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Dual Band Microstrip Antenna for Wi-Fi Applications

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***Abstract* — Microstrip patch antennas are of high demand for its light weight, cheap manufacturing, small size, high gain and high directivity gain. It also offers circular polarization apart from linear polarization. These antennas can be used in satellite applications, space craft, aircraft, wireless applications such as WLAN, WiMAX, Wi-Fi and etc., The proposed antenna operates at 2.4GHz and 5.2GHz which are reserved for IEEE802.11b/g and IEEE802.11a WLAN standard. This paper presents a dual band slotted rectangular patch antenna with partial ground. The basic theory and design are analysed, and simulation can be done by using ADS simulation software.**

Index terms — Microstrip Antenna, Light Weight, Wi-Fi, Dual Band, Slotted Rectangular Antenna, Partial Ground, ADS

1. INTRODUCTION

Patch antennas are assigned different names such as printed antennas, microstrip patch antennas or simply microstrip antennas (MSA). Microstrip antennas are often used where thickness and conformability to the host surfaces are the key requirements. Since patch antennas can be directly printed onto a circuit board, these are becoming increasingly popular within the mobile phone market. They are low cost, have a low profile and are easily fabricated. Apart from these all merits, the microstrip antenna has some limitations too, that is, they suffer from narrow bandwidth operation, low efficiency, surface wave excitations and poor end fire radiations. Microstrip patch antennas have a very high quality factor. The quality factor '*Q*' represents the losses associated with the antenna. A large *Q* leads to narrow bandwidth, and a low efficiency *Q* can be reduced by increasing the thickness of the dielectric substrate. There are different shapes of antenna depending on its applications. The rectangular shape is the simplest and most widely used configuration for fabrication of microstrip antennas. 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 dual band microstrip patch antenna for WLAN application is designed and simulated using Advanced Design System (ADS) Software.

2.MICROSTRIP PATCH ANTENNA

A patch antenna basically is a metal patch suspended over a ground plane. The assembly is usually contained in a plastic radome, which protects the structure from damage. 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.

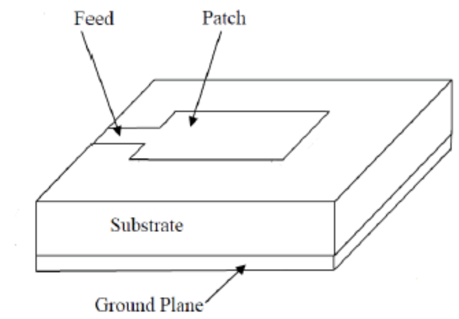

Fig 1: Structure of microstrip patch antenna

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. 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. The microstrip antenna is constructed on a thin dielectric sheet using a printed circuit board. The most common board is a dual copper-coated polytetrafluoroethylene (Teflon) surface.

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3. ANTENNA DESIGN

The proposed antenna is designed to resonate at frequencies 2.4GHz and 5,2GHz. The substrate material FR4 which has the relative permittivity of ε_r =4.6. The substrate thickness is designed as 2.4mm. The dimensions of the patch and the antenna cane be calculated using the following formulas.

Width of the Patch:

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{v_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$$

Where,

υ_0 = free-space velocity of light

f_r = resonating frequency

ε_r = relative permittivity of free space

μ_0 = relative permeability of free space

Effective dielectric Constant:

$$\epsilon_{\mathrm{reff}} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}$$

Where,

h = Thickness of the substrate

W= Width of the patch.

Effective Length:

$$L = \frac{1}{2f_r\sqrt{\epsilon_{\mathrm{reff}}}\sqrt{\mu_0\epsilon_0}} - 2\Delta L$$

Patch length extension:

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

4. METHOD OF FEEDING

Microstrip patch antennas can be fed in different ways. These feeding methods can be classified under the categories of contacting and non-contacting feeds. Feeding technique influences the polarization mechanisms and the input impedance of the desired antenna. There are three feeding techniques which are most commonly used. They are coaxial probe feeds, microstrip line feeds, and aperture coupled feeds. Microstrip line feeds are more suitable for the patch antennas when compared to the other feeding techniques because of its advantages like easy fabrication and lower costs.In this paper, microstrip line feeding technique is used to radiate the power.

