CAT.ES20-160 A

SMC

Mini-Rotary Actuator

Series CRJ

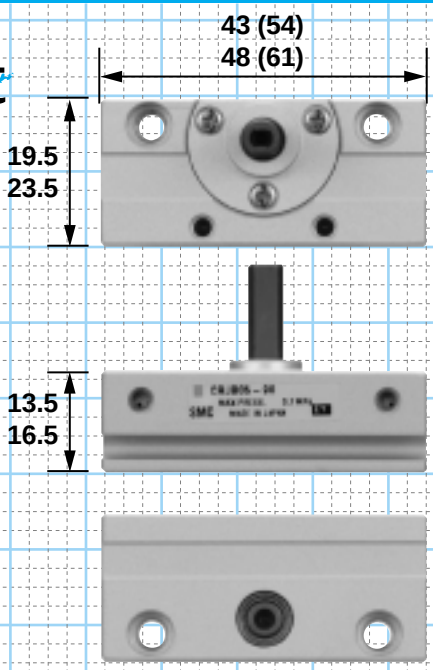
Rack-and-Pinion Type/Size: 05, 1

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

Mini-Rotary Actuator Series CRJ

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

Compact



Actual size (CRJB05-90)

Light weight

CRJ05: 32g (39g)
CRJ 1: 54g (67g)

Dimensions
Weights

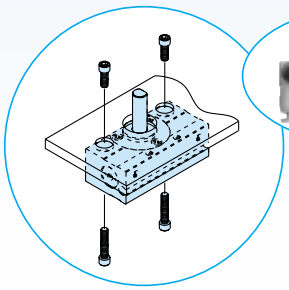
Top CRJ05
Bottom CRJ 1

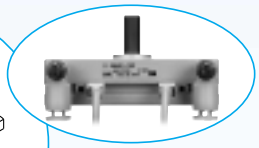
Numbers in ( ) are for 180°.

Flexible mounting

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

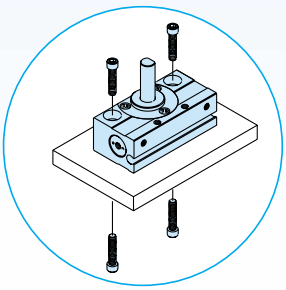
Free mount



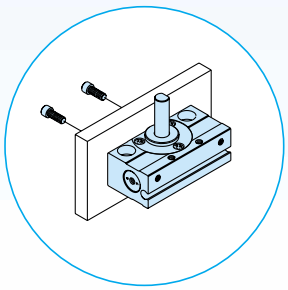


Speed controllers do not protrude from the top of the body.

Top mount



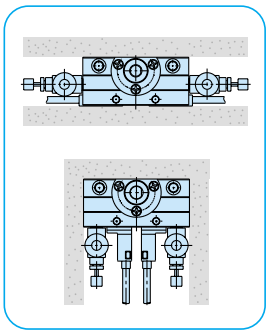
Bottom mount

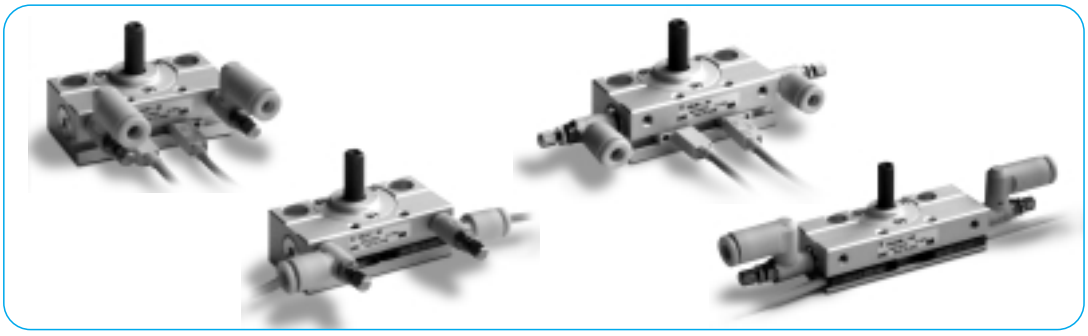


Side mount

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

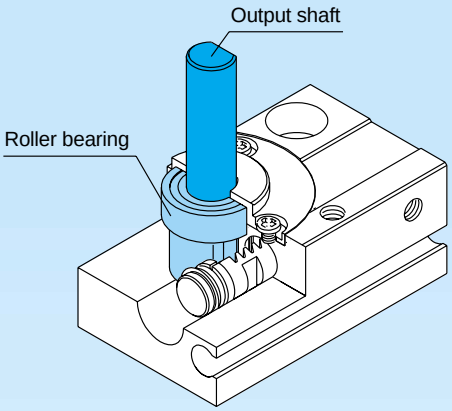
Mounting examples for auto switch and speed controller

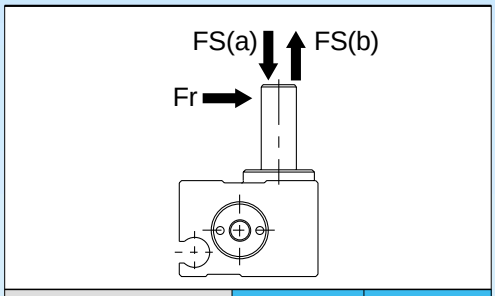




Improved allowable load

Large roller bearing and **large diameter output shaft** add to overall compactness while ensuring high rigidity.

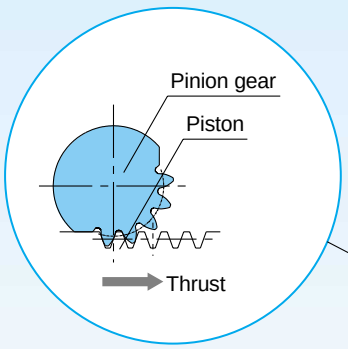




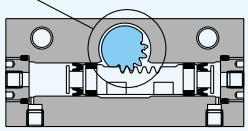
Model		CRJ05	CRJ1
Allowable load (N)	Fr	25	30
	FS(a)	20	25
	FS(b)	20	25
Output shaft size (mm)		ø5	ø6

Reduced backlash

Even with a single rack design, the use of a special construction minimizes backlash.

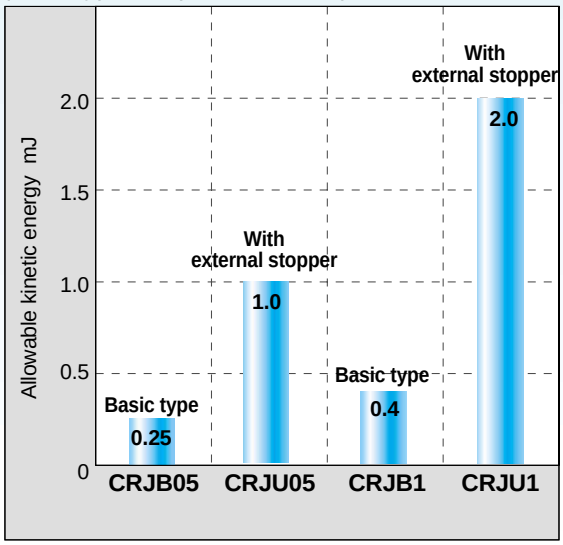


Stopping the pinion gear by having it strike against the flat surface of the piston eliminates backlash.

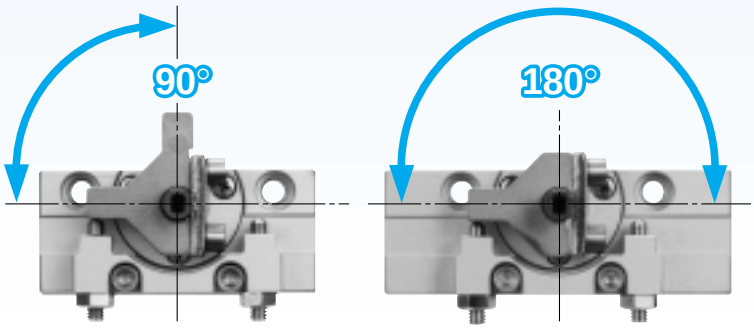


With external stopper/*Series CRJU*

4 to 5 times allowable kinetic energy
(Basic type compared to CRJB)



Angle is adjustable: ±5° at each rotation end



Variations

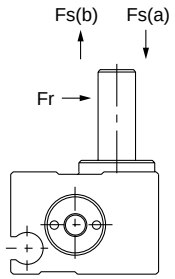
Series		Rotation angle 90°	100°	180°	190°	Port location	Auto switch
Basic type	CRJB05	●	●	●	●	Front port Side port	D-F8 D-F9
	CRJB 1	●	●	●	●		
With external stopper	CRJU05	●	—	●	—		
	CRJU 1	●	—	●	—		

Series CRJ
Model Selection

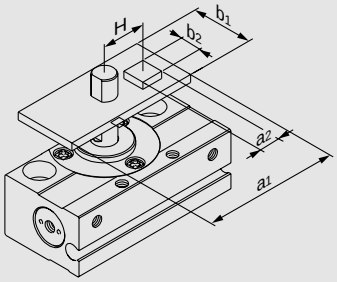
Procedure	Calculation	Example

1 Operating conditions

List all possible operating conditions according to the mounting position.



