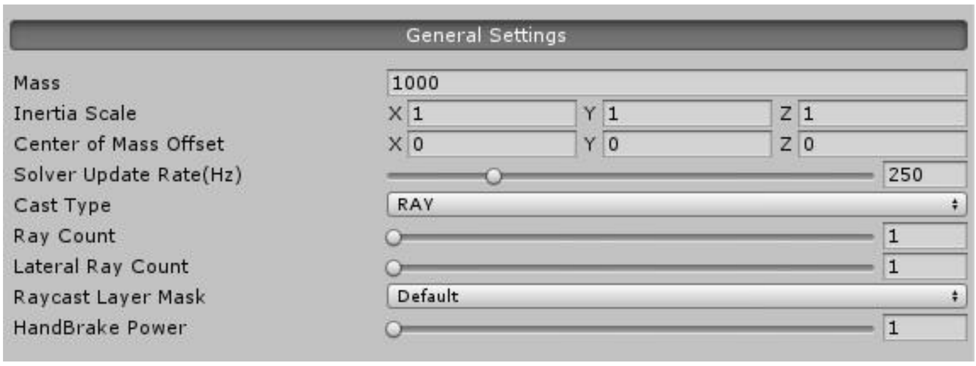
F-GEAR

Core Modules

If you have completed the quickstart tutorial you already have a driveable vehicle. All of the settings of that vehicle are default values so in this tutorial we will walk through all these settings and explain them briefly.

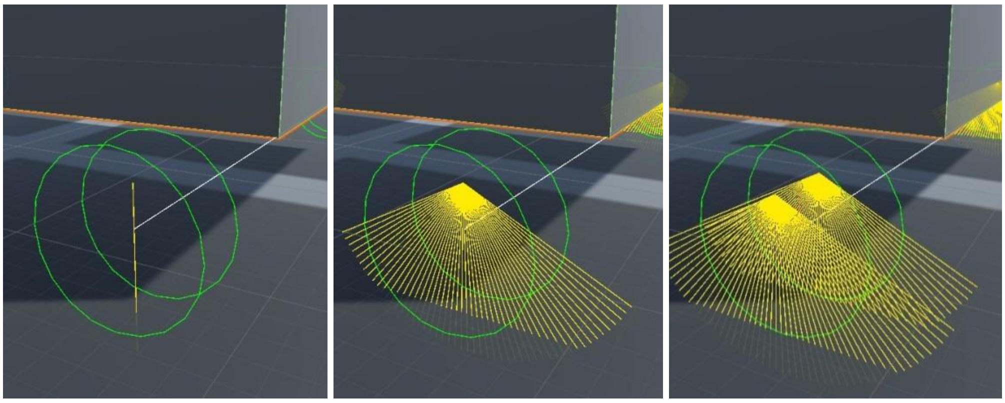
General Settings :



- **Mass** : This is the mass of the vehicle body in kilograms and this value is set as the mass of the rigidbody component. Keep it close to realistic values.
- **Inertia Scale** : This value is a direct multiplier to the rigidbody inertia. Higher values result slower accelerations and more conservation of momentum. Experiment with it as you like.
- **Center of Mass Offset** : As stated in tutorial1, the inertia and center of mass calculation is based on the "Inertia" gameobjects colliders. You can use multiple colliders with various sizes to achieve the desired effect which gives you the freedom to position center of mass as you like and usually you do not need to alter this setting. Center of mass has a dramatic effect on the handling of the vehicle so you can further tweak it with this parameter.
- **Solver Update Rate(Hz)** : Unity physics system is updated 50 times per second at the default rate. This is acceptable for most cases but vehicles usually require much more precise calculations(*). This parameter sets the update frequency of the vehicles so even if the physics rate is 50hz and the update rate is 250hz then the system makes 5 sub steps to make sure you will get a 250hz update rate. This is good enough for most cases but for more decent results you can set unitys physics update rate to 100hz. Keep in mind that higher rates result worse performance.

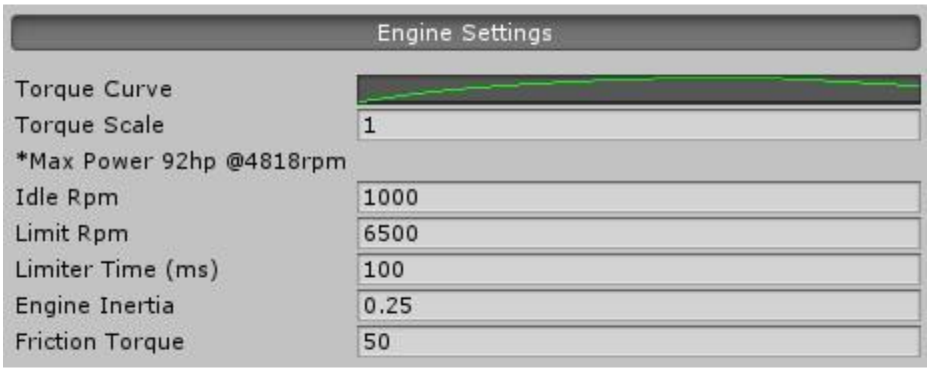
*https://www.lfs.net/forum/thread/48927-Racing-sim-physics-engine-rates

- **Cast Type** : This is the type of raycasting that is used to find the tire contact position. By default raycasting is used. Sphere casting gives a nice 3d wheel effect but the downside is that your wheels will behave like a sphere instead of a cylinder. Convex casting lets you choose a convex collider to be casted. You can specify a custom mesh for each wheel in wheel settings. If you do not specify a mesh collider the default cylinder model in unity is used. Cylinder casting is smooth like sphere casting but not as precise since convex colliders have limited triangle counts. Convex casting creates a rigidbody that is marked as a trigger in order to avoid collisions. If you want to provide a custom mesh for casting, make sure it's size and orientation matches the unity's default cylinder model. You can see the convex mesh used for casting when you select the vehicle and enable gizmo view. Some mesh colliders may have problems with convex casting, try selecting "Everything" in Cooking Options.
- **Ray Count** : This represents the number of rays that are casted for each wheel. If you need a 3d wheel effect you can increase this value. Keep in mind that the higher number of raycasts, the worse performance you get. For a racing game its better to keep its value at 1.



