Ultra Wideband Slotted Modified H-Shaped Microstrip Patch Antenna For Wireless Applications

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Abstract- *The wireless communication system is gaining more and more progress in recent years with the support of microstrip patch antennas. Microstrip patch antennas are more comfortable for wireless devices due to their compactness, easy fabrication, and mounting. The ultra wideband slotted modified H-shaped microstrip patch antenna is presented in this article for wireless devices. Ultra wideband is achieved along with another small band makes it dual band pattern. The first band is a small band radiates at 2.95 GHz ranging from 2.68 GHz to 3.14 GHz with a bandwidth of 460 MHz. This is applicable in the wireless devices like WiMAX, IMT etc. The second band is the ultra-wideband (UWB) radiates at 4.46 GHz, 8.2 GHz and 9.4 GHz ranging from 3.37 GHz to 10.1 GHz with a bandwidth of 6.73 GHz. WLAN, WiFi, WiMax and LTE can occupy this band to operate. Both the bands have maintained at VSWR<2 and the gain are kept at least -10 dB. The proposed antenna is simulated using High Frequency Structural Simulator (HFSS v15) software and fabricated on a low-cost FR4 substrate having a dielectric constant of 4.4 and height 1.6 mm with a 50-ohm microstrip line feeding. The miniaturization of the antenna is achieved with slots in the patch and ground plane, hence the name slotted patch and partial ground. The complete size of the antenna is 34x30x1.6 mm2. The simulated and experimental results are compared to conclude that both are lightly deviated..*

Keywords- UWB, Slotted Patch, FR4, VSWR, Return loss. HFSS, Wireless.

I. INTRODUCTION

Wireless communication needs small size, light weight, the easy mountable antenna for effective performance. So an effective antenna design is required to embed in wireless devices. Microstrip patch antennas [1] are the only solutions to the above problems having all the required properties. But the same patch antennas also suffer from narrow bandwidth and less gain. Various ways of increasing the bandwidth of a patch antenna are discussed in the past research articles includes the use of low permittivity substrate, thick substrate, and etching resonant slots inside the patch [3]. Etching slots in the patch and ground plane improve the bandwidth by introducing multiband characteristics [2] and also reduces the size of the antenna. In this article, multiple resonant slots are taken in the patch to achieve resonance overlapping and finally yield ultra wideband characteristics. The proposed antenna covers the frequency bands ranging from 2.68 GHz to 3.14 GHz in the early part of the graph and 3.37 GHz to 10 GHz in the later part of the graph. The designed antenna is simulated using a high frequency structural simulator (HFSS) [5] software and the parameters like return loss, gain, VSWR, radiation pattern and bandwidth etc are plotted to measure them. A novel ultra wideband slotted modified H-shaped microstrip patch antenna with split ground [5] plane is presented in this paper. The ultra wideband is observed from 3.37 GHz to 10.1 GHz centered at 4.47 GHz, 8.2 GHz and 9.4 GHz with the bandwidth of 6.73 GHz. Along with UWB, another small band is also noticed from 2.68 GHz to 3.14 GHz centered at 2.95 GHz with the bandwidth of 460 MHz. Both these bands are useful for wireless devices like WLAN, WiFi, WiMAX, IMT, LTE and much more. The technique adopted here to improve the bandwidth uses multi-resonance frequencies within -10 dB impedance bandwidth [6]. The fractal geometry on a step by step basis introduces multi-resonance characteristics. Antenna resonates at lower frequencies by the addition of strips in the patch [7], and removal of the slots in the patch resonates at higher frequencies.

