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## **A S-SHAPED PATCH ANTENNA FOR X-BAND WIRELESS/MICROWAVE APPLICATIONS**

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### ABSTRACT

A S-shaped microstrip patch antenna has been designed for wireless X-band applications. Two rectangular slots are cut from the patch of antenna to perturb the surface current path, which is responsible for the excitation of the resonance. A substrate of low dielectric constant is selected to obtain a compact radiating structure that meets the demanding bandwidth specification. The  $S_{11} = -41$  dB at 10.0 GHz of the proposed patch antenna. At the same frequency antenna having gain nearly 6 dB. Simulation of antenna is carried out on Ansoft simulator.

Keywords: Compact, gain nearly 6 dB, S-Shaped, X-band.

### I. INTRODUCTION

Nowadays, wireless networks are widely used in the world. With the strong advancements in wireless communications, there is growing demand for miniature, low-cost, easy-to-fabricate, multiband, dualband and



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wideband antennas for use in commercial communications systems. Autonomous distributed wireless sensor networks are predicted to have major growth opportunities in the coming years in numerous imaging, communication, safety, biomedical and environmental applications. In all of these areas, the design challenges are somewhat different from present wireless communications systems as in them data rates will be low and power consumption and size of the sensor node are of important concern.

A microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in the fig 1. The patch is generally made of conducting material. A microstrip rectangular patch antenna is a low profile patch antenna that has a number of advantages over other antennas. It is lightweight, inexpensive, and easy to integrate with accompanying electronics. The antenna can be three dimensional in structure. Microstrip patch antennas radiate mainly due to the fringing fields between the patch edge and the ground plane. Since the propagating electromagnetic fields lay both in the substrate and in free space, then quasi-TEM mode has been generated. Microstrip antenna is the ideal choice for many application due to its low-profile, lightweight, low-cost and ease of integration with microwave circuits. However, standard rectangular patch antenna has the shortcoming of narrow bandwidth. Enhancement of the performance to cover the demanding bandwidth is necessary. The bandwidth of microstrip antenna may be increased using air substrate [7].

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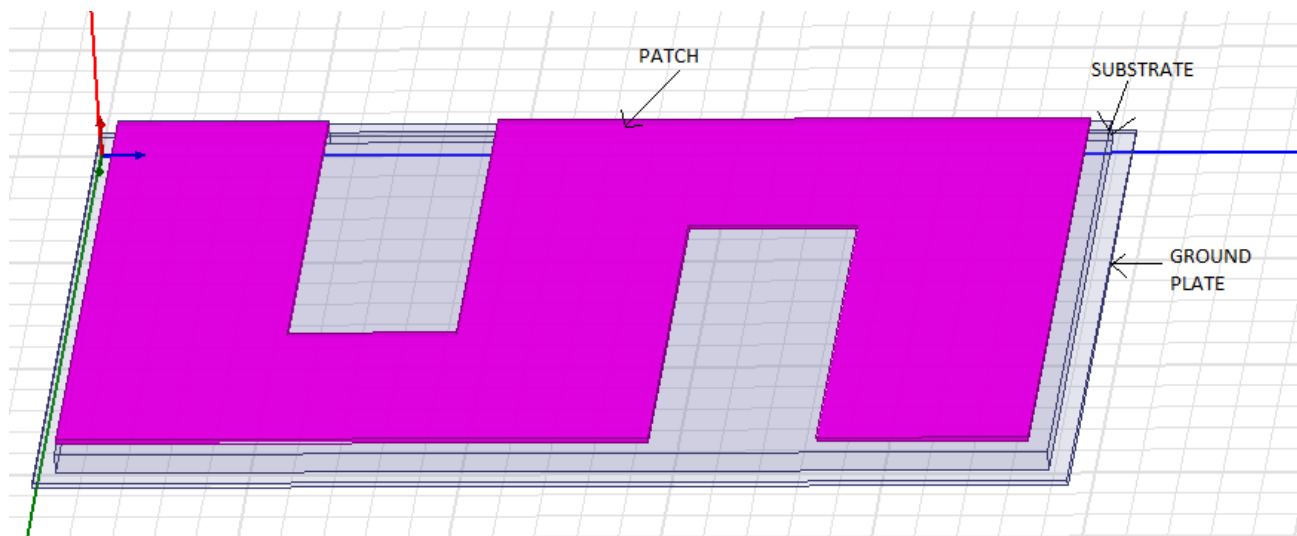


Fig.1 Basic rectangular patch antenna construction.

