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Multi Band Curved U-Slot Edge Feed Triangular Micro-strip Patch Antenna

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Abstract - In this paper a Curved U-Slot Edge Feed Triangular Micro-strip patch antenna was introduced. The antenna is designed to function at 6.8 GHz wireless radio band. It achieves return loss -21.6 dB by the using FR4-Epoxy substrate. The designed antenna has many practical applications like in Bluetooth, WLAN, WI-FI. The patch design is simulated in ANSYS HFSS Vs 17 software.

Key Words: Microstrip Patch Antenna, VSWR, Gain, Return Loss.

1. INTRODUCTION

The idea of micro-strip patch antenna was proposed by De-Chaps in 1953.First radiator was developed by Bob Munson in 1971. In the last decades printed antennas have been largely studied due to their advantages over other radiating systems, which include: The unique property of the micro-strip patch antenna is its two-dimensional structure. Flat antenna, arrays can have a large aperture, with corresponding high gain, but having low volume and weight. The dielectric layer can be manipulated to fit different applications. Air dielectric has very low loss, making patch arrays useful for wireless communications systems, where its low weight and high gain are also valuable. When used with a high dielectric constant material such as ceramics, the effective wavelength is much smaller and the antenna can be greatly reduced in size. Many GPS antennas take advantage of this property to reduce the relatively large size of an L-band patch, resulting in compact antennas. Micro-strip patch reception apparatuses emanate essentially in light of the bordering fields between the Patch edge and the ground plane. The feeding mechanisms of patch antenna can be separated into two categories one is contacting and other one is non-contacting.

Normally in contacting method, the RF power is directly fed to the patch using a connecting element such as a Micro-strip line or probe feed. In the non-Contacting plan electromagnetic field coupling is utilized to exchange power between the Micro-strip line and the patch this includes proximity feeding and aperture feeding.

In this paper Edge Feed U-Slot Triangular Micro-strip antenna is designed for Wi-Fi, Bluetooth applications and is expected to operate at frequencies of 6.8GHz.

In this paper the desired Patch and Micro-strip line both are designed on the same Dielectric substrate FR4-Epoxy with relative permittivity 4.4 was used. In Edge feeding 10RF power is fed to the radiating patch by using a Micro-strip line. But due to improper impedance matching between patch and strip line a quarter wave transformers is introduced. The quarter wave transformer matches the patch impedance with feed line impedance so maximum RF Power is transformed to patch.

In this paper a Curved U-Slot Triangular Micro-strip patch antenna is designed to operate at frequencies 5.GHz. The dimensions of the slots are calculated by considering proper impedance matching condition and antenna parameters like gain, return loss and beam width at resonating frequencies.

2. DESIGN PROCEDURE

The basic structure of the proposed antenna consists of 3 layers. The lower layer, which constitutes the ground plane, covers the partial rectangular shaped substrate with a side of 33×38 mm. The middle substrate, which is made of FR4 epoxy resin, has a relative dielectric constant ϵ_r=4.4 and height 1.5 mm. The upper layer, which is the patch, covers the top surface and the triangular patch that covers the middle portion of the substrate. Two rectangular slots are cut out from the patch near the feeding Micro-strip line for impedance matching. The patch is fed by a Micro-strip line with 50Ω input impedance. Simulations were performed using HFSS. Convergence was tested for a number of times. Once convergence was obtained simulations were conducted in order to obtain swept frequency response extending from 1GHz to 10 GHz. Initially we started with slots symmetrically positioned at the centre of the patch .however it was observed that in order to achieve proper impedance bandwidth slot position and dimensions need to be adjusted accordingly.

Calculation of the Width

The width of the Micro strip patch antenna is given as:

$$W = \frac{c}{2 f_0 \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

where **C** is velocity of light
f_o is Resonant frequency, and
ε_r is Relative Dielectric Constant

Calculation of Length (L)

$$L = \frac{C}{2 f_o \sqrt{\varepsilon_{re}}}$$

Effective Dielectric Constant (ε_{re})

Once W is known, the next step is the calculation of the length which involves several other computations; the first would be the effective dielectric constant.[3] The dielectric constant of the substrate is much greater than the unity; the effective value of ε_{eff} will be closer to the value of the actual dielectric constant ε_r of the substrate. The effective dielectric constant is also a function of frequency. As the frequency of operation increases the effective dielectric constant approaches the value of the dielectric constant of the substrate is given by:

$$\varepsilon_{re} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2}$$

Effective length (L_{eff})

The effective length is: which is found to be

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{re}}}$$

Length Extension (ΔL)

