## **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 filter 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 3rd order distributed Chebyshev bandpass (approximately 10 - 12 GHz) filter can be specified, synthesized, and exported to the Sonnet<sup>®</sup> EM simulator for analysis in a matter of minutes with only a few menu clicks and keystrokes.

Silince Filter Synthesis - [Schematic]

File

Edit

Parts

Select

Distributed (Single-ended)

Distributed (Differential)

First, select **Distributed** (Single-ended) from the Filter menu:

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🔳 Design Sp	pecifications	×
Filter Pa	rameters	
Тор	ology Parameters Layout Other	
	Transmission Response	
	C Lowpass	
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	Bandpass     Second Se	
	O Bandstop	
	Shape Function	
	O Butterworth	
	Chebyshev	
	O Bessel	
	Synthesize Filter EXIT CANCEL	
	Click the <b>Topology</b> tab and Select <b>Bandpass</b> and <b>Chebyshev</b> .	

Click Topology and Select Chebyshev Bandpass:

Enter the detailed filter specifications:

🌃 Design Sp	ecific	ations			X				
Filter Pa	ramete	ers			1				
Тор	ology	Parameters Layout 0	ther						
	Filter Specifications								
		Cutoff Frequency, F1	10500	MHz					
		Cutoff Frequency, F2	12500	MHz					
		Attenuation at Cutoff	3.0103	dB					
		Passband Ripple	0.150	dB					
		Filter Order	3						
		Source Impedance	50	Ohms					
Click the <b>Parameters</b> tab and fill in the filter specifications as shown ( <b>Cutoff</b>									
<b>F1</b> = 10500, <b>Cutoff F2</b> = 12500, <b>Passband Ripple</b> = 0.15, <b>Filter Order</b> = 3).									

🖬 Design Specifications	×
Filter Parameters	
Topology Parameters Layout Other	
Layout Issues Edge-Coupled BandPass: Offset adjacent resonators to prevent shorts	
Synthesize Filter EXIT CANCEL	

Click the **layout** tab to review any layout issues. Make sure that the check box is checked to address the indicated layout issue.

Click the **Synthesize Filter** button and **Exit** to see the filter schematic (below).

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From	File							to p belo	hysical lines ow).	s (see schematic
Save	File			OK						



The resulting schematic is converted to all physical T-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.

				Change De-embed Length	×
😂 Ge	ometry	Layout	De-embed length = 150 (MILS);	ОК	
File	View	EM	,	Enter new length?	
		View EM B <u>o</u> x			Lancel
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		View De-embed		50	
		EM Simulation (Sonnet)		1	
		✓ <u>D</u> e-embed Enabled			
		De-embed <u>L</u> ength			

You can see the relative amount of de-embedding at each port by clicking **View De-embed** in the **EM** menu. The de-embedding view will look as shown in the figure below:

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## The LINC2 FILTER Geometry Layout

(The square boxes drawn at the vertical sides of the EM box represent each port location).

To run the EM simulation, 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<sup>®</sup> xgeom project editor ready for analysis. The EM box, metal and substrate layers and frequency parameters are already loaded. The layout in Sonnet<sup>®</sup> is shown below. Notice the black arrows pointing inward from each port. These represent the 50 mils of de-embedding that was previously selected.



The LINC2 bandpass filter design exported to Sonnet xgeom.

Simply select **Analyze** from the Sonnet<sup>®</sup> 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 has the correct bandpass response. The passband extends from about 10 GHz to slightly above 10.2 GHz as designed. The return loss (S11) in the passband is greater than 15 dB.

Because of its small physical size (line lengths are short at 10 GHz), this filter example ran in a Sonnet<sup>®</sup> simulation using only 3 Mbytes of memory, which means that it would be able to run in all versions of Sonnet, including Sonnet Lite<sup>®</sup>.

## **Optional:**

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

[Home]

