Model Rap™ Modelithics®

Modelithics® World's Best RF & Microwave Simulation Models

Streamline Filter Design with Ansys Nuhertz FilterSolutions and Modelithics Models

October 2022

If designing RF/microwave filters happens to be one of the tasks you're faced with, you may be in search of a good tool that can help streamline the design process. If that's you today, you may want to look no further than Ansys® Nuhertz FilterSolutions. With Ansys Nuhertz FilterSolutions, designers have a tool that makes it possible to automatically design various types of filters.

While FilterSolutions can be used to design several types of filters, this blog post will focus specifically on lumped-element filters. And more specifically, we'll look at how lumped-element filters can be designed using FilterSolutions together with Modelithics Microwave Global Models™ for RLC components. The design process involves first synthesizing the filter with FilterSolutions and then exporting it to Ansys Electronics Desktop (AEDT). In AEDT, the filter can be optimized to achieve the desired performance.

So now that we've spoken about it, let's see this design flow in action. Figure 1 shows the FilterSolutions user interface when using the quick panel, known as FilterQuick. Keep in mind that FilterSolutions also offers a more advanced panel that you may want to take advantage of. But for this example, we'll stay with the FilterQuick panel.

For lumped synthesis, which is what we've chosen here, FilterSolutions requires you to choose from a number of topologies, including Classical, Equal Inductors, Equal Shunt Legs, High/Low Pass, and others. For this example, we'll select the Equal Shunt Legs topology.

Of course, we'll need to enter the parameters for the design. For this example, let's specify a passband frequency of 1.1 GHz and a passband width of 300 MHz. We'll also make this a fifth-order filter. Figure 1 shows the synthesized filter after entering these parameters. Figure 1 also shows the synthesized filter's frequency response.

Contact Us:
Modelithics, Inc.
3802 Spectrum Blvd., Suite 130
Tampa, FL 33612
blogs@modelithics.com
www.modelithics.com

About the Author

Chris DeMartino
Sales & Applications Engineer, Modelithics, Inc.

Chris DeMartino is a Sales and Applications Engineer at Modelithics. His experience includes developing and testing RF/microwave components and assemblies for various applications.

Have another topic that you would like Modelithics experts to cover? Email your suggestions to the **Modelithics Blog Team** and it could be featured in an upcoming post. Please include your contact information in the body of the email.

