KOGANEI

Air Cylinder

ROTARY ACTUATORS PISTON TYPE RAP Series

INSTRUCTION MANUAL Ver.1.0

KOGANEI

Handling Instructions and Precautions

Selection and installation

Selection

1. When selecting a model, calculate the torque and kinetic energy according to "Model Selection Procedure" on p.43 to p.52.

   The inertia load becomes larger when the load mass is large, or during high operating speeds, and it may exceed the rotary actuator's allowable kinetic energy. In this case, install a shock absorber to prevent the rotary actuator from being directly applied to inertia force.

2. The positional relationship between the swing angle and the key (or flat surface of the rod) is as shown in the diagram below. Even though the swing angle allowance is within the range of specification angles, install an external stopper, etc., to maintain accurate positioning.
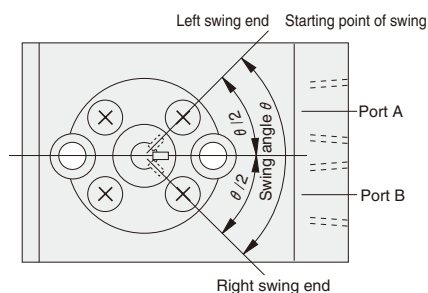
When pressure is supplied through Port A, the rod rotates to the left (counterclockwise direction), and when pressure is supplied through Port B, the rod rotates to the right (clockwise direction).

3. For the swing time of the rotary actuator (the time it takes to reach the swing end from beginning a start), see the table below as a guide.

● Swing time at air pressure 0.5MPa with no load
s

Model	Swing angle				
	90°	100°	180°	190°	360°
RAP□1					0.3～0.6
RAP□5	0.2～0.5		0.3～1.0		0.3～0.8
RAP□10					0.3～1.0
RAP□20	0.2～2.0		0.3～2.0		0.4～1.2

Notes 1. Excessively high kinetic energy could damage the rod of the rotary actuator. Always use within the allowable energy.
2. For details about kinetic energy, see Koganei's "Criteria for Selection."

Installation

1. While any mounting direction is allowed, avoid application that apply the load on the axial direction (thrust). Install external devices, such as bearings, to receive thrust load.

2. Install a rotary actuator so that the rotation center of the load align with the rotary actuator's rod center. When the rotation center cannot align with the rod center, or when moment is applied to the end of the rod, use a flexible coupling or other devices to carry a rotating force only.
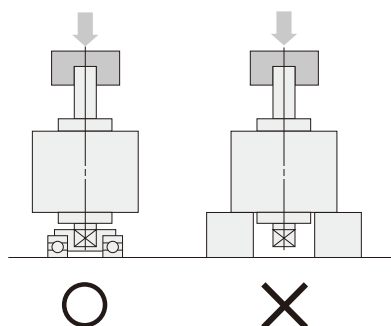
Note : Since thrust load, load moment, eccentricity of the rotating rod, or an excessive inertia load, will cause defective rotary actuator operation, or damage to the rod, always take appropriate counter-measures. Moreover, consult us about **RAP□1** and **RAP□5** bearing specifications.

General precautions

Piping

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.

Atmosphere

1. If using in locations subject to dripping water, dripping oil, etc., or to large amounts of dust, use a cover to protect the unit.

2. The product cannot be used when the media or ambient atmosphere contains any of the substances listed below.
   Organic solvents, phosphate ester type hydraulic oil, sulphur dioxide, chlorine gas, or acids, etc.

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.

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.

3. 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.

ROTARY ACTUATORS

Symbol
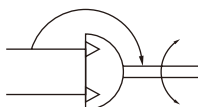
Specifications

Item	Model	RAP□1	RAP□5	RAP□10	RAP□20
Operation type		Double acting piston type (Rack and pinion construction)			
Effective torque Note1	N·m [ft·lbf]	0.078 [0.058]	0.373 [0.275]	0.883 [0.651]	1.863 [1.374]
Swing angle (Tolerance $+_0^{10°}$)	RAP□-90	90°			
	RAP□-100	100°			
	RAP□-180	180°			
	RAP□-190	190°			
	RAP□-360	360°			
Media		Air			
Port size		M5×0.8	Rc1/8		
Rod diameter	mm [in.]	4 [0.157]	6 [0.236]	8 [0.315]	10 [0.394]
Operating pressure range	MPa [psi.]	0.15～0.7 [22～102]		0.06～0.7 [9～102]	
Proof pressure	MPa [psi.]	1.03 [149]			
Operating temperature range	°C [°F]	0～50 [32～122]			
Allowable energy	J [in·lbf]	0.001 [0.009]	0.003 [0.027]	0.008 [0.071]	0.015 [0.133]
Allowable radial load	N [lbf.]	1.5 [0.34]	2.5 [0.56]	4.3 [0.97]	8.0 [1.80]
Allowable thrust load Note2	N [lbf.]	0.08 [0.018]	0.13 [0.029]	0.22 [0.049]	0.40 [0.090]
Lubrication		Not required			
Cushion		None			

