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RESEARCH ARTICLE

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DESIGN OF MICROSTRIP PATCH ANTENNA FOR S-BAND

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ABSTRACT
Micro strip patch antenna is a light weight, conformable to planer and non planer array and is a low-profile antenna. In different application it has proven itself as a good radiator. Simple and when comes to design it is easy to fabricate. Process for designing of a micro strip patch antenna is visualized. Main parameters while designing like S-Parameters, gain, and their relation to antenna performance are also discussed. Coaxial probe feed will be our feeding technique for the design and is easy to implement and fabricate. Our main goal is to analyze different aspects in the design of single patch antenna at a frequency of 2.25 GHz using HFSS and analyze different parameters.

Keywords— Patch Antenna, Bandwidth ,Impedance matching, Transmission Line model, Resonant frequency, circular polarization.

INTRODUCTION

The basic modal of a micro strip antenna consist of an infinite ground plane, dielectric substrate, and a patch element which radiates. Thick dielectric are used to enhance antenna performance with low dielectric constant value, which results in better antenna performance, efficiency, larger bandwidth[1].There are easily used in wireless communication very effectively like satellite and radar applications. First of all feeding and engraving of patch is done on the given substrate. The radiating patch can be of different types but most of them are rectangular and circular.

We have discussed a micro strip Antenna which is single layered and for which a substrate with dielectric constant value is limited within the value of 2.5.The patch boundaries location depends on input impedance, which further provides us a technique for impedance matching [2].Contacting feed find different ways to transfer power to the radiating patch through the feed line. A wide variety of research papers are available for design and development of Microstrip antenna[3][4][5] But we have used a different approach. It is difficult to design non contacting feed because of their higher degree of freedom which makes their designing complex than contacting.

The basic modal of micro strip antenna with rectangular patch is shown in Figure 1 (a) from HFSS. In further evaluation we will summarize the different type of substrate used for a effective fabrication of antenna which comprise of thin substrate and thick substrate both and their effects on resonant frequencies. For better understanding a circuit design is presented in[6][7]. Coaxial probe feed is also a feeding process for circular patch for available frequency bands[8].

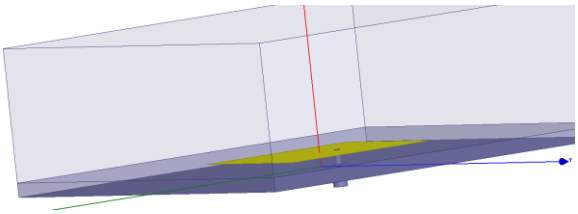

Fig 1: a) Rectangular Patch

Available Substrates

It has found that the most delicate parameter in micro strip antenna's performance estimation is the dielectric constant of the substrate used. There are many substrates in use and their range lies between 1.17 to 25. Poly tetra fluoroethylenes (PTFE) are very often used because of their desirable electrical and mechanical properties. They are imbedded with glass woven or glass fibers [9].Substrate with high dielectric constant is selected to reduce the size of the antenna. Value of dielectric constant for RT/Duroid is 2.45. RT/duroid materials consist of a glass microfibers reinforced PTFE composite. we have selected RT/duroid 5880 with relative permittivity 2.2 and substrate height .32mm(12.59MIL). The change in operating frequency of a thin substrate due to the only change in substrate dielectric constant may be expressed as.

$$\frac{\partial f}{f} = -\frac{1\partial\varepsilon}{2\partial\varepsilon} \qquad (1)$$

Where f is the resonant frequency of the antenna which is 2.25GHz for the design., ε is termed as dielectric constant , ∂f is termed as resonant frequency and $\partial\varepsilon$ is the change in relative dielectric constant. Thin substrate is used for Most of the experiments for the fabrication of micro strip antenna. Recent research has come on electrically thick substrate [10]. This is executed because the antenna operates at higher frequency and due to inherent property of the antenna of having a narrow bandwidth.

Method of Analysis

There are different models for the simulation of micro strip antenna[11] but the most efficiently used model is transmission line model we have calculated patch dimensions using this model.

Transmission line model

The simplest analysis of rectangular patch practises transmission line model. With low accuracy and lack of flexibility transmission line model is simple as compared to another models. Micro strip antenna has two radiating slots parted by a low impedance Z and transmission line of length L.

One of the major effects that come into picture is fringing effect. The field at the edges of the patch suffers fringing effect. For micro strip antenna in order to minimize fringing the range should be L/H>>1. It is considers because it effects the resonant frequency of the antenna. Effective dielectric constant is introduced because of the waves travel in substrate and in air as well, which increases the length of the antenna electrically. The value of effective dielectric constant is calculated with the help of the given equation.

$$\varepsilon_{eff} = \left[\frac{\varepsilon+1}{2}\right] + \left[\frac{\varepsilon-1}{2}\right] * \left[1 + 12\left(\frac{h}{w}\right)\right]^{-\left(\frac{1}{2}\right)} \qquad (2)$$

We should know that for lower frequencies effective dielectric constant is constant .Fringing effect at the two ends of the radiating patch is show in the fig.2.