However, dielectric substrate must be used if compact antenna size is required. A few approaches can be applied to improve the microstrip antenna bandwidth such as increasing the substrate thickness, introducing parasitic element either in coplanar or stack configuration, and modifying the shape of a common radiator patch by incorporating slots. The last approach is particularly attractive because it can provide excellent bandwidth improvement and maintain a single-layer radiating structure to preserve the antenna's thin profile characteristic. The successful examples include E-shaped patch antennas [1], U-slot patch antennas [14] and V-slot patch antennas [10].

## II. ANTENNA DESIGN

The antenna geometry is shown in fig. 2. First, a rectangular microstrip patch antenna is designed based on the standard design procedure to determine the length ( $L$ ) and width ( $W$ ) at resonant frequency 10.0 GHz.



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Then, two rectangular slots are incorporated to perturb the surface current path, introducing local inductive effect that is responsible for resonance in antenna. The slot length ( $L_s$ ), slot width ( $W_s$ ) of the patch controls the frequency of the fundamental resonant mode [2]. The dimension of slots i.e. width and length always affects the performance of antenna as discussed in [1, 7]. The slot dimensions for antenna are  $L_s=20.0$  mm and  $W_s=8.0$  mm. Effects of slots on performance of antenna can be measured by modeling the antenna in terms of its inductance, capacitance and load resistance. The dimensions of patch of antenna for resonant frequency are calculated to be  $L= 30.08$  mm and  $W=45.9$  mm using standard design equations for rectangular microstrip antenna design.