Notes: 1. Values are obtained when the air pressure is 0.5MPa [73psi.].
　　　 2. Numerical values are reference values, not guaranteed values. For details, see p.1231.

Mass

g [oz.]

Model	Main body mass	Additional mass	
		Double rod specification	With sensor switch specification
RAP1-90,100	83 [2.93]	2 [0.07]	With 1 sensor switch: 24 [0.85] With 2 sensor switches: 46 [1.59]
RAP1-180,190	101 [3.56]		
RAP1-360	148 [5.22]		
RAP5-90,100	212 [7.48]	4 [0.14]	
RAP5-180,190	260 [9.17]		
RAP5-360	375 [13.23]		
RAP10-90,100	300 [10.58]	10 [0.35]	
RAP10-180,190	380 [13.40]		
RAP10-360	538 [18.98]		
RAP20-90,100	500 [17.64]	16 [0.56]	
RAP20-180,190	614 [21.66]		
RAP20-360	870 [30.69]		

Calculation example:　Mass of RAP1-180 with double rod and 1 sensor switch;
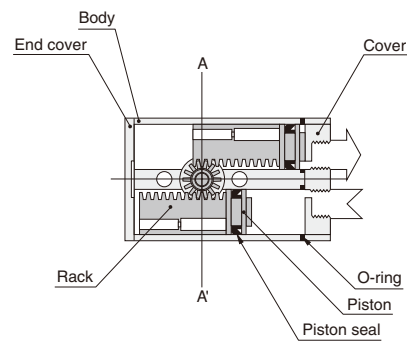　　　　　　　　　　　101＋2＋24＝127g [4.48oz.]
Notes: 1. The additional mass of the sensor switch is the mass of the sensor holder
　　　　　 and the sensor body only, and does not include the lead wire mass.
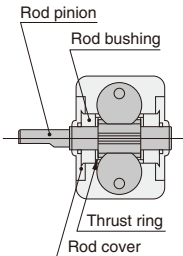　　　 2. The mass remains the same even with different materials for the rod.

Inner Construction and Major Parts
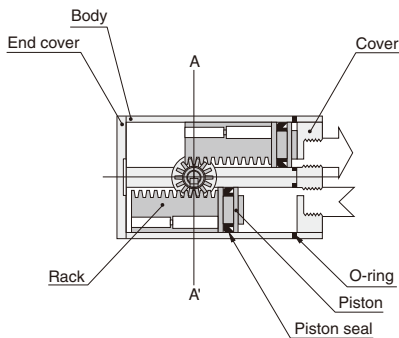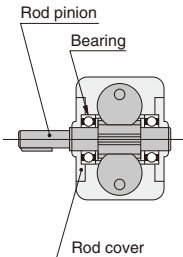
● Standard specification

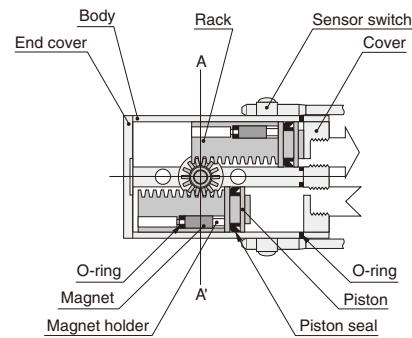### RAP□1, RAP□5

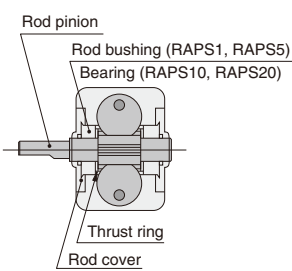
Section A-A'

RAP□10, RAP□20

Section A-A'

● With magnet specification

RAPS□□

Section A-A'

