Design of Rectangular Patch Antenna with Triangular Cut Shape at Dual Band for Wireless Communication

[1]Sudhakar Sharma, [2]Sandeep Kumar Agrawal, [3]Dharmendra Kumar Tripathi
Research scholar, Dept. of Electronics and Communication Engineering, RJIT, Gwalior, India[1]
Assistant professor, Dept. of Electronics and Communication Engineering, RJIT, Gwalior, India[2]
Assistant professor, Dept. of Master & Computer Application, RJIT, Gwalior, India[3]

Abstract: The patch antenna can be used as a feed for radar, Biometric devices and military aircraft. Therefore, we require a patch antenna that will have a wide beam width to provide optimum illustration of wireless communication. Micro strip patch antenna is working on frequencies 1.5789 GHz & 2.5263 GHz; it is a dual band antenna. The s- parameter clearly represents the multi bands with -10db and -17.5db at 1.5789 GHz & 2.5263 GHz respectively. Represents the VSWR (voltage standing wave ratio) of triangular slot antenna whose value should be between 1 and 2. It is used to measure the efficiency of transmission lines. The value of VSWR for the antenna is less than 2 for both 1.5789 GHz & 2.5263 GHz Radiation pattern is the graphical representation of relative field strength of antenna. Generally, the antenna should not have any side lobes. Even if they are present we cannot eliminate them instead we should minimize them the pattern of rectangular patch antenna. The radiation pattern of triangular slot patch antenna 1.5789 GHz & 2.5263 GHz .The directivities are 7.28dbi and 9.3dbi respectively. They are lighter in weight, low volume, low cost, low profile, smaller in dimension and ease of fabrication and conformity. By use of this combination it has been seen that there is a step up of return loss. These structures are simulated using IE3d Electromagnetic simulator of Zealand software incorporation.

Index Terms **- VSWR, Directivity, Dual Band frequency, Beam width, Bandwidth and return loss**

I. INTRODUCTION

It has found that rectangular patch of triangular cut shape micro-strip patch gives more impedance bandwidth than normal patch antenna [1, 2]. For superior antenna performance, a thick dielectric 4.4 substrate with low dielectric constant is advantageous as this provide large bandwidths [4]; high radiation power and better efficiency concurrently reduce conductor loss and Q factor. For antenna designers, bandwidth improvement is the main problem [7]. Improvement of bandwidth can be achieved by working on different parameter such as by varying height, or thickness of dielectric substrate is 1.6mm [13], or by changing of dielectric constant material of substrate, etc. If we compare dielectric resonator antenna with other antenna such as micro-strip antenna [8], we will find out that dielectric resonator antenna (DRA) has better antenna efficiency and wider bandwidth [6].

II. DESIGN PROCEDURE OF PATCH ANTENNA

To design the patch antenna some parameters are necessary such as operating frequency, Dielectric constant of the dielectric material, substrate height etc [8]. By using the formulas we can calculate the patch length, width, effective length, effective dielectric constant, resonant frequency etc.

(a) Designing of Rectangular Micro Strip Patch Antenna

Given: Operating frequency (f_r) = 1.57895 GHz & 2.52632GHz,
Dielectric constant of the substrate ε_r=4.4
Height of the substrate (h) =1.6mm
Loss tangent = 0.02
Feed type Transmission line

(b) Calculation of Width (W)

$$W = \frac{V_0}{2 f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \tag{1}$$

Where, V_0 = free space velocity of light

ε_r = Dielectric constant of substrate

(c) Calculation of Effective Dielectric Constant

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}} \quad (2)$$

(d) Calculation of Effective Length (L_{eff})

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{reff}}} \quad (3)$$

(e) Calculation of Length Extension (ΔL)

$$\Delta L = 0.412h \frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)} \quad (4)$$

(f) Calculation of Actual Length

$$L_{eff} = L + 2\Delta L \quad (5)$$

(g) Calculation of Half Power Beam Width (HPBW)

