Side-Frame Dual-Band MIMO Antennas for 5G Smartphone Applications

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Abstract **─** A side-frame dual-band multi-input multi-output (MIMO) antenna system for fifth-generation (5G) mobile communication in smartphone applications is presented, operating in 3.5 GHz band (3400-3600 MHz) and 5 GHz band (4800-5000 MHz). The proposed four-element antenna array is placed at four corners of the circuit board and printed on the side edge frame. The height of the structure is only 4.1 mm, which is compatible for ultra-thin full screen smartphones. According to the verification of HFSS and CST, ideal impedance matching bandwidths (superior to 10dB) and excellent isolations (superior to 18 dB) are obtained over the 3.5 GHz band and 5 GHz band, with peak gain of 6.18 dB and 4.9 dB, respectively.

Index Terms **─** Dual band, fifth-generation (5G), multi-input multi-output (MIMO), side frame.

I. INTRODUCTION

In recent years, with the rapid development of 5G communication technology, multi-input multi-output (MIMO) antennas have become a hot topic [1-3], due to the advantages of low loss of signal, low co-channel interference and high data rate [1]. China have assigned 3.5 GHz band (3400-3600 MHz) and 5 GHz band (4800-5000 MHz) for 5G mobile phone communication. A dual-band antenna array is come up with 10 T-shaped slot elements, operating LTE 42/43/46 bands [3]. But antenna efficiencies of the system is not high. Nowadays, the side-edge frame antenna is a hot trend in current research, in order to satisfy the demand for ultra-thin and full-screen smartphones. Several side frame MIMO antennas have been proposed for 5G smartphones [4-5]. An eight-port side-edge frame printed antenna array is presented in [4], operating in 3.5 GHz band and 5 GHz band. However, the dimensions of the proposed antenna array are 15 mm × 7 mm. A MIMO antenna array printed along the long frame of the phone is presented in [5], working in the 3.5GHz band and 5GHz band. Each antenna array consists of a gap-coupled branch and a curved monopole, fed by a 50Ω microstrip line.

In this paper, a MIMO antenna operating in the 3.5 GHz band and 5 GHz band for 5G ultra-thin full screen smartphones is proposed. The proposed four-port antennas are printed on the side frame with small requirements for clearance area. And 4.1 mm high is suitable for ultra-thin smartphones. The proposed mobile phone antenna was simulated by HFSS and CST.

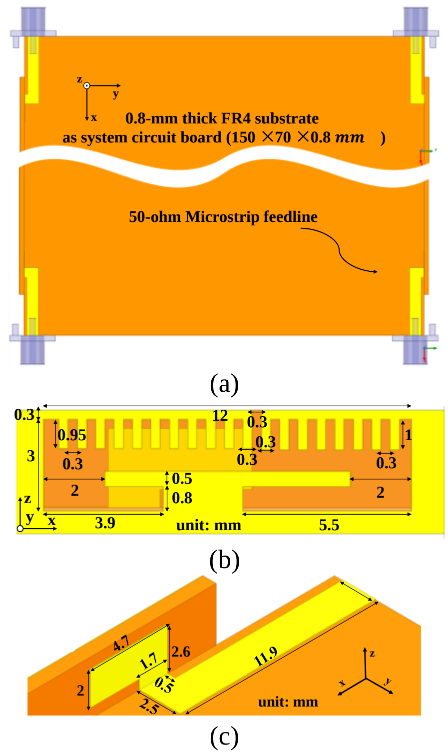

Fig. 1. Geometries and dimensions. (a) Front elevation, (b) side frame structure, and (c) feeding line.

II. ANTENNA DESIGN

The proposed MIMO antenna array is given in Fig. 1, which is composed of four similar elements. A 150 mm × 70 mm × 0.8 mm FR4 substrate (relative permittivity = 4.4, loss tangent = 0.02) is chosen for 5.5-inch smartphone system circuit board. Figure 1 (a) exhibits the main view of the proposed antenna. The details of the radiating slot and 50-ohm feeding line are indicated in Figs. 1 (b) and (c). The pectinate strips and

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the prominent T-shaped structure in the gap of the ground plane are applied to realizing antenna miniaturization and adjust impedance matching, which can be observed in Fig. 2.

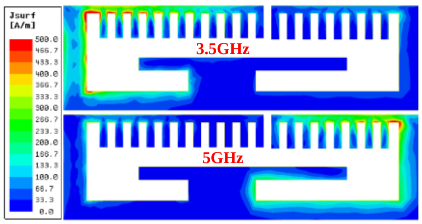

Fig. 2. Current distributions at 3.5GHz and 5GHz.

III. RESULTS AND DISCUSSIONS

Figure 3 shows the simulated S Parameters of the designed antenna by HFSS and CST (commercial software). It is obvious that ideal impedance matching bandwidths and excellent isolations (superior to 18 dB) are obtained (superior to 10 dB) over the 3.5GHz band and 5GHz band. It can be observed that the antenna gains are approximately 4.89-6.18 dB and 4.65-4.90 dB over the desired bands in Fig. 4. The antenna total efficiencies are 62 – 72% and 72 – 80% over the 3.5GHz band and 5GHz band, respectively.

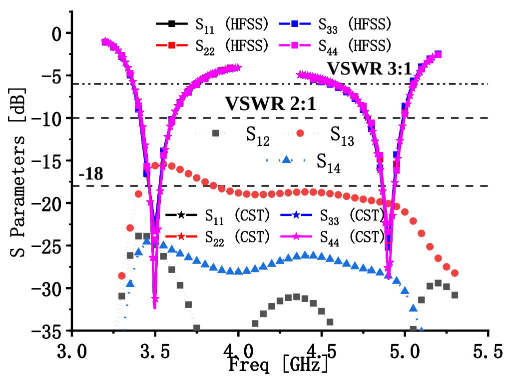

Fig. 3. Simulated S parameters by HFSS and CST.

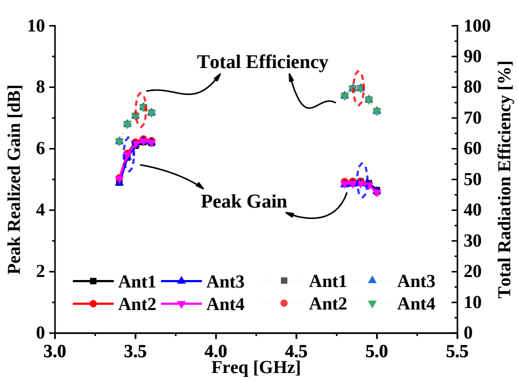

Fig. 4. Peak gains and Radiation efficiencies.

IV. CONCLUSION

Table 1 exhibits the comparison of the proposed antenna with the references. Compared to the references, it can draw a conclusion that the designed antenna performs better impedance matching bandwidth (better than 10 dB), low isolations (better than 18 dB), excellent antenna gains (superior to 4.65 dB and 4.89 dB, respectively) and good antenna efficiencies (62 – 72% and 72 –80 %). Particularly, due to printed on the side frame (4.1-mm high), the designed antenna system is an eligible candidate for 5G ultra-thin full screen smartphones.

Table 1: Contrast of the referenced and proposed antenna

Reference	**Bandwidths (GHz)**	**Isolation (dB)**	**Dimensions (mm × mm)**
3	3.4-3.8 and 5.1-5.9 (-6 dB)	>11	16.2 × 3
5	3.4-3.6 and 4.8-5.1 (-6 dB)	>11.5	15 × 7
The Proposed Antenna	3.40-3.60 and 4.80-5.0 (-10 dB)	>18	12 × 3.3

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