CPW-coupled-fed Elliptical Monopole UWB Antenna with Dual-band Notched Characteristic

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Abstract— This paper presents the results of a coplanar-waveguide (CPW)-coupled-fed elliptical monopole UWB antenna (CCFEMUA) with a dual band-notched characteristic. The antenna has a large bandwidth covering the frequency band from 2.4 GHz to 152 GHz with the return loss larger than 10 dB. Two band notches at 3.7 GHZ and 4.8 GHz are realized by cutting two half-elliptical-arc slots on the radiation patch The return loss, radiation pattern, peak gain and efficiency of the antenna are studied using computer simulation.

1. INTRODUCTION

The FCC (Federal Communications Commission) released an unlicensed frequency band of 3.1–10.6 GHz for ultra-wideband (UWB) applications in 2002 [1]. Since then design of UWB antennas has been attracting much attention. UWB commonly refers to signals or systems that either have a large relative or a large absolute bandwidth [2]. Such large bandwidth offers specific advantages of low power consumption and high data rate which promise solutions for short-range and high-speed indoor mobile communications. The design of UWB antennas is quite challenging because it has to satisfy the requirements of wide impedance bandwidth, omnidirectional radiation pattern, constant gain, high radiation efficiency, constant group delay, low profile and easy manufacturing [3]. Besides these, the UWB antennas should also have notch characteristic to prevent interfering with other systems using frequency bands with the UWB.

UWB antennas with different radiator shapes such as square [4], circular [5], pentagonal [6], hexagonal [7], elliptical [8], ring [9] and trapezoidal [10], different types such as monopoles [6–8, 10–12], dipoles [13] and slot antennas [9], different feeding structures such as microstrip [6, 7, 10, 11], co-planar-waveguide (CPW) [8, 9, 12] and coaxial [14], and different methods for creating the band-notched characteristics have been studied [8, 15, 16]. In this paper, we propose a very simple design of a CPW-coupled-fed elliptical monopole UWB antenna (CCFEMUA) with dualband notched characteristic The two band notches are achieved by cutting two arc slots on the radiator. The return loss, radiation pattern, peak gain, and efficiency are studied using the EM simulation tool CST.

2. ANTENNA DESIGN

The configuration of the proposed dualband notched CCFEMUA is shown in Fig. 1. The antenna is composed of a feeding structure on one side of the substrate and a radiating patch on the other side of it. The antenna is designed in a substrate with a dielectric constant of ε_r and thickness of h. The radiating patch has a simple elliptical shape with the major and minor axes having 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 $w3$, baseline of $w2$ and height of d as shown in Fig. 1. The trapezium patch is used to couple the signal from the CPW to the radiating patch on the other side of the substrate. The width of the CPW tapers from $w1$ to $w2$ for achieving good impedance match. Two notch bands at 3.7 GHz and 4.8 GHz are generated by cutting two half-elliptical-arc slots on the radiating patch as shown in Fig. 2. The lower arc slot in Fig. 2(a) and upper arc slot in Fig. 2(b) are responsible for the notch bands at 3.7 GHz and 4.8 GHz, respectively.

3. RESULTS AND DISCUSSIONS

The proposed dual-band notched CCFEMUA is optimized in terms of impedance bandwidth using the EM simulation tool, CST The simulated return loss in Fig. 3 show that the antenna has an impedance bandwidth (return loss > 10 dB) from 2.4 to 15.2 GHz, covering the bandwidth from 3.1–10.6 GHz for UWB applications. The two notch bands are created at 3.7 GHZ and 4.8 GHz.

The simulated radiation patterns of the antenna in the x-y, x-z and y-z planes at 2.4, 3.0, 3.7, 4.8, 10.0 and 15.2 GHz are shown in Fig. 4. Due to the wavelength is much larger than the antenna size at 2.4 and 3.0 GHz, the patterns in the x-y plane are approximately omnidirectional. The radiation patterns in the x-z and y-z planes are approximately symmetrical along the y-axis. As the electrical length of the radiator increases at the higher frequencies of 10 GHz and 15.2 GHz, the radiation patterns in the y-z plane are still symmetrical along the y-axis, but side lobes appear. The radiation patterns in the x-z plane become asymmetrical because the front (with the feed-line structure) and back (with the radiator) of the antenna structure are not symmetrical. At the notch frequencies of 3.7 GHz and 4.8 GHz, it can be seen that the peak gains are suppressed by about 6 and 5 dB, respectively, compared to that at 3 GHz.

