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Design of Coaxial Feeding Rectangular Microstrip Patch Antenna at 2.45 GHz

S.R. Bhongale

Associate Professor, Dept. of Physics, Yashavantrao Chavan Institute of Science, Satara, Maharashtra, India.

ABSTRACT: The design and analysis of rectangular microstrip patch antenna is studied. For excitation of antenna the coaxial feeding method is used. The RT-duroid is used as substrate for patch antenna with dielectric constant ε_r = 10.2 and thickness 0.254mm. The various parameters like the return loss, s-parameter, VSWR, smith chart and radiation pattern are observed. This antenna was designed and analyzed using Ansoft Designer SV2.2 software at resonance frequency 2.45 GHz for ISM band.

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KEYWORDS: Antenna theory, Microstrip antenna, Coaxial feeding, Return loss.

I. INTRODUCTION

The recent wireless communication field requires a important device like an antenna. These antennas must have light weight, high gain, simple structure. The microstrip antenna has such properties. Microstrip antenna technology was developed from 1970. It gives reliability, mobility, easy transferable and requires small mounting surface. The design parameters like dielectric constant, height of substrate and frequency decides the performance of MCAs. The high value of dielectric constant miniaturizes the antenna size [1].Microstrip antenna is in form of dielectric substrate sandwiched between two conducting metals. The upper metal is a radiating patch generally of copper or gold while lower metal plane is a ground plane. The feeding methods play an important role in impedance matching [2].

II. RELATED WORK

The comparison of feeding technique was studied by using Ansoft HFSS software. In case of coaxial feeding number of trial and error methods were done to obtain good impedance matching[2]. These antennas are simulated by using number of softwares such as IE3D, MATLAB, SONET-LITE[3], ADS, ANSOFT-Designer [4], HFSS[5]. There are various shapes like rectangular[2], circular [6], elliptical [7], ring, triangular [8], square, etc. of microstrip patch antenna. In present paper rectangular microstrip patch antenna is designed

III. DESIGN OF MICROSTRIP PATCH ANTENNA

. This antenna radiates mainly due to the fringing field between patch edge and ground plane. The length of radiating patch in this antenna is usually $0.333\lambda < L < 0.5\lambda$, the thickness of patch is very much less than λ while height h of dielectric substrate is ranges from 0.003λ to 0.05λ,where λ is the free space wavelength. The dielectric constant ε_r of the substrate is $2.2 \leq \varepsilon_r \leq 12$ [1]. Thus the geometry of rectangular microstrip patch antenna is as shown in fig.1.

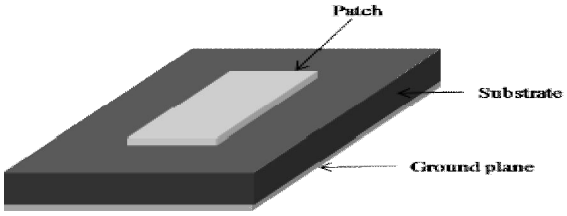

Fig.1: Microstrip Patch Antenna

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The analysis of microstrip antenna can done by using transmission line model and required parameters of antenna are determined. The fringing field between patch edge and ground plane reduces the value of dielectric constant ε_r. The value of effective dielectric constant is in the range of $1 < \varepsilon_{reff} < \varepsilon_r$. This is because the fringing fields are not only in dielectric substrate but are also spread in air as shown in fig.2[1]

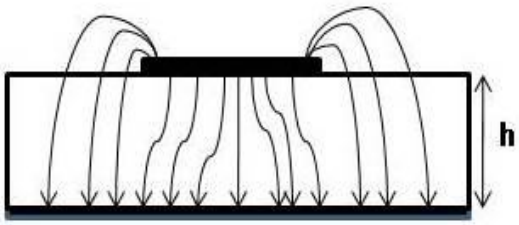

Fig.2: Electric field lines

The parameters of patch antenna are determined by using following various formulae.

1. Width of patch [9],

$$W = \frac{c}{2 f_r \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where c = Velocity of light in air.

f_r = Resonance frequency

ε_r = Dielectric constant of substrate

2. Effective dielectric constant [10] :

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{\frac{1}{2}}$$

where ε_{reff} = Effective dielectric constant

h = Height of substrate,

W = Width of patch.

3. Extension length [11] :

$$\Delta L = 0.412 \frac{\left(\frac{W}{h} + 0.264\right)\left(\varepsilon_{reff} + 0.3\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)}$$

4. Length of patch [10] :

$$L = \frac{c}{2 f_r \sqrt{\varepsilon_{reff}}} - (2 \times \Delta L)$$

A. *Feeding Methods:*

There are different methods can be used to feed microstrip patch antenna. The most useful methods are microstrip line, coaxial probe, aperture and proximity coupling. For present investigation coaxial feed method is used. In this method inner conductor of the coax is attached to the radiation patch and outer conductor is connected to the ground plane. Also it is easy to fabricate and match, and it has low spurious radiation[1]. The location of coaxial feed is decided in such way that antenna gives desired return loss. In this proposed antenna coaxial feed position is obtained by changing position of feed for number of times and observed the value of return loss.

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B. *Design parameters of antenna :*

The dielectric material used for antenna is RT_Duroid. Its dielectric constant (ε_r) is 10.2 and thickness is 0.254mm. The resonance frequency is taken as 2.45 GHz. The width of the patch (W) and Length of the patch (L) of proposed antenna is determined as 26.411mm and 19.5881 mm. By using Ansoft Designer SV2.2 softwarethe rectangular patch antenna with these proper dimensions and feed location is represented in Fig.3 [12].