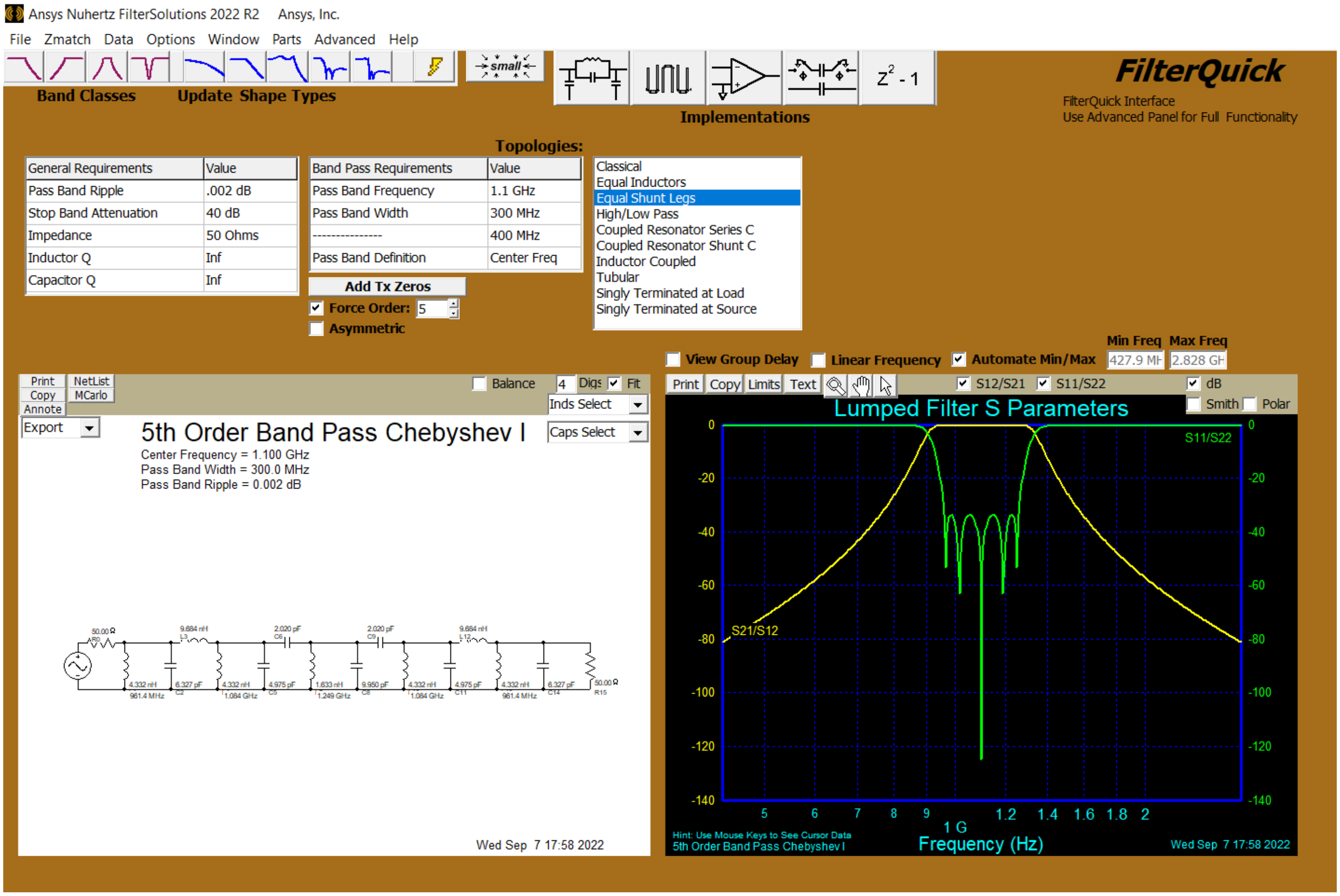

Figure 1. FilterQuick user interface.

Now that we've used FilterSolutions to synthesize our filter, the next step is to export it to AEDT. We can do this by clicking the "Export" dropdown menu (shown in Fig. 1) and then selecting "Setup for AEDT." This will take us to the AEDT interface (Fig. 2).

