Microwave Filters

Microwave filter is a two port network providing signal transmission at passband and signal reflection or signal absorption at stopband. Microwave filters can be lowpass, bandpass, bandstop and highpass. They can also be passive or active. Here, we will focus on passive filters implemented in microstrip technology.

Microwave filters are used in every microwave system (radar, radio astronomy systems, base stations…).

Main characteristics of microwave filters are

- Non-independent magnitude–phase response,
- Signal attenuation because of dielectric presence,
- Relatively difficult full 3D numerical analysis.

WIPL-D Simulation

Two models of band pass filters, simulated using WIPL-D Pro 3D EM solver, are presented here. Interdigital filter, which is an array of resonators with electrical length of 90° at midband frequency, short-circuited at one end and open-circuited at other end alternatively, is shown in Fig. 1. The edge-coupled half-wavelength (at the center of range) resonator filter is shown in Fig. 2. Both models are implemented in microstrip technology. Finite size substrates have been used in both models. Ground plane as well as top metallization is considered to be perfectly conducting.

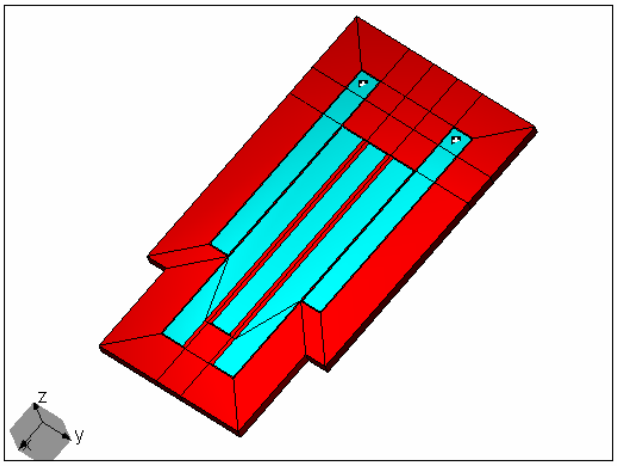

Figure 1. Interdigital band pass filter

Our aim is to inspect simulation times, memory requirements, and S-parameters of analyzed models. We will observe output results for interdigital filter starting from 1.9 GHz up to 2.6 GHz, while for edge-coupled resonators filter, output results will be inspected from 2 GHz up to 2.7 GHz (D and E bands–NATO band classification).

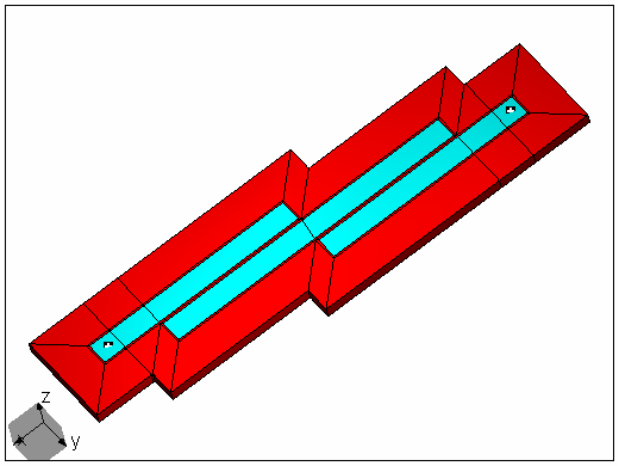

Figure 2. Edge-coupled resonators band pass filter

Dielectric characteristics for simulated models are given in Tab. 1.

Table 1. Dielectric characteristics

Parameter	Value [Unit]
Er	3.38
H	1.524 [mm]

Parameters S_{11} and S_{21} for simulated models, calculated in 15 points within the frequency ranges of interest, are shown in Figs 3-4. We can see the expected behavior of these filters, with a fractional bandwidth of about 10 %.

Number of unknowns, memory requirements, and simulation times for the whole frequency range of interest are given in Tab. 2. Computer used for these calculations is Intel® Core2 Quad CPU @ 2.83 GHz.

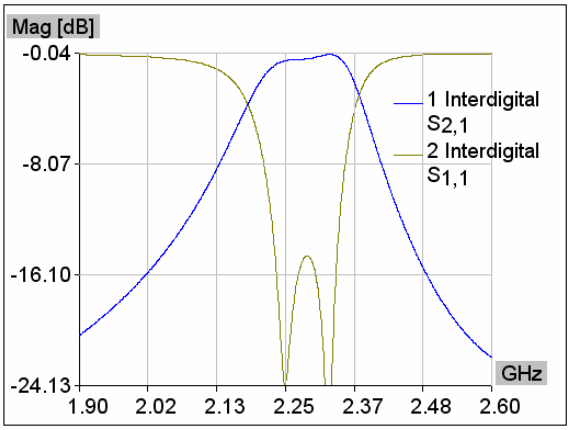

Figure 3. S-parameters for interdigital filter

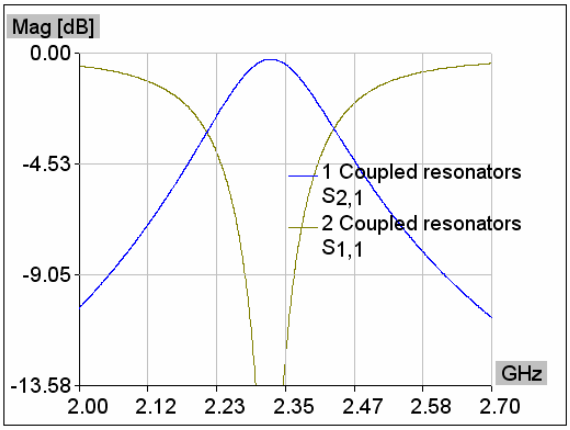

Figure 4. S-parameters for edge-coupled resonator filter

Table 2. Analysis characteristics

Model	Number of unknowns	Time (whole range)[sec]
Interdigital	904	237
Edge-coupled resonators	452	27

Conclusion

Microwave filters are very widely used in various application fields. Using full EM simulation, we are able to get accurate results and thus verify the filter design. Full 3D EM model takes into account EM coupling between discontinuities and possible radiation of all circuit elements.

Results given here by WIPL-D Pro coincide with theoretical expectations.