5. PROPOSED ANTENNA

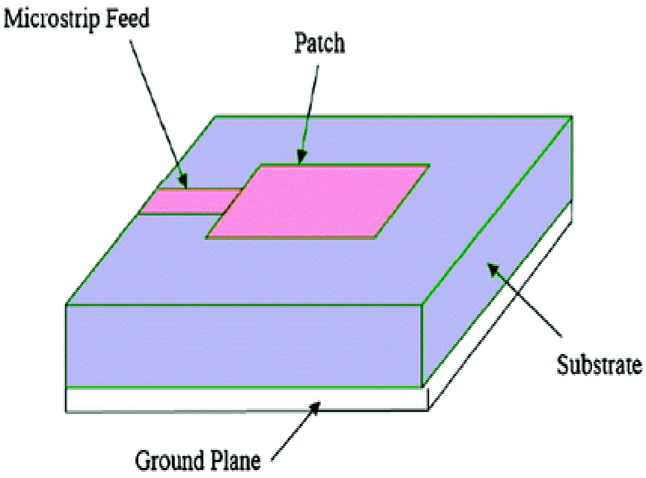

Fig 2 : Microstrip line feed

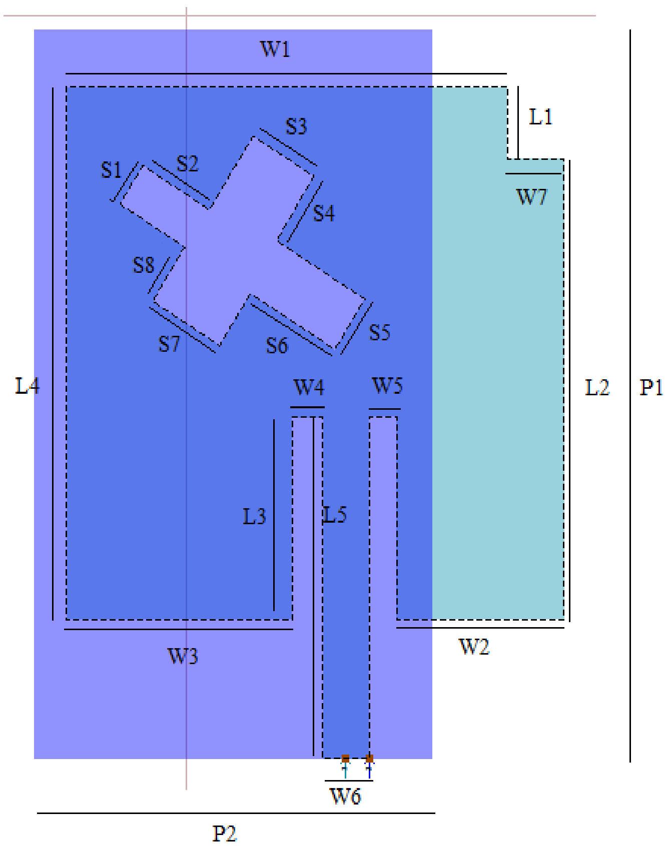

Fig 3 : Proposed antenna top view

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The proposed patch antenna with partial ground plane is fabricated on a FR4 substrate which has an ε_r = 4.6 and a loss tangent of 0.02 and the overall dimension (L x W x H),where L,W and H are the length, width and height of the antenna respectively, and is 29mm x 30mm x 2.4mm.The square patch has been etched on the top layer of the substrate. For the antenna to resonate at dual frequencies a X shaped slot has been cut over the square patch. The dimensions of L1, L2, L3, L4 and L5 are 3.4mm, 20mm, 10mm, 23.4mm and 17mm respectively. The other dimensions W1, W2, W3, W4, W5, W6 and W7 are 24mm, 9mm, 12.5mm, 1.7mm, 1.5mm, 2.5mm and 3mm respectively. Partial ground plane of size (P1 x P2) whre P1 = 29mm and P2 = 23mm is etched on the bottom of the substrate. Fig 3 gives the proposed antenna geometry. The slot can be of different shapes like U, +, X, ring shaped etc,. In this paper, a X shaped slot has been cut on the patch. To resonate at particular frequencies the shape, position and orientation of the slot can be changed. The slot dimensions from S1 to S8 are 2.3mm, 4mm, 4mm, 3.9mm, 5.7mm, 3mm, 4.3mm and 3.3mm respectively. The proposed antenna has been designed and simulated with Advanced Design System (ADS). Fig 4 shows the view of 3D - view of the antenna using the software.

