

Mini-Rotary Actuator

Series CRJ

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



PAT. PEND

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

43 (54)
48 (61)

19.5
23.5

Light weight

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

13.5
16.5

Actual size (CRJB05-90)

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

Top mount

Bottom mount

Side mount

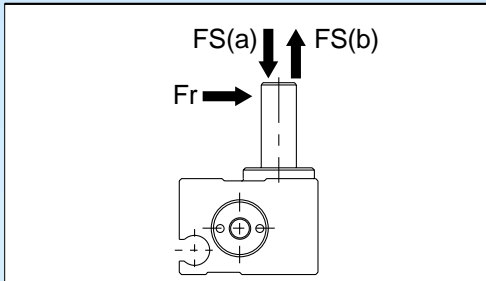
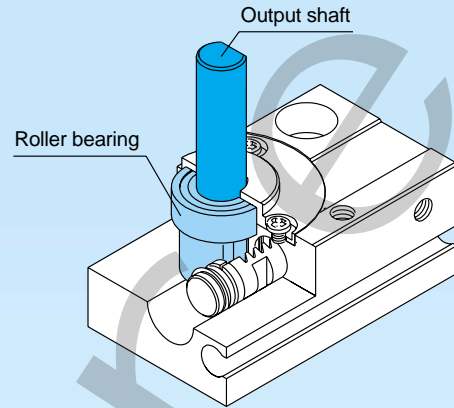
Speed controllers do not protrude from the top of the body.

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

Mounting examples for auto switch and speed controller

Improved allowable load

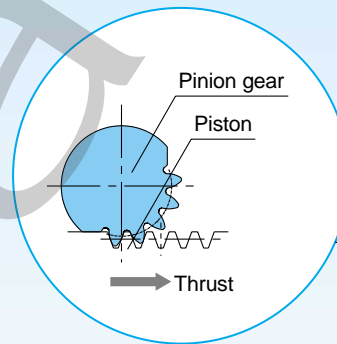
Large roller bearing and large diameter output shaft add to overall compactness while ensuring high rigidity.



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.

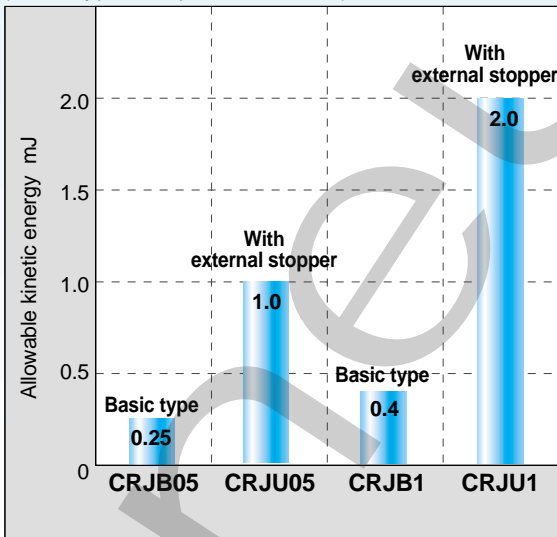


Stopping the pinion gear by having it strike against the flat surface of the piston eliminates backlash.

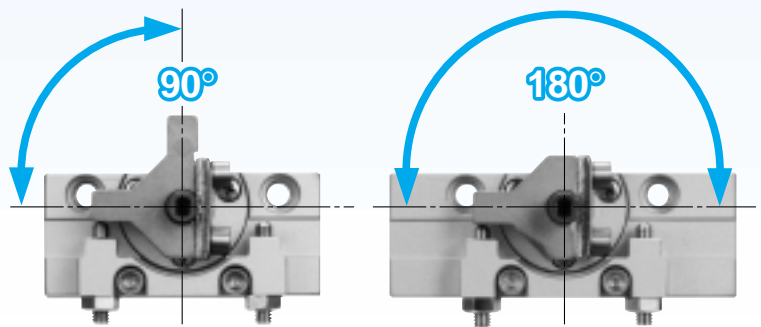


With external stopper/Series CRJU

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



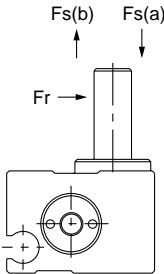
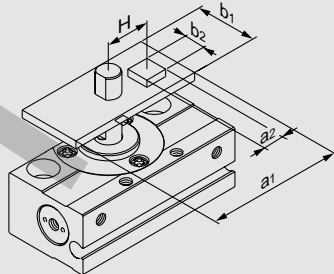
Angle is adjustable: ±5° at each rotation end



