

Chapter 2

Tuning and Optimization

PathWave Advanced Design System (ADS)

PATHWAVE

What is Tuning?

Tuning is a way to change the component values and see the impact on circuit performance. This is a manual way of achieving the required performance from a circuit, which works well in certain cases.

What is Optimization?

Optimization is an automated procedure of achieving the desired circuit performance in which PathWave Advance Design System (ADS) can modify the circuit component values in order to meet the specific optimization goals. Care should be taken to select reasonable values while setting the goals. Otherwise, the optimization may not find a solution. Additionally, the optimized component values should be within the practical limits, which is typically decided by designers considering the practical limitations.

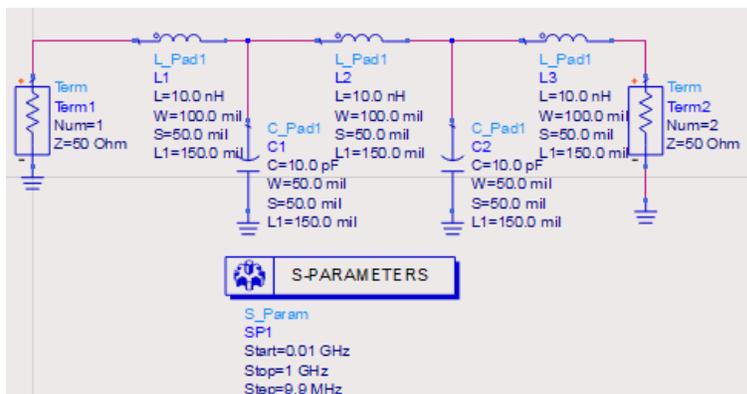


Figure 1. Schematic

Tuning in PathWave ADS

This step introduces the PathWave ADS tuning feature, which allows you to tune parameter values and see the simulation results in real time. To use this feature, first enable tuning and then select the components that will be tuned. For this section, we will use the LPF example from the previous chapter.

1. Open the LPF schematic from Chapter 1 (“Getting Stated with PathWave ADS”). Delete or deactivate  the Display Template component  **Display Template**. Press Simulate .
2. In the data display, delete all the plots and insert a new rectangular plot on top right of the palette.
3. In the window that opens, select S(1,1) and S(2,1) and click >>Add>>. When prompted, select the units as dB.

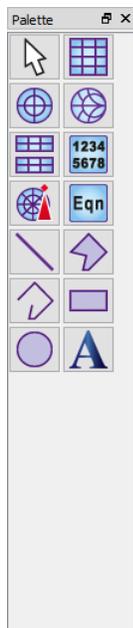


Figure 2. Data Display Palette

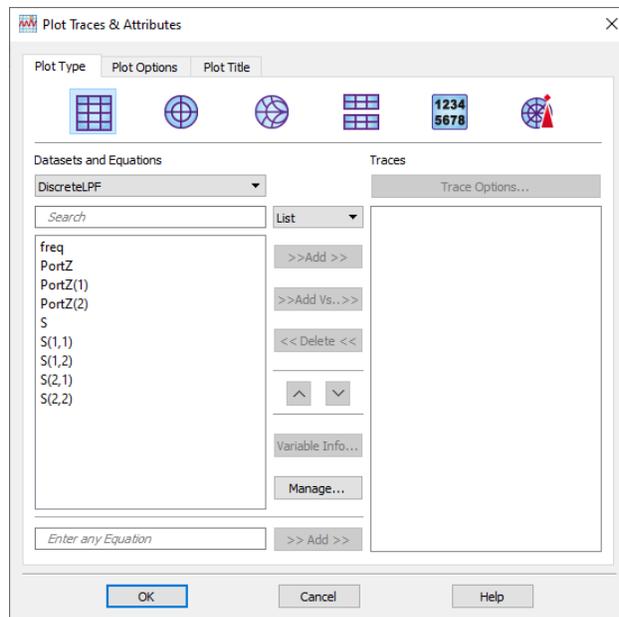


Figure 3. Adding S(1,1) and S(2,1)

