Design of Broadband Microstrip patch Antenna with Scorpion shape slot for WLAN Applications

[1]Sarvesh Kumar Bhartiya, [2]Vinod Kumar Singh

[1]M.Tech Scholars, S.R. Group of Institutions, Jhansi
[2]Asst. Professor, S.R. Group of Institutions, Jhansi
Email: [1]Sarvesh.11289@gmail.com, [2]singhvinod34@gmail.com

Abstract: In this paper, the design and analysis of Microstrip patch antenna with Scorpion shape for the IEEE 801.11b Applications is presented. The Proposed microstrip antenna at frequency 2.90 GHz is designed and simulated using the IE3D software. The effects of different parameters like return loss, radiation pattern are studied. The simulated result shows that the proposed antenna presents dual band width of 50% and 9% which is suitable for WLAN Application.

Keywords: Microstrip patch antenna, Fringing Effect, Return loss, Radiation Pattern, Dual Band.

I. INTRODUCTION

Now a days Microstrip antennas are most popular due to its smart features such as low profile, low cost, light weight, ease of fabrication and compatibility with microwave circuits [1-4]. The microstrip antennas suffer from some disadvantages of narrow bandwidth and low efficiency. Printed monopole antennas are widely used in wideband communication systems. Among the printed monopole antennas of various shapes, Rectangular monopole antenna is simple in geometry and their radiation patterns are omni-directional with wide bandwidth. Printed monopole antenna can be optimized to provide extremely wide impedance bandwidths with acceptable radiation performance [3-4]. They can be developed to cover various functional frequency bands of wireless communication, such as GSM900, DCS, Personal Communication System, and Universal Mobile Telecommunication and WLAN.

Various researches have been made to increase the bandwidth of Microstrip antennas, which includes increase of the substrate thickness, the use of a low dielectric constant, slotted patch antennas, introducing the parasitic elements either in coplanar or stacked configuration, the use of various impedance matching and feeding techniques [5-10].The dielectric constant of the substrate is closely related to the size and the bandwidth of the microstrip antenna. Low dielectric constant of the substrate produces larger bandwidth, while the high dielectric constant of the substrate results in smaller size of antenna. [6-10]

In the past few years researchers have tried various methods to enhance the bandwidth and it is found that as the bandwidth is increased the efficiency and gain decreases. To obtain a larger bandwidth along with optimum gain and efficiency and maintaining the size of antenna is a major challenge to the researchers working with microstrip antennas these days [11-15].

In this paper a wide band line feed microstrip antenna with compact size is presented which have bandwidth of around 50% and 9%.The antenna is suitable for various mobile cellular communication systems where wide band applications are required.

II. ANTENNA DESIGN

The proposed line-fed wide band rectangular patch antenna is presented in Figure1. The ground plane has the dimensions of Lg× Wg and is printed on a substrate of thickness h = 1.6 mm and relative permittivity ε_r =4.4.

The optimized design parameters of the proposed patch antenna are shown in table 1. The scorpion shape is introduced on the patch with glass epoxy substrate provide bandwidth enhancement. There are different slots in designing the microstrip antenna. The slot is scorpion shape .The effect of changing the slot length and width are studied on parameters like gain, return loss, radiation efficiency, antenna efficiency etc. A Coaxial probe feed is used at different points by Changing the feed locations and their effect are seen on above parameters.

Due to fringing effect, electrically the patch of the presented antenna looks larger than its physical dimensions. The enlargement of length Δl is given below equation.

$$\frac{\Delta l}{h} = 0.412\frac{\left(\varepsilon_{reff} + 0.300\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.813\right)}$$

Where the effective (relative) permittivity is given by

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

The larger the h/W, smaller the effective permittivity, finally the effective length of the patch is given by

$$L = \frac{1}{2\, fr\sqrt{\varepsilon_{reff}}\sqrt{\mu_o \varepsilon_o}} - 2\Delta l$$

$$f_{nm} = \frac{cK_{nm}}{2\pi a_e \sqrt{\varepsilon_r}}$$

Where K_{nm} the derivative of the Bessel function of order n & c is velocity of light.

Table 1. Dimensions of the Prescribed Antenna

Parameters	Values
Resonant Frequency(Fr)	2.9 GHz
Dielectric Constant (ε_r)	4.4
Substrate Thickness(h)	1.6mm
Loss Tangent	0.001

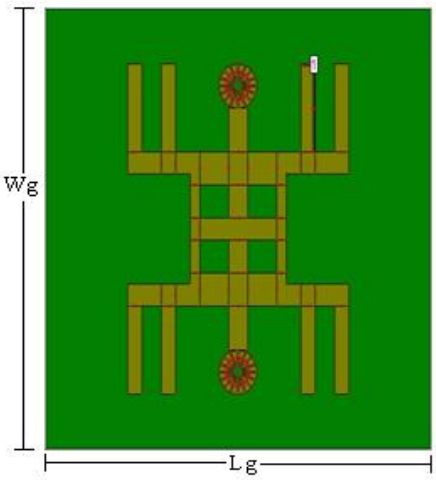

Figure 1: Top view of Proposed Antenna

III. RESULTS AND DISCUSSIONS

Figure 2 shows the variation of return loss versus frequency of proposed MSA which gives dual bandwidths of 50% and 9%. It is seen that the proposed MSA resonates at 2.75 GHz and 3.88 GHz of frequency. Figure 3 shows the VSWR Vs frequency plot of proposed design. Figure 5 shows Gain Vs Frequency plot of proposed Antenna having maximum gain of 6 dBi. Figure 6 shows the smith chart which is used impedance matching.

