Antenna-Simulation of a Half-wave Dielectric Resonator filter

1. Description

A symmetric model of a dielectric resonator filter is analyzed using the Scattering parameters module of HFWorks to determine its pass-band, the attenuation in and out of the band, and the electric field distributions for various frequencies. The cables have a lossy conductor, and have a Teflon inside part. HFWorks gives the possibility to plot various parameters on 2D and smith chart plots. Besides, the electric field can be spotted in vector and fringe 3D plots for all studied frequencies.

The scattering parameters solving might be preceded by a resonance study to make sure that the dimensions of the model fit the desired frequency i.e. the desired resonance mode's.

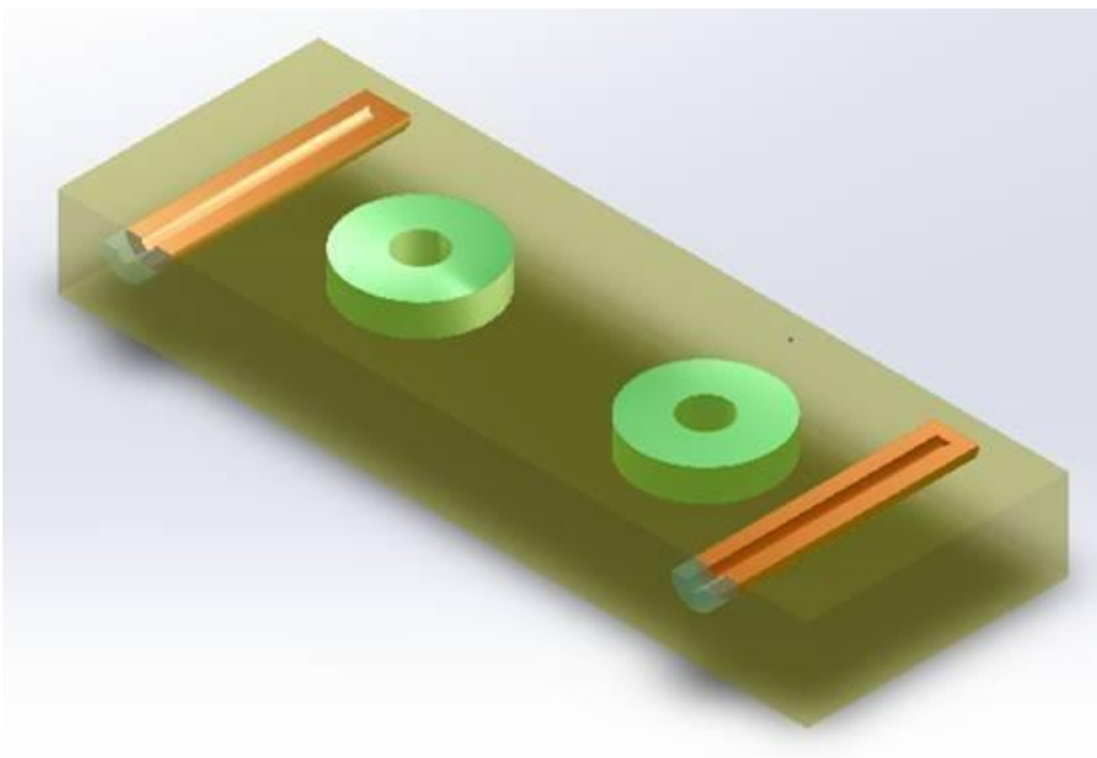


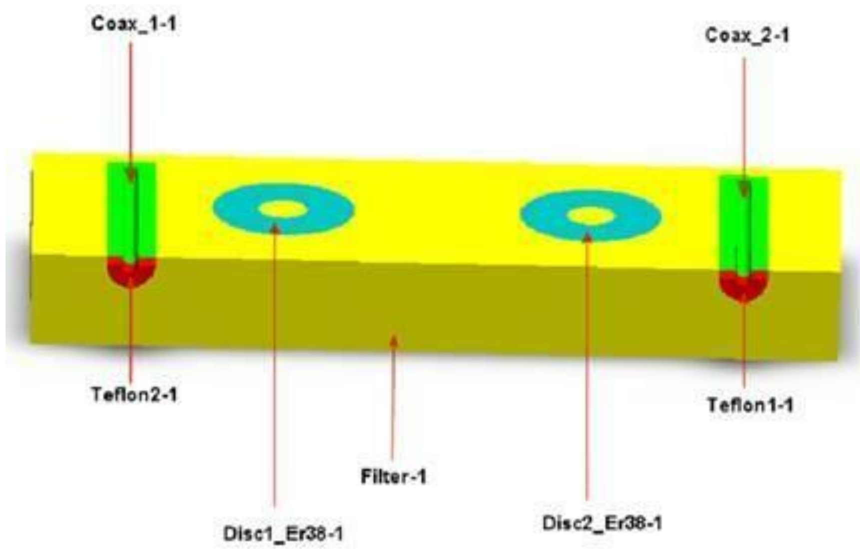
Figure 1: Half-wave DR filter (3D SolidWorks view)

