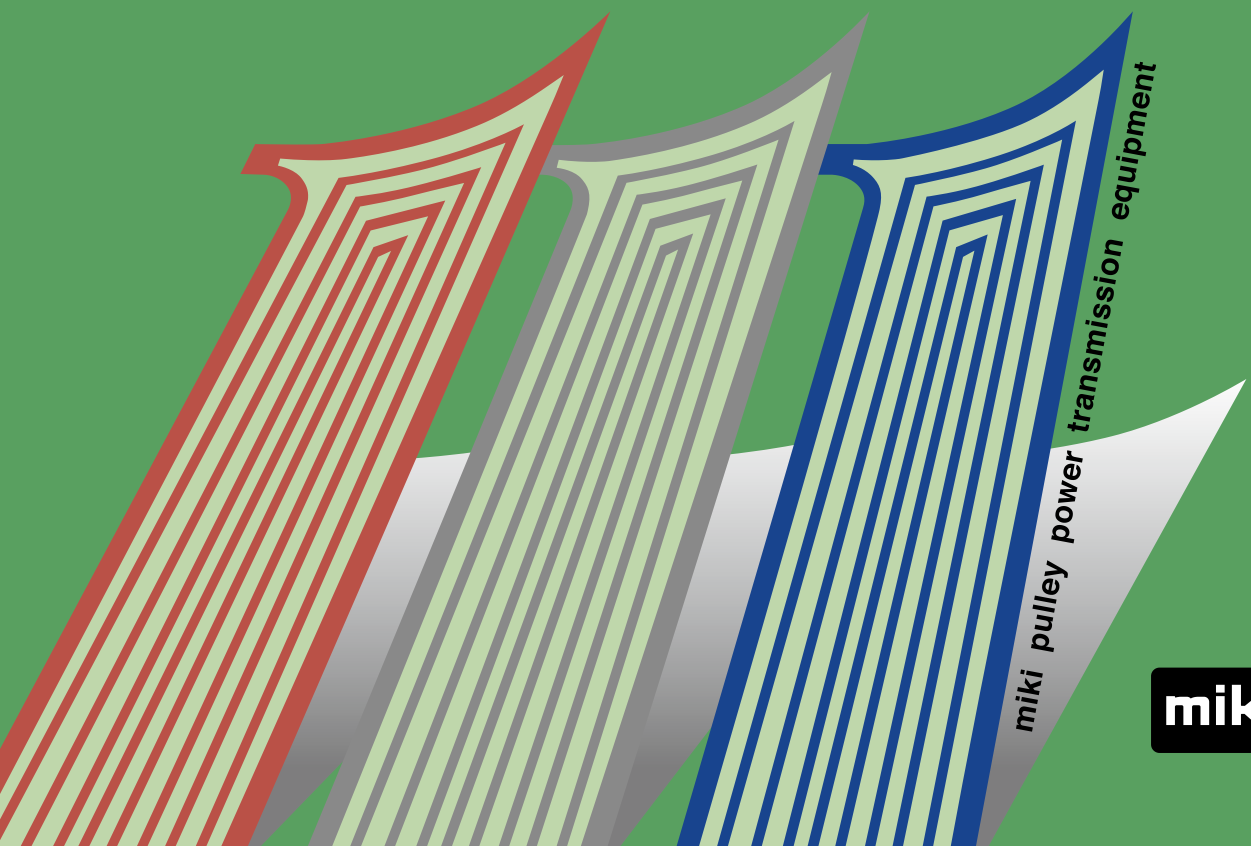
MIKI PULLEY

ELECTROMAGNETIC CLUTCHES & BRAKES

Electromagnetic Actuated Type / Spring-Applied Type



mikipulley

Electromagnetic clutches and brakes

Miki Pulley electromagnetic clutches and brakes belong to the type of dry/single plate/coil static system in the frictional-type electromagnetic clutches and brakes.
The "Electromagnetic clutches and brakes" is a generic term used to refer to the functions such as transmission and interruption or deceleration and stoppage of torque by electro-magnetic action. They are classified mainly by three in accordance with the intended use.

●Electromagnetic clutches and brakes

- Electromagnetic micro clutches and brakes
- Electromagnetic clutches and brakes
- Electromagnetic clutch and brake units

● Electromagnetic micro clutches and brakes

Ideal for use in small precision equipment such as business machine, communications equipment or automobile machinery that has a susceptibility to fluctuations of torque and responsiveness. The 102 model (clutch) and the 112 model (brake) with the same basic design can be provided as well as the customizable CYT model (clutch).

● Electromagnetic clutches and brakes

Compatible with overall general industrial machinery and the rational design offers good performance.
The 101・CS model (clutch) and the 111 model (brake) with the same basic design can be provided as well as the CSZ model (clutch) and the BSZ model (brake) designed to significantly reduce the assembling time by integrating each part.

● Electromagnetic clutch and brake units

Several clutches and brakes can be used when designing a complex mechanism. Various units are available to eliminate a troublesome task to combine the required number of each clutch and brake. A number of models that combined a motor or a reducer are also available.

Basic structure and Principle of operation

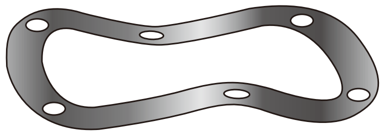
● Constant-force plate spring

As our basic actuation method of "Electromagnetic clutches and brakes", we adopt spring drive using a "constant-force plate spring".

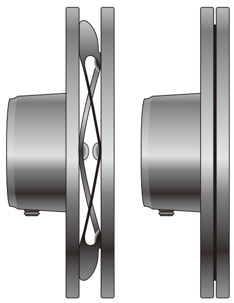
The armature assembly of clutches and brakes consists of two moving parts an armature and an armature hub. A positive connection between these two parts (armature and armature hub) requires transmitting torque and moving the armature in an axial direction.

The "constant-force plate spring" is capable of transmitting torque and releasing the armature by single piece, which offers good performance compared with other methods.

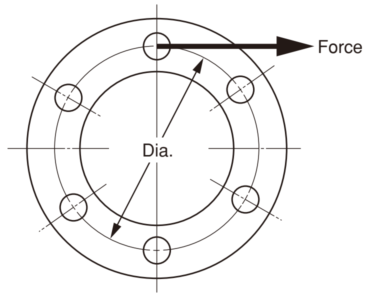
The thin spring is excellent for torque transmission. It is very strong when loaded in the tangential direction. There is structurally no backlash. Stable suction and release can be performed by waving the plate spring to reduce variation of load.



Constant-force plate spring

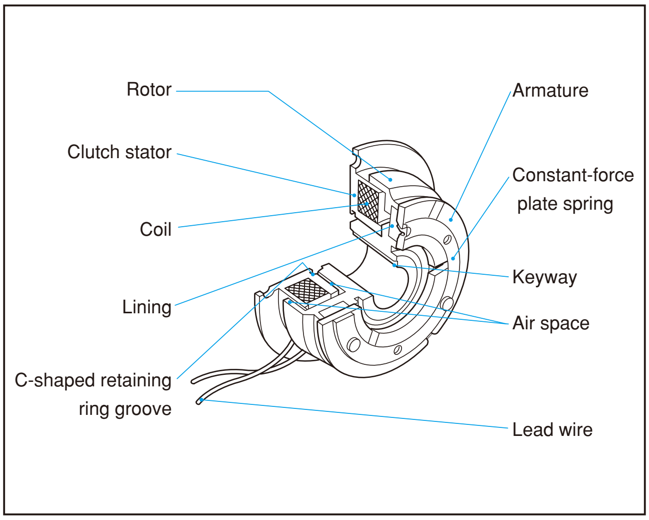


Function of the plate spring



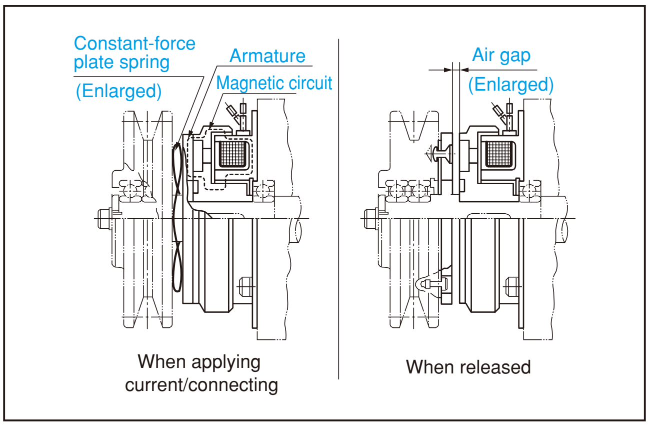
Torque to the plate spring

● Clutch



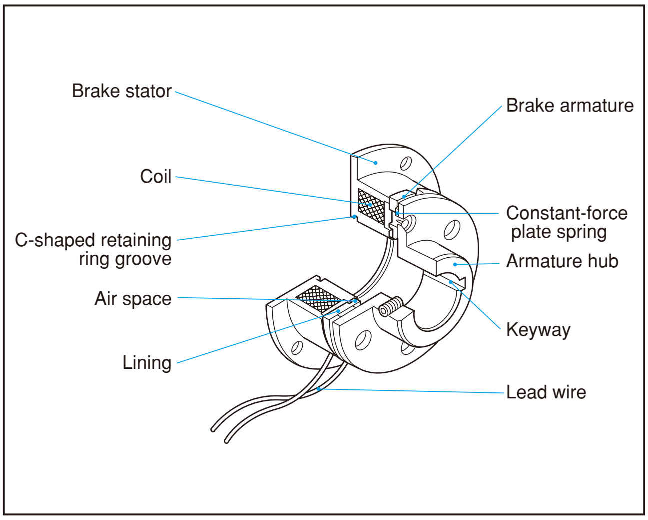
The clutch consists of three basic elements, the armature assembly, rotor of the rotating part, and stator of the static part.

The armature assembly is essentially formed of the armature and the constant-force plate spring. Only the armature is pulled and attached to the rotor by energization of a coil, and the torque is transferred from the driving side to the driven side through the plate spring.



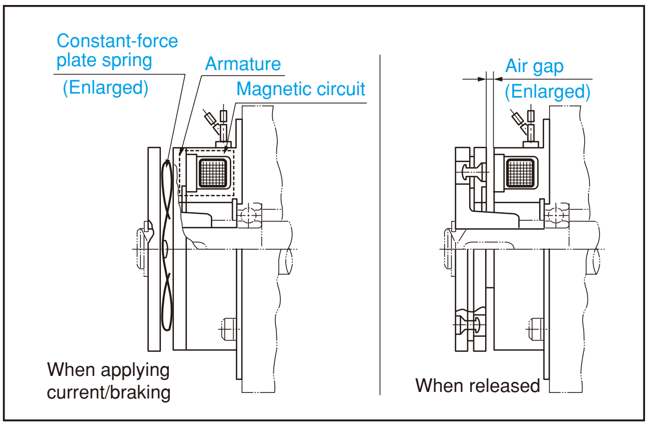
Operation of clutch

● Brake



The brake consists of two basic elements, the armature assembly of the rotating part and the stator of the static part.

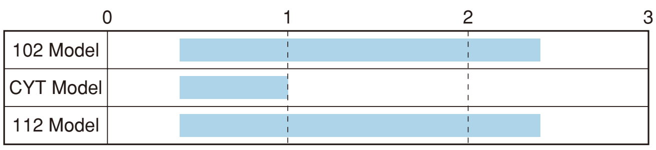
The armature of the armature assembly is pulled and attached to the stator by energization of a coil, and the damping torque is transferred to the rotating body through the plate spring.



Operation of brake

Electromagnetic micro clutches and brakes

■ 102 model (electromagnetic micro clutches)
■ CYT model (customizable electromagnetic micro clutches)
■ 112 model (electromagnetic micro brakes)



Selection

Select the appropriate shape and size in accordance with the use condition and the intended use. The friction type clutches and brakes are useful since the performance is instantaneously exerted. If the clutch and brake is not properly selected the clutch or brake my have performance problems. Fully grasp the following matters when selecting.

1 Intended use (Requirement functions for clutches brakes)

Coupling・Uncoupling, Braking・Holding, Speed change, Forward reverse operation, High-frequency operation, Positioning・Dividing, Inching, etc.

2 Required performance

Torque, Response, Frequency of use, Operating life, Accuracy, Work volume, etc.

3 Load characteristic

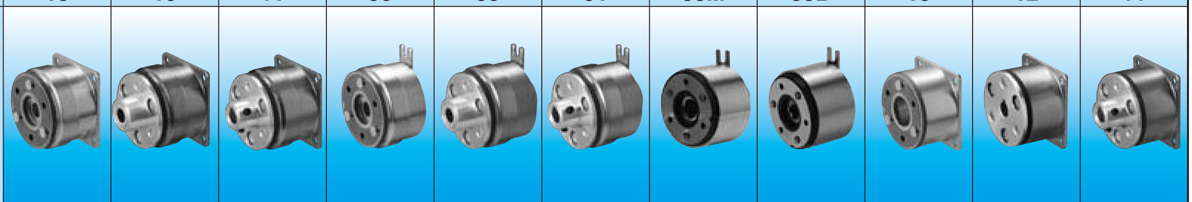
Load torque, Load moment of inertia J, Load change, Rotation speed to be applied, etc.

4 Driving side condition

Motor (three phase, single phase, alternating current, etc.), Engine, Hydraulic・Pneumatic pressure, etc.

Model list

◎…Excellence ●…Adjustment ○…Suitable depending on applications △…Customizing

		Electromagnetic micro clutches and brakes										
Class		Micro clutches								Micro brakes		
Model		102						CYT		112		
Type		13	15	11	33	35	31	33M	33B	13	12	11
Appearance												
Descriptive page		P10～15						P16～19		P20～23		
Adaptability	Rotational transmission	●	●	●	●	●	●	●	●			
	Braking・Holding									●	●	●
	Wall mounting	●	●	●						●	●	●
	Shaft mounting				●	●	●	●	●			
	High-velocity revol. (1000min⁻¹～)	●		●					●	●	●	●
	Parallel axis input/output	●	●		●	●		●	●	●	●	●
	Shaft-to-shaft input/output			●			●			○		●
Characteristic	Compact design	◎	●	●	◎	●	●	◎	◎	◎	◎	●
	Easy to mount and use	●	●	○	●	◎	○	●	●	●	○	●
	One-touch mounting							△	△			
Environmental responsiveness		●	●	●	●	●	●	●	●	●	●	●

Type • Model Selection

Selection of clutches

There are two types of stators and three types of armature assemblies with different mounting methods, and six combinations of those. Select the appropriate type for the configuration of the mounting part.

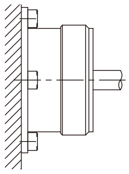
1 Select the place to mount (Selection of stators)

❶ Mount directly on the wall surface

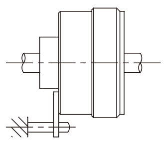
A flange mounted type stator is used. This type is shorter to the axial direction. Mounting space can be saved.

❷ Mount on a shaft and apply a piece or a pin to stabilize.

A bearing mounted type stator is used. This type is relatively easy to mount. The trouble from processing the mounting portion can be saved.



(1) Mount directly on the wall surface



(2) Mount on a shaft

2 Select the shaft configuration to mount (Selection of armature assemblies)

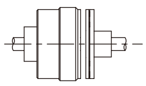
There are two types of connections between the driving side and the driven side.

❶ Couple a mating shaft

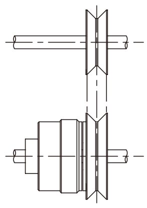
Use an armature assembly for the mating shaft. Positioning such as centering may become complicated. A coupling flange or a flexible coupling may be required.

❷ Wrapping and gear connection of a parallel shaft

Use an armature assembly for through shaft. This method allows for rational mounting, and is relatively easy.



(1) Directly connect the mating shaft.



(2) Wrap the parallel shaft.

Selection of brakes

Since a brake is used to brake and maintain the rotating body, the stator part must be properly fixed on the static part.

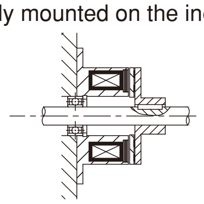
There are three ways to mount an armature assembly on the rotating body. Select the appropriate method in accordance with the configuration of the mounting part.

❶ Mount on the braking shaft

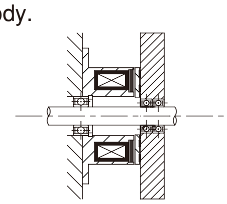
The point for selecting the mounting method from three types is that determining how to fix on the shaft effectively.

❷ Mount directly on the rotating body

Since the inertial body that is not fixed on the shaft will not stop when stopping the shaft, use an armature assembly that can be directly mounted on the inertial body.



(1) Mount directly on a shaft



(2) Mount on a rotating body

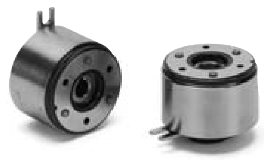
102 model (micro clutches)

There are two types of stators; the flange mounted type that allows effective space use and the bearing mounted type that allows easy setting on a shaft. By combining with three types of armature assemblies with different mounting forms (direct mounting), six types can be selected according to the mounting conditions.

CYT model (customizable micro clutches)

The stator is a bearing mounted type that allows easy setting on a shaft. The dry-metal type or the ball-bearing type can be selected depending on the shaft rotation speed.

Various custom types such as assembling a pulley and gear in the armature type-3 or combing a shaft with it are available.



112 model (micro brakes)

This model is a compact and high-performance brake with the same basic design with the micro clutches.

The optimum condition can be selected from the three types of armature assemblies with different mounting forms.

102 model

Electromagnetic micro clutches

Ideal for use in small precision equipment such as business machines, communications equipment or automobile machinery that has a susceptibility to fluctuations of torque and responsiveness. Many different types are available in order to install in any place. Compact and lightweight, and easy to mount and use.

■Various types

There are two types of stators; the flange mounted type that allows effective space use and the bearing mounted type that allows easy setting on a shaft. By combining with three type of armature assemblies with different mounting forms (direct mounting/shaft mounting type), six types can be selected according to the mounting terms.

■Adapted to the RoHS

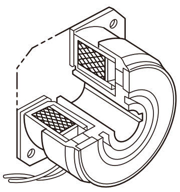
Adapted to the Restriction of Hazardous Substances that bans the use of 6 substances such as mercury or lead can be selected as option.

Clutch torque [N·m]	0.4 ～ 2.4
Operational temperature [℃]	−10 ～ +40
Backlash	Zero

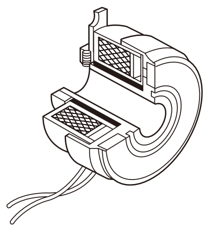
■ 6types

● Stator • Rotor form

The flange mounted type is installed by combining a stator and rotor together. It allows effective wall space use. The bearing mounted type has integral structure of stator and rotor, and also has built-in oil retaining metal bearing. It allows easy setting at the optional position on a shaft.



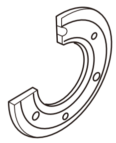
Flange mounted type



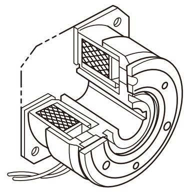
Bearing mounted type

■ With the armature type-3

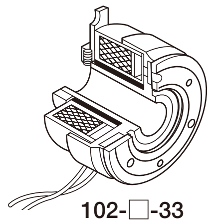
- Mainly used for through shaft.
- Ideal for wrapping and gear drive.
- The armature type-3 is the type of "direct mounting". Easy to install to a sprocket or a spur gear.
- The 102-□-13 uses a wall surface to mount.
- The 102-□-33 is mounted on a shaft.



Armature type-3



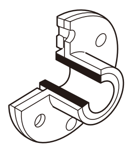
102-□-13



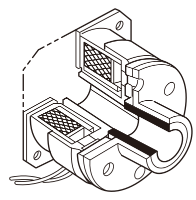
102-□-33

■ With the armature type-5

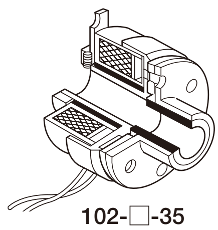
- Mainly used for through shaft.
- The armature type-5 is the type of "bearing mounting". Easy to install to a sprocket or a spur gear.
- The 102-□-15 uses a wall surface to mount.
- The 102-□-35 is mounted on a shaft.



Armature type-5



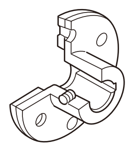
102-□-15



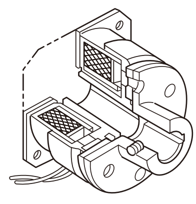
102-□-35

■ With the armature type-1

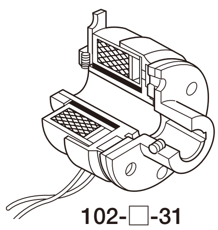
- Mainly used for through shaft.
- The armature type-1 is the type of "shaft mounting".
- The 102-□-11 uses a wall surface to mount.
- The 102-□-31 is mounted on a shaft.



Armature type-1



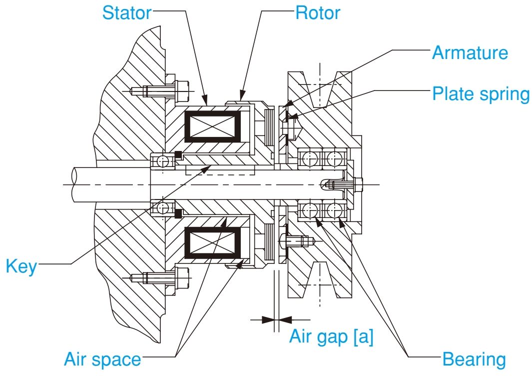
102-□-11



102-□-31

Outline Structure

The micro clutch 102 model consists of the following three parts; the stator with built-in coil, rotor with lining material, and armature assembly. Each part is mutually combined in the correct physical relationship, and forms a magnetic circuit.



Structure of the flange mounted type

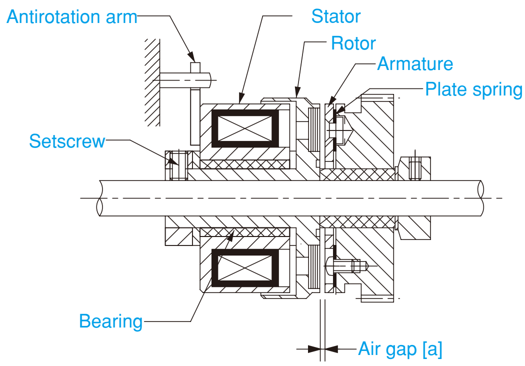
Stator and Rotor

- Flange mounted type

  The stator is directly fixed on the static part such as flange, by a mounting flange. The rotor is fixed against the rotating shaft by a key. The stator and rotor are combined through a narrow air gap which becomes a part of the magnetic circuit, and forms magnetic poles.

- Bearing mounted type

  The stator is integrated with the rotor through the bearing, and is maintained in the static part of the machine by an antirotation arm. The rotor is fixed on the rotating shaft by a setscrew. The stator and rotor form a magnetic pole through the bearing (iron oil-bearing metal).



Structure of the bearing mounted type

Armature assembly

The armature assembly is composed of armature, plate spring and armature hub. It is combined properly with keeping a certain amount of air gap [a] facing the rotor. The though-shaft armature assembly is fixed on the shaft by a bearing. The shaft-to-shaft type armature assembly is fixed on the opposed shaft by a key and set screw.

Stator • Rotor mounting

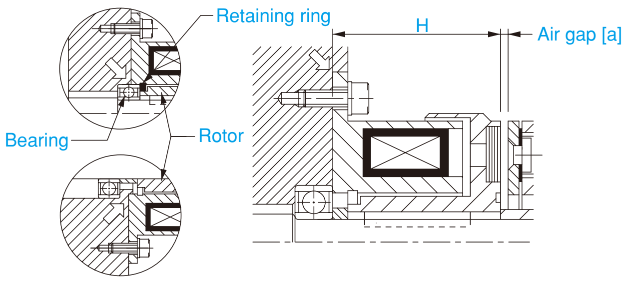
Flange mounted type

- Centering

  For the mounting shaft of the stator and rotor, centering is performed by "positioning fits" using the stator inside diameter or the flange outside diameter. Since the inside diameter is designed to fit into the nominal dimension for the outside diameter of the ball bearing, correct centering can be performed by directly using the bearing that supports the shaft.

- Setting of axial positional relationship (H measurement)

  For the positional relationship between the stator and rotor, set the H measurement in order that it becomes its specified value. If centering is performed by using a ball bearing, use a retaining ring and strike the rotor edge to determine the H measurement.



Stator/Rotor mounting (flange mounted type)

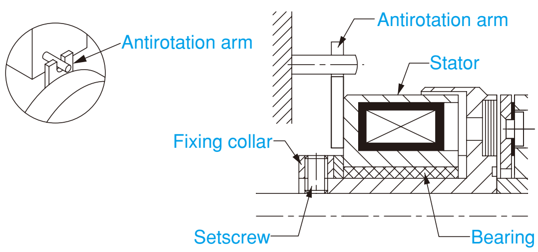
Bearing mounted type

- Centering is not necessary.
- Fix on the shaft

  The stator and rotor can be easily fixed on the shaft by a fixing collar and a setscrew.

- Maintain the stator

  The force acting on the stator is a minimal amount of torque caused by the supporting bearing friction. To prevent free rotation of the stator, and to protect a lead wire, maintain an antirotation arm in the static part of the machine. An antirotation arm must be retained in the suitable form for not turning into the shaft direction.



Stator/Rotor mounting (bearing mounted type)

Electromagnetic micro clutches and brakes

102-□-1□ type

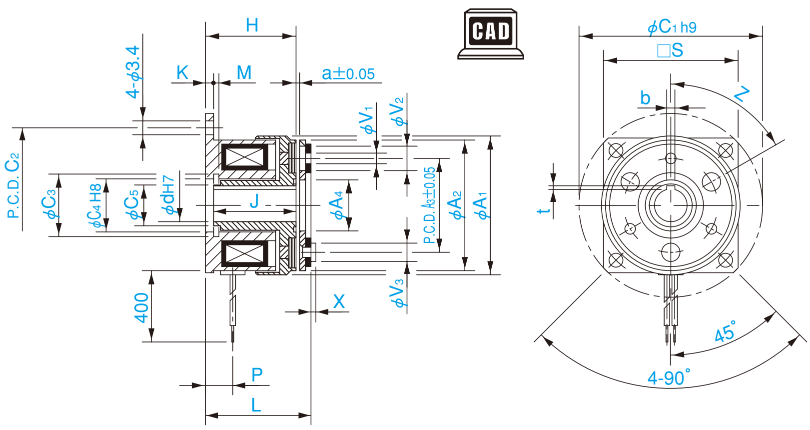
Electromagnetic micro clutches /Flange mounted type

Specifications

Model	Size	Dynamic friction torque T_d [N·m]	Coil (at 20℃) Voltage [V]	Wattage [W]	Amperage [A]	Resistance [Ω]	Heat-resistance class	Maximum rotation speed [min⁻¹]	Rotating part moment of inertia J: Armature [kg·m²]	Rotor [kg·m²]	Allowable engaging energy E_{eal} [J]	Total amount of energy before air gap readjustment E_T [J]	Armature pull in time t_a [s]	Torque build-up time t_p [s]	Torque decaying time t_d [s]	Mass [kg]
102-02-13								10000	6.75×10^{-7}							0.075
102-02-15	02	0.4	DC24	6	0.25	96	B	500	1.00×10^{-6}	2.45×10^{-6}	1500	2×10^{6}	0.009	0.019	0.017	0.081
102-02-11								10000	1.00×10^{-6}							0.079
102-03-13								10000	1.30×10^{-6}							0.096
102-03-15	03	0.6	DC24	6	0.25	96	B	500	1.95×10^{-6}	3.25×10^{-6}	2300	3×10^{6}	0.009	0.022	0.020	0.105
102-03-11								10000	1.95×10^{-6}							0.103
102-04-13								10000	4.38×10^{-6}							0.178
102-04-15	04	1.2	DC24	8	0.33	72	B	500	6.15×10^{-6}	1.41×10^{-5}	4500	6×10^{6}	0.011	0.028	0.030	0.195
102-04-11								10000	6.15×10^{-6}							0.191
102-05-13								10000	9.08×10^{-6}							0.310
102-05-15	05	2.4	DC24	10	0.42	58	B	500	1.38×10^{-5}	3.15×10^{-5}	9000	9×10^{6}	0.012	0.031	0.040	0.335
102-05-11								10000	1.38×10^{-5}							0.325

*Dynamic friction torque (Td) indicates the value when relative velocity is (100min⁻¹).
*Rotating part moment of inertia and mass indicate the values of maximum bore diameter.
*Power supply voltage variation must be within ±10% of the coil voltage.

Dimensions 102-□-13 (For direct mounting)



Unit [mm]

Size	Shaft bore dimensions: d H7	New JIS standards correspondence: b P9	t	Previous edition of JIS standards correspondence: b E9	t
02	5	—	—		
03	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	15	$5^{-0.012}_{-0.042}$	$2^{+0.5}_{0}$	$5^{+0.050}_{+0.020}$	$2^{+0.5}_{0}$

Unit [mm]

Size	Radial dimensions: A_1	A_2	A_3	A_4	C_1	C_2	C_3	C_4	C_5	S	V_1	V_2	V_3	Z	Axial direction dimensions: H	J	K	L	P	M	a	X	CAD File No.
02	31	28	19.5	10.5	39	33.5	11.4	11	8	—	2-2.1	2-5.3	2-4	4-90°	18	16.5	1.5	20.5	5	1.1	0.1	0.8	102-131
03	34	32	23	12.5	45	38	13.6	13	10	33	3-2.6	3-6	3-4.5	6-60°	22.2	20.2	2	24.5	6.7	1.3	0.15	1.2	102-132
04	43	40	30	18.5	54	47	20	19	15.5	41	3-3.1	3-6	3-5	6-60°	25.4	23.4	2	28.2	7	1.3	0.15	1.5	102-133
05	54	50	38	25.5	65	58	27.2	26	22	51	3-3.1	3-6.5	3-5.5	6-60°	28.1	26.1	2	31.3	8.2	1.5	0.2	1.5	102-134

*The size 02 has a round flange.
*There is no keyway on the rotor of the size 02. Fix on the shaft by press fitting.

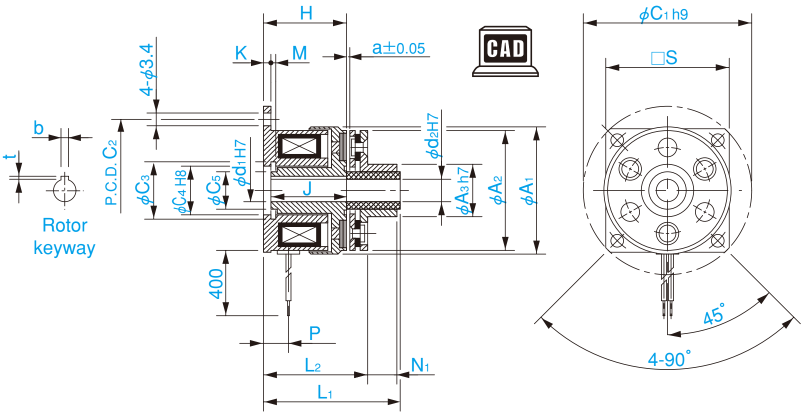
Ordering information

102- 03 -13 24V 6 DIN

Size — 03
Rotor bore diameter (Dimensional sign d) — 6
Keyway standard — DIN
New JIS standards correspondence：DIN
Previous edition of JIS standards correspondence：JIS

*Unnecessary to enter the keyway standard if there is no description (–) in the shaft-bore dimensions table. Specification displayed as diagonal line is not available as a standard product.

Dimensions 102-□-15 (For through shaft)



Unit [mm]

Size	d1 H7	d2 H7	New JIS standards correspondence		Previous edition of JIS standards correspondence	
			b P9	t	b E9	t
02	5	5	–	–		
03	6	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	10	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	10	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	15	15	$5^{-0.012}_{-0.042}$	$2^{+0.5}_{0}$	$5^{+0.050}_{+0.020}$	$2^{+0.5}_{0}$

※The d2 of the 5-type armature is a straight bore.

Unit [mm]

Size	Radial dimensions									Axial direction dimensions									CAD File No.
	A_1	A_2	A_3	C_1	C_2	C_3	C_4	C_5	S	H	J	K	L_1	L_2	M	P	N1	a	
02	31	28	13	39	33.5	11.4	11	8	–	18	16.5	1.5	27.5	22.4	1.1	5	4.8	0.1	102-151
03	34	32	14	45	38	13.6	13	10	33	22.2	20.2	2	34.5	26.5	1.3	6.7	7.8	0.15	102-152
04	43	40	18	54	47	20	19	15.5	41	25.4	23.4	2	40.2	30.8	1.3	7	9.1	0.15	102-153
05	54	50	28	65	58	27.2	26	22	51	28.1	26.1	2	43.3	34.3	1.5	8.2	8.8	0.2	102-154

*The size 02 has a round flange.
*There is no keyway on the rotor of the size 02. Fix to the shaft by press fitting.

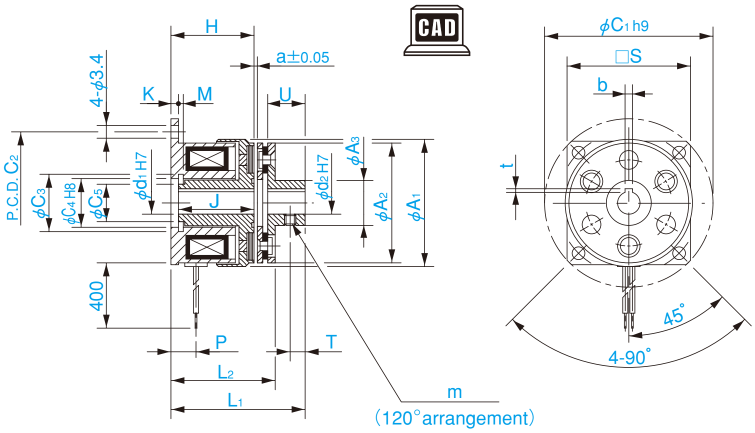
Ordering information

102-03-15 24V R 6 DIN A 6

- Size (03)
- Rotor bore diameter (Dimensional sign d) (6)
- Keyway standard (DIN): New JIS standards correspondence: DIN; Previous edition of JIS standards correspondence: JIS
- Armature bore diameter (Dimensional sign d2) (6)

*It is not necessary to enter the keyway standard if there is no description (–) in the shaft-bore dimensions table.

