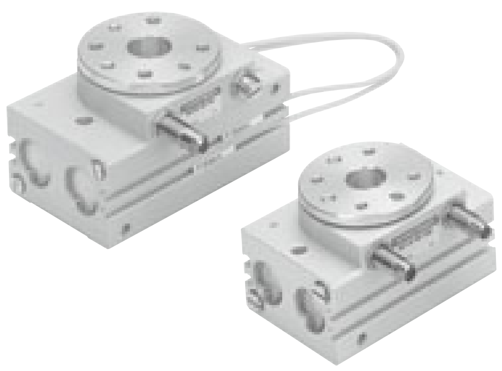
CAD drawing data catalog
is available.



KOGANEI

ACTUATORS GENERAL CATALOG

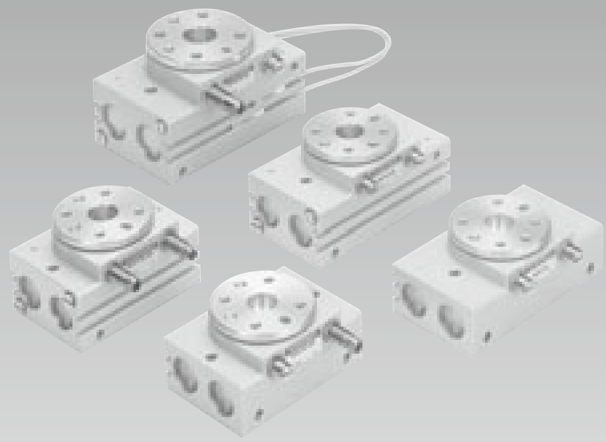
ROTARY ACTUATORS PISTON TYPE

RAT SERIES

CONTENTS

⚠ **Caution** Before use, be sure to read the "Safety Precautions" on p. 57.

ROTARY ACTUATORS
RAT Series



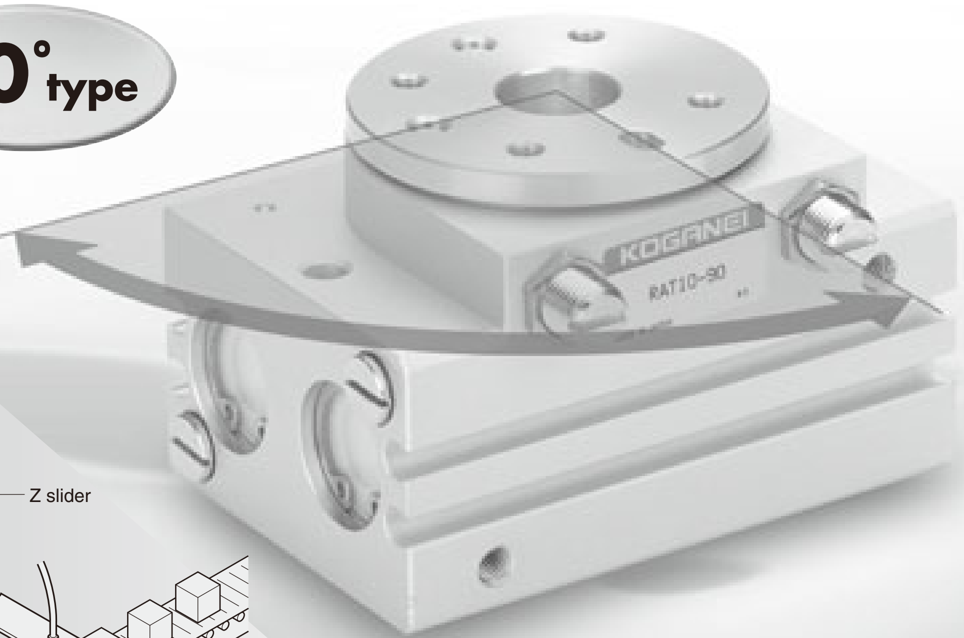
Lightweight and Compact

■High precision by using bearing.
■Workpiece is easily mounted on the RAT table.

Two types are available for swing angle, 90° type and 180° type.

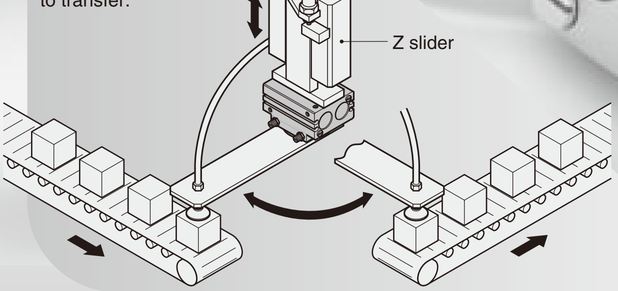
By adjusting threaded length of rubber stopper or shock absorber, ±5° adjustment at the end of the swing stroke is possible.

90° type



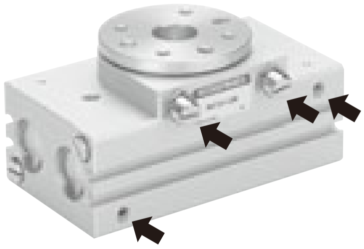
Application example

Pick up a workpiece by vacuum pad at the arm end, and rotate the arm to transfer.



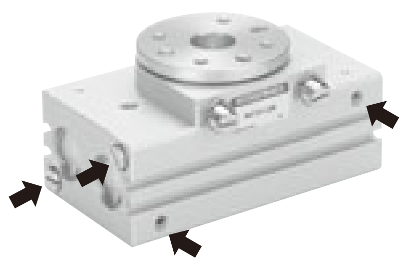
Piping and adjusting swing angle are possible on one surface.

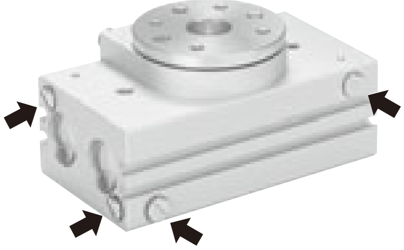
Piping and adjusting swing angle is possible on one surface throughout the product range.
By using a vertical lead wire sensor switch, even lead wire can be run out in the same surface. (Except RAT5)



Piping connection is possible on 4 surfaces.
(one surface for RAT 5)

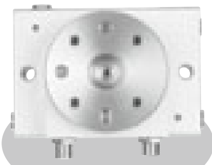
Piping direction can be selected for 4 surfaces.
This enables easy piping in confined spaces or in workpiece installed condition.
For the piping port location and swing direction, see p.1250.



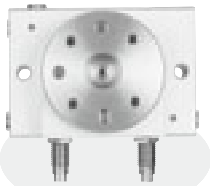


Four types of cushioning are possible.

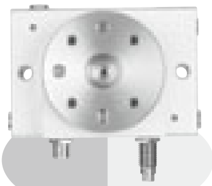
The same mounting thread is used for both the rubber stopper and shock absorber. This allows for change of the rubber stopper to a shock absorber if required later on, or vice versa.



【With rubber stopper on both sides】



【With shock absorber on both sides】



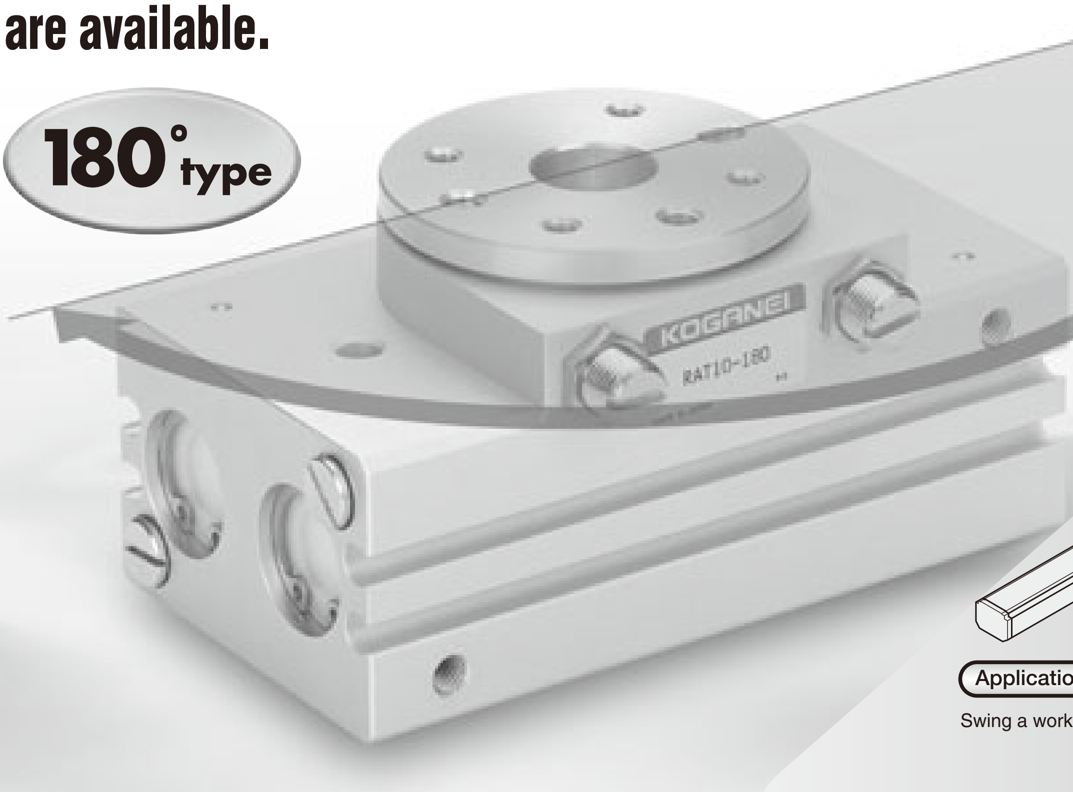
【With shock absorber on right side】
(Mounted at clockwise rotation end)

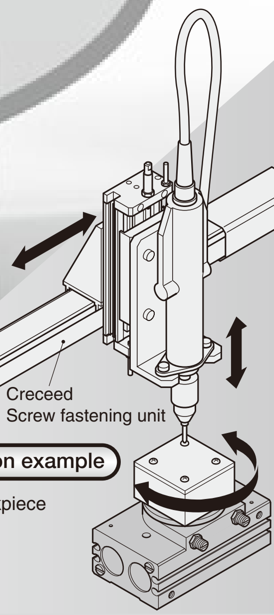
【With shock absorber on left side】
(Mounted at counterclockwise rotation end)

Three types of torque, 0.5, 1.0, 3.0 N·m [0.4, 0.7, 2.2 ft·lbf] are available.

Note: At operating pressure 0.5MPa [73psi.], and nominal values.

180° type



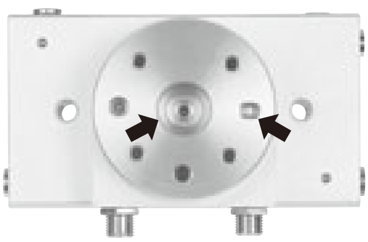


Application example

Swing a workpiece

Locating hole on the table and bottom of the body are available.

Locating hole and mounting hole are common between 90° and 180° types.
Dimensions of those are different in longitudinally only; consequently replacement between 90° type and 180° type is easy.
For details in dimensions, refer to p.1251 to 1254.



Embedded type sensor switch is available.

Sensor switch mounting grooves are available on 2 surfaces. For RAT5, they are available on 1 surface.

General precautions

Media

1. Use air for the media. For the use of any other media, consult us.
2. Air used for the rotary actuator should be clean air that contains no deteriorated compressor oil, etc. Install an air filter (filtration of a minimum 40 μm) near the rotary actuator or valve to remove collected liquid or dust. In addition, drain the air filter periodically.

Piping

1. Always thoroughly blow off (use compressed air) the tubing before connecting it to the rotary actuator. Entering metal chips, sealing tape, rust, etc., generated during piping work could result in air leaks or other defective operation.
2. When screwing in piping or fittings to the actuator, tighten to the appropriate tightening torque shown below.

Connecting thread	Tightening torque N•cm [in•lbf]
M5×0.8	157 [13.9]

Lubrication

The product can be used without lubrication, if lubrication is required, use Turbine Oil Class 1 (ISO VG32) or equivalent.
Avoid using spindle oil or machine oil.

Atmosphere

If using in locations subject to dripping water, dripping oil, etc., use a cover to protect the unit.

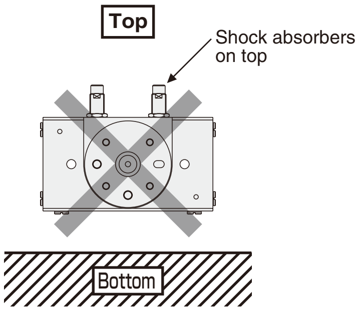
Start-up

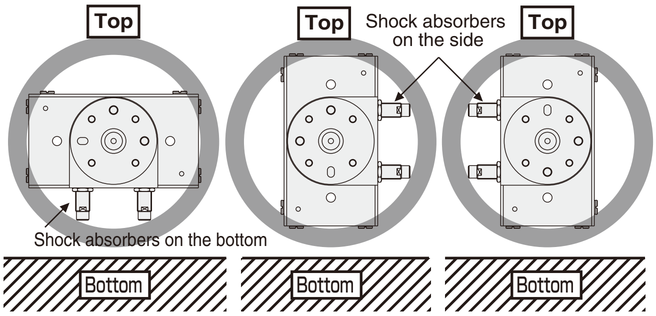
When starting up operations of a device and the rotary actuator by supplying compressed air rapidly, it could not control the speed due to the construction of the rotary actuator, resulting in damage to the device and rotary actuator. When supplying compressed air to the device and rotary actuator where the air has been exhausted, always ensure that the table is in a secure position and cannot be moved further, paying attention to safety, and then apply air pressure from the connection port of not making move the table, first. For the piping port location and swing direction, see p.1250.

Mounting

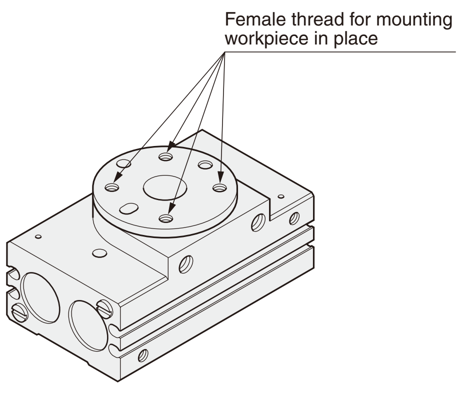
Mounting

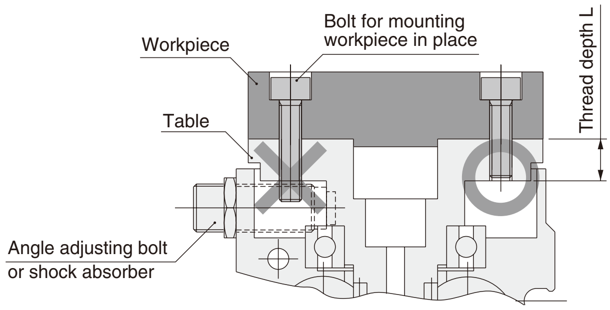
1. Models with rubber stoppers on both sides can be freely mounted in any direction. If using models with shock absorbers (-SS2, -SSR, -SSL), however, avoid using with the shock absorbers mounted on top of the body. This position drastically reduces the shock absorbers' operating life.
   When using with shock absorbers, locate the shock absorbers so that they are mounted on the bottom or side of the body.