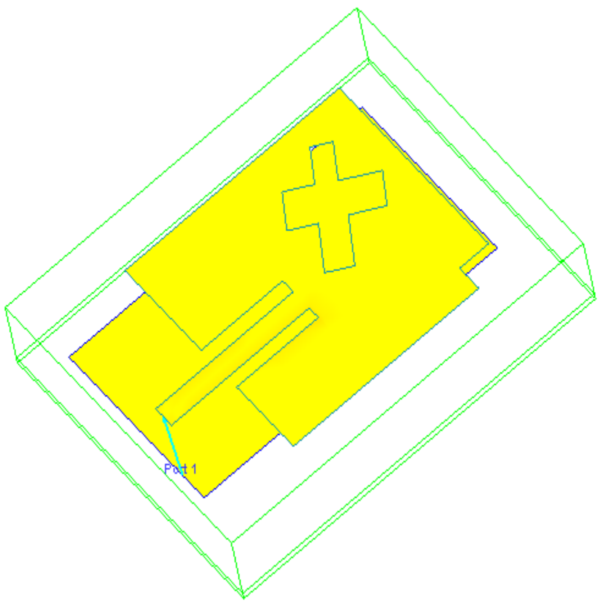

Fig 4 : 3D view of the simulated antenna

6. SIMULATED RESULTS

The return loss S11 was calculated for the designed using ADS software. A plot of frequency versus the return loss is shown in the fig 5. It can be seen that the antenna resonates at 2.4GHz and 5.2GHz with a return loss of -26 dB and -22 dB. From the simulated plot it is clear that the antenna shows dual-band characteristic in the frequency band of 2.4 - 5GHz. When the antenna operates at 2.4 GHz frequency it has a bandwidth of 2.39 – 2.49GHz and when it operates at 5.2GHz frequency it has a bandwidth of 5.07 – 5.26GHz. Both the bands have sufficient bandwidth to cover the wi-fi applications.

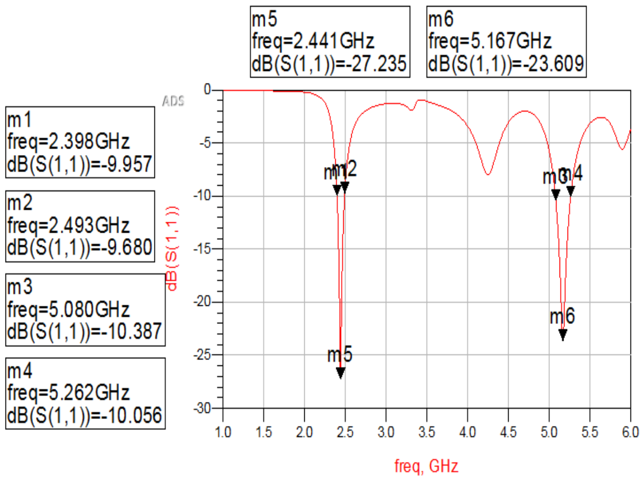

Fig 5 : Frequency versus return plot

7. RADIATION PATTERN AND GAIN OF ANTENNA

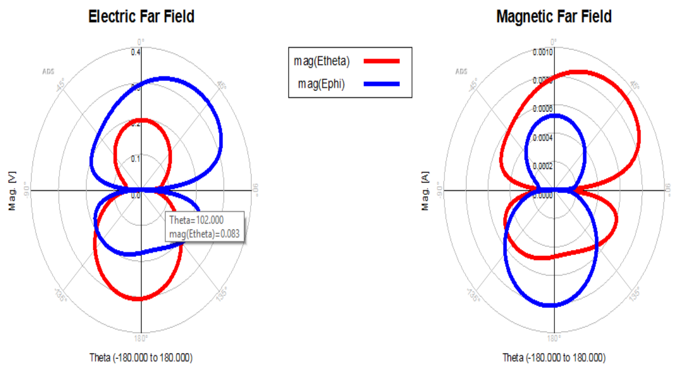

Fig 6 : E and H field patern at 2.4 GHz

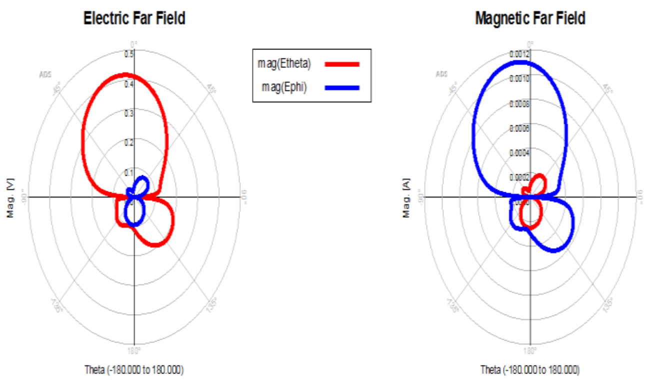

Fig 7 : E and H field pattern at 5.2 GHz

Fig 6 and fig 7 shows the E and H field pattern of the antenna at the frequencies 2.4 and 5.2GHz. The peak gain, corresponding frequencies, directivity and other parameters are shown in the fig 8 and 9.

