Microwave Filters

Microwave filter is 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 be, also passive or active. We will analyze only passive filters which are produced as periodical structures.

For the first time, filter design was developed in 1930s.

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

Theoretical Preferences

Main characteristics of microwave filters are

- Not-independent magnitude–phase response,
- Signal attenuation because of dielectric presence,
- Difficult full 3D numerical analysis.

Two models of band pass filters are designed and analyzed using WIPL-D 3D EM solver. Interdigital filter is shown on Fig. 1, while filter with coupled resonators is shown on Fig. 2. Both of models are implemented in microstrip technology and printed on dielectric substrate.

Interdigital filters consist of a few parallel coupled quarterwave resonators. Coupling between nearby resonators is dominant.

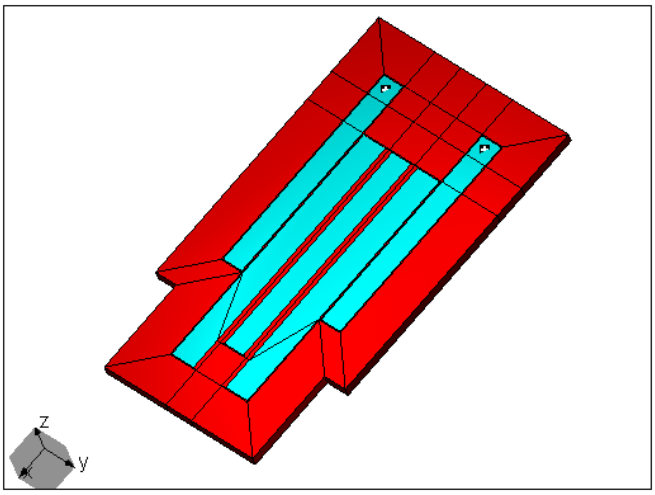

Figure 1. Interdigital band pass filter

Filter with coupled half-wave resonators is shown on Fig. 2. Wavelength is calculated in dielectric and for central operating frequency.

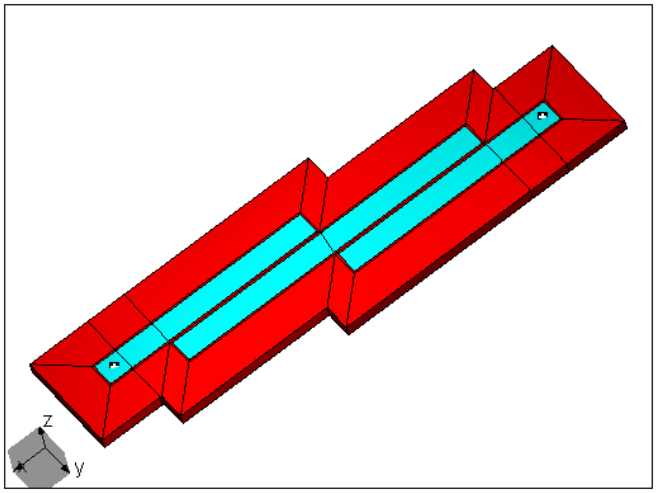

Figure 2. Coupled resonators band pass filter

Our aim is to inspect simulation times and s-parameters of analyzed models. We will observe output results for interdigital model starting from 1900 MHz up to 2600 MHz, while for coupled resonators filter, output results will be inspected from 2000 MHz up to 2700 MHz (D and E bands–NATO band classification).

Bottom filter metallization is considered to be PEC.

WIPL-D Calculation

We will calculate s parameters for every filter model. Computer used for these calculations is Intel® Core2 Quad CPU @ 2.83 GHz.

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

Table 1. Dielectric characteristics

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

Operating bands are divided into 15 points, each.

Parameters s11 and s21 for simulated models are shown on Figs 3-4. Number of unknowns and simulation time are given in Tab. 2.

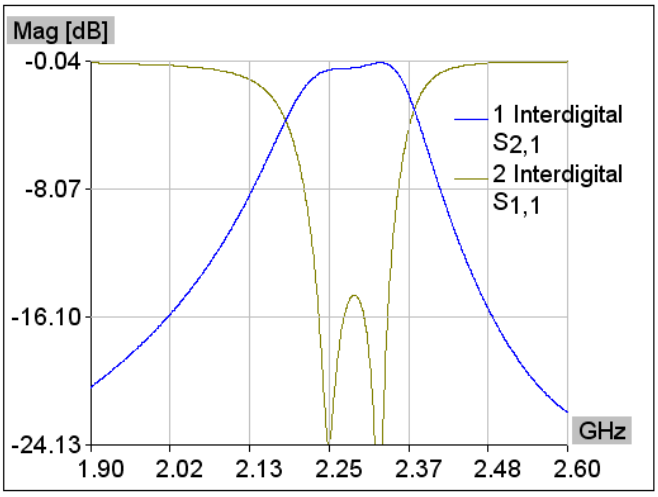

Figure 3. S parameters for interdigital filter

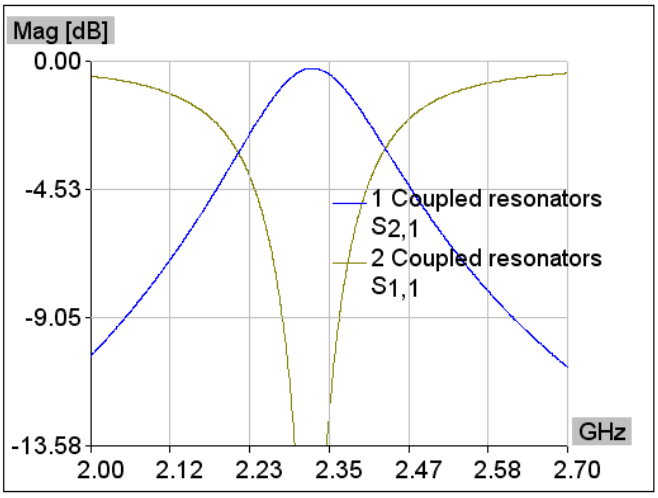

Figure 4. S parameters for coupled resonator filter

Table 2. Analysis characteristics

Model	Number of unknowns	Time [sec]
Interdigital	904	237
Coupled resonators	452	27

Conclusion

Microwave filters are very important structures. We know that presence of dielectric can cause parasite changes in filter characteristics. Using full EM analysis, we get accurate results. Good accuracy of EM model is presented because full 3D EM model involves calculation of EM coupling between discontinuities and elements radiation.

Dielectric is necessary in microstrip filter production because of structure solidity (i.e. metallic conductors are placed on dielectric). Dielectric inserts losses.

Simulation times are relatively small. Reason for this is using PEC for bottom layer modeling and, especially, for coupled resonator filter model, we can see that part of dielectric which does not influence a lot on filter characteristics was not modeled at all.

Results given by WIPL-D and presented here coincide with theoretically assumptions.