INTERNATIONAL JOURNAL OF ELECTRONICS, MECHANICAL AND MECHATRONICS ENGINEERING
Vol.7 Num.3 - 2016 (1433-1439)

Received: 19.03.2017
Accepted:23.06.2017

A New Compact Circular Polarized CPW Antenna Design for UWB Application

Hemrah HIVEHCHI [1], Saeid KARAMZADEH*[2]

Abstract – Current paper proposes a new Coplanar waveguide (CPW) feed antenna for UWB application. The suggested antenna consists of a circular patch with two circular slots and a semicircular gap on the feedline with two rectangular shapes as ground in 2.6 x 30 x1.6mm^3 dimensions with spiral and semicircular slots on it. In this outline, the impedance bandwidth (S11) has increased to a significate number together with the axial ratio bandwidth (ARBW), 123 % (3.3 GHz - 13.9 GHz). The article presents the designing steps of the antenna.

Keywords - *UWB, CP, CPW feed*

1. Introduction

Low specifications, low cost, light weight and being able to integrate with Monolithic Microwave Integrated Circuits (MMICs) for Ultra Wide Band application (UWB) would make a micro-strip slot antenna a good choice for so many applications [1,2]. Circularly Polarized (CP) antennas are more preferred in wireless communications, sensors, radio frequency identifiers (RFID), satellite communication and vehicular radar due to the elimination of multipath fading problem and the enhanced system performance [3,4]. Among feeding methods, coplanar waveguide (CPW) feed provides some advantages such as wideband, easy integration and single metallic layer [5]. Some of the methods for generating CP radiation studied in the literature are slots in the ground [6], S-shaped slots [7], feed networks composed of three Wilkinson power dividers [8], topology-based steps [9], feed positioning with E- and U-shaped slots [10], asymmetric T-shaped strip [11], two linked square slot-rings [12] and inverted L-slits on the ground.

UWB is currently used for receiving special attention and is quite an important topic in communication systems. UWB technology brings the facilities and mobility of wireless communications to high speed inter connects in devices throughout the digital anywhere. Providing wireless connection of multiple devices for the transmission of video, audio and other high bandwidth data, UWB is the mostly preferred technology for freeing people from wires. UWB short-range radio technology supplements other longer-range radio technologies such as Wi-Fi, WiMAX and cellular wide area communications. It is used for connecting data from a host device to other devices in the immediate area (up to 10 m or 30 feet) [13]. Today, antenna designing for UWB systems is a big challenge for the researchers.

Current study presents a new design of a CPW fed Circularly Polarized Square slot antenna by partially improving and combining previous methods for obtaining a better result. Based on the simulated results, the impedance bandwidth is about 123 % and the 3 dB AR bandwidth is about 32 %. Proposed antenna will support an UWB application of which the frequency range is defined as: 3.1-10.6 GHz or fractional bandwidth more than 109 %.

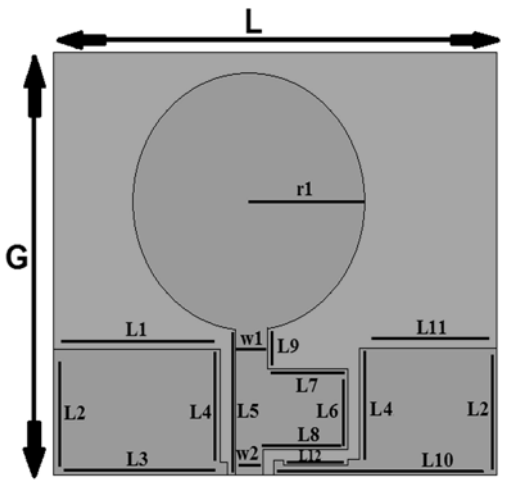
[1]*Department of Electrical and Electronics Engineering, Istanbul Aydin University, Istanbul, Turkey*
[2]*Application & Research Center for Advanced Studies, Istanbul Aydin University, Turkey hemrahhivehchi@stu.aydin.edu.tr, karamzadeh@itu.edu.tr*

