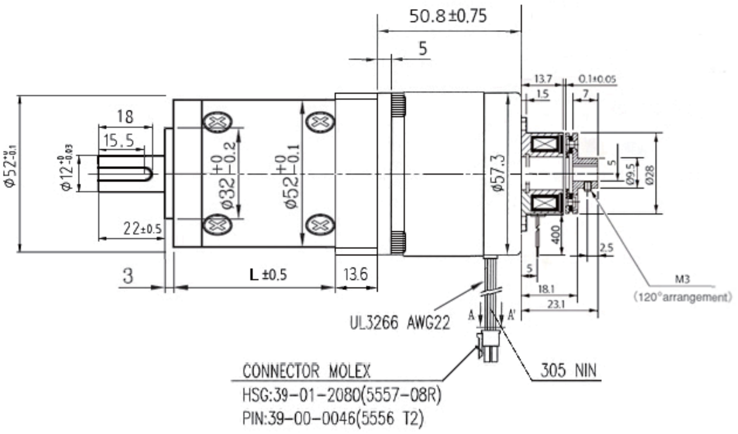
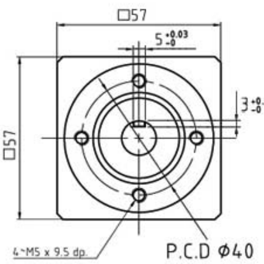
DBG52-BL24V-31W

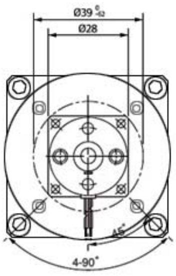
- 사용습도(Operating relative humidity) : 20% ~ 85%
- 사용온도(Operating temperature) : −10℃~ +60℃

SPECIFICATION

Dimension







Geared Motor

감속기 길이 (mm) Gear Head L		47		62.5					78							93.5								
중량(g)		1199		1384					1574							1744								
감속비 Reduction ratio		1/3	1/4	1/12	1/15	1/19	1/21	1/26	1/43	1/53	1/66	1/81	1/100	1/113	1/126	1/150	1/230	1/285	1/353	1/488	1/546	1/676	1/756	1/936
31W 24V	Rated Torque (Kgf.cm)	2.4	3.2	8.4	10.5	13.3	14.7	18.2	25.8	31.8	39.6	48	60	67.8	75.6	75	100	100	100	100	100	100	100	100
	Rated Speed (RPM)	1000	750	250	200	157	142	115	69	56	45	37	30	26.5	24	20	13	10.5	8	6	5	4.4	3.9	3.2
	No Load Speed (RPM)	1166	875	291	233	184	166	134	81	66	53	43	35	31	28	23	15	12	10	7	6	5	4.6	3.7

Motor

31W MOTOR(DC 24V)				
PARAMETER	SYMBOL	UNITS	VALUE	TOLERANCE
RATED VOLTAGE	V	VOLTS	24	Normal
NO LOAD SPEED	SNL	RPM	3500	±10%
RATED TORQUE	TC	Kg-cm	1	Normal
RATED SPEED	SC	RPM	3000	±10%
RATED CURRENT	IC	AMP	1.9	±10%
RATED POWER	Pout	W	31	Normal
PEAK TORQUE	TP	Kg-cm	TBD	Min
PEAK CURRENT	IP	AMP	TBD	Max
VOLTAGE CONSTANT	KE	V/rad/sec	0.065	±10%
RESISTANCE	R	OHM	2	±10%
INDUCTANCE	LM	mH	TBD	±30%
INERTIA	JM	g-cm2	200	±10%
WEIGHT	W	Kg	0.6	Max
AMBENT TEMPERATURE	T	℃	-10~+60	TYP

CLUTCHES & BRAKES

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ELECTROMAGNETIC-ACTUATED CLUTCHES & BRAKES

Clutches

101

13G

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15G

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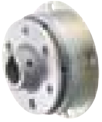
11G



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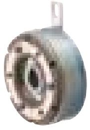
CS

33G



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35G

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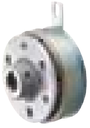
31G



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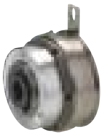
CSZ

35



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Brakes

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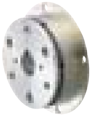
12G



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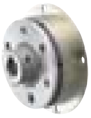
11G



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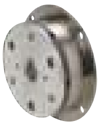
BSZ

12



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Series | **Device**

ELECTROMAGNETIC CLUTCH AND BRAKE UNITS

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A selection guide for electromagnetic clutches and brakes begins on the next page.

Selection Guide

Miki Pulley divides its electromagnetic clutches & brakes into several major categories: electromagnetic-actuated clutches & brakes, spring-actuated clutches & brakes, electromagnetic tooth clutches, brake motors, and power supplies.

When selecting a product, have information handy on your application, required torque, performance, load properties, drive source and the like, and then use the diagram on the page at right as your guide. Selection details are described in the selection procedures given for each series.

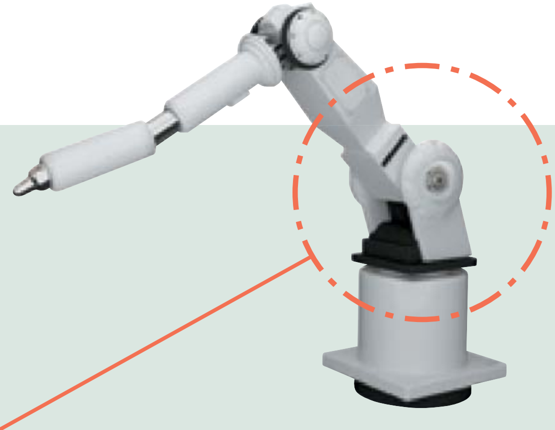
List of Products

- **MIKI PULLEY ELECTROMAGNETIC CLUTCHES & BRAKES**
  - **ELECTROMAGNETIC-ACTUATED CLUTCHES & BRAKES**
    - ELECTROMAGNETIC-ACTUATED MICRO CLUTCHES & BRAKES
    - ELECTROMAGNETIC-ACTUATED CLUTCHES & BRAKES
    - CLUTCH & BRAKE UNITS
  - **SPRING-ACTUATED BRAKES**
  - **ELECTROMAGNETIC TOOTH CLUTCHES**
  - **BRAKE MOTORS**
  - **POWER SUPPLIES**

Select by Product Characteristics

			Torque (N·m)
ELECTROMAGNETIC-ACTUATED CLUTCHES & BRAKES	Electromagnetic-actuated micro	Clutches	**102** [0.4-2.4 N·m] **CYT** [0.4-1.0 N·m]
		Brakes	**112** [0.4-2.4 N·m]
	Electromagnetic-actuated	Clutches	**CSZ** [2.4-10 N·m] **101/CS** [5-320 N·m]
		Brakes	**BSZ** [2.4-10 N·m] **111** [5-320 N·m]
	Clutch & Brake Units	Drip-proof type	**125** [2.4-160 N·m]
		Open-disc brake system type	**121(20G)** [5-320 N·m]
		Motor-coupled type	**126** [5-80 N·m]
		Speed reducer-integrated type	**CBW** [5-40 N·m]
		Motor/speed reducer-integrated type	**CMW** [5-40 N·m]
		Double-clutch units	**121(10G)** [5-320 N·m]
		Double clutch and brake units	**122** [5-160 N·m]
SPRING-ACTUATED BRAKES		Holding use	**BXW(R)**[0.30-2.50 N·m] **BXR** [5-55 N·m] **BXW(S)**[0.36-5.20 N·m] **BXR(LE)**[0.06-3.20 N·m]
		Holding and braking use	**BXW(H)**[0.24-4.00 N·m] **BXH** [4-44 N·m]
		Braking use	**BXW(L)**[0.12-2.00 N·m] **BXL** [2-22 N·m] **BXL(N)**[2-80 N・m]
Tooth clutches			**546** [17.5-2200 N·m]
BRAKE MOTORS		Electromagnetic-actuated	**BMM** [2.5-50 N·m] Motor output 0.2 kW to 3.7 kW
		Spring-actuated	**BMS** [2-15 N·m] Motor output 0.2 kW to 1.5 kW

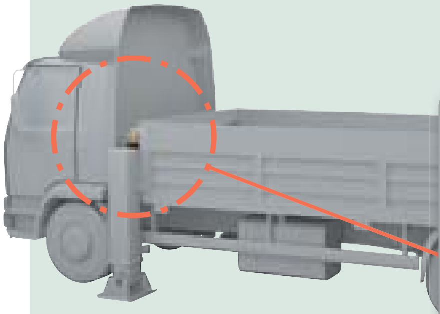
Applications



Product model BXR

Employed device Articulated Robot

BXR spline type for holding arms.
Saves space with slim design and greatly reduces drag wear by using light rotor.



Product model 111

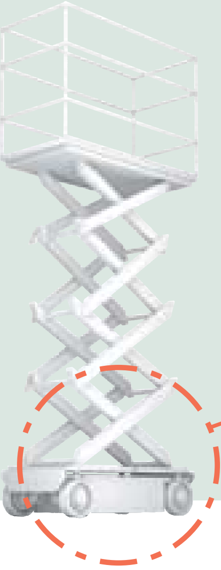
Employed device Special-purpose Vehicles

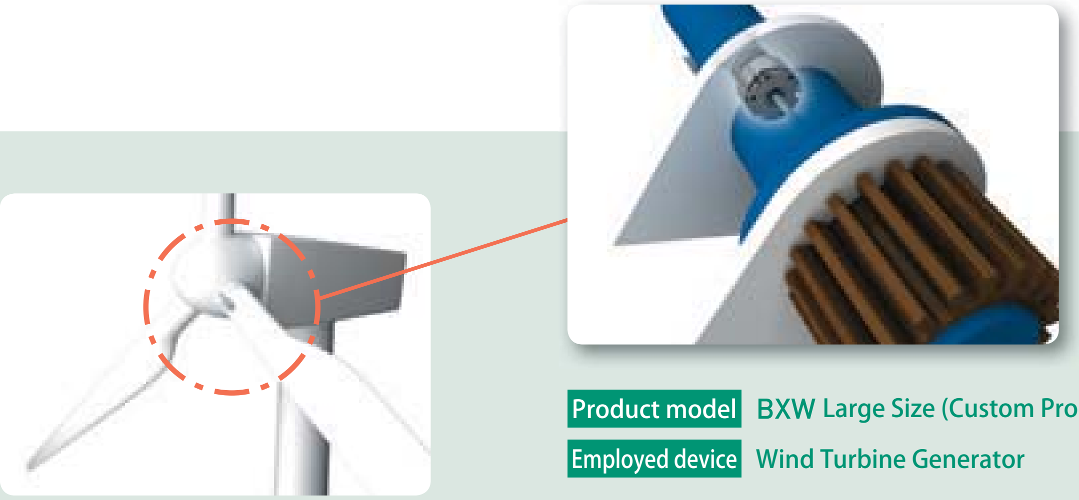
The Electromagnetic-actuated brake 111 model is used in the elevating device for the auxiliary leg.

Product model BXR

Employed device Aerial Vehicle

BXR model as the holding brake for drive motor. Slim design helps save space.

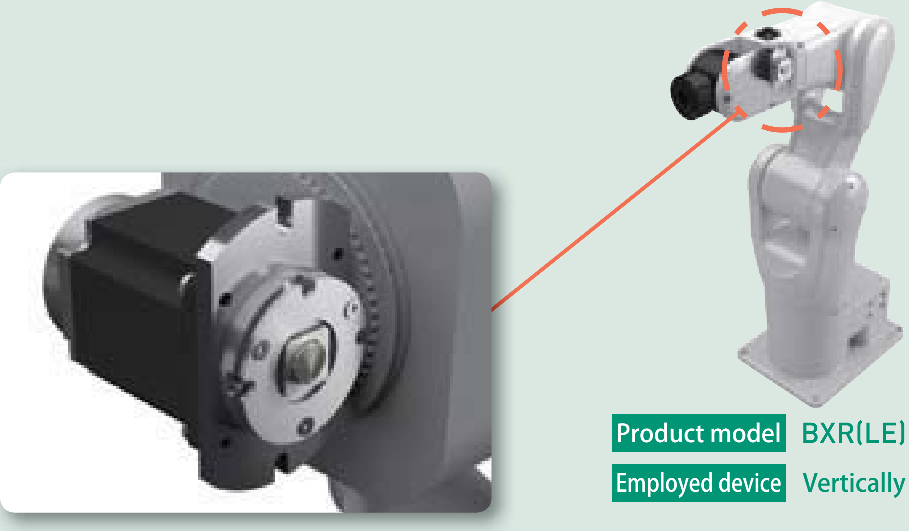




Product model BXW Large Size (Custom Product)

Employed device Wind Turbine Generator

Large BXW as the pitch drive device of a wind turbine generator.



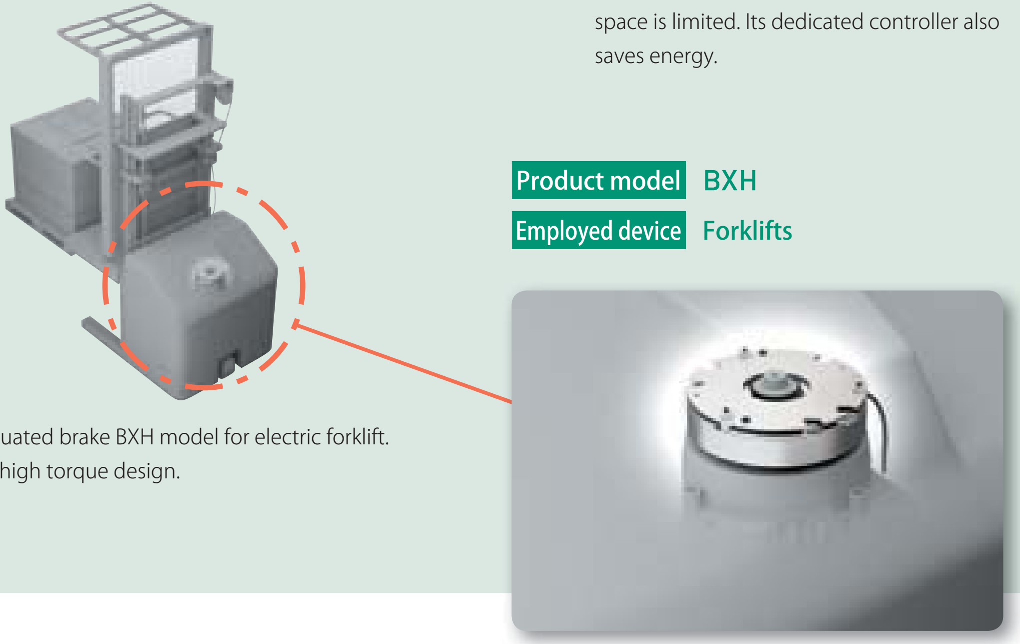
Product model BXR(LE)

Employed device Vertically Articulated Robots

The BXR(LE) models owes its ultra-thin profile to a dedicated controller. Mounted on the output shaft, it is ideal for applications where space is limited. Its dedicated controller also saves energy.

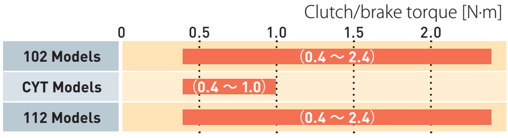
Product model BXH

Employed device Forklifts



Spring-actuated brake BXH model for electric forklift. Compact, high torque design.

ELECTROMAGNETIC-ACTUATED MICRO CLUTCHES & BRAKES

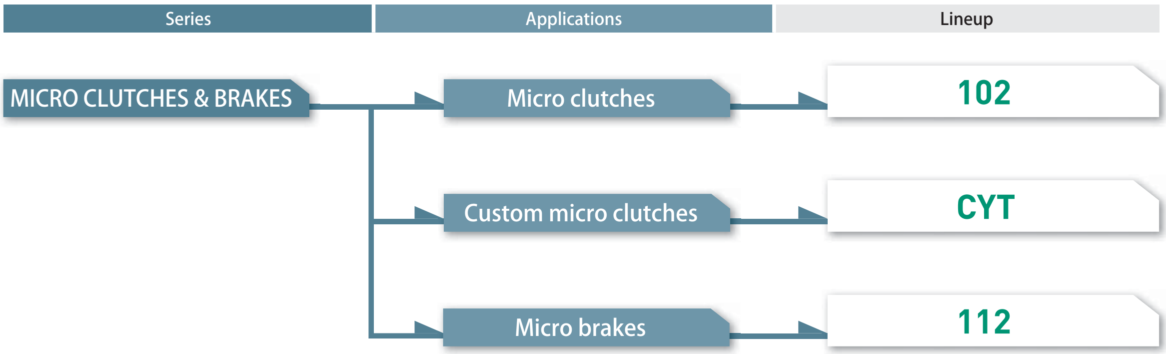


Application	Automated teller machines, sorters, office equipment, weighing and packaging machinery, printing machinery, bookbinding machinery, optical equipment

Micro Clutches and Micro Brakes for Precise Control of Compact Precision Equipment

These micro clutches and micro brakes are ideal for compact precision equipment where fluctuations in torque and response must be avoided, such as office equipment, communication equipment and automobiles. In addition to the 102 (clutch) and 112 (brake) models, which share the same basic clutch/brake design, we also supply CYT models (clutches), which can be customized into a wide variety of types to suit the requirements of our customers.

Available Models



For details on selection, see P.314 to 321.

Micro Clutches

102-□-□□

Size

Mounting

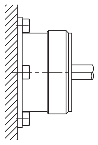
Shaft coupling system (armature)

Mounting

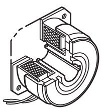
102-□-1□

Wall-mounted type

Uses a flange-mounted stator. Designed to be short in the axial direction, requiring less installation space.



Directly mounted to the wall

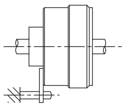


Flange-mounted type

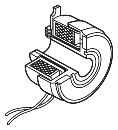
102-□-3□, CYT

Shaft-mounted type

Uses a bearing-mounted stator. Designed to be relatively easy to mount, reducing the processing and work required for mounting.



Mounted onto the shaft



Bearing-mounted type

Shaft coupling system (armatures)

102-□-□3

Butt and parallel shaft type (Armature type-3)

These incorporate non-armature parts provided by the customer such as V pulleys, enabling use in designs that use either butt shafts or through-shafts.

102-□-□5

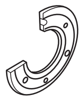
Directly coupled type wound around the parallel axis (armature type-5)

Uses an armature assembly designed for use with through-shafts. Ensures that mounting is relatively easy to complete as well as extremely efficient in its approach.

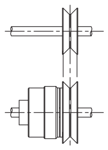
102-□-□1

Butt type (Armature type-1)

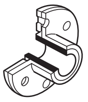
Uses an armature assembly designed for use with butt shafts. May be difficult to mount due to the need for centering and other adjustments, may require the use of a fitting flange, or may require use in combination with flexible couplings.



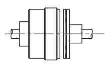
Armature type-3



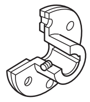
Directly coupled by being wound around the parallel shaft



Armature type-5



Coupled directly to the butt shaft



Armature type-1

Micro Brakes

112-□-1□

Size

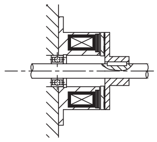
Shaft Coupling System (Armature)

Shaft-mounted type

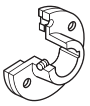
These use axial braking in most cases, the effectiveness of which depends on how efficiently parts are mounted.

Rotor-mounted type

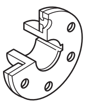
Uses an armature assembly mounted directly to an inertial body not fastened to the shaft that continues to move even after the shaft has stopped.



