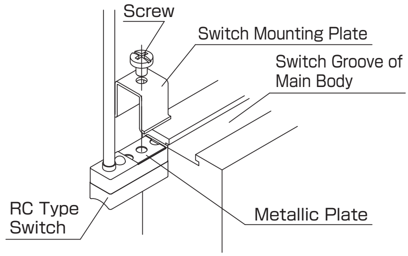
Technical Data — Rotor/Switch Mounting Method —

Rotor Switch Mounting Method

For RC Type

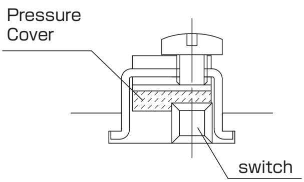
(1) Insert the switch mounting plate into the switch groove of the main body.
(2) Set the switch to the sensitivity position. (Consider the ON width and differential.)
(3) Fit the mounting plate to the metallic plate of the switch.
(4) The screw tightening torque shall be 0.3 N·m or less.



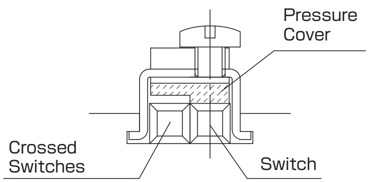
For ZC and EC Types

For the ZC and EC types, up to 4 switches are mountable.
Note that the switch mounting method differs depending on the number of mounted switches and the mounting position.

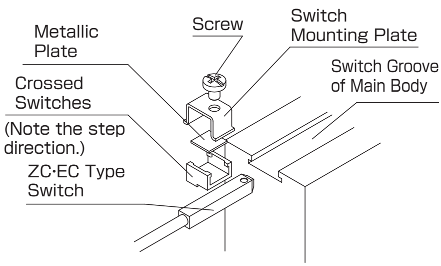
When switches do not cross (1 switch is mounted)



When switches cross (2 switches are mounted)

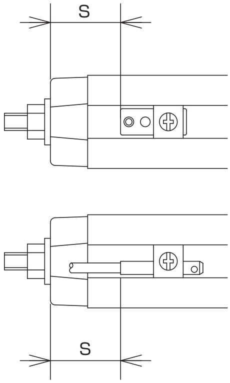


(1) Determine the step direction of the pressure cover according to the switch mounting method. Place the metallic plate on the pressure cover and insert them in the switch mounting plate.
(2) Insert the switch mounting plate into the switch groove of the main body.
(3) Set the switch to the sensitivity position. (Consider the ON width and differential.)
(4) The screw tightening torque shall be 0.3 N·m or less.



Guide for Rotor Switch Mounting Position

	Type	Angle	RCA, RCB			RCM			ZC, EC		
			S	Working Angle	Difference Angle	S	Working Angle	Difference Angle	S	Working Angle	Difference Angle
RS01-10 (Common in RT02)	B	90·180	6	100	13	2.5	45	4	2	52	5
	D	180	8.5			6.5			6		
RS01-13	B	180	15	130	10	12	47	4	6	58	6
RH01 RS01-14 (Common in RT02)	B	180	13	80	10	10	30	3	4	38	3
		90	17.5			14.5			8.5		
	D	180	16			18			7		
RS01-16 (Common in RT02)	B	90·180	16	85	6	13	30	2	8	33	3
	D	180	21			18			13		
RS01-18 (Common in RT01·02)	B	90·180	16	52	4	14	20	2	9	26	3
	D	180	22			20			15		
RS01-22 (Common in RT01·02)	B	90·180	20	47	3	18	20	2	13	22	3
	D	180	25			23			18		



Mounting position: S (mm) ··· Distance from the end face of the rotor to the end face when the maximum sensitivity position at the switch turning ON position is the center of the ON width.

Difference angle (°) ············ Angle from the time when the switch is turned ON to rotate the shaft inversely to the time when the switch is turned OFF under the condition that the switch is fixed and the shaft is rotated.

