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Comparison of Single Feed Single Frequency & Single Feed Dual Frequency Compact Rectangular Microstrip Patch Antenna Using IE3D Software

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ABSTRACT: This paper describes the comparison of single frequency and dual frequency compact rectangular microstrip patch antenna. In this paper rectangular patch with probe feed technique is used. The paper describing how compact microstrip antenna can be designed by introducing shorting pin technique and gives a better understanding of design parameters of an antenna and their effect on return losses, and resonant frequency. Finally simulation is done using design software IE3D.

KEYWORDS: Microstrip patch antenna, probe feed, return loss, dual frequency, resonant frequency, IE3D.

I.INTRODUCTION

Antenna is part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves. Microstrip antenna is only one such type of antenna. A microstrip device in its simplest form is a sandwich of two parallel conducting layers separated by a single thin dielectric substrate. The upper conductor is thin metallic patch (usually Copper) which is a small fraction of a wavelength. The lower conductor is a ground plane which should be infinite theoretically. The patch and ground plane are separated by a dielectric substrate which is usually nonmagnetic. The dielectric constant of the substrate ranges from 1.17 to 25 with the loss tangent ranging from 0.0001 to 0.0004. The patch can assume any shape such as rectangular, circular, triangular, elliptical, helical, circular ring etc**.** Microstrip antennas are used where size, weight, cost, better performance, compatibility with microwave and millimeter wave integrated circuits, robustness, ability to conform to planar and non planar surfaces etc. are required.

Bandwidth and efficiency of a microstrip antenna depends upon patch size, shape, substrate thickness, dielectric constant of substrate, feed point type and its location etc. For good antenna performance a thick dielectric substrate is having a low dielectric constant desirable for higher bandwidth, better efficiency and better radiation leading to a larger antenna size. In this paper comparison of single feed single frequency & single feed dual frequency compact rectangular microstrip patch antenna has been discussed**.**

II.FEEDING TECHNIQUES

The two techniques available to feed or transmit electromagnetic energy i.e. induce excitation to a microstrip antenna are contracting (feeding is done directly via a connecting element such as microstrip transmission line and co-axial probe) non contracting types (like aperture coupling, electromagnetic field coupling is done to transfer power between the microstrip line and the upper conductor.

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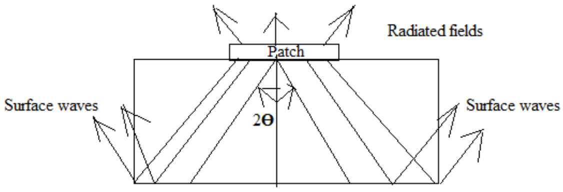

Fig.1 Formation of surface waves

A. Microstrip Line Feed Technique

The simplest way to feed a microstrip patch is to connect a microstrip line directly to the edge of the patch. In this case both the patch and the lines are located on the same substrate. The matching between the characteristic impedance of the microstrip feed line and the patch can be done by selecting the right depth of the inset.

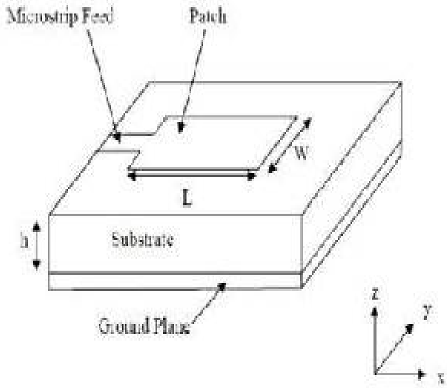

Fig.2 Patch antenna with microstrip line feed

B. Fringing Effect

The radiation from microstrip antenna can be found from the patch spaced of a wavelength above a ground plane. When the length of the patch is about half a wavelength long, then the radiation generates from the fringing electronic fields between the patch and the ground plane. Further, it is assumed that there is no variations of electric field along the width and the thickness of the antenna. The fringing electronic field is an effect of the electrons congregated at the surface of the conductor, especially at the edge. So that most of the radiated power is distributed from the edge of the patch.

III.MODELLING TECHNIQUES

To understand and analysis the behavior of microstrip antennas choosing model to simulate the performance is very helpful in antenna design stage. There are two types of modeling technique available.

1) Transmission line model
2) Cavity model

IV.FOUMULAS USED FOR ANTENNA DESIGNING

Here the formulas used for antenna designing are described below where W is the width of the proposed antenna, L is the length of the antenna ,ϵ_{reff} is the effective permittivity of the antenna, which is given by:

$\varepsilon_{reff}= (\varepsilon_r+1) /2 + (\varepsilon_r-1)/2 *[1+(12(h/w)]^{-.05}$

Calculation of Length Extension ΔL, which is given by :

$(\Delta L/h) =0.412[(\varepsilon_{reff} + 0.3)*((w/h)+0.264)]/ [(\varepsilon_{reff} -0.258)*((w/h)+0.8)]$

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For effective radiation , the Width W is : $W= \lambda_g/2*[(\varepsilon_r+1)/2]^{-0.5}$

Now, to calculate the Length of patch becomes: $L= \{(\lambda_g/2)*(\varepsilon_{reff})^{-0.5}\}-2* (\Delta L)$

The Effective Length of the patch L_{eff} now becomes : $(\lambda_0/ f_0)*(\varepsilon_{reff})^{-0.5}$

Length and Width of ground is : L_g=6h+L & W_g=6h+W.
Where,
μ_0=Permeability constant.
ε_0=Permittivity of a free space.
ε_r=Relative permittivity.
h=Height of a patch antenna.
f_0=Resonant frequency.
λ_g=guided wavelength.

