MULTI-NOTCHED PRINTED MONOPOLE ANTENNA FOR UWB APPLICATION

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ABSTRACT

A compact printed ultra wideband (UWB) monopole antenna with multi-notched characteristics is presented. By inserting multiple E-shaped slot in micro strip feed line and ground plane, additional resonances are excited. The multi notch has been created by embedding a pair of – L shaped arm in the radiating patch and a modified E-slot defected ground structure in the feeding line. The designed antenna has a small size of 20 X 18 mm^2 and operates over the frequency band between 4.5 and 11.8 GHz for VSWR < 2. The VSWR and radiation patterns of the antenna are presented, which prove that the designed antenna is a good candidate for various UWB applications.

Keyboards: Multi notched bands, E-slot, planar monopole antenna, ultra wideband (UWB) antenna.

I INTRODUCTION

Many developments for ULTRAWIDEBAND (UWB) in recent years has been undergoes. However, there still remain many challenges in making this technology alive up to its full potential [1]. Printed monopole antenna widely used in UWB application since they exhibit very attractive merits such as wide impedance bandwidth, simple structure, and omnidirectional radiation pattern. Several printed monopole antennas have been proposed recently [2]-[4] to cover the frequency band that is defined by the Federal Communications Commission (FCC) from 3.1 to 10.6 GHz for UWB applications [5].

However, the WLAN and WiMAX networks operating in 5.15-5.825 and 3.3-3.7 GHz, respectively faces the problem of interfacing . Thus, to prevent interference, a better antenna for UWB applications should have dual notched bands at 3.3-3.7 and 5.15-5.825 GHz [6]-[7]. Federal Communications Commission (FCC) allocate 3.1 – 10.6 GHz for the ultra-wide band applications, for these application micro strip patch antennas have been adopted .Most important part for the ultra –wideband system is that, the UWB antenna should be designed with compact size ,low cost, low return loss , large bandwidth, omnidirectional radiation pattern [8]. In [9] , dual band-notched function is achieved by using a U-slot in the ground plane and an E-slot in the radiation patch.In [10], C-shaped slots used to formed the dual notched bands in the beveled patch. Nevertheless, most of these antennas have the common deficiency of large size, which may lead to a challenging task in miniaturizing antenna design. At present time UWB antennas present more attention to their advantages like ease fabrication, ease integration with monolithic microwave integration circuits (MMICs), simple structure. More challenging work in designing microstrip antenna is the narrow impedance bandwidth (BW). Etching polygon-like slot antennas , modified elliptical antennas using a fork-like tuning stub and parasitic elements are some techniques that are used to design planer antenna.

In this letter, a novel multi notched monopole antenna is proposed. To achieve the multi notched frequency, E -shaped slots inserted on the ground plane are employed. Notched frequency bands are achieved also by embedding L -shaped stubs in the radiation patch. The frequency bandwidth simulated using IE3D Simulator with VSWR < 2 of the antenna that covers 2.8 to over 11.8 GHz with band rejection from 4 GHz to 11 GHz. The parameters of these filtering structures are analyzed in terms of the notch frequency, notched bandwidth, and the lower-edge frequency of the band.

II. ANTENNA DESIGN

Fig. 1 shows the geometry of the proposed antenna. The radiating monopole and feeding mechanism are printed on the top side of the substrate, while the ground plane is printed on the bottom side. This antenna is printed on an FR4 microwave substrate with size of 20X18 mm^2, thickness of 1 mm, and dielectric constant of 4.4. The width of the microstrip feed line W_f is fixed at 1.86 mm to achieve 50- Ω characteristic impedance from 2.8-11.8 GHz. By designing two I-shaped notches in both sides of the microstrip feed line on the ground plane, additional resonances are excited.

