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Circularly Polarized Slot Antenna for wireless Applications

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Abstract
This letter presents a new design for a circularly polarized square slot antenna with an enhanced impedance bandwidth. The antenna structure includes a pair of inverted-L grounded arms, around two opposite corners which can result the CP bandwidth of the proposed antenna at 5.14-7.78 GHz .The designed Circularly Polarized Slot Antenna with size 25 mm (length) ×25mm (width) ×0.8 mm (height) is greatly improved for achieving a significantly enhanced impedance bandwidth of 2–13 GHz with VSWR $\leq$ 2. The simulation results have been showed that using inverted-L grounded arms , circular and strip patches are increasing the CP bandwidth and reduce the size of the proposed antenna .

Keywords: *slot antenna, circular polarization, wireless applications*

1. Introduction

In the past few years, the rapid development of the use of wireless and fast communications an Ultra wide band antenna such as circular polarized square a lot antenna has become an option in wireless communications systems [1]. Because of the advantages of wideband-width, low profile, uniplanar geometry, easy integration with mono- lithic microwave integrated circuits, sending and receiving without causing a polarization mismatch and overcoming the multipath fading problem, circular polarization is becoming popular [4-9]. In recent years wireless systems demand stringent physical requirements from antennas, so different shape and type of broadband Circular polarized slot antenna have been developed to reduce the axial-ratio bandwidths (ARBWs) ,with the various design and techniques, we can achieve the right hand and the left hand CP in these kind of antenna at the same time .Some of the techniques that are used in this design are : adding two inverted-L grounded arms around two opposite corners of the antenna [1], creating inverted-L slot on the ground plane which is connected the two inverted arms together, adding a semicircular –shaped and semi stair-shape on the feed line and inverted-L grounded strips [2-3]. In addition by changing the shape of the feed line such as using arc-shape , lightning-shape , cross-shape , crane-shaped we can achieve good CP radiation characteristics for the slot antenna [1-3].

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This novel presents an Ultra wideband circular polarized slot square antenna (CPSSA), which is used a T-shape grounded metallic strip perpendicular to the axial direction of the coplanar waveguide (CPW) feed line and semicircular and semi steps feed line to reveal the circularly polarized (CP).

2. Antenna Configuration and design

Fig. 1 illustrates the evolution of the proposed single-layer CPW-fed CPSS antenna. As shown, in fig. 1, antennas is printed on a commercially cheap FR4 substrate with a loss tangent of 0.024, permittivity of 4.4 and tiny dimensions of 25 mm (length) ×25mm (width) × 0.8 mm (thickness).As it is indicated in the figure, Two main features have been incorporated within the design: one mainly for enhancing the impedance bandwidth, and the other for enlarging the ARBW, which are reached at the proposed antenna by a tuning circle stub embedded in the feeding structure and a semi-strip main patch stuck to the feed line**.** Two inverted-L grounded arms strips are loaded in the two opposite corner of the antenna, the size of the inverted-L-shaped slot which is connected the two inverted-L-shaped strips around together is modified for having the best result .It should be noted that all units are in millimeter(mm).

The width and length of the waveguide (CPW) feed-line are 3.1 mm and 12 mm, respectively the feed line is terminated with a standard SMA connector, and to achieve 50Ω characteristic impedance the width of the gap between the feed-line and the ground plane is 0.25 mm. Furthermore, the sizes of the inverted-L- shaped strips are L17=5mm and L4=6mm. other parameters of the antenna can be found in Tab. 1

