



Application Note

FilterSolutions® Designs Using “Defected Microstrip Structures”

March 2018

Nuhertz Technologies has introduced a feature in its FilterSolutions® program to deal with design of filters utilizing Defected Microstrip Structures (DMS). When used with AWR’s Microwave Office®, this new modeling capability enables engineers to achieve the accurate synthesis of stripline, microstrip or suspended substrate filter designs in which the use of these resonators proves to be advantageous. The design of these distributed element filters is one of the many capabilities of FilterSolutions. The software also can synthesize the designs of lumped element, active or digital filters.

We are presenting an example of a hairpin resonator microstrip bandpass filter. In this example we will use an unmodified resonator, and then the same filter in which the resonators have been modified to use a T-shaped notch ‘defect’ in the conductors.

The hairpin example (see Figure 1) shows the inherent problem for distributed designs at frequencies far above the design passband frequency. With a design frequency at 1GHz, we see other spurious pass bands at 2GHz and again at 3GHz. If we were to extend the frequency range being examined, we would continue to see spurious passbands at every multiple of the 1 GHz design frequency. At some point, natural parasitic effects will suppress the pass bands, but the lower frequency parasitic passbands would likely continue to be a design problem.

Our thanks to National Instruments’ AWR design group for the use of AWR’s Microwave Office and AXIEM® software tools in the AWR Design Environment, as will be noted.

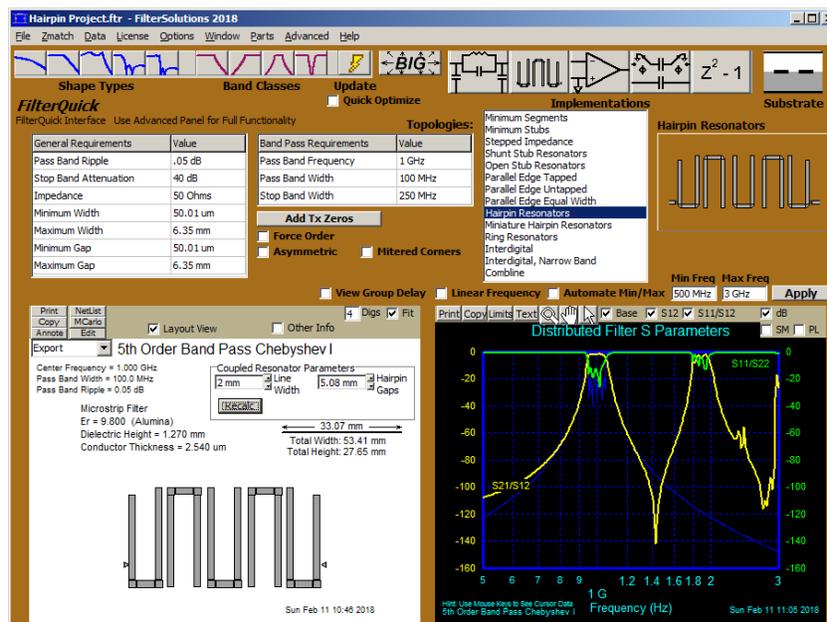


Figure 1: Spurious Pass Bands shown in FilterSolutions design Interface

A major advantage of using DMS in filter designs is to minimize spurious pass bands, or modes, in the frequency response. Such designs are often useful in wide band applications where frequencies much higher than the pass band must continue to be suppressed.

The DMS resonators form a notch inside the resonators of the main filter, tuned to a spurious frequency, which suppresses the spur. Any spurious frequency may be targeted by the DMS notch filter. FilterSolutions provides automated tuning for the first spurious mode. The parasitic issues are particularly handled by adding transmission zeros to the legs of the inductor sections.

Figure 2, below, is the layout of a coupled resonator section in the AWR Microwave Office program. Here we see an example that has two embedded DMS resonators tuned to the first spurious frequency.

