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A Novel CPW Fed MIMO Antenna for UWB Applications

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***Abstract*—** This paper presents two planar antennas designed from a compact novel CPW fed UWB antenna. The first antenna is single UWB antenna. The single UWB antenna covers the entire UWB frequency band. Single antenna operates in 2.8 GHz to 12.6 GHz. The second antenna is MIMO antenna which is made with orthogonal placement of two UWB antennas and MIMO antennas covers the entire UWB frequency band. The MIMO antenna with orthogonal placement of antennas operates in 2.9 GHz to 12.7 GHz band. The designed single antenna has dimensions of 27 X 34 X 1.6 mm^3 and MIMO antennas have volume of 61 X 34 X 1.6 mm^3 for orthogonal placement. Antenna has satisfactory performance in terms gain, radiation pattern, return loss, voltage standing wave ratio, envelope correlation coefficient and diversity gain for UWB MIMO application.

Keywords*—Multiple-input-multiple-output (MIMO), Ultra wideband, Compact, CPW Feed.*

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I. INTRODUCTION

Ever since the Federal Communications Commission (FCC) released 3.1 to 10.6 GHz as an unlicensed band for radio communication, Ultra wideband (UWB) communication has drawn wide interest from the researchers for increasing the data rate in wireless communication. Due to many attractive features, such as simple structure, light weight, and low cost, printed antennas are the most frequently used antennas for UWB applications [1-4]. However, the planar monopole antennas for UWB communication system are still facing many challenges. The UWB communication system has allowed very low power ejection level hence it could be easily interfered by nearby communication. Multiple-input–multiple-output technology is being utilized in 4G wireless standards to meet the high data rate requirements in multiple approaches in wireless channels. The purpose of combining the UWB with MIMO technology is to achieve higher data rates and reliability for better communication. In this paper, two CPW-fed UWB-MIMO antennas are reported. First antenna is single CPW Fed UWB antenna shown in figure 1 and second MIMO antenna is obtained from orthogonal placement of same antenna. The antenna is designed in such a way that no separate structure is required to increase isolation and MIMO antenna operate in entire UWB band. We obtain the frequency range 2.7 GHz to 12.5 GHz for single antenna and 2.9 GHz to 13 GHz for orthogonal arrangement. The antennas are successfully designed by using CST MWS. The antenna design and the restrained return loss, radiation pattern gain, envelope correlation coefficient, diversity gain, isolation curve for MIMO arrangement and other parameters are discussed in detail.

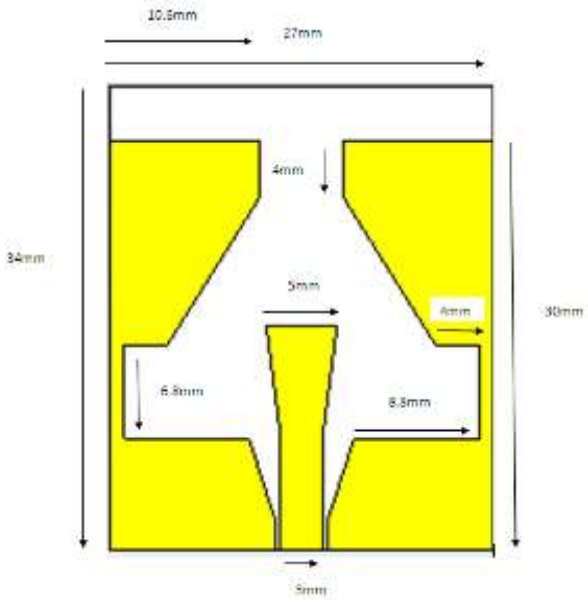

Fig. 1. Proposed UWB antennas system with all dimensions are in millimetres (mm).

II. DESIGN DETAILS

The proposed novel UWB antenna design is shown in figure1. Figure 2 shows the UWB-MIMO antenna system with orthogonal arrangement. The MIMO antenna has a size of 61 X 34 mm^2 and. FR4 material is used as a substrate of antennas with the thickness 1.6 mm, loss tangent 0.02 and dielectric constant value 4.4. The width of central CPW feed line, is fixed at 3 mm to attain 50 Ω Characteristics impedance. Designed UWB-MIMO antenna uses single antenna with dimensions 27 X 34 mm^2.

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A. UWB-MIMO Antenna with orthogonal arrangement

The UWB-MIMO antenna with orthogonal arrangement is shown in figure 2. Designed UWB-MIMO antenna uses single antenna with dimensions 27 X 34 mm^2. The other element is positioned at 90^o with respect to first element thus the overall MIMO antenna has a size of 61 X 34 mm^2. The translation vector of second element are x=32.5 mm and y=0 mm. The rotational vector used has value of z= 90^0.So this MIMO antenna arrangement is orthogonal arrangement. Proposed antenna is resonating with the UWB frequency range 2.9 GHz to 12.7 GHz.