Because of fringing effects, electrically the micro strip antenna looks larger than its actual physical dimensions. For the principle E – plane (x-y plane), where the dimensions of the path along its length have been extended on each by a distance, ΔL, which is a function of the effective dielectric constant and the width-to-height ratio (W/h).The length extension is:

$$\Delta L = 0.412h \frac{(\varepsilon_{re} + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\varepsilon_{re} - 0.258)\left(\frac{w}{h} + 0.8\right)}$$

Calculation of actual length of patch (L)

Because of inherent narrow bandwidth of the resonant element, the length is a critical parameter and the above equations are used to obtain an accurate value for the patch length L. The actual length is obtained by:

$$L_{eff} = L + \Delta L$$

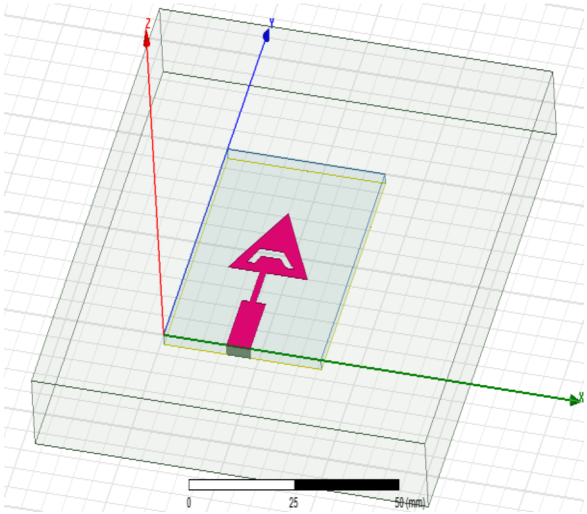

Fig-1: Design of Multi Band Curved U-Slot Edge Feed Triangular Micro-strip Patch Antenna