Major Parts and Materials

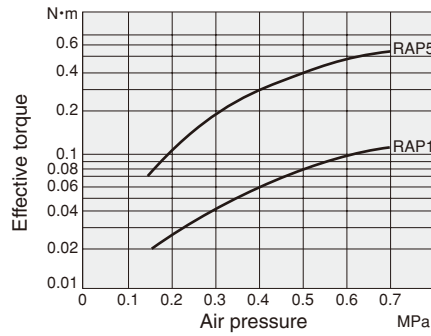| Parts	Materials
Main body	Aluminum (anodized)
Rod pinion	Steel (S45C) or stainless steel (SUS304)
Rack	Plastic
Piston	Plastic
Piston seal	Synthetic rubber (NBR)

Seals

Item / Model	O-ring	Piston seal
Q'ty	2	2
RAP□1	IN10	PPY-10
RAP□5	IN16	PPY-16
RAP□10	IN20	PPY-20
RAP□20	I.D ϕ 25 × ϕ 1.5	PPY-25

Output Characteristic (Effective Torque)

●RAP□1, RAP□5

N·m
Effective torque
0.6 — RAP5
0.4
0.2
0.1
0.08
0.06
0.04
0.02
0.01
RAP1
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 MPa
Air pressure

●RAP□10, RAP□20

N·m
Effective torque
6
4
2
1
0.8
0.6
0.4
0.2
0.1
RAP20
RAP10
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 MPa
Air pressure

1N·m = 0.7376ft·lbf   1MPa = 145psi.

●Effective torque

N·m [ft·lbf]
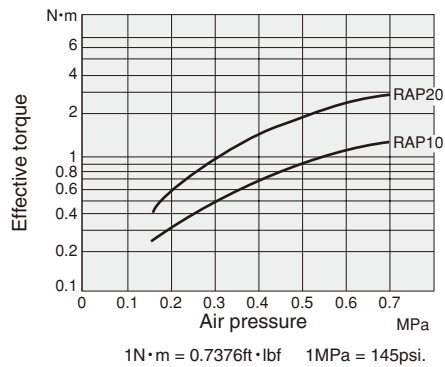
Model	Air pressure MPa [psi.]					
	0.2 [29]	0.3 [44]	0.4 [58]	0.5 [73]	0.6 [87]	0.7 [102]
RAP1	0.025 [0.018]	0.042 [0.031]	0.060 [0.044]	0.078 [0.058]	0.096 [0.071]	0.108 [0.080]
RAP5	0.108 [0.080]	0.196 [0.145]	0.284 [0.209]	0.373 [0.275]	0.451 [0.333]	0.539 [0.398]
RAP10	0.294 [0.217]	0.441 [0.325]	0.657 [0.485]	0.883 [0.651]	1.108 [0.817]	1.334 [0.984]
RAP20	0.588 [0.434]	0.981 [0.724]	1.422 [1.049]	1.863 [1.374]	2.295 [1.693]	2.746 [2.025]

Air Flow Rate and Air Consumption

●RAP□1, RAP□5

cm³/cycle (ANR)
Air consumption
100
80
60
40
20
10
8
6
4
2
1
RAP5-360
RAP5-180
RAP1-360
RAP5-90
RAP1-180
RAP1-90
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 MPa
Air pressure

●RAP□10, RAP□20

cm³/cycle (ANR)
Air consumption
600
400
200
100
80
60
40
20
10
RAP20-360
RAP10-360
RAP20-180
RAP10-180
RAP20-90
RAP10-90
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 MPa
Air pressure

1cm³/cycle = 0.0610in.³/cycle   1MPa = 145psi.

●Cylinder bore size and stroke

mm [in.]

Model / Swing angle	RAP□1	RAP□5	RAP□10	RAP□20
90°	10×7.2 [0.394×0.283]	16×9.5 [0.630×0.374]	20×12.6 [0.787×0.496]	25×15.7 [0.984×0.618]
100°	10×8.0 [0.394×0.315]	16×10.6 [0.630×0.417]	20×14.0 [0.787×0.551]	25×17.5 [0.984×0.689]
180°	10×14.4 [0.394×0.567]	16×19.0 [0.630×0.748]	20×25.2 [0.787×0.992]	25×31.4 [0.984×1.236]
190°	10×15.2 [0.394×0.598]	16×20.1 [0.630×0.791]	20×26.5 [0.787×1.043]	25×33.2 [0.984×1.307]
360°	10×28.8 [0.394×1.134]	16×38.0 [0.630×1.496]	20×50.4 [0.787×1.984]	25×62.8 [0.984×2.472]

Calculation of air flow rate and air consumption
The top-right graphs show 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.

