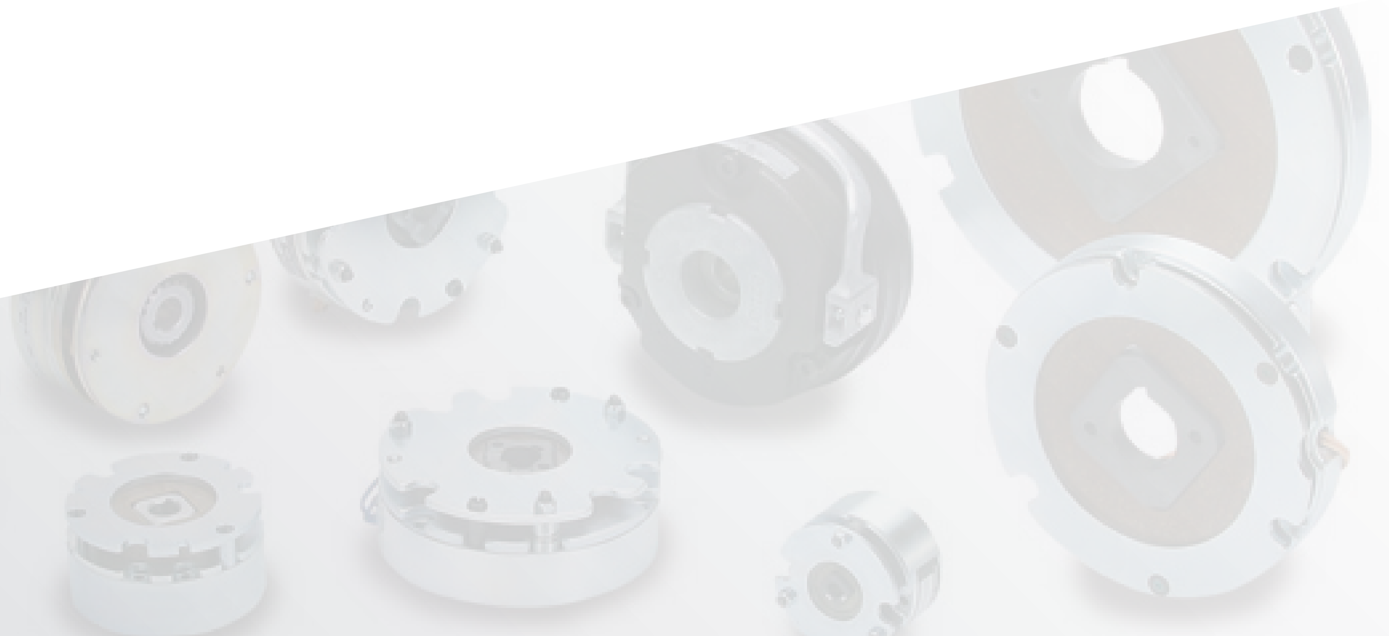
CLUTCHES & BRAKES

CONTENTS



Electromagnetic Clutch & Brake Models

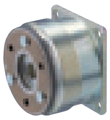
Series ELECTROMAGNETIC-ACTUATED MICRO CLUTCHES & BRAKES

Device Micro Clutches

Models 102

Type

13



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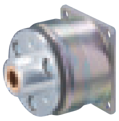

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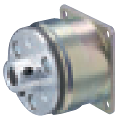

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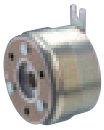

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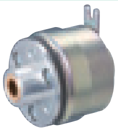

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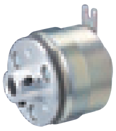

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Models CYT

33M

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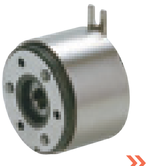
33B



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Device Micro Brakes

Models 112

13

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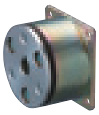

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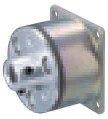

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Series SPRING-ACTUATED BRAKES

Models

BXW-L/H/S

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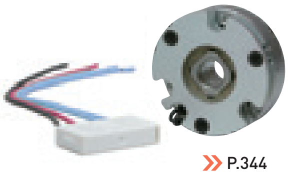
BXR-LE



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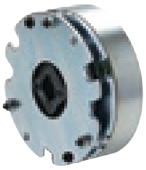
BXL



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BXL-N

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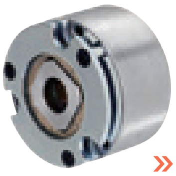
BXW-R



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BXR

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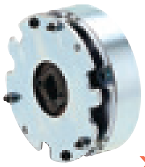
BXH



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Series ELECTROMAGNETIC CLUTCH & BRAKE POWER SUPPLIES

Models

BES

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BEH

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Series RECTIFIED POWER SUPPLIES FOR SPRING-ACTUATED BRAKES DC45/90/180V

Models

BEW

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BEW-S

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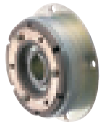
ELECTROMAGNETIC-ACTUATED CLUTCHES & BRAKES

Clutches

101

13G



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15G

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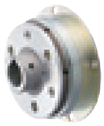
11G



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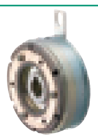
CS

33G



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35G

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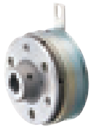
31G



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CSZ

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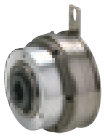

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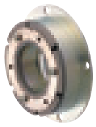
Brakes

111

13G



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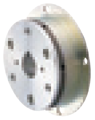
12G



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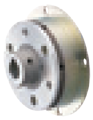
11G



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BSZ

12

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Series

ELECTROMAGNETIC CLUTCH AND BRAKE UNITS

Device

Clutches & Brakes

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Double clutches

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Double clutches & brakes

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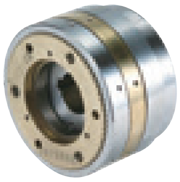
Series

Models

ELECTROMAGNETIC TOOTH CLUTCHES

546



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BRAKE MOTORS

BMS·BMM

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BEW-W

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BEW-FH

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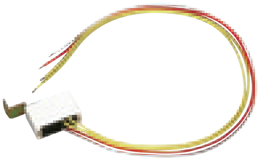
BEM



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BEM-T

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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**

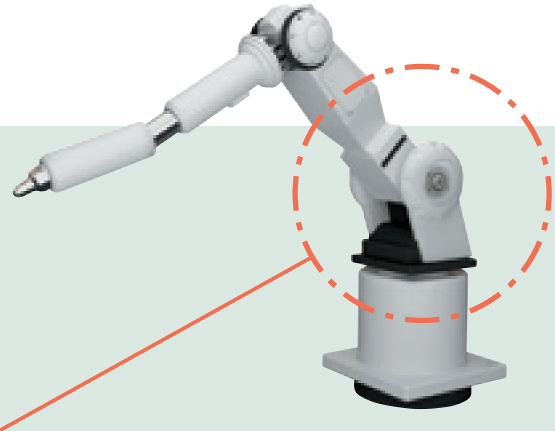
Select by Product Characteristics

			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

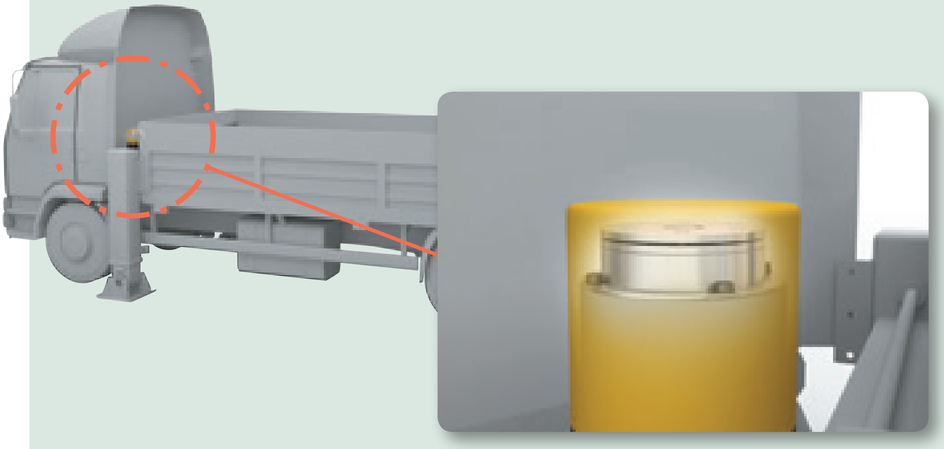
Applications

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

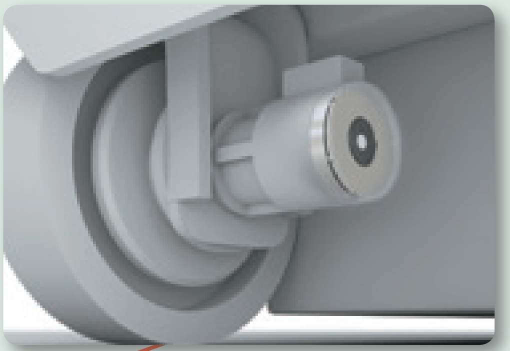
Employed device Special-purpose Vehicles

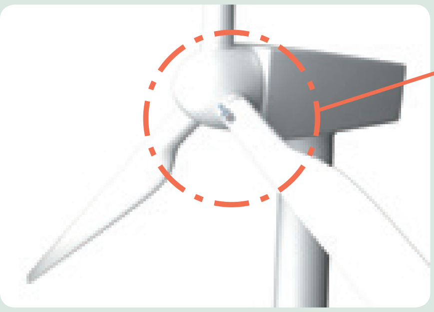
The Electromagnetic-actuated brake 111 model is used in the elevating device for the auxiliary leg.

Product model BXR

Employed device Aerial Vehicle

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

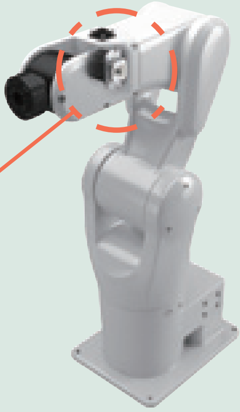


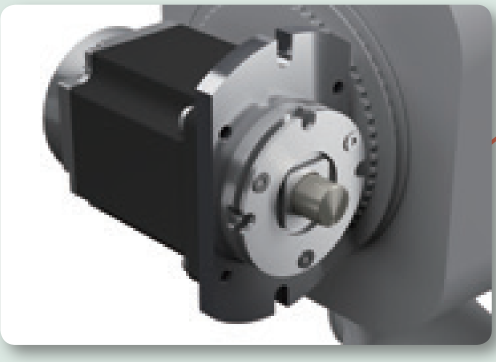


Product model BXW Large Size (Custom Product)

Employed device Wind Turbine Generator

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

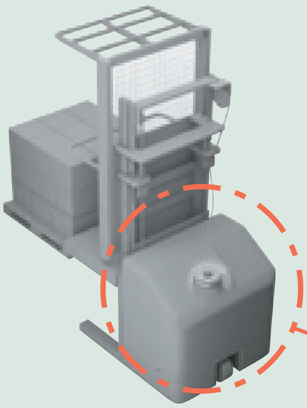




Product model BXR-LE

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 CLUTCH AND BRAKE UNITS

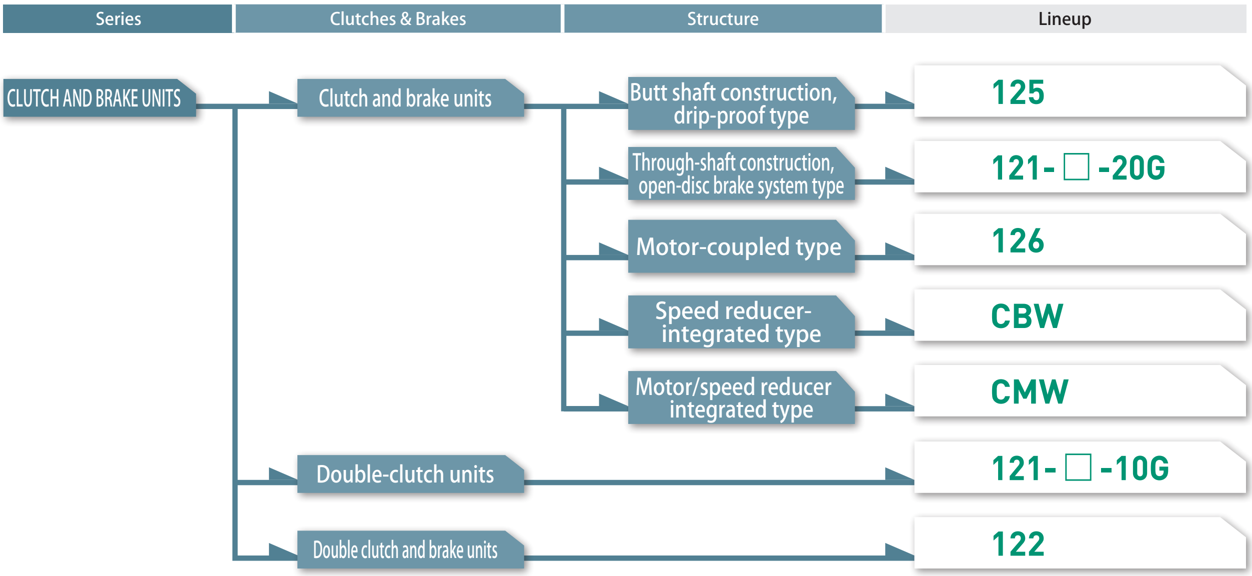
Application	Printing machinery, bookbinding machinery, woodworking machinery, semiconductor manufacturing equipment

Connection and Release, Required Functions Integrated in a Compact Form Factor, Electromagnetic Clutch and Brake Units

Multiple clutches and brakes are required when designing complex actions. You can select from our clutch and brake units to get the operation you require rather than just combine as many clutches and brakes you need. We provide not just clutch and brake combinations, but total solutions that also include motors, speed reducers and the like.

RoHS
Some exceptions apply

Available Models



Model Selection

Model/Type	Torque [N·m]	Device		Shaft structure		Unitized construction		Position control	Forward/ reverse operation	Two-step speed changing
		Clutch	Brake	Through-shaft	Butt shaft	Motor	Speed reducer			
125	2.4 ～ 160	◎	◎		◎			◎		
121-□-20G	5 ～ 320	◎	◎	◎				◎		
126	5 ～ 80	◎	◎		◎	◎		◎		
CBW	5 ～ 40	◎	◎	◎			◎	◎		
CMW	5 ～ 40	◎	◎	◎		◎	◎	◎		
121-□-10G	5 ～ 320	◎ (Double clutch)		◎					◎	◎
122	5 ～ 160	◎ (Double clutch)	◎	◎				◎	◎	◎

For details on selection, see P.312.

Product Lineup

125

125-□-12G only

Butt shaft construction, drip-proof type

Handling is made simpler by drip-proof construction that encloses clutch and brake inside a light alloy housing.

Mounting direction freedom

Disc springs are used, so this clutch/brake unit can be used vertically.

This design preserves the performance of clutch and brake to the maximum extent. Its construction is sturdy, yet lightmass. Its easy-to-use butt-connected construction is drip proof, making it suitable for a variety of general industrial machinery applications. The base can be either steel plate or cast (E type made to order). Mounting is simple and service life is long.

Unit types	125-□-12G	125-□-12E
Clutch/brake torque [N·m]	2.4～80	5～160
Operating temperature [℃]	−10～+40	
Backlash	Zero	

121-□-20G

Through-shaft construction, open-disc brake system type

These are open-disc brake system type with clutch and brake mounted on the outside of a light alloy drum. They use through-shaft construction.

Ideal for winding or geared transmission

The construction holds up well under radial loads due to a wide bearing span, so they can be used under high tension when mounted with V pulleys, spur gears or the like.

Output shaft can be used in many applications

Through-shaft construction means that output is available on both sides of the shaft. Many mechanism layouts are possible, including using both ends in split driving or mounting a detection disc or the like on one end.

This design preserves the performance of clutch and brake to the maximum extent. Its construction is sturdy, yet lightmass. Its compact through-shaft construction is open, making it suitable for a variety of general industrial machinery applications. Mounting is simple and service life is long.

Clutch/brake torque [N·m]	5～320
Operating temperature [℃]	−10～+40
Backlash	Zero

126

Easy to mount and handle

These types directly connect 3-phase induction motors to clutch/brake units, requiring less installation space and eliminating cumbersome tasks such as centering and processing of mounts. Since the output shaft is simply engaged to the load, handling is easy.

Capable of high-frequency operation

These can repeatedly start and stop the output shaft without stopping the motor, so they can operate intermittently at a higher frequency than on/off operation of the motor.

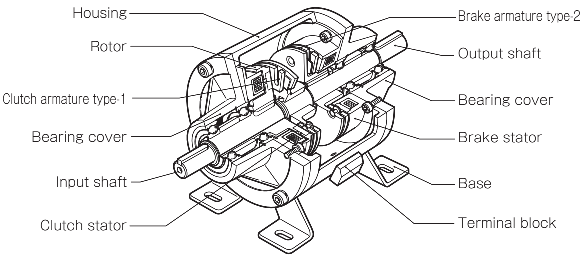
Two ways to mount

Base and flange types are available. Decide which to use based on your installation location. Flange mountings have the same shape mounting surface as general-purpose flange motors, so they can be integrated with speed reducers.

These are practical units in which induction motors are directly connected to clutch/brake units in advance. Base and flange types are available.

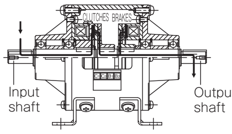
Unit types	126-□-4B	126-□-4F-N
Clutch/brake torque [N·m]	5～80	
Operating temperature [℃]	−10～+40	
Backlash	Zero	
Motor output [kW]	0.2 to 3.7 3-phase 4-pole fully-sealed external fan type	

Structure



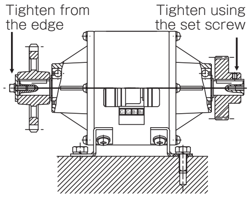
Power transmission

Input and output shafts are isolated. A pulley or the like is mounted on the input shaft, connecting it to the driver so it is always rotating. When electricity flows to the clutch, the two shafts are connected, and rotation is transmitted. If the brake mounted on the output shaft is supplied with electricity simultaneous with clutch current being shut off, the input and output shafts are isolated and the output shaft is quickly braked.

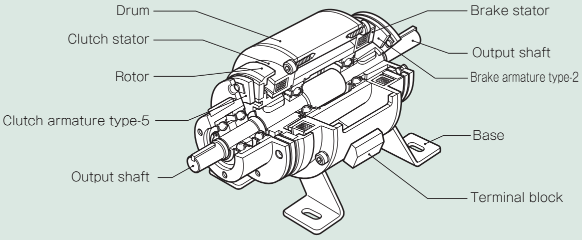


Mounting

The end faces of the input and output shafts are equipped with screw holes, so pulleys and the like can be easily mounted using jig accessories. They are attached by screwing them in from the end face or by using a set screw.

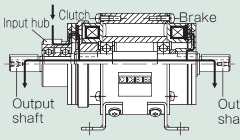


Structure



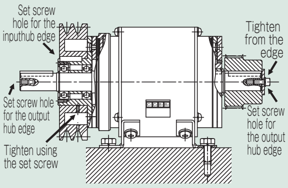
Power transmission

The input hub floats on the shaft on bearings, is connected to the drive by mounting pulleys or the like, and is always rotating. When electricity flows to the clutch, the output shaft is connected, and rotation is transmitted. If a brake mounted on the output shaft is supplied with electricity simultaneous with clutch current being shut off, the input and output shafts are isolated and the output shaft is quickly braked. They have excellent response performance, so they are capable of high-frequency intermittent operation.

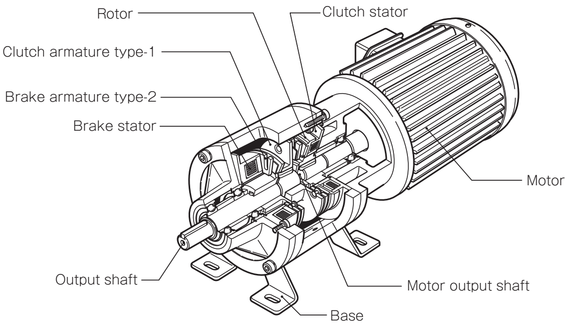


Mounting

The input hub and output shaft end face have screw holes, so they are pushed into each other using a jig accessory. Lock them in place either using a set screw or by pressing from the end face.

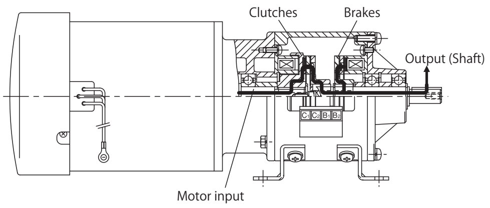


Structure



Power transmission

The motor shaft serves as the clutch input shaft, while the output shaft is isolated. When current flows to the clutch, the motor's rotation is transmitted to the output shaft via the clutch. If the brake is supplied with electricity simultaneous with clutch current being shut off, the output shaft is isolated from the motor side and instantly stopped.