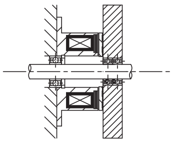
Mounted to the shaft



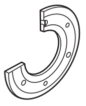
Armature type-1



Armature type-2



Mounted to the rotor

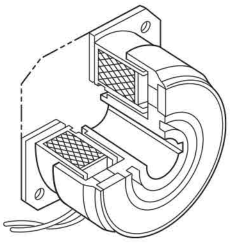


Armature type-3

Product Lineup

102(13/15/11) Electromagnetic-actuated Micro Clutches - Flange-mounted Type

RoHS



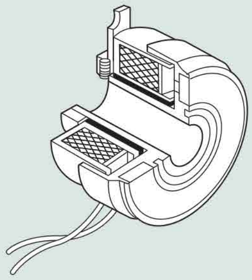
Flange-mounted type

Stator and rotor are combined and directly mounted on stationary parts, such as frames, and fixed in place. These are short in the axial direction and can use space near walls effectively. Select the armature according to the coupling type used (through-shaft, butt shaft, etc.).

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

102(33/35/31) Electromagnetic-actuated Micro Clutches - Bearing-mounted Type

RoHS



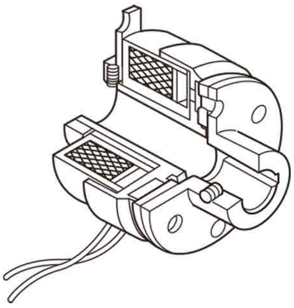
Bearing-mounted type

These integrate the stator and rotor, which are held to the stationary parts of the machine by a drive pin arm; the rotor is locked to the rotation shaft by a set screw. They are designed to be relatively easy to mount, reducing the processing work required for mounting. Select the armature according to the coupling type used (through-shaft, butt shaft, etc.).

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

CYT Electromagnetic-actuated Micro Clutches - Custom Type

RoHS

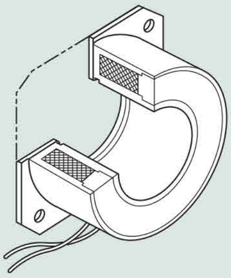


The CYT models are the basic building blocks for customized micro-clutches.

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

112 Electromagnetic-actuated Micro Brakes

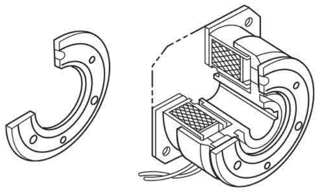
RoHS



Brakes are used to brake and hold rotating bodies. The flange of the stator is locked securely to a strong stationary part. Select an armature that factors in the mounting space available.

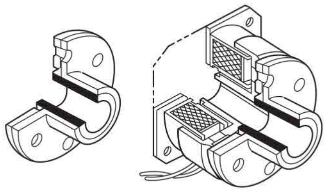
Brake torque	[N·m]	0.4～2.4
Operating temperature	[℃]	−10～+40
Backlash		Zero

Types for through-shaft or butt shaft



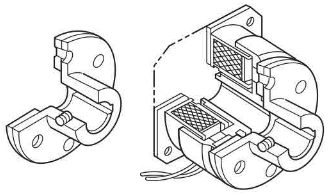
Armature type-3 102(13)

Through-shaft (coupled by winding around parallel shaft) type



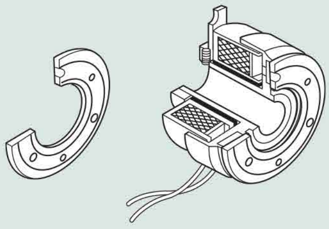
Armature type-5 102(15)

Butt shaft type



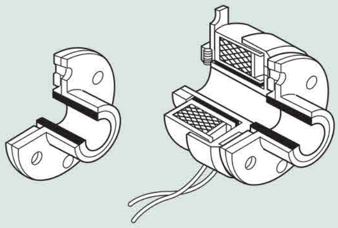
Armature type-1 102(11)

Types for through-shaft or butt shaft



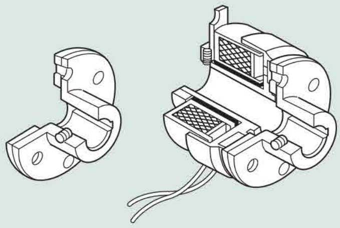
Armature type-3 102(33)

Through-shaft (coupled by winding around parallel shaft) type



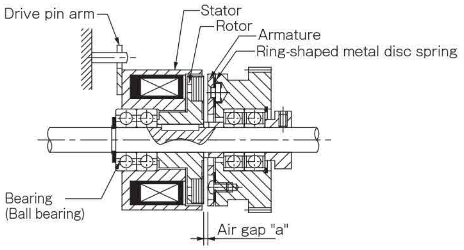
Armature type-5 102(35)

Butt shaft type



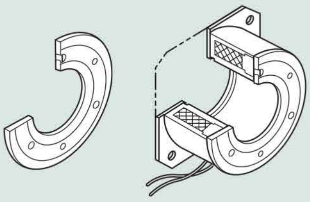
Armature type-1 102(31)

Ball bearing type



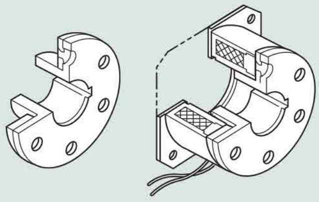
CYT(33B)

Types with many applications



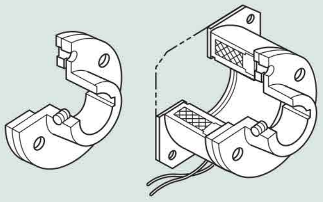
Armature type-3 112(13)

Slim, space-saving type



Armature type-2 112(12)

Easy-to-use standard-shape type

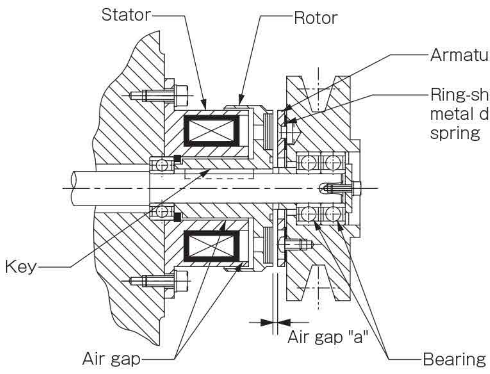


Armature type-1 112(11)

Mounting and CYT Customization Examples

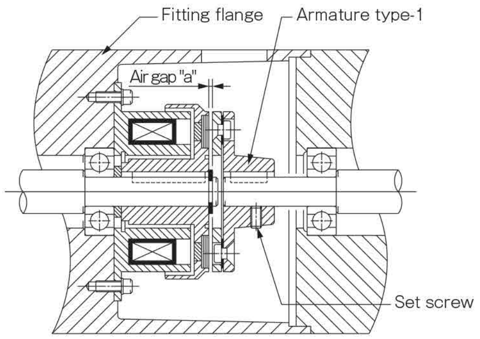
Flange-mounting example with 102

The stator is directly mounted on a stationary part, such as a frame, by a mounting flange, and fixed in place. The rotor is linked to the rotation shaft using a key. The stator and rotor are combined via a narrow air gap that serves as part of the magnetic circuit to form a magnetic pole.



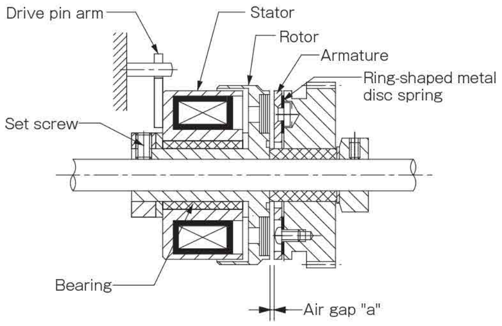
Butt shaft mounting example with 102

In designs that use butt shafts, the two shafts can be reliably centered using fitting flanges, as shown in the figure. For flange mounting, the rotor is fixed in place from the axial direction with a retaining ring or similar item.



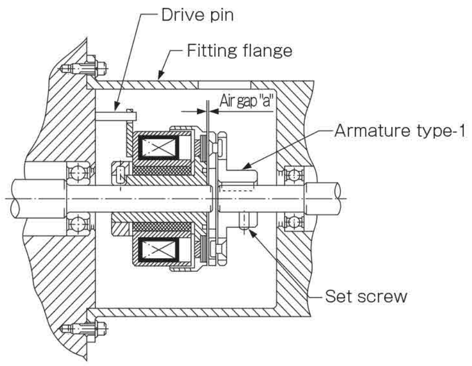
Bearing-mounting example with 102

The stator is integrated with the rotor via a bearing and held to the stationary parts of the machine by a drive pin arm. The rotor is locked to the rotation shaft using a set screw. The stator and rotor form a magnetic pole via the bearing (ferrous oil-impregnated metal).



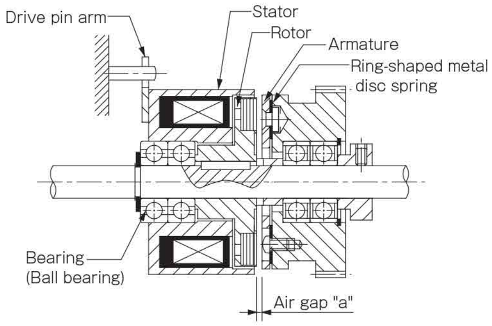
Butt shaft mounting example with 102

In designs that use butt shafts, the two shafts can be reliably centered using fitting flanges, as shown in the figure.



Ball-bearing type mounting example with CYT

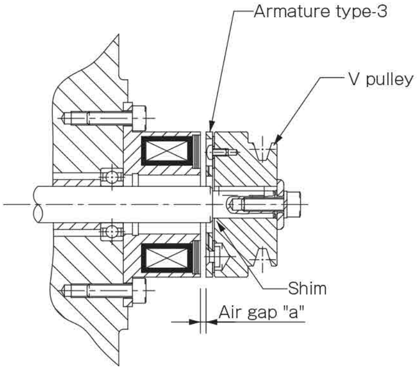
The stator is mounted on the shaft via a bearing and held to the stationary parts of the machine by a drive pin arm. The stator and rotor are combined via a narrow air gap that serves as part of the magnetic circuit to form a magnetic pole.



Mounting and CYT Customization Examples

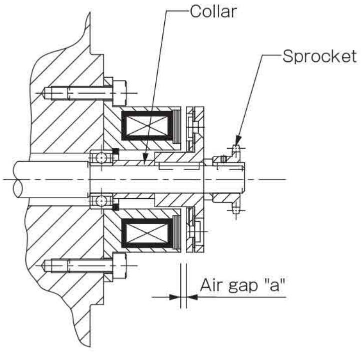
Armature type-3 mounting example with 112

Armature type-3 is used by directly mounting it to a transmission element such as a V-pulley or to a rotating body that stops inertial force.
The shaft of the brake part requires no processing. The shaft diameter may also be determined freely. Air gap "a" can be set easily using collars and shims. Corrections are easily accomplished by adding or removing shims.



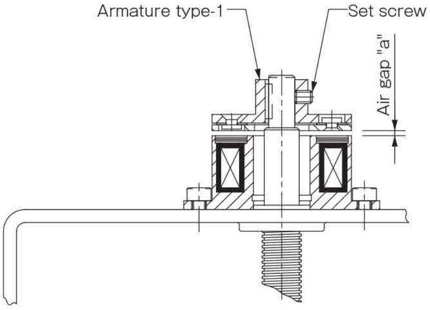
Armature type-2 mounting example with 112

Armature type-2 has the smallest mounting-space footprint of any of the armatures, so overhang is not a concern even when a sprocket or the like is mounted on the brake tip.
Air gap "a" can be set easily using collars and shims.
Corrections are easily accomplished by adding or removing shims.



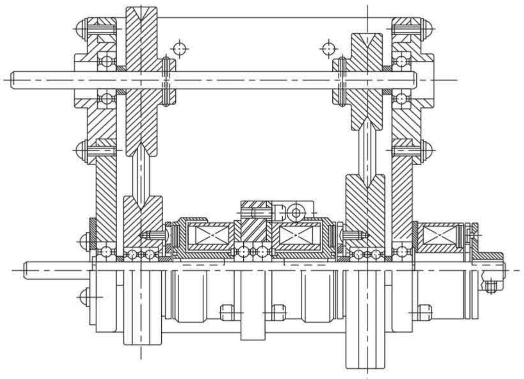
Armature type-1 mounting example on vertical shaft with 112

Since there is no restriction on mounting direction, there is no running torque or abnormal wear even when mounted on vertical shafts.
It is easy to set air gap a: simply move armature type-1 and lock it in place with a set screw.



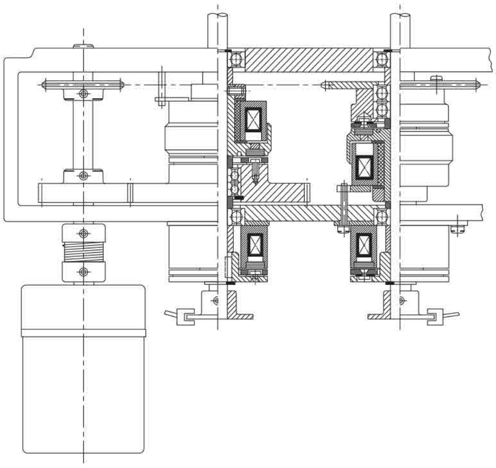
Example of the combination of clutches and brakes

This example uses a two-step speed-change mechanism combining two clutches and a brake.



Example of the combination of clutches and brakes

Shaft drive is both forward and reverse in combination with a clutch in this example. Start and stop freely by mounting brakes on each shaft.



102(13/15/11) Types Electromagnetic Micro Clutches - Flange-mounted Type

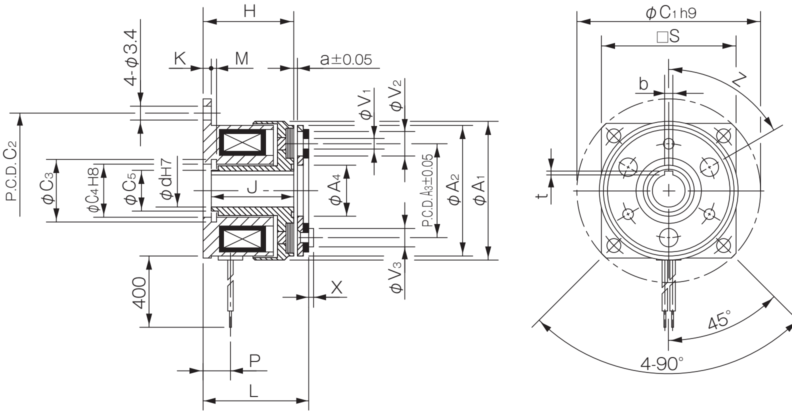
Specifications

Model	Size	Dynamic friction torque Td [N·m]	Coil (at 20℃)				Heat resistance class	Lead wire		Max. rotation speed [min⁻¹]	Rotating part moment of inertia J		Allowable engaging energy E_{eal} [J]	Total work performed until readjustment of the air gap E_T [J]	Armature pull-in time t_a [s]	Torque rise time t_p [s]	Torque extinction time t_d [s]	Mass [kg]
			Voltage [V]	Wattage [W]	Current [A]	Resistance [Ω]		UL style	Size		Armature [kg·m²]	Rotor [kg·m²]						
102-02-13	02	0.4	DC24	6	0.25	96	B	UL3398	AWG26	10000	6.75×10^{-7}	2.45×10^{-6}	1500	2×10^{6}	0.009	0.019	0.017	0.075
102-02-15										500	1.00×10^{-6}							0.081
102-02-11										10000	1.00×10^{-6}							0.079
102-03-13	03	0.6	DC24	6	0.25	96	B	UL3398	AWG26	10000	1.30×10^{-6}	3.25×10^{-6}	2300	3×10^{6}	0.009	0.022	0.020	0.096
102-03-15										500	1.95×10^{-6}							0.105
102-03-11										10000	1.95×10^{-6}							0.103
102-04-13	04	1.2	DC24	8	0.33	72	B	UL3398	AWG26	10000	4.38×10^{-6}	1.41×10^{-5}	4500	6×10^{6}	0.011	0.028	0.030	0.178
102-04-15										500	6.15×10^{-6}							0.195
102-04-11										10000	6.15×10^{-6}							0.191
102-05-13	05	2.4	DC24	10	0.42	58	B	UL3398	AWG22	10000	9.08×10^{-6}	3.15×10^{-5}	9000	9×10^{6}	0.012	0.031	0.040	0.310
102-05-15										500	1.38×10^{-5}							0.335
102-05-11										10000	1.38×10^{-5}							0.325

* The dynamic friction torque, T_d, is measured at a relative speed of 100 min⁻¹. Depending on the initial torque characteristics, break-in to condition the engaging surfaces may also be required.
* Keep supply voltage fluctuation to within 10% of coil voltage. Do not allow the energization rate to exceed 80%.
* The moment of inertia of a rotating body and mass are measured for the maximum bore diameter.

Dimensions (102-□-13)

(For direct mounting)



Unit [mm]

Size	Shaft bore dimensions				
	d_1 H7	Models compliant with JIS standards		Models compliant with the old JIS standards	
		b P9	t	b E9	t
02	5	—	—		
03	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
	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 direction dimensions														Axial direction dimensions							
	A₁	A₂	A₃	A₄	C₁	C₂	C₃	C₄	C₅	S	V₁	V₂	V₃	Z	H	J	K	L	P	M	a	X
02	31	28	19.5	10.7	39	33.5	11.4	11	8	—	2-2.1	2-5.3	2-3.7	4-90°	18	16.5	1.5	20.4	4.9	1.1	0.1	0.8
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
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	28.1	7.2	1.3	0.15	1.6
05	54	50	38	25.5	65	58	27.2	26	22	51	3-3.1	3-6.5	3-6	6-60°	28.1	26.1	2	31.3	8.2	1.5	0.2	1.5

* Size 02 is a rounded flange.
* The rotor of size 02 has no keyway. Lock it in place by press-fitting it onto the shaft or the like.
* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

102-03-13 24V 6DIN

Size

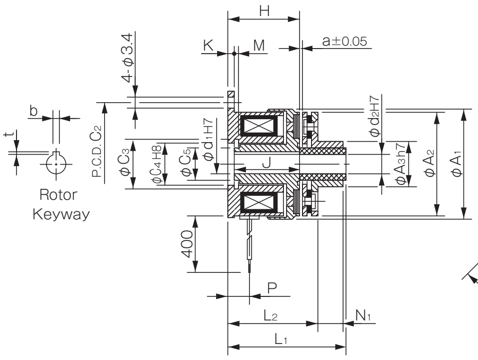
Rotor bore diameter (dimensional symbol d)

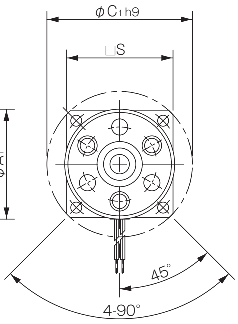
Keyway standards DIN: Compliant with JIS standards P9
JIS: Compliant with the old JIS standards (class 2) E9

*Models for which there are no keyway standards (models marked by [-]) on the Shaft Bore Dimensions table need not be marked with a keyway standards designation. Products with standards marked by diagonal lines are not set as standard products.

Dimensions (102-☐-15)

(For through-shafts)





Unit [mm]

Size	Shaft bore dimensions					
	d_1 H7	d_2 H7	Models compliant with JIS standards b P9	Models compliant with JIS standards t	Models compliant with the old JIS standards b E9	Models compliant with the old JIS standards 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	$5^{-0.012}_{-0.042}$	$2^{+0.5}_{0}$	$5^{+0.050}_{+0.020}$	$2^{+0.5}_{0}$

* The armature type-5 bore d_2 is a straight bore.

