Creating Custom Lumped-Component Library

In this tutorial, we will create a library of practical surface-mounted device (SMD) inductor for ADS2003C. Epcos AG manufactures the inductors. Epcos manufactures this high performance inductor under the brandname SIMID-0603. As it name implies, these SMD inductors are of package size 0603. A picture of the inductor is shown in Figure 1.

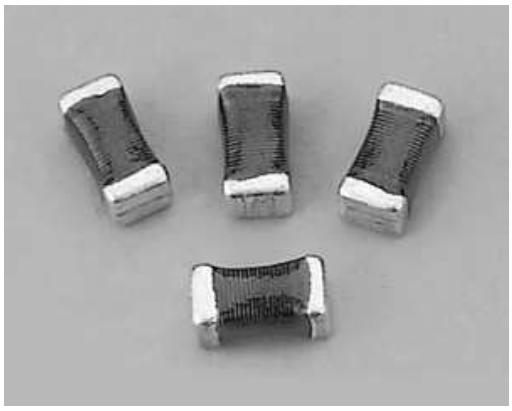

Figure 1 – Epcos's SIMID 0603 range SMD inductor.

1.0 SPICE Netlist for Inductor

Epcos (www.epcos.com) provides the PSPICE library of the inductor in the file "SIMID_0603.lib". A portion of the file is shown Listing 1.0. The first subcircuit (.subckt), **SIMID_0603_BASE1** declares the equivalent electrical circuit of the 0603 inductor. Note that the parameters of the R, L, C and K (coupling factor) of the subcircuit are variables. Subsequent subcircuit declaration uses the base circuit and creates an inductor model by assigning values to the variables. Figure 1.0 shows the schematic of SIMID_0603_BASE1.

```
*
*
* Library SIMID_0603.lib
* Version 1.00 (Mittwoch,  2. Februar 2005, 09:23:34 Uhr MET)
*
*****************************************************************
* SPICE-Simulationsdaten für SIMID 0603
* SPICE simulation data for SIMID 0603
*       SIMID_0603
*
*****************************************************************
*
*****************************************************************
* Library für PSPICE
*
* Libs für weitere Spice-Versionen sind verfügbar (HSPICE ..)
*
*****************************************************************
*
.subckt SIMID_0603_BASE1 A1 A2  PARAMS:
+       ls11_a=10.9935n rs11_a=121m cp11_a=99.8945f rp11_a=10.3032k
+       lwira1_a=300.6000p lwa1_a=2.3056n rwa1_a=410.8216m lwb1_a=5.4770n
+       rwb1_a=11.3773 kw1a1_a=1.0000
ls1_b   A1 31   {ls11_a}
rs1_b   31 A2   {rs11_a}
cp1_b   A1 A2   {cp11_a}
rp1_b   A1 A2   {rp11_a}
lwira_b 900 0   {lwira1_a}
lwa_b   900 901         {lwa1_a}
rwa_b   901 0   {rwa1_a}
lwb_b   900 902         {lwb1_a}
rwb_b   902 0   {rwb1_a}
kw1a_b  ls1_b lwira_b  {kw1a1_a}
.ENDS

*
* B82496C3100J000 SIMID 0603-C standard type (10 nH +-5%)
*
.subckt B82496C3100J000 A1 A2   PARAMS:
+       ls11=10.9935n rs11=121m cp11=99.8945f rp11=10.3032k
+       lwira1=300.6000p lwa1=2.3056n rwa1=410.8216m lwb1=5.4770n
+       rwb1=11.3773 kw1a1=1.0000
X1 A1 A2 SIMID_0603_BASE1  PARAMS:  ls11_a={ls11}
+       rs11_a={rs11} cp11_a={cp11} rp11_a={rp11}
+       lwira1_a={lwira1} lwa1_a={lwa1} rwa1_a={rwa1}
+       lwb1_a={lwb1} rwb1_a={rwb1} kw1a1_a={kw1a1}
.ENDS

*
* B82496C3101J000 SIMID 0603-C standard type (100 nH +-5%)
*
.subckt B82496C3101J000 A1 A2   PARAMS:
+       ls11=112.2848n rs11=1.325 cp11=87.6588f rp11=30.8058k
+       lwira1=300.6000p lwa1=4.2771n rwa1=587.0064m lwb1=5.8060n
+       rwb1=6.5984 kw1a1=1.0000
X1 A1 A2 SIMID_0603_BASE1  PARAMS:  ls11_a={ls11}
+       rs11_a={rs11} cp11_a={cp11} rp11_a={rp11}
+       lwira1_a={lwira1} lwa1_a={lwa1} rwa1_a={rwa1}
+       lwb1_a={lwb1} rwb1_a={rwb1} kw1a1_a={kw1a1}
.ENDS
```

