Comparative Analysis of Pass Band Characteristics of a Rectangular Waveguide with and Without a Dielectric Slab

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Abstract*: Rectangular waveguide with dielectric slab is designed for various applications. Assume waveguide is to be aligned along X direction with length 60mm and width of the waveguide 22.86mm along Y direction and the height of the waveguide is 10.16mm along Z direction. Dielectric slab is placed in between the centre of the waveguide of length and width 1mmx1mm and the height of the dielectric slab is -12mm Dielectric slab is assigned with ferrite material. Various parameters like Return loss and transmission coefficient and also the pass band characteristics have been compared by placing with and without a dielectric slab.

***Index Terms*: Rectangular waveguide, Dielectric slab, An-soft HFSS**

I. INTRODUCTION

Waveguides can be defined as a guided medium to transmit electromagnetic energy from one place to another which are usually operated at dominant modes. Various types of transmission lines such as micro strip lines, coaxial cables, strip lines can also be treated as working of waveguides. Transmission lines are operated at microwave frequencies for different applications like microwave ovens satellite communications and also Radars. Waveguide works on the principle of total internal reflection. Usually waveguides act as a high pass filter. Waveguides handle high power and provides larger bandwidths. To alter the pass band characteristics of a waveguide a dielectric slab is placed at the centre of the waveguide Different types of magnetic materials like Iron Cobalt Nickel also used for dielectric slab. Due to high resistance magnetic material ferrite is used. Electromagnetic waves undergoes phase shift due to the ferrites , hence Ferrite magnetic material is assigned to dielectric slab. The advantage of the waveguides is to provide large bandwidth and handle high power capacity. waveguide simply used as a transmission lines. Waveguides are widely used in the applications like optical fibre communications. various passive components such as filters,dividers, horn antennas can be made of waveguides.

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II. DESIGN TOPOLOGY

Rectangular waveguide has designed by using An -soft software. Waveguides act as a high pass filter which allows all frequencies other than he cut off frequency. Dielectric slab is placed at the centre of the waveguide to propagate radio waves which are at millimetric frequencies. In this work Rectangular waveguide is filled with dielectric slab for the comparison of pass band characteristics with and without dielectric slab. Dielectric slab is coated with ferrite magnetic material. Ferrite is a high resistance magnetic material and the waves which propagate through ferrites having negligible attenuation. The dimension of the rectangular waveguide is calculated by using the formula.

$$f_c = 1/2\sqrt{\mu\epsilon}[(m/a)^2 + (n/b)^2$$

Where f_c is cut off frequency
m, nhalf cycle variations
a,b are length and width of the Rectangular wave guide

II.1 Rectangular waveguide

A rectangular waveguide is a hollow metallic structure which carries high frequency radio waves particularly microwaves. Waveguides propagates electromagnetic waves with minimum loss of energy. Electromagnetic waves transmit through successive reflections from the inner walls of the tube having the dimensions of width a=22.86, height b=10.16, and the length of the waveguide is 60mm.The inner walls of the waveguide is made with copper material.

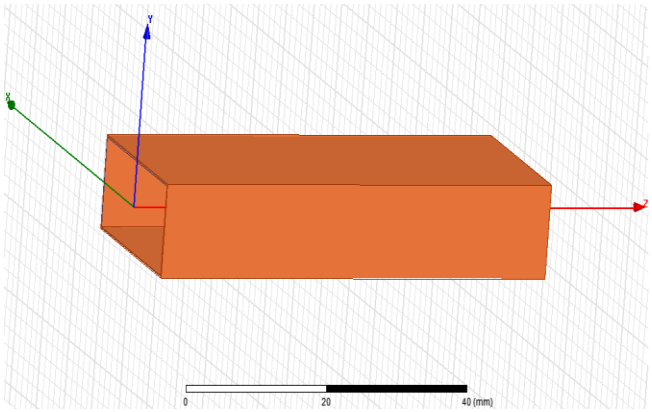


Fig. 1. Rectangular Waveguide

II.2. Rectangular waveguide with dielectric slab

A rectangular waveguide is a hollow metallic structure which carry high frequency waves particularly microwaves. A dielectric slab is placed at the centre of the waveguide to observe the pass band characteristics of the wave guide with and without dielectric slab. The dielectric slab is made with ferrite material. The dimensions of the dielectric slab having length and width 1mmx 1mm and the length of the dielectric slab are -12mm.

