DIAMOND SHAPED FRACTAL ANNTENA DESIGN & SIMULATION FOR WIRELESS APPLICATION

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Abstract*— A Miniature Fractal antenna designed and simulation for wireless application. This paper presents a novel design of a Diamond Shaped Parasitic microstrip antenna with compact nature and the study of various antenna parameters. The antenna is fed by coaxial probe feeding technique. The proposed microstrip antenna is designed and simulated in CST simulation software. Design antenna at 2.8GHz (L-band) frequency, we study and investigate the results using CST software. We use the same dielectric substrate 4.2, loss tangent 0.02 and having the same substrate height 1.6mm. The antenna size is very compact (46mm × 36mm × 1.6mm) and covers 2 GHz to 8 GHz The designed antenna on 2.8GHz (L-band) frequency showing the bandwidth 21.7% and having return loss -29.7526 dB. All the other respective results, i.e., VSWR, gain, directivity and power pattern of both the bands are shown with the help of CST software.

Index Terms: - Microstrip Antenna, Diamond shaped parasitic design, CST Software, Bandwidth, Gain, Directivity and VSWR.

I. INTRODUCTION

In this design study, the main purpose was to design a Diamond Shaped Parasitic microstrip antenna. Previous works are also dealing with the bandwidth increasing techniques by changes on the geometry. Some articles and applications are examined about micro strip antennas [5]. There is a Diamond Shape Parasitic antenna which operates in L band, but they do have a wider bandwidth [1]. The development of antenna for wireless communication also requires an antenna with more than one operating frequencies. This is due to many reasons, mainly because there are various wireless communication systems and many telecommunication operators using various frequencies [6]. However, the general microstrip patch antennas have some disadvantages such as narrow bandwidth etc. Enhancement of the performance to cover the demanding bandwidth is necessary [7]. Among these standards, the following frequency bands can be mentioned:

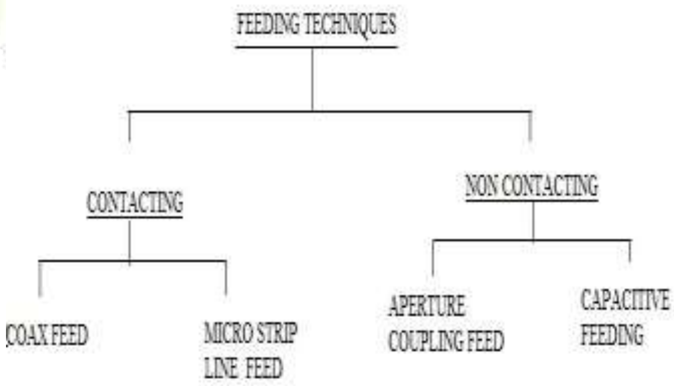
1) PCS-1900 requires a band of 1.85 - 1.99 GHz; 2) IEEE 802.11b/g requires a band of 2.4 - 2.484 GHz; 3) IEEE 802.11a requires a band of 5.15 - 5.35 GHz and an additional band of 5.725 - 5.825 GHz; 4) HiperLAN2 requires a band of 5.47 - 5.725 GHz besides the band of 5.15 - 5.35 GHz. Microstrip antennas are very attractive because of their low profile, low weight, conformal to the surface of objects and easy production.

II. FEEDING TECHNIQUES

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories: contacting and non-contacting.

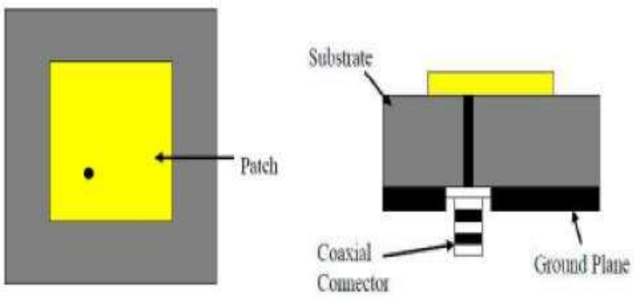
i) In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line.

ii) In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch [8].



COAXIAL PROBE FEEDING:-

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. As seen from below in Fig., The inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. [9] However, a major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates.



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III. ANTENNA DESIGN AND LAYOUT

The length and width of the rectangular patch antenna are calculated from below equations. Where c is the velocity of light, εr is the dielectric constant of substrate.

1: **Calculation of the Width (*W*):**

The width of the Microstrip patch antenna is given by equation as:

$$w = \frac{c}{2f\sqrt{(\varepsilon_r + 1)/2}}$$

2: **Calculation of Effective dielectric constant (ε_{reff})** :

The following equation gives the effective dielectric constant as:

$$\epsilon_{reff} = \frac{\epsilon_{r+1}}{2} + \frac{\varepsilon_r}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2}$$

3: **Calculation of the Effective length (**Leff**):**

The following equation gives the effective length as:

$$L_{eff} = \frac{c}{2f\sqrt{\epsilon_{reff}}}$$

4: **Calculation of the length extension (ΔL):**

The following equation gives the length extension us:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff+0.3})}{(\epsilon_{reff-0.258})}\frac{(\frac{w}{h} + 0.264)}{(\frac{w}{h} + 0.8)}$$

5: **Calculation of actual length of the patch (**L**):**

The actual length is obtained by the following equation-

$$L = L_{eff} - 2\Delta L$$

6: **Calculation of the ground plane dimensions (Lg and Wg):**

Ideally the ground plane is assumed of infinite size in length and width but it is practically impossible to make a such infinite size ground plane, so to calculate the length and width of a ground plane following equations are given as:

$$Lg = L + 6h$$
$$W_g = W + 6h$$

7: **Determination of feed point location (Xf, Yf):** A coaxial probe type feed is to be used in this design. The center of the patch is taken as the origin and the feed point location is given by the coordinates (Xf, Yf) from the origin.

