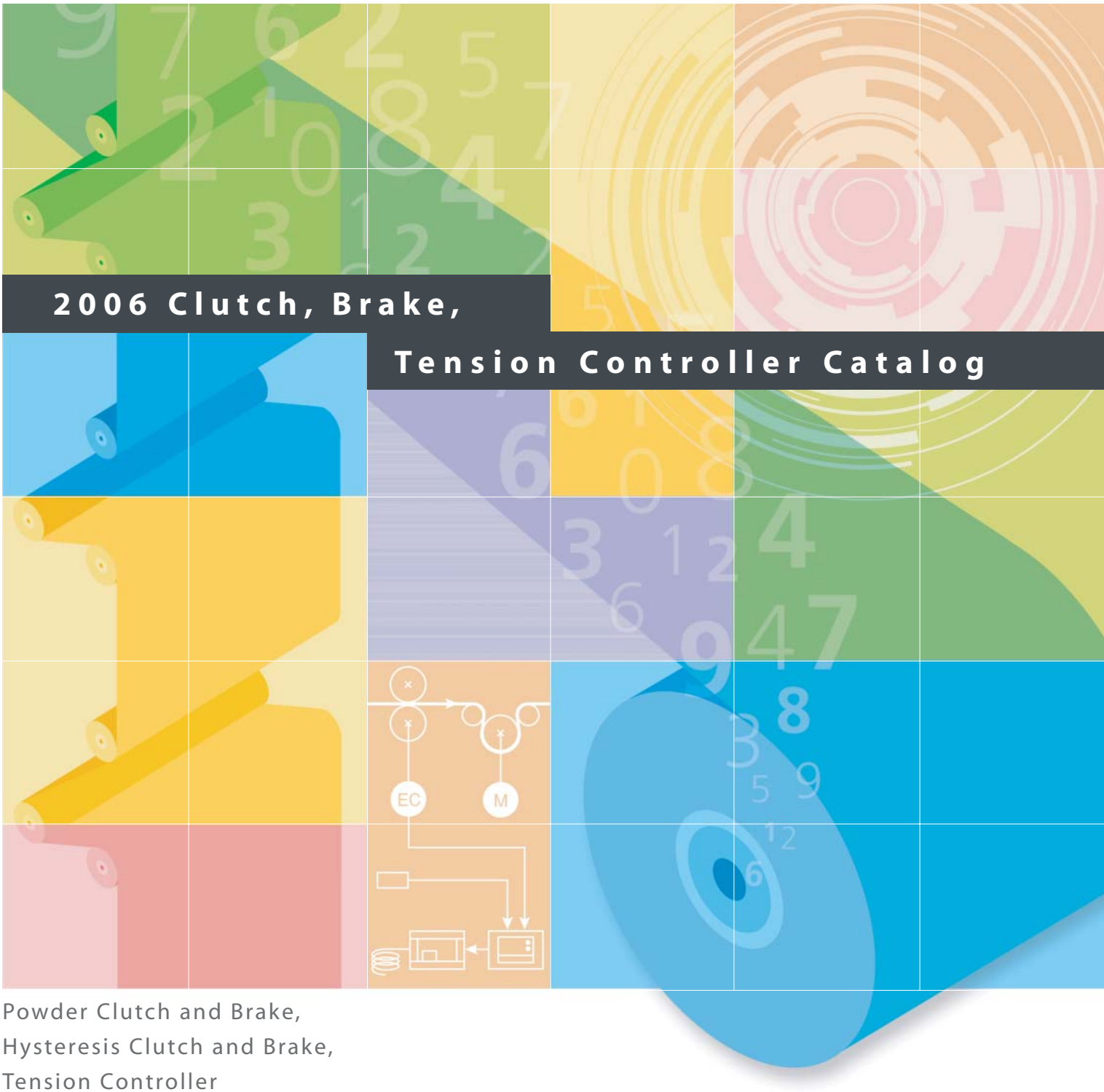
MITSUBISHI ELECTRIC

Changes for the Better

General Catalog 2006

ELECTROMAGNETIC CLUTCHES AND BRAKES
<Powder type·Hysteresis type>
TENSION CONTROLLERS



2006 Clutch, Brake, Tension Controller Catalog

Powder Clutch and Brake,
Hysteresis Clutch and Brake,
Tension Controller
brought to you by
MITSUBISHI ELECTRIC CORPORATION.

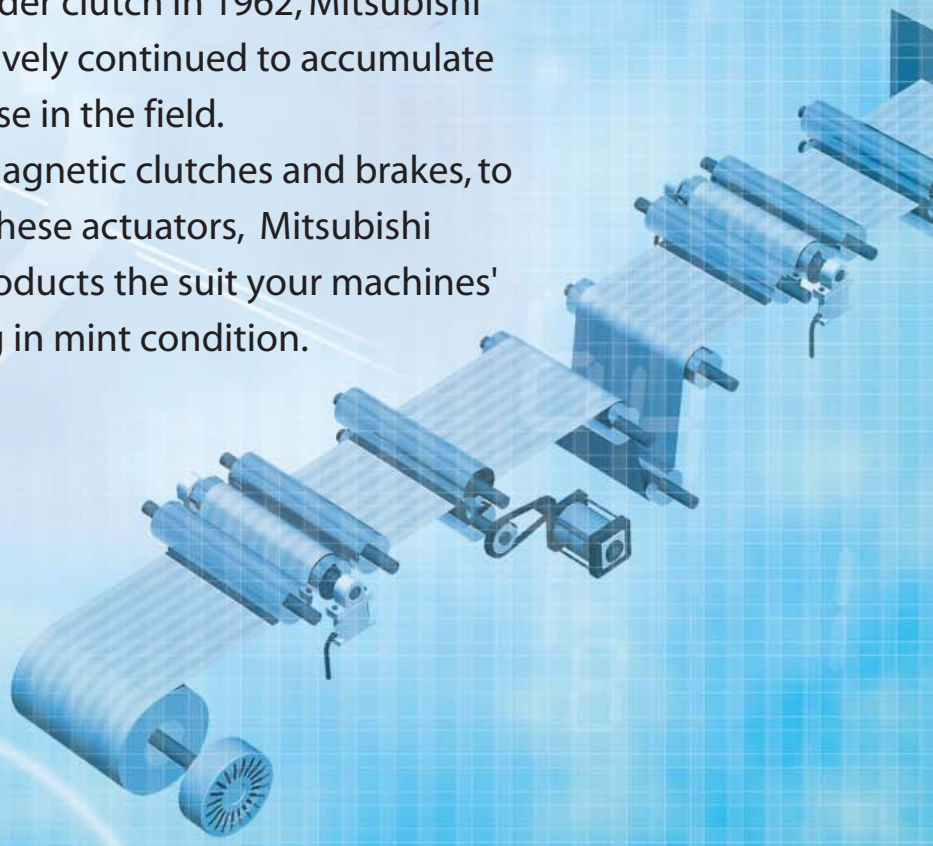
Mitsubishi Electric Corporation Himeji Works is certified for ISO14001 (International standard for environmental management systems) and ISO9001 (International quality standard).

ISO 14001 JACO EC97J1234 UKAS ENVIRONMENTAL MANAGEMENT 051

BVQI ISO 9001 UKAS QUALITY MANAGEMENT 008

Experience and expertise you can count on

Since the first release of the powder clutch in 1962, Mitsubishi Electric Corporation has aggressively continued to accumulate technical know-how and expertise in the field.
From actuators, such as electromagnetic clutches and brakes, to tension controllers that control these actuators, Mitsubishi Electric offers a wide range of products the suit your machines' needs and to keep them running in mint condition.



Clutches & Brakes

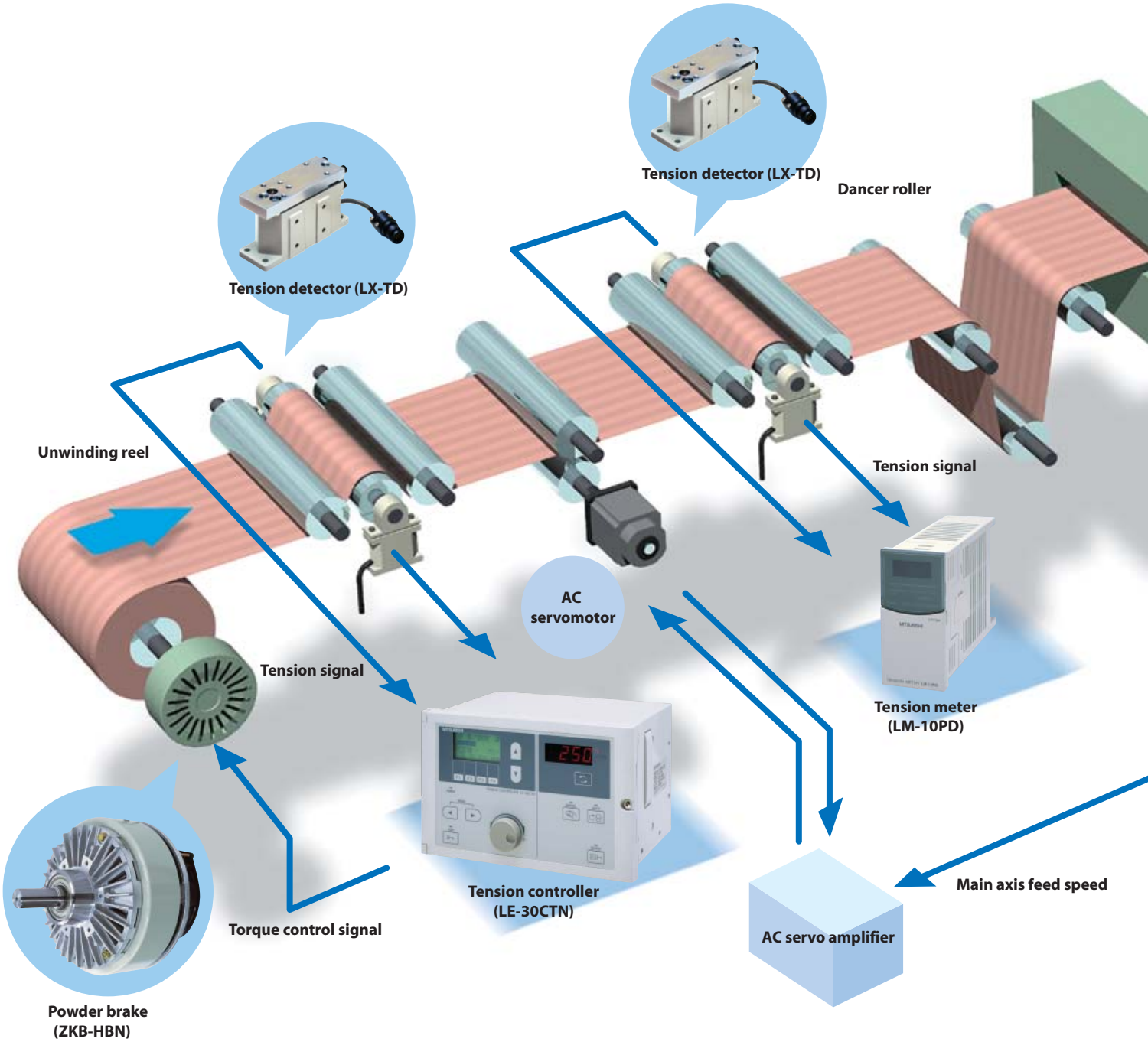
Other Products

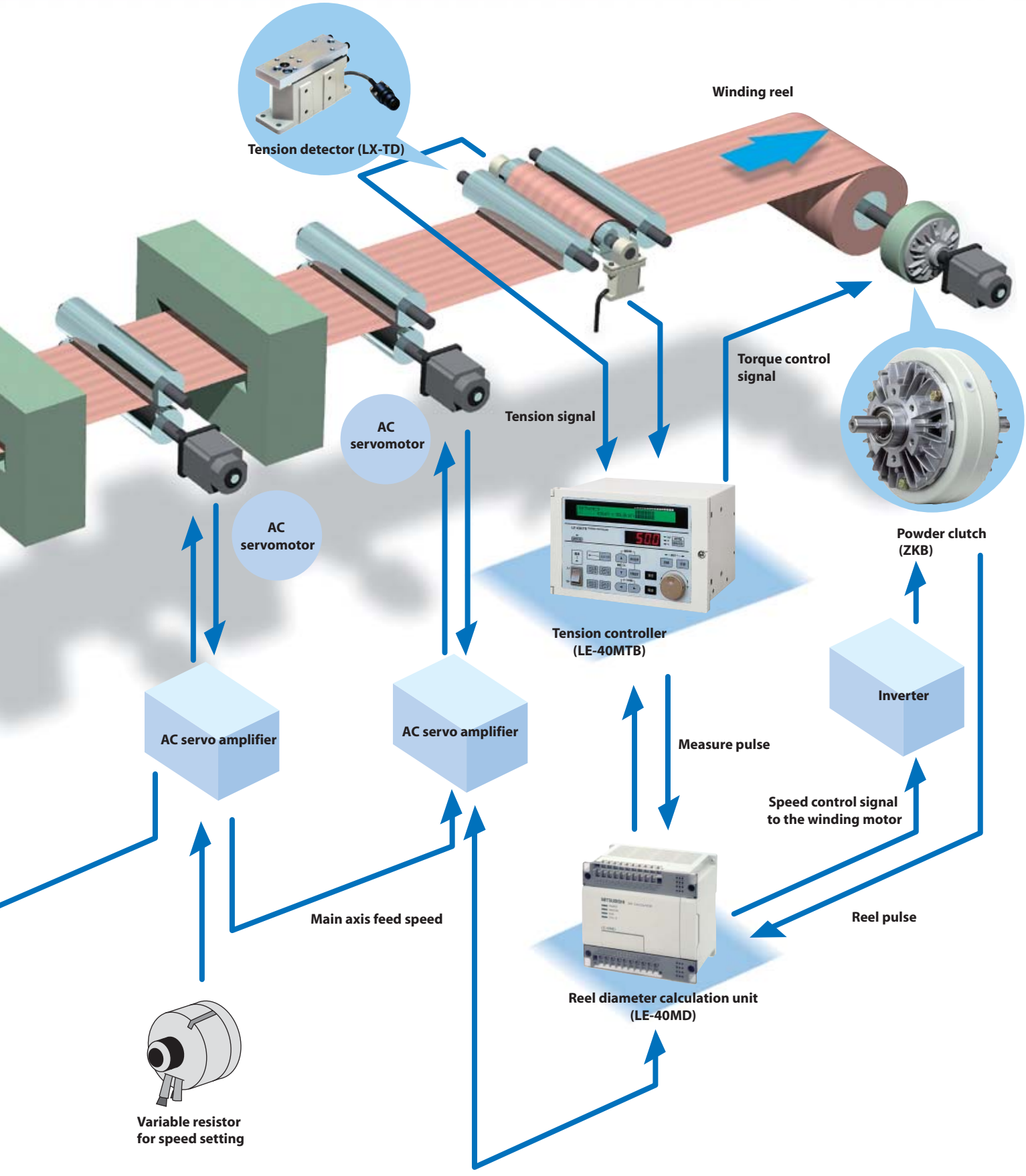
Tension Controllers

Index

System components for winding/unwinding machinery that are available from Mitsubishi

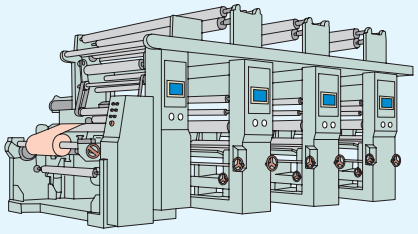
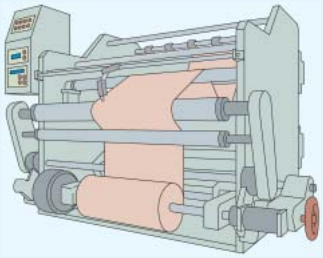
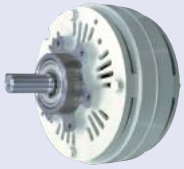
The ability of winding/unwinding machinery to control material tension is a key factor in high-speed, high-efficiency processing of long, thin materials, such as paper, film, thread, electric wire, tape, and other various sheet-like materials.
Being a general electric appliance manufacturer, Mitsubishi Electric Corporation is prepared to offer you a wide array of system components from actuators, such as clutches and brakes, to tension controllers that control these devices.



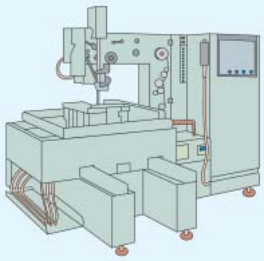

Tension detector (LX-TD)
Winding reel
Torque control signal
Tension signal
AC servomotor
AC servomotor
Powder clutch (ZKB)
Tension controller (LE-40MTB)
Inverter
AC servo amplifier
AC servo amplifier
Measure pulse
Speed control signal to the winding motor
Main axis feed speed
Reel pulse
Reel diameter calculation unit (LE-40MD)
Variable resistor for speed setting

Guaranteed superior performance in any application

A wide range of product lines to choose from for a variety of applications.

Machinery type	Printing machinery	Paper processing machinery
Machine type	 ● Offset rotary press ● Gravure rotary press ● Business form rotary press	 ● Bag making machine ● Laminator ● Slitting machine ● Cardboard machine
Products by purpose		
Powder clutches and brakes Hysteresis clutches and brakes	 ZKB-AN & BN model Powder clutches Torque range: 0.6~400 N·m	 ZA-A1 model Powder clutch Torque range: 0.6~400 N·m
	 ZKB-XN & YN model Powder brakes Torque range: 0.6~400 N·m	 ZKB-XN model Powder brake Torque range: 0.6~400 N·m
	 ZKB-WN model Powder brake Torque range: 25~400 N·m	 ZKB-HBN model Powder brake Torque range: 25~400 N·m
Tension controllers Power amplifiers	 LE-40MT series LE-30CTN model LD-30FTA model	 LE-40MT series LE-30CTN model LD-30FTA model Tension controller
	 LX-TD model Tension detector	
Sample applications		
	● Winding/unwinding tension control (LE-40MT, LE-30CTN, ZKB, ZA) ● Countershaft tension control (LX-TD, ZKB-B) (LE-40MT, LE-30CTN)	● For winding/unwinding materials such as tape, cellophane, film, and aluminum foil (LE-40MT, LE-30CTN, ZKA-W, ZKB-B) ● For unwinding operation of paper surface processing machines (LE-40MT, LE-30CTN, ZKA-W, ZKB-HBN) ● For unwinding operation of film coating machines (LE-40MT, LE-30CTN, ZKB-X) ● For winding operation of film slitters (ZA-A)

Metal processing machinery



- Rolling machine
- Wiredrawing machine
- Presser
- Welding machine
- Wire forming machine
- Cutting machine
- Tube making machine
- Spooling machine

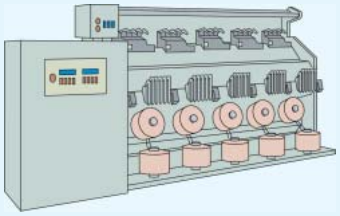
ZKG-YN model
Micro powder brake
Torque range:
0.5~5 N·m

ZKB-XN model
Powder brake
Torque range:
0.6~400 N·m

LD-30FTA model
Tension controller

- For constant tension winding (ZKB-A, ZKG-AN)
- Clutches for wire rope winding (ZKB-B)
- Unwinding brakes (ZKB-X)
- Tension controllers (LD-30FTA)

Textile machinery



- Textile twisting machine
- Preparatory machine
- Spinning machine

ZHA model
Hysteresis clutch
Torque range:
0.06~6 N·m

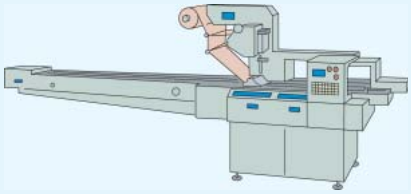
ZKG-AN model
Micro powder clutch
Torque range:
0.5~10 N·m

ZKB-HBN model
Powder brake
Torque range:
25~400 N·m

LE-50PAU model
Power amplifier

- For controlling unwinding tension of sizing machines (ZHY, ZKG-Y, ZKB-HBN)
- Unwinding and idle brakes (ZKB-X, ZA-Y)
- Power amplifiers (LE-50PAU)

Packaging and packing machinery

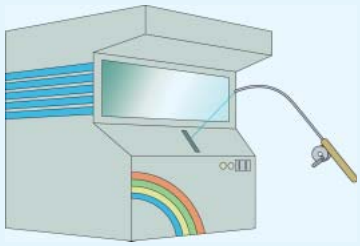


- Wrapping machine
- Packing machine
- Packaging machine

ZX-YN model
Powder brake
Torque range:
3~12 N·m

LD-05ZX model
Tension controller
LL-05ZX model
Power supply device

- Brakes for packing machines (ZX-YN)
- Tension control devices (LD-05ZX, LL-05ZX)

Machinery type	Food processing machine	Miscellaneous machine
Machine type	 ● Meat slicer ● Bottling machine ● Confectionary machine ● Noodle making machine	 ● Speed reducer ● Plating machine ● Game machine ● Lab machine ● Paper machine ● Resin finishing machine ● Fishing machine ● Other types of machinery
Products by purpose		
Powder clutches and brakes Hysteresis clutches and brakes	 ZX-YN model Powder brake Torque range: 3~12 N·m	 ZKG-AN model Micro powder clutch Torque range: 0.5~10 N·m  ZHY model Hysteresis brake Torque range: 0.03~10 N·m
Sample applications	● Tension control (ZX-YN, LL-05ZX, LD-05ZX)	● Game machines (ZKG-AN) ● Load test devices, Inching machines (ZKG, ZKB, ZHY)

Powder Clutches and Brakes

Only Mitsubishi can offer this wide lineup for a variety of applications.

ZKG model micro powder clutches and brakes


ZKG-AN model clutch


ZKG-YN model brake

- Solid shaft.
- Compact Micro series.
- Operational from around 5 r/min.
- Controllable torque range between 3 and 100% (at or less 1000 r/min).

ZX model powder brakes


ZX model brake

- Through shaft.
- Thin, low-profile design.
- Operates on 80V DC and delivers superior cost-performance (Operable by a dedicated remote controller).
- Operational from around 5 r/min.
- Controllable torque range between 10 and 100%.

ZKB model powder clutches and brakes


ZKB model clutch


ZKB-HBN model brake

- Split shaft.
- A variety of cooling options are available (e.g., spontaneous cooling, forced-air cooling, water cooling, thermo block).
- Operational from around 5 r/min.
- Controllable torque range between 1 and 100%.

ZA model powder clutches and brakes


ZA-A model clutch


ZA-Y model brake

- Through shaft.
- High allowable heat dissipation, regardless of its spontaneous cooling design.

ZHA·ZHY model hysteresis clutches and brakes


ZHA model clutch


ZHY model brake

- Wide torque range regardless of size.
- High durability with no parts in mechanical contact.
- Stable operation and precise repeatability.
- 100% transmission efficiency.

Tension Controllers

A variety of control options are available—from fully automatic to manual control—to allow you to choose the best product for your cost and performance needs.

LE-30CTN

- Tension feedback control system with a tension detector.
- Built-in power amplifier (24V DC 3A).
- Settings can be stored in the memory cassette.
- Operation data can be stored and read out using the menu functions.
- Dot matrix LCD display.
- Quick and easy function selection with the function keys.

LE-40MTA/MTB-E

- Tension feedback control system with a tension detector.
- Built-in power amplifier (24V DC 4A).
- Settings can be stored in the memory cassette. Simple and easy batch copying of settings.
- Features a menu function and a PLC linking function (LE-40MTB-E).

LE-40MD

- Reel diameter calculation unit for exclusive use with the LE-40MTB model control device.
- High-precision reel diameter calculation based on the ratio calculation.
- High-precision taper tension control is possible, based on the reel diameter signal.
- Controls slip the rotation speed when used for winding with the use of a powder clutch.
- Easily adoptable for two-axis switchover control.

LD-30FTA

- Open-loop controller that operates based on the integrated thickness monitoring method.
- Operation data can be stored and read out using the menu functions.
- Features a built-in nonlinearity compensation function for powder clutches/brakes.
- With the addition of the optional analog input board, the LD-30FTA model can be configured to accept a signal from the ultrasound sensor or touch lever.
- Enables linear taper tension control.

LE-50PAU-SET

- Open-loop controller that consists of the LE-50PAU model power amplifier and the LE-5AP model operator panel.
- Two types of reel-diameter based control, pulse detection method and speed/thickness setting method (sensorless), are possible.
- Features a built-in nonlinearity compensation function for powder clutches/brakes.
- Enables 3-stage nonlinear taper tension control.

LE-50PAU

- Compact power amplifier capable of constant-current and constant-voltage control.
- Rated power output: 24V DC 4A.
- Features a built-in nonlinearity compensation function for powder clutches/brakes. Superior torque-to-input signal linearity.

LD-40PSU

- Output adjustment by external signal. Variable constant voltage power supply unit with a built-in output ON/OFF function.
- Rated power output: 24V DC 3.8A.

LD-05TL

- Power supply unit for use with powder clutches and brakes that are rated 24V DC 0.5A or less.
- Enables an open-loop tension control when combined with a touch lever.

LL-05ZX/LD-05ZX

- For exclusive use with the ZX type powder brakes that are rated 80V. Offers extremely economical control.
- Available in two types: Manual operation (LL-05ZX) and open-loop tension control based on the unwinding reel diameter (LD-05ZX).

LX- □□□ TD/LX- □□□TD-909

- Differential transformer type tension detector.
- To be used in conjunction with a tension feedback controlled controller or a tension meter.
- LX- □□□TD-909 models are intrinsically safe tension meter that are certified to Ex ia IIB T4 and are used in conjunction with the LX-05BRR model safety barrier.

LM-10PD

- LM-10PD is a tension meter that, when used in combination with the LX- □□□ TD type tension detector, displays tension or outputs tension-proportionate signals.

LM-10TA

- LX-10TA is a compact-size tension amplifier that displays tension or receives tension-proportionate signal inputs when used in combination with the LX- □□□ TD type tension detector.
- Usable for centralized or remote display of tension and for tension control and management.

Clutch and Brake Comparisons

Comparisons

Powder vs. Hysteresis	Powder	Hysteresis
Dimensions	Normal	Large
Torque change according to slip rotation speed	Practically none	Practically none
Heat dissipation	Smaller than hysteresis type	Large
Restrictions for mounting	Some, Diagonal installation or vertical axis installation, for example, is not allowed	None
Product life/Maintenance	Requires maintenance	Long-life
Price	Low	High

Powder clutch/brake vs. Friction disc clutch/brake	Powder clutch/brake	Magnetic disc clutch/brake
Dimensions	Large in all dimensions	Compact
Torque control	Easy and simple	Complex
Slip on the friction surface	Operational under continuous slip	As a general rule, not allowed
Engaging energy	Large	Small
Restrictions for installation	Some, Diagonal installation or vertical axis installation, for example, is not allowed	Practically none
Price	High	Low
Usage	Especially suitable for cushioned start, tension control, and torque limiting	General engaging and braking

Comparison by power-feeding method to the electromagnetic coil	Stationary coil clutch/brake	Rotating coil clutch/brake
Dimensions	Somewhat large, especially in the axial dimension	Compact
Structure	Somewhat complex with the ball bearings etc.	Simple
Power supply system	Simple	Wet-type has a risk of electric shock if not used properly
Restriction on rotation speed	No (Subject to other restrictions)	Not usable at high-speed rotation
Installation into the clutch box	Easy	Somewhat complex, requiring installation of a brush
Maintenance	Nearly maintenance-free	The brush requires replacing

Selection criteria

Function	Operating Principles	
	Powder	Hysteresis
Clutch actuation	○	○
Braking	○	○
Forwarding and reversing	○	○
Speed modulation	△	△
Inching	△	△
Frequent start/stops	○	○
Emergency braking	×	×
Cushioned start/stops	◎	◎
Tension control	◎	◎
Torque limiting	◎	◎
Energy absorption	◎	◎

◎Very Suitable ○ Suitable △Not Very Suitable × Unsuitable

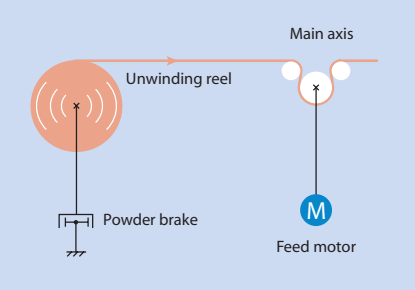
To select the best option, it is essential to have a solid understanding of the operating principles, performance characteristics, and features of different models.
First, select the type of magnetic brake or clutch that suits the purpose. General suitability of the two major types of electromagnetic clutches and brakes for various purposes is shown in the left table as a reference.

Once it is determined which type of brakes/clutches (out of powder and hysteresis types) is better suited for a given purpose, select the most suitable model, taking such factors as operating condition (i.e., in oil or in the atmosphere?), usage environment, load condition, and operation frequency into consideration. Refer to the "Selection criteria and selection examples" for each model for information on the calculation formula.

Usage and Control Methods

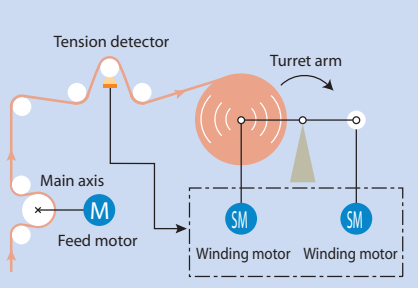
Winding, unwinding, and countershaft control

■ Unwinding control



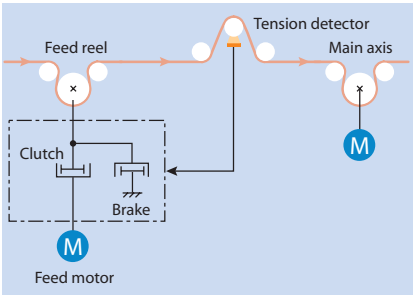
- The left figure shows the scheme of an unwinding control system that uses a powder brake.
- Since unwinding tension equals braking torque divided by unwinding radius, tension can be kept constant by reducing the braking torque according to the decrease in winding diameter.
- An accelerator or a decelerator may be installed between the winding reel shaft and powder brake for the gear as necessary.

■ Winding control



- The left figure shows the scheme of a two-axis switchover winding control system that has a servomotor.
- This is an example of a feedback controlled tension control system based on the signals from the tension detector and in which a pre-drive control for the auto feeder is also performed.

■ Intermediate control

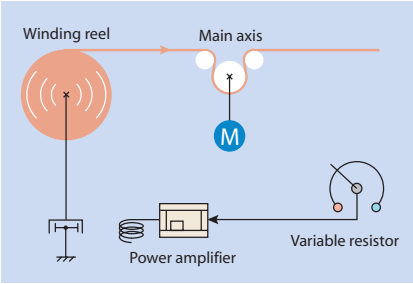


- The left figure shows the scheme of an in-feed control system that uses a powder brake and a powder clutch.
  In-feed control systems include a feed motor before the main shaft motor, while outfeed systems include a feed motor after the main shaft motor.

Usage and Control Methods

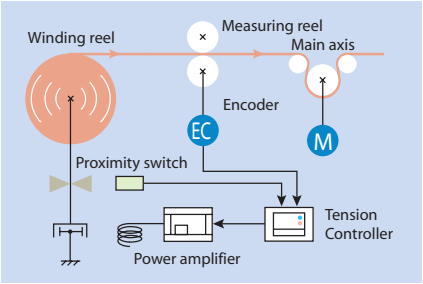
Types of Tension Control

■ Manual control



- Manual control of winding or unwinding tension and of countershaft tension in a system that uses a clutch/brake and only has small variations in reel diameters.
- Performs sudden control during stoppage and remote operation of the variable resistor.

■ Semi-automatic control



- Braking torque and winding torque are controlled according to the reel diameter that is detected contactlessly.
- There are five types of reel diameter-detection methods. Those with fewer sensors require more settings to be made.

  ①Speed/thickness setting..... sensorless

  ②Detection by integrated thickness monitoring method..... single sensor (reel)

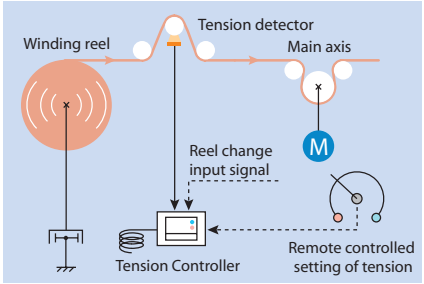
  ③Pulse calculation method..... double sensors

  ④Touch lever method..... potentiometer

  ⑤Detection by ultrasound sensor..... ultrasound sensor

  The above figure shows the scheme of a system that operates on ratio calculation of reel pulse and measure pulse.

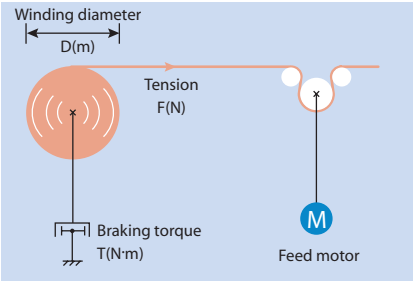
■ Fully automatic control



- A closed-loop tension control system with a tension detector is called a fully automatic system.
- When performing externally sequenced multiple-axis switchover control, new reel preset control is performed, based on the reel change input signal.

Tension control by torque control and by speed control

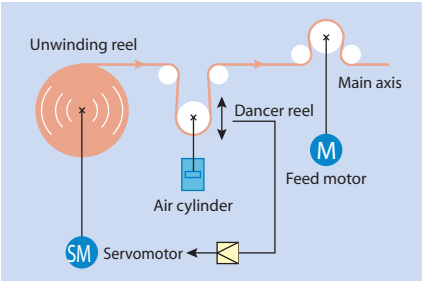
■ Tension control by torque control



- As is shown in the figure above, when the braking torque of the powder brake for the unwinding reel is T(N•m), the tension (F) of the unwound material equals 2T/D (N).
- Tension is kept constant by decreasing the braking torque according to the decrease in the winding diameter D (m).
- "Tension control by torque control" refers to the type of tension control system, such as the one shown in the figure above, in which braking torque or winding torque is applied to the winding or unwinding shaft.

This system requires no dancer reels and can accommodate simple manual or semi-automatic tension controllers. In this system, a powder clutch/brake, hysteresis powder clutch/brake, or servomotor (torque mode) can be used as an actuator.

■ Tension control by speed control



- "Tension control by speed control" or "dancer-controlled tension control" refers to the type of system, such as the one shown in the figure above, in which the rotation speed of the unwinding reel or feed shaft is controlled to keep the dancer reel in the target position. The position of the dancer reel is detected by a potentiometer.
- Since the dancer reel moves down when the in-feed speed is too fast, and moves up when it is too slow, this system requires speed responsiveness and a stability of control operation. The absolute precision of tension, however, depends on the precision of the air pressure.

  (Please note that Mitsubishi does not offer products for use in the above type of system.)

This system is suitable for lower tension control in a system with small operation tension in proportion to the inertia compensated tension at acceleration or deceleration or for a system that is designed to handle materials with low elasticity. A servomotor is used as the actuator in this type of system.

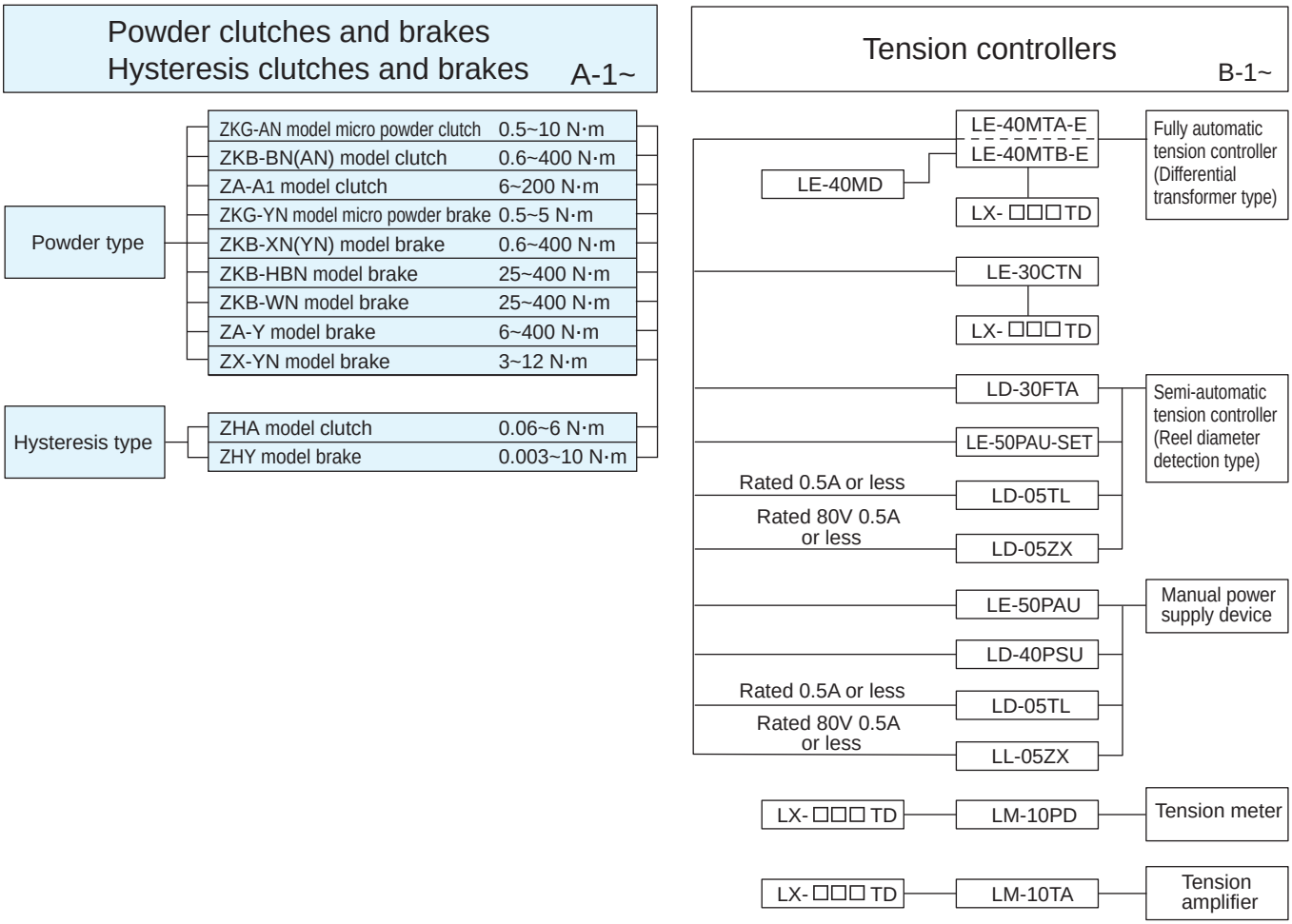
Clutches and Brakes

- Powder clutches and brakes
- Hysteresis clutches and brakes

Contents

Electromagnetic Clutches and Brakes

■ Product Structure (Shaded areas indicate products that are introduced in this chapter.)



Powder Clutches and Brakes

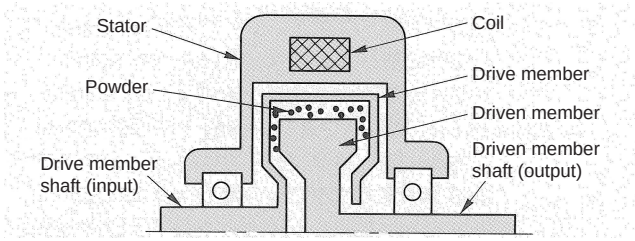
Features

Mitsubishi powder clutches and brakes use magnetic metal powder to transmit torque, which combines the smoothness of fluid clutches and high efficiency of friction disc clutches at clutch/brake engagement. Being a pioneer in the field of powder clutches/brakes, Mitsubishi Electric boasts of a wide range of products that are suitable for various applications, which have been developed through years of accumulated experience and know-how. Along with their numerous innovative and advanced features, Mitsubishi's powder clutches/brakes are used as actuators for winding/unwinding systems (paper, strings, electric wire, various sheet-type materials, and tapes) and play indispensable roles in tension control systems. They are also suitable to use for cushioned start, power absorption, or as overload safety device (torque limiter).

1. **Easy wide-range torque control**
   Transmission torque control over a wide range can be achieved easily, for transmission torque changes in proportion to the exciting current.
2. **Usable under continuous slip conditions**
   With the use of powder to transmit torque, continuous slip on the operating surface is possible, and since transmission torque is independent of slip rotation speed, torque transmission performance is always stable.
3. **Stable torque transmission**
   With an ideal operating surface and labyrinth shape, torque stability is maintained, even when the current is repetitively cycled ON/OFF.
4. **Large heat capacity**
   Mitsubishi's brakes and clutches use highly heat-tolerant powder and have an ideal cooling structure that can be used under extremely demanding continuous slip conditions.
5. **Smooth engagement and driving**
   Coefficients of static and dynamic frictions are nearly equal, which eliminate shocks during complete engagement and allows load-proportionate acceleration/deceleration.

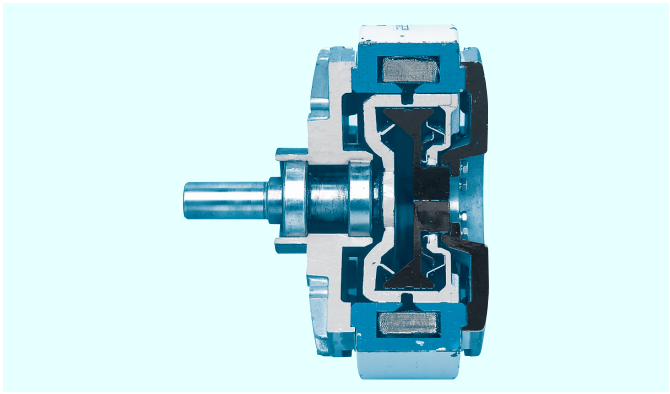
Basic structure and operation

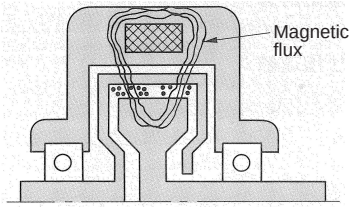
The right figure shows the basic structure of the powder clutch. The powder clutch consists of two concentric, cylindrical parts–a driving member (input side) and a driven member (output side)–that are assembled together in such a way so that there is a narrow gap called a "powder gap" between them. These members are supported by bearings so that they can rotate freely.
This gap is filled with a highly magnetic permeable powder (magnetic metal powder), where an exciting coil is positioned on the outer peripheral to supply an exciting current to the powder.
When the coil is not excited and the driving member is rotating, the powder becomes pressed against the operating surface of the driving member by the centrifugal force, and the driving member and the driven member remain disengaged.
When the coil is excited, magnetic flux passes through the powder and the powder becomes attracted between the pole faces in chain-like clusters. Torque is, then, transmitted by the linking power between the powder particles and by the friction between the powder and the operating surface.
Therefore, the powder clutch can be thought of as a friction clutch that uses magnetic metal powder as a torque transmission medium. When the driven member (output side) is fixed, it becomes the powder brake.



Without excitation
When the coil is not excited, the clutch becomes disengaged and torque is not transmitted. During this time, the powder is pressed against the outer peripheral of the powder gap by the centrifugal force.

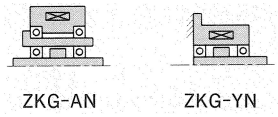
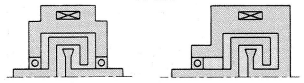
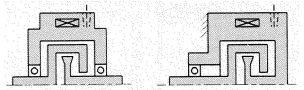
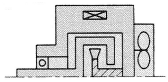
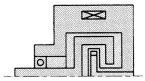
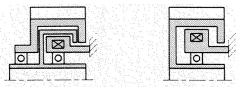
Cross-sectional view of the ZKB-XN model powder brake





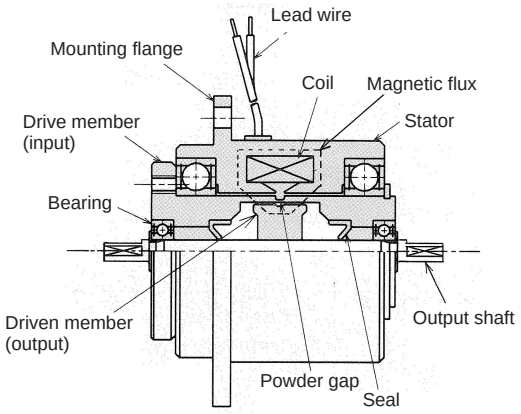
With excitation
When the coil is excited, the powder becomes chained together inside the powder gap due to magnetic flux and torque is transmitted.

Product lineup

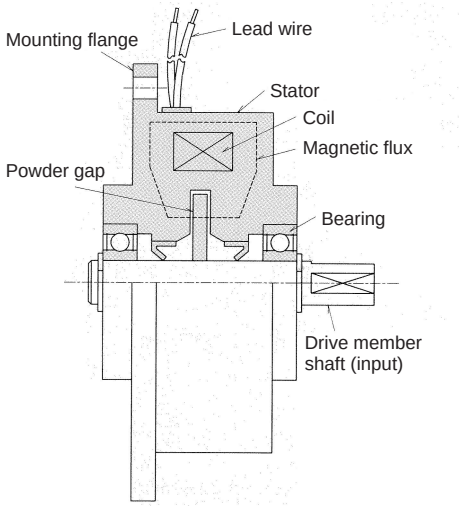
Shaft type	Cooling method	Clutch	Brake	Torque range N·m	Characteristics	Basic structural drawing	Page
Solid shaft	Spontaneous cooling	ZKG-AN	ZKG-YN	ZKG-AN 0.5~10 ZKG-YN 0.5~5	• Compact Micro series • Small rotation moment of inertia • Operable from 5 r/min or more	 ZKG-AN ZKG-YN	A-10 ~ A-11 A-20 ~ A-21
		ZKB-AN	ZKB-YN	0.6~6	• Operable from 5 r/min or more	 ZKB-AN ZKB-YN	A-12 ~ A-13 A-22 ~ A-23
	Both spontaneous and forced-air cooling	ZKB-BN	ZKB-XN	12~400	• Operable from 5 r/min or more • Increased heat capacity with air being blown into the air gap	 ZKB-BN ZKB-XN	A-14 ~ A-17 A-24 ~ A-27
	Thermo block	–	ZKB-HBN	25~400	• Increased heat capacity by using thermo block for the driven member and adding an axial fan • Operable from 5 r/min or more	 ZKB-HBN	A-28 ~ A-29
	Water-cooled	–	ZKB-WN	25~400	• Increased heat capacity by providing a water channel on the driven member • Operable from 5 r/min or more	 ZKB-WN	A-30 ~ A-33
Hole shaft	Spontaneous cooling	–	ZX-YN	3~12	• Ultra thin profile • Operates on 24V DC • Operates on 80V DC • Operable from 5 r/min or more	 ZX-YN	A-38 ~ A-39
		ZA-A_1	ZA-Y	ZA-A_1 6~200 ZA-Y 6~400	• Improved heat dissipation and increased heat capacity with a rotating outer peripheral • Operable from 15 r/min or more	 ZA-A_1 ZA-Y	A-18 ~ A-19 A-34 ~ A-37

Structural drawings (representative examples)

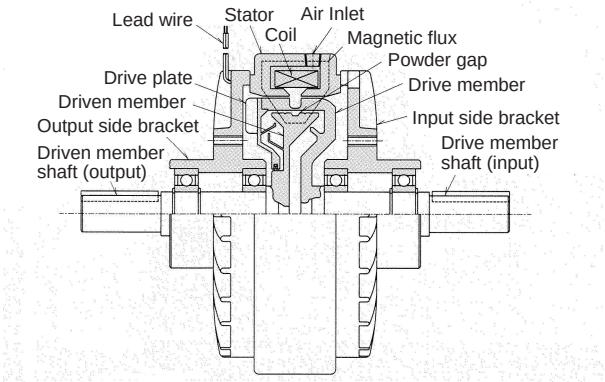
ZKG-AN structural drawing (representative example)



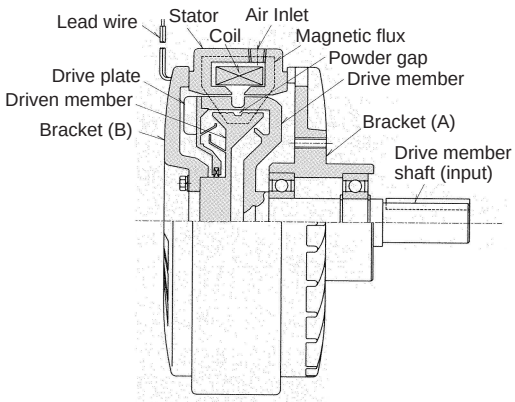
ZKG-YN structural drawing (representative example)



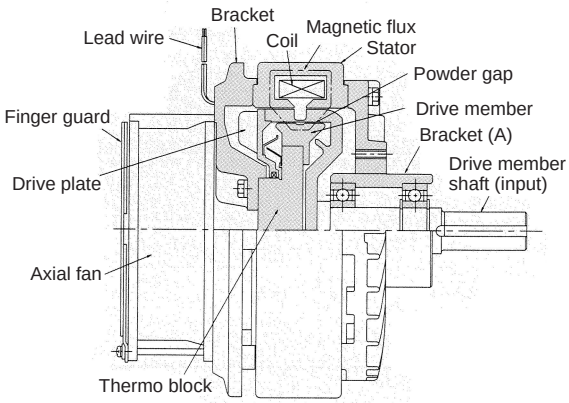
ZKB-BN structural drawing (representative example)



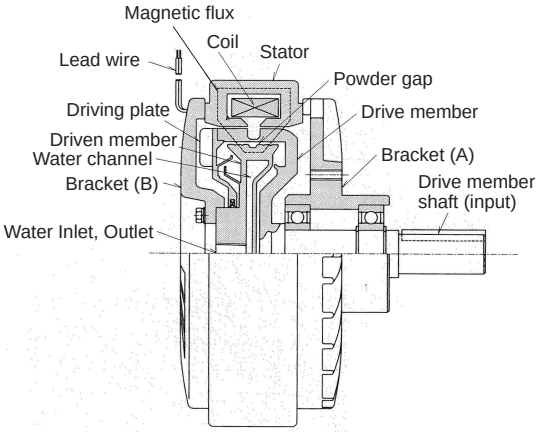
ZKB-XN structural drawing (representative example)



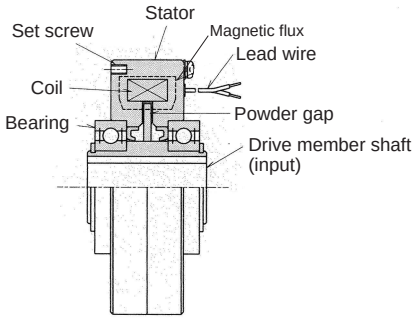
ZKB-HBN structural drawing (representative example)



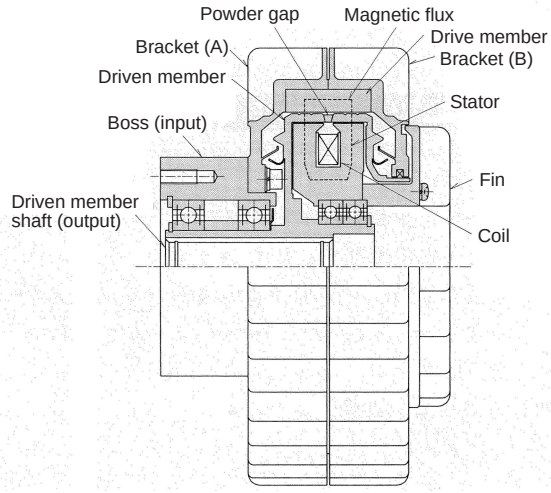
ZKB-WN structural drawing (representative example)



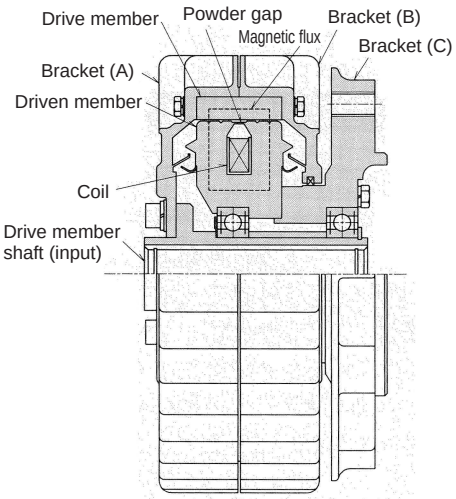
ZX-YN structural drawing (representative example)



ZA-A1 structural drawing (representative example)



ZA-Y1 structural drawing (representative example)



Performance

1. Torque to exciting current characteristics

Figure 1 shows the typical torque to exciting current characteristics of the powder clutch. Torque changes in proportion to exciting current over a wide range, indicating good torque controllability. The approximate range in which torque changes in proportion to exciting current is between 5 and 100% of the rated torque, although there are some variations between different models.

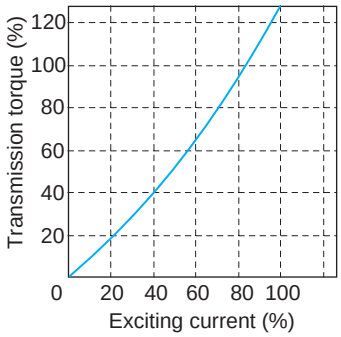


Figure 1. Torque to exciting current characteristics (representative example)

2. Torque to slip rotation speed characteristics

Figure 2 shows the torque to slip rotation speed characteristics with the electric current being set as a parameter. As shown in the figure, torque can be kept constant by keeping the exciting current constant, regardless of the slip rotation speed (difference between the rotation speed of the driving and driven members), which is made possible by the use of what may be called "semisolid" magnetic metal powder as a medium for power transmission. In other words, there is no difference between static and dynamic friction coefficients.

This characteristic allows powder and brakes to be used under continuous slip conditions, and when combined with a large heat capacity, the products can be used in a wider range of applications where tension control and cushioned start are needed.

Simple and precise torque control is possible merely by controlling the exciting current without having to worry about the change in the slip rotation speed of clutches and brakes that varies with the reel diameters.

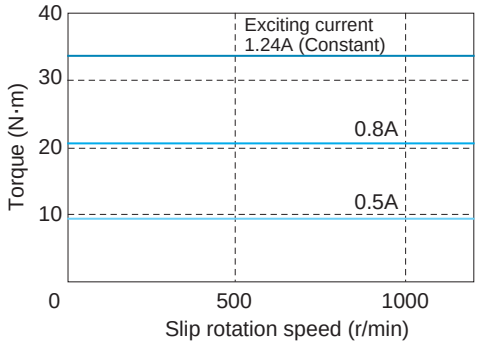


Figure 2. Torque to slip rotation speed characteristics

3. Operating characteristics

This section explains the operating characteristics that are necessary for controlling startup time or for performing frequent repetitive actions.

Figure 3 shows the operations of the powder clutch during engagement and disengagement. When voltage is applied to the exciting coil, exciting current rises exponentially according to the formula T = L/R, where the resistance of the exciting coil is represented by R, inductance is represented by L, and time constant, which equals L divided by R, is represented by T. Torque is independent of the slip rotation speed on the driving or the driven side; it goes up to the preset level of torque according to the exciting current with a slight lag behind the exciting current. This torque provides the force to accelerate the load. In other words, preset torque can be reached without a perfect engagement of the drive and driven members. Combined with the large heat capacity of the clutch, this characteristic is an ideal characteristic for cushioned start/stops or high-speed start/stops.

When rapid engagement or braking is required, torque startup time can be shortened by adding series resistance to the coil to decrease the time constant and the exciting the coil with a high voltage power supply, or by overexciting the coil through applying two to three times the rated voltage only during startup.

Torque startup time at the rated excitation level is approximately four to five times the coil time constant. Torque decay time is approximately 1T.

Refer to the specification table for the coil constant of each model.

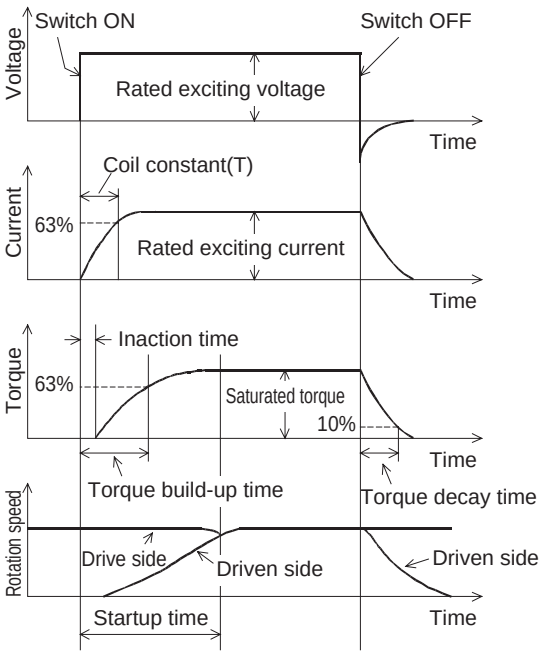


Figure 3. Operating characteristics of the powder clutch

4. Allowable continuous heat dissipation rate

Although powder clutches/brakes can be used under continuous slip conditions, they must be used below the allowable continuous heat dissipation rate that is set for each model in order to restrict the temperature rise of the powder and various clutch/brake components caused by continuous slip.

The allowable continuous heat dissipation rate depends on the cooling methods, such as spontaneous or forced-air cooling, and the value is set for each model. In the case of spontaneous cooling, note that the value can change according to the input rotation speed. Refer to page A-40 for the formula to calculate continuous heat dissipation.

5. Allowable engaging energy

When starting up or braking a load that carries inertia with a powder clutch/brake, frictional heat is generated between the powder and operating surface. This heat raises the temperature of certain components, including the powder. If excessive heat is generated, the temperature of the friction surface becomes abnormally high. The allowable engaging energy is set for each model to prevent overheating, and this limit must be observed to prevent damage to the clutch/brake.

6. Residual torque

Residual torque is transmitted by a fully disengaged clutch to which exciting current has been completely cut off, due to residual magnetization of the power, grease on the bearings, and the mechanical loss caused by the friction of the seals. Residual torque of the brake cannot be controlled.

The output shaft is rotated by the rotational movement of the input shaft, and as with the case in the brake, residual torque cannot be controlled.

Residual torque varies between different models. Refer to the specifications for each model.

ZKG-AN model micro powder clutch

(Torque 0.5~10 N·m)(Spontaneous cooling solid shaft type)

Features

- Rated torque range: 0.5~10 (N·m)
- Spontaneous cooling solid shaft type
  - Compact-design Micro series
  - Smaller rotational moment of inertia
  - Operable from 5 r/min

Specifications

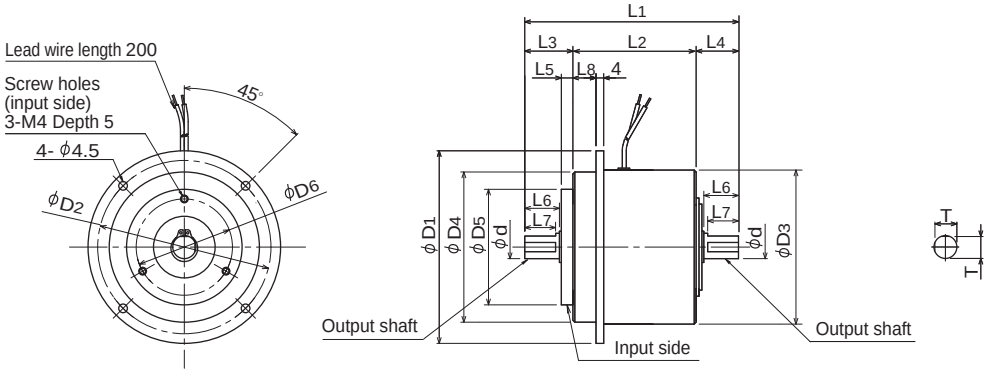
(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)		Allowable rotation speed (r/min)	Product mass (kg)
		Current (A)	Power (W)	Time constant (s)	Input side	Output side		
ZKG-5AN	0.5	0.35	8.4	0.02	2.1×10^{-1}	1.7×10^{-2}	1800	0.67
ZKG-10AN	1	0.47	11.3	0.03	3.46×10^{-1}	4.6×10^{-2}	1800	0.88
ZKG-20AN	2	0.55	13.2	0.06	6.80×10^{-1}	1.03×10^{-1}	1800	1.3
ZKG-50AN	5	0.80	19.2	0.06	1.85	4.0×10^{-1}	1800	2.3
ZKG-100AN	10	1.00	24.0	0.09	5.30	1.10	1800	4.1

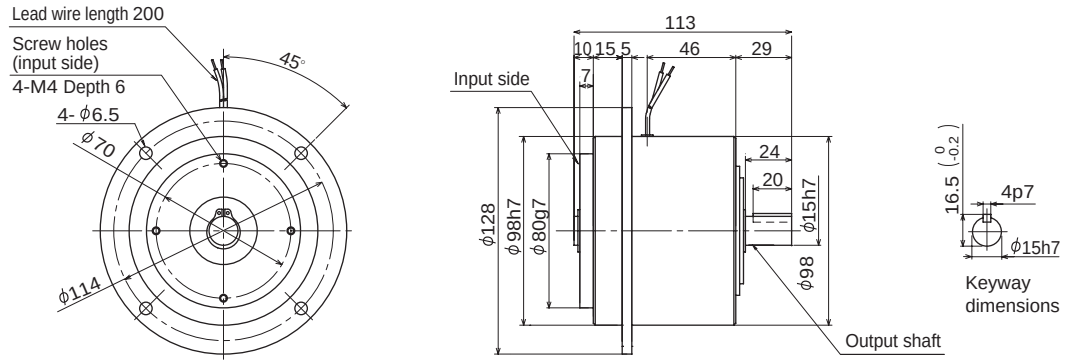
Note: Residual torque is less than 3% of the rated torque at 1000 r/min or less, and less than 5% at 1800 r/min or less.

