Uncovering the ExpertMode Parameter for Filter Optimization, Part 1

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Modelithics Microwave Global Models™ in Cadence® AWR Design Environment® include a parameter called “ExpertMode” that you may not even know about. That’s because this parameter hasn’t been discussed up to this point. However, in this blog post, we’ll introduce you to the ExpertMode parameter and explain why it’s included within Modelithics Microwave Global Models. In Part 2, we’ll continue further by presenting a design example to demonstrate a complete workflow in which the ExpertMode parameter is utilized.

Figure 1 shows the parameters for the Microwave Global Model for the Presidio 0402UP capacitor series. Shown here are all the secondary model parameters, which can be made visible by clicking the appropriate icon at the upper left of the window. Included among these secondary model parameters is the ExpertMode parameter.

The ExpertMode parameter includes several different settings. When set to the default value of 0, the model simply defaults to the Sim_mode parameter. Setting the ExpertMode parameter to 1 removes equivalent series resistance (ESR) from the model, while setting it to 2 removes equivalent series inductance (ESL). In addition, setting ExpertMode to 3 removes both ESR and ESL from the model.

Let’s focus on the ExpertMode setting that removes just ESR from the model because this is the setting we will be using later. Using this setting to remove ESR enables the model to function as a “lossless” model. Be aware that although ESR is removed, the rest of the model’s functionality remains intact.

Now that we’ve given a brief introduction to the ExpertMode parameter, you probably would like to know why this parameter is included in the first place. The ExpertMode parameter was added at the request of DGS Associates, a design and consulting services company that specializes in RF/microwave filter design and offers associated filter design and optimization software.

Here, we’ll focus on the firm’s filter optimization software, known as Equal Ripple Optimization. While this software is available for use in conjunction with several RF/microwave simulators, the focus here will be using Equal Ripple Optimization together with Cadence AWR Design Environment. Figure 2 shows the Equal Ripple Optimization user interface.

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Chris DeMartino is a Sales and Applications Engineer at Modelithics. His experience includes developing and testing RF/microwave components and assemblies for various applications. In addition, Chris spent several years working as a technical editor for an industry publication, making him well equipped to create useful technical content. Some of his roles at Modelithics include designing application circuits, writing technical articles and application notes, and creating demonstration and tutorial videos. Chris has a B.S. in Electrical Engineering from the State University of New York at Binghamton and an M.S. in Electrical Engineering from Polytechnic University.

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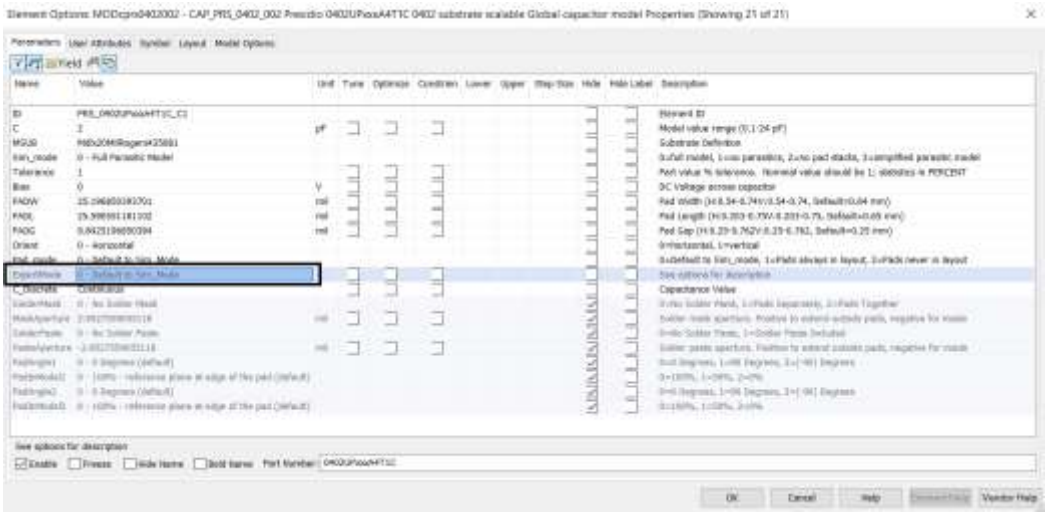

Figure 1. These are the parameters for the Microwave Global Model for the Presidio 0402UP capacitor series. The ExpertMode parameter is among the secondary parameters.

Figure 2. User interface for the Equal Ripple Optimization software.

Equal Ripple Optimization can be used to optimize bandpass, lowpass, and highpass filters. It can also be used to optimize diplexers and multiplexers. What's unique about Equal Ripple Optimization is that it finds an exact equal-ripple response in the filter passband. When a filter of order N has an equal-ripple passband, we expect to see N return loss zeros and N − 1 return loss peaks between those zeros. The return loss peaks are all at the same level, which is defined as the equal-ripple return loss of the filter.

