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# AN H-SHAPED DUAL BAND MICROSTRIP PATCH ANTENNA FOR WIRELESS APPLICATIONS

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***Abstract***: An *H*-shaped dual band microstrip patch antenna has been designed for wireless applications. Six slots at the edges of the patch of antenna and an *H*-shaped central slot are incorporated 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 $S_{11} = -27$ dB, $S_{22} = -27.5$ dB at 3.5 GHz and $S_{11} = -32$ dB, $S_{22} = -28$ dB of at 6.5 GHz of the proposed dual band patch antenna. Investigation of proposed antenna has been done at both microwave frequencies 3.5 GHz and 6.5 GHz and it has been observed that it shows resonance at both the frequencies which proves its dual band nature. Simulation of antenna is carried out on Ansoft simulator.

***Keywords***: Dual band, Central H-Shaped slot, compact.

## 1. 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 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 [7].

A microstrip rectangular patch antenna shown in figure 1 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 [7]. 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].

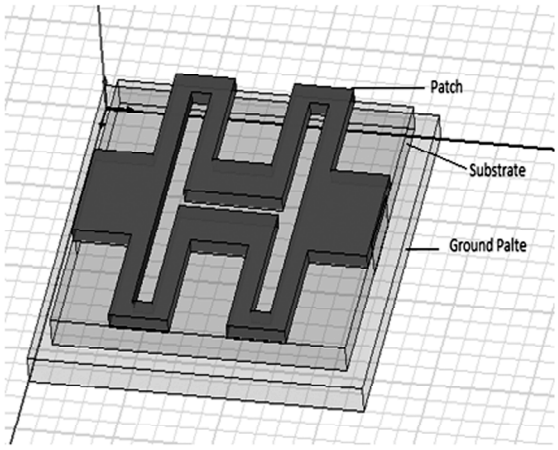


**Figure 1: Basic Rectangular Microstrip Patch Antenna Construction**

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 [8], and V-slot patch antennas [5].

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## 2. ANTENNA DESIGN

The antenna geometry is shown in figure 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 3.5GHz. Then, six rectangular slots at opposite edges and an H-shaped slot at the center of the patch are incorporated to perturb the surface current path, introducing local inductive effect that is responsible for resonance in antenna. The slot length (*Ls*), slot width (*Ws*) of the dual band 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 dual band antenna are *Ls* = 5mm and *Ws* = 3mm. 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 antenna for resonant frequency are calculated to be *L* = 15mm and *W* = 15mm using standard design equations for rectangular microstrip antenna design.

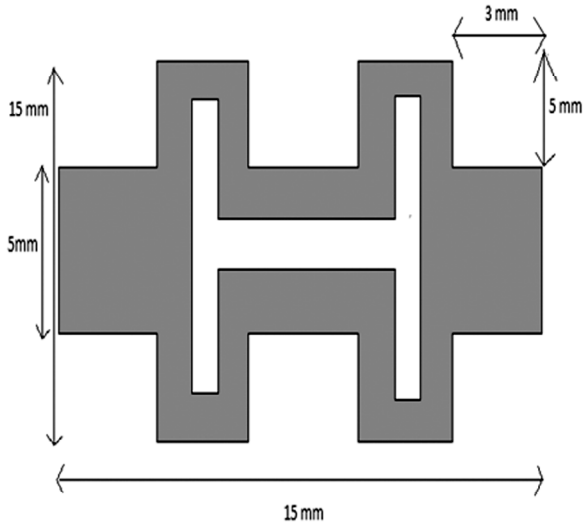


**Figure 2: Front View of Metal Patch**

The substrate is taken as polystyrene having relative permittivity equals to 2.6 and thickness 1 mm. The ground plate is of aluminum of thickness 1mm and having relative permittivity equals to 1. Material of patch chosen as copper for a low cost antenna having relative permittivity 1 and thickness of patch is 0.5 mm to act as perfect conductor ideally.

## 3. RESULTS AND DISCUSSIONS

The purposed H-shaped dual band patch antenna has been simulated using HFSS at 3.5 GHz of frequency. The electric field vector profile and magnetic field vector profiles are shown in figures 3 and 4. These profiles show the resonance nature of antenna and the distribution of field at various positions of dual band antenna. The radiation pattern of dual band patch antenna shown in figure 5 represents radiation intensity in all directions in spherical co-ordinates.