External dimensions (mm)

ZKG-5AN~50AN



ZKG-100AN

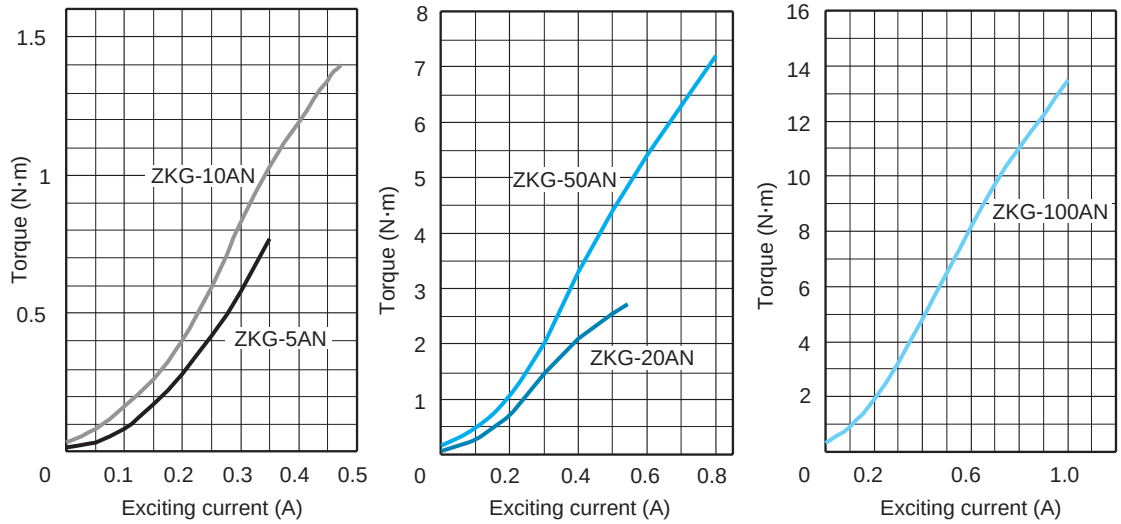


(Outer color: Munsell 10Y 7.5/1)

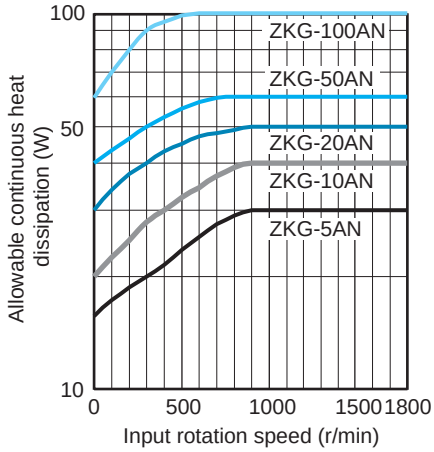
Model	L1	L2	L3	L4	L5	L6	L7	L8	D1	D2	D3	D4 (h7)	D5 (g7)	D6	d (g6)	T
ZKG-5AN	77	47	16.5	13.5	5.5	10.5	9	8.5	70	60	50	48	40	30	5	4.5
ZKG-10AN	83	48.5	18.5	16	5.5	12	10	8.5	76	66	56	54	42	34	7	6.5
ZKG-20AN	95	53	22.5	19.5	6.5	15	13	9.5	85	75	65	63	48	40	9	8.5
ZKG-50AN	111	64	25	22	6	18	16	12	100	90	80	78	60	50	12	11.5
ZKG-100AN	Refer to the figure above.															

Characteristics

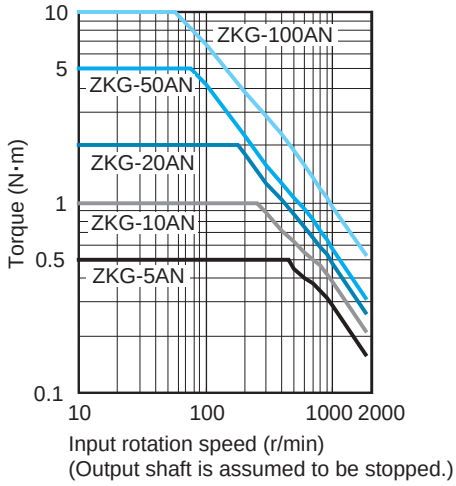
● Standard torque characteristics (representative example)



● Allowable continuous heat dissipation characteristics (See Item 4 under "Sample mounting" for heat radiation surface area.)

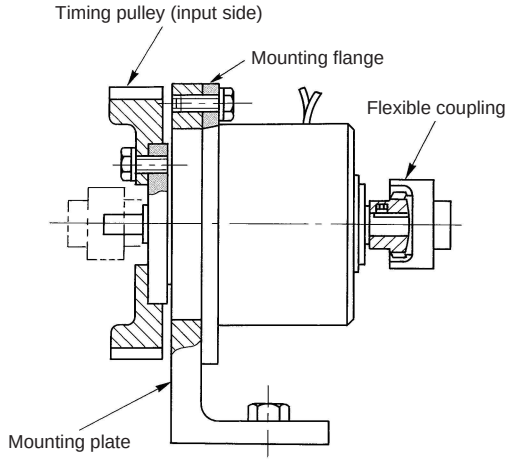


● Allowable continuous slip torque characteristics

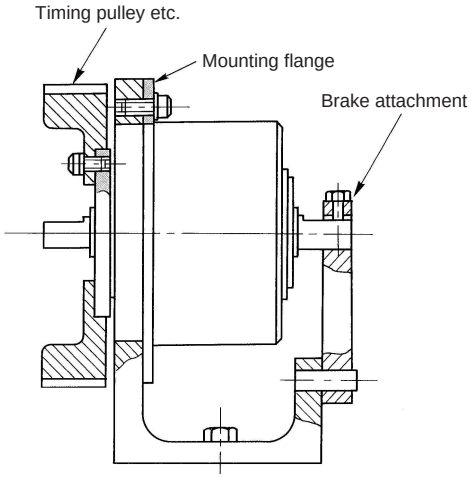


Sample mounting

1. ZKG-AN model powder clutch mounting



2. ZKG-AN model powder clutch used as a brake



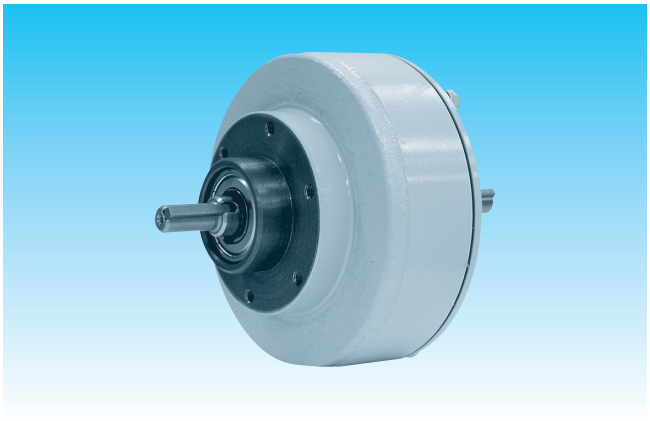
1) Align the mating hole of the mounting flange with its intended mate on the mounting plate and fix it into place.
2) Use flexible coupling to connect the clutch and the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)
4) The heat radiation surface area of the mounting plate must be greater than 350cm^2 (650cm^2 for ZKG-100AN).

ZKB-AN model powder clutch

(Torque 0.6~6 N·m)(Spontaneous cooling solid shaft type)

Features

- Rated torque range: 0.6~6 (N·m)
- Spontaneous cooling solid shaft type
  - Operable from 5 r/min



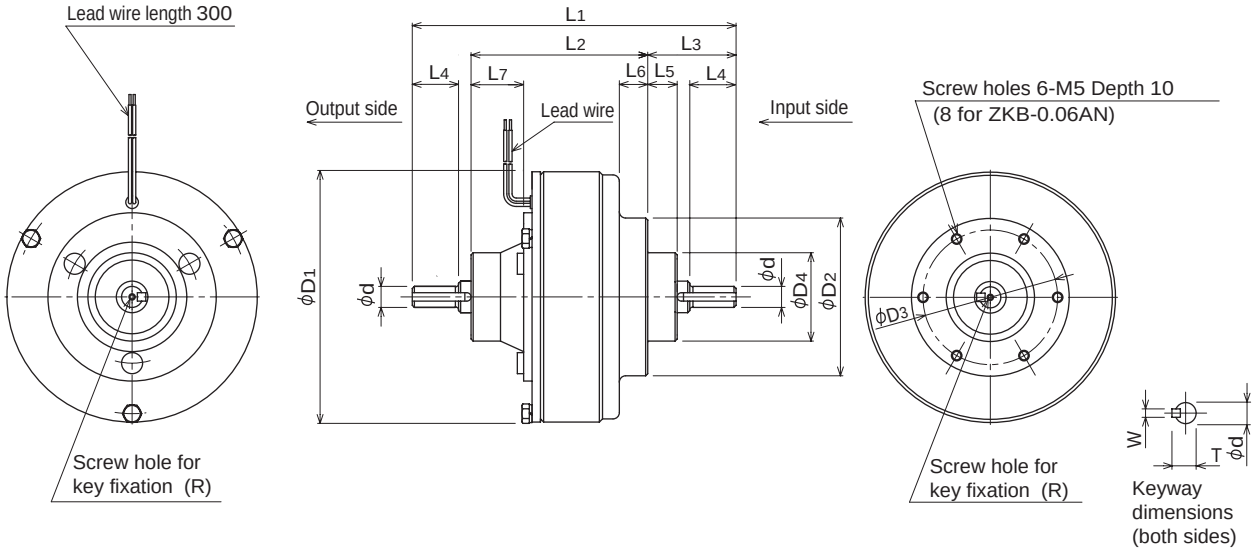
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)		Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)	Input side	Output side			
ZKB-0.06AN	0.6	0.46	11.0	0.03	6.10×10^{-5}	6.60×10^{-6}	1800	1.8	3.5
ZKB-0.3AN	3	0.53	12.7	0.08	3.00×10^{-4}	8.00×10^{-5}	1800	3.3	7.5
ZKB-0.6AN	6	0.81	19.4	0.08	6.00×10^{-4}	1.83×10^{-4}	1800	4	10

Note: Residual torque is less than 4%, 2%, and 1% of the rated torque for 0.06AN, 0.3AN, and 0.6 AN models respectively.

External dimensions (mm)

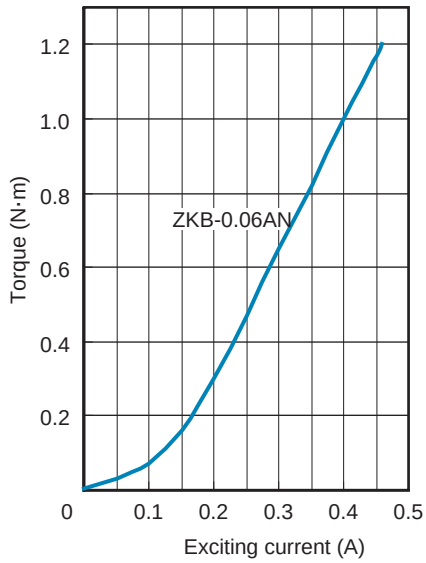


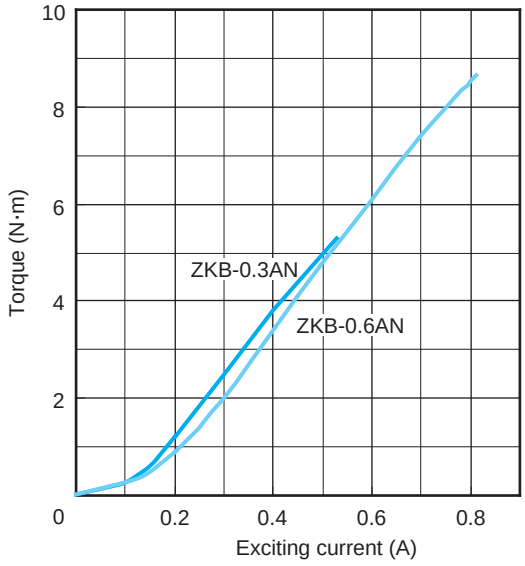
(Outer color: Munsell 10Y 7.5/1)

Model	L_1	L_2	L_3	L_4	L_5	L_6	L_7	D_1	D_2	D_3	D_4 (g7)	Q	R		Keyway		
													Diameter	Depth	d (h7)	W (p7)	T $(^{0}_{-0.2})$
ZKB-0.06AN	132	65	41	22	15	9	16	88	70	55	33	–	–	–	8	3	9.1
ZKB-0.3AN	154	84	42	22	14	13.5	24.5	120	75	64	42	–	M3	6	10	4	11.5
ZKB-0.6AN	164	86	46	26	14	16	22	134	80	64	42	–	M4	8	12	4	13.5

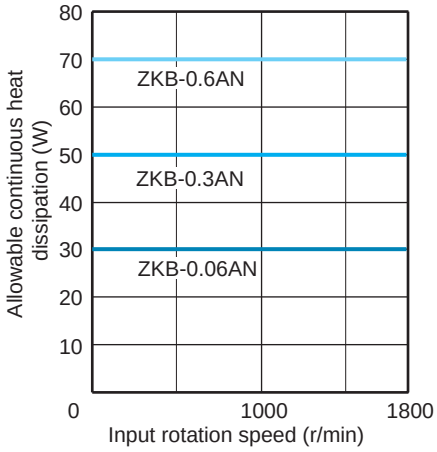
Characteristics

● Standard torque characteristics (representative example)

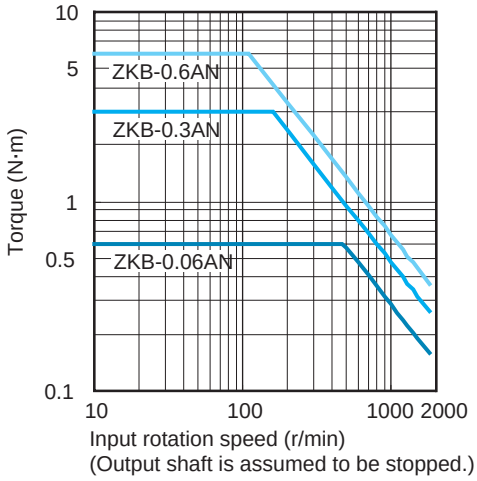




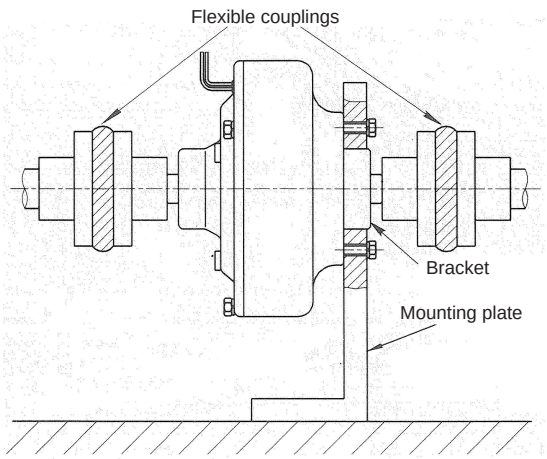
● Allowable continuous heat dissipation characteristics



● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Use flexible couplings to connect the clutch and the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)

ZKB-BN model powder clutch

(Torque 12~50 N·m)(Spontaneous cooling/forced-air cooling solid shaft type)

Features

- Rated torque range: 12~50 (N·m)
- Spontaneous cooling/forced-air cooling solid shaft type
  - Operable from 5 r/min
  - Increased heat capacity by air being blown into the air gap

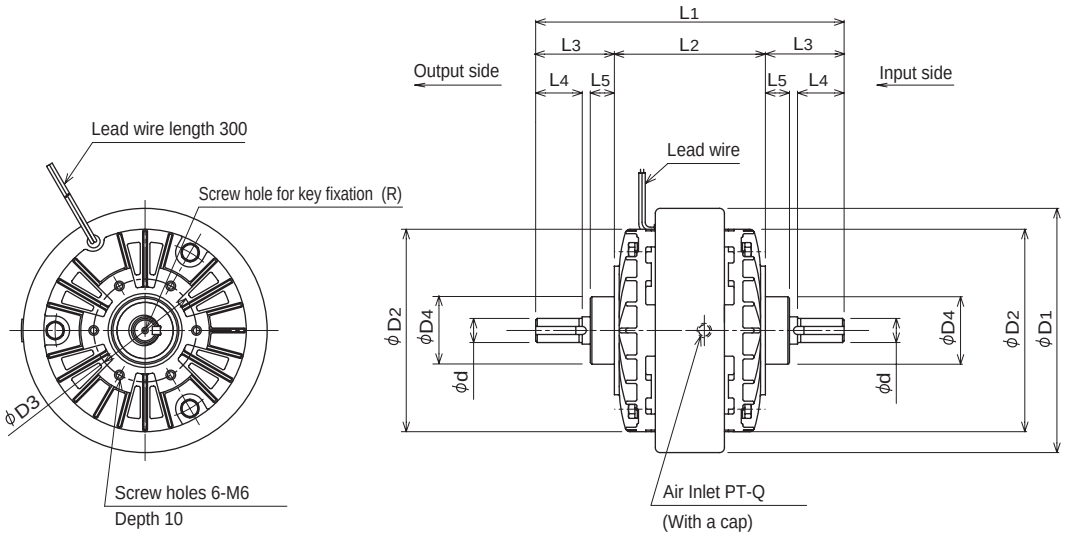
Specifications

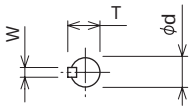
(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)		Forced-air cooling allowable continuous heat dissipation rate*			Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)	Input side	Output side	Air pressure (Pa)	Air flow rate (m^3/min)	Heat dissipation (W)			
ZKB-1.2BN	12	0.94	22.5	0.10	1.34×10^{-3}	4.90×10^{-4}	3×10^{4}	0.2	250	1800	5.5	20
ZKB-2.5BN	25	1.24	30.0	0.12	3.80×10^{-3}	1.49×10^{-3}	5×10^{4}	0.4	380	1800	10	33
ZKB-5BN	50	2.15	51.5	0.13	9.50×10^{-3}	4.80×10^{-3}	1×10^{5}	0.6	700	1800	16	60

Note: 1. * Clean, dry air-filtered air (filtered through a filter capable of complete oil removal) must be used for cooling.
2. Residual torque is less than 1% of the rated torque.

External dimensions (mm)





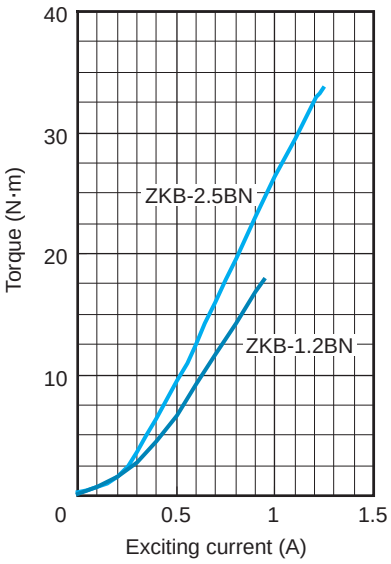
Keyway dimensions
(both sides)

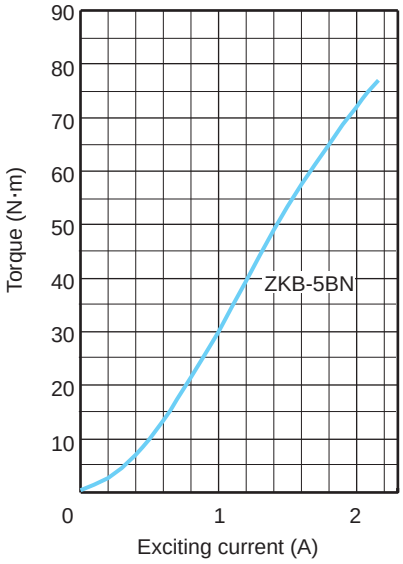
(Outer color: Munsell 10Y 7.5/1)

Model	L1	L2	L3	L4	L5	D1	D2	D3	D4 (g7)	Q	R		Keyway		
											Diameter	Depth	d (h7)	W (p7)	T ($^{0}_{-0.2}$)
ZKB-1.2BN	192	94	49	29	15	152	126	64	42	1/8	M4	8	15	5	17
ZKB-2.5BN	230	102	64	43	17	182	160	78	55	1/8	M5	10	20	5	22
ZKB-5BN	294	112	91	55	30	219	196	100	74	1/4	M6	12	25	7	28

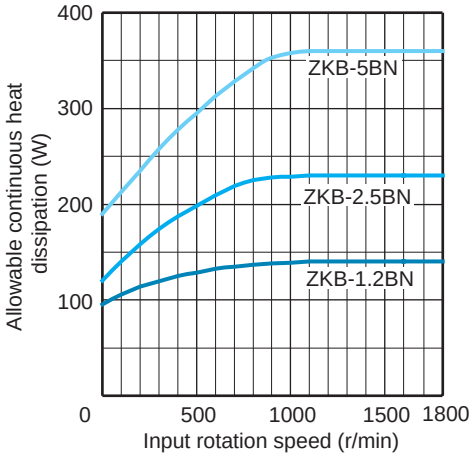
Characteristics

● Standard torque characteristics (representative example)

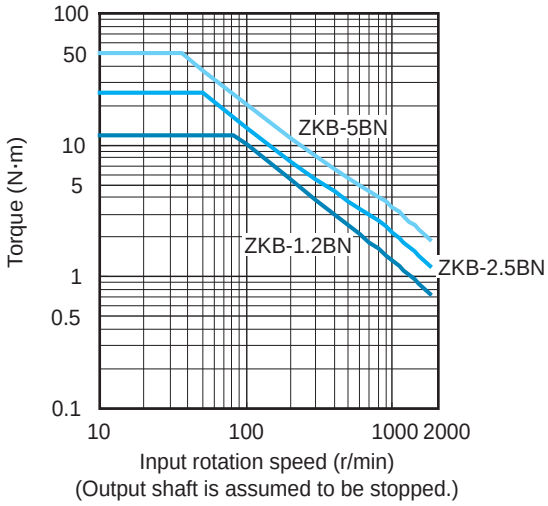




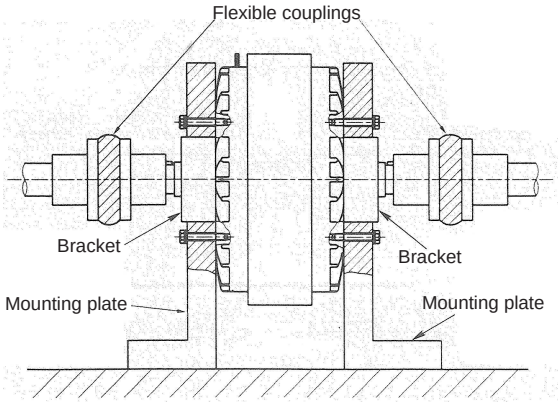
● Allowable continuous heat dissipation characteristics (During spontaneous cooling)



● Allowable continuous slip torque characteristics (During spontaneous cooling)



Sample mounting



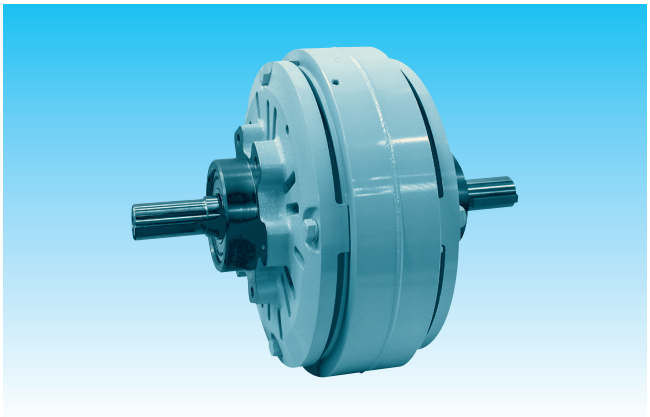
1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it into place.
2) Use flexible couplings to connect the clutch and the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)
4) Install a mounting plate on both sides of the ZKB-5BN model powder clutch.

ZKB-BN model powder clutch

(Torque 100~400 N·m)(Spontaneous cooling/forced-air cooling solid shaft type)

Features

- Rated torque: 100~400 (N·m)
- Spontaneous cooling/forced-air cooling Solid shaft type
  - Operable from 5 r/min
  - Increased heat capacity with air being blown into the air gap



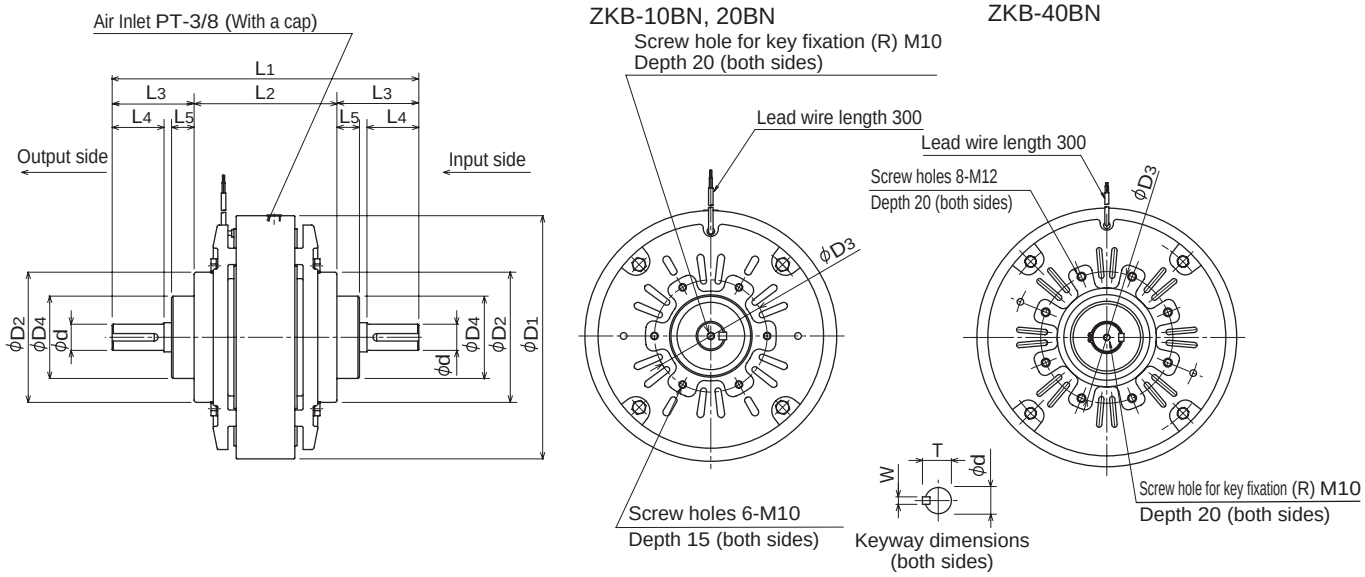
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)		Forced-air cooling allowable continuous heat dissipation rate*			Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)	Input side	Output side	Air pressure (Pa)	Air flow rate (m^3/min)	Heat dissipation (W)			
ZKB-10BN	100	2.4	57.6	0.25	3.50×10^{-2}	2.50×10^{-2}	6×10^{4}	1.1	1100	1800	37	140
ZKB-20BN	200	2.7	64.8	0.37	9.15×10^{-2}	6.89×10^{-2}	5×10^{4}	1.6	1900	1800	59	225
ZKB-40BN	400	3.5	84.0	0.40	2.40×10^{-1}	2.20×10^{-1}	2×10^{5}	2.0	2800	1800	108	370

Notes: 1. *Clean, dry air-filtered air (filtered through a filter capable of complete oil removal) must be used for cooling.
2. Residual torque is less than 1% of the rated torque.

External dimensions (mm)

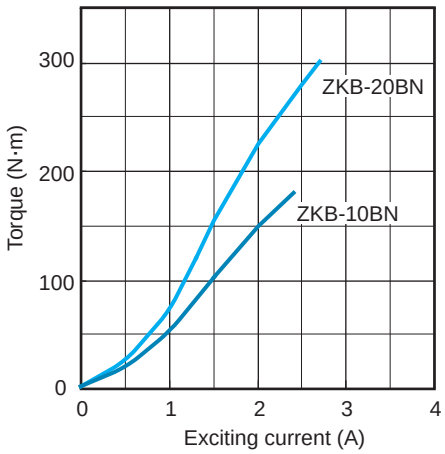


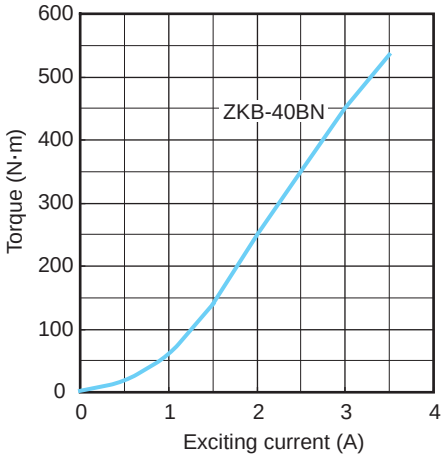
(Outer color: Munsell 10Y 7.5/1)

Model	L1	L2	L3	L4	L5	D1	D2	D3	D4 (g7)	Keyway		
										d (h7)	W (p7)	T ($^{0}_{-0.2}$)
ZKB-10BN	360	160	100	65	28	278	160	140	100	30	7	33
ZKB-20BN	408	190	109	69	30	327	174	150	110	35	10	38.5
ZKB-40BN	500	221	139.5	92	35	395	230	200	130	45	12	48.5

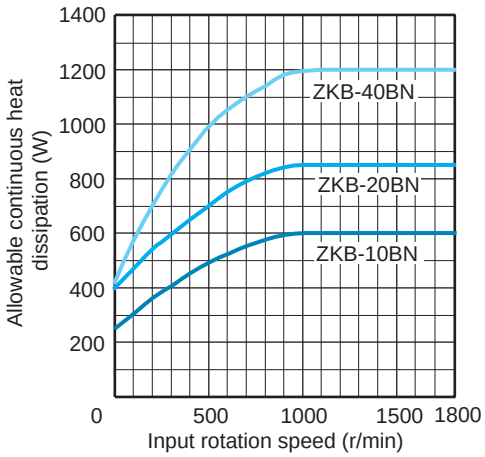
Characteristics

● Standard torque characteristics (representative example)

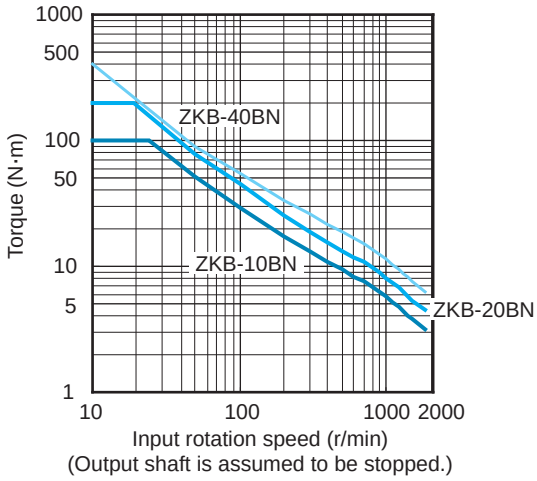




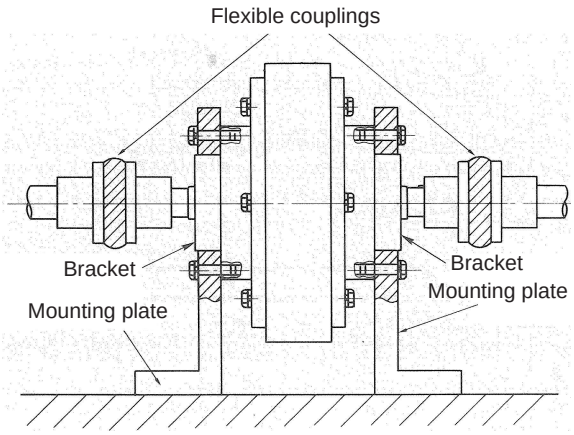
● Allowable continuous heat dissipation characteristics (During spontaneous cooling)



● Allowable continuous slip torque characteristics (During spontaneous cooling)



Sample mounting



1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it into place.
2) Use flexible couplings to connect the clutch and the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)
4) Install a mounting plate on both sides.

ZA-A1 model powder clutch

(Torque 6~200 N·m)(Spontaneous cooling through shaft type)

Features

- Rated torque: 6~200 (N·m)
- Spontaneous cooling through shaft type
  - Increased heat capacity with rotating outer fins

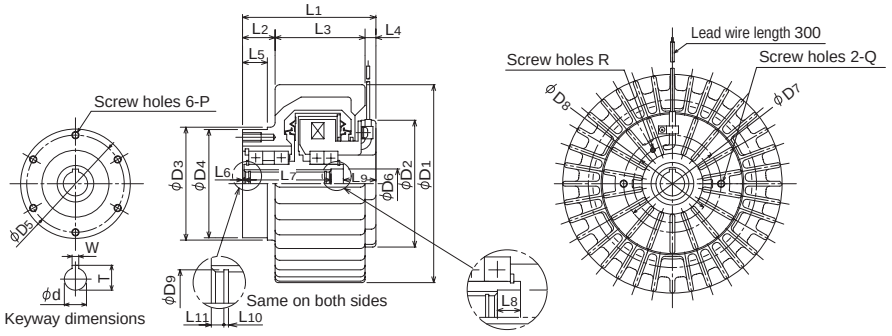
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)		Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)	Input side	Output side			
ZA-0.6A	6	0.74	17.8	0.04	2.70×10^{-3}	5.00×10^{-4}	1800	2.7	14
ZA-1.2A1	12	0.9	21.6	0.04	6.30×10^{-3}	1.10×10^{-3}	1800	4.5	25
ZA-2.5A1	25	1.1	26.4	0.06	1.20×10^{-2}	2.30×10^{-3}	1800	6.8	39
ZA-5A1	50	1.4	33.6	0.09	2.60×10^{-2}	5.80×10^{-3}	1800	11	60
ZA-10A1	100	2.0	48.0	0.14	7.00×10^{-2}	1.50×10^{-2}	1800	20	117
ZA-20A1	200	2.5	60.0	0.30	2.10×10^{-1}	0.50×10^{-1}	1000	41	255

Note: Residual torque is less than 2% of the rated torque.

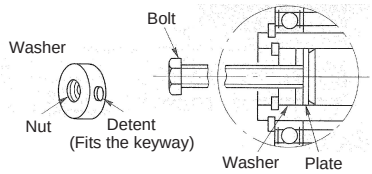
External dimensions (mm)



Model	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	D1	D2	D3	D4 (g7)	D5	D6	D7	D8	D9
ZA-0.6A	86	21	58	7	16	1	56	8	21	1.1	3	128	82	73	70	60	19	60	–	16
ZA-1.2A1	103	32	58	13	20	2	63	13	25	1.1	4	160	96	–	80	68	24	68	54	19
ZA-2.5A1	119	36	66	17	20	2	69	17	31	1.1	4	180	114	–	90	80	27	80	64	21
ZA-5A1	141	47	74	20	20	3	103	–	35	1.3	5	220	140	–	110	95	–	95	78	31.4
ZA-10A1	166	49	100	17	30	4	122	–	40	1.65	5	275	176	130	125	110	–	110	95	37
ZA-20A1	198	59	118	21	30	3	150	–	45	1.95	6	335	218	–	155	136	–	125	–	48

Model	P		R		Q		Keyway		
	Diameter	Depth	Diameter	Depth	Diameter	Depth	d (H7)	W (F8)	T ($^{+0.2}_{0}$)
ZA-0.6A	M6	12	–	–	M4	8	15	4	16.5
ZA-1.2A1	M6	12	M4	10	M6	11.5	18	5	20
ZA-2.5A1	M6	12	M4	10	M6	12	20	5	22
ZA-5A1	M8	15	M6	12	M8	12	30	7	33
ZA-10A1	M10	20	M6	12	M10	18	35	10	38.5
ZA-20A1	M10	20	–	–	M10	15	45	12	49

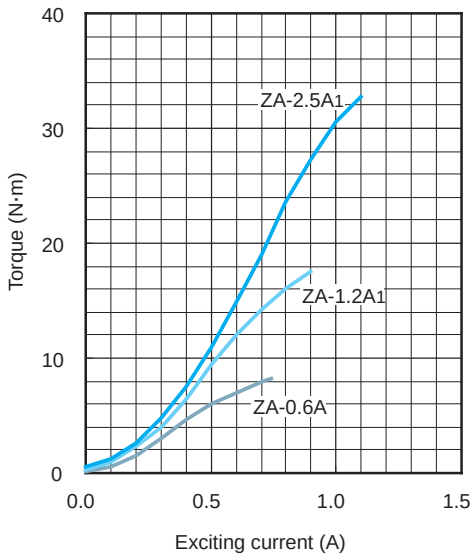
Uninstallation example

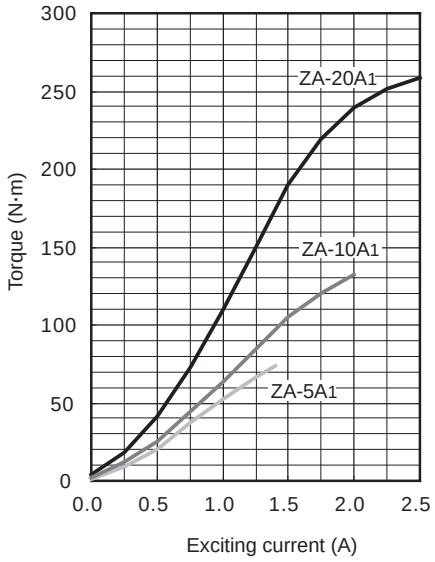


By using the groove (ø D9) on the hollow clutch shaft and doing as shown in the left figure, the clutch can be removed easily by the principle of leverage.
(Select appropriate size washers based on the shaft dimensions.)

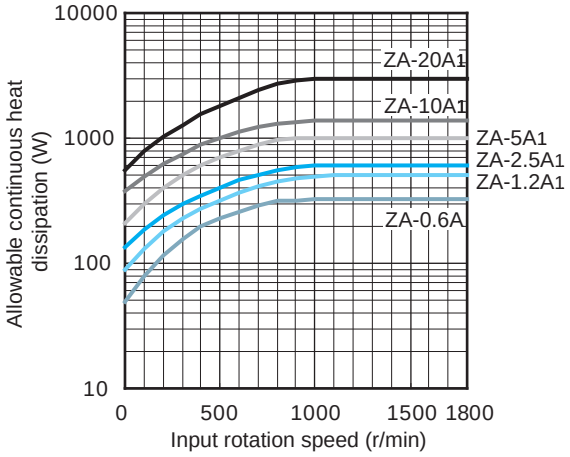
Characteristics

● Standard torque characteristics (representative example)

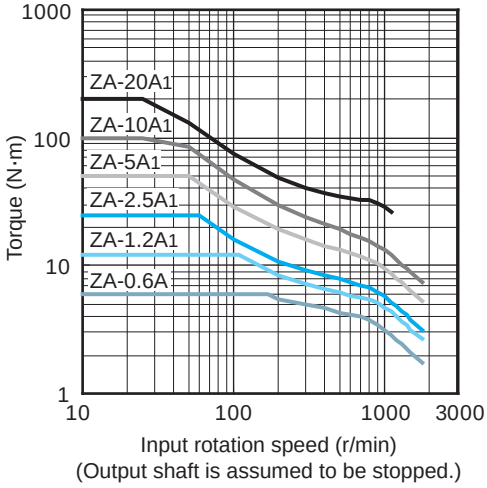




● Allowable continuous heat dissipation characteristics

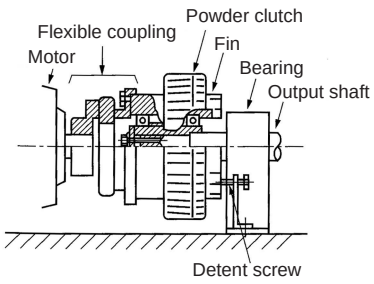


● Allowable continuous slip torque characteristics

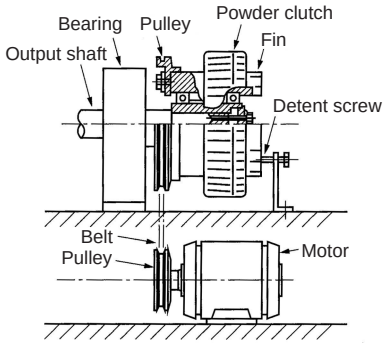


Sample mounting

1. Shaft-driven type



2. Belt-driven type



1) Leave a space between the fan (stator) detent screw and the holder (customer procured) side hole to prevent undue force from being applied to the bearing inside the clutch. Do not tighten the screw in the axial direction.
2) Be sure to use a flexible coupling to connect the shaft to the input side. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range. When bolting down the end of the shaft that is inserted into the clutch, use a flexible coupling to provide adequate play for the thrust to prevent an undue force from being applied to the bearing inside the clutch.
3) In the case of a pulley driven type, observe the allowable load (see page A-50) to prevent undue force from being applied to the bearing inside the clutch.
4) The perimeter of the unit rotates. Cover the entire unit with a breathable net for safety.

ZKG-YN model micro powder brake

(Torque 0.5~5 N·m)(Spontaneous cooling solid shaft type)

Features

- Rated torque: 0.5~5 (N·m)
- Spontaneous cooling solid shaft type
  - Compact-design Micro series
  - Smaller rotational moment of inertia
  - Operable from 5 r/min

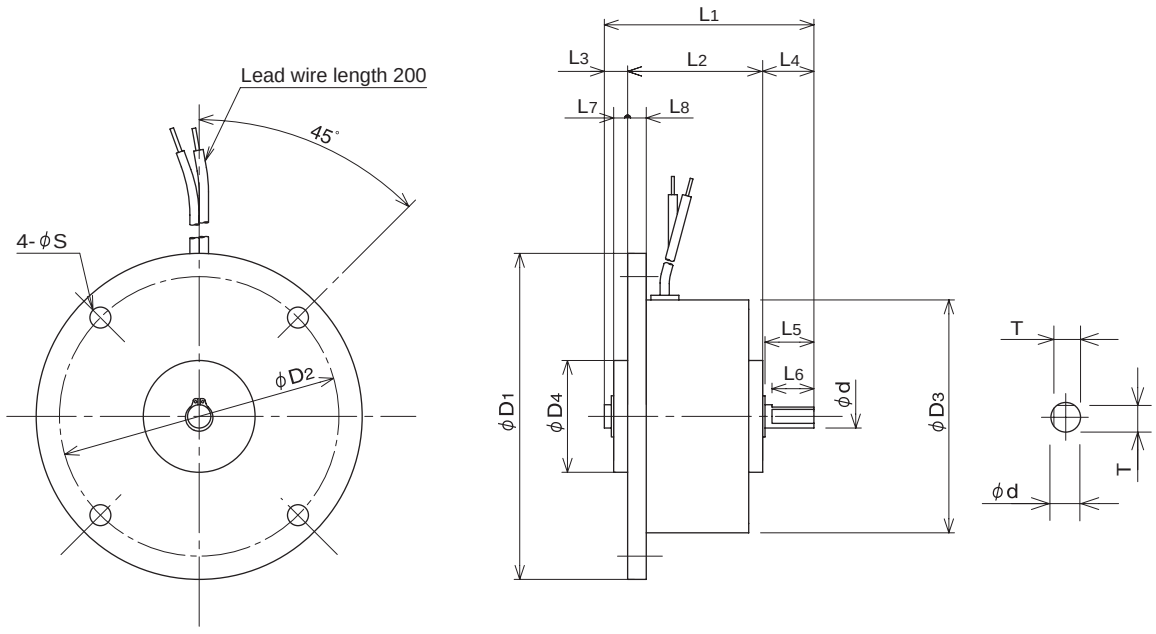
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)	Allowable rotation speed (r/min)	Product mass (kg)
		Current (A)	Power (W)	Time constant (s)			
ZKG-5YN	0.5	0.35	8.4	0.02	9.40×10^{-3}	1800	0.40
ZKG-10YN	1	0.42	10.1	0.02	2.75×10^{-2}	1800	0.54
ZKG-20YN	2	0.5	12.0	0.04	5.25×10^{-2}	1800	0.96
ZKG-50YN	5	0.6	14.4	0.05	1.25×10^{-1}	1800	1.30

Note: Residual torque is less than 3% of the rated torque at 1000 r/min or less, and less than 5% at 1800 r/min or less.

External dimensions (mm)

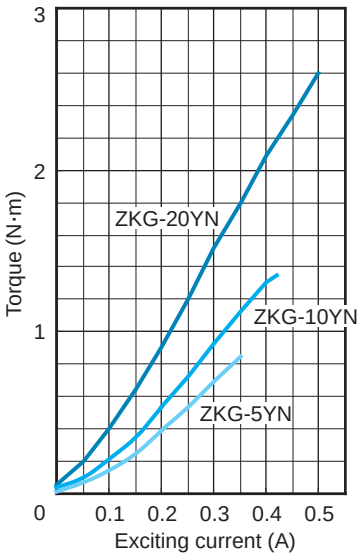


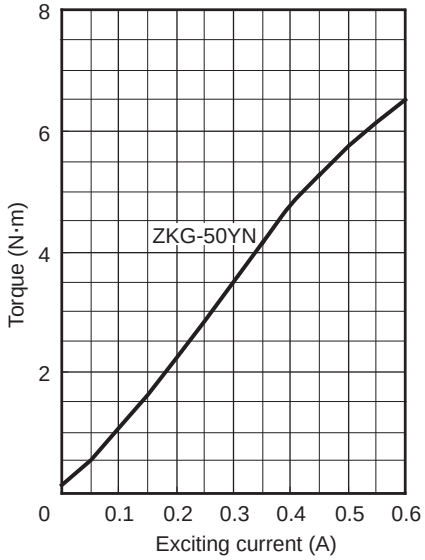
(Outer color: Munsell 10Y 7.5/1)

Model	L1	L2	L3	L4	L5	L6	L7	L8	D1	D2	D3	D4 (g7)	S	d (g7)	T
ZKG-5YN	45	29	5	11	10.5	9	3	4	70	60	50	24	4.5	5	4.5
ZKG-10YN	50	30	7	13	12	10	4	4	76	66	56	30	4.5	7	6.5
ZKG-20YN	59	34	9	16	15	13	6	5	90	80	70	40	4.5	9	8.5
ZKG-50YN	66	36	11	19	18	16	8	5	108	95	82	44	6	15	14

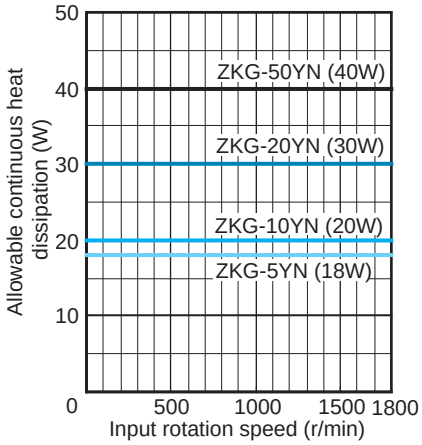
Characteristics

● Standard torque characteristics (representative example)

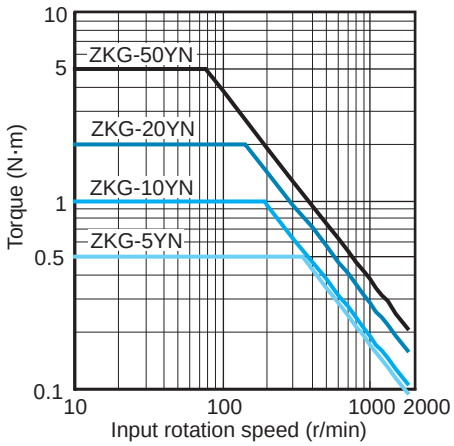




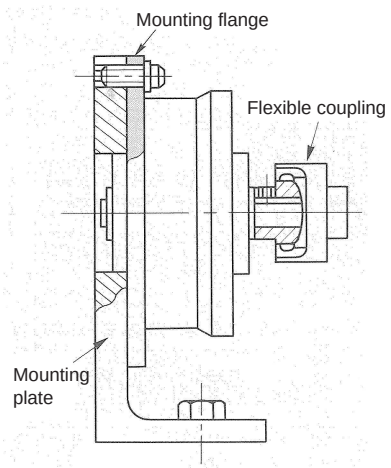
● Allowable continuous heat dissipation characteristics
(The heat radiation surface area of the mounting plate must be greater than 350cm^2.)



● Allowable continuous slip torque characteristics



Sample mounting



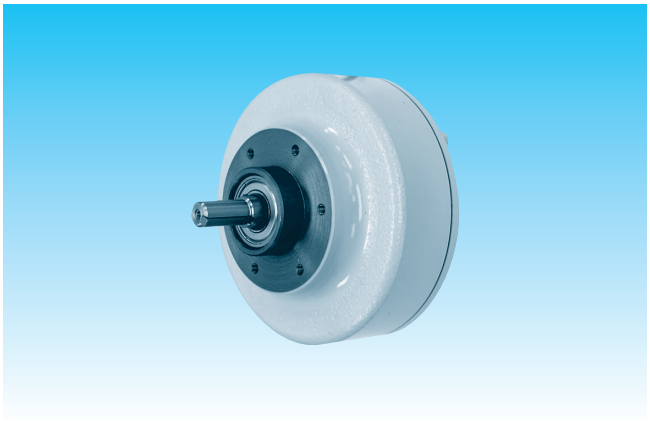
1) Align the mating hole of the mounting plate with its intended mate on the mounting plate and fix it into place.
2) Be sure to use a flexible coupling to connect the brake shaft to the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)
4) The heat radiation surface area of the mounting plate must be greater than 350cm^2.

ZKB-YN model powder brake

(Torque 0.6~6 N·m)(Spontaneous cooling solid shaft type)

Features

- Rated torque 0.6~6 (N·m)
- Spontaneous cooling solid shaft type
  - Operable from 5 r/min



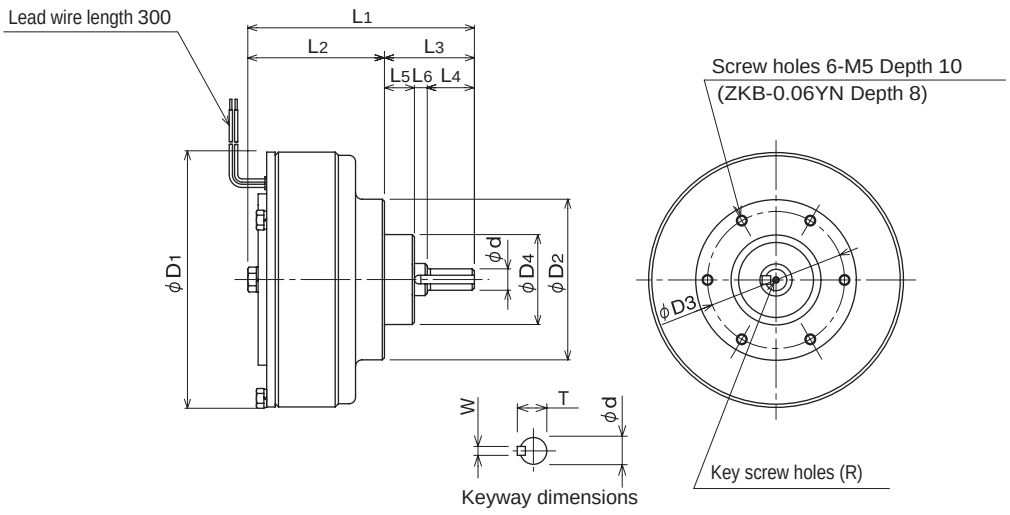
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)	Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)				
ZKB-0.06YN	0.6	0.46	11.0	0.03	6.10×10^{-5}	1800	1.7	3.5
ZKB-0.3YN	3	0.53	12.7	0.08	3.00×10^{-4}	1800	3.1	7.5
ZKB-0.6YN	6	0.81	19.4	0.08	6.00×10^{-4}	1800	3.7	10

Note: Residual torque is less than 4%, 2%, and 1% of the rated torque for the 0.06YN, 0.3YN, and 0.6 YN models respectively.

External dimensions (mm)

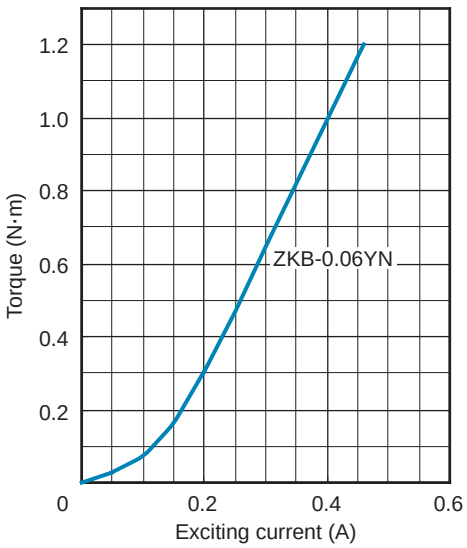


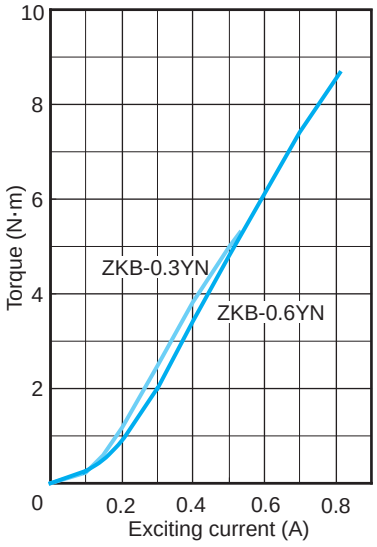
(Outer color: Munsell 10Y 7.5/1)

Model	L1	L2	L3	L4	L5	L6	D1	D2	D3	D4 (g7)	R		Keyway		
											Diameter	Depth	d (h7)	W (p7)	T ($^{0}_{-0.2}$)
ZKB-0.06YN	93	52	41	22	15	4	88	70	55	33	–	–	8	3	9.1
ZKB-0.3YN	106	64	42	22	14	6	120	75	64	42	M3	6	10	4	11.5
ZKB-0.6YN	114	68	46	26	14	6	134	80	64	42	M4	8	12	4	13.5

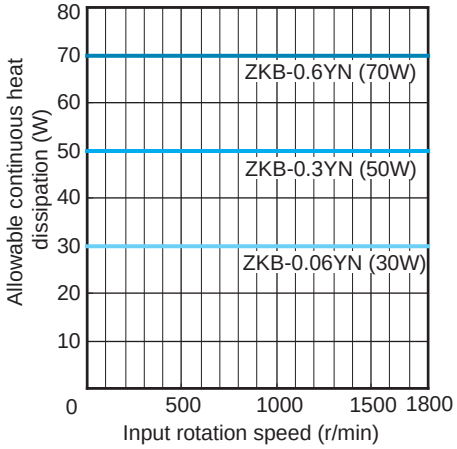
Characteristics

● Standard torque characteristics (representative example)

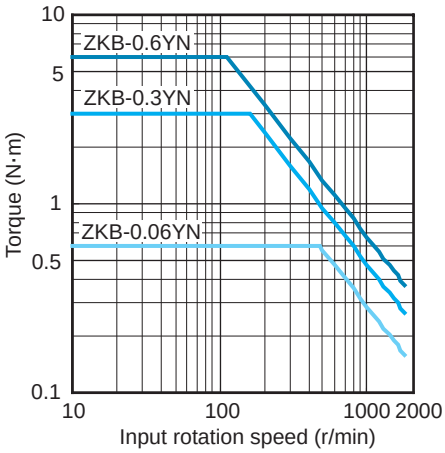




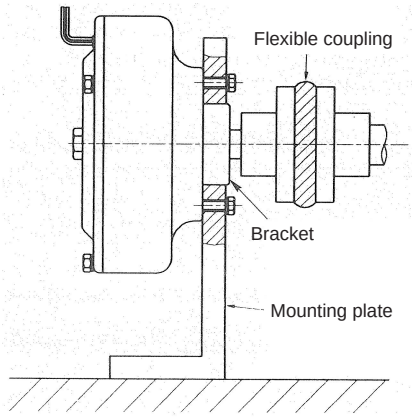
● Allowable continuous heat dissipation characteristics



● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Be sure to use a flexible coupling to connect the brake shaft to the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)

ZKB-XN model powder brake

(Torque 12~50 N·m)(Spontaneous cooling/forced-air solid shaft type)

Features

- Rated torque: 12~50 (N·m)
- Spontaneous cooling/Forced-air solid shaft type
  - Operable from 5 r/min
  - Increased heat capacity by air being blown into the air gap

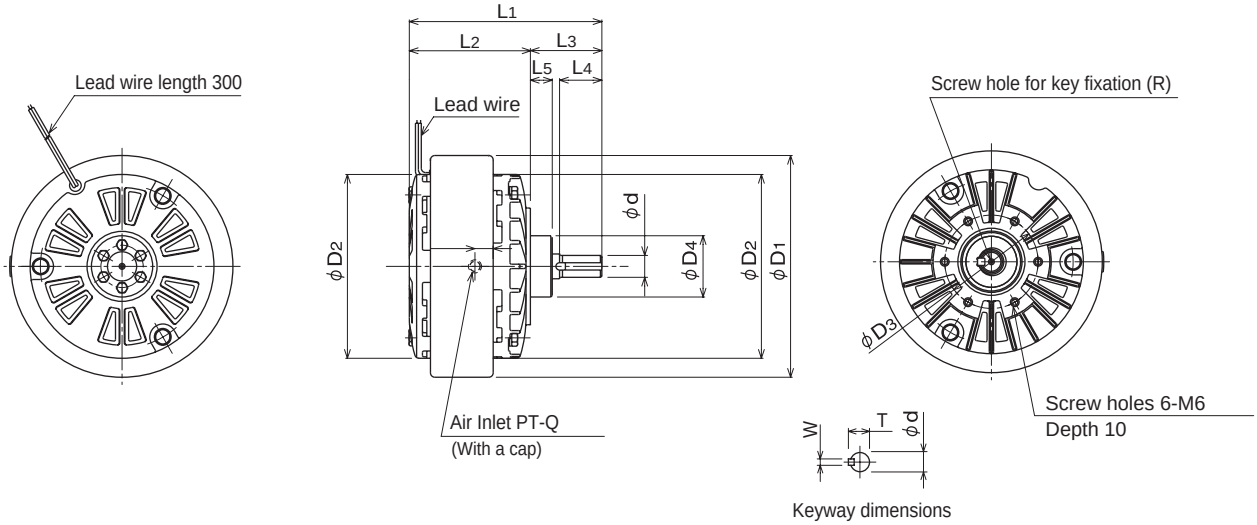
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)	Forced-air cooling allowable continuous heat dissipation rate*			Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)		Air pressure (Pa)	Air flow rate (m^3/min)	Heat dissipation (W)			
ZKB-1.2XN	12	0.94	22.5	0.10	1.34×10^{-3}	3×10^{4}	0.2	250	1800	5.2	20
ZKB-2.5XN	25	1.24	30.0	0.12	3.80×10^{-3}	5×10^{4}	0.4	380	1800	9.0	33
ZKB-5XN	50	2.15	51.5	0.13	9.50×10^{-3}	1×10^{5}	0.6	700	1800	14.5	60

Notes: 1. *Clean, dry air-filtered air (filtered through a filter capable of complete oil removal) must be used for cooling.
2. Residual torque is less than 1% of the rated torque.

