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ELECTOROMAGNETIC TOOTHED CLUTCH

Electromagnetic toothed clutches

Large torque transmission

Since the torque transmission is performed by engagement of teeth, large torque can be transmitted by the compact body. Compared with conventional dry single disc clutches manufactured by Miki Pulley, the electromagnetic toothed clutches can transmit 5 to 10 times torques.

Various benefits due to the nonmagnetic tooth

- Resistant to tooth tip connection. Reliable operation can be performed.
- Due to the less-wearing tooth, it is strong in durability.
- Quick engagement and disengagement can be performed.
- Slight idling torque

High-speed engagement is possible

The special tooth profile has made engagement at a high relative velocity, fastest ever.

Easy to mount

Due to the built-in bearing, centering of a stator and rotor is not required.

Full position・Single position

There are "full position" with entire circumference engagement and "single position" with fixed position engagement (engaged at one position in one revolution).

Particular position coupling

Multiple-position engagement is available on request. (Ex. 8, 12 24 positions, etc.) Contact us for further information.

Torque range [N・m]	17.5 ～ 2200
Operable temperature [℃]	0 ～ +40

Selection

1 Selection of tooth profile

First, select the tooth profile of the toothed clutch by the engagement rotation speed, rotational direction and engagement condition (Full/Single).

2 Selection of size and type

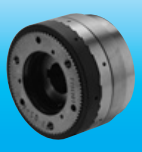
After selecting the tooth profile, select the size and type from the dimensions and specification table.

3 Use conditions

After selecting the size and type, reconfirm if the torque, allowable coupling rotation speed, maximum rotation speed, tooth profile, rotational direction, dimension, bore diameter and exciting voltage correspond to the use conditions.

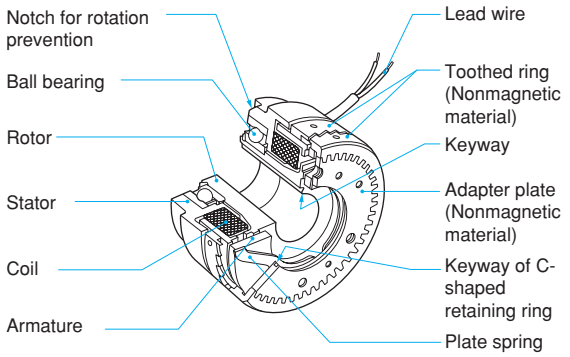
Model list

●…Adjustment　○…Suitable depending on applications

Electromagnetic toothed clutch							
Model		546					
Type		546-□-34-NF	546-□-34-NS	546-□-34-RF	546-□-34-RS	546-□-34-LF	546-□-34-LS
Appearance							
Descriptive page		P133～139					
Adaptability	High responsiveness (multiple teeth)	●	●				
	Fixed position coupling (one position)		●		●		●
	High-speed rotation speed			●	●	●	●
	Normal/reverse rotation transmission	●	●				
	Clockwise rotation transmission			●	●		
	Counterclockwise rotation transmission					●	●
	Particular position coupling		○		○		○
Characteristic	High torque	●	●	●	●	●	●
	Nonmagnetic tooth	●	●	●	●	●	●

Structure

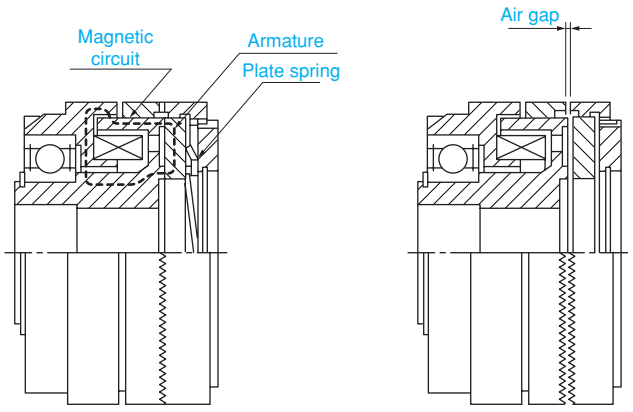
- Notch for rotation prevention
  It is maintained at the static part of the machine to prevent a rotation of the stator.
- Ball bearing
  It maintains the stator on the rotor.
- Rotor
  It is fixed on the shaft by a key, and suctions the armature by forming a magnetic pole with the stator.
- Stator
  It has a built-in coil, and is maintained on the rotor by the ball bearing.
- Coil
  Source that generates strong suction power
- Armature
  When applying current to the coil, the magnetic circuit is formed through the rotor and the armature is suctioned to the rotor.
- Lead wire
  It is connected to a direct-current power supply (DC24).
- Toothed ring (Nonmagnetic material)
  Due to the nonmagnetic material, it doesn't become a magnetic circuit. When the armature is suctioned, torque is transmitted by the engagement of the teeth.



