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Research Article

Triple Band Micro Strip Antenna for Femtocell Applications

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ABSTRACT
A micro strip antenna is designed for increased coverage region in femtocell network, for optimization of femtocell by means of multielement antenna technique. The antenna is designed for Long Term Evaluation by using standard FR4 dielectric substrate, to achieve the gain by changing antenna factor for increasing coverage area and to enhance the bandwidth to use different application by multiband frequency. From this antenna return loss, directivity, antenna gain and radiation characteristicswere simulated and measured. The return loss obtained by this antenna is as follows -17.26 dB at 2.4 GHz, -15.23 dB at 3.09 GHz, -20.26 dB at 4.2 GHz. The characteristic of antenna is analyzed using IE3D software.

Index Terms—Micro strip Antenna, IE3D, Femtocell

I INTRODUCTION
A broader term which is more widespread in the industry is small cell, called femtocell[1-2]. It links to the service provider's network through broadband, present day design generally assist4livelycellular phones in residential settings, and 8 to 16livelycellular phones in enterprises settings. A femtocell is used to extend service coverage for indoor purpose. Femtocell gives better voice quality and battery life. Once connected to, the femtocell interfaces with the mobile network operator's network, and offers additional coverage.

It is user friendly, anyone can install at home. But, user must declare which mobile phone number are allowed to connect to his femtocell. When these cellular phones touch base under scope of femtocell, the versatile scope changed over from macrocell to femtocell naturally. It is used in specific hardware and convert weak signal into strong signal area. It mostly used in densely populated area. Improved battery life for mobile devices due to reduced transmitter and receiver distance. Femtocell can also offload traffic from macrocell network and enables new applications such as location based services. The FAP is positioned 3.3m in height along the corridor to symbolize a mounted access point.It covers a small area.

It provide small amount of interference to outside of enterprise. Femtocell fit in enterprises buildings. The amount of femtocellrequired relies on upon the shape, size and buildingstructure as well as building materials [3-4].

A femtocell is used for compensating poor cellular coverage inside the home (or) in small places. Femtocell will deliver average solution for indoor area. Mobile operators have a complete solution, a small, low cost, easy to install and higher signal-to-interference-plus –noise-ratio (SINR)[5-6]. It decreased distance from femtocell to user, which leads to a higher signal strength in receiving side.

The paper is arranged as follows: antenna design in section II, results in section III, conclusion in section IV.

II ANTENNA DESIGN

In this femtocell, Micro strip antenna is used to design. It is used high profile application like aircraft, space craft, and satellite. It is most efficient antenna. Currently this antenna is commercially tattered like mobile communication, wireless radio other than government custody [7].Micro strip antenna is called Patch Antenna(PA). The shape of the PA depends on the application; more common shapes areRectangular, Square.In patch antenna there are different types of slots are used to achieve multiband for different applications.These slot to improve bands, improve gain and it is used UMTS and Bluetooth[8-9].

Femtocell coverage area is small so, patch antenna is suitable choice. It is cost effective solution. They are different types of antennas are available for femtocell application such as wire antenna, PIFA, micro strip.The micro strip antenna is designed for Long Term Evaluation multiband. Substrate FR4 is used to design the antenna.FR4 is a low cost and available substrate[10-11].In this dissertation, an inverted T shape antenna design is proposed with triple frequency response at the 2.4 GHz, 3.09 GHz, and 4.2GHz. By cutting the patch of the antenna is inverted T shape. The ground plane of the antenna is rectangle with a square slot in the middle. The antenna design steps and experimental results are described below:

In width of the PA is computed by [12-14]:

$$w = \frac{c}{2f_r\sqrt{(\varepsilon_r + 1)/2}} --------(1)$$

Where f_r resonant frequency, ε_r relative dielectric constant.

The effective dielectric constant is given by the equation:

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2} --------(2)$$

where h- height of dielectric substrate.