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



Rotary actuator: CRJB05-90 **Pressure:** 0.4MPa
Mounting orientaion: Vertical **Type of load:** Inertial load Ta
Load 1 configuration: 20mm x 10mm (rectangular plate)
Load 2 configuration: 5mm x 5mm (square plate)
Rotation time t: 0.2s **Rotation angle:** 90°
Load 1 mass m1: 0.03kg **Load 2 mass m2:** 0.006kg
Distance between central axis and center of gravity H: 7mm

2 Required torque

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

- **Static load: Ts**
- **Resistance load: Tf** **Load types**
- **Inertial load: Ta**

Effective torque ≥ Ts
Effective torque ≥ (3 to 5) x Tf
Effective torque ≥ 10 x Ta
Effective torque

Inertial load
$10 \times Ta = 10 \times I \times \dot{\omega}$
$= 10 \times 1.57 \times 10^{-6} \times (2 \times (\pi / 2) / 0.2^2)$
$= 0.0012 N \cdot m <$ Effective torque OK
Note) I substitutes for ⑤, the value for inertial moment.

3 Rotation time

Confirm that it is within the rotation adjustment time range.

0.1 to 0.5s/90°

0.2s/90° OK

4 Allowable load

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

Thrust load: m x 9.8 ≤ Allowable load
Allowable load

(0.03 + 0.006) x 9.8 = 0.35N < Allowable load OK

5 Inertial moment

Find the load's inertial moment "I" for the energy calculation.

$I_1 = m \times (a^2 + b^2)/12$
$I_2 = m \times (a^2 + b^2)/12 + m \times H^2$
$I = I_1 + I_2$
Inertial moment

$I_1 = 0.03 \times (0.02^2 + 0.01^2)/12 = 1.25 \times 10^{-6} kg \cdot m^2$
$I_2 = 0.006 \times (0.005^2 + 0.005^2)/12 + 0.006 \times 0.007^2$
$= 0.32 \times 10^{-6} kg \cdot m^2$
$I = 1.25 \times 10^{-6} + 0.32 \times 10^{-6}$
$= 1.57 \times 10^{-6} kg \cdot m^2$

6 Kinetic energy

Confirm that the load's kinetic energy is within the allowable value.

$1/2 \times I \times \omega^2 \leq$ Allowable energy
$\omega = 2\theta / t$ (ω: Terminal angular velocity)
θ: Rotation angle (rad)
t: Rotation time (s)
Allowable kinetic energy/Rotation time

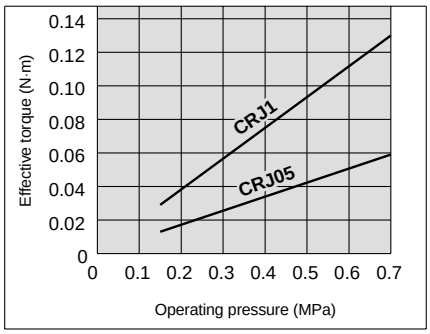
$1/2 \times 1.57 \times 10^{-6} \times (2 \times (\pi/2)/0.2)^2$
$= 0.00019J = 0.19mJ <$ Allowable energy OK

Effective Torque

Unit: N·m

Size	Operating pressure (MPa)						
	0.15	0.2	0.3	0.4	0.5	0.6	0.7
05	0.013	0.017	0.026	0.034	0.042	0.050	0.059
1	0.029	0.038	0.057	0.076	0.095	0.11	0.13

Note) Effective torque values are representative values. They are not guaranteed values. Use them only as a guide.



Load Types

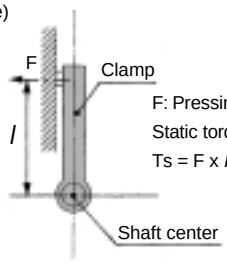
• Static load: Ts

Definition for our purposes:

A load that requires pressing force only, as represented by the clamp.

(If the mass of the clamp itself in the drawing below is considered in the calculations, it should be regarded as an inertial load.)

(Example)



F: Pressing force (N)

Static torque calculation

Ts = F x l (N·m)

• Resistance load: Tf

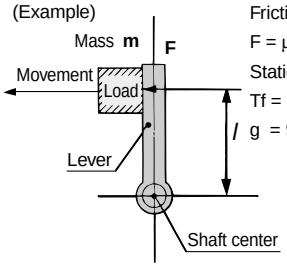
Definition for our purposes:

A load that is affected by external forces such as friction or gravity. Since the purpose is to move the load, and speed adjustment is necessary, allow an extra margin of 3 to 5 times in the effective torque.

∗ Actuator effective torque ≥ (3 to 5) x Tf

(If the mass of the lever itself in the drawing below is considered in the calculations, it should be regarded as an inertial load.)

(Example)



Friction coefficient μ

F = μmg

Static torque calculation

Tf = F x l (N·m)

g = 9.8m/s²

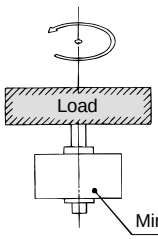
• Inertial load:

Definition for our purposes:

The load that is actually rotated by the actuator. Since the purpose is to rotate the load, and speed adjustment is necessary, allow an extra margin of 10 times or more in the effective torque.

∗ Actuator effective torque ≥ S x Ta
(S is 10 times or more)

Accelerating torque calculation



Ta = I x $\dot{\omega}$ (N·m)

I : Inertial moment

Refer to features page 5.

$\dot{\omega}$: Angular acceleration

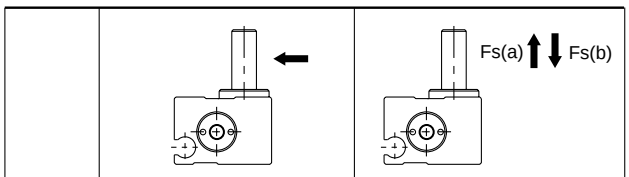
$\dot{\omega} = \frac{2\theta}{t^2}$ (rad/s²)

θ : Rotation angle (rad)

t : Rotation time (S)

Allowable Load

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



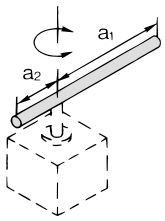
Size	Allowable radial load Fr (N)	Allowable thrust load (N)	
		Fs(a)	Fs(b)
05	25	20	20
1	30	25	25

Inertial Moment Formulas

I: Inertial moment kg·m², m: Load mass kg

1. Thin shaft

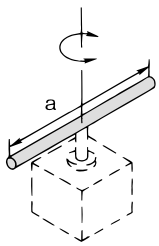
Position of rotational axis: Perpendicular to the shaft anywhere along its length



$$I = m_1 \times \frac{a_1^2}{3} + m_2 \times \frac{a_2^2}{3}$$

2. Thin shaft

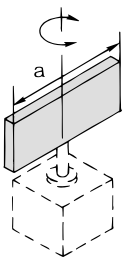
Position of rotational axis: Through the shaft's center of gravity



$$I = m \times \frac{a^2}{12}$$

3. Thin rectangular plate (rectangular parallelopiped)

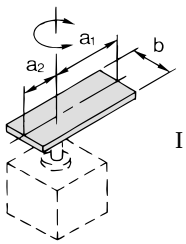
Position of rotational axis: Through the plate's center of gravity



$$I = m \times \frac{a^2}{12}$$

4. Thin rectangular plate (rectangular parallelopiped)

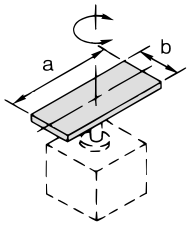
Position of rotational axis: Perpendicular to the plate through one end (also the same in the case of a thicker plate)



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

5. Thin rectangular plate (rectangular parallelopiped)

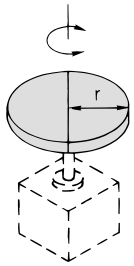
Position of rotational axis: Through the center of gravity and perpendicular to the plate (also the same in the case of a thicker plate)



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

6. Cylinder (including thin round plate)

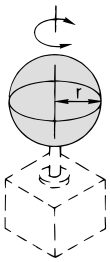
Position of rotational axis: Through the plate's central axis



$$I = m \times \frac{r^2}{2}$$

7. Solid sphere

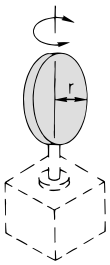
Position of rotational axis: Through the sphere's diameter



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

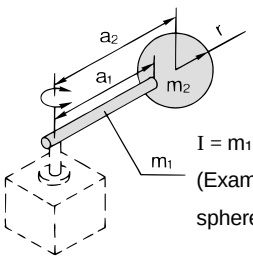
8. Thin round plate

Position of rotational axis: Through the plate's diameter



$$I = m \times \frac{r^2}{4}$$

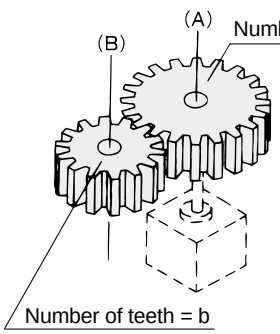
9. Load at the end of lever



$$I = m_1 \times \frac{a_1^2}{3} + m_2 \times a_2^2 + K$$

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

10. Gear transmission



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

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

Kinetic Energy/Rotation Time

Even in cases where the torque required for rotation of the load is small, damage to internal parts may result from the inertial force of the load.
Take into account the load's inertial moment and rotation time during operation when making your model selection.
(The inertial moment and rotation time charts can be used for your convenience in making model selections.)