2. The mounting surface should be always flat. Twisting or bending during the mounting could result in air leaks or improper operation.
3. Care should be taken that scratches or dents on the rotary actuator's mounting surface may damage its flatness.
4. Take some locking measures when shocks or vibrations might loosen the bolts.
5. For workpiece mounting, female threads are available for installing the workpiece in place on the table. Always use bolts so that the screw length is less than the depth of the female thread. Use of longer bolts than the female thread will interfere with the angle adjusting bolt or shock absorber, and prevent them from working properly. When mounting the workpiece, tighten the bolts within the range of the tightening torque.



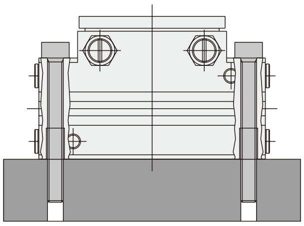


Model	Thread size	Thread depth L mm [in.]	Maximum tightening torque N･m [ft･lbf]]
RAT5	M4×0.7	7 [0.28]	1.37 [1.01]
RAT10			
RAT30	M6×1.0	8 [0.32]	4.80 [3.54]

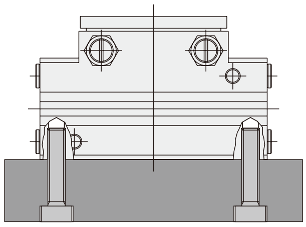
Caution: When using a bolt to mount the workpiece in place on the table, hold either the table or workpiece during the operation. Holding the body for tightening will apply excessive moment to the stopper, rubber stopper and shock absorber, resulting in a change of angle.

6. The rotary actuator RAT series can be mounted in either of the 2 ways shown below. When mounting, ensure that the tightening torque is within the range of allowable values.

Mounting using the through holes on the body



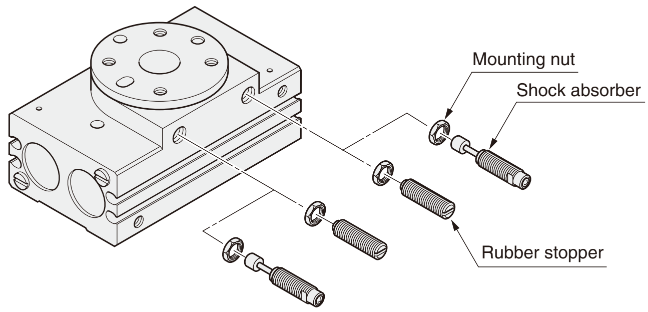
Mounting using the female threads on the body



Model	Mounting method	Thread size	Maximum tightening torque N･m [ft･lbf]
RAT5	Through hole	M5×0.8	2.84 [2.09]
RAT10	Female thread	M6×1.0	4.80 [3.54]
RAT30	Through hole	M6×1.0	4.80 [3.54]
	Female thread	M8×1.25	12.0 [8.85]

Rubber stopper and shock absorber replacement instructions

Loosen and remove the mounting nut of the rubber stopper or shock absorber. Screw the new rubber stopper or shock absorber into the proper position, and then tighten the mounting nut and secure it in place. When tightening the nut, ensure that the tightening torque is within the range of setting values.



Swing angle adjustment

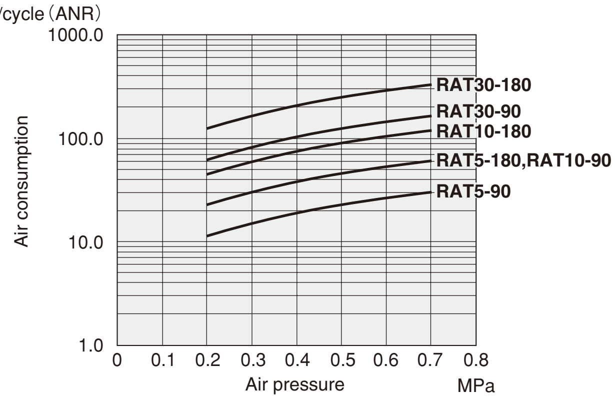
1. The rotary actuator RAT series uses rubber stoppers or shock absorbers for angle adjustment, in the ranges shown on p.1250. For both clockwise and counterclockwise rotation, rotating the rubber stopper or shock absorber to the right (clockwise) will reduce the swing angle. After completing angle adjustment, tighten the nut and secure them in place.
2. Always follow the swing angle within the specified range for use. For the shock absorber, in particular, the angle between the load applying direction and the center line of the shock absorber exceeds the allowable angle variation, it could damage the product.
3. The rubber stopper or shock absorber are only temporarily tightened at shipping. For actual use, always tighten the nut to secure it in place.
4. When tightening the nut, ensure that the tightening torque is within the range shown below.

Model	Nut size	Maximum tightening torque N･m [ft･lbf]
RAT5	M8×0.75	2.45 [1.81]
RAT10		
RAT30	M10×1.0	6.37 [4.70]

●Air consumption for 1 cycle operation

cm³ [in.³]/cycle (ANR)

Model	Air pressure MPa [psi.]					
	0.2 [29]	0.3 [44]	0.4 [58]	0.5 [73]	0.6 [87]	0.7 [102]
RAT5-90	11.3 [0.690]	15.0 [0.915]	18.7 [1.141]	22.5 [1.373]	26.2 [1.599]	29.9 [1.825]
RAT5-180	22.5 [1.373]	30.0 [1.831]	37.5 [2.288]	44.9 [2.740]	52.4 [3.198]	59.9 [3.655]
RAT10-90	22.5 [1.373]	30.0 [1.831]	37.5 [2.288]	44.9 [2.740]	52.4 [3.198]	59.9 [3.655]
RAT10-180	45.0 [2.746]	60.0 [3.661]	74.9 [4.571]	89.9 [5.486]	104.8 [6.395]	119.8 [7.311]
RAT30-90	61.6 [3.759]	82.0 [5.004]	102.5 [6.255]	122.9 [7.500]	143.3 [8.745]	163.8 [9.996]
RAT30-180	123.2 [7.518]	164.0 [10.008]	204.9 [12.504]	245.8 [15.000]	286.7 [17.496]	327.6 [19.991]



1cm³/cycle = 0.06102in³/cycle
1MPa = 145psi.

Calculation of air flow rate and air consumption

The above graph shows the air consumption during 1 cycle of the rotary actuator. The actual air flow rate and consumption required can be found through the following calculations. Note that the calculations varies between "**RAT5**" and "**RAT10/RAT30**" due to the difference between single piston and double piston construction.

● Finding the air flow rate (For selecting F.R.L., valves, etc.)

●RAT5

$$Q_1=\frac{\pi D^2}{4}\times L\times\frac{60}{t}\times\frac{P+0.1013}{0.1013}\times10^{-6}$$

●RAT10, 30

$$Q_1=\frac{\pi D^2}{4}\times2\times L\times\frac{60}{t}\times\frac{P+0.1013}{0.1013}\times10^{-6}$$

● Finding the air consumption

●RAT5

$$Q_2=\frac{\pi D^2}{4}\times L\times2\times n\times\frac{P+0.1013}{0.1013}\times10^{-6}$$

●RAT10, 30

$$Q_2=\frac{\pi D^2}{4}\times2\times L\times2\times n\times\frac{P+0.1013}{0.1013}\times10^{-6}$$

Q_1: Required air flow rate for cylinder	ℓ/min (ANR)
Q_2: Air consumption of cylinder	ℓ/min (ANR)
D: Cylinder bore size	mm
L: Cylinder stroke	mm
t: Time required for cylinder to travel 1 stroke	s
n: Number of cylinder reciprocations per minute	times/min
P: Pressure	MPa

● Finding the air flow rate (For selecting F.R.L., valves, etc.)

●RAT5

$$Q_1'=\frac{\pi D'^2}{4}\times L'\times\frac{60}{t}\times\frac{P'+14.696}{14.696}\times\frac{1}{1728}$$

●RAT10, 30

$$Q_1'=\frac{\pi D'^2}{4}\times2\times L'\times\frac{60}{t}\times\frac{P'+14.696}{14.696}\times\frac{1}{1728}$$

● Finding the air consumption

●RAT5

$$Q_2'=\frac{\pi D'^2}{4}\times L'\times2\times n\times\frac{P'+14.696}{14.696}\times\frac{1}{1728}$$

●RAT10, 30

$$Q_2'=\frac{\pi D'^2}{4}\times2\times L'\times2\times n\times\frac{P'+14.696}{14.696}\times\frac{1}{1728}$$

Q_1': Required air flow rate for cylinder	ft³/min. (ANR)※
Q_2': Air consumption of cylinder	ft³/min. (ANR)※
D': Cylinder bore size	in.
L': Cylinder stroke	in.
t: Time required for cylinder to travel 1 stroke	sec.
n: Number of cylinder reciprocations per minute	times/min.
P': Pressure	psi.

※Refer to p.54 for an explanation of ANR.

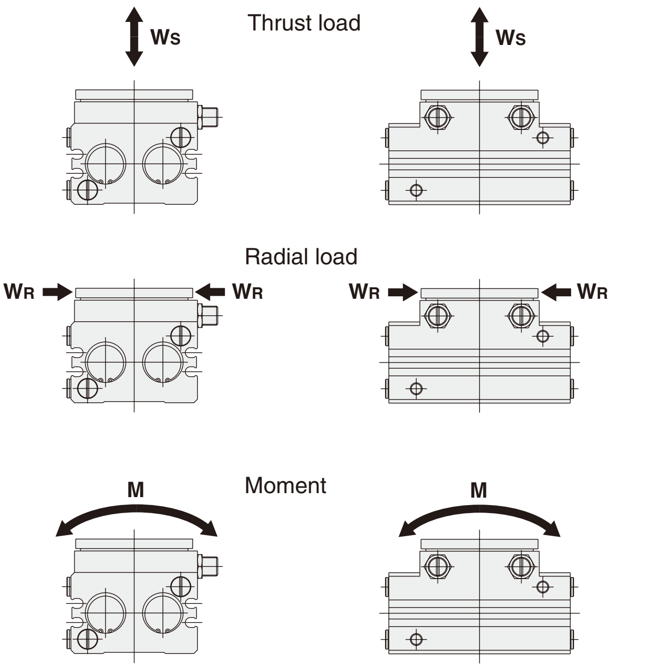
●Cylinder bore and stroke

mm [in.]

Model	Cylinder bore	Cylinder stroke
RAT5-90	16 [0.630]	9.4 [0.370]
RAT5-180	16 [0.630]	18.8 [0.740]
RAT10-90	16 [0.630]	9.4 [0.370]
RAT10-180	16 [0.630]	18.8 [0.740]
RAT30-90	20 [0.787]	16.5 [0.650]
RAT30-180	20 [0.787]	33.0 [1.299]

●Allowable load

Item / Model		RAT5	RAT10	RAT30
Allowable thrust load Ws	N [lbf]	50 [11.2]	80 [18.0]	200 [45.0]
Allowable radial load W_R	N [lbf]	30 [6.7]	80 [18.0]	200 [45.0]
Allowable moment M	N･m [ft･lbf]	1.5 [1.1]	2.5 [1.8]	5.5 [4.1]

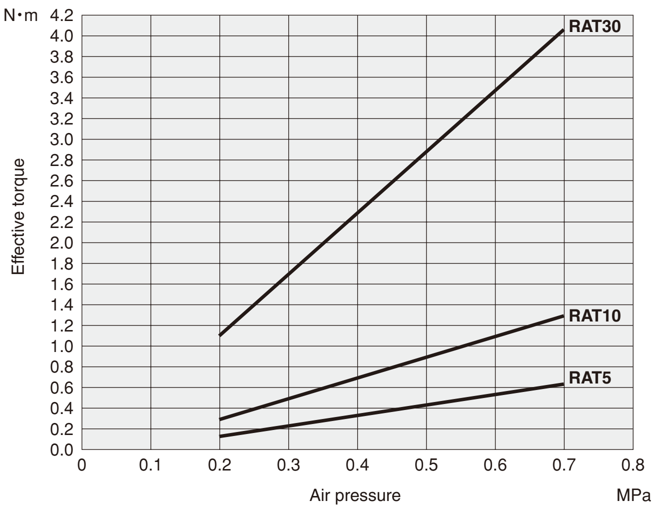


●Effective torque

N･m [ft･lbf]

Model	Air pressure MPa [psi.] 0.2 [29]	0.25 [36]	0.3 [44]	0.35 [51]	0.4 [58]
RAT5	0.12 [0.09]	0.17 [0.13]	0.22 [0.16]	0.27 [0.20]	0.32 [0.24]
RAT10	0.29 [0.21]	0.39 [0.29]	0.49 [0.36]	0.59 [0.44]	0.69 [0.51]
RAT30	1.10 [0.81]	1.40 [1.03]	1.69 [1.25]	1.99 [1.47]	2.28 [1.68]

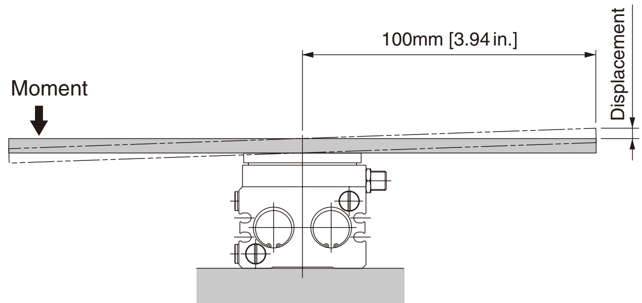
Air pressure MPa [psi.] 0.45 [65]	0.5 [73]	0.55 [80]	0.6 [87]	0.65 [94]	0.7 [102]
0.37 [0.27]	0.42 [0.31]	0.47 [0.35]	0.52 [0.38]	0.57 [0.42]	0.62 [0.46]
0.79 [0.58]	0.89 [0.66]	0.99 [0.73]	1.09 [0.80]	1.19 [0.88]	1.29 [0.95]
2.57 [1.90]	2.87 [2.12]	3.16 [2.33]	3.46 [2.55]	3.75 [2.77]	4.04 [2.98]

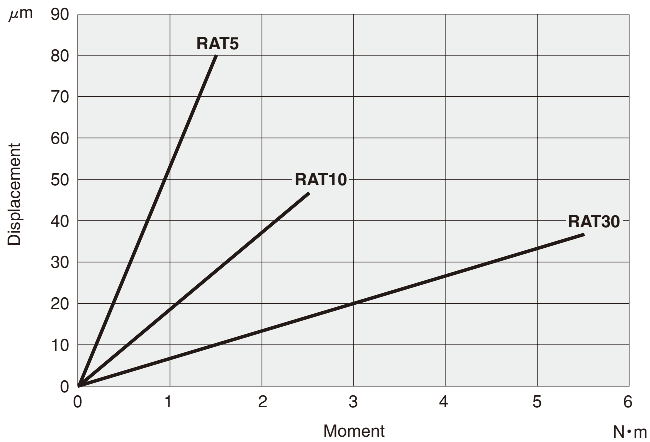


1N･m = 0.7376ft･lbf
1MPa = 145psi.