Working angle (°) ··············· Angle of the range when the switch is ON under the condition that the shaft is fixed and the switch is moved from side to side.

Technical Data — Rotor/Stop Position Adjustment Method —

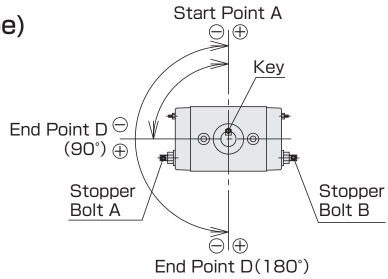
Stop Position Adjustment Method (Common in RS01, RT01, RT02 and RH01)

For 2-position Stop Type (Air Cushion Type)

To adjust the key position of Start Point A, adjust the stopper bolt A. To adjust the key position of End Point D, adjust the stopper bolt B.

⊕side adjustment range: 2.5° at maximum
⊖side adjustment range: 10° at maximum

Note) The angle of the ⊖ side can be adjusted up to 30°, but it must be adjusted up to 10° because the angles larger than that will deteriorate air cushion performance.

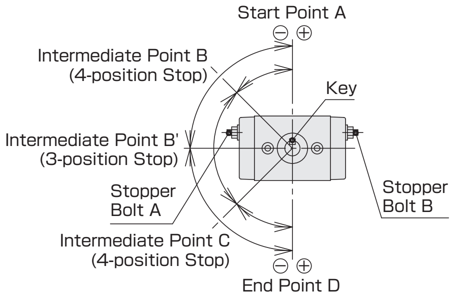


For 3-position/4-position Stop Type

To adjust the key position of Start Point A, adjust the stopper bolt A. To adjust the key position of End Point D, adjust the stopper bolt B.

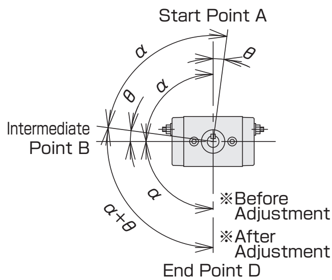
⊕side adjustment range: 2.5° at maximum
⊖side adjustment range: 30° at maximum

However, note the following point to adjust the key position.



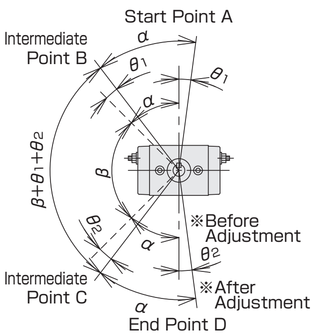
For 3-position Stop

When the Start Point A position is adjusted by θ°, the Intermediate Point B position will change by θ° in the same direction. (Angle α will not change.) However, since End Point D does not change, the angel from Intermediate Point B to End Point D will be $(\alpha + \theta)$°. When you adjust the Start Point A position, you must adjust the End Point D position by the same degrees.



For 4-position Stop

When the Start Point A position is adjusted by θ_1°, the Intermediate Point B position will change by θ_1° in the same direction. When the End Point D position is adjusted by θ_2°, the Intermediate Point C position will change by θ_2° in the same direction. (Angle α will not change.) However, the angle from the Intermediate Point B to the Intermediate Point C will be $(\beta + \theta_1 + \theta_2)$° .



■ Relationship between Rod Rotation Adjustment Angle and Stopper Bolt A/B Rotation Angle

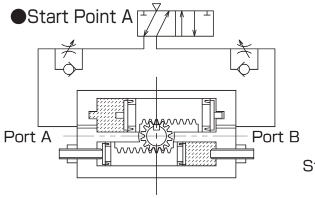
Nominal diameter	φ10	φ13	φ14	φ16	φ18	φ22
Change in Rod Rotation Angle at 1 Bolt Turn	11.5°	11.5°	9.5°	9.0°	7.8°	5.5°
Bolt Rotation Angle at Change of 1° of Rod Rotation Angle	30.9°	31.4°	37.7°	40°	46°	54.5°