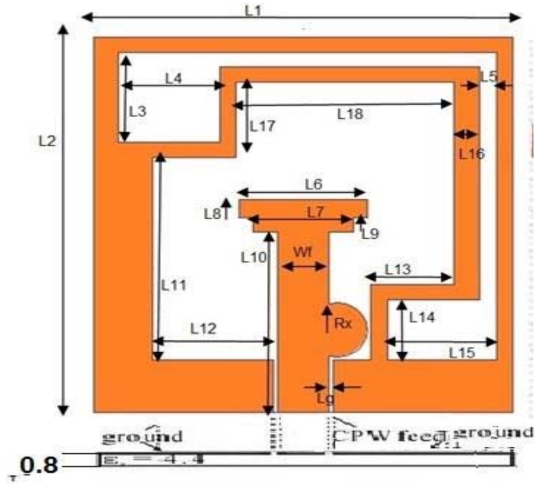


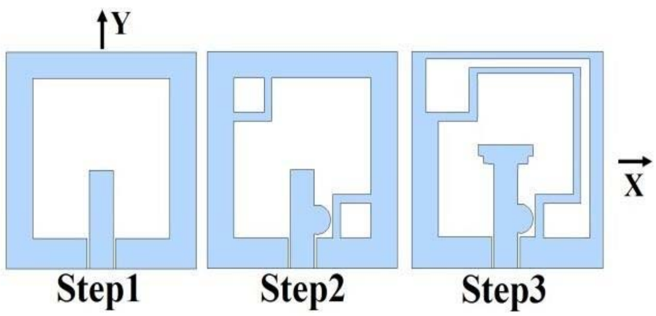
Fig. 1 Geometry of proposed CPW-fed CPSSA (all dimensions are in mm)

Table1: The dimension of the antenna parameters

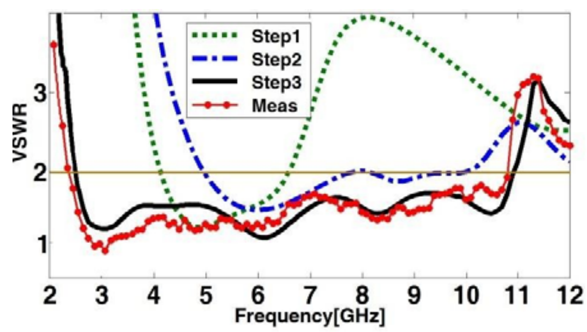
Rx	1.8
Wf	3.1
Lg	0.25
L1	25
L2	25
L3	6
L4	6
L5	1
L6	7.6
L7	6
L8	1.3
L9	1
L10	12
L11	7.2
L12	13.5
L13	5
L14	4
L15	6.5
L16	1.5
L17	5
L18	13

There are three steps to release CPW-fed CP slot antenna: At the first step , embedded only a single strip and ground plane, then adding two inverted-L grounded arms strips to opposite corners and a metal semicircle to feed-line and for the third step, embedding semi-strip shaped main patch and a L-shape slot which connected the two inverted L-shaped strips together. Fig.2.a depicts the three mentioned steps of the design of the proposed antenna and Fig.2.b shows the VSWR curves of the antenna at the three designing steps with the measurement VSWR results. The simulation results show that embedding a semicircle and semi-strip shaped to the feed-line increases the impedance band-width however, the combination of the feed-line with a semicircle and semi-strip shaped patch and the inverted-L strips that lead to expanding the CP bandwidth which is mostly depends on the inverted-L-shaped stripsaround the corners of the antenna so by adding a inverted-L-shaped slot CP bandwidth be widen.

Finally the measured radiation pattern of the offered antenna will be discussed in next section.



(a)



(b)

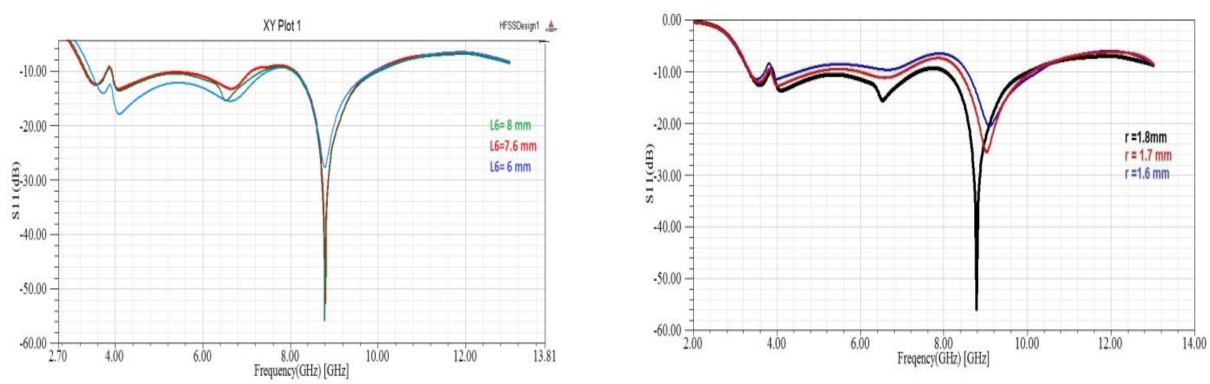
Fig.2 antenna three designing steps with VSWR results
a) Antenna three designing steps
b) VSWR curves of the antenna three designing steps and measurement VSWR results.