1. Allowable kinetic energy and rotation time adjustment range

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

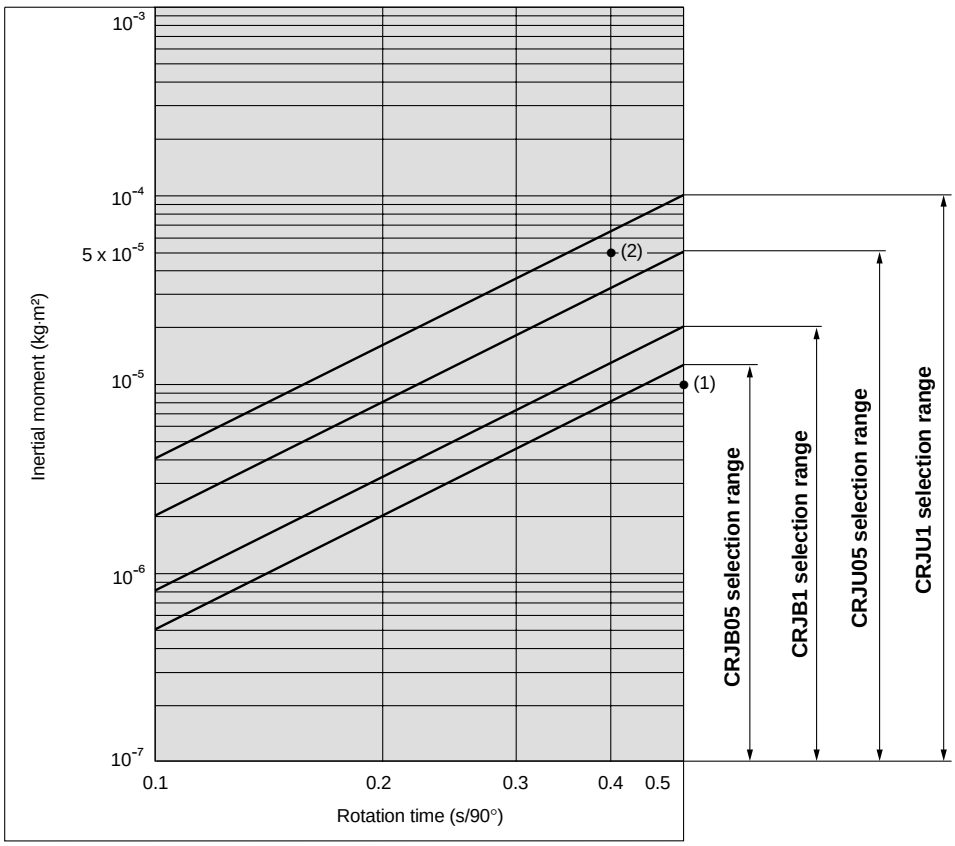
Size			Allowable kinetic energy mJ	Rotation time adjustment range for stable operation s/90°
05	Basic type	**CRJB05**	0.25	0.1 to 0.5
	With external stopper	**CRJU05**	1.0	
1	Basic type	**CRJB 1**	0.40	
	With external stopper	**CRJU 1**	2.0	

2. Inertial moment calculation

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

3. Model selection

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



1. <How to read the chart>

- Inertial moment …… 1 x 10^{-5}kg·m²
- Rotation time ……. 0.5s/90°

CRJB05 is selected in this case.

2. <Calculation example>

Load configuration: A cylinder of radius 0.05m and mass 0.04kg

Rotation time: 0.4s/90°

I = 0.04 x 0.05²/2 = 5 x 10^{-5}kg·m²

In the inertial moment and rotation time chart, find the intersection of the lines extended from the points corresponding to 5 x 10^{-5} kg·m² on the vertical axis (inertial moment) and 0.4s/90° on the horizontal axis (rotation time). Since the resulting intersection point falls within the CRJU1 selection range, CRJU1 may be selected.

Mini-Rotary Actuator
Air Consumption

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

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

Formulas

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

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

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

Q_{CR} = Air consumption of Mini-Rotary Actuator [ℓ (ANR)]

Q_{CP} = Air consumption of tubing or piping [ℓ (ANR)]

V = Internal volume of Mini-Rotary Actuator [cm^3]

P = Operating pressure [MPa]

ℓ = Length of piping [mm]

a = Internal cross section of piping [mm^2]

Q_C = Air consumption required for one reciprocation of Mini-Rotary Actuator [ℓ (ANR)]

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

Formula

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

Q_{C2} = Compressor discharge flow rate

n = Actuator reciprocations per minute

Internal cross section of tubing and steel piping

Nominal size	O.D. (mm)	I.D. (mm)	Internal cross section a (mm^2)
T□ 0425	4	2.5	4.9
T□ 0604	6	4	12.6
TU 0805	8	5	19.6
T□ 0806	8	6	28.3
1/8B	—	6.5	33.2
T□ 1075	10	7.5	44.2
TU 1208	12	8	50.3
T□ 1209	12	9	63.6
1/4B	—	9.2	66.5
TS 1612	16	12	113
3/8B	—	12.7	127
T□ 1613	16	13	133
1/2B	—	16.1	204
3/4B	—	21.6	366
1B	—	27.6	598

Air Consumption

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

Size	Rotation	Internal volume (cm^3)	Operating pressure (MPa)						
			0.15	0.2	0.3	0.4	0.5	0.6	0.7
05	90°	0.15	0.00074	0.00089	0.0012	0.0015	0.0018	0.0021	0.0024
	180°	0.31	0.0015	0.0018	0.0025	0.0031	0.0037	0.0043	0.0049
1	90°	0.33	0.0016	0.0020	0.0026	0.0033	0.0039	0.0046	0.0052
	180°	0.66	0.0033	0.0039	0.0052	0.0065	0.0078	0.0091	0.010

Mini-Rotary Actuator

Series CRJ

How to Order

Rotation angle

90	90°
100	100°
180	180°
190	190°

Basic type **CRJ B 05 — 90 E — F9B S**

With external stopper **CRJ U 05 — 90 E — F9B S**

Size

05
1

Number of auto switches

Nil	2 pcs.
S	1 pc.

Auto switch type

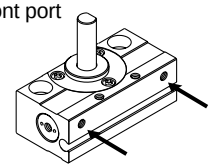
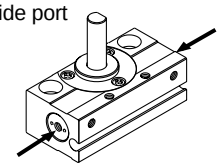
Nil	Without auto switch (built-in magnet)

∗ Select applicable auto switches from the table below.

Rotation angle

90	90°
180	180°

Connecting port position

Nil	Front port 
E	Side port 

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

Type	Special function	Electrical entry	Indicator light	Wiring (output)	Load voltage			Auto switch part no.		Lead wire length (m)∗		
					DC		AC	Electrical entry direction		0.5 (Nil)	3 (L)	5 (Z)
								Perpendicular	In-line			
Solid state switch	—	Grommet	Yes	3-wire (NPN)	24V	12V	—	—	**F9N**	●	●	—
								F8N	—	●	●	○
				3-wire (PNP)				—	**F9P**	●	●	—
								F8P	—	●	●	○
				2-wire				—	**F9B**	●	●	—
								F8B	—	●	●	○
	Diagnostic indication (2-color indication)			3-wire (NPN)				—	**F9NW**	●	●	○
				3-wire (PNP)				—	**F9PW**	●	●	○
				2-wire				—	**F9BW**	●	●	○

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

∗ Auto switches marked "○" are produced upon receipt of order.

Specifications

Size/Type	05		1	
	Basic type	With external stopper	Basic type	With external stopper
Fluid	Air (non-lube)			
Max. operating pressure	0.7MPa			
Min. operating pressure	0.15MPa			
Ambient and fluid temperature	0° to 60°C (with no freezing)			
Rotation angle Note)	$90^{+8°}_{0}$, $100^{+10°}_{0}$ $180^{+8°}_{0}$, $190^{+10°}_{0}$	90, 180	$90^{+8°}_{0}$, $100^{+10°}_{0}$ $180^{+8°}_{0}$, $190^{+10°}_{0}$	90, 180
Angle adjustment range	—	±5° at each rotation end	—	±5° at each rotation end
Cylinder bore size	ø6		ø8	
Port size	M3 x 0.5			

Note) If optimum accuracy of the rotation angle is required, select an actuator with external stopper.

Allowable Kinetic Energy and Rotation Time Adjustment Range

Size/Type			Allowable kinetic energy (mJ)	Rotation time adjustment range for stable operation (s/90°)
05	Basic type	**CRJB05**	0.25	0.1 to 0.5
	With external stopper	**CRJU05**	1.0	
1	Basic type	**CRJB 1**	0.40	
	With external stopper	**CRJU 1**	2.0	

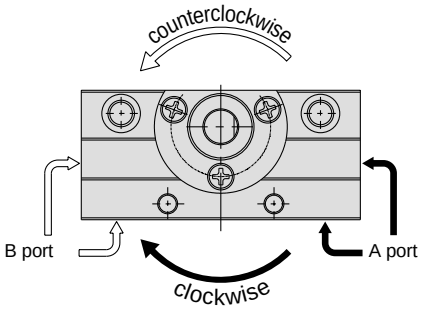
Weights

Type/Size		Model	Weight (g) Note)
Basic type	**05**	**CRJB05-90**	32
		CRJB05-100	
		CRJB05-180	39
		CRJB05-190	
	1	**CRJB 1-90**	54
		CRJB 1-100	
		CRJB 1-180	67
		CRJB 1-190	
With external stopper	**05**	**CRJU05-90**	47
		CRJU05-180	53
	1	**CRJU 1-90**	70
		CRJU 1-180	81

Note) Above values do not include auto switch weights.

