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Rectangular Microstrip Patch Antenna at 2GHZ on Different Dielectric Constant for Pervasive Wireless Communication

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ABSTRACT

In this Paper presents the result for different dielectric constant values and the result is performed by thickness of 2.88mm and resonance frequency of 2GHz where 2.32 (Duroid) 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 frequencies. This technological trend has focused much effort into the design of a Microstrip patch antenna. The proposed antenna design on different dielectric constant and analyzed result of all dielectric constant from 1 to 10, when the proposed antenna designs on Duroid substrate with dielectric constant 2.32. At 2GHz 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.

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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

[i] Type of antenna: Rectangular Microstrip Patch antenna
[ii] Resonance frequency: 2GHz
[iii] Input impedance: 50 Ω
[iv] Feeding method: Microstrip Line Feed

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]

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

2. DESIGN CONSIDERATIONS FOR RECTANGULAR PATCH ANTENNA

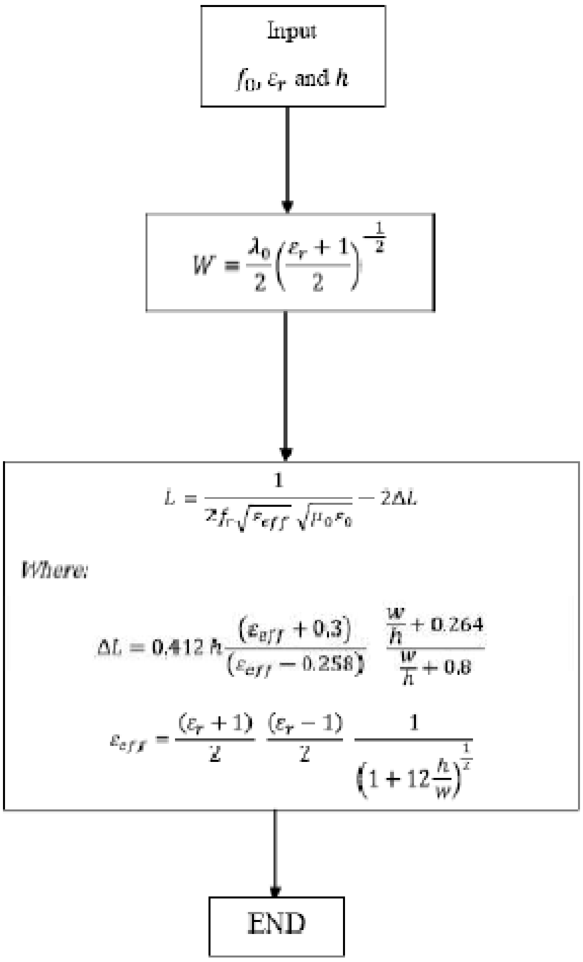

Figure 1. Flow chart based on usual design procedure for rectangular patch antenna

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	45.2mm	58.2mm
Length	34.6mm	47.8mm
Resonance Frequency	2GHz	2GHz
Dielectric Constant	4.5 (Rogers TMM4)	2.32 (Duroid)
Radiation Efficiency	84.38%	91.99%
Directivity	4.2959	5.4211
Directive Gain	3.6251	4.9867
Half power beam Width-H plane	60.8814	99.6123

4. DESIGN OF THE RECTANGULAR MICROSTRIP PATCH ANTENNA USING EAGLE V-5.6.0

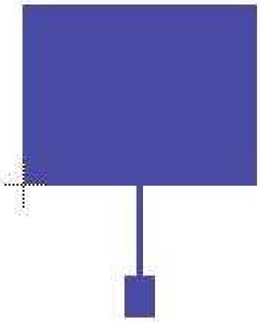

Figure 2. PCB Layout Design for Design 1 consideration
(Thickness h=2.88mm, Resonance frequency=2 GHz, Rogers TMM4 used as Dielectric substrate)

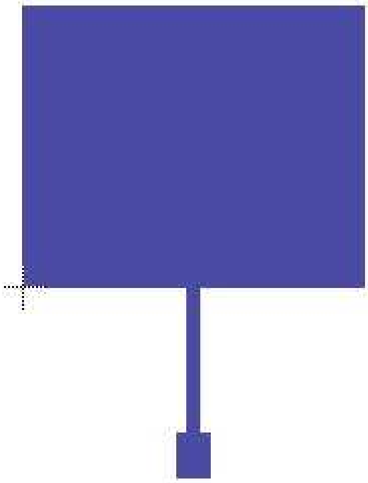

Figure 3: PCB Layout Design for Design 2 consideration
(Thickness h=2.88mm, Resonance frequency=2 GHz, Rogers TMM4 used as Dielectric substrate)

