Square Shaped Mimo Microstrip Patch Antenna For Wireless Applications

[1] Dr.Nagaraj Hanchinamani [2] Mr Ramalingesha Pyati [3] Mamatha L Japate

1 Lecturer Sri Channakeshava Government Polytechnic Bankapur,India
2 Senior Grade lecturer Government Polytechnic, Hanagal, India
3 Lecturer, Government Polytechnic for women Hubli. India

Abstract: This letter presents the design of Square Shaped MIMO Microstrip line feed patch antenna and their 2x1 MIMO implementation for Bluetooth, 4G LTE, WLAN, and WiMAX applications. The proposed antenna consists of modified square shaped patch and microstrip feed line on one side of the substrate, other side on which some rectangular defective ground structure. The proposed antenna in this letter offers improved directivity, bandwidth, and return loss characteristics. The antenna system operates four frequency ranges such as 7.14-7.42GHz, 7.6-8.2GHz, 8.2-8.6GHz, 9.8-10.2GHz frequencies for VSWR≤2. A study was performed to implement in 2x1 MIMO arrangements on the same circuit space have Better mutual coupling and better envelope correlation coefficient are achieved.

Index Terms - Multiple Input Multiple Outputs (MIMO); Wireless Local Area Networks; Long Term Evolution; Worldwide Interoperability for Microwave Access**.**

I. INTRODUCTION

Multiple transmit and multiple receive antennas has emerged as one of the most significant technical breakthroughs in next generation wireless communications. MIMO is considered a key technology for improving the throughput of future wireless broadband data systems; MIMO is the use of multiple antennas at both the transmitter and receiver to improve communication performance. MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without requiring additional bandwidth or transmit power, higher spectral efficiency and reduced fading. Because of these properties, MIMO is an important part of modern wireless communication standards such as IEEE 802.11n (Wifi), IEEE 802.16e (WiMAX), 3GPP Long Term Evolution (LTE), 3GPP HSPA+, 4G and 5G systems to come. In today's environment, technology demands antennas which can operate on different wireless bands and should have different features like low cost, minimal weight, low profile and are capable of maintaining high performance over a large spectrum of frequencies. In next generation networks require high data rate and size of devices are getting smaller day by day. In this evolution three important standards are 4G LTE, WiFi (WLAN) and WiMAX. Wireless local area network (WLAN) and WiMAX technology is most rapidly growing area in the modern wireless communication.

MIMO technique is one of the leading technologies in wireless communication for improving the data rates by using multiple numbers of antennas at the transmitter and receiver side. The upcoming next generation wireless communication methods require larger data rates with high speed, quality of transmission and accuracy. In designing MIMO system, dipole, horn, waveguide slot or microstrip antenna can be used as radiating element. However, microstrip antennas have been proven to be preferable over other types of radiating element due to its compactness and non-electrical characteristic. Microstrip antennas are low profile and lightweight. In terms of fabrication, such system offers easiness, which allows mass production and cost-effective manufacturing as well as high performance [5,6]. However, a normal patch antenna suffers from very narrow bandwidth and this pose a challenge for the engineers to meet the proposed broadband of WiMAX applications.

In this paper present, a spanner shaped patch antenna consists of a microstrip feed line on one side of the substrate, other side on which some rectangular defective ground structure. And their 2x1 MIMO implementation proposed which can be operated frequency range 2.743-11.6 GHz frequencies for VSWR≤2. This is suitable for. The antenna design is simulated using the CST microwave simulator. In section 2, the proposed antenna geometry is presented and in Section 3 the results are presented. The final conclusion of the paper is given in Section 4.

