Features of Standard AC Motors

■ Features

Standard AC motors that rotate when connected to a commercial power source are widely used in everything from household appliances to automated factory production equipment. These motors can be used anywhere. In 1966, we introduced the K series of standard compact AC motors, and we have continued to improve this best seller ever since. Today's motors boast improvements in temperature characteristics, are quieter, and perform better in demanding modern applications. Many changes have improved performance in specialized applications. The basic design, including the mounting dimensions, and the usability have endured. These motors give worry-free performance over a long service life.
Standard AC motors offer many benefits. The following are some of the more important:

1. High Reliability

All that is required to rotate a standard compact AC motor is a commercial power supply and a capacitor. Motors for three-phase power supplies do not even require capacitors. They are the simplest way to get rotational operation from a motor. Their simplicity only improves the reliability and service life they provide.

2. Multiple Functions

The two basic motor types, the continuous-operation induction motor and the forward/reverse-operation reversible motor, are supplemented by speed control functions and an electromagnetic brake to hold loads. These are available in a wide variety of combinations that allow users to select the one best suited to their needs.

3. Quiet

Over the years, new applications have demanded lower levels of noise, so we have made these motors ever quieter. We have also pushed development of low-noise gearheads. Virtually all of the gearheads listed in this catalog are low-noise gearhead types.

● Pinion Shaft and Round Shaft

There are two types of shafts: the pinion shaft is used to connect a gearhead (specialized speed-reducing devices) to the standard compact AC motor output shaft, and the round shaft is used when the motor is operated without a gearhead.

● Motors and Gearheads

Gearheads reduce the speed (r/min) of motors and simultaneously increase the torque. Except for some geared motors, motors and gearheads are sold separately. By matching size and pinion specifications, the full lineup of gear ratios can be combined. There are between 8 and 23 gear ratios for each size motor.

● Geared Motors

The designs of some motors and gearheads have been optimized for special applications where the motors are combined in one assembly with dedicated gearheads. These geared motors are pre-assembled in the factory and can not be removed or changed. The dust-and water-resistant **FPW** series motors are gear motors.

● Speed Control Packages

Speed control package are comprised of a motor and a control pack. The motors cannot be combined with other control packs.

Package Products

- **Speed control motors**
  FBL Ⅱ series
  HBL series
  SC series
  US series

Product Line of Standard AC Motors

Standard AC motors can be divided into three categories according to the motor's function:
1. Constant speed motors
2. Speed control motors
3. Motors equipped with a brake function

Constant Speed

Induction Motors for uni-directional operation A-34

Induction motors are the most commonly used AC motor.
Capacitor-run, single-phase and three-phase motors are available.
Lead type, terminal box type, and conduit box type motors are available.
The **BH** Series is also available with BH6G2-☐ gearheads to provide 347lb-in (40N·m) of maximum permissible torque.

Lead Wire Type

Terminal Box Type

BH series

Conduit Box Type

Reversible Motors for bi-directional operation A-74

These are capacitor-run, single-phase motors. While they are induction motors in basic operating principle, they have a built-in friction brake to improve instantaneous reversing characteristics. These motors are suited for applications where the motor must switch frequently from one direction to the next.

Lead Wire Type

Terminal Box Type

Synchronous Motors A-102

These motors provide rotation at a fixed speed in synchronization with the frequency of the power source.

Torque Motors A-106

The speed and torque can be set to any desired level by changing input voltage.

Synchronous Motor

Torque Motor

Speed Control

Speed Control Motors

FBLⅡ, HBL Series A-120

These are packaged sets combining a brushless DC motor and a driver that operates from a 100-115V AC power source (DC24V, DC48V for the **HBL** series).
High speeds (**FBLⅡ**: 3000r/min ; **HBL**: 2000r/min), can be obtained while maintaining a constant torque over the entire speed range.

SC Series A-142

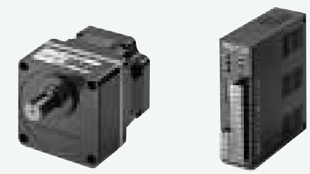
This package set combines a motor and speed control pack.

US Series A-156

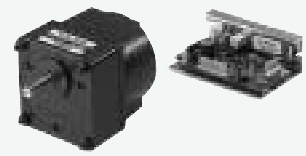
Control units combine a control circuit, a speed potentiometer and a capacitor in one device. Connection between the motor and control unit is made easy by a snap-on connector.

Component Package Type A-170

Select a custom combination of motor and control pack to suit the particular need or application.



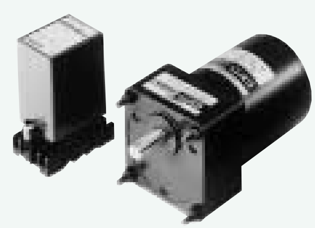
FBLⅡ series



HBL series

SC series

US series



Component Package type

Brake

Electromagnetic Brake Motors A-180

These motors are built with electromagnetic brakes. The brake, which activates when the power is shut off, offers reliable performance and excellent holding power. This brake can be used in case of power failure or other emergencies.

Clutch and Brake Motors A-194

This motor combines clutch and brake mechanism with an induction motor. It is ideal for high-frequency starting and stopping, as well as position holding and positioning control.

Electromagnetic Brake Motor

Clutch and Brake Motor

Washdown Motors

A-203

These geared motors provide splashproof and dust-resistant performance that meets the IP65 standard.

Washdown Motor

Gearheads

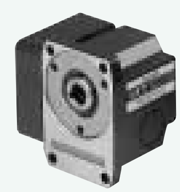
A-213

These dedicated gearheads can be connected directly to pinion shaft motors. The units shown at the right serve a variety of motor types and powers. A right-angle gearhead is also available for outputs between 25W and 90W.

GN type

GU type

Right-Angle Gearheads
Solid shaft type

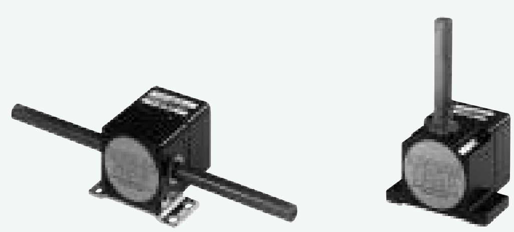


Right-Angle Gearheads
Hollow shaft type

Linear Heads

A-227

The rack-and-pinion linear head is directly coupled to a standard AC motor, which makes linear action like pushing, pulling, lifting and lowering easy to engineer.



Linear Head

List of Standard AC Motor Types

Motor Type		Mounting Size	1.64in.sq. (42mm sq.)	2.36in.sq. (60mm sq.)		2.76in.sq. (70mm sq.)		3.15in.sq. (80mm sq.)		3.54in.sq. (90mm sq.)			4.09in.sq. (104mm sq.)	
		Output Size	1W (1/750 HP)	3W (1/250 HP)	6W (1/125 HP)	10W (1/75 HP)	15W (1/50 HP)	15W (1/50 HP)	25W (1/28 HP)	40W (1/18.5 HP)	60W (1/12.5 HP)	90W (1/8 HP)	90W (1/8 HP)	200W (1/3.73HP)
Power Motors	Induction Motors	Lead Wire Type	●	●	●		●	●	●	●	●	●		
		Cable Type												●
		2-Pole High Speed Type								●	●	●		
		Terminal Box Type			●				●	●	●	●		●
		Conduit Box Type							●	●	●	●		
	Reversible Motors	Lead Wire Type	●	● (4W)	●		●	● (20W)	●	●	●	●		
		Terminal Box Type			●				●	●	●	●		
	Synchronous Motors				● (4W)	●			● (15W)	● (25W)				
	Torque Motors						● (8W)		● (12W)	● (23W)				
Speed Control Motors	**FBLⅡ** Series (Brushless DC Motor, 100-115V/200-230V AC Input)										● (75W)	● (120W)		
	HBL Series (Brushless DC Motor, 24V/48V DC Input)				● (10W)				●	●	●	● (100W)		
	US Series				●		●		●	●	●	●		
	SC Series				●		●		●	●	●			
	Component Type				●		●		● (22W)	●				
Brake Motors	Electromagnetic Brake Motors				●		●		●	●	●	●		
	Clutch and Brake Motors									●	●	●		
Gearheads	Gearheads		●	●	●	●	●	●	●	●	●	●		●
	Right Angle Gearheads								●	●	●	●		
Linear Heads	Linear Heads		●		●				●	●	●	●		
Washdown Motors	FPW Series								●	●	●		●	
Accessories	Motor Mounting Brackets (Metric Size)													●
	Motor Mounting Brackets (Inch Size)		●	●		●		●		●				
	Flexible Coupling		●	●	●	●	●	●	●	●	●			●

Guide for Motor Selection

This chart can help you determine which motor best meets your application needs.

	Desired performance and functions		Output Power (W)	Run state: Uni-directional	Run state: bi-directional	Additional functions: Terminal Box Type	Additional functions: Conduit Box Type ①	Additional functions: Right-Angle Gerhead ②	Voltage: Single-Phase 115VAC	Voltage: Single-Phase 230VAC	Voltage: Three-Phase 230VAC
Constant Speed	Big power	A-68 **BH** Series	200	○		○			○	○	○
	Standard type	A-34 Induction Motor	1~90	○		○	○	○	○	○	○
		Reversible Motor	1~90		○	○		○	○	○	
	Synchronous speed operation	A-102 Synchronous Motor	4~25	○				○	○		

① Sometimes the desired performance is not provided by single products. For details, refer to the specifications values for each product.
② Right-Angle gear heads are combined with 25W, 40W, 60W and 90W output type motors.

	Desired performance and functions		overrun	Operation cycle	Output power (W)	Voltage: Single-Phase 115VAC	Voltage: Single-Phase 230VAC	Voltage: Three-Phase 230VAC
Brake	High-frequency	A-194 **C•B** Motor	1 revolution	100 times/ minute max.	40~90	○		
Load holding (after stop)	Power off activated type	A-180 Electromagnetic Brake Motor	2~3 revolution	50 times/ minute max.	6~90	○	○	○

	Desired performance and functions		Speed Range (r/min)	Output Power (W)	Additional functions: Brake	Additional functions: SSSD	Additional functions: Right-Angle Gearhead ②	Voltage: AC Sngle-Phase 115VAC	Voltage: AC Sngle-Phase 230VAC	Voltage: AC Three-Phase 230VAC	Voltage: DC
Speed Control	Constant Torque Speed Regulation–1%; Three-Phase 200-230V	A-120 **FBL II** Series	300~3000	75,120	○	○		○	○	○	
	DC24(48)V	A-132 **HBL** Series	300~2000	10~100	○						○
	Stand-alone operation; Simple wiring and simple operation	A-156 **US** Series	90~1600①	6~90			○	○	○		
		A-142 **SC** Series	90~1600①	6~60		○	○	○	○		
		A-170 Component type	90~1700①	6~40			○	○			

① The variable speed range displayed is for a power frequency of 60 Hz.
② Right-Angle gear heads are combined with 25W, 40W, 60W and 90W output type motors.

	Desired performance and functions		Performance and functions	Output power (W)	Voltage①: Signal-Phase 115VAC	Voltage①: Signal-Phase 230VAC	Voltage①: Three-Phase 230VAC
Special purpose	Dust-resistant Splashproof	A-203 **FPW** Series	IP65 (Geared motor)	25~90	○	○	○
	Torque Control	A-106 Torque Motor	Locked rotor operation Suitable for winding applications	8~23	○①		

① The torque motor input voltage can be varied between 60 VAC and 115 VAC.

Selection Procedure

1. Required Specifications
First, determine the basic required specifications such as operating speed, load torque, power supply voltage and frequency.