Product Lineup

CBW

Compact, space saving

These are very compact units that combine a worm reducer and clutch/brake in a single unit. They can greatly save on space required for mounting.

Easy to mount and handle

A V pulley comes mounted as standard on the input part, so simply connect it to a drive with a belt. Install the speed reducer to complete the mounting. No troublesome centering or processing is needed.

Efficient starting and stopping

Integration keeps self-inertia low, so the efficiency of starting and stopping is good. It can be combined with a speed changer for a wide range of speed changes, and excellent performance can be achieved in many applications, such as 360° rotation stop of the output shaft.

These are practical units in which worm reducers are directly connected to clutch/brake units in advance. A standard V belt pulley is installed on the input part of the clutch. Two models are available, based on worm reducer type.

Unit types		CBW-□N-H□	CBW-□N-B□
Speed reducer manufacturer		Hirai Reduction Gear Manufacturing Co.	Bellpony Co., Ltd.
Clutch/brake torque	[N·m]	5～40	
Operating temperature	[℃]	0～＋40	
Backlash		Zero (clutch/brake units)	

CMW

Easy to mount and handle

These types integrate induction motors, clutch/brake units, couplings, and speed reducers in a single unit, requiring less installation space and eliminating cumbersome tasks such as centering and processing of mounts. Since the output shaft is simply engaged to the load, handling is easy.

Efficient starting and stopping

Integration keeps self-inertia low, so the efficiency of starting and stopping is good.

Capable of high-frequency operation

These can repeatedly start and stop the output shaft without stopping the motor, so they can operate intermittently at a higher frequency than on/off operation of the motor.

These are practical units in which motors, clutch/brake units, and speed reducers are combined into a single unit in advance. An induction motor and a clutch are coupled by a MIKI PULLEY CENTAFLEX coupling, which features shock absorption, and then combined in a unit with a worm reducer to make a multifunction drive unit.

Clutch/brake torque	[N·m]	5～40
Operating temperature	[℃]	0～＋40
Backlash		Zero (clutch/brake units)
Motor output	[kW]	0.2 to 1.5 3-phase 4-pole fully-sealed external fan type

121-□-10G

RoHS

Compact through-shaft construction

This is an efficient unit whose basic design is the same as that of clutch/brake type 121. It is a strong construction for winding, gear transmission, and the like.

Multi-function unit

This single unit can perform functions such as two-step speed changing, forward/reverse operation, and power distribution, so the transmission mechanism can be simplified.

These are compact, open units that place two clutches (101-□-15) on a through-shaft. Since one unit can perform many functions, and is also easy to install and handle, the transmission mechanism can be simplified.

Clutch torque	[N·m]	5～320
Operating temperature	[℃]	−10～＋40
Backlash		Zero

122

RoHS

Compact through-shaft construction

These unique units have everything placed extremely skilfully on the through-shaft. They are suitable for winding, gear transmission, and the like.

Multi-function unit

These multifunction units perform complex and precision control in a single unit, including two-step speed changing, stopping at predetermined positions, and high-frequency forward/reverse operation. The transmission mechanism can be greatly simplified.

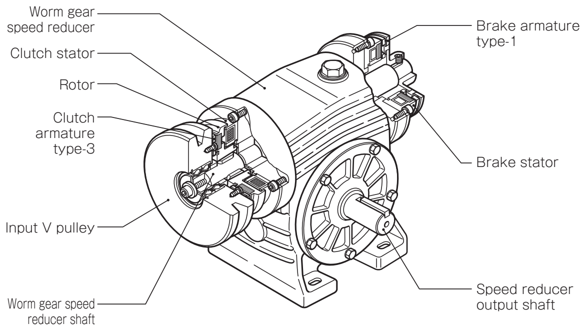
Easy handling

They not only perform many functions, they also are easy to build into machinery, just like other units.

These are units unlike any other, which combine two clutches (101- □ -15G) with a brake (111- □ -12G) in a compact form factor. They provide high-precision positioning and applied control of complex operations from a single unit. Installation and handling are as easy as on other units.

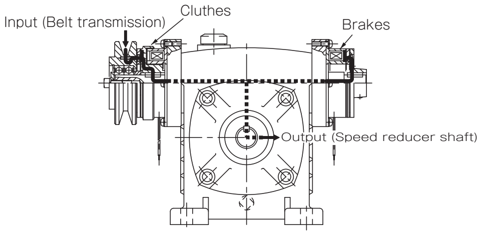
Clutch/brake torque	[N·m]	5～160
Operating temperature	[℃]	−10～＋40
Backlash		Zero

Structure

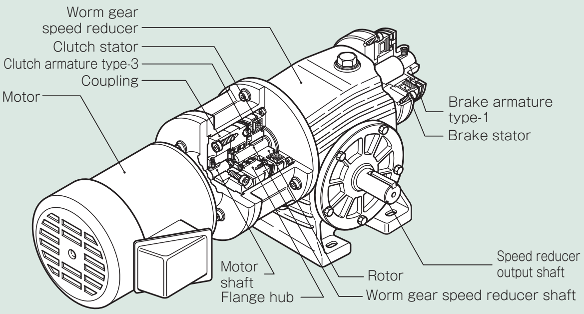


Power transmission

A V pulley is installed on the input part of the clutch, connected by a belt to the drive, and rotates continuously. When current flows to the clutch, rotation is transmitted to the worm shaft, and the output shaft of the speed reducer rotates. If the brake is supplied with electricity when clutch current is shut off, the output shaft stops.

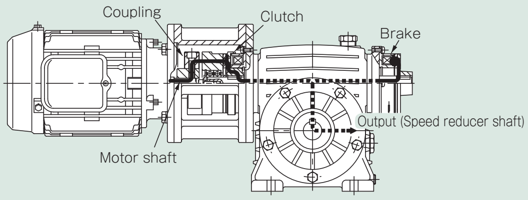


Structure

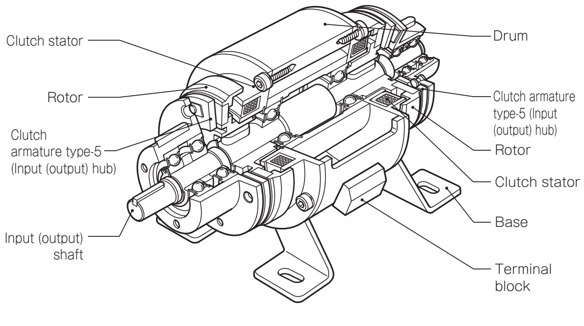


Power transmission

The motor shaft becomes the clutch input shaft via a CENTAFLEX coupling, and the worm shaft is isolated. When current flows to the clutch, the motor's rotation is transmitted to the worm shaft via the clutch, and the output shaft of the speed reducer rotates. If the brake is supplied with electricity when clutch current is shut off, the output shaft stops.

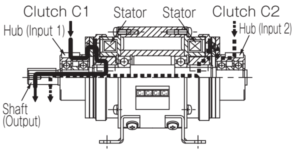


Structure



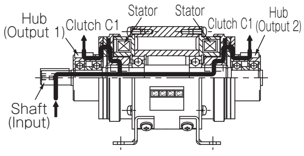
Power transmission

Two clutches, C1 and C2, have a hub shape on the armature side; a V pulley or the like is installed on each. When the hub is used as the input, different force power is connected to the two hubs and they rotate continuously. When current runs to clutch C1, power is transmitted to the shaft via the rotor. When C1 current is shut off and current simultaneously sent to C2, the power switches quickly and the new power is transmitted to the shaft. When the shaft is used as the input, the drive and shaft engage and rotation is continuous. When current flows to the clutches, power is transmitted via the armature to the hub that serves as output.

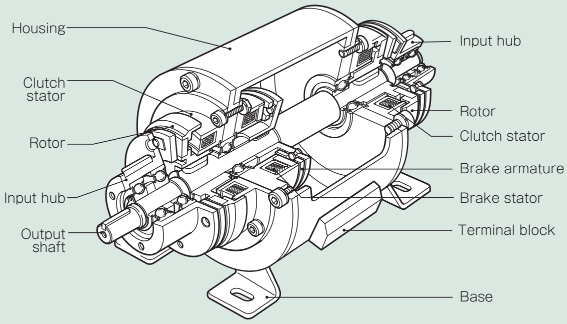


Mounting

Installation of these units and mounting of components and the like is the same as for 121-☐-20G type clutch/brake units.



Structure

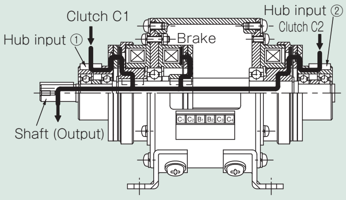


Power transmission

Different force power is connected to the input hubs of the two clutches C1 and C2 to make them rotate continuously. When current flows to clutch C1, that power is transmitted and the output shaft rotates. When C1 current is shut off and current simultaneously sent to C2, power switches quickly and the new power is transmitted to the shaft. If the brake is supplied with electricity simultaneous with clutch current being shut off, the shaft is instantly stopped.

Mounting

Installation of these units and mounting of components and the like is the same as for 121-☐-20G type clutch/brake units.



Customization

Examples of Special Cases

■ Special friction material (lining) specifications

In addition to standard friction materials, high-torque friction materials and long-life friction materials can also be handled. When using non-standard friction materials, the friction torque and total work will differ from catalog specifications tables. Contact Miki Pulley for details.

■ Special voltage specifications

The standard voltage of clutch and brakes is DC 24 V. Special voltages such as DC 12 V, 90 V and 180 V can also be handled.

■ New JIS standard compliance for input and output shafts

Input/output shaft parts other than those of 126-□-4F-N, CBW-□N-□, and CMW-□N-H□H are compliant with old JIS standards. They can also be made compliant with new JIS standards. Contact Miki Pulley for details.

* Please understand that we may not be able to meet all such special specifications, depending on the usage conditions, dimensional restrictions, clutch and brake sizes, mounting restrictions and the like.

■ V pulleys, sprockets, etc.

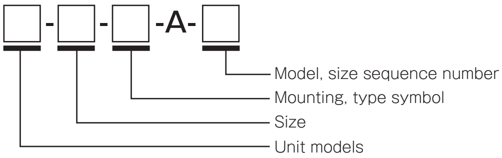
Input and output components that meet your needs, for example, by having V pulleys (including with different pulley diameters), sprockets, or timing pulleys, can be designed and produced.

■ Integrated or unitized products

We can also produce units that combine motors, speed reducers, couplings and the like to meet your needs.

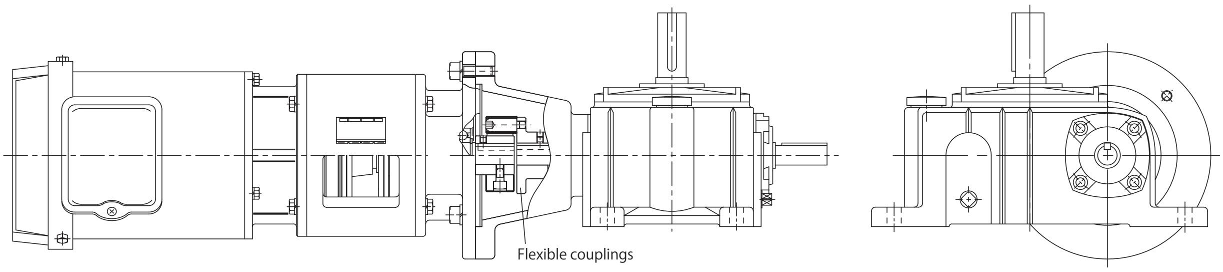
How to Place an Order

After exchanging delivery specifications for designing a product to meet your particular requirements (special production), we will custom manufacture it using the type name at right.

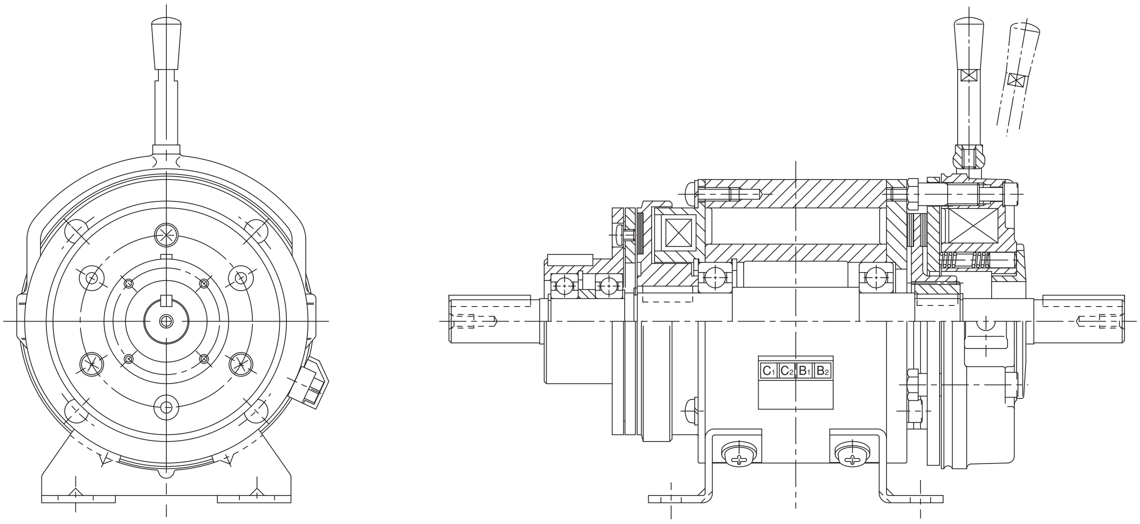


Special Application Examples

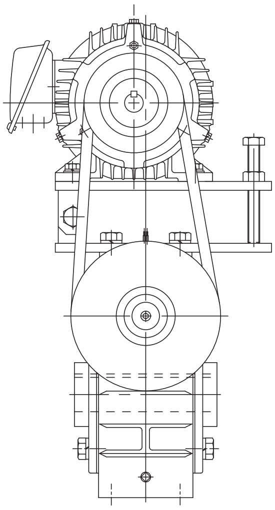
Integrated unit that uses a coupling to connect a 126 model with an above-shaft worm reducer

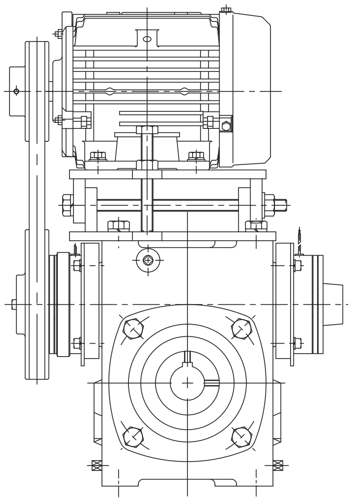


Unit that uses a spring-actuated brake as the brake of a model 121 clutch/brake unit

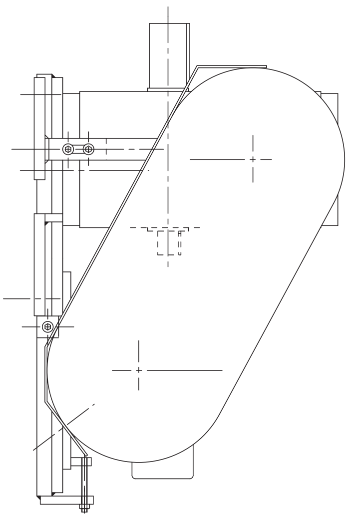


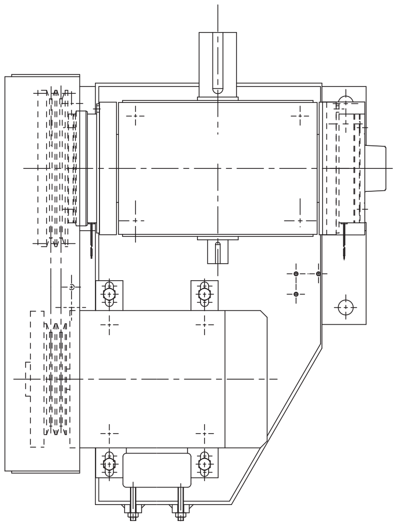
Integrated drive unit that connects a motor and special type of CBW model (hollow-shaft worm reducer) with a belt





Integrated drive unit, covered with a safety cover, that connects a motor and a special CBW model worm reducer with a belt





For details, please visit our website.

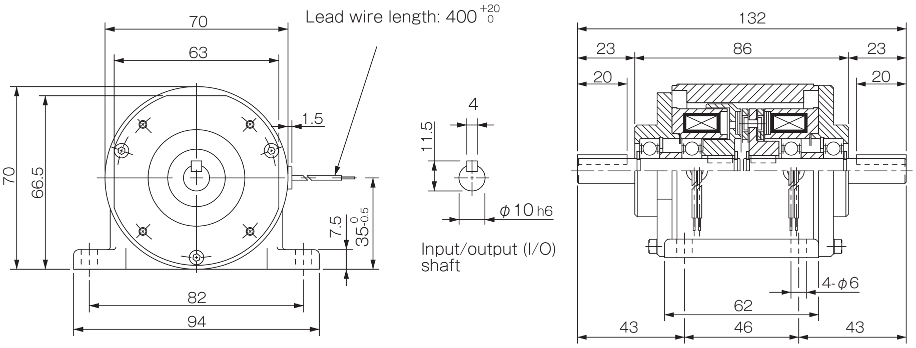
125 Models Clutch/Brake Units

Specifications (125-☐-12G)

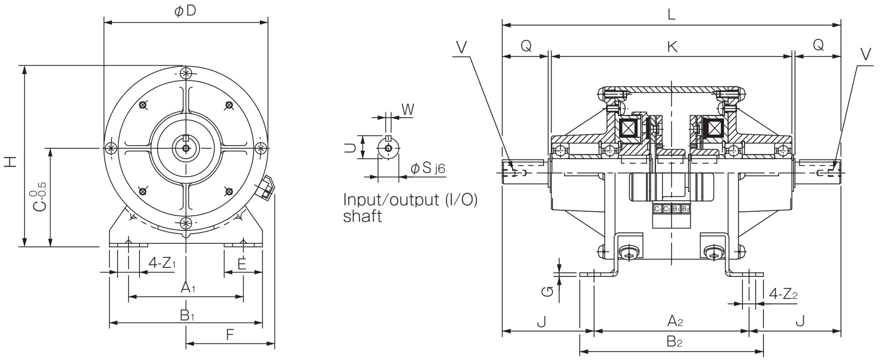
Model	Size	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃) Voltage [V]	Wattage [W]	Current [A]	Resistance [Ω]	Heat resistance class	Max. rotation speed [min⁻¹]	Rotating part moment of inertia J [kg·m²]	Total work performed until readjustment of the air gap E_T [J]	Armature pull-in time t_a [s]	Torque build-up time t_p [s]	Torque decaying time t_d [s]	Mass [kg]
125-05-12G	05	2.4	—	DC24	10	0.42	58	B	3000	2.4×10^{-5}	9×10^6	C:0.012 B:0.010	C:0.031 B:0.023	C:0.040 B:0.012	1.2
125-06-12G	06	5	5.5	DC24	11	0.46	52	B	3000	1.28×10^{-4}	36×10^6	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015	2.1
125-08-12G	08	10	11	DC24	15	0.63	38	B	3000	3.70×10^{-4}	60×10^6	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025	4.2
125-10-12G	10	20	22	DC24	20	0.83	29	B	3000	1.40×10^{-3}	130×10^6	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030	6.8
125-12-12G	12	40	45	DC24	25	1.09	23	B	3000	3.85×10^{-3}	250×10^6	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050	12
125-16-12G	16	80	90	DC24	35	1.46	16	B	3000	1.35×10^{-2}	470×10^6	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	22

* The dynamic friction torque, T_d, is measured at a relative speed of 100 min⁻¹.

Dimensions (125-05-12G)



Dimensions (125-☐-12G)



Unit [mm]

Size	Dimensions of part															Dimensions of shaft				
	A_1	A_2	B_1	B_2	C	D	E	F	G	H	J	K	L	Z_1	Z_2	Q	S	U	V	W
06	65	90	90	105	65	100	27.5	61	2.6	115	48.5	132	187	13.5	6.5	25	11	12.5	M4 × 0.7, length: 8	4
08	80	110	110	130	80	125	32.5	72	3.2	142.5	63	171	236	15.5	9	30	14	16	M4 × 0.7, length: 8	5
10	105	135	140	160	90	150	35	81	3.2	165	80	210	295	20	11.5	40	19	21	M6 × 1, length: 11	5
12	135	160	175	185	112	190	42.5	97	4.5	207	108	270	376	24	11	50	24	27	M6 × 1, length: 11	7
16	155	200	200	230	132	230	45	109	6	247	145	362	490	28	14	60	28	31	M6 × 1, length: 11	7

* The input/output shaft keyways are old JIS standard class 2 while the key is old JIS standard class 1.
* When inserting pulleys or the like onto input/output shafts, use the supplied insertion set.

