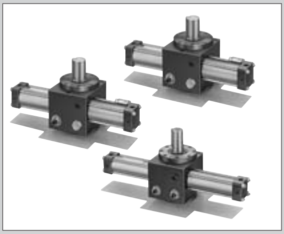
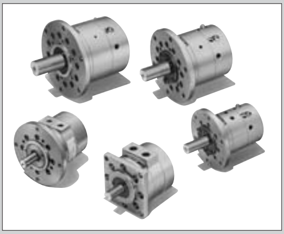
Rotary Actuators

35RP2 Series ··········· HM2



70RV Series ··········· HM16



- The rotary actuators come in five cylinder bores from 32 to 80 mm and three mounting styles, SD, FA and FB.
- The unique backlash eliminating mechanism prevents backlash at the rotating ends.
- The rotating angle can be adjusted in the range of ±5° by the rotation angle fine adjustment mechanism.
- Versatile magnetic proximity sensors of AX and AZ types are standardized.
- The external dimensions and mounting dimensions are completely identical with those of 35RP.
- Since the piston contains a magnet, a sensor can be mounted after installation. (The same sensors as those of 35H-3R can be used.)

Main Body Specifications

Type	35RP2
Series Variation	Rack and pinion type
Bore (mm)	ϕ32·ϕ40·ϕ50·ϕ63·ϕ80
Rotating angle	90°·180°
Angle adjustment	±5°
Rated torque (at 3.5 MPa)	ϕ32: 60N·m ϕ40: 106N·m ϕ50: 220N·m ϕ63: 436N·m ϕ80: 840N·m
Maximum allowable pressure	3.5 MPa
Proof test pressure	5 MPa
Minimum operating pressure	0.5 MPa
Working temperature range	+10 to +60℃ (ambient/fluid temperature)
Adaptable fluid	Petroleum-based fluid (When using another fluid, refer to the table of fluid adaptability.)
Gear oil	JIS 2219, Class 2 (gear oil equivalent to ISO VG680)
Tolerance for thread	JIS 6g/6H
Mounting style	SD, FA, FB

Terminologies

Maximum allowable pressure
Maximum allowable pressure generated in a cylinder (surge pressure, etc.).

Proof test pressure
Test pressure against which a cylinder can withstand without unreliable performance at the return to nominal pressure.

Minimum operating pressure
Minimum pressure at which cylinder installed horizontally operates under no load.

Adaptability of Fluid

Adaptable fluid				
Petroleum-based fluid	Water-glycol fluid	Phosphate ester fluid	Water in oil fluid	Oil in water fluid
○	×	×	△	△

Note) ○: Applicable, ×: Inapplicable. Consult us before using the △-marked items.

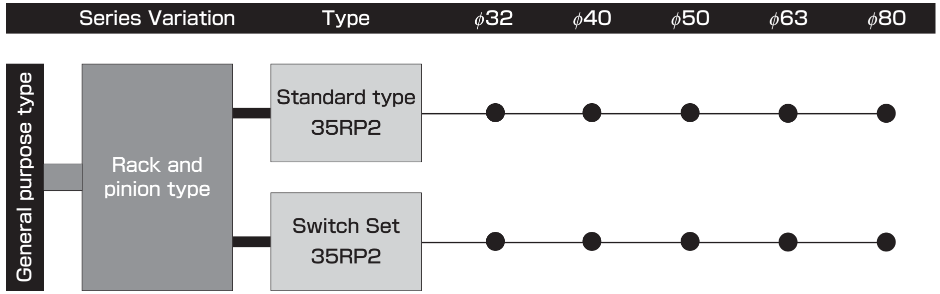
Amount of Fluid Necessary for Rotation

Unit: mℓ

Rotating angle / Bore mm	90°	180°
ϕ32	28.3	53.4
ϕ40	51.9	99.5
ϕ50	104.3	202.6
ϕ63	203.8	399.9
ϕ80	410.5	788.3

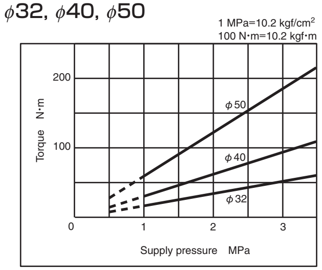
Product Lineup

Unit: mm

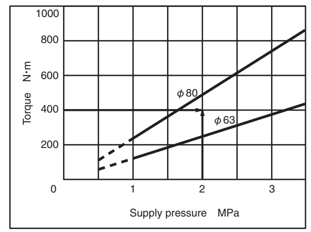


Theoretical Output Torque Charts

● Bore ϕ32, ϕ40, ϕ50



● Bore ϕ63, ϕ80



How to read the graph

When a torque of 400 N·m is required at a working pressure of 2 MPa, determine the intersection of the lines extended from the vertical axis of supply pressure and the horizontal axis of torque. Find the bore above this intersection, and the bore of 80 mm can be selected.

Note) Determine the effective torque based on the following data.
When the inertia force is low: 60 to 80%
When the inertia force is high: 25 to 35%

Weight Table

Unit: kg

Bore / Rotating angle	Basic weight (SD style) Standard type	Mounting accessory weight FA style FB style	Sensor additional weight 1 piece
ϕ32-90°	5.0	0.94	
ϕ32-180°	5.2		
ϕ40-90°	8.8	1.57	AX/AZ type
ϕ40-180°	9.2		Cord length 1.5 m: 0.05
ϕ50-90°	13.9	2.09	Cord length 5 m: 0.13
ϕ50-180°	14.7		With connector: 0.04
ϕ63-90°	24.2	3.56	SR405
ϕ63-180°	25.8		Cord length 5 m: 0.22
ϕ80-90°	41.0	6.54	
ϕ80-180°	44.1		

Calculation formula : Weight of rotary actuator (kg)
=basic weight+mounting accessory weight
+sensor additional weight×sensor quantity

Calculation example: Standard type, bore ϕ40, rotating angle 180°, FA style, 2 pcs of AX215 (cord length 5 m)
9.2+1.57+0.13×2=11.03kg

● How to order

Type ❶ / Mounting style ❷ / Cylinder bore ❸ / Rotating angle ❹ / Sensor symbol ❺ / Sensor quantity ❻

●Standard type: 35RP2 – SD 32 T 90

●Switch Set: 35RP2 – SD 32 T 90 – AH 2

Mounting style
SD, FA, FB

Cylinder bore (mm)
φ32·φ40·φ50·φ63·φ80

90	90°
180	180°

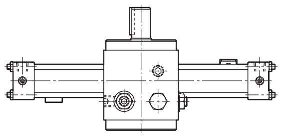
Sensor symbol
Note) Select applicable sensors out of the Sensor List.

Sensor quantity (1 or 2)

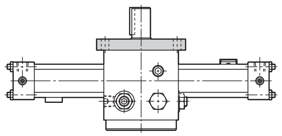
❗ Note on ordering Switch Set
●Sensors are mounted on cylinders at delivery.

Mounting Style

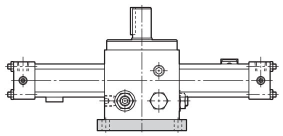
SD SD style (basic style)



FA FA style



FB FB style



Sensor List

Type	Sensor symbol	Load voltage range	Load current range	Max. switching capacity	Protective circuit	Indicating lamp	Wiring method	Cord length	Applicable load
Reed sensor	AF AX101CE	DC:5 to 30 V AC:5 to 120 V	DC:5 to 40 mA AC:5 to 20 mA	DC: 1.5 W AC: 2 VA	None	LED (Lights in red when sensing)	0.3 mm², 2-core, outer dia. φ4 mm, rear wiring	1.5 m	Small relay, programmable controller
	AG AX105CE							5 m	
	AH AX111CE				Provided			1.5 m	
	AJ AX115CE							5 m	
	AE AX125CE	DC: 30 V or less AC: 120 V or less	DC: 40 mA or less AD: 20 mA or less		None	None		5 m	
	AK AX11ACE	AC:5 to 120 V	5 to 20 mA	2 VA	Provided	LED (Lights in red when sensing)	4-pin connector type, rear wiring	0.5 m	
	AL AX11BCE	DC:5 to 30 V	5 to 40 mA	1.5 W				0.5 m	
	AP AZ101CE	DC:5 to 30 V AC:5 to 120 V	DC:5 to 40 mA AC:5 to 20 mA	DC: 1.5 W AC: 2 VA	None	LED (Lights in red when sensing)	0.3 mm², 2-core, outer dia. φ4 mm, upper wiring	1.5 m	
	AR AZ105CE							5 m	
	AS AZ111CE				Provided			1.5 m	
	AT AZ115CE							5 m	
	AN AZ125CE	DC: 30 V or less AC: 120 V or less	DC: 40 mA or less AD: 20 mA or less		None	None		5 m	
	AU AZ11ACE	AC:5 to 120 V	5 to 20 mA	2 VA	Provided	LED (Lights in red when sensing)	4-pin connector type, rear wiring	0.5 m	
	AW AZ11BCE	DC:5 to 30 V	5 to 40 mA	1.5 W				0.5 m	
	AM AX135CE	AC/DC: 90 to 240 V	5 to 300 mA	B contact output	Provided	LED (Lights in red when not sensing)	0.3 mm², 2-core, outer dia. φ4 mm, rear wiring	5 m	
	AY AZ135CE						0.3 mm², 2-core, outer dia. φ4 mm, upper wiring	5 m	
	S SR405	AC: 80 to 220 V	2 to 300 mA	30 VA	Provided	Neon lamp (Lights when not sensing)	0.5 mm², 2-core, outer dia. φ6 mm, rear wiring	5 m	
Solid state sensor	BE AX201CE-1	DC: 5 to 30V	5 to 40 mA	—	Provided	LED (Lights in red when sensing)	0.3 mm², 2-core, outer dia. φ4 mm, rear wiring	1.5 m	Small relay, programmable controller
	BF AX205CE-1							5 m	
	CE AX211CE-1					LED (2-LED type in red/green)		1.5 m	
	CF AX215CE-1							5 m	
	BM AZ201CE-1					LED (Lights in red when sensing)	0.3 mm², 2-core, outer dia. φ4 mm, upper wiring	1.5 m	
	BN AZ205CE-1							5 m	
	CM AZ211CE-1					LED (2-LED type in red/green)		1.5 m	
	CN AZ215CE-1							5 m	
	CT AX211CE-1					LED (2-LED type in red/green)	0.3 mm², 2-core, outer dia. φ4 mm, rear wiring	1.5 m	
	CU AX215CE-1							5 m	
	CV AX21BCE-1						4-pin connector type, rear wiring	0.5 m	
	CW AZ211CE-1						0.3 mm², 2-core, outer dia. φ4 mm, upper wiring	1.5 m	
	CX AZ215CE-1							5 m	
	CY AZ21BCE-1						4-pin connector type, upper wiring	0.5 m	

Notes) ●For the sensors without a protective circuit, be sure to provide a protective circuit (SK-100) with the load when using any induction load (relay, etc.).
●The output logic of AX and AZ135CE is B contact. When the piston is detected, the sensor contact turns off (the lamp turns on).
●The cutting oil proof WR and WS type sensors can be mounted. (However, the rotary actuator bodies are not cutting oil proof.) For the details of the sensors, be sure to see the sensor specifications at the end of this catalog.
●We recommend AND Unit (AU series) for multiple sensors connected in series. For details, refer to AND Unit at the end of this catalog.

●General purpose type

AX type sensor

Cord type

Connector type

SR type sensor

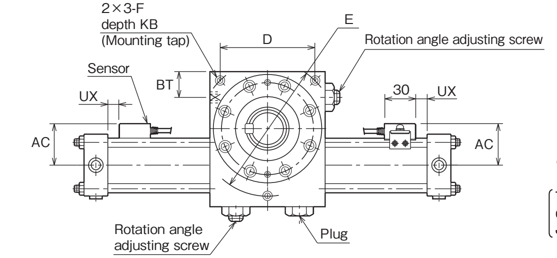
35RP2
Rotary Actuators

Unit: mm

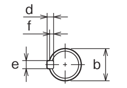
CAD/DATA 35RP2/T35RP2 Bore is available.

