A Survey: Analysis of Dielectric Circular Waveguide

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Abstract— Electromagnetic waves are very strong waves which are used for transmission of signals from one place to other place. The main concern for the transmission is the selection of waveguide and its physical structure, material and dimensions etc. Generally Rectangular and Circular waveguide are used for transmission of EM waves. In rectangular waveguide attenuation losses, return loss and insertion loss are present due to a small corner at the ends. Due to the presence of such losses, the transmission was not as expected and reflection may occur. Attenuation losses, Return loss and Insertion loss are less in dielectric circular waveguide compares Rectangular and Circular Waveguide. In this paper dielectric circular waveguide plays the important role in a waveguide to obtaining the desired results.

Keywords: Rectangular waveguide, Circular waveguide, Dielectric Circular waveguide, dominant mode

I. INTRODUCTION

Microwaves are radio waves (a form of electromagnetic radiations) with wavelengths ranging from as long as one meter to as short as one millimeter or equivalently frequency between 300MHz to 300 GHz [1]. There are so many different types of structures are used. Some of the structures are as popularly known as wires, coaxial cables, dielectric slabs, strip lines and electric power lines but this is become very difficult for high frequency communications [1]. In this paper circular waveguide are uses. Waveguide, like transmission lines are Structures which is used to guide electromagnetic waves from one place to another place Typically waveguide is made of brass, copper, aluminum or any metal that has low bulk resistivity it is possible to use metals with poor conductivity characteristics interior walls are properly plated it is even possible to make dielectric waveguide. Hollow waveguides are widely used in applications requiring high power-handling capability and simple integration with radiating devices, such as horn antenna [1] [2]. As such, they are ideally suited to microwave radio links, radar, and satellite communications. It is well known that air-filled waveguides enclosed by perfect-electric-conducting (PEC) boundaries support a discrete spectrum of modes, each possessing a cut-off frequency, fc, above which it is capable of propagating power. Homogeneously filling the vacuum region of the waveguide with dielectric material serves to reduce these cut-off frequencies, without modifying the corresponding transverse modal field distributions [3]. Less number of conductor losses in the metallic waveguide in this system. Suppose uses the dielectric parts, low losses cost and ease of fabrication in the dielectric material so the dielectric waveguide is more attractive [4].

A. Modes of the waveguide:

Mode means electromagnetic wave inside the waveguide which have infinite number of patterns [1]. Generally two types of the waveguide are uses circular waveguide and rectangular waveguide, which is supported the some of modes. There are basically two types of modes which are as follows, TE and TM modes. Dielectric waveguide supported the all of the TE and TM modes and also supported the HE modes. All of modes are classified below [1].

- TE modes (Transverse Electric) no electric field in the direction of propagation
- TM modes (Transverse Magnetic mode) in the direction of propagation there is no magnetic field
- TEM modes (Transverse Electro Magnetic) both electric and magnetic field are purely transverse to the direction of propagation
- HE modes (hybrid) neither electric nor magnetic field are purely transverse to the direction of propagation

Generally all of the waveguide uses the dominant modes, for Rectangular waveguide TE_{10} modes is dominant mode and for circular waveguide TE_{11} is dominant. A dominant mode means highest cut-off wavelength and lowest cut-off frequency.

B. Existence Works:

In this section first paper describe the difference between rectangular and circular waveguide based on losses. Second paper describes the simple circular waveguide loaded dielectric material while the third paper describes the circular waveguide loaded the dielectric material in this paper some of counterpart is dielectric.

1) Comparative analysis of rectangular and circular waveguide using matlab simulation [5]:

There are so many ways to guide this electromagnetic waves but main consideration in this paper is rectangular waveguide and circular waveguide

A rectangular waveguide and circular waveguide supports TM and TE modes but not TEM modes because it cannot define a unique voltage since there is only one conductor in a rectangular waveguide and circular waveguide. The shape of a rectangular waveguide based on their dimensions and Circular waveguide is basically seems like the circular structure as the frequency of transmitted signal changes the inner diameter of circular waveguide also changes. There are so many uses of Circular waveguides like in communication systems used in specific areas of radar and uses as rotating joints of the mechanical point of the antennas rotation. Generally the values of radius are very important for manufacturing of circular waveguides[5].

