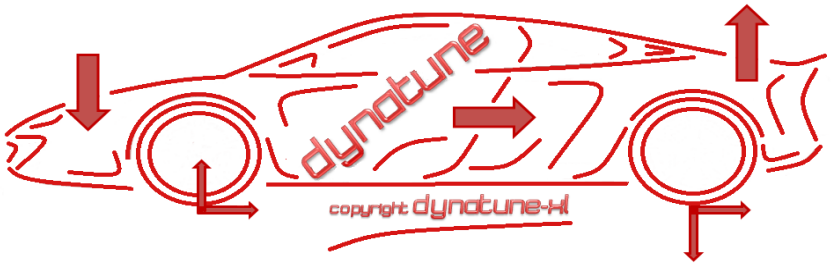

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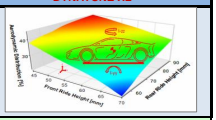
DYNATUNE RIDE & HANDLING "EXPERT" VERSION - RELEASE 8.1

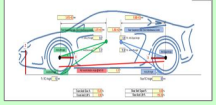
On each worksheet one can click on the pictures in the header which will redirect to the corresponding web page (left) or the related FAQ support page (right). PASSWORD = dyna4xl1989



DYNATUNE has been developed in order to provide a convenient MS EXCEL based tool for quick parameter studies based on a eleme ntary car data set. DYNATUNE is entirely based on analytical equations which are commonly available in automotive engineering and for decades have proven their validity. DYNATUNE has been developed to be used especially in the conceptual phase and/or during the final chassis development where it has proved to be also an excellent support for the engineers providing either a quick setup tool allowing theoretical support to their daily business or a useful tracking tool for their data. Every aspect of setting up a car is analyzed in a specific sheet. Main objective for the development of DYNATUNE was providing a robust customer driven development tool in EXCEL with a minimum of data necessary. **In RACE & EXPERT Version of DYNATUNE a Laptime Simulator & Test-Tracks have been included with resp. Control panels.**

There are 3 main "Sections" in the tool, each with their Specific Application. All Worksheets are related to a Specific Secti on either providing Input Data or presenting detailed Analysis Results.

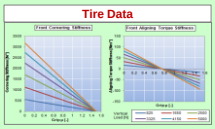
Chassis Data

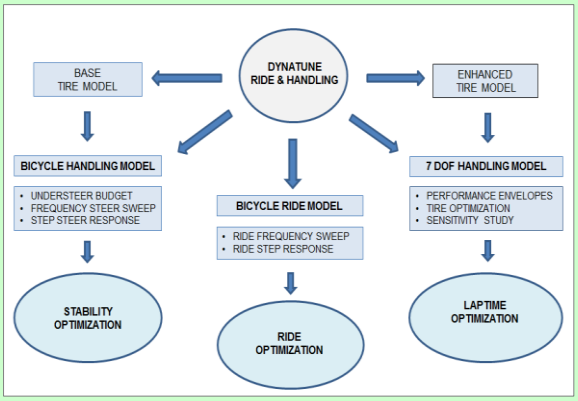


Master Dashboard

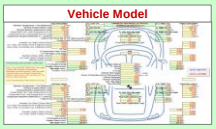
Vehicle Data

Tire Data

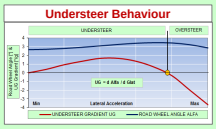




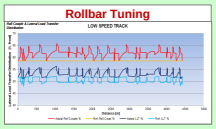
Vehicle Model



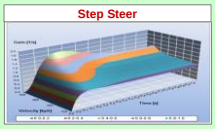
Understeer Behaviour



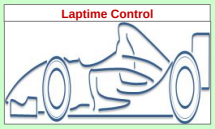
Rollbar Tuning



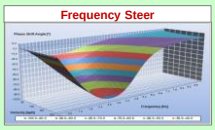
Step Steer



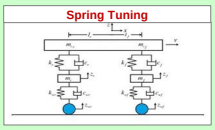
Laptime Control



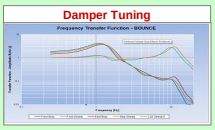
Frequency Steer



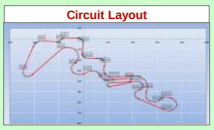
Spring Tuning



Damper Tuning



Circuit Layout



All frequently used data are being entered in the "**MASTER DASHBOARD**" sheet. The sheet permits therefore next to simulation control also a quick model overview. From there on the data will be distributed to the various detailed calculation sheets and further specific calculation options can be set. In the various other sheets ADDITIONAL (less commonly modified) data has to be entered.

All relevant vehicle data (Mass, Dimensions, Pay-Load, Aerodynamics etc.) have to be entered in the "**VEHICLE DATA**" sheet. Inertia Data and Mass Locations are Ride-Height dependent.

In the "**CHASSIS DATA**" sheet all additional specific SUSPENSION data have to be provided: Basic Kinematic Data, Compliances and Suspension Types. In Version 7.0 and above specific User Guidance Tools are available for Suspension K&C Data.

In the "**TIRE DATA**" sheet all additional specific TIRE data have to be provided: In Version 7.0 and above specific User Guidance Tools are available for Tire Data. Also an "Enhanced" Tire model is available for more in depth tire data presentation and calculation of tire slip angles.

The "**VEHICLE MODEL**" sheet represents the core 7 DOF-vehicle model. Based on the requested load condition the 7 DOF-model will calculate all data for the 4 corners and all necessary data will be passed onwards to the other worksheets. Detailed wheel data of all 4 corners are available. From Version 7.0 onwards so called G-G-V Maps can be calculated which plot the vehicle Performance Envelope as function of Ax, Ay and Velocity for traction and braking .

The "**SPRING TUNING**" sheet provides specific information on typical spring setup parameters of a car. Natural Frequencies, Bounce & Pitch Centers etc.

The "**DAMPER TUNING**" sheet requires all DAMPER data and allows a typical analysis of damper characteristics like percentage of critical damping and various transient ride transfer functions like Ride Step and Ride Frequency Sweep (**Not available in RACE Version**).

The "**ROLLBAR TUNING**" sheet provides all necessary info about basic mechanical balance, based on roll couple distribution, roll center heights and lateral load transfer distribution.

In the "**UNDERSTEER**" sheet a prediction of the LINEAR range understeer behaviour (UG) is GENERICALLY calculated (based on a bicycle model & the formulas of BUNDORF). Considering spring & rollbar settings (=load transfer) and elementary tire behaviour, understeer gradients are predicted for various g -Levels. Furthermore, if selected in the MASTER DASHBOARD sheet - for a given SPECIFIC lateral acceleration - the UG for one single operating point (considering eventual effects of non-linear bump-stops) can be calculated. From Version 7.0 onwards a full non-linear lateral acceleration sweep can be executed which in combination with the enhanced tire model both provides vehicle and axle slip angles as driver steering whee l angle over the whole lateral acceleration range. Ultimately a unique 4 Dimensional Performance Envelope Graph for Understeer Gradient and Vehicle Side Slip Angle Gradient can be plotted as functio n of Ax, Ay and Velocity (G-G-V Map).

The "**FREQUENCY STEER**" sheet calculates the Generic Frequency Steer Response for YAW, SLIP ANGLE and LATERAL ACCELERATION. In addition - if selected in the MASTER DASHBOARD sheet - a specific "Partially Linearized" Frequency Response can be calculated by entering a specific STEERING WHEEL ANGLE (SWA). By doing so, degressive tire vertical & lateral load characteristics will be taken into account for the resulting lateral acceleration. All calculations are based on a bicycle model and linear laplace transformation. **Not available in RACE Version**

The "**STEP STEER**" sheet calculates the generic STEP STEER Response for YAW, SLIP ANGLE and LATERAL ACCELERATION. In addition - if selected in the MASTER DASHBOARD sheet - a specific "Partially Linearized" STEP STEER Response can be calculated by entering a specific STEERING WHEEL ANGLE (SWA). By doing so, degressive tire vertical & lateral load characteristics will be taken into account for the resulting lateral acceleration. All calculations are based on a bicycle model and linear laplace transformations. **Not available in RACE Version**

In the **"RESULTS"** Sheet one can find for comparison all input and results data for the actual vehicle and a reference vehicle (each in one colu mn) with metrics and plots . Model Data can be im/-exported into/from external Excel (*.xlsx) sheets.

In the **"USER"** sheet one can create one's own data. The sheet is unprotected and allows standard EXCEL operations. All Created Data & Graphs can be exported into an external Excel Workbook.

The "**CIRCUIT LAYOUT**" Sheet does permit the creation of a virtual Test/Race Track/Stage Section. The track MUST consist of at least 4 Straight/Corner sections. The maximum number of corners is 20. All Track-Data is 2D - only. Available are a typical real life High-Speed & Low-Speed Handling Track and a Generic Test Track for quick comparison studies. The ACTUAL Track Layout can be exported/imported into a specific EXCEL file (*.xlsx) for convenient data transfer.

The "**LAPTIME CONTROL**" Sheet has become the 2nd heart of DYNATUNE Ride & Handling. In analogy to the "MASTER DASHBOARD" Sheet is here all simulatio n control concentrated for the Laptime Simulation and related settings.

The "**LAP RESULTS**" Sheets provides in analogy to the "RESULTS" Sheet a customizable sheet with some example of comparison graphs for a current actual lap and a reference [illegible] be exported for external postprocessing.

GOTO MASTER

This Workbook requires the activation of iterations in EXCEL options (manual, 50 iterations, 0,001 accuracy)

Description of Worksheets

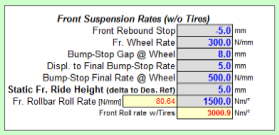
MASTER DASHBOARD - Master Control Sheet

CLICK FAQ → FAQ

Input: **Most Frequently Used common Car Setup Parameters, which will be passed onwards through to the actual reference & calculation sheets.**

- Simple Aerodata:

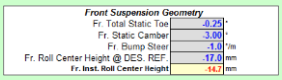
- Commonly Used Platform Data:



NOTE: Will Enable Complex 3D-Aeromaps on the VEHICLE DATA SHEET

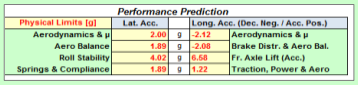
- Most Commonly Used Tire Data:

- Typical Suspension Geometry Tuning Parameters:



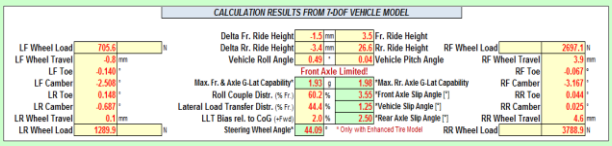
Output: **A Selection of the Most Frequently used Metrics & Graphs:**

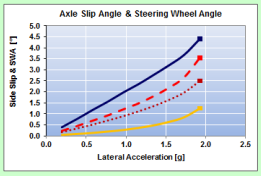
- Performance Estimates from the Bicycle Model:



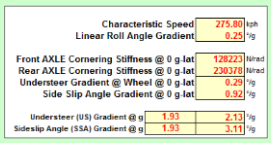
NOTE: The Bicycle Handling Model provides "instantly" an estimation for the Performance Capabilities of the Vehicle at the Imposed Reference Velocity. It does also provide the initial Physical Limits for the Simulation Settings.

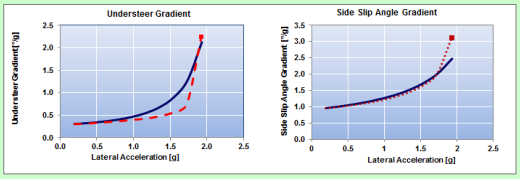
- Metrics & Plots from the 7-DOF Model:



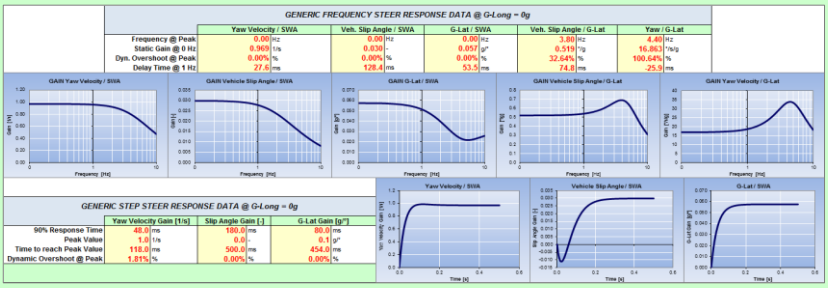


- Understeer Budget Metrics & Plots from the Bicycle Model:



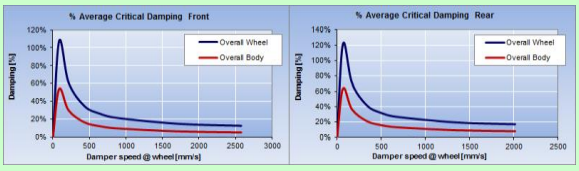


- Step Steer & Frequency Steer Bicycle Model Results **(ONLY IN EXPERT VERSION)**:



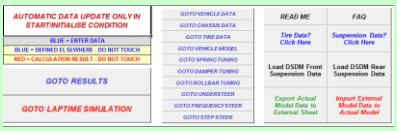
Bounce & Pitch Center				Fwd. Dist. to	Bounce & Pitch Frequency		
m	3.63	-1.87	m	Front Axle	Hz	5.01	10.34	Hz

- Ride Model Results:



Running the Simulations:

At the top of the Worksheet one can find a range of buttons for quick navigation through the Workbook and some Data Handling & Import/Export procedures.



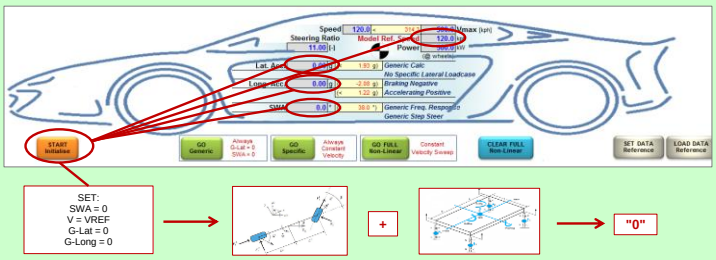
The "START/Initialise" Button will initialise both the Bicycle as the 7-DOF Model to "0" by setting G-Lat = 0, G-Long = 0, Steering Wheel Angle (SWA) = 0 and Model Velocity to Reference Velocity (it will also set some internal iteration parameters to default). After EVERY Setup Change one should run this procedure.

The Bicycle Model is driven by:

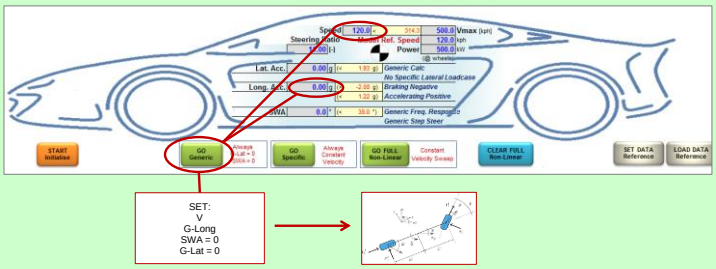
- Speed
- Longitudinal Acceleration
- Steering Wheel Angle

The 7-DOF Model is driven by:

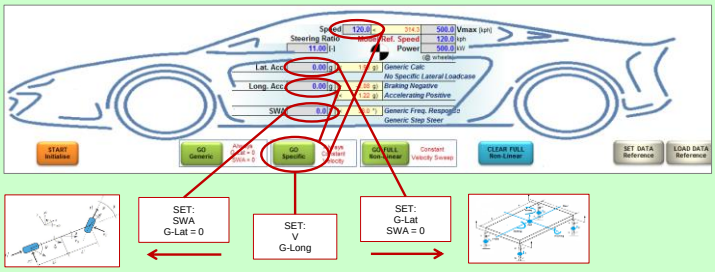
- Speed
- Longitudinal Acceleration
- Lateral Acceleration



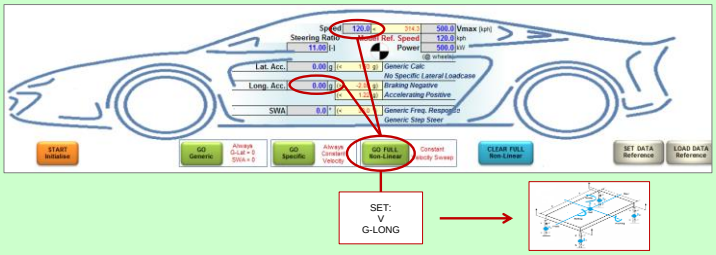
The "GO Generic" Button will run a GENERIC Calculation - primarily addressing the Bicycle Model - and does permit to change only Velocity and Longitudinal Acceleration. The Calculation Procedure will also update all Performance Predictions for the new conditions.



The "GO Specific" Button does run a calculation which will be addressing ONE SPECIFIC Load case for G -Lat, G-Long, SWA & Velocity. However, depending on the Input Values for G-Lat and SWA different models will be used as indicated below. If G-Lat is set to "0" and a SWA is being used, the Bicycle Model will calculate G-Lat out of SWA and calculate the results. If the SWA is set to "0" an a G-Lat Value is used the 7-DOF Model will calculate the corresponding SWA and of course all other Vehicle Data / Metrics.

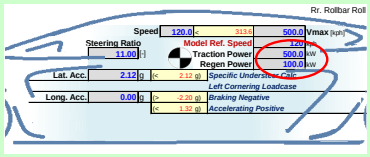


The "GO FULL Non-Linear" Button will run a Full-Lateral-Acceleration - sweep from 0 up to the Maximum Possible Lateral Acceleration for the imposed Velocity & Longitudinal Acceleration.

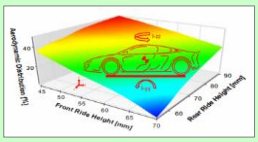


IN RELEASE 8.1 ONE CAN DIFFERENTIATE THE AMOUNT OF TRACTION & REGEN POWER (@ WHEEL) INDEPENDENTLY AND AS SUCH ALLOWING CORRECT SIMULATION OF ICE AND EV POWERTRAIN EFFECTS ON THE DYNAMICS OF THE VEHICLE. THE NEW FEATURE DOES ALSO ALLOW CORRECT IMPLEMENTATION OF DRIVE TORQUE / REGEN TORQUE AND ICE OVERRUN CHARACTERISTICS ON THE NEWLY ADDED LIMITED SLIP DIFFERENTIALS.

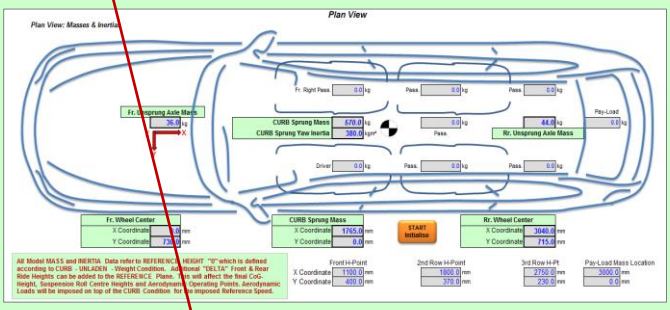
RELEASE 8.1 DOES ALSO ALLOW TO COMBINE REGEN & HYDRAULIC BRAKING IN ORDER TO CORRECTLY REFLECT MODERN EV BRAKE SYSTEMS FULLY CONSIDERING THE PARTICULAR BEHAVIOR OF SUSPENSION ANTI'S.



VEHICLE DATA - Aerodynamics, Dimensions, Masses Input & Other Vehicle Data



Input - Mass Values and Locations of Wheels, Passenger (H-Points) and/or Pay-Load / Ballast Weight:



NOTE: The Vehicle will ALWAYS be kept Symmetrical Left to Right..

All Model MASS and INERTIA Data refer to REFERENCE HEIGHT "0" which is defined according to CURB - UNLADEN - Weight Condition. Additional "DELTA" Front & Rear Ride Heights can be added to the REFERENCE Plane. This will affect the final CoG- Height, Suspension Roll Centre Heights and Aerodynamic Operating Points. Aerodynamic Loads will be imposed on top of the CURB Condition for the imposed Reference

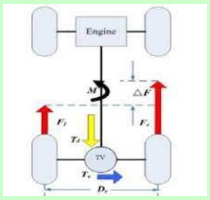
- Brake and Driveline data such as Brake Distribution and Drive Torque Distribution:

RELEASE 8.1 DOES COME WITH QUITE SIGNIFICANT ENHANCEMENTS IN THE POWERTRAIN SECTION. ONE CAN NOW SIMULATE CLASSIC PRE-LOADED LIMITED SLIP DIFFENTIALS AND TURN ON/OFF IDEAL L/R FORCE DISTRIBUTION IN TRACTION OR BRAKING (FULL TORQUE VECTORING) WITH THE CORRESPONDING EFFECT ON THE YAW MOMENT OF THE VEHICLE.

Front Percentage Brake Distribution	50.00%	0 to 100 %	Include Regenerative Braking [1/0]			Percentage Rear Drive Torque	100.00%	0 to 100 %		Front Differential	Rear Differential	
Ideal L/R Brake Distribution [1/0]	0	No	0.000	-0.600	g Regen Only	Ideal LSD (Full Torque Vectoring) - Traction Only [1/0]	0	No	Preload	0.0	50.0	Nm
Max. Deceleration @ Brake Distribution	0.00	g	Fr. max g	Rr. max g		Max. Acceleration @ Traction Configuration	1.32	g	Max % Lock Traction	0.00%	50.00%	%
Optimal Brake Distribution for Max. G	49.30%	% FWD	-2.200	-2.200	g	Optimal AWD Configuration for Max. G	72.26%	% Rr. Torque	Max % Lock Regen	0.00%	0.00%	%

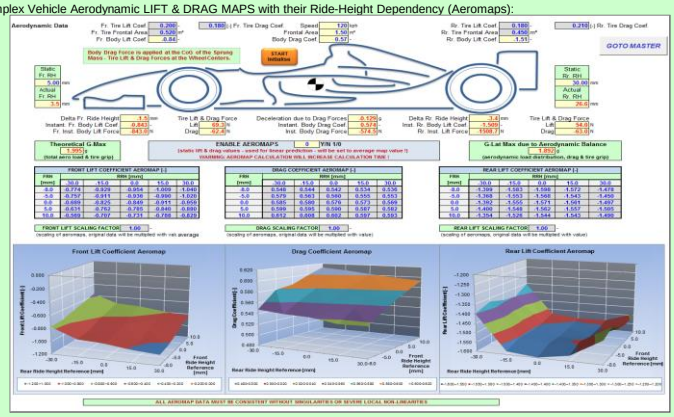
NOTE: One Can Set the Front/Rear Brake Force Distribution to "IDEAL" by entering not a Value but "=OPT_BRAKE_DISTR" in the corresponding Cell.

NOTE: One Can Set the Front/Rear Brake Force Distribution to "IDEAL" by entering not a Value but "=OPT_BRAKE_DISTR" in the corresponding Cell.



Different Left and Right Traction (or Braking Forces) do create a Yaw Moment on the car, which does increase or decrease the amount of Understeer percieved by the driver. When Ideal L/R Braking or Traction Force Distribution is turned off, the simulation will stop when one of the (unloaded) wheels will start slipping. In all Generic and G-Lat = 0 Simulations only the Effects of LSD Preleod will be considerd. The Longitudinal Force Effect on the Yaw Moment of LSD will only be considered when G-Long & G-Lat <> 0.

- Complex Vehicle Aerodynamic LIFT & DRAG MAPS with their Ride-Height Dependency (Aeromaps):



NOTE: When using Aeromaps one must guarantee that the provided data is consistent and make sure that the ride height data points in the maps are covering the Operating Range of the Vehicle. If NOT the data will be incorrectly fitted or wrongly extrapolated.

Output - All Relevant Mass and Inertia Data, Weight Distribution & CoG Location:

Total Mass	650.0	kg	Wheel Base	3040.0	mm	CoG Z-Height	233.1	mm	Total Yaw Inertia	605.3	kgm²
Front Mass	275.1	kg	Fr. Track Width	1460.0	mm	CoG X-Position	1753.6	mm	Total Pitch Inertia	534.4	kgm²
Rear Mass	374.9	kg	Rr. Track Width	1430.0	mm	Weight Distribution	42.32	% Front			

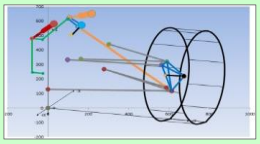
- Instantaneous Aerodynamic Lift & Drag Values:

Delta Fr. Ride Height	-1.5	mm	Tire Lift & Drag Force			Deceleration due to Drag Forces	-0.129	g	Delta Rr. Ride Height	-3.4	mm
Instant. Fr. Body Lift Coef.	-0.843	-	Lift	69.3	N	Instant. Body Drag Coef.	0.574	-	Inst. Rr. Body Lift Coef.	-1.509	-
Fr. Inst. Body Lift Force	-843.0	N	Drag	-62.4	N	Inst. Body Drag Force	-574.5	N	Rr. Inst. Lift Force	-1508.7	N

Tire Lift & Drag Force			
Lift	54.0	N	
Drag	-63.0	N	

REFERENCE RIDE HEIGHT IS DEFINED @ CURB WEIGHT. ONE CAN ADD ON THE MASTERSHEET A "STATIC" RIDEHEIGHT WHICH WILL BE "ON TOP" TO REF. RH. Unsprung Masses are located @ X,Y Wheel Locations and @ Tire Static Loaded Radius Z - Location.

CHASSIS DATA - K&C Suspension Data



Input **- Suspension Type Selection (Independent, Semi-dependent, Solid axle):**

Axle Type	*Front*	*Rear*		
0 = Independent 1 = Solid Axle 2 = Twist Beam (rear only)	0 Independent	0 Independent		U = Understeer O = Oversteer N = Neutral

IN RELEASE 8.1 THE STEERING SYSTEM HAS BEEN REFINED WITH ALL NECESSARY PARAMETERS TO CALCULATE MORE ACCURATELY WHEEL STEER ANGLES & STEERING WHEEL TORQUE FEEDBACK CAUSED BY LATERAL FORCES AND LONGITUDINAL FORCES (Torque Steer).

Front Suspension Steering System Data			
Outer Wheel KP Off. Change w/ Wheel Steer Angle [mm/°]	0.0	80.0	King Pin Offset [mm]
Outer Wheel Scr. Rad. Change w/ Wheel Steer Angle [mm/°]	0.0	10.0	Scrub Radius [mm]
Outer Wheel Trail Change w/ Wheel Steer Angle [mm/°]	-1.5	30.0	Caster Trail [mm]
Percentage Ackermann Steering	100.0	N	

Steering Parameters will not be automatically imported when using SDM Data Import Procedure but will have to be entered manually.

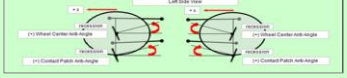
- Suspension Kinematic and Compliance Characteristics (Data from K&C Rig Measurements):

Front Suspension Static Toe and Camber Settings			
Total Static Toe	-0.25	U	°
Static Camber	-3.00	O	°
Front Suspension Wheel Kinematics			
Bump Steer	-1.0	U	°/m
Camber Gain	1.0	U	°/m
Outside Wheel Camber Gain w. Steer Angle	-0.2	O	°/°
Front Suspension Compliances			
Lateral Force Toe Compliance	0.020	O	°/kN
Lateral Force Camber Compliance	0.100	U	°/kN
Brake Steer	-0.030	U	°/kN
Acceleration Steer	0.000	N	°/kN
Aligning Torque Compliance Steer	0.750	U	°/kNm
0			
Front Suspension Anti-Angles & Calculated Anti-Percentage			
Anti-Lift Angle [°]	0.0	0.0	%
Anti-Dive Angle [°]	5.1	55.0	%

Solid Axle & Twist Beam Only (Values will be ignored for Axle Type "0")					
Roll Steer	0.00	N	0.00	N	(° toe) / (° roll)
Roll Camber	0.00	N	0.00	N	(° camber) / (°roll)
Roll Motion					
Actual Roll Steer	-0.01	U	0.01	U	(° toe) / (° roll)
Actual Roll Camber	0.01	U	-0.19	U	(° camber) / (° roll)
Inclination Angle Gain	1.01	U	0.81	O	(° inclination / ° roll)

(Inclination Angle = Vertical Wheel Angle vs. Road)

Front and Rear Anti-Angles Definition



Compliant Data are entered as linear rates.

- Roll Center Location & Roll Center Migration Data:

Front Suspension Roll Center			
Roll Center Height @ DES. REF	-17.0	mm	
Roll Center Height @ Static Ride Height	-12.0	mm	
Roll Center Vert. Mov. vs. Wheel Travel Ratio	1	-	(0=FIXED LOCATION)

- Anti-Dive and Anti-Squat Angles:

Front Suspension Anti-Angles & Calculated Anti-Percentage			
Anti-Lift Angle [°]	0.0	0.0	%
Anti-Dive Angle [°]	5.1	55.0	%

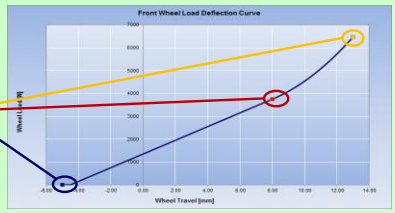
- Special Spring / Rollbar Configurations typically used in Racing Environments (Mono Spring / 3rd Spring Configurations):

☑ COUPLE HEAVE SPRING RATE AND ANTI-ROLLBAR RATE IN ROLL (STANDARD SETTING)

Typically the Heave-Springs do add to the Total Rollrate of the Suspension. However one can create Suspension Spring & Rollbar Linkages which do allow to De-Couple Heave Spring Rate from Anti-Rollbar Rate completely. When De-Coupled, the Heave Springs & Bumpstops will NOT contribute to the Total Rollrate. In such case please START/INITIALIZE the Model new.

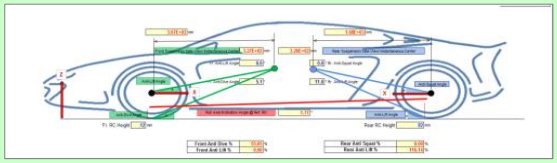
Output - Wheel Load Deflection Curve:

Front Suspension Wheel & Roll Rates		
Linear Wheel Rate	300.0	N/mm
Rebound Stop Position @ Wheel	-5.0	mm
Bump-Stop Gap @ Wheel	8.0	mm
Displ. to Final Bump-Stop Rate @ Wheel	5.0	mm
Final Bump-Stop Rate @ Wheel	500.0	N/mm (set in user tool)
Rollbar Rate	1500.0	Nm/°
Rollbar Wheel Rate	80.6	N/mm
(Total Linear Roll Rate	7080.6	Nm/°)



Wheel rates are linear. If applicable a NON-LINEAR Bump-Stop can be superimposed.
Bump-Stop is defined by Bump-Stop Gap, Bump-Stop Final Rate & Bump-Stop Displacement to Final Bump-Stop Rate.
See User Tool on Sheet.

- Side-View Swing Arm Locations & Suspension Anti - Percentages (Derived from Anti-Angles, CoG Height, Wheelbase and Brake Force Distribution Percentage)



ALL SUSPENSION DATA REFER TO WHEEL PLANE AND NOT TO COMPONENT DATA

Version 8.0 and above comes with specific knowledge base for K&C Data.

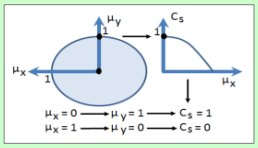
TIRE DATA - Tire Graphs and Tire Database

Input

All relevant Tire Parameters:

- Reference Load
- Cornering Stiffness
- Aligning Torque Stiffness
- Camber Thrust Rate
- Tire CS/AT/Camber Stiffness Load Dependency
- % Growth of Loaded Radius w/ Speed
- % Longitinal Grip Loss per ° Camber/Inclination Angle
- **NEW: % Conering Grip Loss/Gain per kN from Ref. Load**

Front Tire Properties		
Static Loaded Radius (SLR)	327.0	mm
Vertical Stiffness	280.0	N/mm
Front Tire Data		
Cornering Stiffness (CS)	1700.0	N/°
Nominal Grip Coefficient μ @ 0° Camber	1.50	-
Tire Reference Load	2500.0	N
Lateral / AT / Camber Stiffness Load Dependency	87.0	%
Aligning Torque Stiffness (AT)	50.0	Nm/°
Camber Thrust Rate	75.0	N/°
% Growth of Loaded Radius w/ Speed	0.35	%/100kph
% Long. Grip Loss per ° Camber/Inclination Angle	2.00	%/°
% Grip Loss/Gain per kN from Ref. Load	5.00	%/kN



- **Tire Model Selection: BASE TIRE MODEL vs. ENHANCED TIRE MODEL**

☑ *USE ENHANCED TIRE MODEL*

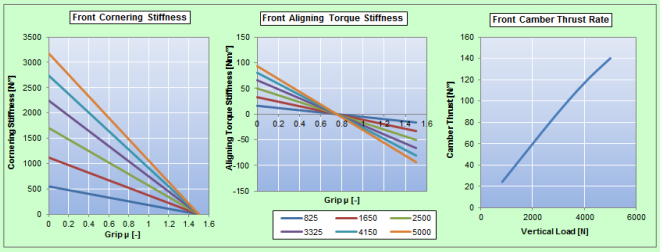
Output

BASE TIRE:

- Cornering Stiffness Maps:
- Aligning Torque Stiffness Maps:
- Camber Thrust Rate Maps:

GENERIC LINEAR BASE TIRE MODEL:
- LINEAR CORNERING STIFFNESS
- LINEAR ALIGNING TORQUE STIFFNESS
- LINEAR CAMBER THRUST RATE

→ NO TIRE LATERAL FORCE, NO TIRE SLIP ANGLE .....



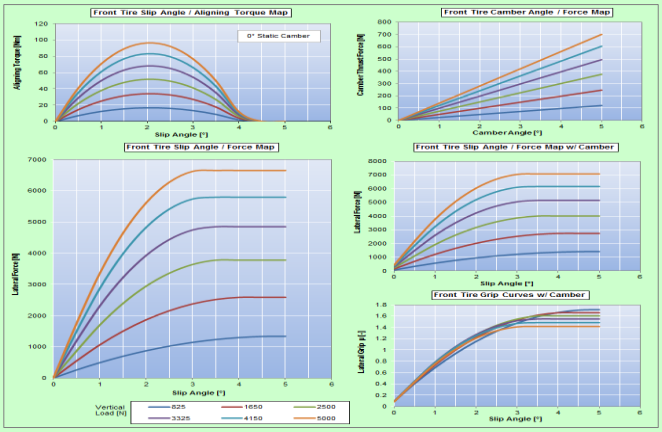
ENHANCED TIRE:

- Lateral Force vs Slip Angle Maps:
- Aligning Torque vs. Slip Angle Maps:
- Camber Thrust Force vs Camber Angle Maps:
- Grip Value Maps:

ENHANCED TIRE MODEL:
- TIRE DATA LOOKUP TABLES
- TIRE DATA TUNING PARAMETERS

→ NON-LINEAR TIRE LATERAL FORCE, NON-LINEAR TIRE ALIGNING TORQUE, TIRE SLIP ANGLE

→ **Max. Grip μ = f (Fz, CS, α,γ)**



THE BASE TIRE MODEL IS PARAMETRIC AND BASED ON CORNERING STIFFNESS APPROACH (GRADIENTS). ALL TIRE DATA (CORNERING STIFFNESS, ALIGNING TORQUE STIFFNESS AND CAMBER THRUST) WILL BE SCALED FROM REFERENCE LOAD (STEPWISE) LINEAR TO IT'S VERTICAL LOAD @ OPERATING POINT.

THE COMBINED SLIP TIRE MODEL IS BASED ON ELEMENTARY FRICTION CIRCLE BEHAVIOUR, MEANING THAT AT 0N LONGITUDINAL FORCE THE TIRE CORNERING STIFFNESS WILL BE MAXIMAL AND AT FULL LONGITUDINAL MUE SATURATION THE CORNERING STIFFNESS WILL BE MINIMAL.

THE BASE TIRE MODEL DOES NOT PRODUCE ANY FORCES, TORQUES OR SLIP ANGLES. GRIP VALUE μ IS ALWAYS CONSTANT

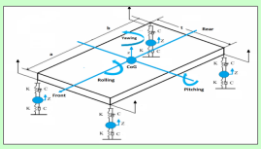
THE ENHANCED TIRE MODEL DOES GENERATE OUT OF THE EQUATIONS FROM THE BASE TIRE MODEL NEW LOOK UP TABLES - AS A FUNTION OF TIRE SLIP ANGLE AND VERTICAL LOAD - FOR TIRE LATERAL FORCE RESP. TIRE ALIGINING TORQUE.

THE ENHANCED TIRE MODEL DOES ALLOW TO CALCULATE THE TIRE SLIP ANGLE AND DOES THEREFORE GIVE IN PARTICULAR MORE ACCURATE RESULTS AT THE NON-LINEAR HIGH-G OPERATING RANGE OF THE TIRE.

THE ENHANCED TIRE MODEL CAN ONLY BE USED IN CALCULATIONS COMBINED WITH THE 7-DOF VEHICLE MODEL.
STEP STEER AND FREQUENCY RESPONSE ARE UNAFFECTED AS THEY USE THE BASE TIRE MODEL ONLY.

Version 8.0 comes also with a specific knowledge/data base for Tire Data and a full plotting feature to visualize the Tire Characteristics in 2D & 3D Format.

VEHICLE MODEL - 7 Degree Of Freedom Handling Model

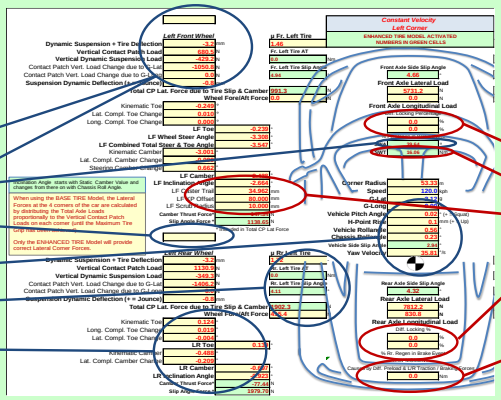


Input

- Longitudinal and Lateral Acceleration
- Speed & Aerodynamic Loads
- Brake & Driveline Data.

Output

- All 4 Wheel Vertical Displacements
- All 4 Wheel Forces in X, Y & Z Direction
- SWA
- Bump/Rebound Stop Activation Flags
- Roll & Pitch Angle, Yaw Velocity
- Tire Forces and Slip Angles
- Kinematic & Compliant Suspension Data



NEW OUTPUT DATA IN RELEASE 8.1

Front Amount of LSD Lock / LR Braking Dist. Percentage Regen Contribution in Braking

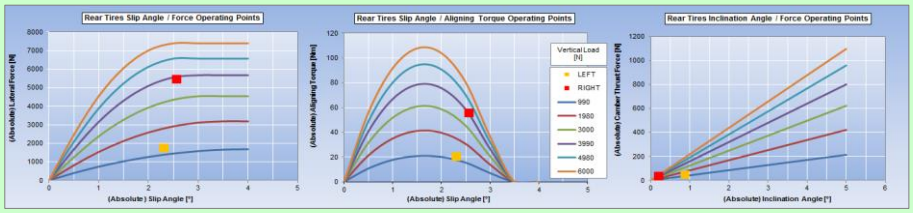
Steering Wheel Torque

Caster Trail, Scrub Radius & KP Offset

Rear Amount of LSD Lock / LR Braking Dist. Percentage Regen Contribution in Braking

Yaw Moment caused by LSD settings & L/R non-symmetrical Longitudinal Forces.

