SuspAct M00

Manual

Track License

Ver 31-12-'13

Installing SuspAct M00

Skip steps 1&2 for new installations

1. Back up files that are stored in your SuspAct program files directory

2. Remove any older versions of SuspAct from your computer
   Setup -> configuaration -> remove software

3. From cd or installation directoy:
   Start setup (.exe)

4. Start SuspAct M00

A printer has to be installed on your computer, or else you will get an error message.

SuspAct geometry software

This the manual for the SuspAct M00 software. The idea for this software was born while working with many different bikes regarding suspension setup. When you change one setting you must have an overview what happens to the rest of your bike!

The first lesson you learn in setting up motorcycles, is to adjust one thing in each outing. But what happens if you change one parameter, like f.i. the shock length?
In SuspAct it can be made clear that many parameters change. Think about CoG position, trail, castor, swing arm squat / anti squat. In this way you can take all parameters into account and possibly compensate for this.

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Contents:

1. General

SuspAct is a program that lets you compare geometry and suspension setup of up to 5 different bikes. Once the bikes parameters are in the program, all the changes you make in the setup can be compared on f.i. steering geometry, spring forces or damping.

It is possible to calculate an advised springrate, and the in plane position during braking or acceleration can be calculated.

The program handles up to 5 bikes that can be selected by clicking one of the five colored squares in the "Legend" box.
When a bike is selected in this way, it is set the active bike. From that moment on all file actions, calculations and so on refer to this active bike. In the top of the main form the filename of the active bike is shown.

2. File types

SuspAct M00 – Track license can open bike files that are prepared by SuspAct dealers. With your track license you can purchase .bk1 and .bk2 files that allow different levels of analyzing. This means you get all the dimensions of the motorcycle in it, and you can start immediately modifying it to make the setup you run on the track.

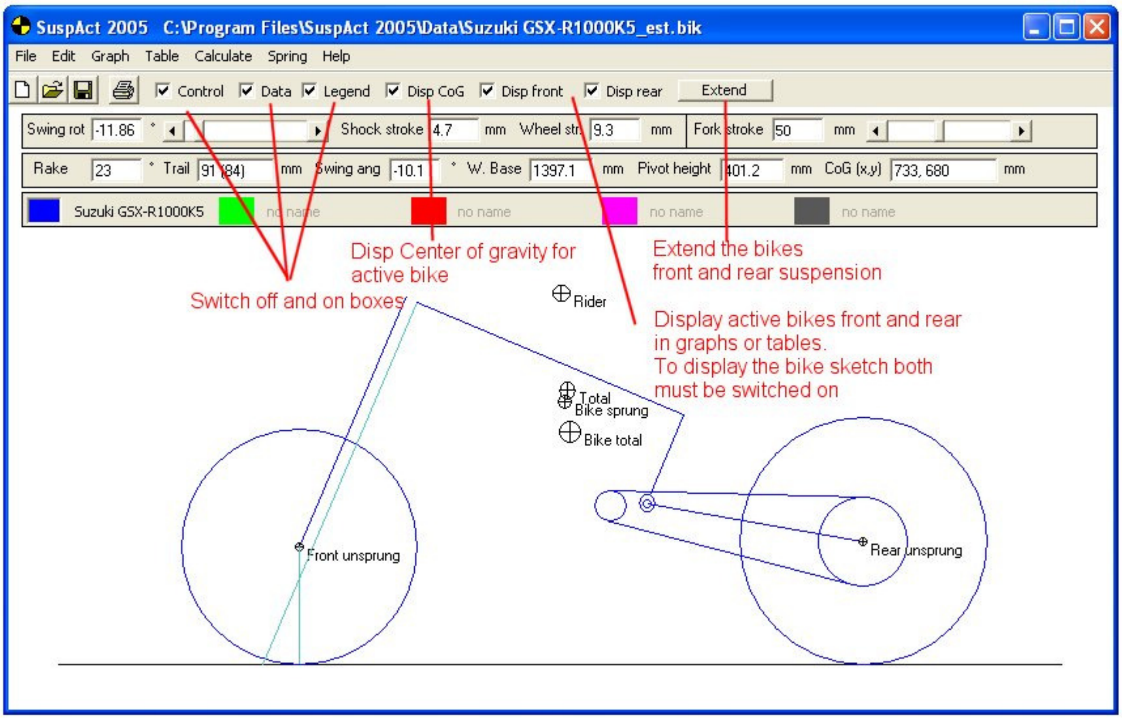
Bike file options	***.bk1**	***.bk2**	***.bik**
Edit all dimensions	X	X	V
Compare bike geometry	V	V	V
Compare CoG	V	V	V
Change masses	V	V	V
Compare braking, entry, mid corner and exit position	V	V	V
Compare wheel forces in Graph	V	V	V
Compare shock and fork forces in graph	V	V	V
Compare and edit bike geometry values in table	V	V	V
Change between preselected linkages if available	V	V	V
Chanhe Head pipe inserts	V	V	V
Estimate inplane bike position, during braking acceleration	V	V	V
Calculate theorethical needed spring rate	V	V	V
Compare Wheel rate Graphs	X	V	V
Compare Link ratios and Link progression	X	V	V
Compare forces rate and link data in tables	X	V	V
Export tables to .csv	X	V	V
Compare Chain angle	X	V	V
Compare Load transfer angle	X	V	V
Spring center and force center	X	V	V
Edit link dims*	X	X	V

In .bk1 and bk2 files all main chassis and linkage dimensions are locked. For the track license it is not possible to input a bike model from scratch.
*.bik files can only be opened with a SuspAct M00 – Team license

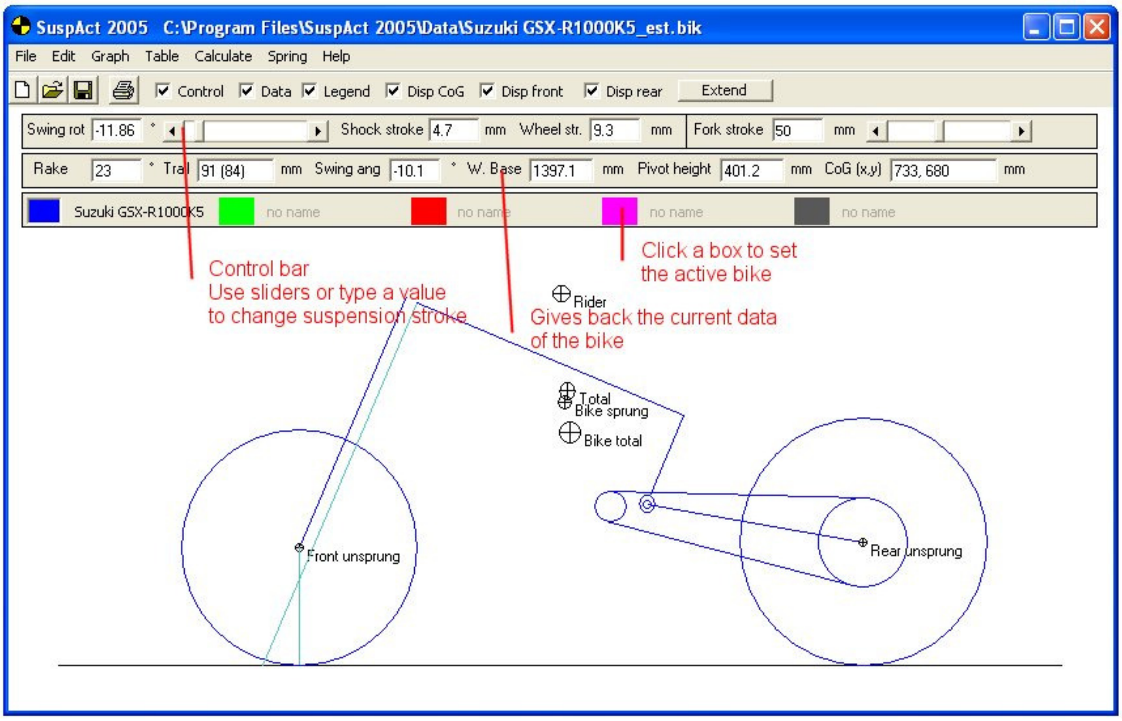
3. Main screen

SuspActs M00 main screen can display a bike sketch with the following features:

- Virtual bike frame
- Front and rear sprockets + chain
- Trail is displayed for the active bike
- CoG: Rider, Bike sprung, Bike total and Total



The bike can be controlled by the boxes in the main screen:

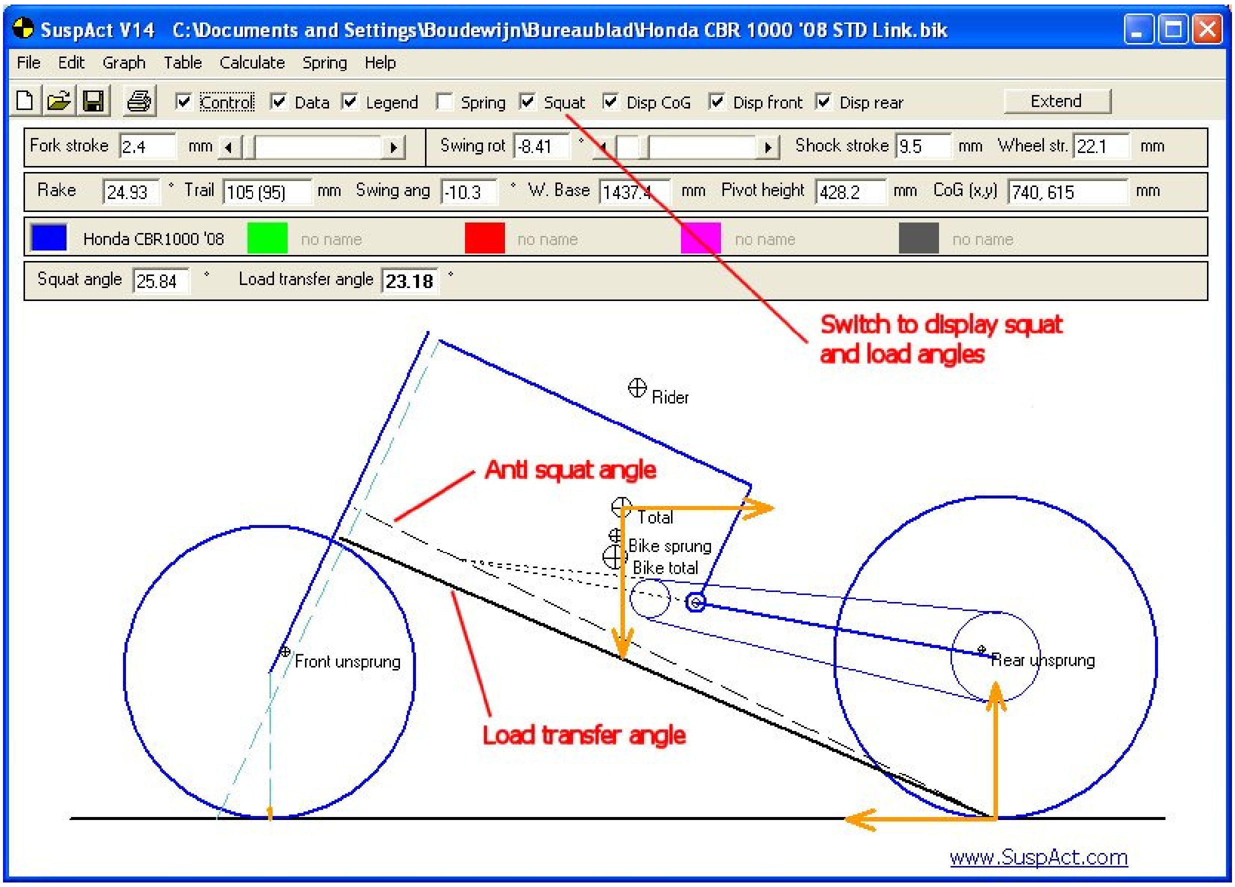


3.1 Squat and Load angle (*.bk2 files only)

For .bk2 files SuspAct M00 can display the Squat Angle, Load transfer angle, Spring center and force centre.

If the anti squat angle is smaller than the load transfer angle, the bike has the tendency to squat. If the anti squat angle is bigger than the load transfer angle, the bikes rear suspension tends to extend on acceleration.The dotted line in the image is the Anti squat line. The bold continuous line is the load transfer line.

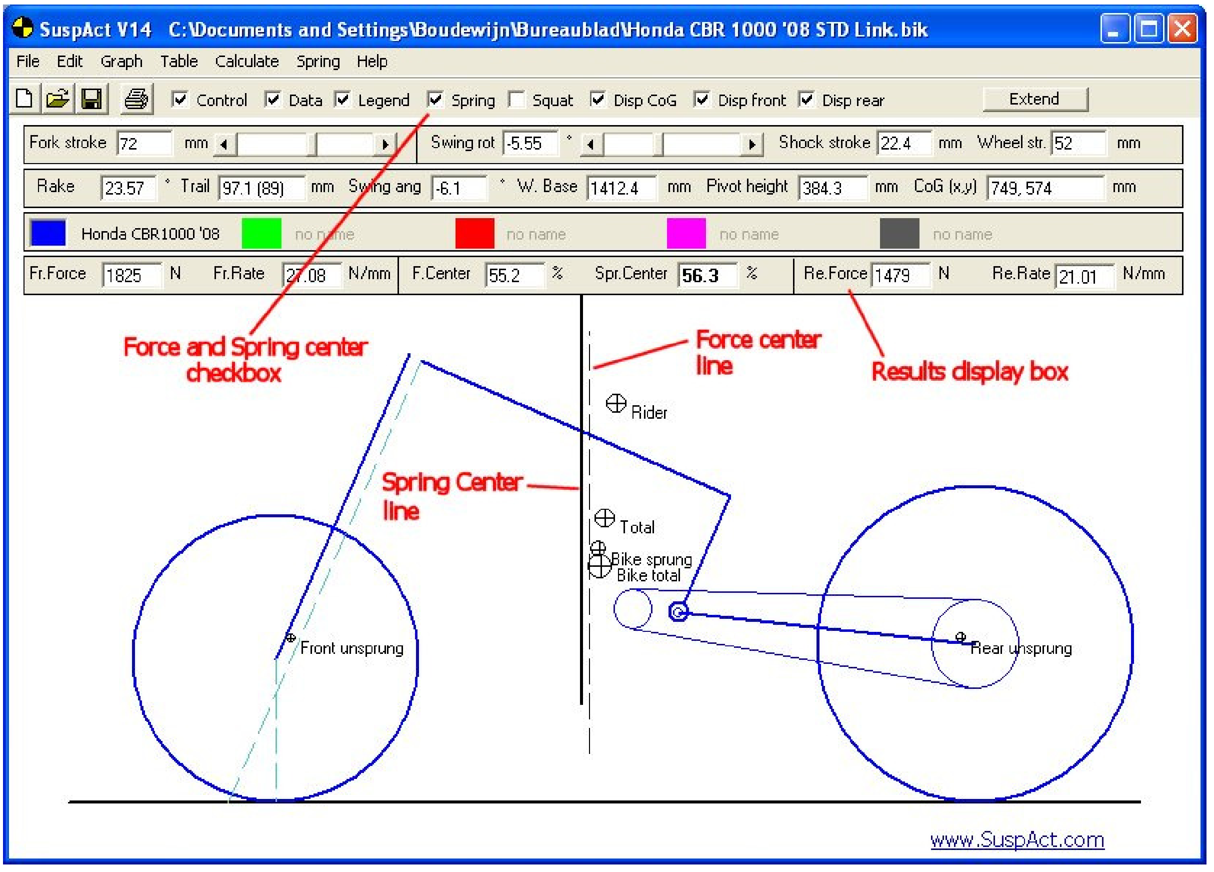
Please note that in cornering tire rolling diameters change with lean angle. This will greatly affect squat and load transfer angles.



3.2 Spring center and force center (*.bk2 files only)

The "spring" checkbox enables you to display and calculate the spring center and the force center (for .bk2 files only).

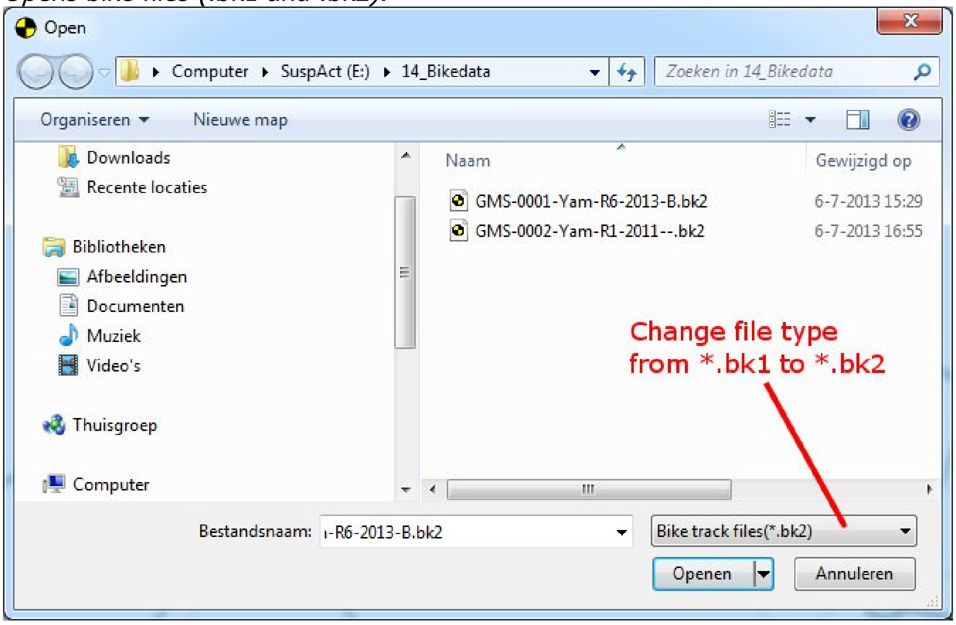
This is a ratio between the front and rear spring rate and spring force. One (simplified) conviction is that in ideal case in mid corner position , both spring center and force center should be 50%.



4. File menu

All actions refer to active bike unless mentioned otherwise!

-> Open
Opens bike files (.bk1 and .bk2).



If the file is already opened then SupAct gives a message and opens the file. In this case the filename will be cleared.
A good way to put in a setup, is to open the standard bike as bikeno. 5, and after that open the same bike as bikeno. 1. In this way the filename will be cleared and you have no change of overwriting the standard bike.

-> Clear
Clears all parameters of the active bike out of the memory

-> Save / Save as
Saves the active bike to the selected file

-> Import setup sheet with template
With this feature text files with setup information can be imported to setup the bike model same as your spec sheet. This feature is explained in chapter…..

-> Print bike
Prints a picture of all bikes that have the display front and rear set.

-> Print bike data
Print all setup data for all the bikes that have the display front and rear set.

-> Printer settings

-> Exit
SuspAct doesn't save your changes! It will ask you to do so.

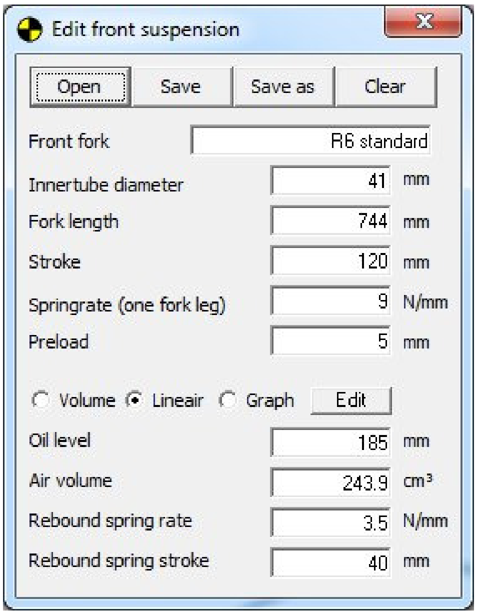
5. Edit menu

All actions refer to active bike unless mentioned otherwise! All bike parameters are saved in the bike file (.bk1/ .bk2). The open and save buttons in the several edit boxes are meant to put a bike together more fast and to get fork and shock files from the SuspAct dealer or Suspension manufacturer.
After a value is changed the geometry and force calculation will all be updated automaticly.

