



Here are some *motor formulas* that may be useful.



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Calculating Motor Speed:

A squirrel cage induction motor is a constant speed device. It cannot operate for any length of time at speeds below those shown on the nameplate without danger of burning out.

To Calculate the *speed of a induction motor*, apply this formula:

$$Srpm = \frac{120 \times F}{P}$$

Srpm = synchronous revolutions per minute.

120 = constant

F = supply frequency (in cycles/sec)

P = number of motor winding poles

Example: What is the synchronous of a motor having 4 poles connected to a 60 hz power supply?

$$Srpm = \frac{120 \times F}{P}$$

$$Srpm = \frac{120 \times 60}{4}$$

$$Srpm = \frac{7200}{4}$$

$$Srpm = 1800 \text{ rpm}$$

Calculating Braking Torque:

Full-load motor torque is calculated to determine the required braking torque of a motor.

To Determine *braking torque* of a motor, apply this formula:

$$T = \frac{5252 \times \text{HP}}{\text{rpm}}$$

T = full-load motor torque (in lb-ft)

5252 = constant (33,000 divided by 3.14 x 2 = 5252)

HP = motor horsepower

rpm = speed of motor shaft

Example: What is the braking torque of a 60 HP, 240V motor rotating at 1725 rpm?

$$T = \frac{5252 \times \text{HP}}{\text{rpm}}$$

$$T = \frac{5252 \times 60}{1725}$$

$$T = \frac{315,120}{1725}$$

$$T = 182.7 \text{ lb-ft}$$

Calculating Work:

Work is applying a force over a distance. Force is any cause that changes the position, motion, direction, or shape of an object. Work is done when a force overcomes a resistance. Resistance is any force that tends to hinder the movement of an object. If an applied force does not cause motion the no work is produced.

To calculate the amount of work produced, apply this formula:

$$W = F \times D$$

W = work (in lb-ft)

F = force (in lb)

D = distance (in ft)

Example: How much work is required to carry a 25 lb bag of groceries vertically from street level to the 4th floor of a building 30' above street level?

$$W = F \times D$$

$$W = 25 \times 30$$

$$W = 750 \text{ -lb}$$

Calculating Torque:

Torque is the force that produces rotation. It causes an object to rotate. Torque consist of a force acting on distance. Torque, like work, is measured is pound-feet (lb-ft). However, torque, unlike work, may

exist even though no movement occurs.

To calculate torque, apply this formula:

$$T = F \times D$$

T = torque (in lb-ft)

F = force (in lb)

D = distance (in ft)

Example: What is the torque produced by a 60 lb force pushing on a 3' lever arm?

$$\begin{aligned} T &= F \times D \\ T &= 60 \times 3 \\ T &= 180 \text{ lb ft} \end{aligned}$$

Calculating Full-load Torque:

Full-load torque is the torque to produce the rated power at full speed of the motor. The amount of torque a motor produces at rated power and full speed can be found by using a horsepower-to-torque conversion chart. When using the [conversion chart](#), place a straight edge along the two known quantities and read the unknown quantity on the third line.

To calculate motor full-load torque, apply this formula:

$$T = \frac{HP \times 5252}{rpm}$$

T = torque (in lb-ft)

HP = horsepower

5252 = constant

rpm = revolutions per minute

Example: What is the FLT (Full-load torque) of a 30HP motor operating at 1725 rpm?

$$\begin{aligned} T &= \frac{HP \times 5252}{rpm} \\ T &= \frac{30 \times 5252}{1725} \\ T &= \frac{157,560}{1725} \\ T &= 91.34 \text{ lb-ft} \end{aligned}$$

Calculating Horsepower:

Electrical power is rated in horsepower or watts. A horsepower is a unit of power equal to 746 watts or 33,000 lb-ft per minute (550 lb-ft per second). A watt is a unit of measure equal to the power produced

by a current of 1 amp across the potential difference of 1 volt. It is 1/746 of 1 horsepower. The watt is the base unit of electrical power. Motor power is rated in horsepower and watts. Horsepower is used to measure the energy produced by an electric motor while doing work.

To calculate the horsepower of a motor when current and efficiency, and voltage are known, apply this formula:

$$HP = \frac{V \times I \times Eff}{746}$$

HP = horsepower
V = voltage
I = current (amps)
Eff. = efficiency

Example: What is the horsepower of a 230v motor pulling 4 amps and having 82% efficiency?

$$HP = \frac{V \times I \times Eff}{746}$$

$$HP = \frac{230 \times 4 \times .82}{746}$$

$$HP = \frac{754.4}{746}$$

$$HP = 1 \text{ Hp}$$

Eff = efficiency / HP = horsepower / V = volts / A = amps / PF = power factor

Horsepower Formulas				
To Find	Use Formula	Example		
		Given	Find	Solution
HP	$HP = \frac{I \times E \times Eff.}{746}$	240V, 20A, 85% Eff.	HP	$HP = \frac{240V \times 20A \times 85\%}{746}$ HP=5.5
I	$I = \frac{HP \times 746}{E \times Eff \times PF}$	10HP, 240V, 90% Eff., 88% PF	I	$I = \frac{10HP \times 746}{240V \times 90\% \times 88\%}$ I = 39 A

To calculate the horsepower of a motor when the speed and torque are known, apply this formula:

$$HP = \frac{rpm \times T(\text{torque})}{5252(\text{constant})}$$

Example: What is the horsepower of a 1725 rpm motor with a FLT 3.1 lb-ft?

$$HP = \frac{rpm \times T}{5252}$$

$$\begin{aligned} & 5252 \\ \text{HP} &= \frac{1725 \times 3.1}{5252} \\ \text{HP} &= \frac{5347.5}{5252} \\ \text{HP} &= 1 \text{ hp} \end{aligned}$$

Calculating Synchronous Speed:

AC motors are considered constant speed motors. This is because the synchronous speed of an induction motor is based on the supply frequency and the number of poles in the motor winding. Motor are designed for 60 hz use have synchronous speeds of 3600, 1800, 1200, 900, 720, 600, 514, and 450 rpm.

To calculate synchronous speed of an induction motor, apply this formula:

$$\text{rpmsyn} = \frac{120 \times f}{N_p}$$

rpmsyn = synchronous speed (in rpm)
 f = supply frequency in (cycles/sec)
 N_p = number of motor poles

Example: What is the synchronous speed of a four pole motor operating at 50 hz.?

$$\begin{aligned} \text{rpmsyn} &= \frac{120 \times f}{N_p} \\ \text{rpmsyn} &= \frac{120 \times 50}{4} \\ \text{rpmsyn} &= \frac{6000}{4} \\ \text{rpmsyn} &= 1500 \text{ rpm} \end{aligned}$$

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If there is anything you would like to add or if you have any comments please feel free to [email E.T.E.](mailto:email@E.T.E.)

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1997, Electricians Toolbox Etc...



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