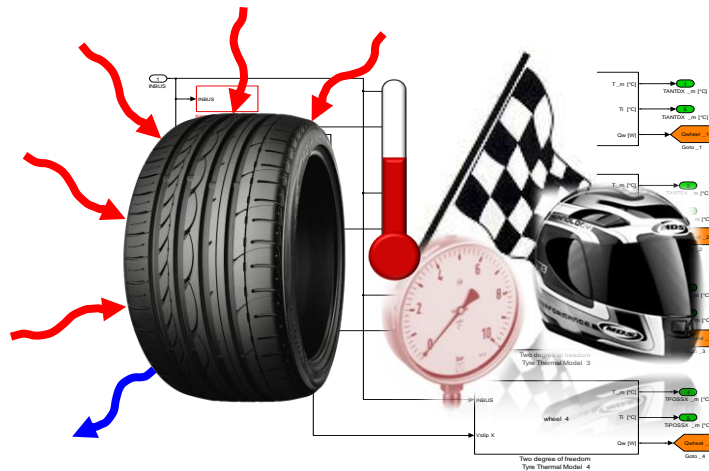




# TTyre Plus Racing™

SOFTWARE FOR TYRES TEMPERATURE AND PRESSURE OFFLINE PREDICTIVE ESTIMATION



## OVERVIEW

**TTyre Plus Racing™** is a suite of software modules, specifically developed for racing applications, that aim at predicting the tyres status of a vehicle e.g after warm-up.

The suite is based on the successful sensorless tyre temperature estimation product **TTyre**, enhanced with sensorless estimation of the tyre pressure, based on wheels pressure reading at the checks.

This suite is a powerful tool for the choice of the initial inflation pressure of the tyres to reach a determined pressure, thus optimizing the performance of the car.

Key features of the **TTyre Plus Racing™** technology are:

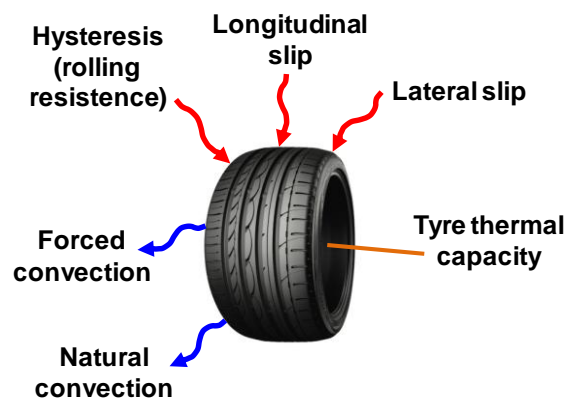
- based only on dynamic signals of the vehicle (accessible and recordable from the CAN network);
- flexible and easily adaptable to different types of racing cars;
- developed in MATLAB®/Simulink®<sup>1</sup> environment;
- automatic code generation with RTW® Embedded Coder™ (certified for use in development processes which need to comply with IEC 61508 standards);
- implementation on various target platforms (Simulink® S-function, Windows XP, Windows CE, microcontrollers).

**TTyre Plus Racing™** can effectively operate both on PC and on easily portable platforms, such as ultra – mobile Pc or smartphones.

## TYRE TEMPERATURE ESTIMATION

**TTyre** estimates the tyre tread and internal temperatures.

The algorithm is based on the modeling of the heating up by hysteresis and friction and the consequent thermal exchange phenomena involving the tyres during the operation of the vehicle.



The model takes as input the vehicle dynamic signals (e.g. accelerations, vehicle speed, etc.).

The output of the model is a simulated time history and the final values of the tyres internal and tread temperatures.

<sup>1</sup> MATLAB® and Simulink® are products made by Mathworks Inc. (Natick, MA)

The flexibility of the model is guaranteed by a set of tunable parameters that can be easily optimized for the specific vehicle by few dedicated test sessions (constant speed steps, steering pad, acceleration and braking).

## TYRE PRESSURE ESTIMATION

**TTyre Plus Racing™** is enhanced by an additional module capable of estimating the tyre working pressure from further thermodynamic calculation and taking into account the starting inflation pressure of tyres, their thermal status and the properties of the inflating gas.

This is a very powerful feature, since it allows an optimized choice of the starting inflation pressure, in order to reach the desired one after real warm-up laps.

## EXTERNAL CONDITIONS

As required by motorsport applications, great relevance is given to the influence of environmental conditions on the behaviour of tyres. In particular the air temperature effect is taken into account as regards the thermal exchange; moreover, also the track temperature can be considered in order to obtain a better estimation.

## OPERATING SEQUENCE – USE OF THE TOOL

Once tuned by training or check laps, **TTyre Plus Racing™** is suitable to perform the simulation and prediction of the tyres temperature and pressure exploiting the CAN signals acquired during some initial warm-up laps.

The operating sequence is the following one:

- warm – up laps with CAN signals acquisition;

- input to the model: external conditions and one or more sets of possible initial values of pressure;
- simulation of the required laps;
- output: final tyres temperatures and pressures.



## MODELS OPTIMIZATION AND TESTING

All the models that compose **TTyre Plus Racing™** are developed in MATLAB®/Simulink® environment. This allows deploying the model not only for the specific end platform, but also as Simulink® S-function module in order to perform:

- off-line parameters optimization;
- off-line testing;
- SIL (Software In-the-Loop) testing.

Attain IT provides a specific service of tuning and optimization to find one or more sets of values for the tunable parameters of the models, corresponding to different car sets, tyres or driving conditions.

**Attain IT S.r.l.**

Santa Croce 664/a, 30135 VENICE (ITALY)

Tel.: +39 329 – 0095712, +39 041 – 2757634

fax: +39 041 – 8871148, +39 041 – 2757633

Email: [info@attainit.eu](mailto:info@attainit.eu)

[www.attainit.eu](http://www.attainit.eu)