Formula CarMaker Lap Time Simulation Event 2026

# Lap Time Simulation Competition Documentation

Version 1.0

# Table of Contents

The Lap Time Simulation (LTS) event within Formula student offers teams a chance to use IPG CarMaker to develop models of a Formula Student vehicle. These models will be submitted for a virtual competition, the details of which are in the FSUK 2026 rules.

# Chapter 1
# 1 Getting Started

This document assumes that you already have CarMaker 14.1.1 installed and set up on your computer and have downloaded and set up the LTS CarMaker project from the IPG customer area. https://www.ipg-automotive.com/en/support/customer-area Please note, registration is required to access this area. Please see Section S7.1 in the FSUK 2026 rules for further information.

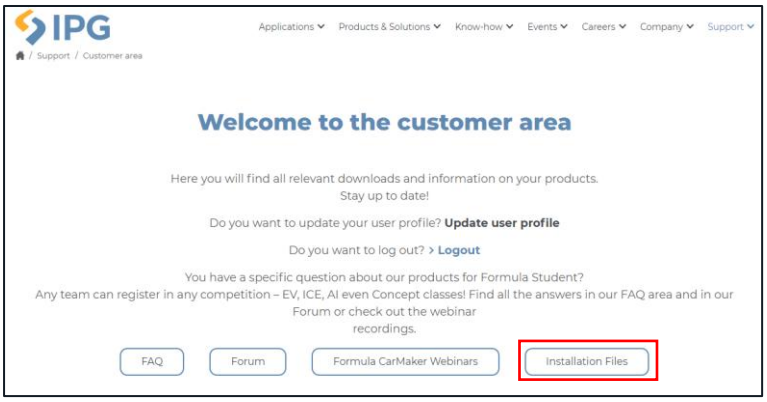


Figure 1.1 – IPG customer area

## 1.1 1.1 Selecting a Vehicle

A starting point for each vehicle is provided in the LTS CarMaker Project. The vehicle that you choose does not have to be the same as your FS Class or Concept class entries. All vehicles have been through several rounds of Balance of Performance tuning, but some architectures may have more performance potential than others once fully developed. Testing multiple vehicles is highly recommended.

There are 2 main decisions to make when selecting a vehicle

1. Powertrain type
    - EV 1EM
    - EV 4EM
    - ICE Normally Aspirated
    - ICE Turbocharged
2. Aerodynamic concept
    - With Aero package
    - Without Aero package

Furthermore, for the rear wheel drive vehicles, there is the choice of differential

- Open differential
- Torsen differential

All possible permutations of these vehicles are included in the installation package for a total of 14 vehicles. Your final submission must be based on one of these, with only changes explicitly listed in the rules.

## 1.2 1.2 Selecting Parts

Since most of the parts differences between the vehicles are already modelled in the 14 vehicles described in 1.1, the only parts that can be selected inside the GUI are the front and rear suspension designs, with different kinematics. The hardpoints of these designs are detailed in appendices 1 and 2.

There are five different designs for the front and another five for the rear. However, each of these designs has multiple options with adjustments for the static alignment.

IPG Kinematics files have been provided if you would like to look into these suspension hardpoints in more detail. The Model Check feature within CarMaker is also very useful when evaluating which parts to use.

## 1.3 1.3 Tuneable parameters

CarMaker has tuneable parameters known as Named Values (Nvalues). These parameters are numbers and represent parameterised physical characteristics of a part or system, for example the stiffness of a spring. As part of LTS, some of these Nvalues are open to tuning

- Suspension tunables (available to tune for front and rear suspensions)
  - Spring rate
  - ARB rate
  - Damper Low speed pull
  - Damper High speed pull
  - Damper Low speed push
  - Damper High speed push
  - Bumpstop push unstressed length
  - Bumpstop pull unstressed length
- Brake tunables – rear only
  - Rear brake pressure ratio
- Powertrain tunables
  - ICE only
    - Gear ratio 1
    - Gear ratio 2
    - Gear ratio 3
    - Gear ratio 4
    - Gear ratio 5
    - Gear ratio 6
  - EV 4EM only
    - Front motor ratio
  - EV 1EM only
    - Differential ratio

- Driver parameters
  - Lateral acceleration time preview
  - Longitudinal acceleration time preview
  - Longitudinal braking time preview
  - Corner cutting coefficient
  - g-g diagram and exponents
  - Speed-dependent maximum acceleration (overwriting driver knowledge)

Exact details of where these values are entered into the CarMaker GUI and the associated name in the vehicle and testrun infofiles are available in Chapter 2.

