Compact dual-band-notched UWB planar monopole antenna with modified SRR


To prevent interference problems due to existing nearby communication systems within an ultra-wideband (UWB) operating frequency, a compact dual-band-notched UWB antenna is presented. This antenna consists of a trapezoidal ground plane with a rectangle slot, a Y-shaped monopole used as the radiator, together with a modified complementary co-directional splitting resonator (SRR) etched on the radiation patch, which leads to the desired dual notched bands for lower and upper bands of the WLAN. Experimental results show that the designed antenna, with compact size of $24 \times 25$ mm, has a wide bandwidth covering $3.05–14.2$ GHz, realising dual notched bands of $5.14–5.36$ and $5.74–6.07$ GHz.

Introduction: Since the FCC permitted its civil application within the frequency band of $3.1–10.6$ GHz, UWB technology has gained a lot of popularity among researchers and wireless industries. As a result, several types of UWB antenna have emerged with its rapid growth, among which the printed monopole UWB antennas should be the most promising candidate for future applications, owing to their remarkably compact size, stable radiation characteristics, ease to build [1, 2], as well as the multitasking capability. However, given the challenges encountered in the UWB antenna design, such as system interference, UWB applications are necessary for the rejection of interference with some narrow bands, for instance, the existing WLAN covering the $5.15–5.35$ GHz and $5.725–5.825$ GHz.

To solve this problem, one can use a spatial filter above the antenna [3] or by loading rejection function designs of different types, different numbers at different spaces [4, 5]. But these existing techniques in extensive use require too much antenna space. Indeed, the complementary co-directional splitting resonator (SRR) is promising for UWB antennas to ensure multiple notched bands [6]. With its help, in this Letter a modified complementary co-directional SRR is proposed, which is etched on a Y-shaped monopole. Both dual-band-notched characteristics and compact size are achieved. The antenna has promising features, including good impedance matching performance over the whole operating frequency band, stable radiation patterns and flexible frequency notched function.

**Antenna configuration and design:** The geometry of the proposed antenna and a photograph of some fabricated prototypes are shown in Figs. 1a and b. The proposed antenna, with compact dimensions of $24 \times 25$ mm, is fabricated on a 1.6 mm-thickness FR4 substrate with relative permittivity of 4.5. A Y-shaped monopole is printed on the front side and a trapezoidal ground plane with a rectangle slot is on the back side. A modified complementary co-directional SRR etched on the Y-shaped radiator is selected to obtain adjacent dual notched bands for lower WLAN and upper WLAN here due to the weaker mutual coupling between inner and outer rings. The geometry of the modified complementary co-directional SRR is shown in Fig. 1c.

**Results and discussion:** The current distributions of the proposed antenna at 3.4, 5.2 and 5.8 GHz are illustrated in Fig. 2. At 3.4 GHz, current is mainly distributed on the edge of the Y-shaped monopole, which acts as the effective radiation part. However, when the antenna is working at the centre of the lower notched band near 5.2 GHz, we find that the current distributes along almost the whole modified complementary co-directional SRR, which determines the lower notched band. Meanwhile, the upper notched band near 5.8 GHz is ensured only by the inner part of the structure. It can be seen that the band-notched characteristic of the proposed antenna is realised by guiding the currents at the notch frequencies concentrated in the modified SRR. Because the currents along the modified SRR are in the opposite direction, the radiation fields generated by them are neutralised. The pair of symmetrical rectangle slots of the modified SRR is critical to achieving the desired notched bands, as
shows in Fig. 3a. Compared with the conventional SRR (without the pair of symmetrical rectangle slots), the modified SRR can greatly affect the strength and optimise the distance of the two notched bands. Particularly, both the centre frequency and the width of the upper rejected band are decreased while the peak rejection goes higher by increasing the ‘e2’. Fig. 3b shows simulated and measured VSWR against frequency for the proposed antenna. The simulated result of the reference antenna without notched characteristics is also shown for comparison. From the experimental results it can be seen that the antenna could provide sufficiently wide impedance bandwidth (VSWR < 2) covering 3.05–14.2 GHz with the dual notched bands. Measured dual notched bands are 5.14–5.36 GHz and 5.74–6.07 GHz, respectively, covering lower WLAN and upper WLAN successfully.

Figs. 4a and b show the radiation patterns at 3.6, 5.6 and 7.6 GHz. It can be observed that the antenna exhibits a nearly omnidirectional radiation pattern in the H-plane (xoz-plane) and a dipole-like radiation pattern in the E-plane (yoz-plane). In addition, the realised gain shown in Fig. 4c illustrates two significant antenna gain decreases at 5.14–5.36 GHz and 5.74–6.07 GHz, which validate the effect of the notched bands.

Conclusions: A novel compact planar monopole UWB antenna with dual notched bands is proposed. By loading the modified complementary co-directional SRR with different centres, narrower and stronger band-notched properties as well as small design space size for the frequency band rejection function are achieved. Furthermore, broad bandwidth and good monopole-like radiation patterns are obtained with a rather compact antenna size. Particularly, the measured results illustrate that the band ranging from 5.36 to 5.7 GHz can also be utilised with the proposed antenna, which is included in the rejected band of other ordinary WLAN band-notched antennas.

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