3. SIMULATION RESULTS

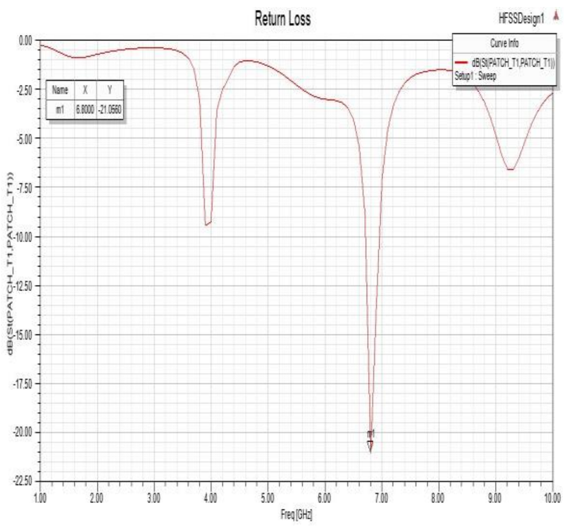

Fig-2: Return Loss of Designed Antenna

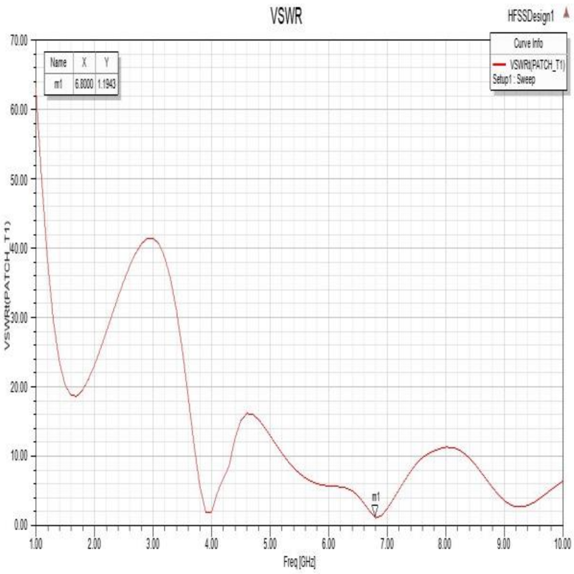

Fig-3: VSWR of Designed Antenna

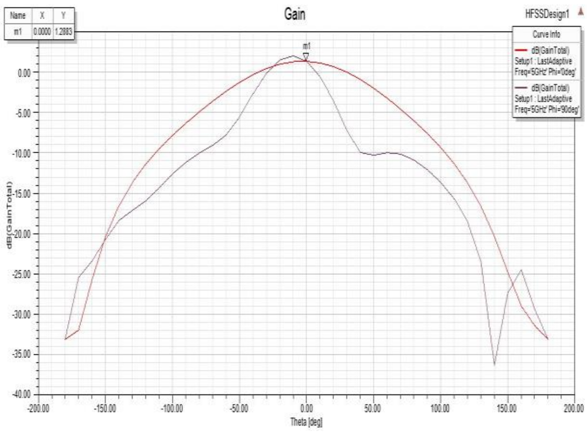

Fig-4: Gain of Designed Antenna

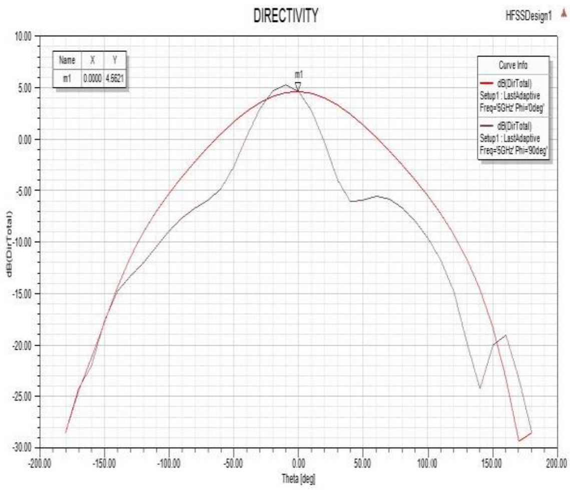

Fig-5: Directivity of Designed Antenna

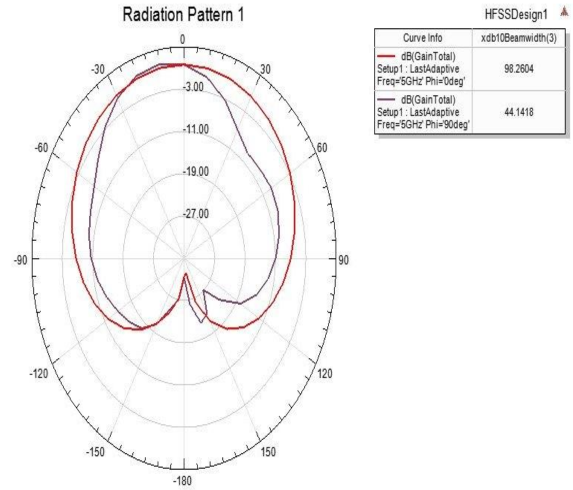

Fig-6: 2D-Radiation Pattern of Designed Antenna

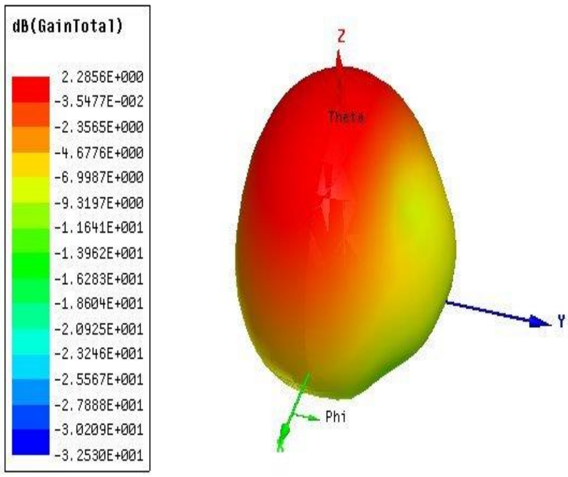

Fig-7: 3D Gain plot of Designed Antenna

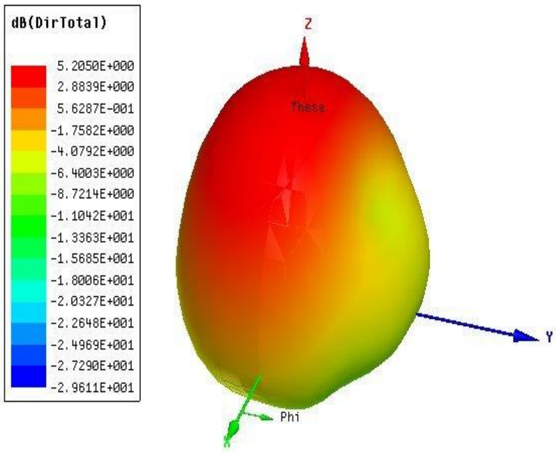

Fig-8: 3D Directivity plot of Designed Antenna

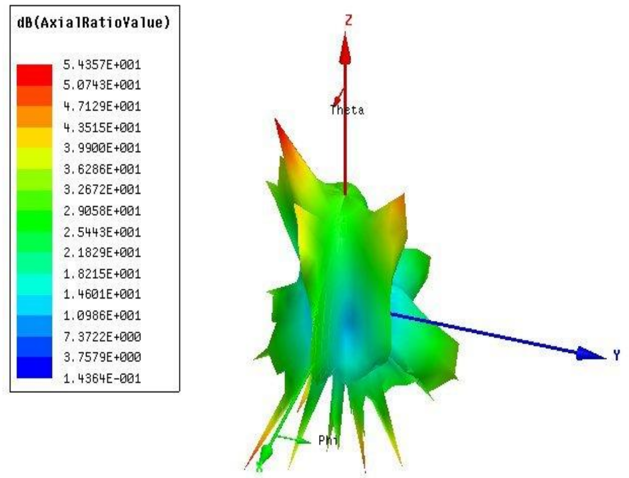

Fig-9: Axial Ratio of Designed Antenna

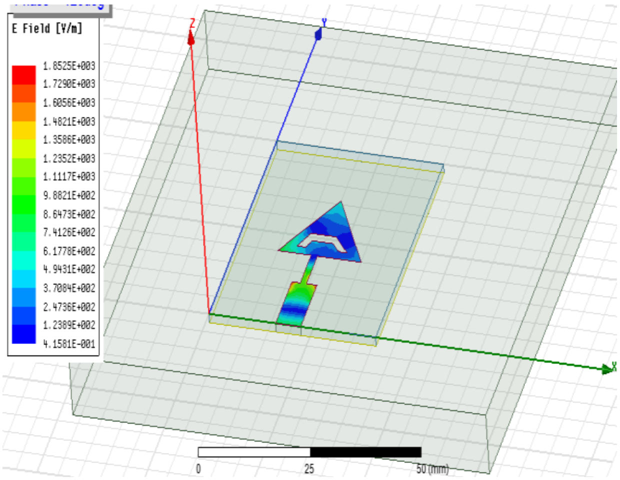

Fig-10: Current Distribution on Designed Antenna

4. CONCLUSION

The Return Loss Plot clearly indicates that the antenna is resonating at 6.8 GHz and the corresponding VSWR is1.19 and its return loss is approximately-21dB which is highly acceptable. The gain of antenna is 2.28dB and its directivity is 5.2 dB. Here the gain of antenna further increased by using highly robust substrates which are expensive, but in terms of return loss and directivity of the antenna is considered this is one of the best design while compromising at slight degradation in gain.