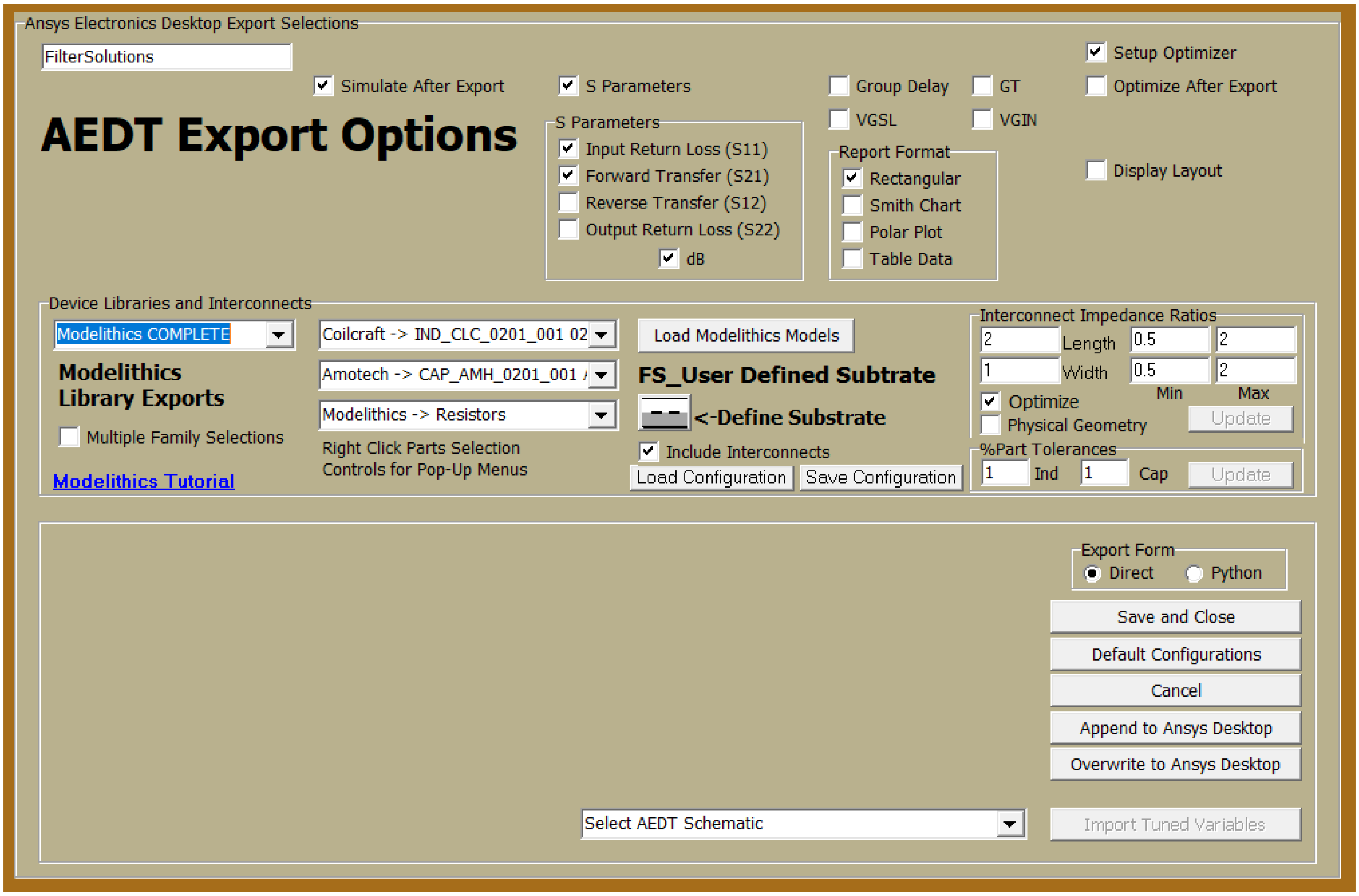

Figure 2. AEDT user interface within FilterSolutions.

After we arrive at the AEDT interface, we'll first want to select the Modelithics COMPLETE Library™ from the dropdown menu labeled "Device Libraries and Interconnects." Doing so will allow us to use the Modelithics models in our design. After loading the models, we'll need to select the specific part families we wish to use. For this design, let's use the Coilcraft 0201DS series for the inductors and the Amotech A60Z series for the capacitors.

After defining the substrate—which in this case is 6.6-mil-thick Rogers RO4350B—we can export the design to AEDT. The exported filter will include the Modelithics models along with the necessary microstrip interconnects. In AEDT, we'll simulate the filter and then optimize it to meet our performance requirements. Note that we've selected the "Setup Optimizer" checkbox so that the optimization configuration will be created for us in AEDT (Fig. 2, again).

As you would expect, the optimization process will involve adjusting the component values to optimal values. On top of that, it's also possible to optimize the dimensions of the microstrip interconnects by selecting the "Optimize" checkbox under the "Interconnect Impedance Ratios" label. With this option enabled, the optimization process would involve adjusting both the component values and the microstrip interconnect dimensions.

As a side note, it's generally more effective to first optimize only the component values. In some cases, it may not even be necessary to optimize the interconnect dimensions if part-value optimization alone allows the design goals to be met. To optimize only the part values of the components, simply uncheck the "Optimize" checkbox we just mentioned. If the performance is not satisfactory after optimizing the part values, you'd want to return to FilterSolutions and select the "Optimize" checkbox to enable interconnect geometry optimization. You would then click the "Update" button located next to the "Optimize" checkbox. After that, return to AEDT and perform a second optimization to also adjust the interconnect dimensions so that you can meet your design goals.

Now that we've said all that, Figure 3 shows the filter schematic in AEDT after the filter is exported from FilterSolutions. Notice the schematic includes Modelithics Microwave Global Models for all the components along with the microstrip interconnects. Figure 4 shows the simulated results.

