Motor Selection

Selecting a fully functional motor of required specifications is a key factor for increasing the durability and economic benefic of the equipment.

The following introduces the selecting steps, examples, calculation formulas and key points related to PeeiMoGer Compact Gear Motor.

Steps:

1. After the structure and rough dimension of the driver are determined, define the weight and the moving speed of the objects to be conveyed.
2. Calculate the rotational speed and the load: work out the load torque, load inertial torque, rotational speed, etc, on the drive shaft of the motor.
3. Define the required specifications: define the specifications of the driving part and the machine, stop accuracy, position fixation, speed range, environmental resistance, etc.
4. Select motor: select the most applicable one according to the required specifications.
5. Decide on the motor and the gear head: based on the rotational speed, load torque and load inertial torque of the selected motor to decide on the motor and gear head.
6. Confirm the selected motor: based on the mechanical strength or the acceleration time, confirm whether the specifications of the motor and the gear head are up to the requirements for final confirmation and selection.

Machine selection list

Motor Type	Induction motor M-□IK□□-A□ (AF□) M-□IK□□-C□ (CF□) M-□IK□□-S□ (SF□) M-□IK□□-ST (SFT) M-□IK□□-U□ (UF□) M-□IK□□-UT (UFT)	Reversible induction motor M-□RK□□-A□ (AF□) M-□RK□□-C□ (CF□)	Single-phase electromagnetic brake motor M-□RK□□-AS (AFS) M-□RK□□-CS (CFS)	Three-phase electromagnetic brake motor M-□RK□□-SS (SFS) M-□RK□□-US (UFS)	Electromagnetic clutch brake induction motor M-□IK□□-AC (AFC) M-□IK□□-CC (CFC) M-□IK□□-SC (SFC) M-□IK□□-UC (UFC)	Single-phase torque motor M-□TK□□-AT	Speed control motor M-□IK□□-AV (AVD) M-□IK□□-CV (CVD)
Strength	Applicable to single-phase motors of continuous operation	Motors capable of instant clock/ counterclockwise rotation	Motors capable of instant clock/ counterclockwise rotation	Motors which can keep high brake and load duration , with built-in safety brake	Type with direct single-/three-phase induction motors and DC (24V) clutch brakes combined type	There is a near linear proportion by inversion between the torque and the rotational speed, so this is especially applicable to fixed tension batching	Motors which can be coupled with speed controllers and are capable of CVT
Voltage	Single-phase: 100V~120V 200V~240V Tri-phase: 200V~230V 380V~400V 415V~460V	Single-phase: 100V~120V 200V~240V	Single-phase: 100V~120V 200V~240V	Three-phase: 200V~230V 380V~400V 415V~460V	Single-phase: 100V~120V 200V~240V Three-phase: 200V~230V 380V~400V 415V~460V	Single-phase: 60V 115V Single-phase: 110V 220V	Single-phase: 100V~120V 200V~240V
Continuous operation	○	×	×	○	○	○ (60V 115V) / × (110V 220V)	○
Instant clock/ counterclockwise rotation	×	○	○	○	×	×	×
Variable speed	×	×	×	×	×	○	○
Load duration	×	○	○	○	○	×	×

Examples of AC Motor Selection

Usage: to drive the conveyor

Operation condition: continuous

Voltage: 110V

Frequency: 60Hz

Rotational speed: 26r/min

For calculation, refer to the conveyor driving machine on page 229.

1. Select the motor:

   Select a single-phase induction motor according to the above table by usage, operation condition, operating environment, and voltage. (M-□IK □N-A)。

2. Decide on the gear ratio of the gear head:

   Based on the example, it is known that when the speed of the conveyor is 140mm per sec, the output rotational speed is 26.7rpm. Supposing the rated output rotational speed corresponding to 60Hz is 1550 rpm before the motors are decided, the gear ratio is 1550rpm÷26rmp, which equals 60.

   (The rated output rotational speed of the induction motors is generally 1550±100rpm)

3. Calculate the required torque:

   Based on the examples from clients, it is calculated that the necessary torque is 3.27 N·m, which belongs to the output shaft of the gear head. Please refer to the allowable torque with a gear ratio of 60 (the maximum allowable torque of the gear head). Select motors (M-5IK40N-A) with an output power of 40W in consideration of double security coefficient, and gear head (G-5N60-K) with a gear ratio of 60.

4. Confirm the capacity of motors according to the actual test:

   The maximum torque of the conveyor occurs when it is started. Therefore, measure the lowest starting voltage corresponding to the torque on startup and the current to confirm the following items.

   a.The starting torque of the motors > the necessary torque on startup

   (= the minimum starting torque)

   b. Actual rotational speed > rated rotational speed

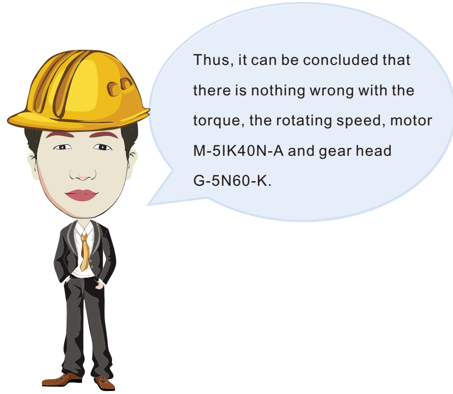
Torque :

Measure with the ampere-meter, only to find that the starting current < the rated output current

For example: the rated output current of M-5IK40N-A is 0.55A corresponding to 110V and 60Hz.

Rotational speed :

Use the revolution meter or the measuring machine to calculate the rotational speed of motors, the actual value > the rated output rotational speed (r/min).



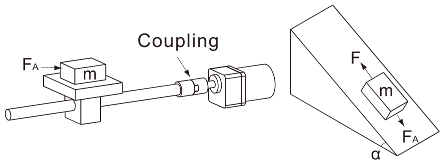
Calculation formula of the load torque :

Calcuate the friction torque of different drivers

Ball screw drive

$$T_L = \left(\frac{FP_B}{2\pi\eta} + \frac{\mu_0 F_0 P_B}{2\pi}\right) \times \frac{1}{i}\ [N\cdot m]$$

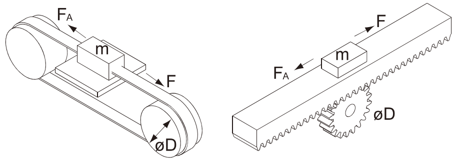
$$F = F_A + mg(\sin\alpha + \mu\cos\alpha)[N]$$



Line/pulley drive/rack/gear drive/

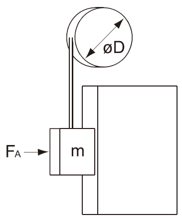
$$T_L = \frac{F}{2\pi\eta} \cdot \frac{\pi D}{i} = \frac{FD}{2i\eta}\ [N\cdot m]$$

$$F = F_A + mg(\sin\alpha + \mu\cos\alpha)[N]$$



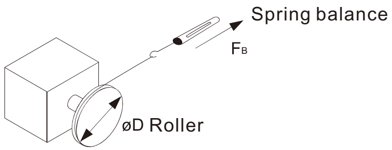
Roller driver

$$T_L = \frac{\mu F_A + mg}{2\pi} \cdot \frac{\pi D}{i} = \frac{(\mu F_A + mg)D}{2i}\ [N\cdot m]$$



Actual measurement calculation

$$T_L = \frac{F_B D}{2}\ [N\cdot m]$$



F = load in the shaft direction [N]

