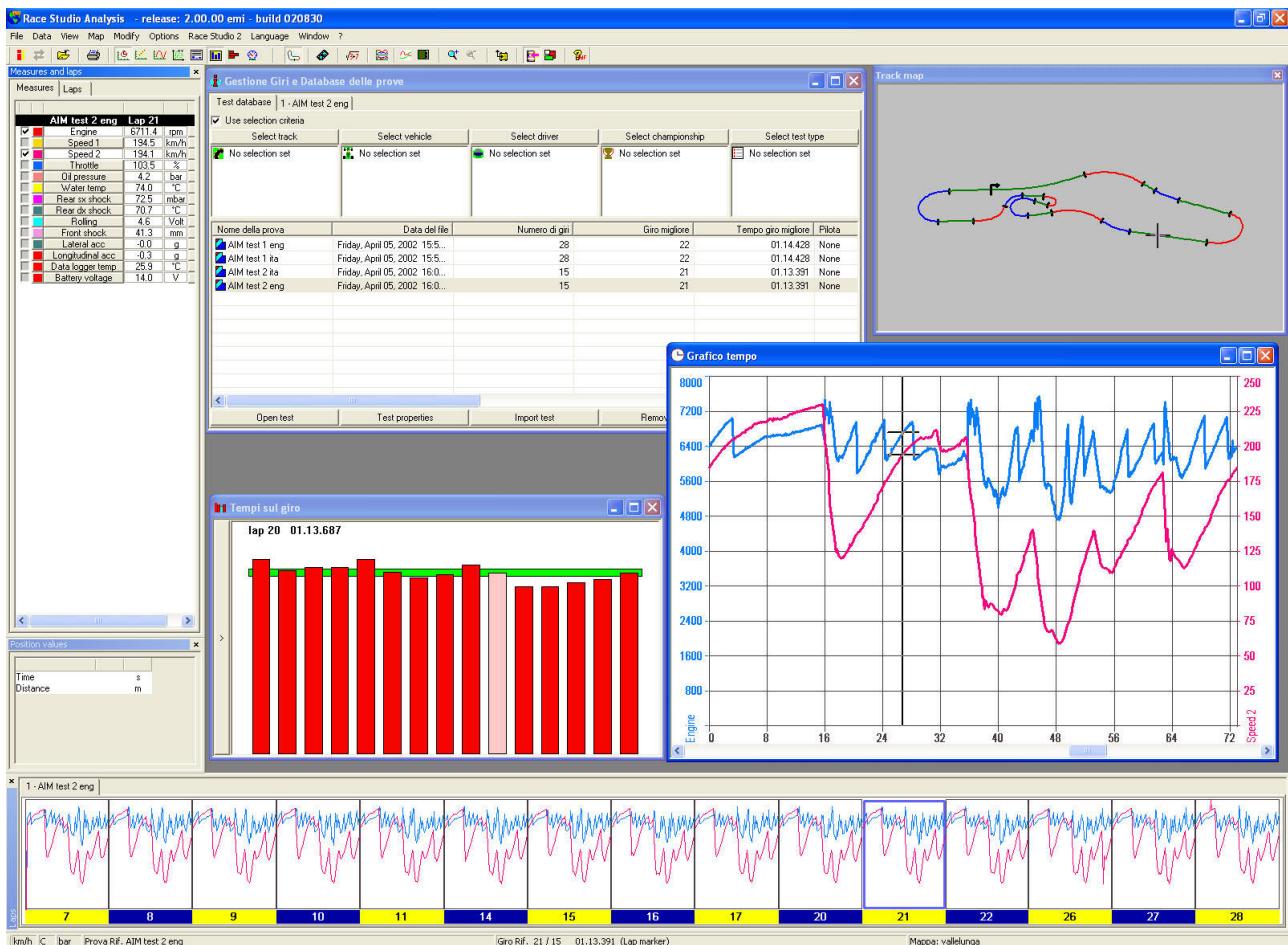


Race Studio 2



Race Studio 2 Analysis

User's manual

Version 1.00.10 – 9th June 2003

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Introduction

The **Race Studio Analysis** software is able to manage data coming from all the **Aim** data loggers. This software has been designed and developed to analyze the data acquired by your gauge, in order to improve the driver's performances and the vehicle's setup.

The aim of this manual is to allow everyone, even those who do not have a good knowledge of both Personal Computers and data analysis techniques, to correctly and usefully analyze the acquired data. For this reason, this manual has been written using a "How to" technique, which consists in writing the manual in order to answer the most frequently asked questions (concerning test loading, database managing, plot settings, track map creating, etc...).

The manual has been written referencing to a Windows® XP operative system.

What may I find in this manual?

Here in the manual you can find an exhaustive description of the **Race Studio Analysis** functions. Here below it is reported, more in details, the chapters' description:

- Chapter 1 gives some general data acquisition concepts for an easier understanding of the data acquisition systems.
- Chapter 2 gives a general description of the main functionalities of the **Race Studio Analysis** software.
- Chapter 3 describes the "How to load a test" functions for the analysis of the recorded data provided by **Race Studio Analysis** software.
- Chapter 4 describes the "How to plot a diagram" functions, explaining the different kinds of diagrams available, the way to change line shape and colour, the zoom tool, etc.
- Chapter 5 concerns the "How to create/manage a map" utilities, showing how to create a new track map and how to load/delete/modify a previously created map.
- Chapter 6 describes a group of functions which allow the user to reach more detailed information concerning a test session, like track report, setup analysis, histogram diagram, maximum and minimum values for the measured channels, etc...
- Chapter 7 concerns the "Data animation" functions, which allow the user to have a graphical replay of the acquired channels.
- Chapter 8 describes the "Math channels": in particular, it will be explained how to create a new math channel, how to load an existing one, how to define a new constant and how to test the mathematic formula.
- Chapter 9 describes some utility functions, like "How to load/save the window status", "How to export a test in Microsoft Excel" and "How to modify the test preferences".

Chapter 1 - Data acquisition concepts

1.1 – Analog and digital signals

The measurement of a physical quantity, such as the speed of a car or the temperature of the exhaust gas is at the same time a very simple and a very complex operation.

The first element necessary to the measurement is the sensor; it is a device that transforms a physical quantity in an electrical signal.

An electrical signal may change between two fixed values or it may assume any value in a fixed range, moreover it can be defined in a continuous time interval or in discrete time.

When a signal is defined in discrete time interval and can assume any value in a fixed range it is named **analog**. When a signal is defined for finite time intervals and can assume only fixed values it is named **digital**.

A data logger records and a Personal Computer elaborates only signals in a numerical (or digital) form, for this reason it is necessary to convert all the signals in a digital form.

The data logger makes the conversion.

The sensors used for the measure of the number of engine revolutions and wheel speed provide an output signal assuming only fixed values and it is defined for a continuous time interval. The data logger converts these signals in a digital form counting the impulses generated by the sensors.

All the other sensors, like potentiometers and thermocouples, have analog outputs. The data logger again performs the analog-to-digital conversion.

1.2 – Sampling rate

The sampling rate is the data acquisition system's recording frequency.

Although the output from the sensors changes continuously and instantaneously, the data acquisition system records data at prefixed time intervals.

The sampling rate is expressed in Hertz (Hz = 1/sec). For example if you have a sampling rate of 10 Hertz, it means that the input is read ten times per second and the time between any two successive readings is 0.1 second.

For a correct representation of a physical phenomenon, like the travel of a suspension, it is very important to read the output of the sensor a number of times enough to have no lost of information about the phenomenon itself. So it is very important to select the right sampling rate.

1.3 – Data analysis

The analysis includes all the functions used to see and understand the recorded data.

The main analysis functions are plots, histograms and map generation.

The plots are the most common way to analyse data.

They show on the vertical axis the recorded values and on the horizontal axis the time or the distance or the frequency.

The plots versus time and space are very easy to read because they show when and where data are recorded. On the contrary plots versus frequency need some more explanations, which are given in next paragraph.

All the analysis functions provided by the **Race Studio Analysis** software are described in Chapters from 3 to 9.

1.4 – Frequency analysis

The frequency analysis is based on the Fourier theorem. This theorem affirms that every signal can be obtained as the sum of a number of finite or infinite sinusoids.

Three parameters give a full characterization of a sinusoid; they are 1) the frequency, 2) the amplitude and 3) the phase.

Therefore each signal can be shown versus time as a sinusoids sum having different values of frequency, amplitude and phase.

The normal way to represent sinusoids against frequency is to show two different plots one for the amplitude and another for the phase. They are named respectively amplitude spectrum and phase spectrum.

The signals usually analysed with the **Race Studio Analysis** program have a very high number of sinusoids' components; the frequencies of these components are very close each other.

A much diffused application of the frequency analysis is to calculate the power spectrum of the signal.

The power spectrum is obtained squaring the amplitude of the different components of the signal.

In order to obtain the power spectrum in the frequency domain it is necessary to make the Fourier Transform of the signal.

The Fourier Transform requires a lot of math operations. For this reason it is usually calculated with a fast algorithm named Fast Fourier Transform (FFT). This algorithm reduces both the complexity and the number of operations and thus the calculation time.

The **Race Studio Analysis** program allows calculating, using the Fast Fourier Transform, the power spectrum for all the channels, both input and math. The power spectrum can be shown selecting the “View-Plot vs. frequency” item from the *View* menu.

The power spectrum is very useful because it allows analysing the characteristic frequencies of the signal. For the typical applications of the EVO 3 system, it is very interesting for the suspensions analysis.

Chapter 2 – Software: general description

2.1 – Getting started

2.1.1 – Before using data acquisition systems

The time invested before using data acquisition systems for the first time produces more accurate data and a more reliable system.

Install the data logger, the sensors and the cables on the vehicle and the software on your Personal Computer well in advance of the departure to the track; in case problems arise they can be solved.

Learn the **Race Studio Analysis** software using the manual and with some example tests.

Make a few trial runs of recording and downloading data in the shop.

2.1.2 – Race Studio Analysis concepts

Tests

The **Race Studio Analysis** software stores data downloaded from the data logger in files, they are defined by the program **tests**. The user at the end of the download operation gives the name of the tests. Changing the name of the tests outside the **Race Studio 2** software may cause the tests to be no more recognised by the program.

Database

The tests are recorded into directories created and named by the user; otherwise, if the user saves the test without specifying the directory, the test file will be automatically saved in the “\Program files\AIM\DATA”.

The downloaded tests are saved in a database. This database is characterized by 5 attributes, which define the Vehicle, the Track, the Driver, the Championship and the Test type. For further information concerning the tests database, please refer to chapter 3.

Channels

The **Race Studio Analysis** software allows analysing two different kinds of measures: *Input channels* and *Math channels*.

The *data logger acquires the Input channels* (for example speed or oil pressure), while the *user defines the Math channels* and the program calculates them on the Personal Computer using the *Input channels* or the *Math channels* themselves (examples of math channels are linear acceleration or gear number).

Reference speed

For tests on track the most important measure for the data acquisition systems is the speed. The speed is necessary for starting to record data and for a lot of analysis functions like the *creation of the map*, the *plot vs. distance*, the *calculation of splits*, the *data animation* and so on.

The **Race Studio Analysis** software has a special channel named *Reference speed* used as the official speed channel of the test. Three input channels are provided to become the *Reference speed*, they are speed #1, speed #2, and the analogue channel with the Pitot tube connected.

It is possible to select the *Reference speed channel* from the *toolbar main menu* inside the “*Modify – Reference speed*” command. After the selection the selected channel becomes the official *reference speed channel* for the current test and for the next downloaded ones. For further information concerning the *Reference speed*, please refer to chapter 5.4.

WARNING. If the Reference speed is not selected or the values of the Reference speed channel are always zero during the analysis there is not visualisation referred to distance, for example Plot vs. distance or Split report.

Maps

Maps are the tracks' drawings. The calculation of the maps is performed using the Reference speed and lateral acceleration channels for four wheels vehicles or the Reference speed and the gyroscope for two wheels vehicles (motorbikes). For a description of how to calculate a new map see chapter 5.

2.1.3 – Run the program

Run the program with a double click of the left button of the mouse over the shortcut to the **Race Studio Analysis** software on the desktop of your computer, the shortcut has been created by the setup program.

Otherwise run it from the Programs menu into the Start menu.

2.2 Functionality

The **Race Studio Analysis** software includes all the functions for the analysis of the downloaded data. This chapter gives a short description of the main functions provided by the software for the analysis of the recorded data.

Before to start describing the program functionality it is necessary to outline the principal window shown running the **Race Studio Analysis** software from your PC's desktop shortcut or from the Start menu.

2.2.1 – Analysis window

Selecting the "Analysis" command, a dialog window for the selection of the test to analyse is displayed. When the test is chosen the Analysis window is displayed; Fig. 2.1 shows it.

All loaded data are shown inside a window named Test database and Lap manager. If you close the Test database and Lap manager window during the Analysis, the current test will be unloaded. It is reminded that closing the Test database and Lap Manager window does not entail the closure of **Race Studio Analysis**.

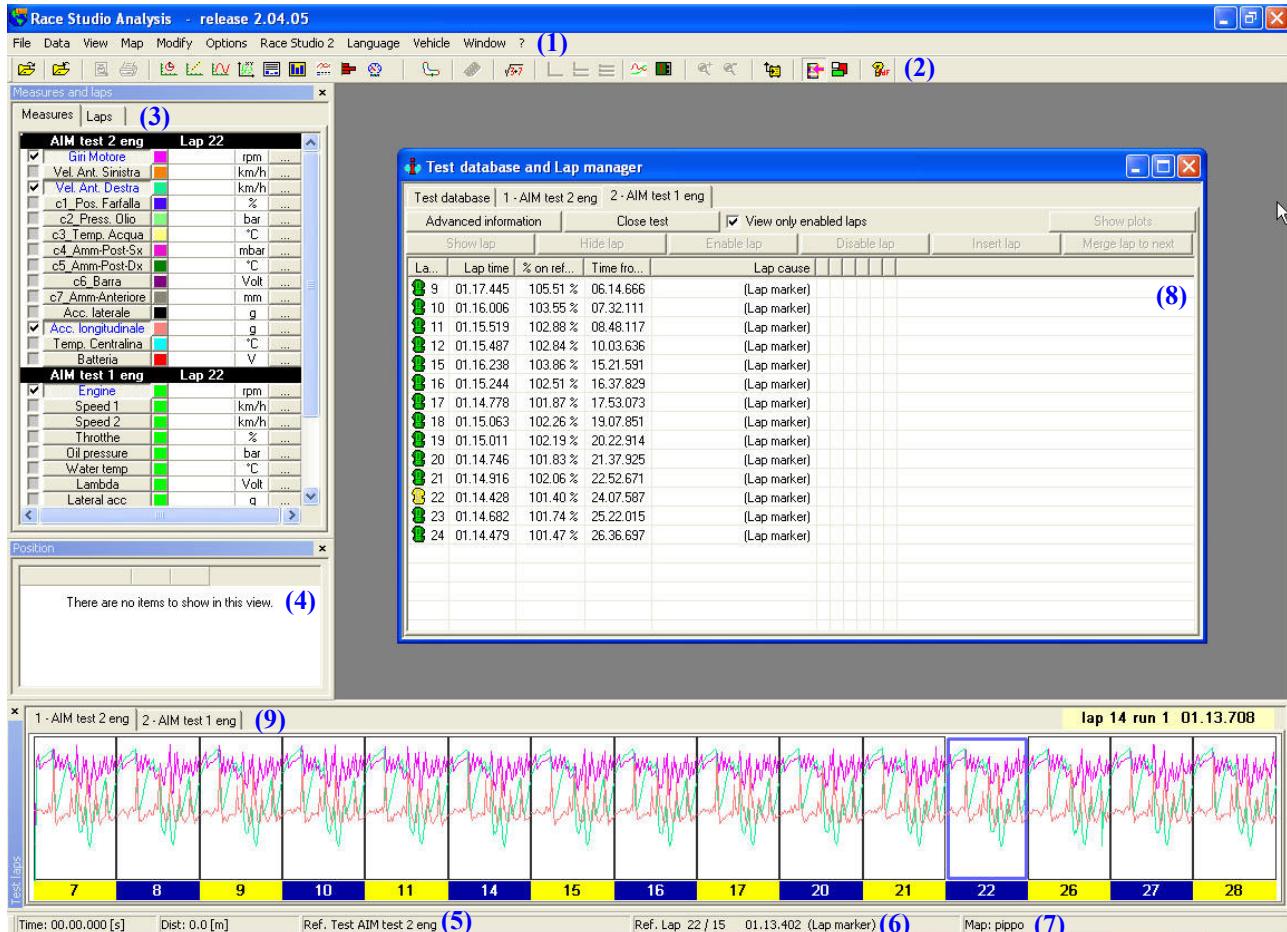


Fig. 2.1– Race Studio Analysis main window

The most important areas in the analysis window are:

- (1) The menu of the window, it includes the commands for the analysis of data.
- (2) The buttons toolbar.
- (3) The Measures and Laps toolbar.
- (4) The Position toolbar.
- (5) The name of the test in evidence shown on the status bar.
- (6) The lap number and the lap time.
- (7) The name of the selected map shown on the status bar.
- (8) The Test database and Lap manager window.
- (9) The Laps toolbar.

The toolbar of the Analysis window includes buttons to run some of the most used commands of the Analysis menu; it is shown below.



Fig. 2.2– Race Studio Analysis toolbar

Starting from the left the buttons run the following commands:

1. Show the Test database and Lap Manager window (shortcut ALT+F7).
2. Cancel a test from the loaded set (ALT+F3).
3. Print preview (SHIFT+F11).
4. Print a diagram (SHIFT+F12).
5. Plot a channel vs. time (CTRL+F1).
6. Plot a channel vs. distance (CTRL+F2).
7. Plot a channel vs. frequency (CTRL+F3).

-
- 8. Plot a channel vs. channel (CTRL+F5).
 - 9. Run the Split times analysis (CTRL+F6).
 - 10. Run the Lap times report (CTRL+F7).
 - 11. Run the Channels report.
 - 12. Display a histogram of the selected channels (CTRL+F8).
 - 13. Show the dashboard simulation (CTRL+F11).
 - 14. Show the track map (SHIFT+F1).
 - 15. Run the Data animation function (F12).
 - 16. Math channels (ALT+F8).
 - 17. Change plot style: overlapped graphs;
 - 18. Change plot style: mixed graphs;
 - 19. Change plot style: tiled graphs;
 - 20. Plot settings dialog window (ALT+F9).
 - 21. Measures info dialog window (ALT+F10).
 - 22. Enable zoom (SHIFT+F9).
 - 23. Disable zoom (SHIFT+F10).
 - 24. Run **Race Studio 2** (F5).
 - 25. Toggle visibility of the Measures toolbar (ALT+F11).
 - 26. Load window status.
 - 27. Online manual (F1).

All these commands will be described in chapters from 3 to 9.

2.3 Data compatibility

If it is necessary to analyse tests recorded with the **WDrack** software, it is possible when they have been recorded with software version starting from the 3.00. These files will be opened and converted to a format compatible with **Race Studio Analysis**; after this conversion, the files will no more be compatible with **Wdrack**.

If the tests include math channels they are lost during the conversion. It is possible to calculate them again running the new user interface for the definition and calculation of math channels.

Race Studio Analysis is also able to open the tests downloaded with **Race Studio 1**; these files, unlike the ones downloaded with the **Wdrack** software, will not be converted into another format.

Chapter 3 – “How to load a test”

3.1 – Introduction: what is a database?

Race Studio 2 has a new and innovative tests storing system based on databases.

This storing system consists in saving the file specifying 5 characteristics (even called “attributes”). Such information, which are saved together with the test file, are listed here below:

- Vehicle name
- Driver name
- Track name
- Championship
- Test type

When you insert a test in the database, the 5 characteristics you specified will be saved as “**sub-categories**” (or **attributes**) of the 5 main database categories. In the following example, for instance, it is reported two main categories (the **driver name** and the **track name**), each one composed of two sub-categories/attributes (Driver 1 and Driver 2 for the Driver name, Indianapolis and Monza for the Track name):

- Driver
 - Driver 1
 - Driver 2
- Track
 - Indianapolis
 - Monza

This new test storing system is very useful as it allows the user both to divide the test files into self-defined groups, each one characterized by 5 attributes, and to load the test files in a very practical and easy way.

For further information concerning the database management, please refer to chapter 3.2.

3.2 – How to load a test from the database

Once run **Race Studio Analysis**, it will appear the *Test database and Lap Manager* window, as shown in Figure 3.1. This window is divided into two separate rows:

- In the upper row there are 5 boxes, labelled from (7) to (11), showing the database’s “selection criteria”. Each one of the 5 boxes has its own pushbutton (Select track (2), Select vehicle (3), Select driver (4), Select championship (5) and Select test type (6), which is used to activate the corresponding selection criterion. Checkbox (1) is used to enable/disable the selection criteria. Button (18) is used to show the graphs when hidden by other windows.
- In the lower part of the *Test database and Lap manager* window it is reported the “available tests” list (12), i.e. a list of all the tests included in the database. In particular, it is shown the test name, the file data, the number of laps, the best lap time and the corresponding lap number, the related database sub-categories and the file path. Moreover, in the lower part of the *Test database and Lap manager* window, there are 5 buttons used to “Open a test” (13), to “Modify the test properties” (14), to “Import a test in the database” (15), to “Remove a test from the database” (16) and to “Export a test file” (17) (on a floppy disk, for instance).

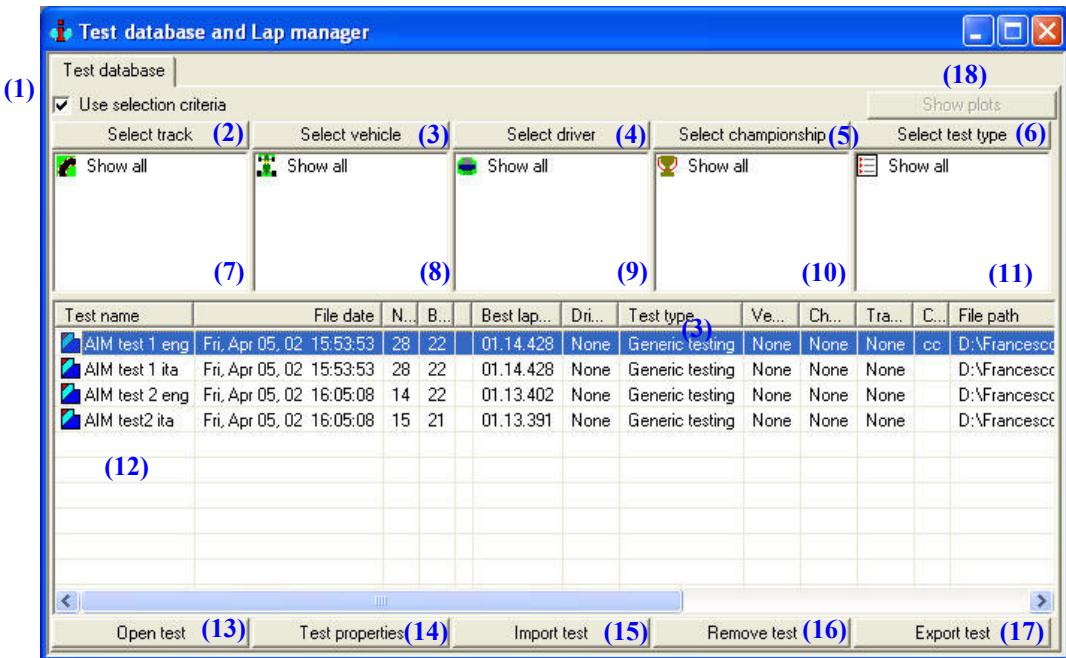


Fig. 3.1– Test database and Lap manager window: Test database layer.

The user is allowed to load a test in two different ways: the checkbox **(1)**, in fact, enables/disables the database's selection criteria. Please, refer to chapters 3.2.1 and 3.2.2 for further information concerning the selection criteria.

3.2.1 – How to load a test using the selection criteria

The selection criteria allow you to use the database as a “tests filter”. This means that, if you select one, or more than one, database's sub-categories, all the tests which do not belong to those sub-categories will be removed from the available tests list.

This procedure is very useful when the database is composed of many tests and/or the user does not remember the test name but remembers some characteristics of the recorded file (for instance, the track or the driver name).

If you wish to use the selection criteria, first of all ensure that the “Use selection criteria” check-box is enabled. If the check-box is disabled, place a check in the proper box. Now follow these instructions:

- Left click on the desired pushbutton: press button “Select track” **(2)** if you wish to select the track name, press button “Select vehicle” **(3)** if you wish to set the vehicle name, etc...In the following figures 3.2 and 3.3, it has been selected the “Test type” button **(6)**.

