How to use STP Calculator

Frequently Asked Questions

STP Calculator is a tool (windows program) that simplifies fractional horsepower motor and gearmotor selection for engineers and product designers. Specifically designed for motor evaluation, STP assists users with the evaluation of the critical relationship between input of electrical power and output of mechanical power.

STP calculator is available two different ways.

1) STP can be used as a stand alone calculator for <u>S</u>peed, <u>T</u>orque and mechanical <u>P</u>ower (thus, the acronym STP) available over the web. When two of the variables are known, such as Speed and Torque, the third variable, (in this case, power) can be calculated. STP supports a number of units for each variable which simplifies the calculation. This portion of STP is provided on-line as a part of Groschopp's website.

(link: http://www.groschopp.com/about-stp-calculator/)

2) STP is also available as a download with expanded features. It can also be used as a stand alone calculator to evaluate the relationship between the known values of voltage, power factor, and electrical power to calculate current. The program allows for different voltage types and multiple power units.

Although STP provides excellent functionality for the two individual features, the greatest benefit of STP is realized when the two separate features are used together to evaluate an electric motor.

A motor is considered because of a need to change electrical power to mechanical power. This conversion is made with some losses in the motor, resulting in less power being produced out of the motor than put into the motor. The relationship between power input and output is known as efficiency. STP is able to evaluate this relationship.
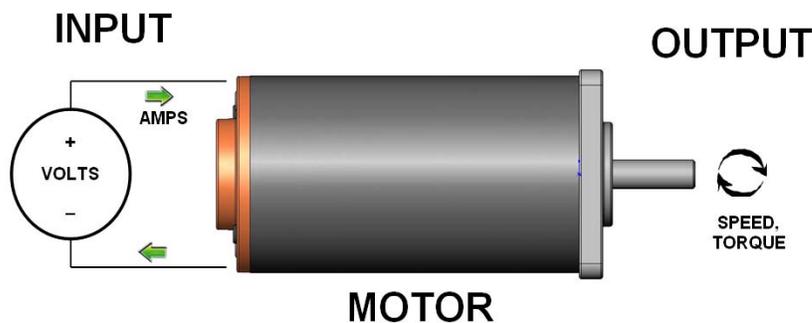
There are a number of questions that STP can help you answer.
1. How much current will my load require?
2. How efficient will the motor need to be if I have a limited current source?
3. Are the input and output specifications realistic?
4. What size motor will I need?
5. If I know my motor current and speed what is the torque and output power?
6. Does it pay to invest in a high efficiency motor?

Before examining these questions, there are some known parameters and others that will need to be estimated. In general, the type of voltage and the voltage value will be known in all cases. Other known values will depend on in the stage of project development. If the development is in the early stages estimates, or perhaps a range of the load in terms of speed and torque will be available. A project that has made it to the testing stage would have speed and current test parameters available. Torque would be the unknown due to measurement difficulties.

Question 1: How much current will my load require?

This question is typical in the design phase where an application now needs a motor to drive the load. Speed and torque have been estimated and a motor and/or gearmotor type has been chosen, allowing for a rough estimate of efficiency.