5. PERFORMANCE ANALYSIS OF THE RECTANGULAR MICROSTRIP PATCH ANTENNA USING MATLAB

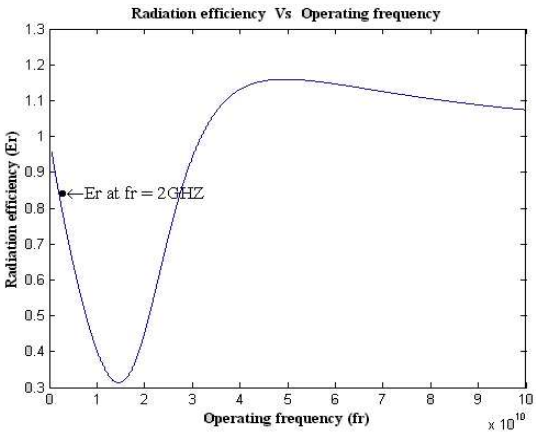

Figure 4. Variation of radiation efficiency with operating frequency for the microstrip patch with h=2.88mm and E_r=4.5[Rogers TMM4]

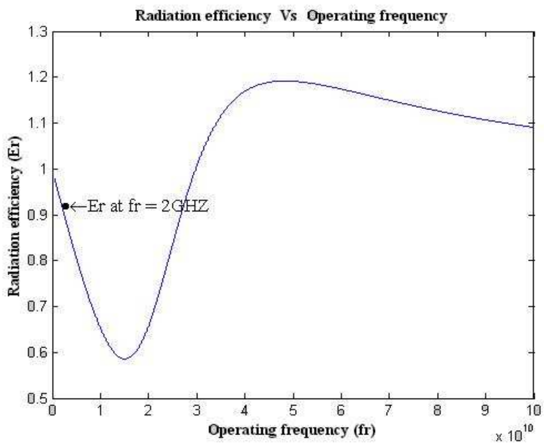

Figure 5. Variation of radiation efficiency with operating frequency for the Microstrip patch with h=2.88mm and εr =2.32 [Duroid]

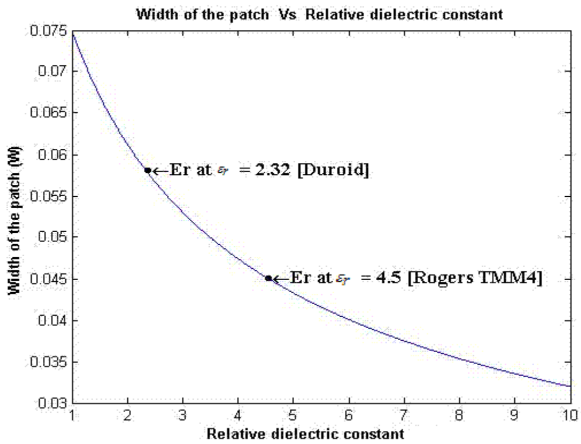

Figure 6. Variation of Width of the Patch with Relative Dielectric constant for the Microstrip patch with h=2.88mm and f_r=2GHz

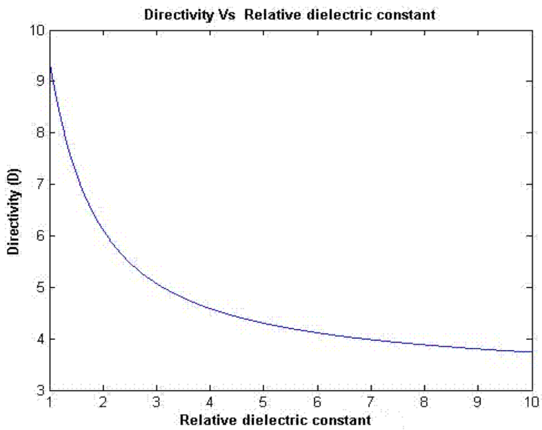

Figure 7. Variation of Directivity with Relative Dielectric Constant for the Microstrip patch with h=2.88mm and f_r=2GHz