F0 = preloading load [N] (≒1 / 3F)

μ0 = internal friction coefficient of the preloading nut (0.1 ~ 0.3)

η = efficiency (0.85 ~ 0.95)

i = gear ratio (This is the gear ratio of the machine, not that of the reducer of the Company)

PB = ball screw pitch [m / rev]

FA = external force [N]

FB = force when the main shaft begins to rotate [N] (Fb = [the value of the spring balance] (kg) ×g [m / s^2])

m = the total weight of the working substance and the workbench [kg]

μ = the friction coefficient of the sliding surface [0.05]

α = inclination angel [°]

D = roller diameter at the final section [m]

g = acceleration of gravity [m / S^2] (9.807)

Unit conversion: take 40W M-5IK40A-A for example:

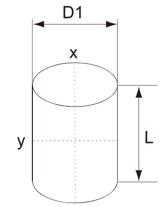
	kgfcm	N·m	mN·m	gfcm
Starting torqu	1.9	0.19	190	1900
Rated torque	2.3	0.23	230	2300
Force	kg	N	N	g

Calcuation Formula of the Inertia :

Inertia of the cylinder

$$J_x = \frac{1}{8} m D_1^2 = \frac{\pi}{32} \rho L D_1^4\ [kg\cdot m^2]$$

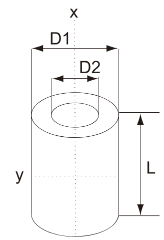
$$J_y = \frac{1}{4} m\left(\frac{D_1^2}{4} + \frac{L^2}{3}\right)[kg\cdot m^2]$$



Inertia of the hollow cylinder

$$J_x = \frac{1}{8} m(D_1^2 + D_2^2) = \frac{\pi}{32} \rho L(D_1^4 - D_2^4)[kg\cdot m^2]$$

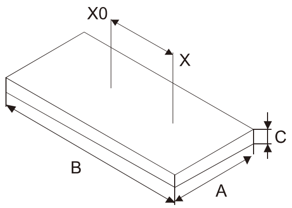
$$J_y = \frac{1}{4} m\left(\frac{D_1^2 + D_2^2}{4} + \frac{L^2}{3}\right)[kg\cdot m^2]$$



Inertia when the center of gravity is not at the center

$$J_x = J_{x0} + m\ell^2 = \frac{1}{12} m(A^2+B^2+12\ell^2) = [kg \cdot m^2]$$

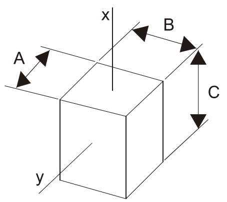
ℓ = distance from X axis to X0 axis [m]



Inertia of the cube

$$J_x = \frac{1}{12} m(A^2+B^2) = \frac{1}{12} \rho ABC(A^2+B^2) = [kg \cdot m^2]$$

$$J_y = \frac{1}{12} m(B^2+C^2) = \frac{1}{12} \rho ABC(B^2+C^2) = [kg \cdot m^2]$$



Inertia of objects in linear motion

$$J = m\left(\frac{A}{2\pi}\right)^2 [kg \cdot m^2]$$

A= unit displacement [m/rev]

Ironρ = 7.9×10^3 [kg / m^3]

Aluminumρ = 2.8×10^3 [kg / m^3]

Yellow brassρ = 8.5×10^3 [kg / m^3]

Nylonρ = 1.1×10^3 [kg / m^3]

Jx = inertia of X axis [kg·m^2]

Jy = inertia of Y axis [kg·m^2]

J0 = inertia of X0 axis (via the center of gravity) [kg·m^2]

m = weight [kg]

D1 = outer diameter [m]

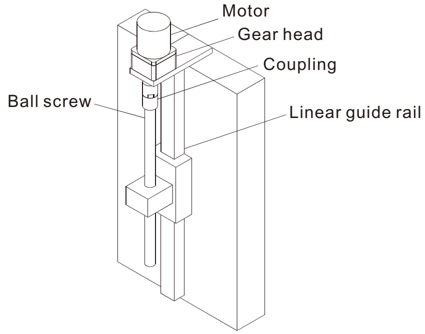
D2 = inner diameter [m]

ρ = density [kg / m^3]

L = length [m]

Examples of Calculation Related to AC Motors

The following is an example of using electromagnetic brake motors on the workbench of ball screw facility and the motors must be selected according to the following specifications.



Required Specifications and Machine Specifications

Total weight of the workbench and the working substance m = 30 [kg]

Moving speed of the workbench v = 15±2 [mm / s]

External force FA = 0 [N]

Inclination angle of the ball screw α = 90 [degree]

Length of the ball screw LB = 800 [mm]

Shaft diameter of the ball screw DB = 20 [mm]

Ball screw pitch PB = 5 [mm]

Displacement of the ball screw for each rotation A = 5 [mm]

Efficiency of the ball screw η = 0.9

Material of the ball screw: iron (density ρ = 7.9×10^3 [kg / m^3])

Internal friction coefficient of preloading nuts μ0 = 0.3

Friction coefficient of the sliding surface μ0 = 0.05

Motor power source: single-phase 110V60Hz

Working time: un-continuous operation for five hours a day

Repeated start-stop

Load duration is necessary.

Define the gear ratio of the gear head

Rotational speed of the output shaft of the gear head :

$$N_G = \frac{V60}{PB} = \frac{(15\pm2)\times60}{5}$$

$= 180\pm24$ [r/min]

Generally, the rated rotational speed of motors is 1550 r/ min , corresponding to 60Hz 4-pole, so the gear ratio should be within this range (i=9).

Gear ratio of the gear head

$$i = \frac{1550}{N_G} = \frac{1550}{180\pm24} = 7.6\sim9.9$$

Calculate the necessary torque

Load of the ball screw:

$F = F_A + mg(\sin\alpha + \mu\cos\alpha)$

$= 0+30\times9.807(\sin90° + 0.05\cos90°)$

$= 294$[N]

Preloading load of the ball screw:

$F0 = \frac{F}{3} = 98$[N]

Load torque : $T_L = \frac{F\times PB}{2\pi\eta} + \frac{\mu0\times F0\times PB}{2\pi}$

$= \frac{294\times5\times10^{-3}}{2\pi\eta} + \frac{0.3\times98\times5\times10^{-3}}{2\pi}$

$= 0.283$[N.m]

This load torque belongs to the output shaft of the gear head, so it has to be adapted to the output shaft of the motors.

Necessary torque T_M of the output shaft of the motors

$$T_M = \frac{T_L}{i\cdot\eta G} = \frac{0.283}{9\times0.81} = 0.0388[N.m] = 38.8[mN.m]$$

(Transmitting efficiency of the gear head ηG = 0.81)

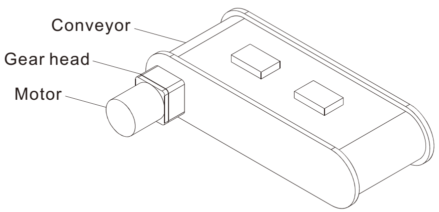
Security factor is set as 2 times.

38.8×2 = 77.6 [mN·m]

For motors with a starting torque over 77.6mN•m (0.776kgfcm), select according to the specification table of AC induction motors.

Select M-3RK15N-AS motors (0.90kgfcm) with electromagnetic brake for load duration and coupled G-3N9-K gear head with a gear ratio of 9.

The following is an example of using induction motors in conveyor driving facility, which must conform to the required specifications.