SD

35RP2 – SD Bore T90 – Sensor symbol Sensor quantity

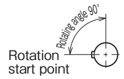


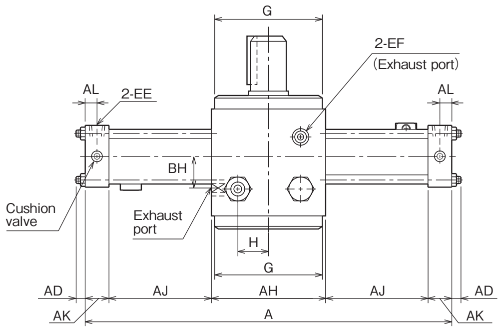
● Shaft end

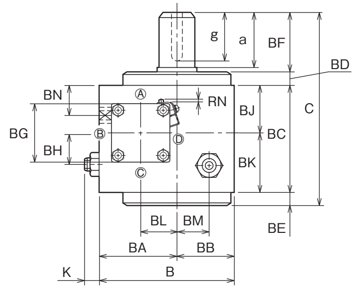


The parallel key conforms to JIS B0903.

● Rotation start point and rotating angle



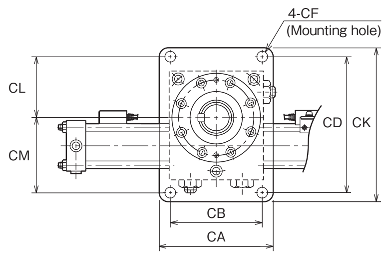


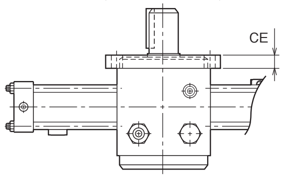


● The standard type and Switch Set Cylinders have the same external dimensions.
● UX is the sensor mounting dimension for detection of rotating end.

FA

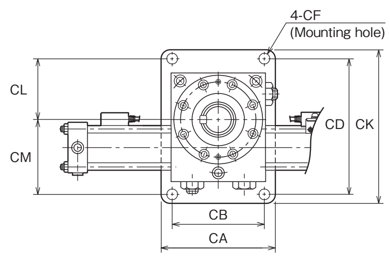
35RP2 – FA Bore T90 – Sensor symbol Sensor quantity

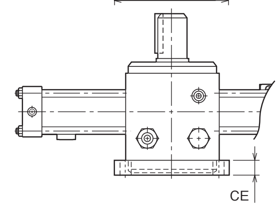




FB

35RP2 – FB Bore T90 – Sensor symbol Sensor quantity





Unit: mm

Dimensional Table

Symbol / Bore	A	AC	AD	AH	AJ	AK	AL	B	BA	BB	BC	BD	BE	BF	BG	BH	BJ	BK
ϕ 32	302	37 or less	7	88	82	25	11	102	58	44	82	12	12	38	□44	24	36	46
ϕ 40	333	40 or less	7	106	88.5	25	11	125	72	53	97	13	14	60	□50	30	43	54
ϕ 50	383	45 or less	9	120	106.5	25	11	140	80	60	112	15	15	60	□62	34	50	62
ϕ 63	455	51 or less	10	144	130.5	25	11	168	96	72	133	14	16	84	□76	40	60	73
ϕ 80	518	59 or less	10	168	143	32	14	200	116	84	156	18	20	84	□94	53	68	88

Symbol / Bore	BL	BM	BN	BT	C	CA	CB	CD	CE	CF	CK	CL	CM	D	E	EE
ϕ 32	24	20	24.5	24	144	105	85	125	13	ϕ9	145	55	70	71.4	101	Rc1/4
ϕ 40	30	27	27	26	184	125	100	150	15	ϕ9	180	65	85	86.3	122	Rc3/8
ϕ 50	40	33	30	27	202	145	120	170	16	ϕ11	195	75	95	98.3	139	Rc3/8
ϕ 63	50	40	34	32	247	175	140	210	18	ϕ14	240	90	120	116.7	165	Rc3/8
ϕ 80	59	48	35	36	278	210	170	250	22	ϕ16	290	110	140	137.9	195	Rc1/2

Symbol / Bore	EF	F	G	H	K	KB	RN	Shaft end					
								a	b	d	e	f	g
ϕ 32	Rc1/4	M8×1.25	ϕ83h7	20	10	16	7 or less	36	ϕ22h6	6	6	3.5	32
ϕ 40	Rc3/8	M8×1.25	ϕ104h7	27	12	16	5 or less	58	ϕ30h6	7	8	4	50
ϕ 50	Rc3/8	M10×1.5	ϕ117h7	33	14	20	4 or less	58	ϕ38h6	8	10	5	50
ϕ 63	Rc1/2	M12×1.75	ϕ140h7	40	16	18	4 or less	82	ϕ50h6	9	14	5.5	70
ϕ 80	Rc1/2	M14×2	ϕ164h7	48	19	21	3 or less	82	ϕ55h6	10	16	6	70

Sensor Mounting Dimension

Bore	UX	
	AX/AZ type	SR type
ϕ 32	8	0
ϕ 40	9	0
ϕ 50	12	5
ϕ 63	13	7
ϕ 80	22	14

Operating Range and Hysteresis

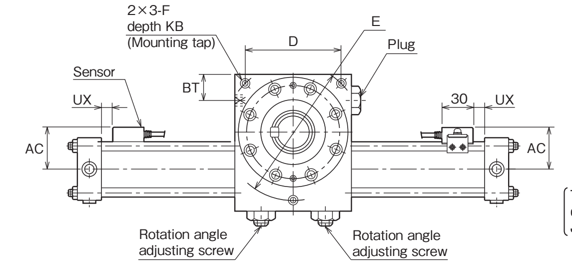
Bore	Reed sensor				Solid state sensor	
	AX/AZ type		SR type		AX/AZ type	
	Operating range	Hysteresis	Operating range	Hysteresis	Operating range	Hysteresis
ϕ 32	5 to 9	1 or less	7 to 10	2 or less	3 to 5	1 or less
ϕ 40	5 to 9	1.5 or less	5 to 7		3 to 5	
ϕ 50	5 to 10	1 or less	7 to 11		4 to 6	
ϕ 63	5 to 10	1 or less	7 to 11		4 to 6	
ϕ 80	5 to 11	1 or less	8 to 12		4 to 6	

Unit: mm

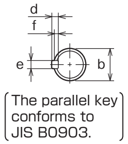
CAD/DATA 35RP2/T35RP2 Bore is available.

SD

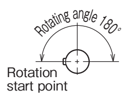
35RP2 – SD Bore T180 – Sensor symbol Sensor quantity

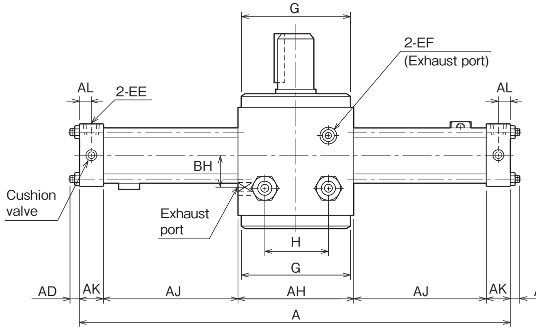


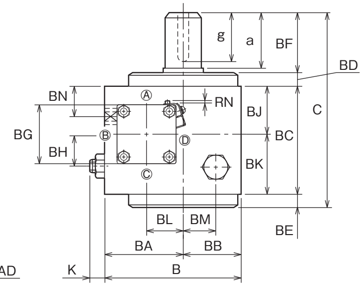
●Shaft end



●Rotation start point and rotating angle



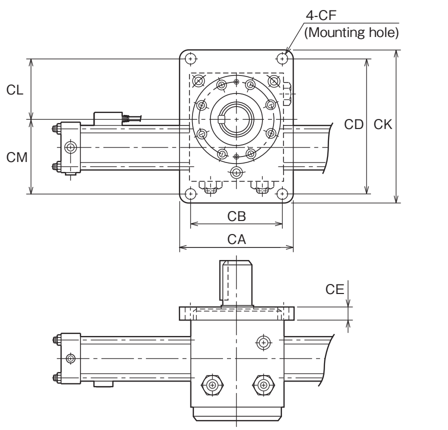




●The standard type and Switch Set Cylinders have the same external dimensions.
●UX is the sensor mounting dimension for detection of rotating end.

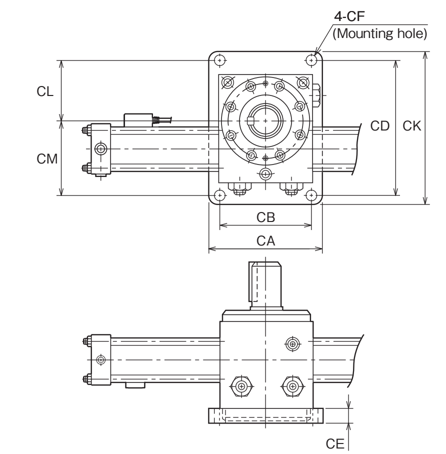
FA

35RP2 – FA Bore T180 – Sensor symbol Sensor quantity



FB

35RP2 – FB Bore T180 – Sensor symbol Sensor quantity



Dimensional Table

Bore \ Symbol	A	AC	AD	AH	AJ	AK	AL	B	BA	BB	BC	BD	BE	BF	BG	BH	BJ	BK
φ32	364	37 or less	7	88	113	25	11	102	58	44	82	12	12	38	□44	24	36	46
φ40	409	40 or less	7	106	126.5	25	11	125	72	53	97	13	14	60	□50	30	43	54
φ50	483	45 or less	9	120	156.5	25	11	140	80	60	112	15	15	60	□62	34	50	62
φ63	581	51 or less	10	144	193.5	25	11	168	96	72	133	14	16	84	□76	40	60	73
φ80	668	59 or less	10	168	218	32	14	200	116	84	156	18	20	84	□94	53	68	88

Bore \ Symbol	BL	BM	BN	BT	C	CA	CB	CD	CE	CF	CK	CL	CM	D	E	EE
φ32	24	20	24.5	24	144	105	85	125	13	φ9	145	55	70	71.4	101	Rc1/4
φ40	30	27	27	26	184	125	100	150	15	φ9	180	65	85	86.3	122	Rc3/8
φ50	40	33	30	27	202	145	120	170	16	φ11	195	75	95	98.3	139	Rc3/8
φ63	50	40	34	32	247	175	140	210	18	φ14	240	90	120	116.7	165	Rc3/8
φ80	59	48	35	36	278	210	170	250	22	φ16	290	110	140	137.9	195	Rc1/2

Bore \ Symbol	EF	F	G	H	K	KB	RN	Shaft end					
								a	b	d	e	f	g
φ32	Rc1/4	M8×1.25	φ83h7	40	10	16	7 or less	36	φ22h6	6	6	3.5	32
φ40	Rc3/8	M8×1.25	φ104h7	54	12	16	5 or less	58	φ30h6	7	8	4	50
φ50	Rc3/8	M10×1.5	φ117h7	66	14	20	4 or less	58	φ38h6	8	10	5	50
φ63	Rc1/2	M12×1.75	φ140h7	80	16	18	4 or less	82	φ50h6	9	14	5.5	70
φ80	Rc1/2	M14×2	φ164h7	96	19	21	3 or less	82	φ55h6	10	16	6	70

Sensor Mounting Dimension

Bore	UX	
	AX/AZ type	SR type
φ32	8	0
φ40	9	0
φ50	12	5
φ63	13	7
φ80	22	14

Operating Range and Hysteresis

Bore	Reed sensor				Solid state sensor	
	AX/AZ type		SR type		AX/AZ type	
	Operating range	Hysteresis	Operating range	Hysteresis	Operating range	Hysteresis
φ32	5 to 9	1 or less	7 to 10	2 or less	3 to 5	1 or less
φ40	5 to 9	1.5 or less	5 to 7		3 to 5	
φ50	5 to 10	1 or less	7 to 11		4 to 6	
φ63	5 to 10	1 or less	7 to 11		4 to 6	
φ80	5 to 11	1 or less	8 to 12		4 to 6	

Selection Materials

To select a type in 35RP2 Series, it is necessary to determine the following conditions.

- ● Supply pressure ● Magnitude and condition of load
- ● Rotating angle ● Rotating speed
- ● Frequency of operation ● Ambient conditions
- ● Place of use ● Existence of external stopper

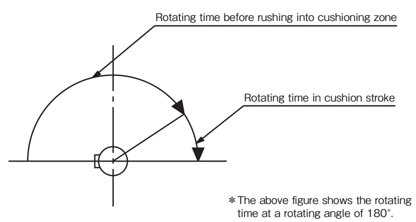
Although 35RP2 Series has a built-in cushioning mechanism, energy which can be absorbed by the internal cushion is limited as in the case of cylinders.
When the kinetic energy of a load is absorbed by the internal cushion without an external stopper, the energy which can be absorbed depends on the inertia moment and the angular speed at the rotating end. In other words, the angular speed at the rotating end depends on the rotating time.
The kinetic energy E of a load at the rotating end is expressed by the following formula:

$$E=\frac{1}{2}I\omega^2 \text{ (J)}$$

I : inertia moment (kg·m^2)
ω: angular speed at rotating end (rad/s)

To correctly use 35RP2 Series, utilize the graph shown right.
For the inertia moment, see the calculation table.

