



Waveguide Applications of FEKO

Waveguide has become an indispensable technology in all industries of transmitting systems. The FEKO support team recognises that FEKO's users may also want to apply FEKO to waveguide structures and this application note highlights some of the benchmark simulations of waveguide components that have been done with FEKO.

Waveguide Magic Tee Coupler

The magic tee is a four-port, 180° hybrid splitter, realised in waveguide technology. Like all coupler and splitter structures, the magic tee can

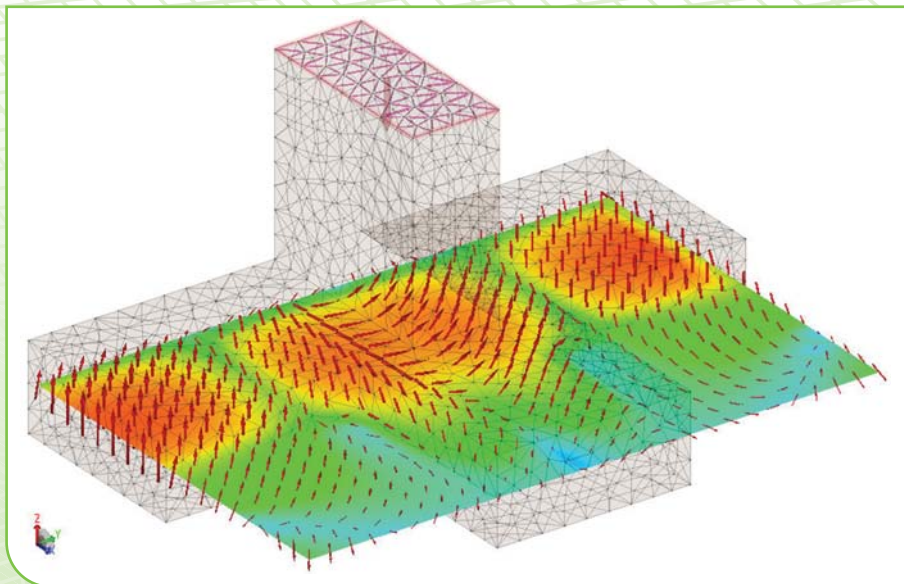


Figure 1: Horizontal plane with field direction vectors

be used as a power combiner or as a power divider. It is ideally lossless, so that all power that is transmitted into a port can be assumed to exit the remaining ports. The magic tee depicted in Figure 1 was simulated while driving the delta port with a waveguide source. The field vectors indicate that the fields at the output ports are indeed 180° out of phase, as is expected from the design.

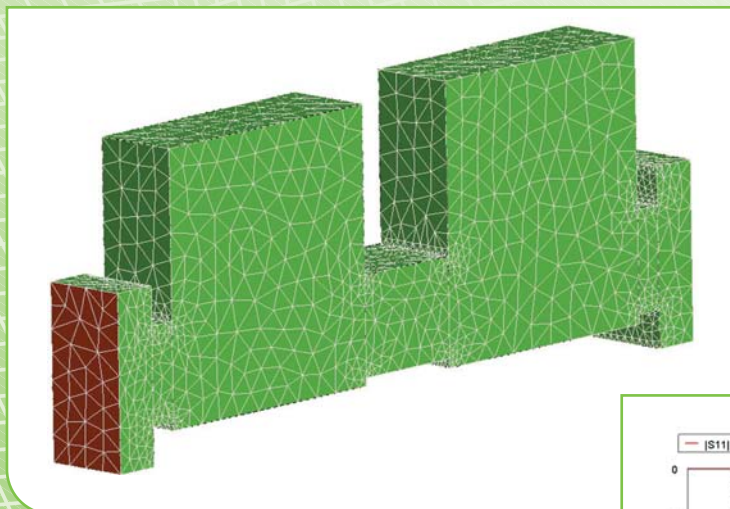
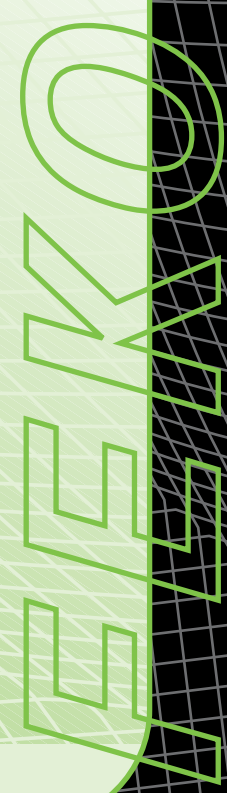
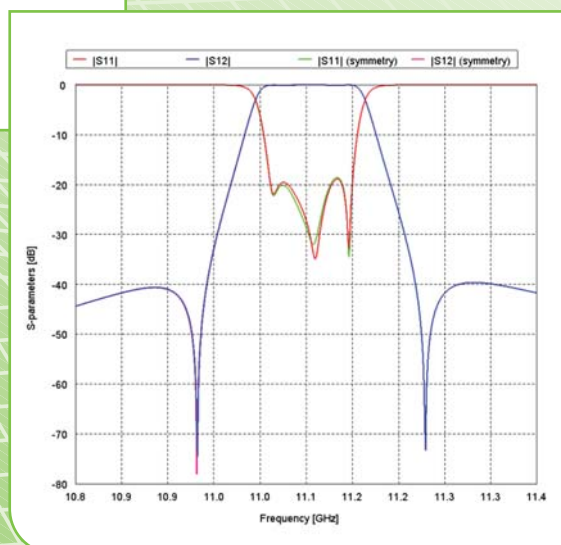