Total weight of the conveyor and the working substance m1 = 20kg

Friction coefficient of the sliding surface μ = 0.3

Diameter of the roller D = 100mm

Weight of the roller m2 = 1kg

Efficiency of the conveyor and the roller η = 0.9

Speed of the conveyor V = 140mm / s±10%

Motor power source: single-phase 110V 60Hz

Working time: 16 hours per day

Define the gear ratio of the gear head

Rotational speed of the output shaft of the gear head :

$$N_G=\frac{V60}{\pi \cdot D}=\frac{(140\pm14)\times60}{\pi\cdot100}$$

$$=26.7\pm2.7[r/min]$$

Since the rated rotational speed of the motors is 1550 rpm，corresponding to 60Hz, the corresponding gear ratio should be i=60.

The gear ratio of the gear head is as follows:

$$I=\frac{1550}{N_G}=\frac{1550}{26.7\pm2.7}=52.7\sim64.5$$

Calculate the necessary torque

The torque reaches the highest when the conveyor is started, which has to be calculated first.

Frictional force of the sliding part is F.

$$F=\mu mg=0.3\times20\times9.807=58.8[N]$$

$$\text{Load torque } T_L=\frac{F\cdot D}{2\cdot\eta}=\frac{58.8\times100\times10^{-3}}{2\times0.9}=3.27[N.m]$$

This load torque belongs to the output shaft of the gear head, so it has to be adapted to the output shaft of the motors.

Necessary torque of the output shaft of motors: T_M.

$$T_M=\frac{T_L}{i\cdot\eta_G}=\frac{3.27}{60\times0.75}=0.0726[N.m]=72.6[mN.m]$$

(transmitting efficiency of gear head $\eta G=0.75$)

Given the variation of voltage for commercial use（110±10%）the security factor should be doubled.

72.6×2=145.2 [mN·m]=1.45（kgfcm）

For selection of motors with a starting torque over 1.45（kgfcm）refer to the specification table of AC induction motors.

Select M-5IK40N-A motors (1.9kgfcm) and coupled M-5IK40N-A gear head with a gear ratio of 60.

Types and Characteristics of Motors

	Characteristic	Type	Retention	Over-rotation amount	Frequency
Induction motor	Applicable single-phase motors of continuous operation	Single-phase induction motor			
	Applicable to single-phase motors of continuous operation	Three-phase induction motor			
	Motors capable of instant clock/ counterclockwise rotation	Reversible motor	Simple brake 70-500gcm	4-6 turns	
Electromagnetic brake	Retentive Safety brake Suitable for emergency (safety brake)	Single-phase electromagnetic brake motor	Safety brake 1-10kgcm	2-3 turns	The safety brake motors can stop six times per minute (the stop time must be over 3 sec) To stop 7~20 times per minute, use electromagnetic brake motors. To stop 20~100 times per minute, use electromagnetic clutch brake motors
		Three-phase electromagnetic brake motor	Safety brake 1-10kgcm	2-3 turns	
		Electromagnetic clutch brake induction motor	24 and 50kgcm	1 turn	
	For motor brakes, select DC 24V MM brake (optional)	Motors with electromagnetic brake	Electromagnetic 24 and 50kgcm	2-3 turns	
		Single-phase torque motor	Single-phase: 110V 60V 220V 115V		There is an almost linear proportion by inversion between the torque and the rotational speed, so they are especially applicable to fixed tension batching.
		Speed control motor			
		PMG DC motor			
Electric brake	Irretentive It can move freely after stop	Electronic brake		0.5-1 turn	To realize un-continuous operation through electronic brakes, it is necessary to ensure the surface temperature of the motors are below 90 degrees
Used together	Mechanical and electric brake		Same as electromagnetic brake	0.5-1 turn	Refer to the information on electromagnetic brake

PeeiMoGer

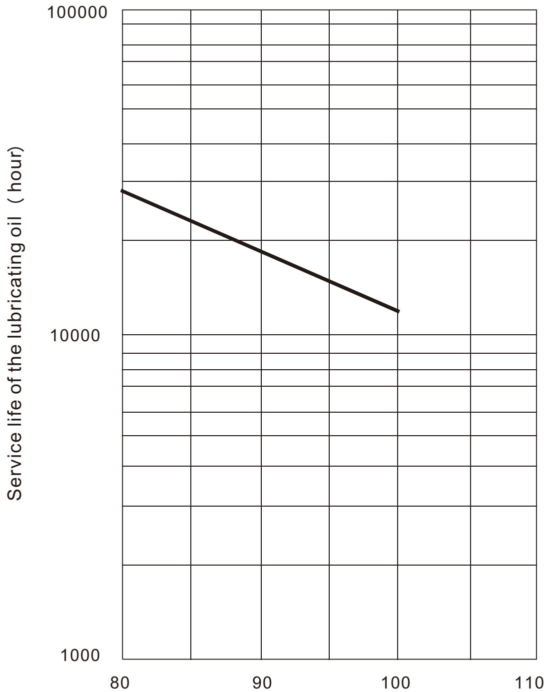
Service Life of Motors

The service life of motors relies on the bearing quality, the abrasion of the transmission facility, the dysfunction resulting from the maintenance by customers, and the inspection time. The service life provided by the Company is not a guaranteed value, but to be used for reference only. Also, the service life depends to a great extent on the bearing condition.

The service life of the bearing depends on two factors:

Service life of the lubricating oil: the oil can degrade due to temperature rise.
Service life of the facility: continuous fatigue.

The influence of heat from motors on the service life of the lubricating oil is greater than that of the load the bearing bears on the service life of the facility. Therefore, the service life of motors can be worked out according to that of the lubricating oil.



Surface temperature of the motor

Relationship between the surface temperature of the motor and the lubricating oil

AC small standard motor, DC motor

Make sure the surface temperature of the AC motor is below 90 degrees during use、DC motor is below 60 degrees during use. As a result from the operating environment or the operating efficiency, the lower the surface temperature is, the longer the service life is. In addition, if over-loaded, the service life of the bearing may be shorter than that of the lubricating oil.

The guaranteed service life of the motor is as follows:

Motor type	Guaranteed service life
AC motor	5000 hours
DC motor	3000 hours

The actual service life is affected by the load, the way to apply load and the rotational speed, which can be calculated through the following formula.

L (service life) = L1 / f

L1 : guaranteed service life

f : coefficient of the service factor

Coefficient table of the service factor

Load type	5hr/day	8hr/day	24hr/day
Fixed	1.0	1.0	1.5
Variable: light	1.25	1.5	2.25
Variable: middl	1.75	2.0	3.0
Variable: heavy	2.25	3.0	4.5

Service Life of the Gear Head (Reducer)

The actual service life is affected by the load, the load applying method, and the rotational speed. To calculate this, please refer to the relationship between the rated service life and the actual service life.

The condition for the guaranteed service life of the gear head defined by PeeiMoGer is as follows:
Torque: allowable torque
Load type: fixed-8 hours per day
Input rotational speed: standard input rotational speed
Thrust load: allowable shaft-direction thrust and load.

Guaranteed service life of all gear head

Motor type	Gear head type	Standard input rotational speed	Guaranteed service life
AC induction motor DC motor	Ball bearing	1500r/min	5000 hours
	Oil bearing		2000 hours

The actual service life is affected by the load, the load applying method, and the rotational speed, which can be calculated using the following formula.

