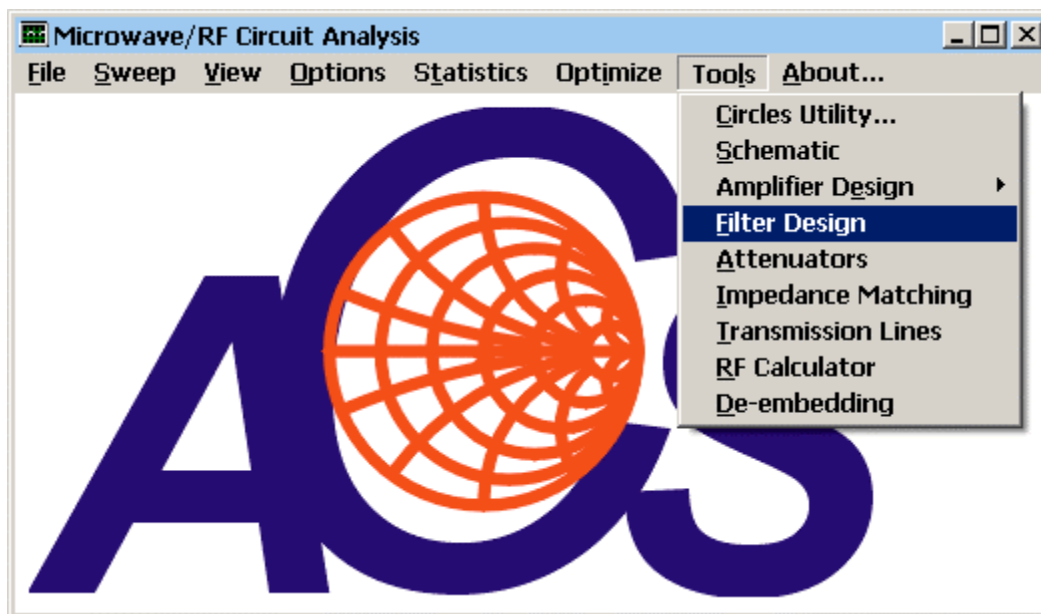# LINC2 FILTER Synthesis

The LINC2 filter synthesis program is started by selecting **Filter Design** from the main LINC2 **Tools** menu as shown above.
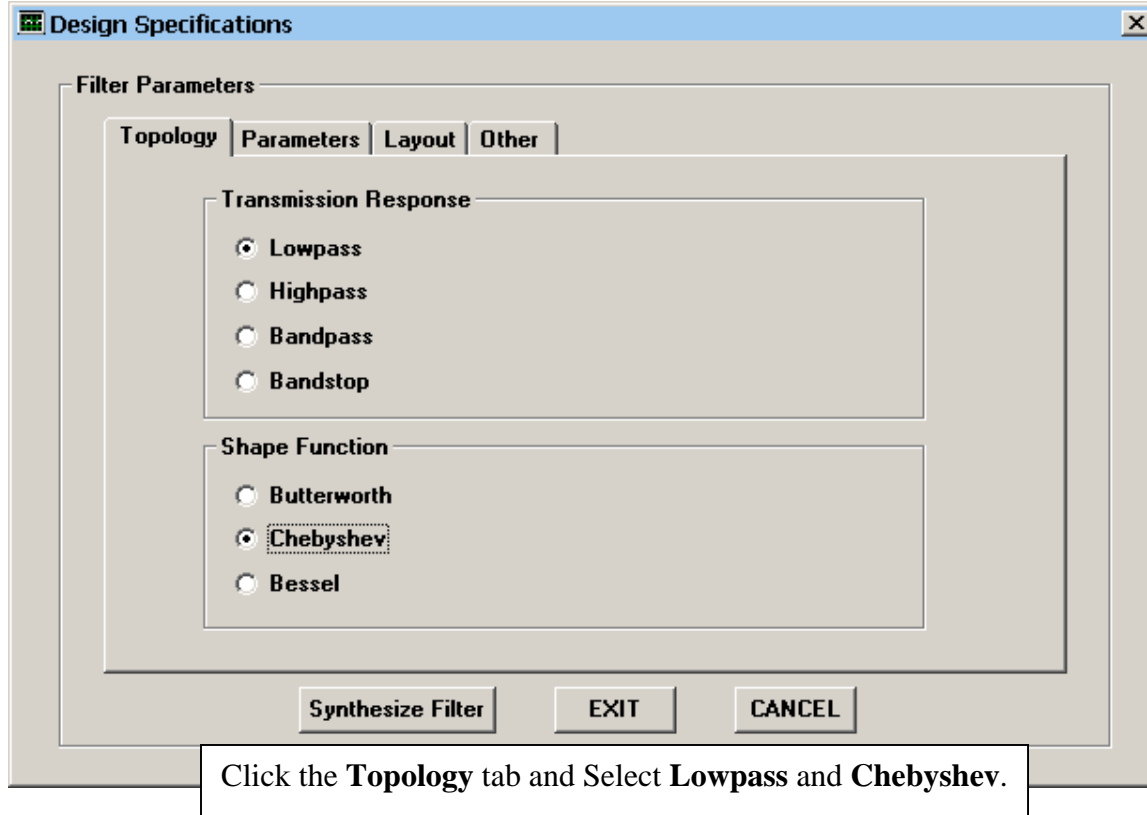
The initial filter synthesis process usually generates an ideal electrical schematic. When the schematic (with ideal elements) is converted to a physical layout, non-ideal attributes are often introduced that alter the desired filter characteristics. EM simulation can help the designer understand these changes so they can be compensated for in the original design (such as a shift in the frequency specification).