Chapter 2

# 2 Developing your vehicle

## 2.1 2.1 Driver adaption

After changing vehicle, changing any parts or tuneable as desired, the driver adaption must be run in order to teach IPG Driver how the vehicle behaves. Like any form of motorsport, the driver behaviour is a very important part of the overall vehicle performance.

New for 2026, the Speed-dependent maximum acceleration knowledge of the driver will be overwritten by the user, to allow for greater freedom of driving styles and reduced reliance on tuning the vehicle specifically for certain maneuvers in the driver adaption. The driver adaption is still required, since the driver must still learn other aspects of the vehicle, such as the powertrain.

A driver adaption will still be required any time that you make a change to the vehicle, no matter how small. In the LTS final competition, the driver adaption will be run for each submission, giving the driver up to date knowledge, though the Speed-dependent maximum accelerations will overwrite some of this data. Testing with a driver with out-of-date knowledge will almost certainly lead to different results in the competition runs.

To start the driver adaption, open the Simulation menu and then select Driver Adaption as shown in Figure 2.1

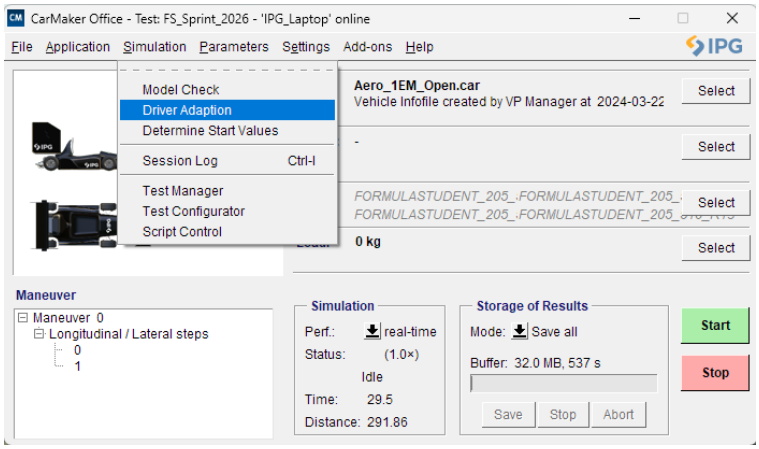


Figure 2.1 – Main GUI Simulation Menu

This will open the Driver Template Editor shown in Figure 2.2

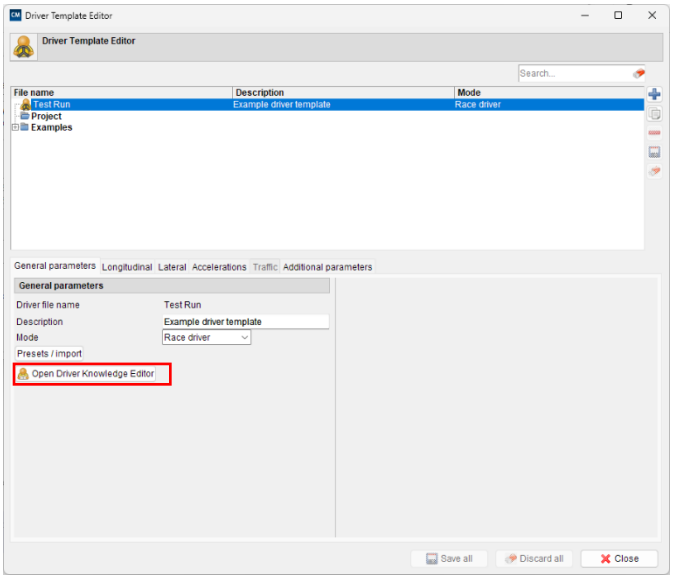


Figure 2.2 – Driver Template Editor

Once inside the Driver Template Editor, you can open the Driver Knowledge Editor. Before starting the Driver Adaption, you must make sure that the Vehicle and Basic Driver Adaption parameters are as per figure 2.3. Note, for the purposes of LTS, even if using the EV 4EM powertrain, the driver must be configured as RWD.