The 'base' equivalent electrical circuit of an inductor, declared as a subcircuit.

Listing 1.0 – Content of "SIMID_0603.lib" from Epcos AG.

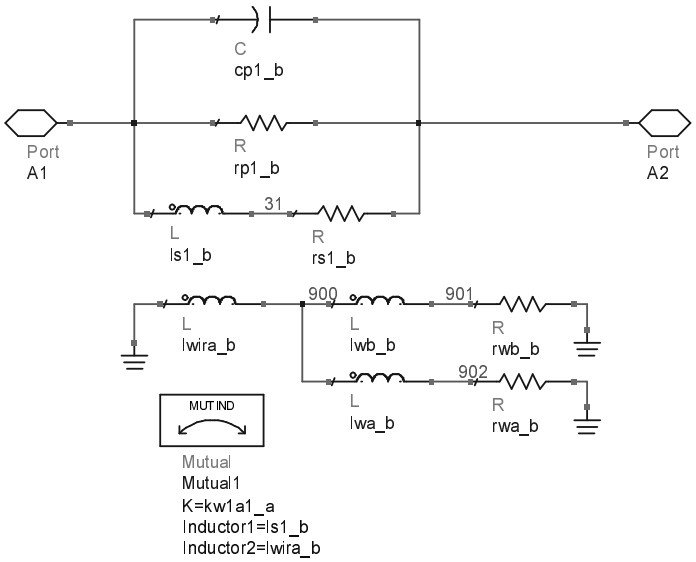

Figure 1.0 – Schematic of SIMID_0603_BASE1.

2.0 Importing SPICE Netlist

First we import the PSPICE library netlist "SIMID_0603.lib" into ADS using the **Import** command under **File** menu.

