Analysis And Design of Rectangular Microstrip Patch Antenna On Different Resonant Frequencies For Pervasive Wireless Communication

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Abstract— These In this Paper presents the result for different resonant frequencies and the result is performed by thickness of 2.88mm and Duroid substrate with dielectric constant of 2.32, L- band frequency 2GHz are gives the best result. In the recent years the development in communication systems requires the development of low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a wide spectrum of frequency. This technological trend has focused much effort into the design of a Microstrip patch antenna. The proposed antenna design on different resonant frequencies and analyze the result of all operating frequency between 1GHz to 10GHz, when the proposed antenna designs 2GHz operating frequency. At 2GHz the verified and tested result on MATLAB are Radiation Efficiency=91.99%, Directivity=5.4dBi, Directive gain=4.98dBi and Half Power Beam Width-H plane=99.6123 degrees.

Index Terms— Microstrip Antenna, Microstrip Line Feed, Patch width, Patch Length, Resonant Frequency, Strip Width and Strip Length,

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1 INTRODUCTION

THE rectangular patch antenna is approximately a one-half wavelength long section of rectangular Microstrip transmission line [1]. When air is the antenna substrate, the length of the rectangular Microstrip antenna is approximately one-half of a free-space wavelength [1, 2]. As the antenna is loaded with a dielectric as its substrate, the length of the antenna decreases as the relative dielectric as its substrate, the length of the antenna decreases as the relative dielectric constant of the substrate increases [3]. The antenna has become a necessity for many applications in recent wireless communication such as radar, microwave and space communication. The specifications for the design purpose of the structure are as follows

- Type of antenna: Rectangular Microstrip Patch antenna
- Resonance frequency: 2GHz
- Input impedance: 50 Ω
- Feeding method: Microstrip Line Feed

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The specifications were chosen to design a light wave and compact Microstrip patch antenna. The design of the whole structure is performed in the following steps [6]

- Initially, select the desired resonant frequency, thickness and dielectric constant of the substrate
- Obtain width(W) of the patch by inserting
- Obtain Length (L) of the patch after determining

2 DESIGN CONSIDERATION FOR RECTANGULAR MICRO STRIP PATCH ANTENNA

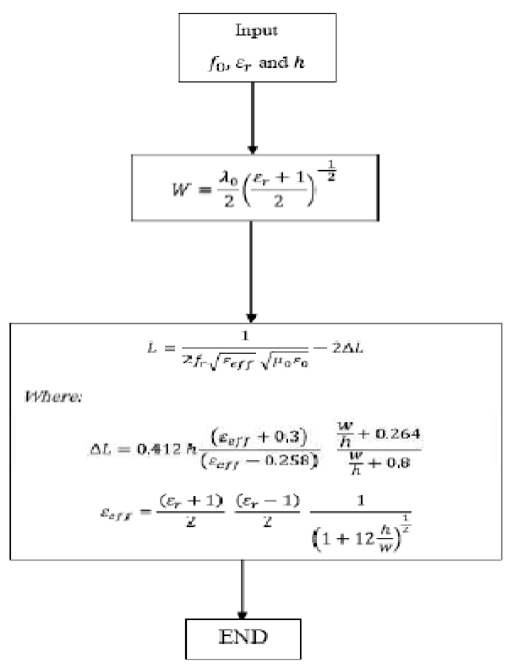

Fig.1: Flow chart based on usual design procedure for rectangular patch antenna

3 Simulation Result

TABLE 1: COMPARISON BETWEEN THE DIFFERENT DESIGN WITH THEIR RESPONSES AND RESULTS

Parameter	Design 1	Design 2
Height	2.88mm	2.88mm
Width	58.2mm	11.66mm
Length	47.8mm	7.8mm
Resonance Frequency	2GHz	10GHz
Dielectric Constant	2.32 (Duroid)	2.32 (Duroid)
Radiation Efficiency	91.99%	65.33%
Directivity	5.4211	4.7478
Directive Gain	4.9867	3.1023
Half power beam Width-H plane	99.6123	56.6638