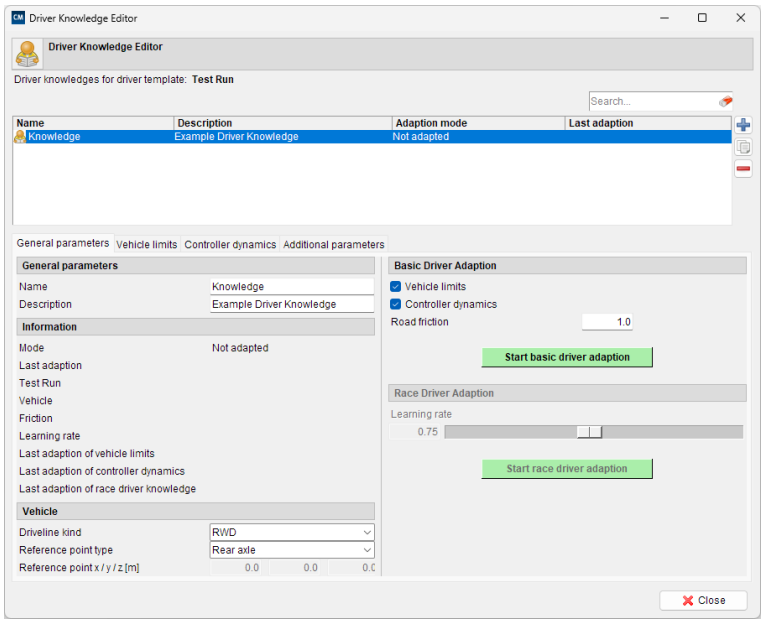


Figure 2.3 – Driver Knowledge parameters

You may now start the basic driver adaption. It is recommended to change the Simulation Speed to be faster than real-time in order to finish the Driver Adaption more quickly, since it is a long test run. You can do this from the main GUI, using the Perf: drop down option as shown in figure 2.4

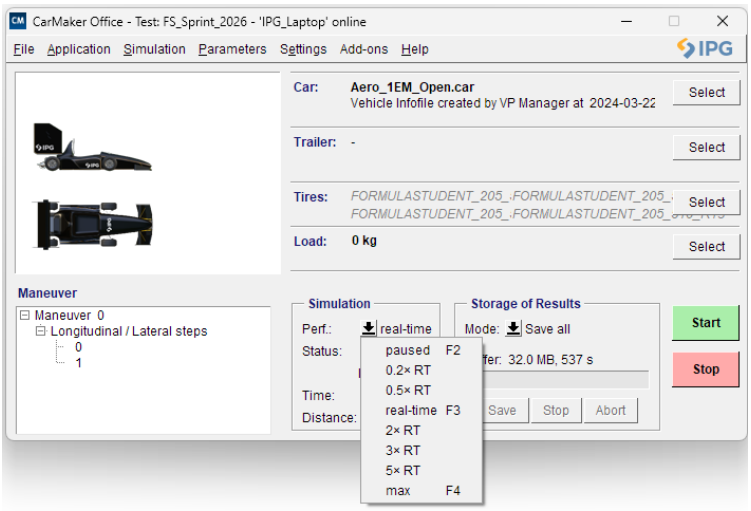


Figure 2.4 – Simulation Speed menu

After the driver adaption is complete, the driver knowledge must be selected in the Ego vehicle parameters. This may also be required after making changes to the driver knowledge, such as tuning the Driver Lateral preview Time.

Access these by selecting Parameters > Manuever to open the Manuever settings, then change to Vehicle Parameters tab and select the appropriate knowledge in the IPG Driver section by using the button highlighted in Figure 2.5

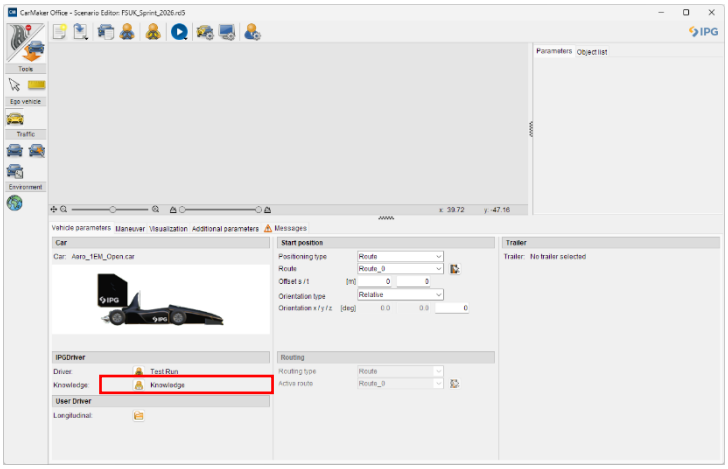


Figure 2.5 – Driver Knowledge selection

Now that the driver has knowledge, we must verify that the driver mode is set to Race Driver. Set this in the Driver Template Editor by selecting Parameters > Driver and set the Mode to Race driver, as shown in figure 2.6.

