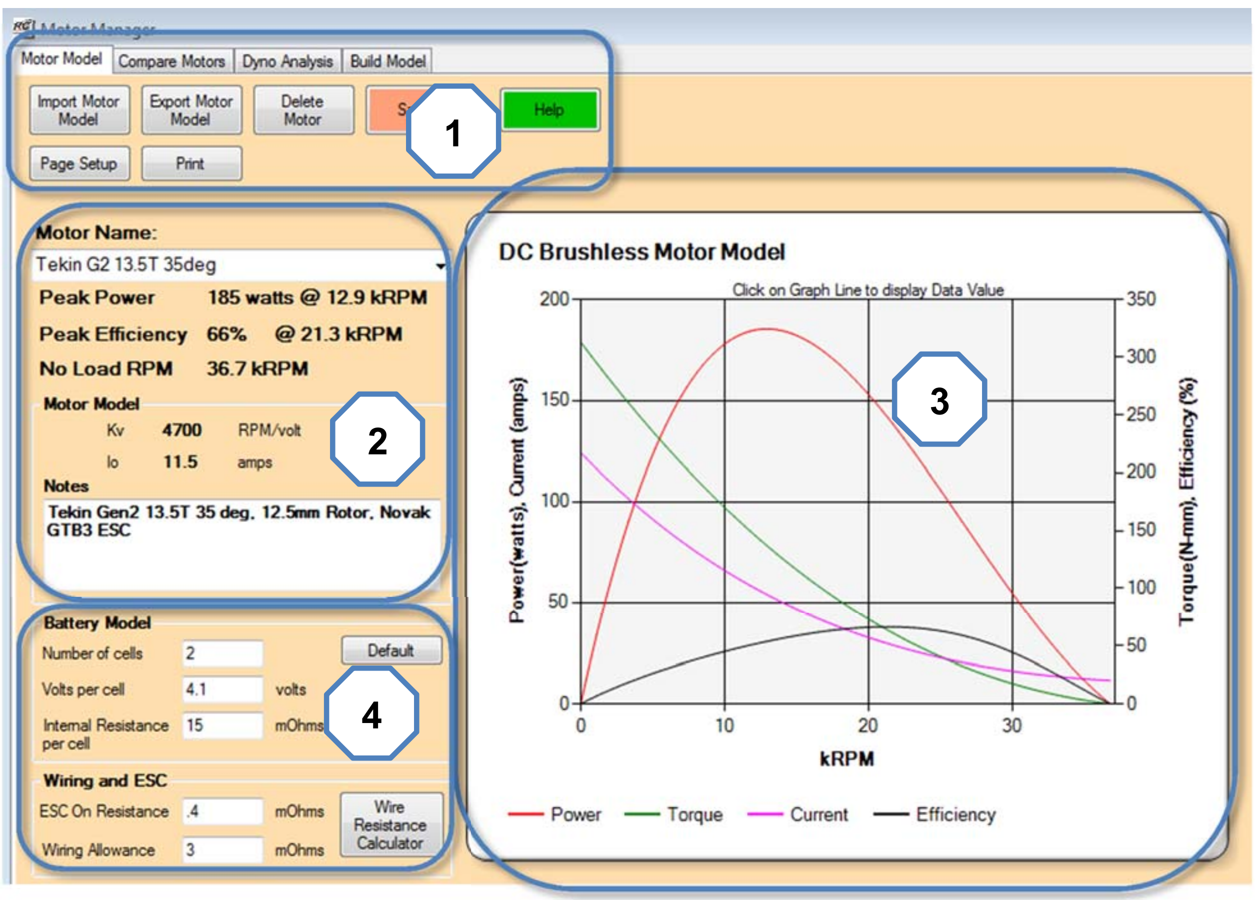
Motor Manager User's Manual

General

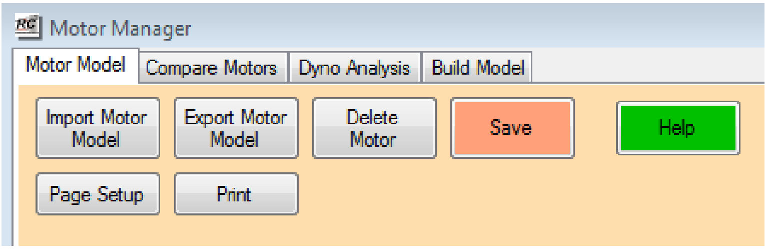
The Motor Manger allows you to view performance graphs of library motor models, compare two motors head to head, analyse Flywheel Dyno data and lastly build new Motor Models validated against motor dyno analysis results.

1. Motor Model Tab

Below you will see the Motor Model tab which is displayed when you open the Motor Manager. Four main areas are boxed below and will be discussed in more detail in the following sections:



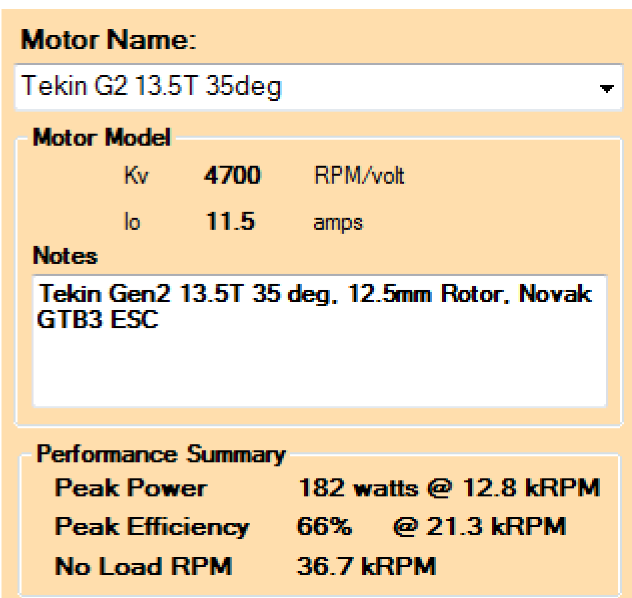
Area 1 – File Management and Selection Tabs



Click the upper tabs to select the different areas of the **Motor Manager** page. Note that the Build Model tab cannot be selected until a Dyno Analysis has been completed.

For the most part the buttons are self-explanatory, however one function is important to discuss. When you add a new model to the library using the Build Model tab it is strongly recommended that you use the **Export Motor Model** button to save the model to your own windows Folder. That way should anything happen to the database which is used to store all the data you will have a backup.

Area 2 – Motor Properties



Click on the drop down box to select the Motor Model to display.

The primary motor constants, a summary of the motor performance numbers and the graph will update when the selected motor is changed.

The displayed Motor Model constants are:

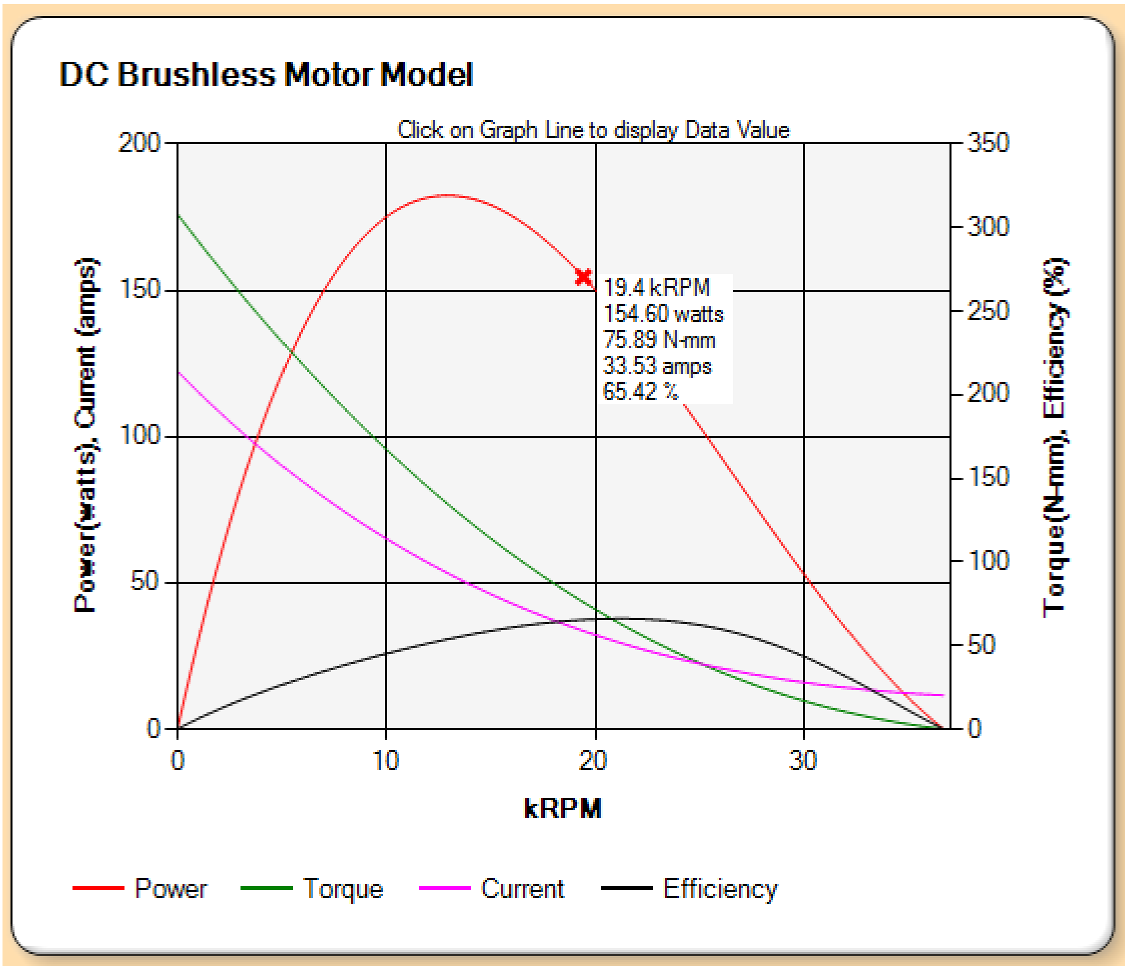
Kv – Called the motor constant. This value establishes the maximum no-load RPM the motor can achieve for a given voltage. As an example a Kv of 3200 at 7.8V the maximum no-load RPM would be 3200 x 7.8 = 24960 RPM.

Io – No load Motor Current. **Io** is the current draw of the motor at the No Load RPM for the operating voltage. **Io** is an indicator of motor efficiency, the lower Io is the higher the motor efficiency.

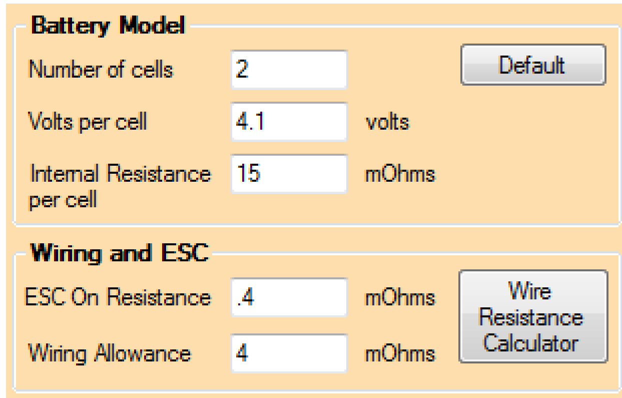
The Peak Power, Peak Efficiency and No Load RPM for the selected motor are summarized at the bottom.

Area 3 –Motor Performance Graph

Power, Torque, Current and Efficiency are graphed versus RPM. Clicking on any of the graphs will display numeric values for the RPM selected.

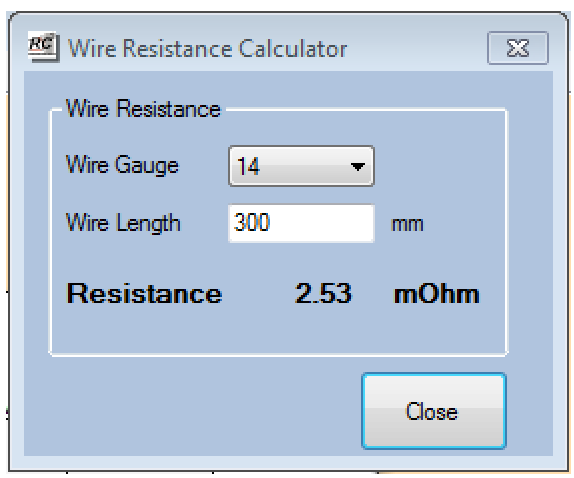


Area 4 –Battery and ESC Model



The calculated motor performance includes the effects of a simulated battery and ESC to depict the performance under real world operating conditions. The Battery values below would be for a 2 cell LiPo at a State of Charge (SOC) near 100%. The values can be adjusted to simulate any battery source. If for example you want to simulate ideal voltage source (voltage drop as a function of current draw is zero) then set the **Number of Cells** to 1, the **Voltage per cell** to the voltage source value and the **Internal Resistance per cell** to zero. The battery voltage will then remain constant regardless of the current draw.

Values can also be entered to simulate ESC and wiring allowance is also included. The **ESC On Resistance** is normally provided by the manufacturer. The Wiring Allowance should include the wire resistance from the battery to the ESC and from the ESC to the motor. A Wire Resistance Calculator is provided to allow these value to be estimated.

