FEKO

Comprehensive Electromagnetic Solutions

Waveguide Applications

Introduction

Waveguides have been widely used since the first space communications. Driven by its use in the defence, aerospace, marine and communications industries, the technology is continuously evolving. Recent advances in technology require accurate and compact waveguide components at higher frequencies, while maintaining a cost-effective solution. Examples of technology dictating these requirements are unmanned aerial vehicles (UAVs) and cellular towers.

FEKO provides an accurate and efficient solution to analyse and design waveguide components. It is well-suited to the full-wave analysis of waveguides and can be used to simulate large radiating structures containing waveguide components such as reflector antennas or slotted waveguide arrays. FEKO enables the creation of waveguide structures by either creating a fully parametric model or by the use of CAD import filters. Parametric modelling allows the user to build and subsequently change the design geometry to facilitate rapid prototype conceptualisation. Reducing the number of prototype iterations results in a shorter time to market and a more cost-effective solution.

Multiple solvers in FEKO allow for cross-validation of models and results. Applying the different solvers builds confidence in the simulation results.

This application sheet presents benchmark simulations of waveguide components performed with FEKO. Examples of waveguide components include couplers, filters, circulators, isolators, amplifiers and attenuators.

Waveguide Magic-T Coupler

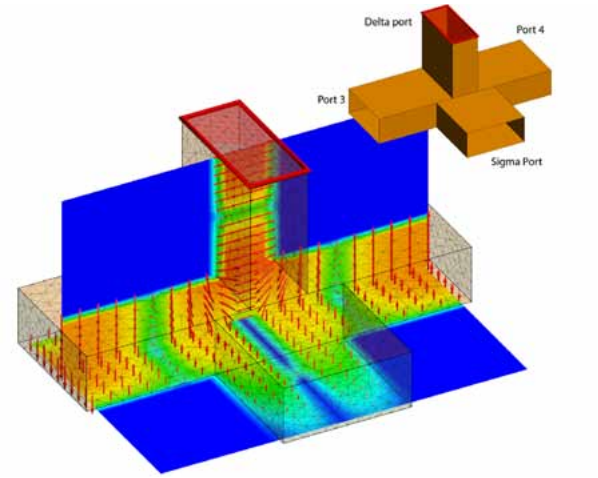
The magic-T is a waveguide 180° hybrid junction. Since coupler and splitter structures are reciprocal devices, the magic-T can be used either as a power combiner or divider.

The coupler is assumed to be ideal (lossless). All power transmitted into a port is assumed to exit the remaining ports. A magic-T can be simulated in FEKO by driving the Delta or Sigma port with a waveguide excitation. When the magic-T is operated as a divider with the input applied to the Delta port, a 180° phase shift occurs between the output ports. Visualisation of the calculated field vectors illustrate the 180° phase shift between the output ports.

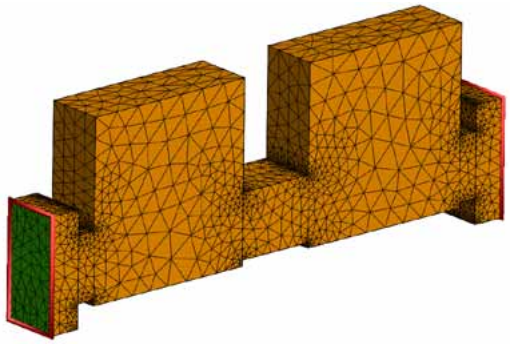
Applications for couplers / splitters include large ground station radars, lightweight space devices and more.

Dual-Mode Waveguide Cavity Filter

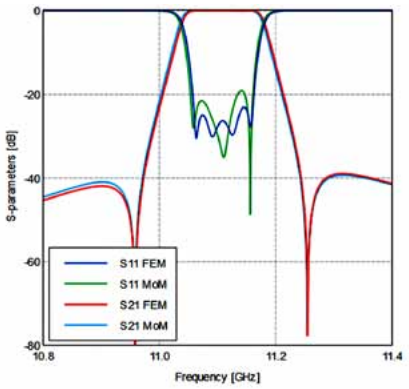
Waveguide filters come in a wide variety of designs. Guglielmi et al. published a design for a cavity based Ku-band dual-mode waveguide filter in [1]. This filter can be simulated in FEKO by exciting the ports with the



The horizontal and vertical planes with field direction vectors for a Delta driven WR-90 magic-T coupler (insert)



The FEKO model of a dual-mode waveguide filter



The frequency response of a dual-mode waveguide filter

method of moments (MoM) or the finite element method (FEM) as the solution method.

The S-parameter simulation results show a passband of approximately 11.0 to 11.2 GHz. Input reflections (S_{11}) are mostly below - 20 dB in this band and transmission zeros are located on either side of the passband. The electric and magnetic near fields in the cavities can be displayed and animated using surface, contour or arrow vector plots.