Bottom Layer

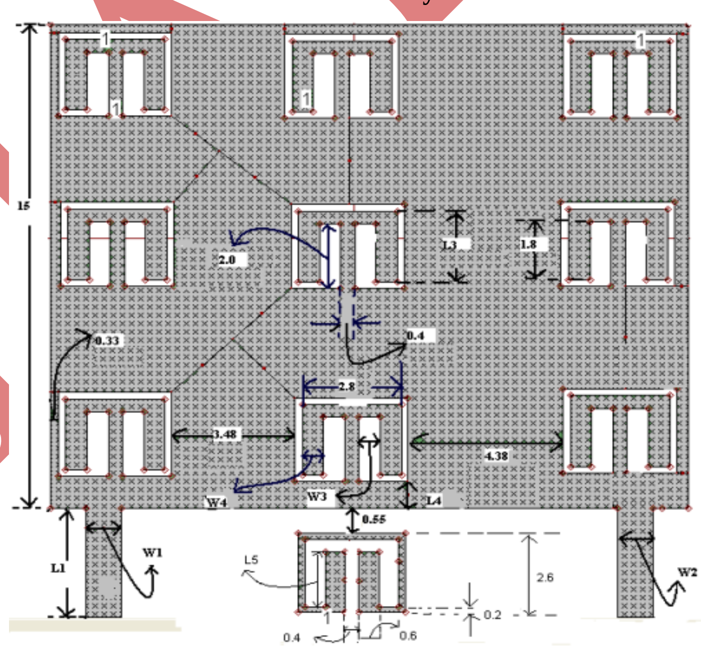


Fig.1 (a). Configuration and parameters of the proposed antenna (unit: millimeters).

To achieve multi notched bands, a pair of L-shaped arm on the radiating patch and a modified E-slot defected ground structure in the feeding line is adopted to generate notched bands.

The optimal dimensions of the designed antenna are as follows: Lsub = 20mm, Wsub= 18mm, Lf = 7.5mm,W1=W2=1 mm,W3 = W4 = 0.6mm,W5 = 4mm,W6 = 1mm, L1= 3.6 mm, L2 = 1.8 mm , L3= 2.2mm, L4 = 0.83 mm, L5 = 1.8 mm, and L = 8.2mm. Moreover, the structure of the antenna is symmetrical with respect to the longitudinal direction. The height of the feed gap between the main patch and the ground is also an important parameter to control the impedance bandwidth [11]. The radiating patch has a distance o f 2.5 mm to the ground plane.

Top Layer

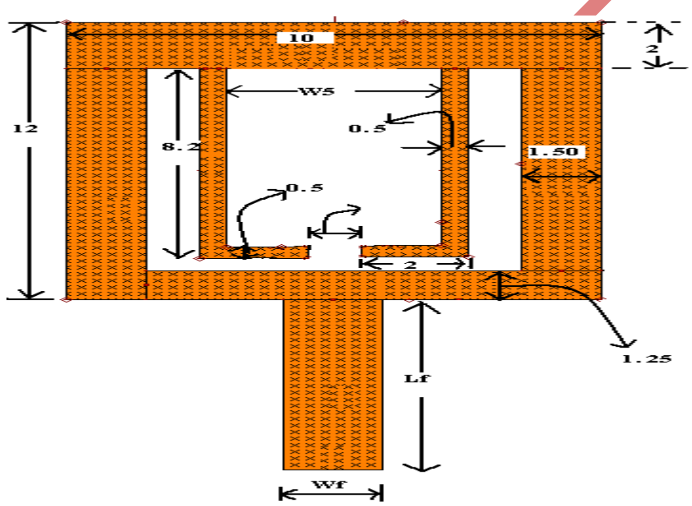


Fig.1(b). Configuration and parameters of the proposed antenna(unit:millimeters).