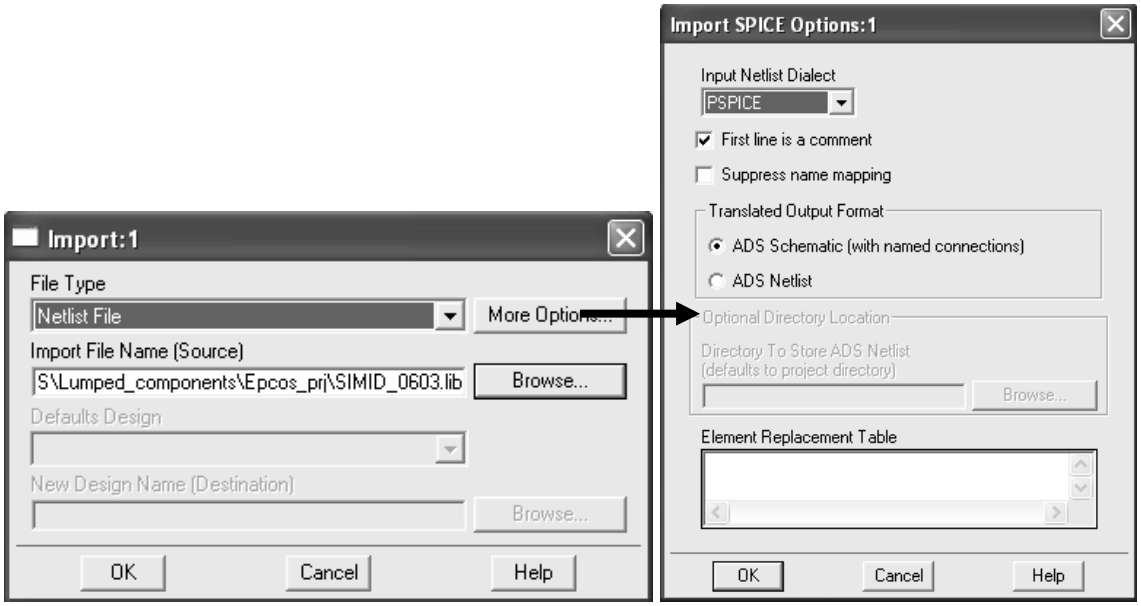

Figure 2.0 – Importing the PSPICE file "SIMID_0603.lib".

The PSPICE netlist will be converted into ADS netlist format. Each subcircuit in the file will be saved as an ADS netlist or network (*.dsn). Browsing the main window of ADS should shows all the subcircuits imported.

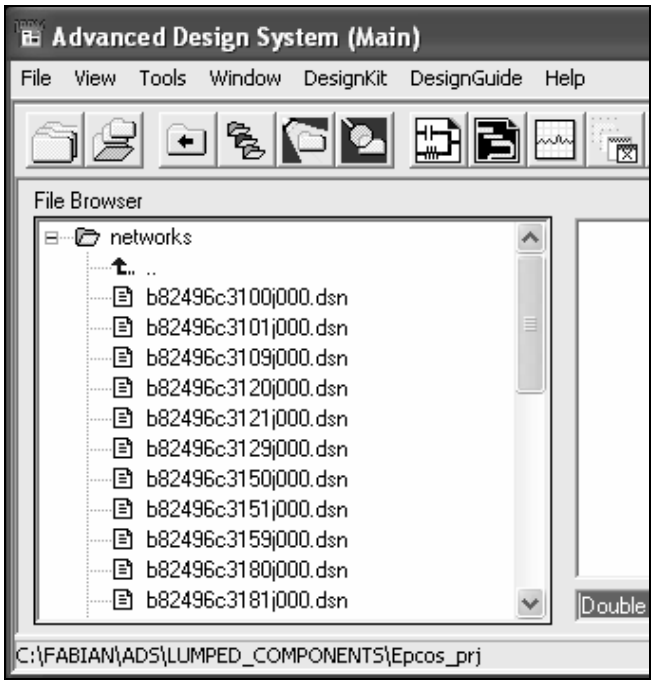

Figure 2.1 - The network for all successfully imported subcircuits will be shownin the Main Window. Each network corresponds to each .subckt declaration in the PSPICE netlist.

3.0 Modifying the Networks and Creating User Library

Open each network individually. Under **File** menu run the **Design Parameters** command. Set the parameter as shown in Figure 3.0. Here we assign an inductor symbol **SYM_L** to this subcircuit instead of the default symbol of a square box with two terminals. We can also change the description to something more intelligible, like "Epcos SIMID 0603 SMD inductors, 10nH, ±5%" instead of the default "b82496c3100j000". Type the library names, for this example I used "**Fkung_subnetworks**"*. You can also assign an artwork (also known as footprint in other literature) to this component, for used during layout. In this case change the artwork type from **Synchronized** to **Fixed**, and select an appropraite file in the **Name** drop-down list. Refer to ADS online help for more information.

For ADS2003C, the details for user created library is stored in text file called Records (.rec). This is usually stored in the default "Temp" folder of the user.