Fig.1
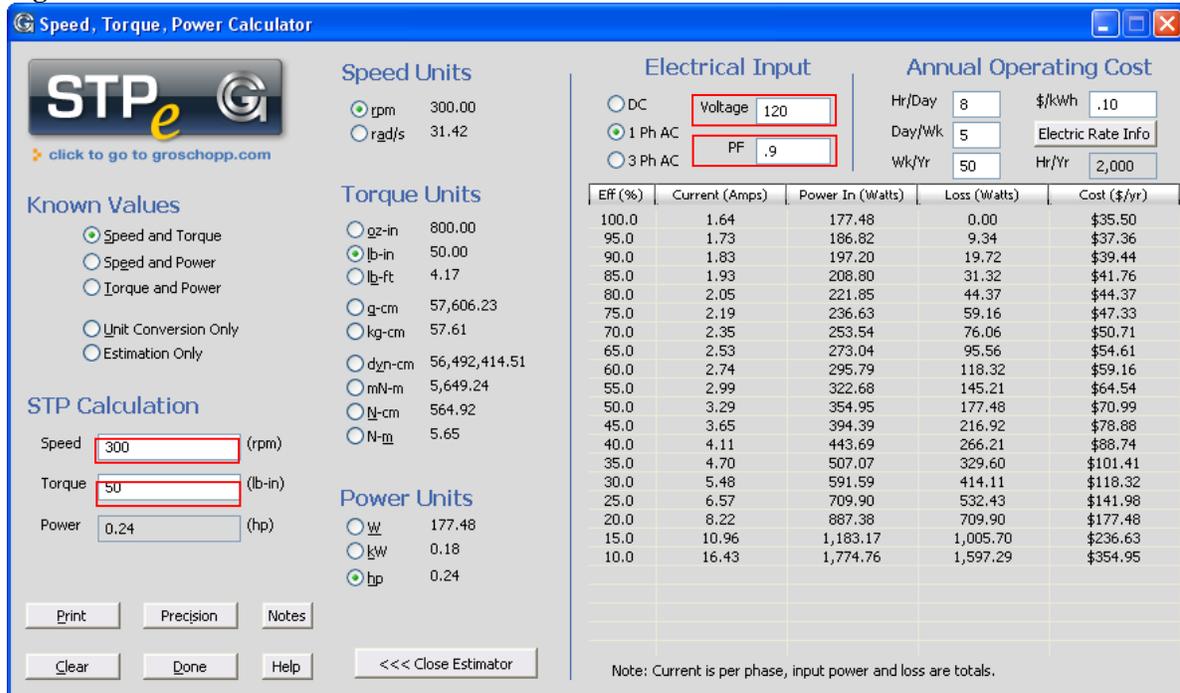
In Figure 1, by entering a speed of 300 rpm and a torque of 50 lb-in along with voltage and power factor information the current at different efficiencies is calculated. By multiplying the motor and gearbox efficiencies (found in the following graphs) it is possible to determine a close approximation of the current. For example, at an efficiency of 75% a current of 2.35 amps is required to drive the application.

Question 2: How efficient will the motor need to be if I have a limited current source?

Using the example above, and using the current as the "look up" value, the corresponding efficiency can be found. This is a useful tool when you are:

- Using a fused circuit with an established fuse rating.
- Going to use a control with an established rating.
  - Note that some control outputs will lower a motor's efficiency.
- Need to meet agency approvals related to the application's power source.
  - Such as typical household wire with 15 amps maximum.

Question 3: Are the input and output specifications realistic?

In many cases a motor/gearmotor will be specified with voltage, current, input watts, speed and torque, corresponding to the inputs of the power source and the load associated with the applications. As an example, a 12 volt application can be more sensitive to current requirement due to drain on a battery. If the specifications from Figure 1 were run at 12 volts the results would be as follows.