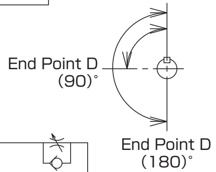
Technical Data — Rotors/Control Method —

Control Method (Common in RS01·RT01·RT02 and RH01)

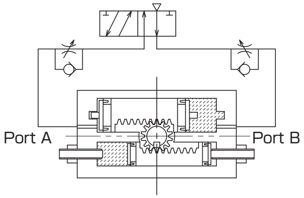
For 2-position Stop

●Start Point A





●End Point D



●Operation control method

Key Position	Port	
	A	B
	○	—
	—	○

The table on the left shows the correlation between the supply air conditions and the rod key position. In the table, ○ indicates the air supply and — indicates the air exhaust.

●Speed control method

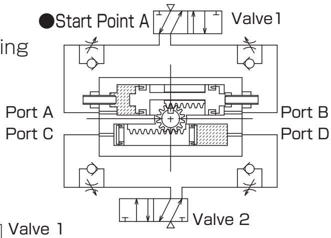
	Adjustment Port
⇨	Port A
⇨	Port B

The table on the left shows the correlation between the rod rotation direction and the port that controls the flow rate for speed adjustment at the time of the rotation. Use the speed controller (meter out) to control the speed. Do not use the speed controller with a high cracking pressure.

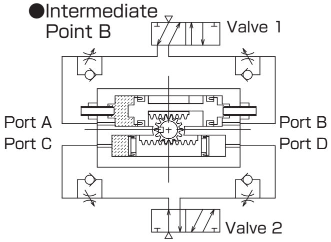
For 3-position Stop

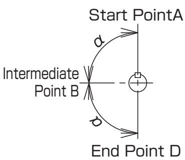
The stop position is controlled by switching between 2 valves.

●Start Point A

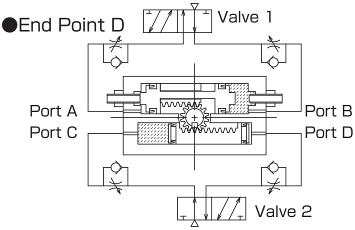


●Intermediate Point B





●End Point D



●Operation control method

Key Position	Valve 1		Valve 2	
	A	B	C	D
	○	—	—	○
	○	—	○	—
	—	○	○	—

The table above shows the correlation between the supply air conditions and the rod key position. In the table, ○ indicates the air supply and — indicates the air exhaust.

●Speed control method

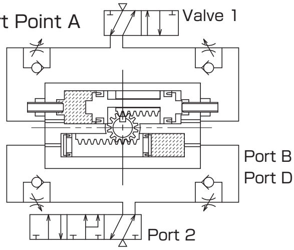
	Adjustment Port
⇨	Port D
⇨	Port A
⇨	Port B
⇨	Port C

The table above shows the correlation between the rod rotation direction and the port that controls the flow rate for speed adjustment at the time of the rotation. Use the speed controller (meter out) to control the speed. Do not use the speed controller with a high cracking pressure. Adjust the A and B ports after adjusting the C and D ports.

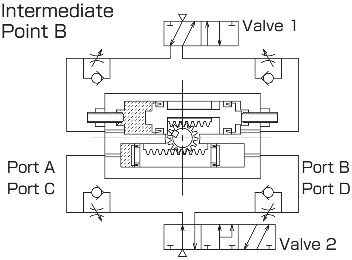
For 4-position Stop

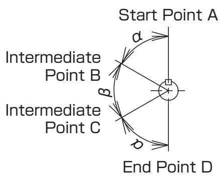
The stop position is controlled by switching between 2 valves.

