International Journal of Electrical and Electronics Research ISSN 2348-6988 (online)
Vol. 3, Issue 1, pp: (53-58), Month: January - March 2015, Available at: www.researchpublish.com

Compact Multiband MIMO Antenna for Future Wireless Applications

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Abstract: **A Design of compact Multiple-Input-Multiple-Output (MIMO) Microstrip Patch Antenna that has 4 ports, been designed and implemented. The proposed antenna consists of four ports with two patches operates at LTE frequencies (1.8, 2, 2.6) GHz and two Patches operates at WLAN frequency (2.4) GHz. The antenna is fabricated on an inexpensive FR4 a dielectric constant ofε = 4.4, loss tangent of tan δ=0.019, with thickness of substrate that is 1.6-mm and the thickness of patch is 0.035 mm. The measured results represents that the proposed antenna obtained a reasonable bandwidth for LTE and WIFI applications defined by 10-dB return loss. Furthermore, The S Parameters of antenna are simulated and measured. In this project, design structure of the MIMO antenna four ports and substrate has been employed to broaden the bandwidth. Since MIMO antenna, good gain and directivity can be achieved. Simulation by using CST microwave studio program and measurement on the final prototype antenna were carried out and compared. A MIMO system characteristic evaluation of a four port MIMO antenna is performed. A four port antenna for wireless applications is designed, the antenna shows good pattern diversity low correlation coefficient.**

Keywords: **Antenna, MIMO, Multiband, Return Loss.**

I. INTRODUCTION

The present communication systems such as 3G and 4G technologies require larger data transfer rates with high speed and accuracy. The Multiple Input Multiple Output (MIMO) technology is one of the advanced wireless communication systems, which is very much capable to accomplish the demands of the present and emerging communication systems like Wi-Fi, 3G and 4G etc. Patch antennas, which are low cost, low in weight, planar or conformal layout, easier to fabricate, and able to be integrated with electronic or signal processing circuitry show good compatible with MIMO systems. In this paper use the MIMO with the Long Term Evolution (LTE) which is a wireless broadband technology, designed to support roaming Internet access via cell phones and handheld devices.

II. LITERATURE REVIEW

MIMO (multiple input multiple output) is one of the most developing technologies in wireless. MIMO improve the performance of communication by using multiple antennas at both the transmitter and receiver. It is one of many forms of smart antenna technology. MIMO was principally introduced to increase the data rate in SISO (single input single output), which is decided by the Shannon's capacity theorem. Many works has been done on increasing the capacity of the channels and making the channel robust. This concept was first proposed by Arogyaswami Paulraj and Thomas Kailath 1993. Moreover in 1996, it was improved by Greg Raleigh and Gerard J. Foschini [1]. MIMO offers significant increase in channel capacity and wireless system efficiency wherefore it has attracted a lot of attention in wireless communication. Many efforts have been devoted in realizing broadband and ultra wideband (UWB) diverse MIMO antenna [2]. The initial work on MIMO focused on basic spatial diversity. Diversity is studied to mitigate the multipath effects to increase the SNR of system to achieve high quality communication links. In this paper use the LTE Long-term evolution (LTE) that is an improvement to the current universal mobile telecommunications system (UMTS) developed at different frequencies ranging from 400 MHz to 4 GHz with bandwidths up to 20 MHz by the third generation partnership project (3GPP) [3].LTE employs multiple input multiple output (MIMO) technology to improve data-rate and spectral efficiency. One of researchers (Muhammad R. Khan) [4], design MIMO antenna with two-element diversity planar antenna at 2.4,5.2,5.8 GHz and the antenna is suitable for WLAN applications, Also Suvarna S. Phule [5], that use MIMO antenna system based on the ESA antenna designed. Operates in the 850MHz band of LTE and 3G cellular standards. In this paper used two systems to cover the LET and WIFI frequencies to increase channel capacity and Wireless efficiency.

III. RESEARCH METHODOLOGY

Firstly design the antenna structure by using CST software tools to achieve a multiband of 1.8, 2, and 2.6 GHz for LTE and 2.4 GHz for WIFI. And simulation the antenna design by using electromagnetic software such as CST microwave studio. After this Fabricate the antenna proposed on the FR4 board with thickness 1.6 mm and relative permittivity εr = 4.4.Finally characterized and compared for the performing with simulation results.

IV. DESIGN AND SIMULATION

A. DESIGN PARAMETERS:

The proposed patch antenna parameters are calculated based on transmission line modal analysis. Two different type of patches been introduced, one for LTE application, and the other is for WIFI application, the detailed geometry of each of the patches, is shown in the following figures and tables.