In chapter 5.1 to 5.6 the edit menu is discussed for .bk1 files. In Chapter 5.7 to 5.10 the extra possibilities for .bk2 files are discussed.

5.1 Edit front suspension

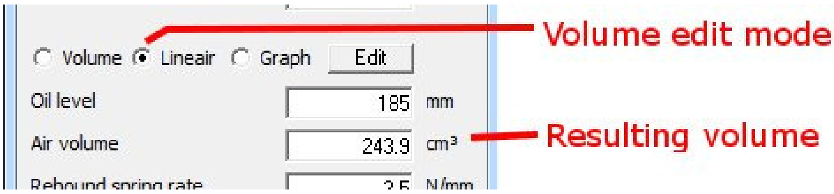
Front forks can opened and saved as separate .frk files. This can be used to put a new bike together more fast in SuspAct. Parameters to be put in:



- Frontfork
  Put in front fork name
- Innertube diameter
  Diameter where the fork seal slides over.
- Fork length
  Fork length is measured from completely extended fork.*
- Stroke
  Front fork stroke is measured from completely extended fork.*
- Spring rate (one fork leg)
  This is the average spring rate of both fork legs. Left leg 9.5 N/mm right leg 10 N/mm -> Input rate of 9.75 N/mm
- Preload
  Average initial spring compression distance of both fork legs, measured from completely extended fork. See also 11.1 measuring fork..)*
- Oil level
  Average oil level of both fork legs. Input can be in mm or cm³, by switching with the volume button.
  See chapter 5.1.1 for setting oil level
- Rebound spring rate
  Average spring rate of both rebound or top out springs.
- Rebound spring stroke
  Rebound spring stroke is measured from completely extended fork.*

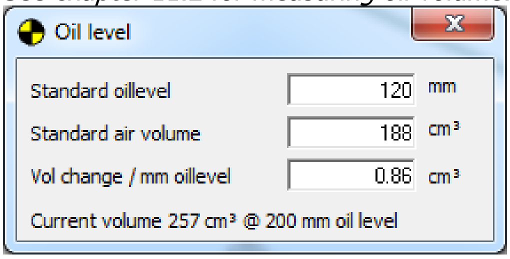
* Extended front fork
For forks with rebound- or top out spring the front fork can be extended by pulling it out completely to block. Depending on the design the extension will be limited by the blocking of the rebound spring or by some spacer. It might be easy to hold the fork in this position sometimes by carefully clamping it with a clamp around the innertube. Measuring length can be done by extending the forks and measure from the outside. For measuring spring preload, rebound spring rate and rebound spring stroke the forks must be opened once.

5.1.1 Setting front fork air volume / oil level



In the edit front menu the volume edit mode can be selected through the option box:

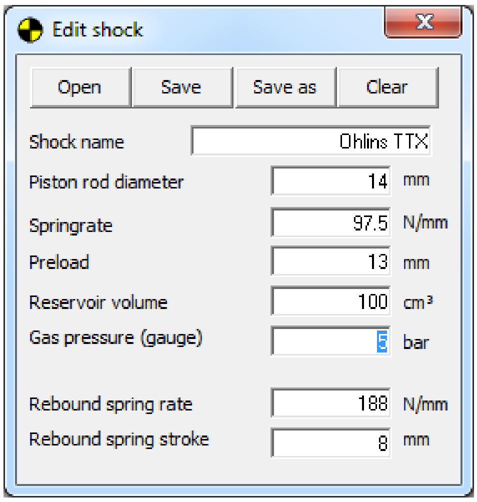
- Option Volume
  In this way you can put in the volume straight as cm3 (=ml) of air
- Option Lineair
  The Air volume will be calculated by a lineair formula input by the user
  See chapter 11.2 for measuring oil volume.



- Option Graph
  The user can input a graph that describes the relation between oil level and air volume for this specific front fork.

5.2 Edit Shock

Shocks can opened and saved as separate .shk files. This can be used to put a new bike together more fast in SuspAct. Parameters to be put in:



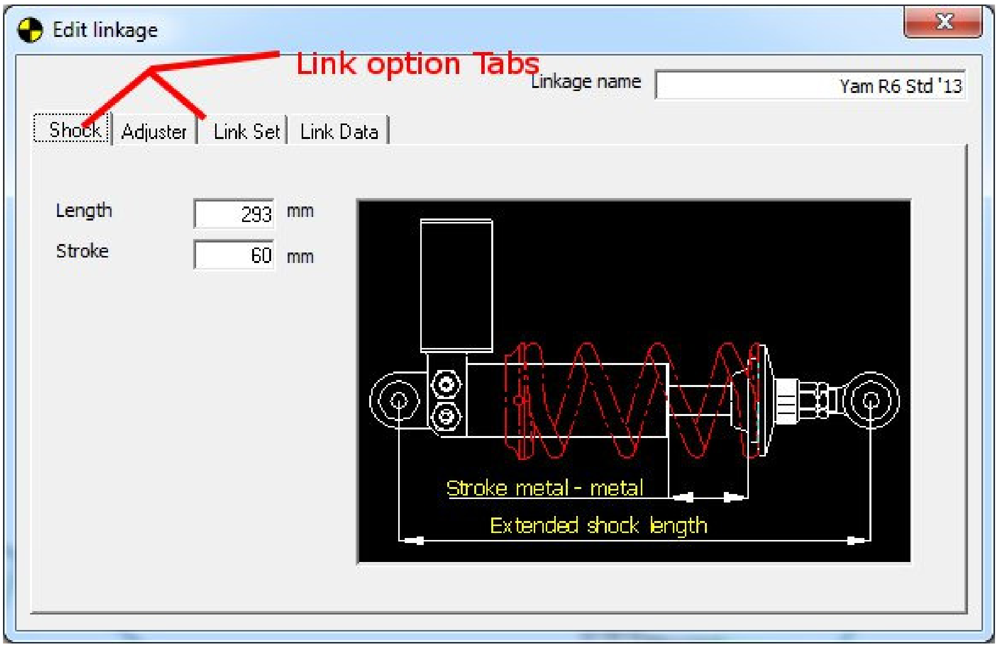
- Shock name
- Piston rod diameter
- Spring rate
- Preload
  Initial spring compression in mm, measured at completely extended shock absorber.*
- Reservoir volume
  For many applications an oversize like 500 cm³ will do. For very accurate calculation or if you are in doubt about reservoir size, measure the reservoir volume.
- Start pressure
  Gas pressure in the shock reservoir at extended shock absorber. This is gauge pressure!*
- Rebound springrate
  Springrate of rebound spring or top out spring.
- Rebound spring stroke
  Rebound spring stroke is measured from completely extended shock.*

! Shock length and stroke can be changed in edit linkage box because they are parameters that change the linkage system.

* Extended shock
For shocks with rebound- or top out spring the shock can be extended by pulling it out completely to block. Depending on the design the extension will be limited by the blocking of the rebound spring or by some spacer.
Measuring length, stroke and preload can be done by extending the shock and measure from the outside. For measuring rebound spring stroke the shock must be opened once.

5.3 Linkage

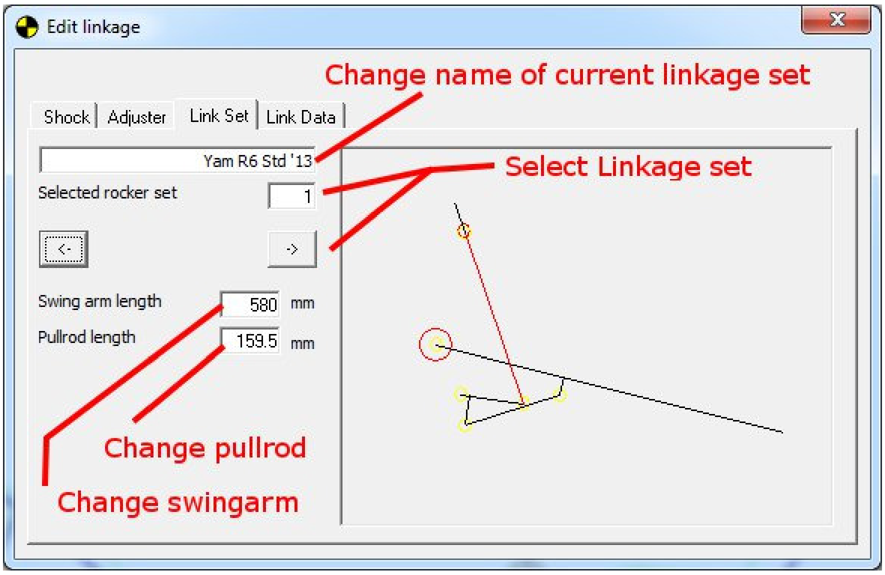
The linkage type and main dimensions are fixed in the bike files as purchased from SuspAct. However pull rod length can be changed and linkage data can be compared.
Every time a value is changed the linkage will be recalculated. A changed pullrod length will result in different bike geometry and force graphs immediately.



There are four option Tabs in the linkage menu:

- Shock
  Fill in shock length and the maximum shock stroke both measured from fully extended shock length.
- Adjuster
  Input the values for the rear suspension height adjuster and the pivot adjuster according to the pictures.

- Link set

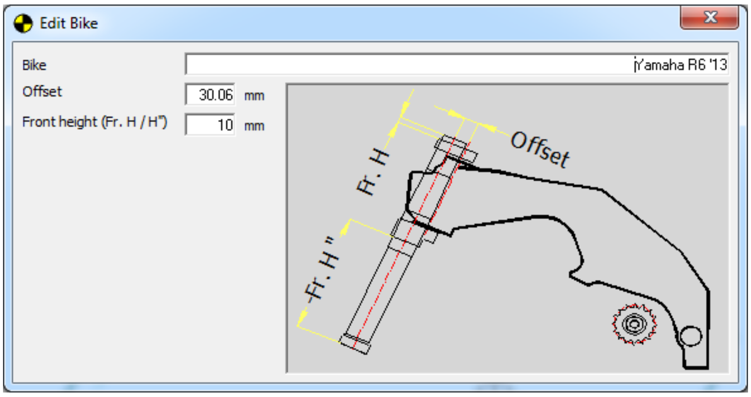


Depending on the bike model there might be different link sets defined in your bike model. This is normally the case for SBK or GP racing bikes where the linkage can be changed according to the rules for that class. Most production bikes will have 1 linkage defined.