Variations

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

Series CRJ Model Selection

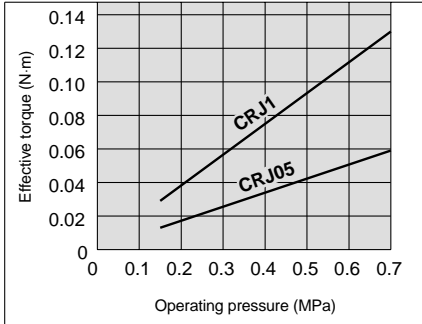
Procedure	Calculation	Example
<p>1 Operating conditions</p> <p>List all possible operating conditions according to the mounting position.</p> 	<ul style="list-style-type: none"> Model used Operating pressure Mounting position Load type <ul style="list-style-type: none"> Ts (N-m) Tf (N-m) Ta (N-m) Load configuration Rotation time t (s) Rotation angle Load mass m (kg) Distance between central axis and center of gravity H (mm) 	 <p>Rotary actuator: CRJB05-90 Pressure: 0.4MPa Mounting orientation: 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</p>
<p>2 Required torque</p> <p>Confirm the type of load as shown below, and select an actuator that satisfies the required torque.</p> <ul style="list-style-type: none"> Static load: Ts Resistance load: Tf Load types Inertial load: Ta 	<p>Effective torque $\geq T_s$ Effective torque $\geq (3 \text{ to } 5) \times T_f$ Effective torque $\geq 10 \times T_a$</p> <p>Effective torque</p>	<p>Inertial load</p> $10 \times T_a = 10 \times I \times \dot{\omega}$ $= 10 \times 1.57 \times 10^{-6} \times (2 \times (\pi/2) / 0.2^2)$ $= 0.0012 \text{ N}\cdot\text{m} < \text{Effective torque} \quad \text{OK}$ <p>(Note) I substitutes for ⑤, the value for inertial moment.</p>
<p>3 Rotation time</p> <p>Confirm that it is within the rotation adjustment time range.</p>	<p>0.1 to 0.5s/90°</p>	<p>0.2s/90° OK</p>
<p>4 Allowable load</p> <p>Confirm that the radial load, thrust load and moment are within the allowable ranges.</p>	<p>Thrust load: $m \times 9.8 \leq \text{Allowable load}$</p> <p>Allowable load</p>	<p>$(0.03 + 0.006) \times 9.8 = 0.35 \text{ N} < \text{Allowable load} \quad \text{OK}$</p>
<p>5 Inertial moment</p> <p>Find the load's inertial moment "I" for the energy calculation.</p>	$I_1 = m \times (a^2 + b^2) / 12$ $I_2 = m \times (a^2 + b^2) / 12 + m \times H^2$ $I = I_1 + I_2$ <p>Inertial moment</p>	$I_1 = 0.03 \times (0.02^2 + 0.01^2) / 12 = 1.25 \times 10^{-6} \text{ kg}\cdot\text{m}^2$ $I_2 = 0.006 \times (0.005^2 + 0.005^2) / 12 + 0.006 \times 0.007^2$ $= 0.32 \times 10^{-6} \text{ kg}\cdot\text{m}^2$ $I = 1.25 \times 10^{-6} + 0.32 \times 10^{-6}$ $= 1.57 \times 10^{-6} \text{ kg}\cdot\text{m}^2$
<p>6 Kinetic energy</p> <p>Confirm that the load's kinetic energy is within the allowable value.</p>	$1/2 \times I \times \omega^2 \leq \text{Allowable energy}$ $\omega = 2\theta / t \quad (\omega: \text{Terminal angular velocity})$ <p>θ: Rotation angle (rad) t: Rotation time (s)</p> <p>Allowable kinetic energy/Rotation time</p>	$1/2 \times 1.57 \times 10^{-6} \times (2 \times (\pi/2) / 0.2)^2$ $= 0.00019 \text{ J} = 0.19 \text{ mJ} < \text{Allowable energy} \quad \text{OK}$

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

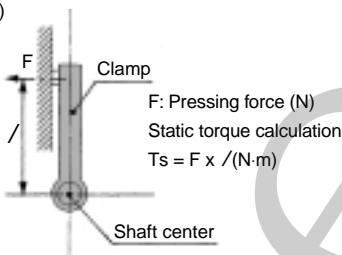
• **Static load: Ts**

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)



• **Resistance load: Tf**

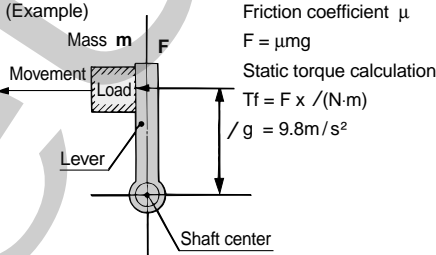
Definition for our purposes:

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 $\geq (3 \text{ to } 5) \times T_f$

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

(Example)



• **Inertial load:**

Definition for our purposes:

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

* Actuator effective torque $\geq S \times T_a$
(S is 10 times or more)

Accelerating torque calculation

$T_a = I \times \dot{\omega}$ (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

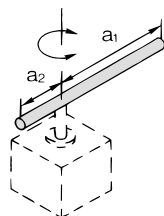
Series CRJ

Inertial Moment Formulas

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

1. Thin shaft

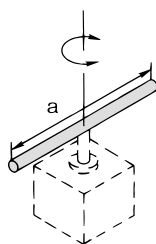
Position of rotational axis: Perpendicular to the shaft anywhere along its length



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

2. Thin shaft

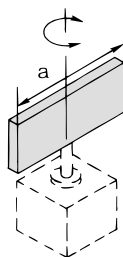
Position of rotational axis: Through the shaft's center of gravity



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

3. Thin rectangular plate (rectangular parallelepiped)

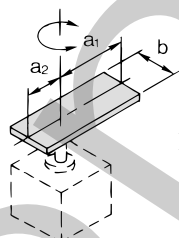
Position of rotational axis: Through the plate's center of gravity