The length of the antenna is by the equation:

$$L = \frac{c}{2f_r\sqrt{\varepsilon_e}} - 2\Delta L ---------(3)$$

Where ΔL is extension of patch length on both ends of the patch.

$$\Delta L = 0.412h\frac{(\varepsilon_e + 0.3)((w/h) + 0.264)}{(\varepsilon_e - 0.258)((w/h) + 0.8)} -------(4)$$

The ground plan length & width is given below,

L_g=6h+L, ------ (5)

W_g=6h+W. ------ (6)

The resonant frequency of antenna is 2.5GHz.The theoretically calculated patch length and width is 28mm and 36mm Figure1 (a).FR4 dielectric substrate with ε_r= 4.6 and h= 1.6mm and tangent loss is 0.02.The patch is cut into the inverted T shape by using these values Figure1 (b).This antenna is feed by micro strip technique. The length of the ground plane is 38mm and width of the plane is 46mm with a square slot in the middle Figure1(c).

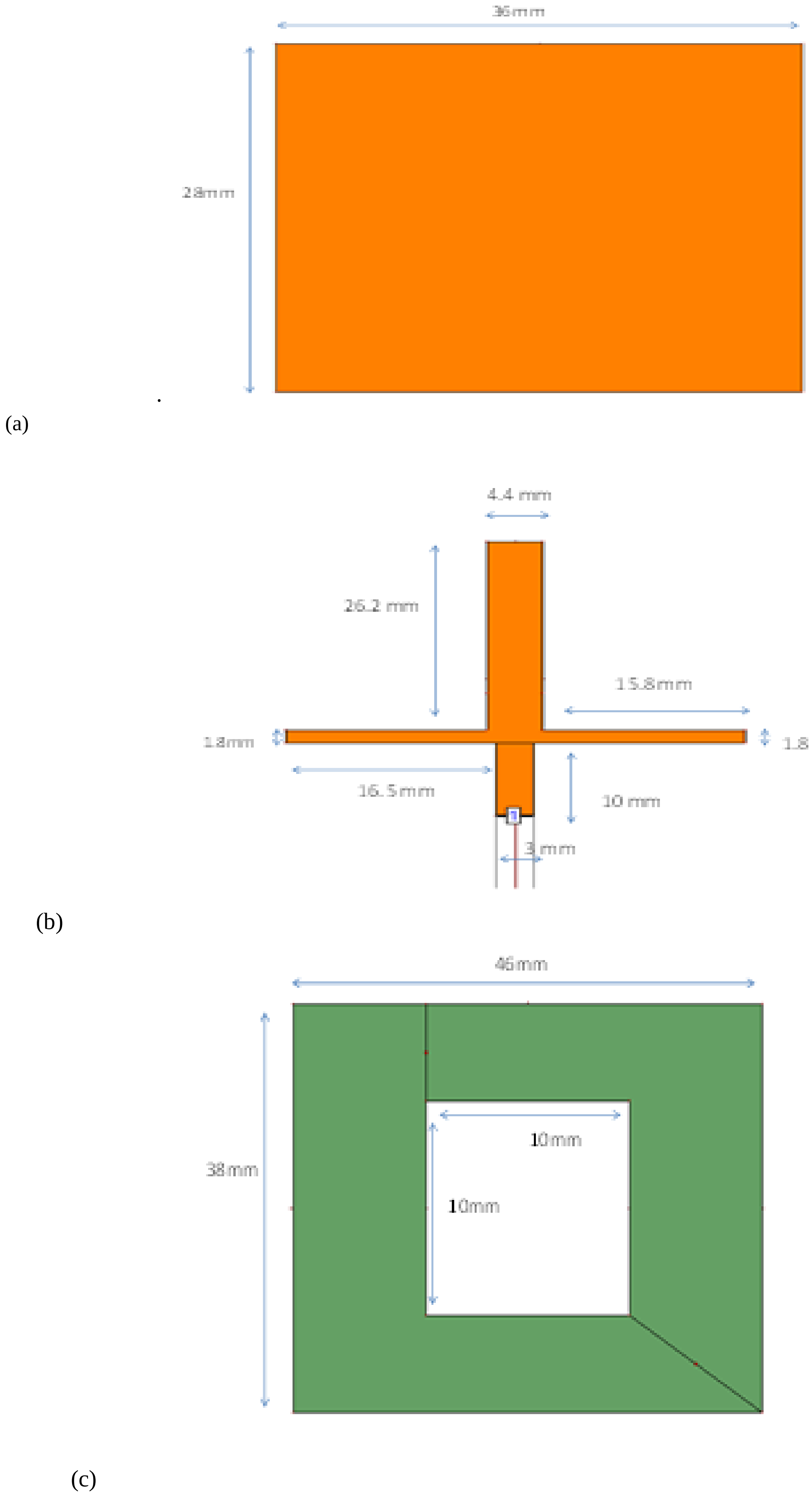


Figure1: Proposed antenna (a) patch (b) inverted T shape patch (c) ground plane

The proposed antenna structure is illustrated in Figure 2.

