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TRUNCATED TIP TRIANGULAR MICROSTRIP PATCH ANTENNA WITH NARROW SLITS FOR S, C BAND OPERATION

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ABSTRACT

This paper represents a design of triangular microstrip antenna with truncated tip and narrow slits. This design technology is achieved by cutting all three tips of the equilateral triangular microstrip antenna and placing a single microstrip inset feed. The main aim of the paper is to obtain a better return loss, band width and directivity with reduced size. The triangular patch antenna is designed on a FR4 substrate of thickness 1.6 mm and relative permittivity of 4.3 and mounted above the ground plane. The proposed antenna is operating on dual band operation. The design frequency of antenna centred at 2.5 GHz and 5.7 GHz frequency. The proposed patched antenna is designed and all the parameters are simulated on CST microwave studio 2014. Microstrip antenna with a single feed and a single layer gives dual band operation by loading a pair of narrow slots close to the patch's radiating edges.

Keywords- *Equilateral triangle, Microstrip Patch Antenna, Slit line, Inset feed, Directivity, Return loss.*

I. INTRODUCTION

The rapid developments of communication technology in resent time define more and more requirements towards communication devices to operate in several frequency bands [1, 2]. Therefore to fulfil these requirements fractal shaped antenna usage in telecommunication devices [3]. Their characteristics correspond to multiple usage and relatively small size [4]. The triangular patch antenna is chosen because it occupies less area on the substrate than the other patch [5]. FR 4 substrate is chosen to fabricate the antenna with the thickness of 1.6 mm and the dielectric constant value of ϵ_r =4.3. The FR4 substrate is chosen because of low cost and resistant it offer to the water. This antenna is centred at two frequency 2.5 GHz and 5.7 GHz frequency having better directivity , gain , low VSWR, and return loss(<-10 dB). A patch antenna possesses many advantages such as low profile, light weight, small volume and capability with microwave integrated circuit and monolithic microwave integrated circuit [6, 7]. In this paper, triangular microstrip antenna with truncated all the three tips is proposed, and two narrow slit cut on the side of the equilateral triangle and also single slit at the centre [8]. For better performance of this antenna the inset feed is used [9]. However the narrow band width is the major problem in wide applications for the microstrip antenna. There are various methods to solve this problem such as by making different type of slot on the patch, by inserting slits and slot and array technique [10]. In this paper truncated tip triangular microstrip antenna with slit on patch is proposed.

Unlicensed frequency band cover ISM band such as 5 GHz band provides sharing of radio resources that is feasible and used more frequently. The 5GHz unlicensed frequency band covers the radio spectrum between 5.15GHz and 5.825GHz. This antenna is applicable for wireless application, RFID applications, and satellite communication and others. The dimension of the patch is very important parameter of antenna which defines the operating frequency of the antenna for different type of patch. These patches are feed by different method but the feed should be 50 ohm resistance. In this paper inset feed is used and the microstrip line feed width and length is calculated by ADS line calculator or microstrip line calculator.

II. DESIGN PROCEDURE

For designing an antenna several parameters are needed like side length, input impedance, width, length etc. For different substrates different shape of triangular patch antennas have been designed because the value of designing parameters changes with the substrates [11, 12].

1) Resonant Frequency (f_r): The resonant frequencies can be obtained from the cavity model with perfect magnetic walls is given by following formula:

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$$f_r = \frac{cK_{mn}}{2\Pi\epsilon_r^{1/2}} \quad (1)$$

Where m, n = mode number
C= free space velocity of light
ϵ_r=Dielectric Constant
And K_{mn}= Wave Number, is given by

$$K_{mn} = \frac{4\pi}{3a}\ (m^2 + mn + n^2)^{1/2} \quad (2)$$

Where a = Side length of triangular patch the resonant frequency of ETMA is given as

$$f_r = \frac{2c}{3a\epsilon_r^{1/2}}(m^2 + mn + n^2)^{1/2} \quad (3)$$

2) Calculation of Effective dielectric constant (ϵ_{eff}): Equation (4) gives the effective dielectric constant as:

$$\epsilon_{eff} = \frac{1}{2}(\epsilon_r + 1) + \frac{1}{4}\frac{\epsilon_r - 1}{\sqrt{1 + \frac{12h}{a}}} \quad (4)$$

