International Journal of Engineering Research in Electronic and Communication Engineering (IJERECE) Vol 2, Issue 12, December 2015

Bandwidth Enhancement of Multi band Microstrip Patch Antenna

[1] Pavan Kumar Shandilya, [2] Poonam Sinha
[1] PG Student [MMW], [2] HOD,
Department of Electrical and Communication Engineering,
UIT, Barkatullah University, Bhopal, [MP]
[1]pavanshandilya14@gmail.com, [2] poonamuit@yahoo.com

***Abstract-* — Microstrip patch antenna is versatile field of antenna theory. A special antenna design that improves electrical performance and sustainability is described here. A single feed compact microstrip patch antenna with resonant frequency 4 GHz is proposed in this paper for two geometries. The proposed antenna design of different geometries (i.e. Rectangular and circular). The simulation results are : For rectangular geometry return loss of -38.86 dB ,VSWR = 1.023 at 5 GHz, and 28% impedance bandwidth at 4.5 – 6 GHz and for circular geometry return loss of -19.54 dB ,VSWR = 1.236 at 7 GHz and 25% impedance bandwidth at 6.2 - 8 GHz.**

***Index Terms*— IE3D simulator, Rectangular antenna, Circular antenna, coaxial probe feed, Return loss, bandwidth**

I. INTRODUCTION

Micro strip patch antenna was proposed in early 1970 and it provides a great revolution in the field of proposed antenna. The antennas were designed for the application of satellite communication that uses frequency of 4GHz as per IEEE standards [11]. Nowadays, microstrip patch antennas has very popular and widely used in various applications [4] that is communication systems, because of its robustness, planar profile, low profile low cost, easy of fabrication and compatibility with integrated circuit technology[1][7]. Different geometries of microstrip patch antenna have been investigated by the researchers. In this paper we have analyzed all the three geometries and try to find out at which feed point geometries will give better return loss, VSWR, efficiency and bandwidth for our detected feeding point, we have checked out all remaining parameters. The proposed antenna is fabricated on an FR4 substrate using IE3D simulator which is based on method of moment [2][3] [10].

II. ANTENNA DESIGN

A. For Rectangular Geometry

The electric field lines in the reception apparatus for the most part move in the substrate and even a bit out of the substrate in the air thus the value of effective dielectric constant (ε_{reff}) is slightly less than that of ε_r. In this communication, a dual U-slot micro strip antenna operating at the 4 GHz [1][4]-[6][9].

The Calculation of the Width (W):

$$W = \frac{C}{2f_0 \frac{\sqrt{\varepsilon r+1}}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

The Calculation of effective dielectric constant ($\varepsilon reff$):

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

The Calculation of effective length ($Leff$):

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

The calculation of length extension (ΔL):

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.30)(\frac{w}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{w}{h}+0.8)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\text{(4)}$$

The calculation of actual length of patch (L):

$$L = L_{eff} - 2\Delta L \quad \ldots\ldots\ldots\ldots\ldots\ldots\text{(5)}$$

The calculation of ground plane dimension (Lg and Wg):

$$Lg = 6h + l \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(6)}$$

$$Wg = 6h + w \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(7)}$$

Taking Resonant frequency of 4 GHz, h= 1.5mm, $\mathcal{E}$r= 4.3 ,L=17.6mm, W=23mm, Lg=26.6mm, Wg= 32mm and loss tangent=0.019

B.For Circular Geometry

The dielectric constant is same as that of above case. This model can be further extended to compute the equivalent dielectric constant of circular microstrip patch antenna [9] using an equivalency relation between a rectangular patch of width and length. In this a U-slot microstrip patches antenna operating at the 4 GHz [1][4][8].

Effective radius is given by:

$$a_e = \{1 + \frac{2h}{\pi \varepsilon_r a}\left[\ln\left(\frac{\pi a}{2h}\right) + 1.7726\right]\}^{1/2} \quad (1)$$

Where

$$a = \frac{F}{\{1+\frac{2h}{\pi\varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\}^{1/2}} \quad (2)$$

$$F = \frac{8.791\times10^9}{fr\sqrt{\varepsilon_r}} \quad (3)$$

Taking Resonant frequency of 4 GHz, h=1.5mm, ε_r= 4.3, a= 8.976mm, a_e = 11.20mm, f=10.59mm and loss tangent=0.019.

