

Design and Analyze of a Planar UWB Antenna for WiMAX and WLAN Applications

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ABSTRACT: A planar UWB antenna with notching at two various frequency ranges is designed and analyzed. This antenna consists of a radiating patch and a partial ground plane. The dual notching characteristics in the antenna are brought about by the inclusion of a T-shaped stub in the square patch and a couple of U-shaped parasitic strips along the feedline. This design works in the well in the 3.1-10.6 GHz with the VSWR < 2 and band notching at 3.26-3.9 GHz (WiMAX) and 5.16-5.4 GHz (LOWER WLAN). Hence this antenna will serves as good for various UWB applications.

KEYWORDS: Planar antenna, ultra wide-band(UWB)antenna, dual notching.

I. INTRODUCTION

In recent past, the need for antennas that work in various multiband applications in the latest wireless communication systems have interested in the researches of the ultra wideband (UWB) systems. The range of operation of UWB antenna is 3.1-10.6 GHz and it has significant advantages such as low cost, low spectral power density, high precision ranging, low complexity, resistant to jamming and multipath, works well for short range high speed wireless communication purpose etc.[1].

There are many number of antennas with notched band property have been introduced, and various methods have been proposed to obtain the desired characteristics. The widely used techniques are bring about slots on the patch or on the ground plane in shapes such as H-shaped slot[2], U-shaped slot[3], C-shaped slot[4], etc. Making use of parasitic strips [5] near the radiation elements or the ground plane is another method to form notched bands. So far most of the before models were intended to bring about single-notched-band design and there have been few works on the dual notched band designs. Dual-notched-bands antennas have been recently reported [6]–[8]. In the semi models, by inserting the proper slits in the interior of the radiation element and the ground plane, two rejected band shave been obtained.

Most of these before mentioned model shave the same dis-advantage of poor voltage standing wave ratio (VSWR)of the dual notched bands. In this letter, a novel UWB planar antenna with dual notched bands at the Wi-MAX and lower WLAN bands is proposed. AT- shaped stub in the radiation patch and two U-shaped stubs beside the feeding line are used to realize dual-band-notch characteristic.

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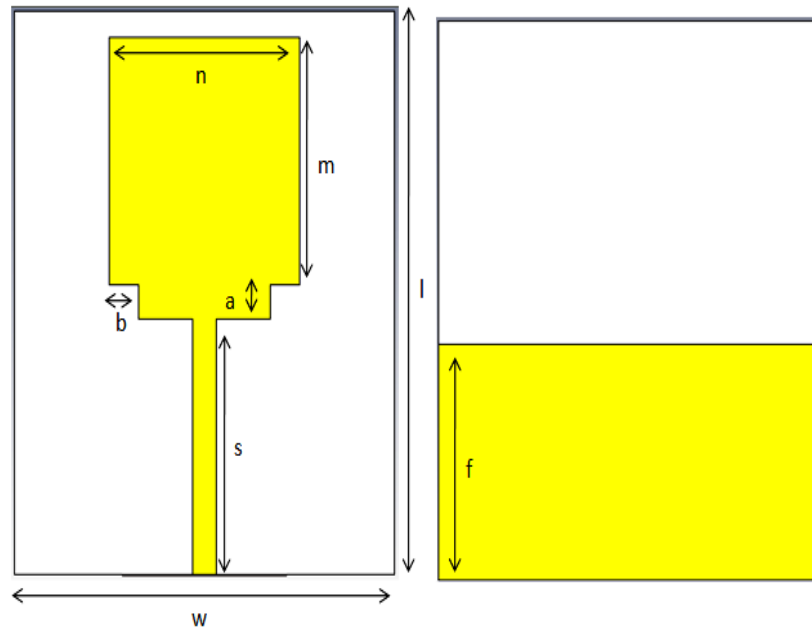


Fig.1. Configuration and parameters of the UWB antenna (unit: millimeters).

