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Circular Slotted MIMO Design to Reduce Mutual Coupling for UWB Applications

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Abstract A compact, Circular slotted Multiple-Input-Multiple-output (MIMO) design for Ultra-Wide Band (UWB) applications to decrease mutual coupling is proposed. It works between 3.1GHz-13.5GHz with impedance transmission capacity of 10.4GHz which incorporates the unlicensed band 3.1GHz -10.6GHz endorsed by Federal Communications Commission (FCC) in 2002. This design is planned on a FR-4 substrate having dimensions 19mm×32mm×1.6mm. This design utilizes incomplete ground plane, with two equal parasitic components and round openings on the ground plane for isolation improvement. The reception apparatus attributes, for example, the return losses, radiation efficiency and gain are studied. Besides, the exhibition of MIMO design, for example, Envelope Correlation Coefficient (ECC) is considered. This design has mutual coupling less than -25db over the 5.5 to13GHz operating band.

Keywords- Ultra wide band (UWB), Multiple Input and Multiple Output (MIMO), Federal Communications Commission (FCC), Envelope Correlation Coefficient (ECC).

I. INTRODUCTION

Wireless communications are utilized in correspondence innovation for sped up and information pace of the hand-held gadgets. There is consistent interest for scaling down and smallness of remote electronic gadgets. The eventual fate of UWB innovation is immense inferable from its gigantic preferences, for example, capability of providing high speed data rates with low power dissipation at short transmission distances. The quick development in remote correspondence frameworks has supplanted the ordinary remote advances with UWB as an exceptional innovation for utilizes like Bluetooth and wireless LANs, and so on. In antenna design as UWB frameworks require a radio wire with a working transfer speed covering the whole UWB (3.1-10.6 GHz) and fit for getting on related frequencies simultaneously. The current pattern in remote UWB frameworks is to fabricate little and low-profile incorporated circuits that are viable with versatile gadgets. The increase and data transfer capacity are influenced by size of the reception apparatus. MIMO innovation has stood out in current remote correspondence frameworks where various radio wires send a similar force at the transmitter and beneficiary along these lines expanding the channel limit without the need of extra data transmission or force.

Mutual coupling between the individual antennas ought to be pretty much as low as feasible for a proficient MIMO reception apparatus framework. Microstrip radio wires are favorable circumstances because of properties like low profile and conformality, expected minimal effort, and the simplicity of manufacture with which they can be coordinated with printed feed organizations and dynamic circuits. Microstrip fix reception apparatus comprises of an emanating patch on one side of a dielectric substrate which has a ground plane on the opposite side. The fix is for the most part made of leading material, for example, copper or gold and can take any shapes like elliptical, circular, triangular and so on. The emanating patch and the feed lines are typically photograph scratched on the dielectric substrate. The circular spaces are utilized on the ground plane to improve gain, transmission capacity and generally radio wire productivity. To take care of or communicate electromagnetic energy to microstrip radio wire there are different strategies accessible like Microstrip line feeding, coaxial probe feeding, aperture coupling and proximity coupling etc and so on. By presenting combined cuts in ground plane of equivalent length upsets and squares the current to spread from one radio wire component to other component and gives high disconnection of more than 20dB is accomplished. L-formed spaces are carved on the three-sided emanating patch to improve impedance transfer speed with surrendered ground and tree-like construction to upgrade wideband seclusion. Stub of T-Shaped is connected to the rectangular fix and set opposite to one another with tight space in the ground plane to upgrade seclusion. Two monopole recieving wires with vertical space on T-molded ground stub gives better coordinating and great detachment between two ports. In this paper, Microstrip patch antennas are concentrated to decrease mutual coupling in MIMO frameworks. This round opened circular molded MIMO reception apparatus is planned in Finite component strategy in light of Ansys electromagnetic High Frequency Structured Simulator (HFSS). In this design FR-4 epoxy dielectric substrate of measurements 19mm×32mm×1.6mm is utilized.

II. ELLIPTICAL SHAPED MIMO DESIGN

The size of the single microstrip reception apparatus is 12mm X 19mm with impedance bandwidth from 2.95GHz-12GHz. This reception apparatus works at a bandwidth of

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3.7GHz-12.5GHZ. This single reception apparatus is stretched out to MIMO with 8mm distance between the emanating patches. MIMO reception apparatus addresses the combination of two UWB radio wires with rectangular plane in the ground and 8mm partition between the receiving wires, bringing about by and large size of 19mm X 32mm.

In MIMO design high mutual coupling emerges between the emanating radio wire components because of surface flows in the ground plane and results in poor isolation.

