

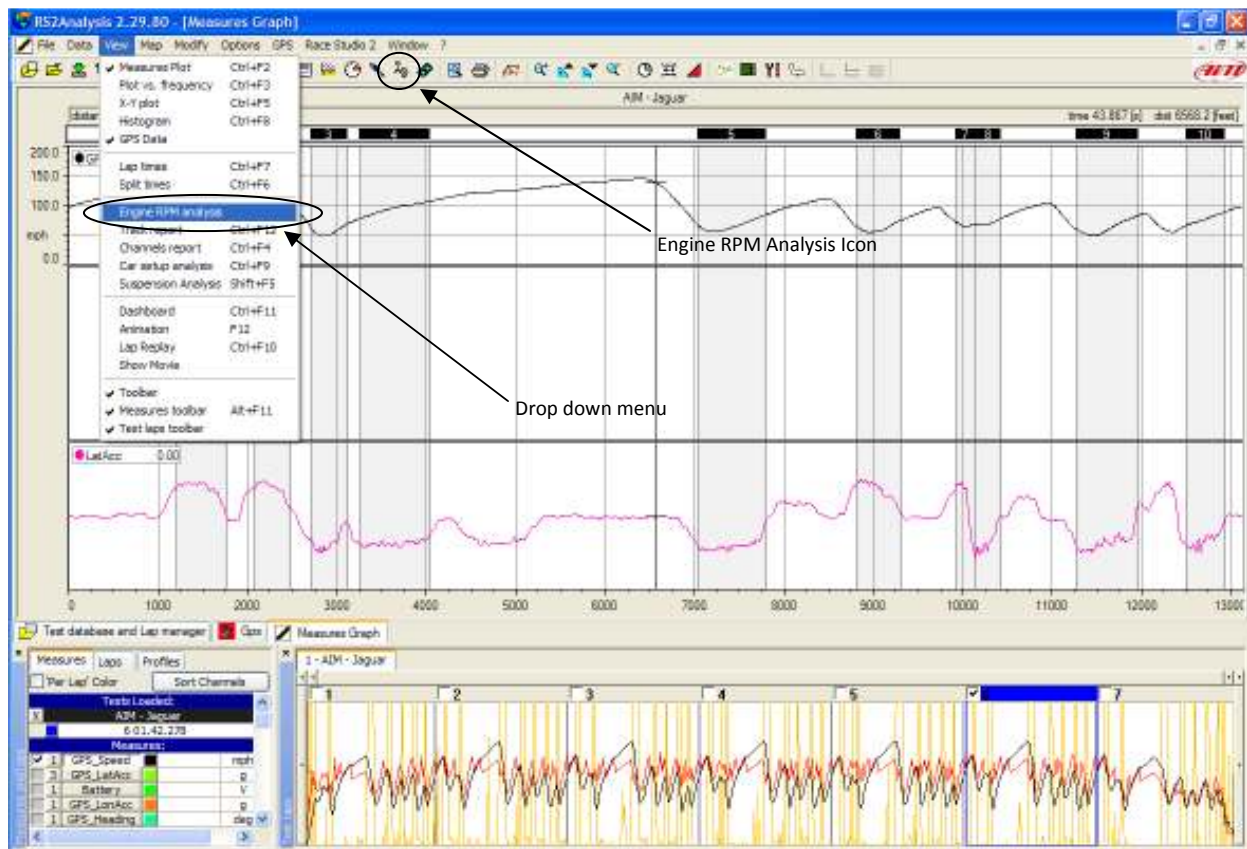
Using Engine RPM Analysis in Race Studio Analysis