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

4. Thin rectangular plate (rectangular parallelepiped)

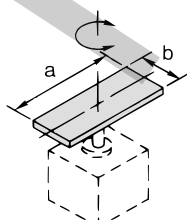
Position of rotational axis: Perpendicular to the plate through one end (also the same in the case of a thicker plate)



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

5. Thin rectangular plate (rectangular parallelepiped)

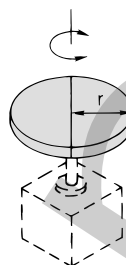
Position of rotational axis: Through the center of gravity and perpendicular to the plate (also the same in the case of a thicker plate)



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

6. Cylinder (including thin round plate)

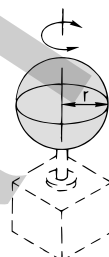
Position of rotational axis: Through the plate's central axis



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

7. Solid sphere

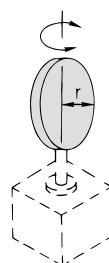
Position of rotational axis: Through the sphere's diameter



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

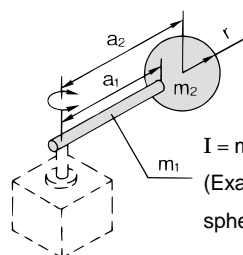
8. Thin round plate

Position of rotational axis: Through the plate's diameter



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

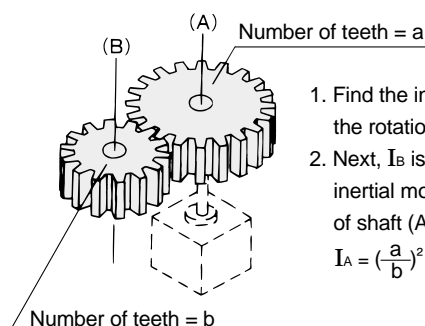
9. Load at the end of lever



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

(Example) When the shape of m₂ 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.

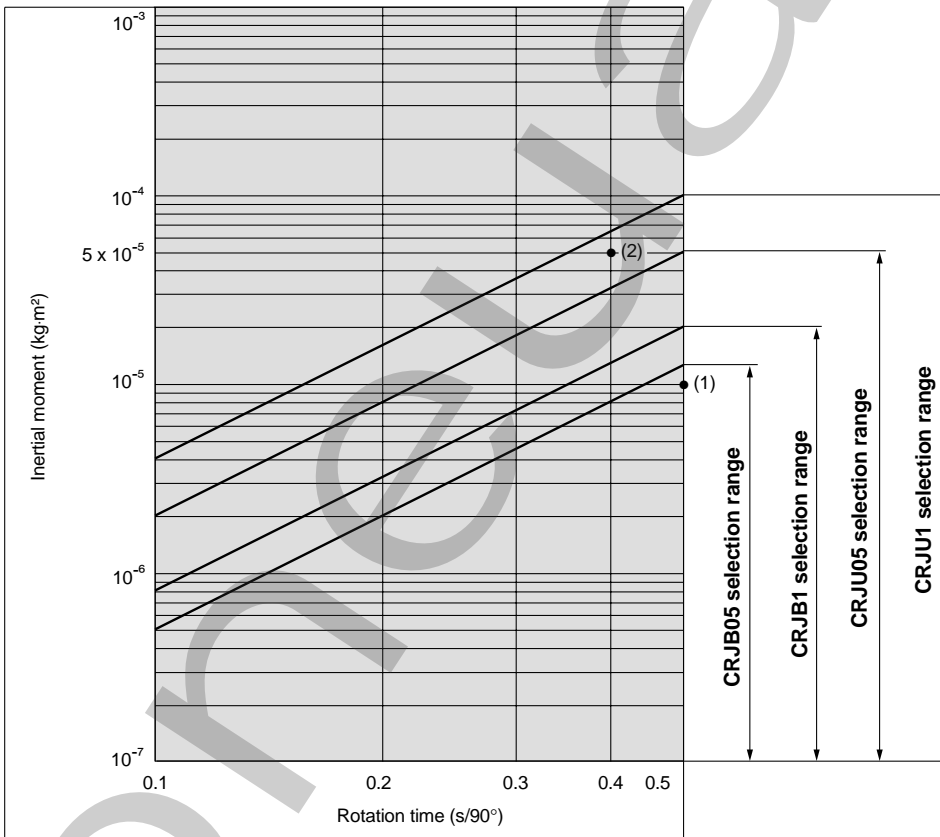
Size		Model	Allowable kinetic energy mJ	Rotation time adjustment range for stable operation s/90°
05	Basic type	CRJB05	0.25	0.1 to 0.5
	With external stopper	CRJU05	1.0	
1	Basic type	CRJB 1	0.40	
	With external stopper	CRJU 1	2.0	

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 $1 \times 10^{-5} \text{kg.m}^2$
 - Rotation time $0.5 \text{s}/90^\circ$
- CRJB05 is selected in this case.

2. <Calculation example>

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

Rotation time: $0.4 \text{s}/90^\circ$

$$I = 0.04 \times 0.05^2 / 2 = 5 \times 10^{-5} \text{kg.m}^2$$

In the inertial moment and rotation time chart, find the intersection of the lines extended from the points corresponding to $5 \times 10^{-5} \text{kg.m}^2$ on the vertical axis (inertial moment) and $0.4 \text{s}/90^\circ$ on the horizontal axis (rotation time).

