Novel Star Shaped Microstrip Patch Wideband Antenna for Wireless Applications

Revanasiddappa Kinagi
Department of E & CE
SUK, Kalaburagi, India

Vilaskumar Patil
Department of E & CE
SUK, Kalaburagi, India

***Abstract*—A novel star shaped patch antenna is obtained by overlapping two orthogonal square patches of 1mm difference in length so that the resonant frequencies are so close enough such that they merge and provide a wide bandwidth microstrip antenna .The proposed antenna is planer in structure which resonates at 5.81 GHz with return loss of -24.7 dB & has a wide bandwidth of 1.69GHz finds suitable applications in parts of C microwave band.**

***Keywords*—Bandwidth, patch antenna; probe feed; WLan; C-Band;**

I. INTRODUCTION

The Microstrip patch antenna cover many applications in wireless communication system for the reason like low profile, light weight, low cost, & mass fabrication [1]. But, microstrip patch antenna presents a narrow bandwidth. Diverse techniques have provided to enhance bandwidth of the antennas. Suitable methods comprise implementation of thick substrates, usage of parasitic elements, either in same plane/stacking configurations, applying slots on the patch or the inclusion of slots in the ground plane [2-4]. Lately, high-speed devices like wireless computer networks have concerned the awareness of many researchers, particularly the 5-6GHz band. This band can accomodate the frequencies of high-speed devices such as wireless computer networks (e.g., IEEE 802.11a) [5] .Such networks offer high-speed service (>50Mb/s) among notebook computers, PCs, and many other wireless digital devices. Even though current 5GHz wireless computer network systems work in the 5.15–5.35GHz band, upcoming devices can utilize the 5.725–5.825GHz band along with 5.15–5.35GHzband, for very high data rates. In addition, an antenna with a large operating band is more apppropriate to service in complex channels, namely buildings, hospitals, & airports, where the EM propagations are affected by multiple scattering processes [6-7]. As a result, additional improvement of the performance of microstrip patch antennas required to cover the challenging bandwidth requirement becomes essential.

In the paper, efforts have been put to obtain the wideband Rectangular Microstrip patch Antenna(RMA). The proposed antenna is studied using Mentor graphics 3DEM simulation environment. A parametric study of patch lengths and feed position is carried out so as to obtain an optimal designed antenna.

II. ANTENNA DESIGN

The procedure for desigining rectangular microstrip patch antenna will be carried out on the basis of transmission line model proposed by Munson .The choice of the substrate material is the first important step in the successful design of microstrip antennas (MSAs). For the selected substrate, the major electrical properties considered are relative dielectric constant (εr) & loss tangent (tanδ). A large dielectric constant provides a small patch, which diminishes impedance bandwidth as well as it leads to tighter fabrication tolerances. A greater loss tangent decreses antenna efficiency and increases feed loss. The substrate thickness (h) is selected as large as feasible to enhance impedance bandwidth and efficiency of antenna but not so large as that result in surface waves. The use of large dielectric constant substrate material will reduce radiation loss since EM field is concentrated in dielectric sandwitched between conductive copper strip and ground plane. The value of h is selected as per the equation,

$$h \leq \left(\frac{0.3c}{2\pi f_0 \sqrt{\varepsilon_r}} \right)_{cm} \qquad (1)$$

Where c is the speed of light in cm & f_0 is maximum operating frequency in GHz.

A. *Design of RMA*

The design of RMA is given. For the known values of εr, h, resonant frequency fr and λ_0, the design of RMA is as follows.

- **Design of elemental width (W):**

The elemental width of RMA is

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}\ \text{cm} \qquad (2)$$

- **Design of extension length (Δl):**

The extension length Δl is usually deducted from the calculated length L of RMA to retain actual length of the antenna. The extension length virtually appears due to fringing fields as

$$\Delta l = 0.412h \left(\frac{(\varepsilon_e + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_e - 0.258)\left(\frac{W}{h} + 0.8\right)} \right)_{cm} \qquad (3)$$

where εe is the effective dielectric constant. It is calculated by using the formula

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + 12\frac{h}{W}\right)^{-\frac{1}{2}} \qquad (4)$$

- **Design of elemental length (L):**

Once the extension length (Δl) and effective dielectric constant (εe) are determined using the above equations (3) and (4) then the elemental length of RMA is found by using the equation.

$$L = \frac{c}{2f_r\sqrt{\varepsilon_e}} - 2\Delta l \quad \text{cm} \qquad (5)$$

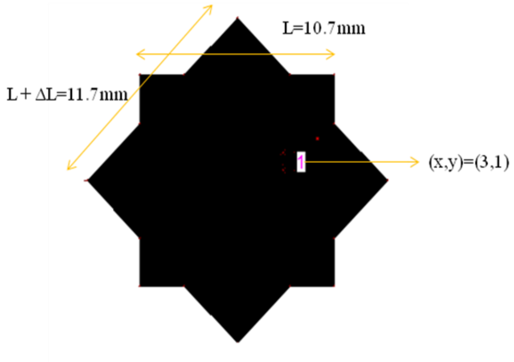

Fig. 1 Design of star shaped antenna

Design of star shaped antenna is carried out by taking 2 orthogonal patches overlapped on one another of length 10.7mm and 11.7 mm, height of the substrate is 3mm, dielectric constant 10.7 and loss tangent of 0.0004.The feed location of coaxial probe is (3,1) from the origin here the centre of the patch is taken as origin which is shown in the Fig 1.

III. RESULTS AND DISCUSSIONS

For the star shaped the return loss is shown in Fig 2 from which we can observe that the return loss is -24.7dB at 5.81GHz and covers bandwidth from 4.92 GHz to 6.61 GHz leading for a wide bandwidth .