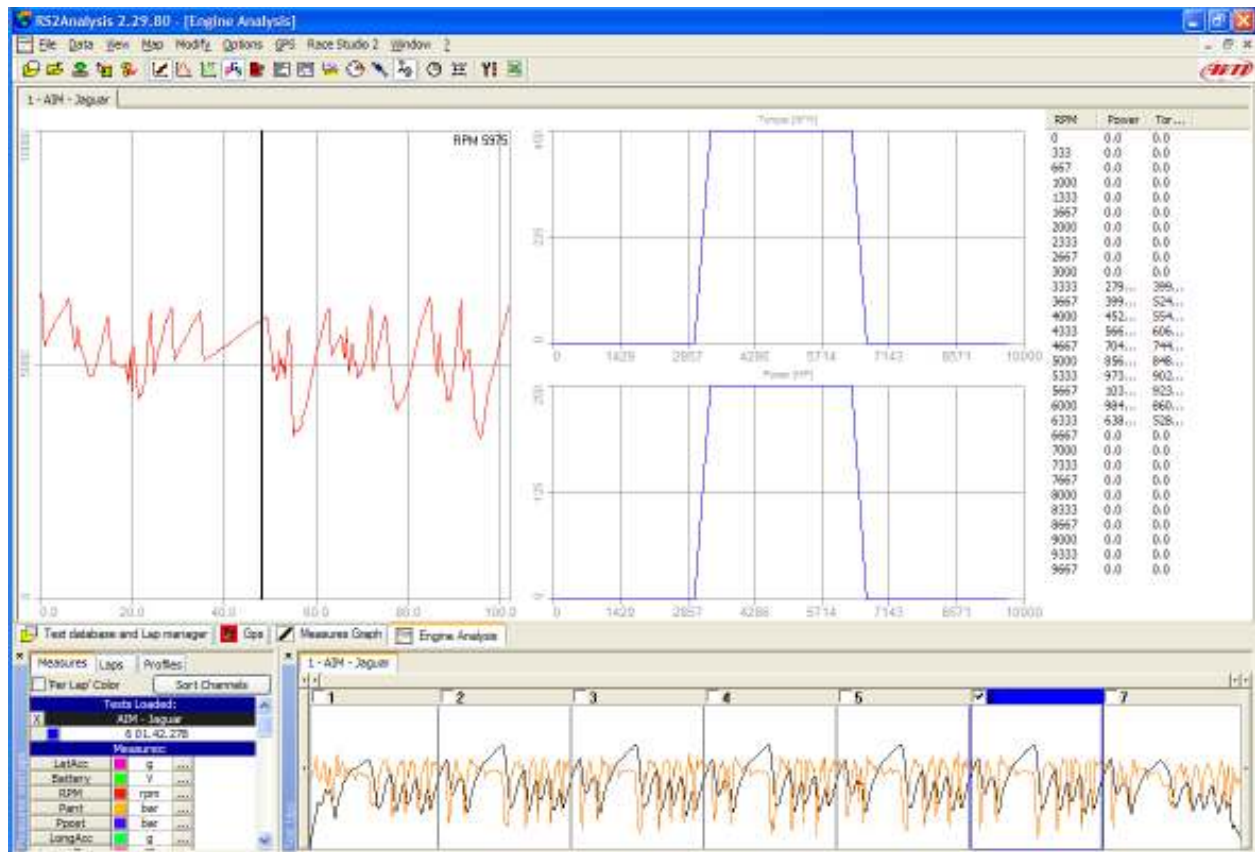
Section 1. Introduction

One of the very useful tools Race Studio Analysis offers is the Engine RPM Analysis software. This feature allows you to take data that has already been acquired by your data logger, and use it to analyze the performance of your engine. Using channels such as RPM, Speed, Throttle Position, and Longitudinal Acceleration, you can plot horsepower and torque curves that the engine put out during that particular test. The program will work using just RPM, but being able to include any or all of the other three will make the estimations much more accurate. As usual, the more you know the better. After selecting which of these you wish to use, and defining a few other simple parameters, you will be able to analyze your engine performance for any given test. In this tutorial I will show you how to calculate and set these existing parameters.

To use the Engine Analysis, simply click on the Engine Analysis icon in the tool bar, or click on the View button, and select Engine RPM Analysis from the drop down menu as shown in the screenshot below.



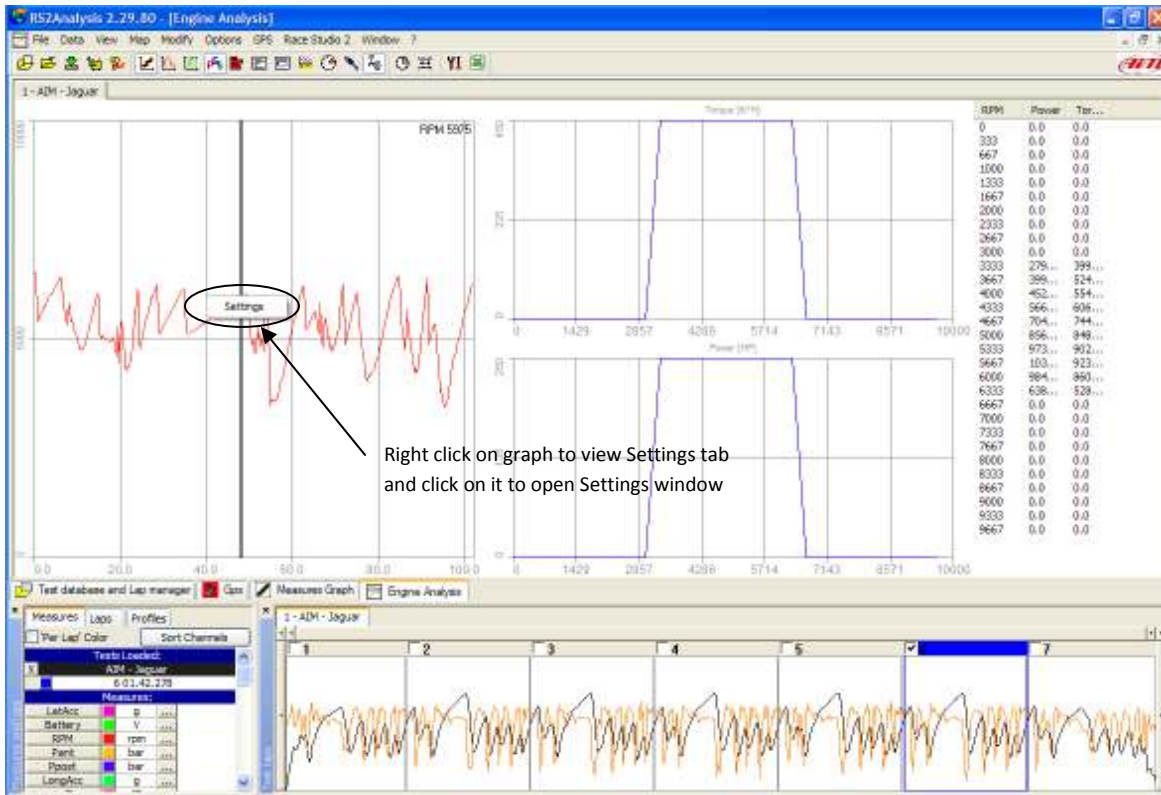
When you open up your Engine Analysis, you will see a screen like the one shown below. On the left side of the screen is a plot of RPM vs. Time for the lap you are analysing. The two plots on the right are your Torque and Power curves. On the far right, you will see a table of numerical values for all three, RPM, Power, and Torque with respect to RPM.