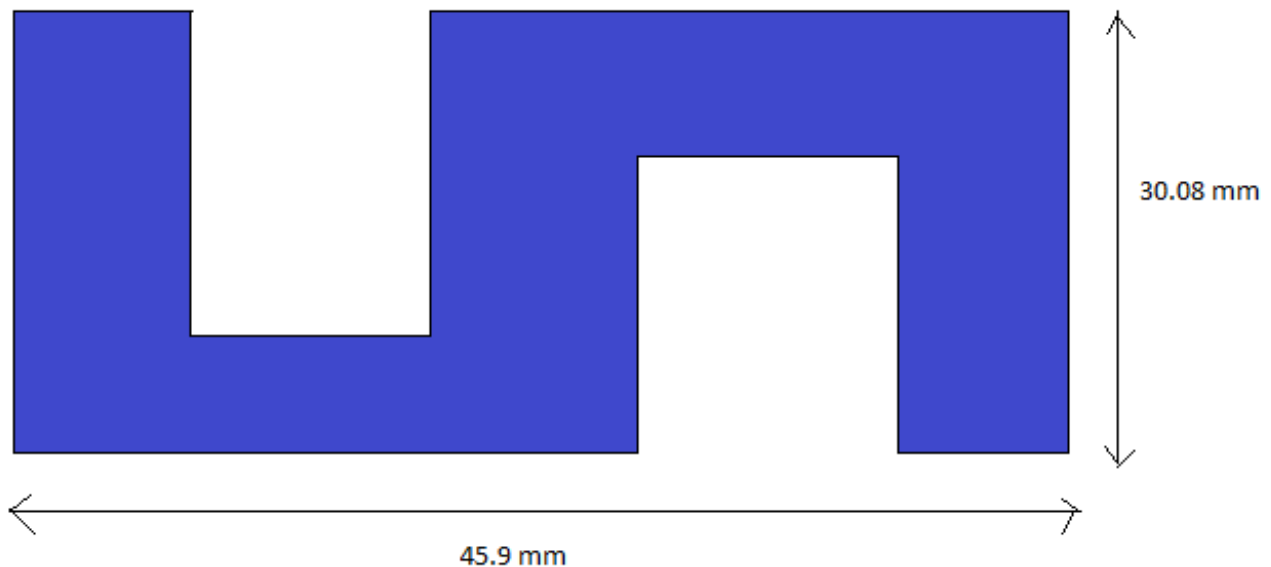


Fig .2 Front View of Metal Patch

The substrate is taken as roger/duroid5880 having relative permittivity equals to 2.2 and thickness 1 mm. The ground plate is of aluminum of thickness 0.2 mm and having relative permittivity equals to 1. Material of patch



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chosen as copper for a low cost antenna having relative permittivity 1 and thickness of patch is 0.2 mm to act as perfect conductor ideally.

### III. RESULTS & DISCUSSIONS

The purposed antenna has been simulated using HFSS at 10.0 GHz of frequency. The electric field vector profile and magnetic field vector profiles are shown in fig. 3 & fig. 4. These profiles show the resonance nature of antenna and the distribution of field at various positions of antenna. The radiation pattern of purposed antenna shown in fig.5 and fig 6 represents radiation intensity in all directions in spherical coordinates.

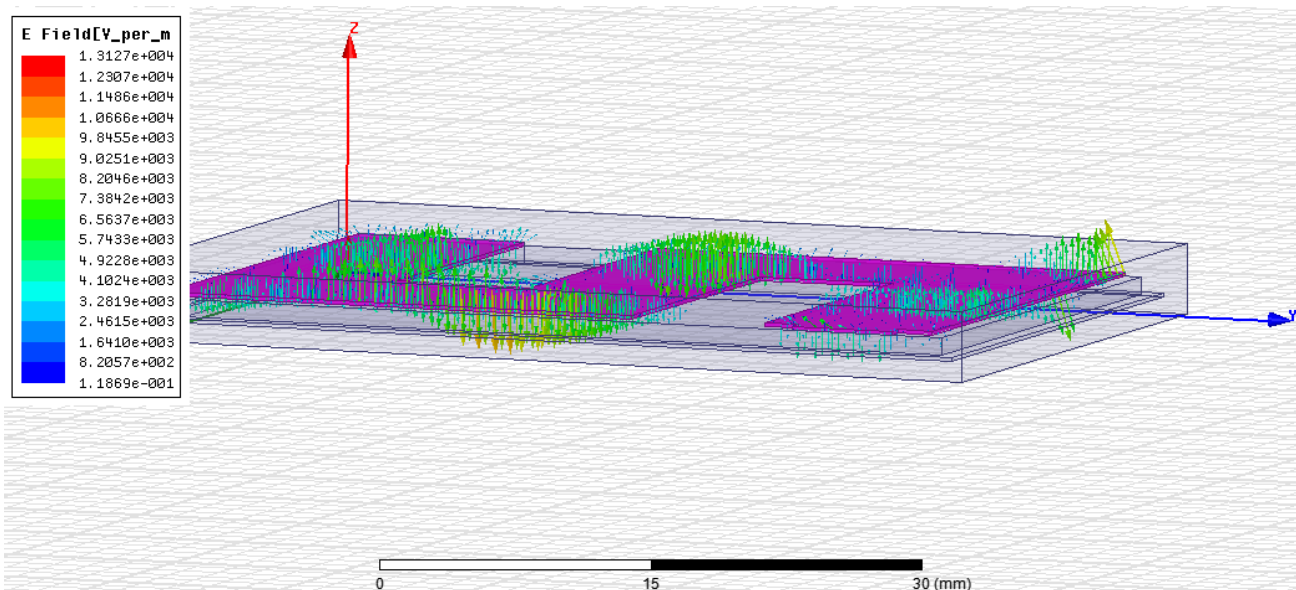


Fig. 3 Electric Field Vector profile of Antenna.