Rotating time



Working Rotating Time (not incl. cushioning zone)

Unit: s

Bore mm \ Rotating angle	90°	180°
ϕ32	0.2 to 4	0.3 to 7
ϕ40	0.2 to 5	0.3 to 8
ϕ50	0.3 to 8	0.4 to 12
ϕ63	0.4 to 11	0.5 to 16
ϕ80	0.4 to 13	0.6 to 19

Setting of rotating time

⚠CAUTION

Use the actuator within the range of rotating time shown in the above table. If it is used for more than the specified rotating time, smooth operation cannot be obtained due to stick-slip, etc. If the rotating time is less than the specified time, the actuator may be damaged.

1. Relationship between inertia moment and rotating time (not incl. cushioning zone)

1kg·m^2=10.2kgf·cm·sec^2

Chart A -1
Rotating angle 90°/Bore ϕ32, ϕ40, ϕ50

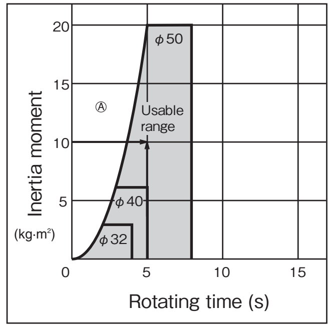


Chart A -2
Rotating angle 90°/Bore ϕ63, ϕ80

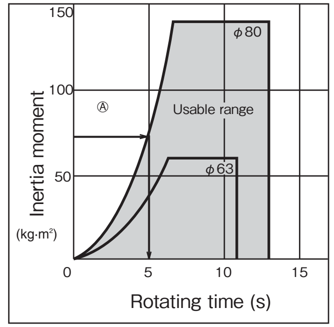


Chart A -3
Rotating angle 180°/Bore ϕ32, ϕ40, ϕ50

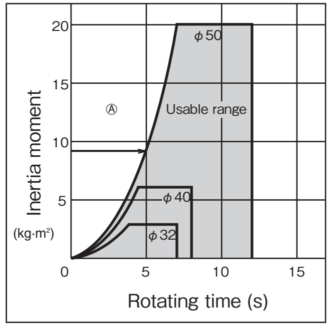
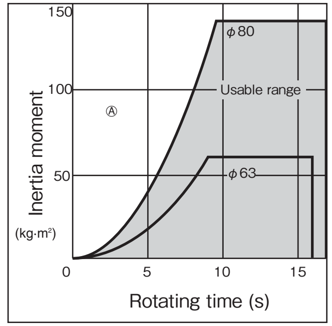


Chart A -4
Rotating angle 180°/Bore ϕ63, ϕ80



2. Relationship between inertia moment and rotating time (cushioning zone)

Chart B -1
Bore ϕ32, ϕ40, ϕ50

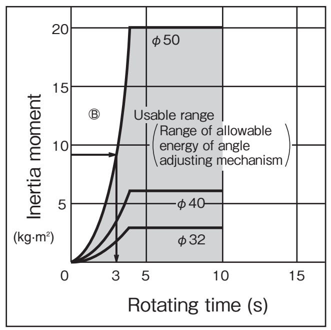
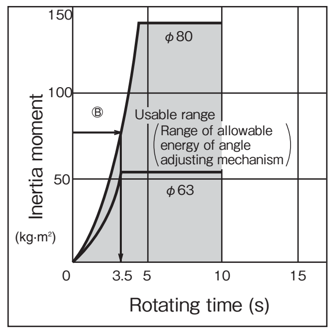
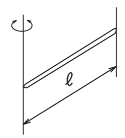
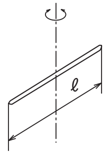
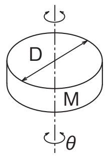


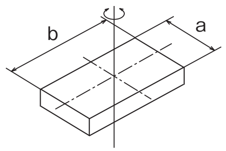
Chart B -2
Bore ϕ63, ϕ80

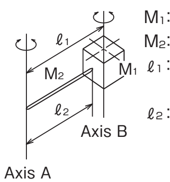


Inertia Moment Calculation Table

<table>
<tr><th>Outline</th><th>I: Inertia moment</th><th>Outline</th><th>I: Inertia moment</th></tr>
<tr><td>● When the axis is at the bar end

</td><td>$I=\frac{M\ell^2}{3}$</td><td>● When the axis is in the center of bar


Note)The axis passes through the center of gravity.</td><td>$I=\frac{M\ell^2}{12}$</td></tr>
<tr><td>● In the case of cylinder solid (incl. disc)


Note)The axis passes through the center of gravity.</td><td>$I=\frac{MD^2}{8}$</td><td>● In the case of rectangular solid


Note)The axis passes through the center of gravity.</td><td>$I=\frac{M}{12}(a^2+b^2)$</td></tr>
<tr><td>● In the case of arm (rotating around axis A)


M_1: weight of weight
M_2: weight of arm
ℓ_1: distance from axis A to weight center
ℓ_2: arm length</td><td>$I=M_1\ell_1^2+I_1+\frac{M_2\ell_2^2}{3}$
I_1: inertia moment of the weight based on the axis (axis B) passing through the center of gravity of the weight</td><td colspan="2">I (I_1): inertia moment kg·m²
M (M_1, M_2): weight kg
ℓ, a, b: length m
D: diameter m</td></tr>
</table>

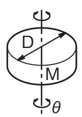
● **Example**

Select a type to rotate a 140-kg and ϕ2-m load 90°.

Weight of disc M=140 kg

Diameter of disc D=2 m

Rotating angle θ=90° =1.5708 rad



① **Determine the inertia moment.**

$I=\frac{MD^2}{8}=\frac{140\times2^2}{8}=70\ \mathrm{kg\cdot m^2}$

The rotating time at an inertia moment of 70 kg·m² is 5 seconds (ϕ80) according to Graph Ⓐ-2.

The rotating time in the cushioning zone is 3.5 seconds (ϕ80) according to Graph Ⓑ-2.

Therefore, adjust the flow control valve to obtain a rotating time of 5 seconds or more, and adjust the cushion to set the rotating time in the cushioning zone to 3.5 seconds.

② **Determine the necessary torque.**

θ_1=cushion angle θ_1 of 80 mm bore actuator is 18° (0.3142 rad).

Angular acceleration $\alpha=\frac{\theta-\theta_1}{t^2}=\frac{1.5708-0.3142}{5^2}=0.05\ \mathrm{rad/s^2}$

The effective torque is 25 to 35% when the inertia force is high. Therefore, the effective torque is regarded as 35%.

Required torque $T=\frac{I\alpha}{0.35}=\frac{70\times0.05}{0.35}=10\ \mathrm{kgf\cdot m}=98\ \mathrm{N\cdot m}$

According to the theoretical output torque charts, an 80 mm bore actuator is usable. Then, select 35RP2-SD80T90.

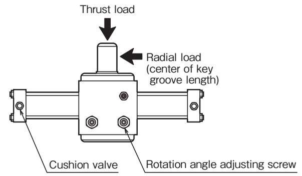
Notes)
- ● If the obtained intersection is in area Ⓐ, the kinetic energy of the load can be effectively absorbed if an external stopper and an external shock absorber are used.
- ● When an external shock absorber is used, use the actuator with the internal cushion fully open.

Precautions for use

⚠CAUTION

- ● To install the rotary actuator, use hex. head bolts (JIS B1180, strength class 10.9 or over) or hex. socket head cap screws (JIS B1176, strength class 10.9 or over).
  1) Secure the actuator using all mounting holes.
  2) Take care not to tighten the bolts unevenly. Tighten them to the tightening torque specified for the bolts used.
  3) Take care not to apply any external load other than the main body load to the bolts. (Use durable mounting materials.)

- ● Take care that loads other than the following will not be applied directly to the shaft.



Allowable Radial and Thrust Loads

Unit: N

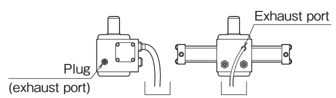
Bore mm \ Load	Radial load	Thrust load
ϕ32	686	392
ϕ40	1420	785
ϕ50	1860	1080
ϕ63	2450	1470
ϕ80	2940	1770

- ● At the rotating end of the rotary actuator, bring the shaft into contact with the rotation angle adjusting screw under the condition of sufficient cushioning effect. If the cushion is not effective, the rotation angle adjusting screw may be damaged.

Cushion Stroke Angle

Bore	Cushion angle
ϕ32	37°
ϕ40	31°
ϕ50	22°
ϕ63	17°
ϕ80	18°

- ● If the kinetic energy is so large that the cushion cannot absorb the energy, the rack and pinion or the key groove may be damaged. In this case, use a shock absorber.
- ● Before shipment, both exhaust ports are plugged to prevent leakage of gear oil during transportation. Before starting the test run, remove the plug of the upper one of the two exhaust ports in the body, and connect a pipe to avoid accumulation of pressure in the body (to open to the atmosphere). If pressure is accumulated in the body, the oil seals may be damaged.



- ● Use gear oil equivalent to ISO VG680. Change the oil 500,000 times of actuation after the start of use and, after this, every 1,000,000 times. (The actuator has been charged with the above gear oil for a single time before shipment.)
- ● Pour the gear oil from the port to be used as an exhaust port. (The oil quantity is shown in the following table.)

Oil Quantity

Unit: mℓ

Bore mm \ Rotating angle	90°	180°
ϕ32	80	90
ϕ40	180	190
ϕ50	270	300
ϕ63	430	490
ϕ80	740	850

Notes on installation

- ● To install the rotary actuator, use hex. head bolts (JIS B1180, strength class 10.9 or over) or hex. socket head cap screws (JIS B1176, strength class 10.9 or over).
- ● Use durable mounting materials.

Operation procedures

① When operating the rotary actuator for the first time, discharge air from the actuator at a low pressure. After the completion of discharge, start the actuator at a reduced pressure, and gradually increase the pressure to the working pressure. However, keep the pinion rotation speed (under no load) at about 1 sec at 90° or about 2 sec at 180° while increasing the pressure.

② Before starting the test run or adjusting the rotating speed or the cushion deceleration, loosen the rotation angle adjusting screw about five turns to avoid application of excessive load or impact to the rotation angle fine adjustment mechanism.

③ Adjust the cushion while gradually increasing the rotation speed. (The cushion has not been adjusted before shipment.) If the rotation speed is increased at the beginning of operation, abnormal surge pressure may occur and damage the rotary actuator or machine.

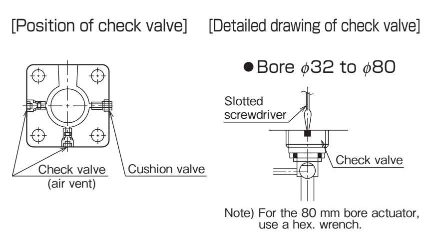
④ Adjust the rotating angle. Before adjusting the rotating angle, turn the seal (Daithread) to separate it from the body end face, and after the completion of adjustment, turn it again to bring it into close contact with the body end face. Then, tighten the locknut.

When overhauling the rotary actuator, replace all seals (seals and gaskets).

How to discharge air

⚠CAUTION

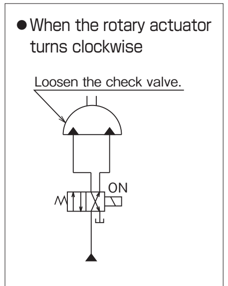
- If the check valve is loosened excessively during discharging of air, the valve may come off the cylinder, and it may fly out or the fluid may spout out.

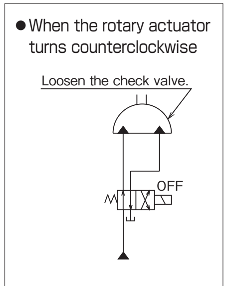


- Feed the fluid at a low pressure (minimum operating pressure: approx. 0.5 MPa) to the rotary actuator, loosen the check valve one or two turns (turn counterclockwise) to discharge air.

Note) Repeat these operations until air is completely discharged.

- After discharging air, tighten the check valve to the specified torque, and make sure that the fluid does not leak. [Specified torque: 8 to 10 N·m]





- Discharge air not only from the rotary actuator, but also from the piping. If air is left in the piping, the following operation failures may occur.