Section 2. Adjusting the Settings

As you can see from the screenshot above, using only RPM for this analysis does not give very accurate values. The settings window allows you to select the different channels you wish to use for your engine analysis, as well as set certain parameters such as vehicle mass, drag coefficient, and frontal surface area of your vehicle. In addition, the settings window also allows you to select which units of measurement you wish to use for your analysis.

To open the settings window, right click anywhere on the graph and click on the settings tab that pops up as shown in the screenshot below.



After clicking on the tab, the window below will appear.

AIM - Jaguar Settings

RPM channel: RPM

Speed channel: RPM

Throttle channel: RPM, threshold: 90,000

Long, Acceleration ch.: RPM

Vehicle body

Mass [lb]: 1000

Cx: 0.35

Front surf. [feet^2]: 1.95

Engine Analysis Settings

Shown

- Time based curves
- Torque
- Power
- Table

Curves

- Points
- Line

Power

max: 250,000

units: HP

Torque

max: 450,000

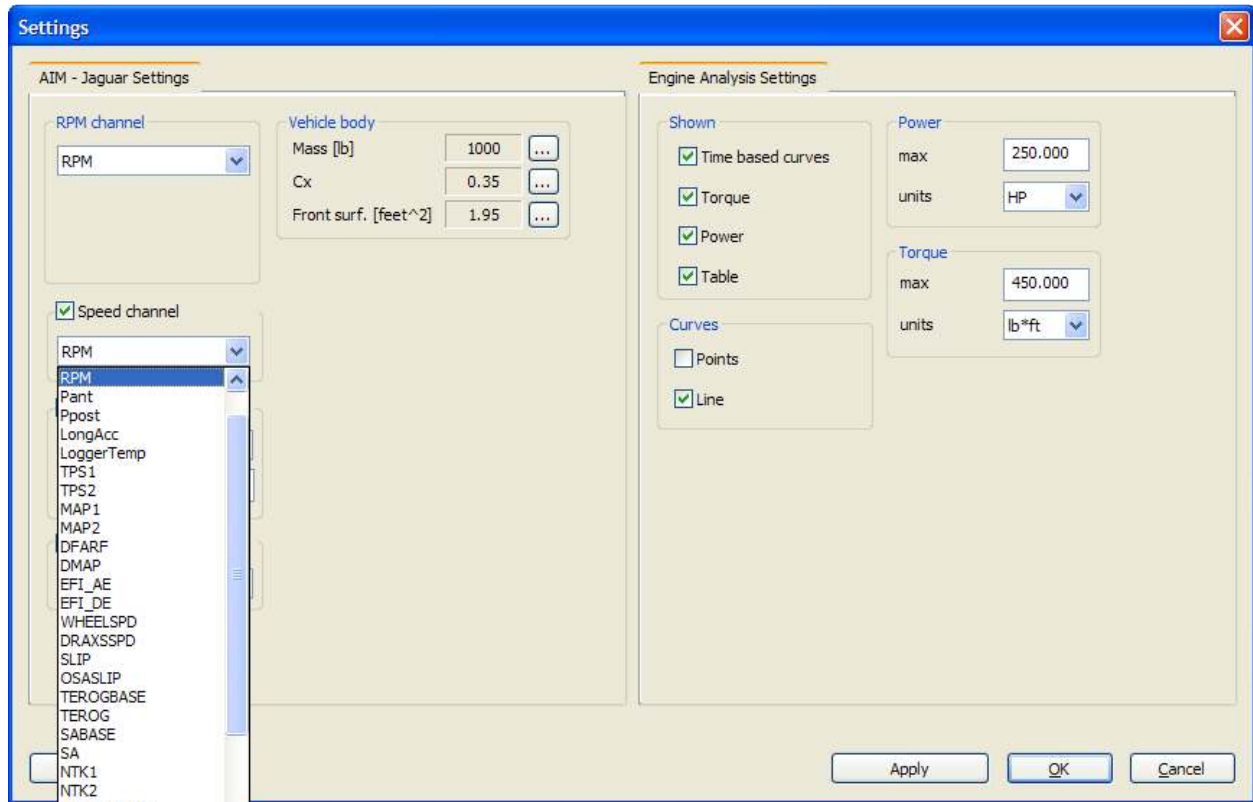
units: lb*ft

Buttons: Reset default, Apply, OK, Cancel