Unit [mm]

Size	Radial direction dimensions									Axial direction dimensions								
	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	N_1	a
02	31	28	13	39	33.5	11.4	11	8	—	18	16.5	1.5	27.5	22.4	1.1	4.9	4.8	0.1
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
04	43	40	18	54	47	20	19	15.5	41	25.4	23.4	2	40.2	30.8	1.3	7.2	9.1	0.15
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

* Size 02 is a rounded flange.
* The rotor of size 02 has no keyway. Lock it in place by press-fitting it onto the shaft or the like.
* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

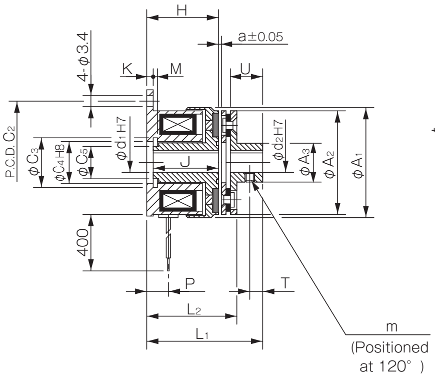
102-03-15 24V R6DIN A6

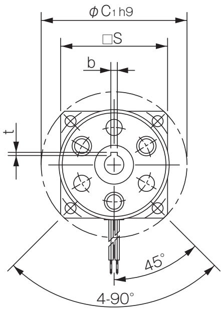
Size
Rotor bore diameter (dimensional symbol d1)
Armature bore diameter (dimensional symbol d2)
Keyway standards DIN: Compliant with JIS standards P9
JIS: Compliant with the old JIS standards (class 2) E9

*Models for which there are no keyway standards (models marked by [-]) on the Shaft Bore Dimensions table need not be marked with a keyway standards designation. Products with standards marked by diagonal lines are not set as standard products.

Dimensions (102-☐-11)

(For butt shafts)





Unit [mm]

Size	Shaft bore dimensions					
	d_1 H7	d_2 H7	Models compliant with JIS standards b P9	Models compliant with JIS standards t	Models compliant with the old JIS standards b E9	Models compliant with the old JIS standards 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 direction dimensions										Axial direction dimensions								
	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	27.4	22.4	1.1	4.9	7	2.5	0.1
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
04	43	40	17	54	47	20	19	15.5	41	2-M3	25.4	23.4	2	40.1	30.8	1.3	7.2	12	5	0.15
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

* Size 02 is a rounded flange.
* The rotor of size 02 has no keyway. Lock it in place by press-fitting it onto the shaft or the like.
* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

102-03-11 24V R6DIN A6DIN

Size
Rotor bore diameter (dimensional symbol d1)
Keyway standards DIN: Compliant with JIS standards P9
JIS: Compliant with the old JIS standards (class 2) E9
Armature bore diameter (dimensional symbol d2)
Keyway standards DIN: Compliant with JIS standards P9
JIS: Compliant with the old JIS standards (class 2) E9

*Models for which there are no keyway standards (models marked by [-]) on the Shaft Bore Dimensions table need not be marked with a keyway standards designation. Products with standards marked by diagonal lines are not set as standard products.

102(33/35/31) Types Electromagnetic Micro Clutches - Bearing-mounted Type

Specifications

Model	Size	Dynamic friction torque T_d [N·m]	Coil (at 20℃)				Heat resistance class	Lead wire		Max. rotation speed [min⁻¹]	Rotating part moment of inertia J		Allowable engaging energy $E_{ea\ell}$ [J]	Total work performed until readjustment of the air gap E_T [J]	Armature pull-in time t_a [s]	Torque rise time t_p [s]	Torque extinction time t_d [s]	Mass [kg]
			Voltage [V]	Wattage [W]	Current [A]	Resistance [Ω]		UL style	Size		Armature [kg·m²]	Rotor [kg·m²]						
102-02-33	02	0.4	DC24	6	0.25	96	B	UL3398	AWG26	500	6.75×10^{-7}	2.75×10^{-6}	1500	2×10^6	0.009	0.019	0.017	0.076
102-02-35											1.00×10^{-6}							0.082
102-02-31											1.00×10^{-6}							0.080
102-03-33	03	0.6	DC24	6	0.25	96	B	UL3398	AWG26	500	1.30×10^{-6}	4.08×10^{-6}	2300	3×10^6	0.009	0.022	0.020	0.101
102-03-35											1.95×10^{-6}							0.110
102-03-31											1.95×10^{-6}							0.108
102-04-33	04	1.2	DC24	8	0.33	72	B	UL3398	AWG26	500	4.38×10^{-6}	1.44×10^{-5}	4500	6×10^6	0.011	0.028	0.030	0.183
102-04-35											6.15×10^{-6}							0.200
102-04-31											6.15×10^{-6}							0.196
102-05-33	05	2.4	DC24	10	0.42	58	B	UL3398	AWG22	500	9.08×10^{-6}	2.90×10^{-5}	9000	9×10^6	0.012	0.031	0.040	0.321
102-05-35											1.38×10^{-5}							0.346
102-05-31											1.38×10^{-5}							0.336

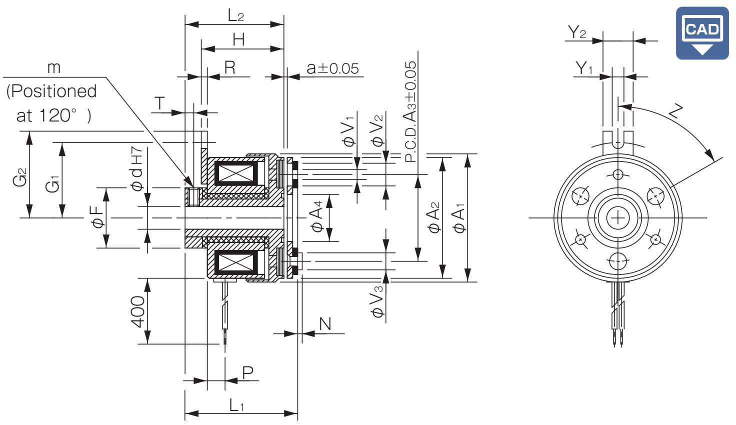
* The dynamic friction torque, T_d, is measured at a relative speed of 100 min⁻¹. Depending on the initial torque characteristics, break-in to condition the engaging surfaces may also be required.

* Keep supply voltage fluctuation to within 10% of coil voltage. Do not allow the energization rate to exceed 80%.

* The moment of inertia of a rotating body and mass are measured for the maximum bore diameter.

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 direction dimensions													Axial direction dimensions							
	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	10.7	14	2-2.1	2-5.3	2-3.7	15.8	19.8	3.1	8	4-90°	2-M3	19.1	1.2	25.9	23.5	4.9	0.8	2.5	0.1
03	34	32	23	12.5	16	3-2.6	3-6	3-4.5	20	23	3.1	8	6-60°	2-M3	22	1.6	28.5	26.2	4.7	1.2	2.3	0.15
04	43	40	30	18.5	22	3-3.1	3-6	3-5	23	26	3.1	8	6-60°	2-M4	25.2	1.6	33.1	30.4	5.2	1.5	2.8	0.15
05	54	50	38	25.5	30	3-3.1	3-6.5	3-6	28	31	3.1	8	6-60°	2-M5	27.9	1.6	37.3	34.1	6.2	1.5	3.3	0.2

* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

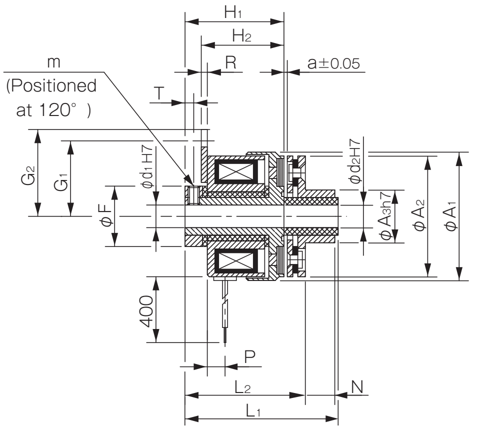
102-03-33 24V 6

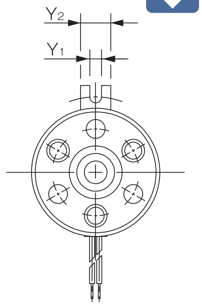
Size

Rotor bore diameter (dimensional symbol d)

Dimensions (102-□-35)

(For through-shafts)





Unit [mm]

Size	Shaft bore dimensions	
	d1 H7	d2 H7
02	5	5
03	6	6
04	8	8
	10	10
05	10	10
	15	15

Unit [mm]

Size	Radial direction dimensions									Axial direction dimensions								
	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	15.8	20	3.1	8	2-M3	23.5	19.1	1.2	33	27.9	4.9	4.8	2.5	0.1
03	34	32	14	16	20	23	3.1	8	2-M3	26.2	22	1.6	38.5	30.5	4.7	7.8	2.3	0.15
04	43	40	18	22	23	26	3.1	8	2-M4	30.4	25.2	1.6	45.2	35.8	5.2	9.1	2.8	0.15
05	54	50	28	30	28	31	3.1	8	2-M5	34.1	27.9	1.6	49.3	40.3	6.2	8.8	3.3	0.2

* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

102-03-35 24V R6 A6

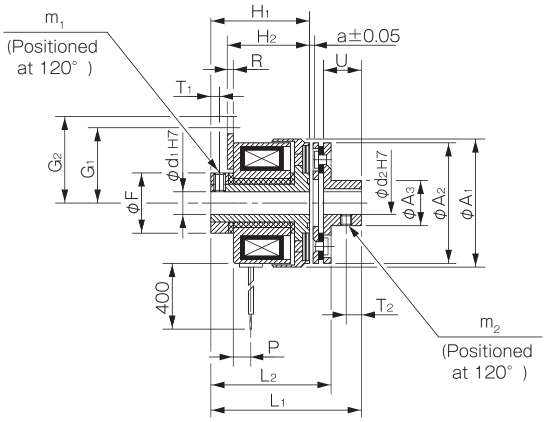
Size

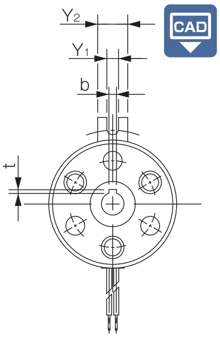
Armature bore diameter (dimensional symbol d2)

Rotor bore diameter (dimensional symbol d1)

Dimensions (102-□-31)

(For butt shafts)





Unit [mm]

Size	Shaft bore dimensions					
	d_1 H7	d2 H7	Models compliant with JIS standards		Models compliant with the old JIS standards	
			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	$5^{-0.012}_{-0.042}$	$2^{+0.5}_{0}$	$5^{+0.050}_{+0.020}$	$2^{+0.5}_{0}$

* Rotor bore d_1 is a straight bore.

Unit [mm]

Size	Radial direction dimensions										Axial direction dimensions									
	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	15.8	20	3.1	8	2-M3	M3	23.5	19.1	1.2	32.9	27.9	4.9	7	2.5	2.5	0.1
03	34	32	12	16	20	23	3.1	8	2-M3	2-M3	26.2	22	1.6	38.5	30.5	4.7	10	2.3	4	0.15
04	43	40	17	22	23	26	3.1	8	2-M4	2-M3	30.4	25.2	1.6	45.1	35.8	5.2	12	2.8	5	0.15
05	54	50	24	30	28	31	3.1	8	2-M5	2-M4	34.1	27.9	1.6	49.3	40.3	6.2	12	3.3	5	0.2

* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

102-03-31 24V R6 A6DIN

Size

Rotor bore diameter (dimensional symbol d1)

Keyway standards DIN: Compliant with JIS standards P9
JIS: Compliant with the old JIS standards (class 2) E9

Armature bore diameter (dimensional symbol d2)

*Models for which there are no keyway standards (models marked by [-]) on the Shaft Bore Dimensions table need not be marked with a keyway standards designation. Products with standards marked by diagonal lines are not set as standard products.

CYT Models Electromagnetic Micro Clutches - Bearing-mounted Type

Specifications

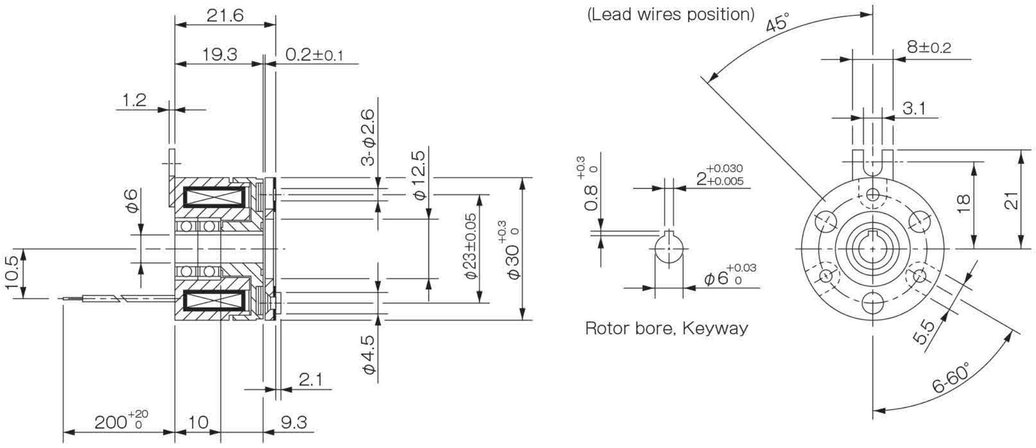
Model	Size	Dynamic friction torque T_d [N·m]	Coil (at 20℃)				Heat resistance class	Lead wire		Max. rotation speed [min^{-1}]	Rotating part moment of inertia		Allowable engaging energy $E_{ea\ell}$ [J]	Total work E_T [J]	Armature pull-in time t_a [s]	Torque rise time t_p [s]	Torque extinction time t_d [s]	Mass [kg]
			Voltage [V]	Wattage [W]	Current [A]	Resistance [Ω]		UL style	Size		Armature [kg·m²]	Rotor [kg·m²]						
CYT-025-33B	025	0.4	DC24	4.5	0.188	128	B	UL3398	AWG26	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	UL3398	AWG26	3600	1.30×10^{-6}	1.85×10^{-6}	900	1.5×10^6	0.015	0.030	0.040	0.13
CYT-04-33B	04	1.0	DC24	5.9	0.25	98	B	UL3398	AWG26	3600	5.15×10^{-6}	1.00×10^{-5}	1900	2.0×10^6	0.030	0.040	0.040	0.26

* The dynamic friction torque, T_d, is measured at a relative speed of 100 min^{-1}. Depending on the initial torque characteristics, break-in to condition the engaging surfaces may also be required.

* Keep supply voltage fluctuation to within 10% of coil voltage. Also, be careful that energization does not exceed 50%.

* The rotating part moment of inertia and mass are measured for the maximum bore diameter.

Dimensions (CYT-025-33B)

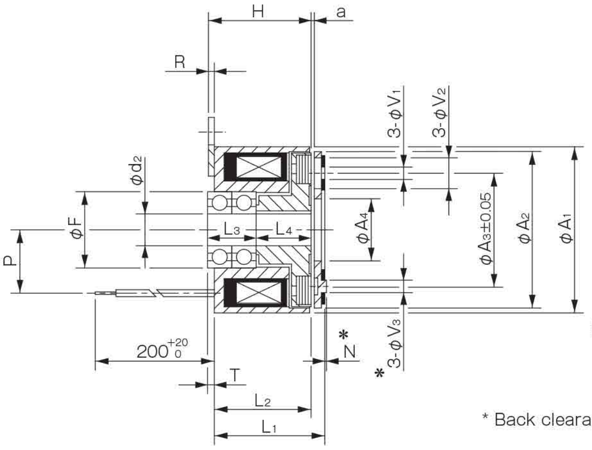


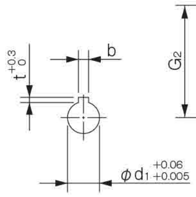
* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

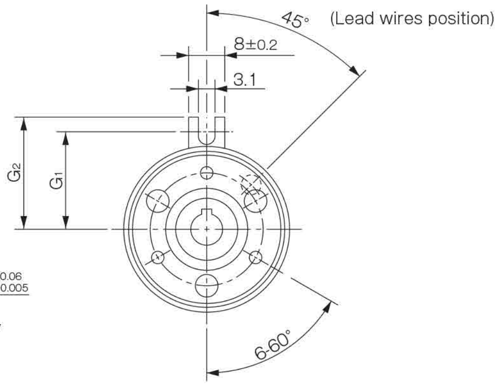
CYT-025-33B 24V 6

Dimensions (CYT-☐-33B)





Rotor bore, Keyway



* Back clearance dimensions for the rivet head during mounting are marked with [*].

Unit [mm]

Size	Nominal diameter	Radial direction dimensions										Axial direction dimensions										Shaft bore dimensions			
		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	$3^{+0.025}_{0}$	$1.2^{+0.3}_{0}$

* Dimensional symbols N and V3 indicate the clearance dimensions for the rivet head during mounting.
* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

CYT-03-33B 24V 6

Size: 03

Nominal diameter: 6

112 Models Electromagnetic Micro Brakes

Specifications

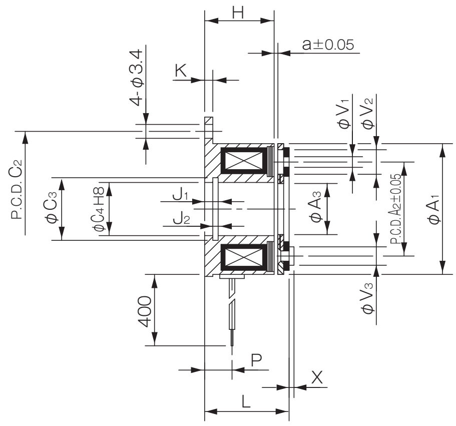
Model	Size	Dynamic friction torque T_d [N·m]	Coil (at 20℃)				Heat resistance class	Lead wire		Max. rotation speed [min⁻¹]	Armature moment of inertia J [kg·m²]	Allowable braking energy Ebaℓ [J]	Total work performed until Readjustment of the air gap E_T [J]	Armature pull-in time t_a [s]	Torque build-up time t_p [s]	Torque decaying time t_d [s]	Mass [kg]
			Voltage [V]	Wattage [W]	Current [A]	Resistance [Ω]		UL style	Size								
112-02-13	02	0.4	DC24	6	0.25	96	B	UL3398	AWG26	10000	6.75×10^{-7}	1500	2×10^{6}	0.004	0.010	0.010	0.053
112-02-12											1.00×10^{-6}						0.057
112-02-11											1.00×10^{-6}						0.057
112-03-13	03	0.6	DC24	6	0.25	96	B	UL3398	AWG26	10000	1.30×10^{-6}	2300	3×10^{6}	0.005	0.012	0.008	0.072
112-03-12											1.95×10^{-6}						0.079
112-03-11											1.95×10^{-6}						0.079
112-04-13	04	1.2	DC24	8	0.33	72	B	UL3398	AWG26	10000	4.38×10^{-6}	4500	6×10^{6}	0.007	0.016	0.010	0.118
112-04-12											6.15×10^{-6}						0.131
112-04-11											6.15×10^{-6}						0.131
112-05-13	05	2.4	DC24	10	0.42	58	B	UL3398	AWG22	10000	9.08×10^{-6}	9000	9×10^{6}	0.010	0.023	0.012	0.200
112-05-12											1.38×10^{-5}						0.215
112-05-11											1.38×10^{-5}						0.215

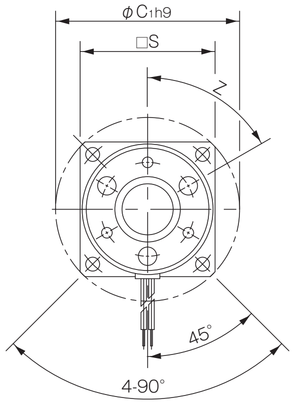
* The dynamic friction torque, T_d, is measured at a relative speed of 100 min⁻¹. Depending on the initial torque characteristics, break-in to condition the engaging surfaces may also be required.

* Keep supply voltage fluctuation to within 10% of coil voltage. Do not allow the energization rate to exceed 80%.

* The rotating part moment of inertia and mass are measured for the maximum bore diameter.

Dimensions (112-□-13)





Unit [mm]

Size	Radial direction dimensions												Axial direction dimensions							
	A_1	A_2	A_3	C_1	C_2	C_3	C_4	S	V_1	V_2	V_3	Z	H	K	J_1	J_2	L	P	X	a
02	28	19.5	10.5	39	33.5	11.4	11	—	2-2.1	2-5.3	2-3.7	4-90°	13.7	1.5	2.6	1.3	16.1	5	0.8	0.1
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
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	22.7	7.2	1.6	0.15
05	50	38	25.5	65	58	27.2	26	51	3-3.1	3-6.5	3-6	6-60°	22	2	3.5	1.5	25.2	8.2	1.5	0.2

* Size 02 is a rounded flange.