How to Place an Order

125-06-12G

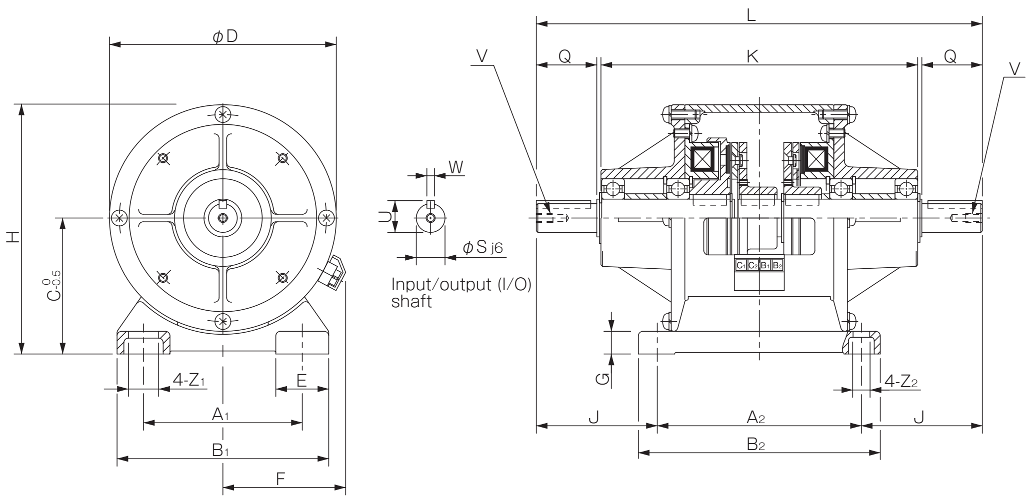
Size

Specifications (125-□-12E) Made to Order

Model	Size	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃) Voltage [V]	Wattage [W]	Current [A]	Resistance [Ω]	Heat resistance class	Max. rotation speed [min⁻¹]	Rotating part moment of inertia J [kg·m²]	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]
125-06-12E	06	5	5.5	DC24	11	0.46	52	B	3000	1.28×10^{-4}	36×10^6	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015	2.1
125-08-12E	08	10	11	DC24	15	0.63	38	B	3000	3.70×10^{-4}	60×10^6	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025	4.2
125-10-12E	10	20	22	DC24	20	0.83	29	B	3000	1.40×10^{-3}	130×10^6	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030	6.8
125-12-12E	12	40	45	DC24	25	1.09	23	B	3000	3.85×10^{-3}	250×10^6	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050	12
125-16-12E	16	80	90	DC24	35	1.46	16	B	3000	1.35×10^{-2}	470×10^6	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	22
125-20-12E	20	160	175	DC24	45	1.86	13	B	2500	4.08×10^{-2}	10×10^5	C:0.090 B:0.065	C:0.250 B:0.207	C:0.130 B:0.070	49

*The dynamic friction torque, T_d, is measured at a relative speed of 100 min⁻¹.

Dimensions (125-□-12E) Made to Order



Unit [mm]

Size	Dimensions of part															Dimensions of shaft				
	A_1	A_2	B_1	B_2	C	D	E	F	G	H	J	K	L	Z_1	Z_2	Q	S	U	V	W
06	65	90	90	105	65	100	27.5	61	10	115	48.5	132	187	13.5	6.5	25	11	12.5	M4 × 0.7, length: 8	4
08	80	110	110	130	80	125	32.5	72	12	142.5	63	171	236	15.5	9	30	14	16	M4 × 0.7, length: 8	5
10	105	135	140	160	90	150	35	81	15	165	80	210	295	20	11.5	40	19	21	M6 × 1, length: 11	5
12	135	160	175	185	112	190	42.5	97	15	207	108	270	376	24.5	11	50	24	27	M6 × 1, length: 11	7
16	155	200	200	230	132	230	45	109	18	247	145	362	490	28	14	60	28	31	M6 × 1, length: 11	7
20	195	240	240	270	160	290	47.5	124	20	305	188	448	616	28	14	80	38	41.5	M10 × 1.5, length: 17	10

* The input/output shaft keyways are old JIS standard class 2 while the key is old JIS standard class 1.
* When inserting pulleys or the like onto input/output shafts, use the supplied insertion set.

How to Place an Order

125-06-12E

Size — 06

Base casting (Made to Order): E

125 Models

List of Stand-alone Clutches and Brakes Used

Model	Stand-alone clutch system	Stand-alone braking system	Bearing number	
			Input part	Output part
125-05-12	-	-	6000	6000
125-06-12	101-06-11G 24V R15JIS A15JIS	111-06-12G 24V 15JIS	6202	6202
125-08-12	101-08-11G 24V R20JIS A20JIS	111-08-12G 24V 20JIS	6004	6004
125-10-12	101-10-11G 24V R25JIS A25JIS	111-10-12G 24V 25JIS	6205	6205
125-12-12	101-12-11G 24V R30JIS A30JIS	111-12-12G 24V 30JIS	6206	6206
125-16-12	101-16-11G 24V R40JIS A40JIS	111-16-12G 24V 40JIS	6208	6208
125-20-12	101-20-11G 24V R50JIS A50JIS	111-20-12G 24V 50JIS	6211	6211

Recommended Power Supplies and Accessory Parts

Model	Recommended power supplies	Accessory parts			
		Circuit protector (Varistor), qty. 2	Tightening collar	Screw stock	Hexagonal nut
125-05-12	BEH-10G	NVD07SCD082 or an equivalent	-	-	-
125-06-12	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55 (hex-socket bolt), qty. 1	M4, qty. 1
125-08-12	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55 (hex-socket bolt), qty. 1	M4, qty. 1
125-10-12	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 100, qty. 1	M6, qty. 2
125-12-12	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 100, qty. 1	M6, qty. 2
125-16-12	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 100, qty. 1	M6, qty. 2
125-20-12	BEH-20G	NVD07SCD082 or an equivalent	Qty. 1	M10 × 160, qty. 1	M10, qty. 2

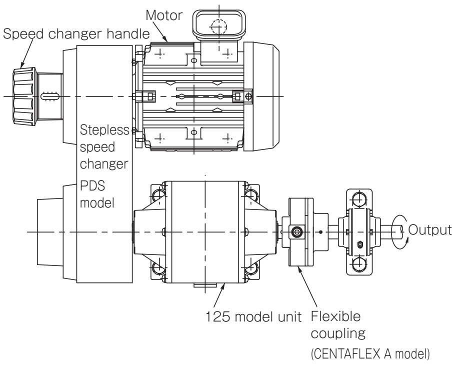
* NVD☐SCD☐ parts are manufactured by KOA Corporation.

* Varistors need not be used when a BEH model overexcitation electromagnetic power supply is used. For details, refer to the section on power supplies.

Mounting Example

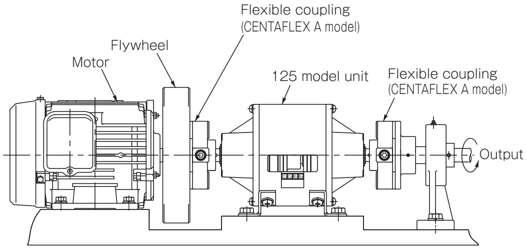
In Combination with Speed Changers

Clutches and brakes are generally used after motors and speed changers. This unit was designed so that it can be used in combination with a Miki Pulley belt-type stepless speed changer.
We provide items precombined into sets. Contact Miki Pulley for details.



Examples of Direct Connection to Motors

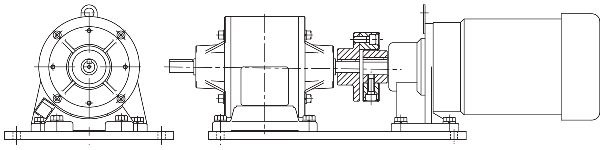
Couplings generally have small inertial moments compared to pulleys, sprockets and the like, so they are often used in combination with clutches and brakes. This unit is often combined with our flexible couplings (CENTAFLEX) in particular. It is very effective to mount it on the motor side in combination with a flywheel.



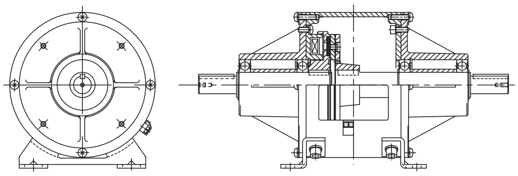
Special Types

In addition to the special application examples shown below, drivers can also be set, and units can be provided with pulleys, sprockets, and the like. Contact Miki Pulley for details.

One-piece Unit Connected to Geared Motor and Coupling



Clutch Unit (No Brake)



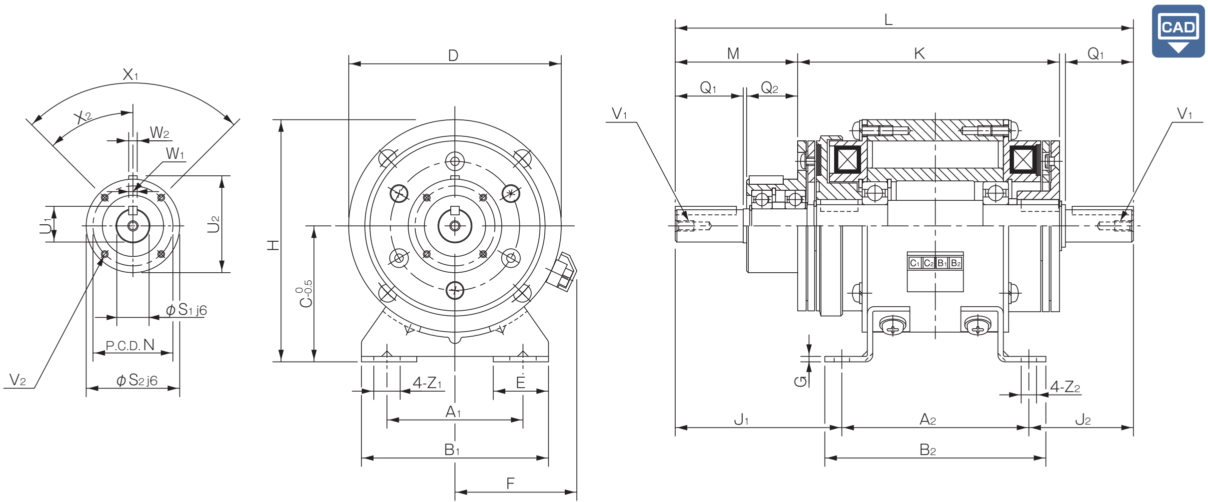
121-☐-20G Types Clutch/Brake Units

Specifications

Model	Size	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃) Voltage [V]	Coil (at 20℃) Wattage [W]	Coil (at 20℃) Current [A]	Coil (at 20℃) Resistance [Ω]	Heat resistance class	Max. rotation speed [min⁻¹]	Rotating part moment of inertia J [kg·m²]	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]
121-06-20G	06	5	5.5	DC24	11	0.46	52	B	3000	1.43×10^{-4}	36×10^{6}	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015	1.5
121-08-20G	08	10	11	DC24	15	0.63	38	B	3000	4.23×10^{-4}	60×10^{6}	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025	2.7
121-10-20G	10	20	22	DC24	20	0.83	29	B	3000	1.42×10^{-3}	130×10^{6}	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030	5.5
121-12-20G	12	40	45	DC24	25	1.09	23	B	3000	4.18×10^{-3}	250×10^{6}	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050	9.6
121-16-20G	16	80	90	DC24	35	1.46	16	B	3000	1.34×10^{-2}	470×10^{6}	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	18.5
121-20-20G	20	160	175	DC24	45	1.88	13	B	2500	4.13×10^{-2}	10×10^{8}	C:0.090 B:0.065	C:0.250 B:0.200	C:0.130 B:0.070	35
121-25-20G	25	320	350	DC24	60	2.50	9.6	B	2000	1.02×10^{-1}	20×10^{8}	C:0.115 B:0.085	C:0.335 B:0.275	C:0.210 B:0.125	64

*The dynamic friction torque, T_d, is measured at a relative speed of 100 min⁻¹.

Dimensions



Unit [mm]

Size	Dimensions of part																		Dimensions of shaft										
	A_1	A_2	B_1	B_2	C	D	E	F	G	H	J_1	J_2	K	L	M	N	Z_1	Z_2	Q_1	Q_2	S_1	S_2	U_1	U_2	V_1	V_2	X_1	X_2	$W_{1,2}$
06	52.5	75	80	90	55	80	27.5	53	2.6	95	65.5	40.5	105.5	181	47	33	13.5	6.5	25	20	11	38	12.5	39.5	M4 × 0.7, length: 8	3-M4 × 0.7, length: 4	3-120°	60°	4
08	65	90	90	105	65	100	27.5	61	2.6	115	78.5	48.5	126.5	217	57	37	13.5	6.5	30	25	14	45	16	47	M4 × 0.7, length: 8	3-M4 × 0.7, length: 6	3-120°	60°	5
10	80	110	110	130	80	125	32.5	72	3.2	142.5	98	62	154	270	72	47	15.5	9	40	30	19	55	21	57	M6 × 1, length: 11	4-M4 × 0.7, length: 8	4-90°	45°	5
12	105	135	140	160	90	150	35	81	3.2	165	121	73.5	184	330	92	52	20	11.5	50	40	24	64	27	67	M6 × 1, length: 11	4-M4 × 0.7, length: 8	4-90°	45°	7
16	135	160	175	185	112	190	43	97	4.5	207	149	90	221	399	113	62	24.5	11.5	60	50	28	75	31	78	M6 × 1, length: 11	6-M5 × 0.8, length: 8	6-60°	30°	7
20	155	200	200	230	132	230	45	109	6	247	187	117	276	504	142	74.5	28	14	80	60	38	90	41.5	93.5	M10 × 1.5, length: 17	4-M6 × 1, length: 12	4-90°	45°	10
25	195	240	240	270	160	290	47.5	124	20	305	238	154	334	632	183	101.5	28	14	110	70	42	115	45.5	118.5	M10 × 1.5, length: 17	8-M6 × 1, length: 12	8-45°	22.5°	12

* The input/output shaft keyways are old JIS standard class 2 while the key is old JIS standard class 1. Note that the keyway dimensions of the unit hub part do not conform to the old JIS standard. Check them on the dimensions table above.

* When inserting pulleys or the like onto input/output shafts, use the supplied insertion set.

* The 121-25-20G base is a casting.

How to Place an Order

121-06-20G

Size

List of Stand-alone Clutches and Brakes Used

Model	Stand-alone clutch system	Stand-alone braking system	Bearing number	
			Main shaft part	Hub part
121-06-20G	101-06-15G 24V R15JIS A12JIS	111-06-12G 24V 15JIS	6202	6001
121-08-20G	101-08-15G 24V R20JIS A15JIS	111-08-12G 24V 20JIS	6004	6002
121-10-20G	101-10-15G 24V R25JIS A20JIS	111-10-12G 24V 25JIS	6205	6004
121-12-20G	101-12-15G 24V R30JIS A25JIS	111-12-12G 24V 30JIS	6206	6005
121-16-20G	101-16-15G 24V R40JIS A30JIS	111-16-12G 24V 40JIS	6208	6006
121-20-20G	101-20-15G 24V R50JIS A40JIS	111-20-12G 24V 50JIS	6211	6008
121-25-20G	101-25-15G 24V R60JIS A50JIS	111-25-12G 24V 60JIS	6214	6010

Recommended Power Supplies and Accessory Parts

Model	Recommended power supplies	Accessory parts				
		Circuit protector (Varistor), qty. 2	Tightening collar	Screw stock	Presser foot	Hexagonal nut
121-06-20G	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 3	Qty. 1	M4, qty. 3
121-08-20G	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 3	Qty. 1	M4, qty. 3
121-10-20G	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 3	Qty. 1	M4, qty. 3
121-12-20G	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 2/M6 × 100, qty. 1	Qty. 1	M4, qty. 2/M6, qty. 1
121-16-20G	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M5 × 70, qty. 2/M6 × 100, qty. 1	Qty. 1	M5, qty. 2/M6, qty. 1
121-20-20G	BEH-20G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 160, qty. 2/M10 × 220, qty. 1	Qty. 1	M6, qty. 4/M10, qty. 2
121-25-20G	BEH-20G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 160, qty. 2/M10 × 220, qty. 1	Qty. 1	M6, qty. 4/M10, qty. 2

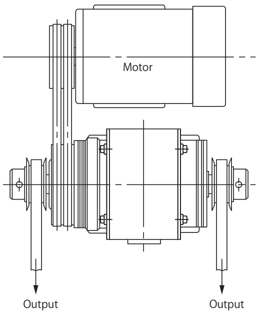
* NVD□SCD□ parts are manufactured by KOA Corporation.

* Varistors need not be used when a BEH model overexcitation electromagnetic power supply is used. For details, refer to the section on power supplies.

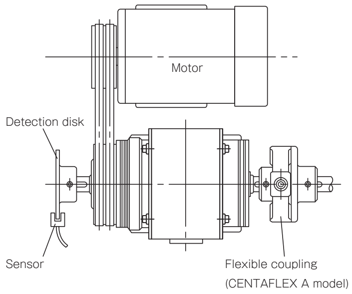
Mounting Example

This clutch/brake unit allows the output shaft to be used in two locations, so both outputs can be used simultaneously, or one can be connected to a load and a rotation detection disk mounted to the other. A variety of transmission paths can be used in layouts.

Example with Two Outputs



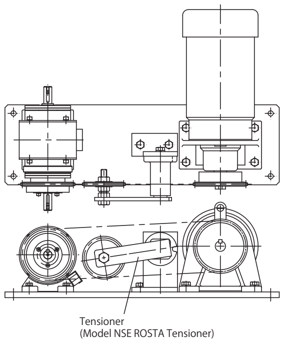
Example with Detection Disk on One Side



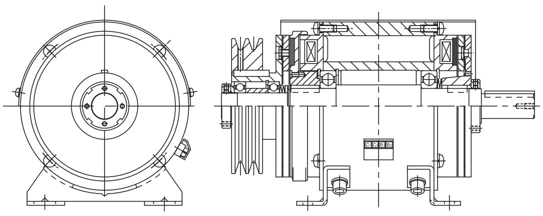
Special Types

In addition to the special application examples shown below, drivers can also be set, and units can be provided with pulleys, sprockets, and the like. Contact Miki Pulley for details.

One-piece Unit Connected by Geared Motor and Sprocket



Clutch/Brake Unit with V Pulley Mounted on Input Side



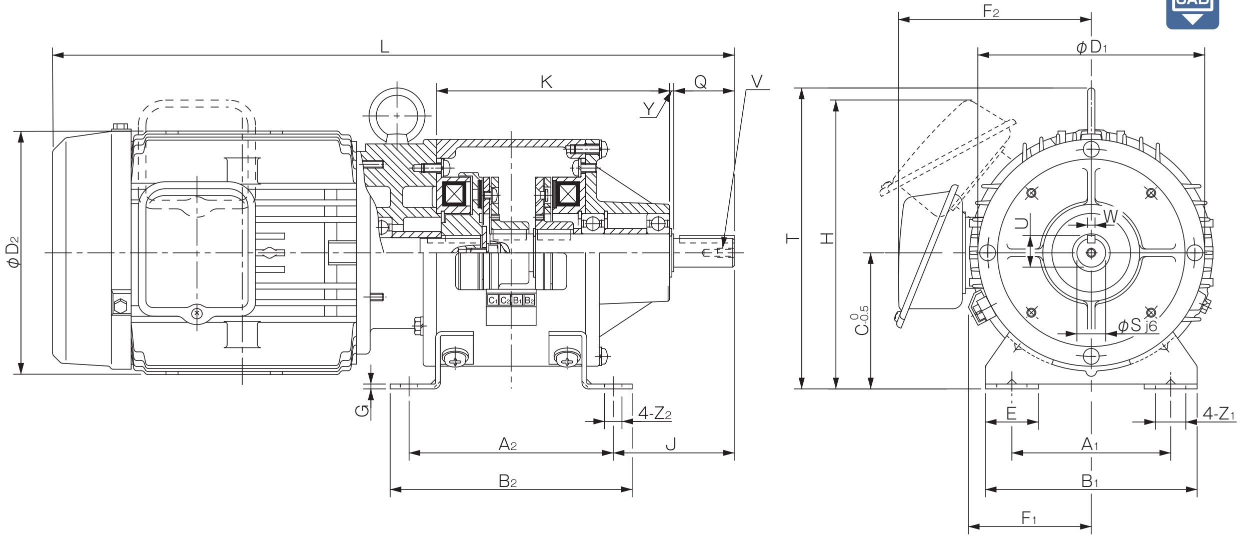
126 Models Clutch/Brake Units - Motor-coupled Type

Specifications (126- □ -4B)

Model	Size	Motor output [kW] 4-poles	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃)				Heat resistance class	Rotating part moment of inertia J [kg·m²]	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]							
126-06-4B-0.2kW	06	0.2	5	5.5	DC24	11	0.46	52	B	1.28×10^{-4}	36×10^6	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015	8.9
126-08-4B-0.4kW	08	0.4	10	11	DC24	15	0.63	38	B	3.70×10^{-4}	60×10^6	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025	13
126-10-4B-0.75kW-IE3	10	0.75	20	22	DC24	20	0.83	29	B	1.40×10^{-3}	130×10^6	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030	20
126-12-4B-1.5kW-IE3	12	1.5	40	45	DC24	25	1.09	23	B	3.85×10^{-3}	250×10^6	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050	41
126-16-4B-2.2kW-IE3	16	2.2	80	90	DC24	35	1.46	16	B	1.35×10^{-2}	470×10^6	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	54
126-16-4B-3.7kW-IE3	16	3.7	80	90	DC24	35	1.46	16	B	1.35×10^{-2}	470×10^6	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	69

* The induction motors are fully sealed external fan motors that conform to the JIS C4210 standard (for 0.2 kW and 0.4 kW models) or the JIS C 4213 standard (for 0.75 kW models or higher).
* The power supplies for the motors are 3-phase, 200 V AC at 50 Hz, or 200/220 V AC at 60 Hz.
* If you desire a special voltage (5 Power Supply Specifications), different number of poles, or the like for the induction motor, contact Miki Pulley.
* The dynamic friction torque, T_d, is measured at a relative speed of 100 min^{-1}.

