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A COMPACT DUAL-BAND MODIFIED T-SHAPED CPW-FED MONOPOLE ANTENNA

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ABSTRACT: *A compact, dual band coplanar waveguide fed modified T-shaped uniplanar antenna is presented. The antenna has resonances at 1.77 and 5.54 GHz with a wide band from 1.47–1.97 GHz and from 5.13–6.48 GHz with an impedance bandwidth of 34% and 26%, respectively. Also the antenna has an average gain of 3 dBi in lower band and 3.5 dBi in higher band with an average efficiency of 90%.* © 2009 Wiley Periodicals, Inc. Microwave Opt Technol Lett 51: 937–939, 2009; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.24249

Key words: *monopole antennas; coplanar waveguide (CPW); dual-band antenna; modified T-shaped antenna*

1. INTRODUCTION

In modern wireless communication system, compact multiband or wideband antennas are in great demand. Various printed monopole antennas satisfying the requirements of low profile and multiband with good impedance matching and omnidirectional radiation pattern have been reported. The stacked T-shaped monopole presented in [1] uses microstrip line as the feed and has a large ground plane. Various CPW fed uniplanar antennas for multiband applications have been reported in [2–6]. Various techniques like embedding slots [7], modifying the signal strips [3], meandering [4] etc are also reported to enhance the band width. But the overall dimensions of these antennas are large, making it incompatible for the miniature electronic gadgets of the present day.

In this aticle, a compact modified T-Shaped CPW-Fed monopole antenna is presented. The presented antenna has an overall dimension of $32 \times 31 \times 1.6$ mm^3 including the ground plane on a substrate of dielectric constant 4.4. The antenna

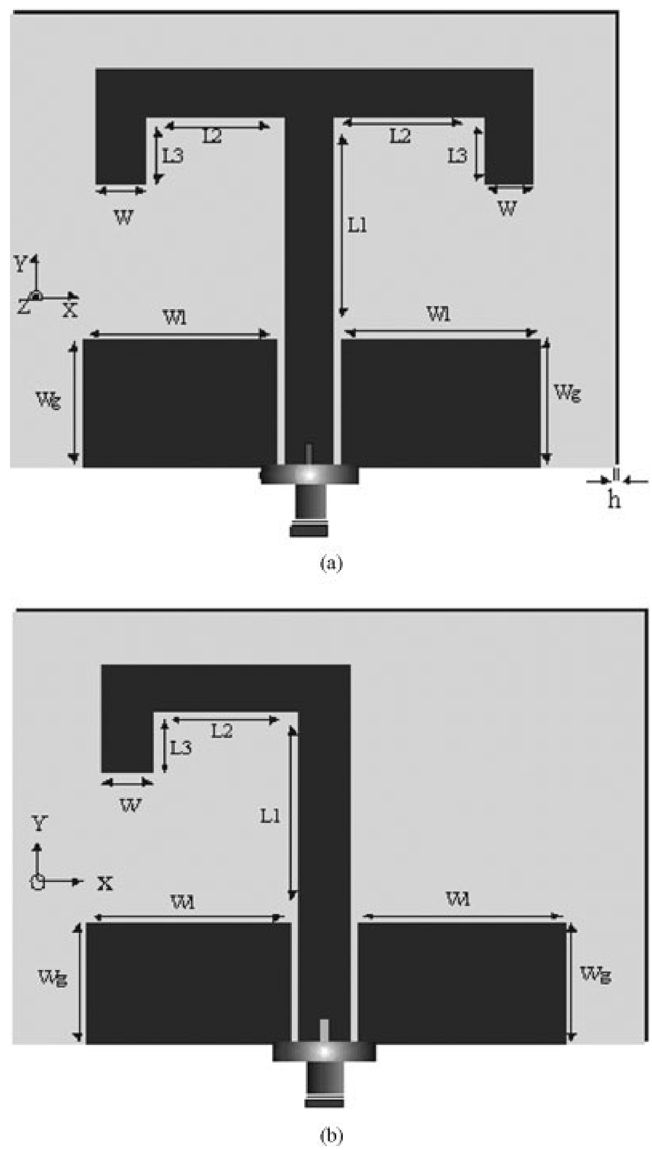


Figure 1 (a) Geometry of the proposed CPW-Fed antenna ($L_1 = 18$ mm, $L_2 = 11.5$ mm, $L_3 = 7$ mm, $W = 3$ mm, $W_1 = 14$ mm, $W_g = 10$ mm, $h = 1.6$ mm, $\varepsilon_r = 4.4$). (b) ($L_1 = 18$ mm, $L_2 = 11.5$ mm, $L_3 = 7$ mm, $W = 3$ mm, $W_1 = 14$ mm, $W_g = 10$ mm, $h = 1.6$ mm, $\varepsilon_r = 4.4$)

