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Design of Microstrip Patch Antenna For Wi-Fi Applications

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Abstract – **In recent years, Microstrip patch antenna can be widely used because of its low profile, small size, weight, cost, Performance, Ease of installation. The Microstrip patch antenna can be used in Satellite applications, space craft, aircraft, wireless applications such as WLAN, WiMAX, Wi-Fi and etc., In this paper, the rectangular patch antenna can be designed for C band application such as Wi-Fi . The proposed antenna can be operated at the frequency of 5.4GHz. The substrate material of the antenna is Rogers RT/ Duroid 5880(tm) and it has the relative permittivity of 2.2. The basic theory and design are analyzed, and simulation can be done by using HFSS 13.0 simulation software.**

Index terms- **Wi-Fi, WLAN, WiMAX, HFSS 13.0**

I. INTRODUCTION

There are different shapes of antenna depending on its application. In general, the Microstrip antenna has many properties which are depending upon its applications. These properties include low profile, light weight, compact and confort to structure, simple fabrication and Ease of installation. These properties contribute to the application of Microstrip antennas in the military applications, such as aircraft, missiles, space craft, and also in the commercial areas, such as mobile satellite system, cellular mobile communications, broadcast satellite system, wireless communication and global positioning system. The choice of antenna selection is based on the requirements of the application such as frequency band, gain, cost, coverage, weight, etc. Wi-Fi is the most rapidly growing area in the modern wireless communication. This gives users the mobility to move around within a broad coverage area and still be connected to the network. This provides greatly increased freedom and flexibility. For the home user, wireless has become popular due to ease of installation, and location freedom. Portable antenna technology has grown along with mobile and cellular technologies. It is important to have the proper antenna for a device. The proper antenna will improve transmission and reception, reduce power consumption, improved lifetime and improved efficiency of the communication device. In this paper, a single band Microstrip patch antenna for WLAN application is designed and simulated using High Frequency Structure Simulation (HFSS) Software. The proposed patch antenna resonates at 5.4GHz frequency.

II.DESIGN GEOMETRY OF MICROSTRIP PATCH ANTENNA

In its basic form, a Microstrip patch antenna consists of a radiating patch which is built on the dielectric substrate and substrate is attached on the ground plane as shown in Figure 1. The patch is generally made of conducting material such as copper or gold and can take any possible shape.

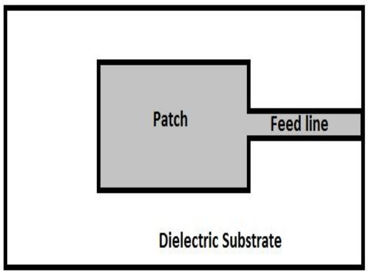

Figure 1. Structure of Microstrip patch Antenna.

The radiating patch and the feed lines are usually photo etched on the dielectric substrate. The relative permittivity of the dielectric substrate is very important for the calculations of the antenna dimensions. In order to simplify analysis , the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape . In this paper, the rectangular patch can be used. Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation.

A. Antenna Design

The proposed antenna is designed for a resonating frequency of 5.4GHz. The substrate material Rogers RT/ Duroid 5880(tm) which has the relative permittivity of ε_r =2.2. The substrate thickness is designed as 1.6mm. The dimensions of the antenna can be calculated by using the following relationship.

i. Width of the Patch:

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$$

Where,
c =free space velocity of light.
fr = resonating frequency.
ε_r= relative permittivity of substrate.

ii. Effective dielectric Constant:

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Where,
h = Thickness of the substrate.
W= Width of the patch.

iii. Effective Length:

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}}$$

iv. Patch length extension:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)}$$

v. Length of the patch:

$$L = L_{eff} - 2\Delta L$$

vi. Width of the substrate:

$$L_g = 6h + L$$

vii. Length of the substrate:

$$W_g = 6h + W$$

B. Antenna Modelling:

From the above relationships, the proposed antenna can have the following dimensions. The following Table 1. can have the dimensions of the antenna that is listed below.

TABLE 1. Dimensions of the antenna

Parameter	Dimension
Operating Frequency(fr)	5.4GHz
Relative Permittivity	2.2
Substrate Width(Wg)	31.56mm
Substrate Length(Lg)	27.39mm
Substrate Height(h)	1.6mm
Patch Width(W)	21.96mm
Patch Length(L)	17.79mm

C. Method of Feeding:

Feeding technique influences the input impedance and polarization characteristics of the antenna. There are three most common structures that are used to feed planar printed antennas. These are coaxial probe feeds, Microstrip line feeds, and aperture coupled feeds.Microstrip linefed structures are more suitable compared to probe feeds, due to ease of fabrication and lower costs. Serious drawba cks of this feed structure are the strong parasitic rad iation and it requires a transformer, which restricts t he broadband capability of the antenna.

In this paper, the Microstrip line feeding can be used to radiate the power of the proposed antenna. The strip line can be united with the patch of the antenna. The basic structure of the Microstrip line feeding can be shown in Figure 2.

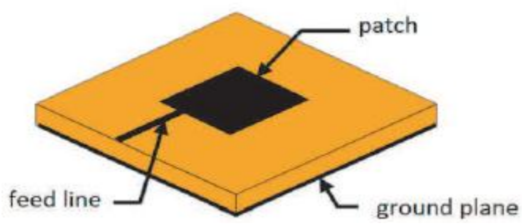

Figure 2. Microstrip Line Feeding.