In this proposed design many slots have been removed in a sequence by the sequence as shown in figure 1. This concept also makes the antenna more compact by reducing the size of the antenna. The overall reduction in the size of the antenna is almost 70%. Zahraoui et al proposed a novel design of a fractal antenna for IMT and WiMAX applications [1] shows dual bands from 4.13 GHz to 4.24 GHz suitable for IMT and 5.13 GHz to 5.75 GHz for WiMAX applications. Mukh Ram et al presented a rhombic fractal patch antenna for multiband applications [2] shows four resonant frequencies at 1.07 GHz, 4.5 GHz, 7.51 GHz and 13.18 GHz having return losses of -21 dB, -20.24 dB, -17.52 dB and -34.82 dB. The related frequency bands are 1.0 to 1.14 GHz, 4.43 to 4.57 GHz, 7.44 to 7.58 GHz and 12.83 to 13.81 GHz having a bandwidth of 13.08%, 3.11%, 1.86% and 7.44%. Bashar B et al explains the design of broadband circular patch microstrip antenna for KU-band satellite communication applications [3] achieved an impedance bandwidth of 40.95% from 11.36 GHz to 17.21

GHZ at -29.18 dB with VSWR less than 2. Nawel Seladji-Hassaine et al explained a miniaturized dual band triangular microstrip antenna with sierpinski fractal ground [4] finds the resonances at 2.35 GHz for iteration-1, 2.4 GHz for iteration-2, and 2.42 GHz for iteration-3 found useful for WLAN and defense applications. A novel UWB slotted modified H-shaped microstrip patch antenna having a UWB along with a narrowband is simulated and fabricated on FR4 substrate presented in this work. It is a step by step investigation to arrive at the final fabricated shape. The design starts with a regular rectangular patch and taking several slots in the patch and also in the ground plane makes the UWB behavior. The said structure is simulated using HFSS v15 software and fabricated for the validation of the results. It is found that the simulated and the measured results are closely compromised each other.

II. PROPOSED ANTENNA DESIGN

The step by step process of designing the proposed antenna is shown in figure 1. The design starts with a simple rectangular patch antenna shown in the iteration 1. The successive iterations are followed by taking slots at the systematic approach. Also, a truncated cone of lower radius 3.5 mm and upper radius 0.25 mm is taken at the center of the patch. Finally plus shaped strips are enclosed on the upper radius of the cone. So in this design, both addition of strips in the patch and removal of the slots in the patch are performed ao obtain lower and upper resonances to make it UWB

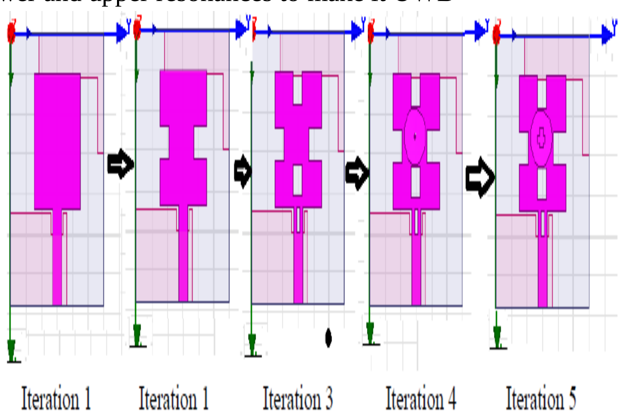
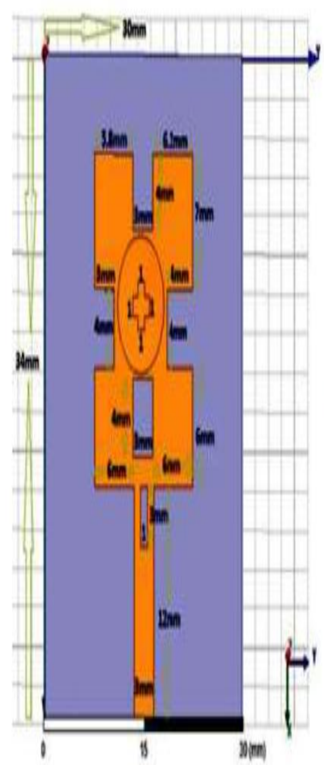