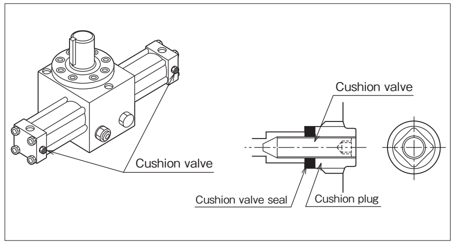
Phenomena

- The cylinder causes stick-slip.
- Smooth speed control cannot be made.
- Temperature rise caused by adiabatic compression can damage the seals.
- Shock and vibration are given to the outside.

How to adjust cushion

⚠CAUTION

- If the cushion valve or plug is excessively loosened while adjusting the cushion, the cushion valve or plug may come off the cylinder, and it may fly out, or the fluid may spout out.



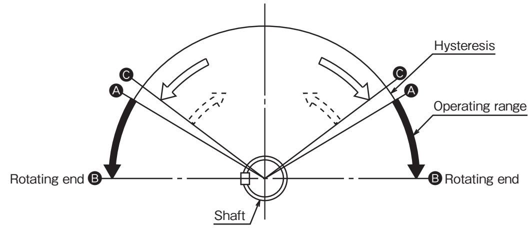
1) Loosen the cushion plug approx. 1/4 turn with a spanner.
2) Turn the cushion valve with a hex. wrench to adjust the speed.
   - Turn clockwise, and the cushion stroke speed will be decreased.
   - Turn counterclockwise, and the cushion stroke speed will be increased.

<Caution>

If the valve is excessively turned counterclockwise, the cushion will not be effective. If it is excessively turned clockwise, the cushion will work so effectively that the piston may not operate full stroke.
In addition, abnormal surge pressure may occur and damage the rotary actuator.

3) After the completion of adjustment of the cushion valve, secure the cushion valve with a hex. wrench, and tighten the cushion valve to the specified torque. [Specified torque: 12 to 15 N·m]
   Make sure that oil does not leak from any part. (If the tightening torque is insufficient, the fluid may leak.)
   - In the following cases, the cushioning effect cannot be obtained.
     - When the rotating speed is extremely low
     - When the rotating speed is high
     - When the inertia moment is large

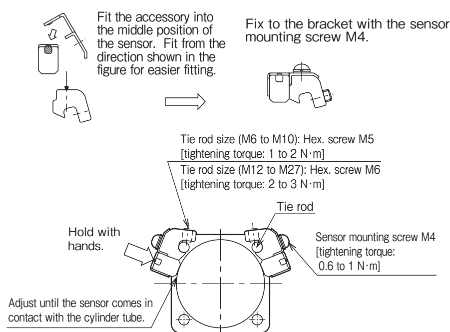
Operating Range and Hysteresis



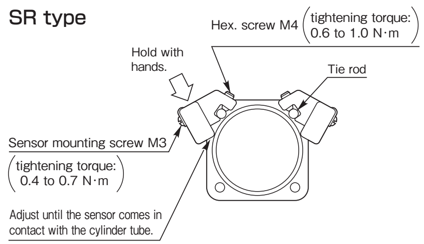
If the shaft rotates in the arrow ⇦ direction, the sensor turns on when the shaft reaches the sensor operating position Ⓐ. The sensor is kept on in the range from Ⓐ to Ⓑ. This range is called the operating range.
If the shaft turns in the reverse direction ⇨ after the shaft reaches the position Ⓐ and the sensor turns on, the sensor is kept on until the shaft reaches the position Ⓒ.
The distance between Ⓐ and Ⓒ is called hysteresis.

Setting method of sensor detecting position

AX type



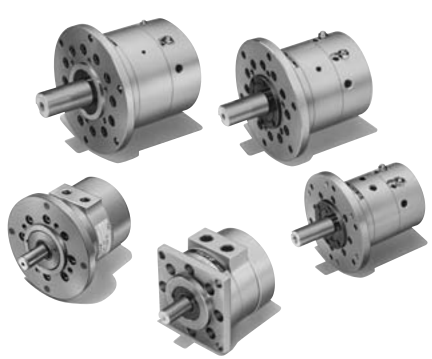
SR type



1. Loosen the two set screws with an allen wrench, and move the sensor along the tie rod.
2. Adjust the detecting position (for the 2-LED type, the position where the green lamp lights up) 2 to 5 mm (about half of the operating range is appropriate) before the required position where the sensor indicator lamp starts to light up (ON). Then, gently hold the top of the sensor so that the cylinder tube contacts the detecting face of the sensor, and clamp the hex. screw to an appropriate tightening torque.
   Note) Inappropriate tightening torque may cause the off-center of the sensor position.
3. The indicating lamp lights up when the sensor is set to the ON position.
   (The lamp of SR405 goes out when the sensor turns on.)
4. Sensors can be mounted to any of four tie rods and on the most suitable position depending on the mounting space of the cylinder and wiring method.
5. Mount a sensor to the most suitable position to detect the stroke end with the "sensor mounting dimension" (dimension UX).

Vane type actuators with max. working pressure of 7 MPa

- Single vane and double vane type rotary actuators are standardized.
- Available the cushion model.
- The shaft parallel key (single key) .



Specifications: Standard type

Model \ Item	Vane type	Rotating angle	Port size	Internal volume cm³	nternal leakage rate cm³ /min (at 40℃)	Allowable inertia energy J	Allowable load: Radial load	Allowable load: Thrust load	Weight kg	Remarks
70RV 10	Single	$270^{\circ}\,^{+3}_{0}$	Rc1/8	10	10	0.013	9.81	4.90	1	Standard
	Double	$90^{\circ}\,^{+3}_{0}$		6.5	20					
70RV 15	Single	$270^{\circ}\,^{+3}_{0}$	Rc1/8	17	15	0.025	19.6	9.81	2	
	Double	$90^{\circ}\,^{+3}_{0}$		11	30					
70RV 20	Single	$270^{\circ}\,^{+3}_{0}$	Rc1/8	24	20	0.046	49.0	24.5	3	
	Double	$90^{\circ}\,^{+3}_{0}$		16	40					
70RV 30	Single	$270^{\circ}\,^{+3}_{0}$	Rc1/8	51	30	0.088	78.5	39.2	4.3	
	Double	$90^{\circ}\,^{+3}_{0}$		34	60				4.5	
70RV 100	Single	$270^{\circ}\,^{+3}_{0}$	Rc1/4	111	50	0.255	147	68.6	10.2	
	Double	$90^{\circ}\,^{+3}_{0}$		74	100				10.4	
70RV 200	Single	$270^{\circ}\,^{+3}_{0}$	Rc3/8	221	100	0.510	294	137	20.0	Order made
	Double	$90^{\circ}\,^{+3}_{0}$		147	200				20.5	
70RV 400	Single	$270^{\circ}\,^{+3}_{0}$	Rc3/8	435	100	0.755	343	167	32	
	Double	$90^{\circ}\,^{+3}_{0}$		290	200				33	
70RV 700	Single	$270^{\circ}\,^{+3}_{0}$	Rc1/2	780	100	0.912	343	167	41	
	Double	$90^{\circ}\,^{+3}_{0}$		520	200				43	

Common conditions

- Adaptable fluids: Petroleum-based fluid (When using another fluid, specify the fluid.) Recommended fluid: ISO VG32 to 56 (ISO viscosity grade)
- Nominal pressure: 7 MPa
- Minimum operating pressure: 1 MPa
- Proof test pressure: 10.5 MPa
- Hydraulic fluid temperature: 0 to +60℃ (No freezing)
- Use the actuators indoors.
- Do not use them in a place where they are exposed to considerable dust or vibration.

Notes) ● For the internal structure, refer to the sectional drawings at the end of this catalog.
● The hydraulic pressure generated in an actuator due to the inertia of load must be lower than the proof test pressure.

Adaptability of Fluid

Adaptable fluid				
Petroleum-based fluid	Water-glycol fluid	Phosphate ester fluid	Water in oil fluid	Oil in water fluid
○	○	×	×	×

Specifications: With cushion

Model \ Item	Vane type	Rotating angle	Port size	Internal volume cm³	nternal leakage rate cm³ /min (at 40℃)	Allowable load: Radial load	Allowable load: Thrust load	Weight kg
70RV 10	Single	$180^{\circ}\,^{+3}_{0}$	Rc1/8	6.5	10	9.81	4.90	1.2
		$90^{\circ}\,^{+3}_{0}$		3.3				
70RV 15	Single	$180^{\circ}\,^{+3}_{0}$	Rc1/8	11	15	19.6	9.81	2.4
		$90^{\circ}\,^{+3}_{0}$		5.5				
70RV 20	Single	$180^{\circ}\,^{+3}_{0}$	Rc1/8	16	20	49.0	24.5	3.3
		$90^{\circ}\,^{+3}_{0}$		8				
70RV 30	Single	$180^{\circ}\,^{+3}_{0}$	Rc1/8	34	30	78.5	39.2	4.7
		$90^{\circ}\,^{+3}_{0}$		17				4.8
70RV 100	Single	$180^{\circ}\,^{+3}_{0}$	Rc1/4	74	50	147	68.6	13.5
		$90^{\circ}\,^{+3}_{0}$		37				13.8
70RV 200	Single	$180^{\circ}\,^{+3}_{0}$	Rc3/8	147	100	294	137	25.7
		$90^{\circ}\,^{+3}_{0}$		73.5				26.4
70RV 400	Single	$180^{\circ}\,^{+3}_{0}$	Rc3/8	290	100	343	167	34
		$90^{\circ}\,^{+3}_{0}$		145				35
70RV 700	Single	$180^{\circ}\,^{+3}_{0}$	Rc1/2	520	100	343	167	44
		$90^{\circ}\,^{+3}_{0}$		260				46

Cushion Specifications

Model \ Item	Max. inertia moment kg·m²	Max. inrush angular speed rad/s	Cushion angle rad	Max. absorbed energy, Working pressure MPa: 2	3	4	5	6	7
70RV 10	0.098	10.4	0.349 (20°)	2.06	1.77	1.47	1.18	0.883	0.588
70RV 15	0.196	10.4	0.436 (25°)	4.81	4.12	3.43	2.75	2.06	1.37
70RV 20	0.294	10.4	0.436 (25°)	7.55	6.47	5.39	4.31	3.24	2.16
70RV 30	0.588	10.4	0.436 (25°)	15.1	12.9	10.8	8.63	6.47	4.31
70RV 100	1.47	8.7	0.436 (25°)	30.9	26.5	22.1	17.7	13.2	8.83
70RV 200	3.92	6.9	0.436 (25°)	78.9	67.7	56.4	45.1	33.8	22.6
70RV 400	6.86	5.2	0.436 (25°)	137	118	98.1	78.5	58.8	39.2
70RV 700	13.7	4.3	0.436 (25°)	251	215	179	143	107	71.6

Note) From the viewpoint of the torque efficiency, the working pressure should be 2 MPa or more. If the actuator is used at a pressure of less than 2 MPa for unavoidable reasons, the max. absorbed energy is the same as that at a working pressure of 2 MPa.

