A CPW Fed Antenna Design for UWB-MIMO Communication System for High isolation

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Abstract— ***A compact planar monopole ultra wide band (UWB) antenna is described with coplanar waveguide (CPW) feed for MIMO applications. The radiator and ground plane of the antenna are etched onto a piece of substrate with an overall size of 28.5mm × 42mm × 1.524mm. Implication from simulation shows that the antenna achieves a broad operating bandwidth of 3.2-10.6 GHz for a -10 dB return loss and Comb shaped DGS has significantly reduced the correlation of MIMO system. The antenna features Omni- directional radiation pattern with high radiation efficiency of 73.3% to 97.2% across ultra wide band bandwidth***.

Keywords- UWB MIMO antenna, omni-directional antennas, Comb DGS, High isolation, CPW feed, Correlation.

I. INTRODUCTION

Modern communication system aimed at high data transmission rate. Implementation of MIMO in small handheld devices is difficult because of its large size and also due to closely spaced antennas signals which are highly correlated. And hence the MIMO communication performance degrades. The requirement of MIMO antenna which is adapted at the mobile application aimed at high isolation, compact size and less correlated.

Ultra wideband (UWB) communication has got greater advantages over any other communication system as, it incorporates with high speed data rate, extremely low spectral power density, high precision ranging, low cost, and low complexity, since the Federal Communication Commission (FCC) allowed 3.1–10.6GHz unlicensed band for UWB communication[1]. Moreover, it provides Ability to work with low SNRs and High performance in multipath channels.

UWB antenna [2] is a very promising technology for short-range wireless communications providing the opportunity of high data rate communications and the MIMO technology exploits multipath to provide higher data throughput, and simultaneous increase in range and reliability all without consuming extra radio frequency. Therefore, UWB antenna along with MIMO technology has been proposed using coaxial feeding technique. As, size of antenna is an important constraint CPW feed offers several advantages like: ease of mounting electronic components due to coplanar nature, no need to drill through substrate, and easy transition to slot line [3].

While UWB MIMO with very high isolation is presented [4-5] moreover it gives bulky structure for handheld application. Most of UWB MIMO antenna [6,7,8] have low isolation and bulky structure with narrow impedance bandwidth. Hence, to achieve good performance and compact structure [9] MIMO communication system requires good isolation between two antennas. And to attain matching within Ultrawideband range, blend edge technique is used. In literature of UWB MIMO few attempts are been made to achieve compact structure [10] but lower UWB band of 3.15- 5.15 GHz is achievable.

Defected ground structure have been proposed by Dal Ahn et al., DGS introduces a slow wave effect and it is very effective in Harmonic suppression [11], changing current path for miniaturization [11] and act as resonator for antennas. To reduce mutual coupling various technologies have been given by researchers such as photonic band gap (PBG), Metamaterials, frequency selective surfaces (FSS). In this paper DGS is used to reduce mutual coupling. DGS have different shapes Dumbbell [11], U shaped, F shaped and many more here we are using comb like DGS which is etched from ground.

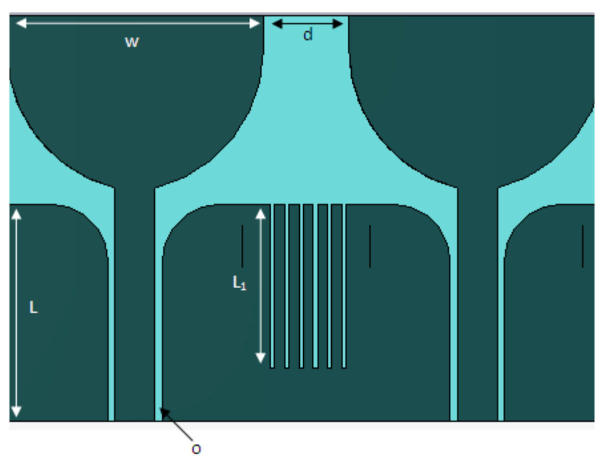


Figure 1: Geometry and configuration of proposed antenna

In this paper, focus has been given on compact structure by giving CPW feeding and to reduce mutual coupling comb DGS has been etched. As, defected ground structure (DGS) helps in reducing the overall size of antenna [12] and Besides reducing the size, DGS also alters the reactive part of the antenna's input impedance [13] and hence impedance bandwidth of the antenna may be tuned. Simulations are carried out by using CST Microwave Studio 2012. And, Antenna design is discussed in section II for 3.2 GHz to 10.6 GHz for Ultra Wide Band. Simulated results are discussed in section III and finally brief conclusion is given in section IV.

II. ANTENNA DESIGN

A. Ultra wide band Antenna

In Fig. 1 geometry of proposed antenna is having patch and ground with same width w i.e. 18 mm. The radius of curvature of patch and ground is 10mm and 4 mm respectively. The length of ground below the gap is denoted as L which is 15.25 mm. The length of coplanar waveguide is 13.8 mm where as the width is 1 mm. There is a comb shaped DGS of length 10.5 mm and width 0.3mm, it is an array of six vertical slots. O is the separation between ground and microstrip line. Antenna is printed on substrate whose relative permittivity is 3.2 with loss tangent of 0.0024 and height is 1.524 mm. Width of feeding line is decided such that characteristic impedance of 50Ω is obtained.

