GLOBE DC MOTORS
Globe Motors manufactures permanent magnet DC motors up to 0.2 horsepower (149.20 watts). These motors can be combined with a number of options such as integral planetary gear trains, clutches, brakes and filters.

GEARMOTORS
Almost any Globe motor can be furnished as a gearmotor. An extensive selection of standard gear ratios is available to meet your speed and torque requirements. Globe planetary gear trains offer efficiencies well over 80% per reduction stage for most models, while larger sizes offer efficiencies up to 93%.

DELIVERY
When you need a prototype, a large stock of standard catalog units is available from our distribution network for delivery in 24 hours. In addition, Globe maintains facilities that are geared to quickly handle the largest production order to meet your needs.

PERMANENT MAGNET MOTORS
In DC motors of 0.1 horsepower (74.60 watts) or less, a permanent magnet field is most useful. Comparing motors below 1.25" in diameter, permanent magnet motors run cooler than wound field types because no power is expended to maintain a magnetic field.

The permanent magnet field functions perfectly for thousands of hours of operation and lasts indefinitely on the shelf.

Permanent magnet motors are easily reversed by changing the polarity of the voltage applied to the connecting terminals. They are capable of high-stall torque and function perfectly in long-duty cycle applications.

Dynamic braking is easily obtained by merely applying a short circuit to the motor terminals after voltage is removed. With Globe permanent magnet motors, this usually results in less than 20 armature revolutions coast.

Figure 1 illustrates a speed-torque/current-torque curve for a permanent magnet motor. Each curve is a theoretical straight line since the permanent magnet field and armature winding are constant in a given motor. Current varies in proportion to torque, and the slope of this curve is a torque constant (K_T) in oz. in./amp.

Figure 2 shows that with the permanent magnet motor, no load speed varies inversely with field strength and stall torque varies directly with field strength. In this illustration, curve “a” is the lowest value, curve “b” is the nominal and curve “c” is the maximum value of field strength.

Figure 3 indicates the result of changing the applied voltage to a permanent magnet motor. No load speed changes proportionally to voltage, resulting in a family of parallel speed-torque curves. Remember that voltage determines speed, and only torque will determine current.

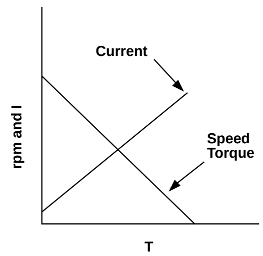


Fig. 1: Permanent Magnet Motor Curve

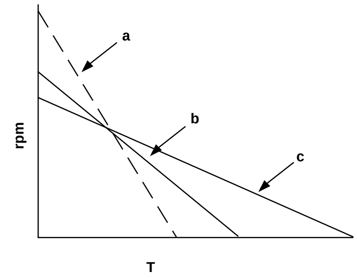


Fig. 2: Speed Tolerance Characteristics

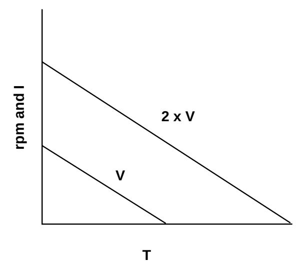
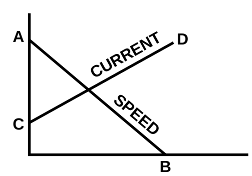


Fig. 3: Voltage Change Effect on Speed

How To Draw Speed Torque Curve



- **A** **no load speed (nominal) (rpm)**
- **B** **stall torque (oz. in.)**
- **C** **no load current (amps)**
- **D** **stall current (amps)**

DC MOTOR CONSTANTS

Motor constants are parameters used to define motor characteristics. Torque constant (K_T) and resistance (R) completely define a permanent magnet motor in terms of determining speeds, torques, efficiencies, currents, etc.

DC motor brushes produce a non-linear voltage drop at the commutator somewhat similar to the forward voltage drop of a silicon diode. It is customary to add a 1- to 2-volt drop factor for this when calculating performance using K_T and R. However, the K_T and R values shown in this catalog are adjusted so that this is not necessary. Motor performance calculations for these motors will indicate actual performance when lead or terminal voltage is used and the torques are within the normal operating range of no load to one-half of stall.