Dimensions (126- □ -4B)



Unit [mm]

Model	Dimensions of part																			Dimensions of shaft				
	A_1	A_2	B_1	B_2	C	D_1	D_2	E	F_1	F_2	G	J	K	L	H	T	Y	Z_1	Z_2	Q	S	U	V	W
126-06-4B-0.2kW	65	90	90	105	65	100	130	27.5	61	—	2.6	48.5	102	335	—	—	3	13.5	6.5	25	11	12.5	M4 × 0.7, length: 8	4
126-08-4B-0.4kW	80	110	110	130	80	125	145	32.5	72	126.5	3.2	63	127.5	389	167.5	—	2.5	15.5	9	30	14	16	M4 × 0.7, length: 8	5
126-10-4B-0.75kW-IE3	105	135	140	160	90	150	163	35	81	136	3.2	80	154	462	184	—	3	20	11.5	40	19	21	M6 × 1, length: 11	5
126-12-4B-1.5kW-IE3	135	160	175	185	112	190	182/176	42.5	97	148.5	15	108	194	550.5	—	244.5	3	24.5	11.5	50	24	27	M6 × 1, length: 11	7
126-16-4B-2.2kW-IE3	155	200	200	230	132	230	198/195	45	109	155.5	18	135	256	649.5	—	286	4	28	14	50	24	27	M6 × 1, length: 11	7
126-16-4B-3.7kW-IE3	155	200	200	230	132	230	225/215	45	109	168.5	18	145	256	681	—	295	4	28	14	60	28	31	M6 × 1, length: 11	7

* The output shaft keyways are old JIS standard class 2 while the key is old JIS standard class 1.
* When inserting pulleys or the like onto output shafts, use the supplied insertion set.
* These models are cast basded on a motor output of 1.5 kW or greater.

How to Place an Order

126-06-4B-0.2kW-IE3

Size
Mounting type
B: Base-mounted
Motor output
IE code
For motors with an output of 0.75 kW or greater, use the IE3 designation.

Specifications (126- □ -4F-N)

Model	Size	Motor output [kW] 4-poles	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃)				Heat resistance class	Rotating part moment of inertia J [kg·m²]	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]							
126-06-4F-N-0.2kW	06	0.2	5	5.5	DC24	11	0.46	52	B	1.28×10^{-4}	36×10^6	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015	8.9
126-08-4F-N-0.4kW	08	0.4	10	11	DC24	15	0.63	38	B	3.70×10^{-4}	60×10^6	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025	13
126-10-4F-N-0.75kW-IE3	10	0.75	20	22	DC24	20	0.83	29	B	1.40×10^{-3}	130×10^6	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030	20
126-12-4F-N-1.5kW-IE3	12	1.5	40	45	DC24	25	1.09	23	B	3.85×10^{-3}	250×10^6	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050	41
126-16-4F-N-2.2kW-IE3	16	2.2	80	90	DC24	35	1.46	16	B	1.35×10^{-2}	470×10^6	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	54
126-16-4F-N-3.7kW-IE3	16	3.7	80	90	DC24	35	1.46	16	B	1.35×10^{-2}	470×10^6	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	69

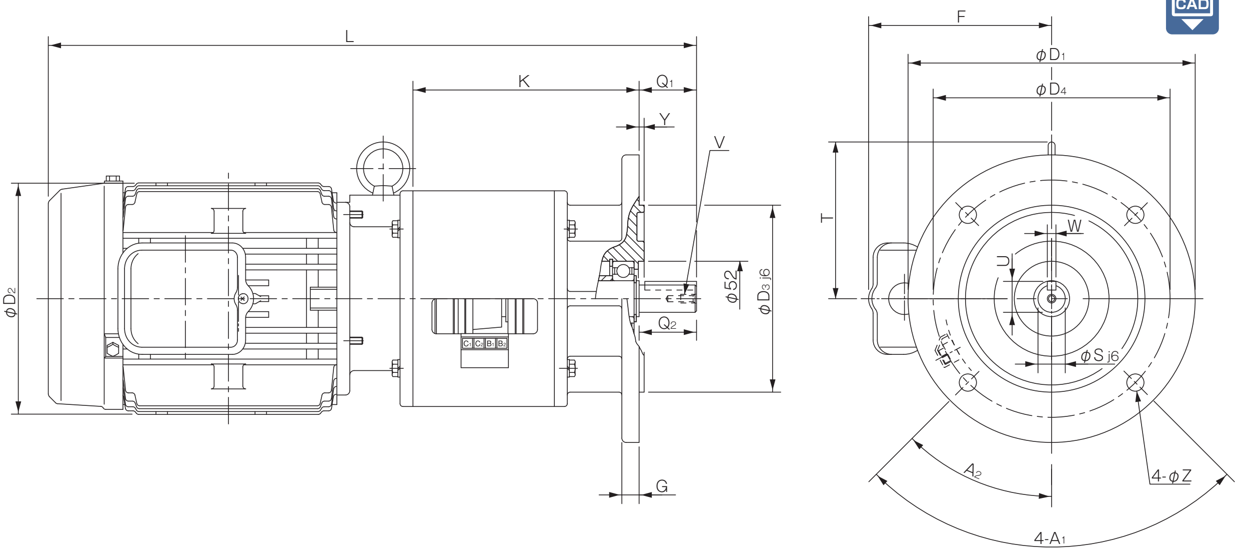
* The induction motors are fully sealed external fan motors that conform to the JIS C4210 standard (for 0.2 kW and 0.4 kW models) or the JIS C 4213 standard (for 0.75 kW models or higher).

* The power supplies for the motors are 3-phase, 200 V AC at 50 Hz, or 200/220 V AC at 60 Hz.

* If you desire a special voltage (5 Power Supply Specifications), different number of poles, or the like for the induction motor, contact Miki Pulley.

* The dynamic friction torque, T_d, is measured at a relative speed of 100 min^{-1}.

Dimensions (126- □ -4F-N)



Unit [mm]

Model	Dimensions of part													Dimensions of shaft					
	A_1	A_2	D_1	D_2	D_3	D_4	F	G	K	L	T	Y	Z	Q_1	Q_2	S	U	V	W
126-06-4F-N-0.2kW	90°	45°	160	130	110	130	—	8	107	335	—	3.5	10	23	25	11	12.5	M4 × 0.7, length: 8	4
126-08-4F-N-0.4kW	90°	45°	160	145	110	130	124	10	130.5	389	—	3.5	10	30	30	14	16	M4 × 0.7, length: 8	5
126-10-4F-N-0.75kW-IE3	90°	45°	200	163	130	165	131	12	157.5	463	—	3.5	12	40	40	19	21.5	M6 × 1, length: 11	6
126-12-4F-N-1.5kW-IE3	90°	45°	200	182/176	130	165	148.5	12	197.5	551	133	3.5	12	50	50	24	27	M6 × 1, length: 11	8
126-16-4F-N-2.2kW-IE3	90°	45°	250	198/195	180	215	155.5	16	260.5	660	154	4	15	60	60	28	31	M6 × 1, length: 11	8
126-16-4F-N-3.7kW-IE3	90°	45°	250	225/215	180	215	168.5	16	260.5	681.5	163	4	15	60	60	28	31	M6 × 1, length: 11	8

* The flange and output shaft dimensions conform to IEC and JEM standard flange motors. (Size 06 has a key and a keyway.)

* When inserting pulleys or the like onto output shafts, use the supplied insertion set.

How to Place an Order

126-06-4F-N-0.2kW-IE3

Size

Mounting type
F: Flange-mount

Flange and output shaft dimension standards
N: Compliant with IEC and JEM flange motor standards

Motor output

IE code
For motors with an output of 0.75 kW or greater, use the IE3 designation.

126 Models

List of Stand-alone Clutches and Brakes Used

Model	Stand-alone clutch system	Stand-alone braking system	Bearing number	
			Input part	Output part
126-06-4☐-0.2kW	101-06-11G 24V R11JIS A15JIS	111-06-12G 24V 15JIS	6202	6202
126-08-4☐-0.4kW	101-08-11G 24V R14DIN A20JIS	111-08-12G 24V 20JIS	6203	6004
126-10-4☐-0.75kW-IE3	101-10-11G 24V R19DIN A25JIS	111-10-12G 24V 25JIS	6204	6205
126-12-4☐-1.5kW-IE3	101-12-11G 24V R24DIN A30JIS	111-12-12G 24V 30JIS	6205	6206
126-16-4☐-2.2kW-IE3	101-16-11G 24V R28DIN A40JIS	111-16-12G 24V 40JIS	6206	6208
126-16-4☐-3.7kW-IE3	101-16-11G 24V R28DIN A40JIS	111-16-12G 24V 40JIS	6306	6208

Recommended Power Supplies and Accessory Parts

Model	Recommended power supplies	Accessory parts			
		Circuit protector (Varistor), qty. 2	Tightening collar	Screw stock	Hexagonal nut
126-06-4☐-0.2kW	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55 (hex-socket bolt), qty. 1	M4, qty. 1
126-08-4☐-0.4kW	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55 (hex-socket bolt), qty. 1	M4, qty. 1
126-10-4☐-0.75kW-IE3	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 100, qty. 1	M6, qty. 2
126-12-4☐-1.5kW-IE3	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 100, qty. 1	M6, qty. 2
126-16-4☐-2.2kW-IE3	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 100, qty. 1	M6, qty. 2
126-16-4☐-3.7kW-IE3	BEH-10G	NVD07SCD082 or an equivalent	Qty. 1	M6 × 100, qty. 1	M6, qty. 2

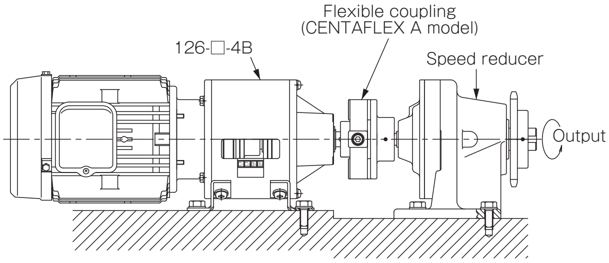
* NVD☐SCD☐ parts are manufactured by KOA Corporation.

* Varistors need not be used when a BEH model overexcitation electromagnetic power supply is used. For details, refer to the section on power supplies.

Mounting Example

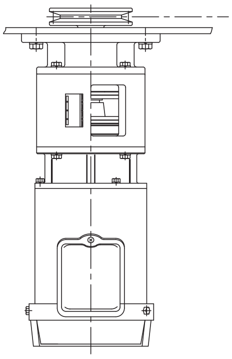
In Combination with Speed Reducers

In the example on right, a clutch/brake unit of the motorcoupled type is combined with a speed reducer by a flexible coupling.
Since the motor is directly coupled, the build-up of the rotation shaft is sharp. That makes it desirable in design to keep inertia on the load side as small as possible. We recommend a flexible coupling with low inertia for connecting to the speed reducer.



Example Using Flange-mounted Type Vertically

They can be mounted in any direction, providing layout freedom and saving space.



CBW Models Clutch/Brake Units - Speed Reducer-integrated Type

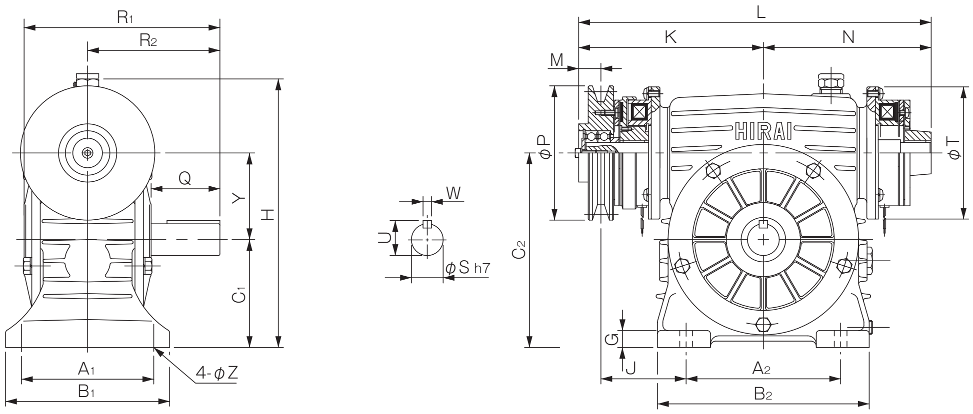
Specifications (CBW-□N-H□)

Model	Size	Dynamic friction Torque T_d [N·m]	Static friction Torque T_s [N·m]	Coil (at 20℃)				Heat resistance class	Max. rotation speed [min⁻¹]	Rotating part moment of inertia J [kg·m²]	Total work performed 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]
				Voltage [V]	Wattage [W]	Current [A]	Resistance [Ω]							
CBW-06N-H□	06	5	5.5	DC24	11	0.46	52	B	1800	1.66×10^{-4}	36×10^6	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015
CBW-08N-H□	08	10	11	DC24	15	0.63	38	B	1800	4.78×10^{-4}	60×10^6	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025
CBW-10N-H□	10	20	22	DC24	20	0.83	29	B	1800	1.71×10^{-3}	130×10^6	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030
CBW-12N-H□	12	40	45	DC24	25	1.09	23	B	1800	4.53×10^{-3}	250×10^6	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050

* The dynamic friction torque, T_d, is measured at a relative speed of 100 min⁻¹.

Model	Size	Input part		Speed reducer									Mass [kg]
		Pulley diameter [mm]	Belt type	Model	Output shaft rated values	Speed reduction ratio 1/□						Oil volume [ℓ]	
						10	20	30	40	50	60		
CBW-06N-H□	06	76.2 (3 in.)	A-1	N-1A	Torque [N·m]	45.3	53.4	46.7	54.7	54.2	55.4	0.25	6.5
					O.H.L. [N]	1560	1760	1760	1760	1760	1760		
CBW-08N-H□	08	101.6 (4 in.)	A-1	N-2A	Torque [N·m]	79.8	102	86.9	104	98.5	100	0.5	15
					O.H.L. [N]	1760	2240	2630	2880	3140	3230		
CBW-10N-H□	10	127 (5 in.)	B-1	N-3A	Torque [N·m]	165	180	180	188	187	164	1.0	24
					O.H.L. [N]	2250	2900	3370	3720	4040	4370		
CBW-12N-H□	12	152.4 (6 in.)	B-1	N-4A	Torque [N·m]	292	293	301	302	—	—	2.0	38
					O.H.L. [N]	2780	3640	4210	4680	—	—		

Dimensions (CBW-□N-H□)



CAD

Unit [mm]

Model	Dimensions of part																			Dimensions of shaft			
	A_1	A_2	B_1	B_2	C_1	C_2	G	H	J	K	L	M	N	P	R_1	R_2	T	Y	Z	Q	S	U	W
CBW-06N-H□	95	95	117	136	65	115.8	11	157	58	120.5	225	15	104.5	76.2	135	90	80	50.8	9.5	45	20	22.5	6
CBW-08N-H□	115	112	140	165	82	146	15	212	75	149	284	18	135	101.6	160	105	100	64	11	50	25	28	8
CBW-10N-H□	125	146	155	205	102	184	16	255	80.5	174.5	333	21	158.5	127	185	125	125	82	12	65	30	33	8
CBW-12N-H□	150	168	185	245	118	213	20	289	93	203	388	25.5	185	152.4	225	150	150	95	14	75	35	38	10

How to Place an Order

CBW-06N-HR-10

Size

Speed reducer manufacturer
HIRAI REDUCTION GEAR MFG. CO.: H

Speed reduction ratio 1/□: 10, 20, 30, 40, 50, 60
(Size 12: 10, 20, 30, 40)

Output shaft direction
R: Right side of the output shaft as viewed from the input pulley
L: Left side of the output shaft as viewed from the input pulley

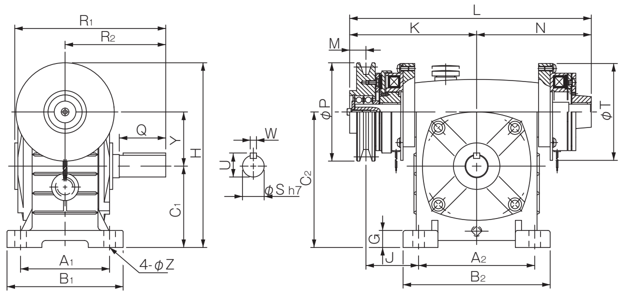
Specifications (CBW-□N-B□)

Model	Size	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃) Voltage [V]	Coil (at 20℃) Wattage [W]	Coil (at 20℃) Current [A]	Coil (at 20℃) Resistance [Ω]	Heat resistance class	Max. rotation speed [mim^{-1}]	Rotating part Moment of inertia J [kg·m²]	Total work performed 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]
CBW-06N-B□-10～30	06	5	5.5	DC24	11	0.46	52	B	1800	1.56×10^{-4}	36×10^6	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015
CBW-06N-B□-40～60										1.76×10^{-4}				
CBW-08N-B□-10～30	08	10	11	DC24	15	0.63	38	B	1800	4.70×10^{-4}	60×10^6	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025
CBW-08N-B□-40～60										4.85×10^{-4}				
CBW-10N-B□-10～30	10	20	22	DC24	20	0.83	29	B	1800	1.48×10^{-3}	130×10^6	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030
CBW-10N-B□-40～60										1.61×10^{-3}				
CBW-12N-B□-10～30	12	40	45	DC24	25	1.09	23	B	1800	4.23×10^{-3}	250×10^6	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050
CBW-12N-B□-40～60										4.35×10^{-3}				

*The dynamic friction torque, T_d, is measured at a relative speed of 100 min^{-1}.