The HPBW of Electric and magnetic field

$$\theta_E = 2\,\mathrm{Sin}^{-1}\sqrt{\frac{7.03}{(3L^2 + h^2)\,k_0^2}} \quad (6)$$

$$\theta_H = 2\,\mathrm{Sin}^{-1}\sqrt{\frac{1}{2 + k_0 W}} \quad (7)$$

$$K_0 = \frac{\pi}{\sqrt{\varepsilon_{reff}}\; L} \quad (8)$$

(h) Calculation of Directivity

$$D = 41253/\theta_E\theta_H \quad (9)$$

(i) Calculation of Gain

$$G = (32400/\theta_E\theta_H) \quad (10)$$

III. PROPOSED DESIGN

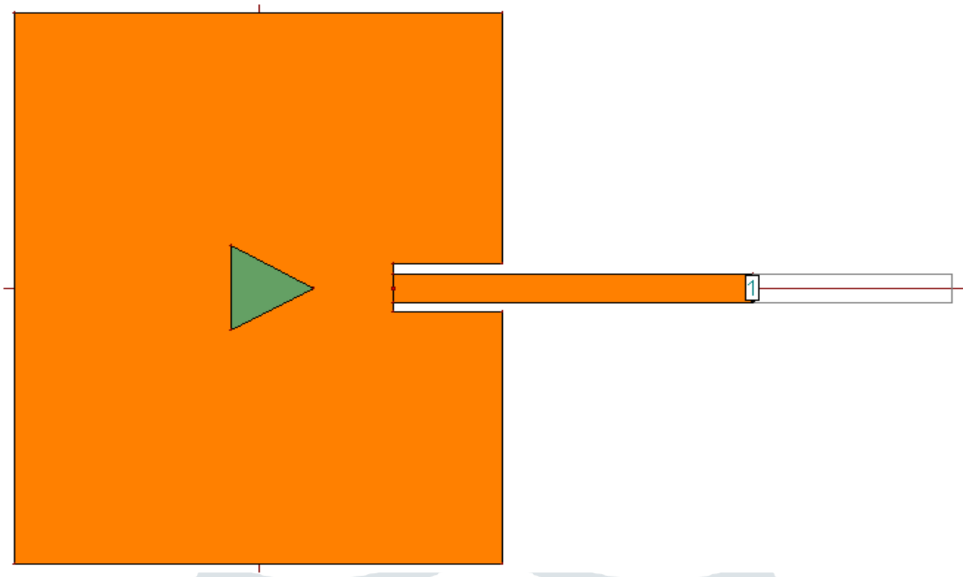

Fig. 1: Rectangular patch of triangular cut Shape Antenna

Specification:

PARAMETER	**VALUE/TYPE**
Width of the patch	44.45m
Cut width	5mm
Length of the patch	57.05 mm
Cut depth	10mm
Dielectric material	Glass epoxy
Path length	32.815mm
Dielectric constant	4.4
Width of feed	3.009mm
Substrate height	1.6 mm
Feed type	Transmission line
Loss tangent	0.02
Length of the Strip Line	38.525 mm
Width of Strip Line	3.009 mm
Operating frequency	1.57895 GHz & 2.5262 GHz
Cut on ground Triangular	Radius 5mm