Dimensions 102-□-11 (For shaft-to-shaft)



Unit [mm]

Size	d1 H7	d2 H7	New JIS standards correspondence		Previous edition of JIS standards correspondence	
			b P9	t	b E9	t
02	5	5	–	–		
03	6	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	10	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	10	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	15	15	$5^{-0.012}_{-0.042}$	$2^{+0.5}_{0}$	$5^{+0.050}_{+0.020}$	$2^{+0.5}_{0}$

Unit [mm]

Size	Radial dimensions										Axial direction dimensions										CAD File No.
	A_1	A_2	A_3	C_1	C_2	C_3	C_4	C_5	S	m	H	J	K	L_1	L_2	M	P	U	T	a	
02	31	28	9.5	39	33.5	11.4	11	8	–	M3	18	16.5	1.5	27.5	22.5	1.1	5	7	2.5	0.1	102-111
03	34	32	12	45	38	13.6	13	10	33	2-M3	22.2	20.2	2	34.5	26.5	1.3	6.7	10	4	0.15	102-112
04	43	40	17	54	47	20	19	15.5	41	2-M3	25.4	23.4	2	40.2	30.8	1.3	7	12	5	0.15	102-113
05	54	50	24	65	58	27.2	26	22	51	2-M4	28.1	26.1	2	43.3	34.3	1.5	8.2	12	5	0.2	102-114

*The size 02 has a round flange.
*There is no keyway on the rotor of the size 02. Fix on the shaft by press fitting.

Ordering information

102-03-11 24V R 6 DIN A 6 DIN

- Size (03)
- Rotor bore diameter (Dimensional sign d_1) (6)
- Keyway standard (DIN): New JIS standards correspondence: DIN; Previous edition of JIS standards correspondence: JIS
- Armature bore diameter (Dimensional sign d2) (6)
- Keyway standard (DIN): New JIS standards correspondence : DIN; Previous edition of JIS standards correspondence : JIS

*Unnecessary to enter the keyway standard if there is no description (–) in the shaft-bore dimensions table. Specification displayed as diagonal line is not available as a standard product.

102-□-3□ type

Electromagnetic micro clutches /Bearing mounted type

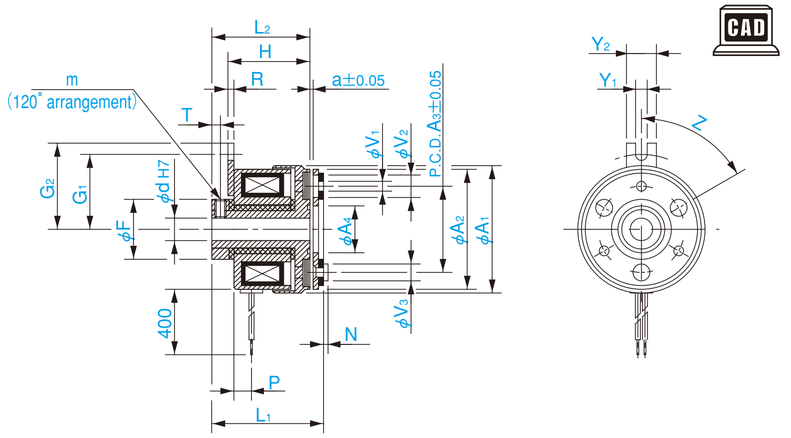
Specifications

Model	Size	Dynamic friction torque T_d [N·m]	Coil (at 20℃)				Heat-resistance class	Maximum rotation speed [min^{-1}]	Rotating part moment of inertia J		Allowable engaging energy $E_{eaℓ}$ [J]	Total amount of energy before air gap readjustment E_T [J]	Armature pull in time t_a [s]	Torque build-up time t_p [s]	Torque decaying time t_d [s]	Mass [kg]
			Voltage [V]	Wattage [W]	Amperage [A]	Resistance [Ω]			Armature [kg·m²]	Rotor [kg·m²]						
102-02-33									$6.75×10^{-7}$							0.076
102-02-35	02	0.4	DC24	6	0.25	96	B	500	$1.00×10^{-6}$	$2.75×10^{-6}$	1500	$2×10^{6}$	0.009	0.019	0.017	0.082
102-02-31									$1.00×10^{-6}$							0.080
102-03-33									$1.30×10^{-6}$							0.101
102-03-35	03	0.6	DC24	6	0.25	96	B	500	$1.95×10^{-6}$	$4.08×10^{-6}$	2300	$3×10^{6}$	0.009	0.022	0.020	0.110
102-03-31									$1.95×10^{-6}$							0.108
102-04-33									$4.38×10^{-6}$							0.183
102-04-35	04	1.2	DC24	8	0.33	72	B	500	$6.15×10^{-6}$	$1.44×10^{-5}$	4500	$6×10^{6}$	0.011	0.028	0.030	0.200
102-04-31									$6.15×10^{-6}$							0.196
102-05-33									$9.08×10^{-6}$							0.321
102-05-35	05	2.4	DC24	10	0.42	58	B	500	$1.38×10^{-5}$	$2.90×10^{-5}$	9000	$9×10^{6}$	0.012	0.031	0.040	0.346
102-05-31									$1.38×10^{-5}$							0.336

*Dynamic friction torque (Td) indicates the value when relative velocity is ($100min^{-1}$).
*Rotating part moment of inertia and mass indicate the values of maximum bore diameter.
*Power supply voltage variation must be within ±10% of the coil voltage.

Dimensions 102-□-33 (For direct mounting)

Unit [mm]



Size	Shaft bore dimensions d H7
02	5
03	6
04	8
	10
05	10
	15

Unit [mm]

Size	Radial dimensions														Axial direction dimensions								CAD File No.
	A_1	A_2	A_3	A_4	F	V_1	V_2	V_3	G_1	G_2	Y_1	Y_2	Z	m	H	R	L_1	L_2	P	N	T	a	
02	31	28	19.5	10.5	14	2-2.1	2-5.3	2-4	16.8	20	3.1	8	4-90°	2-M3	19.5	1.6	25.9	23.5	5	0.8	2.5	0.1	102-331
03	34	32	23	12.5	16	3-2.6	3-6	3-4.5	20	23	3.1	8	6-60°	2-M3	21.9	1.6	28.5	26.2	4.7	1.2	2.3	0.15	102-332
04	43	40	30	18.5	22	3-3.1	3-6	3-5	23	26	3.1	8	6-60°	2-M4	25.1	1.6	33.2	30.4	5	1.5	2.8	0.15	102-333
05	54	50	38	25.5	30	3-3.1	3-6.5	3-5.5	28	31	3.1	8	6-60°	2-M5	27.9	1.6	37.3	34.1	6	1.5	3.3	0.2	102-334

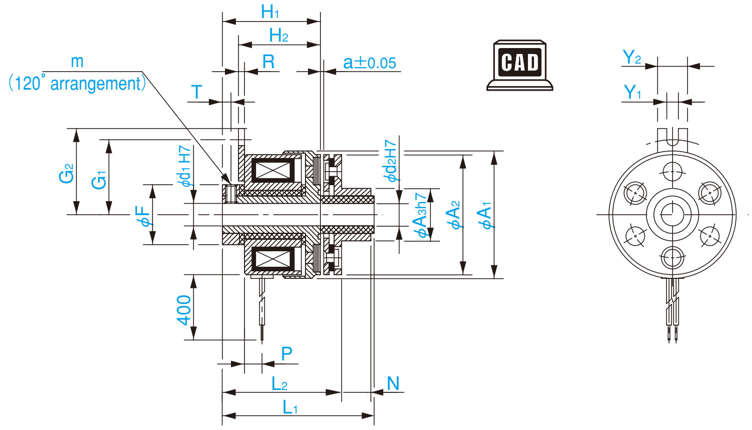
Ordering information

102-03-33 24V 6

Size: 03

Rotor bore diameter (Dimensional sign d): 6

Dimensions 102-□-35 (For through shaft)



Unit［mm］

Size	Shaft bore dimensions	
	d_1 H7	d_2 H7
02	5	5
03	6	6
04	8	8
	10	10
05	10	10
	15	15

Unit［mm］

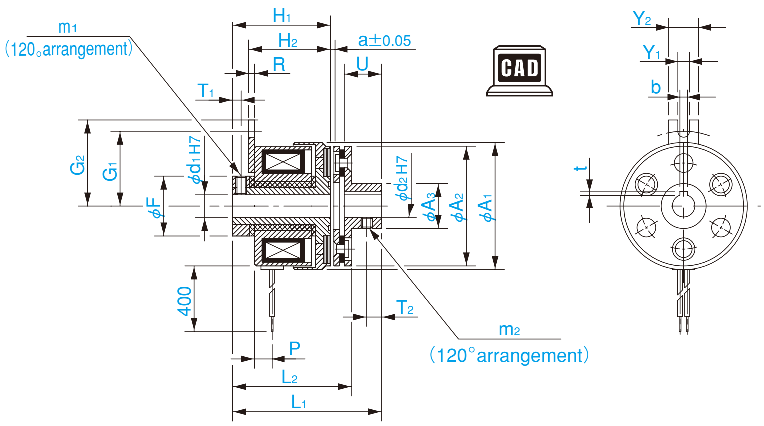
Size	Radial dimensions									Axial direction dimensions									CAD File No.
	A_1	A_2	A_3	F	G_1	G_2	Y_1	Y_2	m	H_1	H_2	R	L_1	L_2	P	N	T	a	
02	31	28	13	14	16.8	20	3.1	8	2-M3	23.5	19.5	1.6	33	27.9	5	4.8	2.5	0.1	102-351
03	34	32	14	16	20	23	3.1	8	2-M3	26.2	21.9	1.6	38.5	30.5	4.7	7.8	2.3	0.15	102-352
04	43	40	18	22	23	26	3.1	8	2-M4	30.4	25.1	1.6	45.2	35.8	5	9.1	2.8	0.15	102-353
05	54	50	28	30	28	31	3.1	8	2-M5	34.1	27.9	1.6	49.3	40.3	6	8.8	3.3	0.2	102-354

Ordering information

102-03-35 24V R6 A6

- Size → 03
- Rotor bore diameter (Dimensional sign d_1) → R6
- Armature bore diameter (Dimensional sign d_2) → A6

Dimensions 102-□-31 (For shaft-to-shaft)



Unit［mm］

Size	d_1 H7	d_2 H7	Shaft bore dimensions: New JIS standards correspondence		Previous edition of JIS standards correspondence	
			b P9	t	b E9	t
02	5	5	—	—		
03	6	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
	10	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	10	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
	15	15	$5^{-0.012}_{-0.042}$	$2^{+0.5}_{0}$	$5^{+0.050}_{+0.020}$	$2^{+0.5}_{0}$

Unit［mm］

Size	Radial dimensions										Axial direction dimensions										CAD File No.
	A_1	A_2	A_3	F	G_1	G_2	Y_1	Y_2	m_1	m_2	H_1	H_2	R	L_1	L_2	P	U	T_1	T_2	a	
02	31	28	9.5	14	16.8	20	3.1	8	2-M3	M3	23.5	19.5	1.6	33	27.9	5	7	2.5	2.5	0.1	102-311
03	34	32	12	16	20	23	3.1	8	2-M3	2-M3	26.2	21.9	1.6	38.5	30.5	4.7	10	2.3	4	0.15	102-312
04	43	40	17	22	23	26	3.1	8	2-M4	2-M3	30.4	25.1	1.6	45.2	35.8	5	12	2.8	5	0.15	102-313
05	54	50	24	30	28	31	3.1	8	2-M5	2-M4	34.1	27.9	1.6	49.3	40.3	6	12	3.3	5	0.2	102-314

Ordering information

102-03-31 24V R6 A6 DIN

- Size → 03
- Rotor bore diameter (Dimensional sign d_1) → R6
- Armature bore diameter (Dimensional sign d_2) → A6
- Keyway standard → DIN: New JIS standards correspondence: DIN; Previous edition of JIS standards correspondence: JIS

* It is not necessary to enter the keyway standard if there is no description (–) in the shaft-bore dimensions table.
Specification displayed as diagonal line is not available as a standard product.

CYT model

Electromagnetic micro clutches

Excellent for use in small precision equipment such as business machines, communications equipment or automobile machinery.
The CYT provides excellent stability of torque and quick response. Various custom types coupled with shafts are available.
The compact design along with high torque capacity is also easy to mount and use.

■Various custom types

The stator is a bearing mounted type that allows easy setting on a shaft. The dry-metal type or the ball-bearing type can be selected depending on the shaft rotation speed.
Various custom types such as assembling a pulley and a gear in the armature type-3 or combing a shaft are available.

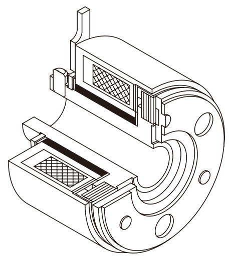
■Adapted to the RoHS

Adapted to the Restriction of Hazardous Substances that bans the use of 6 substances such as mercury or lead can be selected as option.

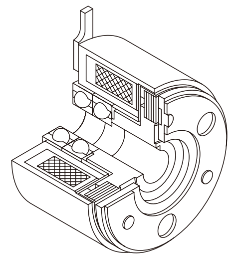
Clutch torque [N･m]	0.4 ～ 1.0
Operational temperature [℃]	−10 ～ +40
Backlash	Zero

Structure

The micro clutch CYT model consists of the following three parts; the stator with built-in coil, rotor with lining material, and armature assembly. Each part is mutually combined in the correct physical relationship, and forms a magnetic circuit.
The stator is a bearing mounted type that allows easy setting on a shaft. The dry-metal type or the ball-bearing type can be selected depending on the shaft rotation speed.



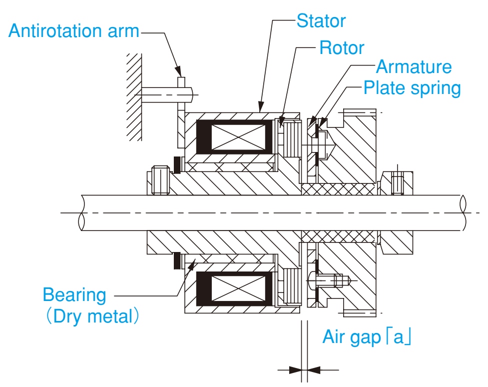
Bearing mounted type (Dry metal type)



Bearing mounted type (Ball bearing type)

● Stator and Rotor

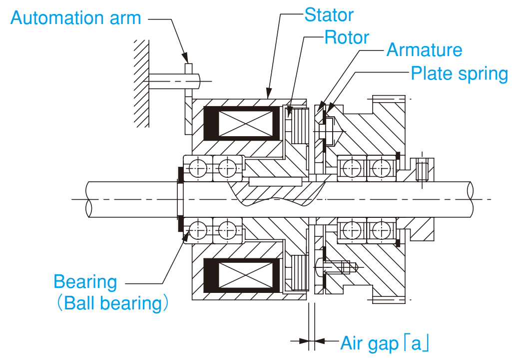
- Bearing mounted type (Dry metal type)
  The stator is integrated with the rotor through the bearing, and is maintained in the static part of the machine by an antirotation arm. The rotor is fixed on the rotating shaft by a setscrew. The stator and rotor form a magnetic pole through the bearing (dry metal).
- Bearing mounted type (Ball bearing type)
  The stator is fixed on the shaft through the bearing, and is maintained in the static part of the machine by an antirotation arm. The stator and rotor are combined through a narrow air gap which becomes a part of the magnetic circuit, and forms magnetic poles.



Structure of the bearing mounted type (Dry metal type)

● Armature assembly

- The armature assembly is composed of armature and plate spring. It is combined properly with keeping a certain amount of air gap [a] facing the rotor, and is fixed on the through shaft by the bearing.

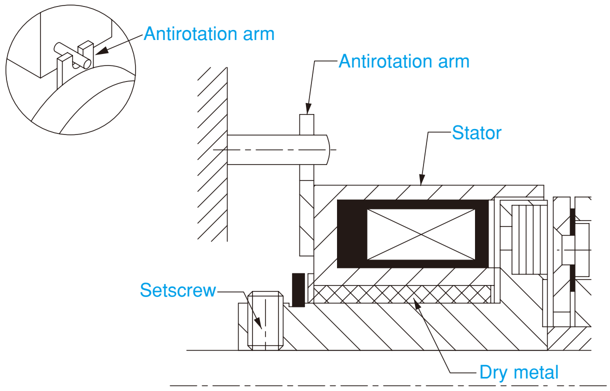


Structure of the bearing mounted type (Ball bearing type)

Stator • Rotor mounting

Bearing mounted type (Dry metal type)

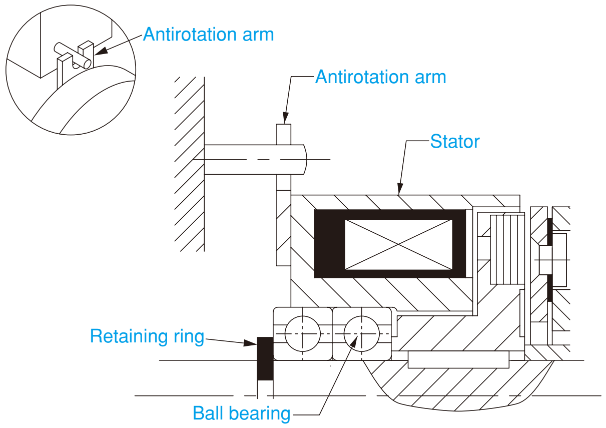
- Centering is not necessary.
- Fix on the shaft
  The stator can be easily fixed on the shaft by a setscrew.
- Maintain the stator
  The force acting on the stator is a minimal amount of torque caused by the supporting bearing friction. To prevent free rotation of the stator, and to protect a lead wire, maintain an antirotation arm in the static part of the machine. An antirotation arm must be retained in the suitable form for not turning into the shaft direction.



Stator/Rotor mounting (Dry metal type)

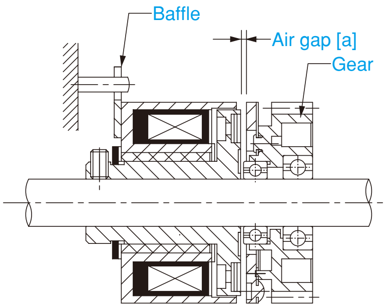
Bearing mounted type (Ball bearing type)

- Centering is not necessary.
- Fix on the shaft
  When mounting the stator, perform positioning for the shaft direction by a retaining ring and a fixing collar. The rotor can be easily fixed on the shaft by a setscrew or keyway.
- Maintain the stator
  The force acting on the stator is a minimal amount of torque caused by the supporting bearing friction. To prevent free rotation of the stator, and to protect a lead wire, maintain an antirotation arm in the static part of the machine. An antirotation arm must be retained in the suitable form for not turning into the shaft direction.

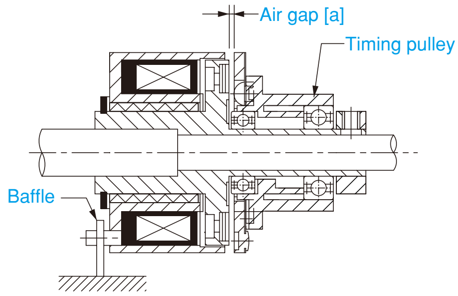


Stator/Rotor mounting (Ball bearing type)

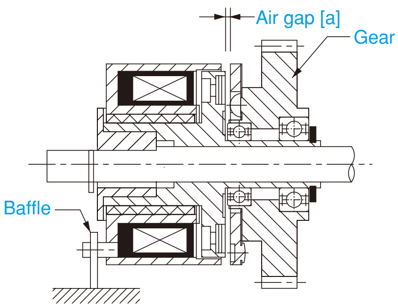
Custom examples



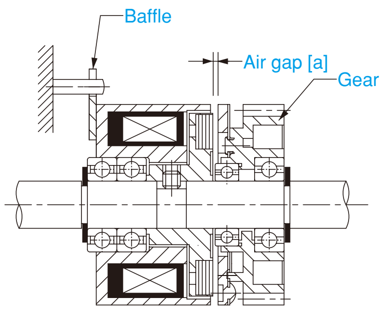
Bearing mounted type (Dry metal type) Mounting example



Bearing mounted type (Dry metal type) Mounting example
Built-in timing pulley



Bearing mounted type (Dry metal type) Mounting example
Built-in gear



Bearing mounted type (Ball bearing type) Mounting example

CYT model

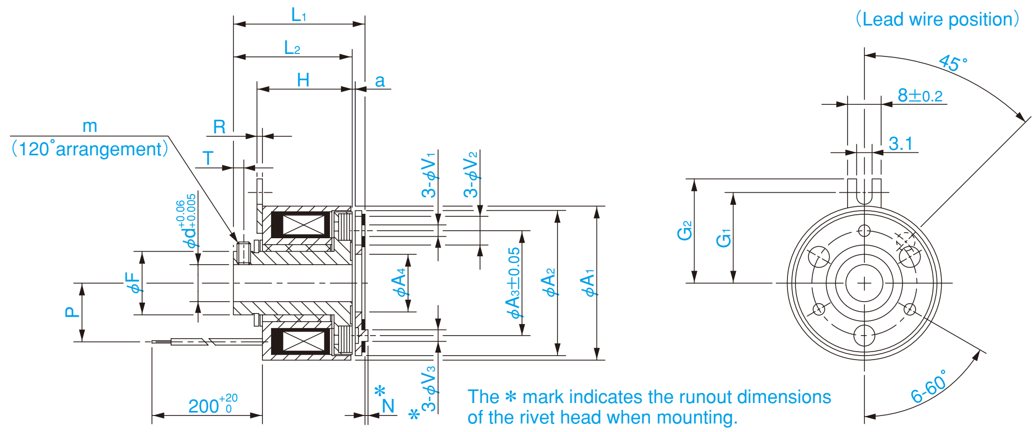
Electromagnetic micro clutches /Bearing mounted type

Specifications

Model	Size	Dynamic friction torque T_d [N·m]	Coil (at 20℃) Voltage [V]	Wattage [W]	Amperage [A]	Resistance [Ω]	Heat-resistance class	Maximum rotation speed [min^{-1}]	Rotating part moment of inertia J: Armature [kg·m²]	Rotor [kg·m²]	Allowable engaging energy $E_{aℓ}$ [J]	Total amount of energy before air gap readjustment E_T [J]	Armature pull in time t_a [s]	Torque build-up time t_p [s]	Torque decaying time t_d [s]	Mass [kg]
CYT-025-33B	025	0.4	DC24	4.5	0.188	128	B	3600	$1.00×10^{-6}$	$1.43×10^{-6}$	800	$1.0×10^{6}$	0.014	0.028	0.030	0.07
CYT-03-33B	03	0.5	DC24	5.5	0.23	105	B	3600	$1.30×10^{-6}$	$1.85×10^{-6}$	900	$1.5×10^{6}$	0.015	0.030	0.040	0.13
CYT-03-33M								500		$1.90×10^{-6}$						0.11
CYT-04-33B	04	1.0	DC24	5.9	0.25	98	B	3600	$5.15×10^{-6}$	$1.00×10^{-5}$	1900	$2.0×10^{6}$	0.030	0.040	0.040	0.26
CYT-04-33M								500		$1.05×10^{-5}$						0.23

*Dynamic friction torque (Td) indicates the value when relative velocity is (100min⁻¹).
*Rotating part moment of inertia and mass indicate the values of maximum bore diameter.
*Power supply voltage variation must be within ±10% of the coil voltage.

Dimensions CYT-□-33M



Unit [mm]

Size	d	Radial dimensions A1	A2	A3	A4	F	V1	V2	V3	G1	G2	m	Axial direction dimensions H	R	L1	L2	P	N	T	a	CAD File No.
03	6	34	32	23	12.5	14	3-2.6	3-5.5	3-6	20	23	M3	21	1.2	28.6	26.2	13	3	2.3	$0.2^{\pm0.05}$	—
	8																				—
04	8	45	42	30	18.5	18	3-3.1	3-6	3-6	25	27.5	M4	25.3	1.2	35.1	32.4	17.5	3.5	3	$0.2^{+0.05}_{-0.1}$	—
	10																				—

*The dimensional sign N and V3 indicate the runout dimensions of the rivet head when mounting.

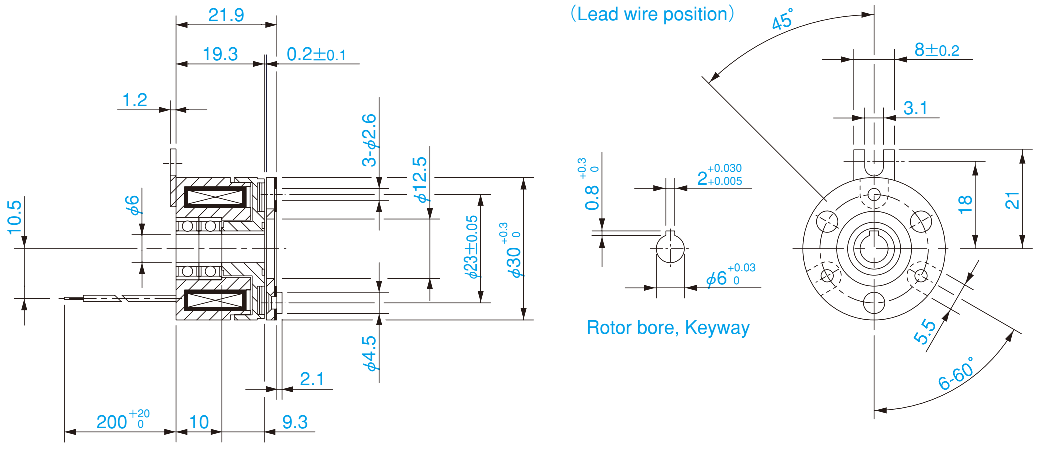
Ordering information

CYT-03-33M 24V 6

Size — 03

Rotor bore diameter (Dimensional sign d) — 6

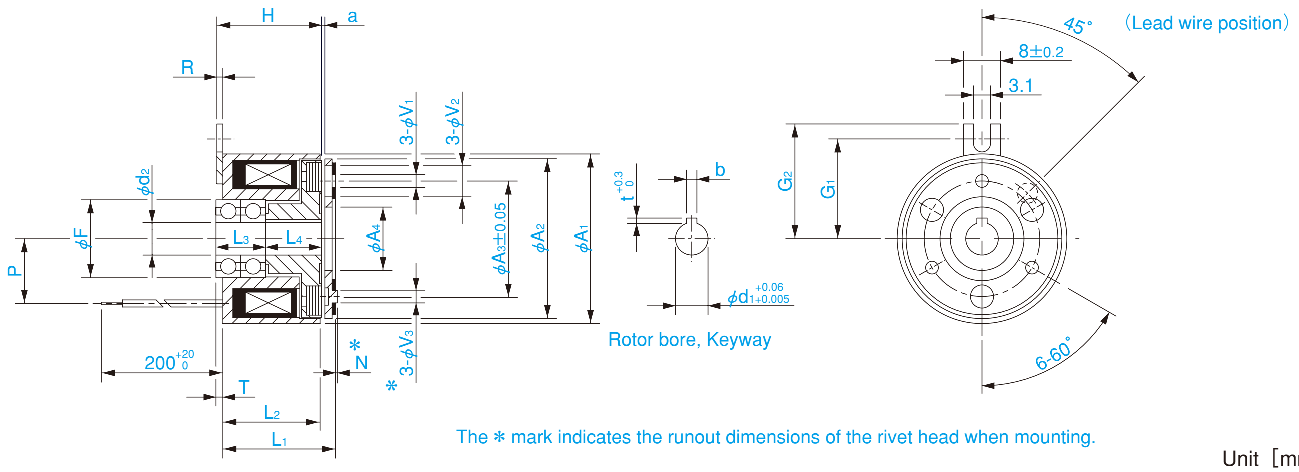
Dimensions CYT-025-33B



Ordering information

CYT-025-33B 24V 6

Dimensions CYT-□-33B



The ∗ mark indicates the runout dimensions of the rivet head when mounting.

Unit [mm]

Size	Nominal diameter	Radial dimensions										Axial direction dimensions										Shaft bore dimensions				CAD File No.
		A_1	A_2	A_3	A_4	F	V_1	V_2	V_3	G_1	G_2	H	R	L_1	L_2	L_3	L_4	P	N	T	a	d_2	d_1	b	t	
03	6	34	32	23	12.5	15	3-2.6	3-5.5	3-6	20	23	21	1.2	22.2	19.8	10	11.3	13	3	1.5	0.2 ±0.05	6	6	$2^{+0.030}_{+0.005}$	$0.8^{+0.3}_{0}$	—
	8	34	32	23	12.5	16	3-2.6	3-5.5	3-6	20	23	21	1.2	22.2	19.8	10	11.3	13	3	1.5	0.2 ±0.05	8	8	$2^{+0.030}_{+0.005}$	$0.8^{+0.3}_{0}$	—
04	8	45	42	30	18.5	19	3-3.1	3-6	3-6	25	28	25.3	1.2	26.8	24.1	12	13	17.5	3.5	0.9	$0.2^{+0.05}_{-0.1}$	8	8	$2^{+0.030}_{+0.005}$	$0.8^{+0.3}_{0}$	—
	10	45	42	30	18.5	19	3-3.1	3-6	3-6	25	28	25.3	1.2	26.8	24.1	14	11	17.5	3.5	0.9	$0.2^{+0.05}_{-0.1}$	10	10	$3^{+0.025}_{0}$	$1.2^{+0.3}_{0}$	—

*The dimensional sign N and V3 indicate the runout dimensions of the rivet head when mounting.

Ordering information

CYT-03-33B 24V 6

Size (03) — Nominal diameter (6)

112 model

Electromagnetic micro brakes

This model is a compact and high-performance brake with a similar basic design to the micro clutches.
It is excellent in breaking performance, and also ideal for high-precision positioning. Due to its design, it fits into many mounting positions of small precision equipment. It is lightweight and easy to use.

■Three types

The optimum condition can be selected from the three types of armature assemblies with different mounting forms.

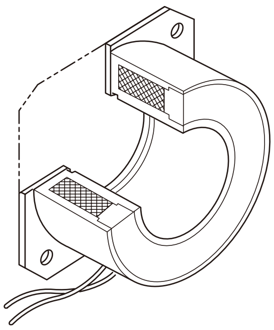
■Adapted to the RoHS

Adapted to the Restriction of Hazardous Substances that bans the use of 6 substances such as mercury or lead can be selected as option.

Brake torque [N·m]	0.4 ～ 2.4
Operational temperature [℃]	−10 ～ +40
Backlash	Zero

■ Flange mounted type stator

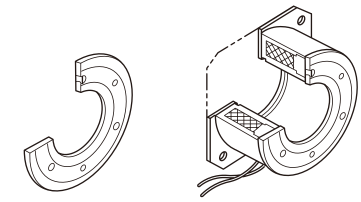
The stator is a flange mounted type that allows easy setting on the wall. Use in combination with three types of assemblies.



■ Three types

■ With the armature type-3

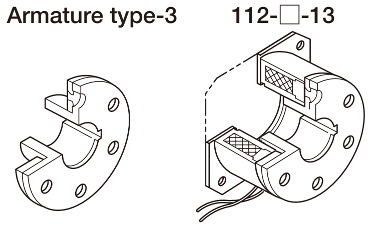
- Wide range of application
- Direct mounting type that is directly mounted on a pulley or spur gear.
- Suitable for braking and holding various types of rotating bodies.
- 112-□-13



Armature type-3　　112-□-13

■ With the armature type-2

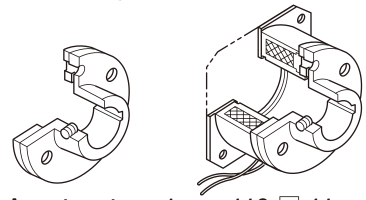
- Unique slim type
- Shaft mounting type. The mounting portion fits into the inside stator.
- Shorter to the axial direction.
- 112-□-12



Armature type-2　　112-□-12

■ With the armature type-1

- Easy-to-use general type
- Shaft mounting type that allows easy setting on the braking shaft.
- 112-□-11



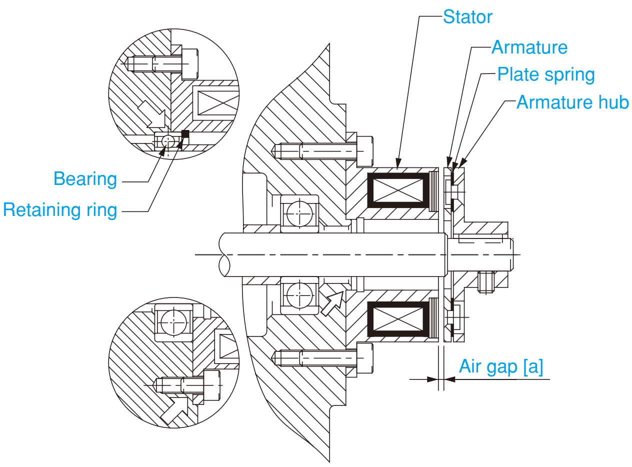
Armature type-1　　112-□-11

■ Structure

The micro brake consists of the stator with built-in coil and with embedded lining material, and the armature assembly.
The stator is fixed on the firm and static portion such as machine frame, by a mounting flange.
The armature assembly is composed of armature, ring plate spring and armature hub. It is combined properly with keeping a certain amount of air gap [a] facing the stator, and is fixed on the braking shaft (rotating body).

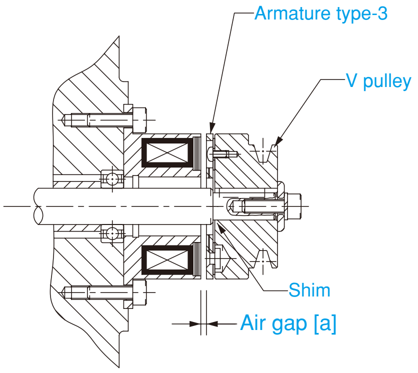
● Stator mounting

Centering is performed by "positioning fits" using the stator inside diameter or the flange outside diameter. (See the arrow on the right figure) Since the inside diameter is designed to fit into the nominal dimension for the outside diameter of the ball bearing, correct centering can be performed by directly using the bearing that supports the armature assembly mounting shaft. In addition, there is a retaining-ring groove on the inside stator that the shaft-directional fixation of the bearing outer ring can be simultaneously performed.