Since the resulting intersection point falls within the CRJU1 selection range, CRJU1 may be selected.

Mini-Rotary Actuator Air Consumption

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

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

Formulas

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

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

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

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

Basic type CRJ B 05 — 90 E — F9B S

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

Rotation angle

90	90°
100	100°
180	180°
190	190°

Size

05
1

Number of auto switches

Nil	2 pcs.
S	1 pc.

Auto switch type

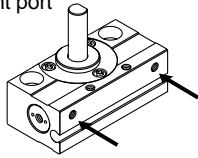
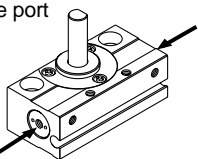
Nil	Without auto switch (built-in magnet)
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* Select applicable auto switches from the table below.

Rotation angle

90	90°
180	180°

Connecting port position

Nil	Front port 
E	Side port 

Applicable auto switches

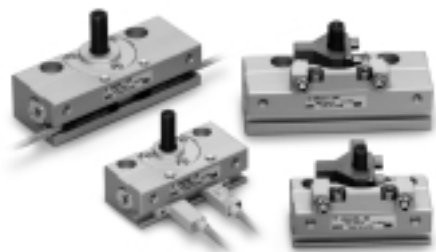
* Refer to pages 7 through 11 for detailed auto switch specifications.

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	—	●	●	○
				3-wire (NPN)				—	F9NW	●	●	○
								F8NW	—	●	●	○
				3-wire (PNP)				—	F9PW	●	●	○
								F8PW	—	●	●	○
2-wire	—	F9BW	●	●	○							
	F8BW	—	●	●	○							

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

* Auto switches marked "O" are produced upon receipt of order.

Series CRJ



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 <small>Note)</small>	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	

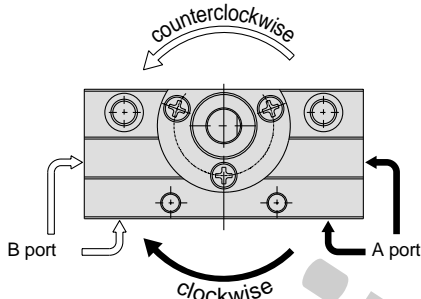
Weights

Type/Size	Model	Weight (g) <small>Note)</small>
Basic type	05	CRJB05-90
		CRJB05-100
		CRJB05-180
		CRJB05-190
	1	CRJB 1-90
		CRJB 1-100
		CRJB 1-180
CRJB 1-190		
With external stopper	05	CRJU05-90
		CRJU05-180
	1	CRJU 1-90
		CRJU 1-180

Note) Above values do not include auto switch weights.

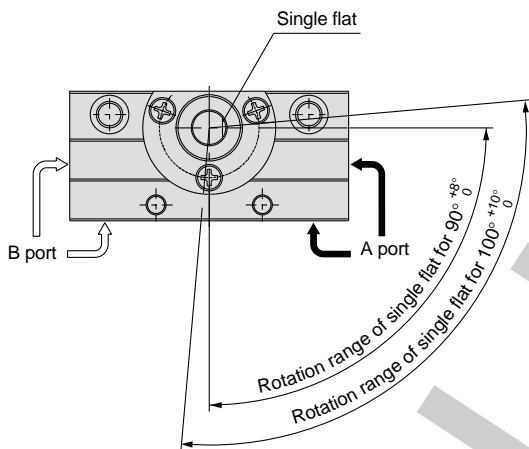
Rotating Direction and Rotation Angle

- 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.