The following example will demonstrate how a 7th order distributed Chebyshev lowpass filter (in microstrip) can be specified, synthesized, and exported to the Sonnet® EM simulator for analysis in a matter of minutes with only a few menu clicks and keystrokes.
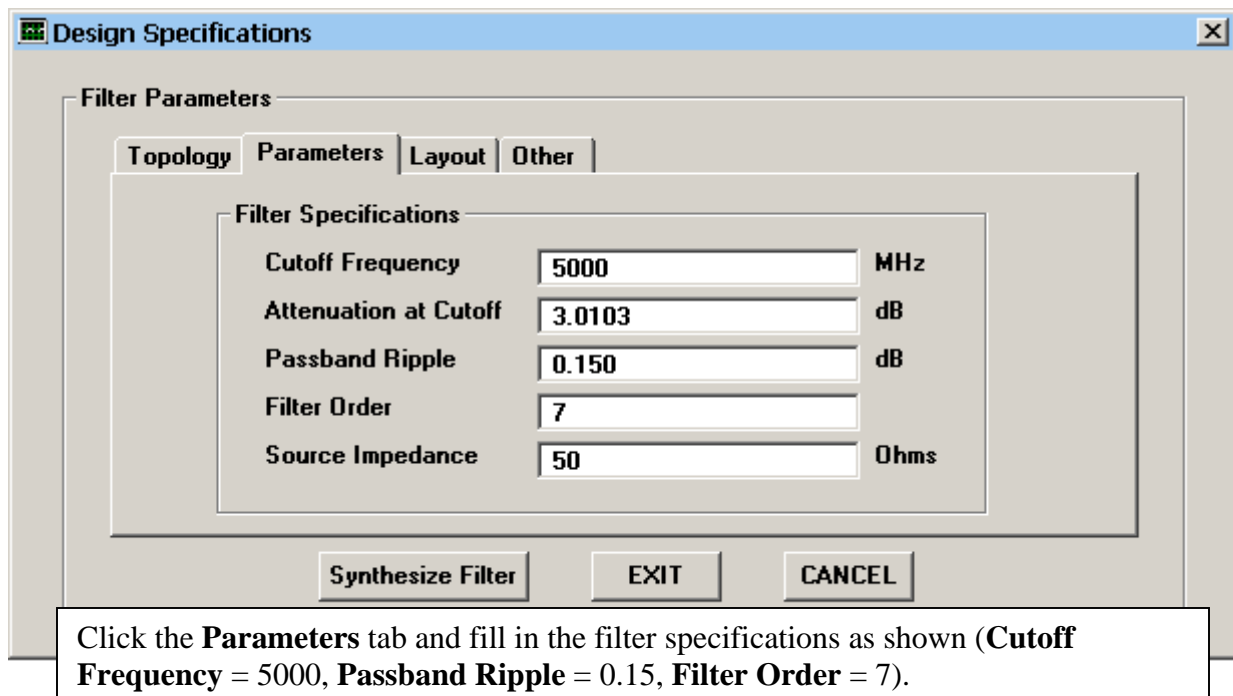
First, select **Distributed (Single-ended)** from the **Filter** menu:

Select **Distributed (Single-ended)** from the **Filter** menu.