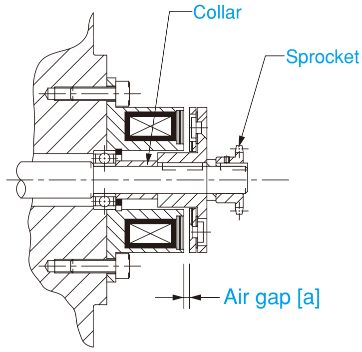
Mounting Example

● Combination of the 112-□-13 and V pulley



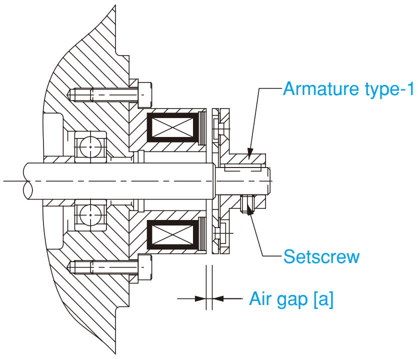
Use the armature type-3 by directly mounting on the transmission device such as V-belt pulley, or the rotating body to break the inertial force.
Shaft processing of the brake part is not necessary. Also, the shaft diameter can be optionally determined.
The air gap [a] can be easily set by a collar and shim. The corrections can also be performed simply by adding or reducing the number of shims.

● Using the 112-□-12 at the shaft end



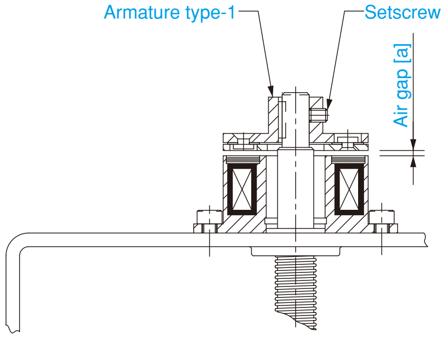
Since the necessary mounting space of the armature type-2 is smallest, the overhung load is no problem if mounting a sprocket on the brake end.
The air gap [a] can be easily set by a collar and shim. The corrections can also be performed simply by adding or reducing the number of shims.

● Using the 112-□-11 at the shaft end



This model can be mounted on the shaft end of the existing machine with the simplest way.
The air gap [a] can be easily set by moving the armature type-1 and fixing with a setscrew.

● Using the 112-□-11 for the vertical shaft



Since there is no limit for the mounting direction, idling torque or abnormal friction will not occur when mounting on the vertical shaft.
The air gap [a] can be easily set by moving the armature type-1 and fixing with a setscrew.

112 model

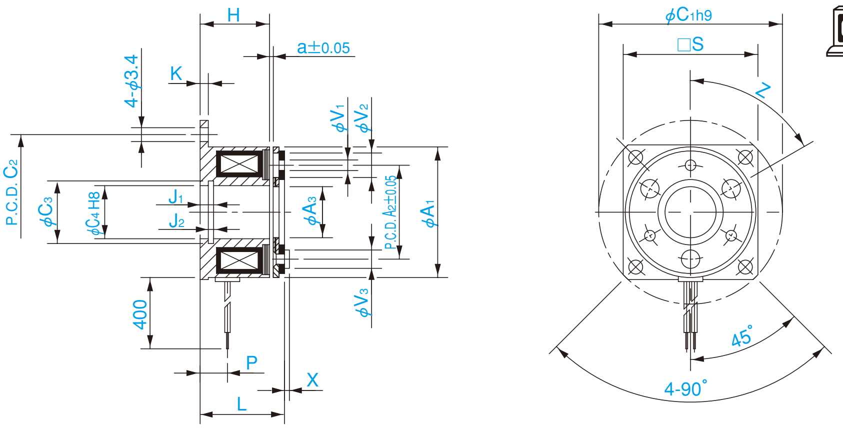
Electromagnetic micro brakes /Flange mounted type

Specifications

Model	Size	Dynamic friction torque T_d [N·m]	Coil (at 20℃) Voltage [V]	Wattage [W]	Amperage [A]	Resistance [Ω]	Heat-resistance class	Maximum rotation speed [min^{-1}]	Armature moment of inertia J [$kg·m^2$]	Allowable engaging energy $E_{eaℓ}$ [J]	Total amount of energy before air gap readjustment E_T [J]	Armature pull in time t_a [s]	Torque build-up time t_p [s]	Torque decaying time t_d [s]	Mass [kg]
112-02-13									$6.75×10^{-7}$						0.053
112-02-12	02	0.4	DC24	6	0.25	96	B	10000	$1.00×10^{-6}$	1500	$2×10^6$	0.004	0.010	0.010	0.057
112-02-11									$1.00×10^{-6}$						0.057
112-03-13									$1.30×10^{-6}$						0.072
112-03-12	03	0.6	DC24	6	0.25	96	B	10000	$1.95×10^{-6}$	2300	$3×10^6$	0.005	0.012	0.008	0.079
112-03-11									$1.95×10^{-6}$						0.079
112-04-13									$4.38×10^{-6}$						0.118
112-04-12	04	1.2	DC24	8	0.33	72	B	10000	$6.15×10^{-6}$	4500	$6×10^6$	0.007	0.016	0.010	0.131
112-04-11									$6.15×10^{-6}$						0.131
112-05-13									$9.08×10^{-6}$						0.200
112-05-12	05	2.4	DC24	10	0.42	58	B	10000	$1.38×10^{-5}$	9000	$9×10^6$	0.010	0.023	0.012	0.215
112-05-11									$1.38×10^{-5}$						0.215

*Dynamic friction torque (Td) indicates the value when relative velocity is (100min^{-1}).
*Rotating part moment of inertia and mass indicate the values of maximum bore diameter.
*Power supply voltage variation must be within ±10% of the coil voltage.

Dimensions 112-□-13



Unit [mm]

Size	Radial dimensions A1	A2	A3	C1	C2	C3	C4	S	V1	V2	V3	Z	Axial direction dimensions H	K	J1	J2	L	P	X	a	CAD File No.
02	28	19.5	10.5	39	33.5	11.4	11	—	2-2.1	2-5.3	2-4	4-90°	13.7	1.5	2.6	1.3	16.1	5	0.8	0.1	112-131
03	32	23	12.5	45	38	13.6	13	33	3-2.6	3-6	3-4.5	6-60°	17	2	3.3	1.3	19.3	6.7	1.2	0.15	112-132
04	40	30	18.5	54	47	20	19	41	3-3.1	3-6	3-5	6-60°	20	2	3.3	1.3	22.8	7	1.6	0.15	112-133
05	50	38	25.5	65	58	27.2	26	51	3-3.1	3-6.5	3-5.5	6-60°	22	2	3.5	1.5	25.2	8	1.6	0.2	112-134

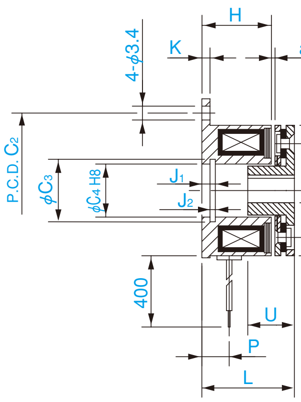
*The size 02 has a round flange.

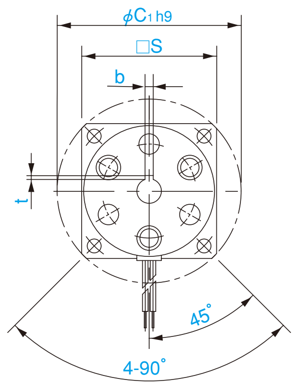
Ordering information

112-03-13 24V

03 — Size

Dimensions 112-□-12





Unit [mm]

Size	d H7	Shaft bore dimensions: New JIS standards correspondence b P9	New JIS standards correspondence t	Previous edition of JIS standards correspondence b E9	Previous edition of JIS standards correspondence t
02	5	—	—		
03	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
	15	$5^{-0.012}_{-0.042}$	$2^{+0.5}_{0}$	$5^{+0.050}_{+0.020}$	$2^{+0.5}_{0}$

Unit [mm]

Size	Radial dimensions						Axial direction dimensions								CAD File No.
	A_1	C_1	C_2	C_3	C_4	S	H	K	J_1	J_2	L	P	U	a	
02	28	39	33.5	11.4	11	—	13.7	1.5	2.6	1.3	18.1	5	7	0.1	112-121
03	32	45	38	13.6	13	33	17	2	3.3	1.3	21.3	6.7	10	0.15	112-122
04	40	54	47	20	19	41	20	2	3.3	1.3	25.5	7	12	0.15	112-123
05	50	65	58	27.2	26	51	22	2	3.5	1.5	28.2	8	12	0.2	112-124

*The size 02 has a round flange.
*There is no keyway on the rotor of the size 02. Fix on the shaft by press fitting.

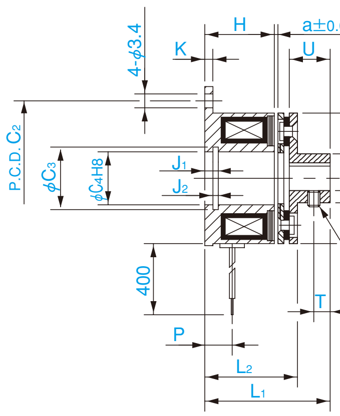
Ordering information

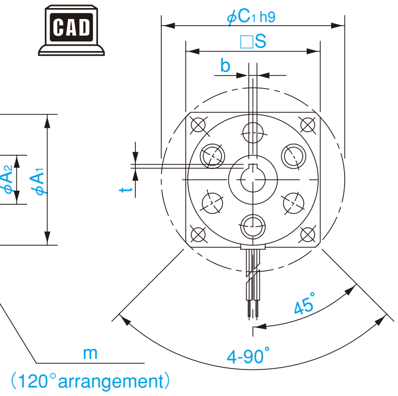
112-03-12 24V 6 DIN

- Size: 03
- Armature bore diameter (Dimensional sign d): 6
- Keyway standard: New JIS standards correspondence : DIN; Previous edition of JIS standards correspondence : JIS

*It is not necessary to enter the keyway standard if there is no description (–) in the shaft-bore dimensions table.
Specification displayed as diagonal line is not available as a standard product.

Dimensions 112-□-11





Unit [mm]

Size	d H7	Shaft bore dimensions: New JIS standards correspondence b P9	New JIS standards correspondence t	Previous edition of JIS standards correspondence b E9	Previous edition of JIS standards correspondence t
02	5	—	—		
03	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
05	10	$3^{-0.006}_{-0.031}$	$1.2^{+0.3}_{0}$	$4^{+0.050}_{+0.020}$	$1.5^{+0.5}_{0}$
	15	$5^{-0.012}_{-0.042}$	$2^{+0.5}_{0}$	$5^{+0.050}_{+0.020}$	$2^{+0.5}_{0}$

Unit [mm]

Size	Radial dimensions								Axial direction dimensions										CAD File No.
	A_1	A_2	C_1	C_2	C_3	C_4	S	m	H	K	J_1	J_2	L_1	L_2	P	U	T	a	
02	28	9.5	39	33.5	11.4	11	—	M3	13.7	1.5	2.6	1.3	23.1	18.1	5	7	2.5	0.1	112-111
03	32	12	45	38	13.6	13	33	2-M3	17	2	3.3	1.3	29.3	21.3	6.7	10	4	0.15	112-112
04	40	17	54	47	20	19	41	2-M3	20	2	3.3	1.3	34.8	25.5	7	12	5	0.15	112-113
05	50	24	65	58	27.2	26	51	2-M4	22	2	3.5	1.5	37.2	28.2	8	12	5	0.2	112-114

*The size 02 has a round flange.

Ordering information

112-03-11 24V 6 DIN

- Size: 03
- Armature bore diameter (Dimensional sign d): 6
- Keyway standard: New JIS standards correspondence: DIN; Previous edition of JIS standards correspondence: JIS

*It is not necessary to enter the keyway standard if there is no description (–) in the shaft-bore dimensions table.
Specification displayed as diagonal line is not available as a standard product.

Torque characteristics

Static friction torque and dynamic friction torque

Clutches and brakes transmit torque by sliding with a certain relative velocity in the process of coupling and braking. The relative velocity gradually becomes smaller, and they are completely connected. The transmittable torque when coupling and braking are completed is called "dynamic friction torque" of the relative velocity. The static friction torque becomes about the same value and the dynamic friction torque changes measurably with the relative velocity.

Dynamic friction torque characteristics

The relationship between relative sliding velocity and dynamic friction torque is indicated in the right diagram. As indicated in the diagram, the difference between the static friction torque and the dynamic friction torque is small, which indicates that the effect in actual use becomes small. The value shown in the specification is when the sliding velocity is 100min^{-1}.

Initial torque characteristics

For the friction type clutches and brakes, the friction surface does not sufficiently conform when initially used. It may not reach the rated torque, which is called initial torque condition. The value of initial torque is 60 to 70% of the indicated torque, however, it will reach the normal value by a short test operation. Please confirm if the indicated torque is needed from the beginning of use. It may take longer time for a test operation for use by light load or low revolution speed.

The duration time of the residual torque (remaining torque after current interruption) is very short due to the plate spring action so that a particular circuit such as reverse excitation is not necessary for normal use.

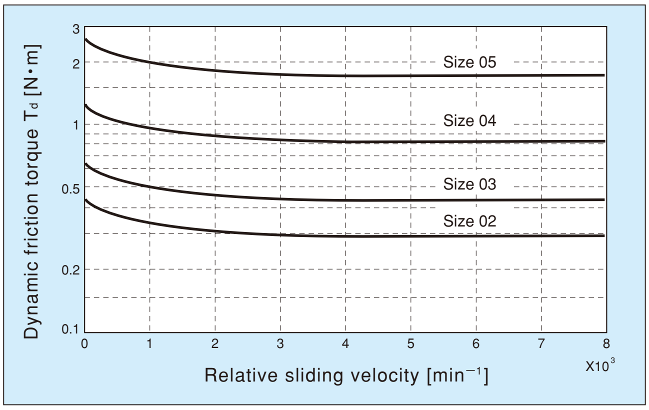
Torque current characteristics

Size of torque (magnitude of torque) is determined by the formula of T= μ (frictional factor) X r (mean radius of frictional surface) X P (suction power).

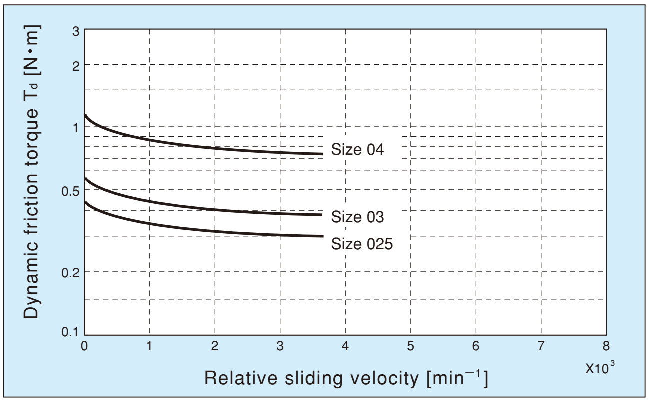
$T=\mu\times r\times P$

μ and r are determined at this time, but P changes depending on the current magnitude (amount of the current) to apply. A current is proportional to a voltage that the friction torque varies by changing the voltage applied to a coil. The relationship between friction torque and excitation current is indicated in the right diagram. Around the rated current value, torque increases and decreases in proportion to the current. As the current increases above the rated value, the magnetic flux density reaches a point of saturation in the magnetic circuit. There is no torque increment after then, and only the calorific power increases. On the other hand, torque decreases as the current decreases.

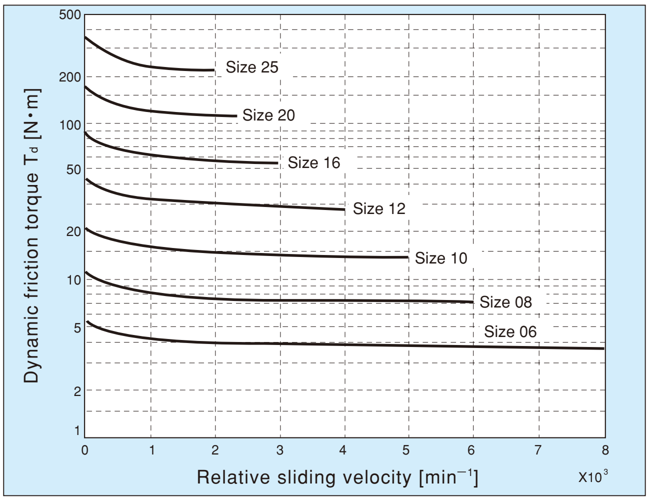
When it becomes closer to the minimum current value to draw the armature, torque becomes unstable. By decreasing more current, the armature becomes unable to draw and torque fades away. To generate torque below the suction current, some procedures are needed. Meanwhile, the diagram is for the specified air gap that the characteristic curve changes as the air gap value changes.



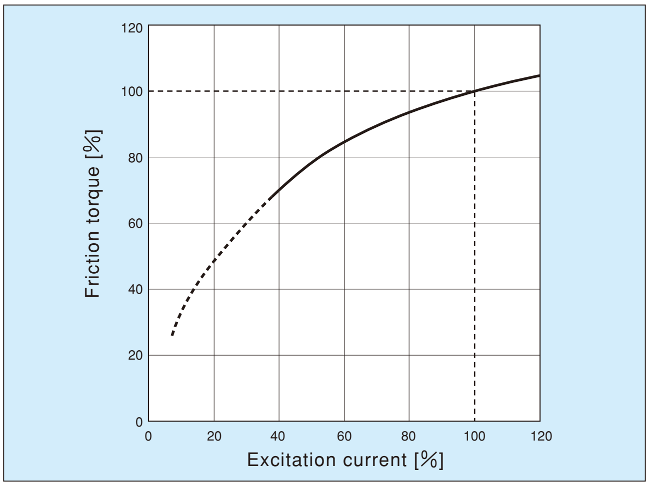
Dynamic friction torque characteristic Micro size 102・112 model



Dynamic friction torque characteristic Micro size CYT model



Dynamic friction torque characteristic Normal size 101・111・CS model, etc.



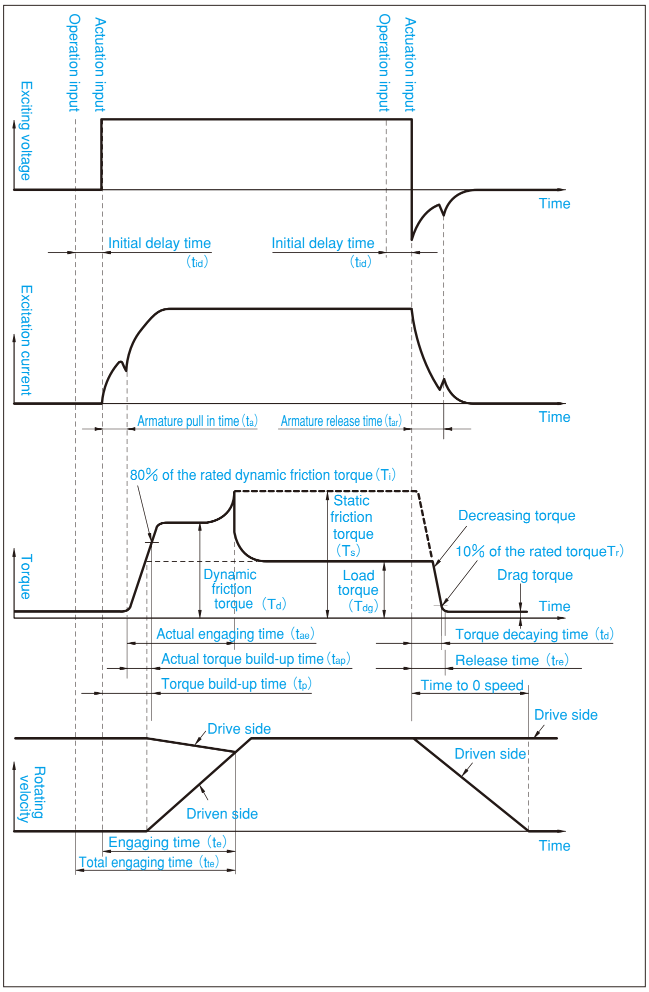
Torque current characteristic

Operating characteristics

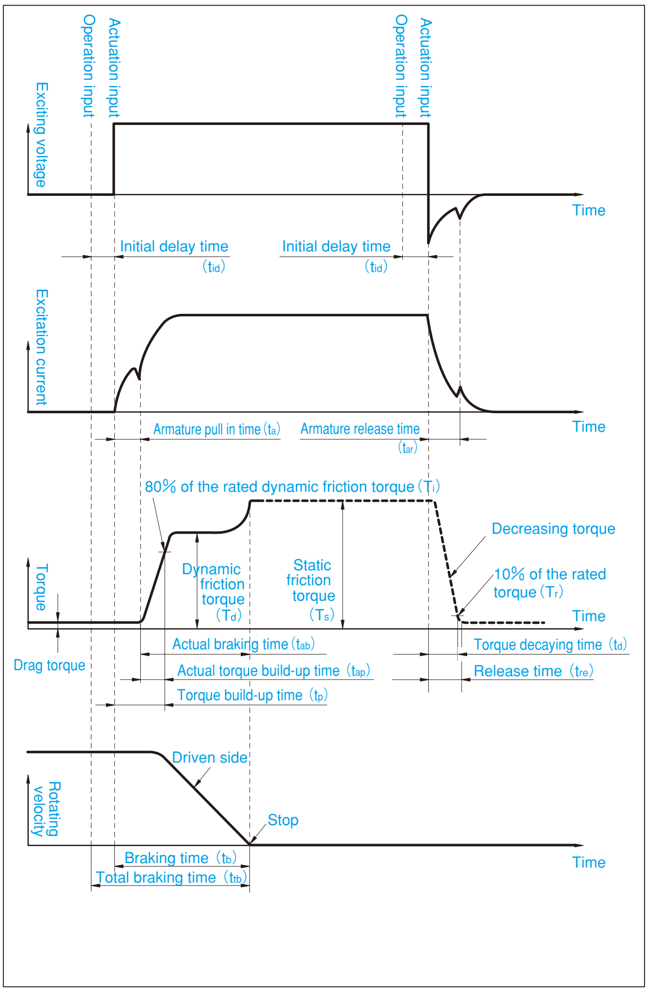
Transient characteristics of clutches and brakes in working condition

The following figure shows the transient phenomena of torque and current when the clutch and brake is connected (braking) and released. It is generally called operating characteristics. When applying a voltage through the clutch and brake, the current increases according to the time constant that is determined by the coil. When the current reaches a certain value, the armature is suctioned and the friction torque is generated. The frictional torque increases as the current increases, and reaches the rated value. As well as when releasing the clutch and brake, the armature starts separation by the releasing action of the plate spring as the current decreases, and torque fades away.

Clutch operating characteristics



Brake operating characteristics



T_a: Armature pull in time: Time from when the current is applied till when the armature is pulled in and torque is generated.

T_{ap}: Actual torque build-up time: Time from when torque is generated till when it becomes 80% of the rated torque.

T_p: Torque build-up time: Time from when the current is applied till when the torque becomes 80% of the rated torque.

T_d: Torque decaying time: Time from when the current is shut off till when the torque decreases to 10% of the rated torque.

T_{id}: Initial delay time: Time from when the operation input is on by the clutch and brake till when the actuating input or releasing input is on for the clutch or brake body.

T_{ae}: Actual engaging time: Time from when torque is generated by clutch till when connection is completed.

T_{ab}: Actual braking time: Time from when torque is generated by brake till when braking is completed.

Operating characteristics

Control circuit and operating time

The standard voltage is DC24V. If there is no DC source, use the direct current that is obtained by step-down and commutation (full-wave rectification) of alternating source. (Refer to the section of power supply.) The on-off operation is generally done on the direct-current side. The following table indicates the operating time at the time. The direct-current side operation allows a quick response, however extremely high surge voltage is generated when the current is shut off, which may cause burnout of the contact in the control circuit or a dielectric breakdown of the coil, therefore, a protective device for surge absorption is recommended. When switching operation is performed on the alternating-current side, torque fading time becomes long, which may cause interference with next operation. In such case, take a time lag. The torque rise time is the same as when operation is performed on the direct-current side.
The following tables indicate each operating time under the transformer step-down and single-phase full-wave rectification method.

Micro size

Clutch operating time

Clutch size	Operating time [s]			
	ta	tap	tp	td
102-02	0.009	0.010	0.019	0.017
102-03	0.009	0.013	0.022	0.020
102-04	0.011	0.017	0.028	0.030
102-05	0.012	0.019	0.031	0.040
CYT-025	0.014	0.014	0.028	0.030
CYT-03	0.015	0.015	0.030	0.040
CYT-04	0.030	0.010	0.040	0.040

Brake operating time

Brake size	Operating time [s]			
	ta	tap	tp	td
112-02	0.004	0.006	0.010	0.010
112-03	0.005	0.007	0.012	0.008
112-04	0.007	0.009	0.016	0.010
112-05	0.010	0.013	0.023	0.012

Standard size

Clutch operating time

Clutch size	Operating time [s]			
	ta	tap	tp	td
101-06	0.020	0.021	0.041	0.020
101-08	0.023	0.028	0.051	0.030
101-10	0.025	0.038	0.063	0.050
101-12	0.040	0.075	0.115	0.065
101-16	0.050	0.110	0.160	0.085
101-20	0.090	0.160	0.250	0.130
101-25	0.115	0.220	0.335	0.210

*The above values correspond to the CS, CSZ model and various clutch and brake units.

Brake operating time

Brake size	Operating time [s]			
	ta	tap	tp	td
111-06	0.015	0.018	0.033	0.015
111-08	0.016	0.026	0.042	0.025
111-10	0.018	0.038	0.056	0.030
111-12	0.027	0.063	0.090	0.050
111-16	0.035	0.092	0.127	0.055
111-20	0.065	0.135	0.200	0.070
111-25	0.085	0.190	0.275	0.125

The above values correspond to the BSZ model and various clutch brake units.

Shorten the coupling • braking time

The current conforms to the specified time constant, but if especially fast rise is required, the operating characteristic can be changed by using an excitation method such as overexcitation. Overexcitation method is the means to quicken the rise by applying overvoltage to the coil. The following table indicates the operating time when overexcitation. Refer to the section of power supply for more detail.

Operating time in the case of clutch overexcitation
(Applicable power supply type: BEH)

Clutch size	Operating time [s]			
	ta	tap	tp	td
101-06	0.008	0.005	0.013	0.005
101-08	0.009	0.008	0.017	0.008
101-10	0.010	0.010	0.020	0.011
101-12	0.013	0.012	0.025	0.018
101-16	0.018	0.016	0.034	0.023
101-20	0.027	0.020	0.047	0.037
101-25	0.045	0.026	0.071	0.045

*The above values correspond to the CS, CSZ model and various clutch and brake units.

Operating time in the case of brake overexcitation
(Applicable power supply type: BEH)

Brake size	Operating time [s]			
	ta	tap	tp	td
111-06	0.005	0.007	0.012	0.004
111-08	0.005	0.007	0.012	0.005
111-10	0.007	0.008	0.015	0.007
111-12	0.009	0.009	0.018	0.007
111-16	0.014	0.010	0.024	0.011
111-20	0.015	0.025	0.040	0.020
111-25	0.021	0.034	0.055	0.038

*The above values correspond to the BSZ model and various clutch and brake units.

T_a- Armature pull in time: Time from when the current is applied till when the armature is suctioned and torque is generated.

T_{ap}- Actual torque build-up time: Time from when torque is generated till when it becomes 80% of the rated torque.

T_p- Torque build-up time: Time from when the current is applied till when it becomes 80% of the rated torque.

T_d- Torque decaying time: Time from when the current is shut off till when it decreases to 10% of the rated torque.

Heat dissipation characteristics

Allowable engaging or braking energy (Eeaℓ or Ebaℓ)

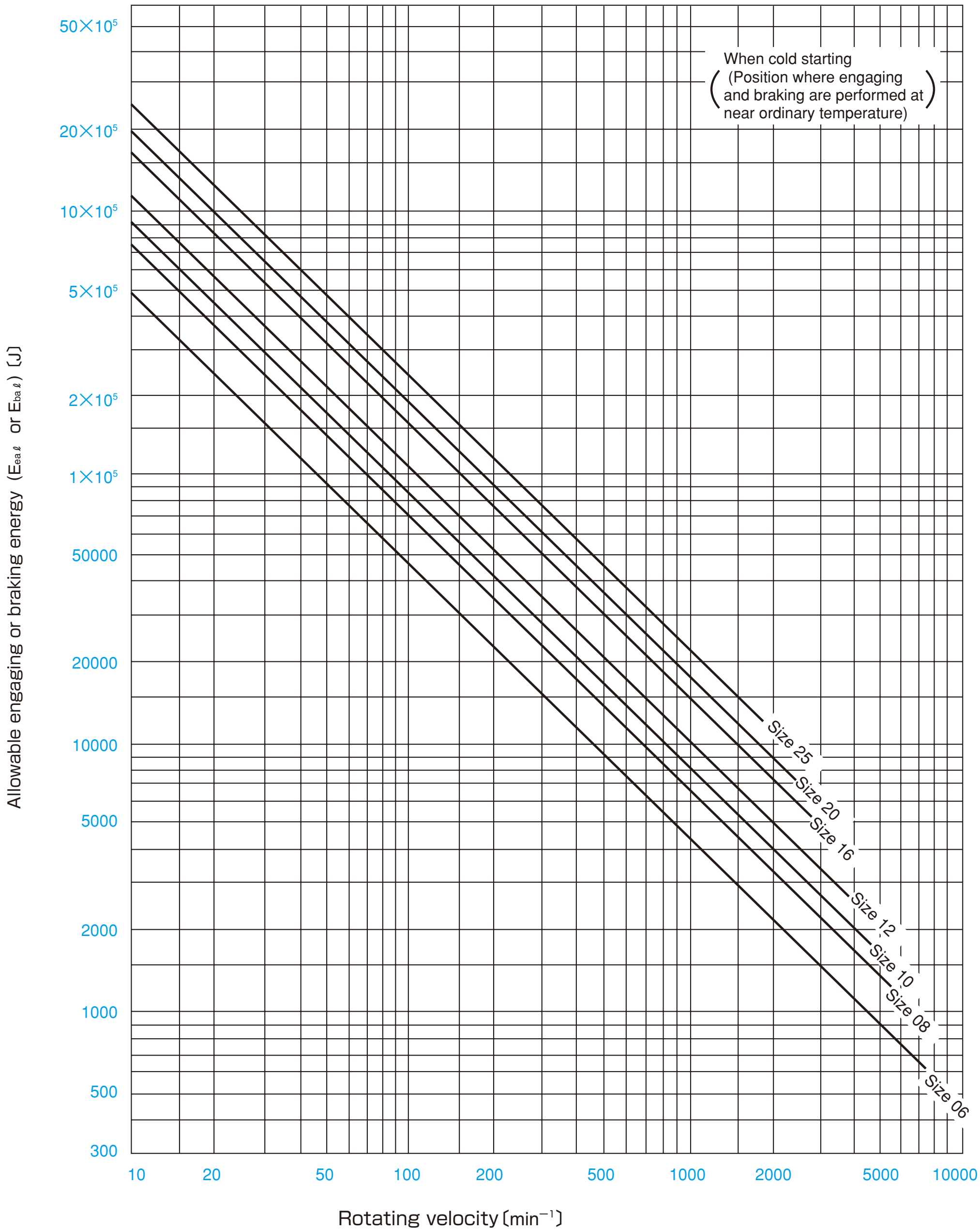
When accelerating or decelerating a load by clutch and brake, heat is generated by sliding friction. The amount of heat changes according to the use condition. A clutch and brake works best if the heat can be dissipated. However, if the core temperature exceeds the operational temperature limit, this may cause an operation trouble or damage. As stated above, the limit of frictional load by heat is called allowable work.

The tolerance is specified for each size. Heat dissipation depends on the mounting condition, rpm's and environment.

When accelerating or decelerating a large load, heat generation of the friction surface is greatly increased due to the intensive slippage. The friction material or armature could be damaged by single connection. The right table indicates the allowable work (allowable friction energy) for each size. Despite its operation frequency, if the work volume is large, apply the value much below the indicated value. For the standard size, apply below the limit line of the following diagram.

Allowable engaging or braking energy of the micro clutches and brakes

Model size	Allowable engaging or braking energy (Eeaℓ or Ebaℓ) [J]
102/112-02	1500
102/112-03	2300
102/112-04	4500
102/112-05	9000
CYT-025	800
CYT-03	900
CYT-04	1900

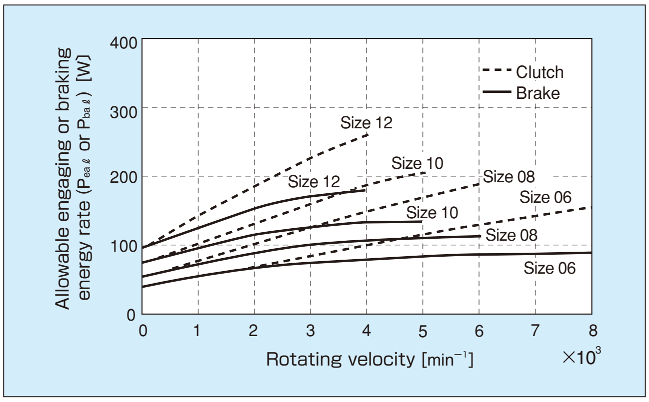


Heat dissipation characteristics

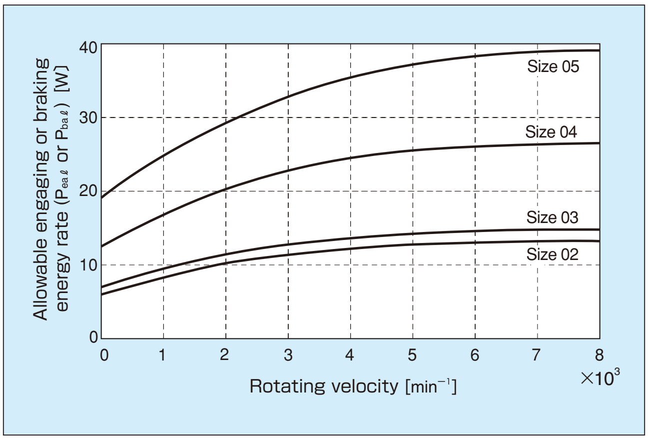
Allowable engaging or braking energy rate (Peaℓ or Pbaℓ)

For high-frequency engaging and braking, the heat dissipation must be fully taken into account. The maximum mount of work per minute is called allowable work rate, and it is determined for each size as indicated in the diagram. For actual use, apply the value much below the permissible value in consideration of the changes of condition.

