- (https://www.facebook.com/radiocontrolinfo)
- (https://www.youtube.com/channel/UCrKM0T_jQkCApz0nSH8Iynw)
- (https://www.instagram.com/propwash1/)

(http://www.radiocontrolinfo.com)

Brushless Motor Efficiency

- Brushless Motor Efficiency and Constants (http://www.radiocontrolinfo.com/brushless-motor-efficiency/)
- Brushless Motor Kv - Measure a Motor's Kv (http://www.radiocontrolinfo.com/brushless-motor-efficiency/brushless-motor-kv-measure-a-motors-kv/)
- Brushless Motor No Load Current (http://www.radiocontrolinfo.com/brushless-motor-efficiency/brushless-motor-no-load-current/)
- Brushless Motor Winding Resistance (http://www.radiocontrolinfo.com/brushless-motor-efficiency/brushless-motor-winding-resistance/)
- Measuring Motor RPM - Unpowered (http://www.radiocontrolinfo.com/brushless-motor-efficiency/measuring-motor-rpm/)

Radio Control Info Articles

- General Electric (http://www.radiocontrolinfo.com/category/general-electric/) (4)
- General Radio Control (http://www.radiocontrolinfo.com/category/general-radio-control/) (8)
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Brushless Motor Efficiency and Constants

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Before looking at Brushless motor efficiency, we must first quickly cover the Motor Constants applicable for determining the efficiency of a brushless motor. There are three important motor constants that allow you to understand the performance of any electric brushless motor. We will try to make use of common house hold tools such as a Multimeter (http://www.amazon.com/gp/product/B000EX0AE4/ref=as_li_tl?ie=UTF8&camp=1789&creative=9325&creativeASIN=B000EX0AE4&linkCode=as2&tag=rcinfosite-20&linkId=EU2BKHCI25GL65AL) in order to measure all the constant.

Brushless Motor Constants

- Kv – Motor Voltage Constant. (http://www.radiocontrolinfo.com/brushless-motor-kv-measure-a-motors-kv/) The Kv brushless motor constant is measured in RPM per volt and is used mainly to determine the unloaded RPM of a particular setup. This can be accomplished by multiplying the constant by a known voltage source. The resulting value is in RPM. The interesting aspect of this motor constant, is that if you take the inverse of it, you will have the torque constant. Now in order to take the inverse of the Kv value, you must convert RPM in to Radians per second and then the torque value units would be in Nm / A. (Newton Meters per Amp) A converter Calculator can be found at the bottom of the page. Visit the Kv voltage Constant page (http://www.radiocontrolinfo.com/brushless-motor-kv-measure-a-motors-kv/) to learn how to measure the constant and apply it for your specific application.
- Rm – Winding Resistance Constant. The motor wind resistance is an indication of the resistance found in the copper winding. The resistance is measured in ohms and is found in only one of the phases. Ultimately it is desired to have a wire that does not have any resistance to it but this is not possible or practical. To learn how to calculate the Winding Resistance Constant, Rm, visit the Motor Wind Resistance Constant page. The wind resistance plays a key role in determining Brushless Motor Efficiency.
- Io – Unloaded Motor Current Constant (http://www.radiocontrolinfo.com/brushless-motor-no-load-current/). Lastly, the final important brushless motor constant is known as the No Load Current Constant. The No load current constant is a measure of how much power a motor consumes to operate at a specific RPM. In general this value is taken at 10 volts, however we will explain the importance of this in the Measuring No Load Current Constant page. This value also plays a key role in determining Brushless Motor Efficiency.

Brushless Motor Efficiency

Brushless Motors are one of the most efficient methods of creating mechanical power from another form of energy. If we look at the internal combustion engine, the performance level of a gas engine in terms of its energy efficiency, is typically less than 30%. Now if we even look at the efficiency of the diesel engine, the efficiency level is not that much better. Brushless motor efficiency is very high in comparison to any combustion engine with values averaging between 70% and 90%.

Copper Losses

We will now look at how the above motor constants effect the efficiency in our motors and then we will calculate the brushless motor efficiency.

The first component we will look at is termed Copper Losses. Copper losses are the product of power lost in the winding's alone. Power lost in the winding's is directly related to the resistance per phase. In an ideal world, the resistance would be 0. Any power lost in copper winding's is known as Copper losses. To calculate the copper losses we multiply the Rm Motor Constant by the Current squared.

Copper Losses = Rm x I^2

Iron Losses

The second component that is required in order to determine brushless motor efficiency is the Iron losses. Iron losses takes in to account the no load current of the motor. The no load current of the motor is the required current to keep a motor running in a condition where there is 0 work or output power. Losses that produce a no load current come from hysteresis, eddy current in the iron core as well as mechanical losses found in the bearing. Keep in mind the motor is spun up in order to determine the no load current, at this rate we can be assured that

bearings and any other mechanical component acting on the motor is going to be considered. For example, if you were to have a cooling fan on the motor shaft, this cooling fan will consume power and be part of the no load current constant in the brushless motor.