Figure 2: Dual-mode waveguide filter

Dual-Mode Waveguide Cavity Filter

Filters are often required to remove unwanted signal content before feeding an antenna. Waveguide filters come in a wide variety of designs, such as that of Guglielmi et al [1] who published a design for a cavity based Ku-band dual-mode waveguide filter. Figure 2 shows the FEKO model for this filter topology, with the ports being excited with the TE10 mode. This filter has a pass-band of approximately 11.0 to 11.2 GHz, with input reflections (S11) around -20 dB in this band, as depicted in the S-parameter simulation results in Figure 3. The transmission zeros on either side of the pass-band are also clearly visible in this figure.

Figure 3: Frequency response of dual-mode waveguide filter



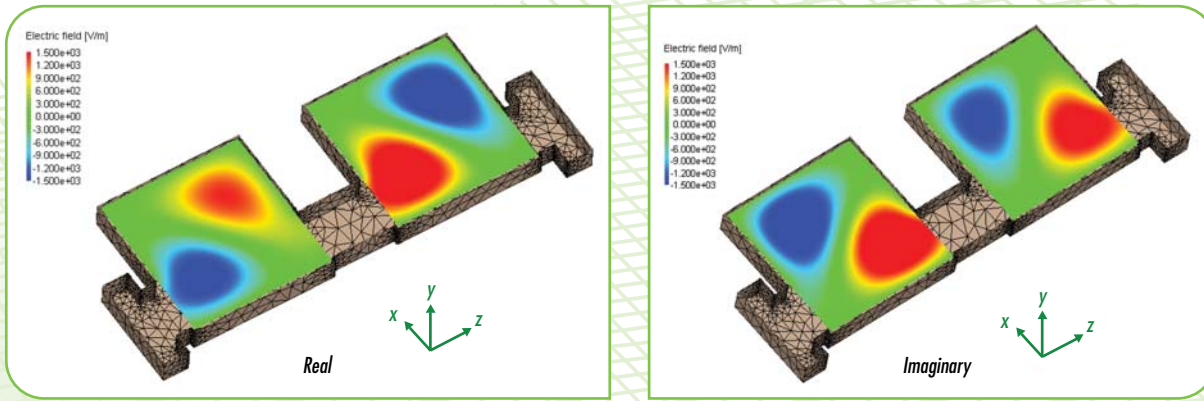


Figure 4: Ey field components inside the dual-mode waveguide filter.