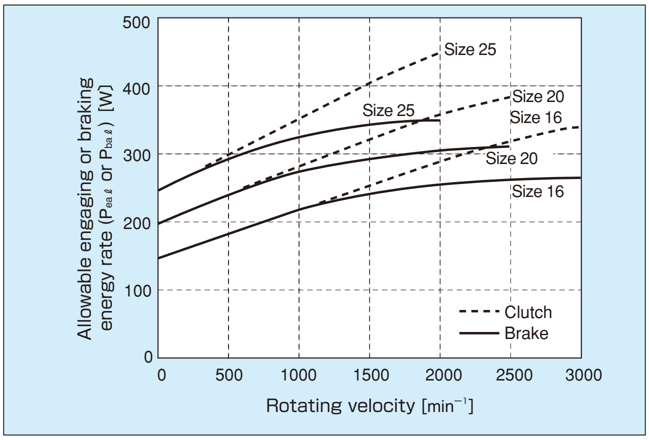
The diagram shows the value when wall mounting. When it is fixed on the shaft like bearing mounting, 80% of each diagram is equal to the permissible value.



Standard size



Micro size (Except CYT model)



Standard size

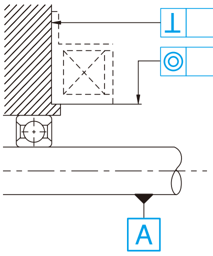
Structural instructions

When using a clutch and brake for machinery, how to maximize the performances and features in design. From the point of view of design, this section describes some useful factors to improve the reliability of machinery.

● Mounting method of stator and rotor

1 Flange mounted type stator (Model: □-□-1□)

This stator must be fixed by an accurate positioning for the rotating shaft. For the inner and outer circumferences of the stator, class of fit (tolerance quality) is set for positioning. For the mounting surface, the concentricity and squareness of the positioning diameter must be below the permissible value to the rotating shaft.

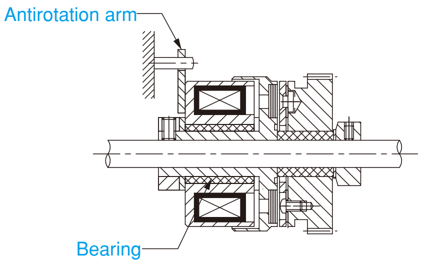


Unit [mm]

Size	Concentricity (T.I.R.)	Squareness (T.I.R.)
02	0.05	0.03
03	0.05	0.04
04	0.06	0.04
05	0.06	0.05
06	0.08	0.05
08	0.08	0.05
10	0.1	0.05
12	0.1	0.07
16	0.12	0.08
20	0.12	0.13
25	0.14	0.13

2 Bearing mounted type stator (Model:□-□-3□)

This stator is subjected to a small amount of torque by a built-in bearing or sliding bearing. Therefore, maintain an antirotation arm in the static part of the machine to prevent corotation.



3 Magnetic shield of stator

When mounting a stator in combination with clutch and brake, the performance may become unstable by the effect of each other's magnetism. Also, if there is an instrument or equipment around the clutch and brake, it could cause a negative effect such as noise or error. In such a case, appropriate measures to shut off the magnetism should be taken. Generally, nonmagnetic material is used for the mounting surface or shaft.

4 Lead wire protection

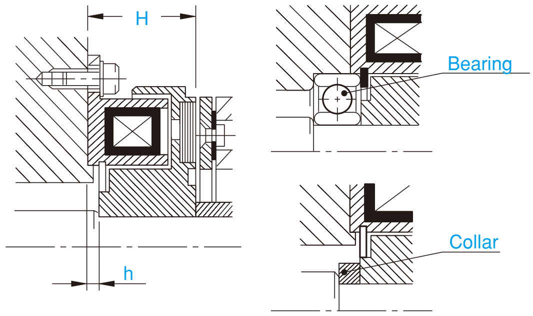
If the coated layer is damaged, it could become the source of troubles such as short circuit or burnout. Therefore, take into consideration the protection of the lead wire in the design phase.

5 Rotor mounting

The rotor is a part of the magnetic circuit. Any bore modifications may cause performance degradation. For rotor bore diameters other than the indicated standard bore diameters, contact us for further information.

6 Relationship between rotor and stator (Model: □-□-1□)

For the flange mounted type clutches, the positional relationship between the stator and rotor is very important. If the H measurement shown in the figure below is too small, the stator and rotor will come into contact with each other. If the H measurement shown is too big, the suction power decreases. The following table indicates the tolerance for each size. The design should be performed by not exceeding the value. As for the permissible value of h, follow the JIS standard tolerance.



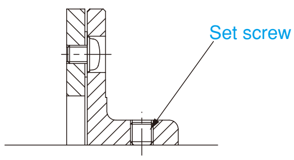
Unit [mm]

Clutch size	H		h
	Standard value	Tolerance	Standard value
102-02	18.0	±0.2	1.6
102-03	22.2		2.0
102-04	25.4		2.0
102-05	28.1		2.0
101-06	24.0		2.0
101-08	26.5		2.5
101-10	30.0	±0.3	3.0
101-12	33.5		3.5
101-16	37.5		3.5
101-20	44.0	±0.4	4.0
101-25	51.0		4.0

● Mounting method of armature

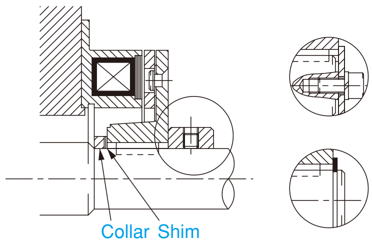
1 Installation of the armature type-1

Tighten completely with the attached hexagon socket bolt to fix. If it comes loose, apply an adhesive thread lock to the threaded part.



2 Installation of the armature type-2

It has a unique configuration that hides the boss in the inside stator. By using a C-shaped retaining ring or collar, fix completely as the figure below indicates.



3 Installation of the armature type-5

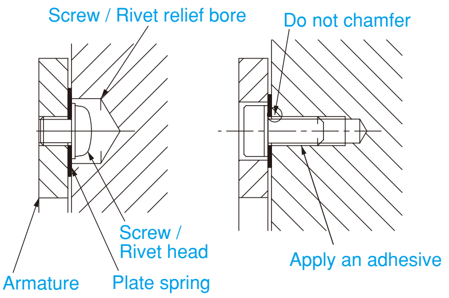
Insert directly if the micro size is below 0.5. As well as the armature type-2, use a C-shaped retaining ring or collar to fix the end face.

4 Installation of the armature type-3

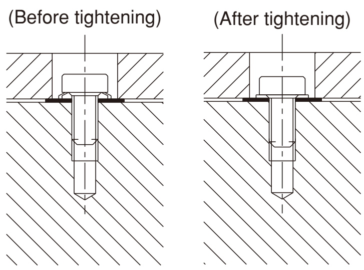
Apply a bore processing to screw or a runout processing for the rivet head on the mounting surface. Mounting is performed with the attached special hexagon socket bolt and disc spring washer. For the thread part, apply a small amount of adhesive to prevent loosening. (Do not apply too much adhesive, which may disrupt the operation if it is attached to the plate spring.) For the mounting screw bore, chamfering is not necessary just remove the burr. The attached hexagon socket bolt is a special bolt with a low head. For the size below 04, the JIS standard cross-recessed head screw is attached. The disc spring washer must be used as the following figure. The tightening force decreases if it is used in reverse. For the armature type-3, the concentricity and squareness of the positioning diameter must be below the permissible value to the rotating shaft.

Unit [mm]

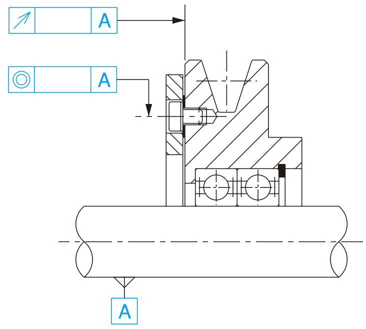
Size	Concentricity (T.I.R.)	Squareness (T.I.R.)
02	0.1	0.02
03	0.1	0.03
04	0.1	0.04
05	0.1	0.04
06	0.16	0.04
08	0.16	0.05
10	0.16	0.05
12	0.16	0.06
16	0.16	0.07
20	0.24	0.11
25	0.24	0.11



How to mount armature type-3

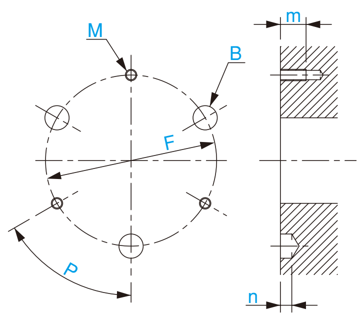


How to use washer



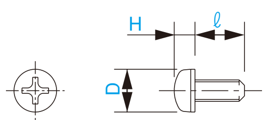
Mounting accuracy

Armature type-3 mounting dimensions

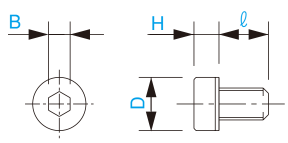


Clutch and brake size	Mounting pitch diameter F (P.C.D.)	Tolerance	Mounting angle P [°]	Tolerance [′]	Mounting screw bore: No. of bores - M (Nominal designation)	Pitch	M Effective screw (minimum)	Screw / rivet relief bore: No. of bores - Bore diameter B	n Depth of counterbore (minimum)
02	19.5	±0.05	90	±5	2-M2	0.4	4	2-5	2.5
03	23		60		3-M2.5	0.45	5	3-6	3
04	30				3-M3	0.5	7	3-6	3.5
05	38							3-7	
06	46	±0.05	60		3-M3	0.5	7	3-7	3.5
08	60				3-M4	0.7	9	3-8.5	3.5
10	76				3-M5	0.8	11	3-10.5	4
12	95				3-M6	1.0	11	3-12.5	4
16	120				3-M8	1.25	16	3-15.5	4.5
20	158				3-M10	1.5	18	3-19	5.5
25	210	±0.1	45		4-M12	1.75	22	4-22	6

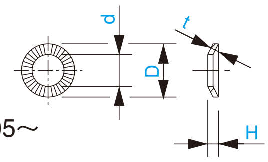
Armature type-3 mounting parts



Size 02～04



Size 05～



Size 05～

Clutch and brake size	Hexagon socket special bolt (*cross-recessed head screw): Nominal dimension x Pitch	ϕD	H	B	ℓ	Disc spring washer: ϕD	ϕd	H	t
02	*M2×0.4	3.5	1.3		3	Disc spring washer is not used			
03	*M2.5×0.45	4.5	1.7		4				
04	*M3×0.5	5.5	2.0		6				
05	M3×0.5	5.5	2.0	2.0	6	6	3.2	0.55	0.36
06									
08	M4×0.7	7	2.8	2.5	8	7	4.25	0.7	0.5
10	M5×0.8	8.5	3.5	3.0	10	8.5	5.25	0.85	0.6
12	M6×1.0	10	4.0	4.0	10	10	6.4	1.0	0.7
16	M8×1.25	13	5.0	5.0	15	13	8.4	1.2	0.8
20	M10×1.5	16	6.0	6.0	18	16	10.6	1.9	1.5
25	M12×1.75	18	7.0	8.0	22	18	12.6	2.2	1.8

● Air gap design and adjustment

Set the air gap [a] between the frictional surfaces (Figure below) in order that it becomes its specified value when released. At this time, adjustable layout should be done for further convenience. As a method of that, the layout with a combination of collar and shim as indicated in the figure below is recommended. (A shim is regularly stocked. Contact us if necessary.)

1 Set the air gap [a]

Prepare a slightly shorter collar than the required length ℓ to maintain the air gap [a], and adjust the remaining gap with a shim to obtain the specified value. At this time, the collar length is determined approximately by the following formula.

$L \fallingdotseq \ell - 2a$ [mm]

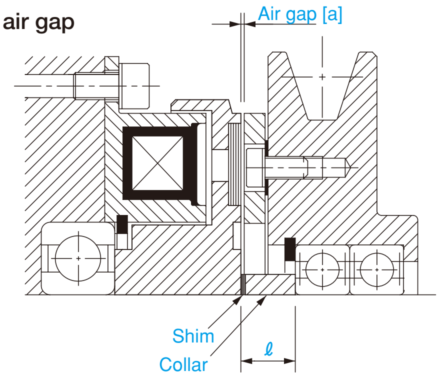
L: length of the collar

ℓ : required length to maintain the air gap

a: specified air gap value

Prepare the collar with appropriate length based on the estimated value. If the layout is done by the above method, the air gap adjustment after a long period of use can be performed simply by removing the required number of shims.

Setting of air gap

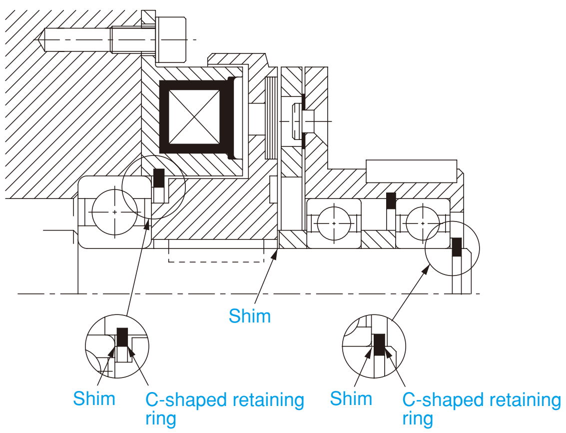


*Refer to the section of technical data for shim dimensions.

2 Remove the allowance of the shaft direction

For the clutch and brake also the parts used in combination, the performance degradation may occur if there is an allowance in the shaft direction after assembling. Therefore, reduce the allowance as much as possible. For controlling a little amount of allowance, various types of shims are available. They correspond to the often-used shaft diameter or bearing outside diameter. In addition, reliable fixing with a spring action can be performed when used in combination with a C-shaped retaining ring.

How to use shims

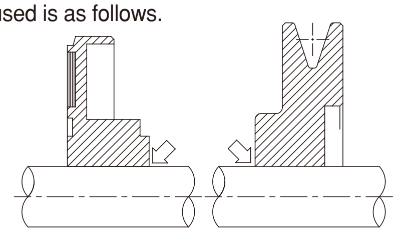


● Fit tolerance

Clutches and brakes perform substantial work in a moment, but high accuracy control is also required at the same time. Therefore, the appropriate integration of each part is necessary for not generating a friction or vibration. For that purpose, the fit tolerance is needed to determine in accordance with the use condition.

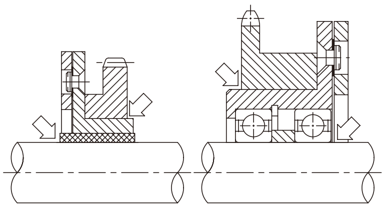
1 Fit tolerance between rotor / armature type 1 & 2 / V-belt pulley and shaft

The standard bore tolerance is H7 class. For the CYT model, a special bore diameter tolerance is applied. The shaft dimensional tolerance used is as follows.



Load condition	Shaft tolerance		Remarks
Shaft below 10 ϕ	h6	h7	H5 for high accuracy
Light, normal and variable load	h6		h6 j6 for motor shaft Clutch and brake j6 for unit shaft
	js6	js7	
	j6	j7	
Heavy load and impact load	k6	k7	
	m6		

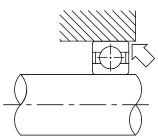
2 Fit tolerance between armature type-5 and sprocket / armature type-5 and shaft



Micro size　　Standard size

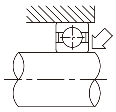
Clutch and brake size	Armature type-5 Boss part tolerance	Armature type-5 Bore tolerance	Bore tolerance of sprocket, etc.	Shaft tolerance
02～05	h7	H7	H7	h7 h8
06 or more	j6	Conforms to table below	H7	Conforms to table above

3 Fit tolerance between ball bearing and housing

Load condition		Bore tolerance	Remarks
Outer-ring rotational load	Heavy load	N7	
	Normal load and variable load	M7	
Unstable load in direction	Heavy impact load		
	Heavy load and normal load	K7	
	Heavy load and normal load	J7	
	Impact load		
Inner-ring rotational load	General load	H7	When it does not have impact from clutch and brake

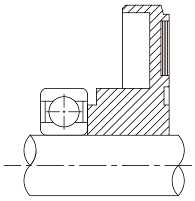
*Apply to the iron-steel or cast-iron housing. For light-alloy housing, tighter fitting is required.

4 Fit tolerance between ball bearing and shaft

Load condition		Bore tolerance		Remarks
Outer-ring rotational load		h6		H5 for high accuracy
Unstable load in direction Inner-ring rotational load	Light load, normal load and variable load	φ18 or less	h5	
		φ100 or less	j6	
	Heavy load and impact load	φ18 or less	j5	
		φ100 or less	k5	

5 Fit tolerance between bearing and other parts

As for the shaft with bearing and rotor or V-belt pulley mounted in the same part, prioritize the bearing and follow the fit tolerance between ball bearing and shaft.



● Bore diameter and keyway

1 Bore diameter

The standard bore diameter is determined for each size as indicated in the measurement. To apply the bore diameter other than the standard, a pilot bore is prepared for the 101 & 111 type rotor and the armature type 1 & 2. Please follow bore specifications and precautions ❶~ ❹. The bore range is indicated in the table below.

❶ The tolerance of bore must be H7 class.

❷ When machining a bore care must be taken with respect to the concentricity and perpendicularity of the bore.

❸ Since the outer part of the rotor is deformed by applying force, do not chuck when machining.

❹ Remove all cutting oil or wash oil and dry completely before mounting.

2 Key and keyway

Our company specification based on JIS standard is applied for the keyway of the rotor and armature. (Refer to the page of clutch and brake standard bore processing specification.)

For the CYT model, a special keyway tolerance (shown in the measurement table below) is applied. For use of the key and keyway of the shaft, the JIS standard is suitable. Refer to the page of the technical data excerpted from JIS B 1301-1996. When performing a keyway processing on the rotor or armature, follow the above as well.

Bore diameter processing range for rotor and armature type 1 & 2

Unit [mm]

Clutch and brake size		5	6	8	(8.5)	10	12	(12.5)	15	17	(18.5)	20	(24)	25	28	30	32	35	40	48	50	60	70	75	80
02	R・A	■																							
03	R・A		■																						
04	R・A			■		■																			
05	R・A					■			■																
06	R				▒	▒	■	▒	■	▒															
	A				▒	▒	■	▒	■	▒															
08	R				▒	▒	▒	▒	■	▒	▒	■													
	A				▒	▒	▒	▒	■	▒	▒	■													
10	R							▒	▒	▒	▒	■	▒	■	▒	▒									
	A							▒	▒	▒	▒	■	▒	■	▒										
12	R							▒	▒	▒	▒	▒	▒	■	▒	■	▒	▒							
	A							▒	▒	▒	▒	▒	▒	■	▒	■	▒								
16	R										▒	▒	▒	▒	▒	■	▒	▒	■	▒	▒				
	A										▒	▒	▒	▒	▒	■	▒	▒	■	▒					
20	R												▒	▒	▒	▒	▒	▒	■	▒	■	▒			
	A												▒	▒	▒	▒	▒	▒	■	▒	■	▒			
25	R												▒	▒	▒	▒	▒	▒	▒	▒	■	■	▒	▒	
	A												▒	▒	▒	▒	▒	▒	▒	▒	■	■	▒	▒	

■ Standard bore diameter
▒ Processable range
( ) indicates a pilot bore
(Finish process is not performed.)
R: Rotor
A: Armature type 1 & 2

*The above table does not correspond to the CYT, CSZ and BSZ model.

Electromagnetic clutches and brakes

● Environment of the mounting

When selecting a clutches or brakes careful consideration of the operating environment must be taken.

1 Temperature

The heat-resistant class of clutch and brake is B type, and the allowable operating temperature is -10℃～ 40℃. When the clutch or brake is used at high temperatures, the heat generated by actual clutching and braking operations does not dissipate, this may cause damage to the coil or friction part. Even if it is used below -10℃, there is no problem if the temperature becomes over -10℃ by heat generation of the clutch and brake. However, if the water of crystalline frosts generated by a longtime stoppage or low-frequency operation is attached on the device, it may cause performance degradation.

2 Humidity and water drop

As in the case of temperature, if water drops are attached on the friction surface, the coefficient of friction decreases temporally until it dries. Also, water contamination causes oxidation as well. Therefore, take appropriate measures such as using a cover.

3 Mixing in of a foreign body such as dust or oil

The friction surface has a susceptibility to foreign body. If any oil is mixed, the coefficient of friction significantly decreases. Metal dust especially damages the friction surface or rotating part. In addition, an agent could also cause oxidation. For such environment, use of a protective cover is recommended.

4 Air ventilation

Since the clutch and brake converts the friction work into heat proper ventilation is required to dissipate the heat build up. Forced cooling is a effective way for increasing an allowable amount of work. Confirm the temperature if the device is used in the place with poor ventilation.

● Maximum rotation speed (RPM)

The maximum rotation speed (rpm) of clutches and brakes is indicated in the specification table. This value is determined by the peripheral velocity of the friction surface. If the speed exceeds the maximum rpm, this may cause premature wear and premature failure of the clutch or brake. Overspeed applications will not transmit rated torque.

● Ball bearing

A ball bearing is generally used in combination with clutches and brakes, and a deep-grooved ball bearing is the most common. Since dry-type clutches and brakes have a susceptibility to oils and fats attached on the frictional surface, use a double sealed bearing which does not require lubrication. A double sealed bearing with contactless rubber seal is effective for preventing dust. For a compact bearing or rare bearing, a metallic double sealed type is also available.

● Mechanical strength

Due to the operating characteristics of clutches and brakes, coupling and braking of load can be immediately performed, thus impactive forces may be applied to each part of the machine, therefore to allow enough strength is important.
(Undue safety design could cause a load torque increase, or affect the coupling and braking accuracy.)

● Vibration and backlash

Both clutch and brake assemblies are balanced to reduce vibration. However, if the device is applied impactive forces repeatedly, backlash could occur to generate vibration noises. Perform the layout with no backlash.

● Antirust

An antioxidation treatment is applied to the clutches and brakes. However, oxidation may be generated depending on the storage condition or environment. Please attempt to prevent oxidation. A small amount of oxidation is acceptable.

● Occurrence of sparks

During the use process of clutches and brakes, sparks may occur by the friction between the magnetic pole part of the frictional surface and the armature. Make sure not to use in a flammable environment.

● Structural design with maintainability

Maintenance of clutches and brakes is not generally required for a long period of time.
By performing maintenance on a ball bearing, for instance, it can be used for a prolonged period. A structural design that can be easily disassembled and reassembled is recommended. Refer to the instruction manual for more detail.

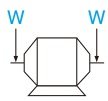
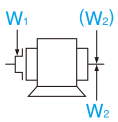
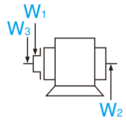
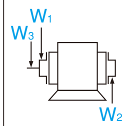
● Use of micro clutches

If a bearing mounted type micro clutch (oil retaining metal) is used, there is a possibility to be regulated by the current-carrying rate or temperature. Contact us for further information.

● Overhung load of the unit

The permissible value of the radial load applied on the shaft is indicated below. For the through shaft type unit, the permissible value slightly changes due to the direction of action of the input-output load. (The indicated value is when the most stringent condition is applied. The load point is the midpoint of the shaft.)

Unit: [N]

Size	125-□-12 126-□-4B	121-□-20		121-□-10 122-□-20
				
05	250	—	—	—
06	320	300 (320)	140	140
08	480	450 (500)	250	250
10	700	700 (800)	450	450
12	900	900 (1000)	700	700
16	1300	1400 (1600)	1000	1000
20	1800	2000 (2500)	1800	1800
25		2900 (3600)	2600	2600

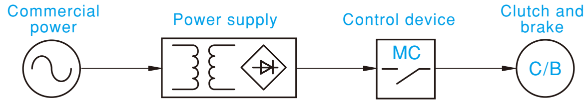
*( ) for load in both directions.

Control circuit

Basic configuration of a control circuit

When designing an electric circuit to control the clutch and brake, the selection of control method and control device is very important. The appropriate selection and circuit design stabilize the performance of the clutch and brake and strengthen the reliability of the machine.

To run the clutch and brake, DC24V (standard specification) power is required. There are two methods to run the clutch and brake. One is to use a direct current, and the other is to step down the voltage and rectify an alternating current power. Various power supplies for exclusive use are available. Refer to the section of power supply for more details.



Standard wiring

Selection of parts of power supply

1 Transformer

Adjust the primary side to the power supply voltage. For the secondary side, use a transformer that has enough capacity to apply the rated voltage to the clutch or brake coil. To get a rough idea, choose a transformer with a capacity of more than 1.25-times the rating capacity of the clutch or brake in temperature of 20℃. In addition, the secondary side output voltage is generally required to be set in accordance with the voltage drop of the rectifier and the impedance of the transformer, however it can be evaluated simply by the formula below (Formula ① and ②).

$$V_2 = \frac{V+1.4}{0.9} \text{ [V]} \quad \cdots\cdots ①$$

Formula ① is a method of single-phase full-wave rectification.

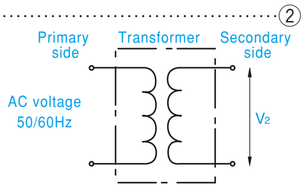
$$P \geqq W_{CB} \times 1.25 \text{ [VA]} \quad \cdots\cdots ②$$

V_2: Transformer secondary side voltage [V]

V: Direct voltage [V]

P: Transformer capacity [VA]

W_{CB}: Clutch (brake) capacity [VA]



2 Rectifier

The "single-phase full-wave rectification (bridge method)" is adopted from various types of rectification methods. For the selection, the maximum rated value of the rectifiers must be followed. It can be evaluated simply by the formula below.

❶Determination of the reverse withstand voltage VRM

$$V_{RM} = V_L \cdot \sqrt{2} \cdot K \quad \cdots\cdots ③$$

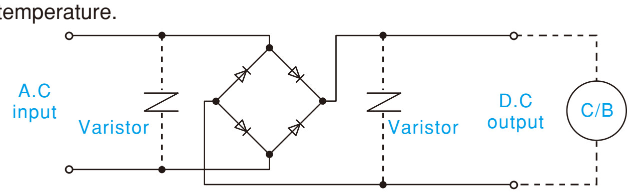
V_L: Alternate current input voltage [V]

K: Factor of safety (take 2〜3)

Protection of rectifier is required if there is a possibility of commingling of more than the withstand voltage of surge.

❷Determination of the average rectified current

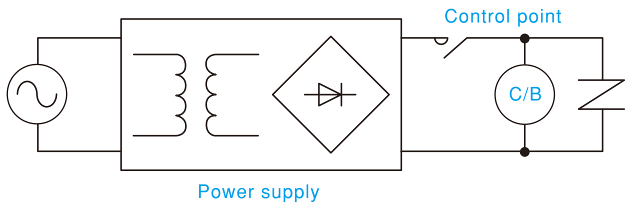
Select a rectifier that has more than 1.5-times the clutch or brake rated current. In the case of high current, temperature rise becomes a problem. Take measures to dissipate the heat and prevent the rise of temperature.



Single-phase full-wave rectification method

3 Relay (Control contact)

Since the electromagnetic clutches and brakes have a magnetic coil inside, they must be used within the conditions of the applied relay direct-current inductive load. This is because the contact erosion occurs by the surge voltage generated when the electromagnetic clutch and brake is controlled. In the case that the operating life or operation frequency is a problem in use, a static relay is required. For details, refer to the section of power supply for electromagnetic clutch and brake control.



Direct-current switching

4 Control circuit structural points to remember

❶Control of clutch and brake

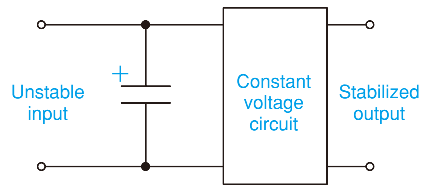
When the clutches and brakes are controlled on the alternating-current side, the armature release time becomes late and high-frequency operation becomes unable to perform. Therefore, set the control contact on the direct-current side.

❷Power supply voltage of clutch and brake

Variation of the exciting voltage must be within ±10% of the clutch and brake rated voltage.

❸Smooth the exciting voltage

A single-phase full-wave rectification is generally used for a clutch and brake power supply. If high accuracy is required, a sufficient result can be obtained by smoothing.



Stabilized power supply circuit

❹Protection of the control contact

When a protection circuit is set for the clutch and brake, the control contact is also protected. In addition, if a CR absorber is applied between the contact points as below, the protection effect increases. C (condenser) and R (resistance) become approximately as below.

Condenser C [μF] : ratio to contact current is;

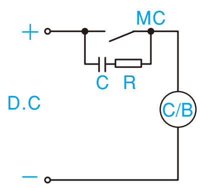
$$\frac{C\ [\mu F]}{I\ [A]} = \frac{0.5\sim1}{1}$$

Withstanding voltage: 600 [V]

Resistance R [Ω]: ratio to contact voltage is;

$$\frac{R\ [\Omega]}{E\ [V]} = 1$$

Capacity: 1 [W]

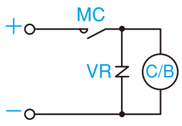
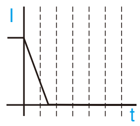
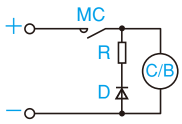
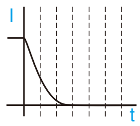
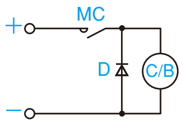
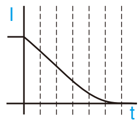
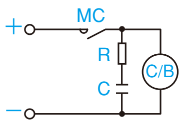
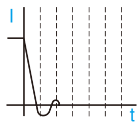


Relay protection circuit

5 Discharge circuit

When a direct exciting current is applied to electromagnetic clutches and brakes, the energy is stored in the inside coil. When interrupting the current, surge energy is generated between the coil terminals by the stored energy. This surge energy could reach more than 1000V by the breaking speed or current, which may cause a dielectric breakdown of the coil or contact burnout of the switch. Therefore, to set an appropriate discharge circuit to prevent these troubles is required.

In addition, the effect to control the armature release time or surge voltage is different depending on the types of discharge circuits. For the characteristics of discharge circuits, refer to the table below. Each discharge circuit has both merits and demerits. We recommend using a varistor.

	Circuit diagrams	Current decay	Characteristics
Varistor			It has a significant effect to reduce a surge voltage. There is no delay of the armature release time.
Resistor + diode			The power consumption of the power section can be reduced as well as its resistance capacitance. Since the armature release time becomes slow in a measure, caution is demanded for high-frequency use.
Diode			It is effective to reduce a surge voltage. However, the armature release time becomes slow, and there is a high possibility of occurrence of mutual interference of the clutch and brake. It is not suitable for high-frequency use.
Resistor + condenser			The armature release time becomes faster, but a condenser with high withstanding voltage is required.

Applicable power supplies specifications

Model	Rectification method	Frequency [Hz]	AC input voltage AC [V]	DC input voltage*1 DC [V]	Capacity [W]	Applicable clutch and brake size
BES-20-05	Single-phase full-wave	50/60	100/200	24	50	02～05
BES-20-10	Single-phase full-wave	50/60	100/200	24	50	06～10
BES-20-16	Single-phase full-wave	50/60	100/200	24	50	12～16
BES-20-20	Single-phase full-wave	50/60	100/200	24	50	20
BES-40-25	Single-phase full-wave	50/60	100/200	24	100	25

* When using the applied power supply BES, varistor is not required. Refer to the section of power supply for more detail.

Accessories

The attached components of clutches and brakes are different depending on the model and type. Refer to the accessory list below. Besides, information in this document is subjected to change without notice.

Micro size

Model	Varistors		Screws*1		Shims	
	Model	Qty	Specifications	Qty	Inside dia. x outside dia. x thickness	Qty
102-02-□1,□5	NVD07SCD082 or equivalent	1	—	—	No accessories	—
102/112-02-□3		1	M2×3	2		—
112-02-□1,□2		1	—	—		—
102-03-□1,□5		1	—	—		—
102/112-03-□3		1	M2.5×4	3		—
112-03-□1,□2		1	—	—		—
102-04-□1,□5		1	—	—		—
102/112-04-□3		1	M3×6	3		—
112-04-□1,□2		1	—	—		—
102-05-□1,□5		1	—	—		—
102/112-05-□3		1	Low-head bolt M3×6	3		—
			Disc spring washer for M3	3		—
112-05-□1,□2		1	—	—		—
CYT-025-□ ϕ6		1	M2.5×4	3	6.3×8.7×0.1t	3
CYT-03-□ ϕ6		1			6.3×8.7×0.1t	3
CYT-03-□ ϕ8		1			8.3×11.7×0.1t	3
CYT-04-□ ϕ8		1	M3×6	3	8.3×11.7×0.1t	3
CYT-04-□ ϕ10		1			10.3×13.7×0.1t	3
CSZ/BSZ-05-□		1	—	—	No accessories	—

* *1 For the size 05, a hexagon socket special bolt is attached. For other sizes, a cross-recessed pan head machine screw is attached.