For motors 1.25" diameter and smaller, any errors out to stall should be less than 5%. At the power levels near stall on motors 1.50" and larger, both brush drop and field distortion due to input current are a much larger factor and actual torques near stall will be less than expected.

In this catalog, all values of K_T are in oz. in./amp. Conversion to other units is as follows:
oz. in./amp x .706155 = Newton centimeters/amp
oz. in./amp x 7.06155 = milli-Newton meters/amp
oz. in./amp x 72 = gm cm/amp
oz. in./amp x .0625 = lb. in. amp
oz. in./amp x .0052 = ft. lbs./amp

The voltage constant K_E in volts/1000 rpm is obtained from the equation $K_E = K_T/1.35$.

The motor constant $K_M = K_T/\sqrt{R}$. This constant is a measure of motor "size," but for comparison be sure that equal units are used. Units will be torque/$\sqrt{\text{WATTS}}$ while the physical realization of this constant is the stall torque at one watt input.

The no-load-torque value shown in this catalog for each motor series includes all no load losses and can be considered a nominal value over the speed ranges where it is anticipated that the unit will be used. While brush and bearing friction are relatively independent of speed, other factors such as grease viscosity, windage, hysteresis and electrical losses will change as exponential functions of speed. The most noticeable variation from unit-to-unit or test-to-test will be caused by temperature effects on grease viscosity. When more exact calculations are required, you may assume that one-half of the no load losses occurs at zero rpm and that these losses will follow a linear curve from this point to the listed catalog value at 8,000 rpm.

K_T and R values in this catalog are all nominal values at +25°C and should not be considered as minimum or maximum.

FORMULAS

When the no load torque is known, an actual speed-torque-current curve can be drawn using:

$$\text{Stall Torque} = \left[\left(K_T \times \frac{\text{volts}}{R}\right) - \text{No Load Torque}\right]$$

$$\text{No Load Current} = \frac{\text{No Load Torque}}{K_T}$$

$$\text{No Load Speed} = \frac{[\text{volts} - (\text{No Load Current} \times R)]}{K_E}$$

$$\text{Stall Current} = \frac{\text{volts}}{R}$$

The speed of any torque can be found using the basic motor performance equation below.

$$\text{Speed (krpm)} = \frac{V - (I_a R)}{K_E} = \frac{V}{K_E} - \frac{\text{Torque} \times R}{K_E K_T}$$

V = applied voltage
I_a = armature current @ load
R = armature resistance
K_E = voltage constant for given motor design and winding

When KE is $\frac{\text{volts}}{\text{krpm}}$, speed will be in krpm

Torque = Load Required + No Load Torque

$$\text{Slope of Speed-Torque Curve} = \frac{R}{K_E K_T} \text{ (krpm/oz. in.)}$$

$$\text{Mechanical Time Constant (seconds)} = \frac{100\,\pi \times \text{Inertia} \times \text{Res.}}{3 \times K_E K_T}$$

$$= \frac{135\,\pi \times \text{Inertia.}}{3(K_M)^2}$$

$$\text{RPM at Peak Efficiency} = \frac{\text{No Load rpm}}{1 + \sqrt{\frac{\text{No Load Current}}{\text{Stall Current}}}}$$

$$\text{Current at Peak Efficiency} = \sqrt{\text{No Load Current} \times \text{Stall Current}}$$

Note: The above are correct when Inertia is in oz. in. sec.^{2}, K_E is volts/krpm and K_T is in oz. in./amp. Remember that the speed is always in thousands of rpm whenever K_E is used.

PULSE WIDTH MODULATION

Most Globe standard DC motors have low electrical time constants of 0.3 to 0.6 milliseconds and mechanical time constants in the 10 to 25 millisecond range. When using pulse width modulated power, be sure to keep the frequency high enough to obtain the velocity uniformity needed for your system. While some systems will work as low as 40 to 50 Hz, 1000 Hz is suggested as a low limit.

These motors have a "Q" of well over 10, so that voltage spike suppression is usually needed to protect the circuits. The diode commonly used for this purpose dissipates part of the inductive energy as heat (I^2R loss) in the motor winding. Because this loss will increase with frequency, very high frequencies should be carefully considered. Motor tests show no advantages in using the 5 kHz to 20 kHz range.