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Design and Simulation of Inset fed Heptagonal Slotted Circular Patch Antenna for Wireless Applications

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Abstract : Microstrip Patch antennas belongs to class of printed antennas having a wide range of beneficial properties including mechanical durability, compactness and cheap manufacturing cost. They have wide ranges of applications in both military and commercial sectors. In this a Inset Fed Heptagonal Slotted Circular patch antenna for Wireless Applications using HFSS is designed at a range of 2.45GHz, 4.53GHz and 5.62GHz. The substrate FR4_epoxy is used for designing the proposed antenna with dielectric constant of 4.4 and height of the substrate is 3.6mm. The designed antenna got return loss for 2.45GHz resonant frequency is -27.32dB, for 4.53GHz resonant frequency is -21.41dB and for 5.62GHz resonant frequency is -26.01dB respectively and the VSWR is 1.31, 1.18 and 1.10 for the 2.45GHz, 4.53GHz and 5.62GHz Operating frequency with Gain of 1.5dB, 3dB and 2dB.

IndexTerms - Inset Fed, Heptogonal Slotted, Circular Patch , HFSS.

I. INTRODUCTION

Microstrip patch antenna are widely used in wireless devices, because of its low profile and easy fabrication having a wide range of beneficial properties including mechanical durability. Now a day's new antenna structures are designed for dual, triple and Multiband applications. So the techniques used for developing Multiband [4] are Slots and Defected ground structures. Based on the type of Feeding, the proposed antenna gives the better performance. So the Contact and Non Contact method feedings are available for[5,6] designed any type of antenna. The Non Contact method feeding is very difficult for fabricating the antenna. So the contact method feeding is used to excite the antenna. The selection of feeding technique for a Microstrip patch antenna is an important design because it directly affects the bandwidth, return loss and Antenna efficiency.

The Substrates are mainly used for the mechanical strength of the antenna in the microstrip antenna. By selecting appropriate dielectric medium, it can also reduce the spread of the surface waves. Generally Microstrip patch antenna gives the low gain and bandwidth. It can also improved by doing structural modifications using Meta surfaces and shorting pins, Slots and DGS Techniques. The proposed circular patch antenna with heptagonal slot is designed using FR4 Substrate and DGS techniques. It is simulated by using HFSS Software. In this work, the proposed antenna resonates at 2.45, 4.53 and 5.62GHz for Bluetooth, Satellite downlink and WiMAX applications. The First frequency band was achieved by a normal circular patch antenna on a FR4 Substrate, Second and Third frequency bands were achieved by Defected Ground Structure and Fourth frequency band was achieved by heptagonal slot.

II. ANTENNA DESIGN

A. Initial Stage

At the starting of the designing of antenna, Circular patch antenna is designed on a FR4 Substrate with a thickness of 3.6mm, a dielectric constant of 4.4 and a loss tangent of 0.0009, it radiates at a frequency band of 2.4GHz. In this design the inset feeding is used for radiating the maximum power into free space by the radiator.