- Link data
  This TAB will display the data for this linkage as well as a graphical representation of the linkage system. The linkage can be moved up and down with the slider

5.4 Bike

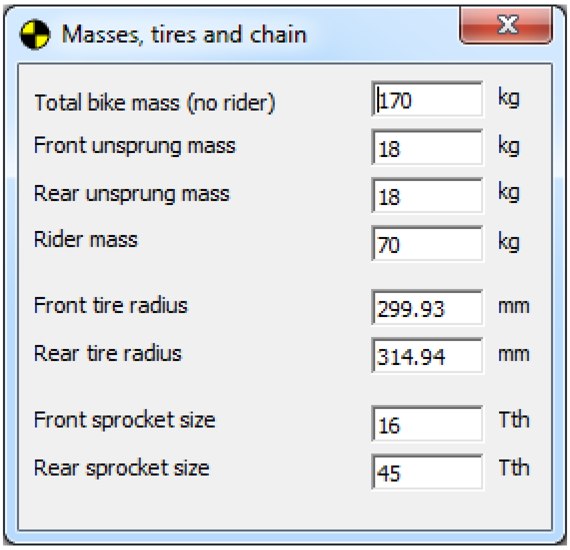
In this window the main parameters for the bike can be changed.



- Bike
  Bikename to be displayed
- Offset
  Steering axle to wheel axle, measured perpendicular to the steering axle. Offset can be in triple clamps or fork bottoms.
- Front height
  The front height can be measured from the top triple clamp to the top of the front fork tube. In alternative mode the front height is measured from the bottom of the outertube to the bottom of the lower triple clamp. Please ask the supplier of the bike file how it is measure in your case

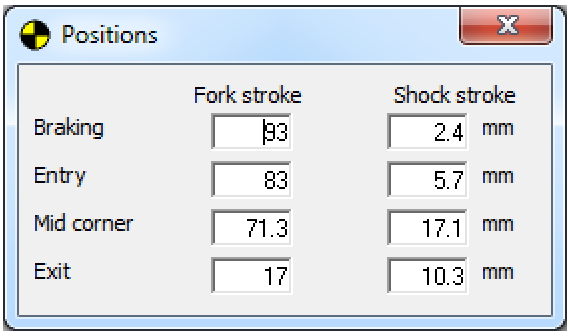
5.5 Masses, Tire and chain

- Total bike mass (no rider)
  Total sprung and unsprung weight
- Front unsprung mass
  See chapter 14, Measuring unsprung masses
- Rear unsprung mass
  See chapter 14, Measuring unsprung masses
- Rider mass
- Front tire radius
  Ground to axle center
- Rear tire radius
  Ground to axle center
- Sprocket size
  Number of teeth for front and rear sprocket
  Used for squat angle and swing arm length calculation

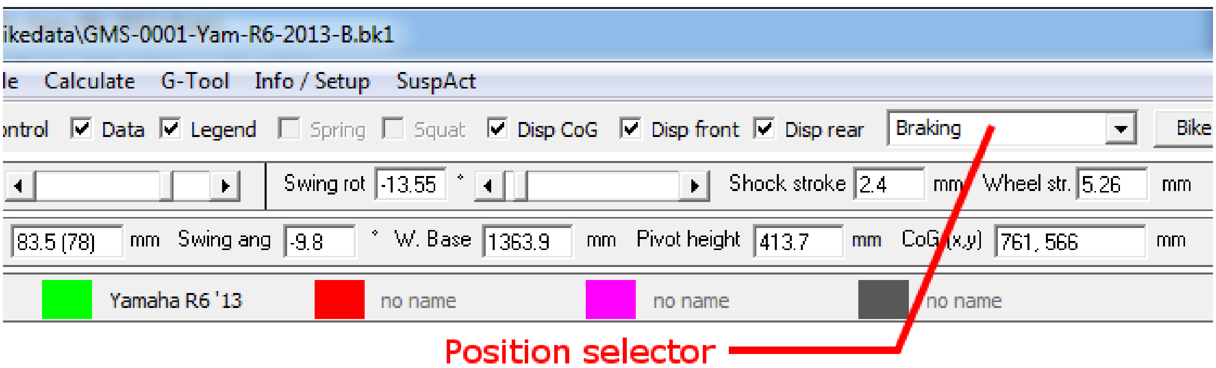


5.6 Positions

In this window the position of the motorcycle can be defined for several conditions. Depending on the file you are using the position is set on displacement [mm] or force [N]. You can change these values with common values you find in your data recording.



Once these values are set, you can make a quick select of the position at the top of your screen with the pull down position selector in the main menu.

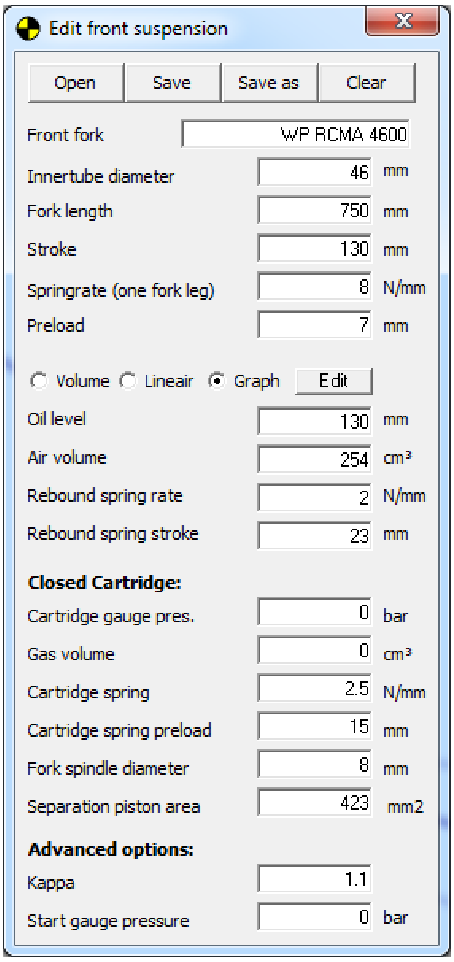


5.7 Edit front suspension (.bk2 files only)

Edit front suspension with .bk2 files offers extra options compared to .bk1 files. Editing basic dimension works the same as for .bk1 files.

The extra function that can be added are static forces for cartridge kit, start pressure fork pressure and the Kappa value that defines the way the air inside the forks is compressed.

Closed cartridge



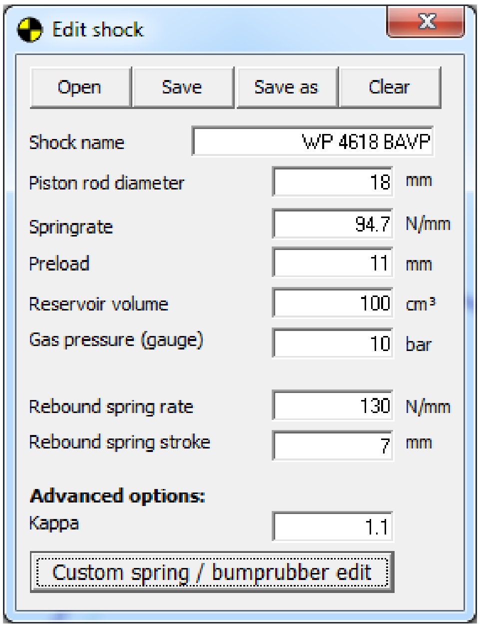
- Closed cartridge gauge pressure
  This is the gauge pressure on which the cartridge pressure reservoir is set. Fill 0 bar for spring loaded cartridges.
- Gas volume
  This is the gas volume of the closed cartridge gas reservoir. If not sure fill a big value like 100cm3
- Cartridge spring
  Springrate for the cartridge pressure spring
  Fill 0 N/mm for gas loaded cartridges.
- Cartridge spring preload
  Preload on cartridge spring with fully extended forks
- Fork spindle diameter
  Diameter of the main piston rod of the front fork
- Separation piston area
  Surface area of the separation piston
  f.i. Gas reservoir diameter 25mm -> Surface area equals pi((25/2)^2) = 490,9mm²*

Advanced options

- Start pressure
  If a fork is not closed at full extension, it will have a slight under pressure at full extension. To take this into account the pressure at full extension can be put in. It can be used also to enter pressurized forks.
- Rebound spring rate
  Average spring rate of both rebound or top out springs.
- Rebound spring stroke
  Rebound spring stroke is measured from completely extended fork.*
- Kappa value
  Naturally determined between 1 and 1.4. See chapter 12 for kappa value

5.8 Edit shock (.bk2 files only)

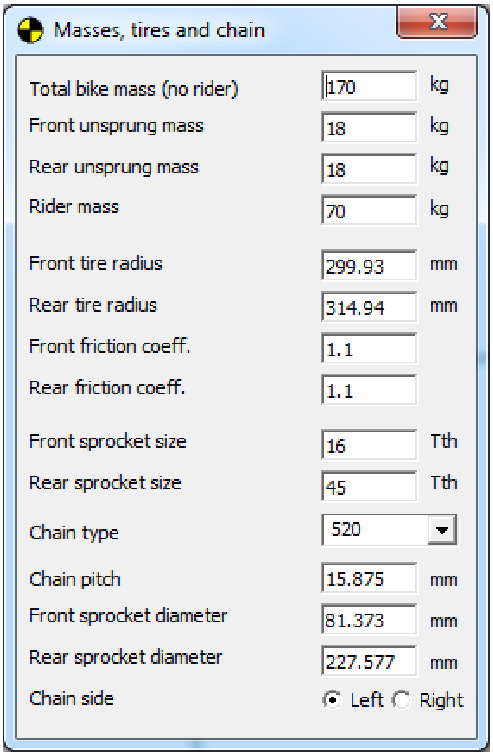
Advanced options



- Kappa value
  Naturally determined between 1 and 1.4. See chapter 12 for kappa value

- Custom spring / bumprubber edit
  Possibility to enter custom spring / bumprubbers. Typically used for MX applications or suspension development companies. Please contact SuspAct for more info.