4. Click **OK**. Figure 4 shows the resulting data display.

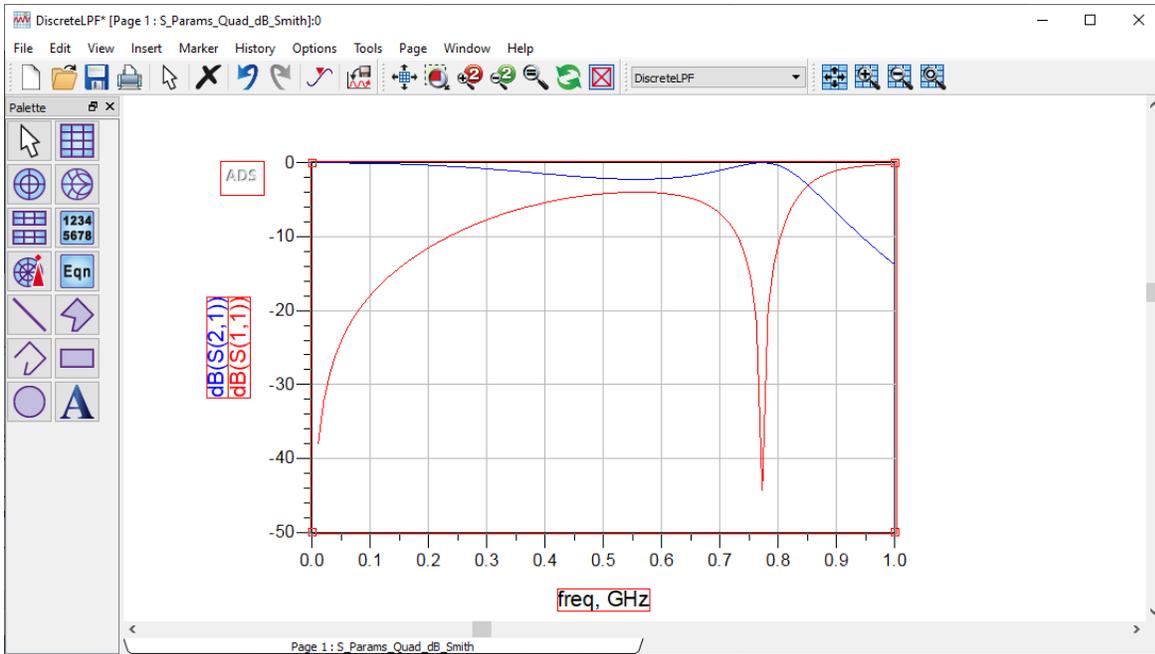


Figure 4. Plot of S(1,1) and S(2,1)

5. Return to the schematic window. Start tuning by pressing the **Tuning** icon . Position the Tune Parameters and the Schematic windows side by side.
6. Once the Tune Parameters window is open, select the capacitors and inductors from the schematic window one-by-one. After each selection, a small window will open. This window will allow you to select the Tunable Parameters for the component. In this window, click the box to select the appropriate values (i.e. select C for the capacitors and L for the inductors) and press OK. Change the max values for all components to be 150.