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Frequency (GHz)	2.37037
Input power (Watts)	0.00206232
Radiated power (Watts)	0.00094627
Directivity(dBi)	6.2502
Gain (dBi)	2.86679
Radiation efficiency (%)	45.8838

Fig 8 : Parameters of antenna at 2.4GHz band

Frequency (GHz)	5.11111
Input power (Watts)	0.00167707
Radiated power (Watts)	0.000699564
Directivity(dBi)	8.37638
Gain (dBi)	4.57913
Radiation efficiency (%)	41.7134

Fig 9 : Parameters of antenna at 5GHz band

8. CONCLUSION

The proposed antenna shows dual band characteristic in 2.4 /5GHz. Bandwidth improvement is done by using a partial ground plane. The antenna has a good return loss of -28 and -24dB which is promising for WLAN applications with a nominal gain. The introduction of the X shaped slot and microstrip feed lines allows us to achieve the dual-polarized radiation. Through optimizing the size of ground plane and the dimension of feeding structure, a broadband impedance matching can be achieved. Results also show that the proposed design has a reduced antenna size for the dual-band operation with a fixed lower-band operating frequency. Therefore, the proposed compact dual-band microstrip antenna is very suitable for Wi-Fi applications.

REFERENCES

[1] Mohammed Y. M. Yousef , Abd Elhamid Gaafar , Abd Elaziz A. Abd Elaziz, Dual Band Circularly Polarized Microstrip Patch Antenna For Wi-Fi Applications . Cairo, Egypt ,2010.

[2] Yuan-Ming Cai, Ke Li, Ying-Zeng Yin, and Xueshi Ren, Dual-Band Circularly Polarized Antenna Combining Slot and Microstrip Modes for GPS With HIS GroundPlane. IEEE antennas and wireless propagation letters, VOL.14, 2015.

[3] Wong kin-lu, Compact and Broadband Microstrip Antennas. A Wiley-Interscience Publication, John Wiley & Sons, inc ,2002.

[4] ADS Circuit Design Cookbook, Keysight.inc.

[5] Constantine A.Balanis, Antenna theory Analysis and Design, Arizona State University Tempe, AZ.

[6] Sai-Wai Wong, Guang-Hua Sun, Lei Zhu, and Qing-Xin Chu, Broadband Dual-Polarization and Stable-Beamwidth Slot Antenna Fed by U-Shape Microstrip Line. IEEE transactions on antennas and propagation, vol. 64, no. 10, october 2016.

[7] Haq Nawaz and Ibrahim Tekin, Dual-Polarized, Differential Fed Microstrip Patch Antennas With Very High Interport Isolation for Full-Duplex Communication . IEEE transactions on antennas and propagation, vol. 65, no. 12, december 2017.

[8] L. Sabri, N. Amiri, and K. Forooraghi, Dual-Band and Dual-Polarized SIW-Fed Microstrip Patch Antenna. IEEE antennas and wireless propagation letters,vol.13,2014.

[9] John D Kraus. Antennas and Wave Propagation, Taine G. McDougal Chair Professor of Electrical Engineering and Astronomy, Emeritus, Ohio State University,1950.

[10] Pradeep Kumar, Neha Thakur, Aman Sanghi , Micro strip Patch Antenna for 2.4 GHZ Wireless Applications , International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 8- August 2013.

[11] Neha Ahuja1, Rajesh Khanna , Jaswinder Kaur , Design of Single Band Rectangular Patch Antenna for WLAN Application , International Conference on Recent Advances and Future Trends in Information Technology (iRAFIT2012) Proceedings published in International Journal of Computer Applications® (IJCA).

[12] Mr. P.C. Dhanawade, Dr. (Mrs.) L.S.Admuthe, Mrs. P.P. Dhanawade , Simulation of Rectangular Patch Antenna with Jeans Substrate, IOSR Journal of Electronics and Communication Engineering (IOSR-JECE).I.S. Jacobs and C.P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

[13] K.Dinakaran, M.Vajikababu, M.Priyadharsini, D.Rajeshwari,Design of Microstrip Antenna for Wi-Fi Applications, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 5, Issue 1, January 2016.

[14] Q. Liu, Y. A. Liu, Y. L. Wu, M. Su, and J. Y. Shen, “Compact wideband circularly polarized patch antenna for CNSS applications,” IEEEAntennas Wireless Propag. Lett., vol. 12, pp. 1280–1283, Sep. 2013.

[15] Siju J Thomas, Mehajabeen Fatima, Bandwidth Improvement of Microstrip Patch Antenna using Partial Ground Plane, International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 05- August 2015.

[16] Sunil Singh, Neelesh Agarwal, Navendu Nitin, Prof. A.K. Jaiswal, Design consideration of Microstrip Patch Antenna‖, International Journal of Electronics and Computer Science Engineering, pp. 1-4,2013.

[17] Y.-K. Jung and B. Lee, Dual-band circularly polarized microstripRFID reader antenna using metamaterial branch-line coupler,‖ IEEE Trans. Antennas Propag., vol. 60, no. 2, pp. 786–791, Feb. 2012.