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Eight-Port Double Band Printed MIMO Antenna Investigated for Mutual-Coupling and SAR Effects for Sub-6 GHz 5G Mobile Applications

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Abstract—An 8-element/8-port antenna with four resonating dual-polarized slot radiator elements for sub-6 GHz 5G multiple-input multiple-output (MIMO) applications is proposed in this paper. The proposed MIMO design comprises four annular slot radiators with dual-polarized characteristic and has rectangular micro-strip line feeds. The designed elements operate in the frequency bands 2.73–3.12 GHz and 4.33–4.68 GHz providing an acceptable characteristic for dual-polarizations. The isolation improvement and reduction in mutual coupling factor are achieved by using split ring resonator (SRR) structures on the top layer along the slot radiator. The proposed design has a -10 dB wide impedance bandwidth in both bands, considerable realized peak gain around 4 dBi, and better efficiencies around 80% with ECC < 0.004 which has enhanced the performance of the MIMO array in terms of diversity. The antenna is fabricated, characterized, and it is shown that the measured results are in good agreement with the simulated ones. The proposed MIMO design has been analyzed for SAR functions and the radiation coverage in the vicinity of the user human head. The SAR values studied are found to be less than '2' which is quite desirable. All the features achieved in the proposed MIMO design suggest it to be suitable for 5G mobile terminal applications.

1. INTRODUCTION

The fifth generation (5G) technologies with incredible speeds are the emerging communication systems targeted to be deployed in 2020 [1]. It is certain that the thriving 5G indoor access microwave wireless devices and 5G wireless routers need to be employed to connect Internet of things in the near future [2]. For 5G communications, 5G antennas will become a necessity to be used along both sides of a communication link in order to achieve higher data rate transmission and short latency in comparison to already existing 4G systems [3]. In order to improve the various constraint parameters including data rates, channel capacity, reliability, etc. for 5G service in multi-path domain MIMO technology has proved to be highly productive [4]. The design of proficient MIMO antenna system requires the antennas with low profile, easy fabrication, and high isolation between antenna elements [5–7].

The international telecommunication union (ITU) has declared sub-6 GHz and mm-wave spectrum for 5G MIMO applications for mobile antenna terminals, mainly including 3.4–3.8 GHz, 3.7–4.2 GHz, 5–6 GHz, 24–28 GHz, etc. frequency bands [8]. For 5G MIMO applications, the sub-6 GHz frequency bands are proved to be more suitable and mainly include n77(3.3–4.2 GHz), n78(3.3–3.8 GHz), n79(4.4–5 GHz), 3.3–3.8 GHz, and 5.15–5.925 GHz that represent a combination of LTE 42, 43, 46 bands [9, 10]. A slot antenna with multi-band operation at 1.5 GHz, 2.75 GHz, and 3.16 GHz with around 3 dB gain and efficiency of 80% is presented in [11], and a wide-band horn antenna with ridged substrate integrated with waveguide (RSIW) structure is given in [12]. The number of techniques for reducing the coupling effects

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