3. Results and Discussion

The performances of the CPSS antenna in parametric studies have been investigated to find optimized parameters using commercial Ansoft by the High Frequency Structure Simulator(HFSS13) software. The impedance bandwidth and axial ratio of the CPSSA are measured using the Agilent 8722ES network analyzer.

According the results of the numerical analysis, The optimized parameters of the proposed antenna is shown is table. 1. The simulated S11 curves for two various CPSSA parameters, Rx and L6 (radius of circle and length of the semi-strip center position, respectively) are plotted in Fig.3 and the results of the measured and simulation of the return loss of the antenna shown in the Fig4 .The measured impedance bandwidths are from 2 to 13 GHz. The result of the simulation and measured of the axial ratio showed in the Fig 6 and the RHCP and LHCP of the presented antenna shown in the Fig 7.According to the Fig.2 impedance bandwidth increase at the step 3and there is a similarity between measurement and simulation of VSWR results.

Fig.4 shows the measurement and simulation results of return loss of the proposed antenna. Our parametric simulations indicate that the radius and position of the tuning stub has important effect on the improvement of the impedance BW. From the numerical results in Fig. 3.a, it is obtained that the impedance bandwidth is expanded at the as Rx increases from 1.6mm to 1.8mm, meanwhile broader impedance BW is obtained by increasing the length of L_6 parameter, the antenna's main parameter and the size of the antenna will increase so for having a good results with reasonable size L_6=7.6 mm is selected.



(a) (b)

Fig. 3 S11 of various value of Rx (radius of circle and length of L6)

a) S11 curves of different values of Rx

b) S11 curves of different values of L6

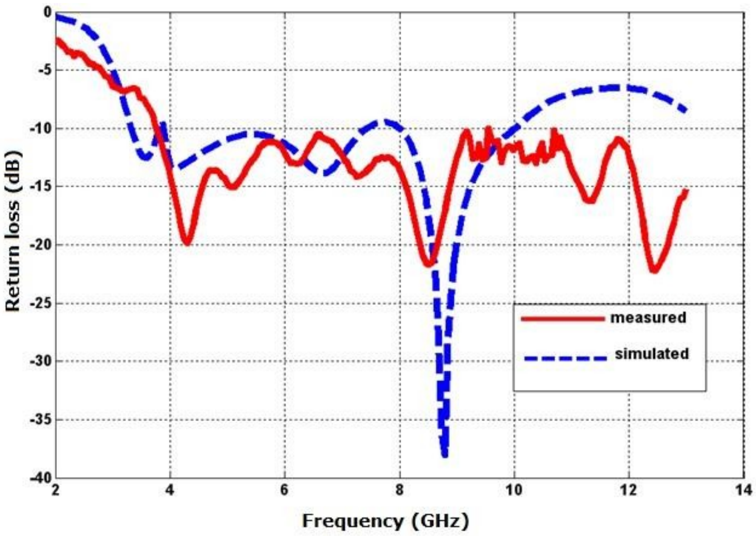


Fig.4 measured and simulated curves of Return loss

As we see in the Fig. 4 there is a good accommodation between the antenna return loss measured and analysis.

The simulated and measured gains and AR curves, depicted in Fig.5 indicates the close correspondence between the measured and simulated curves of gain and AR for the proposed antenna with optimized values presented in Fig.1 and in Table1. As plotted in Fig.6, the ARBW of the proposed antenna is from 5050 MHz to 8200 MHz (47.5%) and the obtained gain is acceptable.