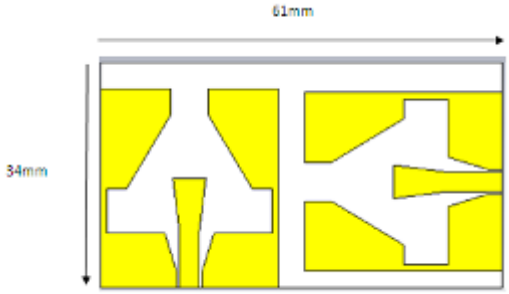

Fig. 2. Proposed UWB-MIMO antennas system with orthogonal placement of antennas

III. SIMULATION AND MEASUREMENT RESULTS

The return loss curve for simulated designed single UWB antenna is shown in Figure 3.Figure 4, 5, 6 and 7 shows the return loss curve for orthogonal arrangement (s11, s12, s21 and s22). From result of simulation, it can found that the designed antenna achieves good impedance matching within frequency band of 3.1 - 10.6 GHz for UWB applications. Voltage standing wave ratio is less than 2 from 2.66 GHz to 13 GHz, which covers the frequency band of UWB band (3.1 - 10.6 GHz or more).

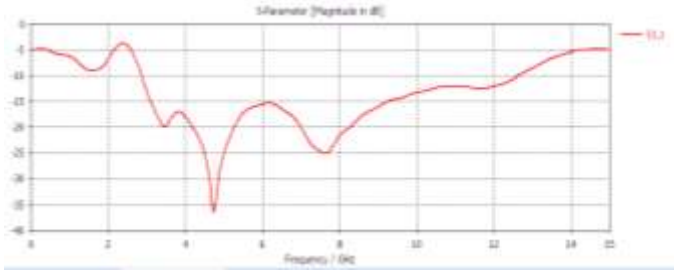

Fig. 3. Return loss curve of simulated single UWB antenna

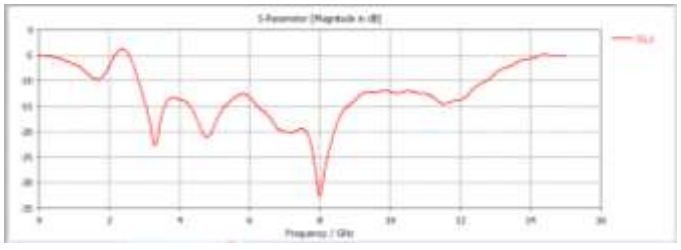

Fig. 4. Return loss curve of UWB-MIMO antenna with orthogonal arrangement (s11)

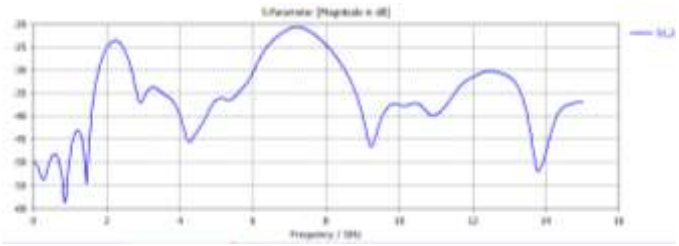

Fig. 5. Return loss curve of UWB-MIMO antenna with orthogonal arrangement (s12)

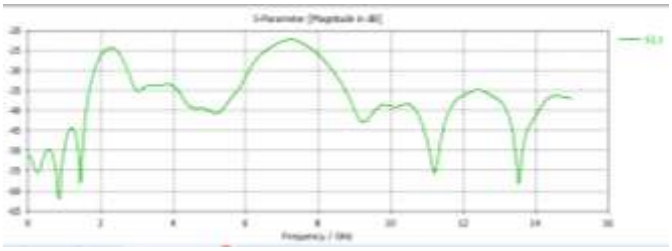

Fig. 6. Return loss curve of UWB-MIMO antenna with orthogonal arrangement (s21)

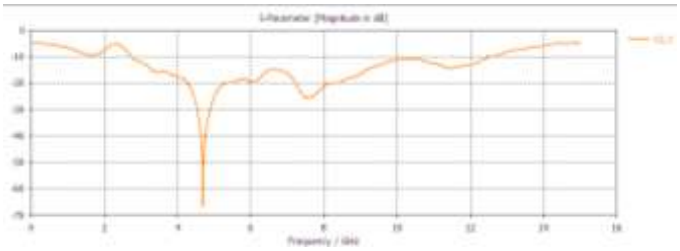

Fig. 7. Return loss curve of UWB-MIMO antenna with orthogonal arrangement (s22)