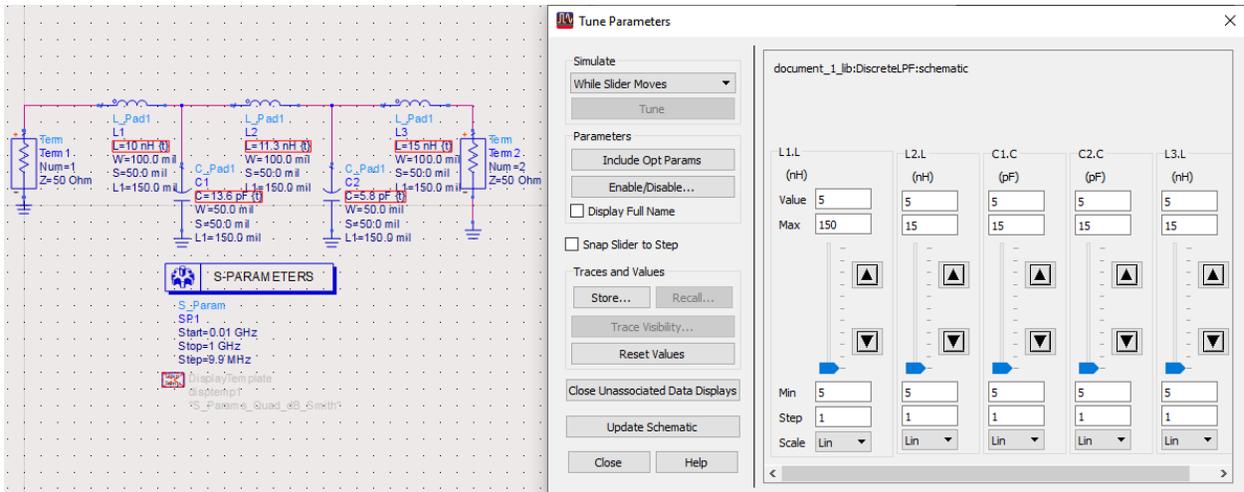


Figure 5. Tuning Window

- Open the data display window. In the Tune Parameters window, move the component value slider. The S(1,1) and S(2,1) values will update as you tune the components. This layout is shown in Figure 6.

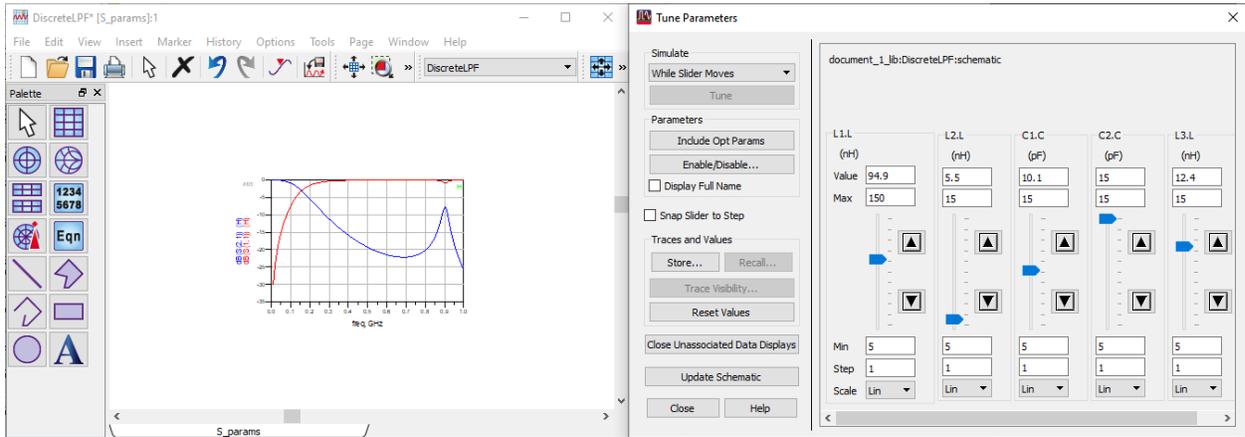


Figure 6. Plot different tuning values

- Once the desired results have been achieved, click **Update Schematic** to update the values on the schematic. If you close the Tune Parameters window without pressing **Update Schematic**, the values will return to their original values.
- Click **Close**. Note that the component values in the schematic have been updated to the tuned values.

Optimization in PathWave ADS

- Go to the PathWave ADS Main Window. Right-click the LPF cell (in this case, **DiscreteLPF**) and select **Copy Cell**. This is shown in Figure 7.

