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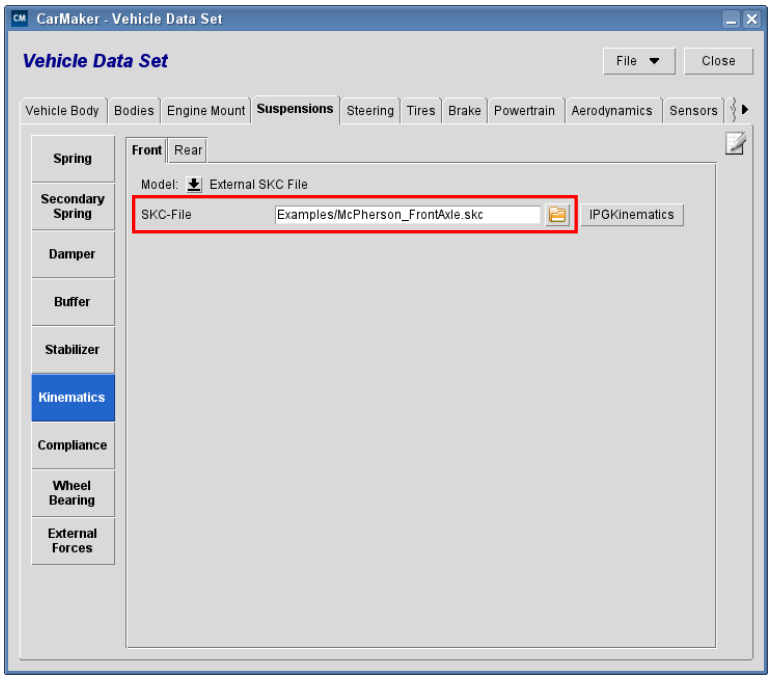
How to read a skc file which parameterizes the suspension kinematics?

In the CarMaker support, we receive many questions on the content of skc files and how these files can be generated. Thus, in this section, I will try to explain a few things about skc files and make clear, why they are very easy and flexible in usage!

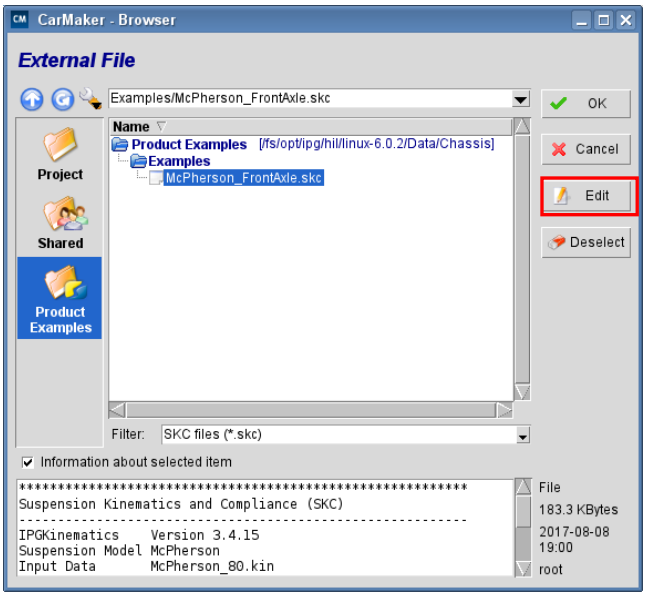
Content of a skc file

The file extension ".skc" stands for "**s**uspension **k**inematics and **c**ompliance". Though the file has that special file extension, it is still a plain CarMaker InfoFile like any other parameter file such as a TestRun, a vehicle data set etc.. The syntax is the same as for all CarMaker InfoFiles in which a key word is followed either be the key or by a matrix with map values. Please find more information on the global InfoFile syntax in the Reference Manual, section "CarMaker Parameter Files".