- Adapter plate (Nonmagnetic material)
  It is mounted to the sprocket or gear and connected to the armature through the leaf spring and spline.
- Keyway of C-shaped retaining ring
  The C-shaped retaining ring is inserted when positioning is performed by using the bearing.
- Plate spring
  Pull back the armature to the release position immediately when the current is turned off.

Principle of operation

When applying current through the coil, magnetic flux is generated. The magnetic circuit is formed among the stator, rotor and armature as indicated by the dotted line. By this action, the armature is suctioned and attached to the rotor. At the same time, the teeth of the toothed ring fixed on the armature engage with the teeth of the toothed ring fixed on the rotor. By the engagement of the teeth, the rotating part mounted on the input shaft and the rotating part mounted on the output shaft are connected to transmit the torque from the drive side to driven side. When turning off the current, the magnetic flux disappears, and the armature is quickly released from the rotor by the resilience of the bended plate spring. At the same time, the engagement of the teeth are completely released, and the torque transmission from the input side (drive side) to output side (driven side) is cut off. The toothed ring on the armature side is maintained by the plate spring with the armature to keep the constant air gap between the tooth tips with the rotor-side toothed ring.



When applying current/connecting　　When releasing

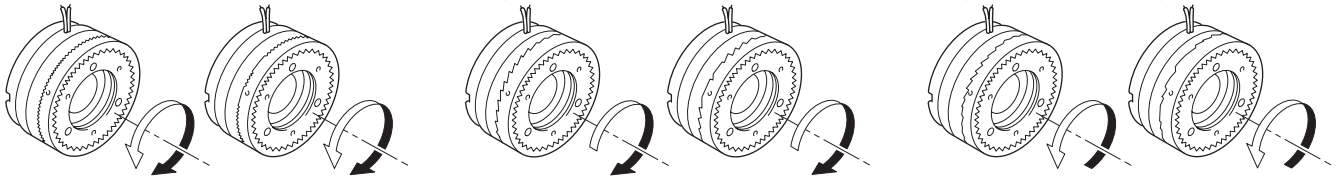
Tooth profile

There are 6 types of tooth profiles. The appropriate tooth profile can be selected in accordance with the intended use.

Nominal designation	NF	NS	RF	RS	LF	LS
Types	Full depth tooth	Full depth tooth	Saw tooth	Saw tooth	Saw tooth	Saw tooth
Postion	Full	Single	Full	Single	Full	Single
Rotative direction	Both	Both	Right	Right	Left	Left

* The standard of rotative direction (rotor) is the direction looked from the adapter plate surface. The rotative direction described above is for armature input. It becomes opposite for shaft input. (Example) If clockwise rotation is required at the shaft input, please use the left-handed rotating sawtooth (L).

[NF] Full depth tooth Full position　[NS] Full depth tooth Single position　[RF] Right-handed rotating sawtooth Full position　[RS] Right-handed rotating sawtooth Single position　[LF] Left-handed rotating sawtooth Full position　[LS] Left-handed rotating sawtooth Single position