Standard size

Model	Varistors		Screws		Shims		Collars	
	Model	Qty	Specifications	Qty	Inside dia. x outside dia. x thickness	Qty	Inside dia. x outside dia. x thickness	Qty
101/CS-06-□1	NVD07SCD082 or equivalent	1	—	—	—	—	—	—
101/CS-06-□3 ϕ12		1	Low-head bolt M3×6 Disc spring washer for M3	each 3	12.3×15.7×0.1t	3	—	—
101-06-13 ϕ15		1		each 3	15.3×20.7×0.1t	3	—	—
101/CS-06-□5 ϕ12		1	—	—	12.3×15.7×0.1t	5	12.2×18×5.5	1
					12.3×15.7×0.5t	1		
111-06-11 ϕ12,15		1	—	—	—	—	—	—
111-06-12 ϕ12		1	—	—	12.3×15.7×0.1t	3	—	—
111-06-12 ϕ15		1	—	—	15.3×20.7×0.1t	3	—	—
111-06-13		1	Low-head bolt M3×6 Disc spring washer for M3	each 3	—	—	—	—
CSZ/BSZ-06-□		1	—	—	—	—	—	—
101/CS-08-□1	NVD07SCD082 or equivalent	1	—	—	—	—	—	—
101/CS-08-□3 ϕ15		1	Low-head bolt M4×8 Disc spring washer for M4	each 3	15.3×20.7×0.1t	3	—	—
101-08-13 ϕ20		1		each 3	20.3×27.7×0.1t	3	—	—
101/CS-08-□5 ϕ15		1	—	—	15.3×20.7×0.1t	5	15.2×22×5.5	1
					15.3×20.7×0.5t	1		
111-08-11 ϕ15,20		1	—	—	—	—	—	—
111-08-12 ϕ15		1	—	—	15.3×20.7×0.1t	3	—	—
111-08-12 ϕ20		1	—	—	20.3×27.7×0.1t	3	—	—
111-08-13		1	Low-head bolt M4×8 Disc spring washer for M4	each 3	—	—	—	—
CSZ/BSZ-08-□		1	—	—	—	—	—	—

Standard size

Model	Varistors		Screws		Shims		Collars	
	Model	Qty	Specifications	Qty	Inside dia. x outside dia. x thickness	Qty	Inside dia. x outside dia. x thickness	Qty
101/CS-10-□1	NVD07SCD082 or equivalent	1	—	—	—	—	—	—
101/CS-10-□3 φ20		1	Low-head bolt M5×10 Disc spring washer for M5	each 3	20.3×27.7×0.1t	3	—	—
101-10-13 φ25		1		each 3	25.3×34.7×0.1t	3	—	—
101/CS-10-□5 φ20		1	—	—	20.3×27.7×0.1t	5	20.2×28×5.9	1
					20.3×27.7×0.5t	2		
111-10-11 φ20,25		1	—	—	—	—	—	—
111-10-12 φ20		1	—	—	20.3×27.7×0.1t	3	—	—
111-10-12 φ25		1	—	—	25.3×34.7×0.1t	3	—	—
111-10-13		1	Low-head bolt M5×10 Disc spring washer for M5	each 3	—	—	—	—
101/CS-12-□1	NVD07SCD082 or equivalent	1	—	—	—	—	—	—
101-12-13 φ25		1	Low-head bolt M6×10 Disc spring washer for M6	each 3	25.3×34.7×0.1t	3	—	—
101-12-13 φ30		1		each 3	30.3×39.7×0.1t	3	—	—
CS-12-33 φ25		1		each 3	25.3×31.7×0.1t	3	—	—
101/CS-12-□5 φ25		1	—	—	25.3×31.7×0.1t	5	25.2×32×7.5	1
					25.3×31.7×0.5t	2		
111-12-11 φ25,30		1	—	—	—	—	—	—
111-12-12 φ25		1	—	—	25.3×31.7×0.1t	3	—	—
111-12-12 φ30		1	—	—	30.3×39.7×0.1t	3	—	—
111-12-13		1	Low-head bolt M6×10 Disc spring washer for M6	each 3	—	—	—	—
101/CS-16-□1	NVD07SCD082 or equivalent	1	—	—	—	—	—	—
101-16-13 φ30		1	Low-head bolt M8×15 Disc spring washer for M8	each 3	30.3×41.7×0.1t	3	—	—
101-16-13 φ40		1		each 3	40.3×51.7×0.1t	3	—	—
CS-16-33 φ30		1		each 3	30.3×39.7×0.1t	3	—	—
101/CS-16-□5 φ30		1	—	—	30.3×39.7×0.1t	5	30.2×40×11.2	1
					30.3×39.7×0.5t	2		
111-16-11 φ30,40		1	—	—	—	—	—	—
111-16-12 φ30		1	—	—	30.3×39.7×0.1t	3	—	—
111-16-12 φ40		1	—	—	40.3×51.7×0.1t	3	—	—
111-16-13		1	Low-head bolt M8×15 Disc spring washer for M8	each 3	—	—	—	—
101-20-11	NVD07SCD082 or equivalent	1	—	—	—	—	—	—
101-20-13 φ40		1	Low-head bolt M10×18 Disc spring washer for M10	each 3	40.3×51.7×0.1t	3	—	—
101-20-13 φ50		1		each 3	50.3×67.7×0.1t	3	—	—
CS-20-33 φ40		1		each 3	40.3×51.7×0.1t	5	—	—
101-20-15 φ40		1	—	—	40.3×51.7×0.1t	5	40.2×50×11.7	1
					40.3×51.7×0.5t	2		
111-20-11 φ40,50		1	—	—	—	—	—	—
111-20-12 φ40		1	—	—	40.3×51.7×0.1t	3	—	—
111-20-12 φ50		1	—	—	50.3×67.7×0.1t	3	—	—
111-20-13		1	Low-head bolt M10×18 Disc spring washer for M10	each 3	—	—	—	—
101-25-11	NVD07SCD082 or equivalent	1	—	—	—	—	—	—
101-25-13 φ50		1	Low-head bolt M12×22 Disc spring washer for M12	each 4	50.3×67.7×0.1t	3	—	—
101-25-13 φ60		1		each 4	60.3×84.7×0.1t	3	—	—
CS-25-33 φ50		1		each 4	50.3×67.7×0.1t	5	—	—
101-25-15 φ50		1	—	—	50.3×61.7×0.1t	5	50.2×60×12.2	1
					50.3×61.7×0.5t	2		
111-25-11 φ50,60		1	—	—	—	—	—	—
111-25-12 φ50		1	—	—	50.3×67.7×0.1t	3	—	—
111-25-12 φ60		1	—	—	60.3×84.7×0.1t	3	—	—
111-25-13		1	Low-head bolt M12×22 Disc spring washer for M12	each 4	—	—	—	—

Selection

Points for selection

Due to the high controllability, clutches and brakes are used not only for on-off control but also complex operation. If the size is determined simply by its torque, an unexpected trouble may occur. When selecting the size, a careful examination from several points of view such as load characteristic or layout of the mechanism where the clutch and brake is assembled is required. This section describes the situational selection methods, calculation examples and required information.

1 Motor and clutch & brake

❶Relationship between motor output and torque

Motor HP is indicated by output, but it is indicated by torque in clutches and brakes.The following relationship is formed between the torque and motor output.

$$T_M = \frac{9550 \cdot P}{n_r}\ \eta\ [\mathrm{N \cdot m}] \quad \cdots\cdots ①$$

P: Motor HP [kW]

n_r: RPM of the clutch and brake shaft [min^{-1}]

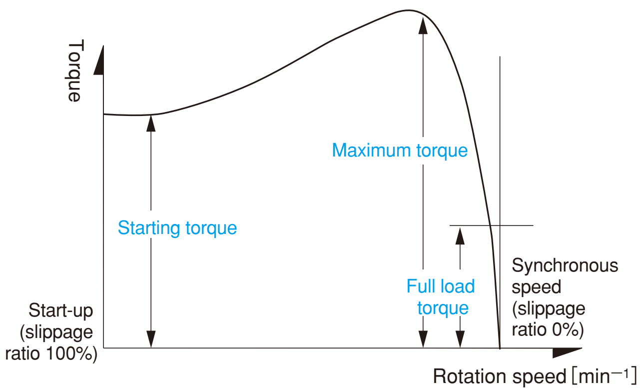
η: Transmission efficiency from the motor to clutch and brake

❷Difference of characteristic

Motor and clutch & brake have different torque characteristics. Therefore, if a motor is used as a drive source and the start-and-stop control of load is performed by a clutch and brake, the selection must be done in consideration of respective characteristics.

A) Motor characteristics

A motor can generate over 200% of the full-load torque at start-up. After passing through the maximum torque while accelerating, it drives the load near the full-load torque until stable operation can be obtained. When the load increases while running the motor RPM will be reduced, the motor momentum will continue to drive the load and the motor will generate additional torque. The following diagram indicates the relationship between motor torque and rotating velocity characteristic.



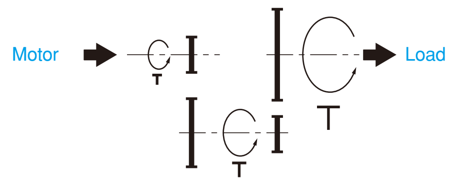
B) Clutch and brake characteristics

As described in the section of torque characteristics, the upper limit of coupling and braking torque is determined, and if more of the load torque is applied, it slips on the friction surface. An appropriate selection can be performed by confirming the difference of characteristic in advance. For a wide range of application, a clutch and brake with a torque value of 200~ 250% of the full load torque of the motor is recommended.

2 Relationship between torque and RPM

❶Difference of characteristic

The shaft in the machine with a high RPM can be rotated by a small force, but the decelerated low-speed shaft needs a large force to rotate. That is, torque is inverse proportion to RPM. This is very important in selecting a clutch and brake. The size or operating life changes depending on the RPM of the shaft.



❷Combination with a speed changer

Like a non-stage speed changer, when a clutch and brake is used in the mechanism that can change the RPM, the torque requirement during low speed and the responsiveness and operating life requirement during high speed must be considered in advance.

3 Understanding of load characteristics

The coupling time or wear life of clutch and brake varies depending on the coupling and braking load characteristics. Therefore, to understand the load characteristics is important to maintain a consistent operation. However, the load characteristics vary in definition and a complete understanding is difficult. As it is now, the size is often determined from an experimental point of view.

❶Importance of safety factor

When the size of clutch and brake is determined, the required torque is evaluated by multiplying the factor empirically. If the driving part is already set, use the factor K empirically depending on the motor to be used. When the factor is too small, it could cause trouble such as slippage when worsening of the condition. Conversely, if the factor is too big, the motor load increases. An excessive load may lead to motor problems.

	Motor/ Turbine	Gasoline engine	Diesel engine (1~2 cylinder gasoline engine)
K	2~2.5	2.5~2.8	2.8~3.4

❷Load torque and moment of inertia

In load torque, there are resistance forces in machine and resistance forces added after coupling (such as cutting resistance). Since load torque is difficult to evaluate the size selection is sometimes calculated incorrectly, this may cause torque insufficiency in the case of clutch. The selection must be done with due caution. Moment of inertia is also called flywheel effect, which indicates the amount of power required to stop or start a rotating object. Overload of clutch and brake can be prevented by reducing the load on the clutch as much as possible. In the design phase apply a measurably larger load for brake. In addition this will minimize the inertia moment and improve responsiveness and operating life. Be sure include the inertia of clutch and brake in your inertia calculations.

Selection

● Simplified selection graph

This selection graph is applied to a relatively light load and low frequency and when a motor is used as a drive source. The size of clutch and brake can be determined by a simplified way if the motor to be used is set appropriately to the load condition, and when there is no complicated mechanism or large inertial system to help the drive between the motor and clutch and brake. The safety factor K is 2.5 in this graph.
If other factors are required, use the value evaluated by multiplying the motor output by K/2.5 as kW of the vertical axis.

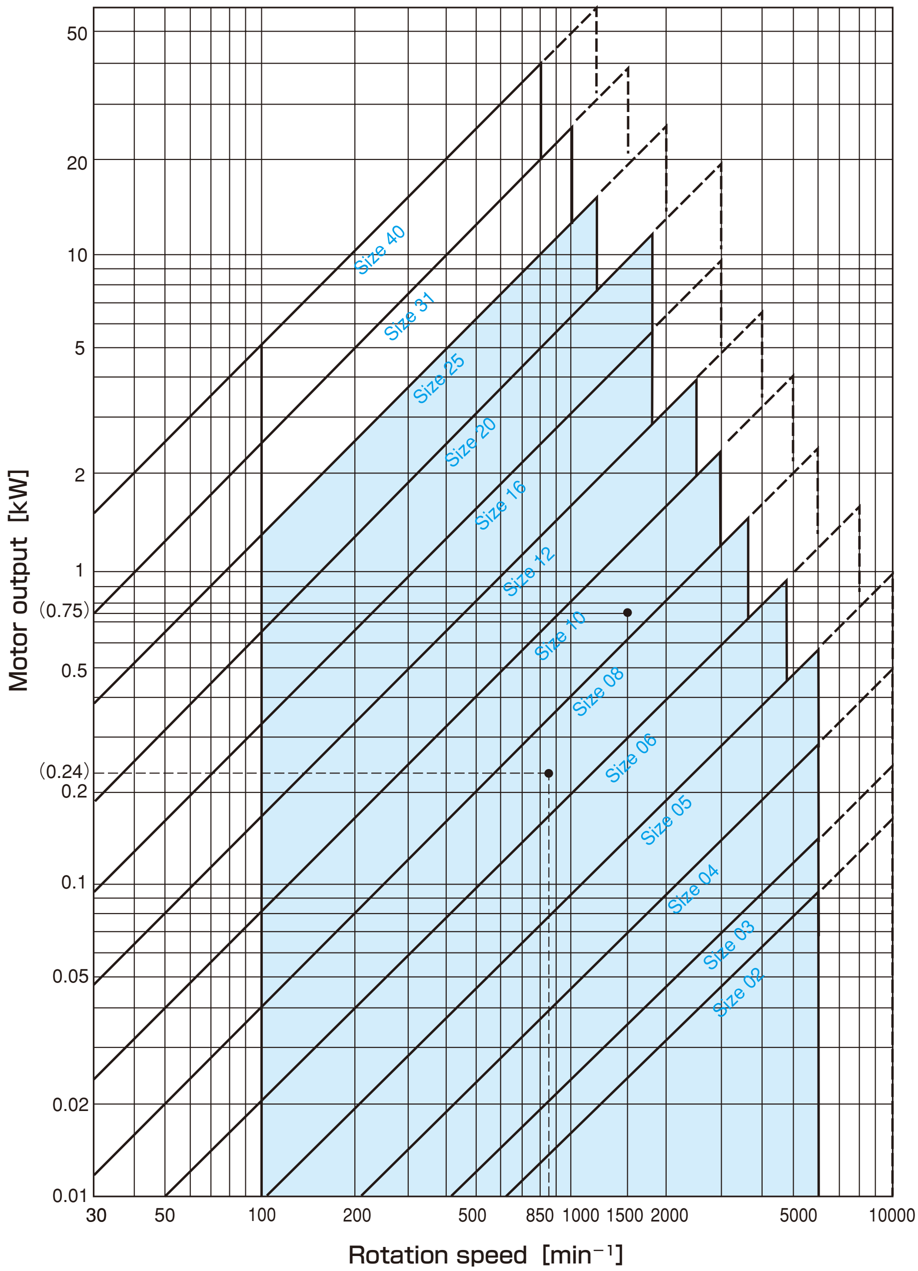
[Selection Example]

❶When the motor output is 0.75 kW and the clutch and brake rotating velocity is 1500min^{-1}, select the size 10 where the intersecting point is.

❷When the motor output is 0.4kW, the clutch and brake rotating velocity is 850min^{-1}, and the safety factor is 1.5,

$$0.4\ [kW] \times \frac{1.5}{2.5} = 0.24\ [kW]$$

evaluate the value as below. The point at intersection of 0.24kw of the vertical axis and 850min^{-1} is in the range of the size 08.



* Perform the selection within the [shaded] range. If the intersecting point is in the dashed line, the amount of work, heat dissipation or wear could become below the specified level.
For the heavy-line frame of below 100min^{-1}, confirm the required torque by the formula.

*For the size 31 and 40, contact us for further information.

Electromagnetic clutches and brakes

● Study of torque

1 Full load torque of motor (T_M)

The full load torque converted to the clutch and brake mounting shaft is;

$$T_M = \frac{9550 \cdot P}{n_r} \cdot \eta \ [\mathrm{N \cdot m}] \quad \text{①}$$

P: Motor output [kW]
n_r: Rotating velocity of the clutch and brake shaft [$\mathrm{min^{-1}}$]
η : Transmission efficiency from the motor to clutch and brake

2 Load torque (T_ℓ)

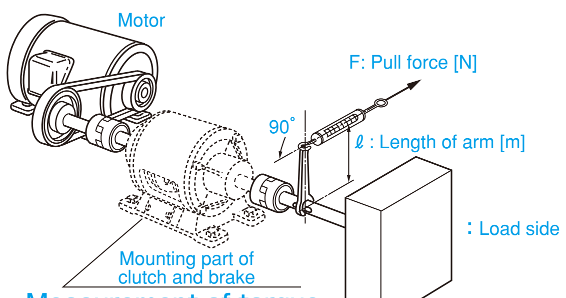
Load torque is difficult to evaluate by a formula. Therefore, the value is estimated empirically or evaluated by measuring directly.

❶Determine form the motor capacity
Assume that the motor is correctly selected for the load condition. Use the evaluated value T_M of ① as its load torque.

$$T_\ell = T_M \ [\mathrm{N \cdot m}] \quad \text{②}$$

❷In a case of direct measurement
A correct T_ℓ can be determined by actual measurement of load. For the measurement, use a torque wrench or rotate the shaft to mount the clutch and brake, and evaluate the product of F (force when the load starts to rotate) and ℓ (length of the arm).

$$T_\ell = \ell \cdot F \ [\mathrm{N \cdot m}] \quad \text{③}$$



Measurement of torque

❸Load torque sign
In the formula, the load torque is indicated by a plus-minus (+/-) sign. In a case of clutch, the load torque works on the direction of counteracting the rotation so that it is subtracted from the clutch torque T_d. In a case of brake, the load torque works on the direction of enhancing the braking so that it is added to the brake torque T_d. (It is relatively rare, but it may work the other way. In such a case, change the sign to calculate.) In the formula, it is indicated as $\pm T_\ell$.

3 Acceleration/deceleration torque (T_a)

❶The required torque to accelerate the load is;

$$T_a = \frac{J \cdot n_r}{9.55 t_{ae}} \ [\mathrm{N \cdot m}] \quad \text{④}$$

t_{ae}: Actual coupling time of clutch (Acceleration time) [s]
J: Total amount of inertia moment engaged by clutch [$\mathrm{kg \cdot m^2}$]

❷The required torque to accelerate the load is;

$$T_a = \frac{J \cdot n_r}{9.55 t_{ab}} \ [\mathrm{N \cdot m}] \quad \text{⑤}$$

t_{ab}: Actual braking time of brake (Deceleration time) [s]
J: Total amount of inertia moment decelerated by brake [$\mathrm{kg \cdot m^2}$]

4 Required torque (T)

The required torque to drive (brake) the load by condition is as follows.

❶When engaged and when J and T_ℓ are applied together.

$$T = (T_a \pm T_\ell)\ K \ [\mathrm{N \cdot m}] \quad \text{⑥}$$

K is a factor by load condition. Refer to the table below and select the value empirically. In a case of clutch, the load torque works on the direction of counteracting the drive so that T_ℓ is plus (+). In a case of clutch, the load torque works on the direction of enhancing the braking so that T_ℓ is minus (-).

❷When engaged and when J and T_ℓ are applied together

$$T = T_\ell \cdot K \ [\mathrm{N \cdot m}] \quad \text{⑦}$$

❸When J is mostly applied

$$T = T_a \cdot K \ [\mathrm{N \cdot m}] \quad \text{⑧}$$

❹In a case of stational engagement
If the clutch is coupled during stationary state and the load is accelerated by a motor, the required torque to prevent a slip of clutch during acceleration is;

$$T = \left\{ \frac{J_\ell}{J_d + J_\ell} (T_M - T_\ell) + T_\ell \right\} K \ [\mathrm{N \cdot m}] \quad \text{⑨}$$

J_d: Total amount of J on the driving side from the clutch [$\mathrm{kg \cdot m^2}$]
J_ℓ : Total amount of J on the loading side from the clutch [$\mathrm{kg \cdot m^2}$]

Safety factor by load condition: K

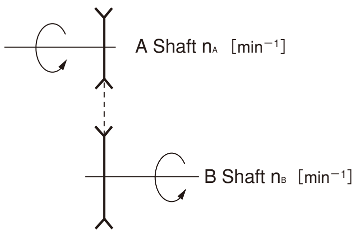
Use condition		Factor K
Light load	Low-frequency use of a small inertial body	1.5
	High-frequency use of a relatively small inertial body	2～2.2
	General use of a standard inertial body	
	High-frequency use	2.2～2.4
Standard load	Low-frequency use of a small inertial body	2～2.4
	General use of a standard inertial body	2.4～2.6
	Drive a large inertial body	2.7～3.2
Heavy load	Operation that involved impact (Large load fluctuations)	3.5～4.5

5 Conversion of torque to the other shaft

To convert the torque of B shaft to the A shaft

$$T_A = T_B \cdot \frac{n_B}{n_A} \ [\mathrm{N \cdot m}] \quad \text{⑩}$$

T_A: Torque of A shaft, T_B: torque of B shaft
n_A: Rotation speed of A shaft, n_B: Rotation speed of B shaft



● Study of energy

1 Engaging or braking energy (E_e, E_b)

The work volume of single coupling or braking by clutch and brake is;

❶During acceleration, the engaging energy E_e is;

$$E_e = \frac{J \cdot n_r^2}{182} \cdot \frac{T_d}{T_d - T_\ell} \ [J] \quad \cdots (11)$$

❷During deceleration, the braking energy E_b is;

$$E_b = \frac{J \cdot n_r^2}{182} \cdot \frac{T_d}{T_d + T_\ell} \ [J] \quad \cdots (12)$$

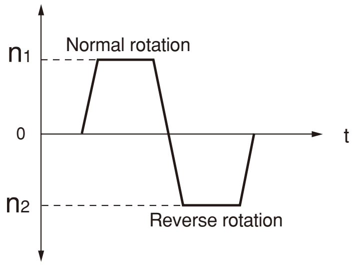
❸Normal/Reverse rotation

The clutch engaging energy when the rotational direction is switched by clutch is;

$$E_e = \frac{J}{182} \left\{ (n_1^2 + 2 \cdot n_1 \cdot n_2) \frac{T_d}{T_d + T_\ell} + n_2^2 \frac{T_d}{T_d - T_\ell} \right\} [J] \quad \cdots (13)$$

n_1: Normal rotation velocity [min^{-1}]

n_2: Reverse rotation velocity[min^{-1}]



❹Energy during slip

$$E_e = \frac{2\pi}{60} \cdot n \cdot t \cdot T_d \ [J] \quad \cdots (14)$$

$$E_b = \frac{2\pi}{60} \cdot n \cdot t \cdot T_d \ [J] \quad \cdots (15)$$

t : Slipping time [s]

n: Rotating velocity to slip min^{-1}]

T_d: Dynamic torque at n [min^{-1}][N·m]

When clutch and brake is used while slipping, an undesirable condition such as heat generation may occur.

❺Allowable energy

The allowable work $E_{ea\ell}$ and $E_{ba\ell}$ are the values under and ideal condition that the values of E_e and E_b must be sufficiently smaller than them.

$$E_e \ll E_{ea\ell} \quad \cdots (16)$$

$$E_b \ll E_{ba\ell} \quad \cdots (17)$$

* For the values of $E_{ea\ell}$ and $E_{ba\ell}$, refer to the page of heat dissipation characteristics.

2 Energy rate

A clutch and brake repeats an on-off operation with a high frequency that examination of capability of heat dissipation is important.

❶Engaging energy rate (P_e)

$$P_e = \frac{E_e \cdot S}{60} \ll P_{ea\ell} \ [W] \quad \cdots (18)$$

❷Braking energy rate (P_b)

$$P_b = \frac{E_b \cdot S}{60} \ll P_{ba\ell} \ [W] \quad \cdots (19)$$

S: Operation frequency [operations/min]

The allowable energy rate $P_{ea\ell}$ and $P_{ba\ell}$ are the values under an ideal condition. Therefore, determine E_e and E_b and S in order that they become sufficiently smaller than them.

* For the values of $E_{ea\ell}$ and $E_{ba\ell}$, refer to the page of heat dissipation characteristics.

3 Engaging/braking frequency (S_a)

The allowable operation frequency determined by heat dissipation S_a is;

$$S_a \ll \frac{60 P_{ea\ell}}{E_e} [operations/min] \quad \cdots (20)$$

$$S_a \ll \frac{60 P_{ba\ell}}{E_b} [operations/min] \quad \cdots (21)$$

This allowable frequency is determined only by heat dissipation. For actual use, consider the operating time also.

● Study of operating time

1 Total engaging and total braking time (t_{te}, t_{tb})

The engaging and braking time of load by clutch and brake is the sum of the clutch and brake operating time itself and the accelerating and decelerating time of load.

❶Total engaging time

$$t_{te} = t_{id} + t_a + t_{ae} \ [s] \quad \cdots (22)$$

t_{id}: Initial delay time

t_a: Armature pull in time [s]

t_{ab}: Clutch actual engaging time (Acceleration time)[s]

❷Total braking time

$$t_{tb} = t_{id} + t_a + t_{ab} \ [s] \quad \cdots (23)$$

t_{id}: Initial delay time

t_a: Armature pull in time [s]

t_{ab}: Brake actual braking time [s]

t_{ae} and t_{ab} are evaluated by the formulas below by the condition.

❸During acceleration/deceleration

Actual engaging time is;

$$t_{ae} = \frac{J \cdot n_r}{9.55 (T_d - T_\ell)} [s] \quad \cdots (24)$$

Actual braking time is;

$$t_{ab} = \frac{J \cdot n_r}{9.55 (T_d + T_\ell)} [s] \quad \cdots (25)$$

❹During normal rotation

The actual engaging time (acceleration time) when switched the normal rotation into reverse rotation is;

$$t_{ae} = \frac{J}{9.55} \left(\frac{n_1}{T_d - T_\ell} + \frac{n_2}{T_d + T_\ell} \right) [s] \quad \cdots (26)$$

n_1: Normal rotation velocity [min^{-1}]

n_2: Reverse rotation velocity [min^{-1}]

2 The coupling/braking time when the coupling/braking is completed in the process of torque rise

In this case, the coupling/braking time is the sum of the armature suction time t_a and t_{ae}' or t_a and t_{ab}'.

❶Total coupling time

$$t_{te}=t_{id}+t_a+t_{ae}'\ [s] \quad (27)$$

$$t_{ae}'=\sqrt{\frac{J\cdot n_r}{4.77}\cdot\frac{t_{ap}}{0.8\cdot T_d}}\ [s] \quad (28)$$

❷Total braking time

$$t_{tb}=t_{id}+t_a+t_{ab}'\ [s] \quad (29)$$

$$t_{ab}'=\sqrt{\frac{J\cdot n_r}{4.77}\cdot\frac{t_{ap}}{0.8\cdot T_d}}\ [s] \quad (30)$$

They are applied in the case of $T_\ell=0$. Generally, the above formulas are used when the load torque (T_ℓ) is small in full measure. Besides, if the calculated value becomes $t_{ae}' > t_{ap}$, $t_{ab}' > t_{ap}$, apply the formula ㉒ ～ ㉖.

● Study of maximum operation number

The available amount of energy of clutch and brake before air gap adjustment is determined. If more volume is required, the space adjustment is necessary.

The operable number before space adjustment is;

❶In a case of clutch

$$L_e=\frac{E_T}{E_e}\text{[operation]} \quad (31)$$

E_T: Total amount of energy before space readjustment [J]

❷In a case of brake

$$L_b=\frac{E_T}{E_b}\text{[operation]} \quad (32)$$

● Study of stopping accuracy

To evaluate the stopping accuracy by a formula is difficult since the friction energy or control system variation is involved. Generally, it is evaluated empirically by the formula below to use as a measure.

1 Stopping angle (θ)

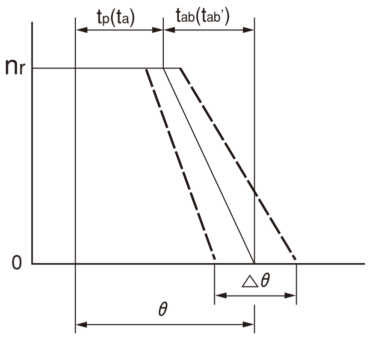
$$\theta=6n_r\left(t_{id}+t_p+\frac{1}{2}t_{ab}\right)\ [°] \quad (33)$$

$$\text{OR}\ \theta=6n_r\left(t_{id}+t_a+\frac{2}{3}t_{ab}'\right)\ [°] \quad (34)$$

2 Stopping accuracy (△θ)

$$\triangle\theta=\pm0.15\theta\ [°] \quad (35)$$

If there is a factor to disturb the braking effect such as load fluctuation, change the constant of the formula ㉟ to 0.2～ 0.25. The system delay or variation caused by a backlash of chain or gear is not included in the stopping angle and accuracy.



Total amount of energy before air gap readjustment E_T

Micro electromagnetic clutch and brake
102•112 model

Size	Total amount of energy E_T [J]
02	2×10^6
03	3×10^6
04	6×10^6
05	9×10^6

CYT model

Size	Total amount of energy E_T [J]
025	1×10^6
03	1.5×10^6
04	2×10^6

Micro electromagnetic clutch and brake (unit)
101•CS•111 model*

Size	Total amount of energy E_T [J]
06	36×10^6
08	60×10^6
10	130×10^6
12	250×10^6
16	470×10^6
20	10×10^8
25	20×10^8

※ Applicable to each model of the unit (except 180 model)

CSZ • BSZ model

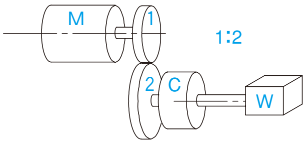
Size	Total amount of energy E_T [J]
05	9×10^6
06	29×10^6
08	60×10^6

180 model

Size	Total amount of energy E_T [J]
06	24×10^6
08	40×10^6
10	62×10^6
12	154×10^6
16	250×10^6

● Selection Example 1

Clutch used for a continued operation of load



The selection of clutches used for a continued operation of load as above figure is performed as follows.

Use conditions

Used motor output	P	0.4kW (Standard three-phase, 4P)
Clutch operation frequency	S	20 [operations/min]
Load moment of inertia	J_A	0.0208 [kg・m²]
Load torque	T_ℓ	Unknown [N・m]
Rotating velocity of the clutch mounting shaft	n	750 [min⁻¹]
Transmission efficiency	η	90%

1 Study of torque

By the above use conditions, evaluate the torque required for coupling. Evaluate the load torque first. Assume that the motor is correctly selected. By the formula ①, the load torque T_ℓ is;

$$T_\ell=\frac{9550\times0.4}{750}\times0.9=4.58\ [N\cdot m]$$

From the formula ④, the acceleration torque is;

$$T_a=\frac{0.0208\times750}{9.55\times0.5}=3.27\ [N\cdot m]$$

The acceleration torque is given as a condition, but in the above formula, it is estimated from the operation frequency as t_{ae}= 0.5 [s]. Therefore, by the formula ⑥, the required torque is;

$$T=(4.58+3.27)\times2=15.7\ [N\cdot m]$$

The sign of the load torque T_ℓ is plus (+). The factor K by load condition is empirically determined as K= 2 for general use of standard load. According to the above information, select the clutch size 10 (torque 20N・m) that has more than the required torque 15.7 [N・m].

2 Study of energy

Determine the model and evaluate the total load moment of inertia by the self-moment of inertia J and load moment of inertia of the model. In the case of model 101-10-13, the rotating part moment of inertia J is 0.000678 [kg・m²].

Therefore, the total moment of inertia J is;

$$J_T'=0.0208+0.000678=0.02148\ [kg\cdot m^2]$$

By the formula ⑪, evaluate the single engaging energy E_e.

$$E_e=\frac{0.02148\times750^2}{182}\times\frac{20}{(20-4.58)}=86.1\ [J]$$

The sign of the load torque T_ℓ is minus (-). The engaging energy E_e is smaller than the allowable energy $E_{ea\ell}$ in full measure.

$$E_e \ll E_{ea\ell}$$

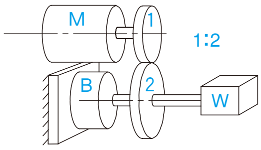
Then, evaluate the energy rate by the formula ⑱.

$$P_e=\frac{86.1\times20}{60}=28.7\ [W]$$

This value is smaller than the allowable energy rate $P_{ea\ell}$ in full measure, which means that the clutch corresponds to the use condition, therefore select the model 101-10-13.

● Selection Example 2

Brake to stop the inertia when turning off a motor



The selection of clutches to stop the inertia when turning off a motor as above figure is performed as follows.

Use conditions

Used motor output	P	0.75kW (Standard three-phase, 4P)
Motor rotating velocity	n_1	1800 [min⁻¹]
Motor moment of inertia	J_M	0.00205 [kg・m²]
V-belt pulley (motor side) moment of inertia	J_1	0.00075 [kg・m²]
V-belt pulley (brake side) moment of inertia	J_2	0.00243 [kg・m²]
Load moment of inertia	J_A	0.05 [kg・m²]
Load torque	T_ℓ	5.0 [N・m]
Rotating velocity of the brake mounting shaft	n	900 [min⁻¹]
Stop time	t	Within 0.5 [s]

1 Study of torque

By the above use conditions, evaluate the total moment of inertia of the brake shaft conversion.

$$J_T\left(\frac{1800}{900}\right)^2\times(0.00205+0.00075)+0.00243+0.05=0.06363\ [kg\cdot m^2]$$

Evaluate the deceleration torque. Since the operating time of the brake itself is included in the deceleration time, calculate as 1/2 of the given stop time.

By the formula ⑤

$$T_a=\frac{0.06363\times900}{9.55\times0.25}=24.0\ [N\cdot m]$$

By the formula ⑥, the required torque is;

$$T=(24.0-5.0)\times2.4=45.6\ [N\cdot m]$$

The sign of the load torque T_ℓ is minus (-). The factor K by load condition is determined empirically as K =2.4 for general use of standard load. By the above information, temporally select the brake size 12 (torque 40N・m) that has brake torque equivalent to the required torque 45.6 [N・m].

2 Study of energy

Determine the model and evaluate the total load moment of inertia by the self-moment of inertia J and load moment of inertia. In the case of model 111-12-11, the moment of inertia of the armature is 0.00181 [kg・m²].

Therefore, the total moment of inertia $J_{T'}$ is;

$$J_T'=0.06363+0.00181=0.06544\ [kg\cdot m^2]$$

By the formula ⑫, evaluate the single braking energy E_b.

$$E_b=\frac{0.06544\times900^2}{182}\times\frac{40}{(40+5)}=258.9\ [J]$$

The sign of the load torque T_ℓ is plus (+). The braking energy E_b is smaller than the allowable energy $E_{bea\ell}$ in full measure.

$$E_b \ll E_{ba\ell}$$

3 Study of operating time

By the formula ㉕, evaluate the braking time.

$$t_{ab}=\frac{0.06544\times900}{9.55\times(40+5)}=0.137\ [s]$$

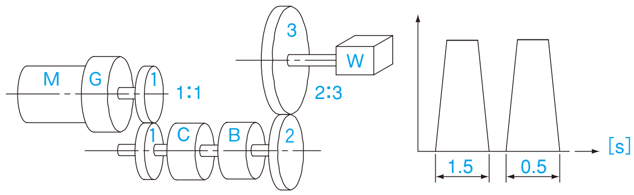
The sign of the load torque T_ℓ is plus (+). And the armature suction time of the size 12 is 0.027 [s] by the specification table. And the initial lagging time is 0.05 [s].
By the formula ㉓,

$$t_{tb}=0.05+0.027+0.137=0.214\ [s]$$

This value meets the requirement of below 0.5 [s], which means that the brake corresponds to the use conditions, therefore select the model 111-12-11.