II. ANTENNA DESIGN

The proposed antenna dimension is 35x40mm^2 printed on an FR4 substrate having dielectric constant ε_r= 4.4, a tangent loss of 0.02 and a thickness of 1.6mm and The antenna system operates four frequency ranges such as 7.14-7.42GHz, 7.6-8.2GHz, 8.2-8.6GHz, 9.8-10.2GHz frequencies for VSWR≤2. spanner shaped patch antenna can be constructed by cutting octagonal shape patch and meandering rectangular slots at the center and edges on a octagonal patch as shown in Figure 1. The designed front view and back view of MIMO antenna shown in figure 1 and figure 2 respectively

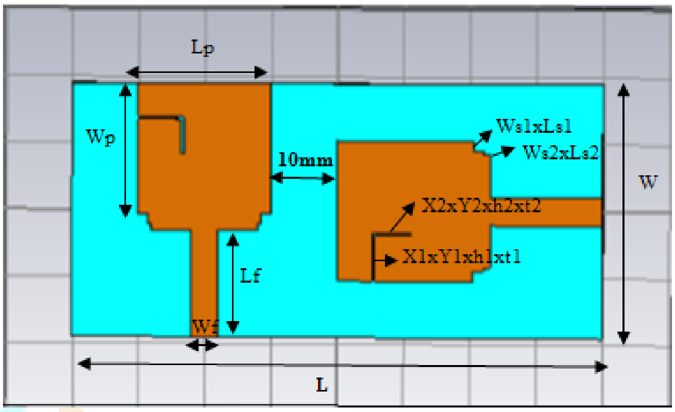


Figure 1 Front view of MIMO antenna

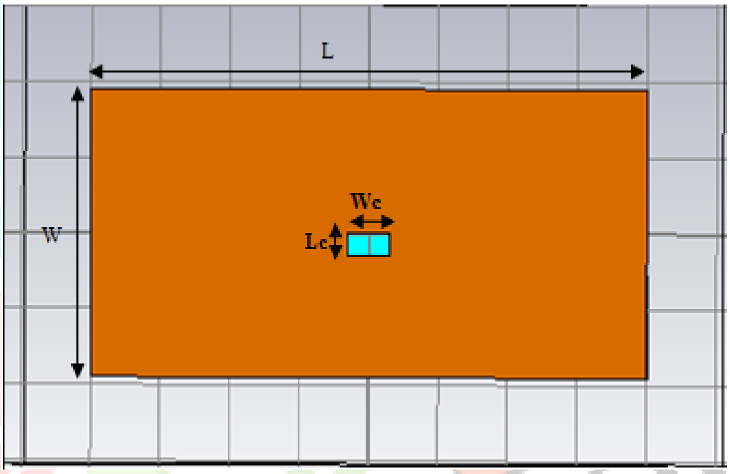


Figure 2 Ground plane of MIMO antenna

For the designing of wideband microstrip patch antenna, the following relationships are used to calculate the dimensions of the wideband microstrip patch antenna. The width of the patch is calculated using the following equation (1)

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Where, W = Width of the patch C= Speed of light ε_r= value of the dielectric substrate

The effective refractive index value of a patch is an important parameter in the designing procedure of a microstrip patch antenna. The radiations traveling from the patch towards the ground pass through air and some through the substrate (called as fringing). Bath the air and the substrates have different dielectric values, therefore in order to account this we find the value of effective dielectric constant. The value of the effective dielectric constant (ε_r) is calculated using the following equation(1)

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

Due to fringing, electrically the size of the antenna is increased by an amount of (ΔL). Therefore, the actual increase in length (ΔL) of the patch is to be calculated using the following equation (1).

$$\Delta L = 0.412h\left[\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}\right]$$

Where h= height of the substrate

The length (L) of the patch is now to be calculated using the below mentioned equation(1).

$$\lambda_g = \frac{c}{f\sqrt{\varepsilon_{reff}}}$$

$$L = \frac{\lambda_g}{2} - 2\Delta L$$

Now the dimensions of a patch are known. The length and width of a substrate is equal to that of the ground plane. The length of a ground plane (Lg) and the width of a ground plane (Wg) are calculated using the following equations (1).

Lg=6h+L

Wg=6h+W

III. RESULTS

The proposed multiband microstrip patch antenna is designed using a CST Microwave studio suit 2015 which works on principle of FIT (Finite Integration Technique). The simulation results of the return loss of the proposed antennas are shown in Figure 3 From the figure we can conclude that the proposed multiband microstrip patch antenna operate frequency range is 2.743-11.6 GHz. The antenna system operates four frequency ranges such as 7.14-7.42GHz, 7.6-8.2GHz, 8.2-8.6GHz, 9.8-10.2GHz frequencies for VSWR≤2. The VSWR of the proposed antenna is presented in the Figure 4.