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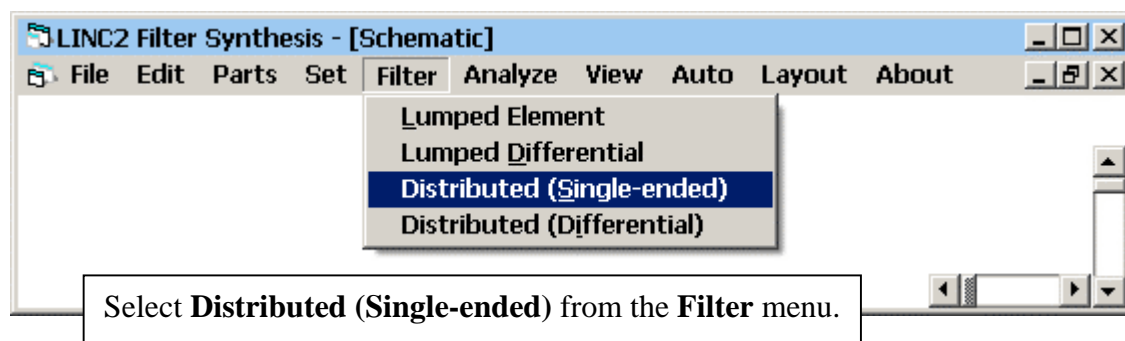
Click **Topology** and Select **Chebyshev Lowpass**.

Click the **Topology** tab and Select **Lowpass** and **Chebyshev**.

Enter the detailed filter specifications:

Click the **Parameters** tab and fill in the filter specifications as shown (**Cutoff Frequency** = 5000, **Passband Ripple** = 0.15, **Filter Order** = 7).