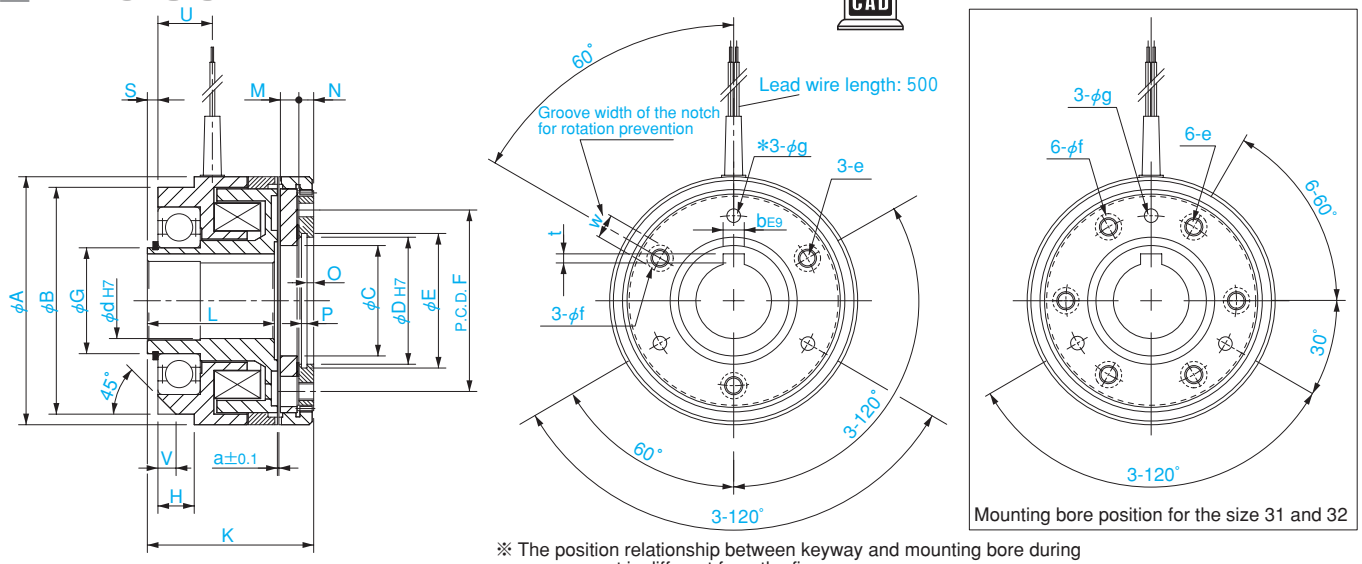
- Full depth tooth
  It is a common tooth profile that can be used regardless of rotative direction.
- Sawtooth
  It has fewer teeth compared with the full depth tooth. Since the engagement angle is smaller than the full depth tooth, engagement in higher relative velocity can be performed.
- Full position
  It is a common tooth profile for an all-around engagement.
- Single position
  It is a tooth profile for a fixed-position engagement at one point in one rotation.

Specification

Model	Size	Torque [N·m]	Coiil (at20℃) Voltage [V]	Wattage [W]	Amperage [A]	Resistance [Ω]	Heat-resistance class	Allowable rotation speed of connection [min⁻¹] NF	NS	Sawtooth	Max. rotation speed [min⁻¹]	Moment of inertia J [kg·m²] Rotor	Armature	No. of teeth Full depth tooth Full	Sawtooth Full	Armature suction time t_a [s]	Armature release time t_{ar} [s]	Mass [kg]
546-12-34-□	12	17.5	DC24	13.3	0.55	44.0	F	50	30	100	1500	6.6×10^{-5}	6.0×10^{-5}	200	25	0.035	0.040	0.5
546-13-34-□	13	25	DC24	18.7	0.78	31.0	F	50	30	100	1500	1.5×10^{-4}	1.2×10^{-4}	220	30	0.040	0.050	0.9
546-15-34-□	15	50	DC24	21.3	0.89	27.1	F	50	30	100	1500	3.7×10^{-4}	3.7×10^{-4}	260	36	0.060	0.060	1.5
546-21-34-□	21	100	DC24	27.0	1.13	21.0	F	50	30	100	1500	8.7×10^{-4}	5.2×10^{-4}	290	36	0.080	0.070	2.4
546-23-34-□	23	250	DC24	36.2	1.51	15.9	F	50	30	100	1500	2.06×10^{-3}	1.85×10^{-3}	280	38	0.090	0.080	3.9
546-25-34-□	25	500	DC24	56.6	2.36	10.2	F	50	30	100	1500	4.88×10^{-3}	4.51×10^{-3}	250	40	0.100	0.090	6.8
546-31-34-□	31	1000	DC24	79.7	3.32	7.2	F	50	30	100	1500	1.12×10^{-2}	1.28×10^{-2}	195	40	0.110	0.110	11.1
546-32-34-□	32	2200	DC24	114.0	4.75	5.1	F	50	30	100	1500	2.87×10^{-2}	2.92×10^{-2}	186	40	0.120	0.130	15.3

※ The armature suction time and release time indicate the reference values under unloaded and static conditions. The value generally becomes longer by the load magnitude or operating condition during connecting.
※ The NF and NS of the allowable rotation speed of connection indicate the full depth tooth for full position and the full depth tooth for single position respectively.