Model	Size	Input part		Speed reducer										
		Pulley diameter [mm]	Belt Model	Model	Output shaft rated values	Speed reduction ratio 1/□ 10	20	30	40	50	60	Oil volume [ℓ]	Mass [kg]
CBW-06N-B□-10～30	06	76.2 (3 in.)	A-1	N-PR-12	Torque [N·m]	35	38	44	—	—	—	0.3	9
					O.H.L. [N]	950	1313	1548	—	—	—		
CBW-06N-B□-40～60				N-PR-15	Torque [N·m]	—	—	—	64	56	56	0.4	11
					O.H.L. [N]	—	—	—	2450	2450	2450		
CBW-08N-B□-10～30	08	101.6 (4 in.)	A-1	N-PR-15	Torque [N·m]	56	57	72	—	—	—	0.4	11.5
					O.H.L. [N]	1421	1862	2322	—	—	—		
CBW-08N-B□-40～60				N-PR-18	Torque [N·m]	—	—	—	143	136	138	0.7	16.5
					O.H.L. [N]	—	—	—	2646	2646	2646		
CBW-10N-B□-10～30	10	127 (5 in.)	B-1	N-PR-18	Torque [N·m]	120	126	150	—	—	—	0.7	17.5
					O.H.L. [N]	1490	2077	2440	—	—	—		
CBW-10N-B□-40～60				N-PR-22	Torque [N·m]	—	—	—	191	187	167	1.2	23.5
					O.H.L. [N]	—	—	—	3057	3146	3155		
CBW-12N-B□-10～30	12	152.4 (6 in.)	B-1	N-PR-22	Torque [N·m]	166	167	213	—	—	—	1.2	25
					O.H.L. [N]	1715	2528	2871	—	—	—		
CBW-12N-B□-40～60				N-PR-25	Torque [N·m]	—	—	—	373	352	336	2.9	40
					O.H.L. [N]	—	—	—	3665	3783	4126		

Dimensions (CBW-□N-B□)



CAD

Unit [mm]

Model	Dimensions of part																			Dimensions of shaft			
	A_1	A_2	B_1	B_2	C_1	C_2	G	H	J	K	L	M	N	P	R_1	R_2	T	Y	Z	Q	S	U	W
CBW-06N-B□-10～30	95	110	130	140	80	130	15	175	56	126	236	15	110	76.2	145	95	80	50	11	40	17	19	5
CBW-06N-B□-40～60	105	120	130	150	90	150	20	200	56	131	246	15	115	76.2	165	110	80	60	11	50	22	24.5	6
CBW-08N-B□-10～30	105	120	130	150	90	150	20	201	59	137	260	18	123	101.6	165	110	100	60	11	50	22	24.5	6
CBW-08N-B□-40～60	115	150	150	190	105	175	25	230	61	154	294	18	140	101.6	195	130	100	70	15	60	28	31	8
CBW-10N-B□-10～30	115	150	150	190	105	175	25	238.5	68	164	312	21	148	127	195	130	125	70	15	60	28	31	8
CBW-10N-B□-40～60	135	180	170	220	120	200	25	265	63	174	332	21	158	127	210	140	125	80	15	65	32	35	10
CBW-12N-B□-10～30	135	180	170	220	120	200	25	276	67.5	179	345	21	166	152.4	210	140	150	80	15	65	32	35	10
CBW-12N-B□-40～60	155	220	190	270	150	250	25	370	76.5	210	405	23.5	195	152.4	260	170	150	100	15	75	38	41	10

How to Place an Order

CBW-06N-BR-10

Size
Speed reducer manufacturer
Bellpony Co., Ltd.: B
Speed reduction ratio 1/□: 10, 20, 30, 40, 50, 60
Output shaft direction
R: Right side of the output shaft as viewed from the input pulley
L: Left side of the output shaft as viewed from the input pulley

CBW Models

List of Stand-alone Clutches and Brakes Used and Recommended Power Supplies and Accessory Parts (CBW-□N-H□)

Model	Stand-alone clutch system	Stand-alone braking system	Bearing number	Recommended power supplies	Accessory parts
					Circuit protector (Varistor), qty. 2
CBW-06N-H□	101-06-13-A-110	111-06-11G 24V 15JIS	6002	BEH-10G	NVD07SCD082 or an equivalent
CBW-08N-H□	101-08-13-A-102	111-08-11G 24V 17JIS	6003	BEH-10G	NVD07SCD082 or an equivalent
CBW-10N-H□	101-10-13-A-113	111-10-11G 24V 20JIS	6004	BEH-10G	NVD07SCD082 or an equivalent
CBW-12N-H□	101-12-13-A-134	111-12-11G 24V 25JIS	6005	BEH-10G	NVD07SCD082 or an equivalent

* NVD□SCD□ parts are manufactured by KOA Corporation.
* Varistors need not be used when a BEH model overexcitation electromagnetic power supply is used. For details, refer to the section on power supplies.

List of Stand-alone Clutches and Brakes Used and Recommended Power Supplies and Accessory Parts (CBW-□N-B□)

Model	Stand-alone clutch system	Stand-alone braking system	Bearing number	Recommended power supplies	Accessory parts
					Circuit protector (Varistor), qty. 2
CBW-06N-B□-10 〜 30	101-06-13-A-110	111-06-11G 24V 15JIS	6002	BEH-10G	NVD07SCD082 or an equivalent
CBW-06N-B□-40 〜 60	101-06-13-A-110	111-06-11G 24V 15JIS	6002	BEH-10G	NVD07SCD082 or an equivalent
CBW-08N-B□-10 〜 30	101-08-13-A-102	111-08-11G 24V 17JIS	6003	BEH-10G	NVD07SCD082 or an equivalent
CBW-08N-B□-40 〜 60	101-08-13-A-102	111-08-11G 24V 17JIS	6003	BEH-10G	NVD07SCD082 or an equivalent
CBW-10N-B□-10 〜 30	101-10-13-A-113	111-10-11G 24V 20JIS	6004	BEH-10G	NVD07SCD082 or an equivalent
CBW-10N-B□-40 〜 60	101-10-13-A-114	111-10-11G 24V 25JIS	6005	BEH-10G	NVD07SCD082 or an equivalent
CBW-12N-B□-10 〜 30	101-12-13-A-134	111-12-11G 24V 25JIS	6005	BEH-10G	NVD07SCD082 or an equivalent
CBW-12N-B□-40 〜 60	101-12-13-A-135	111-12-11G 24V 30JIS	6006	BEH-10G	NVD07SCD082 or an equivalent

* NVD□SCD□ parts are manufactured by KOA Corporation.
* Varistors need not be used when a BEH model overexcitation electromagnetic power supply is used. For details, refer to the section on power supplies.

Selecting a CBW Worm Reducer

For speed reducers with clutches/brakes, loads start and stop abruptly, so load inertia and the like place large loads on worm wheels. Select a worm reducer based on frequency of use, load inertia, usage time, and the like, with due consideration to safety rates.

- Determining speed reduction ratio I

$$\text{Speed reduction ratio I} = \frac{\text{Speed of output shaft rotation } N_2\ [\text{min}^{-1}]}{\text{Speed of input shaft rotation } N_1\ [\text{min}^{-1}]}$$

- Calculating equivalent torque

$$\text{Equivalent torque Te [N•m]} = \text{Load torque Tf [N•m]} \times \text{Load coefficient Sf} \times \text{Frequency coefficient Sh}$$

$$\text{Load torque Tf [N•m]} = \frac{9550 \times \text{kW} \times \text{E}}{N_2}$$

kW: Input Wattage [kW]

E: Speed reducer efficiency [%]/100

* See the speed reducer manufacturer's catalog for the speed reducer efficiency.

N2: Output rotation speed [min^{-1}]

- Load coefficient Sf and frequency coefficient Sh
  Find the equivalent value for conditions such as load type, time, and frequency of use.

Load coefficient Sf

Load type Continuous time	Uniform load	Normal shock	Sharp shock
Up to 2 hrs.	0.80	1.00	1.25
Up to 8 hrs.	1.00	1.25	1.50
Up to 24 hrs.	1.25	1.50	1.75

Frequency coefficient Sh

For sharp starts and stops due to clutch/brake	1.5

- Provisional selection of speed reducer
  Select a speed reducer from the specifications table for which equivalent torque Te ≦ rated output torque T.

- Calculating the equivalent overhang load (O.H.L.)
  O.H.L. refers to the load that acts to bend the shaft when transmitting power using a chain or the like.

$$\text{Equivalent O.H.L.} = \frac{\text{Te} \times \text{K} \times (\text{L}+0.57 \times \text{Ls})}{\text{R} \times 1.07 \times \text{Ls}}$$

Te: Equivalent torque [N•m]

K: Factor based on type of transmission tool

R: Pitch radius of transmission tool [m]

Ls: Length of standard shaft [mm]

L: Distance from shaft base to load center [mm]

Transmission tool	Chain timing belt	Gear	V belt	Flat belt
K	1.00	1.25	1.50	2.50

Use the specifications to confirm that equivalent O.H.L ≦ rated O.H.L. If this condition is not satisfied, change Te, L or R, or increase the selected output.

Operational Cautions

- Before starting, check that the speed reducer has a good amount of oil.
- Loosen or remove the air vent screw or pin.
- Break in the reducer, guided by the manual from the speed reducer manufacturer.
- Periodically replace the oil. Be careful when doing this to not get any oil whatsoever on the clutch and brake parts.

Recommended speed reducer lubricants table

Ambient temperature [℃]	0 ~ 40
ISO viscosity grade	VG320
Idemitsu Kosan	Daphne Super Gear Oil 320
JX Nippon Oil & Energy	Bonnock 320
Cosmo Oil	Cosmo Gear SE320
Showa Shell Sekiyu	Omara 320
Jomo Oil	Reductus 320
Mobil Oil	Mobilgear 632 (320)

* Check the volume of oil for speed reducers on the specifications table.

CMW Models Clutch/Brake Units - Motor/Speed Reducer-integrated Type

Specifications

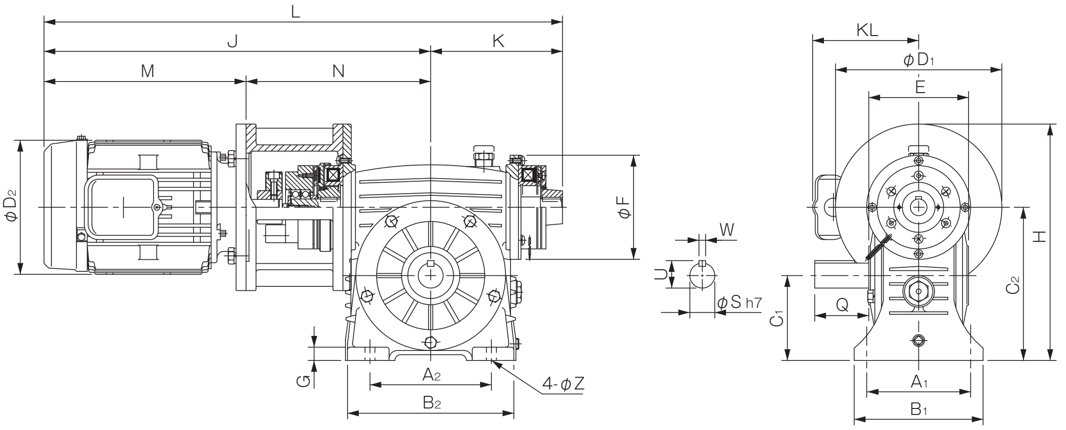
Model	Size	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃) Voltage [V]	Wattage [W]	Current [A]	Resistance [Ω]	Heat resistance class	Rotating part moment of inertia J [kg·m²]	Total work performed until readjustment of the air gap E_T [J]	Armature pull-in time t_a [s]	Torque build-up time t_p [s]	Torque decaying time t_d [s]
CMW-06N-H□H	06	5	5.5	DC24	11	0.46	52	B	1.66×10^{-4}	36×10^6	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015
CMW-08N-H□H	08	10	11	DC24	15	0.63	38	B	4.78×10^{-4}	60×10^6	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025
CMW-10N-H□H	10	20	22	DC24	20	0.83	29	B	1.71×10^{-3}	130×10^6	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030
CMW-12N-H□H	12	40	45	DC24	25	1.09	23	B	4.53×10^{-3}	250×10^6	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050

* The dynamic friction torque, T_d, is measured at a relative speed of 100 min^{-1}.

Model	Size	Motor output [kW] 3-phase 4-pole	Speed reducer									Mass [kg]
			Model	Output shaft rated values	Speed reduction ratio 1/□						Oil volume [ℓ]	
					10	20	30	40	50	60		
CMW-06N-H□H	06	0.2	N-2SA	Torque [N·m]	78.2	79.9	85.3	78.6	88.9	76.1	0.5	16
				O.H.L. [N]	1770	2280	2620	2930	3160	3230		
CMW-08N-H□H	08	0.4	N-2A	Torque [N·m]	79.8	102	86.9	104	98.5	100	0.5	32
				O.H.L. [N]	1760	2240	2630	2880	3140	3230		
CMW-10N-H□H	10	0.75	N-3A	Torque [N·m]	165	180	180	188	187	164	1.0	44
				O.H.L. [N]	2250	2900	3370	3720	4040	4370		
CMW-12N-H□H	12	1.5	N-4A	Torque [N·m]	292	293	301	302	―	―	2.0	72
				O.H.L. [N]	2780	3640	4210	4680	―	―		

* The induction motors are fully sealed external fan motors that conform to the JIS C4210 standard (for 0.2 kW and 0.4 kW models) or the JIS C 4213 standard (for 0.75 kW models or higher).
* The power supplies for the motors are 3-phase, 200 V AC at 50 Hz, or 200/220 V AC at 60 Hz.
* If you desire a special voltage (5 Power Supply Specifications), different number of poles, or the like for the induction motor, contact Miki Pulley.
* Speed reducer is made by Hirai Reduction Gear Manufacturing Co.

Dimensions



Unit [mm]

Model	Dimensions of part																		Dimensions of shaft			
	A_1	A_2	B_1	B_2	C_1	C_2	D_1	D_2	E	F	G	H	J	K	KL	L	M	N	Z	Q	S	U	W
CMW-06N-H□H	105	105	132	157	75	135	160	130	110	86	15	215	375	117	―	492	205	170	12	50	25	28	8
CMW-08N-H□H	115	112	140	165	82	146	160	145	110	100	15	226	412	135	124	547	225	187	11	50	25	28	8
CMW-10N-H□H	125	146	155	200	102	184	200	163	120	125	16	284	477	159	131	636	255	222	12	65	30	33	8
CMW-12N-H□H	150	168	186	245	118	213	210	182/176	150	150	20	318	541	185	148.5	726	286	255	14	75	35	38	10

How to Place an Order

CMW-06N-HRH-10-IE3

Size

IE code
For motors with an output of 0.75 kW or greater,
use the IE3 designation.

Speed reduction ratio 1/□: 10, 20, 30, 40, 50, 60
(Size 12: 10, 20, 30, 40)

Output shaft direction
R: Right side of the output shaft as viewed from the motor side
L: Left side of the output shaft as viewed from the motor side

List of Stand-alone Clutches and Brakes Used and Recommended Power Supplies and Accessory Parts (CBW-□N-H□)

Model	Stand-alone clutch system	Stand-alone braking system	Bearing number	Coupling type	Recommended power supplies	Accessory parts
						Circuit protector (Varistor), qty. 2
CMW-06N-H□H	101-06-13G 24V 15JIS	111-06-11G 24V 15JIS	6002	CF-A-001-01-T5	BEH-10G	NVD07SCD082 or an equivalent
CMW-08N-H□H	101-08-13G 24V 17JIS	111-08-11G 24V 17JIS	6003	CF-A-002-01-1360-14N	BEH-10G	NVD07SCD082 or an equivalent
CMW-10N-H□H	101-10-13G 24V 20JIS	111-10-11G 24V 20JIS	6004	CF-A-002-01-1360-19N	BEH-10G	NVD07SCD082 or an equivalent
CMW-12N-H□H	101-12-13G 24V 25JIS	111-12-11G 24V 25JIS	6005	CF-A-004-01-1360-24N	BEH-10G	NVD07SCD082 or an equivalent

* NVD□SCD□ parts are manufactured by KOA Corporation.

* Varistors need not be used when a BEH model overexcitation electromagnetic power supply is used. For details, refer to the section on power supplies.

Selecting a CMW Worm Reducer

For speed reducers with clutches/brakes, loads start and stop abruptly, so load inertia and the like place large loads on worm wheels. Select a worm reducer based on frequency of use, load inertia, usage time, and the like, with due consideration to safety rates.

- Determining speed reduction ratio I

$$\text{Speed reduction ratio I} = \frac{\text{Speed of output shaft rotation } N_2 \text{ [min}^{-1}\text{]}}{\text{Speed of input shaft rotation } N_1 \text{ [min}^{-1}\text{]}}$$

- Calculating equivalent torque

$$\text{Equivalent torque Te [N•m]} = \text{Load torque Tf [N•m]} \times \text{Load coefficient Sf} \times \text{Frequency coefficient Sh}$$

$$\text{Load torque Tf [N•m]} = \frac{9550 \times \text{kW} \times \text{E}}{N_2}$$

kW: Input Wattage [kW]

E: Speed reducer efficiency [%]/100

* See the speed reducer manufacturer's catalog for the speed reducer efficiency.

N_2: Output rotation speed [min^{-1}]

- Load coefficient Sf and frequency coefficient Sh
  Find the equivalent value for conditions such as load type, time, and frequency of use.

■ Load coefficient Sf

Load type	Uniform load	Normal shock	Sharp shock
Continuous time			
Up to 2 hrs.	0.80	1.00	1.25
Up to 8 hrs.	1.00	1.25	1.50
Up to 24 hrs.	1.25	1.50	1.75

■ Frequency coefficient Sh

For sharp starts and stops due to clutch/brake	1.5

- Provisional selection of speed reducer
  Select a speed reducer from the specifications table for which equivalent torque Te ≦ rated output torque T.

- Calculating the equivalent overhang load (O.H.L.)
  O.H.L. refers to the load that acts to bend the shaft when transmitting power using a chain or the like.

$$\text{Equivalent O.H.L.} = \frac{\text{Te} \times \text{K} \times (\text{L}+0.57 \times \text{Ls})}{\text{R} \times 1.07 \times \text{Ls}}$$

Te: Equivalent torque [N•m]
K: Factor based on type of transmission tool
R: Pitch radius of transmission tool [m]
Ls: Length of standard shaft [mm]
L: Distance from shaft base to load center [mm]

Transmission tool	Chain timing belt	Gear	V belt	Flat belt
K	1.00	1.25	1.50	2.50

Use the specifications to confirm that equivalent O.H.L ≦ rated O.H.L. If this condition is not satisfied, change Te, L or R, or increase the selected output.

Operational Cautions

- Before starting, check that the speed reducer has a good amount of oil.
- Loosen or remove the air vent screw or pin.
- Break in the reducer, guided by the manual from the speed reducer manufacturer.
- Periodically replace the oil. Be careful when doing this to not get any oil whatsoever on the clutch and brake parts.

■ Recommended speed reducer lubricants table

Ambient temperature [℃]	0 ～ 40
ISO viscosity grade	VG320
Idemitsu Kosan	Daphne Super Gear Oil 320
JX Nippon Oil & Energy	Bonnock 320
Cosmo Oil	Cosmo Gear SE320
Showa Shell Sekiyu	Omara 320
Jomo Oil	Reductus 320
Mobil Oil	Mobilgear 632 (320)

■ List of speed reducer oil volumes

Speed reducer type	Oil volume [ℓ]
N-2SA	0.5
N-2A	0.5
N-3A	1.0
N-4A	2.0

121- □ -10G Types Double Clutch Units

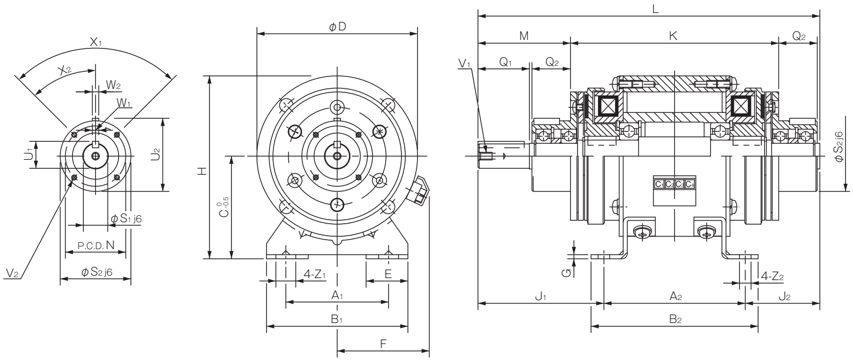
Specifications

Model	Size	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃)				Heat resistance class	Max. rotation speed [min^{-1}]	Rotating part moment of inertia J [kg·m²]		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]			For hub input	For shaft input					
121-06-10G	06	5	5.5	DC24	11	0.46	52	B	3000	1.55×10^{-4}	1.05×10^{-4}	36×10^{6}	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015	1.7
121-08-10G	08	10	11	DC24	15	0.63	38	B	3000	4.75×10^{-4}	3.00×10^{-4}	60×10^{6}	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025	3.1
121-10-10G	10	20	22	DC24	20	0.83	29	B	3000	1.44×10^{-3}	9.45×10^{-4}	130×10^{6}	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030	6.5
121-12-10G	12	40	45	DC24	25	1.09	23	B	3000	4.50×10^{-3}	2.75×10^{-3}	250×10^{6}	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050	10.5
121-16-10G	16	80	90	DC24	35	1.46	16	B	3000	1.34×10^{-2}	9.05×10^{-3}	470×10^{6}	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	21
121-20-10G	20	160	175	DC24	45	1.88	13	B	2500	4.18×10^{-2}	2.65×10^{-2}	10×10^{8}	C:0.090 B:0.065	C:0.250 B:0.200	C:0.130 B:0.070	38.5
121-25-10G	25	320	350	DC24	60	2.50	9.6	B	2000	9.80×10^{-2}	7.45×10^{-2}	20×10^{8}	C:0.115 B:0.085	C:0.335 B:0.275	C:0.210 B:0.125	70

* The dynamic friction torque, T_d, is measured at a relative speed of 100 min^{-1}.

* The rotating part moment of inertia for shaft input is the value with one armature type-5.