● Selection Example 3

Clutch and brake to drive a load



The selection of clutches and brakes to drive a load as above figure is performed as follows.

Usage conditions

Operation frequency	S	30 [operations/min]
Maximum operating number[*1]	L	810×10⁴ [operations] or more
V-belt pulley A moment of inertia	J_1	0.00195 [kg・m ²]
V-belt pulley B moment of inertia	J_2	0.01668 [kg・m ²]
Load moment of inertia	J_A	0.5075 [kg・m ²]
Load torque	T_ℓ	22.0 [N・m]
Rotating velocity of the clutch and brake mounting shaft	n	150 [min ⁻¹]
Rotating velocity of the load shaft	n_2	100 [min ⁻¹]
Coupling time	t_1	Within 0.3 [s]
Stop time	t_2	Within 0.3 [s]

*1 When it is used 15 hours a day with no adjustment over a year, L= 30 x 60 min x 15 hours x 300 days= 8,100,000 times

1 Study of torque

By the above conditions, convert the load torque into the clutch and brake shaft. From the formula ⑩,

$$T_\ell=22.0\times\frac{2}{3}=14.7\ [N\cdot m]$$

Convert all the inertia moment of rotating part into the clutch and brake shaft.

$$J_T=J_1+(J_2+J_A)\times\left(\frac{2}{3}\right)^2$$

$$=0.00195+(0.01668+0.5075)\times\left(\frac{2}{3}\right)^2$$

$$=0.2349\ [kg\cdot m^2]$$

Since the operating time of the clutch and brake is included in the acceleration time, calculate as 1/2 of the given coupling time 0.3 [s].
By the formula ④,

$$T_a=\frac{0.2349\times150}{9.55\times0.15}=24.6\ [N\cdot m]$$

By the formula ⑥, the required torque T is;

$$T=(24.5\pm14.7)\times K\ [N\cdot m]$$

When the factor K by load condition is determined empirically as K= 2 for general use of standard load, the clutch is;

$$T=(24.5+14.7)\times2=78.4\ [N\cdot m]$$

The brake is;

$$T=(24.5-14.7)\times2=19.6\ [N\cdot m]$$

According to the above information select the clutch size 16 (torque 80N・m) and the brake size 10 (torque 20N・m).

2 Study of energy

Determine the model and evaluate the total load moment of inertia by the self-moment of inertia J and load moment of inertia of the model. In the case of clutch model 101-16-15, the rotating part moment of inertia J is 0.0063 [kg・m²]. And in the case of brake model 111-10-11, the armature moment of inertia is 0.000663 [kg・m²].
Therefore, the total moment of inertia J_T' is;

$$J_T'=0.2349+0.0063+0.000663=0.2419\ [kg\cdot m^2]$$

By the formula ⑪, evaluate the single coupling energy of clutch E_e.

$$E_e=\frac{0.2419\times150^2}{182}\times\frac{80}{(80-14.7)}=36.6\ [J]$$

By the formula ⑫, evaluate the single braking energy of brake E_b.

$$E_b=\frac{0.2419\times150^2}{182}\times\frac{20}{(20+14.7)}=17.2\ [J]$$

This value meets the requirements for the allowable energy and the amount of energy per minute of the selected model.

3 Study of maximum operation number

Evaluate the number of operations next. By the specification table for each model, the total energy of the size 16 is (470×10⁶) [J], and for the size 10 is (130×10⁶) [J]. Therefore, by the formula ㉛ and ㉜, the clutch is;

$$L=\frac{470\times10^6}{36.6}=1284\times10^4\ [operations]$$

The brake is;

$$L=\frac{130\times10^6}{17.2}=756\times10^4\ [operations]$$

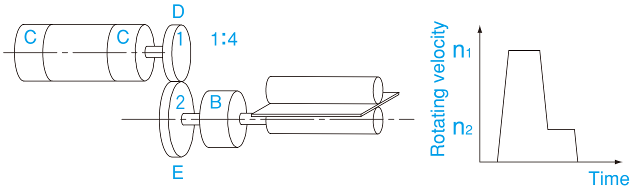
The required maximum operating numbers are approximately 8,100,000 that the size 10 can't meet the requirement. When changing the model to 111-12-11 for a review, it becomes as below and meets the requirement. (The calculation process is omitted.)

$$L=\frac{250\times10^6}{22.0}=1136\times10^4\ [operations]$$

Therefore, the appropriate clutch model is 101-16-15 and brake model is 111-12-11 for this example.

● Selection example 4

Clutch and brake used for two-stage speed change single-stop mechanism



The selection that includes the stopping accuracy of the clutch and brake to drive a load is performed as follows.

Usage conditions

Maximum input rotating velocity	n_1	1500 [min^{-1}]
Minimum input rotating velocity	n_2	200 [min^{-1}]
Roll shaft rotating velocity	n_3	50 [min^{-1}]
Operation frequency	S	12 [operations/min]
Maximum operating number *1	L	130×10^4 [operations] or more
Pulley D moment of inertia	J_1	0.000025 [kg・m^2]
Pulley E moment of inertia	J_2	0.005375 [kg・m^2]
Roll moment of inertia	J_A	0.0133 [kg・m^2]
Roll load torque	T_ℓ	8.0 [N・m]
Roll diameter	R	60 [mm]

*1 When it is used 6 hours a day with no adjustment over a year, L= 12 x 60 min x 6 hours x 300 days= 1,300,000 times

1 Study of brake

❶Study of energy

By the above conditions, evaluate the total moment of inertia for conversion of the feed roll shaft. Assuming that the inertia of rotating part of the clutch brake unit type 121-08-10 is 0.000475 [kg・m²], and the armature inertia moment of the brake model 111-12-12 is 0.00181 [kg・m²],

$$J_T=0.0133\times2+0.00181+0.005375+(0.000025+0.000475)\times\left(\frac{4}{1}\right)^2=0.04179\ [\mathrm{kg\cdot m^2}]$$

By the formula ⑫, evaluate the single braking energy E_b.

$$E_b=\frac{0.04179\times50^2}{182}\times\frac{40}{(40+8)}=0.48\ [\mathrm{J}]$$

The sign of the load torque T_ℓ is Plus (+). This value meets the requirements for the allowable energy and the amount of energy per minute of the selected model.

❷Study of operation numbers

Evaluate the number of operations next. The total energy of the size 12 is (250×10^6) [J] that by the formula ㉜,

$$L=\frac{250\times10^6}{0.48}=52083\times10^4\ [\mathrm{operations}]$$

This value meets the requirement in full measure.

❸Study of operating time

Evaluate the braking time. Either the formula ㉕ or ㉚ is applied. In this case, apply the formula ㉚ to shorten the braking time. Assume that the torque increment time t_{ap} is 0.063 [s].

By the formula ㉚, the braking time t_{ab}' is;

$$t_{ab}'=\sqrt{\frac{0.04179\times50}{4.77}\times\frac{0.063}{(0.8\times40)}}=0.0294\ [\mathrm{s}]$$

❹Study of stopping accuracy

Initial lagging time is 0.05 [s].

By the formula ㉞, the stopping angle is;

$$\theta=6\times50\times\left(0.05+0.027+\frac{2}{3}\times0.0294\right)=28.98\ [^\circ]$$

From the formula ㉟, the stopping accuracy is;

$$\triangle\theta=\pm0.15\times28.98=\pm4.35\ [^\circ]$$

When converting the roll diameter to the circumferential length, it becomes ±2.3 [mm].

2 Study of clutch

❶Study of energy

By the above conditions, evaluate the total moment of inertia converted to the clutch shaft.

$$J_T'=0.000475+0.000025+(0.00181+0.0133\times2+0.005375)\times\left(\frac{1}{4}\right)^2=0.0026\ [\mathrm{kg\cdot m^2}]$$

By using the formula ⑩, convert the load torque to the clutch shaft.

$$T_\ell=8.0\times\frac{1}{4}=2.0\ [\mathrm{N\cdot m}]$$

By the formula ⑪, the single coupling energy E_e of the high-speed side clutch is;

$$E_e=\frac{0.0026\times1500^2}{182}\times\frac{10}{(10-2)}=40.2\ [\mathrm{J}]$$

This value meets the requirement for the allowable energy of the selected model. Evaluate the coupling energy rate P_e next. By the formula ⑱,

$$P_e=\frac{40.2\times12}{60}=8.04\ [\mathrm{W}]$$

This value is smaller than the allowable work rate P_ℓ in full measure.

❷Study of operation numbers

Evaluate the number of operations by the formula ㉛.

$$L=\frac{60\times10^6}{40.2}=149\times10^4\ [\mathrm{operations}]$$

The number of operations in one year is about 1,300,000, which satisfies the requirement.

By the formula ⑫, the single coupling energy E_e of the low-speed side clutch is;

$$E_e=\frac{0.0026\times(1500-200)^2}{182}\times\frac{10}{(10+2)}=20.1\ [\mathrm{J}]$$

This clutch decelerates the load from 1500 [min^{-1}] to 200 [min^{-1}], which is similar actions as brake. Therefore, the sign of the load torque is Plus (+).

Also, it is clear that the value meets the requirements of operating life number since it is smaller than the high-speed side clutch.

By the above information, both clutch and brake meet the requirements.

Safety Precautions (Please read prior to use)

Please look carefully through the instruction manual and the technical information for proper use and safety. In this manual, safety precautions are classified by "DANGER" and "CAUTION".

⚠ DANGER
● Death or serious injury may be caused by mishandling

⚠ CAUTION
● Disability or physical damage may be caused by mishandling

Please contact Miki Pulley for the following applications: atomic energy, aerospace, medical treatment, transportation, or various safety devices. These applications may result in serious bodily injury or loss of life directly by mechanical failure or mishandling, careful examination of the application is necessary. Contact Miki Pulley for further information.
Miki Pulley takes all possible measures to insure quality products. Operational consideration such as a continuous rotational state when the clutch cannot be disengaged or the coasting of the machine when the brakes disengage may cause injury or death. Please maintain and properly operate all equipment in order to prevent injury or death.

1.Structural precautions

⚠ DANGER ●Do not use in explosive or flammable atmospheres.

Sparks may occur by startup or braking slip. Do not use the product near flammable liquids or in gaseous or explosive atmospheres.
If brake or clutch is used in a explosive or flammable environment then the main unit must be contained in a sealed unit, not exposed to the atmosphere.

⚠ DANGER ●Make sure to use a safety cover.

Due to the rotating system, touching the product could cause injury. Use a breathable safety cover to avoid any accident. Also, set up a safety mechanism for quick stop of the rotating body.

⚠ DANGER ●Please check the surrounding environment.

Do not use in a place where the product is exposed to dust, high temperature, dew condensation, wind or rain. Also, do not set the product directly in a place where the product is subjected to shock and vibration. These could lead to damage, malfunction or performance degradation of the product.

2.Mounting precautions

⚠ CAUTION ●Carry and mount the product by using a hoist, etc.

Lifting of a heavy weight could cause back injury. Use a hoist, etc. when carrying or mounting the product.

⚠ DANGER ●Bolt tightening torque and slack prevention must be done completely.

Tighten all bolts to their recommended torque tightening specification. Failure to tighten the bolts to the proper tightening specification may result in fatigue and premature failure of the bolted connection. The use of a thread adhesive and/or a spring washer is recommended.

3.Wiring precautions

⚠ DANGER ●Make sure to connect the motor and the earth terminal of the controller to the ground.

The third ground (below (100), above (1.6)) is suggested as a means of grounding.

⚠ DANGER ●Use the appropriate wire size in accordance with the current capacity.

An electrical shock or a short circuit can result from insulation failure. Which may result in fire.

4.Cautions before operation

⚠ DANGER ●Do not use in explosive or flammable atmospheres.

Spark may occur by starting or brake slippage. Do not operate the product near flammable liquids or in gaseous or explosive atmospheres. If brake or clutch is used in a explosive or flammable environment then the main unit must be contained in a sealed unit, not exposed to the atmosphere.

5.Cautions during operation

⚠ **DANGER** ●Do not operate the product beyond its maximum rpm limit.

If the product's maximum rpm limit is reached, vibrations may cause damage to the product. It may also result in injury. Keep all operational speeds below the maximum rpm limits.

⚠ **DANGER** ●Do not touch the product during operation.

Due to the exposed rotor, touching the product during operation may cause injury. Make sure not to touch the product during operation. All rotating parts should have a safety guard.

⚠ **DANGER** ●Do not touch the product during operation.

The surface temperature of the product could increase up to 90℃ ~ 100℃ by heat generation caused by slippage or built-in coil. Touching the product during operation may cause a burn injury. Additionally, the surface temperature will not decrease immediately.Make sure that the temperature is low enough when disassembling or checking the product.

⚠ **CAUTION** ●The surface of the body could reach a high temperature just by turning on electricity.

Heat generation of the built-in coil, the surface temperature could become high just by turning on electricity. Make sure that the temperature is low enough to prevent a burn injury.

⚠ **CAUTION** ●In case of abnormal noises or vibrations, stop operation immediately.

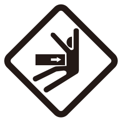
If abnormal noises or vibrations occur during operation, improper mounting should be considered. Do not leave the situation as it is. It may cause damage to the clutch and brake or the equipment itself.

⚠ **CAUTION** ●Voltage variation must be within ±10%. For the model 546 (Toothed clutch), it must be within +5% and -10%.

An incorrect voltage may cause performance problems or fire. Cautions for maintenance and inspection.

6.Cautions for maintenance and inspection

⚠ **DANGER** ●Do not apply any water or grease.



If water or grease is applied on the friction surface or the body, its torque will be significantly reduced. It can cause the machine to go out of control. It can also lead to injury.

⚠ **DANGER** ●Do not turn on the power to the machine.

When performing any service on clutch or brake all machine power must be turned off. Serious injury may occur if machine is started during service.

⚠ **DANGER** ●Do not dismantle the product.

We will refuse to take responsibility for any damaged product that is dismantled, remodeled or repaired by a third party except our company and the designated company.
Please use our authorized service network for repair and dismantlement.

7.Cautions for disposal

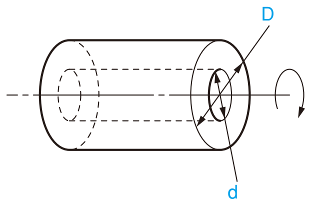
⚠ **DANGER** ●Do not leave the product around where young children may play.

⚠ **CAUTION** ●Properly dispose of all electrical components in accordance with local laws and regulations.

Please note that these safety precautions and specifications described in each manual may be changed without prior notice.
If you have any problem or question on these precautions, contact us.

Inertia moment J calculation formulas

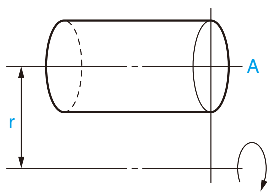
● Inertia moment of a hollow circular cylinder



D : Outside diameter of cylinder [m]
d : Inside diameter of cylinder [m]
M : Mass of cylinder [kg]

$$J=\frac{1}{8}M(D^2+d^2)\ [kg \cdot m^2]$$

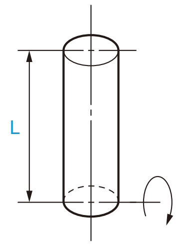
● Inertia moment of a hollow circular cylinder with different rotation center



r : Rotation radius [m]
M : Mass of cylinder [kg]
J_A : Inertia moment of center A rotation [kg·Em²]

$$J=J_A+M \cdot r^2\ [kg \cdot m^2]$$

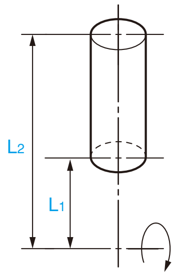
● Inertia moment of a rotating bar



L : Length of bar [m]
M: Mass of bar [kg]

$$J=\frac{1}{12}M \cdot L^2\ [kg \cdot m^2]$$

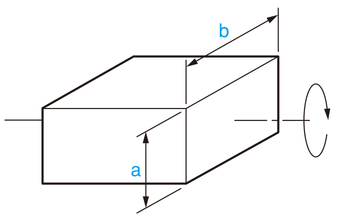
● Inertia moment of a bar with different rotation center



L_1, L_2: Distance from rotation center [m]
M : Mass of bar [kg]

$$J=\frac{1}{12}M(L_1^2+L_1L_2+L_2^2)\ [kg \cdot m^2]$$

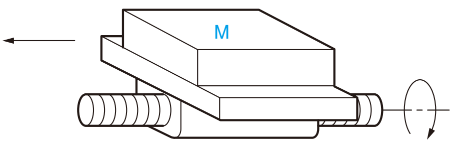
● Inertia moment of a rectangular solid



a, b : Length of side [m]
M : Mass of rectangular solid [kg]

$$J=\frac{1}{12}M(a^2+b^2)\ [kg \cdot m^2]$$

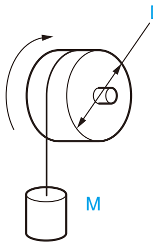
● Inertia moment of a linear-motion object



P : Lead of feed screw [m]
M : Load mass [kg]
J_A : Inertia moment of feed screw [kg·Em²]

$$J=J_A+\frac{M \cdot P^2}{4\pi^2}\ [kg \cdot m^2]$$

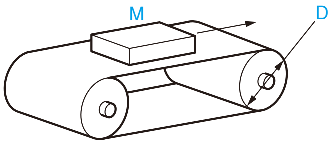
Inertia moment of a winding machine



J_A : Inertia moment of drum [kg·Em²]
D : Diameter of drum [m]
M : Load mass [kg]

$$J = J_A + \frac{1}{4} M \cdot D^2 \ [kg \cdot m^2]$$

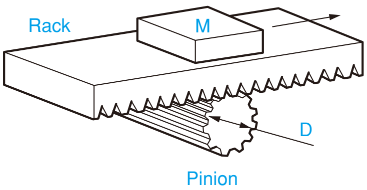
Inertia moment of a belt conveyer



J_A : Inertia moment of roller [kg·Em²]
D : Diameter of roller [m]
M : Load mass [kg]

$$J = J_A + \frac{1}{4} M \cdot D^2 \ [kg \cdot m^2]$$

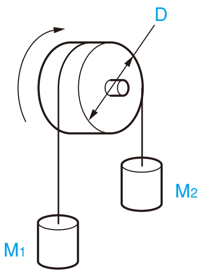
Inertia moment when running on a rack pinion



J_A : Inertia moment of pinion [kg·Em²]
D : Diameter of pinion [m]
M : Mass of rack and load [kg]

$$J = J_A + \frac{1}{4} M \cdot D^2 \ [kg \cdot m^2]$$

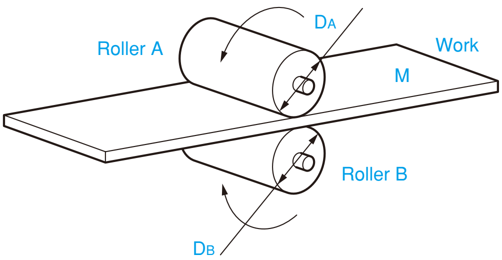
Inertia moment with a counter balance



J_A : Inertia moment of drum [kg·Em²]
D : Diameter of drum [m]
M_1, M_2 : Mass [kg]

$$J = J_A + \frac{1}{4} (M_1 + M_2) D^2 \ [kg \cdot m^2]$$

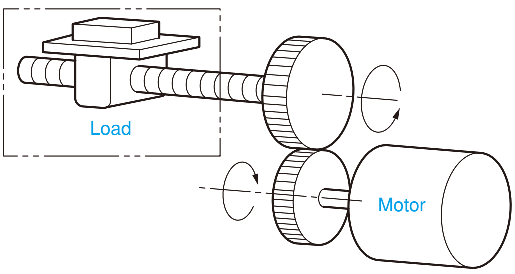
Inertia moment of a work between rollers



J_A : Inertia moment of roller A [kg·Em²]
J_B : Inertia moment of roller B [kg·Em²]
D_A : Diameter of roller A [m]
D_B : Diameter of roller B [m]
M : Equivalent mass of work [kg]

$$J = J_A + \left(\frac{D_A}{D_B}\right)^2 J_B + \frac{1}{4} M \cdot D_A^2 \ [kg \cdot m^2]$$

Inertia moment of a motor shaft conversion



Z_1 : Teeth number of motor-side gear
Z_2 : Teeth number of load-side gear
R Gear ratio Z1/Z2
J_A : Inertia moment of load [kg·Em²]
J_1 : Inertia moment of motor-side gear [kg·Em²]
J_2 : Inertia moment of load-side gear [kg·Em²]

$$J = J_1 + (J_A + J_2) R^2 \ [kg \cdot m^2]$$

Inertia moment J quick reference matrix

This table indicates the J [kg/m²] of a circular disc with a steel (ratio 7.85) thickness of 10mm and diameter of Dmm. The value per 10mm is indicated in the vertical direction and the value per 1mm increment is indicated in the horizontal direction. For discs other than 10mm, the value can be evaluated by dividing the thickness ℓmm by 10mm and multiplying the value by the value in the table. For materials other than steel, the value can be evaluated by multiplying respective factors by the value in the table.

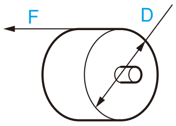
Cast iron 0.93
Aluminum 0.33
Copper 1.1

For an aluminum disc with a diameter of 205mm and thickness of 20mm, the value (0.0089826 [kg･m²]) can be evaluated by multiplying 2 by the intersection value 0.01361 in the 200 Dia. row and in the 5J column and multiplying the value by the material factor 0.33.

Dia. 〔mm〕	J〔kg･m²〕									
	0	1	2	3	4	5	6	7	8	9
10	0.000000077	0.000000113	0.000000160	0.000000220	0.000000296	0.000000390	0.000000505	0.000000644	0.000000809	0.00000104
20	0.00000123	0.00000150	0.00000181	0.00000216	0.00000256	0.00000301	0.00000352	0.00000410	0.00000474	0.00000545
30	0.00000624	0.00000712	0.00000808	0.00000914	0.00001030	0.00001156	0.00001294	0.00001444	0.00001607	0.00001783
40	0.00001973	0.00002178	0.00002398	0.00002635	0.00002889	0.00003160	0.00003451	0.00003761	0.00004091	0.00004443
50	0.00004817	0.00005214	0.00005635	0.00006081	0.00006553	0.00007052	0.00007579	0.00008135	0.00008721	0.00009339
60	0.00009988	0.0001067	0.0001139	0.0001214	0.0001293	0.0001376	0.0001462	0.0001553	0.0001648	0.0001747
70	0.0001850	0.0001958	0.0002071	0.0002189	0.0002311	0.0002439	0.0002571	0.0002709	0.0002853	0.0003002
80	0.0003157	0.0003317	0.0003484	0.0003657	0.0003837	0.0004023	0.0004216	0.0004415	0.0004622	0.0004835
90	0.0005056	0.0005285	0.0005521	0.0005765	0.0006017	0.0006277	0.0006546	0.0006823	0.0007108	0.0007403
100	0.0007707	0.0008020	0.0008342	0.0008674	0.0009016	0.0009368	0.0009730	0.001010	0.001048	0.001088
110	0.001128	0.001170	0.001213	0.001257	0.001302	0.001348	0.001395	0.001444	0.001494	0.001545
120	0.001598	0.001652	0.001707	0.001764	0.001822	0.001882	0.001942	0.002005	0.002069	0.002134
130	0.002201	0.002270	0.002340	0.002411	0.002485	0.002560	0.002636	0.002715	0.002795	0.002877
140	0.002961	0.003046	0.003133	0.003223	0.003314	0.003407	0.003502	0.003599	0.003698	0.003799
150	0.003902	0.004007	0.004114	0.004223	0.004335	0.004448	0.004564	0.004682	0.004803	0.004926
160	0.005051	0.005178	0.005308	0.005440	0.005575	0.005712	0.005852	0.005994	0.006139	0.006287
170	0.006437	0.006590	0.006745	0.006903	0.007064	0.007228	0.007395	0.007564	0.007737	0.007912
180	0.008090	0.008271	0.008456	0.008643	0.008834	0.009027	0.009224	0.009424	0.009627	0.009834
190	0.01004	0.01026	0.01047	0.01069	0.01092	0.01114	0.01137	0.01161	0.01184	0.01209
200	0.01233	0.01258	0.01283	0.01309	0.01335	0.01361	0.1388	0.01415	0.01443	0.01470
210	0.01499	0.01528	0.01557	0.01586	0.01616	0.01647	0.01678	0.01709	0.01741	0.01773
220	0.01805	0.01838	0.01872	0.01906	0.01940	0.01975	0.02010	0.02046	0.02083	0.02119
230	0.02157	0.02194	0.02233	0.02271	0.02311	0.02350	0.02391	0.02431	0.02473	0.02515
240	0.02557	0.02600	0.02643	0.02687	0.02732	0.02777	0.02822	0.02869	0.02915	0.02963
250	0.03010	0.03059	0.03108	0.03158	0.03208	0.03259	0.03310	0.03362	0.03415	0.03468
260	0.03522	0.03576	0.03631	0.03687	0.03744	0.03801	0.03858	0.03917	0.03976	0.04035
270	0.04096	0.04157	0.04218	0.04281	0.04344	0.04408	0.04472	0.04537	0.04603	0.04670
280	0.04737	0.04805	0.04874	0.04943	0.05014	0.05085	0.05156	0.05229	0.05302	0.05376
290	0.05451	0.05526	0.05603	0.05680	0.05758	0.05837	0.05916	0.05996	0.06078	0.06160
300	0.06242	0.06326	0.06411	0.06496	0.06582	0.06669	0.06757	0.06846	0.06935	0.07026
310	0.07117	0.07210	0.07303	0.07397	0.07492	0.07588	0.07685	0.07782	0.07881	0.07981
320	0.08081	0.08183	0.08285	0.08388	0.08493	0.08598	0.08704	0.08812	0.08920	0.09029
330	0.09140	0.09251	0.09363	0.09476	0.09591	0.09706	0.09823	0.09940	0.10059	0.10178
340	0.10299	0.10420	0.10543	0.10667	0.10792	0.10918	0.11045	0.11173	0.11303	0.11433
350	0.11565	0.11698	0.11832	0.11967	0.12103	0.12240	0.12379	0.12518	0.12659	0.12801
360	0.12944	0.13089	0.13234	0.13381	0.13529	0.13679	0.13829	0.13981	0.14134	0.14288
370	0.14444	0.14600	0.14758	0.14918	0.15078	0.15240	0.15404	0.15568	0.15734	0.15901
380	0.16070	0.16239	0.16411	0.16583	0.16757	0.16932	0.17109	0.17287	0.17466	0.17647
390	0.17829	0.18013	0.18198	0.18384	0.18572	0.18761	0.18952	0.19144	0.19338	0.19533
400	0.19729	0.19927	0.20127	0.20328	0.20530	0.20734	0.20940	0.21147	0.21356	0.21566
410	0.21777	0.21991	0.22205	0.22422	0.22640	0.22859	0.23080	0.23303	0.23527	0.23753
420	0.23981	0.24210	0.24441	0.24674	0.24908	0.25143	0.25381	0.25620	0.25861	0.26103
430	0.26348	0.26594	0.26841	0.27091	0.27342	0.27595	0.27849	0.28106	0.28364	0.28624
440	0.28886	0.29149	0.29414	0.29681	0.29950	0.30221	0.30494	0.30768	0.31044	0.31322
450	0.31602	0.31884	0.32168	0.32454	0.32741	0.33030	0.33322	0.33615	0.33910	0.34207
460	0.34506	0.34808	0.35111	0.35416	0.35722	0.36031	0.36342	0.36655	0.36970	0.37287
470	0.37606	0.37927	0.38251	0.38576	0.38903	0.39232	0.39564	0.39897	0.40233	0.40571
480	0.40910	0.41252	0.41597	0.41943	0.42291	0.42642	0.42995	0.43350	0.43707	0.44066
490	0.44428	0.44791	0.45158	0.45526	0.45896	0.46269	0.46644	0.47021	0.47401	0.47783
500	0.48167	0.48553	0.48942	0.49333	0.49727	0.50123	0.50521	0.50922	0.51324	0.51730

Load torque calculation formulas

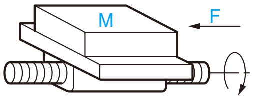
● Torque: T when an external force is added to the rotating body



D : Diameter of drum [m]
F : External force [N]

$$T=\frac{1}{2}D\cdot F\ [N\cdot m]$$

● Torque: T by frictional and external forces of a feed screw

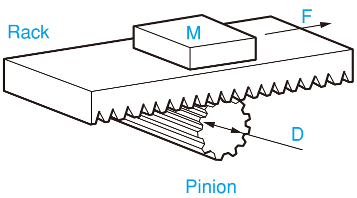


P : Lead of feed screw [m]
M : Load mass [kg]
g : Acceleration of gravity [m/s²]
μ : Friction factor of feed screw
F : External force [N]

$$T=\frac{1}{2\pi}P(F+\mu Mg)\ [N\cdot m]$$

(In ordinary practice, μ : 0.05～0.2)

● Torque: T by frictional and external forces of a rack pinion

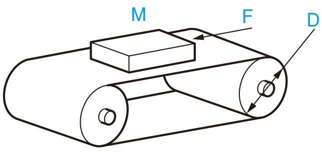


D : Diameter of pinion [m]
M : Load mass [kg]
g : Acceleration of gravity [m/s²]
μ : Friction factor of Rack pinion
F : External force [N]

$$T=\frac{1}{2}D(F+\mu Mg)\ [N\cdot m]$$

(In ordinary practice, μ : 0.08～0.1)

● Torque: T by frictional and external forces of a belt conveyer

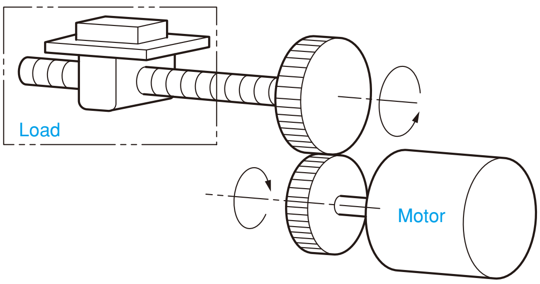


D : Diameter of roller [m]
M : Load mass [kg]
g : Acceleration of gravity [m/s²]
η : Friction factor of conveyer
F : External force [N]

$$T=\frac{1}{2}D(F+\mu Mg)\ [N\cdot m]$$

(In ordinary practice, μ : 0.05～0.1)

● Torque: To of a motor shaft conversion



Z_1 : Teeth number of motor-side gear
Z_2 : Teeth number of load-side gear
R : Gear ratio Z1/Z2
η : Transmission efficiency %/100
T : Load-side torque [N・Em]

$$T_O=\frac{R\cdot T}{\eta}\ [N\cdot m]$$

* The value of each friction factor μ varies depending on the processing accuracy or lubricated condition of the machine.
* The transmission efficiency η between motor and load is different depending on the connection method. In general, it is as follows.
Spur gear: 0.85 Chain: 0.9 V-belt: 0.9

Permissible dimensional shaft deviations

(Excerpts from JIS B 0401)

Unit [μm]

Measurement Classification [mm]		d		e			f			g		h					js			j		k		m		n	p	r	Measurement Classification [mm]	
Over	Incl.	d8	d9	e7	e8	e9	f6	f7	f8	g5	g6	h5	h6	h7	h8	h9	js5	js6	js7	j5	j6	k5	k6	m5	m6	n6	p6	r6	Over	Incl.
3	6	−30 −48	−30 −60	−20 −32	−20 −38	−20 −50	−10 −18	−10 −22	−10 −28	−4 −9	−4 −12	0 −5	0 −8	0 −12	0 −18	0 −30	±2.5	±4	±6	+3 −2	+6 −2	+6 +1	+9 +1	+9 +4	+12 +4	+16 +8	+20 +12	+23 +15	3	6
6	10	−40 −62	−40 −76	−25 −40	−25 −47	−25 −61	−13 −22	−13 −28	−13 −35	−5 −11	−5 −14	0 −6	0 −9	0 −15	0 −22	0 −36	±3	±4.5	±7.5	+4 −2	+7 −2	+7 +1	+10 +1	+12 +6	+15 +6	+19 +10	+24 +15	+28 +19	6	10
10	14	−50 −77	−50 −93	−32 −50	−32 −59	−32 −75	−16 −27	−16 −34	−16 −43	−6 −14	−6 −17	0 −8	0 −11	0 −18	0 −27	0 −43	±4	±5.5	±9	+5 −3	+8 −3	+9 +1	+12 +1	+15 +7	+18 +7	+23 +12	+29 +18	+34 +23	10	14
14	18																												14	18
18	24	−65 −98	−65 −117	−40 −61	−40 −73	−40 −92	−20 −33	−20 −41	−20 −53	−7 −16	−7 −20	0 −9	0 −13	0 −21	0 −33	0 −52	±4.5	±6.5	±10.5	+5 −4	+9 −4	+11 +2	+15 +2	+17 +8	+21 +8	+28 +15	+35 +22	+41 +28	18	24
24	30																												24	30
30	40	−80 −119	−80 −142	−50 −75	−50 −89	−50 −112	−25 −41	−25 −50	−25 −64	−9 −20	−9 −25	0 −11	0 −16	0 −25	0 −39	0 −62	±5.5	±8	±12.5	+6 −5	+11 −5	+13 +2	+18 +2	+20 +9	+25 +9	+33 +17	+42 +26	+50 +34	30	40
40	50																												40	50
50	65	−100 −146	−100 −174	−60 −90	−60 −106	−60 −134	−30 −49	−30 −60	−30 −76	−10 −23	−10 −29	0 −13	0 −19	0 −30	0 −46	0 −74	±6.5	±9.5	±15	+6 −7	+12 −7	+15 +2	+21 +2	+24 +11	+30 +11	+39 +20	+51 +32	+60 +41	50	65
65	80																											+62 +43	65	80
80	100	−120 −174	−120 −207	−72 −107	−72 −126	−72 −159	−36 −58	−36 −71	−36 −90	−12 −27	−12 −34	0 −15	0 −22	0 −35	0 −54	0 −87	±7.5	±11.5	±17.5	+6 −9	+13 −9	+18 +3	+25 +3	+28 +13	+35 +13	+45 +23	+59 +37	+73 +51	80	100
100	120																											+76 +54	100	120
120	140	−145 −208	−145 −245	−85 −125	−85 −148	−85 −185	−43 −68	−43 −83	−43 −106	−14 −32	−14 −39	0 −18	0 −25	0 −40	0 −63	0 −100	±9	±12.5	±20	+7 −11	+14 −11	+21 +3	+28 +3	+33 +15	+40 +15	+52 +27	+68 +43	+88 +63	120	140
140	160																											+90 +65	140	160
160	180																											+93 +68	160	180
180	200	−170 −242	−170 −285	−100 −146	−100 −172	−100 −215	−50 −79	−50 −96	−50 −122	−15 −35	−15 −44	0 −20	0 −29	0 −46	0 −72	0 −115	±10	±14.5	±23	+7 −13	+16 −13	+24 +4	+33 +4	+37 +17	+46 +17	+60 +31	+79 +50	+106 +77	180	200
200	225																											+109 +80	200	225
225	250																											+113 +84	225	250
250	280	−190 −271	−190 −320	−110 −162	−110 −191	−110 −240	−56 −88	−56 −108	−56 −137	−17 −40	−17 −49	0 −23	0 −32	0 −52	0 −81	0 −130	±11.5	±16	±26	+7 −16	+16 −16	+27 +4	+36 +4	+43 +20	+52 +20	+66 +34	+88 +56	+126 +94	250	280
280	315																											+130 +98	280	315
315	355	−210 −299	−210 −350	−125 −182	−125 −214	−125 −265	−62 −98	−62 −119	−62 −151	−18 −43	−18 −54	0 −25	0 −36	0 −57	0 −89	0 −140	±12.5	±18	±28.5	+7 −18	+18 −18	+29 +4	+40 +4	+46 +21	+57 +21	+73 +37	+98 +62	+144 +108	315	355
355	400																											+150 +114	355	400
400	450	−230 −327	−230 −385	−135 −198	−135 −232	−135 −290	−68 −108	−68 −131	−68 −165	−20 −47	−20 −60	0 −27	0 −40	0 −63	0 −97	0 −155	±13.5	±20	±31.5	+7 −20	+20 −20	+32 +5	+45 +5	+50 +23	+63 +23	+80 +40	+108 +68	+166 +126	400	450
450	500																											+172 +132	450	500

* The upper value in each column indicates the upper deviation, and the lower value in each column indicates the lower deviation.