Dimension



※ The position relationship between keyway and mounting bore during engagement is different from the figure.
※ There is no (ϕg) measurement with * mark for the size 12.

Unit [mm]

Model	Shaft bore dimensions											
	New JIS standards correspondence						Previous edition of JIS standards correspondence					
	d H7		b P9		$t^{+0.5}_{0}$		d H7		b E9		$t^{+0.5}_{0}$	
546-12-34-□	10		3		1.2		10		4		1.5	
546-13-34-□	15		5		2		15		5		2	
546-15-34-□	20	25	6	8	2.5	3	20	25	5	7	2	3
546-21-34-□	25	30	8	8	3	3	25	30	7	7	3	3
546-23-34-□	30	40	8	12	3	3	30	40	7	10	3	3.5
546-25-34-□	40	50	12	14	3	3.5	40	50	10	12	3.5	3.5
546-31-34-□	50	60	14	18	3.5	4	50	60	12	15	3.5	5
546-32-34-□	60	70	18	20	4	4.5	60	70	15	18	5	6

Unit [mm]

Model	Radial dimensions										Axial direction dimensions											CAD file No.
	A	B	C	D	E	F	G	e	f	g	H	K	L	M	N	O	P	S	U	V	W	a	
546-12-34-□	57	52	22.5	26	27.2	36	20	M4	8.5	—	10	43	34	4.3	3.1	1.3	1.3	2.0	15	4.5	5	0.2	5461
546-13-34-□	67	58	31	32	33.7	46	25	M5	8.5	4.5	11	49	39	4.9	3.5	1.4	1.3	2.5	16.5	5	6	0.3	5462
546-15-34-□	82	75	36.5	42	44.5	60	35	M6	10	4.5	12	55	42	6.1	4.8	2.2	1.9	3.5	18	6	8	0.3	5463
546-21-34-□	95	88	46	52	55	70	45	M8	12	5.5	14	63	45	8.7	6.0	2.8	2.2	3.0	20	6	10	0.4	5464
546-23-34-□	114	105	55	62	65	80	55	M8	12	7.8	18	69	50	9.0	6.5	3.3	2.2	3.0	24	6	10	0.4	5465
546-25-34-□	134	127	68	72	75	95	70	M12	15	9.5	20	83	61	11.0	8.4	4.3	2.7	3.0	26	8	10	0.4	—
546-31-34-□	166	152	80	90	93.5	120	85	M12	15	9.5	22	93.5	66	13.1	11.4	5.3	3.2	3.5	31	10	12	0.5	—
546-32-34-□	195	175	95	100	103.5	150	100	M12	19	11.5	24	110	80	14.0	11.7	6.3	3.2	4.0	38.5	10	12	0.5	—

Ordering Information

546-[12]-34-[NF] 24V [10] [DIN]

- 12: Size
- NF: Tooth profile
  - Full depth tooth for full position: NF / for single position: NS
  - Right-handed rotating sawtooth for full position: RF / for single position: RS
  - Left-handed rotating sawtooth for full position: LF / for single position: LS
- 10: Rotor bore diameter (dimensional sign d)
- DIN: Keyway standard
  - New JIS standards correspondence: DIN
  - Previous edition of JIS standards correspondence: JIS

Design check items

❶Set the air gap between the tooth tips of the rotor side and armature side in order that it becomes the value [a] of the measurement table. The space adjustment becomes easier by using a shim.

❷Make the collar used for the air gap adjustment with nonmagnetic material (stainless, brass, etc.). Refer to the table below for the collar length in the case of bearing inlay.

Collar length for bearing inlay

Size	Dimension [mm]	Size	Dimension [mm]
12	7.3	23	15.5
13	8.3	25	17.5
15	10.5	31	22.0
21	15.0	32	23.5

※ Form the length of collar by minus tolerance and fine adjust by a shim.
※ Five shims for each shaft bore diameter (0.1mm of thickness) are attached.
※ Perform the collar design separately if it's not a bearing inlay.

❸Fix completely for the shaft direction with no allowance.

❹The h6 class or j6 class is recommended for the shaft tolerance when mounting.