2. Antenna Design

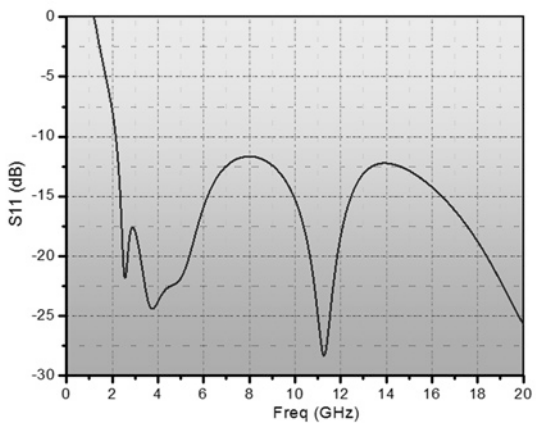
This section is divided in four parts to better describe the proposed antenna designing process in steps. In all the steps, antennas were designed on a commercially cheap FR4-epoxy substrate with ε_r=4.4 and tan (δ) = 0.024, and the feedline of the proposed antennas were CPW which is designed for connecting to a 50 Ω SMA connector.

2.1 Antenna I

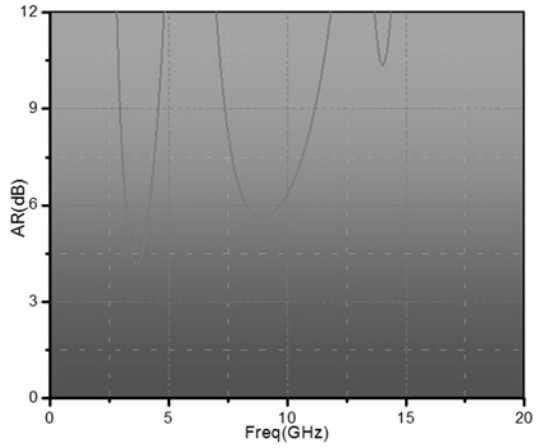
The first step simulates the proposed antenna with the circular patch and CPW feed. The configuration of the provided antenna is shown in Figure 1(a). In this section, we attempt to tune the impedance band on 50 ohms with gaps besides the feed line and grounds. For designing and finding the improved parameters we have utilized the Ansoft High Frequency Structure Simulator Software (HFSS, ver.16). For the predigesting in the antenna design G = 26 mm, L = 30 mm, h = 1.6 mm measurements were selected. Figure 1(b) and (c) have shown results of S11 and AR for the particular antenna. The results are acceptable for S11 (2.2, unlimited) but not for Circular Polarization (CP) therefore AR must be improved for this antenna. The parameters of the antenna are as follows: G = 2.6, L = 30, h = 1.6, r1 = 8, L1=12, L2 = 8, L3 = 12.5, L4 = 7, L5 = 9, L6 = 5.5, L7 = 4.5, L8 = 4.9, L9 = 2, L10 = 14.4, L11 =9, L12=3.5and W1 = 2.5, W2 = 2.1, (All units are given in millimeters).



(a)



(b)

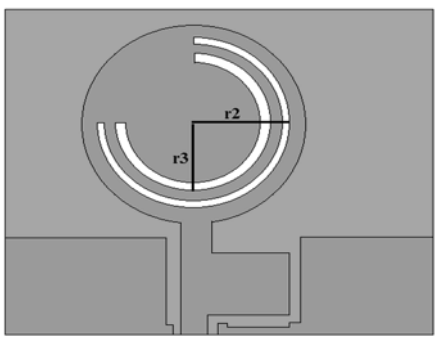


(c)

