer, or water separator (Drain Catch).**

Air that includes excessive drainage or condensate may cause malfunction of valves and other pneumatic equipment. To prevent this, install an after-cooler, air dryer, or water separator (Drain Catch).

3. **Use the product within the specified range of fluid and ambient temperature.**

Take measures to prevent freezing when below 5°C, since moisture in circuits can freeze and cause damage to seals and lead to malfunctions.

Refer to SMC's "Air Preparation System" catalog for further details on compressed air quality.



Series CU

Actuator Precautions 3

Be sure to read before handling.

Operating Environment

Warning

1. Do not use in environments where there is a danger of corrosion.
2. In dusty conditions or where water or oil splashing is a regular occurrence, protect the rod by installing a rod cover.
3. When using auto switches, do not operate in an environment where there are strong magnetic fields.

Maintenance

Warning

1. Perform maintenance inspection and service according to the procedures indicated in the instruction manual.

Improper handling and maintenance may cause malfunctioning and damage of machinery or equipment to occur.

2. Removal of components 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.

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

Caution

1. Filter drainage

Drain out condensate from air filters regularly.



Series CU

Auto Switch Precautions 1

Be sure to read before handling.

Design and Selection

Warning

1. Confirm the specifications.

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

2. Take precautions when multiple cylinders are used close together.

When two or more auto switch cylinders are lined up in close proximity to each other, magnetic field interference may cause the switches to malfunction. Maintain a minimum cylinder separation of 40mm. (When the allowable interval is specified for each cylinder series, use the indicated value.)

3. Monitor the length of time that a switch is on at an intermediate stroke position.

When an auto switch is placed at an intermediate position of the stroke and a load is driven at the time the piston passes, the auto switch will operate, but if the speed is too great the operating time will be shortened and the load may not operate properly. The maximum detectable piston speed is:

$$V(\text{mm/s}) = \frac{\text{Auto switch operating range (mm)}}{\text{Load operating time (ms)}} \times 1000$$

4. Keep wiring as short as possible.

<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.)

Use a contact protection box when the wire length is 5m or longer.

<Solid state switches>

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

5. Monitor the internal voltage drop of the switch.

<Reed switches>

1) Switches with an indicator light (except D-A96, D-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.

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

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

<Solid state switches>

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) above.

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

6. Monitor leakage current.

<Solid state switches>

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.

If the condition given in the below formula is not met, the switch will not reset correctly (it stays on).

$$\text{Current to operate load (off condition)} > \text{Leakage current}$$

Use a 3-wire switch if this condition cannot be satisfied.

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

7. Do not use a load that generates surge voltage.

<Reed switches>

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

<Solid state switches>

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.

8. Cautions for use in an interlock circuit

When an auto switch is used for an interlock signal requiring high reliability, devise a double interlock system to safeguard against malfunctions by providing a mechanical protection function, or by also using another switch (sensor) together with the auto switch.

Also, perform periodic maintenance inspections and confirm proper operation.

9. Ensure sufficient clearance for maintenance activities.

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



Series CU

Auto Switch Precautions 2

Be sure to read before handling.

Mounting and Adjustment

⚠ Warning

1. Do not drop or bump.

Do not drop, bump, or apply excessive impacts (300m/s² or more for reed switches and 1000m/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.

2. Do not carry a cylinder 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.

3. Mount switches using the proper tightening torque.

When a switch is tightened beyond the range of tightening torque, the mounting screws, mounting bracket, or switch may be damaged.

On the other hand, tightening below the range of tightening torque may allow the switch to slip out of position.

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

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

Wiring

⚠ Warning

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. 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.

4. 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 other lines.

Wiring

⚠ Warning

5. Do not allow short circuiting of loads.

<Reed switches>

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 switches>

D-F9□(V), D-F9□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.

6. Avoid incorrect wiring.

<Reed switches>

A 24VDC 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 a light emitting diode and make it inoperable.

Applicable models: D-A93, D-A93V

<Solid state switches>

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

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

* Lead wire colour changes

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

2-wire			3-wire		
	Old	New		Old	New
Output (+)	Red	Brown	Power supply (+)	Red	Brown
Output (-)	Black	Blue	Power supply GND	Black	Blue
			Output	White	Black
Solid state with diagnostic output			Solid state with latch type diagnostic output		
	Old	New		Old	New
Power supply (+)	Red	Brown	Power supply (+)	Red	Brown
Power supply GND	Black	Blue	Power supply GND	Black	Blue
Output	White	Black	Output	White	Black
Diagnostic output	Yellow	Orange	Latch type diagnostic output	Yellow	Orange



Series CU

Auto Switch Precautions 3

Be sure to read before handling.

Operating Environment

Warning

1. Never use in the presence of explosive gases.

The construction of our auto switches does not make them explosionproof. Never use them in the presence of an explosive gas, as 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 cylinders will become demagnetized if used in such an environment. (Consult with SMC regarding the availability of magnetic field resistant auto switches.)

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

Switches satisfy IEC standard IP67 construction (JIS C0920: watertight construction). Nevertheless, they should not be used in applications where they are continually exposed to water splash or spray. This may cause deterioration of the insulation or swelling of the potting resin inside switches and may lead to a malfunction.

