MIMO Dipole Antenna with Triple-band Operation for LTE Femtocell Access Points

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***Abstract* - A novel triple-band three-port diversity dipole antenna for LTE access points is presented. The impedance bandwidths, determined from RL ≥ 10 dB, can reach about 120 / 872 MHz (17.1 / 33.9 %) for the 700 / 2300 / 2500 MHz operating bands, respectively, which are covering the required bandwidth for LTE system. This proposed triple-band dipole array also provides maximum peak antenna gains and efficiencies of 4.8 / 7.4 dBi and 92 / 88 % across 700 / 2300 / 2500 MHz bands, respectively, with uni-directional radiation pattern in XZ- and YZ-plane.**

***Index Terms* —LTE, Dipole antenna, Array.**

1. Introduction

Due to rapid developments in modern mobile communication technology, LTE (Long Term Evolution) system for the Fourth Generation (4G) mobile communication has attracted high attention for broadband access in wireless wide area network (WWAN) environment. To achieve big transmission rate and high quality performance, high-gain operation with multi-beam radiation characteristics is becoming demanding in LTE applications. The femtocell access point is in most cases a piece of equipment located in the customer premises. There are different types of diversity antennas including spatial diversity antenna, frequency diversity antenna [2], polarization diversity antenna [1], [3] and pattern diversity antenna [4], [5]. The pattern and polarization diversity techniques are very effective to solve multipath-fading effects in complex environments [2]. Several antenna structures offering pattern and polarization diversities have been proposed in the literature [4]-[7]. However, triple-band dipole antenna with high gain operation for LTE applications is very scant in the open literature. Therefore, in this article, we propose a novel triple-band dipole antenna mainly comprises an unsymmetrical dipole antenna with a shorting strip (see the geometry shown in Fig. 1). By properly adjusting the arms' lengths of the unsymmetrical dipole element, the operating bandwidths (RL ≥ 10 dB) can reach about 120 / 872 MHz (17.1 / 33.9 %), which are enough for LTE 700 / 2300 / 2500 MHz system. Also, the proposed dipole array provides maximum peak antenna gains and efficiencies of 4.8 / 7.4 dBi and 92 / 88 % across 700 / 2300 / 2500 MHz band, respectively, with good uni-directional radiation pattern in the azimuthal plane. Details of the proposed triple-band dipole antenna designs are described, and experimental results for the obtained high-gain performance are presented and discussed.

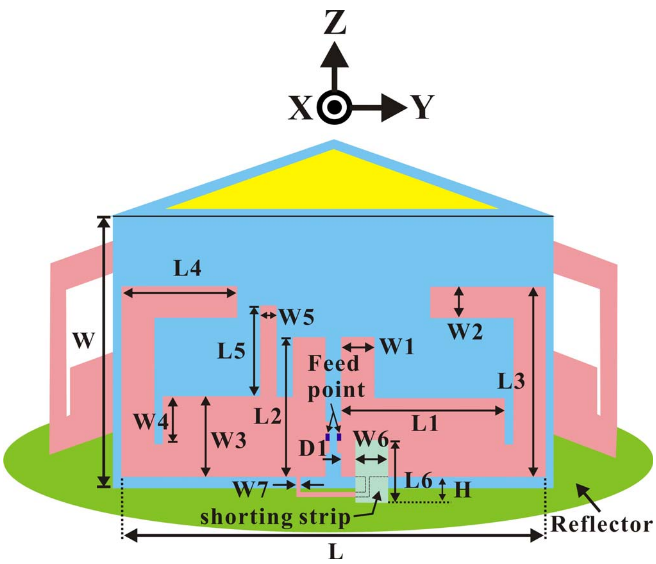

Fig. 1. Geometry of the proposed planar triple-band dipole antenna with high-gain operation.

2. Antenna design and experimental results

Fig. 1 illustrates the geometry of the proposed uni-directional dipole antenna for LTE 700 / 2300 / 2500 MHz access points. The proposed triple-band antenna is fed by a 50Ω coaxial cable line and arranged at the distance of 35 mm before the triangular reflector with the dimension of 104 × 68 mm^2. The MIMO dipole antennas are arranged with 2.2 mm above a circular plate with the radius of 80 mm. This proposed triple-band antenna is comprised of an L-shaped dipole element with the length of 190 mm, which is close to the half-wavelength of the resonant frequency of 780 MHz band. In this study, by introducing a pair of I-shaped strip with the dimension of 15 × 8 mm^2, the resonant mode at 2500 MHz band can be easily excited. Then, another rectangular strip with the dimension of 23 × 4 mm^2 is introduced to excite the 2300 MHz band due to the resonant length of the unsymmetrical element chosen to be corresponding approximately to 0.49 operating wavelength of 2300 MHz band.