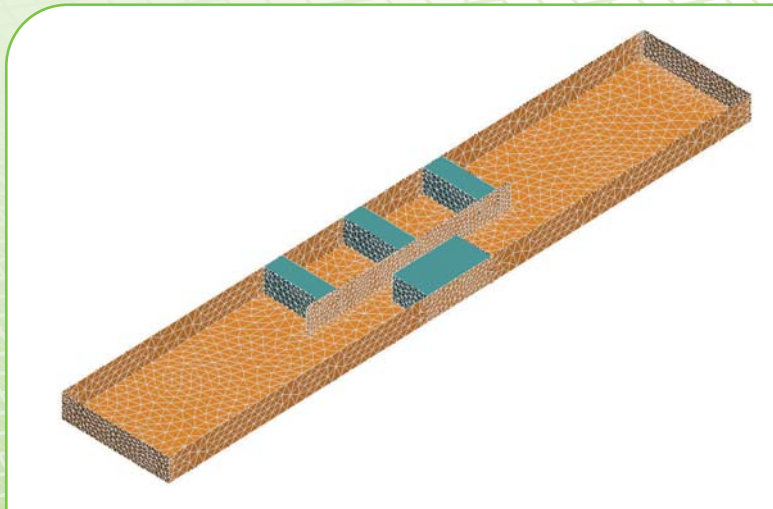


Figure 5: Waveguide filter with dielectric

to simulate this filter. The MoM is used to model the metallic elements of the waveguide, while the dielectric blocks may be modelled with either the Surface Equivalence Principle (SEP) or the Finite Element Method (FEM). Waveguide ports are used to drive the filter and to extract the S-parameters during post-processing. Figure 5 shows a lateral cut-plane view of the model with metallic elements in orange and dielectric blocks in blue. The ports are fed with FEKO's waveguide feed. As this filter is designed for a very wide band of frequencies, FEKO's Adaptive Frequency Sampling (AFS) technology is applied to effectively select the minimum number of frequency points that will accurately characterise the filter's response.

References

- [1] M. Guglielmi, P. Jarry, E. Kerherve, O. Roquebrun, D. Schmitt, "A New Family of All-Inductive Dual-Mode Filter", IEEE Transactions on Microwave Theory and Techniques, Vol. 49, No. 10, Oct. 2001, pp. 1764-1769.
- [2] H. Shigesawa, M. Tsuji, T. Nkao, K. Takiyama, "Two-Path Cutoff Waveguide Dielectric Resonator Filters," IEEE Transactions on Microwave Theory and Techniques, Vol.

Electric near-fields in the cavities were calculated at the resonant frequency of 11.1 GHz. A cross section of the filter is presented in Figure 4, showing the Ey field's real and imaginary components. This filter is electromagnetically symmetric and FEKO's efficient exploitation of this symmetry results in a significant reduction of simulation resource requirements.

Dielectrically Loaded Waveguide Filter

Shigesawa et al [2] describe an evanescent-mode waveguide filter with dielectric blocks forming two parallel cut-off waveguide paths. FEKO's implementation of the extended Method of Moments (MoM) technique makes it the ideal tool

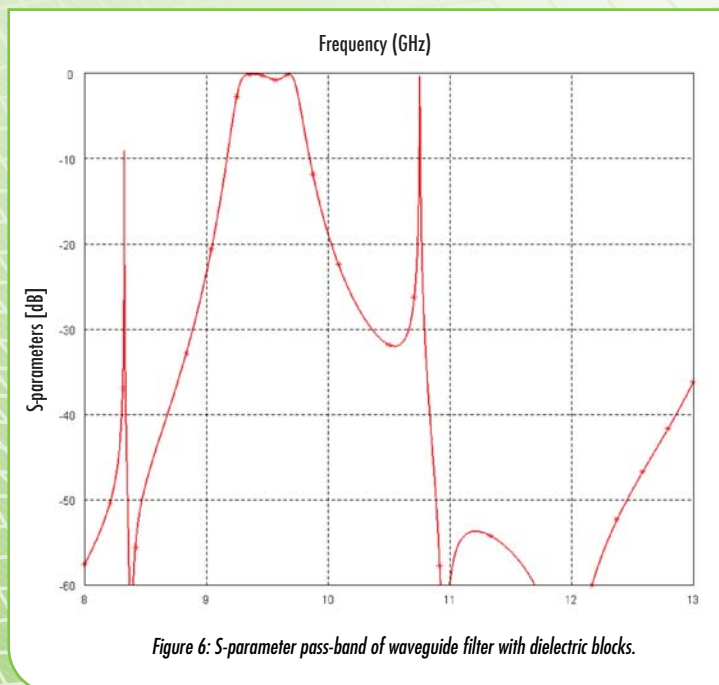


Figure 6: S-parameter pass-band of waveguide filter with dielectric blocks.