A Dual-Polarized Dipole Antenna with Balun Feed

Shun-Yun Lin[1], Tzung-Wern Chiou[2], Wei-Heng Huang[1] and Wen-Shyang Chen[1]
[1] Electronics Engineering, Cheng Shiu University, Kaohsiung city,Taiwan R.O.C
[2] BWant Co., Ltd, Taiwan R.O.C, Taipei city,Taiwan R.O.C

***Abstract*—A novel dual-polarized dipole antenna excited by two cross strip baluns is presented. The operation bandwidth of the proposed antenna can be widely altered by varying the coupled strip of balun. The antenna has good performance in isolation which is more than 20 dB between the two input ports. Moreover, the radiation pattern and antenna peak gain are very stable over the operating band.**

***Keywords*—dual-polarized antenna; microstrip balun; dipole antenna**

I. Introduction

To date, research works on frequency reuse and polarization diversity by using two orthogonal polarizations have been generally developed. Dual-polarized antenna can provide polarization diversity to reduce side effects of multipath fading or increase channel capacity [1]. They have been used in various wireless communications, especially in cellular-phone base stations. To work effectively, high port-to-port isolation and low cross-polarization level are required for dual-polarized antennas [1-2]. The dipole antenna is a promising candidate for dual-polarization radiation. A conventional printed dipole with integrated balun features a broadband performance [3]. Also, the 45°dual-polarized antenna using the electric and magnetic field were disclosed for wideband and high gain operations [4] while the structures are complicate for production.

This paper presents a unique dual-polarized dipole antenna with two cross strip baluns. Good radiation characteristics, including low back radiation, wide half-power-beamwidth, stable antenna gain, and radiation pattern over the operating band, are demonstrated.

II. Antenna Design

The geometry of the proposed dual-polarized folded dipole antenna is shown in Fig. 1, with volume of $70\times70\times37.8$ mm^3 for LTE 2500 band (2300~2700 MHz) operation. The antenna consists of two dipoles which are orthogonal to each other. The dimensions were selected after a detailed parametric study for good performance. The unit element of dipole is a shorted strip, which distinguished into a lower vertically oriented part and an upper horizontally oriented part. The lower part is a rectangular strip with dimension of 37.8×10 mm^2, and vertically stands on the ground plane, while the upper is a taper with length of *w*. Each dipole comprises one pair of the mentioned element in opposite side. Dipole 1 and dipole 2 are placed along y- and x-axis, respectively. The whole structure can be cut form one piece of cooper plate and soldered to the ground plane.

Two cross Γ-shaped strips with the same dimensions are proposed as microstrip baluns to feed the dipole. Each feeding strip consists of two portions, a transmission line and a coupled strip. The transmission line (37.8×1.5 mm^2) is parallel close to the vertical part of the antenna unit. The remaining coupling strip with length *h* can be adjusted to alter the operation band.

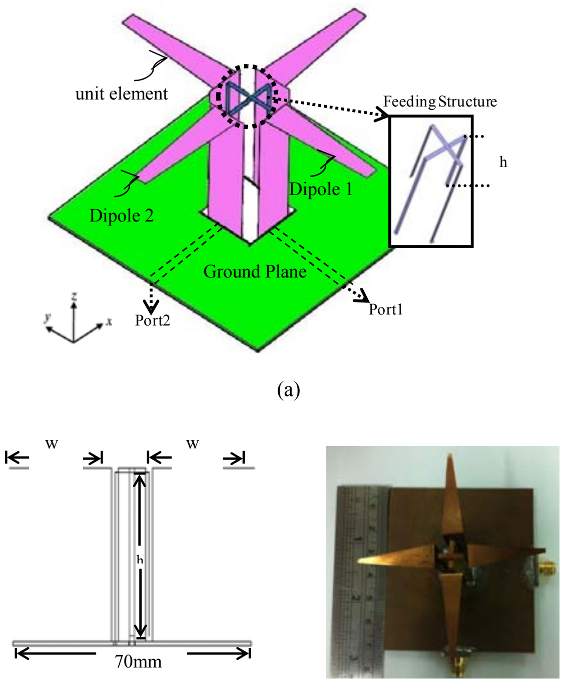
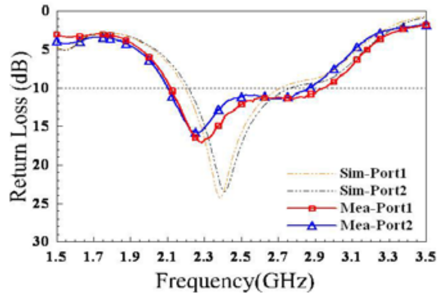


