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Triple Band Characteristics Of Modified U-Shape Patch With Finite Ground Geometry

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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 30x30 mm rectangular patch antenna via conversion of rectangular patch into U- shape. It is found that bandwidth is improved significantly whereas the addition of triple band characteristics is found on modification of patch on top surface provide 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 in triple band characteristics in 30MHz (1.21-1.24) GHz, 300 MHz. (2.1-2.4) GHz. & 100 MHz (2.9-3.0) GHz.
Keywords: *Antenna, photonic band gap structure, bandwidth, probe feed antenna, MOM.*

1- INTRODUCTION

The basic configuration of a microstrip antenna is a metallic patch printed on a thin, grounded dielectric substrate [1]. 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, as in the corporate- fed micro strip array shown in 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 con- figurations 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. 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 [1].

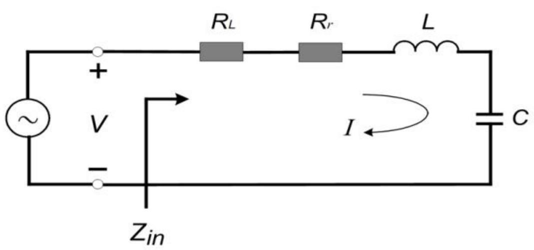

Figure: 1 Equivalent diagram of patch

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, 2].
The basic configuration of a microstrip antenna is a metallic patch printed on a thin, grounded dielectric substrate [6]. 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, as in the corporate- fed micro strip array shown in 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 con- figurations 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 [3]. 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 [6,7].U-shape micro strip patch antenna .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 [6, 7].

3- ANTENNA DESIGN & SPECIFICATION

The rectangular patch antenna of size 30x30 mm on ground plane of size 45x45 mm [fig.3] is being converted into a new dimension of U-shape patch [fig.4] on same layer. The conversion helps in reduction of overall patch area while formation of PBG structure on ground plane [fig.3] causes to improve overall antenna performance. The proposed antenna [fig.4] 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.

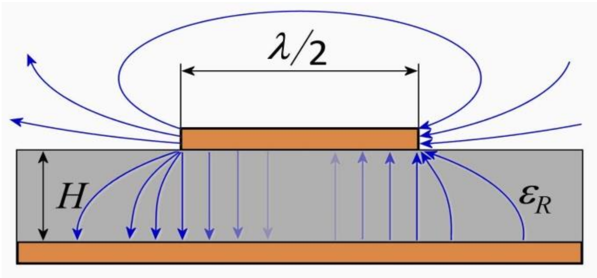

Figure: 2 Radiating patch

A. Dimensions of proposed Antenna

Table 1: Antenna Dimensions

Dimensions	Mm
Length of ground plane	45
Width of ground plane	45
Length of conventional square patch	30
Width of conventional square patch	30
Length of proposed U-shape patch	30
Width of proposed U-shape patch(s)	03
Width of u-shape limb (t)	10

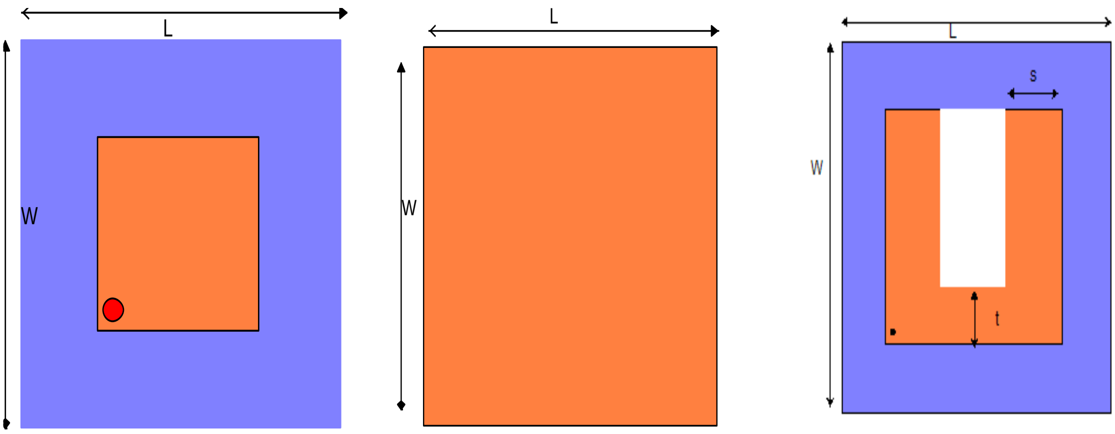

Figure 3: Design of Simple square patch and modified U-shape structure along with finite ground