L (service life) = (L1 × K1) / [(K2)^3 × f (h)]

L1 : guaranteed service life L1

K1 : coefficient of the rotational speed = standard input rotational speed / actual input rotational speed

K2 : load factor = actual torque / allowable torque

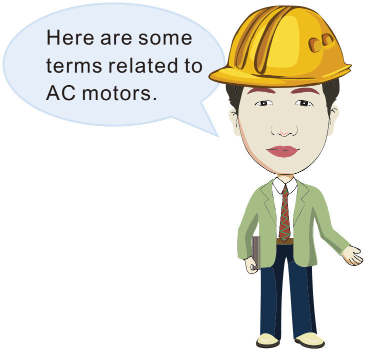
(Referring to the specification value recorded in the catalog)

f : Coefficient table of the service factor

Notes

When gear motors are driven out of the specified specification, or are experiencing random failure, unexpected failure, or irresistible external force during the service life, which may be hard to resolve via technological resolutions, it is then necessary to take preventive measures.

Definitions and Characteristics



A-Rating

- Rated output

  It refers to the output power of motors under basic setting. For example: the rotational speed, current and torque of standard 25W motors are their rated output data, data with full-load.

- Rated time

  It refers to the time motors can operate with normal load. Generally, if the operating time exceeds the rated time, motors will get over-heated.

- Continuous rating and short-time rating

  Under rated output, the normal continuous operating time is the rated time, and the continuous service life is the continuous rating, and specified operating time is called short-time rating.

B - Output

The relationship between the output rotational speed, torque and the output power is as follows:

$$T(N.m)= 9540\times\frac{P}{N}$$

$$T(kgfm)= 973.5\times\frac{P}{N}$$

$$T(kgfcm)= 97.35\times\frac{W}{N}$$

Formula :

T : torque

P : output power（kW）{ W = Watts }

N : revolution times (r / min)

9540（973.5）(97.35) : constant

(1HP = 746Watts)

Use upsine equation by rate rotate、rate output-powers can get,full load torque,for example 25W motor, M-4IK25N-C use rate rotate1625 rpm (60Hz) substituted into the calculation,can get T(kgfcm)=97.35x25W/1625(rpm)=1.5(kgfcm) output.

C - Torque

- Starting torque

  It is the torque instantaneously produced when the motor is started. The starting torque for three -phase motors generally refers to the pull-out torque.

- Stopping torque (pull-out torque)

  It is the maximum torque the motor can output under certain voltage and frequency. Once the load exceeds the torque range, the motor will stop. Stopping torque is also called maximum torque or pull-out torque.

- Rated torque

  It is the torque when the motor produces rated output under rated voltage and frequency, namely , the torque at rated revolving speed.

- Static friction torque

  It is the torque outputted for maintaining load when the electromagnetic brake or electromagnetic clutch brake is applied.

- Allowable torque

  It is the maximum torque allowable during motor operation, and is limited by the rated torque, temperature rise and integrated reducer strength of the motor.

D - Revolving Speed

- Synchronous revolving speed

  It is the revolving speed of the motor's stator magnetic field, determined by the motor pole and power frequency.

  The formula is as follows: $Ns=\frac{120f}{P}$(r/min)

Formula

Ns:synchronous revolving speed (r/min)

P: motor pole

f: frequency (Hz)

120:constant

- No load speed

  No load speed is 20~50rpm behind the synchronous revolving speed, because the armature of the motor cannot rotate until it is inducted in the stator magnetic field and has built up a magnetic field.

  For example: for 4-pole, 60Hz, 1800rpm, the no load speed is 1750~1780rpm.

- Rated revolving speed

  It is the revolving speed corresponding to the motor's rated output, the speed under full load.

- Slippage (%)

  One of the expressions of the motor's revolving speed.

  The formula is as follows:

  $$S(\%)=\frac{Ns-N}{Ns}$$

  Ns : synchronous revolving speed (r/min)

  N : revolving speed under arbitrary load

- Over-rotation amount

  It refers to the excess rotation from the moment the power is cut off to when the motor has stopped, expressed by angles (rpm).

Terms related to the gear head (reducer)

- Gear ratio

It refers to the proportion between the rotational speed after deceleration and the original speed. The rotational speed of the output shaft of the gear head (reducer) equals to the quotient between the synchronous rotational speed of motors (50Hz : 1500r/min, 60Hz : 1800r/min) and the gear ratio. The actual rotational speed is 2-20% smaller due to the influence of the load.

For example:
For Model G-5N3-K
50Hz : 1500r/min,gear ratio:
1 / 3The rotational speed of the output shaft of the gear head
1500r / min× (1 / 3) =500rpm。
60Hz : 1800 r / min ,
the rotational speed of the output shaft of the gear head=1800r/min× (1/3) =600rpm.

- Permissible Torque of Gear Head

It refers to the maximum load torque gear head can bear, depending on the gear of the gear head, bearing quality and size, and other mechanical characteristics and strength. This is different for different gear head and gear ratio.

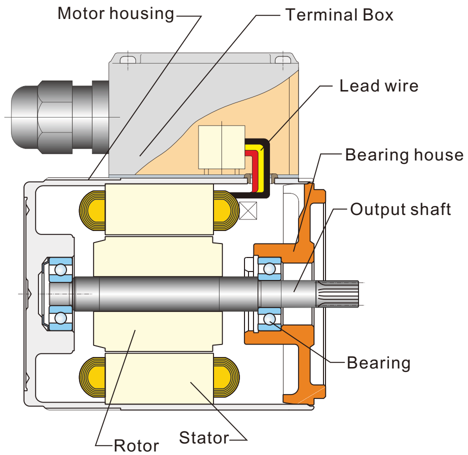
- CW, CCW

It refers to the operation direction of motors. CW means clockwise from the direction of the output shaft, and CCW means counterclockwise.

Structure and usage of AC motors

The basic structure of AC small motors is as follows:

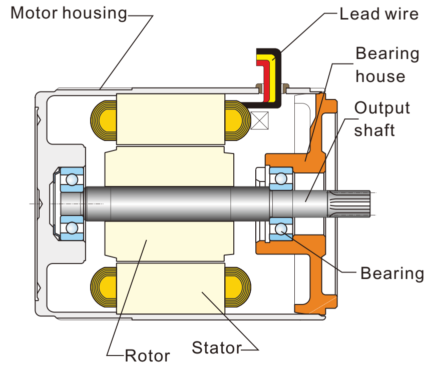
1. Motor housing: machining with aluminum die-casting materials.
2. Stator: composed of a cascaded silicon steel core twined with copper varnished wires and insulating thin film.
3. Rotor: composed of silicon steel cascade and conductors of aluminum die-casting
4. Output shaft: circular shaft or gear shaft, material S45C.
5. Bearing: ball bearing.
6. Bearing house: machining with aluminum die-casting materials.
7. Lead: high quality heat-resistance lead.



Structure of a standard motor

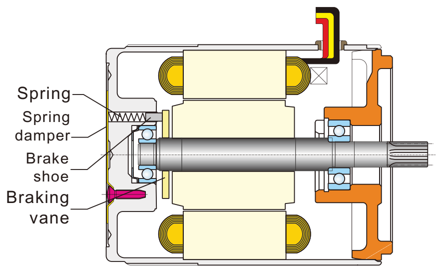
The structure of a standard motor (IK type) is as follows.

For general continuous operation.



