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Corner Cut Microstrip Patch Antenna for Ultra Wide BandApplications

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Abstract: *In this paper, the radiation performance of a small printedmicro strip antennadesigned on glass epoxy FR4 substrate discussed. The proposed antenna is capable to cover Wi MAX, Wi Fi, WBAN and Bluetooth operations and UWB applications. The Simulated results for various parameters like radiation patterns, total field gain, return loss, VSWR, radiation efficiency etc. are also calculated with high frequency structure simulator HFSS. Its simulate results display impedance bandwidth from* ***3.****04 GHz to 10.96GHz the antenna complies with the return loss of S_{11} less then -10db and VSWR < 2 throughout the impedance bandwidth.*

Keywords: *Ultra-Wide Band, Multiband Band, Patch antenna*

I. Introduction

FCC (Federal communications commission) allocated a block of radio spectrum from 3.1GHz to 10.6 GHz for UWB operations [1].UWB systems can support more than 500 Mbps data transmission within 10m [2]. Compact size, low-cost printed antennas with Wideband and Ultra wideband characteristic are desired in modern communications. The Ultra wide band antennas can be classified as directional and Omni-directional antennas [3]. A directional antenna have the high gain and relatively large in size. It has narrow field of view. Whereas the omni-directional antenna have low gain and relatively small in size. It has wide field of view as they radiates in all the directions [4].

The UWB antennas have broad band. There are many challenges in UWB antenna design. One of the challenges is to achieve wide impedance bandwidth. UWB antennas are typically required to attain a bandwidth, which reaches greater than 100% of the center frequency to ensure a sufficient impedance match is attained throughout the band such that a power loss less than 10% due to reflections occurs at the antenna terminals. Various planar shapes, such as square, circular, triangular, and elliptical shapes are analyzed [5].Compared with monopole based planar antennas, the design of ultra wide band circular ring type antennas is difficult because of effect of the ground Plane.

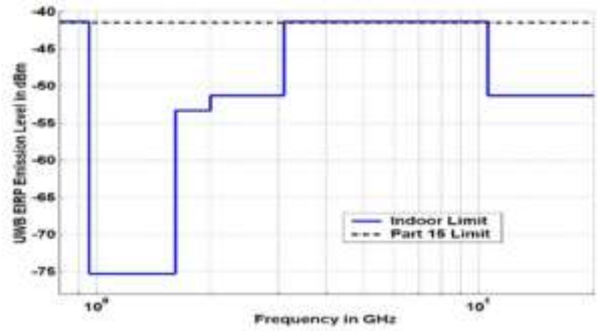

Fig. 1 UWB Spectral Mask per FCC (Modified) Part 15 Rules [1]

II. Antenna Configuration And Design

For patch antenna the length and width are used as calculated from the equations. The expression for ε_{reff} is given by Balanis as [8]

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{1/2} \quad (1)$$

The effective length of the patch L_{eff} now becomes:

$$L_{eff} = L + 2\,\Delta L \quad (2)$$

The dimensions of the patch along its length have now been extended on each end by a distance ΔL, which is given empirically by Hammerstad as:

$$\Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad (3)$$

For a given resonance frequency f_o , the effective length is given by

$$L_{eff} = \frac{c}{2 f_o \sqrt{\varepsilon_{reff}}} \quad (4)$$

For a rectangular microstrip patch antenna, the resonance frequency for TM mn mode is given by James and Hall as-

$$f_o = \frac{c}{2\sqrt{\varepsilon_{reff}}} \left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right]^{1/2} \quad (5)$$

For efficient radiation, the width W is given by –

$$W = \frac{c}{2f_o \sqrt{\frac{\varepsilon_r + 1}{2}}} \quad (6)$$

The motivation of UWB antenna is to design a small and simple omnidirectional antenna that introduces low distortions with large bandwidth. The corner cut shaped antenna presented is fabricated on a 25mm x18 mm 1.6-mm-thick FR4 board.

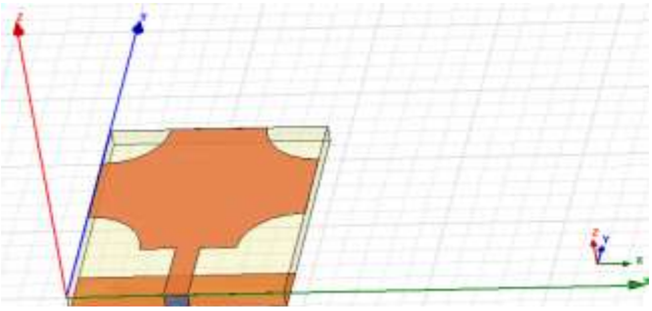

Fig. 2 Geometry of rectangular patch corner cut antenna

The proposed antenna designed on a FR-4 substrate with dielectric constant εr = 4.4 and height of the substrate is h = 1.6 mm. The substrate has length L= 18mm and width W = 25mm.
Vacuum box has length L=73.38mm, width W=18mm and height H=49.98mm

III. Simulation Results

This antenna is suitable for operating frequency 3.04GHz to 10.96 GHz allotted by IEEE 802.16 working group for UWB applications. The VSWR obtained is less than 2 the patch antenna is found to have the compact size and 90% Maximum Fractional Bandwidth. The return loss value of band is -19.82dB at 10GHz. We can obtain the higher values of return loss and VSWR and antenna offers excellent performance in the range of 3.9 GHz -10.96 GHz rather than various different shapes antennas used in this range. The VSWR, total field gain 1.462 dB, directivity 1.542, incident power 100%, E and H fields at 10GHz are also calculated in Fig. 5 to Fig. 13 respectively.