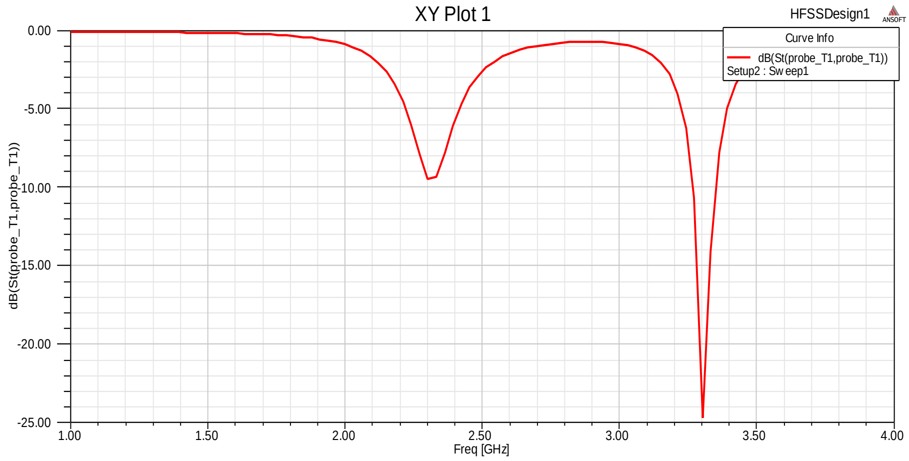

Figure: 5 S-parameter of square patch

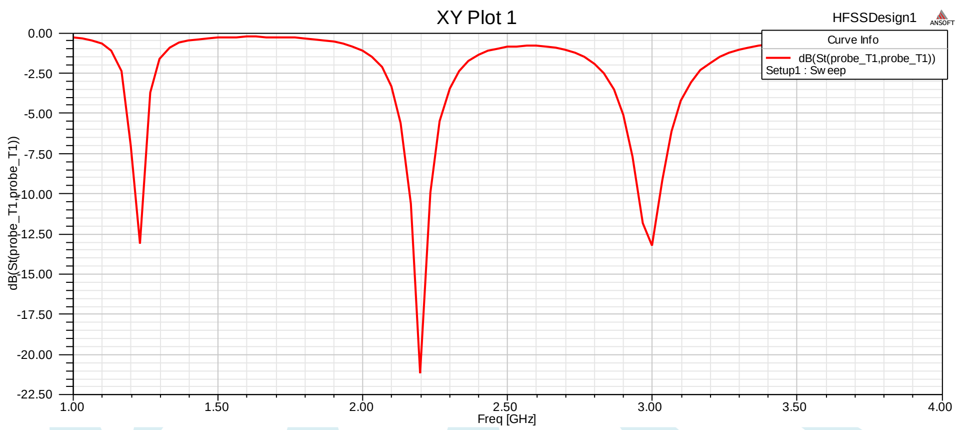

Figure: 6 S-parameter of U-shape patch

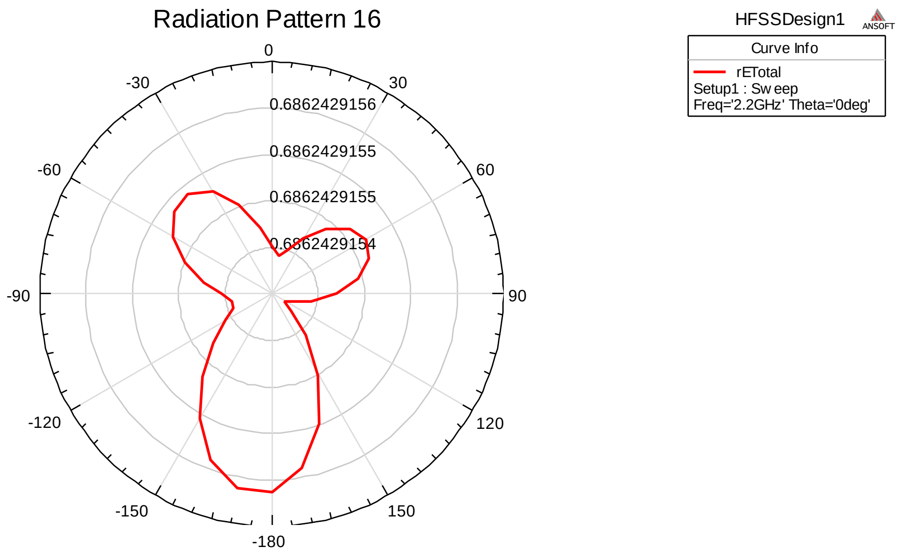

Figure: 7 Radiation pattern of U-shape patch at theta=0 degree

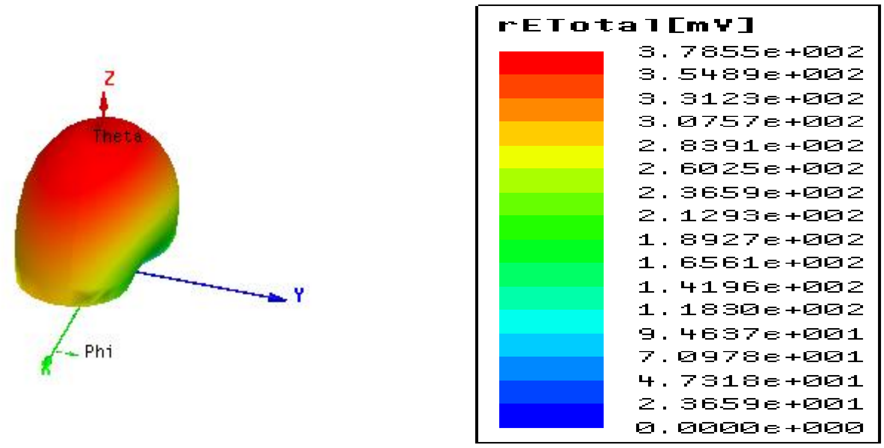

Figure: 8 3-D pattern of U-shape Patch antenna

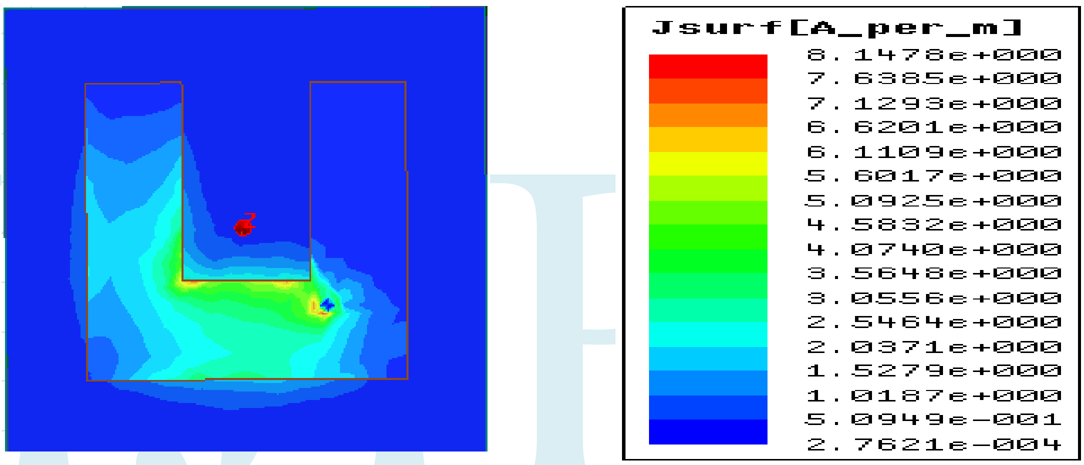

Figure: 9 Current distribution of U-shape Patch antenna