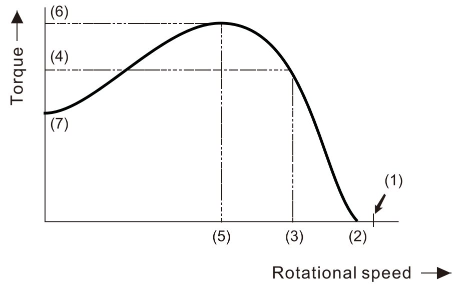
Structure of a reversible motor

The structure of a reversible motor (RK type) is as follows.



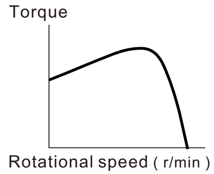
It is used when rapid reversal rotation is necessary after clockwise rotation. When the motor operates for 30 minutes (rated time), its surface temperature approaches 90℃, so it has to be stopped to prevent overheating. PeeiMoGer has set the torque for simple brake to approx. 10% of the output torque.

Relationship between the rotational speed and the torque of induction motors

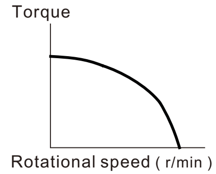


(1) : synchronous rotational speed
(2) : no-load rotational speed
(3) : rated rotational speed
(4) : rated torque
(5) : pull-out rotational speed
(6) : pull-out torque
(7) : starting torque

Induction motors include capacitor single-phase induction motors and tri-phase induction motors. For single-phase motors, the starting torque is usually smaller than the operating torque, while for three-phase motors, the starting torque is usually equal to the pull -out torque (maximum torque).



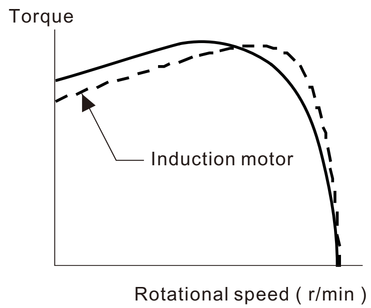
Single-phase induction motor



Three-phase induction motor

Relationship between the rotational speed and the torque of reversible motors

Both reversible motors and single-phase induction motors are capacitor induction motors, with the relationship between the rotational speed and the torque being the same. However, the starting torque of reversible motors is bigger in order to increase the instant reversibility.

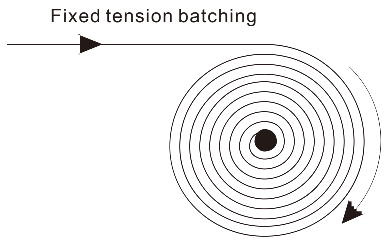


Relationship between the rotational speed and the torque of torque motors

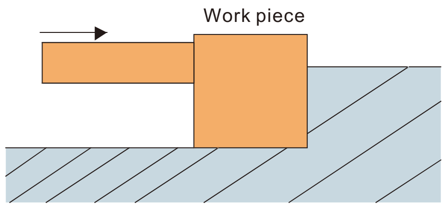
Torque motor

Its structure is similar to that of standard motors, with such main features: there is an almost linear proportion by inversion between the torque and the rotational speed, thus they are especially applicable to fixed tension batching.

To batch objects operating at fixed speed continuously with fixed tension, if the batching diameter is doubled, the output torque of the motors is also doubled, but the rotational speed is reduced by half. Therefore, it is necessary to maintain certain proportion during operation.



Under locked state, torque motors can still operate and will not get over-heated, especially applicable to work-piece positioning and holding. In addition, the torque is the square of the voltage, the locking output torque of the motors can be adjusted through voltage (do not exceed the allowable torque of the gear head when they are used together)



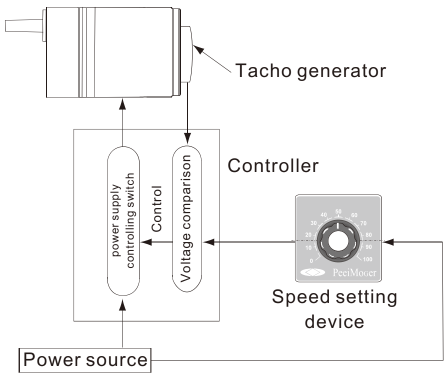
Speed controlling method of the speed control motors

The basic steps are as follows.

The AC speed control motors adopt closed loop speed control method.

AC speed control motor (control method)

1. The speed setting device provides the velocity voltage for setting.
2. Tacho generator provides the voltage corresponding to the rotational speed.
3. Compare the above two voltages of difference.
4. In order to reach the setting speed, you can base on a sliding scale to supply power to motors.



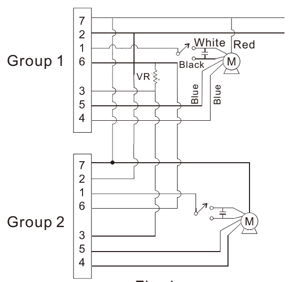


Fig. 1

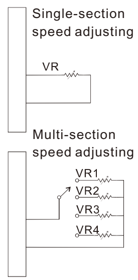


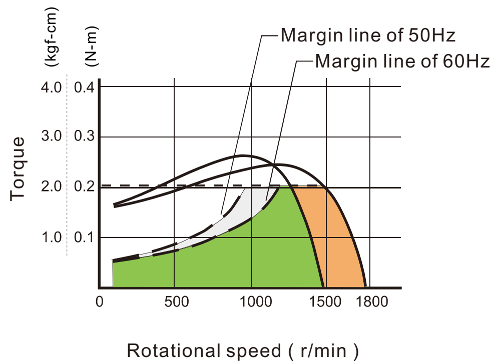
Fig. 2

1. The maximum variable resistance coupled with the speed setting device of the Company is 20Ω.
2. When the resistance reaches the maximum (20Ω), the rotational speed is 1650 rpm for 60Hz and 1350 rpm for 50Hz.
3. The rotational speed is proportional to the resistance. When the resistance is zero, motors stop.
4. In order to reach synchronous speed adjusting in the two groups, the variable resistance in the wiring diagram, as is shown in Fig. 1, is 10KΩ.
5. For multi-section variable speed application, refer to Fig. 2. Speed can be changed rapidly by changing the variable resistance.

Relationship between the rotational speed and the torque of speed control motors controlling method of the speed control motors

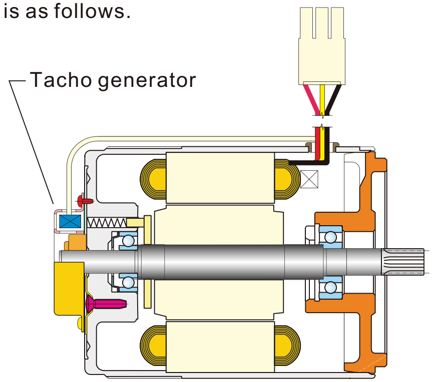
The relationship between the rotational speed and the torque of speed control motors is as follows.

Rotational Speed vs. Torque M-4IK25N-AV



Structure of speed control motors

The structure of AC speed control motors is as follows.



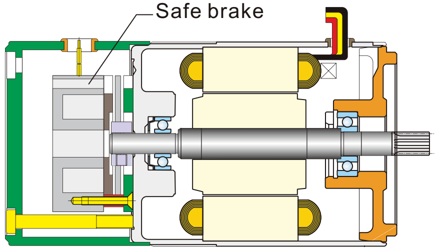
They are mainly used on the occasion when speed needs to be adjusted. It is also necessary to note that the load that speed adjusting motors can bear varies with the rotational speed, with a general adjustment range of 10% to 50%, and increases with the increase of the rotational speed. Within 50%~100%, motors can bear full-load torque (rated load) together with the compensation of the torque of the speed controllers. Generally, speed adjusting motors cannot bear full-load toque with a 50% rotational speed.