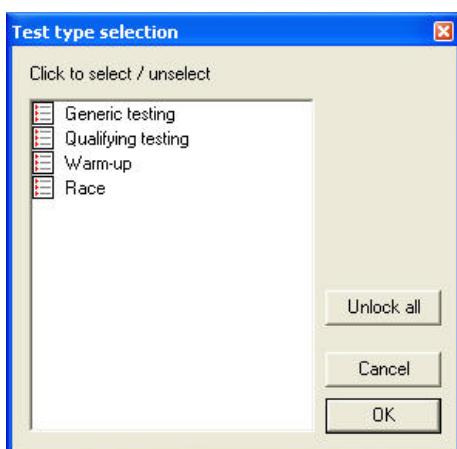


Fig. 3.2– Test type selection: no test type selected

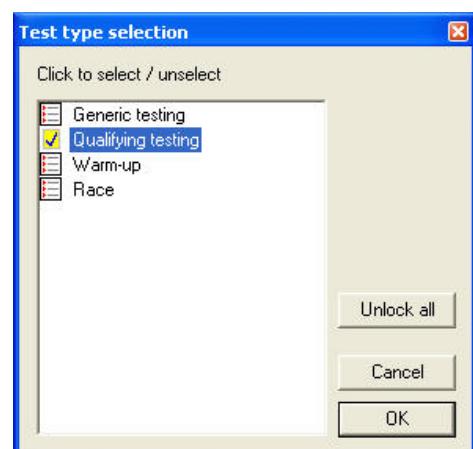


Fig. 3.3– Test type selection: Qualifying testing selected

- As shown in Figure 3.2, it will appear a window showing all the sub-categories included inside the selected database's category. If you wish to select a sub-category, left click the desired one. The selected sub-category will become "checked", as shown in Figure 3.3.
- It is reminded that you may select more than one sub-category at the same time.
- Once all the desired sub-categories have been checked press button "OK" to exit the *Test type selection* window. If you wish to exit discarding the changes, press button "cancel". If you wish to remove all the checks, press button "Unlock all".
- The selected database's sub-categories will appear inside the corresponding "selection box", labelled from (7) to (11). For instance, in the example described in Figure 3.3, it will appear the text "Qualifying testing" inside the selection box number (11) of Figure 3.1.
- Repeat this procedure for all the desired database's categories.
- Now you may load the desired test:
 - Option 1: left click on the file name and press "Open test button" (13).
 - Option 2: right click on the file name and choose the "Open test" function.
 - Option 3: double click on the file name.

Once the desired test has been loaded, inside the *Test database and Lap manager* window it will appear a new layer named as the loaded test file.

It is reminded that the user may load up to 4 tests at the same time.

3.2.2 – How to load a test not using the selection criteria

If you do not wish to use the selection criteria, you may disable this function by placing a check besides the "Use selection criteria" text. The 5 selection boxes and the 5 corresponding buttons will be disabled and will turn grey coloured, as shown in Figure 3.4.

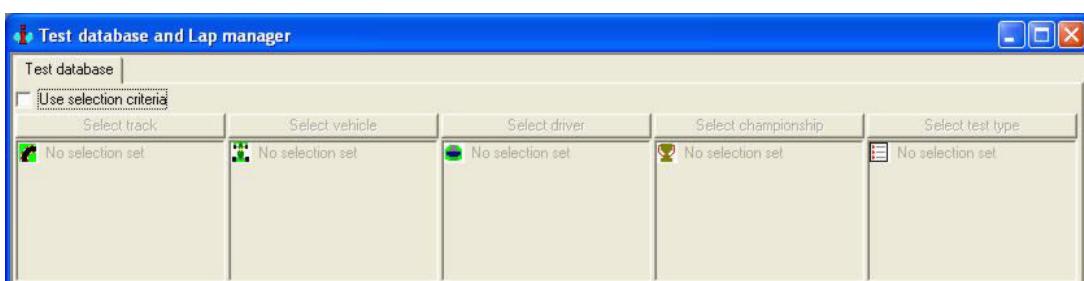


Fig. 3.4– *Test database and Lap manager* window: "selection criteria" option disabled

- Now you may load the desired test by choosing one of these 3 options:
 - Option 1: left click on the file name and press "Open test button" (13).
 - Option 2: right click on the file name and choose the "Open test" function.
 - Option 3: double click on the file name.

3.3 – How to insert a test in the database

- Once run **Race Studio Analysis**, it will appear the *Test database and lap manager* window, as shown in Figure 3.1.
- Push the "Import test" (15) button and select the test you wish to add to the database. It is reminded that you may import a test both from your PC's hard disk and from the floppy disk but **not** from the CD-ROM drive. In this last case, it is suggested first to copy the DRK file on your PC's hard disk and then to import it in the database.
- As shown in Figure 3.5, the user may set 5 parameters, each one of them belongs to a database category (Vehicle name, Driver, Track, Championship and Test type).

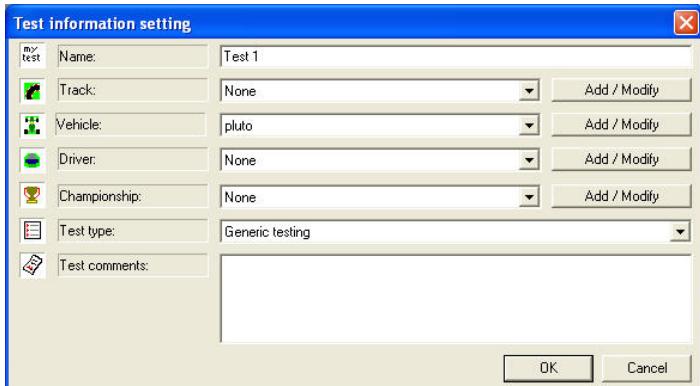


Fig. 3.5– Add test to database window

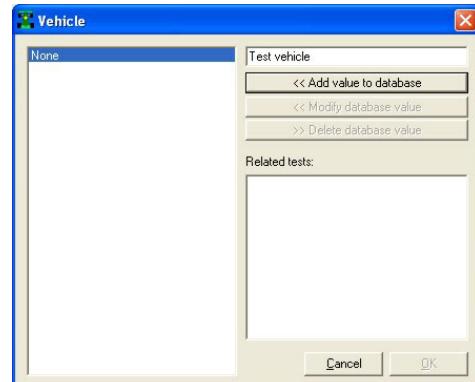


Fig. 3.6– Add/Modify test attributes window

If the database is blank or you wish to set a new database sub-category (i.e. attribute), please follow these instructions:

- To set the Vehicle name, please push the Add/Modify button which corresponds to the Vehicle row. It will appear the window shown in Figure 3.6.
- Now, please fill the upper right corner box with the correct vehicle name and, then, click the “<< Add value to database” pushbutton. The vehicle name will appear in the vehicle name column.
- Once added the value to the database, the OK pushbutton will become enabled: please, select the desired vehicle name from the vehicle name column and, then, click button OK.
- Please, repeat this procedure for the other 4 database categories (i.e. Driver name, Track, Championship and Test type).

Otherwise, if the database is not blank and the user wishes to add the test in a previously set database sub-category, please follow these instructions:

- From the Add test to database window, instead of pressing the “Add/Modify” button, select the desired vehicle name from the corresponding “combo” menu, located in the middle of Figure 3.5.
- Repeat this procedure for the other 4 database categories.

3.4 – How to modify the database test properties

In order to modify the test properties, please select the desired test (single-click on the test name), and then press button *Test properties*. It will appear the *Test information setting* window, as shown in Figure 3.5.

The procedure to be followed is similar to the one described in chapter 3.3 “How to insert a test in the database”: the test may be either moved in a new database sub-categories or in a previously created one.

3.5 – How to delete a test from the database

If you wish to delete a test from the database, please enter the *Test database and Lap manager*, shown in Figure 3.1, and select the test you wish to delete by single-clicking on the test name.

Once the test has been selected, you may either push button “Remove test” or right click on the file name and choose “Delete test from database” function.

The test will be automatically removed from the database but **will not be deleted from your PC's hard disk**, as reminded in the confirmation window, shown in Figure 3.6, which appears on your PC's monitor.

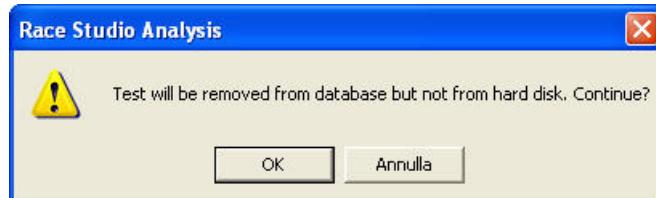


Fig. 3.7 – Delete test from database confirmation window.

3.6 – Which information are shown in the Lap manager layer

The Test database and Lap manager window is organized on different layers (1).

The first one on the left is named Test database and has already been described in chapter 3.2. The other ones (up to 4 as you may load up to 4 separate tests) are related to the loaded tests.

If you wish to select one of these layers, as shown in Figure 3.8, left click on the desired one.

Inside the desired layer you will find the “Advanced info” (2) button (see chapter 3.7 for further information), the “Close test” (3) button (see chapter 3.8) and the “View only enabled laps” (4) checkbox.

In the row below the previously described one there are 6 buttons used for the laps management and described in chapter 4.12.

Lap...	Lap time	% on ref...	Time fro...	Lap cause					
9	01.17.445	103.38 %	06.14.666	(Lap marker)					
10	01.16.006	101.45 %	07.32.111	(Lap marker)					
11	01.15.519	100.80 %	08.48.117	(Lap marker)					
12	01.15.487	100.76 %	10.03.636	(Lap marker)					
15	01.16.238	101.76 %	15.21.591	(Lap marker)					
16	01.15.244	100.44 %	16.37.829	(Lap marker)					
17	01.14.778	99.82 %	17.53.073	(Lap marker)					
18	01.15.063	100.20 %	19.07.851	(Lap marker)					
19	01.15.011	100.13 %	20.22.914	(Lap marker)					
20	01.14.746	99.77 %	21.37.925	(Lap marker)					
21	01.14.916	Reference	22.52.671	(Lap marker)					
22	01.14.428	99.35 %	24.07.587	(Lap marker)					
23	01.14.682	99.69 %	25.22.015	(Lap marker)					
24	01.14.479	99.42 %	26.36.697	(Lap marker)					
(6)									

Fig. 3.8 – Test database and lap manager window: Lap manager layer.

Inside the grid (6) it is listed all the laps included in the loaded test.

The grid is composed of 6 columns (Lap number, Lap time, % on reference, Time from beginning, Lap cause and Run) and as many rows as the test laps.

Button (7) is used to show graphs when hidden by other windows.

Here below it is described the meaning of each grid column:

Lap number	Near the lap number, a small icon shows the selected laps: it is green if the lap is not selected, yellow if the lap is selected. For selecting and deselecting a lap, please double click on it.
Lap time	In minutes: seconds: milliseconds.

% on reference	The best lap (the one with the lowest lap time) is considered the Reference Lap . It is possible to change the reference lap, deselecting it and selecting another lap.
Time from the beginning	Time from the beginning of the test. In minutes: seconds: milliseconds.
Lap cause	A lap may be: Lap marker , First lap , Vehicle stop , Computed merging two laps , Computed splitting a lap or Calculated lap . This last possibility, very rare, means that there is an incompatibility between the value of the lap and the number of samples recorded: the lap time is so recalculated, considering some check points that the logger puts inside the data. The Computed splitting a lap/merging two laps lap causes are shown when the Merge to next lap/Insert lap options are used. The old files, where the lap cause was not specified, show simply Generic lap .
Run	In a test you may have one or more Runs . Whenever the car stops for more than a few seconds, the Run counter is incremented. In this way it is possible to divide the data in accordance with the different test runs.
Split #	These cells show the split times sampled by your data logger. AIM gauges, such as MyChron 3 Basic/Plus/Gold, are able to record up to 5 split times.

As shown in Figure 3.8, the laps are listed from the 1st to the last one.

- If you click on the “Lap number” box, the laps will be displayed from the last to the 1st one.
- If you click on the “Lap time” box, the laps will be listed from the fastest to the lowest. If you click again on the “Lap time” box, the laps will be shown in the opposite order.

3.7 – How to have more information about a test

If you wish to have more information about a test, please select the desired test among the loaded ones and click the “Advanced info” (1) button, as shown in Figure 3.9.

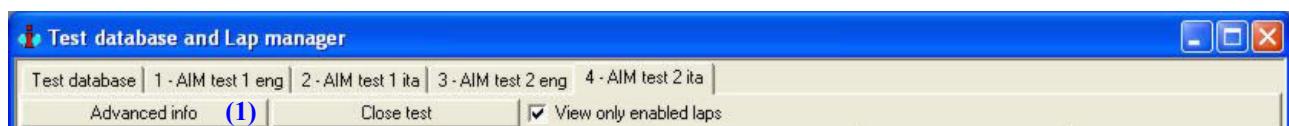


Fig. 3.9– Test database and Lap manager window: layers and buttons.

It will appear the Advanced info window, as shown in Figure 3.10.

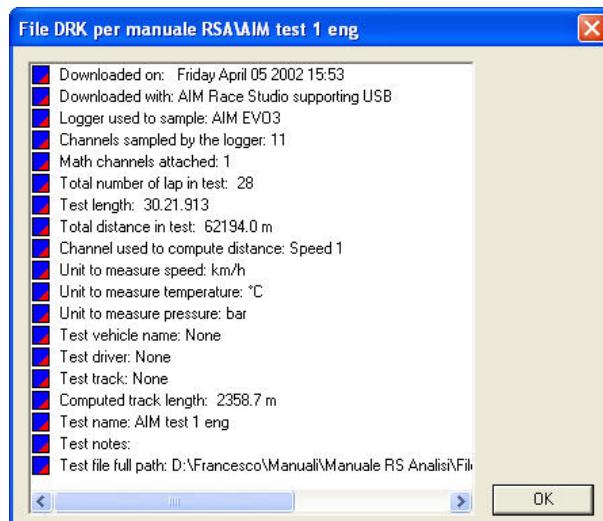


Fig. 3.10– Advanced info window.

The information you may have are listed here below:

Downloaded on	Date
Downloaded with	Wdrack, Race Studio 1, Race Studio 2
Logger used to sample	EVO 3, Drack, MyChron 3 Plus/Gold, Dash ST1
Channel sampled by the logger	Total number of channels sampled by the logger
Math channels attached	Number of math channels attached
Total number of Run in test	Total number of Runs completed during the test session.
Total number of lap in test	Lap number
Total length	Total running time, in minutes, seconds and milliseconds
Total distance in test	Total running distance, in meters (or in feet)
Channel used to compute distance	Speed 1, Speed 2, Average speed
Speed unit of measure	km/h or MPH.
Temperature unit of measure	°C or °F
Pressure unit of measure	Bar or PSI.
Test vehicle	Vehicle name
Test driver	Driver name
Test track	Track name
Computed track length	Track length in meters (or in feet)
Test name	Test name (i.e. file name)
Test notes	Comment of the user
Test file full path	Path of the loaded test file

3.8 – How to close a test

If you wish to close a test, you may select it (left click on the corresponding layer) and then press “Close test” (1) button, as shown in Figure 3.11, you may select it and choose the Unload test function located inside the Data toolbar, you may use the shortcut “ALT+F3” or you may double-click on the loaded test file inside the Test database and Lap manager window.

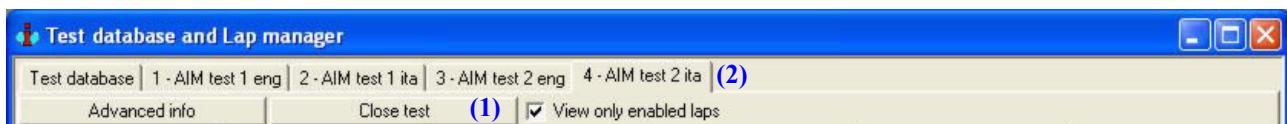


Fig. 3.11– Test database and Lap manager window: how to close a test.

Chapter 4 – “How to plot a test”

4.1 – How to plot a channel vs. time

To plot a channel versus time, you may click the *Plot vs. Time* command, located inside the View toolbar, you may click the proper button in the buttons toolbar or you may use the shortcut “CTRL+F1”.

The *Plot vs. time* view shows the time on the horizontal axis and the channels’ recorded value on the vertical one.

The layout of the view for overlapped graphs is shown in Figure 4.1 and described below.

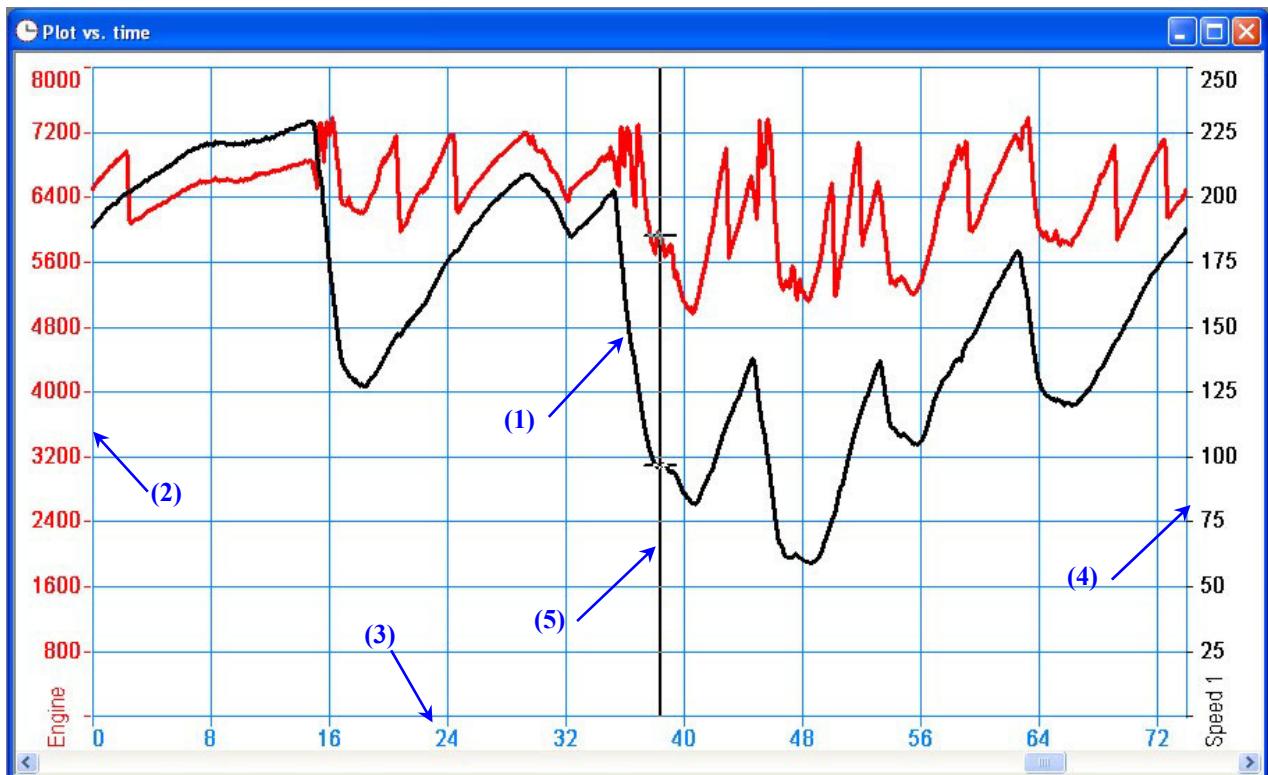


Fig. 4.1– Plot vs. time: overlapped graphs

In this example graph it is reported two measured inputs **(1)**: the engine’s RPM (red) and the vehicle speed (black).

The graph’s abscissa axis **(3)** shows the time in seconds: the axis minimum is set to the default value 0 while the maximum one is set to the lap time.

The graph also reports the RPM’s **(2)** and the speed’s **(4)** axis scale (from 0 to 8000 for the RPM channel and from 0 to 250 for the speed one). To add/remove the scale from the graph, please see chapter 4.4.2; to modify the scale’s limits, please see chapter 4.6.1.

The vertical line **(5)** with a cross every time a graph is met is called “cursor”: if you click in an internal point of the graph, the cursor will move to that point. The values of the sampled data corresponding to that time will be shown in the *Measure toolbar* (see chapter 4.4).

To switch the graph from an overlapped one to a tiled or a mixed one, you may right click when the mouse cursor is on the graph and select the desired graph type, you may choose the desired function inside the *Options* toolbar or you may use the proper buttons located inside the buttons toolbar.

4.2 – How to plot a channel vs. distance

To plot a channel versus time, you may click the *Plot vs. Distance* command, located inside the View toolbar, you may click the proper button in the buttons toolbar or you may

use the shortcut “CTRL+F2”.

The *Plot vs. distance* view shows the distance on the horizontal axis and the channels’ recorded value on the vertical one.

The layout of the view for overlapped graphs is shown in Figure 4.2 and described below.

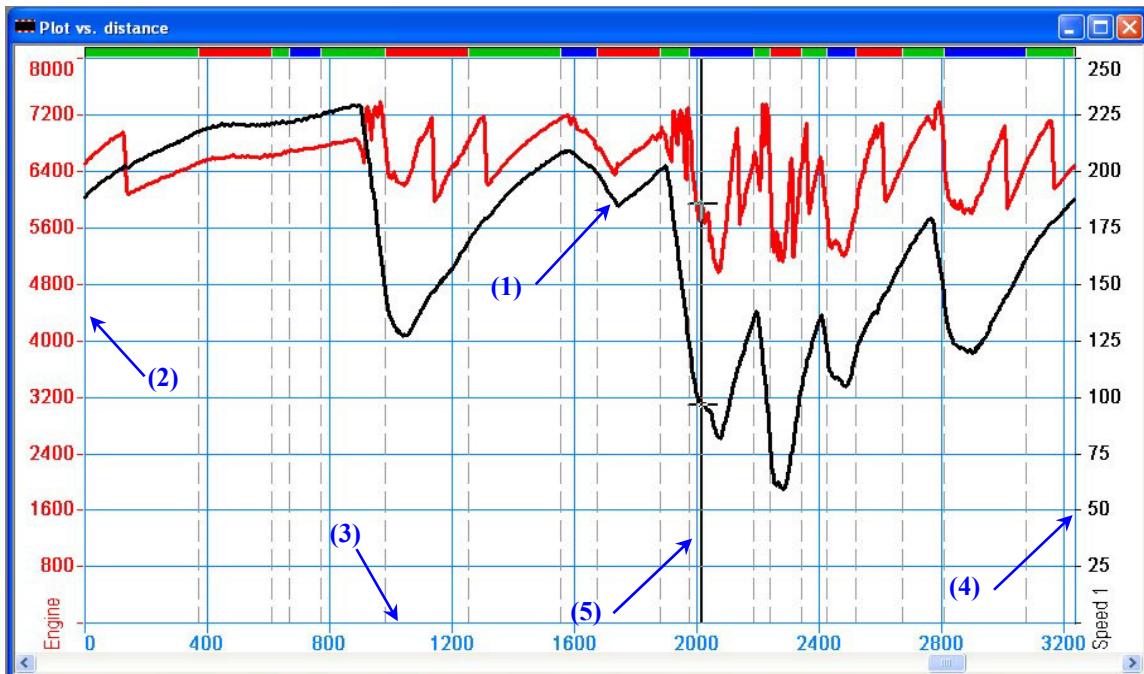


Fig. 4.2– Plot vs. distance: overlaid graphs

In this example graph it is reported two measured inputs **(1)**: the engine’s RPM (red) and the vehicle speed (black).

The graph’s abscissa axis **(3)** shows the track length in meters: the axis minimum is set to the default value 0 while the maximum one is set to the track length.

The graph also reports the RPM’s **(2)** and the speed’s **(4)** axis scale (from 0 to 8000 for the RPM channel and from 0 to 250 for the speed one). To add/remove the scale from the graph, please see chapter 4.4.2; to modify the scale’s limits, please see chapter 4.6.1.

The vertical line **(5)** with a cross every time a graph is met is called “cursor”: if you click in an internal point of the graph, the cursor will move to that point. The values of the sampled data corresponding to that time will be shown in the *Measure toolbar* (see chapter 4.4).

To switch the graph from an overlapped one to a tiled or a mixed one, you may right click when the mouse cursor is on the graph and select the desired graph type, you may choose the desired function inside the *Options* toolbar or you may use the proper buttons located inside the buttons toolbar.

4.3 – How to plot a channel vs. frequency

To plot a channel versus time, you may click the *Plot vs. Frequency* command, located inside the *View* toolbar, you may click the proper button in the buttons toolbar or you may use the shortcut “CTRL+F3”.

The “Plot vs. frequency” view shows the frequency on the horizontal axis and the channels’ recorded power spectrum on the vertical axis.

The maximum frequency shown is half of the higher sampling rate of the loaded channels. For example, if the speed (sampling rate = 10 Hz) and the throttle position (sampling rate = 2 Hz) are plotted, the horizontal axis of the plot shows values up to 5 Hz, obviously the throttle graph is zero for frequency values higher than 1 Hz.