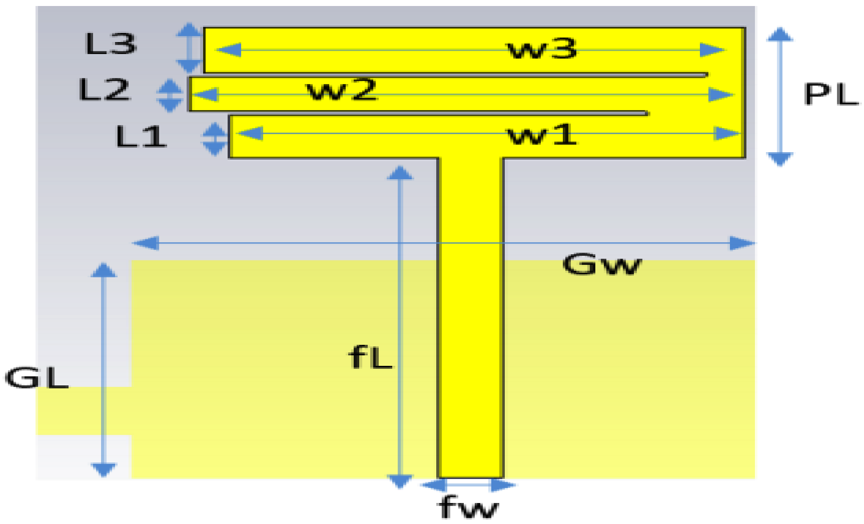

Fig.1 View of the proposed LTE patch with the ground transparency

TABLE I. LTE Patch Dimension

LTE Patch			
Parameter	Value (mm)	Parameter	Value (mm)
fw	3	PL	10.8
fL	26.5	W1	23.5
Gw	28.5	W2	26.25
GL	15	w3	24.7
L1	3.5	L2	2.9
L3	3.8	Gapwidth	0.3

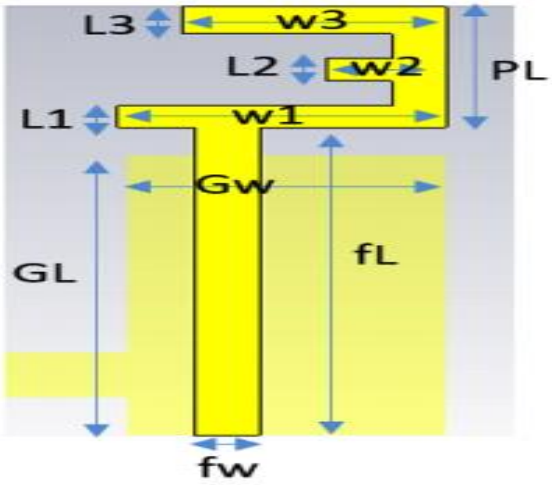

Fig.2 View of the proposed WIFI patch with the ground transparency

TABLE: II. WIFI patch dimensions

WIFI Patch			
Parameter	Value (mm)	Parameter	Value (mm)
fw	3	PL	11
fL	28	W1	15
Gw	14.5	W2	5.5
GL	25.5	W3	12
L1	2	L2	2
L3	2.5	Gapwidth	2.25

B. SIMULATION:

Return Loss: The simulation return loss at the resonant frequencies (1.8, 2, 2.4 and 2.6GHz) shows good resonant, which meets the requirement of the design which is less than -10 dB (90% of power fed is absorbed).The simulation 10 dB bandwidths produced are satisfactory, at about 19% and 12%, which are pretty sufficient to cover the multiband frequencies span of LTE and WIFI.