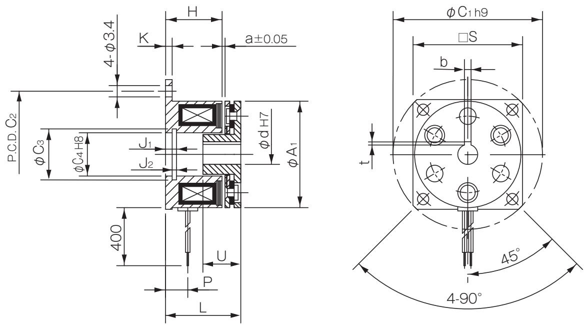
* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

112-03-13 24V

Size

Dimensions (112- □ -12)



Unit [mm]

Size	Shaft bore dimensions				
	d	Models compliant with JIS standards		Models compliant with the old JIS standards	
	H7	b P9	t	b E9	t
02	5	—	—		
03	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
	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 direction dimensions						Axial direction dimensions							
	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
03	32	45	38	13.6	13	33	17	2	3.3	1.3	21.3	6.7	10	0.15
04	40	54	47	20	19	41	20	2	3.3	1.3	25.4	7.2	12	0.15
05	50	65	58	27.2	26	51	22	2	3.5	1.5	28.2	8.2	12	0.2

* Size 02 is a rounded flange.
* The armature hub of size 02 has no keyway. Lock it in place by press-fitting it onto the shaft or the like.
* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

112-03-12 24V 6DIN

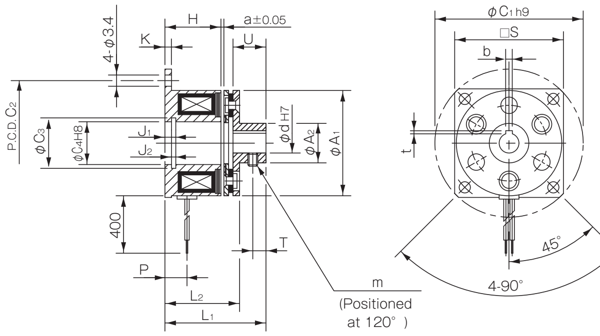
Size

Keyway standards DIN: Compliant with JIS standards P9
JIS: Compliant with the old JIS standards (class 2) E9

Armature bore diameter (dimensional symbol d)

* Models for which there are no keyway standards (models marked by [-]) on the Shaft Bore Dimensions table need not be marked with a keyway standards designation. Products with standards marked by diagonal lines are not set as standard products.

Dimensions (112- □ -11)



Unit [mm]

Size	Shaft bore dimensions				
	d	Models compliant with JIS standards		Models compliant with the old JIS standards	
	H7	b P9	t	b E9	t
02	5	—	—		
03	6	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
04	8	$2^{-0.006}_{-0.031}$	$0.8^{+0.3}_{0}$		
	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 direction dimensions								Axial direction dimensions								
	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
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
04	40	17	54	47	20	19	41	2-M3	20	2	3.3	1.3	34.7	25.4	7.2	12	5	0.15
05	50	24	65	58	27.2	26	51	2-M4	22	2	3.5	1.5	37.2	28.2	8.2	12	5	0.2

* Size 02 is a rounded flange.
* For details on mounting method, see "Items Checked for Design Purposes".

How to Place an Order

112-03-11 24V 6DIN

Size

Keyway standards DIN: Compliant with JIS standards P9
JIS: Compliant with the old JIS standards (class 2) E9

Armature bore diameter (dimensional symbol d)

* Models for which there are no keyway standards (models marked by [-]) on the Shaft Bore Dimensions table need not be marked with a keyway standards designation. Products with standards marked by diagonal lines are not set as standard products.

ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

The Selection Process

Key Issues for Selection

Because of their good controllability, clutches and brakes are often used for complex controls rather than simple on/off operations.
If a size is chosen based solely on torque, problems can unexpectedly result.
When choosing a size, many factors must be considered, including load properties and the layout of the mechanism that incorporates the clutch or brake. In this section on selecting sizes, we explain how to make selections for a variety of situations, and also give calculation examples and data needed for selections.

■ Motors and clutches/brakes

- Relationship between motor output and torque

Motor size is expressed as output, but clutches and brakes are expressed as torque. The following relationship obtains between this torque and motor output.

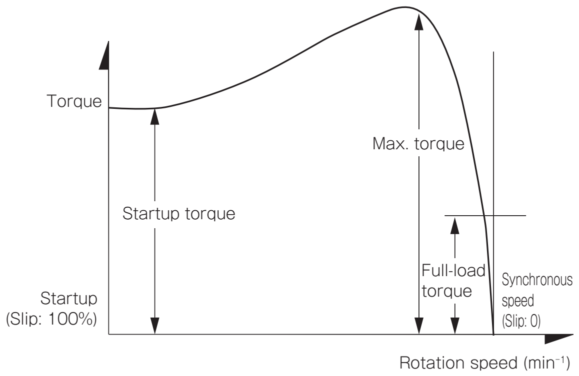
$$T_M = \frac{9550 \cdot P}{n_r} \eta \ [\text{N•m}] \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \ (1)$$

P: Motor output [kW]
n_r: Rotation speed of clutch/brake shaft [min^{-1}]
η : Transmission efficiency from motor to clutch/brake

- Variance of characteristics

Motors have different torque characteristics from clutches and brakes. That requires that the various characteristics be factored in when using a motor as the drive source and starting and stopping loads with a clutch/brake.

Motor characteristics
Motors can generate torque of 200% of total load torque or more at startup, pass through maximum torque while accelerating, and drive the load near the full load torque that enables stable operation. If load increases during rotation, the motor can lower its own rotation speed and drive the load at a rotation speed that generates high torque. The figure below shows the relationship between motor torque and rotation speed characteristics.

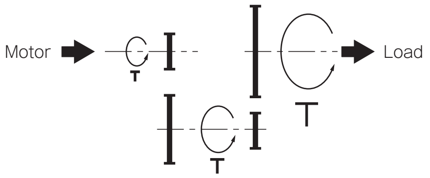


Clutch/brake torque characteristics
The clutch/brake characteristics are determined by the upper limits of engaging and braking torque, as described in the section on torque characteristics. Load torque beyond that causes slipping at the frictional surface.
Knowing these differences in characteristics from the beginning enables you to select the clutch/brake suited for your load conditions. A clutch/brake that has a torque value that is 200 to 250% of the full load torque of the motor will normally be suited to a wide range of applications, factoring in reasonable safety considerations when selecting it.

■ Relationship between torque and rotation speed

- Torque and rotation speed are inversely proportional

Shafts within machinery that are rotating the fastest can be made to rotate with little force, but decelerated slow-rotating shafts require large amounts of force to make them rotate.
In other words, torque and rotation speed are inversely proportional. This is very important for the selection of clutches and brakes. The size and service life of a clutch or brake can change depending on how fast the shaft it is used on is rotating.



- In combination with speed changers

If you are using the clutch/brake within a mechanism that can change rotation speed, such as a stepless speed changer, you must select a clutch/brake that does not fall short on torque at low speeds and that satisfies needs for response and service life at high speeds.

■ Ascertaining load properties

Clutch and brake engaging time, wear life, and the like will vary with the properties of the load being engaged or braked. For that reason, if the load is not ascertained as accurately as possible, even slight changes in load conditions can mean the system will not work adequately.
As it happens, such load properties are quite diverse, and thus difficult to ascertain. Often, users today will determine them empirically.

- Importance of safety factor

When determining the size of the clutch or brake, determine the required torque by multiplying by an empirically derived factor. Once the drive part has been determined, we use an empirical factor K based on the type of drive source used.
If this factor is too small, slipping and other problems can occur when conditions deteriorate; if it is too large, the load on the driver increases, which can cause driver problems when overloads occur.

Types of drivers	Motor/ turbine	Gasoline engine	Diesel engine (1 or 2 cylinder gasoline engine)
Factor K	2 ~ 2.5	2.5 ~ 2.8	2.8 ~ 3.4

- Load torque and moment of inertia

Load torque comes from resistance from the machinery and from resistance applied after engagement (cutting resistance, etc.).
Load torque is generally difficult to determine and is therefore sometimes ignored during size selection. For clutches, however, this can lead to inadequate torque, so it requires attention.
Moment of inertia is also called the flywheel effect. It is a quantity that represents the difficulty of getting an object to move or the difficulty of stopping it.
When designing a mechanism, the work of the clutch and brake are lessened by making the load on the clutch as small as possible while making the brake load somewhat larger. If the moment of inertia is made as small as possible, response and service life are improved.
And since the clutch and brake have inertia of their own, that inertia must be added to calculations.

Selection

Simple Selection Graph

This selection graph applies to cases in which the drive source is a motor, load is relatively light, and frequency is low. The clutch/brake size can be determined easily when the motor used is appropriate to the load, the mechanism between motor and clutch/brake is not complex, and there is no high-inertia body to assist drive.

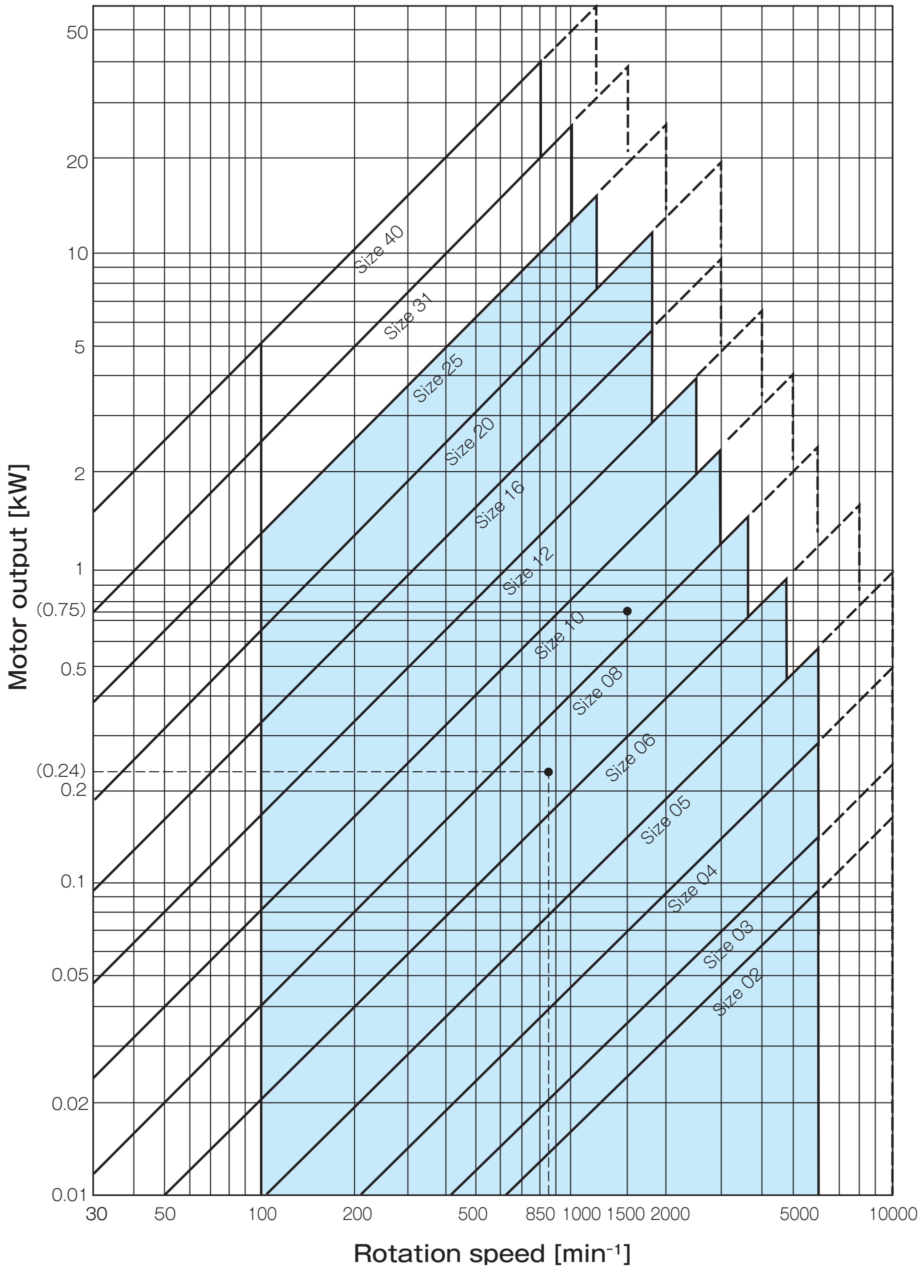
This table is for a safety factor K of 2.5 (ordinary use). You can use this table to select a clutch/brake with other factors. For the vertical axis [kW], use the value obtained by multiplying the motor output by K/2.5.

Selection example

- If the motor output is 0.75 kW and the clutch/brake rotation speed is 1500 min^{-1}, select the size at their intersection, which is size 10.
- To get K = 1.5 when the motor output is 0.4 kW and the clutch/brake rotation speed is 850 min^{-1}:

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

Find 0.24 kW on the vertical axis of the table and find the intersection with 850 min^{-1}. The size to select is size 08.



* Select the size in the 🟦 area. Inside the dotted line area on the right, the amount of energy, heat dissipation, friction or the like may not satisfy requirements, so check them.
Within the bold line under 100 min^{-1}, use the equation to check the required torque.

* Contact Miki Pulley regarding sizes 31 and 40.

ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

Consideration of Torque

Total load torque of motor (T$_M$)

The total load torque translated to the clutch/brake mounting shaft is:

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

P: Motor output [kW]
n_r: Rotation speed of clutch/brake shaft [min^{-1}]
η : Transmission efficiency from motor to clutch/brake

Load torque (T_ℓ)

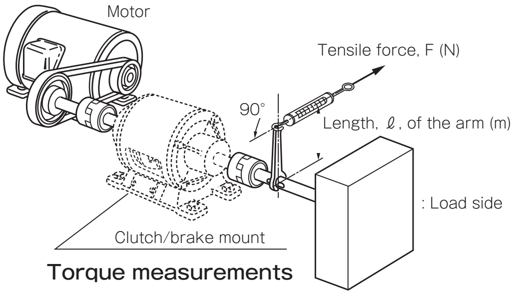
Load torque is difficult to determine through calculations, so it is either determined empirically or by direct measurement.

- When determined from motor capacity
  To select a motor correctly for a load, the T_M of Eq. (1) is used as the load torque.

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

- When measured and then determined
  The load can be actually measured to find an accurate T_ℓ . It can be measured using a torque wrench, or, as in the figure below, the shaft where the clutch or brake will be mounted can be rotated and the value found as the product of the force F to start the load rotating and the length of the arm ℓ .

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



Torque measurements

- Sign of load torque
  Load torque in the equation is shown with a plus or minus sign. For a clutch, it is applied in the direction that opposes rotation, so it is subtracted from clutch torque T_d; for a brake, it is applied in the direction that assists braking, so it is added to brake torque T_d. (In the rare cases in which it works the opposite way, change the signs when calculating.) In the equation, it is expressed as $\pm T_\ell$. Use the value as appropriate.

Acceleration/deceleration torque (T$_a$)

- The torque required to accelerate a load is:

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

t_{ae}: Actual engagement time (acceleration time) of clutch [s]
J: Total moment of inertia engaged by the clutch [kg·m^2]

- The torque required to decelerate a load is:

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

t_{ab}: Actual braking time (deceleration time) of brake [s]
J: Total moment of inertia braked by the brake [kg·m^2]

Required torque (T)

Torque required to drive (brake) a load may be as follows, depending on conditions.

- When J and T_ℓ are applied while engaged

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

K is a factor based on load conditions, which has been empirically found to have values like the following. The sign of T_ℓ is positive for a clutch, since T_ℓ works in the direction that opposes driving, and negative for a brake, since it works in the direction that assists braking.

- When T_ℓ is nearly all that is applied

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

- When J is nearly all that is applied

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

- For stationary engagement
  When engaging the clutch while stationary and then accelerating the load with the driver, the required torque so that the clutch does not slip when accelerating is:

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

J_d: Total drive-side J from clutch [kg·m^2]
J_ℓ : Total load-side J from clutch [kg·m^2]

Safety factor based on load conditions: K

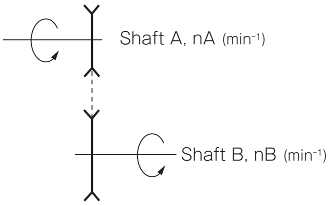
Usage conditions		Factor K
Light load	Low-frequency use of small inertial body	1.5
	High-frequency use of relatively small inertial body Ordinary use of normal inertial body	2 ～ 2.2
	High-frequency use	2.2 ～ 2.4
Normal load	Low-frequency use of small inertial body	2 ～ 2.4
	Ordinary use	2.4 ～ 2.6
	Driving large inertial body	2.7 ～ 3.2
Heavy load	Operation with shock (large load fluctuation)	3.5 ～ 4.5

Translation of torque to other shafts

For the torque of shaft B to be translated to shaft A:

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

T_A: Torque of shaft A, T_B: Torque of shaft B [N·m]
n_A: Rotation speed of shaft A, n_B: Rotation speed of shaft B [min^{-1}]



Consideration of Energy

Engaging or braking energy (E_e, E_b)

The energy when a clutch or brake engages or brakes once is:

- For acceleration, engaging energy E_e is:

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

- For deceleration, braking energy E_b is:

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

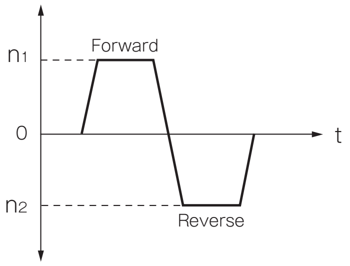
- Forward/reverse rotation

  The engaging energy of the clutch when using the clutch to switch rotation direction is:

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

n_1: Forward rotation speed [min^{-1}]

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



- Energy when using slip

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

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

t: Slip time [s]

n: Rotation speed that forces slip [min^{-1}]

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

If the clutch or brake slips as it is being used, unwanted situations such as heat generation can occur, so perform adequate checks.

- Allowable work

  Allowable work $E_{ea\ell}$ and $E_{ba\ell}$ are the values under ideal conditions, so the values of E_e and E_b must be sufficiently smaller than the values of $E_{ea\ell}$ and $E_{ba\ell}$.

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

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

* For the values of $E_{ea\ell}$ and $E_{ba\ell}$, see the page on heat dissipation characteristics (P.327).

Energy rate

Since clutches and brakes turn on and off at relatively high frequencies, it is important to investigate whether accumulated heat can be dissipated.

- Engaging energy rate (P_e)

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

- Braking energy rate (P_b)

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

S: Frequency of operation [RPM]

Allowable energy rates $P_{ea\ell}$ and $P_{ba\ell}$ are the values under ideal conditions, so E_e, E_b and S must be set so these rates are sufficiently small.

* For the values of $E_{ea\ell}$ and $E_{ba\ell}$, see the page on heat dissipation characteristics (P.327).

Frequency of engaging/braking (S_a)

The allowable operating frequency S_a determined by heat dissipation is:

$$S_a \ll \frac{60 P_{ea\ell}}{E_e} \ [RPM] \quad (20)$$

$$S_a \ll \frac{60 P_{ba\ell}}{E_b} \ [RPM] \quad (21)$$

This allowable frequency reflects only thermal considerations; in actual use, operating time should also be considered.

Consideration of Operating Time

Total engagement/braking time (t_{te}, t_{tb})

The time the load is engaged or braked by the clutch or brake is the sum of the operating time of the clutch or brake itself and the accelerating/deceleration time.

