# A Novel UWB Dielectric Resonator Antenna with Dual Notched Bands


Yinyan Chen[1], Yuehe Ge[1] and Trevor S. Bird[2]

[1]College of Information Science and Engineering
Huaqiao University, Xiamen, Fujian Province 361021, China.
[2]Antengenuity, PO Box 306, Eastwood NSW 2122, Australia
yuehe@ieee.org



***Abstract*—A compact ultra-wideband (UWB) dielectric resonator antenna (DRA) with dual band-notched characteristics is proposed. A shorting conductor is attached to one side of the DRA, to reduce more than half the volume of the antenna. An inverted novel shaped strip is designed to print near the feed probe side, to achieve the dual band-notched characteristics. According to the simulation results, the antenna offers a VSWR<2 bandwidth of 2.9 GHz—11.0 GHz, with the dual notched bands of 5.15 GHz—5.825 GHz (WLAN) and 8.025 GHz—8.40 GHz (ITU), indicating that the antenna is a good candidate for various UWB applications.**



***Keywords—DRA; UWB; dual notched bands.***


## I. INTRODUCTION

In recent years, the increasing demands for UWB antennas that exhibit multiband operation in wireless communication systems has received increased attention since the US Federal Communication Commission (FCC) permitted the authorization of using the commercial telecommunication applications at 3.1—10.6 GHz. However, within the designated UWB frequency band, there are several separate wireless frequency bands, such as the WLAN operating at 5.15—5.825 GHz, and the ITU system operating at 8.025—8.40 GHz where interference from the UWB might occur. To prevent these electromagnetic interferences in these bands, UWB antennas with band-notched characteristics have been also proposed.

Various band-notched UWB antennas have been designed based on the printed monopole antenna technology. Dielectric resonator antennas (DRAs) have received much attention in the past two decades due to their inherent advantages, such as compact size, high radiation efficiency, wide impedance bandwidth and ease of integration to the wireless systems. Recently, DRAs have been demonstrated [1]-[5] to have the potential for UWB applications. Furthermore, the DRA is quite flexible as a UWB DRA has been proposed with a single band-notch characteristic [6].

In this paper, a compact dual band-notched UWB rectangular DRA is presented. An inversed ψ-shaped patch is designed to print near the coaxial probe side on the UWB DRA, to generate the dual notched bands. By changing the size of the proposed printed patch, the rejection bands can be moved within the operating band of 3.1-10.6 GHz. Specifically, dual notched bands centered at 5.75 GHz and 8.10 GHz are designed in this work. Compared with other UWB antenna designs, the band-notched DRA shows a very compact size without compromising the radiation performance over the FCC band of 3.1 -10.6 GHz.

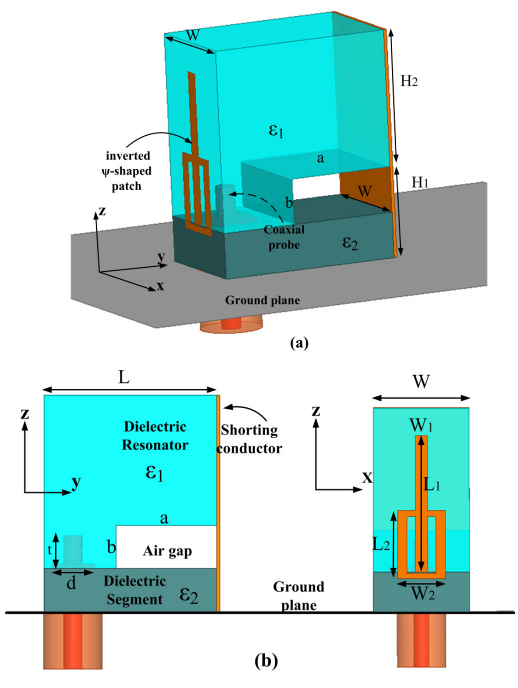



Fig.1. Configuration and parameters of the proposed dual band-notched DRA.

## II. ANTENNA DESIGN

### A. UWB DRA

The proposed band-notched UWB DRA is based on the UWB DRA design presented in [1]. The basic geometry and configuration is shown in Fig. 1. It is a stacked DRA and mainly composed of a dielectric resonator with a higher permittivity of $\varepsilon_1 = 9.2$ and a thin dielectric segment with a lower permittivity of $\varepsilon_2 = 2.2$. A rectangular air gap is designed to improve the impedance matching of the DRA [2]. The shorting conductor is attached to one side of the DRA to create an image so as to reduce halve the volume of the DRA [1]. A printed dipole with $L_1 \times W_1$ is attached to the DRA to generate a notched band within the operating band of the DRA [6]. The length $L_1$ of the dipole can be approximately evaluated by [6]

$$L_1 = \frac{\lambda}{2\sqrt{\varepsilon_1}} \tag{1}$$

where λ is the free space wavelength at the frequency at which the band notch is located.

