IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Compact 2x2 MIMO Development for WiMAX, WLAN and C Band Communications

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Abstract:

The wireless technology demands efficient antenna which could radiates at multiple frequencies. The 2x2 MIMO system has been developed, analyzed, designed and presented. The FR4 material has been utilized as a substrate to consider the proposed structure for cost effective industry applications. The slots are created over the top surface of the presented antenna. This will increase the current distribution and exhibits the optimum radiation. The partial ground plane is created to achieve the Ultra Wide Band (UWB) response from the presented MIMO system. When a couple of radiators are positioned nearer to each other, there is a mutual coupling effect which significantly drop down the antenna performance. To reduce this effect, isolating geometry has been engineered and united with the ground plane. The output parameters such as ECC, CCL and MEG were received and presented. The values of output parameters and reflection coefficient make the antenna suitable for WiMAX, WLAN and C band communications.

Keywords: Wireless communications, MIMO, UWB

I. INTRODUCTION:

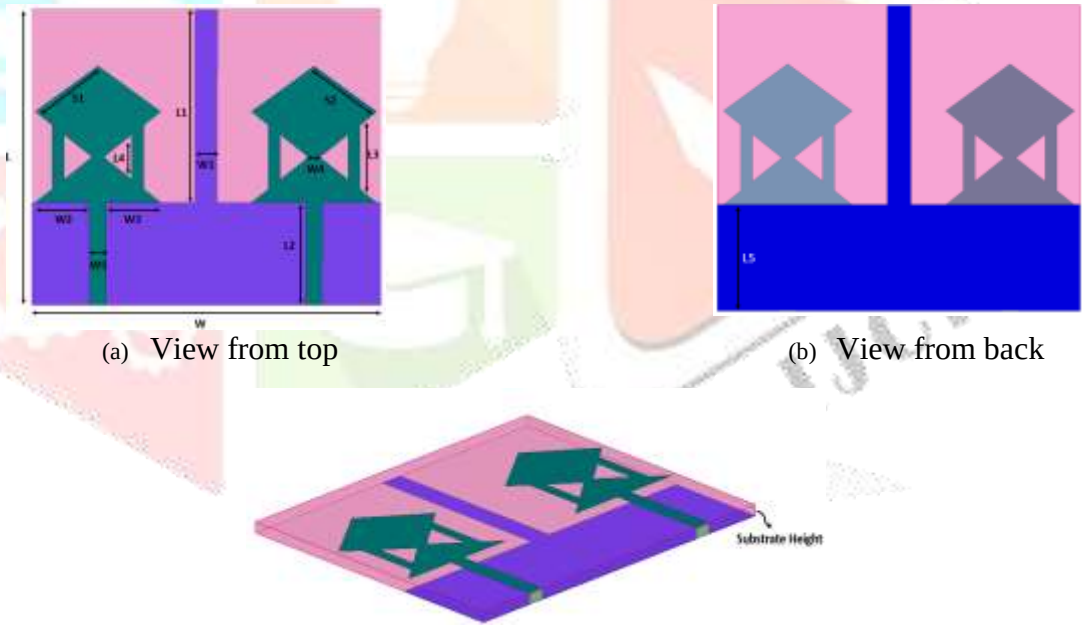
Before two decades, Ultra-Wide Band (UWB) antenna was not investigated and presented due to unawareness regarding its advantages. However, since last 20 years, many researchers have paid their concentration in developing the designing the UWB antennas [1]. The requirement needs a smart, compact antenna that covers the application-oriented frequencies for navigation, WiFi, and satellite communication. In order to get the desired response, various feeding techniques could be utilized, viz., microstrip line feed, insert feed, and quarter-wave feed. The presented design utilizes a quarter-wave feeding technique to meet the maximum impedance matching requirement. The left-handed material helps to reduce the size of an antenna significantly and get the desired frequency bands for specific applications. Metamaterials are artificial materials that show negative permittivity and permeability for certain frequency spectrum [1– 4]. Split Ring Resonator (SRR) is considered a fundamental block for metamaterials. The artificial metamaterials make themselves suitable for enhancing the electromagnetic properties of any microwave devices such as antennas. It also enhances filter performance with overall structure compactness and application-oriented frequency resonance [5, 6]. Dual-band microstrip antennas could be used for higher frequency performances [7]. Complementary Split Ring Resonator (CSRR) could also be an effective technique to enhance antenna performance [8]. The literature also exhibits a combination of microstrip slot and SRR which plays a significant role in designing a miniaturized antenna for dual-band performance [9]. The radiation characteristics and miniaturization techniques have been systematically covered in [10]. The researchers have also tested the SRR technique to get an adequate response from reconfigurable antennas [11]. The literature also covers a wide spectrum of miniaturization without the presence of SRR/CSRR; however, optimum size reduction may not be achievable [12, 13]. There are many effective and interesting techniques are available for antennas miniaturization and bandwidth enhancement like negative refractive index materials [14- 18], planar inverted antennas[19-25] Here, to further improve the isolation level, a fork-shaped slot was created in ground plane. Due to this, the isolation is improved and reach up to 20 dB. In recent time, unique types of UWB antennas were proposed for achieving higher isolation between the internal ports. They have designed the structures with and without

notch filters [26-43]. Despite of 15 dB isolation, it is advisable to achieve higher isolation to receive the adequate MIMO response.