- Total engagement time

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

t_{id}: Initial delay time [s]

t_a: Armature pull-in time [s]

t_{ae}: Actual clutch engagement time (acceleration time) [s]

- Total braking time

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

t_{id}: Initial delay time [s]

t_a: Armature pull-in time [s]

t_{ab}: Actual braking time (deceleration time) of brake [s]

t_{ae} and t_{ab} are found using the following equations based on operating conditions.

- When accelerating/decelerating

  Actual engagement time is:

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

Actual braking time is:

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

- During forward/reverse rotation

  The actual engagement time (acceleration time) when switching from forward to reverse with a clutch is:

$$t_{ae} = \frac{J}{9.55} \left(\frac{n^1}{T_d - T_\ell} + \frac{n^2}{T_d + T_\ell} \right) \ [s] \quad (26)$$

n_1: Forward rotation speed [min^{-1}]

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

ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

■ Engaging/braking time when engaging/braking is completed during the torque rise process

In this case, it is the sum of the armature pull-in time t_a and t_{ae}' or t_a and t_{ab}'.

- Total engagement time

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

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

- Total braking time

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

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

These are when $T_\ell = 0$. Generally, the above equation is used only when load torque (T_ℓ) is very small. When, for calculated values, $t_{ae}' > t_{ap}$ and $t_{ab}' > t_{ap}$, use equations (22) to (26).

Consideration of Number of Operations

The amount of work that a clutch or brake can do before the air gap is adjusted is predetermined. When used beyond that point, the air gap must be adjusted. The number of operations that can be done before air gap adjustment is:

- For a clutch

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

E_T: Total work performed until readjustment of the air gap

- For brakes

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

Consideration of Stopping Precision

Finding stopping precision by calculating is very difficult, since friction energy, control system fluctuations and the like are involved. Generally, it is found empirically with the following equation, and that is then used as a guide.

■ Stopping angle (θ)

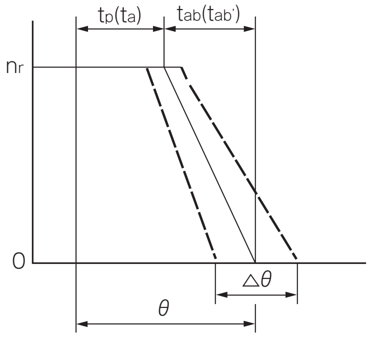
$$\theta = 6n_r(t_{id} + t_p + \frac{1}{2}t_{ab}) \text{ [°]} \quad \cdots\cdots(33)$$

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

■ Stopping precision (△θ)

$$\triangle\theta = \pm 0.15\ \theta \text{ [°]} \quad \cdots\cdots(35)$$

When there are factors that disrupt braking such as load fluctuation, use a value between 0.2 and 0.25 as the constant in Eq. (35) for safety reasons. Note that the stopping angle and stopping precision do not include divergences due to control system delays, or backlash from chains, gears, or the like.



Total Work Performed Until Readjustment of the Air Gap E_T

Electromagnetic Micro Clutches & Micro Brakes 102/112 Models

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

CYT Models

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

Electromagnetic Clutch/Brake (Units) 101/CS/111 Models

Size	Total work 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

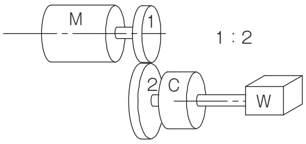
* Also applies to all unit models (except models 180).

CSZ and BSZ Models

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

Selection Example 1

Clutches used for intermittent transport of loads



Selection of a clutch to use to intermittently transport loads as follows, as the figure illustrates.

Usage conditions

Output of motor used	P	0.4 kW (standard 3-phase, 4P)
Clutch operation frequency	S	20 [RPM]
Moment of inertia of load	J_A	0.0208 [kg·m²]
Load torque	T_ℓ	Unknown [N•m]
Clutch mounting shaft rotation speed	n	750 [min⁻¹]
Transmission rate	η	90%

■ Consideration of Torque

We find the required torque for engagement from the above operating conditions.
First, we find the load torque. Based on Eq. (1), load torque T_ℓ (assuming the motor was selected correctly) is:

$$T_\ell = \frac{9550 \times 0.4}{750} \times 0.9 = 4.58\ [\text{N•m}]$$

Next, according to Eq. (4), the acceleration torque T_a is:

$$T_a = \frac{0.0208 \times 750}{9.55 \times 0.5} = 3.27\ [\text{N•m}]$$

The acceleration time is given as a condition, but in the above equation is it projected as t_{ae} = 0.5 [s] based on the operation frequency.
Thus, the required torque (T), according to Eq. (6), is:

$$T = (4.58 + 3.27) \times 2 = 15.7\ [\text{N•m}]$$

Here, the sign of the load torque T_ℓ is +. The factor K for load conditions was empirically set at 2 for general use with ordinary loads.
From the above, the clutch is size 10, which is a clutch that has torque (20 N•m) above the required torque of 15.7 [N•m].

■ Consideration of Energy

Having determined the model, we find the total load moment of inertia from the self-inertia J of that type and the load moment of inertia.
With the model as 101-10-13, the moment of inertia J of the rotor is 0.000678 [kg•m²]. Thus, the total moment of inertia J_{Total}' is:

$$J_{Total}' = 0.0208 + 0.000678 = 0.02148\ [\text{kg•m}^2]$$

We find the engaging energy E_e for a single operation. From Eq. (11)

$$E_e = \frac{0.02148 \times 750^2}{182} \times \frac{20}{(20 - 4.58)} = 86.1\ [\text{J}]$$

Here, the sign of the load torque T_ℓ is -. This engaging energy E_e is sufficiently below the allowable energy $E_{ea\ell}$.

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

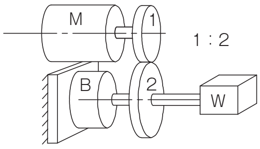
Next, we find the energy rate. From Eq. (18)

$$P_e = \frac{86.1 \times 20}{60} = 28.7\ [\text{W}]$$

This value is sufficiently below the allowable energy rate $P_{ea\ell}$.
Thus, this clutch is suited to the operating conditions, and model 101-10-13 is selected.

Selection Example 2

Brakes that stop momentum when motor goes off



Selection of a brake to stop the momentum of a load when a motor is turned off as follows, as the figure illustrates.

Usage conditions

Output of motor used	P	0.75kW (standard 3-phase, 4P)
Motor rotation speed	n_1	1800 [min⁻¹]
Moment of inertia of motor	J_M	0.00205 [kg·m²]
Moment of inertia of V pulley (motor side)	J_1	0.00075 [kg·m²]
Moment of inertia of V pulley (brake side)	J_2	0.00243 [kg·m²]
Moment of inertia of load	J_A	0.05 [kg·m²]
Load torque	T_ℓ	5.0 [N•m]
Brake mounting shaft rotation speed	n	900 [min⁻¹]
Stopping time	t	Within 0.5 [s]

■ Consideration of Torque

From the above operating conditions, find the total moment of inertia translated to the brake shaft.

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

We find the deceleration torque. The deceleration time also includes the operating time of the brake itself, so calculate it as 1/2 of the given stopping time. From Eq. (5)

$$T_a = \frac{0.06363 \times 900}{9.55 \times 0.25} = 24.0\ [\text{N•m}]$$

The required torque from Eq. (6) is:

$$T = (24.0 - 5.0) \times 2.4 = 45.6\ [\text{N•m}]$$

Here, the sign of the load torque T_ℓ is -. The factor K for load conditions was empirically set at 2.4 for general use with ordinary loads.
From the above, size 12, which has brake torque (40 N•m) equivalent to the required torque of 45.6 [N•m], was provisionally selected

■ Consideration of Energy

Having determined the model, we find the total load moment of inertia from the self-inertia J of that type and the load moment of inertia.
With the model as 111-12-11, the moment of inertia J of the armature is 0.00181 [kg•m²]. Thus, the total moment of inertia J_{Total}' is:

$$J_{Total}' = 0.06363 + 0.00181 = 0.06544\ [\text{kg•m}^2]$$

Find the braking energy E_b for a single operation. From Eq. (12)

$$E_b = \frac{0.06544 \times 900^2}{182} \times \frac{40}{(40 + 5)} = 258.9\ [\text{J}]$$

Here, the sign of the load torque T_ℓ is +. This braking energy E_b is sufficiently below the allowable energy $E_{ba\ell}$.

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

ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

■ Consideration of Operating Time

We find the braking time. From Eq. (25)

$$t_{ab} = \frac{0.06544 \times 900}{9.55 \times (40 + 5)} = 0.137\ [s]$$

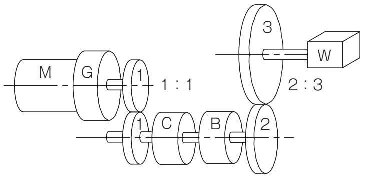
Here, the sign of the load torque T_ℓ is +.
From the specifications table, the armature pull-in time t_a for size 12 is 0.027 [s]. If the initial delay time t_{id} of relays and the like is 0.050 [s],

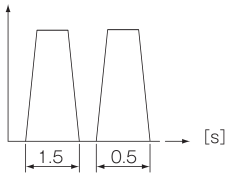
$$t_{tb} = 0.050 + 0.027 + 0.137 = 0.214\ [s]$$

from Eq. (23):
This value satisfies the requirement of being at or below 0.5 [s]. Thus, this brake is suited to the operating conditions, and model 111-12-11 is selected.

Selection Example 3

Clutches and brakes that drive loads





Selection of a clutch and brake to drive the load as follows, as the figure illustrates.

Usage conditions

Operation frequency	S	30 [RPM]
Required service life operations *1	L	810 × 10^4 (operations) or more
Moment of inertia of V pulley A	J_1	0.00195 [kg·m^2]
Moment of inertia of V pulley B	J_2	0.01668 [kg·m^2]
Moment of inertia of load	J_A	0.5075 [kg·m^2]
Load torque	T_ℓ	22.0 [N•m]
Clutch/brake mounting shaft rotation speed	n	150 [min^{-1}]
Load shaft rotation speed	n_2	100 [min^{-1}]
Engagement time	t_1	Within 0.3 [s]
Stopping time	t_2	Within 0.3 [s]

*1: Desired use is 15 hours per day without adjustment for at least 1 year.
L = 30 × 60 min × 15 hr × 300 days = 8.1 million operations

■ Consideration of Torque

From the above operating conditions, load torque is translated to the clutch/brake shaft. From Eq. (10)

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

All of the moment of inertia of the rotating parts is translated to the clutch/brake shaft.

$$J_{Total} = J_{11} + (J_2 + J_A) \times \left(\frac{2}{3}\right)^2$$

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

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

The acceleration time also includes the operating time of the clutch/brake itself, so calculate it as 1/2 of the given engagement time of 0.3 [s].
From Eq. (4):

$$T_a = \frac{0.2349 \times 150}{9.55 \times 0.15} = 24.6\ [N\bullet m]$$

The required torque T from Eq. (6) is:

$$T = (24.5 \pm 14.7) \times K\ [N\bullet m]$$

If the factor K for load conditions is empirically set at 2 for general use with ordinary loads, for the clutch we get:

$$T = (24.5 + 14.7) \times 2 = 78.4\ [N\bullet m]$$

And for the brake, we get:

$$T = (24.5 - 14.7) \times 2 = 19.6\ [N\bullet m]$$

Based on the above, we select a size 16 clutch (torque 80N•m) and size 10 brake (torque 20N•m).

■ Consideration of Energy

Next, having determined the model, we find the total load moment of inertia from the self-inertia J of that type and the load moment of inertia.
If the clutch model is 101-16-15, the moment of inertia of the rotor is 0.0063 [kg•m^2]; if the brake model is 111-10-11, the moment of inertia of the armature is 0.000663 [kg•m^2].
Thus, the total moment of inertia $J_{Total'}$ is:

$$J_{Total'} = 0.2349 + 0.0063 + 0.000663$$

$$= 0.2419\ [kg\bullet m^2]$$

We find the engaging energy of the clutch E_e for a single operation. From Eq. (11)

$$E_e = \frac{0.2419 \times 150^2}{182} \times \frac{80}{(80 - 14.7)} = 36.6\ [J]$$

We find the braking energy E_b of the brake for a single operation. From Eq. (12)

$$E_b = \frac{0.2419 \times 150^2}{182} \times \frac{20}{(20 + 14.7)} = 17.2\ [J]$$

This value satisfies the allowable energy and the energy per minute of the selected model.

■ Consideration of Number of Operations

Next, we find the number of operations. From the specifications tables for the different models, the total energy of sizes 16 and 10 is, respectively, 470 × 10^6 [J] and 130 × 10^6 [J], so from Eqs. (31) and (32), for the clutch we get:

$$L = \frac{470 \times 10^6}{36.6} = 1284 \times 10^4\ [times]$$

And for the brake, we get:

$$L = \frac{130 \times 10^6}{17.2} = 756 \times 10^4\ [times]$$

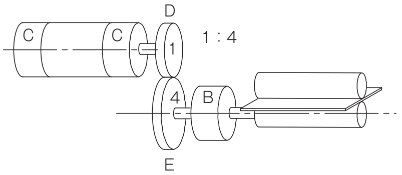
Since the requirement for number of operations in service life is roughly 8.1 million, a size 10 brake cannot satisfy the requirements. When we therefore consider the situation again with a 111-12-11 model brake, we find (leaving out intermediate calculations):

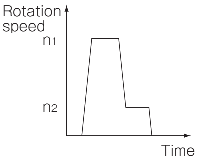
$$L = \frac{250 \times 10^6}{22.0} = 1136 \times 10^4\ [times]$$

This satisfies the requirements. Thus, we select a 101-16-15 model clutch and a 111-12-11 model brake.

Selection Example 4

Clutches and brakes used in two-step speed change/stopping mechanisms





As the figure illustrates, a selection that includes the stopping precision of the clutch and brake that drive the load is as follows.

Usage conditions

Max. input rotation speed	n_1	1500 [min^{-1}]
Min. input rotation speed	n_2	200 [min^{-1}]
Roll shaft rotation speed	n_3	50 [min^{-1}]
Operation frequency	S	12 [RPM]
Required service life operations *1	L	130 × 10^4 (operations) or more
Moment of inertia of pulley D	J_1	0.000025 [kg·m^2]
Moment of inertia of pulley E	J_2	0.005375 [kg·m^2]
Moment of inertia of roll	J_A	0.0133 [kg·m^2]
Load torque of roll	T_ℓ	8.0 [N•m]
Roll diameter	R	60 [mm]

* 1: Desired use is 6 hours per day without adjustment for at least 1 year.
L = 12 × 60 min × 6 hr × 300 days = 1.3 million operations

■ Consideration of Brake

- Consideration of energy

From the above operating conditions, we find the total moment of inertia translated to the feed roll shaft. If the moment of inertia of the rotating parts of clutch/brake unit model 121-08-10 is 0.000475 [kg•m^2] and the moment of inertia of the armature of brake model 111-12-12 is 0.00181 [kg•m^2],

$$J_{Total} = 0.0133 \times 2 + 0.00181 + 0.005375$$
$$+ \ (0.000025 + 0.000475) \times \left(\frac{4}{1}\right)^2$$
$$= 0.04179\ [kg•m^2]$$

Find the braking energy E_b for a single operation. From Eq. (12):

$$E_b = \frac{0.04179 \times 50^2}{182} \times \frac{40}{(40 + 8)} = 0.48\ [J]$$

Here, the sign of the load torque T_ℓ is +. This value satisfies the allowable energy and the energy per minute of the selected model.

- Consideration of number of operations

Next, we find the number of operations. The total energy of size 12 is 250 × 10^6 [J], so from Eq. (32):

$$L = \frac{250 \times 10^6}{0.48} = 52083 \times 104\ [times]$$

This value adequately satisfies the requirements.

■ Consideration of Operating Time

We find the braking time.

We can use either Eq. (25) or Eq. (30), but we use Eq. (30) because the braking time is then shorter. Here, the torque increase time t_{ap} of the brake is 0.063 [s], so from Eq. (30), braking time t_{ab}' is:

$$t_{ab}' = \sqrt{\frac{0.04179 \times 50}{4.77} \times \frac{0.063}{(0.8 \times 40)}}$$
$$= 0.0294\ [S]$$

- Consideration of stopping precision

If the initial delay time t_{id} of relays and the like is 0.050 [s], from Eq. (34), the stopping angle is:

$$\theta = 6 \times 50 \times \left(0.050 + 0.027 + \frac{2}{3} \times 0.0294\right)$$
$$= 28.98\ [^\circ]$$

From Eq. (35), the stopping precision is:

$$\triangle\theta = \pm 0.15 \times 28.98 = \pm 4.35\ [^\circ]$$

Converting from roll diameter to length on the circumference, we get ± 2.3 [mm].

■ Consideration of Clutch

- Consideration of energy

From the above operating conditions, we find the total moment of inertia translated to the clutch shaft.

$$J_{Total'} = 0.000475 + 0.000025 +$$
$$(0.00181 + 0.0133 \times 2 + 0.005375 \times \left(\frac{1}{4}\right)^2$$
$$= 0.0026\ [kg•m^2]$$

Load torque translates to the clutch shaft using Eq. (10).

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

Calculating for the clutch on the high-speed side, the engaging energy E_e for one operation, from Eq. (11), is:

$$E_e = \frac{0.0026 \times 1500^2}{182} \times \frac{10}{(10 - 2)} = 40.2\ [J]$$

This value satisfies the allowable energy of the selected model.

Next, we find the engaging energy rate P_e. From Eq. (18):

$$P_e = \frac{40.2 \times 12}{60} = 8.04\ [W]$$

This value is sufficiently small for the allowable energy rate $P_{ea\ell}$.

- Consideration of number of operations

We find the number of operations. From Eq. (31):

$$L = \frac{60 \times 10^6}{40.2} = 149 \times 10^4\ [times]$$

Since the number of operations over one year is roughly 1.3 million, this meets the requirement.

Next, calculating for the clutch on the low-speed side, the engaging energy E_e for one operation, from Eq. (12), is:

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

This clutch decelerates the load from 1500 (min^{-1}) to 200 (min^{-1}), so it does similar work to the brake. Thus, the sign of the load torque T_ℓ is +. Also, since this value is smaller than the value for the clutch on the high-speed side, it clearly satisfies the requirement for number of operations during the service life.

The above shows that both clutch and brake satisfy conditions.

ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

Accessories

Different models and types of clutches and brakes have different accessories. Consult these tables.
Note that we may change accessories as circumstances dictate.

Micro Sizes

Model	Varistor		Screw type		Disc spring washer		Shim [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.
102-02-□1/□5	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–
112-02-□1/□2	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–
102/112-02-□3	TND07V-820KB00AAA0 or an equivalent	1	M2 × 3	2	–	–	–	–
CYT-025-33B ϕ 6	TND07V-820KB00AAA0 or an equivalent	1	M2.5 × 4	3	–	–	6.3 × 8.7 × 0.1t	3

Model	Varistor		Screw type		Disc spring washer		Shim [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.
102-03-□1/□5	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–
112-03-□1/□2	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–
102/112-03-□3	TND07V-820KB00AAA0 or an equivalent	1	M2.5 × 4	3	–	–	–	–
CYT-03-33B **ϕ 6**	TND07V-820KB00AAA0 or an equivalent	1	M2.5 × 4	3	–	–	6.3 × 8.7 × 0.1t	3
CYT-03-33B **ϕ 8**	TND07V-820KB00AAA0 or an equivalent	1	M2.5 × 4	3	–	–	8.3 × 11.7 × 0.1t	3

Model	Varistor		Screw type		Disc spring washer		Shim [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.
102-04-□1/□5	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–
112-04-□1/□2	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–
102/112-04-□3	TND07V-820KB00AAA0 or an equivalent	1	M3 × 6	3	–	–	–	–
CYT-04-33B **ϕ 8**	TND07V-820KB00AAA0 or an equivalent	1	M3 × 6	3	–	–	8.3 × 11.7 × 0.1t	3
CYT-04-33B **ϕ 10**	TND07V-820KB00AAA0 or an equivalent	1	M3 × 6	3	–	–	10.3 × 13.7 × 0.1t	3

Model	Varistor		Screw type		Disc spring washer		Shim [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.
102-05-□1/□5	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–
112-05-□1/□2	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–
102/112-05-□3	TND07V-820KB00AAA0 or an equivalent	1	M3 × 6	3	M3	3	–	–
CSZ/BSZ-05-□	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–

* Only the screws supplied with 102/112-05-□3 are hex-socket low-head bolts. All others are Phillips pan-head machine screws.

