A Compact Planar Multi-band Antenna with Coupling Feed for LTE/GSM/UMTS Operations

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***Abstract* – This paper proposes a multi-band antenna for LTE/GSM/UMTS band operation. The proposed antenna consists of folded monopole at the top plane and L-shaped line with coupling plate at bottom plane. The antenna provides a wide bandwidth to cover the hepta-band LTE/GSM/UMTS operation. The simulated 6-dB return loss bandwidths are 142 MHz (818 – 960 MHz) at the low frequency band and 1007 MHz (1700 – 2707 MHz) at the high frequency band. The overall dimension of the proposed antenna is 60 mm × 105 mm × 1.2 mm.**

***Index Terms* — wideband antenna, long-term evolution, multiband antenna, planar antenna**

I. Introduction

Recent mobile handset requires a compact internal antenna because space allocated for an antenna part is very small. Moreover, many communication systems should be integrated within a limited volume. Simultaneously, since the mobile antenna is required to cover various communication services, the antenna should have multi-band and wide-band characteristics. Many researchers have investigated various types of antenna to realize the multi-band characteristic with small size [1-3]. To overcome the size limitation, various mobile antennas were presented in these articles in [4-6]. However, the large height of the antennas could cause a significant problem for integration.

In this paper, a planar multiband antenna that operating over the hepta-band in LTE/GSM/UMTS services is proposed. The proposed antenna consists of folded monopole at the top plane and L-shaped line with coupling plate at bottom plane. The folded line operates at the high-frequency band covering GSM1800 (1710–1880 MHz), GSM1900 (1850–1990 MHz), UMTS (1920–2170 MHz), LTE2300 (2305–2400 MHz), and LTE2500 (2500–2690 MHz), and the L-shaped line covers the low-frequency band, including GSM850 (824–894 MHz) and GSM900 (880–960 MHz) [7].

II. Antenna Design and Simulation results

Fig. 1(a) shows the geometry of the proposed multi-band antenna. The antenna is designed on the FR-4 substrate (ε_r = 4.4, tanδ = 0.02) with a dimension of 60 mm × 105 mm × 1.2 mm. The ground plane at the bottom plane of the substrate is connected to feed strip line on the top plane by shorting via. Fig. 1(b) shows the detailed parameters of the proposed antenna. The antenna elements at the top plane are the folded

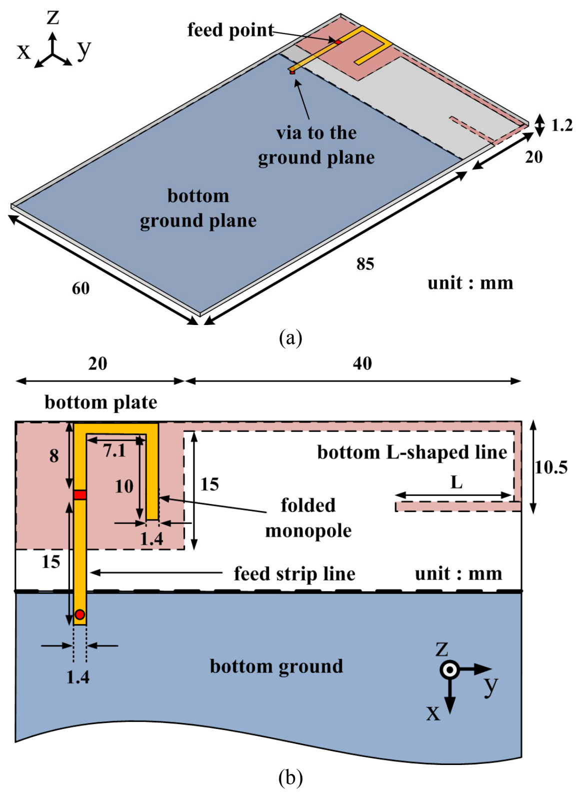

Fig. 1. Configuration of the proposed antenna: (a) perspective view, (b) detailed dimensions

monopole and feed strip line. These structures operate as coupled feed line at the low frequency band and as a radiator at the high frequency band. The radiating elements at the bottom plane consist of square plate coupled feed by folded monopole and L-shaped line for low frequency operation.

Fig. 2(a), (b) and (c) depict the simulated surface current distributions of the proposed antenna at each resonant frequency. For the low frequency resonance, bottom L-shaped line is operating and fed by coupling between bottom plate and top feed strip line. The total length of the current path is about quarter-wavelength at the low frequency band (875MHz). At the high frequency band, the current is strongly distributed in folded monopole and feed strip line as shown in Fig 2(b) and (c).