●Table displacement caused by moment

In the rotary actuator RAT series, mounting a plate and applying moment on it, and then measure the displacement at 100mm [3.94 in.] position from the rotation center.





1N･m = 0.7376ft･lbf

Note: The above values are actual measurement values, and are not guaranteed values.

Caution: For the load and swing time, follow the below "Model selection procedure'' to select within the range of specified values. Moreover, about 80% of the allowable values is recommended to use in the application. By using these values, adverse effects on cylinders and guides can be a minimum.

●Model selection procedure

1. Check the application conditions

Check the following items ①〜④

①Swing angle (90° or 180°)
②Swing time (s)
③Applied pressure (MPa)
④Workpiece shape and materials
⑤Mounting direction

2. Check the swing time

Check the swing time in 1―② is within the swing time adjustment range in the specification.

Angle	Swing time (s)
90°	0.2〜1.0
180°	0.4〜2.0

Note: The swing time is obtained when using the rubber stopper with no load at 0.5MPa condition.

3. Select torque size (select model)

Find the torque T_A required for rotating the workpiece.

$$T_A = I\dot{\omega}K$$

$$\dot{\omega} = \frac{2\theta}{t^2}$$

T_A : Torque (N・m)
I : Mass moment of inertia (kg・m²)
Use the formulas on p.1241〜1244 to find.
$\dot{\omega}$: Uniform angular acceleration (rad/s²)
K : Marginal coefficient 5
θ : Swing angle (rad)
90°→1.57rad
180°→3.14rad
t : Swing time (s)

Select the model secures the required torque T_A by using the applied pressure checked in 1―③, from among the effective torque table or graph on p.1238.

4. Check kinetic energy

If kinetic energy exceeds the allowable energy, the actuator could be damaged. Always select a model so that the energy lies within the allowable energy range. When the kinetic energy is large, use a model with shock absorber (**-SS2**, **-SSR**, or **-SSL)**. For the allowable kinetic energy, see Table 1.

Find the kinetic energy.
●With rubber stopper

$$E = \frac{1}{2} \times I \times \omega^2$$

$$\omega = \frac{2\theta}{t}$$

$$E < Ea$$

E : Kinetic energy (J)
I : Mass moment of inertia (kg・m²)
Use the formulas on p.1241〜1244 to find.
ω : Angular velocity (rad/s)
θ : Swing angle (rad)
90°→1.57rad
180°→3.14rad
t : Swing time (s)
Ea : Allowable energy with rubber stopper ... See Table 1.

●Model selection procedure

1. Check the application conditions

Check the following items ①〜④

①Swing angle [90° or 180°]
②Swing time [sec.]
③Applied pressure [psi.]
④Workpiece shape and materials
⑤Mounting direction

2. Check the swing time

Check the swing time in 1―② is within the swing time adjustment range in the specification.

Angle	Swing time [sec.]
90°	0.2〜1.0
180°	0.4〜2.0

Note: The swing time is obtained when using the rubber stopper with no load at 73psi. condition.

3. Select torque size (select model)

Find the torque T'_A required for rotating the workpiece.

$$T'_A = I'\dot{\omega}K$$

$$\dot{\omega} = \frac{2\theta}{t^2}$$

T'_A : Torque [ft・lbf]
I′ : Mass moment of inertia [lbf・ft・sec.²]
Use the formulas on p.1241〜1244 to find.
$\dot{\omega}$: Uniform angular acceleration [rad/sec.²]
K : Marginal coefficient 5
θ : Swing angle [rad]
90°→1.57rad
180°→3.14rad
t : Swing time [sec.]

Select the model secures the required torque T'_A by using the applied pressure checked in 1―③, from among the effective torque table or graph on p.1238.

4. Check kinetic energy

If kinetic energy exceeds the allowable energy, the actuator could be damaged. Always select a model so that the energy lies within the allowable energy range. When the kinetic energy is large, use a model with shock absorber (**-SS2**, **-SSR**, or **-SSL)**. For the allowable kinetic energy, see Table 1.

Find the kinetic energy.
●With rubber stopper

$$E' = \frac{1}{2} \times I' \times \omega^2$$

$$\omega = \frac{2\theta}{t}$$

$$E' < E'a$$

E′ : Kinetic energy [ft・lbf]
I′ : Mass moment of inertia [lbf・ft・sec.²]
Use the formulas on p.1241〜1244 to find.
ω : Angular velocity [rad/sec.]
θ : Swing angle [rad]
90°→1.57rad
180°→3.14rad
t : Swing time [sec.]
E′a : Allowable energy with rubber stopper ... See Table 1.

●With shock absorber

①Find the equivalent mass m_1.

$$m_1 = \frac{I}{R^2}$$

②Find the equivalent mass m_2.

$$m_2 = \frac{2 \times T \times L}{R^3 \times \omega^2}$$

$$\omega = \frac{2\theta}{t}$$

③Find the total mass m.

$m = m_1 + m_2$

④Find the impact velocity.

$V = R \times \omega$

⑤Find the kinetic energy.

$$E = \frac{1}{2} \times m \times V^2$$

$E < Ea$

m_1 : Equivalent mass (kg)
I : Mass moment of inertia ($kg \cdot m^2$)
Use the formulas on p.1241~1244 to find.
R : Distance from rotation center to impact point (m) ... See Fig.1 and Table 2.
m_2 : Equivalent mass (kg)
T : Effective torque (N·m)
Use the effective torque table or graph to find.
L : Shock absorber stroke (m) ... See Table 2.
ω : Angular velocity (rad/s)
θ : Swing angle (rad)
90°→1.57rad
180°→3.14rad
t : Swing time (s)
m : Total mass (kg)
V : Impact velocity (m/s)
E : Kinetic energy (J)
Ea : Allowable energy with shock absorber ... See Table 1.

Table 1. Allowable energy Ea

Model	Allowable energy with rubber stopper (J)	Allowable energy with shock absorber (J)
RAT5	0.005	0.36
RAT10	0.008	0.53
RAT30	0.030	1.14

Fig.1 R: Distance from rotation center to impact point

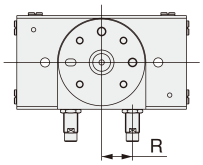


Table 2.

Model	Distance R from rotation center to impact point (m)	Shock absorber stroke L (m)	Shock absorber model
RAT5	0.0175	0.005	KSHAR5×5-D
RAT10	0.0175	0.005	KSHAR5×5-E
RAT30	0.0220	0.008	KSHAR6×8-F

5. Check load ratio

Check that the total sum of the load ratio does not exceed 1. For the allowable load, see Table 3 (For the load direction, see the allowable load on p.1238.)

$$\frac{W_S}{W_{S\,MAX}} + \frac{W_R}{W_{R\,MAX}} + \frac{M}{M_{MAX}} \leqq 1$$

Table 3. Allowable load

Model	Thrust load $W_{S\,MAX}$ (N)	Radial load $W_{R\,MAX}$ (N)	Moment M_{MAX} (N·m)
RAT5	50	30	1.5
RAT10	80	80	2.5
RAT30	200	200	5.5

6. Judgement whether the unit is usable or not

The unit is usable if it satisfies both 4. Kinetic energy and 5. Load ratio.

$E < Ea$

Total sum of load ratio ≦ 1

●With shock absorber

①Find the equivalent weight w_1.

$$w_1 = \frac{I'}{R'^2} \times 32.2$$

②Find the equivalent weight w_2.

$$w_2 = \frac{2 \times T' \times L' \times 32.2}{R'^3 \times \omega^2}$$

$$\omega = \frac{2\theta}{t}$$

③Find the total weight w.

$w = w_1 + w_2$

④Find the impact velocity.

$V' = R' \times \omega$

⑤Find the kinetic energy.

$$E' = \frac{1}{2} \times \frac{w}{32.2} \times V'^2$$

$E' < E'a$

w_1 : Equivalent weight [lbf.]
I′ : Mass moment of inertia [lbf·ft·sec²]
Use the formulas on p.1241~1244 to find.
R′ : Distance from rotation center to impact point [ft] ... See Fig.1 and Table 2.
w_2 : Equivalent weight [lbf.]
T′ : Effective torque [ft·lbf]
Use the effective torque table or graph to find.
L′ : Shock absorber stroke [ft.] ... See Table 2.
ω : Angular velocity [rad/sec.]
θ : Swing angle [rad]
90°→1.57rad
180°→3.14rad
t : Swing time [sec.]
w : Total weight [lbf.]
V′ : Impact velocity [ft./sec.]
E′ : Kinetic energy [ft·lbf]
E′a : Allowable energy with shock absorber ... See Table 1.

Table 1. Allowable energy E′a

Model	Allowable energy with rubber stopper [ft·lbf]	Allowable energy with shock absorber [ft·lbf]
RAT5	0.004	0.266
RAT10	0.006	0.391
RAT30	0.022	0.841

Fig.1 R′: Distance from rotation center to impact point

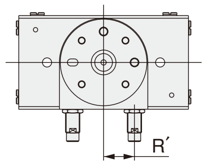


Table 2.

Model	Distance R′ from rotation center to impact point [in.]	Shock absorber stroke L′ [in.]	Shock absorber model
RAT5	0.69	0.20	KSHAR5×5-D
RAT10	0.69	0.20	KSHAR5×5-E
RAT30	0.87	0.31	KSHAR6×8-F

5. Check load ratio

Check that the total sum of the load ratio does not exceed 1. For the allowable load, see Table 3 (For the load direction, see the allowable load on p.1238.)

$$\frac{W'_S}{W'_{S\,MAX}} + \frac{W'_R}{W'_{R\,MAX}} + \frac{M'}{M'_{MAX}} \leqq 1$$

Table 3. Allowable load

Model	Thrust load $W'_{S\,MAX}$ [lbf.]	Radial load $W'_{R\,MAX}$ [lbf.]	Moment M'_{MAX} [ft·lbf]
RAT5	11.2	6.7	1.1
RAT10	18.0	18.0	1.8
RAT30	45.0	45.0	4.1

6. Judgement whether the unit is usable or not

The unit is usable if it satisfies both 4. Kinetic energy and 5. Load ratio.

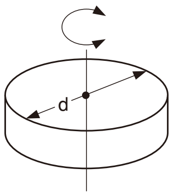
$E' < E'a$

Total sum of load ratio ≦ 1

■Diagram for calculating mass moment of inertia

【When the rotation axis passes through the workpiece】

●Disk

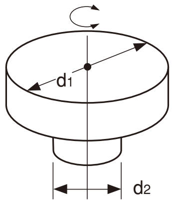


Parameters	■Mass moment of inertia I ($kg \cdot m^2$)	■Rotating radius
●Diameter d (m) ●Mass m (kg)	$I=\frac{md^2}{8}$	$\frac{d^2}{8}$

Parameters	■Mass moment of inertia I´ [$lbf \cdot ft \cdot sec^2$]	■Rotating radius
●Diameter d [ft.] ●Weight w [lbf.]	$I'=\frac{wd^2}{8\times32.2}$	$\frac{d^2}{8}$

Remark: No particular mounting direction.
For sliding use, see separate materials.

●Stepped disk

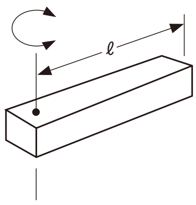


Parameters	■Mass moment of inertia I ($kg \cdot m^2$)	■Rotating radius
●Diameter d_1 (m), d_2 (m) ●Mass d_1 portion m_1 (kg) d_2 portion m_2 (kg)	$I=\frac{1}{8}(m_1d_1^2+m_2d_2^2)$	$\frac{d_1^2+d_2^2}{8}$

Parameters	■Mass moment of inertia I´ [$lbf \cdot ft \cdot sec^2$]	■Rotating radius
●Diameter d_1 [ft.], d_2 [ft.] ●Weight d_1 portion w_1 [lbf.] d_2 portion w_2 [lbf.]	$I'=\frac{1}{8\times32.2}\times(w_1d_1^2+w_2d_2^2)$	$\frac{d_1^2+d_2^2}{8}$

Remark: The d_2 portion can be negligible when it is much smaller than the d_1 portion.

●Bar (rotation center is at the edge)

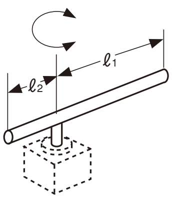


Parameters	■Mass moment of inertia I ($kg \cdot m^2$)	■Rotating radius
●Bar length ℓ (m) ●Mass m (kg)	$I=\frac{m\ell^2}{3}$	$\frac{\ell^2}{3}$

Parameters	■Mass moment of inertia I´ [$lbf \cdot ft \cdot sec^2$]	■Rotating radius
●Bar length ℓ [ft.] ●Weight w [lbf.]	$I'=\frac{w\ell^2}{3\times32.2}$	$\frac{\ell^2}{3}$

Remark: Mounting direction is horizontal.
If the mounting direction is vertical, the swing time will change.

●Slender rod

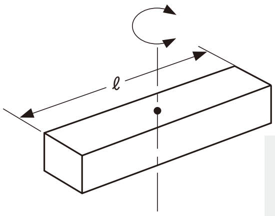


Parameters	■Mass moment of inertia I ($kg \cdot m^2$)	■Rotating radius
●Rod length ℓ_1 (m), ℓ_2 (m) ●Mass m_1 (kg), m_2 (kg)	$I=\frac{m_1\ell_1^2}{3}+\frac{m_2\ell_2^2}{3}$	$\frac{\ell_1^2+\ell_2^2}{3}$

Parameters	■Mass moment of inertia I´ [$lbf \cdot ft \cdot sec^2$]	■Rotating radius
●Rod length ℓ_1 [ft.], ℓ_2 [ft.] ●Weight w_1 [lbf.], w_2 [lbf.]	$I'=\frac{w_1\ell_1^2}{3\times32.2}+\frac{w_2\ell_2^2}{3\times32.2}$	$\frac{\ell_1^2+\ell_2^2}{3}$

Remark: Mounting direction is horizontal.
If the mounting direction is vertical, the swing time will change.

●Bar (rotation center is through the center of gravity)



●Bar length ℓ (m)
●Mass m (kg)

■Mass moment of inertia I ($kg \cdot m^2$)

$$I = \frac{m\ell^2}{12}$$

■Rotating radius

$$\frac{\ell^2}{12}$$

●Bar length ℓ [ft.]
●Weight w [lbf.]

■Mass moment of inertia I′ [$lbf \cdot ft \cdot sec^2$]

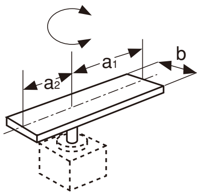
$$I' = \frac{w\ell^2}{12 \times 32.2}$$

■Rotating radius

$$\frac{\ell^2}{12}$$

Remark: No particular mounting direction.