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

$$Q_1 = \frac{\pi D^2}{4} \times L \times \frac{60}{t} \times \frac{P+0.1013}{0.1013} \times 10^{-6}$$

$$\text{or } Q_1 = q \times \frac{60}{t} \times \frac{P+0.1013}{0.1013} \times 10^{-6}$$

●Finding the air consumption

$$Q_2 = \frac{\pi D^2}{4} \times L \times 2 \times n \times \frac{P+0.1013}{0.1013} \times 10^{-6}$$

$$\text{or } Q_2 = q \times 2 \times n \times \frac{P+0.1013}{0.1013} \times 10^{-6}$$

Q_1 : Air flow rate   ℓ/min (ANR)
Q_2 : Air consumption   ℓ/min (ANR)
D : Cylinder bore size   mm
L : Cylinder stroke   mm
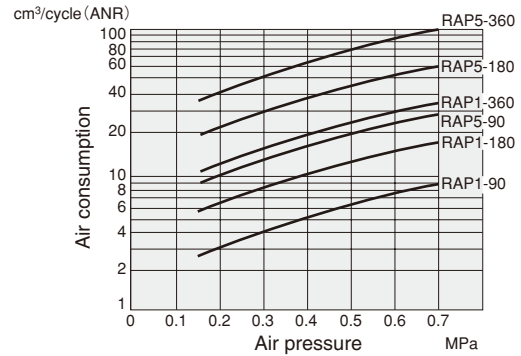q : Cylinder internal capacity (one side cylinder only)   mm³
t : Time required for cylinder to travel 1 stroke   s
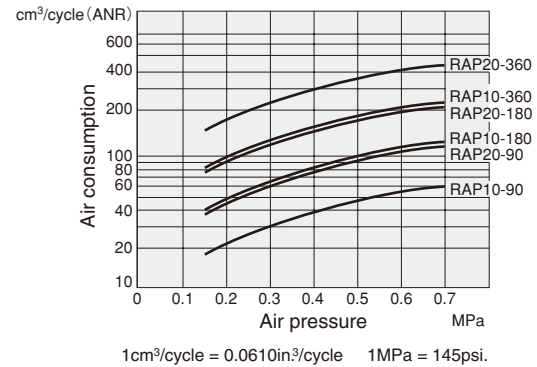n : Number of cylinder reciprocations per minute   times/min
P : Pressure   MPa

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

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

$$\text{or } Q_1' = q' \times \frac{60}{t} \times \frac{P'+14.696}{14.696} \times \frac{1}{1728}$$

●Finding the air consumption

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

$$\text{or } Q_2' = q' \times 2 \times n \times \frac{P'+14.696}{14.696} \times \frac{1}{1728}$$

Q_1' : Air flow rate   ft.³/min (ANR)※
Q_2' : Air consumption   ft.³/min (ANR)※
D' : Cylinder bore size   in.
L' : Cylinder stroke   in.
q' : Cylinder internal capacity (one side cylinder only)   in.³
t : Time required for cylinder to travel 1 stroke   sec.
n : Number of cylinder reciprocations per minute   times/min.
P' : Pressure   psi.

RAP, RAPS

Rotary Actuator Piston Type

Order Codes

■ Specification

Standard specification

Blank

With magnet specification

S

Note: Magnet for sensor switch is not built into the standard specification.

■ Nominal torque

- **1 :** 0.098N·m [0.072ft·lbf]
- **5 :** 0.49N·m [0.36ft·lbf]
- **10 :** 0.981N·m [0.72ft·lbf]
- **20 :** 1.961N·m [1.45ft·lbf]

■ Swing angle

90°
-90

100°
-100

180°
-180

190°
-190

360°
-360

■ Rod type

Single rod type

Blank

Double rod type

-D

■ Rod material

Blank : Steel
S : Stainless steel

■ Sensor switch
(Model, lead wire length, and quantity)

No sensor switch

Blank

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

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

With ZC130

-ZC130

● Solid state type
● With indicator lamp
● DC10~28V
● 2-lead wire

-CS5T

● Reed switch type
● Without indicator lamp
● DC5~28V
● AC85~115V

With ZC153

-ZC153

● Solid state type
● With indicator lamp
● DC4.5~28V
● 3-lead wire

With CS11T

-CS11T

● Reed switch type
● With indicator lamp
● DC10~28V

Basic model

RAP	S	1 5 10 20	-90 -100 -180 -190 -360	-D	S	-ZC130 -ZC153 -CS5T -CS11T	A B	1 2

Dimensions of RAP□1 (mm)