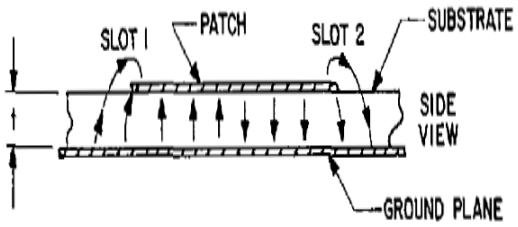

Fig. 2. Fringing Effect

Due to this the length have been increased from each side of the patch by distance ΔL.A relation between width to height ratio (W/h) and effective dielectric constant is given by equation (3).

$$\frac{\Delta L}{h} = \frac{.412\left[(\varepsilon eff+.3)*\left(\frac{W}{h}+.264\right)\right]}{\left[(\varepsilon eff-.258)*\left(\frac{W}{h}+.8\right)\right]} \qquad (3)$$

The effective length of radiating patch due to fringing effect has been extended so that L_{eff} will be

$L_{eff} = L + 2\Delta L$ (4)

Based on this formulation a design is achieved for a rectangular patch antenna. For which some value should be known which consist of resonant frequency (f), height of the substrate (h) and dielectric constant of the substrate (**ε**).

$$W = \left(\frac{v}{2f}\right)\left[\frac{2}{\varepsilon+1}\right]^{\frac{1}{2}}$$

Where v is the free space velocity of light

Above equations helped us to calculate the length and width of the patch. These lengths are not exact values they are just an approx value. More optimization is required to get an accurate result.

Feeding Techniques

The feeding is done by keeping one thing in mind that the patch makes a direct contact with the micro strip line. There are various types of feeding. A different proposal for circular microstrip antenna is given in [12] .One of the commonly used feeding techniques is probe feed, Which is analyzed and used in this paper for result analysis. Where the feed consist of nothing but coaxial cable of certain diameter and a single connected probe and pin the excitation is given through coax and the probe is directly connected to radiating patch. To find the correct location of the feed we use equation (5)

$$Rin = Rcos^2(\theta) \quad (5)$$

Where R is input resistance when patch is feed at a radiating edge and θ is the distance of feed point from the edge [13] .ed probes some researchers chiba, et al., [14] hanfling and schuss [15] have given their contribution by suggesting two symmetric placed probes .A approach is done in [16] to design a high performance antenna array using inset-feed as a different technique and a design for energy harvesting is done using the idea of microstrip patch array[17].In our simulation the inner pin and probe touching the rectangular patch should be of perfect electric conductor (PEC) and the coaxial cable or the outer cylinder can be assigned as Teflon material

This is done to improve the cross polarization of the antenna[18][19]. Mutual coupling is also introduced due to feed line radiation which is minimized by proximity coupling and can also be minimized by probe feed technique. Given diagram represents two feeding techniques widely used in antenna fabrication. Fig3 (a) shows coax probe feed point and fig3 (b) shows patch with inset micro strip transmission line feed.

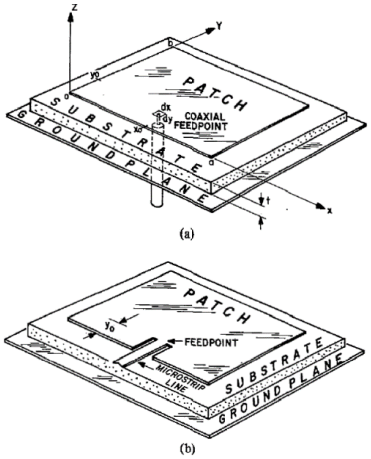

Fig. 3. (a) Coax Fed (b)Inset Microstrip Transmission Line

The feed point location is very important because it is used to control input impedance.

RESULT ANALYSIS

We have used HFSS software to simulate and get the absolute result. The solution frequency is 2.25GHz with sweep type interpolation and number of passes is 10.

In figure 4 return loss is described at feed point location.

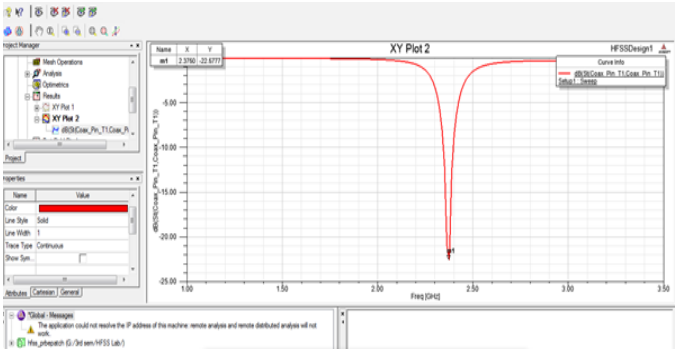

Fig 4: Return loss characteristics of antenna at feed point

Figure 5 shows us the antenna gain at 2.25GHz resonant frequency.

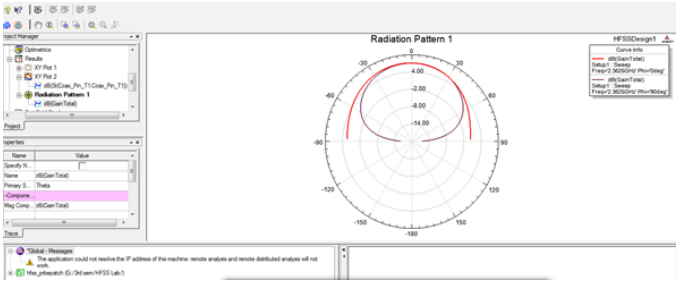

Fig 5: Radiation characteristics total gain of the antenna

CONCLUSION

We have reviewed the state of design methodology of micro strip antenna. The substrate, which is very important in design is mostly used in the design with their electrical and physical properties both. A method of fabrication is provided to simulate and optimize a simple rectangular patch antenna. GPS and communication purposes uses Microstrip antenna widely and it finds good scope in near future.

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