III. RESULTS AND DISCUSSION

Simulated result of two port scattering parameters is shown in Fig. 2. To provide more than 90% of microwave power S11 is less than -10 dB while to stop mutual coupling transmission coefficient should be less than -10 dB, over the wide bandwidth of UWB applications while for reduced mutual coupling transmission coefficient should also be less than -10 dB.

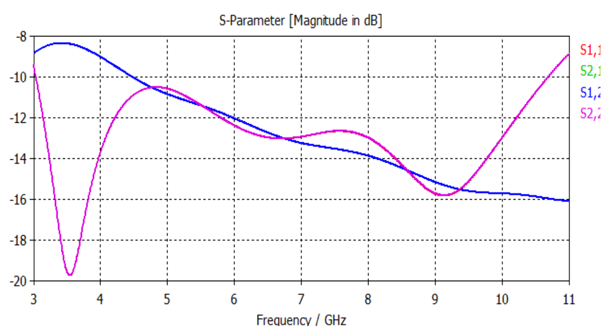


Figure 2: S-parameter of proposed antenna without DGS

Transmission coefficient of Fig. 2 shows at frequency range 3 GHz to 4.5 GHz mutual coupling is very high while return loss is good over ultra wide band and it is proposed antenna without DGS. The transient response of antenna with DGS has been shown in Fig. 3.

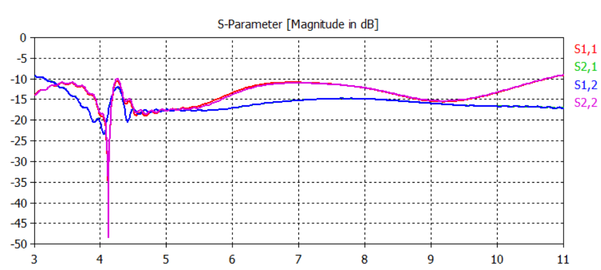
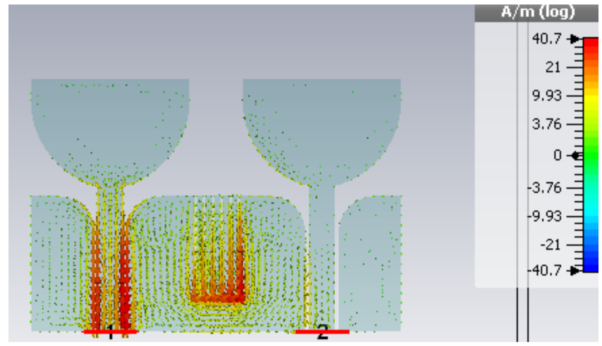
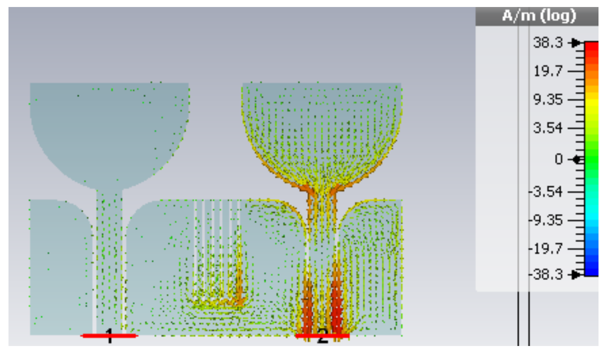


Figure 3: S-parameter of proposed antenna with DGS

To get better perceptive of antenna behavior for achieving high isolation, surface current calculation [14] is carried out and results are shown in Fig. 4. When power is given to one antenna through CPW feeding, a part of this power is coupled to other antenna hence to suppress this mutual coupling, we are using comb shaped defected ground structure and is shown in Fig. 1. with respect to both the antennas of MIMO system. At 5.5 GHz frequency some part of comb DGS is resonating. While at 3.5 GHz nearly maximum length of DGS is resonating supporting high isolation at lower frequency around 3 GHz to 4.5 GHz shown in Fig. 4. For other high frequencies only some part of DGS is resonating.



(a)



(b)

Figure 4: Surface current at (a) 3.5 GHz and (b) 5.5 GHz

Whereas, Fig. 5(a), 5(b) and 5(c) show far field radiation pattern of E-plane and H-plane for UWB antenna at 3.5, 7.5 and 9 GHz respectively with DGS. And parametric results are shown in fig. 6(a) and 6(b), in which the patch and ground edges were further blended for matching purpose.