※ Speed adjusting principle: please refer to the method to control the rotational speed.

Structure of electromagnetic brakes

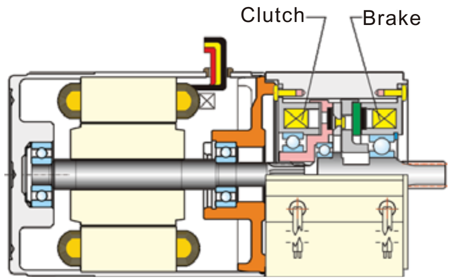
Such motors adopt safety brakes.

The construction is as follows. When there is voltage on magnetic coils, the armature is attracted and presses the spring to lift the brake, and the output shaft of motors can rotate freely. On the contrary, without voltage, electrode is pressed onto the brake pad and the fixed plate by the spring, with such results: the output shaft is fixed and it's a state of brake movement.



Structure of electromagnetic clutch brake motors

Such motors use DC 24V electromagnetic clutch brake, with the structure as follows. Generally, motors operate continuously (normal load within 8 hours), and clutches work when brakes are lifted. Motors drive the output shaft to operate, and brakes work when clutches are lifted. Clutches and brakes cycle, with an action frequency of 100 per min.



Others

- Temperature rise of AC small standard motors

During operation, all kinds of losses (copper loss, core loss and mechanical loss) inside the motors turn into heat, so the temperature will get higher.

2-3 hours after induction motors begin to operate (continuous operation); the temperature reaches saturation, and will not change for a while.

30 minutes after reversible motors begin to operate (30 min rating); the temperature reaches the specified value, and will continue to increase when it keep going to operate.

- Ways to measure temperature rise

A. thermometer

Fix the thermometer in the center of the motor shell to measure the temperature, and take difference between the measured value and the environmental temperature as the temperature rise.

B. resistance

The coil temperature varies with different resistances. Measure it with insulation resistance meter and thermometers to calculate the temperature rise of the coil

- Temperature protection switch (optional)

Over-heating protection device uses bimetallic strips and silver contacts, since the resistance of silver is the lowest and its heat transmission is second to that of copper.

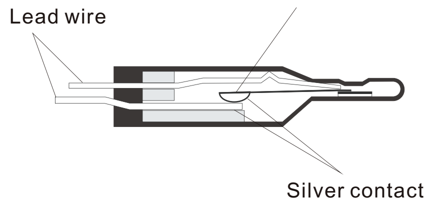
Operating temperature of the temperature protection switch

Open-125°C±5°C

(There are also machines with different operating temperatures, please consult for relevant information)

Close-75°C(reference value)

(There are also machines with different operating temperatures, please consult for relevant information) Bimetallic strip



Capacitor

The AC motors of single-phase power source are capacitor motors. Capacitors are connected in series to the auxiliary coils to promote the current phase of the latter to outstrip.

The main coils and the auxiliary coils produce different helical magnetic fields to make motors operate. Generally, if capacitors are damaged or connected appropriately, motors cannot start automatically, resulting in the so-called “open phase”.

- Capacity and rated voltage

  Wrong capacity of capacitors may cause motors to vibrate and get heated, or result in torque decrease, which will make operation unstable. The unit of capacity is uF. Wrong rated voltage may cause capacitors to discharge smoke or sparks. The unit of the rated voltage of capacitors is V, marked on the surface of the capacitor and different from the rated voltage of motors. Do use capacitors matched with motors.

- Rated electrified time

  It refers to the service life corresponding to the rated load, rated voltage, rated temperature and rated power of capacitors, with 25000 hours as the standard. Capacitor damage can result in smoke or sparks.

Gear head

- Load

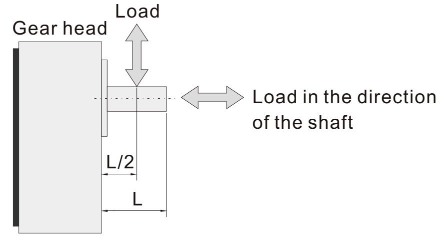
  It refers to the load borne in the vertical direction of the output shaft of gear head. The maximum load that gear head bear is the allowable load, variable with different gear head and different distances from the front end of the output shaft. The tension under belt drive belongs to such kind of load.

- Thrust load

  It refers to the load borne in the direction of the output shaft of gear head. The maximum thrust load gear head bear is the allowable thrust load, variable with different gear head.

- Transmission efficiency

  It refers to the efficiency of torque increase through combining motors with gear head, expressed in percentage (%), and decided by the bearing of gear box, friction of gear head and the impedance of the lubricating oil.



Gear head	Load (kg)	Load in the direction of the shaft
G-2N□-L G-2N□-K	5 10	3
G-3N□-L G-3N□-K	10 20	4
G-4N□-L G-4N□-K	20 30	5
G-5N□-L G-5N□-K	30 40	10
G-5U□-KF G-5U□-KH	60 70	15
G-6U□-KH	80	20

Transmission efficiency of gear head

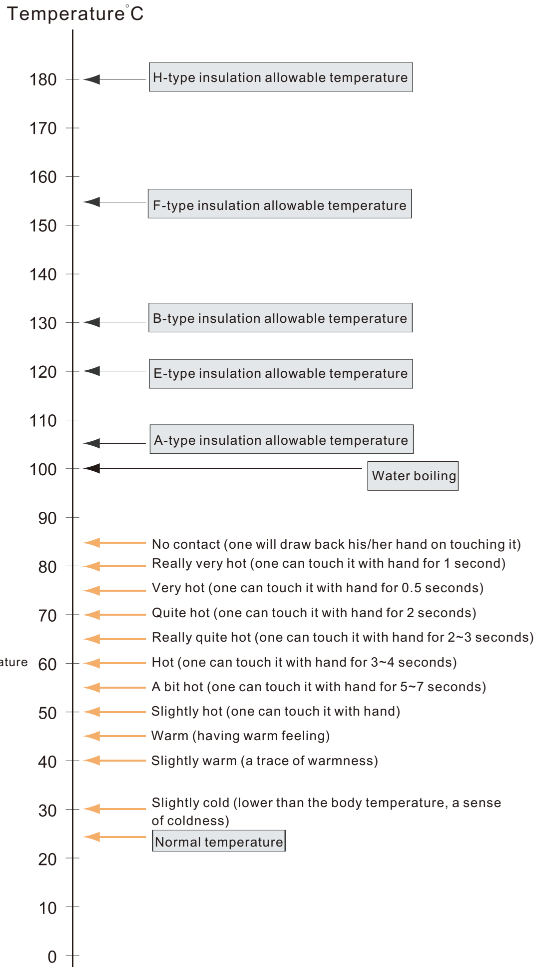
Bearing	Gearhead / Ratio (i)	3~9	10~18	20~60	75~180	Intermediate gear10X
Ball	G-2N□-K G-3N□-K G-4N□-K G-5N□-K	81%		75%	70%	56%
	G-5U□-K	81%	75%	70%	65%	58%
	G-5U□-K G-6U□-KH	—		70%	65%	58%
Metal	G-2N□-L G-3N□-L G-4N□-L G-5N□-L	68%		63%	58%	46%

Class of insulation and temperature rise

Insulation class:

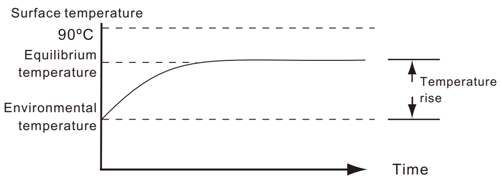
According to the following chart, the insulation class of the induction motors in the Company is B.