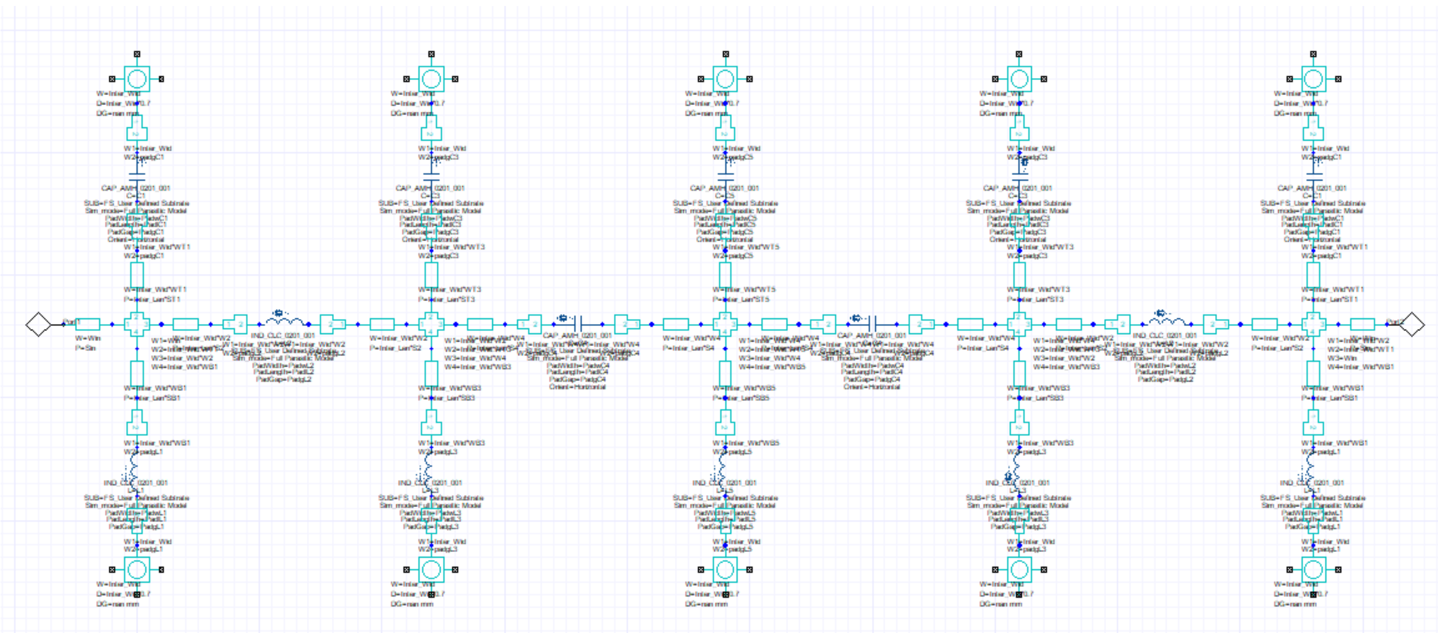

Figure 3. Filter schematic in AEDT after exporting from FilterSolutions.