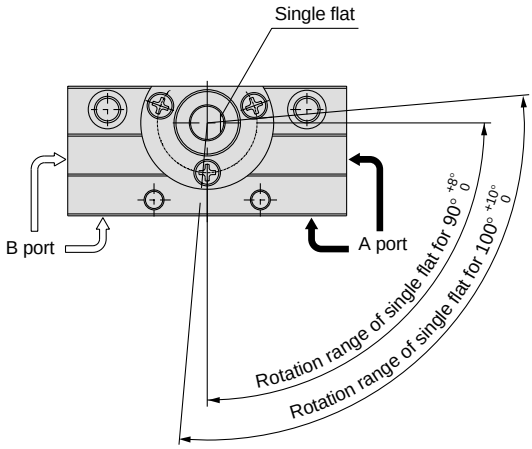
Rotating Direction and Rotation Angle

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

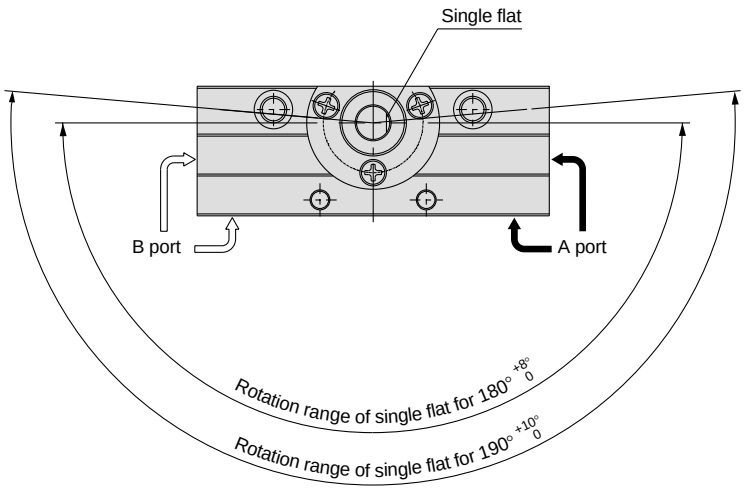


Basic type

For 90° and 100°

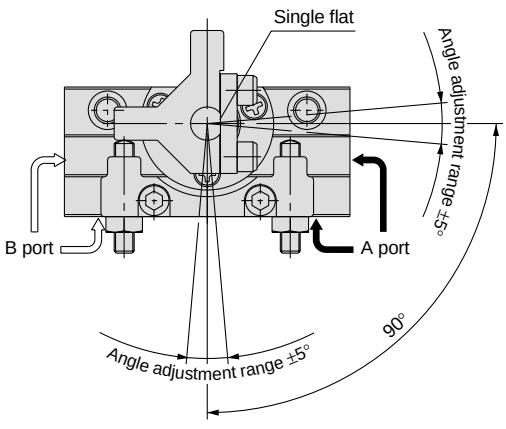


For 180° and 190°

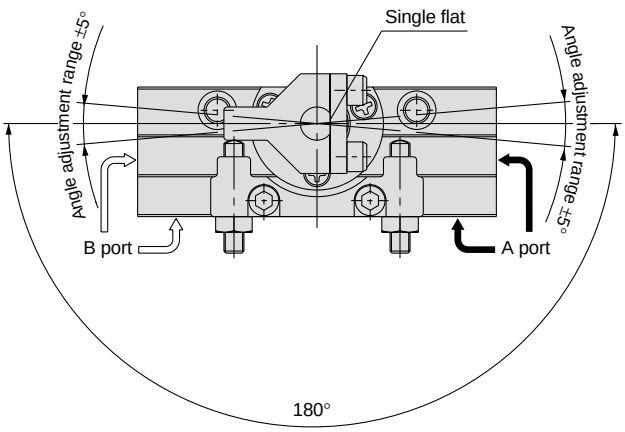


With external stopper

For 90°



For 180°

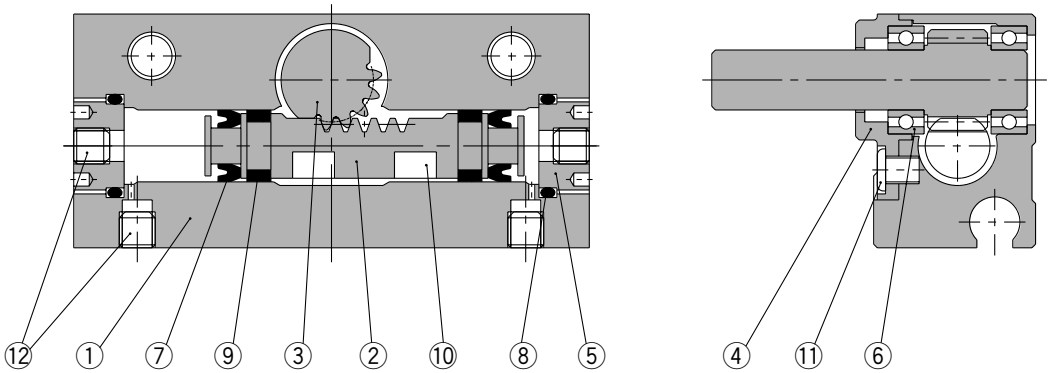


Note) • The drawings show the rotation range for the shaft's single flat.

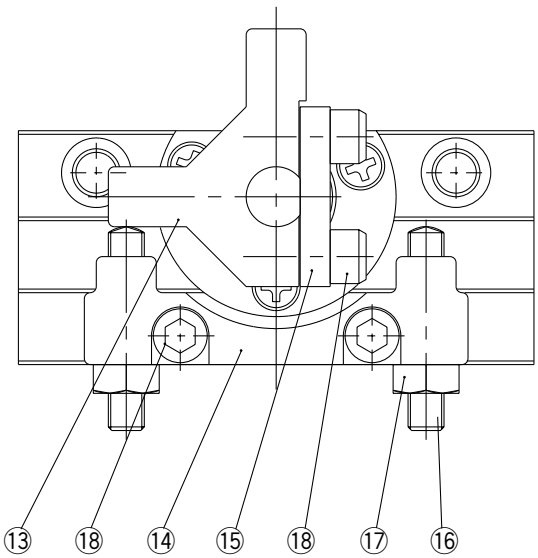
• The single flat position in the drawings shows the counterclockwise rotation end when the rotation angle is adjusted to 90° and 180°.

Construction

Basic type/CRJB



With external stopper/CRJU



Parts list

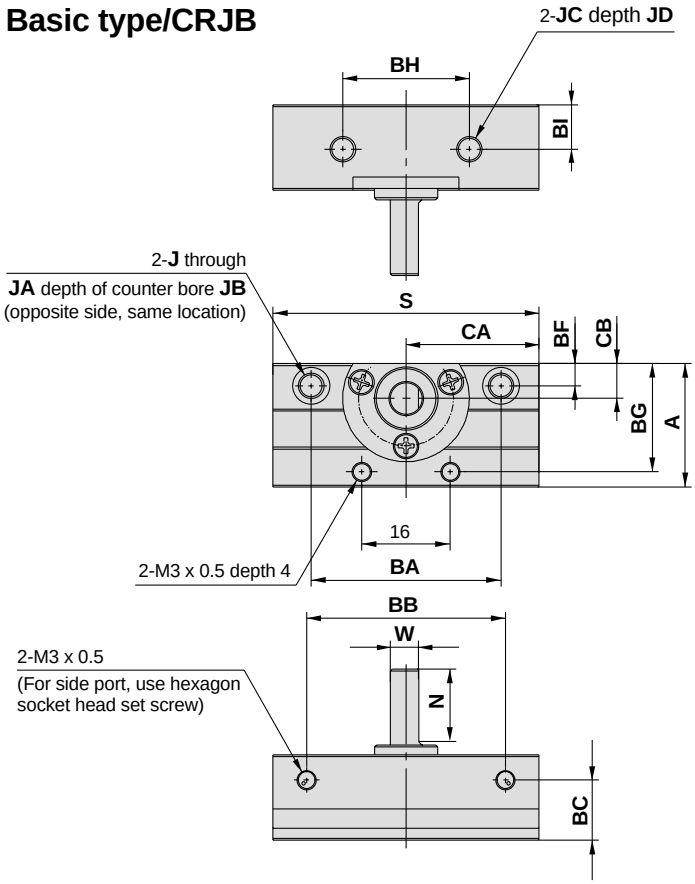
No.	Description	Material
1	**Body**	Aluminum alloy
2	**Piston**	Stainless steel
3	**Shaft**	Stainless steel
4	**Bearing retainer**	Aluminum alloy
5	**Cover**	Aluminum alloy
6	**Bearing**	Bearing steel
7	**Piston seal**	NBR
8	**O-ring**	NBR
9	**Wear ring**	Resin

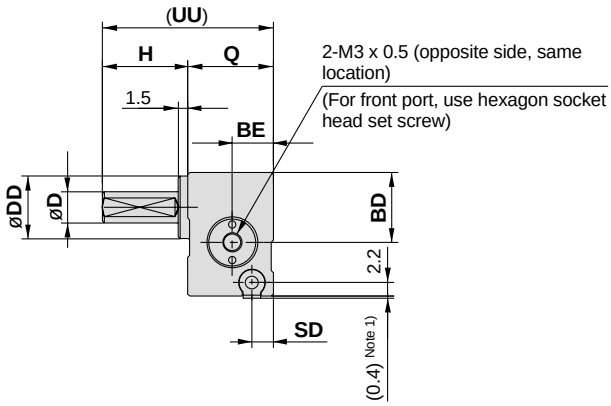
No.	Description	Material
10	**Magnet**	Magnetic material
11	**Round head no. 0 Phillips screw**	Steel wire
12	**Hexagon socket head set screw**	Stainless steel
13	**Stopper**	Chrome molybdenum steel
14	**Holder**	Aluminum alloy
15	**Stopper retainer**	Steel
16	**Hexagon socket head set screw**	Steel wire
17	**Hexagon nut**	Steel wire
18	**Hexagon socket head cap screw**	Stainless steel

∗ The mounting position of hexagon socket head set screws (no. 12) varies depending on the connecting port position.