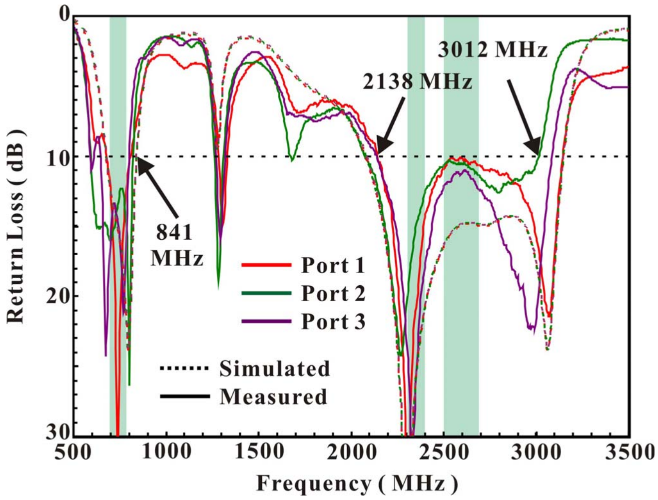

Fig. 2. Simulated and measured return loss against frequency for the proposed triple-band dipole antenna.

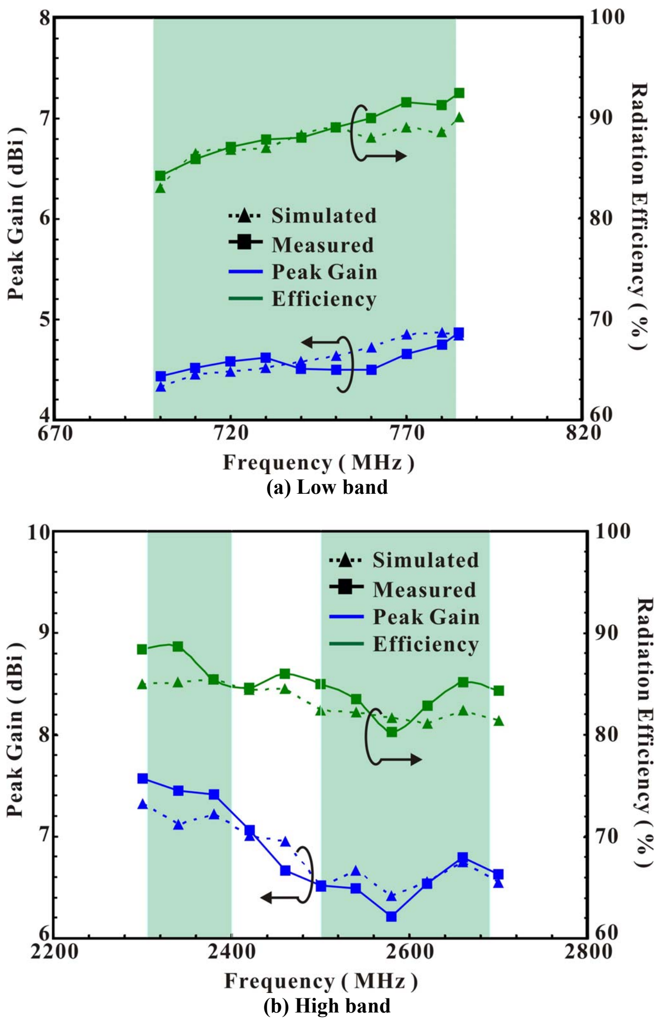

Fig. 3. Simulated and measured peak gains and efficiencies across the operating bands for the proposed triple-band dipole antenna.

To demonstrate the above deduction and guarantee the correctness of simulated results, the electromagnetic simulator HFSS based on the finite element method [8] has been applied for the proposed planar omnidirectional dipole array design. Fig. 2 shows the related simulated and experimental return loss for the proposed triple-band dipole antenna. From the experimental results, the measured impedance bandwidths (RL ≥ 10 dB) can reach 120 / 872 MHz (17.1 / 33.9 %) for the 700 / 2300 / 2500 MHz operating bands, respectively, to provide more impedance bandwidth to meet the specifications of LTE system. The 3D radiation patterns of the proposed triple-band dipole antenna are measured in anechoic chamber by using NSI-800F with Agilent PNA N5230A. Fig. 3 shows the simulated and measured peak gains and efficiencies of the triple-band dipole antenna. The maximum measured peak antenna gains and efficiencies are 4.8 / 7.4 dBi and 92 / 88 % across 700 / 2300 / 2500 MHz bands, respectively, with uni-directional radiation pattern in XZ- and YZ-plane.

3. Conclusions

A novel triple-band dipole antenna with high-gain operation for LTE access point has been proposed and investigated. It provides relatively wider impedance bandwidth of 120 / 872 MHz (17.1 / 33.9 %) for the 700 / 2300 / 2500 MHz operating bands to meet the specifications of LTE system, respectively. Also, the proposed triple-band dipole antenna provides maximum peak antenna gains and efficiencies of 4.8 / 7.4 dBi and 92 / 88 % across 700 / 2300 / 2500 MHz bands, respectively, with uni-directional radiation pattern in XZ- and YZ-plane.

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