There are designs which use two T-shaped stubs to achieve a notched band [9], and in this design two U-shaped stubs along sides of the feeding line are first used in the UWB antenna to achieve a notched band. The parametrical analyses of these filtering structures are carried out. An antenna prototype is designed and fabricated to demonstrate the proposed strategy. The proposed antenna structure is designed using the CST Microwave Studio and simulation results are obtained. The simulation indicate residual bands rejection with central frequencies of 3.6 and 5.3GHz respectively, and significant notched band characteristics.

II. ANTENNA DESIGN AND RESULTS

A. UWB Monopole Antenna

Fig.1 shows the design specifications of a UWB monopole antenna. The antenna is fabricated on FR-4 substrate with dielectric constant of 4.3 and its thickness is taken as 0.8mm. The radiating square patch and feeding linear reprinted on the top side of the substrate and the partial ground plane on the bottom side. The width of the micro strip feed line is taken to be 1.6mm to obtain a characteristic impedance of 50. The thickness of the annealed copper material for the conducting part is 0.018mm. The optimization is carried out and the final design specifications of the various parameters are listed out as follows: $a = 2\text{mm}$, $b = 2\text{mm}$, $f = 13.5\text{mm}$, $s = 14.5\text{mm}$, $l = 32\text{mm}$, $w = 26\text{mm}$, $m = 14\text{mm}$, $n = 13\text{mm}$.

In the presented design, an equivalent dipole antenna is obtained between the top monopole antenna and the bottom partial ground plane [9]. Thus the characteristic impedance of the antenna is affected by the current distribution on the design. By cutting of suitable dimensions at the two lower corners of the patch, it is the same with [10]

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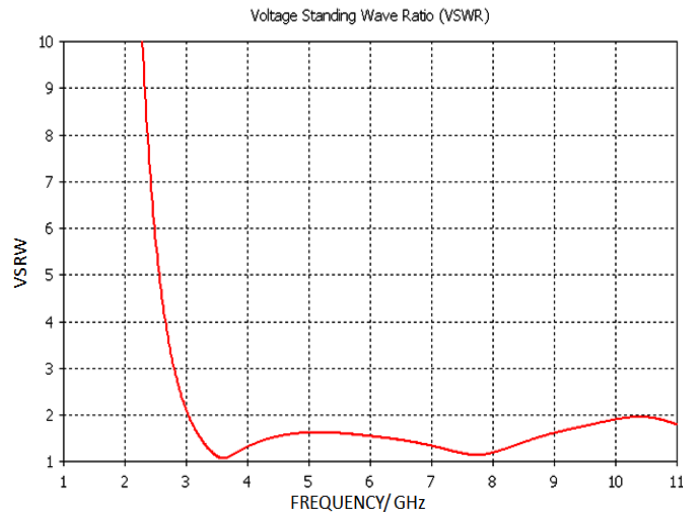


Fig.2. VSWR plot of the proposed antenna without notched bands.

That the impedance band width can be improved to a considerable extent. This phenomenon occurs because the two notches affect the electromagnetic coupling between the rectangular radiating patch and the ground plane is affected by the two notches which cause the improvement in the impedance bandwidth.

The distance between the rectangular radiation patch and ground plane is taken to be 1mm, which is also a significant parameter to control the impedance bandwidth. The patch and the ground plane formant equivalent dipole antenna. The ground plane is a partial plane. The proposed antenna can obtain high gain at low and high frequency with partial ground plane.

B. UWB Monopole Antenna with Two Notched Bands

To obtain dual notched bands, a T-shaped stub on the rectangular radiating patch and a pair of U-shaped stubs along sides the feeding line are implemented to generate notched bands at the desired central frequencies of 3.6 and 5.3GHz, respectively. The configuration is shown in Fig.2.