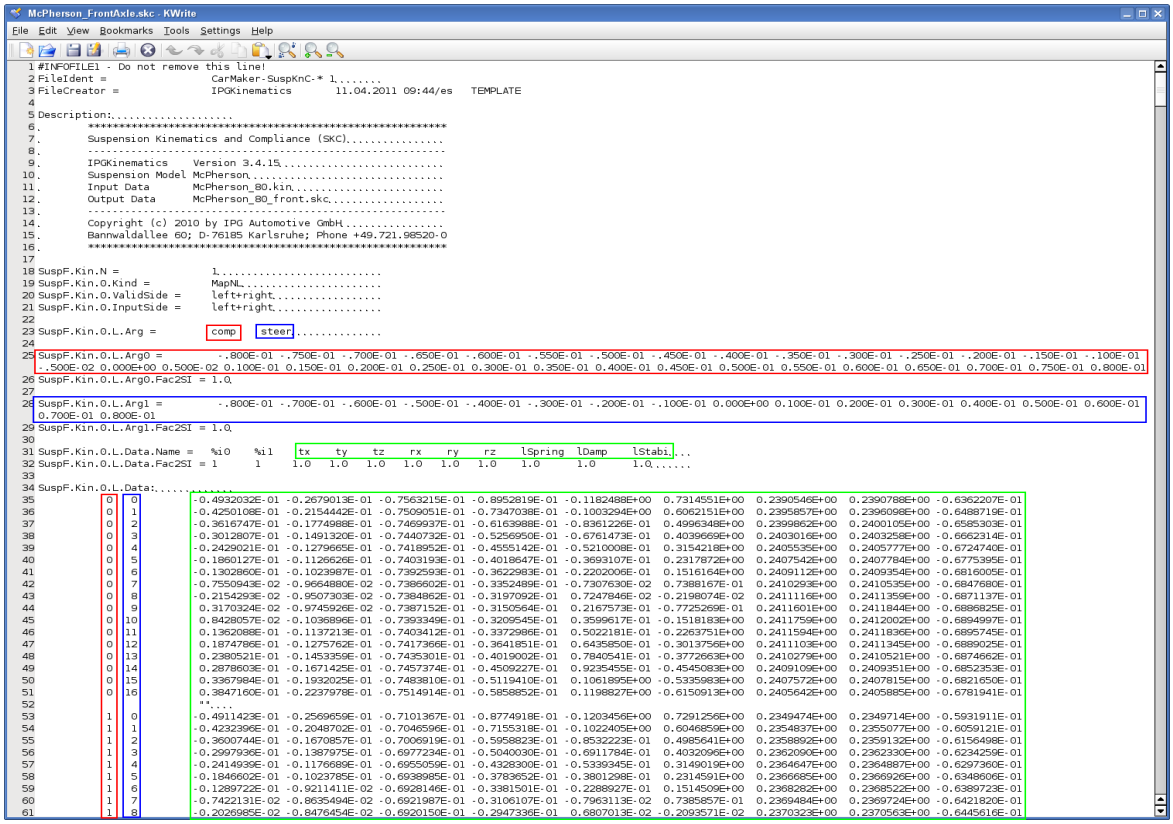
Skc files are used to parameterize the non-linear, map based kinematics and compliance models available in CarMaker. The file describes the movement of the wheel center in dependence of different degrees of freedom (e.g. wheel travel, steering rack movement, wheel travel opposite wheel or external forces/torques for compliance). The curves usually are derived by (virtual or real) KnC test beds. Please find further information about the test procedure required to generate suspension data for CarMaker in the Reference Manual, section "Brief Introduction to the Measurement Procedure of K&C parameters".
Once the data is available, it is just a question of formatting the measurement results to match the CarMaker skc file format. Please note, that IPG Automotive offers a tool named "KnC Data Converter", to convert your measurement data fully automatically into a skc file!
To load or view a skc file, go to the vehicle data set editor under "Parameters > Car > Suspensions > Kinematics" and select the model kind "External SKC File" as shown below. The file browser lets you choose a skc file from the Data/Chassis folder of either your project directory or the CarMaker installation folder.