3) Calculation of the Effective side length (a_{eff}): Equation (5) gives the effective length as:

$$a_{eff} = a + \frac{h}{\sqrt{\epsilon_r}} \quad (5)$$

4) Calculation of the fundamental mode resonance frequency (f_{10}): Equation (6) gives the expression of fundamental mode (m,n)=(1,0) resonance frequency:

$$f_{10} = \frac{2c}{3a_{eff}\sqrt{\epsilon_{eff}}} \quad (6)$$

5) Calculation of the width of microstrip transmission line (w):

$$B = \frac{60\,\Pi^2}{z_0\sqrt{\epsilon_r}}$$

$$W = \frac{2h}{\Pi}\left\{B - 1 - \ln(2B - 1) + \frac{\epsilon_r - 1}{2\epsilon_r}\left[\ln(B - 1) + 0.39 - \frac{0.61}{\epsilon_r}\right]\right\} \quad (7)$$

III. DESIGN GEOMETRY

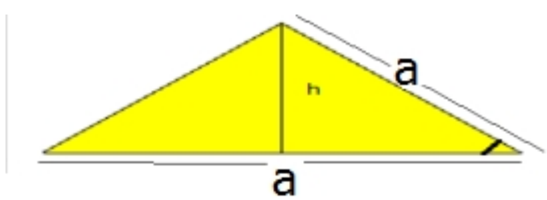

Fig.1 (a) Basic structure of triangular patch

Table 1 Parameter of equilateral triangular patch

a(side length)mm	h(height)mm	ɵ
38	32.9089	60

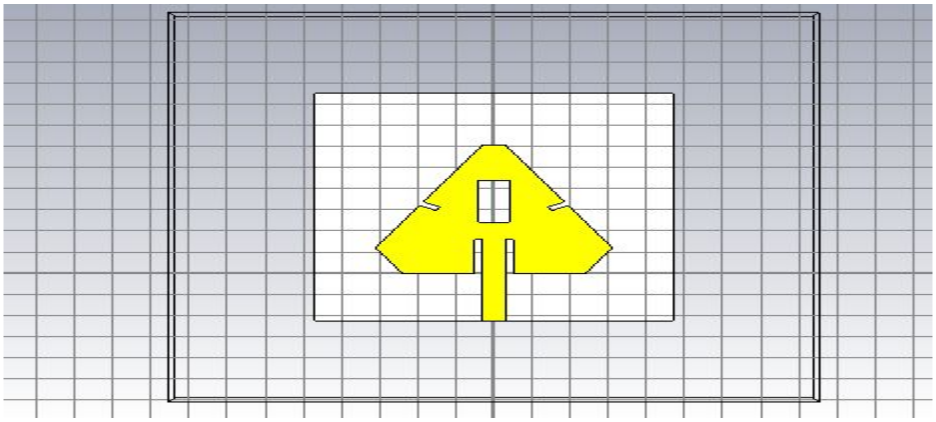

Fig 1(b) structure of truncated tip triangular microstrip patch antenna with narrow slits

Table 2 Parameter of truncated tip

Tip dimension		Tip width (mm)	Tip height(mm)
	Upper tip	w_1=3	h_1=2.5980
	Lower tip	w_2=6.9282	h_2=6

Table 3 Parameter of slit

Smaller slit width(mm)	Smaller slit length(mm)
w_3=1	l_3=2.5
Larger slit width(mm)	Larger slit length(mm)
w_4 =4	l_4 = 10

Table 4 Parameter of inset feed

Inset feed width(mm)	Inset feed length(mm)
w_5=5	l_5=8

Table 5 Parameter of microstrip line feed

Width of microstrip line(mm)	Length of microstrip line(mm)
w_6 =3.0915	l_6=19.24

Table 6 Parameter of substrate

Width of substrate(mm)	Length of substrate(mm)
w_7= 47	l_7=42.5

IV. DESIGN AND METHODOLOGY

The main aim of this paper is to enhance the dual frequency application and improving the parameters of antenna (Beam Width, Directivity, Gain, and Return Loss). Design modification is achieved by the help of cutting all the three tip of equilateral triangle. Two narrow slits are cutting at the midpoint of the sides of triangular patch and a single rectangular slit at the centre. The proposed antenna is simulated using CST microwave studio 2014.

