Mobile handset antenna with parallel resonance feed structures for wide impedance bandwidth

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***Abstract*-In this paper, mobile handset antenna with a novel feed structure is proposed. The feed structure composed of two resonators significantly enhances the impedance bandwidth of reference PIFA. The measured impedance bandwidth of the proposed antenna is 245 MHz in the lower band and 475 MHz in the upper band, covering LTE13, GSM850/900, DCS1800, PCS1900, and WCDMA under a VSWR of 3:1 with good realized efficiency.**

I. INTRODUCTION

Mobile handsets currently on the market require both wide bandwidth capability and high realized efficiency because of their rapidly increasing data usage and high data transfer rates. Recently, Long-term Evolution (LTE) services have been provided by wireless communication service providers. The mobile handsets are being constantly miniaturized due to consumer preference while supporting multi and wideband operation like a versatile electric device. The dimension for antenna design is getting limited as the mobile handsets are being more compact. Unfortunately, expansion of the impedance bandwidth of electrically small antennas is very difficult because the most of radiation performance of the mobile antenna are closely related to its physical volume [1]. Thus, it is impossible for antenna engineers to avoid serious challenges for designing a wide impedance bandwidth antenna with good radiation performance within limited dimension.

In order to expand an impedance bandwidth, [2, 3] modified feed structures of conventional planar inverted-F antennas (PIFAs) with lumped elements to form loop-type parallel resonators seen by the source.

We propose the method to obtain multi and wideband operation. The proposed antenna fully covers LTE 13 (745-787 MHz), GSM850 (824-894 MHz), GSM900 (880-960 MHz) and DCS1800/ PCS1900/WCDMA(1710~2170 MHz). Details of the proposed antenna design and operating mechanism will be presented. The proposed antenna was designed and analyzed using commercial HFSS v13 software.

II. ANTENNA DESIGN AND SIMULATED RESULT

The geometry of the proposed antenna is shown in Fig. 1. The proposed antenna is based on a simple quarter wavelength (λ /4) PIFA. The proposed antenna consists of a feed structure, an antenna element and a ground plane. The only difference between the proposed antenna and the reference PIFA is to insert two shunt capacitors (C_L and C_H) in the feed structure. The size of the ground plane etched on a PCB (FR4 substrate, $\varepsilon_r = 4.4$, $\tan\delta = 0.02$) with 1mm thickness is 60×110 mm^2. The dimension assigned for designing the proposed antenna is $60 \times 10 \times 5$ mm^3. Fig. 2 shows that fundamental and high-order mode of the reference PIFA operate at 770 and 1820 MHz, respectively. In general, PIFAs suffer from narrow impedance bandwidth characteristics because an impedance of the loop formed of the shorting and feed line, operating as a loop-type inductor, is very high. In order to enhance the impedance bandwidth of the reference PIFA, two branch capacitors were inserted to form two resonators operating at different frequencies as shown in Fig. 1. The lower resonant frequency of the resonator composed of C_L and shorting line is decided by loop-size and the component value. When C_L is 6.6 pF, the impedance bandwidth in the lower band is significantly expanded as shown in Fig. 2 because the impedance of the feed structure is decreased by C_L. In a similar way, the resonator composed of C_L and C_H, which is operating at frequencies above 1.5 GHz is resonated by loop-size and the component values. When C_H is 1.1 pF, the impedance bandwidth in the higher band is significantly expanded as shown in Fig. 2. Compared with the reference PIFA, the proposed antenna's impedance bandwidth is enhanced approximately 3.5 times in the lower frequency bands and 5.9 times in the higher frequency bands with criteria of voltage standing wave ratio (VSWR) = 3. That is, the proposed antenna can obtain a wider bandwidth characteristic than reference PIFA by using the parallel resonance in feed structure.

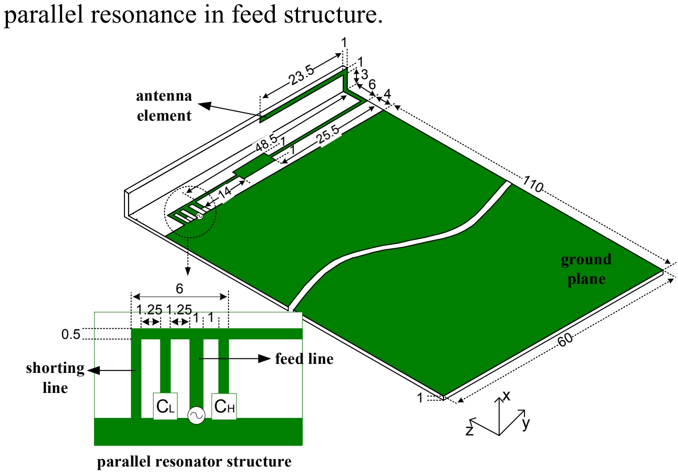

Figure 1. Geometry of proposed antenna.