External dimensions (mm)

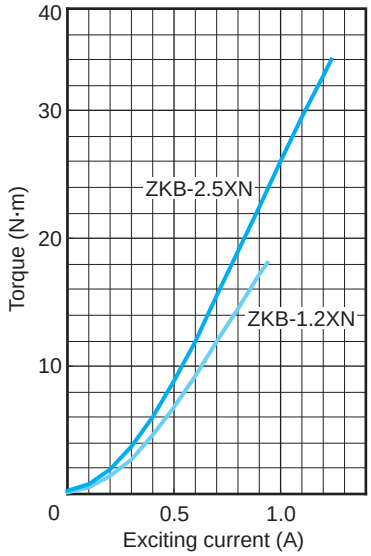


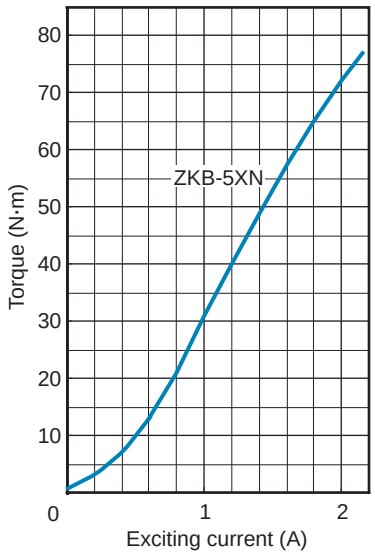
(Outer color: Munsell 10Y 7.5/1)

Model	L1	L2	L3	L4	L5	D1	D2	D3	D4 (g7)	Q	R		Keyway		
											Diameter	Depth	d (h7)	W (p7)	T ($^{0}_{-0.2}$)
ZKB-1.2XN	132	83	49	29	15	152	126	64	42	1/8	M4	8	15	5	17
ZKB-2.5XN	155	91	64	43	17	182	160	78	55	1/8	M5	10	20	5	22
ZKB-5XN	193	102	91	55	30	219	196	100	74	1/4	M6	12	25	7	28

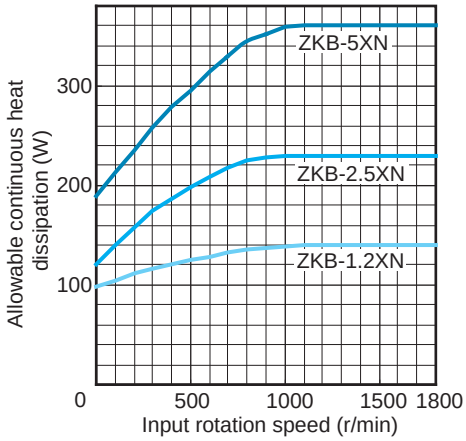
Characteristics

● Standard torque characteristics (representative example)

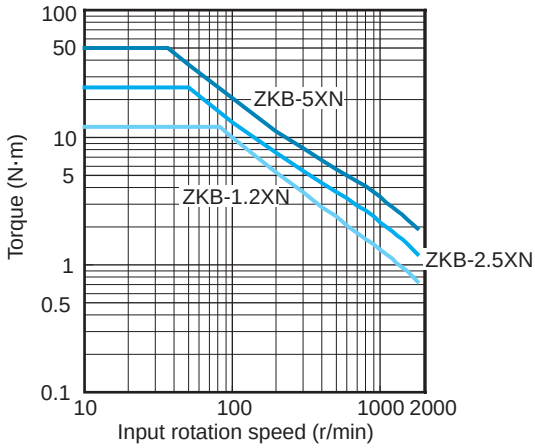




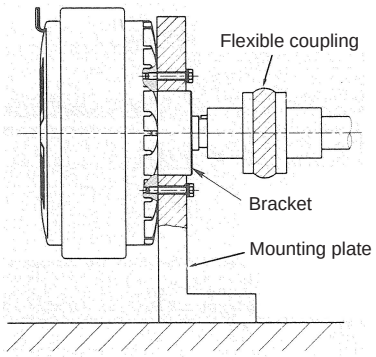
● Allowable continuous heat dissipation characteristics (During spontaneous cooling)



● Allowable continuous slip torque characteristics (During spontaneous cooling)



Sample mounting



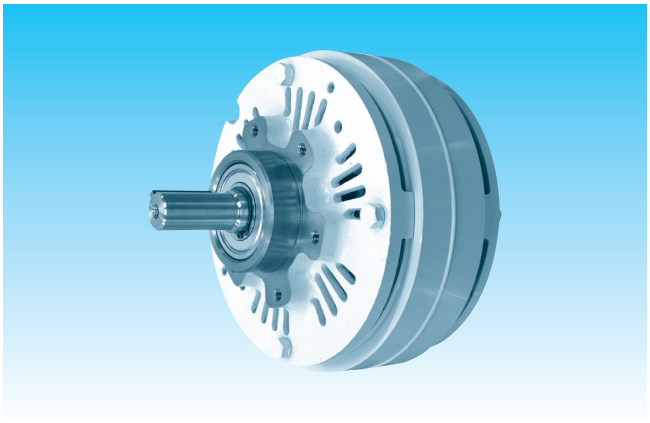
1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Be sure to use a flexible coupling to connect the brake shaft to the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)

ZKB-XN model powder brake

(Torque 100~400 N·m)(Spontaneous cooling/forced-air solid shaft type)

Features

- Rated torque: 100~400 (N·m)
- Spontaneous cooling/Forced-air solid shaft type
  - Operable from 5 r/min
  - Increased heat capacity by air being blown into the air gap



Specifications

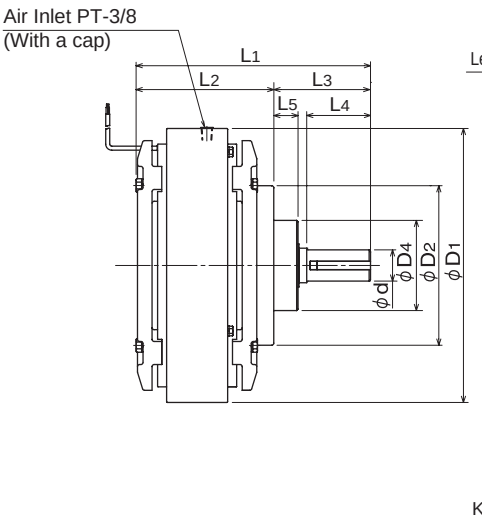
(Rated voltage 24V DC)

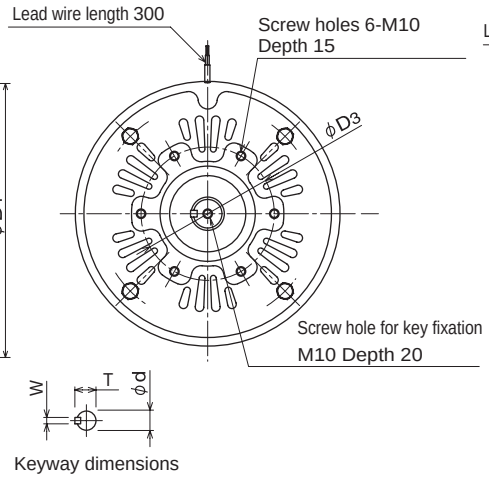
Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)	Forced-air cooling allowable continuous heat dissipation rate*			Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)		Air pressure (Pa)	Air flow rate (m^3/min)	Heat dissipation (W)			
ZKB-10XN	100	2.4	57.6	0.25	3.50×10^{-2}	6×10^{4}	1.1	1100	1800	34	140
ZKB-20XN	200	2.7	64.8	0.37	9.15×10^{-2}	5×10^{4}	1.6	1900	1800	53	225
ZKB-40XN	400	3.5	84.0	0.40	2.40×10^{-1}	2×10^{5}	2.0	2800	1800	100	370

Notes: 1. *Clean, dry air-filtered air (filtered through a filter capable of complete oil removal) must be used for cooling.
2. Residual torque is less than 1% of the rated torque.

External dimensions (mm)

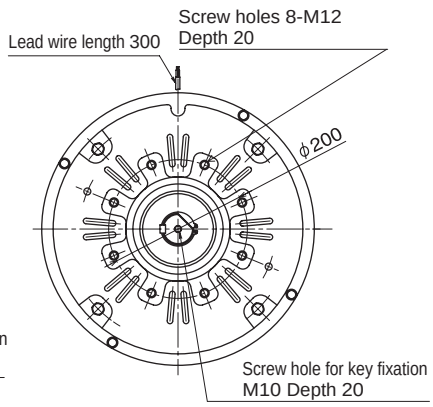
ZKB-10XN, 20XN





Keyway dimensions

ZKB-40XN

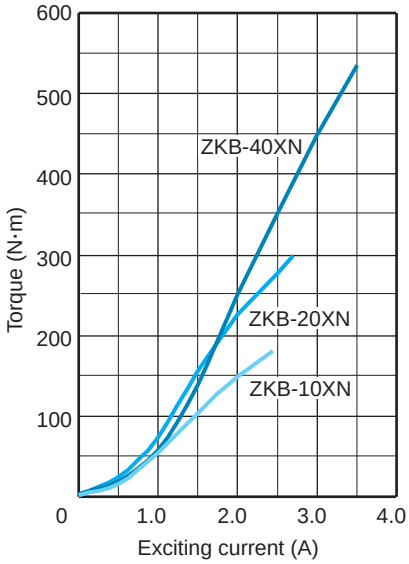


(Outer color: Munsell 10Y 7.5/1)

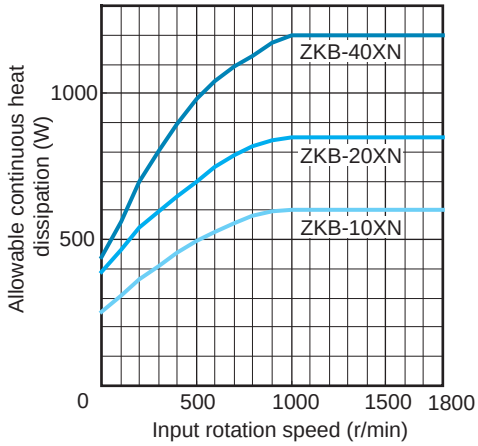
Model	L1	L2	L3	L4	L5	D1	D2	D3	D4 (g7)	Keyway		
										d (h7)	W (p7)	T ($^{0}_{-0.2}$)
ZKB-10XN	239	139	100	65	28	278	160	140	100	30	7	33
ZKB-20XN	278	169	109	69	30	327	174	150	110	35	10	38.5
ZKB-40XN	338	198.5	139.5	92	35	395	230	200	130	45	12	48.5

Characteristics

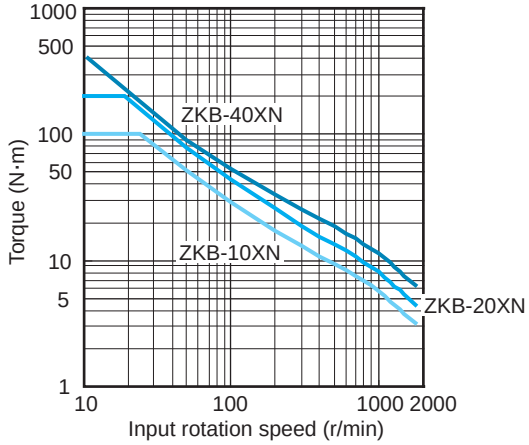
● Standard torque characteristics (representative example)



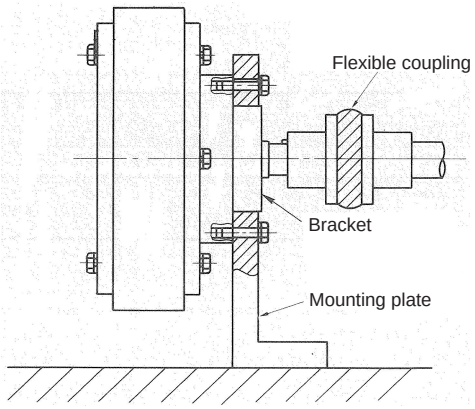
● Allowable continuous heat dissipation characteristics (During spontaneous cooling)



● Allowable continuous slip torque characteristics (During spontaneous cooling)



Sample mounting



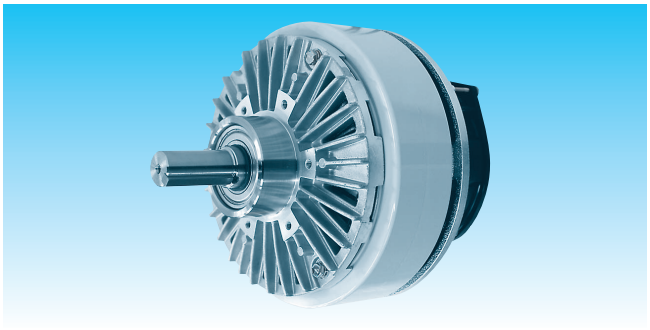
1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Be sure to use a flexible coupling to connect the brake shaft to the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)

ZKB-HBN model powder brake

(Torque 25~400 N·m)(Thermo block cooling solid shaft type)

Features

- Rated torque: 50~200 (N·m)
- Thermo block cooling solid shaft type
  - Increased heat capacity by fixing a thermo block on the driven member and by adding an axial fan
  - Operable from 5 r/min



Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)	Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)	Axial fan					
		Current (A)	Power (W)	Time constant (s)					Voltage AC (V)	Power consumption (W)		Current (A)		No. of fans
										50Hz	60Hz	50Hz	60Hz	
ZKB-2.5HBN	25	1.24	29.8	0.12	3.80×10^{-3}	1800	11	33	200	43	40	0.29	0.25	1
ZKB-5HBN	50	2.15	51.5	0.13	9.60×10^{-3}	1800	16.5	65	200	43	40	0.29	0.25	1
ZKB-10HBN	100	2.40	57.6	0.25	3.50×10^{-2}	1800	37	125	200	43	40	0.29	0.25	1
ZKB-20HBN	200	2.70	64.8	0.37	9.15×10^{-2}	1800	59	190	200	43	40	0.29	0.25	2
ZKB-40HBN	400	3.50	84.0	0.40	2.40×10^{-1}	1800	110	370	200	75	95	0.4	0.5	1

Notes: 1. Residual torque is less than 1% of the rated torque.
2. Specification values for ZKB-20HBN in the table are the values for each axial fan.

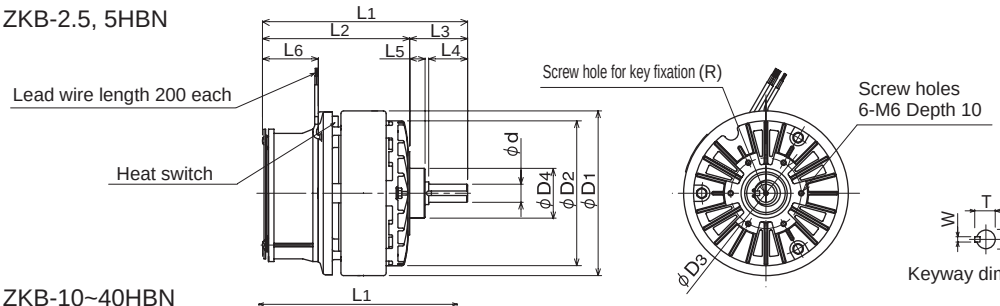
● Heat switch specifications (Manufactured by Sanken Electric Co.)

Model	5003K
Operating temperature	100°C (80°C for ZKB-40HBN)
Allowable rated contact	120V AC 5A/240V AC 3A (Resistive load)
Contact	B-contact

Note: Operating ambient temperature 30°C

External dimensions (mm)

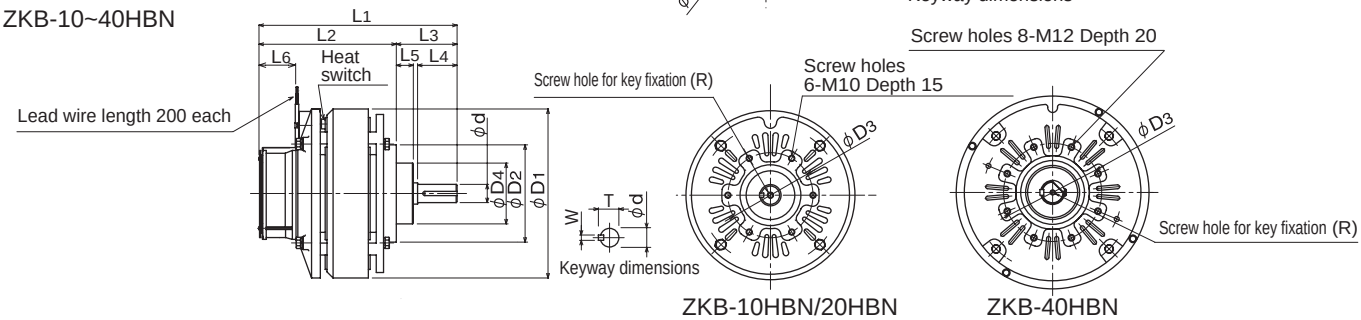
ZKB-2.5, 5HBN



Lead wire marking

	Marking
Axial fan	200
Heat switch	TR
Powder brake	BR

ZKB-10~40HBN



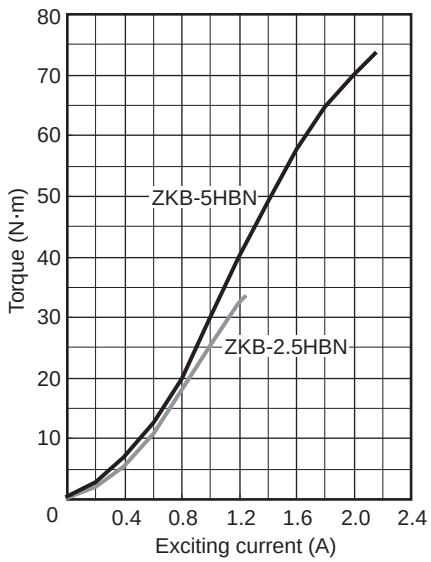
ZKB-10HBN/20HBN ZKB-40HBN

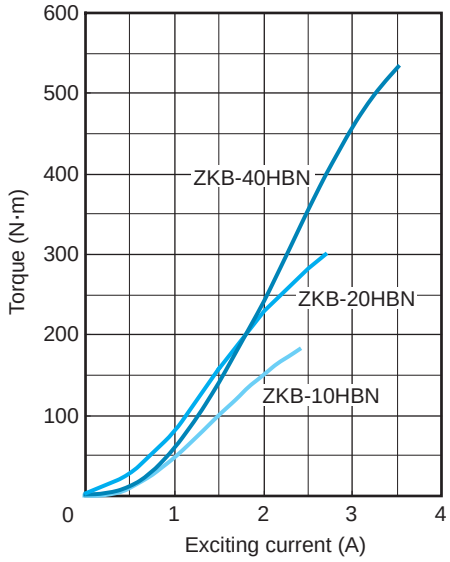
(Outer color: Munsell 10Y 7.5/1)

Model	L1	L2	L3	L4	L5	L6	D1	D2	D3	D4 (g7)	R		Keyway		
											Diameter	Depth	d (h7)	W (p7)	T ($^{0}_{-0.2}$)
ZKB-2.5HBN	227	163	64	43	17	62	182	160	78	55	M5	10	20	5	22
ZKB-5HBN	265	174	91	55	30	62	219	196	100	74	M6	12	25	7	28
ZKB-10HBN	326	226	100	65	28	62	278	160	140	100	M10	20	30	7	33
ZKB-20HBN	366	257	109	69	30	62	327	174	150	110	M10	20	35	10	38.5
ZKB-40HBN	473	333.5	139.5	92	35	98	395	230	200	130	M10	20	45	12	48.5

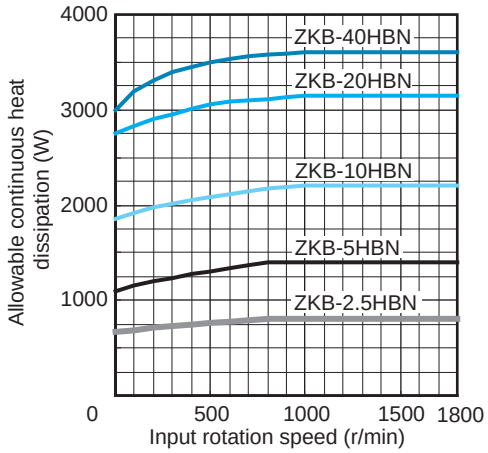
Characteristics

● Standard torque characteristics (representative example)

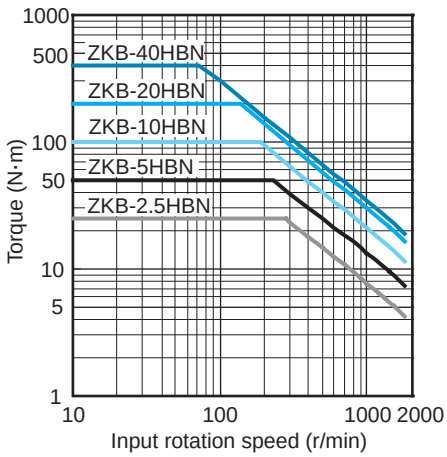




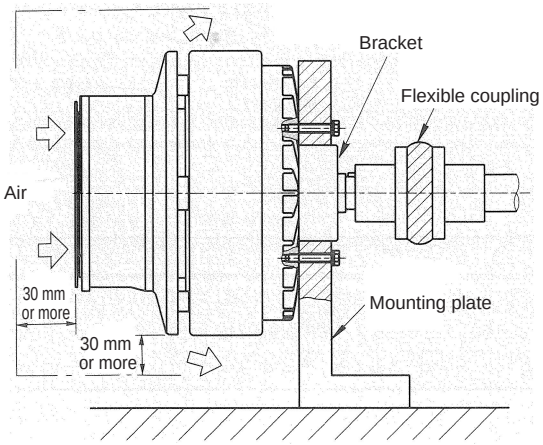
● Allowable continuous heat dissipation characteristics



● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Be sure to use a flexible coupling to connect the brake shaft to the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)
4) Leave a space of at least 30 mm around the brake so as not to block the cooling air.
5) Be sure to connect a heat switch and provide a protection circuit to protect the brake from sustaining damage in case the axial fan stops or the cover becomes clogged.
6) This brake has an open system. Provide a duct and send clean air if used in a dusty environment.

ZKB-WN model powder brake

(Torque 25~50 N·m)(Water-cooled solid shaft type)

Features

- Rated torque: 25~50 (N·m)
- Water-cooled solid shaft type
  - Operable from 5 r/min
  - Increased heat capacity with a water channel in the driven member

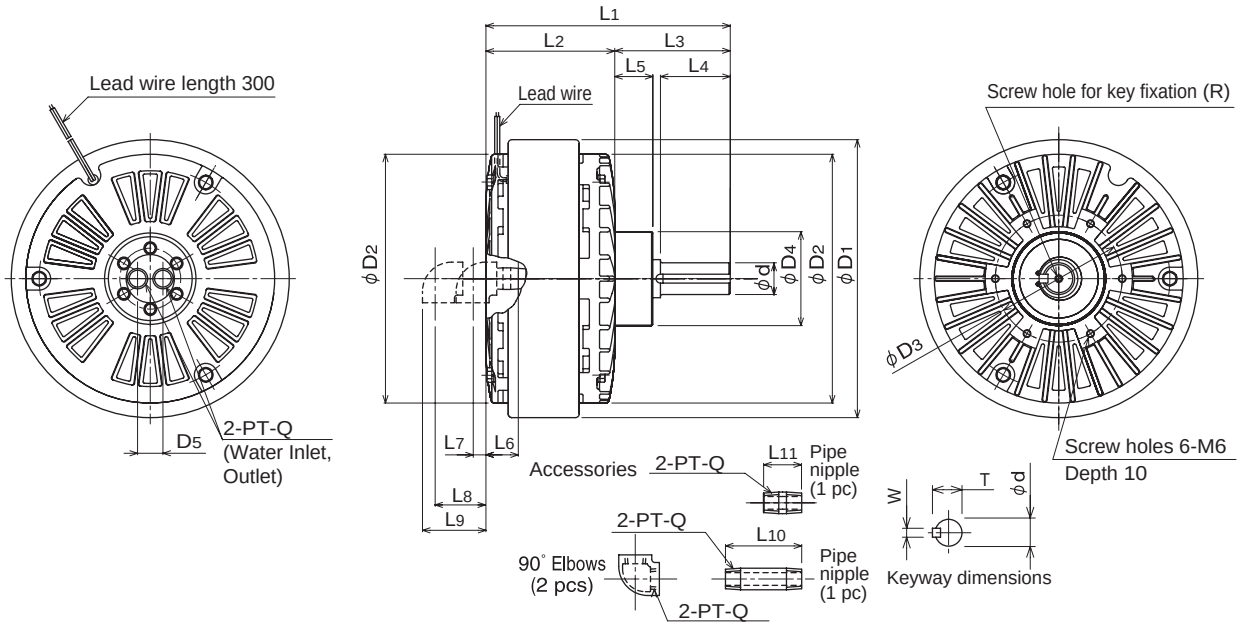
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia *J* (kgm^2)	Cooling-water flow rate (ℓ /min)	Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)					
ZKB-2.5WN	25	1.24	30.0	0.12	3.80×10^{-3}	1.5	1800	9	33
ZKB-5WN	50	2.15	51.5	0.13	9.50×10^{-3}	3.0	1800	14.5	65

Note: Residual torque is less than 1% of the rated torque.

External dimensions (mm)

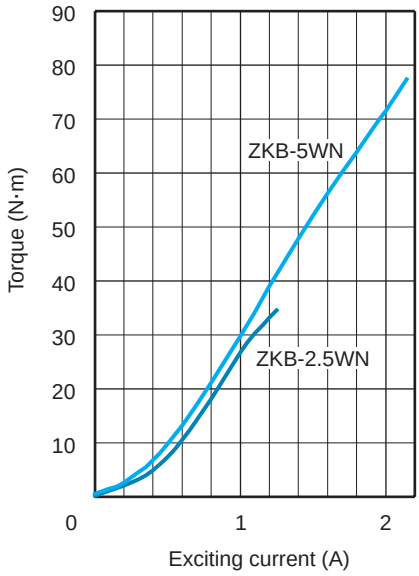


(Outer color: Munsell 10Y 7.5/1)

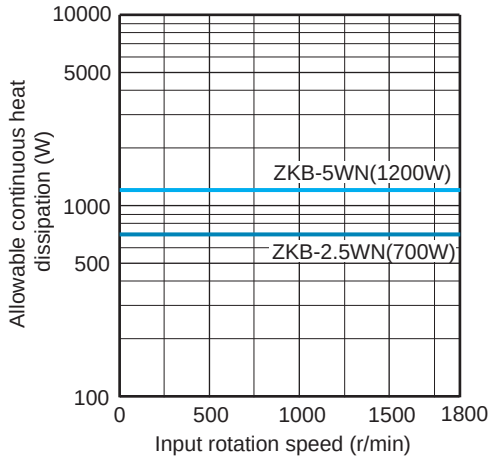
Model	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	D1	D2	D3	D4 (g7)	D5	Q	R		Keyway		
																		Diameter	Depth	d (h7)	W (p7)	T ($^{0}_{-0.2}$)
ZKB-2.5WN	155	91	64	43	17	19	15	41	50	51	25	182	160	78	55	16	1/8	M5	10	20	5	22
ZKB-5WN	193	102	91	55	30	25	10	40	50	60	30	219	196	100	74	20	1/4	M6	12	25	7	28

Characteristics

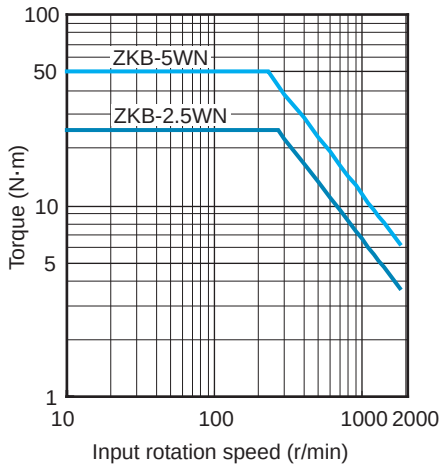
● Standard torque characteristics (representative example)



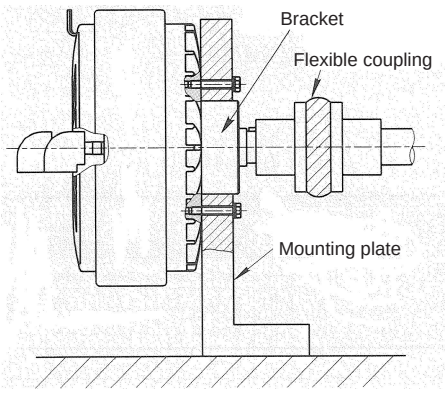
● Allowable continuous heat dissipation characteristics



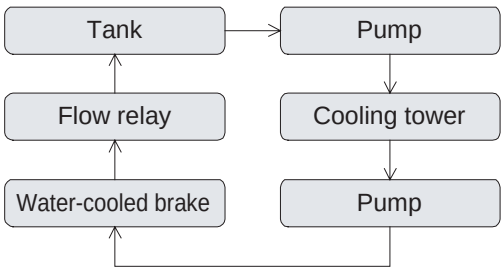
● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Be sure to use a flexible coupling to connect the brake shaft to the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)
4) As a general rule, use a circulating cooling-water system that is configured as shown below. Add an anti-corrosive to the cooling-water. Install a strainer (filter) at the water supply point unless clean water is provided in a circulating cooling-water system.



5) Provide a protection circuit (flow relay) so that the rotation of the brake stops in case the cooling-water supply is cut off.

ZKB-WN model powder brake

(Torque 100~400 N·m)(Water-cooled solid shaft type)

Features

- Rated torque: 100~400 (N·m)
- Water-cooled solid shaft type
  - Operable from 5 r/min
  - Increased heat capacity with a water channel in the driven member

Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia J (kgm^2)	Cooling-water flow rate (ℓ /min)	Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)					
ZKB-10WN	100	2.4	57.6	0.25	3.50×10^{-2}	6	1800	34	140
ZKB-20WN	200	2.7	64.8	0.37	9.15×10^{-2}	9	1800	53	225
ZKB-40WN	400	3.5	84.0	0.40	2.40×10^{-1}	15	1800	98	370

Note: Residual torque is less than 1% of the rated torque.

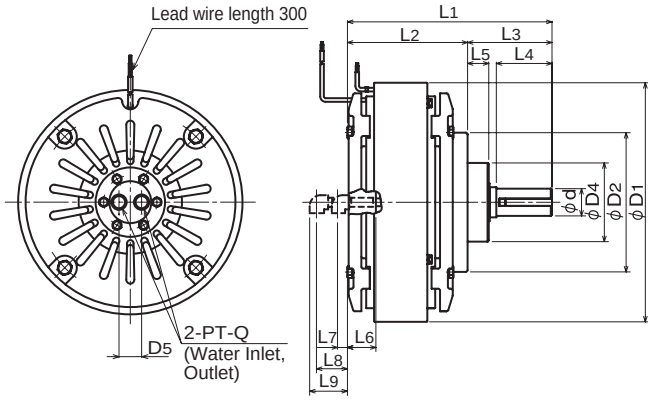
Heat switch specifications (Manufactured by Texas Instruments)

Model	9700K-16-215
Operating temperature	105°C
Allowable rated contact	24V DC 18A/115V AC 18A/230V AC 13A
Contact	B-contact

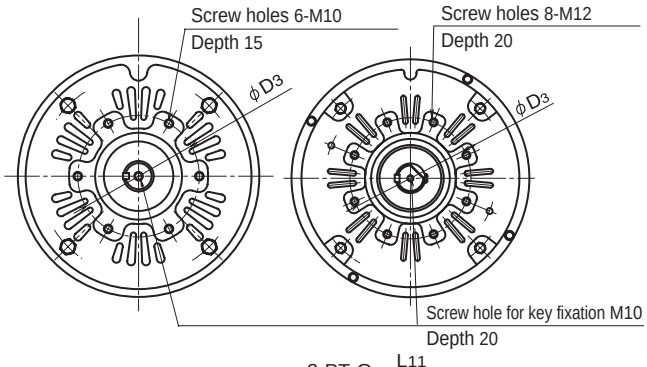
Note: Only on ZKB-40WN.
Operating ambient temperature 30°C.

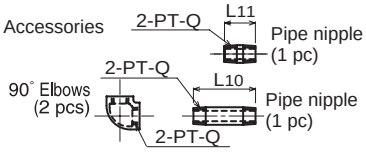
External dimensions (mm)

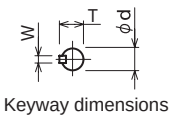
ZKB-10WN, 20WN



ZKB-10WN, 20WN ZKB-40WN







Keyway dimensions

Lead wire marking
(Applicable to ZKB-40WN only)

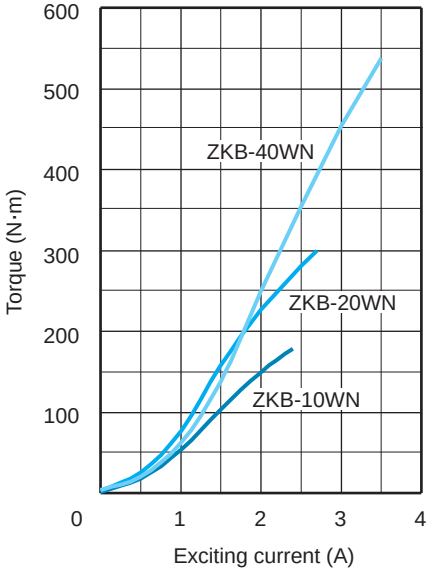
	Marking
Heat switch	TR
Powder brake	BR

(Outer color: Munsell 10Y 7.5/1)

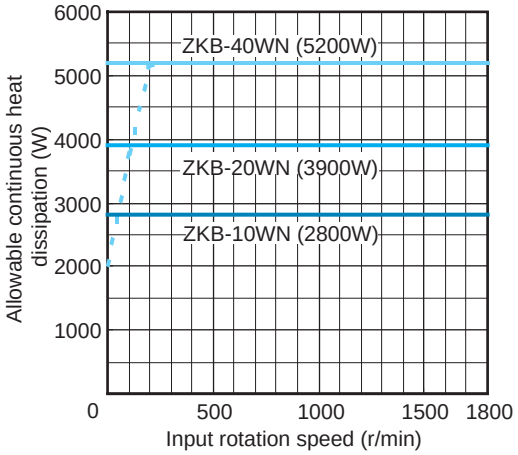
Model	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	D1	D2	D3	D4 (g7)	D5	Q	Keyway		
																		d (h7)	W (p7)	T ($^{0}_{-0.2}$)
ZKB-10WN	239	139	100	65	28	29	21	60	74	75	40	278	160	140	100	28	3/8	30	7	33
ZKB-20WN	278	169	109	69	30	34	27	66	80	90	50	327	174	150	110	32	1/2	35	10	38.5
ZKB-40WN	338	198.5	139.5	92	35	45	16	55	69	90	50	395	230	200	130	32	1/2	45	12	48.5

Characteristics

● Standard torque characteristics (representative example)

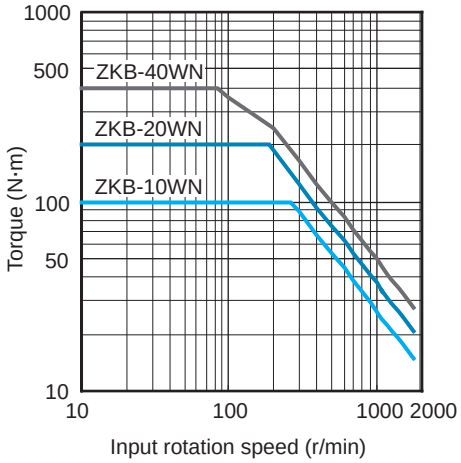


● Allowable continuous heat dissipation characteristics

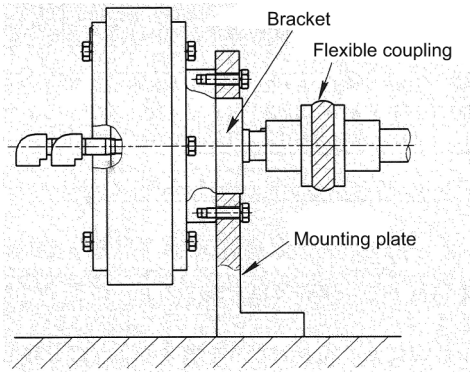


(Note)
When using the ZKB-40WN model at a constant speed of 170 r/min or less, use it in the range below the dashed line on the chart.

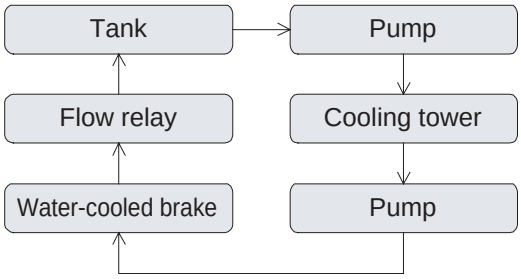
● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Be sure to use a flexible coupling to connect the brake shaft to the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-50.)
4) As a general rule, use a circulating cooling-water system that is configured as shown below. Add an anti-corrosive to the cooling-water. Install a strainer (filter) at the water supply point, unless clean water is provided in a circulating cooling-water system.



5) Provide a protection circuit (flow relay) so that the rotation of the brake stops in case the cooling-water supply is cut off. ZKB-40WN is fitted with a type of heat switch that opens during overheating (B contact).

ZA-Y model powder brake

(Torque 6~50 N·m)(Spontaneous cooling hole shaft type)

Features

- Rated torque: 6~50 (N·m)
- Spontaneous cooling through shaft type
  - Increased heat capacity with rotating outer fins

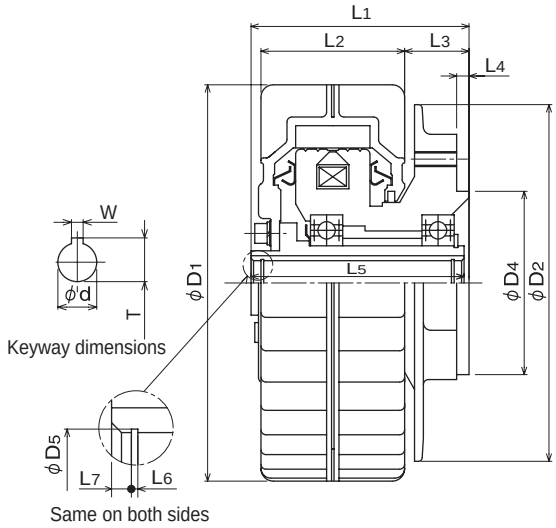
Specifications

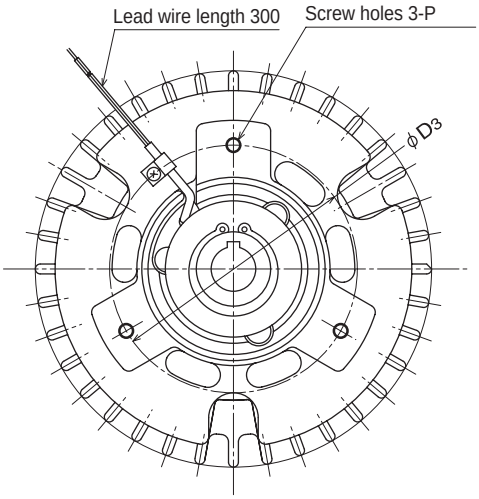
(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia *J* (kgm^2)	Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)				
ZA-0.6Y	6	0.30	7.2	0.10	1.55×10^{-3}	1800	2.4	15
ZA-1.2Y1	12	0.39	9.4	0.13	5.50×10^{-3}	1800	5.0	25
ZA-2.5Y1	25	0.73	17.5	0.15	9.40×10^{-3}	1800	7.4	39
ZA-5Y1	50	0.94	22.6	0.17	2.30×10^{-2}	1800	11	60

Note: Residual torque is less than 3% of the rated torque.

External dimensions (mm)

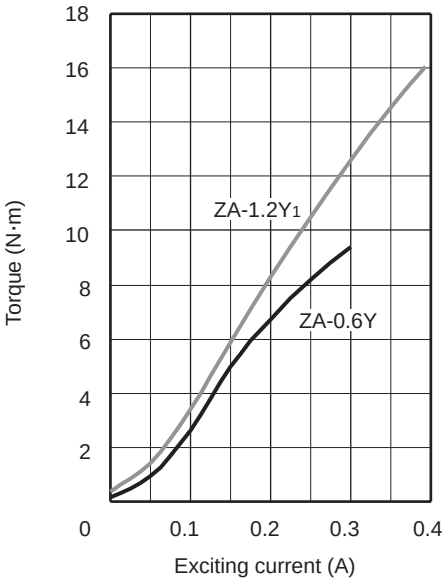


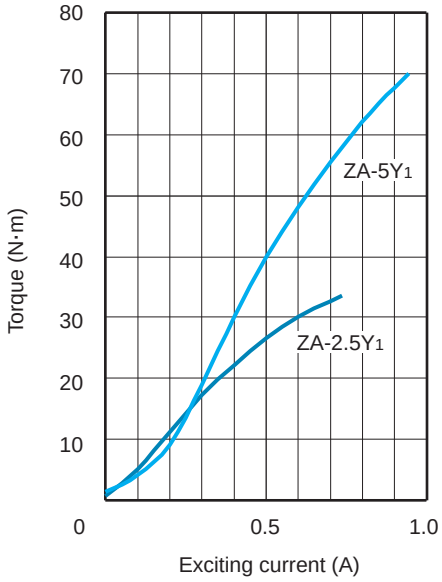


Model	L1	L2	L3	L4	L5	L6	L7	D1	D2	D3	D4 (g7)	D5	P		Keyway		
													Diameter	Depth	d (H7)	W (F8)	T ($^{+0.2}_{0}$)
ZA-0.6Y	68	53	15	2	64	1.1	3	116	116	80	70	12.5	M5	12	12	4	13.5
ZA-1.2Y1	88	58	26	5	86	1.1	4	160	144	100	74	19	M6	17	18	5	20
ZA-2.5Y1	100	66	28	5	92	1.1	4	180	170	140	100	21	M10	19	20	5	22
ZA-5Y1	106	74	27	5	101	1.3	5	220	195	150	110	31.4	M10	19	30	7	33

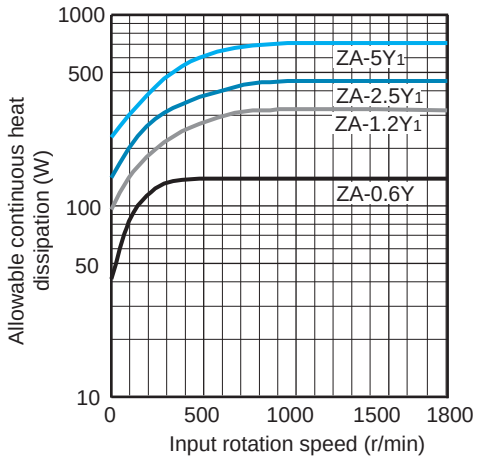
Characteristics

● Standard torque characteristics (representative example)

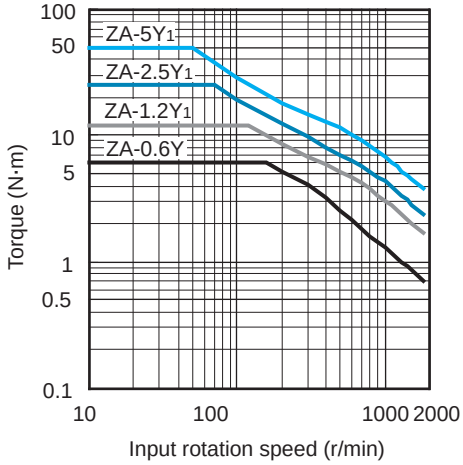




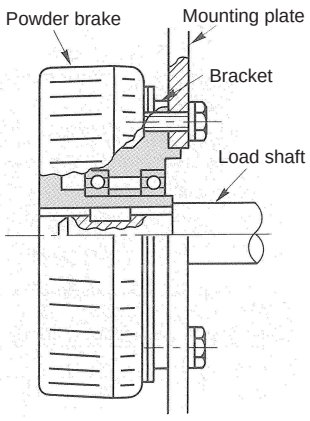
● Allowable continuous heat dissipation characteristics



● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Concentricity between the brake-side through shaft and load shaft must be 0.05 mm or less.
3) The perimeter of the unit rotates. Cover the entire unit with a breathable net for safety.

ZA-Y model powder brake

(Torque 100~400 N·m)(Spontaneous cooling hole shaft type)

Features

- Rated torque: 100~400 (N·m)
- Spontaneous cooling through shaft type
  - Increased heat capacity with rotating outer fins

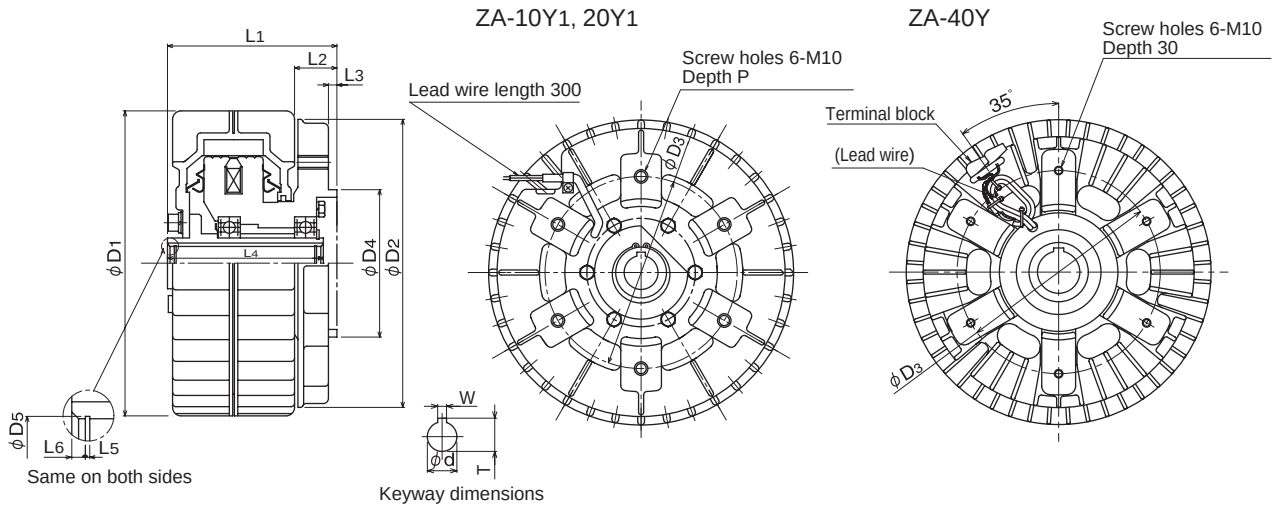
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)			Moment of inertia *J* (kgm^2)	Allowable rotation speed (r/min)	Product mass (kg)	Powder mass (g)
		Current (A)	Power (W)	Time constant (s)				
ZA-10Y1	100	1.21	28.8	0.3	6.60×10^{-2}	1800	22	117
ZA-20Y1	200	1.90	45.6	0.6	2.00×10^{-1}	1000	40	235
ZA-40Y	400	2.20	52.8	0.6	4.63×10^{-1}	1000	64	520

Note: Residual torque is less than 3% of the rated torque.

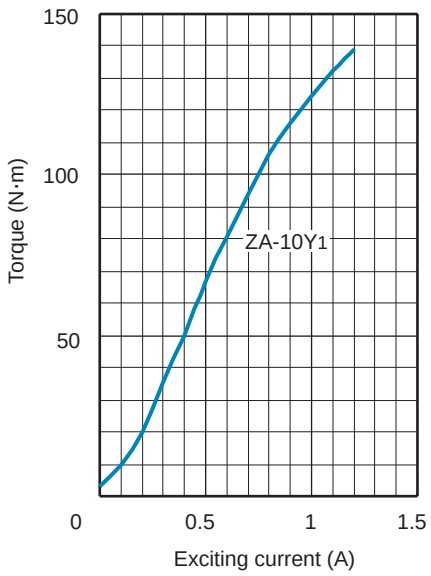
External dimensions (mm)

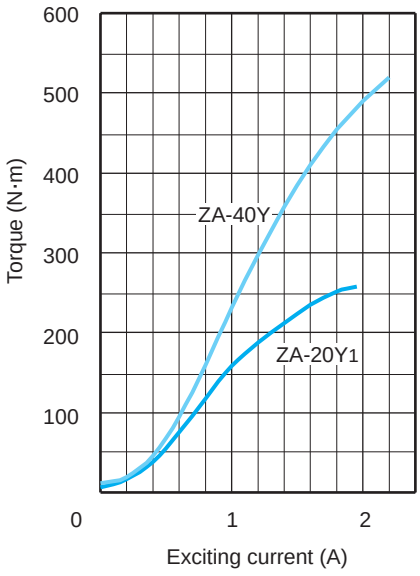


Model	L1	L2	L3	L4	L5	L6	D1	D2	D3	D4 (g7)	D5	P	Keyway		
												Depth	d (H7)	W (F8)	T ($^{+0.2}_{0}$)
ZA-10Y1	140	29	5	130	1.65	5	275	250	150	110	37	22	35	10	38.5
ZA-20Y1	160	42	6	152	–	–	335	320	240	160	–	30	45	12	49
ZA-40Y	210	41	6	202	–	–	360	320	240	160	–	30	50	12	53.5

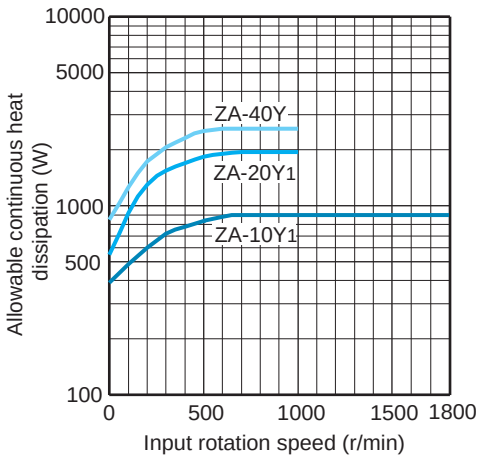
Characteristics

● Standard torque characteristics (representative example)

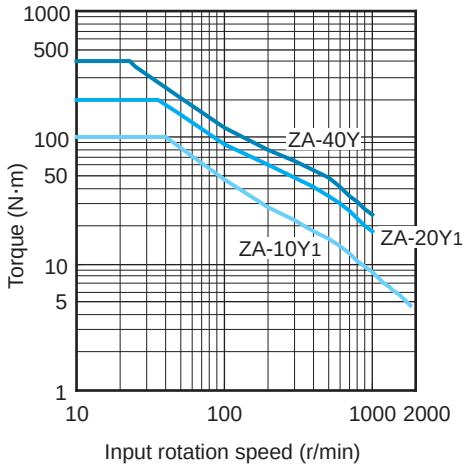




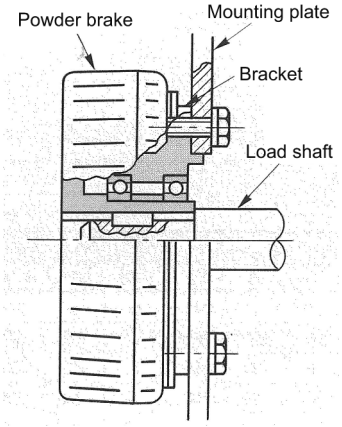
● Allowable continuous heat dissipation characteristics



● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the bracket with its intended mate on the mounting plate and fix it in place.
2) Concentricity between the brake-side through shaft and load shaft must be 0.05 mm or less.
3) The perimeter of the unit rotates. Cover the entire unit with a breathable net for safety.

ZX-YN model powder brake

(Torque 3~12 N·m)(Spontaneous cooling hole shaft type)

Features

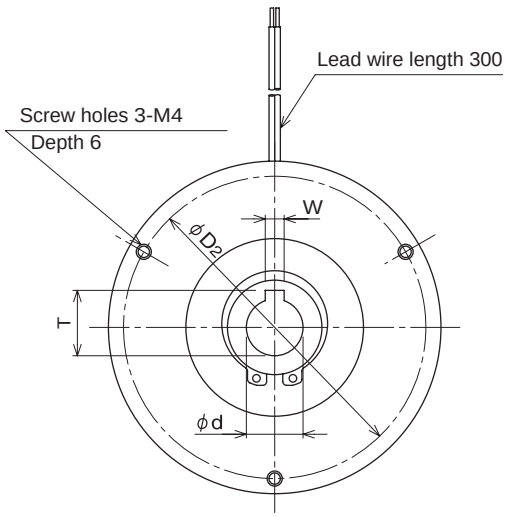
- Rated torque: 3~12 (N·m)
- Spontaneous cooling through shaft type
  - Ultra thin profile
  - Available in rated voltage of 24V DC and 80V DC
  - Operable from 5 r/min

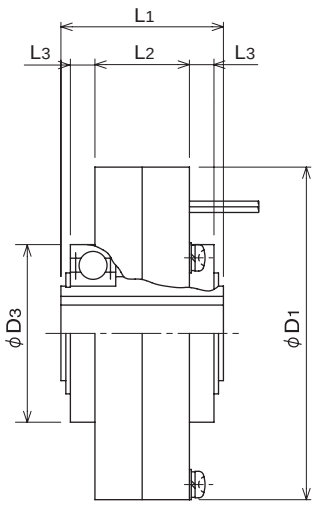
Specifications

Model	Rated torque (N·m)	Coil (75∝C)				Moment of inertia *J* (kgm^2)	Allowable rotation speed (r/min)	Product mass (kg)	Compatible power supply unit
		Voltage (V)	Current (A)	Power (W)	Time constant (s)				
ZX-0.3YN-24	3	24	0.40	9.6	0.035	3.5×10^{-5}	400	1.1	24V DC power supply unit
ZX-0.3YN-80		80	0.12	9.6	0.030				LL-05ZX, LD-05ZX
ZX-0.6YN-24	6	24	0.40	9.6	0.050	9.0×10^{-5}		1.8	24V DC power supply unit
ZX-0.6YN-80		80	0.12	9.6	0.046				LL-05ZX, LD-05ZX
ZX-1.2YN-24	12	24	0.50	12.0	0.070	1.6×10^{-4}		2.3	24V DC power supply unit
ZX-1.2YN-80		80	0.16	12.8	0.070				LL-05ZX, LD-05ZX

Note: Residual torque is less than 10% of the rated torque.

External dimensions (mm)



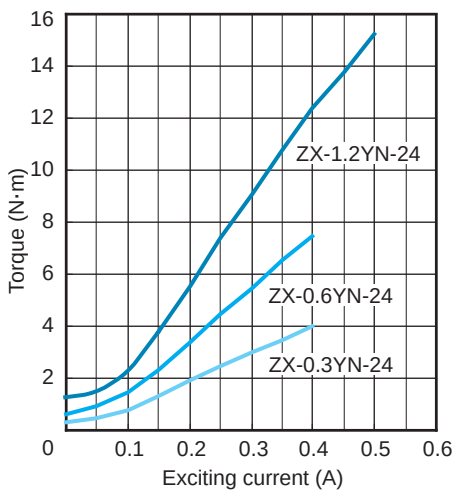


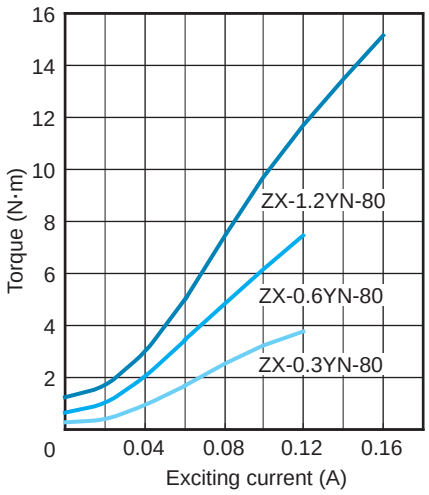
(Outer color: Munsell 10Y 7.5/1)

Model	L1	L2	L3	D1	D2	D3 (h5)	Keyway		
							d (H7)	W (Js9)	T ($^{+0.2}_{0}$)
ZX-0.3YN-24, 80	43	25	6.5	88	80	47	15	5	17.3
ZX-0.6YN-24, 80	49	30	6.5	105	97	55	20	6	22.8
ZX-1.2YN-24, 80	50	30	7	118	110	62	25	8	28.3

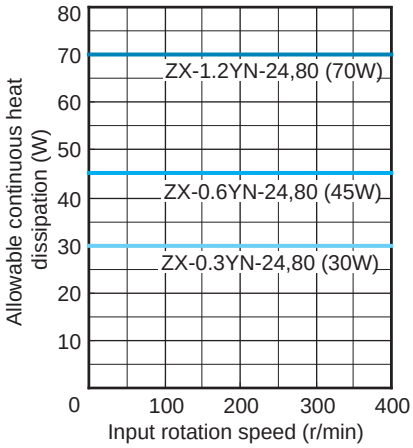
Characteristics

● Standard torque characteristics (representative example)

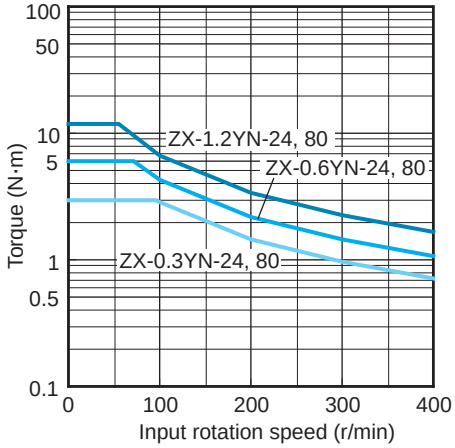




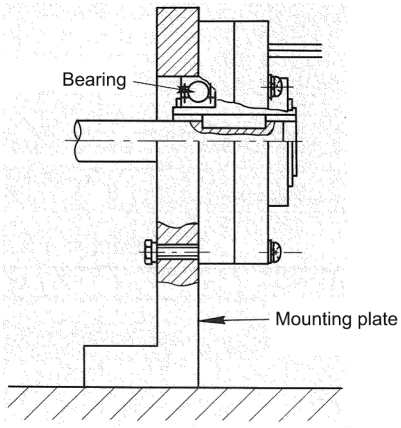
● Allowable continuous heat dissipation characteristics



● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the bearing with its intended mate on the mounting plate and fix it in place.
2) Be sure to use an flexible coupling to connect the brake shaft to the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) Support the load shaft at four points when it is supported with the bearing that is built in on the brake.
(The brake has two built-in bearings.)

Selection Criteria

Usage under continuous slip conditions

Powder clutches and brakes are normally used under the continuous slip conditions, and the heat dissipation (P) (slip heat) that is generated is calculated as follows:

$$P = 0.105 \times T \times Nr \ (W) \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where

Nr: Slip rotation speed (r/min)

T: Transmission torque (N·m).

(1)Select an appropriate clutch/brake model so that the heat dissipation that is calculated using the formula above is below the allowable continuous heat dissipation capacity of the model. Forced-cooling is required if spontaneous cooling is not sufficient to meet the heat dissipation requirement. When used under continuous slip conditions, the size selection of the clutch/brake depends on slip heat, so the operation torque of the selected model may be extremely small in relation to the rated torque of the clutch/brake. By the use of an appropriate decelerator and by changing the range of the operation torque, the selection of a smaller-size clutch/brake is possible.

Selection of powder clutch/brake for use in tension control

1. Machine specifications and selection formula

The flowchart in Figure 1 on page A-42 shows how to select an appropriate-capacity brake/clutch to be used for tension control, which is one of the most common ways to use these devices.

When selecting a model, the following three factors, 1) torque, 2) rotation speed, and 3) heat dissipation (heat generation of the slipping clutch/broke), must be taken into consideration. They are calculated in the following formula, using the machine specifications (tension, line speed, and winding diameter or reel diameter) as variables.

1) Torque $T = F \times \frac{D}{2}$ (N·m) .....(2)

2) Rotation speed $N = \frac{V}{\pi \times D}$ (r/min) .....(3)

3) Heat dissipation $P = 0.105 \times T \times Nr$ (W) ....(4)

where

F : Tension (N)

V : Line speed (m/min)

D : Reel diameter or reel diameter (m)

Nr : Slip rotation speed of powder clutch/brake (r/min)
(Differential between the input and output rotation speed in the case of powder clutches, and input rotation speed in the case of powder brake.)

Based on these calculation results, select a powder clutch/brake using the flowchart in Figure 1 on page A-42.

2. Key points in model selection

1) Torque

Calculate the allowable and minimum torque, and confirm that they are within the controllable range. The controllable torque range for the powder clutch/brake is between 100% of the rated torque and the threshold of the residual torque. (Due to the loss torque of the bearing or seal inside the product, the torque will not be at 0 N·m, even when the exciting current is cut off. Although there are slight variations in specifications between different models, this residual torque is normally approximately 2% of the rated torque. Refer to the specifications table for each model when making a selection.)

Although normal torque control is possible in the range between the threshold of the residual torque and one-hundred percent of the rated torque, better controllability is achieved when the product is used in a range closer to the rated range. The use of powder clutches and brakes in the range between five and one-hundred percent, (in which linearity of the torque to exciting current characteristics is ideal), is recommended, especially for an open-loop control device that uses reel diameter detection method or is manually controlled.

2) Rotation speed

Allowable rotation speed of both the powder clutch and brake must be less than or equal to the allowable rotation speed. In the case of the powder brake, the minimum rotation speed must be 15 r/min or higher, and in the case of the powder clutch, the differential between the input and output rotation speed must be 15 r/min or more. (That is, both the powder clutch and powder brake require a slip rotation speed of 15 r/min or higher.)

A powder clutch, instead of a powder brake, can be used to control the unwinding shaft in a system with a low line speed that does not create sufficient slip rotation speed. By rotating the unwinding shaft in the opposite direction of the shaft rotation by using a geared motor, enough slip rotation speed can be maintained in such a system. (The ZKB-N series, ZKG-N series, and ZX-YN series are operational from 5 r/min.)

3) Heat dissipation (slip heat)

The powder clutch/brake is used under continuous slip conditions when used for tension control, so the temperature of the powder clutch/brake itself rises due to heat dissipation. This heat dissipation (slip heat) during operation must be less than or equal to the allowable continuous heat dissipation capacity of the given model.

3. Powder brake on the unwinding shaft

When the gear ratio of the unwinding shaft and brake shaft is 1 to 1 (direct drive),

Slip rotation speed = rotation speed of the unwinding shaft

Heat dissipation (slip heat) is calculated in the following formula.

$$P = 0.105 \times T \times Nr = 0.105 \times \left(F \times \frac{D}{2}\right) \times \left(\frac{V}{\pi \times D}\right) = 0.0167 \times F \times V. \quad \text{..... (5)}$$

The result shows that the heat dissipation (slip heat) depends on the machine's tension and line speed and is independent of the winding diameter.

4. Powder clutch on the winding shaft

When the gear ratio of the winding shaft and clutch shaft is 1 to 1 (direct drive),

Slip rotation speed = Input rotation speed of the powder clutch - rotation speed of winding shaft.