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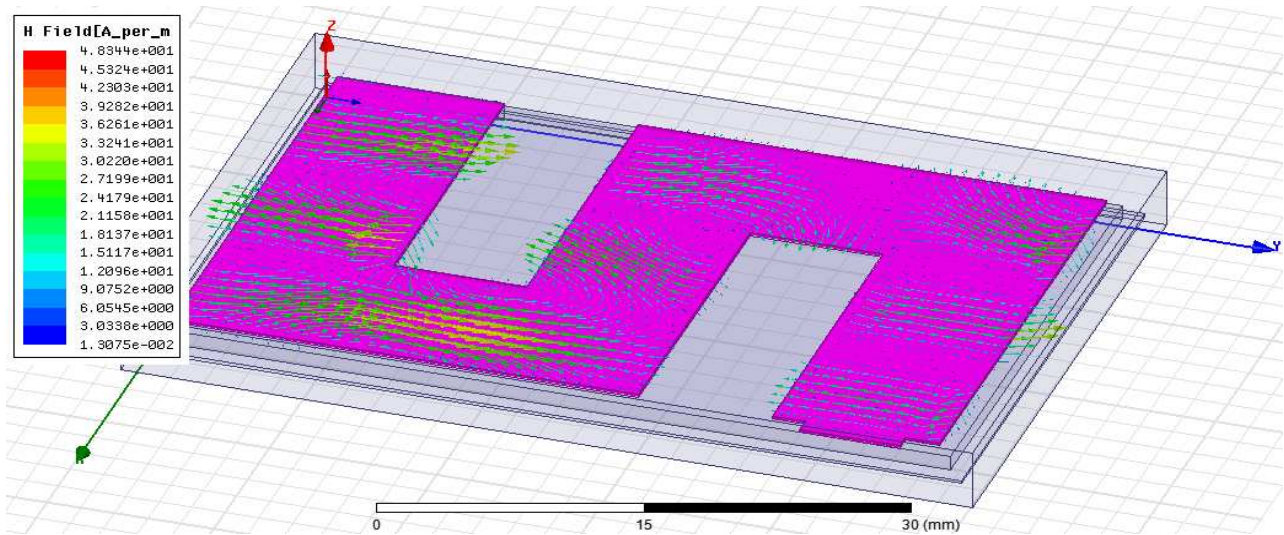


Fig. 4 Magnetic Field Vector Profile of Antenna.



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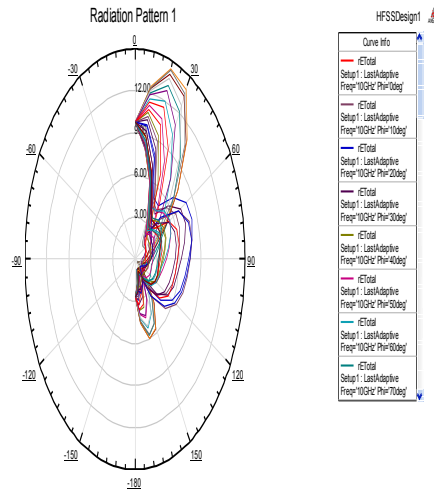


Fig. 5 Radiation Pattern of Microstrip Antenna.



