A RADIATING INVERTED U-SHAPE MICROSTRIP PATCH ANTENNA FOR BANDWIDTH ENHANCEMENT

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***Abstract*— The purpose of this paper is to design a compact size high bandwidth microstrip patch antenna with promising efficiency for various wire-less applications. A modified antenna design is proposed to enhance the bandwidth of 50x50 mm rectangular patch antenna via conversion of rectangular patch into inverted U-shape. It is found that bandwidth is improved significantly when the circular edges are taken at lower part of U-patch a very good improvement in bandwidth keeping other parameters satisfied. The MOM (method of moment) based technique is used to analyze proposed antenna. The proposed antenna design is able to improve bandwidth about 82.16% in the band of frequency 1.47-3.52GHz with center frequency 2.49GHz, the design approach & simulation results are shown with the help of MOM based full-wave simulator IE3D.**

***Keywords*— Antenna, Bandwidth, Probe Feed Antenna, Center Frequency, MOM (method of moments).**

1. INTRODUCTION

Microstrip patch antenna is promising to be a good candidate for wireless technologies. Microstrip patch antenna consists of a dielectric substrate, with a ground plane on the other side[1], [5]. The basic configuration of a microstrip antenna is a metallic patch printed on a thin, grounded dielectric substrate[2]. Originally, the element was fed with either a coaxial line through the bottom of the substrate, or by a coplanar micro strip line, allows feed networks and other circuitry to be fabricated on the same substrate as the antenna element. The micro strip antenna radiates a relatively broad beam broadside to the plane of the substrate. Thus the micro strip antenna has a very low profile, and can be fabricated using printed circuit (photolithographic) techniques. This implies that the antenna can be made conformable, and potentially at low cost. Other advantages include easy fabrication into linear or planar arrays, and easy integration with microwave integrated circuits. Disadvantages of the original microstrip antenna configurations include narrow bandwidth, spurious feed radiation, poor polarization purity, limited power capacity, and tolerance problems. Much of the development work in microstrip antennas has thus gone into trying to overcome these problems, in order to satisfy increasingly stringent systems requirements [6]. This effort has involved the development of novel microstrip antenna configurations, and the development of accurate and versatile analytical models for the understanding of the inherent limitations of microstrip antennas, as well as for their design and optimization [2][3]. Inverted U-shape micro strip patch [8] antenna structure gives a new dimension to antenna performance. The simulation results depiction makes this very clear as the various parameters like bandwidth, VSWR, efficiency, radiation pattern are affected significantly.

2. METHOD OF MOMENT (MOM)

The microstrip antenna models that account for the dielectric substrate in a rigorous manner are referred to as full-wave solutions. These models usually assume that the substrate is infinite in extent in the lateral dimensions, and enforce the proper boundary conditions at the air-dielectric interface. This is most commonly done by using the exact Green's function for the dielectric substrate, which allows space wave radiation, surface wave modes, dielectric loss, and coupling to external elements to be included in the model. Using the Green's function in a moment method solution. Green's function moment method solutions for printed antennas generally employ the electric field integral equation to solve for the unknown currents on antenna elements and feeds. This is done by expanding the unknown electric and/or magnetic currents in a set of expansion modes, then using a set of weighting modes to discretize the integral equation. The key step in this process is the evaluation of impedance matrix elements that involve the integration of the fields due to an expansion mode multiplied by a weighting mode [2][3].

3. ANTENNA DESIGN & SPECIFICATION

The rectangular patch antenna of size 40x40 mm on ground plane of size 50x50 mm (fig. 2) is being converted into a new dimension of Inverted U-shape patch (fig. 3), on same layer. The conversion helps in reduction of overall patch area (fig.3), causes to improve overall antenna performance. The proposed antenna consists of a commercial available FR-4 dielectric substrate glass epoxy with dielectric constant 4.2 and height of 1.6 mm. As compare to conventional rectangular patch antenna of similar size, the proposed antenna could be able to make significant change in bandwidth under satisfactory values of other parameter. The design approach & simulation results are shown with the help of MOM based full-wave simulator IE3D.

