AN OCTA-BAND MONOPOLE ANTENNA FOR LTE/WLAN MOBILE PHONES

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Abstract:-In this letter, a compact multi resonant octa-band antenna for 5.7 in mobile phone with the size of 80mm×6mm×5.8mm is proposed and studied. The proposed antenna consists of coupled line, ground branch and monopole branch. The 0.25-, 0.5- and 0.75-wavelength modes are used in order to cover the lower band (704-960 MHz) and the higher band(1710-2690 MHz). The attractive merits of the proposed antenna are that the height of the non-ground portion is only 6mm and no other lumped elements are used. A prototype of the proposed antenna is simulated and measured. Its simulated -6db bandwidths are 341.5MHz(0.673-1.014 GHz) and 1.292GHz(1.6074-2.9 GHz) at lower and higher bands respectively, which covers LTE700, GSM850, GSM900, GSM1800, GSM1900, UMTS, LTE2300 and LTE2500 bands. Within the two frequency bands, good radiation performances are obtained.

Index terms:-**Non-ground portion, coupled line, ground branch, monopole antenna, monopole branch.**

I. INTRODUCTION

With the rapid development of mobile communications, many more kinds of communication standards are proposed. Many frequency bands such as the LTE700 (704-787 MHz), GSM850 (824-894MHz), GSM900 (880-960MHz), GSM1800 (1710-1880MHz), GSM1900 (1850-1990MHz), UMTS (1920-2170MHz), LTE2300 (2300-2400MHz), LTE2500 (2500-2690MHz) , and LTE 3400 (3400-3800MHz) bands should be covered by the mobile phone antennas to make people communicate in this word. A narrow frame is a common requirement, thus giving the availability of very small space to set antennas in mobile phones. Therefore, it is a big challenge to design multi-band/wideband antenna with limited size for mobile phones.

Many more kinds of antennas are developed for latest smart mobile phones, like monopole antennas[3]-[10], the slot ones and the loop ones[11]-[16]with using multiple branches, a common method to make the antennas cover as many frequency bands as possible. There are many other methods proposed, such as the coupled feeding [4]-[7], [11], [12], lumped-elements [3], [4], [7], [9],[11],[12]and other reconfigurable ways[9], [14]. To make the antenna compact, the non-ground portion height is kept small for mobile phones.. The antenna in [3] is an octa-band antenna which can cover 8 frequency bands with an 8mm non ground portion height. The antenna in [11] can cover the nona band with 7mm non- ground portion height. The octa band/nona band antennas non ground portion heights are not less than 7mm in open literature to our best knowledge. And also, many of the antennas mentioned above with a small non-ground portion height had done using lumped elements in the design.

In this communication, an octa band monopole antenna with size of 80mm×6mm×5.8mm for LTE/WLAN mobile handset applications is proposed. The antennas in [3] and [11] have a small non ground portion height and lumped elements are used. And the antennas in [5], [6] and[8] did not used any lumped sources, but the non-ground portions are not less than 10mm. the attractive merits of the proposed antenna are that the height of non-ground portion is only 6mm and no lumped element is used.

The rest of the part of this communication is structured as follows. In section II, the geometry of the proposed antenna with detailed dimensions are described. In section III, the working mechanism is analyzed based on the functions of the multiple branches and the surface current distributions of the proposed antenna. Section IV presents the simulated results to validate the proposed antenna. Finally conclusion is drawn in section V.

II.ANTENNA STRUCTURE

The geometry and the detailed structure of the proposed octa-band monopole antenna for LTE/WLAN mobile phones are depicted in the Fig.1.The detailed dimension are shown in Fig.1 (b). The proposed antenna consists of a coupled line, a ground branch and a monopole branch. The coupled line in the Fig.1 is a slim line with L-Shaped strip of length L1=44mm with width, d1=0.5mm and a rectangular strip at the right of the length 10mm with width d3=3mm. The ground branch is composed of a distributed inductance and folded copper plate which is folded at DE along x-axis direction and then folded to the z-axis direction. The detailed dimensions are shown in Fig.1 (b). The left of the proposed antenna is a monopole branch. it is composed of U-Shaped

