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Small Size Dual Band Microstrip Antenna with One Band Circularly Polarized Characteristics

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Abstract*— This research article is going to inform a dual frequency band triangular -shaped microstrip antenna. The antenna provides dual frequency bands and a circularly polarized band which is superimposed with the higher frequency band. The dual frequency with circular polarization characteristics has been acquired by using two additional slits on the triangular shaped microstrip patch antenna and a defective ground structure with a small notch. The proposed antenna contributes two frequency bands of 2.2-3 GHz and 8.1-9.2 GHz. The obtained circular polarization bandwidth ranges from 7.95 GHz to 9.13 GHz. The simulated peak gain at 8.1 GHz is 9.13 dBi respectively. The radiation patterns (E plane and H plane) are satisfactory at the different resonate frequencies of the proposed antenna. The proposed antennas are designed and simulated by high-frequency-structure-simulator (HFSS) software and simulated results (reflection co-efficient peak gain and normalized (EH plane) radiation patterns, right-handed circularly polarized radiation pattern and left-handed circularly polarized radiation pattern) are discussed here. The proposed antenna might be beneficial for many wirelessly efficient applications.

Index Terms*— Triangular patch antenna, dual-frequency, circular polarization, reflection co-efficient, gain and radiation patterns.

I. INTRODUCTION

In order to do a variety of functions, modern communication technology depends on small electronic devices with several channels. For multi-services worldwide, many frequency bands are required; for example, mobile technology needs a distinct range of frequency bands to carry out various applications. Therefore, in order to support modern communication systems, a small antenna with multi-band properties is necessary. As wireless technology advances, antennas with circular polarization become increasingly significant. Low profile microstrip antenna is considered as a suitable candidate to fulfill all the above said characteristics. It is crucial to achieve multiband and circular polarization while maintaining its characteristics, such as reflection co-efficient, gain, and radiation patterns etc. Many scientists are working together to complete this difficult task over several days.

A dual band antenna is proposed in [1] for 5G millimeter wave technology. The geometry of the antenna is based on dual loop antennas and microstrip antennas. A dual band antenna uses electric coupling for 5G application was proposed in [2]. A compact antenna was proposed in [3]. It provides two bands with circular polarization. Low profile dual band antenna was proposed in [4]. The dual-band circularly polarized antenna design with structural reuse for one cubic unit (1U) CubeSat applications is proposed in [5]. The proposed antenna is useful in CubeSat applications. A dual band circularly polarized antenna was proposed for wireless application in [6]. It uses multiple slits radiating patch and a modified ground plane. An antenna using defected ground structure and meander line geometry to obtain two bands in [7]. It is useful for X band and C band applications. A dual band circularly polarized antenna was proposed in [8]. It uses a T-like patch and a T-like parasitic element. a crescent-like slot was used in a patch antenna to achieve dual frequency in [9]. The antenna is suitable for IOT applications. Ganesha-like antenna is presented for vehicular application as proposed in [10]. A dual frequency circular polarization (CP) antenna was proposed in [11]. Annular slots were used to achieve two bands. Harmonic rejection achieved in an antenna was proposed in [12]. T like slits were used to achieve dual band and CP nature. A two band CP antenna was proposed in [13]. The antenna geometry uses double pairs of crossed dipoles and it is used for RFID reader. A two band CP antenna was proposed for mm Wave technology [14]. It uses a circular patch and parasitic elements. With a metasurface reflector, a two band CP antenna with excellent gain was suggested in [15] Its geometry consists of an asymmetric ground plane and co-planar waveguide feed technique. A two band CP antenna was proposed for wireless technology in [16]. It uses an L-like slot on the monopole geometry. A CP antenna with eight parasitic elements was proposed in [17] for ISM and medical application.

In this paper, a small size dual frequency triangular-shaped microstrip antenna is proposed. The antenna consists of two slits on the microstrip patch and a defected ground structure. The proposed antenna provides dual frequency bands with one band providing circular polarization. Highlight a section that you want to designate with a certain style, and then select the appropriate name on the style menu. The style will adjust your fonts and line spacing.