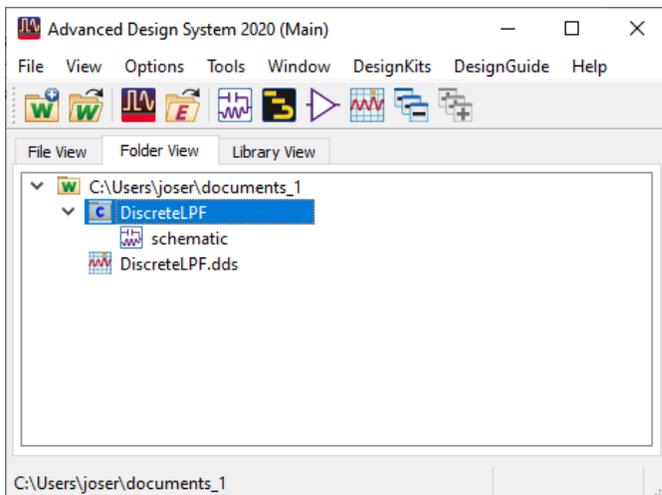


Figure 7. Main Window showing cell to be copied

- The Copy Cell window will open. Name the copied cell **DiscreteLPF_Opt**. Note that if the cell is hierarchical, then we should use the option **Include Hierarchy...**. If the workspace has folders, then you can copy this into the specific folder by clicking on **Choose Folder**. This window is shown in Figure 8. Click **OK**.

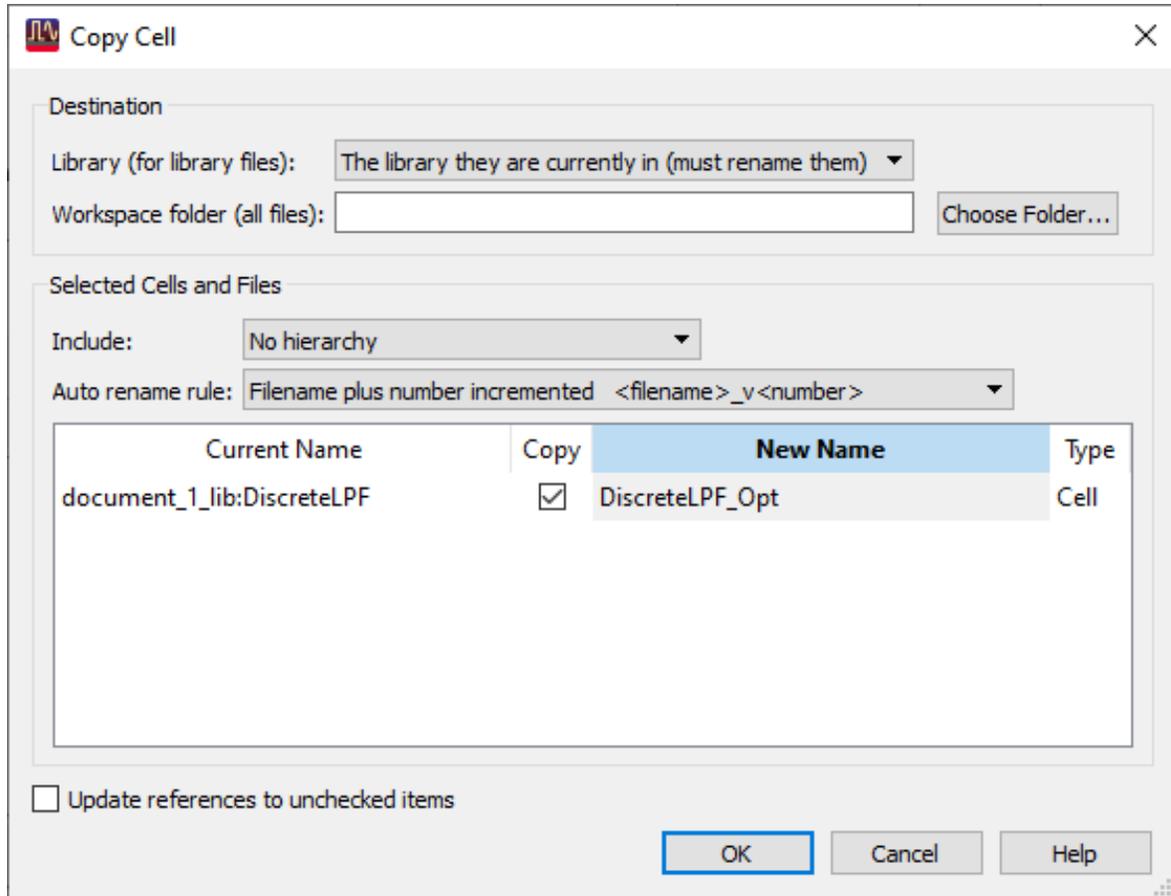


Figure 8. Copy Cell

- Return to the Main Window. The cell has been copied and appears in the list with the new name. Open the schematic. In the parts selector (on the left), select **Optim/Stat/DOE**. This window is shown in Figure 9. Click on **Goal**. Click to place the **Goal** block in the schematic. Use the same process to add a second Goal block to the schematic.