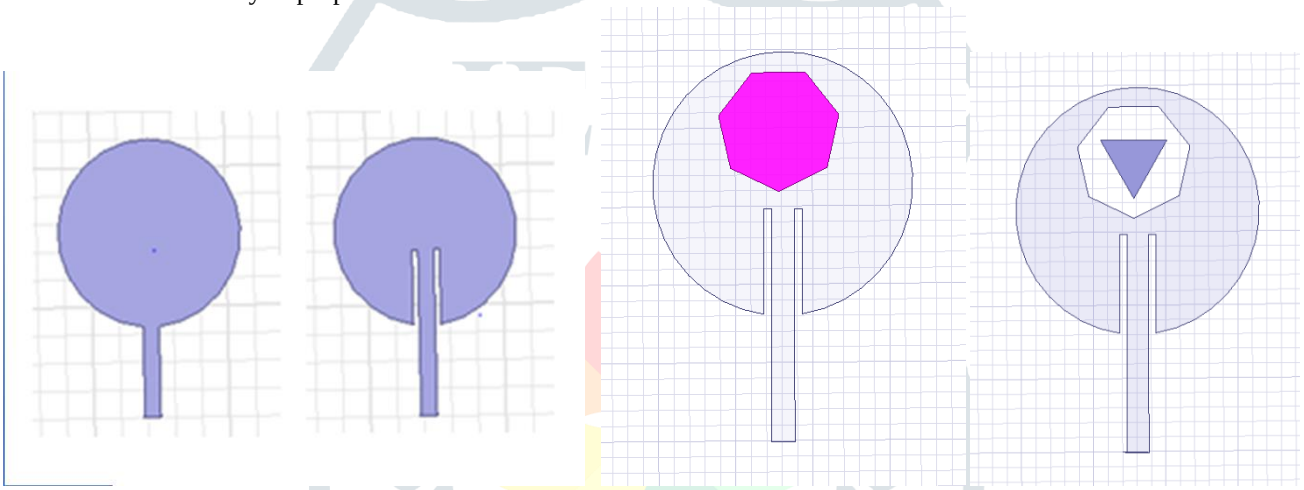
B. Final Stage

In the process of Final stage, the patch is cut by the Heptagonal slot[1], it radiates at a frequency band of 5.62GHz. Now reducing the ground using the DGS technique and it radiates at a frequency band of 4.53GHz. Triangle is placed at the centre of the heptagonal slotted place. Generally the proposed antenna uses 70×70 mm^2 Structure, at this design the antenna resonates at only one frequency band. So this can be changed using DGS techniques for multiband purpose, then the radiating structure is 48×70mm^2.

PARAMETER	VALUE
Operating Frequency	2.45GHz
Ground plane Length	70mm
Ground plane width	70mm
Substrate Height	3.6mm
Radius of patch	16.87mm
Radius of Heptagonal Slot	7mm
Strip line width	3mm
Defected Ground Length	48mm

Table-1: Design parameters of Circular Patch

The parameters of the proposed antenna can be calculated using the reference[3] and shown in Table 1. The proposed antenna is simulated by using HFSS Software and the following Fig-1 describes the design steps of the proposed antenna and Fig-2 describes the Geometry of proposed antenna.