In the top left corner you will see a tab that says “AIM - Jaguar Settings.” If you have multiple tests open, then there will be a separate tab for each test. This allows you to save settings for individual tests. So, when you change the settings for one test, you do not have to worry about settings you have input for other tests being altered. On the other side of the window you will see a tab that reads “Engine Analysis Settings.” All of the items under this tab apply to general Engine Analysis settings. They can be changed at any time to match the general preferences you have set in Race Studio Analysis, and will apply to all tests in your database.

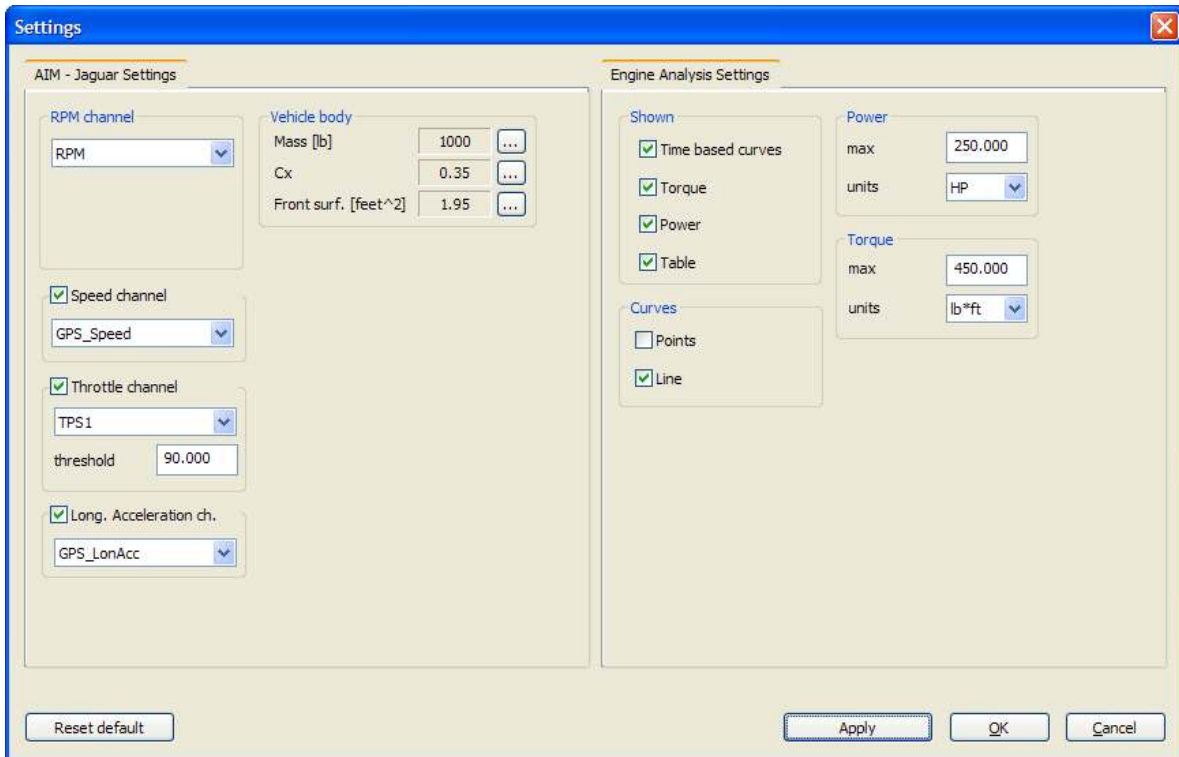
Section 3. Specific Test Settings

Now let us move on to the test settings. For this tutorial we will continue with the AIM - Jaguar test. The first thing you will see, on the left side of the window, is the channels you can use to refine your analysis and make it more accurate. The RPM channel is required, and will already be selected. Below that you will see options for a Speed Channel, Throttle Channel, and Longitudinal Acceleration Channel. Each of those selections has a drop down menu as shown in the figure below, for you to choose which of your sampled channels you wish to use in this analysis. For instance, after you select the check box saying you want to use a speed channel, you must tell the program what channel you wish to use for that speed channel.

