# Novel Compact Uniplanar Printed CPW-fed M-antenna

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***Abstract* - A compact printed CPW-fed novel M-antenna is presented. The proposed antenna consists of an M-shaped radiator with CPW-feed. A parametric study on several geometrical parameters on its performance is provided to optimize the antenna. Hence, with the compact antenna size, two antennas for DCS1800 and 4G systems are achieved. Details of the design considerations are presented, and results of the fabricated prototype are discussed.**

***Index Terms* — M-antenna, DCS antenna, 4G antenna.**

## I. Introduction

With the increasing demand for portable wireless communication terminal, study on compact antennas has attracted much attention.

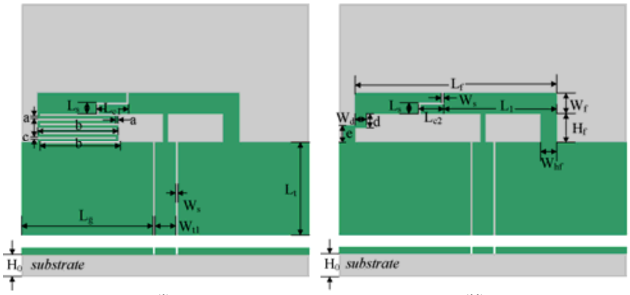
The traditional planar-inverted-F antennas (PIFAs) have attracted interest in the portable device due to their compact planar geometry, easy impedance matching with good radiation efficiency [1-7]. PIFAs are resonating at approximately λ/4 resonant length. Stacked or folded shorted patch used to enhance the impedance bandwidths in [3] and [4]. In order to achieve multiband operation, slot and parasitic patch are used to obtain multimode resonance in [5] and [6]. In [7], a PIFA used as a coupled feed with a band-notching slit for WLAN/WiMAX operation in the laptop computer. In [8], a rectangular folded planar radiator with slot PIFA was designed for GSM, DCS and PCS operation, but the antenna still in 3-D dimension. Moreover, slim profile has been a trend for the handsets, especially for the smartphones.

We present in this paper two novel compact printed CPW-fed printed M-antennas. The proposed antennas consist of a different M-shaped radiator with CPW-feed, respectively. The two antennas cover the DCS1800/4G are designed, and results of the fabricated antenna are discussed.

## II. Antenna Configuration and Design Consideration

The schematic configuration of the proposed CPW-fed M-antennas for DCS1800 and 4G applications is shown in Fig. 1. The two antennas were fabricated and printed on a 1.50-mm-thick F4BM substrate with relative permittivity of 2.55 and a loss tangent of 0.001. To achieve 50Ω characteristic impedance, the width $W_{t1}$ of the CPW feedline is fixed at 1.8mm, with a gap $W_s$ of 0.2mm separated from the ground (see Fig. 1).

The difference between the two antennas is that one of the left parts of the M-antenna has a longer loaded branch using meander line and the other has a shorter one using two lump . The overall size of the two antennas is 25×20 mm$^2$. The detailed dimensions of the proposed antennas are listed in Table I.




(i) (ii)
Fig. 1. Schematic configuration of the proposed compact M-antennas

TABLE I
GOMETRIC DIMENSIONS OF PROPOSED ANTENNA
(UNIT: MILLIMETERS)

| $L_0$ | $L_g$ | $L_t$ | $L_{c1}$ | $L_{c2}$ | $L_f$ | $H_f$ | $L_s$ | $L_1$ |
|---|---|---|---|---|---|---|---|---|
| 0.5 | 11.4 | 8.0 | 2.8 | 2.2 | 17.5 | 2.5 | 1.0 | 6.4 |
| $W_{hf}$ | $W_f$ | $W_s$ | $W_d$ | a | b | c | d | e |
| 1.4 | 1.8 | 0.2 | 1.0 | 0.2 | 7.0 | 0.2 | 1.2 | 1.5 |

The proposed antennas consist of an M-shaped radiator and a CPW-feed. Different from the traditional PIFA (antenna iii) in Fig 2, which has the resonance at 3.48GHz, in the proposed antenna, the radiator is connected by the folded transmission lines. When the length of the radiator is increased, behaving a major factor to cause over strong inductive coupling, the resonant frequency of antenna is decreasing. As shown in Fig.2, the simulated resonant frequency of the proposed antennas exhibit a lower resonance at 1790 MHz (antenna i) and 2320 MHz (antenna ii), respectively.

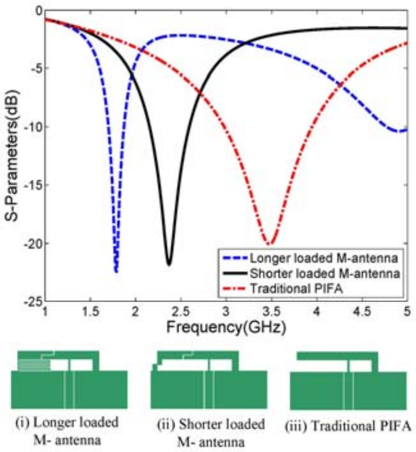
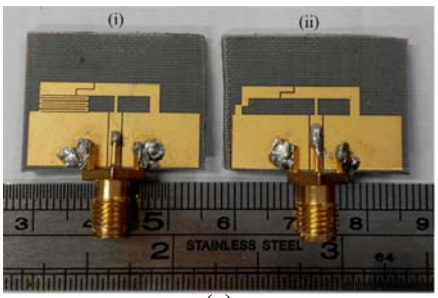



Fig. 2. Simulated return loss against frequency for the proposed M antennas, and traditional PIFA.