- Tire Operating Points for the given Vehicle Condition:



The 7-DOF Vehicle Model does also create the Performance Envelope Graphs for G-Long & G-Lat as function of Velocity both for Traction as for Braking Conditions.

These Performance Envelopes are the fundamental enabler for the Laptime Simulation tool and describe the Combined G-G Performance Operating Range of the Vehicle.

- One can choose to create the Velocity Data Points automatically of if desired enter Custom Points:

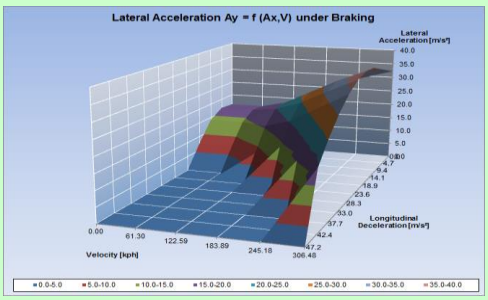
Automatically Calculated Data Points for Velocity [kph]	0.0	61.3	122.6	183.9	245.2	306.5	☐ Use Custom Reference Velocity Points
Custom Data Points for Velocity - STAY WITHIN THE LIMITS !	0.0	120.0	160.0	180.0	220.0	306.5	

The Performance Envelopes can be created in 2 Different Modes:

CREATE **LINEAR** G-G-V MAP | CREATE **NON-LINEAR** G-G-V MAP

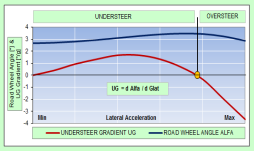
- with the BASE Tire Model and a LINEAR Calculation (for a quick scan). This Simulation is less CPU-Time consuming, but more inaccurate.

- with the ENHANCE Tire Model and a FULL NON-LINEAR Calculation (this is the recommended, most accurate method).



DATA REFERENCE TABLE			
VELOCITY [kph]	Max. Ax TRACTION [g]	Max. Ax BRAKING [g]	Max. Ay LATERAL [g]
61.3	1.053	1.598	1.650
122.6	1.199	2.048	1.948
183.9	1.184	2.759	2.377
245.2	0.583	3.705	2.918
306.5	0.065	4.807	3.229

UNDERSTEER BEHAVIOUR - Bicycle Model for Linear Understeer Behaviour



Input

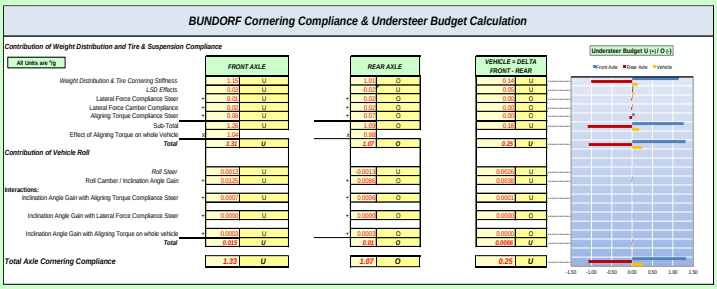
- Speed, Aerodynamics
- Front and Rear Tire Data corresponding to the Vertical Load Condition at the Vehicle Operating Point
- INSTANTENEOUS Spring & Rollbar Settings (Roll Rates)
- Suspension Kinematics & Compliance Data.
- USER Defined Limits for Understeer & Vehicle Side Slip Angle Gradients (set 1000 to de-activate feature):

UNDERSTEER BUDGET	
Maximum Understeer Gradient Limit during Cornering (US)	1000
Maximum Fr. & Rr. Side Slip Angle Gradient Limit (SSA)	1000

- Lateral Acceleration Sweep Setting (Constant Velocity vs. Constant Radius Procedure):
- Bundorf Compliance Setting (Will be automatically activated with BASE Tire Model & De-activated wirh ENHANCED Tire Model):

Output

- Bundorf Cornering Compliance & Understeer Budget Table: Linear Understeer Gradient considering Suspension Kinematics & Compliances **AND IN RELEASE 8.1 LSD EFFECTS**:



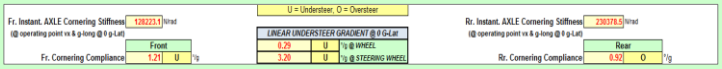
BUNDORF Cornering Compliance & Understeer Budget Calculation

Contribution of Weight Distribution and Tire & Suspension Compliance

All Units are °/g

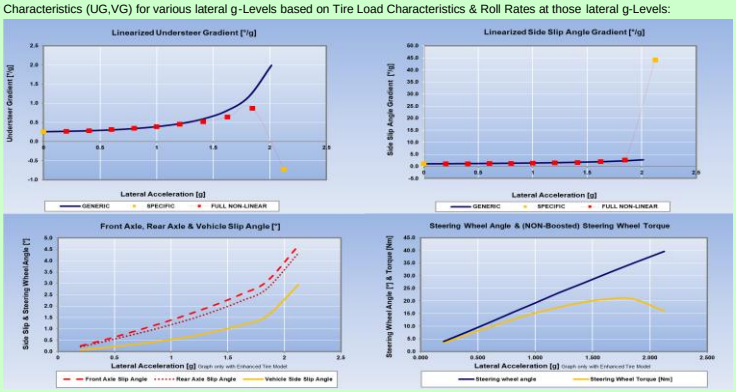
	FRONT AXLE		REAR AXLE		VEHICLE = DELTA FRONT - REAR	
Weight Distribution & Tire Cornering Stiffness	1.59	U	1.03	O	0.34	U
LSD Effects	0.03	U	0.02	U	0.05	U
Lateral Force Compliance Steer	0.01	U	0.02	O	0.00	O
Lateral Force Camber Compliance	0.03	U	0.02	O	0.00	O
Aligning Torque Compliance Steer	0.04	U	0.07	O	0.03	O
Sub-Total	1.70	U	1.09	O	0.31	U
Effect of Aligning Torque on whole Vehicle	1.94		0.98			
Total	*1.33*	*U*	*1.07*	*O*	*0.25*	*U*
Contribution of Vehicle Roll						
Roll Steer	0.001	U	0.0013	U	0.0003	U
Roll Camber / Inclination Angle Gain	0.0125	U	0.0093	O	0.0031	U
Interactions:						
Inclination Angle Gain with Aligning Torque Compliance Steer	0.0001	U	0.0000	O	0.0001	U
Inclination Angle Gain with Lateral Force Compliance Steer	0.0000	U	0.0000	O	0.0000	O
Inclination Angle Gain with Aligning Torque on whole vehicle	0.0000	U	0.0003	O	0.0003	O
Total	*0.015*	*U*	*0.01*	*O*	*0.0036*	*U*
Total Axle Cornering Compliance	*1.33*	*U*	*1.07*	*O*	*0.25*	*U*

Understeer Budget U (+) / O (-)



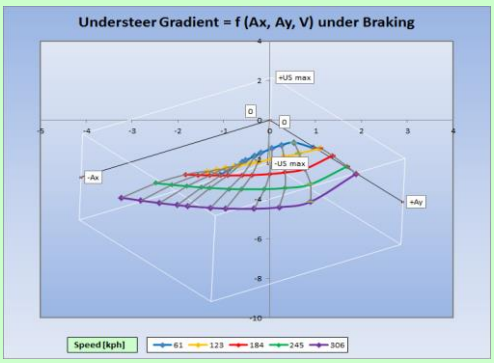
- Front & Rear Axle Cornering Stiffness:
- Linear Range Understeer Gradient (UG):
- Vehicle Slip Angle Gradient (SSAG):

- Understeer Characteristics (UG,VG) for various lateral g-Levels based on Tire Load Characteristics & Roll Rates at those lateral g-Levels:



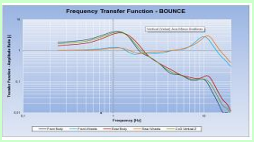
When using the Enhanced Tire Model, Axle Side Slip Angles and Steering Wheel Angle **& Torque** data from the 7-DOF Model can be plotted over the Lateral Acceleration Range.

The G-G-V-Map Procedure allows to create a 4 Dimensional "Understeer and Slip Angle Gradient" Performance Envelope where as a function of G -Long, G-Lat & Velocity, those Parameters are being visualized. It is a unique way to evaluate the Balance of the Vehicle in every possible operating condition.



Graph Reference Data Table			
V [kph]	Ax [g]	Ay [g]	US Grad [°/g]
61	0.00	1.65	-0.7
61	-1.60	0.46	-16.9
123	0.00	1.93	1.7
123	-2.05	0.57	-11.0
184	0.00	2.38	1.7
184	-2.76	0.77	-6.3
245	0.00	2.94	0.8
245	-3.71	0.98	-3.1
306	0.00	3.29	-0.3
306	-4.81	1.24	-1.9

DAMPER TUNING - Percent Critical Damping & Ride Transfer Functions



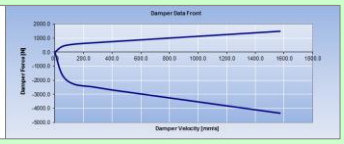
Input - Tire Vertical Stiffness & Suspension INSTANTANEOUS Wheel Rates (Straight Line Running vs. Cornering)

- Sprung & Unsprung Masses, Pitch Inertia

- Measured Damper Force/Velocity Data

Front suspension Shock (measured shock data)

Measured Damper Data			
Jounce Speed [mm/s]	Jounce Force [N]	Rebound Speed [mm/s]	Rebound Force [N]
0.0	0.0	0.0	0.0
52.0	410.0	-52.0	-1617.5
131.0	570.0	-131.0	-2270.0
262.0	670.0	-262.0	-2467.5
393.0	752.5	-393.0	-2682.5
524.0	835.0	-524.0	-2867.5
1048.0	1165.0	-1048.0	-3667.0
1572.0	1495.0	-1572.0	-4347.0



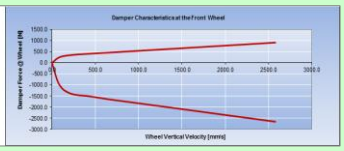
- Damper Motion Ratio's & Scaling Factor:

Fr. Damper to Wheel Motion Ratio	0.61	-
Fr. Damping Scaling Factor (Permits Scaling of Fr. Linear Damping @ Wheel for Analysis)	1.00	-

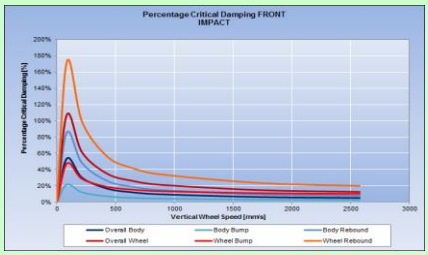
Output - Damper Data @ Wheel:

Output Parameter

Calculated Front Damper Data @ WHEEL (considering motion ratio)			
Jounce Speed [mm/s]	Jounce Force [N]	Rebound Speed [mm/s]	Rebound Force [N]
0.0	0.0	0.0	0.0
85.2	250.1	-85.2	-986.7
214.8	347.7	-214.8	-1384.7
429.5	408.7	-429.5	-1585.2
644.3	459.0	-644.3	-1636.3
859.0	509.4	-859.0	-1749.2
1718.0	710.7	-1718.0	-2288.3
2577.0	912.0	-2577.0	-2651.7



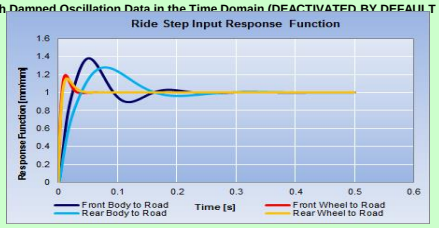
- Curves for Percent Critical Damping for Body and Wheel in Compression and Rebound:



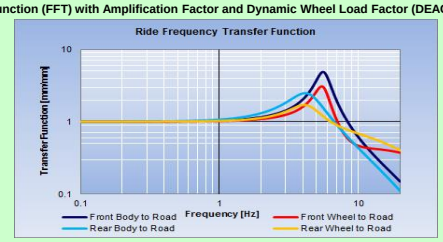
Activate / Re-Calculate Ride Step & Ride Frequency | *De-Activate Ride Step & Ride Frequency*

ONLY IN EXPERT VERSION:

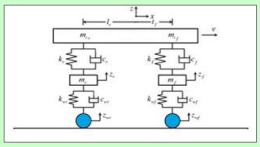
- Ride Step Input Response with Damped Oscillation Data in the Time Domain (DEACTIVATED BY DEFAULT IN ORDER TO SAVE CPU TIME). .



- Ride Frequency Transfer Function (FFT) with Amplification Factor and Dynamic Wheel Load Factor (DEACTIVATED BY DEFAULT IN ORDER TO SAVE CPU TIME).



SPRING TUNING - Natural Frequencies and Pitch & Bounce Center Calculation



Input - INSTANTANEOUS Wheel Rates for specified Load Condition

- Tire Vertical Rates for specified Load Condition

- Sprung & Unsprung Masses, Pitch Inertia

Output - Front & Rear Instantenous Ride Rates:

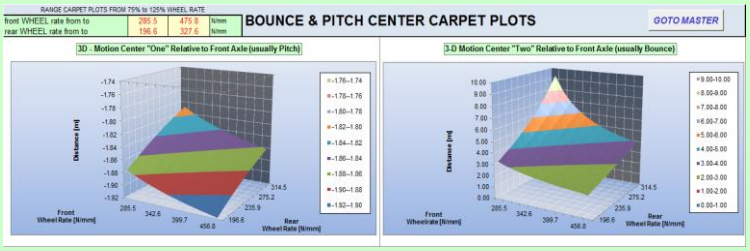
- Front and Rear Unsprung Mass Ride Frequencies:

- Bounce and Pitch Frequencies of the Sprung Mass:

- Bounce and Pitch Center Locations:

Output Parameter	Body	Wheel	
Front Ride & Wheel Frequency	5.847	30.492	Hz
Rear Ride & Wheel Frequency	4.627	25.440	Hz
Ratio Rr/Fr Ride Frequency	0.791	-	
Pitch Frequency (frequency one)	10.345		Hz
Bounce Frequency (frequency two)	5.007		Hz
Pitch Center (motion center one)	-0.114		m
Bounce Center (motion center two)	5.385		m
Relative to FRONT AXLE			
Pitch Center (motion center one)	-1.868		m
Bounce Center (motion center two)	3.631		m

- Carpet Plots for Bounce & Pitch Center Locations



ROLLBAR TUNING - Mechanical Balance

Input - Front and Rear Suspension INSTANTANEOUS Roll Rates

- Front and Rear Instantenous Roll Center Heights

Output - Linear Roll Angle Gradient

- Roll couple Distribution:

- Bump & Rebound Stop Activation Info:

- Rollbar/Spring Rollrate Contribution:

Output Parameter	RESULTS	
Inst. Lat. Load Transfer Distribution	44.4	% front
Inst. Roll Couple Distr. (Wheel Lift)	60.22	% front
Instant. Roll Couple Distribution	60.22	% front
Instant. L.L.T. Bias	2.04	% rel. to CoG
Rollangle due to Spr. Mass Rollmoment	0.18	°
Rollangle @ Bump-Stop Activation	0.52	°
Lateral G @ Bump-Stop	5.54	g
Rollangle @ Rebound-Stop Activation	0.50	°
Lateral G @ Rebound-Stop	5.37	g

(All in Pure Roll, no Lifting Effects of Roll Center Height)

TOTAL FR. & RR. SUSPENSION ROLL RATE		11757.4	**Nm/° (without tires)**		
FRONT TOTAL ROLLRATE	7080.6	Nm/°	REAR TOTAL ROLLRATE	4676.8	Nm/°
Front Roll Rate due to Springs	5580.6	Nm/°	Rear Roll Rate due to springs	2676.8	Nm/°
Front Roll Rate due to ARB	1500.0	Nm/°	Rear Roll Rate due to ARB	2000.0	Nm/°
% Contribution of ARB to total	21.2	%	% contribution of ARB to total	42.8	%
TOTAL FR. & RR. ROLL RATE WITH TIRES		5497.1	**Nm/° (with tires)**		
FRONT			**REAR**		
Front Roll Stiffness w/ Tires	3000.9	Nm/°	Rear Roll Stiffness w/ Tires	2496.1	Nm/°

- Suspension Load Transfer:

- Lateral Load Transfer Distribution:

Lateral Load Transfer Calculation considering Roll Rates, Roll Center Heights & Unsprung Masses					
Suspension Load Transfer	**Total**	1476.5	N		
Fr. Suspension Load Transfer	889.2	N		Rr. Suspension Load Transfer	587.3	N
Fr. Rebound Stop Not Engaged				**Rr. Rebound Stop Not Engaged**		
Total Lateral Load Transfer	**Total**	2237.4	N		
Fr. Total Load Transfer	992.5	N		Rr. Total Lateral Load Transfer	1244.9	N

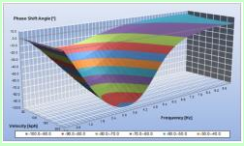
RESULTS - Sheet for Comparison of 2 or more Vehicles

Input All model data and results for the actual model and a reference data set.

Output Comparison of most important metrics and graphs. Sheet can be fully customized and used as a normal Excel Sheet.

Note: Data from a Reference Model can be exported or imported to/from an external EXCEL (*.xlsx) file.

***ONLY IN EXPERT VERSION:* FREQUENCY STEER - Bicycle Model for Frequency Steer Response**



Input

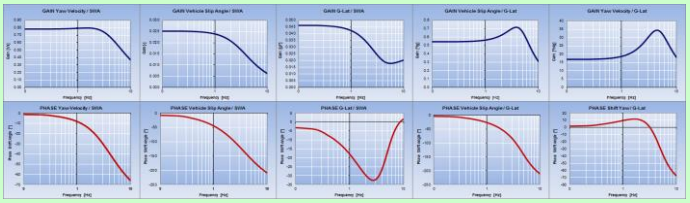
- Speed & Aerodynamics

- Front and Rear Tire Data corresponding to the Vertical Load Condition at the Vehicle Operating Point

- Optionally Steering Wheel Angle, to be entered in the Master Control Sheet (which will acts as a TRIGGER for a Specific Calculation establishing the Vehicle Understeer Characteristics at the Lateral Acceleration corresponding to the given input SWA).

Output

- Typical Frequency Transfer / Response Plots for Yaw, Lateral Acceleration, Slip Angle etc. with corresponding Phase Shifts:



- W/O SWA = GENERIC Calculation: Metrics describing the most important Characteristics of Transfer Function Data:

GENERIC FREQUENCY STEER RESPONSE DATA @ G-Long = 0g

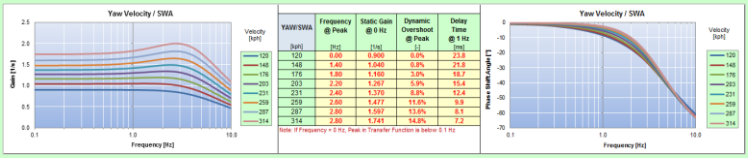
Frequency Steer Results	Yaw Vel. / SWA		Slip Angle / SWA		G-Lat / SWA		Slip Angle / G-Lat		Yaw Vel. / G-Lat	
Frequency @ Peak	0.00	Hz	0.00	Hz	0.00	Hz	3.80	Hz	4.40	Hz
Static Gain @ 0 Hz	0.969	1/s	0.030	-	0.057	g/°	0.519	°/g	16.863	°/s/g
Dyn. Overshoot @ Peak	0.00%	%	0.00%	%	0.00%	%	32.64%	%	100.64%	%
Delay Time @ 1 Hz	27.6	ms	128.4	ms	53.5	ms	74.8	ms	-25.9	ms

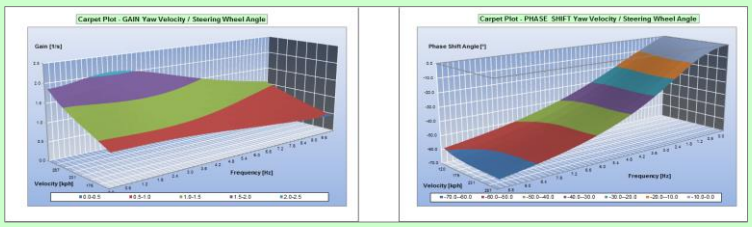
- W/ SWA = SPECIFIC Calculation: Metrics for the Characteristics of the Transfer Function however now at the "Imposed" Lateral Acceleration corresponding to the given input SWA.

SPECIFIC FREQUENCY STEER RESPONSE DATA @ SWA = 15°, G-Lat = 0.7g, G-Long = 0g

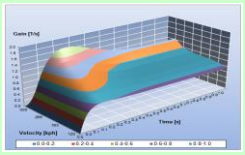
Frequency Steer Results	Yaw Vel. / SWA		Slip Angle / SWA		G-Lat / SWA		Slip Angle / G-Lat		Yaw Vel. / G-Lat	
Frequency @ Peak	1.40	Hz	0.00	Hz	0.00	Hz	4.00	Hz	4.60	Hz
Static Gain @ 0 Hz	0.798	1/s	0.022	-	0.047	g/°	0.472	°/g	16.863	°/s/g
Dyn. Overshoot @ Peak	1.27%	%	0.00%	%	0.00%	%	34.79%	%	93.42%	%
Delay Time @ 1 Hz	22.4	ms	122.6	ms	46.0	ms	76.7	ms	-23.6	ms

- Tables of all Key Metrics & Graphs for various Speeds presented in 2D and 3D Charts:





***ONLY IN EXPERT VERSION:* STEP STEER - Bicycle Model for Step Steer Response**

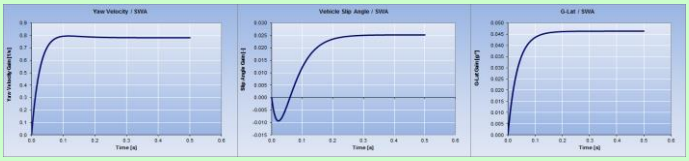


Input

- Speed & Aerodynamics
- Front and Rear Tire Data corresponding to the Vertical Load Condition at the Vehicle Operating Point
- Simulation Time for Step Response (0 - 2.5 sec)
- Optionally Steering Wheel Angle, to be entered in the Master Control Sheet (which will acts as a TRIGGER for a Specific Calculation establishing the Vehicle Understeer Characteristics at the Lateral Acceleration corresponding to the given input SWA).

Output

- Typical Step Response Plots for Yaw, Lateral Acceleration, Slip Angle etc.:



- W/O SWA = GENERIC - Linear Step Steer Time Domain Data for Yaw Velocity, Vehicle Slip Angle and Lateral Acceleration & Corresponding Key Metrics

GENERIC STEP STEER RESPONSE DATA @ G-Long = 0g

Step Steer Response Data	Yaw Velocity Gain [1/s]		Slip Angle Gain [-]		G-Lat Gain [g/°]	
90% Response Time	48.0	ms	180.0	ms	80.0	ms
Peak Value	0.796	1/s	0.025	-	0.046	g/°
Time to reach Peak Value	118.0	ms	500.0	ms	454.0	ms
Dynamic Overshoot @ Peak	1.81%	%	0.00%	%	0.00%	%

Simulation Time: 0.50 s
Keep Simulation Time as short as possible (Max 2.5s) ! If Results are incorrect/noisy then reduce Maximum Simulation Time.

- W/ SWA = SPECIFIC - Step Steer Time Domain Data, however now at the "Imposed"Lateral Acceleration corresponding to the given input SWA:

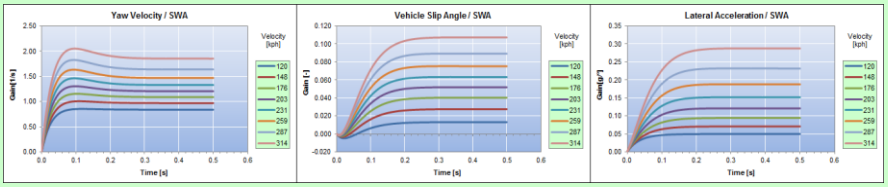
SPECIFIC STEP STEER RESPONSE DATA @SWA = 15°, G-Lat = 0.7g, G-Long = 0g

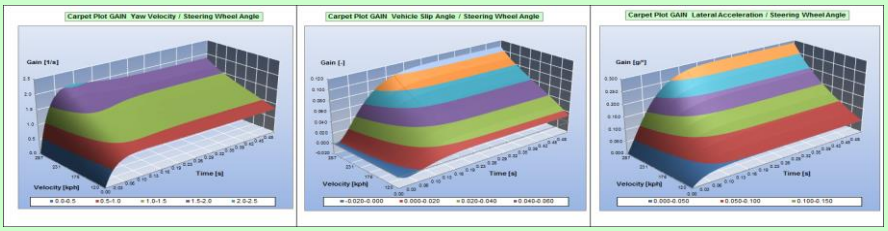
Step Steer Response Data	Yaw [°/s]		Slip Angle [°]		G-Lat [g]	
90% Response Time	54.0	ms	218.0	ms	70.0	ms
Peak Value	12.099	°/s	0.335	°	0.700	g
Time to reach Peak Value	128.0	ms	500.0	ms	174.0	ms
Dynamic Overshoot @ Peak	3.20%	%	0.01%	%	0.74%	%

Simulation Time: 0.50 s
Keep Simulation Time as short as possible (Max 2.5s) ! If Results are incorrect/noisy then reduce Maximum Simulation Time.

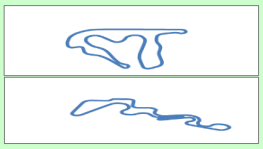
- Tables of all Key Metrics & Graphs for various Speeds presented 2D and 3D Charts:

	YAW / SWA GAIN				SLIP ANGLE / SWA GAIN				G-LAT / SWA GAIN			
Speed [kph]	90% Response Time [ms]	Gain Peak Value [1/s]	Time to reach Peak [ms]	Dynamic Overshoot @ Peak [%]	90% Response Time [ms]	Gain Peak Value [-]	Time to reach Peak [ms]	Dynamic Overshoot @ Peak [%]	90% Response Time [ms]	Gain Peak Value [g/°]	Time to reach Peak [ms]	Dynamic Overshoot @ Peak [%]
120	48.0	0.853	118.0	1.81%	180.0	0.013	500.0	0.00%	80.0	0.050	454.0	0.00%
148	46.0	1.006	110.0	3.85%	170.0	0.028	500.0	0.00%	102.0	0.071	438.0	0.00%
176	44.0	1.155	104.0	6.13%	164.0	0.040	478.0	0.00%	112.0	0.094	348.0	0.01%
203	42.0	1.305	98.0	8.28%	158.0	0.052	360.0	0.03%	116.0	0.121	304.0	0.05%
231	40.0	1.463	96.0	10.04%	154.0	0.063	336.0	0.08%	118.0	0.152	286.0	0.10%
259	38.0	1.634	94.0	11.22%	152.0	0.075	320.0	0.11%	120.0	0.188	284.0	0.13%
287	38.0	1.827	94.0	11.55%	152.0	0.089	330.0	0.09%	124.0	0.232	294.0	0.11%
314	40.0	2.052	96.0	10.80%	158.0	0.107	360.0	0.05%	134.0	0.288	332.0	0.05%





CIRCUIT LAYOUT - Create your own Test Track



Input 2D Circuit Data. X & Y coordinates of "Driving Line".

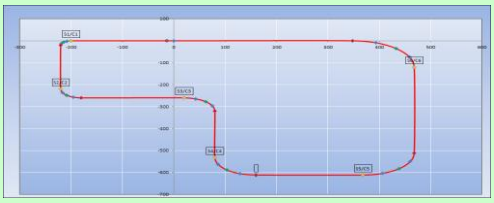
5 Data Points per Corner.

2 Points for every Straight.

Maximum 20 Corners

Section	Description	Actual Track Coordinate x [m]	Actual Track Coordinate y [m]	Calculated Distance s [m]	Calculated Corner Radius R [m]
START	START / STRAIGHT 1	0.0	0.0	0.0	N/A
S1/C1	END OF STRAIGHT / CORNER ENTRY	-200.0	0.0	200.0	20.0
	INTERMEDIATE SECTION	-207.7	-1.5	7.9	20.0
	CORNER APEX POINT	-214.1	-5.9	7.9	20.0
	INTERMEDIATE SECTION	-218.5	-12.3	7.9	20.0
	CORNER EXIT / START OF STRAIGHT	-220.0	-20.0	7.9	20.0

Output Circuit Graph, Distances and Cornering Radii



NOTE: Track data can be ex/-imported to/from and external EXCEL file in *,xlsx format.

LAPTIME CONTROL - CONTROL Sheet for Laptime Simulation

Input - Laptime Simulation Control Data & Number of Iterations:

- Understeer Gradient & Vehicle Side Slip Angle Gradient Limits:
- Standing Start or Flying Lap Simulation:
- Simulation Control Panel:

Understeer Gradient Limit (US)	1000.0	°/g
Lim. Fr. & Rr. Side Slip Angle Gradient (SSA)	1000.0	°/g
Limit of Nr. of Iterations	250	[-] (default 250)
Laptime Module ON/OFF	0	[-] switch (Y/N 1/0)

☑ Flying Lap

CALCULATE / RE-RUN LAPTIME WITHOUT UPDATING G-G-V MAP | CALCULATE NEW LAPTIME WITH UPDATED LINEAR G-G-V MAP | CALCULATE NEW LAPTIME WITH UPDATED NON-LINEAR G-G-V MAP | CREATE TIME HISTORY OF ALL VEHICLE PARAMETERS

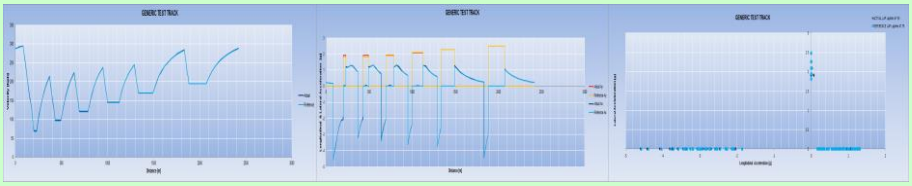
Output - Overal Laptime, Distance & Average Speed:

LAPTIME DATA	ACTUAL	REF.	
TOTAL TIME	47.649	47.790	sec
TOTAL DISTANCE	2419.73	2419.73	m
AVERAGE SPEED	182.82	182.28	kph

- Sector Times & Sector Data,

S1	TIME	3.36	3.41	sec
Section time		3.37	3.41	sec
Braking Distance		115.36	116.35	m
Top Speed		294.89	294.19	kph
Section Length		200.00	200.00	m

- Elementary Laptime Results: Speed, Ax, Ay



- A full Time History Data Set of all Dynatune Metrics can be created for a Laptime Simulation

In Version 8.0 a Laptime Sensitivity Study can be executed with up to 20 Pre-Defined - typically "Track-Use" - Setup Parameters:

LAP RESULTS - Sheet for Comparison of Laptime results of 2 vehicles

Input Time History Data Set of a Laptime Simulation for the actual model and a reference data set .

Output Comparison/Time History of all Dynatune R&H metrics and selected graphs of 2 Setups for Lap Simulation. Sheet can be fully customized.

Note: Data from a Reference Lap can be exported to an external EXCEL(*.xlsx) file.

10 EASY STEPS TO HAPPY SIMULATIONS IN DYNATUNE

1) REMEMBER THAT THE WORKBOOK IS COPY PROTECTED. ONLY THE USER SHEET AND RESULT SHEETS ARE UNPROTECTED AND ALLOWED TO BE CUSTOMIZED BY THE USER. EACH VERSION OF DYNATUNE HAS ITS OWN FEATURES ENABLED/DISABLED. **THE PROTECTION SOFTWARE WILL ALLOW TO SAVE A CUSTOM VERSION OF THE WORKBOOK ON EXIT.**

2) THE WORKBOOK IS BASED ON ANALYTICAL EQUATIONS. THIS IS IT'S STRENGTH FOR VELOCITY - HOWEVER, IF YOU ENTER NUMBERS THAT FOR SOME PHYSICAL REASON DO NOT MAKE SENSE OR CREATE SINGULARITIES THE WORKBOOK CAN SHOW "#NUMBER" - SOMETIMES NOT RECOVERABLE**. WHEN THIS HAPPENS FIRST RUN THE START/INITIALISE PROCEDURE WHICH SHOULD RESOLVE THE PROBLEM.**

3) ALL RELEVANT INPUT FIELDS HAVE BEEN PROVIDED WITH SENSIBLE PHYSICAL LIMITS IN ORDER TO AVOID SINGULARITIES IN THE CALCULATION. SINCE A NOVICE COULD PRODUCE CASE 2) IT IS HOWEVER STRONGLY RECOMMENDED TO MAKE A COPY OF THE ORIGINAL SHEET IN WINDOWS EXPLORER FOR REFERENCE. SEE 1)

4) DO READ THE "README PAGE" AND MAKE SURE THAT YOU HAVE FOLLOWED ALL MENTIONED RECOMMENDATIONS. MOST OF ALL MAKE SURE THAT YOUR TIRE DATA ARE CORRECT FOR THE OPERATING POINT VERTICAL LOAD CONDITION THAT YOU DO WANT TO INVESTIGATE.

5) THE TIRE MODEL IS BASED ON ALGORITHMS OF CORNERING STIFFNESS IN FUNCTION OF VERTICAL , LATERAL & LONGITUDINAL LOAD AND HAS BEEN KEPT AS LEAN AS NECESSARY IN ORDER TO AVOID TO GO TO COMPLEX PACEJKA INTERPOLATIONS OR OTHER TIRE-MODELS. VERIFY WHETHER YOUR TIRES ARE OPERATING IN THE CORRECT LOAD RANGE.

6) DYNATUNE HAS BEEN SPECIFICALLY DEVELOPED AND ADAPTED TO MS EXCEL, ESPECIALLY FOR USING THE STANDARD ITERATION PROCEDURE OF EXCEL. BEAR IN MIND, THAT THE EXCEL-ITERATION ALGORITHM IS NOT AS PERFECT AS SOME SOPHISTICATED COMMERCIALLY AVAILABLE SOLVERS, SO PAY IN PARTICULAR ATTENTION WHEN EXECUTING CALCULATIONS WHILST USING BUMP STOPS. MAKE SURE THAT ALL RATE CHANGES ARE SMOOTH. ALL CALCULATIONS ARE PROGRAMMED IN SUCH A WAY THAT THE CALCULATIONS WILL ALWAYS FINISH. SEE ALSO 7)

7) AS LONG AS YOU DO NOT USE BUMP-STOPS OR RIDEHEIGHT DEPENDENT AERODYNAMICS, YOUR CALCULATIONS WILL BE STRAIGHT FORWARD. ONCE ENTERING INTO NON-LINEARITY OF THOSE FEATURES AND THUS BY PHYSICS ENFORCED NECESSARY "CIRCULAR" ITERATIONS YOUR SOLVER TIME WILL INCREASE S. DO USE THESE ONLY IF YOU WANT OR NEED TO DO SO.

8) IF ACTIVATED, THE RIDE FREQUENCY TRANSFER FUNCTION **WILL SLOW ALL CALCULATIONS** DOWN, SINCE IN THE BACKGROUND VERY COMPLEX (i) FFT CALCULATIONS HAVE TO BE EXECUTED AT EACH ITERATION. DO ONLY USE THIS SWITCH IF YOU WANT TO INVESTIGATE THIS PARTICULAR MATTER AND TURN IT OFF AGAIN WHEN NOT NEEDED.

9) UNDERSTANDING THE WORD "LINEAR" & "GENERIC" IN CHASSIS DYNAMICS

A) **LINEAR BEHAVIOR OF A SYSTEM:** THIS SIGNIFIES THAT THE RESPONSE OF THE SYSTEM IS ALWAYS DIRECTLY PROPORTIONAL TO THE INPUT (EITHER "1" OR "10") WITHOUT ANY CHANGE OF STATE OF YOUR SYSTEM (ALL PARAMETERS REMAIN LINEAR & UNCHANGED). DUE TO THE LINEARITY THESE SYSTEMS CAN BE ANALYZED "GENERICALLY" AND PERMIT LINEAR EXTRAPOLATION TOWARDS A PARTICULAR CONDITION (PREDICTION).
NON-LINEAR BEHAVIOR OF A SYSTEM: THIS SIGNIFIES THAT THERE IS NO DIRECT PROPORTIONAL RESPONSE CAUSING USUALLY A CHANGE OF STATE WHICH MAKES A"SPECIFIC" INVESTIGATION AROUND THIS POINT NECESSARY. A NUMERICAL ITERATION IS NECESSARY TO APPROACH THIS POINT OF NON-LINEARITY, IT CANNOT BE PREDICTED BY LINEAR EXTRAPOLATION.

B) **LINEAR TIRE BEHAVIOUR:** MEANS THAT THE TIRE CHANGES LINEARLY ITS MAJOR CHARACTERISTICS LIKE F.I. CORNERING STIFFNESS WITH LOAD & SLIP ANGLE.
NON-LINEAR TIRE BEHAVIOUR: STARTS BECOMING NOTICEABLE USUALLY ABOVE 0,5 - 0,7 G LATERAL ACCELERATION CAUSING A NON-LINEAR CHANGE OF TIRE CORNERING STIFFNESS. THIS BEHAVIOUR CAN BE SIMULATED BY CHANGING LINEAR CHARACTERISTICS STEPWISE OVER OPERATING RANGE (=PARTIALLY LINEARIZED).

C) **LINEAR SUSPENSION CHARACTERISTICS:** BOTH (ELASTO-)KINEMATICS & VERTICAL WHEEL RATE ARE LINEAR.
NON-LINEAR WHEEL RATES (=BUMP-STOPS) PROVOKE NON-LINEAR VERTICAL FORCE REACTIONS WHICH WILL RESULT IN A DIFFERENT TIRE BEHAVIOR, EFFECTIVELY CAUSING A CHANGE OF STATE WHICH REQUIRES ITERATIONS. NOT USING BUMP-STOPS WHILST CORNERING WILL KEEP YOUR SUSPENSION LINEAR & THEREFORE THE TIRE MORE LINEAR.

D) **LINEAR RANGE UNDERSTEER:** UNDERSTEER IN THE LINEAR RANGE OF VEHICLE DYNAMICS - THIS RANGE IS PRIMARILY DEFINED BY THE LINEAR RANGE OF THE TIRE AND CAN GO - DEPENDING ON THE TIRE - UP TO 0,7 G. THE LINEAR RANGE DEFINES ALL ON-CENTER HANDLING CHARACTERISTICS & BASIC TRANSIENT STABILITY OF A VEHICLE.
IMPORTANT NOTE 1): LINEAR RANGE UNDERSTEER CANNOT BE SENSED BY DRIVERS. THE TYPICAL DRIVER SENSED UNDERSTEER IS THE NON-LINEAR RANGE UNDERSTEER.
IMPORTANT NOTE 2): A VEHICLE WITHOUT LINEAR RANGE UNDERSTEER IS PHYSICALLY NOT STABLE AND CANNOT BE ANALYZED !
NON-LINEAR RANGE UNDERSTEER: UNDERSTEER IN THE RANGE WHERE EITHER TIRE OR SUSPENSION OR BOTH BECOME SIGNIFICANTLY NON -LINEAR (HIGH G-LOADS). THE NON-LINEAR UNDERSTEER BEHAVIOR AT HIGH G CAN BE SIGNIFICANTLY DIFFERENT FROM THE LINEAR RANGE AND CAN BE "UNDERSTEERING", "OVERSTEERING" OR "NEUTRAL".

