# Modeling of Nonuniform Magnetisation of a Ferrite Loaded Waveguide

H. V. Dixit[1], A. R. Jadhav[2], Y. M. Jain[3], A. N. Cheeran[1], V. Gupta[2], P. K. Sharma[3]

[1]Veermata Jijabai Technological Institute, Mumbai, Maharashtra, India
[2]Vidyavardhini's College of Engineering and Technology, Vasai, Maharashtra, India
[3]Institute for Plasma Research, Gandhinagar, Gujarat, India

## Abstract

Non reciprocal phase shifters are used in numerous microwave applications like circulators, etc. The key segment of such phase shifter is the ferrite material which provides the non reciprocal behavior. Rectangular waveguide ferrite phase shifters consists of ferrite slabs placed in the waveguide which are biased using externally placed permanent magnets as shown in Figure 1 and Figure 2. Ferrites are magnetically anisotropic materials whose permeability is defined using Polders tensor when biased[1]. The Polders tensor takes different form when magnetic field is in different directions. When an electromagnetic(EM) wave is excited through such structures, it gives different phase shift for different direction of propagation. Such behaviour can be modeled in COMSOL Multiphysics® software by defining the wave equation electric for the ferrite domains in the geometry. The inbuilt example of a junction circulator in COMSOL® software shows how to model such problems. Such technique does not require to model the magnets and hence it assumes that the ferrite slabs are uniformly biased throughout. Though this is a good approximation for initial simulations, the practical scenario would be quite different. The externally placed magnets will have leakage fluxes and various magnetic paths which would lead to non uniformity in the biasing of the ferrites. In this work, the authors have used the AC/DC Module to simulate the permanent magnets and the permeability tensor within the ferrites is calculated using the value of magnetic field entering the ferrite tiles at each point. This has helped to model the practical case to a more accurate extent. The model is simulated in COMSOL Multiphysics® software using the AC/DC and RF Modules.

## Reference

[1] D. M. Pozar, Microwave Engineering, John Wiley & Sons, 2009.
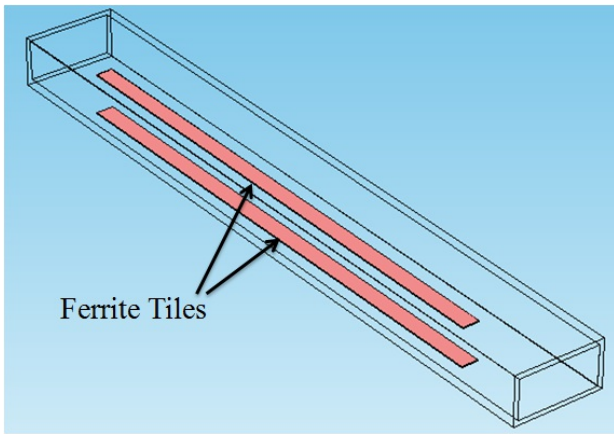
# Figures used in the abstract



Ferrite Tiles

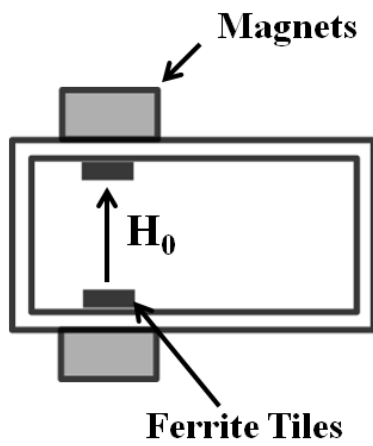**Figure 1**: Placement of Ferrite Tiles in a rectangular waveguide.



Magnets

$H_0$

Ferrite Tiles

**Figure 2**: Placement of magnets with respect to ferrite tiles.