V. DESIGNING

Design-1:

First a simple single feed single frequency rectangular microstrip patch antenna has been designed using IE3D software.

The design parameters are as follows
Patch length (L) =12mm
Patch width (W) =8 mm
Substrate thickness (h) or patch height = 1.5 mm
Dielectric constant (ε_r) = 3
Probe feed distance (dp) = -3 mm (from center)
Probe feed radius (r_p) =0.006mm
Loss tangent=0.001

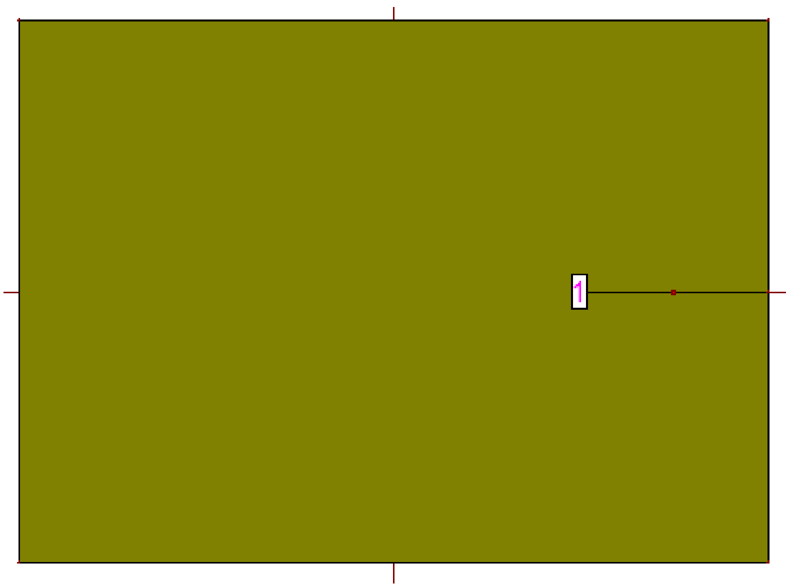

Fig.3 Design of single feed single frequency rectangular microstrip patch antenna

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Fig.3 shows the design of single feed single frequency rectangular microstrip patch antenna using above parameters.

Design-2:

Patch length (L) =19mm
Patch width (W) =8mm
Substrate thickness (H) =1.6mm
Dielectric constant (ε_r) =25
Probe feed distance (dp) = -2.5mm (from center)
Probe feed radius (r_p) =0.63mm
Shorting pin distance (ds) = -3.7mm (from center)
Shorting pin radius (rs) =0.32mm
Loss tangent=0.001

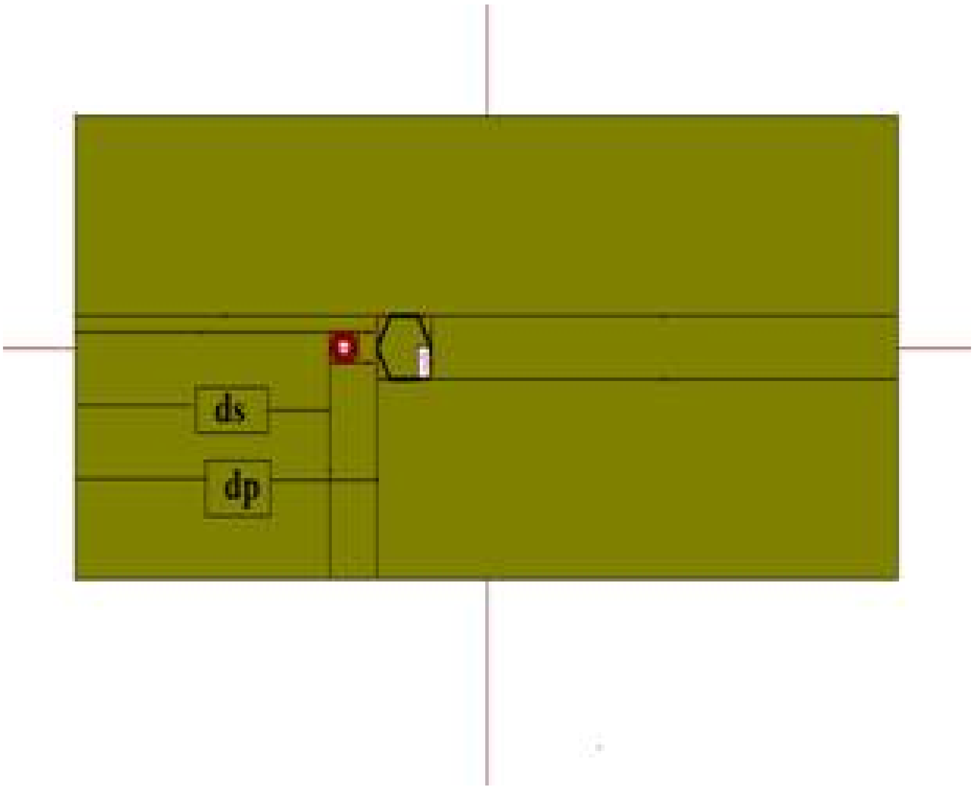

Fig.4 Design of single feed dual frequency rectangular microstrip patch antenna

Fig.4 shows the design of single feed dual frequency rectangular microstrip patch antenna using above parameters.