4 Design of the Rectangular Micro Strip Patch Antenna Using Eagle Version 5.6.0

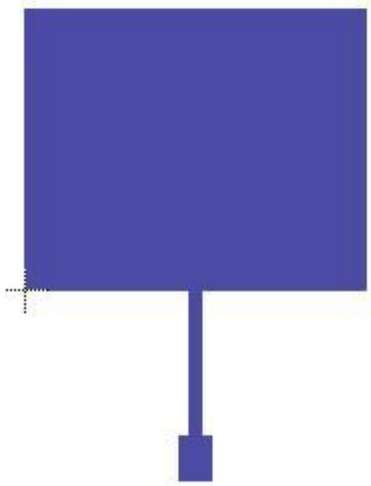

Fig.2: PCB Layout Design for Design 1 consideration (Thickness h=2.88mm, Resonance frequency=2 GHz, Duroid used as Dielectric substrate)

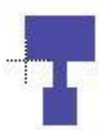

Fig.3: PCB Layout Design for Design 2 consideration (Thickness h=2.88mm, Resonance frequency=10 GHz, Duroid used as Dielectric substrate)

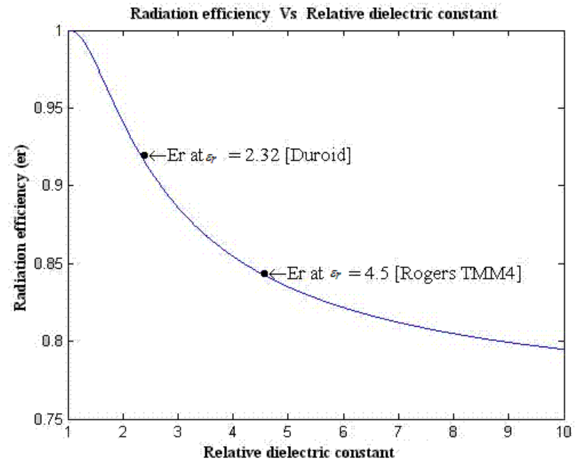

Fig.4: Variation of Radiation Efficiency with Relative Dielectric Constant for the Microstrip patch with h=2.88mm and fr=2GHz

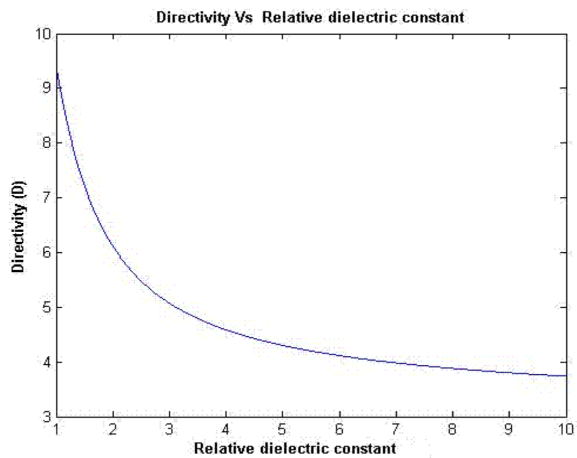

Fig.5: Variation of Directivity with Relative Dielectric Constant for the Microstrip patch with h=2.88mm and fr=2GHz

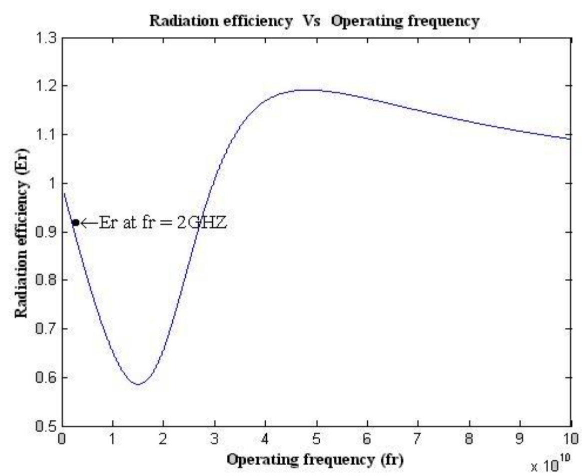

Fig. 6: Variation of Radiation Efficiency with Operating frequency for the Microstrip patch with h=2.88mm and εr =2.32 [Duroid]

