Studies of a CPW-Fed Multiple-Branch Multi-Band Antenna

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1. Introduction

For systems of personal communication services (PCS), there are continuous needs for dual-band/multi-band planar antennas because of the various services available and the limited space on the portable devices [1]. In recent years, there had been researchers employing the multiple branch structures to obtain the multi-band operations desired [2-3]. In this paper, a novel CI-shaped multiple-branch monopole antenna is introduced in order to achieve multi-band operations that cover the GSM 900, GSM 1800/1900, and the 2.4GHz ISM bands with return-loss less than -10dB. The proposed antenna is fed by a 50Ω coplanar waveguide (CPW) transmission line to benefit from the simple structure of single metallic layer and other attractive features such as wide bandwidth, no soldering point needed, and easy integration with active devices [4], while the multi-band characteristics of the proposed antenna are carefully studied and experimentally verified.

2. Antenna Structures

The configuration of the proposed multiple branch CPW-fed monopole antenna is shown in figure 1. The antenna prototypes are designed based on a cheap FR4 board ($\varepsilon_r = 4.4$, $\tan\delta = 0.015$) with thickness h=0.8mm. A 50Ω CPW transmission line with a signal-strip of width 3 mm and a gap of 0.3 mm between the strip and ground is used to feed the antenna. Two finite ground patches of different size (43.53×24.19 mm^2 and 43.53×29.6275 mm^2) were located on each side of the CPW signal line. The radiated part is a multiple-branch structure with dimensions of 48.85 mm (width) and 31 mm (length).

The antenna mainly consists of two branches. One branch is with the shape of C, while the other is with the simple shape of I . The detailed dimensions are listed in Table 1. The proposed antenna is designed with the aid of the EM simulation software and verified by experiments. The measured and simulated return losses, S11, of the proposed multiple branch antenna are shown in Fig. 2. The measured results of the return loss compare quite well with the simulated ones, and are suited for the bands of GSM 900, GSM 1800, GSM1900 and 2.4GHz ISM .

Those shown in the Figs. 3(a) and (b) are the electric currents at the frequencies 0.9GHz and 1.8GHz, from which it is observed that the longer C branch is responsible for the lowest band (0.9GHz), while the shorter I branch is responsible for the higher band (1.8/1.9GHz). In additions, figure 3(c) reveals that the 2.4GHz band is contributed from the excitation of higher order mode along the C branch. Moreover, it is found that wide band operations cover the range from 1.4GHz to 3GHz can be achieved with return loss less than -8dB by utilization of the un-symmetric structure with extended right-hand side ground plane with extra height w2.

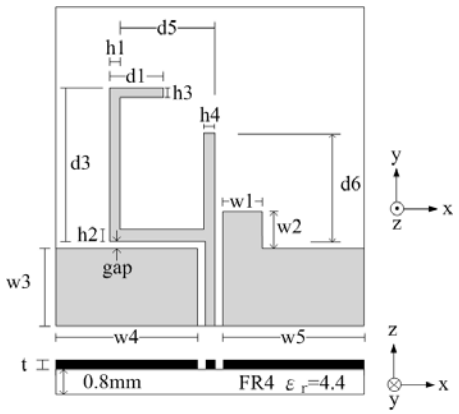


Fig. 1 The configuration of the proposed multiple branch CPW-fed monopole antenna

Table 1 : The detailed dimensions of the proposed multiple branch antenna

	h1	h2	h3	h4	d1	d3	d5
length(mm)	5	3	3	3	21	53.85	26
	d6	w1	w2	w3	w4	w5	gap
length(mm)	42.6	43.53	5.4	24.19	43.53	43.53	0.3

