

LAB #04: Analysis of Different Modes in Rectangular and Circular Resonators using HFSS

Objective:

To familiarize the students with analyzing of different modes in Rectangular and Circular Dielectric Resonator/Waveguide.

Theoretical Background

A **dielectric resonator** is a piece of dielectric (nonconductive) material, usually ceramic, that is designed to function as a resonator for radio waves, generally in the microwave and millimeter wavebands. So resonator is nothing but just a hollow metallic box that naturally oscillates at some frequencies, called its resonant frequencies, with greater amplitude than at others.

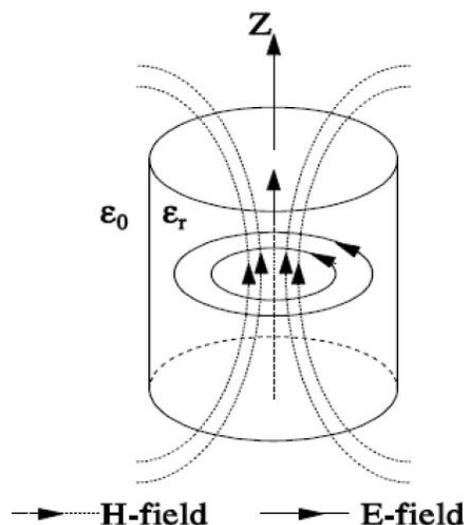
Electromagnetic waves can travel along waveguides using a number of different modes. The different waveguide modes have different properties and therefore it is necessary to ensure that the correct mode for any waveguide is excited and others are suppressed as far as possible, if they are even able to be supported.

Waveguide modes

Looking at waveguide theory it is possible to calculate there are a number of formats in which an electromagnetic wave can propagate within the waveguide. These different types of waves correspond to the different elements within an electromagnetic wave.

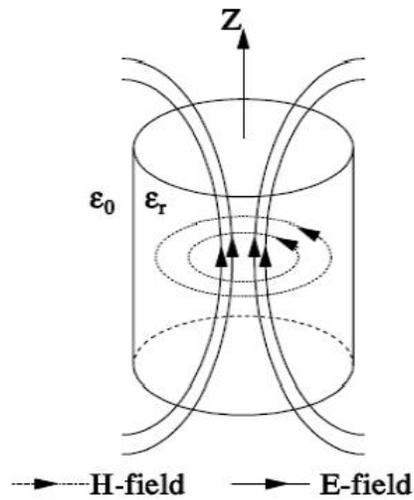
TE mode:

This waveguide mode is dependent upon the transverse electric waves, also sometimes called H waves, characterised by the fact that the electric vector (E) being always perpendicular to the direction of propagation.



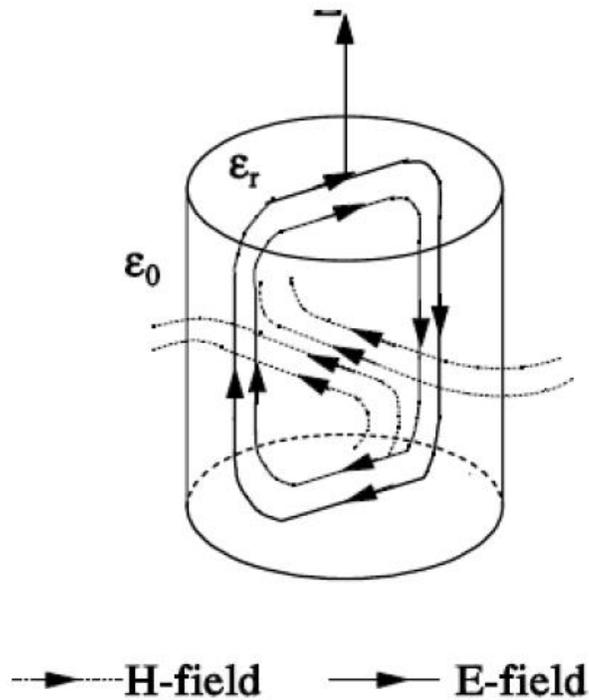
TM mode:

Transverse magnetic waves, also called E waves are characterized by the fact that the magnetic vector (H vector) is always perpendicular to the direction of propagation.



TEM mode:

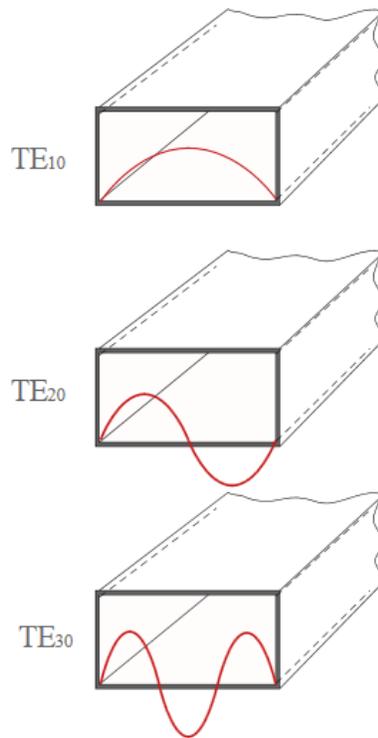
The Transverse electromagnetic wave cannot be propagated within a waveguide, but is included for completeness. It is the mode that is commonly used within coaxial and open wire feeders. The TEM wave is characterized by the fact that both the electric vector (E vector) and the magnetic vector (H vector) are perpendicular to the direction of propagation.



Text about the different types of waveguide modes often indicates the TE and TM modes with integers after them: $TE_{m,n}$. The numerals M and N are always integers that can take on separate values from 0 or 1 to infinity. These indicate the wave modes within the waveguide.

Only a limited number of different m, n modes can be propagated along a waveguide dependent upon the waveguide dimensions and format.

Representation of different modes



Tasks:

1. Analyze different modes of propagation for rectangular resonator in HFSS for 20GHz resonance frequency.
2. Repeat the same process for Circular resonator.