We can calculate the total iron losses by the following formula:

Iron Losses = Voltage x Io (no load current)

Putting it all together – Brushless motor efficiency

Combining the Copper losses and Iron Losses determines the power put to waste. We can then look at the power in to the motor versus the power in subtracting the losses. Power out divided by power in is equal to the efficiency of a motor.

Eff = Power in / Power out

Eff = Power in / (Power in – Copper Losses – Iron Losses)

We can determine from this formula that the efficiency of a motor varies at different throttle inputs. With a high no load current, we can have very poor efficiency at low RPM's. In order to truly look at efficiency we have to compare different loads applied to the motor.

So what's the catch? Well the catch is that the constants have to be accurately measured in order to get to the correct efficiency value. Measuring these values yourself using a common Multimeter (http://www.amazon.com/gp/product/B000EX0AE4/ref=as_li_tl?ie=UTF8&camp=1789&creative=9325&creativeASIN=B000EX0AE4&linkCode=as2&tag=rcinfosite-20&linkId=EU2BKHCI25GL65AL) can better allow for accurate constants. Below you can find the calculator.

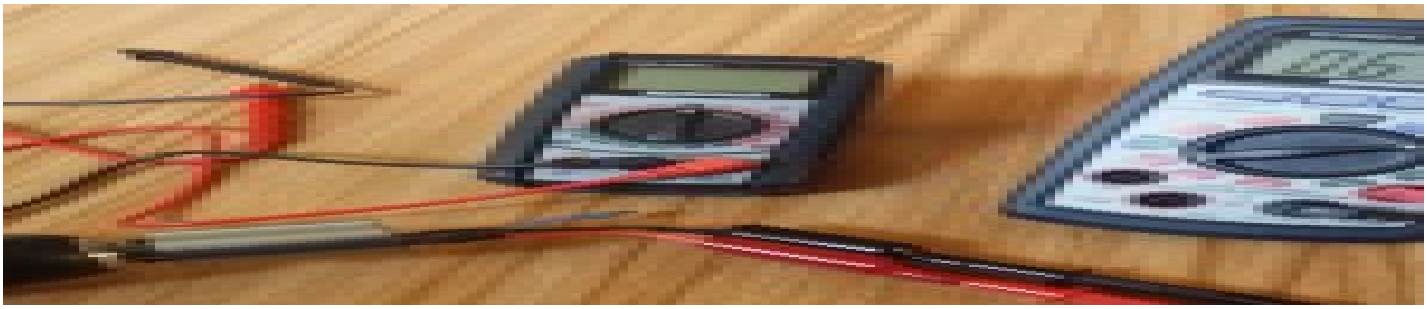
Brushless Motor Efficiency

Voltage (V)	
Current (A)	
Resistance Rm (ohms)	
No Load Current Io (A)	
Voltage Constant Kv (RPM/V)	

Calculate!

Power In (W)	
Copper Losses (W)	
Iron Losses (W)	
Total Losses (W)	
Power Out (W)	
Efficiency (%)	
Torque Constant Kt (mNm/A)	

-



(http://www.radiocontrolinfo.com/brushless-motor-efficiency/brushless-motor-kv-measure-a-motors-kv/)

Brushless Motor Kv – Measure a Motor's Kv (http://www.radiocontrolinfo.com/brushless-motor-efficiency/brushless-motor-kv-measure-a-motors-kv/)

What is a Brushless Motor Kv value? The Brushless Motor Kv value is one of the three important electric motor constants. This motor constant is important as it is one that is used very frequently. When looking for a motor for an RC vehicle, the Kv value is what you will pay attention to. Choosing a …

Brushless Motor No Load Current (http://www.radiocontrolinfo.com/brushless-motor-efficiency/brushless-motor-no-load-current/)

An important motor constant that effects efficiency greatly is known as the brushless motor no load current or the no load brushless motor constant. What is the Brushless Motor No Load Current The no load current of a brushless motor is defined as the current the motor draws, with no load applied, at a specific voltage. …

Brushless Motor Winding Resistance (http://www.radiocontrolinfo.com/brushless-motor-efficiency/brushless-motor-winding-resistance/)

Brushless motor winding resistance is a motor constant that is directly related to the efficiency of the motor. The winding resistance is most likely the easiest parameter in brushless motors to understand. There are no secrets here! Motor winding resistance is just that, the resistance in the motor winding itself. Now I know defining a …

Measuring Motor RPM – Unpowered (http://www.radiocontrolinfo.com/brushless-motor-efficiency/measuring-motor-rpm/)

There is a very simple way for measuring motor RPM quite accurately in order to use this result in the calculation for the Kv of the motor. This method of measuring motor RPM utilizes a Multimeter rather then using a tachometer. What's important about the multimeter is that it must have the ability to measure frequency, which most multimeter do. …