The design is obtained by considering the input resonance frequency (f_r), sides of equilateral triangle (a), dielectric constant (ϵ_r), and the thickness of the dielectric constant (h)

V. SIMULATION RESULTS

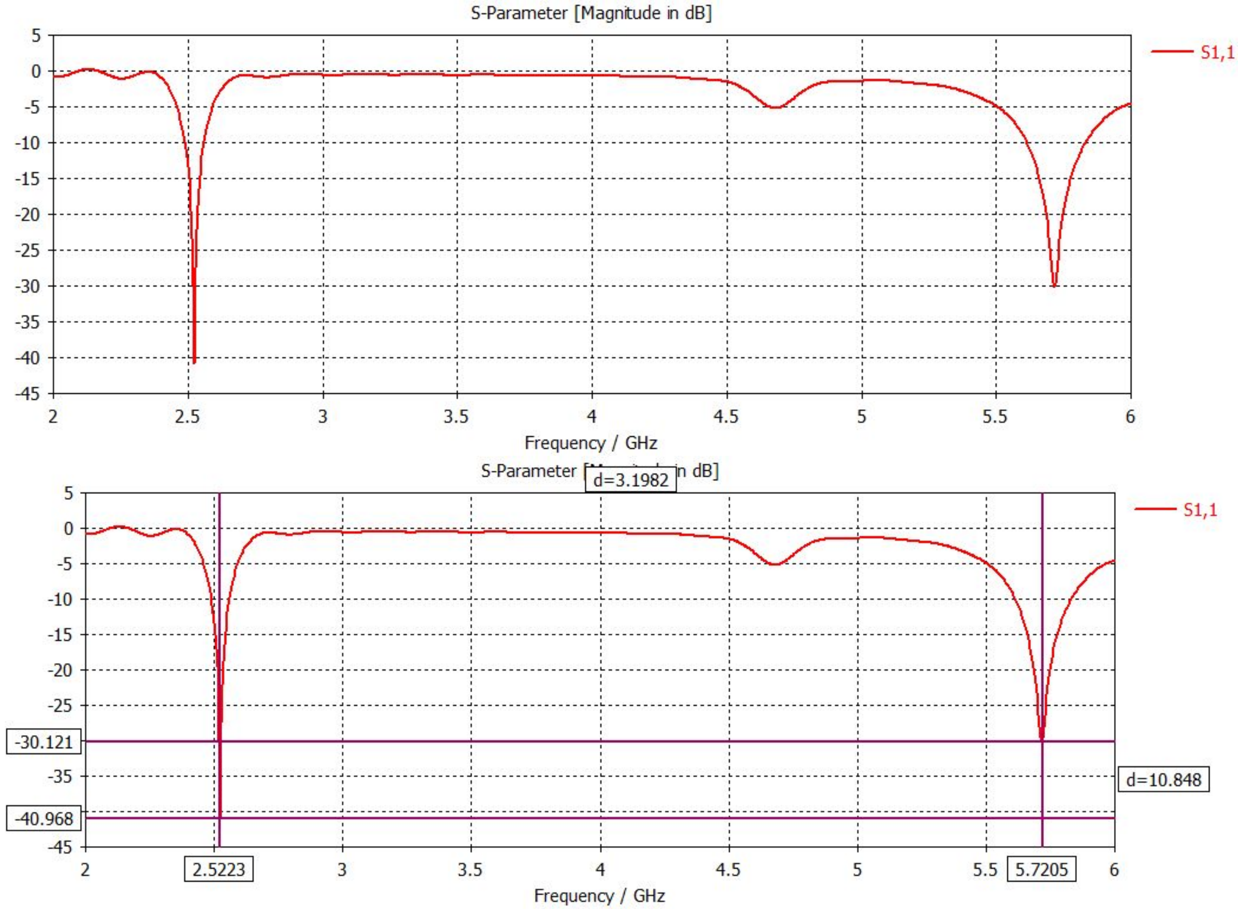

Fig 2(a) return loss plot

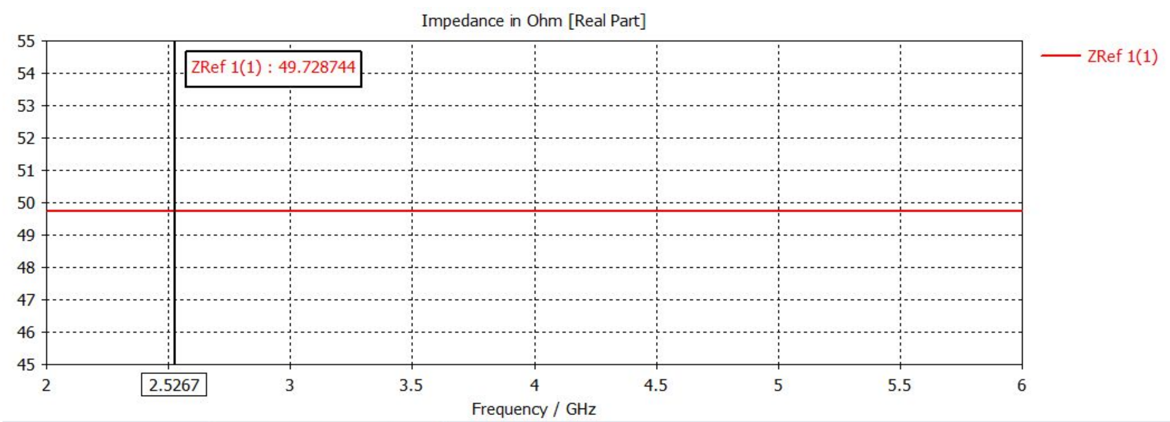

Fig 2(b) reference impedance plot

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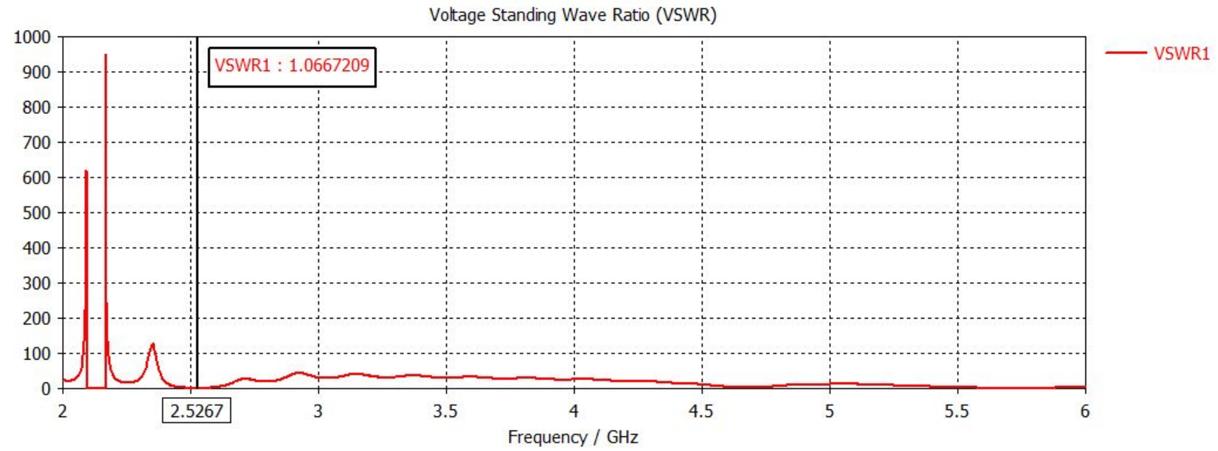