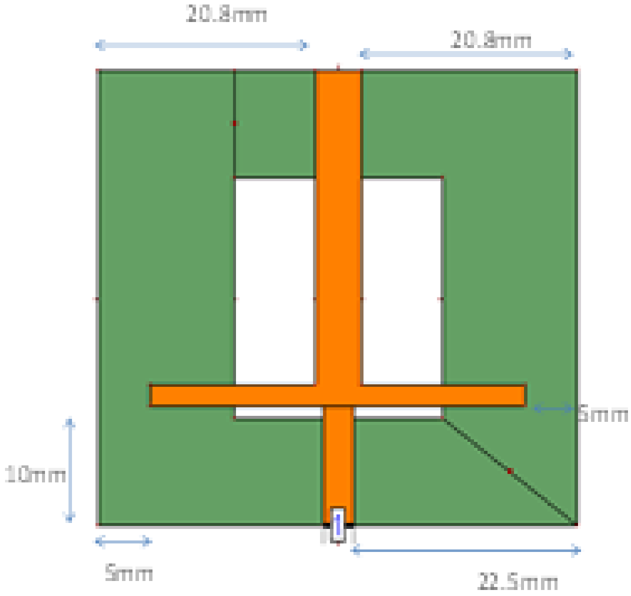


Figure2: Antenna Structure

The fabrication antenna front view and back view is shown infigure3 and 4.The fabrication process of the antenna is involved in patch, substrate, and ground.

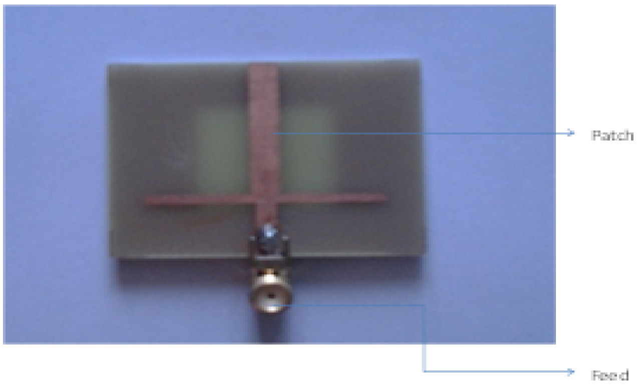


Figure 3: Inverted T shape antenna (front view)

Figure 4: Inverted T shape Antenna (back view)

III.RESULTS ANALYSIS

A.Return Loss

The practical circuit realization suffers with the mismatch between the available source power and the power delivered. This is known as return loss. Return loss = -20log (Γin) of the antenna is obtained as -17.26 dB at 2.4 GHz, -15.23 dB at 3.09 GHz, -20.26 dB at 4.2 GHz. So the designed antenna offers good gain and minimum losses at the specified frequency. Figure 5 shows the reflection coefficient of the Micro strip patch antenna, obtained from the simulation using the IE3D software. The antenna is operating at three frequencies 2.4, 3.09, 4.2GHz.

