

Design of Rectangular Patch Wi-Fi Antenna using Coaxial Feed

Sneha, Raghavendra Patidar

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 ϵ_r 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):

$$W = \frac{1}{2f_r \sqrt{\mu_0 \epsilon_0} \sqrt{\epsilon_r + 1}} \sqrt{\frac{2}{\epsilon_r + 1}} = \frac{C}{2f_r} \sqrt{\frac{2}{\epsilon_r + 1}} \quad (1)$$

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.

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

Sneha, M.E Scholar , Wireless Communication, BIT-Mesra Patna Campus, Patna, India

Raghavendra Patidar, Associate Professor, Global Institute of Technology, Jaipur, India

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left(\frac{1}{\sqrt{1 + \frac{12h}{w}}} \right) \quad (2)$$

(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 L_{eff} of patch is longer than its physical length and is given as:

$$L_{eff} = \frac{C}{2f_r \sqrt{\epsilon_{eff}}} \quad (3)$$

(iv) the actual length of Patch (L)

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

(v) Increase in patch length:

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

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($\tan \delta$)	.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 L_{eff}	30.92mm
9	Coaxial feed (point)	X=6, Y=4

Table 1:- Dimension Used to Design The antenna

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).

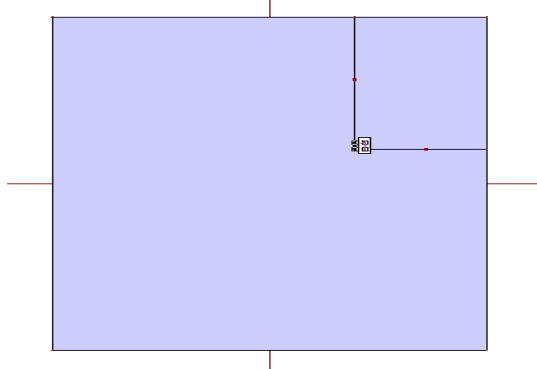


Figure 1 shows the arrangement of microstrip antenna with coaxial feed using the dimension specified in table 1.

(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
 $BW = f_2 - f_1$
 $BW = 49.66\text{MHz}$