II. CONSTRUCTIONAL DETAILS OF ANTENNAS

The proposed antenna is constructed and simulated by HFSS software. FR4 is selected as substrate material to construct the proposed structures. The FR4 having relative permittivity (εr) of 4.4 and height 1.6 mm is used. The loss tangent of FR4 material is .023. Microstrip line feeding technique is applied for excitation of the proposed antenna. The constructional details of the proposed antenna are shown in Fig-(1). The parameters of the proposed antennas are listed in the TABLE (I). The design procedure of the proposed antenna is shown in Fig-(2). (a-d). The first step of the proposed antenna begins with a triangular-shaped microstrip antenna. The first step_1 is shown in Fig-(2) (a). For step_2, a horizontal insert and a vertical insert are introduced in step_1 shown in Fig-(2) (b). Then a modified ring type ground plane is designed in step_2 (Fig-(2) (c)). Finally, a small notch is introduced in step_3 to complete the proposed antenna (Fig-(2) (d)). The reflection-coefficients against frequency of the different steps of the proposed antenna is shown in Fig-(3) and their results are listed in the TABLE (II). The axial ratio against frequency of the different steps of the proposed antenna is shown in Fig-(4) and their results are listed in the TABLE (III). After comparing results of the different steps of the proposed antenna step_4 is considered as the proposed antenna.

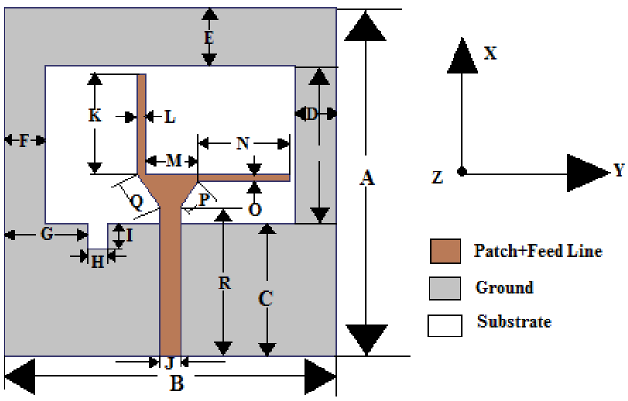

Fig (1): Geometry of the proposed _antenna

Table (I): Dimensions of the different parameters of the proposed antenna in mm

A	B	C	D	E	F
42	40	16	5	7	5
G	H	I	J	K	L
10	2.5	3	2.6	12	1
M	N	O	P	Q	R
6.325	11	1	3	4	18

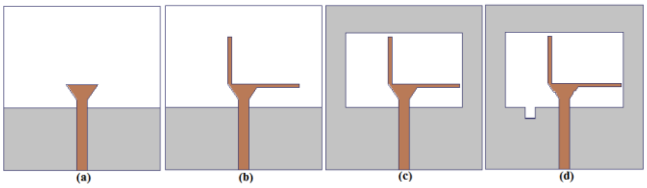

Fig (2) (a-d): Design procedure of the proposed antenna (a) step (1) (b) step (2) (c) step (3) and (d) step (4) (proposed antenna)

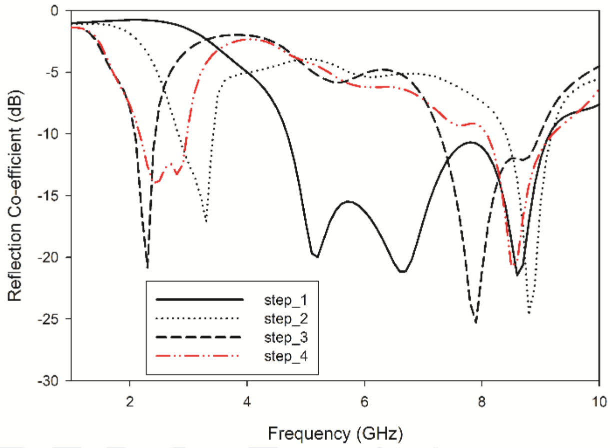

Fig (3): Reflection co-efficient of the different steps of the proposed antenna

Table (II): Reflection co-efficient versus frequency plot results of the different steps of the proposed antenna