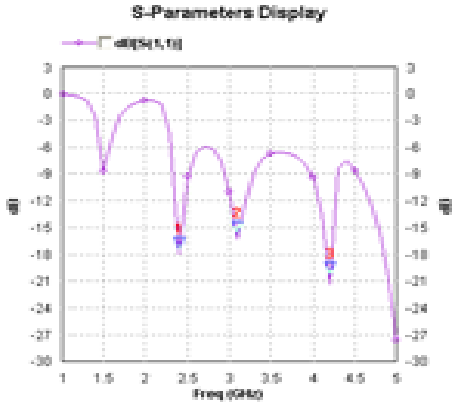


Figure 5: Return Loss

The reflection coefficient of the Micro strip patch antenna, are presented in Figure 6.Reflection coefficients wereobtained from the analyzer using the network analyzer. The antenna is operating at three frequencies 2.4, 3.09, 4.2GHz. In the resonant frequency, the return loss is -14.28dB,-18.66dB and -16.68dB

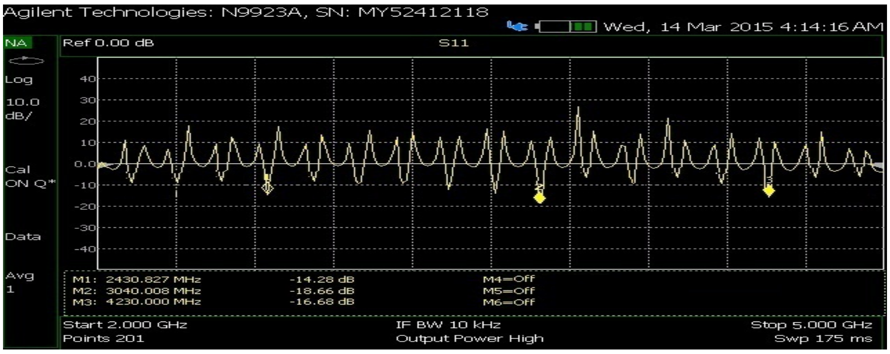


Figure 6: Analyzed Return Loss

B. Gain

The ratio of the power radiated or received by meticulous antenna in a prearranged direction, to the power radiated or received by a taking reference ideal isotropic antenna in cooperation fed by the similar power.

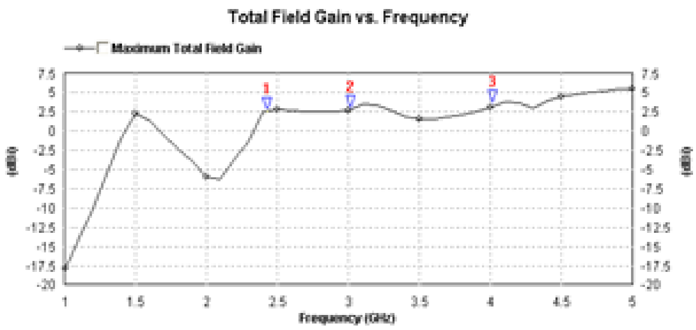


Figure 7: Gain

C. Directivity

The ratio of the radiation intensity in a planned direction from the antenna to the radiation intensity averaged over all directions.

The directivity (D) of the antenna can be calculated as using equation

$D = 4\prod A_e / \lambda 2$ --------- (7)

Figures 7- 9 shows themeasured, simulated gain and directivity of the antenna.

