ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 19, April 2016

E-SHAPE MIMO ANTENNA FOR WLAN APPLICATION

[1]C.V.Umamaheswari, [2]C.V.Ravisankar

[1]Assistant professor, Department of ECE, [2]Assistant professor, Department of ECE,
[1] Kings Engineering College, [2]MadhaEngineeringCollege,
[1] umamaheswarisivagami@gmail.com

***Abstract*-In this project, a new compact 2*2 MIMO antenna is proposed to improve the gain and directivity. This antenna consists of two E-shaped patches and these two E-shaped patches have been arranged at orthogonal to each other, to reduce the mutual coupling with lesser spacing between the elements. The E-shaped antenna array elements are separated by 7mm and this antenna resonates at the frequency of 5.8GHz and having the VSWR value of less than or equal to 2. The proposed antenna is suitable for WLAN application.**

***Keywords:* E-shape patch, Gain, Directivity, VSWR, Mutual coupling.**

1. INTRODUCTION

Microstrip or patch antennas are most preferred antennas because they can be printed directly onto a circuit board. Microstrip antennas are becoming very popular within the mobile phone market these antennas are low cost, have a low profile and are easily fabricated [1]. The general microstrip antennas suffer from narrow bandwidth, which limits their application in modern communication systems like MIMO.

MIMO technology gained popularity in wireless communications as they offer significant data throughput and link range without additional bandwidth or increased transmit power. Also they achieve array gain that improves the spectral efficiency and diversity gain that improves the link reliability with reduced fading .Because of these properties, MIMO is an important part of modern wireless communication standards such as IEEE 803.11 in (Wi-Fi), 4G, 3GPP Long Term Evolution, Wi-MAX and HSPA+.

The main parameter regarding MIMO systems is mutual coupling, which depends on the distance between the elements in a MIMO system. If the distance is more, the mutual coupling between antennas becomes less and vice versa. Hence, by increasing the distance between the elements we can reduce the mutual coupling between the antennas. However, the distance between the antennas cannot be maintained too large, since MIMO systems have their major applications in Mobile terminals, laptops, and WLAN Access Points Wireless communications, where size of the device can't be maintained too large. The main source of mutual coupling is surface current flowing through ground in order to reduce these, there are several techniques like Electromagnetic band gap structure, defected ground structure, decoupling techniques, *etc*… However, these entire methods make the design of the antenna is complicated.

The E-shaped MIMO antenna provide the mutual coupling is only -22dB[2] and broadband method is provide the mutual coupling is -22.5dB and this method consists of G-shaped antenna [3]. The novel F-shaped printed slot antenna provides the mutual coupling is up to -14dB [5]. The multi slot patch antenna provides the mutual coupling is <-27dB [5].

In this paper, an E patch antenna is proposed with improved gain, directivity and reduced mutual coupling .The designed antenna resonates at 5.8GHz frequency with low VSWR value. In section 2, the proposed antenna geometry is presented for single E-shape patch and in section 3 two element antenna geometry is presented. In section 4 simulation results are presented. The final conclusion of the paper is given in section 5.

2. ANTENNA DESIGN FOR SINGLE E-SHAPED PATCH

E-shaped patch antenna is made by cutting two rectangular shapedslots on the edge of a rectangular patch. The configuration of an E-shaped patch antenna is shown in Fig.1The geometrical parameters are also labelled in the figure. The antenna is fed by a 50ohm coaxial probethrough a SMA connector at position x = 4.4 mm, y=7.15 mm. The ground plane is fixed at

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 19, April 2016

25mm*25 mm, and a 2.6 mm thick Rogers RT/duroid5880 substrate is used.

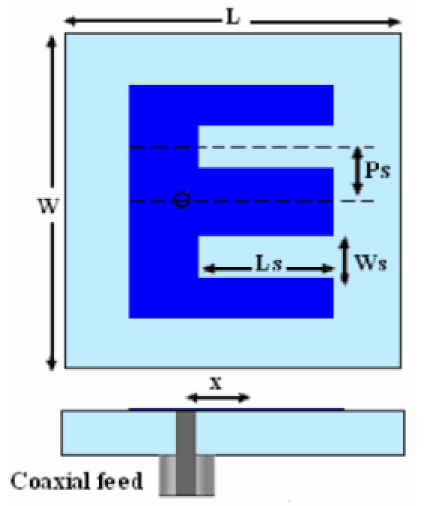

Figure.1 Configuration of an E-shape patch

The patch length is L, the patch width is W, the slots length is Ls, the slots width is $W_s$and the position of slot is Ps. For single E-shaped patch antenna, the return loss at the desired frequencies is optimized using $f = \max(|S11|, \text{at } f = 5.8\text{GHz})$.