Various steps	Bands	Bandwidth
step_1	(4.7-9.1) GHz	4.4 GHz
step_2	(2.9-3.3) GHz and (8.4-9.2) GHz	400 MHz and 800 MHz
step_3	(2.1-2.4) GHz and (7.3-8.9) GHz	300 MHz and 1.6 GHz
step_4 (proposed antenna)	(2.2-3.0) GHz and (8.1-9.2) GHz	800 MHz and 1.1 GHz

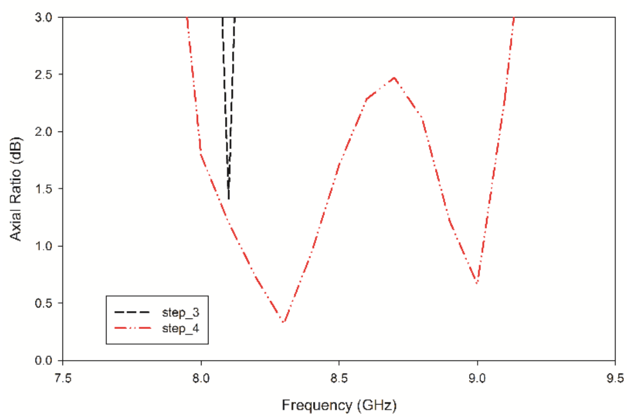

Fig (4): Axial ratio of the different steps of the proposed antenna

Table (III): Reflection co-efficient versus frequency plot results of the different steps of the proposed antenna

Various steps	Axial ratio band	Axial ratio bandwidth
step_1	Nil	Nil
step_2	Nil	NIl
step_3	(8.07-8.12) GHz	50 MHz
step_4(proposed antenna)	(7.95-9.13) GHz	1.18 GHz

III. SIMULATED RESULTS OF ANTENNAS

In this section simulated results of the proposed antenna are discussed. The antennas are simulated by HFSS software. The reflection co-efficient plot for the proposed antenna is shown in Fig-(5). Gain plot of the proposed antenna is shown in Fig-(6). E plane and H plane normalized radiation patterns of the proposed antenna are shown in Fig-(7(a-c)). Normalized LHCP (left-handed circular polarization) and RHCP (right-handed circular polarization) radiation patterns of the proposed antenna are shown in Fig-(8(a-b)). The proposed antenna provides two bands. One band rangse from 2.2 to 3.0 GHz and another band ranges from 8.1 to 9.2 GHz. The bandwidth of the two bands is 800 MHz for the lower band and 1.1 GHz for the upper band respectively. The percentage bandwidth of the lower band is 30.76 % and percentage bandwidth of the upper band is 12.71% respectively. The peak gain of the proposed antenna is 9.4 dBi at 7.9 GHz. The obtained axial ratio ranges from 7.95-9.13 GHz. The axial ratio bandwidth is 1.18 GHz which is 13.81%. The normalized (E-H) plane radiation patterns of the proposed antenna at 2.4, 2.8 and 8.5 GHz are shown in Fig-(7(a-c)). The normalized (LHCP and RHCP) radiation patterns of the proposed antenna at 2.4, 2.8 and 8.5 GHz are shown in Fig-(8(a-b)).