The Correlation coefficient can be calculated from scattering parameter [15]. Correlation coefficient for a simple two network presumptuous uniform multipath environment the envelope correlation ρ is given as [15]. Using MATLAB code correlation coefficient vs frequency has been plotted in figure7.

$$\rho = \left| \frac{S_{11}^{*}S_{12} + S_{21}^{*}S_{22}}{\sqrt{1-|S_{11}|^2 - |S_{21}|^2} * \sqrt{1-|S_{22}|^2 - |S_{12}|^2}} \right|^2 \qquad (1)$$

Generally, it is considered that antenna with a level of envelope correlation less than 0.5 are capable of providing significant diversity performance in wireless communication system. From figure7, it is clear plotted result satisfy this condition.

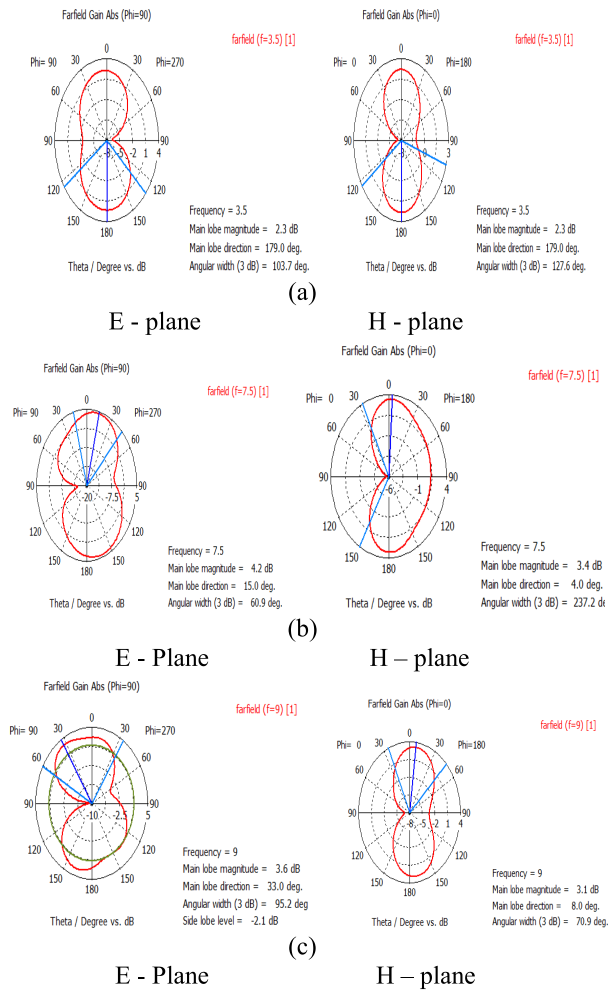


Figure 5: Far field radiation pattern of antenna at (a) 3.5 GHz (b) 7.5 GHz and (c) 9.5 GHz in E – plane and H - plane

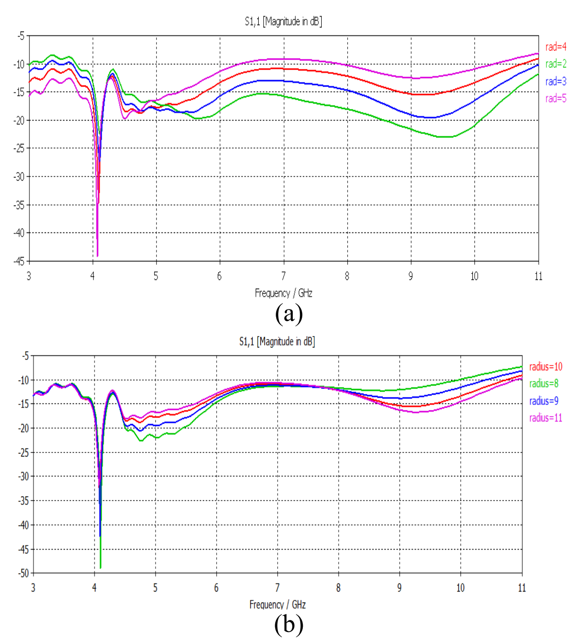


Figure 6: Return loss on blending (a) ground edges (b) patch edges

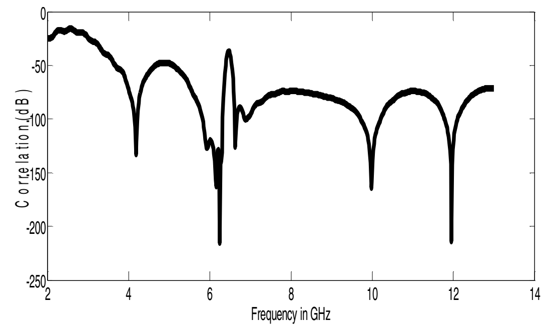


Figure 7: (a) Correlation coefficient in dB

IV. Conclusion

In the present work, compact UWB MIMO antenna has been investigated moreover high isolation with simple structure is achieved and has been shown by plotting Correlation using equation(1) where ρ is less than 0.5. Comb shaped Defected ground structure is another supporting feature for small light weight of antenna has explained. The proposed antenna is successfully designed for 3.2 GHz to 10.6 GHz Ultra Wide Band using coplanar wave guide feeding technique. Current density at different frequencies is shown to certify isolation. Fabrication and measurement of antenna are next tasks to validate proposed prototype.

V. References

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