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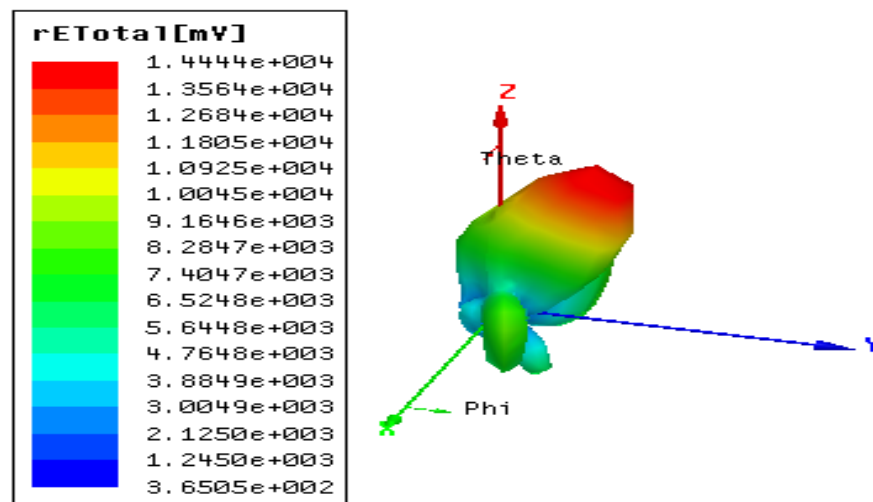


Fig 6- Radiation pattern 2 of the Patch Antenna

The dark red areas observed in pattern shows the maximum values of radiation intensity at these points. From the pattern it is clear that the antenna radiates well in broad dimensions along upward direction. A single back lobe has been observed in radiation pattern which proves minimum power loss in undesired directions makes antenna directional [3].

From the return loss plot shown in fig.7 of the purposed microstrip patch antenna it is observed that the reflection coefficient at the input of the proposed S-shaped microstrip patch antenna is  $-41$  dB of analysis at resonance frequency. At 10 GHz the  $S_{11} = -41$  dB which shows the resonance in antenna at this frequency. The VSWR of purposed microstrip patch antenna for the feed port has been shown in fig.8. From the same it has been observed that the VSWR is very less i.e. nearly 0.0 dB at 10 GHz of frequency.





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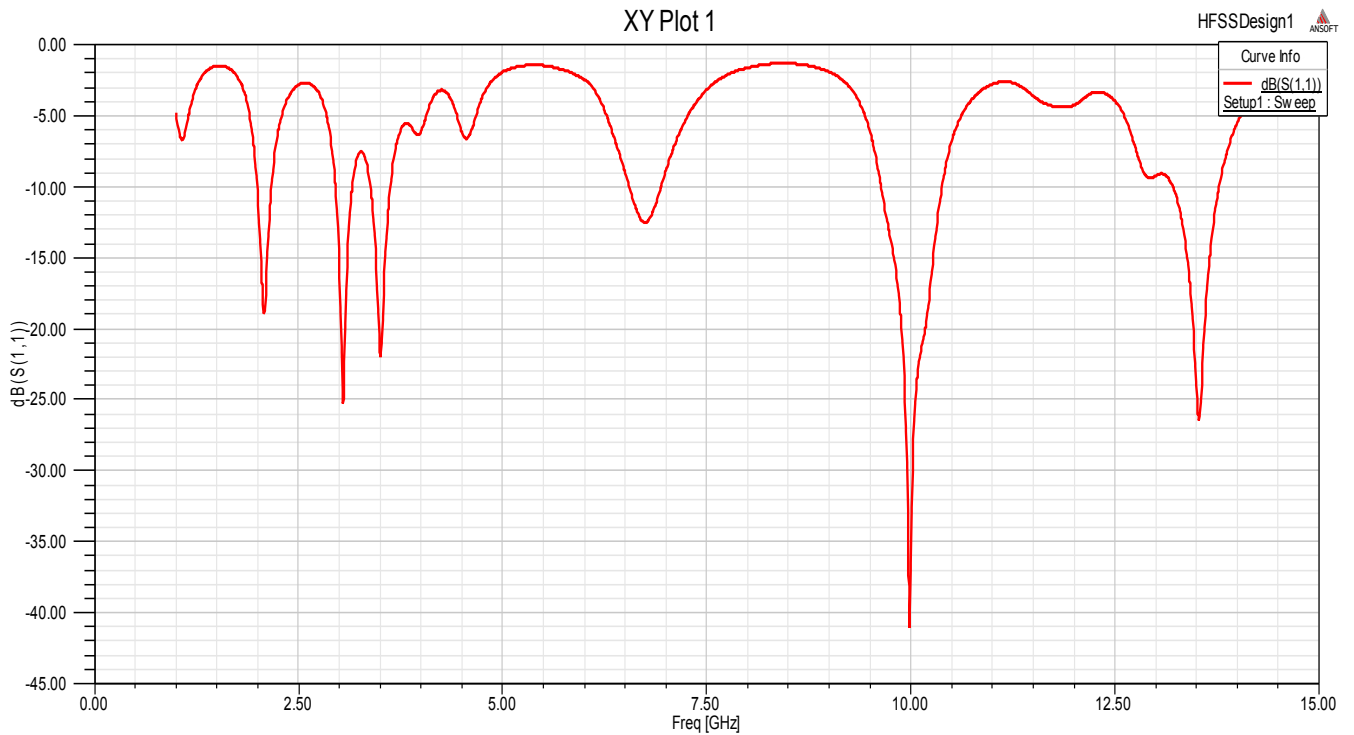


