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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, 70 MHz. (2.1-2.2) GHz. & 74.6 MHz (2.9-3.0) GHz

Keywords*: - Antenna, photonic bandgap 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].

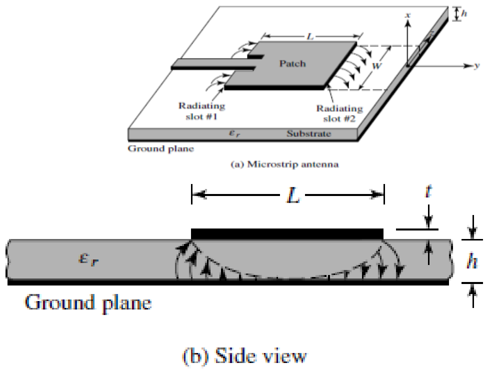

Fig.1. Microstrip patch antenna

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- BASIC EQUATIONS

The effective length of the patch Leff now become

$L_{eff} = L + 2\Delta L$

$$\Delta L = 0.412h\frac{\varepsilon_{reff}+0.3}{\varepsilon_{reff}-0.258}\left(\frac{W/_h+0.264}{W/_h+0.813}\right)$$

For a given resonant frequency fo, the effective length is

$$L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_{reff}}}$$

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

$$f_0 = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right]^{0.5}$$

Where m and n are modes along L and W respectively.

The width W is

$$W = \frac{C}{2f_0}\left(\frac{\varepsilon_r+1}{2}\right)^{-0.5}$$

Where fo = Resonant frequency

C =speed of light in free-space

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 4.4 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.

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)	09
Width of u-shape limb (t)	10

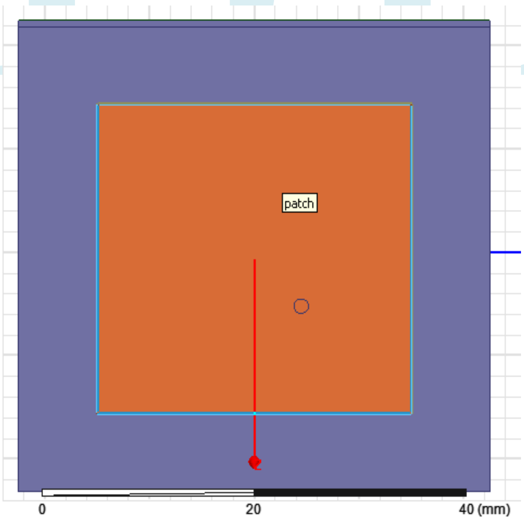

Fig.2. Square patch antenna

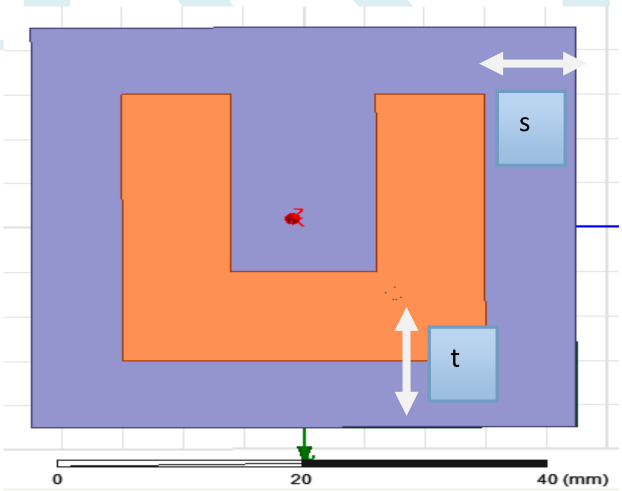

Fig.3. U-shaped square patch antenna

4- SIMULATION RESULTS

1. **S11 parameter:** As from the simulation the antenna is simulated at frequency 2.31GHz. From the simulation graph return loss of -33dB is obtained. The two intersect point on 10dB axis it is clear that the bandwidth of antenna is 65.7MHz. For Ushaped antenna it is clear from the simulation graph that the antenna is simulated at three frequencies 1.23 GHz, 2.2 GHz, and 3 GHz. From the simulation graph return losses of -13.33dB, -21.66dB, -15.15dB obtained. Three bandwidths are 35 MHz, 70.2MHz, and 74.6MHz.