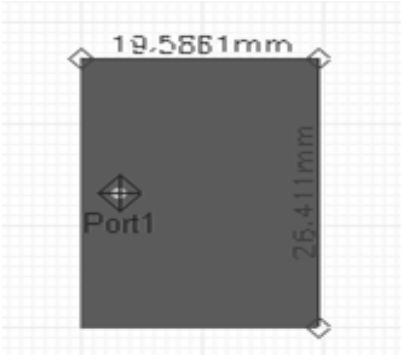

Fig.3: Proposed rectangular microstrip patch antenna

IV. RESULT AND DISCUSSION

From fig.4 the resonance frequency of the rectangular microstrip patch antenna is 2.38GHz with return loss of -21.60dB. This indicates 99.21 % power transferred to an antenna[13]. The 3dB and 10 dB % bandwidths are 1.6 and 0.54 respectively.

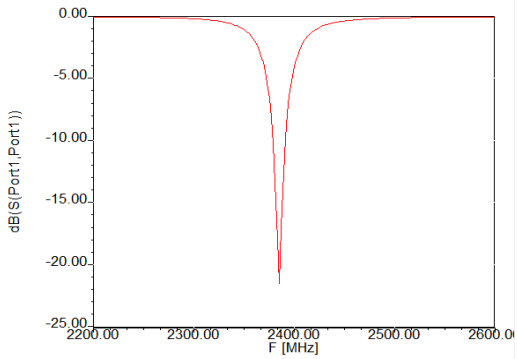

Fig. 4: Variation of Return loss with frequency

The value of S_{11} is observed to be 0.08 at 2.38GHz.in Fig.5.

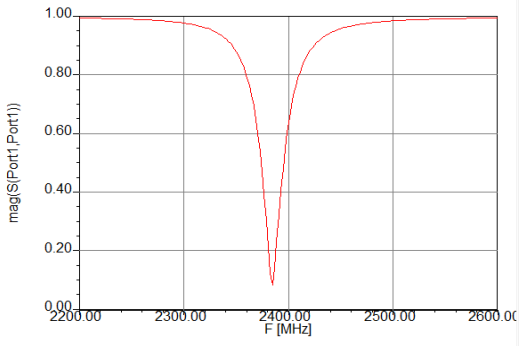

Fig.5. Variation of $S_{11}$with frequency

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At resonance frequency the VSWR is found to be 1.07 shows good impedance matching at feeding point.

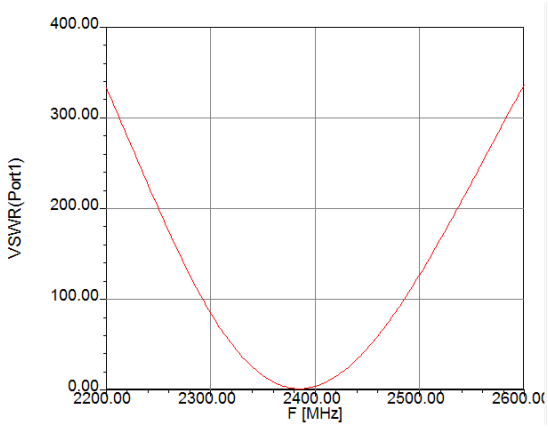

Fig. 6: Variation of VSWR with frequency

The smith chart is presented in Fig.7. indicates good impedance matching at required feed point.

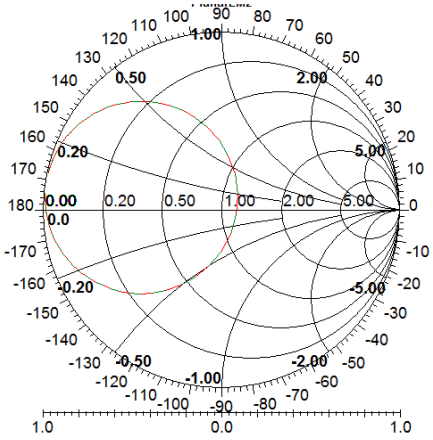

Fig.7: Smith chart

The half power beam width from radiation pattern is found to be 58 degree.

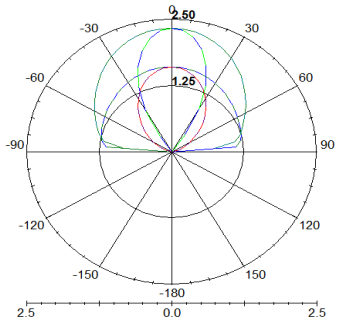

Fig.8: Radiation pattern

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V. CONCLUSION

The rectangular microstrip patch antenna with coaxial feeding on RT_Duroid substrate has been designed. The return loss of antenna is -21.60dB at 2.38GHz frequency indicating optimum impedance matching. The bandwidth of antenna is noticed to very much narrow. The half power beam width is 58 degree.

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BIOGRAPHY

Sanjay R. Bhongale was born in Devarastre, Dist. Sangali (Maharastra State, India) on 1st June 1962. He received the B.Sc. degree and the M.Sc. degree in physics from Shivaji University, Kolhapur in 1984 and 1986 respectively. His research interest is in the areas of applied electromagnetic, ferrites with focus on its application in microstrip patch antenna. He is currently pursuing the Ph.D. degree in Physics at Shivaji University, Kolhapur, India.

He has been Associate Professor at Rayat Shikshan Sanstha's Yashavantrao Chavan Institute of Science, Satara, Maharastra State, India since April 1989.