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Citation	The 2012 IEEE International Symposium on Antennas and Propagation (APSURSI), Chicago. IL., 8-14 July 2012. In IEEE Antennas and Propagation Society. International Symposium, 2012, p. 1-2
Issued Date	2012
URL	http://hdl.handle.net/10722/165224
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Simple Dual-Band Notched Design for CPW-Coupled-Fed Elliptical UWB Monopole Antenna

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***Abstract*—This paper presents the results of a CPW-coupled-fed elliptical UWB monopole antenna (CCFEUMA) with a simple dual-band notched design for the WLAN Band. The antenna has a large bandwidth covering the frequency band from 2.5 to 14.6 GHz with the return loss larger than 10 dB. Two band notches at the lower (5.15-5.35 GHz) and higher (5.725-5.825 GHz) WLAN band are realized by cutting two half-elliptical arc-slots on the radiator. The return loss, radiation pattern, peak gain and efficiency of the antenna are studied using computer simulation and measurement.**

I. INTRODUCTION

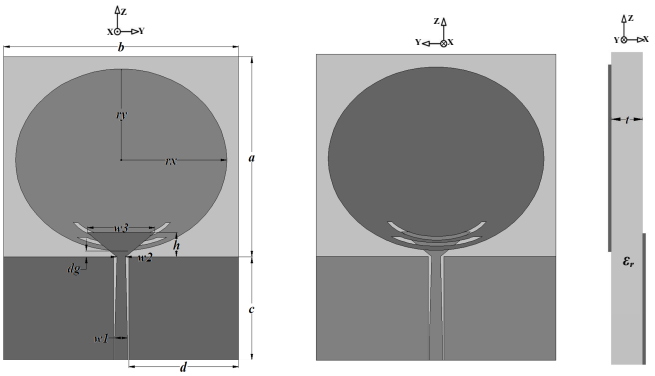
Since the FCC released the frequency band of 3.1-10.6 GHz for ultra-wideband (UWB) applications in 2002 [1], designs of UWB antennas has been attracting much attention. UWB systems commonly refer to systems having relative large or large absolute bandwidths. With large bandwidths, the systems can offer specific advantages of low-power consumption and high-data rate which promise solutions for short-range and high-speed indoor mobile communications.

In the design of antennas for UWB applications, there are important challenges. For example, in the allocated frequency band for UWB applications, there are already several other existing communication systems such as the IEEE 802.11a WLAN which has the lower frequency band of 5.15-5.35 GHz and higher frequency band of 5.725-5.825 GHz. These systems may potentially interfere with the UWB systems. Bandstop filters can be used to suppress interference, but this will increase the cost and system complexity and require more space when integrated with other microwave circuits. One simple possible solution for this problem is to design the UWB antennas with band-notched characteristics. Different design methods have been proposed to implement the band-notched characteristics for UWB planar monopole antennas [2-6], e.g. using simple ground stubs [2], meander lines [3], resonators [4], parasitic patches [5] and fractal structure [6].

In this paper, we propose a very simple design of a CPW-coupled-fed elliptical UWB monopole antenna (CCFEUMA) with a dual-band notched characteristic. The two band-notches are achieved simply by cutting two arc-slots on the radiator. The return loss, radiation pattern, peak gain, and efficiency are studied by computer simulation using the EM simulation tool CST MWS and measurement using the antenna measurement equipment, Satimo Starlab.

II. ANTENNA DESIGN

The configuration of the proposed dual-band notched CCFEUMA is shown in Fig. 1. The antenna is composed of a feeding structure on one side of the substrate and a radiator on the other side of it. The antenna is designed on a substrate with a dielectric constant of ε_r and thickness of t. The radiator has a simple elliptical shape with the major and minor axes having the lengths of $2rx$ and $2ry$ in the y and z directions, respectively. The feeding structure is a CPW terminated with a trapezium patch with a topline of $w3$, a baseline of $w2$ and a height of h as shown in Fig. 1. The trapezium patch is used to couple the signal from the CPW to the radiator on the other side of the substrate. The width of the CPW tapers from $w1$ to $w2$ for achieving good impedance match. The great challenge in our dual band-notched design is the narrow passband (375 MHz) between the higher and lower WLAN bands. Here we simply create a dual-band notch by cutting two half-elliptical arc-slots on the radiator as shown in Fig. 2 where the upper and lower arc-slots are responsible for the notch bands at 5.2 and 5.78 GHz, respectively.