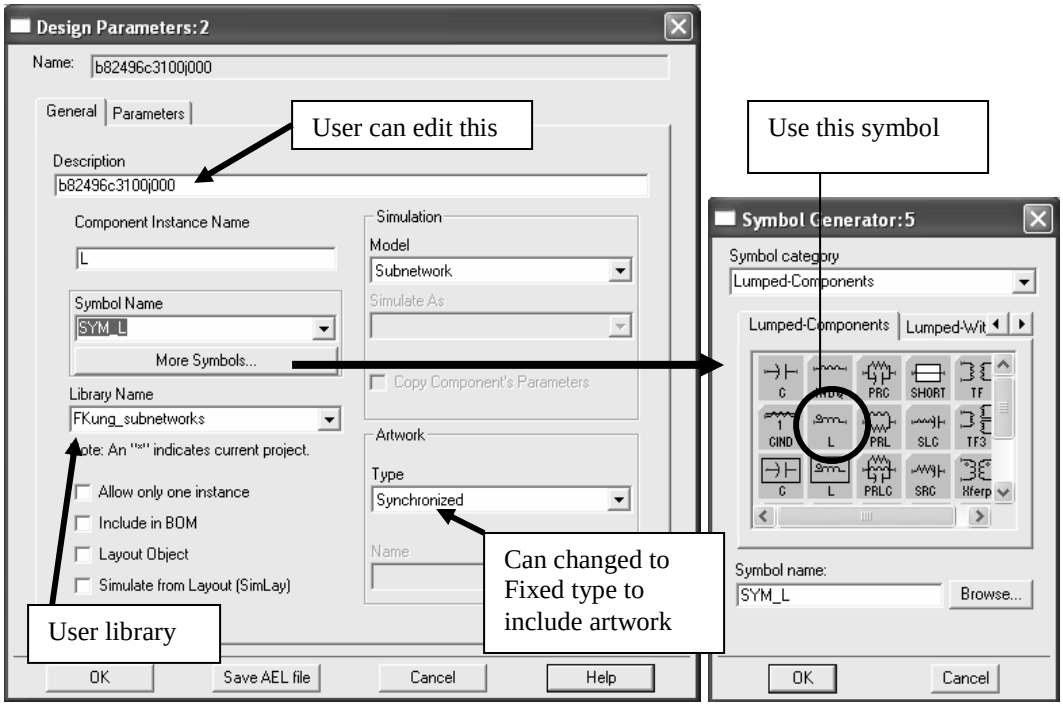

Figure 3.0 – Changing the network general parameters.

Next click on the **Parameters** tab. For each parameter, you can deselect the **Display parameter on schematic** checkbox (the display attribute) and set the **Parameter Type** as shown. For instance for ls11 it is an inductance. If the checkbox is not deselected, all parameters will be shown in the schematic window when you insert this component, clogging up the display area. As can be seen this is a lot of work. We also add a new parameter called Part_Num, and enabled its display attribute. This will provide description of the subnetworks (Figure 3.2).

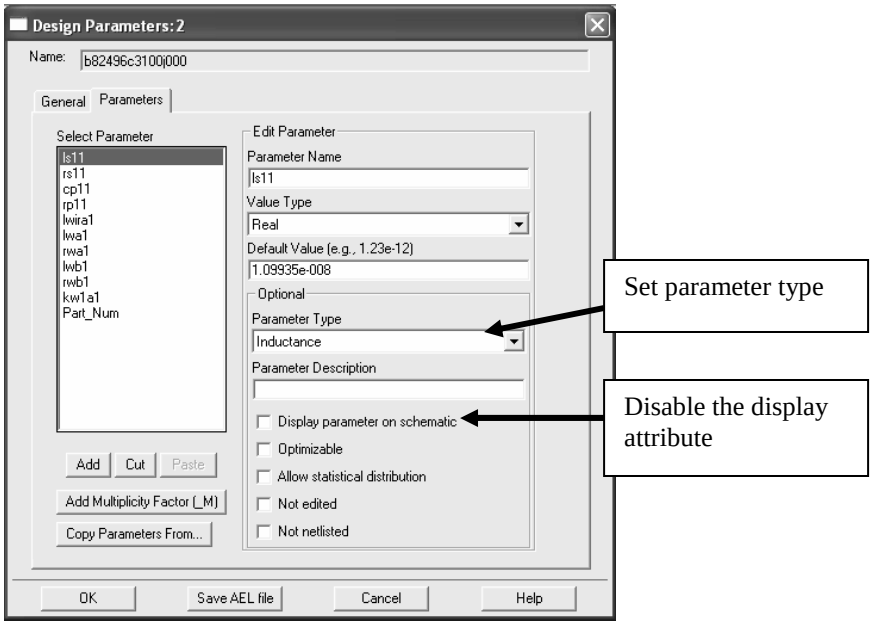

Figure 3.1- Changing the network parameters.

