A Novel Wideband Circular Patch Antenna for Wireless Communication

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***Abstract* - An innovative wideband planar antenna is presented for mobile communications. The proposed planar antenna consists of four pairs of arc dipole, a balun for unbalance–balance transformation, and a conductor ground for gain enhancement. The prototypes of antenna is fabricated and measured. The measurement results show that the proposed antenna can achieve a bandwidth of 1.7–2.4 GHz or a relative bandwidth of 34.1% with the return loss greater than 10 dB, which can cover GSM/PCS/UMTS bands. In addition, the proposed antenna has a peak gain of 3.4–4.2 dBi throughout the entire operational bandwith with the radiation efficiency over 81%.**

***Index Terms* —Base station, monopole-like, printed arc dipole, wideband antennas.**

I. INTRODUCTION

With the increasing demands and significant progress on the wireless communication industry, some features of antenna are required such as simple structure, broadband, low cost and special radiation pattern [1]. Moreover, a 360° coverage is often needed in indoor base station wireless communications since they can transmit or receive wireless signals identically. Improving communication performances and increasing the system capability especially in multipath environments require an antenna possessing the advantages above.

Over the past decade, a number of full coverage antennas have been developed. A classical planar antenna made of four dipoles on an annular substrate was proposed in [1] that covers the frequency range of 2.3–2.7 GHz. A printed dipole with parasitical strips was proposed in [2, 3] that can operate over band of 5.1–6.8 GHz and.1.7-2.7GHz respectively. In [4], a 4-port antenna consisting of four magnetoelectric dipoles and a vertical electric monopole was presented that has a bandwidth of 22.2%. An omnidirectional dual-polarized antenna that operates from 1.7 to 2.2 GHz was presented in [5]. However, all of the above-mentioned designs cannot provide an antenna that meets easy fabrication and broadband simultaneously.

In this paper, a novel wideband planar antenna with four pairs of arc printed dipole is presented. The antenna is fabricated and measured. The measured bandwidth for the antenna is about 34% (1.7–2.4 GHz), which can be developed for potential applications in GSM1800/GSM1900/UMTS base station. By placing a conductor ground underneath the proposed antenna, the radiation pattern becomes unidirectional which is more suitable for indoor communication. Simultaneously, the gain is enhanced from 1.2 to 3.4 dBi.

II. ANTENNA DESIGN

The configuration of the broadband antenna is shownin Fig. 1. It consists of four pairs of arc dipole and tapered transmission lines connecting to the dipole for impedance matching, which are printed on the opposite side of an FR4 substrate. The substrate has a relative permittivity of 4.4 with a thickness of 2.0mm. The dipole antennas are placed in a clockwise manner and connected to four tapered strip lines, respectively.

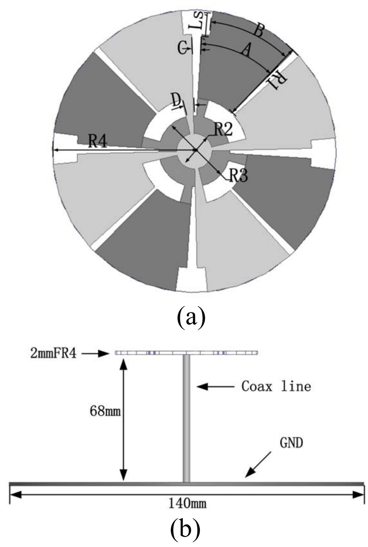

Fig.1 Configuration of the proposed dual-polarized patch antenna (a) the top view (b)the side view

TABLE I
GEOMETRY PARAMETERS OF THE PROPOSED ANTENNA

A(degree)	41.3	R1(mm)	25
B(degree)	39.1	R2(mm)	5.2
C(degree)	4.9	R3(mm)	10.4
D(degree)	10.8	R4(mm)	40.0
Ls(mm)	8.5		

As shown in Fig.1 (a), the antenna has a symetrical structure, thus a full coverage radiation results. The antenna is fed from the ground plane by a 50-Ω coaxial cable with an

SMA connector at the center of the antenna, which is depicted in Fig.1(b). The outer conductor of coaxial cable is connected to the central circular patch on the bottom of the substrate and the inner conductor is linked to the top plane. The top central circular patch, the bottom central circular patch and the tapered lines act as a balun used for unbalance-balance transformation from coaxial cable to the arc dipoles. In the middle of the dipole edge, a rectangular slot is cut to obtain the input impendence perturbation, thereby widening the bandwidth. Table I lists the design parameters of the proposed antenna.