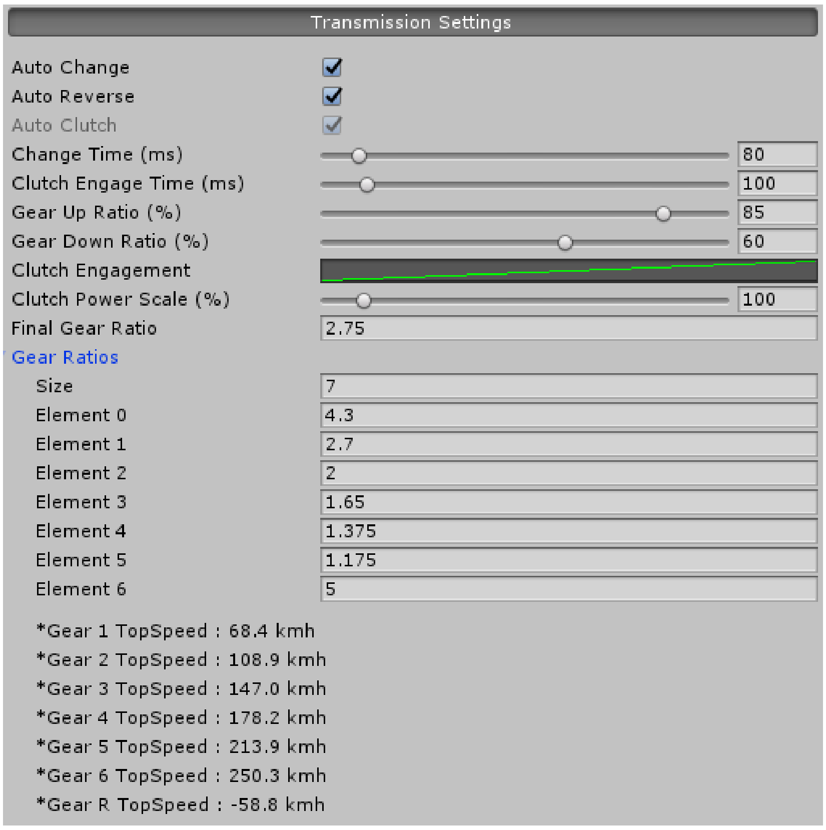
- **Lateral Ray Count** : If you need a wheel with real width than setting this value to 2 or 3 will multiply the Ray Count value and the origins of raycasts are offset to left and right according to the wheel width. For a racing game its better to keep its value at 1.
- **Raycast Layer Mask** : This is the layer mask input to the Physics.Raycast method.
- **Handbrake Power** : Normally brake powers are set per axle but if you want the rear wheels to lock quicker with handbrake you can increase this value. This has little to no effect on actual braking power but wheels lock more easily.

Engine Settings :



- **Torque Curve** : The engine torque is the result of this curve scaled with the next parameter. The X axis of the curve represents engine rpm and Y axis is the torque value in Nm. There are real world vehicles engine curves available on the internet, copying those curves is a good way to start.
- **Torque Scale** : This is the direct multiplier of engine torque curve. Final engine torque is : Curve Result x Scale. Normally you would keep this as "1" but you can alter it for temporary engine boosts.
- **Idle Rpm** : Minumum rpm value of the engine, currently there is no stalling so the engine always keeps revving.
- **Limit Rpm** : This is the maximum rpm that the engine can rev up to, after this point engine input is blocked for a little time, see limiter time.
- **Limiter Time** : When the rpm value reaches the limit value the throttle input is blocked for this long. It is measured in miliseconds. Experiment with it but keep in mind that if the engine inertia is too low, engine rpm will fluctuate a lot so you better keep it as low as possible.
- **Engine Inertia** : This effects the acceleration/deceleration of the engine. Inertia has direct effect on the acceleration of the vehicle so avoid too low or high values. To determine a good value you can rev up/down in neutral gear and see how it behaves.
- **Friction Torque** : This is a constant friction factor(multiplied with rpm) that slows down the engine. Higher values result more engine brake and faster rpm rev downs. Lower values has opposite effect so to determine a good value you can rev up in neutral gear and see how it revs down.

Transmission Settings :



- **Auto Change** : When set to true gears are changed automatically according to the gear up/down values.

- **Auto Reverse** : When set to true the transmission automatically goes to rear gear when you brake and stop. Also the same thing happens when you are going backwards and push the throttle, this time the transmission automatically goes to first gear. This only happens when Auto Change is set.

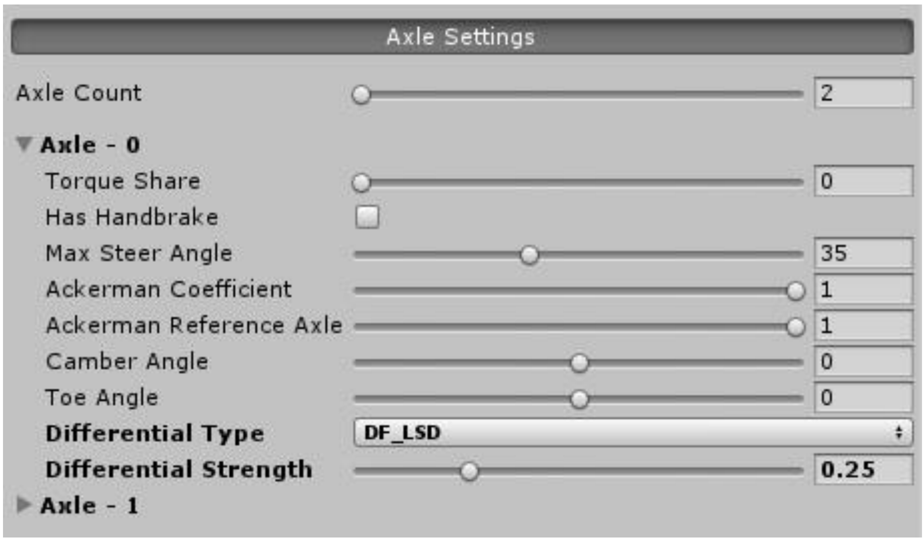
- **Auto Clutch** : When set to true the transmission automatically manages the clutch input for you. Set this to true if you want to manually operate the clutch.

- **Change Time** : When a gear change happens first the transmission goes to neutral and then switches to the next gear, this value determines how long this process takes in miliseconds.
- **Clutch Engage Time** : Before changing gears, the clutch is fully disengaged. After gear change is completed, it takes this amount of time to reengage the clutch. Usually this value should be equal or lower than the change time.
- **Gear Up Ratio** : Suppose you drive in 1st gear, the maximum speed that you can achieve with this gear is calculated(mxs) and if you go over (gearup ratio * mxs) then the gear is changed.
- **Gear Down Ratio** : Suppose you drive in 2nd gear, the maximum speed that you can achieve with the previous gear(1st) is calculated(mxs) and if you go below (geardown ratio * mxs) then the gear is changed.
- **Clutch Engagement** : There is an internal variable called ClutchState which takes values between 0 and 1. If clutch is fully pressed it is 1 and if it is not pressed at all then it is 0. This

value changes linearly as you press the pedal. The ClutchState represents the X-Axis of this curve and the resulting value represent the real clutch power ratio. Clutch pedal behaviour changes from vehicle to vehicle but generally try to leave a dead zone before engaging and then quickly raise the power ratio. The default curve is a simple example to this.

- **Clutch Power Scale** : This is a coefficient to the power transfer of the clutch(between the engine and the wheels). Do not change it if you really need to. Lower values will result high differences between engine and wheel rpms. Higher values will force both rpm values to be in sync but the engine rpm can behave erratic.
- **Final Gear Ratio** : The transmission value is calculated from the current gear ratio and this final gear ratio(also called final drive). In real cars this is the gear ratio between the driveshaft and the axle which can determine the acceleration and the top speed of the vehicle. Higher values result faster accelerations and lower top speeds.
- **Gear Ratios** : This is an array of values which are used for calculating the final transmission ratio along with final drive. If you need a 5 speed car then the size should be 6 with the addition of rear gear. So the first 5 values are forward ratios and the last one is the rear gear ratio. All values should be positive and you can find real cars values on the internet. The default vehicle has only 1 forward and 1 backward gear so you can try the values in the image above.