Fig. 7 S11 Plot of Patch Antenna



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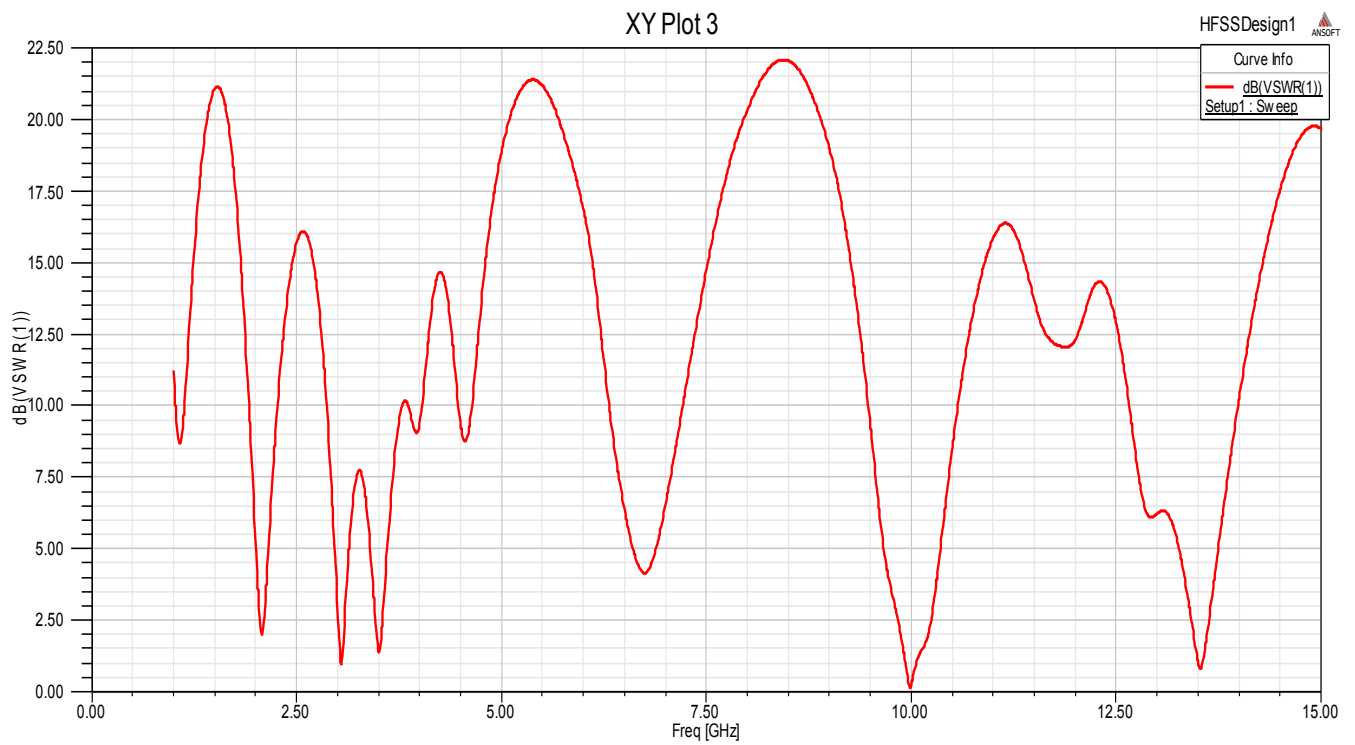


Fig. 8 VSWR Plot of Patch Antenna.