Dimensions/Size 0.5, 1

Basic type/CRJB



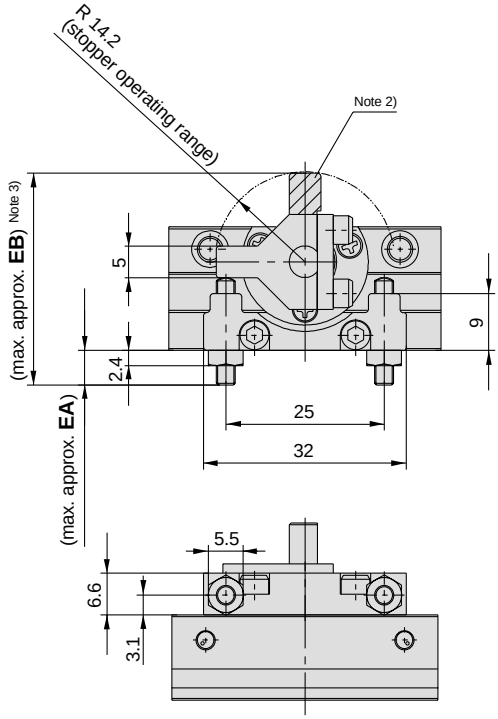


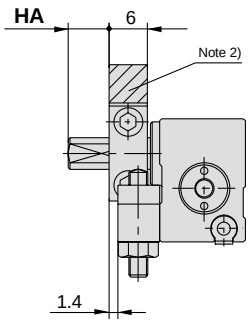
Note 1) This dimension is for the actuator with D-F9 type auto switch (not including the 2-color indication type).

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

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

With external stopper/CRJU





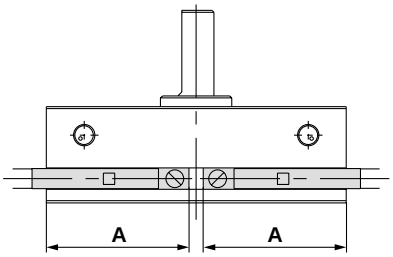
(mm)

Size	EA	EB	HA
CRJU05	5.6	33.8	6.5
CRJU 1	5.6	35.8	7.5

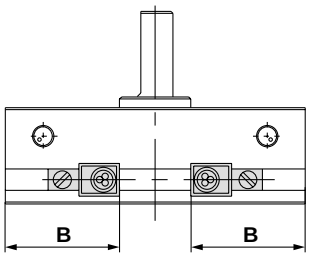
(mm)

Size	Rotation angle	A	BA	BB	BC	BD	BE	BF	BG	BH	BI	CA	CB	D	DD	J	JA	JB	JC	JD	H	N	Q	S	SD	UU	W
CRJB05	90°	19.5	30	32.4	9.5	11	6.5	3.5	17.1	20	7	21.5	5.5	5g6	10h9	M4 x 0.7	5.8	3.5	M4 x 0.7	5	14.5	12.5	13.5	43	3.4	28	4.5
	180°			43.4								27												54			
CRJB 1	90°	23.5	35	37.4	12.5	14	9	4.5	21.1	22	8.5	24	7.5	6g6	14h9	M5 x 0.8	7.5	4.5	M5 x 0.8	6	15.5	13.5	16.5	48	5.9	32	5.5
	180°			50.4								30.5												61			

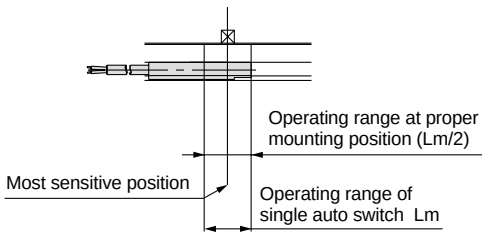
Auto Switch/Proper Mounting Position at Rotation End



For D-F9



For D-F8



Size	Rotation	D-F9 auto switch			D-F8 auto switch		
		A	Rotation range θm	Actuation range	B	Rotation range θm	Actuation range
05	90°	20.5	40°	10°	16.5	20°	10°
	180°	23.2			19.2		
1	90°	22.4	30°	10°	18.4	15°	10°
	180°	25.6			21.6		

Rotation range θm: Value of the operating range Lm of a single auto switch converted to an axial rotation range.

Actuation range: Value of auto switch hysteresis converted to an angle.

Auto Switch Common Specifications

Auto Switch Common Specifications

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

Lead Wire Lengths

Indication of lead wire length

(Example)

D-F9P L

Lead wire length

Nil	0.5m
L	3m
Z	5m

Note 1) Lead wire length Z: Auto switch applicable to 5m length
Solid state switches: All models are produced upon receipt of order.

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

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

(Example)

D-F9PL-61

Flexible specification

Lead Wire Color Changes

Lead wire colors of SMC auto switches have been changed in order to meet standard IEC947-5-2 for production beginning September, 1996 and thereafter, as shown in the tables below.
Take special care regarding wire polarity during the time that the old colors still coexist with the new colors.

2-wire

	Old	New
(+) Output	Red	Brown
(–) Output	Black	Blue

3-wire

	Old	New
(+) Power supply	Red	Brown
GND Power supply	Black	Blue
Output	White	Black

Solid state with diagnostic output

	Old	New
(+) Power supply	Red	Brown
GND Power supply	Black	Blue
Output	White	Black
Diagnostic output	Yellow	Orange

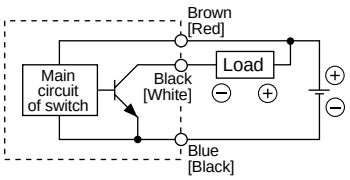
Solid state with latch type diagnostic output

	Old	New
(+) Power supply	Red	Brown
GND Power supply	Black	Blue
Output	White	Black
Latch type diagnostic output	Yellow	Orange

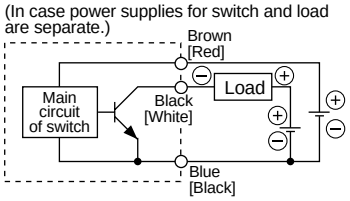
Series CRJ
Auto Switch Connections and Examples

Basic Wiring

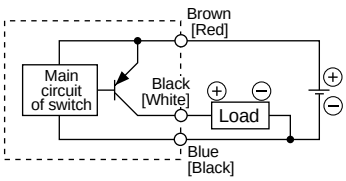
Solid state 3-wire, NPN



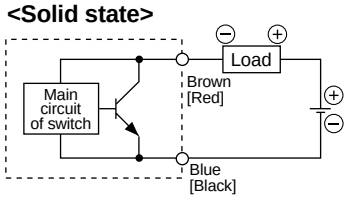
(In case power supplies for switch and load are separate.)

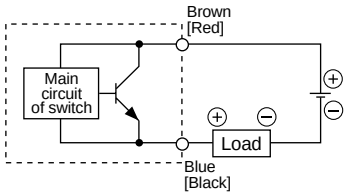


Solid state 3-wire, PNP



2-wire
<Solid state>

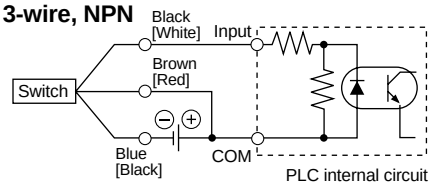




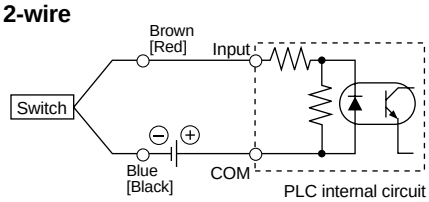
Examples of Connection to PLC

Sink input specifications

3-wire, NPN

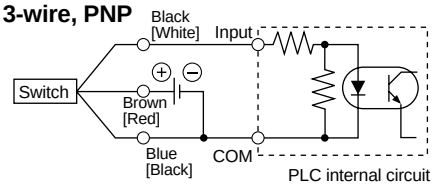


2-wire

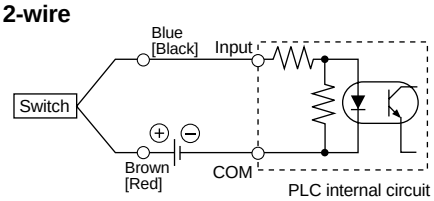


Source input specifications

3-wire, PNP



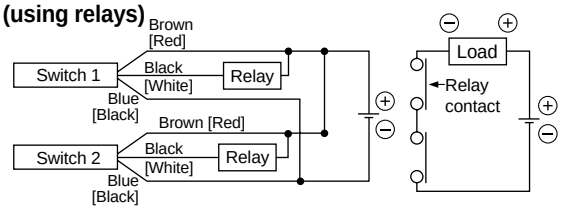
2-wire



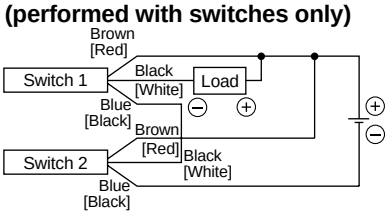
The connection method will vary depending on the applicable PLC input specifications. Connect accordingly.

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

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

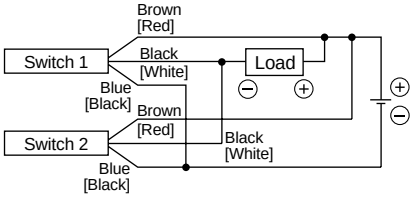


AND connection for NPN output (performed with switches only)

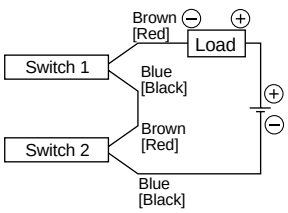


The indicator lights will light up when both switches are turned ON.

OR connection for NPN output

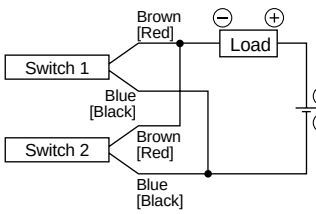


2-wire, with 2-switch AND connection



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.

2-wire, with 2-switch 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.