2. Simulation

To simulate the behavior of this filter (insertion and return loss...), we will create a scattering parameters study, and specify the relevant frequency range at which the antenna operates (in our case 100 frequencies uniformly distributed from 4 GHz to 8 GHz).

3. Solids and Materials

In figure 1, we have shown the discretised model of a dielectric two circuit filter with coaxial input and output couplers. The two dielectric discs act as coupled resonators such that the entire device becomes a high quality band pass filter.



	Part Name	Material Name	Permittivity Type	Permeability Type	Conductivity Type
1	Coax_1-1-Body 1 (Imported1)	Air	Lossy Isotropic	Lossy Isotropic	Isotropic
2	Coax_2-1-Body 1 (Imported1)	Air	Lossy Isotropic	Lossy Isotropic	Isotropic
3	Disc1_Er38-1-Body 1 (Imported1)	Mat1	Lossy Isotropic	Lossy Isotropic	Isotropic
4	Disc2_Er38-1-Body 1 (Imported1)	Mat1	Lossy Isotropic	Lossy Isotropic	Isotropic
5	Filter-1-Body 1 (Imported1)	Air	Lossy Isotropic	Lossy Isotropic	Isotropic
6	Teflon1-1-Body 1 (Imported1)	tefl	Lossy Isotropic	Lossy Isotropic	Isotropic
7	Teflon2-1-Body 1 (Imported1)	tefl	Lossy Isotropic	Lossy Isotropic	Isotropic

therefore we only need to model one half. Consequently, we should announce that to the HFWorks simulator by applying a PEMS boundary condition; whether it is a PECS or PEMS, depends on the orientation of the electric field near the boundary of symmetry. If tangential, then it is PEMS; if orthogonal then it is a PECS.

5. Meshing

The mesh has to be concentrated on these ports and PEC faces. Meshing these surfaces helps the solver refine its precision on the eddy parts, and take their particular forms into account.

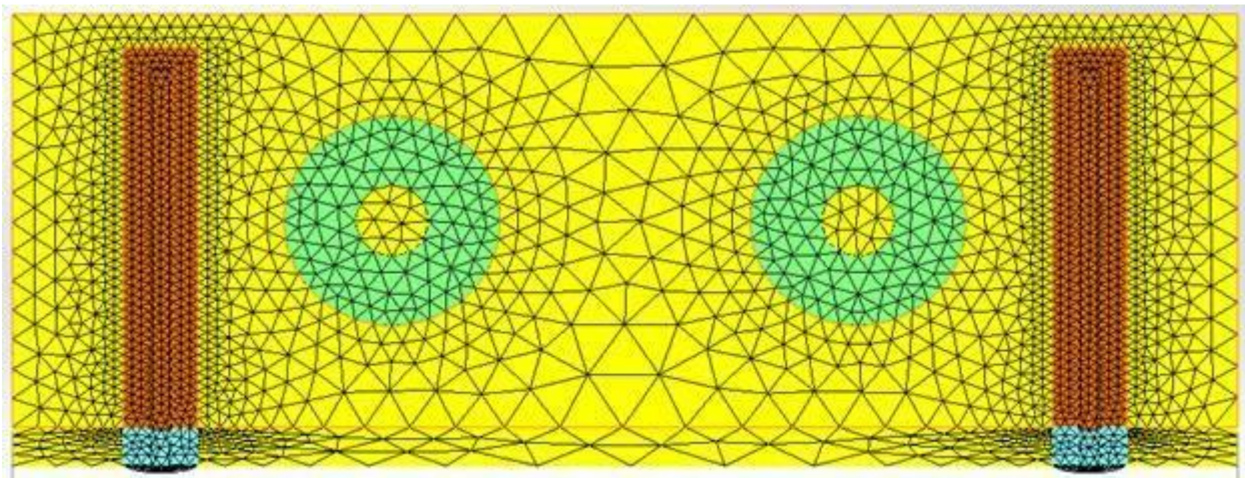


Figure 2: Mesh of the half DR filter

6. Results

Various 3D and 2D plots are available to exploit, depending on the nature of the task and on which parameter the user is interested in. As we are dealing with a filter simulation, plotting the S21 parameter sounds like an intuitive task.