III. Results And Discussion

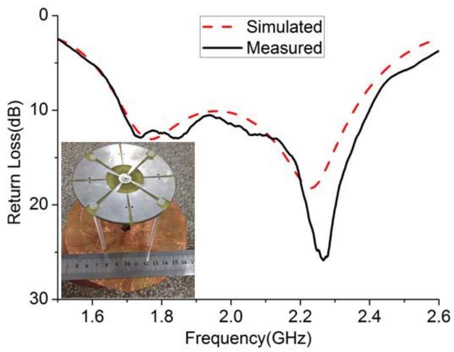

Fig.2 Simulated and measured return loss for the proposed antenna

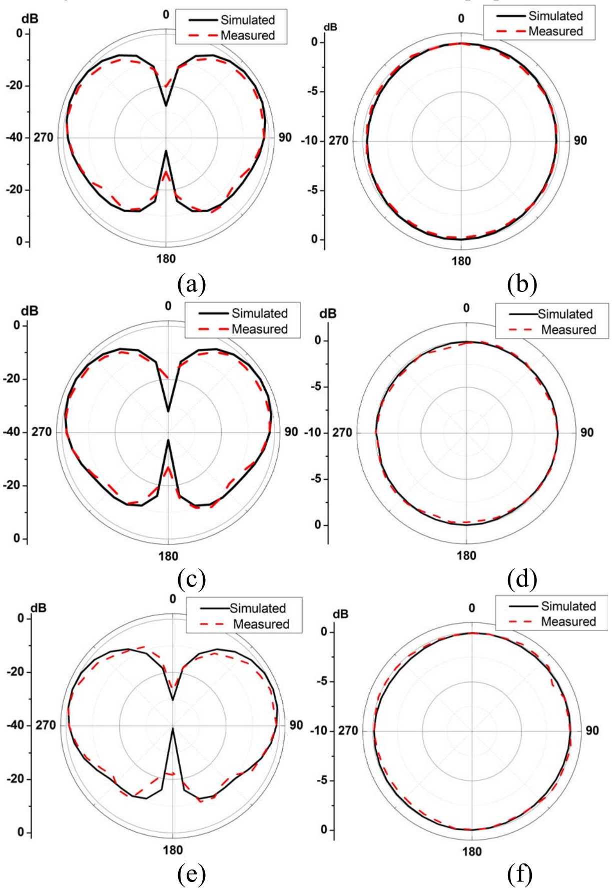

Fig.3 Simulated and measured radiation patterns of the fabricated antenna. (a)*xz* -plane at 1.7 GHz. (b)*xy* -plane at 1.7 GHz. (c)*xz* -plane at 2.0 GHz. (d) *xy*-plane at 2.0 GHz. (e) *xz*-plane at 2.4 GHz. (f) *xy*-plane at 2.4 GH.

A prototype of the proposed antenna is experimentally fabricated and measured for validating feasibility of the proposed design. Fig. 2 presents the photograph of the fabricated antenna prototype. The simulated and measured S-parameters are plotted in Fig. 2, and it suggests that there is little difference between measured and simulated results. As observed, the measured impendence bandwidth for return loss(RL)>10 dB achieves a frequency range from 1.7 GHz to 2.4 GHz, which indicates a percentage bandwidth of 34.1% for proposed antenna. The antenna covers several operation bands of the communication systems (GSM/PCS/UMTS).

Fig. 3 illustrates the simulated and measured radiation patterns of the antenna in two principal planes, E-plane (*xz* -plane) and H-plane (*xy*-plane) at three different frequencies. As shown, the antenna has a full coverage radiation pattern in the azimuthal plane with about 3 dB variation. Due to the conductor ground, in the elevation plane, the back lobe radiation is less than the front lobe in both simulation and measurement. It exhibits a radiation gain of 3.4, 4.1, and 4.2 dBi at 1.7, 2.0, and 2.4GHz, respectively. The simulated radiation efficiency is around 81% over the entire operational band of 1.7–2.4 GHz.

IV. Conclusion

A novel wideband antenna with the advantages of low cost, compactness, broadband and easy fabrication has been presented. The proposed antenna operates from 1.7 to 2.4 GHz with a return loss greater than 10 dB and covers GSM/PCS/UMTS frequency bands. The gain of the antenna is around 3.4 dBi throughout the entire operational bandwidth with the radiation efficiency over 81%.

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