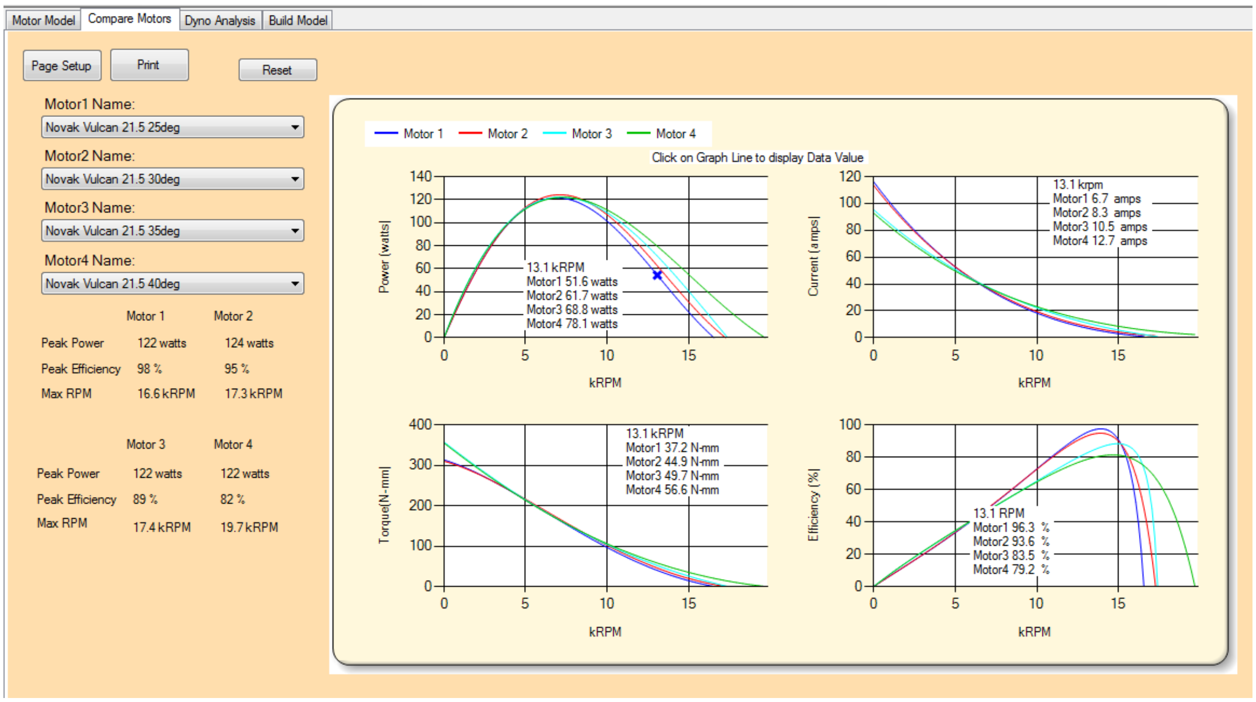


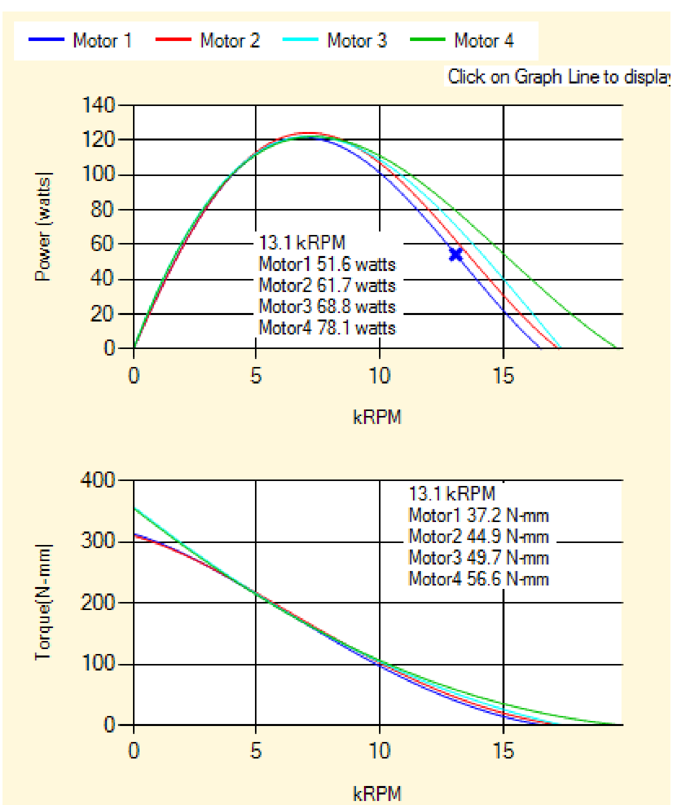
As an example if each lead from the ESC to the Battery is 14 gauge and 150mm (6 inches) long then using the calculator you would enter 2x150mm = 300mm for the wire length. The estimated resistance is then 2.53 mOhm. This process would be repeated for the ESC to Motor wires as well. Contact resistance for connectors can also be added to the total value.

These values can also be set to zero to disable their effect.

2. Compare Motors Tab

The Compare Motors tab is very straight forward. Simply select up to 4 Motors from the drop down boxes each motor will be graphed allowing direct comparison. Numeric Values for the Peak Power, Efficiency and Max RPM for each motor are also displayed.





This feature is very helpful in comparing the effects of timing changes on motor performance. For motors with adjustable timing the models provided in the website library will cover the entire timing range with a separate model provided for each timing setting. The graphs displayed in this screenshot show the performance of a 13.5T motor at four different timing settings. By clicking on the graph a numeric value for each motor is displayed

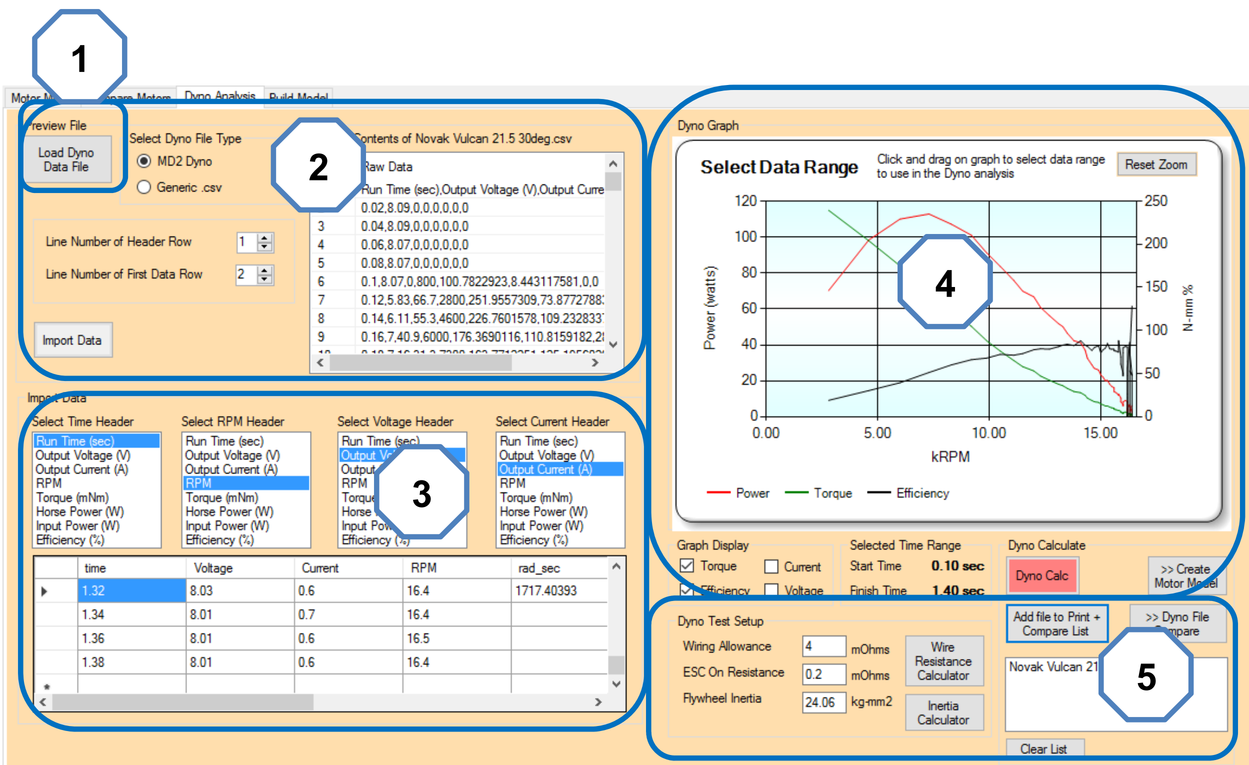
Direct comparisons between different motors should not be undertaken unless the dyno test and motor models have been created using identical conditions. Different ESC's, Batteries, Battery Charge State will all have an effect on the dyno results and the model created. The motor modelling provided here is not intended to be a comparison tool between different manufacturer's products.

3. Dyno AnalysisTab

To complete a Dyno Analysis the results of a flywheel (also called inertia) dyno test is required. The recorded data must contain Time Increment, RPM, Voltage and Current records.