Fig. 2
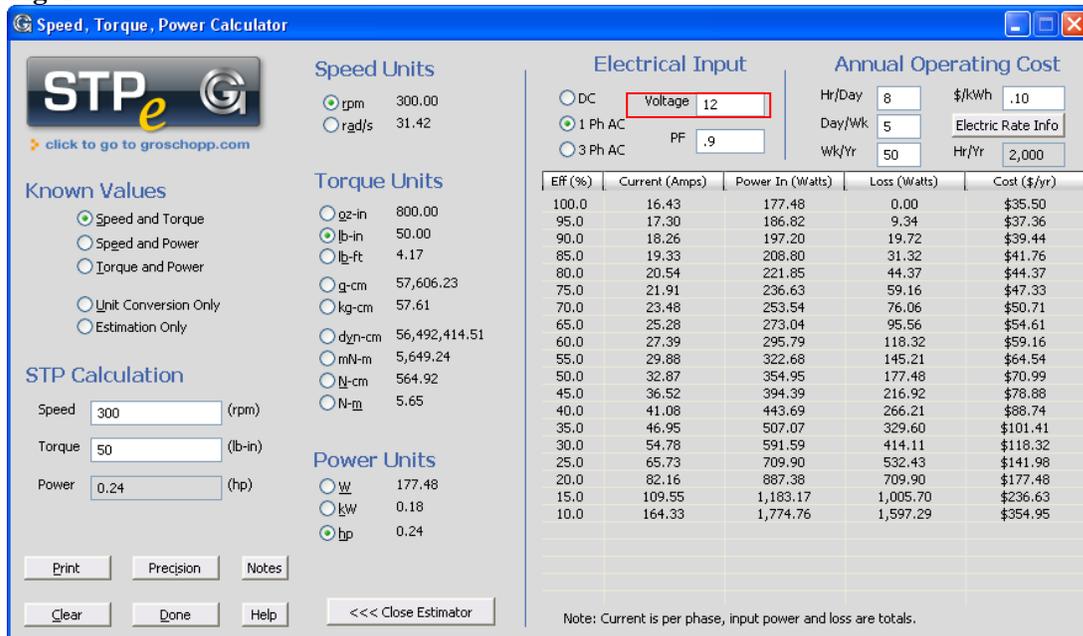
The first observation is that any specification of current less than 16.4 amps is unrealistic because the system efficiency of motor and gearbox would need to be greater than 100%. It may be surprising for you to know that this is a rather common occurrence. It is also important to know about the type of motor and gearbox. A 20 amp maximum current requirement would likely require a brushless DC motor and planetary gearbox to reach the 80% efficiency. If a low cost permanent magnet motor with right angle gearbox was specified it would have about 40% system efficiency and require closer to 40 amps of operating current.

Question 4: What size motor will I need?

If you are able to answer question one and obtain the current at full load you will be able to size the motor. The current rating of the motor and associated efficiency is related to the watt loss associated with the motor. As a motor becomes less efficient the motor size will need to increase

to dissipate the additional heat. These factors are taken into account when the motor manufacturer establishes the current rating.

Question 5: If I know my motors current and speed what is the torque and output power?

This question is frequently asked when a motor is being tested and there is no easy way to measure the torque. The speed can be read with a tachometer or strobe and current can easily be read with an amp meter. The process of finding the torque requires an iteration ("trial and error") process of estimating torques until the corresponding current is reached. As an example we could have an application where there is a speed of 50 rpm, voltage of 24 volts DC and we measure a current of 25 amps. Based on the gearmotor combination that we are using it is estimated that the system is about 55% efficient. Figure 3 shows the initial inputs:

Fig. 3
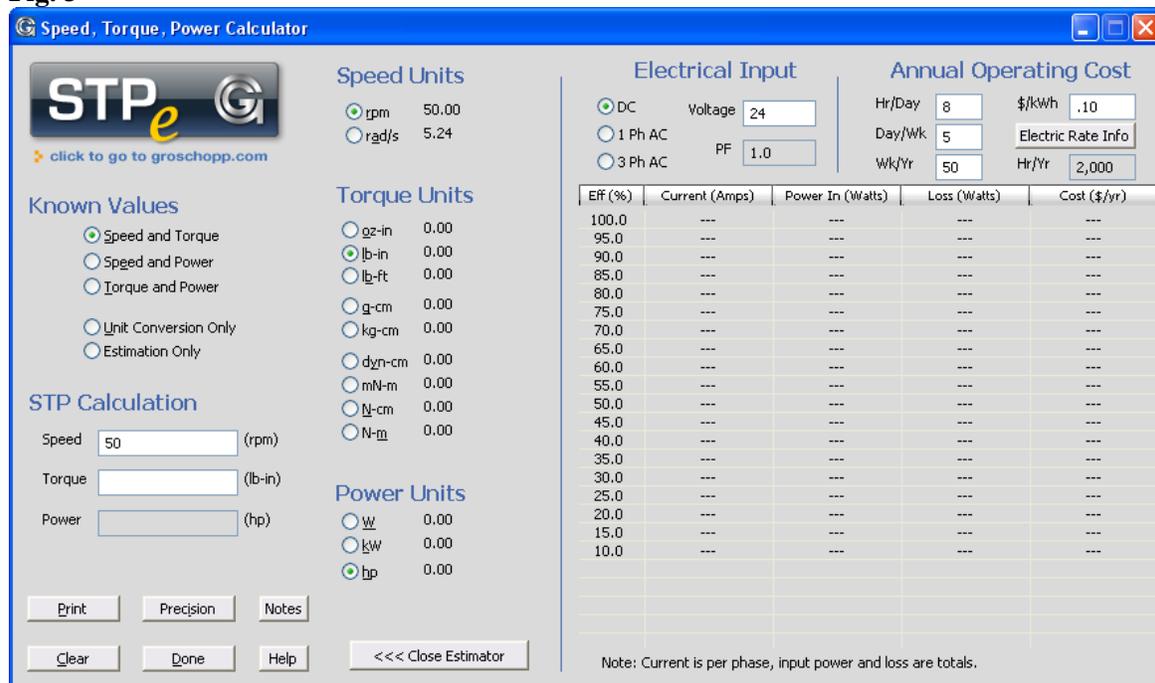
Various torque values are then entered into the STP calculation until a current of 25 amps is found at 55% efficiency. The results are shown in Figure 4:

Fig. 4

Speed, Torque, Power Calculator

STP_e G

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Known Values
- ● Speed and Torque
- ○ Speed and Power
- ○ Torque and Power
- ○ Unit Conversion Only
- ○ Estimation Only

STP Calculation

Speed | 50 | (rpm)

Torque | 560| | (lb-in)

Power | 0.44 | (hp)

[Print] [Precision] [Notes]

[Clear] [Done] [Help] [<<< Close Estimator]

Speed Units
- ● rpm 50.00
- ○ rad/s 5.24

Torque Units
- ○ oz-in 8,960.00
- ● lb-in 560.00
- ○ lb-ft 46.67
- ○ g-cm 645,189.79
- ○ kg-cm 645.19
- ○ dyn-cm 632,715,042.55
- ◐ mN-m 63,271.50
- ○ N-cm 6,327.15
- ○ N-m 63.27

Power Units
- ○ W 331.29
- ○ kW 0.33
- ● hp 0.44

Electrical Input
- ● DC Voltage 24
- ○ 1 Ph AC PF 1.0
- ○ 3 Ph AC

Annual Operating Cost

Hr/Day 8 | $/kWh .10
Day/Wk 5 | Electric Rate Info
Wk/Yr 50 | Hr/Yr 2,000

Eff (%)	Current (Amps)	Power In (Watts)	Loss (Watts)	Cost ($/yr)
100.0	13.80	331.29	0.00	$66.26
95.0	14.53	348.73	17.44	$69.75
90.0	15.34	368.10	36.81	$73.62
85.0	16.24	389.75	58.46	$77.95
80.0	17.25	414.11	82.82	$82.82
75.0	18.40	441.72	110.43	$88.34
70.0	19.72	473.27	141.98	$94.65
65.0	21.24	509.68	178.39	$101.94
60.0	23.01	552.15	220.86	$110.43
55.0	25.10	602.34	271.05	$120.47
50.0	27.61	662.58	331.29	$132.52
45.0	30.67	736.20	404.91	$147.24
40.0	34.51	828.22	496.93	$165.64
35.0	39.44	946.54	615.25	$189.31
30.0	46.01	1,104.30	773.01	$220.86
25.0	55.21	1,325.16	993.87	$265.03
20.0	69.02	1,656.44	1,325.16	$331.29
15.0	92.02	2,208.59	1,877.30	$441.72
10.0	138.04	3,312.89	2,981.60	$662.58

Note: Current is per phase, input power and loss are totals.

Figure 4 shows about 560 lb-in of torque generating an output power of 0.44 horse power.