RAP□1- Swing angle

2-φ 3.4,
φ 6.5 Counterbore, Depth3.3
(both sides)

7.5

Sensor (I)

Swing angle D$^{+10}_{0}$

$D/2$ $D/2$

φ 3

10±0.1   10±0.1   Sensor (II)

7.5   30   7.5

φ 10$^{0}_{-0.1}$

φ 4h8$^{0}_{-0.018}$

55

16   Note

2   2.5   16   23   41.5

2   2.5

φ 4h8$^{0}_{-0.018}$

φ 10$^{0}_{-0.1}$

A

B   C

3.6

8

8

3.6

Remark

7

11   2-M5 Depth4

Remark: No key available in RAP□1.
Note: A counterbore for machining process is located here.
It does not hinder use of the product.

Code Model	A	B	C	D
RAP□1-90	48	17	31	90
RAP□1-100				100
RAP□1-180	60	23	37	180
RAP□1-190				190
RAP□1-360	88	37	51	360

Dimensions of RAP□5 (mm)

RAP□5- Swing angle

2-φ 5.5,
φ 9.5 Counterbore, Depth5.4
(both sides)

7.5

Sensor (I)

Swing angle D$^{+10}_{0}$

$D/2$ $D/2$

φ 3

14±0.1   14±0.1   Sensor (II)

7.5   45   7.5

φ 14$^{0}_{-0.1}$

φ 6h8$^{0}_{-0.018}$

72

20   Note

2   2.5   20   32   54.5

2   2.5

φ 6h8$^{0}_{-0.018}$

φ 14$^{0}_{-0.1}$

A

B   C

5.5

10

10

5.5

Remark

10

16   2-Rc 1/8

Remark: No key available in RAP□5.
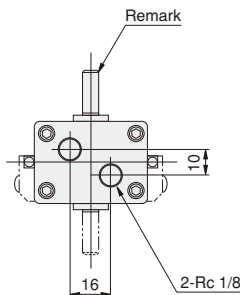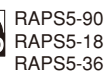Note: A counterbore for machining process is located here.
It does not hinder use of the product.

Code Model	A	B	C	D
RAP□5-90	62	22.5	39.5	90
RAP□5-100				100
RAP□5-180	78	27.5	50.5	180
RAP□5-190				190
RAP□5-360	116	47	69	360

Dimensions of RAP□10 (mm)

RAP□10- Swing angle

4-M4 Depth7 (both sides)

Sensor (I)

7.5

Swing angle D$^{+10}_{0}$

D/2 D/2

φ3

Sensor (II)

20±0.1 20±0.1

20±0.1 20±0.1

7.5 49 7.5

φ16$^{-0.05}_{-0.1}$

φ8h7$^{0}_{-0.015}$

86

25

2

25

63.5

36

2

2.5

Note

Note: A counterbore for machining process is located here. It does not hinder use of the product.

φ8h7$^{0}_{-0.015}$

φ16$^{-0.05}_{-0.1}$

3$^{0}_{-0.025}$

3$^{0}_{-0.025}$

Key (included)

