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Design of Smart Antenna Array of 2×2 MIMO for 4G-LTE

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***Abstract*— A rectangular patch antenna resonating at 2.1GHz for the 4G Long Term Evolution (LTE) is designed and simulated. The rectangular patch antenna designed by using two strip feed line deposited on FR-4 substrate single substrate with thickness of 1.6milimeter, resonates at 1.86GHz. Spurious radiation increases and also limits the bandwidth level by using strip feed which is significant. The return loss achieved is -26dB. Further, the patch is designed by using coaxial feed line to increase resonating frequency at 2.1GHz and also the patch is deposited on FR-4 substrate with triple layer substrate. Bandwidth level and desirable return loss can be achieved with the help of coaxial feed line which results in reduction of spurious radiation. The gain, directivity, return loss, efficiency and radiation pattern are analyzed. Here in this paper MIMO is focused because the activity of multipath technique is attained for a given frequency band. The proposed antenna is designed to adopt 2×2 Multiple Input Multiple Output (MIMO) structure for 4G LTE network .**

***Index Terms*— LTE, patch antenna, coaxial feedline, MIMO**

I. INTRODUCTION

In mobile communication, the wireless access technologies extent uptofourth generation. The basic mobile techniques has been accomplished straightforward towards to the first generation at the same time, coverage and capacity has been introduced in second generation technology, later the third generation which has a mission for mobile broadband. The wide range of telecommunication services are supported for stationary networks, advanced mobile services, which helps to support the low and high mobility services also wide range of data rates. LTE(Long Term Evolution) standard will provide multiple antennas for wireless communication. MIMO technology has been extensively used in LTE application to improve cell coverage, high data rate and downlink peak rate . Some of the possible standards are GPS, WiMAX, WLAN and UMTS proprietary networks, it will harmonize global roaming, super high speed connectivity on every mobile communication device in the world. Patch antennas are becoming very cheap and less cost effective in the mobile phone market. Patch antennas having low profile and are easily fabricated.

The antenna design of consist of four band slots such as two E-shaped stubs, a rectangular slot, a T-shaped feed patch and an inverted T-shaped stub. It is possible to built a many wireless standards like wireless area network(WLAN), global positioning system(GPS), worldwide interoperability for microwave access(WiMAX) standards as possible into a single wireless network [1]-[11]. The structure of the planar dual band monopole antenna is simple which is radiating at omni directional. To generate the frequency bands of 3.4GHz and 2.4GHz by using two branches of the antennafor Worldwide Interoperability for Microwave Access(WiMAX) applications and at the same time the overall bands of noise is eliminated by using narrowband monopole antenna[2]-[10]. The design consist of four loop antennas for Wireless Local Area Network(WLAN) here, two loop antennas for 2.4GHz operation and two loop antennas for 5GHz operation, established to seta square antenna ground which is perpendicular to occupies overall dimensions 10mm x 75mm x 75mm [3]-[13].

A novel compact multiband antenna is madeup of two printed open ended slots. It has been designed as T-shaped slot and E-shaped slot. The antenna is formed by five types of frequency resonant modes are given by UMTS, GSM900, PCS1900 and DCS1800 and WLAN bands [4]-[10]. Here, the MIMO antenna system comprises a three dual loop antennas are operating at different frequencies for WLAN applications. To succeed a directional radiation patterns and high gain embedded which is enclosing the Access Point as an internal MIMO antennas [5].

II. RELATED WORKS

In this paper the antenna can support 2×2 MIMO configuration. The antenna has been designed in such a way to cover the particular bands of frequency at about 1.57, 2.45, 3.5 and 5.2GHz which can be used for wireless standards of GPS, WLAN and WiMAX systems respectively. So, it does not support the optimal MIMO feature stated in the WiMAX standard [1]. Feeding cable is used to increase the accuracy in radiation pattern measurement and to connect the antenna. The substrate layer is made-up of Acrylonitrile Butadiene Styrene(ABS) with 1mm thickness and dielectric constant of 2.45[1]-[10]. A planar dual-band monopole antenna designed by using microstrip-fed. The frequency tunability is achieved by stem and radiating branches of the radiator that is placed

