ULTRA WIDE BAND LIQUID CRYSTAL POLYMER MICROSTRIP ELLIPTICAL PATCH ANTENNA

B.T.P.Madhav, Prof. VGKM Pisipati, Prof. Habibulla Khan, VGNS Prasad, Prof. KSN Murty,

LCRC-R&D, ECE Department, K L University, Guntur DT, A.P, India
R&D, Mother Theresa Institute of Science and Technology, Sattupalli

ABSTRACT

A microstrip elliptical patch antenna was designed on liquid crystal polymer substrate for ultra wide band wireless communications. The proposed ultra wide band antenna simply consist of an elliptical patch with coaxial feeding and liquid crystal polymer substrate of 3.16 permittivity and 0.004 dielectric loss tangent placed on the ground plane. At operating frequencies of 4.5, 6, 8 GHz, the proposed UWB elliptical patch antenna was simulated which covers the range of UWB (3.1 to 10.6 GHZ). This study includes the presentation of return loss, input impedance, 3D-gain, 2D-gain, radiation patterns, E-field, H-field distributions and current distribution.

KEYWORDS: *Ultra Wide Band, Liquid Crystal Polymer, Elliptical Patch.*

1. INTRODUCTION:

For many years, ultra-wide band (UWB) antennas are having many applications in communication systems with broadband and spread-spectrum features in radar systems [1]. Recently, Ultra-wideband (UWB) technology has become one of the most promising technologies in the indoor wireless communications since the Federal Communications Commission (FCC) has released the 3.1 - 10.6 GHz frequency band in 2002 for UWB technology and its applications [2]. It has many advantages over conventional wireless communication technology such as low power consumption, high speed transmission, and simple hardware configuration. Consequently, it is a fascinating solution for short range high speed indoor mobile communications and the emerging reconfigurable and software-defined wireless networks. Therefore, a variety of shapes and designs of UWB antennas have been studied and proposed to satisfy UWB specifications.

Printed antennas offer low cost, light weight, and ease of implementation. These features are desirable for both indoor and outdoor handheld UWB antennas and many microwave applications. Several shapes and designs of UWB antennas such as square, circular, pentagonal, hexagonal, elliptical and trapezoidal shape have been proposed to satisfy UWB specifications [3, 4].

In this paper, we proposed a printed elliptical patch antenna having UWB operating frequencies at 4.5, 6.0 and 8.0 GHz. The simulation is conducted using the commercially available Ansoft High-Frequency Structure Simulator (HFSS) software [5]. The proposed antenna provides an acceptable radiation pattern and a relatively flat gain over the UWB frequency band.

2. ANTENNA SPECIFICATION

Figure (1) illustrates the proposed geometry of the planar elliptical patch antenna. It consists of an elliptical patch with finite-size ground plane. The elliptical patch antenna and the partial ground plane are etched on opposite sides of the LCP substrate with a thickness h = 1.53 mm and a relative permittivity $\varepsilon r=3.1$.

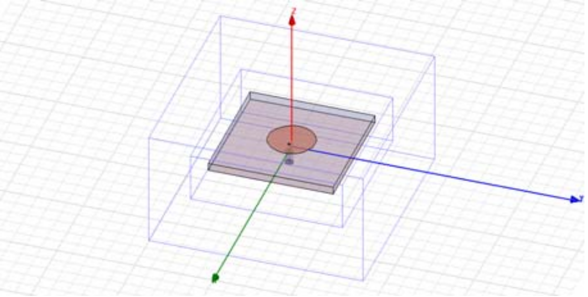


Figure (1) UWB Elliptical patch antenna

The antenna has the following parameters: *Lsub* = 55 mm, *Wsub* = 50 mm, *Lp* = 24.5 mm, *Wp* = 25 mm, and *Lg* = 21.5 mm. Feed location along x-axis is 3.5mm. Coaxial feeding is taken and its inner radius is 0.5mm, outer radius is 1.7mm and coaxial feeding length is 5mm.

3. RESULTS AND DISCUSSION

According to design conditions, the simulation and measurement results of the return loss for the proposed antenna is shown in figure (2). It obviously indicate

that an UWB bandwidth (defined by 2:1 VSWR) covering 3.1–10.6 GHz is achieved for the reference antenna. The return losses obtained at 4.5, 6, 8 GHz is -34.24, -30.62,

-29.75 respectively. The input impedance smith chart for the proposed antenna simulated at selected frequencies is shown in the figure (3). The rms and the bandwidth obtained from the results are 0.7192, 0.8202, 0.8640 and 3.9832, 5.5444, 7.1597 respectively.