A

B   C

9.2

16

16

9.2

14

14

2-Rc 1/8
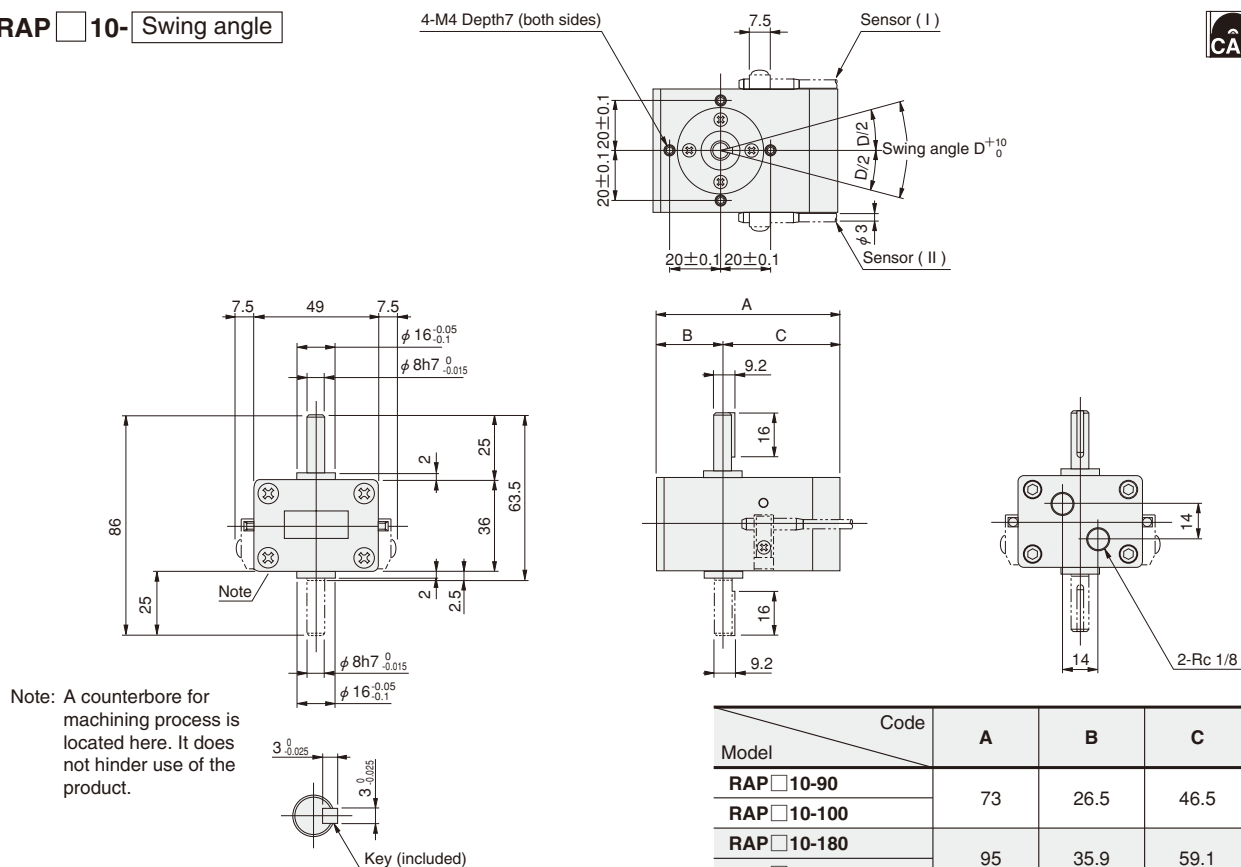
Code / Model	A	B	C	D
RAP□10-90	73	26.5	46.5	90
RAP□10-100	73	26.5	46.5	100
RAP□10-180	95	35.9	59.1	180
RAP□10-190	95	35.9	59.1	190
RAP□10-360	143	59	84	360

Dimensions of RAP□20 (mm)

RAP□20- Swing angle

4-M5 Depth 8 (both sides)

Sensor (I)

7.5

Swing angle D$^{+10}_{0}$

D/2 D/2

φ3

Sensor (II)

24±0.1 24±0.1

24±0.1 24±0.1

7.5 59 7.5

φ20$^{-0.05}_{-0.1}$

φ10h7$^{0}_{-0.015}$

102

30

2

30

74.5

42

2

2.5

Note

Note: A counterbore for machining process is located here. It does not hinder use of the product.

φ10h7$^{0}_{-0.015}$

φ20$^{-0.05}_{-0.1}$

3$^{0}_{-0.025}$

3$^{0}_{-0.025}$

Key (included)