This plot may be very useful to analyze the power spectrum of suspension’s travel.

The layout of the view for overlapped graphs is shown in Figure 4.3 and described below.

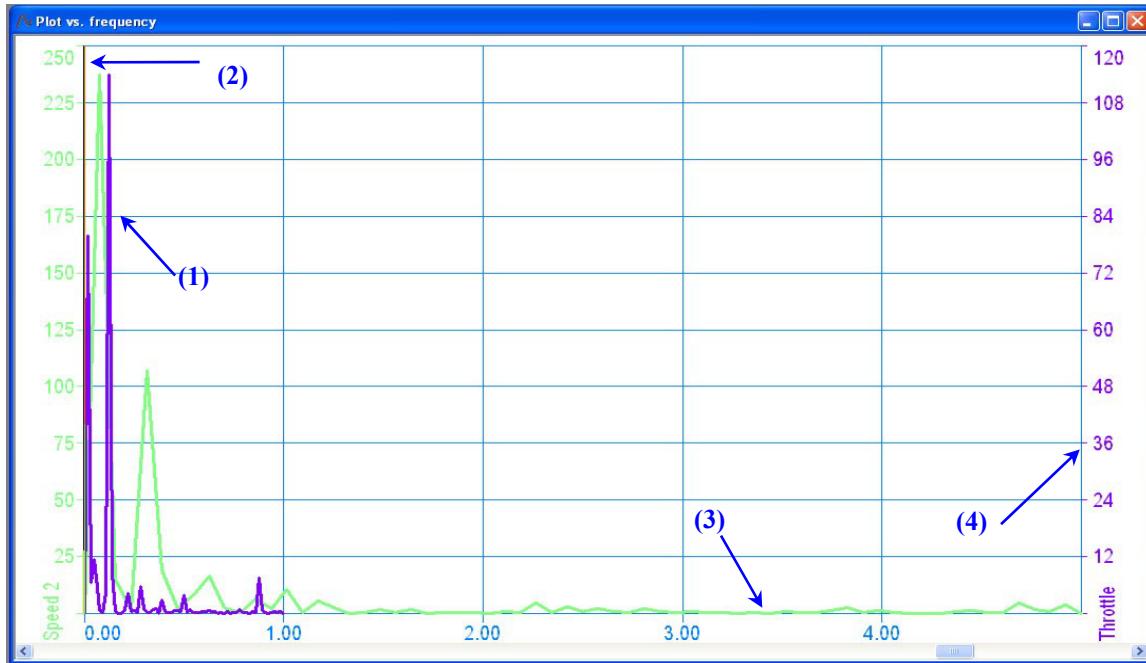


Fig. 4.3– Plot vs. frequency: overlapped graphs

In this example graph it is reported two measured inputs (1): the vehicle speed (green) and the throttle position (violet).

The graph's abscissa axis (3) shows the frequency values.

The graph also reports the speed's (2) and the throttle's percentage (4) axis scale. To add/remove the scale from the graph, please see chapter 4.4.2; to modify the scale's limits, please see chapter 4.6.1.

To switch the graph from an overlapped one to a tiled or a mixed one, you may right click when the mouse cursor is on the graph and select the desired graph type, you may choose the desired function inside the Options toolbar or you may use the proper buttons located inside the buttons toolbar.

4.4 – How to use the Measures and laps toolbar

The Measures and laps toolbar is usually located on the left side of **Race Studio Analysis** window: if it is not shown, please enable it by selecting the Measures toolbar function in the View toolbar, use the shortcut “ALT+F11” or click the Measures and Laps toolbar command in the buttons toolbar.

This window may be moved wherever you wish by dragging and dropping the window itself. Otherwise, you may double-click on the window's title (1) and move the window wherever you wish.

As shown in Figure 4.4, the Measures and laps toolbar is organized on two different layers: the upper layer shows the sampled channels, while the lower one concerns the recorded laps. If you wish to switch from the Measures layer to the Laps one, or vice versa, please select the desired tab (2).

Fig. 4.4– Measures and Laps toolbar

The Measures and laps toolbar shows the following information:

- Sampled channels and recorded laps, on different layers (2);
- Test name (3). If more than one test has been loaded, the Measures and laps toolbar will be divided into as many rows as the loaded tests: in Figure 4.4, for instance, it has been loaded two separate tests “AIM test 1 eng” and “AIM test 2 eng”.
- Graph-scale checkboxes column (4): if a box is checked, the scale corresponding to that channel will be displayed on the graph.
- Channel name column (5): in this column it is listed the channels’ names.
- Graph-colour column (6): in each square it is shown the colour used to plot the corresponding sampled channel (see chapter 4.7 for further information).
- Sampled data value column (7) corresponding to the first selected lap: when moving the vertical cursor on the graph (see chapter 4.1), the Measures and laps toolbar displays the sampled data values corresponding to that track position for the plotted laps.
- Columns (8) and (9) are similar to columns (6) and (7) and are related to the second loaded lap.
- Channels’ units of measure (10).
- Link to the Measures information window (11).

4.4.1 – How to add (remove) a channel to (from) a graph

- To **add** a channel to the graph, please left-click on the desired channel name (6). If a channel is plotted on the graph, its corresponding name inside the Measures and laps toolbar will be blue coloured; otherwise, if the channel is not shown on the graph, the pushbutton will be grey coloured.
- To **remove** a channel from the graph, please left-click on the channel (6) you wish to remove from the graph.

4.4.2 – How to add (remove) the scale to (from) a graph

- To **add** the scale to a graph, please left click in the checkbox (4) corresponding to the desired channel. When the “scale” option is enabled, the graph will show both the channel scale and the channel name (Engine, Speed 1, Throttle, etc...).
- To **remove** the scale from a graph, click again in the same box (4) until the check “V” disappears.

4.5 – How to change lap/plot more laps on the same graph

Race Studio Analysis has been designed and developed to allow the user a user-friendly laps’ management. For such a reason it has been introduced two very useful functions, the Laps layer, inside the Measures and laps toolbar, and the Laps toolbar, usually located in the lower part of **Race Studio Analysis** window.

4.5.1 – How to add (remove) a lap to (from) a graph and “multiple laps selection”

If you wish to load a lap in order to plot it on the graph, you may:

- Double click on the desired lap inside the Test database and Laps manager window. Once the lap has been loaded, the green icon located on the left of the lap number will turn yellow coloured.
- Left click on the desired lap inside the Test database and Laps manager window and click the “Show lap” button (1).
- Right click on the desired lap inside the Test database and Laps manager window and choose the “Show lap” option.
- Check the box besides the desired lap inside the Measures and laps toolbar (see Figure 4.6).

- Right click on the desired lap number inside the Laps toolbar and choose the “Show lap” function.
- Double click on the desired lap number inside the Laps toolbar.

Lap number	Lap time	% on reference	Time from beginning	Lap cause	Run
7	01.13.995	99.42 %	00.00.000	(Lap marker)	0
8	01.13.751	99.09 %	01.13.995	(Lap marker)	0
9	01.13.814	99.18 %	02.27.748	(Lap marker)	0
10	01.13.815	99.18 %	03.41.560	(Lap marker)	0
11	01.13.984	99.40 %	04.55.375	(Lap marker)	0
14	01.13.708	99.03 %	06.09.359	(Lap marker)	0
15	01.13.593	98.88 %	07.23.067	(Lap marker)	0
16	01.13.666	98.98 %	08.36.660	(Lap marker)	0
17	01.13.878	99.26 %	09.50.326	(Lap marker)	0
20	01.13.687	99.00 %	11.04.204	(Lap marker)	0
21	01.13.391	98.61 %	12.17.891	(Lap marker)	0
22	01.13.402	98.62 %	13.31.282	(Lap marker)	0
26	01.13.476	98.72 %	14.44.684	(Lap marker)	0
27	01.13.560	98.83 %	15.58.160	(Lap marker)	0
28	01.13.687	99.00 %	17.11.720	(Lap marker)	0

Fig. 4.5– Test database and Lap manager window: two laps selected (#16 and #21)

Lap	Time	Count
Lap 7	01.13.995	
Lap 8	01.13.751	
Lap 9	01.13.814	
Lap 10	01.13.815	
Lap 11	01.13.984	
Lap 14	01.13.708	
Lap 15	01.13.593	
Lap 16	01.13.666	
Lap 17	01.13.878	
Lap 20	01.13.391	1
Lap 21	01.13.687	
Lap 23	01.13.402	
Lap 28	01.13.476	1
Lap 29	01.00.000	
Lap 30	01.27.247	

Fig. 4.6– Measures and laps toolbar: two laps selected (#20 and #28)

As shown in Figures 4.5 and 4.6, the user will be allowed to plot more than one lap (up to 8) on the same graph.

This function, together with the possibility to load up to 4 different tests, may be very useful to improve the driver’s performances.

If you wish to remove a lap from a graph, you may:

- Double click on the desired lap inside the Test database and Laps manager window. Once the lap has been unloaded, the yellow icon located on the left of the lap number will turn green coloured.
- Left click on the desired lap inside the Test database and Laps manager window and click the “Hide lap” button (2).
- Right click on the desired lap inside the Test database and Laps manager window and choose the “Hide lap” option.
- Remove the check in the box besides the shown lap inside the Measures and laps toolbar (see Figure 4.6).
- Right click on the desired lap number inside the Laps toolbar and choose the “Hide lap” function.
- Double click on the desired lap number inside the Laps toolbar.

4.5.2 – “How to” change lap/use the Laps toolbar

In the lower part of **Race Studio Analysis** window it is usually located the Laps toolbar.

This window shows a summary of the channels shown on the graph for all the recorded channels: if you add a channel to the graph, the same channel will also be added to the Laps toolbar window.

As **Race Studio Analysis** is able to load up to 4 separate tests, the Laps toolbar is organized on different layers (up to 4), each one of them is related to the corresponding test.

In Figure 4.7, for instance, it is shown a Laps toolbar which includes two tests.

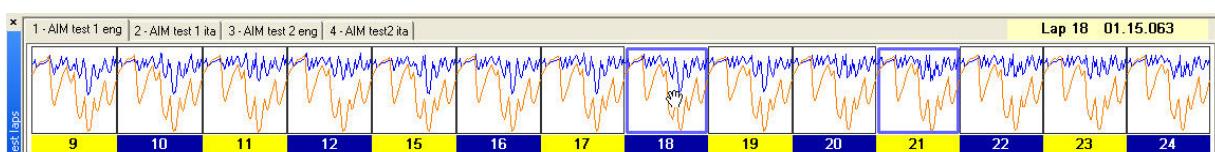


Fig. 4.7– Laps toolbar window: 4 tests loaded

The lap (laps) which is (are) shown on the graph, is (are) blue highlighted. In Figure 4.7, for instance, laps number 18 and 21 of the “AIM test 1 eng” test are shown on the graph.

If you wish to change the lap you are watching on the graph, you may:

- Drag the blue-highlighted lap and drop it on the new lap you wish to show.
- Use the scrollbar located in the lower part of the graph (see Figure 4.1, for instance).

In the window’s right-upper corner it is shown the lap time corresponding to the lap you are highlighting with the mouse cursor.

4.6 – How to use the *Measure information* window

To activate the *Measure information* window, you may click the the *Test channels* command, located inside the *Modify* toolbar, you may click the proper button in the buttons toolbar, you may use the shortcut “ALT+F10”, you may click on the link to the *Measure information* window inside the *Measures and Laps* toolbar (labelled as (11) in Figure 4.4) or you may right click on a graph and select the “Modify test channels” function.

The layout of the view for the *Measure Information* window is shown in Figure 4.8.

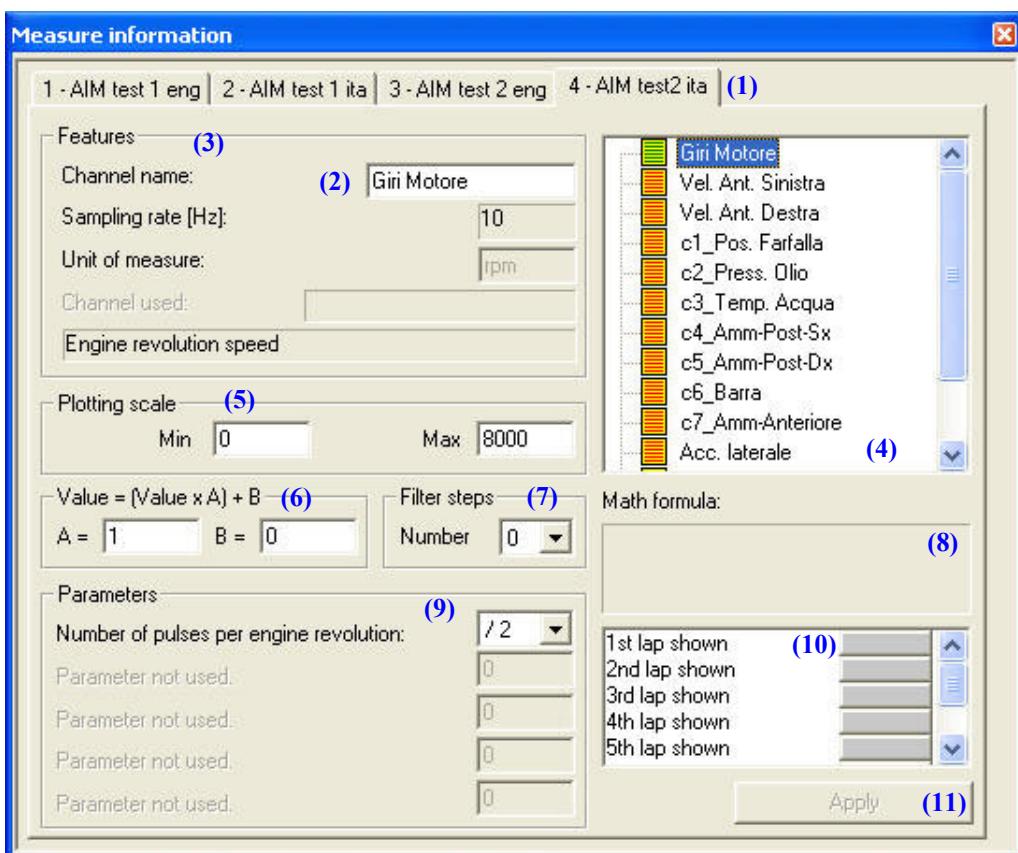


Fig. 4.8 – *Measure information* window

The *Measure information* window displays the following information:

- Test selection flags (1);
- Highlighted/selected channel name (2); this box may be edited in order to change the channel name;
- Channel features (3), such as sampling frequency and unit of measure;
- Channels list (4): to select a channel from the list, please left click on the desired one;
- Plotting scale toolbox (5), used to change a channel’s plotting scale: see chapter 4.6.1 for further information;
- Graph shifting/amplifying toolbox (6): see chapter 4.6.2 for further information;

- Filter steps toolbox (7): used when sampled data are very noisy (see chapter 4.6.3);
- Math formula window (8): in this window it is shown the mathematic formula used to calculate a math channel. This window can not be edited; to modify a math channel formula, please refer to chapter 8;
- Parameters window (9): in this window it is shown the parameters used to convert the sampled data into easily comprehensible information. **It is recommended not to modify such values**;
- Shown laps colour (10): this toolbar shows 8 coloured pushbuttons which are used to set the graph colour. Right click on the desired shown lap to enter the colour management window (see chapter 4.7 for further information).
- The “Apply” pushbutton (11): this button is used to apply the changes to the channel’s features.

4.6.1 – How to change the plotting scale

The plotting scale toolbar, shown in Figure 4.8 as (5), is used to modify the vertical scale of a graph. If you wish to modify the scale, please enter the desired number in the proper box: please, enter the new scale’s minimum value inside the “Min” box, while insert the maximum value inside the “Max” box.

It is reminded that the “Max” value must be greater than the “Min” one. If, because of a mistake, the user sets a “Min” value greater than the “Max” one, the “Max” one will be automatically set to “Min+1”;

These two parameters may be set in a range included between -1.000.000 and +1.000.000

4.6.2 – How to shift/amplify a graph

Race Studio Analysis allows the user to shift and amplify a sampled channel.

To shift and/or amplify a graph, please use the “Value = (Value*A)+B” option, shown in Figure 4.8 as (6). In this math formula, A represents the “amplify factor”, while B represents the “shift factor”. These two values are set, as a default, to 1 (amplify factor) and 0 (shift factor).

- If you wish to shift up or down a graph, please modify only the shift factor B, which may be set in a range included between -500.000 and +500.000;
- If you wish to amplify a graph, please modify the amplify factor A. The amplify factor may be set in a range included between -1000 and +1000;

In the following Figures 4.9 and 4.10 it is reported an example of a shifted and amplified graph.

- Figure 4.9 shows a “no modified” Formula Renault 2000 speed channel. The vertical cursor is placed in the maximum speed track position: the maximum speed is 230 km/h (about 145 MPH).
- Figure 4.10 shows the same channel which has been amplified by 2 (i.e. A = 2) and shifted down by 50 (i.e. B = -50); the graph scale has also been modified, as described in chapter 4.6.1, in order to show the complete graph. The vertical cursor is placed, as in Figure 4.9, in the maximum speed track position: this time the speed reported on the graph is 410 km/h. If you try to calculate the maximum speed using the “Value = (Value*A)+B” formula, you get the following result: $(230*2)-50 = 410$ km/h.

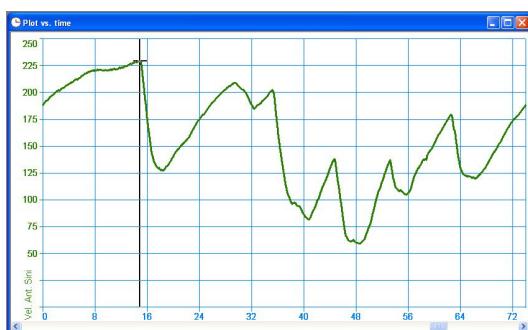


Fig. 4.9– Speed channel: no modify

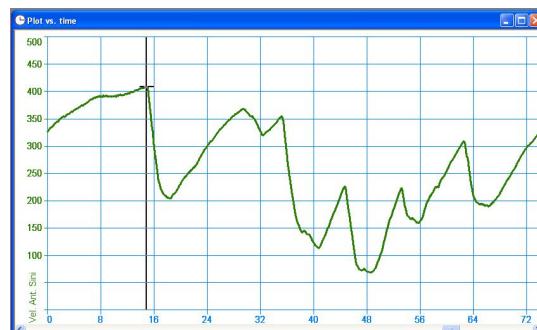


Fig. 4.10– Shifted and amplified graph

4.6.3 – What can I do when sampled data are very noisy?

When sampled data are very noisy, for example because of the sensor's cable has been installed near sources of electrical interference, and you wish to analyze them, it is suggested to use the “Filter” function, shown in Figure 4.8 as (7).

Please, enter the desired “Filter steps” number: this value may be set between 0 (no filtering) and 5 (maximum filter steps number). The higher is the filter steps number, the more are the data filtered.

For instance, in Figure 4.11 it is shown the “no filtered” lateral acceleration channel, while, in Figure 4.12, it is shown the same channel which has been “2 steps” filtered.

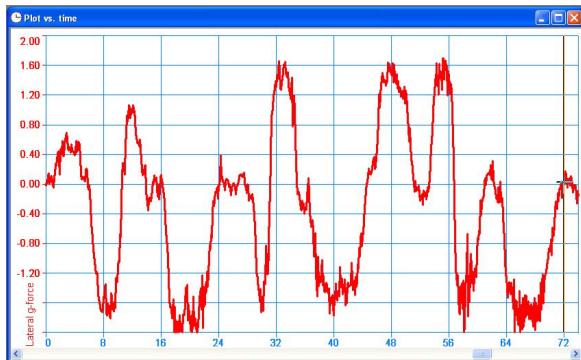


Fig. 4.11– No filtered lateral acceleration

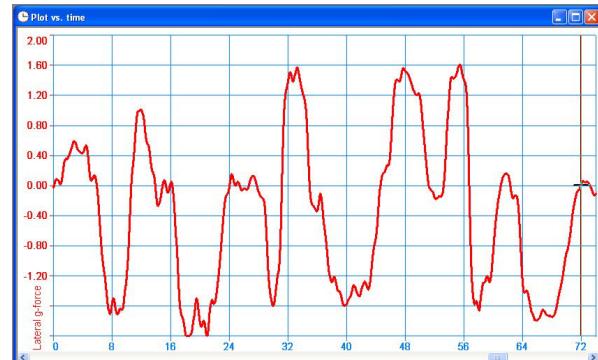


Fig. 4.12– “2 steps” filtered lateral acceleration

4.7 – How to change the graph colours

If you wish to change the graph colours, you may either left click in the graph-colour column, inside the Measures and laps toolbar, on the coloured box corresponding to the desired lap and channel or right click on the Laps colour toolbar inside the Measures information window.

The layout of the view for the Colours window is shown in Figure 4.13 and described below.

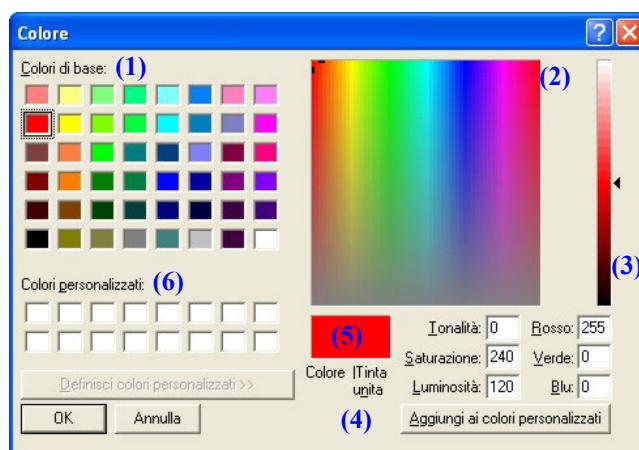


Fig. 4.13– Graph colour window

- If the new graph colour is shown in the “Base colours” grid (1), please select it and then click the OK button;
- Otherwise, if the colour does not appear in that grid, you may select it by clicking inside the “rainbow” colours square (2) and you may choose the desired tonality using the proper toolbar (3): the new colour is shown in (5). Once the correct colour has been selected, it is suggested to add it to custom colours using the (4) button: the new colour will appear in the “Custom colours” grid (6).

4.8 – How to change the plot settings

To activate the Plot settings window, you may click the  the Plot settings command, located inside the Options toolbar, you may click the proper  button in the buttons toolbar, you may use the shortcut “ALT+F9” or you may right-click on the graph area and chose the “Plot settings” function.

The layout of the view for the Plot settings window is shown in Figure 4.14 and described in the following chapters.

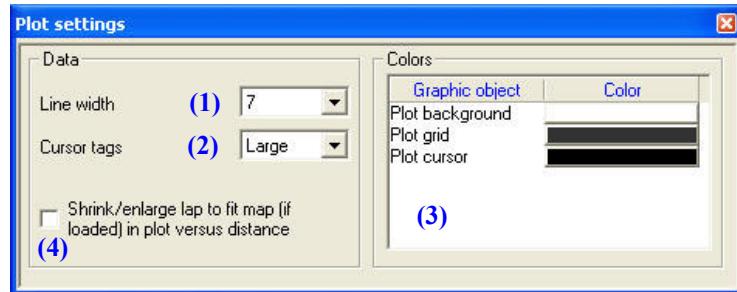


Fig. 4.14 – Plot settings window

4.8.1 – How to change the line width/cursor tags

- To change the graph line width, please select the “line width” menu, shown as (1) in Figure 4.14, and choose the desired line width among the 6 possible values: 1 (the narrowest), 2, 3, 5, 7 and 9 (the widest).
- To change the cursor tag (i.e. the horizontal line which is shown on the diagram’s vertical cursor when a graph is met), please select the “Cursor tags” menu, shown as (2) in Figure 4.14, and choose the desired cursor tags among the 4 possible values: none, small (default value), large and full.

4.8.2 – How to use the “Shrink/Enlarge lap” checkbox

The checkbox (4) is used to shrink/enlarge a lap to fit map length (if loaded) in a plot vs. distance. This function may be very useful if you are comparing two (or more) laps whose calculated track length is appreciably different from the *official* track length (i.e. the track length of the lap on which the map was computed): for instance, the calculated track length is 3300 m for lap #1 and 3200 m for lap #2 while the *official* track length is 3250 m.

In Figure 4.15 it is shown an example of a plot vs. distance where the “shrink lap” function has not been checked.