Permissible dimensional bore deviations

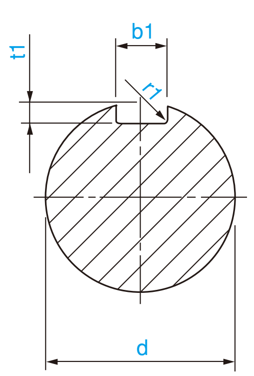
(Excerpts from JIS B 0401)

Unit [μm]

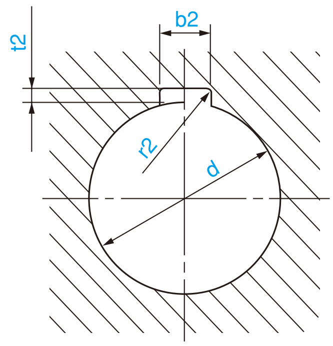
Measurement Classification [mm]		E			F			G		H						Js		J		K		M		N		P	R	Measurement Classification [mm]	
Over	Incl.	E7	E8	E9	F6	F7	F8	G6	G7	H5	H6	H7	H8	H9	H10	Js6	Js7	J6	J7	K6	K7	M6	M7	N6	N7	P7	R7	Over	Incl.
3	6	+32 +20	+38 +20	+50 +20	+18 +10	+22 +10	+28 +10	+12 +4	+16 +4	+5 0	+8 0	+12 0	+18 0	+30 0	+48 0	±4	±6	+5 −3	+6 −6	+2 −6	+3 −9	−1 −9	0 −12	−5 −13	−4 −16	−8 −20	−11 −23	3	6
6	10	+40 +25	+47 +25	+61 +25	+22 +13	+28 +13	+35 +13	+14 +5	+20 +5	+6 0	+9 0	+15 0	+22 0	+36 0	+58 0	±4.5	±7.5	+5 −4	+8 −7	+2 −7	+5 −10	−3 −12	0 −15	−7 −16	−4 −19	−9 −24	−13 −28	6	10
10	14	+50 +32	+59 +32	+75 +32	+27 +16	+34 +16	+43 +16	+17 +6	+24 +6	+8 0	+11 0	+18 0	+27 0	+43 0	+70 0	±5.5	±9	+6 −5	+10 −8	+2 −9	+6 −12	−4 −15	0 −18	−9 −20	−5 −23	−11 −29	−16 −34	10	14
14	18																											14	18
18	24	+61 +40	+73 +40	+92 +40	+33 +20	+41 +20	+53 +20	+20 +7	+28 +7	+9 0	+13 0	+21 0	+33 0	+52 0	+84 0	±6.5	±10.5	+8 −5	+12 −9	+2 −11	+6 −15	−4 −17	0 −21	−11 −24	−7 −28	−14 −35	−20 −41	18	24
24	30																											24	30
30	40	+75 +50	+89 +50	+112 +50	+41 +25	+50 +25	+64 +25	+25 +9	+34 +9	+11 0	+16 0	+25 0	+39 0	+62 0	+100 0	±8	±12.5	+10 −6	+14 −11	+3 −13	+7 −18	−4 −20	0 −25	−12 −28	−8 −33	−17 −42	−25 −50	30	40
40	50																											40	50
50	65	+90 +60	+106 +60	+134 +60	+49 +30	+60 +30	+76 +30	+29 +10	+40 +10	+13 0	+19 0	+30 0	+46 0	+74 0	+120 0	±9.5	±15	+13 −6	+18 −12	+4 −15	+9 −21	−5 −24	0 −30	−14 −33	−9 −39	−21 −51	−30 −60	50	65
65	80																										−32 −62	65	80
80	100	+107 +72	+126 +72	+159 +72	+58 +36	+71 +36	+90 +36	+34 +12	+47 +12	+15 0	+22 0	+35 0	+54 0	+87 0	+140 0	±11	±17.5	+16 −6	+22 −13	+4 −18	+10 −25	−6 −28	0 −35	−16 −38	−10 −45	−24 −59	−38 −73	80	100
100	120																										−41 −76	100	120
120	140	+125 +85	+148 +85	+185 +85	+68 +43	+83 +43	+106 +43	+39 +14	+54 +14	+18 0	+25 0	+40 0	+63 0	+100 0	+160 0	±12.5	±20	+18 −7	+26 −14	+4 −21	+12 −28	−8 −33	0 −40	−20 −45	−12 −52	−28 −68	−48 −88	120	140
140	160																										−50 −90	140	160
160	180																										−53 −93	160	180
180	200	+146 +100	+172 +100	+215 +100	+79 +50	+96 +50	+122 +50	+44 +15	+61 +15	+20 0	+29 0	+46 0	+72 0	+115 0	+185 0	±14.5	±23	+22 −7	+30 −16	+5 −24	+13 −33	−8 −37	0 −46	−22 −51	−14 −60	−33 −79	−60 −106	180	200
200	225																										−63 −109	200	225
225	250																										−67 −113	225	250
250	280	+162 +110	+191 +110	+240 +110	+88 +56	+108 +56	+137 +56	+49 +17	+69 +17	+23 0	+32 0	+52 0	+81 0	+130 0	+210 0	±16	±26	+25 −7	+36 −16	+5 −27	+16 −36	−9 −41	0 −52	−25 −57	−14 −66	−33 −88	−74 −126	250	280
280	315																										−78 −130	280	315
315	355	+182 +125	+214 +125	+265 +125	+98 +62	+119 +62	+151 +62	+54 +18	+75 +18	+25 0	+36 0	+57 0	+89 0	+140 0	+230 0	±18	±28.5	+29 −7	+39 −18	+7 −29	+17 −40	−10 −46	0 −57	−26 −62	−16 −73	−41 −98	−87 −144	315	355
355	400																										−93 −150	355	400
400	450	+198 +135	+232 +135	+290 +135	+108 +68	+131 +68	+165 +68	+60 +20	+83 +20	+27 0	+40 0	+63 0	+97 0	+155 0	+250 0	±20	±31.5	+33 −7	+43 −20	+8 −32	+18 −45	−10 −50	0 −63	−27 −67	−17 −80	−45 −108	−103 −166	400	450
450	500																										−109 −172	450	500

* The upper value in each column indicates the upper deviation, and the lower value in each column indicates the lower deviation.

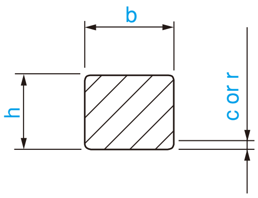
Dimensions and Tolerances of Parallel Keys and Keyways



Cross section of shaft



Cross section of bore



Cross section of key

JIS (Excerpts from JIS B 1301-1996)

Unit [mm]

Nominal dimensions of keys b×h	Applicable shaft diameters d	key dimensions: b Basic dimensions	b Tolerances (h9)	h Basic dimensions	h Tolerance		c or r	keyway dimensions: Basic dimensions of b1 and b2	Fastening type: Tolerances of b_1,b_2 (P9)	Normal type: b_1 Tolerances (N9)	Normal type: b_2 Tolerances (Js9)	r_1 and r_2	t_1 Basic dimensions	t_1 Tolerances	t_2 Basic dimensions	t_2 Tolerances
2× 2	6 to 8	2	0 −0.025	2	0 −0.025	h9	0.16 ~ 0.25	2	−0.006 −0.031	−0.004 −0.029	±0.0125	0.08 ~ 0.16	1.2	+0.1 0	1.0	+0.1 0
3× 3	8 to 10	3		3				3					1.8		1.4	
4× 4	10 to 12	4	0 −0.030	4	0 −0.030			4	−0.012 −0.042	0 −0.030	±0.0150		2.5		1.8	
5× 5	12 to 17	5		5			0.25 ~ 0.40	5				0.16 ~ 0.25	3.0		2.3	
6× 6	17 to 22	6		6				6					3.5		2.8	
8× 7	22 to 30	8	0 −0.036	7	0 −0.090	h11		8	−0.015 −0.051	0 −0.036	±0.0180		4.0	+0.2 0	3.3	+0.2 0
10× 8	30 to 38	10		8			0.40 ~ 0.60	10					5.0		3.3	
12× 8	38 to 44	12	0 −0.043	8				12	−0.018 −0.061	0 −0.043	±0.0215	0.25 ~ 0.40	5.0		3.3	
14× 9	44 to 50	14		9				14					5.5		3.8	
16×10	50 to 58	16		10				16					6.0		4.3	
18×11	58 to 65	18		11	0 −0.110			18					7.0		4.4	
20×12	65 to 75	20	0 −0.052	12			0.60 ~ 0.80	20	−0.022 −0.074	0 −0.052	±0.0260	0.40 ~ 0.60	7.5		4.9	
22×14	75 to 85	22		14				22					9.0		5.4	
25×14	85 to 95	25		14				25					9.0		5.4	
28×16	95 to 110	28		16				28					10.0		6.4	
32×18	110 to 130	32	0 −0.062	18				32	−0.026 −0.088	0 −0.062	±0.0310		11.0		7.4	

Previous edition of JIS First class (Excerpts form JIS B 1301-1959)

Unit [mm]

Nominal dimensions of keys b×h	Applicable shaft diameters d	key dimensions: b Basic dimensions	b Tolerances (h7)	h Basic dimensions	h Tolerances (h9)	c or r	keyway dimensions: Basic dimensions of b1 and b2	b_1 Tolerances (H8)	b_2 Tolerances (F7)	r_1 and r_2	t_1 Basic dimensions	t_1 Tolerances	t_2 Basic dimensions	t_2 Tolerances
4× 4	10 or more 13 or less	4	+0.024 +0.012	4	0 −0.030	0.5	4	+0.018 0	+0.022 +0.010	0.4	2.5	+0.05 0	1.5	+0.05 0
5× 5	More than 13 20 or less	5		5			5				3		2	
7× 7	More than 20 30 or less	7	+0.030 +0.015	7	0 −0.036		7	+0.022 0	+0.028 +0.013		4		3	
10× 8	More than 30 40 or less	10		8		0.8	10			0.6	4.5		3.5	
12× 8	More than 40 50 or less	12	+0.036 +0.018	8			12	+0.027 0	+0.034 +0.016		4.5		3.5	
15×10	More than 50 60 or less	15		10			15				5		5	
18×12	More than 60 70 or less	18		12	0 −0.043	1.2	18			1.0	6		6	
20×13	More than 70 80 or less	20	+0.043 +0.022	13			20	+0.033 0	+0.041 +0.020		7		6	
24×16	More than 80 95 or less	24		16			24				8		8	
28×18	More than 95 110 or less	28		18			28				9		9	
32×20	More than 110 125 or less	32	+0.051 +0.026	20	0 −0.052	2	32	+0.039 0	+0.050 +0.025	1.6	10		10	

Previous edition of JIS Second class (Excerpts from JIS B 1301-1959)

Unit [mm]

Nominal dimensions of keys b×h	Applicable shaft diameters d	key dimensions: b Basic dimensions	b Tolerances (h8)	h Basic dimensions	h Tolerances (h10)	c or r	keyway dimensions: Basic dimensions of b1 and b2	b_1 Tolerances (H9)	b_2 Tolerances (E9)	r_1 and r_2	t_1 Basic dimensions	t_1 Tolerances	t_2 Basic dimensions	t_2 Tolerances
4× 4	10 or more 13 or less	4	0 −0.018	4	0 −0.048	0.5	4	+0.030 0	+0.050 +0.020	0.4	2.5	+0.1 0	1.5	+0.1 0
5× 5	More than 13 20 or less	5		5			5				3		2	
7× 7	More than 20 30 or less	7	0 −0.022	7	0 −0.058		7	+0.036 0	+0.061 +0.025		4		3	
10× 8	More than 30 40 or less	10		8		0.8	10			0.6	4.5		3.5	
12× 8	More than 40 50 or less	12	0 −0.027	8			12	+0.043 0	+0.075 +0.032		4.5		3.5	
15×10	More than 50 60 or less	15		10			15				5		5	
18×12	More than 60 70 or less	18		12	0 −0.070	1.2	18			1.0	6		6	
20×13	More than 70 80 or less	20	0 −0.033	13			20	+0.052 0	+0.092 +0.040		7		6	
24×16	More than 80 95 or less	24		16			24				8		8	
28×18	More than 95 110 or less	28		18			28				9		9	
32×20	More than 110 125 or less	32	0 −0.039	20	0 −0.084	2	32	+0.062 0	+0.112 +0.050	1.6	10		10	

Miki Pulley clutches and brakes standard bore machining specifications

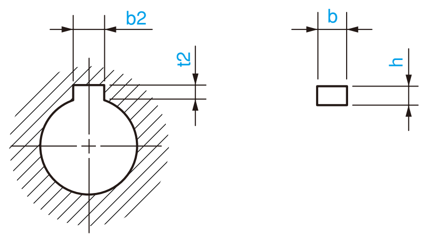
1 Bore machining tolerances for mating shaft tolerance

Unless there is a request, it is machining by H7. For below 10mm of spring-applied brakes, it is H8. Except the tolerance class H7, prearrangement is necessary. When an additional machining of a pilot bore is performed, the surface treatment of the machining portion is shaved. If an additional surface treatment after bore machining is necessary, contact us.
The shaft tolerance by load condition is as follows.

Load conditions	Shaft tolerances	Notes
Shaft below (ϕ 10)	h6 h7	If accuracy is required, it should be h5.
Light/Normal load and variable load	h6 js6 js7 j6 j7	H6 for motor shaft J6 for clutch and brake unit shaft
Heavy load and impact load	K6 K7 m6	

* A keyway is not processed for a bore processing under 10mm.

2 Keyway dimensions for bore diameters (following table)



Previous edition of JIS (Second class) correspondence

Unit [mm]

Bore dia.	b2		t2		Keyway dimensions b×h
	Basic dimensions	Tolerances (E9)	Basic dimensions	Tolerances	
10 or more 13 or less	4	+0.05 +0.02	1.5	+0.5 0	4×4
More than 13 20 or less	5		2.0		5×5
More than 20 30 or less	7	+0.061 +0.025	3.0		7×7
More than 30 40 or less	10		3.5		10×8
More than 40 50 or less	12	+0.075 +0.032			12×8
More than 50 60 or less	15		5.0		15×10
More than 60 70 or less	18		6.0		18×12
More than 70 80 or less	20	+0.092 +0.040			20×13

* Recommended key specification is former JIS 1class (width tolerance P7).

New JIS correspondence

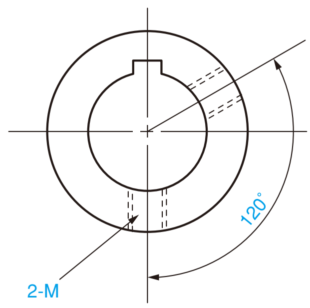
Unit [mm]

Bore dia.	b2		t2		Keyway dimensions b×h
	Basic dimensions	Tolerances (P9)	Basic dimensions	Tolerances	
6 or more 8 or less	2	−0.006 −0.031	0.8	+0.3 0	2×2
More than 8 10 or less	3		1.2		3×3
More than 10 12 or less	4	−0.012 −0.042	1.5	+0.5 0	4×4
More than 12 17 or less	5		2.0		5×5
More than 17 22 or less	6		2.5		6×6
More than 22 30 or less	8	−0.015 −0.051	3.0		8×7
More than 30 38 or less	10				10×8
More than 38 44 or less	12	−0.018 −0.061			12×8
More than 44 50 or less	14		3.5		14×9
More than 50 58 or less	16		4.0		16×10
More than 58 65 or less	18				18×11
More than 65 75 or less	20	−0.022 −0.074	4.5		20×12
More than 75 85 or less	22		5.0		22×14

* Recommended key specification is new JIS (width tolerance h9).

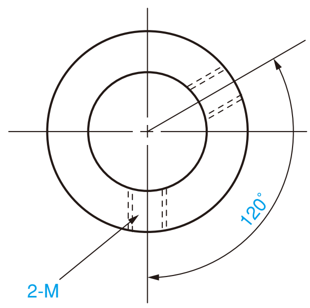
3 Setscrew nominal diameter for keyway

Keyway basic dimensions b2	Setscrew nominal diameters
4	M4
5	M4
6	M5
7	M6
8	M6
10	M8
12	M8
14	M10
15	M10
16	M10,M12
18	M12,M16
20	M16
22	M16



4 Setscrew nominal diameter for bore diameter (in the case of no keyway)

Bore diameter	Setscrew nominal diameter
More than 6 less than 10	M3



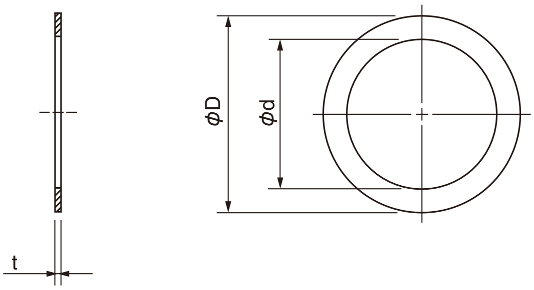
Note

This specification is applicable to bore machining of 6mm˜85mm for the following products. For the clutches and brakes with bore machining as a standard product, it may not suitable.

■Applicable products

- Micro electromagnetic clutches and brakes (except CYT model)
- Electromagnetic clutches and brakes (except CSZ and BSZ model)
- Tooth clutches
- Spring-applied brakes (except BXW model)

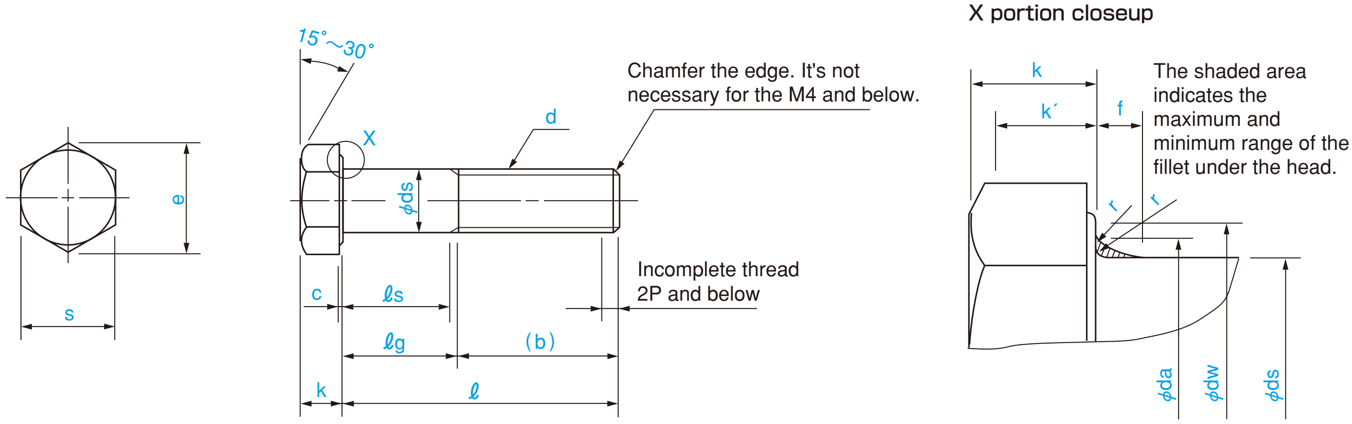
Shim dimensions



Unit [mm]

Inside diameters φ d	Outside diameters φ D	Thickness t				Applicable shafts	Applicable bores
		0.05	0.1	0.15	0.5		
6.3	8.7	○	○	—	○	6	
8.3	11.7	○	○	—	○	8	
10.3	13.7	○	○	—	○	10	
12.3	15.7	—	○	○	○	12	
15.3	20.7	—	○	○	○	15	
17.3	25.7	—	○	○	○	17	26
20.3	27.7	—	○	○	○	20	28
25.3	31.7	—	○	○	○	25	32
25.3	34.7	—	○	—	○	25	35
30.3	39.7	—	○	○	○	30	40
35.3	41.7	—	○	○	○	35	42
35.3	46.7	—	○	—	○	35	47
40.3	51.7	—	○	○	○	40	52
45.3	51.7	—	○	○	○	45	52
45.3	54.7	—	○	—	○	45	55
50.3	61.7	—	○	—	○	50	62
50.3	67.7	—	○	—	○	50	68
55.3	67.7	—	○	—	○	55	68
60.3	71.7	—	○	—	○	60	72
60.3	84.7	—	○	—	○	60	85
65.3	79.7	—	○	—	○	65	80
70.3	79.7	—	○	—	○	70	80
75.3	89.7	—	○	—	○	75	90
85.3	99.7	—	○	—	○	85	100
90.3	109.7	—	○	—	○	90	110
105.3	124.7	—	○	—	○		125
115.3	129.7	—	○	—	○		130

Configurations and Dimensions of Hexagon Bolts (Grade A parts) (Excerpts from JIS B 1180-1985)



Unit [mm]

Nominal designations (d)		M3	M4	M5	M6	M8	M10	M12	(M14)	M16	M20	M24
Screw pitches (P)		0.5	0.7	0.8	1	1.25	1.5	1.75	2	2	2.5	3
b (Reference)	ℓ ≦125	12	14	16	18	22	26	30	34	38	46	54
	125< ℓ ≦150	—	—	—	—	—	—	—	40	44	52	60
c	Minimum	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.2	0.2	0.2
	Maximum	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.8	0.8	0.8
da	Maximum	3.6	4.7	5.7	6.8	9.2	11.2	13.7	15.7	17.7	22.4	26.4
ds	Max (Basic dimensions)	3	4	5	6	8	10	12	14	16	20	24
	Minimum	2.86	3.82	4.82	5.82	7.78	9.78	11.73	13.73	15.73	19.67	23.67
dw	Minimum	4.57	5.88	6.88	8.88	11.63	14.63	16.63	19.64	22.49	28.19	33.61
e	Minimum	6.01	7.66	8.79	11.05	14.38	17.77	20.03	23.36	26.75	33.53	39.98
f	Maximum	1	1.2	1.2	1.4	2	2	3	3	3	4	4
k	Designations (Basic dimensions)	2	2.8	3.5	4	5.3	6.4	7.5	8.8	10	12.5	15
	Minimum	1.875	2.675	3.35	3.85	5.15	6.22	7.32	8.62	9.82	12.285	14.785
	Maximum	2.125	2.925	3.65	4.15	5.45	6.58	7.68	8.98	10.18	12.715	15.215
k'	Minimum	1.31	1.87	2.35	2.7	3.61	4.35	5.12	6.03	6.87	8.6	10.35
r	Minimum	0.1	0.2	0.2	0.25	0.4	0.4	0.6	0.6	0.6	0.8	0.8
s	Max (Basic dimensions)	5.5	7	8	10	13	16	18	21	24	30	36
	Minimum	5.32	6.78	7.78	9.78	12.73	15.73	17.73	20.67	23.67	29.67	35.38

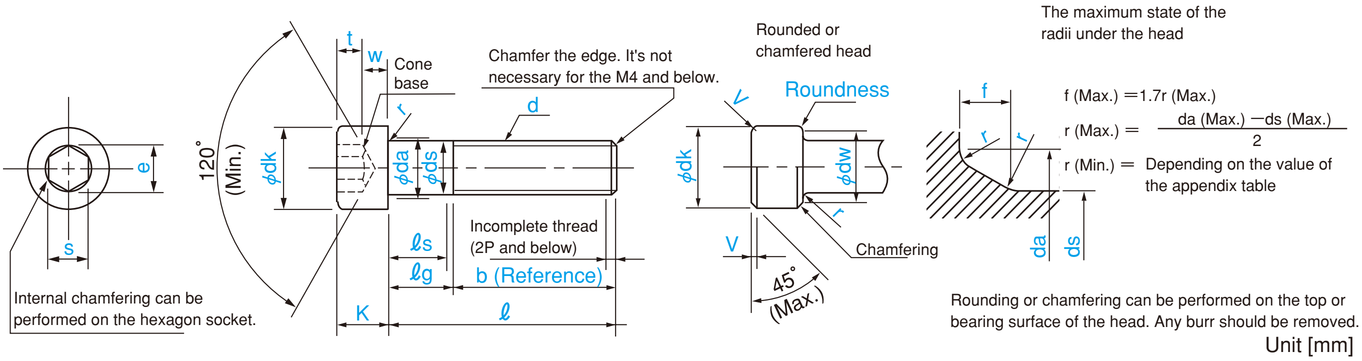
* The nominal diameter in parentheses is preferably not to be used.

Unit [mm]

Nominal designations			M3		M4		M5		M6		M8		M10		M12		(M14)		M16		M20		M24	
ℓ			ℓs and ℓg																					
Nominal lengths (Basic dimensions)	Min.	Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.
20	19.58	20.42	5.5	8																				
25	24.58	25.42	10.5	13	7.5	11	5	9																
30	29.58	30.42	15.5	18	12.5	16	10	14	7	12														
35	34.5	35.5			17.5	21	15	19	12	17														
40	39.5	40.5			22.5	26	20	24	17	22	11.75	18												
45	44.5	45.5					25	29	22	27	16.75	23	11.5	19										
50	49.5	50.5					30	34	27	32	21.75	28	16.5	24	11.25	20								
55	54.4	55.6							32	37	26.75	33	21.5	29	16.25	25								
60	59.4	60.6							37	42	31.75	38	26.5	34	21.25	30	16	26						
65	64.4	65.6									36.75	43	31.5	39	26.25	35	21	31	17	27				
70	69.4	70.6									41.75	48	36.5	44	31.25	40	26	36	22	32				
80	79.4	80.6									51.75	58	46.5	54	41.25	50	36	46	32	42	21.5	34		
90	89.3	90.7											56.5	64	51.25	60	46	56	42	52	31.5	44	21	36
100	99.3	100.7											66.5	74	61.25	70	56	66	52	62	41.5	54	31	46
110	109.3	110.7													71.25	80	66	76	62	72	51.5	64	41	56
120	119.3	120.7													81.25	90	76	86	72	82	61.5	74	51	66
130	129.2	130.8															80	90	76	86	65.5	78	55	70
140	139.2	140.8															90	100	86	96	75.5	88	65	80
150	149.2	150.8																	96	106	85.5	98	75	90

* The gray portion ( ) indicates the nominal length (ℓ) recommended for the nominal designations.

Configurations and Dimensions of Hexagon Socket Bolts (Excerpts from JIS B 1176-1988)



Unit [mm]

Nominal designations (d)		M1.6	M2	M2.5	M3	M4	M5	M6	M8	M10	M12	(M14)	M16	(M18)	M20
Screw pitches (P)		0.35	0.4	0.45	0.5	0.7	0.8	1	1.25	1.5	1.75	2	2	2.5	2.5
b	References	15	16	17	18	20	22	24	28	32	36	40	44	48	52
dk	Max (Basic dimensions) *1	3	3.8	4.5	5.5	7	8.5	10	13	16	18	21	24	27	30
dk	Maximum *2	3.14	3.98	4.68	5.68	7.22	8.72	10.22	13.27	16.27	18.27	21.33	24.33	27.33	30.33
dk	Minimum	2.86	3.62	4.32	5.32	6.78	8.28	9.78	12.73	15.73	17.73	20.67	23.67	26.67	29.67
da	Maximum	2	2.6	3.1	3.6	4.7	5.7	6.8	9.2	11.2	13.7	15.7	17.7	20.2	22.4
ds	Max (Basic dimensions)	1.6	2	2.5	3	4	5	6	8	10	12	14	16	18	20
ds	Minimum	1.46	1.86	2.36	2.86	3.82	4.82	5.82	7.78	9.78	11.73	13.73	15.73	17.73	19.67
e	Minimum	1.73	1.73	2.30	2.87	3.44	4.58	5.72	6.86	9.15	11.43	13.72	16.00	16.00	19.44
f	Maximum	0.34	0.51	0.51	0.51	0.60	0.60	0.68	1.02	1.02	1.45	1.45	1.45	1.87	2.04
k	Max (Basic dimensions)	1.6	2	2.5	3	4	5	6	8	10	12	14	16	18	20
k	Minimum	1.46	1.86	2.36	2.86	3.82	4.82	5.70	7.64	9.64	11.57	13.57	15.57	17.57	19.48
r	Minimum	0.1	0.1	0.1	0.1	0.2	0.2	0.25	0.4	0.4	0.6	0.6	0.6	0.6	0.8
s	Designations (Basic dimensions)	1.5	1.5	2	2.5	3	4	5	6	8	10	12	14	14	17
s	Minimum	1.52	1.52	2.02	2.52	3.02	4.02	5.02	6.02	8.025	10.025	12.032	14.032	14.032	17.050
s	Max. Column 1	1.560	1.560	2.060	2.580	3.080	4.095	5.140	6.140	8.175	10.175	12.212	14.212	14.212	17.230
s	Max. Column 2	1.545	1.545	2.045	2.560	3.080	4.095	5.095	6.095	8.155	10.115	12.142	14.142	14.142	17.230
t	Minimum	0.7	1	1.1	1.3	2	2.5	3	4	5	6	7	8	9	10
v	Maximum	0.16	0.2	0.25	0.3	0.4	0.5	0.6	0.8	1	1.2	1.4	1.6	1.8	2
dw	Minimum	2.72	3.40	4.18	5.07	6.53	8.03	9.38	12.33	15.33	17.23	20.17	23.17	25.87	28.87
w	Minimum	0.55	0.55	0.85	1.15	1.4	1.9	2.3	3.3	4	4.8	5.8	6.8	7.7	8.6

* Perform a knurling on the side surface of the head. In this case, the maximum dk is shown in the Maximum*2. For no knurling, refer to the Maximum *1.
* The column 1 of the S (Maximum) is used for the strength class 8.8 and 10.9, and for the property class A2-50 and A2-70. The column 2 is applied to the strength class 12.9. The column 1 can be applied to the strength class 12.9 by agreement of the parties concerned.
* The nominal diameters in parentheses are preferably not to be used.

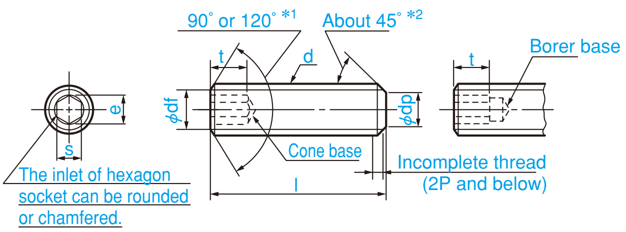
Unit [mm]

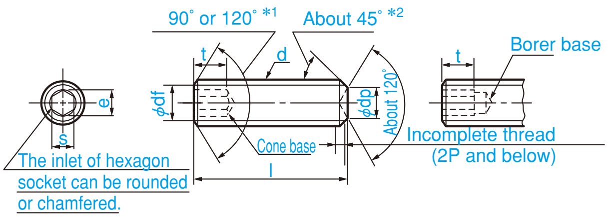
Nominal designations			M1.6		M2		M2.5		M3		M4		M5		M6		M8		M10		M12		(M14)		M16		(M18)		M20	
ℓ			ℓ s and ℓ g																											
Nominal lengths	Min.	Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.	ℓ s Min.	ℓ g Max.
2.5	2.30	2.70																												
3	2.80	3.20																												
4	3.76	4.24																												
5	4.76	5.24																												
6	5.76	6.24																												
8	7.71	8.29																												
10	9.71	10.29																												
12	11.65	12.35																												
16	15.65	16.35																												
20	19.58	20.42			2	4																								
25	24.58	25.42					5.75	8	4.5	7																				
30	29.58	30.42							9.5	12	6.5	10	4	8																
35	34.5	35.5									11.5	15	9	13	6	11														
40	39.5	40.5									16.5	20	14	18	11	16	5.75	12												
45	44.5	45.5											19	23	16	21	10.75	17	5.5	13										
50	49.5	50.5											24	28	21	26	15.75	22	10.5	18	5.25	14								
55	54.4	55.6													26	31	20.75	27	15.5	23	10.25	19								
60	59.4	60.6													31	36	25.75	32	20.5	28	15.25	24	10	20	6	16				
65	64.4	65.6															30.75	37	25.5	33	20.25	29	15	25	11	21	4.5	17		
70	69.4	70.6															35.75	42	30.5	38	25.25	34	20	30	16	26	9.5	22	5.5	18
80	79.4	80.6															45.75	52	40.5	48	35.25	44	30	40	26	36	19.5	32	15.5	28
90	89.3	90.7																	50.5	58	45.25	54	40	50	36	46	29.5	42	25.5	38
100	99.3	100.7																	60.5	68	55.25	64	50	60	46	56	39.5	52	35.5	48
110	109.3	110.7																			65.25	74	60	70	56	66	49.5	62	45.5	58
120	119.3	120.7																			75.25	84	70	80	66	76	59.5	72	55.5	68
130	129.2	130.8																					80	90	76	86	69.5	82	65.5	78
140	139.2	140.8																					90	100	86	96	79.5	92	75.5	88
150	149.2	150.8																							96	106	89.5	102	85.5	98
160	159.2	160.8																							106	116	99.5	112	95.5	108
180	179.2	180.8																									119.5	132	115.5	128
200	199.05	200.95																											135.5	148

* The gray portion ( ) indicates the nominal lengths (ℓ) recommended for the nominal designations. Besides, the nominal length (ℓ) that is above the dashed line position is a complete thread. The incomplete thread length under the head is about 3P.