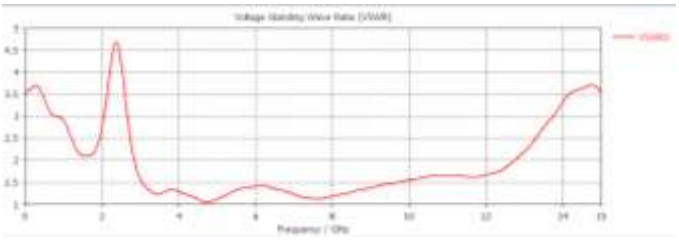

Fig.8. VSWR curve of the proposed single antenna

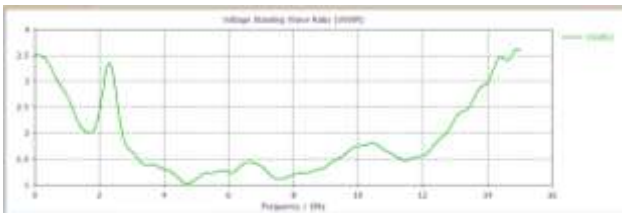

Fig.9. VSWR curve of the proposed MIMO antenna with orthogonal arrangement

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The Envelope correlation coefficient (ECC) is one of the figures of merit which can be helpful to find the performance of diversity for MIMO antenna [16].The ECC measurement is also capable for measuring the faded signal or capability of diversity of antenna. Figure 8 shows the ECC measurement for designed antenna. Obtained ECC value is less than 0.12 and 0.004 respectively for two MIMO antennas. On comparing with other papers the recorded ECC value is approx 50% improved [21-23]. For the diversity gain, a good diversity performance can be attained as the correlation coefficient is less than 0.7 [17]. Hence low envelope correlation and the requirements for good diversity performance are achieved. Proposed MIMO antenna provides diversity gain greater than 9.83 respectively; for entire UWB band and it is good for MIMO antenna. On comparing with other papers the recorded diversity gain value is approx 34% improved [21-23].Diversity gain vs frequency curve shown in figure 9. A wideband matching from 2.8 GHz to 12.7 GHz for orthogonal arrangement as shown in figure 2.The maximum gain vs frequency curve of designed antenna is shown in figure 11 for orthogonal arrangement.

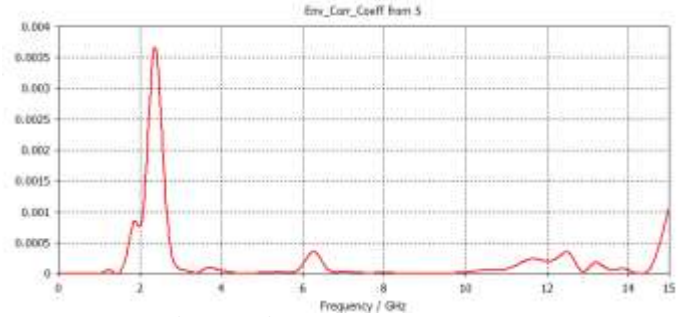

Fig.10. ECC vs frequency for proposed MIMO antenna with orthogonal arrangement

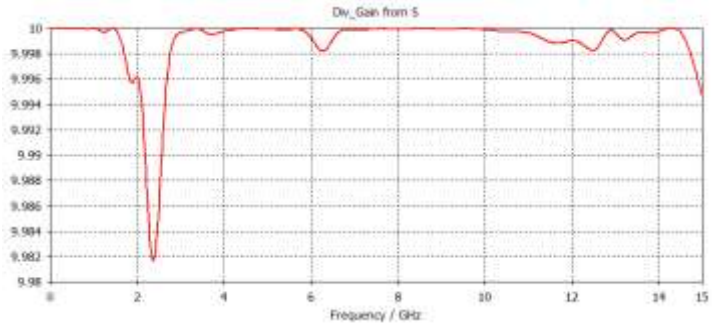

Fig.11. Diversity gain vs frequency for proposed MIMO antenna with orthogonal arrangement