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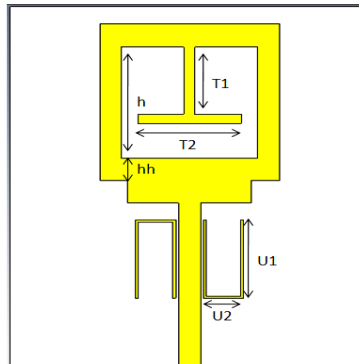


Fig.3. Configuration and parameters of the UWB antenna with dual notched bands.

We may note that the currents will be mainly distributed around the filter structures and will be guided in opposite directions between the interior and exterior edge. Thus increased attenuation occurs near the resonant frequency because of the resultant radiation fields which cancels each other and this phenomenon results in the notched bands.

In order to do a detailed study on the design of this antenna, some parametric investigation and analysis is done to optimize and get the inference of the variations in the results. The T1, T2, U1 and U2 are the vital parameters which determine the characteristics and operations of the notched bands. Changing these parametric values changes the position or shifts the central frequency of the notch bands to either higher or lower values.

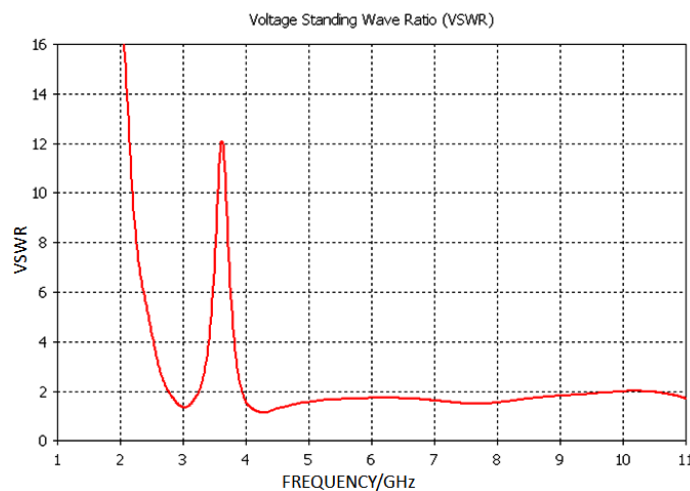


Fig.4.VSWR plot of the proposed antenna with T-shaped stub

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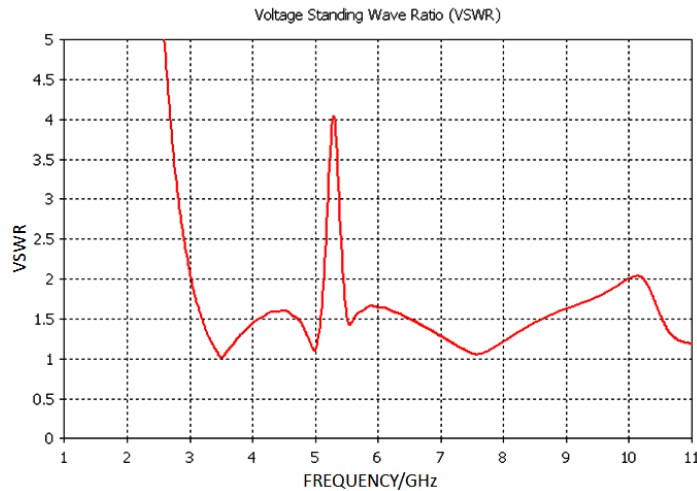


Fig.5.VSWR plot of the proposed antenna with U-shaped parasitic strips.