2. Calculate the Operating Speed
Induction and reversible motor speeds cannot be adjusted. Motor speed must be reduced with gearheads to match the required machine speed. It is therefore necessary to determine the correct gear ratio.

3. Calculate the Required Torque
Calculate the required torque and speed to select a motor and gearhead.

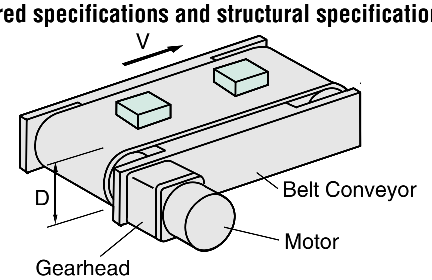
4. Select a Motor and Gearhead
Use the required torque and speed to select a motor and gearhead.

5. Confirm the speed
In a single-phase induction motor, starting torque is always lower than the rated torque. Therefore, to drive a frictional load, select the speed on the basis of starting torque. This will cause the actual speed to exceed the rated speed. Also, the motors are designed so that increases in motor temperature are at their lowest when operating close to the rated speed of rotation.

■ EXAMPLE 1

Here is an example of how to select an induction motor to drive a belt conveyor.
In this case, a motor must be selected that meets the following basic specifications.

Required specifications and structural specifications



Total weight of belt and work ················· W = 30 lb.
Friction coefficient of sliding surface ·········· μ = 0.3
Drum radius ·· D = 4 inch
Weight of drum ································ W_2 = 35.27 oz
Belt roller efficiency ································· η = 0.9
Belt speed ································ V = 7 inch/s±10%
Motor power supply····· Single phase 115VAC 60Hz

1. Determining the Gearhead Reduction Ratio

Speed at the gearhead output shaft:

$$N_G = \frac{V \cdot 60}{\pi \cdot D} = \frac{(7\pm0.7)\times60}{\pi\times4} = 33.4\pm3.3 \text{ r/min}$$

Because the rated speed for a 4-pole motor at 60Hz is 1450~1550 r/min, the gear ratio (i) is calculated as follows:

$$i = \frac{1450\sim1550}{N_G} = \frac{1450\sim1550}{33.4\pm3.3} = 39.5\sim51.5$$

From within this range a gear ratio of i =50 is selected.

2. Calculating the Required Torque

On a belt conveyor, the greatest torque is needed when starting the belt. To calculate the torque needed for start-up, the friction coefficient (F) of the sliding surface is first determined:

$$F = \mu W = 0.3\times30 = 9 \text{ lb.} = 144 \text{ oz.}$$

Load torque (T_L) is then calculated by:

$$T_L = \frac{F \cdot D}{2 \cdot \eta} = \frac{144\times4}{2\times0.9} = 320 \text{ oz-in}$$

The load torque obtained is actually the load torque at the gearhead drive shaft, so this value must be converted into load torque at the motor output shaft. If the required torque at the motor output shaft is T_M, then:

$$T_M = \frac{T_L}{i \cdot \eta_G} = \frac{320}{50\times0.66} = 9.7 \text{ oz-in}$$

(Gearhead transmission efficiency η_G = 0.66)
Look for a margin of safety of 2x, taking into consideration commercial power voltage fluctuation.

$$9.7\times2 = 19.4 \text{ oz-in}$$

The suitable motor is one with a starting torque of 19.4 oz-in or more. Therefore, motor **5IK40GN-AWU** is the best choice. Since a gear ratio of 50 is required, select the gearhead **5GN50KA** which may be connected to the **5IK40GN-AWU** motor.

3. Inertial load check

Roller moment of inertia

$$J_1 = \frac{1}{8}\times W_2\times D^2\times2 = \frac{1}{8}\times35.27\times4^2\times2 = 141 \text{ oz-in}^2$$

Belt and work moment of inertia

$$J_2 = \frac{W_1\times(\pi\times D)^2}{(4\times\pi^2)} = \frac{480\times(\pi\times4)^2}{(4\times\pi^2)} = 1920 \text{ oz-in}^2$$

Gear head shaft load inertia

$$J = J_1 + J_2 = 141 + 1920 = 2061 \text{ oz-in}^2$$

Here, the **5GN50KA** permitted load inertia is: $J_G = 4\times50^2 = 10000 \text{ oz-in}^2$

See page A-22 to confirm this calculated value.
Therefore, $J < J_G$, the load inertia is less than the permitted inertia, so there is no problem.

Since the motor selected has a rated torque of 36.1 oz-in, which is somewhat larger than the actual load torque, the motor will run at a higher speed than the rated speed. Therefore the speed is used under no-load conditions (approximately 1740r/min) to calculate belt speed, and thus determine whether the product selected meets the required specifications.

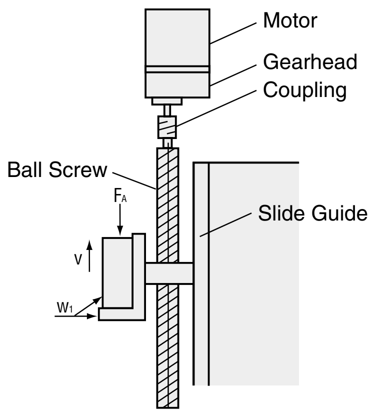
$$V = \frac{N_M \cdot \pi \cdot D}{60 \cdot i} = \frac{1740\times\pi\times4}{60\times50} = 7.3 \text{ in/s}$$

(Where N_M is the motor speed)
The motor meets the specifications.

■ EXAMPLE 2

This example demonstrates how to select a motor with an electromagnetic brake for use on a tabletop moving vertically on a ball screw.
In this case, a motor must be selected that meets the following basic specifications.

Required and structural specifications



Total weight of table and work .... $W_1 = 100$lb
Table speed .... $V = 0.6$ in/s±10%
Ball screw pitch................................. $P_B = 0.197$in
Ball screw efficiency................................. $\eta = 0.9$
Ball screw friction coefficient.................... $\mu_0 = 0.3$
Friction coefficient of sliding surface
(Slide guide) .... $\mu = 0.05$
Motor power supply..... Single phase 115VAC 60Hz
Ball screw total length ....L_B=31.5in
Ball screw shaft diameter ....D_B=0.787in
Ball screw material ....Iron (density ρ=4.64oz/in^3)
Distance moved for one rotation of ball screw
External force..F_A=0lb.
Ball screw tilt angle.......................................α=90°
Movement time...
Brake must provide holding torque Intermittent operation, five hours per day

1. Determining the Gear Ratio

Speed at the gearhead output shaft:

$$N_G = \frac{V \cdot 60}{P} = \frac{(0.6 \pm 0.06) \times 60}{0.197} = 182 \pm 18 \text{ r/min}$$

Because the rated speed for a 4-pole motor at 60Hz is 1450~1550r/min, the gear ratio (i) is calculated as follows:

$$i = \frac{1450\sim1550}{N_G} = \frac{1450\sim1550}{182 \pm 18} = 7.2\sim9.5$$

From within this range a gear ratio of $i = 9$ is selected.

2. Calculating the Required Torque

F, the load weight in the direction of the ball screw shaft, is obtained as follows:

$$F = F_A + W_1 (\sin\alpha + \mu \times \cos\alpha)$$
$$= 0 + 100 (\sin 90 + 0.05 \times \cos 90)$$
$$= 100 \text{ lb.}$$

Preload weight F_0:

$$F_0 = \frac{F}{3} = 33.3 \text{ lb.}$$

Load torque T_L:

$$T_L = \frac{F \times P_B}{2\pi\eta} + \frac{\mu_0 \times F_0 \times P_B}{2\pi} = \frac{100 \times 0.197}{2\pi \times 0.9} + \frac{0.3 \times 33.3 \times 0.197}{2\pi}$$
$$= 3.8 \text{ lb-in}$$

This value is the load torque at the gearhead drive shaft, and must be converted into load torque at the motor output shaft. The required torque at the motor output shaft (T_M) is given by:

$$T_M = \frac{T_L}{i \cdot \eta_G} = \frac{3.8}{9 \times 0.81} = 0.52 \text{ [lb-in]} = 8.32 \text{ oz-in}$$

(Gearhead transmission efficiency $\eta_G = 0.81$)
Look for a margin of safety of 2×, taking into consideration commercial power voltage fluctuation.

$$8.32 \times 2 = 16.64 \text{ oz-in}$$

To find a motor with a start-up torque of 16.64 oz-in or more, select motor **5RK40GN-AWMU**. This motor is equipped with an electromagnetic brake to hold a load. The gearhead with a gear ratio of 9 that can be connected to motor model **5RK40GN-AWMU** is **5GN9KA**.
Just as in Example 1, the rated motor torque is greater than the required torque, so the speed under no-load conditions (1740 r/min) is used to confirm that the motor produces the required speed.

3. Load inertia check

Ball screw moment of inertia $J_1 = \frac{\pi \times \rho \times L_B \times D_B^4}{32}$

$$= \frac{\pi \times 4.64 \times 31.5 \times (0.787)^4}{32}$$
$$= 5.5 \text{ oz-in}^2$$

Table and work moment of inertia $J_2 = \frac{W_1 \times A^2}{(4 \times \pi^2)}$

$$= \frac{1600 \times (0.197)^2}{(4 \times \pi^2)}$$
$$= 1.57 \text{ oz-in}^2$$

Gear head shaft total load inertia $J = 5.5 + 1.57 = 7.07$ [oz-in^2]

Here, the **5GN9KA** permitted load inertia is:

$$J_G = 4 \times 9^2$$
$$= 324 \text{ oz-in}^2$$

See page A-22 to confirm this calculated value. Therefore, $J < J_G$, the load inertia is less than the permitted inertia, so there is no problem. As in Example 1, there is margin for the torque, so the rotation rate is checked with the no-load rotation rate (about 1750 r/min).

$$V = \frac{N_M \cdot P}{60 \cdot i} = 0.64 \text{ in./s}$$

(where N_M is the motor speed).
This confirms that the motor meets the specifications.

Precautions

1. Precautions for Installation

- Do not use in a place where there is flammable gas and/or corrosive gas.
- When installing the motor into your equipment, ensure that the motor lead wires (cable) are fixed and do not move.
  In addition, do not apply any pressure to these lead wires.
- Motors and Drivers for use only in equipment of protection class Ⅰ.
- The motor housing must be mounted with a screw and spring washer to the ground point of the equipment.
- Installation must be performed by a qualified installer.

2. Precautions for Operation

- The Motor case and the Driver enclosure temperature can exceed 158°F (70°C) depending on operation conditions. In case motor is accessible during operation, please attach the following warning label so that it is clearly visible.


Warning label

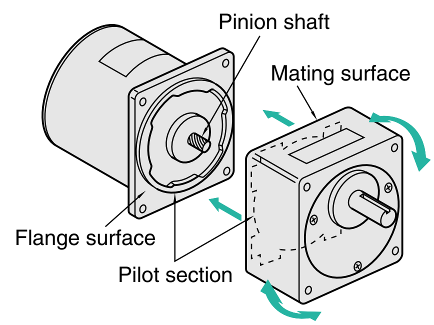
- Always turn off the power to the motor before conducting checks or performing word on the motor.
  Thermally protected motors will restart automatically when motor temperature falls bellow a certain level.
- The electromagnetic brake is designed to activate when power is removed. However, it may not arrest all loads completely. If this motor is designed to hold in emergency situations then a second method of stopping the load must be used to ensure to load stops. If this is not used injury or machine damage may result.

Connecting Gearheads to Motors

1. Connecting Gearheads

As the figure below shows, a gearhead is combined with a motor using the recessed areas on each unit as guides. The gearhead should be moved gently from side to side without forcing the pinion shaft against the plate on the gearhead or against the gear itself.