The VSWR value is observed less than 2 as shown in figure 4. ECC less than 0.05 shown in figure 7 the mutual coupling of proposed antenna is less than -10 dB shown in figure.

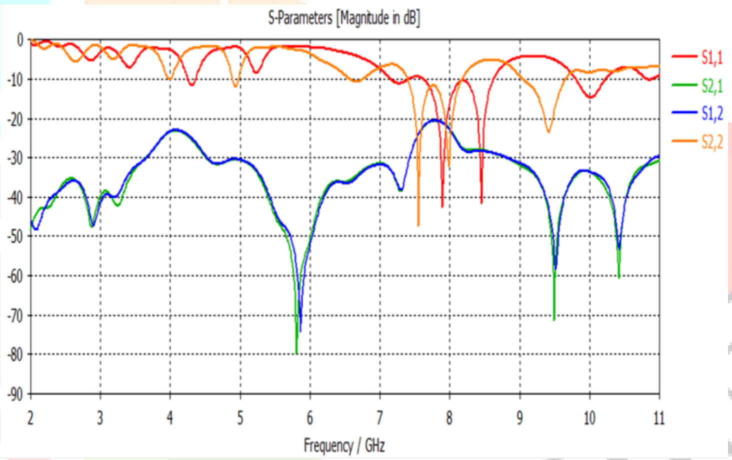


Figure 3 Scattering parameters

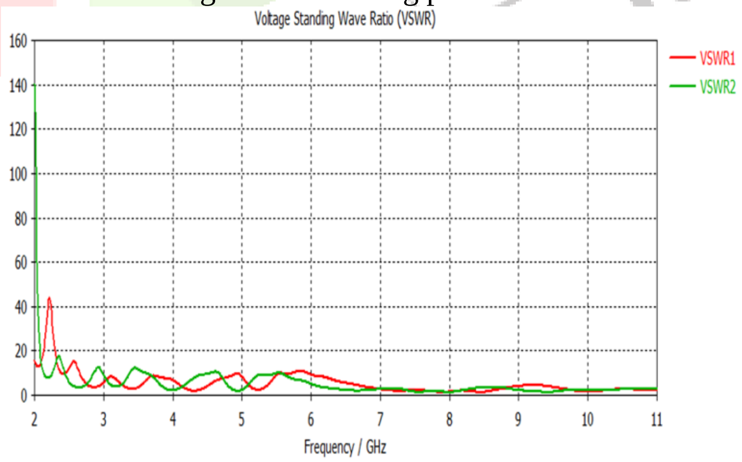


Figure 4 frequency vs vswr