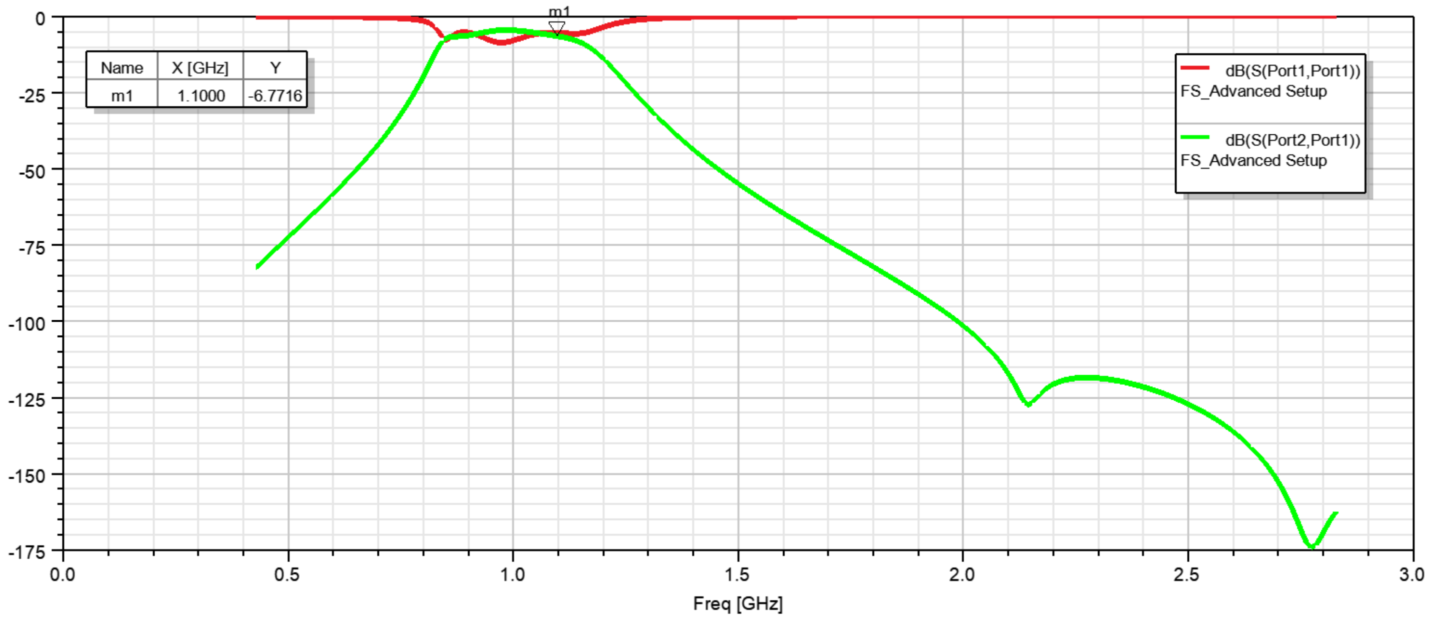

Figure 4. Simulating the filter in AEDT after exporting produces these results. The design goals are not being met.

We can clearly see that we're not meeting our design goals. Remember that we want a center frequency of 1.1 GHz. So, we'll need to optimize the filter to meet our requirements. As mentioned earlier, the optimization setup has already been created for us. Optimization goals have been set for both the passband and the stopband. Of course, you can modify the optimization goals as you see fit. Variables are created to correspond to both the component values and the microstrip interconnect dimensions. These variables are what the optimizer will adjust to meet the desired performance. Keep in mind that the optimization is configured so that the part values are only adjusted to real-life manufacturer part values.

So, let's now optimize this filter. In this case, we'll follow the two-step process described earlier. That is, the first optimization will only adjust the part values. A second optimization will then be performed to also adjust the interconnect dimensions.

Figure 5 shows the frequency response of the filter after the optimization process is complete. We're now meeting our design goals. A further point to mention is that you can also perform an EM/circuit co-simulation as a final verification if you're interested. We won't spend time diving into that here, but you can check out the associated project file to see the EM/circuit co-simulation results. You'll see that the EM/circuit co-simulation results are consistent with the results of the circuit simulation. Finally, Figure 6 shows the layout of the filter.

