# Microstrip Combline Bandpass Filter

**Microstrip combline bandpass filters** are widely used in many microwave applications. This application note will present a model of such a filter, the optimized response of the filter and the optimal dimensions of the model. The bandpass filter consists of three resonators and input and output lines, all short-circuited as appropriate.

The design of the filter will be carried out utilizing **WIPL-D Pro software**, a full wave 3D EM **Method-of-Moments (MoM)** based solver. Simulations of the filter and similar printed structures can be performed in a relatively **short time using moderate computer hardware**. The filter optimization will be carried out bearing in mind **real-life parameters** of the filter fabrication process (the realizable dimensions of the resonators, input and output lines, gaps, available value for substrate dielectric permittivity and corresponding dielectric losses).

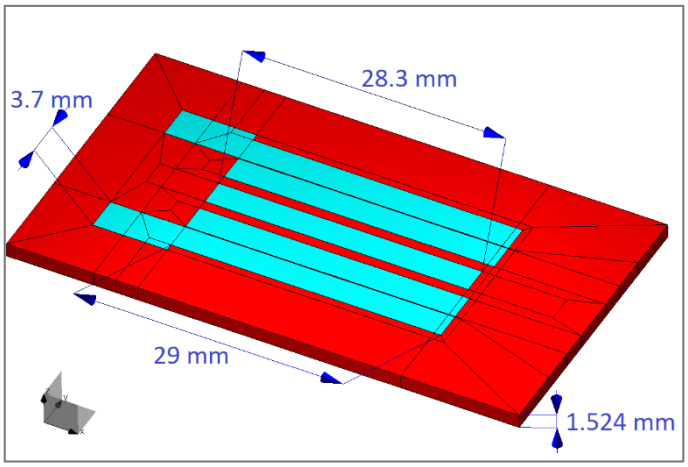


**Figure 1. WIPL-D Pro model of the filter with dimensions.**

## WIPL-D Pro Model of The Filter

The model of this filter was easily created using WIPL-D Pro software. The dimensions of the combline filter are given in Figure 1. Vias used to shortcircuit the ends of the resonators are modeled as infinitesimally thin plates connected to the ground plane. Some details of the feeding line arrangements are shown in Figure 2 where only the conductors are shown. The filter is fed with delta generators. The dimensions of the gaps and the dimensions of resonator\input and output lines are shown in Figure 3. Dielectric substrate has been chosen to conform with a popular, commercially available family with a relative dielectric permittivity of 3.38, and the corresponding loss tangent value of 0.001.

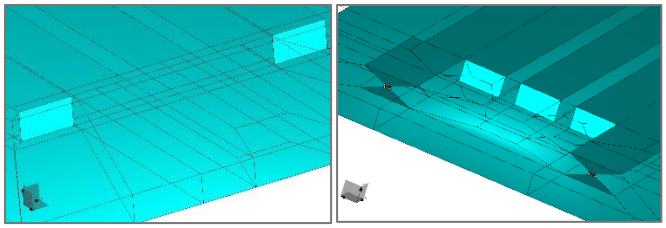

**Figure 2. Metallic components of the filter with vias modeled with infinitesimally thin plates and feeding areas.**

## Simulation and Results

The bandpass filter was simulated from 4.0 GHz to 5.5 GHz. Due to the efficient *Fitter,* which accurately interpolates the calculated response between equidistant frequency points, the wideband response of the filter was calculated from 37 simulated frequencies.

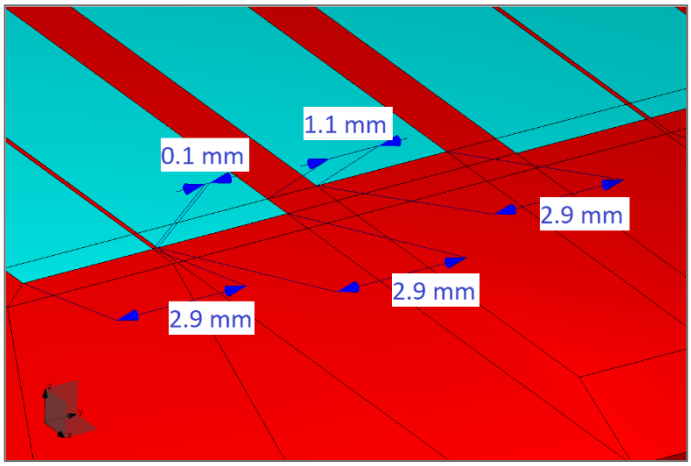


**Figure 3. Dimensions of gaps and resonator widths.**

**Table 1. Computer used for the simulation.**

| Hardware | Description |
|---|---|
| CPU | Intel® Core™ i7-7700 CPU @ 3.60 GHz |
| RAM | 64 GB |

**Table 2. Number of elements, number of unknowns, and simulation time per frequency.**

| Model | Number of elements | Number of unknowns | Simulation time per frequency [seconds] |
|---|---|---|---|
| Microstrip combline bandpass filter | 1,081 | 6,688 | 21 |

Computer used for the simulation is described in Table 1. Number of elements, number of unknowns, and simulation time per frequency are listed in Table 2. Output results (S-parameters) are displayed in Figure 4.