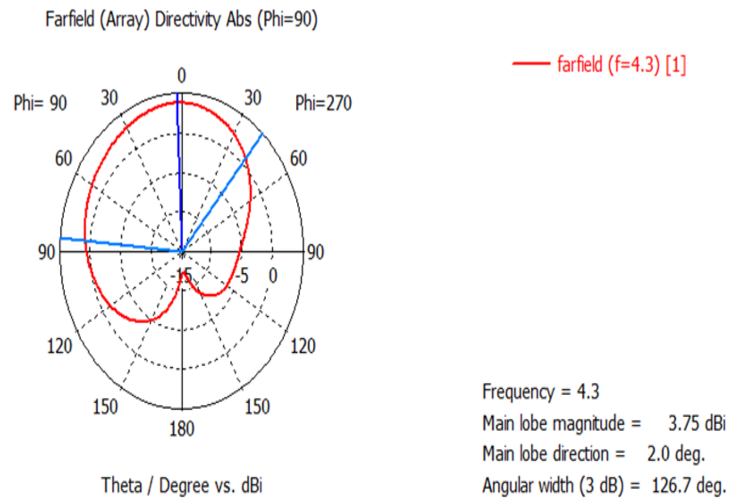


Figure 5 Radiation Pattern

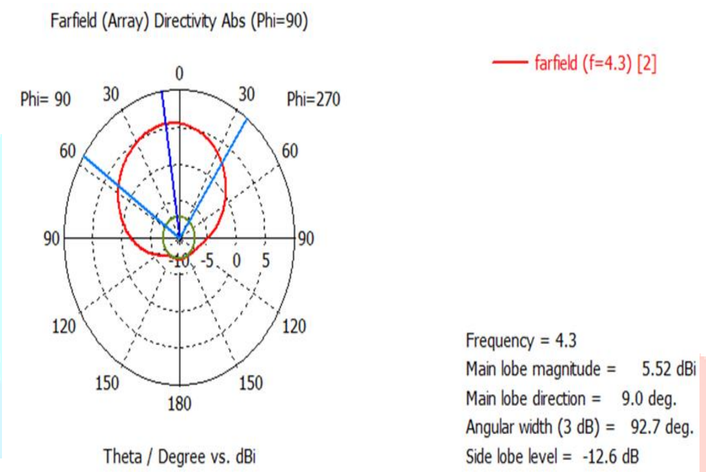


Figure 6 Radiation Pattern

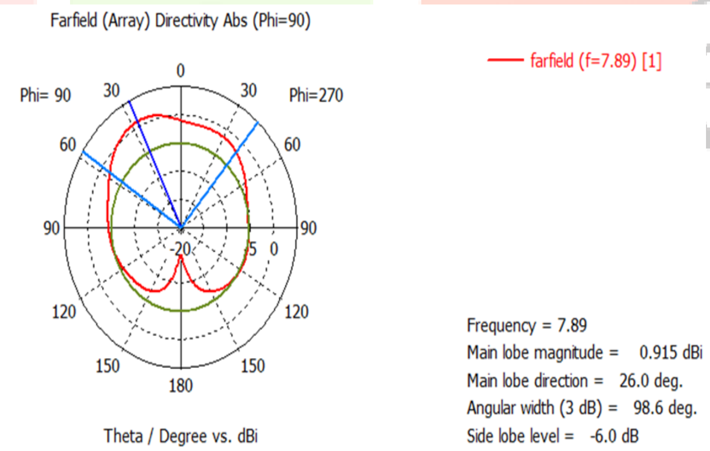


Figure 6 Radiation Pattern

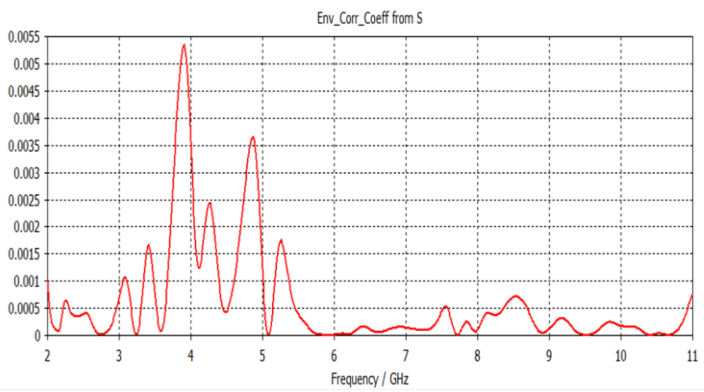
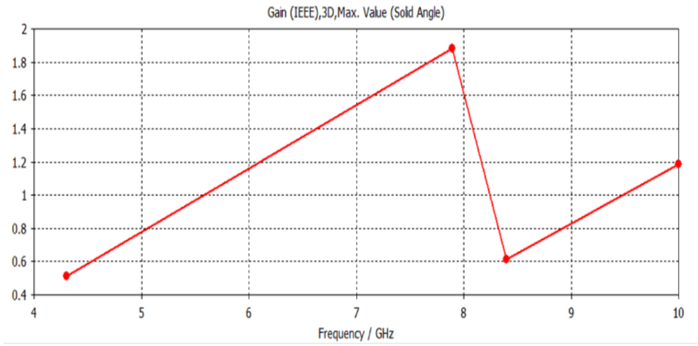