70RV Rotary Actuators

● How to order

General Purpose Type

Model ❶ / Type ❷ / Vane type ❸ / Cushion ❹ / Rotating angle ❺

● Standard type: 70RV 10 S — 270

● With cushion: 70RV 10 S C — 180

Standard type
10·15·20·30·100·200·400·700

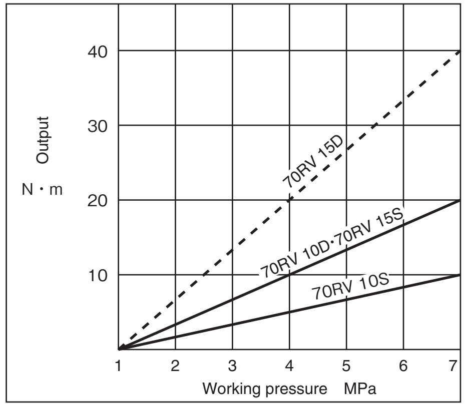
S	Single vane
D	Double vane

Standard type	
270	270° (only single vane type)
90	90° (only double vane type)
With cushion	
90	90°
180	180°

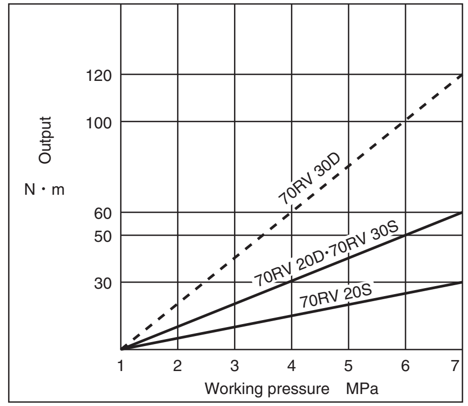
Output Characteristic Charts (Theoretical torque)

1MPa=10.2kgf/cm²
10N·m=1.02kgf·m

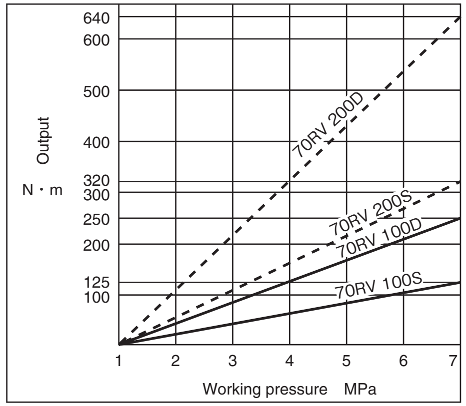
70RV 10·15



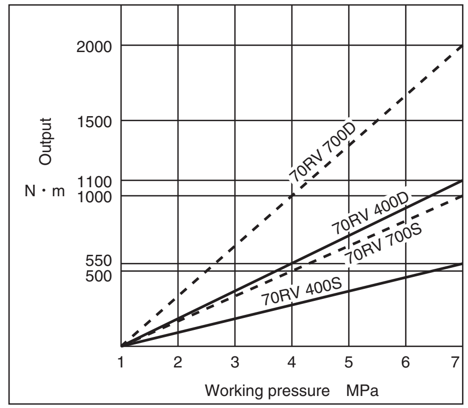
70RV 20·30



70RV 100·200



70RV 400·700



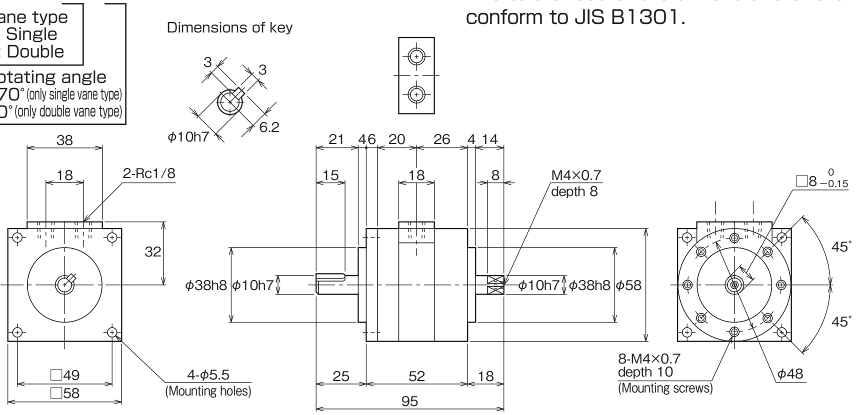
● These charts are common to the standard type and the type with cushion.

CAD/DATA 70RV/T70RV Bore is available.

70RV 10 ＊－＊

Vane type
S: Single
D: Double
Rotating angle
270° (only single vane type)
90° (only double vane type)

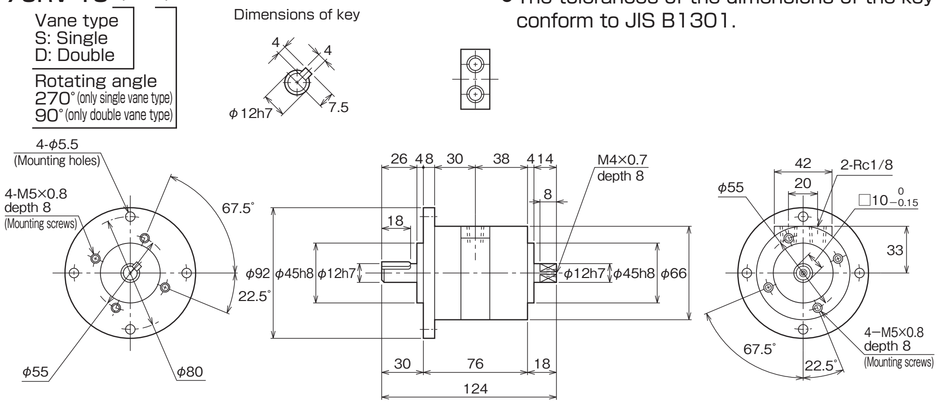
● The tolerances of the dimensions of the key conform to JIS B1301.



70RV 15 ＊－＊

Vane type
S: Single
D: Double
Rotating angle
270° (only single vane type)
90° (only double vane type)

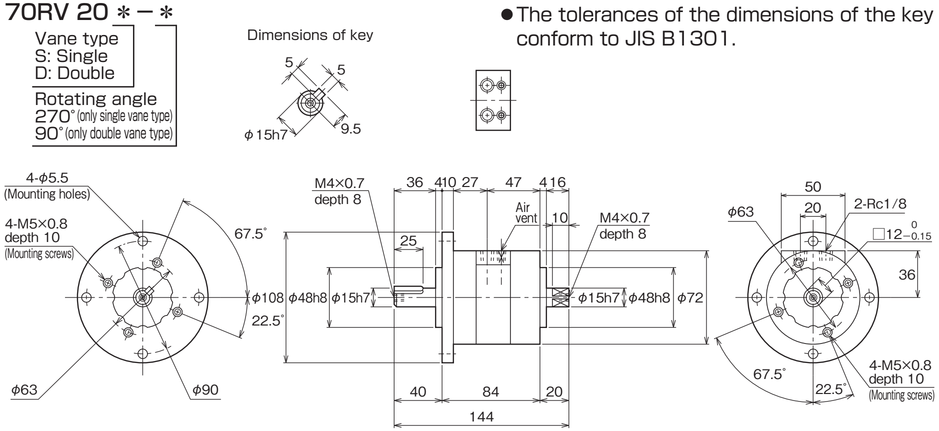
● The tolerances of the dimensions of the key conform to JIS B1301.



70RV 20 ＊－＊

Vane type
S: Single
D: Double
Rotating angle
270° (only single vane type)
90° (only double vane type)

● The tolerances of the dimensions of the key conform to JIS B1301.

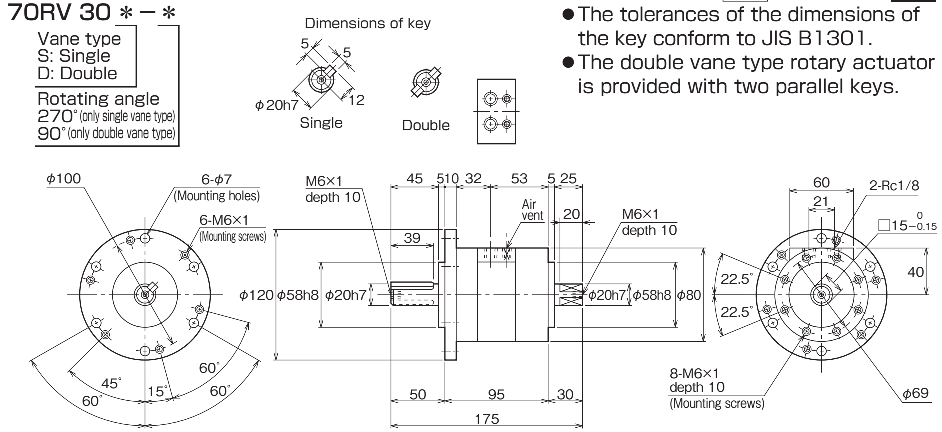


CAD/DATA 70RV/T70RV Bore is available.

70RV 30 ＊－＊

Vane type
S: Single
D: Double
Rotating angle
270° (only single vane type)
90° (only double vane type)

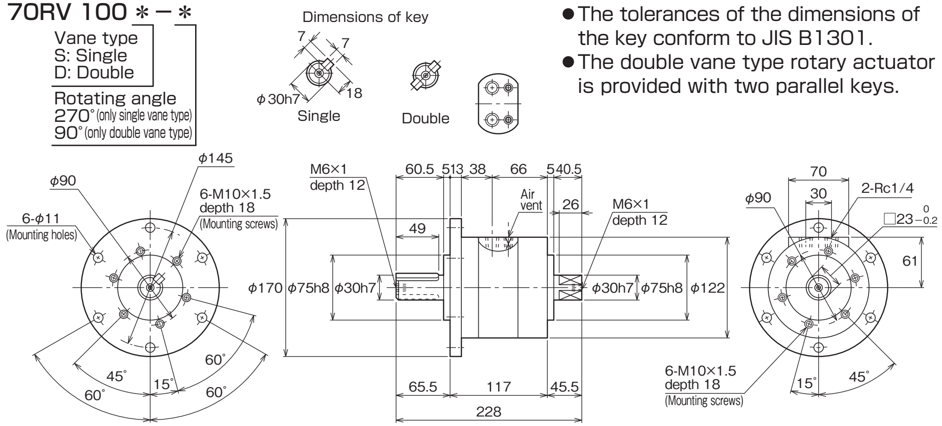
● The tolerances of the dimensions of the key conform to JIS B1301.
● The double vane type rotary actuator is provided with two parallel keys.



70RV 100 ＊－＊

Vane type
S: Single
D: Double
Rotating angle
270° (only single vane type)
90° (only double vane type)

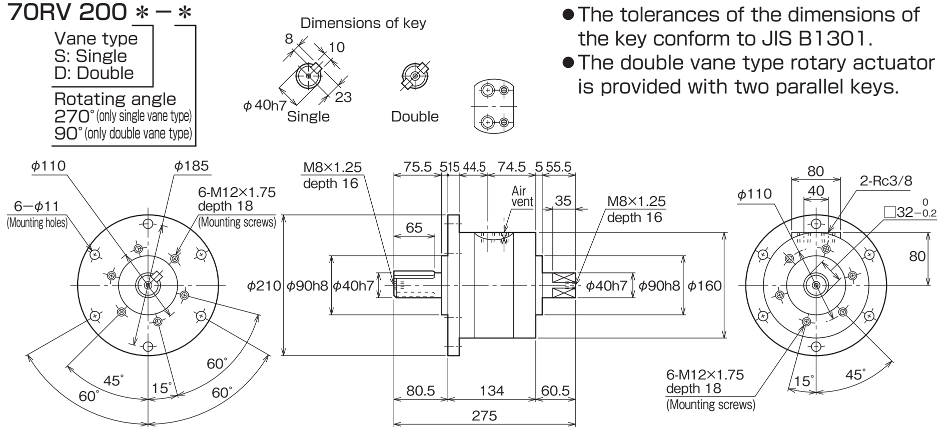
● The tolerances of the dimensions of the key conform to JIS B1301.
● The double vane type rotary actuator is provided with two parallel keys.



70RV 200 ＊－＊

Vane type
S: Single
D: Double
Rotating angle
270° (only single vane type)
90° (only double vane type)

● The tolerances of the dimensions of the key conform to JIS B1301.
● The double vane type rotary actuator is provided with two parallel keys.



7 MPa Vane Type Rotary Actuator Standard Type

Unit: mm

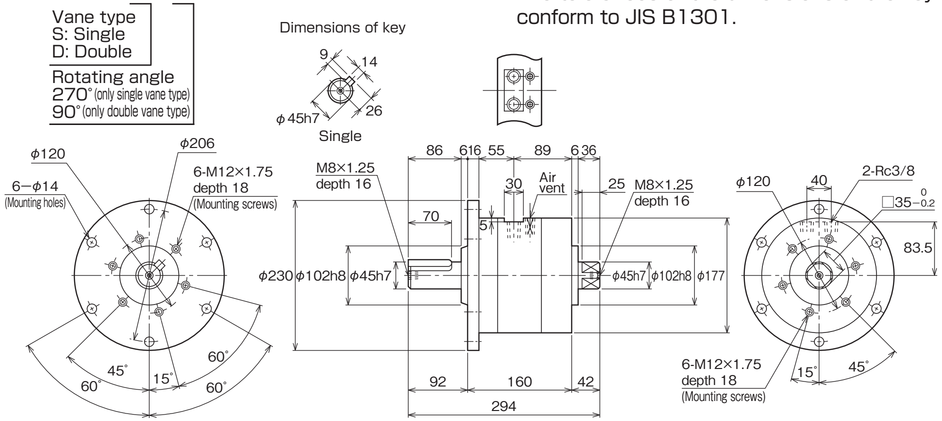
CAD/DATA 70RV/T70RV Bore is available.

70RV 400 ∗－∗

Vane type
S: Single
D: Double

Rotating angle
270° (only single vane type)
90° (only double vane type)

● The tolerances of the dimensions of the key conform to JIS B1301.

