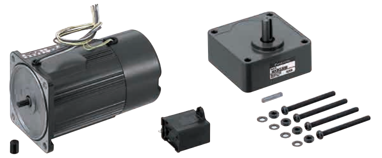
Small Geared Motors - Overview

■Motor Selection

1.Determination of the Driving Facility:
Specify the driving facility and overall dimensions, then check required conditions for the driving facility, such as the mass and travel speed of the material to be transferred.
2.Calculations for Rotational Speed and Loads:
Calculate the load torque, loading moment of inertia and rotational speed of the motor driving shaft.
3.Confirmation of Required Specifications:
Confirm the required specifications, position accuracies, position holding, speed ranges, operating environment, and environmental resistance, etc.
4.Motor Model Selection:
Select the models most suitable for the required specifications.
5.Interim Selection of Motor and Gearhead:
Select motor and gearhead candidates based on calculated speeds, load torque, and inertia values.
6.Confirmation of the Selected Motor:
Finalize the selection by confirming that all the specifications of the motor and the gearhead adequately meet the requirements.

■Model Selection Table

	Induction Motor	Reversible Motor	Motor with Electromagnetic Brake (Single-phase)	Motor with Electromagnetic Brake (3-Phase)
Type	PACMS, PACMT	PACMR	PACMB	PACMTB
	P.1107		P.1113	
				
Features	Motor suitable for continuous one-way direction operations.	Motor capable of instantaneous rotation reversals.	Motor integrated with a power-OFF electromagnetic brake, capable of braking and position holding.	
Voltage	Single-phase 100V/200V 3-Phase 200V/220V	Single-phase 100V/200V	Single-phase 100V/200V	3-Phase 200V/220V
Continuous Operation	○	×	×	○
Instantaneous Direction Reversal Operation	×	○	○	×
Variable Speed	×	×	×	×
Load Holding	×	×	○	○

■Selection Example of Motors

• Required Specifications
Applications: Conveyer, Operation Condition: Continuous, Voltage: 100V, Frequency: 60Hz, Rotational Speed: 25r/min

①Motor Model Selection
A single-phase induction motor with leads (PACMS) is selected from the Motor Model Selection table above based on application, operational condition and environment, and available voltage.

②Interim Selection of Reduction Ratio
Based on the target rotational speed of 25r/min, a reduction ratio 60 is selected to obtain 1500~1550r/min (induction motor rated speed in 60Hz region) divided by 25r/min=60~62.

③Calculation of Required Torque
Approximated load is measured with a spring scale, etc. (Ex.) 2.65N・m
By referring to the data for 60:1 ratio gearhead in "Allowable Torque when Gearheads are Mounted" on **P.1108**, select a 25W motor (PACMS80-W25-V100) and a 60:1 ratio gearhead (PACMGX80-60) with a 200% margin.

④Confirmation of Selected Motor by Actual Measurement
Usually when the conveyer starts moving, the largest torque is required.
Therefore, points below are to be confirmed by measuring the minimum starting voltage (*) .
a. Motor Starting Torque > Required Torque (=Minimum Starting Torque)
b. Actual Measured Rotational Speed > Rated Rotational Speed

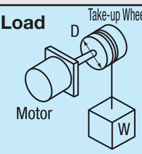
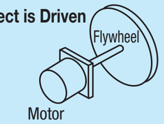
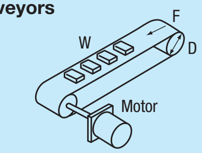
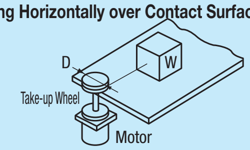
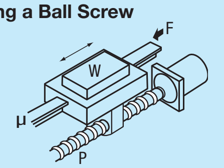
(For example, it is assumed that the actual measurement result of minimum starting voltage is 75V with rotational speed 1700r/min)
a. About Torque
From **P.1108**, Starting torque of PACMS80-W25-V100 is 0.16N・m
Min. Starting Torque = Starting Torque x (Min. Starting Voltage / Rated Voltage)^2 = 0.16 x (75/100)^2 = 0.09N・m
Starting Torque of PACMS80-W25-V100 (0.16N・m) > Min. Starting Torque (0.09N・m)

b. About Rotational Speed
From **P.1108**, Rated Rotational Speed of PACMS80-W25-V100 is 1550r/min
Actually Measured Rotational Speed (1700r/min) > Rated Rotational Speed (1550r/min)

From the above, the PACMS80-W25-V100 motor is adequate for the case.

* How to Measure Min. Starting Voltage
Connect the motor with the load, and connect, in turn, a variable AC transformer with a voltmeter.
Apply and raise the voltage slowly using a variable AC transformer, and measure the voltage when the equipment starts moving.