III. PROPOSED ANTENNA GEOMETRY

A. *For Rectangular Geometry*

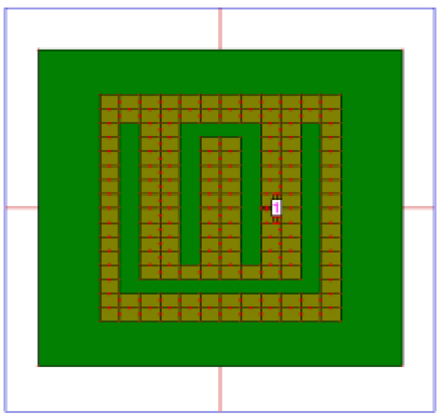

Fig.1 Rectangular Geometry of proposed antenna

S.No.	Parameter	Unit
1	Dialectical Material	FR4
2	Substrate Height	1.5mm
3	Loss Tangent	0.019
4	Dielectric Constant	4.3
5	Resonant frequency	4 GHz
6	L	17.6 mm
7	W	23 mm
8	Lg	26.6mm
9	Wg	32mm

Table 1: Dimensions of proposed rectangular microstrip patch antenna

B. *For Circular Geometry*

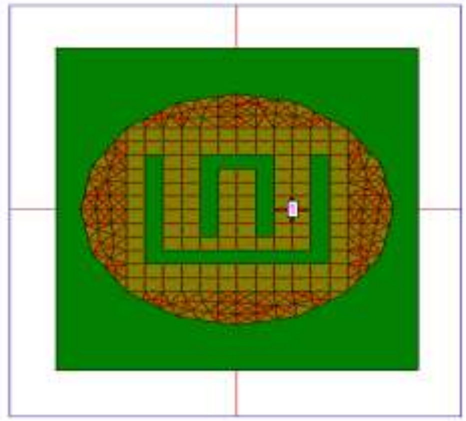

Fig.2 Circular Geometry of proposed antenna

S.No.	Parameter	Unit
1	Dialectical Material	FR4
2	Substrate Height	1.5mm
3	Loss Tangent	0.019
4	Dielectric Constant	4.3
5	Resonant frequency	4 GHz
6	L	17.6 mm
7	W	23 mm
8	Ae	11.20mm
9	A	8.976mm
10	F	10.59mm

IV. SIMULATED RESULTS

A.Simulated Results For Rectangular Geometry

The reproduced aftereffects of proposed reception apparatus are appeared in Fig. by using IE3D simulator. The return loss is – 38.86dB achieved at 5 GHz with is VSWR less than 2.

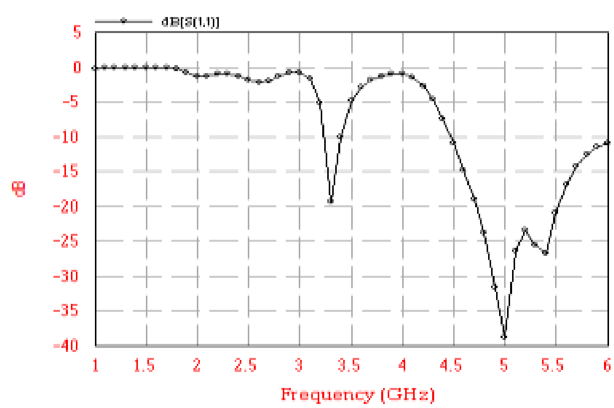

Fig.3 Simulated return loss of proposed rectangular antenna

The simulated result of proposed antenna show that the VSWR is1.023 at 5 GHz.

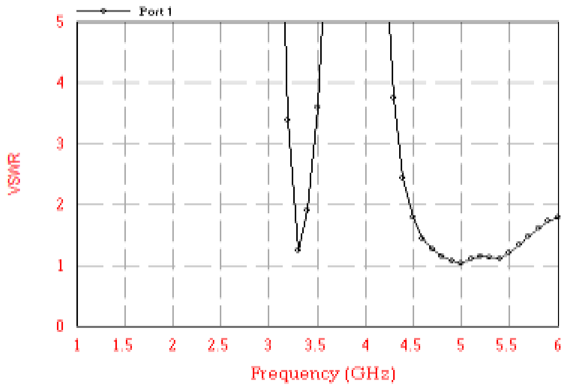

Fig. 4 VSWR of proposed rectangular antenna

B.Simulated Results For Circular Geometry

The simulated results of proposed antenna are shown in Fig. by using IE3D simulator. The return loss is – 19.54dB achieved at 7 GHz with VSWR less than 2.