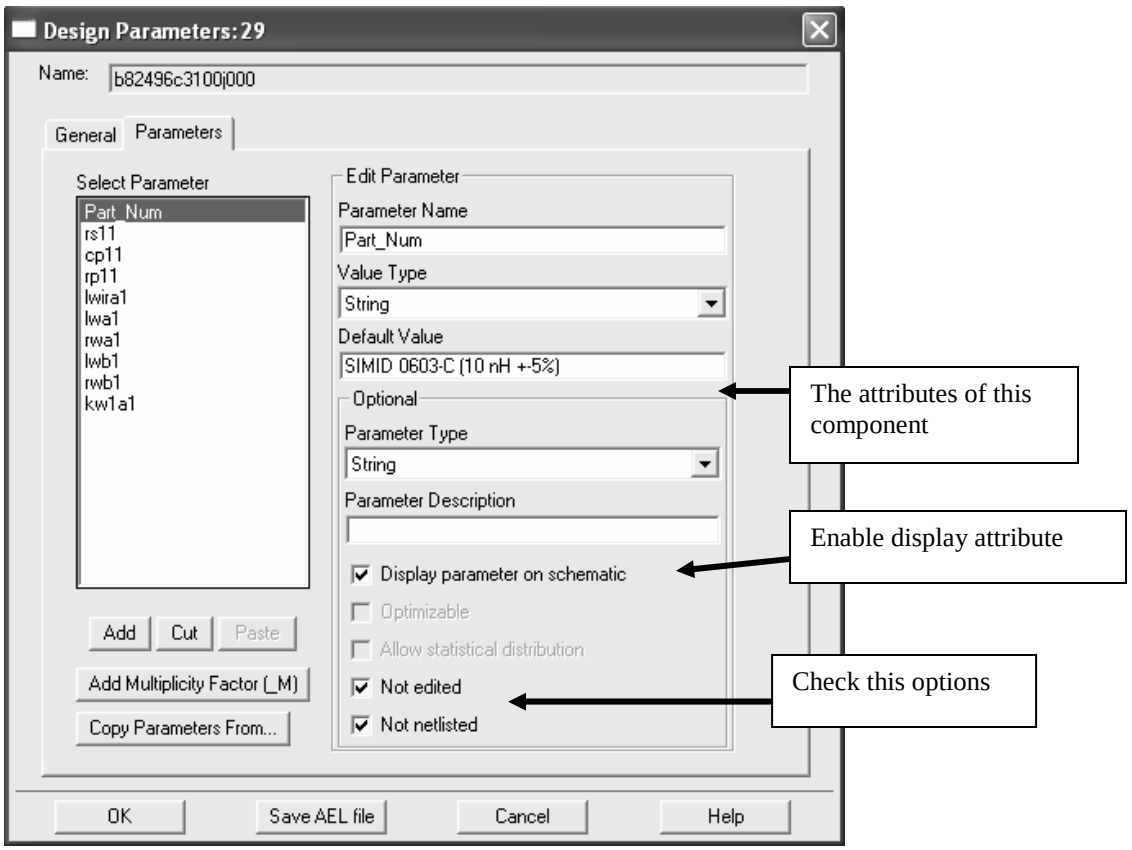

Figure 3.2 – Adding a new parameter **Part_Num**.

Take not in Figure 3.2 the Note edited and Not netlisted checkboxes have to be selected. The former selection will not allow the user to edit the string when the component is inserted into a schematic. The latter selection will not include this parameter into the circuit (or netlist as it is known) during simulation. If left unchecked the simulation engine will report an unresolved parameter and simulation will halt. Repeat these procedures for all the subcircuit imported, as can be seen this is a lot of work. The next time ADS is run, the practical inductor models will appear in the Component Library Browser.