5.9 Edit masses, tire and tire (.bk2 files only)



Edit rear shock with .bk2 files offers extra options compared to .bk1 files. Editing basic parameters works the same as for .bk1 files.

The extra function that can be added are tire friction parameters and custom chain specs

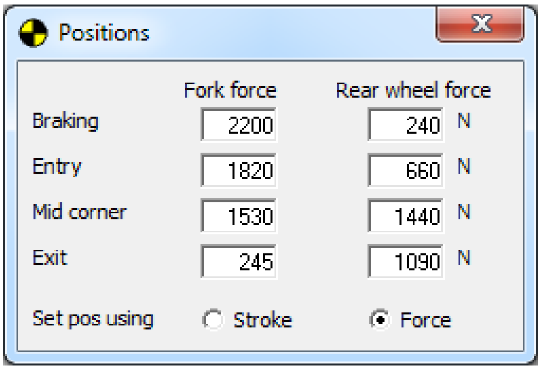
- Front friction coefficient
  Remember that using a linear friction figure for tires is a simplified comparissaon method.
- Rear friction coefficient
  Remember that using a linear friction figure for tires is a simplified comparissaon method.

- Chain type
  Select a standard chain or a custom one. Sprocket dimensions are automaticly recalculated for this.

- Chain side
  Only use for measurements, no influence for Trcack license

5.10 Positions (.bk2 files only)

With .bk2 files it is possible to set the position of the bike to a predefined force for the 4 bike conditions. In this way it is possible to predict the new position of the bike after you make a change to f.i. springs or preload.



With the option button in the bottom you can select if you want to set the position on a certain position or set it at force.

To find the correct force to put in this form you have to change the force in several iterations until you reach the desired position that compares to the value you read from your data.

6 Graphs

The graphs in SuspAct all work in the same way. To switch on and off curves use the disp front and disp rear checkboxes in the main screen. The dashed line always represents the front suspension and the plain line the rear.
To find figures back in this graph, point exactly on the spot with your mouse and the values will be displayed in the lower right corner.
You can zoom in with your left mouse button and on top there is a zoom out button.

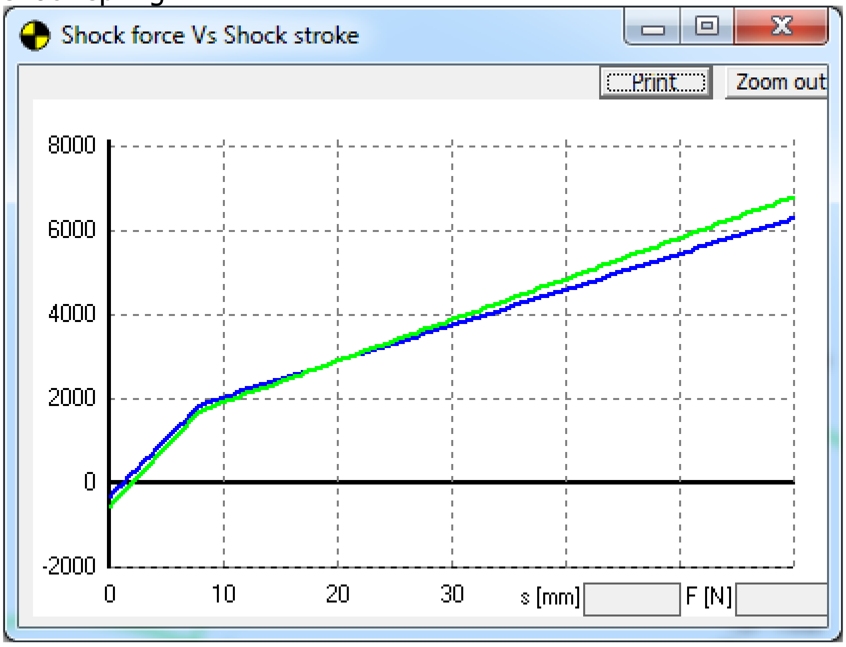
In chapter 6.1 to 6.3 the edit menu is discussed for .bk1 files. In Chapter 6.4 to 6… the extra possibilities for .bk2 files are discussed.

6.1 Force

These are the wheel forces when the bike would be held fixed at the standard castor angle. This means that the front wheel forces will be higher than the front fork forces because the wheel force acts in an angle on the forks.
The rear suspension forces are displayed in regard to the select linakge dimensions and swing arm length.

6.2 Shock Force

These are forces acting on the shock. This graph is used many times when changing the shock spring.



When you want to keep same bike position in mid corner, find your shock stroke @ mid corner position from data. Make 2 setups in SuspAct: 1 with standard spring and preload and 1 with modified spring and changed preload.
You have found right preload (for same mid corner position) if the shock forces lines cross each other at mid corner shock stroke. In the figure above the right height will be the same for mid corner position 20mm.

6.3 Fork Force

These are forces acting on the front fork. This graph is used many times when changing the fork spring or compare air chamber forces to spring forces.
Works similar as explained in 6.2 shock force

6.4 Wheel rate (*.bk2 files only)

This is the derivative of the force graph in respect to the wheel stroke. It represents the "spring rate" measured at the wheel.

6.5 Linkage (*.bk2 files only)

Shows the linkage ratio for the rear suspension. This ratio is measured as:

Ratio = Rear wheel **vertical** movement / shock travel
Over very small distances. Some factories use the reverse figure for this (fi 0.474 instead of 2.11). These figures can be calculated by:

$Ratio_{SuspAct}$ = 1 / Ratio old

6.6 Linkage progression (*.bk2 files only)

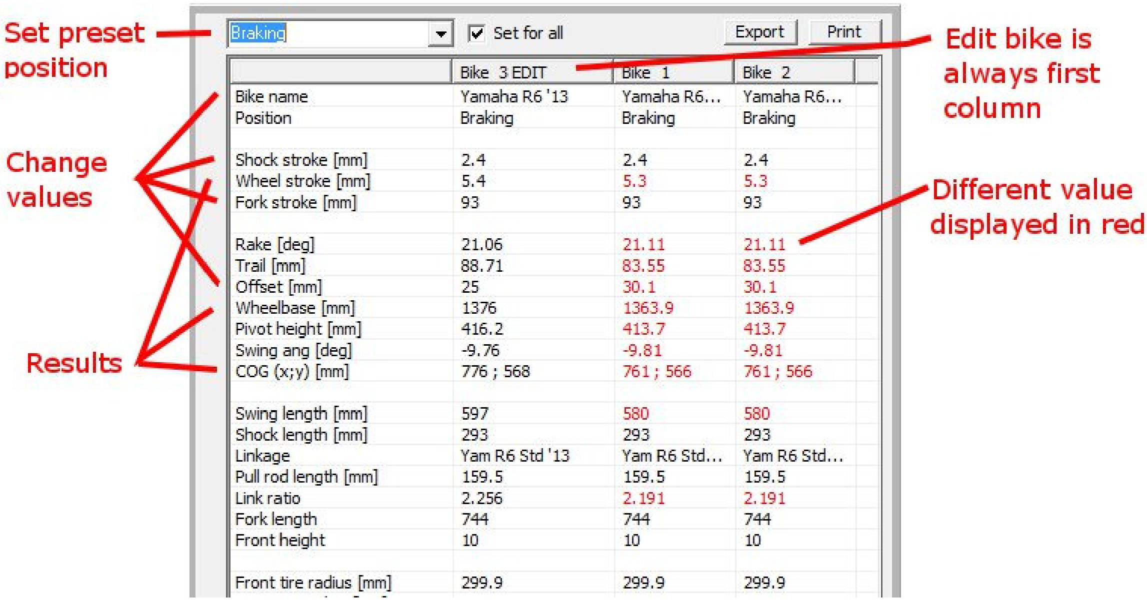
This is the progression of the linkage in % compared to the linkage ratio at fully extended linkage.

7 Tables

7.1 Bike table

In this table most parameters of your setup can be edited. Clicking the bike table button in the main screen will open the bike table. Clicking the bike table button 2x will nest the bike table in the main window.

In the table several outputs of the bike geometry are displayed. These geometry values are automaticly updated when you changes something in the setup



	Bike 3 EDIT	Bike 1	Bike 2
Bike name	Yamaha R6 '13	Yamaha R6...	Yamaha R6...
Position	Braking	Braking	Braking
Shock stroke [mm]	2.4	2.4	2.4
Wheel stroke [mm]	5.4	5.3	5.3
Fork stroke [mm]	93	93	93
Rake [deg]	21.06	21.11	21.11
Trail [mm]	88.71	83.55	83.55
Offset [mm]	25	30.1	30.1
Wheelbase [mm]	1376	1363.9	1363.9
Pivot height [mm]	416.2	413.7	413.7
Swing ang [deg]	-9.76	-9.81	-9.81
COG (x;y) [mm]	776 ; 568	761 ; 566	761 ; 566
Swing length [mm]	597	580	580
Shock length [mm]	293	293	293
Linkage	Yam R6 Std '13	Yam R6 Std...	Yam R6 Std...
Pull rod length [mm]	159.5	159.5	159.5
Link ratio	2.256	2.191	2.191
Fork length	744	744	744
Front height	10	10	10
Front tire radius [mm]	299.9	299.9	299.9

When a bike setup is activated it will always be displayed in the first column of the table. Only the first column of the table can be edited. When a parameter is different for a loaded but non active bike model will be printed in red.

