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Design of Compact Dual-band MIMO Antenna for 5G Smartphone Application

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ABSTRACT: Dual-band MIMO antenna for the 5G Smartphone communication Application is proposed in this paper. The proposed antenna consists of four antennas, it is operating at 3300-3600 MHz and 4800-5000 MHz. The antenna designed in this paper is perpendicular to the edge of the system circuit board, it can be applied to the popular full-screen mobile phone. According to the simulation results, reflection coefficient of the modulus is less than -6 dB, and the isolation is better than 12 dB over the band- frequency of 3300-3600 MHz and 4800-5000 MHz, it will meet the needs of future 5G applications.

KEYWORDS: Antennas, smartphone, 5G operation, MIMO, isolation.

I.INTRODUCTION

The advent of 5G technologies and ICT networks pave the way for digital society. Right now, all over the world, mobile access to the Internet is becoming entirely fundamental to doing business in all industries. Flexible working practices facilitated by mobile networks and devices are already essential and are allowing enterprises to conduct operations across boundaries that previously inhibited growth.

Growing mobile access to the Internet, cloud-based services, and big data analytics are allowing anyone, anywhere to leverage "big wisdom" – a whole new kind of globally connected & shared knowledge base. The continuing rise in the relevance of social media as an important part of how we interact with the Internet is also opening up new kinds of intelligent analytics, ready to be harnessed for tangible business & everyday-life benefits.

The current generation of mobile networks continues to transform the way people communicate and access information. Further development and implementation of technologies that enable true human-centric and machine-centric networks will come to redefine end-user mobility, along with the entire landscape of the global telco industry.

5G will herald an even greater rise in the prominence of mobile access, enabling total ICT network growth and expansion. Over time, any mobile app and any mobile service will be given the potential to connect to anything at anytime – from people and communities to physical things, processes, content, working knowledge, pertinent information, and goods of all sorts in entirely flexible, reliable and secure ways. This is the promise of 5G – to expand the possibilities of what mobile networks can do, and to extend upon what services they can deliver.

In this paper, a dual-band MIMO antenna which consist of four elements is proposed. The proposed antenna not only can operating in the dual frequency band of 3300-3600 MHz and 4800-5000 MHz. but also a 12 dB of isolation is obtained, the four antennas are disposed along two side edges of the smartphone, meet the requirements of a full screen smartphone antenna design, in line with the current trend of full-screen smartphone.

II. DESIGN METHODOLOGY

The structure and dimensions of the proposed antenna array is shown in Fig.1. As is seen, the antenna system consisting of four bent lines and floor protruding branches as smartphones. The single antenna is designed and can be operated in the bands of 3300-3600 MHz and 4800-5000 MHz. The antennas are printed on the inner and outer surfaces of the side frame of the smartphone system circuit board. In order to meet the trend of modern ultra-thin smartphones,

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the height of the edge frame of the mobile phone is only 5 mm. The antenna elements have the same structure and dimensions. The side frames are orthogonal to the system ground plane, and the area of each antenna on the side frames is 3.9 mm 17 mm.

The system circuit board is selected to have a size of 130mm74mm, which is reasonable for the 5-in smartphone. Both the side-edge frame and the system circuit board are fabricated using 0.8-mm-thick FR4 substrate of relative permittivity 4.4 and loss tangent 0.02. The radiation part of the antenna can be divided into two parts: front radiation part is a bending line monopole, feed part as shown in Fig.1 below; the back of the radiation part is a L-shaped short-circuit stub. The monopole adopts the bent line structure, and the coupling capacitance generated by the L-shaped branch behind helps to match the impedance of the low frequency band so that the low frequency can cover the frequency band of 3.5GHz better, the front feeder belt and monopole lengths resonate around 4900MHz and the coupling capacitors created by the back L- shaped branches and the front bend line contribute to high- frequency impedance matching.

Table 1. Dimensions of the proposed antenna

Parameters	L	W	L1	L2	L3	L4	L5
Unit (mm)	130	74	17.7	4.4	2.5	10	1
Parameters	W1	W2	W3	W4	W5		
Unit (mm)	1	1.9	4.2	2	3.9		