Table 1Geometrical parameter for singleE-shaped patch(in mm)

PARAMETER	W	L	L_S	W_S	P_S
E-Shaped patch	15.8	14.3	6.4	3.4	2.95

DESIGN PROCEDURE

1. For an efficient radiator, a practical width that leads to good radiation efficiency

$$w = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{\epsilon_r+1}}$$

2.Determine the effective dielectric constant of microstrip patch antenna.

$$\epsilon_{reff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[1+12\frac{h}{w}\right]^{-1/2}$$

3.Determine the extension of the length ΔL.

$$\Delta L = 0.412h\frac{(\epsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\epsilon_{reff}-0.258)(\frac{w}{h}+0.8)}$$

4. Calculate the actual length of the patch.

$$L = L_{eff} - 2\Delta L$$

Where L_{eff} is the effective length of patch

$$L_{eff} = \frac{1}{2f_r\sqrt{\epsilon_{reff}\sqrt{\mu_0\epsilon_0}}}$$

3. TWO ELEMENT MIMO ANTENNA

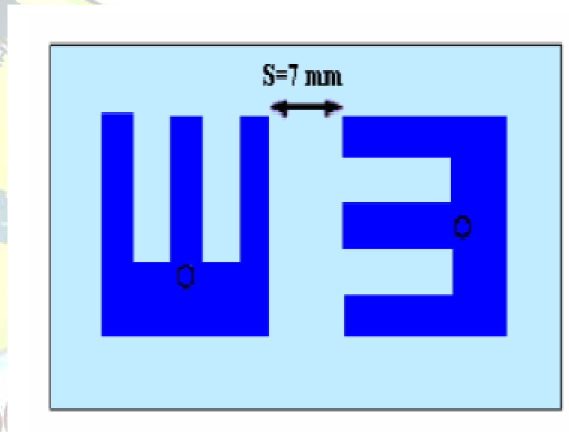

Figure 2 Configuration of two element MIMO

A two-element antenna array is made by using single antenna element and it is shown in figure 1.2. In order to have orthogonal polarization, the two antennas have been arranged at 90 degree angle to each other. The E-shaped antenna array elements are separated by 7mm and dimensions of the E-patches are determined by using the above design equation. Since it is for two element antenna array, our design goal is to improve the isolation between antenna's ports. The mutual coupling between the antennas can be obtained from $S_{ij}$of the scattering matrix.

4. SIMULATION RESULTS

The E-shaped patch antenna is simulated by using Advanced Design System (ADS) software. This simulated single E-shaped antenna has the s_{11} value of -40dB and this antenna is used for 5.8 GHz frequency application.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 19, April 2016

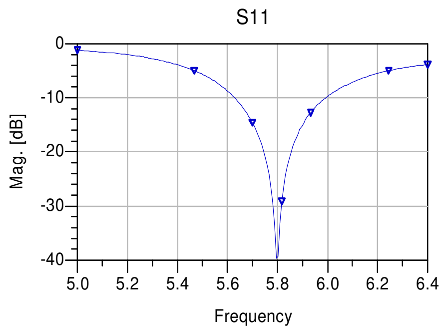

Figure .3 Simulated S_{11} curve for E-shaped patch antenna

The two element E-shaped antenna has the S_{11} and S_{22} value of -24dB that is S_{11} and S_{22} are having the equal value.

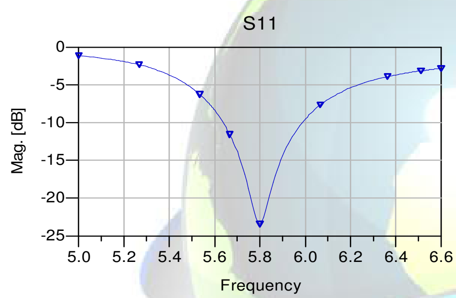

Figure .4 Simulated S_{11} parameter for MIMO

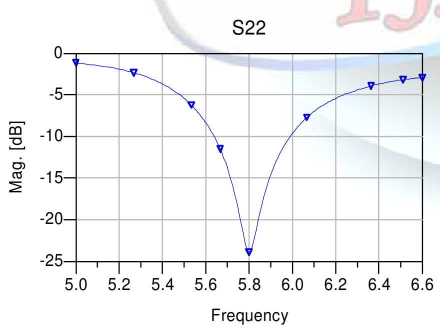

Figure .5 Simulated S_{22}parameter for MIMO

The values of S_{12} and S_{21} are equal that is mutual coupling is reduced to -29.8dB and it is having the low VSWR value. For S_{11} and S_{22} have 1.13 and S_{12} and S_{21} have the 1.06 of VSWR. The proposed antenna is fabricated by using PCB technology and it will be tested by Network Analyser. Network Analyzer is used measure s parameter and radiation pattern of an antenna. Christo Ananth et al.[4] discussed about E-plane and H-plane patterns which forms the basis of Microwave Engineering principles.