III. RESULTS AND DISCUSSIONS

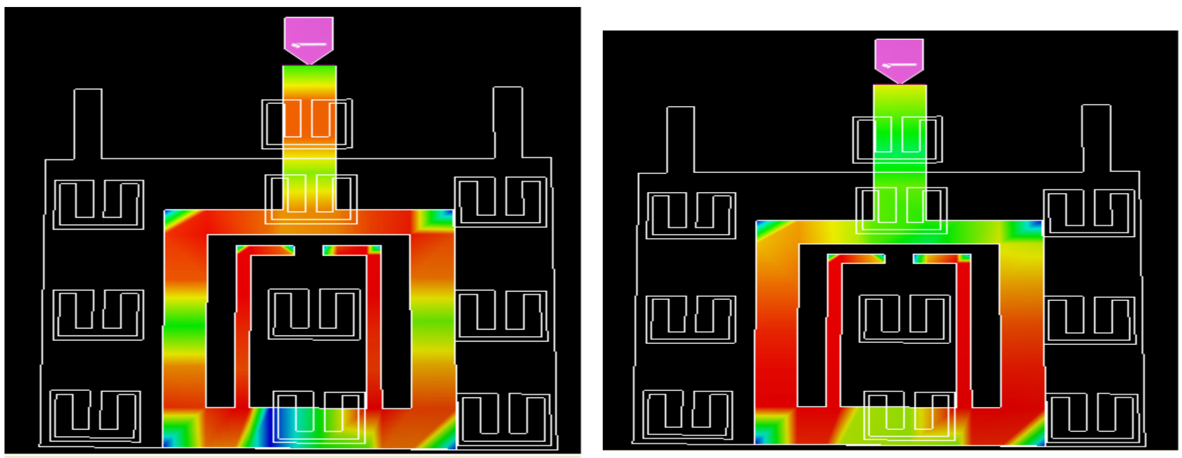
3.1 UWB Monopole Antenna

The parameters of the proposed antenna are studied by changing one parameter at a time and fixing the others.The antenna was analyzed using IE3D. In Fig. 1 show the full structure of the studied antenna with dimension.

Fig. 2 shows the simulated current distribution comparison of the same antenna on different frequency with L-shaped arm. A simple monopole antenna has poor VSWR characteristics at the different frequency band over 10 GHz. Also, the simulated current distribution on the proposed antenna at 11.8 GHz is presented in Fig. 2(a). In Fig. 2(b) it has been observed that the current concentrated on the edges of the two L-shaped notches at 4.15 and 11.8 GHz. Therefore Zin approaches to infinite at the condition of which the current flows across the slots, resonance occurs. At this frequency the antenna impedance changes due to the resonant properties of the L-shaped arm .

3.2 UWB Monopole Antenna With multi Band-Notched Frequency Characteristics

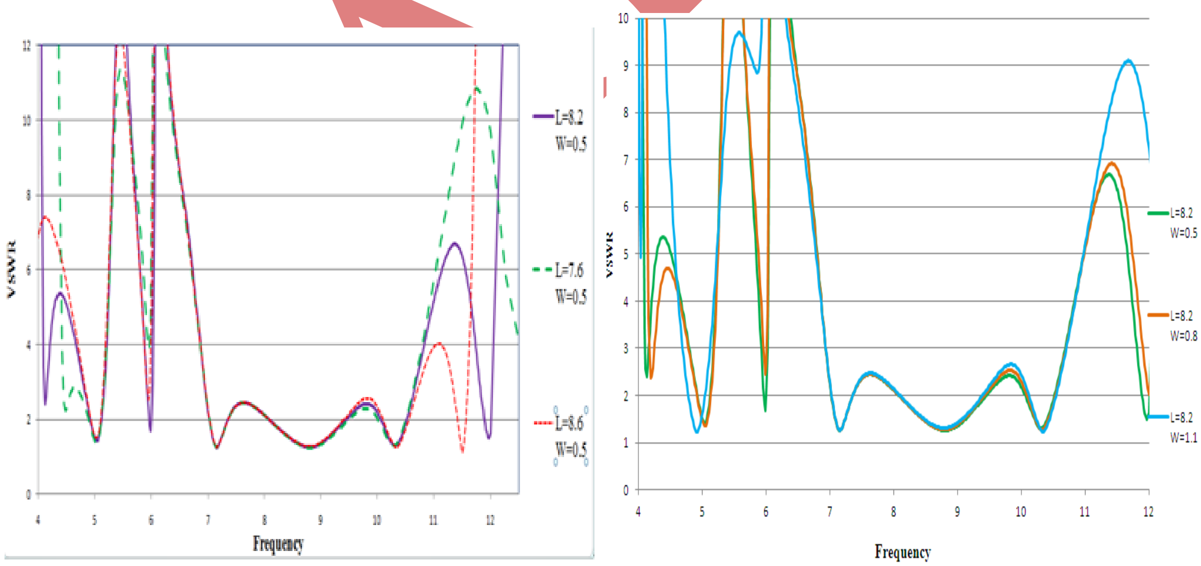
By embedding L- shaped arm in the radiation patch and a modified E-slot in ground structure and in feeding line multi notched frequency bands are achieved.