10) USE THE SIMULATION BUTTONS ON THE MASTER SHEET CORRECTLY

A) AFTER ENTERING DATA DO **ALWAYS** RUN THE "**START/INITIALISE**" PROCEDURE. THIS WILL CALCULATE ALL INITIAL SETTINGS AND VERIFY WHAT PHYSICAL LIMITS ARE APPLICABLE TO THE VEHICLE. YOU WILL SEE THESE LIMITS AS LIMITS FOR THE SIMULATION. THE PROCEDURE WILL SET G-LAT, G-LONG, SWA TO ZERO & SET THE VELOCITY TO 120KPH. ALSO DEFAULT DYNATUNE ITERATION VALUES WILL BE (RE-)SET.

B) THE "**GO GENERIC**" PROCEDURE WILL CREATE GENERIC RESULTS (**G-LAT=0/SWA=0**) FOR LINEAR RANGE UNDERSTEER BEHAVIOR, FREQUENCY STEER RESPONSE AND STEP STEER TEST. ONE CAN MODIFY ONLY "SPEED" AND "G-LONG" (IN ORDER TO SIMULATE THE EFFECTS OF AERO & LONGITUDINAL WEIGHT TRANSFER ON VERTICAL AXLE LOAD CHANGES AND THUS ON THE LINEAR LATERAL DYNAMIC BEHAVIOR OF THE TIRE). ONE CANNOT MODIFY THE STEERING WHEEL ANGLE. THE GENERIC CALCULATION DOES NOT PERMIT A CHANGE OF STATE OF THE MODEL MEANING THAT IN PARTICULAR WHEEL RATES REMAIN CONSTANT AS BEING CALCULATED AT THE START OF THE LATERAL PORTION OF THE CALCULATION.
THE LINEARIZED UNDERSTEER BUDGET CALCULATION FROM 0 TO G-LAT-MAX IS BASED ENTIRELY ON THIS PRINCIPLE AND MERELY CONSIDERS THE EFFECT OF LINEAR LATERAL LOAD TRANSFER ON TIRE CHARACTERISTICS (=CORNERING STIFFNESS) AND THE CONSEQUENT EFFECT ON UNDERSTEER.

C) THE "**GO SPECIFIC**" PROCEDURE WILL ALLOW TO ENTER "**G-LAT**","**G-LONG**", "**SPEED**" & "**SWA**" IN ORDER TO INVESTIGATE **ONE SINGLE SPECIFIC CONDITION** ALLOWING ANALYSIS OF THE RESULTS FOR ALL 4 CORNERS OF THE VEHICLE IN THAT CONDITION. IN THE "SPECIFIC" CALCULATION A CHANGE OF STATE OF THE MODEL - REFLECTING FOR INSTANCE WHEEL RATE CHANGES DUE TO A BUMPSTOP - IS POSSIBLE. SINCE A CHANGE OF STATE IS PERMITTED THE RESULTS FROM C) CAN DIFFER SIGNIFICANTLY FROM B).
THE GO SPECIFIC PROCEDURE TRIES IN "ONE" SINGLE STEP TO ACHIEVE THE TARGETED VALUES FOR G-LAT & G-LONG AND BUT IF NOT SUCCESFULL - DUE TO ANY EXCEEDING OF LIMITS (I.E. FOR UNDERSTEER / OVERSTEER) - IT WILL TRY TO APPROACH THAT LIMIT. IF YOUR MODEL CONTAINS SEVERE NON-LINEARITIES IT IS ALWAYS RECOMMENDED TO RUN THE "FULL NON-LINEAR" SWEEP WHICH WILL CONSIDER ALL POSSIBLE BOUNDARIES AND MORE IMPORTANTLY WILL DOCUMENT THEM IN MORE SIMULATION STEPS.

THE RESULTS OF ALL 4 CORNERS WILL BE USED FOR CALCULATING THE EFFECTIVE AXLE CORNERING STIFFNESS'S WHICH WILL BE USED BY THE BICYCLE MODEL. IF HOWEVER NO CHANGE OF STATE OCCURS (.I.E NO BUMPSTOP ACTIVATION) THE RESULTS OF THE SPECIFIC CALCULATION WILL BE EQUAL TO THE GENERIC ONE.

DO NOTE THAT A SPECIFIC STEERING WHEEL ANGLE (SWA) INPUT WILL ONLY AFFECT THE "STEP STEER" & "FREQUENCY STEER" PROCEDURE CHANGING THEM FROM "GENERIC" RESULTS TO "SPECIFIC" RESULTS FOR ONE PARTICULAR LATERAL ACCELERATION WHICH IS CORRELATED TO THE IMPOSED STEERING WHEEL ANGLE.
ALSO DO NOTE THAT DIFFERENT FROM ALL ABOVE A CHANGE OF STATE OF THE MODEL IS FOR THESE TYPE OF CALCULATIONS NOT POSSIBLE (LINEAR BICYCLE MODEL).
ENTERING A SPECIFIC SWA WILL ALLOW A FAST COMPARISON WITH MEASURED TEST DATA - WHICH ARE USUALLY RECORDED FOR A DEFINED SWA OR A DEFINED LATERAL ACCELERATION. SPEED AND G-LONG ARE AGAIN FREE TO BE CHANGED IN ORDER TO SIMULATE THEIR EFFECT ON VERTICAL AXLE LOAD & CORNERING STIFFNESS.

D) THE "**GO FULL NON-LINEAR**" PROCEDURE REPEATS BASICALLY THE "**GO-SPECIFIC**" PROCEDURE FROM "0" TO "G-LAT-MAX" IN **10** STEPS**. THIS G-LAT-MAX WILL BE ALWAYS APPROACHED BY THE PROGRAM AUTOMATICALLY BASED ON EITHER PHYSICAL LIMIT'S OR BY EXCEEDING THE IMPOSED LIMITS FOR MAXIMUM UNDERSTEER/OVERSTEER.**
ALL RESULTS WILL BE SAVED FOR EACH INTERMEDIATE STEP IN THE "**RESULTS**" SHEET. THE "**GO FULL NON-LINEAR**" PROCEDURE WILL PERMIT DETAILED ANALYSIS OF THE WHOLE RANGE OF LATERAL ACCELERATION.

E) THE "**CLEAR FULL NON-LINEAR**" PROCEDURE WILL ERASE ALL THE RESULTS FROM THE "**GO FULL NON-LINEAR**" PROCEDURE.

F) THE "**SET DATA REFERENCE**" PROCEDURE WILL COPY ALL OF YOUR EXISTING "**ACTUAL**" MODEL DATA IN THE "**RESULTS**" SHEETS TO THE "**REFERENCE**" COLUMN AS VALUES. THIS PERMITS AN EASY COMPARISON BETWEEN TWO VEHICLES. REVERTING THE PROCEDURE CAN BE DONE WITH THE "**LOAD DATA REFERENCE**" PROCEDURE WHICH WILL COPY ALL INPUT DATA FROM THE REFERENCE DATA SET TO THE ACTUAL DATA BEING USED.

G) THE "**EXPORT REFERENCE DATA**" PROCEDURE WILL EXPORT ALL OF YOUR "**REFERENCE**" MODEL DATA IN THE "**RESULTS**" SHEETS TO AN EXTERNAL EXCEL SHEET IN .XLSX FORMAT. VICE VERSA THE "**IMPORT REFERENCE DATA**" PROCEDURE WILL IMPORT A PREVIOUSLY CREATED "EXPORT " DATASET ON TO THE REFERENCE DATA.

F9 however still works and can be used when working in detailed tuning sheets

AND ..... ANOTHER 10 STEPS FOR HAPPY LAPTIME SIMULATION ....

1) APPLY ALL 10 PREVIOUS STEPS FROM HAPPY SIMULATIONS. STRICTLY

2) THE EASIEST TRACKS ARE LIKE THE INCLUDED "GENERIC" TRACK - BRAKE ON THE STRAIGHT AND THEN CORNER TO THE MAX. ALL OTHER COMBINATIONS ARE MORE DEMANDING BOTH FOR THE DRIVER AS FOR THE CALCULATION. REMEMBER THAT.

3) KEEP TRACKS AS SHORT AS POSSIBLE. DO NOT USE 20 CORNERS JUST BECAUSE YOU CAN. A QUICK SCAN ON 4 REFERENCE CORNERS WILL OFTEN GIVE ALSO GOOD INDICATIONS.

4) WHEN RUNNING A NEW TRACK FOR THE FIRST TIME, THE STANDARD 250 ITERATIONS WILL NOT BE SUFFICIENT TO CONVERGE TO A ROBUST SOLUTION. THE MORE COMPLEX THE TRACK, THE MORE NON-LINEAR THE CAR , THE MORE TIME IS NEEDED. DEPENDING ON YOUR HARDWARE INCREASE ITERATIONS TO 10.000 AND LET IT RUN FOR AWHILE. REPEAT IF NECESSARY.

5) ALWAYS VERIFY THE LAPTIME RESULT BY RUNNING AN ADDITIONAL STANDARD RUN (250 ITERATIONS) IN ORDER TO VERIFY THAT THE LAPTIME DOES NOT CHANGE ANYMORE INDICATING THAT THE OPTIMIZATION PROCEDURE HAS FINISHED CORRECTLY.

6) TRY TO AVOID A "NON-LINEAR" CAR WITH BUMPSTOPS ACTING IN CORNERING. A LINEAR CALCULATION IS A LOT FASTER THAN A NON-LINEAR.

7) THE BASE TIRE MODEL IS A LOT FASTER THAN THE ENHANCED TIRE MODEL. WITH RESPECT TO LAPTIMES THE DIFFERENCES BETWEEN THE TWO TIRE MODELS ARE MARGINAL AND DIFFERENCES ARE SOLELY DUE TO LIMIT UNDERSTEER GRADIENT BEHAVIOUR. IF YOU ARE NOT INTERESTED IN DETAILED UNDERSTEER ANALYSIS USE BASE TIRE MODEL.

8) UNLESS YOU ARE INTERESTED IN CORRELATING THE UNDERSTEER LIMITS OF THE MODEL TO DRIVER PERCEPTION LET THE LIMITS FOR UNDERSTEER GRADIENT AND VEHICLE SIDE SLIP ANGLE GRADIENT AS HIGH AS POSSIBLE. THIS WILL AVOID MANY ITERATIVE CALCULATIONS TOWARDS THE IMPOSED LIMITS FOR THEM.

9) DO NOT RUN TIME HISTORY CALCULATIONS UNLESS YOU ARE SURE YOU WANT TO. THE TIME HISTORY CALCULATION WILL TAKE EVERY DATAPOINT OF THE LAPTIME SIMULATION AND RUN IT AS A "SPECIFIC" CALCULATION CREATING ALL DATA FOR THAT SPECIFIC POINT. DO ONLY DO THIS IF YOU ARE SURE THAT YOU NEED THIS INFORMATION.

10) REMEMBER THAT THE MORE COMPLEX YOUR MODEL IS (BUMP-STOPS), THE MORE COMPLEX YOUR TIRE MODEL IS (ENHANCED vs. BASE), THE MORE COMPLEX YOUR TRACK IS AND THE TIGHTER YOUR UNDERSTEER GRADIENT / SIDE SLIP ANGLE GRADIENT LIMITS ARE THE MORE TIME YOUR SIMULATION WILL TAKE. CREATING A NON-LINEAR PERFORMANCE ENVELOPE WILL TAKE BY ITSELF APPROXIMATELY 10 TIMES MORE CPU TIME THAN CREATING A LINEAR MAP. THE ENHANCED TIRE MODEL USES APPROXIMATELY 2,5 TIMES MORE CPU TIME THAN THE BASE TIRE MODEL . TIGHTNING UP THE LIMITS FOR UNDERSTEER GRADIENT / SIDE SLIP ANGLE GRADIENTS WILL INCREASE SIGNIFICANTLY THE NUMBER OF ITERATIONS IN ORDER TO FIND THE ACCORDING AX, AY POINTS ON THE PERFORMANCE ENVELOPE.

UNPROTECTED SHEET FREE FOR USAGE - CANNOT BE RENAMED
Can be used as normal Excel Sheet.
DO NOT DELETE "EXPORT" BUTTON

EXPORT COMPLETE USER SHEET

Example of Custom USER Post-Processing for Steering Wheel Torque as Function of Lateral Acceleration

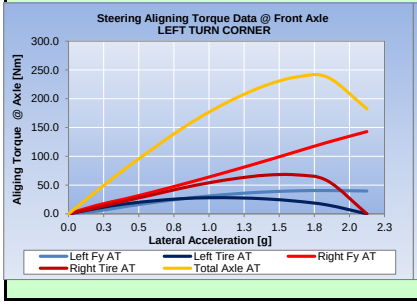
INPUT DATA FROM SDM

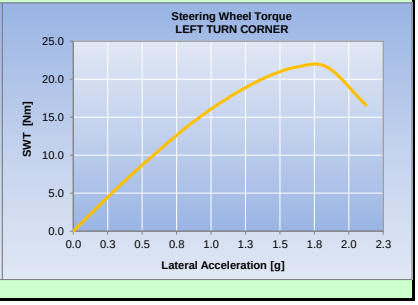
Nominal Trail	35	mm	0.035	m
Caster Trail Change with Steer (direction toe-in)	-1.5	mm/deg	-0.0015	m/deg
Caster Trail Change in Jounce travel	0	mm/mm	0	m/mm

Data from RESULTS Sheet from Lateral Acceleration Sweep Calculation - Only Fy, No Fx Contribution

G-Lat* [g]	*(Absolute) Steering Aligning Torque Data Front Axle - LEFT TURN CORNER [Nm]*							*Steering Wheel Torque [Nm]*
	Left Fy AT	Left Tire AT	Left Total AT	Right Fy AT	Right Tire AT	Right Total AT	Total Axle AT	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.20	4.79	9.41	14.20	14.80	10.75	25.56	39.75	3.61
0.40	12.57	17.16	29.73	25.90	22.30	48.20	77.93	7.08
0.60	19.60	22.40	42.00	37.86	33.10	70.96	112.96	10.27
0.80	25.82	26.26	52.08	50.63	44.25	94.87	146.95	13.36
1.00	30.95	27.94	58.89	63.87	53.91	117.78	176.66	16.06
1.20	35.04	27.70	62.74	77.82	61.72	139.54	202.29	18.39
1.41	38.03	25.84	63.88	92.52	67.18	159.70	223.57	20.32
1.62	39.95	21.91	61.87	108.18	67.60	175.78	237.65	21.60
1.85	40.46	15.25	55.71	124.35	57.10	181.45	237.17	21.56
2.12	39.62	0.00	39.62	142.85	0.00	142.85	182.47	16.59

* at G-Lat = 0 all calculated values are set to 0. On-Centre Data available in Vehicle Model Sheet





MASTER DASHBOARD

AUTOMATIC DATA UPDATE ONLY IN START/INITIALISE CONDITION

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GOTO RESULTS

GOTO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER

READ ME
FAQ
Tire Data ? Click Here
Suspension Data? Click Here
Load DSDM Front Suspension Data
Load DSDM Rear Suspension Data
Export Actual Model Data to External Sheet
Import External Model Data to Actual Model

Aerodynamics

Fr. Lift Coeff.		-

Aerobalance [%] Fr.: 35.09

Drag Coeff. | - | Enable Aeromaps
Frontal Area: 1.500 m² | Disable Aeromaps

AEROMAPS ACTIVATED !

Aerodynamics

Rr. Lift Coeff.		-

Front Suspension Rates (w/o Tires)

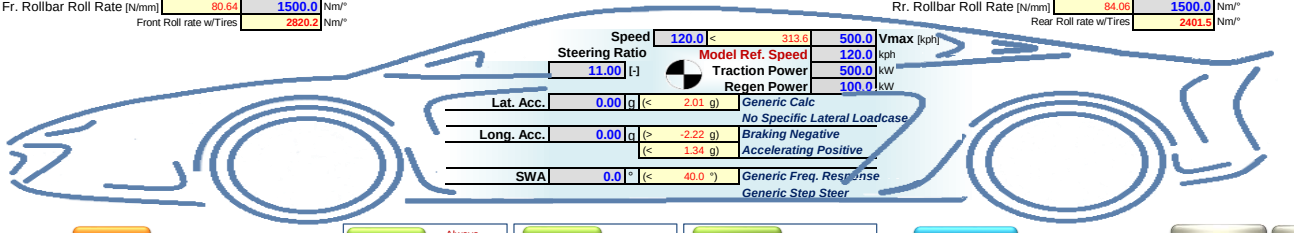
Front Rebound Stop	-5.0	mm
Fr. Wheel Rate	250.0	N/mm
Bump-Stop Gap @ Wheel	5.0	mm
Displ. to Final Bump-Stop Rate	5.0	mm
Bump-Stop Final Rate @ Wheel	2500.0	N/mm
Static Fr. Ride Height (delta to Des. Ref.)	5.0	mm
Fr. Rollbar Roll Rate [N/mm]	1500.0	Nm/°
Front Roll rate w/Tires	2820.2	Nm/°

Performance Prediction

Physical Limits [g]	Lat. Acc.		Long. Acc. (Dec. Neg. / Acc. Pos.)	
Aerodynamics & µ	2.31	g	-2.27	Aerodynamics & µ
Aero Balance	2.31	g	-2.22	Brake Distr. & Aero Bal.
Roll Stability	4.07	g	6.70	Fr. Axle Lift (Acc.)
Springs & Compliance	2.01	g	1.34	Traction, Power & Aero

Rear Suspension Rates (w/o Tires)

Rear Rebound Stop	-12.0	mm
Rr. Wheel Rate	160.0	N/mm
Bump-Stop Gap @ Wheel	30.0	mm
Displ. to Final Bump-Stop Rate	10.0	mm
Bump-Stop Final Rate @ Wheel	1000.0	N/mm
Static Rr. Ride Height (delta to Des. Ref.)	30.0	mm
Rr. Rollbar Roll Rate [N/mm]	1500.0	Nm/°
Rear Roll rate w/Tires	2401.5	Nm/°



Speed	120.0	< 313.6	500.0	Vmax [kph]
Steering Ratio	11.00	[-]	Model Ref. Speed	120.0 kph
			Traction Power	500.0 kW
			Regen Power	100.0 kW
Lat. Acc.	0.00 g	(< 2.01 g)	Generic Calc	
			No Specific Lateral Loadcase	
Long. Acc.	0.00 g	(> -2.22 g)	Braking Negative	
		(< 1.34 g)	Accelerating Positive	
SWA	0.0 °	(< 40.0 °)	Generic Freq. Response	
			Generic Step Steer	

START Initialise

GO Generic — Always G-Lat = 0 SWA = 0

GO Specific — Always Constant

GO FULL Non-Linear — Constant Velocity Sweep

CLEAR FULL Non-Linear

SET DATA Reference

LOAD DATA Reference

Front Tire Data

Fr. Tire Vertical Stiffness	280.0	N/mm	
Fr. Tire Cornering Stiffness (Nominal)	1700.0	1177.3	[N/°] Actual
Max. Actual µ-x & µ-y @ 0 g-lat	1.48	1.80	-

Tire Grip Level

	Front	Rear	
Nominal Grip µ	1.52	1.58	-
Av. Fr. & Rr. Roll. Res. Coeff.		0.010	-

Rear Tire Data

Rr. Tire Vertical Stiffness	300.0	N/mm	
Rr. Tire Corn. Stiff. (Actual)	1823.6	2500.0	[N/°] Nominal
*Max. Actual µ-x & µ-y @ 0 g-lat	1.66	1.67	-

Front Suspension Geometry

Fr. Total Static Toe	-0.50	°
Fr. Static Camber	-3.00	°
Fr. Bump Steer	-1.0	°/m
Fr. Roll Center Height @ DES. REF.	-17.0	mm
Fr. Inst. Roll Center Height	-15.2	mm

Model Settings
ENHANCED TIRE
REAR TRACTION LSD
NO L/R BRAKE SPLIT
REGEN ACTIVATED
CURB WEIGHT CONDITION

Vehicle Data

Wheel Base	3040.0	mm
Total Mass	650.0	kg
Overall CoG Height	246.4	mm
Weight Distribution	42.32	% Front
Total Yaw Inertia	605.3	kgm²
Total Pitch Inertia	534.4	kgm²

Rear Suspension Geometry

Rr. Total Static Toe	0.25	°
Rr. Static Camber	-0.50	°
Rr. Bump Steer	1.0	°/m
Rr. Roll Center Height @ DES. REF	52.0	mm
Rr. Inst. Roll Center Height	75.4	mm

Fr. Track Width	1460.0	mm				Rr. Track Width	1430.0	mm
Fr. Ride Frequency	5.290	Hz	Bounce & Pitch Center: m 2.83 -1.89 m	Fwd. Dist. to Front Axle	Bounce & Pitch Frequency: Hz 4.37 9.26 Hz	Rr. Ride Frequency	3.997	Hz
Fr. Anti-Dive	52.8	%				Rr. Anti Squat	0.0	%
Fr. Anti-Lift	0.0	%				Rr. Anti Lift	0.0	%

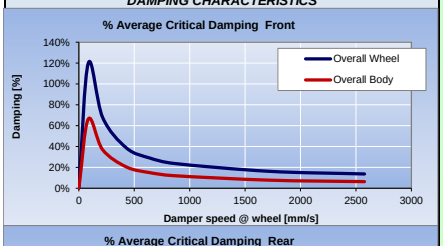
CALCULATION RESULTS FROM 7-DOF VEHICLE MODEL

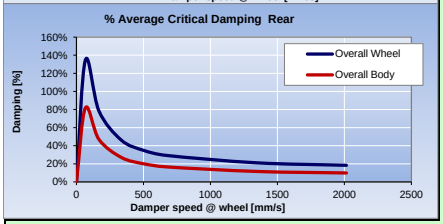
LF Wheel Load	1730.3		N		RF Wheel Load	1730.3	N
LF Wheel Travel	1.8	mm		Delta Fr. Ride Height	-1.8 mm 3.2	RF Wheel Travel	1.8	mm
LF Toe	-0.240	°		Delta Rr. Ride Height	-5.3 mm 24.7	RF Toe	-0.240	°
LF Camber	-2.985	°		Vehicle Roll Angle	0.00 ° 0.07	RF Camber	-2.985	°
LR Toe	0.130	°		Max. Fr. Axle G-Lat Capability	2.02 g 2.29	RR Toe	0.130	°
LR Camber	-0.528	°		Roll Couple Distr. (% Fr.)	58.5 % ° 0.00	RR Camber	-0.528	°
LR Wheel Travel	4.3	mm		Lateral Load Transfer Distr. (% Fr.)	45.4 % ° 0.00	RR Wheel Travel	4.3	mm
LR Wheel Load	2544.1		N	LLT Bias rel. to CoG (+Fwd)	3.1 % ° 0.00	RR Wheel Load	2544.1	N
				Steering Wheel Angle	0.00 ° Nm 0.00			

Vehicle Pitch Angle | * Front Axle Slip Angle | * Vehicle Side Slip Angle | * Rear Axle Slip Angle | Steering Wheel Torque

* Only with Enhanced Tire Model

DAMPING CHARACTERISTICS

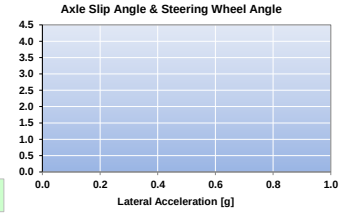




UNDERSTEER BUDGET — 120.0 kph Constant Velocity Test

Characteristic Speed	296.78	kph
Linear Roll Angle Gradient	0.26	°/g
Front AXLE Cornering Stiffness @ 0 g-lat	116657	N/rad
Rear AXLE Cornering Stiffness @ 0 g-lat	196221	N/rad
Understeer Gradient @ Wheel @ 0 g-lat	0.25	°/g
Side Slip Angle Gradient @ 0 g-lat	1.07	°/g
Understeer (US) Gradient @ g	0.00	0.25 °/g
Sideslip Angle (SSA) Gradient @ g	0.00	1.07 °/g

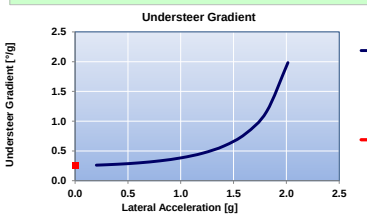
Note: When running a Full Non-Linear Sweep, the last data point is

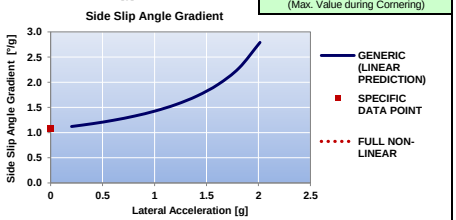


BUNDORF GENERIC CORNERING COMPLIANCE DE-ACTIVATED

Front Axle Slip Angle
Rear Axle Slip Angle
Vehicle Side Slip Angle
Steering Wheel Angle / 10

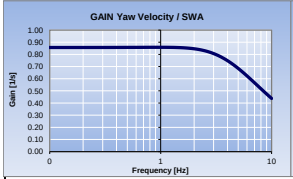
1000.0
Imposed US Gradient Limit [°/g] (Max. Value during Cornering)
1000.0
Imposed Fr. & Rr. SSA Limit [°/g] (Max. Value during Cornering)

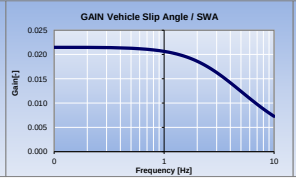


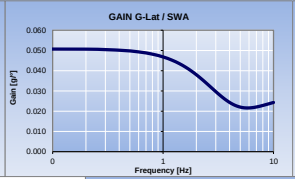


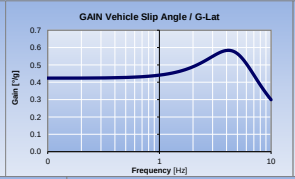
GENERIC FREQUENCY STEER RESPONSE DATA @ G-Long = 0g

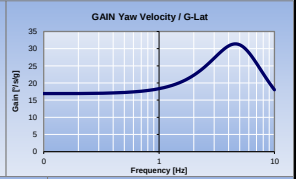
	Yaw Velocity / SWA		Veh. Slip Angle / SWA		G-Lat / SWA		Veh. Slip Angle / G-Lat		Yaw / G-Lat	
Frequency @ Peak	1.00	Hz	0.00	Hz	0.00	Hz	4.20	Hz	4.60	Hz
Static Gain @ 0 Hz	0.857	1/s	0.022	-	0.051	g/°	0.423	°/g	16.863	°/s/g
Dyn. Overshoot @ Peak	0.20%	%	0.00%	%	0.00%	%	37.96%	%	86.09%	%
Delay Time @ 1 Hz	23.0	ms	123.2	ms	44.3	ms	79.0	ms	-21.2	ms





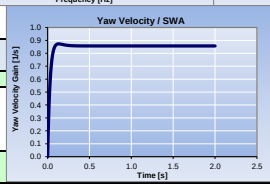


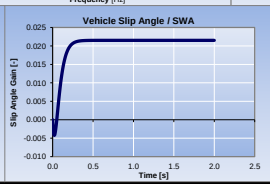


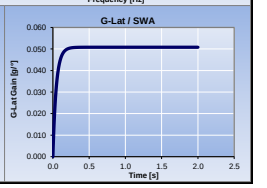


GENERIC STEP STEER RESPONSE DATA @ G-Long = 0g

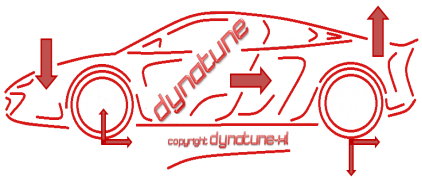
	Yaw Velocity Gain [1/s]		Slip Angle Gain [-]		G-Lat Gain [g/°]	
90% Response Time	48.0	ms	192.0	ms	104.0	ms
Peak Value	0.9	1/s	0.0	-	0.1	g/°
Time to reach Peak Value	136.0	ms	696.0	ms	608.0	ms
Dynamic Overshoot @ Peak	1.87%	%	0.00%	%	0.00%	%







VEHICLE DATA



AUTOMATIC DATA UPDATE ONLY
IN START/INITIALISE CONDITION

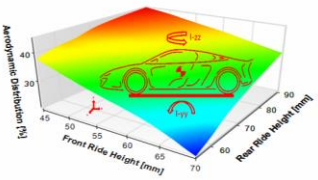
START Initialise

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GOTO MASTER | GOTO RESULTS

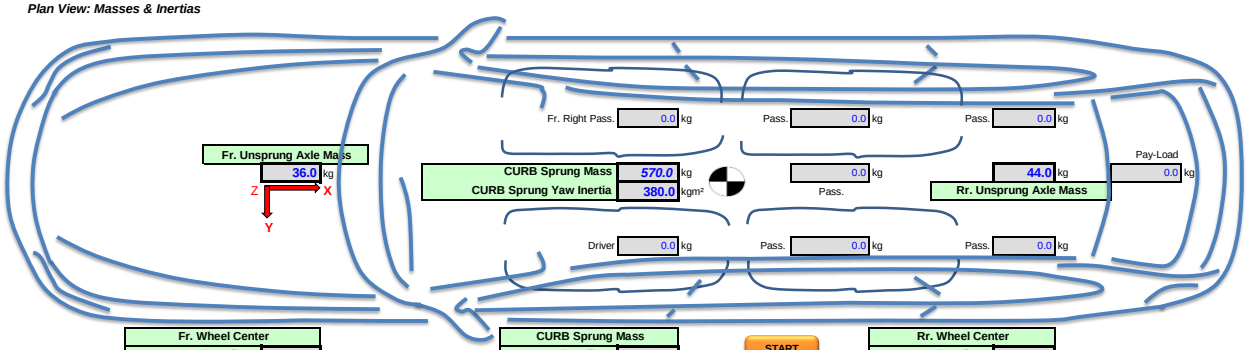
GOTO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER



Plan View

Plan View: Masses & Inertias



Fr. Right Pass.	0.0 kg	Pass.	0.0 kg
Pass.	0.0 kg		
Fr. Unsprung Axle Mass	36.0 kg		
CURB Sprung Mass	570.0 kg		
CURB Sprung Yaw Inertia	380.0 kgm²		
Pass.	0.0 kg		
Rr. Unsprung Axle Mass	44.0 kg	Pay-Load	0.0 kg
Driver	0.0 kg	Pass.	0.0 kg
Pass.	0.0 kg		

Fr. Wheel Center		CURB Sprung Mass		Rr. Wheel Center	
X Coordinate	0.0 mm	X Coordinate	1765.0 mm	X Coordinate	3040.0 mm
Y Coordinate	730.0 mm	Y Coordinate	0.0 mm	Y Coordinate	715.0 mm

START Initialise

All Model MASS and INERTIA Data refer to REFERENCE HEIGHT "0" which is defined according to CURB - UNLADEN - Weight Condition. Additional "DELTA" Front & Rear Ride Heights can be added to the REFERENCE Plane. This will affect the final CoG- Height, Suspension Roll Centre Heights and Aerodynamic Operating Points. Aerodynamic Loads will be imposed on top of the CURB Condition for the imposed Reference Speed.

	Front H-Point	2nd Row H-Point	3rd Row H-Pt	Pay-Load Mass Location
X Coordinate	1100.0 mm	1800.0 mm	2750.0 mm	3000.0 mm
Y Coordinate	400.0 mm	370.0 mm	230.0 mm	0.0 mm

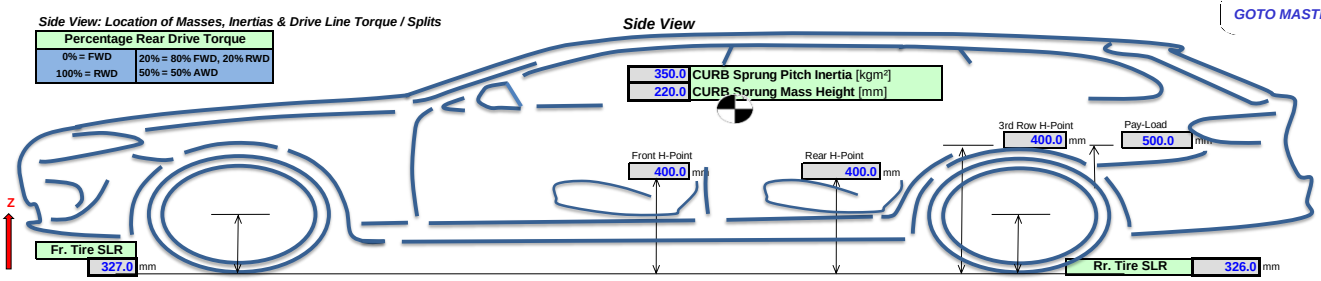
Total Mass	650.0 kg	Wheel Base	3040.0 mm	CoG Z-Height	233.1 mm	Total Yaw Inertia	605.3 kgm²
Front Mass	275.1 kg	Fr. Track Width	1460.0 mm	CoG X-Position	1753.6 mm	Total Pitch Inertia	534.4 kgm²
Rear Mass	374.9 kg	Rr. Track Width	1430.0 mm	Weight Distribution	42.32 % Front		

GOTO MASTER

Side View: Location of Masses, Inertias & Drive Line Torque / Splits

Percentage Rear Drive Torque	
0% = FWD	20% = 80% FWD, 20% RWD
100% = RWD	50% = 50% AWD

Side View



350.0	CURB Sprung Pitch Inertia [kgm²]
220.0	CURB Sprung Mass Height [mm]
Front H-Point	400.0 mm
Rear H-Point	400.0 mm
3rd Row H-Point	400.0 mm
Pay-Load	500.0 mm
Fr. Tire SLR	327.0 mm
Rr. Tire SLR	326.0 mm

Include Regenerative Braking / Overrun [1/0]

Front Percentage Brake Distribution	48.76%	0 to 100 %		1	Yes	Percentage Rear Drive Torque	100.00%	0 to 100 %	
Ideal L/R Brake Distribution [1/0]	0	No	0.000	-0.600	g Regen Only	Ideal LSD (Full Torque Vectoring) - Traction Only [1/0]	0	No	
Max. Deceleration @ Brake Distribution	-2.22	g	Fr. max g	Rr. max g		Max. Acceleration @ Traction Configuration	1.34	g	
Optimal Brake Distribution for Max. G	48.76%	% FWD	-2.240	-2.220	g Braking	Optimal AWD Configuration for Max. G	72.61%	% Rr. Torque	

	Front Differential	Rear Differential	
Preload	0.0	50.0	Nm
Max % Lock Traction	0.00%	50.00%	%
Max % Lock Regen	0.00%	0.00%	%

Aerodynamic Data

Fr. Tire Lift Coef.	0.200 -	0.180 [-] Fr. Tire Drag Coef.	Rr. Tire Lift Coef.	0.180 -	0.210 [-] Rr. Tire Drag Coef.
Fr. Tire Frontal Area	0.520 m²	Speed 120 kph	Rr. Tire Frontal Area	0.450 m²	
Average Fr. Body Lift Coef. Aeromap	-0.843 -	Frontal Area 1.50 m²	Average Rr. Body Lift Coef. Aeromap	-1.509 -	
		Average Body Drag Coef. Aeromap 0.574 -			

GOTO MASTER

Body Drag Force is applied at the CoG of the Sprung

START

Static Fr. RH	Actual Fr. RH	Static Rr. RH	Actual Rr. RH
5.00 mm	3.2 mm	30.00 mm	24.7 mm

Delta Fr. Ride Height	-1.8 mm	Tire Lift & Drag Force		Decel. due to Drag & Rolling Resist.	-0.144 g	Delta Rr. Ride Height	-5.3 mm	Tire Lift & Drag Force	
Instant. Fr. Body Lift Coef.	-0.901 -	Lift	69.3 N	Instant. Body Drag Coef.	0.580 -	Inst. Rr. Body Lift Coef.	-1.518 -	Lift	54.0 N
Fr. Inst. Body Lift Force	-901.0 N	Drag	-62.4 N	Inst. Body Drag Force	-580.0 N	Rr. Inst. Lift Force	-1518.0 N	Drag	-63.0 N

Theoretical G-Max	ENABLE AEROMAPS	G-Lat Max due to Aerodynamic Balance
2.307 g	1 Y/N 1/0	2.306 g
(total aero load & tire grip)	(static lift & drag values - used for linear prediction - will be set to average map value !) WARNING: AEROMAP CALCULATION WILL INCREASE CALCULATION TIME !	(aerodynamic load distribution, drag & tire grip)

FRONT LIFT COEFFICIENT AEROMAP [-]

FRH [mm] \ RRH [mm]	-30.0	-15.0	0.0	15.0	30.0
-8.0	-0.774	-0.929	-0.954	-1.009	-1.040
-5.0	-0.757	-0.911	-0.936	-0.990	-1.020
0.0	-0.689	-0.825	-0.849	-0.911	-0.959
5.0	-0.631	-0.762	-0.785	-0.840	-0.880
10.0	-0.569	-0.707	-0.731	-0.788	-0.829

FRONT LIFT SCALING FACTOR 1.00 -
(scaling of aeromaps, original data will be multiplied with value) average

DRAG COEFFICIENT AEROMAP [-]

FRH [mm] \ RRH [mm]	-30.0	-15.0	0.0	15.0	30.0
-8.0	0.548	0.544	0.542	0.534	0.536
-5.0	0.579	0.563	0.560	0.555	0.553
0.0	0.585	0.580	0.576	0.573	0.569
5.0	0.599	0.595	0.590	0.587	0.582
10.0	0.612	0.608	0.602	0.597	0.593

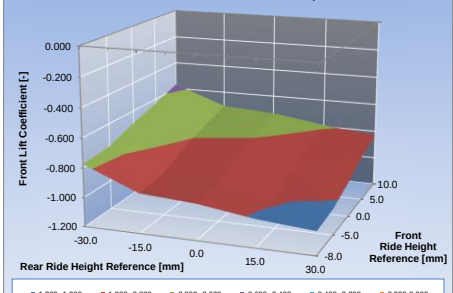
DRAG SCALING FACTOR 1.00 -
(scaling of aeromaps, original data will be multiplied with value)

REAR LIFT COEFFICIENT AEROMAP [-]

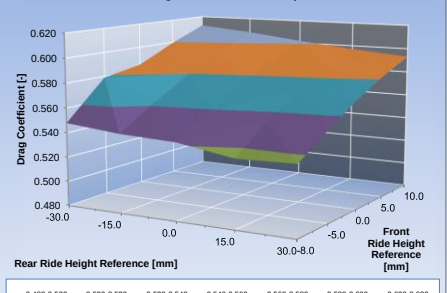
FRH [mm] \ RRH [mm]	-30.0	-15.0	0.0	15.0	30.0
-8.0	-1.399	-1.583	-1.598	-1.572	-1.478
-5.0	-1.368	-1.553	-1.568	-1.543	-1.450
0.0	-1.392	-1.555	-1.571	-1.561	-1.497
5.0	-1.400	-1.548	-1.562	-1.557	-1.505
10.0	-1.354	-1.526	-1.544	-1.543	-1.490

REAR LIFT SCALING FACTOR 1.00 -
(scaling of aeromaps, original data will be multiplied with value)

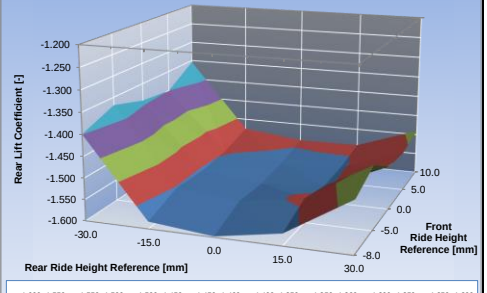
Front Lift Coefficient Aeromap



Drag Coefficient Aeromap



Rear Lift Coefficient Aeromap



ALL AEROMAP DATA MUST BE CONSISTENT WITHOUT SINGULARITIES OR SEVERE LOCAL NON-LINEARITIES

CHASSIS DATA

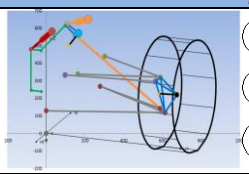
AUTOMATIC DATA UPDATE ONLY IN START/INITIALISE CONDITION

START Initialise

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GOTO MASTER | GOTO RESULTS | GOTO LAPTIME SIMULATION

GOTO VEHICLE DATA | GOTO CHASSIS DATA | GOTO TIRE DATA | GOTO VEHICLE MODEL | GOTO SPRING TUNING | GOTO DAMPER TUNING | GOTO ROLLBAR TUNING | GOTO UNDERSTEER | GOTO FREQUENCY STEER | GOTO STEP STEER

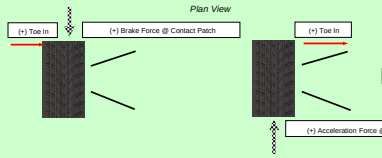


Suspension Data? Click Here

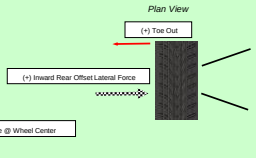
Load DSDM Rear Suspension Data

Load DSDM Front Suspension Data

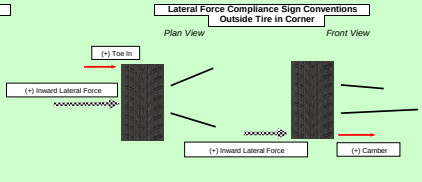
Longitudinal Compliance Sign Conventions



Aligning Torque Compliance Steer Sign Conventions



Lateral Force Compliance Sign Conventions
Outside Tire in Corner



Front Suspension Steering System Data

Outer Wheel KP Off. Change w/ Wheel Steer Angle [mm/°]	0.0	80.0	King Pin Offset [mm]
Outer Wheel Scr. Rad. Change w/ Wheel Steer Angle [mm/°]	0.0	10.0	Scrub Radius [mm]
Outer Wheel Trail Change w/ Wheel Steer Angle [mm/°]	-1.5	30.0	Caster Trail [mm]
Percentage Ackermann Steering	100.0	N	%

Front Suspension Static Toe and Camber Settings

Total Static Toe	-0.50	U	°
Static Camber	-3.00	O	°

Front Suspension Wheel Kinematics

Bump Steer	-1.0	U	°/m
Camber Gain	1.0	U	°/m
Outside Wheel Camber Gain w. Steer Angle	-0.2	O	°/°

Front Suspension Compliances

Lateral Force Toe Compliance	-0.010	U	°/kN
Lateral Force Camber Compliance	0.100	U	°/kN
Brake Steer	-0.030	U	°/kN
Acceleration Steer	0.000	N	°/kN
Aligning Torque Compliance Steer	1.250	U	°/kNm

Front Suspension Anti-Angles & Calculated Anti-Percentage

Anti-Lift Angle [°]	0.0	0.0	%
Anti-Dive Angle [°]	5.1	52.8	%

Front Suspension Roll Center

Roll Center Height @ DES. REF	-17.0	mm
Roll Center Height @ Static Ride Height	-12.0	mm
Roll Center Vert. Mov. vs. Wheel Travel Ratio	1	(0=FIXED LOCATION)

Front Suspension Wheel & Roll Rates

Linear Wheel Rate	250.0	N/mm	
Rebound Stop Position @ Wheel	-5.0	mm	
Bump-Stop Gap @ Wheel	5.0	mm	
Displ. to Final Bump-Stop Rate @ Wheel	5.0	mm	
Final Bump-Stop Rate @ Wheel	2500.0	N/mm	(see user tool)
Rollbar Rate	1500.0	Nm/°	
Rollbar Wheel Rate	80.6	N/mm	
(Total Linear Roll Rate	6150.5	Nm/°)	

• COUPLE HEAVE SPRING RATE AND ANTI-ROLLBAR RATE IN ROLL (STANDARD SETTING)

NOTE: FRONT SUSPENSION STEERING SYSTEM DATA ARE NOT AUTOMATICALLY IMPORTED WITH SDM DATA LOAD PROCEDURE. MUST BE ENTERED MANUALLY.