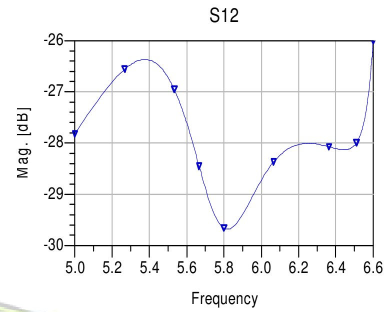

Figure.6 Simulated S_{12} parameter for MIMO

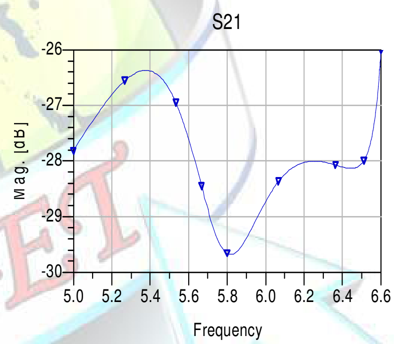

Figure .7 Simulated S_{21} parameterfor MIMO

Figure. 8 photograph of fabricated antenna

E theta E phi

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 19, April 2016

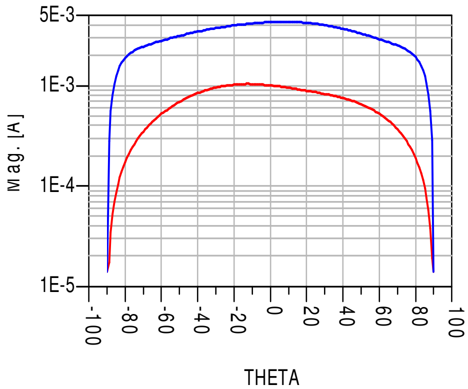

Figure .9 Absolute field for E

H theta H phi

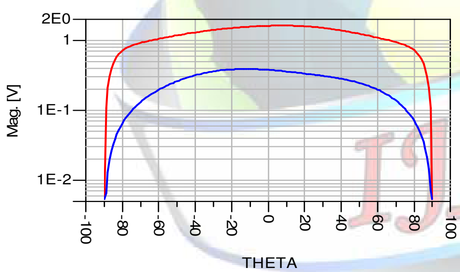

Figure .10 Absolute field for H

The absolute field of E and H are shown in figure .9 and figure.10 respectively. The photograph of fabricated antenna is shown in figure.7.