(a) (b)

Fig.2. Simulated current distributions on the patch and ground plane, respectively, at (a) first notch frequency and (b) second notch frequency.

As shown in Fig. 3(a) and (b), the current flows are more dominant around the filter, in these structures at the notch frequency. As shown in fig 3(a) and (b) higher attenuation near the notch frequency is produced ,so at this notch frequency resultant radiation field cancel out. Hence the antenna does not work effectively.



(a) (b)

Fig. 3(a) Simulated VSWRs of proposed antenna with different length of L-shaped stubs

Fig. 3(b) Simulated VSWR of proposed antenna with different width of L-shaped stubs

By changing the different parameters of the antenna, various notch band can be achived. The notch function is determined by changing the length and width of L-arm. The simulated VSWR of the proposed band-notched UWB antenna are shown in Fig. 3, It can be observed that the proposed antenna has a wideband performance of 4–11 GHz for VSWR < 2, covering the entire UWB frequency band with multi notched bands (1) 4.92-5.12 (2)5.97-6.00 (3)7.03-7.35 (4) 8.10-9.43 (5) 10.07-10.50 (6) 11.90-12.00 GHz .

The behavior of current distribution on the simulated UWB antenna at 4.15 GHz and 11.88 GHz is shown in fig 2. from the dense area of it has been found that the induced electric field is more around the L-shaped arm on radiating patch, the dense current distributions is shown by the red area . Usually, current density around its edge of radiating patch on the monopole antenna can propagate from the edge to its ground plane for the energy radiating. The current is flowed around the L-shaped arm as the L-shaped arm is inserted on radiating patch.