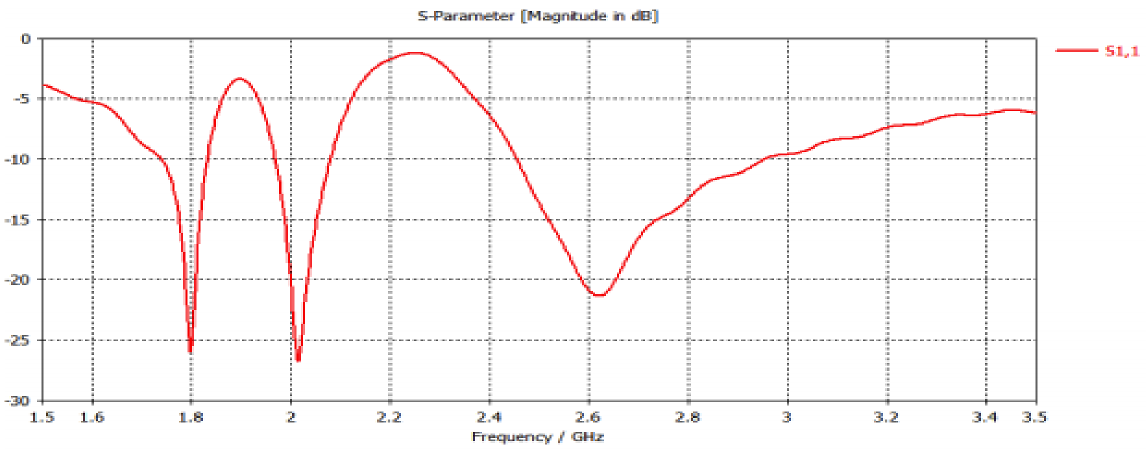

Fig.3 Return loss, S11 vs. Frequency

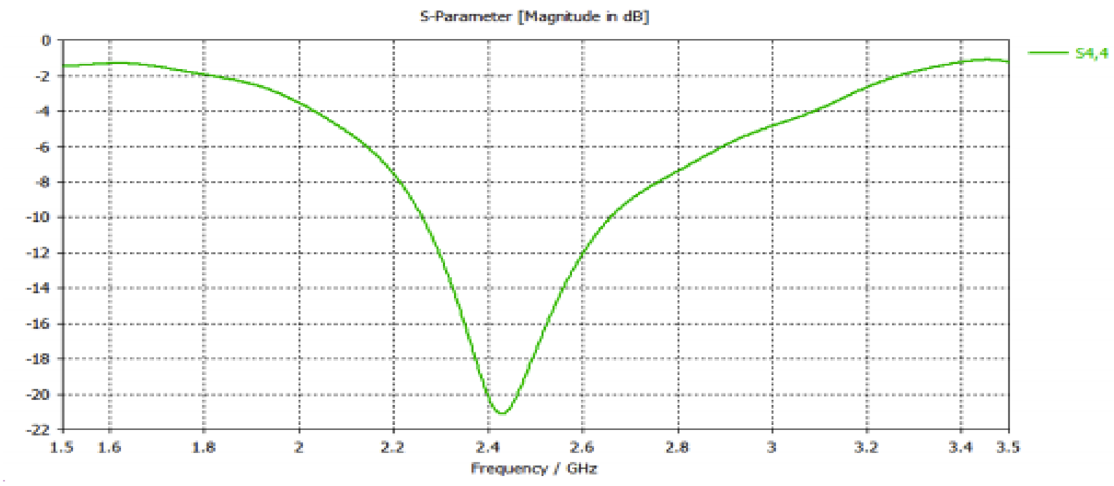

Fig.4 Return loss, S33 vs. Frequency

Radiation Pattern and Gain:

The simulated radiation pattern is as presented in the following figures which are for 1.8 GHz. The simulated HPBW for E-field and H-field and gain are also shown.