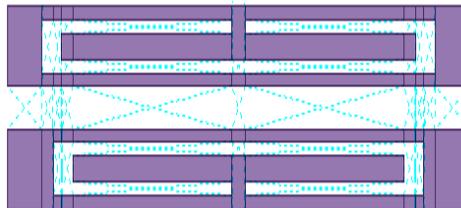


Figure 2: DMS notch resonators embedded inside a coupled resonator section as shown in Microwave Office Layout

After designing the network in FilterSolutions, the filter will be exported to Microwave Office by using the “AWR Export Selections” control panel in FilterSolutions. We have chosen “Use DMS Resonators” in the dialog box, as shown in Figure 3:

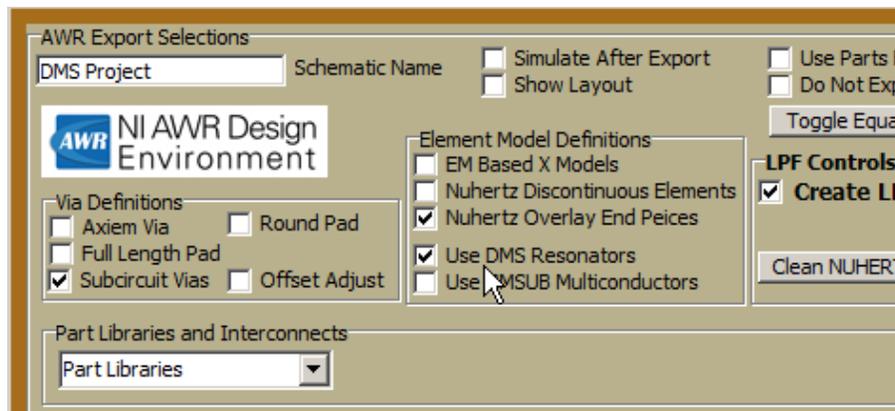


Figure 3: Selecting DMS Resonators from the FilterSolutions’ AWR Export Selection Control Panel

Spurious frequency suppression is best handled with fine tuning in a good optimizer. Given that the DMS will contribute its own parasitics to the circuit, the coupling between the transmission line resonators and other optimization targets need to be optimized, taking these parasitic responses into account. FilterSolutions utilizes NI AWR[®] software to further analyze and optimize the synthesized design for rigorous circuit simulation, electromagnetic analysis and optimization. We have used Microwave Office for circuit simulation and then the AXIEM[®] 3D Planar Simulator, another important tool in the AWR Design Environment[®].

Simulation in Microwave Office

The design will be exported to Microwave Office for initial circuit simulation and optimization. The initial DMS layout and simulation results are shown below in Figure 4. We can see that the first spurious frequency response has been attenuated, and the DMS parasitic effects have slightly altered the design pass band. We then use the optimization capabilities of the program to increase the spurious suppression and minimize the parasitic effects on the passband.

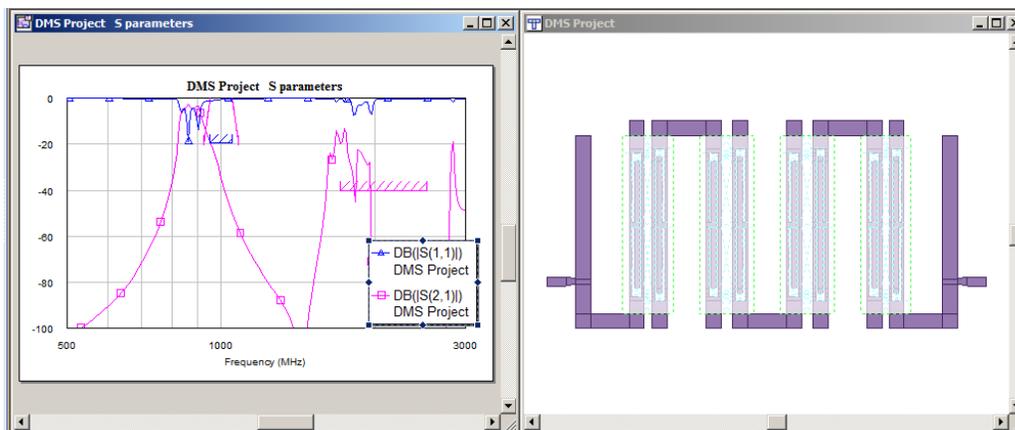


Figure 4: Initial DMS Layout and Simulation Results

After using Microwave Office with its efficient optimization capabilities, we can see that the circuit response has greatly improved. Figure 5 shows that now the suppressed first spurious frequency and main pass band are now inside the S11/S12 optimization goals.