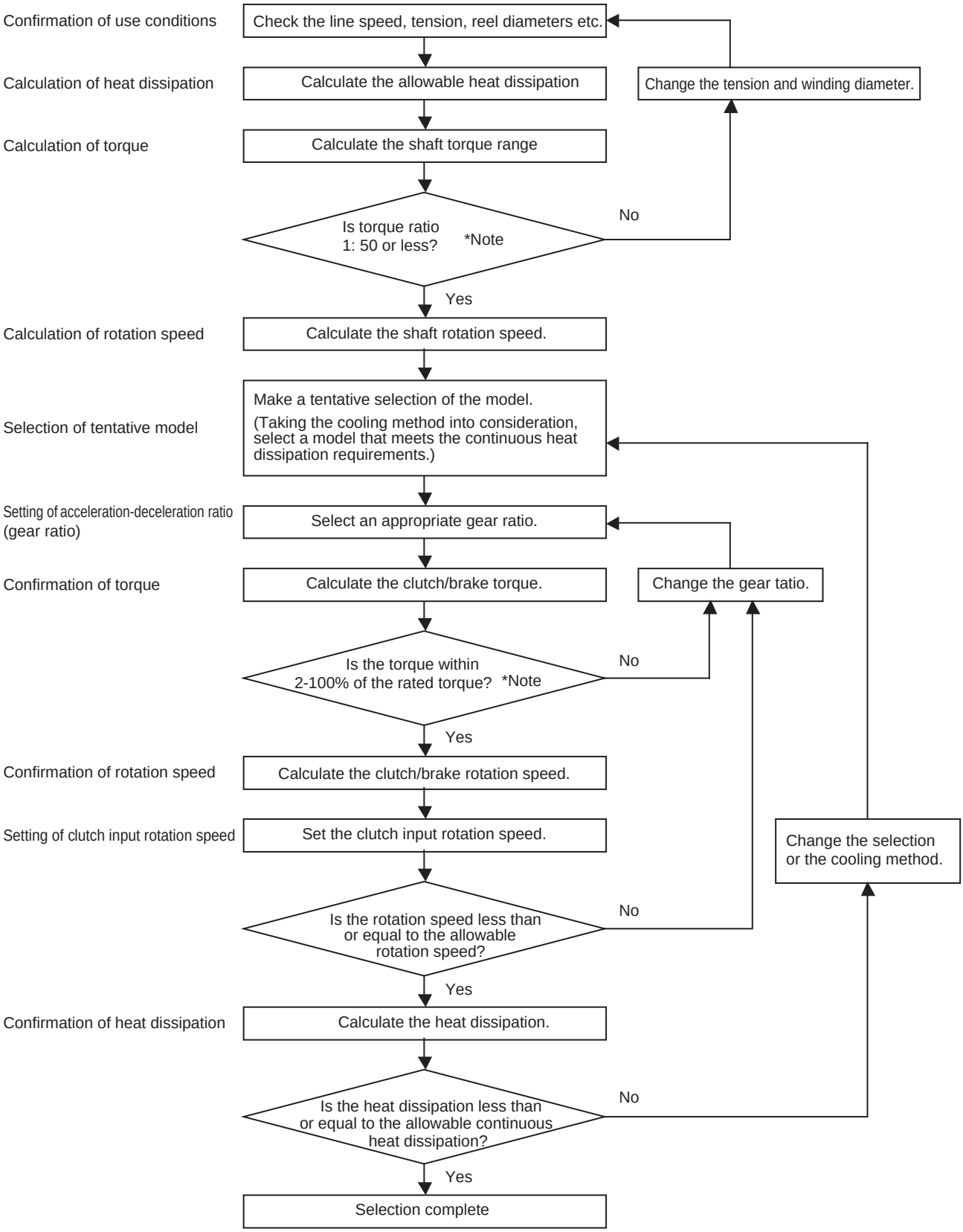
Usually, the input rotation speed of powder clutch is set at a constant rotation speed of 15 r/min or more above the allowable rotation speed of the winding shaft, and the heat dissipation (slip heat) changes according to the winding diameter (rotation speed of winding shaft). The allowable heat dissipation (slip heat) during operation is calculated as follows:

$$P\text{max} = 0.105 \times T\text{max} \times N\text{max} = 0.105 \times T\text{max} \times (Ni\text{-}N\text{min}) \quad \text{..... (6)}$$

where

- Pmax : Allowable heat dissipation (W)
- Tmax : Allowable torque (N·m)
- Nmax: Allowable slip rotation speed (r/min)
- Ni : Clutch input rotation speed (r/min)
- Nmin : Minimum rotation speed (r/min).

Torque and slip rotation speed are at their allowable speed upon completion of the winding operation, when the heat dissipation (slip heat) also reaches its allowable level.
(Note: In a taper-controlled system, in which the tension at the end of winding operation is significantly smaller than that at the beginning, heat dissipation may reach its allowable level during winding operation.)



*Note Controllable torque range varies between different models. Refer to the specification table for each model for details.

Figure 1. Powder clutch/brake selection flowchart

Sample calculation for model selection

Torque controllability and constant torque characteristics can be applied to constant tension winding, in which the winding tension is kept constant, or to taper tension control, in which the tension becomes increasingly loose toward the end of the winding operation.
There are three possible applications of these characteristics: unwinding brake, idle clutch or brake, or winding clutch.
Controllable torque range is between the threshold of the residual torque and rated torque. Residual torque varies between different models. Refer to the specifications table for each model to find out the residual torque for a particular model.

1. Powder brake on the unwinding shaft (1)

Selection of a powder brake for a film winding machine with the following specifications

1) Specifications

Line speed	V: 170 m/min Constant	
Tension	F: 100 N Constant	
Unwinding reel diameter	Allowable diameter	D_1: 660mm
	Minimum diameter	D_2: 110mm

2) Calculation

1Torque

When the required brake torques at the beginning and end of the unwinding operation with a tension of 100N are T1 and T2,

$$T_1 = \frac{D_1}{2} \times F = \frac{660 \times 10^{-3}}{2} \times 100 = 33\ \text{N·m}.$$

$$T_2 = \frac{D_2}{2} \times F = \frac{110 \times 10^{-3}}{2} \times 100 = 5.5\ \text{N·m}.$$

2Rotation speed

If the rotation speeds at the beginning and end of the unwinding operation with a line speed of 170 m/min are N_1 and N_2,

$$N_1 = \frac{V}{\pi D_1} = \frac{170}{\pi \times 660 \times 10^{-3}} = 82\ \text{r/min}.$$

$$N_2 = \frac{V}{\pi D_2} = \frac{170}{\pi \times 110 \times 10^{-3}} = 492\ \text{r/min}.$$

3Heat dissipation

Heat dissipation P is calculated in the formula below:

$$P = 0.105 \times T \times Nr = 0.0105 \times \frac{DF}{2} \times \frac{V}{\pi D}$$
$$= 0.0167 \times F \times V = 0.0167 \times 100 \times 170$$
$$= 284\ \text{W}.$$

Continuous heat dissipation of the unwinding brake is constant in a system with a constant line speed and constant tension.

4Selection

Based on the values of T_1 and T_2 (Torque) and P (heat dissipation), the ZA-5Y_1 model (Rated torque of 50 N·m, approximate allowable continuous heat dissipation capacity of 290 W at input rotation speed of 82 r/min) is selected as a model to be used as a spontaneous-cooling unit.
The unwinding shaft and brake shaft are directly connected, and the torque operation range is 66-11% of the rated torque range.

<Notes>

The allowable continuous heat dissipation rate of the spontaneous-cooling unit depends on the rotation speed of the brake. Use N_1 (during low rotation speed when the allowable continuous heat dissipation rate drops) to determine which model to use.

2. Powder brake on the unwinding shaft (2)

The following example shows an example of changing the gear ratio according to the tension in order to control a wide range of torque.

1) Specifications

Line speed	V: 100 m/min Constant	
Tension	F: 130 ~ 520 N	
Unwinding reel diameter	D: 100 mm ~ 900 mm	
Manual control		

2) Calculation

1 As in the example above, solve for torque (T), rotation speed (N), and heat dissipation (P).

$$T = \frac{D}{2} \times F = \frac{(0.1 \sim 0.9)}{2} \times (130 \sim 520)$$
$$= 6.5 \sim 234\ \text{N·m}.$$

$$N = \frac{V}{\pi D} = \frac{100}{\pi \times (0.1 \sim 0.9)}$$
$$= 35.4 \sim 318\ \text{r/min}.$$

$$P = 0.0167 \times F \times V = 0.0167 \times 520 \times 100$$
$$= 869\ \text{W (Allowable)}.$$

Based on the calculation result above, ZKB-10HBN (Thermo block type) can be selected as an appropriate model.

2 If the allowable T in the calculation result (234 N·m) is set as 100%, the minimum T (6.5 N·m) is 2.8% and is outside of the manual control range (5-100%).
Therefore, torque must be controlled to fall within the adequate range by changing the gear ratio in proportion to tension.
The amount of tension necessary to change the gear ratio (Fm) is calculated in the following formula:

$$Fm = \sqrt{\text{Tension ratio} \times Fmin}$$
$$= \sqrt{\frac{520}{130}} \times 130 = 260\ \text{N}.$$

3 When the tension is between 130 and 260 N
Unwinding shaft

$$Tbo = \frac{(0.1 \sim 0.9)}{2} \times (130 \sim 260)$$
$$= 6.5 \sim 117\ \text{N·m}.$$
$$Nbo = N = 35.4 \sim 318\ \text{r/min}.$$

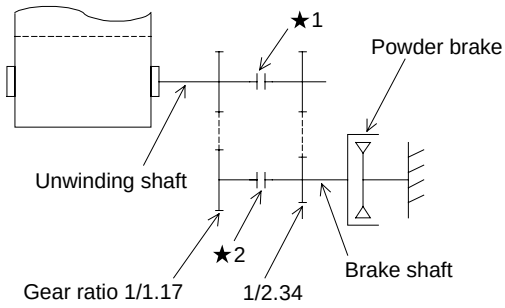
Brake shaft (To be accelerated by 1.17 times)

$$Tbr = Tbo \times \frac{1}{1.17} = 5.6 \sim 100\ \text{N·m}.$$
$$(5.6 \sim 100\%)$$
$$Nbr = Nbo \times 1.17 = 41.4 \sim 372\ \text{r/min}.$$
$$P = 0.0167 \times F \times V = 434\ \text{W (Allowable)}.$$

4 Do the same calculation for tension valves between 260 and 520 N.

Tbo = 13~234 N·m
Nbo = 35.4~318 r/min
Brake shaft (To be accelerated by 2.34 times)
Tbr = 5.6~100 N·m
Nbr = 82.8~744 r/min
P = 869 W (Allowable)

5Sample structure



Note 1. Speed increasing ratios 1.17 and 2.34 are the ratios that are used to adjust each allowable torque to 100%.
Note 2. Increasing the number of gears to increase the speed increasing (or decreasing) ratio will decrease the torque transmission efficiency and make normal torque control difficult. Use only one gear.

★1 and ★2 represent electromagnetic clutches.
When F is between 130 and 260 N,

★1: OFF ★2: ON → Gear ratio = $\frac{1}{1.17}$

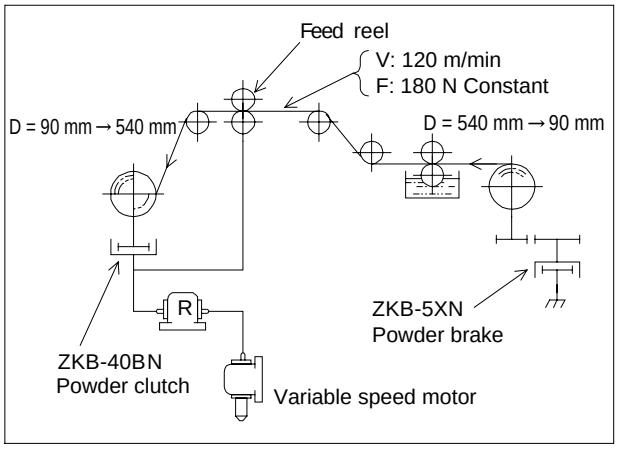
When F is between 260 and 520N,

★1: ON ★2: OFF → Gear ratio = $\frac{1}{2.34}$

3. Powder clutch on the winding shaft

1) Specifications

Line speed V: 120 m/min
Tension F: 180 N Constant
Winding reel diameter Minimum diameter D_1: 90 mm
Allowable diameter D_2: 540 mm



2) Calculation

1Torque

When the required winding torques for the clutch at the beginning and end of the winding operation with a tension of 180 N are T_1 and T_2,

$$T_1 = \frac{D_1}{2} \times F = \frac{90 \times 10^{-3}}{2} \times 180 = 8.1 \text{ N·m.}$$

$$T_2 = \frac{D_2}{2} \times F = \frac{540 \times 10^{-3}}{2} \times 180 = 48.6 \text{ N·m.}$$

2Rotation speed

When the rotation speeds of the winding shaft at the beginning and end of the winding operation with a line speed of 120 m/min are N_1 and N_2 (N_1 and N_2 represent the rotation speed of the winding shaft, not the slip rotation speed.),

$$N_1 = \frac{V}{\pi D_1} = \frac{120}{\pi \times 90 \times 10^{-3}} = 425 \text{ r/min}$$

$$= \frac{V}{\pi D_2} = \frac{120}{\pi \times 540 \times 10^{-3}} = 71 \text{ r/min.}$$

3Heat dissipation

If the input rotation speed of the clutch (N_0) is set 15 r/min* higher than the required rotation speed at the beginning of winding (N_1), and the heat dissipation of the clutch at the beginning and end of the winding operation are P_1 and P_2,

$P_1 = 0.105 \times (440 - 425) \times 8.1 = 12.8$ W
$P_2 = 0.105 \times (440 - 71) \times 48.6 = 1883$ W

When a winding clutch is used for constant tension control, both slip rotation speed and the required winding torque reach their allowable valves at the end of the winding. This means the heat dissipation also reaches its allowable valve at the end of winding, and the required capacity of the clutch must be determined based on the final conditions.
Based on these calculation results, the following models can be selected.

Forced-air cooling:
ZKB-40BN (Rated torque 400 N·m, Allowable continuous heat dissipation rate 2800 W) is usable.
If connected directly to the winding shaft, however, put it on automatic control since the torque at the beginning of the winding will go below 5% of the rated torque.

If the unwinding side is also taken into consideration, the following values are obtained.

$$\begin{cases} N_1 = 425 \text{ r/min} \\ N_2 = 71 \text{ r/min} \end{cases} \quad \begin{cases} T_1 = 8.1 \text{ N·m} \\ T_2 = 48.6 \text{ N·m} \end{cases}$$

These are the same for winding, and heat dissipation P can be calculated as follows:

$P = 0.105 \times T1 \times N1 = 0.105 \times T2 \times N2$
$= 0.0167 \times F \times V = 361W.$

Based on these calculation results, the following model can be selected.

Forced-air cooling:
ZKB-5XN (Rated torque 50N·m, Allowable continuous heat dissipation rate 700 W) is usable.

It is clear from these calculation results that there are no major differences in torque operation range or slip rotation speed between the winding clutch and unwinding brake: however, note that the model selection changes due to significant differences in heat dissipation. On the unwinding side, heat dissipation is kept constant regardless of the reel ratio (the ratio between the minimum and allowable diameters); on the winding side, heat dissipation increases almost in proportion to the reel ratio.

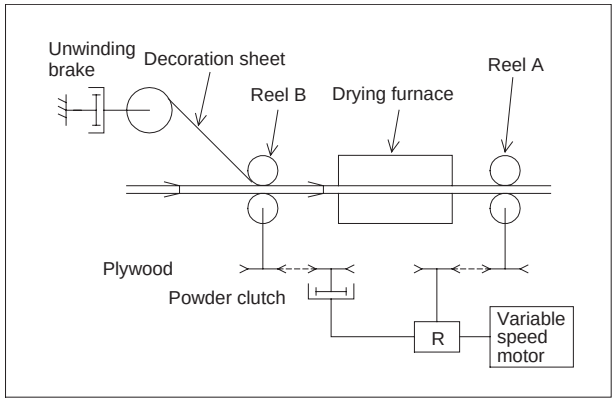
* In the example above, the input rotation speed of the clutch is increased by 15 r/min, although it is usually increased by approximately ten percent.
The ZA-5Y1 blower-cooling model and the ZKB-5HBN model can be selected as the unwinding brake in this example.

4. Powder clutch for driving a pinch reel

1) Specifications

Reel diameter 200 mm
Line speed 45~90 m/min
Tension 100~350 N

When laminating plywood with a decoration sheet, a difference in peripheral speed between feed Reel A and Pinch Reel B is created by a change in the rubber reel diameter that results from pinch reel pressure. A powder clutch can be used to drive Reel B to prevent it from slippage caused by the peripheral speed differential.



2) Calculation

1Rotation speed of Reel B

$$N = \frac{V}{\pi D} = \frac{45\sim90}{\pi \times 200 \times 10^{-3}} = 72\sim144 \text{ r/min.}$$

2Driving torque of the reel

$$T = \frac{D}{2} \times F = \frac{200 \times 10^{-3}}{2} \times (100\sim350)$$

$= 10\sim35$ N·m.

3Heat dissipation

If the input rotation speed of the clutch is determined so that the slip rotation speed is 15 r/min when the line speed is at 45 m/min, the allowable heat dissipation is calculated as follows:

The input rotation speed of the clutch when the line speed is at 90 m/min is calculated first.

$$N_0 = 144 \times \left(\frac{72+15}{72}\right) \cong 144 \times 1.2 = 173 \text{ r/min.}$$

Therefore, solving for heat dissipation,

$P = 0.105 \times (173-144) \times 35 = 107$ W.

Based on these calculation results, the ZKB-2.5BN model (Rated torque: 25 N·m; Heat dissipation: 160 W at 200 r/min) is found to be usable through doubling the rotation speed of Reel B.

In this case, the operating range of the torque is between 5 and 17.5 N·m, and the input rotation number of the clutch N'0 is calculated as follows:

$$N'_0 = 288 \times \left(\frac{144 + 15}{144}\right) \cong 388 \text{ r/min.}$$

which is sufficient.

The heat dissipation at this time is

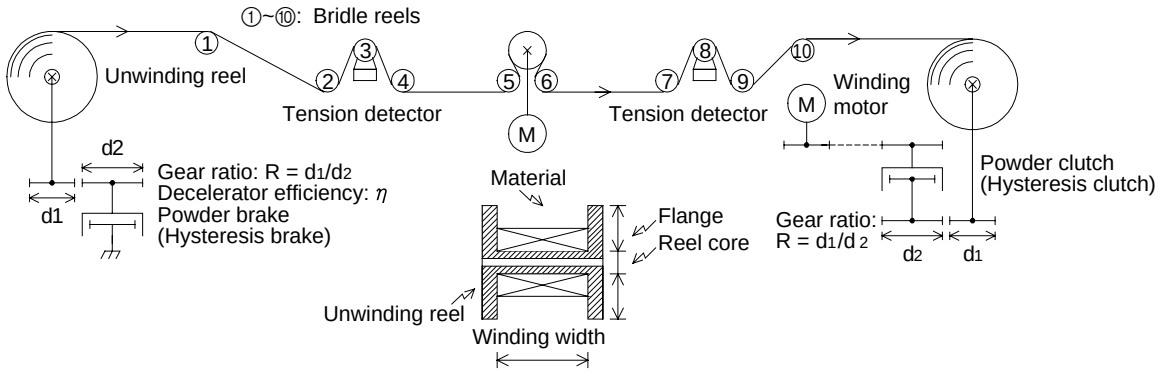
$P = 0.105 \times (318 - 288) \times 17.5 = 55$ W.

Powder clutch/brake (hysteresis clutch/brake) specifications sheet

● Winding/unwinding (Note: Circle one.)

Client's name		Machine type/model		Delivery date		No. of units	

Configuration



* = Required items.

Reel diameter	*	Allowable Dmax = _____m Minimum Dmin = _____m
Line speed	*	Allowable Vmax = _____m/min Minimum Vmin = _____m/min
Acceleration and deceleration time		Allowable tmin = _____s (0 → Vmax, Vmax → 0)
Operating tension	*	Allowable Fmax = _____N Minimum Fmin = _____N
Reel mass		Full reel weight Wm = _____kg Winding width Lm = mm Reel core weight Wc = _____kg Flange weight Wf = _____kg
Operation cycle		Operation time per cycle _____ min Stoppage time _____min
Material		Type _____ Width_____ mm Thickness _____ μm
Ambient conditions		Temperature _____℃ Humidity _____% Vibration _____m/s^2 Need for explosion-proof equipment _____
Method of forced cooling		Forced air-cooling | Yes/No Water-cooling | Yes/No
Control method		(A)Manual (B)Automatic
Type of automatic control		(A)Control based on reel diameter measurement (B)Tension feedback controlled control
Type of tension control		(A)Constant tension (B)Taper tension Rate (Minimum:)% (Allowable:)%
Tarlet		(A)Yes (B)No
Autopaster		(A)Yes (B)No
Reel diameter sensor		(A)Required (B)Not required (for external control of taper tension)

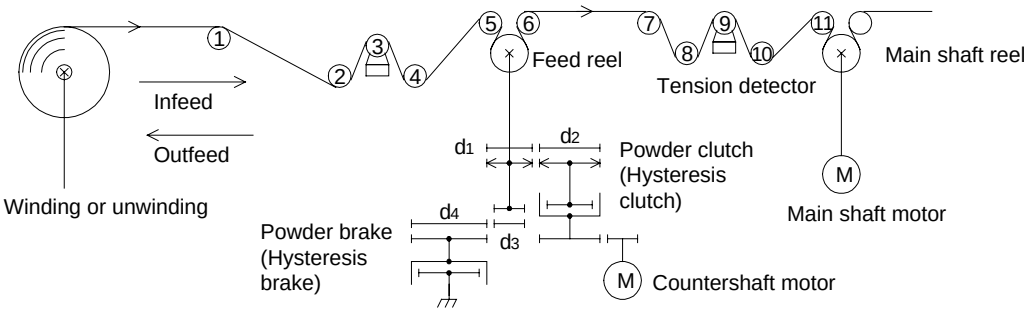
Notes: 1. Attach a power system diagram if available.
2. If the inertia of the bridle reels has a significant impact on the system, write down the reel weight in any blank space.

Powder clutch/brake (hysteresis clutch/brake) specifications sheet

● Countershaft

Client's name		Machine type/model		Delivery date		No. of units	

Configuration



* = Required items.

Feed reel	*	Feed reel diameter Do_____m
Line speed	*	Allowable Vmax = _____m/min Minimum Vmin = _____m/min
Acceleration and deceleration time		Minimum tmin = _____sec (0 → Vmax, Vmax → 0)
Operating tension	*	Input side F_1max = _____N F_1max = _____ N On the reel ⑤ side during infeed and on the reel ⑥ side during outfeed. Output side F_2max = _____N F_2max = _____ N On the reel ⑥ side during infeed and on the reel ⑤ side during outfeed.
Feed reel mass		Wd = _____kg
Operation cycle		Operation time per cycle _____ min Stoppage time _____min
Material		Type_____ Width_____ mm Thickness _____ μm
Ambient conditions		Temperature _____℃ Humidity _____% Vibration _____m/s² Need for explosion-proof equipment _____
Method of forced cooling		Forced air-cooling Yes/No Water-cooling Yes/No
Control method		(A)Manual (B)Tension feedback controlled control
Miscellaneous		It is assumed that the efficiency of the decelerators (d_1/d_2, d_3/d_4) is η = 0.9~1, and the mechanical loss torque is at the negligible level.

Using the basic specifications information above, the selection of an appropriate model clutch/brake and gear ratio d_1/d_2 and d_3/d_4 are determined. The input rotation speed of the clutch must be set so that the peripheral speed of the feed reel is ten percent faster than that of the main shaft when the clutch is completely engaged.

The clutch and brake apply bias torque to each other that is equivalent to ten percent of the allowable tension. The minimum slip rotation speed of the clutch must be greater than the minimum operating rotation speed.
If the tension on the input side is always greater than that on the output side, a brake is not required. Conversely, if the tension on the input side is always smaller than that on the output side, a clutch is not required. If there is only a small tension differential between the input and output sides and if results in the torque going below the minimum control torque of either the clutch or brake, both a clutch and a brake are required.

Notes: 1. Attach a power system diagram if available.
2. If the inertia of the bridle reels has a significant impact on the system, write down the reel weight in any blank space.

Usage Precautions

Read the "Safety Precautions" at the end of this catalog to use the product safely and correctly.

1. General items

1) Correct orientation of the powder clutch.

Install the powder clutch according to the standard mounting procedure with the high-speed rotation side on the input side. (The ZA model must be installed with the hollow shaft on the output side. The input and output sides of the ZKB model are indicated with arrows on the dimensional drawings in this catalog and on the nameplates.) Reverse mounting of the clutch in a system that permits continuous idling is not recommended in terms of torque characteristics and powder life.

Both the powder clutches and brakes are designed to be installed with the shaft in the horizontal position, and vertical mounting is not possible.

If components are going to be used in the following conditions, contact the nearest Mitsubishi office with information on the operating conditions.

a) Inclined mounting of the unit
b) Inverted mounting
c) Special specifications such as low temperature specifications

2) Mounting of pulley, coupling, and shaft

Use parts with clearance fit when installing such parts as pulley, coupling, shaft etc. on the product to prevent undue force from being applied to the product during mounting. If the product receives an impact, the bearing inside the product may sustain damage and may lead to premature breakage.

3) Preventing moisture damage

If the powder becomes damp, performance will suffer and become unstable. Keep water and oil from infiltrating the internal structure. Especially, if the clutch/brake is installed near a gear box, oil may run down the shaft and enter the clutch/brake. Sealing must be done properly to keep the oil out. Mitsubishi powder brakes/clutches are not hermetic. They are not designed to be used in an environment where oil mist, oil, or water may be directly sprayed on them.

4) Surface temperature limit

When running a continuous operation, do not exceed the allowable surface temperature listed in the table below. Operating above these limits will seriously affect the durability of the unit.

Allowable surface temperature of the clutch/brake (stator perimeter)

Model	Temperature limit (approximate)
Spontaneous cooling Thermo block Water-cooled ZKB-WN	90∝C or less
Forced-air cooling	70∝C or less

Standard ambient temperature and cooling-water temperature are assumed to be 30°C.

Use the temperature limit in the table above only as a guide. Use the product with a heat dissipation rate less than or equal to the allowable heat dissipation rate.

2. Rated torque and rated electric current

1) When rated electric current is applied at factory shipment (or during a break-in cycle), the torque exceeds the rated torque significantly. (Refer to the standard torque characteristic for each model.) This is due to higher torque, taking into consideration the deterioration of powder over time. Decrease the current so that the torque will not exceed the rated torque.
2) Although deterioration of powder over time would result in torque drop, a stable torque transmission can be regained by increasing the magnitude of the current to be applied, in proportion to which the torque will increase. Do not apply current above the rated current.

3. Notes on torque

1) The standard torque to electric current characteristic of a new unit at 200 r/min is listed in this catalogue. This standard characteristic changes with the deterioration of the powder over time. Compensate for the change in torque characteristic by changing the magnitude of the current to be applied.
2) Torque can easily be controlled by changing the magnitude of the current that is applied in most applications; however, if a large model (Torque rating of 100 N·m or more) is used with a small amount of current being applied, torque instability may be experienced.
3) It may take considerable time for the torque to reach the predetermined time if ON/OFF control is performed during high-speed rotation.
4) Torque dispersion near the rated current for each unit is approximately ±10%. That against the standard torque characteristics is approximately ±15% (or greater) between units. Therefore, it is recommended that the system be configured in such a way that the current that is applied to each clutch or brake can be controlled individually when installing multiple brakes or clutches in parallel.
5) Torque to current characteristic has a hysteresis characteristic, so torque differential is created by current fluctuations.

4. Product life

1) When used for winding or unwinding under the continuous slip condition, the life of powder depends on the use conditions (e.g., relative slip velocity). Generally, when used below the allowable continuous heat dissipation rate, the time it takes for the powder to reach the point where its torque transmission capacity goes down to the rated torque when rated current is applied is approximately 5000-8000 hours. When used below the rated torque, the powder clutch/brake can continue to be used even after the torque has dropped to the rated torque. Even with the same heat dissipation, if a high slip rotation speed (relative rotation speed) is maintained for a relatively long time, the product life tends to become shorter. Configure the system so as to minimize the relative rotation speed.
2) Life of the powder can be extended by using the clutch or brake significantly below its allowable continuous heat dissipation rate. For example, if the clutch or brake is used at fifty percent of the allowable continuous heat dissipation rate, the life of the powder may be more than doubled.

5. Low-speed operation (at or less 15 r/min)

Although powder clutches and brakes exhibit a stable torque characteristic when used for a continuous operation, such as tension control, they may provide a slow torque startup immediately after a voltage application when they are used for an intermittent idling operation. To avoid a slow torque startup, take the following measures:

1) Maintain a low exciting current level (five to ten percent of the rated current) even at the end of winding so that the powder stays on the operation surface.
2) Increase the operation speed so that the minimum rotation speed is at 15 r/min. Note that if the speed increasing ratio is too large, mechanical loss in the acceleration mechanism may affect the precision of torque control.
3) The ZKB-N, ZKG, and ZX series are operable from approximately 5 r/min.

6. Running a break-in cycle.

1) The powder may be dispersed unevenly inside the clutch/brake due to the impacts that may have been sustained during transport. Run a break-in cycle before starting a regular operation. (Refer to the operation manual for the procedures for running a break-in cycle.)
2) Uneven dispersion of powder may inhibit the normal rotation of the shaft, cause the shaft to lock, or cause the unit to screech. If these happen, lightly tap on the perimeter of the unit with a plastic hammer. These problems usually disappear once the unit is operated.

7. Forced-air cooling

1) Provide an air filter.
Compressed air that is used for cooling usually contains oil and moisture. Be sure to put the cooling air through a filter that is capable of complete oil removal to remove such oil and moisture.
(Moisture and oil in unfiltered compressed air will cause the powder to become damp and seriously affect the performance of the unit.)
2) If piping is long or branched, check the air flow near the suction pipe of the clutch/brake to make sure that it meets the flow rate requirement.

8. Thermo block cooling

1) An axial fan (blower) is provided for the Thermo block cooling models to increase the heat dissipation capacity. These models require an adequate amount of space around the unit for the axial fan to operate properly to maintain an adequate level of continuous heat dissipation capacity.
Periodically clean the axial fan guard when the unit is installed in an environment where the fan guard may collect foreign matter.
2) A heat switch that monitors temperature is provided on the perimeter of the stator. Be sure to connect it to an alarm device so that abnormal temperatures are detected.

9. Water cooled models

1) Install a drain cock.
Provide a drain cock on the water supply side so that the cooling water can be drained when the operation is stopped for an extended period of time to prevent rust and other damage that may be caused by moisture. Especially when used in a cold region, take caution not to let the cooling water freeze while the unit is stopped. Frozen cooling water can damage the water channel inside the powder brake.
Remove water scale buildup in the cooling water channel periodically.

2) Set up a protection circuit against water supply cutoffs.
Even a short period of water supply cutoff may burn the internal structure of the water-cooled brake. Be sure to set up a protection circuit (flow relay) to protect the brake from such damage.

3) Take measures to avoid dew condensation.
When using the water-cooled brake, observe the following instructions to avoid dew condensation resulting from overcooling. (Dew condensation will cause the powder to absorb moisture and adversely affect the powder characteristics.)

a) Use the supply water at approximately the same temperature as the room temperature. When the workload is small and the surface temperature drops below 50°C, decrease the amount of supply water.

b) Stop the water flow immediately after the operation is stopped.

c) When used for a tarlet, do not supply water to the brakes that are not in use.

4) Relatively large brake models, such as the ZKB-W series brakes, may experience problems with a locked shaft if the operation remains stopped for a long time.
This problem is caused when the driving member that was thermally expanded during a high-load operation shrinks during cooling, and the powder gets squeezed in the narrowed powder gap between the drive member and driven member. This problem can be prevented by giving the shaft a few rotations immediately after stopping operation. If the shaft becomes completely locked, lightly tap on the shaft coupling with a plastic hammer to loosen the locked shaft. (Do not hit directly on the brake body or the shaft with a great force.)

10. Model selection

1) The unit may not be used above the rated torque, even if it is used below the allowable continuous heat dissipation rate.
2) In a system with a wide tension range, multiple numbers of clutches may be used by switching between them. Disengage the clutch that is not in use at a given time by using a device such as an electromagnetic clutch so that the output side of the clutch that is not in use is not forced to slip.

11. Abnormal torque at startup

1) Depending on the operation pattern (starting the rotation of the input shaft after coil current is applied, or starting the rotation at the time coil current is applied), torque may temporarily exceed the predetermined value at start up (torque spike). Especially if vibration is transmitted to the unit while the current is not applied, the powder becomes dispersed unevenly, and this tendency becomes more pronounced. Apply a small amount of exciting current to the coil even while the clutch/brake is stopped to deter this problem.
2) Damp powder may also cause torque spikes. If torque spikes are caused by damp powder, replacement of the unit may be necessary.

12. Miscellaneous

1) The allowable continuous heat dissipation rate drops at high altitude. The specifications in this catalog are valid only for the units that are used at an elevation of 1000 m or less.
2) The protection grade is IP00. The powder clutch/brake cannot be used in an environment where the presence of oxidized powder or fine powder that may leak out from the powder clutch casing is not allowed. Please contact the nearest Mitsubishi office to inquire about details. (Hysteresis clutches do not generate oxidized powder.)
3) Although powder clutches and brakes are free of the type of engagement or braking noise that is associated with friction disc clutches and brakes, they do generate friction noise when torque is created by the friction of electromagnetically linked powder. Although this noise is negligible in most applications, it may become louder, depending on the distribution of the powder inside the clutch/brake. (Normally this noise becomes less pronounced after running a break-in cycle and with the passage of time.)
4) Powder clutches/brakes can be used for the types of machines that do not cause an unusual amount of vibration, such as a rotary press, paper processing machine, or wrapping machine, but they cannot be used for machines that create impact force.
5) The mounting shaft becomes magnetized by the flux that is created when a voltage is applied to the clutch or brake. If magnetization of the shaft creates a problem, the use of nonmagnetic material for the mounting shaft can reduce the degree of magnetization, although it cannot completely eliminate magnetization. Note that the solid shaft on such models as the ZKB model also becomes magnetized.

13. Allowable axial load

1) ZKB series

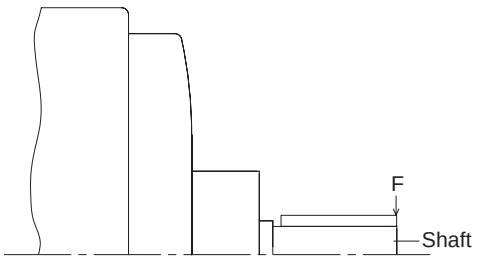
There are two ways to engage the input and output members of the clutch/brake as follows:

a) Engagement with a coupling
b) Engagement with a pulley

When the clutch/brake is engaged with a coupling, the use of a flexible coupling is assumed. Radial load on the shaft will not create a problem in this type of application.
However, when the clutch/brake is engaged with a pulley, radial load on the shaft will be restricted by the shaft strength and the load capacity of the bearing.

Table 1. Allowable axial load (radial load) for the ZKB series

Model	Allowable axial load (N)			
	300 (r/min)	500 (r/min)	1000 (r/min)	1800 (r/min)
ZKB-0.06	140	140	125	120
ZKB-0.3	280	280	245	240
ZKB-0.6	330	330	260	215
ZKB-1.2	360	325	255	210
ZKB-2.5	550	460	365	300
ZKB-5	975	975	770	635
ZKB-10	2090	1760	1400	1150
ZKB-20	2600	2190	1740	1430
ZKB-40	3850	3240	2570	2120



1. Regardless of the cooling method (spontaneous, forced-air, water-cooled), clutches or brakes with the same torque capacity have the same allowable axial load.
2. Allowable load values that are shown in the table are the smaller of either the shaft strength or the bearing radial load.
3. Bearing load is determined based on the expected fatigue life of 15000 hours.
4. Standard load application point is set as the end faces of the shaft. If the application point is outside of the end faces, the allowable axial load allowance will be smaller.
5. As a rule, thrust load cannot be applied.

Axial load (F) is calculated in the following formula:

$$F = \frac{2T}{D} \times K(N).$$

where

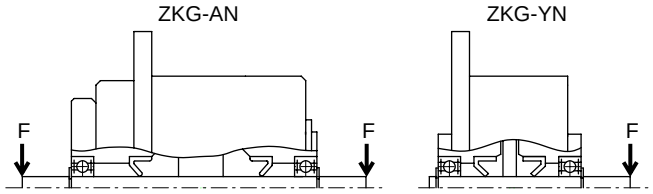
T: Transmission torque (N·m)
D: Pulley diameter (m)
K: Load factor (Timing belt 1.5, V belt 2.5, Sprocket 1.5).

2) ZKG series

Table 2. Allowable axial load (radial load) for the ZKG series

Model	Allowable axial load (N)			
	300 (r/min)	500 (r/min)	1000 (r/min)	1800 (r/min)
ZKG-5AN	16	13	11	9
ZKG-10AN	28	23	18	15
ZKG-20AN	39	32	26	21
ZKG-50AN	77	65	52	42
ZKG-100AN	85	72	57	47
ZKG-5YN	13	11	9	7
ZKG-10YN	23	19	15	12
ZKG-20YN	33	27	22	18
ZKG-50YN	52	44	35	28

Note1: Both shafts of the ZKG model powder clutches have the same structure and have the same allowable axial load capacity.
Note2: Standard load application point is set at the end faces of the shaft.
Note3: If the application point is outside of the end faces, the allowable axial load allowance will be smaller.

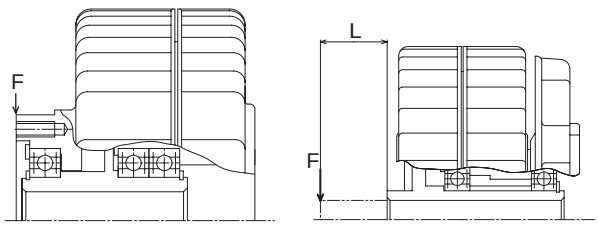


3) ZA series

Table 3. Allowable axial load (radial load) for the ZA series

Model	Allowable axial load (N)				
	L (mm)	300 (r/min)	500 (r/min)	1000 (r/min)	1800 (r/min)
ZA-0.6A	–	560	470	375	310
ZA-1.2A1	–	1080	910	720	590
ZA-2.5A1	–	1120	950	750	620
ZA-5A1	–	1790	1510	1190	980
ZA-10A1	–	1930	1630	1290	1060
ZA-20A1	–	4430	3740	2960	–
ZA-0.6Y	28	305	260	205	170
ZA-1.2Y1	32	340	290	230	185
ZA-2.5Y1	44.5	425	360	285	235
ZA-5Y1	58	880	760	600	500

Note1. Standard load application points are marked with the letter “F” in the figures above.
If the load application point is outside of the end faces, the allowable axial load allowance will be smaller.
Note2. As a rule, thrust load cannot be applied.
Note3. As a rule, a pulley cannot be directly connected to the ZA-10Y1~40Y models.



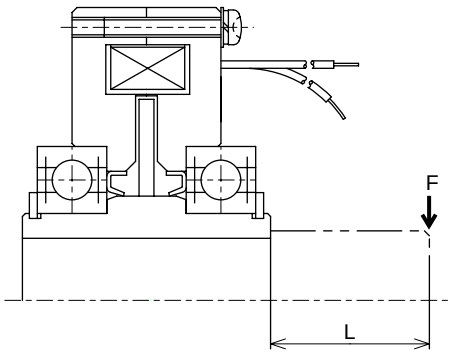
4) ZX series

Table 4. Allowable axial load (radial load) for the ZX series

Model	L (mm)	Allowable axial load (N)		
		100 (r/min)	200 (r/min)	400 (r/min)
ZX-0.3YN-24,80	24	1000	795	630
ZX-0.6YN-24,80	28	1305	1035	820
ZX-1.2YN-24,80	32	1485	1180	935

Note 1. Standard load application points are marked with the letter “F” in the figures.

Note 2. If the application point is outside of the places marked with the letter “F”, the allowable axial load value will be smaller.



Hysteresis Clutches and Brakes

Features

Hysteresis clutches and brakes transmit torque purely magnetically, instead of using mechanical frictions.
Non-contact operation does not only mean absence of frictions; it has numerous advantages over friction disc clutches and brakes. These features play an important role for tension control for machinery that processes electric wires, strings, paper, film, and light metal; as torque limiters for binding machines; thread fastening, and positioning; for taking a torque measurement of compact motors; and as power absorbers in endurance tests.

1. **Long lasting**
   Non-contact operation means no wearable parts and long life.
2. **Ideal torque characteristics**
   Torque changes in proportion to exciting current and is independent of slip rotation speed.
3. **Stable operation and precise repeatability**
   Precise and repeatable outputs in any operating condition.
4. **Allows high-speed operation**
   High-speed capability helps speed up machine operation.
5. **Usable under continuous slip conditions**
   Hysteresis clutches and brakes can be used under continuous slip conditions as long as the heat capacity is not exceeded.
6. **Operable even when the clutch/brake is engaged completely**
   Torque transmission is possible without torque slip, and complete engagement is possible.
7. **No screeching**
   No screeching from mechanical contacts, allowing quiet operation.

Basic structure and operation

As is shown in Figure 1, the hysteresis clutch consists of three major components: the stator, primary rotor, and secondary rotor.
The stator has a built-in exciting coil, and the primary rotor has two magnetic poles, one on the inside and the other on the outside. Between these two magnetic poles is the cup-shaped permanent magnet (non-polarized) of the secondary rotor.
When the primary rotor is rotated and the exciting coil is excited, a rotating magnetic field is created in the gap between the magnetic poles of the inside and the outside of the primary rotor, and the permanent magnet of the secondary rotor in the gap becomes magnetized. Because the permanent magnet has a hysteresis characteristic, its change in polarity lags behind that of the magnetic poles. As a result, the primary and secondary rotors become magnetically engaged. Hysteresis brakes have a stator and a primary motor that are fixed.

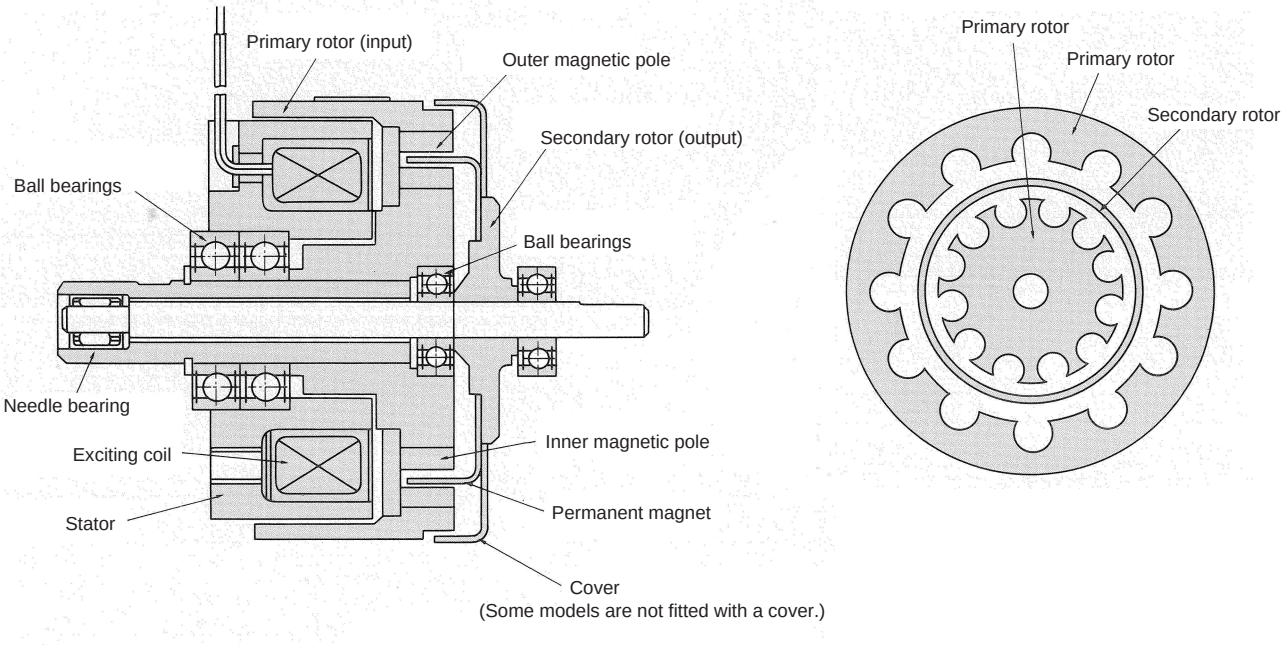


Figure 1. Structure of the hysteresis clutch (representative example)

Performance

1. Torque to exciting current characteristic

As shown in Figure 1, torque has an almost linear relationship with the exciting current in the range between five and one-hundred percent of the rated torque, which is an ideal characteristic for torque control.

Because torque is magnetically transmitted, and not caused by friction, the torque changes stably in proportion to the exciting current, and an accurate torque is transmitted regardless of how many times the operation is performed.

Torque hysteresis created by the fluctuations in exciting current is a few percent of the rated torque at its allowable valve.

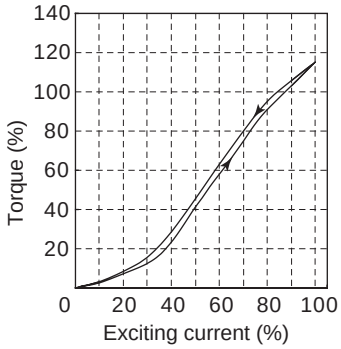


Figure 1. Torque to exciting current characteristic

2. Torque to slip rotation speed characteristics

As shown in Figure 2, torque can be kept nearly constant by keeping the exciting current constant, regardless of the slip rotation speed. This characteristic is ideal for tension control and speed control.

Since torque can be transmitted even at zero slip rotation speed, complete engagement is possible.

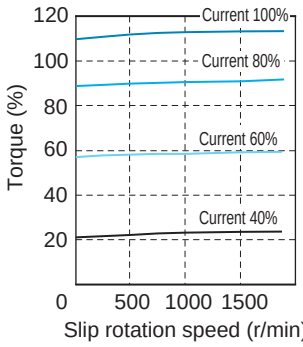


Figure 2. Torque to slip rotation speed characteristic

3. Allowable continuous heat dissipation rate

Hysteresis clutches and brakes can be used under the continuous slip conditions, but the slip heat does raise the temperature of the hysteresis clutch and brake components.

To limit this temperature rise, allowable continuous heat dissipation rate is set for each model, and the unit must be used below the allowable limit.

Note that the allowable continuous heat dissipation rate changes depending on the input rotation speed.

4. Residual torque

Hysteresis clutches do not leave any residual torque if they become unexcited while they are under a certain level of slipping condition. However, if exciting current is cut off when the primary and secondary rotors are not slipping, residual torque (ripples) is created, which equals a value between five and ten percent of the torque that existed before the exciting current was cut off.

There are two control methods to reduce this residual torque as follows:

a) Cut off the exciting current when the relative rotation speed between the primary and secondary rotor (stator in the case of a brake) is 40 r/min or faster, or decrease the exciting current gradually when the relative speed is low.

b) Apply an amount of electric current that equals thirty to fifty percent of the current that was present before cutting off the current in the reverse direction. In this case, however, if both the primary and secondary rotors are unfixed, the poles become disaligned and the demagnetization effect by the reverse application of the current is cancelled out. Therefore, either the input or the output shaft must be fixed, or another measure must be taken so that the rotors do not become disaligned.

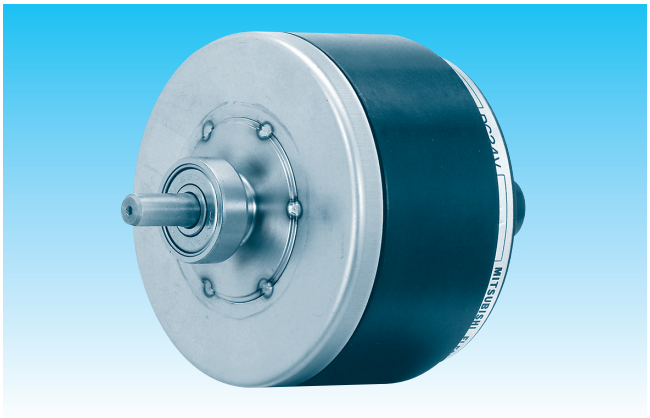
The effect of the residual torque is minimal if the amount of exciting current applied at restart is 60% or more than the amount of current that was present at the time the current was cut off.

ZHA model hysteresis clutch

(Torque 0.06~0.5 N・m)(Spontaneous cooling solid shaft type)

Features

- Rated torque range: 0.06~0.5 (N・m)
- Spontaneous cooling solid shaft type
  - Long-lasting with no mechanical frictions.
  - Quiet operation free of screeching.
  - Stable operation and precise repeatability.



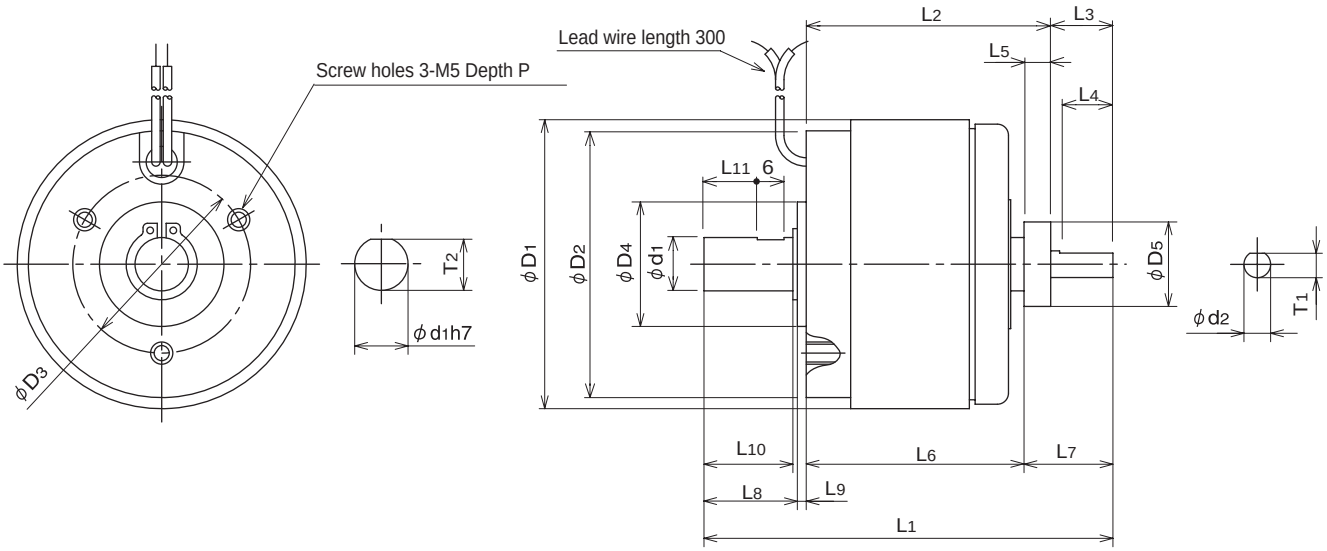
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)		Moment of inertia J (kgm^2)		Allowable rotation speed (r/min)	Product mass (kg)
		Current (A)	Power (W)	Primary rotor side	Secondary rotor side		
ZHA-0.6B	0.06	0.38	9.1	5.90×10^{-5}	1.30×10^{-6}	3600	0.46
ZHA-1.2A	0.12	0.41	9.8	1.50×10^{-4}	3.00×10^{-5}	3600	0.8
ZHA-2.5A	0.25	0.52	12.5	3.50×10^{-4}	6.50×10^{-5}	3600	1.25
ZHA-5A	0.5	0.62	14.9	8.50×10^{-4}	1.50×10^{-4}	3600	2

Note: Residual torque is less than 5% of the rated torque.

External dimensions (mm)



(Outer color: Black oxide)

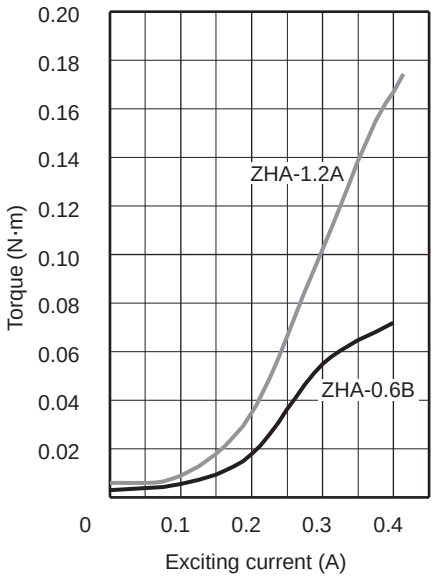
Model	L1	L2	L3	L4	L5	L6	L7	L8	L9 (± 0.10)	L10	L11	D1	D2	D3	D4 ($^{+0.003}_{-0.014}$)	D5 ($^{+0.002}_{-0.011}$)	*D6	T1	T2	d1 (h7)	d2 (g6)	P Depth
ZHA-0.6B	81	47	13	11	5	41	19	19	2	18	10	50	48	36	26	16	–	4.5	9.5	10	5	6
ZHA-1.2A	92	55	14	12	6	46	23	21	2	20	12	65	60	40	28	19	23	5.5	11.5	12	6	7
ZHA-2.5A	103	62	16	14	7	50	28	23	2	22	14	74	68	50	32	22	27	6.5	13.5	14	7	7
ZHA-5A	117	71	18	16	8	59	30	25	3	24	16	88	81	60	35	24	–	7.5	15.5	16	8	7

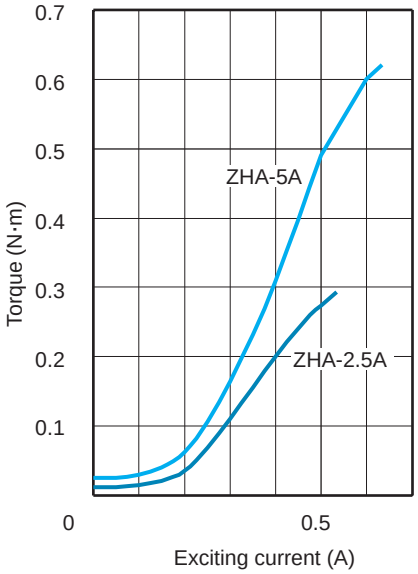
Notes: 1. * The lead wire of the ZHA-0.6B and ZHA-5A models are pulled out to the perimeter through ø D2.

2. The dimensional tolerance of ZHA-0.6B is D4 $^{+0.002}_{-0.011}$, D5 $^{+0.002}_{-0.010}$.

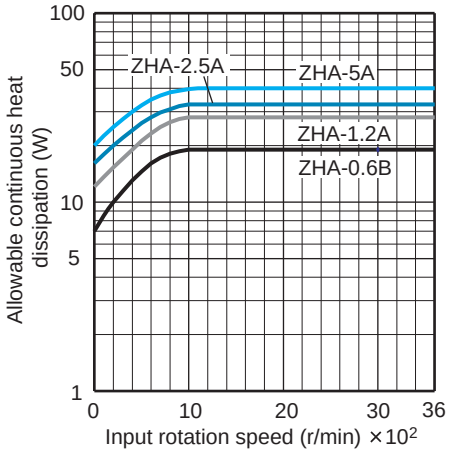
Characteristics

● Standard torque characteristics (representative example)



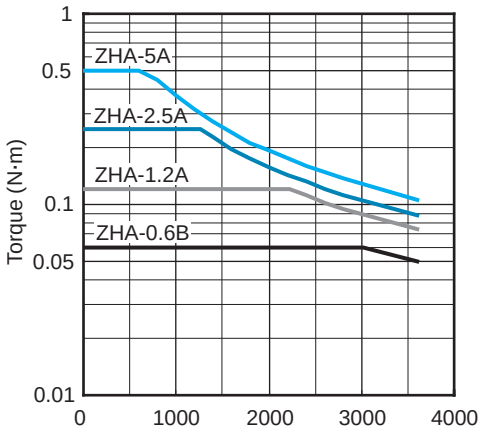


● Allowable continuous heat dissipation characteristics

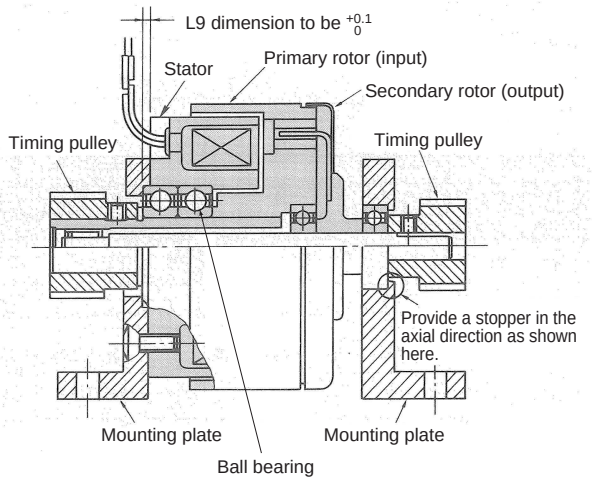


Notes: 1. Allowable continuous heat dissipation rate means the rotation speed of the rotation axis of the secondary rotor.
2. The allowable continuous heat dissipation rate in the graph is the rate measured when the radiation surface area of the mounting attachment is at least 350cm^2 (material = Fe).

● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating holes of the stator and bearing with their intended mate on the mounting plate and fix them in place. Fix the bearing in the axial direction also.
2) Use a flexible coupling to connect the clutch and the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-64.)
4) Place the primary rotor on the input side since the primary rotor has greater loss torque compared to the secondary rotor. Placing the primary rotor on the input side will increase the transition speed (due to smaller moment of inertia) of the secondary rotor on the output side.

ZHA model hysteresis clutch

(Torque 1~6 N・m)(Spontaneous cooling through shaft type) [Made to order]

Features

- Rated torque range: 1~6 (N・m)
- Spontaneous cooling through shaft type
  - Long-lasting with no mechanical frictions.
  - Quiet operation free of screeching.
  - Stable operation and precise repeatability.

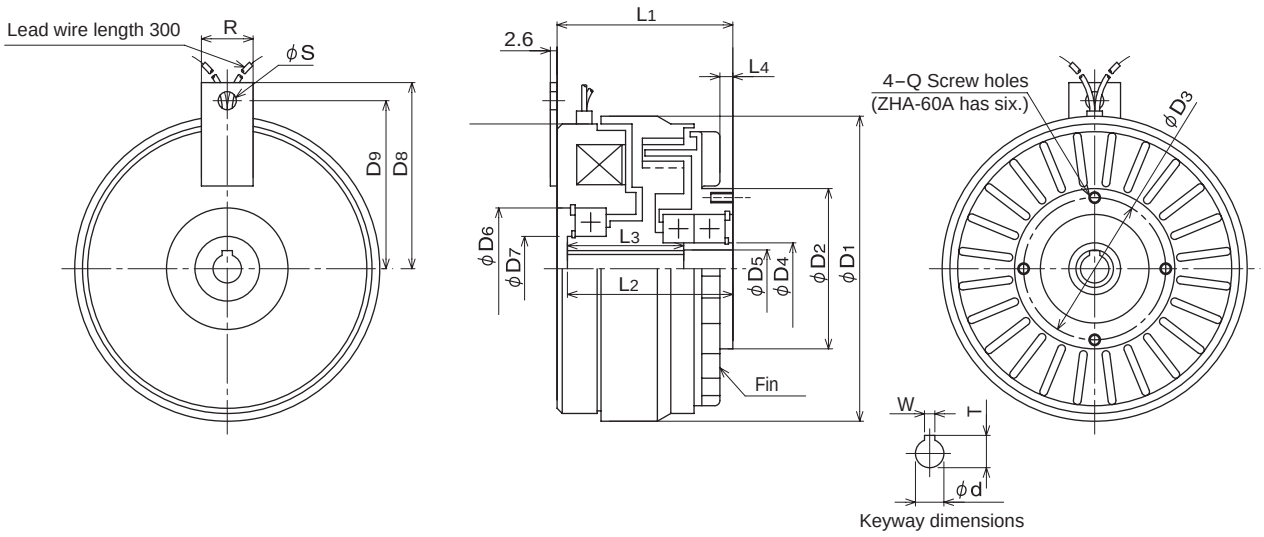
Specifications

(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)		Moment of inertia J (kgm^2)		Allowable rotation speed (r/min)	Product mass (kg)
		Current (A)	Power (W)	Primary rotor side	Secondary rotor side		
ZHA-10A	1	1.00	24.0	3.25×10^{-3}	6.25×10^{-4}	3000	3.5
ZHA-20A	2	1.21	29.0	6.75×10^{-3}	1.58×10^{-3}	3000	6.5
ZHA-40A	4	1.62	38.9	1.53×10^{-2}	4.00×10^{-3}	3000	11
ZHA-60A	6	2.10	50.0	4.00×10^{-2}	8.50×10^{-3}	3000	16.5

Note: Residual torque is less than 5% of the rated torque.