strip and upright L-Shaped strip that is folded at GH along the z-axis direction. The length and width of the bottom plane of the proposed antenna are 134mm and 80mm respectively, so that the size of the antenna is better suitable to fit into a 5.7 inches mobile phone. A printed circuit board whose substrate is FR4 epoxy and with a relative permittivity of 4.4, a loss tangent of 0.02 is used. The size of this PCB is 140mm×80mm×0.8mm. The coupled line and the U-Shaped strip is printed on the top of the PCB and the distributed inductance is printed at the bottom of the PCB. Finally, a 50-Ω microstrip feeding line of width 1.5mm is printed on the top layer of the PCB.

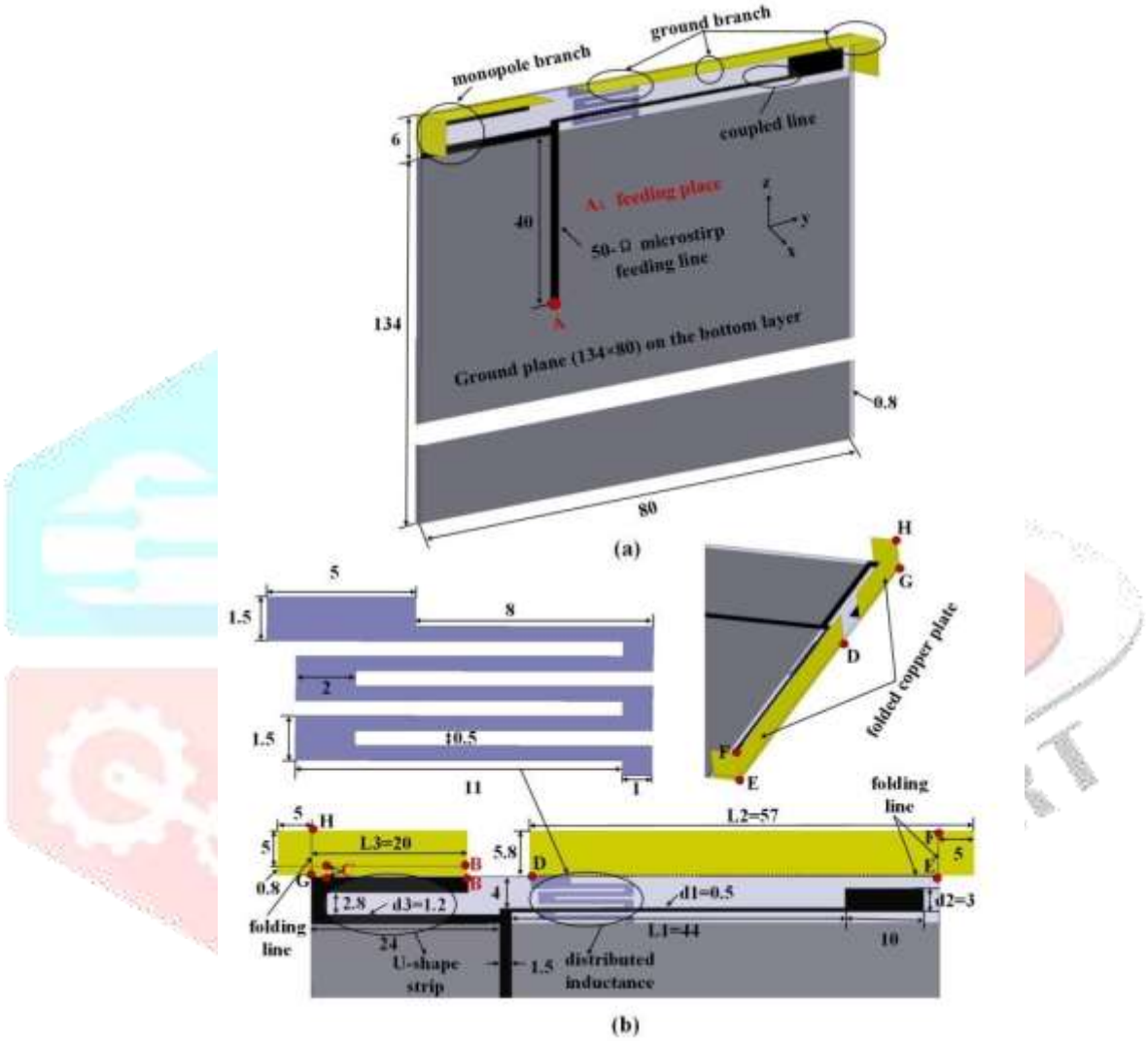


Fig.1 geometry of the proposed antenna structure in millimeter (the back in grey, the front in black, the folded copper plate in yellow) (a) prospective view. (b) detailed unfold structure of the antenna.

III-ANALYSIS OF PROPOSED ANTENNA

To understand the proposed antenna, the couple line, ground branch and monopole branch are analyzed. The working mechanism of the proposed antenna is analyzed by using the s-parameters and the surface current distributions. The results of the S_{11} and the surface current distributions are obtained by simulating in High Frequency Structured Simulator(HFSS) 15.0[17].

A. Analysis of couple line and branches:

To study and understand the functions of the coupled line, the ground branch and monopole branch, three cases are analyzed. They are Ant1(the coupled line), Ant2(the coupled line and ground branch) and Ant3(the monopole branch) which are shown in Fig.2. The S_{11} results of these three Ant1, Ant2and Ant3 are shown in Fig.2

From the Fig.2 Ant1 resonates at about 850MHz and 2.8 GHz with poor matching. When the ground branch is added to the Ant1, Ant2 is formed with coupled line and ground branch together. At the lower bandwidths, it Ant2 covers -6dB bandwidths and at the

higher band frequencies the Ant2 resonates around 1.8 GHz and 2.4GHz. Thus by combining the coupled line to Ant2, it covers the maximum part of the desired lower and higher bands. The Ant3 has a resonance frequency of 2.6 GHz at the higher band. When the Ant2 with coupled line and ground branch and Ant3 with monopole branch are combined, the proposed antenna is formed.

The monopole branch helps the proposed antenna to cover the higher band and also improves the matching at the lower frequency band.