●Thin rectangular plate (rectangular solid)



●Plate length a_1 (m)
a_2 (m)
●Length of side b (m)
●Mass m_1 (kg)
m_2 (kg)

■Mass moment of inertia I ($kg \cdot m^2$)

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

■Rotating radius

$$\frac{(4a_1^2 + b^2) + (4a_2^2 + b^2)}{12}$$

●Plate length a_1 [ft.]
a_2 [ft.]
●Length of side b [ft.]
●Weight w_1 [lbf.]
w_2 [lbf.]

■Mass moment of inertia I′ [$lbf \cdot ft \cdot sec^2$]

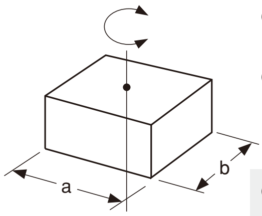
$$I' = \frac{w_1}{12 \times 32.2}(4a_1^2 + b^2) + \frac{w_2}{12 \times 32.2}(4a_2^2 + b^2)$$

■Rotating radius

$$\frac{(4a_1^2 + b^2) + (4a_2^2 + b^2)}{12}$$

Remark: Mounting direction is horizontal.
If the mounting direction is vertical, the swing time will change.

●Rectangular parallelepiped



●Length of sides a (m)
b (m)
●Mass m (kg)

■Mass moment of inertia I ($kg \cdot m^2$)

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

■Rotating radius

$$\frac{a^2 + b^2}{12}$$

●Length of sides a [ft.]
b [ft.]
●Weight w [lbf.]

■Mass moment inertia I′ [$lbf \cdot ft \cdot sec^2$]

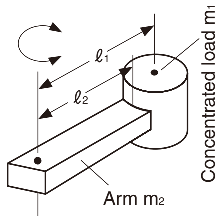
$$I' = \frac{w}{12 \times 32.2}(a^2 + b^2)$$

■Rotating radius

$$\frac{a^2 + b^2}{12}$$

Remark: No particular mounting direction.
For sliding use, see separate materials.

●Concentrated load



●Shape of concentrated load
●Distance to center of gravity of concentrated load ℓ_1 (m)
●Length of arm ℓ_2 (m)
●Mass of concentrated load m_1 (kg)
●Mass of arm m_2 (kg)

■Mass moment of inertia I (kg·m²)

$$I = m_1 k^2 + m_1 \ell_1^2 + \frac{m_2 \ell_2^2}{3}$$

Rotating radius: k^2 is calculated according to shape of the concentrated load.

Remark: Mounting direction is horizontal. When m_2 is much smaller than m_1, calculate as $m_2 = 0$.

●Shape of concentrated load
●Distance to center of gravity of concentrated load ℓ_1 [ft.]
●Length of arm ℓ_2 [ft.]
●Weight of concentrated load w_1 [lbf.]
●Weight of arm w_2 [lbf.]

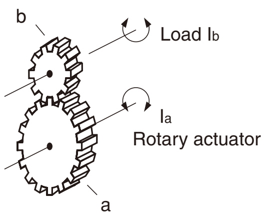
■Mass moment of inertia I´ [lbf·ft·sec²]

$$I' = \frac{w_1 k^2}{32.2} + \frac{w_1 \ell_1^2}{32.2} + \frac{w_2}{32.2} \times \frac{\ell_2^2}{3}$$

Rotating radius: k^2 is calculated according to shape of the concentrated load.

Remark: Mounting direction is horizontal. When w_2 is much smaller than w_1, calculate as $w_2 = 0$.

●Gear Equation for calculating the load J_L with respect to rotary actuator axis when transmitted by gears



●Gear Rotary actuator side a
Load side b
●Inertia moment of load N·m

■Mass moment of inertia I (kg·m²)

Mass moment of inertia of load with respect to rotary actuator axis

$$I_a = \left(\frac{a}{b}\right)^2 I_b$$

●Gear Rotary actuator side a
Load side b
●Inertia moment of load ft·lbf

■Mass moment of inertia I´ [lbf·ft·sec²]

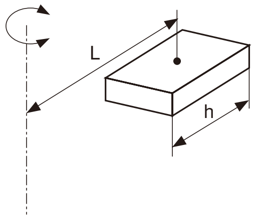
Mass moment of inertia of load with respect to rotary actuator axis

$$I_a = \left(\frac{a}{b}\right)^2 I_b$$

Remark: If the shapes of the gears are too large, the mass moment of inertia of the gears must be also taken into consideration.

【When the rotation axis is offset from the workpiece】

●Rectangular parallelepiped



- ●Length of side h (m)
- ●Distance from rotation axis to the center of load L (m)
- ●Mass m (kg)

■Mass moment of inertia I (kg・m²)

$$I=\frac{mh^2}{12}+mL^2$$

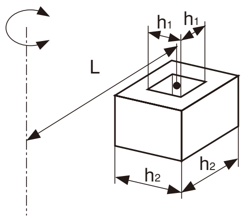
- ●Length of side h [ft.]
- ●Distance from rotation axis to the center of load L [ft.]
- ●Weight w [lbf.]

■Mass moment of inertia I´ [lbf・ft・sec²]

$$I'=\frac{wh^2}{32.2\times 12}+\frac{wL^2}{32.2}$$

Remark: Same for cube.

●Hollow rectangular parallelepiped



- ●Length of side h_1 (m)
  h_2 (m)
- ●Distance from rotation axis to the center of load L (m)
- ●Mass m (kg)

■Mass moment of inertia I (kg・m²)

$$I=\frac{m}{12}(h_2^2+h_1^2)+mL^2$$

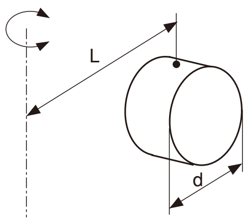
- ●Length of side h_1 [ft.]
  h_2 [ft.]
- ●Distance from rotation axis to the center of load L [ft.]
- ●Weight w [lbf.]

■Mass moment of inertia I´ [lbf・ft・sec²]

$$I'=\frac{w(h_2^2+h_1^2)}{32.2\times 12}+\frac{wL^2}{32.2}$$

Remark: Cross-section is square only.

●Circular cylinder



- ●Diameter d (m)
- ●Distance from rotation axis to the center of load L (m)
- ●Mass m (kg)

■Mass moment of inertia I (kg・m²)

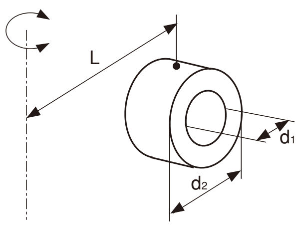
$$I=\frac{md^2}{16}+mL^2$$

- ●Diameter d [ft.]
- ●Distance from rotation axis to the center of load L [ft.]
- ●Weight w [lbf.]

■Mass moment of inertia I´ [lbf・ft・sec²]

$$I'=\frac{wd^2}{32.2\times 16}+\frac{wL^2}{32.2}$$

●Hollow circular cylinder



- ●Diameter d_1 (m)
  d_2 (m)
- ●Distance from rotation axis to the center of load L (m)
- ●Mass m (kg)

■Mass moment of inertia I (kg・m²)

$$I=\frac{m}{16}(d_2^2+d_1^2)+mL^2$$

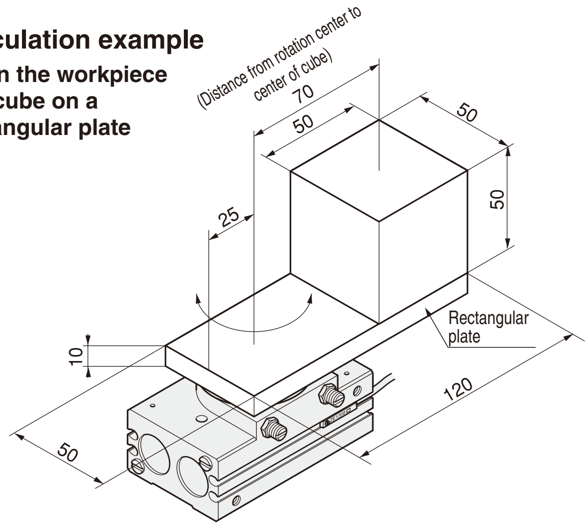
- ●Diameter d_1 [ft.]
  d_2 [ft.]
- ●Distance from rotation axis to the center of load L [ft.]
- ●Weight w [lbf.]

■Mass moment of inertia I´ [lbf・ft・sec²]

$$I'=\frac{w(d_2^2+d_1^2)}{32.2\times 16}+\frac{wL^2}{32.2}$$

●Calculation example

When the workpiece is a cube on a rectangular plate
(mm)



1. Check application conditions

①Swing angle：90°
②Swing time：0.5 (s)
③Applied pressure：0.5 (MPa)
④Workpiece shape: Shown in the above
Workpiece material
Rectangular plate : Aluminum alloy (Specific gravity ＝2.68×10^3 kg/m^3)
Cube : Steel (Specific gravity ＝7.85×10^3 kg/m^3)
⑤Mounting direction : Horizontal

2. Check the swing time

The swing time is 0.5s/90°, which is within the range of 0.2～1.0s/90°, and satisfactory.

3. Select by the torque

Firstly calculate the mass moment of inertia.

Rectangular plate

$m_1=0.05\times(0.12-0.025)\times0.01\times2.68\times10^3=0.127$ (kg)

$m_2=0.05\times0.025\times0.01\times2.68\times10^3=0.034$ (kg)

$$I_1=\frac{0.127}{12}\{4\times(0.12-0.025)^2+0.05^2\}+\frac{0.034}{12}(4\times0.025^2+0.05^2)$$

$$=0.42\times10^{-3}\ (\text{kg}\cdot\text{m}^2)\cdots①$$

Cube

$m_3=0.05\times0.05\times0.05\times7.85\times10^3=0.981$ (kg)

$$I_2=\frac{0.981\times0.05^2}{12}+0.981\times0.07^2$$

$$=5.01\times10^{-3}\ (\text{kg}\cdot\text{m}^2)\cdots②$$

From ① and ②, the total mass moment of inertia I is

$I=I_1+I_2$

$=0.42\times10^{-3}+5.01\times10^{-3}$

$=5.43\times10^{-3}$ (kg·m^2)…③

According to the given conditions, $\theta=90°$, t＝0.5 (s) therefore, the uniform angular acceleration $\dot{\omega}$ is

$$\dot{\omega}=\frac{2\times1.57}{0.5^2}=12.56\ (\text{rad/s}^2)\cdots④$$

From ③ and ④, the required torque T_A is

$T_A=5.43\times10^{-3}\times12.56\times5$

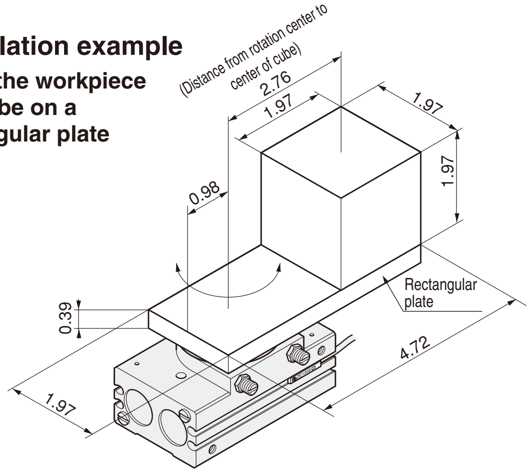
$=0.341$ (N·m)…⑤

From the Effective Torque Table (graph) on p.1238, select a model where the torque is more than 0.341 (N·m) at 0.5 MPa.

RAT5-90

●Calculation example

When the workpiece is a cube on a rectangular plate
[in.]



1. Check application conditions

①Swing angle：90°
②Swing time：0.5 [sec.]
③Applied pressure：73 [psi.]
④Workpiece shape: Shown in the above
Workpiece material
Rectangular plate: Aluminum alloy (Specific gravity ＝167 lbf/ft^3)
Cube: Steel (Specific gravity ＝490 lbf/ft^3)
⑤Mounting direction : Horizontal

2. Check the swing time

The swing time is 0.5sec./90°, which is within the range of 0.2～1.0sec./90°, and satisfactory.

3. Select by the torque

Firstly calculate the mass moment of inertia.

Rectangular plate

$$w_1=\frac{1.97}{12}\times\frac{(4.72-0.98)}{12}\times\frac{0.39}{12}\times167=0.278\ [\text{lbf.}]$$

$$w_2=\frac{1.97}{12}\times\frac{0.98}{12}\times\frac{0.39}{12}\times167=0.073\ [\text{lbf.}]$$

$$I'_1=\frac{0.278}{12\times32.2}\left\{4\times\left(\frac{4.72-0.98}{12}\right)^2+\left(\frac{1.97}{12}\right)^2\right\}+\frac{0.073}{12\times32.2}\left\{4\times\left(\frac{0.98}{12}\right)^2+\left(\frac{1.97}{12}\right)^2\right\}$$

$$=0.31\times10^{-3}\ [\text{lbf}\cdot\text{ft}\cdot\text{sec}^2]\cdots①$$

Cube

$$w_3=\frac{1.97}{12}\times\frac{1.97}{12}\times\frac{1.97}{12}\times490=2.17\ [\text{lbf.}]$$

$$I'_2=\frac{2.17}{12\times32.2}\times\left(\frac{1.97}{12}\right)^2+\frac{2.17}{32.2}\times\left(\frac{2.76}{12}\right)^2$$

$$=3.71\times10^{-3}\ [\text{lbf}\cdot\text{ft}\cdot\text{sec}^2]\cdots②$$

From ① and ②, the total mass moment of inertia I′ is

$I'=I'_1+I'_2$

$=0.31\times10^{-3}+3.71\times10^{-3}$

$=4.02\times10^{-3}$ [lbf·ft·sec^2]…③

According to the given conditions, $\theta=90°$, t＝0.5 [sec.] therefore, the uniform angular acceleration $\dot{\omega}$ is

$$\dot{\omega}=\frac{2\times1.57}{0.5^2}=12.56\ [\text{rad/sec}^2]\cdots④$$

From ③ and ④, the required torque T'_A is

$T'_A=4.02\times10^{-3}\times12.56\times5$

$=0.252$ [ft·lbf]…⑤

From the Effective Torque Table (graph) on p.1238, select a model where the torque is more than 0.252 [ft·lbf] at 73 psi.

RAT5-90

4. Check kinetic energy

With rubber stopper

According to the given conditions, $\theta=90°$, $t=0.5$ (s)

therefore,

$$\omega=\frac{2\times1.57}{0.5}=6.28\ \text{(rad/s)}\cdots①$$

From ①, kinetic energy E is

$$E=\frac{1}{2}\times5.43\times10^{-3}\times6.28^{2}=0.107\ \text{(J)}\cdots②$$

$0.107>0.005$, which means the rubber stopper is not sufficient.
Therefore, recalculate a case with shock absorber.