VI. EXPERIMENTAL RESULTS RETURN LOSS PLOT

Here return loss plot for single frequency and dual frequency compact rectangular microstrip patch antenna is given. The response of microstrip patch antenna is good if return loss plot is below -10dB.

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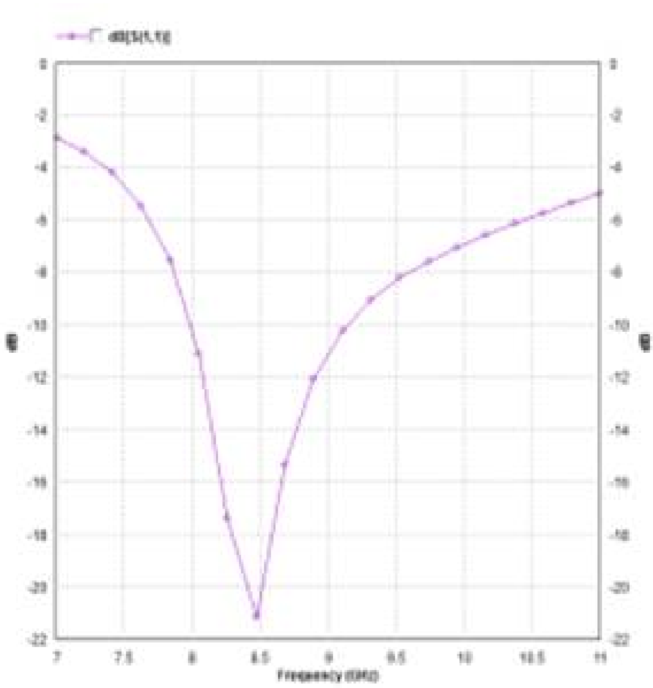

Fig.5 Return Loss plot for single frequency

In Fig.5 return loss plot is below -21dB which is accepted.

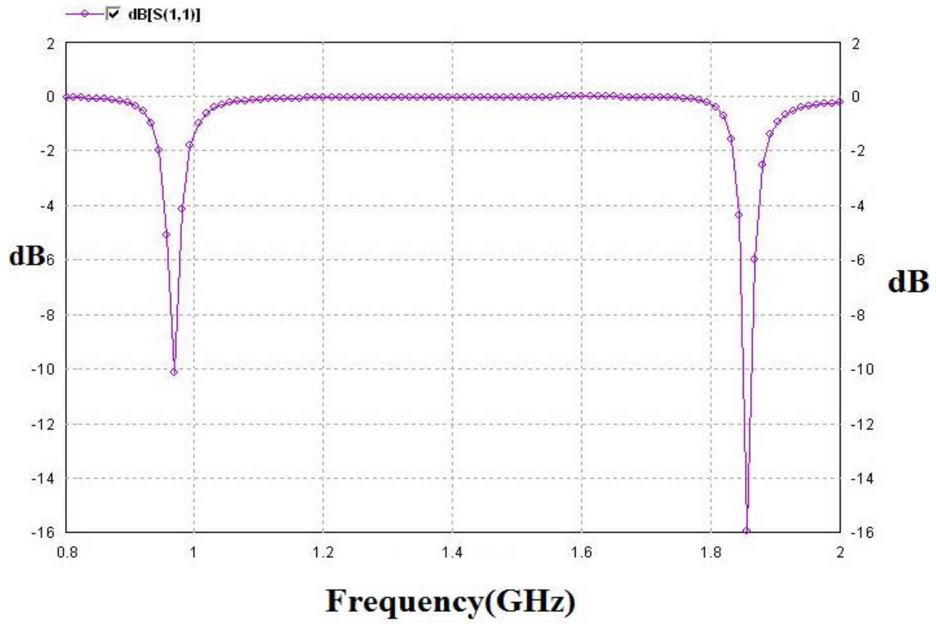

Fig.6. Return Loss plot for dual frequency

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In Fig.6 return loss plot is below -10dB and -16dB which is accepted.

VII. CONCLUSION

The efficiency of microstrip patch antenna can be reduced by introducing shorting pin configuration(dual frequency).For dual frequency operation larger dielectric constant (25)required which leads to lesser efficiency.In case of single frequency operation lower dielectric constant (3) required. Designing a highly efficient antenna requires a lower dielectric constant, lower patch height or substrate thickness leading to a wider bandwidth. This microstrip patch antenna is widely used in wireless communication system

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