A

B   C

11.2

20

20

11.2

18

20

2-Rc 1/8
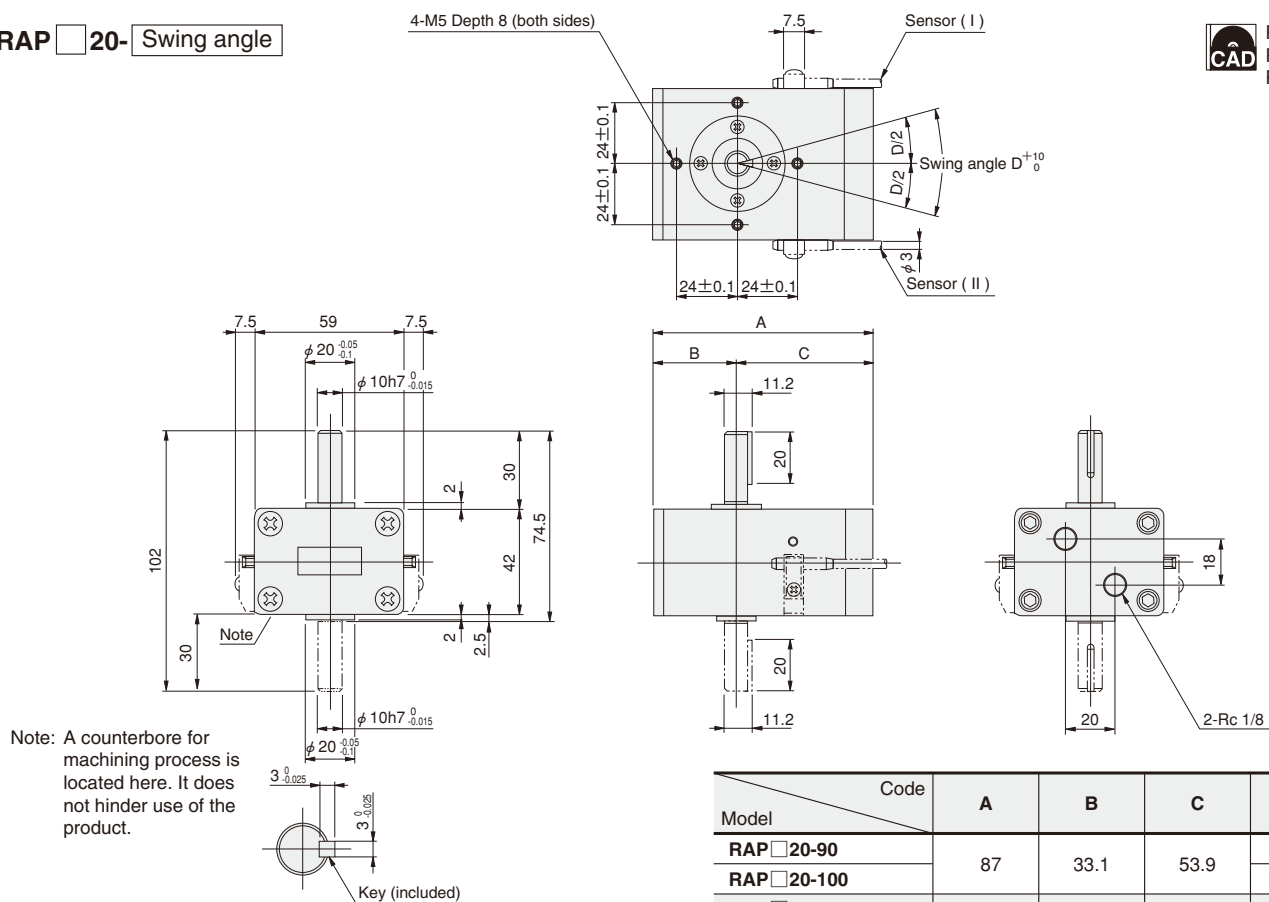
Code / Model	A	B	C	D
RAP□20-90	87	33.1	53.9	90
RAP□20-100	87	33.1	53.9	100
RAP□20-180	113	45	68	180
RAP□20-190	113	45	68	190
RAP□20-360	172	73	99	360

SENSOR SWITCHES

Solid State Type, Reed Switch Type

Order Codes for Sensor Switches

				Sensor switch model	Lead wire length	Holder/nominal torque	
Solid state type	2-lead wire	with indicator lamp	DC10～28V	**ZC130**	**A** **B**	**-RAPS**	**1** **5** **10** **20**
Solid state type	3-lead wire	with indicator lamp	DC4.5～28V	**ZC153**			
Reed switch type	2-lead wire	without Indicator lamp	DC5～28V AC85～115V	**CS5T**			
Reed switch type	2-lead wire	with indicator lamp	DC10～28V	**CS11T**			

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

● **Order codes for holder only**　　　**Nominal torque**
　　　　　　　　　　　　　　　　　　　1
C1-RAPS ☐　　　　　　　　　　　　**5**
　　　　　　　　　　　　　　　　　　　10
　　　　　　　　　　　　　　　　　　　20

● **A** : 1000mm [39in.]
　B : 3000mm [118in.]