IV. RESULT ANALYSIS

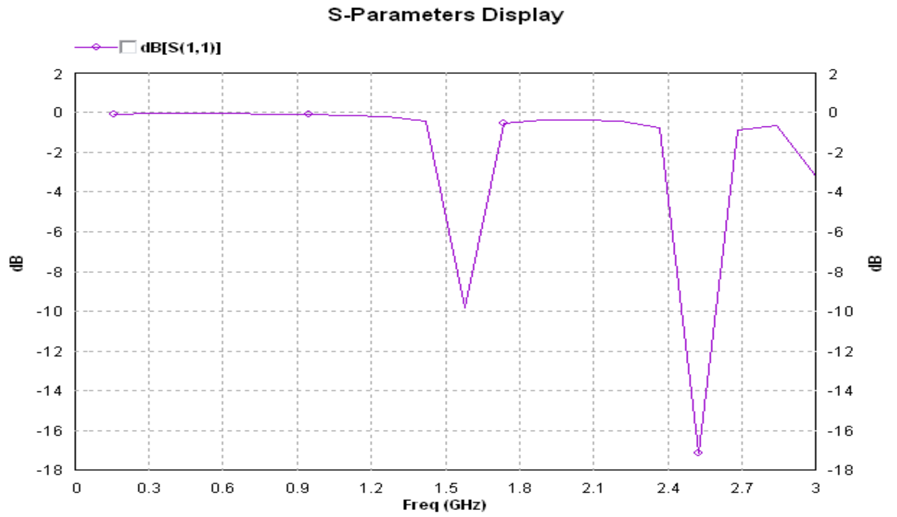

Fig. 2: Return Loss Graph v/s Frequency

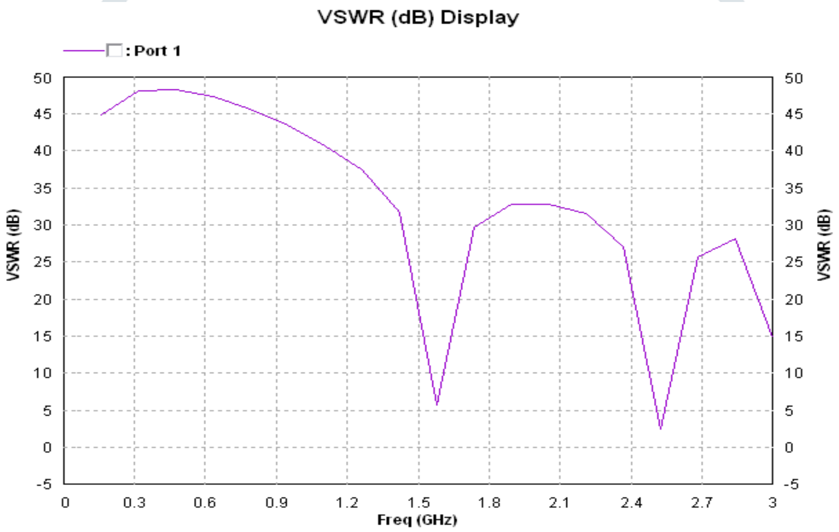

Fig. 3: VSWR Graph v/s Frequency

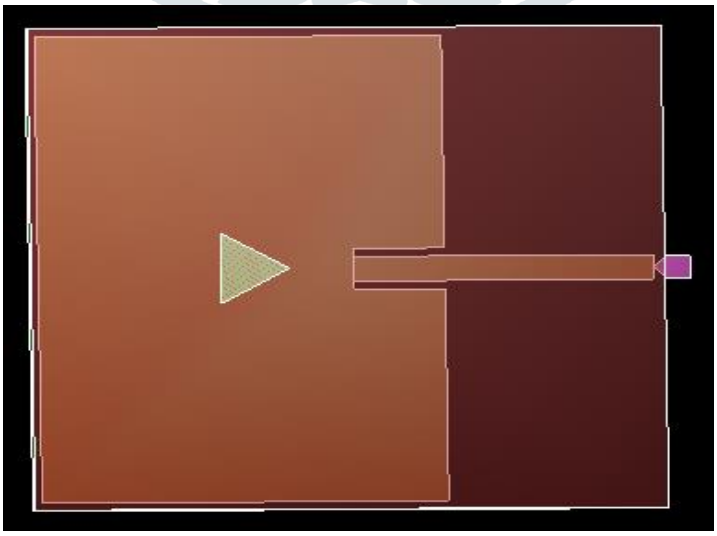

Fig. 4: 2D Pattern

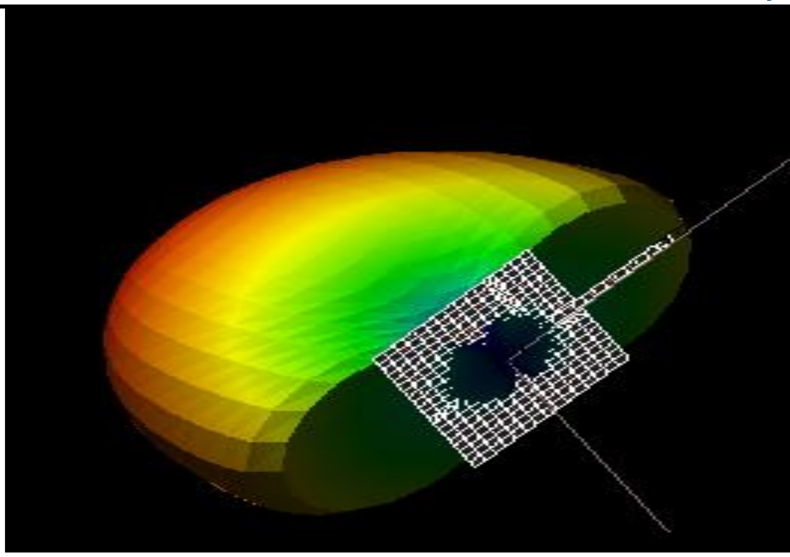

Fig. 5: 3D Pattern

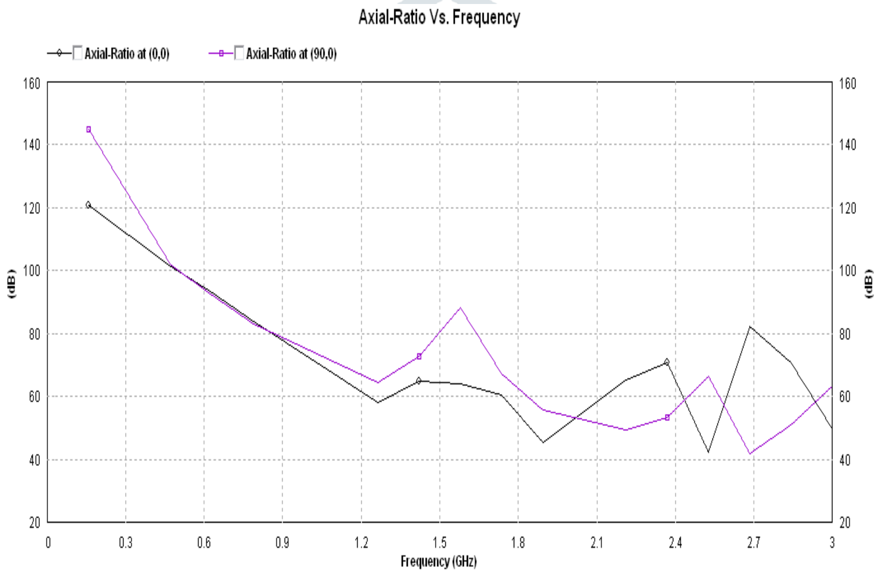

Fig.6: Axial Ratio Vs Frequency

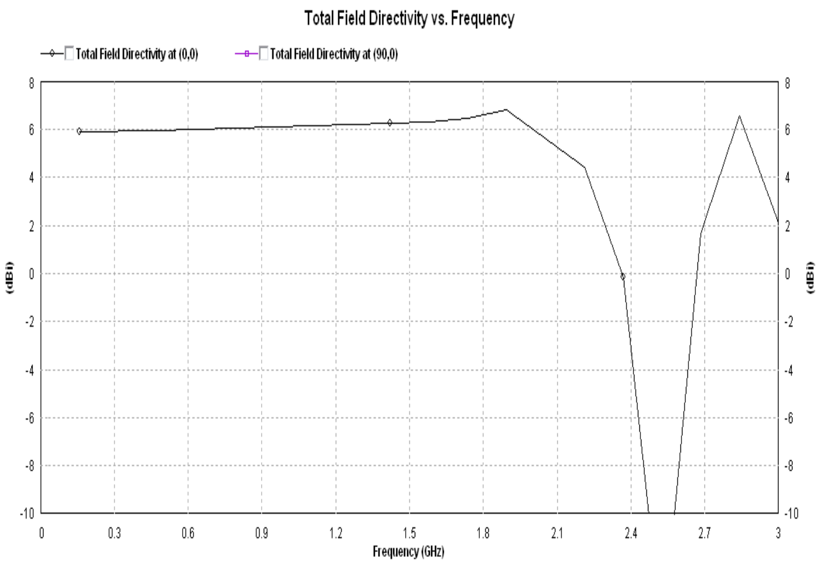

Fig. 7: Total Field Directivity Vs Frequency

Frequency:	1.57895 (GHz)
Incident Power:	0.01 (W)
Input Power:	0.00896238 (W)
Radiated Power:	0.00393439 (W)
Average Radiated Power:	0.000313089 (W/s)
Radiation Efficiency:	43.899%
Antenna Efficiency:	39.3439%
Conjugate Match Efficiency:	21.9495%
Voltage Source Efficiency:	14.9153%