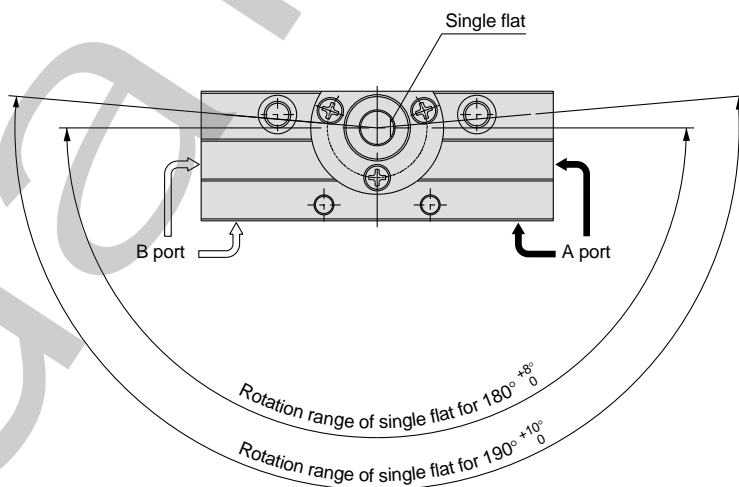


Basic type

For 90° and 100°

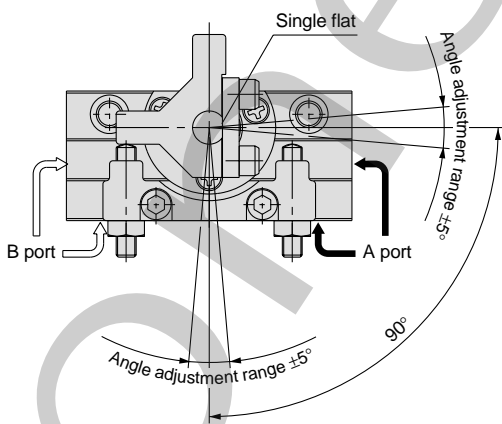


For 180° and 190°

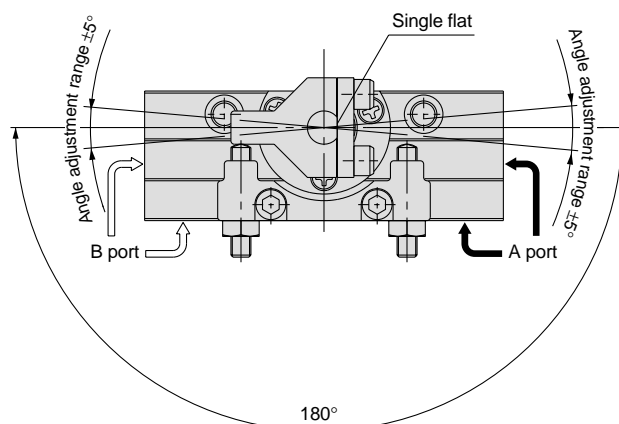


With external stopper

For 90°



For 180°

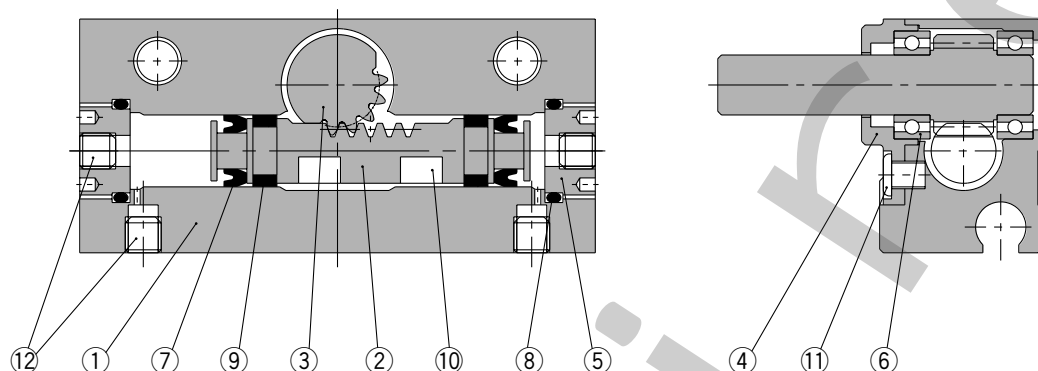


- Note) • The drawings show the rotation range for the shaft's single flat.
 • The single flat position in the drawings shows the counterclockwise rotation end when the rotation angle is adjusted to 90° and 180°.

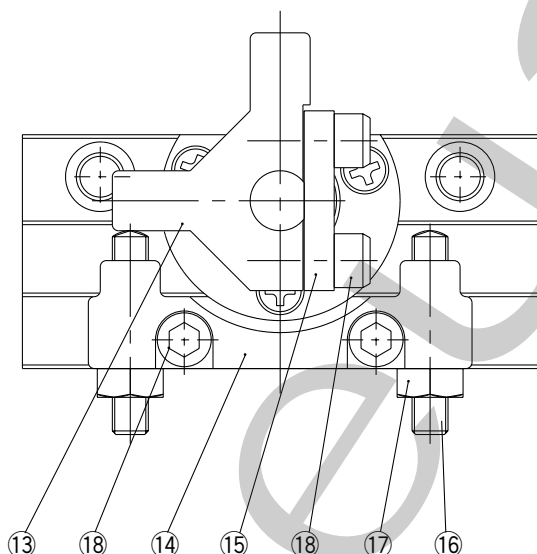
Series CRJ

Construction

Basic type/CRJB



With external stopper/CRJU



Parts list

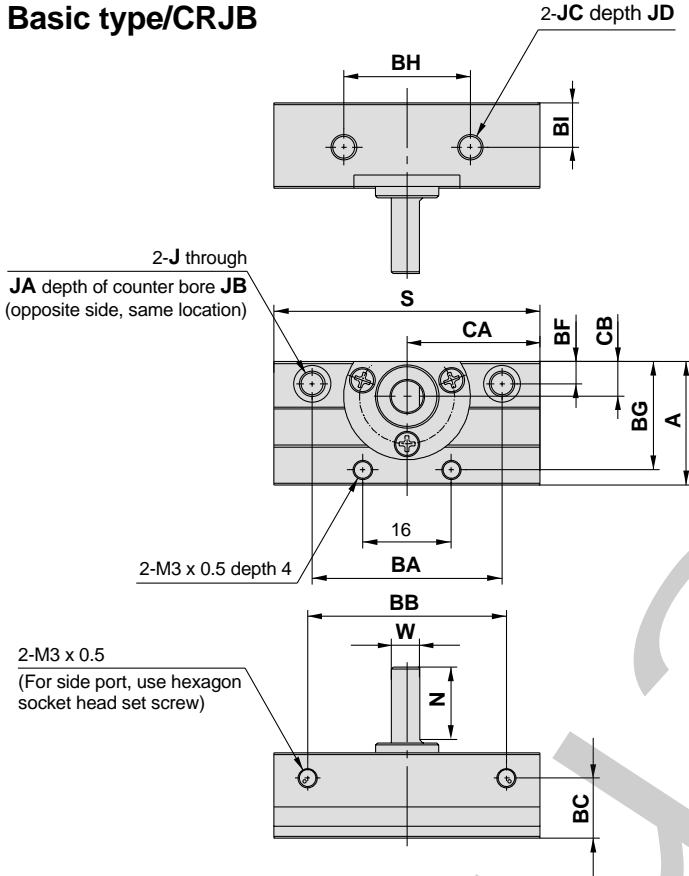
No.	Description	Material
1	Body	Aluminum alloy
2	Piston	Stainless steel
3	Shaft	Stainless steel
4	Bearing retainer	Aluminum alloy
5	Cover	Aluminum alloy
6	Bearing	Bearing steel
7	Piston seal	NBR
8	O-ring	NBR
9	Wear ring	Resin