Figure 1: Successive iterations to design proposed antenna

The patch and ground view of the proposed ultra wideband slotted modified H-shaped microstrip patch antenna is shown in figure 2 and 3. The simulated design is fabricated on FR4 substrate of dimensions 34x30x1.6 mm. The slotted or partial ground is on the other side of the patch. The structure of the proposed antenna consists of a radiating patch, dielectric substrate, microstrip line feeding and a ground plane. The original patch is selected as a rectangular patch 17x15x0.05 mm in which three outer slots were created of size 3x4 mm and an inner slot of size 4x1 mm. The substrate is FR4 with a dielectric constant of 4.4 of size 34x30x1.6. The ground plane is modified as a partial ground with three splits of size 10.6x19 mm, 7.5x18 mm and 12x2 mm. A 50 Ω microstrip line feeding is given to the antenna of size 10.55x3 mm. To improve the impedance matching of the antenna Partial ground [16] concept is used here.



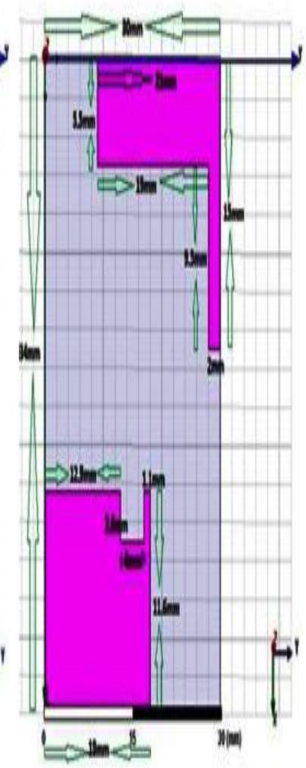


Figure 2: Proposed antenna (Top View) Figure 3: Proposed antenna (Ground View)

III. SIMULATION AND MEASURED RESULTS AND DISCUSSIONS

The properties of the proposed antenna are investigated using HFSS v15 simulator. The simulated results of the proposed antenna such as return loss, bandwidth, VSWR, gain, radiation pattern are plotted in different graphs. Figure 4 shows the simulation result of return loss V/s frequency indicates two bands. Band 1 is a narrow band resonates at 2.95 GHz having the return loss of -17.7 dB ranging from 2.68 GHz to 3.14 GHz with a bandwidth of 460 MHz. Band 2 is an ultra wideband resonates at 4.46 GHz, 8.2GHz and 9.4 GHz having the return loss of -14.9, -22.7 dB ranging from 3.37 GHz to 10.1 GHz with a bandwidth of 6.73 GHz. The summary of these two bands is summarized in Table 1. The 3-D graph of return loss V/s frequency is shown in figure 5. The antenna resonates at three different frequencies of two useful bands. The selection of the response is based on the point where it shows the return loss of -10db. VSWR is kept less than 2:1 shown in figure 6. The proposed antenna at 3 GHz is shown in Figure 7.

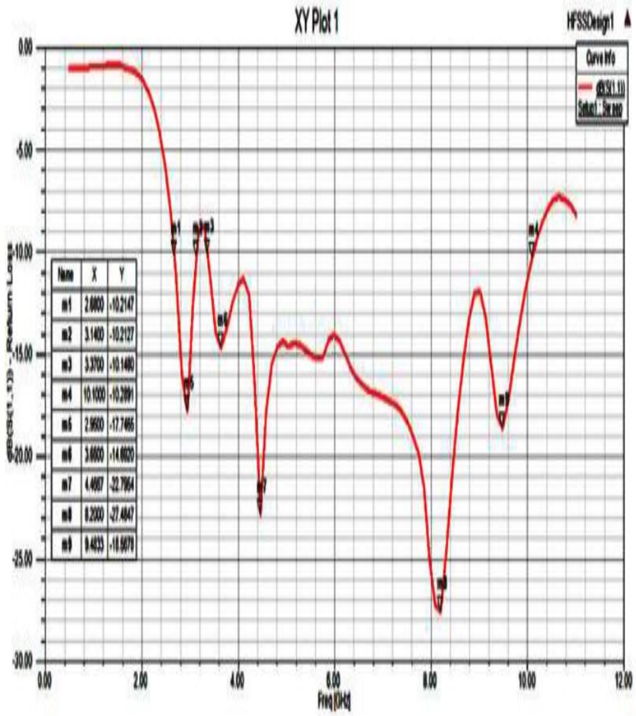


Figure 3: Plot of Simulated Return Loss(dB) vs Frequency(GHz)