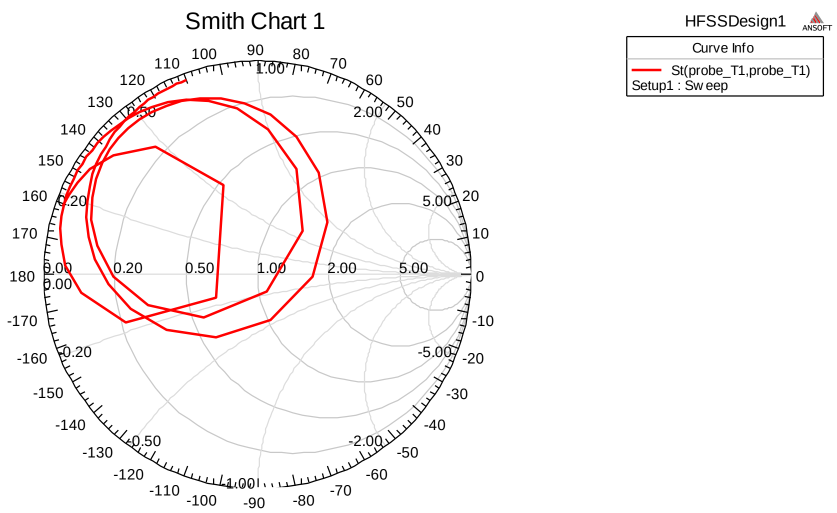

Figure: 10 Smith chart of U-shape Patch antenna

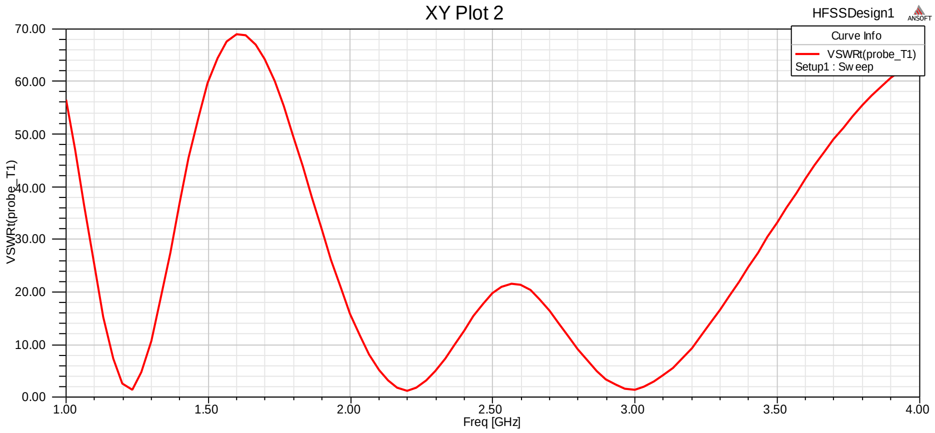

Figure: 11 VSWR of U-shape Patch antenna

Parameters	Square patch MSA	U-shape (freq. band) Tri-band Feature
Bandwidth (MHz) **(Frequency band)**	70 MHz (3.27-3.34 GHz)	30MHz (1.21-1.24) GHz 300 MHz. (2.1-2.4) GHz. 100 MHz (2.9- 3.0 GHz.)
Return loss (dB) **At** **Centre frequency**	-24.5 With centre frequency 3.3GHz	-21 with centre frequency 2.2 GHz

4- CONCLUSION

The simulation results of proposed antenna have shown an enhancement of bandwidth and obtained triple band operation in 30MHz (1.21-1.24) GHz, 300MHz. (2.1-2.4) GHz. & 100 MHz (2.9- 3.0) GHzThe modifications with the help of insertion of U-shape structure and conversion of square patch 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.

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