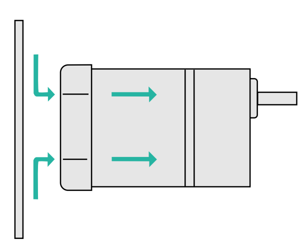
A tempting to put motor and gearhead together by force can result in damage to the gearhead.



2. Mounting Motor/Gearhead to Machinery

The motor flange is provided with a recessed area that serves as a guide not only when assembling the motor and gearhead as shown in the above figure, but also when installing the motor/gearhead unit directly to the machinery.
The figures demonstrate how to install a motor and gearhead in machinery. In this example, the motor/gearhead unit is mounted directly to the machinery, but dedicated mounting brackets such as those shown can also be used.

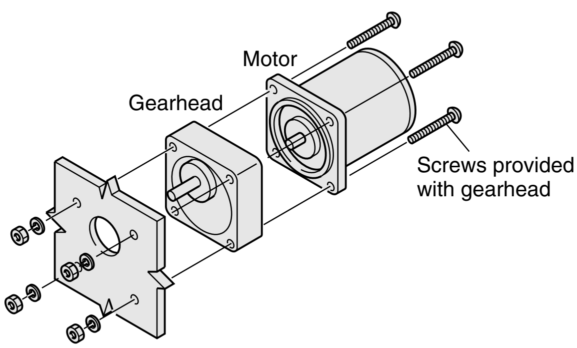
When mounting motors that have a built-in cooling fan, leave a space of approximately 0.5 inch behind the fan cover or make ventilation holes so as not to block the cooling intake.



Installation conditions
Install the motor and capacitor in a location that meets the following conditions. Using the motor and capacitor in a location that does not satisfy these conditions could damage it.
- Indoors (this product is designed and manufactured to be installed within another device)
- Ambient temperature: 14°F~104°F (avoid freezing)
- Ambient humidity: 85% max. (avoid condensation)
- Not exposed to explosive, flammable or corrosive gas
- Not exposed to direct sunlight
- Not exposed to dust
- Not exposed to water or oil
- Place where heat can escape easily
- Not exposed to continuous vibration or excessive impact
- 328 feet (1000 meters) or less above sea level.
- Installation Category Ⅱ, Pollution Degree2, Class Ⅰ (for EN60950)

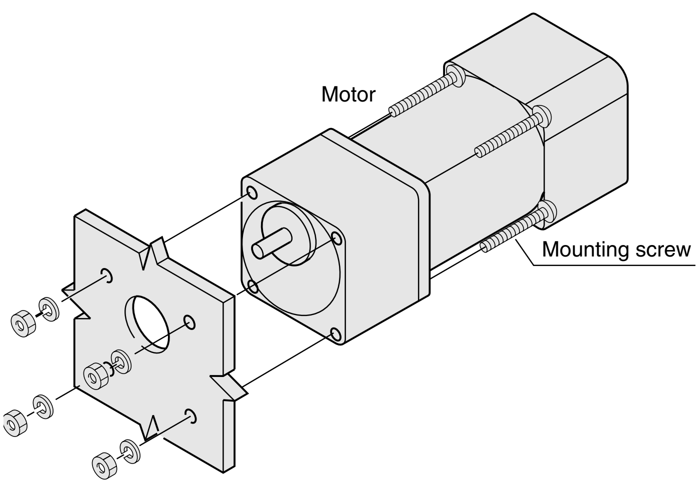
GN, GB and GU type Gearheads

Use the screws provided with the gearhead and secure all the parts so that there are no gaps between the motor flange face and the recessed area of the gearhead.



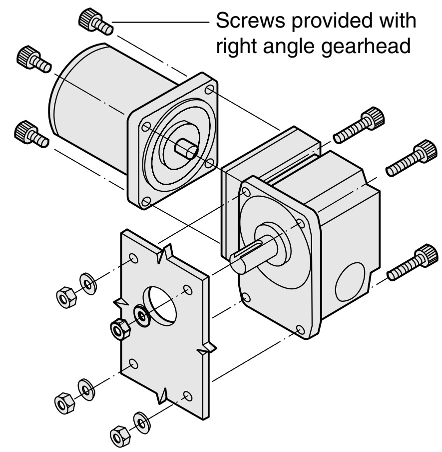
BH series

BH series motors are provided as a gearmotor for easy installation. Use the screws provided with the product to attach the unit from the motor side.



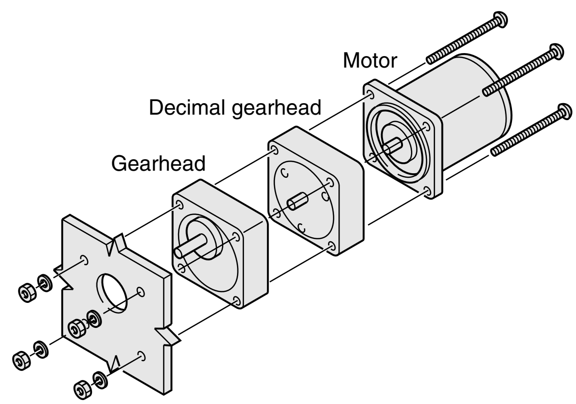
Right Angle Gearheads

Before mounting the right angle gearhead to machinery, assemble the motor and the gearhead using the screws provided.



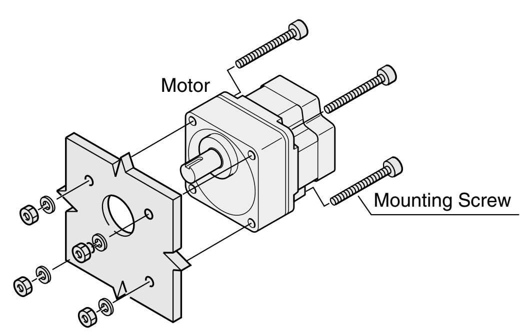
Mounting Decimal Gearhead to GN, GB and GU type Gearheads

Use the screws provided with the decimal gearhead and secure all the parts so that there are no gaps between the motor flange face and the recessed area of the decimal gearhead, or between the decimal gearhead and the gearhead's recessed area.



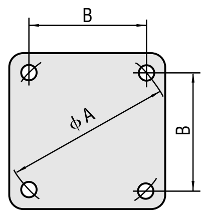
FBLⅡ Series

The **FBLⅡ** series is a gear motor in which the motor and gear head are pre-installed. Use the included installation screws to install on the device.



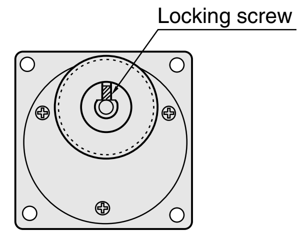
3. *Dimensions of Mounting Holes*

Each product's dimension a drawing shows the mounting holes dimension with diametrical pitch. The distance between mounting holes is shown below.

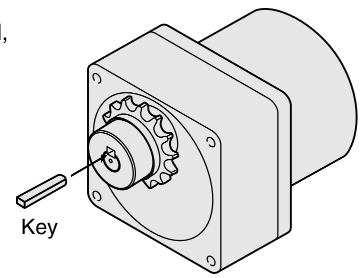


Motor Frame Size	A inch (mm)	B inch (mm)
1.65in. sq.	1.89 (48)	1.336 (33.94)
2.36in. sq.	2.76 (70)	1.949 (49.50)
2.76in. sq.	3.23 (82)	2.283 (57.98)
3.15in. sq.	3.70 (94)	2.617 (66.47)
3.54in. sq.	4.09 (104)	2.895 (73.54)
4.09in. sq.	4.72 (120)	3.341 (84.85)

Securing Load to Shaft Flat
With a shaft flat, use a locking screw to ensure that the load does not slip. We recommend using double point screws or other screws with strong locking power.



Securing Load Using Key Way
Secure loads using the key provided with the gearhead, fitting it into a key way.



Note:
Ensure that the gearhead shaft is not subjected to shock in the axial direction, since this will have an adverse effect on the bearings. Be especially careful not to use a hammer when inserting the key.

4. *Securing Load to Output Shaft*

The output shafts of high power gearheads are provided with a key way to secure the load, while the shafts of gearheads with comparatively low power have been given a shaft flat. Round shaft motors come in two types, those with and without a shaft flat on the motor output shaft.

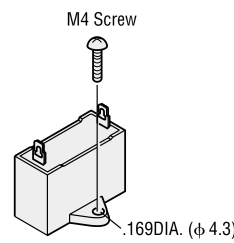
In round shaft types, the output shaft has a tolerance of ±0.0002 inch (except 60W and 90W types) in diameter and is finished to a eccentricity of 0.0008 inch. Therefore, when connecting a load to the shaft, take measurements using a dial gauge or similar instrument. To couple to a shaft, use a helical coupling, to avoid unnecessary strain on the shaft. The same procedure applies when securing a load to gearheads.

Shaft Flat
0GN, **2GN**, **2GB**, **3GN**, **4GN**, **4GB**, **5GN** Gearheads
Round shaft motors with frame size of 3.15in. sq. and 3.54in. sq.

Key Way
5GU, **5GC**, **5GCH**, **BHI62□-□**, **BHI62□T-□**
FBL575□W-□, **FBL5120□W-□**
HBL560N-□, **HBL5100N-□**
gearheads

5. *Capacitor installation method*

Unit = inch (mm)

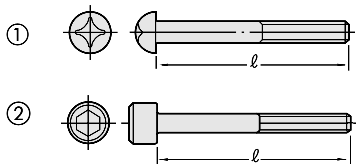


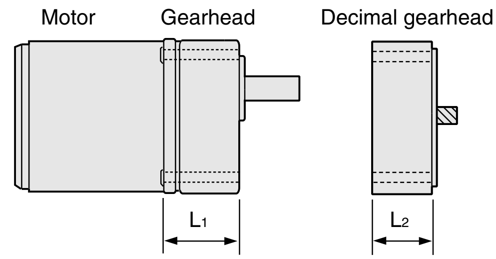
Install securely, using the screw shown on the drawing.

6. Screw Dimensions

GN type, GU type, GB type, GC type, BH Series, FBLⅡ Series, HBL Series,FPW Series, Gearheads

The following screws are provided with the gearhead and decimal gearhead.





Gearhead					Screws			
Model	L_1		L_1+L_2		ℓ			
	inch	mm	inch	mm	inch	mm		Drawing
0GN3KA~180KA	1.22	31	–	–	1.57	40	No.4-40UNC	①
2GN3KA~18KA	1.46	37	–	–	1.97	50	No.8-32UNC	
2GN25KA~180KA	1.85	47	–	–	2.36	60		
3GN3KA~18KA	1.54	39	–	–	1.97	50	No.10-24UNC	
3GN25KA~180KA	1.93	49	–	–	2.56	65		
4GN3KA~18KA	1.54	39	–	–	1.97	50		
4GN25KA~180KA	1.95	49.5	–	–	2.56	65		
5GN3KA~18KA	1.95	49.5	–	–	2.76	70	1/4-20UNC	
5GN25KA~180KA	2.66	67.5	–	–	3.27	83		
5GU3KA~180KA	2.85	72.5	–	–	3.74	95		②
BHI62□-3.6~180, **BHI62□T-3.6~180**	3.27	83	–	–	3.94	100	M8P1.25	
2GN10XK (Decimal Gearhead)	–	–	2.87	73	3.35	85	M4P0.7	①
3GN10XK (Decimal Gearhead)	–	–	3.11	79	3.54	90	M5P0.8	
4GN10XK (Decimal Gearhead)	–	–	3.21	81.5	3.74	95		
5GN10XK (Decimal Gearhead)	–	–	4.11	104.5	4.72	120	M6P1.0	
5GU10XKB (Decimal Gearhead)	–	–	4.43	112.5	5.51	140		②
2GB3KA~18K	1.30	33	–	–	1.77	45	M4P0.7	①
2GB25KA~360KA	1.65	42	–	–	1.97	50		
4GB3KA~18KA	1.54	39	–	–	1.97	50	M5P0.8	
4GB25KA~360KA	1.95	49.5	–	–	2.56	65		
2GB10XK (Decimal Gearhead)	–	–	2.68	68	3.35	85	M4P0.7	
4GB10XK (Decimal Gearhead)	–	–	3.21	81.5	3.74	95	M5P0.8	
FBL575□W-5~20, **FBL5120□W-5~20** (Combination type)	2.17	55	–	–	2.95	75	M8P1.25	②
FBL575□W-30~100, **FBL5120□W-30~100** (Combination type)	2.68	68	–	–	3.54	90		
FBL575□W-200, **FBL5120□W-200** (Combination type)	2.91	74	–	–	3.74	95		
HBL560N-5~20, **HBL5100N-5~20** (Combination type)	2.17	55	–	–	2.95	75		
HBL560N-30~100, **HBL5100N-30~100** (Combination type)	2.68	68	–	–	3.54	90		
HBL560N-200, **HBL5100N-200** (Combination type)	2.91	74	–	–	3.74	95		
HBL425□-□	2.32	59	–	–	3.15	80	M5P0.8	
HBL540□-□	2.85	72.5	–	–	3.54	90	M6P1.0	
HBL560□-□	2.93	74.5	–	–	3.54	90		
HBL690□-□	3.25	82.5	–	–	3.94	100	M8P1.25	

- The figures of L_1+L_2 refer to sizes when a decimal gearhead and a gearhead with gear reduction ratio of 25:1 or greater are connected.
- 4 washers and 4 hexagonal nuts are provided with the screws.
- Stainless steel screws are provided with the **FPW** series washdown motors.