Figure 9. Optim/Stat/Doe Palette

Step 1 - Setting Goals

1. We are going to set two goals. Open the first goal block. This goal block is shown in Figure 10. Set the following parameters for the goal. When finished, press **OK**.

Expression: $\text{dB}(S(1,1))$

Analysis: SP1

Limit 1: < -20

2. Open the second goal block. This goal block is shown in Figure 11. Set the following parameters for the goal. When finished, press **OK**.

Expression: $\text{dB}(S(2,1))$

Analysis: SP1

Limit 1: > -1 (from 0.01 GHz to 0.2 GHz)

Limit 2: < -30 (from 0.4 GHz to 1.0 GHz)

3. From the Parts palette, insert an **Optim** block. This is needed to start the optimization.

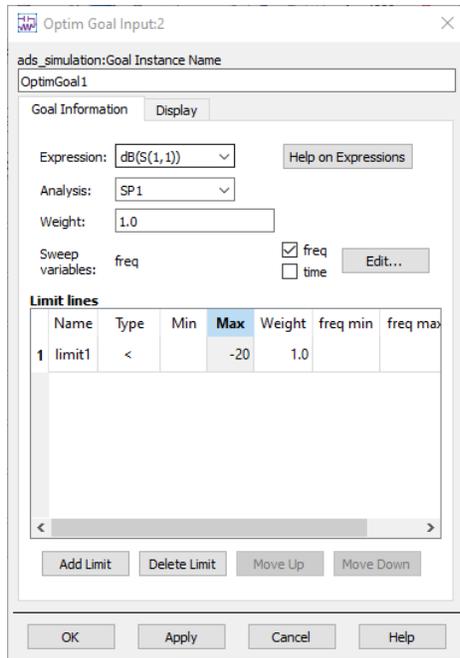


Figure 10. Goal 1

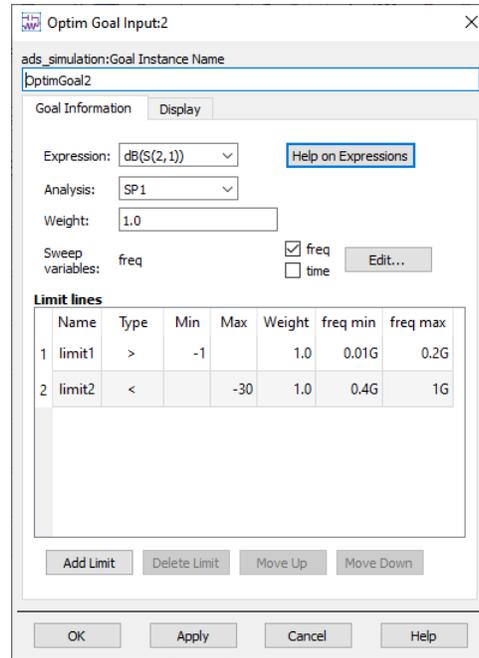


Figure 11. Goal 2

Step 2 – Setting Controller

1. Double-click the Optimization controller and set parameters as below:

Optimization Type = Gradient

Number of Iterations = 2000

2. Go to the **Display** tab and select **Clear All**, which will uncheck all options.
3. Select **OptimType** and **MaxIters**. This will clean up the schematic, so that we only see the important information. This is shown in Figure 12. Click **OK**. The updated schematic is shown in Figure 13.