7. Question 6: Does it pay to invest in a high efficiency motor?

For the purpose of evaluating operating cost it is not necessary to know the speed and torque, only the output power, although it can be calculated with speed and torque values as well. By selecting "Estimation Only" in the known values, STP will prompt for the input power. The other values associated with "Electrical Inputs" will be needed to complete the calculation.

Typical high efficiency motors will be 4% to 7% more efficient than standard motors. The higher the output power and duty cycle of the motor the greater the impact on operating cost. In Fig. 5 a five horse power motor is used full time during a regular work week.

Fig. 5
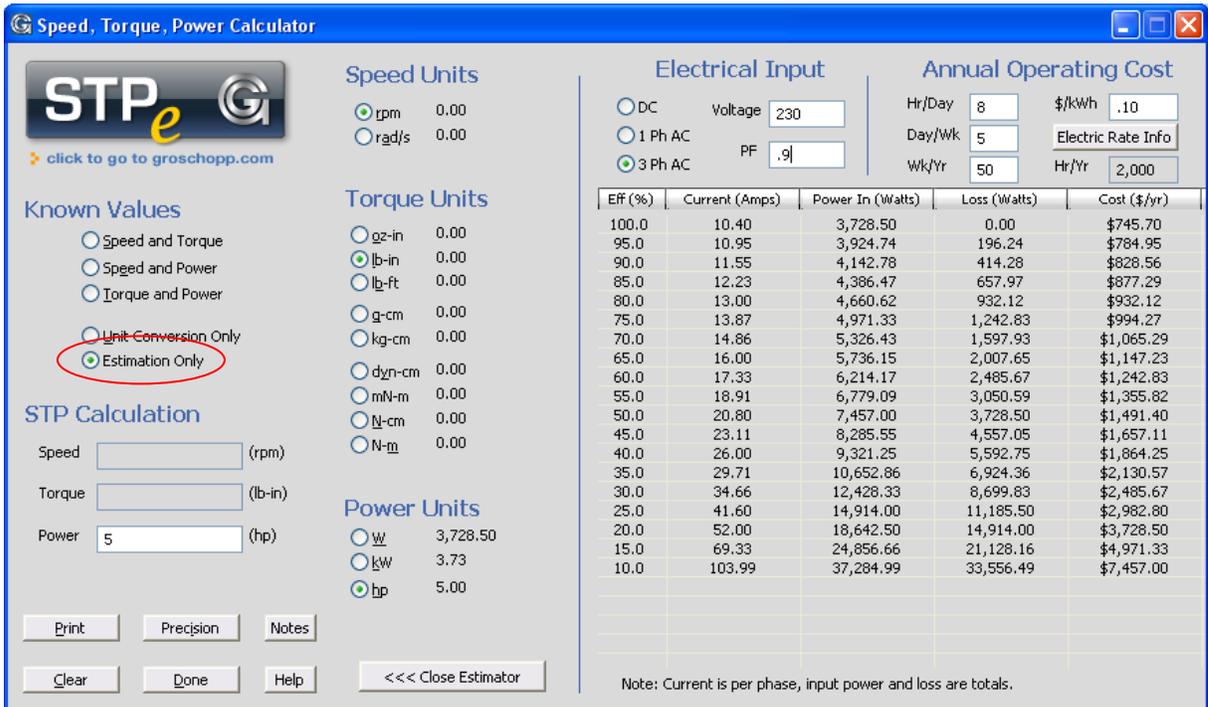
In this case there would be $50 to $70 dollars per year to invest in a more expensive high efficiency motor. There can be greater efficiency savings when changing motor types and evaluating gearboxes with multiple stages and alternate gear types.

Summary:

All of the calculations within STP are accurate, however, there can be a number of estimations required to approximate the unknowns in your application. In general, these estimates and results can give valuable direction during project development.

Additional complications arise when relating a motor's continuous nameplate current to an intermittent duty application. Downsizing the motor and gearbox are typically possible with these conditions. For assistance with this type of application please contact us at Groschopp, Inc., we will be glad to assist you.