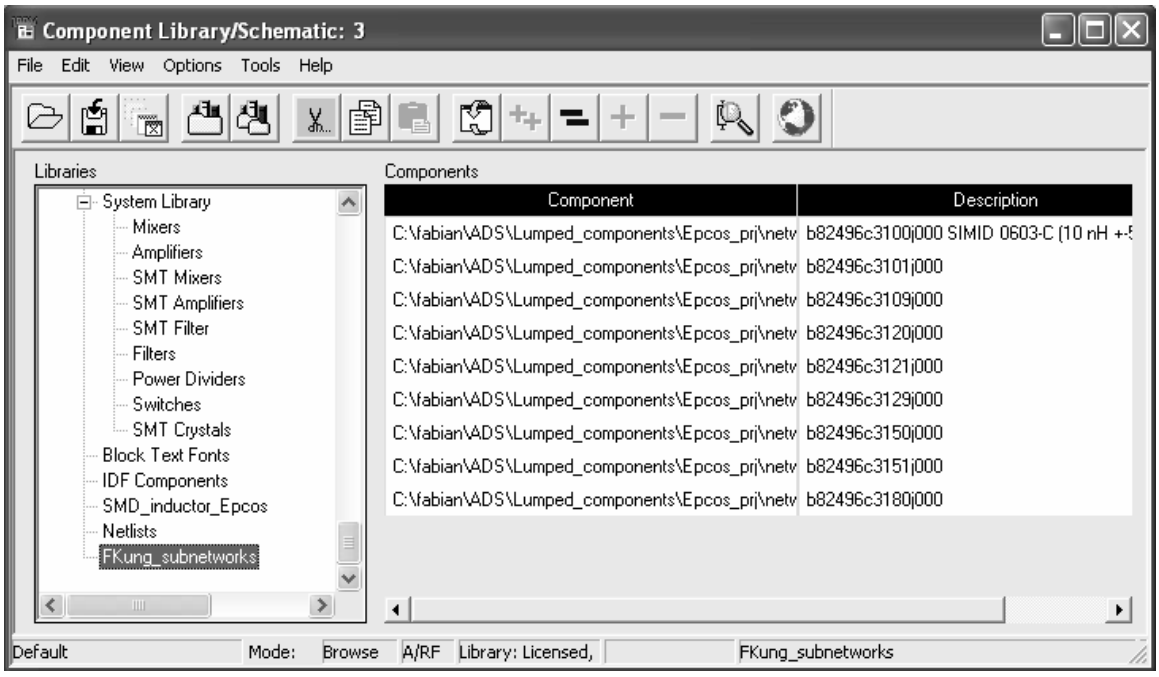

Figure 3.3 – Subcircuits added to Component Library Browser.

If the user library does not appears in the Component Library Browser, we can also include the networks for the inductors by explicitly include it into the Project Hierarchy. An example is shown in Figure 3.4, where the project **feedback_LNA** includes the project **Epcos**, which contain all the SIMID-0603 inductor networks. In the Main Window, move the cursor to the project, right click on the mouse to perform explicit include. Upon succesfully inserting the inductor, it will appear as shown in Figure 3.6.