Standard Sizes

Model	Varistor		Low head bolt		Disc spring washer		Shim 1 [mm]		Shim 2 [mm]		Collar [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.
101/CS-06-□1	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–	–	–	–	–
101/CS-06-□3 ϕ 12	TND07V-820KB00AAA0 or an equivalent	1	M3 × 6	3	M3	3	12.3 × 15.7 × 0.1t	3	–	–	–	–
101-06-13 ϕ 15	TND07V-820KB00AAA0 or an equivalent	1	M3 × 6	3	M3	3	15.3 × 20.7 × 0.1t	3	–	–	–	–
101/CS-06-□5 ϕ 12	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	12.3 × 15.7 × 0.1t	5	12.3 × 15.7 × 0.5t	1	12.2 × 18 × 5.5	1
111-06-11 ϕ 12/ ϕ 15	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–	–	–	–	–
111-06-12 ϕ 12	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	12.3 × 15.7 × 0.1t	3	–	–	–	–
111-06-12 ϕ 15	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	15.3 × 20.7 × 0.1t	3	–	–	–	–
111-06-13	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–	–	–	–	–
CSZ/BSZ-06-□	TND07V-820KB00AAA0 or an equivalent	1	M3 × 6	3	M3	3	–	–	–	–	–	–

Model	Varistor		Low head bolt		Disc spring washer		Shim 1 [mm]		Shim 2 [mm]		Collar [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.
101/CS-08-□1	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–	–	–	–	–
101/CS-08-□3 ϕ 15	TND07V-820KB00AAA0 or an equivalent	1	M4 × 8	3	M4	3	15.3 × 20.7 × 0.1t	3	–	–	–	–
101-08-13 ϕ 20	TND07V-820KB00AAA0 or an equivalent	1	M4 × 8	3	M4	3	20.3 × 27.7 × 0.1t	3	–	–	–	–
101/CS-08-□5 ϕ 15	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	15.3 × 20.7 × 0.1t	5	15.3 × 20.7 × 0.5t	1	15.2 × 22 × 5.5	1
111-08-11 ϕ 15/ ϕ 20	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–	–	–	–	–
111-08-12 ϕ 15	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	15.3 × 20.7 × 0.1t	3	–	–	–	–
111-08-12 ϕ 20	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	20.3 × 29.7 × 0.1t	3	–	–	–	–
111-08-13	TND07V-820KB00AAA0 or an equivalent	1	M4 × 8	3	M4	3	–	–	–	–	–	–
CSZ/BSZ-08-□	TND07V-820KB00AAA0 or an equivalent	1	–	–	–	–	–	–	–	–	–	–

Standard Sizes

Model	Varistor		Low head bolt		Disc spring washer		Shim 1 [mm]		Shim 2 [mm]		Collar [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.
101/CS-10-□1	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101/CS-10-□3 ϕ 20	TND07V-820KB00AAA0 or an equivalent	1	M5 × 10	3	M5	3	20.3 × 27.7 × 0.1t	3	—	—	—	—
101-10-13 ϕ 25	TND07V-820KB00AAA0 or an equivalent	1	M5 × 10	3	M5	3	25.3 × 34.7 × 0.1t	3	—	—	—	—
101/CS-10-□5 ϕ 20	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	20.3 × 27.7 × 0.1t	5	20.3 × 27.7 × 0.5t	2	20.2 × 28 × 5.9	1
111-10-11 ϕ 20/ ϕ 25	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-10-12 ϕ 20	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	20.3 × 27.7 × 0.1t	3	—	—	—	—
111-10-12 ϕ 25	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	25.3 × 34.7 × 0.1t	3	—	—	—	—
111-10-13	TND07V-820KB00AAA0 or an equivalent	1	M5 × 10	3	M5	3	—	—	—	—	—	—

Model	Varistor		Low head bolt		Disc spring washer		Shim 1 [mm]		Shim 2 [mm]		Collar [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.
101/CS-12-□1	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101-12-13 ϕ 25	TND07V-820KB00AAA0 or an equivalent	1	M6 × 10	3	M6	3	25.3 × 34.7 × 0.1t	3	—	—	—	—
101-12-13 ϕ 30	TND07V-820KB00AAA0 or an equivalent	1	M6 × 10	3	M6	3	30.3 × 39.7 × 0.1t	3	—	—	—	—
CS-12-33 ϕ 25	TND07V-820KB00AAA0 or an equivalent	1	M6 × 10	3	M6	3	25.3 × 31.7 × 0.1t	3	—	—	—	—
101/CS-12-□5 ϕ 25	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	25.3 × 31.7 × 0.1t	5	25.3 × 31.7 × 0.5t	2	25.2 × 32 × 7.5	1
111-12-11 ϕ 25/ ϕ 30	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-12-12 ϕ 25	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	25.3 × 31.7 × 0.1t	3	—	—	—	—
111-12-12 ϕ 30	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	30.3 × 39.7 × 0.1t	3	—	—	—	—
111-12-13	TND07V-820KB00AAA0 or an equivalent	1	M6 × 10	3	M6	3	—	—	—	—	—	—

Model	Varistor		Low head bolt		Disc spring washer		Shim 1 [mm]		Shim 2 [mm]		Collar [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.
101/CS-16-□1	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101-16-13 ϕ 30	TND07V-820KB00AAA0 or an equivalent	1	M8 × 15	3	M8	3	30.3 × 41.7 × 0.1t	3	—	—	—	—
101-16-13 ϕ 40	TND07V-820KB00AAA0 or an equivalent	1	M8 × 15	3	M8	3	40.3 × 51.7 × 0.1t	3	—	—	—	—
CS-16-33 ϕ 30	TND07V-820KB00AAA0 or an equivalent	1	M8 × 15	3	M8	3	30.3 × 39.7 × 0.1t	3	—	—	—	—
101/CS-16-□5 ϕ 30	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	30.3 × 39.7 × 0.1t	5	30.3 × 39.7 × 0.5t	2	30.2 × 40 × 11.2	1
111-16-11 ϕ 30/ ϕ 40	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-16-12 ϕ 30	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	30.3 × 39.7 × 0.1t	3	—	—	—	—
111-16-12 ϕ 40	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	40.3 × 51.7 × 0.1t	3	—	—	—	—
111-16-13	TND07V-820KB00AAA0 or an equivalent	1	M8 × 15	3	M8	3	—	—	—	—	—	—

Model	Varistor		Low head bolt		Disc spring washer		Shim 1 [mm]		Shim 2 [mm]		Collar [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.
101-20-11	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101-20-13 ϕ 40	TND07V-820KB00AAA0 or an equivalent	1	M10 × 18	3	M10	3	40.3 × 51.7 × 0.1t	3	—	—	—	—
101-20-13 ϕ 50	TND07V-820KB00AAA0 or an equivalent	1	M10 × 18	3	M10	3	50.3 × 67.7 × 0.1t	3	—	—	—	—
CS-20-33 ϕ 40	TND07V-820KB00AAA0 or an equivalent	1	M10 × 18	3	M10	3	40.3 × 51.7 × 0.1t	5	—	—	—	—
101-20-15 ϕ 40	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	40.3 × 51.7 × 0.1t	5	40.3 × 51.7 × 0.5t	2	40.2 × 50 × 11.7	1
111-20-11 ϕ 40/ ϕ 50	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-20-12 ϕ 40	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	40.3 × 51.7 × 0.1t	3	—	—	—	—
111-20-12 ϕ 50	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	50.3 × 67.7 × 0.1t	3	—	—	—	—
111-20-13	TND07V-820KB00AAA0 or an equivalent	1	M10 × 18	3	M10	3	—	—	—	—	—	—

Model	Varistor		Low head bolt		Disc spring washer		Shim 1 [mm]		Shim 2 [mm]		Collar [mm]	
	Model	Qty.	Standards	Qty.	Standards	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.	Internal dia. × External dia. × Thickness	Qty.
101-25-11	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101-25-13 ϕ 50	TND07V-820KB00AAA0 or an equivalent	1	M12 × 22	4	M12	4	50.3 × 67.7 × 0.1t	3	—	—	—	—
101-25-13 ϕ 60	TND07V-820KB00AAA0 or an equivalent	1	M12 × 22	4	M12	4	60.3 × 84.7 × 0.1t	3	—	—	—	—
CS-25-33 ϕ 50	TND07V-820KB00AAA0 or an equivalent	1	M12 × 22	4	M12	4	50.3 × 67.7 × 0.1t	5	—	—	—	—
101-25-15 ϕ 50	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	50.3 × 67.7 × 0.1t	5	50.3 × 67.7 × 0.5t	2	50.2 × 60 × 12.2	1
111-25-11 ϕ 50/ ϕ 60	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-25-12 ϕ 50	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	50.3 × 67.7 × 0.1t	3	—	—	—	—
111-25-12 ϕ 60	TND07V-820KB00AAA0 or an equivalent	1	—	—	—	—	60.3 × 84.7 × 0.1t	3	—	—	—	—
111-25-13	TND07V-820KB00AAA0 or an equivalent	1	M12 × 22	4	M12	4	—	—	—	—	—	—

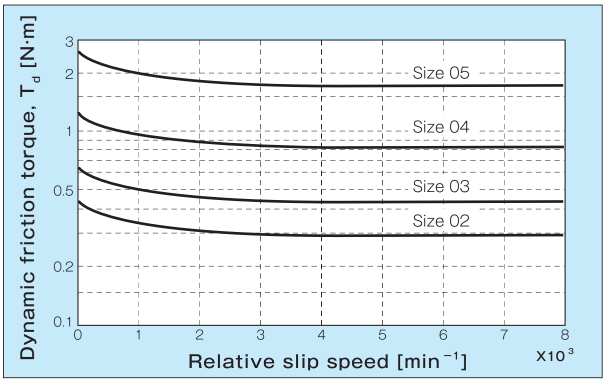
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

Torque Characteristics

Static and Dynamic Friction Torque Characteristics

Clutches and brakes transmit torque as they slip at certain relative speeds in the engaging/braking process. Then, the relative speed gradually decreases until the clutch is fully engaged. The torque that can be transmitted when this engaging/braking is complete is called the dynamic friction torque at that relative speed.

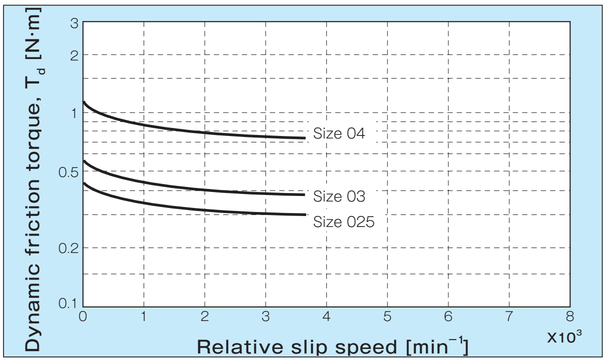
Static friction torque is a nearly predetermined value, while dynamic friction torque varies somewhat with relative speed.



Dynamic friction torque characteristics (micro size models 102 and 112)

Dynamic Friction Torque Characteristics

The figure at right shows the relationship between relative slip speed and dynamic friction torque. As the figure shows, the difference between static friction torque and dynamic friction torque is small, so the effects in actual use are diminished. Note that the specifications present the values when the relative slip speed is 100 min^{-1}.

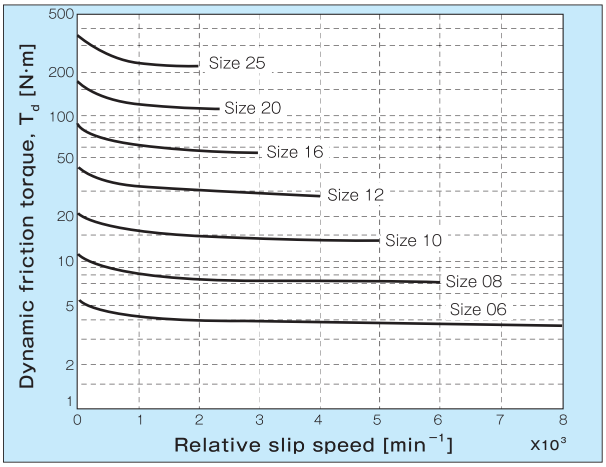


Dynamic friction torque characteristics (micro size CYT models)

Initial Torque Characteristics

The frictional surfaces of clutches and brakes that use friction will not be fully broken during initial use, so they may not always reach rated torque. This is referred to as the initial torque state. The initial torque value will be 60 to 70% of indicated torque; after a little breaking in, the indicated value will be reached. Check these values if you require the indicated torque right from the initial use. Breaking in may take longer when the equipment is used with light loads or at low speeds.

Residual torque (torque remaining after current is shut off) also exists. Due to the action of the disc spring, residual torque persists for a very short time, so special circuits for reverse excitation or the like are not necessary in normal use.



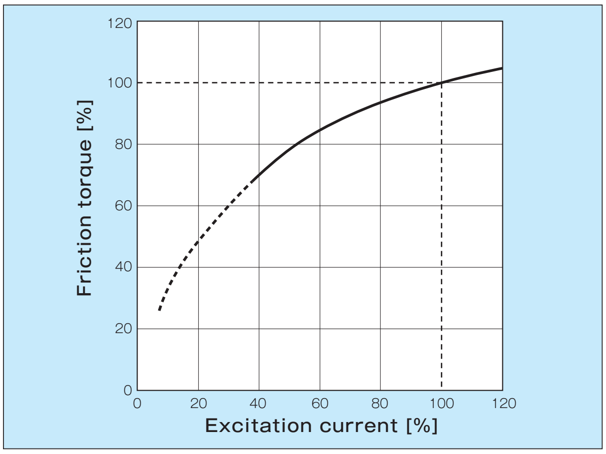
Dynamic torque characteristics (standard size models 101, 111, CS etc.)

Torque-Current Characteristics

The size of the friction torque, when the friction coefficient is μ, the average radius of the frictional surface is r, and the pull-in force is P, is given by:

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

Here, μ and r are predetermined, but pull-in force P varies with the size of the current supplied. Since current is proportional to voltage, friction torque changes when the voltage applied to the coil changes. The figure at right shows the relationship between friction torque and excitation current. Near the rated current value, torque increases and decreases nearly proportionally to current. As current is increased beyond the rated value, magnetic flux in the magnetic circuit reaches saturation. Further increases do not increase torque but merely increase the amount of heat generated. Conversely, as current is decreased, torque decreases. However, as the minimum current required to attract the armature is neared, torque becomes unstable; when decreased further, the armature can no longer be attracted, and torque is extinguished. (To generate torque below the armature pull-in current value, appropriate measures must be taken.) Note that this characteristics chart is at the prescribed air gap; if the air gap value changes, the characteristics curve will also change.



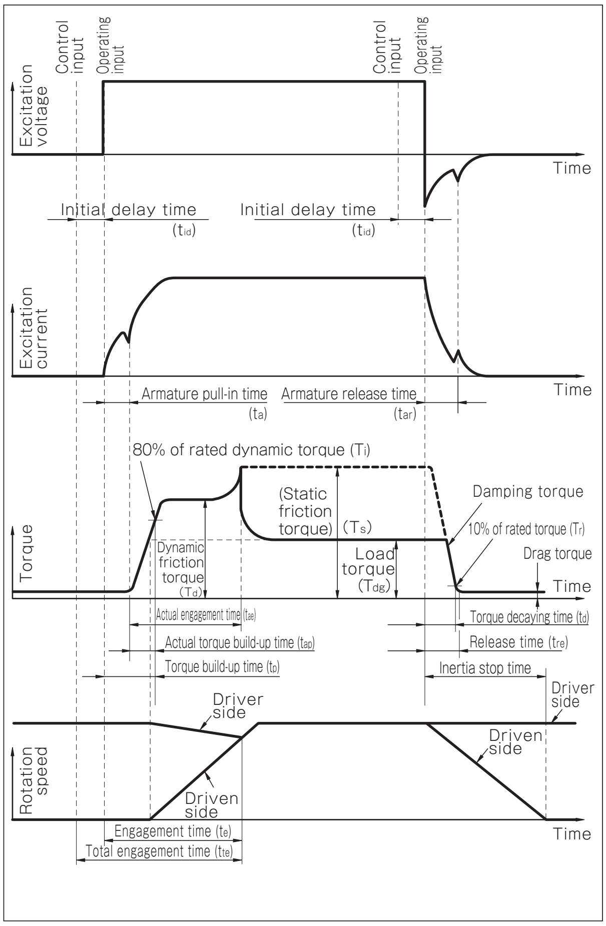
Torque-current characteristics

Operating Characteristics

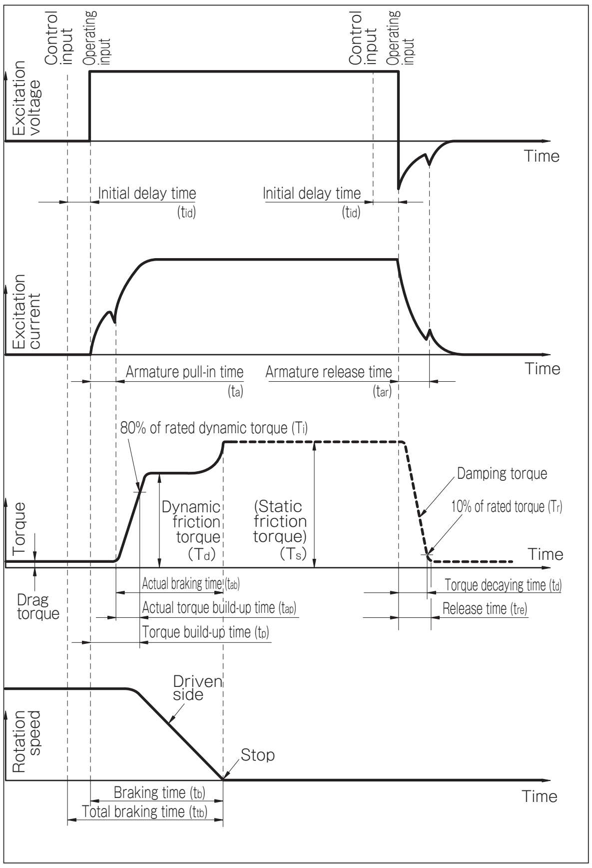
Transient Characteristics When Clutch/Brake Are Actuated

The figure below illustrates transient phenomena of current and torque when clutches and brakes engage (brake) and release. These are generally called dynamic characteristics. When a voltage is applied to the clutch/brake, current increases according to a time constant determined by the coil. Once current has increased to a certain value, the armature is pulled in and the generation of friction torque begins. Thereafter, as current increases, friction torque also increases to reach the rated value. At the time of release, current decreases in the same way as when engaging (braking), the armature starts its withdrawal with the release action of the disc spring, and torque is extinguished.

Clutch operating characteristics



Brake operating characteristics



t_a: Armature pull-in time
(The time from when current flow first starts until the armature is pulled in and torque begins to be generated)

t_{ap}: Actual torque build-up time
(The time from when torque first begins to be generated until it reaches 80% of rated torque)

t_p: Torque build-up time
(The time from when current flow first starts until torque reaches 80% of rated torque)

t_d: Torque decaying time
(The time from when current flow is shut off until torque decreases to 10% of rated torque)

t_{id}: Initial delay time
(The time from the arrival of operational input at the clutch and brake until the actuation input or release input arrives at the clutch or brake body)

t_{ae}: Actual engagement time
(The time from when the clutch begins generating torque until engagement is complete)

t_{ab}: Actual braking time
(The time from when the brakes begins generating torque until braking is complete)

ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

Operating Characteristics

Control Circuit System and Operation Times

The standard voltage is DC 24 V. If there is no DC power supply, the direct current obtained by stepping down and rectifying (full-wave rectification) the AC power supply is used. (See page on power supplies.) The clutch or brake is normally turned on or off on the DC side. The operation times in that case are shown in the table below. Performing these command operations on the DC side provides fast response, but a very large surge current is generated when the current is shut off. This surge current can burn contacts within the control circuit or damage the coil insulation. For this reason, circuit protectors are used to absorb surges.

