

GEARMOTOR Sizing Guide

1 Determining Torque

Selecting the proper gearmotor is a matter of matching output speed and torque to an application's needs. RPM is determined by the driven machine's requirements and should be known. That leaves torque to be determined.

For machines where the load is primarily friction, running torque and starting torque are approximately the same. Here's an easy method of determining starting torque.

1. Attach a pulley securely to the shaft of the machine the gearmotor is required to drive.
2. Wrap a cord securely around the pulley and fasten the end to a spring scale.
3. Pull on the scale noting the weight at the time the shaft begins to turn. Do this several times and average the reading.
4. Then multiply the reading in pounds or ounces, depending upon the scale used, by the radius of the pulley in inches. The resulting figure will be torque either in inch-pounds or inch-ounces. Metric measurements, of course, may be used as well.

$$T \text{ (torque)} = F \text{ (force)} \times R \text{ (radius)}$$

2 Adjust For Duty Cycle

It is not enough to look into a manufacturer's catalog and find the gearmotor whose speed and torque match your parameters. For one thing his ratings may be based on a duty cycle that differs from yours. For example, ratings based upon intermittent duty must be decreased if your need is continuous. Ratings based upon continuous may be increased if your usage is only intermittent.

USAGE*	FACTOR
Continuous loads—8-10 hours per day.	1.00
Intermittent loads—several minutes per hour	1.25
Occasional loads—15-30 minutes per day with a maximum of two minutes at any one time.	1.50

• As defined by AGMA, Bison gearmotors and reducers can generally run continuously for 24 hours a day without rating loss. Specific applications should be reviewed by Bison application engineers.

3 Consider Overhung Load

A pinion, sprocket, pulley or crank mounted to a gearmotor output shaft exerts a force perpendicular to it. This force is termed overhung load (OHL) and care should be taken to make sure the OHL does not exceed the maximum load shown on the appropriate Performance/ Ratings Specifications. Note that ratings shown on charts are for loads applied perpendicular to the output shaft at the center of key, or flat on the output shaft.

The formula for overhung load:

$$\text{OHL (pounds)} = \frac{T \text{ (torque in-lbs.)} \times K \text{ (load factor)}}{R \text{ (radius of pulley or sprocket)}}$$

OHL load factors (K)

DRIVE TYPE	"K" FACTOR
Chain and Sprocket	1.00
Gear	1.25
V-Belt	1.50
Flat Belt	2.50

4 Factor In Shock Load

Some applications subject gearmotors to unusually heavy, erratically occurring loads. Ice cubes in an ice cube dispenser, for example, rather than remaining separate, occasionally freeze up. That places a much greater demand than normal on the gearmotor. A very thick tree root may require more than normal torque from a power rodder. And heavy objects that, from time to time, are dropped on a conveyer can present a problem. Under these circumstances, the extent of the "shock" and its duration become important considerations when determining proper gearmotor or reducer size. For while some gearmotors have little difficulty handling these high momentary loads, others may require higher ratings.

Determining a quantitative number for shock load is extremely difficult. An analysis of the application by amount of testing will likely be required.

5 Select Input Motor

Since input motor characteristics differ depending upon motor type, it is important to match the motor selected to the demands of the application.

Type	Starting Torque	Stall Torque	Starting Current	Recomm. Starting Frequency
Perm. split capacitor	Low	Moderate	Low	High
Split Phase	Moderate	Moderate	High	Medium
Poly Phase	High	High	Moderate	Medium
Perm. magnet DC	High	High	High	Duty cycle analysis required

6 Not A Science

One would think that sizing is simply a matter of examining the torques and output speeds listed for the gearmotors under consideration and selecting those whose ratings fall within your requirements.

But that's simply where you begin. The fact is that not all manufacturer's published ratings are based upon empirical testing. Even if they were, your application may differ radically from test conditions. That's why, after making the "first cut" from the formula provided, it is prudent to test a sample under actual operating conditions.