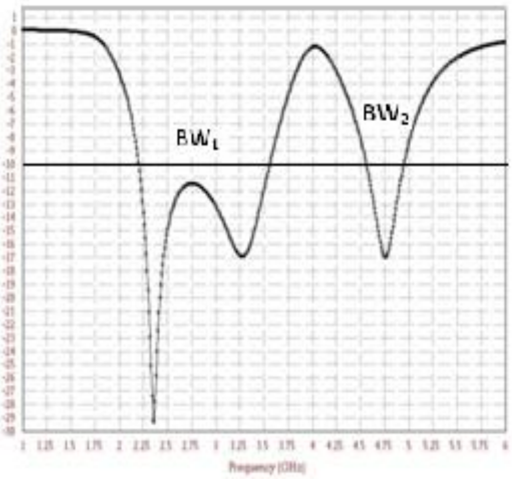

Figure 2: S11 parameter of Proposed Antenna

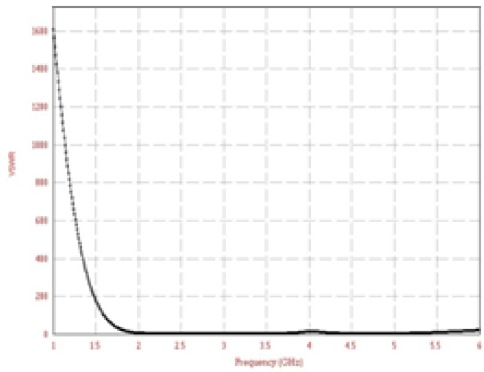

Figure 3: VSWR of Proposed Antenna

Table 2. Results of Proposed antenna design

Parameters	Obtained Results
Band Width(BW_1, BW_2)	50% & 09%
Maximum Gain	6 dBi at 5.5 GHz
Maximum Antenna Efficiency	88% at 3.88 GHz

The bandwidth of antenna can be defined as the percentage of the frequency difference over the center frequency [5]. According to these definitions can be written in terms of equations as follows

$$BW(\%) = \left[\frac{f_H - f_L}{f_C}\right]100$$

Where f_H and f_L are the upper and lower cut off frequencies of the resonated band when its return loss reaches -10 dB and f_C is a centre frequency between f_H and f_L respectively. The impedance bandwidth of proposed MSA is found to be 50% and 9%.

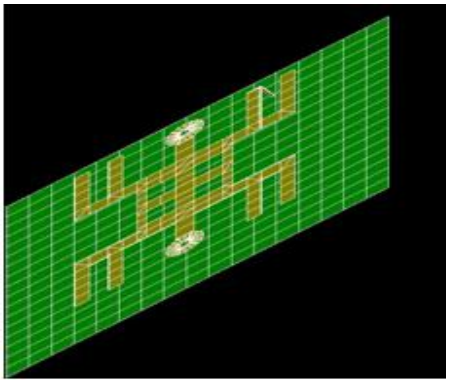

Figure 4: Efficiency plot of proposed Antenna

.