While selecting the file, you can use the “Edit” button on the right side to view the content of the file:



When opening one of our example skc files, the content of the file might be a bit scaring at a first look. However, once you know how to read the file, it is pretty simple, for sure!
Let me explain the general structure of the file based on our product example “Examples/McPherson_FrontAxle.skc”:



```
McPherson_FrontAxle.skc - KWrite
File  Edit  View  Bookmarks  Tools  Settings  Help

 1 #INFOFILE1 - Do not remove this line!
 2 FileIdent =                CarMaker-SuspKnC-* 1.......
 3 FileCreator =              IPGKinematics       11.04.2011 09:44/es   TEMPLATE
 4
 5 Description:.....................
 6.       ************************************************************
 7.       Suspension Kinematics and Compliance (SKC).................
 8.       ------------------------------------------------------------
 9.       IPGKinematics    Version 3.4.15.........................
10.       Suspension Model McPherson.............................
11.       Input Data       McPherson_80.kin.......................
12.       Output Data      McPherson_80_front.skc.................
13.       ------------------------------------------------------------
14.       Copyright (c) 2010 by IPG Automotive GmbH..............
15.       Bannwaldallee 60; D-76185 Karlsruhe; Phone +49.721.98520-0
16.       ************************************************************
17
18 SuspF.Kin.N =              1.........................
19 SuspF.Kin.O.Kind =         MapNL.....................
20 SuspF.Kin.O.ValidSide =    left+right................
21 SuspF.Kin.O.InputSide =    left+right................
22
23 SuspF.Kin.O.L.Arg =        comp  steer..............
24
25 SuspF.Kin.O.L.Arg0 =           -.800E-01 -.750E-01 -.700E-01 -.650E-01 -.600E-01 -.550E-01 -.500E-01 -.450E-01 -.400E-01 -.350E-01 -.300E-01 -.250E-01 -.200E-01 -.150E-01 -.100E-01
   -.500E-02 0.000E+00 0.500E-02 0.100E-01 0.150E-01 0.200E-01 0.250E-01 0.300E-01 0.350E-01 0.400E-01 0.450E-01 0.500E-01 0.550E-01 0.600E-01 0.650E-01 0.700E-01 0.750E-01 0.800E-01
26 SuspF.Kin.O.L.Arg0.Fac2SI = 1.0
27
28 SuspF.Kin.O.L.Arg1 =           -.800E-01 -.700E-01 -.600E-01 -.500E-01 -.400E-01 -.300E-01 -.200E-01 -.100E-01 0.000E+00 0.100E-01 0.200E-01 0.300E-01 0.400E-01 0.500E-01 0.600E-01
   0.700E-01 0.800E-01
29 SuspF.Kin.O.L.Arg1.Fac2SI = 1.0
30
31 SuspF.Kin.O.L.Data.Name =   %iO    %i1    tx    ty    tz    rx    ry    rz    lSpring  lDamp    lStabi...
32 SuspF.Kin.O.L.Data.Fac2SI = 1      1     1.0   1.0   1.0   1.0   1.0   1.0     1.0      1.0      1.0.....
33
34 SuspF.Kin.O.L.Data:.............
35          0   0    -0.4932032E-01 -0.2679013E-01 -0.7563215E-01 -0.8952819E-01 -0.1182488E+00  0.7314551E+00  0.2390546E+00  0.2390788E+00 -0.6362207E-01
36          0   1    -0.4250108E-01 -0.2154442E-01 -0.7509051E-01 -0.7347038E-01 -0.1003294E+00  0.6062151E+00  0.2395857E+00  0.2396098E+00 -0.6488719E-01
37          0   2    -0.3616747E-01 -0.1774988E-01 -0.7469937E-01 -0.6163988E-01 -0.8361226E-01  0.4996348E+00  0.2399862E+00  0.2400105E+00 -0.6585303E-01
38          0   3    -0.3012807E-01 -0.1491320E-01 -0.7440732E-01 -0.5256950E-01 -0.6761473E-01  0.4039669E+00  0.2403016E+00  0.2403258E+00 -0.6662314E-01
39          0   4    -0.2429021E-01 -0.1279665E-01 -0.7418952E-01 -0.4555142E-01 -0.5210008E-01  0.3154218E+00  0.2405535E+00  0.2405777E+00 -0.6724740E-01