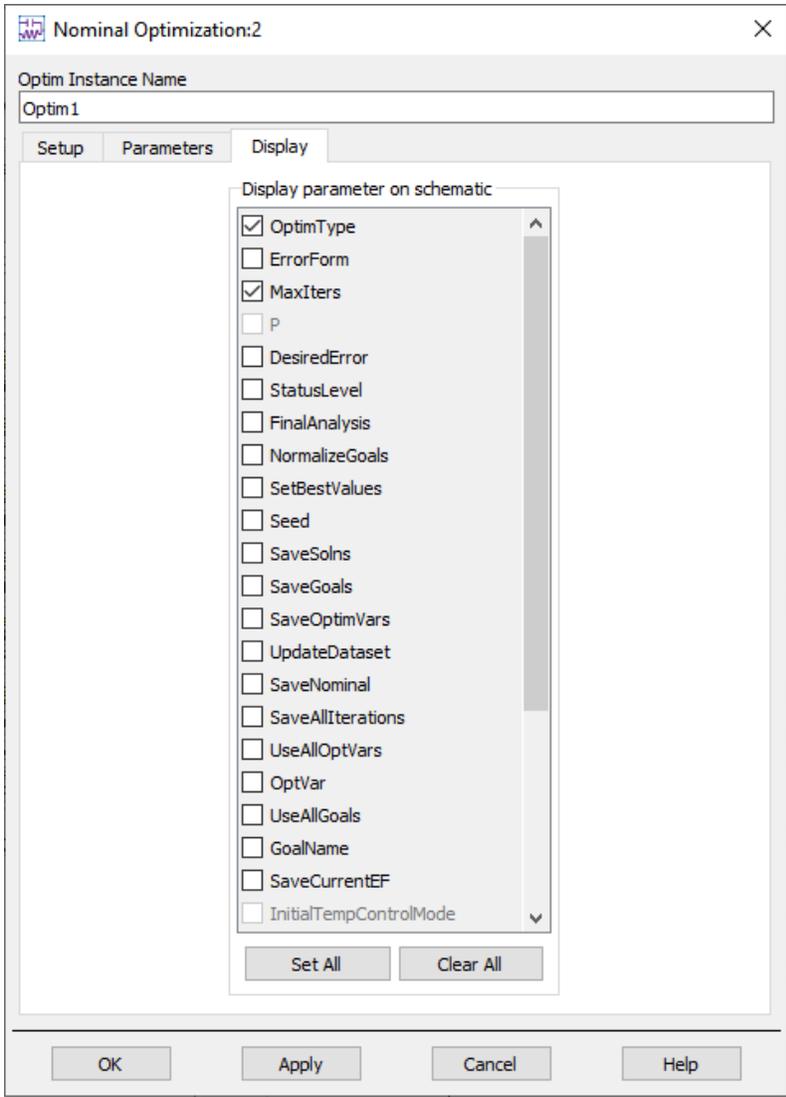


Figure 12. Optimization Controller

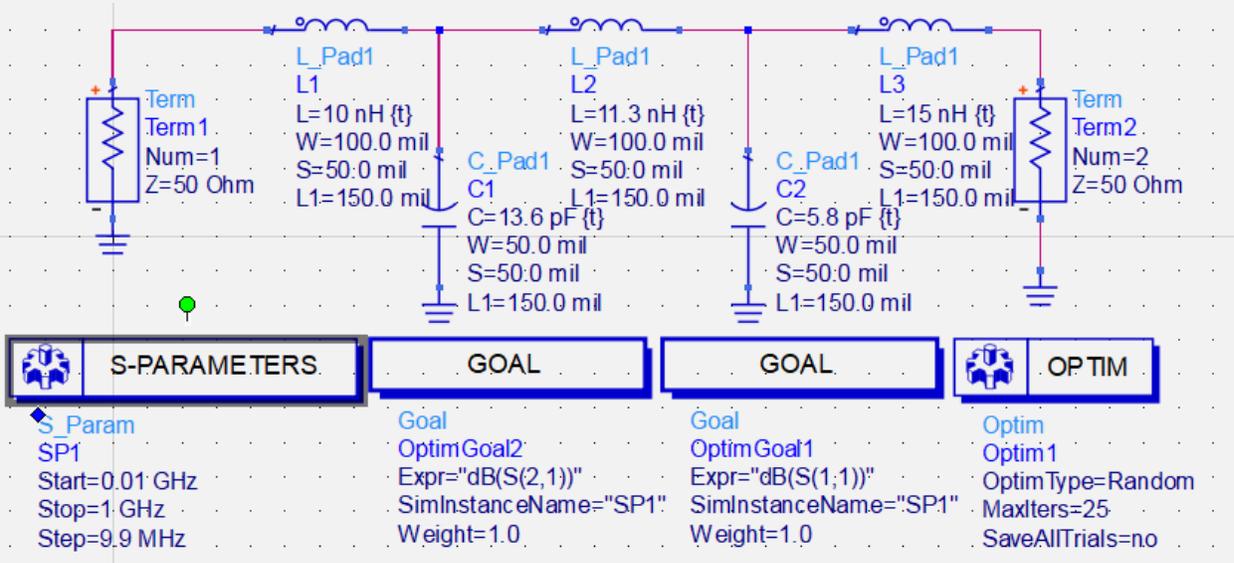


Figure 13. Schematic after tuning

Step 3 – Define Component Values

1. Go to **Simulate > Simulation Variables Setup**.
2. Instead of setting the optimization for each component individually, this window allows you to set several tuning or optimization variables at once. Click the **Optimization** tab. Check the **Optimize** box for the inductors and capacitors. Set the optimization values to match Figure 14. Press **OK**.

The Simulation Variables Setup window shows the Optimization tab with the following data:

Name	Optimize	Value	Unit	Format	Min/+/-	Unit	Max	Unit	Step	Unit
MyLibrary_lib:cell_1:schematic										
Term1										
Z	<input type="checkbox"/>	50	Ohm	min/max						
Term2										
Z	<input type="checkbox"/>	50	Ohm	min/max						
L1	<input checked="" type="checkbox"/>	65.9	nH	min/max	10	nH	150	nH		
L2	<input checked="" type="checkbox"/>	58.65	nH	min/max	10	nH	150	nH		
L3	<input checked="" type="checkbox"/>	5	nH	min/max	5	nH	150	nH		
C1	<input checked="" type="checkbox"/>	60.1	pF	min/max	1	pF	100	pF		
C2	<input checked="" type="checkbox"/>	42.7	pF	min/max	1	pF	100	pF		

Figure 14. Variables Schematic

Step 4 – Optimize

1. Click the Optimize button  in the schematic toolbar.
2. The Optimization Cockpit window will open. This window shows the process of the optimization, as well as the current component values as the optimization progresses. The optimization will continue until the goals are met or the maximum number of iterations is reached.