Axle Settings :

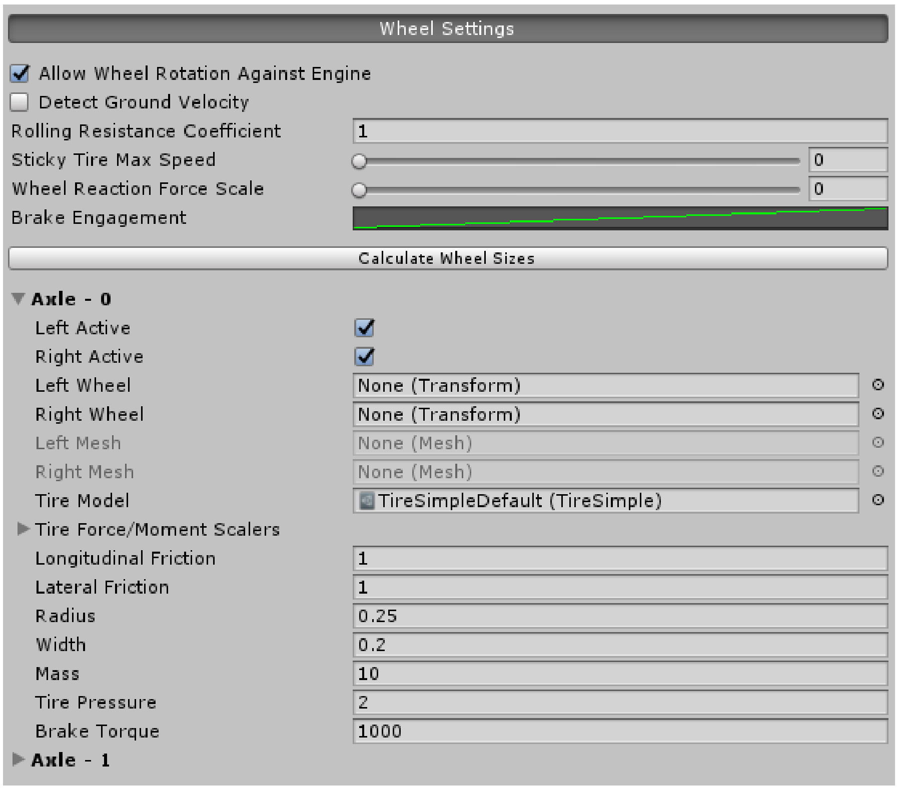


- **Axle Count** : This project is currently focused on 2 axled cars but you may add additional axles if you want. Axles are indexed/named with numbers starting with 0.
- **Torque Share** : The ratio of the torque received from engine. In reality the sum of the shares should be 1 but it is not constraint.
- **Has Handbrake** : If set this axles wheels are effected by handbrake.
- **Max Steer Angle** : Maximum angle(degree) of steering for this axles wheels. For non steering wheels just leave it at 0.
- **Ackerman Coefficient** : Ackerman steering values are automatically calculated from this axle and the reference axle. This value determines the rate this calculation is applied. Providing negative values for anti ackerman is also possible.
- **Ackerman Reference Axle** : Ackerman calculation is based on the current axle and the axle that is referenced by this index value. Normally this value is the index of the rear axle.
- **Camber Angle** : Camber angle value in degrees. This value visually changes the wheels roll angle and is fed to the tire model. To get a better idea of camber and toe check some videos*.
- **Toe Angle** : Toe angle value in degrees. This value visually change the wheels yaw angle and modifies the direction of the force output of the wheel.
- **Differential Type** : If you do not know what a differential is check some videos**. Currently open, locked and lsd differentials are supported.
- **Differential Strength** : This parameter is only visible if lsd type is selected and determines the magnitude of the extra force that is applied to the gripping wheel.

*https://www.youtube.com/watch?v=_D_vg8gnMms

**https://www.youtube.com/watch?v=yYAw79386WI

Wheel Settings :

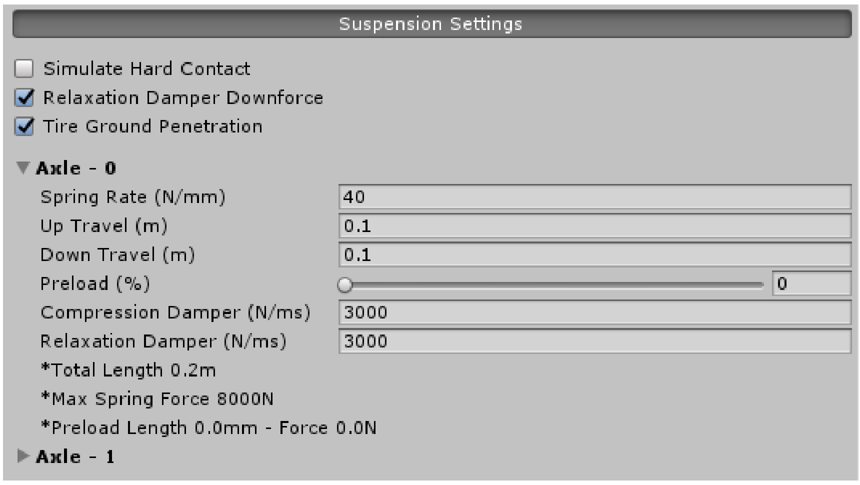


- **Allow Wheel Rotation Against Engine :** Suppose you are climbing a ramp in 1st gear and you release the throttle and wait for the car to slow down and stop. Since there is no engine stalling the car will start going backwards as if you have pressed the clutch if this value is set. If not set, the wheels will resist going backwards.
- **Detect Ground Velocity :** Check this if you want your vehicle to stay on moving platforms. Normally the ground velocity of the wheels are calculated just from the rigidbody but if you enable this, the velocity of the rigidbody that the wheels have contact with, will be taken into account while calculating the ground velocity. If the ground has no rigidbody then this will have no effect.
- **Rolling Resistance Coefficient :** This is the inherent friction factor of wheels. The applied friction force increases linearly as the wheels rotate faster. You may adjust it to limit the maximum speed but be aware that it also decreases the acceleration of the vehicle. Warning : Giving high values usually results unwanted behavior with this one.
- **Sticky Tire Max Speed** : Pacejka tire model does not work well at low speeds. When the velocity gets too small the calculations get problematic so tires can slide slowly on a slope even if the vehicle is fully stopped. This is an experimental hacky solution to solve this issue. When the vehicles velocity is below this speed(kmh) the tires will switch to sticky state. If you keep this value at 0 then it is disabled.
- **Wheel Reaction Force Scale** : Tires generate friction forces to move the vehicle and suspensions generate forces to keep the vehicle away from ground. If you want the generated forces applied back to dynamic objects in your scene set this variable to 1. Sometimes generated forces are too large for objects with low mass so you can use a smaller value instead.