■Calculation Formula of Load Torque

	SI Unit	Gravitational Metric Unit
When Lifting a Load 	$T=\frac{1}{2}D\cdot W$[N・m] D : Drum Diameter [m] W : Load [N]	$T=\frac{1}{2}D\cdot W$[kgf・m] D : Drum Diameter [m] W : Load [kgf]
When Inertial Object is Driven 	$T=\frac{J}{9.55\times10^4}\cdot\frac{N}{t}$ [N・m] N : Rotational Speed [r/min] J : Inertia [kg・cm^2] t : Time [sec.]	$T=\frac{GD^2}{375\times10^4}\cdot\frac{N}{t}$ [kgf・m] N : Rotational Speed [r/min] GD^2 : Flywheel Effect [kgf・cm^2] t : Time [sec.]
For Belt Conveyors 	$T=\frac{1}{2}D(F+\mu Wg)$[N・m] D : Roller Diameter [m] W : Load Mass [kg] g : Gravitational Acceleration [m/s^2] μ : Friction Coefficient F : External Force [N]	$T=\frac{1}{2}D(F+\mu W)$[kgf・m] D : Roller Diameter [m] W : Load Weight [kgf] μ : Friction Coefficient F : External Force [kgf]
When Moving Horizontally over Contact Surface 	$T=\frac{1}{2}D\cdot\mu Wg$[N・m] D : Drum Diameter [m] W : Mass [kg] μ : Friction Coefficient g : Gravitational Acceleration [m/s^2]	$T=\frac{1}{2}D\cdot\mu W$[kgf・m] D : Drum Diameter [m] W : Weight [kgf] μ : Friction Coefficient
When Driving a Ball Screw 	$T=\frac{1}{2\pi}P(F+\mu Wg)$[N・m] F : External Force [N] W : Workpiece Mass [kg] μ : Friction Coefficient of Sliding Surface [approx. 0.05 ~ 0.2] g : Gravitational Acceleration [m/s^2] P : Ball Screw Lead [m]	$T=\frac{1}{2\pi}P(F+\mu W)$[kgf・m] F : External Force [kgf] W : Load Weight [kgf] μ : Friction Coefficient of Sliding Surface [approx. 0.05 ~ 0.2] P : Ball Screw Lead [m]

■Allowable Moment of Inertia at Gear Head Output Shaft and Motor Shaft

If a large inertial load is linked to the gearhead, a large torque is instantaneously generated when a frequent, intermittent motion starts. If this shock load is too large, the gearhead and motor may be damaged.
To select motors, convert inertia of load (J_G) applied to gearhead output shaft to motor shaft inertia (J_M), to be within the values listed below. The inertia varies depending on the type of load.

・How to Calculate Moment of Inertia Applied to Motor Shaft

$$JM=JG\times\frac{1}{i^2}$$

J_G : Gear Head Output Shaft Inertia [kg・cm^2]
J_M : Motor Shaft Inertia [kg・cm^2]
i : Reduction Ratio [e.g. i=5 if 1:5]

Part Number		Output (W)	Allowable Moment of Inertia at Motor Shaft			
			Except Electromagnetic Brake Motor		Motors with Electromagnetic Brake	
Type	A		J_M(kg・cm^2)	GD^2_M(kgf・cm^2)	J_M(kg・cm^2)	GD^2_M(kgf・cm^2)
PACMGX	60	6	0.125	0.50	0.08	0.32
	70	15	0.125	0.50	0.158	0.63
	80	25	0.138	0.55	0.178	0.71
	90	40	0.400	1.60	0.735	2.94
PACMGZ	90	60	0.650	2.60	0.875	3.50
		90	0.650	2.60	1.000	4.00

*** The allowable load inertia for the 3-phase motors are for static reversal operation.**

* Inertia moments are expressed with J or GD^2. The J is generally called "inertia" and is equal to physical inertia moments expressed with SI Units. The unit is [kg・m^2]. On the other hand, the unit "GD^2" (gee-dee-square) is typically used in industrial calculations using conventional gravitational units, and is also called a "Flywheel Effects". The units used to express are [kgf・m^2] and/or [kgf・cm^2]. The relationship between "J" and "GD2" is: $J=GD^2/4$.
(The unit for "J" should primarily be expressed with [kg・m^2] from the physics standpoint, but [kg・cm^2] will be used here in order to simplify the calculation steps.)

■Allowable Overhang Load and Allowable Thrust Load on Gear Heads

An overhanging load applied perpendicular to the gear head output shaft is generated when the gear head output shaft is linked to the other machine with a chain or belt, but not when it is directly coupled with couplings.
Overhang loads and thrust loads on output shafts greatly affect the bearing life. Ensure that applied loads do not exceed the allowed values shown below.

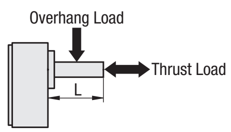
Part Number		Allowable Overhang Load * N(kgf)	Allowable Thrust Load N(kgf)
Type	A		
PACMGX (for Motor Output 40W or lower)	60	98(10)	29(3)
	70	196(20)	39(4)
	80	294(30)	49(5)
	90	392(40)	98(10)
PACMGZ (for Motor Output 60W or higher)	90	588(60)	147(15)

■Service Factor

Generally load is fluctuant. When thinking of service life in such a case, use coefficient called Service Factor according to type of load.
Select Service Factor from the following table, and multiply necessary power to calculate design power.

Load Type	Example of Load	Service Factor		
		5 hours/day	8 hours/day	24 hours/day
Constant Load	Belt Conveyer, Continuous One-way Operation	0.8	1.0	1.5
Light Impact	Start, Stop, Cam Drive	1.2	1.5	2.0
Moderate Impact	Instantaneous Direction Reversal, Instantaneous Stop	1.5	2.0	2.5
Heavy Impact	Frequently Occurring Impact	2.5	3.0	3.5

For technical data on temperature increase of motor, see our website.



* Applied at L/2 of output shaft