With shock absorber

$$m_1=\frac{5.43\times10^{-3}}{0.0175^{2}}=17.73\ \text{(kg)}\cdots③$$

$$m_2=\frac{2\times0.42\times0.005}{0.0175^{3}\times6.28^{2}}=19.87\ \text{(kg)}\cdots④$$

From ③ and ④,

$m=17.73+19.87=37.60$ (kg)…⑤

$V=0.0175\times6.28=0.110$…⑥

From ⑤ and ⑥, find the kinetic energy.

$$E=\frac{1}{2}\times37.60\times0.110^{2}=0.227\ \text{(J)}$$

$0.227<0.36$, which means there is no problem in the application with shock absorber.

5. Check load ratio

【Thrust load】

The total mass is

$0.034+0.127+0.981=1.142$ (kg)

Therefore,

$W_S=1.142\times9.8=11.192$ (N)…①

【Radial load】

Since no radial load is applied,

$W_R=0$ (N)…②

【Moment】

The moment M_1 by the rectangular plate is

$$M_1=(0.034+0.127)\times9.8\times\left(\frac{0.12}{2}-0.025\right)=0.055\ \text{(N·m)}\cdots③$$

The moment M_2 by the cube is

$M_2=0.981\times9.8\times0.07=0.673$ (N·m)…④

From ③ and ④, the total moment is

$M=0.055+0.673=0.728$ (N·m)…⑤

From ①, ②, and ⑤, find the load ratio

$$\frac{W_S}{W_{S\,MAX}}+\frac{W_R}{W_{R\,MAX}}+\frac{M}{M_{MAX}}=\frac{11.192}{50}+\frac{0}{30}+\frac{0.728}{1.5}=0.71<1.0$$

the load ratio is less than 1.0, and satisfactory.

6. Check the unit specifications

Selection of **RAT5-90-SS2** satisfies both the kinetic energy and load ratio requirements.

4. Check kinetic energy

With rubber stopper

According to the given conditions, $\theta=90°$, $t=0.5$ [sec.]

therefore,

$$\omega=\frac{2\times1.57}{0.5}=6.28\ \text{[rad/sec.]}\cdots①$$

From ①, kinetic energy E′ is

$$E'=\frac{1}{2}\times4.02\times10^{-3}\times6.28^{2}=0.0793\ \text{[ft·lbf]}\cdots②$$

$0.0793>0.004$, which means the rubber stopper is not sufficient.
Therefore, recalculate a case with shock absorber.

With shock absorber

$$w_1=\frac{4.02\times10^{-3}\times32.2}{\left(\frac{0.69}{12}\right)^{2}}=39.15\ \text{[lbf.]}\cdots③$$

$$w_2=\frac{2\times0.31\times\frac{0.2}{12}\times32.2}{\left(\frac{0.69}{12}\right)^{3}\times6.28^{2}}=44.38\ \text{[lbf.]}\cdots④$$

From ③ and ④,

$w=39.15+44.38=83.53$ [lbf.]…⑤

$$V'=\frac{0.69}{12}\times6.28=0.361\cdots⑥$$

From ⑤ and ⑥, find the kinetic energy.

$$E'=\frac{83.53\times0.361^{2}}{2\times32.2}=0.169\ \text{[ft·lbf]}$$

$0.169<0.27$, which means there is no problem in the application with shock absorber.

5. Check load ratio

【Thrust load】

The total weight is

$0.278+0.073+2.17=2.52$ [lbf.]

Therefore,

$W'_S=2.52$ [lbf.]…①

【Radial load】

Since no radial load is applied,

$W'_R=0$ [lbf.]…②

【Moment】

The moment M'_1 by the rectangular plate is

$$M'_1=(0.073+0.278)\times\left(\frac{1}{2}\times\frac{4.72}{12}-\frac{0.98}{12}\right)=0.040\ \text{[ft·lbf]}\cdots③$$

The moment M'_2 by the cube is

$$M'_2=2.17\times\frac{2.76}{12}=0.499\ \text{[ft·lbf]}\cdots④$$

From ③ and ④, the total moment is

$M'=0.040+0.499=0.539$ [ft·lbf]…⑤

From ①, ②, and ⑤, find the load ratio

$$\frac{W'_S}{W'_{S\,MAX}}+\frac{W'_R}{W'_{R\,MAX}}+\frac{M'}{M'_{MAX}}=\frac{2.52}{11.2}+\frac{0}{6.7}+\frac{0.539}{1.1}=0.715<1.0$$

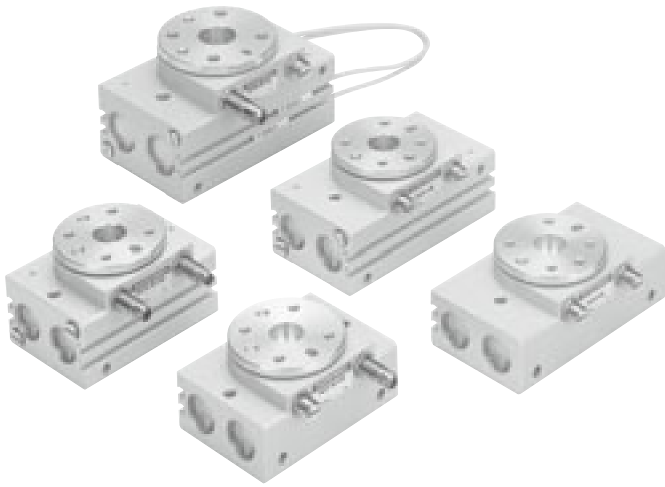
the load ratio is less than 1.0, and satisfactory.

6. Check the unit specifications

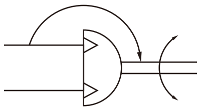
Selection of **RAT5-90-SS2** satisfies both the kinetic energy and load ratio requirements.

ROTARY ACTUATORS

RAT Series



Symbol



Specifications

Item		Model	RAT5	RAT10	RAT30
Operation type			Double acting single piston type (rack and pinion construction)	Double acting double piston type (rack and pinion construction)	
Effective torque Note 1		N•m [ft•lbf]	0.42 [0.31]	0.89 [0.66]	2.87 [2.12]
Media			Air		
Operating pressure range		MPa [psi.]	0.2～0.7 [29～102]		
Proof pressure		MPa [psi.]	1.05 [152]		
Operating temperature range		°C [°F]	0～60 [32～140]		
Cushion	With rubber stopper		Rubber bumper		
	With shock absorber		Shock absorber		
Swing angle range	90° type		–5°～95°		
	180° type		–5°～185°		
Swing angle adjustment range Note 2	90° type		Clockwise rotation end: ±5° referred to 0° position/Counterclockwise rotation end: ±5° referred to 90° position		
	180° type		Clockwise rotation end: ±5° referred to 0° position/Counterclockwise rotation end: ±5° referred to 180° position		
Swing time adjustment range Note 3		s/90°	0.2～1.0		
Allowable energy J [ft•lbf]	With rubber stopper		0.005 [0.004]	0.008 [0.006]	0.03 [0.022]
	With shock absorber		0.36 [0.27]	0.53 [0.39]	1.14 [0.841]
Allowable thrust load		N [lbf.]	50 [11]	80 [18]	200 [45]
Allowable radial load		N [lbf.]	30 [6.7]	80 [18]	200 [45]
Allowable moment		N•m [ft•lbf]	1.5 [1.1]	2.5 [1.8]	5.5 [4.1]
Lubrication			Not required (If lubrication is required, use Turbine Oil Class 1 [ISO VG32] or equivalent.)		
Port size			M5×0.8		

Notes: 1. Effective torque is the value when the pressure is 0.5 MPa [73 psi.].
2. For the swing end position, see p.1250.
3. The swing time adjustment range is the value by using the rubber stopper option, with no load at air pressure of 0.5 MPa [73 psi.].

Shock Absorber Specifications

Item	Model	KSHAR5×5-D	KSHAR5×5-E	KSHAR6×8-F
Applicable model		RAT5	RAT10	RAT30
Maximum absorption	J [ft•lbf]	1.0 [0.7]	2.0 [1.5]	3.0 [2.2]
Absorption stroke	mm [in.]	5 [0.20]		8 [0.31]
Maximum operating frequency	cycle/min	60		30
Maximum impact speed	mm/s [in./sec.]	300 [11.8]		
Angle variation		8° or less		12° or less
Operating temperature range	°C [°F]	0～60 [32～140]		

Caution: Even if applications are within the shock absorber absorption range, follow also within the rotary actuator RAT series swing time adjustment and allowable energy range.

Remarks: 1. Do not loosen or remove the small screw on the rear end of the shock absorber. The oil inside will leak out which will fail the function of the shock absorber.
2. The life of shock absorber may vary from the rotary actuator RAT series depending on its operating conditions.

Order Codes

RAT □ - □ - □ - □ □ □

Number of sensor switches
1： With 1 sensor switch
2： With 2 sensor switches
⋮
n： With n switches

Lead wire length
A： 1000mm [39 in.]
B： 3000mm [118 in.]

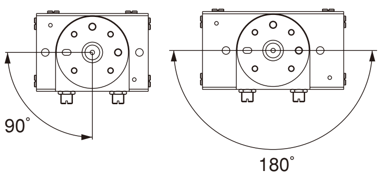
Sensor switch

Blank	No sensor switch		
ZE101	Reed switch type, without indicator lamp	Horizontal lead wire	DC5～28V, AC85～115V
ZE102	Reed switch type, with indicator lamp	Horizontal lead wire	DC10～28V, AC85～115V
ZE201	Reed switch type, without indicator lamp	Vertical lead wire Note3	DC5～28V, AC85～115V
ZE202	Reed switch type, with indicator lamp	Vertical lead wire Note3	DC10～28V, AC85～115V
ZE135	2-lead wires solid state type, with indicator lamp	Horizontal lead wire	DC10～28V
ZE155	3-lead wires solid state type, with indicator lamp	Horizontal lead wire	DC4.5～28V
ZE235	2-lead wires solid state type, with indicator lamp	Vertical lead wire Note3	DC10～28V
ZE255	3-lead wires solid state type, with indicator lamp	Vertical lead wire Note3	DC4.5～28V

●For details of sensor switches, see p.1544.

Angle adjustment
Blank：With rubber stopper on both sides
SS2：With shock absorber on both sides
SSR：With shock absorber on right side (Clockwise rotation end side) Note 2
SSL：With shock absorber on left side (Counterclockwise rotation end side) Note 2

Swing angle
90：90°
180：180°



Nominal torque
5：0.42N･m [0.31ft･lbf]
10：0.89N･m [0.66ft･lbf]
30：2.87N･m [2.12ft･lbf]

Basic model
Rotary actuator RAT series

Notes: 1. Standard, with magnet type.
2. The opposite side of the shock absorber (SSR or SSL) comes with the rubber stopper.
3. In the vertical lead wire type, the lead wire protrudes the sensor switch at right angles.

Additional Parts

●Rubber stopper

CRK □

588：For RAT5-□, and RAT10-□
589：For RAT30-□

●Shock absorber

KSHAR □

5×5-D：For RAT5-□
5×5-E：For RAT10-□
6×8-F：For RAT30-□

Remark: The shock absorber or rubber stopper comes as a set consisting of its body and 1 mounting nut.

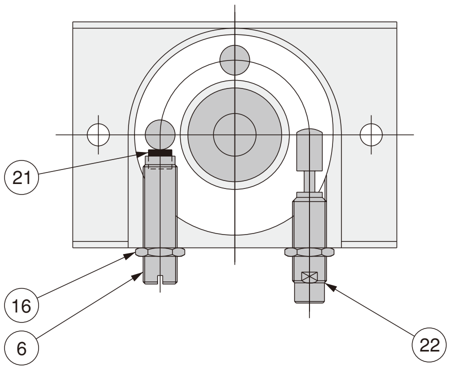
Mass

g [oz.]

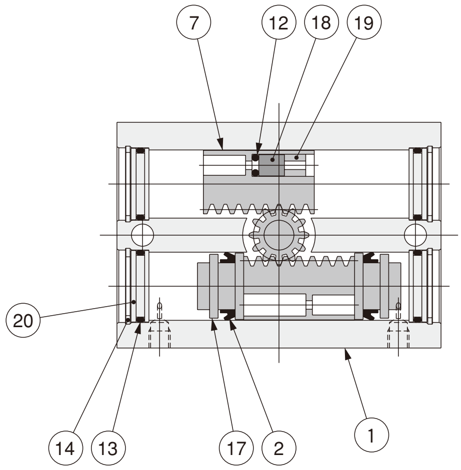
Model	Mass
RAT5-90	285 [10.05]
RAT5-90-SS2	285 [10.05]
RAT5-90-SSR（L）	285 [10.05]
RAT5-180	340 [11.99]
RAT5-180-SS2	340 [11.99]
RAT5-180-SSR（L）	340 [11.99]
RAT10-90	350 [12.35]
RAT10-90-SS2	350 [12.35]
RAT10-90-SSR（L）	350 [12.35]
RAT10-180	420 [14.81]
RAT10-180-SS2	420 [14.81]
RAT10-180-SSR（L）	420 [14.81]
RAT30-90	690 [24.34]
RAT30-90-SS2	694 [24.48]
RAT30-90-SSR（L）	692 [24.41]
RAT30-180	855 [30.16]
RAT30-180-SS2	859 [30.30]
RAT30-180-SSR（L）	857 [30.23]
CRK588	10 [0.35]
CRK589	20 [0.71]
KSHAR5×5-D	10 [0.35]
KSHAR5×5-E	10 [0.35]
KSHAR6×8-F	22 [0.78]

Inner Construction

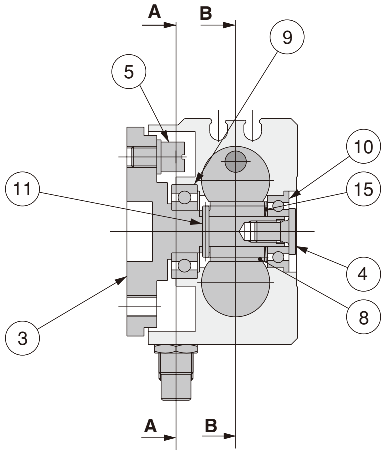
RAT5



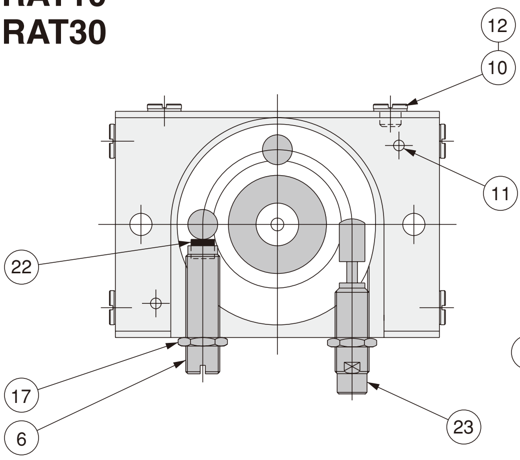
Section A — A



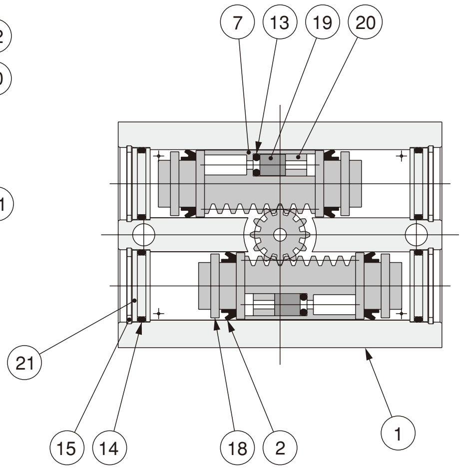
Section B — B



RAT10
RAT30



Section A — A



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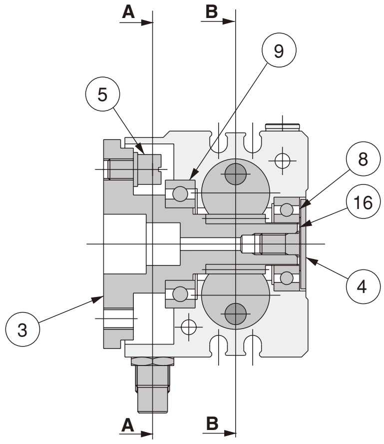