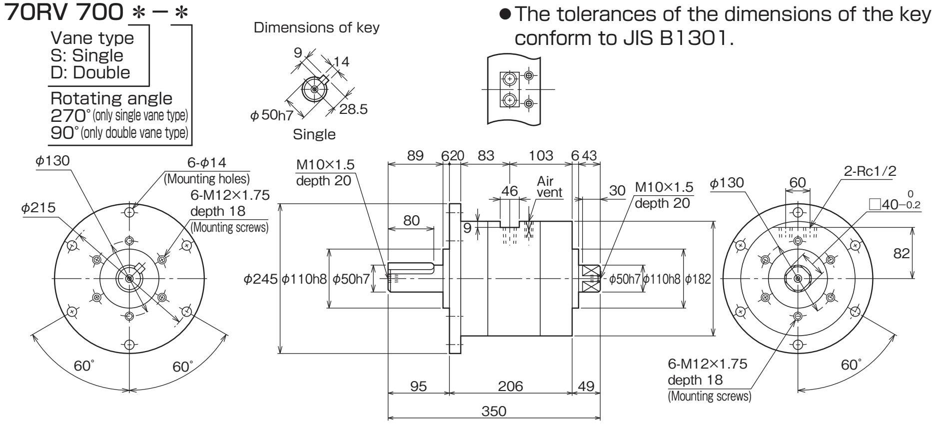


70RV 700 ∗－∗

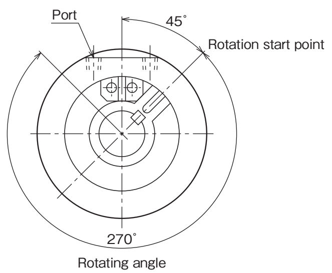
Vane type
S: Single
D: Double

Rotating angle
270° (only single vane type)
90° (only double vane type)

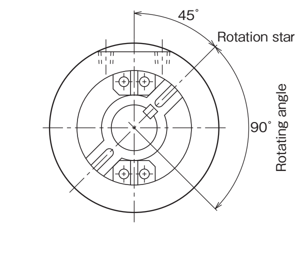
● The tolerances of the dimensions of the key conform to JIS B1301.



Rotation start point and rotating angle viewed from the front: Standard type



When the rotating angle is 270°



When the rotating angle is 90°

● The position at 45° from the port (position of the parallel key) is the rotation start point.

7 MPa Vane Type Rotary Actuator With Cushion

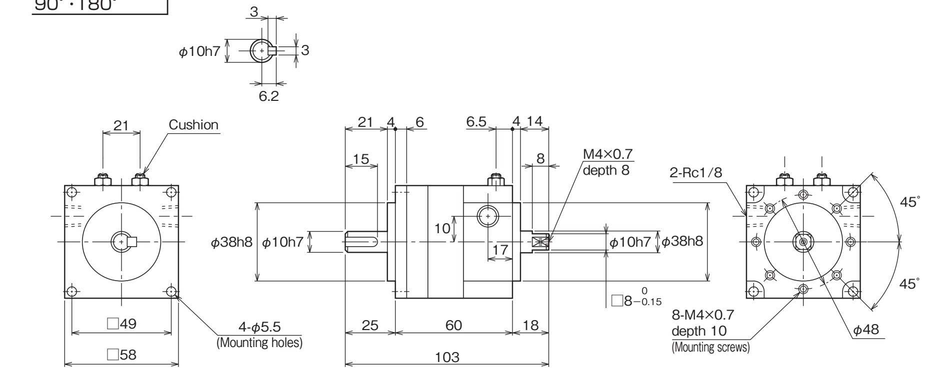
Unit: mm

CAD/DATA 70RV/T70RV Bore is available.

70RV 10SC∗

Rotating angle
90°・180°

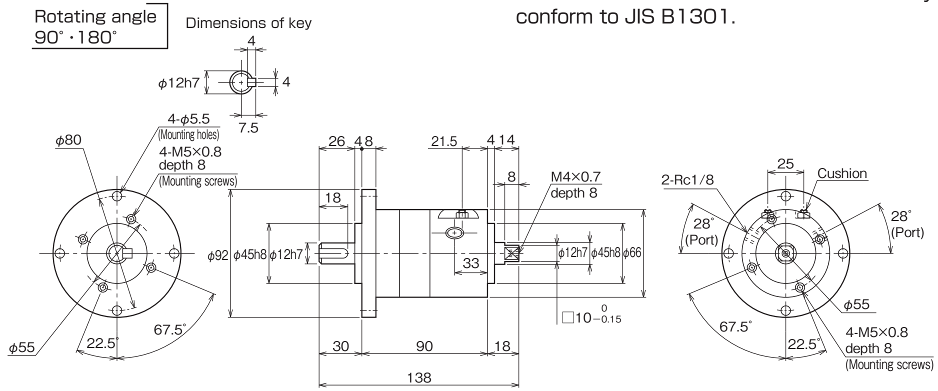
● The tolerances of the dimensions of the key conform to JIS B1301.



70RV 15SC∗

Rotating angle
90°・180°

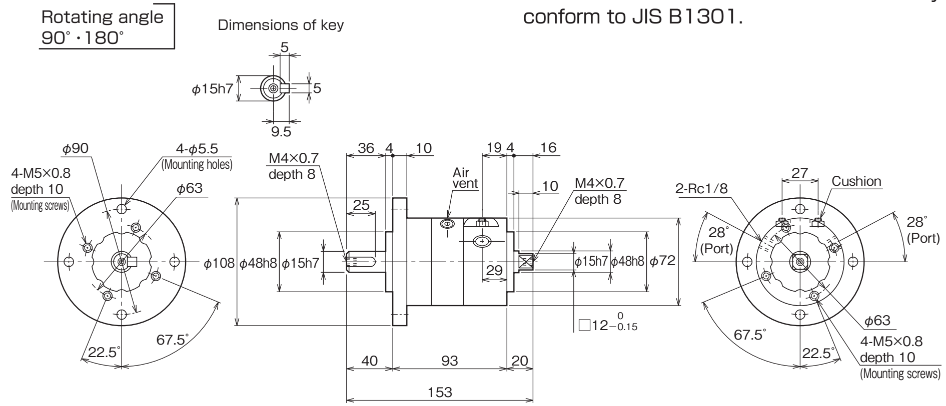
● The tolerances of the dimensions of the key conform to JIS B1301.



70RV 20SC∗

Rotating angle
90°・180°

● The tolerances of the dimensions of the key conform to JIS B1301.



7 MPa Vane Type Rotary Actuator With Cushion

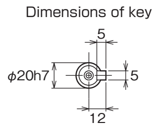
Unit: mm

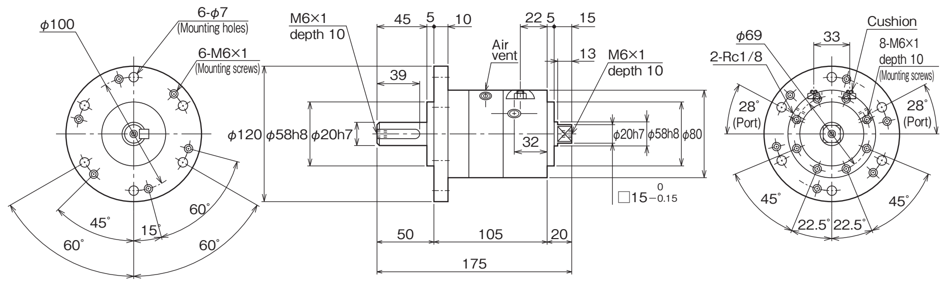
CAD/DATA 70RV/T70RVC Bore is available.

70RV 30SC*

Rotating angle 90°・180°

● The tolerances of the dimensions of the key conform to JIS B1301.

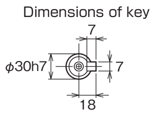


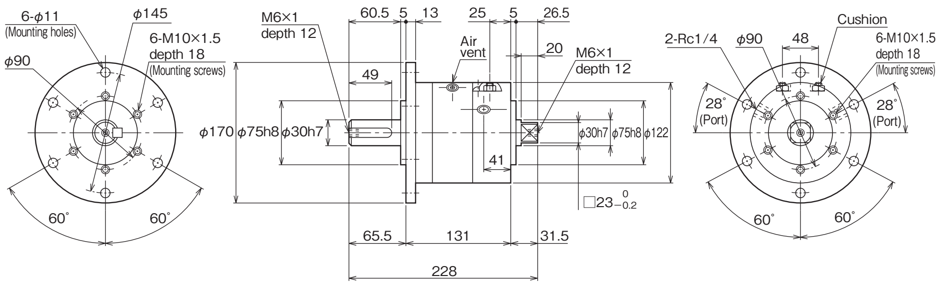


70RV 100SC*

Rotating angle 90°・180°

● The tolerances of the dimensions of the key conform to JIS B1301.

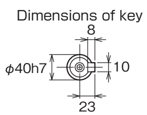


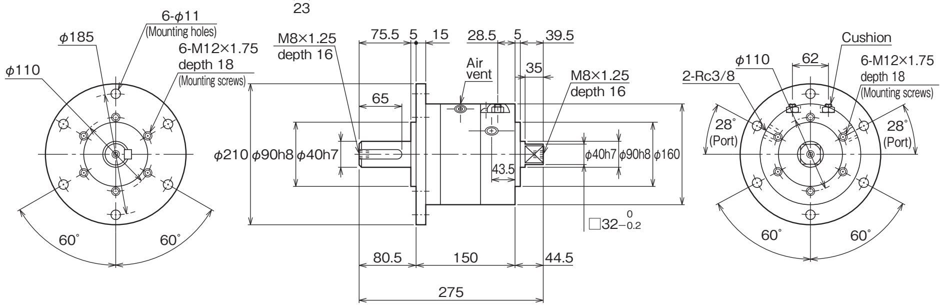


70RV 200SC*

Rotating angle 90°・180°

● The tolerances of the dimensions of the key conform to JIS B1301.





7 MPa Vane Type Rotary Actuator With Cushion

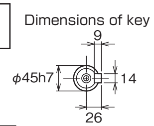
Unit: mm

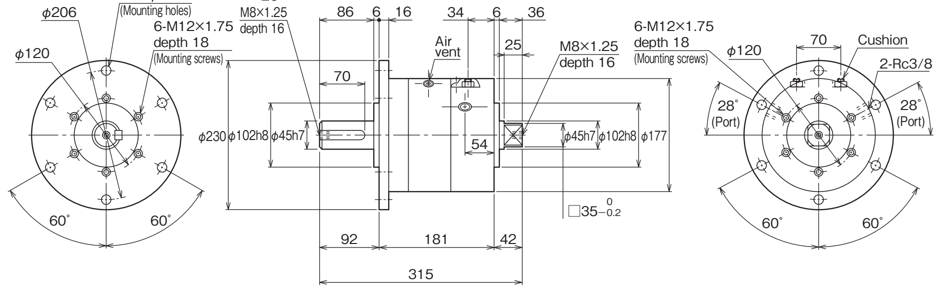
CAD/DATA 70RV/T70RVC Bore is available.

70RV 400SC*

Rotating angle 90°・180°

● The tolerances of the dimensions of the key conform to JIS B1301.

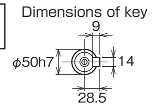


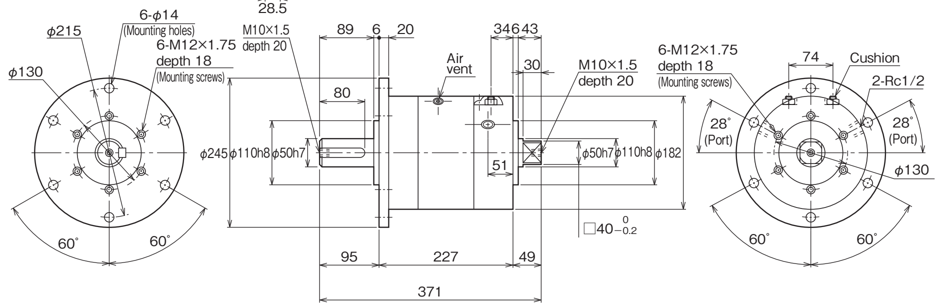


70RV 700SC*

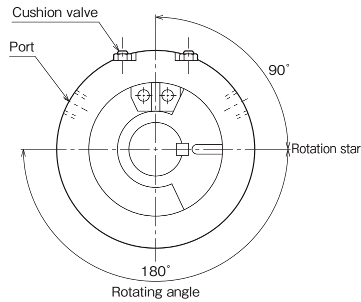
Rotating angle 90°・180°

● The tolerances of the dimensions of the key conform to JIS B1301.