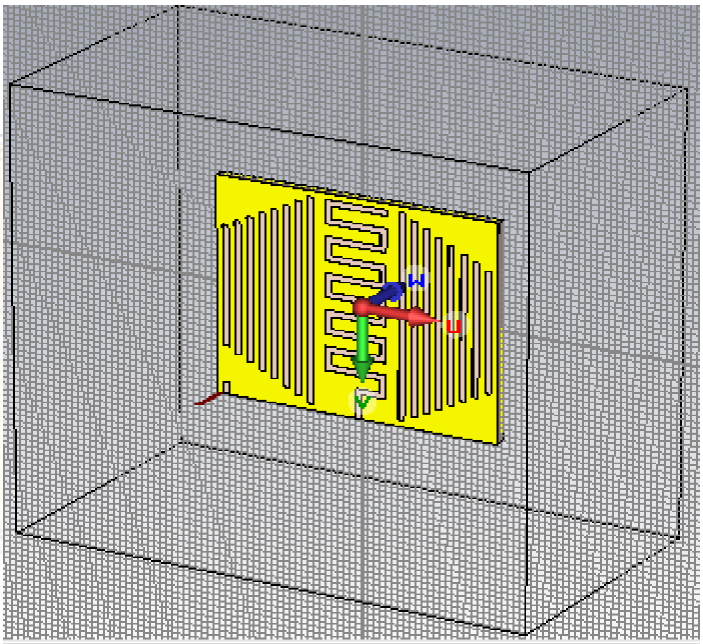


Fig1. Diamond Shape

Table I Design Parameters

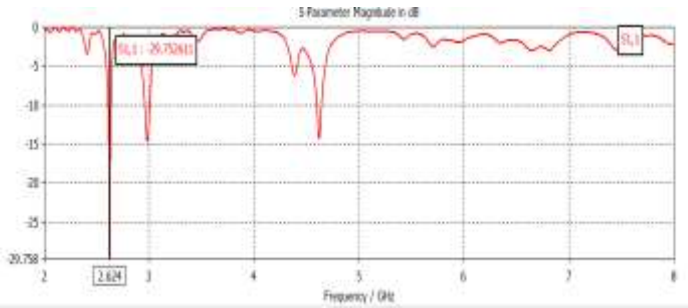
S NO.	DESIGN OF MICROSTRIP ANTENNA	DESIGN
01	Name of Pattern	Diamond Shaped Parasitic
02	Operating Frequency	2.8 GHz
03	Dielectric Constant Of Substrate	4.2
04	Loss Tangent	0.02
05	Height Of Substrate	1.6 mm
06	Width Of Ground (W_g)	46 mm
07	Length Of Ground (L_g)	36 mm
08	Width Of Patch (W_p)	46 mm

09	Length Of Patch (L_p)	36 mm

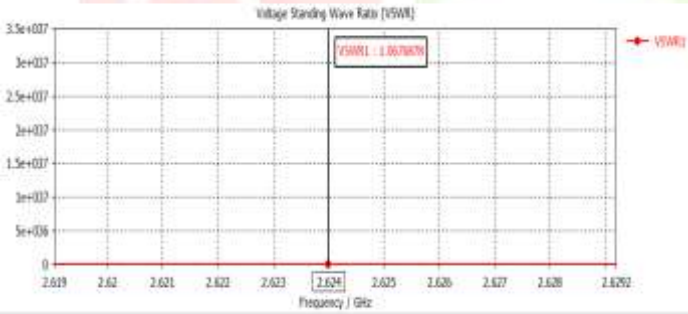
IV. SIMULATION AND RESULT

All the simulation results for design using CST software are shown below: Analysis of 2.8 GHz Diamond Shaped Parasitic microstrip antenna.

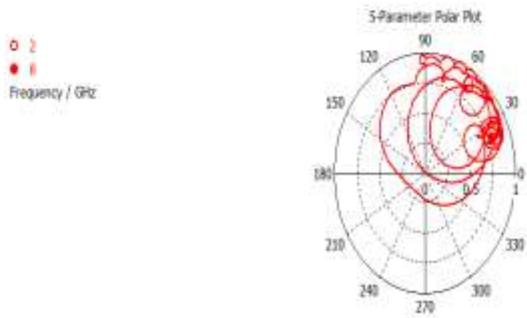
A. S Parameter: - S parameter does not use open or short circuit conditions to characterize a linear electrical network instead match load are used by using s parameter we expressed mainly electrical properties of network of components.