Major Parts and Materials

RAT5

No.	Parts	Materials
①	Body	Aluminum alloy (anodized)
②	Piston seal	Synthetic rubber (NBR)
③	Table	Aluminum alloy (anodized)
④	Table holding screw	Stainless steel
⑤	Stopper	Special steel
⑥	Adjusting bolt	Steel (nickel plated)
⑦	Rack	Plastic
⑧	Spur gear	Steel
⑨	Bearing	Steel
⑩	Bearing	Steel
⑪	Spring pin	Steel
⑫	O-ring	Synthetic rubber (NBR)
⑬	O-ring	Synthetic rubber (NBR)
⑭	Snap ring	Steel (nickel plated)
⑮	Washer	Steel
⑯	Hexagon nut	Mild steel (zinc plated)
⑰	Piston	Plastic
⑱	Magnet	Plastic magnet
⑲	Magnet holder	Plastic
⑳	End plate	Plastic
㉑	Bumper	Synthetic rubber (NBR)
㉒	Shock absorber	—

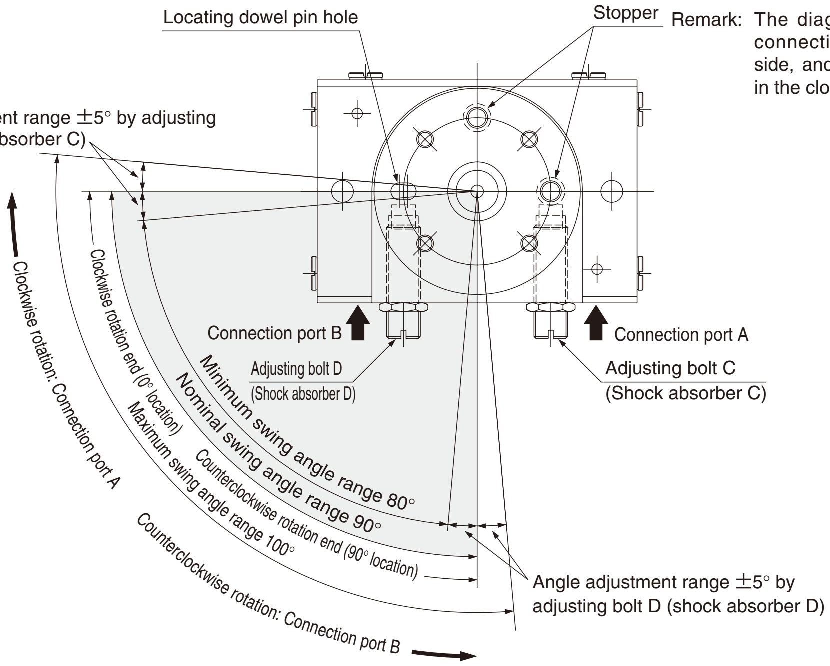
RAT10, RAT30

No.	Parts	Materials
①	Body	Aluminum alloy (anodized)
②	Piston seal	Synthetic rubber (NBR)
③	Table	Aluminum alloy (anodized)
④	Table holding screw	Stainless steel
⑤	Stopper	Special steel
⑥	Adjusting bolt	Steel (nickel plated)
⑦	Rack	Plastic
⑧	Bearing	Steel
⑨	Bearing	Steel
⑩	Plug	Mild steel (nickel plated)
⑪	Steel ball	Stainless steel
⑫	Seal	Mild steel ＋ Synthetic rubber (NBR)
⑬	O-ring	Synthetic rubber (NBR)
⑭	O-ring	Synthetic rubber (NBR)
⑮	Snap ring	Steel (nickel plated)
⑯	Washer	Steel
⑰	Hexagon nut	Mild steel (zinc plated)
⑱	Piston	Plastic
⑲	Magnet	Plastic magnet
⑳	Magnet holder	Plastic
㉑	End plate	Plastic
㉒	Bumper	Synthetic rubber (NBR)
㉓	Shock absorber	—

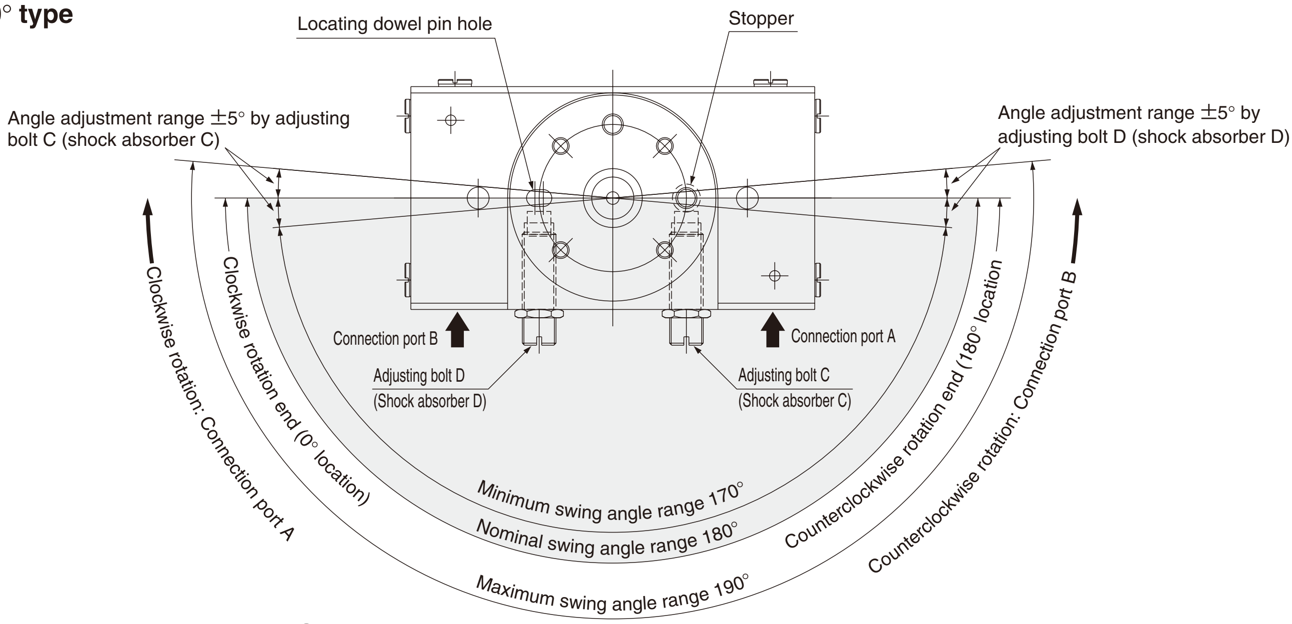
Swing Angle Range and Swing Direction

●90° type

Remark: The diagrams show when air is supplied to connection port A on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).



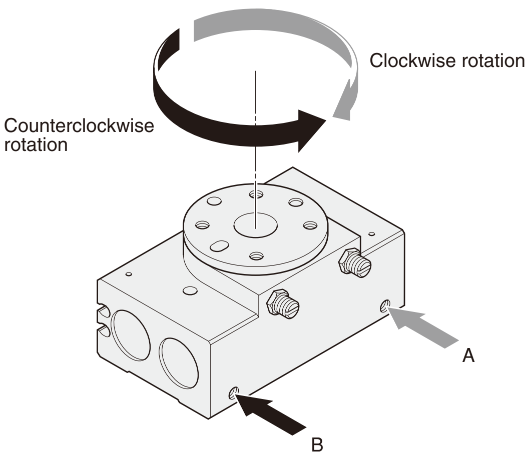
●180° type



Piping Port Location and Swing Direction

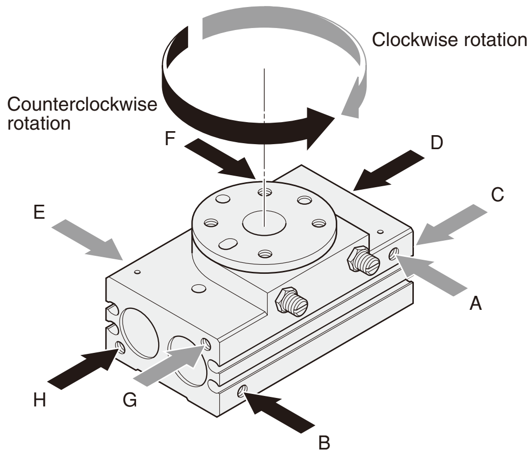
●RAT5

The table swings in clockwise rotation when air is supplied to connection port A, and in counterclockwise rotation when air is supplied to connection port B. (The other surfaces do not have connection ports.)



●RAT10, 30

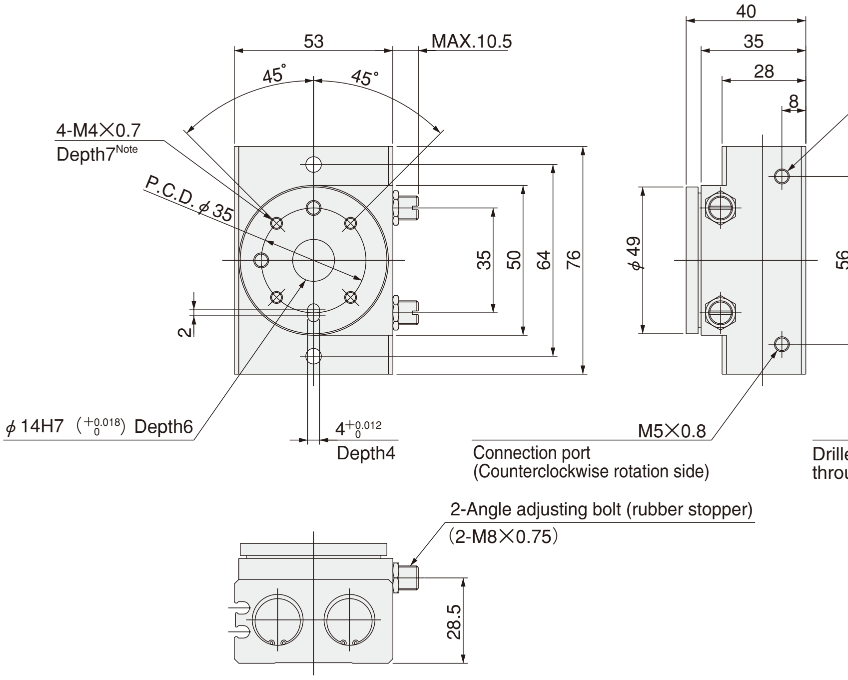
The table swings in clockwise rotation when air is supplied to connection port A, C, E or G, and in counterclockwise rotation when air is supplied to connection port B, D, F or H. Note that connection ports C, D, E, F, G and H are plugged at shipping.

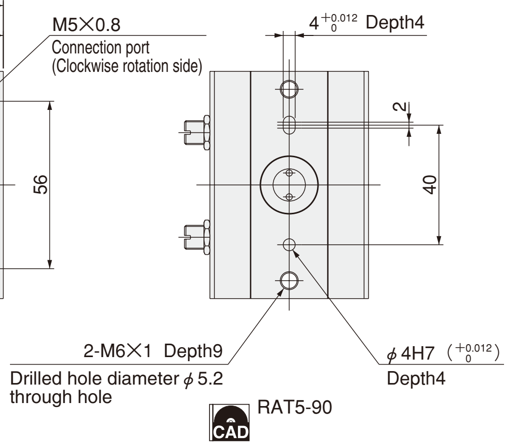


Dimensions (mm)

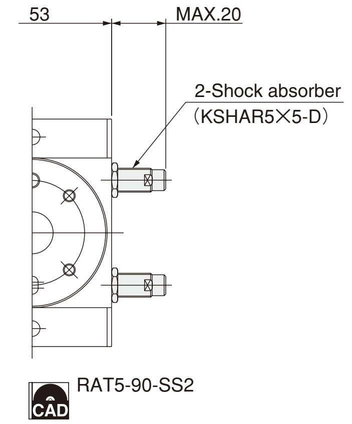
RAT5-90

Remark: The drawings show when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).

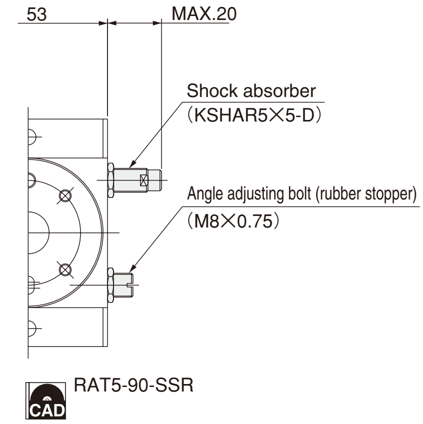




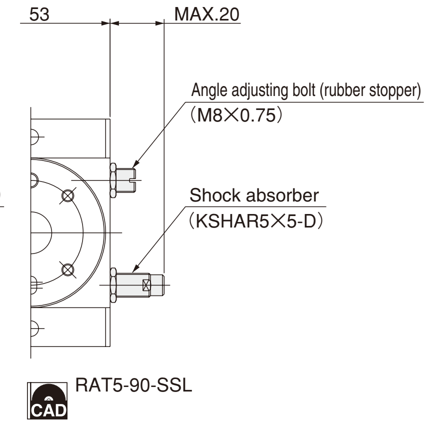
RAT5-90-SS2



RAT5-90-SSR

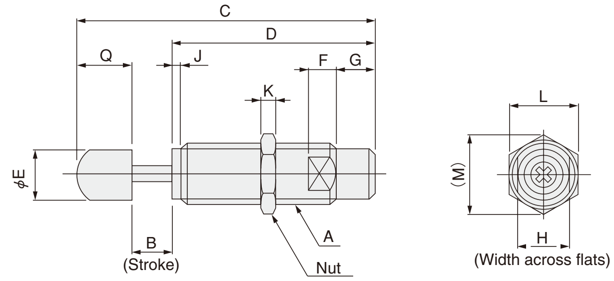


RAT5-90-SSL



Note: Do not screw the bolt deeper than the thread depth.
For mounting a workpiece on the table, see the Handling Instructions and Precautions, "Mounting," on p.1235.