●Start Point A

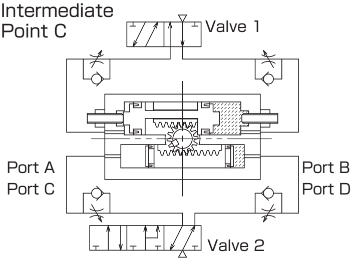


●Intermediate Point B

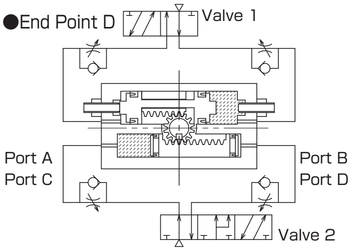




●Intermediate Point C



●End Point D



●Operation control method

Key Position	Valve 1		Valve 2	
	A	B	C	D
	○	—	—	○
	○	—	○	—
Note	○	—	○	○
Note	—	○	○	○
	—	○	—	○
	—	○	○	—

The table above shows the correlation between the supply air conditions and the rod key position. In the table, ○ indicates the air supply and — indicates the air exhaust.

Note) To perform the sequential operation from to , the intermediate process between these 2 is required.

●Speed control method

	Adjustment Port
	Port D
	Port A
	Port D
	Port C
	Port B
	Port C

The table above shows the correlation between the rod rotation direction and the port that controls the flow rate for speed adjustment at the time of the rotation. Use the speed controller (meter out) to control the speed. Do not use the speed controller with a high cracking pressure. Adjust the A and B ports after adjusting the C and D ports.

Technical Data — Terminology —

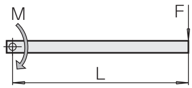
Vector and Scalar

A quantity determined by the magnitude and direction in space (e.g. force, speed) is called "Vector". A quantity that does not have a direction in space but is determined only by its magnitude (e.g. mass, length, area, volume, density, time) is called "Scalar".

Moment of Force

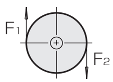
When a force is applied to an object that can rotate around the shaft freely, the degree of the rotation of the object is determined by multiplying Force F by L (the distance from the shaft to the force acting point). This is called "Moment of Force".

$$M=FL$$



Couple of Force

Two object rotating forces which are equal in magnitude but opposite in direction are called "Couple of Force".



$$F_2=-F_1$$

Inertia

An object remains at rest if it is at rest. It keeps moving eternally if it is moving. As just described, the nature that tries to maintain the present state is called "Inertia".

Newton's Law of Motion

The relationship between an object's mass m, its acceleration a, and the applied force F is:

$$F=ma$$

Inertia Force

An imaginary force supposed to act upon an accelerated body, equal in magnitude is called "Inertia of Force". For example, when an object hanged from a string is turned, centripetal force is acting toward the center. In this case, it seems that centrifugal force that is equal in magnitude and opposite to this force is acting. This centrifugal force is one of the inertial force.

Inertia Moment

The magnitude of inertia against rotary motion generated when an object is rotating around the rotary shaft is called "Inertia Moment". When the total mass of an object is M, inertial moment, I, is expressed as follows.

$$I=MK^2$$

This formula is based on the assumption that the total mass M concentrates on the point that is distanced K from the rotary shaft. K is called "Turning Radius". K differs depending on the object shape.

Gravity Acceleration

If an object falls freely on earth, it falls at certain acceleration. This acceleration is called "gravity acceleration" and expressed as g. In the engineering sense, "$g=9.8m/s^2$" is generally used although it differs slightly to be exactly depending on where on the earth you are.

Work and Energy

A force does work when it results in movement χ of an object of m in mass. The work is expressed as follows.

$$\text{Work}\quad W=m\chi$$

The ability of an object to do work is called "Energy".

Kinetic Energy

When an object of m in mass is moving at the speed of V, the kinetic energy is asked in the following formula.

$$E=\frac{1}{2}mv^2$$

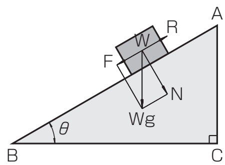
Positional Energy

The positional energy of an object of m in mass at the height h is asked in the following formula.

$$E=mgh \quad g: \text{Gravity acceleration } (9.8m/s^2)$$

Equilibrium of Force

When an object is on the slope as shown in the figure below, the equilibrium of force is expressed as shown below.