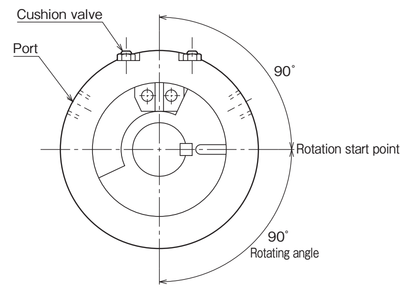




Rotation start point and rotating angle viewed from the front: With cushion



When the rotating angle is 180°



When the rotating angle is 90°

● The position at 90° from the cushion valve (position of the parallel key) is the rotation start point.

70RV
Rotary Actuators
70RV
Rotary Actuators

1. Selection of size

To obtain simple static force for clamping, etc.

①Determine the working pressure. P(MPa)
②Determine the required force. F(N)
③Determine the arm length from the rotary actuator. L(m)

→ Calculation of required torque
T_S=F×L(N·m)

→ Determine the rotary actuator size which ensures $T_S \leqq T_H$ from the output characteristic charts.
T_H: effective torque of rotary actuator

To move a load

Resistance load

When frictional force, gravity or other external force (resistance force) is applied
①Determine the working pressure. P(MPa)
②Determine the required force. F_R(N)
③Determine the arm length from the rotary actuator. L(m)

→ Calculation of resistance torque
T_R=K×F_R×L(N·m)
K: allowance coefficient
When the load does not fluctuate: K=2
When the load fluctuates: K=3
(When the resistant moment caused by gravity acts)
If K is less than 3 when the load fluctuates, the angular speed will significantly change.

Inertia load

To rotate an article
①Determine the rotating angle, rotating time and working pressure.
Rotating angle θ(rad)
Rotating time t(s)
Working pressure P(MPa)
90°=1.5708 rad
180°=3.1416 rad
270°=4.7124 rad
②Calculate the inertia moment of the load from the shape and weight of the load. For the calculation formula, see the Inertia Moment Calculation Table.
I(kg·m²)
③Calculate the average angular acceleration.
$\alpha=\frac{\theta}{t^2}$ (rad/s²)
θ: rotating angle (rad)
t: rotating time (s)

Note) In the case that the cushion is equipped, use the angle (θc) before entry to the cushion stroke as the rotating angle θ, and use the time (tc) before entry to the cushion stroke as the rotating time t.
θc=rotating angle (θ)−cushion angle (θt)
$\alpha=\frac{\theta c}{tc^2}$ (rad/s²)

→ Calculation of accelerating torque
T_A=5×I×α(N·m)
T_A is the torque required to accelerate the inertia load to a certain speed.

Required torque T=T_R+T_A

→ Determine the size of the rotary actuator which ensures $T \leqq T_H$ from the output characteristic charts.
T_H: effective torque of rotary actuator

2. Check of allowable inertia energy

In the case of inertia load, keep the load inertia energy lower than the allowable inertia energy of the rotary actuator.
①Calculation of average angular speed $\omega=\frac{\theta}{t}$ (rad/s)
θ: rotating angle (rad) t=rotating time (s)
②Calculate the impact angular speed ω_0
ω_0=1.2ω(rad/s)
③Calculation of load inertia energy
E=1/2Iω_0^2(J)
I: load inertia moment (kg·m²)
④Make sure that the load inertia energy E is less than the allowable inertia energy of the rotary actuator.
If E exceeds the allowable inertia energy, select a larger rotary actuator or a rotary actuator with cushion.

3. Confirmation of cushion performance (in the case of rotary actuator with cushion)

Determine the inertia moment I from the shape and weight of the load, and make sure that the inertia moment is within the load range. I≦Imax I(kg·m²)

↓

Make sure that the impact angular speed for rushing into the cushion is less than the max. impact angular speed.
$\omega=\frac{\theta c}{tc}$ (rad/s)
ω_0≒1.2ω(rad/s) $\omega_0 \leqq \omega$max

θc: angle before entry to cushion stroke (rad)
tc: time before entry to cushion stroke (s)
ω : average angular speed (rad/s)
ω_0: impact angular speed (rad/s)

↓

Determine the impact energy from the load inertia moment and impact angular speed.
E_1=½Iω_0^2(J) I=inertia moment (kg·m²) ω_0=impact angular speed (rad/s)

↓

Determine the energy of external force applied during cushion stroke.
E_2=(Mg+Mf)θt(J) E_2: energy of external force
Mg: gravity moment caused by unbalanced load (N·m)
Mg=L×Fg Fg: force caused by load gravity (N)
In the case of a balanced load or motion on a horizontal surface, Mg=0.
Mf: moment generated by other thrust forces (for example, when the cylinder force acts) (N·m)
Mf=L×Ff Ff: thrust force (N)
When there are no other thrust forces, Mf=0.
θt: cushion angle (rad)

↓

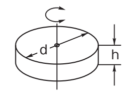
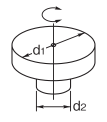
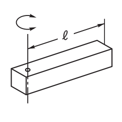
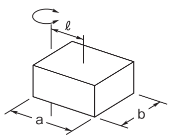
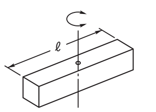
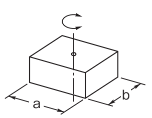
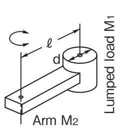
Make sure that E_1+E_2 is less than the max. absorbed energy.

↓

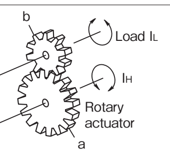
When all requirements stated above are met, the rotary actuator is acceptable. If any of them is not met, the rotary actuator cannot be used.
A shock absorber with higher absorbing performance is necessary.
See "TAIYO General Catalog of Shock Absorbers".

70RV Rotary Actuators

Inertia Moment Calculation Table

Shape	Sketch	Requirements	Inertia moment I(kg·m²)	Radius of rotation K_1^2	Remarks
Disc		Diameter d(m) Weight M(kg)	$I=M\cdot\frac{d^2}{8}$	$\frac{d^2}{8}$	
Stepped disc		Diameter d_1(m) d_2(m) Weight Part d_1 M_1(kg) Part d_2 M_2(kg)	$I=M_1\cdot\frac{d_1^2}{8}+M_2\cdot\frac{d_2^2}{8}$		When part d_2 is significantly small as compared to part d_1, it is allowed to ignore d_2.
Bar (rotation center at end)		Length of bar ℓ(m) Weight M(kg)	$I=M\cdot\frac{\ell^2}{3}$	$\frac{\ell^2}{3}$	When the width of the bar is 30% or more of the length (ℓ), regard the bar as a rectangular solid.
Rectangular solid		Length of side a(m) b(m) Distance to center of gravity ℓ(m) Weight M(kg)	$I=M(\ell^2+\frac{a^2+b^2}{12})$	$\ell^2+\frac{a^2+b^2}{12}$	
Bar (rotation center at center)		Length of bar ℓ(m) Weight M(kg)	$I=M\cdot\frac{\ell^2}{12}$	$\frac{\ell^2}{12}$	When the width of the bar is 30% or more of the length (ℓ), regard the bar as a rectangular solid.
Rectangular solid		Length of side a(m) b(m) Weight M(kg)	$I=M\cdot\frac{a^2+b^2}{12}$	$\frac{a^2+b^2}{12}$	
Lumped load		Shape of lumped load: Disc Diameter of disc d(m) Length of arm ℓ(m) Weight of lumped load M_1(kg) Weight of arm M_2(kg)	$I=M_1\cdot\ell^2+M_1\cdot K_1^2+M_2\cdot\frac{\ell^2}{3}$ In case of disc $K_1^2=\frac{d^2}{8}$	For other shapes, see K_1^2 shown above.	When M_2 is significantly small as compared to M_1, it is allowed to consider M_2 to be 0.

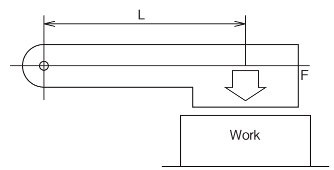
Method of converting load J_L to the load around the rotary actuator axis when a gear is used

Shape	Sketch	Requirements	Inertia moment		Remarks
Gear		No. of teeth Rotary actuator side a Load side b Inertia moment of load I_L(kg·m²)	Inertia moment of load around rotary actuator axis $I_H=(\frac{a}{b})^2 I_L$		When the gear is larger, the inertia moment of the gear must be taken into consideration.

Example of selection of vane type rotary actuator

1. To use for a clamp

- Length of arm L=0.2m
- Clamp force F=500N
- Working pressure P=7MPa

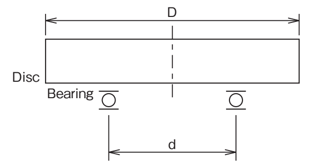


To use for a clamp

<Selection of size>
Static torque T_S=
According to the Output Characteristic Charts (Theoretical torque), the rotary actuator 70RV-30D or larger model can be used.

2. To rotate a circular table

- Weight of table M=50kg
- Diameter of table D=1m
- Center diameter of plain bearing d =0.3m
- Friction coefficient of plain bearing μ =0.05
- Rotating angle θ =180°
- Rotating time t =3s
- Working pressure t =7MPa



To rotate a circular table

<Selection of size>
①Determine the resistance torque T_R.
$T_R=K\times F_R\times L$
Consider that the allowance coefficient K is 2.
Resistance force $F_R=\mu\times M=0.05\times50\times9.8=24.5$(N)
Therefore, $T_R=2\times24.5\times0.3/2=7.35$(N·m)
②Determine the accelerating torque T_A.
$T_A=5\times I\times\alpha$(N·m)
Inertia moment I(kg·m²)
Since the load has the shape of a disc,
$I=M\cdot D^2/8=50\times1^2/8=6.25$(kg·m²)
Calculation of angular acceleration α(rad/s²)
$\alpha=\theta/t^2=3.1416/3^2=0.35$(rad/s²)
$T_A=5\times6.25\times0.35=10.94$(N·m)
③Determine the required torque T.
$T=T_R+T_A=7.35+10.94=18.29$(N·m)
According to the Output Characteristic Charts (Theoretical torque), the rotary actuator 70RV-15S or larger model can be used.

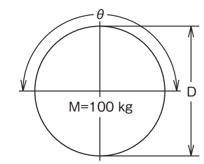
<Check of allowable inertia energy>
①To stop with the stopper in the rotary actuator
Calculation of average angular speed
$\omega=\theta/t=3.141/3=1.05$(rad/s)
Calculation of impact angular speed ω_0
$\omega_0=1.2\omega=1.2\times1.05=1.26$(rad/s)
Calculation of load inertia energy E
$E=1/2I\omega_0^2=1/2\times6.25\times1.26^2=4.96$(J)
Judging from the allowable inertia energy, there is no usable rotary actuator.
②To use a cushion
Judging from the max. absorbed energy and max. inertia moment, the rotary actuator 70RV-200SC or larger model can be used.

<Selection of size based on torque and allowable inertia energy>
Use 70RV-100SC, and rotate the load only by the rotary actuator.

<Check of rotating time, radial load and thrust load>
Rotating time: 3 sec
Radial load: 0 kg
Thrust load: 0 kg (because of use of a bearing)
Therefore, the rotary actuator 70RV-200SC or larger model can be used.

3. To rotate a disc

- Weight of disc M=100kg
- Diameter of disc D=0.5m
- Rotating angle θ =180°
- Rotating time t =5s
- Working pressure P=7MPa



To rotate a disc

<Selection of size>
①Determine the resistance torque T_R.
Since no external force acts on the disc, the resistance torque T_R is 0.

②Determine the accelerating torque T_A.
$T_A=5\times I\times\alpha$ (N·m)
Calculation of inertia moment I (kg·m²)
Since the load has the shape of a disc,
$I=M\cdot D^2/8=100\times0.5^2/8=3.13$ (kg·m²)
Calculation of angular acceleration α (rad/s²)
$\alpha=\theta/t^2=3.1416/5^2=0.13$ (rad/s²)
$T_A=5\times3.13\times0.13=2.03$ (N·m)
③Determine the required torque T.
$T=T_R+T_A=0+2.03=2.03$ (N·m)
According to the Output Characteristic Charts (Theoretical torque), the rotary actuator 70RV-10S or larger model can be used.

<Check of allowable energy>
①To stop with the stopper in the rotary actuator
Calculation of average angular speed
$\omega=\theta/t=3.1416/5=0.63$ (rad/s)
Calculation of impact angular speed ω_0
$\omega_0=1.2\omega=1.2\times0.63=0.76$ (rad/s)
Calculation of load inertia energy E
$E=1/2I\omega_0^2=1/2\times3.13\times0.76^2=0.90$ (J)
Judging from the allowable inertia energy, the rotary actuator 70RV-700S or larger model can be used.
②To use a cushion
Judging from the max. absorbed energy and max. inertia moment, the rotary actuator 70RV-200SC or larger model can be used.