40          0   5    -0.1860127E-01 -0.1126626E-01 -0.7403193E-01 -0.4018647E-01 -0.3693107E-01  0.2317872E+00  0.2407542E+00  0.2407784E+00 -0.6775395E-01
41          0   6    -0.1302860E-01 -0.1023987E-01 -0.7392593E-01 -0.3622983E-01 -0.2202006E-01  0.1516164E+00  0.2409112E+00  0.2409354E+00 -0.6816005E-01
42          0   7    -0.7550943E-02 -0.9664880E-02 -0.7386602E-01 -0.3352489E-01 -0.7307630E-02  0.7388167E-01  0.2410293E+00  0.2410535E+00 -0.6847680E-01
43          0   8    -0.2154293E-02 -0.9507303E-02 -0.7384862E-01 -0.3197092E-01  0.7247846E-02 -0.2198074E-02  0.2411116E+00  0.2411359E+00 -0.6871137E-01
44          0   9     0.3170324E-02 -0.9745926E-02 -0.7387152E-01 -0.3150564E-01  0.2167573E-01 -0.7725269E-01  0.2411601E+00  0.2411844E+00 -0.6886825E-01
45          0  10     0.8428057E-02 -0.1036896E-01 -0.7393349E-01 -0.3209545E-01  0.3599617E-01 -0.1518183E+00  0.2411759E+00  0.2412002E+00 -0.6894997E-01
46          0  11     0.1362088E-01 -0.1137213E-01 -0.7403412E-01 -0.3372986E-01  0.5022181E-01 -0.2263751E+00  0.2411594E+00  0.2411836E+00 -0.6895745E-01
47          0  12     0.1874786E-01 -0.1275762E-01 -0.7417366E-01 -0.3641851E-01  0.6435850E-01 -0.3013756E+00  0.2411103E+00  0.2411345E+00 -0.6889025E-01
48          0  13     0.2380521E-01 -0.1453359E-01 -0.7435301E-01 -0.4019002E-01  0.7840541E-01 -0.3772683E+00  0.2410279E+00  0.2410521E+00 -0.6874662E-01
49          0  14     0.2878603E-01 -0.1671425E-01 -0.7457374E-01 -0.4509227E-01  0.9235455E-01 -0.4545083E+00  0.2409109E+00  0.2409351E+00 -0.6852353E-01
50          0  15     0.3367984E-01 -0.1932025E-01 -0.7483810E-01 -0.5119410E-01  0.1061895E+00 -0.5335983E+00  0.2407572E+00  0.2407815E+00 -0.6821650E-01
51          0  16     0.3847160E-01 -0.2237978E-01 -0.7514914E-01 -0.5858852E-01  0.1198827E+00 -0.6150913E+00  0.2405642E+00  0.2405885E+00 -0.6781941E-01
52                     "....
53          1   0    -0.4911423E-01 -0.2569659E-01 -0.7101367E-01 -0.8774918E-01 -0.1203456E+00  0.7291256E+00  0.2349474E+00  0.2349714E+00 -0.5931911E-01
54          1   1    -0.4232396E-01 -0.2048702E-01 -0.7046596E-01 -0.7155318E-01 -0.1022405E+00  0.6046859E+00  0.2354837E+00  0.2355077E+00 -0.6059121E-01
55          1   2    -0.3600744E-01 -0.1670857E-01 -0.7006919E-01 -0.5958823E-01 -0.8532223E-01  0.4985641E+00  0.2358892E+00  0.2359132E+00 -0.6156498E-01
56          1   3    -0.2997936E-01 -0.1387975E-01 -0.6977234E-01 -0.5040030E-01 -0.6911784E-01  0.4032096E+00  0.2362090E+00  0.2362330E+00 -0.6234259E-01
57          1   4    -0.2414939E-01 -0.1176689E-01 -0.6955059E-01 -0.4328300E-01 -0.5339345E-01  0.3149019E+00  0.2364647E+00  0.2364887E+00 -0.6297360E-01
58          1   5    -0.1846602E-01 -0.1023785E-01 -0.6938985E-01 -0.3783652E-01 -0.3801298E-01  0.2314591E+00  0.2366685E+00  0.2366926E+00 -0.6348606E-01
59          1   6    -0.1289722E-01 -0.9211411E-02 -0.6928146E-01 -0.3381501E-01 -0.2288927E-01  0.1514509E+00  0.2368282E+00  0.2368522E+00 -0.6389723E-01
60          1   7    -0.7422131E-02 -0.8635494E-02 -0.6921987E-01 -0.3106107E-01 -0.7963113E-02  0.7385857E-01  0.2369484E+00  0.2369724E+00 -0.6421820E-01
61          1   8    -0.2026985E-02 -0.8476454E-02 -0.6920150E-01 -0.2947336E-01  0.6807013E-02 -0.2093571E-02  0.2370323E+00  0.2370563E+00 -0.6445616E-01
```