The simulated peak gain and efficiency of the antenna are shown in Fig. 5. It can be seen that there are two notches occurring at the notched frequencies of 3.7 and 4.8 GHz, with the gains

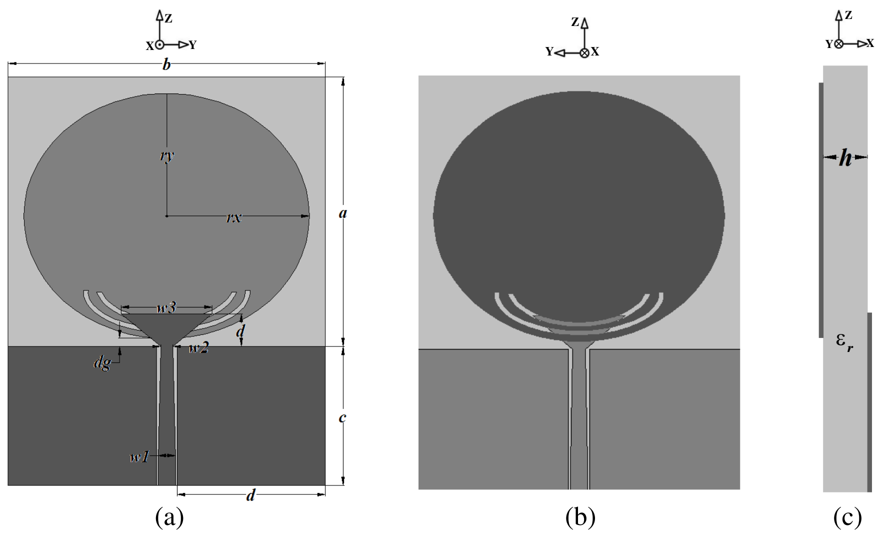


Figure 1: Geometry of antenna. (a) Front view, (b) back view and (c) side view. $\varepsilon_r = 3.5$, $h = 0.8$ mm, $rx = 18$ mm, $ry = 15$ mm, $w1 = 2.2$ mm, $w2 = 1.5$ mm, $w3 = 11.5$ mm, $d = 4$ mm, $dg = 1$ mm, $a = 33$ mm, $b = 40$ mm, $c = 17$ mm, $d = 18.7$ mm.

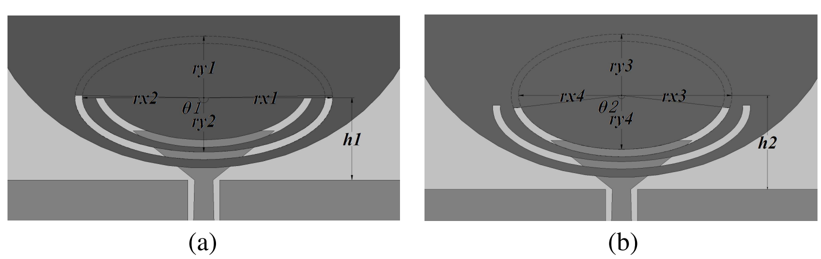


Figure 2: Half-elliptical-arc slots with large scale Dimensions of (a) lower slot with $h1 = 6.7$ mm, $\theta1 = 185°$, $rx1 = 10.5$ mm, $ry1 = 5$ mm, $rx2 = 9.9$ mm, $ry2 = 4.4$ mm, and (b) upper slot with $h2 = 7.7$ mm, $\theta2 = 155°$, $rx3 = 9$ mm, $ry3 = 5$ mm, $rx4 = 8.4$ mm, $ry4 = 4.4$ mm.