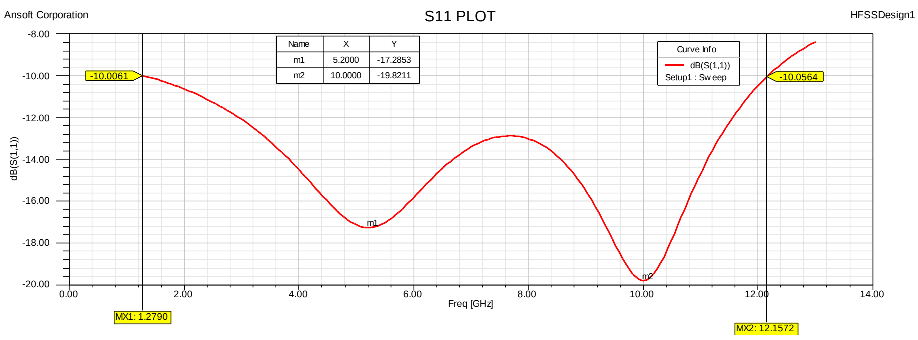

Fig. 3 Return Loss Curve

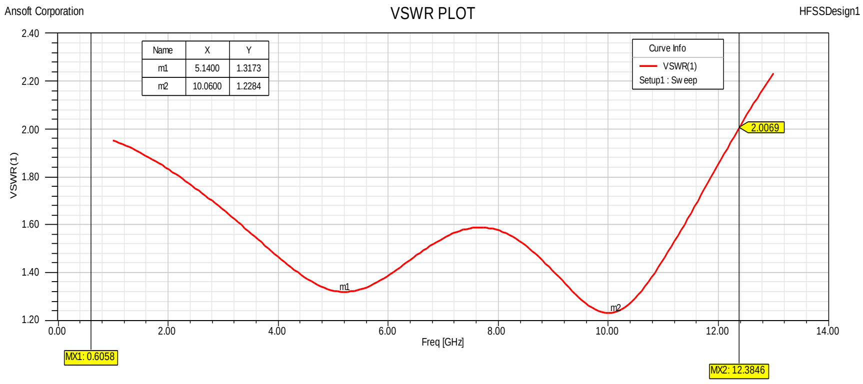

Fig. 4 VSWR value of the antenna

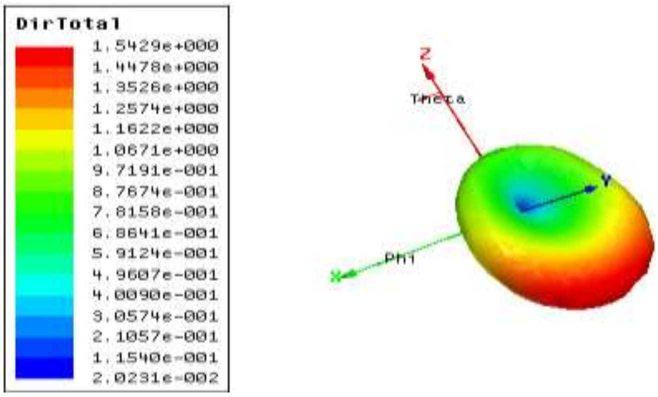

Fig. 5 Directivity of antenna is 1.5429

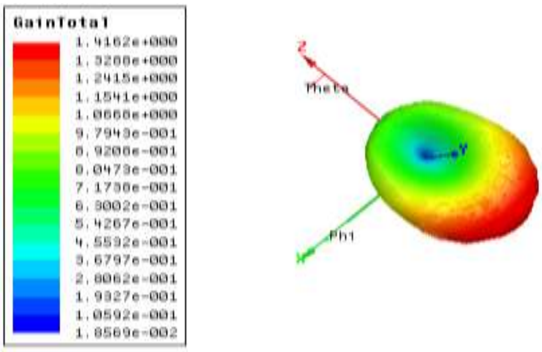

Fig. 6 Gain of micro strip patch antenna is 1.4162 dB

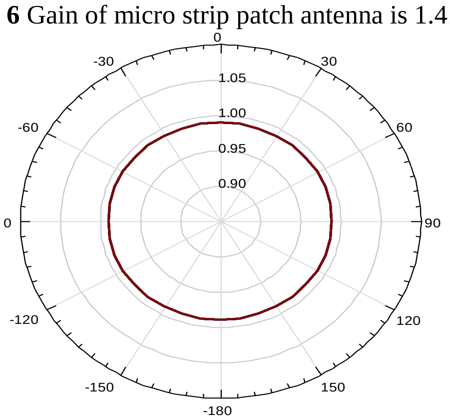

Fig. 7 Accepted Power at different ‘Phi’ (10GHz)