W : Mass of object
F : Force parallel to the slope
N : Force vertical to the slope
R : Frictional force
θ : Angle of slope
μ : Friction coefficient of slope
g : Gravity acceleration

$$F=Wg\sin\theta \quad N=Wg\cos\theta$$

Since the frictional force is proportional to the load vertical to the slope, friction coefficient is expressed as:

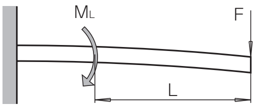
$$F=R=\mu N$$

$$Wg\sin\theta=\mu Wg\cos\theta$$

$$\mu=\frac{Wg\sin\theta}{Wg\cos\theta}=\frac{\sin\theta}{\cos\theta}=\tan\theta$$

Bending Moment

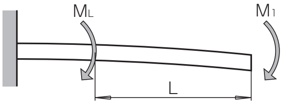
When the beam (rod) is bent by external force F, the moment generated by this external force is called "Bending Moment".



Bending moment at Point L

$M_L = F \times L$

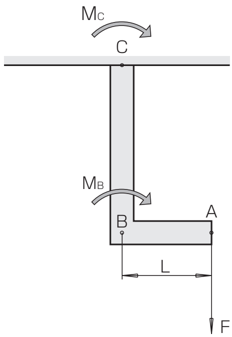
When the beam (rod) is bent by the moment, the applied moment is constant at any position on the beam.



$M_1 = M_2$

In the figure above, moment M_1 is equal to Moment M_2 at the position L.

For example, when force F is applied to Point A of the L-shaped angle as shown in the figure below, the moment of Points B and C is:



Moment at Point B is:

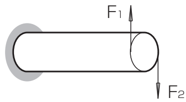
$M_B = F \times L$

As described above, when the moment is applied to the beam (rod), the moment is the same at any point. Therefore, the moment at Point C is:

$$M_C = M_B = F \times L$$

Twisting Moment

When a shaft is twisted, the twisting force is a couple of force. The moment by the couple of force is called "Twisting Moment".



Second Moment of Area and Section Modulus

When the beam (rod) receives a bending moment, the stress is asked in the following formula.

$$\sigma = \frac{M}{Z}$$

σ : Bending stress
M : Bending moment
Z : Section modulus

$$Z = \frac{I}{\chi}$$

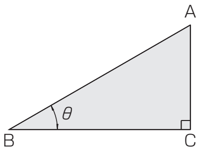
I : Second moment of area
χ : Distance from the neutral axis to any point on the cross-section
Z : Section modulus

When the beam receives a bending moment, there is a face that is not compressed or tensioned. This face is called "neutral plane". The section where this neutral plane crosses with the traverse plane is called "neutral axis".