Configurations and Dimensions of Hexagon socket set screws (Excerpts from JIS B 1176-1988)

The inlet of a hexagon socket can be rounded or chamfered.





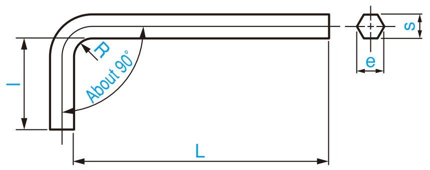
Nominal designations (d)				M1.6	M2	M2.5	M3	M4	M5	M6	M8	M10	M12	M16	M20	M24
Pitches (P)				0.35	0.4	0.45	0.5	0.7	0.8	1	1.25	1.5	1.75	2	2.5	3
dp	Maximum			0.80	1.00	1.5	2.00	2.50	3.5	4	5.5	7.00	8.50	12.00	15.00	18.00
	Minimum			0.55	0.75	1.25	1.75	2.25	3.2	3.7	5.2	6.64	8.14	11.57	14.57	17.57
dz	Maximum			0.80	1.00	1.20	1.40	2.00	2.50	3.00	5.0	6.0	8.00	10.00	14.00	16.00
	Minimum			0.55	0.75	0.95	1.15	1.75	2.25	2.75	4.7	5.7	7.64	9.64	13.57	15.57
df				Almost the diameter of screw groove												
e*3	Minimum			0.803	1.003	1.427	1.73	2.3	2.87	3.44	4.58	5.72	6.86	9.15	11.43	13.72
s*4	Designation			0.7	0.9	1.3	1.5	2	2.5	3	4	5	6	8	10	12
	Maximum			0.724	0.902	1.295	1.545	2.045	2.560	3.071	4.084	5.084	6.095	8.115	10.115	12.142
	Minimum			0.711	0.889	1.270	1.520	2.020	2.520	3.020	4.020	5.020	6.020	8.025	10.025	12.032
t	Minimum*5			0.7	0.8	1.2	1.2	1.5	2	2	3	4	4.8	6.4	8	10
	Minimum*6			1.5	1.7	2	2	2.5	3	3.5	5	6	8	10	12	15
	ℓ			(Reference) Outline mass per 1000 units / kg (Density:7.85kg/dm³)												
	Nominal lengths	Minimum	Maximum													
Flat point	2	1.8	2.2	0.021	0.029	0.05	0.059									
	2.5	2.3	2.7	0.025	0.037	0.063	0.08	0.099								
	3	2.8	3.2	0.029	0.044	0.075	0.1	0.14	0.2							
	4	3.76	4.24	0.037	0.059	0.1	0.14	0.22	0.32	0.41						
	5	4.76	5.24	0.046	0.074	0.125	0.18	0.3	0.44	0.585	0.945					
	6	5.76	6.24	0.054	0.089	0.15	0.22	0.38	0.56	0.76	1.26	1.77				
	8	7.71	8.29	0.07	0.119	0.199	0.3	0.54	0.8	1.11	1.89	2.78	4			
	10	9.71	10.29		0.148	0.249	0.38	0.7	1.04	1.46	2.52	3.78	5.4	8.5		
	12	11.65	12.35			0.299	0.46	0.86	1.28	1.81	3.15	4.78	6.8	11.1	15.8	
	16	15.65	16.35				0.62	1.18	1.76	2.51	4.41	6.78	9.6	16.3	24.1	30
	20	19.58	20.42					1.49	2.24	3.21	5.67	8.76	12.4	21.5	32.3	42
	25	24.58	25.42						2.84	4.09	7.25	11.2	15.9	28	42.6	57
	30	29.58	30.42							4.94	8.82	13.7	19.4	34.6	52.9	72
	35	34.5	35.5								10.4	16.2	22.9	41.1	63.2	87
	40	39.5	40.5								12	18.7	26.4	47.7	73.5	102
	45	44.5	45.5									21.2	29.9	54.2	83.8	117
	50	49.5	50.5									23.7	33.4	60.7	94.1	132
	55	54.4	55.6										36.8	67.3	104	147
	60	59.4	60.6										40.3	73.7	115	162
Concave point	2	1.8	2.2	0.019	0.029	0.05										
	2.5	2.3	2.7	0.025	0.037	0.063	0.079									
	3	2.8	3.2	0.029	0.044	0.075	0.1	0.155								
	4	3.76	4.24	0.037	0.059	0.1	0.14	0.23	0.3							
	5	4.76	5.24	0.046	0.074	0.125	0.18	0.305	0.42	0.565						
	6	5.76	6.24	0.054	0.089	0.15	0.22	0.38	0.54	0.74	1.25					
	8	7.71	8.29	0.07	0.119	0.199	0.3	0.53	0.78	1.09	1.88	2.71				
	10	9.71	10.29		0.148	0.249	0.38	0.68	1.02	1.44	2.51	3.72	5.3			
	12	11.65	12.35			0.299	0.46	0.83	1.26	1.79	3.14	4.73	6.7	10.5		
	16	15.65	16.35				0.62	1.13	1.74	2.49	4.4	6.73	9.5	15.7	22.9	
	20	19.58	20.42					1.42	2.22	3.19	5.66	8.72	12.3	20.9	31.1	40.2
	25	24.58	25.42						2.82	4.07	7.24	11.2	15.8	27.4	41.4	55.2
	30	29.58	30.42							4.94	8.81	13.7	19.3	33.9	51.7	70.3
	35	34.5	35.5								10.4	16.2	22.7	40.4	62	85.3
	40	39.5	40.5								12	18.7	26.2	46.9	72.3	100
	45	44.5	45.5									21.2	29.7	53.3	82.6	115
	50	49.5	50.5									23.6	33.2	59.8	92.6	130
	55	54.4	55.6										36.6	66.3	103	145
	60	59.4	60.6										40.1	72.8	114	160

* *1 For the nominal lengths (ℓ) that is shorter than the stepped double line, perform a 120° of chamfering.
* *2 The angle of approx. 45° corresponds to the slope portion below the core diameter.
* *3 e minimum= 1.14 x s minimum. Nominal diameters M1.6, M2 and M2.5 are excluded.
* For the *4 s, use the specified hexagon socket gauge to examine.
* The upper value of *5 t minimum is applicable to the nominal lengths (ℓ) shorter than the stepped double line.
* The lower value of *6 t minimum is applicable to the nominal lengths (ℓ) longer than the stepped double line.

Remarks

1. The recommended nominal lengths (ℓ) for the nominal designations are indicated within the heavy-line frame.
2. Dimensional symbols correspond to the JIS B 0143.
3. The configuration of a hexagon socket base can be either cone or borer base. For a borer base, the bore depth must not be more than 1.2 times the hexagon socket depth t.

Configurations and Dimensions of Hexagon bar wrenches (Excerpts from JIS B 4648-1994)



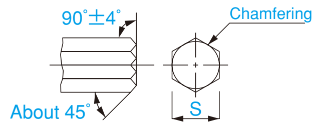
Nominal designations	Configurations/Dimensions [mm]							Mechanical properties		
	s		e		L	l	R	Hardness (Min.) *1		Proof torque *2 [N · m]
	Max.	Min.	Max.	Min.	About	About	About	Rockwell hardness	Vickers hardness	
0.7	0.711	0.698	0.79	0.76	32	6	1.5			0.08
0.9	0.889	0.876	0.99	0.96	32	10	1.5			0.18
1.3	1.270	1.244	1.42	1.37	40	12	1.5			0.53
1.5	1.500	1.475	1.68	1.63	45	14	1.5			0.82
2	2.00	1.960	2.25	2.18	50	16	2	52HRC	545HV	1.9
2.5	2.50	2.460	2.82	2.75	56	18	2.5			3.8
3	3.00	2.960	3.39	3.31	63	20	3			6.6
4	4.00	3.952	4.53	4.44	70	25	4			16
5	5.00	4.952	5.67	5.58	80	28	5			30
6	6.00	5.952	6.81	6.71	90	32	6			52
8	8.00	7.942	9.09	8.97	100	36	8	50HRC	513HV	120
10	10.00	9.942	11.37	11.23	112	40	10			220
12	12.00	11.89	13.65	13.44	125	45	12	48HRC	485HV	370
14	14.00	13.89	15.93	15.70	140	56	14			590
17	17.00	16.89	19.35	19.09	160	63	17			980
19	19.00	18.87	21.63	21.32	180	70	19			1360
22	22.00	21.87	25.05	24.71	200	80	22			2110
24	24.00	23.87	27.33	26.97	224	90	24	45HRC	446HV	2750
27	27.00	26.87	30.75	30.36	250	100	27			3910
32	32.00	31.84	36.45	35.98	315	125	32			6510
36	36.00	35.84	41.01	40.50	355	140	36			9260

* The hardness *1 corresponds to either Rockwell hardness or Vickers hardness.
* A wrench will not be damaged by the torque *2 or below. Avoid any abnormalities such as unendurable torsion, hexagon shape deformation or bending.

Remarks

Chamfering of the wrench edge is not necessary if it can be inserted easily into the hexagon socket. If chamfering is required, leave the width across bolt (s) as shown in the right figure. Besides, the side surfaces of long and short shafts are at a right angle to respective shafts.
Therefore, it must not bend more than ±4°. (Refer to the right figure.)

Chamfering of spanner edge



Proof torque of strength class 45H (Reference)

Nominal designations d	Proof torques [N·m]	Recommended tightening torques [N·m]	Wrench sizes
M1.6	0.07	0.04	0.7
2	0.15	0.09	0.9
2.5	0.44	0.26	1.3
(2.6)	0.44	0.26	1.3
3	1.17	0.69	1.5
4	2.74	1.67	2
5	5.88	3.53	2.5
6	9.8	5.9	3
8	23.5	14.2	4
10	45.1	27.5	5
12	77.5	47.1	6
(14)	88.3	53.0	6
16	186	118	8
(18)	211	128	8
20	363	216	10

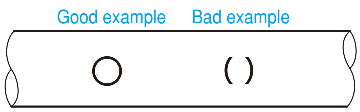
How to use Hexagon socket set screws

Hexagon socket set screws are widely used as a fixation method of shafts and hubs or flanges. It is a highly reliable and a low cost method if it is used properly. How to use hexagon socket set screws based on test results is described below. Use as a reference for size selection.

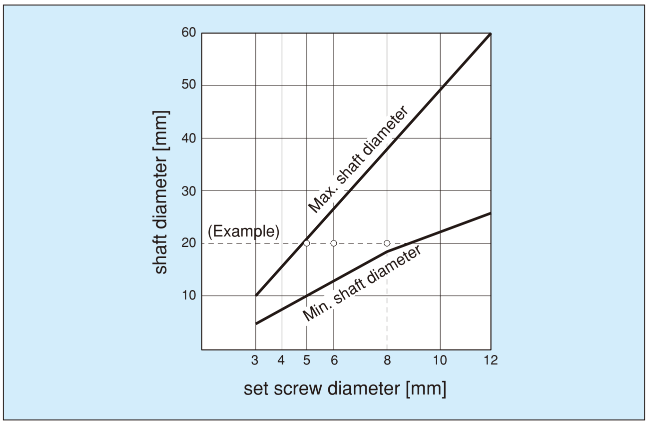
How to select a set screw

1 Shaft diameter and set screw size

The impression of screw tip should clearly appear on the shaft cylinder surface. A correlation between the shaft diameters and set screws are shown below.



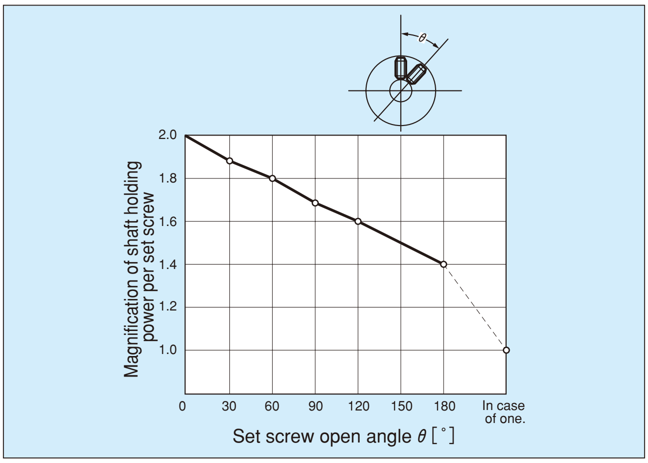
Screw tip impression



Correlation between the set screws and shaft diameters

2 If the size of set screw can not be enlarged

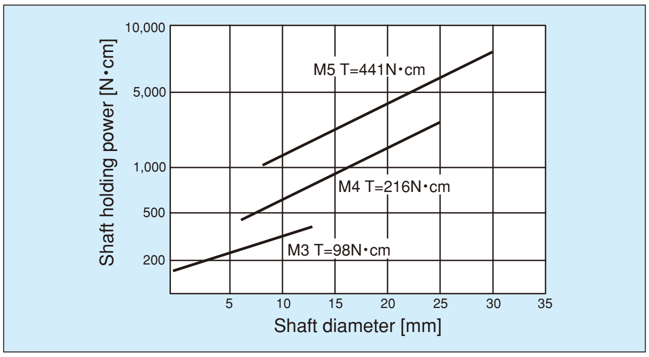
Two set screws are sometimes used when a large shaft holding power is required. However, using two set screws does not necessarily mean that the shaft holding power is doubled. This is because shaft holding power is different depending on the open angle (alignment) between two set screws. The following diagram indicates the relationship between set screw open angles and shaft holding power.



Correlation between the set screw open angles and shaft holding power

3 Shaft diameter and shaft holding power

The fixation limit (shaft holding power) of shaft and hub or flange is related to the friction factor between the tip of set screw and shaft. The fixation limit based on the data of examination results is described below.

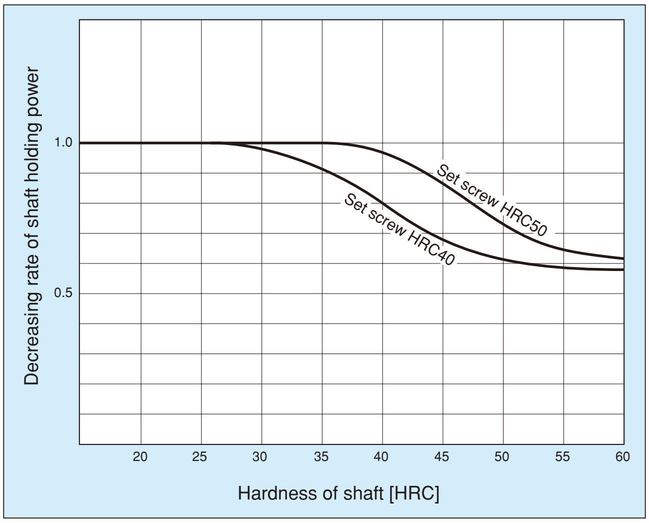


Correlation between the shaft diameters and shaft holding power (concave point)

* Shaft holding power of set screws are related to the size of the shaft diameter.

4 Hardness and shaft holding power

Shaft holding power decreases as the hardness of the shaft increases. The relationship between the hardness and the shaft holding power is described below.

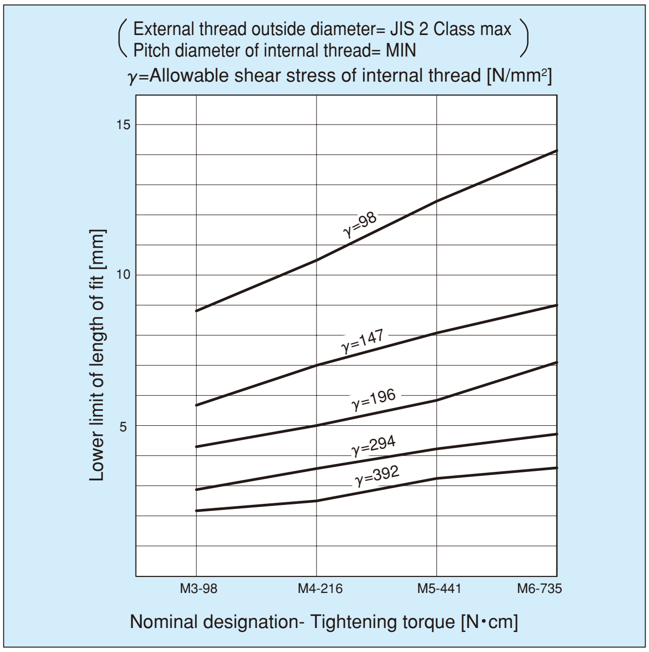


Correlation between the set screws and shaft hardness and shaft holding power

Internal thread

1 Set screw and length of fit

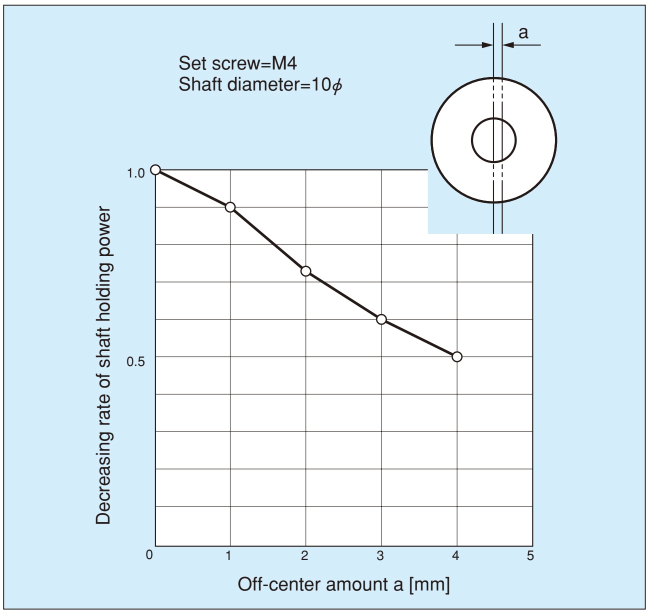
Because of the widespread use of zinc die casting or iron sintered alloy an internal thread material, the maximum load of internal thread decreases, and which can be a source of trouble. However, it can be solved by increasing the thickness of the internal thread part. The relationship between the length of fit and the material strength is described below.



Correlation between the strength of internal threads and set screw lengths of fit

2 Off-center distance of internal thread bore

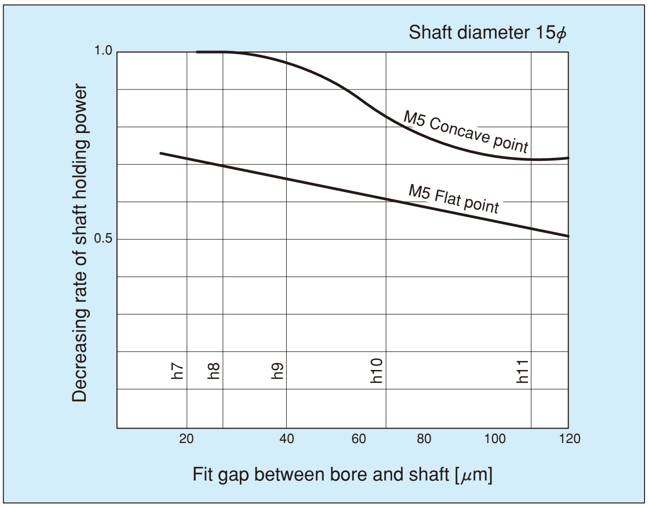
If the internal thread bore is not centered with the shaft center, the shaft holding power may decrease. The following is the test results using a M4 set screw.



Correlation between the off-center distance of setscrew bores and shaft holding power

Accuracy of fit between shaft and hub or flange bore

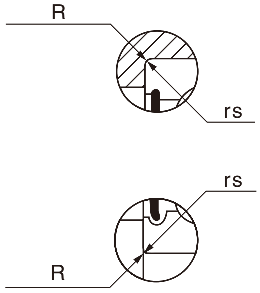
As indicated below, shaft holding power doesn't decrease till shaft accuracy of h9. However, the effect of fit accuracy is expected in the actual use environment.

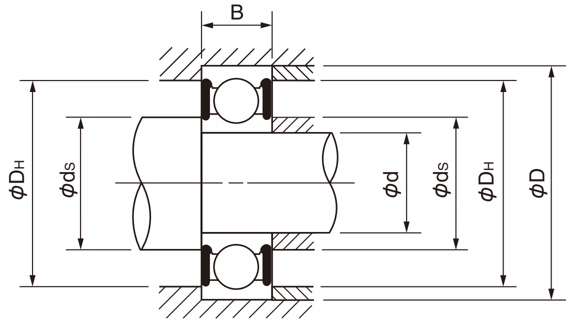


Correlation between the fit accuracy with bush bores and shaft holding power

Reference: Socket screw group technology
How to select and use hexagon socket set screw

Bearing mounting methods





Unit [mm]

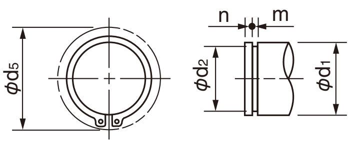
Nominal No.	d	D	B	rs min	DH max	ds min	R max
6000	10	26	8	0.3	23.5	12.5	0.3
6001	12	28	8	0.3	25.5	14.5	0.3
6002	15	32	9	0.3	29.5	17.5	0.3
6003	17	35	10	0.3	32.5	19.5	0.3
6004	20	42	12	0.6	37	25	0.6
6005	25	47	12	0.6	42	30	0.6
6006	30	55	13	1	49	36	1
6007	35	62	14	1	56	41	1
6008	40	68	15	1	62	46	1
6010	50	80	16	1	74	56	1
6011	55	90	18	1.1	83	62	1
6012	60	95	18	1.1	88	67	1
6013	65	100	18	1.1	93	72	1
6014	70	110	20	1.1	103	77	1
6015	75	115	20	1.1	108	82	1

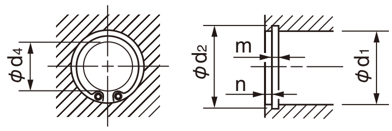
* Seal symbol of each maker
* NTN: LLB NSK: VV KOYO: 2RU
* rs min is the minimum permissible value of chamfering.

Unit [mm]

Nominal No.	d	D	B	rs min	DH max	ds min	R max
6201	12	32	10	0.6	27	17	0.6
6202	15	35	11	0.6	30	20	0.6
6203	17	40	12	0.6	35	22	0.6
6204	20	47	14	1	41	26	1
6205	25	52	15	1	46	31	1
6206	30	62	16	1	56	36	1
6208	40	80	18	1.1	73	47	1
6210	50	90	20	1.1	83	57	1
6211	55	100	21	1.5	91.5	63.5	1.5
6212	60	110	22	1.5	101.5	68.5	1.5
6214	70	125	24	1.5	116.5	78.5	1.5
6302	15	42	13	1	36	21	1
6303	17	47	14	1	41	23	1
6304	20	52	15	1.1	45	27	1
6305	25	62	17	1.1	55	32	1
6306	30	72	19	1.1	65	37	1
6307	35	80	21	1.5	71.5	43.5	1.5

Groove dimensions for C-shaped retaining rings (Excerpts from JIS B 2804-1978)





Unit [mm]

d1	d2 Basic dimensions	d2 Tolerances	m Basic dimensions	m Tolerances	n min (References)	d5 (Reference values)
10	9.6	0 / −0.09	1.15	+0.14 / 0	1.5	17
12	11.5	0 / −0.11				19
15	14.3					23
17	16.2					25
20	19	0 / −0.21	1.35			28
25	23.9					34
30	28.6		1.75			40
35	33	0 / −0.25				46
40	38		1.95		2	53
45	42.5					58
50	47		2.2			64
55	52	0 / −0.3				70
60	57					75
65	62		2.7		2.5	81
70	67					86
75	72					92
80	76.5					97
85	81.5	0 / −0.35	3.2	+0.18 / 0	3	103
90	86.5					108
95	91.5					114
100	96.5					119
110	106	0 / −0.54	4.2		4	131
120	116					143
125	121	0 / −0.63				148

Unit [mm]

d1	d2 Basic dimensions	d2 Tolerances	m Basic dimensions	m Tolerances	n min (References)	d4 (Reference values)
26	27.2	+0.21 / 0	1.35	+0.14 / 0	1.5	16
28	29.4					18
32	33.7	+0.25 / 0				21
35	37		1.75		2	24
40	42.5		1.95			28
42	44.5					30
47	49.5					34
52	55	+0.3 / 0	2.2			39
55	58				2.5	41
62	65					48
68	71		2.7			53
72	75					57
80	83.5	+0.35 / 0				64
90	93.5		3.2	+0.18 / 0	3	73
95	98.5					77
100	103.5					82
110	114	+0.54 / 0	4.2		4	89
115	119					94
125	129	+0.63 / 0				103
*160	165	+0.7 / 0	4.2	+0.2 / 0		134
*200	205					171

* with * mark is not included in the JIS standard.

Technical Data

Physical and Mechanical Properties of Metals

Physical properties

Metal materials	Ratios	Longitudinal elastic modulus ×10^3 [N/mm^2]	Rigidity modulus ×10^3 [N/mm^2]	Thermal conductivities [W/(M・k)]	Thermal expansions ×10^{-6} [1/k]
Low-carbon steel (0.08C～0.12C)	7.86	206	79	57～60	11.3～11.6
Medium carbon steel (0.40C～0.50C)	7.84	205	82	44	10.7
High-carbon steel (0.8C～1.6C)	7.81～7.83	196～202	80～81	37～43	9.6～10.9
Chrome steel (SCr430)	7.84	—	—	44.8	12.6（300～470k）
Chrome-molybdenum steel (SCM440)	7.83	—	—	42.7	12.3
Martensitic stainless steel (SUS410)	7.80	200	—	24.9	9.9
Austenitic stainless steel (SUS304)	8.03	197	73.7	15	17.3
Tool steel (SKD6)	7.75	206	82	42.2(373k)	10.8
Gray iron (FC)	7.05～7.3	73.6～127.5	28.4～39.2	44～58.6	9.2～11.8
Nodular graphite cast iron (FCD)	7.10	161	78	33.5～37.7	10
Duralumin (A2017-T4)	2.79	69	—	201	23.4
Super duralumin (A2024-T4)	2.77	74	29	121	23.2
Extra super duralumin (A7075-T6)	2.80	72	28	130	23.6
Lautan (AC2A-T6)	2.79	72	—	121	24.0
Silumin (AC3A-F)	2.66	71	—	121	20.4
Aluminum casting alloy (AC4CH-T6)	2.68	72	—	151	21.5
Aluminum die casting alloy (ADC12)	2.70	72	—	100	21.0
Zinc die casting alloy (ZDC-2)	6.60	89	—	113	27.4

Mechanical properties

Metal materials	Yield points [N/mm^2]	Tensile strengths [N/mm^2]	Hardnesses [HB]
S20C-N	245	402	116～174
S30C-N	284	471	137～197
S30C-H	333	539	152～212
S45C-N	343	569	167～229
S45-H	490	686	201～269
SS400	216	402～510	—
SCM420	—	932	262～352
SCM435	785	932	269～331
SUS303	206	520	187 or less
SUS304	206	520	200 or less
FC200	—	200	223 or less
FC250	—	250	241 or less
FC300	—	300	262 or less
FC350	—	350	277 or less
FCD400	250	400	201 or less
FCD450	280	450	143～217
FCD500	320	500	170～241
A2014-T4	245	412	—
A2017-T4	196	353	—
A7075-T6	471	539	—

World's power source conditions

Country names	Frequencies	Voltages
Japan	50Hz/60Hz	Single-phase 100V, Three-phase200V
U.S.A.	60Hz	Single-phase 120V, Three-phase240V
Canada	60Hz	Single-phase 120V, Three-phase240V
Korea	60Hz	Single-phase 220V, Three-phase220V/380V
Taiwan	60Hz	Single-phase 110V/220V, Three-phase220V/380V
Hong Kong	50Hz	Single-phase 200V, Three-phase346V
China	50Hz	Single-phase 220V, Three-phase380V
Philipines	60Hz	Single-phase 110V, Three-phase220V
Thailand	50Hz	Single-phase 220V, Three-phase380V
Singapore	50Hz	Single-phase 230V, Three-phase400V
Malaysia	50Hz	Single-phase 240V, Three-phase415V
Indonesia	50Hz	Single-phase 220V, Three-phase380V
Australia	50Hz	Single-phase 240V, Three-phase415V
New Zealand	50Hz	Single-phase 230V, Three-phase400V
Austria	50Hz	Single-phase 220V, Three-phase380V
Belgium	50Hz	Single-phase 220V, Three-phase380V
Bulgaria	50Hz	Single-phase 220V, Three-phase380V
Denmark	50Hz	Single-phase 220V, Three-phase380V
Finland	50Hz	Single-phase 220V, Three-phase380V
France	50Hz	Single-phase 220V, Three-phase380V
Germany	50Hz	Single-phase 220V, Three-phase380V
Greece	50Hz	Single-phase 220V, Three-phase380V
Hungary	50Hz	Single-phase 220V, Three-phase380V
Italy	50Hz	Single-phase 220V, Three-phase380V
Luxembourg	50Hz	Single-phase 220V, Three-phase380V
Netherlands	50Hz	Single-phase 220V, Three-phase380V
Norway	50Hz	Single-phase 230V, Three-phase380V
Poland	50Hz	Single-phase 220V, Three-phase380V
Portugal	50Hz	Single-phase 220V, Three-phase380V
Romania	50Hz	Single-phase 220V, Three-phase380V
Spain	50Hz	Single-phase 220V, Three-phase380V
Sweden	50Hz	Single-phase 220V, Three-phase380V
Switzerland	50Hz	Single-phase 220V, Three-phase380V
England	50Hz	Single-phase 240V, Three-phase415V

* The above voltages may differ depending on the area and the city in the country.
* The standard voltage of USA and Canada is a single-phase 115V, but it is normally indicated as 120V.

General-purpose motor specifications list

Two-poles

Outputs [kW]		0.2	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45
Frame numbers		63	71M	80M	90L	90L	112M	132S	132S	160M	160M	160L	180M	180L	200LB	200LB
Shaft diameters [mm]		11	14	19	24	24	28	38	38	42	42	42	48	55	55	55
Rated currents [A]	200V 50Hz	1.1	2.0	3.5	6.0	9.0	14.2	21.5	28	41	55	67	82	109	133	161
	200V 60Hz	1.0	1.8	3.1	5.8	8.4	13.4	20	27	38	52	63	76	104	127	152
	220V 60Hz	1.0	1.8	3.0	5.4	8.0	12.4	18.5	25	35	47	57	70	94	117	141
Rated rotation speeds [min^{-1}]	200V 50Hz	2800	2910	2890	2900	2870	2880	2900	2900	2910	2920	2920	2920	2930	2930	2930
	200V 60Hz	3340	3480	3470	3470	3440	3440	3490	3480	3500	3510	3510	3510	3510	3510	3510
	220V 60Hz	3400	3500	3490	3490	3460	3460	3510	3510	3520	3530	3530	3530	3530	3530	3530

* The above values are reference values. They may differ depending on the motor maker.

Four-poles

Outputs [kW]		0.2	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45
Frame numbers		63	71M	80M	90L	100L	112M	132S	132M	160M	160L	180M	180M	180L	200LB	200L
Shaft diameters [mm]		11	14	19	24	28	28	38	38	42	42	48	48	55	60	60
Rated currents [A]	200V 50Hz	1.26	2.5	3.9	7.0	9.9	15.8	23	30	44	58	72	84	114	139	168
	200V 60Hz	1.1	2.1	3.5	6.3	8.9	14.5	21	28	40	53	66	78	106	132	159
	220V 60Hz	1.1	2.2	3.4	6.0	8.6	13.6	20	26	38	50	62	73	99	123	148
Rated rotation speeds [min^{-1}]	200V 50Hz	1430	1420	1420	1430	1430	1430	1440	1440	1450	1450	1455	1455	1460	1460	1460
	200V 60Hz	1730	1700	1700	1720	1720	1710	1730	1730	1740	1740	1750	1750	1750	1750	1750
	220V 60Hz	1740	1710	1710	1730	1730	1730	1740	1740	1750	1750	1760	1760	1760	1760	1760

* The above values are reference values. They may differ depending on the motor maker.

Six-poles

Outputs [kW]		0.2	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45
Frame numbers		71	80M	90L	100L	112M	132S	132M	160M	160L	180M	180L	180L	200L	200L	225S
Shaft diameters [mm]		14	19	24	28	28	38	38	42	42	48	55	55	60	60	65
Rated currents [A]	200V 50Hz	1.4	2.8	4.4	7.5	10.8	16.8	25	32	43	61	75	89	120	145	174
	200V 60Hz	1.3	2.5	3.9	6.8	9.8	16	23	28	40	56	69	82	110	134	163
	220V 60Hz	1.3	2.5	3.9	6.6	9.4	15	22	27	38	53	65	77	105	128	156
Rated rotation speeds [min^{-1}]	200V 50Hz	930	940	940	940	950	940	950	960	960	965	965	965	970	970	970
	200V 60Hz	1110	1130	1130	1120	1130	1120	1140	1150	1150	1160	1160	1160	1165	1165	1165
	220V 60Hz	1120	1140	1140	1130	1140	1130	1150	1160	1160	1170	1165	1165	1170	1170	1170

* The above values are reference values. They may differ depending on the motor maker.

miki pulley co., ltd.
461 Imai-Minami-Cho, Nakahara-Ku, Kawasaki-Shi, Kanagawa-Ken, 211-8577, Japan
http://www.mikipulley.co.jp/

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