Right Angle Gearhead

To assemble the motor and gearhead, use the screws provided with the gearhead. To mount an additional decimal gearhead, use the screws provided with the decimal gearhead. To attach the gearhead to other devices, obtain the screws separately.

Gearhead	Screws 4 Washers and 4 hexagonal nuts are provided		
Model	ℓ inch (mm)	Size of Screws	Shape of Screws
4GN □RAA•RH	0.59 (15)	M5P0.8	②
5GN (U) □RAA•RH	0.79 (20)	M6P1.0	②

Control circuit installation

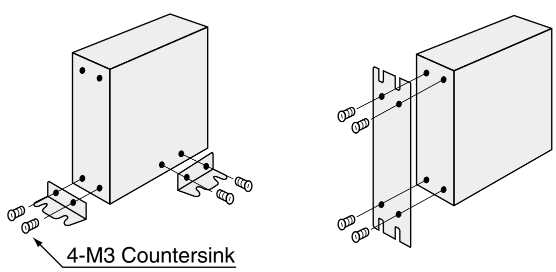
1. Control circuit installation method

When installing the driver, speed control pack, control unit, and other control circuits in the device, use the fittings and screws that are provided. (DIN rail installation plates are also available as an option. For details, see Page A-271.)

Note:
When attaching the driver in an enclosed space such as a control box, or somewhere close to a heat-radiating object, vent holes should be used to prevent the drivers from overheating. If the ambient temperature listed in the installation conditions for the control circuit is exceeded, use forced-air cooling with a fan.

● FBLⅡ Series✻

Base Mounting　　Back Mounting

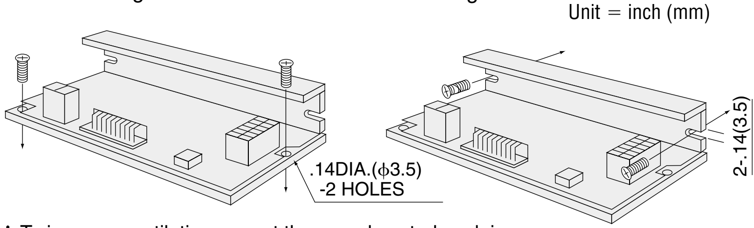


● HBL Series

Use M3 screws for mounting (not provided)

Base Mounting　　Back Mounting

Unit = inch (mm)



✻ To improve ventilation, mount the speed control pack in an upright position as shown in the figures above.

● US Series Control Unit

Please see Page A-163.

2. Installation conditions

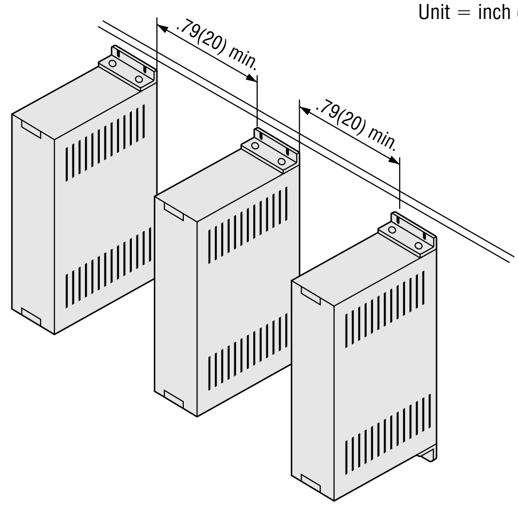
Install the driver, speed control pack and speed control unit in a location that meets the following conditions. Using the unit in a location that does not satisfy these conditions could cause damage.

- Indoors (this product is designed and manufactured to be installed within another device)
- Ambient temperature : Depends on the product, so see the appropriate page.
- Ambient humidity: 85% max. (avoid condensation)
- Not exposed to explosive, flammable or corrosive gas
- Not exposed to direct sunlight
- Not exposed to dust
- Not exposed to water or oil
- Place where heat can escape easily
- Not exposed to continuous vibration or excessive impact
- 328 feet (1000 meters) or less above sea level.
- Installation Category Ⅱ, Pollution Degree 2, Class Ⅰ (for EN60950)

3. Mounting Two or More Drivers

When mounting two or more drivers, separate them by a space of at least 0.79 inch (20mm). Leave at least 0.98 inch (25mm) between of space the driver and other devices or structures.

Unit = inch (mm)



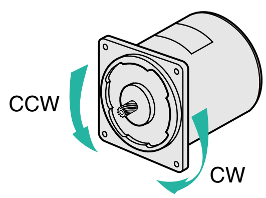
Motor Use

1. Power

Oriental Motor standard AC motors are available for single-phase 115VAC, single-phase 230VAC and three-phase 230VAC specifications.
Capacitors must always be connected to single-phase motors.

2. Direction of Rotation

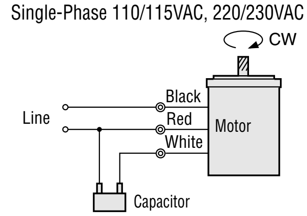
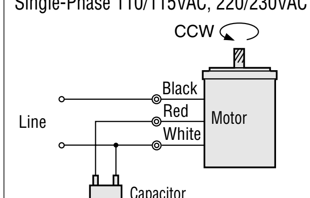
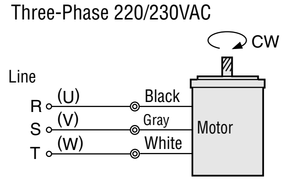
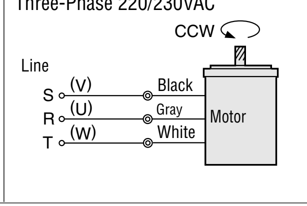
Clockwise (CW) and counterclockwise (CCW) direction of rotation, as referred to in the motor connection diagrams of this catalog, is defined as the direction of rotation when viewing the mounting face end of the motor. The direction of rotation of a gearhead used with the motor is determined by its design and, depending on the gear ratio, may be the same or the opposite of the direction of rotation of the motor. Changing the direction of rotation of the gearhead can be done by changing the direction of rotation of the motor.



● Induction Motors

Change the direction of motor rotation only after the motor comes to a complete stop. If an attempt is made to change the direction of rotation while the motor is rotating, the motor may ignore the reversing command or change its direction of rotation after some delay.

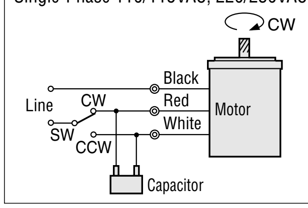
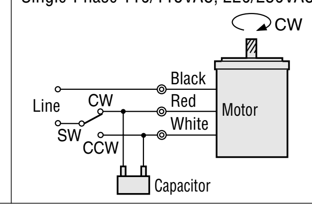
Example

<table>
<tr><th>Clockwise direction</th><th>Counterclockwise direction</th></tr>
<tr><td>Single-Phase 110/115VAC, 220/230VAC

</td><td>Single-Phase 110/115VAC, 220/230VAC

</td></tr>
<tr><td>Three-Phase 220/230VAC

</td><td>Three-Phase 220/230VAC

</td></tr>
</table>

● Reversible Motors

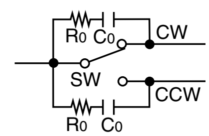
The direction of rotation can be reversed during motor rotation using a switch. Moving the switch to CW causes the motor to rotate clockwise; moving the switch to CCW causes the motor to rotate counterclockwise.

Example

<table>
<tr><th>Clockwise direction</th><th>Counterclockwise direction</th></tr>
<tr><td>Single-Phase 110/115VAC, 220/230VAC

</td><td>Single-Phase 110/115VAC, 220/230VAC

</td></tr>
</table>

● Contact capacity

Connect a CR circuit (surge suppressor) like that in the drawing in order to protect the contacts.



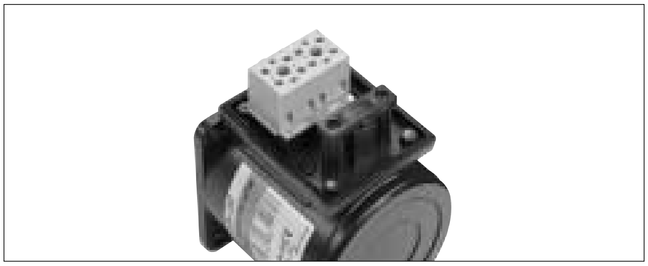
Code	Contact capacity, others	Remarks
SW	AC125V 5Amin.or AC250V 5Amin.(Induction load)	–
Ro・Co	Ro=5~200Ω Co=0.1~0.2μF 200W (400WV)	Accessories **EPCR1201-2** A-272

3. Grounding

Lead Wire Type and Small Terminal Box Type
Any one of the four mounting bolts may be used to attach the ground wire to the motor casing when installing the unit. If necessary, remove all paint that may impede conductivity around the bolt mounting hole.

● Terminal Box Type (for 4IK, 4RK, 5IK, 5RK and BH types)

Connect the ground wire to the ground terminal inside the terminal box.

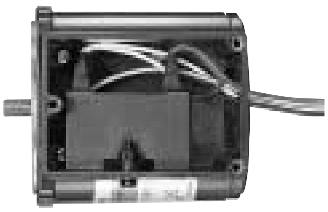


● Conduit Box Type

Conduit box mounted motors have a ground lead wire (green wire). Connect the ground wire to this green lead wire.

Single-Phase Motors

Conduit Box



Three-Phase Motors

Conduit Box

4. *Terminal Box*

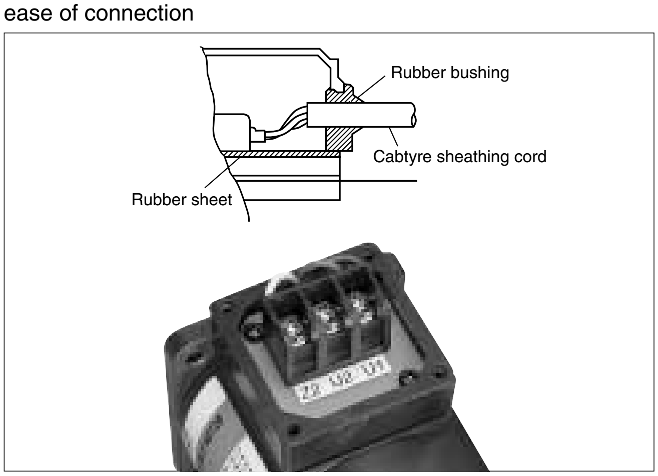
Induction motors and reversible motors are available with mounted terminal boxes for easy and secure connections of electrical wiring. They are suitable for automated and laborsaving applications where their ability to withstand rough operating conditions is essential, e.g. for machine tools and plant machinery.