Technical Data — Terminology —

Trigonometric function

For the rectangular triangle,



$\sin\theta = \frac{AC}{AB}$ $\mathrm{cosec}\,\theta = \frac{AB}{AC}$

$\cos\theta = \frac{BC}{AB}$ $\sec\theta = \frac{AB}{BC}$

$\tan\theta = \frac{AC}{BC}$ $\cot\theta = \frac{BC}{AC}$

$\sin^{-1}\frac{AC}{BC} = \theta$

$\cos^{-1}\frac{BC}{AB} = \theta$

$\tan^{-1}\frac{AC}{BC} = \theta$

$\sin^2\theta + \cos^2\theta = 1$

$\frac{\sin\theta}{\cos\theta} = \tan\theta$

$\sin(90^\circ+\theta) = \cos\theta$

$\cos(90^\circ+\theta) = -\sin\theta$

$\tan(90^\circ+\theta) = -\cot\theta$

$\sin(90^\circ-\theta) = -\cos\theta$

$\cos(90^\circ-\theta) = \sin\theta$

$\tan(90^\circ-\theta) = \cot\theta$

Quadratic equation

$aX^2 + bX + c = 0$ $X = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

Law of exponent

$(a^m)^n = a^{mn}$ $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

$(ab)^n = a^n b^n$

$a^{-n} = \frac{1}{a^n}$

$a^0 = 1$

Power

$a^n = b$ if $a = \sqrt[n]{b}$ $\sqrt[n]{a^m} = a^{\frac{m}{n}}$

$\sqrt{ab} = \sqrt{a}\sqrt{b}$ $\sqrt{\frac{b}{a}} = \frac{\sqrt{b}}{\sqrt{a}}$

Identity

$a^2 - b^2 = (a+b)(a-b)$

$a^3 - b^3 = (a-b)(a^2+ab+b^2)$

$a^3 + b^3 = (a+b)(a^2-ab+b^2)$

Log

$a^X = N$

When a is a positive number other than 1, X is a log of N whose base is a and expressed as shown below.

$X = \log_a N$

The log of a=10 is called common logarithm. In this case, indication of 10 (base) may be omitted.
The log of the base a=e (=2.718) is called natural logarithm.

$\log AB = \log A + \log B$

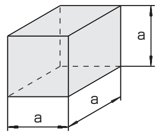
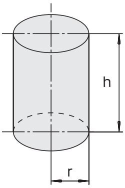
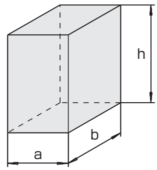
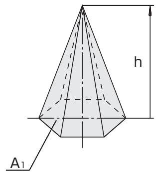
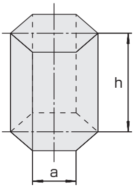
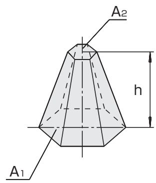
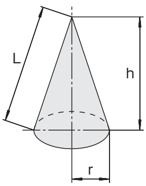
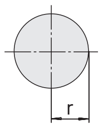
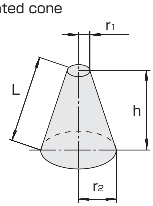
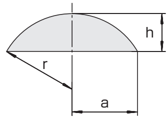
$\log\frac{A}{B} = \log A - \log B$

$\log A^B = B\log A$

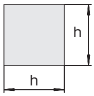
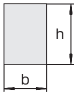
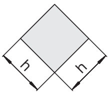
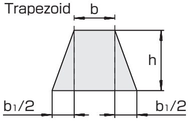
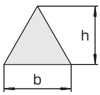
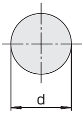
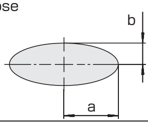
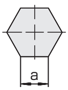
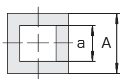
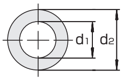
$\log \sqrt[B]{A} = \frac{1}{B}\log A$

Technical Data
Terminology

Technical Data — Volume and Surface Area of Solid —

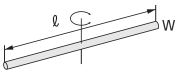
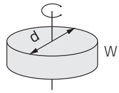
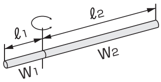
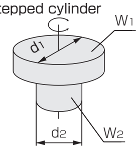
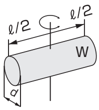
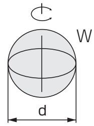
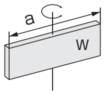
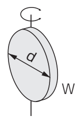
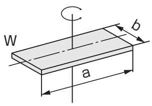
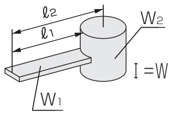
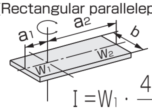
Shape of Solid	Volume : V Surface Area : S	Shape of Solid	Volume : V Surface Area : S
Regular solid 	$V=a^3$ $S=6a^2$	Circular cylinder 	$V=\pi r^2 h$ $S=2\pi r^2+2\pi rh$
Parallelepiped 	$V=abh$ $S=2(ab+ah+bh)$	Pyramid 	$V=\frac{1}{3}A_1h$
Regular hexagonal prism 	$V=\frac{3\sqrt{3}}{2}a^2h$ $S=2\left(\frac{3\sqrt{3}}{2}a^2\right)+6ah$	Truncated pyramid 	$V=\frac{1}{3}h(A_1+A_2+\sqrt{A_1A_2})$
Cone 	$V=\frac{1}{3}\pi r^2 h$ $S=\pi rL+\pi r^2$	Globe 	$V=\frac{4}{3}\pi r^3$ $S=4\pi r^2$
Pointed cone 	$V=\frac{1}{3}\pi h(r_1^2+r_2^2+r_1r_2)$ $S=\pi(r_1+r_2)L+\pi(r_1^2+r_2^2)$	Spherical segment 	$V=\frac{1}{6}\pi h(3a^2-h^2)$ $=\frac{1}{3}\pi h^2(3r-h)$