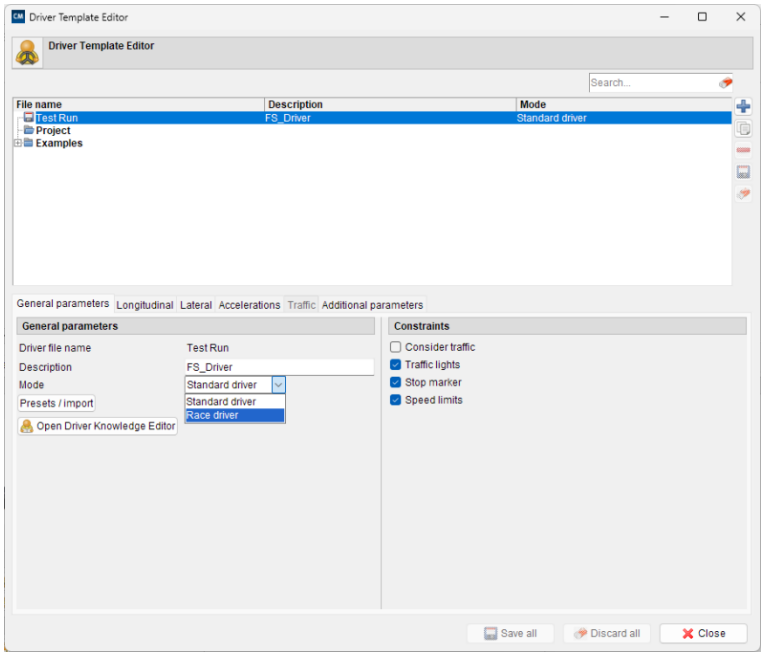


Figure 2.6 – Race drive Mode selection.

Please note, this process may have to be performed each time you make any change to the vehicle or change the test run.

## 2.2 2.2 Driver Tuning

IPG Driver has a vast number of parameterisations to be able to replicate real driver behaviours. As part of the LTS event, there are a limited number of Driver parameters you may tune. These can be broken down into Driver parameters and Driver Knowledge Parameters.

The tunable Driver parameters are

- Corner cutting coefficient (Carmaker infofile name *Driver.Course.CornerCutCoef*)
- g-g Diagram (*Driver.Acc.GGExp*)
- Speed-dependent maximum acceleration table (*Driver.Acc.VelDepend*)

These can be found in the Driver Template Editor, under the Lateral and Accelerations tabs. Please note, **for the g-g-Diagram, you must set the speeds to 40 and 70km/h** as per Figure 2.7, the values in the 4 highlighted cells are free to tune. **For the Speed-dependent maximum acceleration table, the speeds must be set to 30, 40, 50, 60 and 70km/h** as per Figure 2.7, the values in the 15 highlighted cells are free to tune.

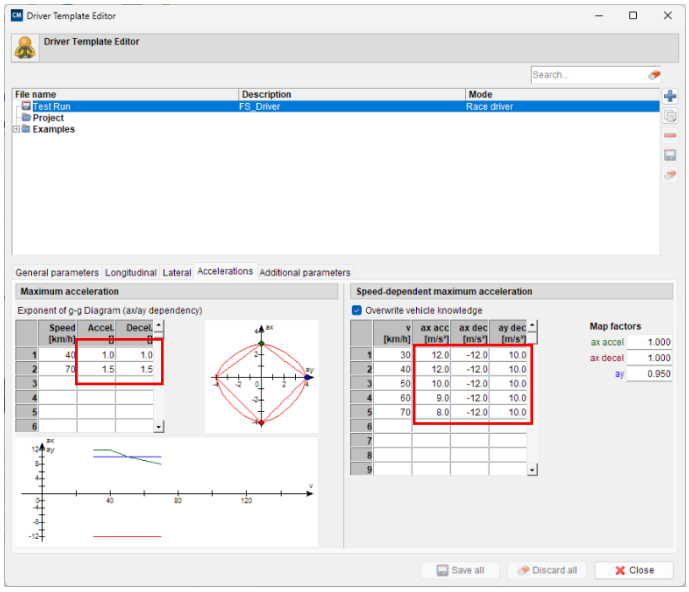


Figure 2.7 – Driver g-g Diagram

The driver adaption process will provide a table of Speed-dependent maximum accelerations, which we are now overwriting to give the user greater control over the driving style of the vehicle. However, the adapted table may provide a good starting point for the user tuned Speed-dependent maximum accelerations. This table may be manually copied across from the Speed-dependent max. accelerations table on the Vehicle Limits tab of the Driver Knowledge Editor, as shown in Figure 2.8. Please note the x-axis (velocity) and make sure to copy the values at the appropriate velocities.