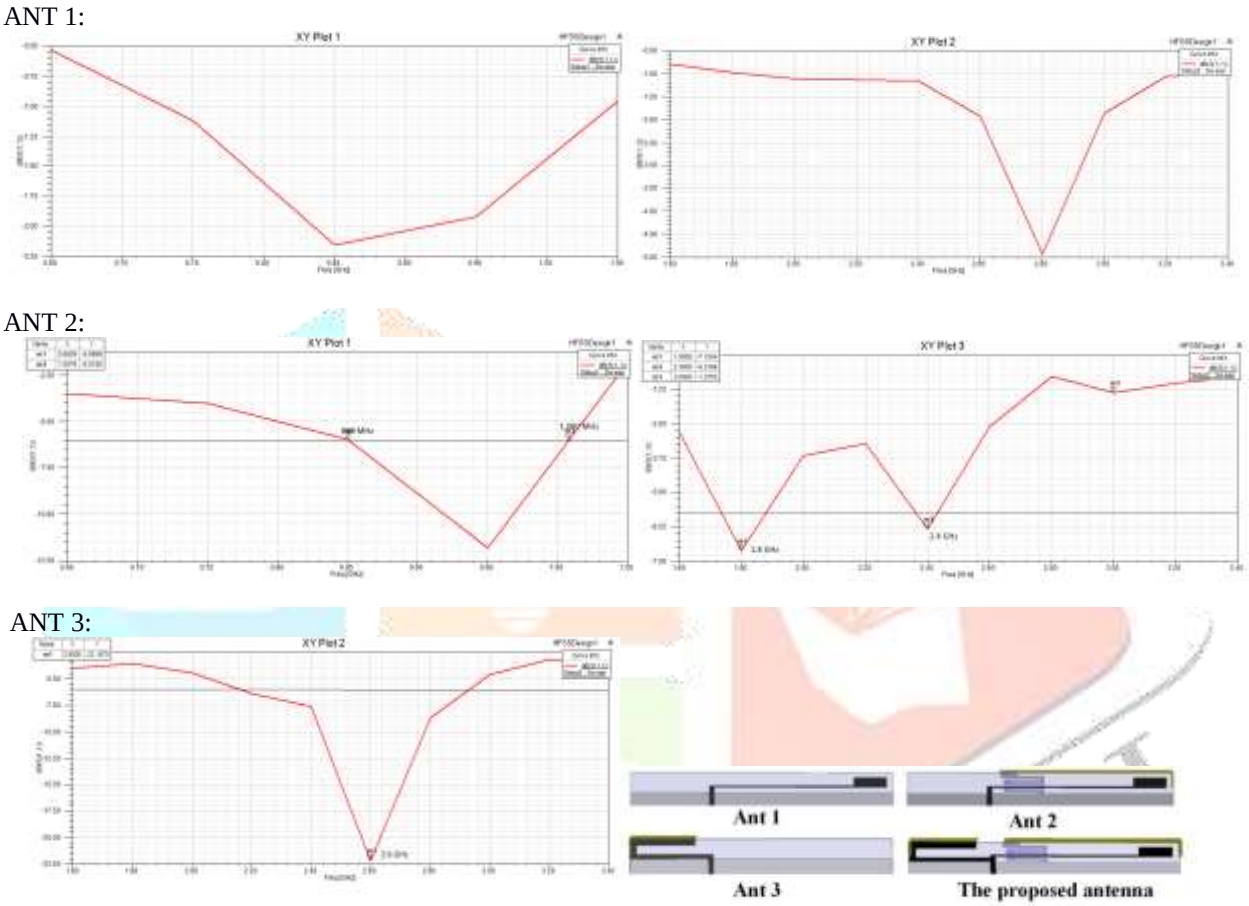
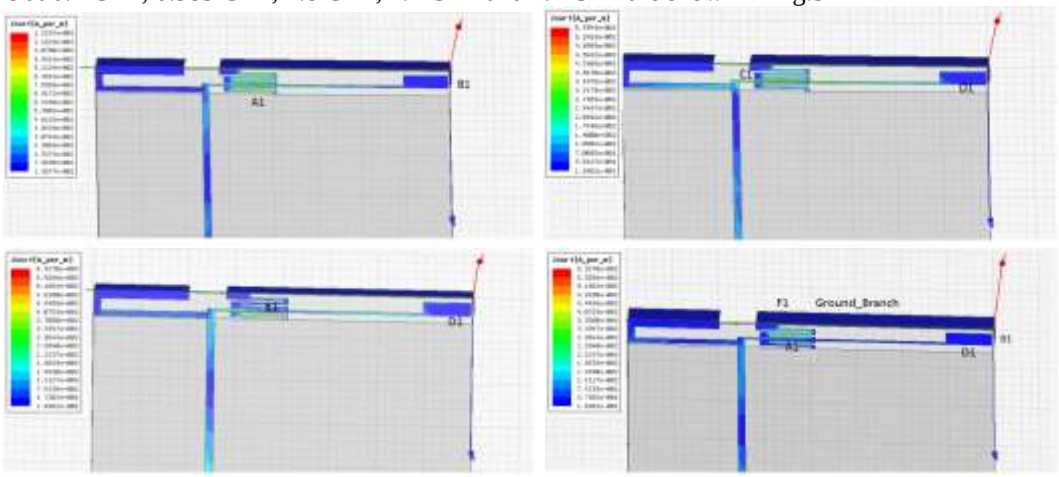


Fig.2 Simulated S11of Ant 1, Ant 2, Ant 3 and the proposed antenna

B. Surface Current Distributions:

The surface current distributions are used to study the working modes of the proposed antenna. The simulated surface current distributions at 0.7 GHz, 0.985 GHz, 1.8 GHz, 2.4 GHz and 2.7 GHz are shown in Fig.3



