PAR Calculator Explanation & Instructions

The PAR Calculator has been developed keeping in mind the high power loading that Extreme Aerobatic and Hardcore 3D maneuvers typically require. This should not deter anyone else from using this tool, since it will provide useful and accurate results for all flying styles.

In order for you to receive the intended accuracy from this tool, the menu items you select, and data values you apply, must be accurate as well. The better the information you put into the PAR Calculator, the better the results will be.

The Gas Engine Option –

Although this tool is extremely valuable for predicting the power and thrust production of electric power setups, some of the information it provides can be very useful to gas power enthusiasts as well. For example, if you know the length and pitch measurements of your propeller, and you have an accurate RPM reading, the PAR Calculator can predict important power information for you, such as Horsepower, torque, pitch speed, and the approximate thrust you would measure on the ground, if you were to use a scale to take this reading.

This information, along with the all-up weight of your aircraft, can help determine the power loading and thrust loading. By knowing some simple wing measurements as well, the PAR Calculator can reveal other aircraft performance profiles that will affect the flight characteristics.

Here are some hints on how to get the most from the PAR Calculator:

The Motor –

Kv: It is important to understand your motor. The most important and basic things you must know about your motor is the Kv. This can typically be found either on the motor label, or on the specifications section of the motor's website page. The PAR Calculator will ask you the Kv of the motor.

Motor Load Efficiency: It is important to know the relative size of your motor in order for the PAR Calc to accurately calculate the potential RPMs. Since RPMs is the most important value in the power loading calculations, selecting the correct motor weight is important.

The Propeller –

It is also important to understand certain simple physical characteristics of your propeller. Not only will the PAR Calculator ask you the length and pitch of the propeller, but it will also ask you the material that the propeller is made of, as this will influence the results.

Propeller Material: All you need to know is if the propeller is made of wood, carbon fiber, or another composite material, such as plastics, or epoxy-filled plastics. The rule of thumb here is that the physical appearance will make it easy for you to determine between the three choices, and the specifications page of the propeller manufacturer's website should provide this information.

Propeller Type: Knowing if the propeller is intended for electric motors or gas engines will be important. Propellers intended for only electric motors have the luxury of a narrow margin between mass and efficiency. The PAR Calculator will ask you if the propeller you are using is intended for electric only.

Since many physical calculations taking place in the PAR Calculator address things like angular momentum and angular kinetic energy, it is important to predict the mass of the propeller by the menu items you select. Distinguishing between a standard carbon fiber propeller and carbon fiber propeller that is intentionally built to be lighter than standard, can change the power and thrust results. The PAR Calculator will ask you if your carbon fiber propeller is represented by the manufacturer as being of the "Lite" variety.

Thin hub carbon fiber propellers, such as the Mejzlik TH props, do not fit into this category since you will find that they are still nearly as heavy as other carbon fiber propellers from other brands, such as Falcon. Therefore, this category is restricted to propellers that are designated as electric propeller, and have terms like Lite, Light, or Extra Lite, to define them.

Batteries –

The number of cells, and the capacity of the battery in milliamp hours (mAh) will be helpful in accurately determining some of the results the PAR Calculator is capable of. You must at least know the number of cells you are using in your power setup, and the PAR Calculator will ask you for the cell count.

Volts per Cell: Since the RPMs is a direct calculation between the voltage, the Kv of the motor, and the Kv Efficiency, the PAR Calculator will ask you for the Volts per Cell. For this data field, you can simply use something like 3.7 volts per cell, which is widely used to represent an average Lipo cell under load at wide open throttle (WOT).

But knowing that heavily loaded systems will "sag" the electromotive force (EMF) could help with more accurately selecting something closer to reality, such as 3.6 volts per cell. Systems with older batteries could cause more severe sag to 3.5 volts per cell, for example. On the other hand, systems with newer batteries and a reduced propeller load may hold 3.80 to 3.85 volts per cell at WOT.

Using a Watts meter on your system will show you the minimum and maximum volts your system is using. Taking the average, and dividing this number by your cell count, can help you input more accurate information, and therefore receive a better 'average power' representation from the PAR Calculator.

Additional Detail –

The PAR Calculator will not only calculate power and thrust information, but will also calculate performance ranking values as well. Aircraft performance rankings have always been used in both model and full scale airplanes, and most modelers and build enthusiasts use wing loading and wing cube loading to determine the weight and wing area needed to build models that not only look as scale as possible, but also fly as scale as possible.

3D and Extreme Aerobatics enthusiasts use these values and rankings to determine power and thrust requirements in order to develop the speed and high thrust energy needed to perform and recover quickly from full stall maneuvers.

In order to accurately calculate the relative power and thrust loading values, accurate weights and measurements are needed. If you can obtain these values from your airplane, and accurate input them to the PAR Calculator, Performance Average Rankings (PAR) can be determined. In this tool, rankings have been adjusted from Jaffe and Moore in order to compare with my personal PAR. There is also a 3D PAR Plus value that will illustrate a setup that delivers a minimum of specific speed, power loading, thrust loading, wing cube loading, and wing loading values, combined. This is a purely subjective values, but one that many 3D and XA pilots share.

Data Input Values Tips –

Kv – The Kv that is published on the motor's specifications chart is a good number to use. If you have logging ability similar to what's provided by Castle HV ESCs, the running your motor unloaded for a few second will give you a better indication of the unloaded Kv, which us a much more accurate value to use. I am in no way suggesting you run your motor unloaded, and some manufactures warn against this.

Motor Load Efficiency – Use the published weight in grams for your motor. If you feel the motor can be borderline between two values, try both. You may notice that one result makes more sense than the other. Motor weight, along with Kv, is usually published on the motor's webpage, which can be found by doing a simple Google search.

Volts per Cell – I suggest that you use 3.70 volts per cell in most cases. I personally will lower the volts per cell value when I know my propeller load is higher, like to 3.65 volts per cell, and I will raise it when I know I am using a propeller that may load the motor less, like to 3.80 to 3.85 volts per cell. Going over 3.85 volts per cell can give you an understanding of peak values, but these values will not last long under normal flight conditions.

The rest of the data input fields should be self-explanatory, but please ask if something seems unclear. There is much potential for confusion here, so don't hold back. Hearing about confusing issues is the only way I know to correct them, or explain them better.

**For more information about the PAR Calculator, and to ask specific questions about its use, please PM me (Aeroplayin) on RCGroups.com, or join the discussion on the "Power Systems for Extreme Flight Fanatics" thread on the 3D Flying Forum on RCGroups.com.**