Figure 1: Flow of antenna designing

II. ANTENNA GEOMETRY:

The design of two port MIMO antenna with defected ground plane is visible in figure 1 (a). The figure 1 (b) depicts the antenna view from backside. The slots are deployed on the top of the surface to increase the current distribution. As the current path increase, the radiation increase. The partial ground plane is depicted in figure 1(b). It is required to receive the optimum wide band response. An extra conducting strips are added and united with the ground plane to reduce the effect of mutual coupling by improving the isolation.



(a) View from top (b) View from back

(c) Bird-eye view

Fig. 1. Antenna design

The figure 2 (a) and (b) depict top view and back view of the fabricated antenna model.

III. RESULT AND DISCUSSION:

The developed design is fabricated and measured. The design was first developed using High Frequency Structure Simulator(HFSS). The software generated and actual return losses were compared for systematic analysis. The figure 3 depicts the graph of comparison aforesaid comparison. The measured graph is having very good correlation with the simulated graph. Certain sets of experiments are performed to receive the adequate trade-off between the antenna size miniaturization and output parameters. It is seen from the graph

of reflection coefficients that the MIMO antenna elements are having satisfactory isolation level. The MIMO structure radiates from 1.8 GHz to 11.6 GHz frequency band where all targeted resonances are covered for specific applications.

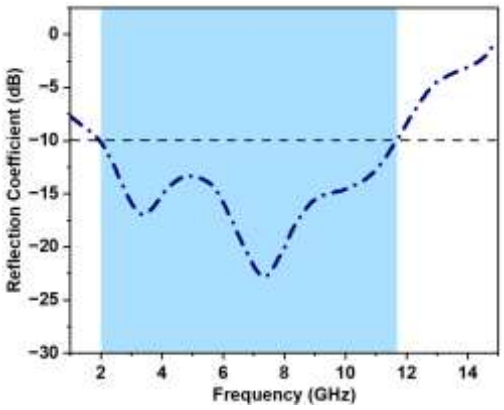


Fig. 3. Graph of reflection coefficient Vs. Frequency

IV. MIMO Diversity Characteristics:

Necessary all diversity parameters of proposed MIMO structures are carried out and presented through figure 4. Channel Capacity Loss (CCL), Mean Effective Gain (MEG) and Envelop Correlation Coefficients (ECC) were carried out for resonating band. The threshold level of data transmission rates could be predicted by close observation of CCL. The depicted CCL values for targeted resonance are below 0.4 bits/sec/Hz. The MEG is nearer to the one for both adjacent and diagonal elements. The correlation factor could be depicted from Envelope Correlation Coefficient (ECC).