- **Brake Engagement :** Brake input takes values between 0 and 1. If brake is fully pressed it is 1 and if it is not pressed at all then it is 0. This value changes linearly as you press the pedal. The brake input represents the X-Axis of this curve and the resulting value represents the real brake power ratio. Brake pedal behaviour changes from vehicle to vehicle so you can customise it with this curve. The default curve is a linear pedal.
- **Calculate Wheel Sizes :** This button tries to calculate the wheel sizes(radius and width) from the attached wheel models. If Left/Right wheel transforms are not provided, it won't work.
- **Left/Right Active :** You can check/uncheck this to enable/disable a wheel. The effect is only physical so if you want to hide the disabled wheel you need to do it yourself. Check runtime.scene for a demonstration.
- **Left/Right Wheel** : Transform of the wheels visual representation. This will be positioned and rotated according to the simulation. When the suspension is fully compressed in game, the position of wheels will be at this position. If no transform is provided by user, the code will look for game objacts with the following name format : AxleIndex + L or R + Wheel. For ex. "0LWheel" for front left wheel or "1rwheel" for rear right wheel. If you use this format you do not have to assign these values.
- **Left/Right Mesh** : These will become active if you select convex casting option. You can provide a custom mesh for casting but you need to make sure it's size and orientation matches the unity's default cylinder model. If you keep them null unity's default cylinder mesh is used. You can see the convex mesh used for casting when you select the vehicle and enable gizmo view.
- **Tire Model** : This is a reference to the TireModel scriptable object that is used for calculating wheel forces. When you try to select a tire model you will see a list of all the tiremodels that are found in the project and existing tire models can be found in Resources/Tires folder. If you do not select a tire model the first model(Tire96Basic) will be created automatically for you. If you want to create a new tire model use "Create->FGear" menu in the project panel. Check "TireModels" section for more detailed information.
- **Tire Force/Moment Scalers** : These scale parameters are direct multipliers to the resulting forces so using values other than "1" is out of realism. All tire models generate Fx, Fy and My. <u>Mx and Mz are only generated by MF6.1 tire model</u>. Keep in mind that the force names Fx, Fy, Mx, My, Mz are taken from formulas so their axis convention is different then unity. For ex. Mz is actually a yaw moment.
    - **(Fx)Longitudinal Force Scale**: The final longitudinal tire force is multiplied with this.
    - **(Fy)Lateral Force Scale:** The final lateral tire force is multiplied with this.
    - **(Mx)Over-Turn Moment Scale:** The final Z-Axis moment is multiplied with this.
    - **(My)Wheel-Roll Moment Scale:** The final X-Axis moment is multiplied with this.
    - **(Mz)Self-Align Moment Scale:** The final Y-Axis moment is multiplied with this.
- **Lateral Friction** : The output of the tire models lateral force is multiplied with this value. Even if you use large values the final tire force will be limited. If you want to directly adjust resulting forces then you should use the scaler parameters above.
- **Longitudinal Friction** : The output of the tire models longitudinal force is multiplied with this value. Even if you use large values the final tire force will be limited. If you want to directly adjust resulting forces then you should use the scaler parameters above.
- **Radius** : Radius of the wheel in meters. You can see the resulting circle in the editor mode and in the play mode if you enable gizmos.

- **Width** : Wheels do not have real width in this system but the width(in meters) parameter is integrated to effect one thing. If you set lateral ray count to 2 or 3 then the distance between the rays are calculated using the width value. The best practice is to use realistic values and you can preview the tire width with the gizmos drawn.
- **Mass** : Represents the mass of the wheel and used for calculating the rotational acceleration of the wheels. Lower mass wheels tend to spin more and higher mass wheels spin less. Too small values usually result jittery behaviour and too high values limit accelerations so try to experiment and use logical values.
- **Tire Pressure** : Inflation pressure of tire in bars. The default value 2 bars is about 29 psi. This is only used by MF6.1 tire model. You can preview the effect of tire pressure in TireMF61 scripts editor ui, play with the reference tire pressure.
- **Brake Torque** : Brake torque applied when the braking input is %100. If you need more torque for handbrakes, there is a parameter for that in General Settings.

Suspension Settings :

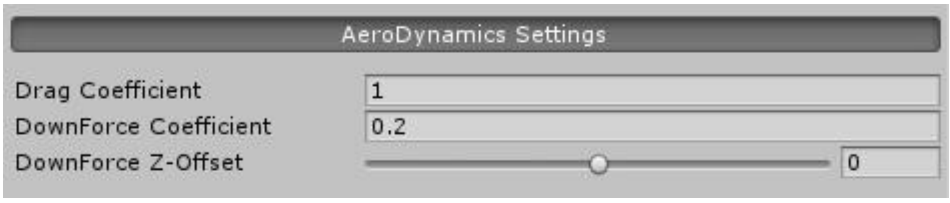


- **Simulate Hard Contact :** If checked the suspension will generate an extra force after being fully compressed. This extra force will try to prevent the suspension from compressing more then its limit. Warning : This feature is not recommended anymore, try SuspensionConstraint script instead, check *constraint.scene* and see its explanation in 3-Extras.pdf
- **Relaxation Damper Downforce :** If this is checked the relaxation damper can generate forces that pulls the vehicle towards the ground. This is mostly unnoticable at low values but if you provide a large value to relexation damper then you can observe that the vehicle will tend to stick to the ground even on bumpy surfaces. This is unrealistic but can be useful in certain cases where you need stable vehicles on rough terrain.
- **Tire Ground Penetration :** It is not always possible to keep the suspension compression within limits. If the suspension is compressed beyond its limits then there are two possibilities. If this is checked the tires will penetrate the ground else the tires will stay on ground but can penetrate the fenders.

- **Spring Rate :** Suspension spring force per mm, total force is displayed at the bottom. If your spring rate is not sufficient then you can not get the desired ride height so you are recommended to open telemetry gui and tweak accordingly.
- **Up Travel :** Total suspension spring length is divided into up&down travel values. This is the maximum distance in meters that your suspension will compress after the default pose. This will not effect the visible ride height.
- **Down Travel :** This is the maximum distance in meters that your suspension will extend after the default pose. This value is the one that will effect the visible ride height.
- **Preload :** This is the percentage of suspension length that is already compressed while it is fully extended. Final preload length and force is displayed at the bottom.
- **Compression Damper :** Suspension compression damper force per 1 ms velocity. This value is used when suspension is compressing and it absorbs some of the spring force and reduces suspension oscillations.
- **Relaxation Damper** : Suspension relaxation damper force per 1 ms velocity. This value is used when suspension is compressing and it absorbs some of the spring force and reduces suspension oscillations. Also see *Relaxation Damper Downforce.*

Suspensions have a great effect of your vehicles driving behaviour. To get a better idea of suspensions check some videos : https://www.youtube.com/watch?v=e_EAWKGvSp0

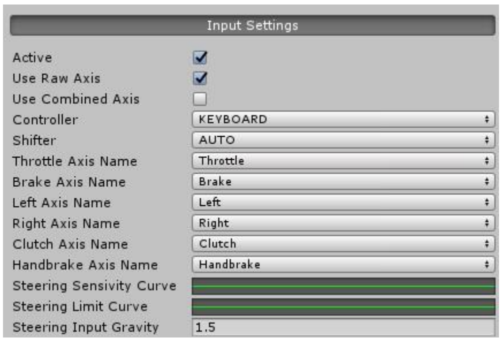
AeroDynamics Settings :