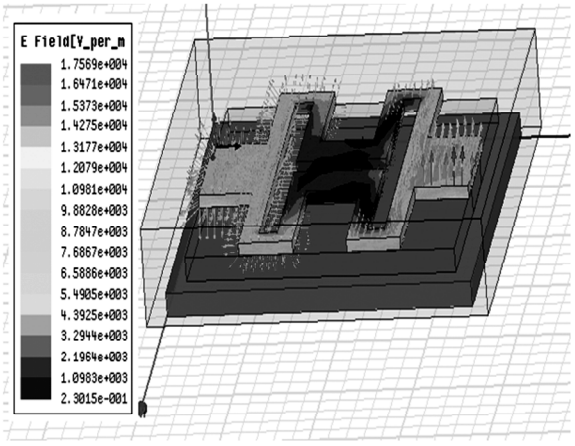


**Figure 3: Electric Field Vector Profile of Antenna**

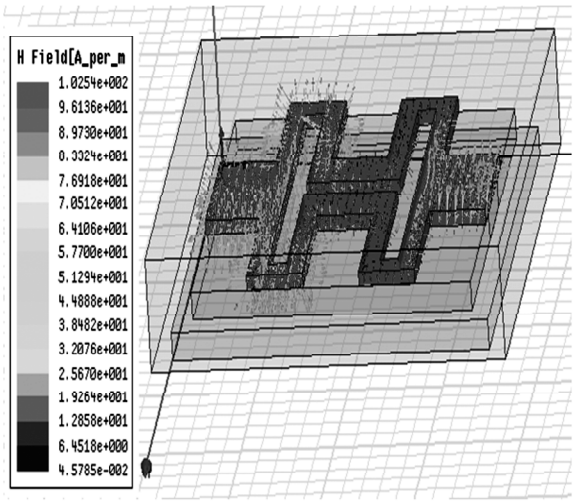


**Figure 4: Magnetic Field Vector Profile of Antenna**

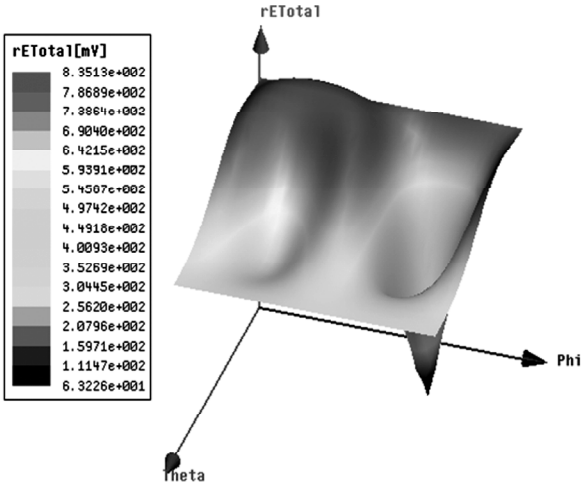


**Figure 5: Radiation Pattern of Microstrip Antenna**

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 figure 6 and figure 7 of the microstrip antenna it is observed that the reflection coefficient at the input of the proposed H-shaped dual band microstrip patch antenna is below –27 dB of analysis at both the frequencies. At 3.5 GHz the $S_{11} = -27$ db, $S_{22} = -28.5$ db and at 6.5 GHz $S_{11} = 32$ dB, $S_{22} = 28$ dB which shows the resonance in antenna at both frequencies.

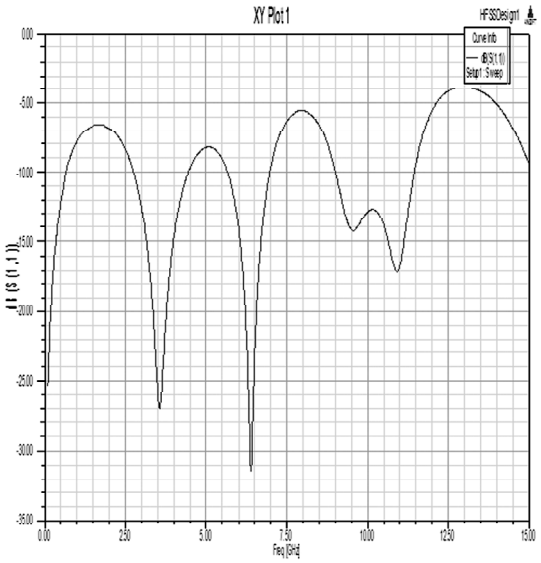


**Figure 6: $S_{11}$ Plot of Multi Band Patch Antenna**

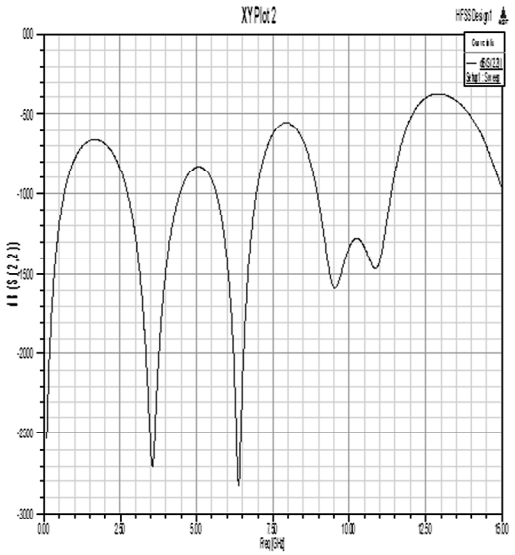


**Figure 7: $S_{22}$ Plot of Dual Band Patch Antenna**

The VSWR of H-shaped dual band microstrip patch antenna for both the feed ports has been shown in fig.8. From the same it has been observed that the VSWR is very less i.e. nearly 0.8 dB at 3.5 GHz of frequency and nearly 0.4 dB at 6.5 GHz of frequency.