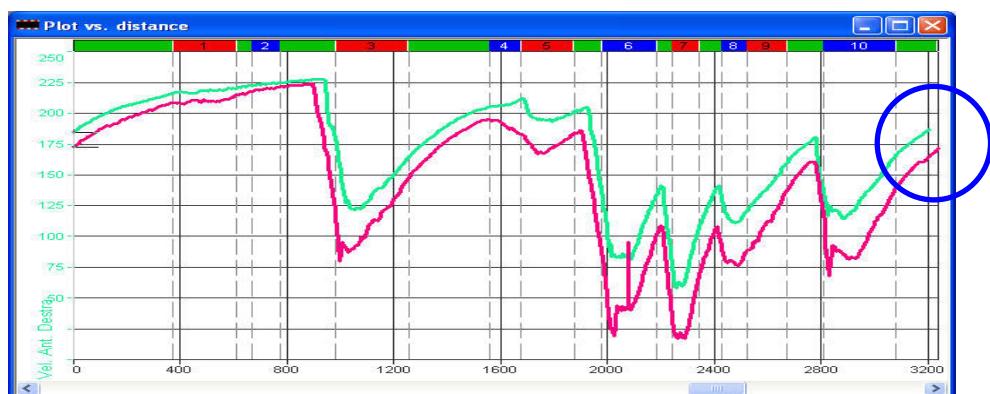


Fig. 4.15 – Plot vs. distance: checkbox “Shrink/Enlarge lap” not selected

Once checked the “shrink/enlarge lap” checkbox, all the laps shown on the “Plot vs. distance” graph will be shrunk/enlarged in order to fit the *official* track length.

4.8.3 – How to change the background (grid/cursor) colour

- To change the background (grid/cursor) colour, please select the “Colours” menu, shown as (3) in Figure 4.14, choose the desired graphic object you wish to change the colour and right click on the colour box. It will appear the “Colour window” previously described in chapter 4.7: please, refer to this chapter for further information.

4.9 – How to Zoom in/Zoom out a graph

The zoom function expands the horizontal axis of the plot.

To activate the Zoom function, you may click the Zoom enable command, located inside the Options toolbar, you may click the proper button in the buttons toolbar, you may use the shortcut “SHIFT+F9” or you may click the right button when the mouse cursor is on a graph and select the Zoom enable function.

Once the zoom has been enabled, the mouse cursor will turn into a circle: to “zoom in” a graph, please click the left button on the first point of the “to be zoomed” area, then keep the mouse button pushed and un-click it on the last point of the “to be zoomed” area.

To disable the Zoom function, you may click the Zoom disable command, located inside the Options toolbar, you may click the proper button in the buttons toolbar, you may use the shortcut “SHIFT+F10” or you may click the right button when the mouse cursor is on a graph and select the Zoom disable function.

4.10 – How to plot a X-Y graph

The X-Y plot view allows displaying two channels of the test one vs. the other. To run this function, you may click the X-Y plot command, located inside the View toolbar, you may click the proper button in the buttons toolbar or you may use the shortcut “CTRL+F5”.

In Figure 4.16 it is shown the X-Y plot setup window.

The user may choose which will be the channel shown on the graph’s horizontal axis by selecting it inside all the available channels (both sampled and calculated) shown in (2). The horizontal axis channel may be selected even among different tests, as shown in (1).

The channel/channels shown on the graph’s vertical axis are the ones currently selected to be displayed.

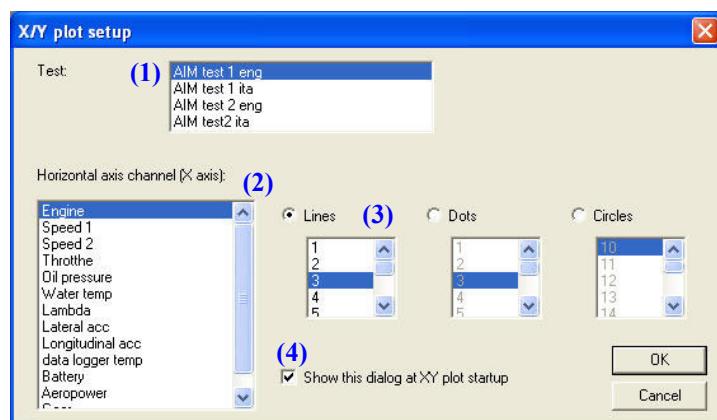


Fig. 4.16– X-Y plot setup window

It is suggested to plot only one channel vs. another one, in order not to have a hardly comprehensible graph.

The user may set the graph’s line type among 3 choices: Lines (a continuous line), Dots and Circles. When you have chosen the desired line type, you may also set the lines (dots or circles) dimension among some default values.

If the checkbox (4) is enabled, the window shown in Figure 4.16 will be shown each time the X-Y plot is started. Otherwise, if the checkbox is disabled, it will be shown the X-Y plot; right click inside the graph area to activate the *X-Y Plot setup* window.

The *X-Y plot* has some differences from the other plots. In fact it has not the vertical cursor and the zooming functions are not defined.

This graph can become very useful to analyze, for instance, the lateral acceleration (on the vertical axis) vs. the lateral one (on the horizontal axis), as shown in Figure 4.17.

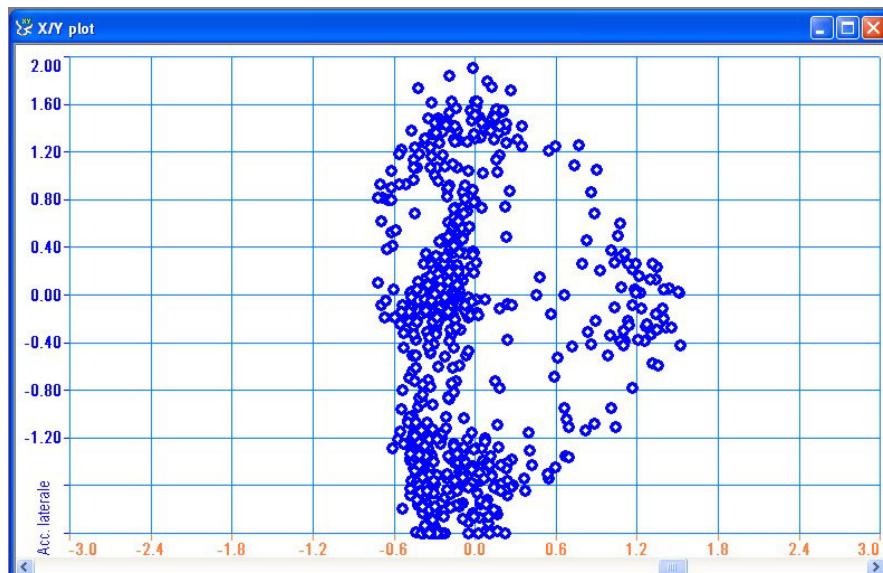


Fig. 4.17– *X-Y plot*: longitudinal acceleration (horizontal axis) vs. lateral acceleration (vertical axis)

4.11 – How to change graph type

The *Graphs type* option allows changing the style of graphs' view from "Tiled" to "Overlapped" or "Mixed" and vice versa.

To run this function, you may click the desired graph type inside the *Options* toolbar, you may click the right button when the mouse cursor is on a graph and select the desired graph type or you may click the proper button inside the *Button toolbar*, as shown below:

- Overlapped graphs;
- Mixed graphs;
- Tiled graphs.

4.12 – Laps management

The *Test database and Lap manager* window, shown in Figure 4.18, includes some buttons which are very useful for the laps management.

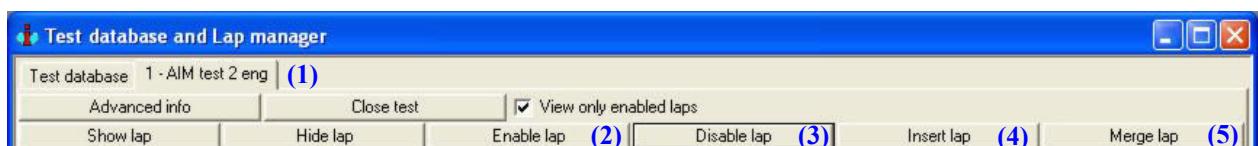


Fig. 4.18– *Test database and Lap manager* window: laps management functions

4.12.1 – How to enable (disable) a lap

When a new test is loaded, all the laps included inside that test will be **enabled**. When a lap is enabled, it is shown both inside the Laps toolbar and inside the Measures and laps toolbar. Otherwise, if the lap is **disabled**, it will not be shown in the toolbars and the user will not be allowed to plot it on the graph.

- If you wish to **disable** a lap, you may select the desired one and press button “Disable lap” (3), you may right click on the desired lap inside the Test database and lap manager window and choose the “Disable” function or you may right click on the desired lap inside the Laps toolbar and choose the “Disable” function.
- If you wish to **enable** a disabled lap, you may select it and press button “Enable lap” (2) or you may right click on the desired lap inside the Test database and lap manager window and choose the “Enable” function.

If you wish to remove the disabled laps from the Test database and Laps manager window, you may check the checkbox “View only enabled laps” (1).

It is suggested to disable all the “First laps” and “Vehicle stop laps”.

4.12.2 – How to insert a lap

If the lap receiver has not been able to capture a lap (because of an incorrect installation or technical problems), the Test database and Lap manager window will show a lap (and its corresponding lap time) obtained by merging two consecutive laps. If you have manually elapsed the lap time, or you may read the lap time from the official times list, **Race Studio Analysis** will allow you to split the lap into two separate laps.

Select the lap you wish to split (**double click** on the lap number) and press button “Insert lap” (4). The Insert lap time window is shown in Figure 4.19 and described below.

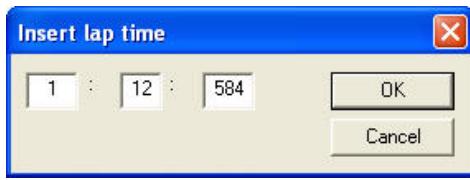


Fig. 4.19– Insert lap time window

Please insert the lap time (minutes, seconds and milliseconds) inside the three boxes. Once the lap time has been set, press button “OK”. Inside the Test database and Lap manager window it will appear a new lap labelled, inside the “Lap cause” column, as “Computed splitting a lap”.

4.12.3 – How to merge a lap to the next one

If you wish to merge a lap to the next one, please select the desired lap and press button “Merge lap” (5). Inside the Test database and Lap manager window it will appear a new lap labelled, inside the “Lap cause” column, as “Computed merging two laps”.

Chapter 5 – “How to create a track map”

5.1 – Introduction

Race Studio Analysis software allows calculating the track map directly from the recorded data. The map commands allow a full management of the track maps (creating a new map, modifying and loading an existing one, using the map database)

The Fig. 5.1 shows an example of the map of Vallelunga (Rome) track created by **Race Studio Analysis**.

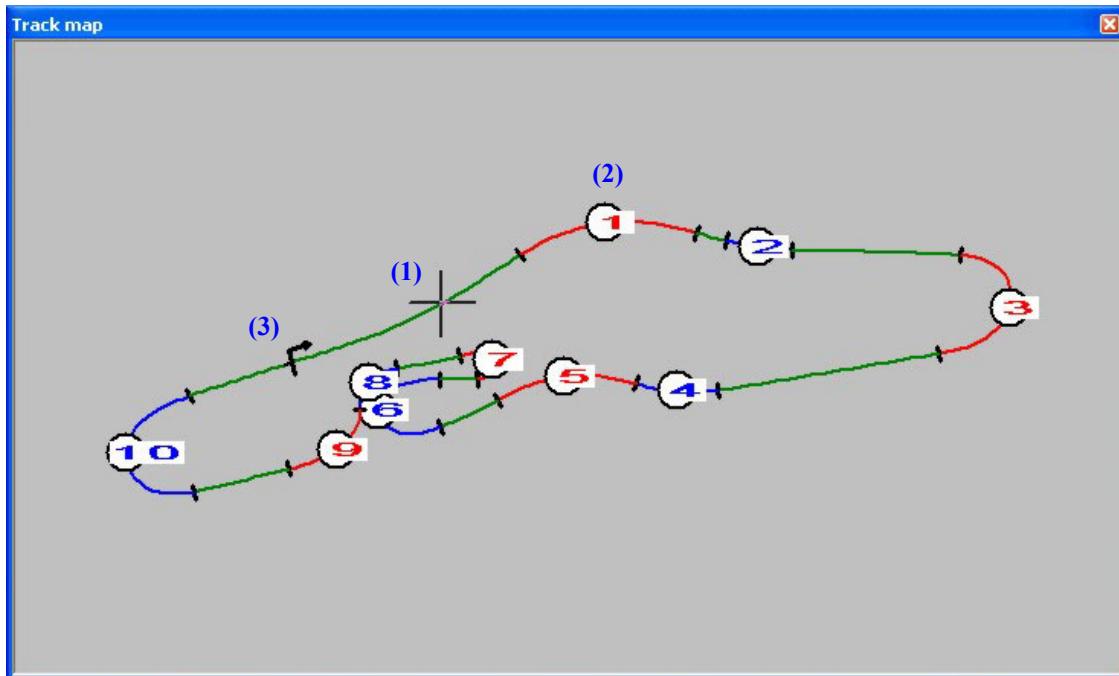


Fig. 5.1– Vallelunga track map

The straights are green painted, the corners are blue or red painted and they are numbered. The corners' numbers are shown (2) when the dimensions of the map window exceed the 30% of the screen area, otherwise they are not displayed.

The cursor (1) moves pressing the “arrow keys” or the mouse left button and it is linked to the other cursors (in plots and reports); automatic cursor motion is provided running the “View-animation” command.

The track map also shows the Start/Finish line (3) position and the clockwise/counter clockwise direction.

Pressing the right button of the mouse inside the window area a menu is shown. It includes all the command for the maps' management and the printing command.

5.2 – How to create a new map

To create a new map, you may click the New command, located inside the Map toolbar or you may use the shortcut “SHIFT+F4”.

The New command allows creating a new map of the track from the test lap selected as “reference” lap. When a new test is loaded, the software automatically assigns the “reference lap” label to the test’s best lap. Anyway, a new map may be created for every lap of the test.

For the creation of a map some channels have to be recorded, they differ because of the vehicle in use.

- For a four wheels vehicle the reference speed channel and the lateral acceleration channels are necessary
- For a two wheels vehicle the reference speed channel and the gyroscope channels are needed.

If these channels are not available, it WILL NOT BE POSSIBLE to calculate the track map.

The layout of the view for the *New Track map* window is shown in Figure 5.2 and described below.

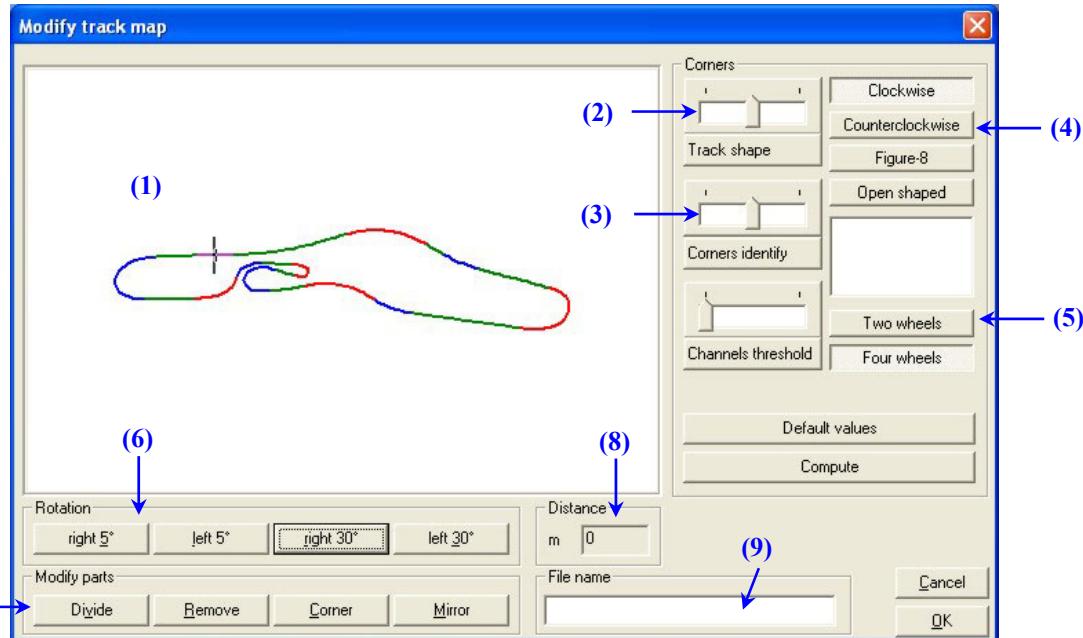


Fig. 5.2– *New track map* window: Vallelunga (Rome) track map

Here below it is reported a short description of all the pushbuttons shown in Figure 5.2:

Option/Display	Use and description
Track map area (1)	The track map is shown in (1): the map is segmented into “splits”, each one underlined with different colours: red and blue for corners green for straights;
Track shape slider (2)	The track shape scrollbar (2) allows changing the shape of the map: when the slider is left-shifted, the track map is more “opened”, while, when the slider is right shifted, the map is more “closed”.
Corners identify slider (3)	The corners identify slider (3) allows changing the segmentation of the map.
Track type (4)	The track type toolbar (4) allows changing the track type, among 4 possible choices: Clockwise, Counter-clockwise, Figure-8 and Open Shaped. Most of circuits belong to the first two types, while, for instance, the circuit of Suzuka (Japan) is a Figure-8 track.
Vehicle type (5)	This option allows setting the vehicle type among two choices: a two wheels vehicle or a four wheels one. When this parameter has been set, Race Studio Analysis checks if the channels necessary to the map computation (speed and lateral acceleration for a 4-wheels vehicle, speed and gyroscope for a 2-wheels one) have been recorded.
Rotation toolbar (6)	These 4 buttons allow the user to left rotate (Counter-clockwise) or to right rotate (Clockwise) the track map of a 5 or 30 degrees angle.

Modify parts toolbar (7) This toolbar allows modifying the track map. In particular, it is possible to:

- Divide a split into two separate splits: the new split starts at the cursor position and finishes at the end of the current split. Each modified part is created as a corner;
- Remove an intermediate split;
- Change a circuit part from corner to straight and vice versa. **WARNING:** it is not possible to have two consecutive straights;
- Mirror the track map.

Distance (8)

When clicking on the track map, in this box it is shown the distance calculated from the Start/Finish line.

File name (9)

If you wish to save the map, before clicking the OK button, it is necessary to insert the **track name** inside the (9) box; the maximum name input length is 40 characters.

Otherwise, if you wish to exit without saving, please press button “Cancel”.

When the map has been created, if you wish to see it on your PC's monitor, you may click the Show track map command, located inside the Map toolbar, you may click the proper button  in the buttons toolbar, you may use the shortcut “SHIFT+F1” or you may click the right  button when the mouse cursor is on a graph and select the Track map function.

5.3 – Track map creation troubleshooting

In this chapter it will be described the solutions to the most frequently asked questions concerning the map creation problems.

- If, when trying to create a new track map, it appears the warning message “Invalid data to compute track map”, please select a “good” lap, labelled as “Lap marker” in the Test database and Lap manager window (see Figure 3.8). It is reminded to select the new lap and then, before retrying to create the map, to deselect the lap previously used.
- It is recommended to select a lap without many skids and sudden braking.
- Verify that you have set the correct vehicle type (i.e. 2 or 4 wheels) in the New track map window (see Figure 5.2).
- Verify that speed and acceleration (4 wheels vehicle) or speed and gyroscope (2 wheels vehicle) channels are sensible:
 - The speed must be greater than 0 and must not have high or low peaks. In case the speed channel is very noisy and you have recorded 2 speed inputs (for instance the 2 front wheels speed), you may change the reference speed channel, as explained in chapter 5.4.
 - The lateral acceleration must be near 0 on the straight line;
- If lateral acceleration in the straight line is not near 0, it is probable that the lateral accelerometer has not been calibrated. In this case, it is possible to calculate the map shifting up or down the lateral acceleration graph, as here below explained:
 - Plot the lateral acceleration vs. time;
 - Place the vertical cursor on the graph in a position corresponding to a straight: in this track position the lateral acceleration should be 0;

- Read the lateral acceleration value in the Measure toolbar;
- Run the Measure information window (ALT+F10) and insert the value (positive or negative) previously read inside the “B” box;
- Click OK.
- Now the graph has been shifted in order to have a lateral acceleration near 0 on the straight line.
- Run again the New track map function.

5.4 – How to modify the reference speed

The “Reference speed” is a fundamental parameter, together with the acceleration, to create the track map.

To modify this parameter, please click the Reference speed function, located inside the Modify toolbar. The layout of the view for the Reference speed window is shown in Figure 5.3 and described below

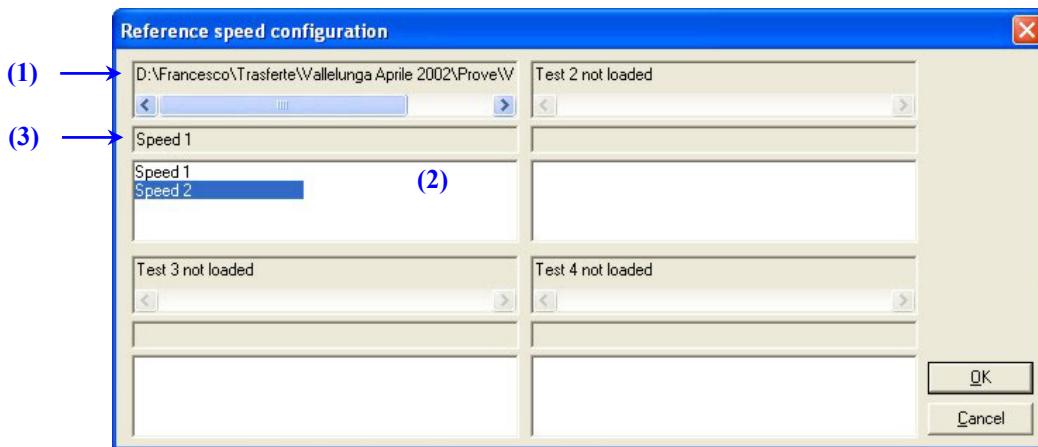


Fig. 5.3– Modify reference speed window

The Modify reference speed window is divided into 4 parts, as **Race Studio Analysis** is able to load up to 4 separate tests contemporarily.

In (1) it is shown the currently loaded test name, in (2) it is listed the speed channels belonging to that test, while the channel currently used as “Reference speed” is reported in (3).

In the example shown in Figure 5.3, the available speed channels are “Speed 1” and “Speed 2”, and the channel used as “Reference speed” is “Speed 1”.

If you wish to change the Reference speed, please **double-click** on the desired channel in (2): the new reference speed channel name will appear in (3).

5.5 – How to import a map in the database

Race Studio Analysis has been designed and developed to manage track maps using a database.

As previously described (in chapter 3) for the test file, even the track maps may be inserted/loaded/deleted using a database.

Once the map has been correctly created and saved on your PC’s hard disk, you may insert it inside the database.

To run this function, you may click the Map manager command, located inside the Map toolbar or you may use the shortcut “SHIFT+F2”.

The layout of the view for the Map manager window is shown in Figure 5.4 and described below.

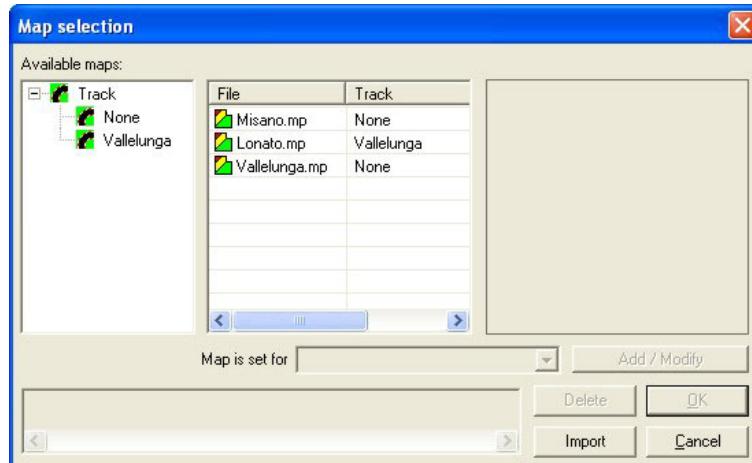


Fig. 5.4– Database Map manager window

To import a map in the database, please click the “Import” pushbutton and browse your PC and select the track map you wish to add to the database (N.B. track files are saved with the “.mp” extension). Once the desired map has been imported (double-click on the file name or single-click and click on the OK pushbutton), the map will be inserted inside the “None” sub-category of the database’s “Track” category.

If you wish to modify a database’s sub-category (creating a new one or moving the map to an existing one), please select the map from the Map manager window and click the “Add/modify” button. The procedure to be followed is the same described in chapter 3.3 (“How to insert a test in the database”).

5.6 – How to open a map from the database

The Map manager window also allows the user to load a map from the database.

Once run the Map manager function, please select the desired track map from the available ones and click the OK button. The map will be automatically loaded.

If you wish to see the map on your PC’s monitor, you may click the Show track map command, located inside the Map toolbar, you may click the proper button in the buttons toolbar, you may use the shortcut “SHIFT+F1” or you may click the right button when the mouse cursor is on a graph and select the Track map function.

