IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-6, Issue-3 E-ISSN: 2347-2693

# Design of CPW-Fed Circularly-Polarized Antenna with Cross Tuning Stub for WLAN/ISM Band Applications

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**Available online at: www.ijcseonline.org**

Received: 14/Feb//2018, Revised: 21/Feb2018, Accepted: 15/Mar/2018, Published: 30/Mar/2018

***Abstract*** – A CPW-fed circularly polarized cross tuning stub antenna is presented. Proposed antenna with cross tuning stub has successfully been designed for WLAN (2.4/5.2/5.8 GHz) and ISM (2.4/5.8GHz) bands for frequency range 2.40-2.48/5.15-5.35/5.725-5.82 GHz and 2.40-2.48/5.72-5.78 GHz respectively. The physical dimension of proposed antenna is 50mm (length) ×50mm (width)× 0.88mm(thickness) and printed on a FR-4 substrate($\mathcal{E}_r = 4.4$). The CPW feed is designed for 50 Ωimpedance. The proposed antenna has characterized by measuring the return loss of less than -10 dB, VSWR< 2 dB. The gain of proposed antenna from 3 dB to 5 dB is attained in the desired band with good radiation pattern characteristics and suitable axial ratio of less than 3 dB in prescribed band of operation. This antenna is designed by modifying the rectangular tuning stub to cross tuning stub. The antenna parameters like gain, return loss and bandwidth is improvised to acceptable limit with reasonable radiation pattern by using CST V.17 simulator.

***Keywords—***Circular Polarization (CP), Coplanar Waveguides (CPW), Wireless Local Area Network (WLAN), Industrial, Scientific and Medical(ISM), Voltage Standing Wave Ratio (VSWR), Axial Ratio (AR)

## I. INTRODUCTION

Due to the fast development of wireless technology, the general wireless transmission demand for the message and video-information content is very important and it seeks the feasible track case that the products go on the market fast. At present, the designers should must choose Wi-Fi, IEEE802.15.3/802.11b/g, and ultra-wideband (UWB). These network technologies will compete to the leading position of the wireless communication equipment in the following five years. The CPW-fed wide slot antennas have received much attention and have been increasingly used because the advantages of wide bandwidth, low profile, uniplanar geometry and easy integration with monolithic microwave integrated circuits and stable radiation patterns [1].

However, the drawback of slot antennas is bi-directional radiation. Recently, different types of bandwidth enhancement techniques on micro strip line fed slot antennas are reported. One method is to use different shapes of tuning stubs to achieve wideband performance [2-4]. Other methods use different slot shape, such as square, rectangular and ring slots with appropriate turning stubs [5-8]. The impedance bandwidths of these antennas achieve as much as 100%. However concept is not feasible until an impedance-matching technique is proposed [9-12]. In this paper simulation is carried out using CST micro wave studio 2017.

The geometry of antenna is discussed in section II. Results analysis of dual band at 2.4 GHz, 5.8 GHz are discussed in section III and finally conclusion is given in section IV.

## II. ANTENNA DESIGN

Different types of antenna design was tested for required bands. All the designs was tested in CST (Computer Simulation Technology).The design for antenna is two layer open slot circularly polarized antenna. Different designs of tuning stub were implemented. Three Designs were tested with different tuning stub.

### *A. Antenna Design I*

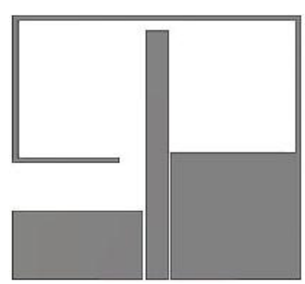


Figure 1: Geometry of antenna [1, 2]

Fig. 1 illustrates the evolution of the proposed CPW-fed broadband circularly polarized slot antennas. In Fig. 1 , antennas are printed on a square microwave substrate of FR4 with a side length of 50 mm, a thickness of 0.8 mm and a dielectric constant of permittivity $\varepsilon_r$=4.4 . They are fed by a 50Ω CPW feeding line, where the signal strip and gaps have widths of 4mm and 0.35 mm, respectively. An asymmetrical ground plane is used in Fig.1 for the wider impedance bandwidth operation as well as the AR bandwidth. Fig. 1 shows an antenna with a simply straight CPW feeding line. In order for the CP operation, an open slot having an open width of 4.5 mm is used at the lower left of the feeding line. This is an open slot with a configuration which is open along the ground plane in x-direction and the CPW feeding line in y-directions. Then the new technique of this slot configuration can provide the perturbation with magnetic current distributions in x and y directions. This can generate the CP operation by exciting two orthogonal modes in x and y directions with equal amplitude but in phase quadrature. Because of the reason that the open slot is especially along the ground plane in x-direction, it is obvious that the change of the ground plane would sensitively influence the performance of CP operation .Fig. 1, a wide tuning stub having a length of 47mm and a width of 4mm is used.