External dimensions (mm)

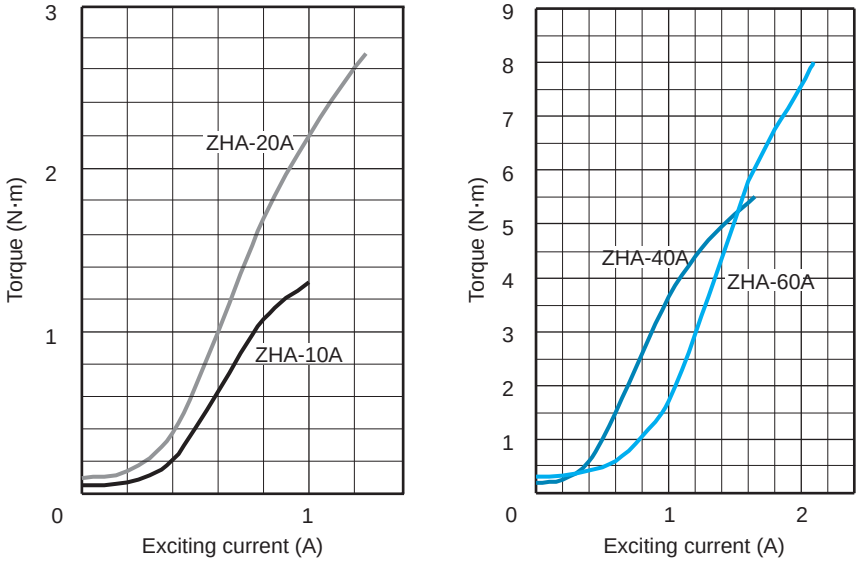


(Outer color: Munsell 2.5G 5.5/2.5)

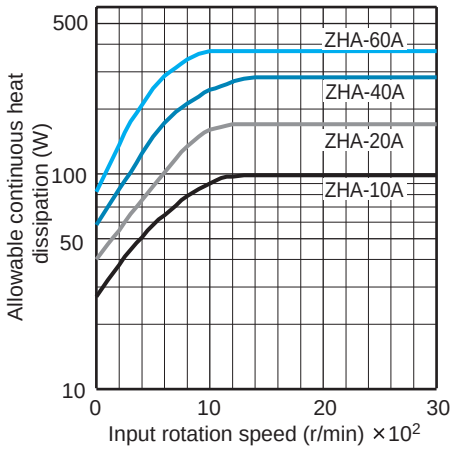
Model	L1	L2	L3	L4	D1	D2 (h7)	D3	D4	D5	D6	D7	D8	D9	S	R	P		Keyway		
																Diameter	Depth	d (H7)	W (F7)	T ($^{+0.2}_{0}$)
ZHA-10A	68	64	45	5	118	62	55	20	14.5	47	25	72	65	7	20	M4	6	11	4	12.5
ZHA-20A	79	75	50	5	146	72	62	25	18.5	62	35	82	75	7	20	M5	7	14	5	16
ZHA-40A	93	87	55	6	172	92	82	35	24	75	45	100	90	9	25	M6	8	19	5	21
ZHA-60A	112	110	75	6	196	110	100	50	38	80	50	110	100	9	25	M6	10	30	7	33

Characteristics

● Standard torque characteristics (representative example)

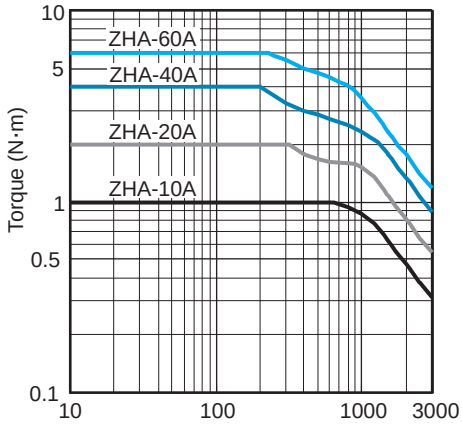


● Allowable continuous heat dissipation characteristics

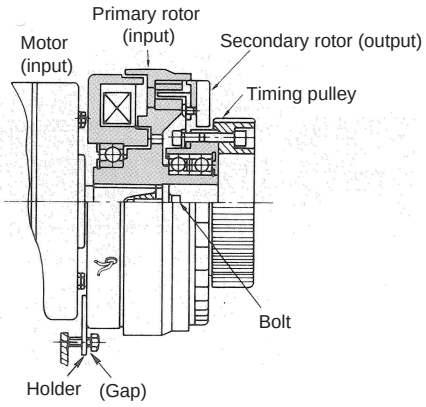


Note: The allowable continuous heat dissipation rate means the rotation speed of the rotation axis of the secondary rotor.

● Allowable continuous slip torque characteristics



Sample mounting



1) To connect the primary rotor, put the shaft through the hole, and bolt it down.
2) The holder must be fixed to prevent undue force from being exerted on the clutch bearing. Leave a space of approximately 0.5 mm between the holder fixing bolt and the holder. When vibration of the machine is transmitted to the clutch and creates noise because of this gap, decrease the gap as much as possible or insert a flexible body.
3) Place the primary rotor on the input side since the primary rotor has greater loss torque compared to the secondary rotor. Placing the primary rotor on the input side will increase the transition speed (due to smaller moment of inertia) of the secondary rotor on the output side.
4) Use a flexible coupling for a direct connection to the load shaft. The concentricity and perpendicularity requirements of the axes must fall within the coupling's allowable range.

ZHY model hysteresis brakes

(Torque 0.003~0.5 N·m)(Spontaneous cooling solid shaft type)

Features

- Rated torque range: 0.003~0.5 (N·m)
- Spontaneous cooling solid shaft type
  - Long-lasting with no mechanical frictions.
  - Quiet operation free of screeching.
  - Stable operation and precise repeatability.

Specifications

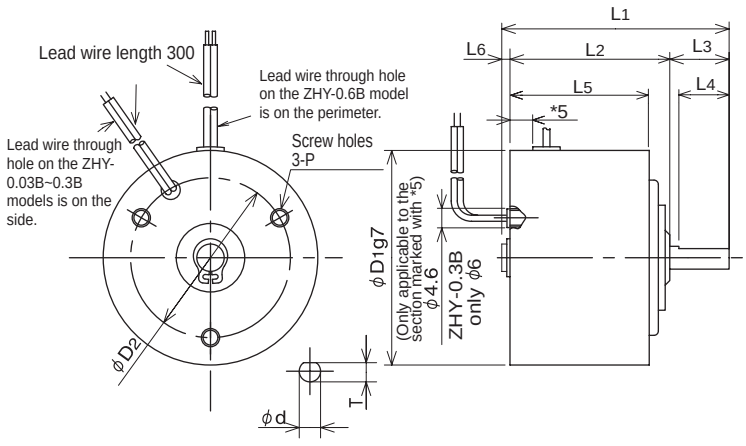
(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)		Moment of inertia *J* (kgm^2)	Allowable rotation speed (r/min)	Product mass (kg)
		Current (A)	Power (W)			
ZHY-0.03B	0.003	0.14	3.4	$3.30x10^{-8}$	5000	0.13
ZHY-0.08B	0.008	0.14	3.4	$4.40x10^{-8}$	5000	0.13
ZHY-0.3B	0.03	0.17	4.1	$5.50x10^{-7}$	5000	0.24
ZHY-0.6B	0.06	0.20	4.9	$1.30x10^{-6}$	3600	0.32
ZHY-1.2A	0.12	0.28	6.5	$3.00x10^{-5}$	3600	0.85
ZHY-2.5A	0.25	0.36	8.6	$6.50x10^{-5}$	3600	1.2
ZHY-5A	0.5	0.47	11.3	$1.50x10^{-4}$	3600	2

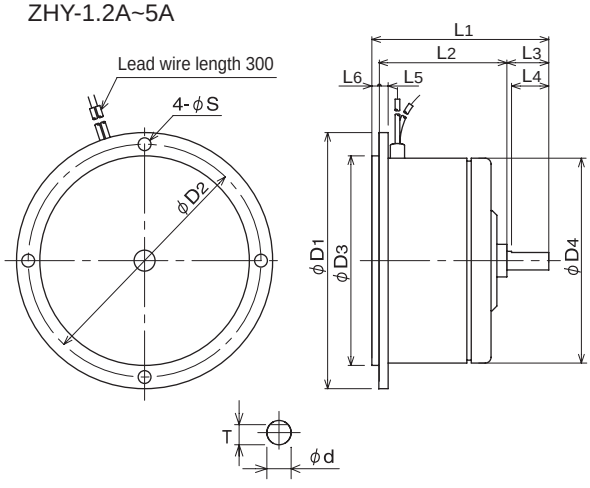
Note: Residual torque is less than 10% of the rated torque for the ZHY-0.03B model, and 5% for the ZHY-0.08B model and above.

External dimensions (mm)

ZHY-0.03B~0.6B



ZHY-1.2A~5A



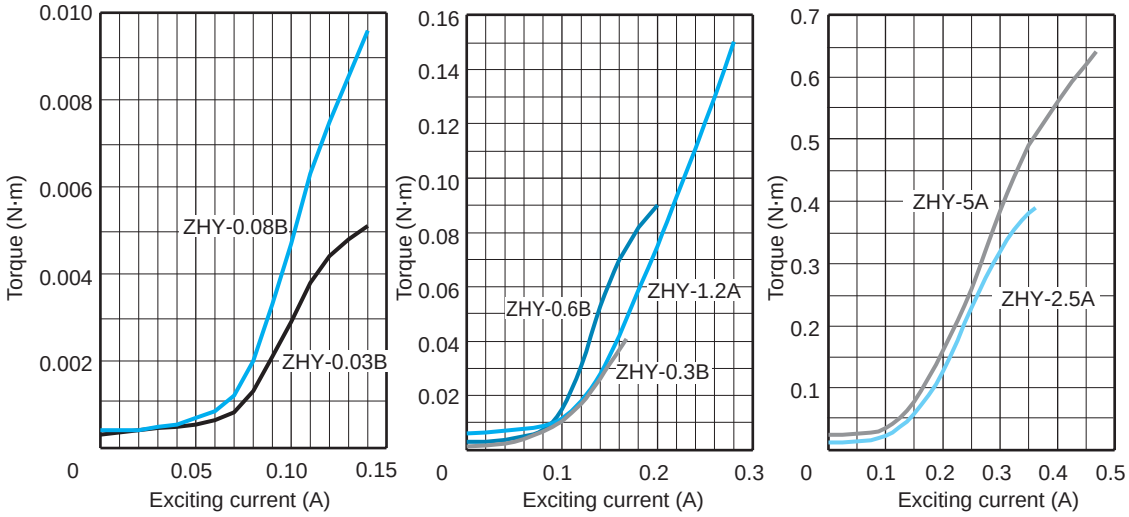
(Outer color: Black oxide)

Model	L1	L2	L3	L4	L5	L6	D1	D2	D3 (h7)	D4	T	d (g6)	S	P	
														Diameter	Depth
ZHY-0.03B	32.5	25.5	5	–	21	2	35	18	–	–	–	2 (Note)	–	M3	4
ZHY-0.08B	32.5	25.5	5	–	21	2	35	18	–	–	–	2 (Note)	–	M3	4
ZHY-0.3B	41.5	29	10	8	25	2.5	42	26	–	–	3.5	4	–	M3	4
ZHY-0.6B	49.8	35	13	11	30.5	1.8	47	35	–	–	4.5	5	–	M4	5
ZHY-1.2A	58	42	14	12	4	2	86	76	66	63	5.5	6	5.5	–	–
ZHY-2.5A	65	47	16	14	4	2	98	88	78	74	6.5	7	5.5	–	–
ZHY-5A	76	55	18	16	4	3	110	100	90	88	7.5	8	5.5	–	–

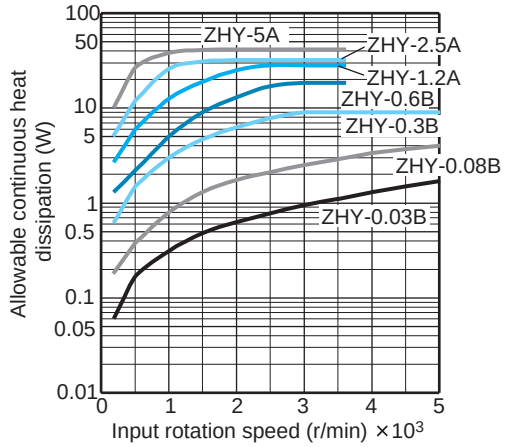
Note: The dimensional tolerance of the ø d on the ZHY-0.03B - 0.08B models is $^{-0.004}_{-0.010}$.

Characteristics

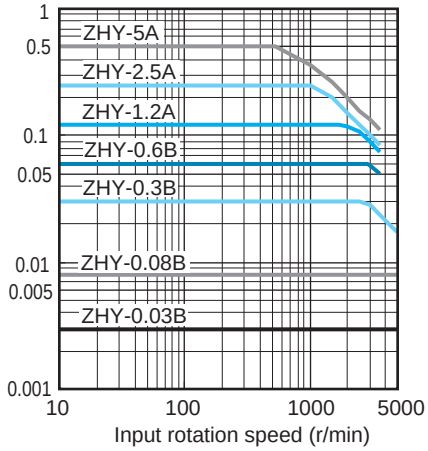
● Standard torque characteristics (representative example)



● Allowable continuous heat dissipation characteristics

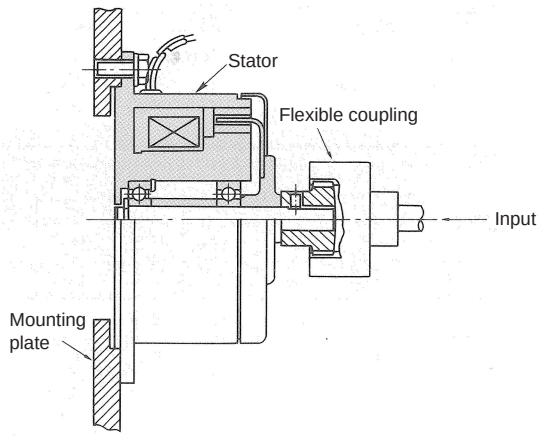


● Allowable continuous slip torque characteristics



Note: The allowable continuous heat dissipation rate in the graph is the rate measured when the radiation surface area of the mounting attachment is at least 350cm^2 (material = Fe).

Sample mounting



1) Align the mating hole of the stator with its intended mate on the mounting plate and fix it in place.
2) Use a flexible coupling to connect the brake shaft and the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.
3) If a pulley is installed, observe the allowable axial load. (Refer to page A-64.)

ZHY model hysteresis brakes

(Torque 1~10 N·m)(Spontaneous cooling through shaft)[Some models are made to order]

Features

- Rated torque range: 1~10 (N·m)
- Spontaneous cooling through shaft type
  - Long-lasting with no mechanical frictions.
  - Quiet operation free of screeching.
  - Stable operation and precise repeatability.

Specifications

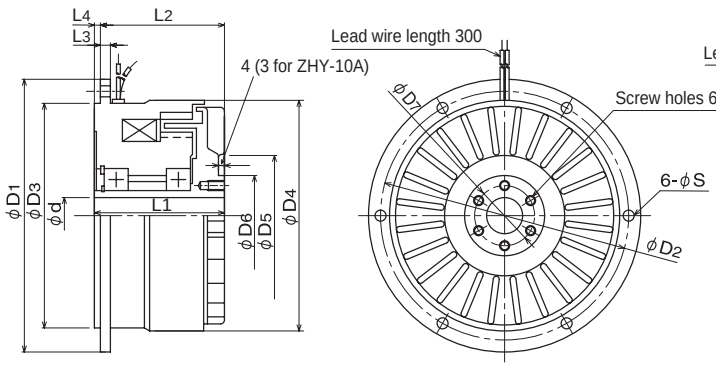
(Rated voltage 24V DC)

Model	Rated torque (N·m)	Coil (75°C)		Moment of inertia J (kgm^2)	Allowable rotation speed (r/min)	Product mass (kg)
		Current (A)	Power (W)			
ZHY-10A	1	1.00	24.0	$6.00x10^{-4}$	3000	4
ZHY-20A	2	1.25	30.0	$1.78x10^{-3}$	3000	8.5
ZHY-40A	4	1.58	37.9	$3.75x10^{-3}$	3000	10.5
ZHY-60A*	6	2.20	52.8	$7.00x10^{-3}$	1800	15
ZHY-100A2*	10	2.00	48.0	$1.13x10^{-2}$	1800	19

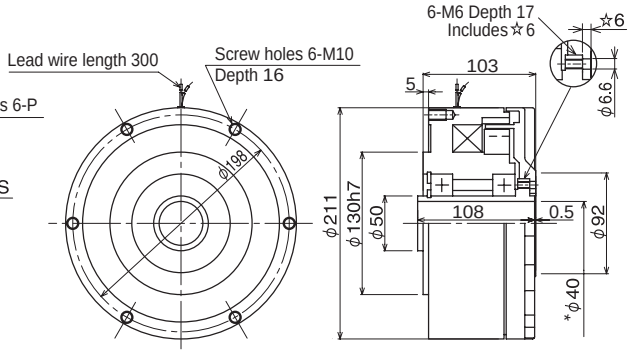
Notes: 1. Residual torque is less than 5% of the rated torque. (Less than 10% for the ZHY-60A model with the allowable rotation speed of 1000 r/min or more.)
2. Items marked with * are made to order.

External dimensions (mm)

ZHY-10~60A



ZHY-100A2



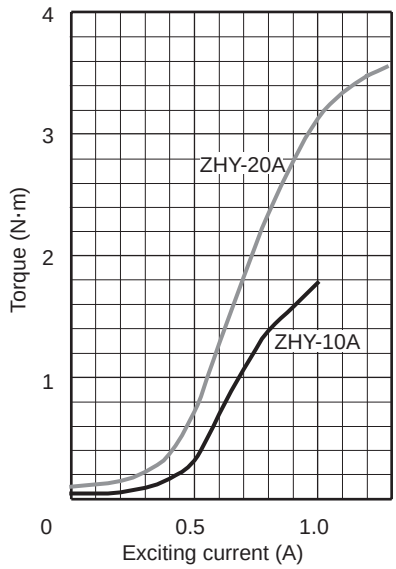
(Outer color: Munsell 2.5G 5.5/2.5)

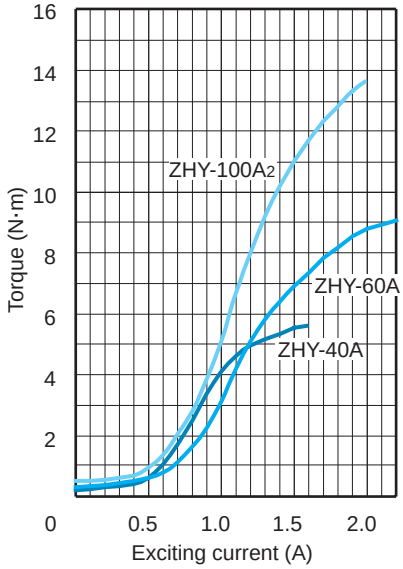
Model	L1	L2	L3	L4	D1	D2	D3 (h7)	D4	D5	D6 (h7)	D7	d	S	P	
														Diameter	Depth
ZHY-10A	65	62	5	3	136	124	112	115	60	40	30	18	5.5	M5	8
ZHY-20A	80	76	7	4	180	166	140	162	84	60	50	30	6.5	M6	12
ZHY-40A	83	79	7	4	180	166	140	162	84	60	50	40	6.5	M6	12
ZHY-60A	101	97	10	4	222	205	130	192	105	65	52	40	6.5	M6	12
ZHY-100A2	Refer to the figure above.														

Note: * The area between the edges to the 10 mm from the edge on either side is finished with H_7.

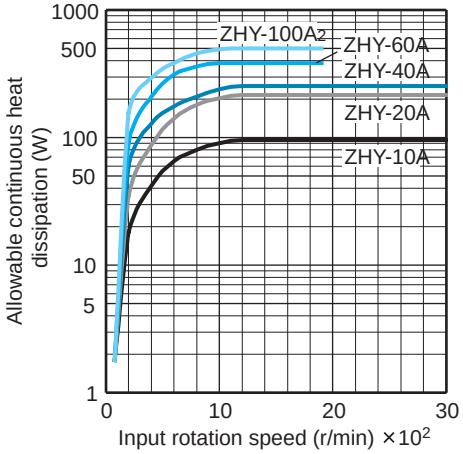
Characteristics

● Standard torque characteristics (representative example)

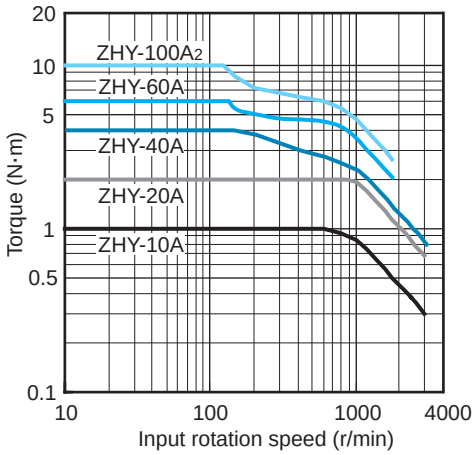




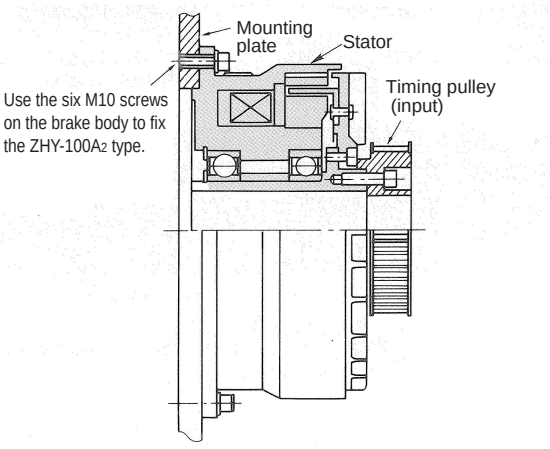
● Allowable continuous heat dissipation characteristics



● Allowable continuous slip torque characteristics



Sample mounting



1) Align the mating hole of the stator with its intended mate on the mounting plate and fix it in place.
2) Use a flexible coupling to connect the brake shaft and the load shaft. The concentricity and perpendicularity between the axes must fall within the coupling's allowable range.

Selection Criteria and Applications

No-contact torque control and the precise repeatability characteristics of hysteresis brakes and clutches are applied to machines such as textile machines and electric wire processing machines, which have been requiring faster speed and higher precision, and these brakes and clutches deliver superior performance in these applications. When used under continuous slip conditions, such as for tension control, select an appropriate model primarily based on the heat dissipation (slip heat). Heat dissipation (P) is calculated as follows:

$$P = 0.105 \times T \times Nr \text{ (W)} \quad \ldots\ldots\ldots\ldots (1)$$

where Nr: Slip rotation speed (r/min)
T: Transmission torque(N·m)

Besides the formula for heat dissipation, the same formulas that are used for powder clutches and brakes can be used for hysteresis clutches and brakes. Refer to the powder clutches/brakes section for those formulas and specifications.
The controllable range of torque is approximately between five and one-hundred percent (10~100% for the ZHY-0.03B model) of the rated torque.

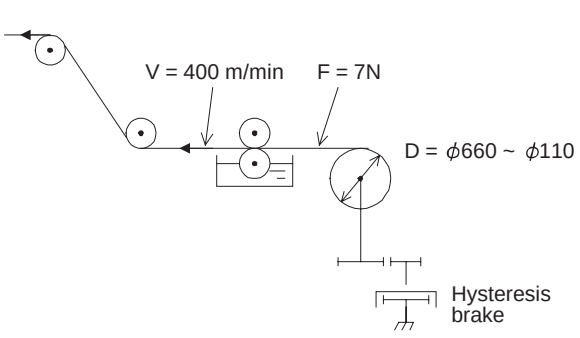
1. Tension control

●Hysteresis brake on the unwinding shaft

Selection of a hysteresis brake for use as an unwinding brake

1) Specification

Line speed V: 400 m/min
Tension F: 7 N For 300 strings
Allowable unwinding reel diameter D_1: 660 mm
Minimum unwinding reel diameter D_2: 110 mm



Unwinding tension control with a hysteresis brake

2) Calculation

When the initial required unwinding shaft torque is T_1, slip rotation speed is N_1, those at the end are T_2 and N_2 respectively, and continuous heat dissipation is P,

$$T_1 = \frac{D_1}{2} \times F = \frac{660 \times 10^{-3}}{2} \times 7 = 2.31 \text{ N·m.}$$

$$N_1 = \frac{V}{\pi D_1} = \frac{400}{\pi \times 660 \times 10^{-3}} = 193 \text{ r/min.}$$

$$T_2 = \frac{D_2}{2} \times F = \frac{110 \times 10^{-3}}{2} \times 7 = 0.39 \text{ N·m.}$$

$$N_2 = \frac{V}{\pi D_2} = \frac{400}{\pi \times 110 \times 10^{-3}} = 1158 \text{ r/min.}$$

$$P = 0.105 \times T \times Nr = 0.0167 \times F \times V$$
$$= 0.0167 \times 7 \times 400 = 47 \text{ W.}$$

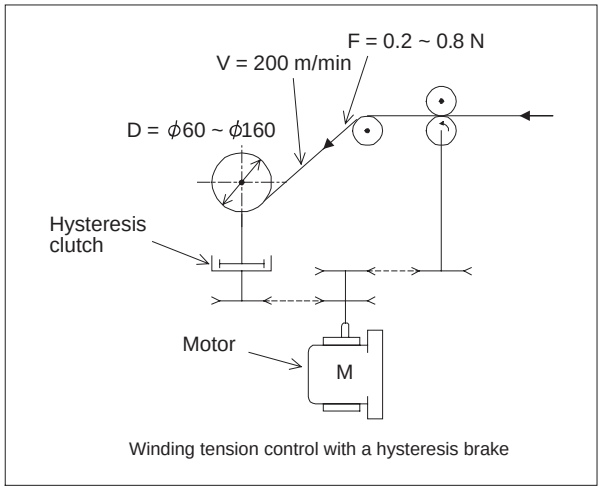
These calculation results indicate that this system requires a model with the continuous heat dissipation capacity of 47 W or more. The ZHY-10A model brake meets this requirement and also meets the torque capacity requirement when its unwinding shaft speed is accelerated by 2.4 times.

●Hysteresis clutch on the winding shaft

Selection of a hysteresis brake for use as an winding clutch

1) Specification

Line speed V: 200 m/min
Tension F: 0.2 ~ 0.8 N
Minimum winding reel diameter D_1: 60 mm
Allowable winding reel diameter D_2: 160 mm



Winding tension control with a hysteresis brake

2) Calculation

When the initial reel rotation speed is N_1, required winding torque is T_1, those at the end are N_2 and T_2 respectively, and allowable heat dissipation is P,

$$N_1 = \frac{V}{\pi D_1} = \frac{200}{\pi \times 60 \times 10^{-3}} = 1061 \text{ r/min.}$$

$$T_1 = \frac{D_1}{2} \times F = \frac{60 \times 10^{-3}}{2} \times 0.8 = 0.024 \text{ N·m.}$$

$$N_2 = \frac{V}{\pi D_2} = \frac{200}{\pi \times 160 \times 10^{-3}} = 398 \text{ r/min.}$$

$$T_2 = \frac{D_2}{2} \times F = \frac{160 \times 10^{-3}}{2} \times 0.8 = 0.064 \text{ N·m.}$$

When clutch rotation speed is $1061 \times 1.1 \cong 1200$ r/min, the allowable heat dissipation (P) can be obtained using the following formula:

$$P = 0.105 \times Nr \times T = 0.105 \times (1200 - 398) \times 0.064$$
$$= 5.4 \text{ W.}$$

Based on these calculation results, the ZHA-1.2A model clutch is found to meet the torque capacity and heat dissipation requirement.

2. Torque limiter

Taking advantage of the constant torque characteristics, the hysteresis clutch can be used as a torque limiter that protects motors or machinery from being overloaded by slipping. That is, the torque above a certain level can be kept from being transmitted to the load side.

Sample calculation for the selection of a torque limiter

Figure 1 shows a sample application in which a hysteresis clutch is used for the feeding mechanism of a cutting machine.
First, the feed reel feeds the light metal sheet until it hits the stopper. Then, while the cutter is down and cutting the sheet into the predetermined length, the feed reel is stopped and the hysteresis clutch keeps slipping at 100%. When the cutter moves up, the feed reel starts feeding the metal sheet again until it hits the stopper.

1) Specification

Feed reel diameter D: 100 mm
Thrust F: 40 N
Feed speed V: 100 m/min
Frequency 60 times/min
Clutch slip time per cycle 0.3 second

2) Calculation

$$\text{Required feed reel torque } T = \frac{100 \times 10^{-3}}{2} \times 40 = 2 \text{ N·m.}$$

$$\text{Feed reel rotation speed } N = \frac{100}{\pi \times 100 \times 10^{-3}} = 318 \text{ r/min.}$$

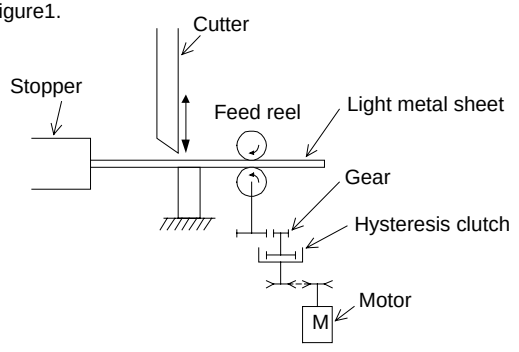
Slip time per minute $0.30 \times 60 = 18$ seconds

Solving for the heat dissipation as equivalent heat dissipation,

$$P = \sqrt{\frac{(0.105 \times 2 \text{ N·m} \times 318 \text{ r/min})^2 \times 18 \text{ seconds}}{60 \text{ seconds}}} = 36.6 \text{ W.}$$

Based on the calculation results above, it is found that the ZHA-5A model clutch, whose allowable continuous heat dissipation capacity is 40W at 1500 r/min, can be used by accelerating the feed reel speed by five times.
In this case, use the secondary rotor on the input side to increase the heat dissipation capability. Equivalent heat dissipation may not be used depending on the heat generation condition during slipping. Consult the nearest Mitsubishi office for any questions you may have.

Figure1.



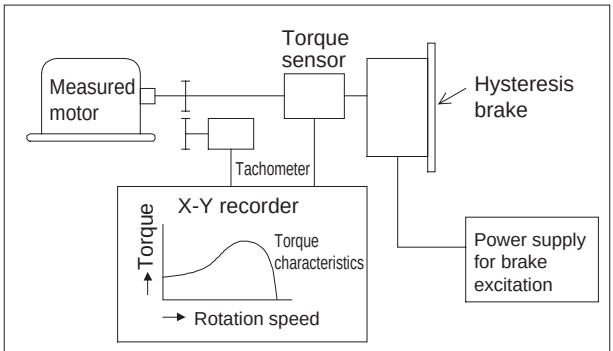
Application of the hysteresis clutch as a torque limiter

3. Hysteresis brake for use as a power absorber in a load simulation

Since hysteresis brakes can easily control torque, they can be used to create simulated loads through control with a program control system. Hysteresis brakes can be used for an endurance test for power-transmitting elements such as gears and belts.

4. Torque meter

Taking advantage of the ideal torque characteristic that is independent of slip rotation and has a linear relationship with the exciting current, and of the infinitely precise and stable operation characteristics, the hysteresis brake can be used to apply a load to devices such as compact motors.



Sample torque measurement with a hysteresis brake

Operation Precautions

Read the "Safety Precautions" at the end of this catalog to learn to use the products safely and correctly.

1. Torque characteristics

1) The torque to current characteristic curves that are listed in this catalog are standard torque to current characteristic curves. Repeatability for each product is very stable, but repeatability may vary between products as much as ±20% near the rated current. When using multiple units in parallel, it is recommended that the system be configured in a way so that the electric current supply to each unit can be individually controlled to allow for torque adjustment.
2) The torque to current characteristic has a hysteresis characteristic, and torque differential is created by current fluctuations. However, repeatability is stable.
3) Even when the electric current supply remains constant, torque has a tendency to increase slightly when rotation speed increases. (Refer to the figure under the performance section on page A-59.)
4) When voltage is controlled, the torque changes according to the current fluctuations that result from fluctuations in coil resistance. Current-controlled control is recommended. (LE-50PAU controller etc.)
5) Performing the following types of control will create residual ripples (cogging).
   ①Turning off the current after rotation has stopped, then idling afterwards, will produce torque ripples.
   ②If the current is turned off after the rotation has stopped and then current is applied that equals approximately 70% of the current that was being applied immediately before it was turned off, the level of torque that was present before turning off the current will momentarily reemerge, and some additional ripples will appear afterwards. If the magnitude of this current is smaller, this symptom becomes more pronounced. Especially, if an over-voltage is applied to the clutch or brake, this symptom becomes even more pronounced.

   This symptom continues until the following steps are taken.

   (Note) "Stoppage" includes a lack of relative speed between the primary and secondary rotors.

   Possible remedies include the following. Check to see if torque ripples pose a problem for a given system.
   ①Cut off the electric current while the rotation speed is between 40 and 50 r/min.
   ②Apply electric current that equals 30% to 50% of the current that was being applied before it was cut off in the reverse direction. The input and output poles must be properly aligned. It is difficult to completely eliminate ripples.

   Rippling happens with all hysteresis type clutches and brakes.
6) If a non-magnetic material is used for the mounting plate for the secondary rotor, the level of torque may be greater than the standard torque.

2. General items

1) Magnetic flux is created when exciting current is applied. Since leaked flux attracts iron particles around the unit and may cause locking or abnormal sounds, keep the environment free of such contaminants that would be attracted to magnetic flux. The ZHA-0.6B and the ZHY-0.6B model or less are not fitted with a cover on the operation surface and require special attention.
2) On the ZHA-5A model or lower, the secondary rotor may come out from the unit body along with the shaft by design. Take caution not to let it drop.
3) The protection grade is IP00.

3. Allowable axial load

There are two ways to engage the input and output members of the ZHA and ZHY models of hysteresis clutches and brakes as follows:

1) Engagement with a coupling
2) Engagement with a pulley

When the clutch/brake is engaged with a coupling, the use of a flexible coupling is assumed. Radial load on the shaft will not create a problem in this type of application.
However, when the clutch/brake is engaged with a pulley, radial load on the shaft will be restricted based on the shaft strength and the load capacity of the bearing.
Allowable axial load is listed in a table elsewhere. The figures in the table were obtained under the following conditions:
① Allowable axial load is the smaller of either the shaft strength or the bearing radial load.
② Bearing load is determined based on the expected fatigue life of 15000 hours.
③ The standard load application point is set at the end faces of the shaft. If the application point is outside of the end faces, the allowable axial load allowance will be smaller.

ZHA-0.6B~5A

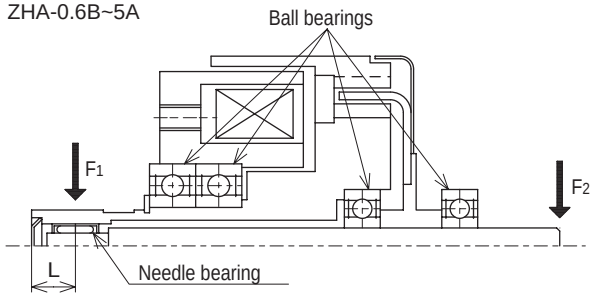


Table 1. ZHA-0.6B~5A Allowable axial load

Model	L dimension (mm)	Allowable axial load F (N)									
		100 (r/min)		1000 (r/min)		1800 (r/min)		3000 (r/min)		3600 (r/min)	
		F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
ZHA-0.6B	7	315	49	160	49	135	49	116	49	110	48
ZHA-1.2A	8	415	85	225	85	190	85	165	81	155	76
ZHA-2.5A	8.5	680	120	340	120	285	120	245	115	230	110
ZHA-5A	8.5	685	160	345	160	285	140	245	120	235	110

ZHA-10A~60A

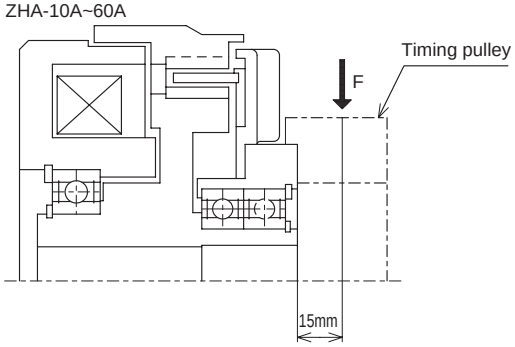


Table 2. ZHA-10A~60A Allowable axial load

Model	Allowable axial load F (N)			
	100 (r/min)	1000 (r/min)	1800 (r/min)	3000 (r/min)
ZHA-10A	690	320	260	220
ZHA-20A	740	340	280	230
ZHA-40A	1240	580	470	400
ZHA-60A	1760	820	670	560

ZHY-0.03B~5A

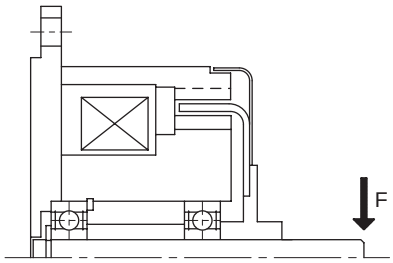


Table 3. ZHY-0.03B~5A Allowable axial load

Model	Allowable axial load F (N)				
	100 (r/min)	1000 (r/min)	1800 (r/min)	3000 (r/min)	3600 (r/min)
ZHY-0.03B	8	8	8	8	8
ZHY-0.08B	8	8	8	8	8
ZHY-0.3B	29	29	29	29	29
ZHY-0.6B	49	49	49	49	49
ZHY-1.2A	86	86	86	79	74
ZHY-2.5A	120	120	120	105	100
ZHY-5A	155	155	130	110	105

ZHY-10A~100A2

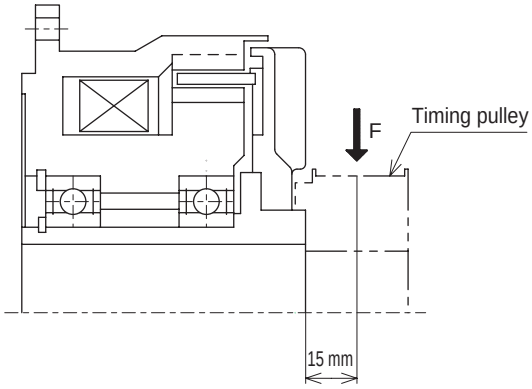


Table 4. ZHY-10A~100A2 Allowable axial load

Model	Allowable axial load F (N)			
	100 (r/min)	1000 (r/min)	1800 (r/min)	3000 (r/min)
ZHY-10A	1010	460	380	320
ZHY-20A	1650	760	630	530
ZHY-40A	2280	1060	870	730
ZHY-60A	3470	1610	1320	–
ZHY-100A2	4380	2030	1670	–

Shaft load calculation formula

$F = \frac{2T}{D} \times K$

$F = F_1, F_2$

T: Transmission torque (N·cm)

D: Pulley diameter (cm)

K: Load coefficient (Timing belt 1.5, V belt 2.5, Sprocket 1.5)

memo

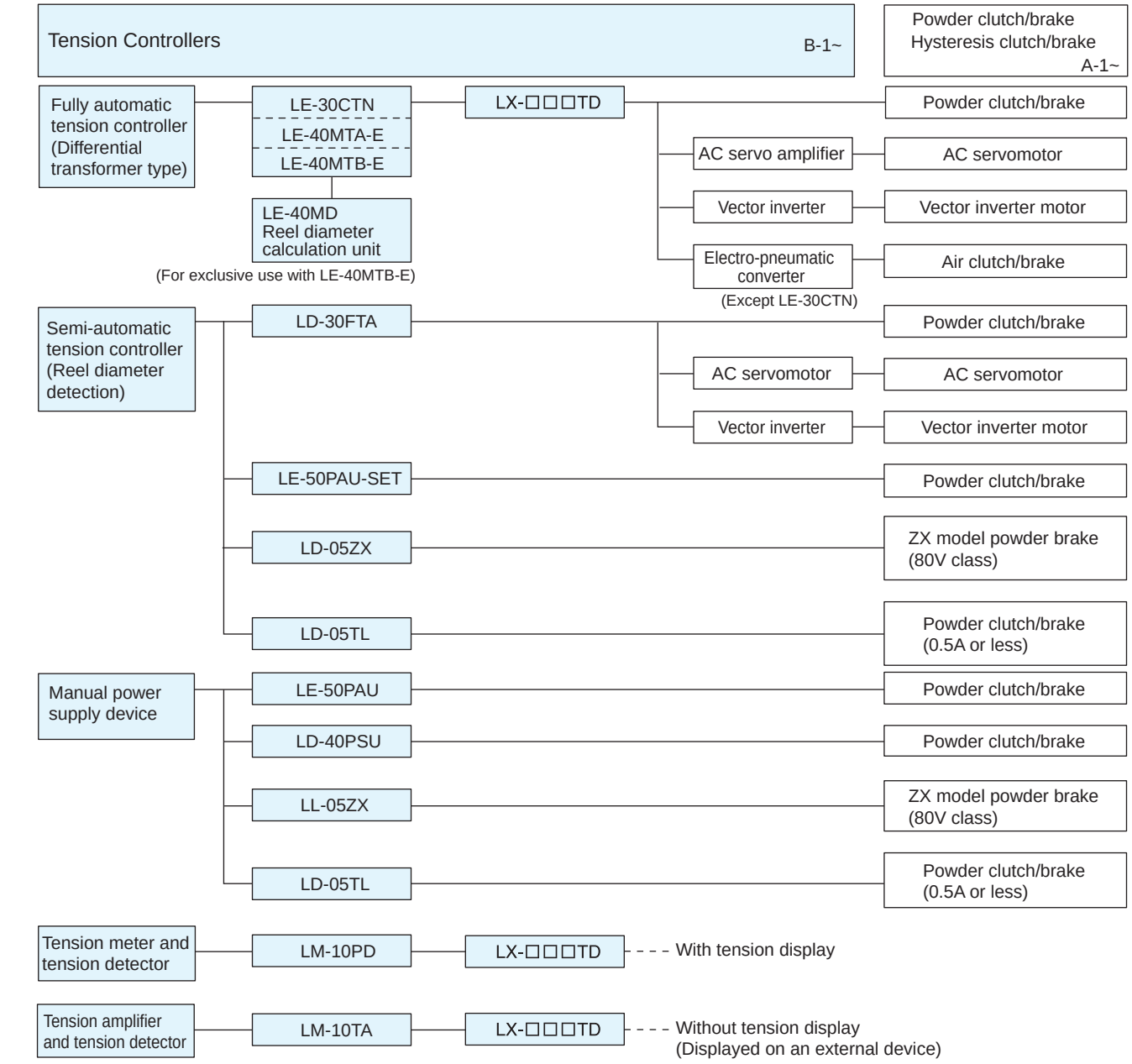
Tension Controllers

- Tension controllers
- Tension detectors
- Power amplifiers
- Tension meters

Contents

Tension Controllers

■ Product Structure (Shaded areas indicate products that are introduced in this chapter.)



Notes: 1. Powder clutches and brakes, when used as actuators, include hysteresis clutches and brakes.
2. AC servomotors and vector inverter motors refer to only those motors that allow torque control.

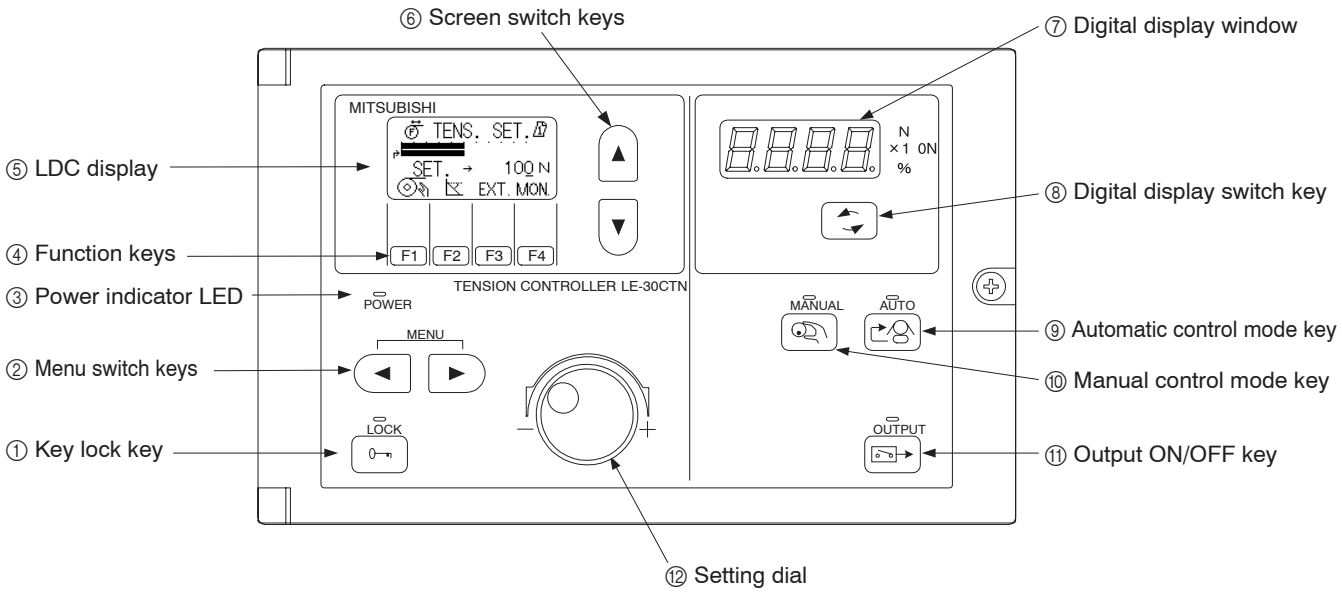
LE-30CTN model fully automatic tension controller

The LE-30CTN models of tension controllers automatically control unwinding, intermediate, or winding tension by receiving signals from either the LX-TD or LX-TD-909 model of tension detector. These controllers generate a control voltage of 0 to 24V to the powder clutch/brake or hysteresis clutch/brake, or generate a torque command voltage of 0 to 5 V to the AC servo amplifier.

Main features

- Menu function as a standard feature. Allows storage and readout of eight kinds of operation data.
- Set values can be written to and stored in the memory cassette. Simple and easy batch copying/modification of the set values.
- Quick and easy function selection with the function keys (F1-F4).
- Dot matrix LCD display.
- Language displayed on the LCD display can be selected between Japanese, English, and simplified Chinese by the DIP switch.
- Automatic detection of the signal polarity of tension detector. Simple wiring without the need to worry about the load type (compression or pull load).
- Auto zero/span adjustment for the tension detector is adopted, eliminating the need for adjustment.
- Operates on a wide range of supply voltage from 100V to 240V AC.

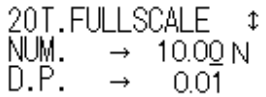
Panel Components



①Key lock key ..... Disables other keys to prevent accidental changes in the set values.
②Menu switch keys ..... Reads out the operation data that are stored in the menu.
③Power indicator LED..... Lights up at power on. There is no power switch on the unit. Provide a switch that switches all phases on the power supply wiring ON/OFF.
④Function keys ..... Switches the displays on the LCD screen. The function of these keys varies on different screens.
⑤LDC display ..... Dot matrix LCD display. Displays various set values, setting items, control status etc.
⑥Screen switch keys..... Scroll up/down the LCD display or move the cursor up/down.
⑦Digital display window ..... Displays the tension and output values.
⑧Digital display switch key..... Switches among the items to be displayed on the digital display window ⑦.
⑨Automatic control mode key . Selects the automatic control mode.
⑩Manual control mode key ..... Selects the manual control mode.
⑪Output ON/OFF key..... Turns ON/OFF the control output.
⑫Setting dial..... Changes the values for each setting.

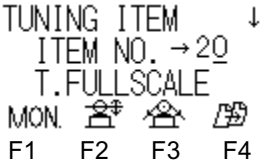
Sample display switching

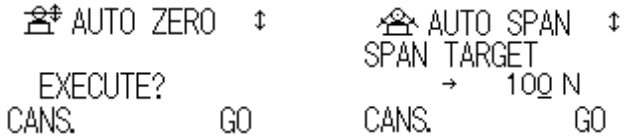
- By the item number



Select the item number using the setting dial, and press the display switch key to go to the screen that corresponds to the item number.

- By the function key

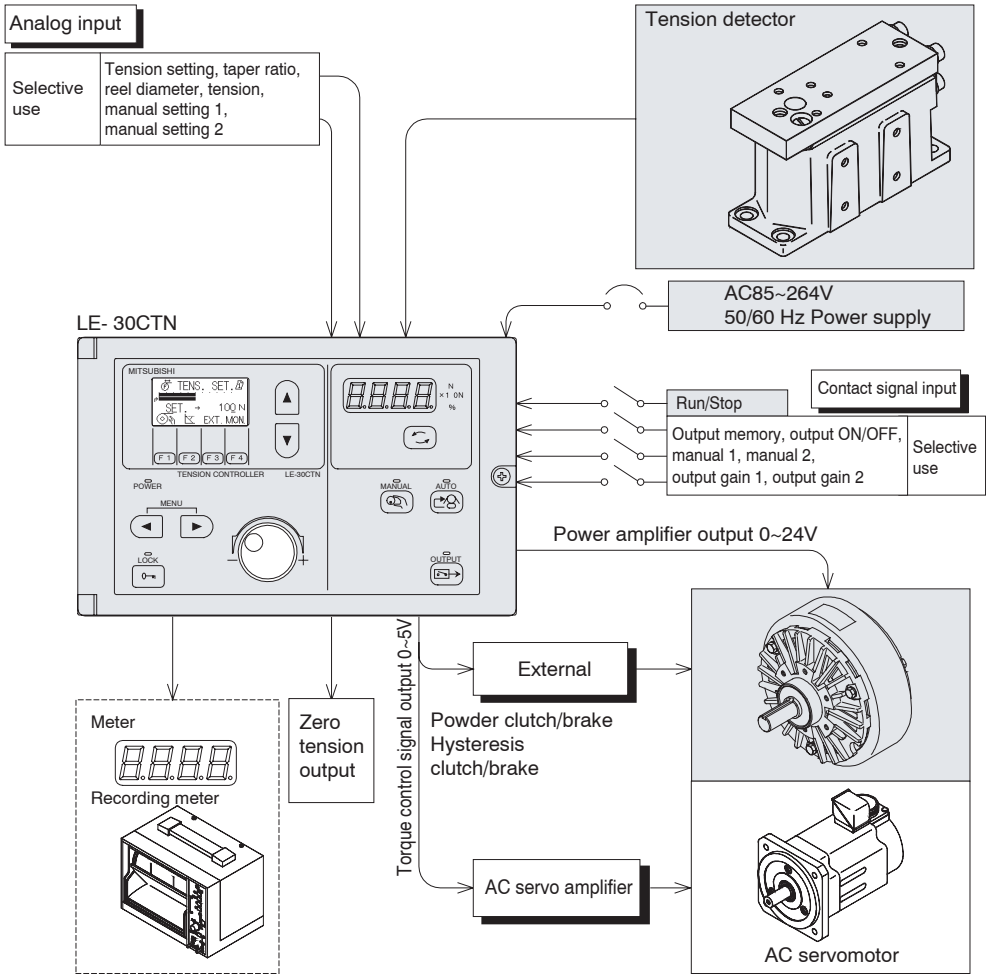




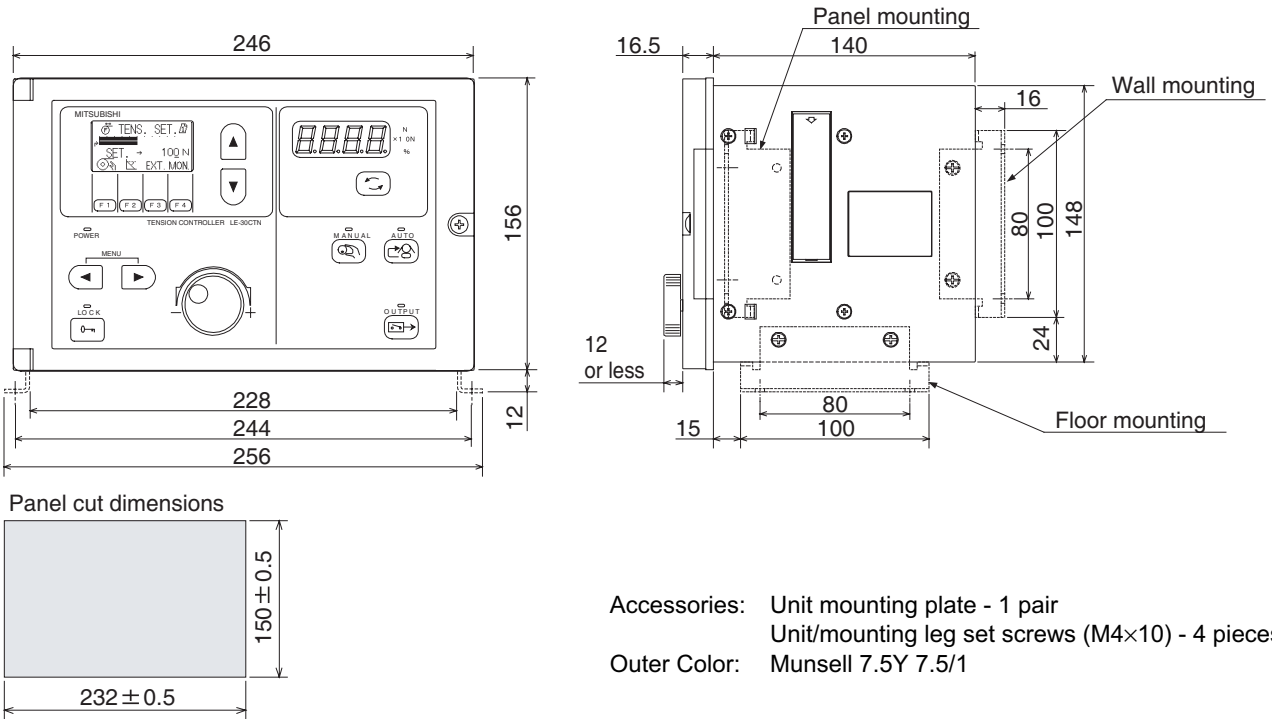
Press the function key (F1~F4) to go into the screen that corresponds to the pictorial symbol that appears above each function key.
(The function of these keys varies on different screens.)

■Externally connected devices

Some of the devices that are connected to the input/output terminals of this model of tension controllers include the following. Tension detector, actuator, and some of the signal input switches are essential to the system; other components are connected as necessary.



■External dimensions

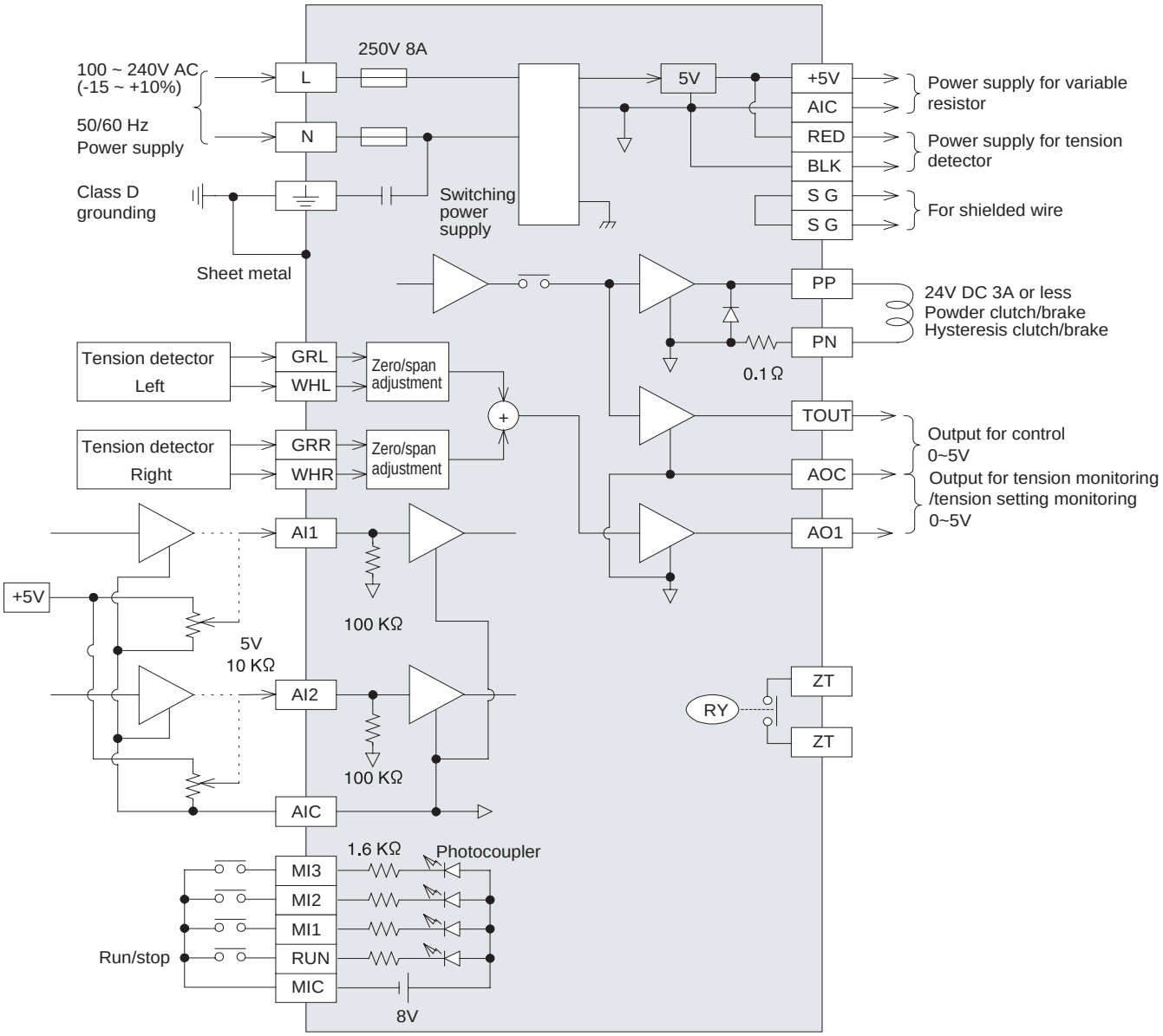


Accessories: Unit mounting plate - 1 pair
Unit/mounting leg set screws (M4×10) - 4 pieces
Outer Color: Munsell 7.5Y 7.5/1

■ Major specifications

Specification item		Specification		
Power supply	Input	100~240V AC (-15 ~ +10%) 50/60 Hz Power consumption 400VA (At 24V DC 3A) Power supply fuse 250V 8A × 2 Built-in Rush current 30 A 300 ms		
	Output	Up to two 5V DC LX-TD models of tension controllers are connectable.		
		Service power supply for external variable resistor ···· 5V DC 50 mA or less 5V DC 50 mA or less		
Contact signal	Input	Contact input common terminal		8V DC 4.5 mA/One input Internal power feed
		Run/stop ···· ON : Automatic operation, OFF : Stop		
		Contact signal input can be allocated to the following functions: Output memory, output gain 1, output gain 2, output ON-OFF, manual output 1, manual output 2	Allocated to certain functions according to the parameters.	
	Output	Zero tension detection output ···· Set value 0~1999 N (199.9 × 10 N) 250V AC 0.5A or 30V DC 0.5A		
Analog signal	Input	Tension detector input. Connect the green lead wire to GR and white lead wire to WH. If only one unit is used, between the GR and WH on the unused unit must be short-circuited by wire. Compression and pull load are auto-differentiated.		
		Analog input common terminal		
		Anolog signal input can be allocated to the following functions. Tension setting signal, reel diameter signal, external tension signal, taper ratio setting signal, manual setting signal 1, manual setting signal 2 Voltage signal of 0 to 5V DC or 10 KΩ variable resistor		Allocated to certain functions according to the parameters.
	Output	Analog output common terminal		
		Output for control 0~5V DC Power amplifier, For AC servo amplifier		Load resistance 1 KΩ or more
		Output for tension monitoring/tension setting monitoring 0~5V DC Functions selected with the DIP switches		
		For 24V DC powder clutch/brake and hysteresis clutch/brake, 0~24 V DC 3A or less		
Mass		Approximately 3.5 kg		
Mounting method		Floor, wall, or panel mounting		
Major functions		Display: Dot matrix LCD (64 x 128) Tension display: 1~2000 N (Digital and bar graph formats), output percentage display Constant setting: Value setting with a rotary pulser Screen switching: By entering the item number or by pressing the function key Control function: Stop timer, stop gain, output correction, taper control, weak excitation function, fixed output setting, auto-detection of tension detector signal polarity, auto zero/span adjustment, storage of set values on the memory cassette, and setting of the set values from the memory. Menu storage/readout function		
Operating ambient temperature		0 ~ +40 °C		
Operating ambient humidity		35 ~ 85% RH (Non-condensing)		
Vibration resistance		Conforms to JIS C0040 ···· 10 ~ 55 Hz 0.5 mm (4.9 m/S^2 allowable) ···· Two hours each in three axial directions		
Shock resistance		Conforms to JIS C0041 98 m/S^2 Three times each in three axial directions		
Power supply noise resistance		Noise voltage 1000 Vp-p Noise width 1μs Measured by a noise simulator with a frequency range of 30 to 100 Hz		
Voltage endurance		1500 V AC One minute ···· Measured between all terminals connected together and the earth terminal		
Insulation resistance		5 MΩ or more when measured with a 500V DC megger ····· Measured between all terminals connected together and the earth terminal		
Grounding		Class D grounding (Not to be grounded together with the grounding wire from a high voltage system)		
Operating environments		Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust		

■Connection from/to external devices



■Terminal arrangement

L	▪	N	▪	⏚	▪	ZT	▪	PP	MIC
▪	▪	▪	▪	▪	▪	ZT	▪	PN	RUN

MI1	MI3	+5V	AI1	GRL	RED	BLK	GRR	AOC	AO1
MI2	▪	AIC	AI2	WHL	SG	SG	WHR	TOUT	▪

■ Parameter table

Setting item		Unit	Setting range		Initial setting
			Minimum	Allowable	
Tension	Tension setting	N, ×10N	1	Full-scale tension	200
	Full-scale tension setting	N, ×10N	1	2000	500
	Decimal point of tension display	–	0.01, 0.1, 1		1
	Zero adjustment	–	0	0	0
	Span adjustment target value	N, ×10N	1 ~ full-scale tension (At least 1/3 of the full-scale tension is required.)		500
	Manual zero correction	N, ×10N	-999	+999	0
	Manual span correction	%	50	300	100
	Zero tension setting	N, ×10N	0	2000	0
Tension display filter time setting		s	0.2~4.0		2.0
Tension output filter time setting		s	0.2~4.0		2.0
Manual set value 1		%	0	100	20
Manual set value 2		%	0	100	20
Taper ratio (Inner reel diameter)		%	0	80	0
Taper ratio (Outer reel diameter)		%	0	100	0
Gain 1		%	5	400	100
Gain 2		%	5	400	100
Stop timer		s	0.0	30.0	0.0
Stop gain		%	5	400	100
Weak excitation set value		%	0	50	0
Control gain	Proportional gain	%	0	100	50
	Integral time	%	1	100	50
	Add gain	%	0	100	0
	Dead band width	%	0	50	50
Selection item	MI1 contact input setting	–	Output memory, output ON/OFF, manual output 1, manual output 2, output gain 1, output gain 2		Unset
	MI2 contact input setting				Unset
	MI3 contact input setting				Unset
	AI1 analog input setting	–	Tension setting, taper ratio, reel diameter Manual tension setting 1, manual tension setting 2, external tension		Unset
	AI2 analog input setting				Unset
Extension screen setting 1		–	10	53	0
Extension screen setting 2			10	53	0
Password setting		–	0	30000	0

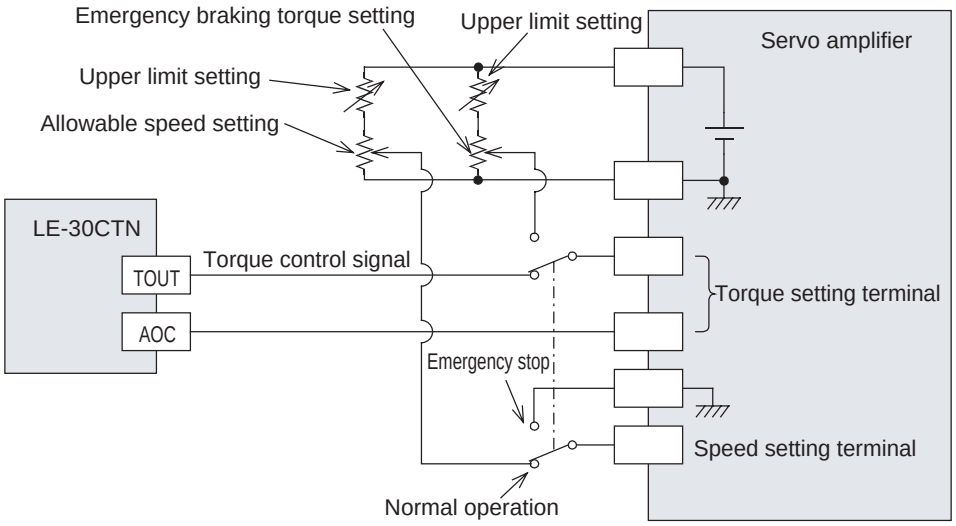
■Sample usage of the LE-30CTN model tension controller in combination with a servomotor

● By using output signals [TOUT] and [AOC] for control, the controller can be used in combination with an AC servomotor that allows torque control.