5.7 – How to modify an existing map

If you wish to modify a track map, you have to select click the “Modify” command, located inside the Map manager function, you have to select the map you wish to modify (1 click on the map name) and then click button “Modify”.

It will appear a window much similar to the Map creation window: such is shown in Figure 5.5 and described below.

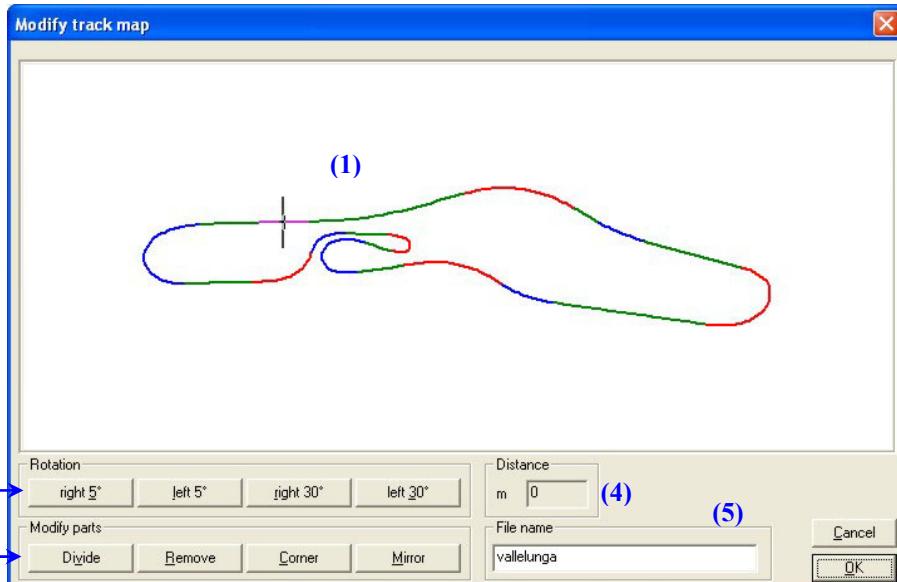


Fig. 5.5– *Modify track map* window

Here below it is reported a short description of all the pushbuttons shown in Figure 5.5:

Option/Display	Use and description
Track map area (1)	The track map is shown in (1): the map is segmented into “splits”, each one underlined with different colours: red and blue for corners green for straights;
Rotation toolbar (2)	These 4 buttons allow the user to left rotate (Counter-clockwise) or to right rotate (Clockwise) the track map of a 5 or 30 degrees angle.
Modify parts toolbar (3)	This toolbar allows modifying the track map. In particular, it is possible to: <ul style="list-style-type: none"> • Divide a split into two separate splits: the new split starts at the cursor position and finishes at the end of the current split. Each modified part is created as a corner; • Remove an intermediate split; • Change a circuit part from corner to straight and vice versa. WARNING: it is not possible to have two consecutive straights; • Mirror the track map.
Distance (4)	When clicking on the track map, in this box it is shown the distance calculated from the Start/Finish line.
File name (5)	If you wish to save the map, before clicking the OK button, it is necessary to insert the track name inside the (5) box; the maximum name input length is 40 characters. Otherwise, if you wish to exit without saving, please press button “Cancel”.

5.8 – How to shift the Start/Finish line

Sometimes may be necessary to shift the Start/Finish line. It happens when tests of different sessions would be compared but the track side beacon has not been placed in the same position.
If you wish to shift the Start/Finish line (i.e. the Beacon transmitter), you may click the [Beacon shift](#) command, located inside the [Modify](#) toolbar.

NOTES: it is reminded that the Beacon shift option may be used only if the track map has been created / loaded.

The layout of the view for the Beacon shift window is shown in Figure 5.6 and described below.

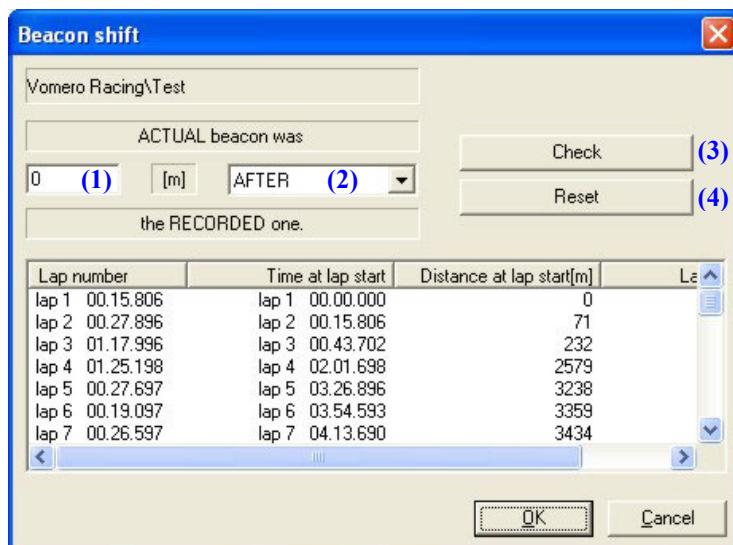


Fig. 5.6 – Beacon shift window

This function allows the user to set the distance between the actual **Beacon** (i.e. the track start/finish line) and the **recorded** one (i.e. the position where you installed your Beacon transmitter).

To shift the Start/Finish line, please enter the distance between the actual Beacon and the recorded one in (1) and, in (2), set if the actual Beacon was installed before or after the recorded one.

Click the “Check” button (3) to verify if the values you set are correct. It is reminded that the Beacon may be shifted up to 500 m.

The “Reset” button (4) will allow you to cancel the changes.

To exit saving and applying the changes press button “OK”; to exit discarding the changes press button “Cancel”.

Chapter 6 – “How to get further information from sampled data”

6.1 – Introduction

The functions here below described will allow the user to get further information from sampled data, such as Histogram graphs, Lap/Split times analysis. These functions will also allow the user to calculate the car (bike, kart) acceleration (picking up of speed) times. If correctly used, these commands will allow the driver to improve both his performances and the vehicle setup.

6.2 – How to plot a Histogram graph

The “Histogram” command allows displaying the histogram of the channel in evidence. To run this function, you may click the Histogram command, located inside the View toolbar, you may click the proper button in the buttons toolbar or you may use the shortcut “CTRL+F8”. The histogram shows the distribution of data into individual ranges (1).

The example of a histogram for the “Engine” channel is shown in Figure 6.1.

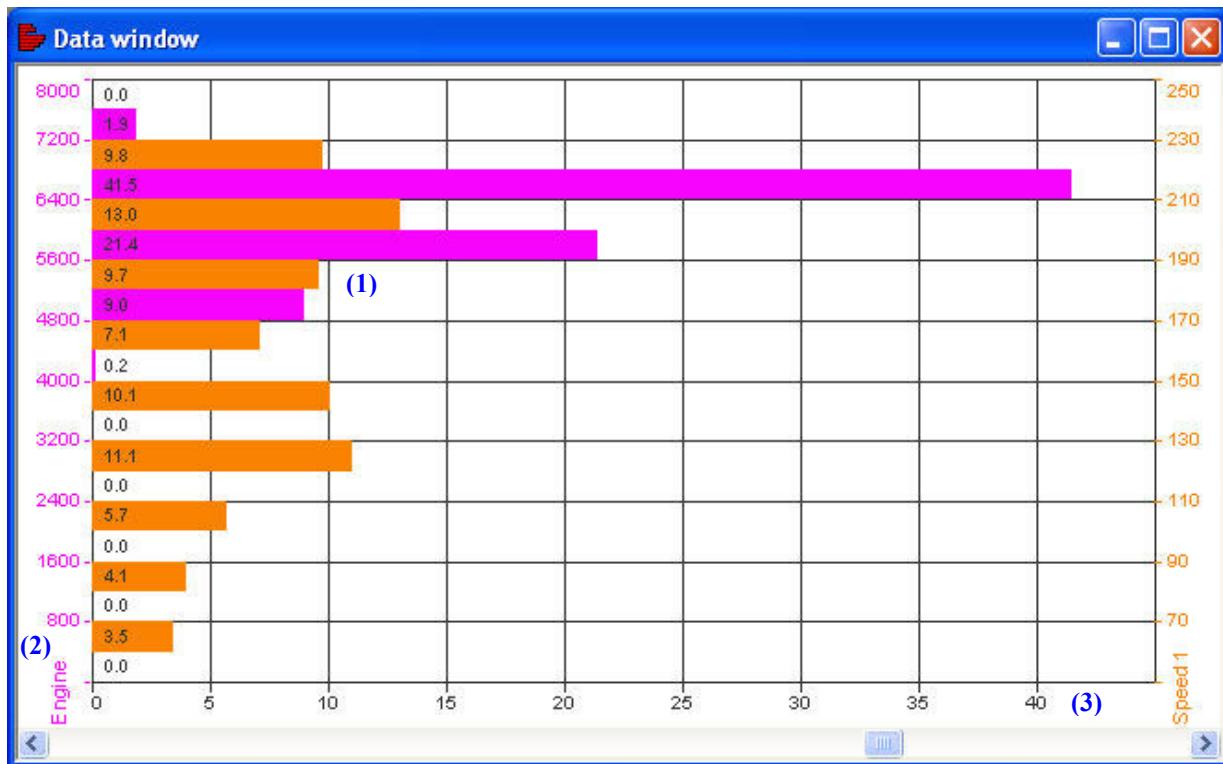


Fig. 6.1– Histogram graph: engine’s RPM and speed

The histogram may show either percentage of data samples falling into each range (as shown in Figure 6.1) or total time spent in the range. The percentage or time may be changed using the mouse right button menu or the Percentage/Time function, located inside the Options toolbar.

On the left side of the window the vertical axis (2) shows the data range. The zero – full scale interval of the channel is divided in a configurable number of bins: if you want to change the scale interval of the channel, select the Change bins function by right-clicking on the drawing area. The number of bins may be set in a range included between 3 and 50.

The horizontal axis (3) shows the percentage (or time) for each range.

Pressing the right button of the mouse, when the mouse cursor is inside the histogram drawing area, a menu is displayed. It includes the most important commands for the “Histogram” management.

The printing function is available.

6.3 – How to use the Lap Times analysis

The “Lap times” command allows displaying a histogram graph of the laps belonging to the loaded tests.

To run this function, you may click the Lap times command, located inside the View toolbar or you may use the shortcut “CTRL+F7”.

An example of a Lap Times analysis graph is shown in Figure 6.2 and described below.

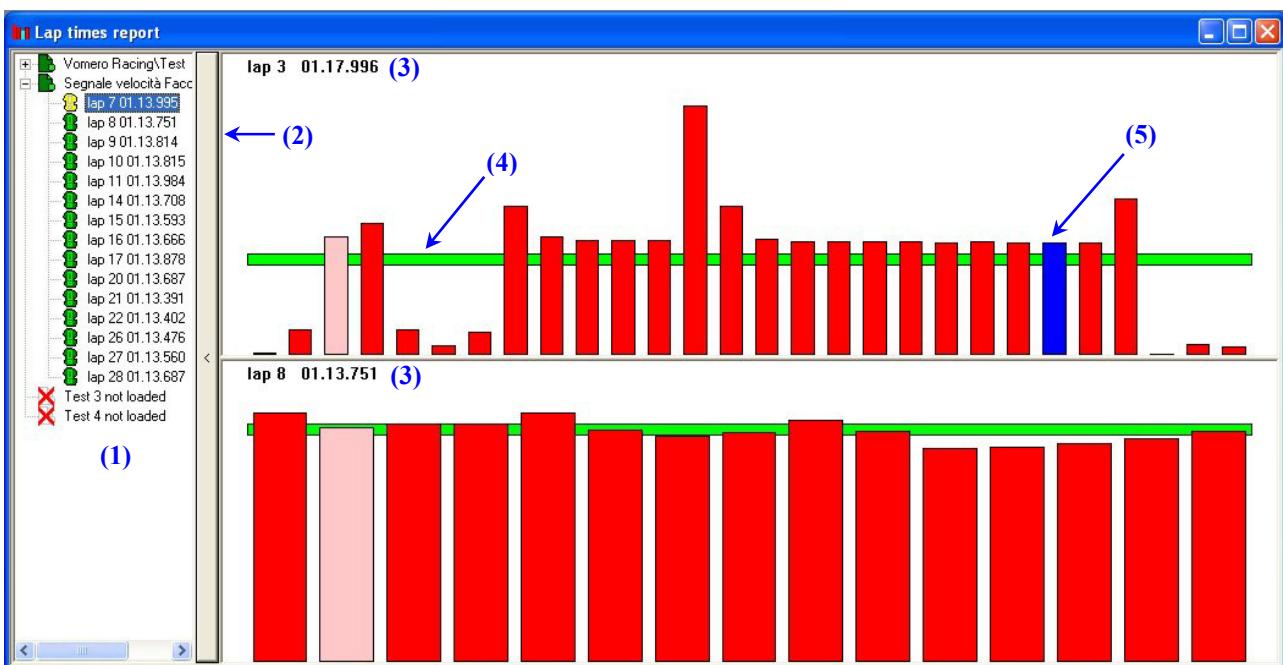


Fig. 6.2 – Lap times analysis: 2 tiled graphs

The Lap Times report window is divided into two separate parts: on the left (1) it is shown the loaded tests and the tests' laps, while, on the right, it is shown a histogram graph reporting the lap times. When more than one test has been loaded, the histograms are displayed on a tiled graph, as reported in Figure 6.2 (2 tests loaded).

The left side of the graph may be hidden by clicking the vertical bar (2), in order to amplify the plotting area of the histogram graph.

The lap times are shown as red histograms: the best lap for each test is shown with a blue histogram (5). When you move the mouse cursor on a lap, the histogram turns pink coloured and the corresponding lap time is shown in the graph's upper left corner (3).

The Lap times function also shows a green horizontal bar (4), which represents the test's average time.

6.4 – How to use the Split Times analysis

This report calculates the time necessary to run along each part of the active map (corners and straights are the track parts) for each lap. The program, during the map creation, calculates the number and the length of the parts.

The Split times function allows the user to make both a numerical and a graphical compare between the split times.

To run this function, you may click the Split times command, located inside the View toolbar, you may click the proper button in the buttons toolbar or you may use the shortcut “CTRL+F6”.

An example of a Split Times analysis graph (numerical compare) is shown in Figure 6.3 and described below.

Test compare 1 - AIM test 2 eng 2 - AIM test 1 eng (1)		Numerical (5)										Graphical (6)									
Export to Excel (2)																					
(3)	(4)	1	2	3	4	5	6	7	8	9	1	1	1	1	1	1	1	1	1	1	1
Absolute split time																					
AIM test 1 eng	lap 9 run 1	6.645	3.997	0.928	1.730	3.958	7.314	5.816	2.257	4.147	2.310	7.415	1.826	5.488	2.456	3.329	3.944	3.036	7.		
AIM test 1 eng	lap 10 run 1	6.611	3.918	0.909	1.700	3.838	7.093	5.760	2.178	4.027	2.296	7.330	1.926	5.352	2.415	3.207	3.805	3.002	7.		
AIM test 1 eng	lap 11 run 1	6.582	3.905	0.905	1.694	3.730	6.893	5.722	2.105	3.939	2.304	7.317	1.974	5.415	2.385	3.152	3.812	2.991	7.		
AIM test 1 eng	lap 12 run 1	6.631	3.910	0.904	1.693	3.847	6.951	5.707	2.141	3.827	2.258	7.308	1.855	5.371	2.382	3.147	3.810	3.030	7.		
AIM test 1 eng	lap 15 run 1	6.693	3.977	0.923	1.731	3.836	7.120	5.765	2.100	3.955	2.290	7.435	1.821	5.429	2.423	3.217	3.859	2.971	7.		
AIM test 1 eng	lap 16 run 1	6.593	3.908	0.908	1.703	3.727	6.967	5.724	2.121	3.840	2.260	7.295	1.801	5.310	2.399	3.245	3.823	2.951	7.		
AIM test 1 eng	lap 17 run 1	6.599	3.912	0.907	1.704	3.736	6.915	5.718	2.072	3.773	2.220	7.258	1.716	5.292	2.385	3.153	3.822	2.927	7.		
AIM test 1 eng	lap 18 run 1	6.599	3.917	0.907	1.703	3.728	6.862	5.701	2.079	3.837	2.253	7.390	1.805	5.303	2.391	3.203	3.841	2.912	7.		
AIM test 1 eng	lap 19 run 1	6.586	3.911	0.908	1.706	3.774	6.807	5.701	2.126	3.817	2.296	7.341	1.865	5.278	2.396	3.150	3.771	2.962	7.		
AIM test 1 eng	lap 20 run 1	6.614	3.928	0.910	1.702	3.722	6.824	5.714	2.086	3.792	2.265	7.297	1.743	5.247	2.408	3.145	3.770	2.932	7.		
AIM test 1 eng	lap 21 run 1	6.669	3.942	0.911	1.709	3.734	6.877	5.675	2.078	3.758	2.156	7.365	1.760	5.386	2.392	3.159	3.820	2.933	7.		
AIM test 1 eng [best]	lap 22 run 1	6.570	3.894	0.904	1.693	3.617	6.791	5.680	2.091	3.800	2.227	7.390	1.710	5.291	2.396	3.079	3.789	2.893	7.		
AIM test 1 eng	lap 23 run 1	6.570	3.896	0.906	1.701	3.662	6.863	5.712	2.065	3.778	2.255	7.412	1.754	5.267	2.398	3.094	3.787	2.896	7.		
AIM test 1 eng	lap 24 run 1	6.556	3.895	0.907	1.703	3.613	6.784	5.683	2.080	3.726	2.213	7.336	1.671	5.288	2.405	3.138	3.850	2.913	7.		
minimum value		6.556	3.894	0.904	1.693	3.613	6.784	5.675	2.065	3.726	2.156	7.258	1.671	5.247	2.382	3.079	3.770	2.893	7.		
maximum value		6.693	3.997	0.928	1.731	3.958	7.314	5.816	2.257	4.147	2.310	7.435	1.974	5.488	2.456	3.329	3.944	3.036	7.		
average value		6.693	3.997	0.928	1.731	3.958	7.314	5.816	2.257	4.147	2.310	7.435	1.974	5.488	2.456	3.329	3.944	3.036	7.		
standard deviation		6.693	3.997	0.928	1.731	3.958	7.314	5.816	2.257	4.147	2.310	7.435	1.974	5.488	2.456	3.329	3.944	3.036	7.		

Fig. 6.3 – *Split times* analysis: numerical compare

Each column represents a segment; colours at the top of the column are so labelled: red and blue for corners and green for straights.

The *Split report* window is organized on different layers and you may switch among them using the tab (1). The first layer is called *Test compare* and is used to compare 2 or more tests (up to 4), while the other ones are used to switch among the loaded tests (up to 4).

Buttons *Numerical* (5) and *Graphical* (6) are used to select the compare type: in Figure 6.3 it is shown the *Numerical* compare, while the *Graphical* one is shown in Figure 6.5.

The first column (3) on the left shows the loaded test name, the second one shows the lap number, columns from the third to the last but one report the split times and the last column shows the lap time. Button *Export to Excel* (2) is used to export the split times in a format compatible with Microsoft Excel™.

The *Numerical split times* window is also divided into horizontal fields.

- The first one, starting from the top of the window, shows the “Absolute split times”: the best lap time within each lap is blue highlighted, while the best lap’s split times are red coloured. In the lower part of the “Absolute split times” field it is shown some statistics values, such as the minimum/maximum/average value and the standard deviation.
- The second one reports the “Theoretical best lap”, which assembles the best lap that could have been run in the session. Segments which make up the theoretical best lap are red painted;
- The “Best rolling lap” represents the fastest lap done irrespective of the location of the beacon;
- The last field shows the “Split time differences from the best lap within test”: a negative value means that the track segment has been run in a time lower than the corresponding split time of the best lap.

If button *Histogram* (4) is pressed, the split times shown in the corresponding column will be displayed both on a numerical and graphical view.

The graphical view consists in a blue histogram. The histogram’s length is directly proportional to the split time: the higher it is the split time, the longer it is the histogram.

In Figure 6.4 it is shown the numerical compare with 3 histograms (concerning curves number 2, 3 and 4).

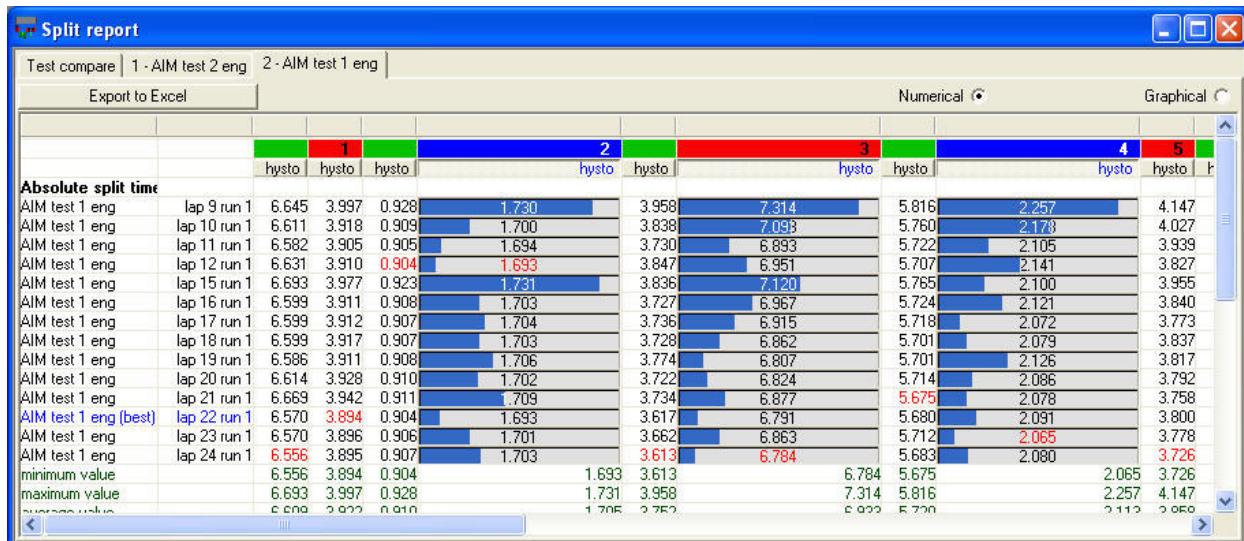


Fig. 6.4– *Split times* analysis: numerical compare, Histograms

The *Split times* analysis is able to manage numerical and graphical compare between laps belonging to separate tests.

To switch from the numerical view to the graphical one, please click button *Graphical* (6) on the top side of Figure 6.3.

An example of a *Split Times* graphical compare is shown in Figure 6.5 and described below.

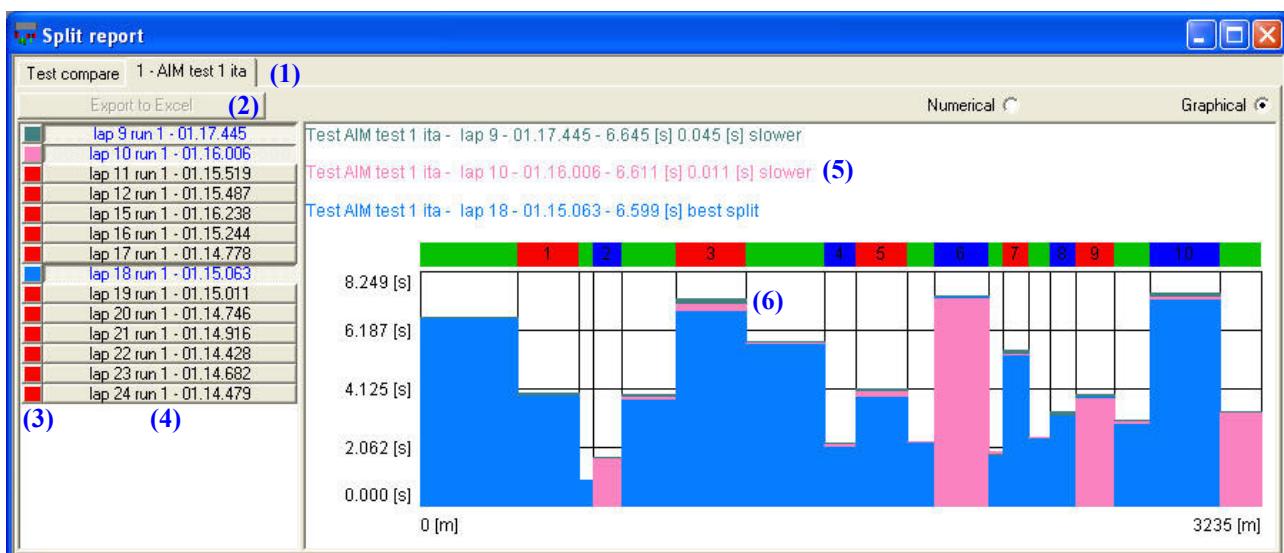


Fig. 6.5– *Split times* analysis: graphical compare

The graphical compare window is divided into two separate parts: on the left (4) it is shown the test laps (lap number and lap time) while, on the right, it is reported the graphical compare between the selected laps.