*B. Antenna Design II*

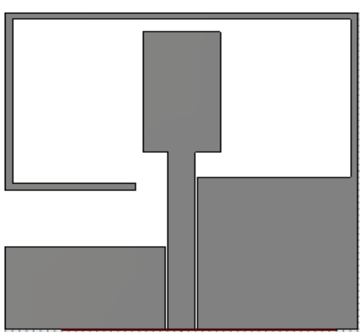


Figure 2: Geometry of antenna [1, 2]

Fig. 2is same as fig. 1 but tuning stub is changed and made wider at the top. A wide tuning stub, having a length of 19 mm and a width of 11mm, is used instead at the top of CPW feeding line in Fig. 1

*C. Antenna Design III*

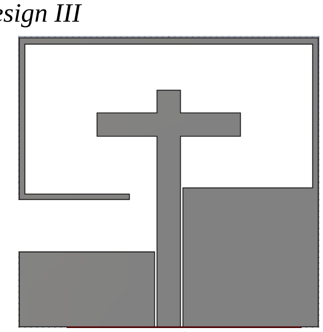


Figure 3: Geometry of proposed antenna

Fig. 3 is same as fig. 1 but tuning stub is changed and made cross at the top. The cross tuning stub having a length of 41mm and a width of 4mm is used. Cross of length 24 mm and width4 mm instead at the top of CPW feeding below 4 mm above the feed.

## III. RESULT AND DISCUSSION

This section discusses and analyzes simulated results of three different types of proposed antennas. The results include reflection coefficient as well as other parametric values. S-parameters obtained during simulation can be seen in fig.4, 5, and 6. Generally, reflection co-efficient ($S_{11}$) has been taken less than -10 dB over the wide bandwidth of WLAN/ISM application but for simulation -20 dB is sufficient so that fabricated antenna must provide $S_{11}$ around -10dB.The return loss of design I is presented in fig 4. Central frequencies at which this antenna is tuned in 1.85 GHz and 5.15 GHz having bandwidth 200 MHz and 1 GHz respectively. Another design II has central frequency 1.85 GHz with bandwidth 200 MHz and 5.15 GHz with bandwidth 700 MHz . The S-parameters of proposed antenna shown in fig. 6 suggest that the center frequencies of each operation are 2.4 GHz and 5.8 GHz for WLAN/ISM operation and having good bandwidth of 1.2GHz and 1 GHz respectively

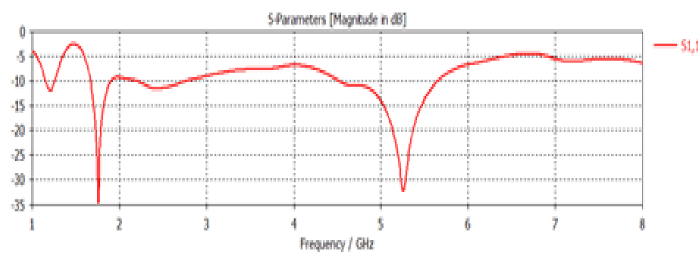



Figure 4: Reflection co-efficient of antenna design I

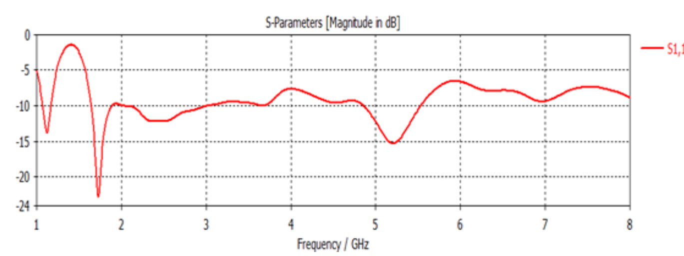



Figure 5: Reflection co-efficient of antenna design II

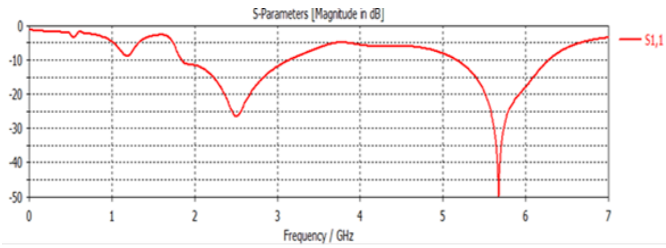
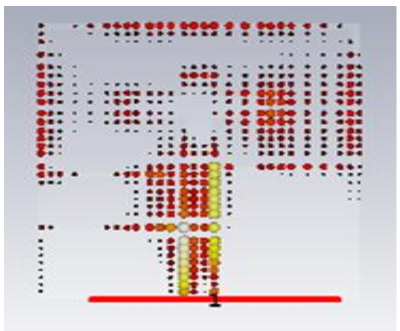
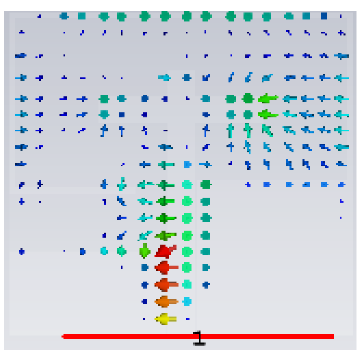



Figure 6: Reflection co-efficient of proposed antenna for dual band operation

The other parameters of proposed antenna are shown in figure 7, 8, 9 and 10 respectively. The surface current density of proposed antenna at different operating frequencies have been shown in figure 7.