❺This is a through-shaft type clutch. If it is used for shaft-to-shaft, perform positioning on the other shaft by a bearing. By using the CENTA FLEX coupling, centering becomes relatively easier. Refer to the mounting example.

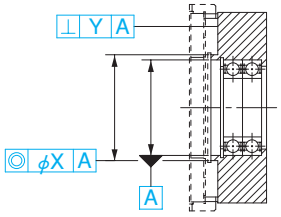
❻The inside diameter of the adapter plate is the same as the outside diameter of the ball bearing. Therefore, centering becomes easier by inlaying the ball bearing directly into the plate.

Recommended bearing when using the adapter plate inside diameter for inlay

Size	Inlay diameter ϕD [mm]	Bore diameter ϕd [mm]	Bearing
12	26	10	6000
13	32	15	6002
15	42	20	6004
		25	6905
21	52	25	6205
		30	—
23	62	30	6206
		40	6908
25	72	40	—
		50	6910
31	90	50	6210
		60	—
32	100	60	—
		70	6914

Depending on the shaft diameter, the ball bearing may not be able to use for inlay. In such case, perform centering by setting an inlay on the armature mounting flange. For the armature mounting surface accuracy, refer to the figure and table below.

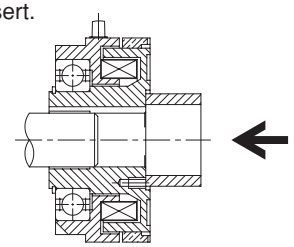
Armature mounting surface accuracy



Size	X [mm]	Y [mm]
12	0.04	0.03
13	0.05	0.04
15	0.05	0.04
21	0.06	0.05
23	0.07	0.05
25	0.08	0.06
31	0.08	0.07
32	0.10	0.08

❼ Use two ball bearings for the flange where the armature is mounted (gear, sprocket, etc.) for preventing runout on the armature side.

❽ When inserting the stator side to the shaft, do not hit strongly with a hammer or press the outer part, which may cause damage. Apply a pipe backing metal around the shaft bore of the boss part, and insert carefully. The material is soft do not bend to insert.



❾ Maintain the stator only for the rotative direction by using the notch part. At this time, make sure not to apply any force to the shaft direction.

❿ Applying lubricant agent (molybdenum disulfide grease) to the tooth top will improve the abrasion resistance and is recommended.

⓫ A pilot bore for pin mounting is machined on the adapter plate. After mounting on the gear or sprocket, perform an additional process in accordance with the actual stuff and make sure to use a pin in combination. For the size 12, a pin is not required. Refer to the "Assembly of the armature part" for detail.

⓬ Apply a small amount of thread adhesive to the bolt used to mount the adapter plate on the gear or sprocket to prevent loosening.

⓭ Do not pull or damage the lead wire. Maintain the lead wire without applying any force.

⓮ If the moment of inertia on the driven side is too large, the engagement of the teeth may fail. In such case, lower the rotation speed or use the shock-absorbing CENTA FLEX coupling in combination.

⓯ For the single-position tooth profile, idling torque is generated by the contact between tooth tips until the tooth is in the engagement position. For the toothed clutch, a magnetic circuit is not formed that the idling torque is small. However, if the load torque is small to a remarkable degree compared with the clutch torque, the driven side may concurrently rotate. In such case, use a brake in combination to prevent a rotation of the driven side.

⓰ The positioning between the keyway and adapter-plate mounting bore at the engagement position can not be performed. If the positioning is required, adjust by the element of the other side of the clutch.

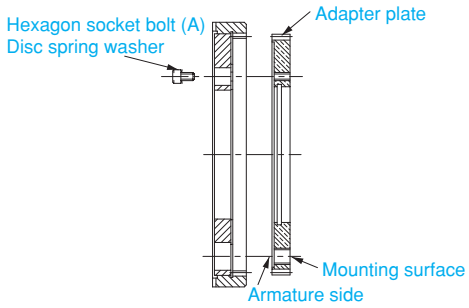
⓱ If it is used in static coupling, there is a possibility that the teeth may not engage during suctioning and their tooth tips may become the condition of contact. If it is rotated in this condition, slippage may occur. Adjust the accelerating time of the drive side to engage the teeth.

⓲ The operational power supply for the clutch is DC24V. Suppress the fluctuation of applied voltage within -10% ~ +5%. Exclusive power supply BEZ is available, which is recommended to use.