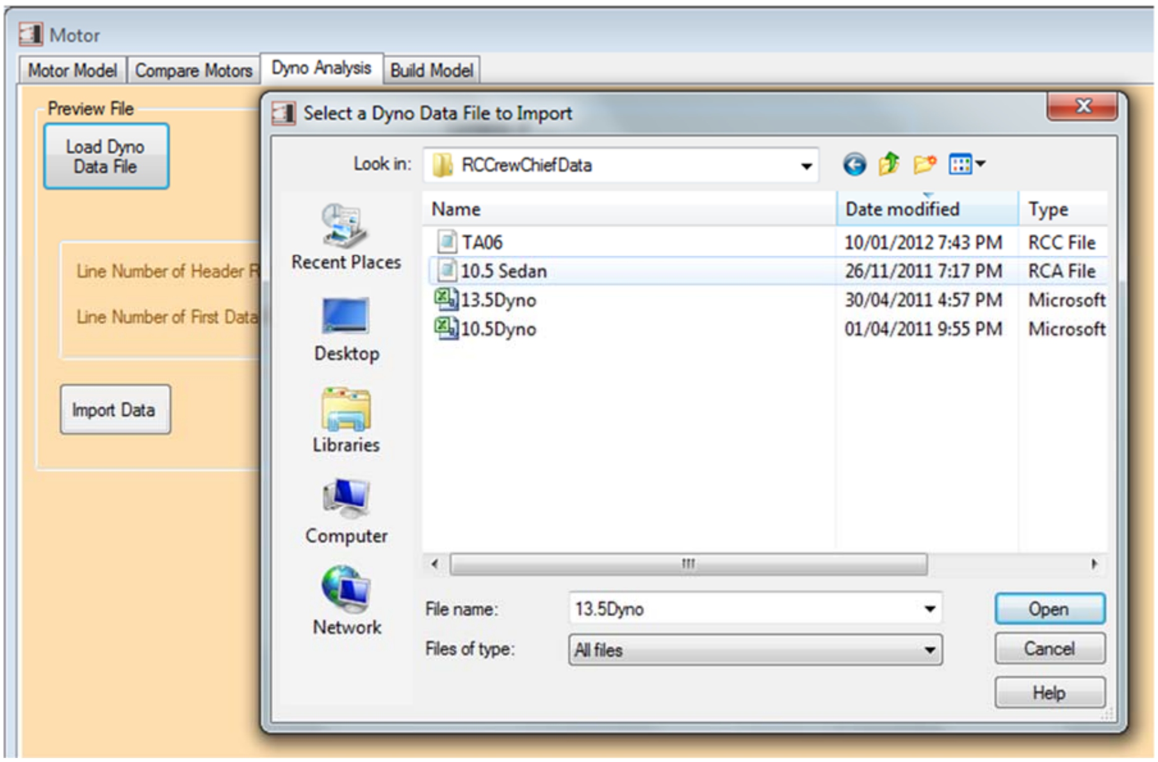
Completing the Dyno analysis is a multi-step process. A screenshot of a completed analysis is shown below. The procedures are also provided in Youtube Videos on the RC Crew Chief Channel.

Step 1 – Load a data file.
Step 2 – Import Data
Step 3 – Assign the Time, RPM, Voltage and Current data
Step 4 – Select the RPM Data Range for Analysis
Step 5 – Dyno Calc



Step 1 - Load Data File

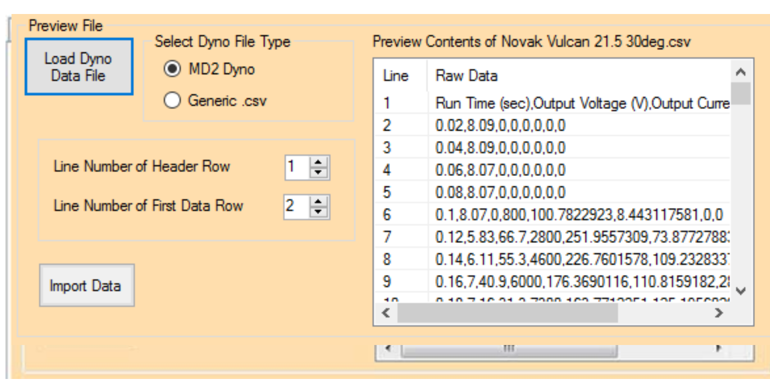
Click the **Load Dyno Data File** and the open file dialog box will open. Navigate to the folder containing the raw data file, select the file and click open. Currently the program can only import data from a comma separated text file which is a common format.



Step 2 - Select the Header Row and first Row of Data

Once the file is loaded the raw data will be displayed in the Preview box with **Line** numbers assigned to each data row. If you are Importing the Data from the Eagle Racing MD2 Dyno then simply click the **Import Data** button and go directly to Step 4.

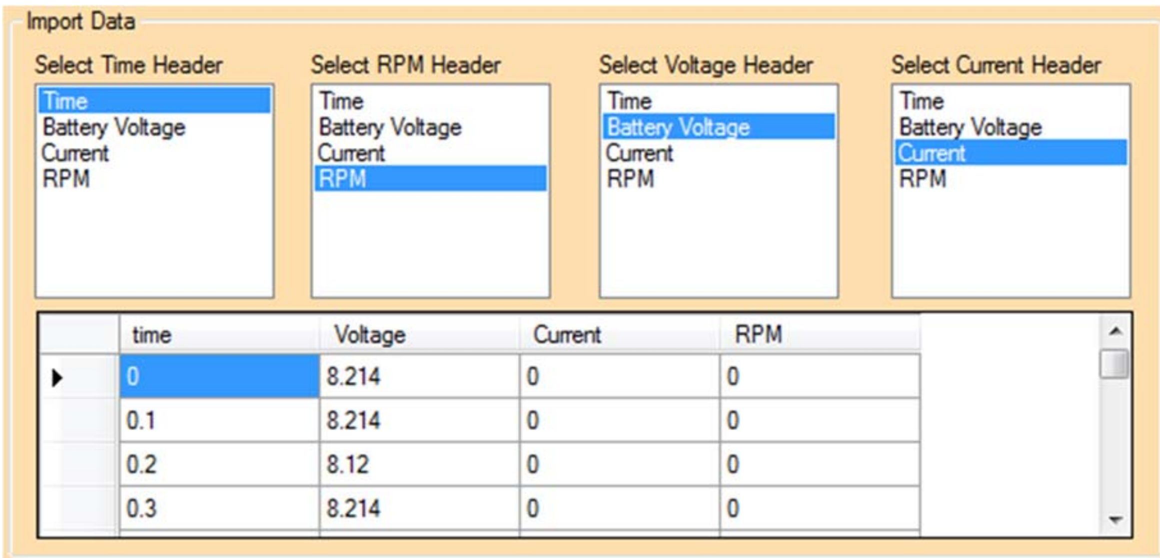
If the File is a Generic .csv file then use the **Numeric up/down** buttons to specify the line numbers that contain the Header row and the First Data Row. The



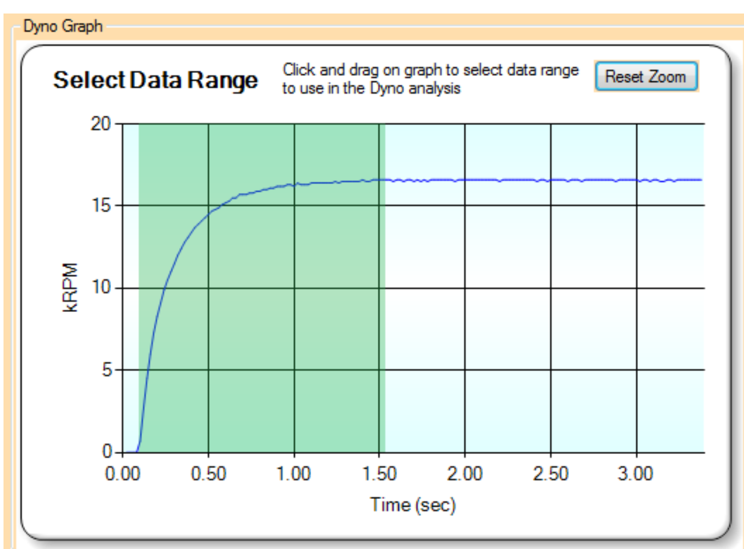
header row contains the text that defines the content of each column. In this case the header row is Line 1 and the first row of data is Line 2. Once this step is complete click the **Import Data** button.

Step 3 - Assign the Time, RPM, Voltage and Current data

From the lists provided select the text which corresponds to the header required in each box. As the headers are selected the table will be filled with data from the file and a graph of RPM versus time will be displayed.

