An Eight-Port Dual-Band Antenna Array for 5G Smartphone Applications

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***Abstract*—A compact MIMO dual-band (3.45 / 4.9GHz) antenna array for future 5G smartphone is presented in this paper. The array consists of two symmetric 4-antenna arrays disposed in the narrow spacing between the display panel and the long side edges and four corners of the smartphone. The simulated result shows that the presented antenna has dual-band at 3.3-3.6 GHz and 4.8-5.0 GHz, which has a bandwidth of 300 MHz and 200 MHz respectively for reflection coefficient less than -6dB, and an acceptable isolation (better than -13.75 dB) are obtained. Envelope correlation coefficient are calculated to evaluate the MIMO performances of the proposed antenna array.**

Keywords—smartphone antenna; formatting; dual band multi-input multi-output(MIMO).

I. INTRODUCTION

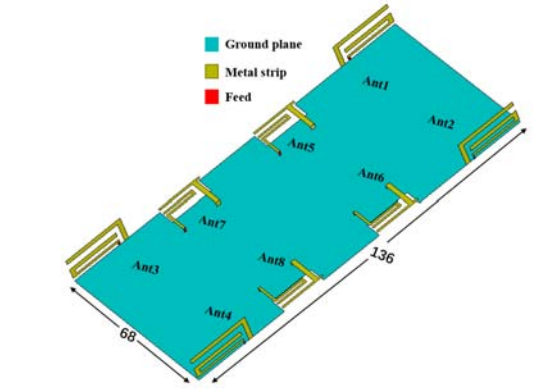
In recent years, wireless communications have grown explosively, they must support the rising demand for high rates due to the rapid increase in devices [1]. In order to achieve high data rate, the next-generation communication (5G) is now drawing even more attention and being studied a lot. In addition to multi-input multi-output (MIMO) antennas will be introduced in mobile devices for high rates, two or more antennas with high isolation and low envelope correlation coefficient (ECC) are required and should be placed in a limited space[2]. To decrease the mutual coupling between two closely placed antennas, many different techniques have been proposed and neutral line technique is a very common way to increase isolation [3]. Considering the increasing numbers of operating bands and the limited space of mobile terminals, the most significant challenge is realizing MIMO capability within the compact volume of a mobile phone [4-5]. Therefore, loading multiple antennas into a smartphone for 5G communication is presently a challenging topic for antenna engineers.

In this paper, a novel 8-port dual-band massive MIMO antenna array that can cover both the 3.3-3.6 GHz and 4.8-5.0 GHz for future 5G mobile handsets is proposed. The antenna structure is very simple and easy to fabricate, can be placed at the corners of a 5G mobile handset. By using the symmetry, the implementation of pattern diversity is demonstrated to be very effective in reducing the mutual coupling between antenna elements, and good isolations of more than -13.75 dB have been achieved without introducing additional decoupling structures. The envelope correlation coefficients (ECCs) have been obtained from the radiation patterns and good results have been obtained.

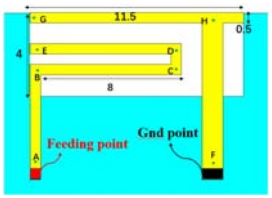
II. ANTENNA DESIGN

A. Antenna element design

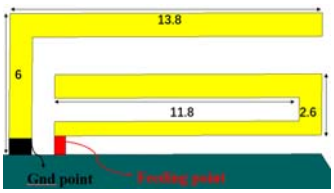
Fig. 1 shows the detailed structure of the proposed 8-element dual-band antenna array for sub-6GHz smartphone applications. Here, eight antenna elements are integrated into the PCB of the handset, and amid these antenna elements, two different way of placement of antenna. The Ant-1,2,3,4 are printed on a FR4-Epoxy substrate and placed horizontally on both sides of the smartphone. The relative permittivity ε_r of the dielectric is 4.4 and it has a thickness of 0.8 *mm* with length of 136 mm and width of 38 mm. The radiation structure is fed by a transmission line designed to achieve 50 Ω characteristic impendence. The Ant-1,2,3,4 are located on the edges of the substrate and placed vertically at the corners symmetrically. Four rectangular clearance regions of 11.5 × 4 *mm* are reserved for accommodating the proposed Ant-5,6,7,8.