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

Consult with SMC if auto switches will be used in an environment laden with coolants, cleaning solvents, various oils or chemicals. If auto switches are used under these conditions for even a short time, they may be adversely affected by 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 switches are to be 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 switches>

When excessive impact (300m/s² or more) is applied to a reed switch during operation, the contact point may malfunction and generate or cut off a signal momentarily (1ms or less). Consult with SMC regarding the need to use a solid state switch depending on the 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) that generate a large amount of surge in the area around cylinders with solid state auto switches, their proximity or pressure may cause deterioration or damage to the internal circuit elements of the switches. Avoid and protect against sources of surge generation and crossed lines.

8. Avoid close contact with accumulated iron waste or 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 cylinder with auto switches, this may cause the auto switches to malfunction due to a loss of the magnetic force inside the cylinder.

Maintenance

Warning

1. Perform the following maintenance inspection and services 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 screws securely after readjusting the mounting position.

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

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

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

Confirm that the Green LED is ON 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.

Other

Warning

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



Series CU Specific Product Precautions

Be sure to read before handling.

Refer to pages 12 through 18 for Safety Instructions, Actuator Precautions, and Auto Switch Precautions.

Installation and Removal of Snap Rings

⚠ Caution

1. Use appropriate pliers (C-type snap ring installing tool) for installation and removal of snap rings.
2. Even when using appropriate pliers (C-type snap ring installing tool), proceed with caution as there is a danger of the snap ring flying off the end of the pliers (tool) and causing bodily injury or damage to nearby equipment. After installation, make sure that the snap ring is securely seated into the snap ring groove before supplying air.

Mounting

⚠ Caution

1. Refer to the below table for mounting cylinders.

Tightening torque

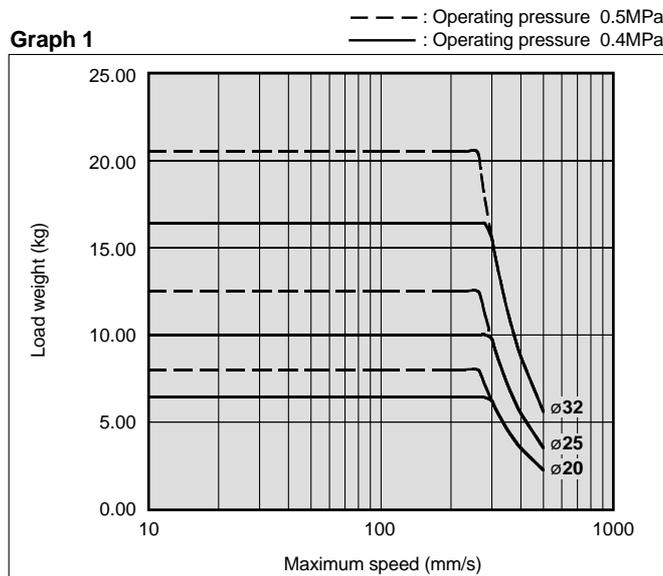
Bore sizes (mm)	Hexagon socket head cap screw (mm)	Proper tightening torque (N·m)
20, 25	M5	5.10 ±10%
32	M6	8.04 ±10%

Selection

⚠ Caution

1. Operate the cylinder to the stroke end.
When the stroke is restricted by an external stopper or a clamped work piece, sufficient cushioning and noise reduction may not be achieved.
2. Strictly observe the limiting ranges for load weight and maximum speed (Graph 1). Also, the limiting ranges provided here are based on the condition that the cylinder is operated to the stroke end with a proper cushion needle adjustment.

If operated beyond the limiting ranges, excessive impact will occur and this may cause damage to equipment.



Selection

⚠ Caution

3. Adjust the cushion needle to reduce excessive kinetic energy from the piston impact at the stroke end by allowing it to absorb sufficient kinetic energy during the cushion stroke.

If due to improper adjustment, the piston impacts the stroke end with excessive kinetic energy (values above those given in Table 1), an excessive impact will occur and this may cause damage to equipment.

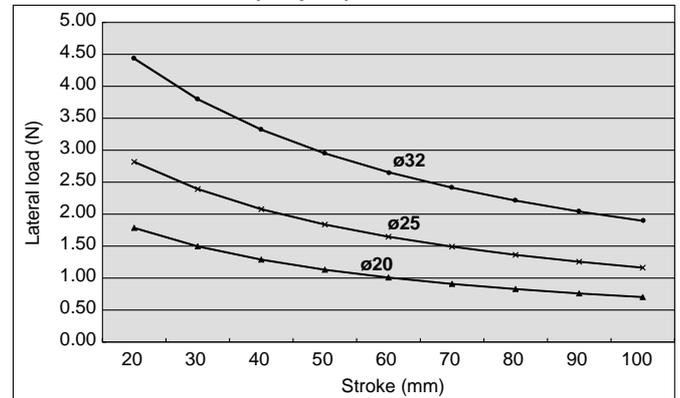
Table 1. Allowable kinetic energy at piston impact Unit: J

	20	25	32
Piston speed	50 to 500mm/s		
Allowable kinetic energy	0.055	0.09	0.15

4. Strictly observe the limiting ranges for the piston rod lateral load (Graph 2).

If operated beyond the limiting ranges, equipment life may be reduced or damage to equipment may occur.

Piston rod lateral load (Graph 2)



Cushion Needle Adjustment

⚠ Caution

1. Keep the adjustment range for the cushion needle between the fully closed position and the rotations shown below.

	Rotations
ø20 to ø32	2.5 rotations or less

Use a 3mm flat head watchmakers screwdriver to adjust the cushion needle. The adjustment range for the cushion needle must be between the fully closed position and the open position ranges indicated in the above table. A retaining mechanism prevents the cushion needle from slipping out; however, it may spring out during operation if it is rotated beyond the ranges shown above.