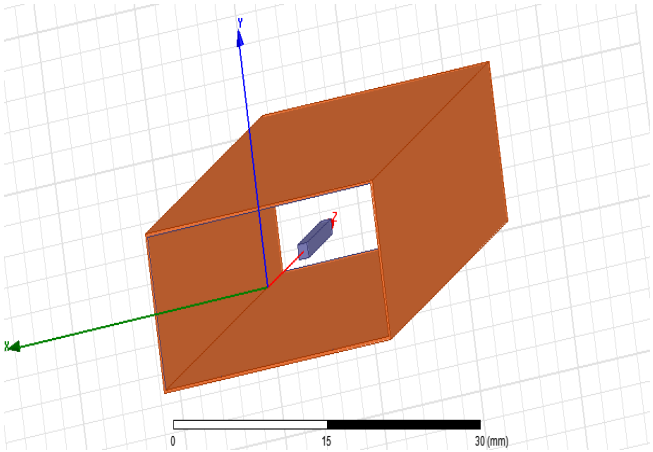


Fig. 2. Rectangular Waveguide with dielectric slab

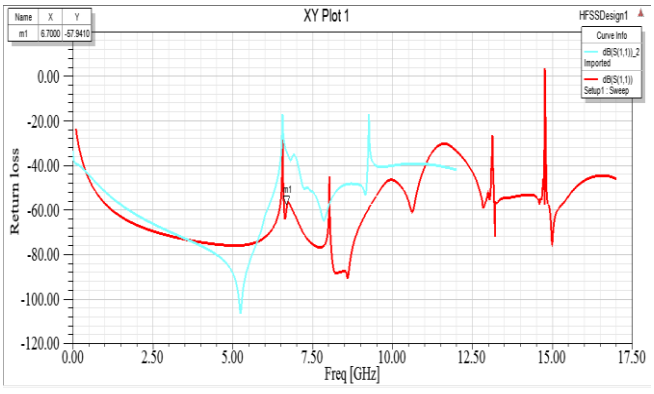
III. RESULTS AND COMPARISONS

Rectangular waveguide has been designed and also by placing a dielectric slab at the centre of the waveguide to observe the pass band characteristics of a rectangular waveguide with and without dielectric slab. We also observe the parameters like return loss and transmission coefficient.

III.1 RETURN LOSS

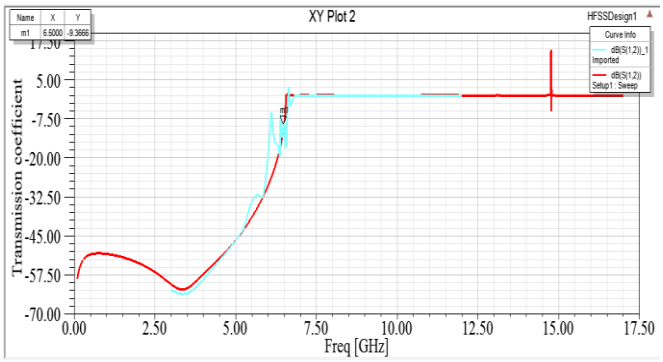
III.1.1 Return Loss (S_{11})

The return loss of a rectangular waveguide with and without a dielectric slab as shown below

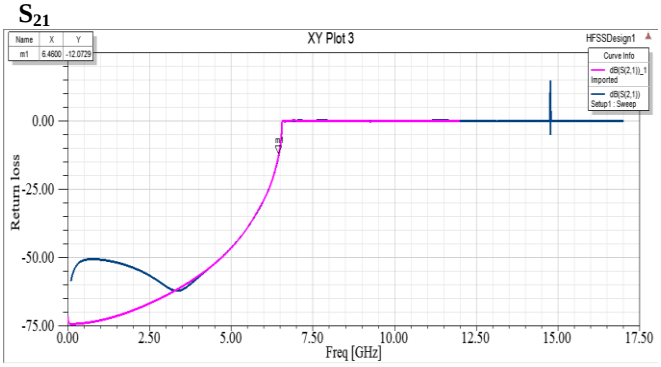


III.1.2 Transmission coefficient(S_{12})

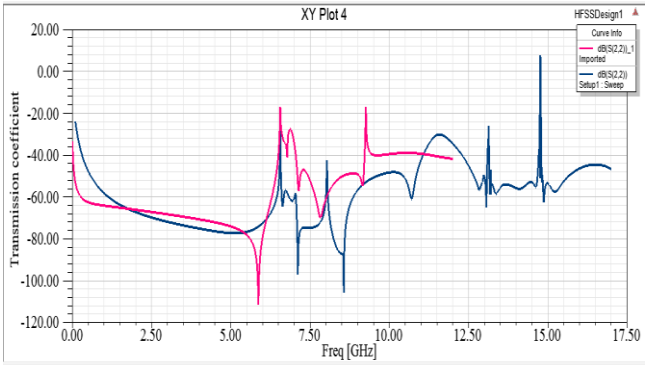
The transmission coefficient of a rectangular waveguide with and without dielectric slab is as shown below



S_{21}



S_{22}



IV. CONCLUSION

Rectangular waveguide with dielectric slab is simulated by using Ansoft-HFSS. The parameters like Return loss and transmission coefficient are simulated. We observed the pass band characteristics of a Rectangular wave guide by placing a ferrite dielectric slab at the centre of the waveguide.

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