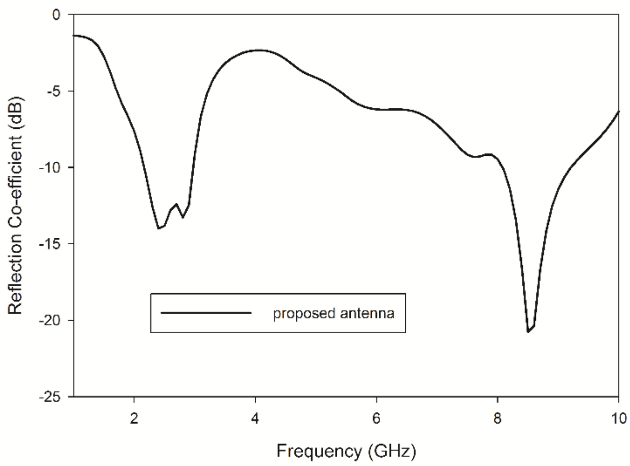

Fig (5): Reflection co-efficient of the proposed antenna

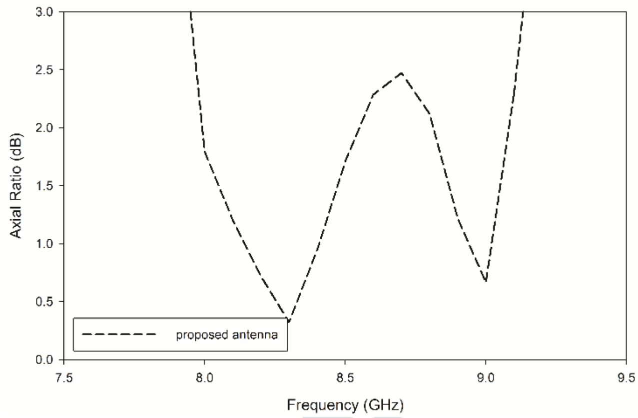

Fig (6): Axial ratio plot of the proposed antenna

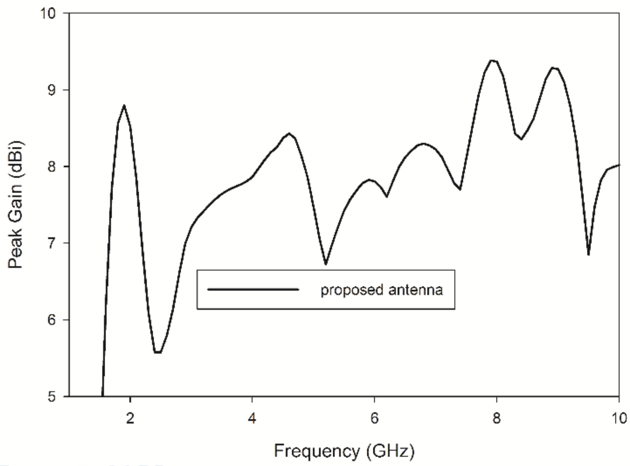

Fig (3): peak gain plot of the proposed antenna

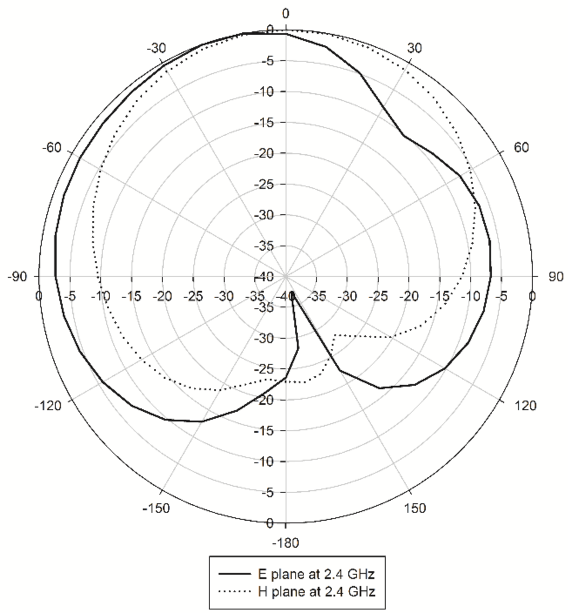

Fig (7. a): Radiation patterns of the proposed antenna at 2.4 GHz

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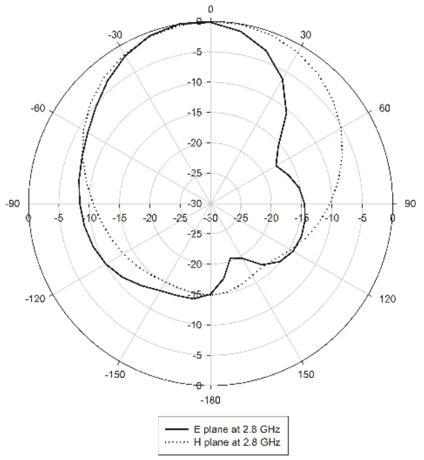