The notch for the first coming Wi-MAX band is significantly controlled by the T-shaped stubs in the rectangular radiating patch. The optimized values for the T1 and T2 are obtained as 6mm and 7.5mm respectively. It was found that increasing T1 value shifted the central notch frequency towards lower values and decreasing its value shifted the central notch frequency towards higher frequency value. Similarly when increasing the T2 value the centre notch frequency shifted towards lower values and decreasing the T2 value shifted the centre notch frequency value towards higher frequency values. Optimization of these values is obtained by varying these values

The parameters U1 and U2 significantly controls the lower WLAN notched band. The optimized values for the U1 and U2 are obtained to be 7mm and 2.6mm. Increasing the U1 and U2 value shifts the centre frequency towards lower values of frequency and increasing these parameters shifts the centre frequency towards the higher values of the frequency. The final design parameter specifications are as follows: T1 = 6mm, T2 = 7mm, U1 = 7mm, U2 = 2.6mm, Ut = 0.2mm (Thickness of U-shaped strips), Tt = 0.8mm (Thickness of T-stub), h = 9.9mm, Uh = 6mm (distance of the U-shaped strips from the bottom), hh = 2mm.

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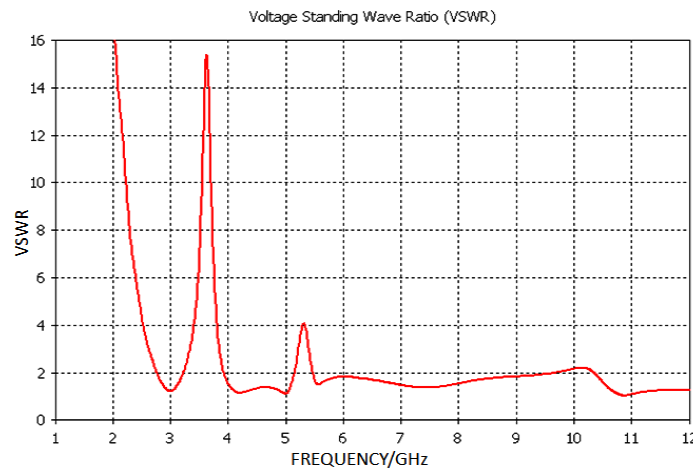


Fig.6.VSWR plot with dual notched bands in case of final integrated design.

The Fig. 4, 5 and 6 shows the VSWR plot when only T-stubs, only U-shaped parasitic strips and when both the T-stub and U-shaped strips are present.

From results obtained through the simulation, it is clear that the antenna characteristics are highly dependent on the thickness of the substrate material and it affects the width of the feed line in order to obtain desired bandwidth impedance of 50Ω . The proposed metal for the patch and ground planes is annealed copper and its thickness during fabrication will be 0.018mm. The fabricated antenna has the frequency range from 2.7 to 9.6 GHz with $VSWR < 2$, covering the entire UWB band with dual notched band of 3.2–3.9 GHz and 5.14–5.45 GHz, respectively.

In addition, the comparisons for several different dual-notched-band UWB antennas are studied. Compared to [6] and [8], the proposed UWB antenna with dual notched bands has better band-notch characteristics and when compared to that of the [11] the cost of the substrate is considerably low and hence it commercially efficient. And in it the band notch is for the entire 5-6 GHz of bandwidth which causes loss of data in between the upper and lower WLAN frequency bands. But this proposed design notches only the lower WLAN bandwidth.

III. CONCLUSION

In this paper, a monopole printed antenna is presented analyzed and designed for operation in the UWB bandwidth range. Adjusting the gap between the radiation patch and partial ground plane, a wide impedance band width is obtained. Moreover this antenna is proposed to be fabricated on FR-4 substrate and hence the design parameters have been reconfigured accordingly. Hence this antenna is much cost efficient than those which are present earlier as they were fabricated in Rogers 4003 substrates [11] which is much costlier than FR-4 substrate. Thus the total fabrication cost of the design increases considerably.

By implementing a T-shaped stub in the rectangular radiation patch and a pair of U-shaped parasitic strip elements besides the feed line, dual stop bands for applications of Wi-MAX and lower WLAN are achieved. The interference of the Wi-MAX and the lower WLAN applications in the desired UWB range for applications using this antenna is

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appreciatively reduced and performance is desirably obtained.

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