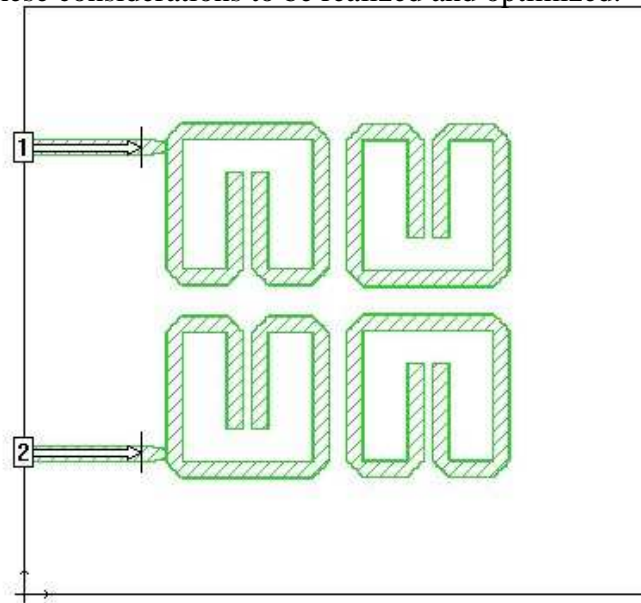




## Miniaturizing and Optimizing the design of Miniaturized Hairpin Resonator Filters

Nuhertz Technologies' *FilterSolutions*<sup>®</sup> and *FilterQuick*<sup>™</sup> programs enhance the design techniques for standard and miniaturized Hairpin Resonator or Ring Resonator filters. Using circuit and electromagnetic simulation tools from NI-AWR Corporation and Sonnet Software, the synthesized design of optimized cross-coupled circuits minimizes the use of circuit board space. The techniques offered by Nuhertz, allow the filter's resonators to be folded down or inside the Hairpin structure, solving for electromagnetic interaction of the resonators. Cross-coupled designs enhance space efficiency as well, by narrowing the passband. (See Figures 1 and 2).

Hairpin Resonator designs can meet manufacturing geometry limitations without the need for vias between layers. The design synthesis programs available from Nuhertz Technologies are valuable in allowing these considerations to be realized and optimized.



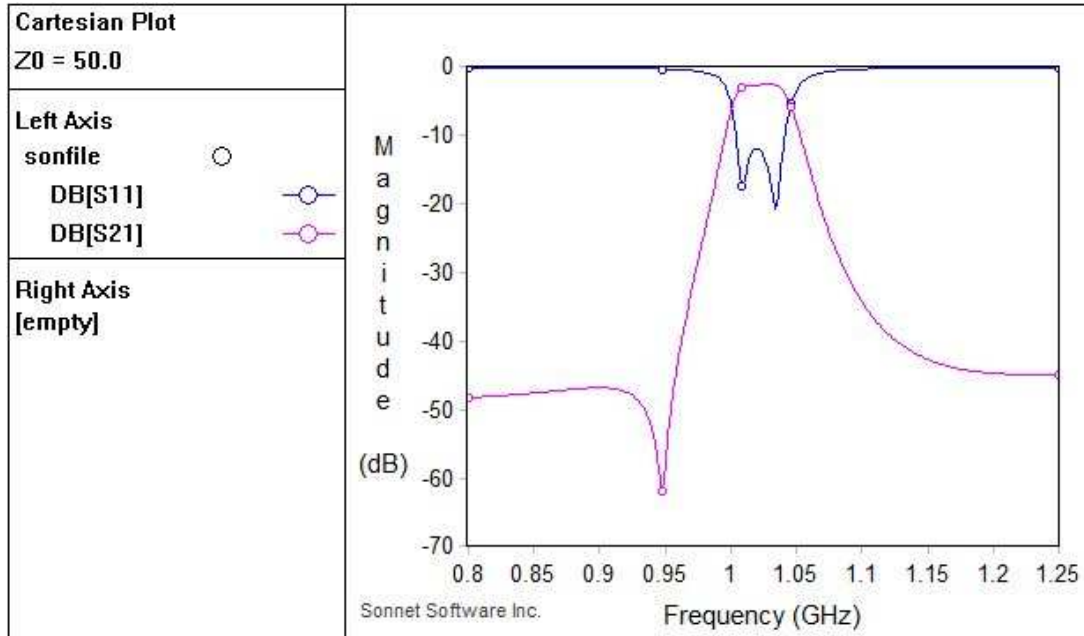
**Figure 1: Narrow passband Bandpass Filter design centered at 1 GHz. Design using Hairpin Resonators with legs folded. (Approximate size: 650 mm<sup>2</sup>)**



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## Best in Filter Designs

Figure 2: Narrowed Passband Produced by Cross Coupled Resonator Filter



FilterSolutions supports these miniaturized filters, including cross-coupled designs, within manufacturing geometry limitations. Internal circuit tuning may be employed to tune to the desired response. Optimization may be accomplished by exporting the synthesized design into a robust transmission line circuit optimization program, such as NI-AWR Corp *Microwave Office*™. (Direct export into NI-AWR's circuit simulators is a standard feature of *FilterSolutions* and *FilterQuick*).

FilterSolutions sets up the AWR tuning equations to enforce geometry limitations. The *Microwave Office* optimized filter may then be re-imported into the Nuhertz program, if needed.

In consideration of manufacturing and electrical performance requirements, electromagnetic optimization is usually necessary to account for the interaction between the various conductor segments of the Hairpin. The interactions cannot be readily modeled in a circuit analysis program.

The electromagnetic optimization of the design may be accomplished with the use of Sonnet Software's *em*® Port Tuning optimization technique, AWR's *Axiem*™ extraction, CST's *Design Studio*®, or other third party extraction optimization.

For further information, please visit: [www.nuhertz.com](http://www.nuhertz.com), or call: (973) 228-7800.

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