

# Planar Dual-band Dipole Array for LTE / WiMAX Access Points

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**Abstract** – This work describes a planar  $1 \times 4$  dipole array with dual-band operation for LTE / WiMAX access points. The impedance bandwidths, determined from  $VSWR \leq 2.0$ , can reach about 525 / 747 MHz (20.2 / 21.3 %) for the 2.6 / 3.5 GHz operating bands, respectively, which are covering the required bandwidth for LTE (2.5 ~ 2.7 GHz) and WiMAX (3.3 ~ 3.7 GHz) system. This proposed dual-band dipole array also provides maximum peak antenna gains and efficiencies of 7.3 / 7.5 dBi and 89 / 75 % across 2.6 / 3.5 GHz bands, respectively, with good omni-directional radiation pattern in XY-plane.

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

## I. INTRODUCTION

Recently, LTE (Long Term Evolution) and WiMAX (the Worldwide Interoperability for Microwave Access) systems for the Fourth Generation (4G) mobile communication has attracted high attention for broadband access in wireless metropolitan area network (WMAN) environment. For the LTE / WiMAX base stations or access points, the high-gain array antenna with omni-directional radiation in the azimuthal plane is usually required for long-distance communication. The related array designs had been presented by using two  $1 \times 2$  dipole arrays [1], collinear array antenna with three in-phase half-wavelength radiating elements [2] and four-element collinear array antenna [3]. However, these above array antennas were focused on the single-band operation. For dual-band operation, only the array design [4] had been proposed by using one dipole antenna for 2.4 GHz and  $1 \times 2$  array antenna for 5.2 GHz WLAN communication. And, there was a disadvantage of lower antenna gain (less than 4 dBi), which were unsuitably in the practical applications for LTE / WiMAX access points. Meanwhile, dual-band dipole array for LTE / WiMAX applications is very scant in the open literature. Therefore, in this article, we propose a novel planar dual-band dipole array mainly comprises two  $1 \times 4$  dipole arrays arranged back to back, and can be easily constructed by printing on both sides of a dielectric substrate (see the geometry shown in Fig. 1). By properly adjusting the arms' lengths of each unsymmetrical dipole element, the operating bandwidths ( $VSWR \leq 2.0$ ) can reach about 525 / 747 MHz (20.2 / 21.3 %), which are enough for LTE and WiMAX system. Also, the proposed dipole array provides maximum peak antenna gains and efficiencies of 7.3 / 7.5 dBi and 89 / 75 %

across 2.6 / 3.5 GHz bands, respectively, with good omnidirectional radiation pattern in the azimuthal plane and narrow-beamwidth pattern in the elevation plane. Details of the proposed dual-band dipole array designs are described, and experimental results for the obtained high-gain performance are presented and discussed.

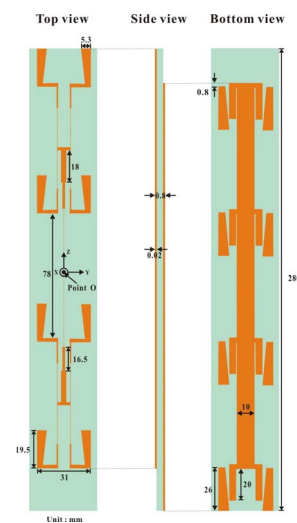


Fig. 1. Geometry of the proposed planar dual-band dipole array with high-gain operation.

## II. ANTENNA DESIGN AND EXPERIMENTAL RESULTS

Fig. 1 illustrates the geometry of the proposed omnidirectional dipole array antenna for 2.6 / 3.5 GHz LTE / WiMAX access points. The proposed dual-band array is fed by a  $50\Omega$  coaxial cable line at the center of the  $100\Omega$  microstrip line (point O) which is etched on the printed both sides of an inexpensive FR4 substrate with the volume of  $280 \times 31 \times 0.8 \text{ mm}^3$ , dielectric constant  $\epsilon_r = 4.7$  and loss tangent  $\tan \delta = 0.0245$ . This proposed planar dual-band array is comprised of four dipole back-to-back elements with the spacing of 78 mm, which are arranged symmetrically with respect to the central narrow rectangular ground plane of width, 10mm, printed on the rear surface of the FR4 substrate to obtain omni-directional radiation pattern in the azimuthal plane. In this study, by introducing the inverted U-shaped strip with the length of 20 mm in the ground plane to form the unsymmetrical dipole element, the resonant mode

operating at 3.5 GHz band can be excited due to the resonant length of the unsymmetrical dipole chosen to be corresponding approximately to 0.46 operating wavelength of 3.5 GHz band. And, a parasitic strip with the length of 26 mm is arranged parallel with the inverted U-shaped ground strip as the lower arm of the printed dipole element for the excitation of 2.6 GHz operating band with the resonant length of 45.5 mm, which is less than that of the conventional half-wavelength dipole to have compact operation.