●Types of Terminal Boxes

Depending on the motor model two types of terminal boxes are available: a small terminal box and a large terminal box, the latter being outfitted with a pressure sealing ring at the point of cord entry.

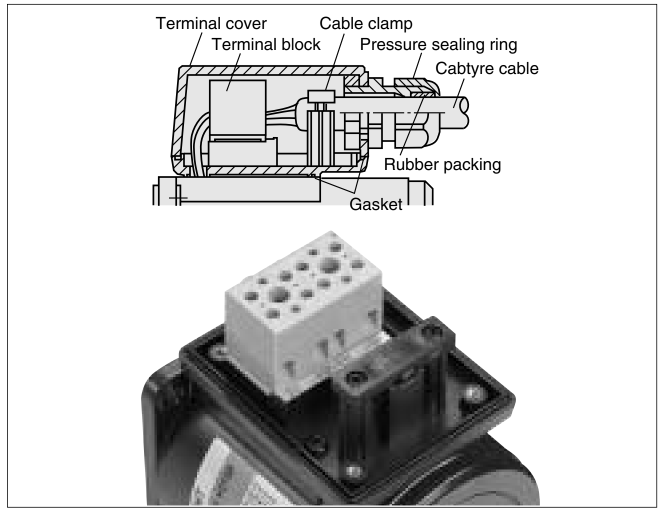
Small Terminal Box (for 2IK and 2RK types)

Light, compact and with in-line arrangement of terminals for ease of connection



Terminal Box (for 4IK, 4RK, 5IK, 5RK and BH types)

A cable clamp and pressure sealing ring securely fasten the cable at two points.



The material of the terminal box is a PBT resin with excellent insulation performance. The terminal block has met safety standards and been recognized ro certified by major certification bodies.

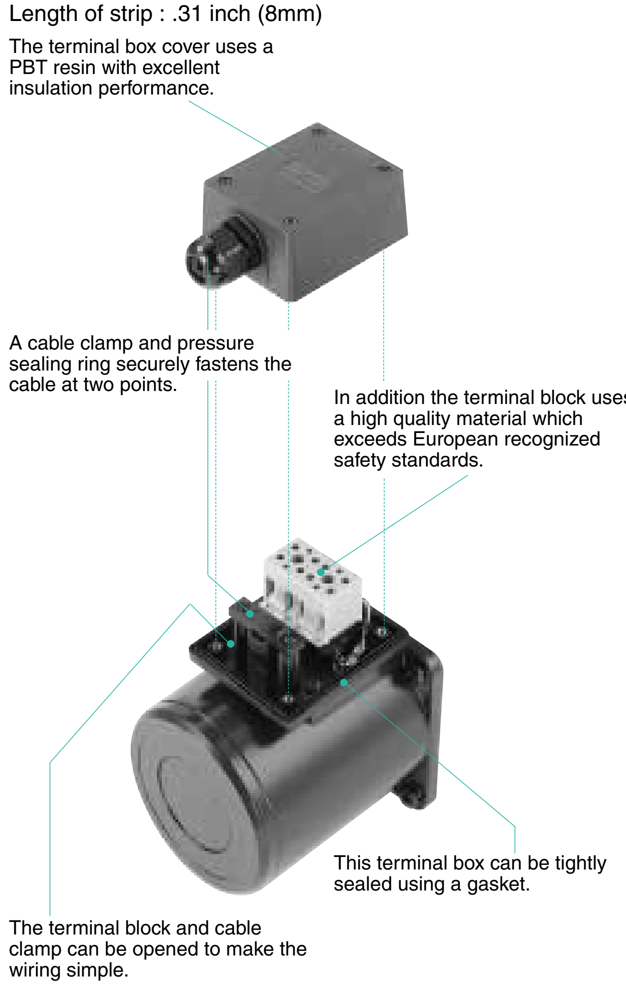
When connecting cables to the terminal block, unfasten the screw of the connector and insert the lead wire with a screw driver. Then insert the lead wire to the insert port and refasten the screw securely.

Diameter of the suitable cabtyre cable: .24DIA. (ϕ6mm) ~.47DIA. (ϕ12mm)

Lead wires specifications

Thickness : AWG 24~12

Length of strip : .31 inch (8mm)



5. Capacitor

Capacitor motors are wound so that the axis of the primary coil and the secondary coil poles are 90˚ apart. The capacitor is connected in series to the secondary coil and its function is to advance the phase of the current flowing in the secondary coil. The motors employ vapor-deposition polar capacitors which are UL recognized models. These capacitors have elements created on paper or plastic film through metal vapor deposition and can repair themselves, so they are commonly dubbed SH (self-healing) capacitors. Paper elements used to be the most common, but in recent years miniaturization of capacitors has made plastic film elements the dominant type.

Our single-phase motors are capacitor motors. When using a capacitor with the motor, make sure that the rated capacitance and voltage as indicated on the capacitor correspond to the specifications on the motor and that all electrical connections are correct.

Capacitance

If a capacitor of the wrong value is used, motor vibration and heat generation will become abnormally large and operation will become unstable due to a loss of torque. For this reason, always use a capacitor of the correct capacitance. Capacitance is indicated by the unit of microfarads (μF).

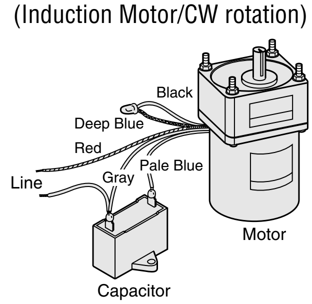
Rated Voltage

Using the motor beyond the rated voltage can drastically shorten the operating life of the capacitor. Always use a capacitor of proper voltage ratings. The voltage rating of the capacitor is indicated in the unit of Volts (VAC).

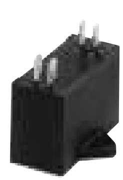
● Connecting the Capacitor

2-terminal type

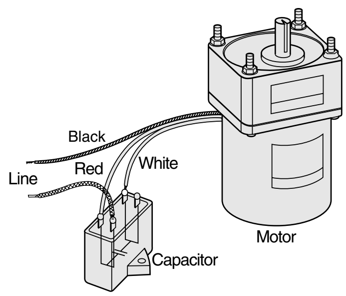
●Connection of capacitor and motor (Induction Motor/CW rotation)



4-terminal type

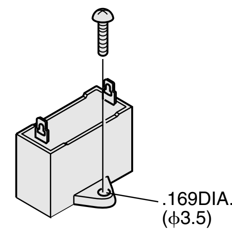


●Connection of capacitor and motor (Induction Motor/CW rotation)

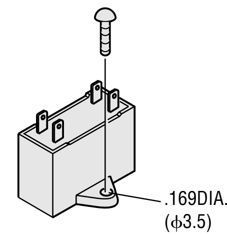


● Installing the Capacitor

Unit = inch (mm)



Use screws to install the capacitor to your machine.



Use screws of size M-4 to install the capacitor to your machine.

Note: When motors are running, a voltage of twice the motor power supply voltage is applied across the terminals of the capacitor. The terminals must therefore be insulated to ensure safety.

6. Ambient Temperature and Temperature Rise in Motor

The ambient temperature and the rise of the motor temperature are limiting parameters for the suitability of a motor in a given application.

Ambient Temperature

Use motors at ambient temperatures between 14°F(−10°C) and 104°F(+40°C) Part of motor : between 14°F(−10°C) and 122°F(+50°C). When used at temperatures outside of this range, an additional rise in temperature caused by motor operation may lead to deterioration of the winding insulation of the motor or may drastically shorten the operating life of the ball bearings. Low ambient temperatures result in problems primarily with starting characteristics. Inner friction of the motor increases with the decrease in viscosity of gearhead and ball bearing lubricants resulting in a slower ramp up of the motor or failure of the motor to start.

Temperature Rise in Motor

When a motor is operating, all energy losses of the motor are transformed into heat, causing the motor temperature to rise.

● **Induction Motors**

The induction motor, which is rated for continuous duty, reaches the saturation point of temperature rise after two or three hours of operation, whereupon the temperature stabilizes.

● **Reversible Motors**

Reversible motors reach their limit for temperature rise after 30 minutes of operation. If operation continues beyond that normal temperature rise, it may lead to damage or shortened life of the motor.

Measuring the Temperature Rise

The following is a description of the methods Oriental Motor uses for temperature measurement and for the determination of the maximum allowable temperature rise of a motor.

● **Thermometer Method**

The temperature at which the temperature rise during motor operation becomes saturated is measured using a thermometer or thermocouple attached to the center of the motor case. The temperature rise is defined as the difference between the ambient temperature and the measured temperature.

● **Resistance Change Method**

In this method, the coil resistance is measured before running and again after a period of running. The measurement should be taken at the point of maximum temperature rise.

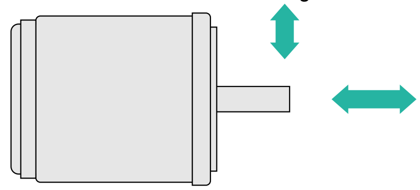
The point of the highest motor temperature rise is the windings. For this reason, the maximum allowable temperature of the windings is the one stated in the EN/IEC, UL, CSA standards for the given type of insulation materials. Some Oriental Motor motors employ Class B insulation. According to EN/IEC, UL, CSA standards, the temperature of the windings is 266˚F(+130°C). Note that if the motor is started and stopped frequently, if the direction of motor rotation is frequently changed, or if the motor is frequently brought to an instantaneous stop using an electromagnetic brake or similar mechanism, the temperature of the motor may rise more than that of normal operation. The lower the temperature, the longer the life of the motor. Some of the motors are equipped with a thermal protector as overheat protection.

Some of the motors have Type E insulation (248˚F[+120°C]) or Type A insulation (221˚F[+105°C]).

Although the motor case may become very hot while the motor is in operation, in some case as high as 200˚F (+93°C), this does not indicate a malfunction. Take precautions against heat before touching the motor, and avoid accidents by keeping flammable materials away from the motor.

7. Permissible Overhung Load and Permissible Thrust Load

Thrust load and overhung load exceeding the permitted values invite short-term fatigue on the bearings and breakdown due to the repeated load on the output shaft.



Operate so that the overhung load does not exceed the permitted values in the table below. When a chain, belt, etc. is used as the transmission mechanism, the method for calculating the load on the output shaft is the same as for a gear head output shaft. For details, see Page A-22.
Also, avoid thrust loads as much as possible. If thrust load is unavoidable, keep it to no more than half the motor weight.

