Design of Rectangular Patch Wi-Fi Antenna using Coaxial Feed

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***Abstract*— In this Paper, a rectangular patch Wi-Fi antenna using coaxial feed is designed, with complete mathematical calculations and the results are simulated using IE3D software with an operating frequency of 2.4 GHz. Wi-Fi is a wireless networking technology that allows computers and other devices to communicate over a wireless signal, it is also used to create a wireless LAN .Wi-Fi antenna are used at both 2.4GHz and 5 GHz. The Wi-Fi frequency is highest frequency on the mobile phone among all the application frequency. As the Microstrip patch antennas are small in size, light weight and integrated easily on device. the antenna performance is measured on IE3D software and we get optimum result.**

***Index Terms*— Microstrip patch, s11 parameter, coaxial feed .**

I. Introduction

Microstrip patch antenna is preferred for wireless communication applications. Microstrip patch antenna consists of a a conducting rectangular patch of width W and length L on one side of dielectric substrate of thickness h and dielectric constant εr which has a ground plane on the other side . To enhance the fringing fields that accounts for the radiation pattern of the antenna and larger bandwidth but it results in larger antenna size . To increase the bandwidth of the antenna stacked and slotted patch antenna can be used.

II. Design Procedure and Specification

(i) Calculation of Width (W):

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (1)$$

Where
C= free space velocity of light
ε_r = dielectric constant of the substrate

(ii).The effective dielectric constant of the rectangular microstrip patch antenna.

$$\frac{w}{h} > 1$$

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right) \qquad (2)$$

(iii) The resonant length of patch is not exactly equal to the physical length due to the fringing fields on the sides of patch. Effective length Leff of patch is longer than its physical length and is given as:

$$Leff = \frac{C}{2f_r\sqrt{\varepsilon_{eff}}} \qquad (3)$$

(iv) the actual length of Patch (L)

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

(v) Increase in patch length:

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{w}{h}+0.8\right)} \qquad (5)$$

III. Analysis of Rectangular Microstrip Patch Antenna and Simulated Results

Table 1 below, shows various dimensions of micro-strip patch antenna which has been calculated using the equation (1-8)

S.No	Parameter	value
1	Dielectric constant ε_r	4.4
2	Loss Tangent(tan∂)	.018
3	Thickness(h)	1.6
4	Operating Frequency f r	2.4GHz
5	Length (L)	29.440mm
6	Width (W)	38.036mm
7	Effective dielectric constant ε_{reff}	4.086
8	Effective length Leff	30.92mm
9	Coaxial feed (point)	X=6, Y=4

Table 1:- Dimension Used to Design The antenna

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Different parameters drawn and plotted in IE3D software, The results obtained by the simulation of the microstrip patch antenna with coaxial feed. We performed measurements of various parameters and radiation characteristics of antenna. In order to investigate the antenna were measured the following parameters: VSWR, gain, radiation patterns and input impedance. The measurement of VSWR and input impedance (real and imaginary part) of the discussed microstrip active antennas in frequency domain are presented above (Figure 3 and 4).

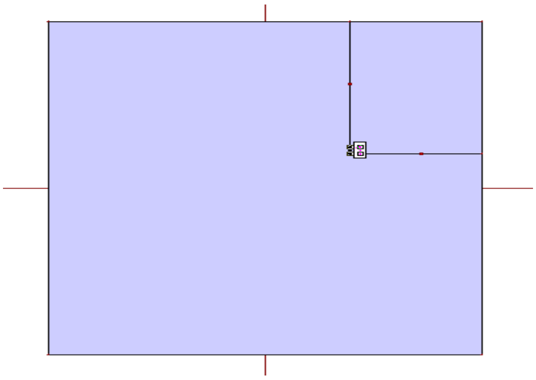

Figure 1 shows the arrangement of microstrip antenna with coaxial feed using the dimension specified in table 1.

