Conical Shape Antenna with Circular Slots for Ultra Wideband Applications

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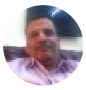

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Abstract— **In this paper an ultra wideband of conical shaped with different configurations are designed and simulated. The antenna is printed on FR4 dielectric substrate of dimensions 42 mm X 42 mm X 1.5 mm. conical shape using as a stub with circular slot etched on the ground plane, with microstrip line and CPW fed. The results shows a good bandwidth impedance below (S11< -10 dB) for the ultra wideband UWB range from 3.1-10.6 GHz. Parametric study is done to optimize these antennas to be fit with UWB wireless applications.**

Keywords- UWB antennas , Circular slots, CPW

I. INTRODUCTION

UWB is an emerging wireless technology for commercial high-data-rate, short-range communications, radar systems, and measurement. The technology can be used within an ultra-wide spectrum but with an extremely low emission power level. For example, in 2002 the Federal Communications Commission (FCC) regulated the emission limits of −41 -3 dBm/MHz for an allocated spectrum ranging from 3.1 GHz to 10.6 GHz. In future, universal antenna solutions completely embedded into portable devices are desirable, which may cover frequencies from 800MHz to 11 GHz or above in order to include all the existing wireless communication[1]. Two antenna designs for Ultra Wideband 3.1-10.6 GHz communication are introduced. The primary antenna design is an equiangular spiral slot patch antenna with an outer radius of 2.25 cm. Viability of these antennas is tested with a UWB pulse transmitter, time domain responses are compared to that of a commercial 1-18GHz double ridged waveguide horn[2]. An UWB antenna designed for green wireless applications, the proposed antenna is fabricated on an AgHT-8 film and measured. The antenna designed has better radiation efficiency relative to its size than the previous designs, good omni-directional radiation patterns throughout the FCC bandwidth of 3.1 – 10.6 GHz and a comparable gain[3]. A planar elliptical/circular slots have been demonstrated to exhibit an ultra wideband characteristic from 3.1 to 10.6 GHz are presented, printed on a dielectric substrate and fed by either microstrip line or coplanar waveguide with different shapes for tuning stub. The performances and characteristics of the proposed antennas are investigated both numerically and experimentally[4-8].

An antenna structure for UWB applications is presented. This antenna uses a radiating structure in the same plane as the ground plane, while the strip line feed is extended within the elliptical shaped structure with two circular cuts. The ultra-wideband antenna has monopole characteristics which are confirmed experimentally[9, 10]. A bow-tie aperture antenna is proposed for ultra-wide band (UWB) application. The measured impedance bandwidth is 2.7 to 12 GHz for $S_{11} < -10$ dB, the proposed antenna maintains the advantages of ease of fabrication and relatively small electrical size[11]. An ultra wideband (UWB) antenna with co-planar waveguide (CPW) feed is presented. The antenna is based on an egg-shaped conductor printed on a 30×40 mm^2 FR4 substrate of 1.6-mm thickness. The radiation patterns, peak gain, and radiation efficiency of both configurations are presented and compared, shows that the design based on the large slot yields better omnidirectional patterns and higher gains in the principal planes[12]. A novel design of an ultra-wideband (UWB) slot antenna is presented. This antenna operates as a transmitter and receiver antenna. Design procedures are developed and verified for different frequency bands[13]. A CPW fed UWB slot antenna is designed, analyzed and presented. The proposed antenna has a simple structure consisting of a rectangular slot and a triangular patch at the anterior portion of the feed that acts as tuning stub of the antenna. The prototypes has been designed and fabricated and both the impedance bandwidth and radiation characteristics are experimentally studied, the measured and stimulated results show excellent agreement. These simple structures and low profile nature of the proposed antennas leads to easy fabrication that may be built for any wireless UWB device applications[14-16]. A simple and compact coplanar waveguide fed ultra-wideband monopole-like slot antenna is presented. The proposed antenna comprises a monopole-like slot and a CPW fork-shaped feeding structure. The simulation and experiment show that the proposed antenna achieves good impedance matching, consistent gain, stable radiation patterns and consistent group delay over an operating bandwidth of 2.7–12.4 GHz (128.5%)[17]. A compact printed UWB elliptical-slot antenna of split ring resonator (CSRR) is etched inside the inner patch to obtain band-notched function. The antenna demonstrates omnidirectional radiation patterns across nearly whole operating bandwidth that is suitable for UWB applications. The prototype has been fabricated and tested, and the measured results agree well with the simulation[18]. A compact coplanar waveguide-fed ultra wideband slot antenna is designed and analysis. This antenna has simple structure consisting octagon shape on a square patch fed by 50Ω probe feed. The impedance matching and radiation characteristics of the designed structure are investigated. This antenna achieved -10dB impedance bandwidth cover about 41% and gain is about 7.5dBi[19]. A planar antenna for UWB applications has been proposed, this antenna consists of a square patch, a partial ground plane and a slot on the ground plane. various slotted rectangular mompole antenna is designed in order to meet UWB requirements and applications, such as PAN devices and medical application of microwave imaging system. Simulated are presented to validate and measured results to usefulness of the proposed antennas structure[20-22]. In this paper we present an planar antenna with multi circular slots on the tuning stub and the ground plane, to enhanced the impedance bandwidth to use for the ultra wideband applications. Tow antenna models have been design and simulate; the first one is microstrip line feed and the other is coplanar waveguide (CPW).