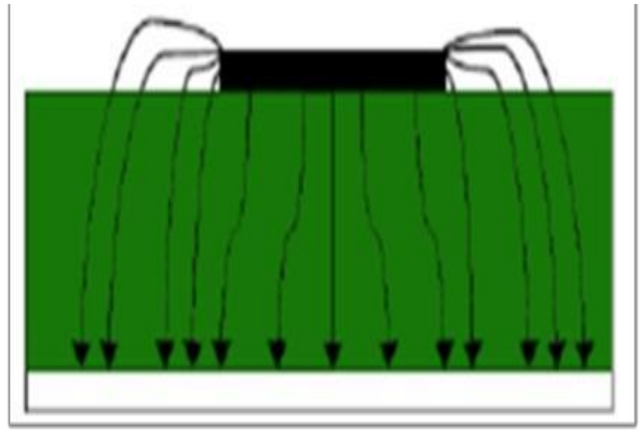

Fig. 1 Radiating Patch

3.1 DIMENSIONS OF PROPOSED ANTENNA

TABLE I

Dimensions	mm
length of ground plane	50
width of ground plane	50
length of proposed U-shape patch	40
width of proposed U-shape patch	40
semi- circle specifications: inner radius outer radius center segments start and end point sharp edges	 10 20 (0,0) 6 0° to 180°
feed point	(-10,-20)