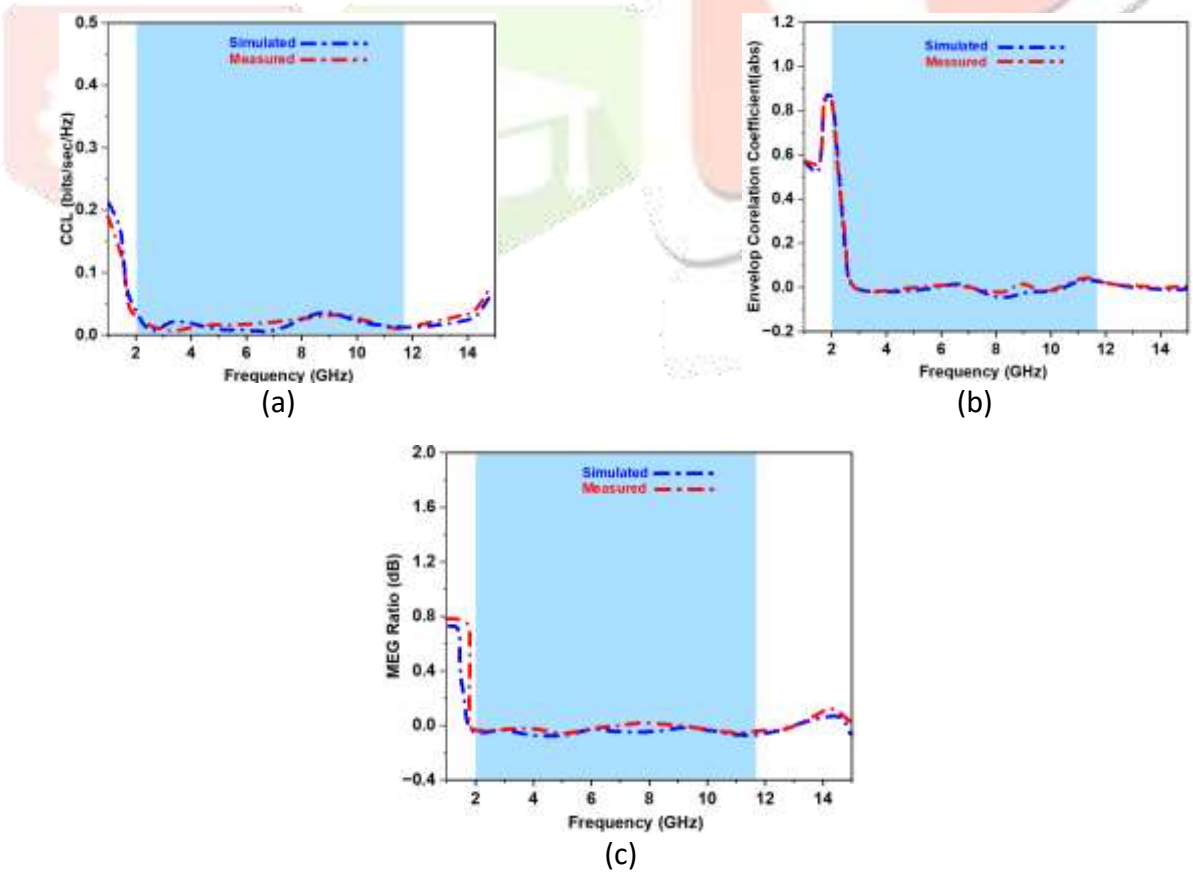
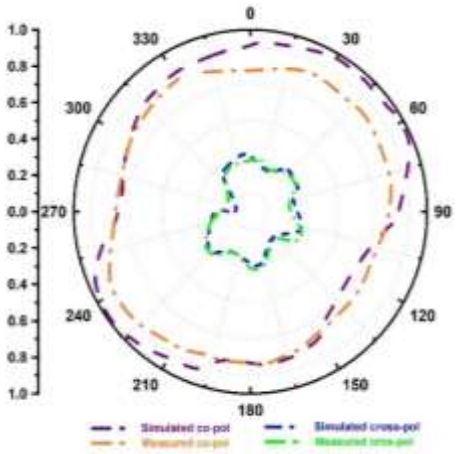
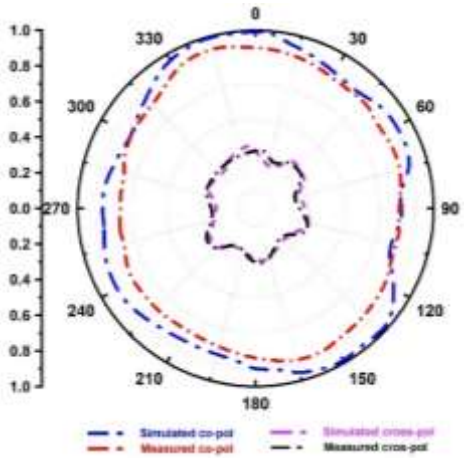


Fig. 4. MIMO Antenna Parameter (a) CCL (b) MEG (c) ECC

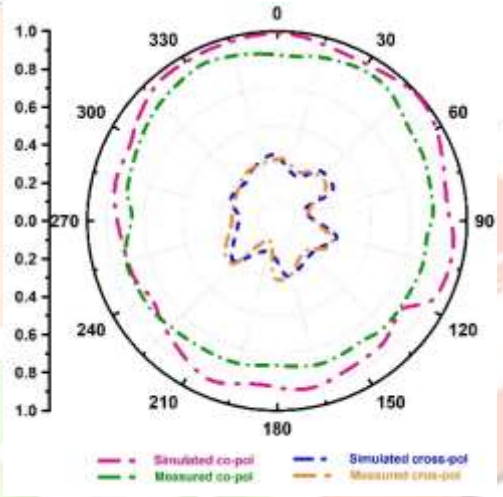
The figure 5 (a), (b) and (c) depicts the 2D radiation pattern for 2.4 GHz, 3.5 GHz and 5 GHz respectively. The figure illustrates the co-polarization and cross polarization graphs. The satisfactory isolation is received between the co-pol and cross polarization.



(a) 2.4 GHz



(b) 3.5 GHz



(c) 5 GHz

Fig. 5. 2-D Radiation pattern

V. Conclusion:

The 2x2 MIMO antenna structure has been developed, analysed and presented in this paper. The FR4c material was used as a substrate material. The geometry of the proposed structure is very simple to fabricate. The presented structure includes all the materials which are cost effective so the proposed structure could be consider for mass production. The antenna radiates from 2 GHz to 11.60 GHz which is considered as ultra-wide band. The other MIMO diversity parameters such as CCL, MEG and ECC are carried out and found to be satisfactory. The presented structure is also very compact which shows its potential for embedded applications as well. The compactness and cost effectiveness of the propose structure makes the antenna suitable for WiMAX, WLAN and C band communications.

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