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GEARMOTOR Equations

Input Horsepower

Once torque and output speed are known, a further calculation determines the horsepower of the input motor required to produce that torque and speed.

$$\text{HP (input motor)} = \frac{\text{RPM (gearmotor output)} \times \text{T (torque)}}{63025 \times E \text{ (gearmotor efficiency)}}$$

Gearmotor Efficiency

In the case of an in-line or parallel shaft gearmotor, efficiency is a function of the number of stages. A conservative formula for efficiency for in-line gearmotors is

$$E \text{ (efficiency)} = .96^N \text{ (Number of stages)}$$

The efficiency of right angle gearmotors can vary greatly with size and ratio. A conservative formula for estimating efficiency of worm gears is:

$$E \text{ (efficiency)} = \frac{74 - .66 \text{ mg (gear ratio)}}{100}$$

Can we help?

Our staff of application engineers are available through phone, fax or email. Challenge us with your application!

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Output Horsepower

Output horsepower may be determined with the following formula:

$$\text{HP (output)} = \frac{\text{T (in-lbs.)} \times \text{RPM (output)}}{63025}$$

An alternative method:

$$\text{HP (output)} = \frac{\text{T (in-oz.)} \times \text{RPM (output)}}{1,008,400}$$

An alternative approximate method:

$$\text{HP (output)} = \text{T (in-oz.)} \times \text{RPM (output)} \times 10^{-6}$$

Wattage Measurements

(1 HP = 746 Watts)

Input Watts = DC Volts x Amps

Output Watts = HP (output) x 746

Due to the nature of AC motor characteristics (power factor) no single formula can be easily applied. It is best to measure AC watts with a wattmeter. Because of the power factor, amperage is not a true indication of load change. Thus a wattmeter is necessary to measure load change.

Form Factor

Form factor is an indication of how well AC power is converted to DC.

$$\text{Form Factor} = \frac{\text{Amps RMS}}{\text{Amps DC}}$$

A form factor of up to 1.4 is generally considered acceptable for SCR rated designs. Longer brush life and a cooler running motor are benefits of a lower form factor. Measuring form factor requires an amp meter with both DC+RMS capability. Connect the amp meter in series with motor leads and take both AC and DC amp readings at full load.

TORQUE CONVERSION TABLE

MULTIPLY	BY	TO OBTAIN
Foot-Pounds	12	Inch-Pounds
Foot-Pounds	16	Ounce-Feet
Foot-Pounds	192	Ounce-Inches
Foot-Pounds	1.356	Newton-Meters
Inch-Pounds	1.333	Ounce-Feet
Inch-Pounds	16	Ounce-Inches
Inch-Pounds	0.113	Newton-Meters
Ounce-Feet	12	Ounce-Inches
Ounce-Feet	0.085	Newton-Meters
Newton-Meters	0.738	Foot-Pounds
Newton-Meters	8.851	Inch-Pounds
Newton-Meters	141.612	Ounce-Inches

QUALITY FACTORS

Gearmotor performance is affected by the quality of its components. Consider the following quality factors if you are concerned about field failures, noise, heat and other factors that affect gearmotor life.

Gearing

Gears are made of molded plastic, powdered metal, steel and hardened steel. While hardened steel gears are normally the most expensive, they provide the greatest strength and longest life. The width of the gears can affect gear life as well. Because of their larger surfaces, wide gears normally outwear narrow gears.

Hobbing

Precision and smoothness of gear teeth are a function of hobbing quality which varies among manufacturers. The American Gear Manufacturers Association ranks hobbing quality number. While some industrial gearmotor gears are hobbed to Class 9, others can be as low as Class 6. These lower numbered gears can exhibit surface irregularities and tooth spacing errors which cause them to run noisier, produce more heat and wear out sooner.

Housings

FHP gearmotor housings are generally made of cast zinc or cast aluminum. Each material offers approximately the same degree of strength. Differences occur in wall thickness and reinforcement design. Gearmotors with thicker walled housings tend to wear longer and are more capable of withstanding rugged handling.

Bearings

Check to determine whether shafts have bronze sleeve bearings or ball and needle bearings. Ball and needle bearings are preferred since they're more efficient, increase load handling capability and lengthen service life.

Lubrication

Two different systems are used to reduce friction and heat: grease and oil bath. While grease systems are normally less expensive, they thin and migrate over time, leaving parts with little or no protection. Oil bath systems, by lubricating the entire gear box, eliminate that potential problem. Sealed oil bath systems that offer lifetime lubrication are preferable in that they do not require periodic replenishment.