Waveguides can support traveling waves at frequencies higher than their cut-off frequencies. However,

the traveling waves are attenuated by losses in the dielectric medium that fills a waveguide and by losses in the conducting sidewalls attenuation is less in circular waveguide compare rectangular waveguide. The frequency increase with linearly increase the attenuation in rectangular waveguide and frequency increased the attenuation is decreased in circular waveguide[5].

2) Dielectric Loaded Circular Waveguide Feeds[6]:

Prime focus reflectors are widely used in many applications such as terrestrial, satellite and radio communication. It is economical to manufacture but suffers from the blockage caused by the feeds and feed supports. This reduces the gain and raises the side-lobe levels. Therefore, the performance of the reflector can be realized if a high performance feed is used [6].

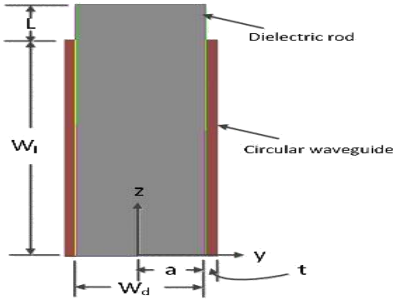

Fig. 1: Circular waveguide loaded with dielectric rod

Circular waveguide feed is a good choice for reflector feed provided that the diameter is small, which reduces the weight and the central blockage of the reflector [6]. It is also easy to fabricate. In this paper designed and investigated small diameter circular waveguide feeds loaded by dielectric material for additional investigation [6]. The S_{11} of the antenna was also investigated from 8 to 12 GHz. It was below -10 dB level over the entire frequency range [6].

3) Analysis of Alternate Dielectric and Metal Vane Loaded Circular waveguide for a wideband Gyro- TWT[7]:

In this review paper waveguide is made from metal waveguide and loaded the dielectric material [7]. But the some of counterpart is dielectric material. Dielectric and metal-vane-loaded waveguide that providing a wide bandwidth of the device without much sacrifices of its gain [7]

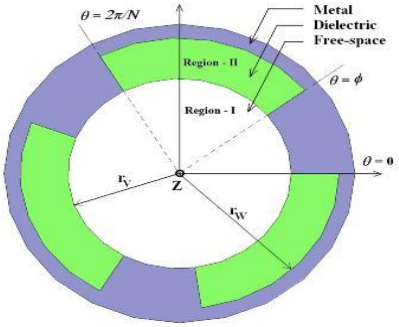

Fig. 2: Dielectric and vane-loaded circular waveguide

4) Wave propagation characteristics of dielectric tube waveguide filled with plasma[4]:

In this paper dielectric waveguide uses. At frequencies above 30 GHz, metallic waveguide has significant amount of conductor losses and their dielectric Counter parts have low loss, cost and ease of fabrication, so dielectric waveguide are become attractive Dielectric tube waveguide filled with plasma is an open waveguide structure and the increase bandwidth in this paper and change the bandwidth by changing the plasma density[4].

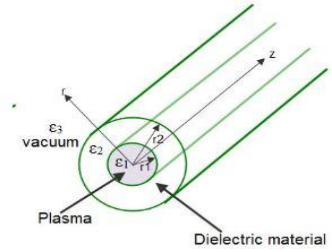

Fig. 3: Geometry of dielectric tube filled with plasma

II. Conclusion

We can conclude that in this Dissertation, detailed overview regarding to the circular, rectangular and dielectric waveguide made up of different material, it can be concluded that the waveguide made up of dielectric material is better and effective as compared to the circular and rectangular waveguide, it was noticed that the attenuation loss, return loss and insertion loss in waveguide which is made up of dielectric material is less, while it is more in the case of rectangular waveguide and circular waveguide, which plays a important role in the propagation of waves in waveguide and increase the gain and bandwidth in dielectric waveguide compare circular waveguide and rectangular waveguide.

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