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Monopole Antenna for WI-FI Applications

Sneha

***Abstract*—In this Paper, a monopole patch CPW fed Wi-Fi antenna is designed with complete mathematical calculations and the results are simulated using HFSS software with an operating frequency of 2.48 GHz. The antenna has a low profile and is nearly is four times smaller in size than a conventional patch antenna. The designed antenna is compared with previous designed rectangular patch antenna [2] . 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 2.4 GHz 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 performance of the antenna is evaluated using ANSYS HFSS.**

***Index Terms*—CPW, Monopole , Patch antenna, S11.**

I. Introduction

The purpose of this paper is to develop a new structure for the wi-fi applications that provides a better performance and functionality as compared to normal rectangular patch antenna. 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.

II. Design Specification and Formula

The proposed antenna is monopole antenna fed with coaxial Connector and coplanar waveguide (CPW) feed line is used. The antenna has been designed using the rectangularpatch in monopole configuration of length lambda/2. The monopoleconfiguration provides impedance matching over thewide range of frequency.

The initial Length (L) and width(W) of the patch has been determined using the following Formula [7].

(i) Calculation of Width (W):

$$W = \frac{c}{2 * f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

WhereC= free space velocity of light

ε_r= dielectric constant of the substrate

(ii). The effective dielectric constant of the rectangular microstrip patch antenna .$\frac{W}{h} > 1$

$$\varepsilon_{r_{eff}} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} + \left(1 + \frac{12 * h}{W}\right)^{1/2} \qquad (2)$$

(iii).The resonant length of patch is not exactly equal to the physical length due to the fringing fields on the sides of patch. The actual length of Patch (L)

$$L = \frac{c}{2 * f_r * \sqrt{\varepsilon_r}} \qquad (3)$$

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

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

(v). Increase in patch length:

$$\frac{\Delta L}{h} = 0.412\,\frac{\left(\varepsilon_{r_{eff}} + 1\right)\left(\frac{W}{h} + 0.244\right)}{\left(\varepsilon_{r_{eff}} - 0.258\right)\left(\frac{W}{h} + 0.8\right)} \qquad (5)$$

III. Design and Analysis of Patch Antenna

The monopole design of the microstrip patch antenna is mention in figure 1.

The mention parameter are mention in table 1.

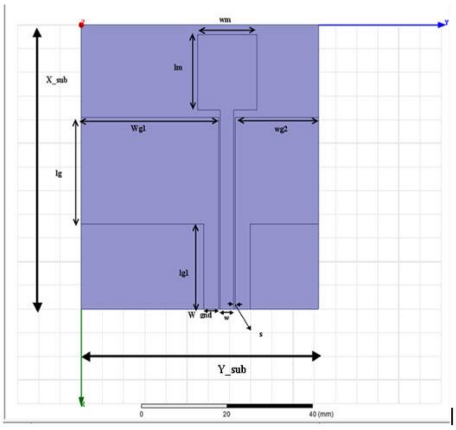

Figure 1.**Geometry of the monopole structure Design (HFSS).**

Sneha, ECE, MIET college, AKTU University, Meerut, INDIA

A rectangular patch was chosen as the monopole radiation element. The length of the patch was adjusted according to the general design guideline that the lowest resonance is determined when the length of the monopole, approximately $\lambda_g/4$.

The antenna is fed by a CPW transmission-line, which can be easily integrated with other CPW-based microwave circuits printed on the same substrate. The CPW feed was connected to the coaxial cable through a standard 50 SMA connector. The main advantage of the CPW is that all the conductors lie on the same plane and therefore there is no need for via/holes which makes it easy to connect shunt and series lumped element. Other important properties CPW is that the line impedance and phase velocity are less dependent on the substrate height than on the aspect ratio.

Table 1:- Dimension Used to Design the antenna

S.No	Parameter	value
1	Dielectric constant ε_r	4.4
2	Loss Tangent(tan∂)	.016
3	Thickness(h)	3.2
4	Operating Frequency f r	2.4GHz
5	X_sub	57
6	Y_sub	56
7	Lg	22.5
8	W_gnd	3.6
9	S	0.3
10	W	3.2
11	Lg1	18
12	Wg1	32.5
13	Wg2	19.7
14	Lm	16
15	wm	14

Different parameters drawn and plotted in HFSS software, the results obtained by the simulation of the microstrip patch monopole antenna with coaxial feed. We performedmeasurements 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).

When operating in the folded monopole mode, the antenna acts as a two-arm folded monopole along the x-axis. the monopole resonance at around 2.35 GHz – 2.54GHz. At this higher frequency the current along the top edges of the two ground plane are out of phase and the balanced CPW mode is preserved, therefore these currents do not contribute to any radiation. In this mode the top monopole patch acts as a radiating element.