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between under the process of reverse bias voltage through a varactor[2]. The antenna has been designed by five resonant modes whose dimensions are 100mm in length and 50mm in width, is printed on a 1mm thickness FR4 substrate. These modes are controlled autonomously by the five respective open ended slots of different lengths [4]-[16]. The design of antenna consist of two loops such as a small 5GHz inner loop and large 2.4GHz outer loop to support a MIMO antenna structure [5]-[17]. Three sickle shaped slots which operates on three different frequencies such as 5.8GHz WLAN, 2.4GHz Bluetooth and 3.5GHz WiMAX are obtained by the design of slot antenna with the help of FR4 substrate. The antenna has been simulated by using microstrip feed line which increase the poor radiation patterns with slots. By changing rectangular slot to L-shaped slot decreases the antenna size[6]-[14]. It is incorporating embedded arc-shaped metallic strips which is connected two tuning sections one is CPW feed line and tuning stub [7]. Hexagonal patch antennas on 1.8GHz frequency with coaxial feed line for L-band applications [8]. Microstrip patch antennas are light weight, low profile and it is designed by Time Division Multiple Access based wireless network technology for GSM applications [9]-[15].

III. ANTENNA LAYOUT DESIGN

The desired rectangular patch antenna is shown in Fig. 1. It is mainly used for 4G-LTE applications compared to 3G technology. It has high speed data rate. The proposed antenna which operates on 2.1GHz is used for 4G connectivity.4G supports IPV6 for faster internet access. 4G-LTE technology acquires the prime spectrum level of 960MHz, 1.8GHz and 2.1GHz.Here the patch antenna designed at the frequency of 2.1GHz.

The design of antenna comprises of three different layers such as ground plane, feeding design and patch antenna. The antenna excitation methodology was changed from microstrip feed line coaxial feed line. If the thickness of dielectric substrate is increased spurious feed radiation also increases. The feed radiation also primes to the undesired radiation of cross polarization . The coaxial feed or probe feed technique fetching microstrip patch antennas. The outer conductor is used to connect the ground plane while the inner conductor of coaxial connector enlarge to the dielectric and it is joined to the radiating patch.

Antenna reconfigurability is used to enrich single antenna by adding more functionalities and Multiple Input Multiple Output(MIMO) antenna systems for a specific frequency band. The proposed antenna system reaching up to 2×2 MIMO configuration. By introducing MIMO concept it will increase the number of users. The MIMO systems use more than one transmit antenna (T_x) to send a signal on the same frequency to multiple receive antennas (R_x). MIMO technology is a standard feature of next generation LTE networks and its significantly boost data rates and overall system capacity.

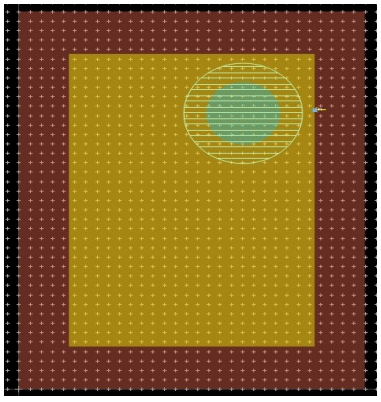

Fig. 1. Rectangular patch antenna

The rectangular patch antenna represented in Fig. 1. efficiently suits for the application of 4G-LTE.The layout model of MIMO structure shown by below Fig. 2.

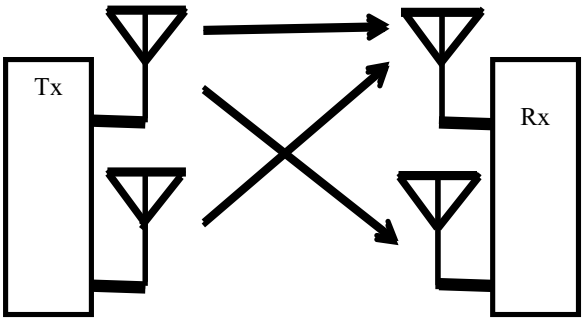

Fig. 2. MIMO 2×2 model

IV. SUBSTRATE SPECIFICATIONS

The substrate of rectangular patch antenna consist of triple layer substrate. The antenna designs are given by for following layers.

- Ground plane
- Dielectric medium
- Rectangular patch

The FR-4 glass epoxy material is very low cost and used in wide range of electronic component applications. The FR-4 substrate used for rectangular patch antenna resonating at the frequency of up to 2.1GHz and coaxial feed is connected between the ground plane and patch antenna via dielectric medium.

The proposed design, substrate with triple layer having a thickness is described by Table 1.

Table1: Substrate layer specification

Substrate layer	***Thickness***
Ground plane	0.5mm
Dielectric medium	0.5mm
Rectangular patch antenna	0.75mm

The designed triple layer substrate is shown by Fig. 3.

