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Low Cost Dual Band Fractal Antenna with DGS for Wireless Communication Applications

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Abstract: ***A low cost dual band fractal antenna with Defected ground Structure resonating at the frequencies of 5.4GHz and 8.8GHz is presented. The resonating frequencies serves the need of wireless communication systems in the C and X bands. Fr4 epoxy is been used as substrate which can provide a high gain of 9.39dB and 8.3dB can be achieved at the operating frequencies. The antenna is having a dimension of 45mm×45mm×1.6mm which indeed is very small making a proposed antenna a compact one. To feed the antenna a micro strip is taken and is inserted in the patch for proper impedance matching. Proposed antenna is consisting a circular patch with perforated perimeter and the ground plane is also truncated at the four corners and a fractal grid is etched at the centre of the ground plane which will aid in enhanced radiation and in turn increase the gain of the antenna.***

Index Terms: Perforated patch, fractal, Dual Band, High gain.

I. INTRODUCTION

The major challenge for the antenna designers is to design a compact antenna for the multiple applications which can serve the system requirements. Microstrip antenna is a promising candidate which can meet all the requirements. The major limitation of the microstrip antenna is low bandwidth and gain which can be overcome by implementing the Partial grounding technique to achieve the necessary bandwidth and gain [1-2]. Many researchers proposed different techniques [3-6] to develop dual band antennas like placing slots in the radiating element, stacked patch technique etc., but in all these one or the other limitation will be there like poor radiation characteristics at higher frequency of operation in slotted antenna and high profile to antenna in stacked patch technique.

One of the conventional techniques in microstrip antennas to achieve compact size with high gain at multiple resonating frequencies is fractal structures. In this the basic structure of the antenna is divided into smaller parts and each small part is again a scaled copy of the basic structure [7-9].

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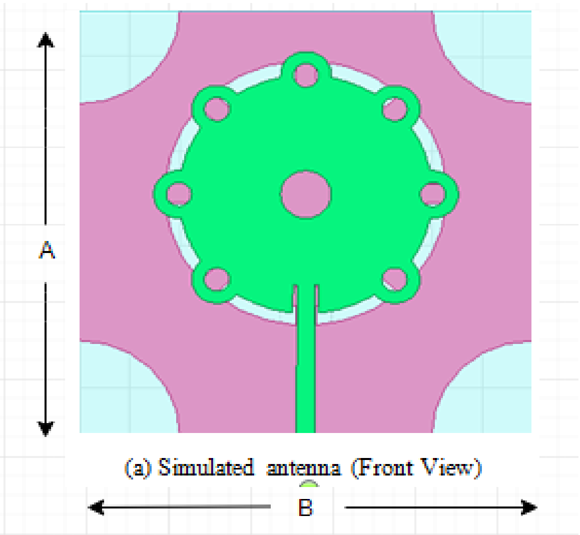
As these structures and their levels increases the antenna model will become complex at the same time will have enhanced radiation characteristics [10].

A High gain compact dual band antenna has been proposed, to achieve compactness the techniques of fractal geometry and defected ground structures are been used as radiating elements. Microstrip line has been used to excite the perforated radiating patch of the proposed antenna.

II. ANTENNA DESIGN AND CONFIGURATION

Proposed antenna is a High gain compact dual band antenna with perforated radiating patch and a defected ground structure. The antenna is fed by a 50Ω microstrip line which is connected to the perforated circular radiating patch.

The radiating patch is basically a circular patch in which at the centre we have taken a circular slot of radius 3mm and we took seven perforation along the perimeter of the circular patch. The perforations are made with a circular ring with a width of 1.26 mm and the radius of the outer perimeter of the ring is 2.52mm. For the resonance at 5.4GHz perforations at the top and lower areas of the radiating patch are responsible and for the resonance at 8.8GHz the perforations at middle area of the patch are responsible.