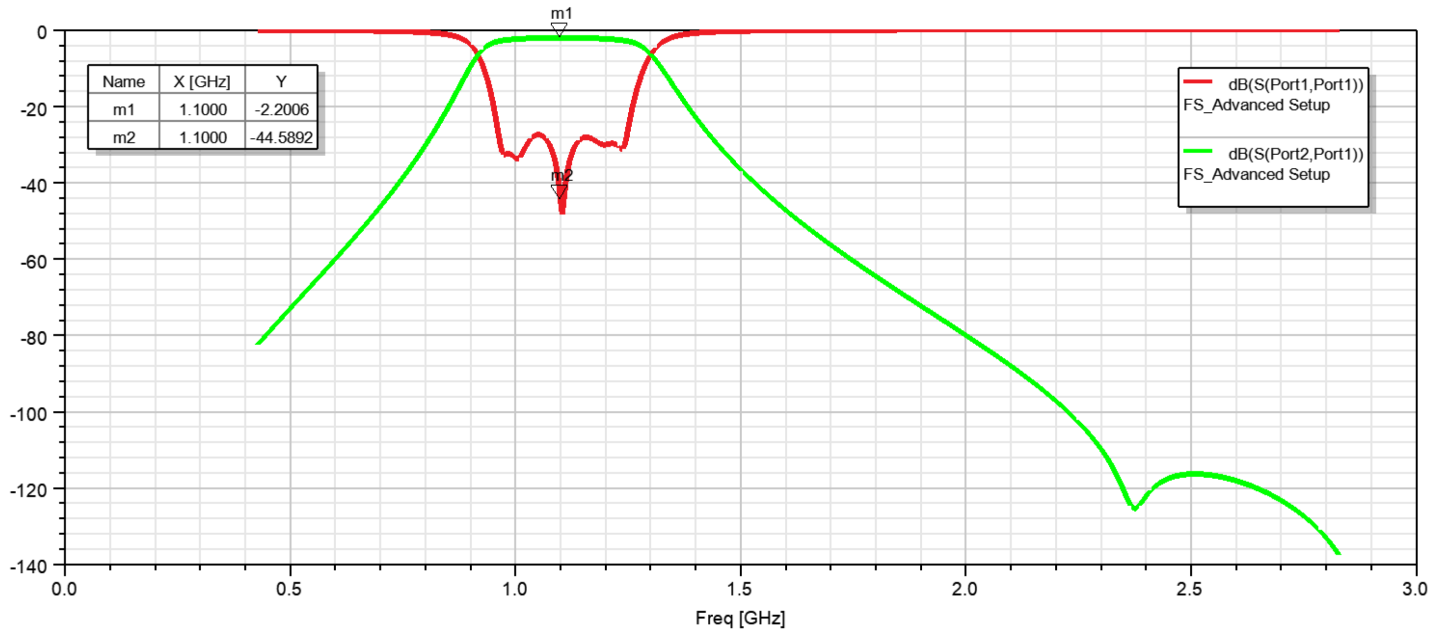

Figure 5. Simulated results after optimizing.

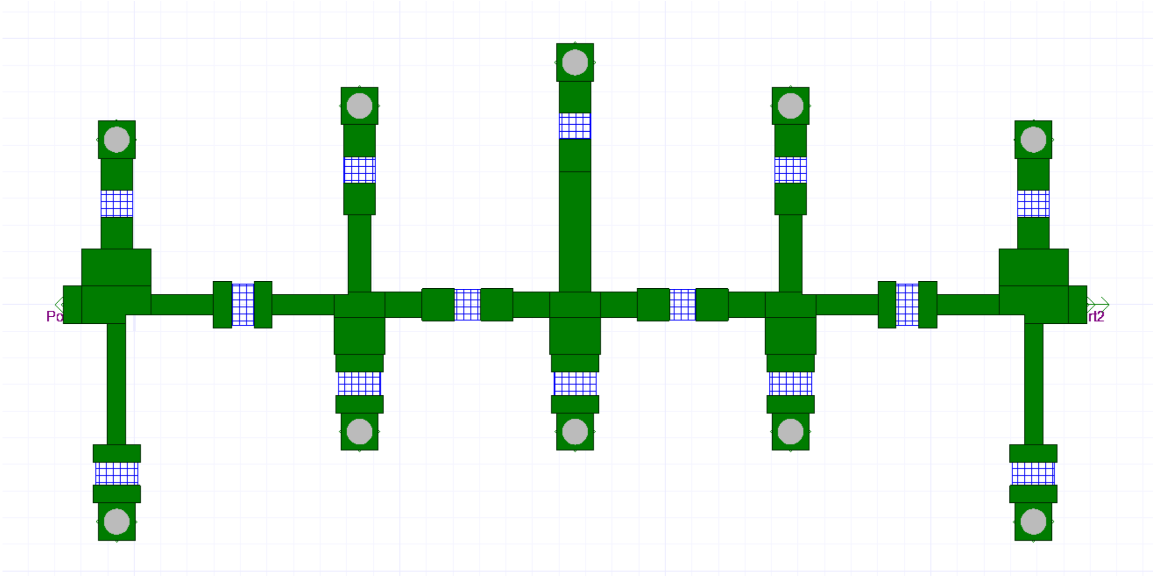

Figure 6. Filter layout.

To wrap it all up, we've shown how the combination of Ansys Nuhertz FilterSolutions and Modelithics Microwave Global Models allows for a simple and efficient way to design lumped-element filters. For more on this topic, be sure to check out our video titled, "Filter Design with Ansys Nuhertz FilterSolutions and Modelithics Microwave Global Models." Also, be on the lookout for a future application note that will compare measured data with final simulation results.

References

1. I. Bedford, "Application Note 054: Modelithics CLR Library in ANSYS HFS." Modelithics literature: https://www.modelithics.com/Literature/AppNote.

2. B. Weedon, C. DeMartino, "A Case Study in Successful First-Pass Filter Design." Microwave Product Digest, Jan. 2021.

3. I. Bedford, L. Levesque, L. Dunleavy, J. Kahler, "Synthesize Filters with Wideband Success." Microwaves & RF, 2014.