Load voltage at ON = $\frac{\text{Power supply voltage}}{\text{Internal voltage drop}}$ – x 2 pcs.
= 24V – 4V x 2 pcs.
= 16V

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

Load voltage at OFF = $\frac{\text{Leakage current}}{\text{Load impedance}}$ x 2 pcs. x
= 1mA x 2 pcs. x 3kΩ
= 6V

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

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

Grommet

Auto Switch Specifications

D-F8□ (with indicator light)			
Auto switch part no.	**D-F8N**	**D-F8P**	**D-F8B**
Electrical entry direction	Perpendicular	Perpendicular	Perpendicular
Wiring	3-wire		2-wire
Output	NPN type	PNP type	—
Applicable load	IC circuit, 24VDC 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	2.5 to 40mA
Internal voltage drop	1.5V or less (0.8V or less at a load current of 10mA)	0.8V or less	4V or less
Leakage current	100μA or less at 24VDC		0.8mA or less at 24VDC
Indicator light	Red LED lights up when ON		

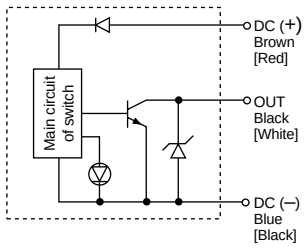
• Lead wires — Heavy duty oil resistant vinyl cord, ø2.7, 0.5m (standard)
D-F8N, D-F8P 0.15mm² x 3-wire (Brown, Black, Blue [Red, White, Black])
D-F8B 0.18mm² x 2-wire (Brown, Blue [Red, Black])

• Refer to page 7 for auto switch common specifications and lead wire length options.

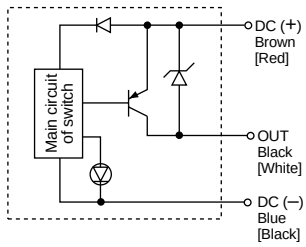
Auto switch internal circuits

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

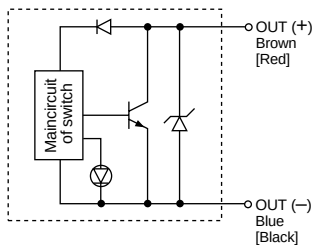
D-F8N



D-F8P



D-F8B



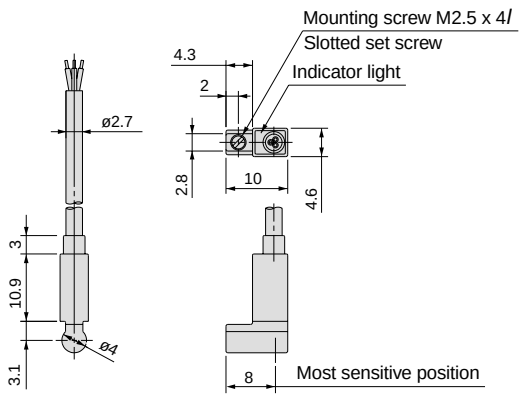
Auto Switch Weights

Unit: g

Model	**D-F8N**	**D-F8P**	**D-F8B**
Lead wire length 0.5m	7		
Lead wire length 3m	32		

Auto Switch Dimensions

D-F8N, D-F8P, D-F8B



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

Grommet

Auto Switch Specifications

D-F9□ (with indicator light)			
Auto switch part no.	**D-F9N**	**D-F9P**	**D-F9B**
Electrical entry direction	In-line	In-line	In-line
Wiring	3-wire		2-wire
Output	NPN type	PNP type	—
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	1.5V or less (0.8V or less at a load current of 10mA)	0.8V or less	4V or less
Leakage current	100μA or less at 24VDC		0.8mA or less
Indicator light	Red LED lights up when ON		

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

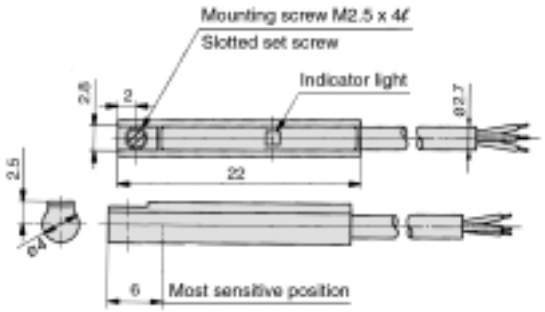
Auto Switch Weights

Unit: g

Model	**D-F9N**	**D-F9P**	**D-F9B**
Lead wire length 0.5m	7	7	6
Lead wire length 3m	37	37	31

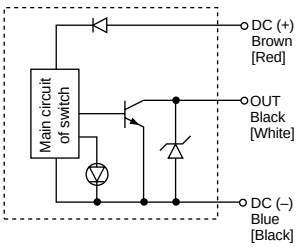
Auto Switch Dimensions

D-F9N, D-F9P, D-F9B

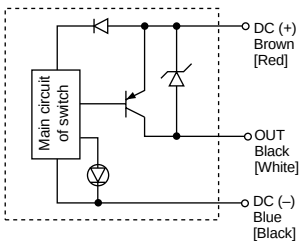


Auto switch internal circuits
Lead wire colors inside [ ] are those prior to conformity with IEC standard.

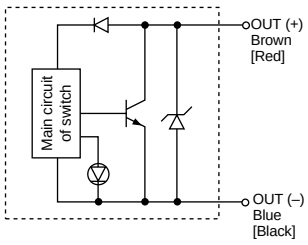
D-F9N



D-F9P



D-F9B



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

Grommet

Auto Switch Specifications

D-F9□W (with indicator light)			
Auto switch part no.	**D-F9NW**	**D-F9PW**	**D-F9BW**
Electrical entry direction	In-line	In-line	In-linw
Wiring	3-wire		2-wire
Output	NPN type	PNP type	—
Applicable load	IC circuit, Relay IC, 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	0.4mA or less	80mA or less	5 to 40mA
Internal voltage drop	1.5V or less (0.8V or less at a load current of 10mA)	0.8V or less	4V or less
Leakage current	100μA or less at 24VDC		0.8mA or less
Indicator light	Actuated position ..... Red LED lights up Optimum operating position ..... Green LED lights up		

• Lead wires — Heavy duty oil resistant vinyl cord, ø2.7, 0.5m (standard)
D-F9NW, D-F9PW 0.15mm² x 3-wire (Brown, Black, Blue [Red, White, Black])
D-F9BW 0.18mm² x 2-wire (Brown, Blue [Red, Black])

• Refer to page 7 for auto switch common specifications and lead wire length options.

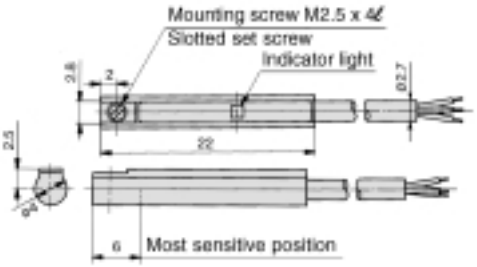
Auto Switch Weights

Unit: g

Model	**D-F9NW**	**D-F9PW**	**D-F9BW**
Lead wire length 0.5m	7	7	7
Lead wire length 3m	34	34	32

Auto Switch Dimensions

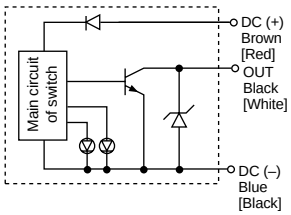
D-F9NW, D-F9PW, D-F9BW



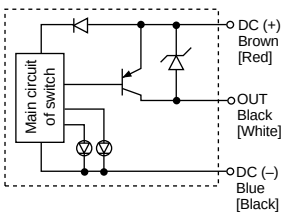
Auto switch internal circuits

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

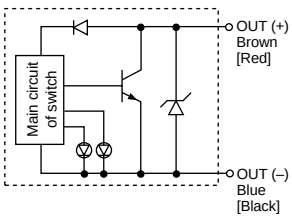
D-F9NW



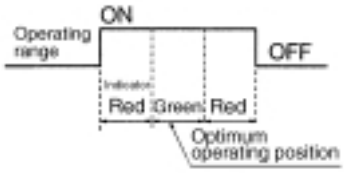
D-F9PW



D-F9BW



Indicator light/Display method



Series CRJ
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 handled incorrectly. Assembly, handling or repair of pneumatic systems should be performed by trained and experienced operators.

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

1. Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.
2. When equipment is to be removed, confirm the safety process as mentioned above. Cut the supply pressure for this equipment and exhaust all residual compressed air in the system.
3. Before machinery/equipment is restarted, take measures to prevent shooting-out of cylinder piston rod, etc. (Bleed air into the system gradually to create back pressure.)

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

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

Series CRJ
Rotary Actuator Precautions 1

Be sure to read before handling.

Design

⚠Warning

1. In cases of load variations, lifting/lowering operations or changes in frictional resistance, employ a safety design which allows for these factors.

Increases in operating speed can cause human injury as well as damage to equipment and machinery.

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

If driven objects and moving parts of the product pose a danger of human injury or equipment damage, design the structure to avoid contact with that area.

3. Make secure connections so that stationary parts and connecting parts do not become loose.

Particularly when operation frequency is high or a rotary actuator is used in a location with excessive vibration, employ a secure method of connection.

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

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

5. Consider a possible drop in operating pressure due to a power outage.

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

6. Consider a possible loss of power supply.

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

7. When a meter-out speed controller is used, employ a safety design which takes into account residual pressure.

If the air supply side is pressurized when there is no residual pressure on the exhaust side, operation will be abnormally fast and this can cause human injury as well as damage to equipment and machinery.

8. Consider emergency stops.

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

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

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

In the case that the rotary actuator needs to be reset at the starting position, install safe manual control equipment.

Design

⚠Warning

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

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

Selection

⚠Warning

1. Keep the speed setting within the product's allowable energy value.

Operating with the kinetic energy of the load exceeding the allowable value can cause damage to the product, leading to human injury as well as damage to equipment and machinery.

2. Provide a shock absorbing mechanism when kinetic energy applied to the product exceeds the allowable value.

Operation exceeding the allowable kinetic energy can cause damage to the product and lead to human injury and damage to equipment and machinery.

