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Pentagonal patch antenna for wireless band application with asymmetric CPW feed for Minimum scattering parameter

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Abstract: In this work a new pentagonal CPW antenna designed and simulate using electromagnetic solver for wireless band applications. The proposed antenna consists of on CPW layer with helical ring and having pentagonal patch. The proposed antenna consists of the dimensions of 22x24x1.6mm ^{3} over FR-4 substrate. The proposed antenna showing return loss value <-15db and VSWR <2 moreover the antenna showing high gain value of >3dBi across the operating frequencies with efficiency >80%. The radiation patterns of the proposed antenna were also stated in this paper.

Key words: pentagonal patch, wireless band, CPW, Antenna parameters.

Introduction

Now a days the communication system tending to wireless technologies and their applications. The main aim of multiband antennas are to integrate many application standards in a single functioning antenna. Many applications such as WLAN, Wi-Fi, and WiMAX are able to be operated in single operating antenna. In order to gain knowledge, many multiband antennas have been studied [1], [4], [7], [11]. WiMAX is a technology which took the communication a great leap in advancement. It is preferred because of its long range and capability. WiMAX uses IEEE standard 802.16. Microstrip antennas are vividly known for their small size, low cost and efficiency. They can be used for multi-band applications and high frequencies based on the type of arrangement and application considered. In [3] a zigzag slot E-shaped antenna is proposed and in that to increase the bandwidth zigzag slots are realized on a metallic patch. A meandering split ring slot antenna with CPW feeding mechanism is proposed in [4] with a dual band result stating that notching the frequency can reduce unwanted bands. An asymmetric CPW-fed antenna is designed [5] for WiMAX application for dual band operation but the proposed design matches the reflection coefficient in comparison and the frequency proposed is higher. E-shaped antenna is proposed in [6]. A multipath fading of can be reduced by hexadecogonal circular patch antenna with DGS [7] and used for satellite applications at Ku band. CPW-fed stepped-impedance slot dipole antennas [8] for both dual and triple band applications. Focused on impedance matching of the antenna. A printed LPDA antenna with CPW feeding is proposed in [9] for wireless applications with reflection coefficient of -17 dB and -19 dB for operating frequencies 2.4 GHz and 5.5 GHz. A monopole antenna with meandering resonators [10] is proposed which have four resonating frequencies, with triple frequency

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operation [11] for wireless applications each one having a reflection coefficient greater than -20 dB which is higher than the proposed antenna. In gain comparison high frequency having less gain of 0.6 dBi which is less than proposed design. A substrate integrated wave guide antenna [12] with E-shaped patch having a reflection coefficient of -27 dB for which it is very high frequency yet the gain is also high with 7dBi. A compact CPW-fed antenna [13] with three operating frequencies and the reflection coefficient is less than -25 dB in all three bands which are more than the proposed antenna. A concentric circular patch with DGS antenna [14] is proposed to dual-band operation. A CPW-fed monopole [15] antenna to two notched bands. A flexible CPW-fed antenna is proposed with gain 2.05 dBi and reflection coefficient no more than -24.45 dB and the proposed antenna has better result compared to this design except for its flexibility [16]. The theory of microstrip antennas and their applications have studied through [17].

In this paper the design of a miniaturized dual band antenna using hexagonal ring in the ground structure for ISM band and wireless application has been presented. We have shown the comparison of simulated results and literature survey results.