⓳ The ON-OFF operation of the clutch should be performed on the direct-current side. If it is performed on the alternating-current side, the operating time delays. In addition, connect the varistor for contact protection parallel to the clutch.

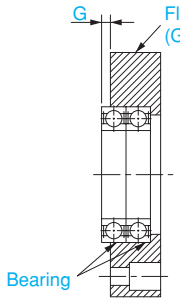
Assembly of the armature part

❶ Remove the previously fixed hexagon bolt (A) from the armature side to separate the armature and adapter plate. At this time, put a match mark at the combined position of the armature and adapter plate, which is useful for reassembly.



❷ Press the bearing into the flange (gear, sprocket, etc.). Design the flange in order that the bearing projecting amount (G measurement) in the case of bearing inlay becomes the value of the table below.

Bearing projecting amount



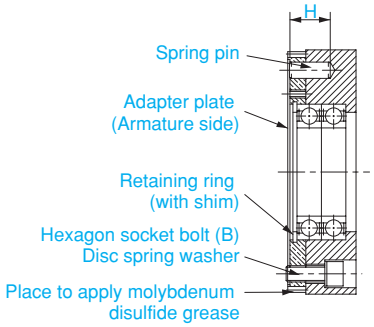
unit [mm]

Size	Demension G
12	1.3
13	1.4
15	2.2
21	2.8
23	3.3
25	4.3
31	5.3
32	6.3

* Apply a bearing mount (adhesive) to the outer ring of the bearing when pressed.
* Finish the depth of the bearing insertion bore by plus tolerance (recommended tolerance: 0¯ +0.1), and adjust with no allowance for the thrust direction by using a shim.

❸ Set the C-shaped retaining ring for the ring groove of the adapter plate. Adjust the space between the bearing and retaining ring by a shim.

❹ Mount the adapter plate on the flange and tighten the hexagon socket bolt (B) to fix.



* Confirm the adapter plate direction.
* Apply a small amount of thread adhesive to the hexagon socket bolt.
* Refer to the following table for the tightening torque of the hexagon socket bolt.

Tightening torque of the adapter plate mounting bolt

Size	Bolt	Tightening torque [N·m]	
		With a spring pin	Without a spring pin
		Bolt intensity class 8.8 and above	Bolt intensity class 10.9 and above
12	3-M4	—	3.4
13	3-M5	5.2	7.0
15	3-M6	8.8	11.8
21	3-M8	22.0	29.5
23	3-M8	22.0	29.5
25	6-M12	77.0	104.0
31	6-M12	77.0	104.0
32	6-M12	77.0	104.0

❺ By using the pilot bore on the adapter plate, perform the bore processing of the spring pin simultaneously. (deburring is required.) As for the pin bore processing, refer to the dimensional table of the recommended bore processing for the spring pin part.

Dimensions of the recommended bore processing for the spring pin part

Unit [mm]

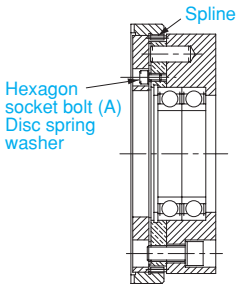
Size	Bore processing	Recommended depth H	Spring pin
13	$5^{+0.12}_{0}$	13	5×10
15	$5^{+0.12}_{0}$	13	5×10
21	$6^{+0.12}_{0}$	15	6×12
23	$8^{+0.15}_{0}$	19	8×16
25	$10^{+0.15}_{0}$	21	10×18
31	$10^{+0.15}_{0}$	25	10×22
32	$13^{+0.2}_{0}$	25	13×22

* The recommended depth H includes the processing cost of the adapter plate.

❻ Drive the spring pin into the bore processing place by pointing the split in the direction of outer circumference (spline side). Make sure that the spring pin does not come out from the adapter plate surface.

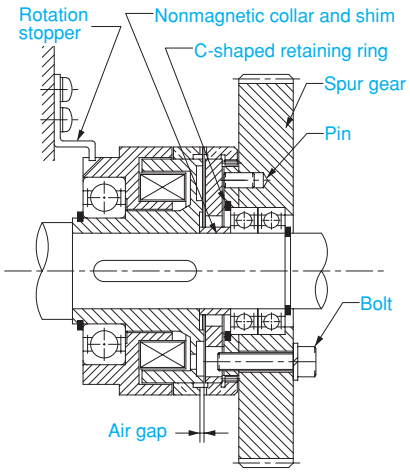
❼ Remove the cutting powder or dust completely and apply molybdenum disulfide grease to the spline part.