3. Do not perform stops or holding operations by containing air pressure inside the product.

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

⚠Caution

1. Do not operate the product at low speeds that are below the prescribed speed adjustment range.

If operated at low speeds below the speed adjustment range, this may cause sticking and slipping or stopping of operation.

2. Do not apply external torque that exceeds the product's rated output.

If external force is applied that exceeds the product's rated output, the product can be damaged.

3. When repeated accuracy of the rotation angle is required, the load should be directly stopped externally.

The initial rotation angle may vary even in products equipped with angle adjustment.

4. Avoid operation on hydraulic systems.

Operation on hydraulic systems can cause damage to the product.

Series CRJ
Rotary Actuator Precautions 2

Be sure to read before handling.

Mounting

⚠Warning

1. When angle adjustment is performed while applying pressure, make advance preparations to keep equipment from rotating any more than necessary.

When adjustment is performed with pressure applied, there is the possibility that the equipment will rotate and fall out during adjustment depending on its mounting orientation. This can cause human injury and damage to equipment and machinery.

2. Do not loosen the angle adjustment screw above the adjustment range.

If the angle adjustment screw is loosened past the adjustment range, it may come out causing human injury and damage to equipment and machinery.

3. Do not allow external magnetism close to the product.

Since the auto switches used are types sensitive to magnetism, external magnetism in close proximity to the product can cause malfunction leading to human injury and damage to equipment and machinery.

4. Do not perform additional machining on the product.

Additional machining of the product can adversely affect product strength and cause damage to the product leading to human injury and damage to equipment and machinery.

5. Do not enlarge the fixed orifice on the piping port by reworking.

If the bore is enlarged, rotation speed and impact force will increase. This can cause damage to the product leading to human injury and damage to equipment and machinery.

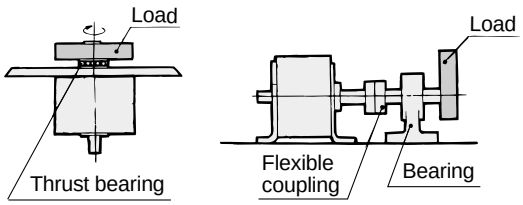
6. When using a shaft coupling, use one with a sufficient degree of freedom.

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

7. Do not apply loads to the shaft exceeding the values shown on features 4.

If loads exceeding the allowable values are applied to the product, this can cause malfunction and product damage leading to human injury and damage to equipment and machinery.

A load up to the allowable radial/thrust load can be applied provided that a dynamic load is not generated. However, applications which apply a load directly to the shaft should be avoided whenever possible. In order to further improve operating conditions, methods such as shown in the drawings below are recommended so that a direct load is not applied to the shaft.

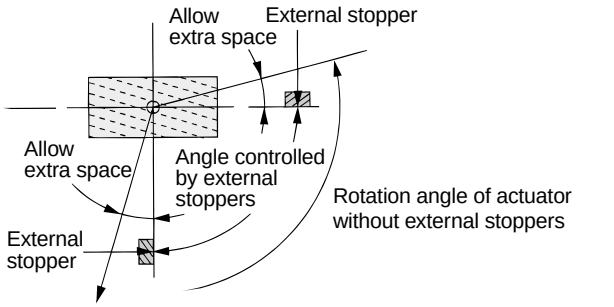


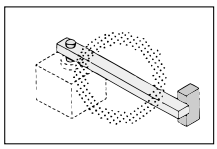
8. Attach external stoppers away from the axis of rotation.

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

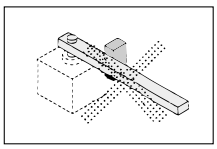
Precautions when using external stoppers

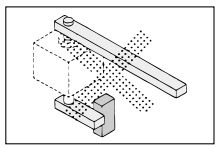
When the kinetic energy generated by the load exceeds the limit value of the actuator, an external shock absorbing mechanism must be provided to absorb the energy. The correct method for mounting external stoppers is explained in the figure below.





External stopper becomes a fulcrum, and the load's inertial force is applied to the shaft as a bending moment.





If an external stopper is installed on the shaft side opposite the load, the inertial force generated by the load is applied directly to the shaft.

⚠Caution

1. Do not secure the body and strike the shaft, or secure the shaft and strike the body.

This can bend the shaft and cause damage to the bearing. When installing a load on the shaft, secure the shaft.

2. Do not step directly on the shaft or on any equipment installed on the shaft.

Stepping directly on the shaft can cause damage to the shaft and bearing.

3. Operate products equipped with the angle adjustment function within the prescribed adjustment range.

Operation outside the adjustment range can cause malfunction and product damage. Refer to product specifications for the adjustment range of each product.

Series CRJ
Rotary Actuator Precautions 3

Be sure to read before handling.

Air Supply

⚠Warning

1. Use clean air.

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

⚠Caution

1. Install air filters.

Install air filters at the upstream side of valves. The rated filtration should be 5μm or finer.

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

Compressed air that includes excessive drainage may cause malfunction of rotary actuators and other pneumatic equipment. To prevent this, install an after-cooler air dryer or water separator.

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

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

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

Operating Environment

⚠Warning

1. Do not use in environments where there is a danger of corrosion.

Refer to the construction drawings regarding rotary actuator materials.

2. Do not use in dusty environment or where the equipment would be exposed to the splashes of water, oil, and other liquids.

Speed Adjustment

⚠Warning

1. Perform speed adjustment gradually from the low speed side.

Speed adjustment from the high speed side can cause product damage leading to human injury and damage to equipment and machinery.

⚠Caution

1. When operating at high speed with a large load weight, a large amount of energy is applied to the actuator and can cause damage.

Refer to the model selection procedure on features page 3 to find the proper operating time.

2. Do not machine the fixed orifice of the port to enlarge its size. If the fixed orifice size is enlarged, the actuator operating speed and impact force will increase and cause damage.

Lubrication

⚠Caution

1. Use this product without lubrication.

This product is lubricated with grease at the factory, and further lubrication will result in a failure to meet the product's specifications .

Maintenance

⚠Warning

1. Maintenance should be performed according to the procedure indicated in the instruction manual. Improper handling can cause damage and malfunction of equipment and machinery.

2. During maintenance, do not disassemble while the electric power and supply air are turned ON.

3. Conduct suitable function tests after the product has been disassembled for maintenance.

Failure to test functions can result in the product's inability to operate according to specifications.

⚠Caution

1. For lubrication, use the grease specified for each product.

Use of a lubricant other than the specified grease can cause damage to seals and other components.

Series CRJ
Auto Switch Precautions 1

Be sure to read before handling.

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 for load current, voltage, temperature or impact.

2. Take precautions when actuators are used close together.

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

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

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

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

4. Keep wiring as short as possible.

<Solid state switch>

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

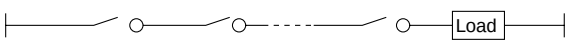
5. Monitor the internal voltage drop of the switch.

<Solid state switch>

1) Generally, the internal voltage drop will be greater with a 2-wire solid state auto switch than with a reed switch.
   - If auto switches are connected in series as shown below, take note that there will be a large voltage drop. (Refer to internal voltage drop in the auto switch specifications.)

   [The voltage drop will be “n” times larger when “n” auto switches are connected.]

   Even though an auto switch operates normally, the load may not move.



- 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.

  Supply voltage − Internal voltage drop of switch > Minimum operating voltage of load

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

⚠Warning

6. Be careful of leakage current.

<Solid state switch>

With a 2-wire solid state auto switch, current (leakage current) flows to the load to operate the internal circuit even when in the OFF state.

Operating current of load (OFF condition) > Leakage current

If the condition given in the above formula is not met, it will not reset correctly (stays ON). Use a 3-wire switch if this specification cannot be satisfied.

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

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

<Solid state switch>

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

8. Cautions for use in an interlock circuit

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

Also perform periodic maintenance and confirm proper operation.

9. Ensure sufficient clearance for maintenance activities.

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

Series CRJ
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 (1000m/s² or more for solid state switches) while handling. Although the external body of the switch (switch case) may not be damaged, the inside of the switch could be damaged and cause a malfunction.

2. Do not carry a cylinder by the auto switch lead wires.

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

3. Mount switches using the proper tightening torque.

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

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

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

Wiring

⚠Warning

1. Avoid repeatedly bending or stretching lead wires.

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

2. Be sure to connect the load before power is applied.

<2-wire type>

If the power is turned ON when an auto switch is not connected to a load, the switch will be instantly damaged because of excess current.

3. Confirm proper insulation of wiring.

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

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

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

Wiring

⚠Warning

5. Do not allow short circuit of loads.

<Solid state switch>

Model D-F9□(V), F9□W(V) and all models of PNP output type switches do not have built-in short circuit protection circuits. As in the case of reed switches, if loads are short circuited, the switches will be instantly damaged.

Take special care to avoid reverse wiring with the brown [red] power supply line and the black [white] output line on 3-wire type switches.

6. Avoid incorrect wiring.

<Solid state switch>

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

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

∗ Lead wire color changes

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

2-wire

	Old	New
(+) Output	Red	Brown
(–) Output	Black	Blue

3-wire

	Old	New
(+) Power supply	Red	Brown
GND Power supply	Black	Blue
Output	White	Black

Solid state with diagnostic output

	Old	New
(+) Power supply	Red	Brown
GND Power supply	Black	Blue
Output	White	Black
Diagnostic output	Yellow	Orange

Solid state with latch type diagnostic output

	Old	New
(+) Power supply	Red	Brown
GND Power supply	Black	Blue
Output	White	Black
Latch type diagnostic output	Yellow	Orange

Series CRJ
Auto Switch Precautions 3
Be sure to read before handling.

