ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 3, Issue 3, March 2015

Design of an Inverted U-Shaped MIMO Patch Antenna for Dual Band Applications

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Abstract: A compact design of two element Multiple Input MultipleOutput (MIMO) system is proposed using an inverted U-shaped patch antenna. The antenna is fed by a coaxial feeding technique printed on a dielectric FR-4 substrate. The proposed MIMO system offers good return loss and isolation characterstics. This two element MIMO system produces dual band of frequencies with resonating frequencies at 2.8GHz and6.4GHz,which can be used for WLAN and satellite applications. The simulation results of return loss,mutual coupling and radiation pattern are presented in this paper.

Keywords: Inverted U-Shaped, MIMO, Return loss, WLAN,S atellite, Mutual Coupling.

1.INTRODUCTION

Now a day's communication system changes into wireless ubiquity which means that every person wants to reach whatever he wants, whenever he wants, wherever he wants and for this we must have broad frequency spectrum. Microstrip antenna is generally used for many wireless applications due to light weight and patch can be of any shape. Patch is generally made of material such as copper or gold. In radar and satellite communication, it is necessary to design antennas with very high directive characteristics to meet the demand of long distance communication and the most common configuration to satisfy this demand is the array form of the Microstrip antenna.

The main objective of MIMO antenna is to reduce the correlation between the received signals among the antenna ports and maximize the channel capacity[1].The correlation between the received signals is mainly due to the mutual coupling of the transmitting MIMO antennas.By calculating the mutual coupling,we can analyze the electromagnetic field interaction which are existed between antenna elements of MIMO systems.The mutual coupling mainly depends on the distance between the antenna elements. The main source for this mutual coupling is studied in [2,3].For the reduction of mutual coupling there are various methods like, using Electronic Band Gap (EBG) structures, defected ground structures, decoupling techniques, etc..

Further, most of the antennas presented in the literature are either complex in their structure or bigger in size and hence require careful manufacturing procedure than that of the regular microstrip antenna for practical applications. In this paper, we have designed a simple inverted U-shaped MIMO antenna [4] to achieve dual band of frequencies resonating at 2.8GHz and 6.4GHz with a return loss of <-10dB. The proposed antenna may find applications in wireless and satellite communications.

2.ANTENNA DESIGN

In this design, microstrip antenna is used due to its light weight, thin size and patch can be of any shape. MIMO patch microstrip antenna has been selected for this investigation as it is simple in design. The structure of an inverted U-shaped MIMO patch antenna is shown in Fig.1.

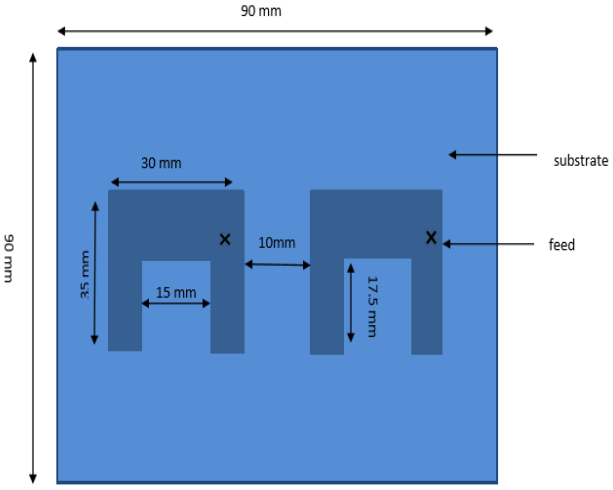

Figure 1: Inverted U-Shaped MIMO Patch Antenna

This antenna is etched on a FR-4 substrate with relative permittivity 4.4 and thickness of 1.8 mm. FR-4 in comparison has a higher dielectric constant which results in a smaller patch size. On the top layer of antenna, there is rectangular shape radiating plane with dimension of 35x30 mm with U-shaped fractal [5] with dimension of 17.5 mm x15 mm. On the bottom layer, there is a square shape ground plane with side length of 90 mm. Co-axial feeding technique is used as excitation method.

The two antenna elements are separated by a distance of 10 mm in this proposed MIMO system. For the proposed antenna we have obtained the dual band of resonating frequencies at 2.8GHz and 6.4GHz. These frequency bands of operation with less mutual coupling can be used for Wireless LAN, Aeronautical radio navigation at 2.8GHz[6] and Satellite communications (uplinks) at 6.4GHz[7]. Some of these band frequencies are also used for WiMAX (Wireless interoperability for microwave access) and wireless communications.

