Design of Micro-strip star patch Antenna for WLAN/Bluetooth Application

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Abstract— This paper presents a micro strip star patch antenna on a FR4 substrate (glass epoxy) having thickness of 3.2mm. This antenna consists of a star shape radiating patch along with a partial ground plane. Two equilateral triangles of same dimensions (30x30 mm) are mounted to get a star shaped patch. The star patch and the ground plane is made up of conducting material (copper). The star patch is excited using a micro-strip feed line from the edge of the patch which results in enhanced bandwidth. Antenna parameters such as return loss; radiation pattern; gain & Voltage Standing Wave Ratio (VSWR) are investigated. The proposed antenna has high gain at 2.4GHz frequency. This antenna finds application in Wireless Local Area Network (WLAN) and Bluetooth. Advanced Design System (ADS) software is used to model and simulate this micro-strip patch antenna.

Keywords— Antenna; Micro strip star patch; Probe feed; ADS software; Return loss; Radiation pattern; VSWR.

INTRODUCTION

The rapid development of wireless communication systems and the subsequent burst of wireless devices place several demands on the antenna designs. Compared to conventional microwave antennas, Microstrip antennas (also known as Printed antennas) have several advantages, and therefore various applications cover the broad frequency range from 100MHz to 100GHz [1]. Microstrip antennas are characterized by a large number of physical parameters and they can be designed to have numerous geometric shapes and dimensions. A Microstrip Patch Antenna (MPA) consists of a radiating patch of any planar or non-planar geometry on one side of the dielectric substrate with ground plane on other side. Various patch configurations such as square, annular-ring, ellipse, rectangular, equilateral triangular and dipole have been investigated for past few years [2][6].

These patch antennas possess many desirable features like low profile, light weight, relatively inexpensive to manufacture, thin profile configuration , linear and circular polarization are possible with simple feed and can be easily integrated with microwave integrated circuits. These antennas have excellent low power handling capacity and hence they can be used in low power transmitting and receiving applications. These features make microstrip patch antennas useful for many applications in radar and wireless communication systems [7][10].

Besides having more advantages, one of the principal limitations of such microstrip patch antennas is their very narrow bandwidth, which is on the order of a few percent and low directive gain. Many techniques have been suggested to enhance the impedance bandwidth of microstrip antennas. Among the various patch configurations available the equilateral triangle patch has more advantages. They occupy less metalized area on the dielectric substrate than other existing configurations and a low radiation loss.

In this paper two equilateral triangles of same dimensions are considered and are placed one above the other to get a star shape patch [11][15]. The star shape radiating patch is energized by probe-feed line. Microstrip line feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is simple to model and easy to match by controlling the inset position. The modified equilateral triangle patch in the form of star is simulated using ADS momentum software. The results obtained in accordance with the proposed antenna are given below. The designed antenna has high gain at the frequency 2.4GHz respectively.

ANTENNA GEOMETRY

Figure.1 shows the structural view of equilateral triangular patch of dimension 30mm.Two equilateral triangles of same dimensions (30mm) are considered. The star shaped patch is formed by inverting and adding these two equilateral triangles of same dimensions as shown in figure 2.

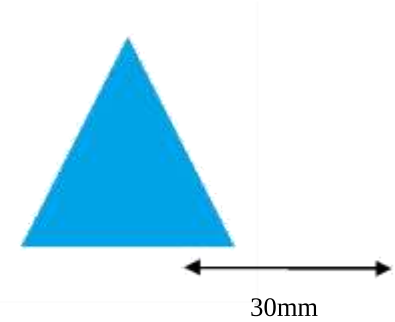


Figure: 1 Equilateral triangle

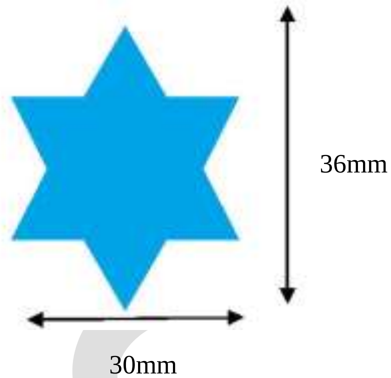


Figure 2: Star shaped patch

Figure3: shows the antenna with patch size of 30mm × 36mm with substrate size of 38mm × 48mm is preferred in this design. A microstrip probe-feed line of 0.5mm × 13.7mm is used to energize the radiating patch. The dimension of the ground plane is 17.5mm × 11.5mm. Star patch and ground plane is made up of copper. The antennas are printed on one side of a FR4 Epoxy substrate of thickness *3.2* mm, relative permittivity ε_r= 4.*4* and loss tangent tan ± = 0*:*019.