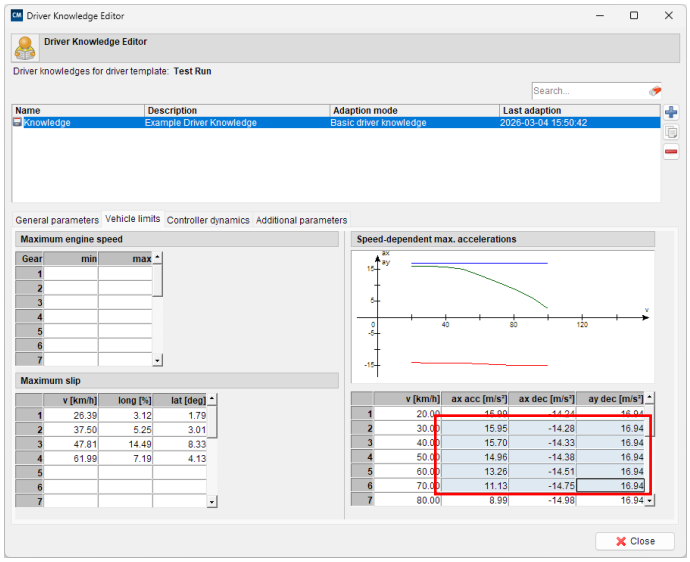


Figure 2.8 – Driver Adaption learned Speed-dependent maximum accelerations

The tunable Driver Knowledge Parameters are

- Longitudinal Preview time acceleration (Carmaker infofile name *Knowl.Long.tPreviewAcc*) Determines the reference point for throttle control. A starting point for a typical FS car would be 0.3s
- Longitudinal Preview time braking **(***Knowl.Long.tPreviewBra***)** Determines the reference point for braking control. A starting point for a typical FS car would be 0.3s
- Lateral preview time (*Knowl.Lat.tPreviewAcc)* Determines the reference point for steering control. A starting point for a typical FS car would be 0.5s

These can be found in the Driver Knowledge Editor, under the Controller dynamics tab as shown in figure 2.9

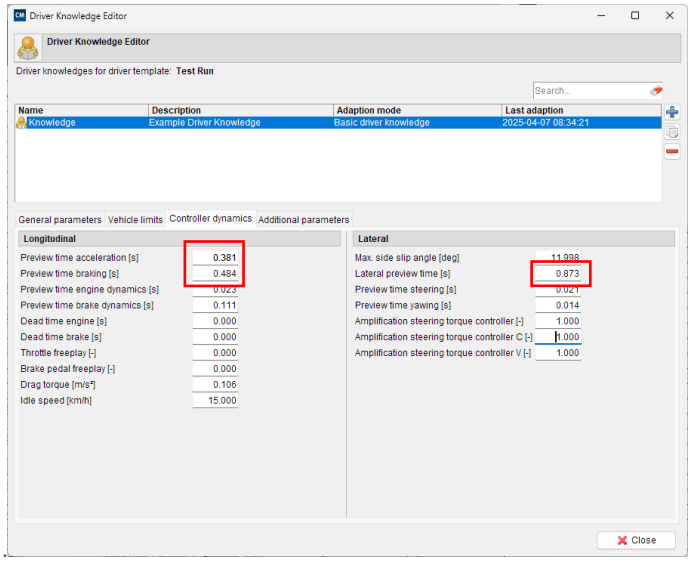


Figure 2.9 – Driver Knowledge tuneable Parameters

If the driver is not able to finish the Sprint Lap and goes out of the track, changing Knowl.Lat.tPreview might help. The combination of this parameter and the Cutting Corner Coefficient has a significant effect on the number of cones hit

## 2.3 2.3 Vehicle Selection

To select a vehicle, click the Select button in the Car section as shown in figure 2.10.

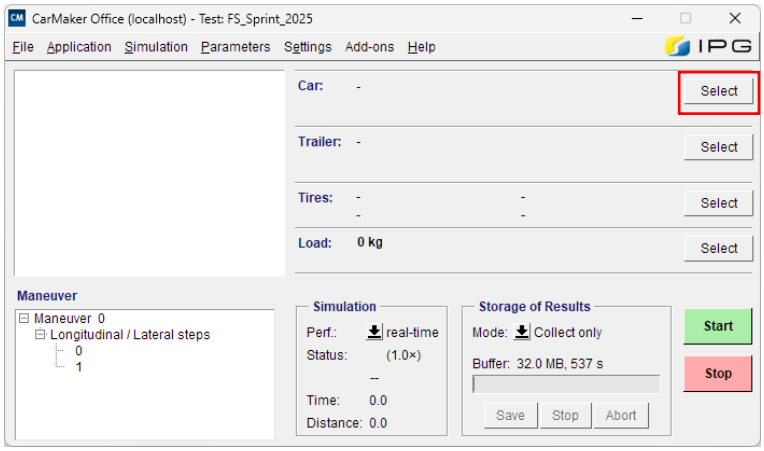


Figure 2.10 – Car selection in the main GUI

The starting vehicles for LTS are saved in the folder Baseline_Vehicles in the project directory as shown in figure 2.11. If would like to make any changes, it is recommended to create a copy of this in the project directory, so that you can always return to a baseline vehicle if needed.