(i) S- Parameter

s11 parameter of the microstrip antenna in which we get the reflection coefficient(return loss) of -24.315db at 2.40GHz.
At -10 db
BW= f2 – f1
BW= 49.66MHz

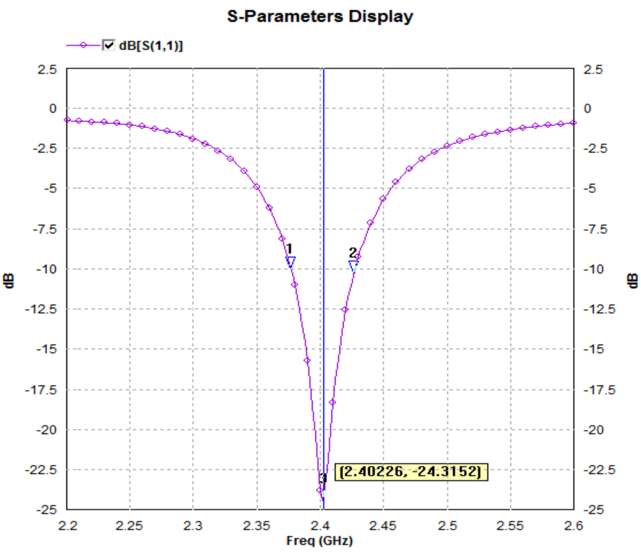

Figure 2 shows the s11 parameter of the microstrip antenna

(ii)VSWR Versus Frequency plot

VSWR defined as measurement of matching of the antenna with the transmission line impedance. . A perfectly matched antenna would have a VSWR of 1:1. This indicates how much power is reflected back or transferred into a transmission line. VSWR obtained from the simulation is 1.26 dB which is
approximately equals to 1.1:1 as shown in Fig. 3

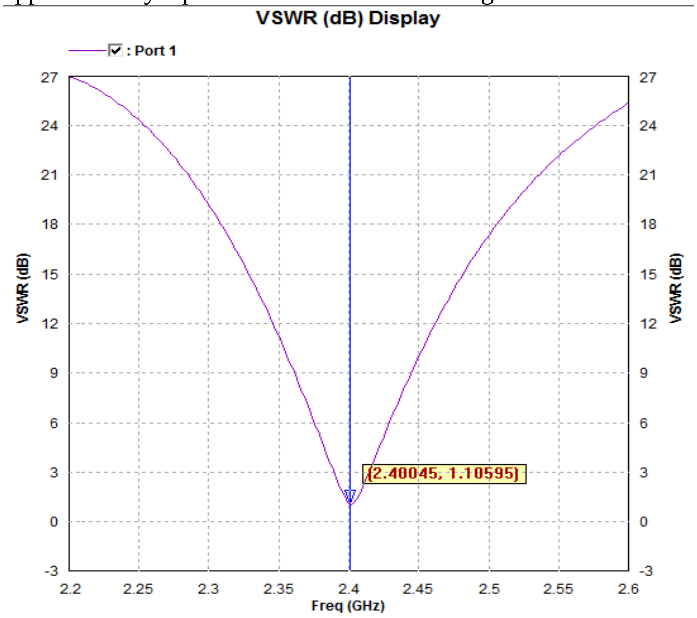

Figure 3 VSWR versus frequency plot of the patch antenna

(iii) Impedance Versus Frequency

Z-parameter graph for the patch shows that the input impedance of the antenna at the center frequency 2.4 GHz is 46.98 Ω; this is very close to the expected 50 Ω

