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Design and Simulation of Single Band Rectangular Microstrip Patch Antenna for WLAN Application

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Abstract— **A micro strip patch antenna for WLAN is designed. The antenna has a frequency bandwidth of 5GHz – 5.5GHz. The micro strip patch antenna consists from a ground, a substrate, a patch and a feed line. The basic theory and design are analyzed, and simulation done by using HFSS to optimize the antenna's properties. Results show that the designed antenna has promising characteristics for WLAN application at 5.25 GHz frequency.**

Index Terms— **Micro strip Antenna, WLAN Communication Standard, HFSS, Micro strip line feed, single frequency.**

I. Introduction

In recent years demand of microstrip antennas are increased due to its use in high frequency, high speed data communication applications [1]. Printed antennas are economical and The key features of a Micro strip antenna [2-5] are relative ease of construction, light weight, low cost and either conformability to the mounting surface Microstrip antennas are best form of antennas because they are light weight, low profile, low cost, ease to analyze, fabricate and are compatible with the integrated circuits but one of the serious limitations of these antennas have narrow bandwidth characteristics as it limits the frequency ranges over which the antenna can perform satisfactorily [6-9]. These features are major design considerations for practical applications of microstrip antennas [10]. Recent development of technologies enables wireless communication devices to become smaller in size physically.

Antenna size is a major factor that limits miniaturization. With the rapid development of the wireless communication technology, the future technologies need antenna have a very small size. Wireless local area network (WLAN) technology increased the freedom and Flexibility and mobility of users. For the homes and small area locations users [3] [9] [11], WLAN has become suitable due to easy installation. This being the case, portable antenna technology has grown along with mobile and cellular technologies. It is important for proper antenna for a device .The proper miniaturized antenna will improve transmission and reception, reduce power consumption [1].

In this paper, a single band microstrip patch antenna for WLAN application is designed and simulated using HFSS. The proposed patch antenna resonates at 5.25 GHz frequency.

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II. Design of Microstrip Patch Antenna

In this design the substrate has a thickness h=1.6 mm and a relative permittivity εr = 4.4. The length of patch is L=12.636 mm and width of patch is W=25.8 mm .The length of ground are L=22.83 mm and width of ground is W=27.154 mm .In this work, used microstrip feed line (50 ohm). Antenna is designed for a resonating frequency of 5.25 GHz and is analyzed using of HFSS Software. For the designing of rectangular microstrip patch antenna, the following mathematical calculations are used to calculate the dimensions of rectangular microstrip patch antenna [3].

The expression for ε_{reff} is given:

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

Where, ε_{reff} = Effective dielectric constant, ε_r = Dielectric constant of substrate, h = Height of dielectric substrate, W = Width of the patch,

A practical approximation relation for the normalized extension of the patch length is

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad (2)$$

and the effective length (L_{eff})

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}} \quad (3)$$

So the actual length of patch is

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

For designing of microstrip patch antenna use actual length L. Width of the patch is

$$w = \frac{c}{2f_0\sqrt{\frac{(\varepsilon_r + 1)}{2}}} \quad (5)$$

The ground plane dimensions would be given as:

$$L_g = 6h + L \quad (6)$$

$$W_g = 6h + W \quad (7)$$

where, L = length of patch, L_{eff} = effective length, c = speed of light f_0 = resonant frequency, L_g = Length of ground plane, W_g = Width of ground plane.

III. Design of Microstrip Patch Antenna

Figure 1 and 2 show the front view geometry and the structure designed on HFSS software of proposed microstrip line fed patch antenna with single band for WLAN application. The dimensions and feed point location for proposed antenna have been optimized so as to get the best possible impedance match to the antenna. The following parameters are used for design of proposed antenna.