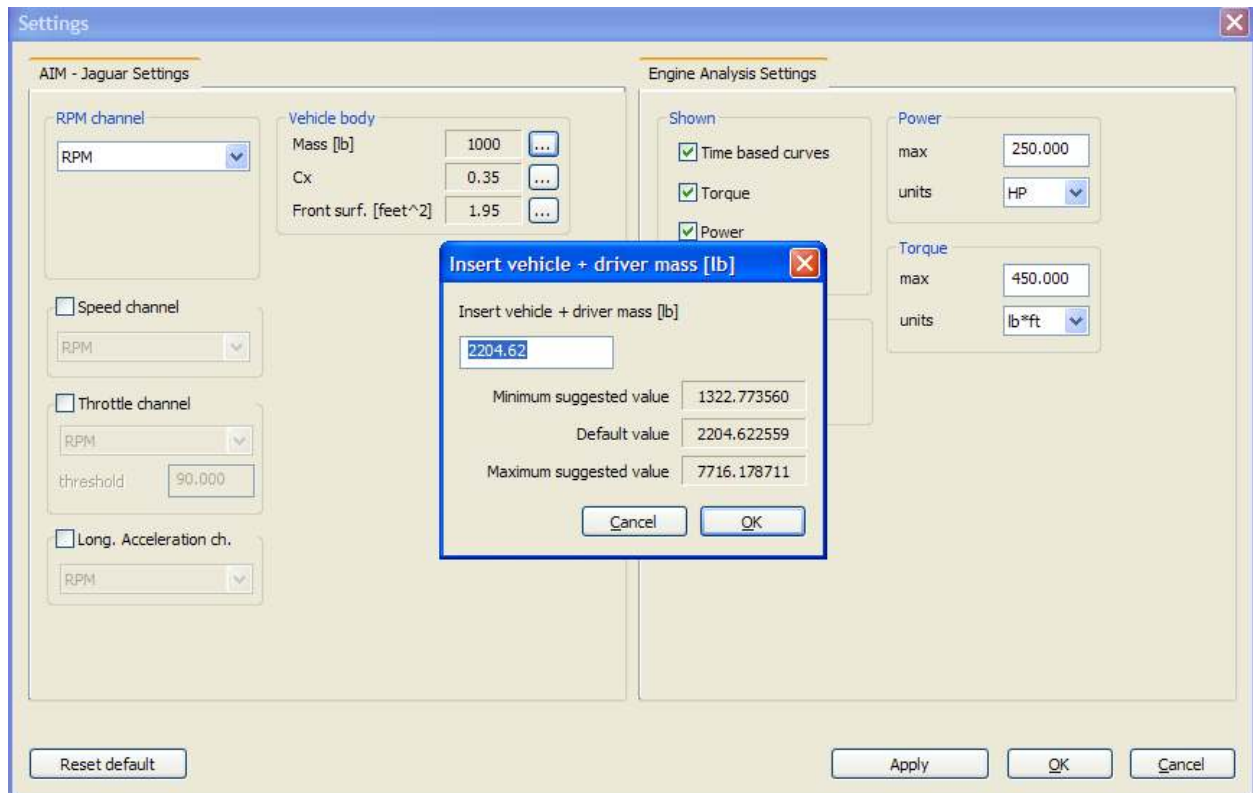


You will also notice that under the “Throttle Channel” tab, there is a threshold to be set. The default setting for this is 90.000, which refers to 90%.

Once again, the more of these channels you can utilize, the more accurate your analysis will be. For this test, I have selected GPS_Speed for the Speed Channel, TPS1 for Throttle Channel, and GPS_LonAcc for the Longitudinal Acceleration Channel, as shown in the figure below.



Also underneath the test's settings tab, you will see the field where you can set the parameters for the Vehicle Body. These settings include Mass, Drag Coefficient (Cx) and Frontal Surface Area. These can be adjusted by clicking on the boxes directly to the right of the values. When you click on one of those boxes to make a change, the window shown in the screenshot below will appear.