III.ANALYSIS OF MICROSTRIP PATCH ANTENNA

The proposed Rectangular Microstrip patch antenna can be analysed and simulated by using HFSS antenna simulation software. Figure 3. Shows the design geometry of the proposed Microstrip patch antenna for C band applications.

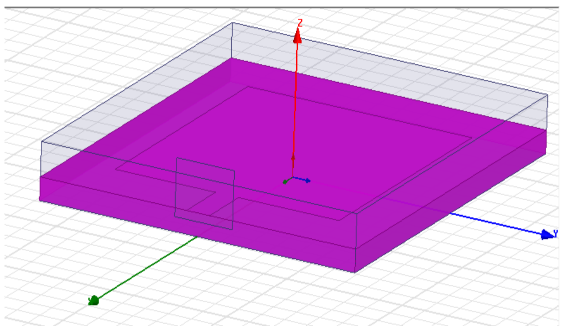

Figure 3. Design of the proposed antenna.

IV. SIMULATED RESULTS

The parameters S11 for the designed antenna were calculated and the simulated return loss results are shown in Figure 4. The resonating frequency 5.4GHz with the corresponding value of return loss as -26.9590 dB and it can be operated at 4.4125GHz with no reflections.

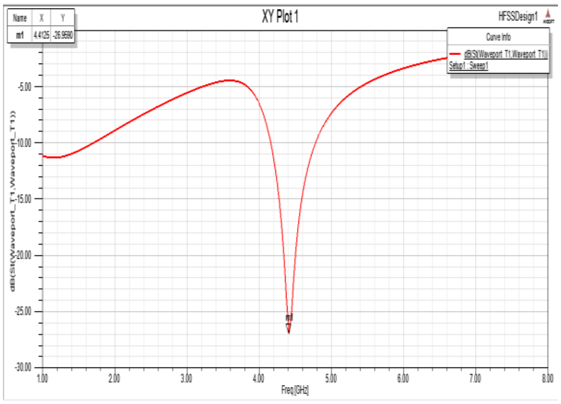

Figure 4. Simulated return loss curve

The antenna covers the WLAN standard IEEE 802.11 (5.4GHz band for Wi-Fi). The achieved value of return loss is small enough and frequency is closed enough to the specified frequency band for 5.4 GHz WLAN applications. The antenna characteristic impedence can be shown in Figure 5. The achieved antenna impedance is 0.59 ohm.

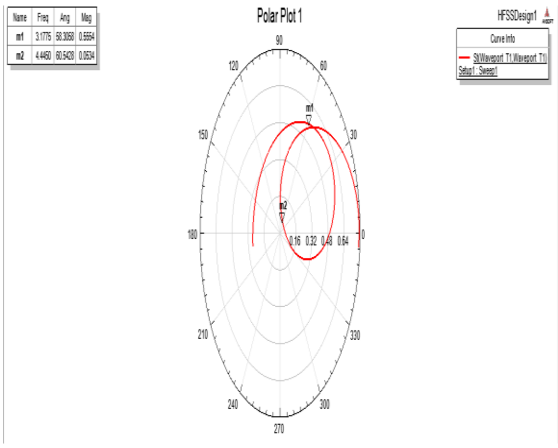

Figure 5. Curve showing antenna characteristic impedance

The Radiation pattern for the proposed rectangular Microstrip patch antenna can be shown in Figure 6. This can be shown below. This proposes the function of Theta with X-Y direction radiation.

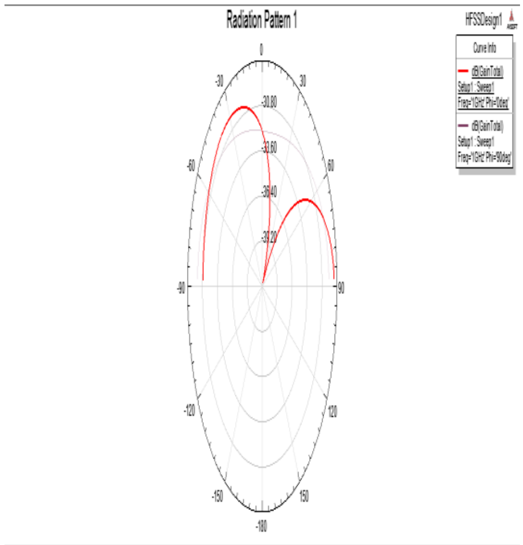

Figure 6. Radiation Pattern for the proposed antenna.

V.CONCLUSION

A Microstrip line fed single frequency Microstrip patch antenna has been designed and simulated using HFSS 13.0 Antenna Simulation software. This is operating in the frequency of 5.4 GHz Wi-Fi communication in the IEEE 802.11 standard. The simulated corresponding value of return loss as -16.7269dB which is small enough and frequency is closed enough to the specified frequency band feasible for Wi-Fi application. However, the size of the Microstrip antenna, reported here, is not very small. Cutting inclined slots on the patch, the size of the Microstrip antenna may be reduced; also the bandwidth may be enhanced. Work is going on to achieve even better results with good axial ratio over a wide bandwidth.

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