Fig (7. b): Radiation patterns of the proposed antenna at 2.8 GHz

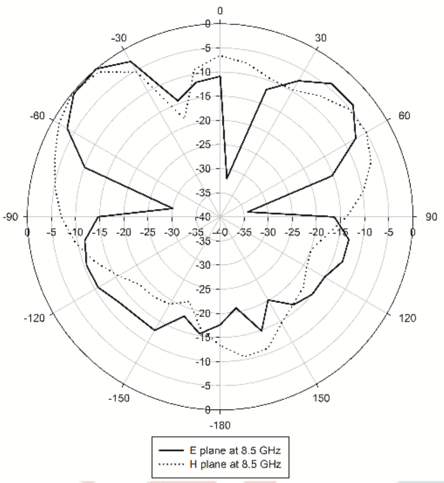

Fig (7.c): Radiation patterns of the proposed antenna at 8.5 GHz

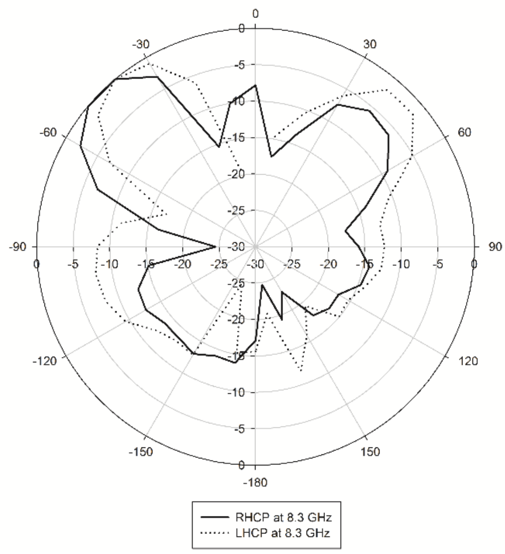

Fig (8. a): (LHCP and RHCP) Radiation patterns of the proposed antenna at 8.3 GHz

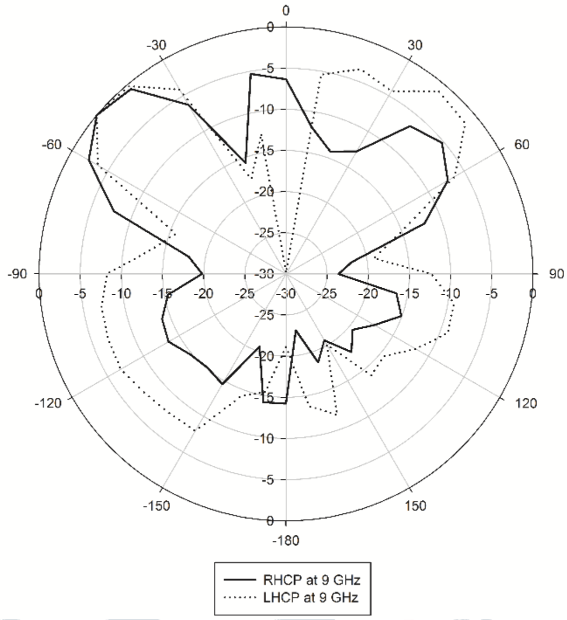

Fig (8. b) :(LHCP and RHCP) Radiation patterns of the proposed antenna at 9 GHz

IV. CONCLUSION

In this paper, A small size triangular-shaped microstrip antenna has been proposed. The antenna provides dual band of frequencies. Two bands are (2.2-3.0) GHz and (8.1 -9.2) GHz. Two bandwidths are 800 MHz and 1.1 GHz for the first band and second band respectively. The percentage bandwidth of 30.76 % and 12.71% are obtained for the first band and second band respectively. The maximum 9.4 dBi gain has been obtained at 7.9 GHz. An axial ratio band has been overlapped with the second band of frequencies. (7.95-9.13 GHz) 3 dB axial ratio is obtained from the proposed antenna which is 1.18 GHz ARBW and 13.81% of ARBW. E-plane and H-plane, RHCP and LHCP radiation patterns at different resonant frequencies are also presented in the previous section. Proposed antenna is designed by HFSS software. The antenna uses small geometry. The antenna may be useful for wireless applications

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