Design Specifications

Filter Parameters

Topology | Parameters | Layout | **Other**

Additional Specifications

○ Series Element First, Minimum Capacitor

◉ Shunt Element First, Minimum Inductor

TLine, Resonator Impedance: `50` Ohms

TLine, Minimum Impedance: `10` Ohms

TLine, Maximum Impedance: `90` Ohms

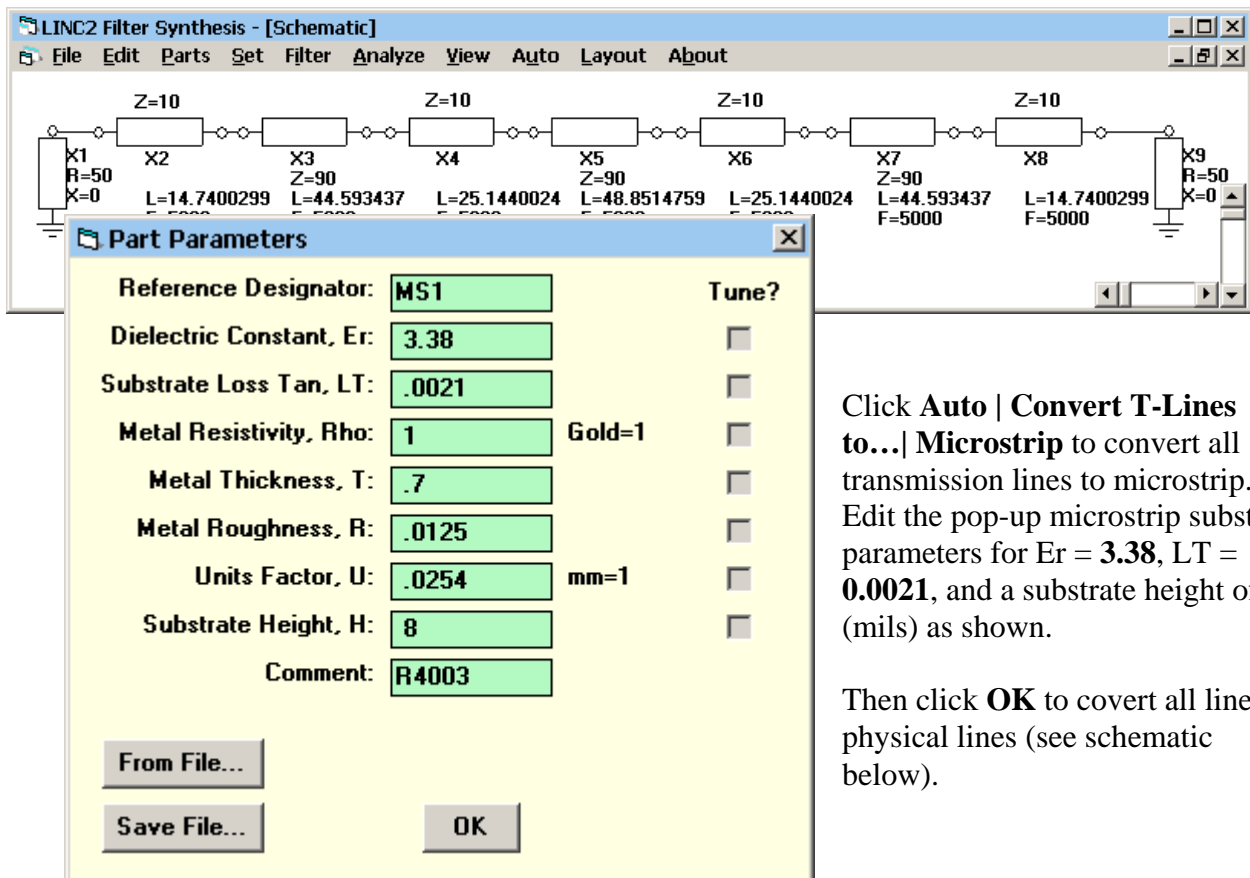Synthesize Filter   EXIT   CANCEL

Click the **Other** tab. Select **Shunt Element First** and change the TLine (transmission line) minimum and maximum impedances to 10 and 90 ohms respectively. The filter specifications are now complete. Click the **Synthesize Filter** button and **Exit** to see the filter schematic (below).

LINC2 Filter Synthesis - [Schematic]

File Edit Parts Set Filter Analyze View Auto Layout About

Z=10   Z=10   Z=10   Z=10

X1   X2   X3   X4   X5   X6   X7   X8   X9
R=50   Z=90   Z=90   Z=90   R=50
X=0   L=14.7400299 L=44.593437 L=25.1440024 L=48.8514759 L=25.1440024 L=44.593437 L=14.7400299 X=0
                                                                              F=5000   F=5000

Part Parameters

Reference Designator:	MS1	Tune? ☐
Dielectric Constant, Er:	3.38	☐
Substrate Loss Tan, LT:	.0021	☐
Metal Resistivity, Rho:	1	Gold=1 ☐
Metal Thickness, T:	.7	☐
Metal Roughness, R:	.0125	☐
Units Factor, U:	.0254	mm=1 ☐
Substrate Height, H:	8	☐
Comment:	R4003	

From File...

Save File...   OK

Click **Auto | Convert T-Lines to…| Microstrip** to convert all transmission lines to microstrip. Edit the pop-up microstrip substrate parameters for Er = **3.38**, LT = **0.0021**, and a substrate height of **8** (mils) as shown.