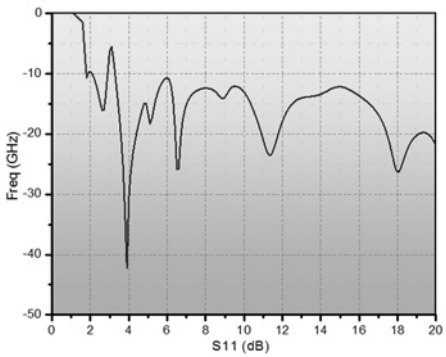
Figure 1. (a) Configuration of the antenna I, (b) S11and (c) AR for antenna I

2.2. Antenna II

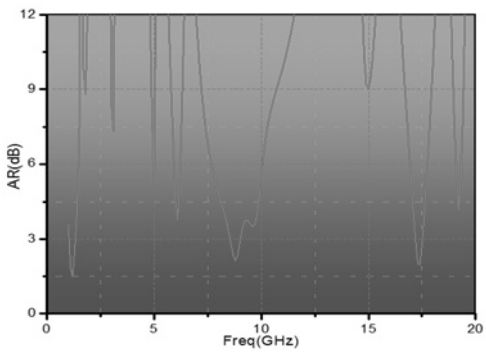
In this step, the AR is improved by two circular gaps on the patch. The antenna configuration and the results of the antenna II are shown in Figure 2. According to the impedance band -10 dB s11 graphs from Figure 2(b), the operation frequency starts from 2 GHz, which is a good result and proper for UWB application as well. However, 3-dB AR graph in Figure 2(c) shows that it can be improved for a better performance in Circularly Polarized Mode. The diameters of circular gaps are r2=6.5mm and r3=4.5mm.



(a)



(b)

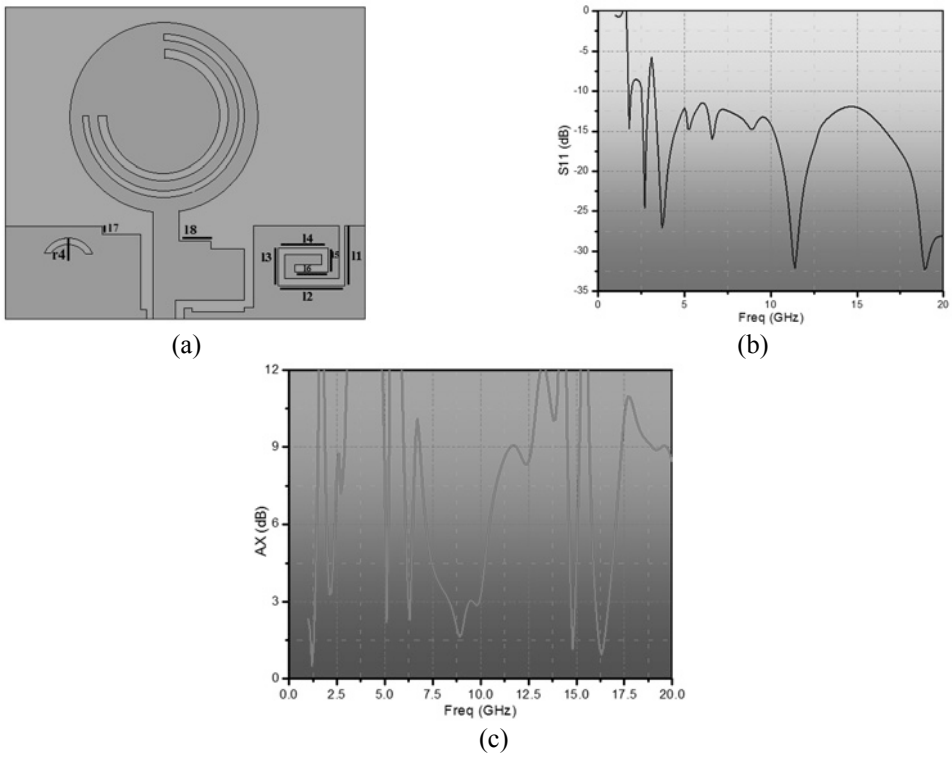


(c)

Figure 2. (a) Configuration of the antenna II, (b) S11and (c) AR for Antenna II

2.3 Antenna III

This step utilizes spiral gap and semicircular shapes in the ground stepping up the ground and patch for the improvement of the AR. The antenna configuration and results of the antenna III are shown in Figure 3. The parameters are l1=5.5, l2=5, l3=3.5, l4=3.5, l5=2, l6=2, l7= 3, l8=2.5 (all in mm).