- Wiring (Example)

  The following signals are input to the torque-setting terminal on the servo amplifier and to the speed control terminal.

	Torque setting terminal	Speed control terminal
During operation and normal stoppage	[TOUT] and [AOC] signals from LE-30CTN	Signal from variable resistor for allowable speed setting
During emergency stoppage	Signal from variable resistor for braking torque setting	0V



- Setting

  Make the following settings for the servomotor.

  1) Control method..... Set this to torque control.
  2) Output torque ..... Make the setting so that the output torque of the servomotor will be at the rated torque when the torque control signal is 5V.

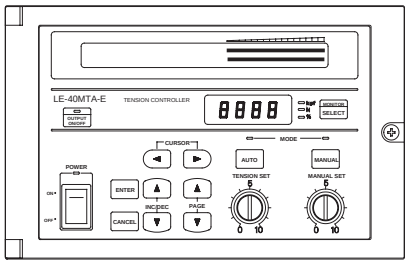
memo

LE-40MTA-E/LE-40MTB-E model fully automatic tension controller

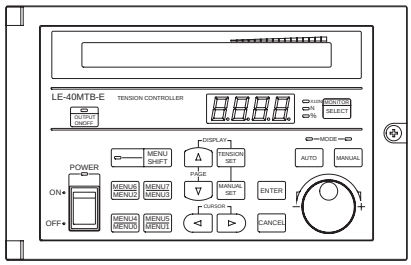
The LE-40MTA-E and MTB-E models of tension controllers are used in combination with the LX-TD or LX-TD-909 models of differential transformer type tension detectors to automatically control the unwinding, intermediate, and winding tension of the web.
Such actuators as powder clutches/brakes, hysteresis clutches/brakes, servomotors (torque mode), and air clutches/brakes can be used with these controllers, and they come with a built-in amplifier and auxiliary power supply for clutches and brakes that operate on 24V DC.

■Main features

- Significantly smaller in size and lighter in weight with the adoption of microcomputer control and a switching regulated power supply.
- Operates on a wide range of supply voltage from 100V to 240V AC.
- Set values can be written to and stored in the memory cassette.
- Two types of displays: Large LCD (2 lines x 40 characters) and an LED (7 segments).
  Easier viewing with the simultaneous display of tension and output, display of tension in bar graph format, and display of control status in characters.
- Auto zero/span adjustment method is adopted, eliminating the need for adjustment. Automatic adjustment of control gain is possible.



LE-40MTA-E model fully automatic tension controller



LE-40MTB-E model fully automatic tension controller

■LE-40MTA-E: Standard type

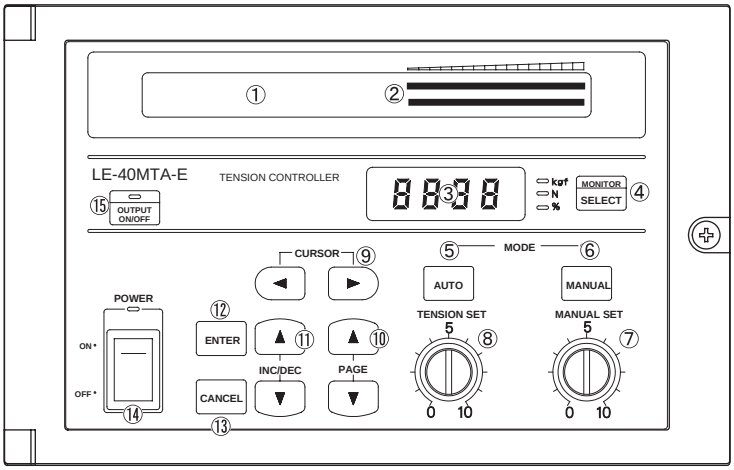
- Familiar dials for ease of operation.

■LE-40MTB-E: Advanced function type

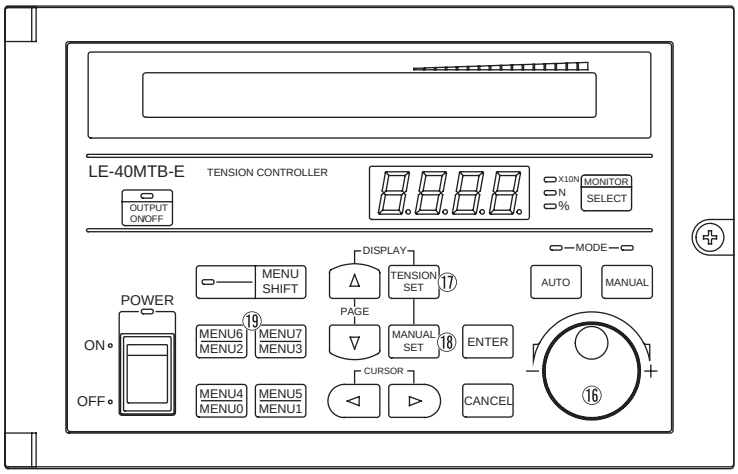
- Easy value setting with a rotary pulser.
- Connectable to the CC-Link and wire-linkable to an FX PLC.
  - CC-Link
    Uses the FX2N-32CCL (Interface block), LE-60EC (Extension cable for the added block), and FX2N-CNV-BC (Connector adapter).
  - FX PLC
    Uses a twist pair cable for parallel linking to an FX PLC.
- Set values can be selected on the menu screen.
  Seven material types can be registered, and the preset values for each material type can be registered using the eight types of menus. These set values can be read out and selected with the pressing of menu selection buttons.

■ Panel Components

● LE-40MTA-E



● LE-40MTB-E



①LCD display
2 lines x 40 charactors display. Displays various set values, and control status.

②Bar graph
Part of the LCD display that displays control tension and the percentage of tension setting in bar graph format.

③LED display
Displays the value of tension and output. The display is switched with the LED display switch ④.

④LED display switch key
Switches the display contents that appear on the LED.

⑤⑥Mode switch buttons
Switches between automatic and manual modes.

⑦Manual torque setting dial (Type A)
Sets the output torque when in manual control.

⑧Tension setting dial (Type A)
Sets the control tension when in automatic control.

⑨Cursor buttons
Scroll the cursor or screen right or left on the LCD setting display screen.

⑩Screen switch buttons
Jump to the next or previous LCD setting display screen.

⑪Value input buttons (Type A)
Set all values except tension setting and manually set torque setting.

⑫⑬Enter/cancel buttons
Executes or cancels the constant setting operation or selects/cancels the setting values.

⑭Power supply ON/OFF switch

⑮Output ON/OFF button

⑯Setting dial (Type B)
Sets various settings. Turn right to increase the value, left to decrease.

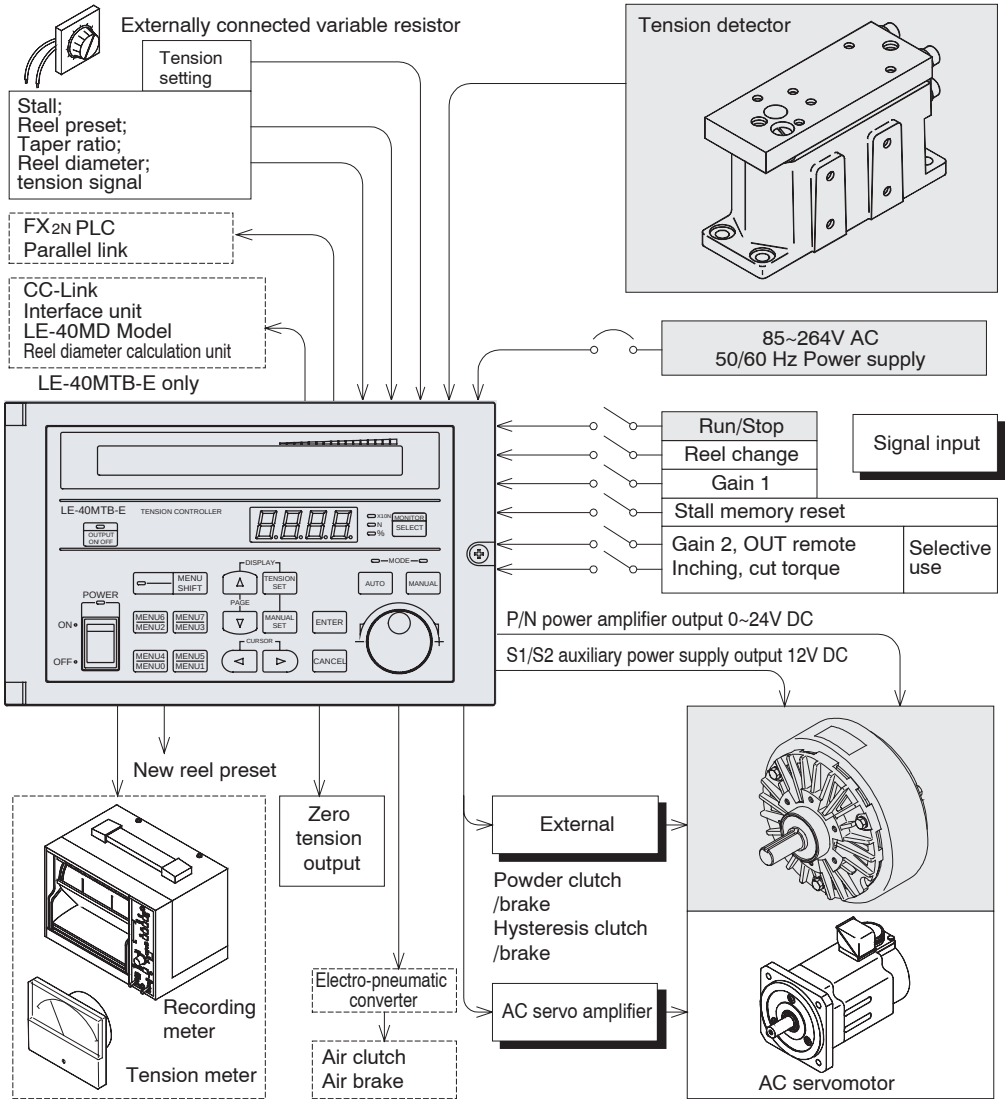
⑰Tension setting button (Type B)
Switches the LCD setting display screen to the tension-setting screen.

⑱Manual setting button (Type B)
Switches the LCD setting display screen to the manual setting mode.

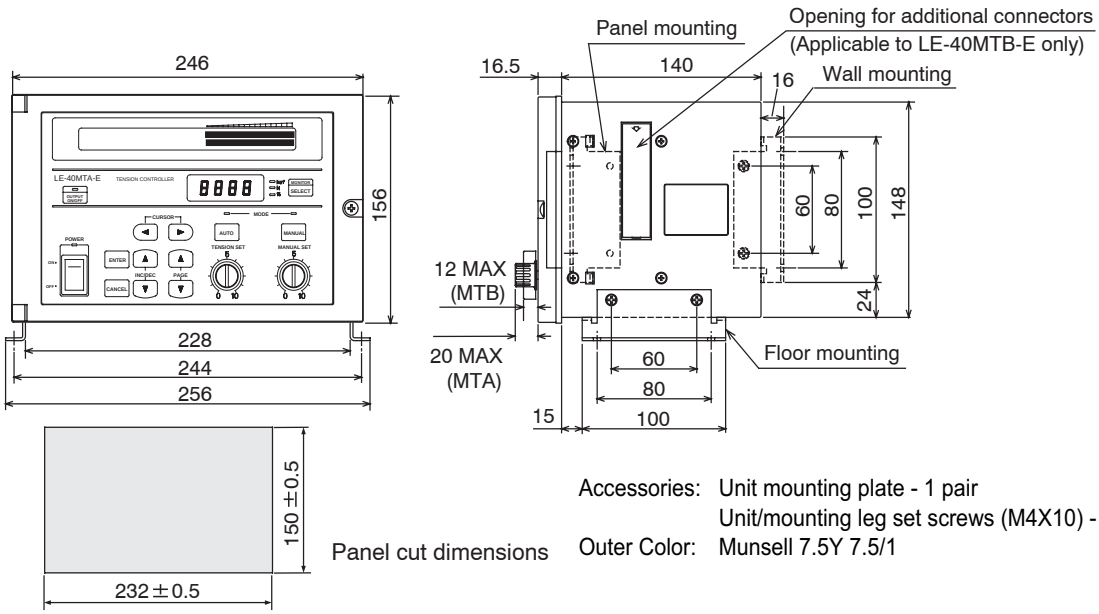
⑲Menu selection buttons (Type B)
Registers the set values or selects the menu number that corresponds to the settings that are stored in the memory to be read out.

■Externally Connected Devices

Some of the devices that are connected to the input/output terminals of this tension controller include the following. Tension controller, actuator, and some of the signal input switches are essential to the system; other components are connected as necessary.



■External dimensions

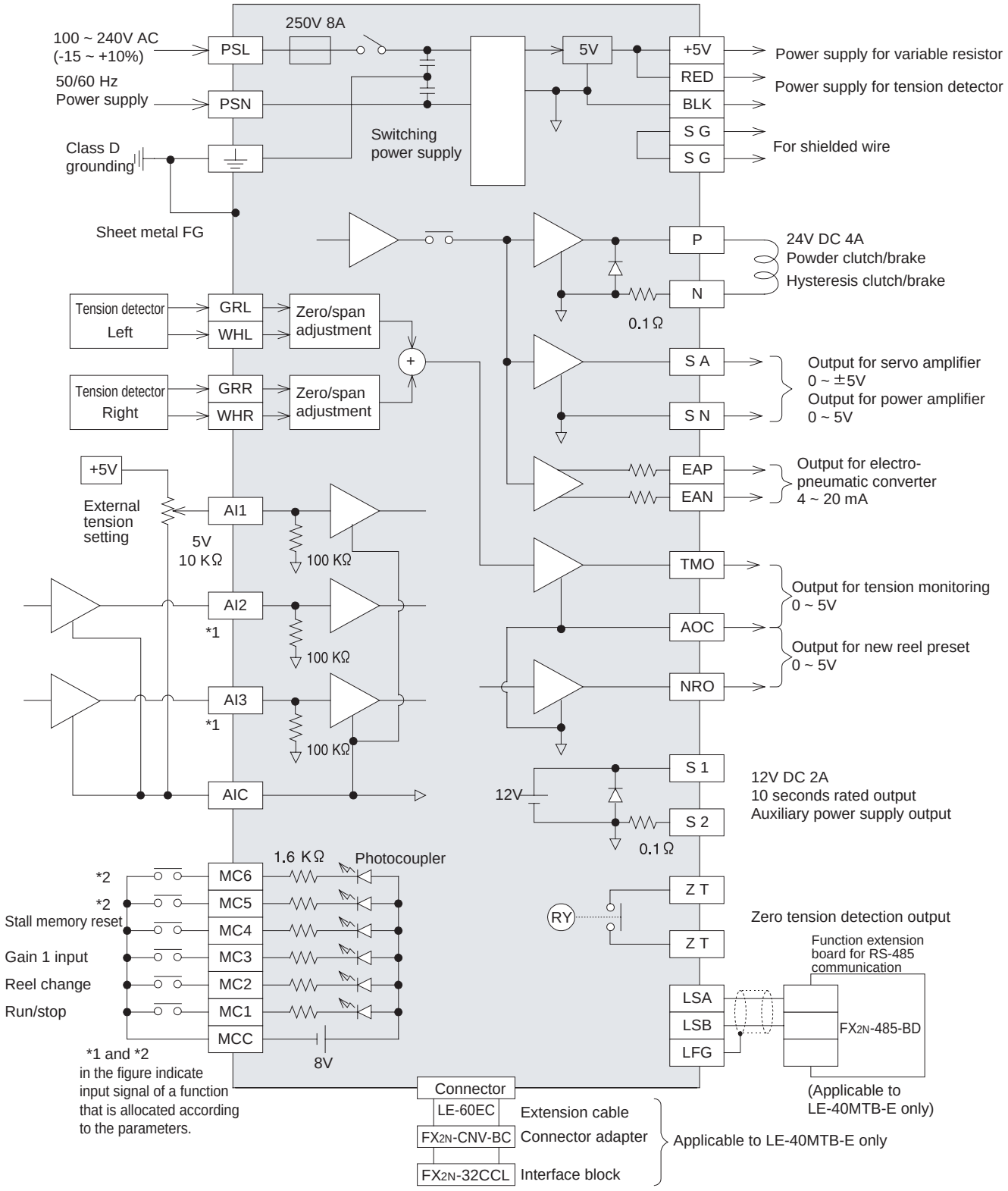


Accessories: Unit mounting plate - 1 pair
Unit/mounting leg set screws (M4X10) - 4 pieces
Outer Color: Munsell 7.5Y 7.5/1

■ Major specifications

<table>
<tr><th colspan="2">Specification item</th><th colspan="2">Specification</th></tr>
<tr><td rowspan="2">Power supply</td><td>Input</td><td colspan="2">100~240 V AC (-15 ~ +10%) 50/60 Hz Power consumption 400VA Power supply fuse 250V 8A Built-in
Rush current 30A 300 ms</td></tr>
<tr><td>Output</td><td colspan="2">Auxiliary power supply ..... 12V DC 2A 10 output
Power supply for tension detector..... Up to two LX-TD models of tension controllers are connectable
Service power supply for external variable resistor.... 5V DC 50 mA or less</td></tr>
<tr><td rowspan="2">Contact signal</td><td>Input</td><td>Run/Stop .....ON = Operation OFF = Stop
Reel change signal.....OFF = Axis A ON = Axis B
Gain 1 operation signal .....Gain 1 is valid while the signal is ON.
Stall memory reset signal
General contact input signal (2 points)..... Input signal can be allocated to the following functions
Gain 2 operation, inching, minimum-torque control during material cutting, output ON/OFF
Switches between external and internal tension setting(*) (*)Applicable to LE-40MTB</td><td>8V DC
4 mA/One input
Internal power feed</td></tr>
<tr><td>Output</td><td colspan="2">Zero tension detection output.....Set value 0~1999 N (199.9×10 N)
250V AC 0.5A or 30V DC 0.5A</td></tr>
<tr><td rowspan="2">Analog signal</td><td>Input</td><td>Tension detector input.....Use one or two LX-TD piece tension detectors</td><td></td></tr>
<tr><td></td><td>External tension setting.....0 to full-scale tension at 0 to 5V DC
General analog input signal (2 points) ....Analog input signal can be allocated to the following functions.
・Reel diameter signal for external taper control.....Minimum diameter ~ allowable diameter at 0~5V
・External stall setting .....0~100% output torque at 0~5V
・External new reel preset.....0~100% output torque at 0~5V
・External setting of tapering ratio.....at 0~5V
Inner diameter tapering.....0~80%
Outer diameter tapering.....0~100%
・Auxiliary tension detection input.....0 to full-scale tension at 0 to 5V</td><td>Recommended variable resistor
5V 10 KΩ</td></tr>
<tr><td></td><td>Output</td><td colspan="2">Power amplifier output .....24V DC 4A or less
Control signal output ・In the powder mode..... 0 ~ 5V DC Load resistance: 1 KΩ or more
・In the AC servo mode..... 0 ~ ±5V DC Load resistance: 1 KΩ or more
New reel preset output..... 0 ~ 5V DC Load resistance: 1 KΩ or more
Output for tension monitoring..... 0 ~ 5V DC Load resistance: 1 KΩ or more
Control signal output for electro-pneumatic converter ... 4 ~ 20mA DC Load resistance: 470 Ω or less</td></tr>
<tr><td colspan="2">Mass</td><td colspan="2">Approximately 3.5 kg</td></tr>
<tr><td colspan="2">Mounting method</td><td colspan="2">Floor, wall, or panel mounting</td></tr>
<tr><td colspan="2" rowspan="3">Major functions</td><td>LE-40MTA-E</td><td>LE-40MTB-E</td></tr>
<tr><td colspan="2">Display: LCD (2 lines × 40 characters) + seven-segment LED
Tension display: 1~19990 N (Digital and bar graph formats), output percentage display
Control function: Start/stop timer, stop gain, torque correction during acceleration/deceleration, taper control, mechanical loss compensation, new reel preset setting, auto zero/span adjustment, auto gain adjustment, cut torque setting, storage of set values on and retrieval of the set values from the memory cassette</td></tr>
<tr><td>Setting the value on the digital display: with the up/down keys
Tension setting: with the setting dial</td><td>Setting the value on the digital display: Setting dial
Tension setting: Setting dial
Menu storage/readout function
FX2N series PLC wire link
CC-Link network link (Optional)</td></tr>
<tr><td rowspan="8">Environmental specifications</td><td>Operating ambient temperature</td><td colspan="2">0 ~ 40°C</td></tr>
<tr><td>Operating ambient humidity</td><td colspan="2">35 ~ 80% RH (Non-condensing)</td></tr>
<tr><td>Vibration resistance</td><td colspan="2">Conforms to JIS C0040 10~55 Hz 0.5 mm (4.9 m/s^2 allowable) Two hours each in three axial directions</td></tr>
<tr><td>Shock resistance</td><td colspan="2">Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions</td></tr>
<tr><td>Power supply noise resistance</td><td colspan="2">Noise voltage 1000 Vp-p Noise width 1 μs Measured by a noise simulator with a frequency range of 30 to 100 Hz</td></tr>
<tr><td>Voltage endurance</td><td colspan="2">1500V AC One minute (Measured between all terminals connected together and the earth terminal)</td></tr>
<tr><td>Insulation resistance</td><td colspan="2">5 MΩ or more when measured with a 500V DC megger</td></tr>
<tr><td>Grounding</td><td colspan="2">Class D grounding</td></tr>
<tr><td>Operating environments</td><td colspan="2">Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep away from water sources such as rain.</td></tr>
</table>

External connection



Terminal arrangement

PSL	PSN	ZT	P	S1	MCC	MC2	MC4	MC6	+5V
⏚	·	ZT	N	S2	MC1	MC3	MC5	AIC	AI1

AI2	GRL	RED	BLK	GRR	SA	EAP	AOC	NRO	LSA
AI3	WHL	SG	SG	WHR	SN	EAN	TMO	LSB	LFG

■ Parameter Table

Setting item			Initial value	Unit	Setting range		Initial value
					Minimum	Allowable	
Tension	Tension setting		Set value (N)	N	0.1, 1, 10 ~ Full-scale tension		200
			Set value (×10N)	N	0.01, 0.1, 1 ~ Full-scale tension		20.0
	Full-scale tension		Full-scale value	–	1	1999	500
			Decimal point (N)	–	Selectable from 0.1, 1, or 10		×1
			Decimal point (×10N)	–	Selectable from 0.01, 0.1, or 1		×0.1
	Tension detector		Zero adjustment	–	0	0	0
			Span adjustment target value	N	1 digit ~ Full-scale tension (At least 1/3 of the full-scale value is required.)		500
				×10N			50.0
	Filter		Display time setting	s	Selectable from 1/4, 1/2, 1, 2, or 4		1/2
			Time constant during TMO output	s			1/2
	Zero-tension detection value		Zero-tension setting (N)	N	0	1999	0
			Zero-tension setting (×10N)	×10N	0.0	199.9	0.0
Manual setting			Manual setting value	%	0	100	20
Tapering	Linear tapering		Taper ratio (Inner reel diameter)	%	0	80	0
			Taper ratio (Outer reel diameter)	%	0	100	0
	Stage tapering		Corner 1~4	mmø	0	2000	0
			Tapering 1~4	%	0	100	0
Start-up	Stall		Stall setting value	%	0	100	20
	Timer		Start timer	s	0.0	10.0	4.0
Output gain			Gain 1	%	5	400	100
			Gain 2	%	5	400	100
New/orignal reel change			New reel preset value	%	0	100	50
			Preset timer	s	0.0	30.0	4.0
			Cut torque	%	0	100	10
Stop control			Stop timer	s	0.0	100.0	6.0
			Stop gain	%	5	400	100
			Stop bias	%	0	50	0
Mechanical loss bias		Axis A setting	Powder mode	%	0	100	0
			AC servo mode	%	-50	100	0
		Axis B setting	Powder mode	%	0	100	0
			AC servo mode	%	-50	100	0
Reel diameter			Minimum diameter setting	mmø	0	2000	100
			Allowable diameter setting	mmø	Minimum set diameter	2000	1000
Control gain	Manual setting		Proportional gain	%	0	100	50
			Integral time	%	1	100	50
			Dead band gain	%	0	100-proportional gain	0
			Dead band width	%	0	100	50
	Auto gain setting		Add torque	%	0	100	20

■Sample application

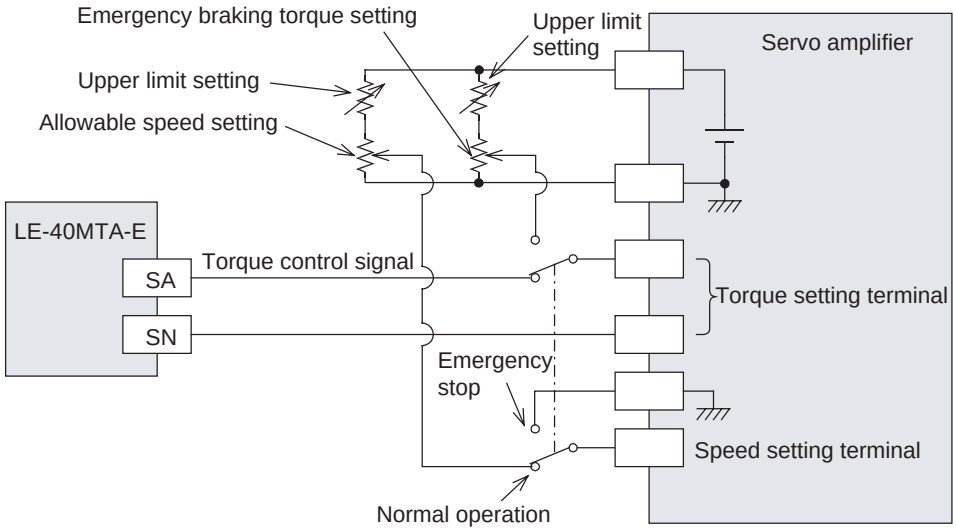
● Combined use with an AC servomotor

By using the output signals [SA] and [SN] for control, these controllers can be used in combination with an AC servomotor that allows torque control.

Wiring (Example)

The following signals are input to the torque-setting terminal on the servo amplifier and to the speed control terminal.

	Torque setting terminal	Speed control terminal
During operation and normal stoppage	[SA] and [SN] signals from the tension controller	Volume signal for allowable speed setting
During emergency stoppage	Volume signal for braking torque setting	0V



Setting

When using these controllers in combination with the servomotor, secure the following settings for the servomotor.

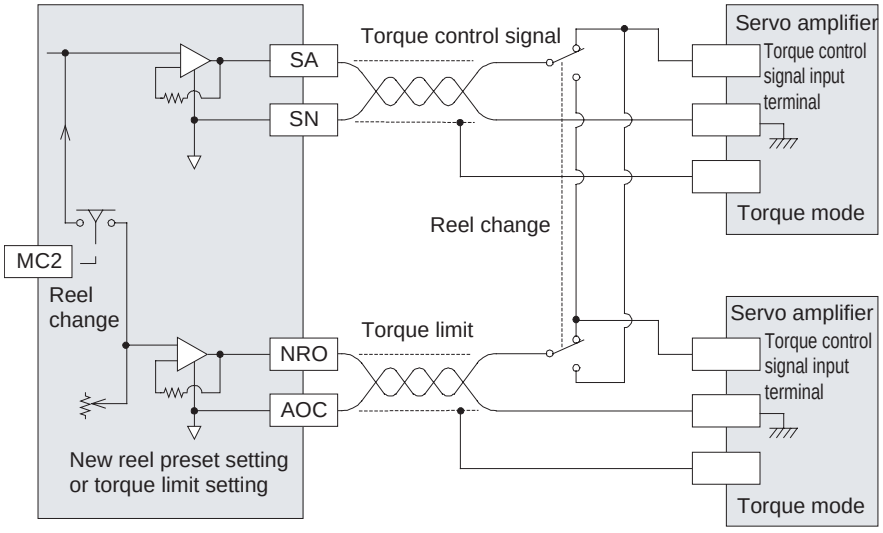
1) Control method . . . . .Set this to torque control.

2) Output torque . . . . . .Adjust the setting so that the output torque of the servomotor will be at the rated torque when the torque control signal is 5V.

● Two-axis switching with an AC servomotor

Servomotor torque is controlled by sending the control output from the SA terminal to the servo amplifier torque control input of either axis A or B with the reel change switch.
To stop the original axis, the speed control signal is brought down to zero and a separate torque limiting input is sent to the axis.
The NRO output limits the torque during pre-drive operation and controls the servomotor speed input (VC) to keep the pre-drive rotation speed in proportion with the main shaft speed.

Wiring (Example)

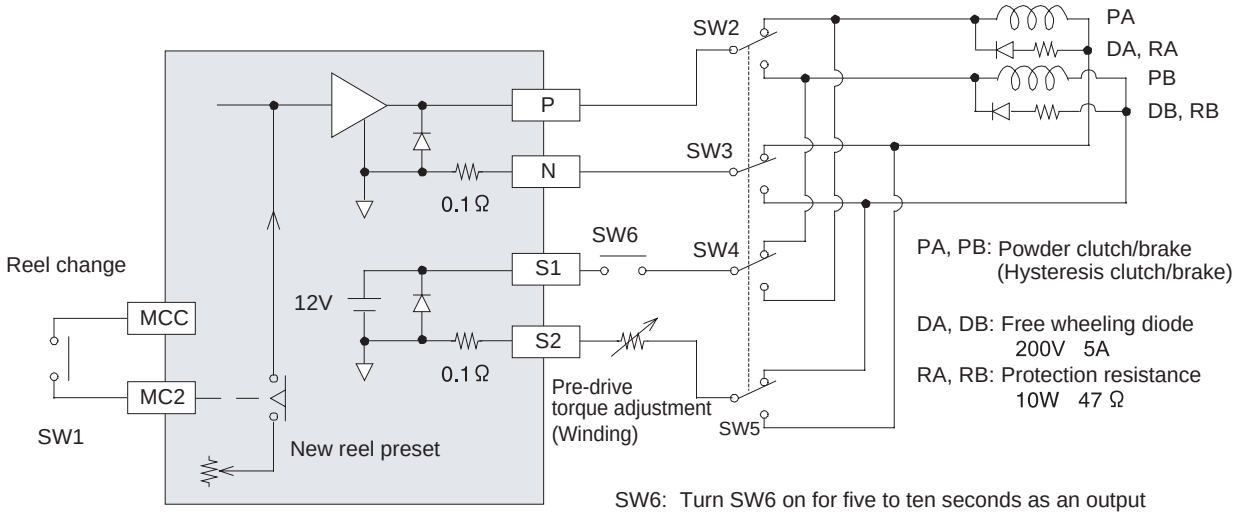


Sample application

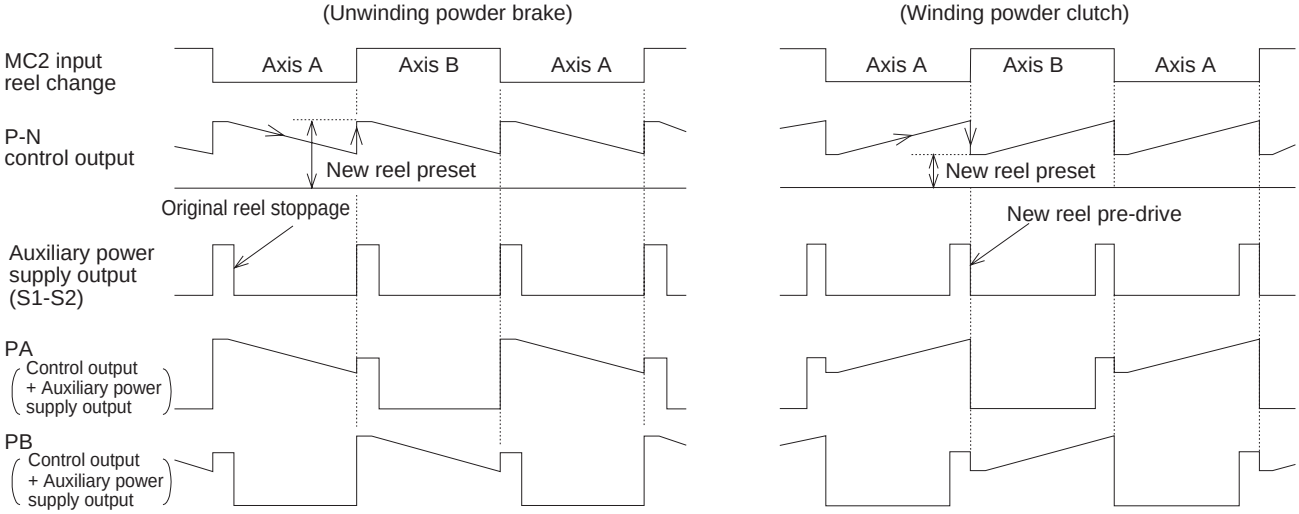
- Two-axis switching with a powder clutch/brake

Connect the contact signal that was interlocked with the reel change during a two-axis operation to MC2. When this input signal changes from OFF to ON or ON to OFF, the control output is reset to the new reel preset value, and automatic control is performed after the preset timer is up.
SW1, SW2, and SW3 are switched simultaneously by an interlocked operation with the cutter operation.

Wiring (Example)



SW6: Turn SW6 on for five to ten seconds as an output for the pre-drive before a reel change (winding) or for stopping the original reel after the reel change.

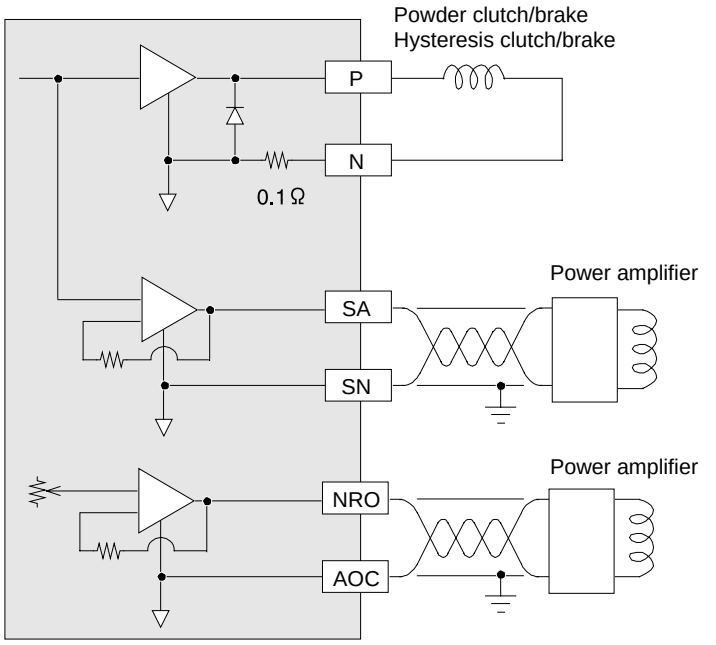


PA and PB indicate powder output of axis A and B respectively.

■Sample application

● **Intermediate control with a powder clutch/brake**

Wiring (Example)



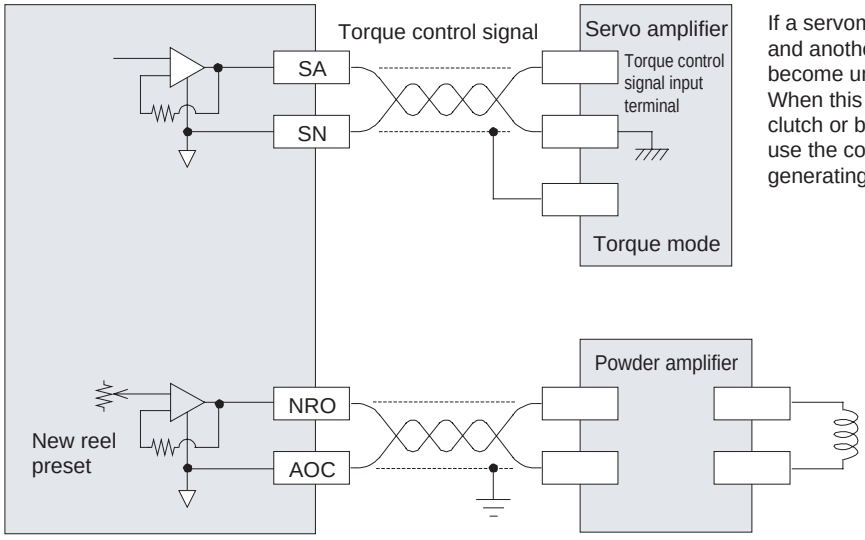
Connect a powder clutch (out-feed) /brake (in-feed) (24V DC, 4A or less). (Same for the hysteresis clutch/brake)

To use an 80V DC powder clutch/brake, use an SA output for control and an external 80V DC power amplifier.

When an auxiliary brake (out-feed) or clutch (in-feed) for the countershaft is used, a manual control of the output can easily be performed by using the new reel preset output (NRO output).

● **Intermediate control with an AC servomotor**

Wiring (Example)



If a servomotor is used for regenerating and another for powering, control may become unstable near zero.
When this happens, provide an auxiliary clutch or brake for the countershaft, and use the control output on either the generating or the powering side.

LE-40MD model reel diameter calculation unit

Used in combination with the LE-40MTB-E model of tension controller, the LE-40MD model of reel diameter calculation unit makes precise tension control possible. (LE-40MD is not a stand-alone unit.)

Main features

1. High-precision taper tension control

Precise calculation of reel diameter based on pulse ratio calculation allows high-precision taper tension control such as stage taper control.

2. Allows constant slip control of the powder clutch for winding

For winding operation with an inverter and powder clutch, slip heat can be significantly reduced by maintaining constant slipping of the powder clutch using a reel rotation speed signal. This control method has numerous advantages over operating the powder clutch at a fixed input rotation speed.

- It may be possible to switch the cooling method for the powder clutch from water-cooling to air-cooling in some applications.
- The selection of a powder clutch with a smaller rated torque may be possible.
- The life of the powder clutch may be significantly extended.

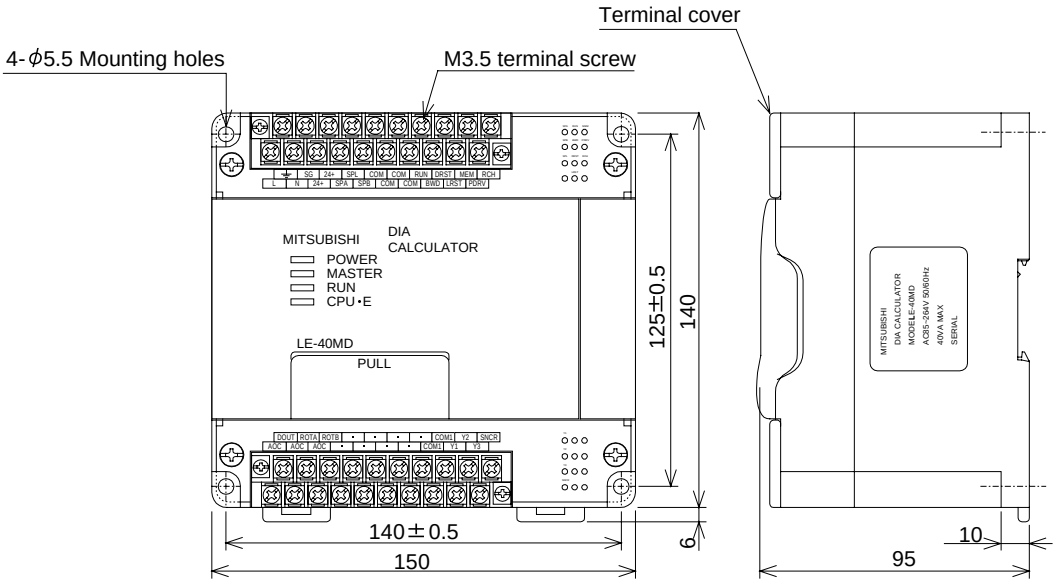
3. Allows for easy two-axis control

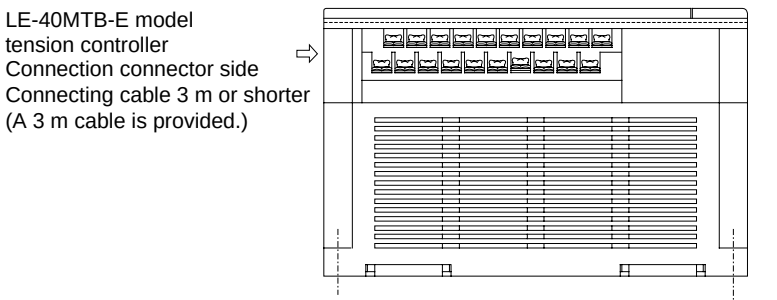
With the use of peripheral speed sync signal and reel rotation speed signal, it is easy to switch between pre-drive control and two-axis control.

4. Timing detection of reel diameter and length measurement is possible

Three contact points are provided for connection to various timing detectors.

External dimensions



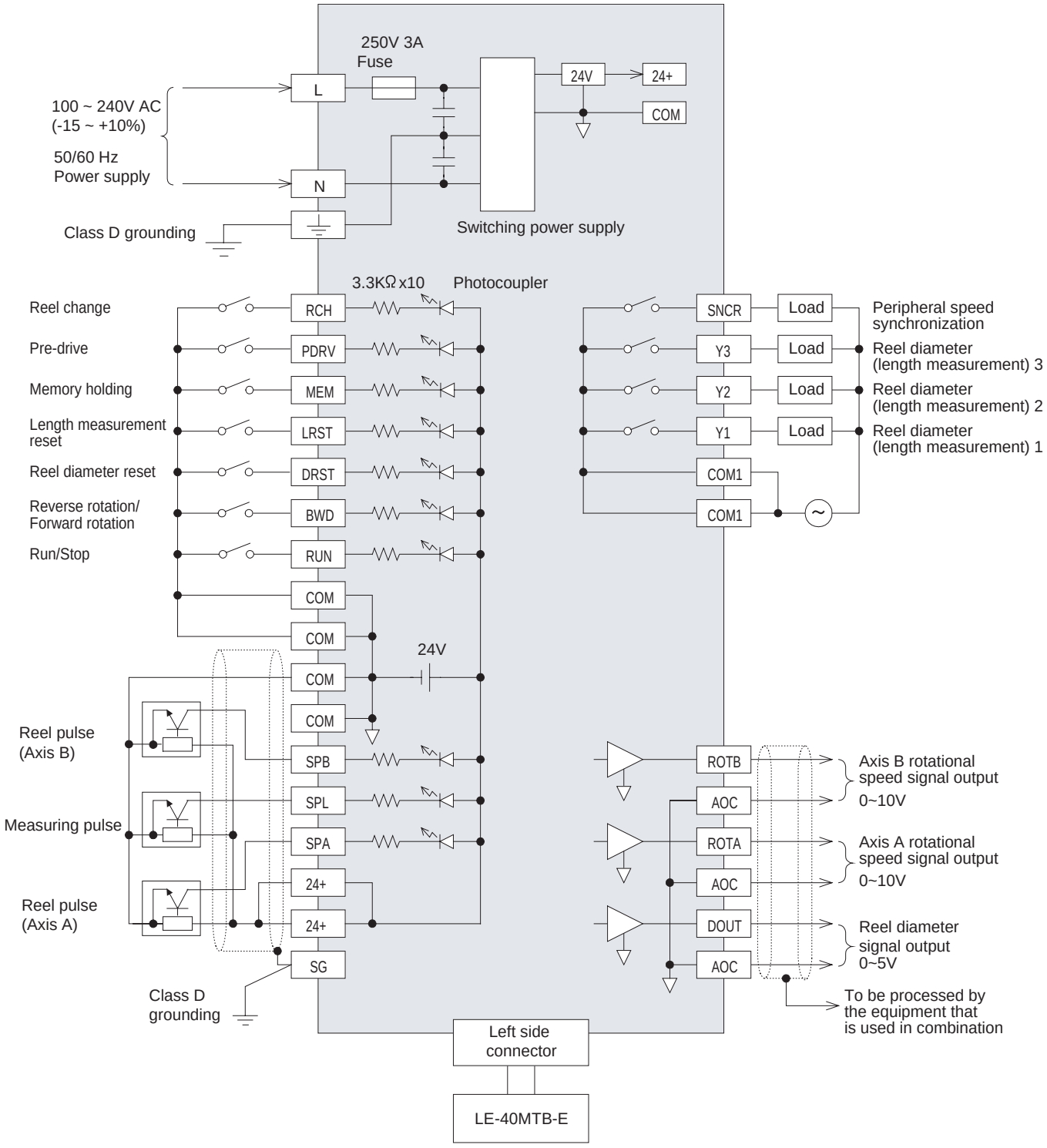


Units : mm
Outer color : Munsell 7.5Y 7.5/1
Accessory : Connecting cable 1 pc (3 m)

■Major specifications

Specification item		Specification	
Power supply	Input	100~240V AC (-15 ~ +10%) 50/60 Hz Power consumption 40VA Power supply fuse 250V 3A Built-in	
	Output	Power supply for sensor ..... 24V DC, 150 mA or less	
Pulse signal	Input	Reel pulse input .....Response frequency: 500 Hz or less (For Axis A and Axis B) Measuring pulse input..... Response frequency: 20 kHz or less	24V DC, 7 mA / input Open-collector type
Contact signal	Input	Run/Stop ..... ON: Run, OFF: Stop Forward rotation/Reverse rotation ON: Reverse rotation, OFF: Forward rotation Reel diameter reset..... One-shot input of approx. 0.5 sec Length measurement reset ..... One-shot input of approx. 0.5 sec Memory holding ..... Reel diameter data is held while the signal is ON. (Length measurement data is updated.) Pre-drive ..... Rotation speed control signal for pre-drive is output while the signal is ON. Reel change..... OFF: Axis B, ON: Axis A	24V DC, 7 mA/input Internal power feed
	Output	Length measurement signal (three points) Turns ON when greater than or equal to the preset to value Reel diameter signal (three points)..... Turns ON when greater than or equal to the preset to value Peripheral speed sync signal ..... Turns ON when the rotation speed control signal for pre-drive is synchronized with the equivalent line speed	250V AC 0.5A/output or 30V DC 0.5A/output
Analog signal	Output	Reel diameter signal ..... 0 ~ 5V DC Load resistance: 1 KΩ or more Rotational speed signal..... 0 ~ 10V DC Load resistance: 2 KΩ or more (For Axis A and Axis B)	
Mass		Approximately 1.2 kg	
Mounting method		DIN rail or wall mounting	
Setting range	Reel diameter	ø50 ~ 2,000 mm	
	Length measurement range	0 ~ 32,767 m	
	Line speed	5 ~ 1,000 m/min	
	Material thickness	2 μm ~ 10 mm	
Major functions		Reel diameter calculation..... Taper control and reel diameter monitoring etc. for the LE-40MTB model tension controller Length measurement calculation ..... Axis switching timing etc. Reel rotation speed calculation .....Powder clutch slip rotation speed control for winding etc. Detection of peripheral speed synchronization .. Axis switching timing etc.	
Environmental specifications	Operating ambient temperature	0 ~ 55°C	
	Operating ambient humidity	35 ~ 85% RH (Non-condensing)	
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (19.6 m/s^2 allowable, 4.9 m/s^2 when installed on a DIN rail) Two hours each in three axial directions	
	Shock resistance	Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions	
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width 1 μs Tested by a noise simulator with a frequency range of 30 to 100 Hz	
	Voltage endurance	1500V AC One minute (Between all terminals connected together and the ground terminal)	
	Insulation resistance	5 MΩ or more when measured with a 500V DC megger	
	Grounding	Class D grounding	
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep out of water such as rain.	

External connection



Terminal arrangement

⏚	SG	24+	SPL	COM	COM	RUN	DRST	MEM	RCH
L	N	24+	SPA	SPB	COM	COM	BWD	LRST	PDRV

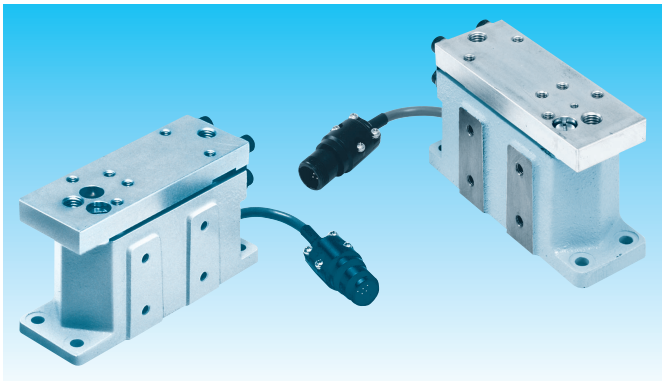
DOUT	ROTA	ROTB	·	·	·	·	COM1	Y2	SNCR
AOC	AOC	AOC	·	·	·	·	COM1	Y1	Y3

LX-TD model differential transformer type tension detector

The LX-TD model of differential transformer type tension detector is used in combination with such tension feedback controlled tension controllers as the LE-40MTA-E, LE-40MTB-E, or LE-30CTN models.
The differential transformer type LX-TD model tension detector can also be used to monitor tension when used in combination with the LM-10PD model tension meter or LM-10TA tension amplifier.

LX-TD model tension detector

- Fifty percent or less hysteresis, temperature fluctuation, and deterioration with time (based on the comparison with the older model).
- Only 48 mm in width (LX-050TD model) and helps downsize the overall size of devices.
- Allows wall mounting or floor mounting. Adoption of the connector connection method. Pillow block mounting plate (optional) is available.



■Major specifications

Specification item		Specification					
Model name	Non-explosion-proof type	LX-005TD	LX-015TD	LX-030TD	LX-050TD	LX-100TD	LX-200TD
Rated load (N)		50	150	300	500	1000	2000
Load application direction		Both compression load and expansion load direction					
Mounting		Floor, wall, and ceiling mounting					
Cable specifications		7 m×ø7 (Supplied)					
Unit mass (kg)		1.8				3	
Use conditions		Ambient temperature: -5 ~ +60°C Vibration: 2 m/s^2 or less					
External dimensions		Figure 1				Figure 2	
Compatible bearings		UCP201-204 The use of UCP205 is possible with the use of the optional LX-030PLT.				UCP201-204 The use of UCP205 and 206 are possible with the use of the optional LX-100PLT.	

■External dimensions

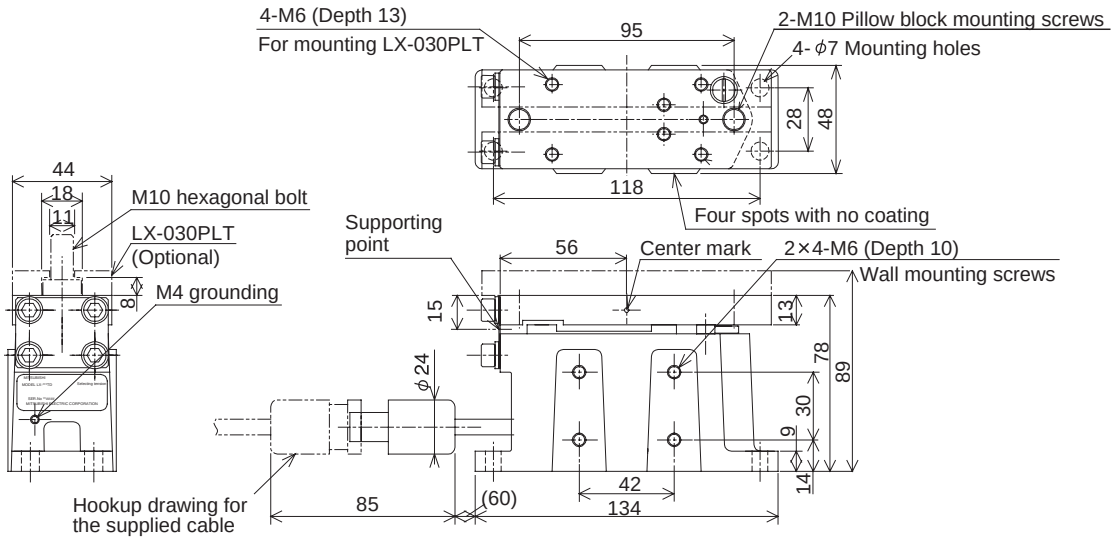


Figure 1.

Units: mm

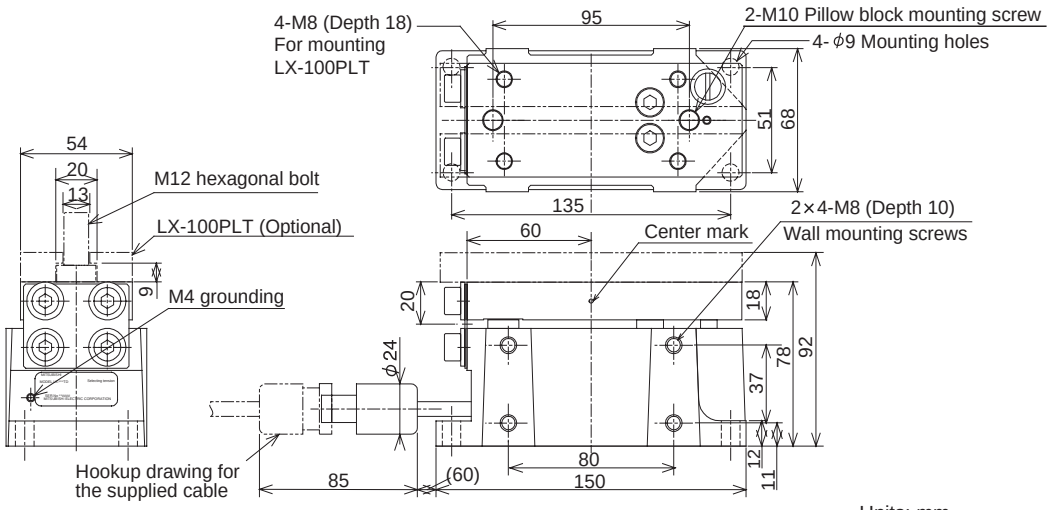


Figure 2.

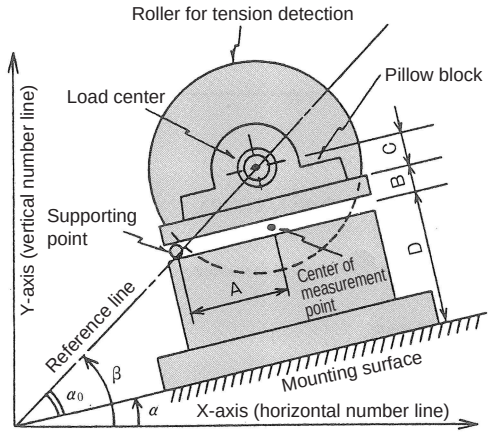
Units: mm

■ Selecting a tension controller

Tension detector selection method for various applications with different mounting angles and feed angles are described below. Depending on the mounting conditions, none of the available models may be found to be suitable. If this is the case, change the mounting conditions and recalculate to make another selection.

● Calculating the reference angle β

Using C (height of the pillow block), calculate the reference angle β.
The intersection of the reference line (the line that goes through the supporting point of the detector and the load center), the line that passes through the mounting surface, and the X-axis (horizontal number line) is set as the origin of the coordinate.



Detector type	A	B	Recommended pillow block model
LX-005~050TD	56.3	15	UCP-201~204
LX-005~050TD-909	56.3	15	UCP-201~204
LX-100, 200TD	60.3	20	UCP-201~204
LX-100, 200TD-909	60.3	20	UCP-201~204

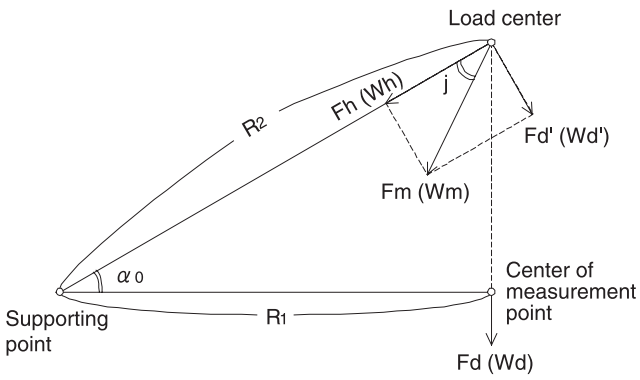
A: Distance between the detector's supporting point and the center of measurement point
B: Height between the detector's supporting point and the roller mounting surface
C: Height of the pillow block

α: Mounting angle $\alpha = 0 \sim 360$

α_0: Supporting point angle $\alpha_0 = \tan^{-1}\frac{B+C}{A}$ .....①

β: Reference angle $\beta = \alpha \pm \alpha_0$ (Depending on the position of the supporting point, $+\alpha_0$ or $-\alpha_0$ may be applicable.)

● Components of load force and effective load



- Tension components
  - Fm: Allowable tension per detector (N)
  - Fh: Tension component that pulls in the direction of the supporting point (N)
  - Fd: Tension component that pulls in the direction of the measurement point center(N)
- Reel load components
  - Wm: Reel load per detector (N)
  - Wh: Reel load component that is applied in the direction of the supporting point (N)
  - Wd: Reel load component that is applied in the direction of the measurement point center(N)

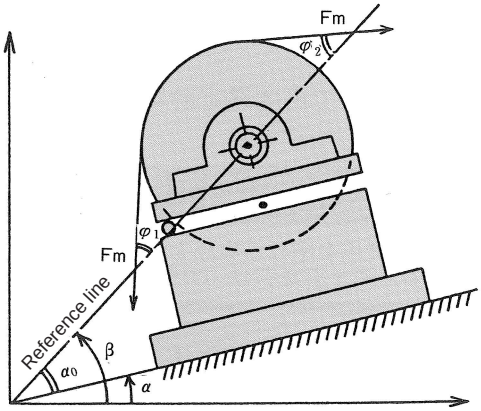
$Fh = Fm \cos\varphi$

$Fd = Fd' \frac{R_2}{R_1} = Fm \sin\varphi / \cos\alpha_0$

Use the same formula to calculate reel load components.