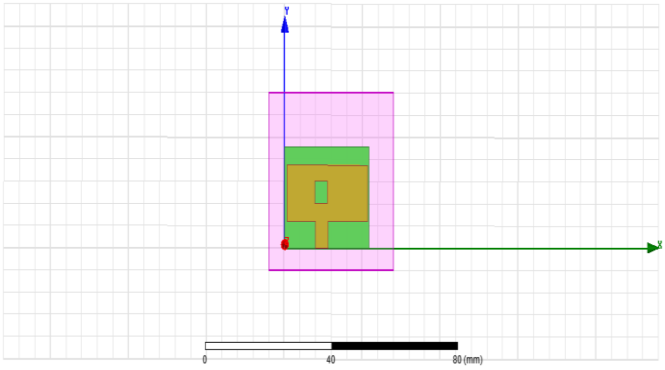

Figure 1 Front (2D) view of patch antenna

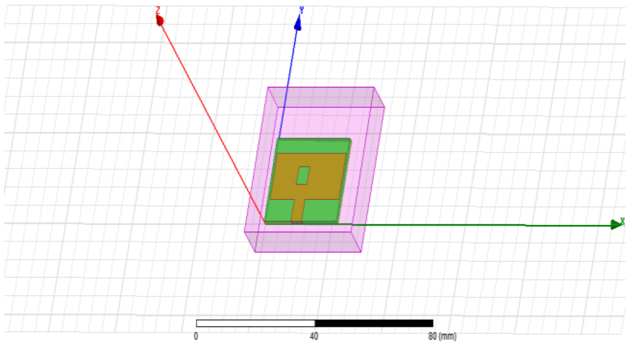

Figure 2 3D view of simulated patch antenna

Design frequency = 5.25 GHz
Substrate permittivity = 4.4
Thickness of substrate = 1.6 mm
Length of patch (L) = 12.636 mm
Width of patch (W) = 25.8 mm
Length of Ground (Lg) = 22.83 mm
Width of Ground (Wg) = 27.154 mm

IV. Simulated Results

The parameters for the designed antenna were calculated and the simulated return loss results are shown in Figure 3. The bandwidth at the resonating frequency 5.25 GHz is with the corresponding value of return loss as -55.68 dB.The bandwidth of 5.25 GHz shown in Figure 4.1.The antenna

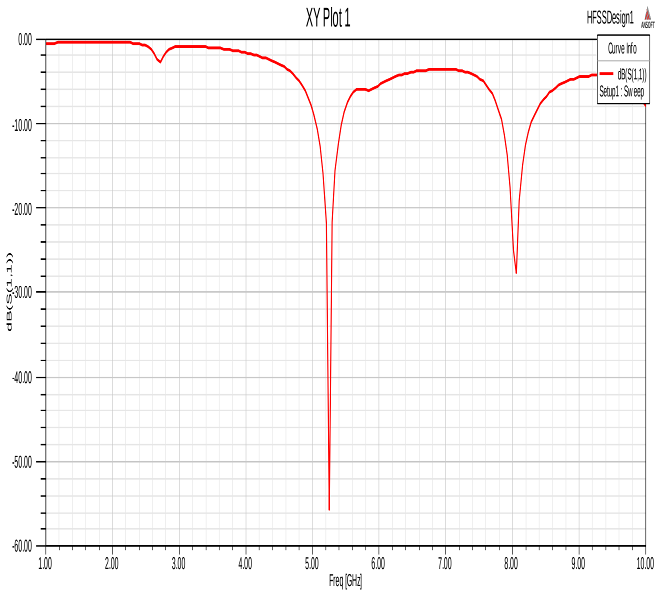

Figure 3 Plot between frequency and S11 with different variation in feed position

covers the WLAN standard IEEE 802.11 (5.2GHz band). The achieved value of return loss is small enough and frequency is closed enough to the specified frequency band for 5.2 GHz WLAN applications. The return loss value i.e. -55.68 dB is good matching at the frequency point below the -10 dB region. The achieved antenna impedance is 50 ohm as shown which is very close to the required impedance of 50 ohm. The VSWR shown in Figure 4 , which should lie in between 1 and 2.