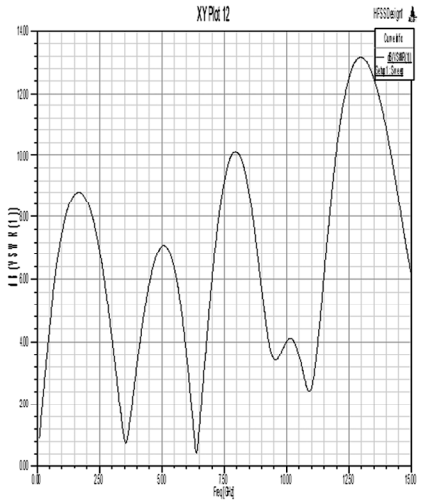


**Figure 8: VSWR-1 Plot of Dual Band Patch Antenna**

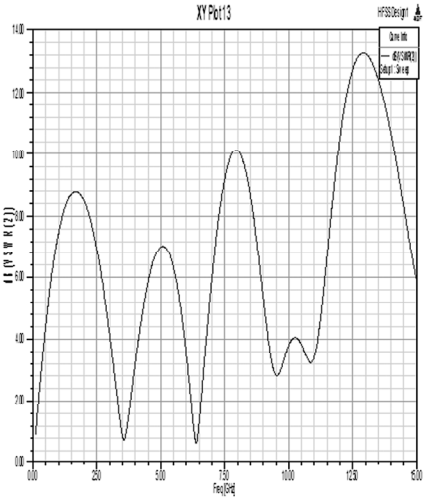


**Figure 9: VSWR-2 Plot of Dual Band Patch Antena**

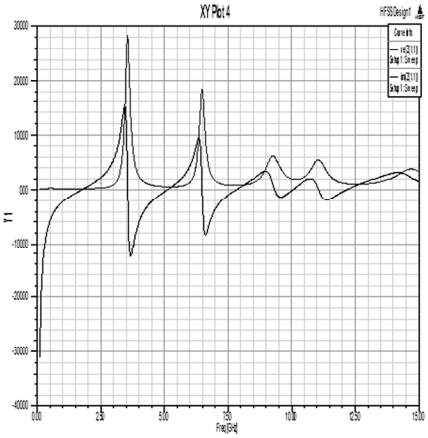


**Figure 10: Impedance Plot-1 of Dual Band Patch Antenna**

Figures 10 and 11 shows the impedance plot of the purposed dual band patch antenna. Impedance plots shows very high real value at resonance frequency i.e. nearly 275db at 3.5 GHz and 180 db at 6.5 GHz which proves that antenna have high gain at the both the frequencies and it has quite less power loss in undesired directions at resonance.

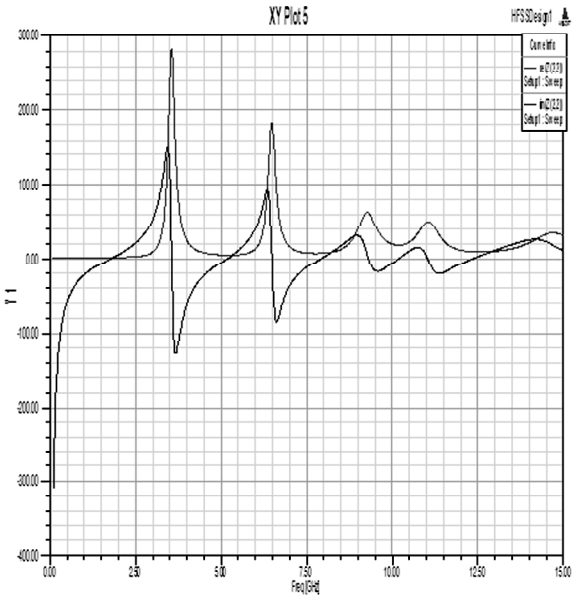


**Figure 11: Impedance Plot-2 of Dual Band Patch Antenna**

## 5. CONCLUSION

An H-shaped dual band microstrip patch antenna for wireless applications covering the (0.5-11) GHz frequency has been designed. It shows good resonance at frequency 3.5 GHz, 6.5 GHz and at same frequencies it has very low VSWR and high real value of impedance. 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 S-band applications like in bluetooth, cordless phone etc. and C-band applications like in radar (find snow cover land), long distance communication etc. It can also be used for microwave applications like in RADAR and in bio-medical applications etc.

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