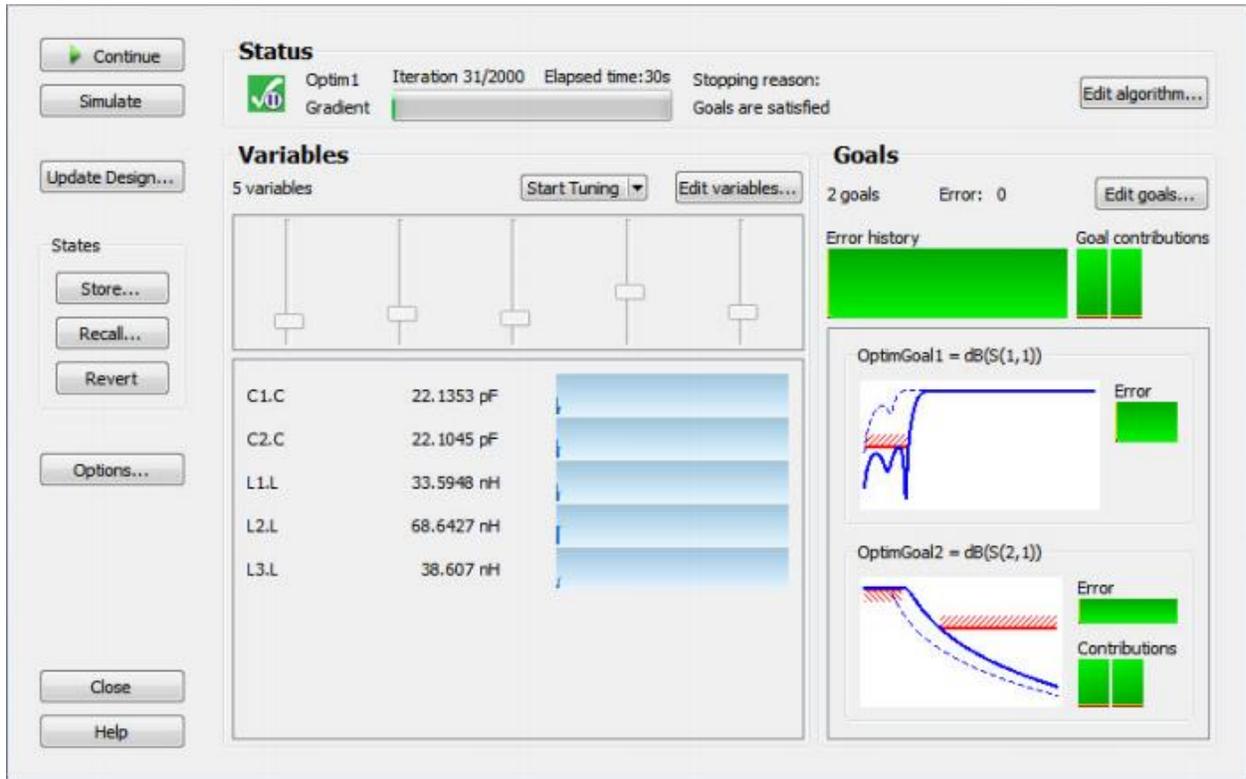


Figure 15. Optimization cockpit

3. Once the optimization stops, click **Close**. Select **Update the Design** when prompted.
4. In the data display, add rectangular plots and show $S(1,1)$ and $S(2,1)$. Check the circuit performance against the optimization goals. Add markers from the Marker toolbar  to analyze the graphs. The final plot is shown in Figure 16.
5. Save all your work by going to **File > Save All** from the PathWave ADS Main Window.

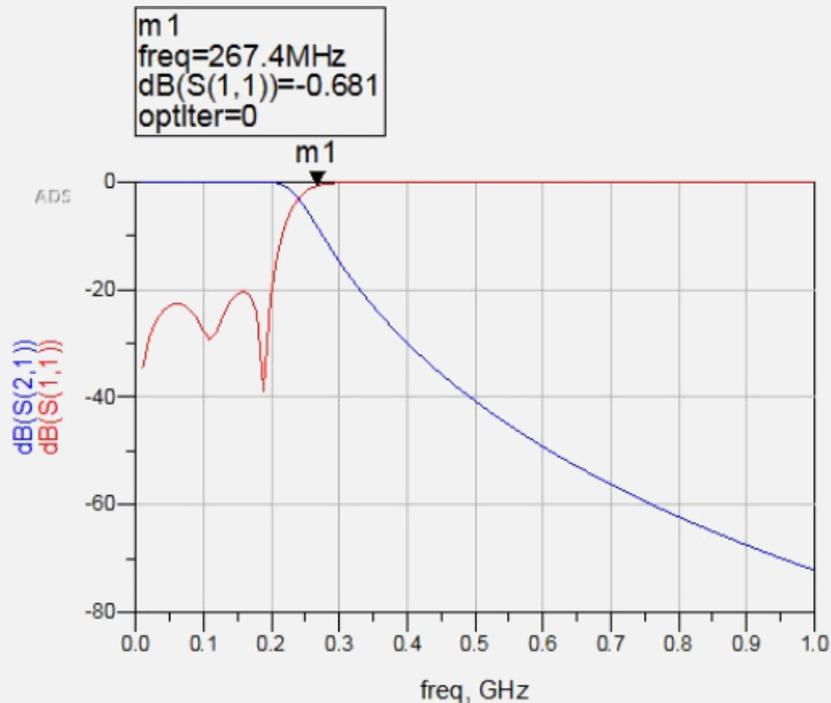


Figure 16. Plot of S(1,1) and S(2,1) for the optimized design

Notes

You can simplify the Optimization Goals setup, involving Optimization Goals and Controller, by saving this as a template. To do so, place the components on a new blank schematic and go to File > Save Design as Template.

This template can be inserted into any workspace by going to Insert > Template.

Conclusion

Congratulations! You have completed Tuning and Optimization.

Check out more examples:

www.keysight.com/find/eesof-ads-rfmw-examples

Learn more at: www.keysight.com

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