1)Step-1 2) Step-2 3) Step-3 4) Step-4

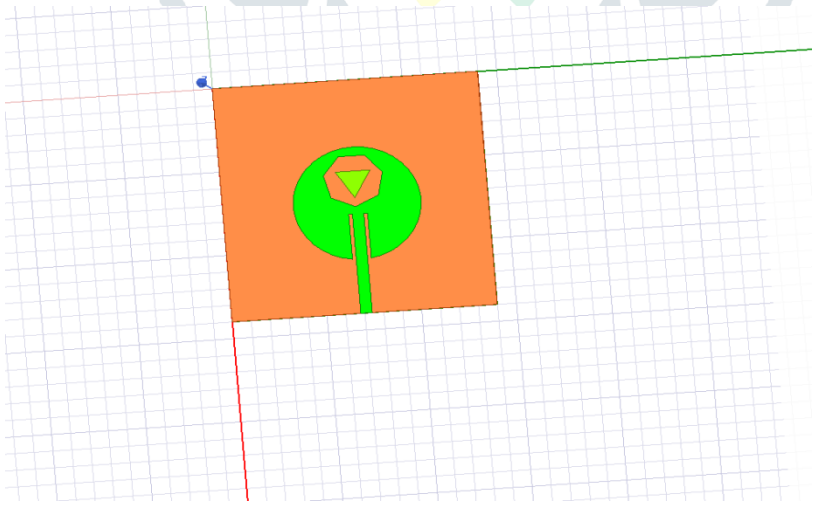


Fig-5: Geometry of the Proposed Antenna

III. Results and Discussion

In this antenna results are obtained using High Frequency Structured Simulator. The various Antenna parameters like Return loss, VSWR, gain in terms 3D pattern and bandwidth of the resonant frequencies are simulated and observe their variation with respect to frequency in Figs 6, 7, 8, 9, 10 and 11. The proposed antenna resonates at 2.45, 4.53 and 5.62GHz. The return loss and VSWR of these frequencies are -17.13dB, -21.41dB, -26.01dB and 1.31,1.18,1.10. The gain obtained at these resonating frequencies are 1.5dBi, 3dBi and 2dBi. And the Bandwidth of the resonating frequencies are 100MHz, 240MHz and 200MHz.

