IEEE Access
Multidisciplinary ⋮ Rapid Review ⋮ Open Access Journal

Received 13 August 2023, accepted 31 August 2023, date of publication 5 September 2023, date of current version 12 September 2023.

Digital Object Identifier 10.1109/ACCESS.2023.3312122

RESEARCH ARTICLE

A Compact Two-Element Linearly and Orthogonal Circularly Polarized MIMO Antenna System for 5G Cellular and WLAN/Wi-Fi 6E Application

WATHEQ A. NEAMAH[1,2], HAIDER M. AL SABBAGH[1], (Senior Member, IEEE), AND HUSSAIN AL-RIZZO[3]

[1]Department of Electrical Engineering, College of Engineering, University of Basrah, Basrah 61004, Iraq
[2]College of Engineering, University of Thi-Qar, Nasiriyah 64001, Iraq
[3]Department of Systems Engineering, University of Arkansas at Little Rock, Little Rock, AR 72204, USA

Corresponding author: Watheq A. Neamah (watheq.neamah@utq.edu.iq)

ABSTRACT This paper presents the design, analysis, and experimental validation of a compact 2 × 1 MIMO antenna operating in two bands. Band 1 is Linearly Polarized (LP) with spatial diversity operating in the sub-6 GHz band for the Fifth Generation (5G). Band 2 is Circularly Polarized (CP) for polarization and pattern diversity with an axial ratio below 3 dB for WLAN, Wi-Fi 6E, and C-band applications. The proposed single antenna consists of a Squared Shape Modified Monopole with partially Defected Ground (SMMDG) fed by Co-Planar Waveguide CPW. The partial ground has a defect on its upper left side and an I-shaped strip on the right side. The two MIMO radiators are arranged in oppositely flipped shapes. The decoupling and common partial ground structure consists of an opposite, Double T-shaped strip (DTSS) with a common strip head that performs as a band-stop filter. The overall dimensions of the MIMO antenna are 31.5 × 45 × 1.6 mm^3. The simulated impedance bandwidth of the first band with LP lies between 3.1 and 4.7 GHz, for which S_{11} and $S_{22} < -10$ dB, while the measured values are between 3.45 GHz and 4.8 GHz. The simulated impedance bandwidth for the second band for S_{11} and $S_{22} < -10$ dB lies between 5.24 and 7.9 GHz, while the measured one lies between 5.65 GHz and 9 GHz. The simulated 3-dB Axial Ratio Bandwidth (ARBW) within Band 2 is (5.6–8.5) GHz, while the measured 3-dB ARBW is (5.95–8.1) GHz. The minimum simulated isolation between the two ports is 17 dB in Band 1 and 26 dB in Band 2, while the minimum measured isolation is 21 dB in Band 1 and 26 dB in Band 2. Wi-Fi 6E (n96) (5.925-7.125) GHz is covered with right-hand circular polarization (RHCP) in the positive Z direction and left-hand circular polarization (LHCP) in the negative Z direction, covering Band 2 with an axial ratio less than 3 dB. Other crucial MIMO metrics are also calculated, such as the Envelope Correlation Coefficient (ECC), Mean Effective Gain (MEG), and Diversity Gain (DG). The antenna provides excellent MIMO diversity performance, which makes it an excellent candidate for many portable wireless applications.

INDEX TERMS Dual band, low profile, sub 6 band, Wi-Fi 6E, circularly polarized, MIMO antenna.

I. INTRODUCTION

5G-enabled MIMO wireless systems enable greater range, higher data rates, lower latencies, improved mobility, and more reliable connections through spatial multiplexing and diversity techniques [1]. The world is transitioning to 5G technology to accommodate the exponential rise of global mobile data traffic and the billions of existing wireless devices [2]. Due to its capacity to transmit large amounts of data across vast distances, the sub-6 GHz band is an excellent choice for 5G systems [3], [4]. A multi-band antenna is always better than separate antennas operating at different frequencies. The size of the antennas is a limiting factor for many communication devices, including those with MIMO systems.

However, the existing wireless network technology limits download speeds for applications such as 4K and 8K video and the Internet of Things (IoT). Current WLAN upload and

The associate editor coordinating the review of this manuscript and approving it for publication was Jiankang Zhang.