Dimensions of Shock Absorber (mm)

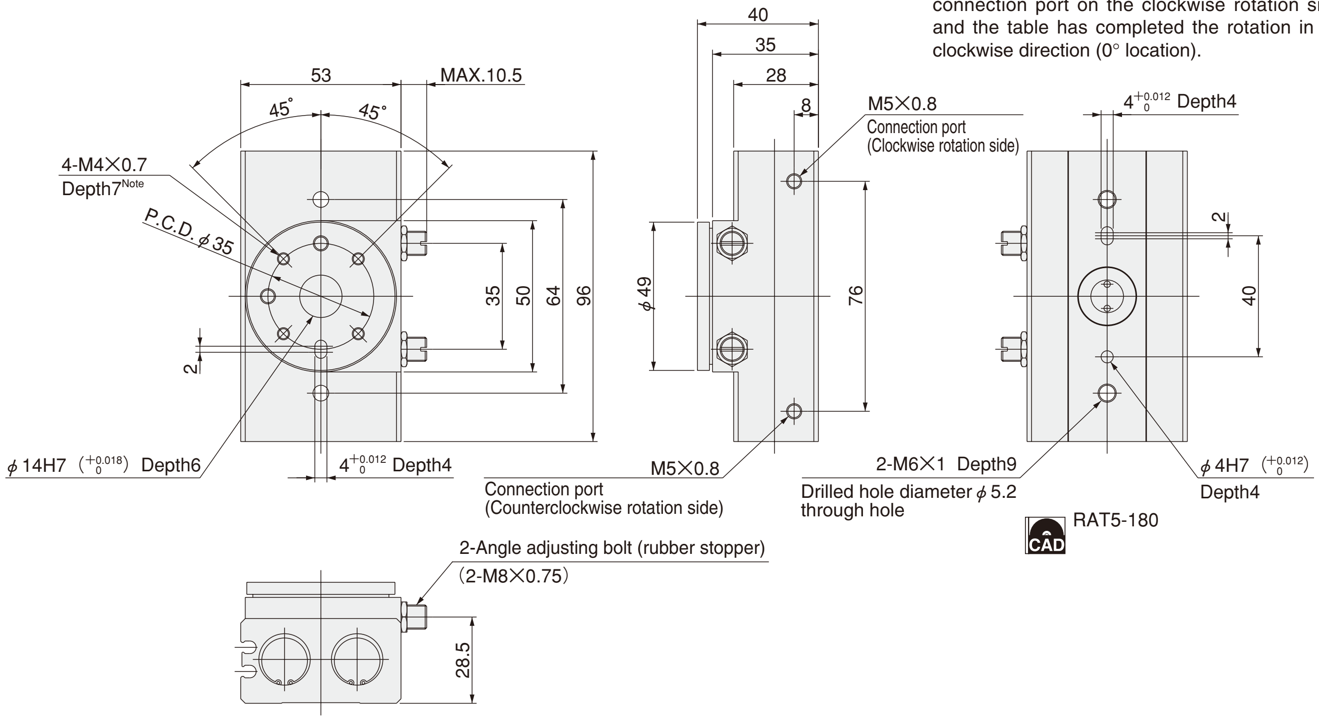


Model	A	B	C	D	E	F	G	H	J	K	L	M	Q
KSHAR5×5-D	M8×0.75	5	46	31	6	3	5	7	1.2	2	10	11.5	10
KSHAR5×5-E	M8×0.75	5	46	31	6	3	5	7	1.2	2	10	11.5	10
KSHAR6×8-F	M10×1	8	61	45	8	4	5	9	2	3	12	13.9	8

Dimensions (mm)

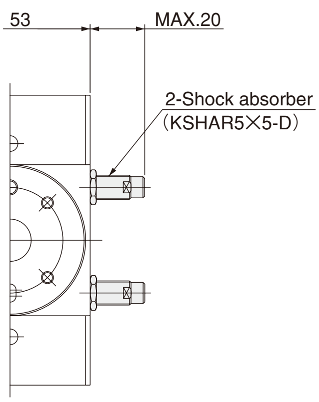
RAT5-180

Remark: The drawings show when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).



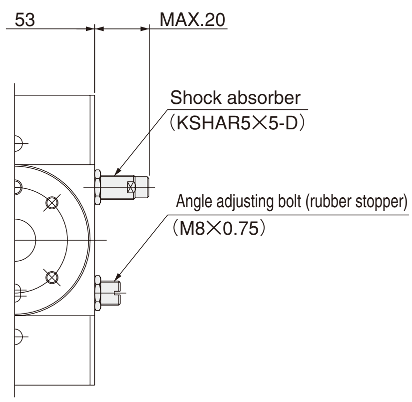
CAD RAT5-180

RAT5-180-SS2



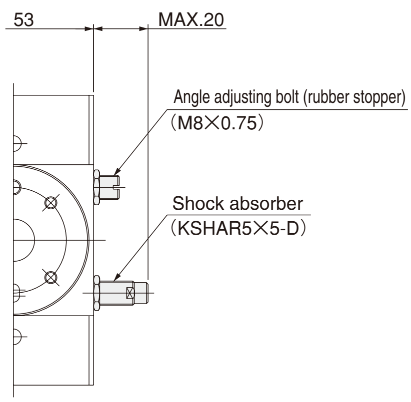
CAD RAT5-180-SS2

RAT5-180-SSR



CAD RAT5-180-SSR

RAT5-180-SSL

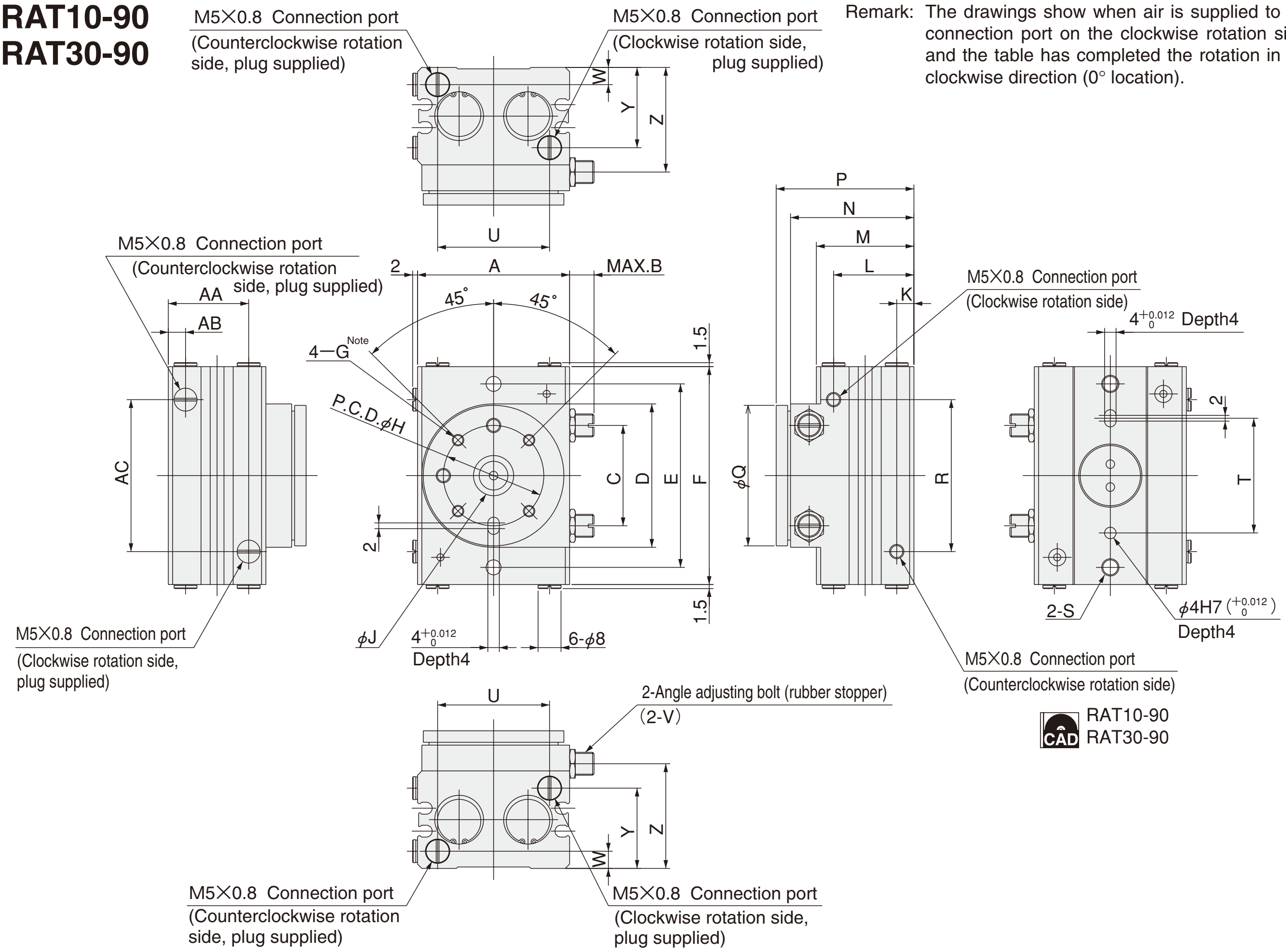


CAD RAT5-180-SSL

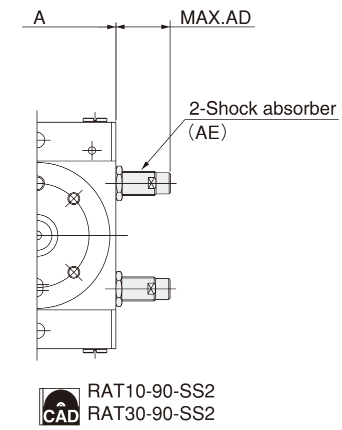
Note: Do not screw the bolt deeper than the thread depth.
For mounting a workpiece on the table, see the Handling Instructions and Precautions, "Mounting," on p.1235.

RAT10-90
RAT30-90

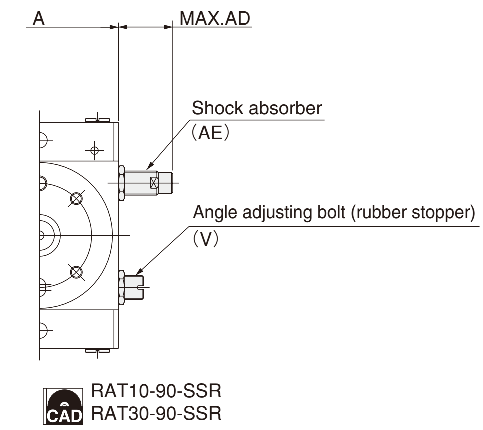
Remark: The drawings show when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).



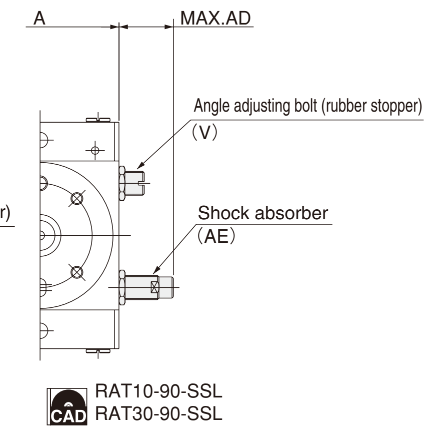
RAT10-90-SS2
RAT30-90-SS2



RAT10-90-SSR
RAT30-90-SSR



RAT10-90-SSL
RAT30-90-SSL



Note: Do not screw the bolt deeper than the thread depth.
For mounting a workpiece on the table, see the Handling Instructions and Precautions, "Mounting," on p.1235.

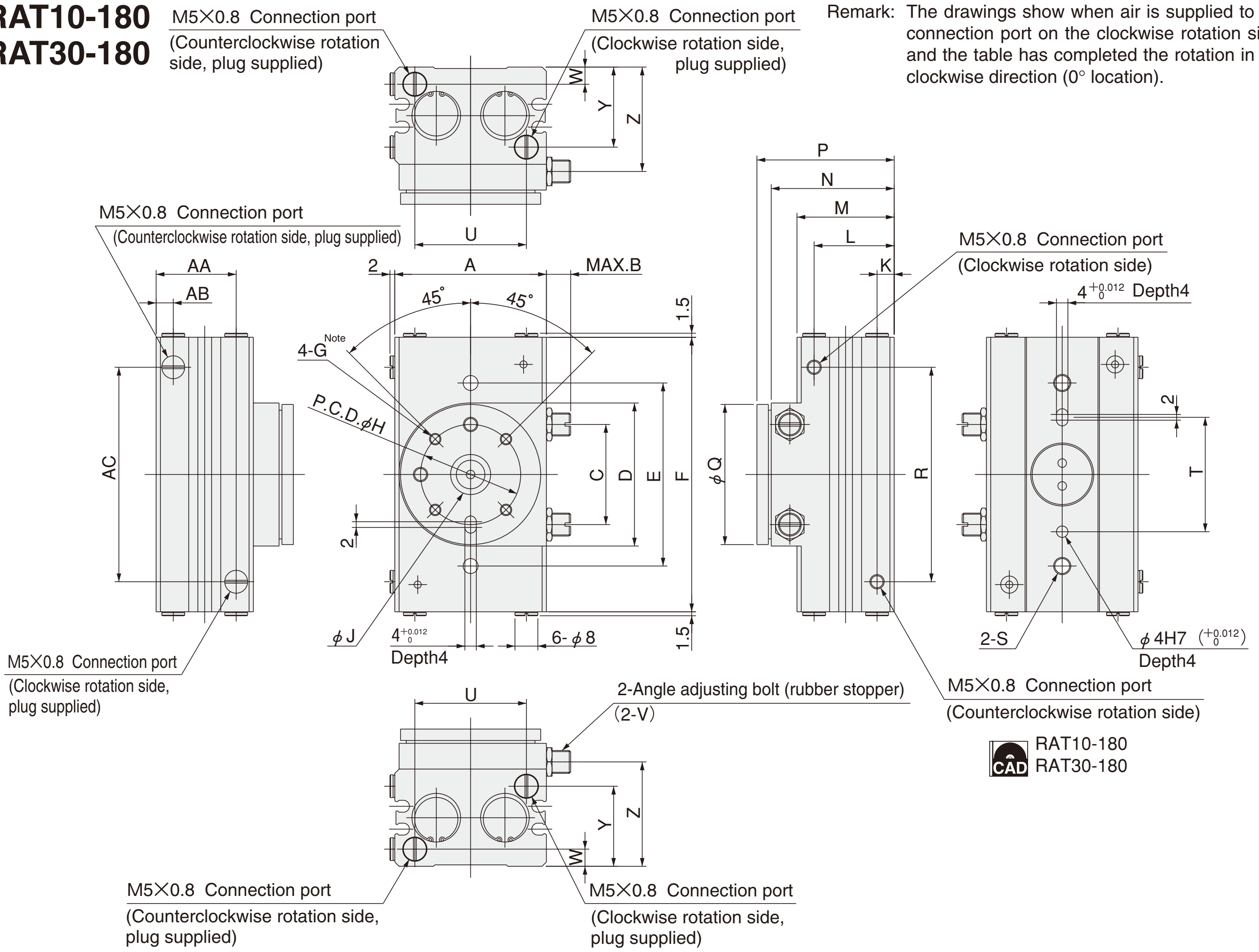
Model \ Code	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
RAT10	53	10.5	35	50	64	76	M4×0.7 Depth7	35	14H7 ($^{+0.018}_{0}$) Depth6	6	28	34	43	48	49	53
RAT30	63	11.5	44	60	72	102	M6×1 Depth8	44	18H7 ($^{+0.018}_{0}$) Depth12	6	35	41	54	60	59	84

Model \ Code	S	T	U	V	W	Y	Z	AA	AB	AC	AD	AE
RAT10	M6×1 Depth9 Drilled hole diameter ϕ5.2 through hole	40	39	M8×0.75	6	28	36.5	28	6	53	20	KSHAR5×5-E
RAT30	M8×1.25 Depth12 Drilled hole diameter ϕ6.6 through hole	48	50	M10×1	6	35	46.5	35	6	84	27	KSHAR6×8-F

Dimensions (mm)

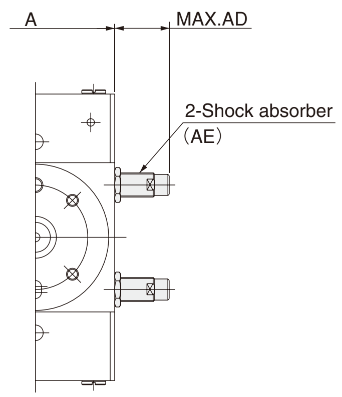
RAT10-180
RAT30-180

Remark: The drawings show when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° location).