Operating Environment

⚠Warning

1. Never use in an atmosphere of explosive gases.

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

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

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

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

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

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

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

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

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

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

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

<Solid state switch>

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

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

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

Maintenance

⚠Warning

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

1) Securely tighten switch mounting screws

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

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

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

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

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

Other

⚠Warning

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

Series CRJ/Specific Product Precautions

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

Rotation Angle Adjustment

⚠Caution

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

Size	Angle adjustment per single rotation of angle adjustment screw
05	2.3°
1	2.3°

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

Mounting of Speed Controller and Fittings

⚠Caution

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

- Speed controller
  AS12□1F/Elbow type
  AS13□1F/Universal type
- One-touch fitting
  One-touch mini Series KJ
- Reducer bushing Series M3

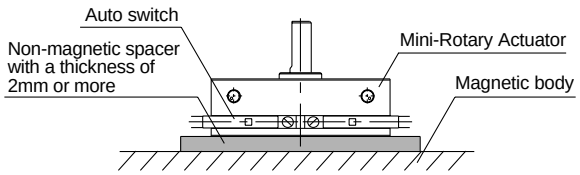
Auto Switch Mounting

⚠Caution

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

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

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



Maintenance

⚠Caution

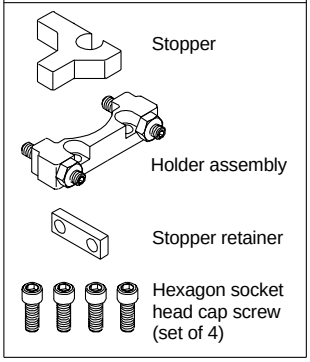
This product requires special tools; therefore, it cannot be disassembled for maintenance.

External Stopper Unit

⚠Caution

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

Component parts



Model	Unit part no.
CRJU05- 90	P531010-1
CRJU05-180	P531010-2
CRJU 1- 90	P531020-1
CRJU 1- 180	P531020-2

Note 1) External stopper units for 180° cannot be applied to the 90° Mini-Rotary Actuators.
Note 2) When using external stoppers for 90°, use Mini-Rotary Actuators with a rotation range of 100°, and for 180°, use actuators with a rotation range of 190°.

External Stopper Assembly Procedure

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

⚠Caution

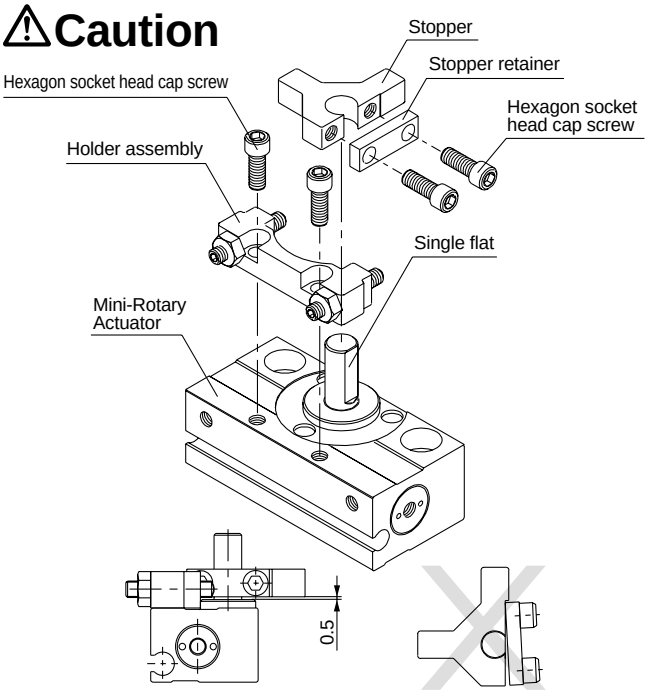


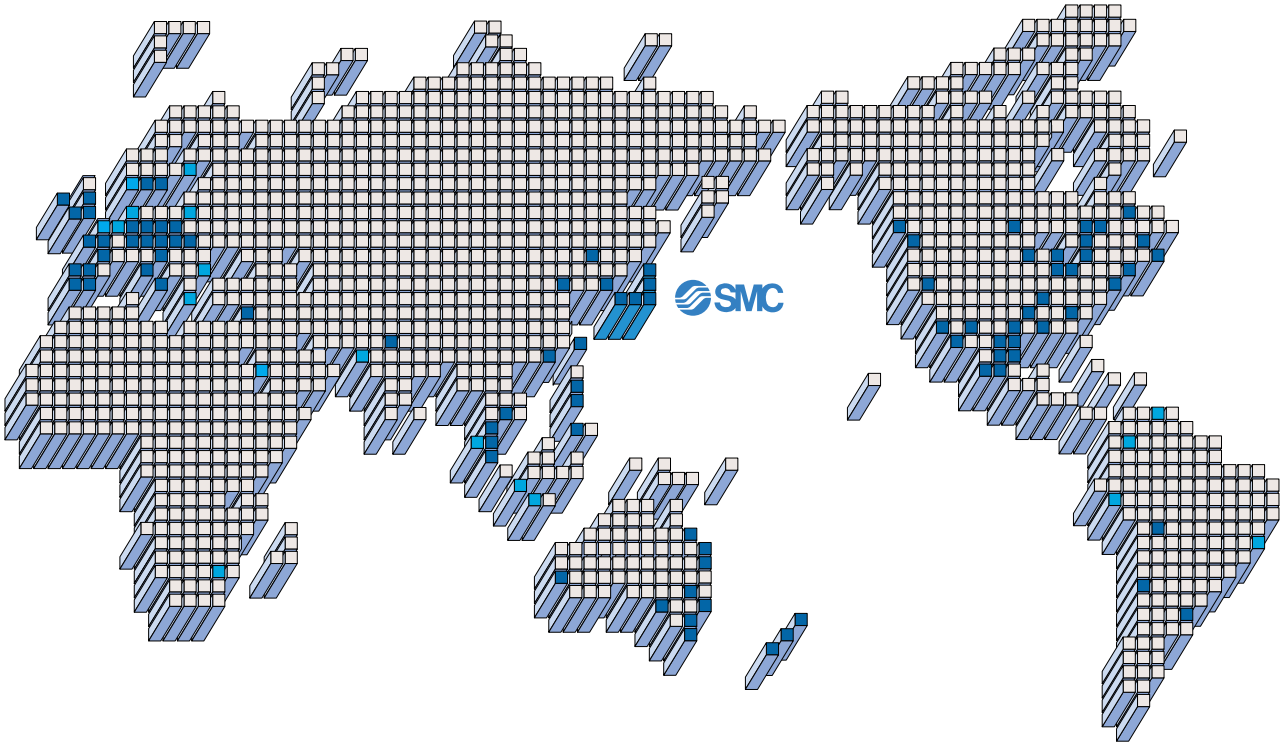
Figure 1 **Figure 2**

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

2 Tighten the holder assembly with hexagon socket head cap screws.

	Tightening torque N·m
Hexagon socket head cap screws	0.8 to 1.2

SMC'S GLOBAL MANUFACTURING, DISTRIBUTION AND SERVICE NETWORK



EUROPE

AUSTRIA
SMC Pneumatik GmbH

CZECH
SMC Czech s.r.o.

DENMARK
SMC Pneumatik A/S

FINLAND
SMC Pneumatiikka OY

FRANCE
SMC Pneumatique SA

GERMANY
SMC Pneumatik GmbH

HUNGARY
SMC Hungary Kft.

IRELAND
SMC Pneumatics (Ireland) Ltd.

ITALY
SMC Italia S.p.A.

NETHERLANDS
SMC Pnuematics BV.

NORWAY
SMC Pneumatics Norway A/S

ROMANIA
SMC Romania s.r.l.

RUSSIA
SMC Pneumatik LLC.

SLOVAKIA
SMC Slovakia s.r.o.

SLOVENIA
SMC Slovenia d.o.o.

EUROPE

SPAIN/PORTUGAL
SMC España, S.A.

SWEDEN
SMC Pneumatics Sweden AB

SWITZERLAND
SMC Pneumatik AG.

UK
SMC Pneumatics (U.K.) Ltd.

ASIA

CHINA
SMC (China) Co., Ltd.

HONG KONG
SMC Pneumatics (Hong Kong) Ltd.

INDIA
SMC Pneumatics (India) Pvt. Ltd.

MALAYSIA
SMC Malaysia (S.E.A.) Sdn. Bhd.

PHILIPPINES
SMC Pneumatics (Philippines), Inc.

SINGAPORE
SMC Pneumatics (S.E.A.) Pte. Ltd.

SOUTH KOREA
SMC Pneumatics Korea Co., Ltd.

TAIWAN
SMC Pneumatics (Taiwan) Co., Ltd.

THAILAND
SMC Thailand Ltd.

NORTH AMERICA

CANADA
SMC Pneumatics (Canada) Ltd.

MEXICO
SMC Corporation (Mexico) S.A. de C.V.

USA
SMC Corporation of America

SOUTH AMERICA

ARGENTINA
SMC Argentina S.A.

BOLIVIA
SMC Pneumatics Bolivia S.R.L.

BRAZIL
SMC Pneumaticos Do Brazil Ltda.

CHILE
SMC Pneumatics (Chile) S.A.

VENEZUELA
SMC Neumatica Venezuela S.A.

OCEANIA

AUSTRALIA
SMC Pneumatics (Australia) Pty. Ltd.

NEW ZEALAND
SMC Pneumatics (N.Z.) Ltd.

SMC CORPORATION

1-16-4 Shimbashi, Minato-ku, Tokyo 105-0004, JAPAN
Tel: 03-3502-2740 Fax: 03-3508-2480
URL http://www.smcworld.com

1st printing May, 2001 D-SMC.L.A. P-80 (YG)

This catalog is printed on recycled paper with concern for the global envionment.