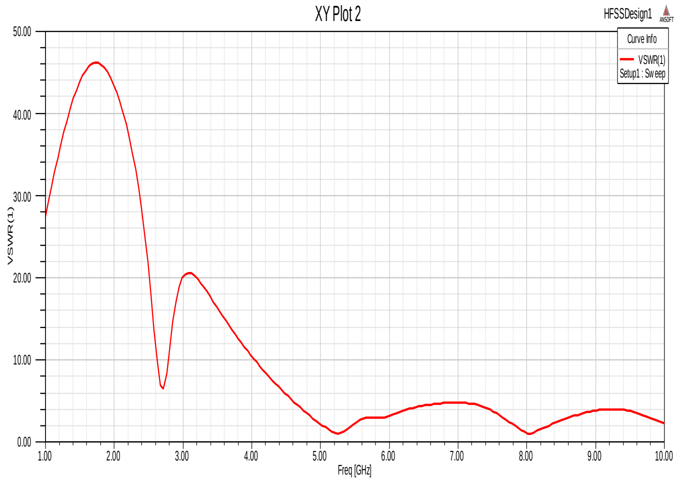

Figure 4 Plot between frequency and VSWR

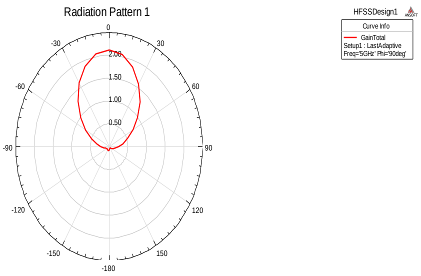

Figure 5 E -field Radiation pattern θ all, $\varphi=90^{o}$

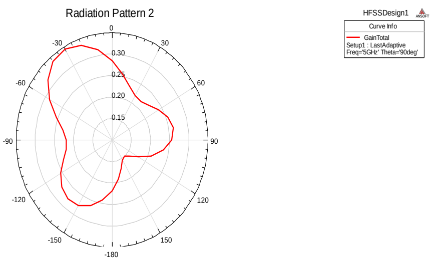

Figure 6 H -field Radiation pattern φ all, $\theta=90^{o}$

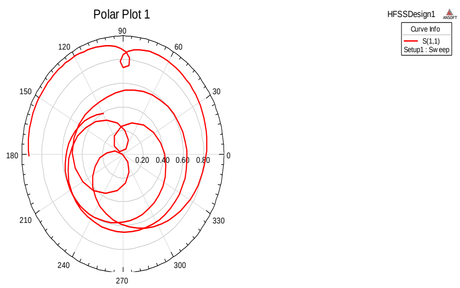

Figure 7 Polar plot of designed antenna

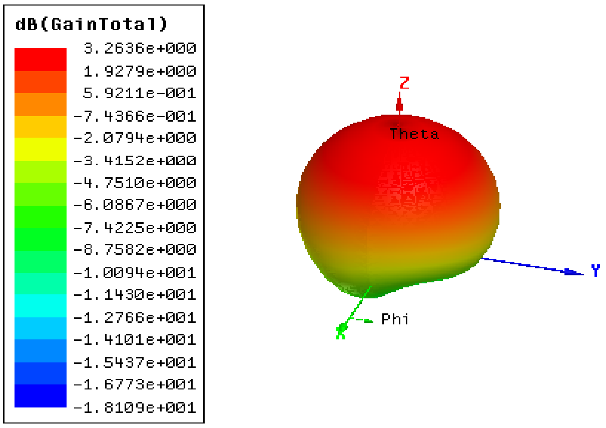

Figure 8 Radiation pattern of the Microstrip patch antenna

V. Conclusion

A microstrip line fed single frequency microstrip patch antenna has been designed and simulated using HFSS software. This is operating in the frequency band of 5.00 GHz – 5.5GHz covering 5.2 GHz WLAN communication standard. The simulated impedance bandwidth at the 5.25 GHz band is corresponding value of return loss as -55.68 dB which is small enough and frequency is closed enough to the specified frequency band feasible for WLAN application. This return loss value i.e. -55.68 dB that there is good impedance matching at the frequency point below the -10 dB region.

However, the size of the microstrip antenna, 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. .

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References

[1] C. A. Balanis, Antenna Theory-Analysis and Design, 2nd edition. Wiley India, pp. 1-11, 722-775, reprint 2007

[2] K. D. Prasad, Antenna and Wave propagation, 3rd edition. Satya Prakashan , New Delhi, pp 529-573, reprint 2005

[3] Rajesh Khanna , Jaswinder Kaur , Neha Ahuja "Design of single Band rectangular patch antenna for WLAN Application" at 5.21GHz International Conference on Recent Advances and Future Trends in Information Technology (iRAFIT2012)Proceedings published in International Journal of Computer Applications® (IJCA) 2012

[4] R.Garg, P.Bhartia, I.Bahl, A.Itipiboon,. "Micro Strip Antenna Design Handbook", Artech House, Boston –London 2000

[5] James,J.R., and P.S.Hall, 1989. "Handbook of Micro Strip Antennas", Vol.1, London: Peter Peregrinus Ltd.

[6] Z. I. Dafalla, W. T. Y. Kuan, A. M. Abdel Rahman, and S. C. Sudhakar "Design of Rectangular Micro Strip Patch Antenna at 1GHz", Multimedia University, Faculty of engineering and technology, Melaka, Malaysia, „"RF and Microwave Conference, October 5-6"". Malaysia , 2004

[7] B. Gokce(1), C. Karakus(2), F. Aklema "Micro Strip Patch Antenna Design for Umts Handsets " (1)Nortel Networks Netas Telekomunikasyon AS, Alemdag Caddesi, No:171 umraniye Istanbul Turkey,e-mail: burakgokce@gmail.com

[8] Atinder Pal Singh(1), Ravinder Kumar(2) and Hartej Singh Dadhwal(3) "Edge Fed Rectangular Micro Strip Patch Antenna "VSRD-IJEECE, Vol. 2 (4), 2012, 160-167

[9] R L Yadav "H-shaped Micro strip Patch Antenna for Bluetooth Applications" International Journal of Engineering Science and Technology Vol. 2(11), 2010, 6335-6348

[10] Sundeep Sunari(1),K.K Tripathi(2) "Design and analysis of Micro Strip Antenna using HFSS". International Journal of Engineering Science and Communication , vl.3 no. 1 January-june 2012

[11] Fabrication and Optimisation of Biquad Antenna for Wireless Local Area Network https://www.researchgate.net