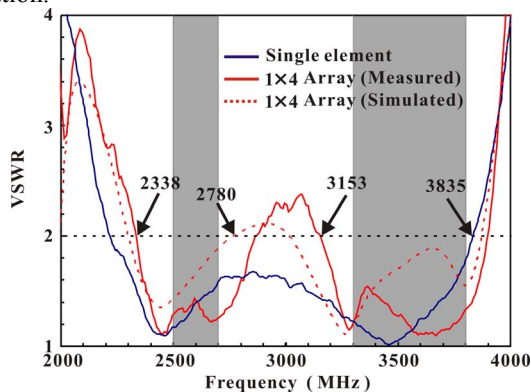


Fig. 2. Simulated and measured VSWR against frequency for the proposed planar dual-band dipole array.

To demonstrate the above deduction and guarantee the correctness of simulated results, the electromagnetic simulator HFSS based on the finite element method [5] has been applied for the proposed planar omnidirectional dipole array design. Fig. 2 shows the related simulated and experimental results of the VSWR for the proposed planar dual-band dipole array. From the experimental results, the measured impedance bandwidths ( $VSWR \leq 2.0$ ) can reach 525 / 747 MHz (20.2 / 21.3 %) for 2.6 / 3.5 GHz bands, respectively, to provide more impedance bandwidth to meet the specifications of LTE and WiMAX systems. The 3D radiation patterns of the proposed dual-band dipole array 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 planar dual-band dipole array. The maximum measured peak antenna gains and efficiencies are 7.3 / 7.5 dBi and 89 / 75 % across 2.6 / 3.5 GHz bands, respectively. Fig. 4 shows the measured 2D radiation patterns of the proposed planar dipole array operating at 2.6 / 3.5 GHz bands. It is found that the radiation patterns are with good omni-directional radiation patterns in the X-Y plane, which resemble typical patterns in symmetry with respect to the antenna axis ( $\theta = 0$ ) since the proposed dipole array structure is symmetrical.

III. CONCLUSIONS

A planar dual-band dipole array with high-gain operation for LTE / WiMAX access point has been proposed and investigated. It provides relatively wider impedance bandwidth of 525 / 747 MHz (20.2 / 21.3 %) to meet the specifications of LTE ( 2.5 ~ 2.7 GHz ) and WiMAX ( 3.3 ~ 3.7 GHz ) systems, respectively. Also, the proposed dual-band dipole array provides maximum peak antenna gains and

efficiencies of 7.3 / 7.5 dBi and 89 / 75 % across the 2.6 / 3.5 GHz operating bands with good omni-directional radiation pattern in the X-Y plane, respectively.

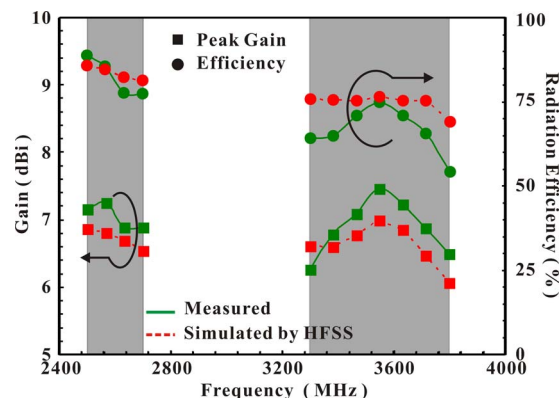


Fig. 3. Simulated and measured peak gains and efficiencies across the operating bands for the proposed dual-band dipole array.

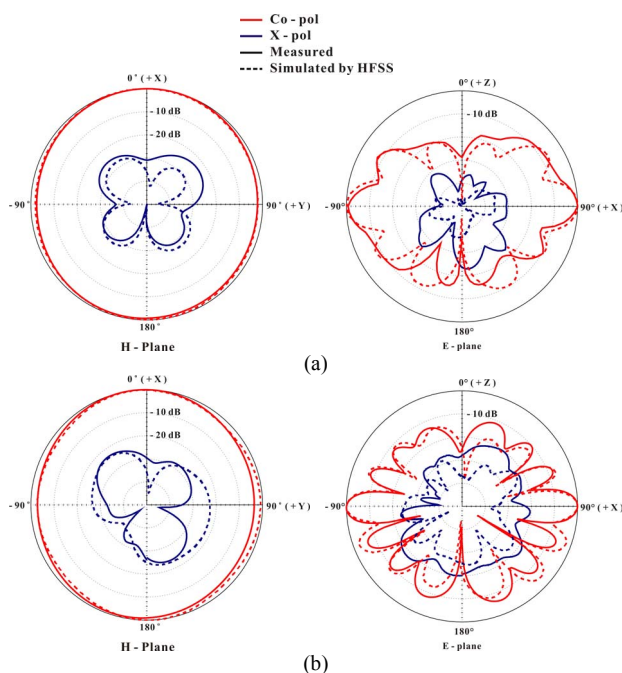


Fig. 4. Simulated and measured 2D radiation patterns for the proposed dual-band dipole array. (a)  $f = 2600$  MHz. (b)  $f = 3500$  MHz.

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