Technical Data — Cross-section, Gravity Center, Second oment of Area, SectionModulus —

Cross-section Shape	Cross-section	Position of the Center of Gravity	Second moment of area	Section modulus
Square 	h^2	$\frac{h}{2}$	$\frac{h^4}{12}$	$\frac{h^3}{6}$
Rectangular 	bh	$\frac{h}{2}$	$\frac{bh^3}{12}$	$\frac{bh^2}{6}$
Diamond shape 	h^2	$\frac{h}{2}\sqrt{2}$	$\frac{h^4}{12}$	$\frac{\sqrt{2}}{12}h^3$
Trapezoid 	$(2b+b_1)\frac{h}{2}$	$\frac{1}{3}\frac{3b+2b_1}{2b+b_1}h$	$\frac{6b^2+6bb_1+b_1^2}{36(2b+b_1)}h^3$	$\frac{6b^2+6bb_1+b_1^2}{12(3b+b_1)}h^2$
Triangle 	$\frac{bh}{2}$	$\frac{2}{3}h$	$\frac{bh^3}{36}$	$\frac{bh^2}{24}$
Circle 	$\frac{\pi d^2}{4}$	$\frac{d}{2}$	$\frac{\pi d^4}{64}$	$\frac{\pi d^3}{32}$
Ellipse 	πab	a	$\frac{\pi}{4}a^3b$	$\frac{\pi}{4}a^2b$
Regular hexagon 	$\frac{3\sqrt{3}}{2}a^2$	$\frac{\sqrt{3}}{2}a^2$	$\frac{5\sqrt{3}}{16}a^4$	$\frac{5}{8}a^3$
Square (hollow) 	A^2-a^2	$\frac{A}{2}$	$\frac{A^4-a^4}{12}$	$\frac{1}{6}\left(\frac{A^4-a^4}{A}\right)$
Circle (hollow) 	$\frac{\pi}{4}(d_2^2-d_1^2)$	$\frac{d_2}{2}$	$\frac{\pi}{64}(d_2^4-d_1^4)$	$\frac{\pi}{32}\left(\frac{d_2^4-d_1^4}{d_2}\right)$