Design of the proposed antenna

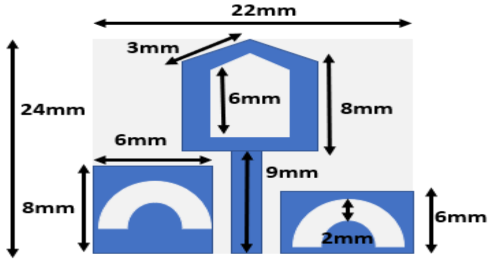

Figure.1. Schematic view of pentagonal CPW patch antenna

The proposed geometry of the antenna is small and straightforward. As illustrated in Figure 1, the proposed patch antenna is CPW feed. This antenna comprises an pentagonal patch with helical ring in the CPW feed. The antenna is built on an FR-4 substrate (relative dielectric constant 4.4). The dimensions are $20x24x1.6mm^3$. The proposed antenna dimensions are stated in the figure 1.

$$f_0 = 5GHz$$

$$€_r = 5$$

$h = 2$ mm

Step 1: Determining the factor which undergoes the property of the material through the Able dielectric constant ($€_r$), which has been formulated using equation (1) as,

$$€_{eff} = \frac{€_r + 1}{2}(1 + 0.3 * h) \quad (1)$$

Step 2: Developing the measuring fields for the material patched to the design by calculating the Length of the Strip (L_s), exemplified in equation (2) for MPA as,

$$L_s = \frac{0.42 * c}{f_r * \sqrt{€_{eff}}} \quad (2)$$

Step 3: Determining the Width of the Ground Plane (W_g) attained with the surface of material developed so far with the patch design, supported through equation (3)

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$$W_g = \frac{1.38*c}{fr*\sqrt{\epsilon_{eff}}} \quad (3)$$

Step 4: Length of Ground Plane (L_g) determined as,

Moreover, the ground plane dimension can be attained through the formulation of equation (4), as

$$L_g = \frac{0.36*c}{fr*\sqrt{\epsilon_{eff}}} \quad (4)$$

Step 5: Certain frequency set for samples ranging through the communication line within a factor that recognizes the range is Resonant Frequency (f_r), and is given through equation (5),

$$f_r = 3 + \frac{2}{\sqrt{\epsilon_{ref}}}\left[\frac{21}{L_s} + \frac{65}{W_g} + \frac{18}{L_g} - 3\right] \quad (5)$$

Results and Discussions

For wireless applications, various types of printed monopole antennas are investigated, including circular, square, elliptical, hexagonal, pentagonal, octagonal, and so on. Such shapes have been associated with Pentagonal-shaped antennas with helical CPW feed for the consideration of analysis within the design developed.

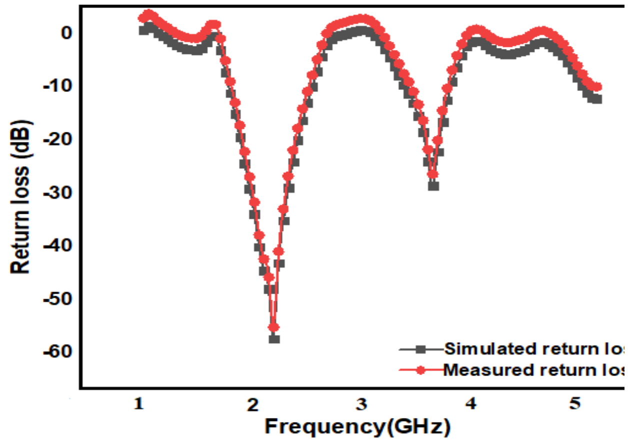


Figure.2 Return loss value of proposed antenna

The above figure 2 stating the return loss value of the proposed antenna across the operating frequency. The proposed antenna having the return loss value of -58dB across the operating frequency of 2.1GHz, similarly across the operating frequency of 3.8 GHz the antenna stating the return loss value of -30dB.By the implementation of the helical ring in CPW layer and pentagonal patch of the proposed antenna showing high performance values in terms of the antenna parameter in figure 2.