(a) Simulated antenna (Front View)

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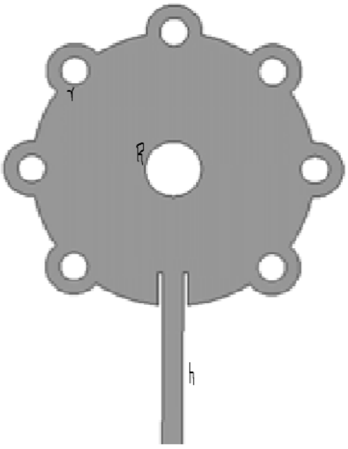


(b) Schematic of Patch

Fig. 1 Geometry of the proposed antenna

Table. 1 Dimensions of each antenna parameter

S. no.	Parameter	Value, mm
1	radius of bigger ring: outer, inner(R)	12.6, 2.52
2	radius of smaller ring: outer inner (r)	2.52, 1.26
3	length, width of 50 Ω line	12.99, 1.8
4	length, width of inset	3.06, 0.4
5	height of substrate(h)	1.6
6	A	45
7	B	45

The antenna is designed on a FR4 substrate and is having overall dimension of 45mm×45mm×1.6mm. To achieve a considerable bandwidth a defective ground plane has been considered for these four corners of the ground has been truncated with sectors of radius 10 mm exactly. And three circular rings with width of 2mm has been removed from the ground plane and Four rectangles of width 2mm are aligned in a wheel structure as shown in the Figure 2. The radius of the outer circle of the three circular rings are 14mm, 10mm, 6mm respectively. The simulated antenna structure of the proposed High gain compact dual band antenna is shown in the Figure 1,2 respectively. Figure 1(a) depicts the top view of the simulated antenna and figure 1(b) depicts the schematic view of the radiating patch. Figure 2 depicts the ground plane of the proposed simulated antenna.

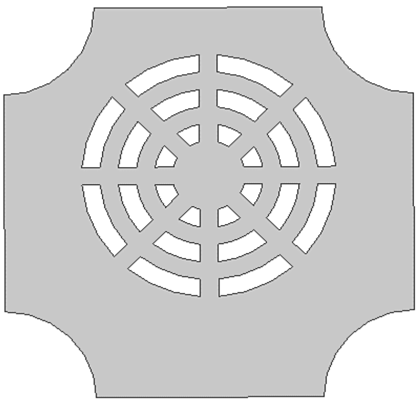


Fig. 2 Simulated antenna (rare View)

III. RESULTS

The performance of the proposed High gain compact dual band antenna is analysed using Ansys HFSS software. Various antenna parameters like return loss, VSWR, gain, radiation pattern, directivity and antenna field distribution were studied. All the above mentioned parameters were analysed for both the operating frequencies. Figure 3 below depicts the return loss plot of the proposed antenna.

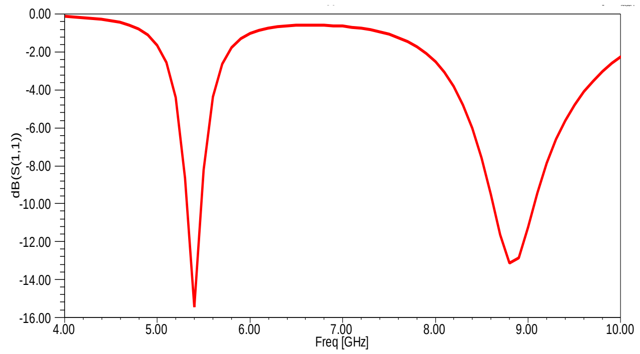


Fig. 3 Return lossof antenna element

Observed a return loss of -15.75dB for 5.4GHz and -13dB for 8.8GHz. From the return loss values achieved we can say that the antenna is having a good impedance matching at both the resonating frequencies Figure 4 below depicts the VSWR plot of the proposed antenna. Observed a VSWR of 1.1dB for 5.4GHz and 1.2dB for 8.8GHz.