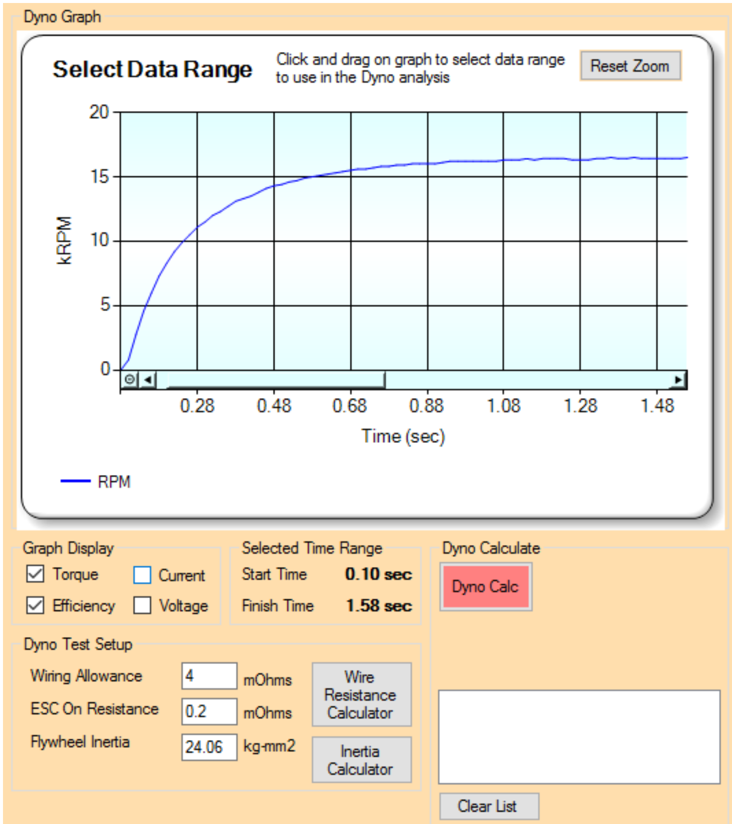


Step 4 – Select the RPM Data Range for Analysis



In the displayed kRPM versus Time graph, click and drag to select the data range to use. The selected range should start near zero RPM and end close to the peak RPM reached during the test.

Once the data range has been selected the graph will update to display the selected range and the

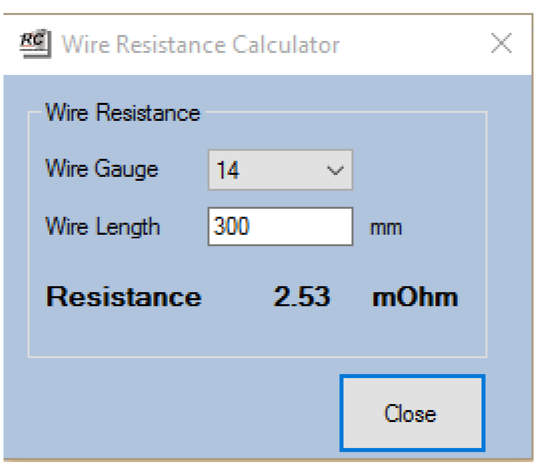


values for the selected time range will be displayed.

If the selected range is not correct click **Reset Zoom** and try again.

Step 5 – Dyno Calc

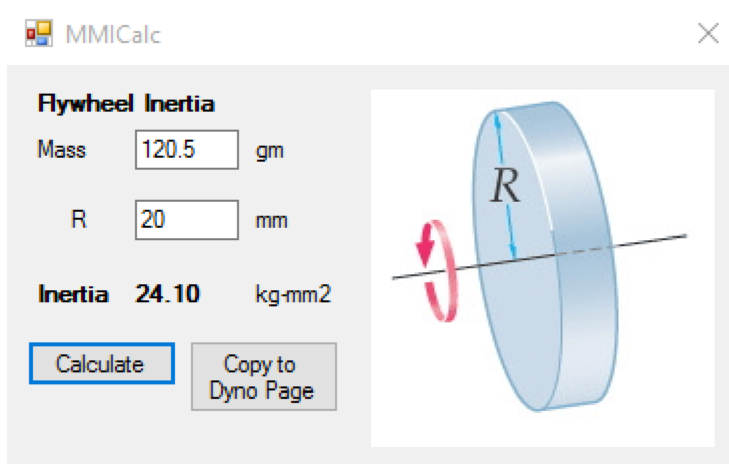
Before executing the Dyno Analysis enter the **Wiring Allowance**, **ESC On Resistance** and the **Flywheel Inertia**. Calculators have been provided to assist in determining the Wiring Allowance and Flywheel Inertia.

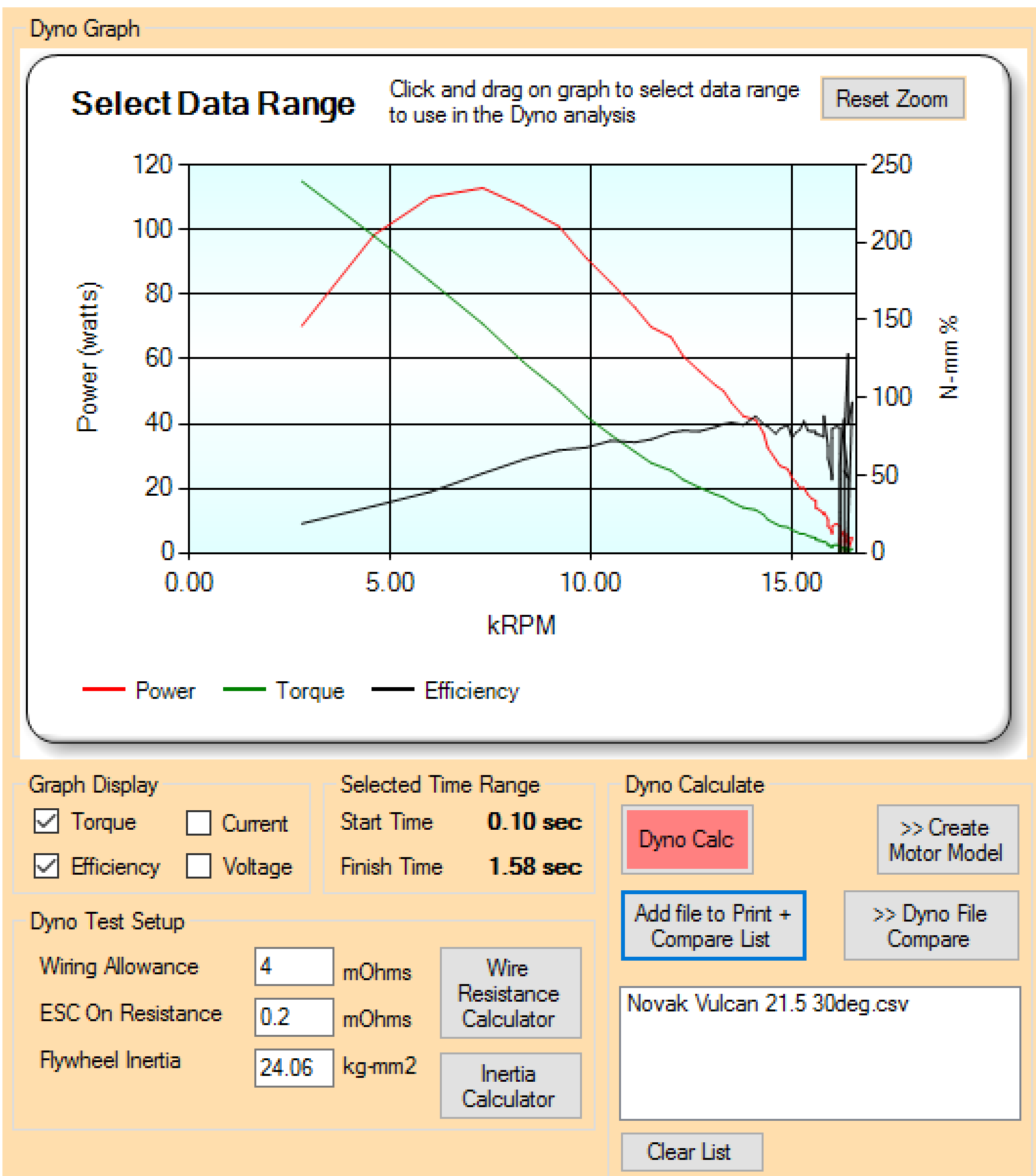


Enter the total length of wire from the point where the voltage is measured to the Motor Terminals and then double it to account for the return path. The ESC on Resistance is normally provided by the manufacturer.