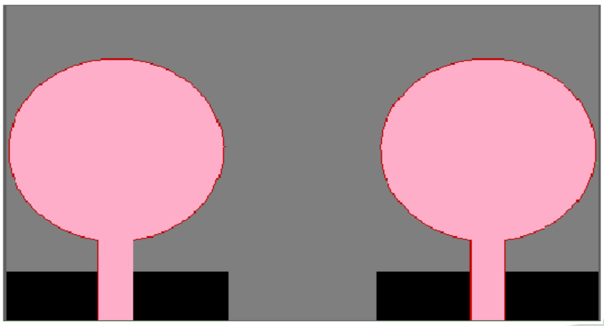

Figure 1: Elliptical shaped MIMO antenna

III. CIRCULAR SLOTTED ELLIPTICAL SHAPED MIMO DESIGN

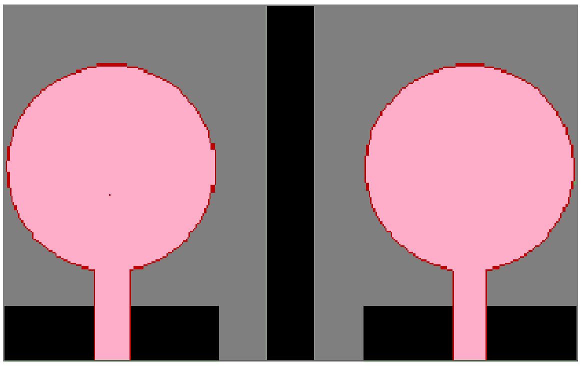

Figure 2 (A): MIMO antenna with rectangular stub

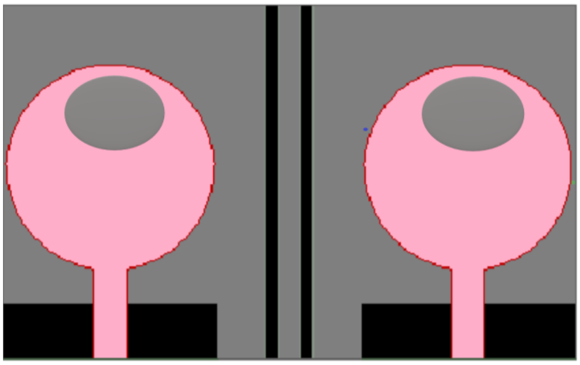

Figure 2(B): Circular slotted elliptical shaped MIMO antenna with parasitic elements.

In compact gadgets space is one of the significant limitation and execution of MIMO reception apparatus decreases because of strong mutual coupling. The principle challenge is to diminish the mutual coupling utilizing a decoupling structure while keeping up the recieving wire with reduced size.

In Figure MIMO design 2(A) a rectangular stub is fixed in the ground plane because of which there is change in conveyance of surface flows in ground plane prompting isolation improvement i.e., S12/S21< - 20dB. In Figure MIMO reception apparatus 2(B) the ground stub is opened vertically and made into two equal strips. And furthermore, a round fix is opened on curved fix to improve antenna parameters. Therefore, isolation is improved in the whole working reach i.e., S12/S21 < - 25dB.

IV. SIMULATION RESULTS

High Frequency Structure Simulator (HFSS) is utilized for examination and recreation of Elliptical molded UWB-MIMO design. The outcomes acquired in present work reason that the planned Antenna is effective from the boundaries of reception apparatus like return loss, Radiation efficiency and Radiation patterns.

A. Return losses:

S11 is called as the Reflection Coefficient or Return loss which implies the measure of influence reflected from the radio wire. The power accepted by the antenna is either transmitted or consumed in the form of losses. By and large, low loss antennas are planned where the most extreme measure of power is conveyed and transmitted to the radio wire. To do force of the proposed DGS and setting equal parasitic component MIMO reception apparatus framework with and without DGS and parasitic component are examined concerning return loss parameter.

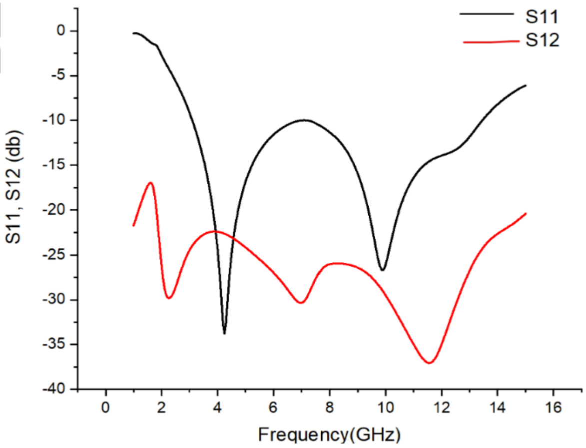

Figure 3: Simulated S11 and S12 results with Decoupling Structure

From 4 GHz to 12 GHz S11 is less than - 10 dB without setting any circular slot and parasitic component between the reception apparatus components yet subsequent to putting the roundabout space and pair of equal parasitic components between the radio wire

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components it is demonstrated that the design is working between 3.1 GHz to 13.5 GHz with palatable -10 dB return misfortune as demonstrated in Figure 3. S21 is called as Transmission Coefficient. In the wake of putting the circular slot and pair of equal parasitic components as decoupling structure an increment in the measure of separation is noticed. All through the working recurrence range, S21 is under -15 dB without decoupling structure and subsequent to setting a circular slot and pair of equal parasitic components as decoupling structure a most extreme isolation of - 25 dB is accomplished from 5.5 to 13.5GHz as demonstrated in Figure 3.