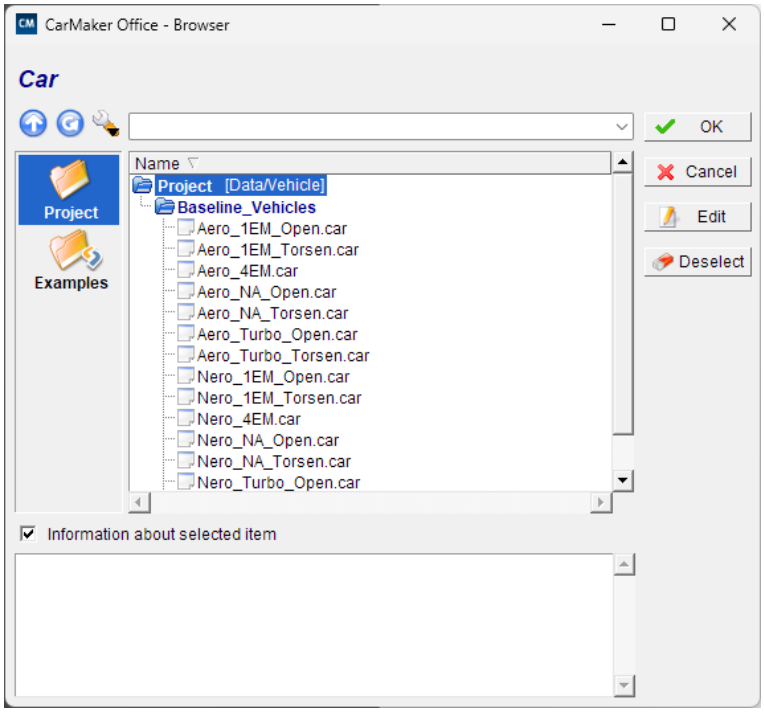


Figure 2.11 – Baseline vehicle folder

## 2.4 2.4 Vehicle Parts changes

As explained in Chapter 1, the only parts requiring user changes during LTS competition are the front and rear suspension kinematics. These can be changed by navigating to Parameters > Car and selecting the suspension tab. The kinematics option is visible here, as per Figure 2.12. Clicking the Model drop down menu gives you the option to change the suspension parameterisation file (.skc).

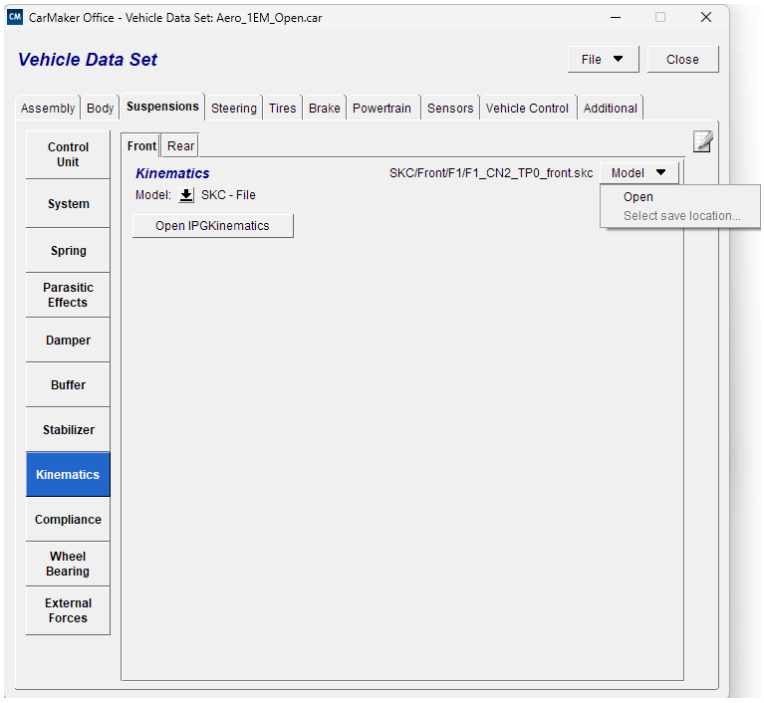


Figure 2.12 – Suspension kinematics model change

## 2.5 2.5 Vehicle tuning parameter (Nvalue) changes

Nvalue changes are simple to make either through the GUI or through the vehicle infofile. The variables that are allowed to be tuned are as below. Please note the exact name and order of these variables, since these will have to be filled into the submission form.