■ Permissible Overhung Load on the Motor Shaft

● **AC Motor**

Motor			Permissible Overhung Load lb.(N)			
Motor Frame Size inch(mm)	Motor Shaft Size inch(mm)	Series	0.4 inch(10mm) from shaft end		0.8 inch(20mm) from shaft end	
1.64 (42) sq.	.1969DIA. (ϕ 5)	K	8.8	(40)	–	–
2.36 (60) sq.	.2500DIA. (ϕ 6.35)	J	11	(50)	24.3	(110)
		K	11	(50)	24.3	(110)
2.76 (70) sq.	.2500DIA. (ϕ 6.35)	J	8.8	(40)	13.2	(60)
		K	8.8	(40)	13.2	(60)
3.15 (80) sq.	.3125DIA. (ϕ 7.937)	J	19.8	(90)	30.9	(140)
		K	19.8	(90)	30.9	(140)
3.54 (90) sq.	.3750DIA. (ϕ 9.525)	K	30.9	(140)	44.1	(200)
	.4724DIA. (ϕ 12)	K(with fan)	52.9	(240)	59.5	(270)
4.09 (104) sq.	.5512DIA. (ϕ 14)	BH	70.5	(320)	77.2	(350)

● **Brushless DC Motor**

Motor			Permissible Overhung Load lb.(N)			
Motor Frame Size inch(mm)	Motor Shaft Size inch(mm)	Series	0.4 inch(10mm) from shaft end		0.8 inch(20mm) from shaft end	
2.36 (60) sq.	.2362DIA.(ϕ 6)	**HBL**	17.6	(80)	19.8	(90)
3.15 (80) sq.	.3150DIA.(ϕ 8)	**HBL**	17.6	(80)	24.3	(110)
3.54 (90) sq.	.3937DIA.(ϕ 10)	**HBL** (40W)	26.5	(120)	30.9	(140)
		HBL (60W)	28.7	(130)	33.1	(150)
		FBLII	28.7	(130)	33.1	(150)
	.4724DIA.(ϕ 12)	**HBL**	35.3	(160)	37.5	(170)
		FBLII	35.3	(160)	37.5	(170)

Using Gearheads

Oriental Motor gearheads are specifically designed for easy and direct attachment to AC motors with a pinion shaft. With the reduction of the motor speed through the gearhead, an increase of torque is achieved. A large number of gear ratios are available for many applications.

1. Types of Gearhead

These gearheads listed below are all low noise types. Motors that can be used with these gearheads have a helical cut spline on the shaft that mates with the first stage of gears in the gearhead. This helical gear mating with the first stage, which is the primary source of noise in a gearhead, along with a redesigned gearcase and ball bearings, reduces noise by 7 to 10 dB.
Depending on the motor type and output power, the following gearheads are available.

Application	Gearheads	Decimal Gearheads
light load	**2GB□KA**	**2GB10XK**
	4GB□KA	**4GB10XK**
normal load	**0GN□KA**	—
	2GN□KA	**2GN10XK**
	3GN□KA	**3GN10XK**
	4GN□KA	**4GN10XK**
	5GN□KA	**5GN10XK**
heavy load	**5GU□KA**	**5GU10XKB**
	BHI62F-□, BHI62□T-□	—
impact load	**5GC□KA**	—
	5GCH□KA	—
heavy and/or high speed load	**FBL575□W-□**	—
	FBL5120□W-□	—
	HBL560N-□	—
	HBL5100N-□	—

The box (□) in the model number represents the desired gear ratio, which thereby becomes part of the code for the gearhead.

● Connection Procedures

When connecting gearheads, be sure to match the pinion shafts and frame sizes.

● Decimal Gearheads

The **GB**, **GN** and **GU** type gearheads are also available as gear decimal gearheads (sold separately) with a gear ratio of 10:1. They should be used in applications in which large gear ratios cannot be attained with a single gearhead unit. Any number of decimal gearheads can be used in series.

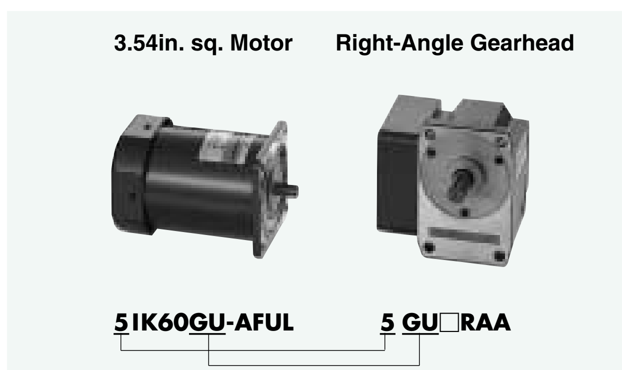
Note

Although the gear ratio of 10:1 of the decimal gearhead theoretically translates into a 10 time increase of torque available on the output shaft, it is not possible to make full use of this torque. The torque permissible in actual use is limited by the physical construction of the gearhead and is expressed as its rated maximum torque. (See the torque table of each product)

● Right-Angle Gearheads

The **4GN**, **5GN** and **5GU** type gearheads are also available as right-angle gearheads.

Type	Model	Motor Output Power
Hollow shaft	**4GN□RH**	25W
	5GN□RH	40W
	5GU□RH	60 · 90W
Solid shaft	**4GN□RAA**	25W
	5GN□RAA	40W
	5GU□RAA	60 · 90W

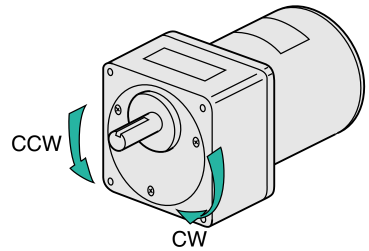


2. Speed and Direction of Rotation

The speed when a gearhead is directly coupled to a motor is calculated according to the following formula:

$$N_G = \frac{N_M}{i}$$

N_G: Speed of Gearhead [r/min]
N_M: Speed of motor [r/min]
i : Gear ratio of gearhead



■ Same direction as the motor shaft
□ Opposite direction as the motor shaft

The direction of gearhead shaft rotation may differ from motor shaft rotation depending on the reduction ratio of the gearhead.

Gearhead Model \ Gear Ratio	3	3.6	5	6	7.5	9	12.5	15	18	25	30	36	50	60	75	90	100	120	150	180	250	300	360
2GN□KA, 3GN□KA, 4GN□KA, 5GN□KA	■	■	■	■	■	■	■	■	■	□	□	□	■	■	■	■	■	■	■	■			
2GB□KA, 4GB□KA	■	■	■	■	■	■	■	■	■	□	□	□	■	■	■	■	■	■	■	■	□	□	□
0GN□KA, 5GU□KA	■	■	■	■	■	■	□	□	□	■	■	■	■	■	□	□	□	□	□	□			
BHI62□-□		■		■		■		□	□		□	□		■		■		■		□			

Connection of a decimal gearhead reduces the speed by 10 : 1 but does not affect the direction of rotation.

Gearhead Model \ Gear Ratio	5	10	15	20	30	50	100	200
FBL575□W-□, FBL5120□W-□ HBL560N-□, HBL5100N-□	■	■	■	■	□	□	□	■

3. Output Torque of Gearmotor

The output torque when a gearhead is directly connected is calculated as follows:

$$T_G = T_M \times i \times \eta$$

T_G: Output Torque at Gear Shaft [oz-in]
T_M: Motor Torque [oz-in]
i : Gear Ratio of Gearhead
η: Gearhead Efficiency

● Gearhead Efficiency

Gearhead Model \ Gear Ratio	3	3.6	5	6	7.5	9	12.5	15	18	25	30	36	50	60	75	90	100	120	150	180	250	300	360
2GN□KA, 3GN□KA, 4GN□KA, 5GN□KA	81%									73%			66%										
2GB□KA, 4GB□KA	81%									73%			66%								59%		
0GN□KA, 5GU□KA	81%						73%			66%					59%								
BHI62F-□, BHI62□T-□		90%		90%		90%		86%			86%			81%		81%		81%		81%			

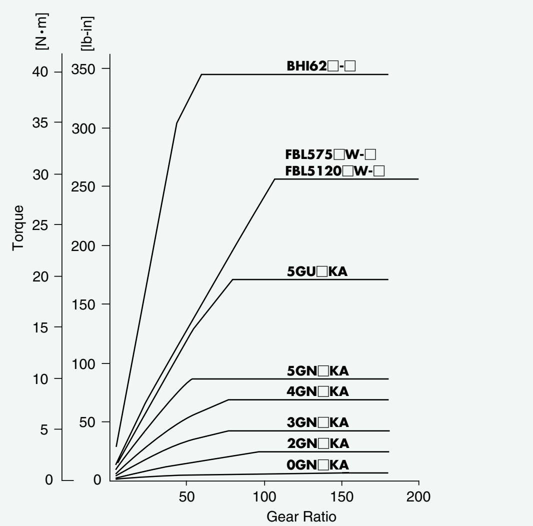
Gearhead efficiency of all the decimal gearheads is 81%.

Gearhead Model \ Gear Ratio	5	10	15	20	30	50	100	200
FBL575□W-□, FBL5120□W-□ HBL560N-□, HBL5100N-□	90%				86%			81%

● Maximum Permissible Torque

Since the output torque of the gearhead increases proportionally with the reduction of speed, a high gear ratio will result in an output torque that cannot be handled by physical construction of the gearhead. The maximum permissible torque of the gearhead and the speed-reduction ratio is as follows:

Maximum Permissible Torque of Gearheads



Example: If induction motor **4IK25GN-AWU** is combined with gearhead **4GN100KA**, the output torque is...
The rated torque of motor **4IK25GN-AWU** is 23.6 oz-in.
The gearhead output torque is calculated using the equation on the previous page.

Output torque $T_G = T_M \times i \times \eta$
$= 23.6 \times 100 \times 0.66$
$= 1558$ oz-in (≒97.4 lb-in)

The maximum permissible torque for **4GN100KA** is 69 lb-in as shown in the diagram above. Therefore, the load torque that can be exerted is only 69 lb-in even if the gearhead has theoretical output torque is 94 lb-in.

4. *Permissible Load Inertia for Gearheads*

When a high load inertia (J) is connected to a gearhead, high torques are exerted instantaneously on the gearhead when starting up in frequent, discontinuous operations (or when stopped by an electromagnetic brake).
Excessive impact loads can be the cause of gearhead or motor damage.
The table shown below gives values for permissible inertial load on the motor shaft. Use the motor and gearhead within these parameters.
The permissible inertial load value shown for three-phase motors is the value when reversing after a stop.
The permissible J on the gearhead output shaft is calculated with the following equation. The life of the gearhead when operating at the permissible inertial load with instantaneous stops of the motors with electromagnetic brakes is at least 2 million cycles.

● Permissible Inertia Load

Gear ratio 1/3~1/50 ················ $J_G = J_M \times i^2$

Gear ratio 1/60 or higher ·········· $J_G = J_M \times 2500$

J_G : Permissible Inertia Load (oz-in^2) on the gearhead output shaft
J_M : Permissible Inertia Load (oz-in^2) on the motor shaft
i : Gear ratio (Example : $i = 3$ means the gear ratio of 1/3)

Permissible Load Inertia on the motor shaft

AC Motor

No. of Phase	Frame Size inch (mm)	Output Power (W)	Permissible Inertial Load at Motor Shaft oz-in^2 ($\times 10^{-4}$kgm^2)
Single-Phase	1.64 (42) sq.	1W	0.088 (0.016)
	2.36 (60) sq.	3W, 4W	0.26 (0.047)
		6W	0.34 (0.062)
	2.76 (70) sq.	10W	0.56 (0.10)
		15W	0.78 (0.14)
	3.15 (80) sq.	15W, 20W	1.2 (0.22)
		25W	1.6 (0.31)
	3.54 (90) sq.	40W	4.0 (0.75)
		60W	6.2 (1.1)
		90W	6.2 (1.1)
	4.09 (104) sq.	200W	11 (2.0)
Three-Phase	3.15 (80) sq.	25W	1.6 (0.31)
	3.54 (90) sq.	40W	4.0 (0.75)
		60W	6.2 (1.1)
		90W	6.2 (1.1)
	40.9 (104) sq.	200W	11 (2.0)

Brushless DC Motor

Series	Frame Size inch (mm)	Output Power (W)	Permissible Inertial Load at Motor Shaft oz-in^2 ($\times 10^{-4}$kgm^2)
FBLⅡ Series	3.54 (90) sq.	75W	5.4 (1.0)
		120W	5.4 (1.0)
HBL Series	2.36 (60) sq.	10W	0.34 (0.062)
	3.15 (80) sq.	25W	1.2 (0.22)
	3.54 (90) sq.	40W	2.1 (0.40)
		60W	5.4 (1.0)
		100W	5.4 (1.0)

5. Service Life of Gearhead

Gearhead life is almost completely determined by bearing life. When gearheads are operated under the following conditions, the life of the gearheads is approximately 5000 hours for ball bearing types. This is termed "rated life".

