Compact Lotus Shape Planar Microstrip Patch Antenna for UWB Application

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***Abstract*— A compact lotus shape microstrip patch antenna is presented for ultra-wide band (UWB) applications. The proposed antenna is a combination of semicircle and triangular patch, which is fed by coplanar waveguide (CPW) feed. The total size of the proposed antenna is 44 × 38 × 1.58 mm^3. Simulated results indicate that the antenna achieved an ultra-wideband impedance bandwidth (S_{11}< -10dB) of 132.14 % (2.86 to 14.0 GHz). The peak realized gain values of proposed antenna from 2.3 to 5.3 dBi against UWB frequency band.**

Keywords— lotus shape; microstrip patch antenna; coplanar waveguide; impedance bandwidth; ultra-wideband.

I. INTRODUCTION

UWB antenna is defined by the U.S. Federal Communication (FCC) [1] to have a range from 3.1 to 10.6 GHz bandwidth for commercial use. At the same time, satisfactory radiation pattern properties over the entire frequency range are also necessary. The advantages of printed antenna such as low profile, light weight and small size make them a good candidate for UWB antenna design. In addition, an advantage of printed circuit board, this also makes them suitable for integration with monolithic microwave integrated circuit (MMICs). The narrow impedance bandwidth is a disadvantage for conventional microstrip antennas. Many techniques have been explored and reported to increase microstrip antenna impedance bandwidth [2], for example, use of coplanar directly coupled and gap coupled parasitic patches [3], design using U-slot patches [4] and E-shapes patches [5]. However, results show that these techniques cannot increase the antenna impedance bandwidth more than a few tens of a percent.

Various types of UWB microstrip antenna have been investigated and implemented with different feed lines, such as microstrip line [7]-[9], coplanar waveguide (CPW) [10] and different shapes, such as the crescent patch [11].

In this paper, we have proposed a lotus shape planar microstrip antenna which is the combination of semicircular and triangular patches. The combination of these two makes radiator to radiate the incident energy across ultra-wide frequency range. Simulated return loss of the proposed antenna is presented. The return loss curve indicates that this structure achieves an impedance bandwidth as high as 132.14 %, which makes it suitable for UWB applications. The radiation patterns of the antenna in two planes are presented. The characteristics of the proposed antenna through the parametric study are investigated and presented.

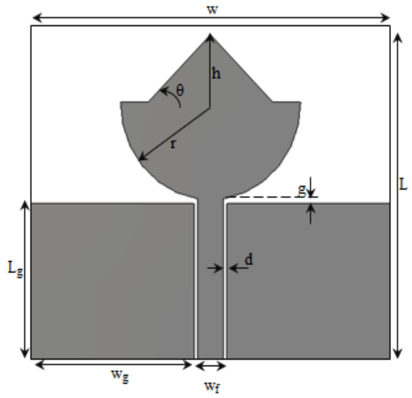

Fig. 1 antenna geometry and its design parameters

II. ANTENNA GEOMETRY

The configuration of antenna and its dimensional design parameters are shown in Fig. 1. The proposed antenna radiator is combination of semicircular and triangular patch (lotus shape), which is fed by 50 Ω CPW microstrip line. The antenna is oriented on a standard FR-4 substrate with a dielectric constant ε_r=4.4, loss tangent tan δ = 0.025 and thickness of 1.58mm.The dimensions of proposed antenna are w=44 *mm*, L=38 *mm*, r=11 *mm*, θ=*45*°, h=7.6 *mm*, w_g=20 *mm*, L_g=17.6 *mm*, w_f=3.2 *mm*, g=0.6 *mm*, d=0.4 *mm*.