Dimensions



CAD

Unit [mm]

Size	Dimensions of part																	
	A_1	A_2	B_1	B_2	C	D	E	F	G	H	J_1	J_2	K	L	M	N	Z_1	Z_2
06	52.5	75	80	90	55	80	27.5	53	2.6	95	65.5	40.5	111.5	181	47	33	13.5	6.5
08	65	90	90	105	65	100	27.5	61	2.6	115	78.5	48.5	133	217	57	37	13.5	6.5
10	80	110	110	130	80	125	32.5	72	3.2	142.5	98	58	162	266	72	47	15.5	9
12	105	135	140	160	90	150	35	81	3.2	165	121	71	193	327	92	52	20	11.5
16	135	160	175	185	112	190	42.5	97	4.5	207	149	87.5	232	397	113	62	24.5	11.5
20	155	200	200	230	132	230	45	109	6	247	187	105	290	492	142	74.5	28	14
25	195	240	240	270	160	290	47.5	124	20	305	238	125	350	603	183	101.5	28	14

Size	Dimensions of shaft									
	Q_1	Q_2	S_1	S_2	U_1	U_2	V_1	V_2	X_1	X_2	$W_{1,2}$
06	25	20	11	38	12.5	39.5	M4 × 0.7, length: 8	3-M4 × 0.7, length: 4	3-120°	60°	4
08	30	25	14	45	16	47	M4 × 0.7, length: 8	3-M4 × 0.7, length: 6	3-120°	60°	5
10	40	30	19	55	21	57	M6 × 1, length: 11	4-M4 × 0.7, length: 8	4-90°	45°	5
12	50	40	24	64	27	67	M6 × 1, length: 11	4-M4 × 0.7, length: 8	4-90°	45°	7
16	60	50	28	75	31	78	M6 × 1, length: 11	6-M5 × 0.8, length: 8	6-60°	30°	7
20	80	60	38	90	41.5	93.5	M10 × 1.5, length: 17	4-M6 × 1, length: 12	4-90°	45°	10
25	110	70	42	115	45.5	118.5	M10 × 1.5, length: 17	8-M6 × 1, length: 12	8-45°	22.5°	12

* The input/output keyways are old JIS standard class 2 while the key is old JIS standard class 1. Note that the keyway dimensions of the unit hub part do not conform to the old JIS standard. Check them on the dimensions table above.

* When inserting pulleys or the like onto input/output shafts, use the supplied insertion set.

* The 121-25-10G base is a casting.

How to Place an Order

121-06-10G

Size

List of Stand-alone Clutches Used

Model	Stand-alone clutch system	Bearing number	
		Main shaft part	Hub part
121-06-10G	101-06-15G 24V R15JIS A12JIS	6202	6001
121-08-10G	101-08-15G 24V R20JIS A15JIS	6004	6002
121-10-10G	101-10-15G 24V R25JIS A20JIS	6205	6004
121-12-10G	101-12-15G 24V R30JIS A25JIS	6206	6005
121-16-10G	101-16-15G 24V R40JIS A30JIS	6208	6006
121-20-10G	101-20-15G 24V R50JIS A40JIS	6211	6008
121-25-10G	101-25-15G 24V R60JIS A50JIS	6214	6010

Recommended Power Supplies and Accessory Parts

Model	Recommended power supplies	Accessory parts				
		Circuit protector (Varistor), qty. 2	Tightening collar	Screw stock	Presser foot	Hexagonal nut
121-06-10G	BES-20-10	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 3	Qty. 1	M4, qty. 3
121-08-10G	BES-20-10	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 3	Qty. 1	M4, qty. 3
121-10-10G	BES-20-10	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 3	Qty. 1	M4, qty. 3
121-12-10G	BES-20-16	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 2/M6 × 100, qty. 1	Qty. 1	M4, qty. 2/M6, qty. 1
121-16-10G	BES-20-16	NVD07SCD082 or an equivalent	Qty. 1	M5 × 70, qty. 2/M6 × 100, qty. 1	Qty. 1	M5, qty. 2/M6, qty. 1
121-20-10G	BES-20-20	NVD07SCD082 or an equivalent	Qty. 1	M6 × 160, qty. 2/M10 × 220, qty. 1	Qty. 1	M6, qty. 4/M10, qty. 2
121-25-10G	BES-40-25	NVD07SCD082 or an equivalent	Qty. 1	M6 × 160, qty. 2/M10 × 220, qty. 1	Qty. 1	M6, qty. 4/M10, qty. 2

* NVD□SCD□ parts are manufactured by KOA Corporation.
* Recommended BES model power supplies are required for each clutch. Varistors need not be used when a BES model is used. For details, refer to the section on power supplies.

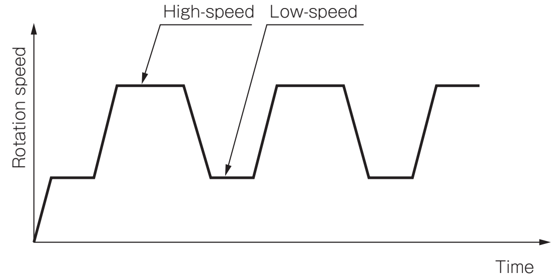
Mounting Example

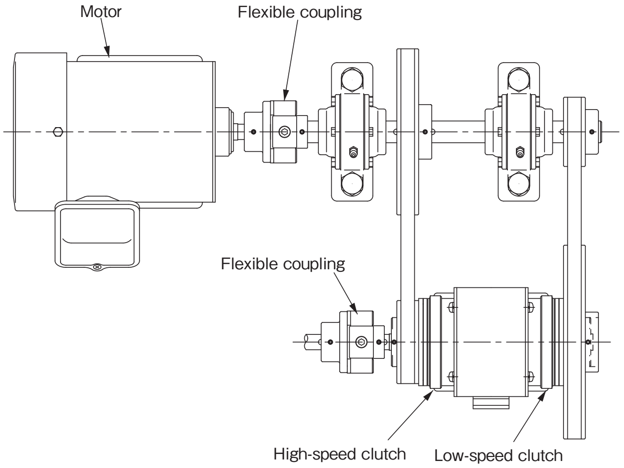
Example When Used in Two-step Speed Change

In two-step speed changing, two hubs are linked respectively to high-speed and low-speed power; by switching the clutches, the output shaft is made to rotate at high speed or low speed.

Caution

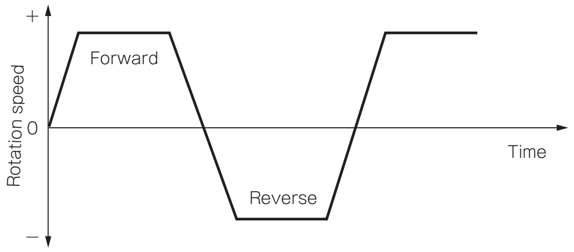
Conversely, when using the shaft as the input, one of the clutches is made to rotate at very high speed at some speed change ratios, so the bearings and the like may be damaged.

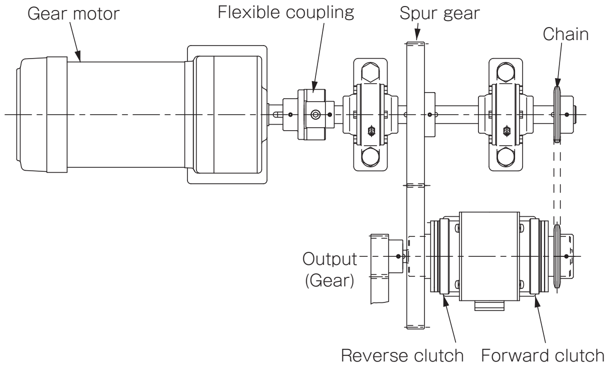




Example When Used in Forward/Reverse Operation

This unit does not have a brake, so forward/reverse operation is effective at relatively low speeds and light loads. In the example depicted, forward/reverse rotation is obtained from the drive-side rotation shaft with a chain and spur gear, and engages the individual hubs. By switching the clutches, the output shaft goes back and forth between forward and reverse rotation. There is also a method of forward/reverse rotation that uses two motors.





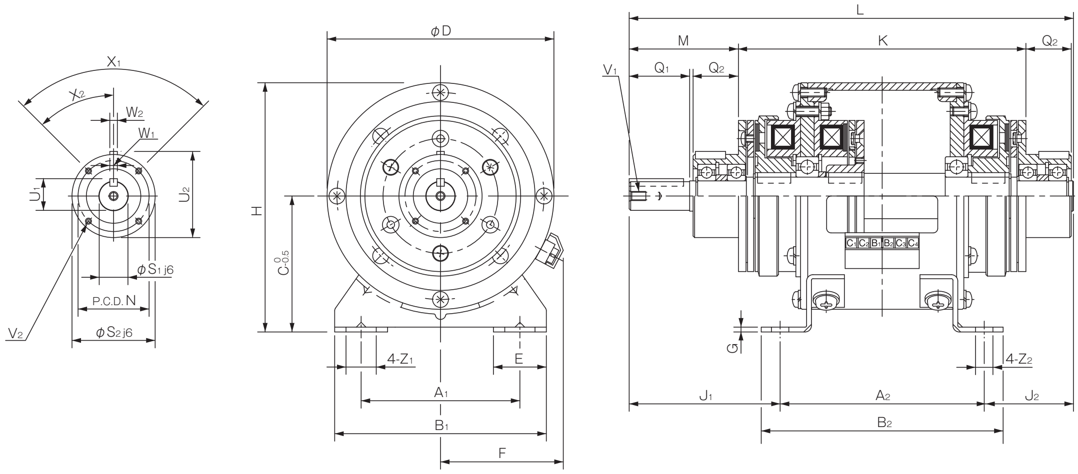
122 Models Double Clutch/Brake Units

Specifications

Model	Size	Dynamic friction torque T_d [N·m]	Static friction torque T_s [N·m]	Coil (at 20℃)				Heat resistance class	Max. rotation speed [min^{-1}]	Rotating part moment of inertia J [kg·m²]	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]								
122-06-20G	06	5	5.5	DC24	11	0.46	52	B	3000	2.19×10^{-4}	36×10^6	C:0.020 B:0.015	C:0.041 B:0.033	C:0.020 B:0.015	4
122-08-20G	08	10	11	DC24	15	0.63	38	B	3000	6.55×10^{-4}	60×10^6	C:0.023 B:0.016	C:0.051 B:0.042	C:0.030 B:0.025	6
122-10-20G	10	20	22	DC24	20	0.83	29	B	3000	2.12×10^{-3}	130×10^6	C:0.025 B:0.018	C:0.063 B:0.056	C:0.050 B:0.030	9
122-12-20G	12	40	45	DC24	25	1.09	23	B	3000	6.35×10^{-3}	250×10^6	C:0.040 B:0.027	C:0.115 B:0.090	C:0.065 B:0.050	17
122-16-20G	16	80	90	DC24	35	1.46	16	B	3000	1.99×10^{-2}	470×10^6	C:0.050 B:0.035	C:0.160 B:0.127	C:0.085 B:0.055	29
122-20-20G	20	160	175	DC24	45	1.88	13	B	2500	6.15×10^{-2}	10×10^8	C:0.090 B:0.065	C:0.250 B:0.200	C:0.130 B:0.070	58

* The dynamic friction torque, T_d, is measured at a relative speed of 100 min^{-1}.

Dimensions



Unit [mm]

Size	Dimensions of part																	
	A_1	A_2	B_1	B_2	C	D	E	F	G	H	J_1	J_2	K	L	M	N	Z_1	Z_2
06	65	90	90	105	65	100	27.5	61	2.6	115	73	48	142	211	47	33	13.5	6.5
08	80	110	110	130	80	125	32.5	72	3.2	142.5	83	53	162	246	57	37	15.5	9
10	105	135	140	160	90	150	35	81	3.2	165	100	59	190	294	72	47	20	11.5
12	135	160	175	185	112	190	42.5	97	4.5	207	124	74	222	358	93	52	24.5	11.5
16	155	200	200	230	132	230	45	109	6	247	150.5	89.5	272	440	114.5	62	28	14
20	195	240	240	270	160	290	47.5	124	20	305	197	114	348	551	143	74.5	28	14

Size	Dimensions of shaft										
	Q_1	Q_2	S_1	S_2	U_1	U_2	V_1	V_2	X_1	X_2	$W_{1,2}$
06	25	20	11	38	12.5	39.5	M4 × 0.7, length: 8	3-M4 × 0.7, length: 4	3-120°	60°	4
08	30	25	14	45	16	47	M4 × 0.7, length: 8	3-M4 × 0.7, length: 6	3-120°	60°	5
10	40	30	19	55	21	57	M6 × 1, length: 11	4-M4 × 0.7, length: 8	4-90°	45°	5
12	50	40	24	64	27	67	M6 × 1, length: 11	4-M4 × 0.7, length: 8	4-90°	45°	7
16	60	50	28	75	31	78	M6 × 1, length: 11	6-M5 × 0.8, length: 8	6-60°	30°	7
20	80	60	38	90	41.5	93.5	M10 × 1.5, length: 17	4-M6 × 1, length: 12	4-90°	45°	10

* The output keyways are old JIS standard class 2 while the key is old JIS standard class 1. Note that the keyway dimensions of the unit hub part do not conform to the old JIS standard. Check them on the dimensions table above.

* When inserting pulleys or the like onto output shafts, use the supplied insertion set.

* The 122-20-20G base is a casting.

How to Place an Order

122-06-20G

06: Size

List of Stand-alone Clutches and Brakes Used

Model	Stand-alone clutch system	Stand-alone braking system	Bearing number	
			Main shaft part	Hub part
122-06-20G	101-06-15G 24V R15JIS A12JIS	111-06-12G 24V 15JIS	6202	6001
122-08-20G	101-08-15G 24V R20JIS A15JIS	111-08-12G 24V 20JIS	6004	6002
122-10-20G	101-10-15G 24V R25JIS A20JIS	111-10-12G 24V 25JIS	6205	6004
122-12-20G	101-12-15G 24V R30JIS A25JIS	111-12-12G 24V 30JIS	6206	6005
122-16-20G	101-16-15G 24V R40JIS A30JIS	111-16-12G 24V 40JIS	6208	6006
122-20-20G	101-20-15G 24V R50JIS A40JIS	111-20-12G 24V 55JIS	6211	6008

Recommended Power Supplies and Accessory Parts

Model	Recommended power supplies	Accessory parts				
		Circuit protector (Varistor), qty. 3	Tightening collar	Screw stock	Presser foot	Hexagonal nut
122-06-20G	BES-20-10	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 3	Qty. 1	M4, qty. 3
122-08-20G	BES-20-10	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 3	Qty. 1	M4, qty. 3
122-10-20G	BES-20-10	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 2/M6 × 100, qty. 1	Qty. 1	M4, qty. 2/M6, qty. 2
122-12-20G	BES-20-16	NVD07SCD082 or an equivalent	Qty. 1	M4 × 55, qty. 2/M6 × 100, qty. 1	Qty. 1	M4, qty. 2/M6, qty. 2
122-16-20G	BES-20-16	NVD07SCD082 or an equivalent	Qty. 1	M5 × 70, qty. 2/M6 × 100, qty. 1	Qty. 1	M5, qty. 2/M6, qty. 2
122-20-20G	BES-20-20	NVD07SCD082 or an equivalent	Qty. 1	M6 × 160, qty. 2/M10 × 220, qty. 1	Qty. 1	M6, qty. 2/M10, qty. 2

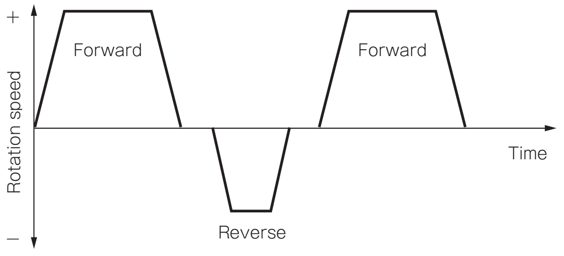
* NVD☐SCD☐ parts are manufactured by KOA Corporation.

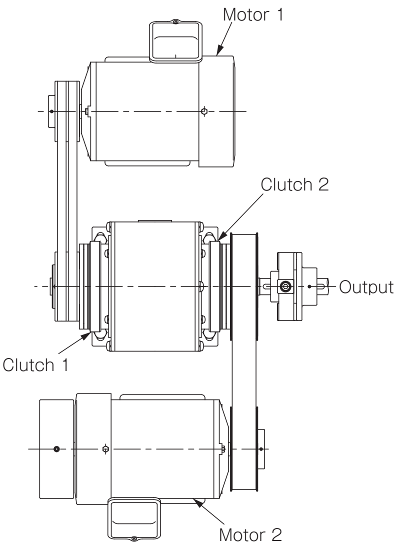
* Recommended BES power supplies are available for each clutch/brake. Varistors need not be used when a BES model is used. For details, refer to the section on power supplies.

Mounting Example

Example When Used in Forward/Reverse Operation

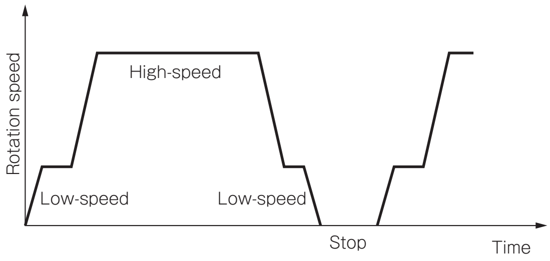
This is an example of forward/reverse rotation using two motors. The motor rotates continuously, forward and reverse operation are achieved by switching clutches, and any load can be stopped during that period.

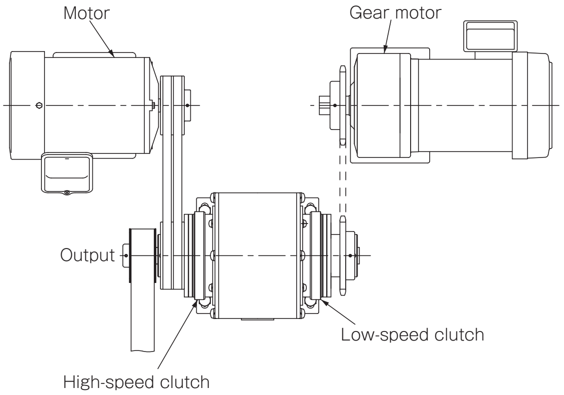




Example When Used in Two-step Speed Change/Stop

High-precision stopping at a predetermined position, winding control on winders, and the like can be controlled simply and with high precision by using this unit to perform a series of operations: slow, fast, slow, stop.





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.

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

P: Motor output [kW]

n_r: Rotation speed of clutch/brake shaft [min^{-1}]

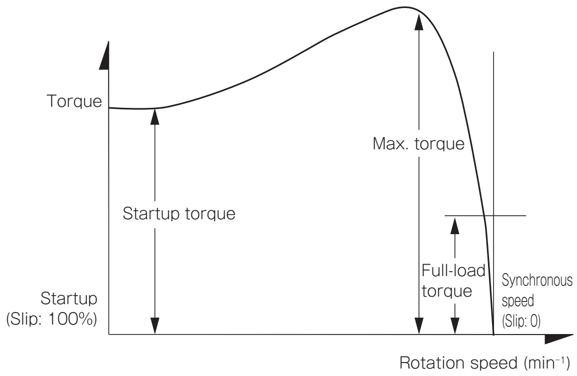
η : Transmission efficiency from motor to clutch/brake

- 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.

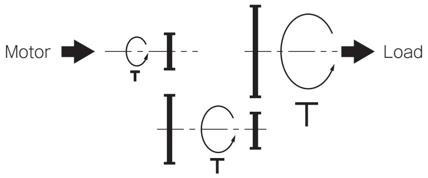
Knowing these differences in characteristics from the beginning enables you to select the clutch/brake suited for your load conditions. A clutch/brake that has a torque value that is 200 to 250% of the full load torque of the motor will normally be suited to a wide range of applications, factoring in 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.