- Torque: Rated Torque
- Load: Uniform and continuous
- Operating time: 8 hours per day
- Case temperature: 176°F(80°C) (Ball bearing type)

However, there is usually some fluctuation in load. To evaluate gearhead life expectancies, a "service factor" is used.

Service Factor

Type of Load	Service Factor		
	5 hours/day Intermittent	8 hours/day	24 hours/day
Uniform	0.8	1.0	1.5
Light impact	1.2	1.5	2.0
Medium impact	1.5	2.0	2.5

Example of Load

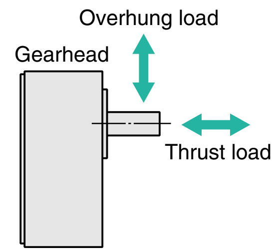
Type of Load	Example of Load
Uniform	Belt conveyor, Uni-directional operation
Light impact	Frequent start/stop, Cam drive
Medium impact	Frequent CW/CCW operation, Frequent instantaneous stop

A gearhead under continuous operation for eight hours per day under a uniform load has been given the reference service factor of 1.0. The life of the gearhead when operated within the limit for permissible torque is then 5000 hours for a ball bearing type gearhead. (Temperature of gearhead casing not exceeding 176°F[80°C].)

However, when such a gearhead is operated continuously for 24 hours a day, the service factor rises to 1.5. With an identical load torque, the life of the motor will be reduced to 1/1.5 of the original life expectancy. For example, if a life of 5000 hours is required for a **4GN□KA** type gearhead, it must be operated with 2/3 or less of the torque for 8-hour operation, or a gearhead with a larger permissible torque must be used.

6. Permissible Overhung Load and Permissible Thrust Load

"Overhung load" refers to load placed on the output shaft as shown in the figure below. The "thrust load" is a load applied in the axial direction of the output shaft. Since the overhung load and thrust load have a great influence on the life of the bearings and strength of the shaft, be careful not to exceed the maximum values shown in the chart below.



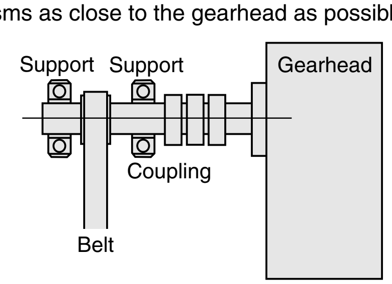
$$W = \frac{K \times T \times f}{\gamma}$$

W: Overhung Load [lb]
K: Load Coefficient for Driving Method (See table below)
T: Torque at Gearhead Output Shaft [lb-in]
f: Service Factor
γ: Effective Radius of Gear or Pulleys [in]

Drive System	K
Chain or toothed belt	1
Gear	1.25
V-belt	1.5
Flat belt	2.5

Take precautions so that the overhung load as calculated by the above equation does not exceed the permissible values given in the table to the right. If the overhung load greatly exceeds the permissible value, it will lead to the shortening of bearing life or damage to the bearing, as well as warping or breaking the output shaft after continued heavy load. In such situations, a support such as the one shown below must be designed to take up the overhung load.

Since connecting a transmission mechanism directly to the output shaft exerts an unbalanced load on the shaft, connect mechanisms as close to the gearhead as possible.



Permissible Overhung Load and Permissible Thrust Load

Gearhead Mode	Gear Ratio	Maximum Permissible Torque lb-in (N·m)	Permissible Overhung Load lb.(N) 0.4 inch(10mm) from shaft end	0.8 inch(20mm) from shaft end	Permissible Thrust Load lb.(N)
0GN□KA	**3~180**	8.7 (1.0)	4.4 (20)	–	3.3 (15)
2GB□KA	**3~360**	13 (1.5)	8.8 (40)	13 (60)	6.6 (30)
2GN□KA	**3~18**	26 (3.0)	11 (50)	18 (80)	6.6 (30)
	25~180		26 (120)	40 (180)	
3GN□KA	**3~18**	43 (5.0)	18 (80)	26 (120)	8.8 (40)
	25~180		33 (150)	55 (250)	
4GB□KA	**3~18**	43 (5.0)	18 (80)	26 (120)	11 (50)
	25~360		33 (150)	55 (250)	
4GN□KA	**3~18**	69 (8.0)	22 (100)	33 (150)	11 (50)
	25~180		44 (200)	66 (300)	
5GN□KA	**3~18**	87 (10)	55 (250)	77 (350)	22 (100)
	25~180		66 (300)	99 (450)	
5GU□KA	**3~9**	174 (20)	88 (400)	110 (500)	33 (150)
	12.5~18		99 (450)	132 (600)	
	25~180		110 (500)	154 (700)	
BHI62F-□	**3.6~9**	347 (40)	121 (550)	176 (800)	44 (200)
BHI62□T-□	**12.5~180**		143 (650)	220 (1000)	
5GC□KA	**3.6~18**	87 (10)	55 (250)	77 (350)	22 (100)
	30~180		66 (300)	99 (450)	
5GCH□KA	**3.6~9**	174 (20)	88 (400)	110 (500)	33 (150)
	15~18		99 (450)	132 (600)	
	30~180		110 (500)	154 (700)	
FBL575□W-□	**5**	260 (30)	66 (300)	88 (400)	33 (150)
FBL5120□W-□	**10~20**		8 (400)	110 (500)	
	30~200		110 (500)	143 (650)	
HBL560□-N	**5**	260 (30)	66 (300)	88 (400)	33 (150)
HBL5100□-N	**10~20**		88 (400)	110 (500)	
	30~200		110 (500)	143 (650)	
4GN□RAA	**3.6~18**	69 (8.0)	22 (100)	33 (150)	22 (100)
	30~180		44 (200)	66 (300)	
5GN□RAA	**3~18**	87 (10)	55 (250)	77 (350)	44 (200)
	25~180		66 (300)	99 (450)	
5GU□RAA	**3~9**	174 (20)	88 (400)	110 (500)	55 (250)
	12.5~25		99 (450)	132 (600)	
	30~180		110 (500)	154 (700)	
FPW425_-□	**3.6~18**	69 (8.0)	22 (100)	33 (150)	11 (50)
	30~180		44 (200)	66 (300)	
FPW540_-□	**3.6~18**	87 (10)	55 (250)	77 (350)	22 (100)
	30~180		66 (300)	99 (450)	
FPW560_-□	**3.6~9**	130 (15)	88 (400)	110 (500)	33 (150)
	15~18		99 (450)	132 (600)	
	30~180		110 (500)	154 (700)	
FPW690_-□	**3.6~9**	260 (30)	121 (550)	176 (800)	44 (200)
	15~180		143 (650)	220 (1000)	

See page [A-217] for Right-Angle gearhead **RH** type

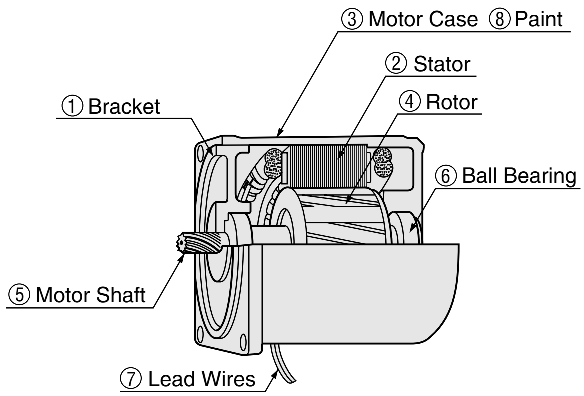
Note: **Permissible torque varies with the gear ratio. Do not exceed the maximum value.**

When using transmission mechanisms involving helical gears or worm gears, they are subject not only to overhung load but to thrust load as well. Ensure that thrust load does not exceed the permissible levels given in the above table.

General Information

■ Construction and Material of AC Motors

The following figure shows the construction of a standard AC motor.



① **Bracket:** Die cast aluminum bracket with cut-finish. Press-fitted into the motor case.
② **Stator:** Comprised of stator core made from laminated silicon steel plate, a polyester-coated copper coil and insulation film.
③ **Motor Case:** Die cast aluminum with cut-finish inside.
④ **Rotor:** Laminated silicon steel plate with die cast aluminum .
⑤ **Shaft:** Available in round shaft and pinion shaft type. The metal used in shaft is S45C(carbon steel). Round shafts receive a shaft flat (output power of 25W or more), while pinion shafts undergo precision gear finishing.
⑥ **Ball Bearing:** Sealed ball bearings with long-life grease.
⑦ **Lead Wire:** Lead wires with heat-resistant polyethylene coating.
⑧ **Painting:** Baked finish of acrylic resin or melamine resin.

■ Handling

When handling motor during test or installation, hold the body of the motor so that the output shaft points upward. Also, when the unit is removed from the package for installation and placed in shelves, it is safer to place the motor upright with the shaft pointing upwards so that it cannot strike other motors.
The lead wires are insulated and securely fixed to the stator and the case mechanically. They can, therefore, withstand a certain degree of tension applied to them. However, lifting the unit by the lead wires may cause them to break, or may damage the insulation or result in some other potentially hazardous situation.

■ Storage

Temperature and humidity are important considerations if the motor is to be stored for an extended period of time. Storage in places where there are large temperature and humidity variations will reduce the stator's insulation performance. Moreover, leaving the motor for extended periods in places with high temperature and humidity is likely to lead to corrosion. When storing for long periods, it is therefore recommended to coat the output shaft with an anti-corrosion agent, seal the motor in a polyethylene bag and store in a place with normal temperature and humidity.

AWG (Lead Wire Gage)

"AWG" is an abbreviation for "American Wiring Gage." The AWG standards stipulate the core construction and conductor cross-sectional area of lead wires as AWG numbers. The larger the AWG number, the smaller the cross-sectional area. When the lead wire is also UL listed, it is further distinguished by a number called the "UL Style". The AWG number is shown on the motor's external appearance drawing.

AWG No.	Conductor Cross-Section(mm^2)
26	0.128
24	0.205
22	0.325
20	0.519

Q&A for Standard AC Motors

Q1. I may have to put the motor in an environment of 0˚F to – 20˚F during transport. Will this create a problem?

A1. Extreme changes in temperature may lead to condensation within the motor. Should this occur, parts may rust, greatly shortening the service life. Take measures to prevent condensation.

Q2. Can the motors be shipped through tropical climates?

A2. No. When the humidity and temperature differences within the cargo space of ships and airplanes are severe, the insulation may deteriorate due to condensation. Successful countermeasures are to ship the motors packed in sealed containers or bags containing de-oxygenating material.

Q3. The motor gets extremely hot. Is this all right?

A3. The internal loss generated when the motor converts electrical energy to rotational movement becomes heat, making the motor hot. The motor temperature is expressed as the ambient temperature plus the temperature rise caused by loss within the motor. If internal loss within the motor is 90˚F (32˚C) and the ambient temperature is 85˚F, the surface of the motor will be 175˚F (79˚C). This is not abnormal for a small motor.

Q4. Will large fluctuations in power supply voltage affect the motor?