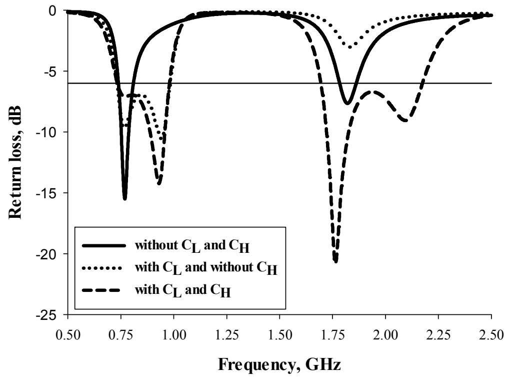

Figure 2. Simulated return loss characteristics with and without C_L and C_H

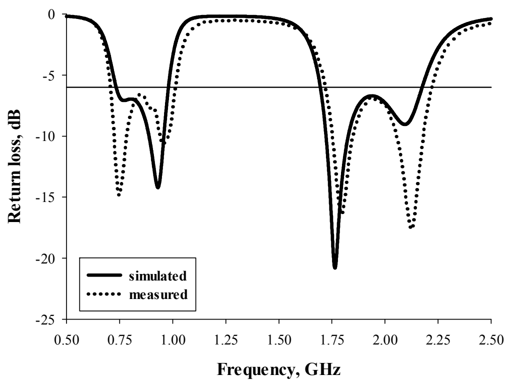

Figure 3. Simulated and measured return loss

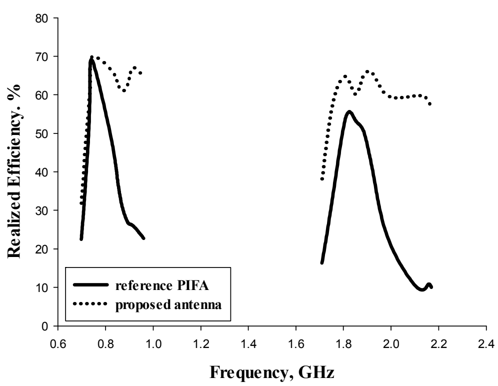

Figure 4. Efficiency of conventional PIFA and proposed antenna

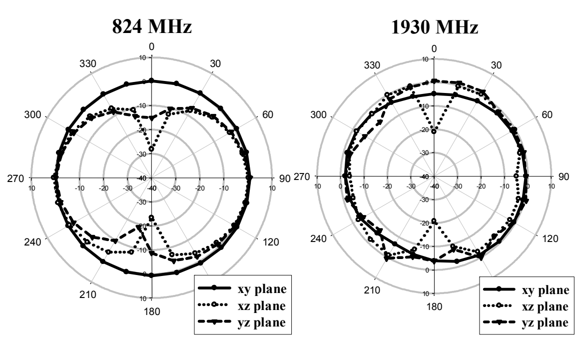

Figure 5. Measured radiation patterns at 824 and 1930 MHz

III. Experimental Result and Discussion

The simulated and measured return loss characteristics are shown in Fig. 3. The impedance bandwidth with VSWR = 3 are 245MHz (735-980MHz) for the lower band and 475MHz (1700-2175MHz) for the higher band. It is obvious that the proposed antenna can cover all of the desired bands, which are LTE 13, GSM850/900, DCS1800, PCS1900, and WCDMA. In Fig. 4, the measured realized efficiency of the proposed antenna is shown. The average realized efficiency of the proposed antenna is 62.85% in lower band and 57.14% in higher band while the reference PIFA's average realized efficiency is much less in all bands because of its narrow impedance bandwidth characteristic. The measured total radiation patterns at 824 MHz and 1930 MHz are shown in Fig. 5. These are the total electric field of the theta and phi components on the xy, xz, and yx plane. The measured radiation patterns in desired bands are omni-directional like monopole antennas, which is good for practical application.

IV. Conclusion

The proposed antenna significantly enhances an impedance bandwidth in the lower and high band by inserting parallel resonance circuit in the feed structure. In addition, the proposed antenna can be easily fabricated because it used only one antenna element without any branch line and parasitic element for wideband operation. Since resonance frequencies of two loop-type resonators can be individually controlled, we easily carry out the enhancement of bandwidth in desired bands. The measured impedance bandwidth with VSWR = 3 are 245MHz (735-980MHz) for the low band and 475MHz (1700-2175MHz) for the high band. The proposed antenna for mobile handsets is competitive for practical applications because of sufficient wide impedance bandwidth, simple antenna pattern and good radiation performance, which covers LTE 13, GSM850/900, DCS1800, PCS1900, and WCDMA applications.

Acknowledgment

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