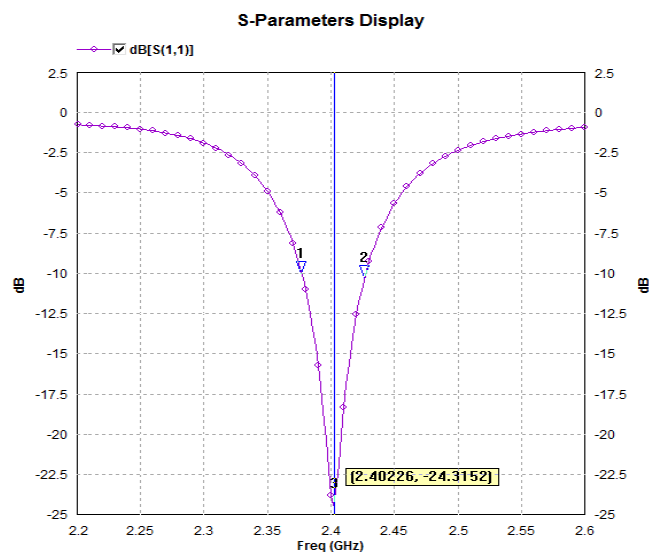


Figure 2 shows the s11 parameter of the microstrip antenna

(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

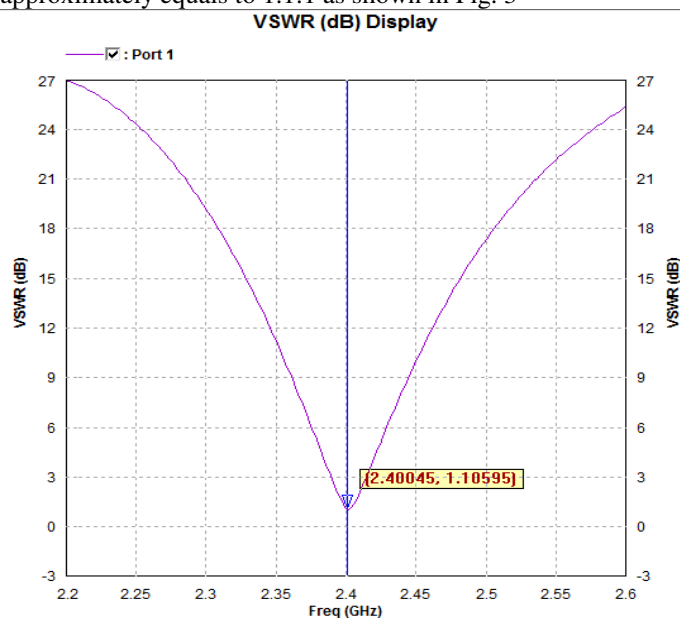


Figure 3 VSWR versus frequency plot of the patch antenna

(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

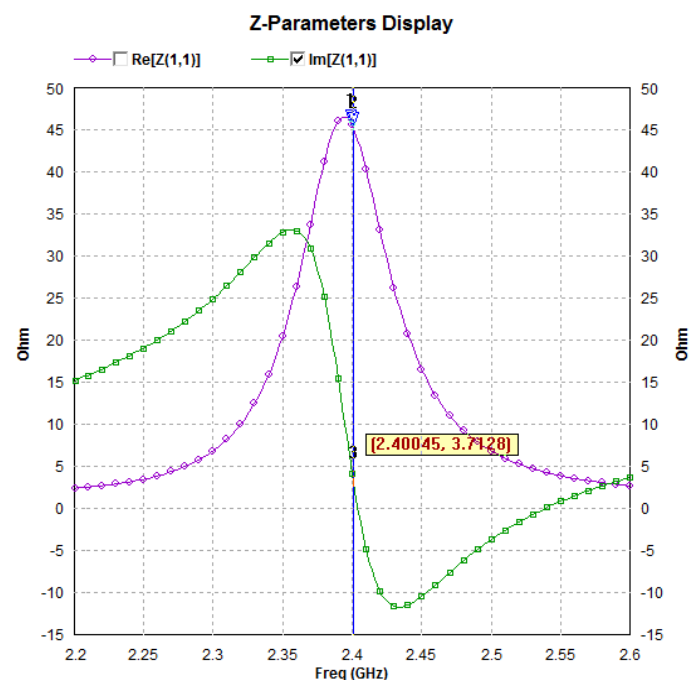


Figure 4. Z-parameter graph for the microstrip antenna

(vi) Efficiency versus Frequency

(iv) Radiation pattern

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

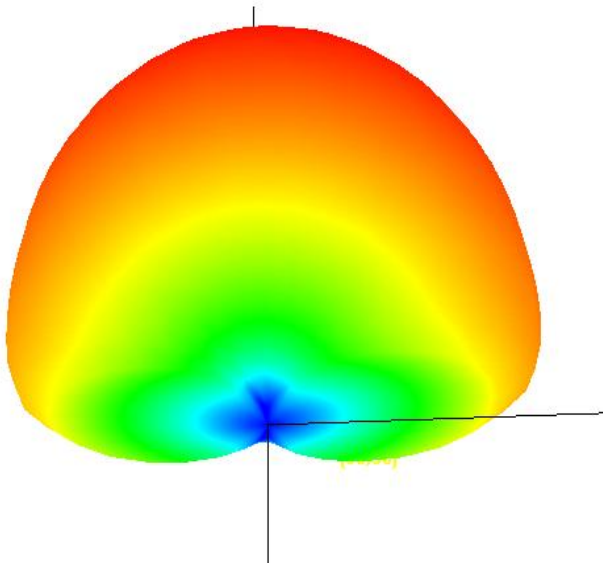


Figure 5. 3-D Radiation pattern of patch antenna

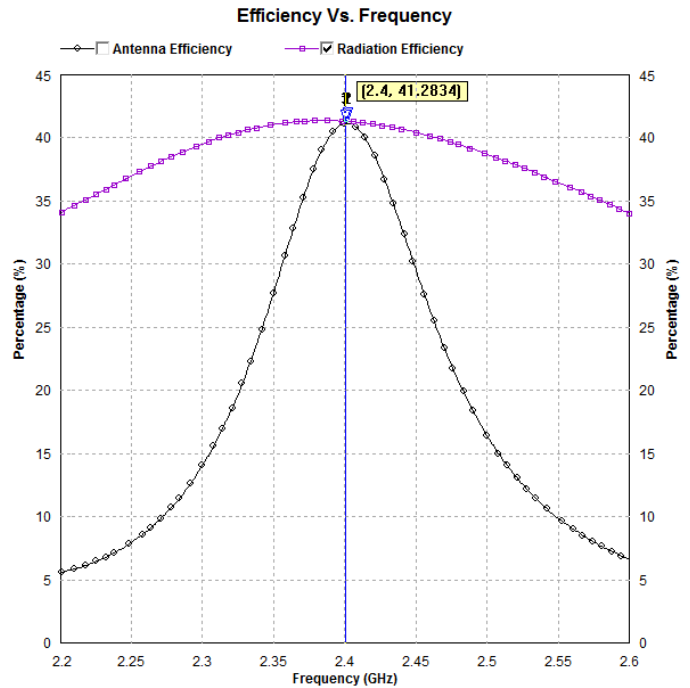


Figure 7. antenna and radiation efficiency of the antenna

(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.

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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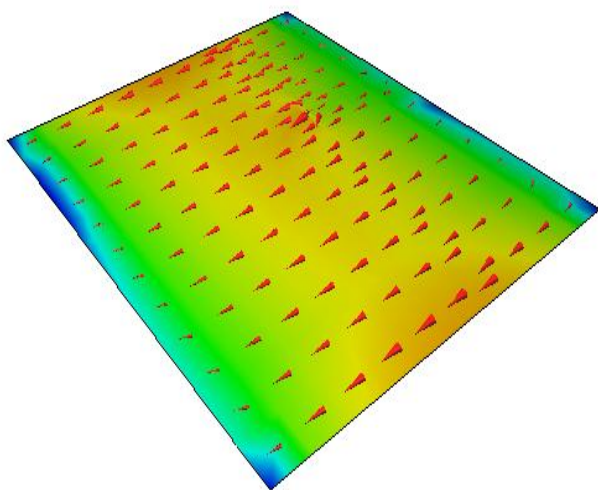


Figure 6. current distribution in microstrip tapered line transfer coupled antenna

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Author's Profile

Sneha she has completed her B.Tech from RCEW, Jaipur , India. She is pursuing M.E in Wireless Communication from BIT-mesra Patna branch ,Patna, India. Her area of interest is antenna and signal propagation, and fibre communication.

Raghavendra Patidar has completed his B.Tech. degree from sobhasaria engineering college, sikar, Rajasthan in 2004 and completed his M.Tech. Degree in 2009 from Rajasthan Technical University Kota. He has published 5 books on Microwave, Wireless and Telecommunication Engineering. His area of interest is digital communication and optical fibre communication.