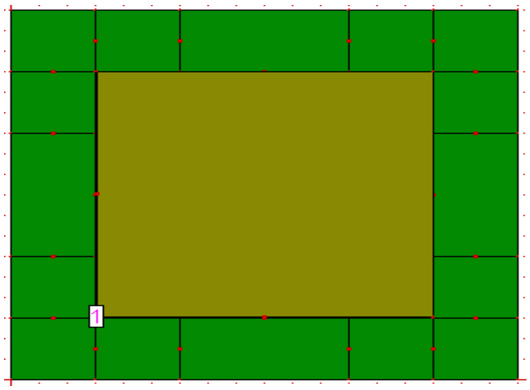

Fig 2: Conventional Square Patch MSA

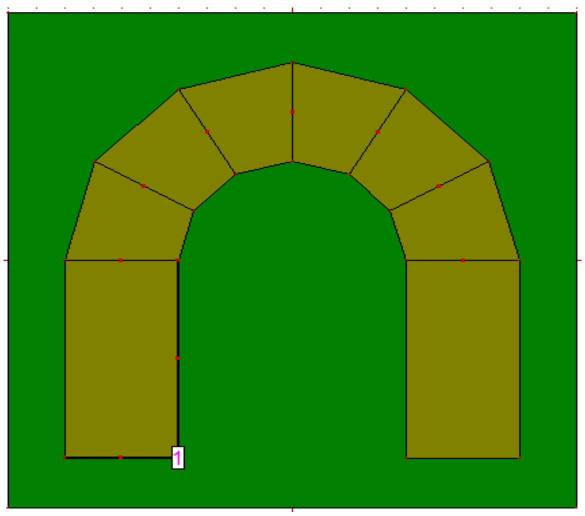

Fig. 3 Inverted U-Shape MSA on Positive Side

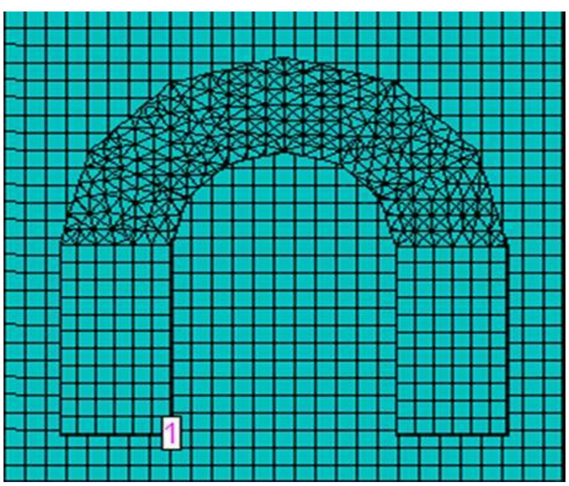

Fig. 4 Meshing of Inverted U-Shape structure

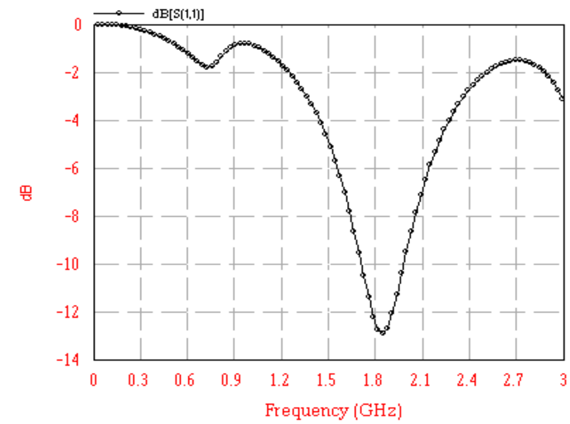

Fig. 5 S_{11} Parameter for Conventional Square MSA

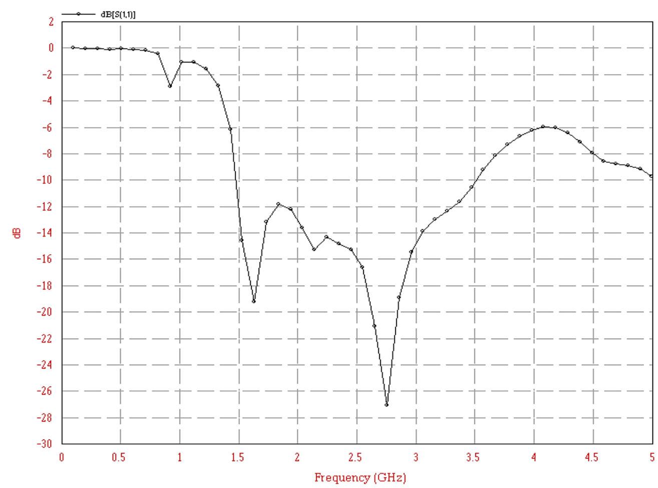

Fig. 6 S_{11} Parameter for Inverted U-Shape MSA

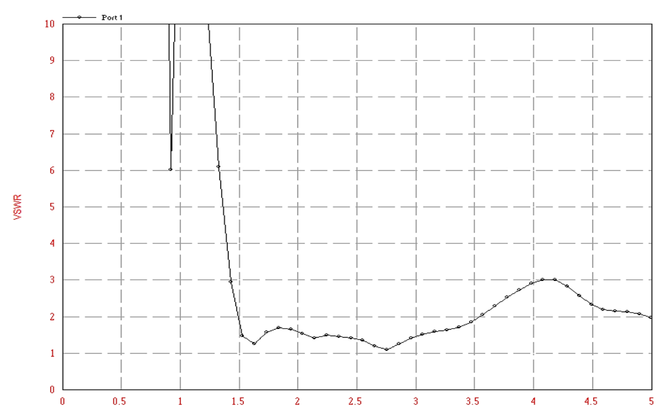

Fig. 7 VSWR for Inverted U-Shape MSA

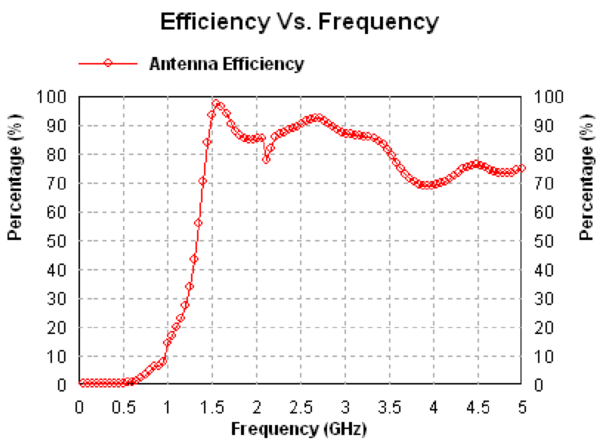

Fig. 8 Efficiency vs. Frequency graph for Inverted U-MSA

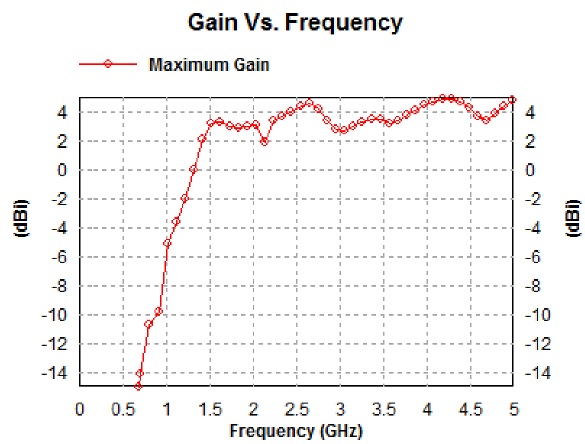

Fig. 10: Gain vs. Frequency graph for Inverted U-MSA

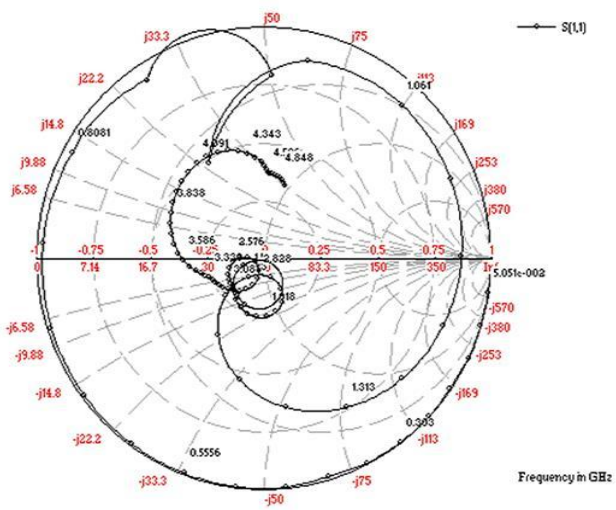

Fig. 9 Smith Chart of Inverted U-Shape MSA

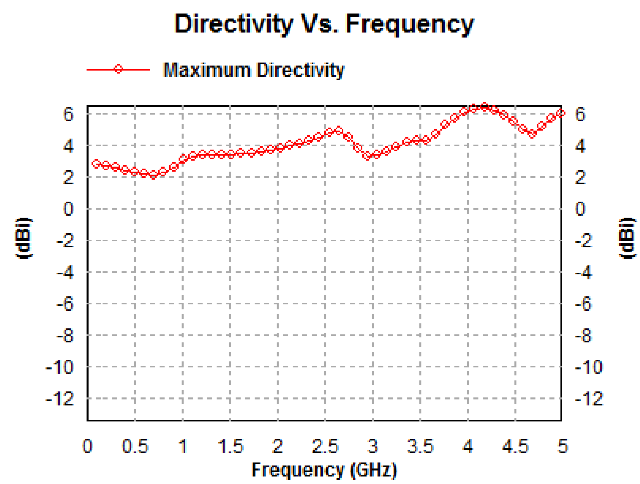

Fig. 11 Directivity vs. Frequency graph for Inverted U-MSA

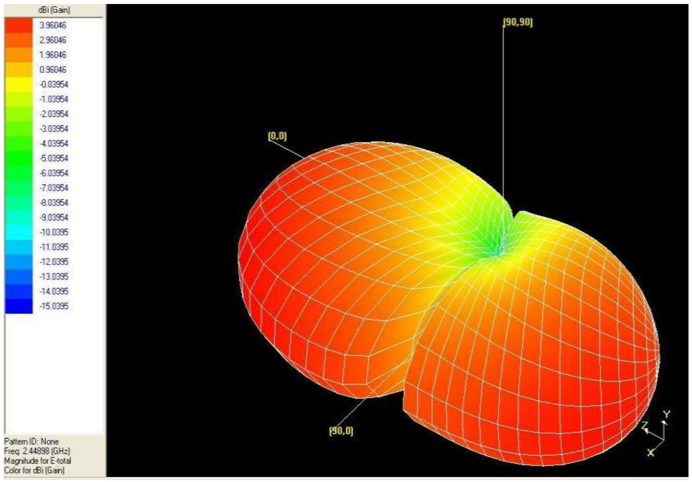

Fig. 12 3D radiation pattern view for Inverted U-MSA

3.2 SIMULATION RESULTS OF INVERTED U-SHAPE MSA & COMPARISON TABLE WITH CONVENTIONAL SQUARE PATCH MSA