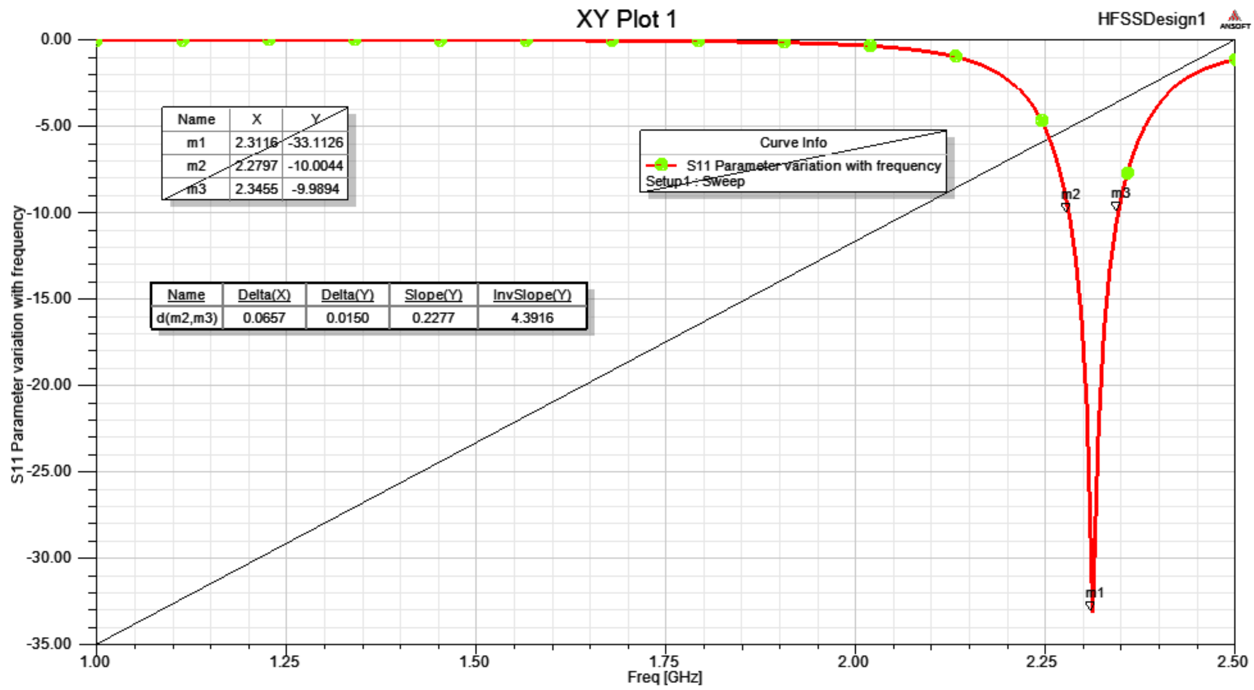

Fig.4.S11 Parameter Vs. Frequency Graph

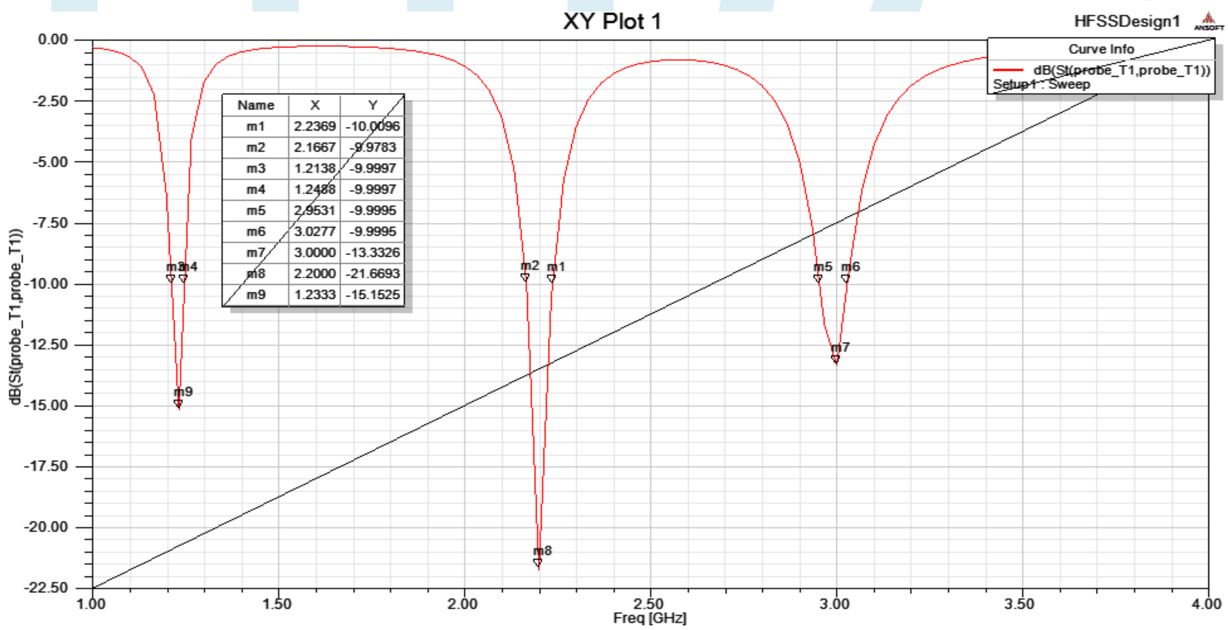

Fig.5.S11 Parameter Vs. Frequency Graph for U shaped antenna

2. **VSWR:** For a good antenna the value of VSWR Should be less than 2. As from the simulation the antenna is simulated at frequency 2.31 GHz. At frequency 2.31GHz the value of VSWR is 1.04 which is less than 2 from the simulation graph it is clear that the U shaped antenna is simulated at three frequencies 1.23 GHz, 2.2 GHz, and 3 GHz. The values of VSWR are 1.42, 1.17, and 1.54 which is less than 2.