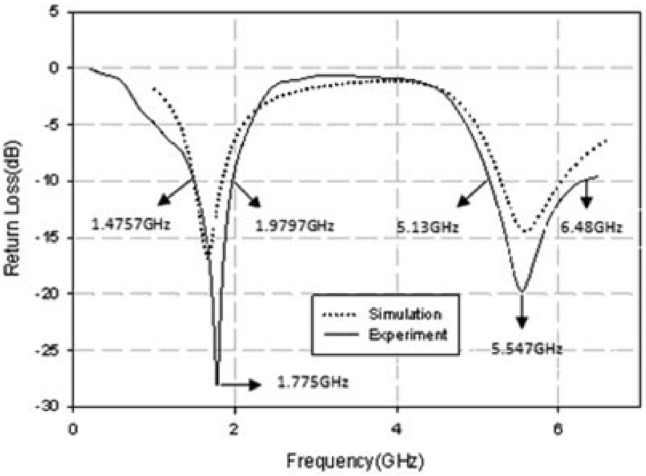


Figure 2 Measured and simulated Return loss of the proposed dual frequency antenna

resonates at 1.77 and 5.54 GHz and has a wide band from 1.47–1.97 GHz and from 5.13–6.48 GHz covering DCS 1800, DCS 1900/PCS, RFID(5.75–5.85 GHz), ISM WLAN 5.2(5.15–5.35 GHz), HIPERLAN2(5.47–5.725 GHz), and ISM WLAN 5.8(5.725–5.825 GHz) communication bands. The omnidirectional radiation properties of monopole antenna make it suitable for base-station and indoor applications. Ansoft HFSS (high frequency structure simulator) is used for the simulation analysis of the antenna. Details of the antenna design and experimental result are presented in the following sections.

2. ANTENNA GEOMETRY

Figure 1(a) shows the schematic of the CPW fed optimized compact antenna. The antenna consists of a T-shaped monopole with two symmetrical vertical strips on both sides. The T monopole has a dimension 21 mm ($L_1 + w$) $\times$ 32 mm ($2 \times L_2 + 3 \times W$), whereas each of the two symmetrical vertical strips has a length of 7 mm (L_3). The dimensions of the coplanar waveguide feed are chosen from standard design equations for 50 Ω impedance matching. The lateral ground plane dimension of the antenna is optimized as 10 mm (W_g) $\times$ 14 mm (W_l) for maximum compactness. The antenna is printed on a substrate of dielectric constant 4.4 and thickness 1.6 mm.

3. RESULTS AND DISCUSSIONS

Because a top-loaded monopole can excite resonances, the antenna shown in Figure 1(b) has two resonances but with poor matching. It is showing high capacitive reactance in the desired resonating bands, so by adding an inductive stub ($L_2 + L_3$) as in Figure 1(a) we can improve matching efficiently, resulting in a modified T-shaped structure. The antenna is tested using HP 8510C Network analyzer and the simulated and experimental return loss of the final antenna is shown in Figure 2(a). The lower band centered at 1.77 GHz has a wide bandwidth from 1.47–1.97 GHz with a percentage bandwidth of about 34% covering DCS 1800 and DCS 1900/PCS bands. The measured impedance bandwidth of the upper band centered at 5.54 GHz with wide bandwidth from 5.13–6.48 GHz determined by 10-dB return loss is good enough to cover the ISM WLAN 5.2 (5150–5350 MHz), ISM WLAN 5.8(5.725–5.875 GHz), and HIPERLAN2(5.47–5.725 GHz) communication bands.