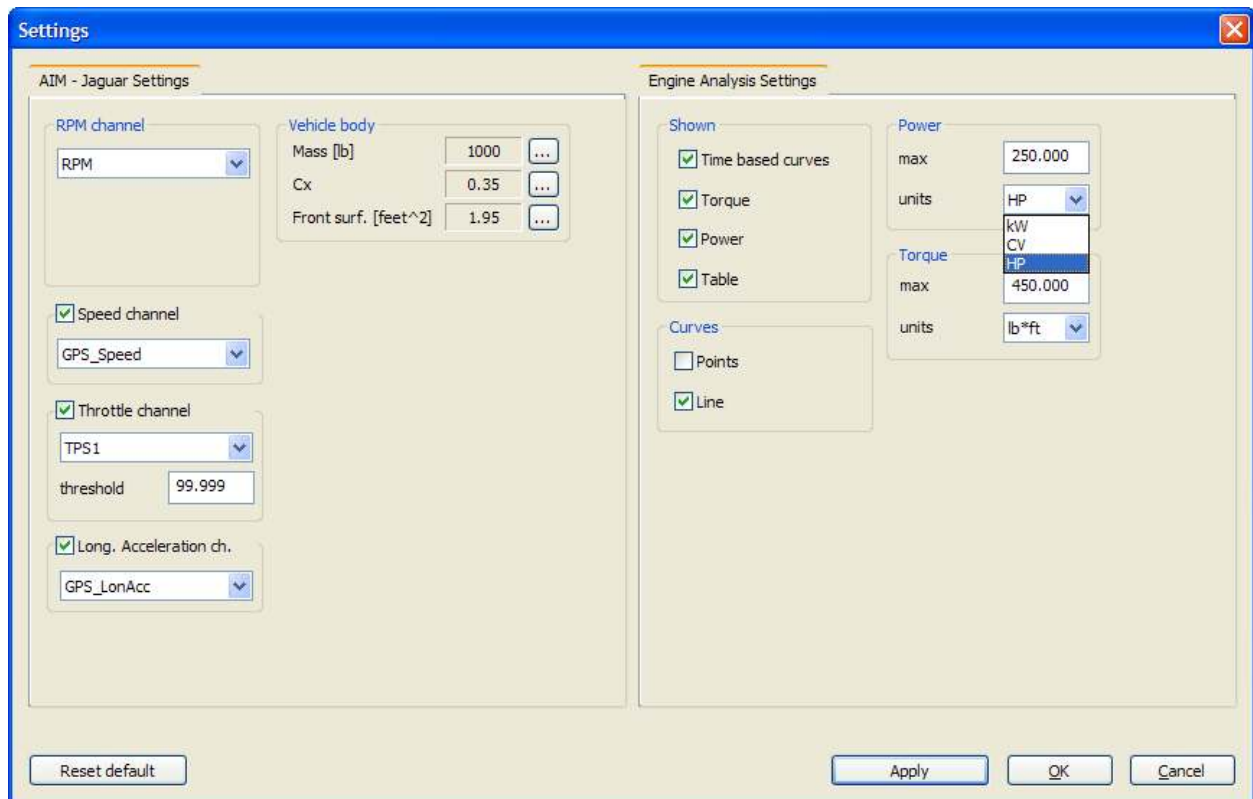
The screenshot above shows the window that will appear to adjust Mass. If your general Race Studio Analysis settings are set for Imperial units (i.e. mph and psi) this part may be slightly confusing. The settings I am referring to are the ones you set before you have any tests open by going to File, clicking on Preferences, and selecting the type of vehicle and unit settings. As you can see in the screenshot above, the value in the Insert vehicle + driver mass window of 2204.62 does not match up with the value shown in the Vehicle body section of the Settings window of 1000. If you have your Race Studio Analysis settings set for mph and psi, then the Engine Analysis Settings will allow you to input your values in units of pounds (lb) and square feet (ft²). The values that you see in the Vehicle body box have already been converted back to kilograms (kg) and square meters (m²) by the program. For example, as in the screenshot above, the vehicle + driver mass has been input as 2204.62lb, but is displayed in the Settings window as 1000kg. The same goes for the Frontal surface area. It has been input as 20.9896 ft² but is displayed as 1.95 m². If your Race Studio Settings are set for metric units, then the values in the vehicle + driver mass window will appear exactly the same as they do in the Vehicle body box. As for the drag coefficient value (Cx), this can be a very difficult value to estimate. For many vehicles, manufacturers may have a standard value for certain vehicles. For some racing cars, aerodynamic data has been published, and some vehicles' drag coefficient (referred to as C_D) can be found in those publications.