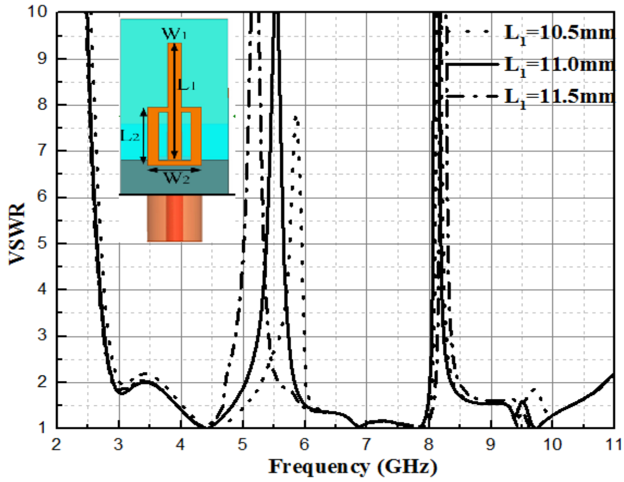
In order to create a second resonance frequency, and hence another rejection band, a rectangular loop is employed and this joins with the dipole mentioned above. As shown in Fig. 1, an inverted ψ-shaped printed patch is attached to the DRA, opposite to the side of the shorting conductor. The novel patch will resonate and cause dual notched bands within the UWB band of 3.1 – 10.6 GHz. By adjusting its dimensions, the dual rejection bands, with central frequencies of 5.75 GHz and 8.10 GHz, respectively, can be created. The full-wave solver ANSYS HFSS was used to evaluate the antenna performance.

### B. UWB DRA With Dual notched Bands

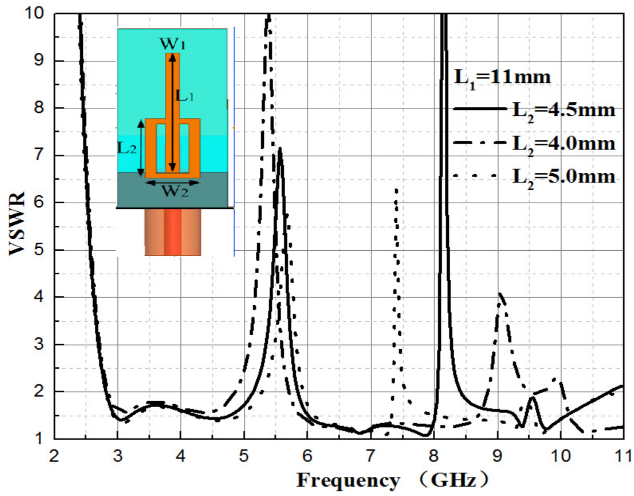
To achieve dual notched bands, a novel inverted Ψ-shaped patch printed on the dielectric resonator near the feeding line was adopted to generate notched bands with central frequencies of 5.75 GHz and 8.10 GHz, respectively. The configuration is shown in Fig. 1. To investigate the design of the proposed antenna, some parametric studies are carried out. The notched performances are mainly determined by $L_1$ and $L_2$. Fig. 2 show the simulated band-rejecting characteristics of the antenna when varying the parameters $L_1$ and $L_2$. The first rejection band changes from around 4.75 GHz to 5.35 GHz when $L_1$ changes from 10.5 to 11.5 mm. Similarly the second band shifts from around 7.42 GHz to 8.73 GHz when $L_2$ is varied from 4.0 to 5.0 mm. It was observed that changing parameter $L_2$ has a minor affect on the first rejection band while the second rejection band is similarly affected when $L_1$ is varied.

The dimensions of the final design are listed in Table I. The simulated VSWRs of the proposed UWB DRA with and without the inverted ψ-shaped patch are both plotted in Fig. 3 for comparison. With the help of the specific DR structure and the feeding mechanism, the proposed antenna exhibits wideband operation from 2.9 to 11.0 GHz for VSWR < 2, which covers the UWB FCC band of 3.1—10.6 GHz. Because of the inverted ψ-shaped patch, dual notched bands at 5.15—5.83 GHz and 8.0—8.4 GHz occur within the operating band.

The simulated current distributions on the inverted ψ-shaped patch of the UWB DRA at notched frequencies are shown in Fig. 4. It can be seen that strong current density is mostly on the dipole stub at 5.75 GHz, while at 8.1 GHz is mainly on the loop and the part of the dipole inside the loop. This demonstrates how the dual notched bands are generated.