The current distribution for the centre frequencies of the designed antenna is shown in Figure 3. The current distribution on the horizontal arms is equal and opposite and cancels at the far field. So the radiation is primarily due to the *y*-component and hence it is polarized along *y*-direction in the two bands. It is also noted that the fundamental mode at 1.77 GHz due to the lengths $L_1 + L_2 + L_3$ which is nearly equal to λ/4. The second

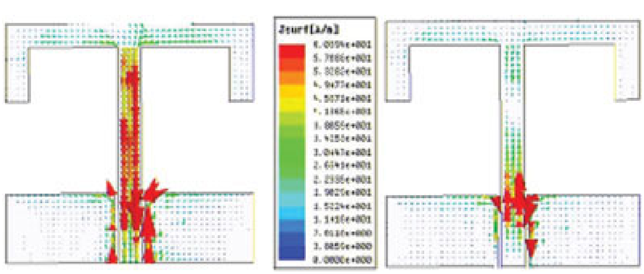
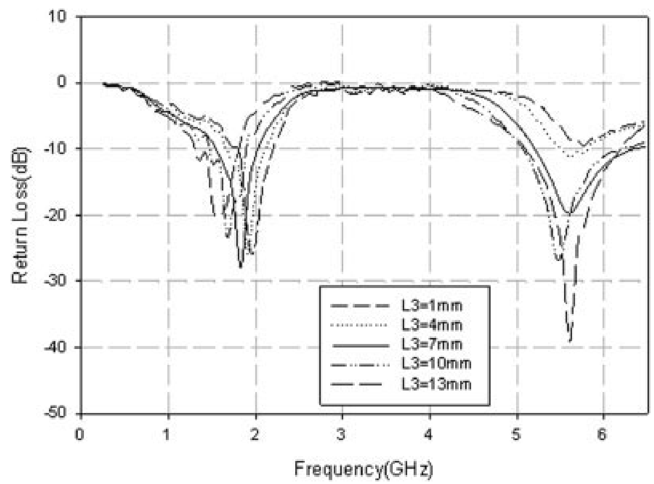
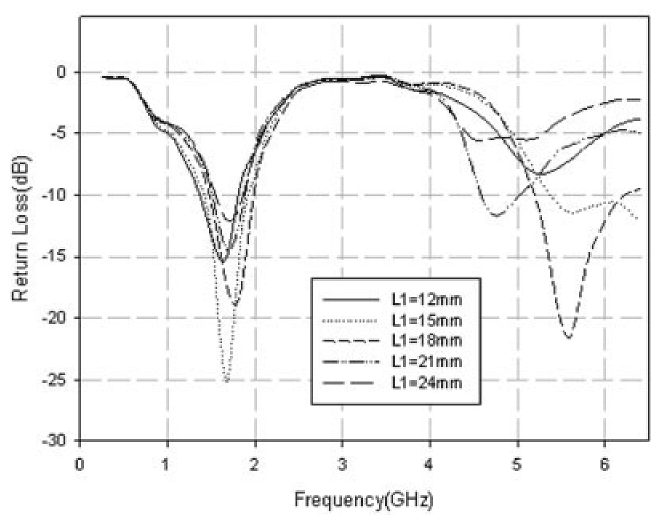


Figure 3 Simulated surface current distribution of antenna at (a) 1.77 GHz and (b) 5.54 GHz. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]



(a)



(b)

Figure 4 (a) variation of return loss with L_3. (b) Variation of return loss with L_1.

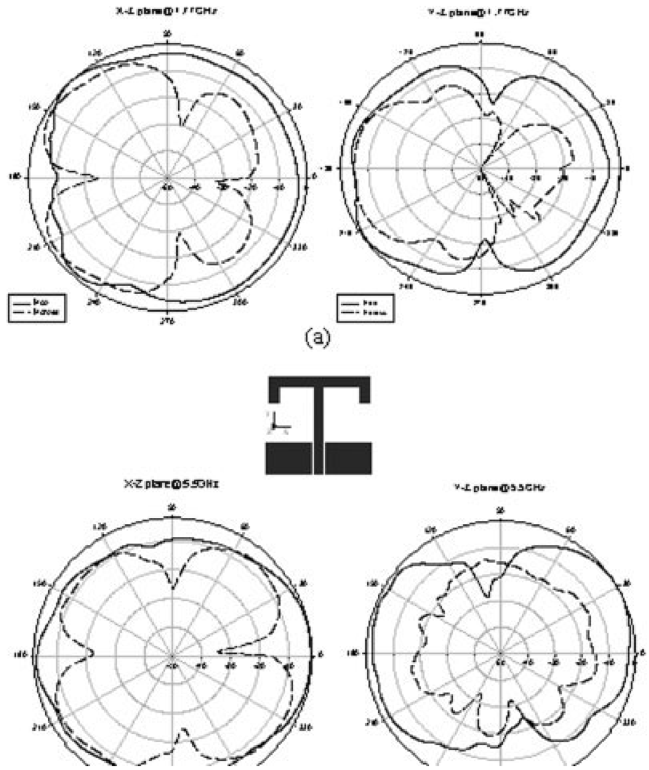


Figure 5 Measured radiation pattern of the proposed dual frequency antenna at (a) 1.77 GHz and (b) 5.54 GHz