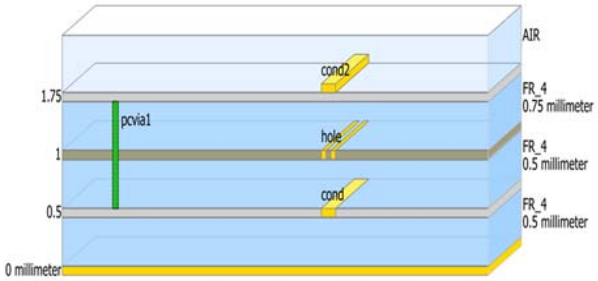

Fig.3 Triple layer substrate

V. Simulated Results And Discussion

The proposed reconfiguration antenna has been simulated by using Advanced Design System(ADS). The analyzing effects of the rectangular patch antenna around coaxial feed line is essentially connect the antenna for the measurement system as shown in below by Fig. 4. The return loss is achieved by -26dB at the resonant frequency of 2.1GHz. The return loss and phase result of S_{11} parameter has been shown in Fig. 5.

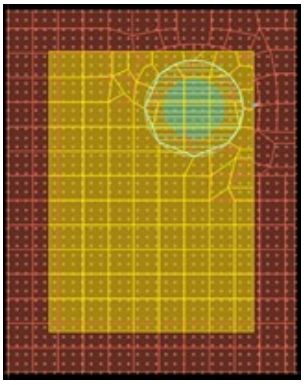

Fig. 4. Simulation Effects

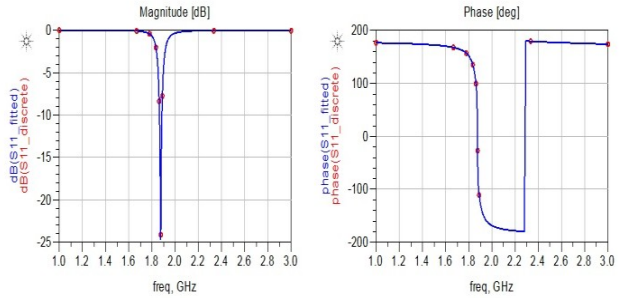

Fig. 5. Return loss and phase

VI. Radiation Performance And Current Distribution Analysis

The simulated and current distribution analysis pattern of the rectangular patch antenna cut at the resonating frequency of 2.1GHz is shown in Fig. 6. The electromagnetic simulations are generated by using Advanced Design System(ADS) and also the current distribution directions are shown in Fig. 7.

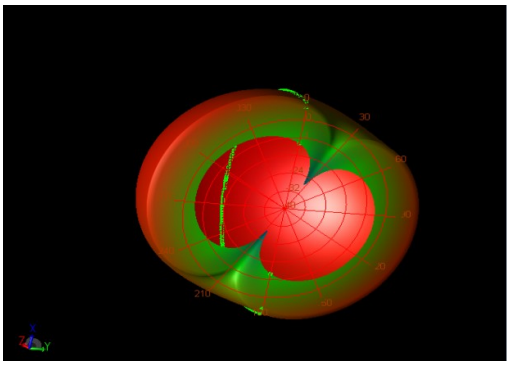

Fig. 6. Radiation Pattern

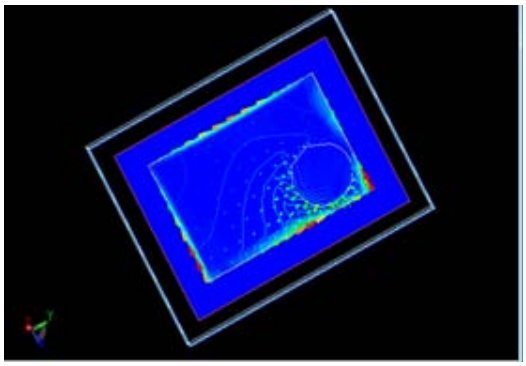

Fig. 7.Current distribution

VII. Antenna Parameters

The antenna gain achieved is 6.05281dB and the directivity of the antenna 6.3364dB at 2.1GHz which is represented in Fig. 8 and Fig. 9.

$$\text{Antenna Gain} = \frac{\text{Power delivered by the antenna from a far field source}}{\text{Power delivered by a hypothetical loss}}$$