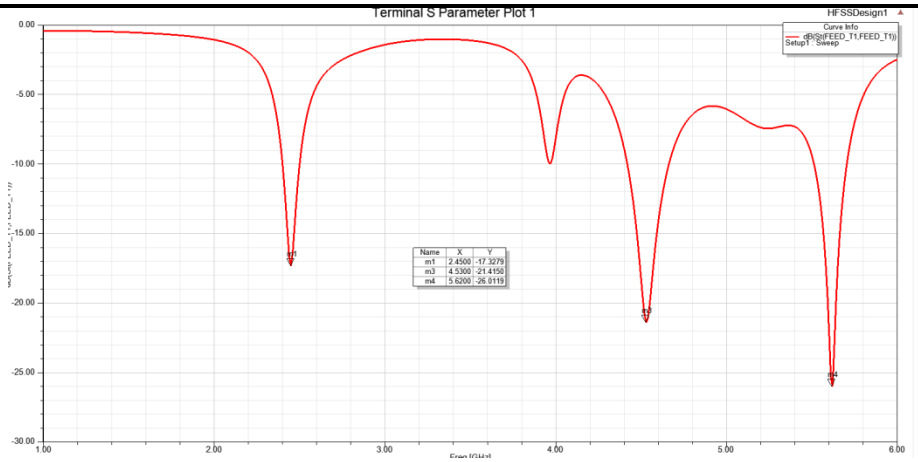


Fig-6: Return loss with frequency

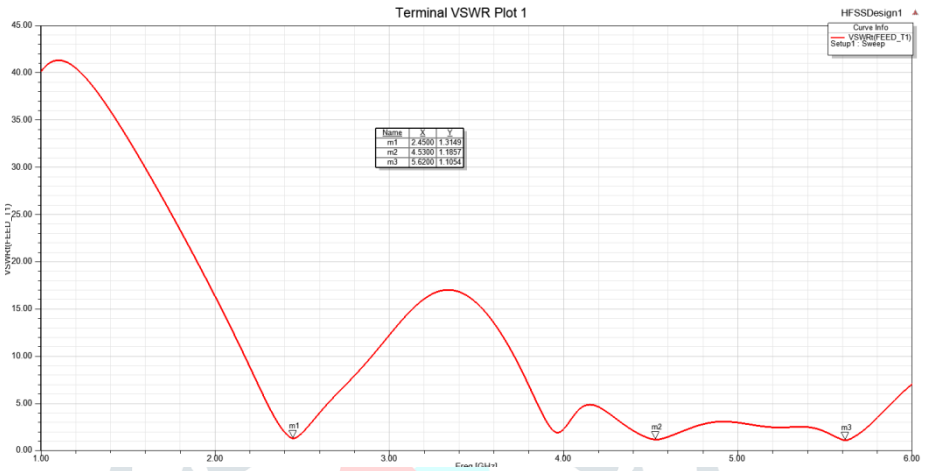


Fig-7: VSWR with frequency

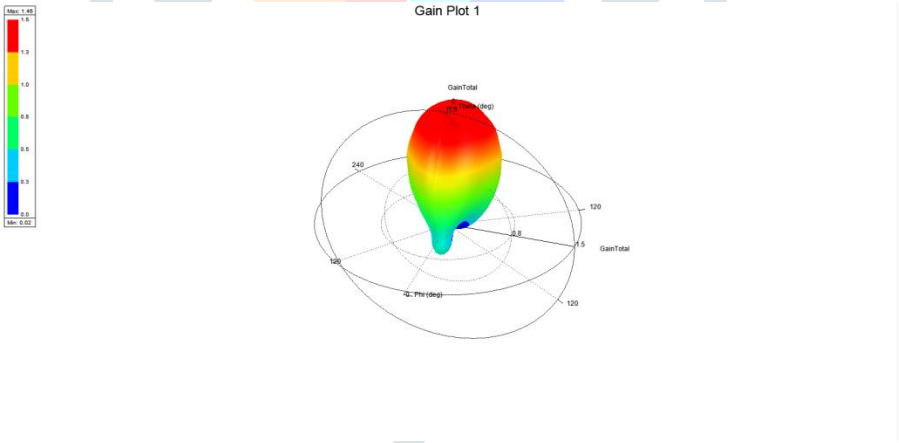


Fig-8: Radiation pattern at 2.45GHz

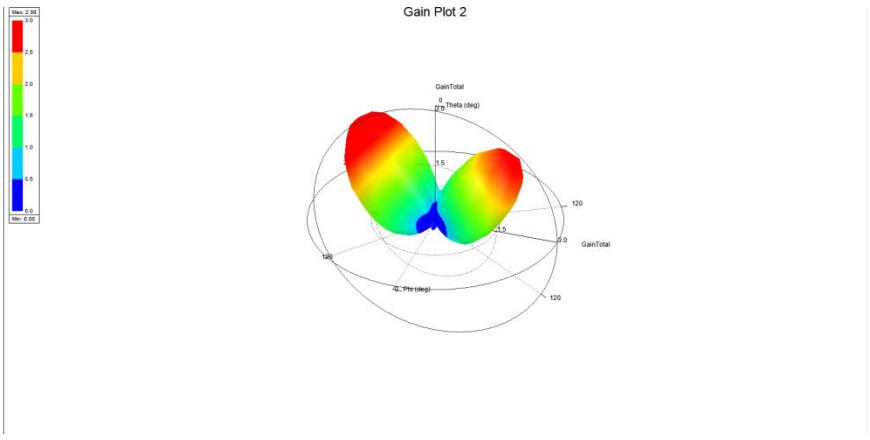


Fig-9: Radiation pattern at 4.53GHz

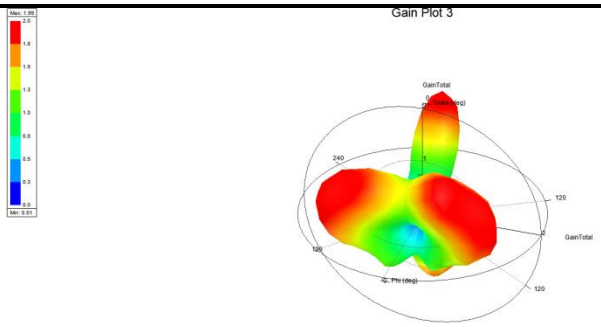


Fig-10: Radiation pattern at 5.62GHz

Summary of the proposed antenna results ares shown in the below table 2.

Resonant Frequency	2.45GHz	4.53GHz	5.62GHz
S11(dB)	-17.13	-21.41	-26.01
VSWR	1.31	1.18	1.10
Gain(dBi)	1.5	3	2
Bandwidth (MHz)	100	240	200

IV. CONCLUSION

This is the paper for new configuration of Heptagonal slotted circular patch antenna for Wireless applications. The circular patch, Heptagonal slot and DGS technique gives the multiband response and resonates in between 2.45-5.62GHz with a gain of 2 to 3dB and VSWR less than 2. The antenna resonating at multiple frequencies are used for Bluetooth, Satellite and WiMAX Applications.

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