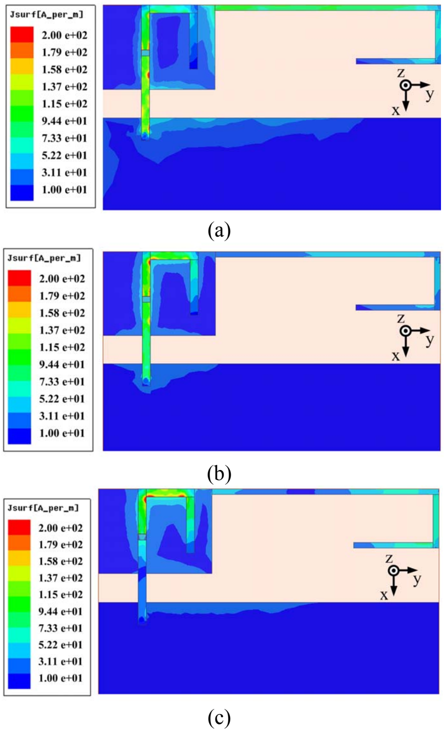

Fig. 2. Simulated surface current distributions of the proposed antenna: (a) at low band (875 MHz), (b) for the first resonance at high band (1900 MHz), (c) for the second resonance at high band (2650 MHz)

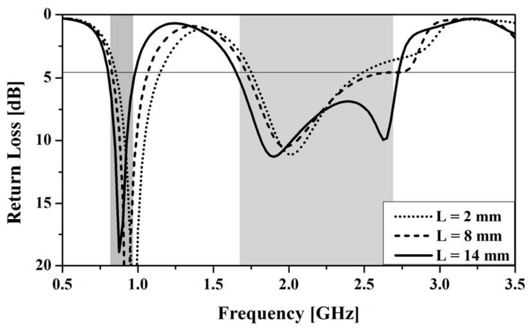

Fig. 3. Simulated return loss characteristics for various lengths of the L-shaped line.

Fig. 3 shows the simulated return loss characteristic for various lengths of the L-shaped line L. As L is increased, the total length of the bottom structures which operate at low frequency band is increased. Thus the resonant frequency in the low frequency band shifts toward the low frequency side. When L = 14 mm, simulated 6-dB return loss bandwidths are 142 MHz (818 – 960 MHz) at the low frequency band and 1007 MHz (1700 – 2707 MHz) at the high frequency band. These antenna bandwidths are wide enough to cover the desired hepta band.

Fig. 4 shows the simulated radiation patterns at each resonant frequency. At the low frequency band, bottom structures which consist of bottom plate and L-shaped line shows omnidirectional radiation pattern. Fig. 4(b) and (c) show the nearly omnidirectional radiation patterns at each resonant frequency. The simulated antenna gains are 1.72 dBi at 875 MHz, 4.27 dBi at 1900 MHz, and 3.81 dBi at 2650 MHz, respectively.

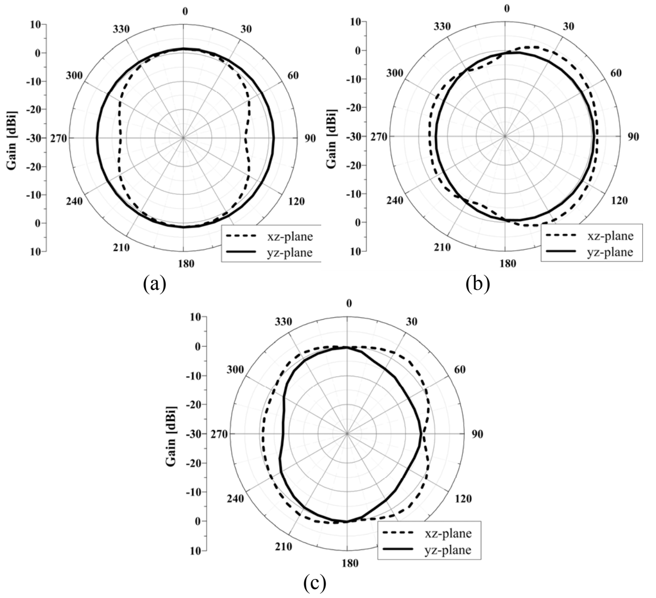

Fig. 4. Simulated radiation patterns of the proposed antenna: (a) at 875 MHz, (b) at 1900 MHz, (c) at 2650 MHz

III. CONCLUSIONS

In this paper, a compact planar multi-band antenna with coupling feed for LTE/GSM/UMTS operation is proposed. Simulated 6-dB return loss bandwidths are wide enough to cover the desired hepta LTE/GSM/UMTS band. The antenna has nearly omnidirectional radiation patterns at each resonant frequency. The proposed multi-band antenna can be a good candidate for 4G mobile applications.

ACKNOWLEDGMENT

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