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

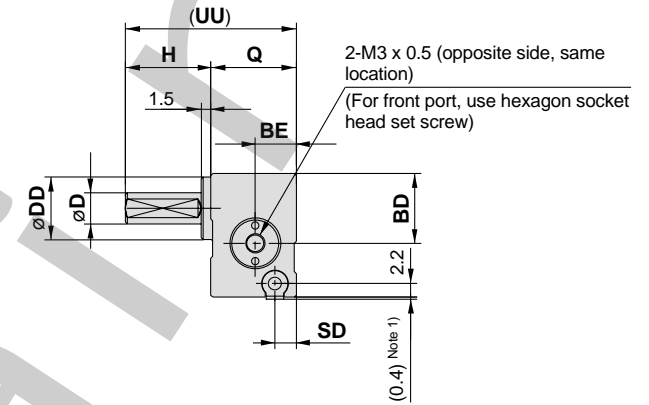
* The mounting position of hexagon socket head set screws (no. 12) varies depending on the connecting port position.

Dimensions/Size 0.5, 1

Basic type/CRJB



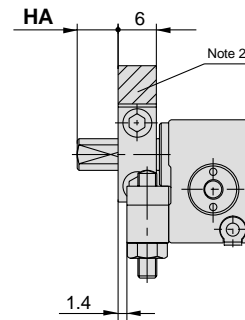
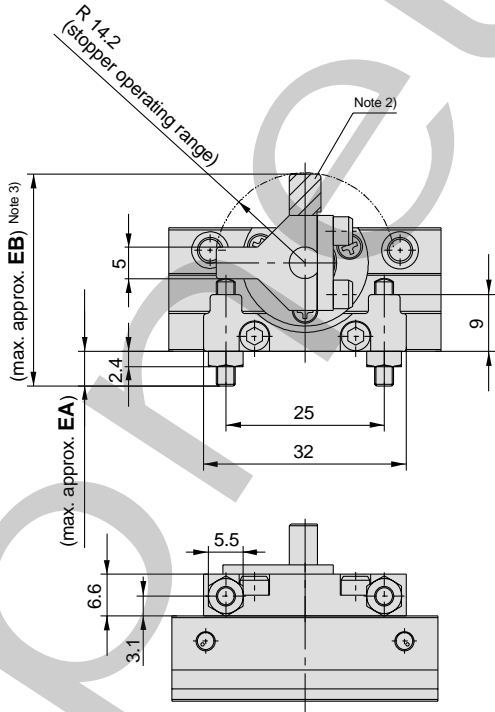
Note 1) This dimension is for the actuator with D-F9 type auto switch (not including the 2-color indication type).



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)

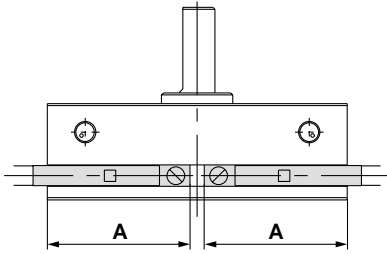
Size	EA	EB	HA
CRJU05	5.6	33.8	6.5
CRJU 1	5.6	35.8	7.5

(mm)

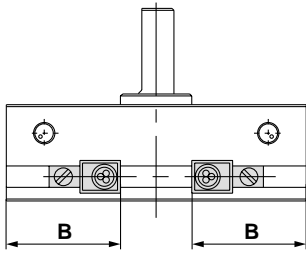
Size	Rotation angle	A	BA	BB	BC	BD	BE	BF	BG	BH	BI	CA	CB	D	DD	J	JA	JB	JC	JD	H	N	Q	S	SD	UU	W
CRJB05	90°	19.5	30	32.4	9.5	11	6.5	3.5	17.1	20	7	21.5	5.5	5g6	10h9	M4 x 0.7	5.8	3.5	M4 x 0.7	5	14.5	12.5	13.5	43	3.4	28	4.5
	180°			43.4								27												54			
CRJB 1	90°	23.5	35	37.4	12.5	14	9	4.5	21.1	22	8.5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

Series CRJ

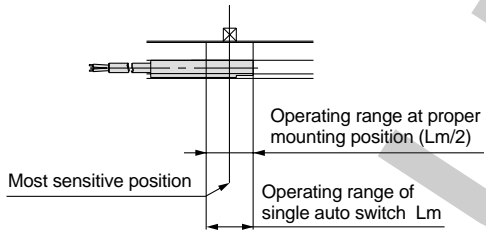
Auto Switch/Proper Mounting Position at Rotation End



For D-F9



For D-F8



Size	Rotation	D-F9 auto switch			D-F8 auto switch		
		A	Rotation range θ_m	Actuation range	B	Rotation range θ_m	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 θ_m : Value of the operating range L_m of a single auto switch converted to an axial rotation range.