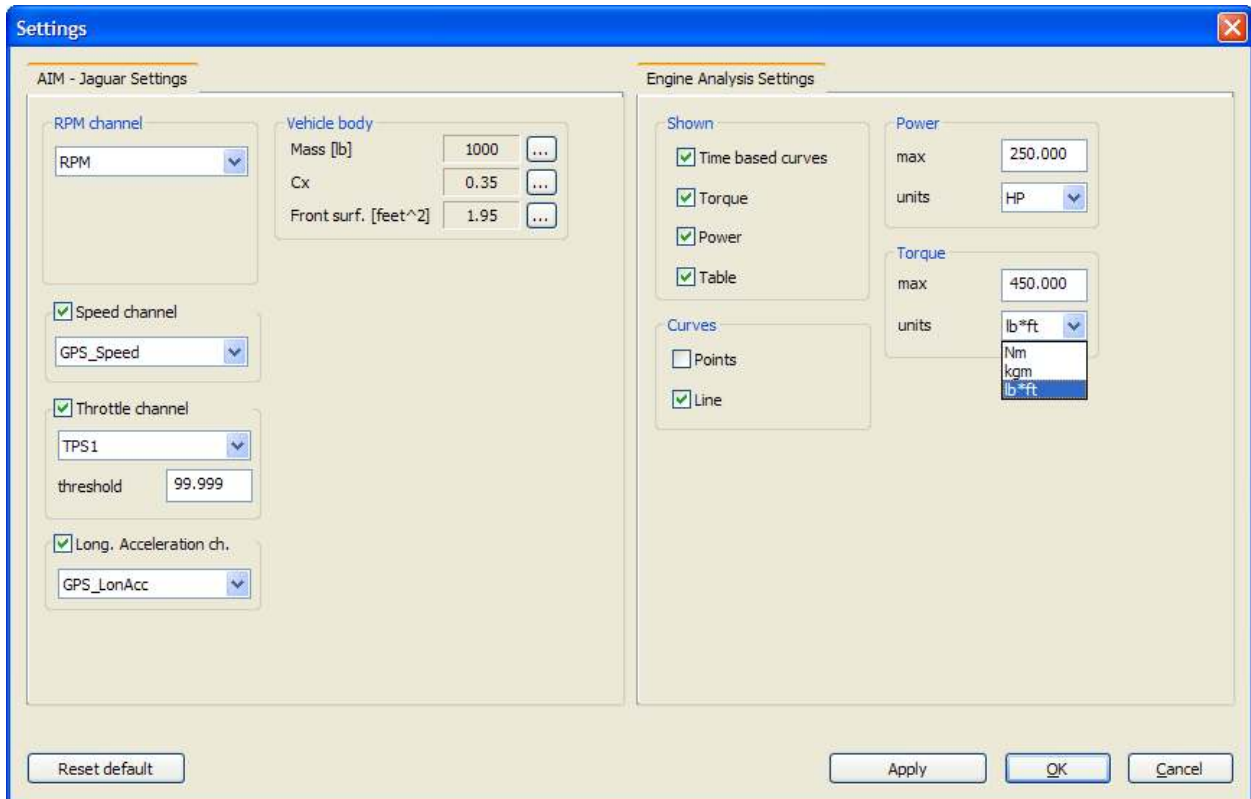
Section 4. General Settings

Now we will take a look at the general engine analysis settings. These settings simply determine how everything is displayed. It lets you decide which curves you wish to display, whether or not you wish to see the table, and if you want those curves to be shown as points or lines. In this section you will also choose the units of measurement for Power and Torque, along with the maximum values you would like those graphs to display.

We will start with the “Shown” section of this window. The “Time based curves” refer to a time based plot of the four channels (or fewer) that you are using to do the analysis. If you have this box checked, you will see on the left half of the Engine Analysis screen a plot of whichever of these four channels you have chosen versus time for the lap you are doing your analysis on. The next three, torque, power, and table, simply refer to the torque and power curves you will see in the center of the screen, and the table of values that appears on the right side of the screen. Simply check the boxes of the ones you want shown. In the “Curves” section of the window, you just decide if you would like to see line graphs, or individual points displayed on those curves.

In the “Power” and “Torque” sections of this window you will be able to change the limits on their respective graphs, as well as choose the units of measure you wish to use. You will not be able to change the lower limits on the plots, as they will remain at zero. You can, however, change the upper limit. Simply type in what you wish that to be in the open box next to “max.” For the units, both Power and Torque have small drop down menus as shown in the two screenshots directly below.