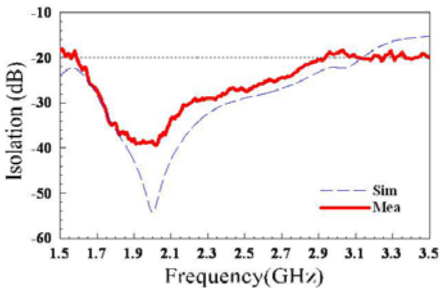
Fig. 1. Configuration of the proposed antenna: (a) 3D view, (b) side view, and (c) Photograph

III. Experimental Results and Discussions

Fig. 2 shows the measured and theoretical return-loss against frequency. Both results are almost the same and similar to the disclosed dipole antenna in [4], that is, two resonant modes are combined. By considering currents in the dipole arms traveling in the same direction, the even mode dominates over the operation band. It is suggests that a good antenna radiation is expected. The measured results indicate that the 10-dB impedance bandwidths are about from 2.1- to 2.9 GHz. It is sufficient for LTE 2500 operation. Also, the isolation between tow input ports is more than 20 dB over the impedance bandwidth.



(a)



(b)

Fig. 2. Measured and theoretical frequency responses. (a) Return-loss and (b) Isolation. *w* = 28 mm, *h* = 33.8 mm.

The effect of the dipole length *w* is shown in Fig. 3. It is noted that the dipole length 2*w* is about $0.5\lambda_0$ at the resonant wavelength. The resonant frequency lowers from 2.5- to 2.4 GHz as *w* increase from 28 mm to 30 mm.

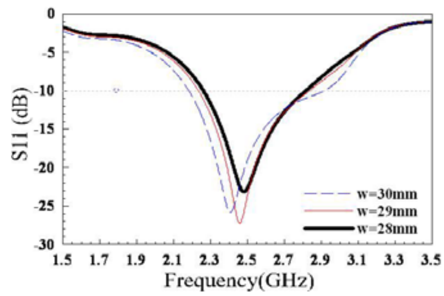


Fig. 3. Simulated S11 against dipole length.

The effect of coupling strip length *h* is studied in Fig.4. By judicious selection of the parameters *h*, one can achieve an impedance match over a very wide bandwidth. In our study, the bandwidth is adjustable from 31% (2.25~3.1 GHz) to 65% (2.3~4.5 GHz, not shown in this figure) with *h* decrease from 33.8- to 23.8 mm. The radiation characteristics are studied. The experimental results indicate that the proposed antenna has stable radiation patterns and antenna peak gain, and low cross-polarization radiation over the operation band. Fig. 5 (a) and (b) shows the measured radiation pattern at 2500MHz contributed by the dipole 1 and dipole 2, respectively. Both radiations are similar in symmetric x-z and y-z plane (vertical plane), and have a dipole-like pattern in x-y plane. The antenna peak gain is within 5.8~ 6.5 dBi over the operation band.

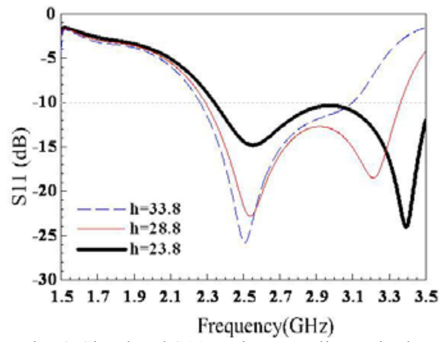


Fig. 4. Simulated S11 against coupling strip length.

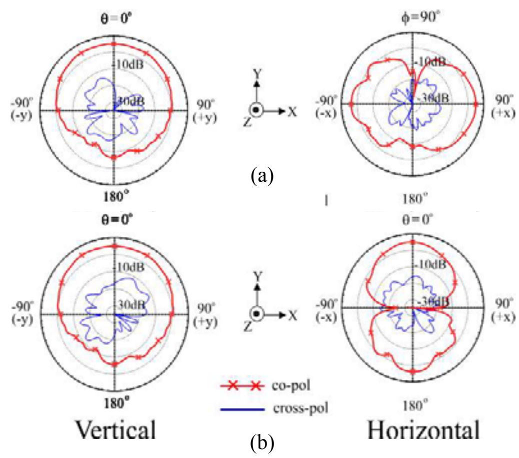


Fig. 5. Measured radiation pattern at 2500 MHz. (a) Dipole 1, (b) Dipole 2.

IV. Conclusions

A dual-polarized planar antenna excited by two U-shaped baluns is simulated, fabricated, and tested. The operation band can be widely adjusted by varying the coupling strip length. The radiation pattern and antenna gain across the operating bandwidth are stable. The proposed antenna is with compact dimension, 6.5 dBi antenna gain, and wide 130° 3dB-beamwidth. These features are suitable for the small base station of the 4^{th} generation wireless communication systems.

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