A4. The torque produced by the motor is affected by changes in power supply voltage. The torque the motor produces is proportional to roughly twice the power supply voltage. For example, if the voltage of a motor rated at 115 VAC fluctuates between 103.5 VAC (90%) and 126.5 VAC (110%), the torque produced will vary between 80% and 120%. When using motors under large power voltage fluctuations, remember that the torque produced will vary, so select a motor that provides a sufficient margin.

Q5. Can a reversible motor be used as an induction motor if the brake shoe is removed?

A5. A reversible motor is not simply an induction motor with a simple braking mechanism added. The ratio of coils between the primary coil and the secondary coils in a reversible motor is different from that of an induction motor. The simple brake mechanism is added to the rear of the motor. The capacitor capacity is also increased to increase starting torque. This means that if only the brake mechanism is removed, the reversible motor will not be usable at a continuous rating like an induction motor; it will simply lose its holding power and its reversing characteristics will be reduced.

Q6. What does it mean to say that a reversible motor is rated for 30 minutes?

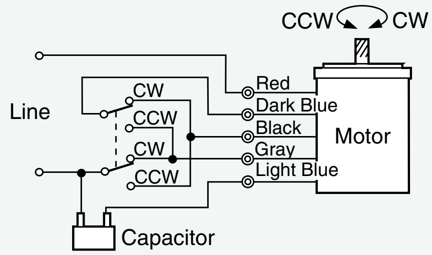
A6. Reversible motors require a larger input power than induction motors to increase the starting torque and improve the instant reversing characteristics. This means that loss is high and the temperature rises more during continuous operation. If operated continuously, the motor will burn out. It is thus designed to provide maximum performance if operated for no more than 30 minutes continuously.

Q7. **Can the speed of induction motors and reversible motors be changed?**

A7. The speed of single-phase (AC) induction and reversible motors is determined by the power supply frequency. To change the speed of induction and reversible motors, the power supply frequency can be changed using inverter control or gears and pulleys. If your application requires changing speed, we recommend a speed control motor.

Q8. **I want to run an induction motor in forward and reverse directions. Can I use the same wiring as a reversible motor?**

A8. Induction motors are designed to be optimal for continuous operation in one direction. They are not suitable for instant forward/reverse operation. The problem that occurs when the same wiring is used to reverse an induction motor like a reversible motor is that the prescribed power cannot be obtained in reverse. This is because the electrical balance of the coils degrades and the output torque decreases. To reverse an induction motor (five lead wire type), connect it as shown below, bring the motor to a complete stop and then reverse it.



Q9. **Can instant reversal of a reversible motor be implemented using a SSR (solid state relay)?**

A9. When instant forward/reverse operation is controlled with an SSR, the SSR characteristics can cause shorts in the circuit. Time must be allowed between switching from the SSR for clockwise rotation to the SSR for counterclockwise rotation.

Q10. **The connection diagrams shows that a capacitor must be connected. Why is this necessary?**

A10. Most all of Oriental Motors standard compact AC motors that fall within the broad group of single-phase induction motors are “capacitor-run motors”. To run an induction motor, a rotational magnetic field must be created. Capacitors perform the role of creating a power supply with the phase shift that is required for creating such a rotational magnetic field. Three-phase motors, by contrast, always supply power with different phases, so they do not require capacitors.

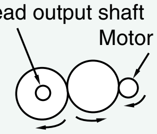
Q11. **Can I use a capacitor other than the one that comes with the motor?**

A11. The capacitor that comes with the motor has a capacitance that was selected to work optimally with the motor. When another capacitor is used, it should be a motor capacitor with the same capacitance and rated voltage as the capacitor that comes with the motor. Electrolytic capacitors may not be used.

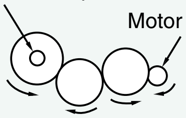
Q12. **Why do some gearheads output in the same direction as the motor while others output in the opposite direction?**

A12. Gearheads reduce the motor speed by 3:1 to 180:1. They do not, however, reduce the speed with a single gear, but with several. The number of speed reductions depends on the gear ratio, so the direction of output shaft rotation differs.

●Rotating in motor axis direction

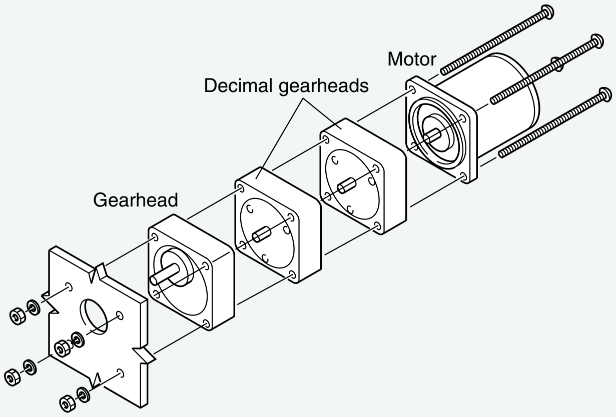


●Rotating opposite of motor axis direction



Q13. **Can gearheads be used to reduce the motor speed to 1/18,000?**

A13. Yes. A gearhead with a gear ratio of 180:1 must be connected to two decimal gearheads with a gear ratio of 10:1. The permissible torque is the same as if the 180:1 gearhead were used alone. The mounting screws must also be longer.



Q14. **Do gearheads require oiling?**

A14. Oriental Motor lubricates the surface of gears in gearheads with grease. Oiling is not required.

Q15. **We wired the induction motor according to the wiring diagram, but it does not move. When we turned the shaft by hand, it started to move in the direction we turned it. What could be the cause of this?**

A15. In order to turn a single-phase induction motor, it is necessary to use a capacitor to create two power supplies with different phases to obtain the rotating magnetic field. Therefore, if the capacitor is not properly connected, the phenomenon described occurs. Check for a cut line or contact defect in the capacitor section. The way to check is to measure the voltage across the capacitor terminals and check whether or not it is at least 1.5 times the power supply voltage.
If not, the capacitor may not be working properly.

1. Ratings

■ Ratings
Motor rating limitations pertaining to temperature rise are divided into two categories: continuous and short-term ratings. These establish working limitations on output, as well as on voltage, frequency and speed (r/min), and are known as rated output, rated voltage, rated frequency and rated speed (r/min).

■ Continuous and Short-term Ratings
The period during which output can continue without abnormality is called a rating period. When continuous operation at rated output is possible, it is known as the continuous rating. When operation at rated output is only possible for a limited period, it is known as the short-term rating.

2. Output Power

■ Output Power
The amount of work that can be performed in a given period of time is determined by the motor's speed and torque. This rated output value is marked on each motor.

$$\text{Output Power [HP]} = (10^{-6}) \times T \times N$$

1 HP = 746 Watts

where:

10^{-6}: Constant
T (oz-in): Torque
N (r/min): Speed

■ Rated Output Power
When optimum characteristics are achieved at rated voltage and frequency in continuous operation, the motor is said to be operating at the rated output. The speed and torque which produce the rated output are called the rated speed and the rated torque. Generally, the term "output" refers to the rated output.

3. Torque

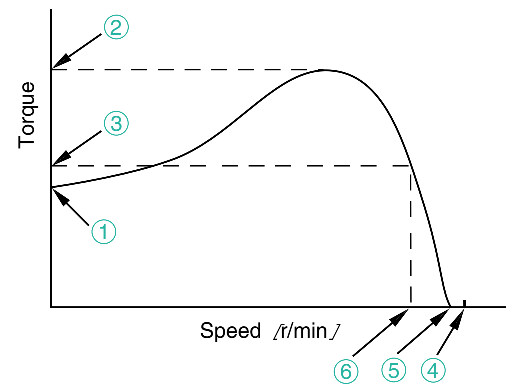
■ Starting Torque ①
This term refers to the torque generated the instant the motor starts. If the motor is subjected to a load greater than this torque, it will not operate.

■ Stalling Torque ②
This is the maximum torque under which the motor will operate at a given voltage and frequency. If a load greater than this torque is applied to the motor, it will stall.

■ Rated Torque ③
This is the torque created when the motor is continuously producing rated output at rated voltage and frequency. It is the torque at rated speed.

■ Static Frictional Torque
Static frictional torque is the torque output required to hold a load when the motor is stopped by an electromagnetic brake or similar device.

■ Permissible Torque
The permissible torque is the maximum torque that can be used when the motor is running. It is limited by the motor's rated torque, temperature rise and the strength of the gearhead used with the motor.



Speed-Torque Characteristics
① Starting torque
② Stalling torque
③ Rated Torque
④ Synchronous speed
⑤ No-load speed
⑥ Rated speed

4. Speed

■ Synchronous Speed ④
This is an intrinsic factor determined by the number of poles and the line frequency. It is calculated according to the following formula, and is normally indicated in r/min.

$$N_S = \frac{120f}{P} \text{[r/min]}$$

where:

N_S: Synchronous speed [r/min]
f: Frequency [Hz]
P: Number of poles
120: Constant

For example, for a 4-pole motor with the line frequency of 60Hz, this would be:

$$N_S = \frac{120 \times 60}{4} = 1800 \text{ r/min}$$

■ **No-load Speed** ⑤
The speed of induction or reversible motors under no-load conditions is 20 ~ 60 r/min lower than synchronous speed because of rotor slip.

■ **Rated Speed** ⑥
This is the appropriate speed of the motor at rated output. From the standpoint of utility, it is the most desirable speed.

■ **Slip**
The following formula is one method of expressing speed:

$$S = \frac{Ns - N}{Ns} \quad \text{or} \quad N = Ns\,(1 - S)$$

where:
(S: slip)
Ns: Synchronous speed [r/min]
N: Speed under a given load [r/min]

In the case of a 4-pole, 60Hz induction motor operated with a slip of S=0.1, this becomes:

$$N = \frac{120 \times 60}{4}(1 \times 0.1) = 1800\,(1 - 0.1) = 1620 \text{ r/min}$$

5. Overrun

■ **Overrun**
This is the number of revolutions the motor makes between the time power is cut off and the time that it stops. It is normally indicated either by an angle or by revolutions.

6. Gearhead

■ **Gear Ratio**
The gear ratio is the ratio by which the gearhead reduces the motor speed [r/min]. The speed at the gearhead's output shaft is the reciprocal of the gear ratio × motor speed.

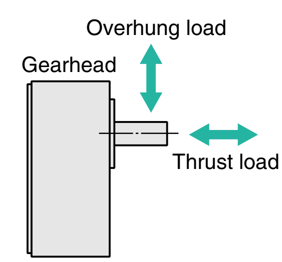
■ **Maximum Permissible Torque**
This is the maximum load torque that can be applied to the gearhead. It is dependent upon such mechanical strength factors as the size and construction of the gears and bearings, and thus varies according to the type and gear ratio of the gearhead.

■ **Service Factor**
This is a coefficient used to estimate the life of a gearhead. These values are determined from experience in service life tests under various loads and usage conditions.

■ **Gearhead Efficiency**
This is the efficiency of transmission when the torque is increased with the gearhead engaged. It is expressed as a percentage (%) and is determined by the friction in the gears and bearings used in the gearhead and the resistance of the lubrication oil. The transmission efficiency is usually 90% for each stage of reduction gears, and is 81% for gearheads with only two stage gearheads. As the reduction ratio becomes larger, the number of stages of gears increases, with a consequent reduction in the gear efficiency to 73%, 66% and 59% for each stage of gears added.

■ **Overhung Load**
This is the load on the gearhead output shaft in the radial direction. The maximum overhung load on a gearhead is called the permissible overhung load and varies with the gearhead type and the distance from the shaft end. This is equivalent to tension under belt drive.

■ **Thrust Load**
This is the load that is placed in the direction of the gearhead output axis shaft. The maximum thrust load on the gearhead is called the permissible thrust load and differs by the type of gearhead.



7. Others

■ **CW, CCW**
This shows the motor rotation direction.
CW is clockwise as seen from the output shaft side and CCW is counterclockwise.