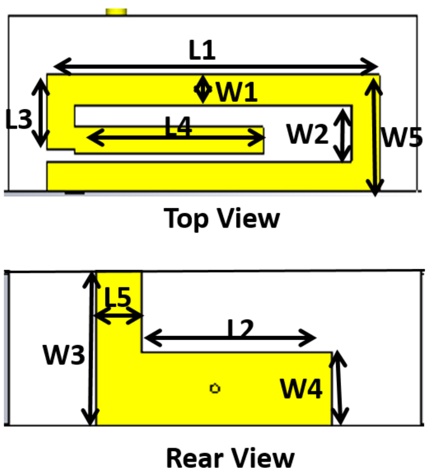

Figure 1. Radiating Element of MIMO Antenna

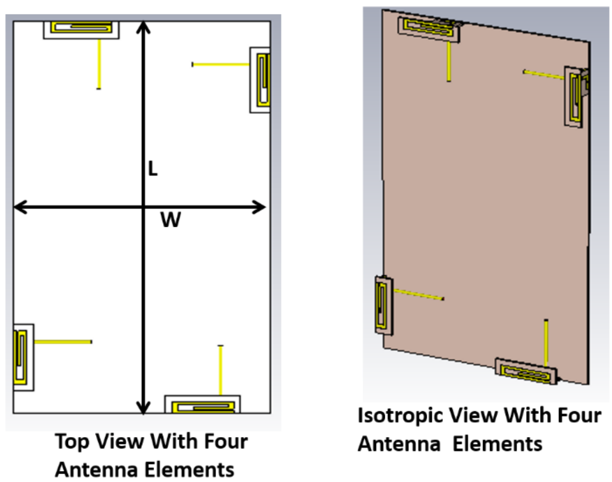

Figure 2. Proposed structure of 4 element MIMO Antenna

III.RESULTS AND DISCUSSION

The Simulated results were performed by using CST Microwave Studio 2019. Fig 3. Shows the simulated S parameters for the proposed antenna array. Fig. 3. Shows that the reflection Coefficients (S11, S22, S33, S44) of four antennas in the dual frequency bands 3.3 – 3.6 GHz and 4.5 – 5 GHz is less than -10 dB. Fig. 5. Shows the VSWR of the proposed MIMO antenna indicating that acceptable impedance matching is obtained ie.. VSWR is less than 2. Figure 2. Indicates the 3D view similar antenna elements kept a quarter wave distance for improving the isolation between the elements. Fig 3. Indicates that over the band isolation is greater than -20 dB. Which is acceptable for smart applications.

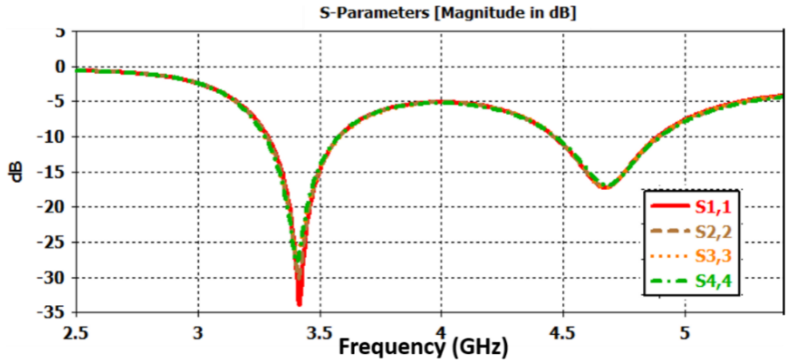

Figure 3. Reflection coefficient of 4-port Dual Band MIMO antenna

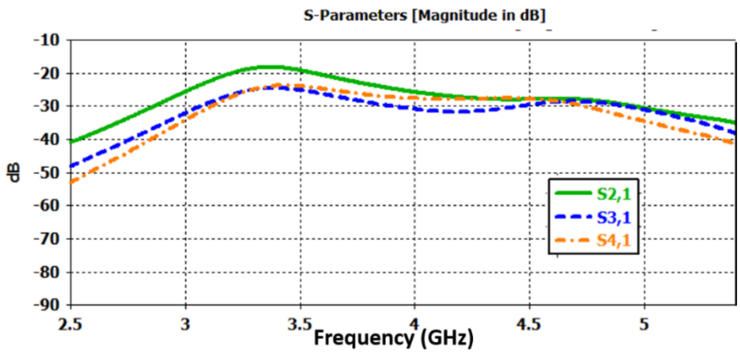

Figure 4. Isolation of 4-port Dual Port MIMO Antenna

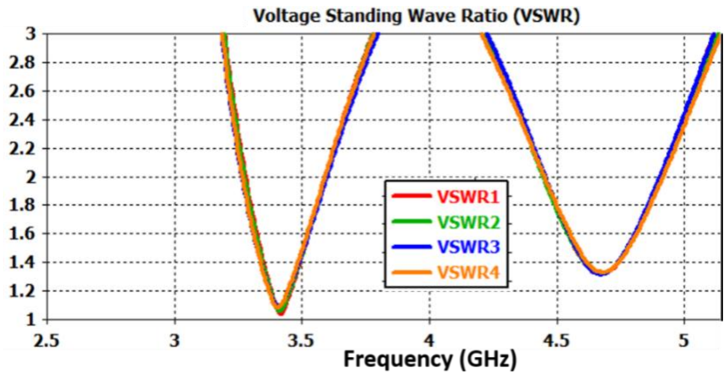

Figure 5. VSWR of the 4-port Dual Port MIMO Antenna

Figure 6 shows that 3D view of radiation patterns of 4 -port antenna which exhibit Omni directional pattern. Figure 7 and Figure 8 indicates the 2D view of the radiation pattern which shows 8-shaped pattern (Omni directional). The correlation coefficient of an envelope (ECC) is a key parameter to check the radiative criterion for the MIMO system. For the smaller ECC of MIMO antenna system diversity gain is higher. The value of ECC is lower signifies less correlation between the antenna elements, if ECC is having greater value means it shows the negative impact. The Simulated ECC value is all much less than 0.01 Shown in Figure 9. Which indicates that the it will be suitable for smart phone applications.