Spring rate, Carmaker infofile name *SuspF.Spring* and *SuspR.Spring*

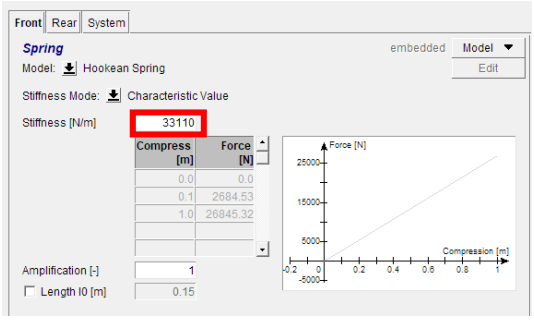


Figure 2.13– Spring rate GUI entry

ARB rate, *SuspF.Stabi* and *SuspR.Stabi*

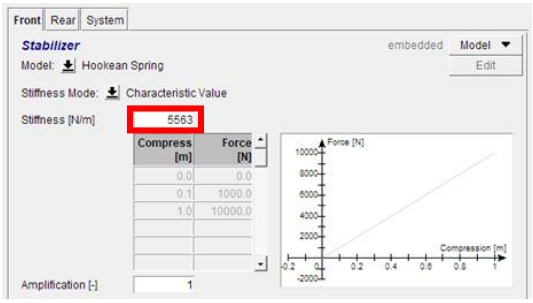


Figure 2.14 – ARB rate GUI entry

Damper rates, please note, the velocity values are fixed

- Damper Low speed push, *SuspF.Damp_Push, SuspR.Damp_Push*
- Damper High speed push, *SuspF.Damp_Push, SuspR.Damp_Push*
- Damper Low speed pull, *SuspF.Damp_Pull. SuspR.Damp_Pull*
- Damper High speed pull, *SuspF.Damp_Pull. SuspR.Damp_Pull:*


Figure 2.15 – Damper rate GUI entry

Bumpstop push unstressed length, *SuspF.Buf_Push.tz0*, *SuspR.Buf_Push.tz0*
Bumpstop pull unstressed length *SuspF.Buf_Pull.tz0, SuspR.Buf_Pull.tz0*


Figure 2.16 – Bumpstop unstressed length GUI entry

Rear brake torque to pressure ratio (only one value, both left and right must be the same), *Brake.System.pWB2Trq*

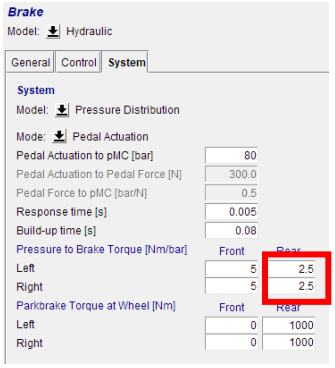


Figure 2.17 – Rear brake torque pressure ratio GUI entry

ICE only, Gear ratios 1-6, *PowerTrain.Gearbox.0.iForwardGears*

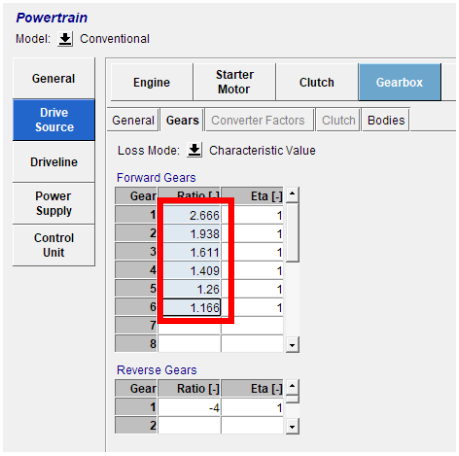


Figure 2.18 – ICE only gear ratio GUI selection

EV 4EM only, Electric motor front ratio, *PowerTrain.Motor.Ratio* and *PowerTrain.Motor1.Ratio* (only one value, Drive Source 0 and Drive Source 1 must be the same)