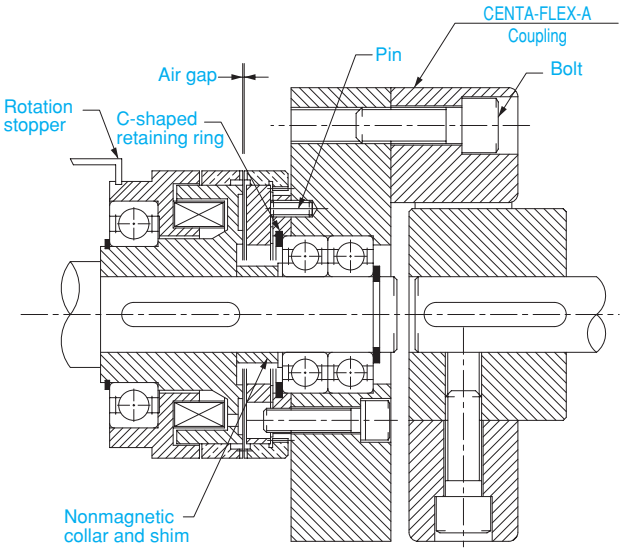
❽ Insert the adapter plate into the armature according to the marked position ❶, and tighten with the hexagon socket bolt (A) that was removed in the procedure ❶. (Adhesive is not required.) Refer to the following table for tightening torque.



Size	Bolt	Tightening torque [N·m]
12	M3×3	1.5
13	M3×4	1.5
15	M3×3	1.5
21	M4×6	3.4
23	M4×6	3.4
25	M4×8	3.4
31	M5×10	7.0
32	M6×10	11.8

Mounting Example





Selection

Evaluate from the motor capacity

The motor torque converted to the clutch shaft is;

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

P: Motor output [kW]

n: Rotating velocity converted to the clutch shaft [min^{-1}]

η :Transmission efficiency from the motor to clutch

Assuming that the motor is correctly selected for the load, the required torque (T) is;

$$T = T_M \cdot K [N \cdot m] \quad \cdots\cdots ②$$

K: Safety factor

Raise the loading rotation after coupling

The required accelerating torque (T_A) to raise the rotation to the rotation number n is;

$$T_A = \frac{J \cdot n}{9.55 \cdot t_A} [N \cdot m] \quad \cdots\cdots ③$$

J : Total moment of inertia on the load side [$kg \cdot m^2$]

T_A: Accelerating time [s]

Therefore, the required torque (T) is;

$$T = (T_L + T_A)\ K [N \cdot m] \quad \cdots\cdots ④$$

T_L: Load torque [s]

Select the appropriate clutch with a satisfactory value for the required torque from the specification table.

Safety factor: K

Load condition	Factor
Low-speed rotation/Small torque fluctuation	1.5
Standard load/Small torque fluctuation	2
High-speed rotation/Large torque fluctuation	3

Exclusive power supply and accessory list

Unit [mm]

Model	Exclusive power supply	Accessory	
		Protective device*1 (Varistor) 1	Shim (Inside dia. x outside dia. x thickness) 5
546-12-34-□ 24V 10□	BEZ-10	NVD07SCD082 or equivalent	10.3×13.7×0.1t
546-13-34-□ 24V 15□	BEZ-10	NVD07SCD082 or equivalent	15.3×20.7×0.1t
546-15-34-□ 24V 20□	BEZ-10	NVD07SCD082 or equivalent	20.3×27.7×0.1t
546-15-34-□ 24V 25□	BEZ-10	NVD07SCD082 or equivalent	25.3×34.7×0.1t
546-21-34-□ 24V 25□	BEZ-10	NVD07SCD082 or equivalent	25.3×34.7×0.1t
546-21-34-□ 24V 30□	BEZ-10	NVD07SCD082 or equivalent	30.3×41.7×0.1t
546-23-34-□ 24V 30□	BEZ-10	NVD07SCD082 or equivalent	30.3×41.7×0.1t
546-23-34-□ 24V 40□	BEZ-10	NVD07SCD082 or equivalent	40.3×51.7×0.1t
546-25-34-□ 24V 40□	BEZ-10	NVD07SCD082 or equivalent	40.3×51.7×0.1t
546-25-34-□ 24V 50□	BEZ-10	NVD07SCD082 or equivalent	50.3×61.7×0.1t
546-31-34-□ 24V 50□	BEZ-20	NVD14SCD082 or equivalent	50.3×61.7×0.1t
546-31-34-□ 24V 60□	BEZ-20	NVD14SCD082 or equivalent	60.3×84.7×0.1t
546-32-34-□ 24V 60□	BEZ-20	NVD14SCD082 or equivalent	60.3×84.7×0.1t
546-32-34-□ 24V 70□	BEZ-20	NVD14SCD082 or equivalent	70.3×79.7×0.1t