7.2 Front and rear tables (*.bk2 files only)

There are tables for both front and rear suspension. These tables can be adjusted for figures round off, number of rows or the wheel stroke step in between rows.
Below you see the table for the rear suspension:

Rear table

Round 0 Step[mm] 5 Rows 25 Export Print

#	Wheel stroke [mm] *2*	Shock stro... [mm] *2*	Ratio [] *2*	Wheel force [N] *2*	Wheel rate [N/mm] *2*	Shock force [N] *2*	Shock stro... [mm] *1*	Ratio [] *1*	Wheel force [N] *1*	Wheel rate [N/mm] *1*	Shock force [N] *1*
0	0	0	1.967	-233	44	-439	0	1.933	-237	45	-439
1	5	3	1.961	-13	44	-7	3	1.927	-9	46	1
2	10	5	1.955	210	45	426	5	1.922	221	46	441
3	15	8	1.95	434	41	858	8	1.916	454	39	881
4	20	10	1.944	558	22	1095	10	1.911	575	22	1109
5	25	13	1.938	666	22	1298	13	1.905	687	23	1316
6	30	15	1.933	776	22	1501	16	1.899	801	23	1523
7	35	18	1.927	886	22	1705	18	1.894	915	23	1730
8	40	21	1.922	997	22	1908	21	1.888	1030	23	1937
9	45	23	1.916	1110	23	2112	24	1.883	1147	23	2144
10	50	26	1.91	1223	23	2315	26	1.877	1264	24	2351
11	55	28	1.905	1337	23	2519	29	1.872	1383	24	2558
12	60	31	1.899	1453	23	2722	32	1.866	1502	24	2765
13	65	34	1.894	1569	23	2925	34	1.86	1623	24	2972
14	70	36	1.888	1687	24	3129	37	1.854	1745	25	3179
15	75	39	1.883	1805	24	3332	40	1.848	1868	25	3386
16	80	42	1.877	1925	24	3536	42	1.843	1993	25	3593
17	85	44	1.871	2045	24	3739	45	1.837	2119	25	3800
18	90	47	1.866	2167	24	3942	48	1.83	2246	26	4007
19	95	50	1.86	2290	25	4146	51	1.824	2374	26	4214
20	100	52	1.854	2414	25	4349	53	1.818	2504	26	4421
21	105	55	1.848	2539	25	4553	56	1.812	2635	26	4627
22	110	58	1.843	2666	25	4756	59	1.805	2768	27	4834
23	115	60	1.837	2793	26	4959	62	1.799	2902	27	5041
24	120	63	1.831	2922	26	5163	64	1.792	3038	27	5248
25	123	65	1.827	3007	26	5296	65	1.791	3128	27	5384

In the tables for front and rear the bike that is set as active is displayed as the first bike. The number of this bike can be seen behind the units of each table column.
The wheel stroke is only displayed for the first bike. The other values are displayed relative to the first bikes wheel stroke.

Tables have following options:

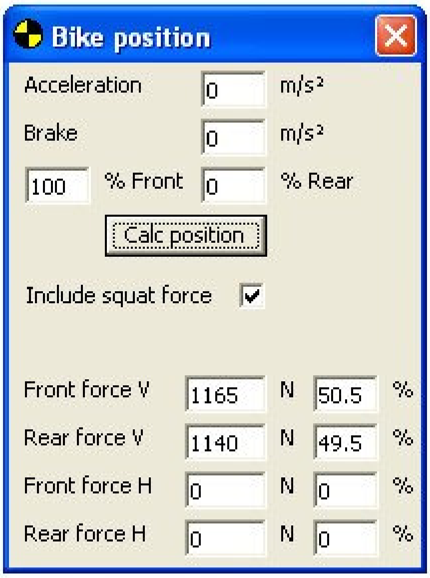
- Round
  Changes the number of digits in the table from 0 – 3
- Step
  Changes the number of table rows by changing the step in wheel stroke
- Rows
  Changes the number of rows
- Export
  Exports the table to a comma separated file (CSV), which can be imported to MS Excel
- Print

8 Calculate

SuspAct can calculate bike positions and setups for you.

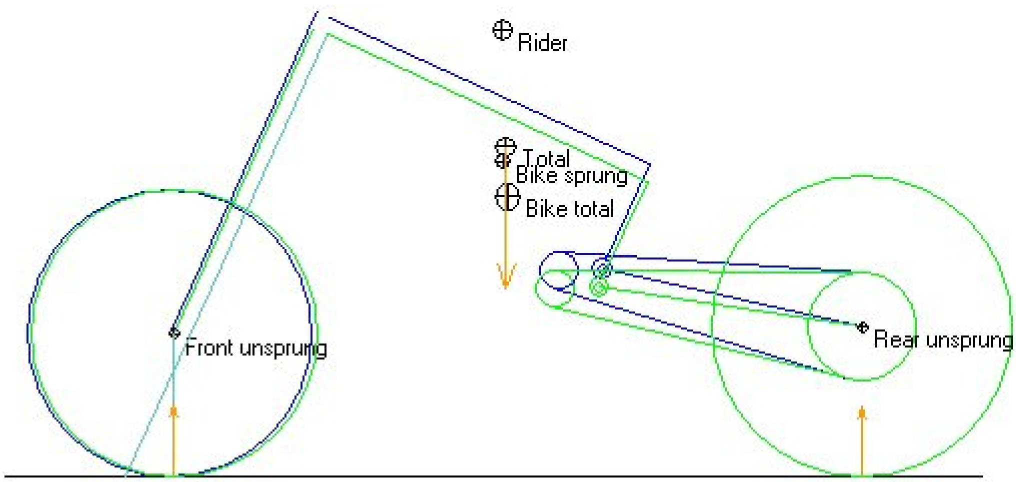
8.1 Bike position

Calculating bike position can be used to compare suspension setup or seeing the difference when shifting COG's. The bike can be calculated in the vertical plane and acceleration and breaking forces can be applied.



To calculate the static sag with rider, set the acceleration and brake both to zero. After pressing the calc position button, the forces will be displayed for both front and rear tires.

In the main screen the bike can be seen with suspension set to the matching position (green), compared to the bike with extended suspension in blue.

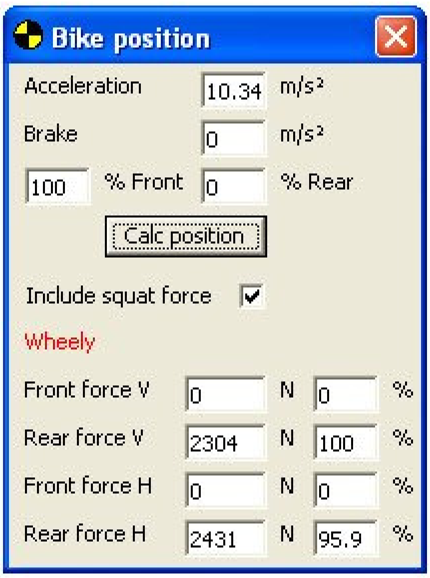


The arrows in orange display the force vectors. In this picture there is a vertical load from the total bike + rider CoG, which is supported by two vertical tire forces.

8.1.1 Calculating bike acceleration

To calculate the position of the bike in acceleration fill in the acceleration in m/s², and press calculate. SuspAct will calculate the new bike position taken into account the squat force of the rear suspension.

To calculate maximum acceleration, fill in a value to big like 20 m/s². The maximum value will be calculated as shown below.

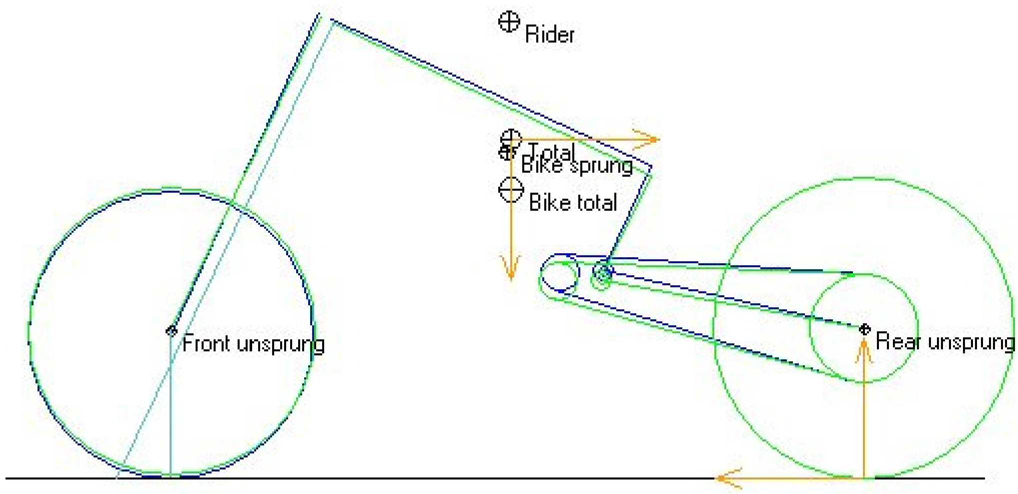


The example bike has a maximum acceleration of 10.34 m/s², which is limited by wheely as can be seen by the red text.

The rear tire vertical load is 100%, and so equals the bike + rider weight which is 2304 N or about 230 kg in this case.

From the give friction coefficient it is calculated that the rear tire is at 95,9% of maximum acceleration.

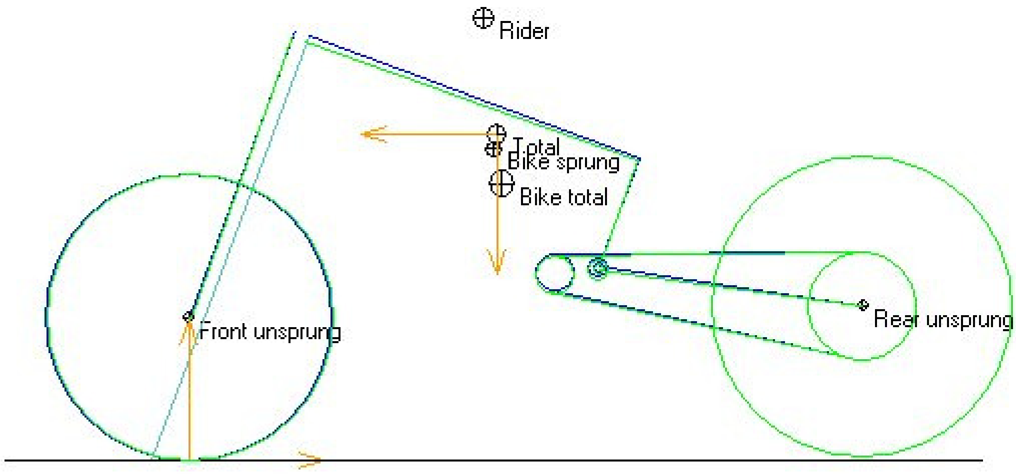
This would say that in theory 5% higher acceleration is possible by lowering the COG or moving the rider more forward.



There are no forces on the front wheel. The forces on the CoG and the rear wheel are in balance, as can be seen at the orange arrows.