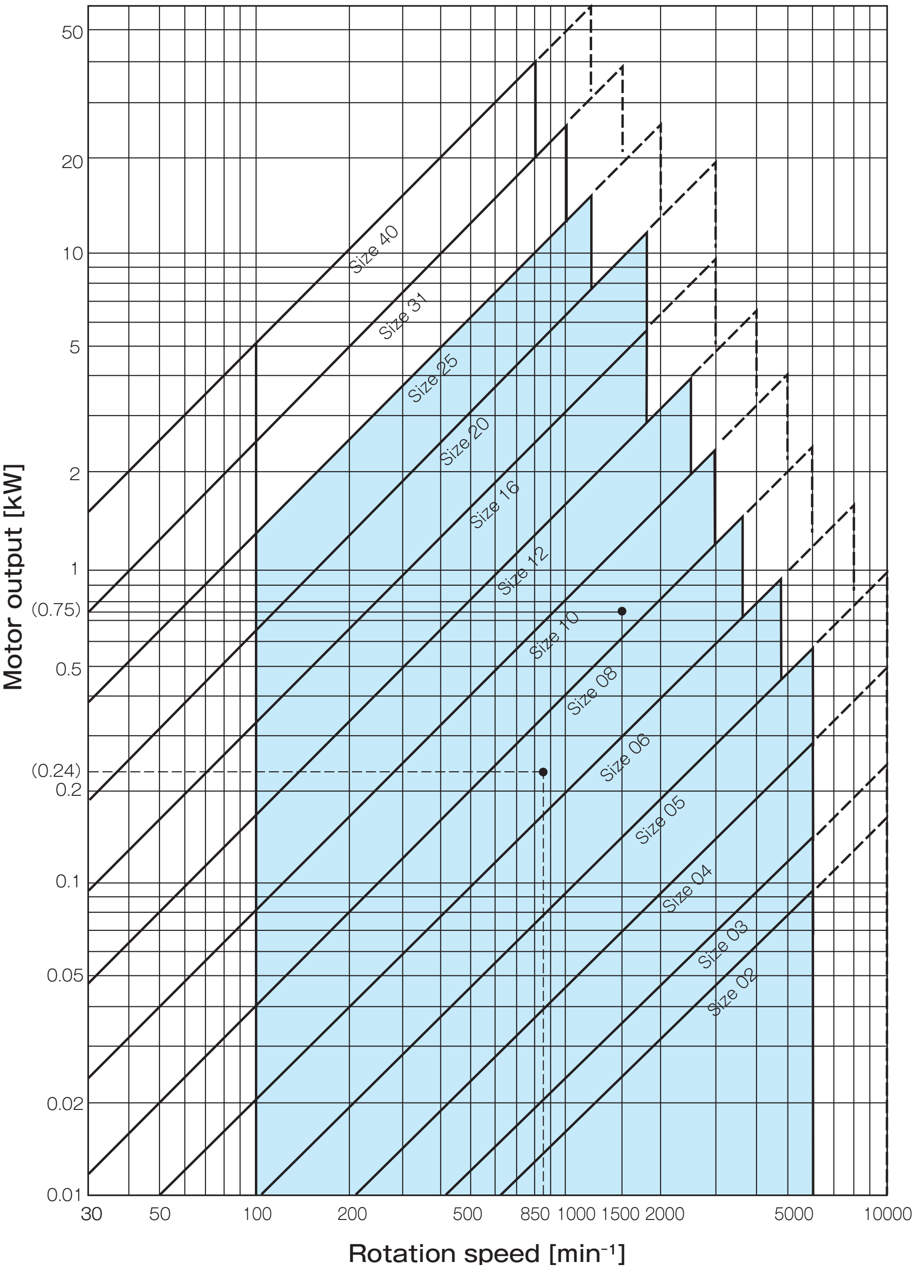
This table is for a safety factor K of 2.5 (ordinary use). You can use this table to select a clutch/brake with other factors. For the vertical axis [kW], use the value obtained by multiplying the motor output by K/2.5.

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:

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

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

■ Load torque (Tℓ)

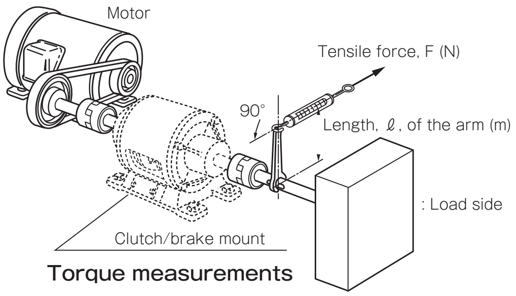
Load torque is difficult to determine through calculations, so it is either determined empirically or by direct measurement.

- 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.

$$T_\ell = T_M \text{ [N•m]} \quad \cdots\cdots (2)$$

- When measured and then determined
  The load can be actually measured to find an accurate Tℓ . 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 .

$$T_\ell = \ell \cdot F \text{ [N•m]} \quad \cdots\cdots (3)$$



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 ±Tℓ . Use the value as appropriate.

■ Acceleration/deceleration torque (T$_a$)

- The torque required to accelerate a load is:

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

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:

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

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 Tℓ are applied while engaged

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

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

- When Tℓ is nearly all that is applied

$$T = T_\ell \cdot K \text{ [N•m]} \quad \cdots\cdots (7)$$

- When J is nearly all that is applied

$$T = T_a \cdot K \text{ [N•m]} \quad \cdots\cdots (8)$$

- 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:

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

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

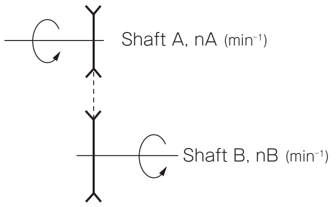
Usage conditions		Factor K
Light load	Low-frequency use of small inertial body	1.5
	High-frequency use of relatively small inertial body Ordinary use of normal inertial body	2 ～ 2.2
	High-frequency use	2.2 ～ 2.4
Normal load	Low-frequency use of small inertial body	2 ～ 2.4
	Ordinary use	2.4 ～ 2.6
	Driving 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:

$$T_A = T_B \cdot \frac{n_B}{n_A} \text{ [N•m]} \quad \cdots\cdots (10)$$

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:

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

- For deceleration, braking energy E_b is:

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

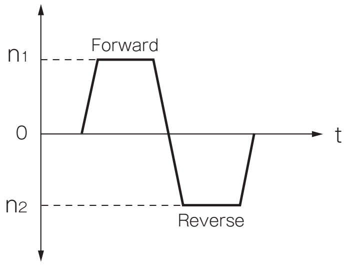
- Forward/reverse rotation

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

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

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

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



- Energy when using slip

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

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

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 $E_{ba\ell}$.

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

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

* For the values of $E_{ea\ell}$ and $E_{ba\ell}$, see the page on heat dissipation characteristics (P.325).

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)

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

- Braking energy rate (P_b)

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

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.325).

Frequency of engaging/braking (S_a)

The allowable operating frequency S_a determined by heat dissipation is:

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

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

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

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

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

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

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:

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

Actual braking time is:

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

- During forward/reverse rotation

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

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

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

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

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

- Total braking time

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

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

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

$$L_e = \frac{E_T}{E_e} \ [\text{operations}] \tag{31}$$

E_T: Total work performed until readjustment of the air gap

- For brakes

$$L_b = \frac{E_T}{E_b} \ [\text{operations}] \tag{32}$$

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)

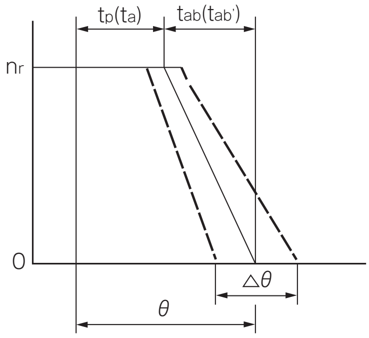
$$\theta = 6n_r(t_{id} + t_p + \frac{1}{2} t_{ab}) \ [°] \tag{33}$$

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

■ Stopping precision ($\triangle\theta$)

$$\triangle\theta = \pm 0.15\ \theta \ [°] \tag{35}$$

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

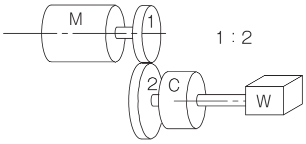
* Also applies to all unit models (except models 180).

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:

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

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

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

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:

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

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:

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

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

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

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

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

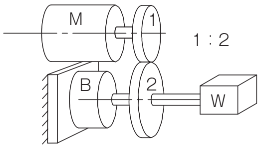
Next, we find the energy rate. From Eq. (18)

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

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.

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

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)

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

The required torque from Eq. (6) is:

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

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:

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

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

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

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],

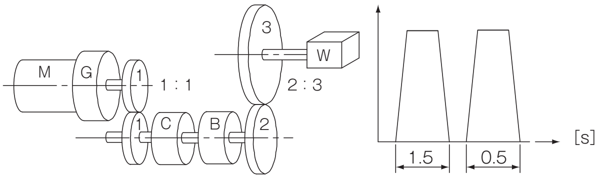
$$t_{tb} = 0.050 + 0.027 + 0.137 = 0.214\ [s]$$

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)

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

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

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

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

$$= 0.2349\ [kg•m^2]$$

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):

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

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

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

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

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

And for the brake, we get:

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

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:

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

$$= 0.2419\ [kg•m^2]$$

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:

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

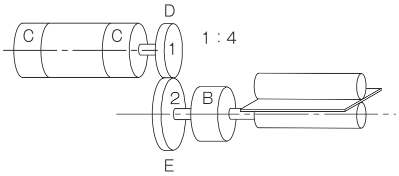
Since the requirement for number of operations in service life is roughly 8.1 million, a size 10 brake cannot satisfy the requirements. When we therefore consider the situation again with a 111-12-11 model brake, we find (leaving out intermediate calculations):

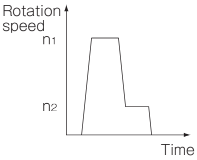
$$L = \frac{250 \times 10^6}{22.0} = 1136 \times 10^4\ [times]$$

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•m²] and the moment of inertia of the armature of brake model 111-12-12 is 0.00181 [kg•m²],

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

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

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

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):

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

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:

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

- 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.

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

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

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

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

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

This value satisfies the allowable energy of the selected model.

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

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

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):

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

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:

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

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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—
112-02-□1/□2	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—
102/112-02-□3	NVD07SCD082 or an equivalent	1	M2 × 3	2	—	—	—	—
CYT-025-33B ϕ 6	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—
112-03-□1/□2	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—
102/112-03-□3	NVD07SCD082 or an equivalent	1	M2.5 × 4	3	—	—	—	—
CYT-03-33□ ϕ 6	NVD07SCD082 or an equivalent	1	M2.5 × 4	3	—	—	6.3 × 8.7 × 0.1t	3
CYT-03-33□ ϕ 8	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—
112-04-□1/□2	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—
102/112-04-□3	NVD07SCD082 or an equivalent	1	M3 × 6	3	—	—	—	—
CYT-04-33□ ϕ 8	NVD07SCD082 or an equivalent	1	M3 × 6	3	—	—	8.3 × 11.7 × 0.1t	3
CYT-04-33□ ϕ 10	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—
112-05-□1/□2	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—
102/112-05-□3	NVD07SCD082 or an equivalent	1	M3 × 6	3	M3	3	—	—
CSZ/BSZ-05-□	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101/CS-06-□3 ϕ 12	NVD07SCD082 or an equivalent	1	M3 × 6	3	M3	3	12.3 × 15.7 × 0.1t	3	—	—	—	—
101-06-13 ϕ 15	NVD07SCD082 or an equivalent	1	M3 × 6	3	M3	3	15.3 × 20.7 × 0.1t	3	—	—	—	—
101/CS-06-□5 ϕ 12	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-06-12 ϕ 12	NVD07SCD082 or an equivalent	1	—	—	—	—	12.3 × 15.7 × 0.1t	3	—	—	—	—
111-06-12 ϕ 15	NVD07SCD082 or an equivalent	1	—	—	—	—	15.3 × 20.7 × 0.1t	3	—	—	—	—
111-06-13	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
CSZ/BSZ-06-□	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101/CS-08-□3 ϕ 15	NVD07SCD082 or an equivalent	1	M4 × 8	3	M4	3	15.3 × 20.7 × 0.1t	3	—	—	—	—
101-08-13 ϕ 20	NVD07SCD082 or an equivalent	1	M4 × 8	3	M4	3	20.3 × 27.7 × 0.1t	3	—	—	—	—
101/CS-08-□5 ϕ 15	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	15.3 × 20.7 × 0.5t	1	—	—	—	—
111-08-12 ϕ 15	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-08-12 ϕ 20	NVD07SCD082 or an equivalent	1	—	—	—	—	15.3 × 20.7 × 0.1t	3	—	—	—	—
111-08-13	NVD07SCD082 or an equivalent	1	M4 × 8	3	M4	3	20.3 × 27.7 × 0.1t	3	—	—	—	—
CSZ/BSZ-08-□	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101/CS-10-□3 φ 20	NVD07SCD082 or an equivalent	1	M5 × 10	3	M5	3	20.3 × 27.7 × 0.1t	3	—	—	—	—
101-10-13 φ 25	NVD07SCD082 or an equivalent	1	M5 × 10	3	M5	3	25.3 × 34.7 × 0.1t	3	—	—	—	—
101/CS-10-□5 φ 20	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-10-12 φ 20	NVD07SCD082 or an equivalent	1	—	—	—	—	20.3 × 27.7 × 0.1t	3	—	—	—	—
111-10-12 φ 25	NVD07SCD082 or an equivalent	1	—	—	—	—	25.3 × 34.7 × 0.1t	3	—	—	—	—
111-10-13	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101-12-13 φ 25	NVD07SCD082 or an equivalent	1	M6 × 10	3	M6	3	25.3 × 34.7 × 0.1t	3	—	—	—	—
101-12-13 φ 30	NVD07SCD082 or an equivalent	1	M6 × 10	3	M6	3	30.3 × 39.7 × 0.1t	3	—	—	—	—
CS-12-33 φ 25	NVD07SCD082 or an equivalent	1	M6 × 10	3	M6	3	25.3 × 31.7 × 0.1t	3	—	—	—	—
101/CS-12-□5 φ 25	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-12-12 φ 25	NVD07SCD082 or an equivalent	1	—	—	—	—	25.3 × 31.7 × 0.1t	3	—	—	—	—
111-12-12 φ 30	NVD07SCD082 or an equivalent	1	—	—	—	—	30.3 × 39.7 × 0.1t	3	—	—	—	—
111-12-13	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101-16-13 φ 30	NVD07SCD082 or an equivalent	1	M8 × 15	3	M8	3	30.3 × 41.7 × 0.1t	3	—	—	—	—
101-16-13 φ 40	NVD07SCD082 or an equivalent	1	M8 × 15	3	M8	3	40.3 × 51.7 × 0.1t	3	—	—	—	—
CS-16-33 φ 30	NVD07SCD082 or an equivalent	1	M8 × 15	3	M8	3	30.3 × 39.7 × 0.1t	3	—	—	—	—
101/CS-16-□5 φ 30	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-16-12 φ 30	NVD07SCD082 or an equivalent	1	—	—	—	—	30.3 × 39.7 × 0.1t	3	—	—	—	—
111-16-12 φ 40	NVD07SCD082 or an equivalent	1	—	—	—	—	40.3 × 51.7 × 0.1t	3	—	—	—	—
111-16-13	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101-20-13 φ 40	NVD07SCD082 or an equivalent	1	M10 × 18	3	M10	3	40.3 × 51.7 × 0.1t	3	—	—	—	—
101-20-13 φ 50	NVD07SCD082 or an equivalent	1	M10 × 18	3	M10	3	50.3 × 67.7 × 0.1t	3	—	—	—	—
CS-20-33 φ 40	NVD07SCD082 or an equivalent	1	M10 × 18	3	M10	3	40.3 × 51.7 × 0.1t	5	—	—	—	—
101-20-15 φ 40	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-20-12 φ 40	NVD07SCD082 or an equivalent	1	—	—	—	—	40.3 × 51.7 × 0.1t	3	—	—	—	—
111-20-12 φ 50	NVD07SCD082 or an equivalent	1	—	—	—	—	50.3 × 67.7 × 0.1t	3	—	—	—	—
111-20-13	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
101-25-13 φ 50	NVD07SCD082 or an equivalent	1	M12 × 22	4	M12	4	50.3 × 67.7 × 0.1t	3	—	—	—	—
101-25-13 φ 60	NVD07SCD082 or an equivalent	1	M12 × 22	4	M12	4	60.3 × 84.7 × 0.1t	3	—	—	—	—
CS-25-33 φ 50	NVD07SCD082 or an equivalent	1	M12 × 22	4	M12	4	50.3 × 67.7 × 0.1t	5	—	—	—	—
101-25-15 φ 50	NVD07SCD082 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	NVD07SCD082 or an equivalent	1	—	—	—	—	—	—	—	—	—	—
111-25-12 φ 50	NVD07SCD082 or an equivalent	1	—	—	—	—	50.3 × 67.7 × 0.1t	3	—	—	—	—
111-25-12 φ 60	NVD07SCD082 or an equivalent	1	—	—	—	—	60.3 × 84.7 × 0.1t	3	—	—	—	—
111-25-13	NVD07SCD082 or an equivalent	1	M12 × 22	4	M12	4	—	—	—	—	—	—

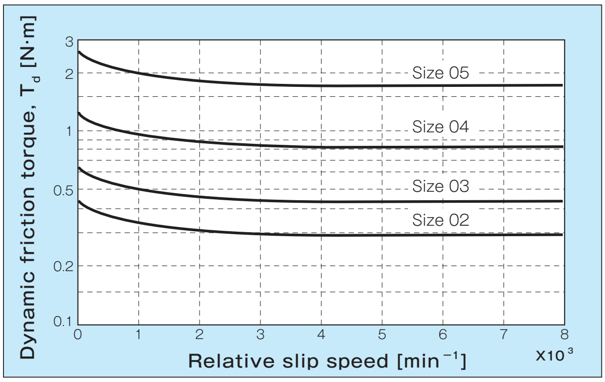
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

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.

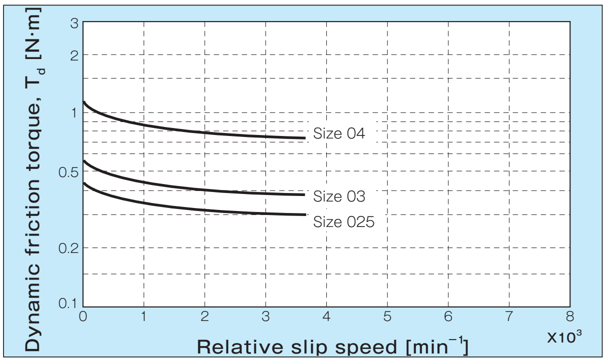
Static friction torque is a nearly predetermined value, while dynamic friction torque varies somewhat with relative speed.



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}.

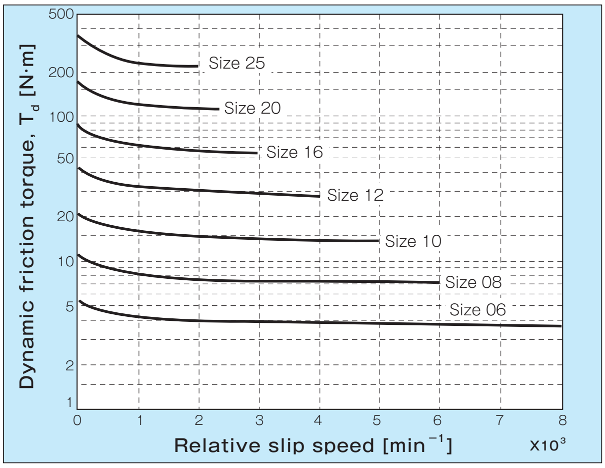


Dynamic friction torque characteristics (micro size CYT models)

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.



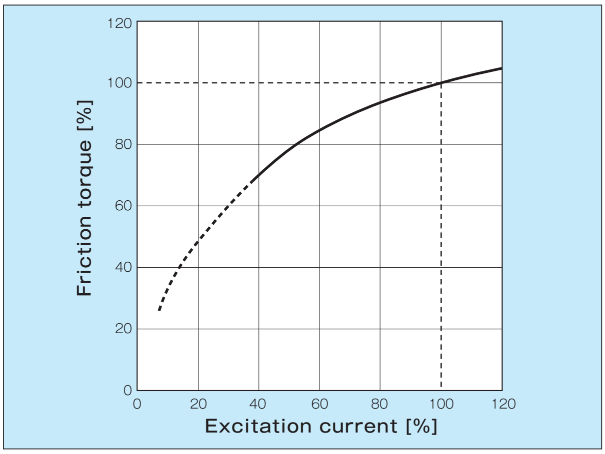
Dynamic torque characteristics (standard size models 101, 111, CS etc.)

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.