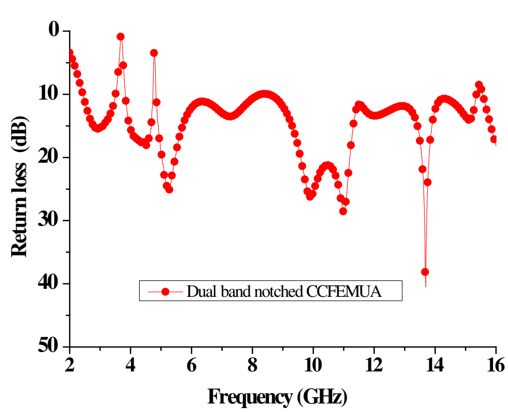
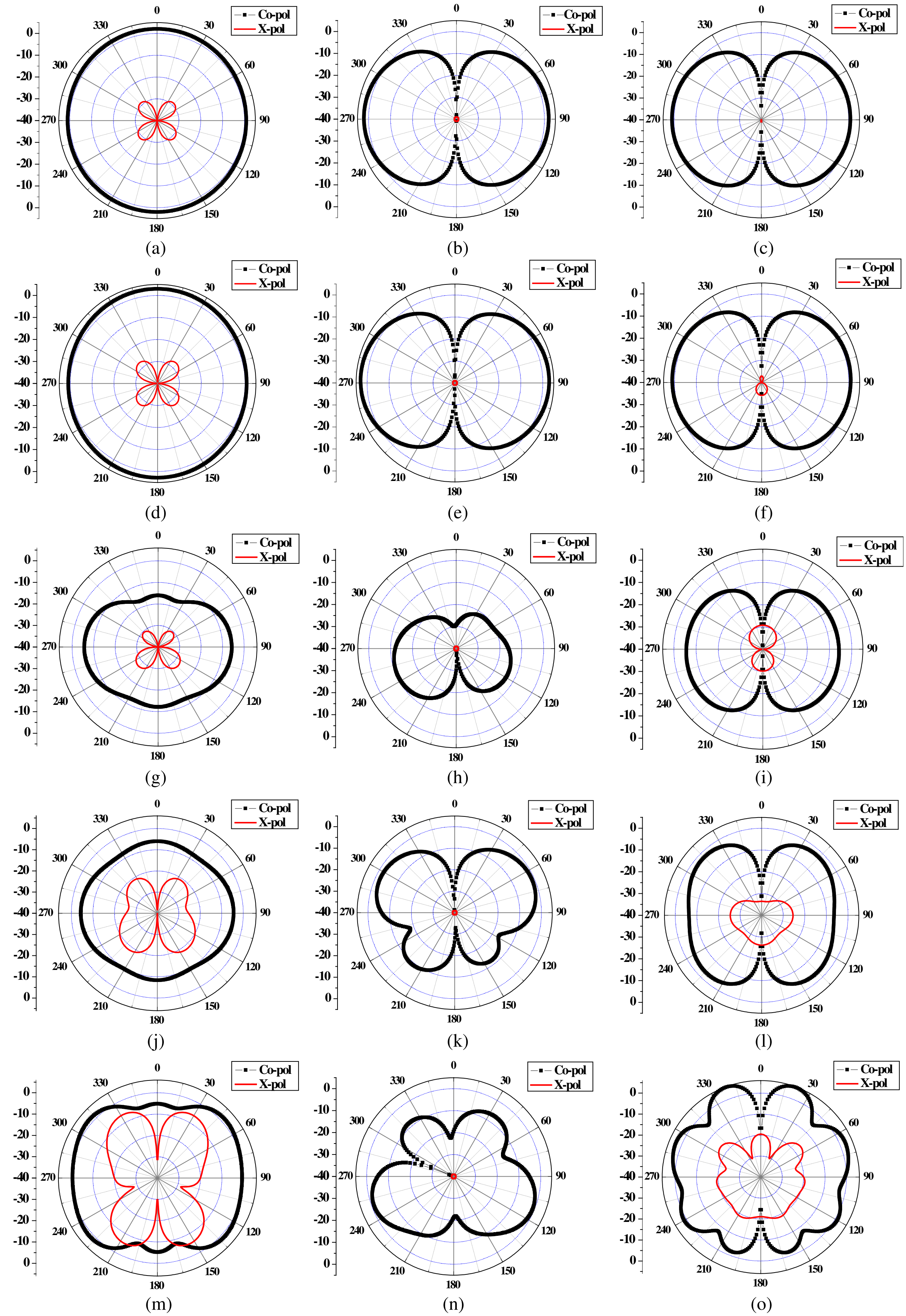


Figure 3: Return loss.