Conjugate Match Factor:	0.896238
Gain:	2.23076 dBi
Directivity:	6.28198 dBi
Maximum:	at (0, 20) deg.
3dB Beam Width:	(81.1586, 166.539) deg.
Conjugate Match Gain:	-0.303772 dBi
Voltage Source Gain:	-1.9817 dBi
Radiated Power in Whole Space:	0.00393439 (w)
Radiated Power in Upper Space:	0.00393316 (w)
Radiated Power in Lower Space:	1.23325e-006 (w)
Radiation Efficiency in Whole Space:	43.899%
Radiation Efficiency in Upper Space:	43.8852%
Radiation Efficiency in Lower Space:	0.0137603%
Antenna Efficiency in Whole Space:	39.3439%
Antenna Efficiency in Upper Space:	39.3316%
Antenna Efficiency in Lower Space:	0.0123325%

Frequency:	2.52632 (GHz)
Incident Power:	0.01 (W)
Input Power:	0.00980534 (W)
Radiated Power:	0.0034434 (W)
Average Radiated Power:	0.000274017 (W/s)
Radiation Efficiency:	35.1176%
Antenna Efficiency:	34.434%
Conjugate Match Efficiency:	17.5588%
Voltage Source Efficiency:	19.9874%
Conjugate Match Factor:	0.980534
Gain:	3.21956 dBi
Directivity:	7.84969 dBi
Maximum:	at (70, 270) deg.
3dB Beam Width:	(56.1411, 67.219) deg.
Conjugate Match Gain:	0.294632 dBi
Voltage Source Gain:	0.857257 dBi
Radiated Power in Whole Space:	0.0034434 (w)
Radiated Power in Upper Space:	0.00344309 (w)
Radiated Power in Lower Space:	3.12551e-007 (w)
Radiation Efficiency in Whole Space:	35.1176%
Radiation Efficiency in Upper Space:	35.1144%
Radiation Efficiency in Lower Space:	0.00318755%
Antenna Efficiency in Whole Space:	34.434%
Antenna Efficiency in Upper Space:	34.4309%
Antenna Efficiency in Lower Space:	0.00312551%