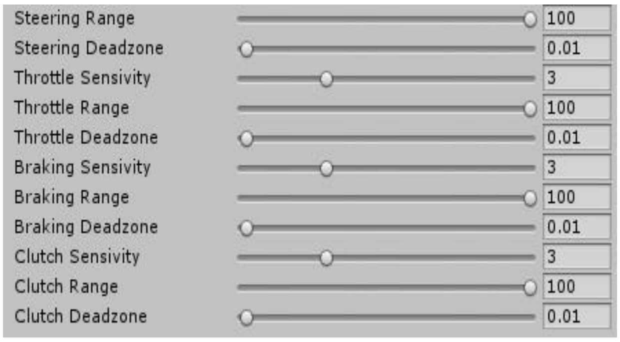


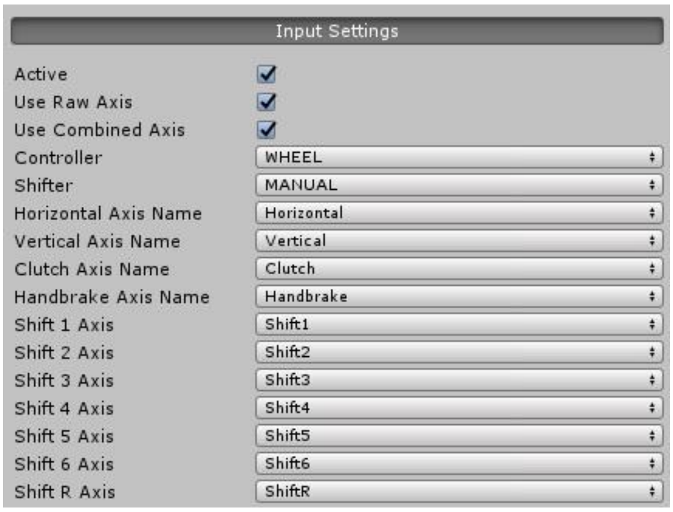
- **Drag Coefficient** : Aero drag is calculated using a unit area factor, vehicle speed and air density constant. This value is multiplied with the result of this calculation. The direction of the force is always the opposite of vehicles velocity.
- **DownForce Coefficient** : Just like drag force, the calculated down force is multiplied with this value. The direction of the down force is against the gravity.
- **DownForce Z-Offset** : If you want the down force to be applied more to the front of the vehicle give a positive value in meters and negative for the rear side.

Input Settings : Unity input manager is used for configuring inputs. Top left image shows common options for the keyboard and joystick. Top right image shows the common options for all controller types and the bottom image shows the options for a steering wheel+shifter. The axis settings that were used in development is available here :
https://www.dropbox.com/s/h69d08r1lbf460i/InputManager.asset?dl=0

Download the file and overwrite yours if you want to get a head start instead of preparing axis configurations. Steering wheel input is tested with a logitech g29 wheel and if you want to use a steering wheel, you need a combined axis for throttle and brakes(for ex. check combined pedals option in logitech gaming software).







- **Active** : If unchecked user inputs will not have any effect. For example the AIInput component automatically unchecks this if attached.
- **UseRawAxis** : This applies only to horizontal(steering), vertical(throttle/braking) and clutch axis. Unity input system has two methods for retrieving axis data, GetAxis and GetAxisRaw. GetAxis smooths/filters raw values according to the settings in unity input manager. If checked raw axis will be used and axis data will be filtered by fgears input system. If unchecked both unity and fgear will be filtering axis data so the result will be cumulative which might be undesirable. With unity you get global input filtering on the other hand fgears filtering will be per vehicle.
- **UseCombinedAxis** : This applies only to throttle, brake and steering controls. If you want to use a combined axis like *Vertical Axis* for throttle/brake controls and *Horizontal Axis* for

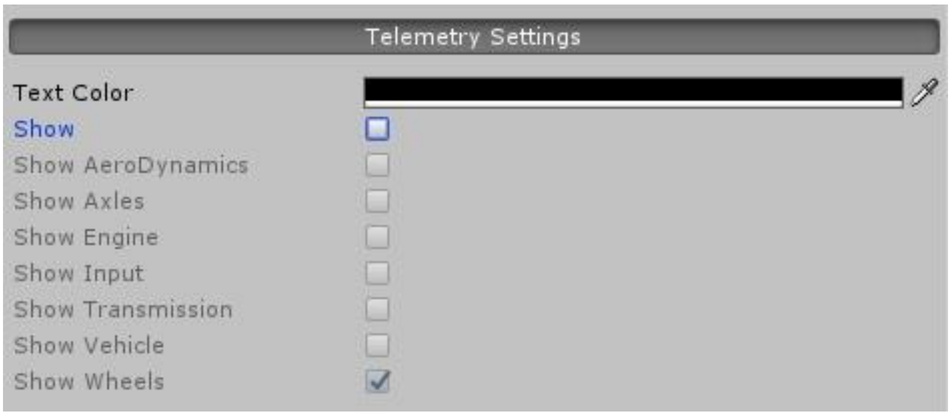
steering then enable this. If you want to use seperate axis for those then uncheck this option and setup proper axis values.

- **Controller** : Type of the controller : Keyboard, joystick or wheel. Most of the controls can work at the same time, for ex. even if you select keyboard you can play with joystick too.
- **Shifter** : Type of the shifter : Auto, sequential or manual. If the AutoChange option of the transmission is checked this selection has no effect but if you want to manually change gears then you can choose a sequential mode or full manual mode.
- **Horizontal Axis Name** : This is the steering axis name and this is only available if you check UseCombinedAxis option. Range : [-1, 1]. If UseRawAxis is checked dead zone or other settings of the input manager has no effect, use the provided settings like sensivity or deadzone, check them below.
- **Vertical Axis Name** : This is a combined axis for throttle and brakes and only available if you check UseCombinedAxis option. Range : [-1, 1]. If UseRawAxis is checked RawAxis is read from unity input system.
- **Throttle Axis Name** : If you uncheck UseCombinedAxis option you can assign an axis for throttle with this. Range : [0, 1]. If UseRawAxis is checked dead zone or other settings of the input manager has no effect, use the provided settings like sensivity or deadzone, check them below.
- **Brake Axis Name** : If you uncheck UseCombinedAxis option you can assign an axis for braking with this. Range : [0, 1]. If UseRawAxis is checked dead zone or other settings of the input manager has no effect, use the provided settings like sensivity or deadzone, check them below.
- **Left Axis Name** : If you uncheck UseCombinedAxis option you can assign an axis for left steering with this. Range : [0, 1]. If UseRawAxis is checked dead zone or other settings of the input manager has no effect, use the provided settings like sensivity or deadzone, check them below.
- **Right Axis Name** : If you uncheck UseCombinedAxis option you can assign an axis for right steering with this. Range : [0, 1]. If UseRawAxis is checked dead zone or other settings of the input manager has no effect, use the provided settings like sensivity or deadzone, check them below.
- **Clutch Axis Name** : Clutch axis for manual transmission. Range : [-1, 1] but internally normalized to [0,1]. If UseRawAxis is checked RawAxis is read from unity input system.
- **Handbrake Axis Name** : Handbrake input axis. Range : [0, 1]. Smoothed axis is read from unity which means you can use the settings of the input manager of unity.
- **Shift Axis Name** : This is a combined axis for gear up and gear down. Range : [-1, 1]. Smoothed axis is read from unity.
- **Shift 1/2/../R Axis Name :** Axis names for each gear. Range : [0, 1]. Smoothed axis is read from unity.
- **Steering Sensivity Curve** : If you want the steering speed to decrease as the vehicle goes faster you can use this curve. The x-axis represents speed in kmh and the y-axis is the steering speed.
- **Steering Limit Curve** : If you want the maximum steering angle to be limited as the vehicle goes faster you can use this curve. The x-axis represents speed in kmh and the y-axis should

be a value between 0 and 100. 100 means steering is not limited and 0 means no steering possible at all. The limit angle is calculated as (value/100) * MaxSteerAngle.

