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Eight-Port Wideband MIMO Antenna for Sub-6 GHz 5G Base Stations

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***Abstract*—An eight-port wide-band multiple-input multiple-output (MIMO) antenna is presented for base stations applications. The antenna is composed by four unit cells (2×2) separated by a cross-shaped isolating block with a total size of 220×220×28 mm^3 (2.42λ×2.42λ×0.3λ, at central frequency f=f$_c$=3.3 GHz). The unit cell is defined by a square cavity-backed antenna fed with two I-shaped crossed dipoles. The antenna provides 8 independent ports with 21.5 dB of minimum isolation and an impedance bandwidth (S$_{11}$ < -10 dB) of 97% ranging at 1.8-5 GHz. Results show an efficiency higher than 87%, unidirectional radiation patterns and low envelope correlation coefficient. The geometry of the antenna is suitable for scaling this design to a massive MIMO system with the replication of the proposed antenna.**

I. Introduction

The 5th generation of wireless communication systems (5G) is currently being deployed to provide higher data rates to the growing number of connections [1]. The early deployment of the 5G has been settled in the so-called sub-6 GHz bands due to their rapid installation due to the retro-compatibility with the previous communication systems which are working in contiguous bands.

Multiple antenna solutions are being proposed to be installed in 5G base stations. One of the most common solution is the use of dual polarization antennas. The main advantage of this solution is the isolation between ports provided by orthogonal polarizations. Dual-polarized base station antennas are divided in wideband solutions and multiple-band (multi-resonant) solutions. Some features which are also appreciated are in a base station antenna are, unidirectional radiation pattern, multiple independent ports, high efficiency and if possible low-profile and low-cost. A feature which is getting more attention is the compatibility with the massive MIMO technology which will provide higher capacities.

Regarding multiple-band solutions, a crossed-dipoles design is presented in [2], an antenna with filtering structures is studied in [3] and in [4] a solution with a frequency-selective surface is proposed.

Wideband solution are commonly used due to their versatility in the current scenario where some bands are still in process to be licensed and also due to their world-wide compatibility. In [5] a solution with a pair of opened-loop dipoles is presented for 1.8-4 GHz band, a design with four diferentially fed monopoles is proposed in [6] covering the 1.66-2.8 GHz band.

In this paper we propose a cavity-backed dual-polarization wideband antenna fed with two I-shaped crossed dipoles based on previous author's designs [7]-[8]. It provides two orthogonal unidirectional radiation patterns with low correlation, high efficiency and a wideband impedance bandwidth (S$_{11}$ < -10 dB) ranging at 1.8-5 GHz.

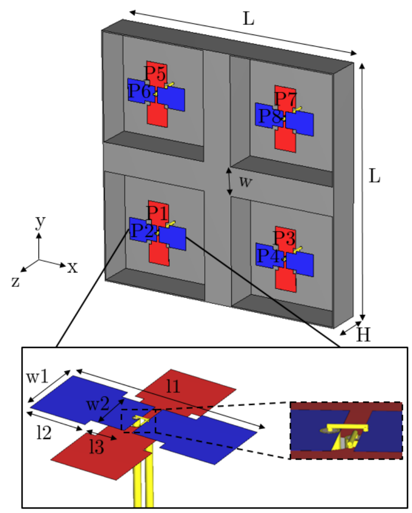

Fig. 1. Geometry of the proposed antenna.

II. Proposed Antenna

The proposed design is an eight-port wideband MIMO antenna composed by an aggregation of 4 unit cells as shown in Fig. 1 with L=220 mm, H028 mm, l1=55 mm, l2=16.5 mm, l3=10 mm, w=25 mm, w1=19 mm and w2=15 mm. The unit cell has been designed with two orthogonal I-shaped wideband dipoles providing two orthogonal polarizations. For feeding the two dipoles, two coaxial cables come through the center of the bottom of the cavity and are connected to the dipoles. The two dipoles are separated 1.5 mm for properly feed them (Fig. 1). The 2×2 disposition provides 8 independent radiation patterns for MIMO applications but the geometry of this design supports an easy escalation to a massive MIMO system with an N×N replication of the unit cell. For increasing the isolation between unit cells, a cross-shaped block has been added.