Calculating the tension components

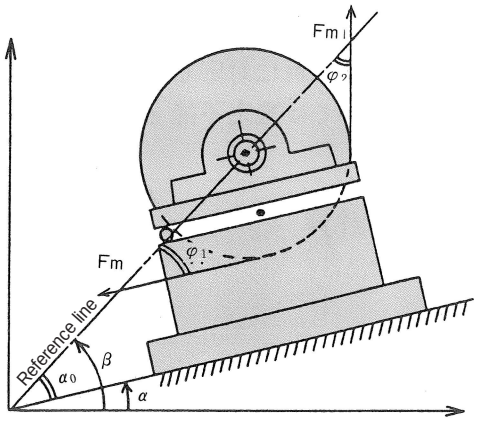
● **Compression load**



$Fh = Fm(\cos\varphi_1 - \cos\varphi_2)$ ..... ②'

$Fd = Fm(\sin\varphi_1 + \sin\varphi_2)/\cos\alpha_0$ ..... ③'

● **Expansion load**

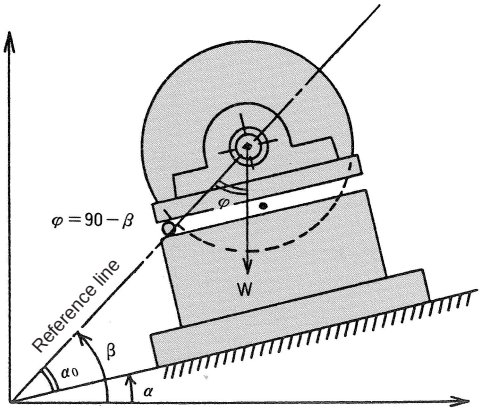


$Fh = Fm(\cos\varphi_1 - \cos\varphi_2)$ ..... ②"

$Fd = -Fm(\sin\varphi_1 + \sin\varphi_2)/\cos\alpha_0$ ..... ③"

Calculating the reel load components

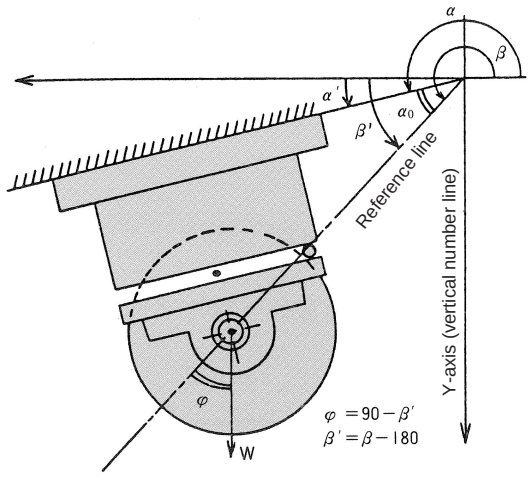
● **Compression load**



$Wh = Wm\cos\varphi = Wm\sin\beta$ ..... ④'

$Wd = Wm\sin\varphi/\cos\alpha_0 = Wm\cos\beta/\cos\alpha_0$ ..... ⑤'

● **Expansion load**



$Wh = -Wm\cos\varphi = Wm\sin\beta$ ..... ④"

$Wd = -Wm\sin\varphi/\cos\alpha_0 = Wm\cos\beta/\cos\alpha_0$ ..... ⑤"

Selection criteria

Select a detector whose load rating (G_0) meets the following criteria.

1) Reel load component that is applied in the direction of the measurement point center $Wd = |Wm\cos\beta/\cos\alpha_0| \le 0.8\ G_0$.
(The range that allows zero adjustment. It is best to minimize this value.)

2) Tension component that pulls in the direction of the measurement point center $Fd = |\pm Fm(\sin\varphi_1 + \sin\varphi_2)/\cos\alpha_0| \ge 0.2G_0$.
(Tension component Fd at the allowable tension is to be 20% of the load rating or higher so that it will fall within the range that allows span adjustment. It is best to maximize this value.)

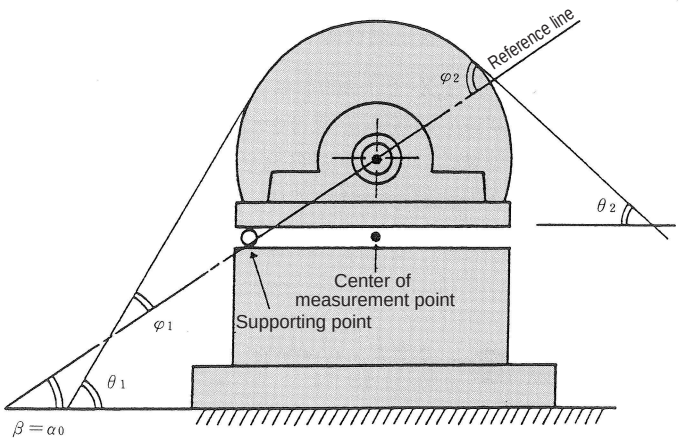
3) Total load that is applied in the direction of the measurement point center Gd
$= |Fd+Wd|$
$= |[\pm Fm(\sin\varphi_1 + \sin\varphi_2) + Wm\cos\beta]/\cos\alpha_0|$
$\le G_0$(To protect the detector. When one detector is used to control the tension of such material as wire)
$\le 0.8\ G_0$(When two detectors are used to control the tension of a wide material. Considering the uneven tensioning on one side and its tension variation of up to 20%, allowable Gd is set at 80% of the load rating.)

4) Supporting point load that is applied to the detector Gh
$= |Fh + Wh|$
$= |Fm(\cos\varphi_1 - \cos\varphi_2) + Wm\sin\beta| \le 2\ G_0$(To protect the supporting point)|.

● Sample calculation

- Conditions

Tension F = 400 ~ 150 N
Reel load W = 250 N
Material angle $\theta_1 = 60°$, $\theta_2 = 30°$
Number of detectors N = 2 units
Center height of the pillow block
33.3 mm (UCP-204)



Mounting angle $\alpha = 0$ (Horizontal mounting)

● Detailed calculation formula

Make a tentative selection of LX-100TD, whose G_0 = 1000 N
Supporting point angle : $\alpha_0 = \tan^{-1}(20+33.3)/60.3) = 41.47°$.
Reference angle : $\beta = 41.47°$
Feed angle : $\varphi_1 = \theta_1 - \alpha_0 = 18.53°$.
$\varphi_2 = \theta_2 + \alpha_0 = 71.47$.
Fd = 400(sin18.53° + sin71.47°)/cos41.47°
= 675.8 N.
If the percentage of Fd in relation to the load rating is represented as Fd',
Fd' = Fd/(N × G0) = 33.79% ≥ 20% is within the range that allows for span adjustment.
35% or more is recommended.
The higher the value, the higher the precision.
Wd = 250(cos 41.47°/cos 41.47°)
= 250 N
If the percentage of Wd in relation to the load rating is represented as Wd',
Wd' = Wd/(N × G0) = 12.5% ≤ 80% AND ≥ –80% is within the range that allows for zero adjustment.
If the percentage of Gd in relation to the load rating is represented as Gd',
Gd' = Fd' + Wd' = 46.29% ≤ 80% AND ≥ –80% is within the allowable load range.
With the tension imbalance of 20%
When one detector is used to detect the tension of such material as wire, it can be used in the range of ±100% of the load rating.
In the same manner
Gh = 252.1 + 165.6 = 417.7 N
If the percentage of Gh in relation to the load rating is represented as Gd',
Gh' = Gh/(N × G0) = 20.89% ≤ 100%
≥ –100% It is within the allowable load range.

● Selection result

Based on the above calculation, the use of two LX-100TD tension detectors is recommended.

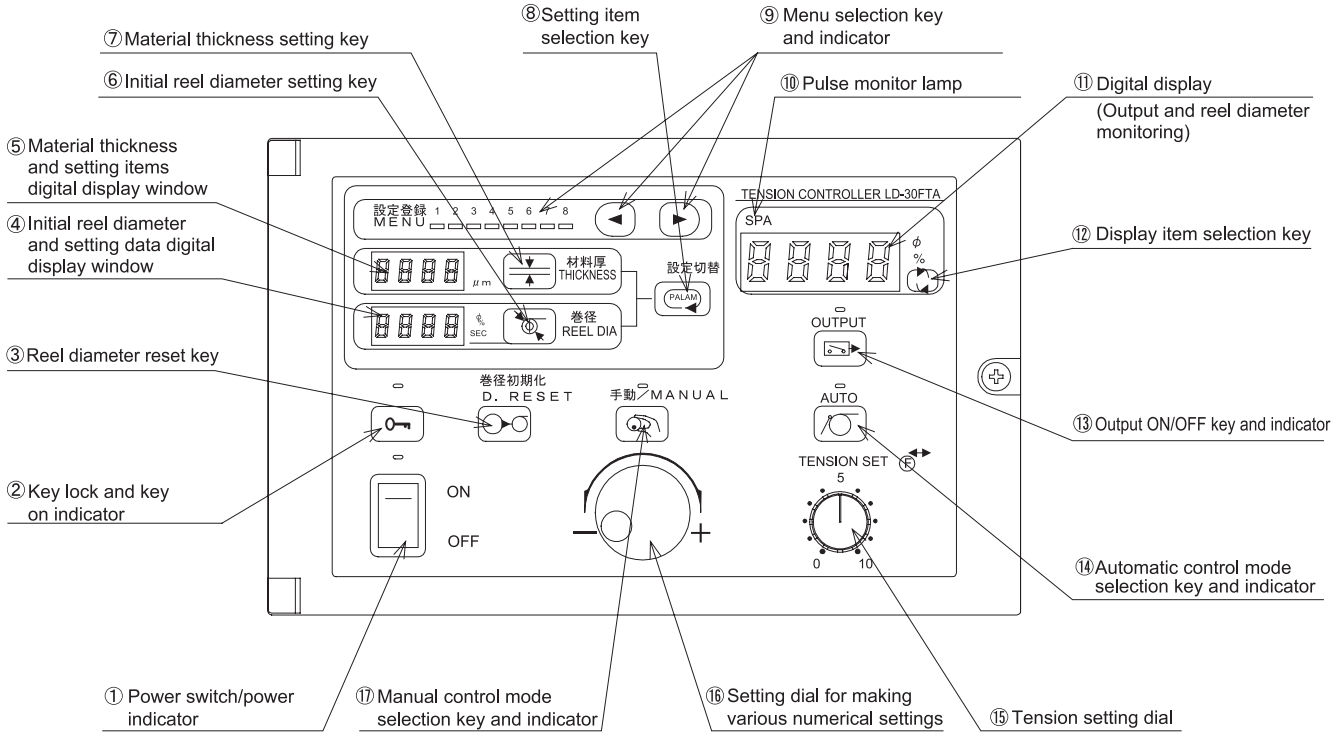
LD-30FTA model semi-automatic tension controller

The LD-30FTA tension controller is a semi-automatic controller that operates on an integrated thickness monitoring method.
In this method, the reel diameter at any given moment is calculated out by presetting the initial reel diameter and the material thickness on the controller and by subtracting (unwinding) or adding (winding) the material thickness times the number of rotations from/to the initial value. (A proximity sensor is used on the reel shaft to count the number of rotations.)
Based on the calculation results, a voltage between 0 and 24V is output to the powder clutch or hysteresis clutch/brake that is used as an actuator, and a command voltage between 0 and 5V is also output to the amplifier for the servomotor.

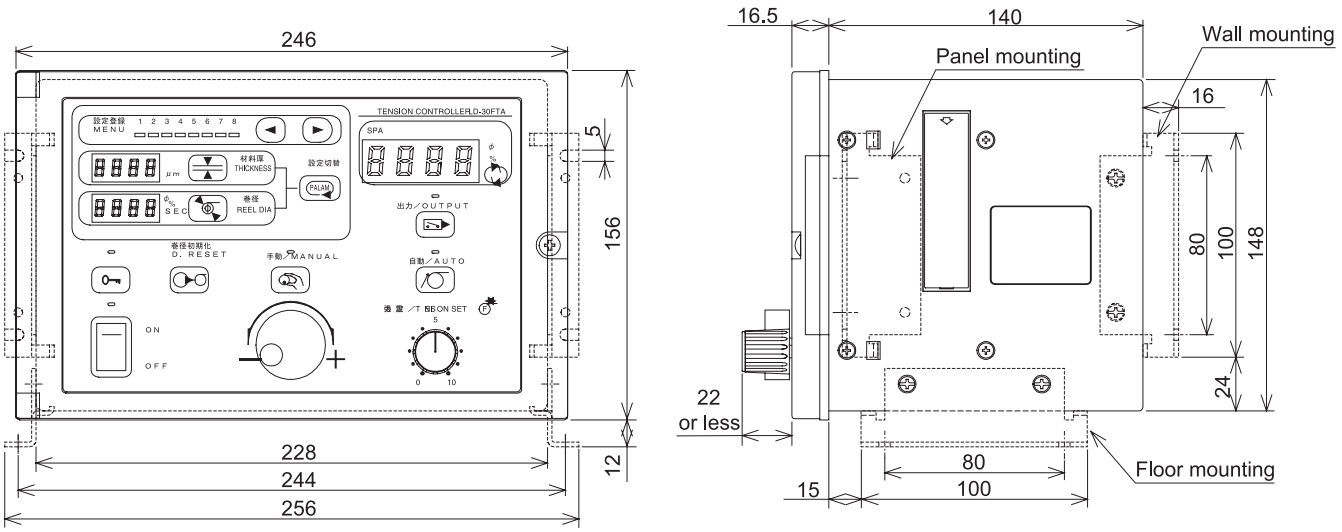
Main features

- **Easy control and adjustment of tension with simple operation**
  - Only requires tension, material thickness, and initial reel diameter setting to run an automatic control operation
  - Operates on a wide voltage range from 100 to 240V AC
  - A wide range of material thickness and initial reel diameter can be set
  - Retains the current reel diameter even when the power supply is cut off such as in the case of power failure
  - Compatible with various types of actuators such as AC servomotors
- **Features an advanced function mode that supports various applications**
  - Enables tapered winding
  - Inertia compensation at acceleration/deceleration
  - Compensation function for the clutch/brake torque nonlinearity
  - Mechanical loss compensation
- **Simple operation**
  - Values are entered with the dial
  - Quick switching between the advanced function mode and basic mode with the built-in dipswitch
  - Preset value memory function allows the storage of eight types of settings using the menu function.
    Up to eight operation constants (material thickness, initial reel diameter, taper ratio etc.) can be stored in memory
  - Key lock function to prevent accidental change of settings and disable the display of inactive functions
- **Accepts input ultrasonic sensor and touch lever**
  With the use of an optional analog input board (LD-30FTA-1AD), signal input from an ultrasonic sensor or a touch lever can be received.
  The use of an analog input board eliminates the need to set the thickness and initial reel diameter for each material.

■Components of the operation panel

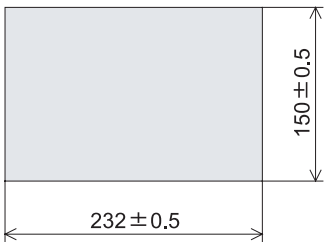


■External dimensions

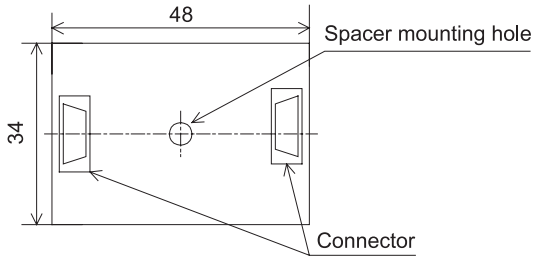


Accessories: Unit mounting plate - 1 pair　Unit mounting plate set screws (M4×10) - 4 pieces
Outer color: Munsell 7.5Y 7.5/1

Panel cut dimensions



LD-30FTA-1AD model option board (Spacer provided separately)



Units: mm

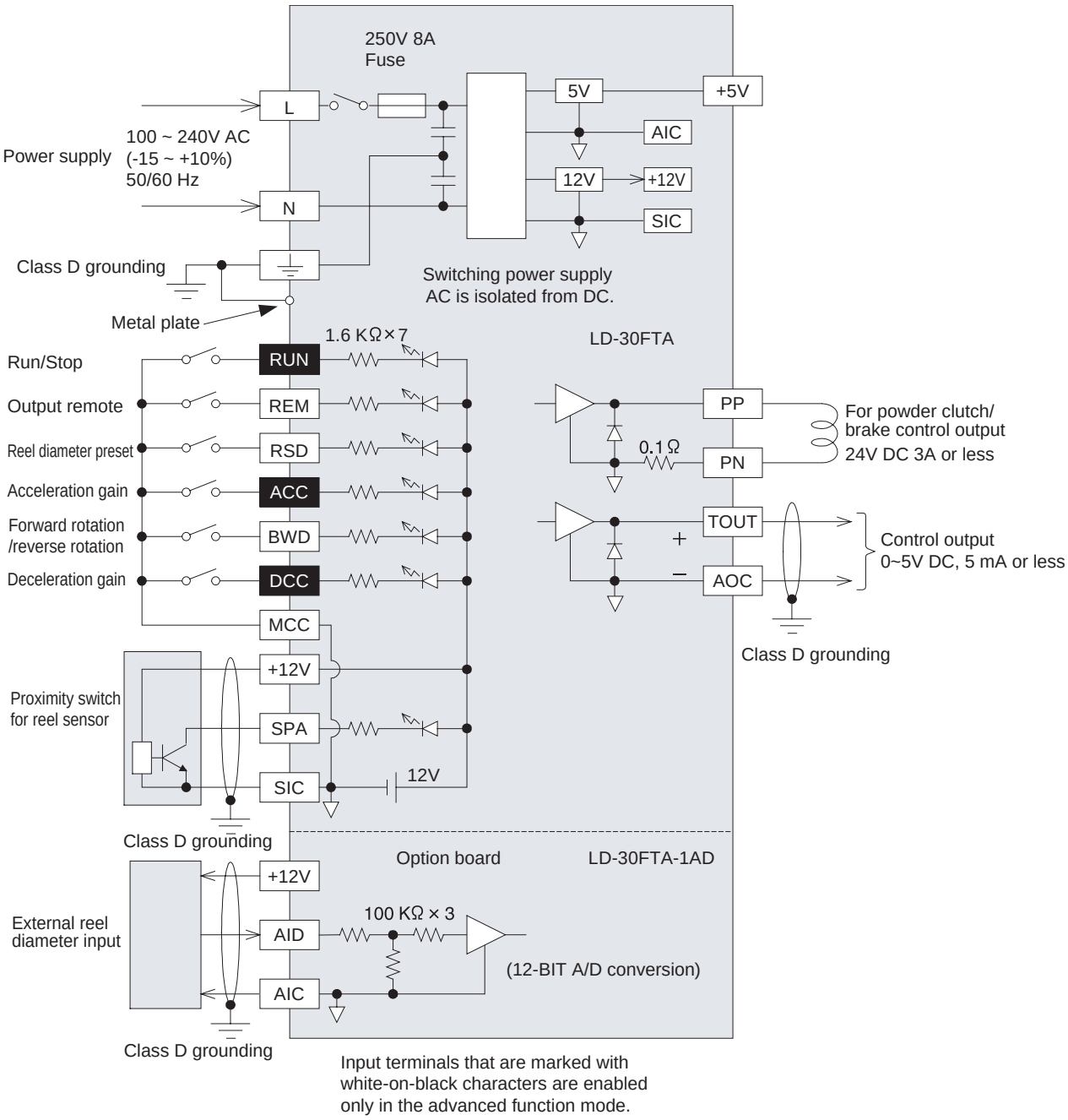
■Major specifications

Specification item		Specification	
Power supply	Input	100~240V AC (-15 ~ +10%) 50/60 Hz Power consumption 300VA Power supply fuse 250V 8A Built-in Rush current 30A 300 ms	
	Output	Power supply for sensor ..... 12V DC 100 mA or less	
Pulse signal	Input	Reel pulse ..... Open collector signal 12V DC 7 mA Response frequency: 300 Hz or less Settable to 1, 2, 4, or 8 pulse(s) per reel rotation	
Contact signal	Input	Run/Stop ..... ON: Run, OFF: Stop Output remote ..... ON: Signal is output. OFF: Signal output is stopped. Reel diameter reset..... Resets the reel diameter while contact signal is ON Acceleration gain ..... Effective while contact signal is ON Forward rotation/reverse rotation. ON: Reverse rotation, OFF: Forward rotation Deceleration gain ..... Effective while contact signal is ON	12V DC 7 mA / input Internal power feed
Analog signal	Input	External reel diameter input ..... 0~10V (When a LE-30FTA-1AD model option board is used) Ultrasonic sensor, potentiometer for touch lever etc.	
	Output	Power amplifier output ..... 24 V DC, 3A or less Control signal output ..... 0~5V DC 5 mA or less Load resistance: 1 KΩ or more	
Mass		Approximately 3.5 kg	
Mounting method		Floor, wall, and panel mounting	
Environmental specifications	Operating ambient temperature	0 ~ 40°C	
	Operating ambient humidity	35 ~ 85% RH (Non-condensing)	
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (4.9 m/s^2 allowable) Two hours each in three axial directions	
	Shock resistance	Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions	
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width 1μs Tested using a noise simulator with a frequency range of 30 to 100 Hz	
	Voltage endurance	1500V AC One minute (Between all terminals connected together and the ground terminal)	
	Insulation resistance	5 MΩ or more when measured with a 500V DC megger	
	Grounding	Class D grounding	
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep out of water such as rain.	
Major functions		Reel diameter detection: Integrated thickness monitoring method, external analog signal (ultrasonic sensor etc.) Tension control: Constant tension control, taper tension control (linear) Control functions: Stop timer, stop gain, stop bias, acceleration/deceleration gain, mechanical loss compensation, and weak excitation Torque Compensation for nonlinearity 5-stage non-linear control. Setting made by entering the correction number for each clutch/brake.	

■Parameter table

Setting items	Setting items		Initial value	Unit	Function mode
	Minimum	Allowable			
Tension	0	100	–	%	Easy/Advanced function mode
Material thickness	1/0.1	9,999/999.9	50	μm	Easy/Advanced function mode
Initial reel diameter	1	2,000	500	mm	Easy/Advanced function mode
Tape tension rate	0	100	100	%	Advance function
Stop timer	0.0	100.0	0.0	sec	Advance function
Stop gain	5	400	100	%	Advance function
Stop bias	0	50	0	%	Advance function
Deceleration gain	5	400	100	%	Advance function
Acceleration gain	5	400	100	%	Advance function
Mechanical loss	0	50	0	%	Advance function
Low excitation	0	50	0	%	Advance function
Reel pulse	1, 2, 4, 8		1	–	Advance function
Nonlinearity correction	0	200	0	–	Advance function
Minimum reel diameter	1	Allowable reel diameter setting value	100	mm	Easy/Advanced function mode
Allowable reel diameter	Minimum reel diameter setting value	2,000	500	mm	Easy/Advanced function mode

External connection



Terminal arrangement

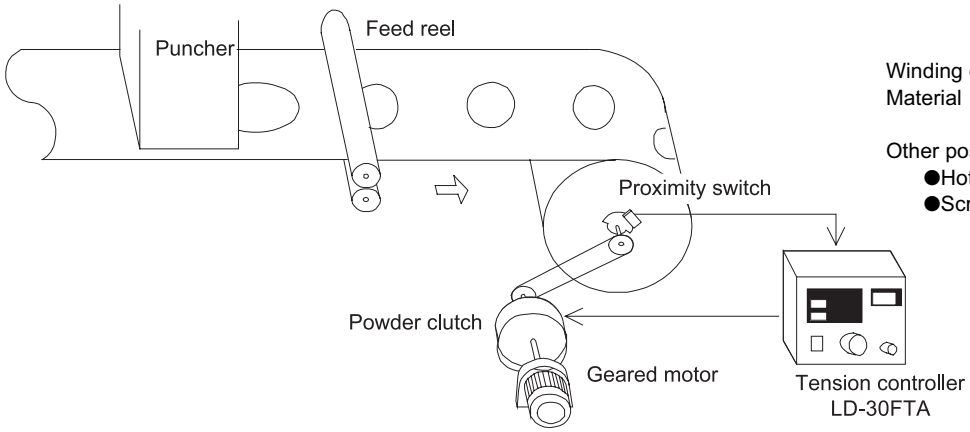
L	·	N	·	·	·	PP	RUN	RSD	BWD
⏚	·	·	·	·	PN	MCC	REM	ACC	DCC

·	+12V	SPA	+5V	·	·	TOUT	·	LSA	LSB
·	SIC	·	AIC	AID	·	AOC	·	LSG	·

LSA, LSB, and LSG are not used.

■Sample usage: using a proximity switch

Shown below is an example of winding control in an application in which material advancing is intermittent and is stopped while the material is being punched out.
Although material advancing is intermittent, the motor rotates continuously, and the tension is applied constantly using the slipping clutch.



Winding diameter: D = ø92→ø500 mm
Material : Paper (Thickness 200μm)

Other possible usage
●Hot stamping
●Screen-printing

1. Dipswitch setting (Required only at initial setting. Not required during normal operation)

	1	2	3	4	5	6	7	8
ON	Unwinding	× 1	Disabled	Disabled		Normal	Basic	Run
DIP switch	Control axis	Unit of thickness	Reel diameter input	Output remote	(No function assigned)	Memory initialization	Function mode	Operation mode
OFF	Winding	× 0.1	Enabled	Enabled		Initialize	Advanced function	Adjust

(Initial setting)

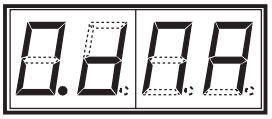
	1	2	3	4	5	6	7	8
ON	Unwinding	× 1	Disabled	Disabled		Normal	Basic	Run
DIP switch	Control axis	Unit of thickness	Reel diameter input	Output remote	(No function assigned)	Memory initialization	Function mode	Operation mode
OFF	Winding	× 0.1	Enabled	Enabled		Initialize	Advanced function	Adjust

* Set the dip switch to "RUN" to perform an operation.

2. Allowable reel diameter setting procedures (Required only at initial setting. Not required during normal operation)

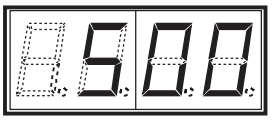
1) Select "Allowable Diameter" with the Setting Item Selection key ⑧, and enter "ø 500" with the setting dial.
2) Set the operation mode of the dipswitch #8 to "RUN," and turn the power back on.

●Allowable reel diameter display



μm

●Reel diameter display



ϕ

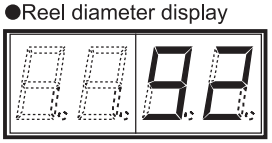
3. Setting procedures (Setting is required only when the material is changed.)

1) Press the "Material Thickness Setting" key ⑦, and enter the material thickness "200μm" with the setting dial.
2) Press the "Initial Reel Diameter Setting" key ④, and enter the reel diameter "ø 92" with the setting dial.
3) Press the "Reel Diameter Reset" key for 1 second③.

●Material thickness display

μm

●Reel diameter display



ϕ

4. Test run procedures (Required only at initial setting. Not required during normal operation)

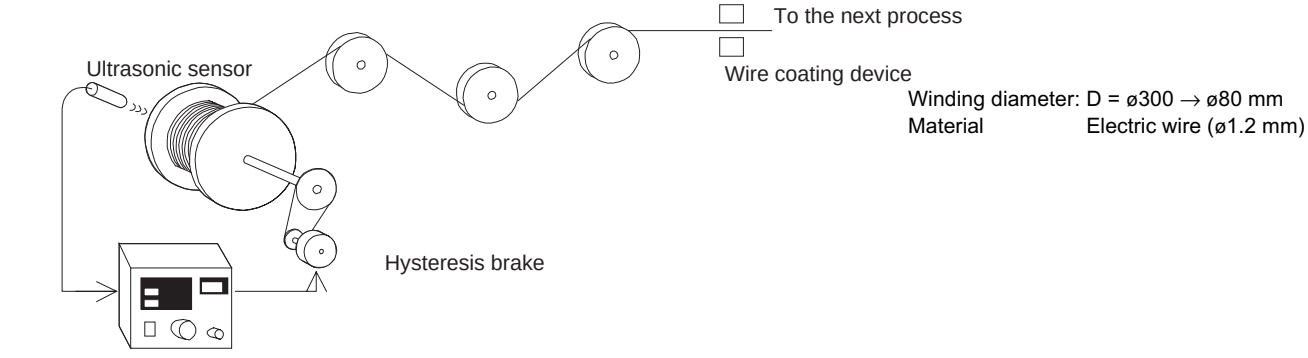
1) Press the "Manual Mode Selection" key, and turn on the output ON/OFF switch.
2) Check the functions of the connected devices such as the motor and PLC.

5. Automatic operation procedure

1) Press the "Automatic Control Mode Selection" key.
2) Adjust the tension with the tension-setting dial.

■Sample usage: using an ultrasonic sensor

Shown below is a sample application in which wire is unwound and passed to the coating process. In this application, a proper amount of tension is being applied to keep the wire from loosening.
Because this is an open loop control system, there is no need to worry about hunching.
Reel diameter is monitored with an ultrasonic sensor, and it is not necessary to set the initial reel diameter or wire thickness.



1. Dipswitch setting (Required only at initial setting. Not required during normal operation)

	1	2	3	4	5	6	7	8
ON	Unwinding	×1	Disabled	Disabled		Normal	Basic	Run
DIP switch	Control axis	Unit of thickness	Reel diameter input	Output remote	(No function assigned)	Memory initialization	Function mode	Operation mode
OFF	Winding	×0.1	Enabled	Enabled		Initialize	Advanced function	Adjust

(Initial setting)

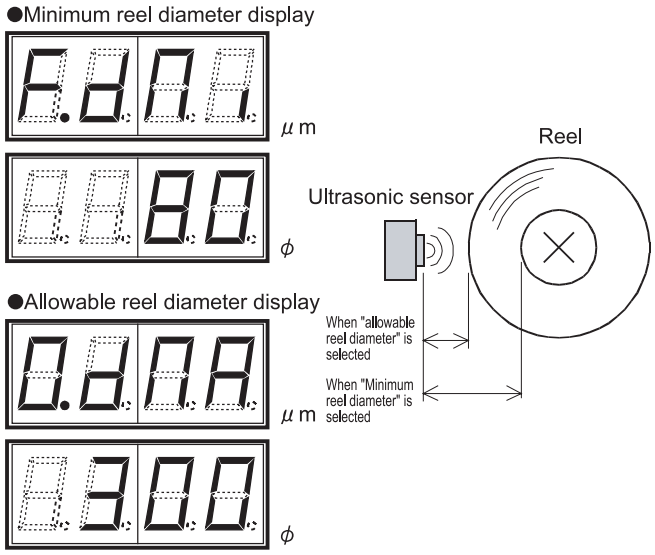
	1	2	3	4	5	6	7	8
ON	Unwinding	×1	Disabled	Disabled		Normal	Basic	Run
DIP switch	Control axis	Unit of thickness	Reel diameter input	Output remote	(No function assigned)	Memory initialization	Function mode	Operation mode
OFF	Winding	×0.1	Enabled	Enabled		Initialize	Advanced function	Adjust

* Set the dip switch to "RUN" to perform an operation.

2. Teaching operation (Required only at initial setting. Not required during normal operation)

1) Select "Minimum Reel Diameter" with the "Setting Item Selection" key, set the minimum diameter to "ø 80" with the setting dial, install a reel with a diameter of ø 80, and press the "Reel Diameter Reset" key.

2) Select "Allowable Reel Diameter" with the "Setting Item Selection" key, set the allowable diameter to "ø 300" with the setting dial, install a reel with a diameter of ø 300, and press the "Reel Diameter Reset" key.



3) Set the operation mode of the dipswitch #8 to "RUN," and turn the power back on.

3. Manual operation procedures (Required only at initial setting. Not required during normal operation)

1) Press the "Manual Mode Selection" key, and turn on the output ON/OFF switch.
2) Check the functions of the connected devices such as the motor and PLC.

4. Automatic operation procedure

1) Press the "Automatic Control Mode Selection" key.
2) Adjust the tension with the tension-setting dial.

LE-50PAU-SET model semi-automatic tension controller

The LE-50PAU-SET model of tension controller is a semi-automatic tension controller that consists of the LE-50PAU model of amplifier and the LE-5AP model of operator panel that uses the speed/thickness (sensor-less) or integrated thickness monitoring method (requires a reel sensor).

■Operating principles

- **Speed/thickness method**

  In this method, output from the power amplifier is controlled according to the change in the reel diameter that is calculated by setting the initial reel diameter, average operation speed (line speed), and material thickness and using the operation time as the variable.

- **Integrated thickness monitoring method**

  In this method, output from the power amplifier is controlled according to the change in the reel diameter that is calculated by setting the initial reel diameter and material thickness and by receiving the pulse signal from the reel sensor that is installed on the reel.

■Main features

- **Compensation for clutch/brake torque nonlinearity**

  The powder clutch's/brake's non-linear transmission torque to exciting current characteristic is compensated in five stages. In this way, fluctuation of tension caused by the change in reel diameter can be minimized.

- **Supports both constant-current and constant-voltage control**

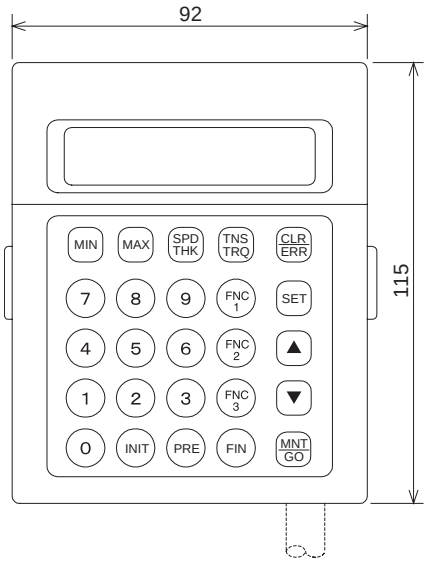
  Both constant-current and constant-voltage control are supported (Setting is adjusted with the built-in DIP switch). Constant-current control can eliminate the effects of torque fluctuations that are caused by a rise in powder clutch/brake coil temperature and enable more stable tension control.

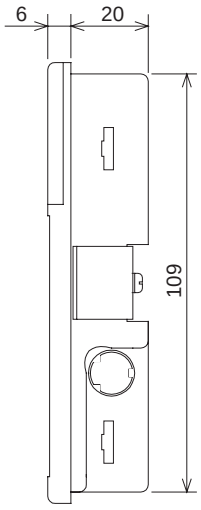
- **Taper control**

  By setting two intermediate diameters in addition to setting the minimum and allowable reel diameters, three-stage taper tension is possible.

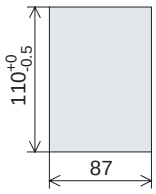
■External dimensions

LE-5AP-E operator panel





Panel cut dimensions



Units : mm
Outer color : Munsell 7.5Y 7.5/1
Accessory : Mounting metal fittings 1 set
Connecting cable 1 pc (3 m)

Refer to page B-42 for information on the LE-50PAU model power amplifier.

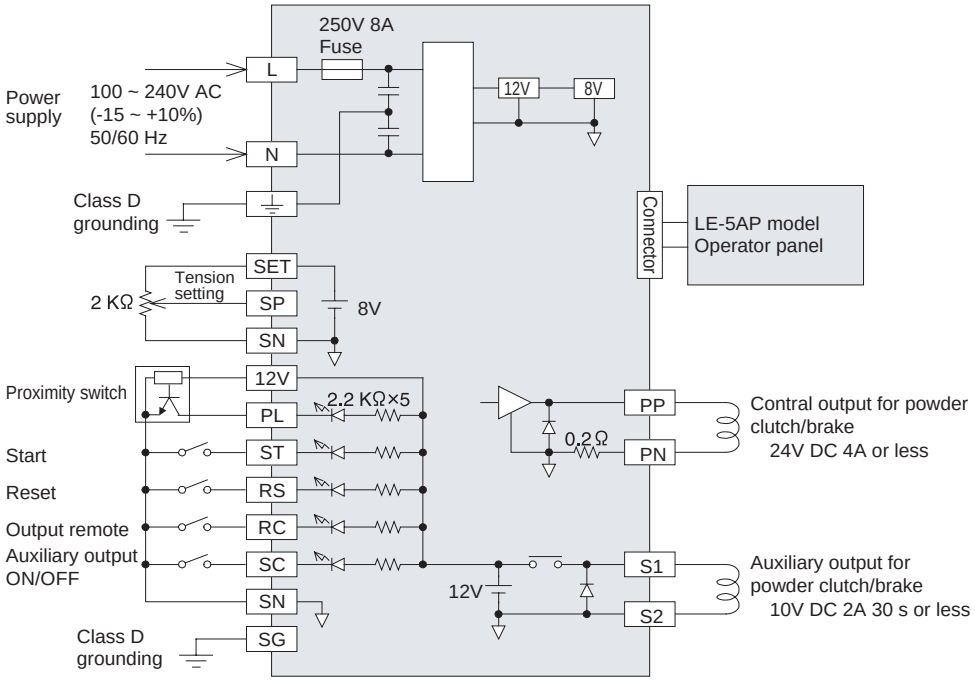
■Setting item table

Setting items		Unit	Setting range	Initial value	Setting items		Unit	Setting range	Initial value
Material thickness		μm	0.1 ~ 3,276.7	0	Line speed		m/min	1 ~ 999	0
Taper control characteristics	Minimum reel diameter	mm	1 ~ 1,999	0	Torque compensation	10% torque	%	1.0 ~ 99.9	10
	Small diamter	mm	1 ~ 1,999	0		20% torque	%	1.0 ~ 99.9	20
	Large diamter	mm	1 ~ 1,999	0		40% torque	%	1.0 ~ 99.9	40
	Allowable reel diameter	mm	1 ~ 1,999	0		80% torque	%	1.0 ~ 99.9	80
	Minimum diameter tension	%	20 ~ 500	100	Stop control	Stop gain	%	0 ~ 300	100
	Small diameter tension	%	20 ~ 500	0		Stop bias	%	0 ~ 60	0
	Large diameter tension	%	20 ~ 500	0		Stop timer	s	0 ~ 30	10
	Allowable diameter tension	%	20 ~ 500	100	Auxiliary output timer		s	0 ~ 30	10

Major specifications

Specification item		Specification	
Power supply	Input	100~240V AC (-15 ~ +10%) 50/60 Hz Power consumption 400VA Power supply fuse 250V 8A Built-in Rush current 50A 300 ms	
	Output	Power supply for variable resistor... 8V DC Variable resistor resistance: 2 KΩ or more Power supply for reel sensor..... 12V DC, 15 mA or less	
Pulse signal	Input	Reel pulse ..... Open collector signal 12V DC 7 mA Response frequency: 250 Hz or less	
Contact signal	Input	Start..... When the signal changes from ON to OFF, the stop timer is triggered, and inertia-compensated operation is performed. Reset..... Resets the reel diameter calculation when the start signal is OFF and the reset signal is ON Output remote ..... ON: Signal is output, OFF: Signal output is stopped Auxiliary output ON/OFF ..... ON: Auxiliary output is ON	12V DC 5 mA/one input Internal power feed
Analog signal	Input	Tension setting signal..... 0 ~ 8V Internal resistance 22 KΩ	
	Output	Power amplifier output ..... 24V DC 4A or less Auxiliary output..... 10V DC 2A or less 30 seconds Load resistance: 4.8 Ω or more	
Mass		Power amplifier ..... Approximately 2.5 kg Operator panel ..... Approximately 200 g	
Mounting method		Power amplifier ..... Floor and wall mounting Operator panel ..... Panel mounting	
Major functions		Reel diameter detection ..... Speed/thickness method, integrated thickness monitoring method Tension control ..... Constant tension, taper tension (three-stage) Control function ..... Constant-current/constant-voltage control, compensation function for torque nonlinearity, stop timer, stop gain, stop bias	
Environmental specifications	Operating ambient temperature	Power amplifier ..... 0 ~ 55°C Operator panel ..... 0 ~ 50°C	
	Operating ambient humidity	35 ~ 85% RH (Non-condensing)	
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (19.6 m/s^2 allowable) Two hours each in three axial directions	
	Shock resistance	Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions	
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width 1μs Tested by a noise simulator with a frequency range of 30 to 100 Hz	
	Voltage endurance	1500V AC One minute	·Power amplifier only ·Between all terminals connected together and the unit body
	Insulation resistance	5 MΩ or more when measured with a 500V DC megger	
	Grounding	Class D grounding	
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep out of water such as rain.	

External connection



Terminal arrangement

⏚	·	SET	SP	SN	ST	SC	PL	12V	·	S2	S1	
L	N	·	SN	SG	RS	SN	RC	SN	·	PN	PP	

LD-05TL model tension controller for touch lever

The LD-05TL tension controller is powered by a general 24V DC stabilizing power supply and controls winding/unwinding tension by receiving an analog reel diameter signal from devices such as a potentiometer that are interlocked with the touch lever. It has a separate reel diameter signal processing block and a constant-current (constant-voltage) amplifier block, making it possible to be used as an amplifier only.
This model of controller is used in combination with a powder clutch/brake that is rated at 24V DC 0.5A or less.

■Main features

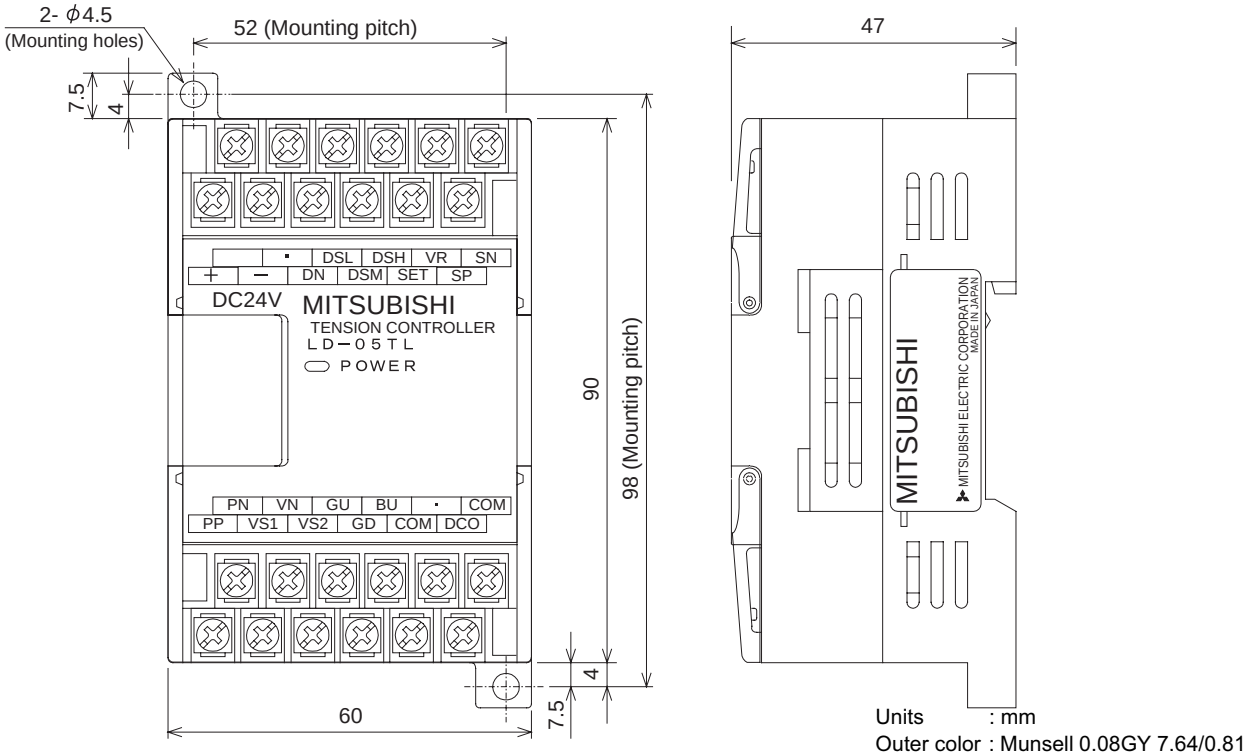
- Tension controller with a touch lever
  Allows for tension control with a touch lever using a potentiometer.
  Automatic operation is possible only by adjusting the tension setting on the external variable resistor.
- Usable as a power amplifier for the powder clutch/brake
  Through the combined use with a PLC or other types of controllers, this model can be used as a power amplifier for a powder clutch/brake or hysteresis clutch/brake.
- Stable output characteristics against temperature fluctuations
  Constant-current control provides stable torque. (Constant-voltage control is also possible.)
- Proper material tension is maintained during stoppage
  Inertia is compensated by the external contact signal such as output increase, output decrease, and output addition.

■Specifications

Specification item		Specification	
Power supply		24V DC ±15%	
Analog signal	Input	Reel diameter signal .....Input one of the voltage signals below between the minimum and allowable diameters. 0 ~ 5V Internal resistance: 50 KΩ 0 ~ 8V Internal resistance: 80 KΩ 0 ~ 10V Internal resistance: 100 KΩ Tension-setting signal .....0 ~ 5V Internal resistance: 200 KΩ	
	Output	Control output .....To the tension-setting signal of 0 to 5V Current output .....0 ~ 0.5A DC (In the constant-current control mode) Voltage output .....0 ~ 22V DC (In the constant-voltage control mode)	
Contact signal	Input	Output compensation signal ・For output increase: Multiplication coefficient can be set between approximately 100 and 500%. ・For output decrease: Multiplication coefficient can be set between approximately 0 and 500%. ・For output addition: Approximately 0 ~ 0.1A (while constant-current controlled) Output addition of approximately 0 ~ 4.4V (while constant-voltage controlled) Constant-voltage/constant-current switching signal	24V DC 7 mA / input
	Output	Reel diameter detection output ・ON when less than or equal to the preset reel diameter Open collector output 30V DC 0.2A or less	
Mass		Approximately 220 g	
Mounting method		With two M4 screws or on a 35 mm-wide DIN rail	
Environmental specifications	Operating ambient temperature	0 ~ 55°C	
	Operating ambient humidity	35 ~ 85% RH or less (Non-condensing)	
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (19.6 m/s^2 allowable) Two hours each in three axial directions X, Y, and Z	
	Operating environments	Free of corrosive gas, flammable gas, or dust. Keep out of water such as rain.	

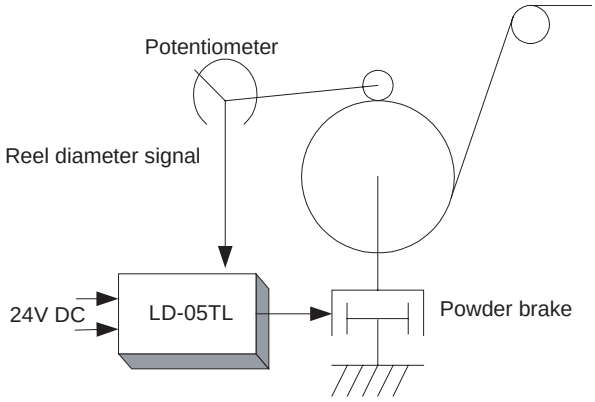
Note: The allowable output voltage of this product is approximately 20.5V (85% of rated voltage) or more at the power supply voltage of 24V, or 17.5V (72% of rated voltage) at 20.4V (24V-15%). Select a clutch or brake that has sufficient torque capacity.

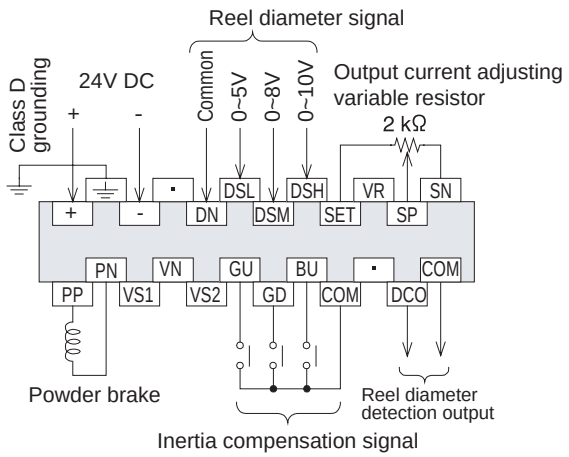
External dimensions



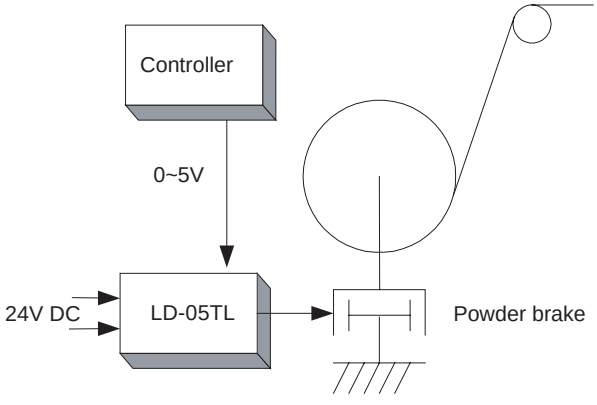
External wiring

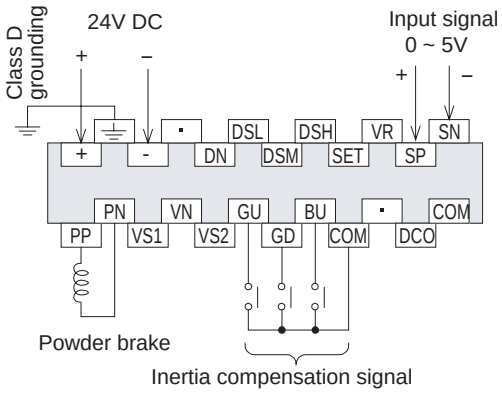
- Controlling tension with the potentiometer installed on a touch lever





- Controlling tension by using the LD-05TL as a power amplifier that receives an external analog voltage signal





LE-50PAU model power amplifier

The LE-50PAU power amplifier is used to control the electromagnetic current to the powder clutch/brake or hysteresis clutch/brake. It can also be used as a manual power supply or as a power amplifier for a semi-automatic or automatic tension controller.

Main features

- **Supports both constant-current and constant-voltage control**

  Both constant-current and constant-voltage control are supported (Setting is switched with the built-in DIP switch). Constant-current control can eliminate the effects of torque fluctuations that are caused by a rise in powder clutch/brake coil temperature and enable more stable tension control.
  In a system with multiple powder clutches/brakes that are connected in parallel in which the current is distributed by a variable resistor, constant voltage-control allows for easier adjustment than constant-current control does.

- **Compensation for clutch/brake torque nonlinearity**

  The powder clutch's/brake's non-linear transmission torque to exciting current characteristic is compensated in five stages. Fluctuation of tension that is caused by the change in reel diameter can be minimized.

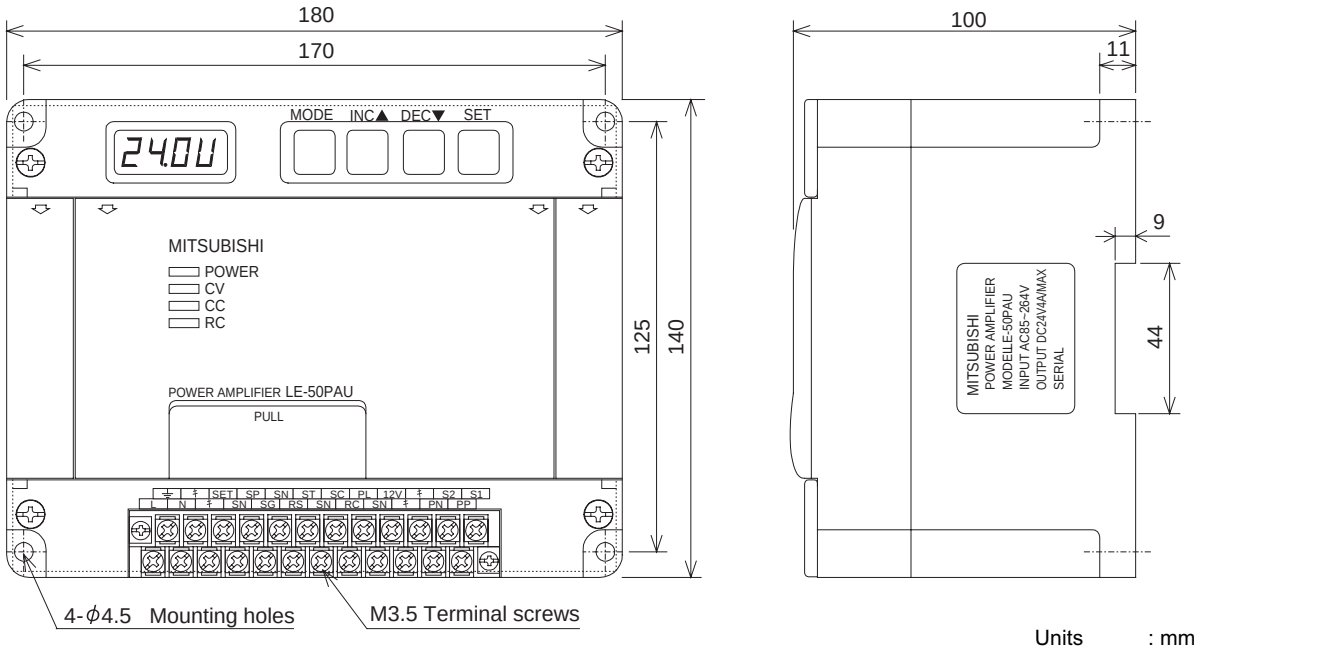
- **Variable input signal level setting**

  Input signal voltage level can be set to 0 ~ 5V, 0 ~ 8V, or 0 ~ Vmax (Vmax can be set to a level between 0.5 and 8V.)

- **Built-in setting display functions**

  Four-digit LED display, four push buttons, and ten-position dipswitches allows for easy setting of input signal level, output full-scale value, and nonlinearity compensation data.
  Inertia compensation or output can also be displayed during control.

External dimensions

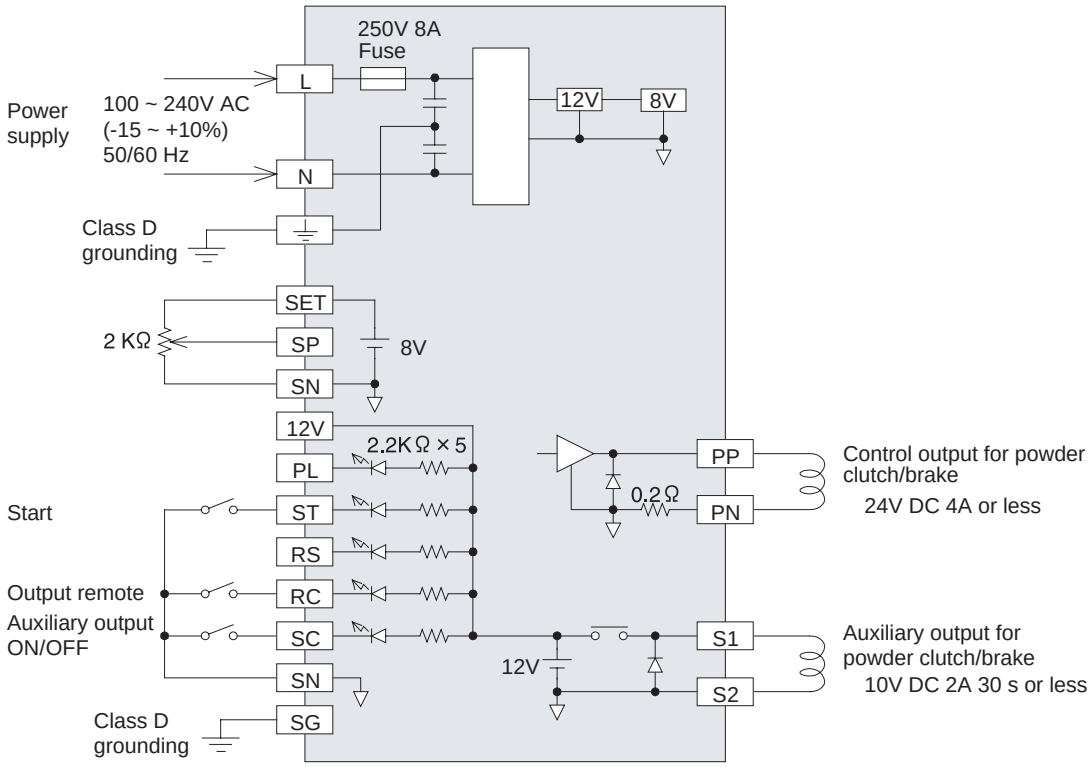


Units : mm
Outer color : Munsell 7.5Y 7.5/1

■ Major specifications

Specification item		Specification	
Power supply	Input	100 ~ 240V AC (-15 ~ +10%) 50/60 Hz Power consumption 400VA Power supply fuse 250V 8A Built-in Rush current 50A 300 ms	
	Output	Power supply for variable resistor 8V DC Variable resistor resistance: 2 KΩ or more Power supply for reel sensor..... 12V DC, 15 mA or less	
Contact signal	Input	Start..... When the signal changes from ON to OFF, the stop timer is triggered, and inextra-compensation is performed. Output remote ..... ON: Signal is output, OFF: Signal output is stopped Auxiliary output ON/OFF ..... ON: Auxiliary output is ON	12V DC 5 mA / input Internal power feed
Analog signal	Input	Control signal ..... 0 ~ 8V Internal resistance 22 KΩ	
	Output	Power amplifier output ..... 24V DC 4A or less Auxiliary output..... 10V DC 2A or less 30 seconds Load resistance: 4.8 Ω or more	
Mass		Approximately 2.5 kg	
Mounting method		Floor and wall mounting	
Major functions		Constant-current/constant-voltage control, compensation function for torque nonlinearity, stop timer, stop gain, stop bias	
Environmental specifications	Operating ambient temperature	0 ~ 55°C	
	Operating ambient humidity	35 ~ 85% RH (Non-condensing)	
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (19.6 m/s^2 allowable) Two hours each in three axial directions	
	Shock resistance	Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions	
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width 1μs Tested by a noise simulator with a frequency range of 30 to 100 Hz	
	Voltage endurance	1500V AC One minute	Between all terminals connected together and the unit body
	Insulation resistance	5 MΩ or more when measured with a 500V DC megger	
	Grounding	Class D grounding	
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep out of water such as rain.	

■ External connection



■ Terminal arrangement

⏚	·	SET	SP	SN	ST	SC	PL	12V	·	S2	S1

L	N	·	SN	SG	RS	SN	RC	SN	·	PN	PP

LD-40PSU model manual power supply device

The LD-40PSU manual power supply device is a constant-voltage controlled power supply device for the powder clutch/brake and hysteresis clutch/brake. Voltage is controlled with the dial on the panel, external signal voltage, or external variable resistor.

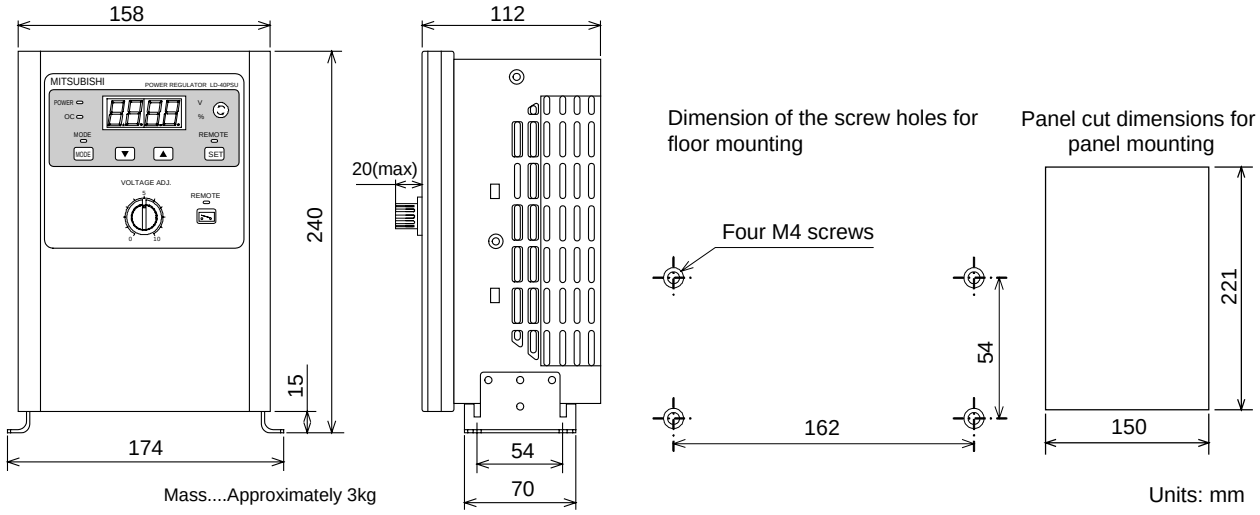
■Main features

- External control signal (remote ON/OFF)
  With an external signal of 0~5V, output voltage can be controlled remotely in the range of 0~24V.
- Output ON/OFF function
  Output can be turned on or off with the buttons on the panel or by using the external remote contact signal (RC signal).
- Inertia compensation function
  In the manual tension control mode, stop timer operation and inertia compensated output in response to the RC signal are possible.
- Load short-circuit protection/warning
  The short-circuit protection circuit is triggered by a load short-circuiting. The LED on the panel turns on when the circuit is triggered.
- Two-level output setting
  This device can be set to supply two different levels of output voltage: one with and the other without RC input.
  The one without the RC input can be set to provide weak excitation etc.