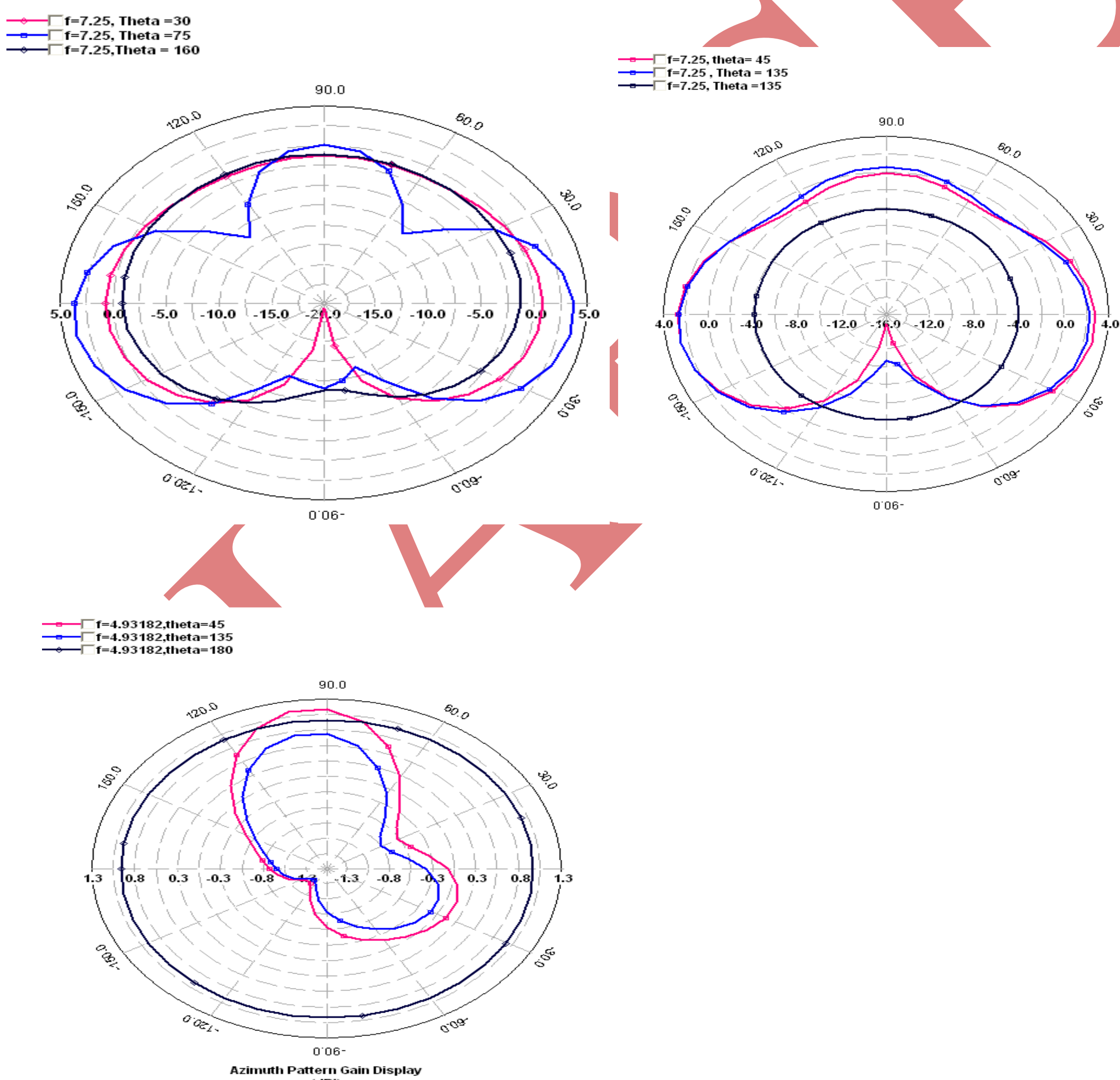


Fig.4 Measured radiation patterns of the proposed antenna at different angle (a) 7.25 GHz, (b) 4.93 GHz and.

Weak current distribution are shown by the blue area, this is non -effective area.The far-field radiation pattern of the proposed antenna are also presented at 4.93 and 7.25 GHz in Fig. 4. Based on these patterns, it can be seen that the proposed antenna has the asymmetric radiation characteristics at H-plane mainly because of its inherent asymmetric structure. We can observe that the antenna pattern is approximately omnidirectional at all simulated frequencies.

IV. CONCLUSION

In this paper, a UWB antenna with Multi sharp notched-band behavior have been designed, and measured. By adding the L-arm to the feed line, avoid the interference between the UWB application and other narrow band wireless systems. The measured results of the proposed antenna, which has a good agreement with the simulated ones, mainly satisfy the requirements for UWB as defined by the FCC. Analysis of the antenna show that the frequency bandwidth covers from 4 to 12 GHz .Two band-rejection structures are used to prevent interference with WiMAX and WLAN systems. We found that the measured, maximum VSWR is 2 at different frequency band as show in fig. 3(a) and 3(b).

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