Fig. 2(a) show the S-parameters of the antenna. Due to the symmetry only the S-parameters of P1 and P2 are shown. Results show an impedance bandwidth (S$_{nn}$ <-10 dB, for n=1,2...8) of 97% ranging from 1.8 to 5 GHz. The isolation is always higher than 21.5 dB thanks to the orthogonal

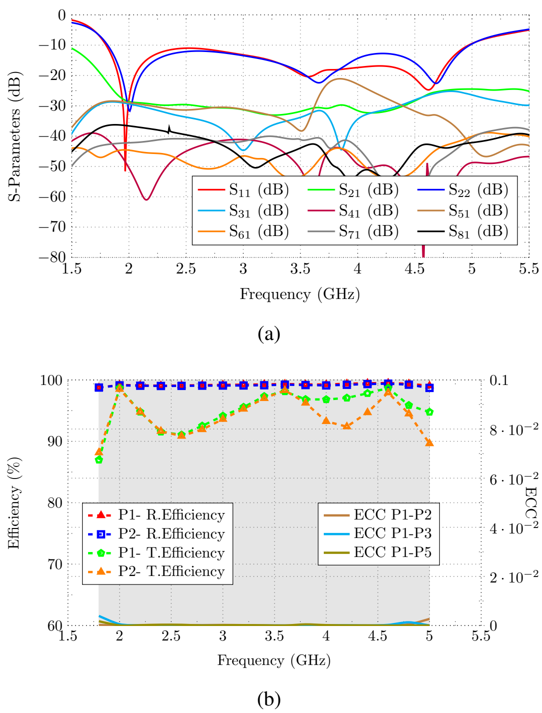

Fig. 2. a) S-Parameters of Port P1 (S_{22} also added) and, b) left axis: Radiation Efficiency of Ports P1 and P2, right axis: ECC between P1-P2, P1-P3 and P1-P5.

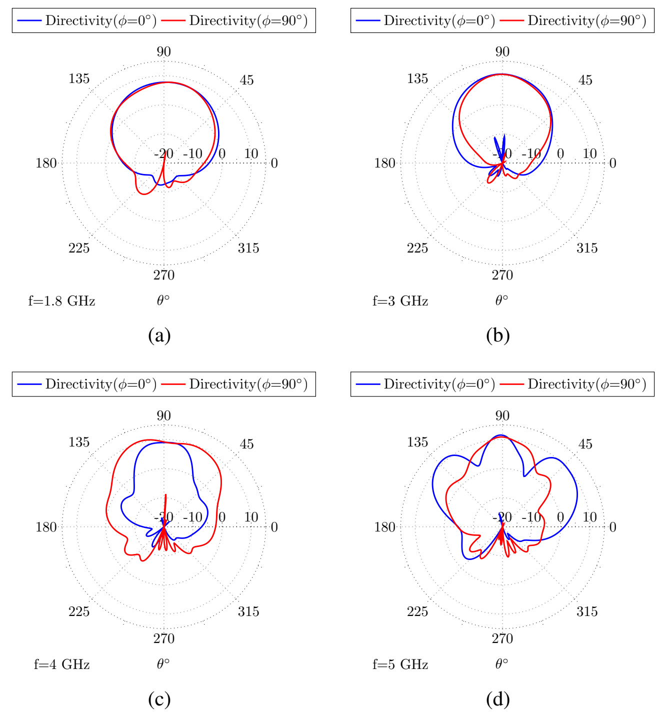

Fig. 3. Simulated radiation pattern when Port P1 is excited. Plane $\phi = 0°$ (blue) and $\phi = 90°$ (red) at: a) f=1.8 GHz, b) 3 GHz, c) 4 GHz and d) 5 GHz.

polarization and the isolating block between unit cells.

Fig. 3 depicts the simulated radiation patterns in XZ plane (ϕ=0°) and YZ plane (ϕ=90°) at 1.8 GHz (Fig. 3(a)), 3 GHz (Fig. 3(b)), 4 GHz (Fig. 3(c)) and 5 GHz (Fig. 3(d)). As observed, the antenna has unidirectional pattern at the whole operating band.

In Fig. 2(b) the envelope correlation coefficient (ECC) is represented for P1-P2, P1-P3 and P1-P5 (most problematic ones), confirming the MIMO performance. The ECC describes the independence between radiation patterns, and results show an ECC always lower than 0.01. In the same figure, the radiation and total efficiency are also represented for P1 and P2 exhibiting values higher than 87%.

III. Conclusion

An eight-port MIMO antenna is proposed for its installation in a 5G sub-6 GHz base station. The antenna is compose by an 2×2 aggregation defining as unit cell a cavity-backed antenna with crossed dipoles. The geometry of the unit cell permits to scale the design to a N×N aggregation for a massive MIMO system application.

Results confirms a wideband behaviour between 1.8-5 GHz, an isolation higher than 21.5 dB, unidirectional radiation patterns, low ECC (confirming MIMO performance) and high efficiency (higher than 87%). The analysis confirms that this antenna is a good candidate to be installed in 5G base stations.

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