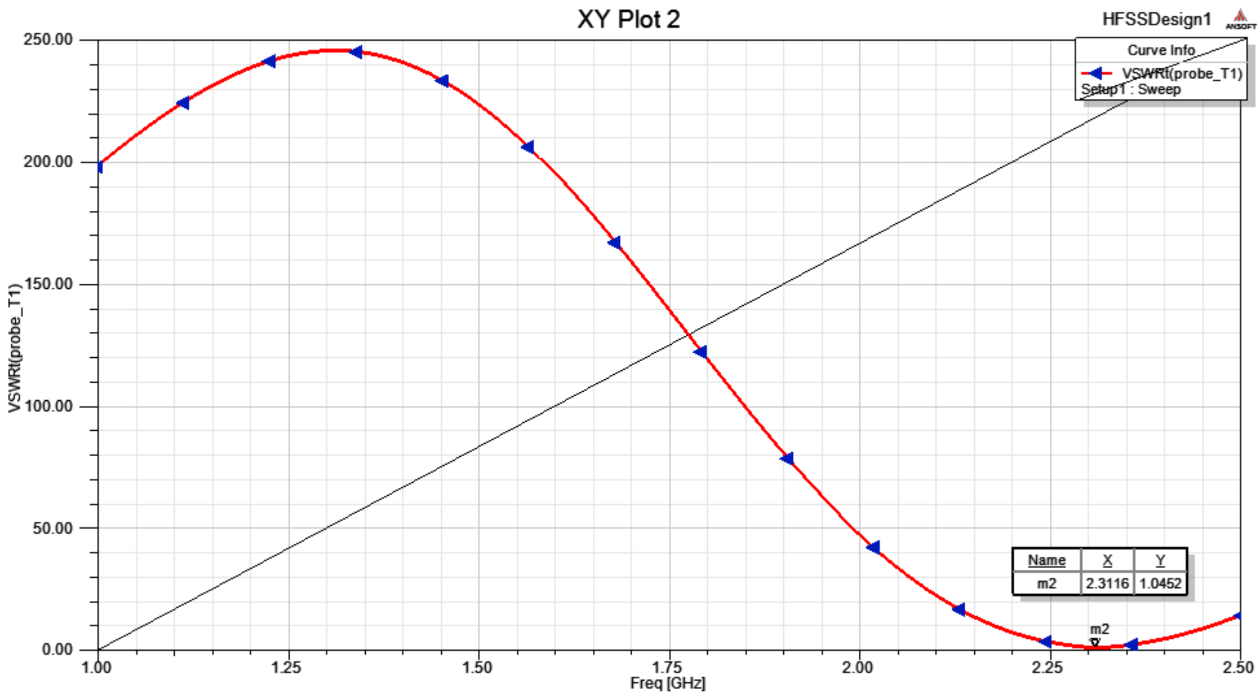

Fig.6.VSWR Vs. Frequency Graph

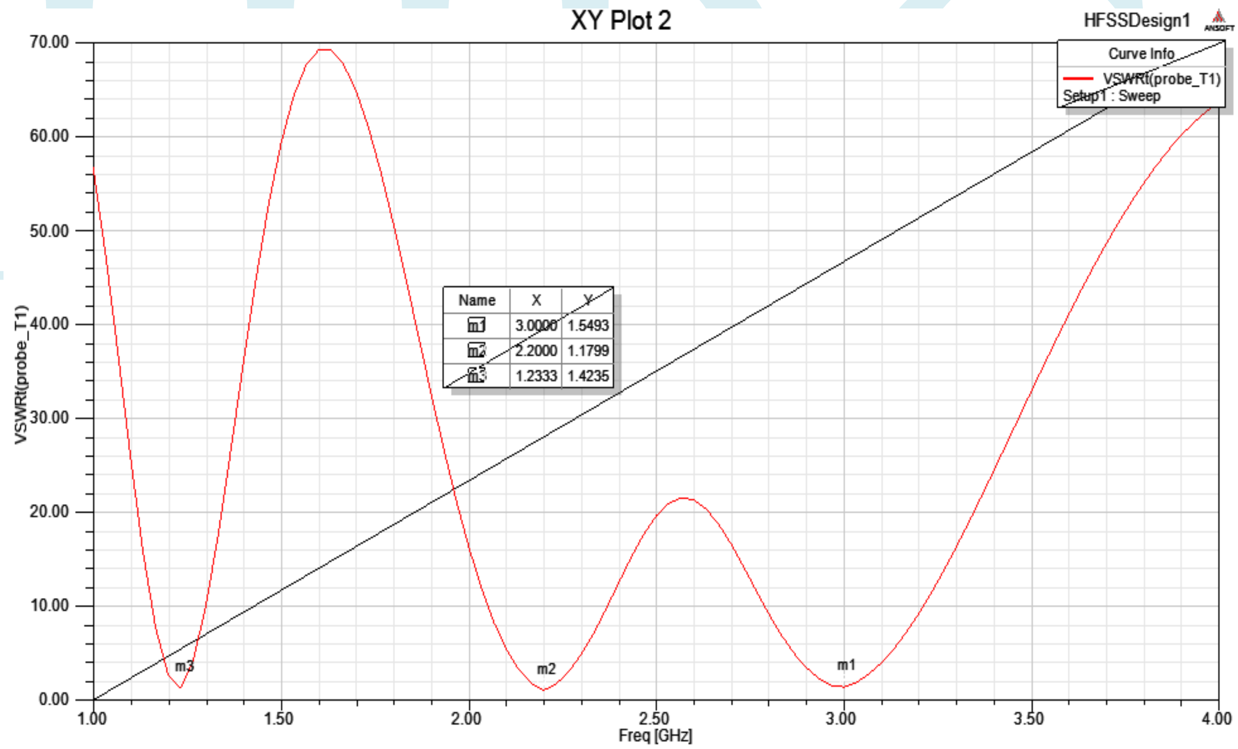

Fig.7.VSWR Vs. Frequency Graph for U-Shaped antenna

3. **Smith Chart:** Smith chart is used to calculate the reflection coefficient. From reflection coefficient it is easy to calculate VSWR, power delivered and mismatching of load.