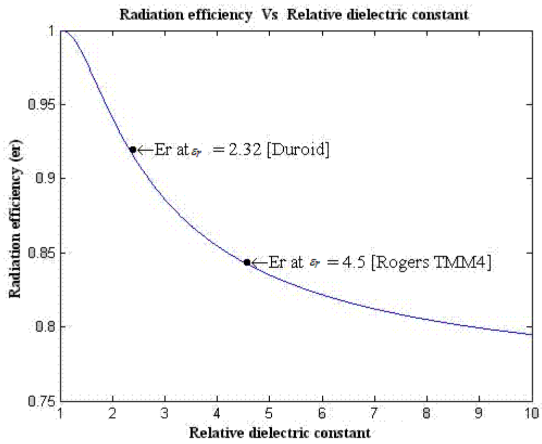

Figure 8. Variation of radiation efficiency with relative dielectric constant for the microstrip patch with h=2.88mm and f_r=2GHz

6. RADIATION PATTERN ANALYSIS USING PCAAD 5.0

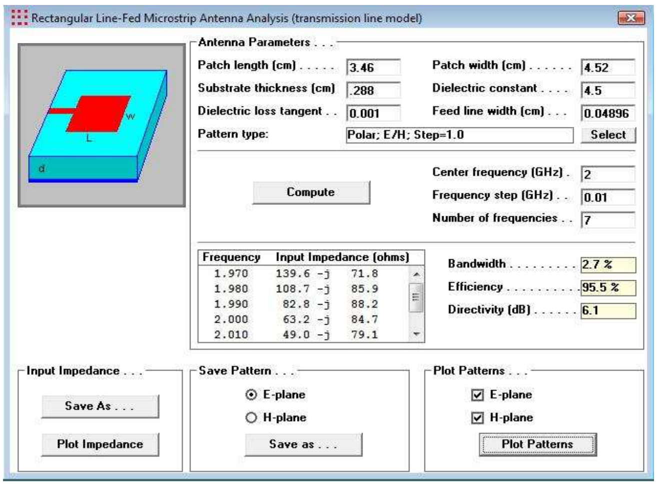

Figure 9. PCAAD arrangement and result

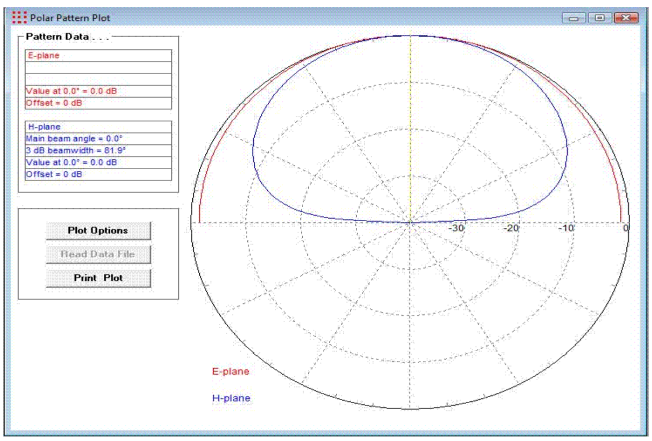

Figure 10. Radiation pattern of E-field and H-field

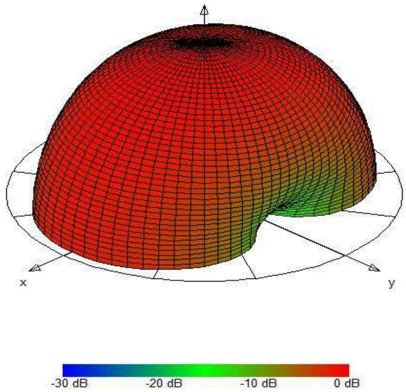

Figure 11. 3-D Radiation Pattern of the Rectangular Microstrip Patch Antenna using PCAAD 5.0

7. COMPARISON BETWEEN THE TWO DIFFERENT DESIGNS WITH RESPONSES USING PCAAD 5.0

Table 2. Comparison between two different designs with their responses

Parameter	Design 1	Design 2
Bandwidth	2.7%	2.6%
Efficiency	95.5%	95.4%
3dB Beam Width	81.90^o	77.30^o