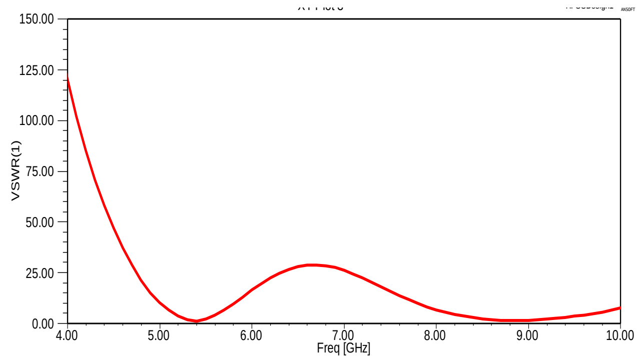
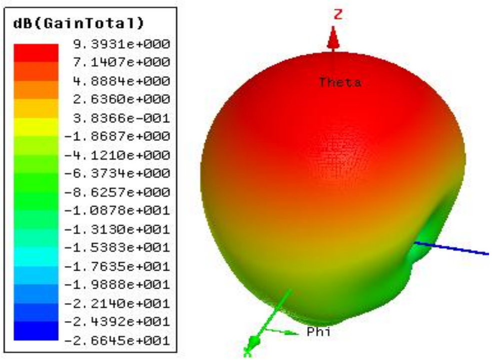


Fig. 4 VSWR of antenna element

Figure 5 below depicts the Gain of the antenna for both operating frequencies. Observed a gain of 9.39dB for 5.4GHz and 8.3dB for 8.8GHz.



(a) 3-D radiation pattern at 5.4GHz

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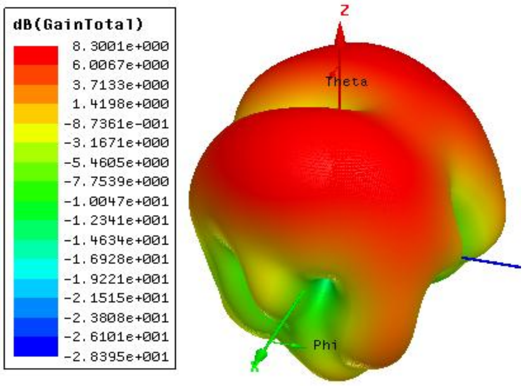
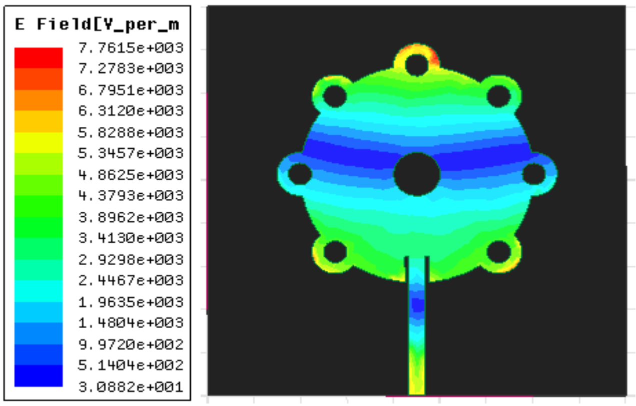


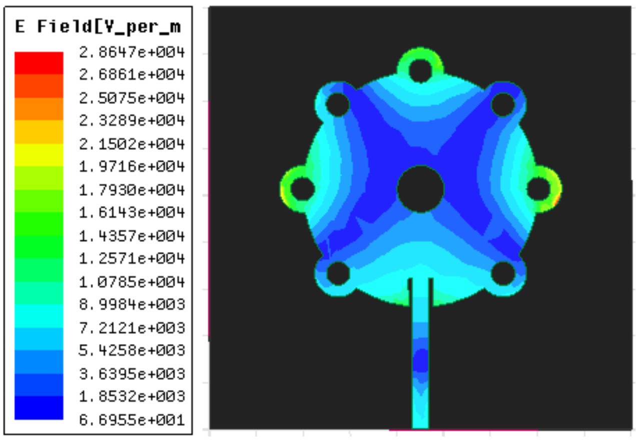
(b) 3-D radiation pattern at 8.8GHz

Fig. 5 3-D radiation patterns of proposed antenna for dual operating bands

Figure 6 below depicts the field distribution in the proposed antenna for different operating frequencies. From the plots we can observe that for the resonance at 5.4GHz top and lower areas of the radiating patch are responsible and for the resonance at 8.8GHz the middle is alone is responsible.