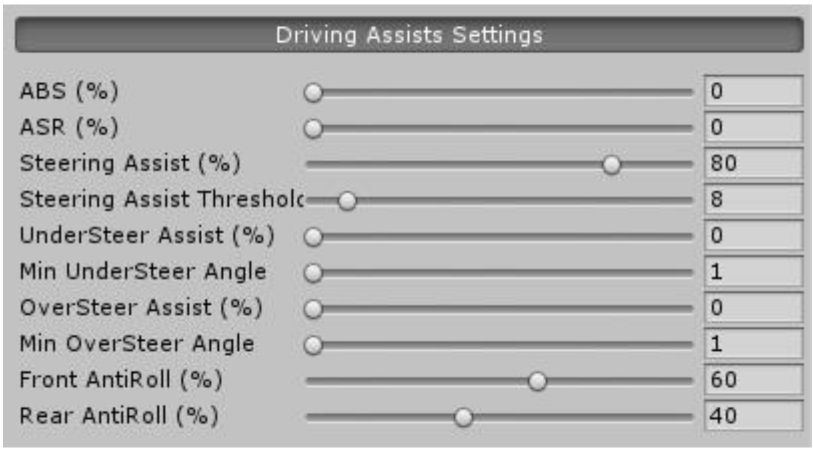
- **Steering Input Gravity** : If the current steering angle and the desired steering angle have different signs than current steering speed is multiplied with this value. This lets user to counter steer more easily with the keyboard or joystick.
- **Steering Sensivity** : This value is only used when the controller is a wheel. This determines how fast the steering value catches up with the input axis value. Higher values result sharper steering.
- **Steering Range** : The percentage of steering range. For ex. if you set this to %10 then a %10 input will result %100 steering. Another example is that a steering wheel with 900 degress of working range needs 450 degrees of rotation to make a full turn but if this value is %10 then a 45 degrees of rotation will make a full turn.
- **Steering Deadzone** : Input values below this value are discarded. A small dead zone is mostly usefull.
- **Throttle Sensivity** : This determines how fast the throttle value catches up with the input axis value. Higher values result sharper throttle.
- **Throttle Range** : The percentage of throttle range. Works similar to steering range.
- **Throttle Deadzone** : Input values below this value are discarded. A small dead zone is mostly usefull.
- **Braking Sensivity** : This determines how fast the braking value catches up with the input axis value. Higher values result sharper braking.
- **Braking Range** : The percentage of braking range. Works similar to steering range.
- **Braking Deadzone** : Input values below this value are discarded. A small dead zone is mostly usefull.
- **Clutch Sensivity** : This determines how fast the clutch value catches up with the input axis value. Higher values result sharper clutch engagement.
- **Clutch Range** : The percentage of clutch range. Works similar to steering range.
- **Clutch Deadzone** : Input values below this value are discarded. A small dead zone is mostly usefull.

Telemetry Settings :



- **Text Color** : Text color of telemetry ui.
- **Show** : Shows/Hides all telemetry windows available. Use other checkboxes for each individual window to show or hide. A sample of engine and transmission windows are show below. These windows can be dragged around.

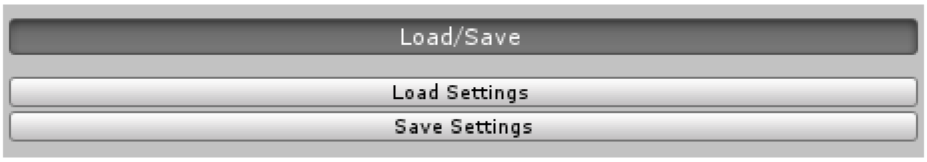
Driving Assists Settings :



- **ABS** : The antilock braking system helps to prevent wheels from locking up when braking.
- **ASR** : Traction control assist helps to prevent loss of traction of driven wheels when accelerating.
- **Steering Assist** : Steering assist tries to steer towards the direction that the vehicle body travels.
- **Steering Assist Threshold** : If the angle between the steering direction and the vehicles velocity direction is above this value, steering assist is activated.
- **Under Steer Assist** : Helps to prevent understeering by using brakes like an esp system. This only works for 4 wheel vehicles.
- **Min UnderSteer Angle** : If the angle between the steering direction and the vehicles velocity direction is above this value, under steer assist is activated.
- **Over Steer Assist** : Helps to prevent oversteering by using brakes like an esp system. This only works for 4 wheel vehicles.
- **Min OverSteer Angle** : If the angle between the steering direction and the vehicles velocity direction is above this value, over steer assist is activated.
- **Front AntiRoll** : Anti roll bars help to reduce body roll during fast cornering. Front antirollbars help to reduce oversteering. This only works for 4 wheel vehicles. Current implementation of antiroll bars transfer spring force between wheels which is kinda realistic but as the values get close to %100 instabilities may occur so try to keep it around %50. There is also an alternative(unrealistic but effective) implementation in ArcadeAssists.cs script.
- **Rear AntiRoll** : Rear anti rollbars help to reduce understeering. This only works for 4 wheel vehicles.

Save/Load Settings: Saves and loads current vehicle settings to/from a json file. Instead of making multiple prefabs for a vehicle, you can use this feature to change between different setups.

Warning : This is only intended to be used as an editor tool not to be used in play mode.