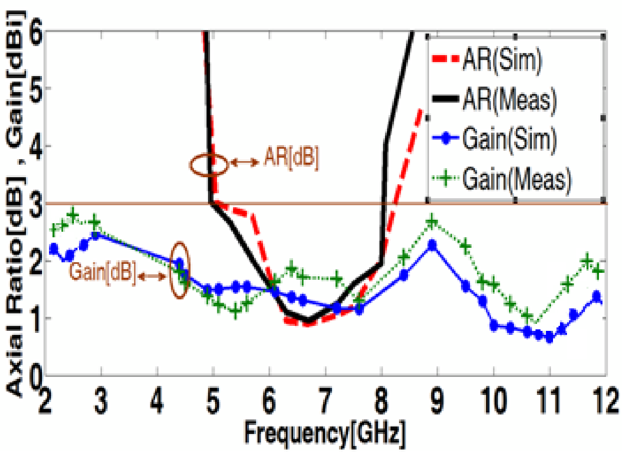


Fig.5 Measured and simulated CP axial ratios and gain of the proposed antenna

Fig.6 shows the simulated normalized RHCP and LHCP radiation patterns of the offered CPSSA at 5.5 GHz and 7.3 GHz.
Fig.7shown the simulation results of surface current distribution for the presented antenna.

As we can see the surface distribution in phase of 0° and 90° are equal in magnitude and opposite in phase 180° and 270°. The antenna right/left hand circular polarization (RCHP/LHCP) happened when the current rotates in the clockwise or counter clockwise direction. The proposed is shown at Fig. 8.

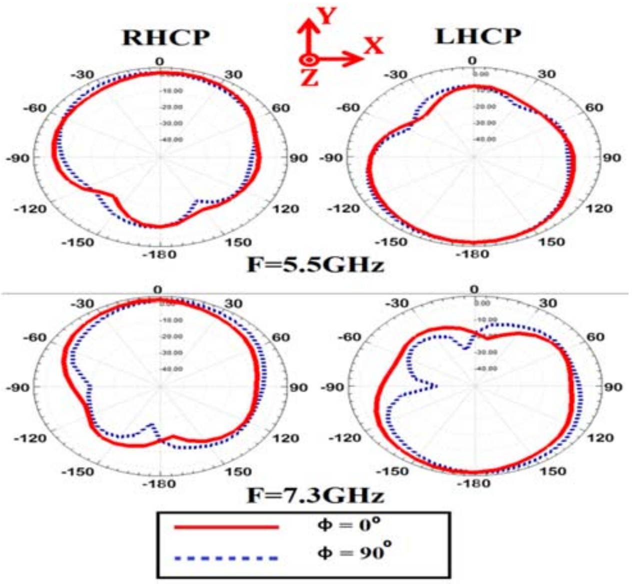


Fig. 6 Simulated radiation patterns of the proposed antenna at 5.5GHz and 7.3GHz

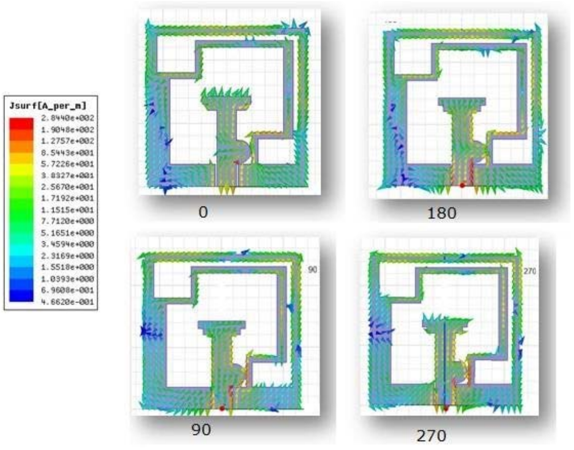


Fig. 7 Distribution of the surface current of the proposed antenna

Fig. 8. Photograph of the antenna

4. Conclusions

An Ultra-width band circular polarized square slot antenna with the CPW-fed was designed and successfully implemented. Results show that using reverse L-shaped ground arms and L-shaped notch can significantly enhance the antenna's 3 dB ARBW.

According to the results of the gain level, radiation patterns, current distributions and measured result this antenna is a good candidate for wireless and WLAN applications.

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