Figure 7 frequency vs ECC



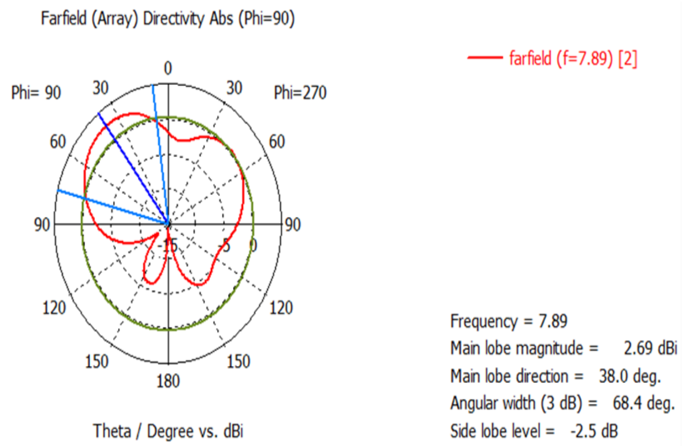


Figure 6 Radiation Pattern

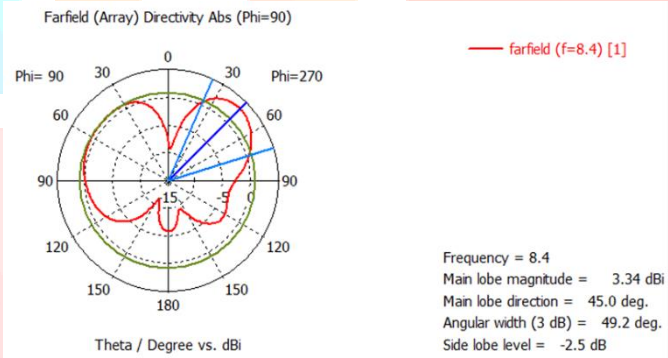


Figure 6 Radiation Pattern

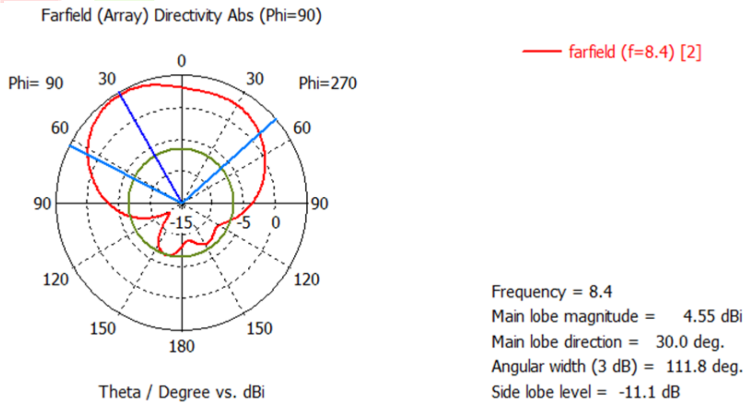


Figure 6 Radiation Pattern

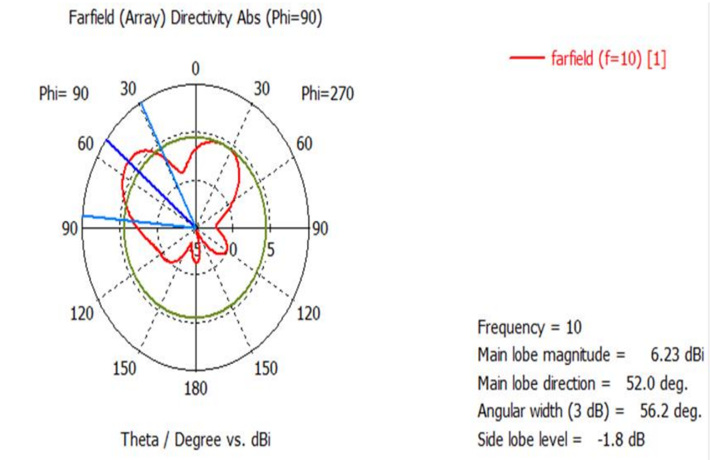


Figure 6 Radiation Pattern

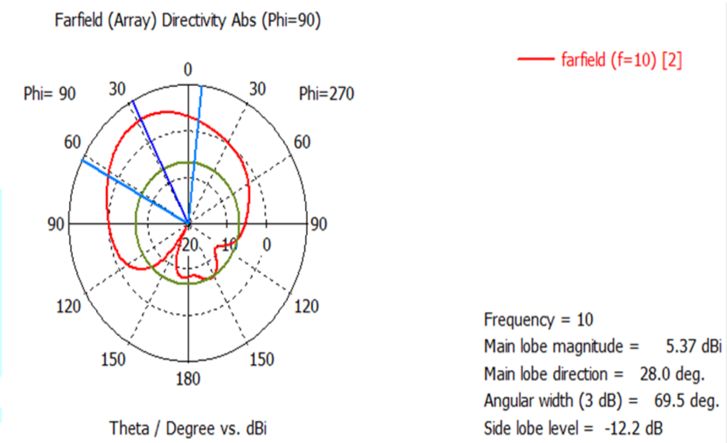


Figure 6 Radiation Pattern

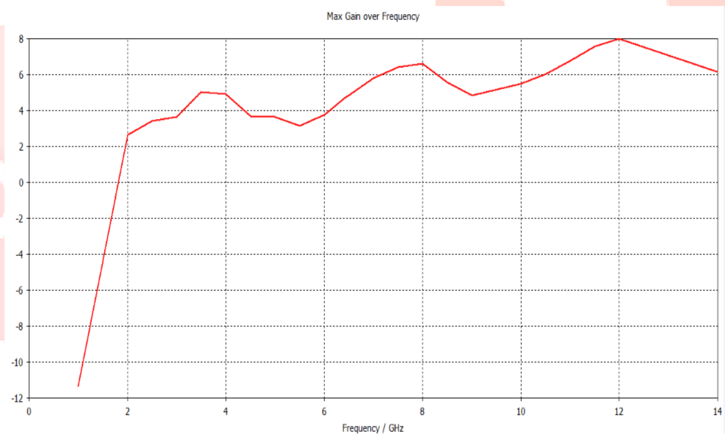


Figure 9 frequency vs gain

IV. CONCLUSION

In this paper presents the design of a Square Shaped MIMO Microstrip line feed patch antenna and their 2x1 MIMO implementation for Bluetooth, 4G LTE, WLAN, and WiMAX applications and the proposed antenna system operates frequency range from 2.743-11.6 GHz frequencies for VSWR≤2. A study was performed to implement this antenna in 2x1 MIMO arrangements on the same circuit space. The proposed Antenna have Better mutual coupling and better envelope correlation coefficient are achieved.

V. REFERENCES

[1] C. A.Balanis "Antenna Theory, Analysis and Design" john wiley & sons, inc, new York 1997.