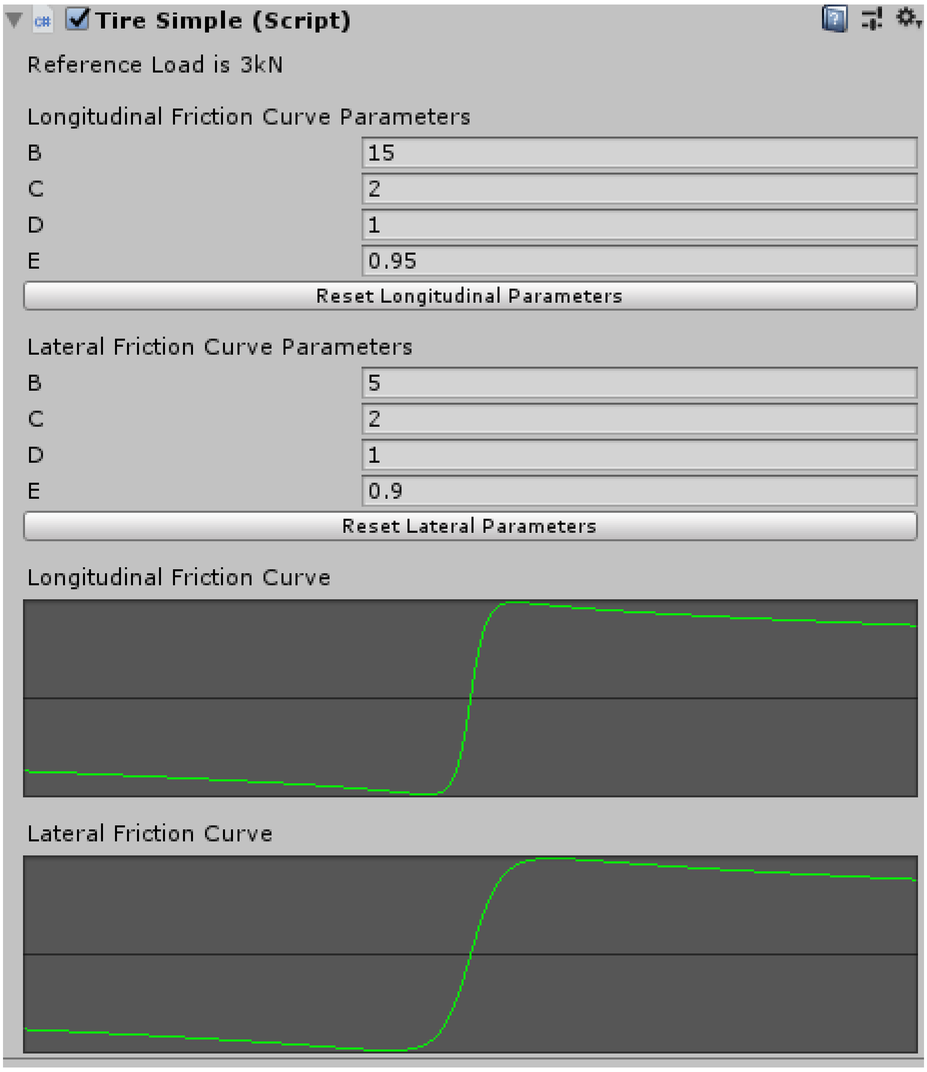
- **Save :** Asks for a save location and creates a json file that contains all serialized fields of the vehicle.
- **Load :** Loads the selected json file, retrieves the saved settings and applies to the current vehicle.

Note : *Since version 1.1 you can also save/load tire models.*

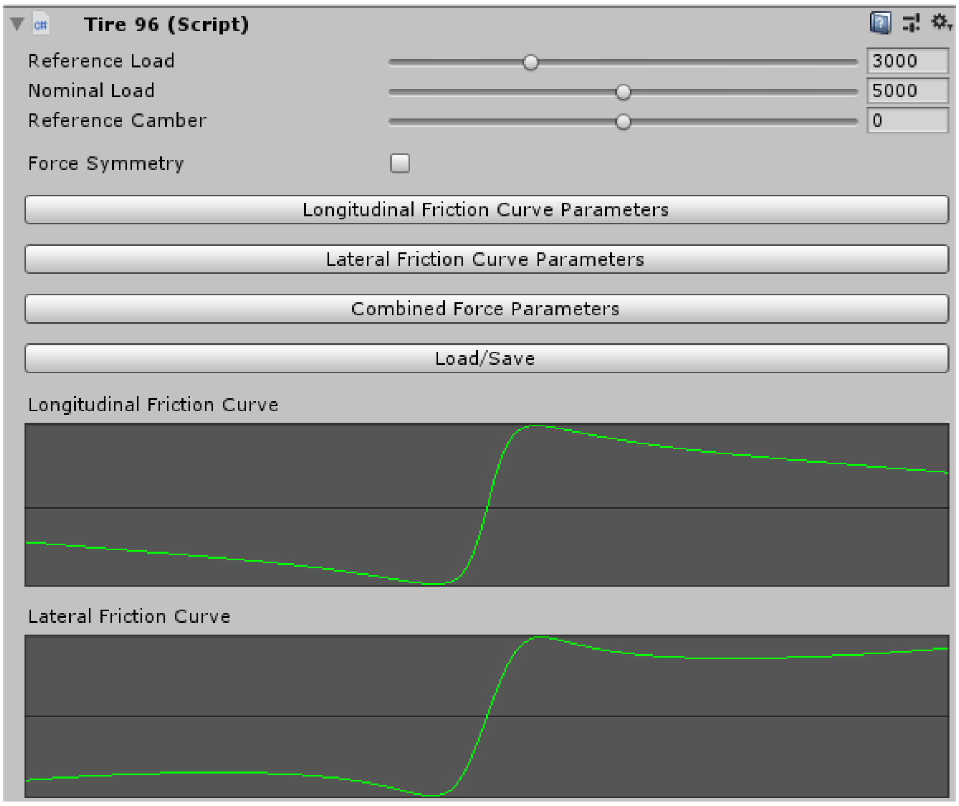
Tire Models : FGear uses pacejka's magic formula tire modelling approach. This is a curve fitting algorithm and it has no releation to physical properties of a tire but it has great precision and widely used in lots of fields. Pacejka's formula has multiple versions but the fundamentals are the same. FGear uses pacejka96 and MF6.1 version but a simplified version is also available. There are a couple of ready to use tire models in Resources/Tires folder and they will appear in the TireModel combobox of Wheel options. If you want to create a new tire model use "Create->FGear" menu in the project panel.

TireSimple : This version has only 4 parameters(B,C,D,E) and is independent from load or camber.

B : Stiffness - C : Shape - D : Peak - E : Curvature



Tire96 : This is the pacejka96 tire model and it has many parameters. There are lots resources available on the internet about tire models so if you want to learn its details you can easily find them but the real deal is about finding good parameter sets. Real pacejka sets are not free and not easy to come by. The default parameters provided in this package are a good starting point for you to tweak.



List of longitudinal friction pure slip paremeters:

PCX1 : Shape factor Cfx for longitudinal force
PDX1 : Longitudinal friction Mux at Fznom
PDX2 : Variation of friction Mux with load
PEX1 : Longitudinal curvature Efx at Fznom
PEX2 : Variation of curvature Efx with load
PEX3 : Variation of curvature Efx with load squared
PEX4 : Factor in curvature Efx while driving
PKX1 : Longitudinal slip stiffness Kfx/Fz at Fznom
PKX2 : Variation of slip stiffness Kfx/Fz with load
PKX3 : Exponent in slip stiffness Kfx/Fz with load
PHX1 : Horizontal shift Shx at Fznom
PHX2 : Variation of shift Shx with load
PVX1 : Vertical shift Svx/Fz at Fznom
PVX2 : Variation of shift Svx/Fz with load

List of lateral friction pure slip paremeters:

PCY1 : Shape factor Cfy for lateral forces
PDY1 : Lateral friction Muy
PDY2 : Variation of friction Muy with load
PDY3 : Variation of friction Muy with squared inclination
PEY1 : Lateral curvature Efy at Fznom
PEY2 : Variation of curvature Efy with load
PEY3 : Inclination dependency of curvature Efy
PEY4 : Variation of curvature Efy with inclination
PKY1 : Maximum value of stiffness Kfy/Fznom
PKY2 : Load at which Kfy reaches maximum value
PKY3 : Variation of Kfy/Fznom with inclination
PHY1 : Horizontal shift Shy at Fznom
PHY2 : Variation of shift Shy with load
PHY3 : Variation of shift Shy with inclination
PVY1 : Vertical shift in Svy/Fz at Fznom
PVY2 : Variation of shift Svy/Fz with load
PVY3 : Variation of shift Svy/Fz with inclination
PVY4 : Variation of shift Svy/Fz with inclination and load