(a) (b) (c)

(d) (e) (f)

(g) (h) (i)

(j) (k) (l)

(m) (n) (o)

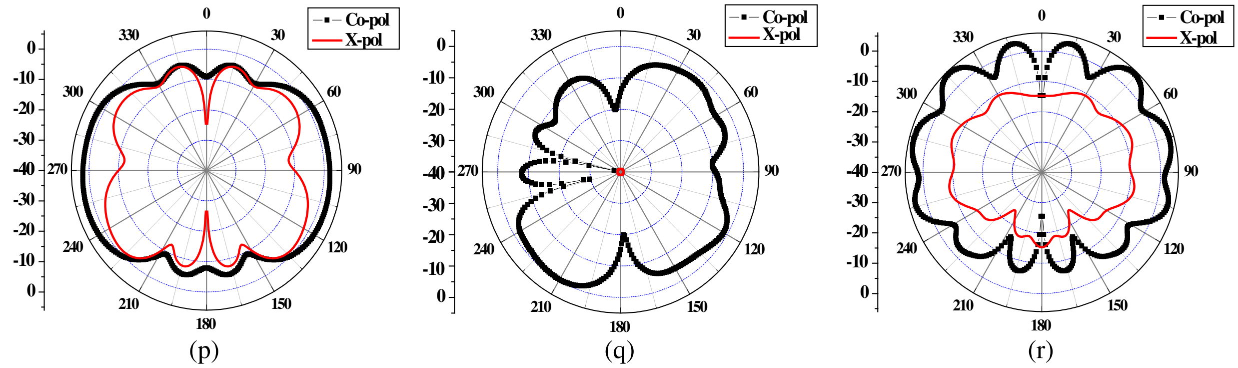


Figure 4: Simulated radiation patterns. 2.4 GHz in (a) x-y, (b) x-z and (c) y-z plane; 3 GHz in (d) x-y, (e) x-z and (f) y-z planes; 3.7 GHz in (g) x-y, (h) x-z and (i) y-z planes; 4.8 GHz in (j) x-y, (k) x-z plane and (l) y-z planes; 10 GHz in (m) x-y, (n) x-z plane and (o) y-z planes; 15.2 GHz in (p) x-y, (q) x-z plane and (r) y-z.

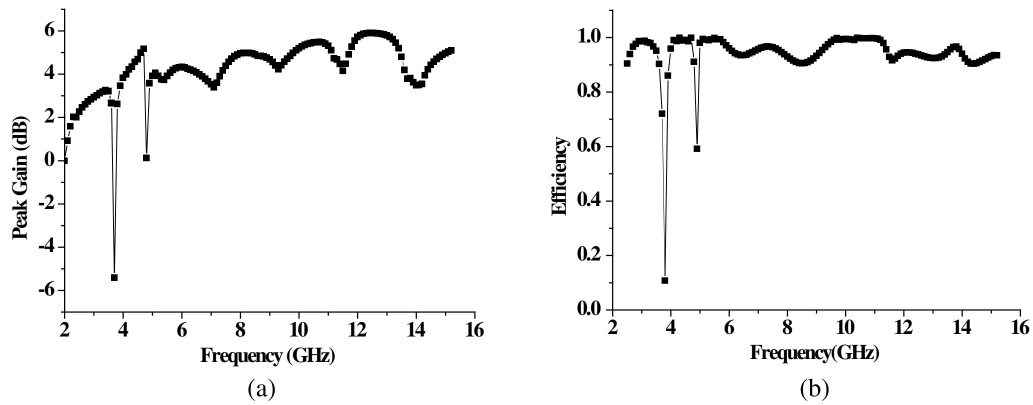


Figure 5: Efficiency and peak gain. (a) peak gain, (b) efficiency.

suppressed to −5 dBi and 0.1 dBi and radiation efficiencies reduced to 10% and 60%, respectively.

4. CONCLUSIONS

The design of a CCFEMUA with a dual band-notched characteristic has been presented. The antenna is simple and 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 3.7 GHz and 4.8 GHz. Simulation results have shown that it has a wide operation bandwidth of 2.4–15.2 GHz and approximately omnidirectional radiation patterns, and so is suitable for UWB applications.

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