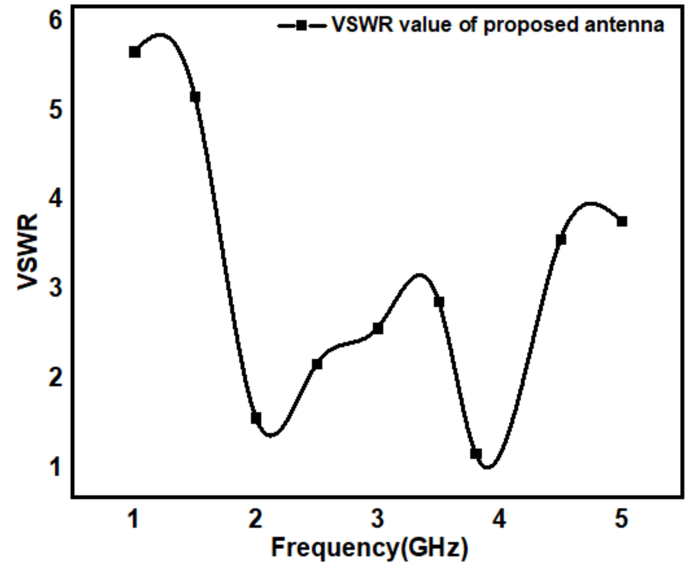


Figure.3 VSWR value of proposed antenna

VSWR is a measure that describes the matching of impedance in the antenna to the connecting line it is associated to. The above figure stating the VSWR value of the proposed antenna across the operating frequency. The proposed antenna having the VSWR value of 1.6 across the operating frequency of 2.1GHz, similarly across the operating frequency of 3.8 GHz the antenna stating the VSWR value of 1 which are in acceptable range. By the implementation of the helical ring in both patch and CPW layer the proposed antenna showing high performance values in terms of the antenna parameters in figure 3.

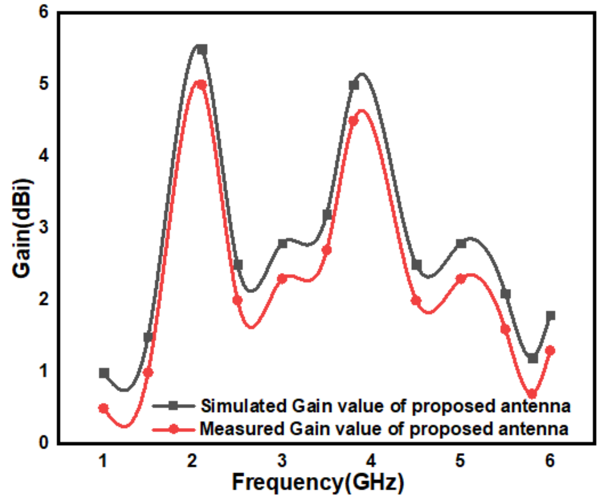


Figure.4 Gain value of proposed antenna

The proposed antenna stating the gain value of >2.5dbi across the operating frequency of 2.1and 3.8 GHz which are used in wireless and ISM band applications in figure 4.