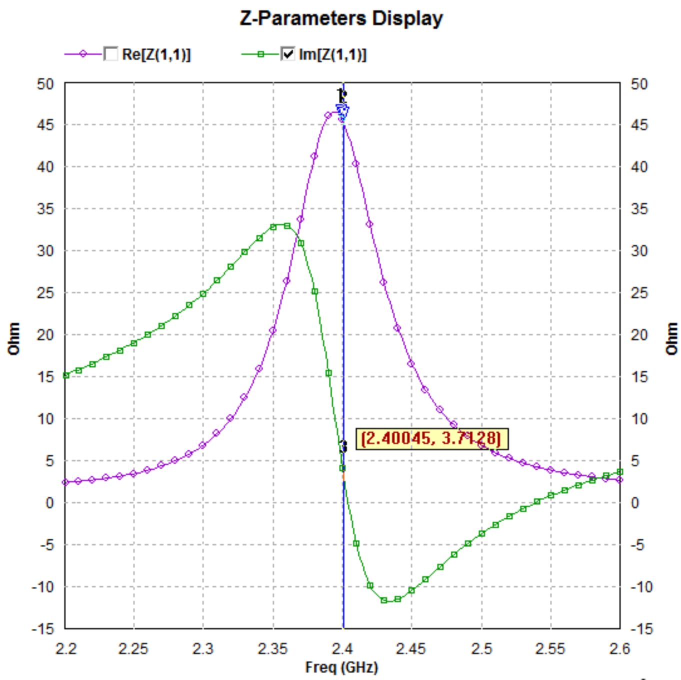

Figure 4. Z-parameter graph for the microstrip antenna

(iv) Radiation pattern

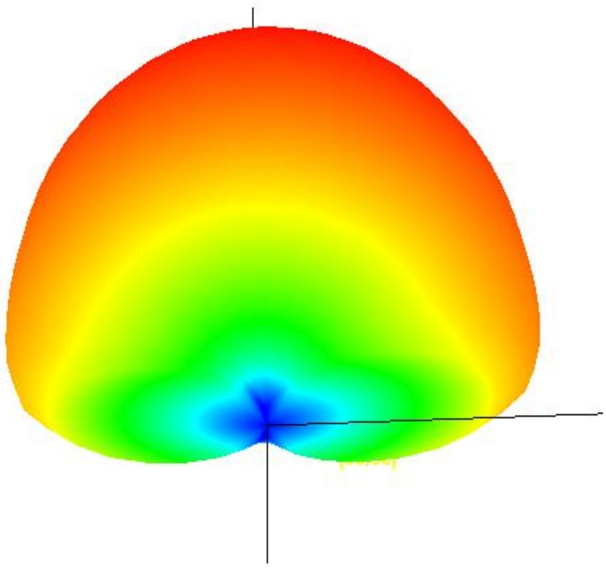

Figure 5. 3-D Radiation pattern of patch antenna

(v) Current distribution of the antenna

The 3D current distribution plot gives the relationship between the co-polarization (desired) and cross-polarization (undesired) components. Moreover, it gives a clear picture as to the nature of polarization of the fields propagating through the patch antenna. The average current density is shown clearly in figure 6 as different colors on the surface of the antenna which implies that the patch antenna is linearly polarized.

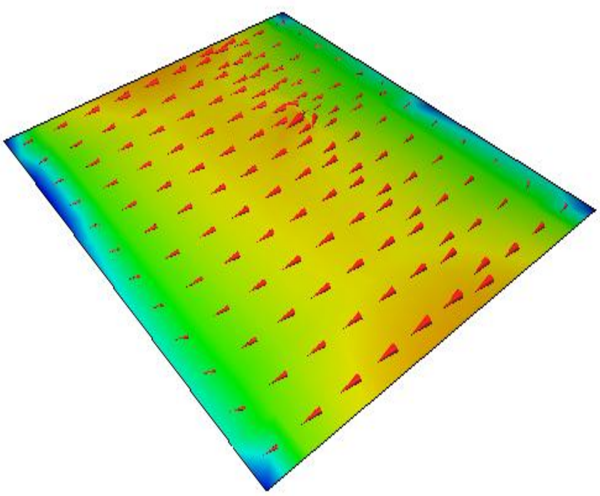

Figure 6. current distribution in microstrip tapered line transfer coupled antenna

(vi) Efficiency versus Frequency

The radiation efficiency of the designed antenna is approx. 41.28 %.