## Conclusion

In this application note we demonstrated **successful simulation** of microstrip combline bandpass filter. The software tool used for simulation is **WIPL-D Pro software**, a full wave 3D EM **Method-of-Moments (MoM)** based solver.

Simulation of one of the classical printed structure, the microstrip combline bandpass filter, was performed in a **reasonable time on cost-effective, moderate computer platform**. The fabrication of the filter prototype can follow immediately after the optimization. The optimal dimensions of the resonators, input and output lines and the gaps between the lines are all realizable in any standard microstrip technology. In addition, dielectric parameters have been chosen targeting a popular, commercial substrate.

The filter was simulated between 4.0 GHz and 5.5 GHz. The efficient *Fitter,* which is part of the WIPL-Graph window, enabled the wideband response of the filter to be accurately interpolated from model simulation at 37 discrete frequency points.

Described bandpass filter is very simple, but it still has very good properties as calculated S-parameters confirm the existence of a transmission zero above the passband which can be used to increase the selectivity at high passband edge.

According to all of the analysis details presented, it can be concluded that **WIPL-D software is very suitable for the simulation of various microstrip filter structures for both, commercial and academic purposes.**

In addition, the practical and educative value of this document should be recognized. This document with published dimensions of the structure **can be used as a starting point for microstrip combline bandpass filter design and further research**.

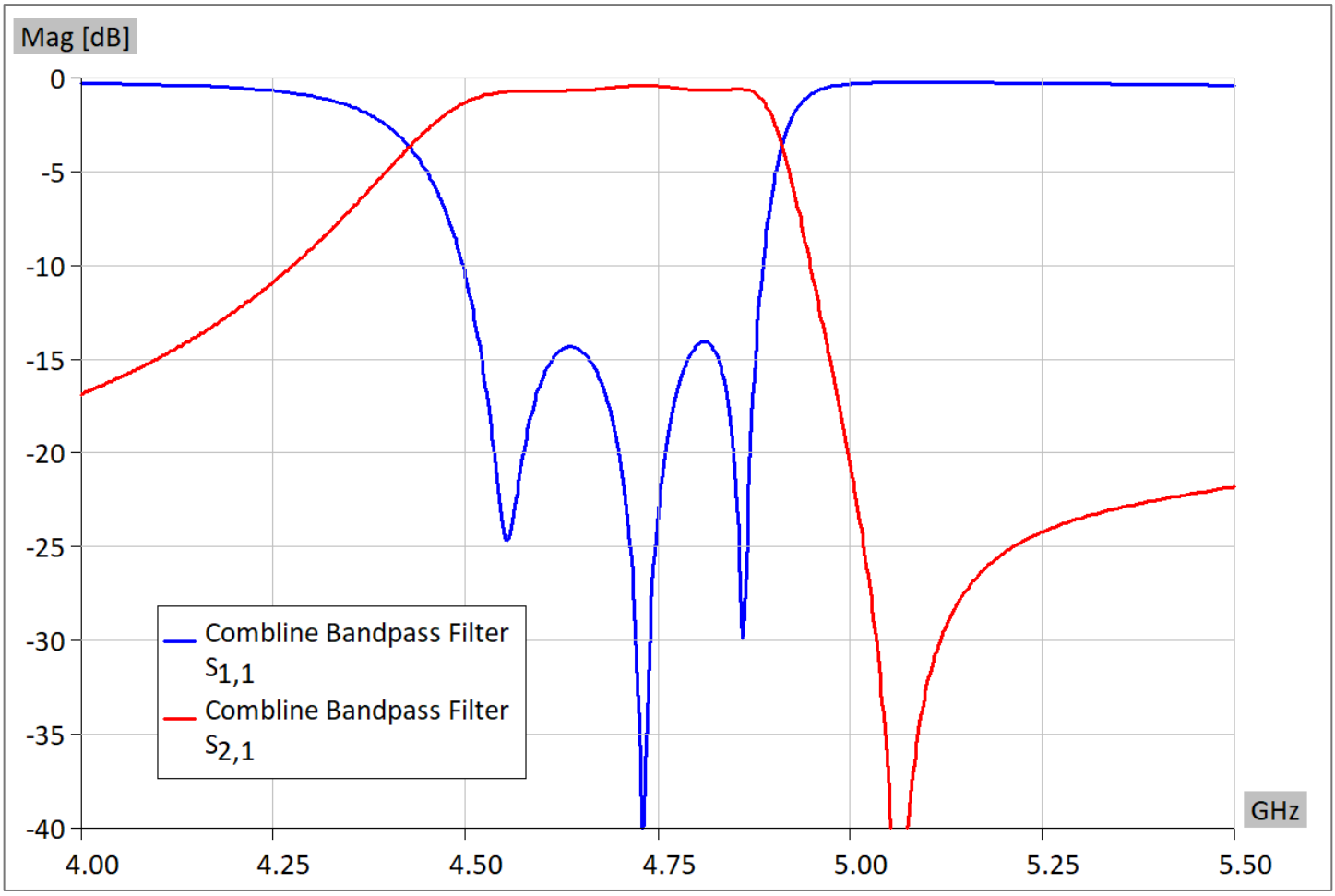


**Figure 4. S-parameters.**