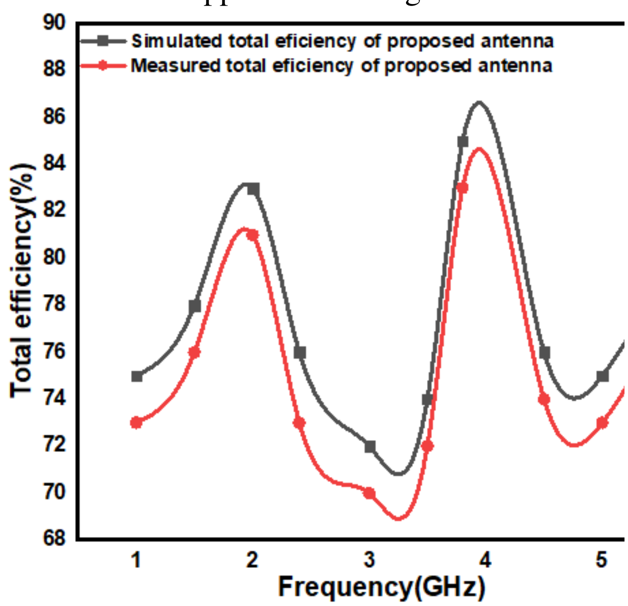
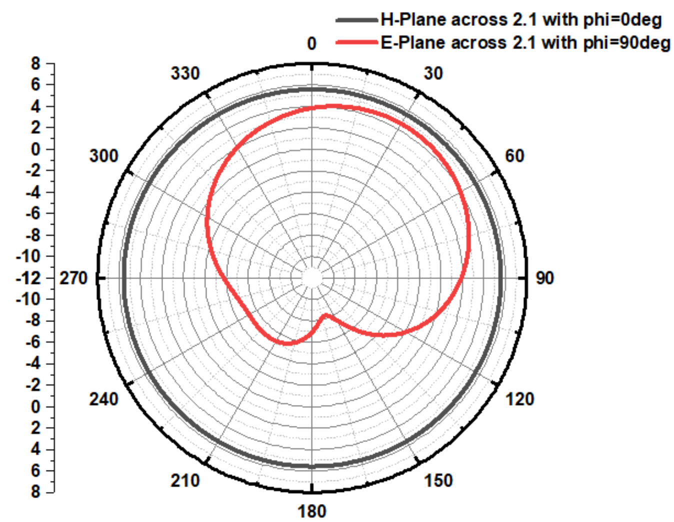
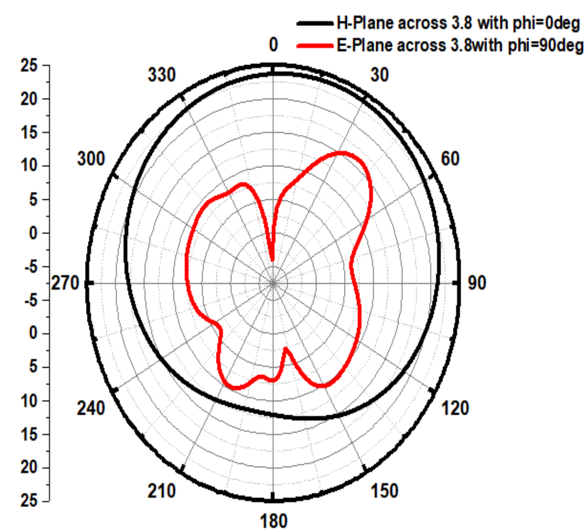


Figure.5 Efficiency value of proposed antenna

The proposed antenna stating efficiency value of >80% across the operating frequency of 2.1GHz, next across the operating frequency of 3.8GHz the proposed antenna showing the efficiency value of >85% in figure 5.



(a)



(b)

Figure.6. Radiation patterns of the proposed antenna across the operating frequency

The proposed antenna stating the radiation pattern across the operating frequency 2.1GHz, and 3.8 GHz. The antenna showing the omni direction in h-plane and single and butterfly shape in E-plane.

Table.1 Comparision work of proposed antenna with literature survey

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Ref	Dimensions(mm)	Operating frequency (GHz)	Band width (B.W)	Peak Gain(dBi)
[19]	42x42x1.6	4.42-6.22	1.8	11
[20]	59x59x3.25	4.77-6.52	1.75	9
[21]	69x69x1.6	5.1-6	0.9	9.85
[22]	69x69x1.6	4-6.5	2.5	11.6
Proposed Work	22x24x1.6	2.1-3.8	0.5,0.8	5.8,5.1

Conclusion:

A dual band hexagonal shape patch antenna covering wireless applications application across 2.1 and 3.8 GHz bands are evaluated with high gain and stable patterns presented in this paper. The proposed design was compact and simple which was easily fabrication with using available FR-4 material. The hexagonal rings in the CPW layer and hexagonal patch improves the performance of the proposed antenna acting as a radiating element. The proposed antenna finds wide applications in modern multiple wireless applications.

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