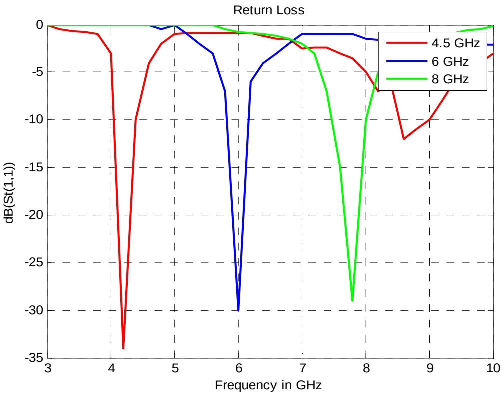


Figure (2) Return Loss

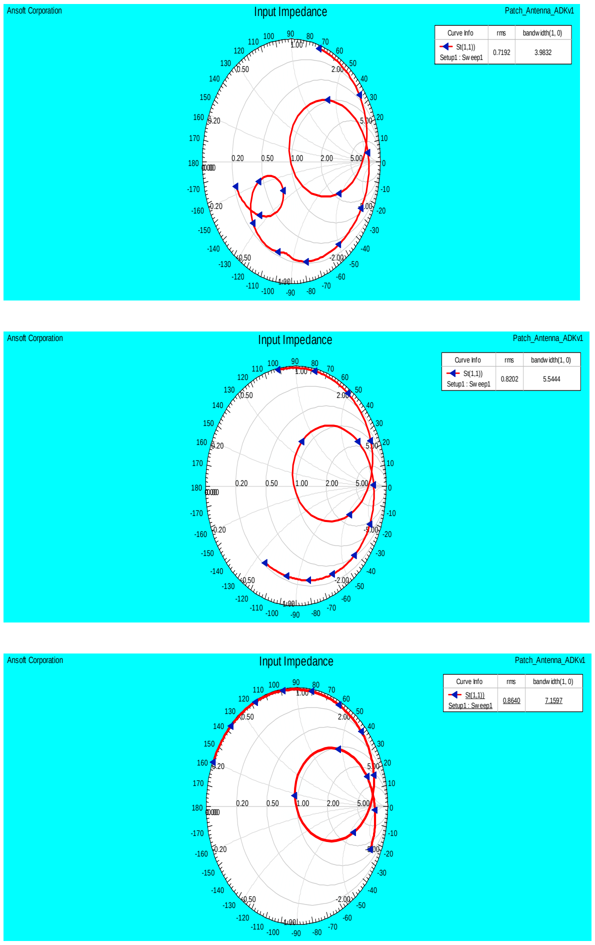
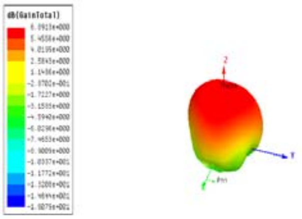
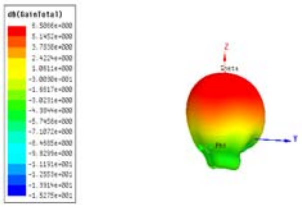


Figure (3) Input impedance at 4.5, 6, 8GHz

The 3D gain for the proposed antenna at three different frequencies are shown in the below figure (4)





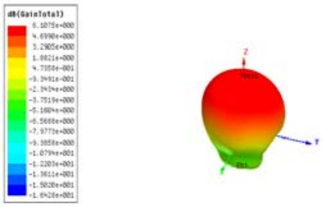


Figure (4) 3D-Gain

The radiation characteristics of the proposed antenna are also investigated. Figure (5) and Figure (6) illustrates the simulated H-plane and E-plane radiation patterns at 4.5, 6 and 8 GHz. The proposed antenna is characterized by an omnidirectional pattern in the H-plane (x–z plane) while it is a quasi-omnidirectional pattern in the E-plane (y–z plane). It can be seen that the good broadside radiation patterns are observed.