Then click **OK** to covert all lines to physical lines (see schematic below).
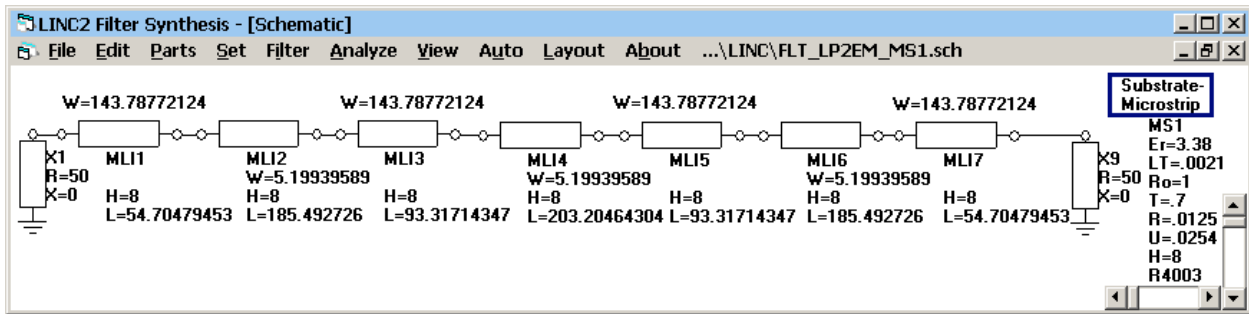
The resulting schematic is converted to all physical microstrip lines. Click **Layout** to see the layout geometry (below).
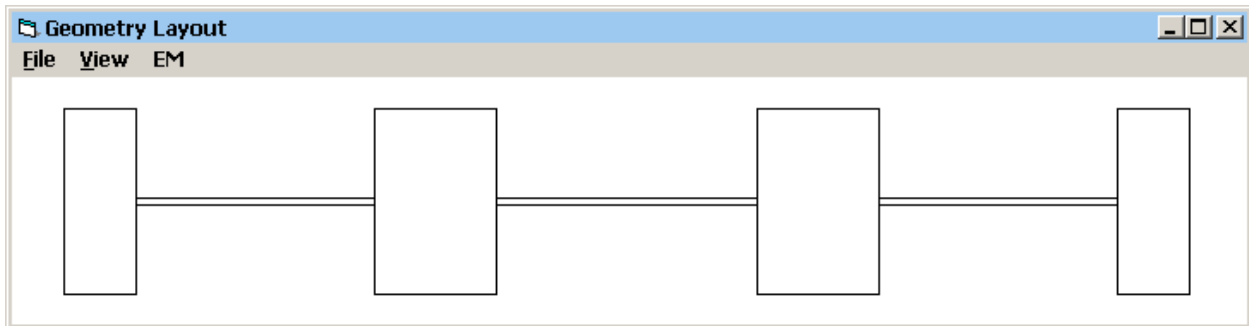

For this example, change the default de-embedding length from 150 mils to 50 mils by selecting **De-embed Length** from the EM menu as shown below. Enter 50 and click OK. Then select **EM Simulation (Sonnet)** from the EM menu.
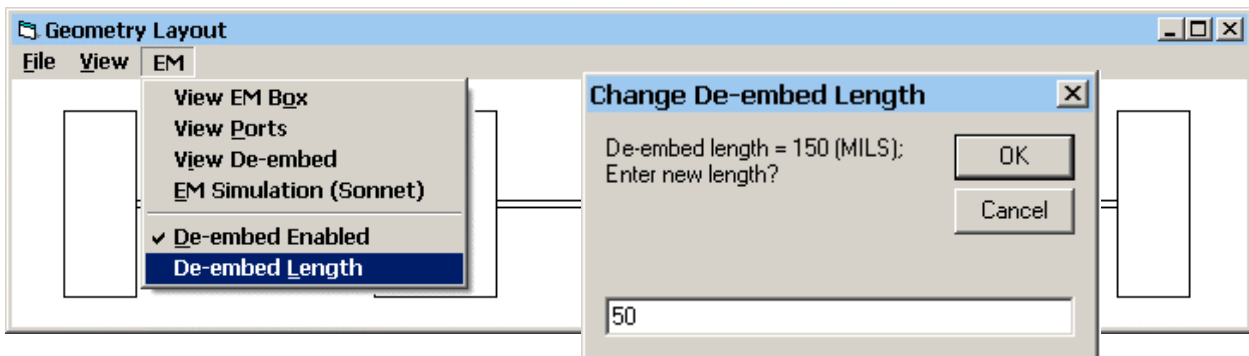
When EM Simulation (Sonnet) is selected, the file EMTest.SON is created and automatically exported to the Sonnet® xgeom project editor ready for analysis. The EM box, metal and substrate layers and frequency parameters are already loaded. The layout in Sonnet® is shown below. Black arrows pointing inward from each port show the amount of de-embedding at the ports.