II. ANTENNA STRUCTURE

Planar antenna of conical stub and circular slots etched on the top and bottom of the FR4 dielectric substrate of ε_r= 4.4 dielectric constant and height h_g=1.52 mm . The antenna dimensions shown in Figure1 and Figure2.

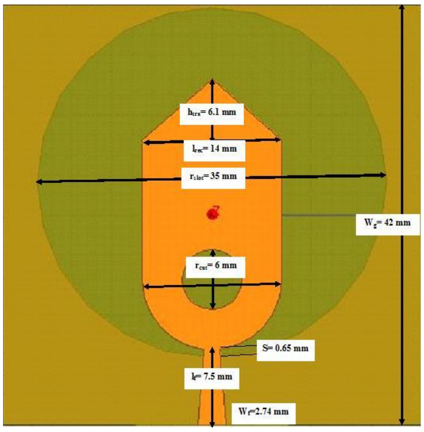


Figure 1. Microstrip line feed antenna

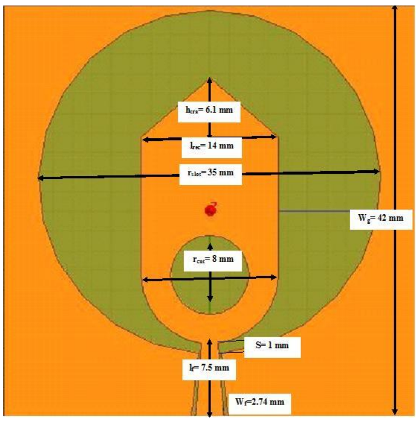
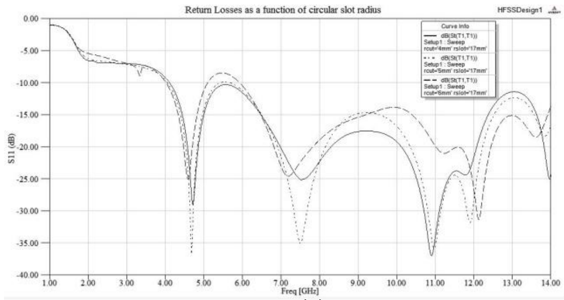


Figure 2. Coplanar waveguide (CPW) feed antenna.

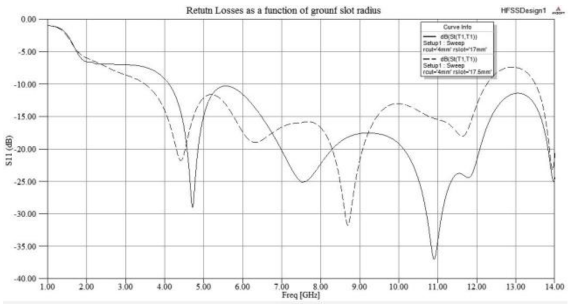
Two antennas have the same dimension and characteristics of the dielectric substrate as shown in figures above.