As mentioned within the beginning of this report, HFWorks plots curves for electrical parameters on 2D plots as well as on smith charts. The latter is more suitable for matching issues, and is more relevant when we deal with filter designs. We notice here that the we have sharp pass-bands and that we reach great isolation outside the band.

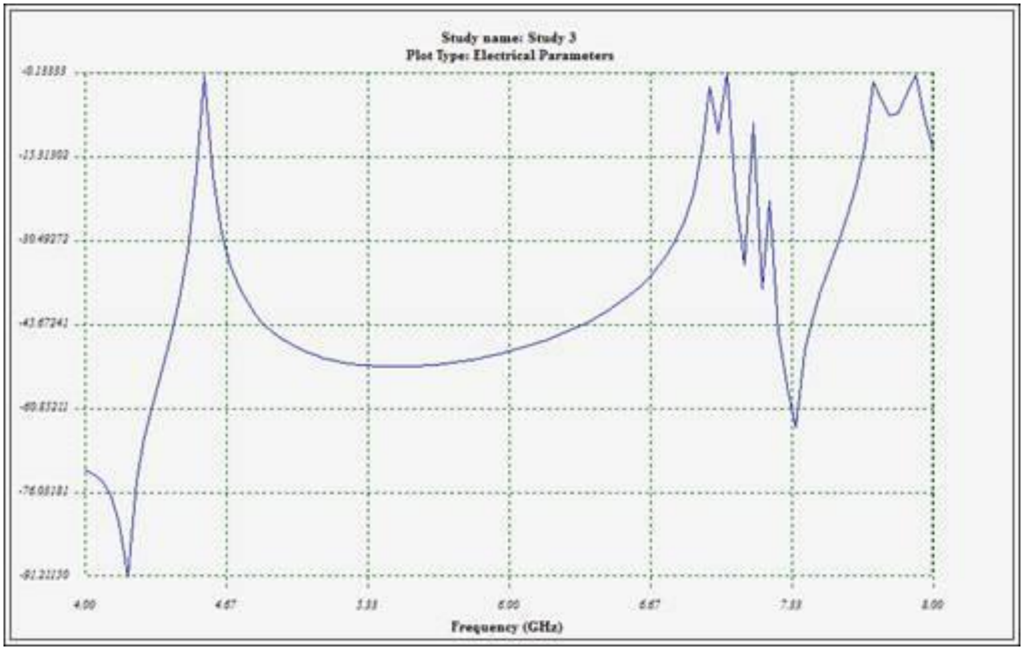


Figure 3: Simulation of insertion loss (S21)