Technical Data — Calculation of Inertia Moment —

I : Inertia Moment　　W : Mass

No.	Shape	Inertia Moment	Turning radius	No.	Shape	Inertia Moment	Turning radius
1	Slim Rod 	$I = W \cdot \frac{\ell^2}{12}$	$K^2 = \frac{\ell^2}{12}$	7	Cylinder (including thin disks) 	$I = W \cdot \frac{d^2}{8}$	$K^2 = \frac{d^2}{8}$
2	Slim Rod 	$I = W_1 \cdot \frac{\ell_1^2}{3} + W_2 \cdot \frac{\ell_2^2}{3}$	$K^2 = \frac{\ell_1^2}{3} + \frac{\ell_2^2}{3}$	8	Stepped cylinder 	$I = W_1 \cdot \frac{d_1^2}{8} + W_2 \cdot \frac{d_2^2}{8}$	$K^2 = \frac{d_1^2}{8} + \frac{d_2^2}{8}$
3	Thick Rod 	$I = W\left(\frac{\ell^2}{12} + \frac{d^2}{16}\right)$	$K^2 = \frac{\ell^2}{12} + \frac{d^2}{16}$	9	Globe 	$I = W \cdot \frac{d^2}{10}$	$K^2 = \frac{d^2}{10}$
4	Thin rectangular plate (Rectangular parallelepiped) 	$I = W \cdot \frac{a^2}{12}$	$K^2 = \frac{a^2}{12}$	10	Thin disk 	$I = W \cdot \frac{d^2}{16}$	$K^2 = \frac{d^2}{16}$
5	Rectangular plate (Rectangular parallelepiped) 	$I = W \cdot \frac{a^2+b^2}{12}$	$K^2 = \frac{a^2+b^2}{12}$	11	When load focuses on the tip of the rod 	$I = W_1 \cdot \frac{\ell_1^2}{3} + W_2 \cdot K^2 + W_2 \cdot \ell_2^2$	Calculated based on the W_2 shape.
6	Rectangular plate (Rectangular parallelepiped) 	$I = W_1 \cdot \frac{4a_1^2+b^2}{12} + W_2 \cdot \frac{4a_2^2+b^2}{12}$	$K^2 = \frac{4a_1^2+b^2}{12} + \frac{4a_2^2+b^2}{12}$				

Technical Data — International System of Units —

Quantity	Unit	Conversion from Previous Unit to SI Unit	Conversion from SI Unit to Previous Unit
Force	N	1kgf=9.8N	1N=0.102kgf
Moment of Force	N · m	1kgf · m=9.8N · m	1N · m=0.102kgf · m
Pressure	MPa	1kgf/㎠=0.098MPa	1MPa=10.2kgf/㎠
Inertia Moment	kg · ㎠	1kgf · m · s^2=9.8kg · m^2	1kg · m^2=0.102kgf · m · s^2
Kinetic Energy	J	1kgf · m=9.8J	1J=0.102kgf · m

●Force N ➡ kgf (1N=0.102kgf)

N	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
kgf	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
N	1	2	3	4	5	6	7	8	9
kgf	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
N	10	20	30	40	50	60	70	80	90
kgf	1.0	2.0	3.1	4.1	5.1	6.1	7.1	8.2	9.2
N	100	200	300	400	500	600	700	800	900
kgf	10	20	31	41	51	61	71	82	92
N	1000	2000	3000	4000	5000	6000	7000	8000	9000
kgf	100	200	310	410	510	610	710	820	920

●Pressure MPa ➡ kgf/㎠ (1MPa=10.2kgf/㎠)

MPa	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
kgf/㎠	0.10	0.20	0.31	0.41	0.51	0.61	0.71	0.82	0.92
MPa	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
kgf/㎠	1.02	2.04	3.06	4.08	5.10	6.12	7.14	8.16	9.18
MPa	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
kgf/㎠	10.2	11.2	12.2	13.3	14.3	15.3	16.3	17.3	18.4

Basic Unit

Quantity	Unit Name	Unit
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Current	Ampere	A
Thermodynamic Temperature	Kelvin	K
Substance Quantity	Mol	mol
Light Intensity	Candela	cd

Ancillary Unit

Quantity	Unit Name	Unit
Plane Angle	Radian	rad
Solid Angle	Steradian	sr

Prefix

Multiple Number to be Multiplied on the Unit	Prefix		Multiple Number to be Multiplied on the Unit	Prefix		Multiple Number to be Multiplied on the Unit	Prefix	
	Name	Code		Name	Code		Name	Code
10^{18}	Exa	E	10^{2}	Hecto	h	10^{-9}	Nano	n
10^{15}	Peta	P	10	Deca	da	10^{-12}	Pico	p
10^{12}	Tera	T	10^{-1}	Deci	d	10^{-15}	Femto	f
10^{9}	Giga	G	10^{-2}	Centi	c	10^{-18}	Atto	a
10^{6}	Mega	M	10^{-3}	Milli	m			
10^{3}	Kilo	k	10^{-6}	Micro	μ			