III. SIMULATION RESULTS

In order to achieves best characteristics for antennas for using it in UWB application, a parametric study was done to get a best dimensions; such as slot radius and the slot of the tuning stub. Figure3 show the results of the parametric study.



(a)



(b)

Figure 3. Return losses as a function of the (a) ground plane slot radius and (b) tuning stub slot radius.

As shown from figures above the best values for the slots radii are r_{slot} =17.5 mm and r_{cut} = 4 mm for the CPW antenna. Return losses is illustrated in Figure4.

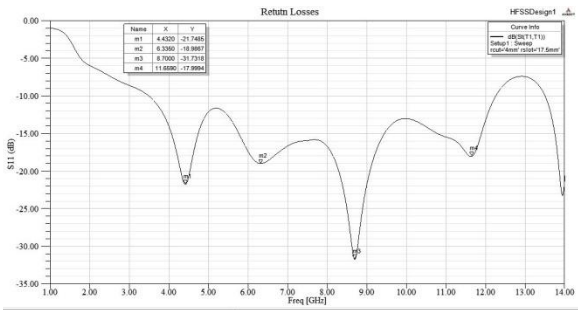


Figure 4. Return losses of the CPW feed antenna.

To avoid the reader from the sequences results same manner was done with the microstrip line feed antenna to get the best dimension for the antenna. Theses values for the slots radii are r_{slot} =17.5 mm and r_{cut} = 3 mm. Fig. V show the return losses of the microstrip line feed antenna. As shown from Fig. III and Fig. VI there are many resonant frequencies in the range of 1 GHz to 14 GHz, while; the UWB frequency range is 3.1 GHZ to 10.6 GHz. Table I list the result of resonant frequencies of the two antennas.

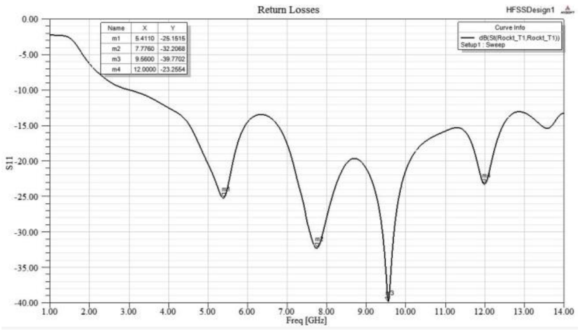


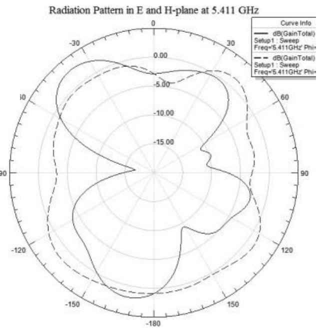
Figure 5. Return losses of the microstrip line feed antenna.

TABLE I. RESONANT FREQUENCIES FOR THE PROPOSED ANTENNAS.

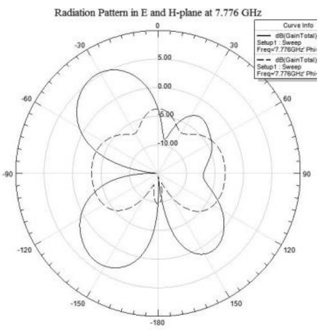
Region	CPW Antenna	MSL Antenna
1	4.432 GHz	5.411GHz
2	6.335 GHz	7.776 GHz
3	8.700 GHz	9.560 GHz
4	11.659 GHz	12.000 GHz

The radiation pattern of the proposed antennas are depicted in the Figure6 and Figure7.