(a) (b)

(c)

Figure 3. (a) Configuration of the antenna III, (b) S11and (c) AR for antenna III

2.4 Antenna IV

Finally, with a C shaped feed line and more stepped up in ground, Antenna IV design has given better results regarding AR. The configuration and the results of the proposed antenna (i.e. the final step of the antenna designing process) are shown in Figure 4 (r5 is 2 mm). Figure 5 shows the 3-D radiation pattern and antenna maximum gain (6.7dB). Right Hand Circularly Polarization (RHCP) and Left Hand Circularly Polarization (LHCP) radiation pattern for spatial frequency and different degrees are shown in Figure 6. In comparison with the recently published related works, the antenna performances such as impedance bandwidth, axial ratio and gain has improved in this study. Besides, the size of the antenna has been reduced impressively. Table 1 shows a comparison of the proposed antenna with the related work.

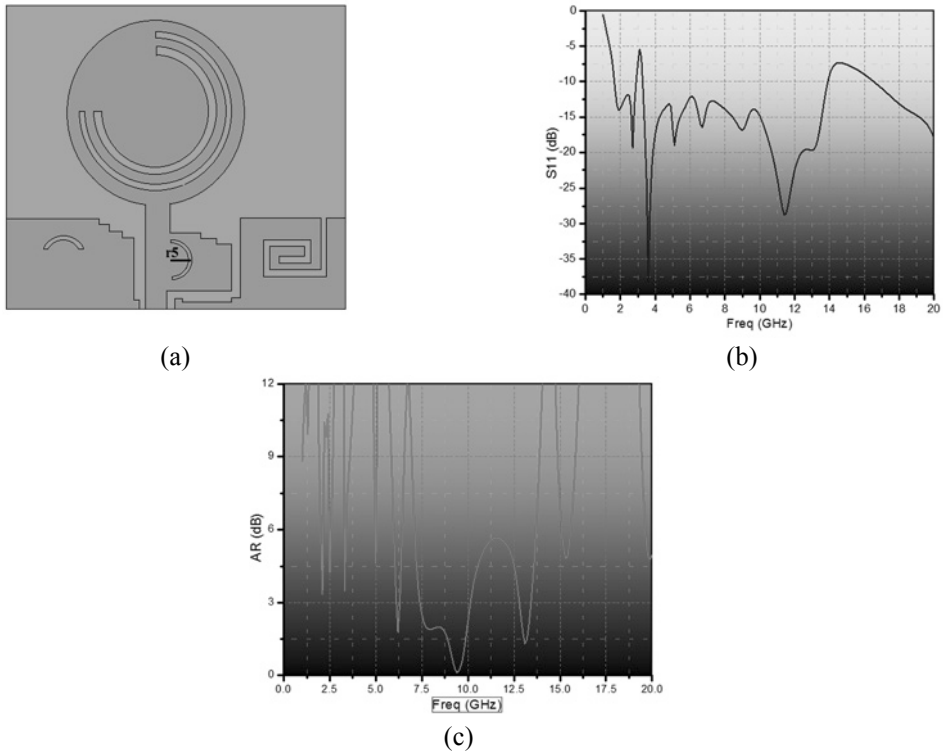


Figure 4. (a) Configuration of the proposed antenna, (b) S11and (c) the AR of the proposed antenna