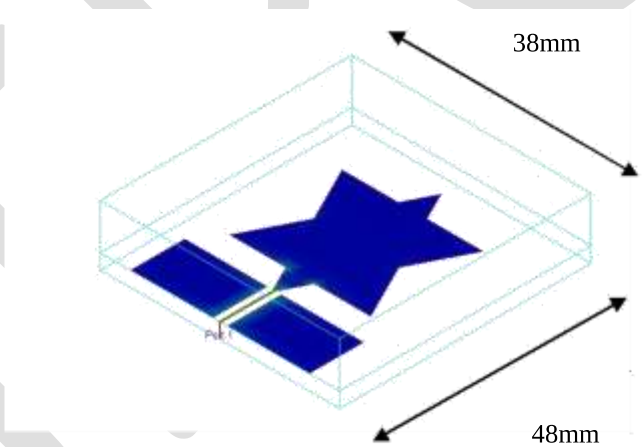


Figure 3: 3D representation of simulated antenna

RESONANT FREQUENCY

The resonant frequency of the microstrip star patch antenna can be determined from the empirical formula is given in equation (1)

$$f_r = \frac{2c}{3a_{eff}\sqrt{\epsilon_{eff}}} \qquad (1)$$

Where,

f_r = Resonant frequency(GHz)

c = Velocity of light (3×10^{-8} ms^{-1})

Equations (2) and (3) are used to calculate the side length of the equilateral triangle and relative permittivity of the substrate effectively.

$$a_{eff} = a + \frac{h}{\sqrt{\epsilon_r}} \quad (2)$$

Where,

a_{eff} = Effective side length of the equilateral triangle(mm)

$$\epsilon_{eff} = \frac{1}{2}(\epsilon_r + 1) + \frac{1}{4}\frac{(\epsilon_r - 1)}{\sqrt{1 + \frac{12h}{a}}} \quad (3)$$

Where,

ε_r = Substrate relative permittivity

ε_{eff} =Effective relative permittivity

a =Side length of the equilateral triangle(mm)

h =Height of dielectric substrate (mm)

SIMULATED RESULTS

Figure 4 shows the Voltage Standing Wave Ratio (VSWR) plot against the frequency in terms of GHz. The proposed star patch antenna has a value of 1.181 at 2.4GHz. Figure 5 shows the plot of return loss (dB) against the frequency(GHz).The value of S_{11} at 2.4 GHz is -21.592dB. Figure 8 and 9 shows the radiation pattern of the star patch antenna.

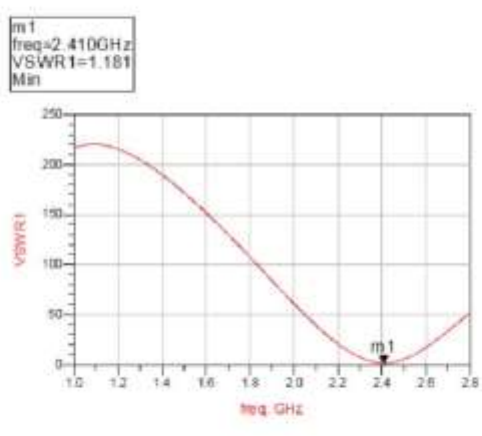


Figure 4: Voltage standing wave ratio (VSWR)