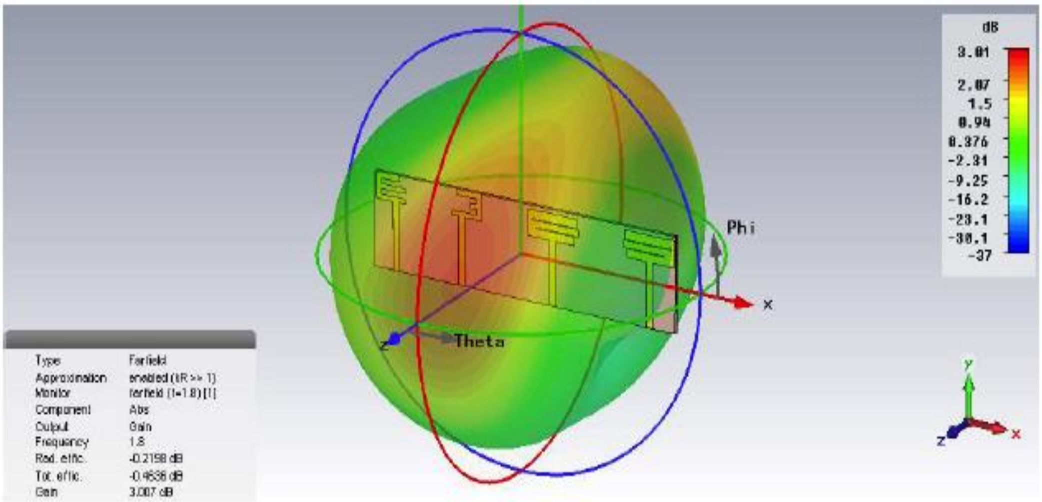

Fig.5 3D far field at 1.8 GHz

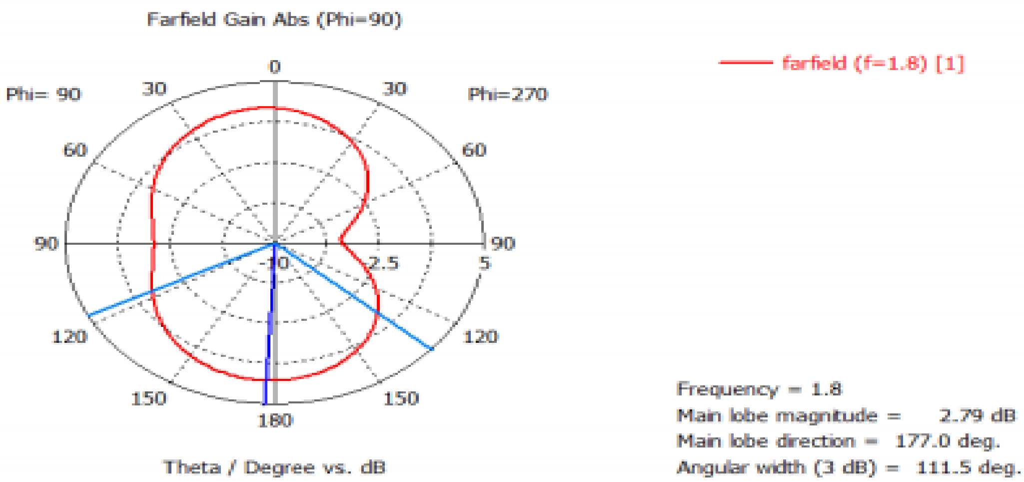

Fig.6 polar far field view at 1.8 GHz, phi=90

TABLE: III. Frequency (GHz) vs. Peak Gain (dBi)

Freq (GHz)	2.4	1.8	2	2.6
Peak Gain (dBi)	1.96	2.79	2.77	2.2

This proposed antenna shows a good isolation performance in terms of correlation coefficient which is less than 0.07

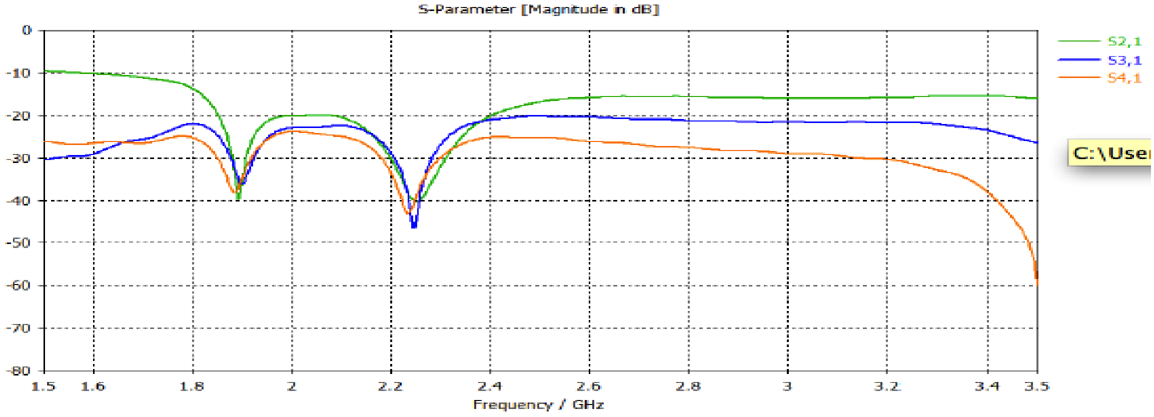

Fig.7 Isolation of port 1

V. RESULTS

Fabrication consists of three main stages. The stages are, UV exposure, developing and etching process

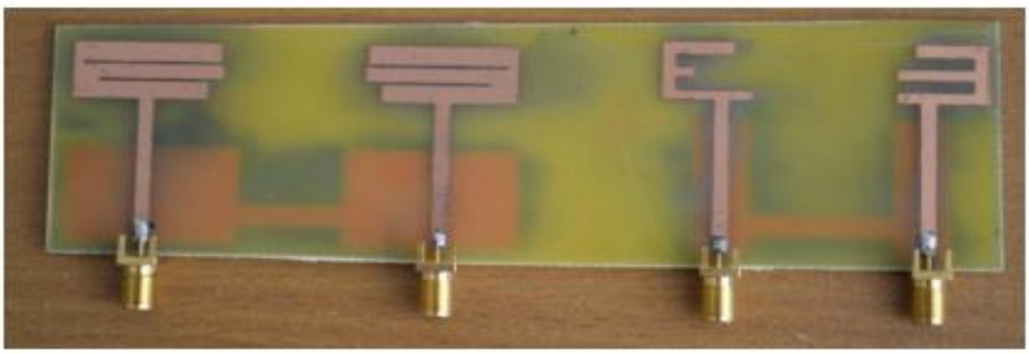

Fig.8 Antenna prototype

Measured and simulated results in the aspect of return loss of The antenna and return loss bandwidth response are shown in Figure 5.2 for S11 and figure 5.3 for S44.