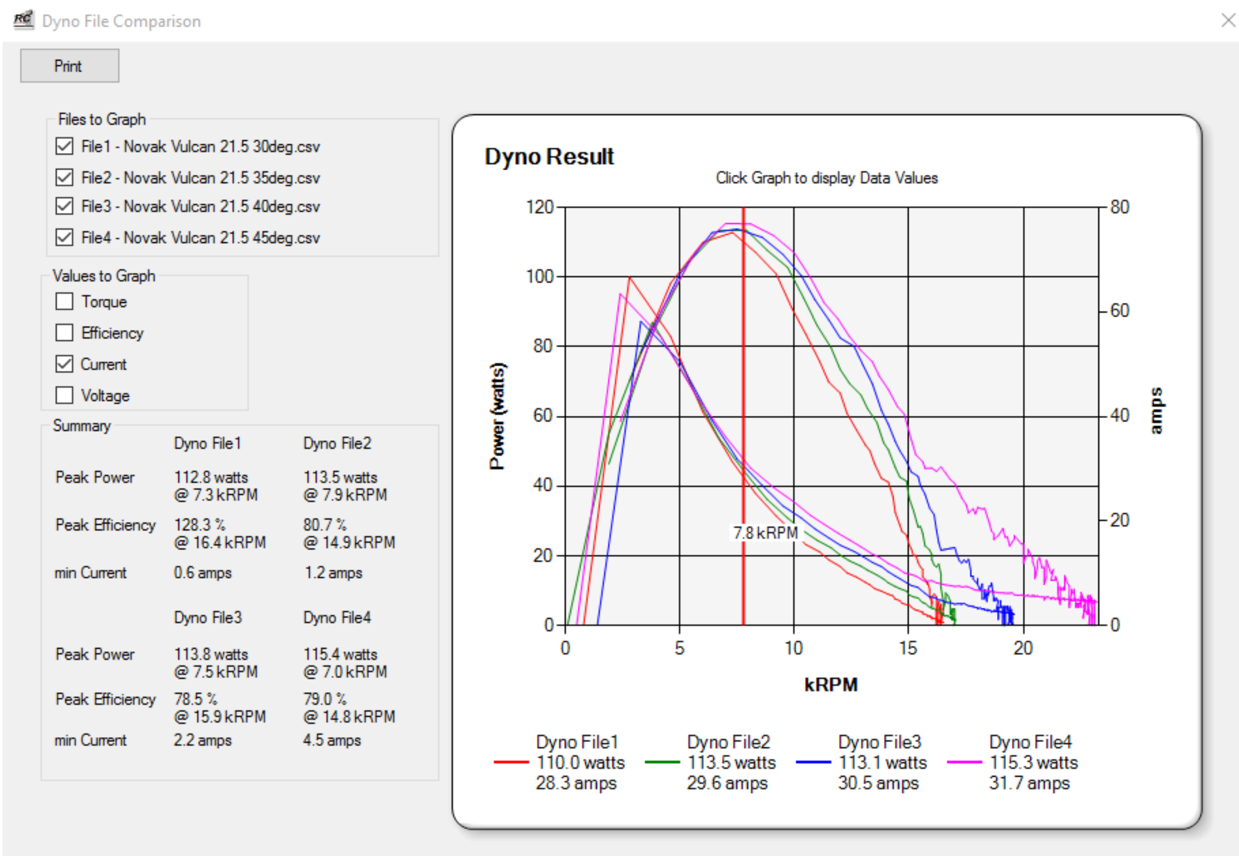
The Flywheel Inertia can be estimated knowing the mass of the Flywheel and the radius.

Lastly click the **Dyno Calc** button and the tested Motor Performance will be displayed.





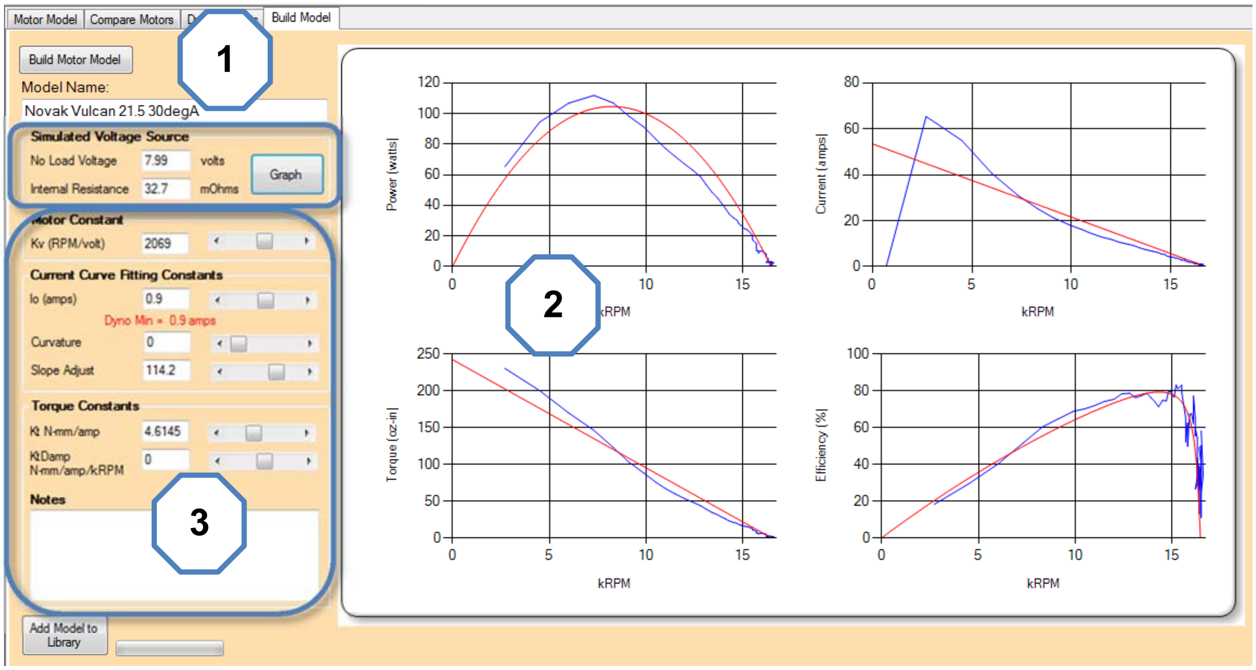
To display a graph that allows single or successive dyno runs to be printed or compared click the **Add file to Print + Compare** List. Up to 4 files can be added to this list. Once all the files have been added click the **>> Dyno File Compare** button.



The Dyno results can also be used to build a motor model for use in car acceleration simulations. Just click the **Create Motor Button** to switch to the Build Model tab.

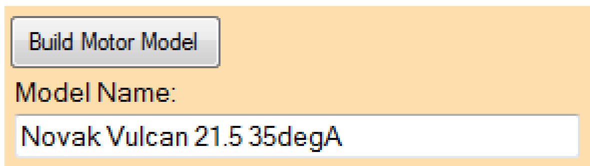
4. Build Model Tab

Now that we have results from a dyno test we will use this data to build a Motor Model. The model can be added to the library and used in the car acceleration simulation.



Area 1 – Model Build and File Name

If no graphs are displayed then click the **Build Motor Model** button and the program will estimate the motor constants as a starting point and fill the graphs with the dyno data and the initial motor model. Any time you wish to start over click the **Build Motor Model** button to reset.