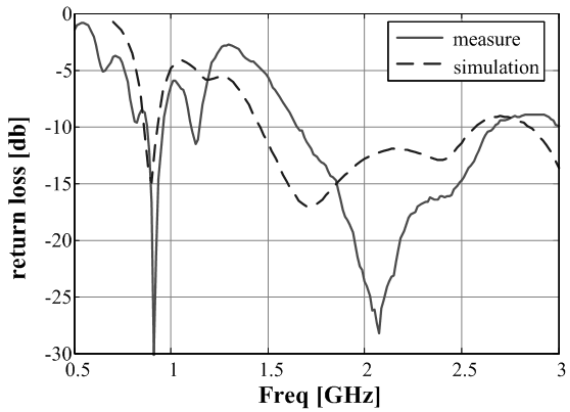
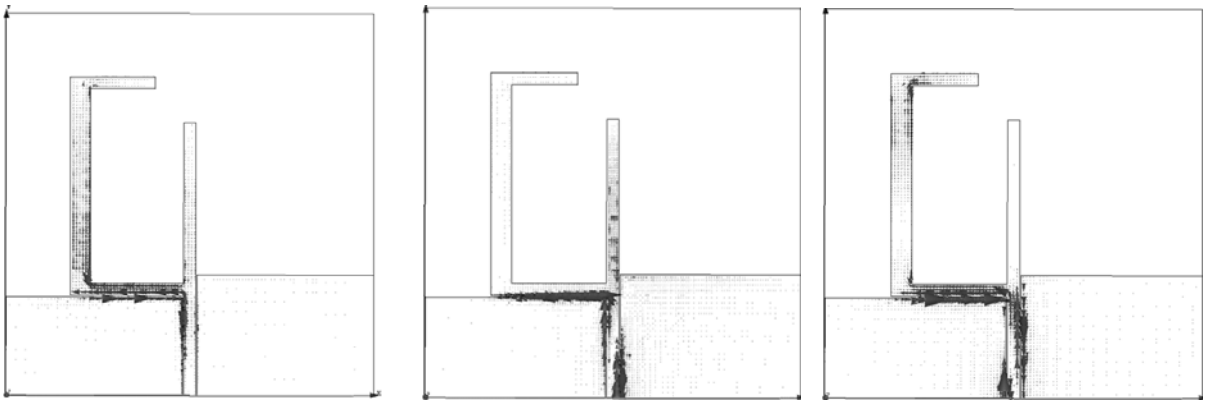


Fig.2 The measured and simulated return loss, S11, of the proposed multiple-branch antenna.

3. Antenna Designs and Characteristics

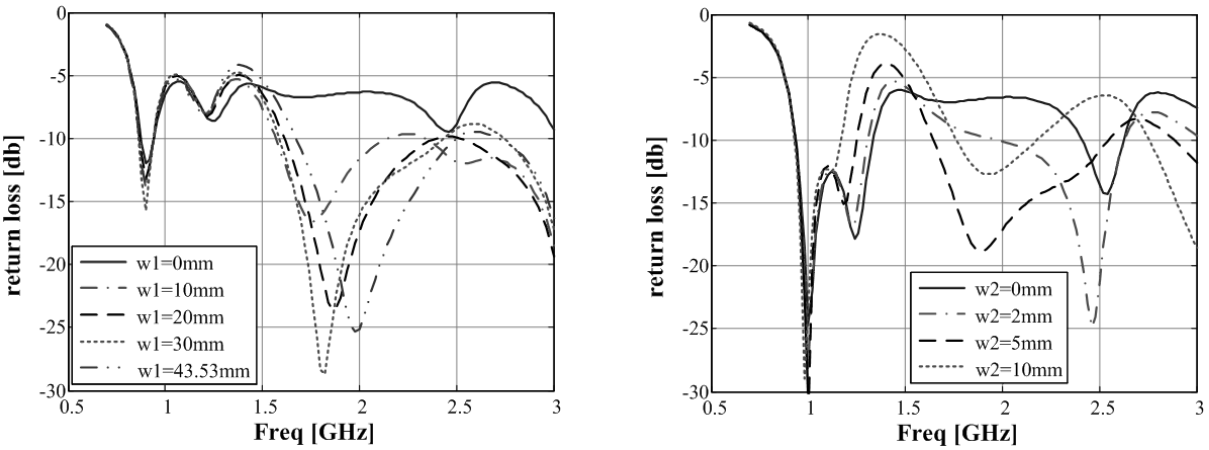
In this paper, the un-symmetric antenna structure with extended right-hand side ground plane (characterized by the lengths w1 and w2) is utilized to improve the antenna bandwidth. The effects of the ground plane parameters w1 and w2 upon the characteristics of return loss are examined next as shown in Figs. 4(a) and 4(b). It is observed that the parameters w1 and w2 have little effects upon the lower band ~0.9GHz, while the other frequency ranges are strongly affected. The effects of other parameters upon the characteristics of return loss are saved here for the sake of brevity.