Axle Type	Front	Rear	U = Understeer O = Oversteer N = Neutral
0 = Independent 1 = Solid Axle 2 = Twist Beam (rear only)	0	0	
	Independent	Independent	

Solid Axle & Twist Beam Only (Values will be ignored for Axle Type "0")

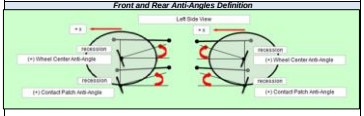
Roll Steer	0.00	N	0.00	N	(° toe) / (° roll)
Roll Camber	0.00	N	0.00	N	(° camber) / (°roll)

Roll Motion

Actual Roll Steer	-0.01	U	0.01	U	(° toe) / (° roll)
Actual Roll Camber	0.01	U	-0.19	U	(° camber) / (° roll)
Inclination Angle Gain	1.01	U	0.81	O	(° inclination) / ° roll)

(Inclination Angle = Vertical Wheel Angle vs. Road)

Front and Rear Anti-Angles Definition



Gaps to Bump-Stop / Rebound-Stop in ROLL

Fr. Roll Gap to Bump-Stop	0.25	"	2.06	Rr. Roll Gap to Bump-Stop
Fr. Roll Gap to Reb.-Stop	0.53	"	1.31	Rr. Roll Gap to Reb.-Stop

(assuming pure roll motion)

Typically the Heave-Springs do add to the Total Rollrate of the Suspension. However one can create Suspension Spring & Rollbar Linkages which do allow to De-Couple Heave Spring Rate from Anti-Rollbar Rate completely. When De-Coupled, the Heave Springs & Bumpstops will NOT contribute to the Total Rollrate. In such case please START/INITIALIZE the Model new.

Rear Suspension Static Toe and Camber Settings

Total Static Toe	0.25	U	°
Static Camber	-0.5	U	°

Rear Suspension Wheel Kinematics

Bump Steer	1.0	U	°/m
Camber Gain	-15.0	U	°/m

Rear Suspension Compliances

Lateral Force Toe Compliance	-0.010	O	°/kN
Lateral Force Camber Compliance	0.110	O	°/kN
Brake Steer	0.010	O	°/kN
Acceleration Steer	-0.010	O	°/kN
Aligning Torque Compliance Steer	0.750	O	°/kNm

Rear Suspension Anti-Angles & Calculated Anti-Percentage

Anti-Squat Angle [°]	0.0	0.0	%
Anti-Lift Angle [°]	0.0	0.0	%

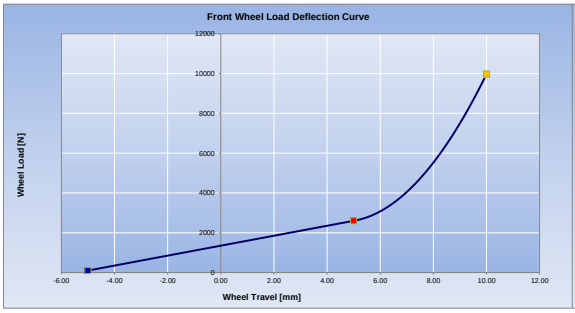
Rear Suspension Roll Center

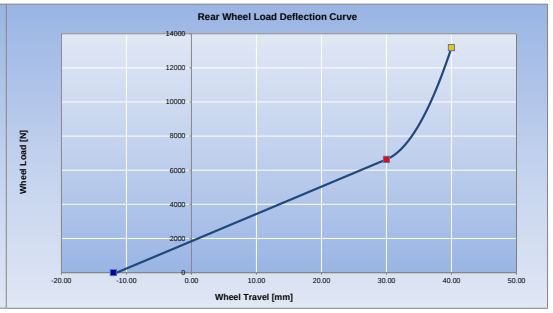
Roll Center Height @ DES. REF	52.0	mm
Roll Center Height @ Static Ride Height	82.0	mm
Roll Center Vert. Mov. vs. Wheel Travel Ratio	1	(0=FIXED LOC.)

Rear Suspension Wheel & Roll Rates

Linear Wheel Rate	160.0	N/mm	
Rebound Stop Position @ Wheel	-12.0	mm	
Bump-Stop Gap @ Wheel	30.0	mm	
Displ. to Final Bump-Stop Rate @ Wheel	10.0	mm	
Fin. Bump-Stop Rate @ Wheel	1000.0	N/mm	
Rollbar Rate	1500.0	Nm/°	
Rollbar Wheel Rate	84.1	N/mm	
(Total Linear Roll Rate	4355.3	Nm/°)	

• COUPLE HEAVE SPRING RATE AND ANTI-ROLLBAR RATE IN ROLL (STANDARD SETTING)





Front	Chart Plotting Feature: Set x-Axis Data Limits Manually		Rear	
Minimum Value	Maximum Value		Minimum Value	Maximum Value
-5.00 mm	10.00 mm		-12.00 mm	40.00 mm

GOTO MASTER

Copy Only Front Suspension Data to Input Cells

Copy Only Rear Suspenion Data to Input Cells

Copy Front & Rear Suspension Data to Input Cells

FRONT SUSPENSION K&C DATA TOOL

Select Suspension - Click on Type

Double Wishbone Standard	Typical Suspension Data Numbers	• Power Steering
Front Bump Steer	-3.0	°/m
Front Camber Gain	-20.0	°/m
Front Lateral Force Toe Compliance	-0.25	°/kN
Front Lateral Force Camber Compliance	0.20	°/kN
Front Brake Steer	-0.03	°/kN
Front Acceleration Steer	0.03	°/kN
Front Aligning Torque Compliance Steer	3.50	°/kNm
Roll Steer (Solid Axle Only)	0.00	°/°
Roll Camber (Solid Axle Only)	0.00	°/°
Front Roll Center Height	50.0	mm
Roll Center Movement vs. Wheel Travel Ratio	1.50	-
Front Anti-Lift Angle	2.0	°
Front Anti-Dive Angle	5.0	°
Front Damper to Wheel Motion Ratio	0.80	-

VERIFY STEERING RATIO ! If Suspension not available select closest similar

REAR SUSPENSION K&C DATA TOOL

Select Suspension -Click on Type

Twist Beam Standard	Typical Suspension Data Numbers	
Rear Bump Steer	0.0	°/m
Rear Camber Gain	0.0	°/m
Rear Lateral Force Toe Compliance	-0.04	°/kN
Rear Lateral Force Camber Compliance	0.30	°/kN
Rear Brake Steer	-0.03	°/kN
Rear Acceleration Steer	0.02	°/kN
Rear Aligning Torque Compliance Steer	1.00	°/kNm
Roll Steer (Solid Axle & Twist Beam Only)	0.05	°/°
Roll Camber (Solid Axle & Twist Beam Only)	-0.20	°/°
Rear Roll Center Height	150.0	mm
Roll Center Movement vs. Wheel Travel Ratio	0.00	-
Rear Anti-Squat Angle	-2.0	°
Rear Anti-Lift Angle	5.0	°
Rear Damper to Wheel Motion Ratio	1.00	-

If Suspension not available select closest similar

USER TOOL - CONVERSION FROM SPRING TO WHEELRATE

	Rate of Spring	Spring to Wheel Motion Ratio	Suspension Parasitic Wheel Rate (N/mm)	Final Result Total Wheel Rate	
Spring Rate (Component) [N/mm]	23.0	0.9	4.0	22.6	N/mm WHEEL rate
Rollbar Rate @ Point 1 [N/mm]	62.6	0.94	0.0	55.3	N/mm WHEEL rate

USER TOOL - CONVERSION VERTICAL TO ROLL RATE

Conversion Calculator from N/mm -->Nm/°

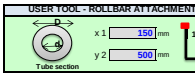
Spring Rate @ wheel	118.0	N/mm
Rollbar Rate @ wheel	0.0	N/mm
Track Width	1.480	m
Total Roll Rate @ wheel	118.0	N/mm
Roll Stiffness in Nm/deg	2255.5	Nm/°

NOTES on Conversion Calculator:

* Best to use K&C data
** Rate conversion is an approximate since the effects of nonlinear motion ratio and spring force on wheel rate are only considered in the parasitic rate
*** Motion ratio is assumed to be standard between 0 and 1 (= same displacement as wheel).
**** ATTENTION In User Tool for Spring & Anti-rollbar calc. consider protection coating thickness on effective diameter of steel coil / rollbar

USER TOOL - ROLLBAR ATTACHMENT VERTICAL RATE CALCULATION

(ROLL MOTION, STEEL MATERIAL ONLY)

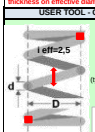


x 1	150	mm	
y 2	500	mm	
D	18.0	mm	
d	0.0	mm (0 for solid bar)	
Rollbar Vertical Rate @ Pt 1 (in roll motion)	62.6	N/mm	

X,Y=0 (middle of car)

USER TOOL - CALCULATION COIL SPRING COMPONENT RATE

(STEEL MATERIAL ONLY)

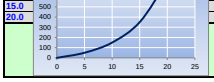


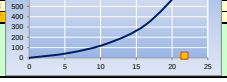
Coil d	10.0	mm
Spring D	120.0	mm
Coil Nr. i eff	2.50	-
(typically Nr. of total coils -1)		
Spring Rate	23.44	N/mm

i eff = number of effectively working coils.

USER TOOL - BUMP-STOP COMPONENT TO WHEEL RATE CALCULATOR

Component Displacement [mm]	Component Force [N]	Comp. Inst. Rate [N/mm]	Displacement @ Wheel [mm]	Force @ Wheel [N]	Rate @ Wheel [N/mm]
0.0	0.0	0.0	0.0	0.0	0.0
5.0	50.0	10.0	5.4	46.0	8.5
10.0	150.0	20.0	10.9	138.0	16.9
15.0	350.0	40.0	16.3	322.0	33.9
20.0	750.0	80.0	21.7	690.0	67.7





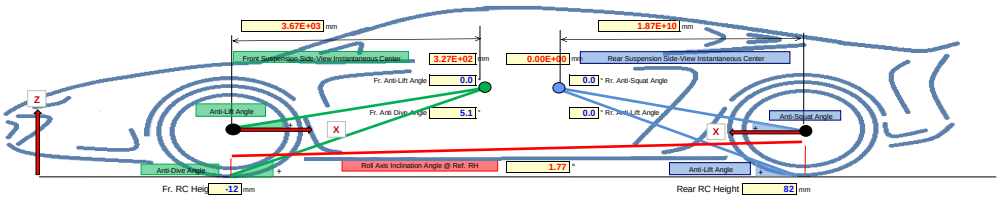
Motion Ratio Bump-Stop to Wheel: 0.92 -

Bumpstop Final Rate @ Wheel

Bump-Stop Final Displ. @

PERCENTAGE ANTI-LIFT / ANTI-DIVE CALCULATION OUT OF ANTI-ANGLES

GOTO MASTER



Front Anti Dive %	52.84	%
Front Anti Lift %	0.00	%

Rear Anti Squat %	0.00	%
Rear Anti Lift %	0.00	%

TIRE DATA

AUTOMATIC DATA UPDATE ONLY
IN START/INITIALISE CONDITION

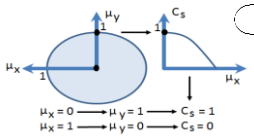
START Initialise

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GOTO MASTER | GOTO RESULTS

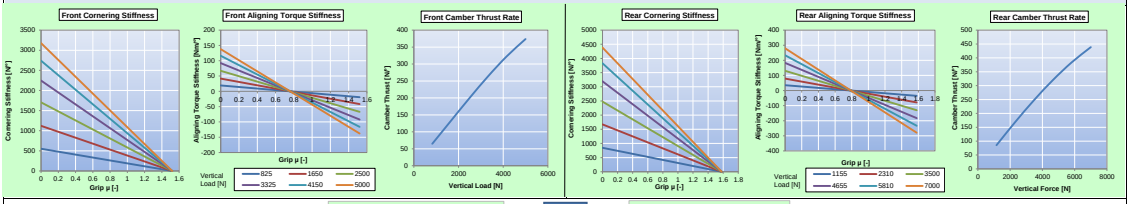
GOTO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER



Tire Data ?
Click Here

GENERIC - LINEAR - BASE TIRE MODEL



Tire Data are Linear -> Straight Lines

GENERIC LINEAR BASE TIRE MODEL:
- LINEAR CORNERING STIFFNESS
- LINEAR ALIGNING TORQUE STIFFNESS
- LINEAR CAMBER THRUST RATE

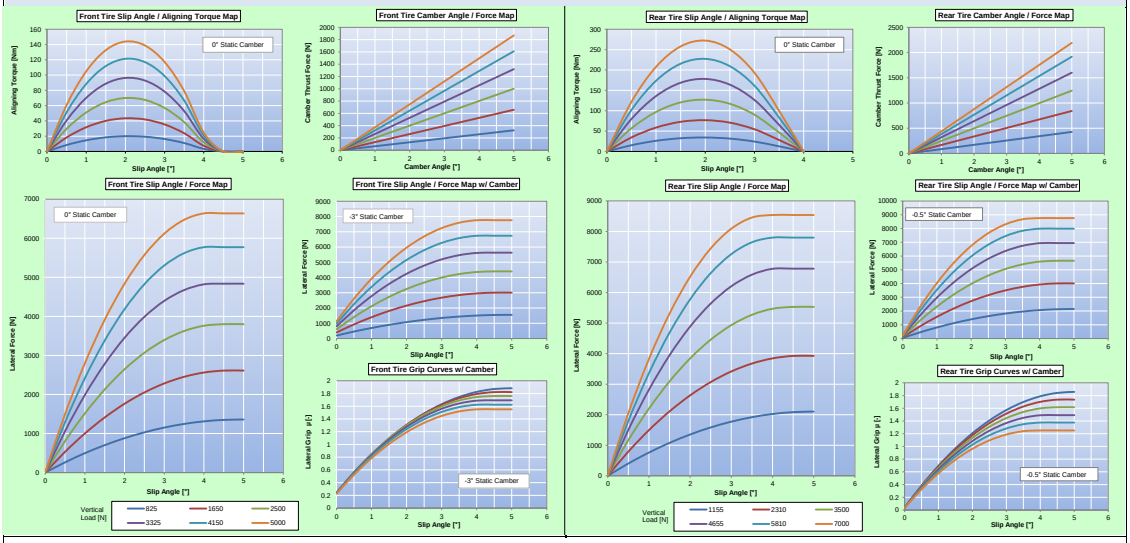
NO TIRE LATERAL FORCE, NO TIRE SLIP ANGLE .....

ENHANCED TIRE MODEL:
- TIRE DATA LOOKUP TABLES
- TIRE DATA TUNING PARAMETERS

NON-LINEAR TIRE LATERAL FORCE, NON-LINEAR TIRE ALIGNING TORQUE, TIRE SLIP ANGLE

Tire Data are Non- Linear -> Curved Lines

LOOKUP TABLE - ENHANCED TIRE MODEL



Front Tire Properties

Static Loaded Radius (SLR)	327.0	mm
Vertical Stiffness	280.0	N/mm

Front Tire Data

Cornering Stiffness (CS)	1700.0	N/°
Nominal Grip Coefficient μ @ 0° Camber	1.52	-
Tire Reference Load	2500.0	N
Lateral / AT / Camber Stiffness Load Dependency	87.0	%
Aligning Torque Stiffness (AT)	65.0	Nm/°
Camber Thrust Rate	200.0	N/°
% Growth of Loaded Radius w/ Speed	0.35	%/100kph
% Long. Grip Loss per ° Camber/Inclination Angle	2.00	%/°
% Grip Loss/Gain per kN from Ref. Load *	5.00	%/kN

** Only Affecting Tire Forces due to Slip Angle*

All Values @ Tire Reference Load & Static Camber

Only for TIRE MODEL Graph Plotting - Combined Slip - Percentage μ-x Saturation vs. Remaining CS & μ-y

	Saturated % μ-x	Remaining CS & μ-y		Saturated % μ-x	Remaining CS & μ-y
	0.00%	1700.0	N/°	0.00%	2500.00	N/°
% CS & μ-y	100.0%	1.52	-	100.0%	1.58	-

USE ENHANCED TIRE MODEL

Rear Tire Properties

Static Loaded Radius (SLR)	326.0	mm
Vertical Stiffness	300.0	N/mm

Rear Tire Data

Cornering Stiffness (CS)	2500.0	N/°
Nominal Grip Coefficient μ @ 0° Camber	1.58	-
Reference Load	3500.0	N
Lateral / AT / Camber Stiffness Load Dependency	75.0	%
Aligning Torque Stiffness (AT)	125.0	Nm/°
Camber Thrust Rate	250.0	N/°
% Growth of Loaded Radius w/ Speed	0.35	%/100kph
% Long. Grip Loss per ° Camber/Inclination Angle	2.50	%/°
% Grip Loss/Gain per kN from Ref. Load *	6.50	%/kN

** Only Affecting Tire Forces due to Slip Angle*

TIRE DATA TOOL - CREATE YOUR OWN TIRE

Copy Front & Reat Tire Data to Input Cells

SELECT TIRE & RIM SIZE, ASPECT RATIO AND TIRE TYPE FOR ESTIMATED TIRE CHARACTERISTICS *	Select Tire Width [mm]	Size Rim [°]	Select Aspect Ratio [%]	Select Tire Type [-]	Enter Tire Data Reference Load [N]		Cornering Stiffness [N/mm]	Aligning Torque Stiffness [Nm/°]	Camber Thrust [N/°]	Load Dependancy [%]	Tire Grip μ [-]	Vertical Stiffness [N/mm]
Selected Front Tire out of Database	285	17	55	High Performance Tire	4000	4000	1735	60	66	75	1.1	209
Selected Rear Tire out of Database	225	20	25		4000	4000	1373	48	69	81	1.1	200

* Nominal Values for One Specific Reference Load (4kN)

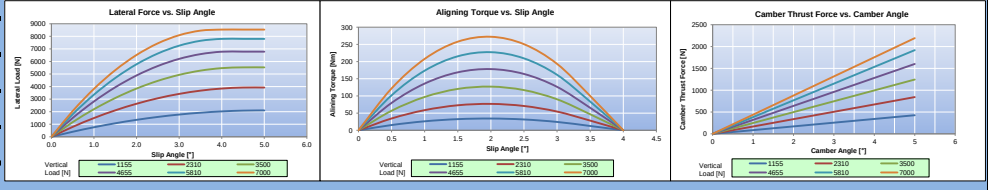
Tire Graph Generator:
Enter Basic Tire Parameters to see resulting Graphs (Enhanced Tire Model)

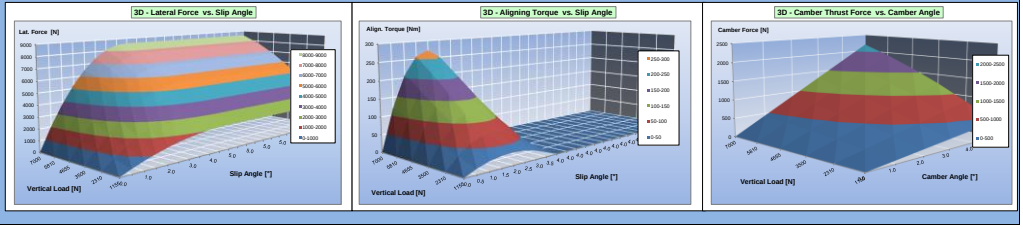
Cornering Stiffness [N/°]	μ [-]	Cornering Stiffness Load Dependency [%]	Reference Load [N]
2500	1.50	87	2500

Aligning Torque Stiffness [Nm/°]	μ [-]	Aligning Torque Stiffness Load Dependancy [%]	Reference Load [N]
75	1.50	87	2500

Camber Thrust [N/°]	Camber Thrust Load Dependancy [%]	Reference Load [N]
100	87	2500

Activate Manual Input & Plot
Plot Front Tire from Database
Plot Rear Tire from Database
Plot Actual Front Tire from Model
Plot Actual Rear Tire from Model





VEHICLE SIMULATION MODEL

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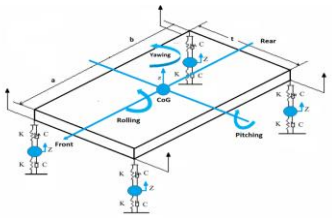


Instant. Total Fr. Aerodynamic Lift [N]	-762.3	N	**Instantaneous Total Drag Force**	-830.8	N
Fr. Body Lift	-901.0	N			
Fr. Tires Lift	138.7	N			
Speed	0.0	kph			
Steering Ratio	0.00	-			
Sprung Mass	570.0	kg			
Instant. CoG Height Sprung Mass	235.7	mm			
Total Mass	650.0	kg			
Instant. Total CoG Height	246.4	mm			
Wheel Base	3040.7	mm			

Inst. Total Rr. Aerodyn. Lift	-1410.0	N			
Rr. Body Lift	-1518.0	N			
Rr. Tires Lift	108.0	N			

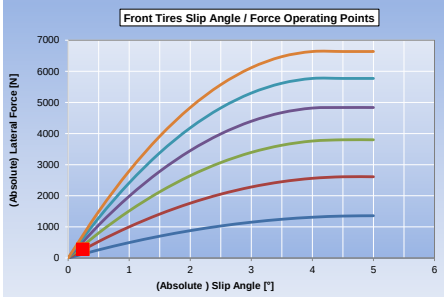
Fr. Track Width	1460.0	mm	Rr. Track Width	1430.0	mm
Instant. Fr. Vertical Wheel Rate	250.0	N/mm	Instant. Rr. Vertical Wheel Rate	160.0	N/mm
Fr. Instant. Lateral Load Transfer Distribution	45.4	%	Instant. Rr. Lateral Load Transfer Distribution	54.6	%
Instant. Fr. Average Tire Loaded Radius	327.0	mm	**Instant. Rr. Average Tire Loaded Radius**	325.0	mm
Instant. Fr. Ride Height Change & Actual RH	-1.8	3.2 mm	**Instant. Rr. Ride Height Change & Actual RH**	-5.3	24.7 mm
Instant. Fr. Roll Center Height	-15.2	mm	**Instant. Rr. Roll Center Height**	75.4	mm
Instant. Fr. Tire Drag & Lift Force	-62.4	69.3 N	Instant. Rr. Tire Drag &Lift Force	-63.0	54.0 N

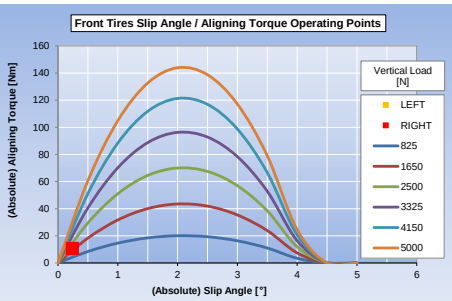
7-Degree of Freedom Handling Model

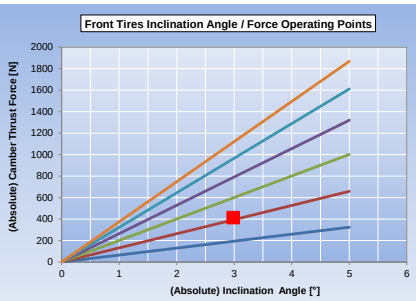
Slip Angle (+) when Creating (+) Lateral Force
(+) Lateral Force is Pushing Vehicle into a Left Turn

Aligning Torque (+) when Creating Toe-Out Compliance on Suspension
Yaw Moment Positive When Forcing Vehicle into Left Turn

Camber Thrust Force (+) when Creating (+) Lateral Force
(+) Lateral Force is Pushing Vehicle into a Left Turn







Constant Velocity
Straight Line Running
ENHANCED TIRE MODEL ACTIVATED
NUMBERS IN GREEN CELLS

	Left Front Wheel		μ Fr. Left Tire		μ Fr. Right Tire	Right Front Wheel
Dynamic Suspension + Tire Deflection	3.2	mm	0.08		0.08	3.2 mm
Vertical Contact Patch Load	1730.3	N	Fr. Left Tire AT		Fr. Right Tire AT	1730.3 N
Vertical Dynamic Suspension Load	455.8	N	-10.5	Nm	-10.5 Nm	455.8 N
Contact Patch Vert. Load Change due to G-Lat	0.0	N	Fr. Left Tire Slip Angle		Fr. Right Tire Slip Angle	0.0 N
Contact Patch Vert. Load Change due to G-Long	0.0	N	0.24	°	-0.24 °	0.0 N
Suspension Dynamic Deflection (+ = Jounce)	1.8	mm				1.8 mm
Total CP Lat. Force due to Tire Slip & Camber			-131.1	N	131.1 N	
Wheel Fore/Aft Force			0.0	N	0.0 N	
Kinematic Toe (Static & Bump Steer)	-0.252	°				-0.252 °
Lat. Compl. Toe Change (Force & Aligning Torque)	0.012	°				0.012 °
Long. Compl. Toe Change (Acc. & Braking Forces)	0.000	°				0.000 °
LF Toe	-0.240	°				-0.240 °
LF Wheel Steer Angle	0.000	°				0.000 °
LF Combined Total Steer & Toe Angle	-0.240	°				-0.240 °
Kinematic Camber (Static & Gain)	-2.998	°				-2.998 °
Lat. Compl. Camber Change (Force)	0.013	°				0.013 °
Steering Camber Change	0.000	°				0.000 °
LF Camber	-2.985	°				-2.985 °
LF Inclination Angle	-2.985	°				-2.985 °
LF Caster Trail	30.000	mm				30.000 mm
LF KP Offset	80.000	mm				80.000 mm
LF Scrub Radius	10.000	mm				10.000 mm
Camber Thrust Force*	-413.45	N				413.45 N
Slip Angle Force *	282.47	N				-282.47 N

* Included in Total CP Lat Force

Inclination Angle starts with Static Camber Value and changes from there on with Chassis Roll Angle.

When using the BASE TIRE Model, the Lateral Forces at the 4 corners of the car are calculated by distributing the Total Axle Loads proportionally to the Vertical Contact Patch Loads on each corner (until the Maximum Tire Grip has been achieved).

Only the ENHANCED TIRE Model will provide correct Lateral Corner Forces.

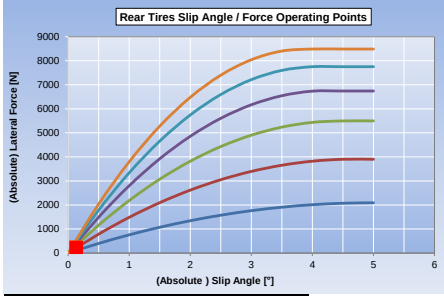
Front Axle Side Slip Angle: 0.00 °
Front Axle Lateral Load: 0.0 N / 0.0 N
Front Axle Longitudinal Load
Diff. Locking Percentage: 0.0 %
% Fr. Regen in Brake Event: 0.0 %
SWA: 0.00 °
SWT: 0.00 Nm

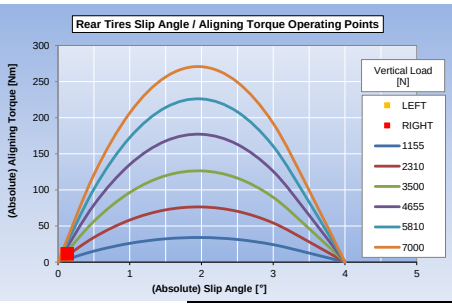
Corner Radius	N/A	m			
Speed	120.0	kph			
G-Lat	0.00	g			
G-Long	0.00	g			
Vehicle Pitch Angle	0.07	° (+ = Squat)			
H-Point Rise	-4.4	mm (+ = Up)			
Vehicle Rollangle	0.00	°			
Chassis Rollangle	0.00	°			
Veh. Slip Angle	0.00	°			
Yaw Velocity	N/A	°/s			

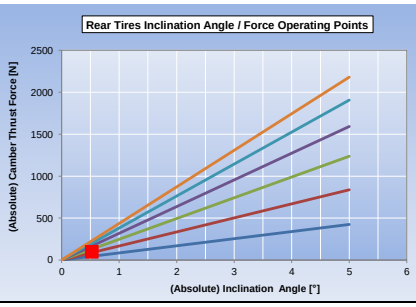
	Left Rear Wheel		μ Rr. Left Tire		μ Rr. Right Tire	Right Rear Wheel
Dynamic Suspension + Tire Deflection	6.7	mm	0.22		0.22	6.7 mm
Vertical Contact Patch Load	2544.1	N	Rr. Left Tire AT		Rr. Right Tire AT	2544.1 N
Vertical Dynamic Suspension Load	689.8	N	11.5	Nm	11.5 Nm	689.8 N
Contact Patch Vert. Load Change due to G-Lat	0.0	N	Rr. Left Tire Slip Angle		Rr. Right Tire Slip Angle	0.0 N
Contact Patch Vert. Load Change due to G-Long	0.0	N	-0.13	°	0.13 °	0.0 N
Suspension Dynamic Deflection (+ = Jounce)	4.3	mm				4.3 mm
Total CP Lat. Force due to Tire Slip & Camber			-332.7	N	332.7 N	
Wheel Fore/Aft Force			458.1	N	458.1 N	
Kinematic Toe (Static & Bump Steer)	0.129	°				0.129 °
Lat. Compl. Toe Change (Force & Aligning Torque)	0.005	°				0.005 °
Long. Compl. Toe Change (Acc. & Braking Forces)	-0.005	°				-0.005 °
LR Toe	0.130	°				0.130 °
Kinematic Camber (Static & Gain)	-0.565	°				-0.565 °
Lat. Compl. Camber Change (Force)	0.037	°				0.037 °
LR Camber	-0.528	°				-0.528 °
LR Inclination Angle	-0.528	°				-0.528 °
Camber Thrust Force*	-96.27	N				96.27 N
Slip Angle Force *	-237.03	N				237.03 N

* Included in Total CP Lat Force

Rear Axle Side Slip Angle: 0.00 °
Rear Axle Lateral Load: 0.0 N / 916.3 N
Rear Axle Longitudinal Load
Diff. Locking %: 0.0 %
% Rr. Regen in Brake Event: 0.0 %
YAW MOMENT
Caused by Diff. Preload & L/R Traction / Braking Forces: 0.0 Nm







Gx-Gy-V Performance Envelope Plots

USE 100% GRID POINT VERIFICATION PROCEDURE

GOTO MASTER | GOTO LAPTIME

Creating a LINEAR G-G-V Map is CPU time consuming. If any Bump-Stops are activated in Roll the results can be incorrect. In that particular case a NON-LINEAR calculation is recommended.
The LINEAR G-G-V Map procedure will ALWAYS use the BASE Tire Model !