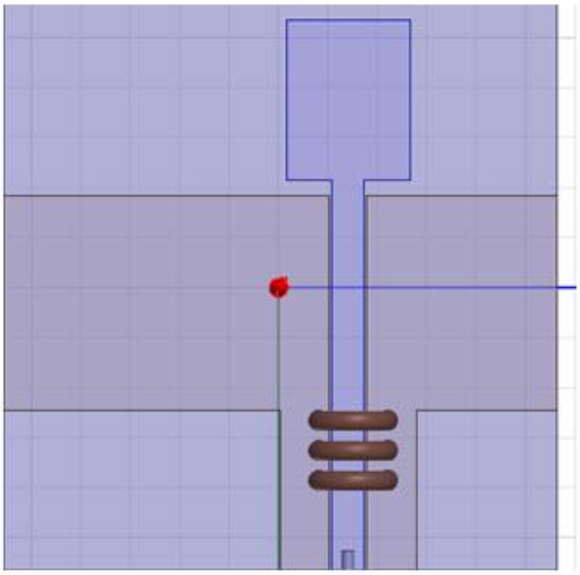

Figure 2 shows the top view of monopole designed antenna with coaxial feed at the edge using the dimension specified in table 1.

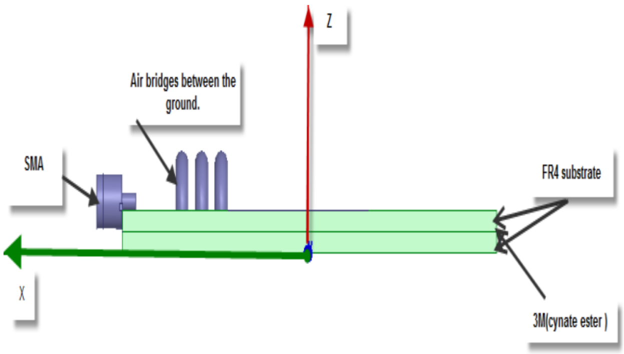

Figure 3 Shows the side view of designed antenna in HFSS Software.

IV. RESULT OF SIMULATED ANTENNA

Here in this design monopole with CPW feed is simulated. With that we can obtain vertical polarization. The return loss we got is -24.11db at 2.4 GHz.Realized gain at 2.4 GHz is 1.5 dB.

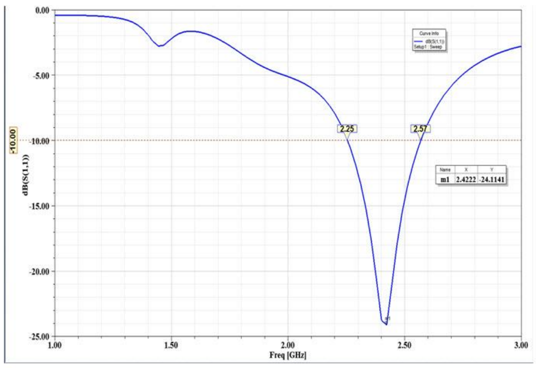

Figure 4 shows the s11 parameter of the microstrip antenna.

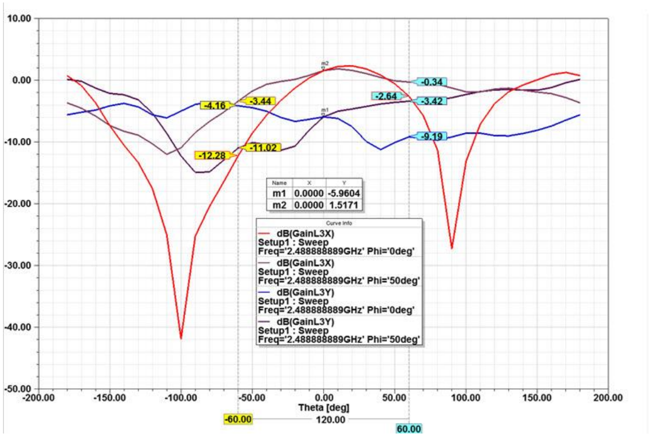

Figure 5 Cross and co-polarization of the antenna (HFSS) at2.48GHz**.**

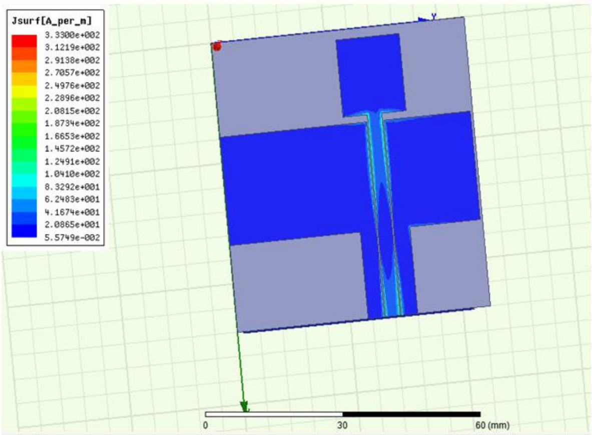

Figure 6. The Current Distribution of the antenna.

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.

V. Conclusion

In this paper we design a rectangular patch antenna which is feed with coaxial connector with CPW feed line and is operated at 2.4 GHz .this antenna can be easily fabricated as the thickness of substrate and small size. The efficiency of antenna is approx. 88% at S band .

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

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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Sneha she has completed her, M.E in Wireless Communication from BIT-mesra .Patna, India. Her area of interest is antenna and signal propagation, and fibre communication .Presently she is working as assistant professor in MIET,Meerut