Figures 5 (a)~(c) show the simulated and measured radiation patterns of the proposed antenna of 1.8GHz. The radiations for the 1.8GHz are mainly contributed by the straight I branch, the patterns for which are consistent with the monopole-like ones as expected. Similar patterns are observed for the 2.4GHz except that the branch C is mainly responsible for the radiations at this time. The antenna gains are larger than 2dB across the frequency ranges interested.



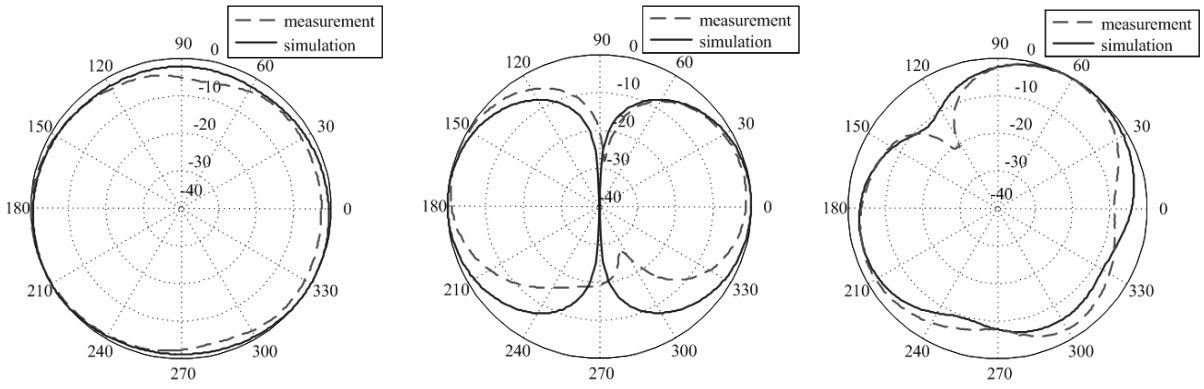
(a) (b) (c)

Fig.3. The electric currents at the frequencies of (a) 0.9GHz, (b) 1.8GHz and (c) 2.4GHz.



(a) (b)

Fig.4. The dependencies of return loss on the parameters (a) w1 and, (b) w2.



(a) (b) (c)

Fig.5 The radiated patterns for the 1.8GHz across the (a) XZ-plane, (b) YZ-plane and (c) XY-plane.

4. Conclusions

In this paper, a novel CI-shaped multiple-branch monopole antenna is introduced in order to achieve multi-band operations that cover the GSM 900, GSM 1800/1900, and the 2.4GHz ISM bands with return-loss less than -10dB. The characteristics of the proposed antenna are carefully studied and experimentally verified. It is found that the longer C branch is responsible for the radiation of the lowest band (0.9GHz), while the shorter I branch is responsible for the higher band (1.8/1.9GHz). In additions, the 2.4GHz band is contributed from the excitation of higher order mode along the C branch. Moreover, the un-symmetric structure with extended right-hand side ground plane with extra height is employed to achieve a wide band operation covering the range from 1.4GHz to 3GHz.

Acknowledgments

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