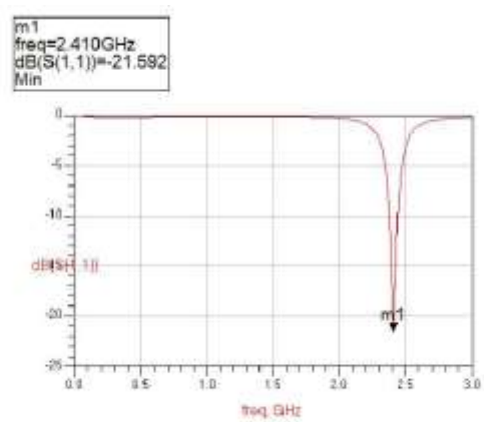
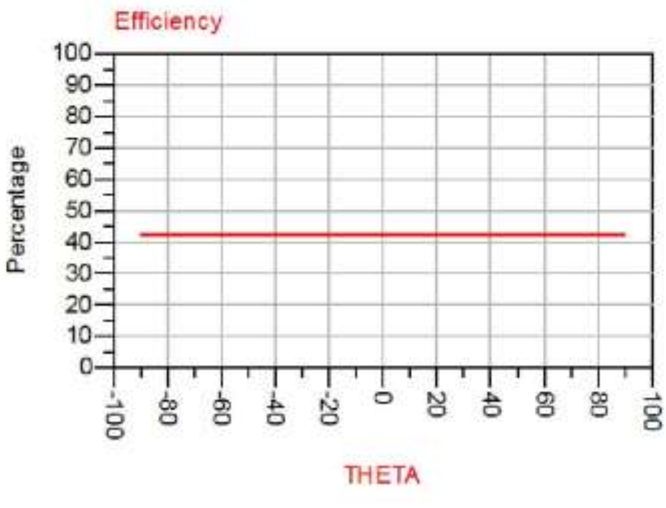


Figure 5: Return loss (S_{11})



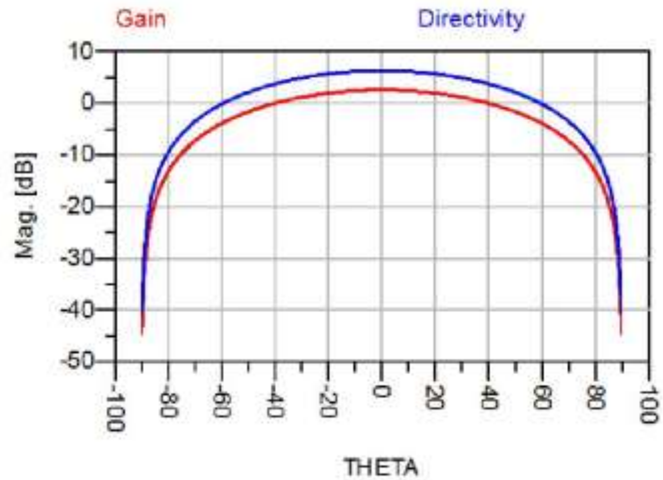


Figure 6: Efficiency of the star patch antenna

Figure 7: Gain and Directivity of the star patch antenna

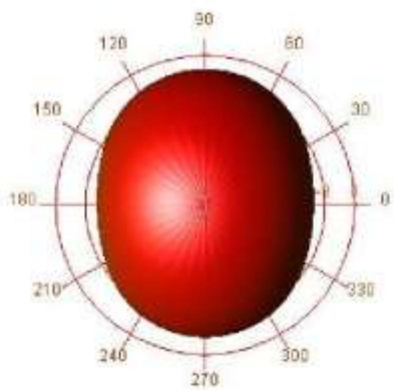


Figure 8: Radiation pattern (E)

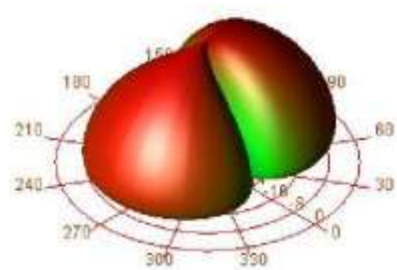


Figure 9: Radiation pattern (E- Theta)