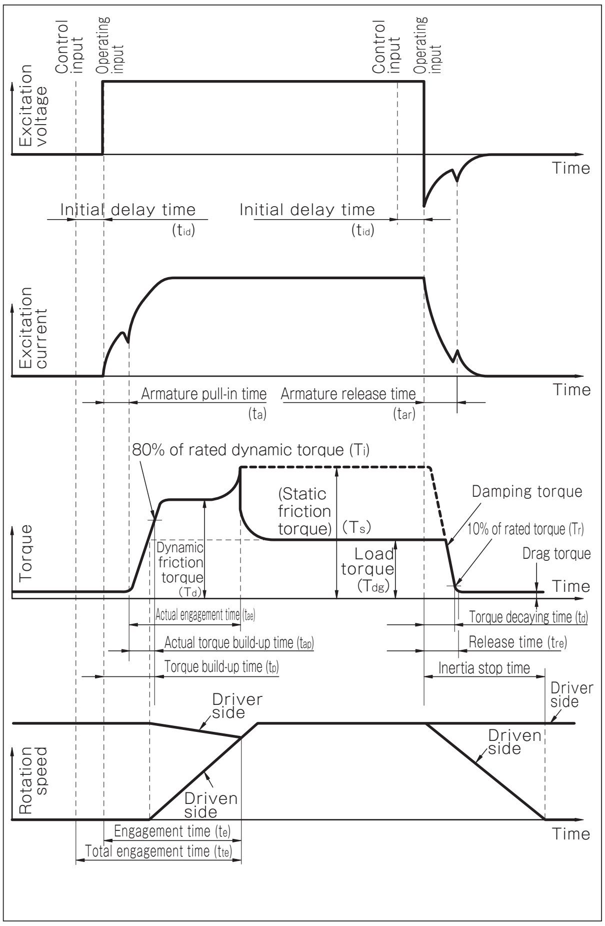
Torque-current characteristics

Operating Characteristics

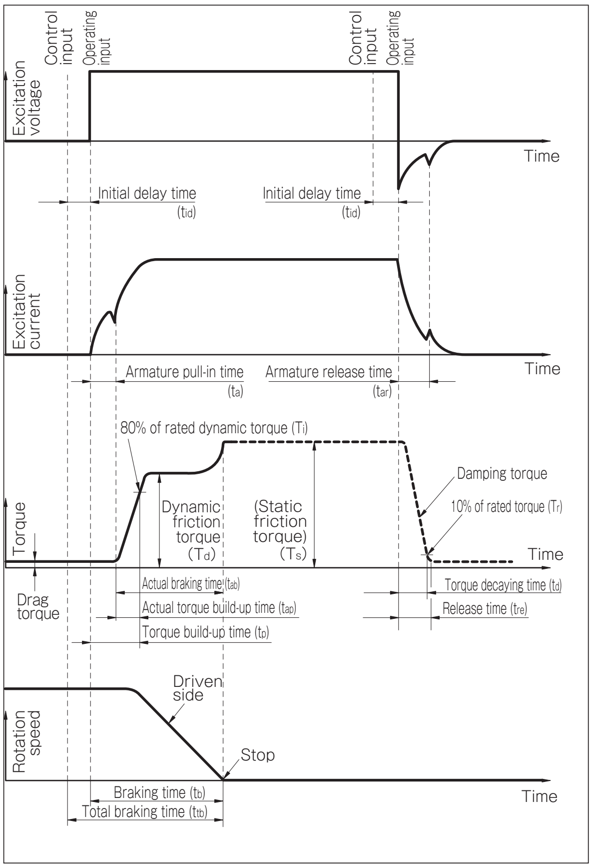
Transient Characteristics When Clutch/Brake Are Actuated

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 ($E_{a\ell}$ 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.

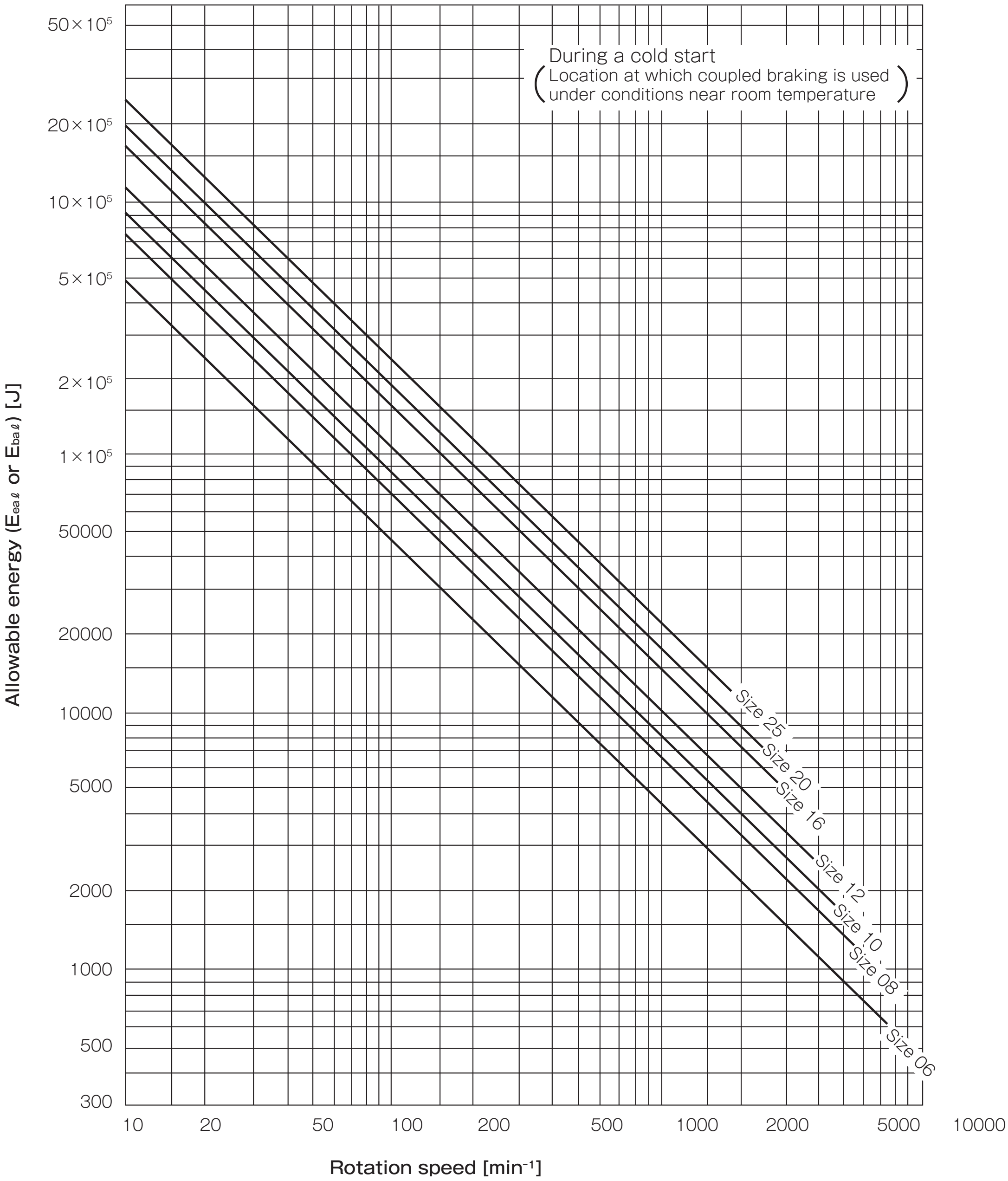
When large loads are accelerated or decelerated, violent slipping occurs, and the frictional surface generates larges amounts of heat. The frictional material and armature can be damaged by even a single engagement.

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 ($E_{a\ell}$ 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



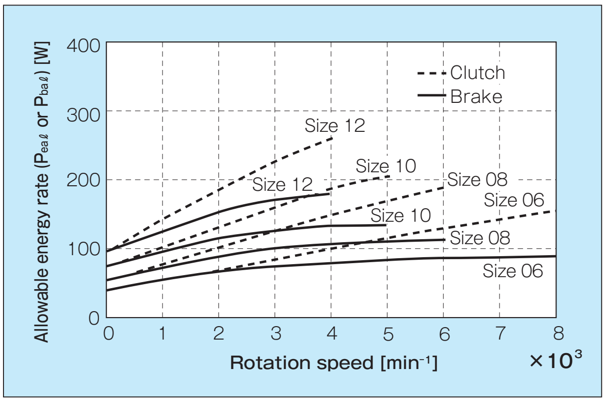
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

Heat Radiation Characteristics

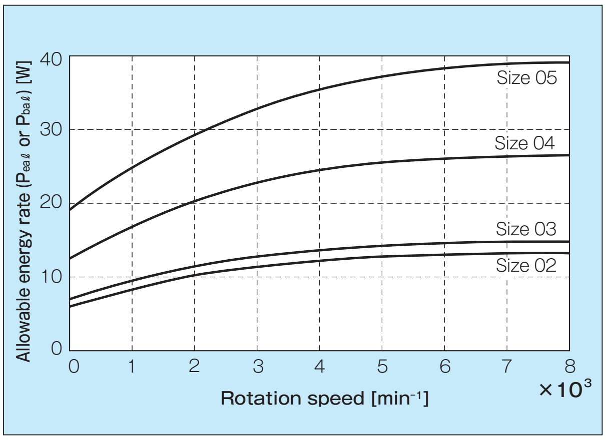
Allowable Energy Rate ($P_{ea\ell}$ or $P_{ba\ell}$)

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.

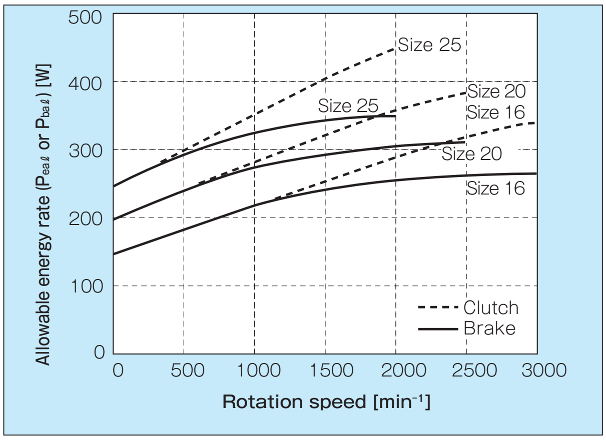
The figure shows values for wall-mounted devices. For devices mounted on shafts such as bearing-mounted models, use 80% of the allowable values in the figures.



Standard sizes



Micro sizes (excludes CYT models)



Standard sizes

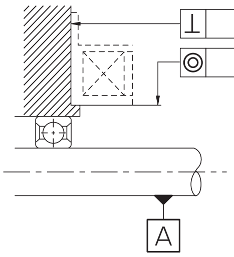
Items Checked for Design Purposes

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.

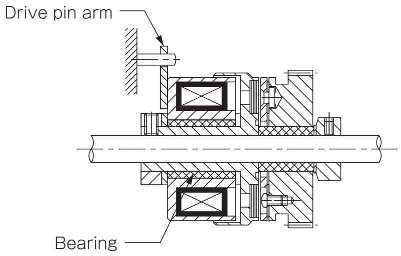


Unit [mm]

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.

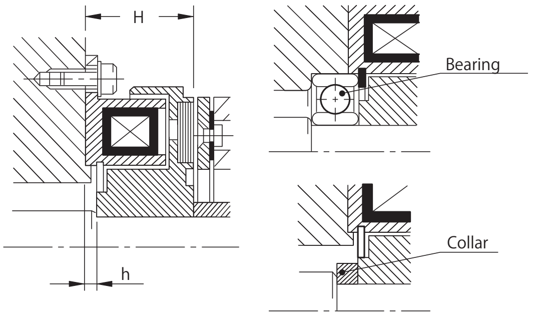
Rotor mounting

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]

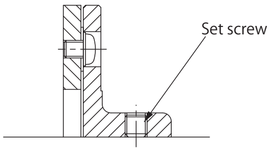
Clutch size	H		h
	Reference value	Tolerance	Reference value
102-02	18.0	±0.2	1.6
102-03	22.2	±0.2	2.0
102-04	25.4	±0.2	2.0
102-05	28.1	±0.2	2.0
101-06	24.0	±0.2	2.0
101-08	26.5	±0.2	2.5
101-10	30.0	±0.3	3.0
101-12	33.5	±0.3	3.5
101-16	37.5	±0.3	3.5
101-20	44.0	±0.4	4.0
101-25	51.0	±0.4	4.0

Armature Mounting Methods

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

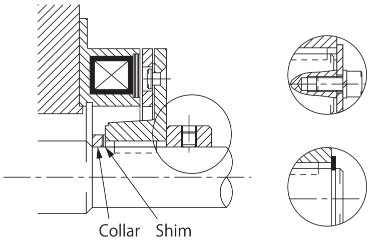
Mounting armature type-1

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.

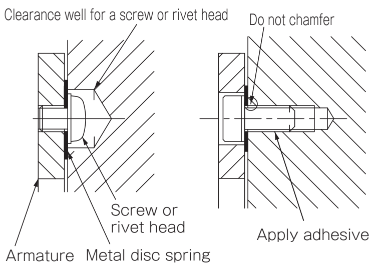
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

■ Armature type-3 mounting

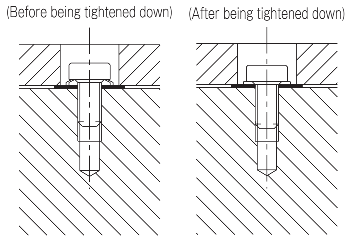
Machine in the screw bores and clearance well for screw and/or rivet heads in the mounting surface. Mount the armature using the supplied special hex-socket-head bolts and disc spring washers, applying a small amount of adhesive to the threads to prevent loosening. (Note that any excess adhesive will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

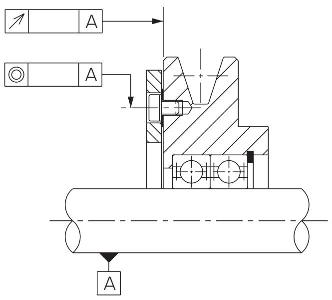
Size	Surface runout (T.I.R.)	Concentricity (T.I.R.)
02	0.1	0.02
03	0.1	0.03
04	0.1	0.04
05	0.1	0.04
06	0.16	0.04
08	0.16	0.05
10	0.16	0.05
12	0.16	0.06
16	0.16	0.07
20	0.24	0.11
25	0.24	0.11



Armature type-3 mounting

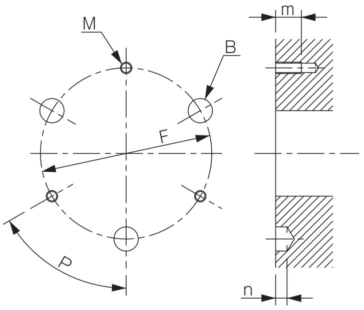


How to use washers



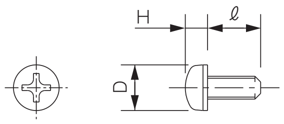
Mounting precision

Armature type-3 mounting dimensions

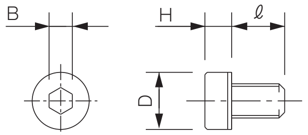


Clutch/ brake size	Mounting pitch diameter		Mounting angle		Mounting screw bore			Clearance well for screw/rivet head	
	F (P.C.D.)	Tolerance	P [°]	Tolerance [′]	No. of bores-M (nominal)	Pitch	Effective thread depth m (MIN)	No. of bores-Bore diameter B	Spot facing depth n (MIN)
02	19.5	±0.05	90	±5	2-M2	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

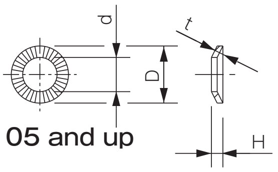
Armature type-3 mounting components



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"

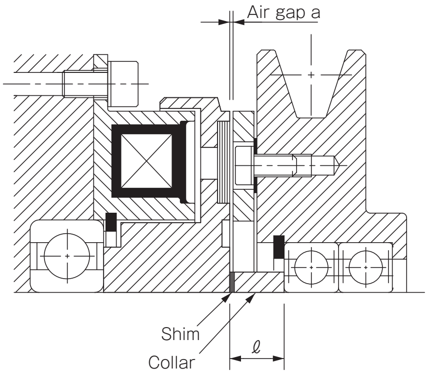
Prepare a collar that is slightly shorter than the length ℓ needed to maintain air gap "a", and then adjust the remaining gap with shims to achieve the control value for "a". The collar length at this time is roughly the value given by the following equation.

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

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



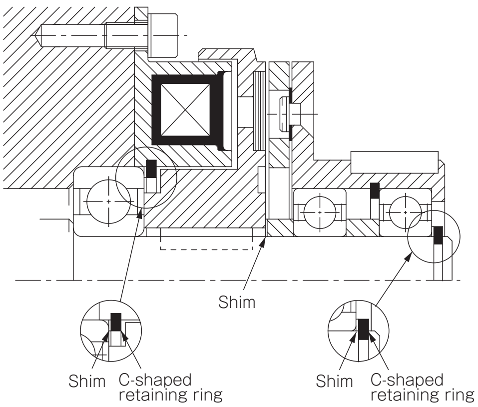
* Use the section on technical documentation to check the shim dimensions.

■ 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 are also used, a secure lock can be achieved while preserving the spring effect of the retaining ring.

How to use shims

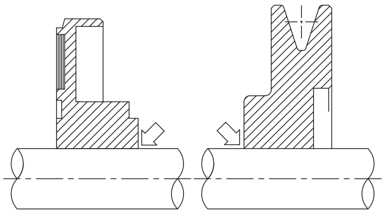


Fitting Tolerances

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.

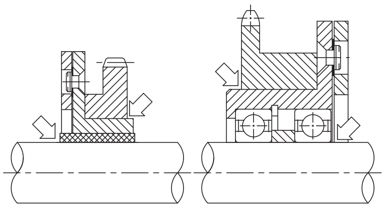
■ Fitting tolerance for rotor, armatures type-1 and type-2, V pulley, and shaft

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		

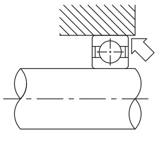
■ Fitting tolerances for armature type-5 and sprockets, or the like, and for armature type-5 and shafts



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

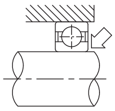
■ Tolerances for fitting ball bearing to housings

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.

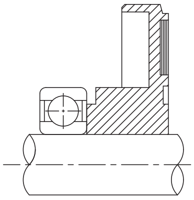
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

■ 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.

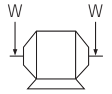
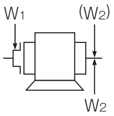
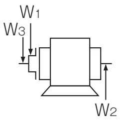
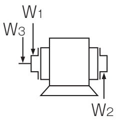
Use of Micro Clutches

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-□-12 126-□-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.

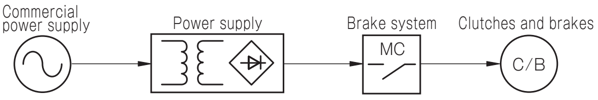
ELECTROMAGNETIC-ACTUATED CLUTCHES AND BRAKES

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.

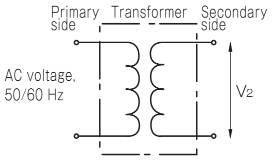
As a guideline, select a transformer that has a capacity 1.25 times the rated capacity of the clutch (brake) at 20° C. Note that the secondary-side output voltage must be set according to the rectifier's voltage drop or the transformer's impedance drop. These can be found in simplified terms, from Eqs.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

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

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

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

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

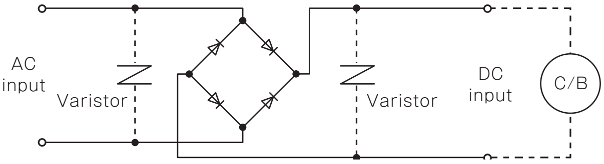
$$V_{RM} = V_L \cdot \sqrt{2} \cdot K \cdots\cdots (3)$$

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.



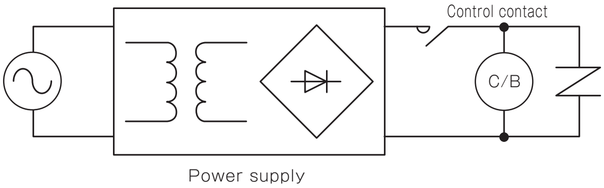
Single-phase full-wave rectified

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

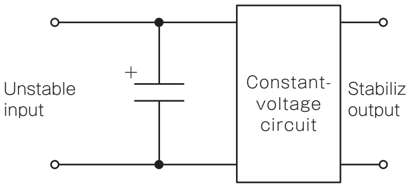
Points to note on control circuit structure

- 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:

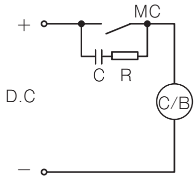
$$\frac{C\,[\,\mu\text{ F]}}{I\,[A]} = \frac{0.5 \text{ to } 1}{1}$$

Withstand voltage: 600 [V]

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

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

Capacity = 1 [W]

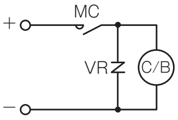
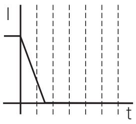
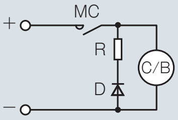
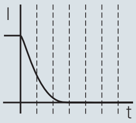
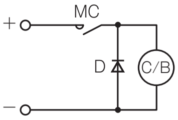
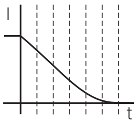
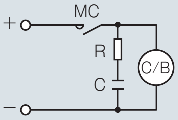
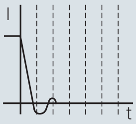


Relay protector circuit

■ 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