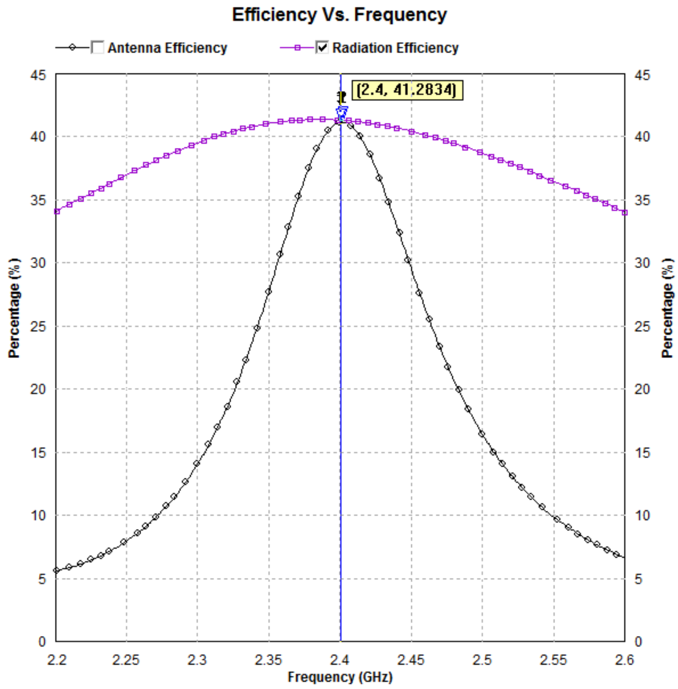

Figure 7. antenna and radiation efficiency of the antenna

IV. CONCLUSION

In this paper we design a rectangular patch antenna which is feed with coaxial and is operated at 2.4 GHz .this antenna can be easily fabricated as the thickness of substrate and small size.

Considering the graph which we get after simulation of microstrip antenna can be stated that the designed antenna is characterized by good electrical parameter. The shape of the radiation pattern is approximately matched with theoretical assumption. Even the designed antenna characterized by the highest bandwidth of 50 MHz while maintaining the radiation pattern of the antenna. The design antenna exhibits a good Impedance matching of approximately 50 Ohms at the center frequency. Microstrip patch antenna are widely used in the Wi-Fi antenna at 2.4 GHz produces a very good business model as it uses free unlicensed frequency and applied in various application includes corporates wireless data network, hotspot medical facilities , in departmental store using wireless barcode scanner, and number of wireless communication as printer, television and cameras.

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REFERENCES

[1] C.A. Balanis, Antenna Theory Analysis & Design, 2ndEdition, John Wiley & Sons, New York, 1997.

[2] Sneha, Ashutosh Kumar Chaubey International Journal of Engineering, Management & Sciences (IJEMS)ISSN-2348 –3733, Volume-1, Issue-10, October 2014

[3] K.R. Carver and J.W. Mink, “Microstrip Antenna Technology”, IEEE Trans.Antenna Propagation, Vol. AP –29 , No. 1, pp.2 – 24, January 1981.

[4] I.J.Bahl and P. Bhartia , Microstrip Antenna, Washington 1980Nazifa Mariam, “ Comparison between inset and coaxial feed excitation technique of microstrip antenna”,

[5] Proceedings of Conference on information science, technology and management (CISTM2007) Hyderabad, India, July 16-18, 2007

[6] W.F. Richards, Y.T Lo, and D.D Harrison, “ An Improved theory of Microstrip Antenna with Applications”, IEEE Trans. Antenna Propagation, Vol. AP – 29 , No. 1, pp. 38 – 46, January 1981

[7] W.L. Stutzman, G.A. Thiele, Antenna Theory and design, John Wiley & Sons, 2nd Ed., New York, 1998.

[8] E. H. Miller, “A note on reflector arrays (Periodical style—Accepted for publication),” *IEEE Trans. Antennas Propagat.*, to be published.

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