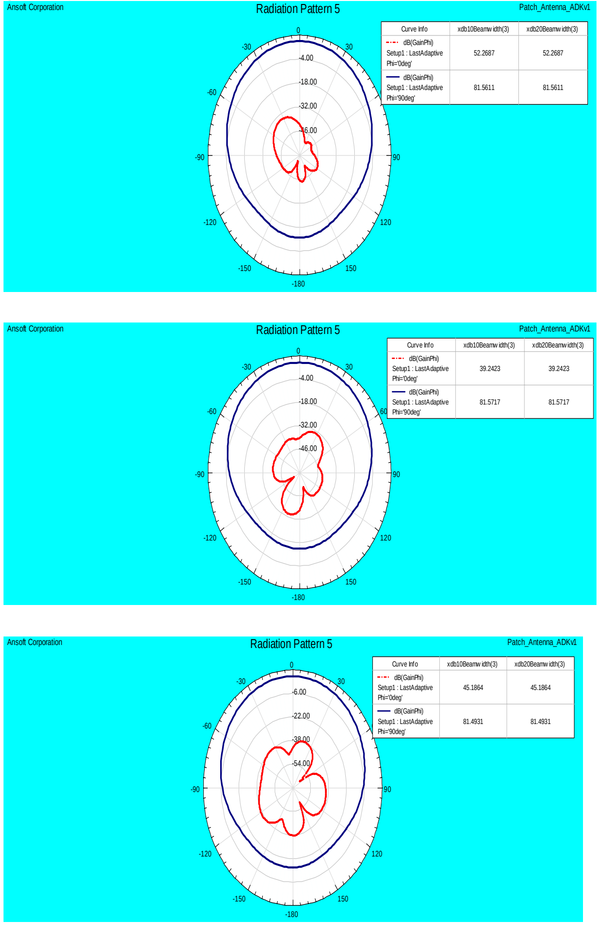


Figure (5) gain-phi at 0° and 90° for 4.5, 6, 8 GHz

It is obvious from these results that the radiation patterns are acceptable over the UWB bandwidth.

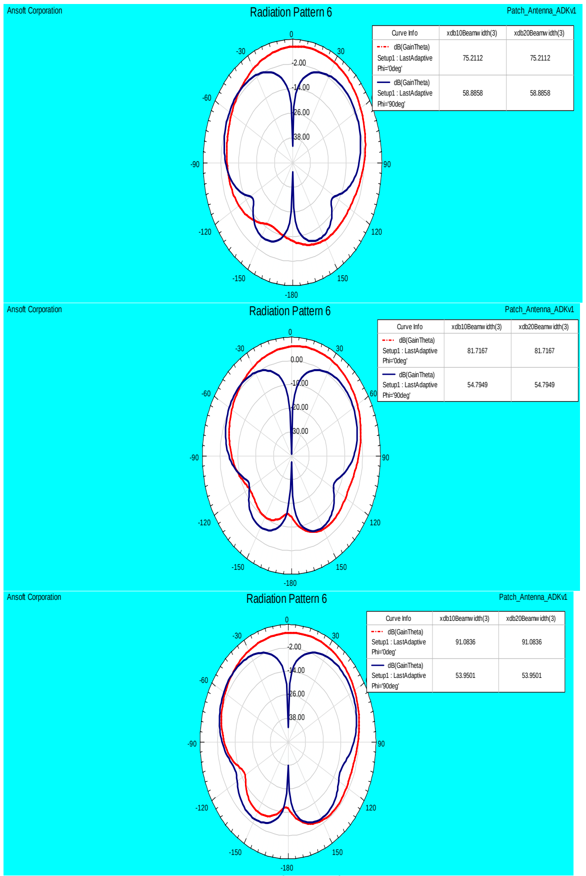
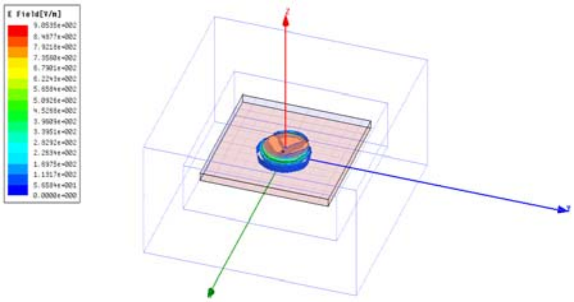


Figure (6) gain-Theta at 0^0&90^0 for 4.5, 6,8GHz

The 3D field distribution plots give the relationship between the co-polarization (desired) and cross-polarization (undesired) components. Moreover it gives a clear picture as to the nature of polarization of the fields propagating through the UWB patch antenna.



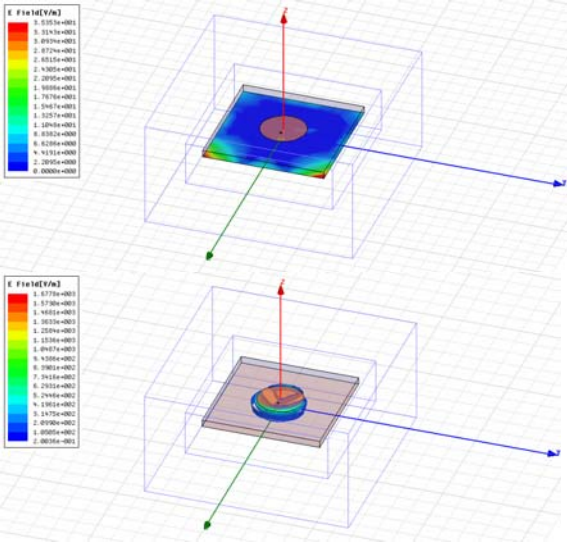


Figure (7) E-Field distribution at 4.5, 6, 8 GHz

Figure (7) and (8) clearly shows the ultra wide band elliptical patch antenna E-field and H-field distribution.

