Round Rod Interdigital Filter Optimization Using WIPL-D

This application note presents the analysis of round rode interdigital filters using **WIPL-D Pro, a full wave 3D electromagnetic simulation software**.

A coupling structure often used to construct interdigital filters is a pair of coupled circular rods between flat ground planes. A convenient way to construct a filter utilizing this coupling structure is to use a metallic box with lids acting as ground planes and arrange coupled resonators to be alternately grounded at opposite sidewalls of the box. The electrical lengths of the resonators are close to 90°. From the fabrication perspective it is preferable to utilize the resonators of the same diameter. In the cases where direct coupling to the external circuit is not convenient e.g. due to tight spacings required, the coupling of the end resonators can be replaced with tapped structures.

Although there are some approximative formulas that can be used to design such kind of filters, the most reliable results enabling **"the first time right"** scenario are obtained using a full 3D electromagnetic (EM) simulation software. In this application note **WIPL-D Pro** is used for **fast and accurate EM simulation**. WIPL-D Pro model of a 5th order interdigital filter with coupled round rods is presented in Figure 1.

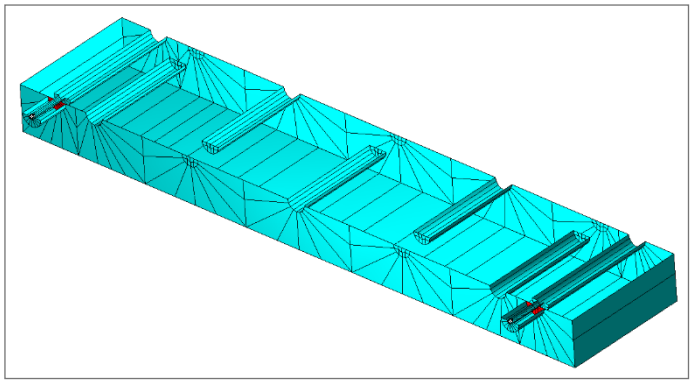

Figure 1. WIPL-D Pro model of 5th order round rode interdigital filter.

The input and output ports are in the form of the dielectric-filled coaxial transmission lines. The outer conductor of the coaxial line is connected to the box wall while the inner conductor is connected to the input coupling structure. Such a construction is very convenient from the practical point of view as the small discontinuity occurring at the coaxial – resonator connection can be absorbed into the filter design and does not influence significantly the filter performance.

Filter Optimization

Two filter responses have been considered, one with 180 MHz bandwidth and the other with 240 MHz bandwidth, both centered around 3.75 GHz**. The lengths of the resonators, the gaps between the resonators and the height of the metallic box** have been optimized using **WIPL-D Optimizer** add-on tool to obtain the responses. The optimized responses are presented in Figure 2 and Figure 3.

As the filter is symmetrical, only one half of the structure should be modeled and analyzed which reduces the number of unknowns approximately by factor two. **The optimization iteration takes only under 30 sec** on any modern quad core laptop or desktop computer.

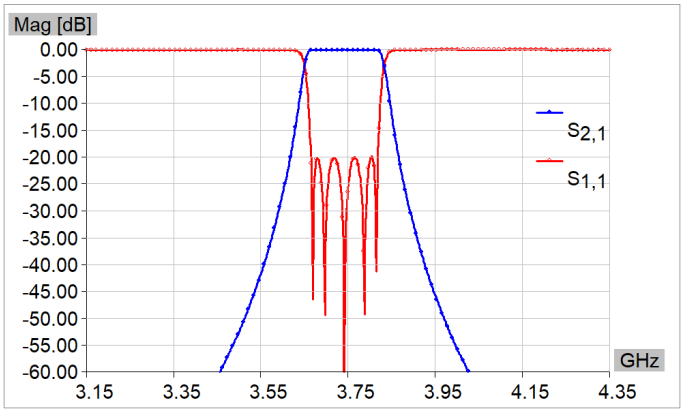

Figure 2. S parameters of the 5th order round rod interdigital filter optimized for 180 MHz bandwidth.

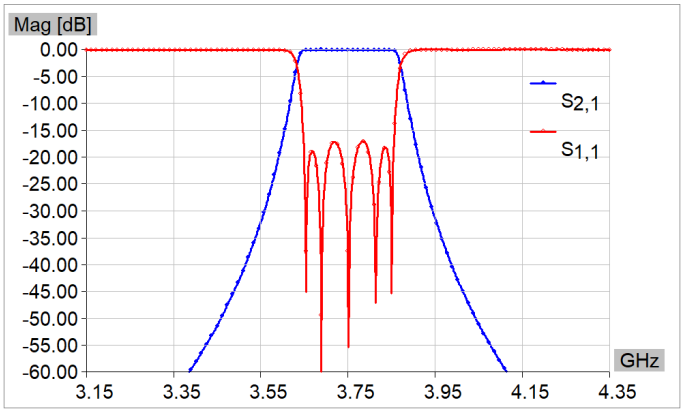

Figure 3. S parameters of the 5th order round rod interdigital filter optimized for 240 MHz bandwidth.

Conclusion

An illustrative example of 5th order round rod interdigital filter optimization has been presented. An example demostrates that WIPL-D Pro can be succesfuly used to aid the real life design of a important filter structure. The basic strengths of the full 3D EM simulation program are **high accuracy and extremely fast simulation execution** which allows for quick optimization against various filter specifications.