(a)




(b)

Fig. 2. Simulated VSWRs for the proposed antenna according to: (a) the variation of $L_1$ and (b) the variation of $L_2$

TABLE I. DIMENSIONS OF THE PROPOSED UWB DRA (UNIT:MM).

| Parameter | W | L | a | b | $H_1$ | $H_2$ |
|---|---|---|---|---|---|---|
| Value | 8 | 12 | 7 | 3 | 6 | 9 |
| Parameter | $W_1$ | $L_1$ | $W_2$ | $L_2$ | t | D |
| Value | 1 | 11 | 4 | 4.5 | 2.5 | 3 |

The simulated gain of the antenna is plotted in Fig. 5 for frequencies from 3 to 11 GHz. As expected, the gain decreases in the vicinity of 5.75 GHz and 8.10 GHz. Outside the notched bands, antenna gain with a variation of 1.6 - 7 dBi is achieved. In Fig. 6, the symmetrical and non-symmetrical simulated radiation patterns of the band-notched UWB DRA are obtained in the H- and E-planes respectively.

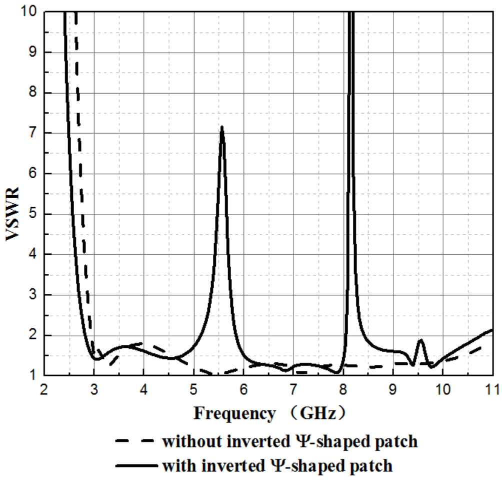



Fig. 3. Simulated VSWRs for the proposed dual band-notched UWB DRA.

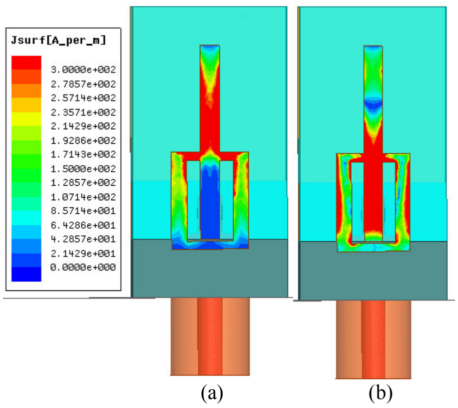



Fig. 4. Simulated current distributions on the inverted ψ-shaped patch at frequencies of: (a) 5.75 GHz and (b) 8.10 GHz.

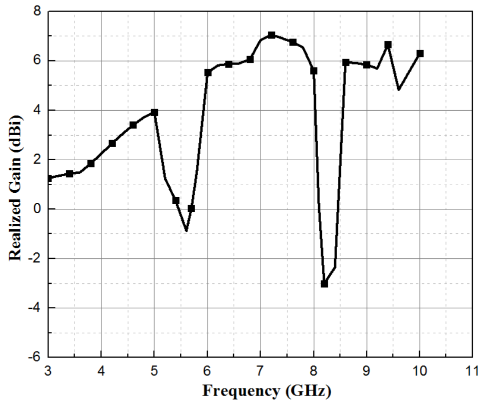



Fig. 5. Simulated gain versus frequency.

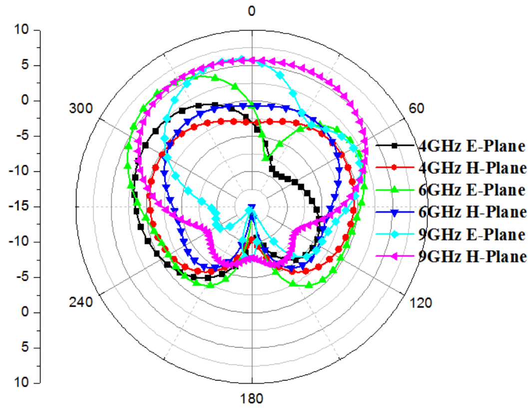



Fig. 6. Simulated radiation patterns.

## III. CONCLUSION

The design of compact rectangular DRA with the characteristics of dual notched bands for UWB applications has been described. An inverted ψ-shaped patch is designed and investigated for the generation of dual rejecting bands. Band rejections for the WLAN and the ITU frequencies are obtained through the adjustment of the lengths of a dipole stub and a loop. Satisfactory radiation performance is obtained throughout the UWB frequency range.

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