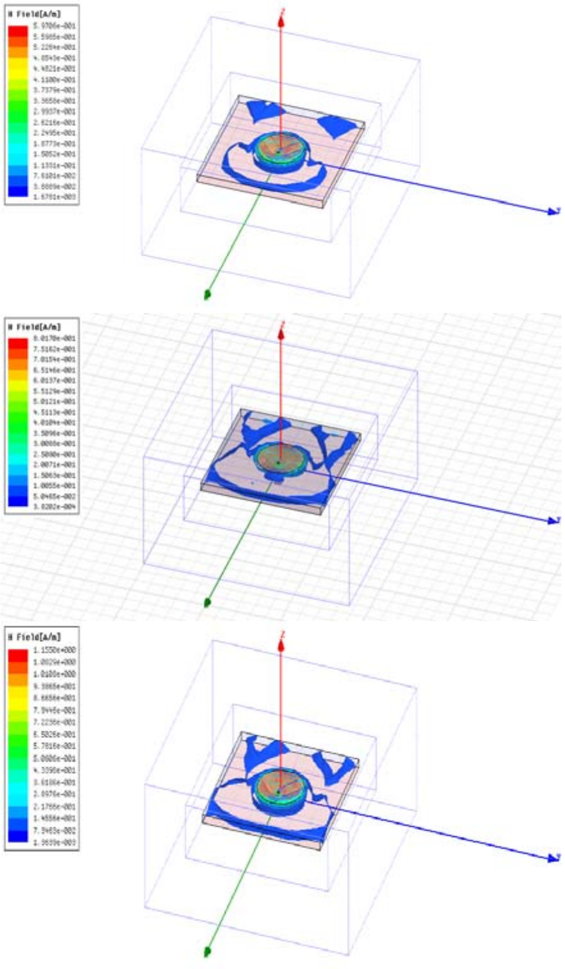


Figure (8) H-Field Distribution at 4.5, 6, 8 GHz

Mesh generation is the practice of generating a polygonal or polyhedral mesh that approximates a geometric domain to the highest possible degree of accuracy. The term "grid generation" is often used interchangeably. Typical uses are for rendering to a computer screen or for physical simulation such as finite element analysis or computational fluid dynamics. The triangulated zones in the mesh shown in figure (9) indicate the points in the grid where the current distributed is concentrated.

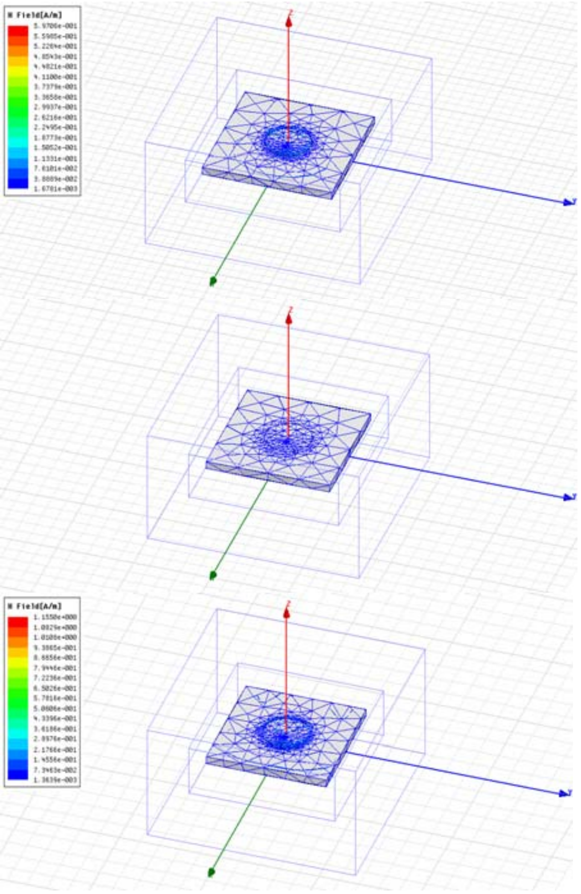


Figure (9) Mesh Generation of 4.5, 6, 8 GHz

S-parameters are calculated from the average current distribution of the cross section, and thus the exact current distribution is not required to be precise.

4. CONCLUSION:

This paper explored a novel concept in the development of wideband elliptical microstrip patch antennas using liquid crystal polymer substrate at UWB frequencies. Various parameters of the antenna design are optimized and the optimized design is prototyped. Measurement results of return loss characteristics, radiation pattern and gain of the proposed design ensures that the antenna is suitable for modern wireless communication gadgets. The measured parameters were also in good agreement with the simulated results. The results shown here demonstrate the applicability of Liquid crystals for the development of low-cost, lightweight antennas on an “all-package” solution for future communication and remote sensing systems.

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