Let's illustrate this by showing a lumped-element bandpass filter as an example (Fig. 3). Figure 3 also shows the filter response after optimizing the filter with the Equal Ripple Optimization software. Notice how the response has four return loss zeros. Between those zeros, we have three return loss peaks at equal levels.

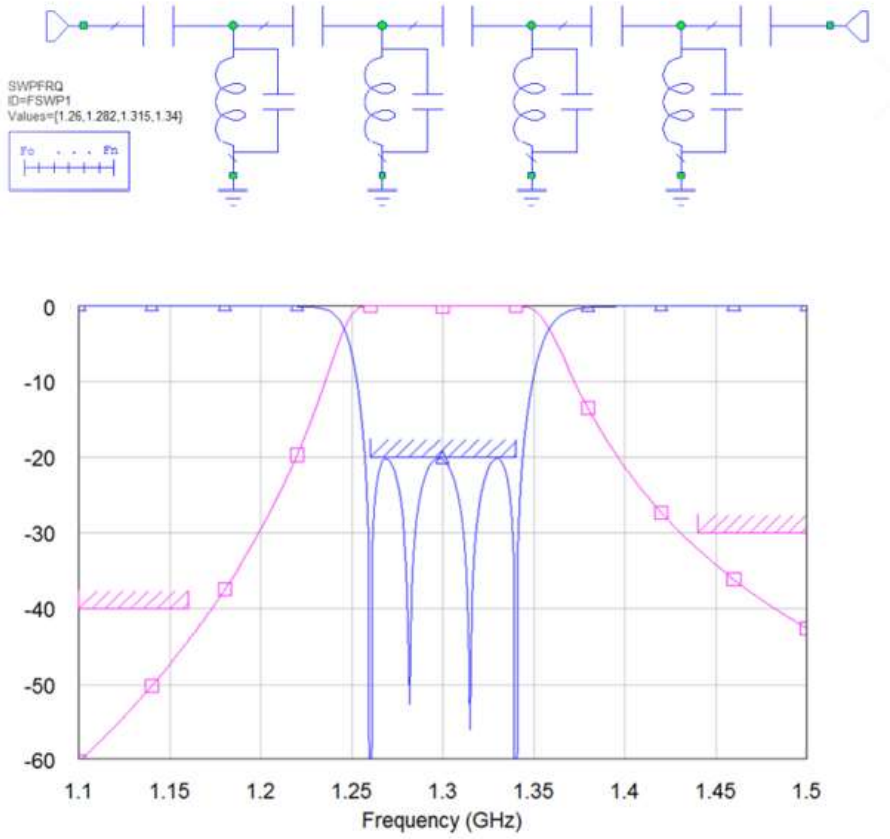

Figure 3. Lumped-element bandpass filter (top) along with the filter response (bottom) after optimizing with the Equal Ripple Optimization software.

So, we've introduced both the ExpertMode parameter and the Equal Ripple Optimization software. But what do they have to do with one another? Let's explain. When using Equal Ripple Optimization, one of the basic rules is that the filter you're trying to optimize should generally be lossless. This is because the math used to find the filter transfer function is exact only for lossless scenarios. (Note that for a symmetrical filter of order N defined by N variables, it is still possible to optimize with loss.)

Therefore, since Equal Ripple Optimization is designed to work for lossless networks, the ExpertMode parameter should be utilized when optimizing a design with Microwave Global Models to allow for simulations with lossless component models. After performing an optimization, the loss is then turned back on (i.e., set ExpertMode back to 0) for the final simulation.

As an example, Figure 4 shows the schematic of a lumped-element diplexer in Cadence AWR Design Environment. Here, we are using Microwave Global Models for the Presidio 0402UP capacitor series and TDK MHQ1005P inductor series. Figure 5 shows the response after optimizing with Equal Ripple Optimization. The ExpertMode parameter of all models was set to 1 before running the optimization. Note that this diplexer cannot be optimized with Equal Ripple Optimization when the component models are not lossless.