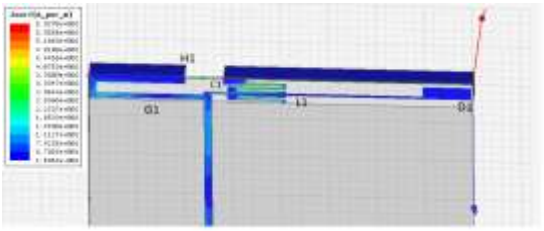


Fig.3 Simulated surface current distributions of proposed antenna (a) 0.73GHz. (b) 0.985GHz. (c) 1.8GHz. (d) 2.4GHz. (e) 2.7GHz.

IV.MEASURED RESULTS AND DISCUSSIONS

A. S-Parameters:

The simulated S_{11} of the proposed octa-band antenna are shown in Fig.4. The simulated -6dB bandwidths are 341.5MHz (0.673-1.014 GHz) at lower band and 1.292(1.607-2.9 GHz) at higher bands. These simulated S_{11} results covers the bands LTE700, GSM850, GSM900, GSM1800, GSM1900, UMTS, LTE2300, and LTE2500 for LTE/WLAN mobile handsets.

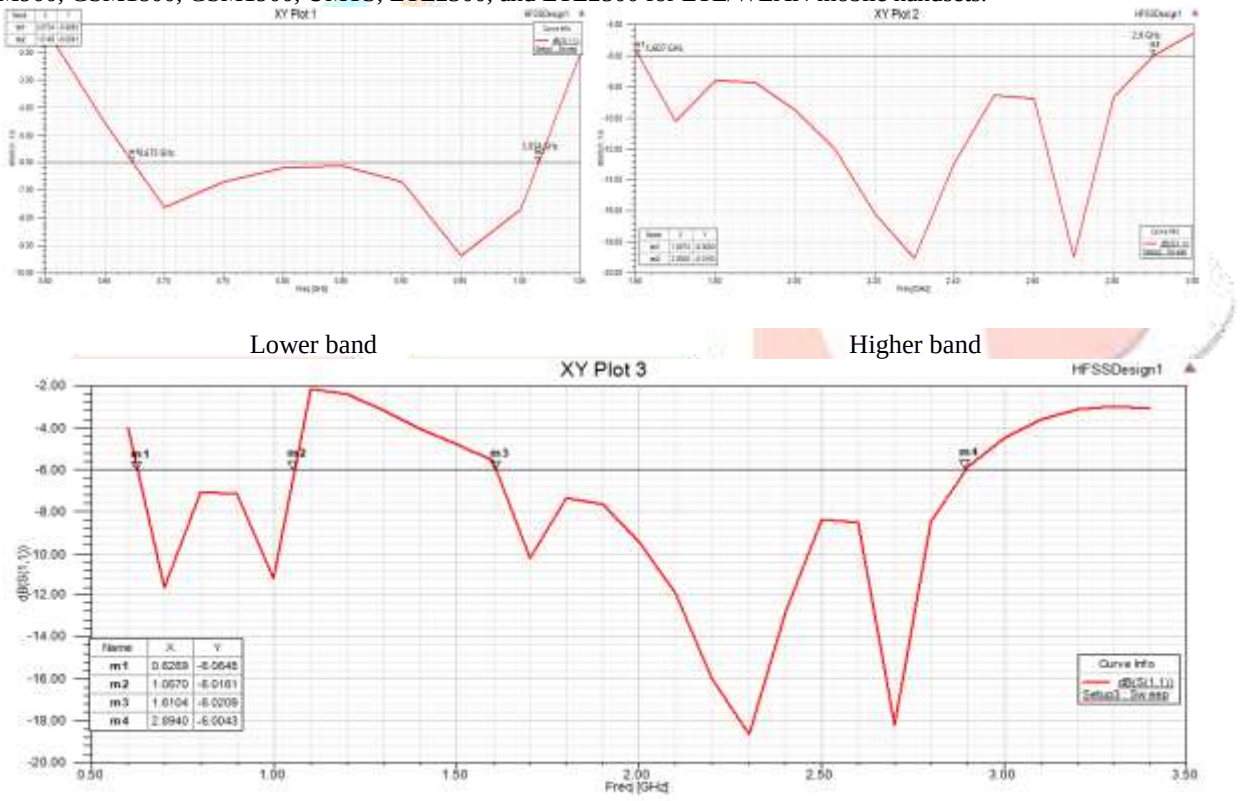
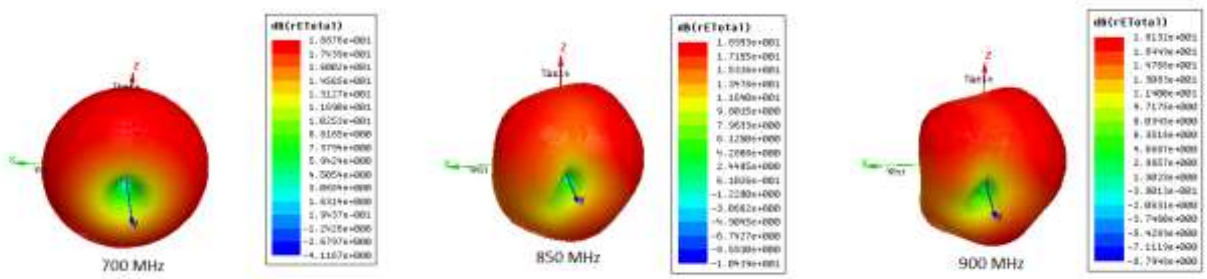