CREATE **LINEAR** G-G-V MAP | CREATE **NON-LINEAR** G-G-V MAP

US Gradient Limit (Cornering)	1000	[°/g]
Fr. & Rr. SSA Grad. Limit (Cornering)	1000	[°/g]

MAP CALC.	TIRE FOR MAP
NON-LINEAR	ENHANCED TIRE

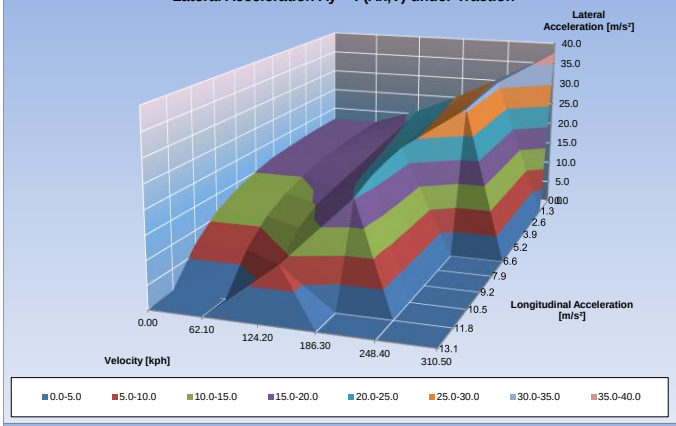
BUNDORF COMPLIANCE OFF

Creating a NON-LINEAR G-G-V Map causes a major increase of CPU time (up to 10x). If no Bump-Stops are activated in Roll and the BASE Tire model is being used a LINEAR Analysis is sufficient. The NON-LINEAR G-G-V Map Calculation in combination with the ENHANCED Tire Model represents the most detailed graphic presentation of a vehicles Performance

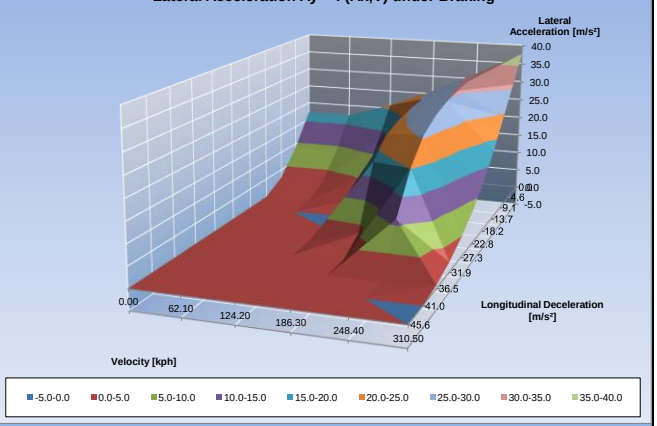
Automatically Calculated Data Points for Velocity [kph]	0.0	62.1	124.2	186.3	248.4	310.5
Custom Data Points for Velocity - STAY WITHIN THE LIMITS !	0.0	120.0	160.0	180.0	220.0	310.5

Use Custom Reference Velocity Points

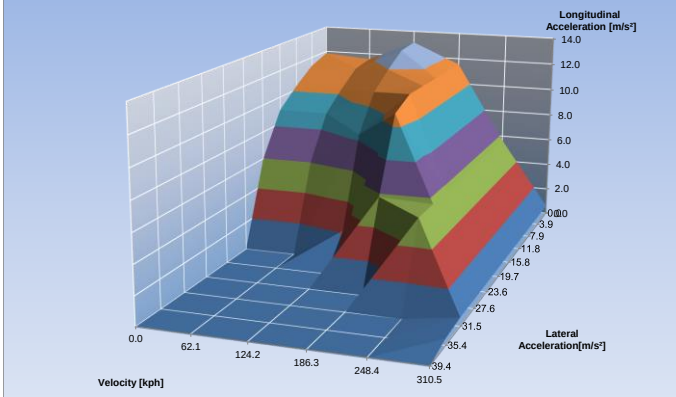
Lateral Acceleration Ay = f (Ax,V) under Traction



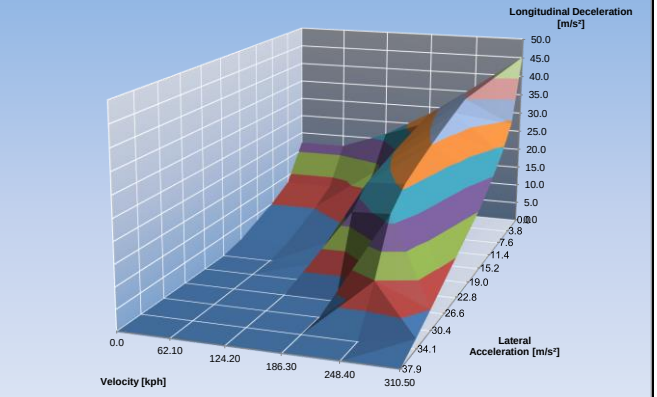
Lateral Acceleration Ay = f (Ax,V) under Braking



Longitudinal Acceleration Ax = f (Ay,V) under Traction



Longitudinal Deceleration Ax = f (Ay,V) under Braking



GOTO MASTER
GOTO LAPTIME

DATA REFERENCE TABLE

VELOCITY [kph]	Max. Ax TRACTION [g]	Max. Ax BRAKING [g]	Max. Ay LATERAL [g]
62.1	1.179	1.743	1.743
124.0	1.337	2.189	2.123
186.3	1.177	2.873	2.629
249.5	0.566	3.735	3.224
313.5	0.036	4.646	3.868

GENERAL VEHICLE REFERENCE DATA

	VELOCITY [kph]				
Front End	**62.1**	**124.0**	**186.3**	**249.5**	**313.5**
Instant. Fr. Vertical Wheel Rate [N/mm]	250.0	250.0	250.0	900.0	1400.0
Instant. Fr. Lateral Load Transfer Distribution [%]	45.8	45.4	46.0	64.6	64.9
Instant. Fr. Average Tire Loaded Radius [mm]	327.4	327.0	325.7	323.7	321.2
Instant. Fr. Ride Height Change (- = Jounce) [mm]	0.0	-1.9	-5.8	-9.6	-13.1
Instant. Fr. Roll Center Height [mm]	-12.8	-15.4	-19.9	-24.5	-28.7
Instant. Total Fr. Aerodynamic Lift [N]	-198.3	-812.9	-1917.0	-3464.2	-5231.6
Body					
Instant. Total Drag Force [N]	-223.6	-887.1	-1976.0	-3487.8	-5446.5
Instant. CoG Height SM [mm]	239.1	235.4	228.4	218.9	208.2
Instant. Total CoG Height [mm]	249.8	246.1	239.2	229.7	219.1
Rear End					
Instant. Rr. Vertical Wheel Rate [N/mm]	160.0	160.0	160.0	160.0	320.0
Instant. Rr. Lateral Load Transfer Distribution [%]	54.2	54.6	54.0	35.4	35.1
Instant. Rr. Average Tire Loaded Radius [mm]	326.1	324.9	322.3	318.2	313.2
Instant. Rr. Ride Height Change (- = Jounce) [mm]	-0.7	-5.7	-14.9	-28.6	-44.4
Instant. Rr. Roll Center Height [mm]	80.6	74.9	64.9	50.5	34.1
Inst. Total Rr. Aerodyn. Lift [N]	-369.9	-1512.1	-3521.4	-6402.4	-9796.5

UNDERSTEER BEHAVIOUR

AUTOMATIC DATA UPDATE ONLY
IN START/INITIALISE CONDITION

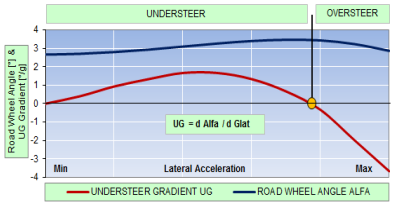
START Initialise

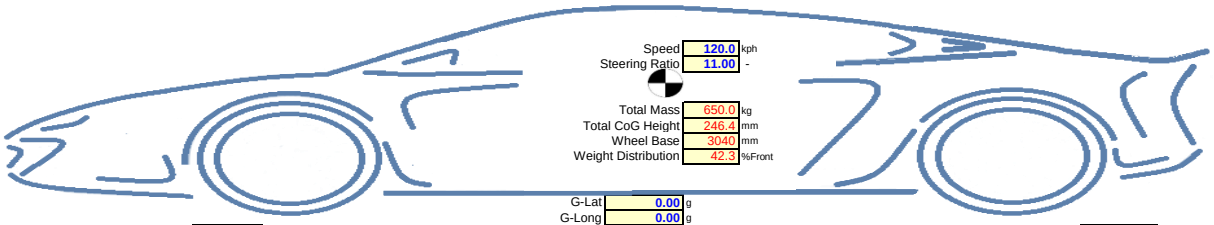
BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GOTO MASTER | GOTO RESULTS

GOTO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER





Speed	120.0	kph
Steering Ratio	11.00	-
Total Mass	650.0	kg
Total CoG Height	246.4	mm
Wheel Base	3040	mm
Weight Distribution	42.3	%Front
G-Lat	0.00	g
G-Long	0.00	g

Fr. Tire Vert. Stiffness	280.0	N/mm
Fr. Instant. Roll Center Height	-15.2	mm
Fr. Instant. Roll Stiffness w/ Tires	2820.2	Nm/°
Fr. Instant. Lateral Load Transfer	45.4	%
Fr. Delta Ride Height (-jounce)	-1.8	mm

Generic Understeer			
		0.00	g Longitudinal Acc.
0.25	U	°/g	@ Wheel
2.75	U	°/g	@ Steering Wheel

Rr. Tire Vertical Stiffness	300.0	N/mm
Rr. Instant. Roll Center Height	75.4	mm
Rr. Instant. Roll Stiffness w/ Tires	2401.5	Nm/°
Rr. Instant. Lateral Load Transfer	54.6	%
Rr. Delta Ride Height (-jounce)	-5.3	mm

Fr. Instant. Tire Cornering Stiffness	1177.3	N/°
Fr. Instant. Tire Camber Thrust Rate	138.5	N/°
Fr. Instant. Tire AT Stiffness	43.9	Nm/°
(@ operating point Vx & G-Long @ 0 G-Lat)		
Fr. Instant. AXLE Cornering Stiffness	116657.5	N/rad

UNDERSTEER BUDGET		
Maximum Understeer Gradient Limit during Cornering (US)	1000	[°/g] (max 25) - 1000 No Limit
Maximum Fr. & Rr. Side Slip Angle Gradient Limit (SSA)	1000	[°/g] (max 25) - 1000 No Limit

U = Understeer, O = Oversteer

Rr. Inst. Tire Cornering Stiffness	1823.6	N/°
Rr. Instant. Camber Thrust Rate	185.2	N/°
Rr. Instant AT Stiffness	88.1	Nm/°
(@ operating point Vx & G-Long @ 0 G-Lat)		
Rr. Inst. AXLE Cornering Stiffness	196221.2	N/rad

GOTO MASTER

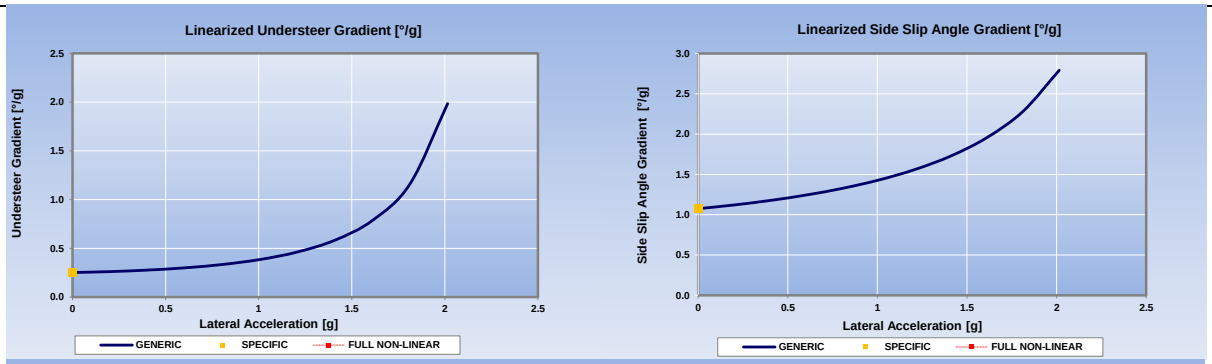
Front		
Fr. Cornering Compliance @ 0 G-Lat	1.33	U °/g

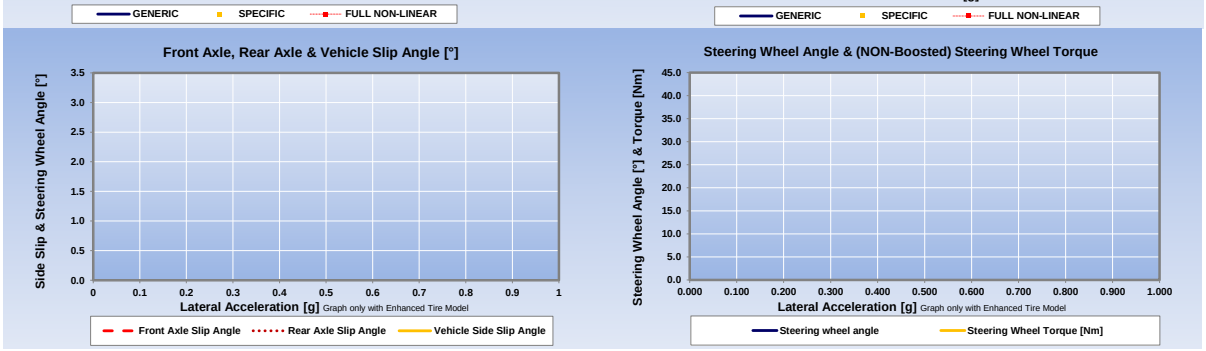
LINEAR UNDERSTEER GRADIENT @ 0 G-Lat		
0.25	U	°/g @ WHEEL
2.77	U	°/g @ STEERING WHEEL

Rear		
Rr. Cornering Compliance @ 0 G-Lat	1.07	O °/g

Constant Velocity Sweep

NOTE: When running a Full Non-Linear Sweep the First and Last data point are indicated by the "Specific" Orange Marker





° GENERIC BUNDORF CORNERING COMPLIANCE CALCULATION ACTIVATED (BASE TIRE)

° USE CONSTANT RADIUS TEST FOR FULL NON-LINEAR SWEEP

RADIUS 65.78 m

GOTO MASTER

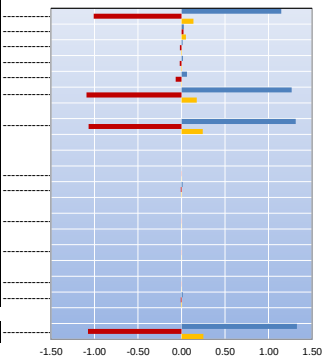
BUNDORF Cornering Compliance & Understeer Budget Calculation

Contribution of Weight Distribution and Tire & Suspension Compliance

All Units are °/g

		FRONT AXLE			REAR AXLE			VEHICLE = DELTA FRONT - REAR	
Weight Distribution & Tire Cornering Stiffness		1.15	U		1.01	O		0.14	U
Limited Slip Differential Effects	+	0.03	U	+	-0.02	U		0.05	U
Lateral Force Compliance Steer	+	0.01	U	+	0.02	O		0.00	O
Lateral Force Camber Compliance	+	0.02	U	+	0.02	O		0.00	O
Aligning Torque Compliance Steer	+	0.06	U	+	0.07	O		0.00	O
Sub-Total		1.26	U		1.09	O		0.17	U
Effect of Aligning Torque on whole Vehicle	x	1.04		x	0.98				
Total		***1.31***	***U***		***1.07***	***O***		***0.24***	***U***
Contribution of Vehicle Roll									
Roll Steer		0.0013	U		-0.0013	U		0.0026	U
Roll Camber / Inclination Angle Gain	+	0.0125	U	+	0.0086	O		0.0038	U
Interactions:									
Inclination Angle Gain with Aligning Torque Compliance Steer	+	0.0007	U	+	0.0006	O		0.0001	U
Inclination Angle Gain with Lateral Force Compliance Steer	+	0.0000	U	+	0.0000	O		0.0000	O
Inclination Angle Gain with Aligning Torque on whole vehicle	+	0.0003	U	+	0.0003	O		0.0000	O
Total		***0.015***	***U***		***0.008***	***O***		***0.007***	***U***
Total Axle Cornering Compliance		***1.33***	***U***		***1.07***	***O***		***0.25***	***U***

Understeer Budget U (+) / O (-)



Understeer Gradient & Side Slip Angle Gradient Performance Envelope Plots

GOTO MASTER | GOTO LAPTIME

Creating a LINEAR G-G-V Map is CPU time consuming. If any Bump-Stops are activated in Roll the results can be incorrect. In that particular case a NON-LINEAR G-G-V Map calculation is recommended.
The LINEAR G-G-V Map procedure will ALWAYS

CREATE **LINEAR** G-G-V MAP

Understeer & Side Slip Angle Gradient are calculated automatically within the G-G-V Map Procedure.

CREATE **NON-LINEAR** G-G-V MAP

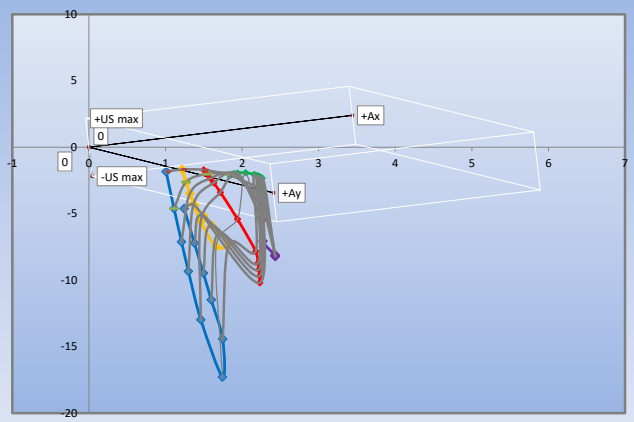
Creating a NON-LINEAR G-G-V Map will causes a major increase of CPU time (about 10x). If no Bump-Stops are activated in Roll and the BASE Tire model is being used a LINEAR Analysis is sufficient. The NON-LINEAR G-G-V Map Calculation in combination with the ENHANCED Tire Model represents the most detailed graphic presentation of a

Imposed US Gradient Limit (Cornering)	1000	[°/g]
Imposed SSA Gradient Limit (Cornering)	1000	[°/g]

MAP CALCULATION	TIRE MODEL USED FOR MAP
NON-LINEAR	ENHANCED TIRE

BUNDORF COMPLIANCE OFF

Understeer Gradient f (Ax, Ay, V) under Traction



Speed [kph] 62 124 186 250 314

Angles of Rotation for Chart

185 X Angle [°]
359.9 Y Angle [°]
325 Z Angle [°]

* the graph will follow with a small delay due to recalcs iso-view

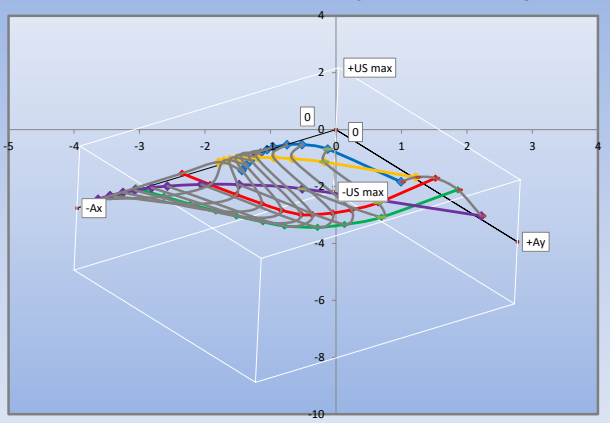
Top View | Front | Side | Activate/Reset Iso Graph

Default Angles

Graph Reference Data Table

V [kph]	Ax [g]	Ay [g]	US Grad [°/g]
62	0.00	1.74	-4.7
62	1.18	0.31	-57.8
124	0.00	2.12	0.7
124	1.34	0.33	-55.9
186	0.00	2.63	5.0
186	1.18	1.88	-107.1
250	0.00	3.22	6.0
250	0.57	3.13	-1.0
314	0.00	3.87	1.4
314	0.04	4.01	-55.8

Understeer Gradient = f (Ax, Ay, V) under Braking



Speed [kph] 62 124 186 250 314

Angles of Rotation for Chart

185 X Angle [°]
0.1 Y Angle [°]
325 Z Angle [°]

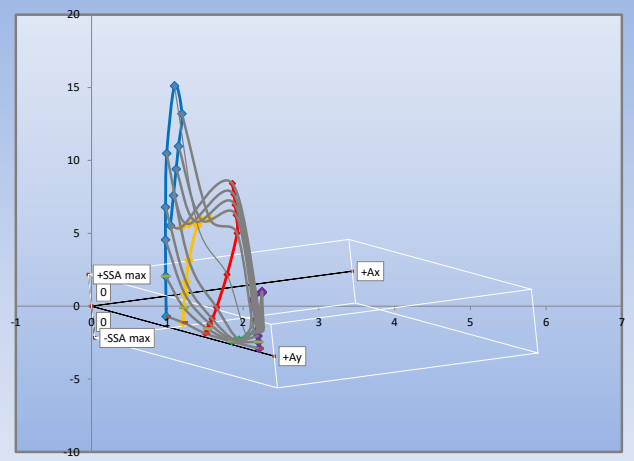
Top View | Front | Side View | Activate/Reset Iso Graph

Default Angles

Graph Reference Data Table

V [kph]	Ax [g]	Ay [g]	US Grad [°/g]
62	0.00	1.74	-4.7
62	-1.74	0.00	-5.0
124	0.00	2.12	0.7
124	-2.19	0.00	1.2
186	0.00	2.63	5.0
186	-2.87	0.00	1.2
250	0.00	3.22	6.0
250	-3.73	0.00	1.0
314	0.00	3.87	1.4
314	-4.65	0.00	0.7

Rear Side Slip Angle Gradient f (Ax, Ay, V) under Traction



Speed [kph] 62 124 186 250 314

Angles of Rotation for Chart

185 X Angle [°]
359.9 Y Angle [°]
325 Z Angle [°]

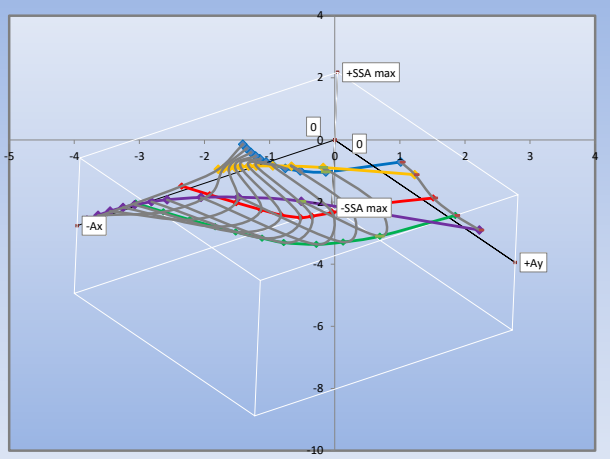
Top View | Front View | Side View | Activate/Reset Iso Graph

Default Angles

Graph Reference Data Table

V [kph]	Ax [g]	Ay [g]	SSA Grad [°/g]
62	0.00	1.74	8.2
62	1.18	0.31	58.6
124	0.00	2.12	7.1
124	1.34	0.33	56.4
186	0.00	2.63	3.2
186	1.18	1.88	106.5
250	0.00	3.22	2.3
250	0.57	3.13	9.2
314	0.00	3.87	3.0
314	0.04	4.01	48.2

Rear Side Slip Angle Gradient f (Ax, Ay, V) under Braking



Speed [kph] 62 124 186 250 314

Angles of Rotation for Chart

185 X Angle [°]
0.1 Y Angle [°]
325 Z Angle [°]

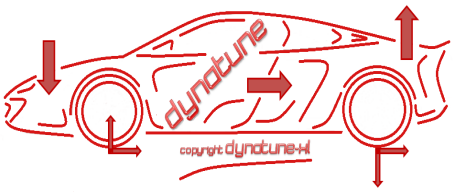
Top View | Front | Side View | Activate/Reset Iso Graph

Default Angles

Graph Reference Data Table

V [kph]	Ax [g]	Ay [g]	SSA Grad [°/g]
62	0.00	1.74	8.18
62	-1.74	0.00	9.85
124	0.00	2.12	7.08
124	-2.19	0.00	3.51
186	0.00	2.63	3.18
186	-2.87	0.00	1.81
250	0.00	3.22	2.34
250	-3.73	0.00	1.14
314	0.00	3.87	2.96
314	-4.65	0.00	0.85

SPRING TUNING



AUTOMATIC DATA UPDATE ONLY
IN START/INITIALISE CONDITION

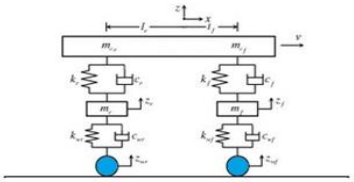
START
Initialise

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

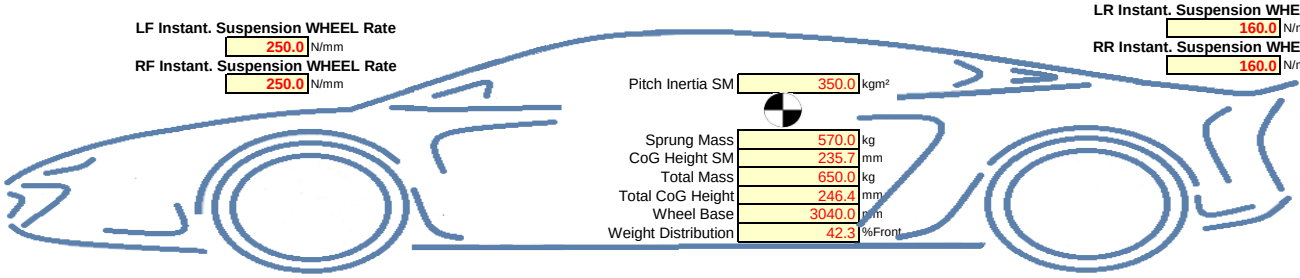
GO TO MASTER | GO TO RESULTS

GO TO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER



LF Instant. Suspension WHEEL Rate: 250.0 N/mm
RF Instant. Suspension WHEEL Rate: 250.0 N/mm
LR Instant. Suspension WHEEL Rate: 160.0 N/mm
RR Instant. Suspension WHEEL Rate: 160.0 N/mm



Pitch Inertia SM	350.0	kgm²
Sprung Mass	570.0	kg
CoG Height SM	235.7	mm
Total Mass	650.0	kg
Total CoG Height	246.4	mm
Wheel Base	3040.0	mm
Weight Distribution	42.3	%Front

Fr. Tire Vert. Stiffness	280.0	N/mm	G-Long	0.00	g
Fr. Delta Ride Height (-jounce)	-1.8	mm	G-Lat	0.00	g

Rr. Tire Vert. Stiffness: 300.0 N/mm
Rr. Delta Ride Height (-jounce): -5.3 mm

Output Parameter	Body	Wheel	
Front Ride & Wheel Frequency	5.290	27.311	Hz
Rear Ride & Wheel Frequency	3.997	23.014	Hz
Ratio Rr/Fr Ride Frequency	0.755	-	

Average Wheelrate (In case of a-symmetric left & right Bump-Stop activation the average of left & right will be used)					
Average Front Wheel Rate	250.0	N/mm	Average Rear Wheel Rate	160.0	N/mm

Ride Rates (including tires)					
Average Front Ride Rate	132.1	N/mm	Average Rear Ride Rate	104.3	N/mm

Pitch Frequency (frequency one)	9.256	Hz
Bounce Frequency (frequency two)	4.373	Hz

Pitch Center (motion center one)	-0.134	m
Bounce Center (motion center two)	4.588	m

The sign indicates whether the Motion Center is located fore or aft relative to CoG position
with respect to CoG x-position (positive numbers = distance from CoG in forward direction)
with respect to CoG x-position (negative numbers = distance from CoG in rearward direction)

Relative to FRONT AXLE		
Pitch Center (motion center one)	-1.887	m
Bounce Center (motion center two)	2.834	m

negative = behind front axle
negative = behind front axle

The differential equations for the analytical model of the body movement provide 2 solutions, so called motion centres ("one" and "two").
The Motion Center that is located at the nearest distance from the CoG (usually solution "one") is called PITCH CENTER and is located within the Wheel Base
The Motion Center that is located at the furthest distance from the CoG (usually solution "two") is called BOUNCE CENTER and is located outside of the Wheel Base

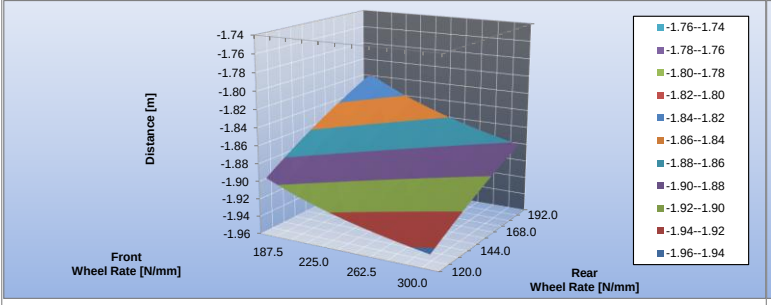
RANGE CARPET PLOTS FROM 75% to 125% WHEEL RATE

front WHEEL rate from to	187.5	312.5	N/mm
rear WHEEL rate from to	120.0	200.0	N/mm

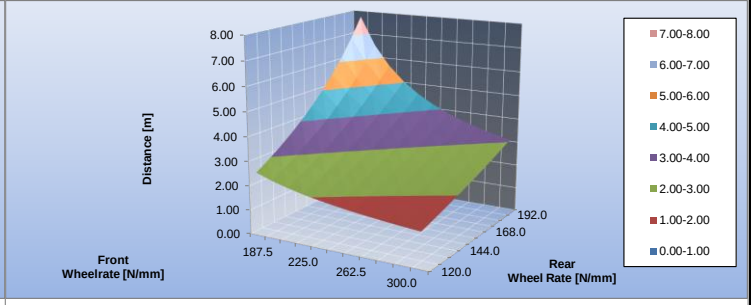
BOUNCE & PITCH CENTER CARPET PLOTS

GOTO MASTER

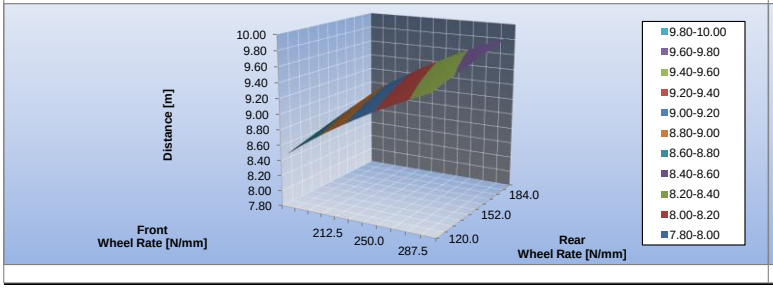
3D - Motion Center "One" Relative to Front Axle (usually Pitch)



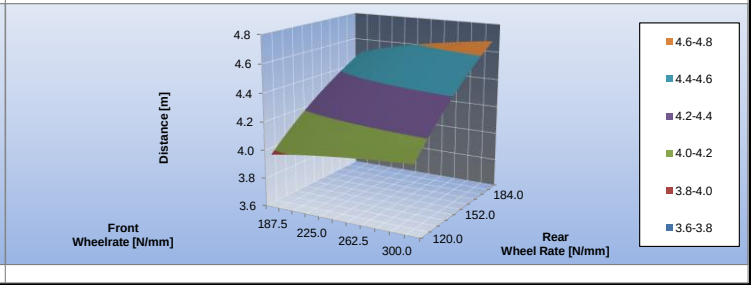
3-D Motion Center "Two" Relative to Front Axle (usually Bounce)



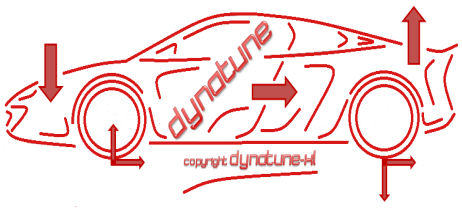
3D - Frequency "One" (usually Pitch)



3D - Frequency "Two" (usually Bounce)



ROLLBAR & MECHANICAL BALANCE



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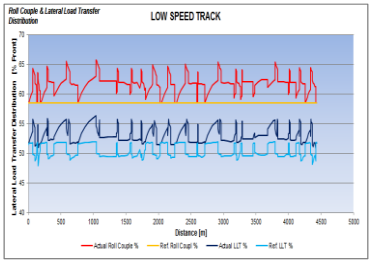
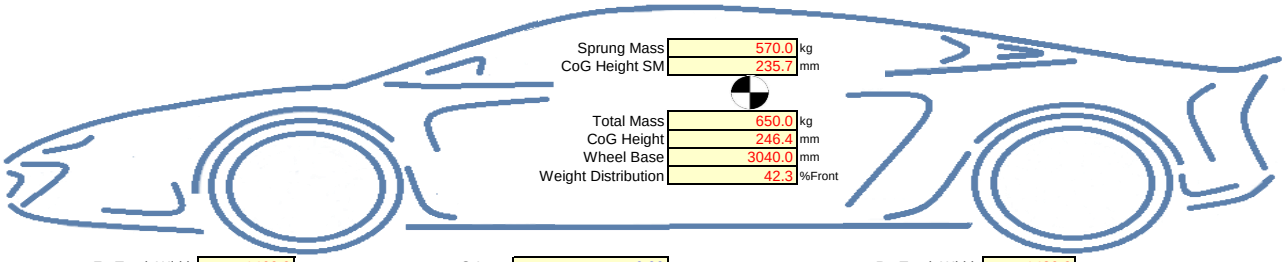




Sprung Mass	570.0	kg
CoG Height SM	235.7	mm
Total Mass	650.0	kg
CoG Height	246.4	mm
Wheel Base	3040.0	mm
Weight Distribution	42.3	%Front

Fr. Track Width	1460.0	mm
Fr. Tire Vert. Stiffness	280.0	N/mm
Fr. Delta Ride Height (-jounce)	-1.8	mm
Fr. Instant. Roll Center Height	-15.2	mm
Fr. Instant. Total Roll Rate	6150.5	Nm/°

G-Long	0.00	g
G-Lat	0.00	g

Rr. Track Width	1430.0	mm
Rr. Tire Vert. Stiffness	300.0	N/mm
Rr. Delta Ride Height (-jounce)	-5.3	mm
Rr. Instant. Roll Center Height	75.4	mm
Rr. Instant. Total Roll Rate	4355.3	Nm/°

SPECIFIC CALCULATION (G-lat <>0) INSTANTANEOUS VALUES

Output Parameter	RESULTS	
Inst. Lat. Load Transfer Distribution	45.4	% front
Inst. Roll Couple Distr. (Wheel Lift)	58.54	% front
Instant. Roll Couple Distribution	58.54	% front
Instant. L.L.T. Bias	3.08	% rel. to CoG
Rollangle due to Spr. Mass Rollmoment	0.00	°
Rollangle @ Bump-Stop Activation	0.25	°
Lateral G @ Bump-Stop	2.40	g
Rollangle @ Rebound-Stop Activation	0.53	°
Lateral G @ Rebound-Stop	5.10	g

(All in Pure Roll, no Lifting Effects of Roll Center Height)

TOTAL FR. & RR. SUSPENSION ROLL RATE		10505.7	Nm/° (without tires)		
FRONT TOTAL ROLLRATE	6150.5	Nm/°	REAR TOTAL ROLLRATE	4355.3	Nm/°
Front Roll Rate due to Springs	4650.5	Nm/°	Rear Roll Rate due to springs	2855.3	Nm/°
Front Roll Rate due to ARB	1500.0	Nm/°	Rear Roll Rate due to ARB	1500.0	Nm/°
% Contribution of ARB to total	24.4	%	% contribution of ARB to total	34.4	%

TOTAL FR. & RR. ROLL RATE WITH TIRES		5221.7	Nm/° (with tires)		
FRONT			REAR		
Front Roll Stiffness w/ Tires	2820.2	Nm/°	Rear Roll Stiffness w/ Tires	2401.5	Nm/°

Lateral Load Transfer Calculation considering Roll Rates, Roll Center Heights & Unsprung Masses					
Suspension Load Transfer	**Total**	0.0	N		
Fr. Suspension Load Transfer	0.0	N	Rr. Suspension Load Transfer	0.0	N
Fr. Rebound Stop Not Engaged			**Rr. Rebound Stop Not Engaged**		
Total Lateral Load Transfer	**Total**	0.0	N		
Fr. Total Load Transfer	0.0	N	Rr. Total Lateral Load Transfer	0.0	N

GENERIC CALCULATION (G-Lat=0) GENERIC VALUES

Output Parameter	RESULTS	
Linear Body on Chassis Rollangle	0.10	°/g
Linear Vehicle Rollangle (w/ Tires)	0.26	°/g
(pure roll, no jacking effects of Roll Center Height)		
Linear Lateral Load Transfer Distribution	45.4	% front
Linear Roll Couple Distribution	58.54	% front
L.L.T. Bias	3.1	% rel. to CoG

TOTAL FR. & RR. SUSPENSION ROLL RATE		10505.4	Nm/° (without tires)		
FRONT TOTAL ROLLRATE	6150.3	Nm/°	REAR TOTAL ROLLRATE	4355.1	Nm/°
Front Roll Rate due to Springs	4650.3	Nm/°	Rear Roll Rate due to springs	2855.1	Nm/°
Front Roll Rate due to ARB	1500.0	Nm/°	Rear Roll Rate due to ARB	1500.0	Nm/°
% Contribution of ARB to total	24.4	%	% contribution of ARB to total	34.4	%

TOTAL FR. & RR. ROLL RATE WITH TIRES		5221.6	Nm/° (with tires)		
FRONT			REAR		
Front Roll Stiffness w/ Tires	2820.1	Nm/°	Rear Roll Stiffness w/ Tires	2401.5	Nm/°

Total Roll Rate of Tires Only		10561.7	Nm/°		
Front Tires Roll Rate	5208.3	Nm/°	Rear Tires Roll Rate	5353.4	Nm/°

Lateral Load Transfer Calculation considering Roll Rates, Roll Center Heights & Unsprung Masses					
Total Lateral Load Transfer	**Total**	1049.2	N/g		
Fr. Total Load Transfer	476.2	N/g	Rr. Total Load Transfer	572.9	N/g

DAMPER TUNING

AUTOMATIC DATA UPDATE ONLY
IN START/INITIALISE CONDITION

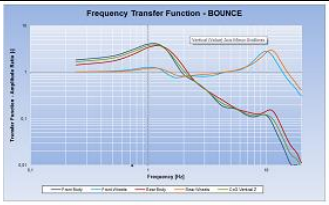
START Intialise

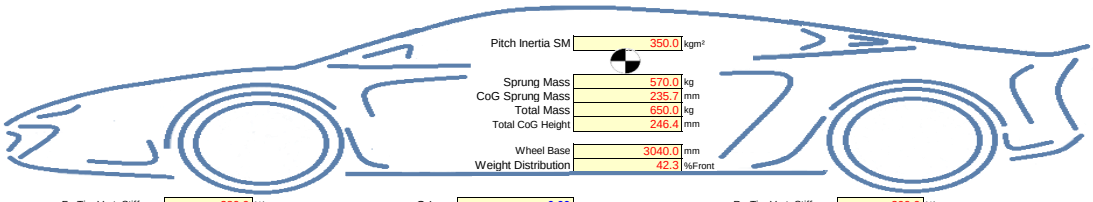
BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GO TO MASTER | GO TO RESULTS

GO TO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER





Pitch Inertia SM	350.0	kgm²
Sprung Mass	570.0	kg
CoG Sprung Mass	235.7	mm
Total Mass	650.0	kg
Total CoG Height	246.4	mm
Wheel Base	3040.0	mm
Weight Distribution	42.3	%Front

Fr. Tire Vert. Stiffness	280.0	N/mm
Fr. Average Vert. Wheel Rate	250.0	N/mm
Fr. Delta Ride Height (-jounce)	-1.8	mm
Fr. Damper to Wheel Motion Ratio	0.61	-

G-Long	0.00	g
G-Lat	0.00	g

Rr. Tire Vert. Stiffness	300.0	N/mm
Rr. Average Vert. Wheel Rate	160.0	N/mm
Rr. Delta Ride Height (-jounce)	-5.3	mm
Rr. Damper to Wheel Motion Ratio	0.78	-

START Intialise

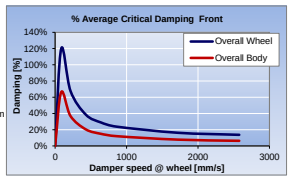
FRONT SUSPENSION

Fr. Body Frequency	7.28	Hz
Fr. Body Ride Frequency	5.29	Hz
Fr. Wheelhop Frequency	27.31	Hz
Fr. Linear Damping @ Wheel	4505.2	Ns/m

(Average out of first 3 damper velocity for bump & rebound)

Fr. Damping Scaling Factor	1.00	-

(Permits Scaling of Fr. Linear Damping @ Wheel for Analysis)



START Intialise

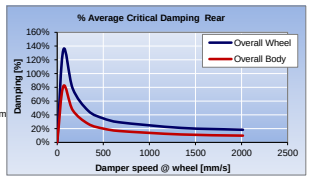
REAR SUSPENSION

Rr. Body Frequency	4.95	Hz
Rr. Body Ride Frequency	4.00	Hz
Rr. Wheelhop Frequency	23.01	Hz
Rr. Linear Damping @ Wheel	5338.1	Ns/m

(Average out of first 3 damper velocity for bump & rebound)

Rr. Damping Scaling Factor	1.00	-

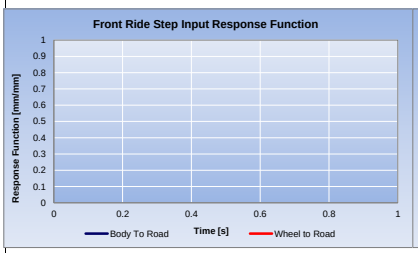
(Permits Scaling of Rr. Linear Damping @ Wheel for Analysis)

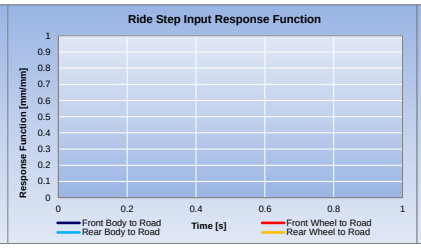


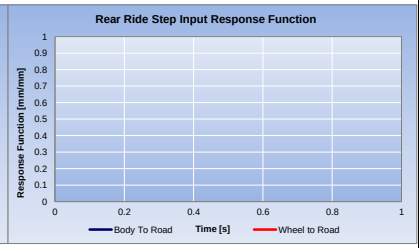
Activate / Re-Calculate Ride Step & Ride Frequency

De-Activate Ride Step & Ride Frequency

ENABLE RIDE STEP RESPONSE CALCULATION MODULE	0	(Y/N 1/0)	Note: Time Delay's / Phase Shifts due to Wheelbase are not considered !
Maximum Simulation Time	0.00	sec	(Max 2.5s) If Results are incorrect/noisy then reduce Maximum Simulation Time.