To select a lap, please click it: the selected lap (4) will turn blue coloured. To unselect a lap, re-click on the lap.

It is reminded that the graphical compare is able to manage up to 8 laps contemporarily.

As the *Numerical* compare, even the *Graphical* one is organized on different layers: you may switch among them using the tabs (1). The *Export to Excel* function (2) is disabled when running the *Graphical* compare.

Left click on the coloured squares (3) if you wish to change the histograms' colour.

On the right of the *Graphical* compare window it is shown:

- The test name, the lap number, the lap time and the split time (5) are shown in the upper part. The best split time is also labelled as “Best split”, while the other ones are labelled as “Slower”.
- The histograms (6) in the lower part of the right side of the *Graphical* compare window are directly proportional to the split time. The best split time is shown on the foreground, while the other ones are shown on the background.

6.5 – How to use the *Channels report*

The *Channels report* function allows the user to visualize a complete summary both of sampled data and of recorded laps.

In particular, this function allows the user to visualize, for each sampled data, the maximum/minimum value, the time and the distance (from the start/finish line) corresponding to the maximum/minimum value and the average value.

To run this function, you may select the *Channels report* command inside the *View* toolbar or you may use the proper pushbutton inside the *Buttons toolbar*. An example of the channels report window for a sample test is shown in Figure 6.6.

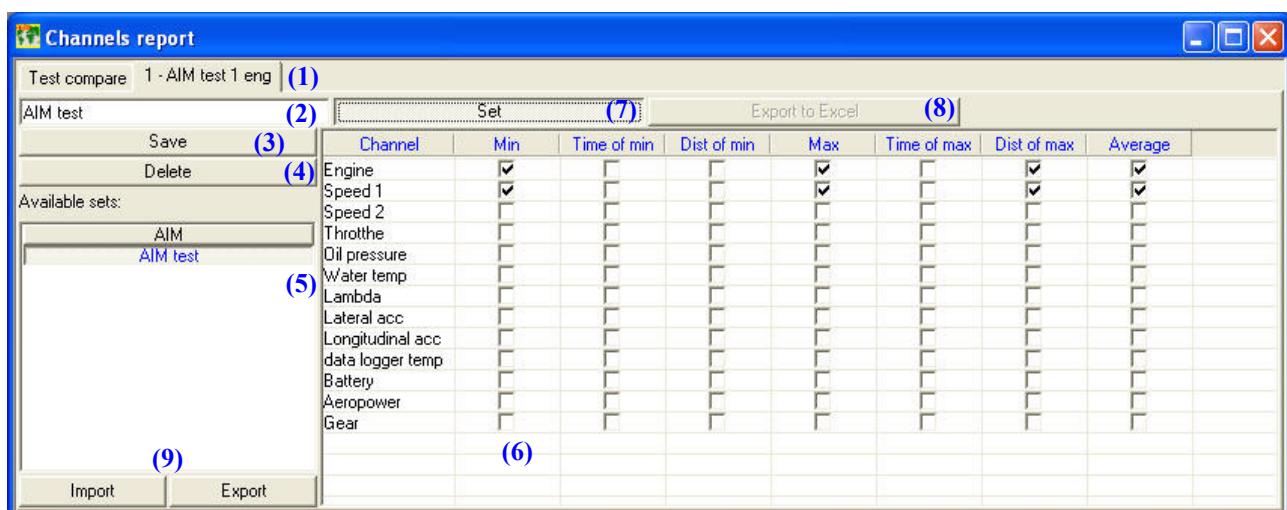


Fig. 6.6– *Channels report* window: configuration layer

The *Channels report* window is organized on as many layers as the number of the loaded tests. Please, select the desired test clicking on the proper flag (1).

Place a check in the checkboxes (6) corresponding to the desired channels and features (max/min value, etc...). Once selected the desired features, please enter the setting name inside box (2) and press button “Save” (3) to save the new setting. The setting will appear inside the available sets list (5).

If you wish to delete an undesired setting, please select it and press button “Delete” (4).

The *Export to Excel* function (8) is available only when button *Set* is not pressed.

Buttons *Import* and *Export* (9) are used to import / export the desired setting. These settings will be saved in the hard disk in a “.CRP” file.

Now you may press the “Set” button (7) in order to switch the *Channels report* window from the “configuration” layer to the “graphical visualization” one, shown in Figure 6.7.

AIM test									
Lap	Engine (min)	Engine (avg)	Engine (max)	Engine (dist of m...)	Speed 1 (min)	Speed 1 (avg)	Speed 1 (max)	Spe	Spe
lap 9 run 1 01.17.445	3521	6067	7393	957 [m]	56	151	226		
lap 10 run 1 01.16.006	3606	6168	7653	950 [m]	56	154	229		
lap 11 run 1 01.15.519	4617	6323	7540	1976 [m]	54	155	231		
lap 12 run 1 01.15.487	4768	6358	7695	947 [m]	56	154	230		
lap 15 run 1 01.16.238	3586	6186	7514	2791 [m]	56	153	226		
lap 16 run 1 01.15.244	3612	6234	7359	939 [m]	56	155	229		
lap 17 run 1 01.14.778	3591	6314	7492	2797 [m]	56	156	228		
lap 18 run 1 01.15.063	3733	6275	7482	957 [m]	59	155	230		
lap 19 run 1 01.15.011	3661	6306	7443	927 [m]	57	156	229		
lap 20 run 1 01.14.746	4985	6407	7410	2208 [m]	58	156	229		
lap 21 run 1 01.14.916	4764	6386	7423	962 [m]	56	156	229		
lap 22 run 1 01.14.428	5055	6427	7379	1972 [m]	58	157	230		
lap 23 run 1 01.14.682	4925	6415	7474	2316 [m]	59	156	237		
lap 24 run 1 01.14.479	4967	6408	7390	966 [m]	59	156	229		

Fig. 6.7– *Channels report* window: graphical visualization layer

Inside this window it is shown the desired values and input channels corresponding to the active laps. As shown in Figure 6.7, it is reminded that the best lap (lap #22) is written in bold character and the overall best input channels' values are white highlighted.

If button *Histo* is pressed, the values shown in the corresponding column will be displayed both on a numerical and graphical view.

The graphical view consists in a blue histogram. The histogram's length is directly proportional to the channel's value: the higher it is this value, the longer it is the histogram (see Figure 6.8 for further information).

AIM test									
Lap	Engine (min)	Engine (avg)	Engine (max)	Engine (dist of max)	Speed 1 (min)	Speed 1 (avg)	Speed 1 (max)	Spe	Spe
lap 9 run 1 01.17.445	3521	6067	7393	957 [m]	56	151	226		
lap 10 run 1 01.16.006	3606	6168	7653	950 [m]	56	154	229		
lap 11 run 1 01.15.519	4617	6323	7540	1976 [m]	54	155	231		
lap 12 run 1 01.15.487	4768	6358	7695	947 [m]	56	154	230		
lap 15 run 1 01.16.238	3586	6186	7514	2791 [m]	56	153	226		
lap 16 run 1 01.15.244	3612	6234	7359	939 [m]	56	155	229		
lap 17 run 1 01.14.778	3591	6314	7492	2797 [m]	56	156	228		
lap 18 run 1 01.15.063	3733	6275	7482	957 [m]	59	155	230		
lap 19 run 1 01.15.011	3661	6306	7443	927 [m]	57	156	229		
lap 20 run 1 01.14.746	4985	6407	7410	2208 [m]	58	156	229		
lap 21 run 1 01.14.916	4764	6386	7423	962 [m]	56	156	229		
lap 22 run 1 01.14.428	5055	6427	7379	1972 [m]	58	157	230		
lap 23 run 1 01.14.682	4925	6415	7474	2316 [m]	59	156	237		
lap 24 run 1 01.14.479	4967	6408	7390	966 [m]	59	156	229		

Fig. 6.8– *Channels report* window: graphical visualization layer – button *Histo* pressed

The “Test compare” button is used to make a comparison between the loaded tests. It is reminded that, in order to make this comparison, the tests must have the settings (i.e. you have to set the same setting among the “available settings list” for all the loaded tests).

6.6 – How to use the *Acceleration report*

The “Acceleration report” allows calculating the time needed to reach up to 4 different speed values. This view is very useful for the evaluation of the acceleration of the vehicle.

To run this function, you may click the *Acceleration view* command, located inside the *View* toolbar or you may right-click on the graph area when you plot a channel vs. time.

A correct procedure for the use of this function is described here below:

1. Be sure the *Plot vs. time* has been run and the speed channel is displayed.
2. Put the cursor at the beginning of the section you would like to analyse: in Figure 6.10, the cursor has been placed in a low-peak speed position.
3. Run the “View-Acceleration report” command from the analysis menu or the “Acceleration report” command from the menu shown pressing the right button of the mouse in the “Plot vs. time” window. The dialog window shown in Figure 6.9 is displayed.
4. In the dialog window input the speed threshold values (maximum 4), when finished press the “Compute” button (2). The program calculates the acceleration time and shows them in (6).

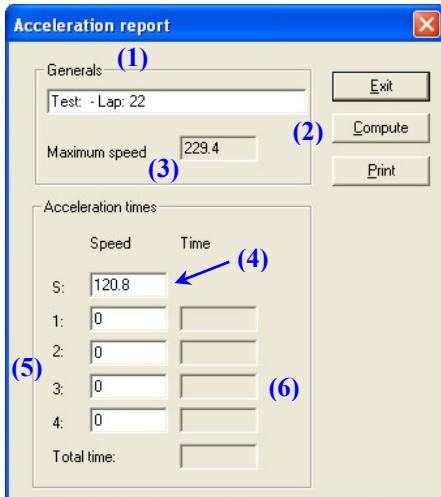


Fig. 6.9– *Acceleration report* window

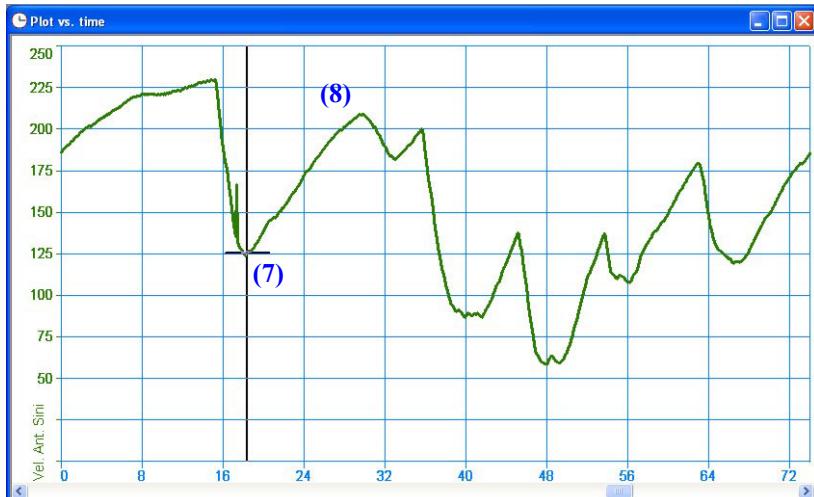


Fig. 6.10– Vehicle speed graph

Option/Display	Use
Generals (1)	In this field the name of the test and the number of the lap are shown. Moreover the maximum speed (3) in the lap is shown.
Acceleration times: Speed and Time	<p>Input in column (5) the speed threshold values. (4) shows the speed at the cursor position (7).</p> <p>It is reminded that it is not possible to set a threshold value greater both than the maximum speed (3) and than the nearest speed high peak (8), and that the values set in (5) must be greater than (4).</p> <p>Calculated time to reach the threshold values from the previous step will be shown in (6).</p>
Exit	Choose this command to exit the dialog window.
Compute (2)	Choose this command to start the computation of the time values.
Print	Choose this command to print the report.

6.7 – How to use the *Track report*

The “Track report” view command allows showing the map of the track painted with different colours depending on the values of a channel.

The cursor motion around the track map may be performed manually (using some buttons on the view or clicking the mouse button in the desired track position) or automatically (selecting the *Animation* command). The cursor is linked to all the other ones, in plots or reports.

To run this function, please select the *Track report* function, located inside the *View* menu, or use the shortcut “CTRL+F12”.

The layout of the *Track report* view is shown in Figure 6.11.

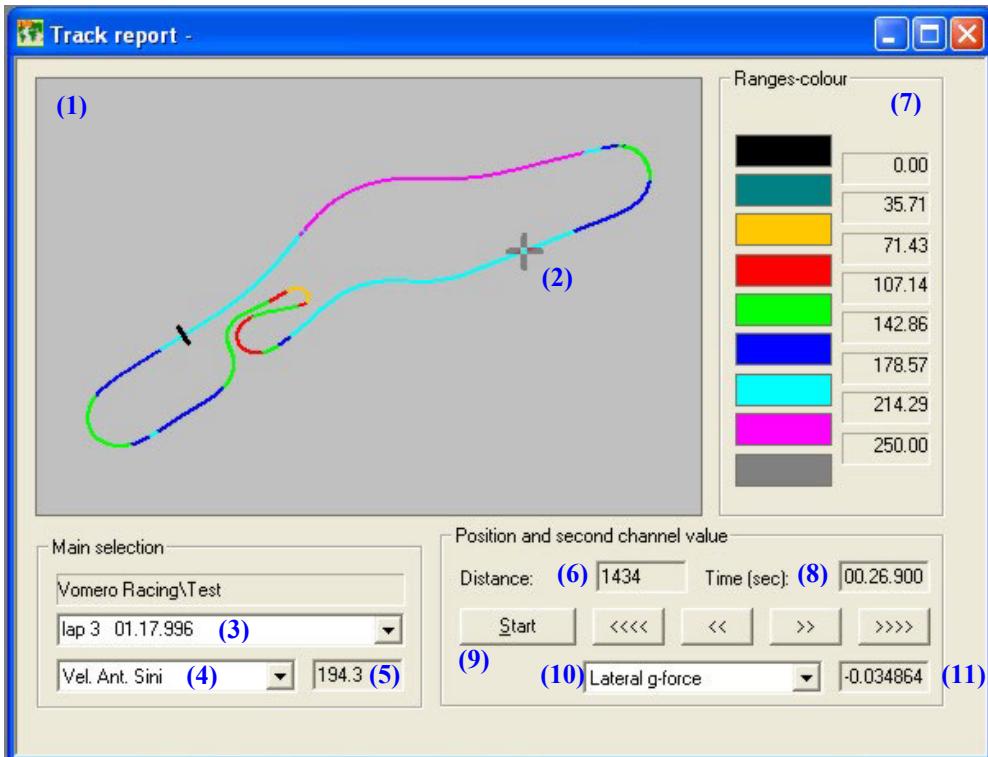


Fig. 6.11 – *Track report* window

Layout description:

- The map of the track is drawn in (1) and is painted in different colours depending on the channel value for every position. The grey cursor (2) is linked to all the other ones, in plots or reports.
- The “Main selection” field shows the loaded test name, allows the user to choose the lap number (3) and the primary displayed channel (4). It also shows the primary channel value (5) at the cursor’s position on the track map.
- The “Position and second channel value” field shows the distance (6) and the time (8) at the cursor position. The “Start” button (9) moves the cursor at the beacon position.
- The “Position and second channel value” field also allows the user to choose the secondary displayed channel (10) and its value (11) at the cursor’s position on the track map.
- The “Ranges-Colours” field (7) shows the correspondence between ranges and colours, the ranges threshold values are also shown.
- The “Moving” field includes four buttons for the manual motion of the cursor.

6.8 – How to use the *Engine RPM analysis*

The *Engine RPM analysis* function is used to analyse the sampled data in order to create your engine’s **Power and Torque diagrams**.

The algorithm used by **Race Studio Analysis** is based on a “Power balance” between the engine’s power, the aerodynamic resistant power and the inertial power.

In order to correctly work, this algorithm needs both the RPM channel and the Speed one (most of Aim’s loggers record both RPM and Speed). If your logger is not able to record the speed channel (for instance: MyChron 3 Basic), the software is able to calculate the vehicle’s speed using the “Transmission ratio” (i.e. the pinion vs. crown teeth number ratio).

To run this function, please select the *Engine RPM analysis* function, located inside the *View* menu, or right click on a graph and select the *Engine RPM analysis* command.
The layout of the *Engine RPM analysis* view is shown in Figure 6.12.

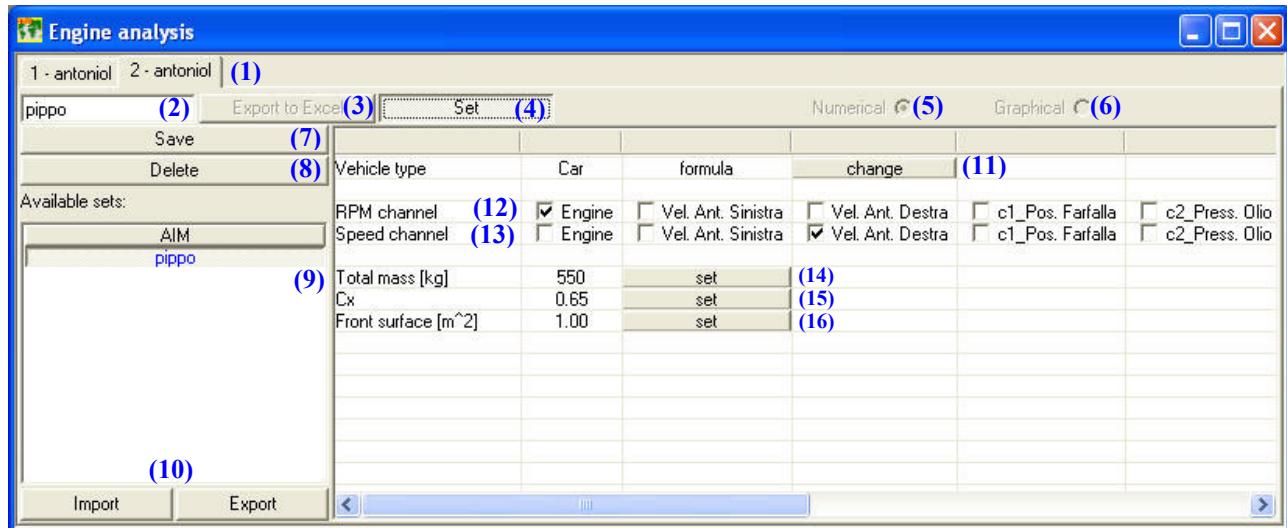


Fig. 6.12 – *Engine RPM analysis* window: settings

The *Engine RPM analysis* window is organized on different layers: you may switch among them (up to 4, as **Race Studio Analysis** is able to manage up to 4 tests at the same time) using tabs (1). Buttons *Numerical* (5) and *Graphical* (6) are used, once the correct vehicle's parameters have been set, to show, either in a numerical or in a graphical way, the engine's **power** and **torque** diagrams.

When button *Set* (4) is pressed, the user will be allowed to set the vehicle type (kart, car, bike), the channels to be used to calculate the engine's power and the vehicle's parameters (total mass, front surface, C_x and Transmission ratio).

The function *Export to Excel* (3) is available.

Once a new setting has been created, it is suggested to set its name in (2) and to press button *Save* (7). The new setting will appear inside the *Available sets* list (9). Use button *Delete* (8) to remove a setting from the *Available sets* list.

Buttons *Import* and *Export* (10) are used to import and export the desired settings. The exported setting will be saved in an ".ENA" file.

Here below it is described the suggested procedure to be followed in order to allow Race Studio Analysis to calculate the correct **power** and **torque** diagrams.

Step 1:

Set the vehicle type among the available ones.

Press button *Change*, labelled as (11) in Figure 6.12, or button *Vehicle*, inside the *Command* toolbar. Figure 6.13 will be prompted on your PC.

Select the vehicle type among the available ones:

- Kart (no gear-box / gear-box)
- Car (formula / touring)
- Bike

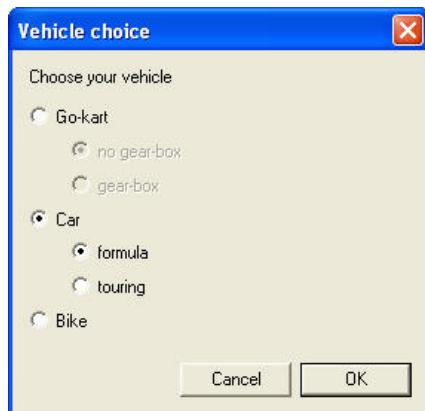


Fig. 6.13 – *Vehicle choice* window

Press button *OK*.

Step 2:

Set the vehicle total mass.

Press button Set (14). Figure 6.14 will be prompted on your PC.
Insert the **vehicle + driver mass** and press button OK.

Do not exceed the maximum / minimum suggested values.

If you set a value greater than the maximum one (or lower than the minimum one), it will be red highlighted in Figure 6.12.



Fig. 6.14 – Vehicle Mass window

Step 3:

Set the vehicle front surface.

Press button Set (16). Figure 6.14 will be prompted on your PC.
Insert the **vehicle's front surface** and press button OK.

Do not exceed the maximum / minimum suggested values.

If you set a value greater than the maximum one (or lower than the minimum one), it will be red highlighted in Figure 6.12.

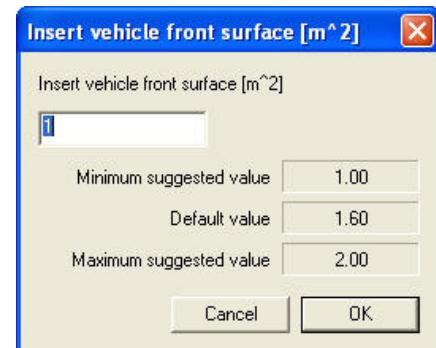


Fig. 6.15 – Front surface window

Step 4:

Set the vehicle C_x (aerodynamic resistance coefficient).

Press button Set (15). Figure 6.14 will be prompted on your PC.
Insert the C_x value and press button OK.

Do not exceed the maximum / minimum suggested values.

If you set a value greater than the maximum one (or lower than the minimum one), it will be red highlighted in Figure 6.12.



Fig. 6.16 – Vehicle Cx window

Step 5 (no gear-box karts only):

Set the transmission ratio.

Press button Set corresponding to the transmission ratio (not shown in Figure 6.12). Figure 6.17 will be prompted on your PC.

Insert the **pinion** and **crown** teeth number and press button OK.

Do not exceed the maximum / minimum suggested values.

If you set a value greater than the maximum one (or lower than the minimum one), it will be red highlighted in Figure 6.12.

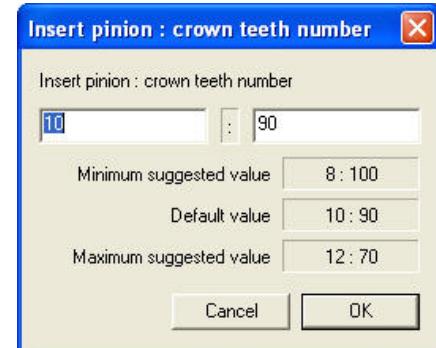


Fig. 6.17 – Transmission ratio window

Step 6:

Set the RPM and Speed channels: place a check besides the desired RPM (12) and Speed (13) channel. It is reminded that, if your gauge is not able to sample the speed channel (for instance: MyChron 3 Basic), the algorithm will calculate it using the RPM, the transmission ratio and the wheel circumference.

Once all these parameters have been set, it is suggested to save the new settings:

- Insert the setting name inside (2);
- Press button Save (7).

Now you may press button Set (4) in order to visualize the engine's **power** and **torque** diagrams, as shown in Figure 6.18.

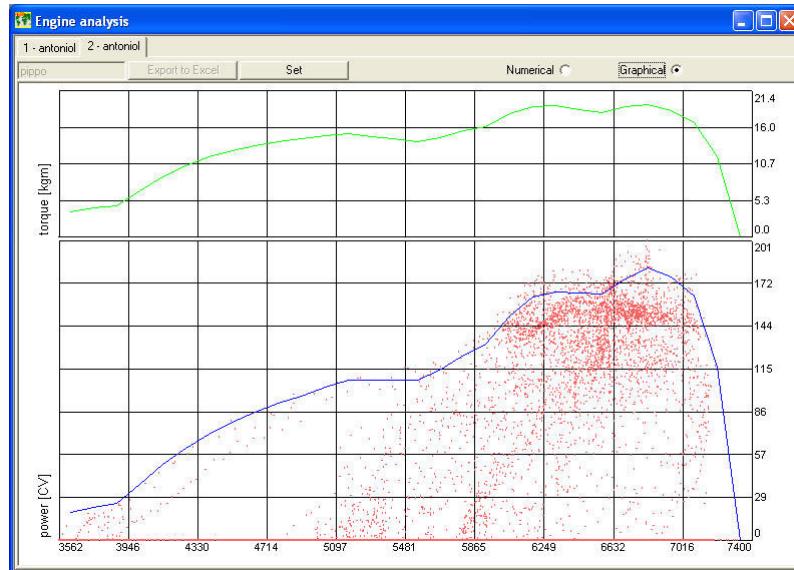


Fig. 6.18– *Engine RPM analysis* window: Graphical compare - Power and Torque diagrams

The **torque** diagram, green coloured, is shown in the upper part of Figure 6.18.