—— E-plane
- - - H-plane

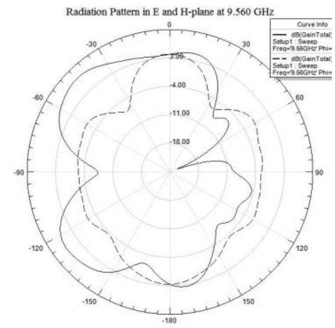


f = 4.4 GHz

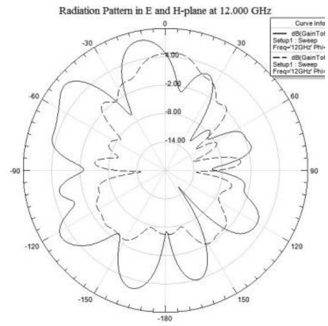


f = 6.3 GHz

—— E-plane
- - - H-plane



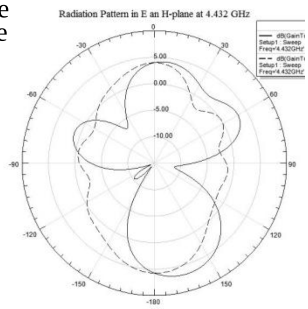
f = 8.7 GHz



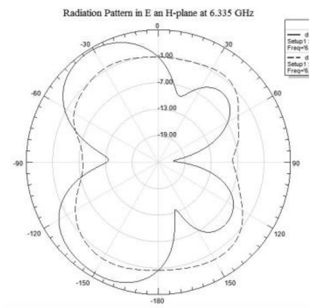
f = 11.6 GHz

Figure 6. Radiation pattern of the microstrip line feed antenna i E-plane —— and H-plane- - -

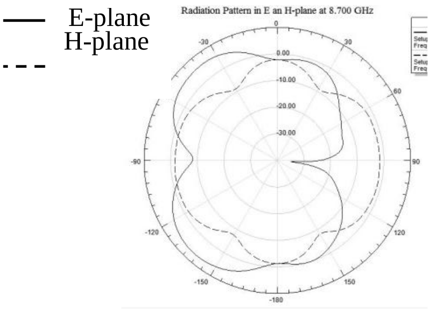
—— E-plane
- - - H-plane



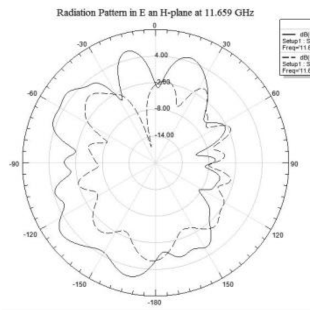
f = 5.4 GHz



f = 7.7 GHz



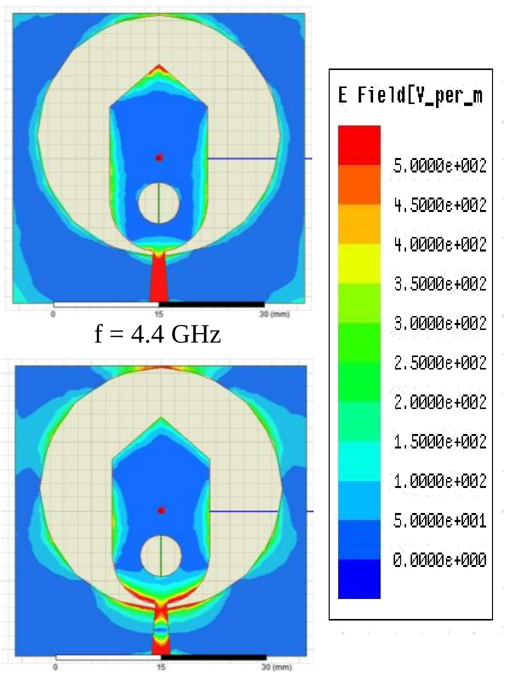
f = 9.5 GHz



f =12 GHz

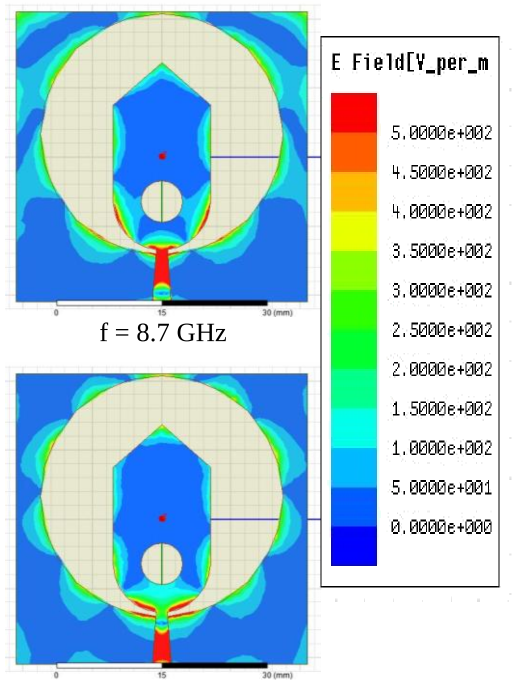
Figure 7. Radiation pattern of the CPW line feed antenna in E-plane and —— H-plane- - -