<Selection of size based on torque and allowable inertia energy>
Use 70RV-400SC, and rotate the load only by the rotary actuator.
<Check of rotating time, radial load and thrust load>
Rotating time 5 sec
Radial load 100 kg
Thrust load 0 kg
Therefore, 70RV-200SC or larger model can be used.

Working Rotating Time

Standard type — Unit: s

	90°	270°
70RV 10	0.22 to 6	0.54 to 18
70RV 15	0.22 to 6	0.54 to 18
70RV 20	0.23 to 6	0.54 to 18
70RV 30	0.5 to 9	0.54 to 27
70RV 100	0.6 to 9	0.67 to 27
70RV 200	0.75 to 9	0.81 to 27
70RV 400	1 to 18	1.08 to 54
70RV 700	1.8 to 18	1.35 to 54

With cushion (not incl. cushioning zone) — Unit: s

	90°	180°
70RV 10	0.18 to 6	0.36 to 12
70RV 15	0.18 to 6	0.36 to 12
70RV 20	0.18 to 6	0.36 to 12
70RV 30	0.18 to 9	0.36 to 18
70RV 100	0.22 to 9	0.45 to 18
70RV 200	0.27 to 9	0.54 to 18
70RV 400	0.36 to 18	0.72 to 36
70RV 700	0.45 to 18	0.9 to 36

Setting of Rotating Time

⚠CAUTION

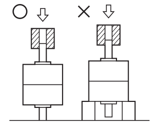
Use the actuator within the range of rotating time shown in the above table. If the rotary actuator is used longer than the above rotating time, smooth operation or cushioning effect cannot be obtained due to stick-slip, etc. If the rotating time is shorter than the above time, the rotary actuator may be damaged.

Precautions for use

⚠CAUTION

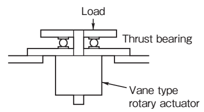
- To install the body, use bolts of strength class 8.8 or over in the specified size. When installing, observe the following instructions.
  1) Secure the actuator using all mounting holes.
  2) Take care not to tighten the bolts unevenly. Tighten them to the tightening torque specified for the bolts used.
  3) Take care not to apply any external load other than the main body load to the bolts. (Use durable mounting materials.)

Fig. 1



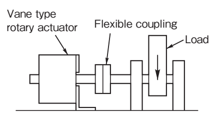
- When attaching a load or a joint to the shaft of the vane type rotary actuator, attach it in such a way that its force is not applied to the body as shown in Fig. 1.
- A load in the axial direction (thrust load) on the shaft of the vane type rotary actuator can cause operation failure. Avoid applying such a load to the actuator. Use a thrust bearing as shown in Fig. 2 so that the thrust load is not applied to the rotary actuator.

Fig. 2 <Thrust load>



- Application of a bending load (radial load) to the shaft end of the vane type rotary actuator can cause operation failure. Avoid applying such a load to the actuator. If this cannot be avoided, provide the rotary actuator with a mechanism as shown in Fig. 3 to convey only the rotating force to the actuator.

Fig. 3 <Radial load>



- When the weight of the load is large and the operating speed is high, shock may be caused by the inertia force, and it may not be absorbed only by the internal shock receiver, thereby resulting in damage to the equipment. In this case, provide a shock absorber to absorb the inertia energy.
- When installing the vane type rotary actuator or starting it after a long-term suspension, discharge air from it. Insufficient discharge of air may cause operation failure.

⚠CAUTION

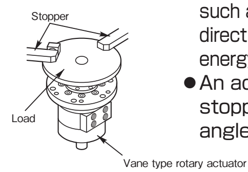
If you have any questions about repair or maintenance, consult us. Never disassemble the actuator.

Notes on piping work

- Take care that dirt and pipe cuttings do not enter the piping.
- Take care that air does not accumulate in the piping.
- When connecting the actuator with a rubber hose, do not bend the hose in a radius lower than the specified radius.
- Be sure to flush the piping. After flushing, connect the piping to the rotary actuator. If the piping is not flushed, contaminants in the piping may cause operation failure of the rotary actuator or fluid leak.
- The vane type rotary actuators cause internal leak. Also, the solenoid valves used on the control circuits cause internal leak. Therefore, they cannot be stopped in the middle of operation under load torque. To suspend any of the actuators in the middle for a long time, provide it with an external mechanical stopper.

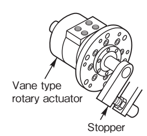
External stopper

Fig. 4



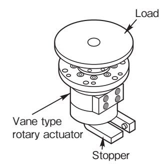
- Attach an external stopper in such a way that the stopper directly receives the inertia energy of the load. (Fig. 4)
- An adjustable external stopper is convenient for angle adjustment.

Fig. 5



- When the actuator must be stopped more accurately, provide an external stopper.
- An adjustable external stopper is convenient for angle adjustment. To ensure the stopping accuracy, it is recommended to attach the stopper to a position with as large radius as possible. (Fig. 5)

Fig. 6

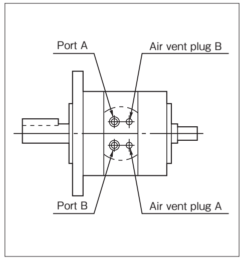


- When the load is driven on the key groove side and an external stopper is provided on the square shaft side, make sure that the load is less than the allowable energy. If the load exceeds the allowable energy, the shaft may be broken. (Fig. 6)

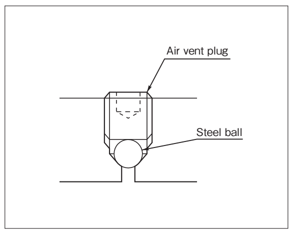
How to discharge air

⚠CAUTION

If the air vent plug is loosened excessively, the plug may fly out or the fluid may spout out.



- Feed the fluid at a low pressure to the rotary actuator, and, when the pressure is applied to the port A, loosen the air vent plug A one or two turns (turn counterclockwise) to discharge air.
  When the pressure is applied to the port B, loosen the air vent plug B to discharge air.
- If air has accumulated in the rotary actuator, white turbid hydraulic fluid flows out of the air vent plug. Discharge air repeatedly until the white turbidity of the fluid is lost.
- After discharging air, tighten the air vent plug to the specified tightening torque (turn clockwise), and make sure that the fluid does not leak. [Torque: 8 N·m]
- Discharge air not only from the rotary actuator, but also from the piping. If air remains in the piping, operation failure may be caused.
- After discharging air, start the rotary actuator at a reduced pressure, and gradually increase the pressure to the working pressure.
  Note) 70RV-10 and 15 do not have air vents.



How to adjust cushion

⚠CAUTION

If the rotating speed is increased at the start of adjustment of the cushion, abnormal surge pressure will occur, and the rotary actuator or the machine may be damaged.

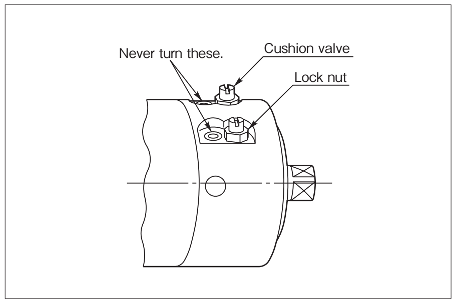
The cushion has been adjusted before shipment. However, since the cushion attenuation effect changes depending on the rotating speed and load inertia, adjust the cushion valve as stated below.

- Loosen the lock nut.
- Turn the cushion valve to the right or left to adjust the speed at the rotating end to reduce the shock and smoothen the operation. Turn the cushion valve to the right, and it will close. Turn it to the left, and it will open.

⚠CAUTION

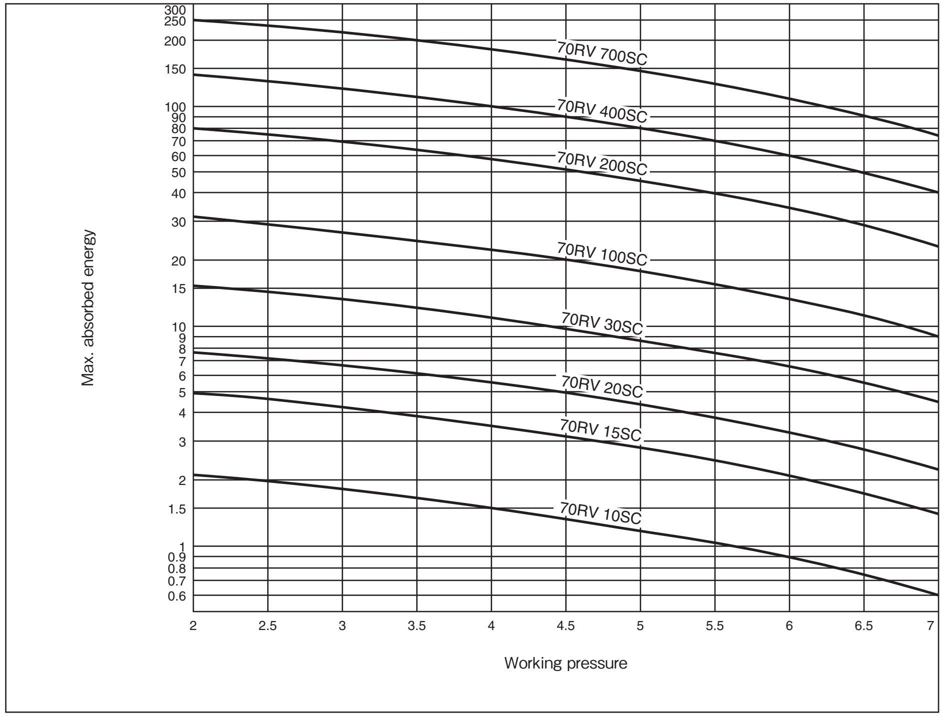
If the cushion plug is loosened excessively, the cushion valve may fly out or the fluid may spout out.

- After the completion of adjustment, secure the lock nut.
  The energy which can be absorbed by the cushion is limited.
  Adjust the cushion while gradually increasing the rotary actuator rotating speed from the state where the flow control valve is fully closed.
- The set screw beside the cushion valve is not designed to discharge air. Never turn it.



■Dependence of max. energy absorbed by cushion on working pressure on vane type rotary actuator with cushion

1 MPa=10.2 kgf/cm²
1 J=10.2 kgf·cm



■Control circuit

When using any vane type rotary actuator under light loading conditions, control the actuator with the basic circuit shown in Fig. 1. When using any vane type rotary actuator under heavy loading conditions, use a circuit as shown in Fig. 2, 3 or 4 to prevent application of shock and damage to the equipment due to surge pressure.
As aggressive measures to prevent shock and surge pressure, use a 2-stage deceleration control method as shown in Fig. 2, and adjust the deceleration time according to the loading conditions, reduction ratio, etc. As a control device for this purpose, use a pilot type switching valve or a proportional electromagnetic control valve.

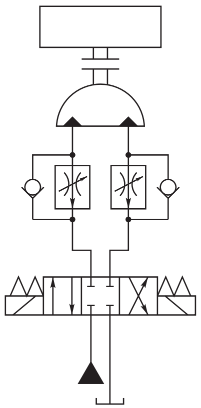


Fig. 1 (Basic circuit)

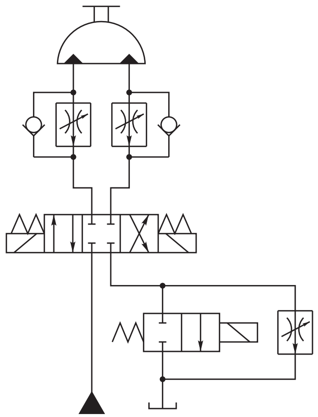


Fig. 2 (2-stage deceleration)

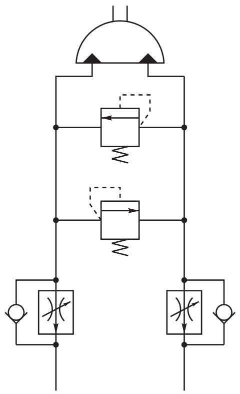


Fig. 3 (Brake valve)

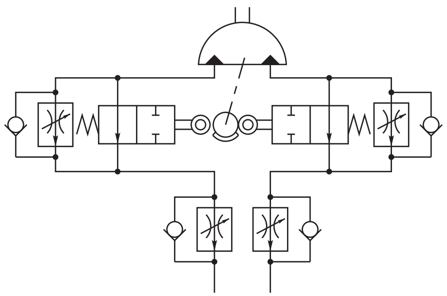


Fig. 4 (Deceleration valve)