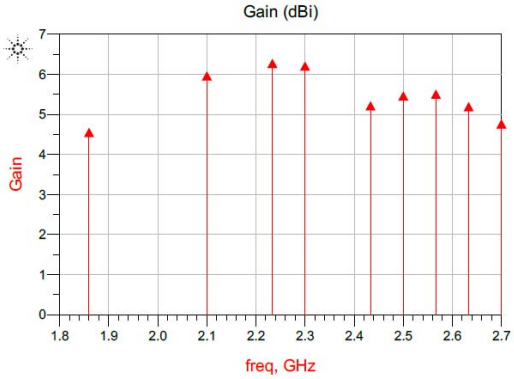

Fig. 8. Antenna gain

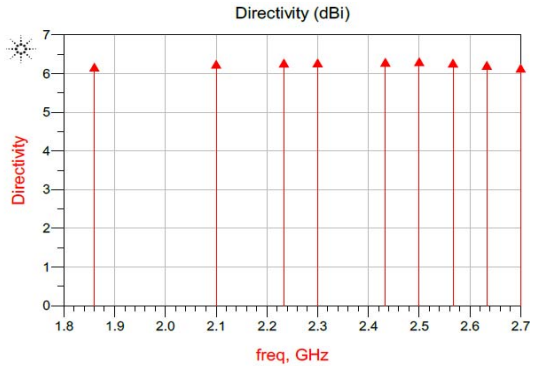

Fig. 9. Directivity

The proposed antenna radiation efficiency is about 93.67% shown by Fig. 10.The average power measured by an antenna can be shown as above Fig. 11. The average power density measured by the antenna depends on direction of signal. The antenna parameters of rectangular patch such as gain, directivity, efficiency and radiated power which resonate at the frequency of 2.1GHz.The antenna gain is approximately similar to the directivity and other parameters also analyzed is shown in Fig. 12.

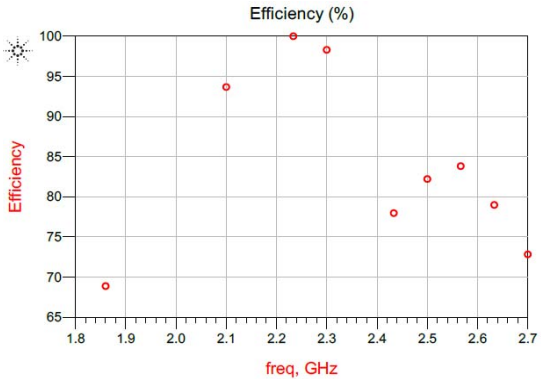

Fig. 10. Antenna Efficiency

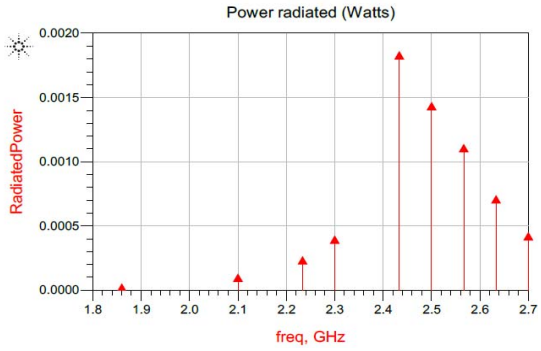

Fig. 11. Radiated power

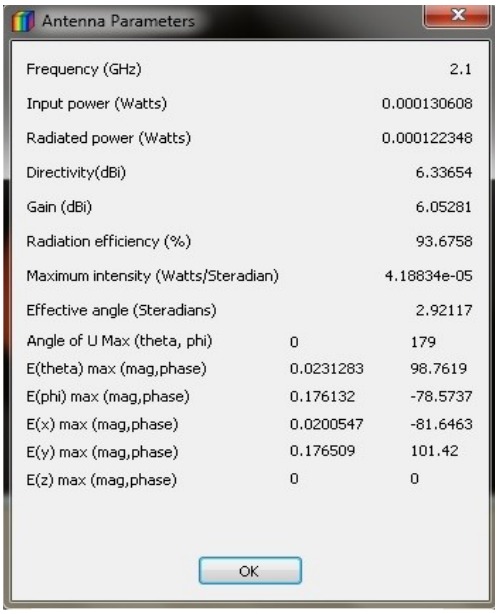

Fig.12: Antenna parameters

VIII. CONCLUSION

In this paper a rectangular patch antenna has been designed at the frequency of 2.1GHz for 4G-LTE applications that the antenna has a gain of 6.05281 and directivity of 6.33654 achieved. The performance of rectangular patch antenna has been analyzed from the simulated parameters of gain, directivity, return loss and efficiency. A 2×2 MIMO structure has been designed for the purpose of improving the communication performance. Thus the radiation efficiency obtained by the antenna about 93.67%. Future work, can be concentrated by increasing the antenna gain and directivity. The proposed multiple type antennas like circular patch may also be suited for different level of MIMO configurations.

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