When switching is performed on the AC side, the torque decaying time lengthens. When the torque decaying time lengthens, one clutch or brake operation may interfere with the next. Accordingly, a time lag should be designed in. The torque build-up time is the same as when the command operation is performed on the DC side.

The electromagnetic clutch/brake operation times below are values using transformer stepdown/single-phase full-wave rectification.

■ Micro sizes

Clutch operation time

Clutch size	Operating time [s]			
	t_a	t_{ap}	t_p	t_d
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]			
	t_a	t_{ap}	t_p	t_d
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 sizes

Clutch operation time

Clutch size	Operating time [s]			
	t_a	t_{ap}	t_p	t_d
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 are suitable for CS and CSZ models as well as for the various clutch/brake unit models.

Brake operating time

Brake size	Operating time [s]			
	t_a	t_{ap}	t_p	t_d
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 are suitable for BSZ models as well as for the various clutch/brake unit models.

To Shorten the Engagement/Braking Time

Current obeys a predetermined time constant, but when a particularly fast build-up time is required, the operation characteristics can be changed by using an excitation method, such as overexcitation. The overexcitation method applies an overvoltage to the coil to speed up the rise. Operation times in the case of overexcitation are shown in the table below.

For details, refer to the section on power supplies.

Operation times for overexcitation of clutch (using a BEH power supply)

Clutch size	Operating time [s]			
	t_a	t_{ap}	t_p	t_d
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 are suitable for CS and CSZ models as well as for the various clutch/brake unit models.

Operation times for overexcitation of brake (using a BEH power supply)

Brake size	Operating time [s]			
	t_a	t_{ap}	t_p	t_d
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 are suitable for BSZ models as well as for the various clutch/brake unit models.

t_a Armature pull-in time: The time from when current flow first starts until the armature is pulled in and torque begins to be generated.

t_{ap} Actual torque build-up time: The time from when torque first begins to be generated until it reaches 80% of rated torque.

t_p Torque build-up time: The time from when current flow first starts until torque reaches 80% of rated torque.

t_d Torque decaying time: The time from when current flow is shut off until torque decreases to 10% of rated torque.

Limit on Number of Operations

There are some limits for command operations that turn clutches and brakes on and off per unit time. Due to their size, micro sizes are particularly prone to being unable to externally dissipate heat at some energization frequencies, and may malfunction or be damaged. That limit is expressed as an energization rate. For that limit, being energized for 0.5 seconds over a one second period is treated as 50%. Operations must be designed so that the energization rate does not exceed the following rates shown for each model. These limits may not apply, however, if the clutch or brake is effectively cooled.

Models	Energization rate
102 Models	80%
CYT Models	50%
112 Models	80%
101/CS Models	100%
CSZ Models	100%
111 Models	100%
BSZ Models	100%

Furthermore, in the case of overexcitation intended to speed up the build-up by applying overvoltage to the coil, a voltage higher than the normal excitation voltage is applied, so care is required even with standard sizes. Ascertain your operating conditions and the like and then check these issues for your particular situation.

Heat Radiation Characteristics

Allowable Energy ($E_{ea\ell}$ or $E_{ba\ell}$)

When loads are accelerated or decelerated by a clutch/brake, heat will be generated by sliding friction. This is because frictional energy is converted to heat, so the amount of heat will vary with the conditions of use.

Clutches and brakes dissipate this heat externally as they work, but if they cannot dissipate all the heat, they accumulate it internally and the temperatures of the components rise. If temperatures exceed allowable values, malfunctions and damage result.

The limit for friction work undergone due to this heat is called allowable energy. The allowable energy is predetermined for each size. Heat dissipation is affected by the mounting situation, rotation speed, atmosphere, and the like.

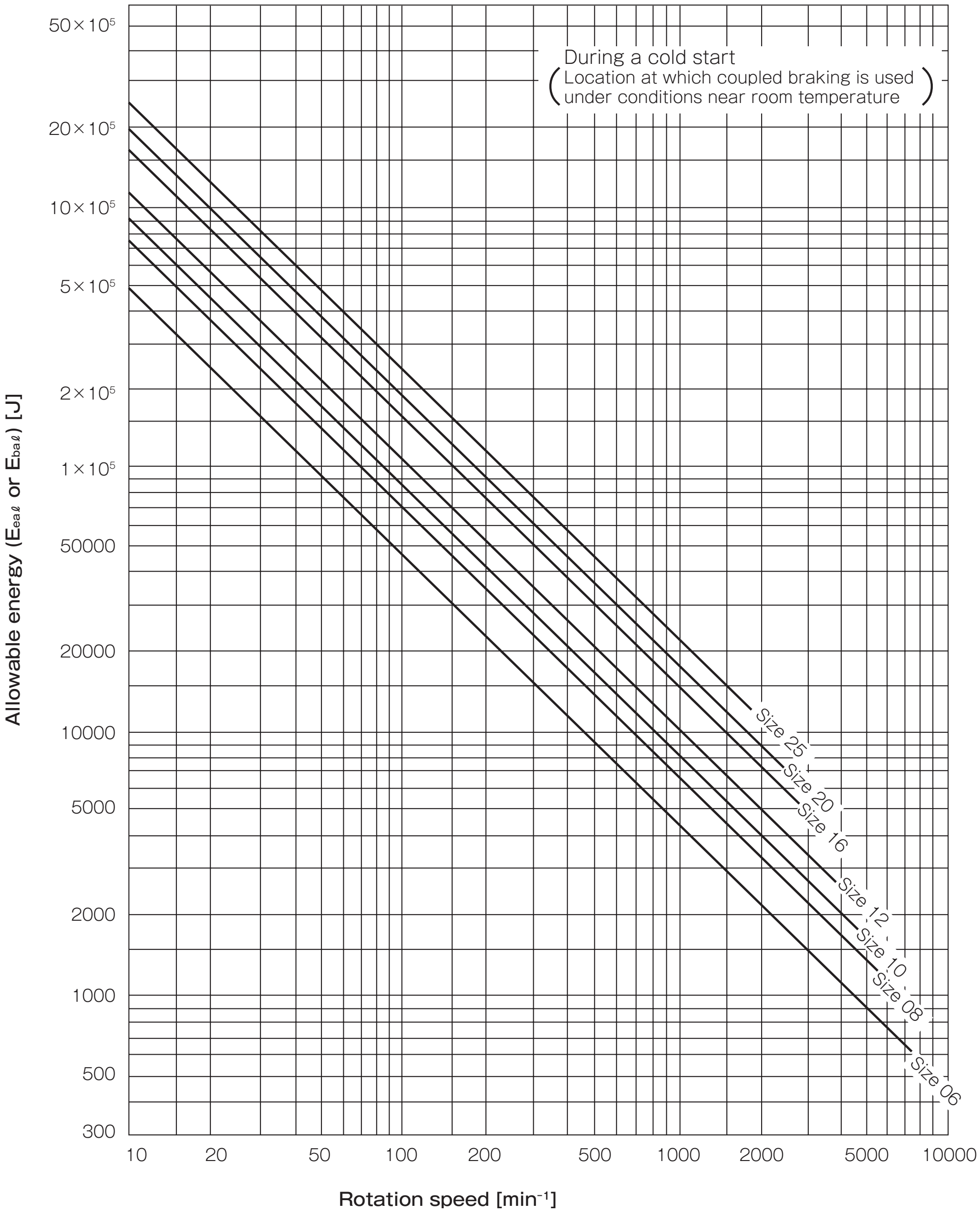
When large loads are accelerated or decelerated, violent slipping occurs, and the frictional surface generates larges amounts of heat. The frictional material and armature can be damaged by even a single engagement.

The table at right shows the allowable energy (allowable friction energy) for each size of micro clutches and micro brakes. Even if frequency is low, use the device at a value that is sufficiently smaller than the table value if you have a single engagement whose amount of energy is high.

Use standard sizes below the limit lines of the figure below.

Allowable energy of micro clutches and micro brakes

Model size	Allowable (engagement/braking) energy ($E_{ea\ell}$ or $E_{ba\ell}$) [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



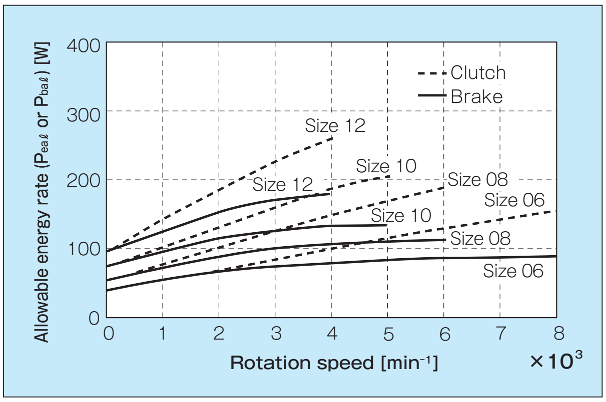
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

Heat Radiation Characteristics

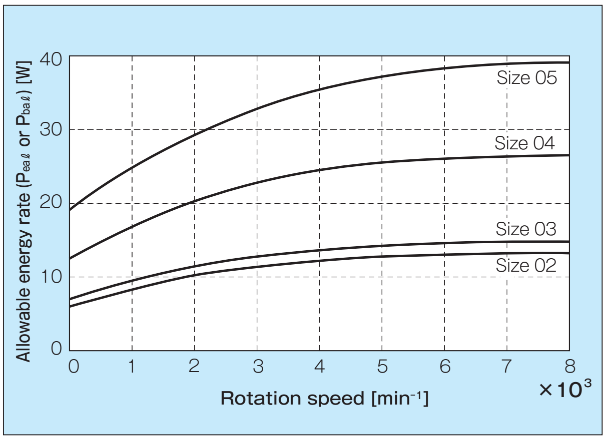
Allowable Energy Rate ($P_{ea\ell}$ or $P_{ba\ell}$)

High frequency of engagement and/or braking must take heat dissipation fully into account. The maximum energy amount per unit time is called the allowable energy rate. It is predetermined for each size as shown in the figure. In actual use, use a value that is sufficiently smaller than the allowable value to allow for changes in conditions and the like.

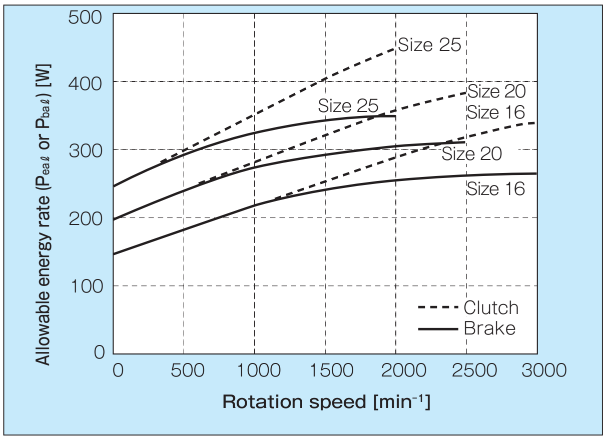
The figure shows values for wall-mounted devices. For devices mounted on shafts such as bearing-mounted models, use 80% of the allowable values in the figures.



Standard sizes



Micro sizes (excludes CYT models)



Standard sizes

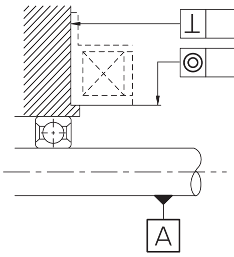
Items Checked for Design Purposes

What is the best way to ensure that the design allows clutches and brakes used in machinery and equipment to perform and function adequately? We describe here approaches to design that we feel are useful in improving machinery reliability.

Mounting Stators and Rotors

■ Flange-mounted stators (models □-□-1□)

These stators must be correctly positioned with respect to the rotation shaft before mounting. The inner and outer circumferences of the stators have grades for fit. The surface on which the stator is mounted should be positioned relative to the rotation shaft and the allowable values for concentricity and perpendicularity of the diameter should not be exceeded.

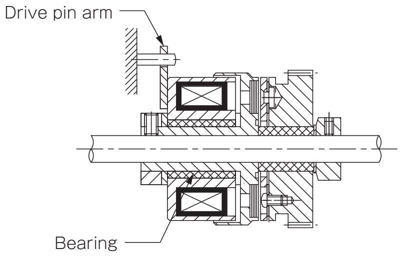


Unit [mm]

Size	Concentricity (T.I.R.)	Perpendicularity (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

■ Bearing-mounted stators (models □-□-3□)

This stator is subject to a slight amount of rotation force from the built-in bearing or the slide bearing. The drive pin arm should therefore be held to the machinery's stationary parts to prevent drag turning.



■ Magnetic shield of stator

Installing clutches and brakes in combination can lead to instability of clutch/brake operation due to their magnetic effects on each other. Also, if there are instruments or machinery in the vicinity of the clutch or brake, adverse effects such as noise or malfunction may result.

In such cases, measures to block magnetism are advised. The method generally used is to adopt non-magnetic materials for the surface on which the stator is mounted and for the shaft.

■ Lead wire protection

Damage to the covering of the leads can cause shorts, breaks or other problems. Keep protection of these coverings in mind from the design stage.

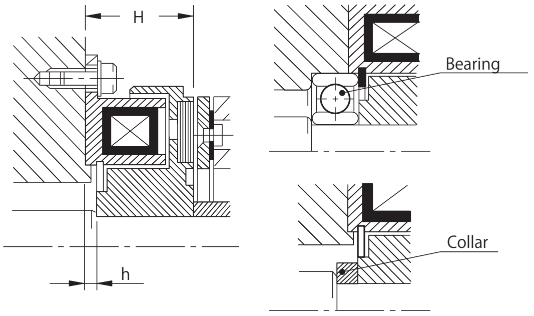
■ Rotor mounting

The rotor is part of the magnetic circuit. Machining other than bore drilling can lower performance, so it should be avoided.

Consult Miki Pulley if you are creating a rotor bore with a non-standard diameter not shown in the dimensions table.

■ Relationship between rotor and stator (models □-□-1□)

In flange-mounted clutches, the positional relationship between rotor and stator is important. If the dimension H in the figure below is too small, the rotor and stator will touch; if H is too large, the pull-in force will decline. The table below lists allowable values for each size. Design your setup so that these values are not exceeded. The allowable value for h should conform to the normal JIS allowable value.



Unit [mm]

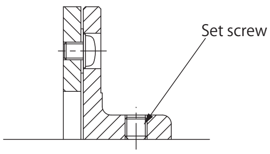
Clutch size	H		h
	Reference value	Tolerance	Reference value
102-02	18.0	±0.2	1.6
102-03	22.2	±0.2	2.0
102-04	25.4	±0.2	2.0
102-05	28.1	±0.2	2.0
101-06	24.0	±0.2	2.0
101-08	26.5	±0.2	2.5
101-10	30.0	±0.3	3.0
101-12	33.5	±0.3	3.5
101-16	37.5	±0.3	3.5
101-20	44.0	±0.4	4.0
101-25	51.0	±0.4	4.0

Armature Mounting Methods

When mounting the armature hub, do not hammer or otherwise apply impact. Doing so may cause damage.

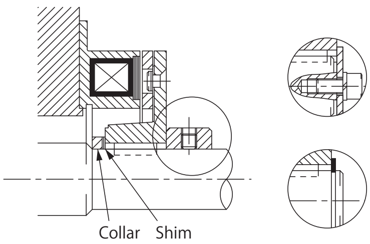
■ Mounting armature type-1

Securely fasten the armature with the provided hex-socket-head set screw. If you are concerned that it might be loosened by vibration or high-frequency operations, apply adhesive to the threads, which is effective in stopping loosening.



■ Mounting armature type-2

Since the boss is hidden on the inside of the stator, secure it firmly using a C-shaped snap ring, collar, or the like, as shown in the figure below.



■ Mounting armature type-5

For size 05 and smaller micro sizes, insert the armature directly onto the shaft. As when assembling armature type-2, firmly press the end face of the armature with a C-shaped snap ring, collar or the like.

ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

■ Armature type-3 mounting

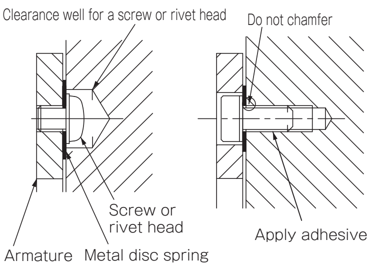
Machine in the screw bores and clearance well for screw and/or rivet heads in the mounting surface. Mount the armature using the supplied special hex-socket-head bolts and disc spring washers, applying a small amount of adhesive to the threads to prevent loosening. (Note that any excess adhesive will seep into the disc spring, impeding operation.)

The mounting screw bores should not be beveled; simply removing burr is sufficient. The hex-socket-head bolts supplied are special low-head bolts. For sizes 04 and smaller, Phillips-head round head screws that meet JIS standards are supplied. Use disc spring washers like that depicted in the figure below. Their fastening effect is diminished if used facing backwards.

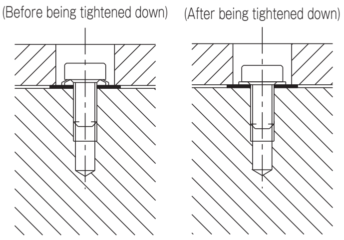
Assemble armature type-3 correctly so that the concentricity and perpendicularity relative to the rotation shaft do not exceed the allowable values.

Unit [mm]

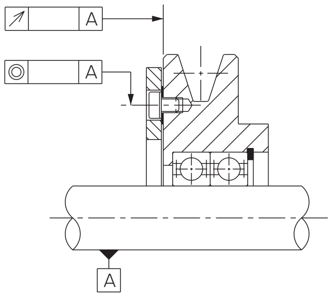
Size	Surface runout (T.I.R.)	Concentricity (T.I.R.)
02	0.1	0.02
03	0.1	0.03
04	0.1	0.04
05	0.1	0.04
06	0.16	0.04
08	0.16	0.05
10	0.16	0.05
12	0.16	0.06
16	0.16	0.07
20	0.24	0.11
25	0.24	0.11



Armature type-3 mounting

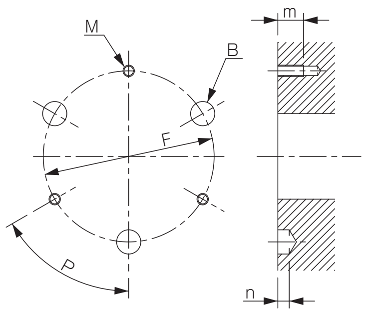


How to use washers



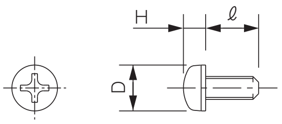
Mounting precision

Armature type-3 mounting dimensions

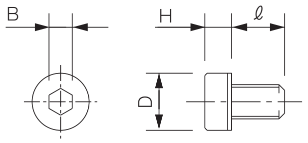


Clutch/ brake size	Mounting pitch diameter		Mounting angle		Mounting screw bore			Clearance well for screw/rivet head	
	F (P.C.D.)	Tolerance	P [°]	Tolerance [′]	No. of bores-M (nominal)	Pitch	Effective thread depth m (MIN)	No. of bores-Bore diameter B	Spot facing depth n (MIN)
02	19.5	±0.05	90	±5	2-M2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

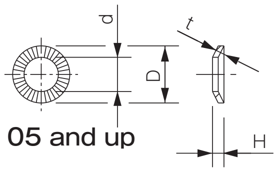
Armature type-3 mounting components



Size 02 to 04



Size 05 and up



Size 05 and up

Clutch/ brake size	Special hex-socket-head bolt (* Phillips-head round head screw)					Disc spring washer			
	Nominal × pitch	ϕD	H	B	ℓ	ϕD	ϕd	H	t
02	* M2 × 0.4	3.5	1.3	–	3	–	–	–	–
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	M3 × 0.5	5.5	2.0	2.0	6	6	3.2	0.55	0.36
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

* Sizes 02, 03, and 04 do not use disc spring washers.