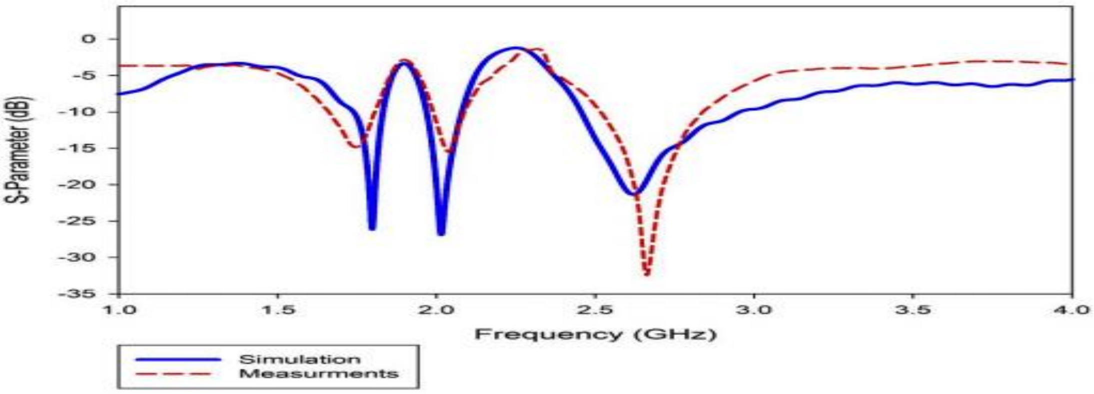

Fig.9 Simulation and measurement Antenna Loss for port 1

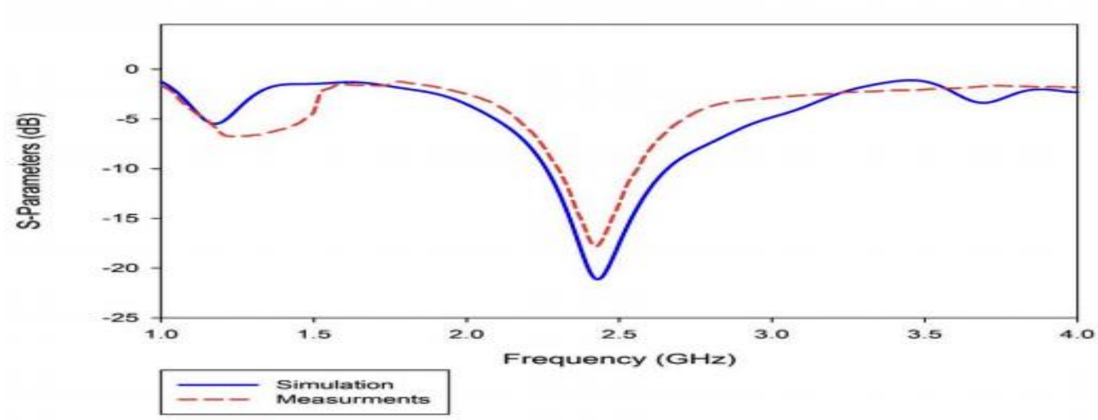

Fig.10 Simulation and measurement Antenna Loss for port 4

VI. CONCLUSION AND FUTURE WORKS

A. Conclusion:

A MIMO system characteristic evaluation of a four port multi band antenna operating at 1.8GHz, 2 GHz and 2.6 GHz for LTE and 2.4 for WIFI is performed. A four port antenna multi band is designed, the antenna shows good pattern diversity but with little spatial and polarization diversity. The fabricated MIMO MPA was tested and the experimental results show very good agreement with simulated results. The MPA has high bandwidth for both two ports up to 30% and it has low profile, has a small ground plane and has low mutual coupling. The proposed antenna is potentially suitable to use in LTE and WIFI application.

B. Suggestions for Future Works:

Future works related to this paper will be a frequency reconfigurable MIMO multi band which can easily be adapted to other LTE bands and other wireless standards. And it is recommended for the future to reduce the overall size by applying more diversity techniques that gives better isolation between the elements.

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