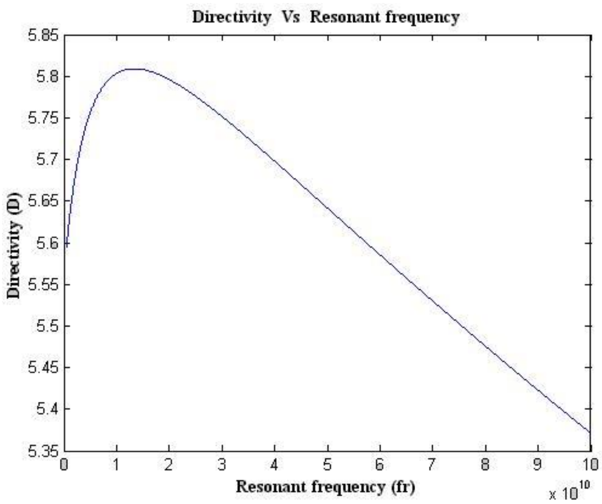

Fig.7: Variation of Directivity with Operating frequency for the microstrip patch with h=2.88mm and εr =2.32 [Duroid]

5 Radiation Pattern Analysis Using PCAAD 5.0

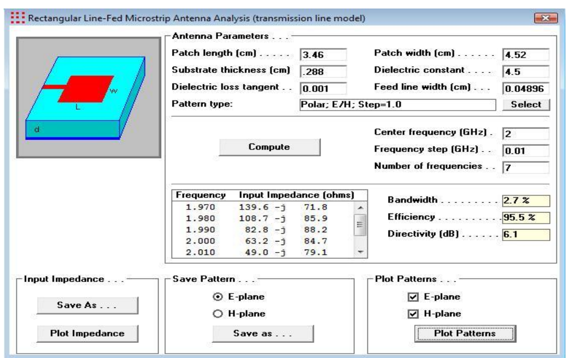

Fig.8: PCAAD arrangement and result

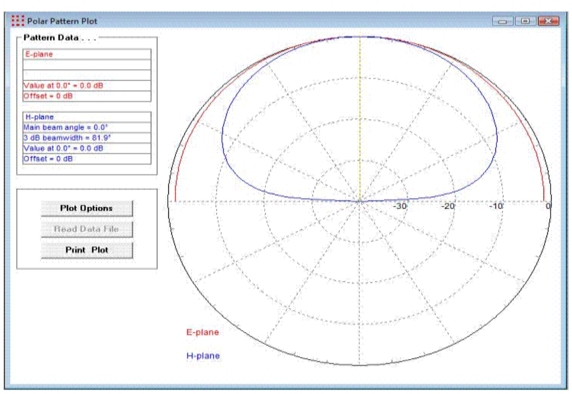

Fig.9: Radiation Pattern of E-field and H-field

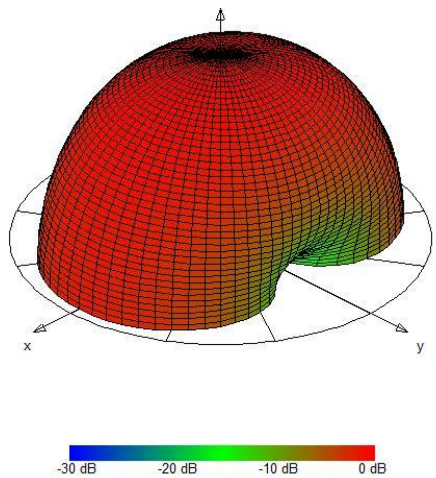

Fig.10: 3-D Radiation Pattern of the Rectangular Microstrip Patch Antenna using PCAAD 5.0