※ *1 The protective device NVD□SCD□ is manufactured by KOA.

※ Refer to the section of power supply for the detailed specification.

BEZ model

Exclusive power supply for toothed clutches

Exclusive power supply for toothed clutches

It is recommended to use in combination with a toothed clutch.

Integrate a transformer and rectifier compactly.

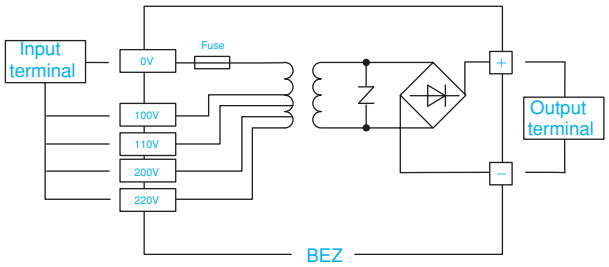
Convert to an excitation power supply by connecting a commercial alternating-current power supply (AC100/110・200/220V).

The output voltage is set by considering the voltage variation and the fluctuation by the loading rate. Regardless of the size of the electromagnetic toothed clutch (coil capacity), continuous current is possible.

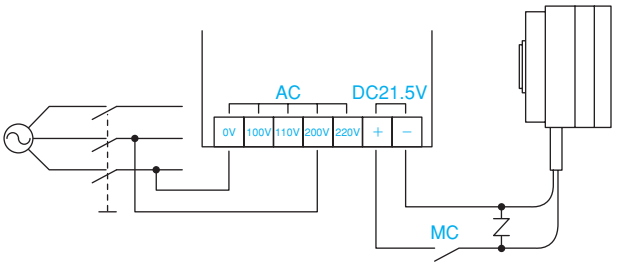
Specification

Model	Size	Input voltage [V]	Output voltage [V]	Capacity [W]	Fuse capacity [A]	Rating	Toothed clutch applicable size
BEZ-10	10	AC100/110	DC21.5	56.6	3	Continuous	12,13,15,21,23,25
BEZ-20	20	AC200/220		114	5		31,32

Structure



Connecting diagram

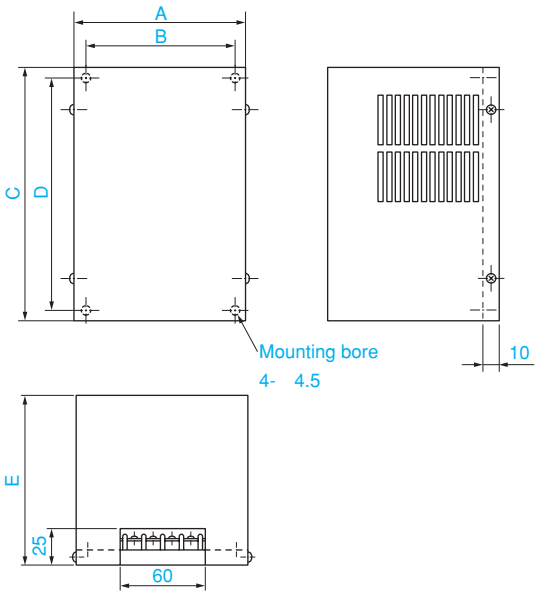


- Perform the ON-OFF operation of the clutch on the direct-current side. If it is performed on the alternating-current side, the operating time delays.
- Connect the varistor (accessory) parallel to the clutch.

※Refer to the section of the power supply for more detail.

Dimension

CAD



Unit [mm]

Model	A	B	C	D	E	CAD file No
BEZ-10	105	90	160	145	100	BE4
BEZ-20	120	105	180	165	120	BE5

Ordering Information

BEZ-□

Size