B. Radiation Pattern:

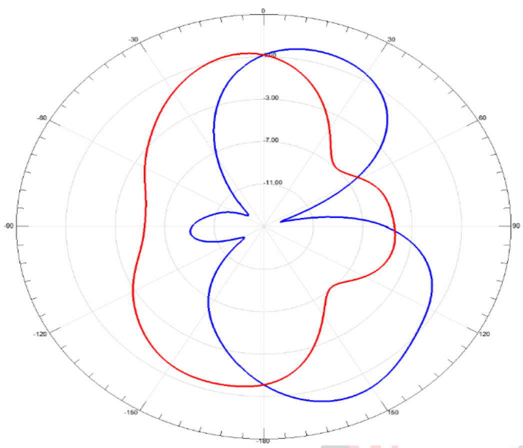

Figure 4: Simulated radiation pattern of the Proposed Antenna System at 10.6 GHz.

In the working recurrence scope of 3.1-13.5 GHz the radiation qualities of the design are examined. The radiation lobe parts at higher frequencies as a result of higher request modes. The radiation patterns are steady across the UWB. The radiation patterns appeared in Figure 4 are gotten at one port, when the other port is ended with 50 Ω load.

C. Gain and Radiation Efficiency:

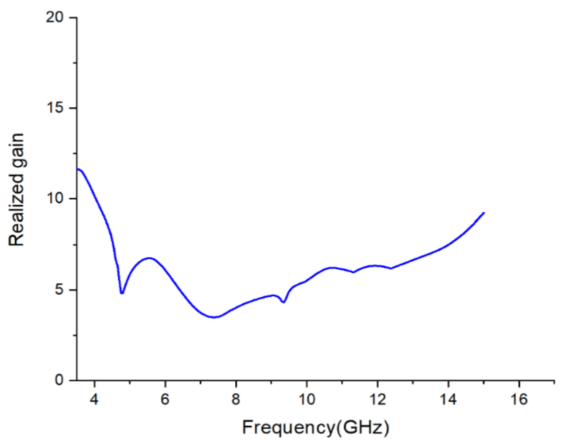

Figure 5: Simulated Gain of Proposed Antenna

The proportion between the measure of power conveyed to the antenna and the measure of power emanated from the antenna is called as Radiation Efficiency of a reception apparatus. An antenna is supposed to be high effectiveness when the majority of the power is emanated from the reception apparatus. At the point when a large portion of the power is absorbed as losses or reflected because of impedance mismatches then the antenna is called as low efficiency antenna. The proportion of the power emanated from the radio wire to the power at the input is called as Radiation efficiency. Radiation efficiency is a proportion number somewhere in the range of 0 and 1. In any case, as a rule antenna efficiency is given as percentage; Efficiency of significant worth 0.5 is equivalent to 50%. The measure of power sent in the peak radiation direction of an isotropic source is given by "antenna Gain". As demonstrated in Figure 5, the proposed design shows 7 dB gain top increase at 6 GHz. As demonstrated in Figure 6, the proposed design shows radiation efficiency above 94% in the whole operating band.

