LTE MIMO Antenna for USB Dongle Applications

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Abstract

This paper presents LTE MIMO antenna for USB dongle applications. The proposed antenna consists of two adjacent PIFAs. In the operating LTE700 band (746~787 MHz), the isolation of proposed antenna is higher than 10 dB, and the ECC (Enveloped Correlation Coefficient) is lower than 0.5.

Keywords : MIMO Antenna USB Dongle Long Term Evolution

1. Introduction

The LTE (Long Term Evolution) mobile communication system is a one of the candidate technologies as a 4th generation mobile communication technology because LTE networks have advantages such as the improvement of data transmitting efficiency, use of effective frequency, high quality services. The commercial service of LTE systems is already in progress in US (LTE class 17, 13 and 4; 704~746 MHz, 746~787 MHz and 1710~2155 MHz respectively) [1]. Differently from the present mobile communication technology, the LTE is based on the OFDM (Orthogonal Frequency Division Multiplexing) and the MIMO (Multiple Input Multiple Output) technologies. Especially the MIMO system demands the multiple antennas, so that the MIMO antenna design within the limited antenna space of mobile terminal such as USB dongle and mobile handset has many difficulties. Besides, interference by the mutual coupling between the adjacent antennas can cause the degradation on the antenna performances such as isolation, ECC (Enveloped Correlation Coefficient), and efficiency. To reduce the mutual coupling, many researches have been conducted by adding resonant element [2], connecting neutralization line [3], and modifying system ground [4]. However, these researches have problems because the electrical length of wave is too large to apply to LTE applications in 700 MHz band.

In this paper, the MIMO antenna, which consists of two equal symmetrical PIFAs (Planar Inverted-F Antennas), is proposed for the LTE USB dongle applications in the LTE class 13 band (746~787 MHz). The proposed antenna structure can reduce the mutual coupling without additional structures by using the polarization diversity and the near field coupling between the antenna and the ground plane.

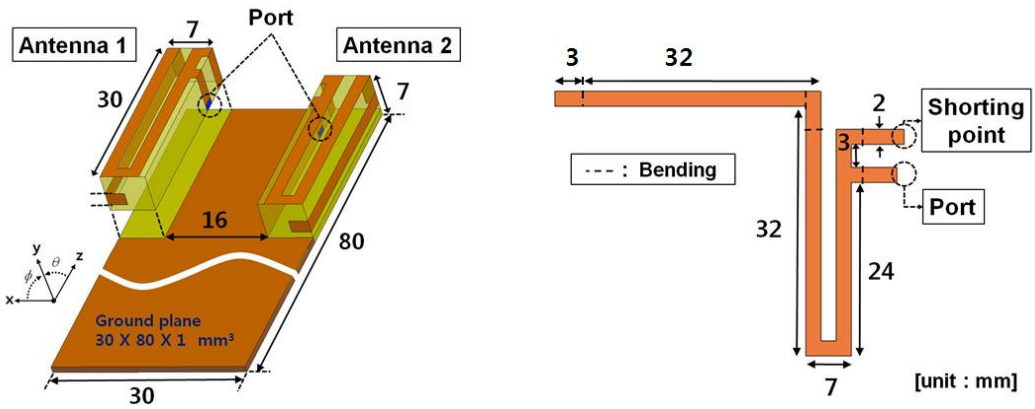
2. Structure and Results

The structure of the proposed MIMO antenna for LTE700 USB dongle applications is shown in Fig. 1. The proposed MIMO antenna consists of the two symmetrical PIFAs and the ground plane. The overall dimension of the proposed PIFA is 7×30×7 mm^3, and the ground plane size is 30×80×1 mm^3. Two PIFAs are printed on FR4 substrate (dielectric constant=4.4). This antenna structure is designed and analyzed using the SEMCAD X 3D EM field simulation tool [5]. The feeding ports and shorting points of the PIFAs are located on the top edge of the ground plane, and the maximum electric field points of the PIFAs are located on the side edges. Fig. 3 presents the measured s-parameters and the efficiency of the fabricated antenna shown in Fig. 2. The impedance bandwidth (VSWR<3) covers the entire LTE class 13 band (746~787 MHz), and the efficiency is higher than 40% in the operating frequency band. Although the distance between the two PIFAs is

only 16 mm (0.04 λ_0), the isolation between two antennas is higher than 10 dB (see Fig. 3(a)) because the polarization of electric field generated by each antenna is orthogonal each other (see Fig 4(a)). In addition to this polarization diversity, the near field coupling between the antenna and the ground plane, especially in the region of the electric field maximum point causes to reduce the mutual coupling between PIFAs because the amount of the mutual coupling from the PIFAs, that is the electric field source antenna, can be controlled by the electric coupling in the near field region [6]. Table 1 presents the calculated ECC values based on the electric field patterns in the far field region [7]. The ECC values of the proposed MIMO antenna satisfy is less than 0.5, which can be calculated from the statistical model of the incident waves in the mobile communication environments [8].

3. Conclusion

In this paper, the USB dongle MIMO antenna for the LTE700 applications is proposed. The proposed antenna consists of two adjacent PIFAs so that it gives higher isolation and lower ECC in the limited space of USB dongle without additional structures through the polarization diversity and the coupling between the PIFAs and the ground plane.