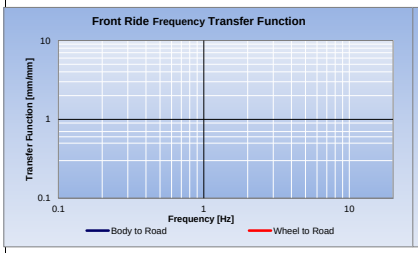


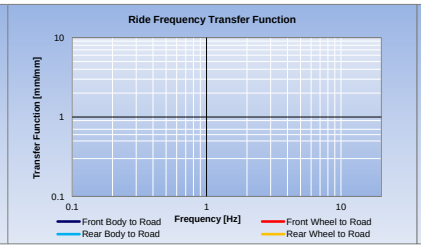
Front Body		Rear Body	
Time to 95% dampened oscillation	N/A s	Time to 95% dampened oscillation	N/A s
Peak Overshoot	N/A -	Peak Overshoot	N/A -
Time to reach Peak Value	N/A s	Time to reach Peak Value	N/A s

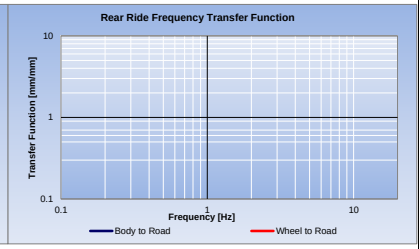
Activate / Re-Calculate Ride Step

De-Activate Ride Step

ENABLE FREQUENCY RESPONSE CALCULATION MODULE	0	(Y/N 1/0)
WARNING: FREQUENCY RESPONSE CALCULATION WILL SIGNIFICANTLY INCREASE CALCULATION TIME !!!		







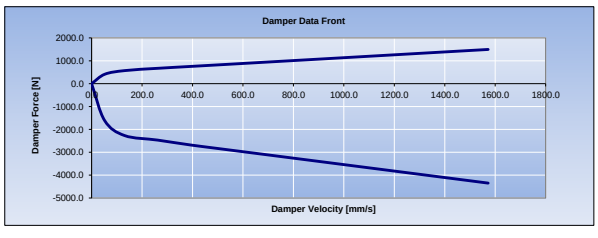
Front Frequency Sweep Results		Rear Frequency Sweep Results	
Body Dynamic Overshoot @ Peak Freq.	N/A -	Body Dynamic Overshoot @ Peak Freq.	N/A -
Front Wheel Dyn. Load Indicator 0 - 20 Hz	N/A -	Rear Wheel Dyn. Load Indicator 0 - 20 Hz	N/A -

Activate / Re-Calculate Ride Frequency

De-Activate Ride Frequency

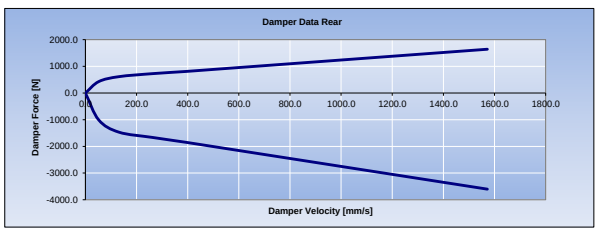
Front suspension Shock (measured shock data)

Measured Damper Data			
Jounce Speed [mm/s]	Jounce Force [N]	Rebound Speed [mm/s]	Rebound Force [N]
0.0	0.0	0.0	0.0
52.0	410.0	-52.0	-1617.5
131.0	570.0	-131.0	-2270.0
262.0	670.0	-262.0	-2467.5
393.0	752.5	-393.0	-2682.5
524.0	835.0	-524.0	-2867.5
1048.0	1165.0	-1048.0	-3607.0
1572.0	1495.0	-1572.0	-4347.0



Rear suspension Shock (measured shock data)

Measured Damper Data			
Jounce Speed [mm/s]	Jounce Force [N]	Rebound Speed [mm/s]	Rebound Force [N]
0.0	0.0	0.0	0.0
52.0	427.5	-52.0	-1010.0
131.0	612.5	-131.0	-1467.5
262.0	725.0	-262.0	-1665.0
393.0	807.5	-393.0	-1847.5
524.0	900.0	-524.0	-2042.5
1048.0	1270.0	-1048.0	-2822.5
1572.0	1640.0	-1572.0	-3602.5



GOTO MASTER

Output Parameter

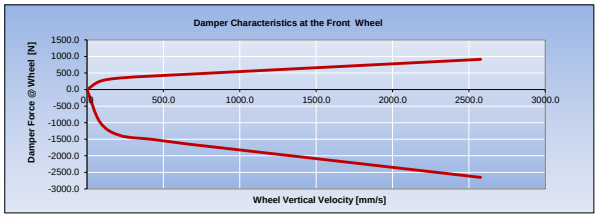
Calculated Front Damper Data @ WHEEL (considering motion ratio)			
Jounce Speed [mm/s]	Jounce Force [N]	Rebound Speed [mm/s]	Rebound Force [N]
0.0	0.0	0.0	0.0
85.2	250.1	-85.2	-986.7
214.8	347.7	-214.8	-1384.7
429.5	408.7	-429.5	-1505.2
644.3	459.0	-644.3	-1636.3
859.0	509.4	-859.0	-1749.2
1718.0	710.7	-1718.0	-2200.3
2577.0	912.0	-2577.0	-2651.7

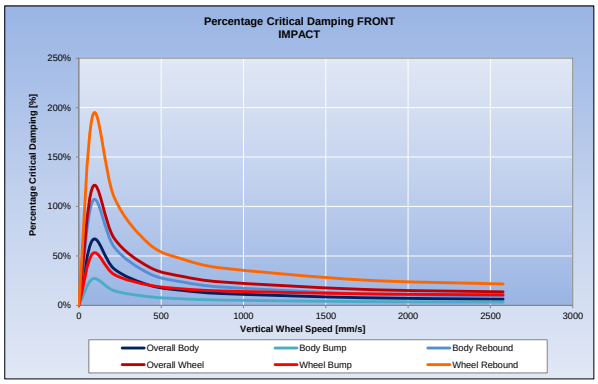
Front Body Percent Critical Damping for "IMPACT" events (damper "rate" from 0 to operating point)			
Wheel Vertical Speed [mm/s]	Overall Body	Body Bump	Body Rebound
0.0	0.0	0.0	0.0
85.2	0.66	0.27	1.06
214.8	0.37	0.15	0.59
429.5	0.20	0.09	0.32
644.3	0.15	0.07	0.23
859.0	0.12	0.05	0.19
1718.0	0.08	0.04	0.12
2577.0	0.06	0.03	0.09

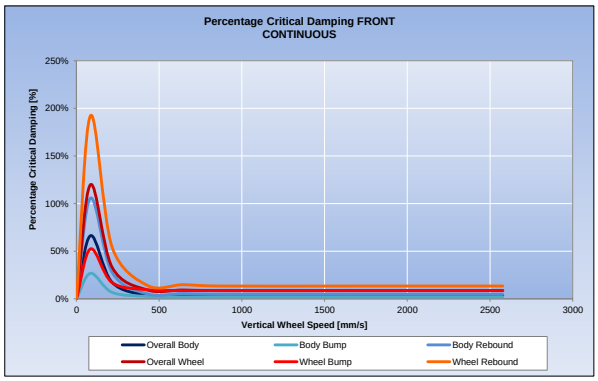
Front Wheel Percent Critical Damping for "IMPACT" events (damper "rate" from 0 to operating point)			
Wheel Vertical Speed [mm/s]	Overall Wheel	Wheel Bump	Wheel Rebound
0.0	0.0	0.0	0.0
85.2	1.20	0.52	1.92
214.8	0.68	0.31	1.09
429.5	0.39	0.20	0.62
644.3	0.29	0.17	0.46
859.0	0.24	0.15	0.38
1718.0	0.16	0.12	0.26
2577.0	0.14	0.11	0.22

Front Body Percent Critical Damping for "CONTINUOUS" EVENTS (instantaneous damper rate)			
Wheel Vertical Speed [mm/s]	Overall Body	Body Bump	Body Rebound
0.0	0.0	0.0	0.0
85.2	0.66	0.27	1.06
214.8	0.18	0.07	0.28
429.5	0.04	0.03	0.05
644.3	0.04	0.02	0.06
859.0	0.03	0.02	0.05
1718.0	0.03	0.02	0.05
2577.0	0.03	0.02	0.05

Front Wheel Percent Critical Damping for "CONTINUOUS" EVENTS (instantaneous damper rate)			
Wheel Vertical Speed [mm/s]	Overall Wheel	Wheel Bump	Wheel Rebound
0.0	0.0	0.0	0.0
85.2	1.20	0.52	1.92
214.8	0.33	0.17	0.55
429.5	0.09	0.10	0.14
644.3	0.09	0.09	0.15
859.0	0.09	0.09	0.14
1718.0	0.09	0.09	0.14
2577.0	0.09	0.09	0.14







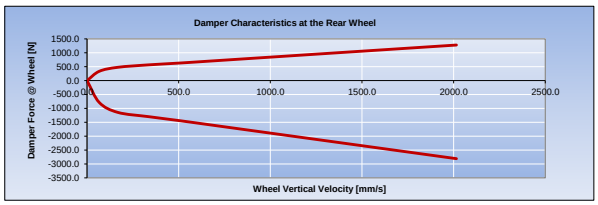
Calculated Rear Damper Data @ WHEEL (considering motion ratio)			
Jounce Speed [mm/s]	Jounce Force [N]	Rebound Speed [mm/s]	Rebound Force [N]
0.0	0.0	0.0	0.0
66.7	333.5	-66.7	-787.8
167.9	477.8	-167.9	-1144.7
335.9	565.5	-335.9	-1298.7
503.8	629.9	-503.8	-1441.1
671.8	702.0	-671.8	-1593.2
1343.6	990.6	-1343.6	-2201.6
2015.4	1279.2	-2015.4	-2810.0

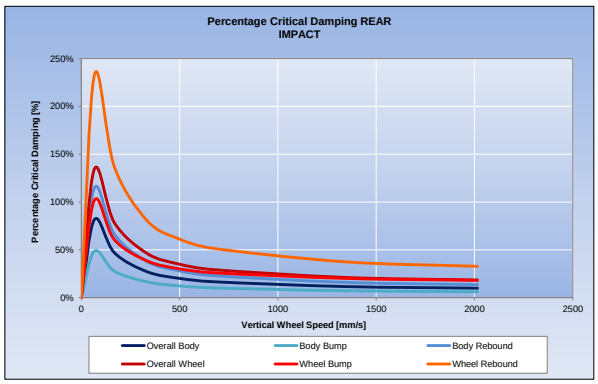
Rear Body Percent Critical Damping for "IMPACT" events (damper "rate" from 0 to operating point)			
Wheel Vertical Speed [mm/s]	Overall Body	Body Bump	Body Rebound
0.0	0.0	0.0	0.0
66.7	0.82	0.49	1.15
167.9	0.47	0.28	0.66
335.9	0.27	0.16	0.38
503.8	0.20	0.12	0.28
671.8	0.17	0.10	0.23
1343.6	0.12	0.07	0.16
2015.4	0.10	0.06	0.14

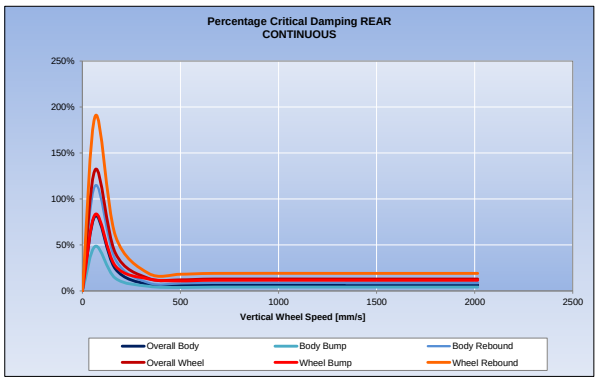
Rear Wheel Percent Critical Damping for "IMPACT" events (damper "rate" from 0 to operating point)			
Wheel Vertical Speed [mm/s]	Overall Wheel	Wheel Bump	Wheel Rebound
0.0	0.0	0.0	0.0
66.7	1.35	1.02	2.33
167.9	0.78	0.61	1.37
335.9	0.46	0.38	0.80
503.8	0.35	0.30	0.61
671.8	0.29	0.26	0.51
1343.6	0.21	0.20	0.37
2015.4	0.18	0.18	0.33

Rear Body Percent Critical Damping for "CONTINUOUS" EVENTS (instantaneous damper rate)			
Wheel Vertical Speed [mm/s]	Overall Body	Body Bump	Body Rebound
0.0	0.0	0.0	0.0
66.7	0.82	0.49	1.15
167.9	0.24	0.14	0.34
335.9	0.07	0.05	0.09
503.8	0.06	0.04	0.08
671.8	0.06	0.04	0.09
1343.6	0.06	0.04	0.09
2015.4	0.06	0.04	0.09

Rear Wheel Percent Critical Damping for "CONTINUOUS" EVENTS (instantaneous damper rate)			
Wheel Vertical Speed [mm/s]	Overall Wheel	Wheel Bump	Wheel Rebound
0.0	0.0	0.0	0.0
66.7	1.32	0.83	1.91
167.9	0.41	0.27	0.60
335.9	0.14	0.13	0.19
503.8	0.12	0.11	0.18
671.8	0.13	0.12	0.19
1343.6	0.13	0.12	0.19
2015.4	0.13	0.12	0.19







* motion ratio from 0 to 1 (1 = wheel travel)
** Unsprung mass is considered for each corner
*** Damping in tire empirically considered (5% critical)
**** Bump positive, rebound negative

FREQUENCY STEER RESPONSE

AUTOMATIC DATA UPDATE ONLY
IN START/INITIALISE CONDITION

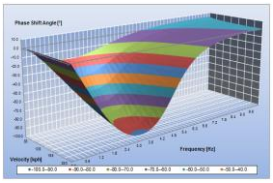
START Initialise

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GO TO MASTER | GO TO RESULTS

GO TO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER



Frontal Area	1.50	m²			
Fr. Body Lift Coef.	-0.90	-	Speed	120.0	kph
			Steering Ratio	11.0	-
			SWA	0.0	° (0=Generic)
			Total Mass	650.0	kg
			Total CoG Height	246.4	mm
			Total Yaw Inertia	605.3	kgm2
			Wheel Base	3040	mm
			Weight Distribution	42.3	%Front
					Rr. Body Lift Coef. -1.52 -

Fr. Tire Vert. Stiffness	280	N/mm	G-Long	0.00	g
Fr. Delta Ride Height (-jounce)	-1.8	mm			
Fr. Instant. Roll Center Height	-15.2	mm	Characteristic Speed	296.78	km/h
Fr. Instant. Roll Stiffness w/ Tires	2820.2	Nm/°			
Fr. Instant. Lateral Load Transfer	45.4	%			
Fr. Instant. AXLE Cornering Stiffness	116657.5	N/rad			
(@ operating point Vx & G-Long @ 0 G-Lat)					

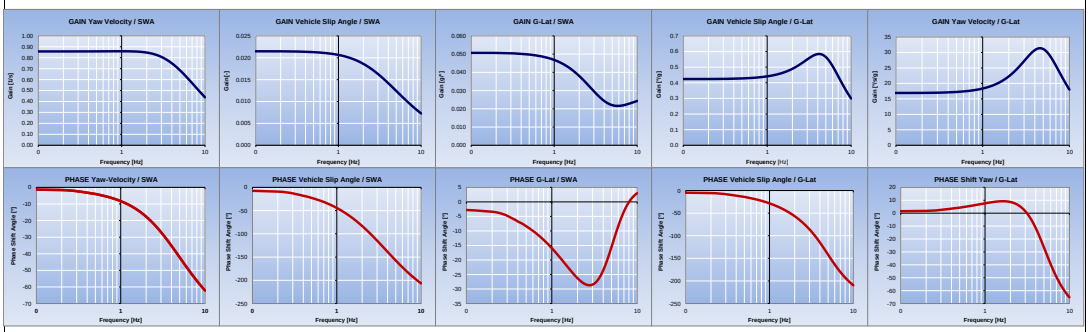
Rr. Tire Vert. Stiffness	300.0	N/mm
Rr. Delta Ride Height (-jounce)	-5.3	mm
Rr. Instant. Roll Center Height	75.4	mm
Rr. Instant. Roll Stiffness w/ Tires	2401.5	Nm/°
Rr. Instant. Lateral Load Transfer	54.6	%
Rr. Instant. AXLE Cornering Stiffness	196221.2	N/rad

(@ operating point Vx & G-Long @ 0 G-Lat)

• DO NOT UPDATE FREQUENCY STEER MODULE

GENERIC FREQUENCY STEER RESPONSE DATA @ G-Long = 0g

Frequency Steer Results	Yaw Vel. / SWA		Slip Angle / SWA		G-Lat / SWA		Slip Angle / G-Lat		Yaw Vel. / G-Lat	
Frequency @ Peak	1.00	Hz	0.00	Hz	0.00	Hz	4.20	Hz	4.60	Hz
Static Gain @ 0 Hz	0.857	1/s	0.022	-	0.051	g/°	0.423	°/g	16.863	°/s/g
Dyn. Overshoot @ Peak	0.20%	%	0.00%	%	0.00%	%	37.96%	%	86.09%	%
Delay Time @ 1 Hz	23.0	ms	123.2	ms	44.3	ms	79.0	ms	-21.2	ms



CARPET PLOTS - FREQUENCY DOMAIN DATA FOR VELOCITY RANGE & IMPOSED LONGITUDINAL ACCELERATION = 0g

SPEED TABLE DOES NOT UPDATE AUTOMATICALLY !

Characteristic Speed 296.78 kph
For Imposed Speed & Aerodynamic Load

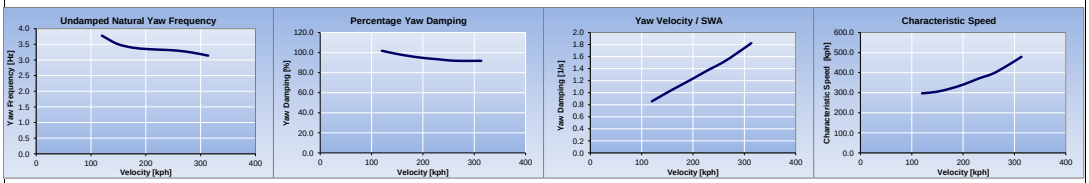
Update / Calculate Table

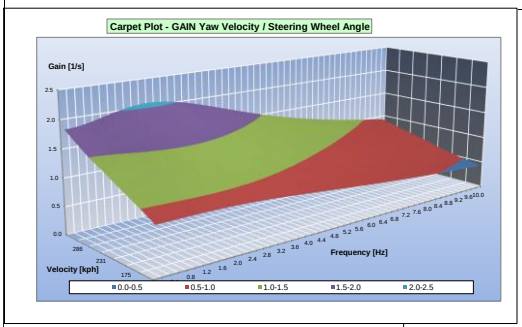
Carpet Plot Data Generation
Minumum Speed 120.0 km/h
Minimum Speed for Table Generation should be 80kph

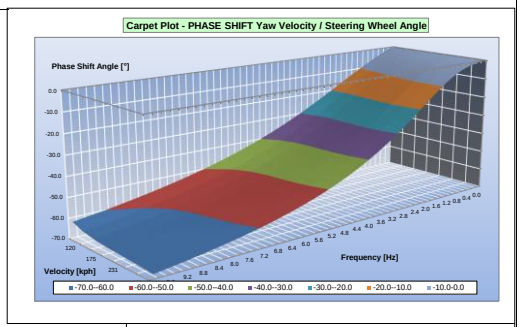
THE DATA & GRAPHS SHOWN IN THE SECTION BELOW ARE ONLY VALID FOR SWA = 0 !

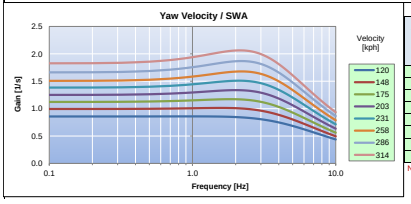
SPEED TABLE DOES NOT UPDATE AUTOMATICALLY - RUN UPDATE CALC.

	UNDAMPED NATURAL YAW FREQUENCY		YAW DAMPING		YAW GAIN		CHARACTERISTIC SPEED	
120	km/h	3.78	Hz	101.8	%	0.86 1/s	296.8	km/h
148	km/h	3.51	Hz	98.6	%	0.99 1/s	304.3	km/h
175	km/h	3.39	Hz	96.4	%	1.12 1/s	320.7	km/h
203	km/h	3.35	Hz	94.5	%	1.25 1/s	343.0	km/h
231	km/h	3.32	Hz	93.3	%	1.38 1/s	371.1	km/h
258	km/h	3.30	Hz	91.9	%	1.50 1/s	395.5	km/h
286	km/h	3.23	Hz	91.7	%	1.66 1/s	434.9	km/h
314	km/h	3.14	Hz	91.8	%	1.82 1/s	478.8	km/h



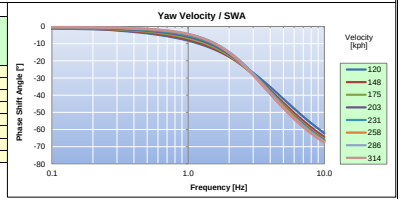




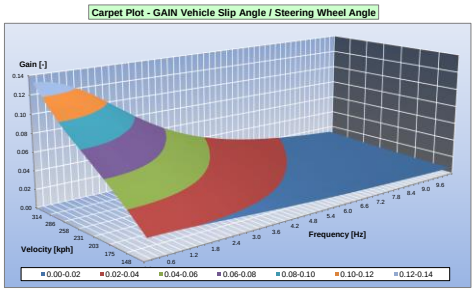


YAW/SWA	Frequency @ Peak	Static Gain @ 0 Hz	Dynamic Overshoot @ Peak	Delay Time @ 1 Hz
[kph]	[Hz]	[1/s]	[-]	[ms]
120	1.00	0.857	0.2%	23.0
148	1.60	0.993	2.0%	21.4
175	1.80	1.121	4.6%	19.0
203	2.00	1.249	7.1%	16.6
231	2.20	1.382	9.2%	14.6
258	2.20	1.504	11.6%	12.6
286	2.20	1.659	12.6%	12.1
314	2.20	1.823	13.1%	12.1

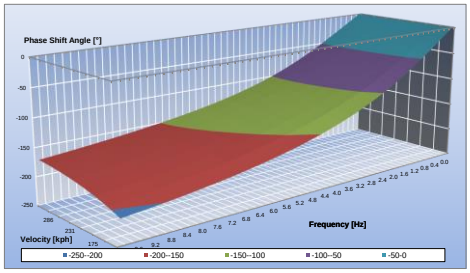
Note: If Frequency = 0 Hz, Peak in Transfer Function is below 0.1 Hz



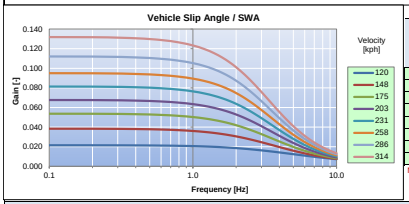
Carpet Plot - GAIN Vehicle Slip Angle / Steering Wheel Angle



Carpet Plot - PHASE Vehicle Slip Angle / Steering Wheel Angle



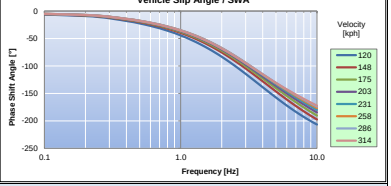
Vehicle Slip Angle / SWA



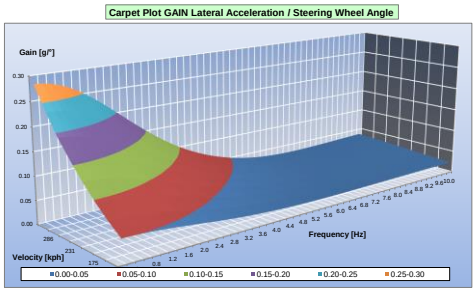
SLIP/SWA [kph]	Frequency @ Peak [Hz]	Static Gain @ 0 Hz [1/s]	Dynamic Overshoot @ Peak [-]	Delay Time @ 1 Hz [ms]
120	0.00	0.022	0.0%	123.2
148	0.00	0.038	0.0%	110.7
175	0.00	0.054	0.0%	105.4
203	0.00	0.054	0.0%	101.7
231	0.00	0.081	0.0%	99.1
258	0.00	0.095	0.0%	97.2
286	0.00	0.112	0.0%	97.5
314	0.00	0.132	0.0%	99.2

Note: If Frequency = 0 Hz, Peak in Transfer Function is below 0.1 Hz

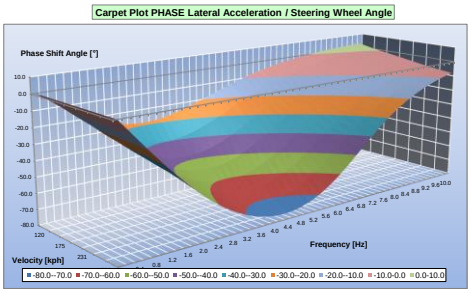
Vehicle Slip Angle / SWA



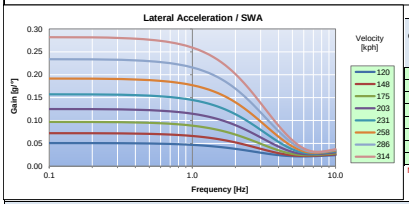
Carpet Plot GAIN Lateral Acceleration / Steering Wheel Angle



Carpet Plot PHASE Lateral Acceleration / Steering Wheel Angle



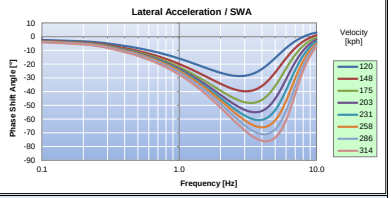
Lateral Acceleration / SWA



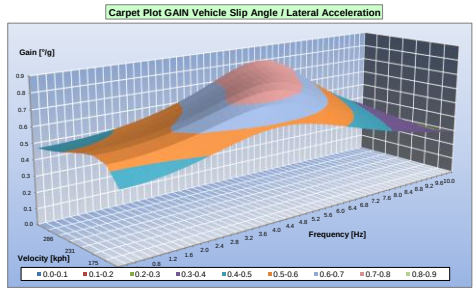
G-LAT/SWA [kph]	Frequency @ Peak [Hz]	Static Gain @ 0 Hz [1/s]	Dynamic Overshoot @ Peak [-]	Delay Time @ 1 Hz [ms]
120	0.00	0.051	0.0%	44.3
148	0.00	0.072	0.0%	55.3
175	0.00	0.097	0.0%	61.5
203	0.00	0.125	0.0%	65.0
231	0.00	0.158	0.0%	67.5
258	0.00	0.192	0.0%	69.4
286	0.00	0.234	0.0%	72.7
314	0.00	0.283	0.0%	76.8

Note: If Frequency = 0 Hz, Peak in Transfer Function is below 0.1 Hz

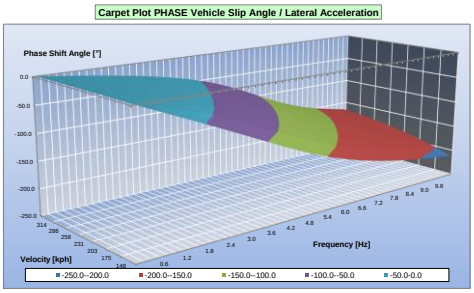
Lateral Acceleration / SWA



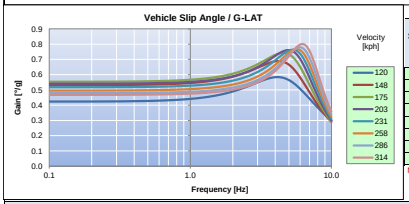
Carpet Plot GAIN Vehicle Slip Angle / Lateral Acceleration



Carpet Plot PHASE Vehicle Slip Angle / Lateral Acceleration



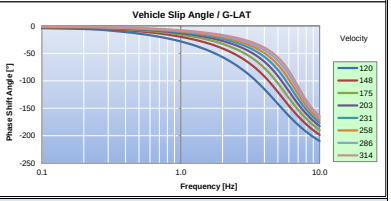
Vehicle Slip Angle / G-LAT



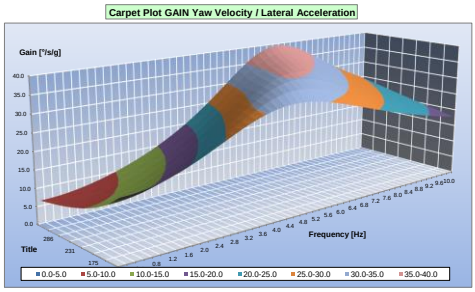
SLIP/G-LAT [kph]	Frequency @ Peak [Hz]	Static Gain @ 0 Hz [1/s]	Dynamic Overshoot @ Peak [-]	Delay Time @ 1 Hz [ms]
120	4.20	0.423	38.0%	79.0
148	4.20	0.531	29.8%	55.3
175	4.60	0.553	34.3%	43.9
203	5.00	0.541	40.7%	36.7
231	5.40	0.517	47.6%	31.6
258	5.60	0.496	54.9%	27.8
286	6.00	0.479	62.8%	24.8
314	6.20	0.467	71.4%	22.4

Note: If Frequency = 0 Hz, Peak in Transfer Function is below 0.1 Hz

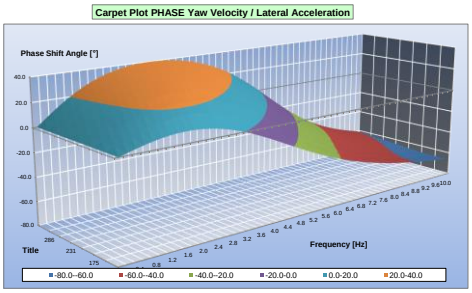
Vehicle Slip Angle / G-LAT



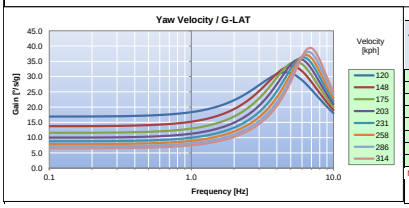
Carpet Plot GAIN Yaw Velocity / Lateral Acceleration



Carpet Plot PHASE Yaw Velocity / Lateral Acceleration



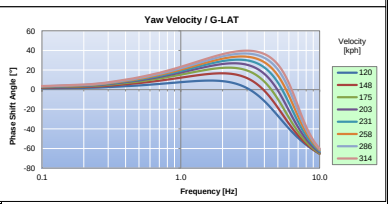
Yaw Velocity / G-LAT



YAW/G-LAT [kph]	Frequency @ Peak [Hz]	Static Gain @ 0 Hz [1/s]	Dynamic Overshoot @ Peak [-]	Delay Time @ 1 Hz [ms]
120	4.60	16.863	186.1%	-21.2
148	5.00	13.704	244.1%	-33.9
175	5.40	11.542	302.0%	-42.5
203	5.80	9.969	358.2%	-48.4
231	6.20	8.773	413.9%	-52.9
258	6.40	7.834	473.2%	-56.8
286	6.60	7.076	537.9%	-60.7
314	6.80	6.452	610.6%	-64.7

Note: If Frequency = 0 Hz, Peak in Transfer Function is below 0.1 Hz

Yaw Velocity / G-LAT



STEP STEER RESPONSE

AUTOMATIC DATA UPDATE ONLY
IN START/INITIALISE CONDITION

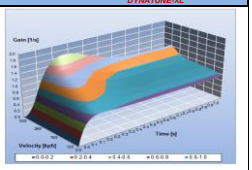
START Initialise

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GOTO MASTER | GOTO RESULTS

GOTO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER



Frontal Area	1.50	m²			
Fr. Body Lift Coef.	-0.90	-	Speed	120.0	kph
			Steering Ratio	11.0	-
			SWA	0.0	(0=Generic)
			Total Mass	650.0	kg
			CoG Height	246.4	mm
			Yaw Inertia	605.3	kgm²
			Wheel Base	3040.0	mm
			Weight Distribution	42.5	%Front
Rr. Body Lift Coef.	-1.52	-			

Fr. Tire Vert. Stiffness	280.0	N/mm	G-Long	0.00	g
Fr. Delta Ride Height (-)ounce)	-1.8	mm			
Fr. Instant. Roll Center Height	-15.2	mm	Characteristic Speed	296.78	km/h
Fr. Instant. Roll Stiffness w/ Tires	2820.2	Nm/°			
Fr. Instant. Lateral Load Transfer	45.4	%			
Fr. Instant. Total AXLE Cornering Stiffness	116657.5	N/rad			
(@ operating point Vx & G-Long @ 0 G-Lat)					
Rr. Tire Vert. Stiffness	300.0	N/mm			
Rr. Delta Ride Height (-)ounce)	-5.3	mm			
Rr. Instant. Roll Center Height	75.4	mm			
Rr. Instant. Roll Stiffness w/ Tires	2401.5	Nm/°			
Rr. Instant. Lateral Load Transfer	54.6	%			
Rr. Instant. Total AXLE Cornering Stiffness	196221.2	N/rad			
(@ operating point Vx & G-Long @ 0 G-Lat)					

DO NOT UPDATE STEP STEER MODULE IN

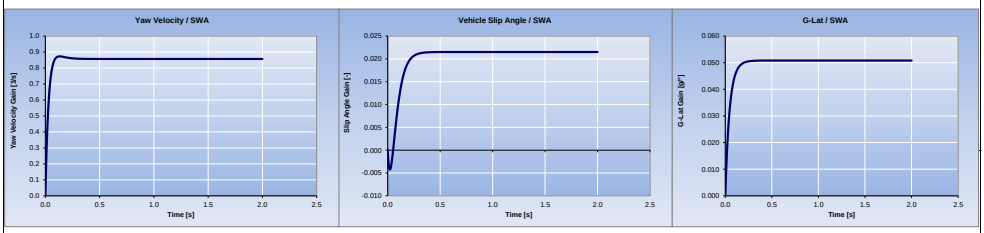
GENERIC STEP STEER RESPONSE DATA @ G-Long = 0g

Step Steer Response Data	Yaw Velocity Gain [1/s]	Slip Angle Gain [-]	G-Lat Gain [g/°]
90% Response Time	48.0 ms	192.0 ms	104.0 ms
Peak Value	0.873 1/s	0.022 -	0.051 g/°
Time to reach Peak Value	136.0 ms	696.0 ms	608.0 ms
Dynamic Overshoot @ Peak	1.87% %	0.00% %	0.00% %

Simulation Time: 2.00 s

Keep Simulation Time as short as possible (Max 2.5s) ! If Results are incorrect/noisy then reduce Maximum Simulation Time.

START Initialise



CARPET PLOTS - STEP STEER TIME DOMAIN DATA FOR VELOCITY RANGE & IMPOSED LONGITUDINAL ACCELERATION = 0g

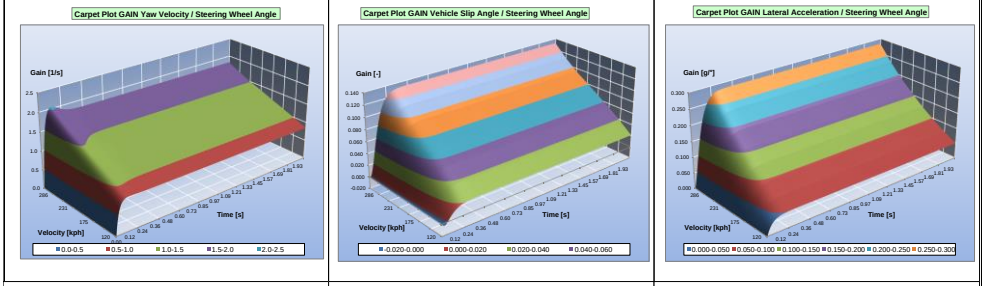
SPEED TABLE DOES NOT UPDATE AUTOMATICALLY !

Characteristic Speed: 296.78 kph (For Imposed Speed & Aerodynamic Load)

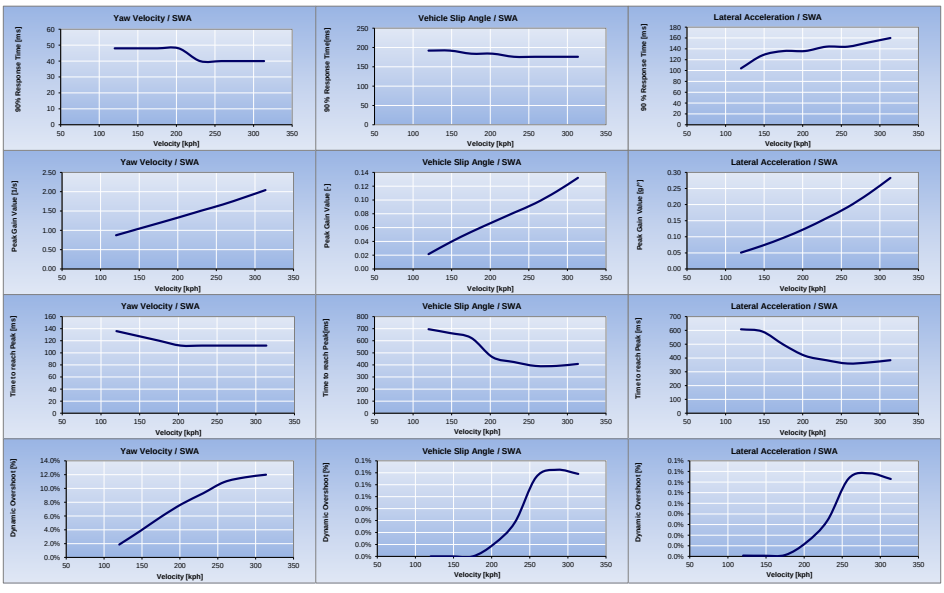
Update / Calculate Table

Carpet Plot Data Generation Minumum Speed: 120.0 km/h (Minimum Speed for Table Generation should be 80kph)

THE DATA & GRAPHS SHOWN IN THE SECTION BELOW ARE ONLY VALID FOR SWA = 0 !