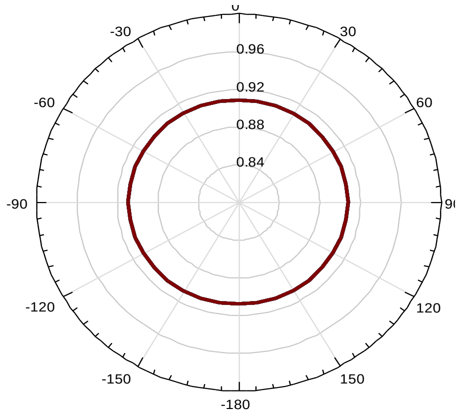

Fig. 8 Radiated power at different 'Phi' (10GHz)

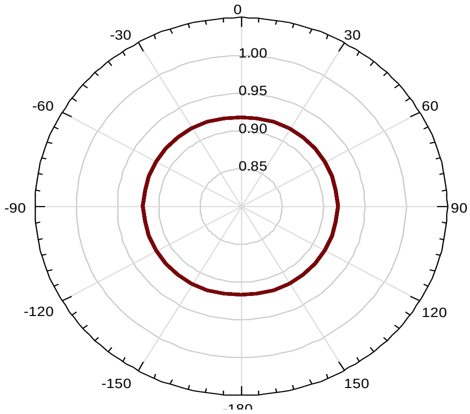

Fig. 9 Radiation Efficiency at different 'Phi' (10GHz)

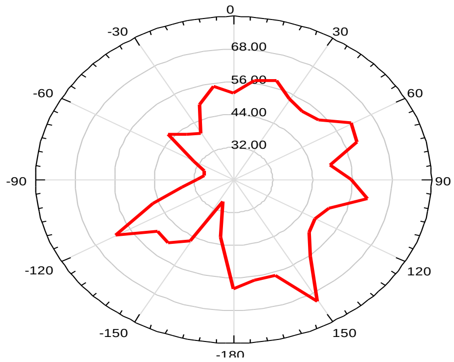

Fig. 10 Axial ratio of the antenna

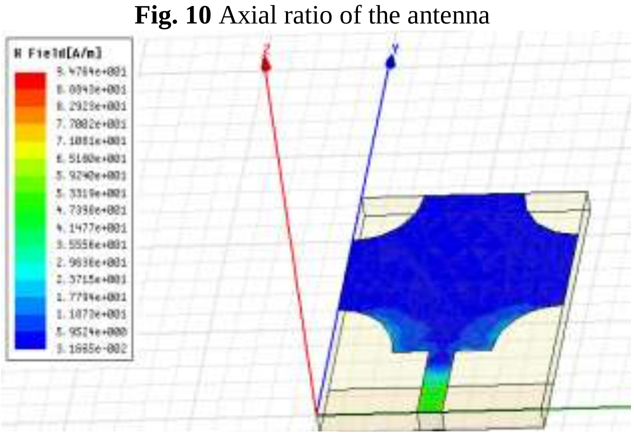

Fig. 12 Electric field of the antenna

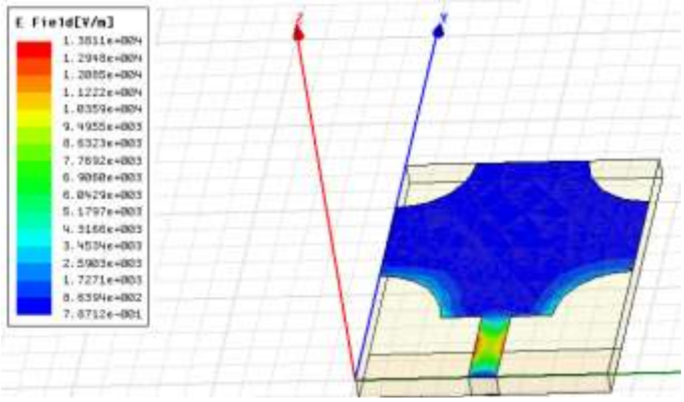

Fig. 13 Magnetic field of the antenna

Fabrication

The antenna structure is fabricated on a printed circuit board (PCB) using Photolithography technique.

IV. Conclusion

The fabricated antenna has advantages of small size, easy fabrication and simple construction. Antenna operates at 3.04GHz -10.96 GHz with Absolute Bandwidth 10.8782 GHz. Radiation performance of patch antenna is also presented in this paper. The simulated results indicate that an ultra-wide band antenna with Maximum Fractional Bandwidth 90% can be achieved by removing corners of rectangular micro strip patch antenna. The directivity of an antenna is 1.5429 and gain is 1.462 dB and we conclude that proposed geometry is applicable for ultra-wide band from 3.1 GHz to 10.6 GHz .In future the Radiation performance this rectangular patch antenna can be improved by using different feeding techniques.

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