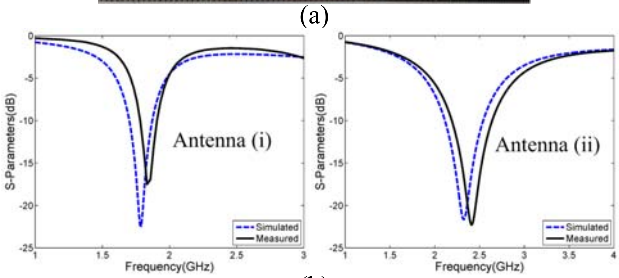
## III. Results and Discussion

To demonstrate the validity of the design strategies, two samples of the proposed M-antennas were fabricated and measured. The photograph of the proposed M-antennas is shown in Fig. 3 (a).

The measured results are surveyed by Anritsu 37347C Vector Network Analyzer (VNA) and extracted by MATLAB. The simulated and the measured reflection coefficient of the proposed antennas are compared and the results are depicted in Fig.3 (b). Although a minimum return loss level of 6 dB (VSWR = 3) is generally used for mobile phone antenna design, as depicted in the figure, the measured impedance bandwidth of the proposed antennas for a 7.36-dB reflection coefficient (VSWR = 2.5) is 1710-1880 MHz and 2180-2630 MHz respectively. Better antenna return loss levels would improve the overall performance of a system since the reflected power level in transmission and reception is reduced. The comparison between the measured and simulated results in Fig.3 (b) shows some discrepancies. The discrepancies might be due to factors such as fabrication tolerances and material parameter uncertainty.




(a)




(b)

Fig. 3. (a)Photograph of the fabricated antennas. (b)Simulated and measured $S_{11}$ for the proposed M antennas

## IV. Conclusion

Two compact single band printed CPW-fed M-antennas respectively for DCS1800 and 4G applications are presented. The proposed printed antennas have a uniplanar and simple structure and are easily fabricated on the same plane as the substrate so that the position alignment and circuit process are simplified. The proposed antennas consist of a radiating M radiator, by properly tuning the lengths of the left loaded branches, the resonant frequency can be controlled.

For the two fabricated prototype of the proposed M antennas, the sizes are 4.3×17.5mm$^2$ and 4.3×18.5mm$^2$ (excluding the solid rectangular ground), respectively. Moreover, although the antenna shows a simple structure and compact volume, they still cover the DCS1800 and 4G for operators with a VSWR better than 2.5.

## V. References

[1] C.R.Rowell and R.D.Murch, "A capacitively loaded PIFA for compact mobile telephone handsets", *IEEE Trans. Antennas Propagat.*, Vol.45, pp.837-842, May 1997.

[2] C.R.Rowell and R.D.Murch, "A compact PIFA suitable for dual frequency 900/1800MHz operation", *IEEE Trans. Antennas Propagat.*, Vol.46, pp.596-598, April 1998.

[3] Jian-Yi Wu and Kin-Lu Wong, "Two integrated stacked shorted patch antennas for DCS/WLAN dual-band operations", *Microwave Opt. Technol. Lett.*, Vol. 30, pp.134-136, February 2001.

[4] Yen-Liang Kuo and Kin-Lu Wong, "Coplanar waveguide-fed folded inverted-F antenna for UMTS application", *Microwave Opt. Technol. Lett.*, Vol.32, No.5, pp.364-366, March 2002.

[5] Pascal Ciais, Robert Staraj Georges Kossiavas and Cyril Luxey, "Design of an internal quad-band antenna for mobile phones", *IEEE Microw. Wirel. Co.*, Vol.14, pp.148-150, May 2004.

[6] D. M. Elsheakh and E. A. Abdallah, "Compact Multiband Multifolded-Slot Antenna Loaded With Printed-IFA", *IEEE Antenn. Wirel. Pr.*, Vol.11, pp.1478-1481, December 2012.

[7] Cheng-Tse Lee and Kin-Lu Wong, "Uniplanar Printed Coupled-Fed PIFA With a Band-Notching Slit for WLAN/WiMAX Operation in the Laptop Computer", *IEEE Trans. Antennas Propagat.*, Vol.57, pp.1252-1258, April 2009.

[8] Murilo Hiroaki Seko and Fatima Salete Correra, "A novel TRI-band planar inverted-F antenna for GSM/DCS/PCS operation in mobile handsets", *Microwave Opt. Technol. Lett.*, Vol.55, pp.821-825, April 2013.