(a) (b) (c)

Fig. 1. Geometry of antenna. (a) Front view, (b) back view and (c) side view. ε_r = 3.5, t = 0.8 mm, rx = 18 mm, ry = 15 mm, $w1$ = 2.2 mm, $w2$ = 1.5 mm, $w3$ = 11.5 mm, h = 4 mm, dg = 1 mm, a = 33 mm, b = 40 mm, c = 17 mm, d = 18.7 mm

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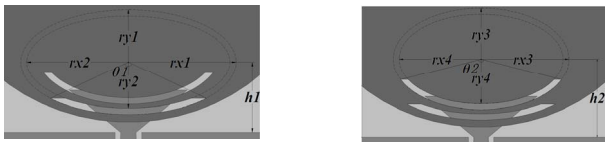


(a) (b)

Fig. 2 Half-elliptical arc-slots with large scale. Dimensions of (a) lower slot with $h1$ = 7.7 mm, $\theta1$ = 125^0, $rx1$ = 9 mm, $ry1$ = 5 mm, $rx2$ = 8.4 mm, $ry2$ = 4.4 mm, and (b) upper slot with $h2$ = 6.7 mm, $\theta2$ = 148^0, $rx3$ = 10.5 mm, $ry3$ = 5 mm, $rx4$= 9.9 mm, $ry4$ = 4.4 mm

III. Results and Discussions

The proposed dual-band notched CCFEUMA is optimized in terms of impedance bandwidth using CST MWS and fabricated on the substrates with an area of 50×40 mm^2 as shown in Fig. 3. The simulated and measured return losses in Fig. 4(a) show that the antenna has an impedance bandwidth (return loss > 10 dB) from 2.5 to 14.6 GHz, covering the bandwidth from 3.1–10.6 GHz for UWB applications. At the notch frequencies of 5.2 and 5.78 GHz, Fig. 4(b) shows that the simulated peak gains drop by about 10 dB to -5.5 and -4.5 dBi, respectively, with the simulated efficiencies dropping to below 10%, as shown in Fig. 4(c). The discrepancies between the measurement and simulation results are due to the small ground plane and fabrication tolerance. Fig. 5 shows that the radiation patterns at 2.5, 5.2, 5.78 and 14.6 GHz.

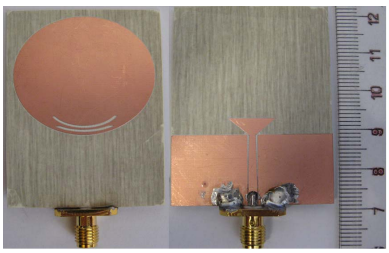
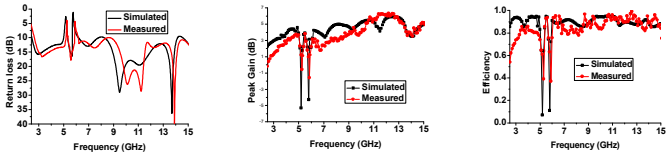
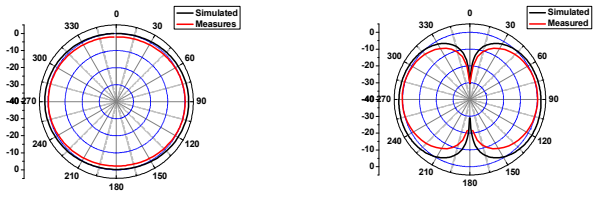


Fig. 3 Photograph of the CCFEUMA.

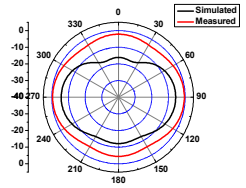


(a) (b) (c)

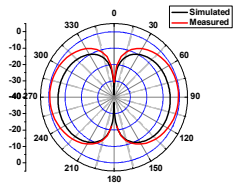
Fig. 4 Simulated and measured (a) return loss, (b) peak gain and (c) efficiency



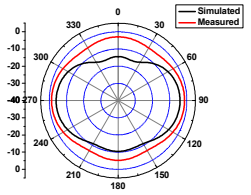
(a) 2.5GHz in x-y plane (b) 2.5GHz in x-z plane



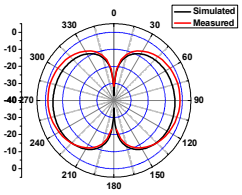
(c) 5.2 GHz in x-y plane



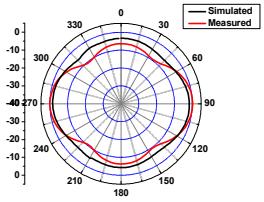
(d)5.2 GHz in x-z plane



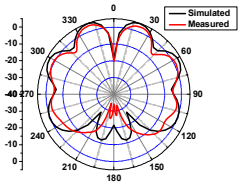
(e) 5.78 GHz in x-y plane



(f) 5.78 GHz in x-z plane



(g) 14.6 GHz in x-y plane



(h) 14.6 GHz in x-z plane

Fig. 5 Simulated and measured radiation patterns

IV. Conclusions

A simple design of a CCFEUMA with dual-band notched characteristic for WLAN band has been presented. The antenna has a CPW-coupled-fed structure with an elliptical patch for radiation. Two half-elliptical arc-slots are cut on the radiator to generate two band notches at 5.2 and 5.78 GHz. Simulation and measurement results have shown that it has a wide operation bandwidth of 2.5-14.6 GHz, good notched characteristic and is suitable for UWB applications.

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