Gain   directivity

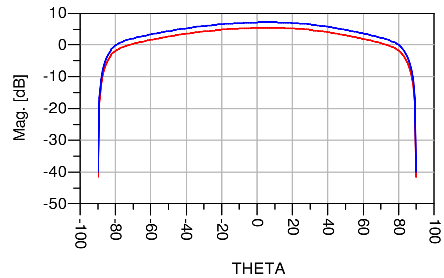

Figure .11 Power

Effective area

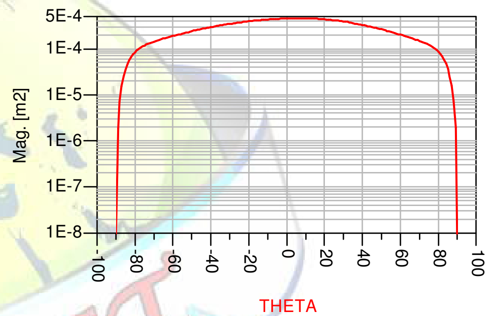

Figure .12 Power

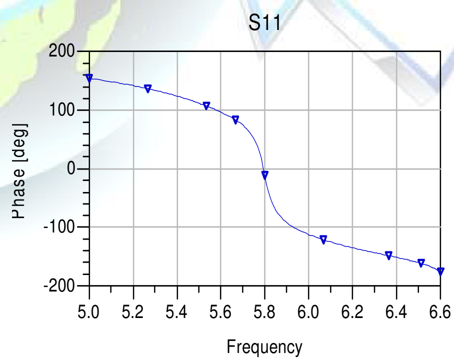

Figure 13 phase plot of S_{11}

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 19, April 2016

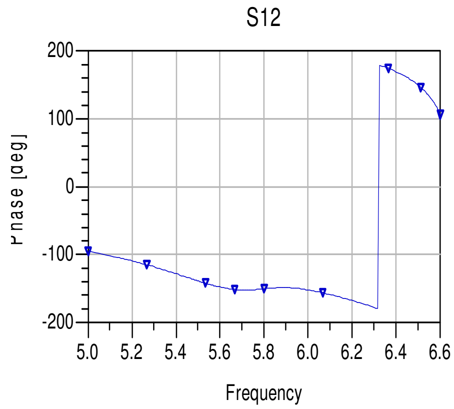

Figure .14 phase plot of S_{12}

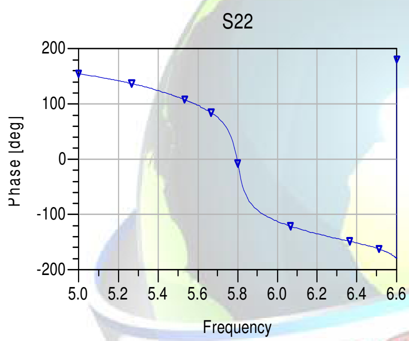

Figure .15 phase plot of S_{22}

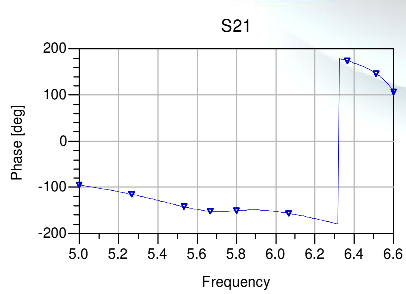

Figure .16 phase plot of S_{21}

The phase plots of simulated S parameters are shown in figure.13, 14, 15 and 16. The phase plots are used to calculate the correlation co-efficient. The formula for calculating correlation co-efficient is,

$$\rho = \frac{|S_{11}^* S_{12} + S_{21}^* S_{22}|^2}{\left(1 - |S_{11}|^2 - |S_{21}|^2\right)\left(1 - |S_{22}|^2 - |S_{12}|^2\right)}$$

RT/Duroid 5880. By using RT/Duroid 5880 material, the value of S_{11} (S_{22})and S_{12} (S_{21}) as -24dB and -29.8dB respectively at resonant frequency of 5.8GHz is achieved. This antenna is suitable for WLAN application. It has the VSWR value of less than 2. The gain and directivity is obtained from the simulation and it has the values of 6.94 dB and 7.72 dB respectively.

5. CONCLUSION

The proposed antenna has low profile, good radiation characteristics, compact size of 15.8mm*14.3mm and enough wide bandwidth to cover 20MHz which is required for the WLAN application. In this project, the design of MIMO E-shape patch is presented. The two antennas have been arranged at 90 degree angle to each other. The E-shaped antenna array elements are separated by 7mm. This antenna is simulated by using the ADS software. It is fabricated by using PCB technology. This antenna is designed with different substrate material, such as FR4, RT/Duroid 5880. By using RT/Duroid 5880 material, the value of S_{11} (S_{22})and S_{12} (S_{21}) as -24dB and -29.8dB respectively at resonant frequency of 5.8GHz is achieved. This antenna is suitable for WLAN application. It has the VSWR value ofless than 2. The gain and directivity is obtained from the simulation and it has the values of 6.94 dB and 7.72 dB respectively.

REFERENCES

[1]. Xing-Xing Xia, Qing-Xin Chu, and Jian-Feng Li ‘DESIGN OF A COMPACT WIDEBAND MIMO ANTENNA FOR MOBILE TERMINALS’ *Progress in electromagnetic s research C.Vol.41,163 174, 2013.*

[2]. Reza karimian, HomayoonOraizi,Seniormember, IEEE, Saeed Fakhte, and Mohammed Farahani ‘Novel F-Shaped Quad-Band Printed Slot Antenna for WLAN and WiMAX MIMO system’ *IEEE antenna and wireless propagation letters, vol.12,2013.*

[3]. K.JagadeeshBabu, Dr.K.Sri Rama Krishna , Dr.LPratap Reddy ‘ A Multi Slot Patch Antenna for 4G MIMO Communications ‘ *International journal of future generation communication and networking vol4 no2,june , 2011*

[4]. Christo Ananth, S.Esakki Rajavel, S.Allwin Devaraj, M.Suresh Chinnathampy. "RF and Microwave Engineering (Microwave Engineering)." (2014): 300.

[5]. Constantine, A.Balanis, ‘ Antenna Theory analysis and design ‘ Willey Student Edition,2006