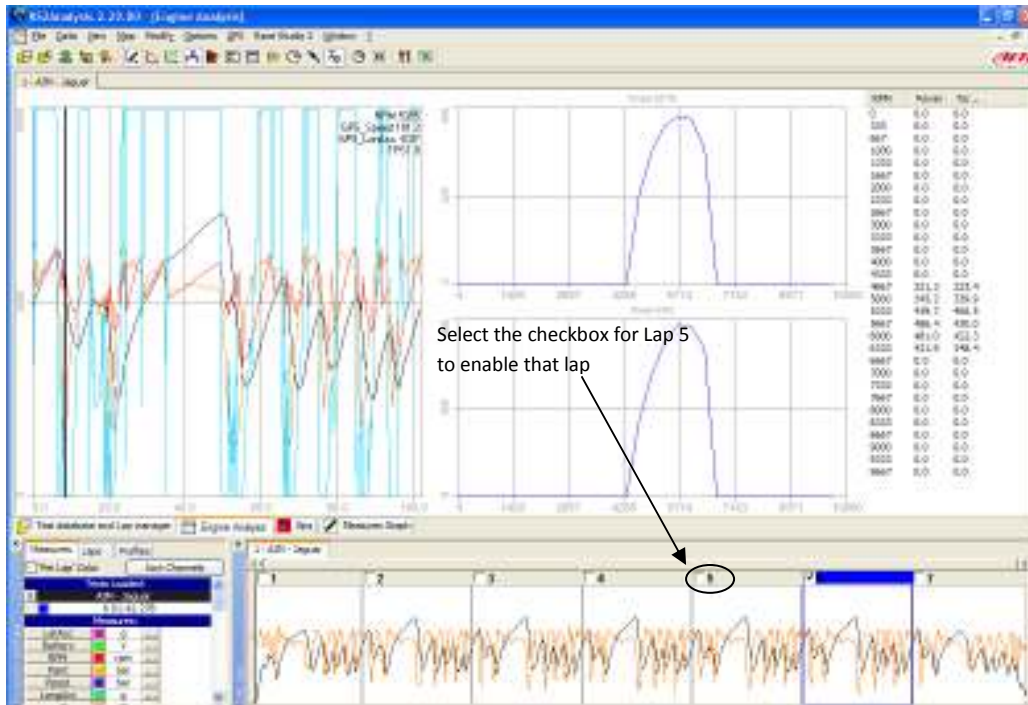


For the power curve, you can choose between units of measurement of kilowatts, cavallo vapore, or horsepower. For the torque curve, you can choose between units of measurement of Newton meters, kilogram meters, or foot pounds, also referred to as pound feet.

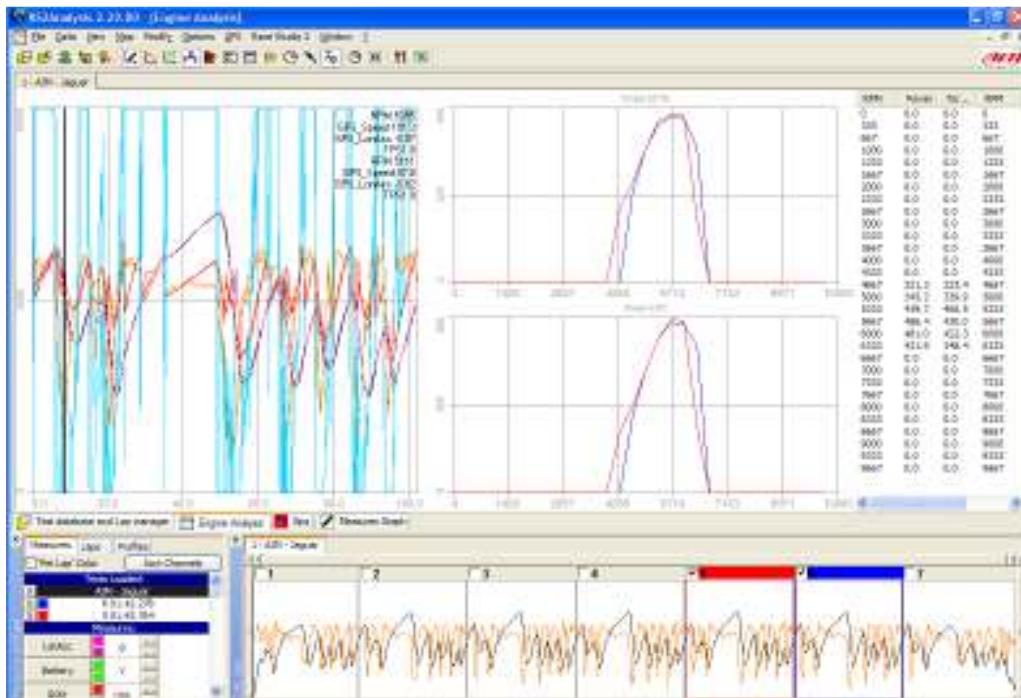
Section 5. Viewing the Analysis

Once you have input all your settings to your liking, click on the “Apply” button, and you will see your settings take effect. If they show up in the Analysis how you would like, then click “OK” to begin your analysis. You can always go back to the default settings for the Engine Analysis by clicking on the “Reset default” button in the lower left hand corner of the settings window.

When you open the Engine RPM Analysis, it will bring up an analysis on the current lap, or laps, you have open in your main Race Studio Analysis window. If you wish view a different lap, simply select which lap, or laps, you wish to view the same way you would when doing your normal analysis. The easiest way is to click on the box corresponding to the desired lap in the test plot at the bottom of the screen. As shown in the screenshot below, I currently have Lap 6 selected, and would like to view Lap 5 as well.



After you have selected that lap, it will be highlighted in that lower plot as shown in the figure below, and will also appear on all of the graphs in the same color as it is highlighted in. In this case, Lap 5 will show up red, and you can see in the Power and Torque curves below, there is one for each lap. Also, the newly selected lap will also appear in the table in the right of the screen to show the actual values in comparison to any other lap that is also enabled.



To disable a lap simply click on the checkbox to remove the checkmark and disable the lap.

Section 6. Reminders

When using the Engine RPM Analysis, there are a few things to remember so you can make sure your numbers are not all over the place. First of all, be very careful with your units. Make sure you know exactly which units you are working with, whether metric or imperial. Also, pay attention to which lap you are analyzing. If you have accidentally selected a warm up or cool down lap, your values will certainly be much lower than expected. Your reference lap (fastest lap) is always a good one to use for this type of analysis. Furthermore, the more channels you can include for this the better. Using all four of RPM, Speed, Throttle, and Longitudinal Acceleration will give you a much more accurate analysis than using just RPM. The more of those you can include the better.