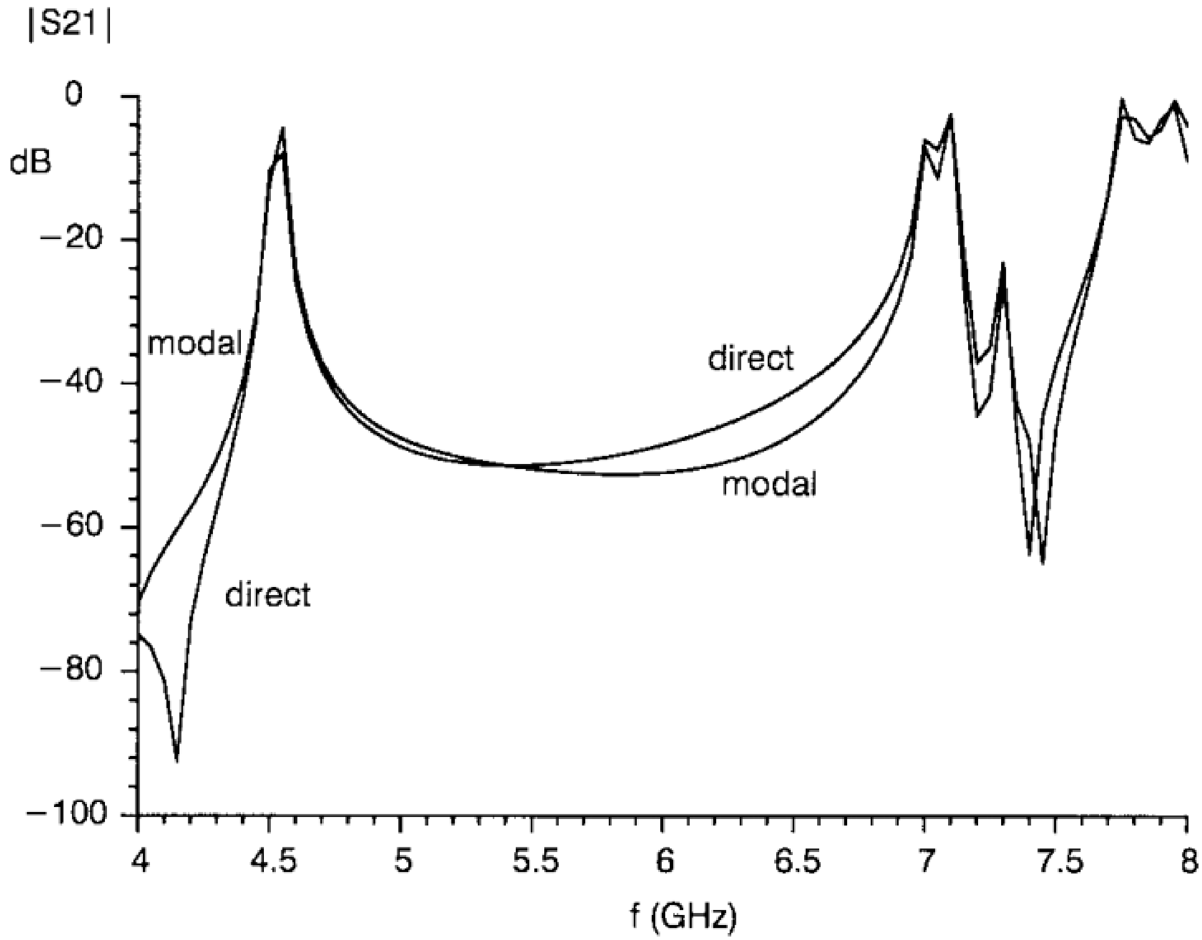


Figure 3: S21 as presented in the paper

The 3D plots for the scattering-parameters studies cover a wide range of parameters: the following two figures show the electric field distribution for two frequencies (one is inside the band and the other is outside the band)

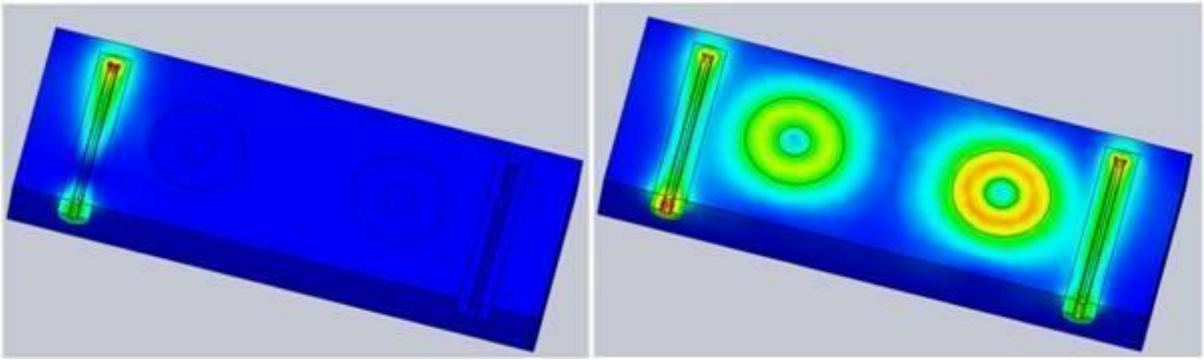


Figure 4: Electric field vector distribution (at 4 GHz (left) and 4.56 GHz (right))

The model can be simulated using the resonance solver of HFWorks too. We can detect as many modes as we wish. It is easy to derive such a study from the S-Parameter simulated study: HFWorks allows drag and drop operations to quickly set up the resonance simulation. The resonance solver takes into consideration the model's EM matrix and delivers the various Eigen mode solutions. The results match very well the former studies' results. We show here the result table:

Resonance Results

	Frequency (Mhz)	*Q-Dielectric*	*Q-Conductor*	*Q-Effective*	*Stored Energy*
Mode 1	4.460803e+003	1.228558e+002	1.338969e+004	1.217388e+002	2.467872e-015
Mode 2	4.475383e+003	1.268338e+002	1.206847e+004	1.255147e+002	2.177107e-015
Mode 3	4.793330e+003	1.029495e+002	4.447214e+004	1.027117e+002	1.029392e-014
Mode 4	4.804784e+003	1.023469e+002	5.202915e+004	1.021459e+002	1.100928e-014
Mode 5	7.033565e+003	2.338744e+002	1.243990e+004	2.295586e+002	1.688384e-015