8. VARIATION OF RADIATION EFFICIENCY WITH RELATIVE DIELECTRIC CONSTANT BY USING MATLAB PROGRAM

```
clc
clear
fr=input('Enter the value of resonant frequency:  ');
h=input( 'Enter the HIGHT of the substrate:');
disp('    ')
i1=input('Enter the lower limit of the Relative dielectric constant   :');
i2=input('Enter the upper limit of the Relative dielectric constant   :');
 er=i1:.01:i2;
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)))));
Er=Pr./(Pr+Psur);
  figure(1)
er13=i1:.01:i2;
       plot(er13,Er)
       xlabel('Relative dielectric constant (er)')
       ylabel('Radiation efficiency (er)')
       grid on
       title('Radiation efficiency  Vs  Relative dielectric constant')
k=(2*pi*fr).*(sqrt((8.854e-12)*(pi*4e-7)));
Pr=40.*(k.^2).*((k.*h).^2).*(1-(1./4.5)+(2./(5.*4.5.^2)));
x0=1+( 0.5.*  ((4.5-1).*k.*h./4.5).^2 );
X0=(x0.^2)-1;
Psur1=((30.*pi.*k.^2).*(4.5.*((x0.^2)-1)))./((4.5.*((1./sqrt(X0))+(sqrt(X0)./4.5-
x0.^2)))+((k.*h).*(1+((X0.*4.5.^2)./(4.5-x0.^2)))));
Ef1=Pr./(Pr+Psur1);
 text(4.5,Ef1,...
'\bullet\leftarrow\fontname{times}Er at {er} = 4.5 [Rogers TMM4] ',...
'FontSize',12)
k=(2*pi*fr).*(sqrt((8.854e-12)*(pi*4e-7)));
Pr=40.*(k.^2).*((k.*h).^2).*(1-(1./2.32)+(2./(5.*2.32.^2)));
x0=1+( 0.5.*  ((2.32-1).*k.*h./2.32).^2 );
X0=(x0.^2)-1;
```

```
Psur2=((30.*pi.*k.^2).*(2.32.*((x0.^2)-1)))./((2.32.*((1./sqrt(X0))+(sqrt(X0)./2.32-
x0.^2)))+((k.*h).*(1+((X0.*2.32.^2)./(2.32-x0.^2)))));
Ef2=Pr./(Pr+Psur2);
text(2.32,Ef2,...
'\bullet\leftarrow\fontname{times}Er at {er} = 2.32 [Duroid]',...
'FontSize',12)
```

Program Input:
Enter the value of resonant frequency: 10e9
Enter the HIGHT of the substrate:2.88e-3
Enter the lower limit of the Relative dielectric constant :2
Enter the upper limit of the Relative dielectric constant :9

9. 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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REFERENCES

[1] C. A. Balanis, *Antenna Theory Analysis and Design*, Jhon Wiley & Sons, Inc., Second Edition, 1996.
[2] Manik Gujral, Tao Yuan, Cheng-Wei Qui, Le-Wei Li and Ken Takei, "Bandwidth Increment of Microstrip Patch Antenna Array with Opposite Double- E Ebg Structure for Different Feed Position", *International Symposition on Antenna and Propagation*, Inc. NY, USA, ISP- 2006.
[3] Richard C. Johnson, Henry Jasik, "Antenna Engineering Handbook" Second Edition, pp. 7-1 to 7-14, McGraw Hill, 1984.
[4] Pozar, D. M., and D. H. Schaubert (Eds), "The Analysis and Design of Microstrip Antennas and Arrays", *IEEE Press*, New York, 1996.
[5] D. Urban and G. J. K. Moernaut, "The Basics of Patch Antennas" *Journal, Orban Microwave Products*.
[6] Y T Lo and S W Lee, editors, "Antenna Handbook Theory, Applications & Design", Van Nostrand Rein Company, NY, 1988.
[7] Franco Di Paolo, "Networks and Devices using Planar Transmission Lines", pp 71, CRS Press, LLC, NY, 2000.
[8] Stutzman Warren L & Tuicle Gray A, "Antenna Theory & Design", John Wiley & SonsInc., NY, 1988.
[9] M. Olyphant, Jr. and T.E Nowicki, "Microwave Substrates Support MIC technology" Microwaves, Part I, vol. 19, no. 12, pp. 74-80, Nov. 1980.
[10] Richard, W.F., Y.T. Lo, and D.D Harrison, "An Improved Theory for Microstrip Antennas and Application," *IEEE Trans. On Antennas and Propagation*. vol. AP-29, pp. 38-46, 1981.

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