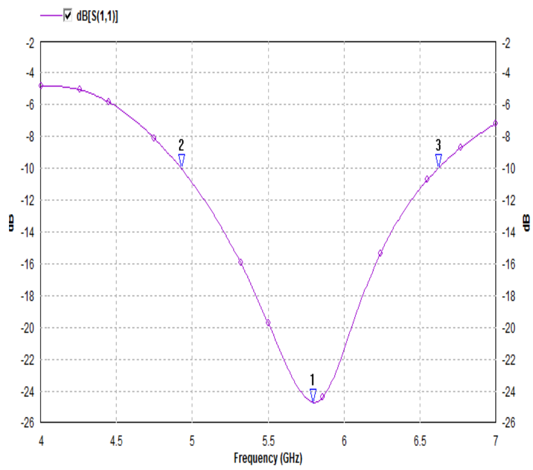

Fig. 2 Return loss of star shaped antenna

Further the pattern of the radiation is stable for the entire band of operation. Pattern of radiation of 4.92 GHz,5.81GHz and 6.61GHz are shown in the Fig (3),(4) and Fig(5) and found to be of broadside in nature.

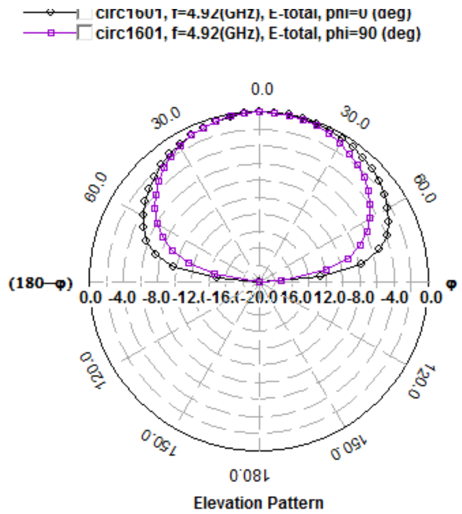

Fig. 3 Pattern of radiation at frequency 4.92GHz

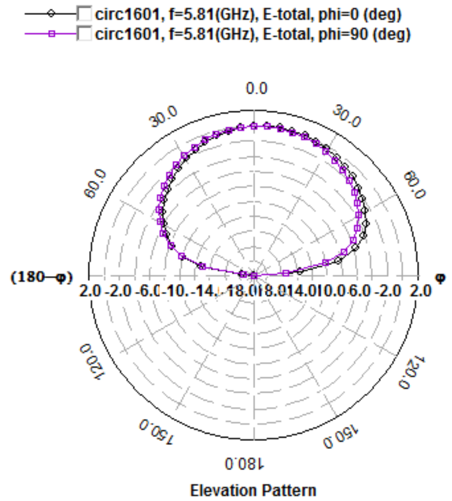

Fig. 4 Pattern of radiation at frequency 5.81GHz

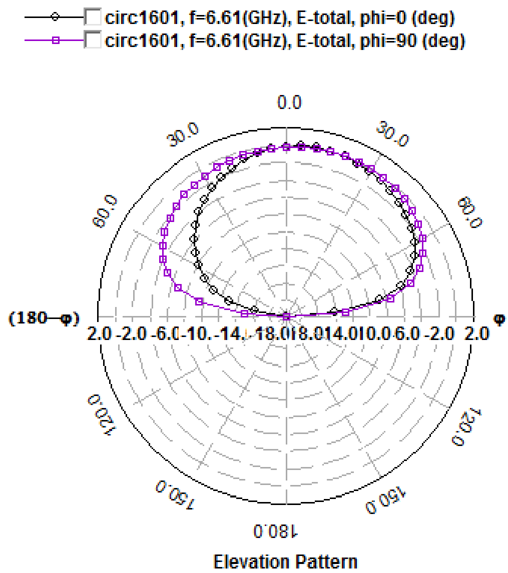

Fig. 5 Pattern of radiation at frequency 6.61GHz

IV. CONCLUSION

A star shaped antenna is designed and simulation is carried out. It has been observed that this antenna gives a wide bandwidth coverage because the two frequency are close enough to merge and results in wide band. The radiation patterns of all proposed antennas are of broadside in nature.

ACKNOWLEDGMENT

I would like to thank Chancellor, Vice-chancellor and all the office bearers of Sharnbasva University and Chairman of E&CE department for their support.

REFERENCES

[1] C. A. Balanis, Antenna Theory_Analysis and Design. John Wiley & Sons, New Jersey, third edition, 2005.
[2] S. Baligar, U. K. Revankar and K. V. Acharya "Broadband stacked annular ring Coupled shorted Circular microstrip antenna", Electronic Letters., Vol. 36, No.21, pp 1756-1757, Oct 2000.
[3] J. S. Baligar, U. K. Revankar and K. V. Acharya "Broadband two layer Shorted patch Antenna with low cross polarization." Electronic Letters. Vol. 37, No.9, pp 547-548, April 2001.
[4] Amit A. Deshmukh and Girish Kumar "Compact broadband Gap-coupled Square ring and W-shaped Microstrip antennas", International RADAR Symposium,. pp 853-861, India- 2001.
[5] R. Garg, P. Bhartia, I. Bahl,, A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, Boston-London, 2001.
[6] J. Burbank, J. Andrusenko, J. Everett, and W. Kasch, Wireless Local Area Networks, Wiley-IEEE Press, New York, NY, USA,2013.
[7] P. Bernardi, R. Cicchetti, and O. Testa, "An accurate UTD model for the analysis of complex indoor radio environments in microwave WLAN systems," IEEE Transactions on Antennas and Propagation, vol. 52, no. 6, pp. 1509–1520, 2004.