● **Blank**: No holder
　-RAPS:With holder

● **Blank** : No holder
　1 : For **RAPS1**
　5 : For **RAPS5**
　10 : For **RAPS10**
　20 : For **RAPS20**
Note: If ordering with holder, enter the nominal torque.

## Swing End Detection and Mounting Location of Sensor Switch

When the sensor switch is mounted in the location shown in the diagram, the magnet comes to the maximum sensing location of the sensor switch at the end of the swing. At this time, the sensor switch A operates at the end of the swing in the A direction, and sensor switch B operates at the end of the swing in the B direction.
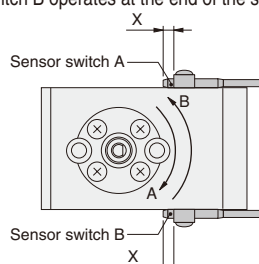
Notes: 1. Do not mount the sensor switch in the reverse direction.
2. When an external stopper, etc., restricts the swing angle, note that there may be cases where the sensor switch does not operate within the above adjusting range.

mm [in.]

Model	**X** : Maximum sensing location		
	ZC130, ZC153	**CS5T**	**CS11T**
RAPS1	6.5 [0.256]	5.0 [0.197]	8.5 [0.335]
RAPS5	7.0 [0.276]	5.5 [0.217]	9.0 [0.354]
RAPS10	6.5 [0.256]	5.0 [0.197]	8.5 [0.335]
RAPS20			

Sensor Switch Operating Range and Response Differential

mm [in.]
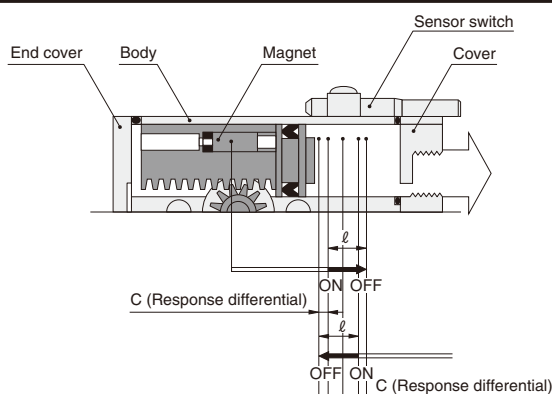
CS5T☐		**CS11T☐**		**ZC1☐☐☐**	
Operating range ℓ	Response differential C	Operating range ℓ	Response differential C	Operating range ℓ	Response differential C
4.7～10.8 [0.185～0.425]	1.4 [0.055] or less	6.8～9.5 [0.268～0.374]	1.4 [0.055] or less	1.5～4.7 [0.059～0.185]	0.3 [0.012] or less

Remark: The above table shows reference values.

Reference

● When use of an external stopper restricts the swing angle, 2 sensor switches can be used up to the angle (α) shown below. The recommended type of the sensor switch is a solid state sensor switch for its short operating range.


D : Swing angle
θ : Range where sensor switch cannot detect
α : Range where sensor switch can detect
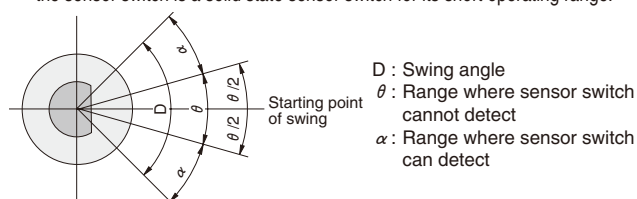
Model	Swing angle	θ Note	α
RAPS1	90°	56°	17°
	100°		22°
	180°		62°
	190°		67°
	360°	100°	130°
RAPS5	90°	42°	24°
	100°		29°
	180°		69°
	190°		74°
	360°	170°	95°
RAPS10	90°	32°	29°
	100°		34°
	180°		70°
	190°	40°	75°
	360°	220°	70°
RAPS20	90°	26°	32°
	100°		37°
	180°		50°
	190°	80°	55°
	360°	250°	55°

Note: Two sensor switches may be ON at the same time when the angle adjustment is set to this value or below.
Remark: For the use of reed switch type sensor switches, or for swing starting points other than those listed above, consult us.

● **Caution when installing a sensor switch on the actuator**
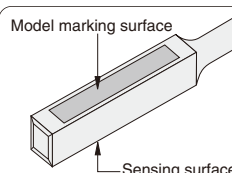
In the ZC type sensor switches, the opposite side from the model marking surface is the sensing surface side. Mount it so that the cylinder magnet comes to the sensing surface side.