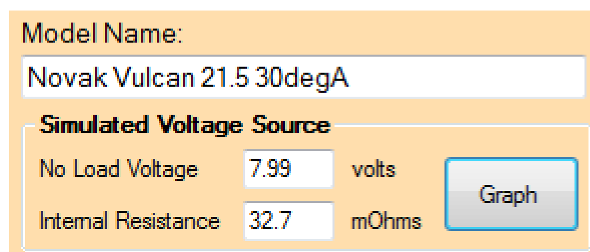


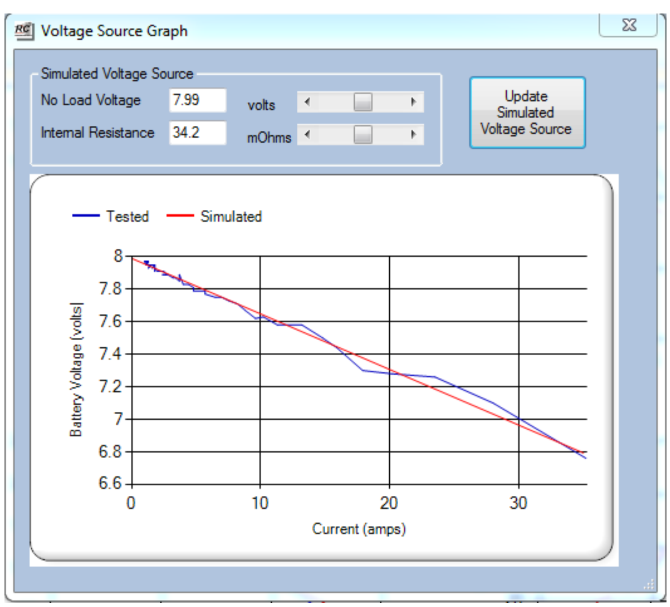
The displayed model may not match the dyno results very closely at this stage. It will be much closer by the time we are finished.

The Model Name displayed will be the filename of the dyno data file. The name can be changed if desired.

Area 2 – Simulated Voltage Source

Prior to creating a Motor Model the voltage source that was used for the dyno test must also be simulated. Two values are required, the **No Load Voltage** and the **Internal Resistance**. Both these values are estimated by completing a linear curve fit on the voltage and current data logged in the Dyno test. To ensure the values from the curve fit are appropriate and there are no anomalies in the data it is recommended you review the Graph as a check.



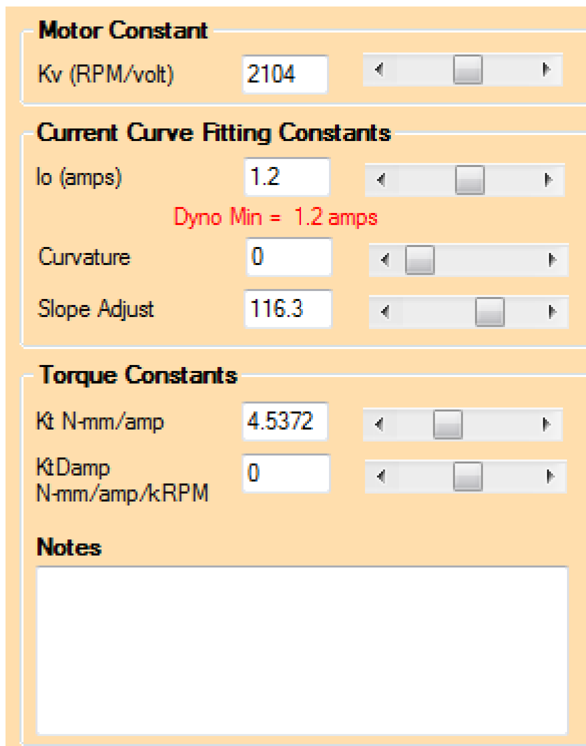


The blue line is the test data and the red line the simulated voltage source. In this case the match is reasonable so no adjustment is needed.

Should adjustment be required the sliders can be used for fine tuning. The **No Load Voltage** sets the voltage at zero current and the **Internal Resistance** adjusts the slope.

Area 3 - Motor Model Constants

Six motor constants are used to simulate Motor performance. Values can be entered directly in the boxes or by using the sliders. Generally the arrow buttons on the sliders will be used as this is the easiest way to make small incremental changes.



The constants and their primary effect are:

Motor Constant

Kv –. This value establishes the maximum no-load RPM the motor can achieve for a given voltage. As an example a Kv of 3200 RPM/V at 7.8V means the maximum no-load RPM would be 3200 x 7.8 = 24960 RPM. A higher **Kv** value higher maximum RPM.

Current Curve Fitting Constants

Io – No load Motor Current is the current draw of the motor at the No Load RPM for the operating voltage. **Io** is an indicator of motor efficiency, the lower **Io** is the higher the motor efficiency.

Curvature – Use to adjust the curvature of the Current vs RPM graph.

Slope – This value is closely related to the Line-Line motor resistance. The primary effect is on the power output of the motor. The lower the resistance the higher the power output.

Torque Constants

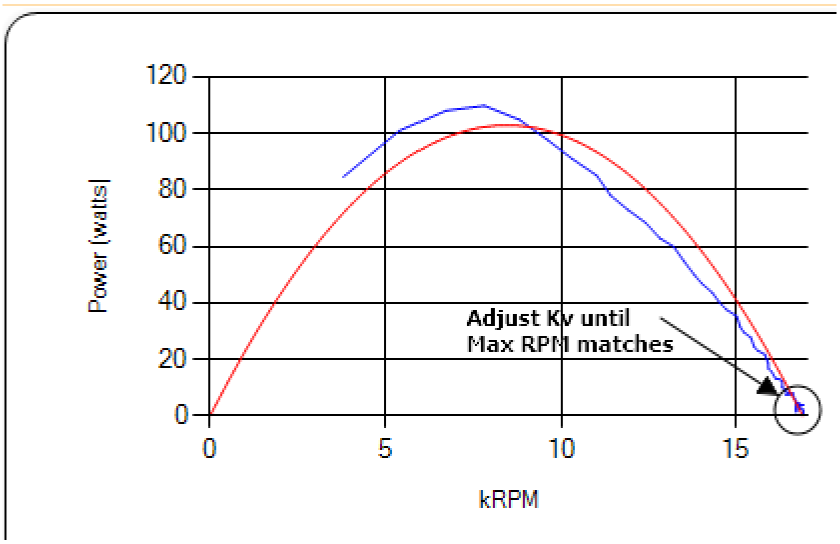
Kt – Motor Torque constant defines the output motor as a function of the motor current. **Kt** affects the slope of the torque RPM graph, peak power and efficiency.

Kt Damp– Motor Torque damping constant accounts for magnetic losses, aerodynamic windage and other non-linear effects. **KtDamp** affects power, position of the power peak, efficiency and shape of the Torque versus RPM curve.

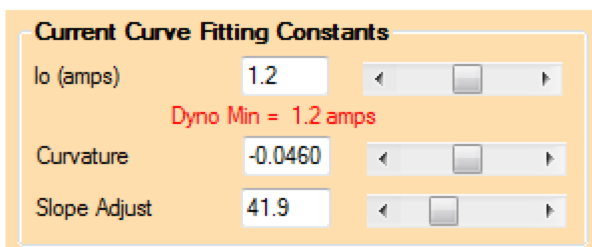
Building the Motor Model

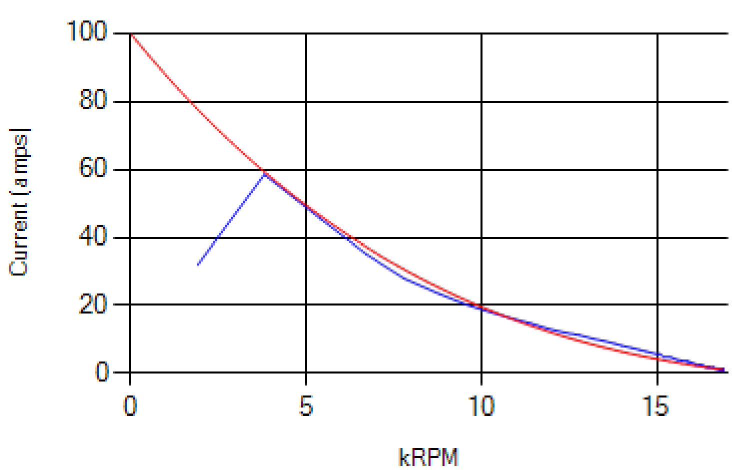
Follow this sequence to set the motor constants

Step 1 - Adjust the motor **Kv** to match the max RPM on the Power graph.