Air Gap Design and Adjustment

Set the air gap "a" (below figure) between the frictional surfaces so that when released the gap becomes the control value. Handling will be easier if the device is designed to facilitate this adjustment.

We recommend designs with both collars and shims as shown below to accomplish this. (We always have shims available; please contact Miki Pulley for details.)

■ Setting air gap "a"

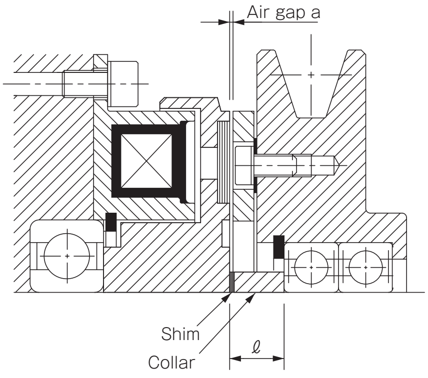
Prepare a collar that is slightly shorter than the length ℓ needed to maintain air gap "a", and then adjust the remaining gap with shims to achieve the control value for "a". The collar length at this time is roughly the value given by the following equation.

$$L \fallingdotseq \ell - 2a \text{ [mm]}$$

Here, L: Collar length.
ℓ : Length required to maintain air gap "a"
a: Control air gap value

Based on the value of L found with this equation, prepare a collar of a length that is easy to machine. Using a design like this that employs shims will enable you to adjust the air gap after long periods of use by simply removing the necessary number of shims.

Air gap setting



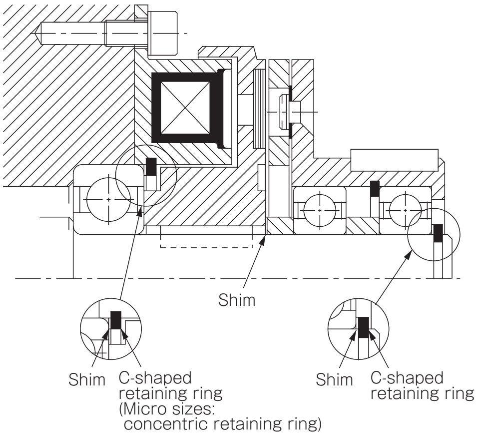
* Use the section on technical documentation to check the shim dimensions.

■ Eliminating axial play

If there is any axial play between the clutch or brake and the components used in combination with it after assembly, the performance of the clutch or brake could be impaired. Design to keep play extremely small. Many types of shims are available for keeping the axial play to a very slight amount. They match the shaft diameters and bearing outer diameters dimensions used most.

If C-shaped retaining rings (concentric retaining rings) are also used, a secure lock can be achieved while preserving the spring effect of the retaining ring.

How to use shims

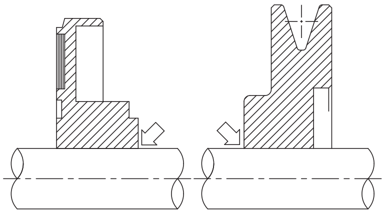


Fitting Tolerances

Clutches and brakes must be able to do large amounts of work instantly while also performing precise control. That means that the precision of all components must be appropriately unified so they do not cause wear or generate vibration. Fitting tolerances (grades) must also be determined so that they match the conditions of use.

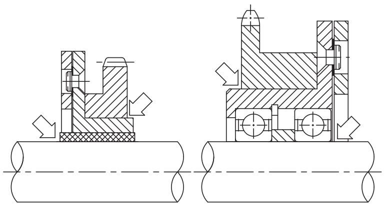
■ Fitting tolerance for rotor, armatures type-1 and type-2, V pulley, and shaft

The reference bore tolerance is H7 class. CYT models, however, have a special bore diameter tolerance (shown in the dimensions table). The table below shows dimensional tolerances for the shaft to be used.



Load conditions	Shaft tolerance		Remark
Shaft with ø10 or below	h6	h7	h5 if accuracy is required
Light/normal loads and fluctuating loads	h6		For motor shaft, h6 or j6 For clutch/brake unit shafts, j6
	js6	js7	
	j6	j7	
Heavy loads and shock loads	k6	k7	
	m6		

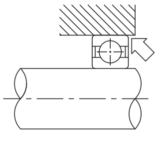
■ Fitting tolerances for armature type-5 and sprockets, or the like, and for armature type-5 and shafts



Micro size Standard size

Clutch/brake size	Armature type-5		Bore tolerance for sprockets, etc.	Shaft tolerance
	Boss tolerance	Bore tolerance		
02 ～ 05	h7	H7	H7	h7 h8
06 or over	j6	As given in table below	H7	As given in table above

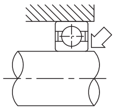
■ Tolerances for fitting ball bearing to housings

Load conditions		Bore tolerance	Remark
Rotating outer ring load	Heavy loads	N7	
	Normal load and fluctuating loads	M7	
Directionally unstable loads	Heavy shock loads		
	Heavy loads and normal loads	K7	
	Normal loads and light loads	J7	
Rotating inner ring load	Shock loads		
	Ordinary loads	H7	When clutch/brake is not subject to shock

* Applicable to steel or iron housings. For light alloy housings, the fit must be stiffer.

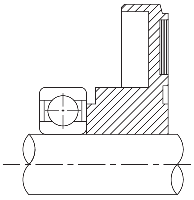
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

■ Tolerances for fitting ball bearings to shafts

Load conditions		Bore tolerance		Remark
Rotating outer ring load		h6		When precision is required, h5
Dimensionally unstable loads and rotating inner ring loads	Light loads, normal loads and fluctuating loads	ø18 or below	h5	
		ø100 or below	j6	
	Heavy loads and shock loads	ø18 or below	j5	
		ø100 or below	k5	

■ Fitting tolerances for bearings and other components

If bearings are mounted on the same part of the shaft as rotors, V pulleys or other components, give priority to the bearing when determining the grade of the shaft by using the tolerance for fitting ball bearings to shafts.



Bore Diameters and Keyways

■ Bore diameters

Standard bore diameters are determined for each size (shown in the dimensions table) and available for selection. If you wish to use a non-standard bore diameter, pilot bores are provided on 101 and 111 type rotors and armatures type-1 and type-2. Adhere to the drilling ranges and cautions noted below. The ranges of bore diameters that can be drilled are shown in the table below.

- Make the fitting tolerance of the bore H7 class.
- Pay sufficient attention to concentricity and perpendicularity when drilling bores.
- The outer circumference of the rotor can become misshapen if force is applied, so do not chuck it.
- Completely remove all cutting oil, cleaning oil, and the like from the bore and dry it before mounting the piece on machinery.

■ Keys and keyways

Keyways of rotors and armatures are made to Miki Pulley standards, which are based on JIS standards. (See the page on standard bore drilling standards for clutches and brakes.) CYT models, however, use special keyway tolerances (shown in the dimensions table).

Use JIS standard keys and keyways on the shafts to be used. (Refer to the pages on technical documentation extracted from JIS B 1301-1996) Follow this standard also for rotor and armature hub.

Bore diameter processing ranges for rotors, armature type-1, and armature type-2.

Unit [mm]

Clutch/brake size		Bore diameter																						
		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
02	Rotor (R)	●																						
	Armature (A)	●																						
03	Rotor (R)		●																					
	Armature (A)		●																					
04	Rotor (R)			●		●																		
	Armature (A)			●		●																		
05	Rotor (R)					●			●															
	Armature (A)					●			●															
06	Rotor (R)				▨	▨	●	▨	●	▨														
	Armature (A)				▨	▨	●	▨	●	▨														
08	Rotor (R)				▨	▨	▨	▨	●	▨	▨	●	▨											
	Armature (A)				▨	▨	▨	▨	●	▨	▨	●	▨											
10	Rotor (R)							▨	▨	▨	▨	●	▨	●	▨									
	Armature (A)							▨	▨	▨	▨	●	▨	●	▨									
12	Rotor (R)							▨	▨	▨	▨	▨	▨	●	▨	●	▨	▨						
	Armature (A)							▨	▨	▨	▨	▨	▨	●	▨	●	▨							
16	Rotor (R)										▨	▨	▨	▨	▨	●	▨	▨	●	▨	▨			
	Armature (A)										▨	▨	▨	▨	▨	●	▨	▨	●	▨				
20	Rotor (R)												▨	▨	▨	▨	▨	▨	●	▨	●	▨		
	Armature (A)												▨	▨	▨	▨	▨	▨	●	▨	●	▨		
25	Rotor (R)												▨	▨	▨	▨	▨	▨	▨	▨	●	●	▨	▨
	Armature (A)												▨	▨	▨	▨	▨	▨	▨	▨	●	●	▨	▨

* The ● mark indicates a standard bore diameter. ▨ is the range of bore diameters that can be drilled in products with pilot bores.
* If a bore diameter is given in parentheses, the bore is a pilot bore. (The final bore has not been drilled.)
* The above table does not apply to CYT, CS, CSZ, and BSZ models.

Environment for Mounting Parts

Take the environment where the clutch or brake will be used into account in your design.

■ Temperature

Clutches and brakes are heat resistance class B. Their operating temperature range is -10 to 40°C. If used at higher temperatures, heat generated by actual engagement and braking work cannot be dissipated and the coil and/or frictional parts may be damaged. The devices may be used at temperatures below -10°C if the heat generated by the clutch or brake keeps the devices at -10°C or above. However, moisture may adhere through condensation if stationary for longer periods of time or if used at low frequency, potentially leading to decreased performance. Use in extreme environments of -20°C and below may lead to problems. Consult Miki Pulley for details.

■ Humidity and dripping

As with temperature, water droplets adhering to the frictional surfaces will temporarily decrease frictional force until the surface dries, so place a cover on the equipment or otherwise protect it. The adherence of moisture can cause rust.

■ Infiltration of dust, oils, and other foreign matter

The infiltration of foreign matter into the frictional surface is undesirable. Infiltration of oils markedly degrades frictional force. Dust, especially if it contains metal particles, can cause problems by damaging the frictional surface and rotating parts. Chemical infiltration can cause corrosion, in addition to the rust described above.
In addition to friction surfaces, lead wires are not oil resistant. Lead wire covers may deteriorate noticeably in environments exposed to oil, cutting oil, etc.
In such environments, consider the use of a protective cover.

■ Ventilation

Since clutches and brakes convert frictional energy into heat and dissipate it externally, it is preferable to install them in well ventilated locations. Forced air cooling (with a fan or the like) can be used effectively to increase the allowable energy. If you are using the equipment in a poorly ventilated location, consider temperatures carefully.

Max. Rotation Speed

The max. rotation speeds of clutches and brakes are shown in the specifications table. This value is determined by the circumferential speed of the frictional surface, so when used beyond the max. rotation speed, not only will the indicated torque not be generated, abnormal wear, heat damage, and the like may occur.

Ball Bearings

Ball bearings are widely used in combination with clutches and brakes, with deep groove ball bearings the most widely used among them.
Since it is undesirable to get oils on the frictional surfaces of dry-style clutches and brakes, use double-sealed bearings that do not require the addition of oil. Non-contact style double-sealed bearings that use rubber seals not only do not require the addition of oil, they are also excellent at keeping out dust. Metal double-sealed bearings can also be used for compact bearings and some hard-to-obtain bearings.

Mechanical Strength of Components

Clutches and brakes have excellent operational characteristics, so they are able to instantly engage or brake loads. For that reason, machinery components may experience impact forces. Be sure to build sufficient strength into your design. (Note that an overly safe design may increase load torque or affect the precision of engagement/braking.)

Vibration and Rattle

The structural components of clutches and brakes are adequately balanced so vibration does not occur. Mounting rattle can occur, however, after repeated shocks, and that can produce vibration noise. Use a design without rattle.

Corrosion Prevention

Clutches and brakes are treated to prevent corrosion, but rust may occur if storage conditions are poor or if the device is used in certain environments. Moderate rust does not present a problem for use, but we advise that you care for the equipment so that it does not rust.

Sparking

Sparks may be produced during clutch or brake use. This is because of friction between the armature and the magnetic part of the frictional surface. Adequate checks are required when using this equipment in volatile atmospheres.

Designing for Maintenance

Clutches and brakes require virtually nothing in the way of maintenance over the long term.
However, you can get even longer use out of them by proper maintenance of the air gap of the frictional parts and the ball bearings used. We recommend that you design structures so they can be easily disassembled and reassembled.
For details, refer to the operating manual.

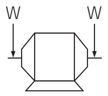
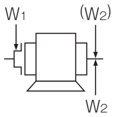
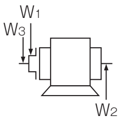
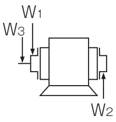
Use of Micro Clutches

When using bearing-mounted micro clutches (in which the bearings are oil-impregnated metal), energization rate, temperature and the like may sometimes be restricted. Consult Miki Pulley for details.

Overhang Load of Unit

The table below shows the allowable values for radial load that can be applied to the shaft of the unit. Allowable values will vary somewhat on through-shaft structure units due to the directions in which input and output loads act. (The values shown are for the most demanding conditions. The load point is the center point of the shaft.)

Unit [N]

Size	125 126(4B)	121(20G)		121(10G) 122(20G)
				
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

* Numbers in parentheses are for loads in the same direction.

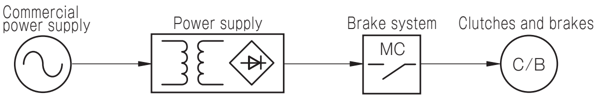
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

Control Circuits

Basic Structure of Electrical Circuits

When designing the electrical circuitry that controls clutches and brakes, the selection of the control method and control equipment is very important. The correct selection of these and designing the circuit both stabilize the operating characteristics of clutches and brakes and increase the reliability of machinery.

A DC 24 V (standard specification) power supply is needed to operate clutches and brakes. For this, either a DC power supply can be used, or an AC power supply can be stepped down and rectified. We have a variety of power supply devices dedicated for clutches and brakes available. For details, refer to the page on power supplies.



Standard wiring

Selecting Components for Power Supplies

■ Transformers

Match the primary side to the supply voltage. On the secondary side, use something with sufficient capacity to be able to apply the rated voltage to the clutch (brake) coil.

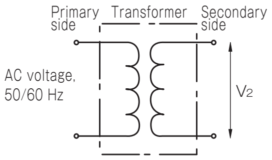
As a guideline, select a transformer that has a capacity 1.25 times the rated capacity of the clutch (brake) at 20° C. Note that the secondary-side output voltage must be set according to the rectifier's voltage drop or the transformer's impedance drop. These can be found in simplified terms, from Eqs. (1) and (2) below.

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

Eq. (1) is from the single-phase full-wave rectification system.

$$P \geqq W_{CB} \times 1.25\ [VA] \quad (2)$$

V_2: Transformer secondary voltage [V]
V: DC voltage [V]
P: Transformer capacity [VA]
W_{CB}: Clutch (brake) capacity [VA]



■ Rectifiers

There are several different rectification systems. Miki Pulley uses single-phase full-wave rectification (the bridge system). For a system to be selected, the maximum rated value of the rectifier must not be exceeded. The rated maximum can be found in simplified terms using the following Eq. (3).

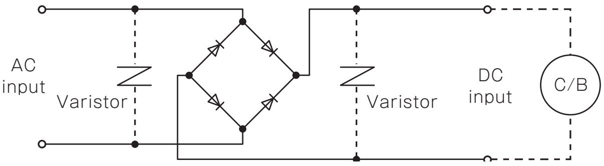
- Determining withstand voltage V_{RM} in the reverse direction

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

V_L: AC input voltage [V]
K: Safety factor (make the factor between 2 and 3)

Note that if a surge voltage at or above the withstand voltage may find its way in from outside, the rectifier must be protected.

- Determining the average rectification current
  Select a rectifier that has an average rectification current value of 1.5 or more times the rated current of the clutch (or brake) used. Note that when large currents flow, temperature rise becomes a problem. Take measures to give the device a heat dissipation effect and to suppress extreme temperature rises.



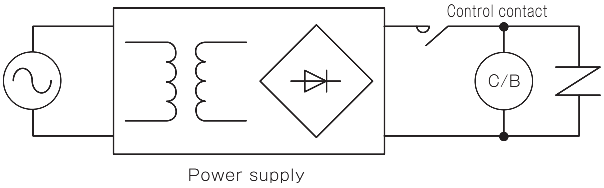
Single-phase full-wave rectified

■ Relays (control contacts)

Since electromagnetic clutches and brakes have internal electromagnetic coils, they must be used under the conditions of the DC inductive load of the relay you will use.

This is because contacts are heavily worn by surge voltage generated during electromagnetic clutch or brake control.

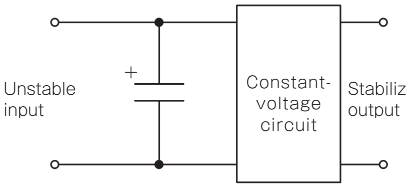
If relay service life, operational frequency, and the like are problems in use, the design must be contactless. For details, see the page on controlling electromagnetic clutches and brakes using power supplies.



DC switching

■ Points to note on control circuit structure

- Control of clutches and brakes
  When controlling the clutch or brake on the AC side, armature release time lengthens and high-frequency operation becomes impossible. Install control contacts on the DC side.
- Voltage supplied to the clutch or brake
  When designing a power supply circuit, keep fluctuation of the excitation voltage to within ± 10% of the rated voltage of the clutch or brake.
- Smoothing of excitation voltage
  Normally, the power supply for the clutch or brake is a single-phase full-wave rectifier. When high precision is required, however, better results are obtained by smoothing.



Stabilized power supply circuit

- Protection of control contacts
  If a protective circuit is placed in the clutch/brake, the control contacts will be protected, but the protective effect will be greater if CR absorbers are used between contacts, as shown in the figure. C (capacitor) and R (resistor) are roughly as follows.
  Capacitor C [μ F]: Ratio to contact current is:

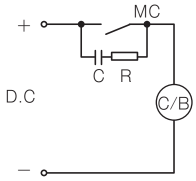
$$\frac{C\,[\mu F]}{I\,[A]} = \frac{0.5 \text{ to } 1}{1}$$

Withstand voltage: 600 [V]

Resistance R[Ω]: Ratio to contact voltage is:

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

Capacity = 1 [W]



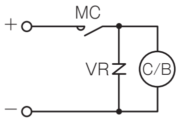
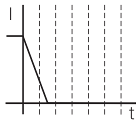
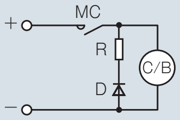
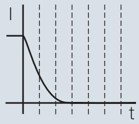
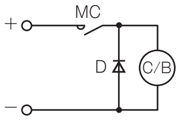
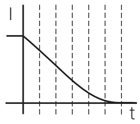
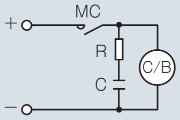
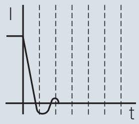
Relay protector circuit

■ Discharge circuits

When a DC excitation current flows in an electromagnetic clutch or brake, energy accumulates in the coil. If current is then shut off, a surge voltage is generated between the coil terminals by the accumulated energy. This surge voltage may reach 1000 V or more depending on the shutoff speed, shutoff current, and other factors, so it can cause damage to the coil insulation, burn the contacts in switches, and more. Appropriate discharge circuits must therefore be installed to prevent such problems.

Different types of discharge circuits have differing armature discharge times and effectiveness in suppressing surge voltages. The table below shows the characteristics of some discharge circuits.

While different discharge circuits have many advantages and disadvantages, the type we recommend are varistors.

	Circuit diagram	Current decay	Characteristics
Varistor			Very effective in keeping surge voltage small without adding delay to the armature release time.
Resistors + diodes			Can lower power consumption in the power supply part and reduce resistor capacity. The armature release time becomes somewhat longer, so care is required in high frequency use.
Diodes			Good at suppressing surge voltage, but armature release is delayed, so clutch and brake are more prone to interfere with each other, making diodes unsuitable for high frequency use.
Resistors + capacitors			Have a short armature release time, but require capacitors with high pressure resistance.

Commercial Power Supply Specifications

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