[2] Kamili J. Babu, Rabah W. Aldhaheri, Mohammed Y. Talha, and Ibrahim S. Alruhail "Design of a Compact Two Element MIMO Antenna System with Improved Isolation", Progress In Electromagnetics Research Letters, Vol. 48, 27–32, 2014.

[3] A.A. Asaker, R.S. Ghoname, A.A. Zekry, " Design of a Planar MIMO Antenna for LTE-Advanced"International Journal of Computer Applications (0975 – 8887) Volume 115 – No.12, April 2015

[3] T. Svantesson. On the Capacity and Correlation of Multi-Antenna Systems Employing Multiple Polarizations. Proceedings of IEEE Antennas and Propagation Symposium vol. 3, pp. 202-205, June 2002

[4] Abouda, A. A. and S. G. H¨ aggman, "Effect of mutual coupling capacity of MIMO wireless channels in high SNR scenario," Progress In Electromagnetics Research, PIER 65, 27–40,

[5] K.-L, Lau, , K.-M., Luk and K.-F., Lee. 2006. Design of a circularly polarized vertical patch antenna. IEEE Transactions on Antennas and Propagation, 54(4): 1332- 1335.

[6] Y.P., Zhang and J.J. Wang. 2006. Theory and analysis of differentially-driven microstrip antennas. IEEE Transactions on Antennas and Propagation, 54(4): 1092-1099