8.1.2 Calculating braking

Calculating breaking position works in the same way as acceleration. The brake balance can de varied between front and rear wheel.
The calculation is based on a rear caliper that is fixed to the swing arm. For calculations with a reaction arm to the chassis the values will not be 100% correct if the rear brake is used in calculation.



Above braking position is shown with different front fork oil levels. Rear wheel is lifted from the ground.

8.1.3 Changes in grip / Rain

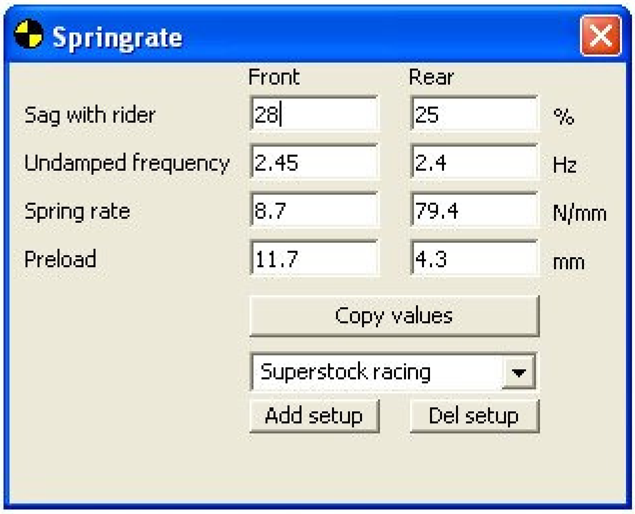
When there is a big change in grip level, as with rain or when tracks are dusty, SuspAct can be used to calculate the needed change in CoG position. To do this change the friction coefficients in the edit tire menu.

To get maximum acceleration at these conditions the CoG's have to be made higher or moved to the back of the bike. In this way there will be maximum pressure at the rear wheel, resulting in maximum drive.

This can already be seen by riders sitting up in rainy conditions. SuspAct however will give you an idea of the magnitude of these forces and changes. Making it possible for you to get the most out of your bike.

8.2 Spring rates

SuspAct can calculate spring rates and preload settings for your front and rear suspension for you.

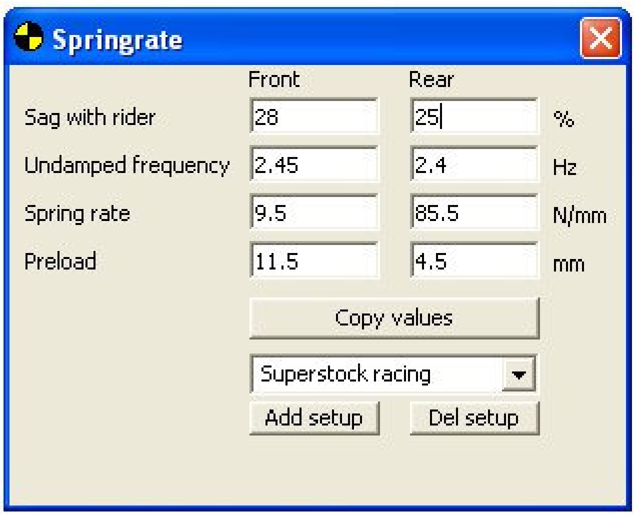


Fill in:

- Static sag with rider
  Percentage of total wheel stroke
- Undamped frequency
  For more info on undamped frequency see chapter 14 Motion frequencies

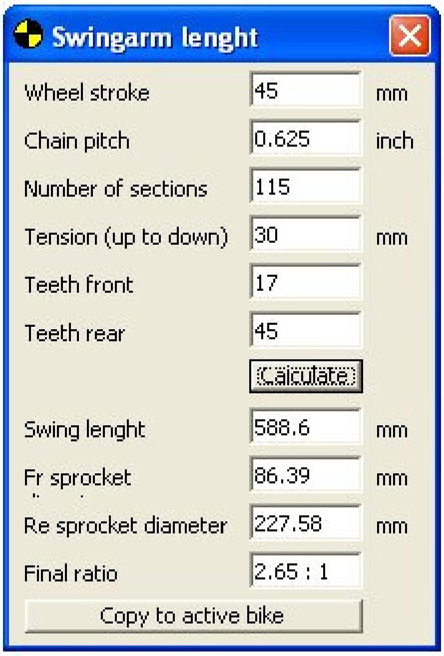
When this form is filled, SuspAct will calculate the advised spring rates and preload settings. It is advised to set rebound springs to length 1 mm when doing this calculation. SuspAct will make a remark when rebound springs are in the problem area.

By comparing spring rates with undamped frequencies it is possible to make the same bike setup independed of weight.
Example:
A 70 kg rider uses the setup above. To determine the springs for a 85 kg rider the same calculation can be done giving the results below. This makes an end to guess work and also different bike weights can be compared.



The used settings can be saved as presets with the buttons in the bottom of the screen.

8.3 Swing length



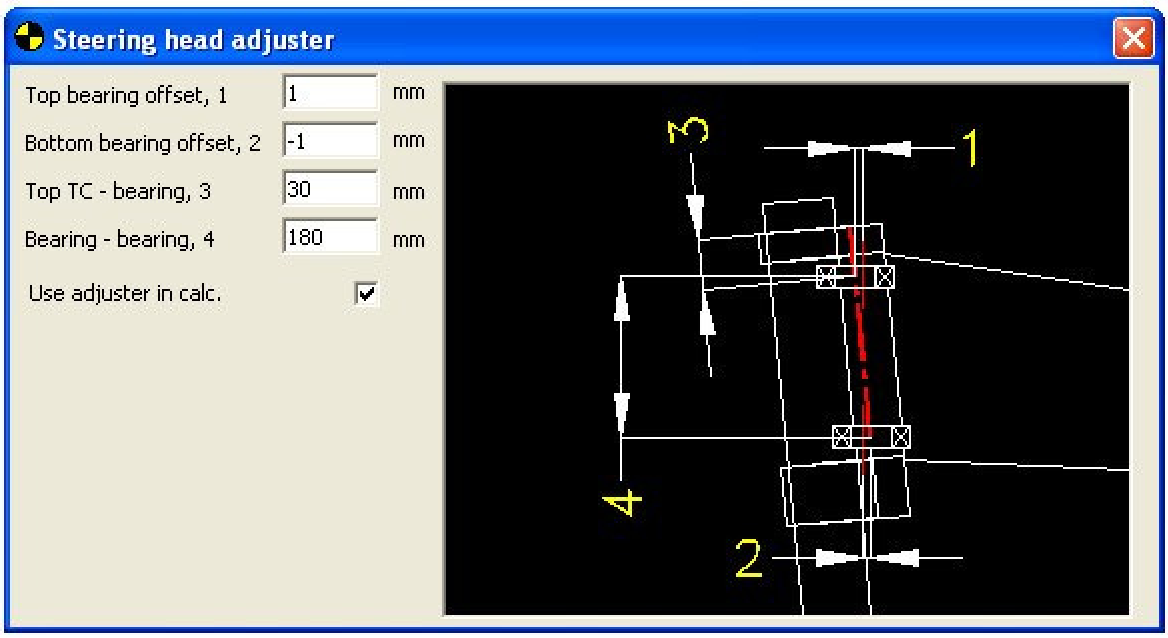
The swing arm length can be calculated based on bike geometry and sprocket dims. Many times the gearing is know, but the suspension guy has to wait with making his setup until the bike is rebuild. After filling the following the swing length is calculated:

- Wheel stroke
  Position at which the chain length is measured
- Chain pitch
  Inches!
- Tension (up to down)
  Experience show that measured chain tension of f.i. 30 mm has to filled in higher. It is not possible to pull the chain completely straight.
- Number of sections
- Teeth front
- Teeth rear

Values can be copied to the active bike

Steering head adjuster

The frame can be changed with rake adjusters in the calculations.



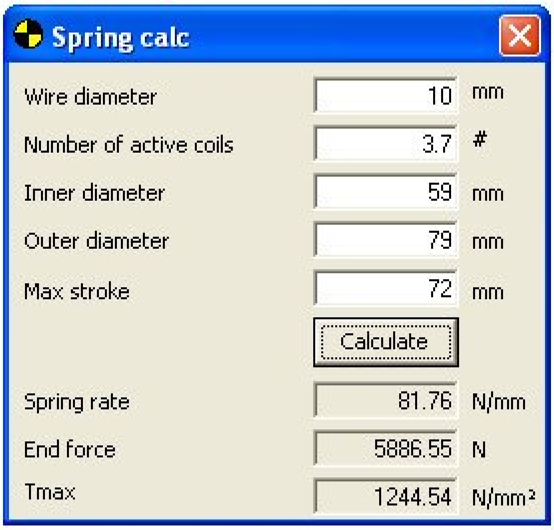
- Top bearing offset
  Offset in the center of the top bearing. To the front is positive direction.
- Bottom bearing offset
  Offset in the center of the bottom bearing. To the front is positive direction.
- Top TC – bearing
  Center of the top bearing, to the top of the upper triple clamp
- Bearing – bearing
  Center to center bearing distance

Check the use adjuster box to use this steering head in the calculation. If not checked the standard frame will be used.
For calculating center of gravity the steering head must be switch off. This means that the CoG must be measure with standard steering head.