Table 1: Details of Band-1 and Band-2

Bands	Resonant Frequency in GHz	Maximum Return Loss in dB	Range in GHz	Bandwidth in GHz	Applications
Band-1	2.95	-17.7	2.68-3.14	0.460	GSM
Band-2	4.46, 8.2, 9.4	-14.9, -22.7	3.37-10.1	6.73	WiFi, DMB

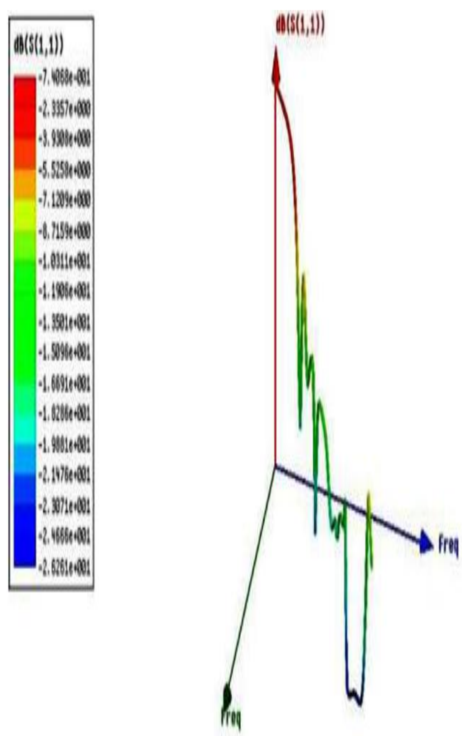


Figure 4: 3-D Plot of Simulated Return Loss vs Frequency

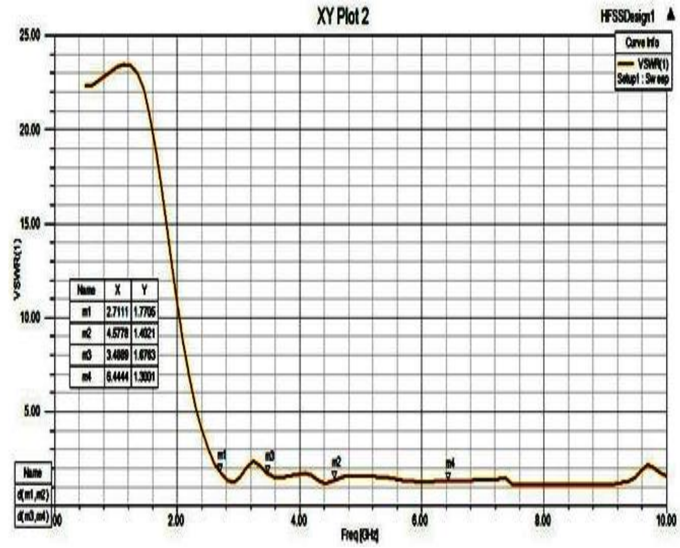


Figure 5:Plot of VSWR v/s Frequency

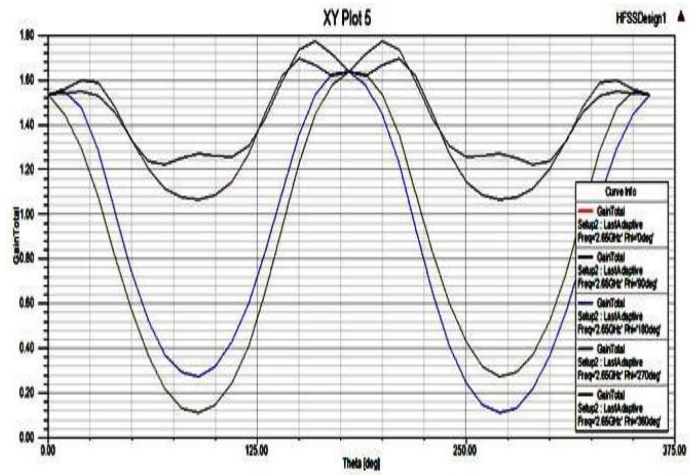


Figure 6 Plot of Gain at 3 GHz

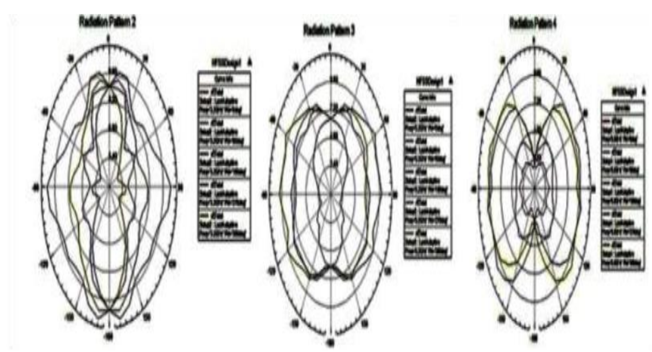


Figure 7: Plot of Radiation Pattern at 2.4 GHz, 3 GHz, 5.2 GHz and 5.8 GHz

The simulated radiation patterns at 2.4 GHz, 3 GHz, 5.2 GHz and 5.8 GHz are shown in figure 8. The graph is observed to be moderately omnidirectional radiation patterns. So the proposed ultra wideband slotted modified H-shaped microstrip patch antenna represents omnidirectional radiation patterns in the all the frequency bands. The 3-D plot of the simulation radiation pattern is shown in figure 9. The Surface

Current density distribution, Electric field density, and Magnetic field density are noticed in the figures 12,13 and 14. Figure 10 shows the simulated radiation patterns at 2.4 GHz, 3 GHz, 5.2 GHz and 5.8 GHz. Moderately omnidirectional radiation patterns are observed in the above graph. Hence the proposed regular heptagonal shaped slotted broad band microstrip patch antenna represents good omnidirectional radiation patterns in the entire frequency bands. The figures 10,11 and 12 represents the simulated plots of Surface Current density distribution, Electric field density, and Magnetic field density.