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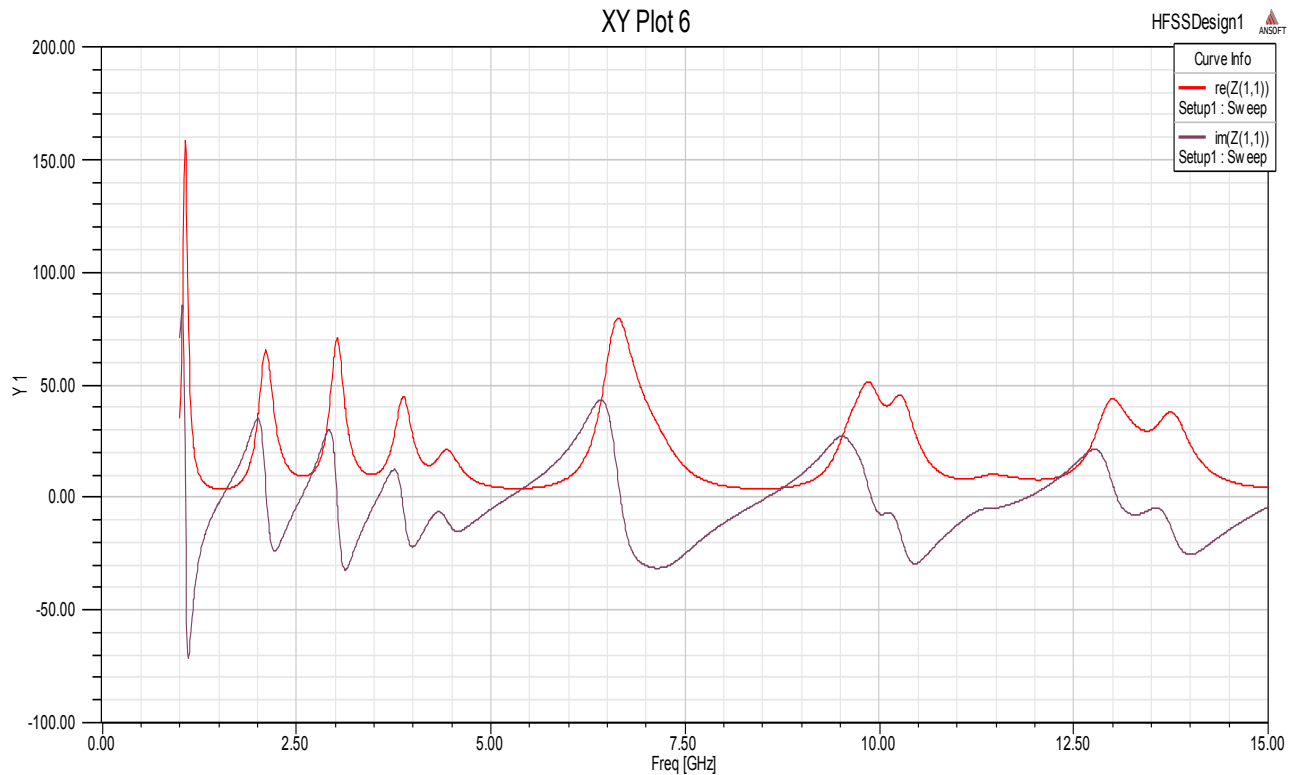


Fig 9 Impedance plot of Patch Antenna

Fig 9 shows the impedance plot of the proposed patch antenna. Impedance plot shows very high real value at resonance frequency i.e. nearly 50 dB at 10 GHz which proves that antenna has high gain at this frequency and it has quite less power loss in undesired directions at resonance. Fig 10 shows the gain plot of proposed antenna. Fig 10 shows that the proposed antenna has nearly 6 dB gain at the resonance frequency.