9 Springs

There are two spring calculators in the software

9.1 Measured spring



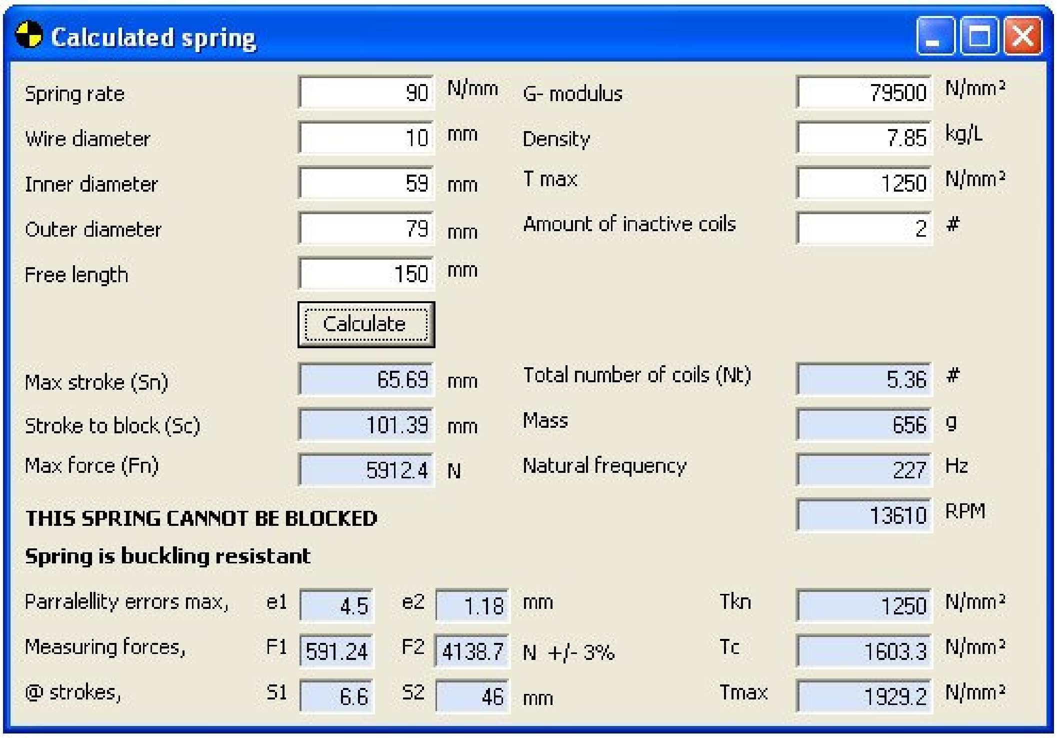
With this calculator existing steel springs can be calculated for their stiffness.

- Wire diameter
  M*easured wire diameter, think about paint thickness*
- Number of active coils
  Substract "dead"coils which are normaly about 1.1 winding each side
- Inner diameter
  Inner diameter of the spring
- Outer diameter
  Outer diameter of the spring
- Max stroke
  Max stroke for force and tension calculation.

9.2 Calculated spring

The calculated spring form is suitable for calculating springs that you want to manufacture. More detailed information needs to be known about the material.

This calculation is only for indication, spring and suspension design can only be done by qualified persons. Final spring design must be done by spring manufacturer under the condition that all data of vehicle is supplied.



Input

- Spring rate
  Changes of force per mm
- Wire diameter
  M*easured wire diameter, think about paint thickness*
- Inner diameter
  Inner diameter of the spring
- Outer diameter
  Outer diameter of the spring
- Free length
  Unloaded spring length with grinded end coils
- G- modulus
  The torsional modulus for the spring material being used. Steel is 79.500 N/mm² with small variation. Titanium has more variation, but a typical value is 42.000 N/mm²
- Density
  Mass per volume
- Maximum torsional stress
  Maximum torsional stress of the spring material being used. Go with spring manufacturers values!
- Amount of inactive coils
  The amount of coils not working in the spring. For standard flattened and grinded spring this is 2- 2.2.

Calculated values

- Max stroke (Sn)
  Maximum stroke to the maximum allowed torsional stress. Going over this stroke will mean change of breaking the spring.
- Stroke to block (Sc)
  The stroke of the spring until all the coils are blocked on each other. If this value is equal to Sn, the spring can be safely blocked. In the example it says "This spring cannot be blocked"
- Max force (Fn)
  The maximum force which is reached at Sn.
- Total number of coils
  Active + inactive coils neede to make this springrate
- Mass
  Total mass of this spring in grams
- Natural frequency
  The own vibrating frequency of this spring. The spring is sensitive to vibrating at these RPM's.

! The spring calculator will tell you if the spring is buckling resistant.

! As mentioned above it will also tell you if the spring can be blocked. If the spring cannot be blocked, the maximum stroke Sn should be used for maximum stroke.

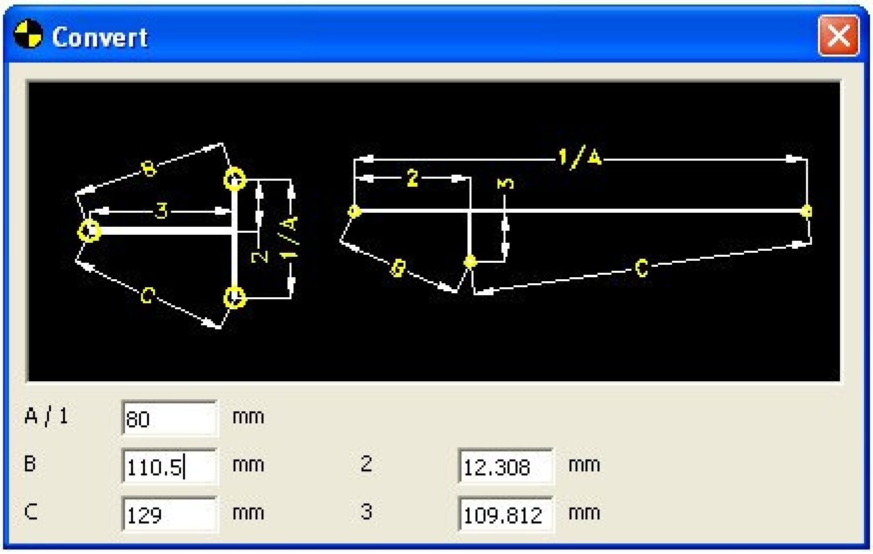
! The values in the bottom are mentioned in the DiN (german standard) norms. Springs should only be designed by qualified persons.

10 Help

In this menu there are some tools for converting dimensions.

10.1 Convert dims

This menu makes it possible to convert rocker or swingarm dimensions. When dimensions are given from center to center, they can be converted to perpendicular and vice versa.



Fill the values according to one of the pictures. When all values are in, the program converts them automatically.

11 Front fork dimensions

11.1 Measuring front fork preload

To measure the preload, the forks have to be opened one time:

- Turn back preload adjuster to 0
- Measure spring length with extended cartridge (1)
- Measure free spring length (2)
- 0 preload = (2) - (1)

Example: 0 preload = 2 mm
Preload given in setup position = 3 turns = 3mm
Input preload 2 + 3 = 5mm

Measured in this way, the preload can be negative sometimes. This means that the spring will have free play when the forks are extended.

11.2 Measuring air chamber volume

- Fill a fork leg up with oil completely. Make sure there is no air trapped in the fork cap and the preload adjuster. Sometimes its best to drill a hole in an old fork cap.
  When filling the forks up it must be fully extended into the reb spring, so you might want to put a clamp of some sort around the inner tube.
- Now take out the oil out of the fork carefully, as you have to measure everything that comes out.
- After taking some oil out, put the forks in the position where you check your oillevel at. Normally this is when the outer tube sits on the axle clamp or bottom.
- Use the bottle with the gauge to take the rest of the oil out. If your working range is for example 95 - 140 mm oillevel, suck the oil out until 95 mm.
  Measure all the oil that you have taken out sofar and note the volume.
  1 cc = 1 ml = 1 cm3
- Repeat this in steps of 5 mm until you reach 140 mm. Note all volumes
- Choose your standard oil level in the middle of the working range. Example:
  standard Oil level = 120 mm
  standard air volume = 230 cm3
- Work out the figure for lineair change of air volume vs oil level.
  Oil level min = 95 mm
  Air volume = 201.5 cm3
  Oil level max = 140 mm
  Air volume = 253 cm3
  Vol change / mm oillevel = (253.2 - 201.5) / (140- 95) = 1.144 cm3 / mm
- Check if this fork adjusts lineair. Calculated air volume at 120 mm would be:
  201.5 + 25 mm * 1.144 = 230.1 cm3
  If this error is to big, you have to fill in the volume manually for change.
- Fill **these** figure in by clicking volume in fork edit box

12 The Kappa value

The adiabatic index of a gas, is the ratio of its specific heat capacity at constant pressure. It is denoted by the greek letter κ (kappa).

$\kappa = CP / CV$

When air is compressed unlimited fast, like in a piston engine, all the heat of the compression stays in the gas. When this happens the temperature and the pressure rise according to the following formula:

$$PV^{\kappa} = \text{constant}$$

In this case the value for κ will be 1.4. Meaning that pressure will be much higher when the air is compressed that fast.

When the air is compressed slow, all the heat will flow out of the gas. The pressure can be calculated with:

$$PV = \text{constant}$$

Or in other words, this will match a κ value of 1.

In practice, front fork movement will almost always be in between these values, meaning that there is great difference in the forces generated from the air chamber. The relation between speed and κ, is different for every situation.

13 Measuring unsprung masses

In SuspAct the unsprung masses are calculated to act on the same arm as the wheels. Therefore these masses should be measured at the wheel:

Front:

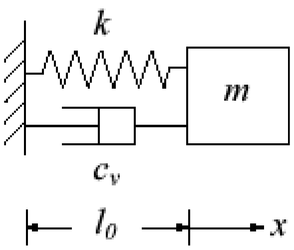
- Put a weighing scale under the front wheel
- Support the bike in the front at normal riding castor angle.
- Unscrew fork caps
- Measure the unsprung
- 0.4 kg might be subtracted for fork cap weight and halve of the springs.

Rear:

- Put a weighing scale under the rear wheel
- Support the bike in the rear with swing arm in normal riding angle.
- Unscrew the bottom of the shock
- Measure unsprung
- There should not be an to big error from the shock unsprung. To check: measure once with loosened top shock mount, and measure once with loosened bottom shock mount.

14 Motion frequencies

When a mass moves on a spring without any damping, the mass will start oscilliating with a certain frequency. This natural frequency can be used to signify the harshness or comfort level of suspension.



In many papers several modes of vibration have been described (f.i. pitch and heave). Because motorcycles almost always have a same weight distribution, it showed that front and rear end can be considered separate for some comparisons.

By using these undamped frequencies springs can be compared independent from rider and bike weight. The following frequencies could be taken as a guideline:

Bike type	Front	Rear
GP 125 road race	2.65 Hz	2.5 Hz
Supersport racer	2.45 Hz	2.35 Hz
Touring street bike	2.35 Hz	2.2 Hz
Calculated with rider in “average riding position”		
MX GP bike	2.3 Hz	1.6 Hz
Calculated with rider in sitting position		