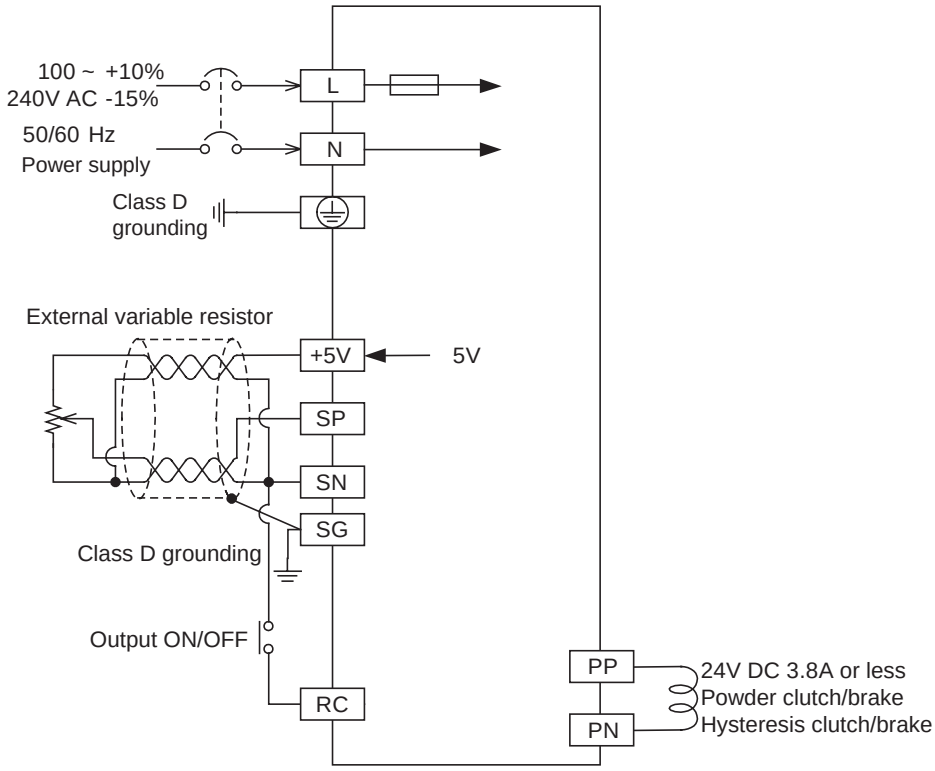
■Major specifications

Specification item		Terminal	Specification
Power supply		L/N	100~240V AC (+10%, -15%) 50/60 Hz Power consumption: 200VA (At 24V DC, 3.8A)
Output	Power amplifier output	PP/PN	24V DC 3.8A or less
	Power supply for variable resistor	+5V/SN	5V DC 10 mA or less External variable resistor 500 ~ 2 KΩ
Input	Analog signal	SP/SN	Input signal for control 0 ~ 5V DC
	Contact signal	RC/SN	Remote output ON/OFF 12V DC/mA Internal power feed
Environmental specifications	Ambient temperature	-5 ~ +55°C	
	Ambient humidity	35 ~ 85% RH (Non-condensing)	
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (4.9 m/s^2 allowable) .... Two hours each in three axial directions	
	Shock resistance	Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions	
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width 1μs Tested by a noise simulator with a frequency range of 30 to 100 Hz	
	Voltage endurance	1500V AC One minute Measured between all terminals (except the ground terminals) connected together with the ground terminal, and all terminals (except the ground terminals) connected together with the mounting metal fitting	
	Insulation resistance	5 MΩ or more when measured with a 500V DC megger....Between all terminals connected together and the unit body	
	Grounding	Class D grounding (100 Ω or less, Not to be grounded together with the strong-current system)	
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep out of water such as rain.	

External dimensions



External connection



Terminal arrangement

L	▪	N	▪	⏚	SG	RC	SN	SP	+5V	PN	PP

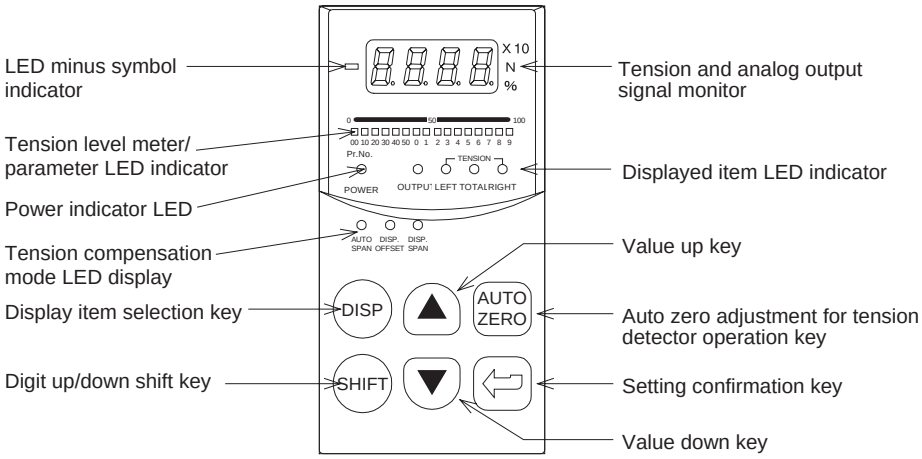
LM-10PD model tension meter

The LM-10PD tension meter displays the winding, unwinding, and intermediate tension in applications that handle paper, wires, and various sheet-like materials by receiving signals from the LX-TD tension detector or a distortion gauge sensor as well as outputs amplified signals to devices such as a recorder, external tensiometer, or PLC.

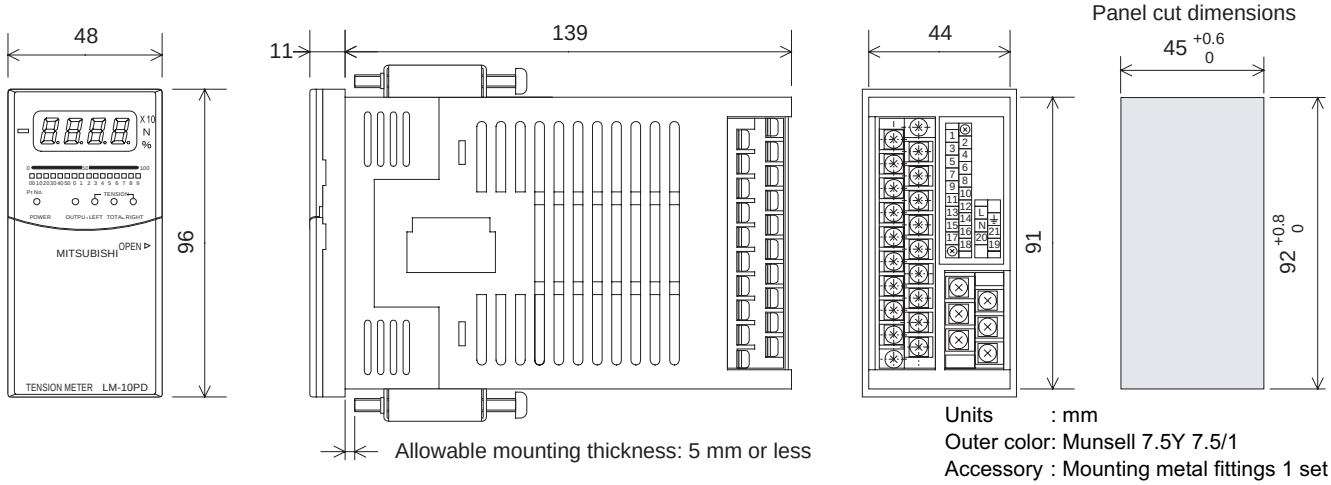
Main features

- Significantly smaller and lighter than the older version. Volume, panel area, and mass are 41%, 40%, and 30% of the older version, respectively.
- Auto zero/auto span adjustment
  Auto zero/span adjustment of the tension detector with the touch of a button.
- Digitally set parameters
- Upper and lower limit of tension detection (two detection points)
- Peak tension memory function
- Usable in combination with a strain gauge sensor
- Individually adjustable output filters
- Manual offset/span adjustment for display and output is possible

Components of the operation panel

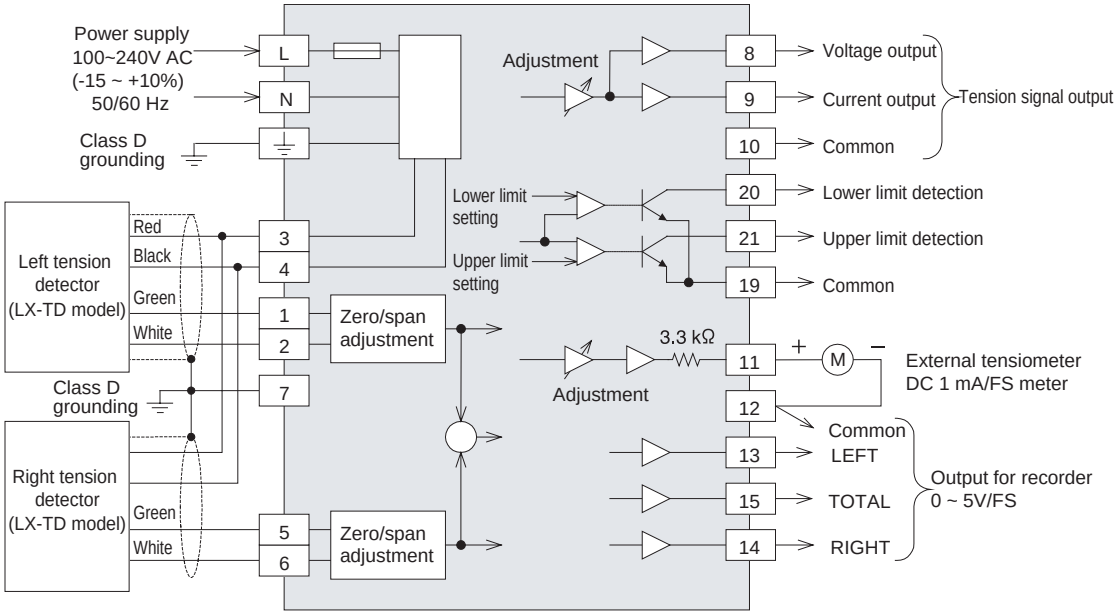


External dimensions

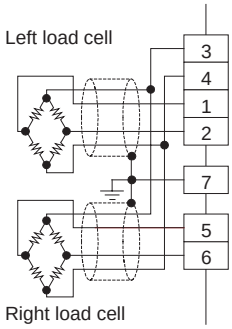


Units : mm
Outer color: Munsell 7.5Y 7.5/1
Accessory : Mounting metal fittings 1 set

External connection



In the case of a distortion gauge tension detector



Major specifications

Specification item		Specification
Power supply voltage		100~240V AC (-15 ~ +10%) 50/60 Hz Power consumption 50VA
Tension signal output		0 ~ 5V, 0 ~ 10V, Switchable between 1 ~ 5V/FS (Load resistance of 1 KΩ or more) and 4 ~ 20 mA/FS (Load resistance of 500 Ω or less)
Tension detection output		Upper/lower limit tension detection (2 points) Open collector output 30V DC/0.5A or less
External tensiometer		DC 1 mA/FS meter (Internal resistance:1.5 KΩ or less)
Output for recorder		0 ~ 5V to full-scale tension (Load resistance 10 KΩ or more)
Tension display		Four-digit seven-segment digital LED display. Full-scale can be set to a range between 0.01 and 20000 N, Unit display selection between [N] and [x10N]. Level meter display with 16 LED indicators. Display selection between left, total, and right
Output display		Percentage display of analog output on the seven-segment LED display
Setting parameter display		Display of item numbers on the LED and display of set values on the seven-segment LED display
Environmental specifications	Operating ambient temperature	0 ~ 55°C.....During operation
	Operating ambient humidity	35 ~ 85% RH or less (Non-condensing).....During operation
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (4.9 m/s^2 allowable) Two hours each in three axial directions X, Y, and Z
	Shock resistance	Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions X, Y, and Z
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width 1μs Tested by a noise simulator with a frequency range of 30 to 100 Hz
	Voltage endurance	1500V AC One minute: Between all terminals connected together with the case, and between the power supply terminal and input-output terminal 500V AC One minute: Between open collector output and input-output terminal (Input terminal is not isolated from output terminal)
	Insulation resistance	5 MΩ or more when measured with a 500V DC megger (Between all terminals connected together with the case)
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust.
Mass		Approximately 500 g
Mounting method		Panel mounting

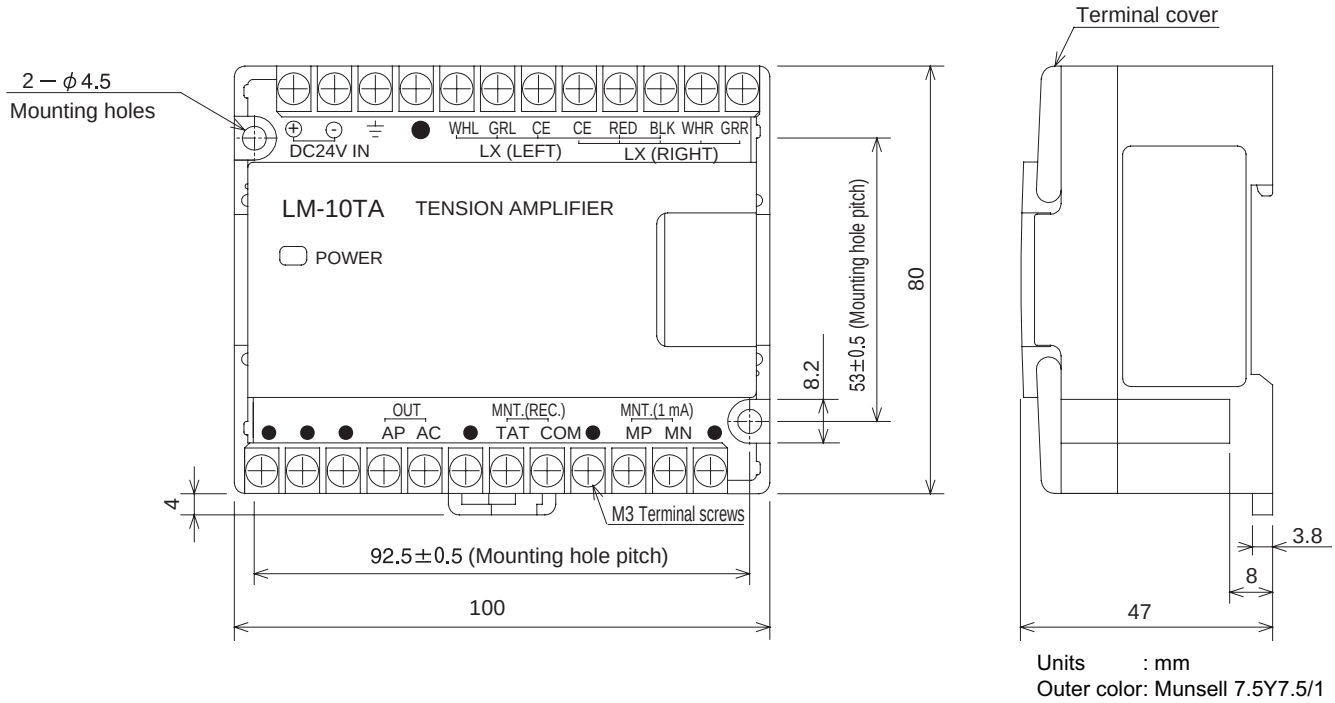
LM-10TA model tension amplifier

The LM-10TA tension amplifier is used in combination with the LX-TD tension detector and outputs signals that correspond to winding, unwinding, or countershaft tension (to the recorder, external tension meter, controller, etc.) in applications that handle paper, electric wire, or various sheet-like materials.

Main features

- **Smaller size**
  Compact profile made possible by supporting only absolutely necessary functions. It fits easily inside a control panel or in almost any space on a machine.
- **Various usage possibilities**
  Analog or digital display of tension by the addition of an external meter. Can also be used to input signals to the tension controller.
- **Ideal for centralized display**
  When used in combination with a PLC, this amplifier provides for a centralized display of tension in each process.
- **Easy remote display of tension**
  Easy remote display of tension with the use of an output signal (0 ~ 5 or 10V DC).
- **Easy recording of tension fluctuations**
  Tension data can be recorded by connecting a recorder and using recorder signals.
- **Installable on a DIN rail**

External dimensions

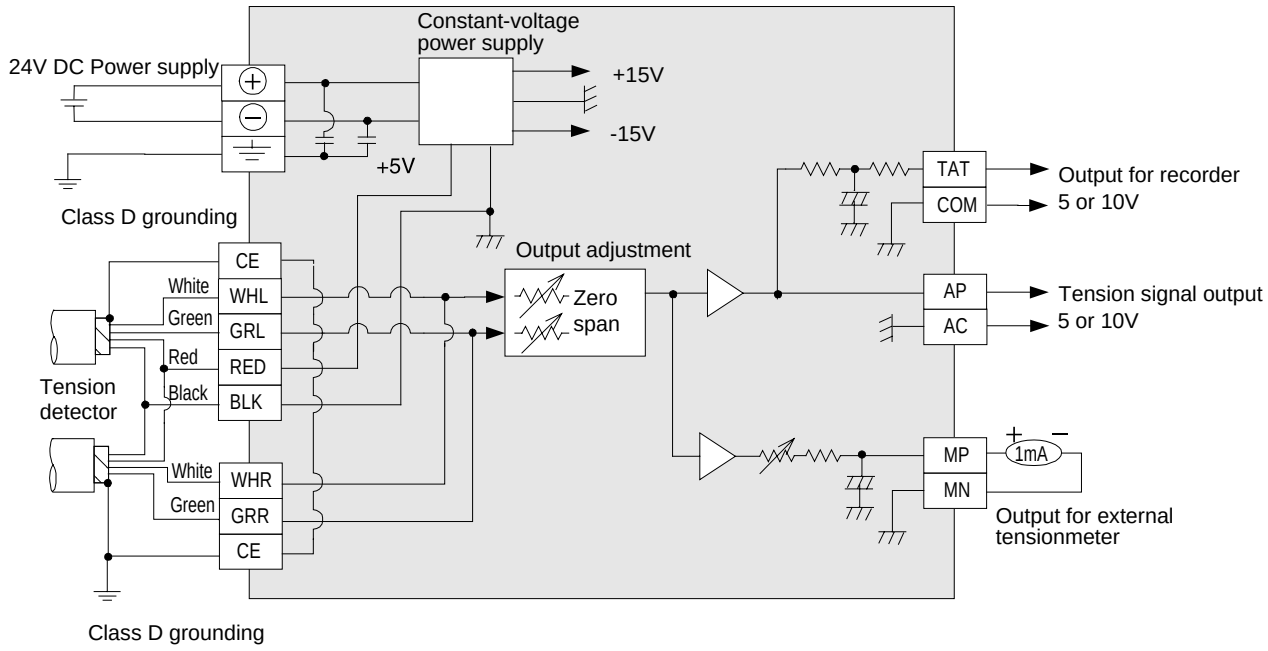


Units : mm
Outer color: Munsell 7.5Y7.5/1

■ Major specifications

Specification item		Specification
Power supply	input	24V DC ±15% Power consumption Approximately 0.2A
	Output	Power supply for tension detector .....Up to two LX-TD piece of tension detectors are connectable.
Output signal		Tension signal.....Adjustable range during tension scaling: (0~5) ~ (0~10)V DC Load resistance: 1 KΩ or more Signal to the recorder .....Adjustable range during tension scaling: (0~5) ~ (0~10)V DC Load resistance: 100 KΩ or more Signal to the external tensiometer.....DC 1mA ammeter Load resistance: 300 Ω or less
Variable resistor for adjustment		For zero/span adjustment (4 pcs.) For external tension meter (1 pc.) } Built into the opening
Mass		Approximately 200 g
Mounting method		With set screws or on the DIN rail
Environmental specifications	Operating ambient temperature	0 ~ 55°C
	Operating ambient humidity	35 ~ 85% RH (Non-condensing)
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (19.6 m/s^2 allowable) Two hours each in three axial directions
	Shock resistance	Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width1μs Tested by a noise simulator with a frequency range of 30 to 100 Hz
	Insulation resistance	5 MΩ or more when measured with a 500V DC megger
	Grounding	Class D grounding
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep out of water such as rain.

■ External connection



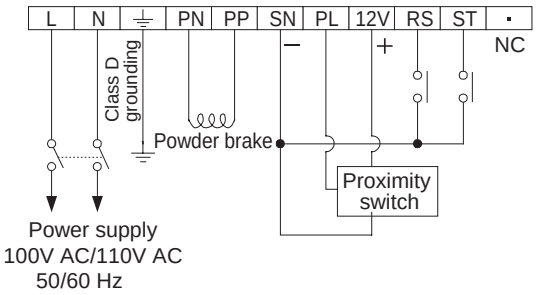
LD-05ZX model semi-automatic tension controller

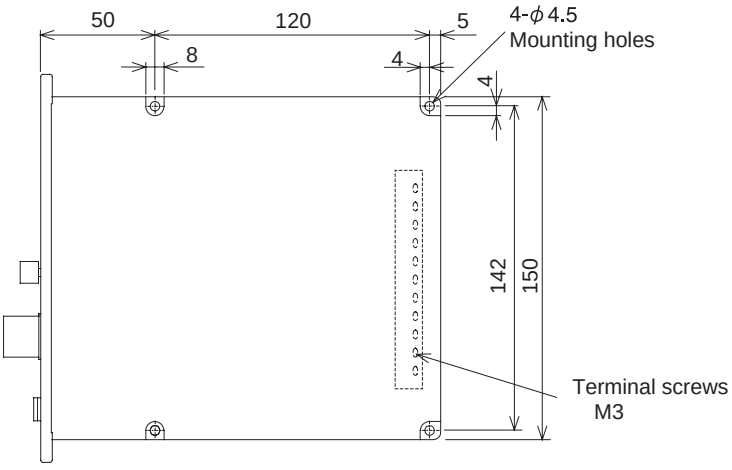
LD-05ZX is a semi-automatic tension controller for use with the ZX model of 80V powder brake.
This model is constant-current controlled and provides stable control.

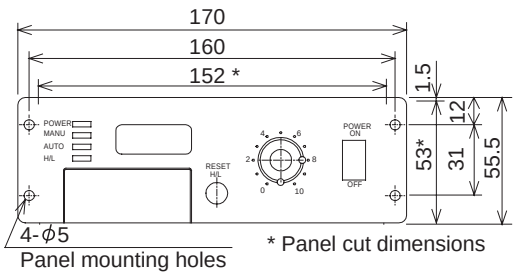
Main features

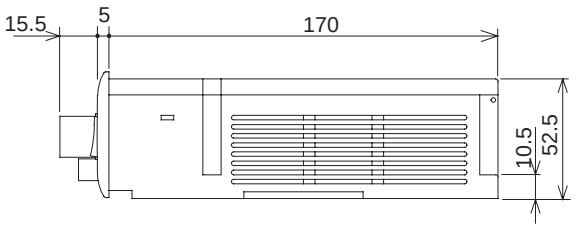
- **Constant-current controlled**
  Constant-current control can eliminate the effects of torque change that is caused by a rise in powder clutch/brake coil temperature and enable more stable tension control.
- **Compensation function for powder brake torque non-linearity**
  Features a built-in compensation function for the non-linear transmission torque to exciting current characteristic of the powder brake. Minimizes tension fluctuations that result from reel diameter variation (Applicable to ZX model 80V powder brake only).
- **Sensor-less semi-automatic control**
  Semi-automatic tension control with the use of reel pulse signal is possible (integrated thickness monitoring method).
  Sensor-less semi-automatic tension control is possible by entering the speed and thickness setting.
- **Allows taper tension control**
  Operating tension automatically changes according to the change in reel diameter.

External dimensions/external connections









Units : mm
Outer color: Munsell 7.5Y7.5/1

■ Major specifications

Specification item		Specification	
Power supply	Input	100/100/110V AC (-15 ~ +10%) 50/60/60 Hz Power consumption: 75VA Power supply fuse 250V 5A Built in	
	Output	Power supply for reel sensor.....12V DC 30 mA	
Rated output		80V DC 0.5A Select an appropriate allowable output current level that is appropriate to the powder brake, using the built-in switch • 0.12A.....ZX-0.3YN-80, ZX-0.6YN-80 • 0.16A.....ZX-1.2YN-80	
Contact input signal		Stop .....For inertia compensation during stoppage Reset.....For resetting reel diameter calculation	12V DC 10 mA / input
Pulse input signal		Reel pulse .....Open collector signal 12V DC 10 mA Response frequency: 250 Hz or less	
Function		Two types of semi-automatic tension control • Pulse/thickness setting method (reel sensor method) • Speed/thickness setting method (sensor-less) Taper tension control Compensation for torque nonlinearity of the powder torque (Automatically calculated from the allowable output current setting) Inertia compensation during stoppage Manual setting with the output variable resistor (manual power supply) • HIGH/LOW output setting selection	
Mass		Approximately 700g	
Mounting method		Floor standing, panel mounting	
Environmental specifications	Operating ambient temperature	0 ~ 55°C	
	Operating ambient humidity	35 ~ 85% RH (Non-condensing)	
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (19.6 m/s^2 allowable) Two hours each in three axial directions	
	Shock resistance	Conforms to JIS C0041 98 m/s^2 Three times each in three axial directions	
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width 1µs Tested by a noise simulator with a frequency range of 30 to 100 Hz	
	Insulation resistance	1500V AC one minute (Measured between power supply terminal and ground terminal)	
	Grounding	Class D grounding	
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep out of water such as rain.	

■ Setting item table

Setting items	Unit	Setting range	Initial value
Allowable output current	A	0.05 ~ 0.5	0
Initial reel diameter	mm	1 ~ 1999	0
Material thickness	µm	0.1 ~ 1999	0
Line speed	m/min	1 ~ 999	0
Reel pulse	Pulse/rev	0.1 ~ 10	1

	Setting items	Unit	Setting range	Initial value
Stop control	Stop gain	%	0 ~ 300	100
	Stop bias	%	0 ~ 60	0
	Stop timer	s	0 ~ 30	0
Taper ratio		%	20 ~ 500	100

LL-05ZX model manual power supply (for 80V DC powder brake)

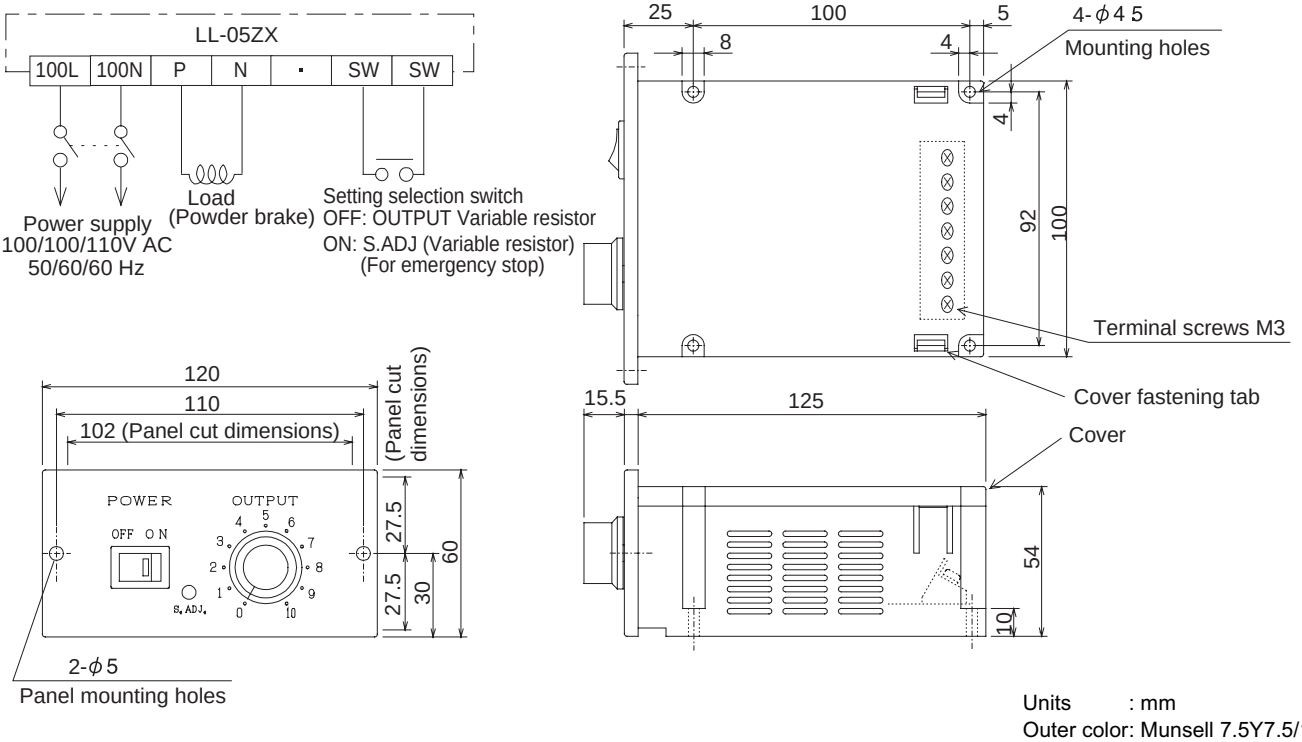
LL-05ZX is a constant-current controlled manual power supply for the ZX 80V powder brake.
Constant-current control provides stable powder brake torque.

■Major specifications

Specification item		Specification
Power supply		100/100/110V AC (-15 ~ +10%) 50/60/60 Hz Power consumption: 40VA Power supply fuse 250V 5A Built in
Rated output		80V DC 0.2A Select the appropriate allowable output current level that is appropriate to the powder brake, using the built-in switch • 0.12A.....ZX-0.3YN-80, ZX-0.6YN-80 • 0.16A.....ZX-1.2YN-80
Input signal		Switch signal for output switching 20V DC 13 mA
Function		Variable output current setting with the variable resistor for output setting Constant-current control output Inertia compensation output setting with an auxiliary variable resistor Switched with a switch input
Mass		Approximately 500 g
Mounting method		Floor and panel mounting
Environmental specifications	Operating ambient temperature	0 ~ 55°C
	Operating ambient humidity	35 ~ 85% RH (Non-condensing)
	Vibration resistance	Conforms to JIS C0040 10 ~ 55 Hz 0.5 mm (19.6 m/s^2 allowable) Two hours each in three axial directions
	Power supply noise resistance	Noise voltage 1000 Vp-p Noise width 1μs Tested by a noise simulator with a frequency range of 30 to 100 Hz
	Grounding	Class D grounding
	Operating environments	Free of corrosive gas, flammable gas, electro-conductive dust, or excessive dust. Keep out of water such as rain.

Note: Please note that the input-output terminal is not isolated from the AC power supply.

■External dimensions/External connections



Units : mm
Outer color: Munsell 7.5Y7.5/1

Common Items

- Calculating the mechanical load torque
- Calculating the moment of inertia *J*
- Quick reference chart of moment of inertia *J*
- SI and Non-SI unit conversion chart

Calculating the Mechanical Load Torque

It is generally difficult to calculate the precise amount of power that is required to operate any given machine because of the complexity that is associated with such factors as load condition setting or torque transmission efficiency, and mechanical load torque is often determined from experience rather than by calculation. It is important, however, to know a fairly precise amount of load torque when making a selection of magnetic clutches: general calculation formulas to figure out load torque are shown below. Because there are so many variables that can affect the load torque as mentioned earlier, use your experience as well as the calculation formulas as a guide to calculate the mechanical load torque for a given application.

1. Calculating the load torque when only the motor output is known

Use the following formula to obtain the load torque when only the motor output is known.

$$T_L = 9550 \frac{P}{N} \eta \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

where

T_L: Load torque (N·m)
P: Rated motor output (kW)
N: Rotation speed of clutch axis (r/min)
η: Mechanical conductivity efficiency from the motor axis to the clutch axis

2. Calculating the load torque in the vertical work

(e.g., hoisting)

$$T_L = \frac{W \cdot V}{6.3\ N \cdot \eta} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

where

T_L: Load torque (N·m)
W: Total weight of the parts that are involved in the vertical movement (N)
V: Speed of the parts that are involved in the vertical movement (m/min)
N: Rotation speed of the axis whose torque is to be obtained (r/min)
η: Efficiency
(Example: Approximately 0.95 for gears, chains, and belts)

Note: This formula can also be used to calculate the load torque of the main axis of a machine, such as a lathe, that performs similar tasks, except that the W must be substituted with cutting resistance (N).

3. Calculating the load torque in the horizontal work that involves friction

(e.g., table feeding, crane traveling)

$$T_L = \frac{\mu \cdot W \cdot V}{6.3\ N \cdot \eta} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (3)$$

where

μ: Running resistance friction coefficient
(e.g., Approximately 0.005 for ball bearings and 0.15* for bed surface)
W: Total weight of the parts that are involved in the horizontal movement (N)
V: Speed of the parts that are involved in the horizontal movement (m/min)

Note: The value marked with * may be greater, depending on the assembly and finish of a given machine.

Calculating the Moment of Inertia *J*

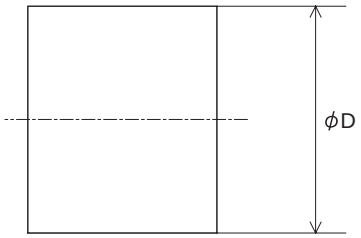
Use the following formula to calculate the moment of inertia *J* (kgm^2) of a rotating body where the mass of the rotating body is M (kg) and the unit of length is (m).

1. Moment of Inertia *J* of a rotating body

1) Solid cylindrical body

$$J = \frac{1}{8} \cdot M \cdot D^2 \quad \cdots\cdots (1)$$

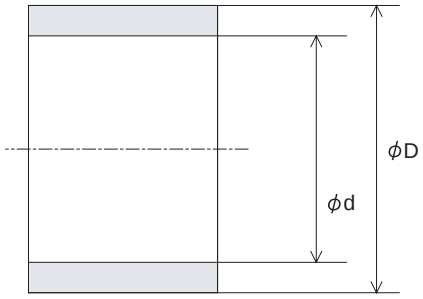
where *J*: Moment of inertia (kgm^2)
M: Mass (kg)
D: Outer diameter of a cylindrical object (m)



2) Hollow cylindrical body

$$J = \frac{1}{8} \cdot M \cdot (D^2 + d^2) \quad \cdots\cdots (2)$$

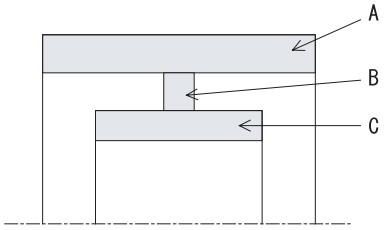
where d represents the inner diameter of a cylindrical body (m)



3) Composite shape

To calculate the moment of inertia of a composite shape such as the one below, divide the shape into smaller sections, calculate the *J* for each section, and add them up. That is,

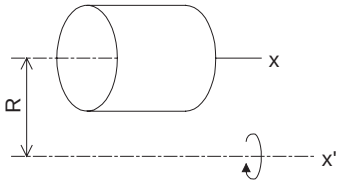
$$J = J_A + J_B + J_C \quad \cdots\cdots (3)$$



4) An arbitrary axis x' that runs parallel to the axis x that goes through the center of the body in question

$$J = J_X + M \cdot R^2 \quad \cdots\cdots (4)$$

where J_X: The moment of inertia of the body whose axis is X (kgm^2)
R: Distance between axis X and axis X' (m)



2. Moment of inertia *J* in linear motion

1) General formula

$$J = \frac{W \cdot V}{4\pi^2 \cdot N} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (5)$$

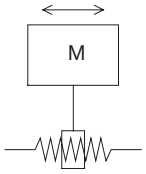
where M: Mass of the body that is involved in the linear movement (kg)
V: Speed of the parts that are involved in the linear movement (m/min)
N: Rotation speed of the rotation axis whose *J* is to be obtained (r/min)

2) Calculating the moment of inertia *J* of various bodies that are involved in linear movement

①When a screw causes the body to move in linear fashion (*J* of the screw axis)

$$J = \frac{M}{4}\left(\frac{P}{\pi}\right)^2 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (6)$$

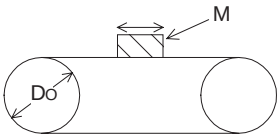
where P: Screw lead (m)
M: Mass of the body that is involved in the linear movement (kg)



②Belt conveyer (*J* of axis Do)
(The *J* of such components as a pulley or a belt is not included.)

$$J = \frac{M}{4} Do^2 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (7)$$

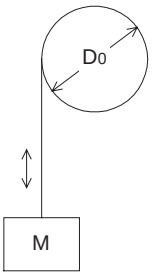
where Do represents pulley diameter (m) etc.



③When the mass is moved with the rope as in a crane or winch (*J* of the drum axis)

$$J = \frac{M}{4} Do^2 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (8)$$

where Do represents drum diameter (m)

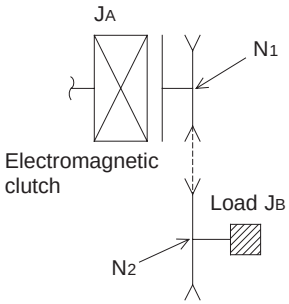


3) Conversion of the *J* of an axis into the *J* of the clutch axis

To convert the J_B of axis N_2 into the *J* of the clutch axis as shown in the figure below, use the following formula:

$$J_A = \left(\frac{N_2}{N_1}\right)^2 \times J_B \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (9)$$

where J_A: *J* of clutch axis (kgm^2)
J_B: *J* of axis N_2 (load axis) (kgm^2)
N_1: Rotation speed of clutch axis (r/min)
N_2: Rotation speed of axis J_B (r/min)



Quick Reference Chart of Moment of Inertia *J*

This chart shows the moment of inertia J (kgm^2) for objects 10mm to 509mm in diameter per 10 mm in length.

1. Specific gravity ρ = 7.85 steel
2. To obtain the moment of inertia of a hollow body, subtract the J of the body that is obtained with the inner diameter from that obtained with the outer diameter.
3. When the following materials are used, multiply by the applicable coefficient listed below:
   Cast iron....× 0.92 Brass....× 1.14 Aluminum....× 0.35
4. How to read the chart
   <Example>
   Obtaining the moment of inertia of a hollow rotating cylindrical body with a diameter of 352 mm and a thickness of 25 mm.
   <Solution>
   By finding the intersection of Row 350 and Column 2, "$1.1832\times10^{-1}kgm^2$" is obtained. Multiply this by the thickness divided by 10 $\left(\frac{25}{10}\right)$. Solving for J, the following result is obtained.

$$J = 1.1832 \times 10^{-1} \times \frac{25}{10} = 0.2958\ kgm^2.$$

Diameter (mm)	J (kgm^2)									
	0	1	2	3	4	5	6	7	8	9
10	7.7×10^{-8}	1.13×10^{-7}	1.6×10^{-7}	2.2×10^{-7}	2.96×10^{-7}	3.9×10^{-7}	5.05×10^{-7}	6.44×10^{-7}	8.09×10^{-7}	1×10^{-6}
20	1.23×10^{-6}	1.5×10^{-6}	1.81×10^{-6}	2.16×10^{-6}	2.56×10^{-6}	3.01×10^{-6}	3.52×10^{-6}	4.1×10^{-6}	4.74×10^{-6}	5.45×10^{-6}
30	6.24×10^{-6}	7.12×10^{-6}	8.08×10^{-6}	9.14×10^{-6}	1.03×10^{-5}	1.157×10^{-5}	1.294×10^{-5}	1.444×10^{-5}	1.607×10^{-5}	1.783×10^{-5}
40	1.973×10^{-5}	2.178×10^{-5}	2.398×10^{-5}	2.635×10^{-5}	2.889×10^{-5}	3.16×10^{-5}	3.451×10^{-5}	3.761×10^{-5}	4.091×10^{-5}	4.443×10^{-5}
50	4.817×10^{-5}	5.214×10^{-5}	5.635×10^{-5}	6.081×10^{-5}	6.553×10^{-5}	7.052×10^{-5}	7.579×10^{-5}	8.135×10^{-5}	8.721×10^{-5}	9.339×10^{-5}
60	9.988×10^{-5}	1.067×10^{-4}	1.139×10^{-4}	1.214×10^{-4}	1.293×10^{-4}	1.376×10^{-4}	1.462×10^{-4}	1.553×10^{-4}	1.648×10^{-4}	1.747×10^{-4}
70	1.85×10^{-4}	1.958×10^{-4}	2.071×10^{-4}	2.189×10^{-4}	2.311×10^{-4}	2.438×10^{-4}	2.571×10^{-4}	2.709×10^{-4}	2.853×10^{-4}	3.002×10^{-4}
80	3.157×10^{-4}	3.317×10^{-4}	3.484×10^{-4}	3.657×10^{-4}	3.837×10^{-4}	4.023×10^{-4}	4.216×10^{-4}	4.415×10^{-4}	4.622×10^{-4}	4.835×10^{-4}
90	5.056×10^{-4}	5.285×10^{-4}	5.521×10^{-4}	5.765×10^{-4}	6.017×10^{-4}	6.277×10^{-4}	6.546×10^{-4}	6.823×10^{-4}	7.18×10^{-4}	7.403×10^{-4}
100	7.707×10^{-4}	8.02×10^{-4}	8.342×10^{-4}	8.674×10^{-4}	9.016×10^{-4}	9.368×10^{-4}	9.73×10^{-4}	1.01×10^{-3}	1.048×10^{-3}	1.088×10^{-3}
110	1.128×10^{-3}	1.17×10^{-3}	1.213×10^{-3}	1.257×10^{-3}	1.302×10^{-3}	1.348×10^{-3}	1.395×10^{-3}	1.444×10^{-3}	1.494×10^{-3}	1.545×10^{-3}
120	1.598×10^{-3}	1.652×10^{-3}	1.707×10^{-3}	1.764×10^{-3}	1.822×10^{-3}	1.882×10^{-3}	1.942×10^{-3}	2.005×10^{-3}	2.069×10^{-3}	2.134×10^{-3}
130	2.201×10^{-3}	2.27×10^{-3}	2.34×10^{-3}	2.411×10^{-3}	2.485×10^{-3}	2.56×10^{-3}	2.636×10^{-3}	2.715×10^{-3}	2.795×10^{-3}	2.877×10^{-3}
140	2.961×10^{-3}	3.046×10^{-3}	3.133×10^{-3}	3.223×10^{-3}	3.314×10^{-3}	3.407×10^{-3}	3.502×10^{-3}	3.599×10^{-3}	3.698×10^{-3}	3.799×10^{-3}
150	3.902×10^{-3}	4.007×10^{-3}	4.114×10^{-3}	4.223×10^{-3}	4.335×10^{-3}	4.448×10^{-3}	4.564×10^{-3}	4.682×10^{-3}	4.803×10^{-3}	4.926×10^{-3}
160	5.051×10^{-3}	5.178×10^{-3}	5.308×10^{-3}	5.44×10^{-3}	5.575×10^{-3}	5.712×10^{-3}	5.852×10^{-3}	5.994×10^{-3}	6.139×10^{-3}	6.287×10^{-3}
170	6.437×10^{-3}	6.59×10^{-3}	6.745×10^{-3}	6.903×10^{-3}	7.064×10^{-3}	7.228×10^{-3}	7.395×10^{-3}	7.564×10^{-3}	7.737×10^{-3}	7.912×10^{-3}
180	8.09×10^{-3}	8.272×10^{-3}	8.456×10^{-3}	8.643×10^{-3}	8.834×10^{-3}	9.027×10^{-3}	9.224×10^{-3}	9.424×10^{-3}	9.627×10^{-3}	9.834×10^{-3}
190	1.004×10^{-2}	1.026×10^{-2}	1.047×10^{-2}	1.069×10^{-2}	1.092×10^{-2}	1.114×10^{-2}	1.137×10^{-2}	1.161×10^{-2}	1.184×10^{-2}	1.209×10^{-2}
200	1.233×10^{-2}	1.258×10^{-2}	1.283×10^{-2}	1.309×10^{-2}	1.335×10^{-2}	1.361×10^{-2}	1.388×10^{-2}	1.415×10^{-2}	1.443×10^{-2}	1.47×10^{-2}
210	1.499×10^{-2}	1.528×10^{-2}	1.557×10^{-2}	1.586×10^{-2}	1.616×10^{-2}	1.647×10^{-2}	1.678×10^{-2}	1.709×10^{-2}	1.741×10^{-2}	1.773×10^{-2}
220	1.805×10^{-2}	1.838×10^{-2}	1.872×10^{-2}	1.906×10^{-2}	1.94×10^{-2}	1.975×10^{-2}	2.011×10^{-2}	2.046×10^{-2}	2.083×10^{-2}	2.119×10^{-2}
230	2.157×10^{-2}	2.194×10^{-2}	2.233×10^{-2}	2.271×10^{-2}	2.311×10^{-2}	2.35×10^{-2}	2.391×10^{-2}	2.431×10^{-2}	2.473×10^{-2}	2.515×10^{-2}
240	2.557×10^{-2}	2.6×10^{-2}	2.643×10^{-2}	2.687×10^{-2}	2.732×10^{-2}	2.777×10^{-2}	2.822×10^{-2}	2.869×10^{-2}	2.915×10^{-2}	2.963×10^{-2}
250	3.01×10^{-2}	3.059×10^{-2}	3.108×10^{-2}	3.158×10^{-2}	3.208×10^{-2}	3.259×10^{-2}	3.31×10^{-2}	3.362×10^{-2}	3.415×10^{-2}	3.468×10^{-2}
260	3.522×10^{-2}	3.576×10^{-2}	3.631×10^{-2}	3.687×10^{-2}	3.744×10^{-2}	3.801×10^{-2}	3.858×10^{-2}	3.917×10^{-2}	3.976×10^{-2}	4.035×10^{-2}
270	4.096×10^{-2}	4.157×10^{-2}	4.218×10^{-2}	4.281×10^{-2}	4.344×10^{-2}	4.408×10^{-2}	4.472×10^{-2}	4.537×10^{-2}	4.603×10^{-2}	4.67×10^{-2}
280	4.737×10^{-2}	4.805×10^{-2}	4.874×10^{-2}	4.943×10^{-2}	5.014×10^{-2}	5.084×10^{-2}	5.156×10^{-2}	5.299×10^{-2}	5.302×10^{-2}	5.376×10^{-2}
290	5.451×10^{-2}	5.526×10^{-2}	5.603×10^{-2}	5.68×10^{-2}	5.758×10^{-2}	5.837×10^{-2}	5.916×10^{-2}	5.996×10^{-2}	6.078×10^{-2}	6.16×10^{-2}
300	6.242×10^{-2}	6.326×10^{-2}	6.411×10^{-2}	6.496×10^{-2}	6.582×10^{-2}	6.669×10^{-2}	6.757×10^{-2}	6.846×10^{-2}	6.935×10^{-2}	7.026×10^{-2}
310	7.117×10^{-2}	7.21×10^{-2}	7.303×10^{-2}	7.397×10^{-2}	7.492×10^{-2}	7.588×10^{-2}	7.685×10^{-2}	7.782×10^{-2}	7.881×10^{-2}	7.981×10^{-2}
320	8.081×10^{-2}	8.183×10^{-2}	8.285×10^{-2}	8.388×10^{-2}	8.493×10^{-2}	8.598×10^{-2}	8.704×10^{-2}	8.812×10^{-2}	8.92×10^{-2}	9.029×10^{-2}
330	9.14×10^{-2}	9.251×10^{-2}	9.363×10^{-2}	9.476×10^{-2}	9.591×10^{-2}	9.706×10^{-2}	9.823×10^{-2}	9.94×10^{-2}	1.0059×10^{-1}	1.0178×10^{-1}
340	1.0299×10^{-1}	1.0421×10^{-1}	1.0543×10^{-1}	1.0667×10^{-1}	1.0792×10^{-1}	1.0918×10^{-1}	1.1045×10^{-1}	1.1174×10^{-1}	1.1303×10^{-1}	1.1433×10^{-1}
350	1.1565×10^{-1}	1.1698×10^{-1}	1.1832×10^{-1}	1.1967×10^{-1}	1.2103×10^{-1}	1.224×10^{-1}	1.2379×10^{-1}	1.2581×10^{-1}	1.2659×10^{-1}	1.2801×10^{-1}
360	1.2944×10^{-1}	1.3089×10^{-1}	1.3234×10^{-1}	1.3381×10^{-1}	1.3529×10^{-1}	1.3679×10^{-1}	1.3829×10^{-1}	1.3981×10^{-1}	1.4134×10^{-1}	1.4288×10^{-1}
370	1.4444×10^{-1}	1.4601×10^{-1}	1.4759×10^{-1}	1.4918×10^{-1}	1.5079×10^{-1}	1.524×10^{-1}	1.5404×10^{-1}	1.5568×10^{-1}	1.5734×10^{-1}	1.5901×10^{-1}
380	1.607×10^{-1}	1.6239×10^{-1}	1.6411×10^{-1}	1.6583×10^{-1}	1.6757×10^{-1}	1.6933×10^{-1}	1.7109×10^{-1}	1.7287×10^{-1}	1.7466×10^{-1}	1.7647×10^{-1}
390	1.7829×10^{-1}	1.8013×10^{-1}	1.8198×10^{-1}	1.8384×10^{-1}	1.8572×10^{-1}	1.8761×10^{-1}	1.8952×10^{-1}	1.9144×10^{-1}	1.9338×10^{-1}	1.9533×10^{-1}
400	1.9729×10^{-1}	1.9927×10^{-1}	2.0127×10^{-1}	2.0328×10^{-1}	2.053×10^{-1}	2.0734×10^{-1}	2.094×10^{-1}	2.1147×10^{-1}	2.1356×10^{-1}	2.1566×10^{-1}
410	2.1777×10^{-1}	2.1991×10^{-1}	2.2205×10^{-1}	2.2422×10^{-1}	2.264×10^{-1}	2.2859×10^{-1}	2.308×10^{-1}	2.3303×10^{-1}	2.3528×10^{-1}	2.3753×10^{-1}
420	2.3981×10^{-1}	2.421×10^{-1}	2.4441×10^{-1}	2.4674×10^{-1}	2.4908×10^{-1}	2.5144×10^{-1}	2.5381×10^{-1}	2.562×10^{-1}	2.5861×10^{-1}	2.6104×10^{-1}
430	2.6348×10^{-1}	2.6594×10^{-1}	2.6841×10^{-1}	2.7091×10^{-1}	2.7342×10^{-1}	2.7595×10^{-1}	2.7849×10^{-1}	2.8106×10^{-1}	2.8364×10^{-1}	2.8624×10^{-1}
440	2.8886×10^{-1}	2.9149×10^{-1}	2.9414×10^{-1}	2.9681×10^{-1}	2.995×10^{-1}	3.0221×10^{-1}	3.0494×10^{-1}	3.0768×10^{-1}	3.1044×10^{-1}	3.1322×10^{-1}
450	3.1602×10^{-1}	3.1884×10^{-1}	3.2168×10^{-1}	3.2454×10^{-1}	3.2741×10^{-1}	3.3031×10^{-1}	3.3322×10^{-1}	3.3615×10^{-1}	3.391×10^{-1}	3.4208×10^{-1}
460	3.4507×10^{-1}	3.4808×10^{-1}	3.5111×10^{-1}	3.5416×10^{-1}	3.5723×10^{-1}	3.6032×10^{-1}	3.6342×10^{-1}	3.6655×10^{-1}	3.697×10^{-1}	3.7287×10^{-1}
470	3.7606×10^{-1}	3.7927×10^{-1}	3.8251×10^{-1}	3.8576×10^{-1}	3.8903×10^{-1}	3.9232×10^{-1}	3.9564×10^{-1}	3.9897×10^{-1}	4.0233×10^{-1}	4.0571×10^{-1}
480	4.0911×10^{-1}	4.1253×10^{-1}	4.1597×10^{-1}	4.1943×10^{-1}	4.2291×10^{-1}	4.2642×10^{-1}	4.2995×10^{-1}	4.335×10^{-1}	4.3707×10^{-1}	4.4066×10^{-1}
490	4.4428×10^{-1}	4.4792×10^{-1}	4.5158×10^{-1}	4.5526×10^{-1}	4.5886×10^{-1}	4.6269×10^{-1}	4.6644×10^{-1}	4.7021×10^{-1}	4.7401×10^{-1}	4.7783×10^{-1}
500	4.8167×10^{-1}	4.8554×10^{-1}	4.8942×10^{-1}	4.9334×10^{-1}	4.9727×10^{-1}	5.0123×10^{-1}	5.0521×10^{-1}	5.0922×10^{-1}	5.1325×10^{-1}	5.173×10^{-1}

Formulas for obtaining J

Steel .... $J = D^4 \times L \times 775$ [kgm^2]
Brass ... $J = D^4 \times L \times 880$ [kgm^2]
Aluminum ... $J = D^4 \times L \times 270$ [kgm^2]
where D represents diameter (m) and L represents length (m)

SI and Non-SI Unit Conversion Chart

SI units have been adopted since October 1st, 1999, although some non-SI terms may still be found in the catalog. Clutch- and brake-related non-SI to SI conversion formula are listed in the table below for your reference.

Property	Non-SI unit (symbol)	SI unit (symbol)	Conversion formula
Length	micron (μ)	meter (m)	1 μ = 1 μm
Frequency	cycle (c) cycle per second (c/s)	hertz (Hz)	1 c = 1 c/s = 1 Hz
Magnetic field	ampere turns per meter (AT/m) oersted (Oe)	ampere per meter (A/m)	1 AT/m = 1 A/m 10 e ≒ 79 A/m
Magnetomotive force	ampere turns (AT)	ampere (A)	1 AT = 1 A
Magnetic flux density	gamma (γ) gauss (G)	tesla (T)	1 γ = 1 nT 1 G = 100 μT
Magnetic flux density	maxwell (Mx)	weber (Wb)	1 Mx = 10 nWb
Sound pressure	phon	decibel (dB)	1 phon = 1 dB
Power (load/tension)	kilogram-force (kgf) gram-force (gf) ton-force (tf)	newton (N)	1 kgf ≒ 9.8 N 1 gf ≒ 9.8 mN 1 tf ≒ 9.8 kN
Moment of force (torque)	kilogram-force meter (kgf·m)	newton meter (N·m)	1 kgf·m≒ 9.8 N·m
Pressure	kilogram-force per square meter (kgf/m^2)	pascal (Pa)	1 kgf/m^2 ≒ 9.8 Pa
Stress	kilogram-force per square meter (kgf/m^2)	pascal (Pa)	1 kgf/m^2 ≒ 9.8 Pa
Work (energy)	kilogram-force meter (kgf/m)	joule (J)	1 kgf·m ≒ 9.8 J
Power	kilogram-force meter per second (kgf/m/s)	watt (W)	1 kgf·m/s ≒ 9.8 W
Quantity of heat	calorie (cal)	joule (J)	1 cal ≒ 4.2 J
Rotation	rotational speed (rpm)	rotation per minute (r/min)	1 rpm = 1 r/min
Time	second (sec) minute (min) (reference) hour (Hr) (reference)	second (s) minute (min) hour (h)	1 sec = 1 s 1 min = 1 min 1 Hr = 1 h
Moment of inertia	GD^2 (kgfm^2)	moment of inertia (kgm^2)	1 kgfm^2 ≒ 0.25 kgm^2
Temperature	degree (°C)	degree Celsius (°C)	1°C = 1°C
Temperature difference	degree (deg)	degree Celsius (°C)	1 deg = 1°C
Mass	kilogram-force (kgf)	kilogram (kg)	1 kgf = 1 kg

Refer to the International System of Units (JIS Z 8203) for the units not listed here and for more detailed information.

Safety Precautions

(Please read before purchasing any of the products in this catalog.)

For your safety

- Read this catalog and the operation manual that comes with each product to learn to use the product safely and correctly prior to use.
- The products in this catalog are designed for general industrial use. They are not designed or manufactured for use with a machine or in a system that has a potential to cause serious personal injury or death.
- If you are considering the use of any of the products in this catalog for a special application such as nuclear-related, electric-power-related, aerospace, medical, or a passenger carrying vehicle or system, consult the sales department customer desk at Mitsubishi Electric Corporation.
- Although all the products in this manual are manufactured under a stringent quality control system, if there is a potential for serious accidents, damage, or loss should the products malfunction, provide necessary backup systems and fail-safe functions to secure safety.

The following two symbols [⚠WARNING] and [⚠CAUTION] are used in this catalog to designate the degree of hazard seriousness.

⚠ **WARNING**	This symbol indicates that failure to follow instructions poses a risk of death or serious injury.
⚠ **CAUTION**	This symbol indicates that failure to follow instructions poses a risk of minor to moderate injury or results in property damage only.

Cautionary notes on clutches and brakes

⚠WARNING Be sure to provide a protective cover.

Some rotating parts are exposed and pose a risk of hand/finger injury. Install a protective cover that does not block the airway to keep body parts from coming in contact with rotating parts. Set up a safety function that triggers the rotating parts to stop when the cover is removed.

⚠WARNING Use the product below the allowable heat capacity.

Using the product above its allowable heat capacity will cause the working surface to become overheated and red, and it may result in fire. Use the product below its allowable heat capacity to gain its allowable performance.

⚠WARNING Observe the allowable rotation speed.

If the product is operated above its allowable rotation speed, those rotating members in the product may sustain damage from excessive vibration and the broken pieces may scatter, presenting a risk of serious injury. Provide a protective cover, and observe the allowable rotation speed.

⚠WARNING If a direct-current block is used, connect a surge absorber in parallel with the clutch/brake coil.

When the electric current is cut off, a large surge voltage is generated and may pose adverse effects on the peripheral equipment. Use a surge absorber (diode, varister, registor etc.)

⚠WARNING Use wires that are adequate for the current capacity.

Use wires that are adequate for the current capacity. The use of a wire of inadequate size may cause the insulation coating to melt and cause insulation failure, posing a risk of electric shock, electric leakage, and fire.

⚠WARNING Check the environment.

Do not use the product in a dusty, high-temperature place or in a place where dew condensation may occur or is in direct exposure to wind or rain. Do not install the product in a place that is subject to vibration or mechanical shock. If installed in such environment, the product may sustain damage or malfunction, or performance may suffer.

⚠WARNING Do not use the product in an environment where it can start a fire or cause an explosion.

Sparks may be created on the working surface inside the product during slipping. Do not use the product in an environment where oil or flammable gas provides an ignition source. Enclose the product where highly flammable materials such as cotton are present. Please note that the allowable heat dissipation rate drops when the product is enclosed. (Consider the use of a pressure-resistant explosion-proof powder clutch.)

⚠WARNING Keep moisture and oil from infiltrating the product.

Not to mention the working surface, even water or oil that gets on the product's body eventually reaches the working surface and causes the torque to drop significantly. It can cause the machine to coast or run out of control and present a risk of injury.

⚠WARNING Use the product at or less the rated torque.

The use of the product above its rated torque will adversely affect its performance and cause mechanical damage, presenting a risk of injury. Use the products at or less the rated torque.

⚠WARNING Use bolts that meet the strength requirements, and take appropriate measures to keep nuts and bolts from loosening.

Bolts with low strength may break and cause injury. Use bolts that are rated 7T or more on the strength class II of JIS B 1051 (Mechanical properties of fasteners) or its equivalent, and use an adhesive or spring washers to keep nuts and bolts from loosening.

ZKA model powder clutch

⚠WARNING Provide a cover on the feeder of the ZKA model powder clutch.

The feeder is exposed and presents a risk of electric shock if hands or fingers come in contact. Provide a protective cover to keep body parts out of contact during maintenance and inspection, not to mention during operation.

Cautionary notes on tension controllers

⚠WARNING Provide an emergency-stop circuit through an external circuit without having it integrated into the tension controller device.

Provide an emergency-stop circuit through an external circuit to keep the product from running out of control and causing injury when it malfunctions.

⚠WARNING Provide class D grounding (100Ω or less).

For the wires that are connected to the product's earth terminal or for the steel case, use wires that are at least 2mm^2 thick, and provide class D grounding (100Ω or less). Failure to do so presents a risk of electric shock.

⚠WARNING Do not operate switches and buttons with wet hands.

Touching switches and buttons with wet hands may result in electric shock.

⚠WARNING Do not use the products in the presence of flammable gases on materials.

Doing so presents a risk of fire or an explosion.

⚠WARNING Do not alter, modify, or disassemble the product.

Improper modification, alteration, or disassembling may cause malfunctions, damage, fire, or personal injury.

⚠CAUTION Separate the wires from a strong-current system and a weak-current system.

Do not ground the wires from a strong-current system and a weak-current system together. Wires from the weak-current system may receive noise interference and result in malfunctions.

⚠WARNING Use wires that are adequate for the current capacity.

Use wires that are adequate for the current capacity. The use of a wire of inadequate size may cause the insulation coating to melt and cause insulation failure, posing a risk of electric shock, electric leakage, and fire.

⚠CAUTION Check the environment.

Do not install the product in a place where dust, oil mist, electrically conductive dust, or corrosive gas is present. Also avoid installing the product in a place at high temperature, where dew condensation may occur, or in direct exposure to wind or rain.
Do not install the product in a place that is subject to vibration or mechanical shock. mounting of the product in such place may result in damage to the product or malfunctions.

[Additional Notes]

- Mitsubishi Electric shall not be held responsible for any damage that may result from repair, disassembling, or alteration that is performed by a third party, other than by those who are designated to provide service by Mitsubishi Electric Corporation.
- These safety precautions and other items in this catalog are subject to change without notice.

ELECTROMAGNETIC CLUTCHES AND BRAKES <Powder type·Hysteresis type>
TENSION CONTROLLERS

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