The inverted U-shape patch antenna surprising results are simulated and verified on Zealand_IE3D_V9.0. The simulation results show a very surprising improvement about 21.75% at center frequency 2.3GHz. Its compatible performance in another bandwidth of the antenna is improved tremendously about 82.16% at center frequency 2.49GHz.

Comparative study of proposed design with conventional MSA

TABLE II

Parameter	**Square patch MSA**	**Inverted U-shape MSA**
Bandwidth (Frequency band)	0.5 GHz (2.05-2.55 GHz)	2.05 GHz (1.47-3.52) GHz
Return loss (dB) At Center frequency	-28.5 dB With center frequency (2.3 GHz)	-27.1 dB with center frequency (2.49 GHz)

4. CONCLUSION

The simulation results of proposed antenna have shown an enhancement of bandwidth to 82.16% (from 21.75%) at center frequency of 2.49 GHz. The modifications with the conversion of square patch into radiating Inverted U-shape gives a good result as the bandwidth enhancement with promising efficiency as well as dual band operation. Hence the proposed antenna deserves perfectly for various wireless applications due to its compact size and improved performance.

REFERENCES

[1] Rahman, M., Stuchly, M.A.,"*Wide-band microstrip patch antenna with planar PBG structure*", Proc. IEEE Symp. on Antennas and Propagation, 8–13 July, 2001, Vol. 2, pp. 486 – 489.

[2] H. F. AbuTarboush, H. S. Al-Raweshidy, "*A Connected E-Shape and U-Shape Dual-Band Patch Antenna for Different Wireless Applications*", The Second International EURASIP Workshop on RFID Technology, July, 2008.

[3] C.A. Balanis, "*Antenna Theory*", 2nd ed. New York: John Wiley & Sons, Inc., 1997.

[4] Joannopoulos, J.D., Meade, R.D., Winn, J.N., "*Photonic crystals molding the flow of light*", (Princeton University Press, Princeton, NJ, 1995.

[5] R. Gonzalo, P. De Maagt, M. Sorolla, "*Enhanced patch antenna performance by suppressing surface waves using photonic bandgap substrates*", IEEE Trans Microwave Theory Tech., Vol. 47, pp. 2131–2138, 1999.

[6] Sharma, S.K., Shafai, L., "*Enhanced performance of an aperture coupled rectangular microstrip antenna on a simplified unipolar compact photonic bandgap (UC- PBG) structure*", Proc. IEEE Symp. on Antennas and Propagation, July 2001, Vol. 2, pp. 8–13.

[7] David M. Pozar, proceedings of the IEEE, Vol. 80, No. 1,January 1992.

[8] [Online] Available: http://www.ieeexplore.ieee.org.