Class of insulation	Max. allowable temp.
A	105℃
E	120℃
B	130℃
F	155℃
H	180℃

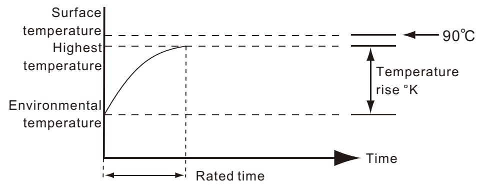


Motor temperature rises (standard environment temp. is -10℃~40℃)

See the figure below for continuous rated motors.



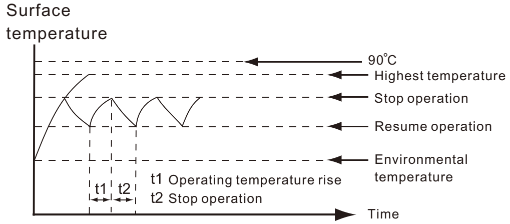
Short-time rated motor

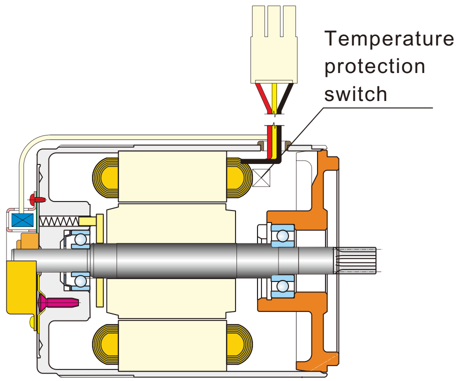


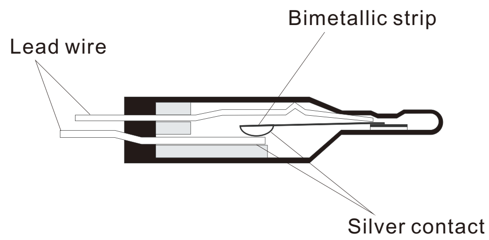
Short-time rated motors are easy to get heated, so the temperature when long-time un-continuous operation stops should be lower than the highest temperature to ensure the coil insulation does not deteriorate untimely and prevent the bearing from lacking oil and stuck prematurely.

When the temperature of the motors get too high (exceeding 90℃), the coil insulation will deteriorate and the bearing will lack oil and get stuck.

RK motors can reach long-time operation through un-continuous operation or forced cooling. The following figure shows how to operate un-continuously with the temperature switch.







Troubleshooting

1 Motors do not operate

a.First, confirm whether there is something wrong with the main and auxiliary coils, and measure their resistance value. If they are of three colors, the red-white line is the main coil, while the red-black is auxiliary. When the resistance of the main coil is close to that of the auxiliary coil (both resistances exist), it means the coils are normal.
(The difference between the resistance value of the main coil and that of the auxiliary coil is less than 14%)

b.If motors still do not operate even if the power is on, but begin to operate when rotated with hand and stop when the output shaft is held by hand, it means the capacitor does not work, perhaps due to wrong wiring or capacitor damage (such probability is quite low).

2 Motors rotate too slowly or get over-loaded

Confirm the operating current of motors with the amperemeter. If it exceeds the rated current, it means over-load (when the coils of motors are normal). When motors are over-loaded,

a.The rotational speed is lower than the rated speed.

b. The current exceeds the rated current.

c. The surface temperature of motors exceed 90℃ (the room temperature is below 40℃)

3 Leakage of electricity

Adjust the avometer to AC voltage gear, with one end connected to the motor, and the other end connected to the ground (ensure the motor is connected to the ground). If the ammeter still displays voltage,it means there is leakage of electricity.When the motor is not connected to the ground, measure the 220V AC motors operating with the power on, and the voltage of 80V AC will be measured out

Notes: ground connection method: pressing the grounding lines in ring form and pressure-welding terminals, and then fixing them to one of the four screw holes on the frame of the motors with bolts. Before fixation, scraping the stoving varnish around the screw holes to ensure the motors and the grounding lines are conductive.

IP Code

Protection grade and testing conditions of electrical equipment shields

The first figure in the IP code represents the protection grade for solid foreign matters

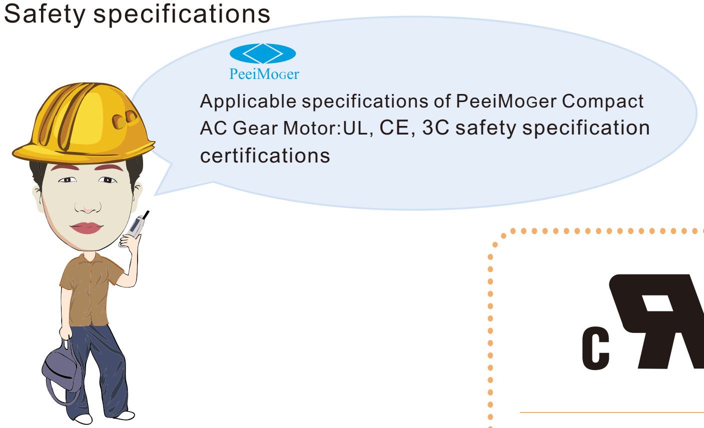
The first figure	Protection grade	
	Summary	Definition
0	No protection	No protection
1	Protect solid foreign matters with a diameter greater than or equal to 50mm	Spheroidal detectors with a diameter of 50mm cannot be passed through completely
2	Protect solid foreign matters with a diameter greater than or equal to 12.5mm	Spheroidal detectors with a diameter of 12.5mm cannot be passed through completely
3	Protect solid foreign matters with a diameter greater than or equal to 2.5mm	Spheroidal detectors with a diameter of 2.5mm cannot be passed through completely
4	Protect solid foreign matters with a diameter greater than or equal to 1.0mm	Spheroidal detectors with a diameter of 1.0mm cannot be passed through completely
5	Dustproof	Dust is not complete isolate, but the total amount of the dust passing through cannot affect the normal operation of electrical machines or ruin the safety.
6	Airtight dustproof	Complete dustproof

The second figure in the IP code represents the protection grade against water

The second figure	Protection grade	
	Summary	Definition
0	No protection	No protection
1	Protect against water dropping vertically	To ensure water dropping vertically will not cause damage
2	Protect against water dropping vertically when the shield inclines 15 degrees	To ensure water dropping vertically from any angle will not cause damage as long as the inclination angle of the shield does not exceed 15 degreestect against water dropping vertically when the shield inclines 15 degrees
3	Protect against leaked water	To ensure leaked water will not cause damage
4	Protect against sprayed water	To ensure water sprayed from any direction will not cause damage
5	Protect against injected water	To ensure water injected from any direction will not cause damage
6	Protect against water column of crush injection	To ensure water column of crush injection will not cause damage
7	Protect against short-time soaking	Within normative pressure and time, the water infiltrating during short-time soaking (30 min) will not cause damage
8	Protect against continuous soaking	With the approval of the manufacturer and the user, under stricter conditions than the seventh, ensure the water infiltrating during continuous soaking will not cause damage

PeeiMoGer

Safety specifications



CE

Based on the LVD in EU, besides insulation and flame resistance, it is required that the coils will not get over-heated and burned up when there is something wrong with motors. The main exceptions include:

4.2.1 Motor locking

4.2.2 Short-circuit and open-circuit of capacitors

4.2.3 Under-phase of three-phase motors

In order to meet the above requirements, temperature protection switch is indispensible to motors of other specifications other than 6W 220V, which has impedance protection. CE products are declared to conform to CE requirements when exiting the factory, as is shown in the above figure.

c UL US ®

To realize insulation and flame resistance, motors of UL and UL 1004-1 standard should meet the following requirements.