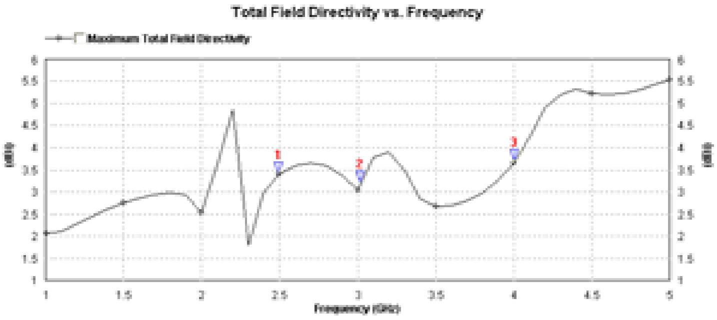


Figure 8: Directivity

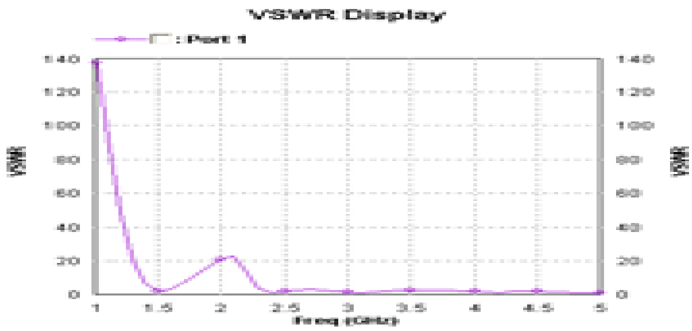


Figure9: VSWR

Figure 10 shows the VSWR of the Micro strip patch antenna, obtained from the analyzer using the network analyzer.

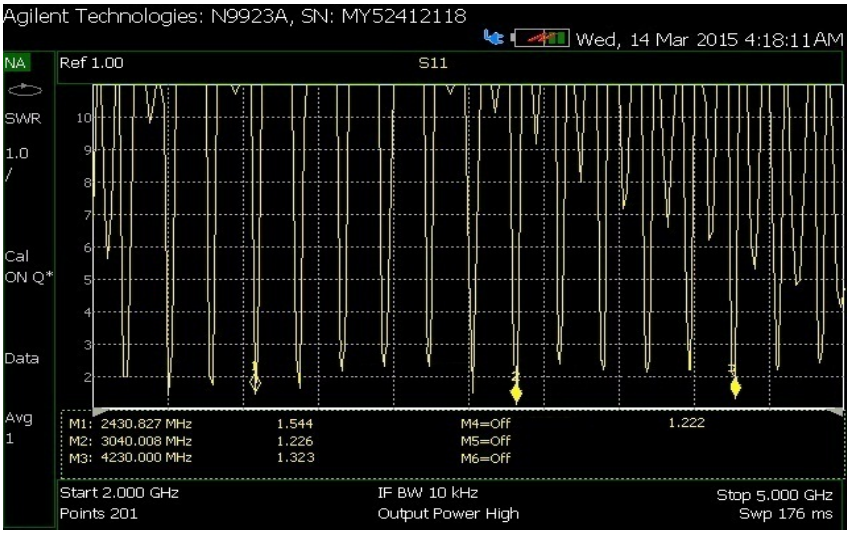
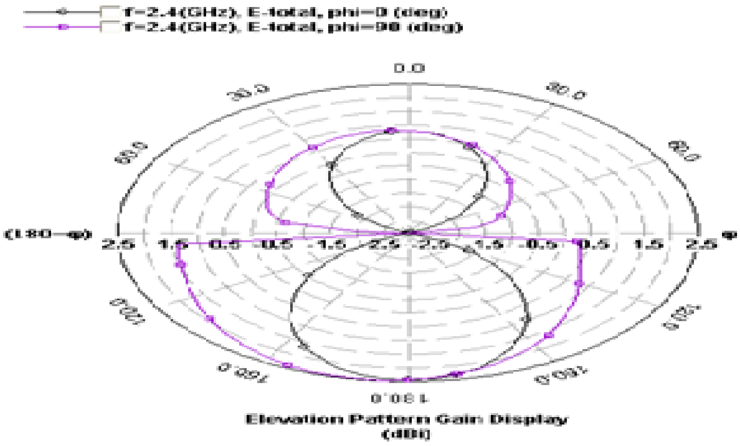