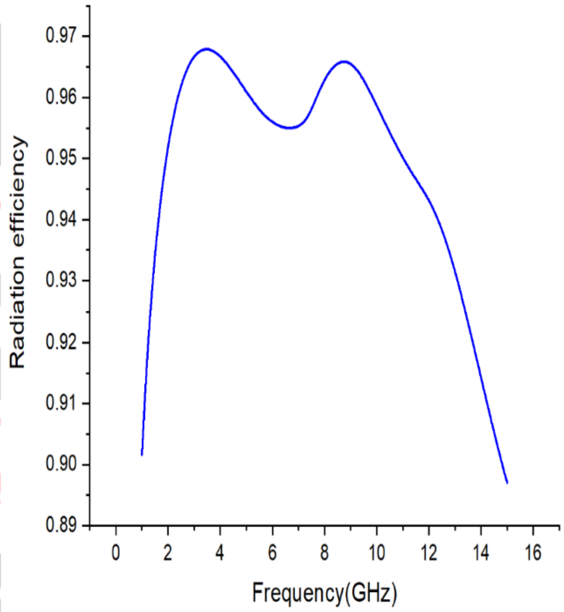

Figure 6: Radiation Efficiency of Proposed Antenna

D. Envelope Correlation Coefficient (ECC):

The dependency of one antenna radiation pattern with respect to other is given by Envelope Correlation Coefficient (ECC). At the point when one antenna is polarized horizontally, and the other is polarized vertically, the correlation between two radio wire antenna elements is zero. In like manner, when one antenna's radiation is towards the sky, and the other antenna's radiation is towards the ground, at that point the subsequent ECC is zero. Subsequently, the antenna parameters like radiation pattern, polarization, and relative phase of the fields between the two antennas are considered to compute ECC. Reproduced Simulated envelope connection coefficient (ECC) for the proposed design is appeared in Figure 7.

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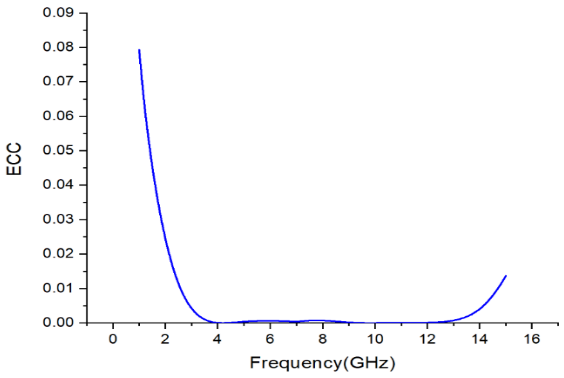

Figure 7: Simulated Envelope Correlation Coefficient (ECC) of Proposed Antenna

E. Surface Current Distributions:

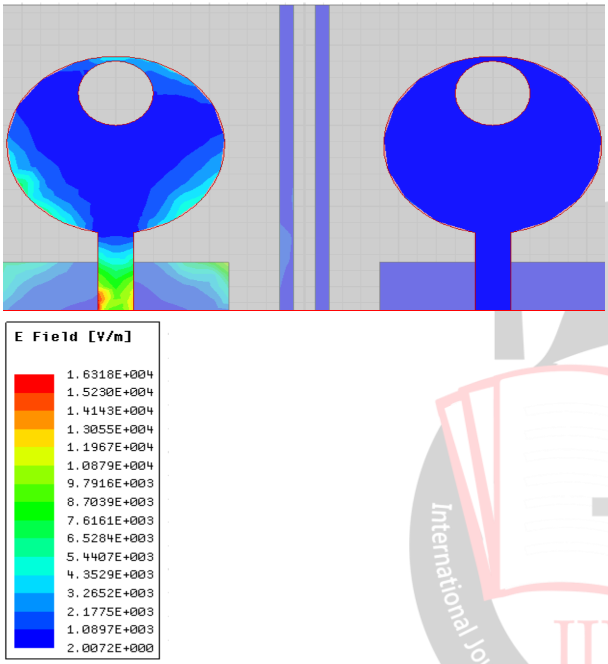

Figure 8: Simulated Surface Currents of the Proposed Antenna System at 10.6GHz

To show the fruitfulness of the proposed decoupling structure, the surface current distribution of the antenna is illustrated in Figure 8. When one port is excited and the other is terminated with a matched load the current distribution at separate frequencies is investigated. There exists a strong amount of coupling from port 1 to port 2 without the parallel parasitic elements as decoupling structure, which results in high mutual coupling between the antenna elements. With parasitic elements as decoupling structure, more current is concerted at port 1, resulting in improved isolation at port 2. Hence, due to parasitic elements in the ground plane, the amount of coupling current from port 1 to port 2 is put down.

V. CONCLUSION

The major performance characteristics namely viz. isolation and bandwidth for a circular slotted elliptical shaped microstrip patch UWB MIMO antenna are analyzed. The bandwidth of the proposed antenna covers the entire UWB and partly X band and K_U bands. The proposed antenna is of compact size providing a wide bandwidth of 10GHz ranging from 3 to 13.5GHz. There has been observed a good simulation results. This paper resulted with good return loss and less amount of mutual coupling between the antennas thus making it suitable for all MIMO applications. The bandwidth is improved by introducing circular slots on the patch and disturbing the ground plane by parasitic elements. The designed UWB antenna achieved 10db return loss frequencies ranging from 3 to 13.5 GHz, a highest peak gain of 7db at 6 GHz and a radiation efficiency above 94% in the whole operating frequencies. Proposed UWB antenna can be used for different UWB applications like Wi-Fi, WiMAX etc. Substrate size reduction, Improvement in the decoupling structure and types of slots and its placement will be a part of immediate future work.

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