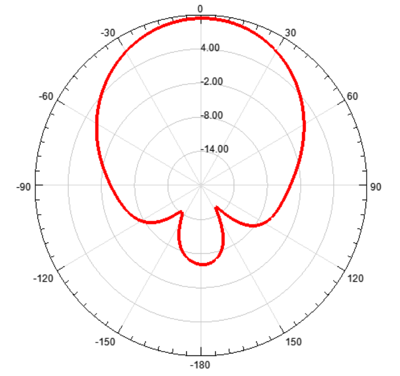
(a) E-Field distribution at 5.4GHz



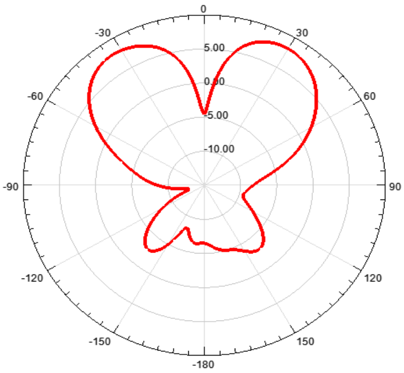
(b) E-Field Distribution at 8.8GHz

Fig. 6 E-Field Distriution of proposed antenna at dual operating bands

Figures 7,8 below depicts the elevation plane and azimuthal plan radiation patterns of the proposed antenna. Observed a uniform radiation pattern without any nulls at 5.4GHz and a bidirectional radiation pattern at 8.8GHz.

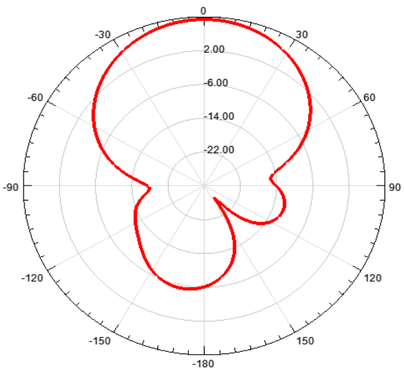


(a) 5.4GHz

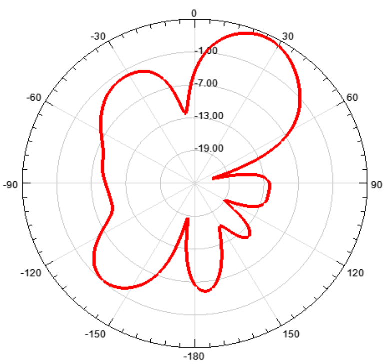


(b) 8.8GHz

Fig. 7 Radiation Pattern (Elevation Palne)



(a) 5.4GHz



(b) 8.8GHz

Fig. 8 Radiation Pattern(Azimuthal Plane)

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IV. CONCLUSION

In this paper, High gain compact dual band antenna has been proposed and the performance is analysed, to achieve compactness the techniques of fractal geometry and defected ground structures are been used as radiating elements. Microstrip line has been used to excite the perforated radiating patch of the proposed antenna. The antenna resonates at the frequencies of 5.4GHz and 8.8GHz. The radiating element is having a perforated circular patch and it is responsible for different resonating frequency. The perforations will generate a secondary perimeter which will generate the second resonating frequency. To achieve a considerable bandwidth with a high gain a defected ground plane has been considered. The antenna is fed by a microstrip line feed. From the obtained results it is evident that the proposed antenna is best suited for the wireless communication applications.

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