Simply select **Analyze** from the Sonnet® project menu to run the simulation. When the simulation is complete, select **Project | View Response | New Graph** to get the response plots shown below.
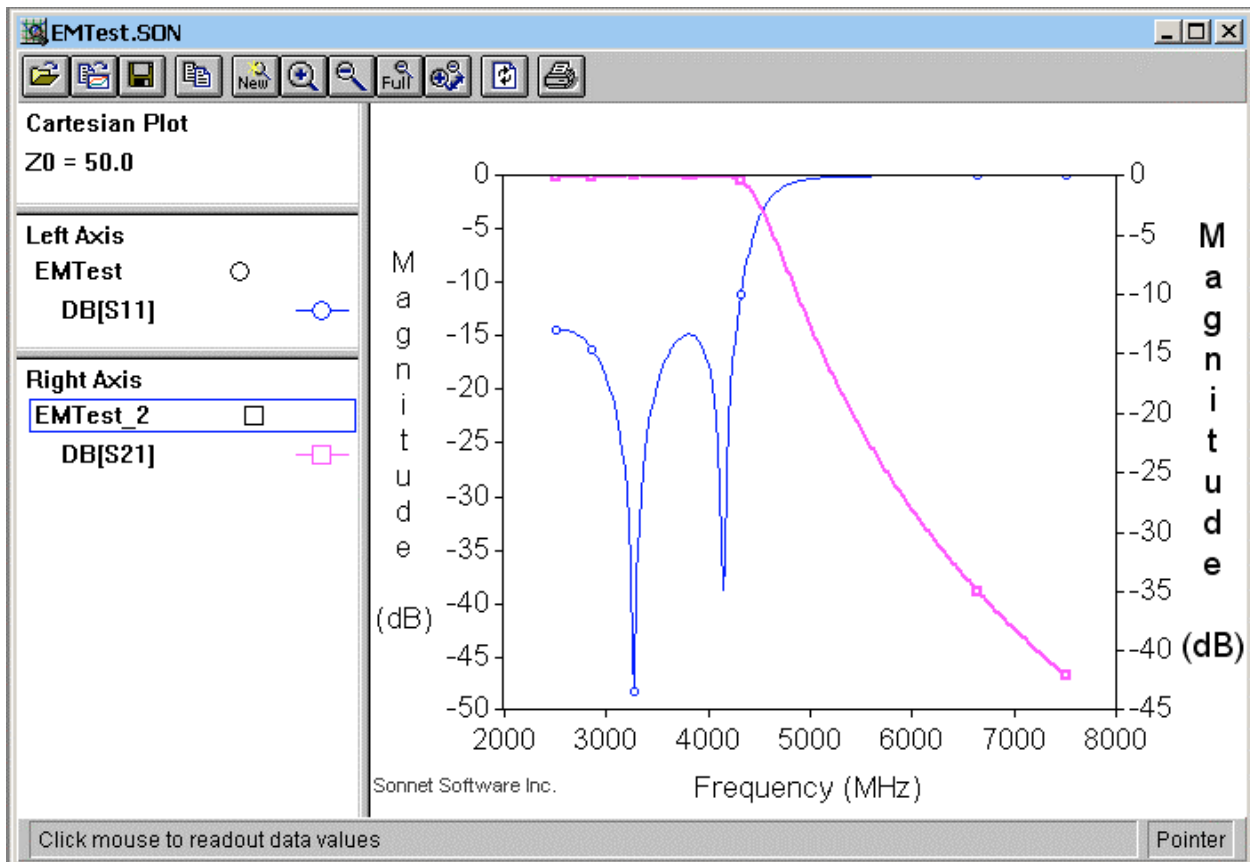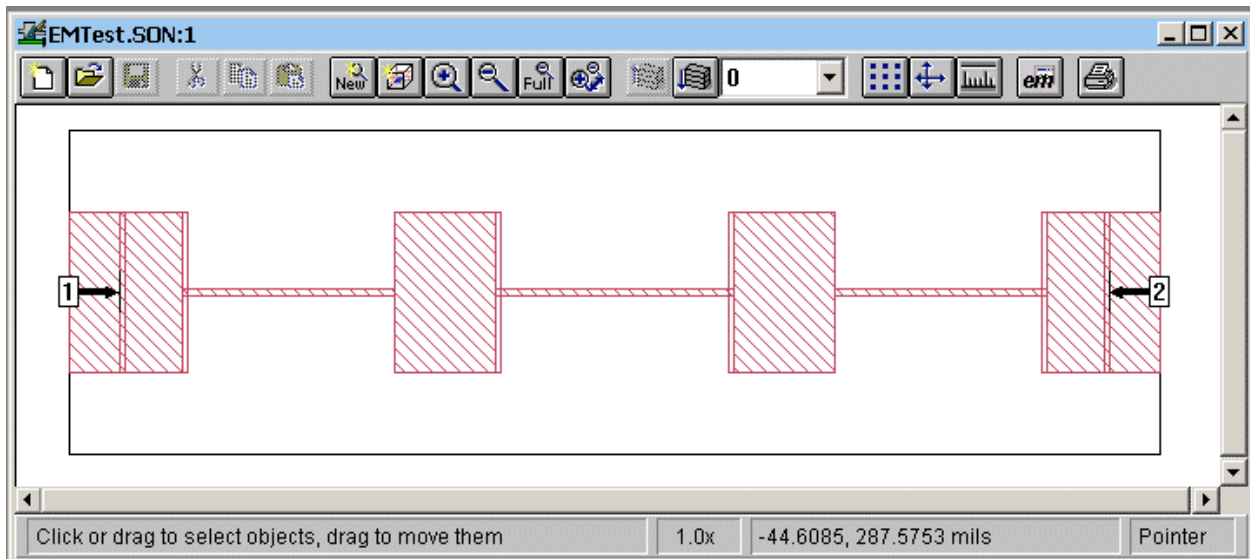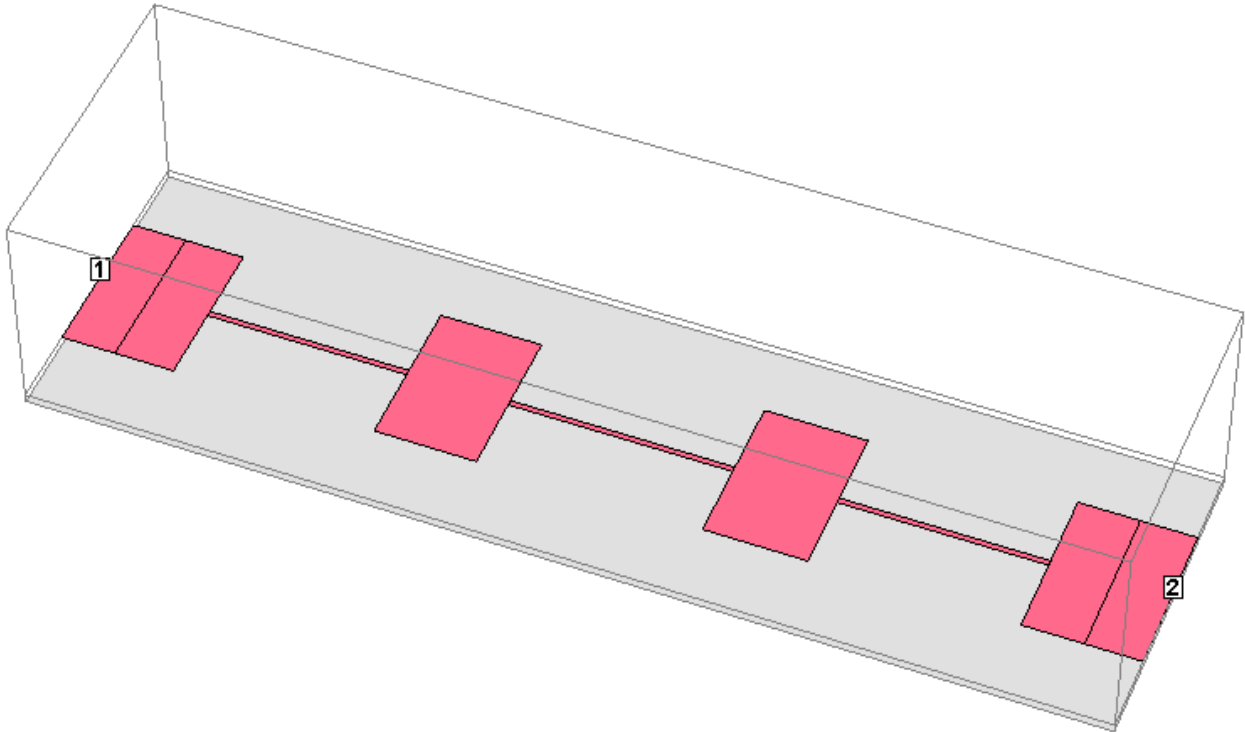
The plot of S21 shows that the filter response is lowpass with a cutoff frequency slightly ahead of the 5000 MHz design goal. The return loss (S11_dB) in the passband is 15 dB or greater.

The slight downshift in the frequency response can easily be compensated for by re-running the LINC2 synthesis again with a new frequency specification that is higher by approximately the same amount.

Optional:

Click **View | View 3D** from the Sonnet xgeom **View** menu to see the 3-D physical layout (below).

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