6 Comparison Between the Two Different Designs with Their Responses Using PCAAD 5.0

Table 2: Comparison between two different designs with their responses

Parameter	Design 1	Design 2
Bandwidth	2.6%	13.5%
3dB Beam Width	77.30	77.30

7 Variation of Radiation Efficiency with Resonant Frequency by Using MATLAB Program

```
clc
clear
er=input('Enter the Dielectric Constant of the Patch:');
h=input( 'Enter the HIGHT of the substrate:');
c=3e8 ;
fr1=input('Enter the lower limit of the operating frequency   :');
fr2=input('Enter the upper limit of the operating frequency   :');
fr=fr1:1000000:fr2;
k=(2.*pi.*fr).*(sqrt((8.854e-12).*(pi.*4e-7)));
Pr=40.*(k.^2).*((k.*h).^2).*(1-(1./er)+(2./(5.*er.^2)));
x0=1+( 0.5.*  ((er-1).*k.*h./er).^2 );
X0=(x0.^2)-1;
Psur=((30.*pi.*k.^2).*(er.*((x0.^2)-1)))./((er.*(
(1./sqrt(X0))+(sqrt(X0)./er-x0.^2)))+((k.*h).*(1+
((X0.*er.^2)./(er-x0.^2)))));
Ef=Pr./(Pr+Psur);
figure(1)
fr11=fr1:1000000:fr2;
plot(fr11,Ef)
xlabel('Operating frequency (fr)')
ylabel('Radiation efficiency (Er)')
grid on
title('Radiation efficiency  Vs  Operating frequency')
k=(2.*pi.*2e9).*(sqrt((8.854e-12).*(pi.*4e-7)));
```

```
Pr=40.*(k.^2).*((k.*h).^2).*(1-(1./er)+(2./(5.*er.^2)));
x0=1+( 0.5.*  ((er-1).*k.*h./er).^2 );
X0=(x0.^2)-1;
Psur1=((30.*pi.*k.^2).*(er.*((x0.^2)-1)))./((er.*(
(1./sqrt(X0))+(sqrt(X0)./er-x0.^2)))+((k.*h).*(1+
((X0.*er.^2)./(er-x0.^2)))));
Ef1=Pr./(Pr+Psur1);
text(2e9,Ef1,...
'\bullet\leftarrow\fontname{times}Er at {fr} = 2GHZ ',...
'FontSize',12)
k=(2.*pi.*10e9).*(sqrt((8.854e-12).*(pi.*4e-7)));
Pr=40.*(k.^2).*((k.*h).^2).*(1-(1./er)+(2./(5.*er.^2)));
x0=1+( 0.5.*  ((er-1).*k.*h./er).^2 );
X0=(x0.^2)-1;
Psur2=((30.*pi.*k.^2).*(er.*((x0.^2)-1)))./((er.*(
(1./sqrt(X0))+(sqrt(X0)./er-x0.^2)))+                ((k.*h).*(1+
((X0.*er.^2)./(er-x0.^2)))));
Ef2=Pr./(Pr+Psur2);
text(10e9,Ef2,...
'\bullet\leftarrow\fontname{times}Er at {fr} = 10GHz',...
'FontSize',12)
```

Program Input:

Enter the Dielectric Constant of the Patch: 4.5
Enter the HIGHT of the substrate: 2.88e-3
Enter the lower limit of the Resonant frequency : 5e6
Enter the upper limit of the Resonant frequency : 20e9

4 CONCLUSION

The aim of this project is to design a rectangular patch Microstrip antenna and to study the responses and the radiation properties of the same. In this project an antenna has been designed with 2 different design parameters. Taking all this into consideration we can say that there are many aspects that affect the performance of the antenna. Dimensions, selection of the substrate, feed technique and also the Operating frequency can take their position in effecting the performance. A rigorous analysis of the problem begins with the application of the equivalence principle that introduces the unknown electric and magnetic surface current densities on the dielectric surface. The formulation of the radiation problems is based on the numerical solution of the combined field integral equations.

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