Fig.4: SimulatedS_{11} of the proposed antenna.

B. Radiation Performance:



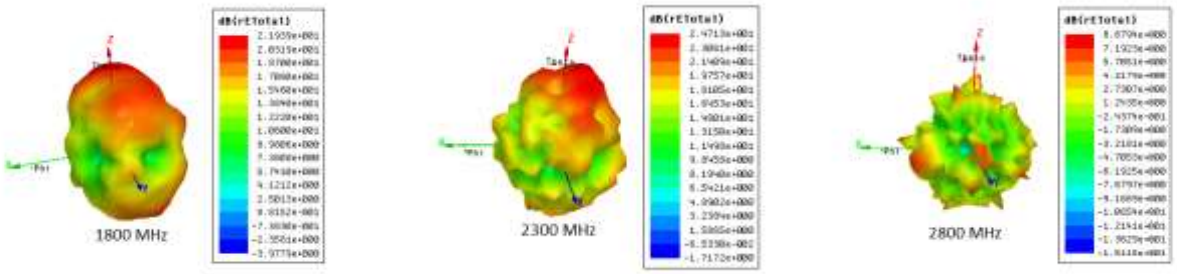


Fig.5: Simulated 3-D radiation patterns of the proposed antenna

The simulated three dimensional (3-D) radiation patterns of the proposed octa-band antenna at 700, 850, 900, 1800, 2300, 2800 MHz are shown in Fig.5. At the lower band frequency (750, 850 and 925) the dipole like radiation pattern with omnidirectional radiation are observed in XY plane. At the higher frequency (1800, 2300 and 2800MHz) there are more variations in the patterns with strong radiation in the lower hemisphere are observed.

V.CONCLUSION

This Communication presents an octa band monopole antenna with the size of 80mm×6mm×5.8mm for LTE/WLAN mobile phones. The proposed antenna made use of coupled line, ground branch and monopole branch. The attractive merits of the proposed antenna are that the non-ground portion height is only 6mm and no lumped elements are used in the design. The measured -6dB impedance bandwidths are 341.5MHz(0.673-1.014 GHz) and 1.292GHz(1.6074-2.9 GHz) at lower and higher bands respectively, which covers LTE700, GSM850, GSM900, GSM1800, GSM1900, UMTS, LTE2300 and LTE2500 bands. Within the two frequency bands, good radiation performances are obtained**.**

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