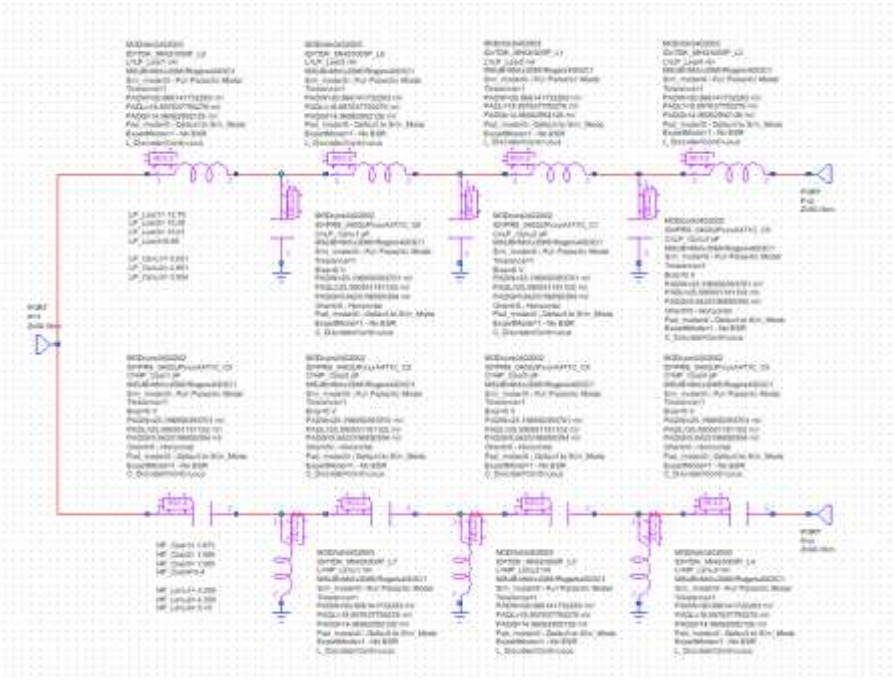

Figure 4. Diplexer schematic with Microwave Global Models. The ExpertMode parameter is set to 1 for all models.

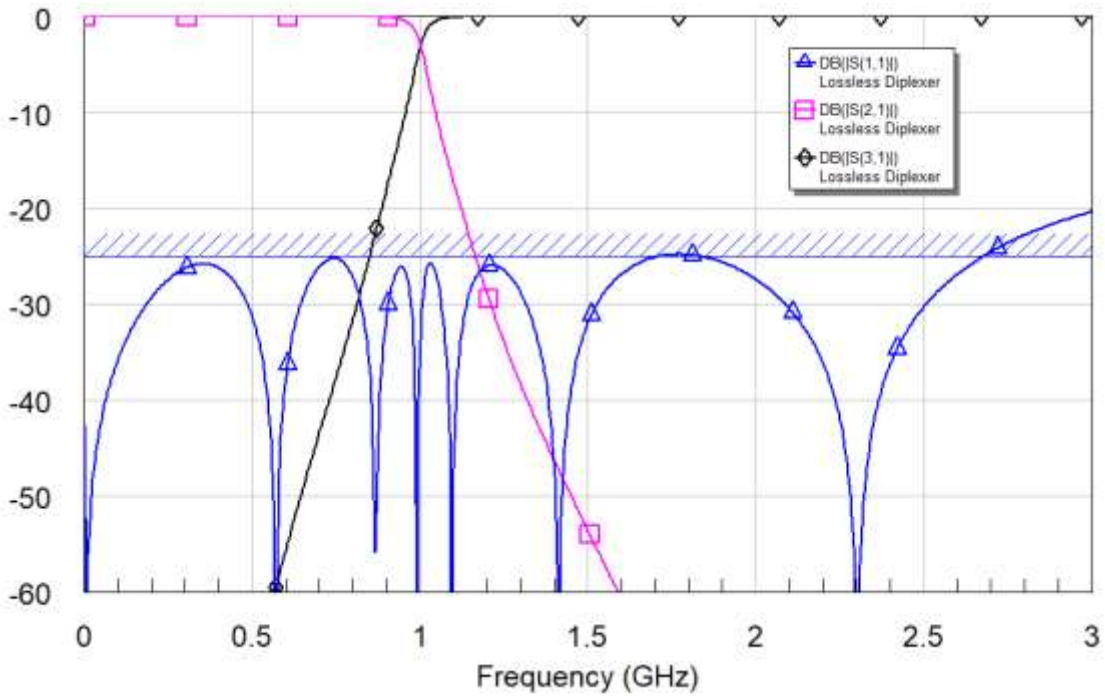

Figure 5. Simulated results after optimizing the diplexer with the Equal Ripple Optimization software.

Of course, the design process is not yet complete, since we still need to add the microstrip interconnections and vias to the design. In Part 2, we'll continue by demonstrating a complete workflow that involves using lossless component models in conjunction with the Equal Ripple Optimization software from DGS Associates. In the meantime, be sure sure to check out other content from the Modelithics website that focuses on using Microwave Global Models within Cadence AWR Design Environment, such as Application Note 66 titled, "Filter Design Using Discrete Part-Value Optimization in Cadence AWR Design Environment" and Application Note 73, titled "Filter Design Flow in Cadence AWR Design Environment with Substrate Scalable Models."