The **power** diagram, blue coloured, is shown in the lower part of Figure 6.18. Together with the power diagram, it is shown (red spots) the experimental values corresponding to the engine's power.

It is reminded that the user may set the desired unit of measure (**CV** or **HP** for power diagram and **kgm** or **lb*ft** for torque diagram) using the File - Preferences function.

If button Numerical (5) is pressed, it will be shown the numerical values corresponding to the power and torque diagrams, as shown in Figure 6.19.

rpm	power [CV]	torque [kgm]	Max power [CV]	Max power [rpm]
3626	18.82	3.77		
3754	22.19	4.29		
3882	24.94	4.67		
4010	37.55	6.80		
4138	50.88	8.93		
4266	61.87	10.53		
4394	71.05	11.74		
4522	79.20	12.72		
4650	86.19	13.46		
4778	92.04	13.99		
4905	96.86	14.34		
5033	102.77	14.83		
5161	107.38	15.11		
5289	107.85	14.81		
5417	107.57	14.42		
5545	107.19	14.04		
5673	114.14	14.61		
5801	124.28	15.56		
5929	131.98	16.16		
6057	150.35	18.03		
6185	162.92	19.13		
6313	166.75	19.18		

Fig. 6.19– *Engine RPM analysis* window: numerical compare

The RPM, Power and Torque values are organized on three columns (on the left), while on the right it is shown the maximum value for both power and torque, and the corresponding RPM.

The Export to Excel function is enabled: you may export such values, in order to analyse them using Microsoft Excel™.

6.9 – How to use the *Time compare analysis*

The *Time compare analysis* allows the user to make a graphical time-compare between up to 8 laps at the same time. This function makes a point-to-point time compare for the selected laps and shows the lap-time difference corresponding to the selected track position.

It is reminded that you may compare lap times belonging to different test sessions made on the same track.

To run this function, you may click the *Time compare* command, located inside the *View* in the buttons toolbar.

An example of a *Time compare analysis* is shown in Figure 6.20 and described below.

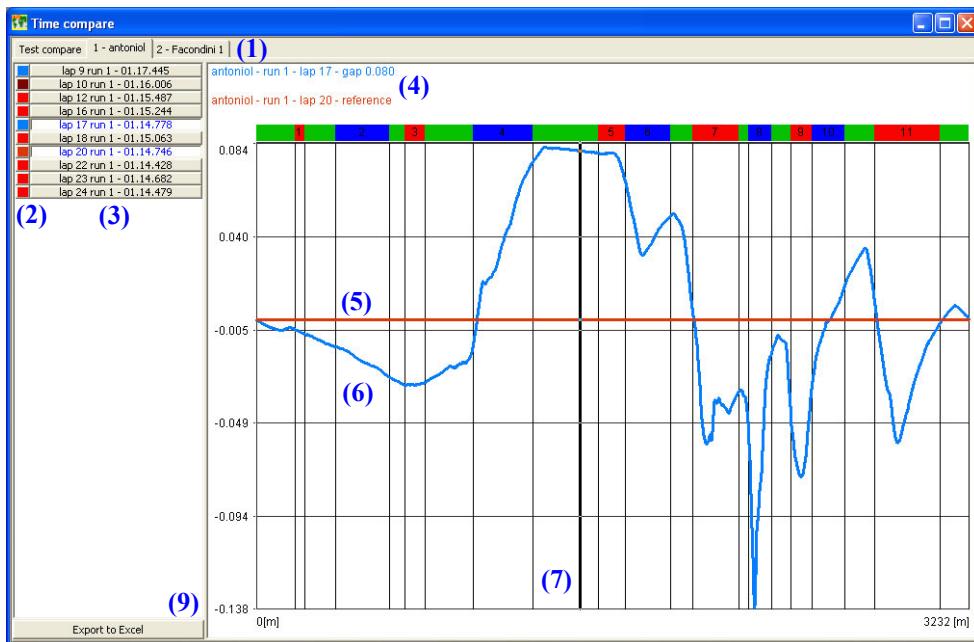


Fig. 6.20– *Time compare analysis* window

The *Time compare analysis* window is organized on as many layers as the number of the loaded tests. Please, select the desired test clicking on the proper flag (1).

The user may select up to 8 laps among the available ones (shown in (3)) and may set the channel's colour using the proper toolbar (2).

The best lap among the selected ones is set as “reference” and is drawn as a horizontal line (5). The other selected laps, instead, are drawn (6) as a time-difference between the current and the reference lap.

Moreover, the time difference between the reference lap and the other laps is also shown in (4). It is reminded that you may load up to 8 different laps.

A vertical cursor (7) will allow the user to easily control the time difference in each track position.

As shown in Figure 6.20, the time difference may be *positive*, i.e. the selected lap is slower than the reference one, or *negative*, i.e. the selected lap is faster than the reference one.

The user is also allowed to export the data to Excel for further analysis.

Moreover, the *Time compare analysis* allows the user to make a comparison between lap times belonging to different test sessions (up to 4) hold on the same track.

If you want to make such a comparison, please load 2 (up to 4) tests and select button “Test compare”: it will appear the screenshot shown in Figure 6.21.

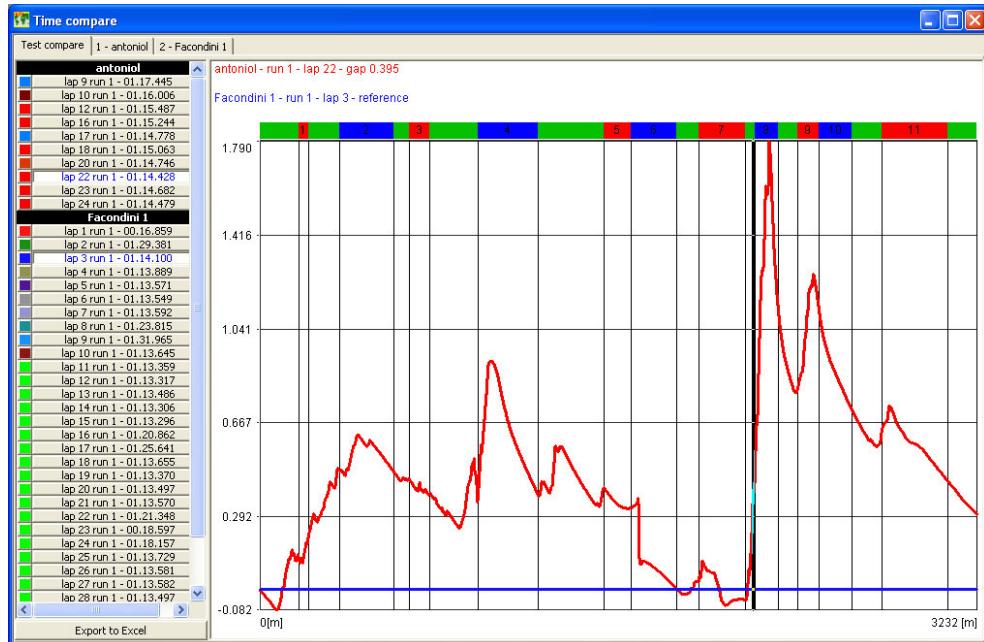


Fig. 6.21 – *Time compare analysis* window: Test compare layer

Chapter 7 – “How to use the data animation functions”

7.1 – Introduction

The “data animation” functions allow the user to automatically move the cursors of graphs, reports and maps and to generate a graphical simulation of sampled data.

In fact, it is possible to simulate the driver’s dashboard (RPM, speed, throttle and brake pedals position, gear and steering angle) and to graphically compare two laps (watching a lap replay).

These functions may be very useful to improve the driver’s performances.

7.2 – How to use the Data animation function

To run this function, you may click the  Animation command, located inside the View toolbar, you may click the proper button in the buttons toolbar or you may use the shortcut “F12”.

The Animation command allows moving automatically the linked cursors of plots, reports, map, dashboard and replays.

7.3 – How to use the Lap replay command

The Lap replay command allows seeing a replay and a comparison of two different laps. The laps can belong to the same test or to two separate tests.

The Lap replay dialog window shows a track drawing (with different colours for each part) and two coloured cursors (one for each lap) moving on the track (signed (2) in Figure 7.1).

To run this function, you may click the Lap replay command, located inside the View toolbar or you may use the shortcut “CTRL+F10”.

The layout of the Lap replay window is shown in Figure 7.1.

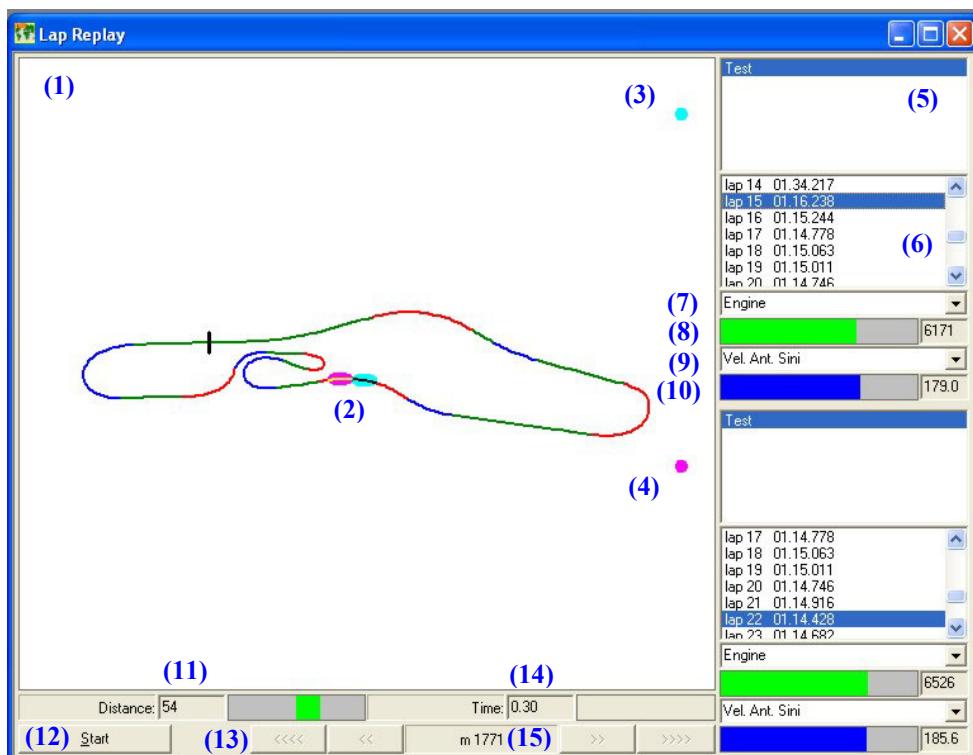


Fig. 7.1– Lap replay window

Each cursor simulates the position of the vehicle on the track. The cursor for the first lap is painted cyan (3) while the one for the second lap is painted magenta (4).

The cursors motion may be automatic or manual; when the automatic style is selected the cursors are linked to the *Animation* function and to the cursors of the other views (like plots). If the manual style is chosen four buttons (13) are provided in order to move the cursors on the track.

For each position on the track the difference, in time (14) and in distance (11), between the two laps is also displayed; the *Lap replay* window also shows the current distance (15) between the first lap and the start line.

Pushbutton “start” (12) will allow you to return to the beginning of the current lap and to restart the lap replay.

If you wish to select a lap, please click with the mouse cursor on the desired lap in (6). The *Lap replay* function is able to manage lap compares between different tests: to switch between tests, please select the desired one in (5).

The *Lap replay* function is able to show, together with the vehicle’s track position, two sampled channels for each selected lap. To set the desired channels, please use the menus (7) and (9); the sampled data belonging to these channels are shown in (8) and (10).

Option/Display	Use
Distance (11)	Shows the difference in metres or feet between the two laps. The colour of the next bar-graph depends on the leading lap.
Time (14)	Shows the difference in seconds between the two laps. The colour of the next bar-graph depends on the leading lap.
Position (15)	Shows the distance in metres or feet from the start of the leading lap.
Manual run (13)	The four buttons of the manual run allow moving the cursors on the track. If the automatic motion is selected these buttons are disabled.
Automatic/Manual	To switch from manual replay to automatic replay, please run the <i>Animation</i> function (shortcut “F12”).
Start (12)	Choose this command to position the cursors at the start.

7.4 – How to use the *Dashboard* function

The “Dashboard” view command allows showing the simulation, in a dashboard like view, of RPM, speed, brake pedal position, steering wheel angle, throttle pedal position and gear number (if available or, otherwise, if calculated as a math channel).

The simulation of the dashboard is linked to the cursor motion of plots and to the *Animation*.

To run this function, you may  click the *Dashboard* command, located inside the *View* toolbar, you may use the proper button in the buttons toolbar or you may use the shortcut “CTRL+F11”.

When the command is run, the *Dashboard* window is shown as in Figure 7.2.

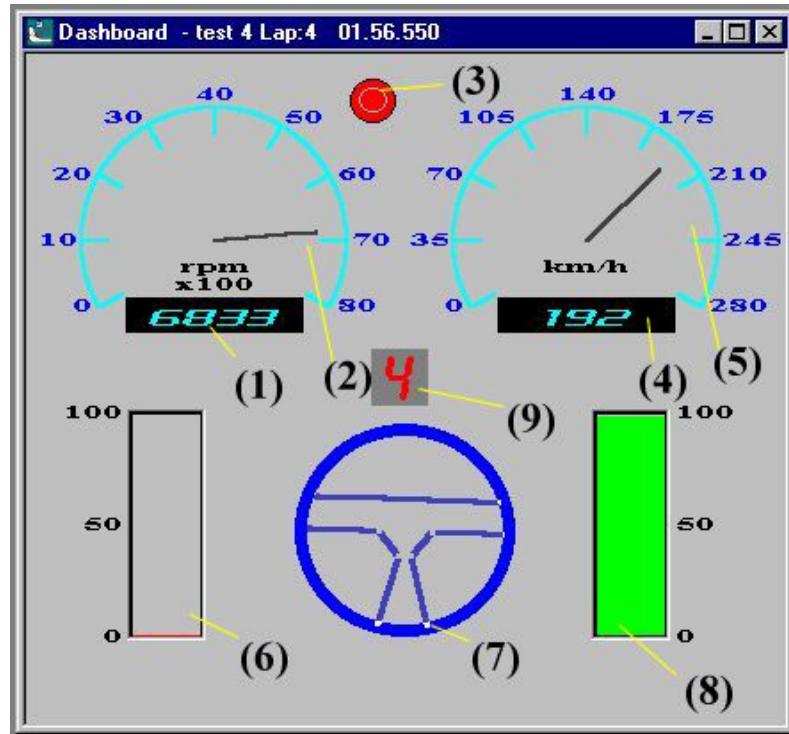


Fig. 7.2– Dashboard window

Layout description:

- (1) Numerical RPM value.
- (2) Analogue RPM value.
- (3) The alarm circle becomes red when the RPM value reaches the limiting threshold value.
- (4) Numerical speed value.
- (5) Analogue speed value.
- (6) Brake pedal position.
- (7) Steering wheel position.
- (8) Throttle pedal position.
- (9) Engaged gear.

To add/modify a channel to the Dashboard simulator, please right-click on the dashboard area: the Dashboard setup window is shown in Figure 7.3 and described below.

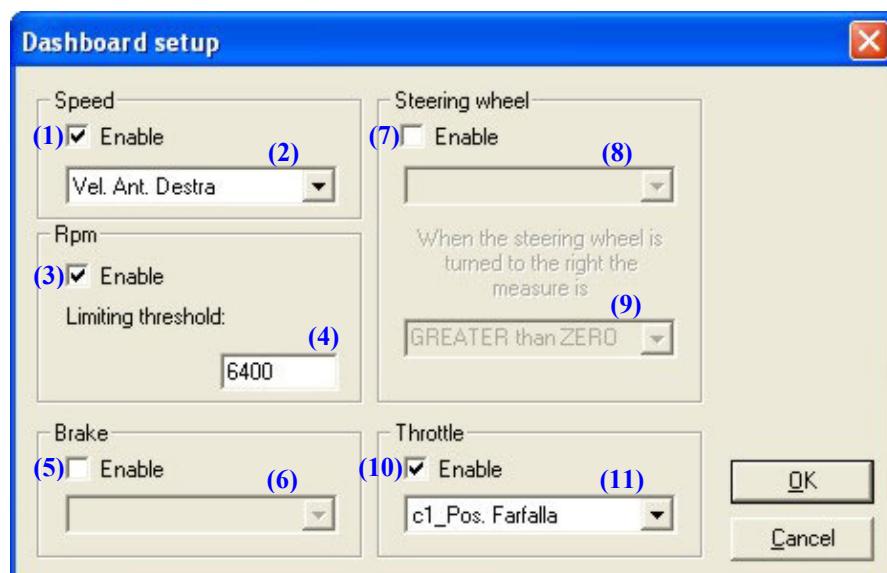


Fig. 7.3– Dashboard setup window

To add/remove a channel displayed on the Dashboard simulation or to modify the Dashboard settings, please follow the instructions reported here below.

Option	Use
Speed channel	Select if the visualisation of the speed is enabled or disabled (1). If it is enabled, please set the correct speed channel from the channels list using the menu (2).
RPM channel	Select if the visualisation of the RPM is enabled or disabled (3). If it is enabled, please input the limiting threshold value for the RPM (4).
Brake position	Select if the visualisation of the brake pedal position is enabled or disabled (5). If it is enabled, please set the correct brake pedal channel from the channels list using the menu (6).
Steering angle	Select if the visualisation of the steering wheel is enabled or disabled (7). If the display is enabled, please select the steering wheel channel among the recorded ones (8). Then select the sign of the channel values (greater or lower than zero) when the steering wheel is turned to the right (9).
Throttle position	Select if the visualisation of the throttle pedal position is enabled or disabled (10). If the display is enabled, select the throttle channel among the recorded ones (11).
Ok	Choose this command to exit the dialog window applying the changes.
Cancel	Choose this command to exit the dialog window.

Chapter 8 – “How to use the Math channels”

8.1 – Introduction to Math channels

Race Studio Analysis allows analysing two different kinds of measures: Input channels and Math channels.

The data logger acquires the Input channels (for example speed or oil pressure), while the user defines the Math channels and the program calculates them on the PC using the Input channels or the Math channels themselves

Examples of math channels are “gear number”, “Wheel-power”, “Slip factor” etc...

These channels are intended for **expert users** only.

8.2 – Math channels window’s description

Race Studio Analysis math formula interpreter is a general-purpose, full featured interpreter that works with the natural math language syntax.

Each formula may include **identifiers**, **constants**, **functions**, **symbols** and **operators**:

- The **identifiers** are the input or the math channels;
- The **constants** are symbolic constant values user-defined. For example, the acceleration of gravity ACCGRAV = 9.81 m/s² is a constant;
- The **symbols** and the **operators** allow the user to create a math formula;
- The **functions** are predefined math formulas: the user has to set the argument of the functions.

To run this function, you may click the Math channels command, located inside the Modify toolbar, you may use the proper button in the buttons toolbar or you may use the shortcut “ALT+F8”.

The Math channel window is shown in Figure 8.1 and described below.

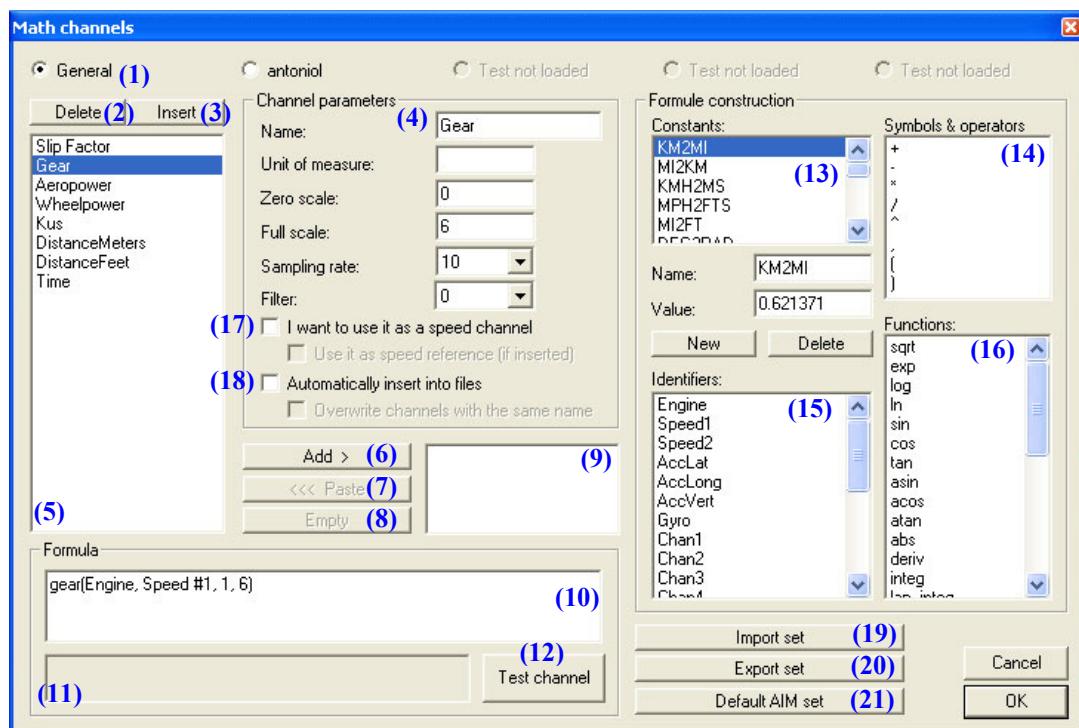


Fig. 8.1– Math channels window

In the window's upped side it is shown 5 checkboxes (1): the "General" one is always enabled, while the other ones are enabled if the corresponding test has been loaded (in Figure 8.1 it has been loaded one test only). The selected checkbox will start blinking.

When the "General" box is checked, the predefined math channels are shown in (5). When you click over a math channel, you can see its properties in the "channel parameters" panel (4), and its associated math formula in the "Formula" panel (10).

With the buttons "Insert" (3) and Delete (2) you may insert or delete channels; if you need to modify an existing math channel, you have to select it and change the parameters (4) and/or the math formula. To change the formula, you may either manually edit the string (10) or use the four panels "Constants" (13), "Symbols & operators" (14), "Identifiers" (15) and "Functions" (16) to automatically build-up the formula. If you double click on an item of these four panels, the corresponding item is automatically copied inside the "formula" panel (10).

If you wish to add to currently loaded test a predefined math channel, please select it from the channel list (5) and press button "Add" (6): the test name will appear in (9). Then select the currently loaded test from the checkboxes (1) and click button "Paste" (7). The math channel, now, will appear in the channel list (5) of the current test.

To delete a math channel from (9), please use button "Empty" (8).

Once the formula has been defined, you should use the button "Test channel" (12) to check if the formula has been correctly interpreted. You can find the result of this check in the grey line (11) below the formula string. If there is something wrong you can see the offending item highlighted in the formula string (10). It is suggested to try to misspell some identifiers or constants to see how the "Test channel" function works.

The *Math channels* window also allows the user to set the new channel as a "speed" one (17). If checkbox (17) is enabled, the user is also allowed to set this channel as "Reference speed" (see paragraph 5.4 "How to modify the reference speed").

Moreover, the new *Math channels* graphical interface also allows the user to "Automatically insert the channel into the DRK file" each time a DRK file is opened. Moreover, if you enable the checkbox "Overwrite channels with the same name", each channel labelled as the one you are going to insert will be overwritten.

The new *Math channels* window also allows the user to import (19) or export (20) the math channels set. Moreover, you may load a "Default math channels set" by pressing button *Default AIM set* (21).

For further information and examples concerning the insertion of a predefined/new math channel, please refer to chapters 8.3 and 8.4.

8.2.1 – The predefined math channels

Race Studio Analysis provides a list of predefined math channels shown in (5). Each customer may both use these channels and create his own predefined math channels.

User defined math channels will not be removed or deleted when upgrading the software.

The predefined math channels list is described here below.

Name	Description	Needed channels	Parameters
Wheel Power	The available engine power.	Reference speed.	Vehicle weight.