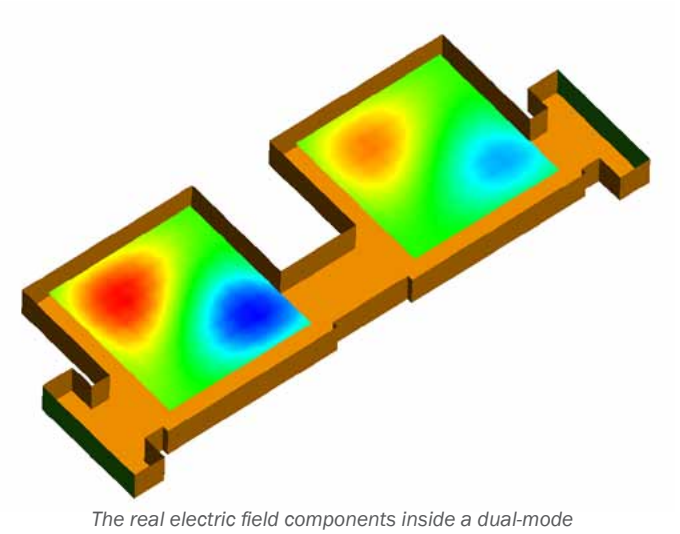
Dielectric Loaded Waveguide Filter

The authors of [2] describe an evanescent-mode waveguide filter with dielectric blocks forming two parallel cut-off waveguide paths. In FEKO the parameters of a dielectric material can either be defined manually or be read from the FEKO media library. New materials can be defined by the user and added to the library for future re-use.

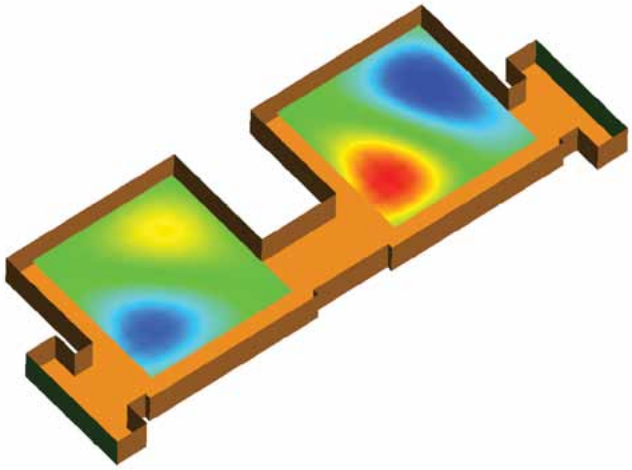
The dielectric loaded filter is solved the most efficiently in FEKO by using the FEM decoupled from the MoM. As this filter is designed for a wide band of frequencies, FEKO's adaptive frequency sampling (AFS) technology is applied to select the minimum number of frequency points that is required to accurately characterise the filter's response.

References

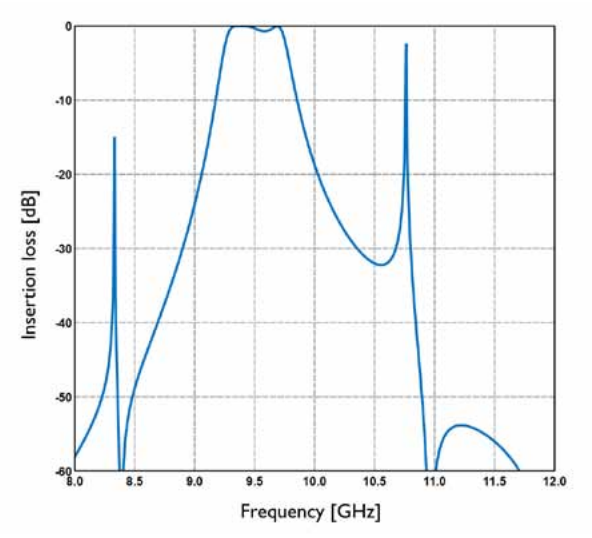
[1] M. Guglielmi, P. Jarry, E. Kerherve, O. Roquebrun, D. Schmitt, "A New Family of All-Inductive Dual-Mode Filter", IEEE Transactions on Microwave Theory and Techniques, Vol. 49, No. 10, Oct. 2001, pp. 1764-1769.
[2] H. Shigesawa, M. Tsuji, T. Nkao, K. Takiyama, "Two-Path Cutoff Waveguide Dielectric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



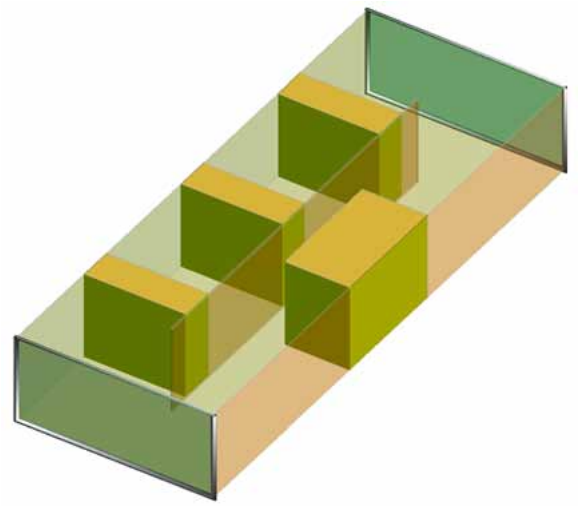
The real electric field components inside a dual-mode waveguide filter at the resonant frequency of 11.1 GHz



The imaginary electric field components inside a dual-mode waveguide filter at the resonant frequency of 11.1 GHz



The S-parameter passband result for a waveguide filter with dielectric blocks



A waveguide filter with dielectric blocks

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