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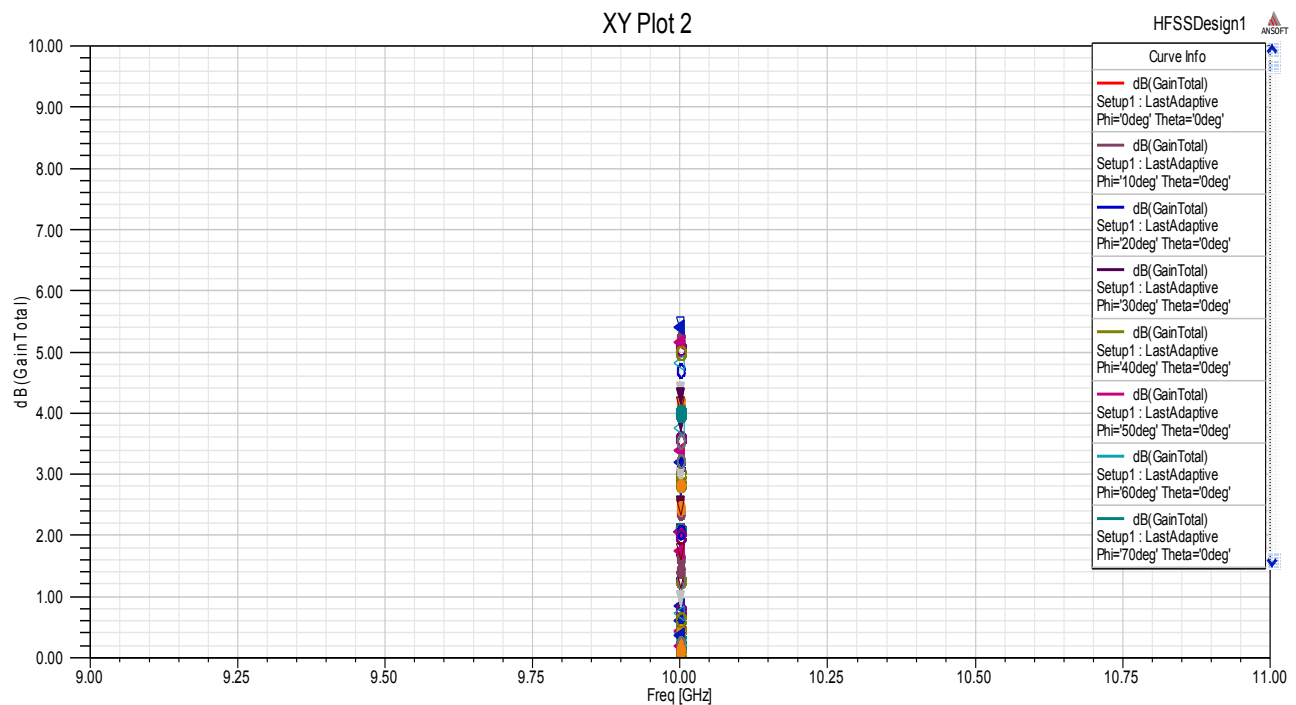


Fig 10 – Gain plot of Patch Antenna

## V. CONCLUSION

An S-shaped microstrip patch antenna for wireless applications has been designed. It shows good resonance at frequency 10 GHz; at same frequency it has very low VSWR 0 dB and high real value of impedance nearly 50 with gain of 6 dB. It has also been observed that slot incorporation in a well defined manner change the performance of antenna remarkably. Proposed antenna can be used for X band applications like in bluetooth, cordless phone etc. It can also be used for microwave applications like in RADAR and in bio-medical applications etc.



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