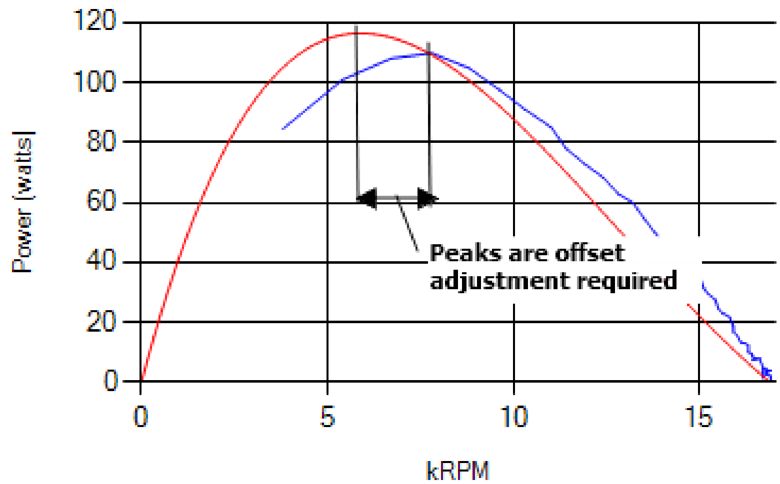
Step 2 – Adjust Current Slope and Curvature sliders to match the upper 2/3rds of the RPM range. Generally flywheel dynos work best on the higher RPM so focus on matching these areas. The **Io** normally does not require adjustment.



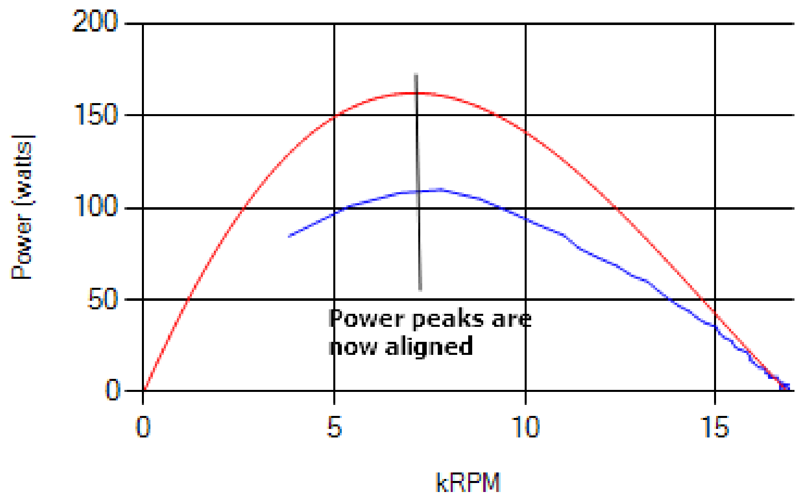


Step 3 – Adjust the Torque Constants.

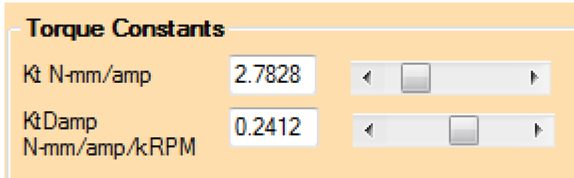
To determine which constant to adjust first look at the position of the Power peak relative to the dyno curve. If the peaks are aligned then only the **Kt** value needs adjustment. Usually the peaks are not aligned as shown below.

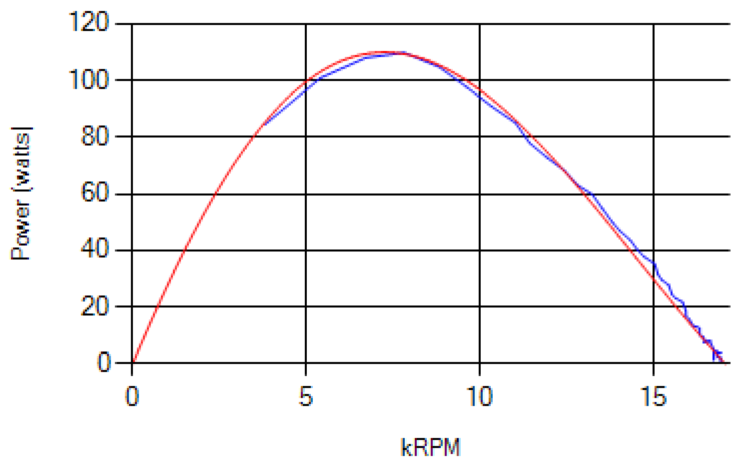


Increase the KtDamp value until the peaks align.

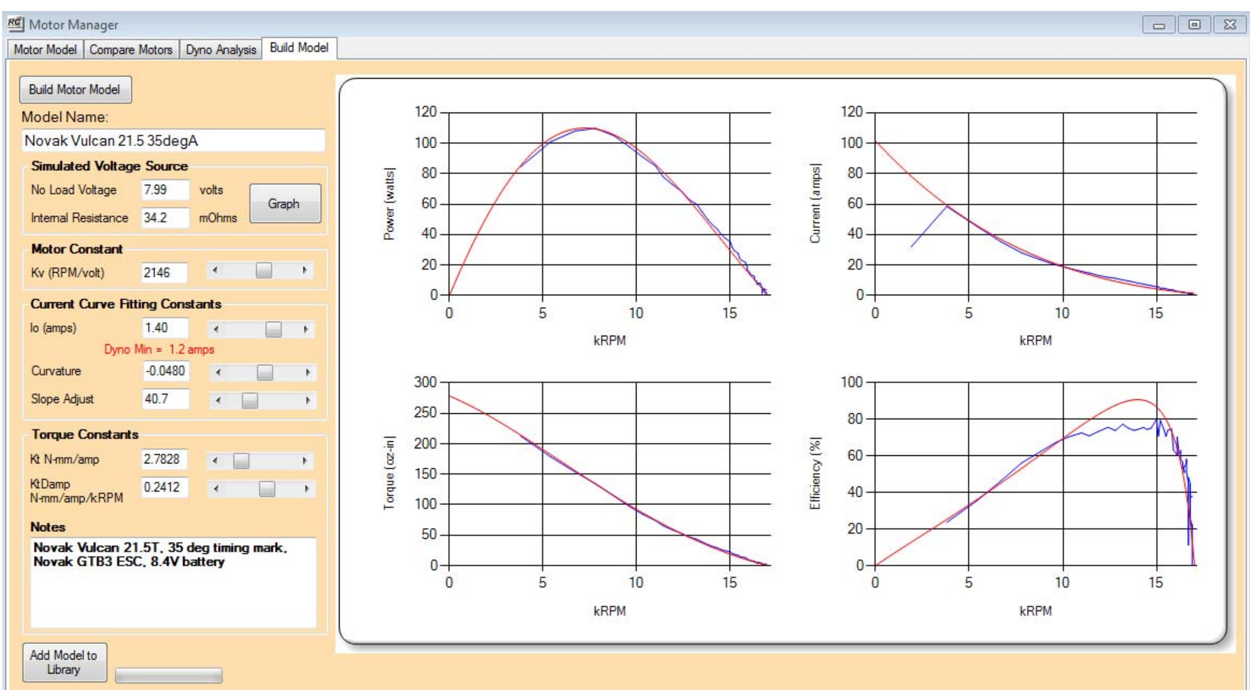


Now obviously the power is way off. To correct this reduce the **Kt** slider until the peak power matches.





By cycling through this process a few times you can fine tune the model. With a little practice you should be able to achieve a match like that shown below.



You now have a new motor model that has been validated against dyno test data. Add some notes to identify the conditions the model was created, full motor name, timing mark, test ESC and battery volts. Only thing left to do is click the **Add Model to Library** button and you are done.