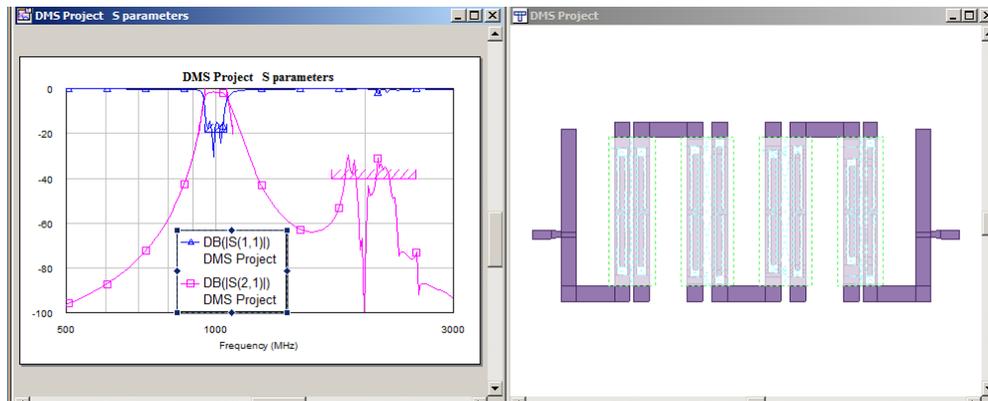


Figure 5: MWO Circuits Optimized DMS Layout and Simulation Result

Electromagnetic Analysis in the AWR Axiem program

To insure full design accuracy, the DMS filter will be electromagnetically optimized using AWR's AXIEM. This electromagnetic solver is sufficiently fast to support extraction optimization. The results are shown in Figure 6.

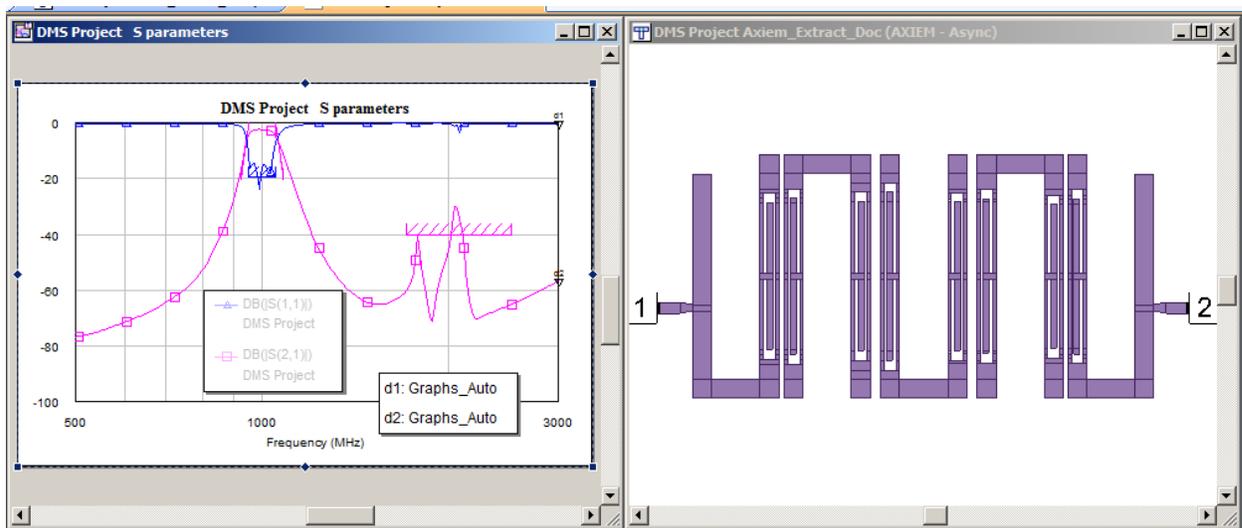


Figure 6: DMS Filter layout and response after optimization with AWR's AXIEM[®]



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Aside from solving spurious response issues, the resulting filter design may also yield other advantages for circuit production. The design may be a factor in reducing the overall size of the filter by removing otherwise needed circuitry required to reduce spurious effects, and thereby reduce overall product costs.

For further information, visit www.nuhertz.com.