A Compact Broadband Monopole Antenna with Circulary Polaraized

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***Abstract*— The design and characterization of a microstrip-fed planar monopole antenna with circular polarization is presented. The antenna operates in the Industrial, Scientific and Medical (ISM) (5.725–5.875GHz),and WLAN (5150–5350 MHz) with return loss lower than -10 dB. The antenna has a compact aperture size 20 × 20 mm^2, fabricated on FR4 substrate with dielectric constant of 4.4, thickness of 1 mm. The advantages of the proposed antenna are the simple yet efficient design of the radiator, a 3-dB axial-ratio operating band with a compact size.**

Keywords—Circularly polarized antenna, compact antenna, ISM band antenna.

I. INTRODUCTION

Circularly polarized antennas have been widely used in wireless communication applications such as global positioning system, Industrial, Scientific, and Medical (ISM), radio-frequency identification (RFID) system, radar, and readers since they can enhance the signal reception with flexible orientation. Because the transmitter and the receiver are not fixed or their operation is variable with weather conditions, circular polarization (CP) is desired to prevent the effects of displacement and path loss of the antennas[1], [2], [3]. Therefore, designing a compact antenna with circular polarization is an essential challenge. Therefore, a number of antenna designs have been proposed for circularly polarized radiation[4]. Circular polarization can be realized by exciting two orthogonal modes of equal amplitude with a 90 phase difference. A printed antenna with the advantages of low cost, easy fabrication, and low profile is commonly used for CP antenna design[5].

Reviewing the literature reveals a great effort in implementing various methods and techniques both for achieving compact and wideband circularly polarized antennas Some of the utilized techniques include using an artificial ground [6], slots in the ground [7], S-shaped slots [8], feed networks composed of three Wilkinson power dividers [9], four notch slots [10], topology-based steps [11], feed positioning with E- and U-shaped slots [12], asymmetric T-shaped strip [13] two linked square slot-rings [13], slotted monopole [14], and inverted L-slits on the ground [15].

In this paper, a wideband circularly polarized monopole antenna is proposed using microstrip feed shaped line and presents a novel compact planar square monopole UWB antenna with a circular shaped patch and a rectangular shaped ground plane. From the related simulation results, this designed monopole antenna can achieve relatively wider impedance bandwidth of 8.08GHz which is operating from 3.76 to 11.84 GHz.

II. ANTENNA DESIGN

The basic configuration of the proposed antenna is fed by a strip line and was printed on one side of a 1.0-mm thick FR4 substrate that was used herein, with a 4.4 relative permittivity, whereas the other side of the substrate was printed on a ground plane. In this design, the total size of the substrate is 20mm×20mm. An inverted L-shaped slot with dimension of 2.5×2 mm^2 are created in the ground plane of the antenna to improving its impedance matching. By creating the L-shaped arm with dimension of 5.9×4.8 mm^{2}we have better impedance matching and axial ratio value. The main goal of the design is to create circular polarization. The success of the design of a circularly polarized antenna depends mainly on whether the 3-dB axial-ratio (AR) band is entirely enclosed by the 10-dB return-loss band. Therefore, the main challenge in the design procedure focuses on how the circular-shaped radiator improve the impedance matching and axial ratio of the antenna. By adjusting the dimensions of the L-shaped slot and circular-shaped radiator, circular polarization can be created in the 5–6GHz frequency band.

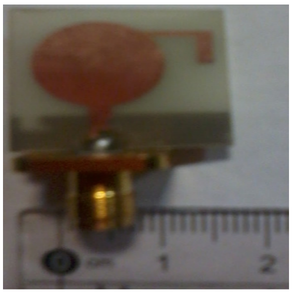

Fig. 1. Photograph of proposed semi circular shaped monopole antenna with standard SMA connector

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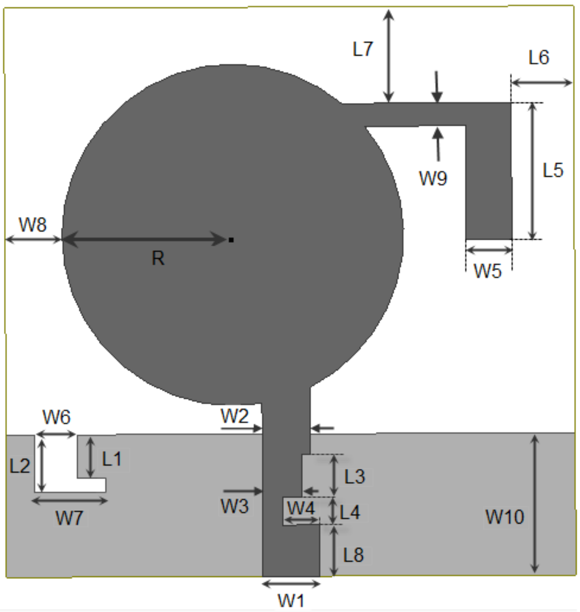

Fig. 2. Geometry of the proposed CP square monopole antenna.
R = 6, W_1 = 2, L_1 = 1.5, W_2 = 1.7, L_2 = 2, W_3 = 1,4, L_3 = 1.5, W_4 = 1.3, L_4 = 1, W_5 = 1.6, L_5 = 4.8, W_6 = 1,5, L_6 = 2.2, W_7 = 2.5, L_7 = 3.4 , W_8 = 2, L_8= 1.8, W_9=0.8, W_{10} = 5 (unit: millimeters).

III. RESULTS

In this section, the planar monopole antenna with several design parameters were designed and results of the input impedance and radiation characteristics are presented. It is essential to accomplish a parametric study of geometry parameters which affect the performance of the proposed antenna to obtain a better insight of antennas behavior for design purposes. The simulated results are obtained using the ANSYS HFSS (High Frequency Structure Simulator) 3-D EM simulator [14].