III. SIMULATION RESULTS AND DISCUSSIONS

The simulation is performed using CST MW Studio 2012. The return loss of proposed antenna is shown in Fig. 2. It is observed that the impedance bandwidth of 132.14 % from 2.86 to 14 GHz is achieved, which is suitable for UWB application. Fig. 3 depicts the simulated return loss curves with different values of angles when other parameters are fixed, the angle (θ) affects the resonance frequencies and the impedance bandwidth of antenna. It can be seen that the lower edges of the return loss curve moving towards higher frequency and the impedance bandwidth decreases. Another observation is for radius (r) of lotus shape geometry. It can be seen from Fig. 4, when we increasing the '*r*', it affects the resonance frequencies shifts towards the higher frequency as well as the impedance bandwidth of antenna not matching for UWB frequency range. At *r=11 mm* the impedance bandwidth is well matched below the -10 dB.

The return loss can only describe the behavior of antenna as a lumped load at the end of the feeding line. Fig. 5 shows the radiation patterns of proposed lotus shape planar antenna at 3.4, 6.5 and 9.0 GHz. The patterns are Omnidirectional in nature for two principal planes (E- and H- plane). The antenna gain in broadside direction is plotted in Fig. 6. It is varied between 2.1 dB and 5.36 dB.

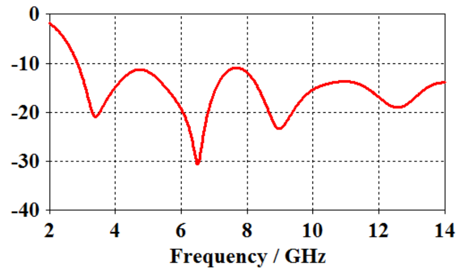

Fig. 2 Simulated return loss curve of prposed UWB antenna

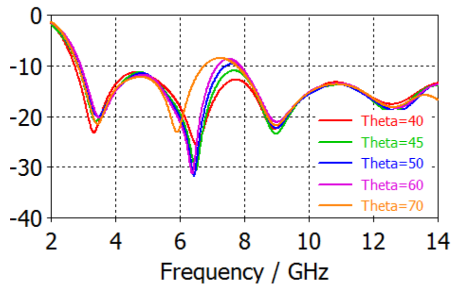

Fig. 3 Simulated return loss curve of different angles (theta) proposed UWB antenna

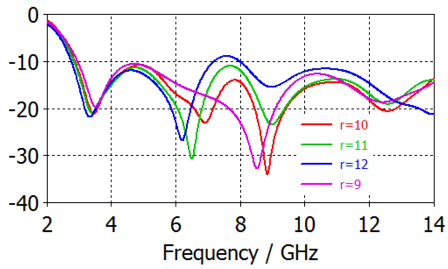

Fig. 4 Simulated return loss curve of different radis for proposed UWB antenna

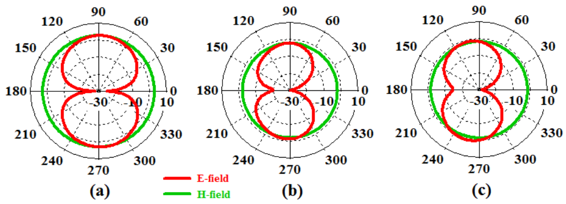

Fig. 5 Simulated radiation patterns of proposed UWB antenna at (a)3.4 GHz (b) 6.5GHz (c)9 GHz

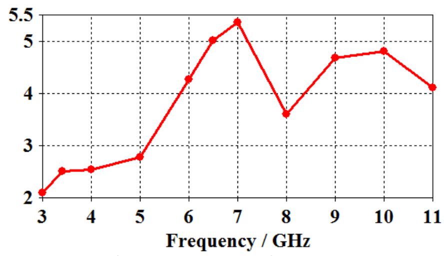

Fig. 6 Simulated gain vs. frequency curve of prposed UWB antenna

IV. Conclusion

A CPW fed microstrip antenna, is presented for UWB applications. The patch consists of a combination of semicircular and triangular patches. The antenna has a minimized total size equals to 44 × 38 × 1.58 mm^3. The proposed antenna shows an impedance bandwidth as high as 132.14% which is from 2.86 to 14GHz .The presented results show that the proposed antenna is suitable for UWB applications.

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