(a) (b)

Figure 1: Geometry of the proposed MIMO antenna; (a) overall view, (b) detailed view of antenna pattern.

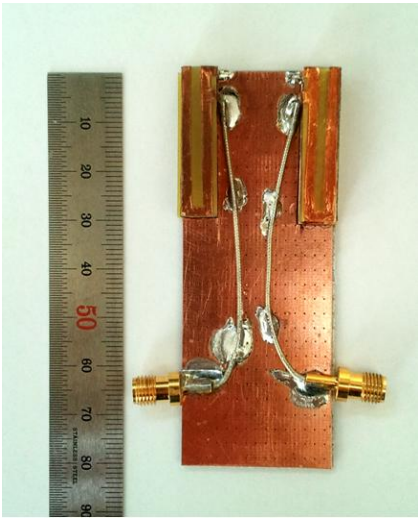
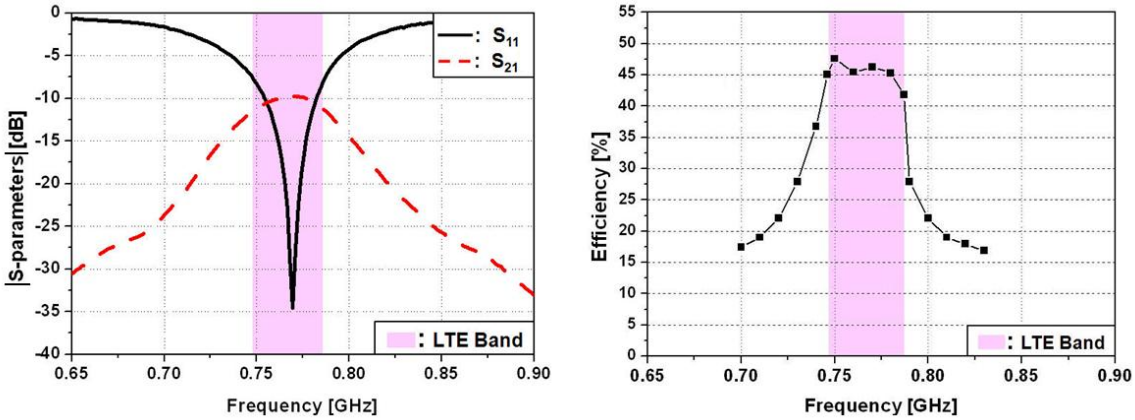
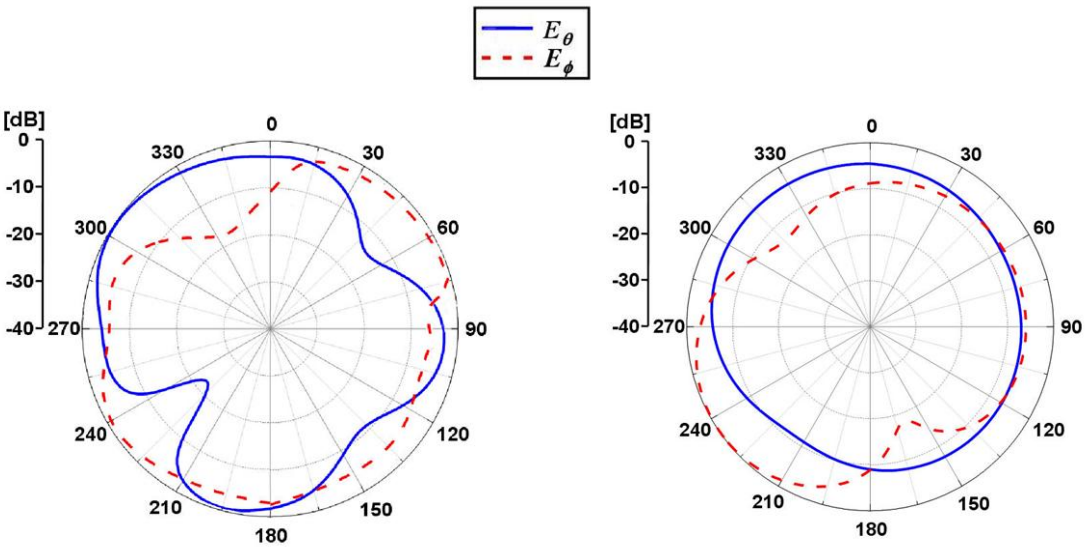


Figure 2: Photograph of fabricated MIMO antenna.



(a) (b)

Figure 3: Measured results of the proposed antenna; (a) S-parameters, (b) efficiency.



(a) (b)

Figure 4: Measured radiation patterns of the proposed MIMO antenna at 766 MHz (fed by port 1); (a) z-x plane, (b) x-y plane.

Table 1: Measured ECC of proposed MIMO antenna.

Frequency [GHz]	Incident Wave Distribution Model(Elevation/Azimuth)		
	Uniform/Uniform	Gaussian/Uniform	Gaussian/Gaussian
	ECC(XPR=0 dB)	ECC(XPR=6 dB)	ECC(XPR=6 dB)
0.746	0.47	0.19	0.38
0.756	0.39	0.10	0.33
0.777	0.43	0.07	0.40
0.787	0.44	0.07	0.43

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Acknowledgments

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