Fig 2(c) VSWR plot

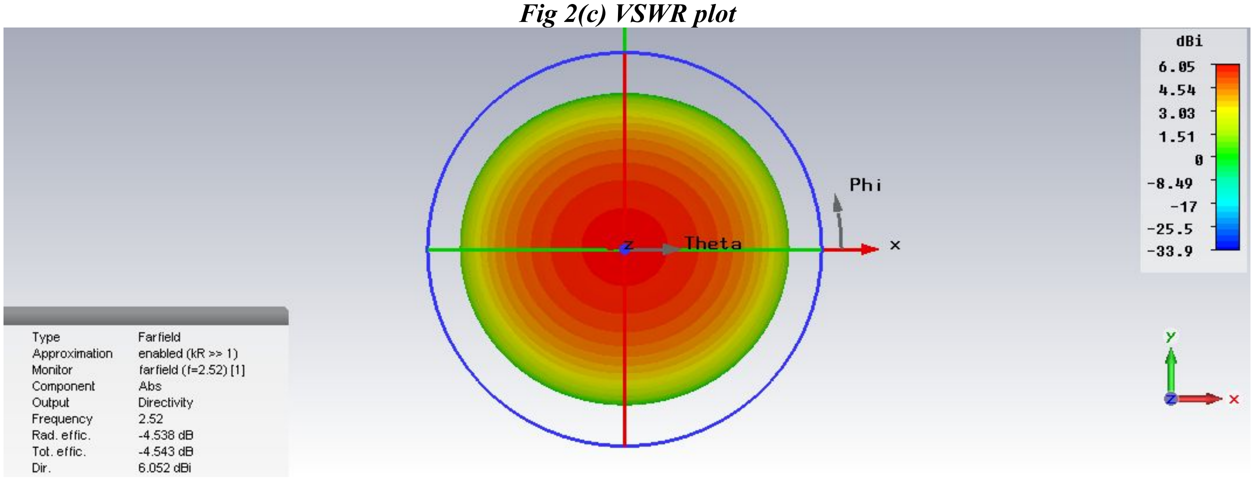

Fig 2(d) far field pattern at (2.52GHz)

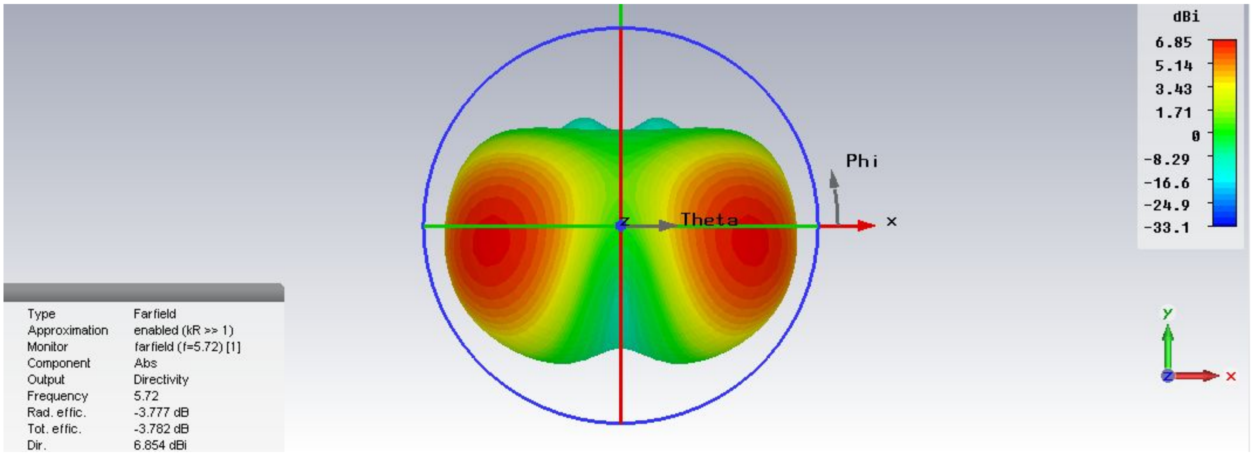

Fig 2 (e) far field patterns at (5.7GHz)

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Table 7 Optimum results for truncated tip triangular microstrip patch antenna with slit

Resonance frequency(GHz)	Return loss(dB)	Directivity(dBi)	VSWR	Band width(MHZ)	Reference Impedance(Ohm)
2.52	-40.968	6.052	1.06	85	49.72
5.72	-30.121	6.854	1.07	245	49.72

VI. RESULT ANALYSIS

The truncated tip triangular microstrip patch antenna with narrow slits provides two resonant frequencies which are centred about 2.5 GHz and 5.7 GHz. The maximum gain of the antenna 4.672(dB) achieved at lower frequency and at higher frequency is 3.077(dB). The result of proposed antenna like directivity, VSWR, return loss and band width is far better than the previous work.

VII. CONCLUSION

In this paper the dimension of the antenna is calculated carefully to achieve the optimum result. The design of the antenna is simulated by the help of computer simulation technology microwave studio. The results for return loss and VSWR plot are obtained and compared. The narrow slits provide the improvement in the band width. This antenna is beneficial in the field of wireless communication, RFID application, satellite communication and Wi-max technology.

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