B. Frequency Vs VSWR: - Voltage standing wave ratio is defined as the ratio of partial standing wave's amplitude at an antinode of the amplitude at a node along the line. VSWR is < 2
In the result VSWR is 1.06.



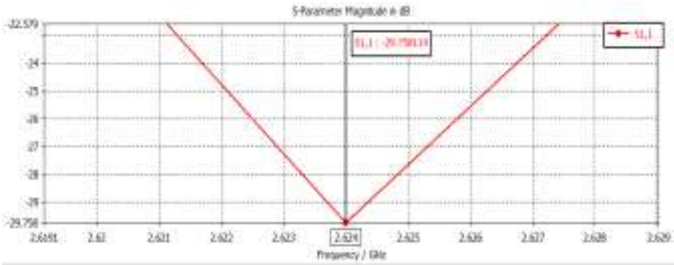
C. Gain: - Gain is a measure of the ability of two port circuit to increase the power or amplitude of a signal from the input to output port by adding energy converted from sun power supply to the signal.



D. Directivity: - Directivity is a figure of merit for an antenna. It measures the power density the antenna radiates in the direction of its strongest emotion, versus the power density radiated by an ideal isotropic radiator.

E. Power Pattern: - The power pattern is the power per unit solid angle.

F. Return Loss: - Return loss is the loss of power in the signal returned or reflected by a discontinuity in a transmission line or optical fiber. It is measured in dB.



G. Farfield:- The farfield are region of the electromagnetic field around an object ,such as a transmitting antenna, or the result of radiation scattering off an object.

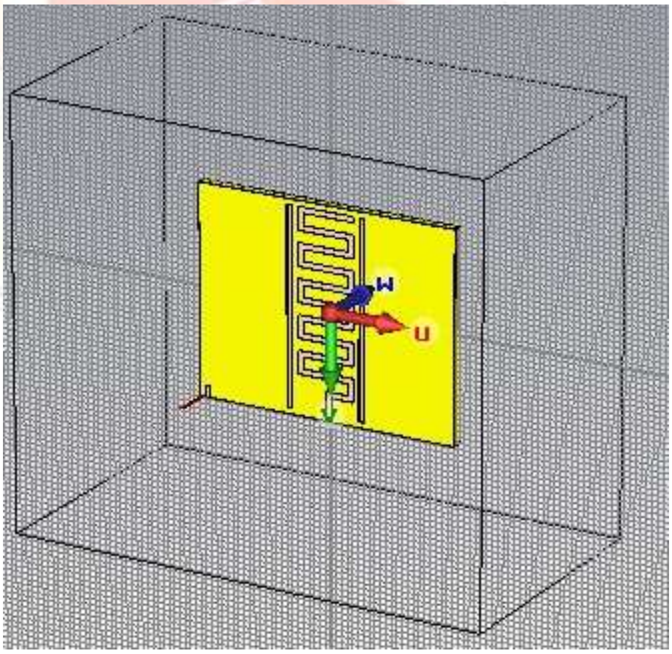


Fig2. Semi Diamond Shape

TABLE II. GEOMETRY TABLE

DIAMOND SHAPED PARASITIC DESIGN

FREQUENCY	BAND WIDTH	RETURN LOSS (dB)	VSWR
2.624 GHz	2-8 GHz	-29.758	1.06
2.983 GHz	2-8 GHz	-14.610	1.45
2.622 GHz	2-8 GHz	-14.351	1.47
SEMI DIAMOND SHAPED PARASITIC DESIGN			
FREQUENCY	BAND WIDTH	RETURN LOSS (dB)	VSWR
2.624 GHz	2-8 GHz	-8.198	2.27
2.983 GHz	2-8 GHz	-4.505	3.94
4.622 GHz	2-8 GHz	-1.550	11.23

Software Analysis Table:

S.N	Frequency (GHz)	Bandwidth (MHz)	Return Loss (dB)	VSWR
1	2.414	49.0	-3.474	5.067
2	2.624	76.4	-29.758	1.060
3	2.840	34.5	-3.761	4.690
4	2.984	31.6	-14.614	1.456
5	3.451	114.0	-1.844	9.450
6	4.621	125.6	-14.346	1.474
7	5.432	80.0	-1.593	10.930
8	5.709	82.8	-2.535	6.899
9	6.648	142.6	-3.024	5.801
10	7.462	150.9	-2.986	5.872

V. CONCLUSION

In this paper, a novel design technique for enhancing the return loss of the proposed Diamond Shaped Parasitic microstrip antenna. Modifications to the patch geometry helped too much to maintain and improve the specified design parameters such as; return loss, input impedance and gain. The proposed micro strip antenna achieves a fractional bandwidth of 21.7% between 2 - 8 GHz, and a very good return loss of -29.7526 dB. Their ease of mass production using printed circuit technology leads to a low fabrication cost and easier to integrate with other microstrip circuits. They support both linear polarization and circular polarization, and can be realized in a very compact for desirable for personal and mobile communication handheld devices.

VI. REFERENCES

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