(a)



(b)

Figure 7: Surface current density of proposed antenna at (a) 2.4 GHz and (b) at 5.8 GHz

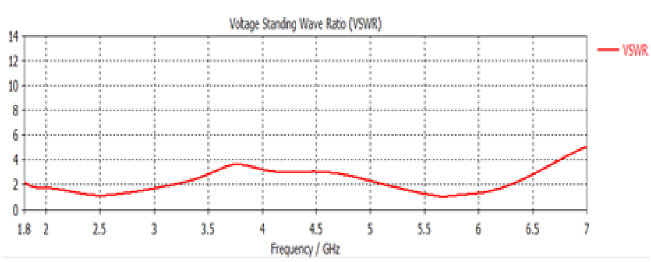



Figure 8: VSWR of Proposed Antenna (<2 dB)

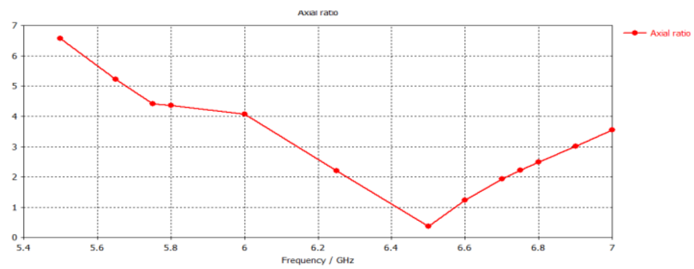
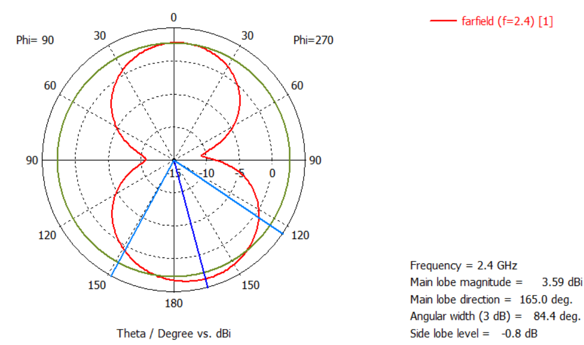
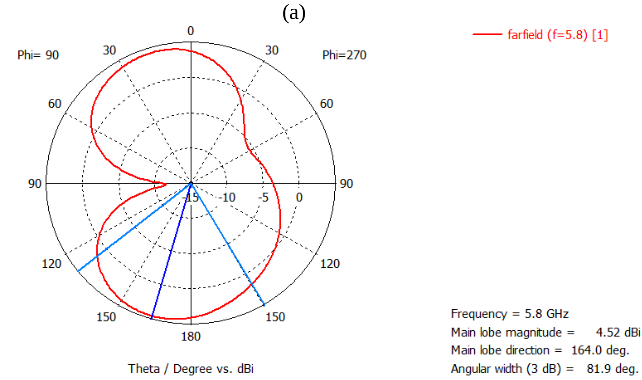



Figure 9: Axial Ratio of Proposed Antenna (<3 dB)




(a)




(b)

Figure 10: Far field pattern of proposed antenna at (a) 2.4 GHz and (b) 5.8 GHz

Table 1: Comparison between antenna I, antenna II and proposed antenna III

| **Parameters** | **Antenna (I)** | **Antenna (I)** | **Proposed antenna (III)** |
|---|---|---|---|
| Return Loss | $f_c$=1.85GHz,5.15GHz B.W.=200MHz, 1GHz | $f_c$=1.85GHz,5.15GHz B.W.=200MHz,700 MHz | $f_c$=2.4GHz,5.8GHz B.W.=1.2GHz, 1GHz |
| VSWR | <2 | <2 | <1.5 |
| Axial Ratio | No | No | Yes |

## IV. CONCLUSION

In this paper, dual band antenna with cross tuning stub is presented for WLAN/ISM Applications. Proposed antenna has successfully been designed for WLAN (2.4/5.8 GHz) and ISM

(2.4/5.8 GHz) bands for frequency range (1.9GHz-3.1GHz, 5.2GHz-6.2GHz) with bandwidth 1.2 GHz and 1.0 GHz respectively. The proposed antenna has axial ratio less than 3 dB, so this antenna is circularly-polarized and VSWR less than 2 dB. The antenna parameters like gain (3-5 dB), return loss notch upto -27/ -50 dB and bandwidth 1.2 /1.0 GHz respectively has improvised to acceptable limit with reasonable radiation pattern. The simulated results of proposed prototypes are yet to be validated through fabrication.

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## Authors Profile

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