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

Series CRJ

Auto Switch Common Specifications

Auto Switch Common Specifications

Type	Solid state switch
Operating time	1ms or less
Impact resistance	1000m/s ²
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 P/A 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

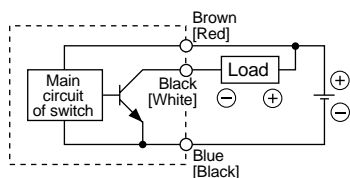
Solid state with latch type diagnostic output

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

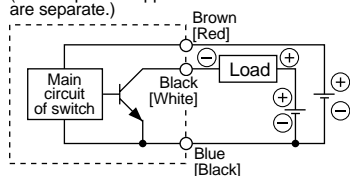
Series CRJ Auto Switch Connections and Examples

Basic Wiring

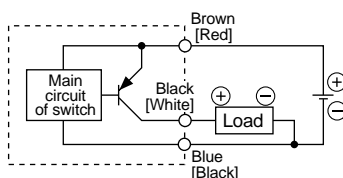
Solid state 3-wire, NPN



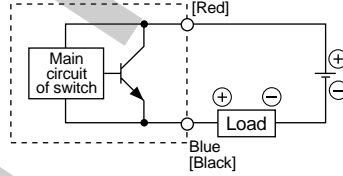
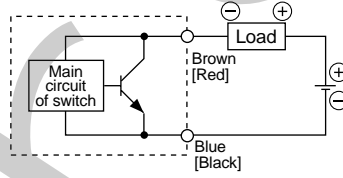
(In case power supplies for switch and load are separate.)



Solid state 3-wire, PNP



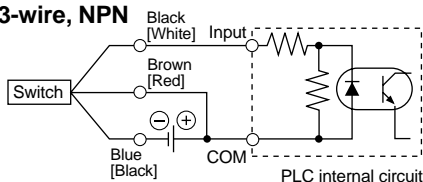
2-wire <Solid state>



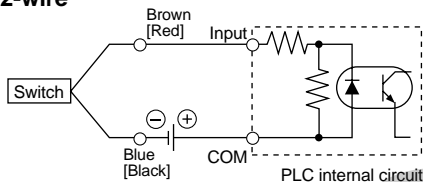
Examples of Connection to PLC

Sink input specifications

3-wire, NPN

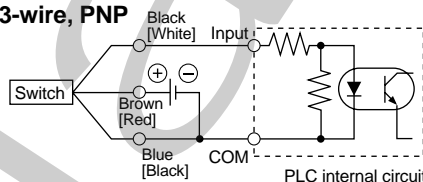


2-wire

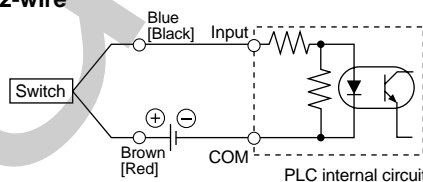


Source input specifications

3-wire, PNP



2-wire

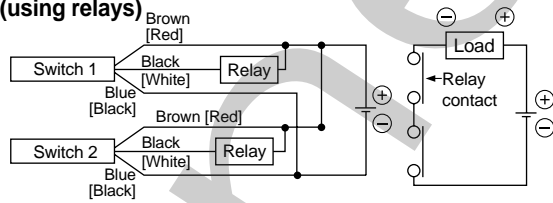


The connection method will vary depending on the applicable PLC input specifications. Connect accordingly.

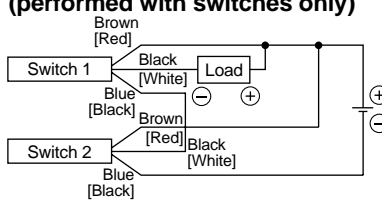
Connection Examples for AND (Series) and OR (Parallel)

3-wire

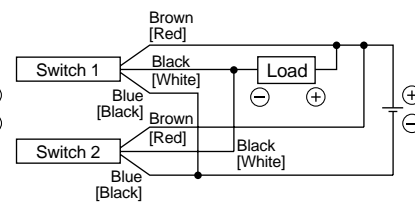
AND connection for NPN output (using relays)



AND connection for NPN output (performed with switches only)

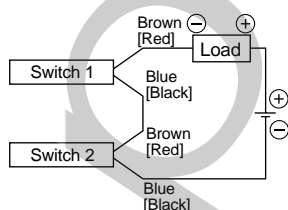


OR connection for NPN output



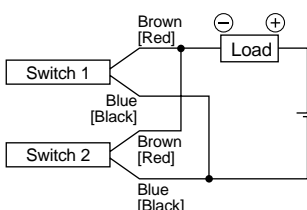
The indicator lights will light up when both switches are turned ON.