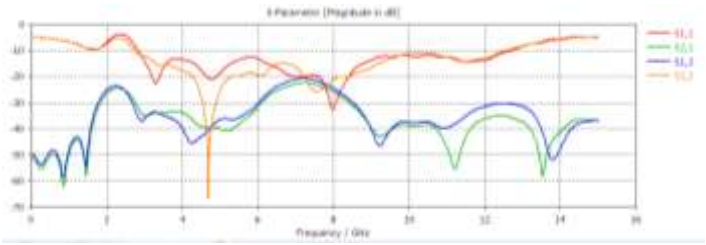

Fig.12. Isolation of the proposed MIMO antenna with orthogonal arrangement

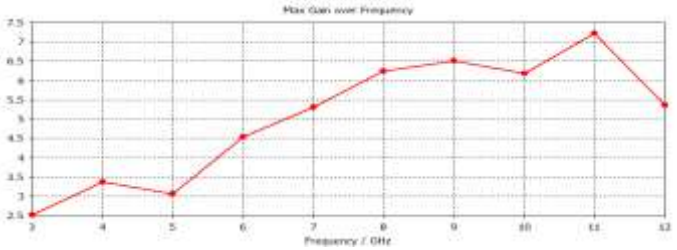

Fig.13. Maximum gain vs frequency for proposed MIMO antenna with orthogonal arrangement

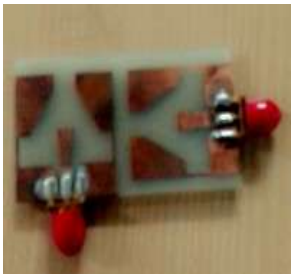

Fig.14. Hardware of Proposed CPW fed UWB-MIMO antenna

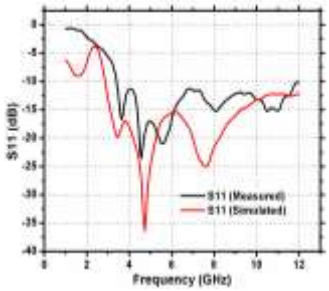

Fig.15. Comparison between simulated and measured result (S11) of primitive antenna

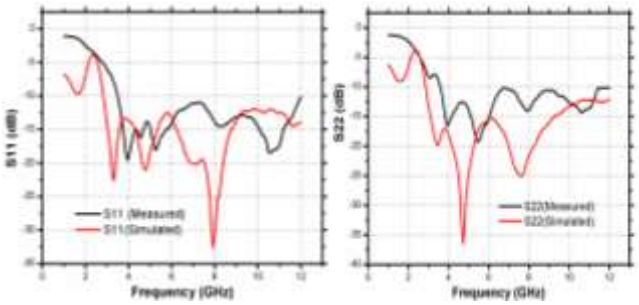

Fig.16. Comparison between simulated and measured result (S11 and 22) of UWB-MIMO antenna with orthogonal arrangement

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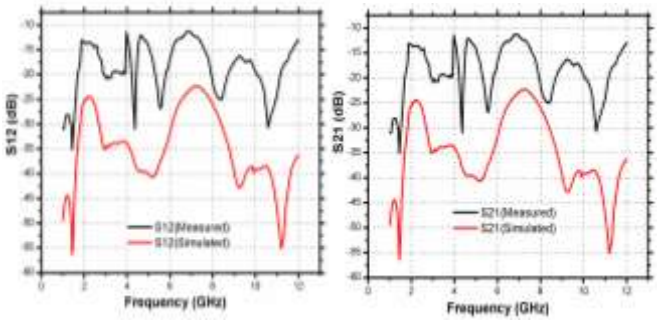

Fig.17. Comparison between simulated and measured result (S12 and 21) of UWB-MIMO antenna with orthogonal arrangement

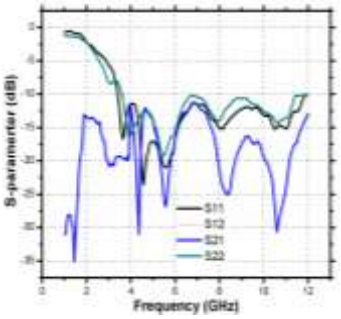

Fig.18. Measured isolation curve of the proposed UWB-MIMO antenna with orthogonal arrangement

IV. CONCLUSION

In this paper, two 2 X 2 multiple input and multiple output antenna arrays are designed for UWB application. The UWB-MIMO orthogonal arrangement has been designed for UWB applications. The entire UWB operation frequency range is achieved by MIMO arrangements. The proposed antenna is studied and simulated by the CST MWS. First antenna has a wide operating band of 2.8 GHz to 12.6 GHz (voltage standing wave ratio is less than 2). The MIMO antenna operates in 2.9 GHz to 12.7 GHz and has orthogonal arrangement of antenna. The radiation patterns proposed antenna show good omnidirectional pattern over the entire operating band. The designed antennas are expected to find application in various UWB systems. The antennas show good isolation, diversity gain and ECC < 1 which make them suitable candidate for UWB MIMO applications.

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