(a) Overall view



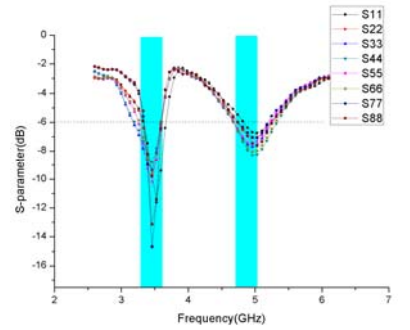
(b)Ant-5



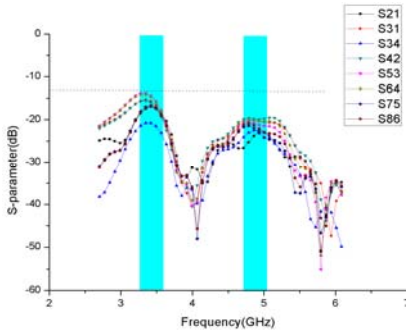
(c)Ant-1

Fig.1.Gemetry and the detailed of the 8-array antenna

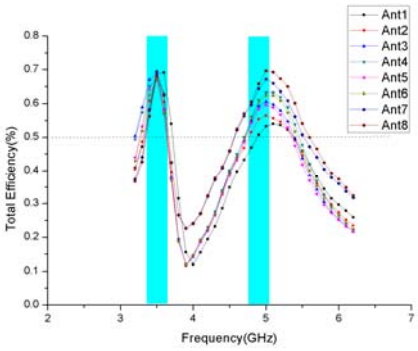
Fig.1(b) and (c) show the detailed geometry two antenna elements, which is a coupling dual-band monopole antenna, fed at point A. The antenna element is mainly composed of two branch, branch 1 (with path ABCDE) is the monopole arm that is folded to make sure the antenna can resonate at around 3.45 GHz, branch 2 is the short strip (with path FHG) that generates its high-order mode at approximately 4.9 GHz, which coupling with the monopole arm to improve the impedance of dual band.



(a)



(b)



(c)

Fig. 2.Simulation S-parameters and efficiency.(a) Reflection coefficients of (b) Isolations.(c)Total efficiency of antenna array

B. Antenna array design

Fig.2(a) and (b) shows the simulated reflection coefficients of antenna array, and their corresponding isolations. Fig.2(a) shows the reflection coefficients of all 5G antenna, it have shown good impedance matching of less than 6 dB between 3.3-3.6 GHz and 4.8-5.0 GHz. Fig.3(b) show their corresponding isolations, and good isolation of less than 13.75 dB are also exhibited between any two antennas. Fig.2(c) show the Total efficiency for all antenna, and it are approximately 45%–70% in dual band, the efficiencies of these antennas can still meet the requirement. As a result, the efficiencies of these 5G antennas can meet the requirement for smartphone applications results. The calculated ECC is presented in Fig.4. Typical ECC results between every two antennas are presented. The ECC values are all less than 0.1 in the 3.45 GHz and the 4.9 GHz which is good for the MIMO operation

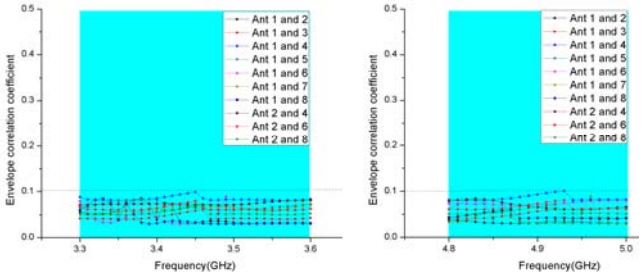


Fig. 4. Calculated ECC of the eight-antenna array.

CONCLUSION

An eight-port dual-band antenna array for future possible 5G is proposed, and it can be applied in an 8 × 8 MIMO system. The symmetric structure has been designed and simulated for Mobile Handset application operating for 5G Band. The -6 dB bandwidths cover 3.3-3.6 GHz and 4.8-5.0 GHz , respectively. The simulated minimum isolation between ports is 13.75 dB in operating bands. A good ECC of less than 0.1 between any two antenna elements indicate that the proposed array has good MIMO performances. Due to good performances and simple structures, the proposed eight-antenna array is a promising candidate for future 5G smartphone application.

ACKNOWLEDGEMENT

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