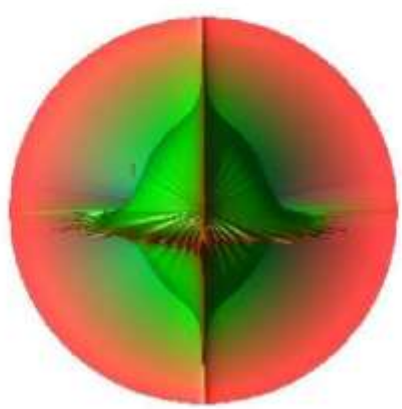


Figure10: Circular axial ratio

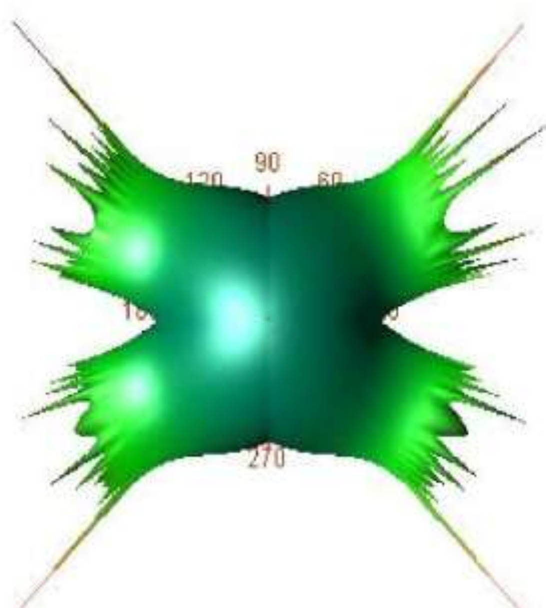


Figure11: Linear axial ratio

CONCLUSION

The compact microstrip star patch antenna with a probe-feed line is presented. A partial conducting ground plane was used to enhance the bandwidth of the antenna. The design and simulated results were performed using ADS software. Antenna parameters such as return loss, VSWR, gain, directivity and radiation pattern are shown in the figures achieves relatively high gain. This antenna is applicable for various wireless applications like Bluetooth, Wireless Local Area Network (WLAN).

REFERENCES

1. Microstrip Antenna Design Handbook I. J. Bahl and P.Bhartia, Dedham,MA:Artech House ,1980.
2. Balanis, C.A., Antenna Theory: Analysis and Design, John Wiley & Sons, Inc, 1997.
3. ―Broadband Microstrip Antennas‖ Girish Kumar K. P. Ray
4. James, J. R., Hall, P. S., and Wood, C., ―Microstrip Antenna: Theory and Design,‖ IEEE electromagnetic Waves, Series 12
5. (London: Peter Peregrinus), 1986.
6. Zucher, J.-F., and Gardiol, F. E.,Broadband Patch Antennas, Artech House, 1995.
7. Stutzman, W.L. and Thiele, G.A., Antenna Theory and Design, John Wiley & Sons, Inc, 199
8. Ramesh Garg, PrakashBartia, InderBahl, ApisakIttipiboon, ―Microstrip Antenna Design Handbook‖ , 2001, pp 1•]68, 253•]316 Artech House Inc. Norwood, MA.
9. Wentworth M. Stuart (2005), ―Fundamentals of Electromagnetic with Engineering Applications‖, pp 442-445, John Wiley & Sons, NJ, USA.
10. J. D. Kraus, R. J. Marhefka, ―Antenna for all applications‖ third Ed., McGraw- Hill, 2002.
11. Robert A. Sainati, CAD of Microstrip Antennas for Wireless Applications, Artech House Inc, Norwood, MA, 1996.
12. Design and full-wave analysis of super shaped patch antennas by VasilikiParaforou November 2013 Microwave Sensing, Signals and Systems Group Faculty Electrical Engineering, Mathematics and Computer Science Delft University of Technology,Delft, The Netherlands.
13. Design of a Dual PatchTriangularMicrostrip Antenna By S. H. Al-Charchafchi, W .K. Wan Ali, M. R. Ibrahim and S. R. Barnes Cranfield College of Aeronautics, Cranfield University.
14. Equilateral Triangular Micro strip Patch Antenna Using Different Substrates Rajuverma, NamrataDewangan Student Member of IEEE, RCET Bhilai(C.G.),India , Asst. Prof. RCET,Bhilai (C.G),India.
15. Miniaturization of Equilateral Triangular Microstrip Patch Antenna using Parallel Slotting Technique 1S.R.Chowdhury, 2Dr.
16. S.Basu1,2Dept. of ECE, Kalyani Government Engineering College, West Bengal, India.
17. Design of wideband equilateral triangle microstripantennas , G M Pushpanjali, R B Konda, S N Mulgi, S K Satnoor, P M Hadalgi& P V Hunagund, Department of Applied Electronics, Gulbarga University, Karnataka , India