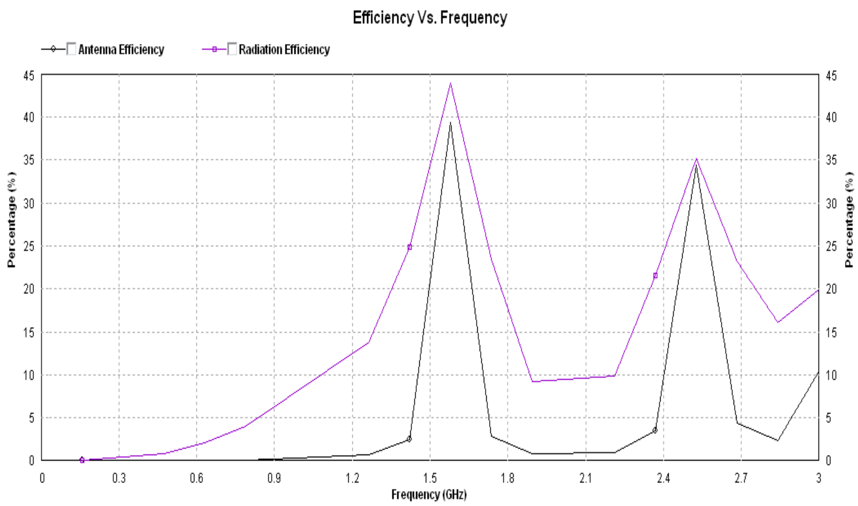

Fig. 8: Efficiency Vs Frequency

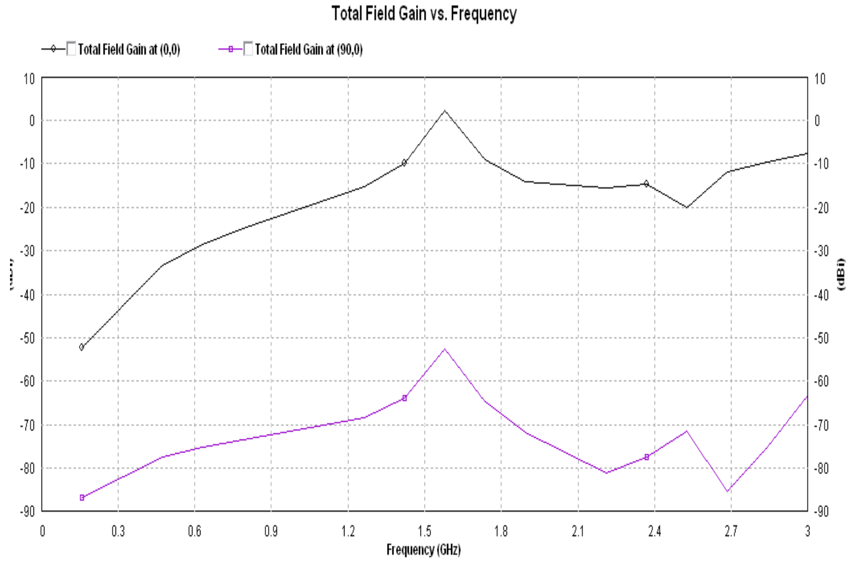

Fig. 9: Total Field Gain Vs Frequency

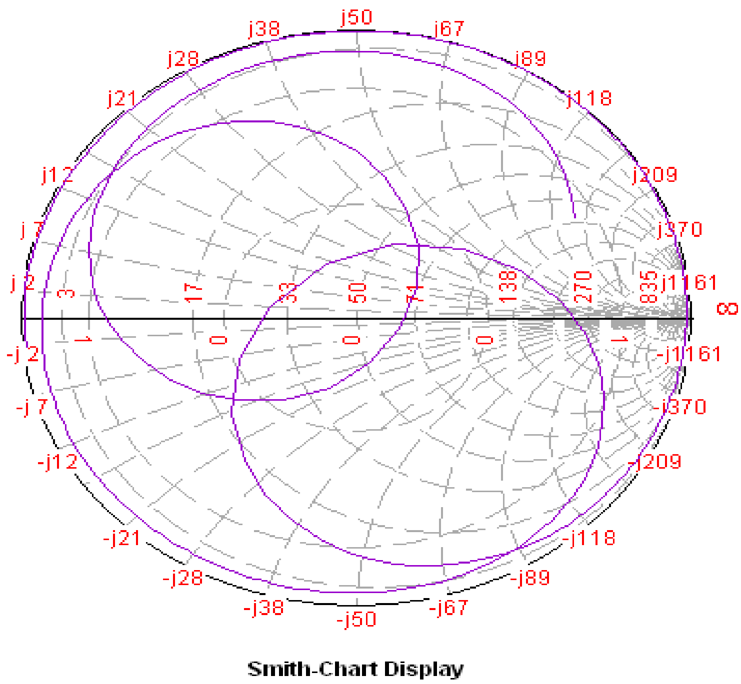

Fig. 10: Smith Chart Display

V. CONCLUSION

The simulation result that represents the multiband behavior of antenna when a triangular slot is cut shape. The s- parameter clearly represents the multi bands with -10db and -17.5db at 1.57895 GHz & 2.52632GHz respectively. The VSWR of rectangular patch antenna which is less than 2.It is used to measure the efficiency of transmission lines. The value of VSWR for the antenna is less than 2 for both 1.57895 GHz & 2.52632GHz. Radiation pattern is the graphical representation of relative field strength of antenna. The directivities are 7.28dbi and 9.3dbi respectively. It is very important to take the feed technique the impedance and the substrate is the main parameters into consideration. The proper position to terminate the Feed line also affects the performance of the antenna. As said different type of feed technique affects the performance of the antenna. The difference between two feed techniques Co-axial feed and Micro strip feed line is shown in this paper and the results implies the performance of the antenna. A single patch can give limited output such as gain, directivity and scanning capabilities.

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