	YAW / SWA GAIN				SLIP ANGLE / SWA GAIN				G-LAT / SWA GAIN			
Speed [kph]	90% Response Time [ms]	Gain Peak Value [1/s]	Time to reach Peak [ms]	Dynamic Overshoot @ Peak [%]	90% Response Time [ms]	Gain Peak Value [-]	Time to reach Peak [ms]	Dynamic Overshoot @ Peak [%]	90% Response Time [ms]	Gain Peak Value [g/°]	Time to reach Peak [ms]	Dynamic Overshoot @ Peak [%]
120	48.0	0.873	136.0	1.87%	192.0	0.022	696.0	0.00%	104.0	0.051	608.0	0.00%
148	48.0	1.031	128.0	3.83%	192.0	0.038	664.0	0.00%	128.0	0.072	592.0	0.00%
175	48.0	1.188	120.0	5.90%	184.0	0.054	624.0	0.00%	136.0	0.097	496.0	0.00%
203	48.0	1.346	112.0	7.77%	184.0	0.068	464.0	0.01%	136.0	0.125	416.0	0.01%
231	40.0	1.511	112.0	9.29%	176.0	0.082	424.0	0.03%	144.0	0.158	384.0	0.03%
258	40.0	1.668	112.0	10.92%	176.0	0.095	392.0	0.07%	144.0	0.192	360.0	0.07%
286	40.0	1.851	112.0	11.61%	176.0	0.112	392.0	0.07%	152.0	0.235	368.0	0.08%
314	40.0	2.042	112.0	11.99%	176.0	0.132	408.0	0.07%	160.0	0.283	384.0	0.07%



CUSTOM DASHBOARD - RESULTS

	ACTUAL	REF	
Aerodynamics			
Fr. Lift Coef.	-0.84	-0.84	-
Front Suspension Rates (w/o Tires)			
Fr. Wheel Rate	250.0	250.0	N/mm
Bump-Stop Gap @ Wheel	5.0	5.0	mm
Displ. to Final Bump-Stop Rate	5.0	5.0	mm
Bump-Stop Final Rate @ Wheel	2500.0	2500.0	N/mm
Fr. Rollbar Roll Rate	1500.0	1500.0	Nm/°
(Total Roll rate	6150.5	6150.5	Nm/°)
Front Tire Data			
Fr. Tire Vertical Stiffness	280.0	280.0	N/mm
Fr. Tire Cornering Stiffness	1700.0	1700.0	N/°
(@ operating point	1177.3	1178.0	N/°)
Front Suspension Geometry			
Fr. Total Static Toe	-0.50	-0.50	°
Fr. Static Camber	-3.00	-3.00	°
Fr. Bump Steer	-1.0	-1.0	°/m
Fr. Roll Center Height	-17.0	-17.0	mm
Motion Centers			
Fr. Anti-Dive	52.8	51.8	%
Fr. Anti-Lift	0.0	0.0	%
Fr. Inst. Roll Center Height	-15.2	-15.2	mm

	ACTUAL	REF	
Drag Coef.	0.57	0.57	-
Frontal Area	1.50	1.50	m2
Grip Level			
Fr. Tire Friction Coefficient (Mue)	1.52	1.52	
rr. Tire Friction Coefficient (Mue)	1.58	1.58	-
G-MAX theoretical. (Aero & Frict. Coef.)	2.31	2.30	g
G-Lat MAX (Aero Distribution)	2.31	2.30	g
G-Lat MAX (CoG, Wheel Lift, US/OS)	2.01	2.10	g
Simulation Control			
Speed	120.0	120.0	kph
G-Lat	0.00	2.10	g
G-Long	0.00	0.00	g
SWA	0.0	0.0	°
Steering System			
Steering Ratio	11.00	11.00	-
Vehicle Data			
Fr. Track Width	1460.0	1460.0	mm
Rr. Track Width	1430.0	1430.0	mm
Wheel Base	3040.0	3040.0	mm
Total Mass	650.0	650.0	kg
Overall CoG Height	246.4	247.5	mm
Weight Distribution (% Fr.)	42.3	42.3	%
Total Yaw Inertia	605.3	605.3	kgm2
Total Pitch Inertia	534.4	534.4	kgm2

	ACTUAL	REF	
Aerodynamics			
Rr. Lift Coef.	-1.51	-1.51	-
Rear Suspension Rates (w/o Tires)			
Rr. Wheel Rate	160.0	160.0	N/mm
Bump-Stop Gap @ Wheel	30.0	30.0	mm
Displ. to Final Bump-Stop Rate	10.0	10.0	mm
Bump-Stop Final Rate @ Wheel	1000.0	1000.0	N/mm
Rr. Rollbar Roll Rate	1500.0	1500.0	Nm/°
(Total Roll Rate	4355.3	4355.3	Nm/°)
Rear Tire Data			
Rr. Tire Vertical Stiffness	300.0	300.0	N/mm
Rr. Tire Cornering Stiffness	2500.0	2500.0	N/°
(@ operating point	1823.6	1818.8	N/°)
Rear Suspension Geometry			
Rr. Total Static Toe	0.25	0.25	°
Rr. Static Camber	-0.50	-0.50	°
Rr. Bump Steer	1.0	1.0	°/m
Rr. Roll Center Height	52.0	52.0	mm
Motion Centers			
Rr. Anti Squat	0.0	0.0	%
Rr. Anti Lift	0.0	0.0	%
Rr. Inst. Roll Center Height	75.4	75.4	mm

	ACTUAL	REF	
Fr. Ride Frequency	5.290	5.668	Hz

	ACTUAL	REF	
Pitch Center rel. to Fr. Axle	-1.89	-1.86	m
Bounce Center rel. to Fr. Axle	2.83	3.89	m

	ACTUAL	REF	
Rr. Ride Frequency	3.997	4.539	Hz

CALCULATION RESULTS FROM VEHICLE MODEL

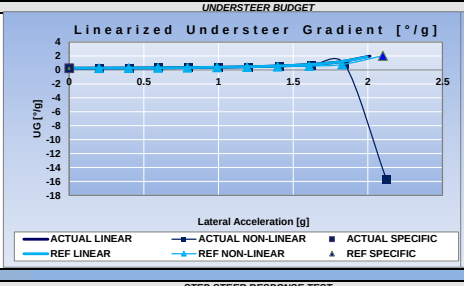
Front Left Corner	1730.35	692.43	
LF Wheel Travel	1.8	-0.8	mm
LF Toe	-0.240	-0.237	°
LF Camber	-2.985	-2.445	°
LR Toe	-0.240	-0.237	°
LR Camber	-2.985	-2.445	°
LR Wheel Travel	4.3	-0.7	mm
Rear Left Corner	2544.07	1146.65	

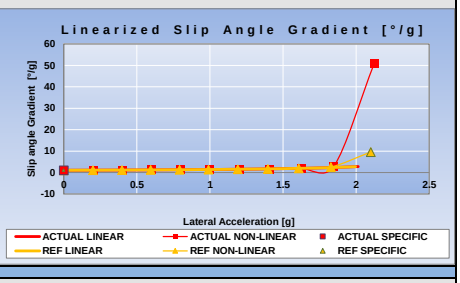
Delta Fr. Ride Height (-jounce)	-1.8	-2.1	mm
Delta Rr. Ride Height (-jounce)	-5.3	-3.1	mm
Vehicle Roll Angle	0.00	0.55	°
Lat. Load Transf. Distr. (% Fr.)	45.4	42.8	%
LLT Bias rel. to CoG (+Fwd)	3.1	0.5	%
Vehicle Pitch Angle	0.07	0.02	mm
Delta H-Point (Pitch & Roll)	-4.42	0.10	mm

Front Right Corner	1730.35	2770.26	
RF Wheel Travel	1.8	4.9	mm
RF Toe	-0.240	-0.312	°
RF Camber	-2.985	-3.164	°
RR Toe	0.130	0.062	°
RR Camber	-0.528	0.070	°
RR Wheel Travel	4.3	4.8	mm
Rear Right Corner	2544.07	3927.49	

UNDERSTEER BUDGET

	ACTUAL	REF	
Characteristic Speed	296.78	296.78	kph
Linear Roll Angle Gradient	0.26	0.26	°/g
SWA @ g	0.000	0.00	°
SWA @ g	2.100		38.25 °
Fr. AXLE Cornering Stiffness @ 0 g	116657	116657	N/rad
Rr. AXLE Cornering Stiffness @ 0 g	196221	196221	N/rad
Understeer Gradient @ Wheel @ 0 g	0.25	0.25	°/g
Sideslip Angle Gradient @ 0 g	1.07	1.07	°/g
Understeer Gradient @ g	0.00	0.25	°/g
Sideslip Angle Gradient @ g	0.00	1.08	°/g
Understeer Gradient @ g	2.10		2.03 °/g
Sideslip Angle Gradient @ g	2.10		9.58 °/g
Front Slip Angle @ g	0.00	0.00	°
Vehicle Slip Angle @ g	0.00	0.00	°
Rear Axle Slip Angle @ g	0.00	0.00	°
Front Slip Angle @ g	2.10		4.19 °
Vehicle Slip Angle @ g	2.10		2.57 °
Rear Axle Slip Angle @ g	2.10		3.94 °



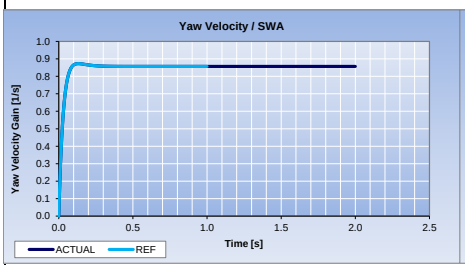


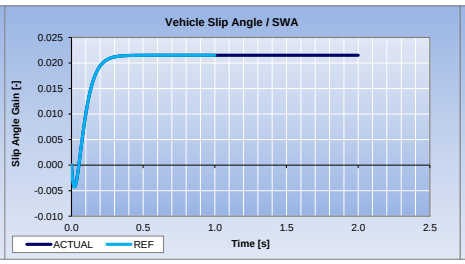
STEP STEER RESPONSE TEST

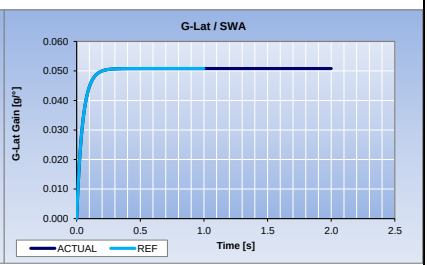
	ACTUAL	REF	
	Yaw Gain		
SWA (0=Generic)	0.0	0.0	°
G-Long	0.0	0.0	g
Calculated G-Lat @ SWA	0.00	0.00	g
90% Response Time	48.000	52.000	s
Peak Value	0.873	0.873	1/s
Time to Peak Value	136.000	132.000	s
Overshoot @ Peak	0.019	0.019	-

	ACTUAL	REF	
	Slip Angle Gain		
SWA (0=Generic)	0.0	0.0	°
G-Long	0.0	0.0	g
Calculated G-Lat @ SWA	0.00	0.00	g
90% Response Time	192.000	196.000	s
Peak Value	0.022	0.022	-
Time to Peak Value	696.000	640.000	s
Overshoot @ Peak	0.000	0.000	-

	ACTUAL	REF	
	Lateral Acceleration Gain		
SWA (0=Generic)	0.0	0.0	°
G-Long	0.0	0.0	g
Calculated G-Lat @ SWA	0.00	0.00	g
90% Response Time	104.000	108.000	s
Peak Value	0.051	0.051	g/°
Time to Peak Value	608.000	576.000	s
Overshoot @ Peak	0.000	0.000	-







FREQUENCY STEER RESPONSE TEST

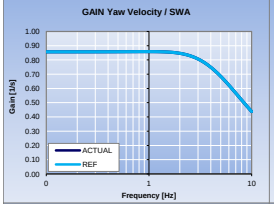
	ACTUAL	REF	
	Yaw Gain / SWA		
SWA (0=Generic)	0.0	0.0	°
G-Long	0.0	0.0	g
Calculated G-Lat @ SWA	0.00	0.00	g
Peak Frequency	1.000	1.000	Hz
Static Gain @ 0 Hz	0.857	0.857	1/s
Overshoot @ Peak	0.002	0.002	-
Delay Time @ 1 Hz	23.046	23.046	ms

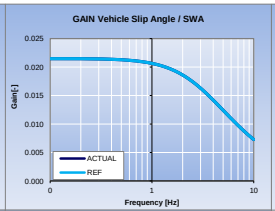
	ACTUAL	REF	
	Slip Angle Gain / SWA		
SWA (0=Generic)	0.0	0.0	°
G-Long	0.0	0.0	g
Calculated G-Lat @ SWA	0.00	0.00	g
Peak Frequency	0.001	0.001	Hz
Static Gain @ 0 Hz	0.022	0.022	-
Overshoot @ Peak	0.000	0.000	-
Delay Time @ 1 Hz	123.221	123.221	ms

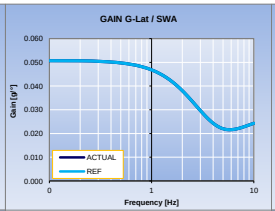
	ACTUAL	REF	
	G-Lat Gain / SWA		
SWA (0=Generic)	0.0	0.0	°
G-Long	0.0	0.0	g
Calculated G-Lat @ SWA	0.00	0.00	g
Peak Frequency	0.001	0.001	Hz
Static Gain @ 0 Hz	0.051	0.051	g/°
Overshoot @ Peak	0.000	0.000	-
Delay Time @ 1 Hz	44.253	44.253	ms

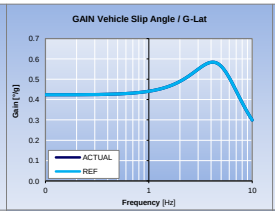
	ACTUAL	REF	
	Slip Angle Gain / G-Lat		
SWA (0=Generic)	0.0	0.0	°
G-Long	0.0	0.0	g
Calculated G-Lat @ SWA	0.00	0.00	g
Peak Frequency	4.200	4.200	Hz
Static Gain @ 0 Hz	0.423	0.423	°/g
Overshoot @ Peak	0.380	0.380	-
Delay Time @ 1 Hz	78.969	78.969	ms

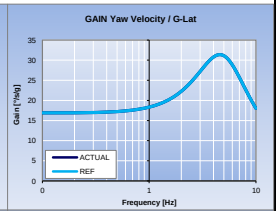
	ACTUAL	REF	
	Yaw Gain / G-Lat		
SWA (0=Generic)	0.0	0.0	°
G-Long	0.0	0.0	g
Calculated G-Lat @ SWA	0.00	0.00	g
Peak Frequency	4.600	4.600	Hz
Static Gain @ 0 Hz	16.863	16.863	°/s/g
Overshoot @ Peak	0.861	0.861	-
Delay Time @ 1 Hz	-21.206	-21.206	ms

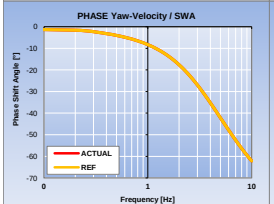


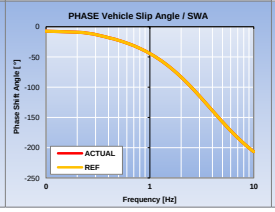


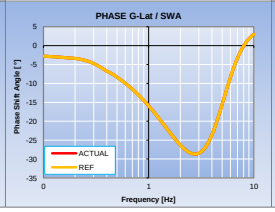


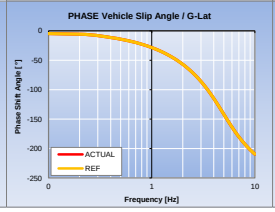


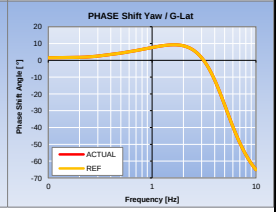




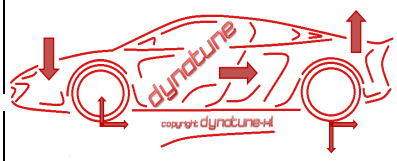








CIRCUIT & TEST TRACK LAYOUT



AUTOMATIC DATA UPDATE ONLY IN START/INITIALISE CONDITION

START Initialise

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GOTO MASTER | GOTO RESULTS

GOTO LAPTIME SIMULATION

GOTO VEHICLE DATA
GOTO CHASSIS DATA
GOTO TIRE DATA
GOTO VEHICLE MODEL
GOTO SPRING TUNING
GOTO DAMPER TUNING
GOTO ROLLBAR TUNING
GOTO UNDERSTEER
GOTO FREQUENCY STEER
GOTO STEP STEER

LOW SPEED TRACK
(enter above the name of the track for graphs)

MANDATORY START SECTION

MANDATORY START SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

INCLUDE SECTION

MANDATORY

MANDATORY FINISH SECTION

Section	Description	Actual Track Coordinate x [m]	Actual Track Coordinate y [m]	Calculated Distance s [m]	Calculated Corner Radius R [m]	ERROR MESSAGES
START	START / STRAIGHT 1	-50.0	8.0	0.0	N/A	
S1/C1	END OF STRAIGHT / CORNER ENTRY	-154.5	11.0	104.5	26.8	
	INTERMEDIATE SECTION	-164.9	9.4	10.6	22.3	
	CORNER APEX POINT	-170.3	6.7	6.1	17.7	
	INTERMEDIATE SECTION	-173.9	3.1	5.1	30.7	
	CORNER EXIT / START OF STRAIGHT	-177.3	-1.2	5.4	43.7	
S2/C2	END OF STRAIGHT / CORNER ENTRY	-189.0	-14.0	17.4	48.4	
	INTERMEDIATE SECTION	-192.0	-17.7	4.8	34.2	
	CORNER APEX POINT	-197.0	-22.5	7.0	20.0	
	INTERMEDIATE SECTION	-206.6	-25.9	10.2	32.1	
	CORNER EXIT / START OF STRAIGHT	-216.7	-27.0	10.2	44.2	
S3/C3	END OF STRAIGHT / CORNER ENTRY	-340.0	-20.0	123.5	80.6	
	INTERMEDIATE SECTION	-363.4	-25.0	24.0	74.4	
	CORNER APEX POINT	-380.0	-33.6	18.7	68.1	
	INTERMEDIATE SECTION	-395.0	-48.0	20.9	72.1	
	CORNER EXIT / START OF STRAIGHT	-408.0	-72.9	28.3	76.0	
S4/C4	END OF STRAIGHT / CORNER ENTRY	-492.3	-299.9	242.1	63.7	
	INTERMEDIATE SECTION	-491.2	-324.1	24.4	48.8	
	CORNER APEX POINT	-478.7	-349.4	28.6	34.0	
	INTERMEDIATE SECTION	-443.5	-354.1	36.6	41.9	
	CORNER EXIT / START OF STRAIGHT	-415.6	-336.3	33.7	49.8	
S5/C5	END OF STRAIGHT / CORNER ENTRY	-182.8	-101.9	330.5	88.1	
	INTERMEDIATE SECTION	-129.8	-80.7	58.0	86.2	
	CORNER APEX POINT	-63.5	-106.0	73.2	84.4	
	INTERMEDIATE SECTION	-40.0	-174.0	74.3	84.9	
	CORNER EXIT / START OF STRAIGHT	-62.1	-223.0	54.7	85.4	
S6/C6	END OF STRAIGHT / CORNER ENTRY	-87.2	-246.1	34.1	58.4	
	INTERMEDIATE SECTION	-98.4	-279.9	36.2	57.7	
	CORNER APEX POINT	-83.0	-320.0	44.0	56.9	
	INTERMEDIATE SECTION	-31.7	-337.2	55.4	74.2	
	CORNER EXIT / START OF STRAIGHT	6.2	-329.9	38.8	91.4	
S7/C7	END OF STRAIGHT / CORNER ENTRY	34.7	-312.3	33.5	76.9	
	INTERMEDIATE SECTION	65.7	-302.1	32.9	68.1	
	CORNER APEX POINT	107.1	-309.3	42.7	59.3	
	INTERMEDIATE SECTION	132.5	-340.0	40.0	128.5	
	CORNER EXIT / START OF STRAIGHT	143.7	-359.0	22.0	197.7	
S8/C8	END OF STRAIGHT / CORNER ENTRY	153.0	-372.2	16.2	53.8	
	INTERMEDIATE SECTION	164.2	-383.0	15.6	46.1	
	CORNER APEX POINT	174.9	-389.0	12.4	38.5	
	INTERMEDIATE SECTION	183.2	-391.0	8.5	53.6	
	CORNER EXIT / START OF STRAIGHT	197.6	-392.0	14.5	68.7	
S9/C9	END OF STRAIGHT / CORNER ENTRY	370.1	-373.9	173.4	16.5	
	INTERMEDIATE SECTION	385.4	-378.2	16.6	15.1	
	CORNER APEX POINT	389.8	-385.6	8.7	13.6	
	INTERMEDIATE SECTION	385.1	-399.0	14.7	16.5	
	CORNER EXIT / START OF STRAIGHT	375.4	-405.1	11.6	19.4	
S10/C10	END OF STRAIGHT / CORNER ENTRY	208.7	-419.0	167.3	17.9	
	INTERMEDIATE SECTION	196.5	-427.1	15.0	17.3	
	CORNER APEX POINT	194.0	-439.3	12.8	16.7	
	INTERMEDIATE SECTION	202.6	-451.2	15.2	16.8	
	CORNER EXIT / START OF STRAIGHT	215.2	-452.5	12.9	16.8	
S11/C11	END OF STRAIGHT / CORNER ENTRY	423.0	-403.0	213.7	46.3	
	INTERMEDIATE SECTION	457.6	-406.5	35.6	44.4	
	CORNER APEX POINT	476.0	-424.2	25.9	42.5	
	INTERMEDIATE SECTION	479.0	-458.0	34.9	42.9	
	CORNER EXIT / START OF STRAIGHT	457.9	-483.0	33.6	43.3	
S12/C12	END OF STRAIGHT / CORNER ENTRY	436.9	-489.3	21.9	42.3	
	INTERMEDIATE SECTION	421.5	-505.5	22.7	41.5	
	CORNER APEX POINT	417.0	-531.8	27.1	40.6	
	INTERMEDIATE SECTION	427.6	-553.1	24.1	44.5	
	CORNER EXIT / START OF STRAIGHT	450.7	-568.0	27.9	48.4	
S13/C13	END OF STRAIGHT / CORNER ENTRY	677.0	-677.4	251.3	67.2	
	INTERMEDIATE SECTION	724.3	-672.4	48.6	60.5	
	CORNER APEX POINT	758.6	-630.9	55.8	53.7	
	INTERMEDIATE SECTION	749.0	-590.2	42.6	63.2	
	CORNER EXIT / START OF STRAIGHT	715.1	-560.0	46.1	72.6	
S14/C14	END OF STRAIGHT / CORNER ENTRY	675.0	-550.0	41.3	66.1	
	INTERMEDIATE SECTION	655.0	-551.0	20.1	57.4	
	CORNER APEX POINT	640.0	-556.0	15.9	48.7	
	INTERMEDIATE SECTION	630.0	-563.0	12.2	57.5	
	CORNER EXIT / START OF STRAIGHT	618.9	-575.0	16.4	66.4	
S15/C15	END OF STRAIGHT / CORNER ENTRY	604.4	-592.0	22.4	72.6	
	INTERMEDIATE SECTION	583.4	-597.2	21.7	71.5	
	CORNER APEX POINT	537.7	-586.1	47.9	70.4	
	INTERMEDIATE SECTION	512.0	-556.0	40.1	70.6	
	CORNER EXIT / START OF STRAIGHT	511.0	-500.0	57.6	70.8	
S16/C16	END OF STRAIGHT / CORNER ENTRY	521.0	-478.5	23.7	113.5	
	INTERMEDIATE SECTION	517.0	-426.0	53.1	112.2	
	CORNER APEX POINT	492.9	-384.2	48.7	110.9	
	INTERMEDIATE SECTION	451.0	-355.7	51.1	111.8	
	CORNER EXIT / START OF STRAIGHT	402.4	-348.3	49.5	112.7	
S17/C17	END OF STRAIGHT / CORNER ENTRY	248.5	-364.0	154.6	76.4	
	INTERMEDIATE SECTION	206.1	-356.9	43.6	74.9	
	CORNER APEX POINT	171.4	-323.2	49.2	73.5	
	INTERMEDIATE SECTION	163.7	-289.9	34.4	78.7	
	CORNER EXIT / START OF STRAIGHT	169.0	-258.5	32.1	83.8	
S18/C18	END OF STRAIGHT / CORNER ENTRY	176.0	-232.6	26.8	65.2	
	INTERMEDIATE SECTION	165.6	-210.5	24.6	64.1	
	CORNER APEX POINT	151.0	-196.0	20.6	63.0	
	INTERMEDIATE SECTION	132.7	-187.0	20.5	65.0	
	CORNER EXIT / START OF STRAIGHT	109.8	-184.0	23.1	66.9	
S19/C19	END OF STRAIGHT / CORNER ENTRY	30.8	-183.5	79.1	63.2	
	INTERMEDIATE SECTION	14.4	-178.1	17.3	51.4	
	CORNER APEX POINT	1.3	-169.5	15.8	39.7	
	INTERMEDIATE SECTION	-8.3	-154.5	17.9	41.2	
	CORNER EXIT / START OF STRAIGHT	-11.0	-140.3	14.6	42.6	
S20/C20	END OF STRAIGHT / CORNER ENTRY	-2.0	-34.0	106.6	58.7	
	INTERMEDIATE SECTION	-6.0	-16.0	18.5	43.9	
	CORNER APEX POINT	-10.0	-7.7	9.2	29.2	
	INTERMEDIATE SECTION	-24.0	3.0	17.8	36.7	
	CORNER EXIT / START OF STRAIGHT	-37.0	7.0	13.7	44.2	
FINISH	FINISH / STRAIGHT	-50.0	8.0	13.0	N/A	

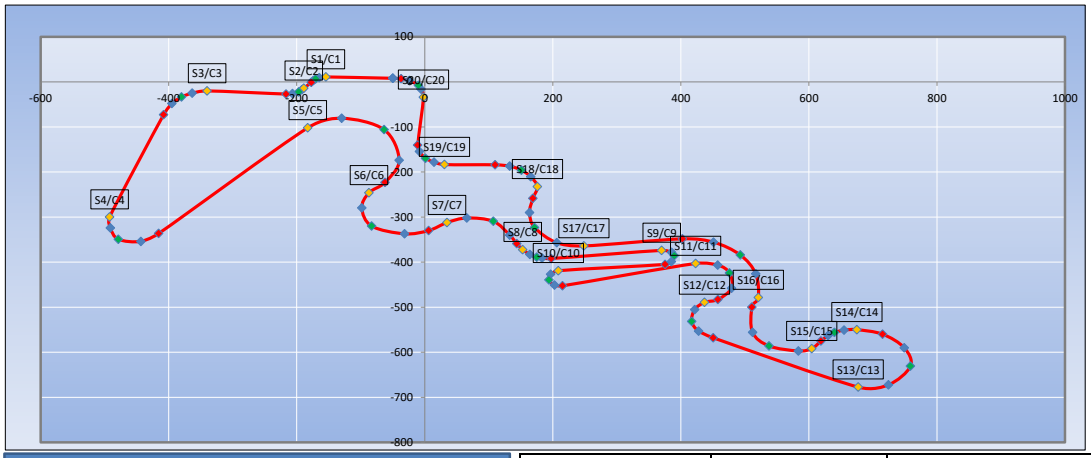
Total Length 4434.5 m

Include All Sections

(Re-) Load **High Speed Track** | (Re-) Load **Low Speed Track** | (Re-) Load **Gen. Test Track** | **F9** (calc)

GOTO LAPTIME

Export Track Data to External | *Import Track Data from External*



ZOOM * selected chart | UNDO ZOOM * selected chart | RESET * selected chart

* Track Map can be zoomed into: Select Map Click Zoom Button and draw Rectangle to zoom in Chart

ZOOM FEATURE CAN BE CUSTOMIZED TO VARIOUS GEOMETRIC FORMS (RECTANGLE,

RECTANGLE

THE ZOOM FEATURE IS STANDARD BEING SETUP FOR ENGLISH VBA LANGUAGE SUPPORT. IF YOUR EXCEL VERSION HOWEVER IS IN A DIFFERENT LANGUAGE IT CAN HAPPEN THAT YOU MUST ENTER THE NAME OF THE FORM IN THE LANGUAGF OF YOUR EXCEL VERSION.

	HIGH SPEED TRACK		LOW SPEED TRACK		GENERIC TEST TRACK	
START	0.0	5.0	-50.0	8.0	0.0	0.0
S1/C1	-950.0	5.0	-154.5	11.0	-200.0	0.0
	-1150.0	-60.0	-164.9	9.4	-207.7	-1.5
	-1255.0	-150.0	-170.3	6.7	-214.1	-5.9
	-1290.0	-250.0	-173.9	3.1	-218.5	-12.3
	-1295.0	-300.0	-177.3	-1.2	-220.0	-20.0
S2/C2	-1290.0	-340.0	-189.0	-14.0	-220.0	-220.0
	-1280.0	-365.0	-192.0	-17.7	-217.0	-235.3
	-1250.0	-385.0	-197.0	-22.5	-208.3	-248.3
	-1230.0	-385.0	-206.6	-25.9	-195.3	-257.0
	-1200.0	-380.0	-216.7	-27.0	-180.0	-260.0
S3/C3	-1170.0	-371.0	-340.0	-20.0	20.0	-260.0
	-1150.0	-369.0	-363.4	-25.0	43.0	-264.6
	-1125.0	-375.0	-380.0	-33.6	62.4	-277.6
	-1110.0	-391.0	-395.0	-48.0	75.4	-297.0
	-1105.0	-417.0	-408.0	-72.9	80.0	-320.0
S4/C4	-1100.0	-438.0	-492.3	-299.9	80.0	-532.0
	-1095.0	-471.0	-491.2	-324.1	86.1	-562.6
	-1080.0	-500.0	-478.7	-349.4	103.4	-588.6
	-1055.0	-520.0	-443.5	-354.1	129.4	-605.9
	-1025.0	-532.0	-415.6	-336.3	160.0	-612.0
S5C5	-925.0	-555.0	-182.8	-101.9	160.0	-612.0
	-876.0	-581.0	-129.8	-80.7	160.0	-612.0
	-852.0	-596.0	-63.5	-106.0	160.0	-612.0
	-825.0	-617.0	-40.0	-174.0	160.0	-612.0
	-773.0	-664.0	-62.1	-223.0	160.0	-612.0
S6/C6	-621.0	-815.0	-87.2	-246.1	160.0	-612.0
	-587.0	-818.0	-98.4	-279.9	160.0	-612.0
	-568.0	-801.0	-83.0	-320.0	160.0	-612.0
	-565.0	-776.0	-31.7	-337.2	160.0	-612.0
	-582.0	-753.0	6.2	-329.9	160.0	-612.0
S7/C7	-621.0	-740.0	34.7	-312.3	160.0	-612.0
	-650.0	-725.0	65.7	-302.1	160.0	-612.0
	-680.0	-702.0	107.1	-309.3	160.0	-612.0
	-720.0	-650.0	132.5	-340.0	160.0	-612.0
	-746.0	-607.0	143.7	-359.0	160.0	-612.0
S8/C8	-802.0	-501.0	153.0	-372.2	160.0	-612.0
	-825.0	-465.0	164.2	-383.0	160.0	-612.0
	-847.0	-437.0	174.9	-389.0	160.0	-612.0
	-880.0	-410.0	183.2	-391.0	160.0	-612.0
	-914.0	-391.0	197.6	-392.0	160.0	-612.0
S9/C9	-1030.0	-346.0	370.1	-373.9	160.0	-612.0
	-1070.0	-280.0	385.4	-378.2	160.0	-612.0
	-1060.0	-171.0	389.8	-385.6	160.0	-612.0
	-990.0	-125.0	385.1	-399.0	160.0	-612.0
	-900.0	-135.0	375.4	-405.1	160.0	-612.0
S10/C10	-753.0	-255.5	208.7	-419.0	160.0	-612.0
	-709.0	-268.0	196.5	-427.1	160.0	-612.0
	-671.0	-263.0	194.0	-439.3	160.0	-612.0
	-633.0	-239.0	202.6	-451.2	160.0	-612.0
	-606.0	-202.0	215.2	-452.5	160.0	-612.0
S11/C11	-579.0	-155.0	423.0	-403.0	160.0	-612.0
	-507.0	-122.0	457.6	-406.5	160.0	-612.0
	-425.0	-135.0	476.0	-424.2	160.0	-612.0
	-373.0	-198.0	479.0	-458.0	160.0	-612.0
	-370.0	-270.0	457.9	-483.0	160.0	-612.0
S12/C12	-425.0	-500.0	436.9	-489.3	160.0	-612.0
	-432.0	-545.0	421.5	-505.5	160.0	-612.0
	-433.0	-607.0	417.0	-531.8	160.0	-612.0
	-430.0	-636.0	427.6	-553.1	160.0	-612.0
	-415.0	-705.0	450.7	-568.0	160.0	-612.0
S13/C13	-389.0	-811.0	677.0	-677.4	160.0	-612.0
	-375.0	-821.0	724.3	-672.4	160.0	-612.0
	-355.0	-830.5	758.6	-630.9	160.0	-612.0
	-330.0	-835.0	749.0	-590.2	160.0	-612.0
	-303.0	-834.0	715.1	-560.0	160.0	-612.0
S14/C14	-199.0	-782.0	675.0	-550.0	160.0	-612.0
	-180.0	-760.0	655.0	-551.0	160.0	-612.0
	-168.9	-737.0	640.0	-556.0	160.0	-612.0
	-164.0	-714.0	630.0	-563.0	160.0	-612.0
	-165.0	-685.0	618.9	-575.0	160.0	-612.0
S15/C15	-192.0	-572.0	604.4	-592.0	160.0	-612.0
	-199.0	-540.5	583.4	-597.2	160.0	-612.0
	-201.5	-509.0	537.7	-586.1	160.0	-612.0
	-199.0	-478.0	512.0	-556.0	160.0	-612.0
	-195.0	-457.0	511.0	-500.0	160.0	-612.0
S16/C16	-188.0	-434.0	521.0	-478.5	160.0	-612.0
	-186.0	-410.0	517.0	-426.0	160.0	-612.0
	-184.4	-385.0	492.9	-384.2	160.0	-612.0
	-185.0	-366.0	451.0	-355.7	160.0	-612.0
	-187.0	-347.0	402.4	-348.3	160.0	-612.0
S17/C17	-206.0	-307.0	248.5	-364.0	160.0	-612.0
	-217.0	-287.0	206.1	-356.9	160.0	-612.0
	-225.0	-266.1	171.4	-323.2	160.0	-612.0
	-229.0	-249.0	163.7	-289.9	160.0	-612.0
	-232.0	-231.0	169.0	-258.5	160.0	-612.0
S18/C18	-234.0	-185.0	176.0	-232.6	160.0	-612.0
	-225.0	-150.0	165.6	-210.5	160.0	-612.0
	-214.0	-130.0	151.0	-196.0	160.0	-612.0
	-183.0	-100.0	132.7	-187.0	160.0	-612.0
	-123.0	-75.0	109.8	-184.0	160.0	-612.0
S19/C19	-44.0	-71.0	30.8	-183.5	368.0	-612.0
	-22.0	-67.0	14.4	-178.1	406.3	-604.4
	0.0	-66.0	1.3	-169.5	438.7	-582.7
	15.0	-68.0	-8.3	-154.5	460.4	-550.3
	35.0	-72.0	-11.0	-140.3	468.0	-512.0
S20/C20	60.0	-83.0	-2.0	-34.0	468.0	-120.0
	100.0	-75.0	-6.0	-16.0	458.9	-74.1
	121.0	-45.0	-10.0	-7.7	432.9	-35.1
	110.0	-15.0	-24.0	3.0	393.9	-9.1
	87.0	5.0	-37.0	7.0	348.0	0.0
FINISH	0.0	5.0	-50.0	8.0	0.0	0.0

LAPTIME CONTROL SHEET

AUTOMATIC DATA UPDATE ONLY IN START/INITIALISE CONDITION

START Initialise

BLUE = ENTER DATA
BLUE = DEFINED ELSEWHERE - DO NOT TOUCH
RED = CALCULATION RESULT - DO NOT TOUCH

GOTO MASTER | GOTO RESULTS | GOTO VEHICLE MODEL | GOTO UNDERSTEER

GOTO VEHICLE DATA | GOTO CHASSIS DATA | GOTO TIRE DATA | GOTO VEHICLE MODEL | GOTO SPRING TUNING | GOTO DAMPER TUNING | GOTO ROLLBAR TUNING | GOTO UNDERSTEER | GOTO FREQUENCY STEER | GOTO STEP STEER

		ACTUAL	REF.	
S1	TIME	2.91	2.87	sec
Section time		2.91	2.87	sec
Braking Distance		43.07	41.30	m
Top Speed		173.04	174.84	kph
Section Length		104.52	104.52	m
C1	TIME	4.32	4.25	sec
Section time		1.40	1.38	sec
Corner Entry		72.33	76.62	kph
Apex Speed		62.63	62.63	kph
Corner Exit		88.97	88.97	kph
Section Length		27.18	27.18	m
S2	TIME	4.96	4.87	sec
Section time		0.64	0.63	sec
Braking Distance		6.56	5.10	m
Top Speed		106.88	109.11	kph
Section Length		17.40	17.40	m
C2	TIME	6.45	6.34	sec
Section time		1.49	1.47	sec
Corner Entry		89.89	95.99	kph
Apex Speed		67.22	67.22	kph
Corner Exit		93.98	93.98	kph
Section Length		32.12	32.12	m
S3	TIME	9.36	9.25	sec
Section time		2.91	2.90	sec
Braking Distance		24.98	22.85	m
Top Speed		199.39	200.86	kph
Section Length		123.51	123.51	m
C3	TIME	11.67	11.54	sec
Section time		2.31	2.30	sec
Corner Entry		149.31	152.75	kph
Apex Speed		139.57	139.57	kph
Corner Exit		146.98	146.98	kph
Section Length		91.91	91.91	m
S4	TIME	16.10	15.92	sec
Section time		4.43	4.37	sec
Braking Distance		66.48	60.98	m
Top Speed		249.98	251.51	kph
Section Length		242.13	242.13	m
C4	TIME	20.56	20.35	sec
Section time		4.46	4.43	sec
Corner Entry		115.88	121.82	kph
Apex Speed		91.13	91.13	kph
Corner Exit		108.30	108.30	kph
Section Length		123.30	123.30	m
S5	TIME	26.40	26.18	sec
Section time		5.84	5.83	sec
Braking Distance		52.79	49.66	m
Top Speed		267.19	267.82	kph
Section Length		330.47	330.47	m
C5	TIME	32.17	31.95	sec
Section time		5.77	5.77	sec
Corner Entry		164.85	164.86	kph
Apex Speed		161.34	161.34	kph
Corner Exit		162.33	162.33	kph
Section Length		260.15	260.15	m

		ACTUAL	REF.	
S6	TIME	32.97	32.74	sec
Section time		0.80	0.79	sec
Braking Distance		22.65	21.93	m
Top Speed		172.97	173.61	kph
Section Length		34.09	34.09	m
C6	TIME	37.78	37.55	sec
Section time		4.81	4.81	sec
Corner Entry		125.32	125.58	kph
Apex Speed		123.95	123.95	kph
Corner Exit		156.37	156.37	kph
Section Length		174.42	174.42	m
S7	TIME	38.53	38.29	sec
Section time		0.75	0.74	sec
Braking Distance		15.34	14.01	m
Top Speed		173.62	174.79	kph
Section Length		33.51	33.51	m
C7	TIME	42.04	41.78	sec
Section time		3.51	3.49	sec
Corner Entry		141.97	144.66	kph
Apex Speed		127.31	127.31	kph
Corner Exit		145.96	151.59	kph
Section Length		137.64	137.64	m
S8	TIME	42.50	42.22	sec
Section time		0.46	0.44	sec
Braking Distance		16.19	16.19	m
Top Speed		145.96	151.59	kph
Section Length		16.18	16.18	m
C8	TIME	44.22	43.92	sec
Section time		1.72	1.70	sec
Corner Entry		109.84	114.93	kph
Apex Speed		97.99	97.99	kph
Corner Exit		124.84	124.84	kph
Section Length		50.93	50.93	m
S9	TIME	48.31	47.99	sec
Section time		4.09	4.07	sec
Braking Distance		68.53	66.25	m
Top Speed		215.35	216.56	kph
Section Length		173.43	173.43	m
C9	TIME	51.55	51.22	sec
Section time		3.24	3.23	sec
Corner Entry		58.97	59.83	kph
Apex Speed		54.94	54.94	kph
Corner Exit		62.98	62.98	kph
Section Length		51.68	51.68	m
S10	TIME	56.26	55.91	sec
Section time		4.71	4.70	sec
Braking Distance		57.66	56.13	m
Top Speed		195.90	196.96	kph
Section Length		167.28	167.28	m
C10	TIME	59.55	59.20	sec
Section time		3.29	3.28	sec
Corner Entry		62.38	62.60	kph
Apex Speed		60.90	60.90	kph
Corner Exit		61.07	61.07	kph
Section Length		55.90	55.90	m