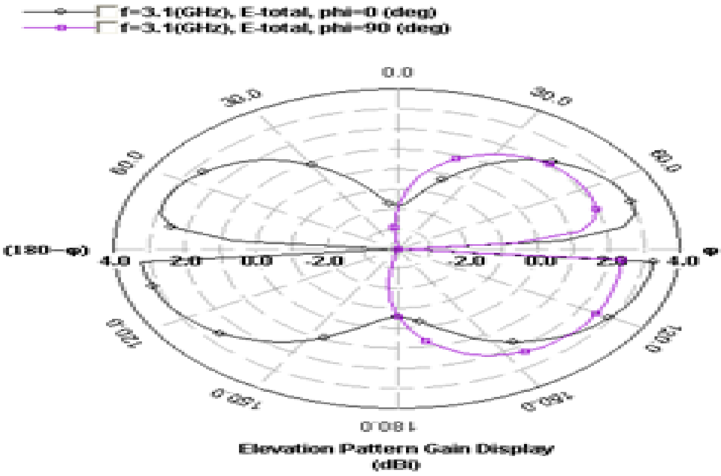
Figure 10: Analyzed VSWR

D. Radiation Pattern

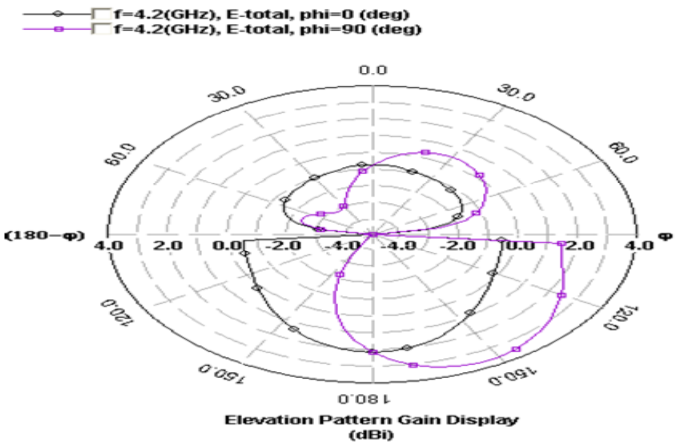
The radiation pattern states to the directional dependence of the field strength of the sourceantenna Figure 11and 12 shows the near field and far field radiation pattern of the antenna atfrequencies 2.4 GHz, 3.1 GHz, and 4.2 GHz.



(a)

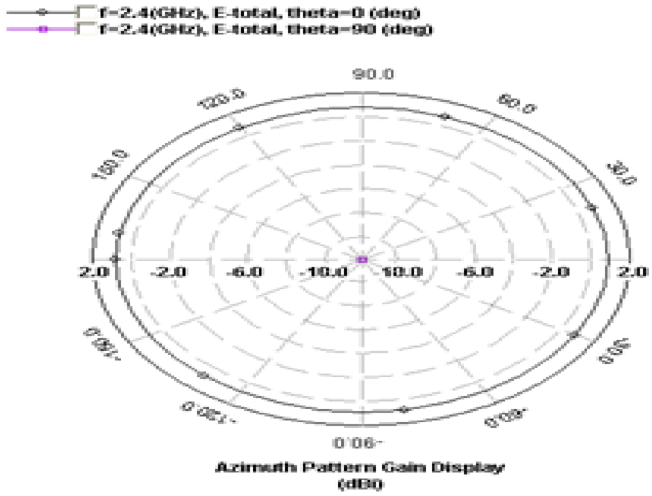


(b)

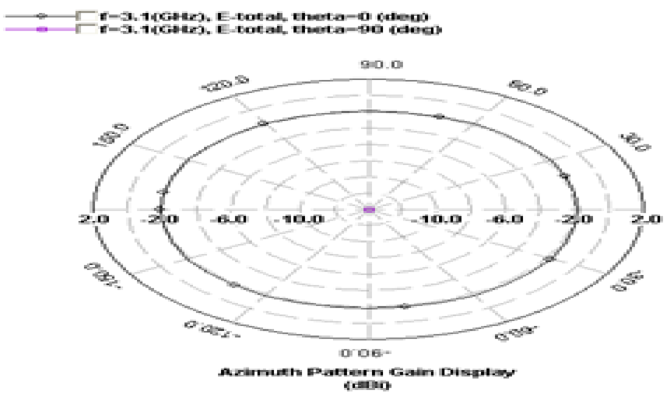


(c)