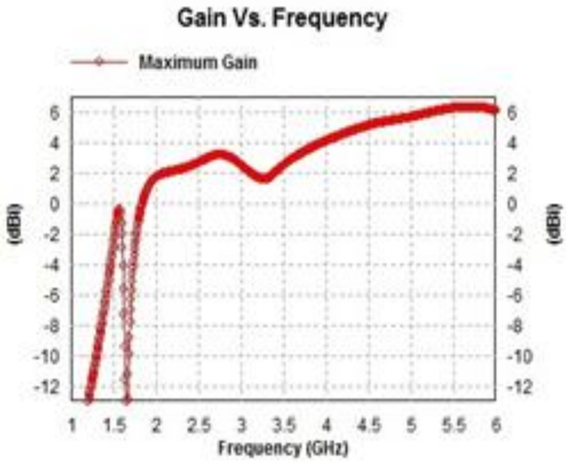

Figure 5: Gain Vs Frequency plot of proposed Antenna

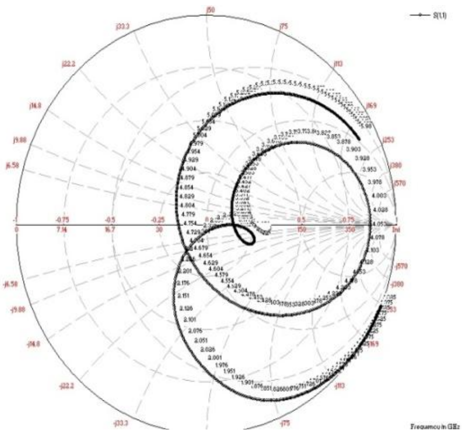

Figure 6: Smith chart of Proposed Antenna

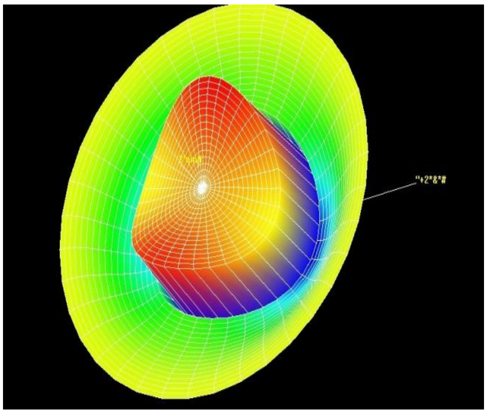

Figure 7: 3D Radiation Pattern of Proposed Antenna

IV. CONCLUSION

The proposed designed antenna is suitable for broad band application. The simulated result shows that the proposed antenna presents a bandwidth of 50% and 9%. The maximum achievable gain of the antenna is 6.dBi.The developed line feed wide band compact microstrip antenna is suitable for dual band applications.

REFERENCES

[1] Girish Kumar and K.P. Ray, Broadband Microstrip antennas, Norwood: Artech House 2003.

[2] I. J. Bahl and P. Bhartia, Microstrip Antennas, Artech House, Dedham, MA, 1980

[3] Stutzman, W.L. and Thiele, G.A., Antenna Theory and Design, John Wiley & Sons, Inc, 1998

[4] Balanis, C.A., Antenna Theory: Analysis and Design, John Wiley & Sons, Inc, 1997.

[5] E.O. Hammerstad, “Equations for Microstrip Circuit Design,”Proc. Fifth European Micro-wave Conf., pp. 268–272, September 1975.

[6] Kuldeep K. Parashar, V.K. Singh, Ratnesh Tiwari, “Microstrip Patch Antenna for WiMax/WLAN Applications” International Journal of Applied Physics Letter, ISSN (Online): 2349-1108, Vol 1, Issue 1, pp-34-37, 2014.

[7] M. T. Islam, M. N. Shakib and N. Misran, “Broadband E-H shaped microstrip patch antenna for wireless systems,” Progress In Electromagnetics Research, PIER 98, pp. 163-173, 2009.

[8] Vinod Kumar Singh, Zakir Ali, Shahanaz Ayub, Ashutosh Kumar Singh, “A wide band Compact Microstrip Antenna for GPS/DCS/PCS/WLAN Applications”, a book chapter in the book entitled “Intelligent Computing, Networking, and Informatics”,

(Book ISBN: 978-81-322-1664-3) Chapter 113, pp: 183–204 in Springer

[9] Ansari, J. A. and R. B. Ram, "Broadband stacked U-slot microstrip patch antenna, "Progress In Electromagnetic Research Letters, Vol. 4, 17-24, 2008.

[10] Vinod Kumar Singh, Zakir Ali, Ashutosh Kumar Singh, Shahanaz Ayub "Dual Band Microstrip Antenna for UMTS/WLAN/WIMAX Applications" IEEE Proc.Communication Systems and Network Technologies (CSNT-2013),Print ISBN: 978-0-7695-4958-3/13, pp- 47 – 50, April-2013, Gwalior, India

[11] Nagraj Kulkarni, S. N. Mulgi, and S. K. Satnoor "Design and Development of Triple Band Tunable Microstrip Antenna" Microwave and Optical Technology Letters Vol. 54, No. 3, pp 614-617March 2012.

[12] Avisankar Roy and Sunandan Bhunia, "Compact Broad Band Dual Frequency Slot Loaded Microslot Patch antenna with Defecting Ground Plane for WI-MAX and WLAN", IJSCE, ISSN: 2231-2307, Vol.1, Issue-6, January -2012.

[13] Saurabh Jain, Vinod Kumar Singh, Shahanaz Ayub, "Bandwidth and Gain Optimization of a Wide Band Gap Coupled Patch Antenna",IJESRT, ISSN: 2277-9655, March 2013.

[14] Vinod Kumar Singh, Zakir Ali, A. K. Singh, Shahanaz Ayub "Dual band triangular slotted stacked microstrip antenna for wireless applications" Central European Journal of Engineering (CEJE), Springer ISSN: 1896 1541Volume 3, Issue 2, pp 221-225 June, 2013.

[15] Stuti Srivastava, Vinod Kumar Singh,Zakir Ali, Ashutosh Kumar Singh,"Duo Triangle Shaped Microstrip Patch Antenna Analysis for WiMAX lower band Application" Procedia Technology Elsevier 10 pp-554 – 563, 2013

[16] Sarvesh Kumar Bhartiya, Vinod Kumar Singh, Rajeev Shankar Pathak, "Design of broadband circular patch microstrip antenna with plus slot for WLAN and WiMAX Application" International Journal of Applied Physics Letter, ISSN (Online) : 2349-1108, Vol 1, Issue 1,pp-57-60, 2014.

◈◈◈