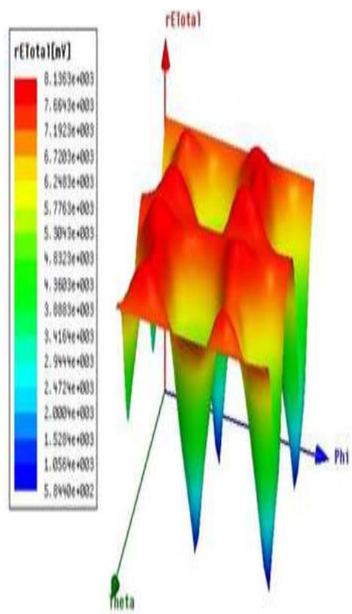


Figure 8 3-D Plot of Simulated Radiation Pattern

IV. CONCLUSION

The ultra-wideband H-shaped micro strip patch antenna for wireless devices such as WLAN, Wi-Fi, WiMAX, IMT, and LTE has been presented in this paper. The parameters of the proposed antenna were simulated and Practically measured using antenna measuring setup. The slots on the patch and the ground plane not only reduce the size of the antenna but also create the multiresonance behavior for several applications. The proposed antenna has good return loss, radiation patterns, higher gain, and VSWR<2 suggest that the antenna is suitable for WLAN, WiFi, WiMAX, IMTS and other applications. The wideband operation in the second band has the overall bandwidth of about 85.19% is achieved from 2.68 GHz to 10.1 GHz. The simulated and the measured and simulated results shows identical response and resonate at 2.95 GHz, 4.46 GHz, 8.2 GHz and 9.4 GHz having the return loss of -17.7 dB, -14.9 dB and -22.7 dB. The two bands can be seen from 2.68 GHz-3.14 GHz (Band 1) and 3.37-10.1 GHz (Band 2) which finds useful for many wireless devices such as WLAN, WiMAX, WiFi and IMT applications.

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