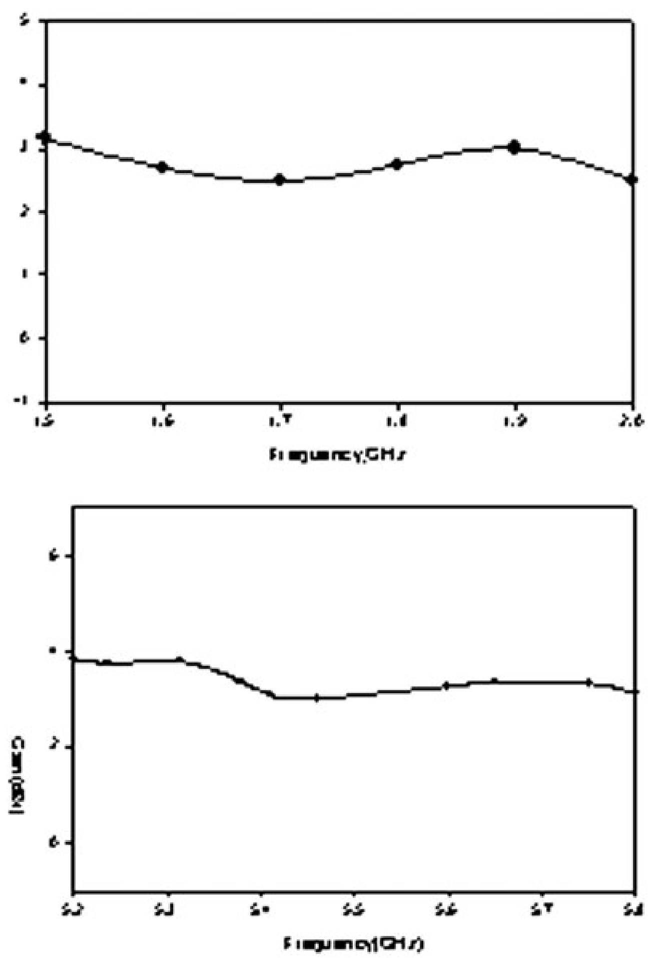


Figure 6 Measured gain of proposed antenna at (a) 1.77 GHz and (b) 5.54 GHz

resonance at 5.55 GHz is due to the length L_1 which is nearly equal to $\lambda/2$. This aspect is reconfirmed by conducting experiments with different lengths. Figure 4(a) illustrates the variation of return loss with L_3 without varying other parameters. Figure 4(b) shows the variation of return loss with L_1, keeping the total length ($L_1 + L_2 + L_3$) constant. It is found that the higher resonance exited by the length L_1 is affected without much change to the lower resonance which is due to the length $L_1 + L_2 + L_3$. It has to be noted that when L_1 is lowered, keeping $L_1 + L_2 + L_3$ constant, the radiating element comes closer to the ground plane resulting in anomalous behavior at the bands due to coupling.

The measured radiation patterns are shown in Figure 5 and are nearly omnidirectional. The measured antenna gain is 3 dBi in lower band (1.47–1.97 GHz) and 3.5 dBi in higher band (5.13–6.48 GHz) as shown in Figure 6.

4. CONCLUSION

A CPW fed planar monopole antenna built on a substrate of thickness 1.6 mm and dielectric constant 4.4 for multiband operation has been developed. It is shown that by modifying a monopole additional resonances can be excited. Antenna is showing a 2:1 VSWR for the two bands centered at 1.77 GHZ (1.47–1.97 GHz) and 5.54 GHz(5.13–6.48 GHz) with a impedance bandwidth of 34.15% and 26.31% covering DCS, PCS, and ISM WLAN bands with an average gain of 3.0 and 3.5 dBi, respectively.

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