Fig. 5 shows comparison of return loss between simulation and measurement results. The simulated curve of return loss for the frequency range 5.1 to 5.8 GHz is lower than -10 dB. which is sufficient for the biomedical application.The antenna gain is observed and displayed in Fig 6. The antenna gain is above 5 dBi at 4.5 to 5.8 GHz and we can observe the decrease in gain from frequency 5.5GHz.

The measured axial-ratio results for the antenna are presented in Fig. 7. The 3-dB axial ratio of the antenna is measured. The antenna has a wide measured 3-Db ARBW from 3 to 6.8 GHz.

The far- field radiation patterns of the antenna in both the xz-and yz- planes at 5.2 is measured. As it can be seen in Fig. 8, the antenna produces mainly LHCP radiation in the-y-direction and RHCP radiation in y-direction.

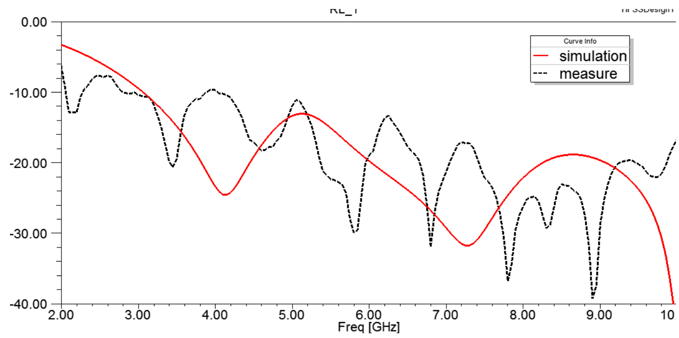

Fig. 5. Measured and simulated diagrams the return loss of the proposed antenna

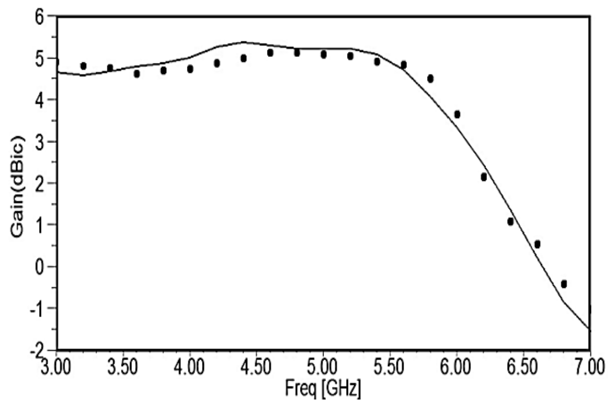

Fig. 6. Measured and simulated antenna gains in the +Z-direction.

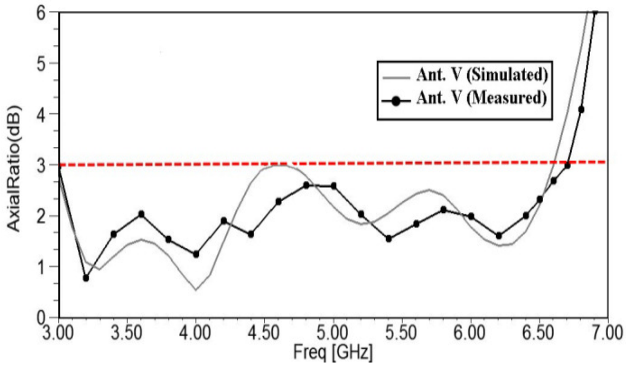

Fig. 7. Measured and simulated diagrams the axial ratio of the proposed antenna.

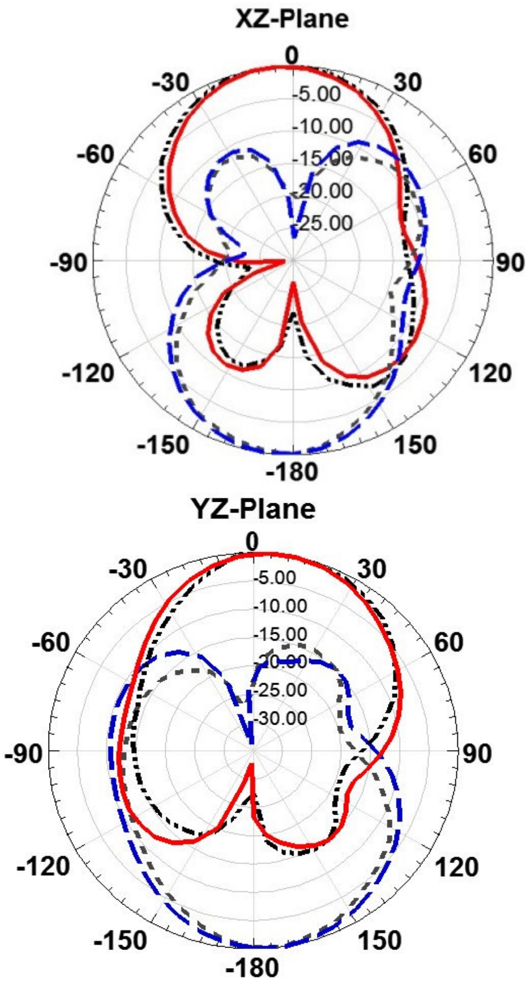

Fig. 8. Simulated and measured radiation patterns of the proposed antenna at 5.2 GHz.
Simulated RHCP. Measured RHCP.
Simulated LHCP. Measured LHCP.

IV. CONCLOSION

A low-profile, low-cost, wideband, circularly polarized, has been proposed and studied. The antenna exhibits wideband circularly polarized radiation. The proposed antenna is compact with low-profile and can be fabricated with low cost. It may be potentially very useful in many wireless communication systems.

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