Slip Factor	The ratio between the Reference speed and None. reference speed and the engine rpm. engine rpm.	
Gear no.	Calculates the current gear number.	Reference speed and engine RPM. The maximum and minimum really used gear number.
Time	For every lap is calculated the elapsed time from the start of the lap	None.
Calculated speed	The maximum, the minimum or the average between Speed #1 and Speed #2. This channel can be selected as <u>reference speed</u> .	Two speeds input channels. The algorithm for the calculation
Kus	A representation of Speed, understeer/oversteer.	lateral acceleration and steering angle. The wheel base of the vehicle and the threshold value for the lateral acceleration.
DistanceMeters	For every lap is calculated the travelled distance in meters	Reference speed.
DistanceFeet	For every lap is calculated the travelled distance in Feet	None.

8.2.2 – The “Channel parameters” panel

The “Channel parameters” panel (4) allows changing the math channel name, the unit of measure, the minimum and maximum plotting scale values and the sampling rate.

It is also possible to “filter” the math channel if data are very noisy (for further information on filters, refer to chapter 4.6.4).

The “Channel parameters” panel also allows the user to define a math channel as a “speed channel”. For instance, if you have two speed sensors installed on the vehicle, you may create a math channel called “average speed” with the following equation $\frac{Speed1+Speed2}{2}$ and use this channel as reference speed (for further information on changing the reference speed, please see chapter 5.4).

8.2.3 – The “Formula” box

In the “Formula” box (10) it is shown the math formula used to calculate the math channel.

This formula is totally modifiable: to change the formula you may either use the “Formula construction” tools or manually edit the string.

8.2.4 – The “constants” table

The “Constants” table (13) shows a list of predefined constants: these constants load some common numbers (such as the acceleration of gravity, the mass of the vehicle, etc...). These values may be used in the formulas.

Pressing button “New” it is possible to create a new constant: the user has to define its value and the name. It is suggested to use a name which reminds the function of the constant: for instance, the constant MI2KM changes the distance’s unit of measure from Miles (MI) to Kilometres (km).

To add a new constant, please press button “New” and define the constant’s value and name. To delete a constant, please select it from the list and press button “Delete”.

8.2.5 – The “Symbols & operators” table

This panel (14) contains five formula operators (+ - * / ^), the commas (used as function parameters separator) and the brackets (used to define the precedence of operator and functions).

Please, refer to next table to have a more detailed explanation of “Symbols and Operators”:

Operator	Parameters	Result
+ (sum)	A,B could be - Integer numbers - Decimal numbers - Identifiers - Constants	A+B
- (subtraction)	A,B could be - Integer numbers - Decimal numbers - Identifiers - Constants	A-B
* (product)	A,B could be - Integer numbers - Decimal numbers - Identifiers - Constants	A*B
/ (division)	A,B could be - Integer numbers - Decimal numbers - Identifiers - Constants	A/B
[^] (integer power)	A could be - Integer number - Decimal number - Identifier - Constant B must be - integer number	A ^B

Parentheses “()” and comma “,” Parentheses are used to include the argument of a function and to give the math formula a correct syntactic form.
Commas are used to separate the identifiers inside the functions.

8.2.6 – The “Identifiers” table

The “Identifiers” table (15) shows the names of both input and math channels already defined by the user.

These are the only channels the interpreter can use to compute a new math channel. If the channel name is misspell when testing the math formula (using button “Test channel”), the interpreter warns you, as shown in Figure 8.2.

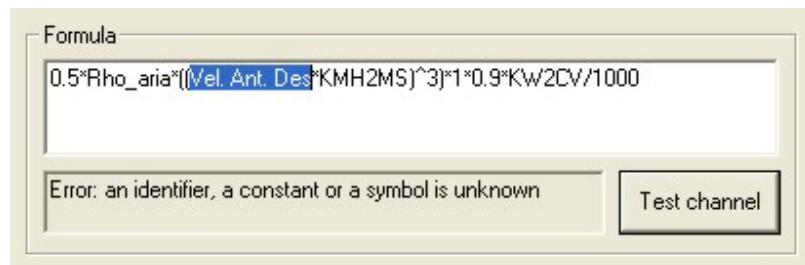


Fig. 8.2– The interpreter warns the user of an error concerning the identifier name

8.2.7 – The “Functions” table

This panel contains the list of functions supported by the interpreter. It is strongly recommended to use this panel to insert the function inside the formulas, because this way the software automatically inserts also the brackets and the commas needed, indicating also the number of parameters that each function uses.

Please, refer to next table to have a more detailed explanation of “Functions”:

Function	Argument(s)	Result
Sqrt(p1)	p1 = channel identifier	The square root of the argument
Exp(p1)	p1 = channel identifier	The exponential of the argument
Log(p1)	p1 = channel identifier	The base 10 logarithm of the argument
Ln(p1)	p1 = channel identifier	The natural logarithm (base e) of the argument
Sin(p1)	p1 = channel identifier	The trigonometric sine of the argument (argument in radians)
Cos(p1)	p1 = channel identifier	The trigonometric cosine of the argument (argument in radians)
Tan(p1)	p1 = channel identifier	The trigonometric tangent of the argument (argument in radians)
Asin(p1)	p1 = channel identifier	The arc, in radians, whose trigonometric sine is the argument
Acos(p1)	p1 = channel identifier	The arc, in radians, whose trigonometric cosine is the argument
Atan(p1)	p1 = channel identifier	The arc, in radians, whose trigonometric tangent is the argument
Abs(p1)	p1 = channel identifier	The absolute value of the argument

Deriv(p1)	p1 = channel identifier	The first derivative function of the argument function over time, computed as $(F(t_0 + dt) - F(t_0)) / dt$
Integ(p1)	p1 = channel identifier	The integral function of the argument function, with $t_0 = 0$ as start integration point
Lap_integ(p1)	p1 = channel identifier	The integral function of the argument function, with $t_0 = \text{startlap}$ as start integration point for each lap
Min(p1, p2)	p1,p2 = channel identifier	The minimum value between the arguments
Med(p1, p2)	p1,p2 = channel identifier	The mean value between the arguments
Max(p1, p2)	p1,p2 = channel identifier	The maximum value between the arguments
High_pass(p1,p2)	p1 = channel identifier p2 = constant	If $p1(t) \geq p2 \rightarrow p1(t)$ If $p1(t) < p2 \rightarrow 0$
Low_pass(p1, p2)	p1 = channel identifier p2 = constant	If $p1(t) \leq p2 \rightarrow p1(t)$ If $p1(t) > p2 \rightarrow 0$
Band_pass(p1, p2, p3)	p1 = channel identifier p2,p3 = constant	If $p2 \leq p1(t) \leq p3 \rightarrow p1(t)$ Else $\rightarrow 0$
Bit_and(p1, p2)	p1 = raw channel identifier p2 = integer constant	The logical AND operation between the arguments The function is meaningless if applied to decimal numbers
Bit_or(p1, p2)	p1 = raw channel identifier p2 = integer constant	The logical OR operation between the arguments The function is meaningless if applied to decimal numbers
Bit_xor(p1, p2)	p1 = raw channel identifier p2 = integer constant	The logical XOR operation between the arguments The function is meaningless if applied to decimal numbers
Time()		It builds a function whose value for each t is the actual lap time, the time calculation is started at the beginning of each lap.
Bike_angle(p1, p2)	p1 = Vertical acceleration channel identifier p2 = Gyroscope channel identifier	The bike inclination angle (degrees)

Slip(p1,p2)	p1 = Engine RPM channel identifier p2 = Speed channel identifier	The slip factor
Gear(p1, p2, p3, p4)	p1 = Engine RPM channel identifier p2 = Speed channel identifier p3 = minimum gear used along the track (integer number) p4 = maximum gear used along the track (integer number)	The gear number (from p3 to p4)
Bike_aclat(p1,p2)	p1 = Speed channel identifier p2 = Gyroscope channel identifier	The bike's lateral acceleration
Bike_cornrad(p1,p2)	p1 = Speed channel identifier p2 = Gyroscope channel identifier	The bike's radius of corner

8.3 – How to add a predefined math channel

This chapter shows how to add a predefined math channel to the channels list. The different procedure steps are labelled with a progressive number starting from 1 to 9 (see also Figure 8.3). It is recommended to follow the procedure explained here below:

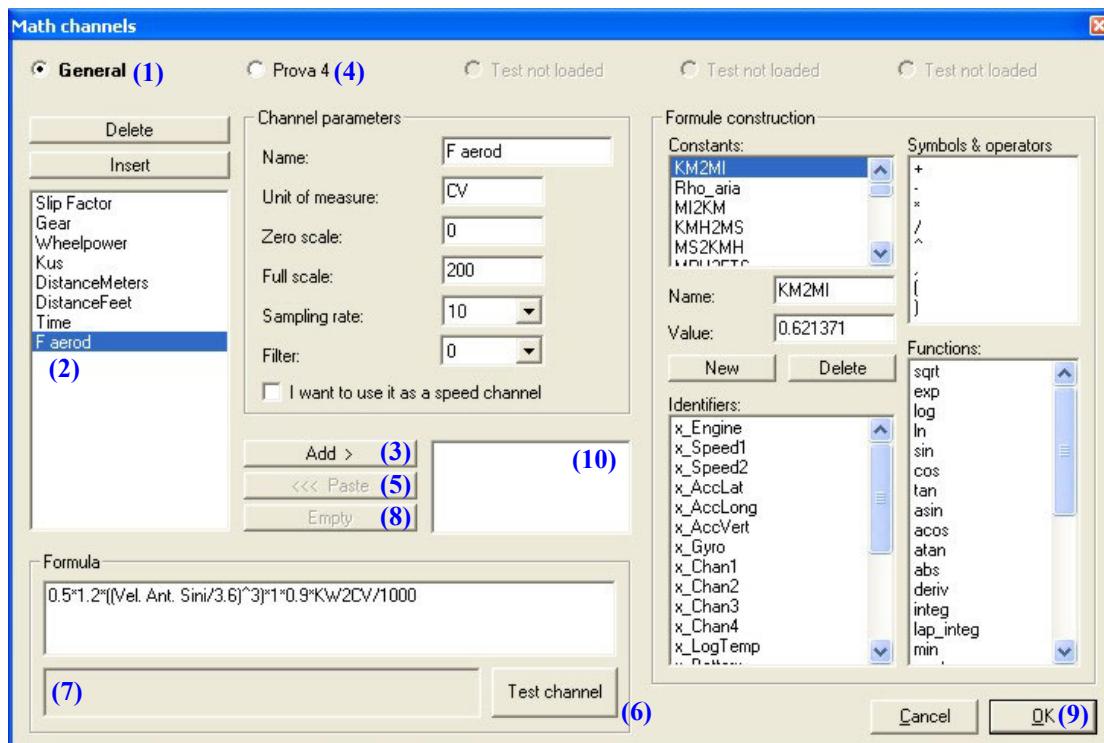


Fig. 8.3– *Math channels* window: adding a predefined math channel

1. Select the “General” checkbox; once selected, it will start blinking.
2. Select the desired predefined math channel: single click on the channel name.
3. Click the “Add” button.
4. Change the test from “General” to the currently loaded one by clicking on the corresponding checkbox.

5. Click the “Paste” button: this function copies the math channel from the general math channels list to the one corresponding to the loaded test.
6. Test the math formula using button “Test channel”. If there is no warning and it appears the text “OK, the formula has been correctly interpreted”, skip to point 9.
7. If it appears a warning message in (7), you have to fix the problem. The most common problem concerns misspell constant names or incorrect channel names: this last event is quite common because the predefined math channels use default channel names (such as “x_Engine”) while the user may have saved that channel with another name (such as “RPM” or “Engine_RPM”, etc...). The offending item is blue-highlighted: please, double-click on the correct channel (or constant) name to replace the incorrect parameter.
8. Click “Empty” to delete the pasted channel from (10).
9. Click button “OK” to apply the changes.

8.4 – How to add a new math channel

This chapter shows how to add a new channel to the math channel list.

For instance, the example reported here below shows how to add the math channel “average speed” to the currently loaded test channel list (in this example, it is supposed that two speed signals have been sampled).

1. Select the checkbox corresponding to the loaded test.
2. Click the “Insert” button.
3. Input the channel name in the corresponding box (located inside the “Channel parameters” panel): for instance, digit “avg_speed”.
4. Input the channel’s unit of measure: km/h, m/s, MPH, etc...
5. Set the plotting scale limits (i.e. the zero/full scale).
6. Do not modify the “Sampling frequency” menu: the correct sampling frequency is fixed by the program.
7. As this new math channel is a speed one, place a check besides the “I want to use it as a speed channel” box. This event will allow you choosing this new channel as “Reference speed”.
8. Now you are able to insert the math formula inside the “Formula” panel. It is strongly recommended to use the “Formula construction” panel to insert the formula, because this way the software automatically inserts the brackets and the commas needed.
9. Now select from the “Functions” list the “med” one and double click on it.
10. It is reminded that, as previously explained in chapter 8.2.7, the function “med” needs 2 identifiers, which are the first and the second speed channel
11. Once double-clicked on the function, it will appear in the “Formula” panel in the following way: **med()**
12. Now click with the mouse in the space between the open-bracket “(” and the comma “,” in order to set the **first** identifier and, then, select the correct first speed channel from the “Identifiers” list by double-clicking on it.
13. Now click with the mouse in the space between the comma “,” and the close-bracket “)” in order to set the **second** identifier and, then, select the correct second speed channel from the “Identifiers” list by double-clicking on it.
14. Now you may test the new math channel by pressing the “Test channel” function.
15. If the parameters/identifiers have been correctly set, it will appear the text “OK, the formula has been correctly interpreted”. Click “OK” to save the new channel inside the currently loaded test’s channel list.

Chapter 9 – Utility functions

9.1 – How to change the messages language

Race Studio Analysis has been designed to manage multi-languages using a database.

To change the text/messages language, please click the Language command on the commands toolbar. The Language selection window is shown in Figure 9.1 and described below:



Fig. 9.1 – Language selection window

To change the software language, select the desired one and then click the “OK” button; otherwise, if you wish to exit without saving, please click button “Cancel”.

9.2 – How to print a graph

If you wish to plot a  graph, you may use the Print function, located inside the File toolbar, you may click the proper  button in the buttons toolbar, you may select the Print option by right-clicking on the graph area or you may use the shortcut “SHIFT+F12”.

Race Studio Analysis also allows the user to have a Print preview of the current graph. To run this function, please select the Print Preview command inside the File toolbar or use the shortcut “SHIFT+F11”.

When you are running the Print preview function, you may both zoom in/out the graph and print it. To exit this function, please press button “Close” or the red cross in the right upper corner of the window.

9.3 – How to modify the unit of measures/wheel number

If you wish to modify the software’s general setup (i.e. the wheel number and the units of measure), please run the Preferences function by clicking the corresponding command in the File toolbar or using the shortcut “SHIFT+F6”.

The Preferences window is shown in Figure 9.2 and described below:

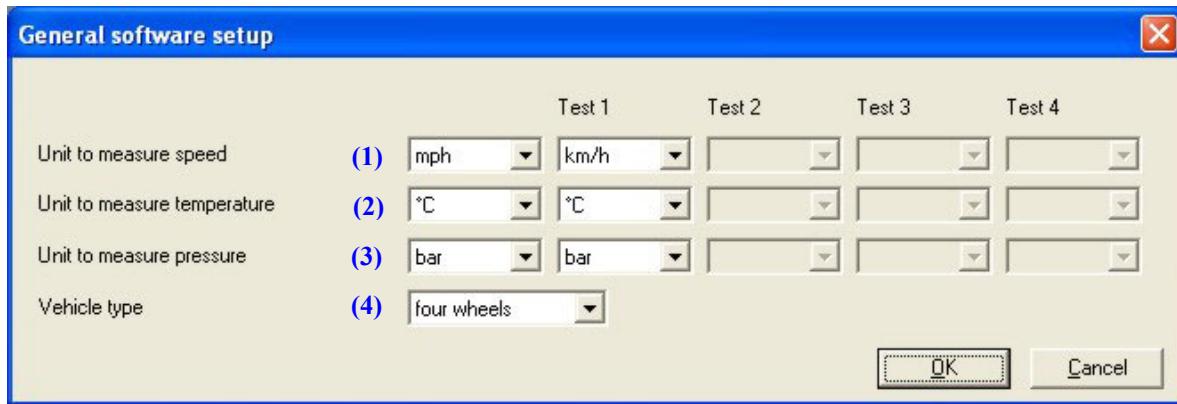


Fig. 9.2– *Preferences* window

The user may apply the following changes:

- Speed unit of measure (1): km/h or MPH;
- Temperature unit of measure (2): °C or °F;
- Pressure unit of measure (3): Bar or PSI;
- Vehicle type (4): 2 or 4 wheels.

Once you load a test whose unit of measure are different from the ones set as default for **Race Studio Analysis**, the software warns you with a message similar to the one shown in Figure 9.3

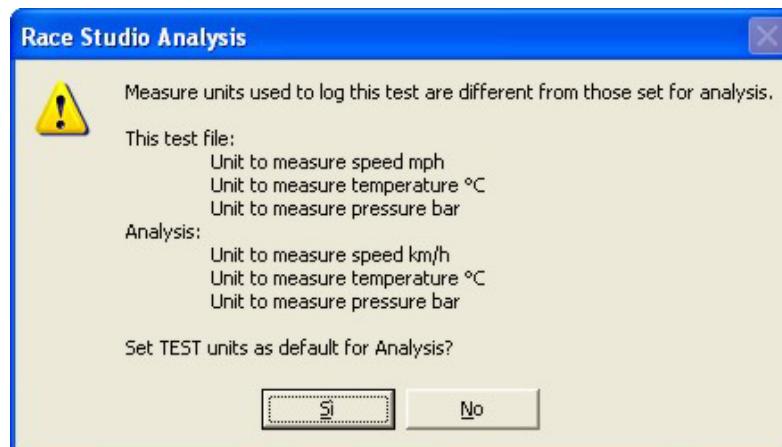


Fig. 9.3– *Unit of measure* control window

If you select the “OK” option, the test’s unit of measure will be set as default for **Race Studio Analysis**; otherwise, if you select the “NO” option, the test’s channels will be shown with the unit of measure set as default for **Race Studio Analysis**.

9.4 – How to save the windows status

The user is allowed to save the window/screenshot status.

This function is very useful as it allows the user to save the currently loaded test, the plotted graphs/channels, the colours used in the graphs and the laps shown in the graphs.

After having exited the software, if the window status has been previously saved, the user will be allowed to reload the test he was analyzing, the graphs he was watching, etc...

To run this function, you have to select the Save windows status function inside the File toolbar. The Save windows status window is shown in Figure 9.4 and described below:

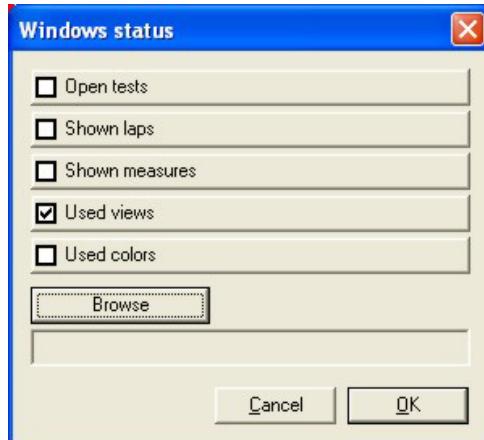


Fig. 9.4 – Save windows status window

First of all, the user has to select which parameters he wants to save by placing a check besides the desired features: it is suggested to select them all.

Once the desired features have been checked, press button *browse* to choose the file name and the folder where you wish to save the file.

Then press button “OK” to save the window status or button “Cancel” to exit without saving.

9.5 – How to load the windows status

If you wish to load the previously save window status, you may select the *Load windows status* function, located inside the *File* toolbar, you may click the proper button in the buttons toolbar or you may use the shortcut “ALT+F12”.

The *Load windows status* window is shown in Figure 9.5 and described below:

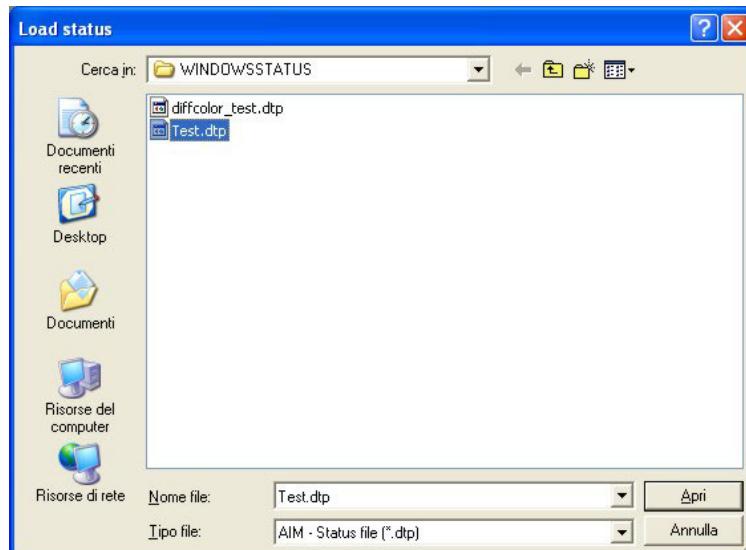


Fig. 9.5 – Load windows status window

To load the window status, you may double click on the corresponding file or you may single-click on the file name and then press button “Open”.

9.6 – How to export data in an Excel® compatible format

Race Studio Analysis allows the user to export sampled data in a format compatible with Microsoft Excel®. This event may be useful to those who are used to analyze data with that software. This function is recommended only for **expert users**.

To run this function, please select the *Excel compatible format conversion* option inside the *File* toolbar. The “Conversion to Excel” window is shown in Figure 9.6.

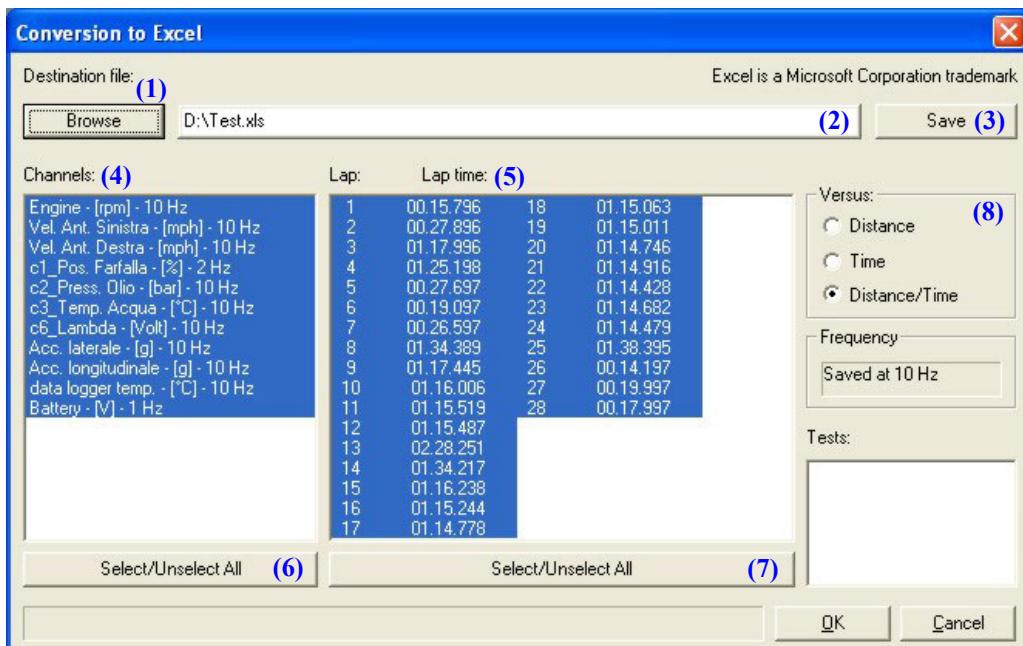


Fig. 9.6—*Conversion to Excel*[®] window

To export the sampled data to Excel[®] follow these instructions:

- Select the Channels you wish to export from the channel list (4) by single-clicking on the channel name. The selected channel becomes blue-highlighted. To select/unselect all channels, use button (6).
- Select the laps you wish to export from the lap list (5); use button (7) to select/unselect all laps.
- Once the desired channels/laps have been selected, click button “Browse” (1) to set the folder and the file name.
- The channel name and the saving path are shown in (2).
- The user may also set if he wishes to export the channels/laps vs. Distance, vs. Time or vs. both by placing a check in (8).
- Once all the previously operations have been completed, you may click the “Save” button (3).

9.7 – How to load the user’s manual

If you wish to load the user’s manual when working under **Race Studio Analysis**, you may select the *Manual* command from the *?* toolbar, you may click the proper button  located inside the buttons toolbar or you may use the shortcut “F1”.

9.8 – How to run the **AIM electronic documentation library**

If you installed **Race Studio 2** (version 2.13.13 or later) from a CD-ROM (this feature is not available for Race Studio 2 WEB-version), you run the **AIM electronic documentation library** by pressing button *AIM products* from the *?* toolbar.

This function runs a PDF file called **AimProds_1XX_eng.pdf** (where 1XX represents the version number): this file is a “link-file” used to load documentation concerning user manuals, datasheets, wirings, installation manuals, etc...