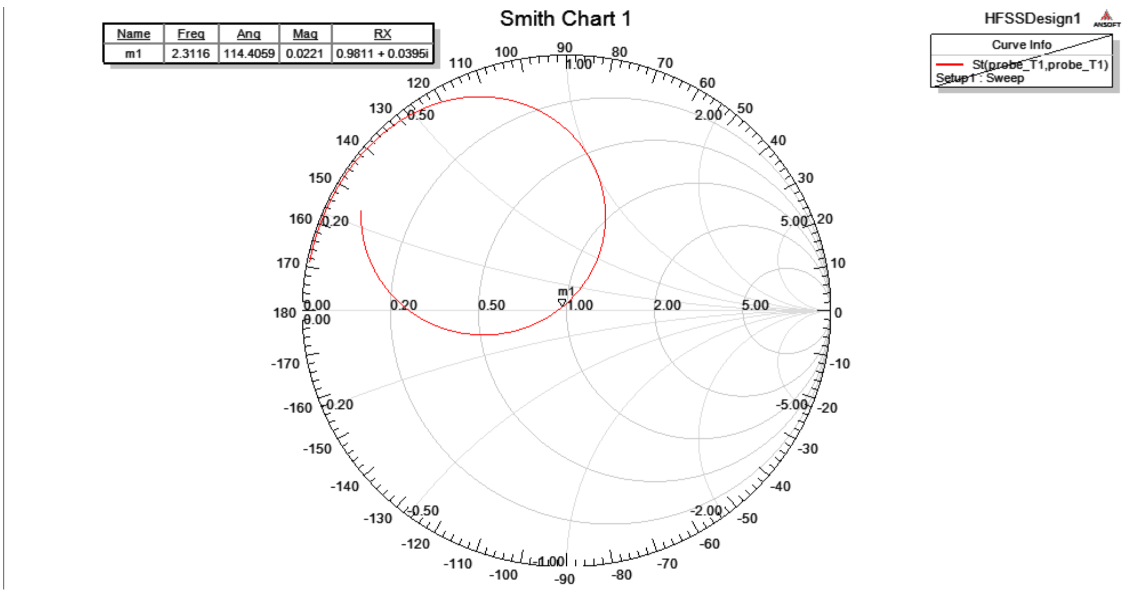

Fig.8. Smith Chart for Square patch antenna

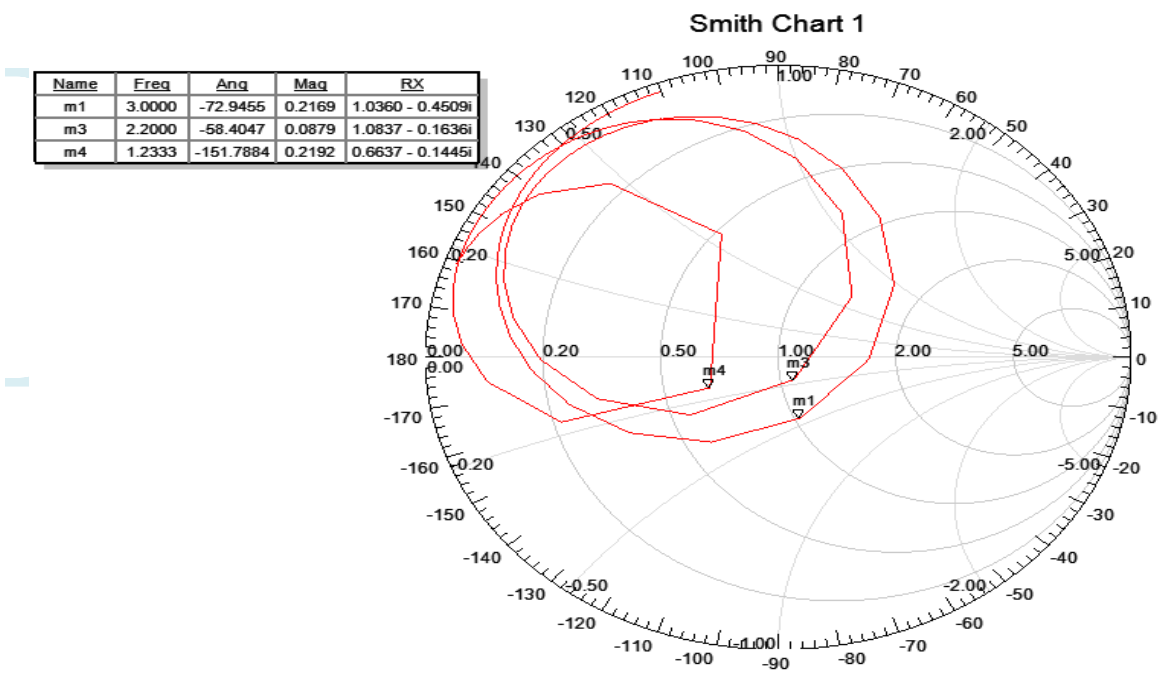

Fig.9. Smith Chart for U shaped square patch antenna

5- CONCLUSIONS

After simulation of both antennas it is clear that the antenna of u-shaped provide good result for radiation properties of microstrip patch antenna. As the bandwidth is dependent on the Q factor of the antenna and Q factor is dependent on the energy stored beneath the patch .as for the U shaped patch antenna less energy stored beaneath the patch .so bandwidth improve to triple band. Hence the proposed antenna deserves perfectly for various wireless applications due to its compact size and improved performance.The comparison chart as follows:

Parameters	Square patch MSA	U-shape (freq. band) Tri-band Feature
Bandwidth (MHz) (Frequency band)	65.7MHz (2.27-2.34GHz)	30MHz (1.21-1.24) GHz 70.2MHz. (2.166-2.236) GHz 74.6MHz (2.95- 3.02 GHz.)
Return loss (dB) At Centre frequency	-33.11 With centre frequency 2.3GHz	-21 with centre frequency 2.2 GHz

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