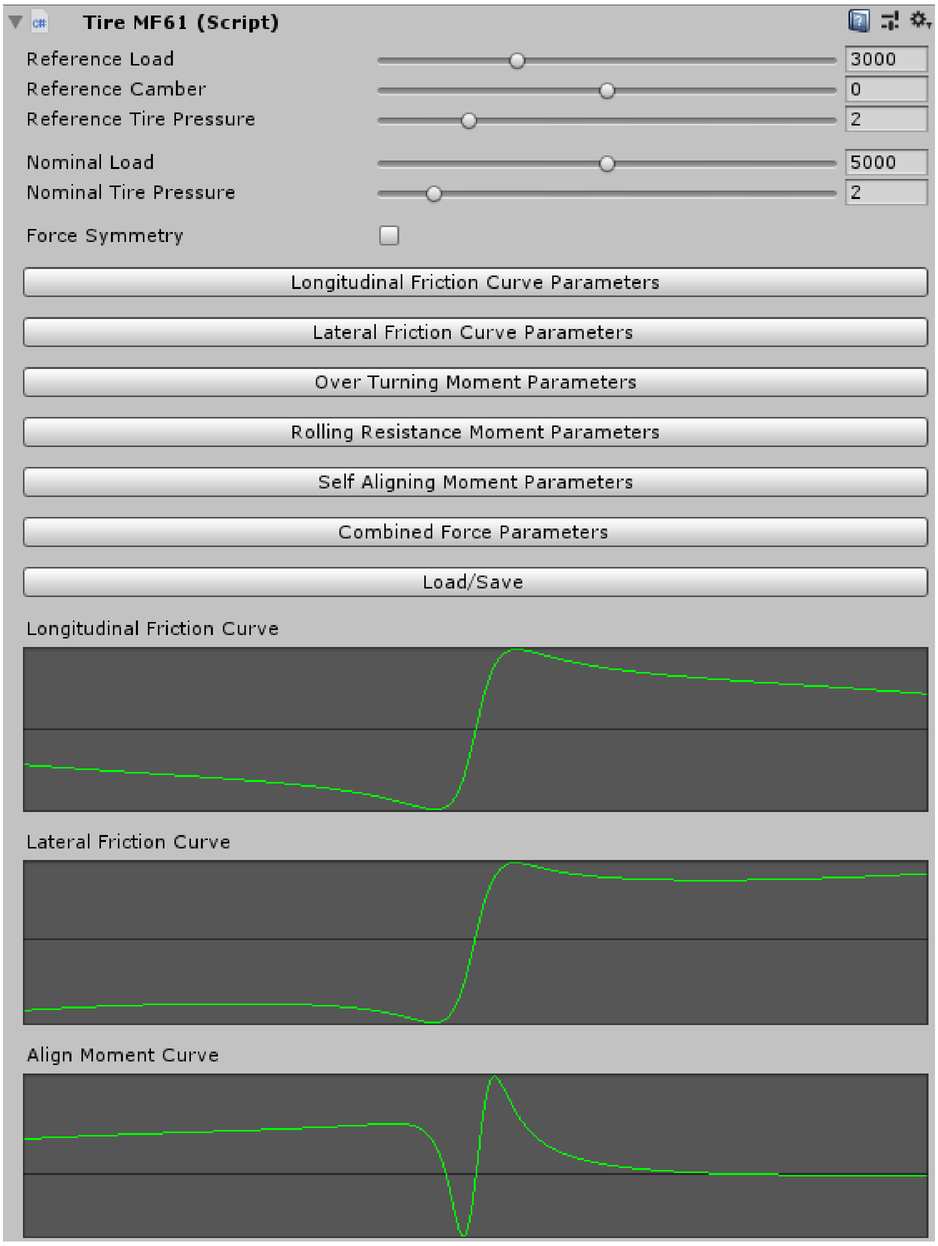
List of longitudinal friction combined slip paremeters:

RBX1 : Slope factor for combined slip Fx reduction
RBX2 : Variation of slope Fx reduction with kappa
RCX1 : Shape factor for combined slip Fx reduction
REX1 : Curvature factor of combined Fx
REX2 : Curvature factor of combined Fx with load
RHX1 : Shift factor for combined slip Fx reduction

List of lateral friction combined slip paremeters:

RBY1 : Slope factor for combined Fy reduction
RBY2 : Variation of slope Fy reduction with alpha
RBY3 : Shift term for alpha in slope Fy reduction
RCY1 : Shape factor for combined Fy reduction
REY1 : Curvature factor of combined Fy
REY2 : Curvature factor of combined Fy with load
RHY1 : Shift factor for combined Fy reduction
RVY1 : Kappa induced side force Svyk/Muy*Fz at Fznom
RVY2 : Variation of Svyk/Muy*Fz with load
RVY3 : Variation of Svyk/Muy*Fz with inclination
RVY4 : Variation of Svyk/Muy*Fz with alpha
RVY5 : Variation of Svyk/Muy*Fz with kappa
RVY6 : Variation of Svyk/Muy*Fz with atan (kappa)

TireMF61 : This is the magic formula 6.1 tire model and it has many more parameters(over 100). Tire96 is limited to Fx and Fy outputs but this one also generates momentum effects namely Mx, My and Mz. The details of this model is covered in Pacejkas *Tire and Vehicle Dynamics* book. The default parameter set is taken from the book but the parameters of pacejka 96 could also be adapted. The reference parameters like Reference Load, Reference Camber and Reference Tire Pressure are for previewing so they do not effect the tire model and they are not saved.



Nominal Load : This value is also used in pacejka formula and here is a good explanation : https://www.tut.fi/ms/muo/vert/11_tyre_as_car_component/handling_braking_pure.htm

Quoting from that source:

The nominal tyre load is related to the maximum admissible static load for the specific temperature and speed index, usually referred to as the ***ETRTO value****(European Tyre and Rim Technical Organisation). The speed index indicates the maximum speed for which the tyre is allowed to be used, before it destroys itself due to overheating, as a result of high-frequency standing waves responsible for a strong increase of internal deformation power being converted into heat*
Choosing the nominal value F_{z0} being equal to 80% of this ETRTO value, a reasonable choice for F_{z0} is listed in table below:

Class	***F_{z0} [N]***	***Example***
Compactclass	*3000*	*VW-Polo*
Middleclass	*5000*	*VW-Passat, BMW-5,..*
Topclass	*6000*	*Audi A8*

Hence, a specific nominal tyre load is related to a class of tyres, with the same maximum allowable operating speed. Different nominal tyre loads refer therefore to different classes of tyres, in contrast to the variation in tyre load for one specific tyre (due to static load variations, load transfer during cornering, etc.).

Nominal Tire Pressure : This value is required by the MF6.1 tire model for the pressure dependent effects. Normally this can be set to the default tire pressure(P) of the tire. Keep it between P - 0.5 and P + 0.5 bars.

Force Symmetry : If checked the negative side of the tire model curves will be symmetrical to the positive sides. Some tire model parameters can shift the origin of tire model curves and it might be desirable to avoid that but in most cases leave this disabled.