2-wire, with 2-switch AND connection



When two switches are connected in series, a load may malfunction because the load voltage will 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.

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

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

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

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

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

Grommet



Auto Switch Specifications

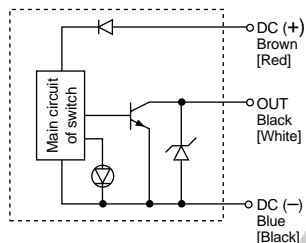
D-F8□ (with indicator light)			
Auto switch part no.	D-F8N	D-F8P	D-F8B
Electrical entry direction	Perpendicular	Perpendicular	Perpendicular
Wiring	3-wire		2-wire
Output	NPN type	PNP type	—
Applicable load	IC circuit, 24VDC relay, PLC		24VDC relay, PLC
Power supply voltage	5, 12, 24VDC (4.5 to 28VDC)		—
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, $\phi 2.7$, 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.

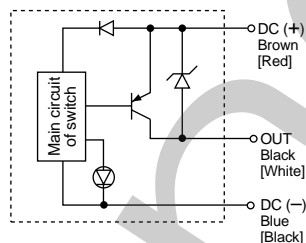
Auto switch internal circuits

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

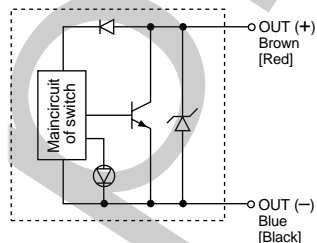
D-F8N



D-F8P



D-F8B



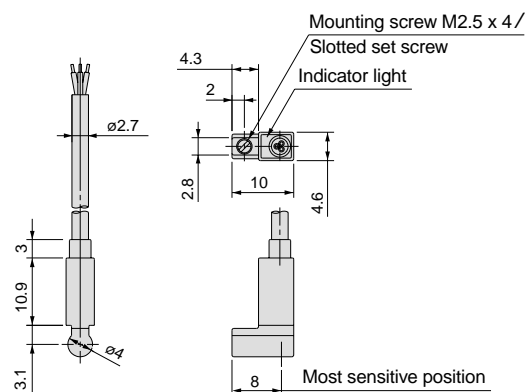
Auto Switch Weights

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

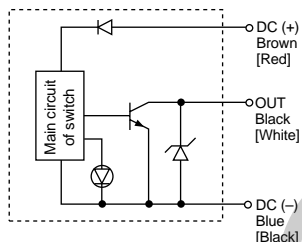
D-F9□ (with indicator light)			
Auto switch part no.	D-F9N	D-F9P	D-F9B
Electrical entry direction	In-line	In-line	In-line
Wiring	3-wire		2-wire
Output	NPN type	PNP type	—
Applicable load	IC circuit, Relay, PLC		24VDC relay, PLC
Power supply voltage	5, 12, 24VDC (4.5 to 28VDC)		—
Current consumption	10mA 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.

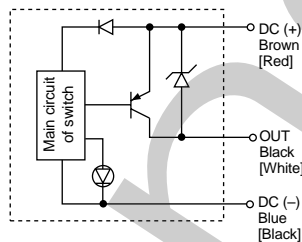
Auto switch internal circuits

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

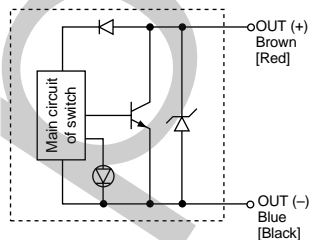
D-F9N



D-F9P



D-F9B



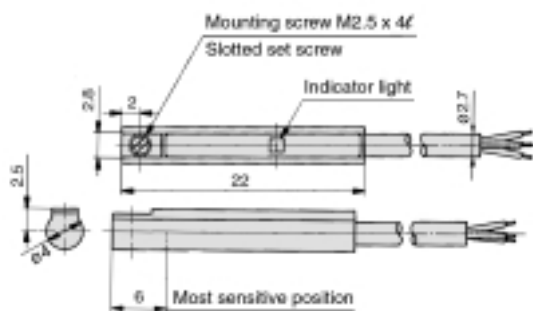
Auto Switch Weights

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



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

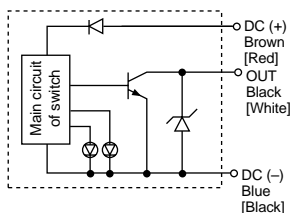
Grommet



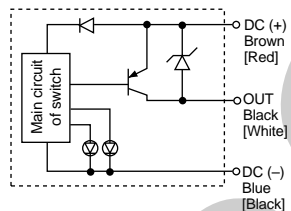
Auto switch internal circuits

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

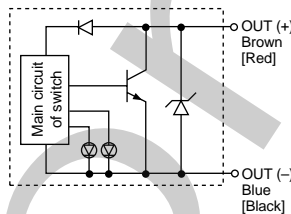
D-F9NW



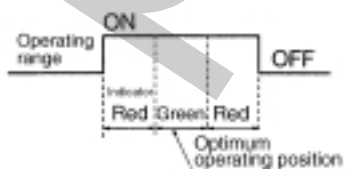
D-F9PW



D-F9BW



Indicator light/Display method



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, $\phi 2.7$, 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

Model	Unit: g		
	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