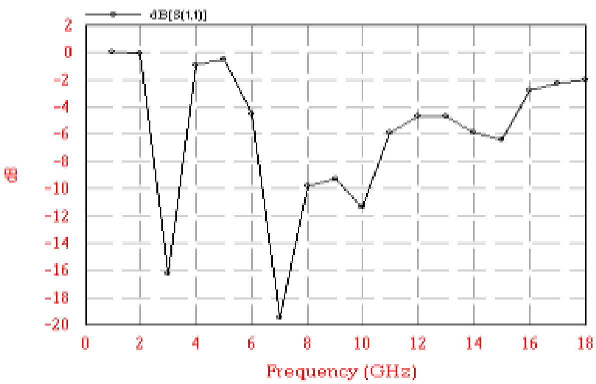

Fig. 5 Simulated return loss of proposed circular antenna.

The recreated after effect of proposed antenna appears that the VSWR is 1.236 at 7 GHz.

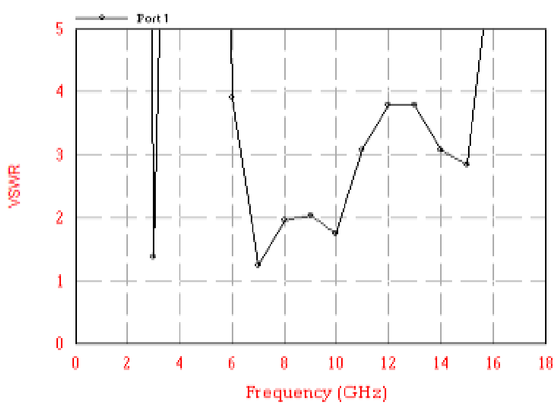

Fig.6 VSWR of proposed circular antenna

V. CONCLUSION

Both geometries of patch antenna are investigated and results are found to be best in case of rectangular microstrip patch antenna. However the supply positions which produce the important results be positioned on rectangular microstrip patch. In circular geometry the results are not good as in case of rectangular microstrip patch antenna. The proposed Rectangular microstrip patch antenna return loss of -38.86 dB with VSWR is 1.023, Gain of 2.94 dBi, Efficiency of about 82% at 5 GHz *and 28% impedance bandwidth at 4.5 – 6 GHz* with VSWR less than 2 and Circular microstrip patch antenna has return loss of -19.54 dB with VSWR is 1.236, Gain of 3.604 dBi, Efficiency of about 74% at 7 GHz and *25% impedance bandwidth at 6.2 - 8 GHz* with VSWR less than 2.

REFERENCES

[1] Ahmed Khidre, Kai-Fong Lee, Atef Z. Elsherbeni, and Fan Yang, "Wide Band Dual Beam U-Slot Microstrip Antenna", IEEE Transaction on Antenna and propagation , vol. 61, no. 3, pp. 1415-1418, March 2013.

[2] S Bhunia "Effects of Slot Loading on Microstrip Patch Antennas", International Journal of Wired and Wireless Communications Vol.1, Issue 1, October, 2012

[3] Amber Haidery, Reshma Tawde, Tazeen Shaikh,"l- Slot Rectangular Microstrip Patch Antenna for WiMAX and WLAN Application" International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 10, October 2013.

[4] Kumari Nidhi Lal , Ashutosh Kumar Singh "Modified Design of Microstrip Patch Antenna for WiMAX Communication System"

[5] D.M. Pozar, Microwave Engineering. New York: Addison- Wesley, 1990, P.185.

[6] C. A. Balanis, Antenna theory: Analysis and Design. New York: Wiley, 1997, p. 734.

[7] Kai-Fong Lee, Fellow IEEE, and Kin-Fai Tong, Member IEEE "Microstrip Patch Antennas Basic Characteristics and Some Recent Advances"

[8] Kaushik Mandal and Partha Prtim Sarkar" High Gain Wide-Band U-Shaped Patch Antennas With Modified Ground Planes", IEEE Transactions on Antenna and Propagation ,vol. 61, no.4,pp.2279-2282,April 2013.

[9] Teruhisa Nakamura and Takeshi Fukusako, "Broadband Design of Circularly Polarized Microstrip Patch Antenna Using Artificial Ground Structure With Rectangular Unit Cells" IEEE Transactions on Antenna and Propagation, VOl. 59, no.6,pp.2103-2110, June 2011.