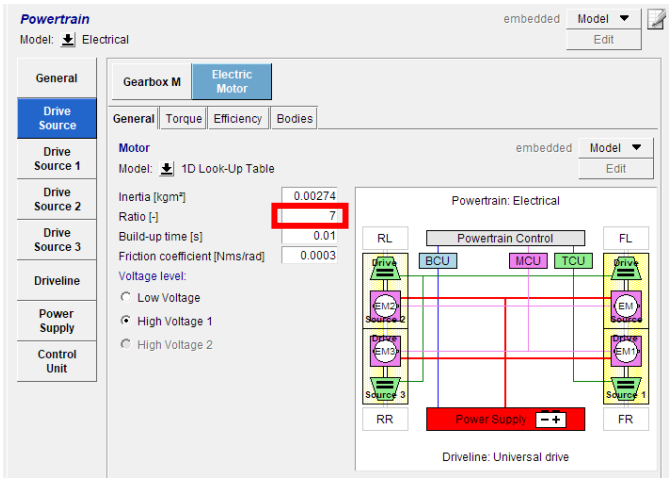


Figure 2.19 – EV 4EM front motor ratio

EV 1EM only, Differential ratio

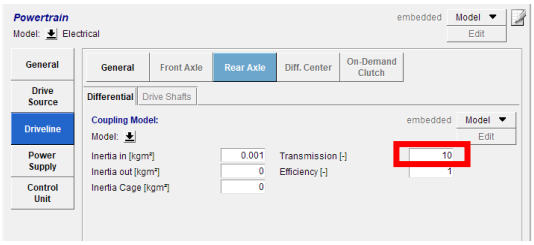


Figure 2.20 – EV 1EM rear differential ratio

Chapter 3

# 3 Entering your vehicle for the competition

Once you have finished developing your vehicle and wish to submit your final submission, please fill in your vehicle data and driver parameters in the online form, the link for which will be provided no less than 4 weeks prior to submission date. Please see Chapter 2 if you are unclear about exactly which values to enter. All units are to be the default units as displayed in the GUI.

You are only permitted to enter data in the blue cells. Any data entered outside of these will not be considered in the virtual competition. Please note that for guidance, example data is already filled in, this must be overwritten with your entry details, otherwise this example data will be used!

The Data check category is not used for scoring, but may be used in the event of investigating a failed run or other issue. In the competition, every test run will be calculated from scratch using the parameters provided in the online form.

Once you have filled in your entry form, it is advisable to start from a fresh copy of the LTS CarMaker Project and start from the original vehicle, changing values via the GUI to recreate your final submission, to verify that this creates the intended vehicle. The competition will be run with what is submitted on the form and any inputs that lead to non-completion of events will be scored accordingly.

# 4 Appendix 1: Front Suspension Config Hardpoints

| | Vehicle - Bushing Front Upper Wishbone (A) | | | Vehicle - Bushing Rear Upper Wishbone (B) | | | Subframe - Bushing Front Lower Wishbone (C) | | | Subframe - Bushing Rear Lower Wishbone (D) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *x* | *y* | *z* | *x* | *y* | *z* | *x* | *y* | *z* | *x* | *y* | *z* |
| **F1** | -44.0 | -234.0 | 320.0 | 227.0 | -234.0 | 320.0 | -46.0 | -144.0 | 128.0 | 292.0 | -144.0 | 128.0 |
| **F2** | -44.0 | -234.0 | 310.0 | 227.0 | -234.0 | 310.0 | -46.0 | -144.0 | 138.0 | 292.0 | -144.0 | 138.0 |
| **F3** | -44.0 | -234.0 | 330.0 | 227.0 | -234.0 | 330.0 | -46.0 | -144.0 | 118.0 | 292.0 | -144.0 | 118.0 |
| **F4** | -44.0 | -234.0 | 330.0 | 227.0 | -234.0 | 330.0 | -46.0 | -144.0 | 138.0 | 292.0 | -144.0 | 138.0 |
| **F5** | -44.0 | -234.0 | 310.0 | 227.0 | -234.0 | 310.0 | -46.0 | -144.0 | 118.0 | 292.0 | -144.0 | 118.0 |

# 5 Appendix 2: Rear Suspension Config Hardpoints

| | Vehicle - Bushing Front Upper Wishbone (A) | | | **Vehicle - Bushing Rear Upper Wishbone (B)** | | | **Subframe - Bushing Front Lower Wishbone (C)** | | | **Subframe - Bushing Rear Lower Wishbone (D)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *x* | *y* | *z* | *x* | *y* | *z* | *x* | *y* | *z* | *x* | *y* | *z* |
| 1 | -646.0 | -300.0 | 299.0 | -110.0 | -235.0 | 299.0 | -670.0 | -144.0 | 125.0 | -110.0 | -180.0 | 125.0 |
| R2 | -646.0 | -300.0 | 289.0 | -110.0 | -235.0 | 289.0 | -670.0 | -144.0 | 135.0 | -110.0 | -180.0 | 135.0 |
| R3 | -646.0 | -300.0 | 309.0 | -110.0 | -235.0 | 309.0 | -670.0 | -144.0 | 115.0 | -110.0 | -180.0 | 115.0 |
| R4 | -646.0 | -300.0 | 309.0 | -110.0 | -235.0 | 309.0 | -670.0 | -144.0 | 135.0 | -110.0 | -180.0 | 135.0 |
| R5 | -646.0 | -300.0 | 289.0 | -110.0 | -235.0 | 289.0 | -670.0 | -144.0 | 115.0 | -110.0 | -180.0 | 115.0 |