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TheS11andS21results are presented in Fig.2(a) & 2(b) respectively. From the observed results it is evident that the proposed MIMO antenna exhibits excellent isolation properties (*S*21) at the resonant frequencies of 2.8GHz and 6.4GHz with better return loss (*S*11) of -25 dB and -27 dB respectively, which gives good impedance matching for the antenna. [8,9]

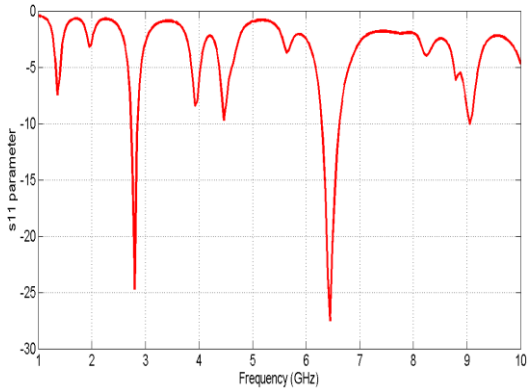

Figure 2(a): *S*11 Parameters of the Proposed Antenna

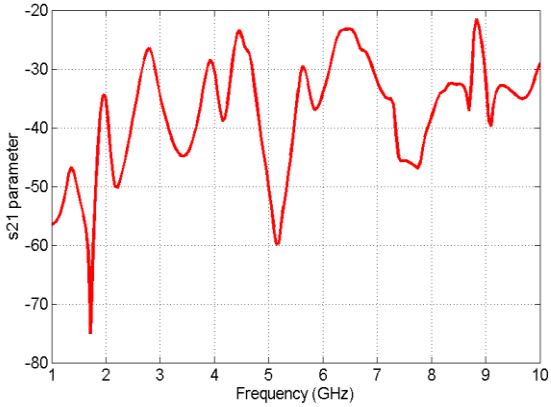

Figure 2(b): *S*21Parameters of the Proposed Antenna

The VSWR plot of the proposed MIMO array is presented in the Fig.3.The plot gives the desired values of VSWR at the resonant frequency which is less than 2.

The less VSWR value is observed at the resonant frequencies 2.8GHz and 6.4GHz, indicating good matching conditions. The radiation pattern of the proposed antenna at the resonant frequencies is as shown in Fig.4(a) & 4(b).

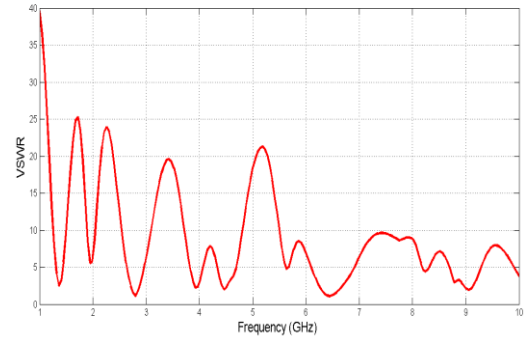

Figure 3: VSWR Plot of the Proposed MIMO Antenna

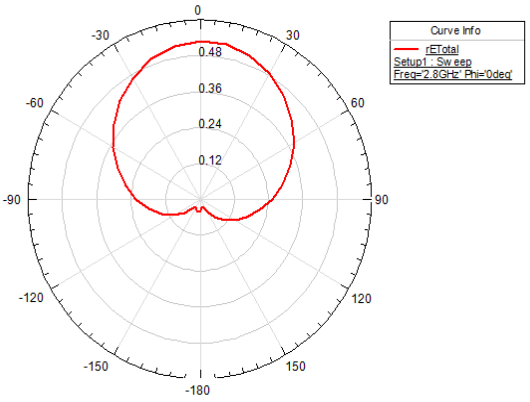

Figure 4(a): Radiation Pattern at 2.8 GHz for $\Phi=0^0$

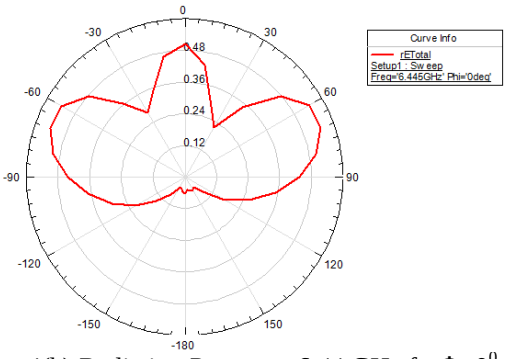

Figure 4(b):Radiation Pattern at 6.44 GHz for$\Phi=0^0$

The 3D polar plot of proposed MIMO antenna is shown in figure 5.

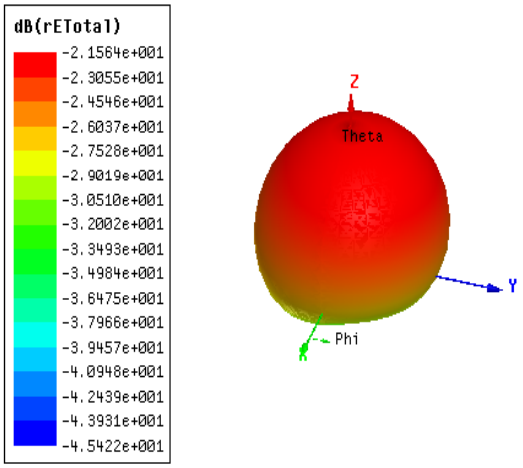

Figure 5: 3D Polar Plot of Proposed MIMO Antenna

3. CONCLUSION

A good design of antenna can improve the performance of the system. In this paper we have proposed an inverted U-shaped MIMO patch antenna which produces dual band of frequencies resonates at 2.8GHz and 6.4GHz with excellent return loss of <-25dB. Hence from the above results we can conclude that this MIMO antenna is well suited for wireless(WLAN) and satellite communications.

DOI 10.17148/IJIREEICE.2015.3325

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