Understeer Gradient Limit (US)	1000.0	°/g
Lim. Fr. & Rr. Side Slip Angle Gradient (SSA)	1000.0	°/a
Limit of Nr. of Iterations	250	[-] (default 250)
Laptime Module ON/OFF	0	[-] switch (Y/N 1/0)

Last Calculated G-G-V Map - Setting
NON-LINEAR & ENHANCED TIRE
Flying Lap

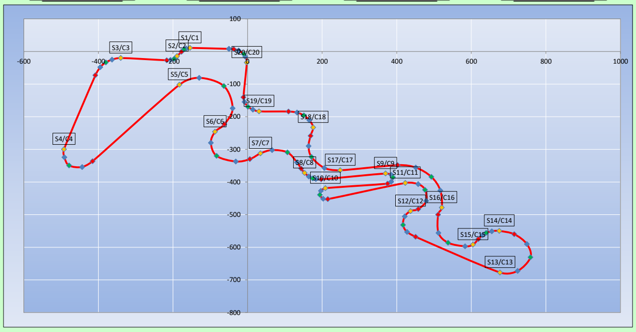
LAPTIME DATA	ACTUAL	REF.	
TOTAL TIME	115.037	114.384	sec
TOTAL DISTANCE	4434.51	4434.51	m
AVERAGE SPEED	138.77	139.57	kph

SET REFERENCE LAP | CLEAR REFERENCE LAP

SCROLL DOWN FOR LAPTIME SENSITIVITY STUDY

GOTO LAP RESULTS | GOTO CIRCUIT

CALCULATE / RE-RUN LAPTIME **WITHOUT UPDATING** G-G-V MAP | CALCULATE NEW LAPTIME WITH **UPDATED LINEAR** G-G-V MAP | CALCULATE NEW LAPTIME WITH **UPDATED NON-LINEAR** G-G-V MAP | CREATE **TIME HISTORY** OF ALL VEHICLE PARAMETERS



		ACTUAL	REF.	
S11	TIME	64.69	64.32	sec
Section time		5.14	5.12	sec
Braking Distance		55.87	53.42	m
Top Speed		223.05	224.21	kph
Section Length		213.68	213.68	m
C11	TIME	69.15	68.77	sec
Section time		4.46	4.45	sec
Corner Entry		107.51	108.39	kph
Apex Speed		103.89	103.89	kph
Corner Exit		104.82	104.82	kph
Section Length		129.93	129.93	m
S12	TIME	69.84	69.47	sec
Section time		0.69	0.69	sec
Braking Distance		8.91	8.69	m
Top Speed		123.84	124.13	kph
Section Length		21.92	21.92	m
C12	TIME	73.39	73.01	sec
Section time		3.54	3.54	sec
Corner Entry		102.75	103.08	kph
Apex Speed		101.18	101.18	kph
Corner Exit		109.73	109.73	kph
Section Length		101.77	101.77	m
S13	TIME	78.25	77.85	sec
Section time		4.86	4.84	sec
Braking Distance		57.79	54.24	m
Top Speed		246.77	247.86	kph
Section Length		251.32	251.32	m
C13	TIME	83.76	83.35	sec
Section time		5.52	5.51	sec
Corner Entry		131.74	133.33	kph
Apex Speed		119.68	119.68	kph
Corner Exit		139.05	139.05	kph
Section Length		193.21	193.21	m
S14	TIME	84.77	84.34	sec
Section time		1.00	0.99	sec
Braking Distance		17.96	15.80	m
Top Speed		163.88	165.93	kph
Section Length		41.32	41.32	m
C14	TIME	86.72	86.27	sec
Section time		1.95	1.93	sec
Corner Entry		125.73	131.29	kph
Apex Speed		112.72	112.72	kph
Corner Exit		128.28	128.29	kph
Section Length		64.56	64.56	m
S15	TIME	87.29	86.84	sec
Section time		0.57	0.57	sec
Braking Distance		3.10	2.93	m
Top Speed		151.04	151.22	kph
Section Length		22.37	22.37	m
C15	TIME	91.50	91.05	sec
Section time		4.21	4.21	sec
Corner Entry		144.53	144.82	kph
Apex Speed		142.75	142.75	kph
Corner Exit		143.16	143.16	kph
Section Length		167.28	167.28	m

		ACTUAL	REF.	
S16	TIME	92.05	91.60	sec
Section time		0.55	0.55	sec
Braking Distance		0.00	0.00	m
Top Speed		167.55	167.55	kph
Section Length		23.74	23.74	m
C16	TIME	95.89	95.44	sec
Section time		3.84	3.84	sec
Corner Entry		167.55	167.55	kph
Apex Speed		195.77	195.77	kph
Corner Exit		197.27	197.30	kph
Section Length		202.43	202.43	m
S17	TIME	98.49	98.03	sec
Section time		2.61	2.59	sec
Braking Distance		49.08	46.37	m
Top Speed		246.04	246.87	kph
Section Length		154.65	154.65	m
C17	TIME	102.34	101.88	sec
Section time		3.85	3.85	sec
Corner Entry		149.52	149.79	kph
Apex Speed		146.85	146.85	kph
Corner Exit		156.49	156.49	kph
Section Length		159.38	159.38	m
S18	TIME	102.96	102.50	sec
Section time		0.62	0.62	sec
Braking Distance		15.76	15.12	m
Top Speed		167.25	167.85	kph
Section Length		26.80	26.80	m
C18	TIME	105.35	104.89	sec
Section time		2.39	2.39	sec
Corner Entry		134.25	134.87	kph
Apex Speed		132.54	132.54	kph
Corner Exit		136.19	136.19	kph
Section Length		88.90	88.90	m
S19	TIME	107.18	106.68	sec
Section time		1.83	1.80	sec
Braking Distance		31.27	28.24	m
Top Speed		183.43	185.90	kph
Section Length		79.09	79.09	m
C19	TIME	109.45	108.92	sec
Section time		2.26	2.24	sec
Corner Entry		117.64	124.58	kph
Apex Speed		99.86	99.86	kph
Corner Exit		102.81	102.81	kph
Section Length		65.56	65.56	m
S20	TIME	112.12	111.53	sec
Section time		2.68	2.61	sec
Braking Distance		35.37	30.74	m
Top Speed		183.05	186.83	kph
Section Length		106.64	106.64	m
C20	TIME	114.50	113.85	sec
Section time		2.38	2.33	sec
Corner Entry		107.45	119.75	kph
Apex Speed		83.38	83.38	kph
Corner Exit		76.42	76.91	kph
Section Length		59.18	59.18	m
FINISH	TIME	115.04	114.38	sec
Section time		0.53	0.53	sec
Braking Distance		0.00	0.00	m
Top Speed		99.86	100.26	kph
Section Length		13.04	13.04	m

Run Linear GGV-Map Laptime Sensitivity Study | Run Non-Linear GGV-Map Laptime Sensitivity Study

LAPTIME SENSITIVITY STUDY

ACTUAL LAP DATA

ACTUAL LAP — *Laptime 115.04*

Time	Distance	Ax	Ay	V
0.00	0.00	1.28	0.00	99.86
0.38	11.38	1.32	0.00	117.16
0.72	23.10	1.31	0.00	132.86
1.03	35.32	1.28	0.00	147.25
1.33	48.12	1.24	0.00	160.58
1.62	61.45	1.21	0.00	173.06
1.62	61.46	-2.73	0.00	173.01
1.81	70.07	-2.53	0.00	155.47
2.02	78.69	-2.33	0.00	137.26
2.26	87.30	-2.15	0.00	118.05
2.55	95.92	-1.99	0.00	96.97
2.91	104.53	-1.82	0.00	72.33
2.91	104.54	-0.15	1.53	72.33
3.46	115.10	-0.13	1.54	66.05
3.81	121.24	0.00	1.75	62.63
4.08	126.36	0.87	1.37	73.16
4.32	131.72	0.90	1.42	88.97
4.32	131.72	1.25	0.00	88.97
4.40	133.88	1.26	0.00	92.76
4.49	136.05	1.27	0.00	96.44
4.57	138.22	1.28	0.00	100.01
4.64	140.39	1.28	0.00	103.48
4.72	142.57	1.29	0.00	106.87
4.72	142.58	-2.07	0.00	106.88
4.76	143.89	-2.04	0.00	103.62
4.81	145.20	-2.02	0.00	100.30
4.86	146.51	-1.99	0.00	96.91
4.91	147.82	-1.97	0.00	93.44
4.96	149.13	-1.94	0.00	89.89
4.96	149.13	-0.34	1.31	89.89
5.16	153.90	-0.27	1.34	76.42
5.51	160.87	0.00	1.77	67.22
6.02	171.09	0.59	1.48	77.69
6.45	181.25	0.75	1.57	93.98
6.45	181.25	1.26	0.00	93.98
7.08	200.35	1.33	0.00	123.02
7.59	219.56	1.28	0.00	146.69
8.04	239.19	1.23	0.00	166.65
8.46	259.20	1.18	0.00	184.13
8.84	279.80	1.05	0.00	199.39
8.84	279.81	-3.05	0.00	199.38
8.93	284.80	-2.92	0.00	189.64
9.03	289.80	-2.80	0.00	179.81
9.13	294.79	-2.69	0.00	169.84
9.24	299.78	-2.58	0.00	159.68
9.36	304.78	-2.47	0.00	149.31
9.36	304.78	-0.16	2.17	149.31
9.95	328.78	-0.10	2.16	142.98
10.43	347.52	0.00	2.25	139.57
10.96	368.42	0.12	2.20	142.11
11.67	396.68	0.14	2.24	146.98
11.67	396.68	1.28	0.00	146.98
12.33	426.51	1.20	0.00	176.10
12.95	458.74	1.04	0.00	200.51
13.55	493.88	0.85	0.00	220.52
14.15	531.94	0.69	0.00	236.75
14.75	572.50	0.56	0.00	249.99
14.75	572.51	-3.74	0.00	249.98
14.95	585.77	-3.39	0.00	224.60
15.17	599.03	-3.04	0.00	198.93
15.43	612.30	-2.72	0.00	172.70
15.73	625.56	-2.42	0.00	145.34
16.10	638.82	-2.13	0.00	115.88
16.10	638.82	-0.24	1.66	115.88
16.91	663.20	-0.20	1.64	100.88
17.98	691.81	0.00	1.92	91.13
19.38	728.39	0.12	1.77	97.13
20.56	762.12	0.27	1.85	108.30
20.56	762.12	1.30	0.00	108.30
21.84	810.59	1.23	0.00	165.25
22.84	861.95	1.00	0.00	204.64
23.75	917.55	0.73	0.00	232.61
24.64	977.17	0.54	0.00	252.48
25.50	1039.75	0.42	0.00	267.21
25.50	1039.76	-3.99	0.00	267.16
25.65	1050.33	-3.70	0.00	247.08
25.81	1060.90	-3.43	0.00	226.88
25.99	1071.47	-3.15	0.00	206.50
26.18	1082.04	-2.87	0.00	185.92
26.40	1092.61	-2.64	0.00	164.85
26.40	1092.61	-0.05	2.43	164.85
27.68	1150.65	-0.02	2.41	162.56
29.30	1223.82	0.00	2.43	161.34
30.96	1298.10	0.01	2.42	161.69
32.17	1352.76	0.02	2.43	162.33
32.17	1352.76	1.24	0.00	162.33
32.22	1354.78	1.23	0.00	164.27
32.26	1356.94	1.23	0.00	166.32
32.31	1359.24	1.22	0.00	168.46
32.37	1361.67	1.22	0.00	170.68
32.42	1364.21	1.21	0.00	172.97
32.42	1364.22	-2.73	0.00	172.98
32.52	1368.75	-2.63	0.00	163.83
32.62	1373.27	-2.52	0.00	154.52
32.73	1377.80	-2.42	0.00	145.01
32.84	1382.33	-2.31	0.00	135.29
32.97	1386.86	-2.20	0.00	125.32
32.97	1386.86	-0.01	2.11	125.32
34.01	1423.02	-0.01	2.11	124.47
35.29	1467.06	0.00	2.12	123.95
36.82	1522.48	0.22	1.96	135.90
37.78	1561.28	0.57	2.10	156.37
37.78	1561.28	1.25	0.00	156.37
37.86	1564.78	1.25	0.00	159.89
37.94	1568.35	1.24	0.00	163.37
38.02	1571.99	1.23	0.00	166.83
38.10	1575.69	1.22	0.00	170.24
38.17	1579.45	1.21	0.00	173.62
38.18	1579.46	-2.73	0.00	173.62
38.24	1582.53	-2.67	0.00	167.45
38.31	1585.60	-2.60	0.00	161.20
38.38	1588.66	-2.53	0.00	154.88
38.45	1591.73	-2.46	0.00	148.47
38.53	1594.80	-2.39	0.00	141.97
38.53	1594.80	-0.18	2.06	141.97
39.39	1627.73	-0.11	2.04	132.89
40.57	1670.41	0.00	2.15	127.31
41.54	1710.42	1.09	1.78	170.33
42.04	1732.44	-1.38	0.85	145.96
42.04	1732.44	-2.43	0.00	145.96
42.08	1733.91	-2.40	0.00	142.83
42.11	1735.38	-2.36	0.00	139.69
42.15	1736.85	-2.33	0.00	136.51
42.19	1738.32	-2.29	0.00	133.31
42.23	1739.79	-2.26	0.00	130.09
42.27	1741.26	-2.22	0.00	126.83
42.31	1742.73	-2.19	0.00	123.54
42.36	1744.20	-2.16	0.00	120.20
42.40	1745.67	-2.14	0.00	116.81
42.45	1747.14	-2.11	0.00	113.36
42.50	1748.61	-2.09	0.00	109.84
42.50	1748.61	-0.16	1.76	109.84
43.02	1764.19	-0.12	1.79	102.33
43.47	1776.54	0.00	1.96	97.99
43.77	1785.08	0.65	1.69	107.43
44.22	1799.54	0.57	1.78	124.84
44.22	1799.54	1.34	0.00	124.84
44.69	1817.44	1.28	0.00	146.75
45.13	1836.75	1.23	0.00	166.39
45.56	1857.54	1.18	0.00	184.54
45.98	1880.02	1.04	0.00	200.98
46.40	1904.47	0.90	0.00	215.40
46.40	1904.48	-3.27	0.00	215.30
46.65	1918.18	-2.91	0.00	188.68
46.93	1931.88	-2.60	0.00	161.29
47.27	1945.58	-2.28	0.00	132.35
47.69	1959.28	-2.02	0.00	100.15
48.31	1972.99	-1.74	0.00	58.97
48.31	1972.99	-0.05	1.65	58.97
49.35	1989.60	-0.05	1.65	56.25
49.91	1998.31	0.00	1.74	54.94
50.85	2013.05	0.09	1.59	57.75
51.55	2024.67	0.21	1.60	62.98
51.55	2024.67	1.18	0.00	62.98
52.44	2045.10	1.28	0.00	101.78
53.08	2065.82	1.32	0.00	131.17
53.62	2087.45	1.26	0.00	155.84
54.12	2110.25	1.20	0.00	177.21
54.58	2134.30	1.08	0.00	195.93
54.58	2134.31	-3.00	0.00	195.88
54.80	2145.84	-2.73	0.00	173.11

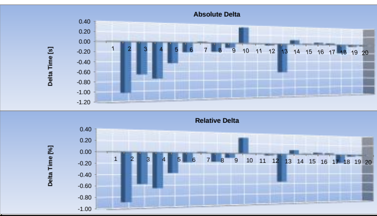
REFERENCE LAP DATA

REFERENCE LAP — *Laptime 114.38*

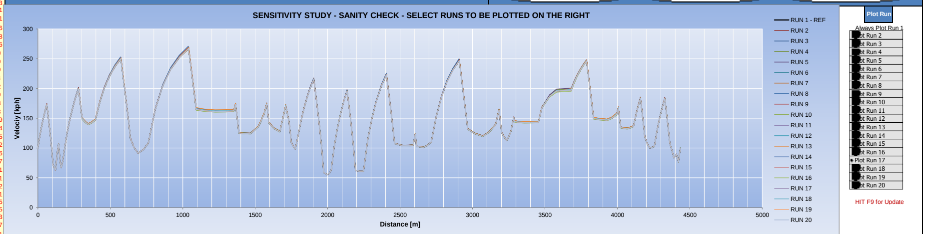
Time	Distance	Ax	Ay	V
0.00	0.0	1.28	0.00	100.26
0.39	11.7	1.32	0.00	117.93
0.73	23.7	1.31	0.00	133.92
1.05	36.3	1.27	0.00	148.56
1.36	49.5	1.24	0.00	162.13
1.65	63.2	1.21	0.00	174.82
1.65	63.2	-2.90	0.00	174.85
1.83	71.5	-2.67	0.00	157.27
2.03	79.8	-2.44	0.00	139.18
2.26	88.0	-2.22	0.00	120.34
2.53	96.3	-2.06	0.00	99.97
2.87	104.5	-1.87	0.00	76.62
2.87	104.5	-0.52	1.72	76.62
3.39	115.1	-0.36	1.59	67.00
3.74	121.2	0.00	1.75	62.63
4.01	126.4	0.87	1.37	73.16
4.25	131.7	0.90	1.42	88.97
4.25	131.7	1.25	0.00	88.97
4.34	134.2	1.26	0.00	93.28
4.44	136.6	1.27	0.00	97.43
4.52	139.1	1.28	0.00	101.44
4.61	141.6	1.29	0.00	105.33
4.69	144.0	1.30	0.00	109.11
4.69	144.0	-2.13	0.00	109.11
4.73	145.1	-2.11	0.00	106.56
4.76	146.1	-2.09	0.00	103.98
4.80	147.1	-2.07	0.00	101.36
4.83	148.1	-2.05	0.00	98.70
4.87	149.1	-2.02	0.00	95.99
4.87	149.1	-1.45	1.50	95.99
5.07	153.9	-1.00	1.45	79.34
5.41	160.9	0.00	1.77	67.22
5.92	171.1	0.59	1.48	77.69
6.34	181.3	0.75	1.57	93.98
6.34	181.3	1.26	0.00	93.98
6.99	200.8	1.34	0.00	123.59
7.51	220.4	1.28	0.00	147.64
7.97	240.5	1.22	0.00	167.85
8.39	260.9	1.18	0.00	185.52
8.78	281.9	1.04	0.00	200.86
8.78	281.9	-3.27	0.00	200.87
8.86	286.5	-3.12	0.00	191.41
8.95	291.1	-2.99	0.00	181.91
9.04	295.6	-2.86	0.00	172.32
9.14	300.2	-2.74	0.00	162.61
9.24	304.8	-2.61	0.00	152.75
9.24	304.8	-0.43	2.28	152.75
9.83	328.8	-0.25	2.19	143.83
10.30	347.5	0.00	2.25	139.57
10.84	368.4	0.12	2.20	142.11
11.54	396.7	0.14	2.24	146.98
11.54	396.7	1.28	0.00	146.98
12.23	427.5	1.20	0.00	176.94
12.86	460.7	1.03	0.00	201.83
13.47	497.0	0.83	0.00	222.04
14.09	536.1	0.67	0.00	238.33
14.70	577.7	0.55	0.00	251.54
14.70	577.7	-4.08	0.00	251.45
14.88	589.9	-3.68	0.00	226.20
15.09	602.1	-3.27	0.00	200.94
15.32	614.4	-2.90	0.00	175.48
15.59	626.6	-2.57	0.00	149.33
15.92	638.8	-2.23	0.00	121.82
15.92	638.8	-0.71	1.83	121.82
16.70	663.2	-0.29	1.68	102.07
17.77	691.8	0.00	1.92	91.13
19.17	728.4	0.12	1.77	97.13
20.35	762.1	0.27	1.85	108.30
20.35	762.1	1.30	0.00	108.30
21.64	811.2	1.23	0.00	165.86
22.65	863.3	0.99	0.00	205.48
23.57	919.7	0.72	0.00	233.44
24.46	979.9	0.54	0.00	253.23
25.34	1043.0	0.41	0.00	267.84
25.34	1043.0	-4.33	0.00	267.83
25.47	1052.9	-4.02	0.00	247.39
25.63	1062.8	-3.69	0.00	226.88
25.79	1072.8	-3.36	0.00	206.33
25.97	1082.7	-3.03	0.00	185.74
26.18	1092.6	-2.77	0.00	164.86
26.18	1092.6	-0.05	2.43	164.86
27.45	1150.6	-0.02	2.41	162.56
29.08	1223.8	0.00	2.43	161.34
30.73	1298.1	0.01	2.42	161.69
31.95	1352.8	0.02	2.43	162.33
31.95	1352.8	1.24	0.00	162.33
32.00	1354.9	1.23	0.00	164.38
32.05	1357.2	1.23	0.00	166.55
32.10	1359.6	1.22	0.00	168.82
32.15	1362.2	1.22	0.00	171.18
32.21	1364.9	1.21	0.00	173.60
32.21	1364.9	-2.88	0.00	173.62
32.30	1369.3	-2.76	0.00	164.31
32.40	1373.7	-2.64	0.00	154.88
32.51	1378.1	-2.52	0.00	145.29
32.62	1382.5	-2.40	0.00	135.54
32.74	1386.9	-2.27	0.00	125.58
32.74	1386.9	-0.03	2.12	125.58
33.78	1423.0	-0.01	2.11	124.51
35.06	1467.1	0.00	2.12	123.95
36.59	1522.5	0.22	1.96	135.90
37.55	1561.3	0.57	2.10	156.37
37.55	1561.3	1.25	0.00	156.37
37.64	1565.0	1.24	0.00	160.15
37.72	1568.9	1.23	0.00	163.89
37.81	1572.8	1.23	0.00	167.57
37.89	1576.8	1.22	0.00	171.21
37.97	1580.8	1.21	0.00	174.79
37.97	1580.8	-2.89	0.00	174.80
38.03	1583.6	-2.82	0.00	168.88
38.09	1586.4	-2.74	0.00	162.91
38.16	1589.2	-2.67	0.00	156.88
38.22	1592.0	-2.59	0.00	150.80
38.29	1594.8	-2.51	0.00	144.66
38.29	1594.8	-0.37	2.14	144.66
39.14	1627.7	-0.15	2.06	133.43
40.32	1670.4	0.00	2.15	127.31
41.29	1710.4	1.09	1.78	170.33
41.78	1732.4	-1.08	0.91	151.59
41.78	1732.4	-2.60	0.00	151.59
41.82	1733.9	-2.56	0.00	148.38
41.85	1735.4	-2.52	0.00	145.14
41.89	1736.8	-2.48	0.00	141.89
41.93	1738.3	-2.43	0.00	138.62
41.97	1739.8	-2.39	0.00	135.32
42.01	1741.3	-2.35	0.00	132.00
42.05	1742.7	-2.31	0.00	128.66
42.09	1744.2	-2.27	0.00	125.30
42.13	1745.7	-2.23	0.00	121.90
42.17	1747.1	-2.20	0.00	118.44
42.22	1748.6	-2.18	0.00	114.93
42.22	1748.6	-0.63	1.93	114.93
42.73	1764.2	-0.36	1.83	103.58
43.17	1776.5	0.00	1.96	97.99
43.47	1785.1	0.65	1.69	107.43
43.92	1799.5	0.57	1.78	124.84
43.92	1799.5	1.34	0.00	124.84
44.40	1817.6	1.28	0.00	146.96
44.85	1837.2	1.23	0.00	166.86
45.29	1858.5	1.18	0.00	185.31
45.71	1881.5	1.03	0.00	202.01
46.15	1906.7	0.88	0.00	216.63
46.15	1906.8	-3.52	0.00	216.50
46.38	1920.0	-3.09	0.00	189.05
46.66	1933.2	-2.72	0.00	161.13
46.98	1946.5	-2.35	0.00	131.99
47.39	1959.7	-2.06	0.00	99.99
47.99	1973.0	-1.75	0.00	59.83
47.99	1973.0	-0.10	1.70	59.83
49.02	1989.6	-0.07	1.66	56.39
49.58	1998.3	0.00	1.74	54.94
50.52	2013.1	0.09	1.59	57.75
51.22	2024.7	0.21	1.60	62.98
51.22	2024.7	1.18	0.00	62.98
52.11	2045.2	1.28	0.00	101.98
52.76	2066.1	1.32	0.00	131.57
53.31	2088.1	1.25	0.00	156.46
53.81	2111.3	1.20	0.00	178.08
54.28	2135.8	1.07	0.00	197.00
54.28	2135.8	-3.21	0.00	196.92
54.50	2147.1	-2.88	0.00	173.46

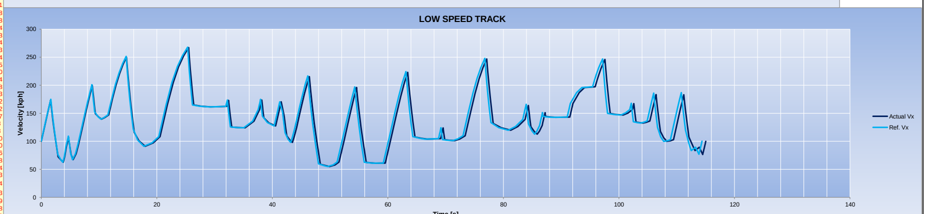
Elapsed time for Selected Parameter Sensitivity Study	31.6	[min]			
Approximate CPU Time for 1 Setup & Laptime Simulation	94.8	[s]			

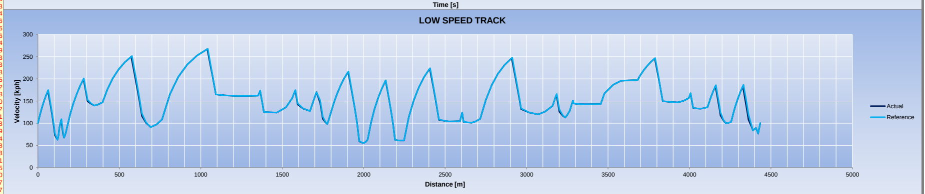
SENSITIVITY STUDY - TRACK FOCUSED	Run Nr.	Include Run	Delta Value		Keep Result	Laptime [s]	Delta Laptime [s]	Delta Laptime [%]	Percentage Gain/Loss per (Absolute) Unit of Delta
Reference Setup	1	Always	0		Always	115.036	0.000	0.000	0.000
Body Curb Mass Delta	2	Run 2	-25	kg	Keep 2	114.015	-1.022	-0.888	-0.036
Overall Tire Grip µ Delta	3	Run 3	1.00%		Keep 3	114.379	-0.657	-0.571	-0.571
Overall Aero Lift & Drag Delta	4	Run 4	5.00%		Keep 4	114.290	-0.746	-0.648	-0.130
Aero Front Lift Delta	5	Run 5	5.00%		Keep 5	114.605	-0.431	-0.375	-0.075
Aero Rear Lift Delta	6	Run 6	5.00%		Keep 6	114.834	-0.202	-0.176	-0.035
Aero Drag Force Delta	7	Run 7	5.00%		Keep 7	115.060	0.024	0.021	0.004
Power Delta	8	Run 8	5.00%		Keep 8	114.848	-0.188	-0.163	-0.033
Spr. Mass CoG z-Height Delta	9	Run 9	-25.00	mm	Keep 9	114.937	-0.099	-0.086	-0.003
Weight Distribution Delta	10	Run 10	1.00%	%Fwd (+)	Keep 10	115.386	0.350	0.304	0.304
Front Wheel Rate Delta	11	Run 11	25.00%		Keep 11	115.030	-0.006	-0.005	0.000
Front Roll Rate Delta	12	Run 12	25.00%		Keep 12	115.002	-0.034	-0.029	-0.001
Front RH Delta	13	Run 13	-5	mm	Keep 13	114.396	-0.641	-0.557	-0.111
Rear Wheel Rate Delta	14	Run 14	25.00%		Keep 14	115.129	0.093	0.081	0.003
Rear Roll Rate Delta	15	Run 15	25.00%		Keep 15	115.055	0.019	0.016	0.001
Rear RH Delta	16	Run 16	-5	mm	Keep 16	115.080	0.044	0.038	0.008
Front Static Toe Angle Delta	17	Run 17	0.25	°	Keep 17	115.069	0.033	0.029	0.115
Front Static Camber Angle Delta	18	Run 18	-0.5	°	Keep 18	114.837	-0.199	-0.173	-0.345
Rear Static Toe Angle Delta	19	Run 19	0.25	°	Keep 19	114.998	-0.038	-0.033	-0.133
Rear Static Camber Angle Delta	20	Run 20	-0.25	°	Keep 20	115.016	-0.021	-0.018	-0.071
		TRUE			FALSE				

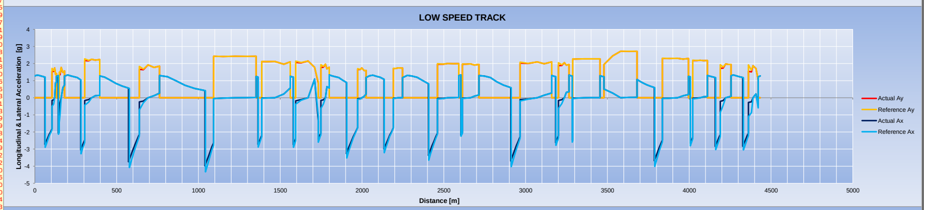


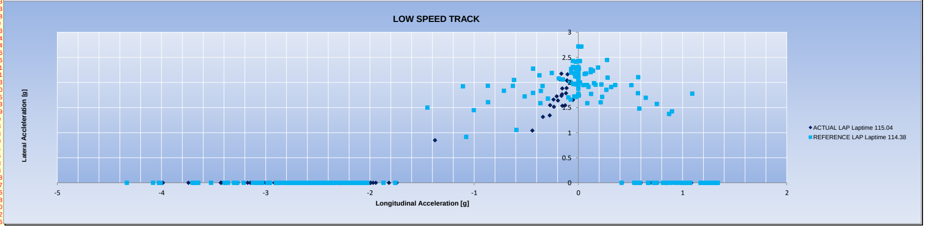
ZOOM * selected XY-Chart ONLY | UNDO ZOOM * selected chart | RESET * selected chart











CUSTOM LAP - RESULTS EXAMPLE

LAP TIME HISTORY DATA - ALL RESULTS

GOTO LAPTIME | GOTO MASTER | EXPORT ALL LAPTIME

The Coloured Cell Ranges are being used by DYNATUNE. Do NOT Modify !
(all other areas can be customized, see example below)

* Charts can be zoomed into. Select Chart, Click Zoom Button and draw Rectangle to zoom in Chart

ACTUAL LAP - LAP SIMULATION TIME HISTORY DATA

NOTE: THE VALUES IN GREEN CELLS WILL BE UPDATED WITH EVERY CALCULATION. THE VALUES IN YELLOW CELLS WILL ONLY BE UPDATED AFTER A TIME HISTORY CALCULATION.

ZOOM * selected chart
UNDO ZOOM * selected chart
RESET * selected chart

Time	0.00	0.38	0.72	1.03	1.33	1.62	1.62	1.81	2.02	2.26	2.55	2.91	2.91	3.46
Distance	0.00	11.38	23.10	35.32	48.12	61.44	61.45	70.07	78.68	87.30	95.92	104.53	104.54	115.10
Ax	1.28	1.32	1.31	1.28	1.24	1.21	-2.73	-2.53	-2.33	-2.15	-1.99	-1.82	-0.15	-0.13
Ay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53	1.54
Velocity	99.86	117.16	132.86	147.24	160.57	173.04	173.02	155.48	137.28	118.07	96.99	72.33	72.33	66.05
Radius	0.00													22.25
SWA	0.00													83.68
Instantaneous Front Inside Wheel Rate	250.00													330.64
Instantaneous Front Outside Wheel Rate	250.00													330.64
Instantaneous Rear Inside Wheel Rate	160.00													244.06
Instantaneous Rear Outside Wheel Rate	160.00													244.06
Instantaneous Front Averaged Wheel Rate	250.00													330.64
Instantaneous Rear Averaged Wheel Rate	160.00													244.06
Instantaneous Front Averaged Ride Rate w/Tires	132.08													151.61
Instantaneous Rear Averaged Ride Rate w/Tires	104.35													134.58
Front Body Frequency	7.28													8.37
Front Body Ride Frequency	5.29													5.67
Front Wheelhop Frequency	27.31													29.31
Rear Body Frequency	4.95													6.11
Rear Body Ride Frequency	4.00													4.54
Rear Wheelhop Frequency	23.01													25.03
Ratio Rr. To Fr. Ride Frequency	0.76													0.80
Pitch Frequency (Frequency One)	9.26													10.06
Bounce Frequency (Frequency Two)	4.37													4.90
Pitch Center (Motion Center One) relative to CoG	-0.13													-0.11
Bounce Center (Motion Center Two) relative to CoG	4.59													5.64
Pitch Center (Motion Center One) relative to Front Axle	-1.89													-1.86
Bounce Center (Motion Center Two) relative to Front Axle	2.83													3.89
Instantaneous Front Total Roll Rate (Springs & Rollbar)	6150.48													6150.48
Instantaneous Front Roll Rate due to Springs	4650.48													4650.48
Instantaneous Front Roll Rate due to Anti-Rollbar	1500.00													1500.00
Instantaneous % Contribution of Front ARB to Total Front Roll Rate	24.39													24.39
Instantaneous Rear Total Roll Rate (Springs & Rollbar)	4355.27													4355.27
Instantaneous Rear Roll Rate due to Springs	2855.26													2855.26
Instantaneous Rear Roll Rate due to Anti-Rollbar	1500.00													1500.00
Instantaneous % Contribution of Rear ARB to Total Rear Roll Rate	34.44													34.44
Instantaneous Total Roll Rate	10505.74													10505.74
Instantaneous Front Roll Rate w/Tires	2820.17													2820.17
Instantaneous Rear Roll Rate w/Tires	2401.51													2401.51
Instantaneous Total Roll Rate w/Tires	5221.67													5221.67
Instantaneous Front Lateral Load Transfer	0.00													769.11
Instantaneous Front Suspension Load Transfer	0.00													694.15
Instantaneous Rear Lateral Load Transfer	0.00													1048.82
Instantaneous Rear Suspension Load Transfer	0.00													491.54
Instantaneous Total Lateral Load Transfer	0.00													1812.96
Instantaneous Total Suspension Load Transfer	0.00													1185.68
Instantaneous Front Lateral Load Transfer Distribution	45.77													42.30
Instantaneous Linear Roll Couple Distribution	58.54													58.54
Instantaneous Lateral Load Transfer Bias	3.45													-0.02
Instantaneous Front Ride Height Change	1.60													-0.40
Instantaneous Rear Ride Height Change	-6.70													1.00
Instantaneous Front Lift Coefficient	-0.85													-0.88
Instantaneous Rear Lift Coefficient	-1.53													-1.47
Instantaneous Drag Coefficient	0.59													0.58
Instantaneous Front Lift Force	-586.60													-266.90
Instantaneous Rear Lift Force	-1058.20													-446.00
Instantaneous Drag Force	-408.60													-176.90
Vehicle Pitch Angle	0.16													-0.03
Driver H-Point Rise Due to Pitch and Roll	-2.53													2.20
Vehicle Rollangle	0.00													0.41
Chassis Rollangle	0.00													0.16
Front Axle Slip Angle	0.00													2.64
Steering Wheel Angle	0.00													83.68
Vehicle Slip Angle	0.00													-0.49
Rear Axle Slip Angle	0.00													2.82
Instantaneous Front Roll Centre Height	-11.50													-13.10
Instantaneous Rear Roll Centre Height	74.30													80.60
Instantaneous Front Anti-Dive Percentage	53.12													53.12
Instantaneous Front Anti-Lift Percentage	0.00													0.00
Instantaneous Rear Anti-Lift Percentage	0.00													0.00
Instantaneous Rear Anti-Squat Percentage	0.00													0.00
Instantaneous Front Loaded Tire Radius	328.40													327.30
Instantaneous Rear Loaded Tire Radius	324.40													326.10
Instantaneous Overall CoG-Height	247.00													250.60
Instantaneous CoG-Height Sprung Mass	236.30													239.93
Instantaneous Roll Couple Distribution	58.54													58.54
Instantaneous Front Lateral Load Transfer Distribution	45.77													42.30
Instantanous Lateral Load Transfer Bias	3.45													-0.02
Instantaneous Front Total Roll Rate (Springs & Rollbar)	6150.48													6150.48
Instantaneous Front Roll Rate due to Springs	4650.48													4650.48
Instantaneous Front Roll Rate due to Anti-Rollbar	1500.00													1500.00
Instantaneous % Contribution of Front ARB to Total Front Roll Rate	0.00													0.00
Instantaneous Rear Total Roll Rate (Springs & Rollbar)	4355.27													4355.27
Instantaneous Rear Roll Rate due to Springs	2855.26													2855.26
Instantaneous Rear Roll Rate due to Anti-Rollbar	1500.00													1500.00
Instantaneous % Contribution of Rear ARB to Total Rear Roll Rate	0.00													0.00
Instantaneous Total Roll Rate	10505.74													10505.74
Instantaneous Front Roll Rate w/Tires	2820.17													2820.17
Instantaneous Rear Roll Rate w/Tires	2401.51													2401.51
Instantaneous Total Roll Rate w/Tires	5221.67													5221.67
Instantaneous Front Lateral Load Transfer	0.00													769.11
Instantaneous Front Suspension Load Transfer	0.00													694.15
Instantaneous Rear Lateral Load Transfer	0.00													1048.82
Instantaneous Rear Suspension Load Transfer	0.00													491.54
Instantaneous Total Lateral Load Transfer	0.00													1812.96
Instantaneous Total Suspension Load Transfer	0.00													1185.68
Front Axle Total Vertical Force	2527.84													2969.11
Rear Axle Total Vertical Force	5322.64													4045.55
Front Axle Total Longitudinal Force	0.00													-278.16
Rear Axle Total Longitudinal Force	8715.49													-278.16
Front Axle Total Lateral Force	0.00													4161.23
Rear Axle Total Lateral Force	0.00													5672.17
Instantaneous Front Average Tire Cornering Stiffness @ G-Lat	855.63													427.65
Instantaneous Rear Average Tire Cornering Stiffness @ G-Lat	126.72													567.05
Front Cornering Compliance @ G-Lat	1.78													2.93
Rear Cornering Compliance @ G-Lat	13.96													3.20
Understeer Gradient @ G-Lat	-12.18													-0.26
Instantaneous Front AXLE Cornering Stiffness @ G-lat	86689.33													52712.12
Instantaneous Rear AXLE Cornering Stiffness @ G-lat	15093.76													65956.62
Instantaneous Front Ride Height Change	1.60													-0.40
Instantaneous Rear Ride Height Change	-6.70													1.00
Instantaneous Front BODY Lift Coefficient	-0.85													-0.88