Solving Rectangular-Shaped Waveguides Partially-Filled with Anisotropic Materials by Modal Techniques

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The solution to simple boundary-value electromagnetic problems was typically based on analytic techniques which looked for analytical solutions. These kinds of solutions are usually limited to some canonical geometries. However, this is not the case of modern structures used today, which do not admit closed expressions. In these cases, numerical methods are needed for their characterization. These methods must be as efficient as possible, in CPU processing time as well as in storage requirements.

The mode matching technique (MM) is based on the direct solutions to Maxwell's equations, with some boundary conditions. The MM is very useful when the geometry of the structure can be split into two or more regions, each of one having a separable coordinate system. This method is very useful in analysing waveguide discontinuities and it can be also used to obtain the resonant frequency of cavities.

When such structures are partially filled with materials, the coupled Mode Method (CMM) can be applied to calculate the propagation constants and the field profiles of the characteristic modes (proper modes) as a function of those of the corresponding empty waveguide (basis modes). In the case of more complex structures whose analysis cannot be directly performed by modal techniques, they can be decomposed into simpler structures (microwave networks). Then, each of these microwave networks can be analyzed separately with the best suited method, and thereinafter joined together with the aid of generalized circuit analysis.

In this work, some modal techniques are described and applied to microwave power devices which can be decomposed as microwave discontinuities. The different analysed discontinuities encompass the waveguides filled with material and of irregular configurations which are solved with the aid of the finite element method.