Whereas the first lines just indicate the CarMaker InfoFile and its kind, lines 18-21 specify the input data. The prefix “SuspF” stands for a front axle, and all keys with the term “.Kin.” are related to the wheel kinematics.
In line 19, the key “MapNL” defines that a non-linear map is used to define the kinematics. The following two lines make clear, that independent measurements are available for the left and right wheel. Optionally, the maps for one side can be mirrored to the other side, too.

With the two arguments “comp” and “steer” in line 23, a 2D map is introduced which is based on the two degrees of freedom (DOFs): wheel travel (comp) and steering rack movement (steer).
The measured states of the two degrees of freedom are listed in line 25 (“Arg0” = comp) and in line 28 (“Arg1” = steer). Obviously, the wheel travel was changed by steps of 5mm ranging from -80mm to +80mm, whereas the steering rack was moved in 10mm steps again from -80 to +80mm. For each state, the translational and rotational wheel center movement was recorded (labeled as tx, ty, tz and rx, ry, rz), as well as the deflection of the spring, damper, stabilizer and buffer. All this is defined in the lines 35 and following.
The first block with a “zero” in the first column refers to the naught item of argument 0 (comp), which is -80mm wheel travel. The wheel travel is fixed for the next 17 lines. The second DOF, however, changes. The second column refers to the content of vector “Arg1” which defines the steering rack movement. At constant wheel travel, the steering rack is moved from one side to the other (from -80mm to +80mm).

The second block starting with “1” in the first column, now moves the wheel to the next value of “comp”, which is -75mm. At this point, the steering rack is again moved from one side to the other.
Thus, each block comes with a constant wheel travel, but varying steering rack movement. This results in the huge data table – but it is indeed pretty easy to read!

Of course, the non-linear suspension model also supports other combinations of DOFs, too. A maximum of three degrees of freedom can be used, which compromises apart from wheel compression and steering rack movement the wheel compression of the opposite wheel. The content and number of data maps is quite flexible: Each DOF can be measured independently and listed in a separate map, or two DOFs are combined in one map with the third provided in an additional map – various kinds of measurement techniques are supported. Find out more in the Reference Manual, section “Suspension Kinematics and Compliance > MapNL”!