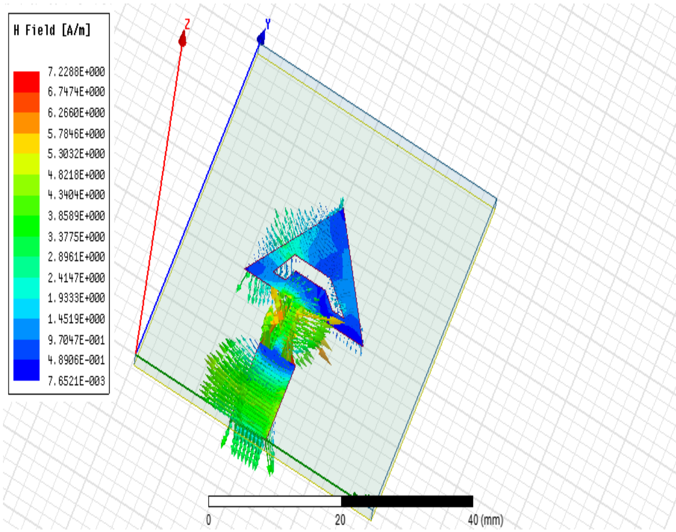

Fig-11: E-Field and H-Field Pattern of Curved U-Slot Triangular Micro-strip Patch Antenna

5. REFERENCES

[1] Constantine A. Balanis, Antenna theory analysis and design, 2nd edition, John Wiley &sons, Inc, 1997.
[2] David M.Pozar, Microwave Engineering, 3rd edition, Wiley international edition, 2005.
[3] John D.Kraus, Antennas, 2nd edition, McGaraw–Hill Company, 1988.
[4] Roger F.Harrington, Time Harmonic Electromagnetic Fields, Mcgraw–Hill Company.

[5] Warren L.Stutzman, Gary A.Thiele, Antenna Theory and Design, 2nd edition, John Wiley & sons, Inc, 1998.
[6] Robert E.Collin, Antennas and Radio Wave Propagation, McGraw-Hill, Inc, 1985.
[7] Kin-Lu Wong, Planar Antennas for Wireless Communications, Wileyinterscience, 2005.
[8] Shimels Mamo,"Analysis and Design of Dual band Microstrip Antennas for Mobile Handsets Master's thesis, Unpublished, 2005.

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