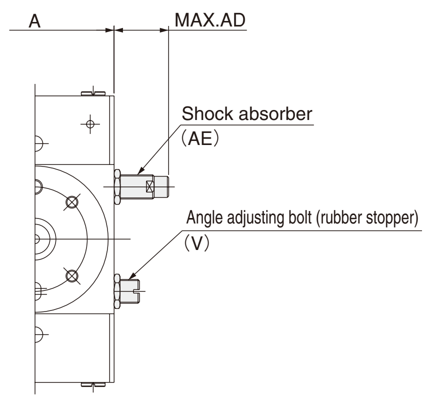
CAD RAT10-180
RAT30-180

RAT10-180-SS2
RAT30-180-SS2



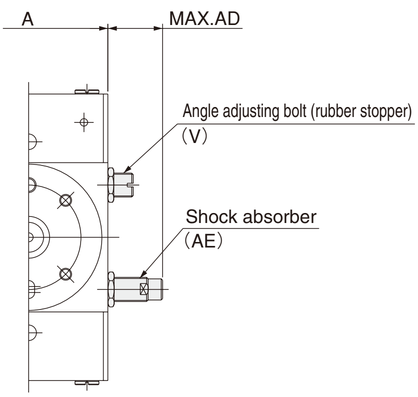
CAD RAT10-180-SS2
RAT30-180-SS2

RAT10-180-SSR
RAT30-180-SSR



CAD RAT10-180-SSR
RAT30-180-SSR

RAT10-180-SSL
RAT30-180-SSL



CAD RAT10-180-SSL
RAT30-180-SSL

Note: Do not screw the bolt deeper than the thread depth.
For mounting a workpiece on the table, see the Handling Instructions and Precautions, “Mounting,” on p.1235.

Model \ Code	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
RAT10	53	10.5	35	50	64	96	M4×0.7 Depth7	35	14H7 $(^{+0.018}_{0})$ Depth6	6	28	34	43	48	49	75
RAT30	63	11.5	44	60	72	135	M6×1 Depth8	44	18H7 $(^{+0.018}_{0})$ Depth12	6	35	41	54	60	59	117

Model \ Code	S	T	U	V	W	Y	Z	AA	AB	AC	AD	AE
RAT10	M6×1 Depth9 Drilled hole diameter ϕ5.2 through hole	40	39	M8×0.75	6	28	36.5	28	6	75	20	KSHAR5×5-E
RAT30	M8×1.25 Depth12 Drilled hole diameter ϕ6.6 through hole	48	50	M10×1	6	35	46.5	35	6	117	27	KSHAR6×8-F

SENSOR SWITCHES

Solid State Type, Reed Switch Type

Order Codes

☐ ☐ - **RAT**

Series
RAT : Rotary actuators RAT series

Lead wire length
A — 1000mm [39in.]
B — 3000mm [118in.]

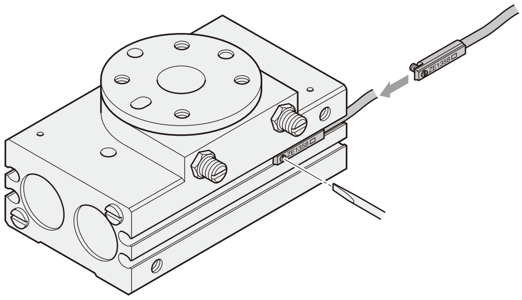
Sensor switch

ZE135	Solid state type	with indicator lamp	DC10～28V	Horizontal lead wire	**ZE155**	Solid state type	with indicator lamp	DC4.5～28V	Horizontal lead wire
ZE235	Solid state type	with indicator lamp	DC10～28V	Vertical lead wire	**ZE255**	Solid state type	with indicator lamp	DC4.5～28V	Vertical lead wire
ZE101	Reed switch type	without indicator lamp	DC5～28V AC85～115V	Horizontal lead wire	**ZE102**	Reed switch type	with indicator lamp	DC10～28V AC85～115V	Horizontal lead wire
ZE201	Reed switch type	without indicator lamp	DC5～28V AC85～115V	Vertical lead wire	**ZE202**	Reed switch type	with indicator lamp	DC10～28V AC85～115V	Vertical lead wire

●For details of sensor switches, see p.1544.

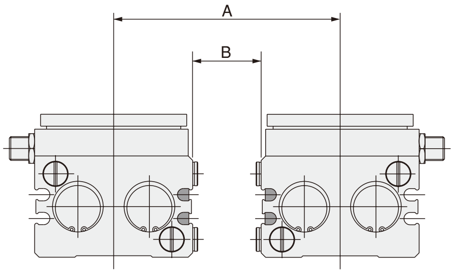
Moving Sensor Switch

- Loosening the mounting screw allows the sensor switch to be moved along the switch mounting groove on the rotary actuator.
- Tighten the mounting screw with a tightening torque of 0.1～0.2N･m [0.9～1.8in･lbf].



When Mounting the Actuators with Sensor Switches in Close Proximity

When mounting the actuators in close proximity, use them at the values shown in the table below, or larger.



●Solid State Type mm [in.]

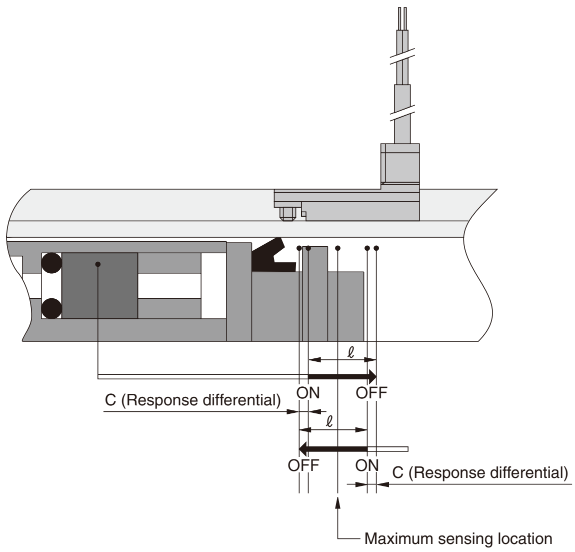
Model	A	B
RAT5	70 [2.76]	17 [0.67]
RAT10		
RAT30	80 [3.15]	

●Reed Switch Type mm [in.]

Model	A	B
RAT5	57 [2.24]	4 [0.16]
RAT10		
RAT30	67 [2.64]	

Sensor Switch Operating Range, Response Differential, and Maximum Sensing Location

- **Operating range:** ℓ
  The distance the piston travels in one direction, while the switch is in the ON position.
- **Response Differential:** C
  The distance between the point where the piston turns the switch ON and the point where the switch is turned OFF as the piston travels in the opposite direction.



●Solid state type mm [in.]

Item \ Model	**RAT5**	**RAT10**	**RAT30**
Operating range: ℓ	2.0～6.0 [0.079～0.236]		
Response differential: C	1.0 or less [0.039 or less]		
Maximum sensing location Note	6 [0.236]		

Remark: The above table shows reference values.
Note: This is the length measured from the switch's opposite end side to the lead wire.

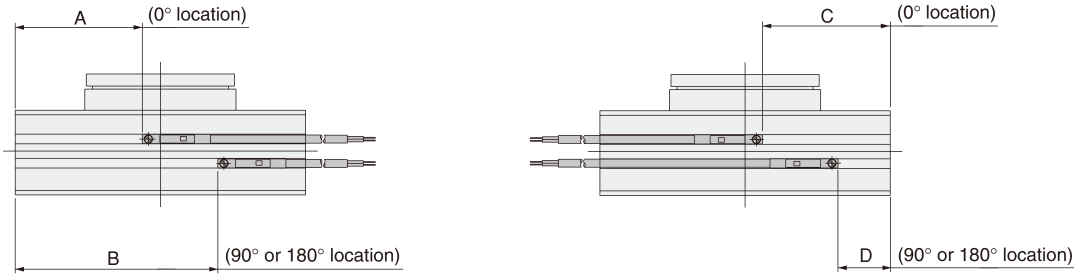
●Reed switch type mm [in.]

Item \ Model	**RAT5**	**RAT10**	**RAT30**
Operating range: ℓ	5.5～9.5 [0.217～0.374]		
Response differential: C	1.5 or less [0.059 or less]		
Maximum sensing location Note	10 [0.394]		

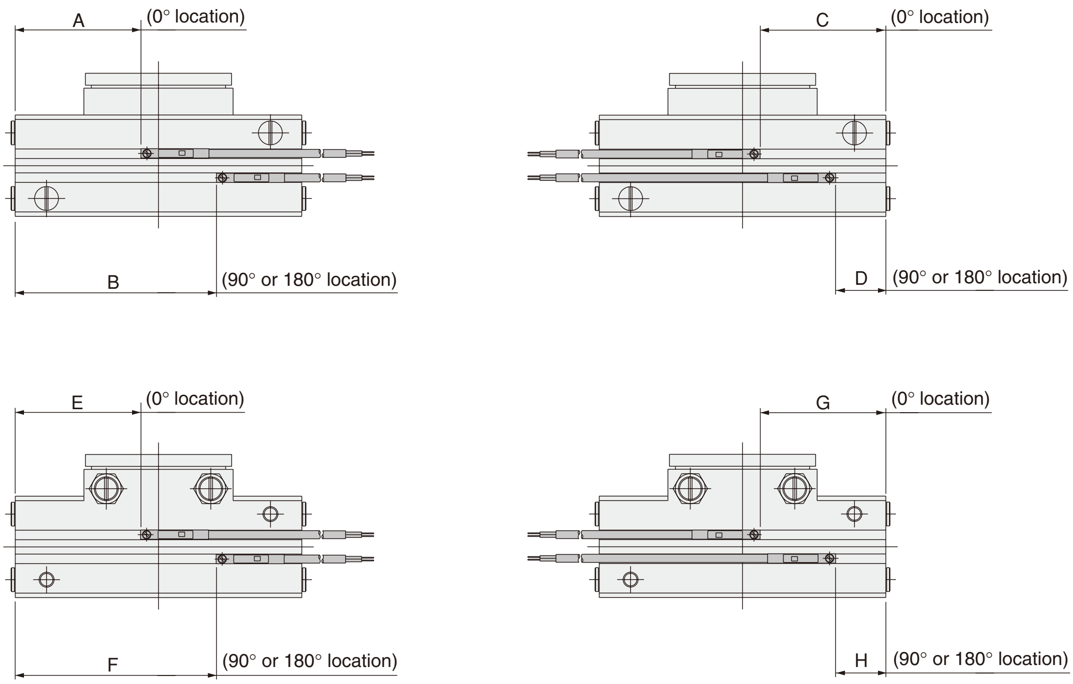
Remark: The above table shows reference values.
Note: This is the length measured from the switch's opposite end side to the lead wire.

Mounting Location of Swing End Detection Sensor Switch

RAT5-90/180



RAT10-90/180
RAT30-90/180



Remark: For the table's 0°, 90° and 180° locations, see p.1250.

●Solid State Type (ZE135, ZE155, ZE235, ZE255)

mm [in.]

	90° specification								180° specification							
	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
RAT5	30.3 [1.193]	39.7 [1.563]	33.7 [1.327]	24.3 [0.957]	—	—	—	—	40.3 [1.587]	59.1 [2.327]	43.7 [1.720]	24.9 [0.980]	—	—	—	—
RAT10	30.3 [1.193]	39.7 [1.563]	33.7 [1.327]	24.3 [0.957]	30.3 [1.193]	39.7 [1.563]	33.7 [1.327]	24.3 [0.957]	40.3 [1.587]	59.1 [2.327]	43.7 [1.720]	24.9 [0.980]	40.3 [1.587]	59.1 [2.327]	43.7 [1.720]	24.9 [0.980]
RAT30	48.8 [1.921]	65.3 [2.571]	41.2 [1.622]	24.7 [0.972]	47.2 [1.858]	63.7 [2.508]	42.8 [1.685]	26.3 [1.035]	65.3 [2.571]	98.2 [3.866]	57.7 [2.272]	24.8 [0.976]	63.7 [2.508]	96.7 [3.807]	59.3 [2.335]	26.3 [1.035]

●Reed Switch Type (ZE101, ZE102, ZE201, ZE202)

mm [in.]

	90° specification								180° specification							
	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
RAT5	26.3 [1.035]	35.7 [1.406]	29.7 [1.169]	20.3 [0.799]	—	—	—	—	36.3 [1.429]	55.1 [2.169]	39.7 [1.563]	20.9 [0.823]	—	—	—	—
RAT10	26.3 [1.035]	35.7 [1.406]	29.7 [1.169]	20.3 [0.799]	26.3 [1.035]	35.7 [1.406]	29.7 [1.169]	20.3 [0.799]	36.3 [1.429]	55.1 [2.169]	39.7 [1.563]	20.9 [0.823]	36.3 [1.429]	55.1 [2.169]	39.7 [1.563]	20.9 [0.823]
RAT30	44.8 [1.764]	61.3 [2.413]	37.2 [1.465]	20.7 [0.815]	43.2 [1.701]	59.7 [2.350]	38.8 [1.528]	22.3 [0.878]	61.3 [2.413]	94.2 [3.709]	53.7 [2.114]	20.8 [0.819]	59.7 [2.350]	92.7 [3.650]	55.3 [2.177]	22.3 [0.878]