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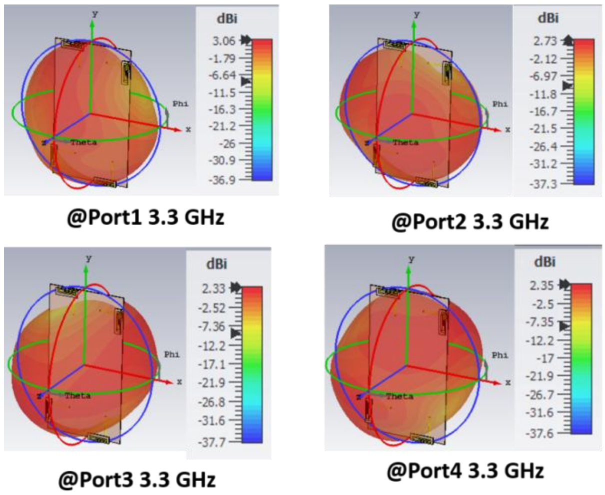

Figure 6. 3D Radiation Pattern of 4 –port dual band MIMO Antenna

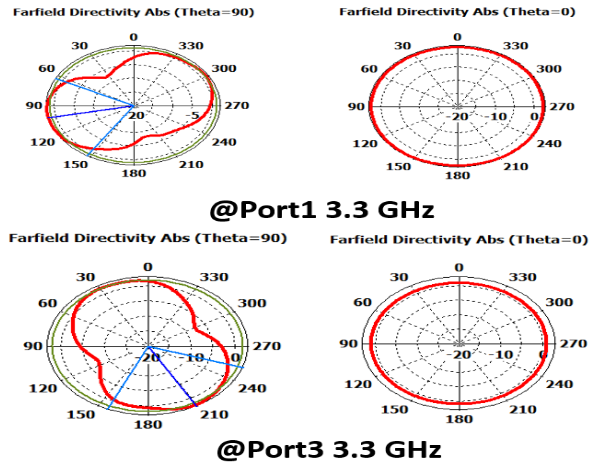

Figure 7. 2D Radiation Pattern of 4-port dual band MIMO Antenna

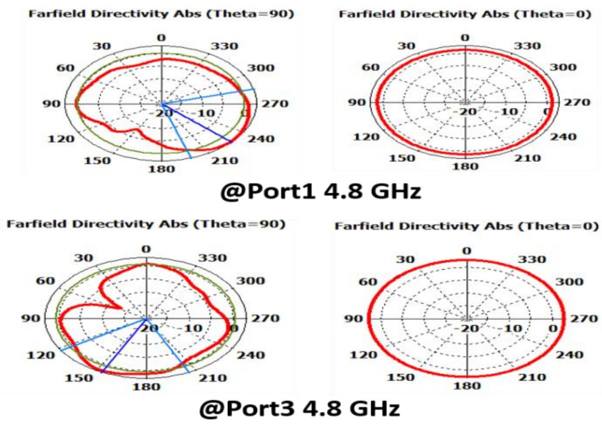

Figure 8. 2D Radiation Pattern of 4-port Dual band MIMO Antenna

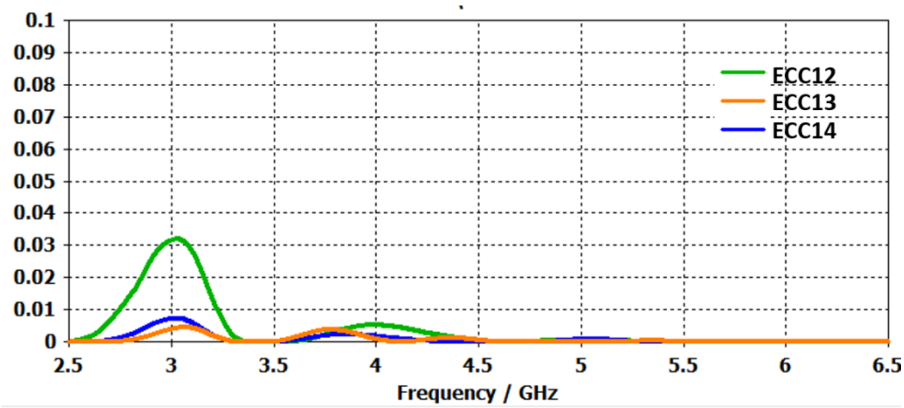

Figure 9. ECC of the 4-port Dual Band MIMO Antenna

IV.CONCLUSION

A dual-band four-antenna MIMO array for 5G smartphone applications is proposed. The proposed antenna is located in the side frame, in line with the trend of a full screen smartphone antenna design, in the premise of the reflection coefficient to meet the requirements, to achieve a relatively high isolation, the antenna size is relatively small, ideal for today's ultra-thin smartphone communications.

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