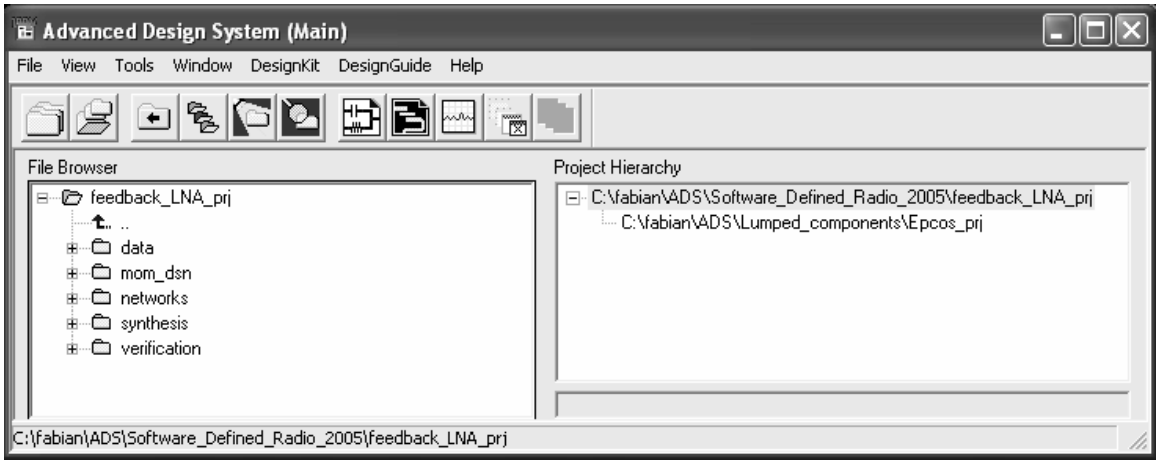

Figure 3.4 – Explicitly include the networks into another project.

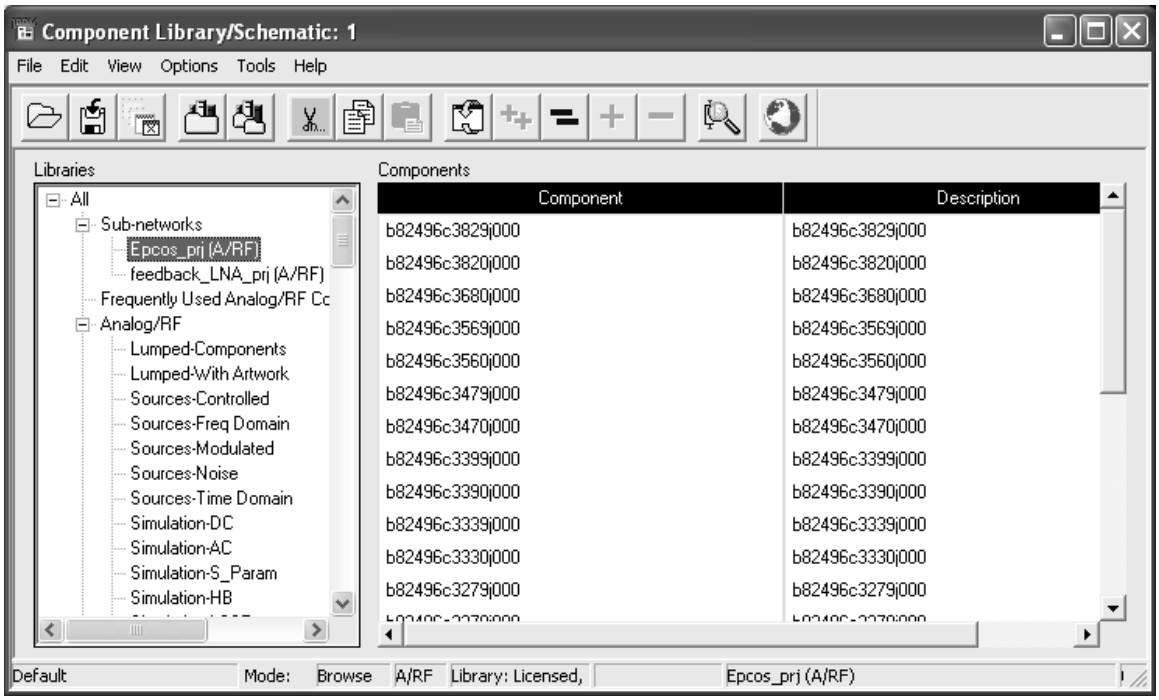

Figure 3.5 – The inductor networks appear in the **Sub-networks** of the Component Library Browser window for explicit include.

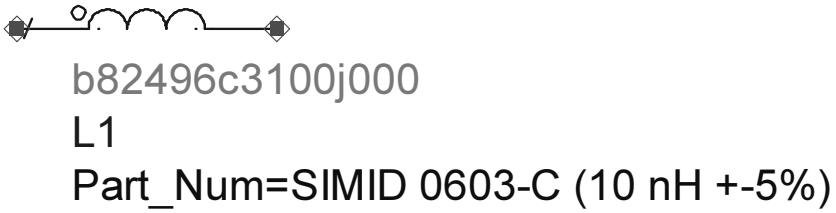

Figure 3.6 – The new component inserted into ADS schematic window.