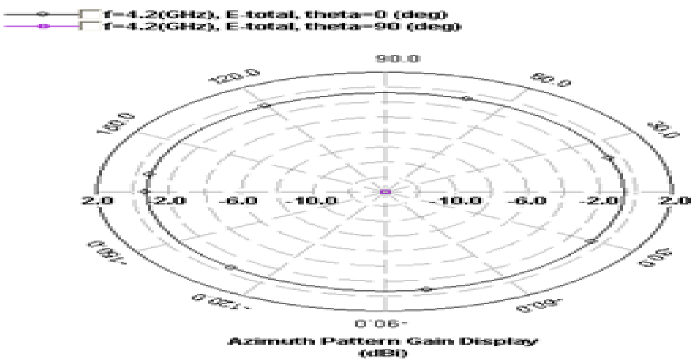
Figure 11: Near FieldRadiation Patternat (a) 2.4GHz, (b) 3.1GHz, (c)4.2GHz



(a)



(b)



(c)

Figure 12: Far field Radiation Patternat (a) 2.4GHz,(b)3.1GHz, (c)4.2GHz

F. Efficiency

The antenna efficiency (η) can be calculated as using equation

$$\eta = G\lambda 2 / Ae4 \quad \text{------ (8)}$$

The efficiency of proposed antenna has enhanced with different frequency is shown in Figure 12.

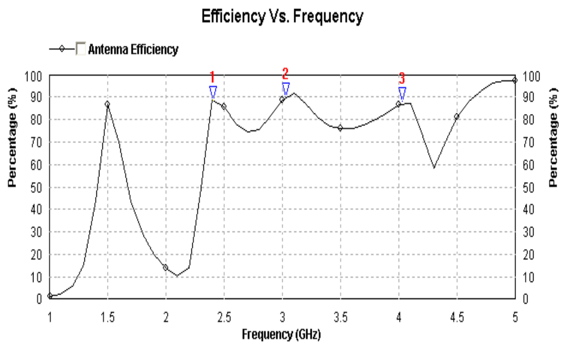


Figure13: Efficiency

Comparison of simulated results and analyzed results is given in Table 1. The values for the return loss are around 16 dB at 4.2 GHz and superior return loss, Gain and Directivity is perceived in that frequency. From that frequency the proposed antenna can cover Bluetooth, WLAN aplications and also enhance coverage area and bandwidth to use different application by multiband frequency.

Table1. Performance Analysis

S.No	Parameters	Simulation Results	Analyzer Results
1.	Return Loss	2.4GHz- -17.5dB 3.09GHz- -16dB 4.2GHz- -20dB	2.4GHz- -14.28dB 3.09GHz--18.66dB 4.2GHz--16.68dB
2.	VSWR	2.4GHz- 1.4 3.09GHz- 1.4 4.2GHz- 1.6	2.4GHz - 1.5 3.09GHz- 1.3 4.2GHz- 1.2
3.	Gain	2.4GHz- 2.8dB 3.09GHz- 3.5dB 4.2GHz- 3.75dB	
4.	Directivity	2.4GHz- 4.8dBi 3.09GHz- 3.7dBi 4.2GHz- 5.1dBi	

IV.CONCLUSION

The lack of quality coverage in indoor environment has created the substantial need of femtocells.

Especially the increase of multimedia application has created the higher data demand. Femtocells are spread cells; it can be feasible to access gigabyte data speed.

To achieve this target, higher bands are preferable. The proposed antenna covers triple frequency bands and meets the need of indoor environment.

This is proved by the parameters return loss, VSWR,radiation pattern, gain and directivity as obtained.

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