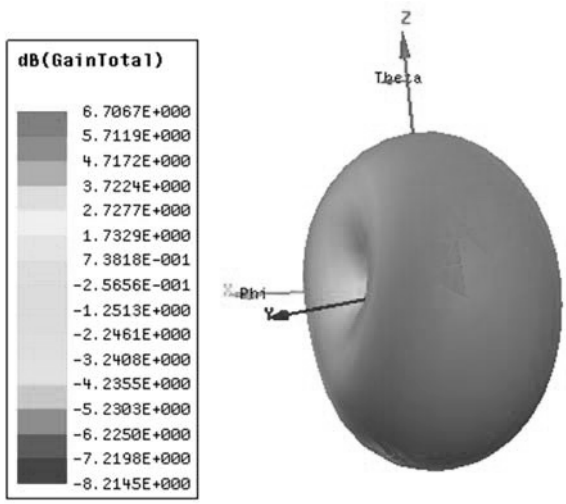


Figure 5. 3D radiation pattern

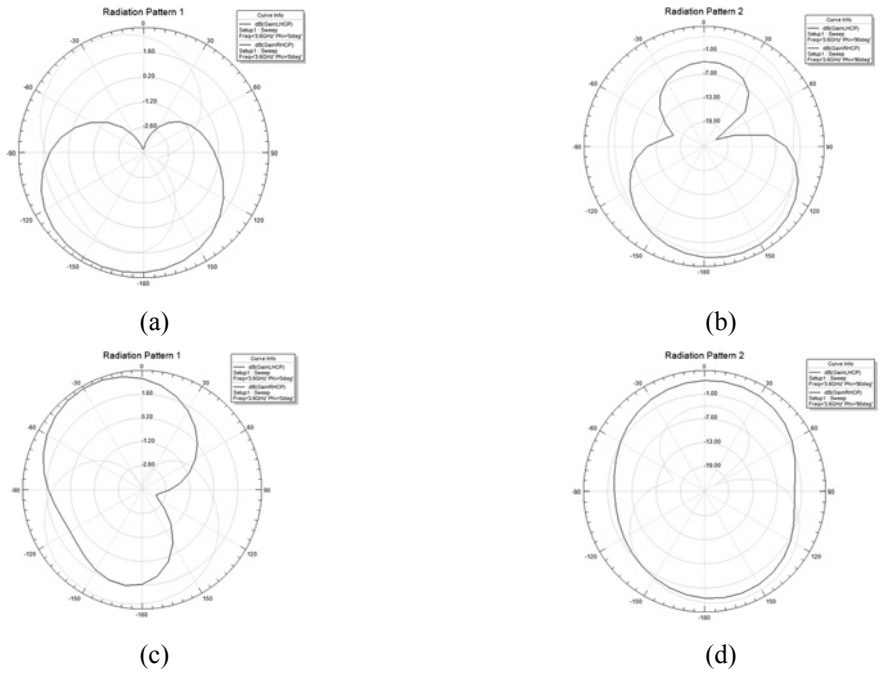


Figure 6. Simulated radiation patterns of the proposed antenna at (a) 3.6 GHz, 0 degree (b) 3.6 GHz,90 degrees for left hand and (c) 3.6 GHz, 0 degree (d) 3.6 GHz,90 degrees for right hand

Table 1. A comparison of the characteristics of some antennas with the proposed work (BW: Impedance Bandwidth and P.A: Proposed Antenna)

References	Gain	BW	Size
	(dB)	(GHz)	mm^3
[3]	4	1.6-3.05=52%	60x60x0.74
[14]	4.5	3-10.1=108%	60 x 60x0.8
[15]	4.32	2.6-13.1=132%	60 x 60x0.8
[16]	3.4	2.02-3.4=51.4%	60 x 60x0.8
P.A	6.7	3.3-13.9=123%	26 x 30x1.6

3. Conclusion

Current study proposes a new CP antenna presenting the designing steps and result improvement in this paper. The simulated results demonstrate that the proposed antenna has an impedance bandwidth of about 10.6 GHz (123 %) and a 3 dB AR bandwidth of about 1.8 GHz (32 %). Furthermore, the significant reduction in size is another novelty that the proposed antenna brings.

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