The electric field distribution of the resonance modes on the ground plane and tuning stub are shown in the Fig. IX and Fig. X.



f = 4.4 GHz

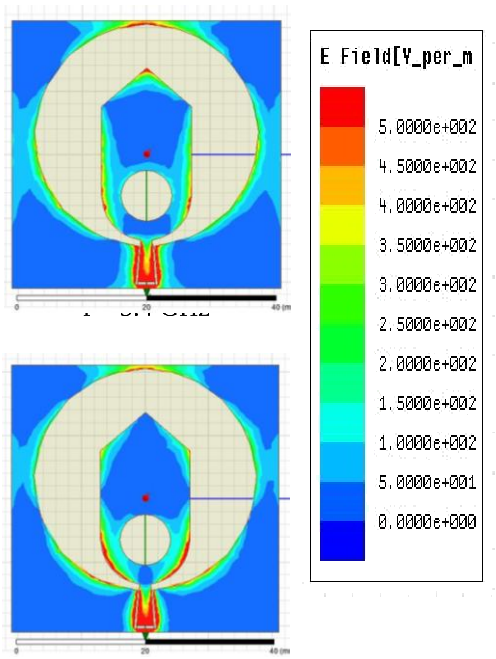
f = 6.3 GHz



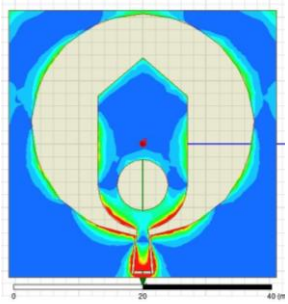
f = 8.7 GHz

f = 11.6 GHz

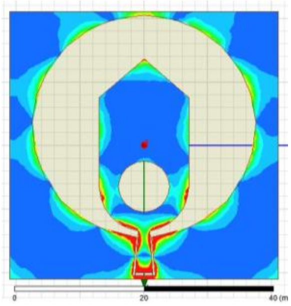
Figure 8. Electric field distribution for the microstrip line feed antenna.



f = 7.7 GHz



f = 9.5 GHz



f = 12 GHz

Figure 9. Electric field distribution for the CPW line feed antenna.

IV. CONCLUSIONS

An ultra wideband (UWB) antennas has been designed and simulated using Ansoft® **H**igh **F**requency **S**tructure **S**imulation HFSS 13.0, based on **F**inite **E**lement **M**ethod FEM, the proposed antennas is introduces high impedance bandwidth in the range of 1 GHz to 14 GHz to uses it for the UWB wireless communications applications. A parametric study has been done to optimize the best parameter for antenna design. The new design is more efficient compared with the same design without circular slot on the tuning stub as shown in Fig. XI of the return losses.

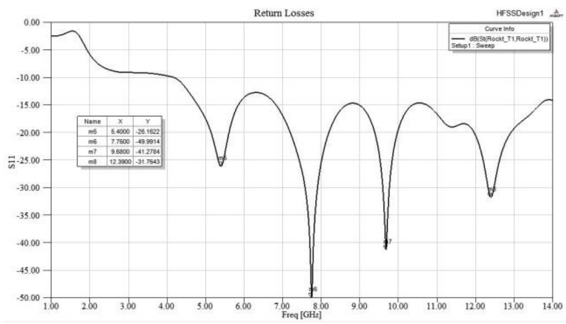


Figure 10. Return losses of the microstrip line feed antenna without circular slot on tuning stub.

The results shows a good bandwidth impedance below (S_{11}< -10 dB) for the ultra wideband UWB range from 3.1-10.6 GHz.

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