4.1.1 The flame resistance and insulation property of motors should conform to UL 1004-1 requirements and certified by UL.

4.1.2 The voltage resistance, insulating ability, construction and dimension should meet UL 1004-1 requirements.

4.1.3 UL construction is shown in the above figure.

4.1.4 The product model on the label of motors of UL specification is composed of the construction number of motors (refer to page 11). If the label includes other numbers (such as serial code), it means the motors are not of UL specification.

CCC

The manufacturing process, components (coils, insulating materials, insulating varnish, outgoing lines etc) are required to conform to CQCCNCA-01-013 specification. Certified motors should be equipped with ground screws and be labeled with 3C certification, which is shown in the above figure.

Preparation before assembly

1.Take down the sealed cap of the gear head and erase the oil content on the end face (refer to Fig. 1)

2.Take down the O-ring on the sealed cap and flatten it to the motor flange, without any floating (refer to Fig. 2).

3.Place the motor upward and take down the protection sleeve of the gear shaft (refer to Fig. 2)

4.The motor and the gear head should be vertical to each other, and prevent left and right rotation to avoid damage to the gear shaft and the gear set (refer to Fig . 3).

5.After assembling the motor and the gear head together, lock them with specialized bolts.

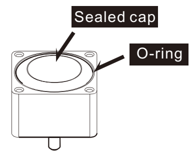


Fig. 1

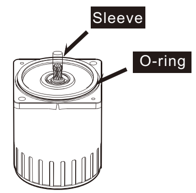


Fig. 2

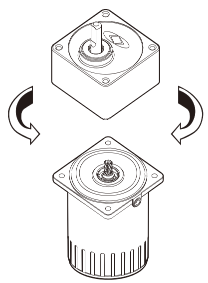


Fig. 3

Notes:

1. When the gear head falls flat for a long time or the output shaft is placed upward, some oil content will leak out (please refer to Fig. 4).

2. When the gear head is not in use, the O-ring should be nested in the sealed cap, which then covers the mating face of the gear head. The output shaft of the gear head should be placed downward to avoid oil leakage (refer to Fig. 4).

3. Incorrect assembly of the motor and the gear head will damage the gear shaft and the gear group, resulting in abnormal noisy and shorter service life.

4. To assemble the motor and the gear head together, the bolts should be crossed and fixed (refer to Fig. 5)

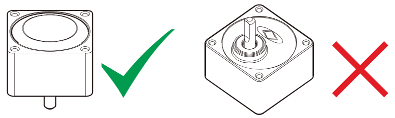


Fig. 4

The correct way to fix bolts | The wrong way to fix bolts

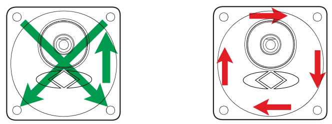
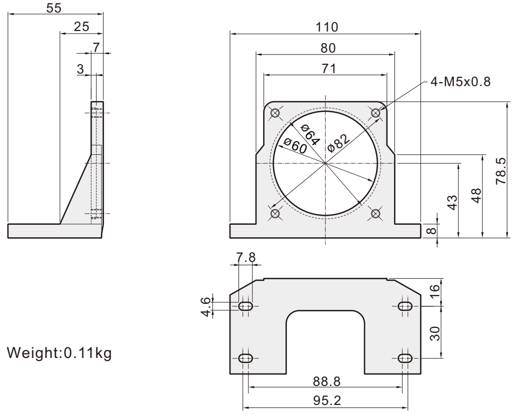


Fig. 5

Frame dimension of the gear head	Bolt specification	Lock torque
60mmsq	M4	20kg.cm
70mmsq	M5	25kg.cm
80mmsq	M5	25kg.cm
90mmsq	M6	30kg.cm
104mmsq	M8	40kg.cm

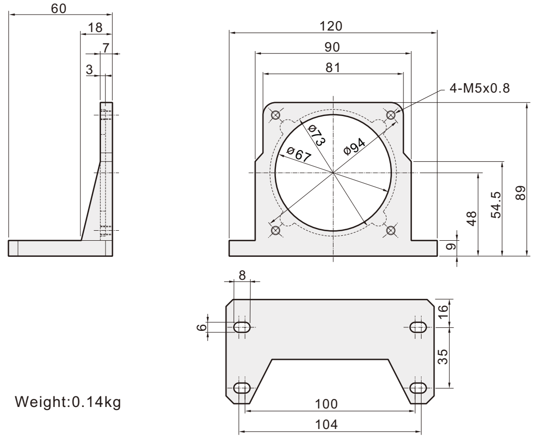
Dimension drawing of motor Mounting Brackets

Frame 3 15W
6015-91119



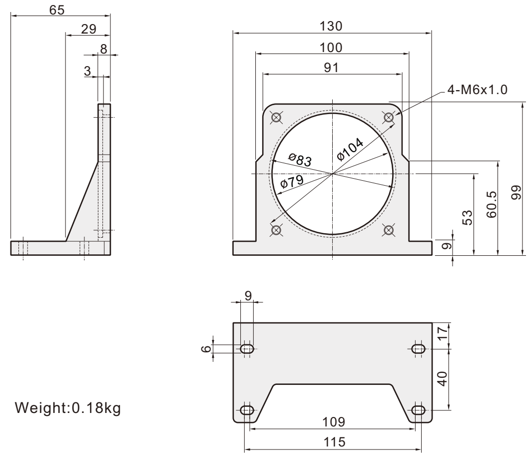
Weight:0.11kg

Frame 4 25W
6025-91119



Weight:0.14kg

Frame 5 40W~150W
6040-91119



Weight:0.18kg

Introduction of electromagnetic clutch brake motors and gear head

Table of comparison between the output shaft of the clutch brake and the gear head

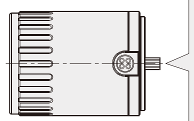
S24

Output shaft	No. of teeth	Tooth type	Product model	Coupled gear head
5S24-81119-2	11	helical N type	S-S24-A26-2	Peei 4 N gear head

S50

Output shaft	No. of teeth	Tooth type	Product model	Coupled gear head
5S50-81119-2	11	helical N type	S-S50-A26-3	Peei 5 N gear head
5S50-81119-3	11	helical U type	S-S50-A26-4	Peei 5 U gear head

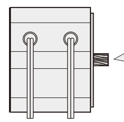
Motor



Output shaft of motors

Type	Modulus	No. of teeth
4N	0.6	10T
5N	0.8	12T
5U		

Clutch brake



Gear head

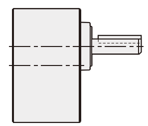


Table of comparison between the motor and the gear head

Frame No.	Output power	Type	Coupled gear head
4	25W	M-4IK25N-□□	Peei 4 N gear head
5	40W	M-5IK40N-□□	Peei 5 N gear head
	60W	M-5IK60N-□□	
		M-5IK60U-□□	Peei 5 U gear head
	90W	M-5IK90U-□□	
	120W	M-5IK120U-□□	
	150W	M-5IK150U-□□	