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Design of Pentagonal Slot Circular Patch Antenna for S and C Band Applications

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Abstract - *In this paper present a new configuration microstrip patch antenna for Bluetooth, WiMAX and Satellite downlink applications. The proposed circular patch antenna with inset fed pentagonal slot is resonates at 2.45, 4, 4.45 and 5.6GHz. The antenna performance parameter return loss at resonating frequencies are -21.50dB, -11dB, -36dB, -13.64dB and the VSWR is 1.17, 1.86, 1.10 and 1.53. The proposed antenna achieves a gain of 2 to 4dBi. The pentagonal slot circular patch antenna is simulated by using High Frequency Structured Simulator.*

Key Words*: *Circular patch, Pentagonal slot, Inset Fed, Defected Ground Structure, Bluetooth, WiMAX.

1. INTRODUCTION

Microstrip patch antennas 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 [2] 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 [3, 6] designing 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 pentagonal 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, 4.45 and 5.6GHz 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 pentagonal slot.

2. ANTENNA DESIGN

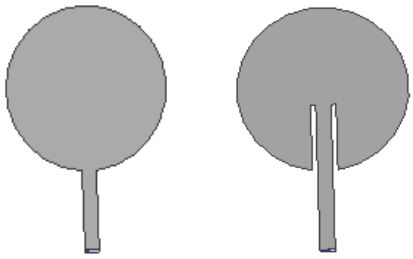
The designing of proposed antenna can be described in Four steps. In First step the Normal Circular Patch antenna is designed on a FR4 Substrate with a thickness of 3.6mm, a dielectric constant of 4.4 and a loss tangent of 0.0009, it radiates at a frequency band of 2.4GHz. In this design the inset feeding is used for radiating the maximum power into free space by the radiator. The Second step is cut the circular patch with Circular slot [4] and third step is change the circular slot to pentagonal slot, it radiates at a frequency band of 5.6GHz. The Fourth step is reducing the ground using the DGS technique and it radiates at a frequency band of 4GHz and 4.45GHz. Generally the proposed antenna uses 70x70 mm^2 Structure, at this design the antenna resonates at only one frequency band. So this can be changed using DGS technique for multiband purpose, then the radiating structure is 48x70mm^2. The radius of circular patch antenna can be calculated [1] by using the equation (1)

$$a = \frac{F}{\sqrt{\left\{1+\frac{2h}{\pi\varepsilon_r a}\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\right\}}} \quad (1)$$

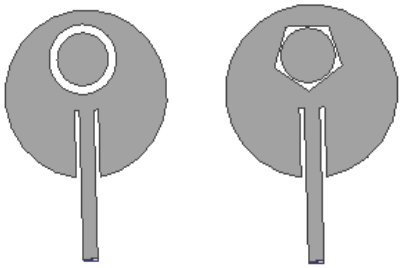
Table -1: Design parameters of Circular patch

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 pentagonal slot	7mm
Strip line width	3mm
Defected Ground Length	48mm

The parameters of the proposed antenna can be calculated using the reference [5] 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.



a) Step-1 b) Step-2



c) Step-3 d) Step-4

Fig-1: Design Steps of Proposed Antenna

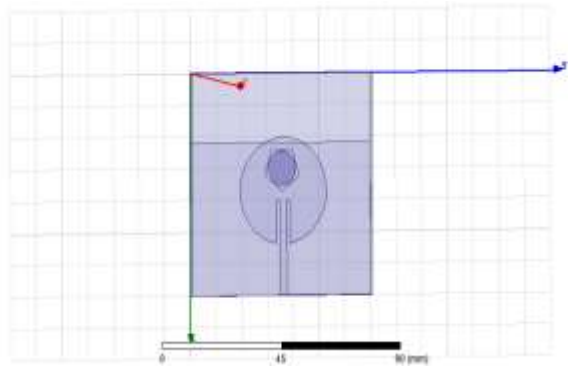


Fig-2: Geometry of the Proposed Antenna

3. RESULTS AND DISCUSSION

The proposed antenna results are obtained using High Frequency Structured Simulator. The various Antenna parameters like Return loss, VSWR and gain in terms 3d pattern are simulated and observe their variations with respect to frequency in Figs 3, 4, 5, 6, 7 and 8. The proposed antenna resonates at 2.45, 4, 4.45 and 5.6GHz. The return loss and VSWR of these frequencies are 21.50dB, -11dB, -36dB, -13.64dB and 1.17, 1.86, 1.10 and 1.53. The gain obtained at these resonating frequencies is 2.19dBi, 4.35dBi, 4.39dBi, 3.98dBi.

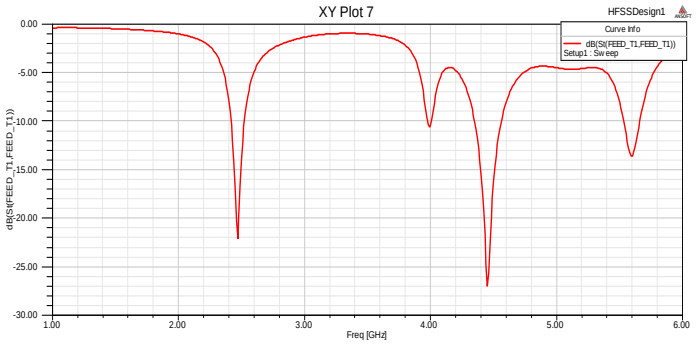


Fig-3: variation of return loss with frequency

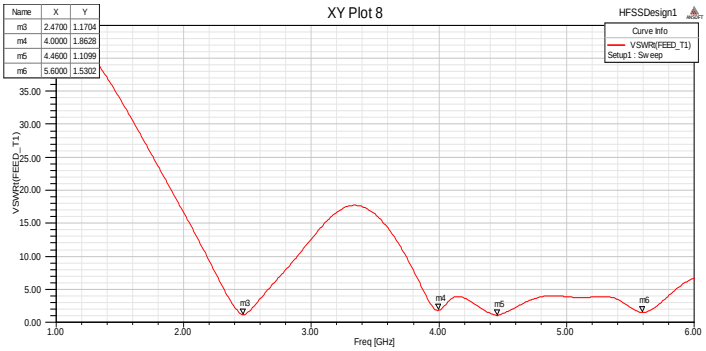


Fig-4: variation of VSWR with frequency

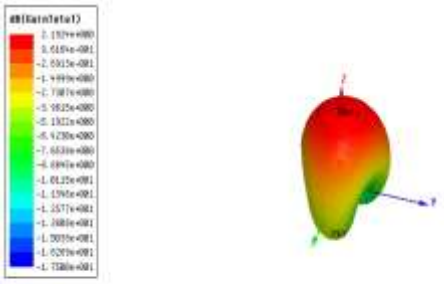


Fig-5: Radiation pattern at 2.45GHz

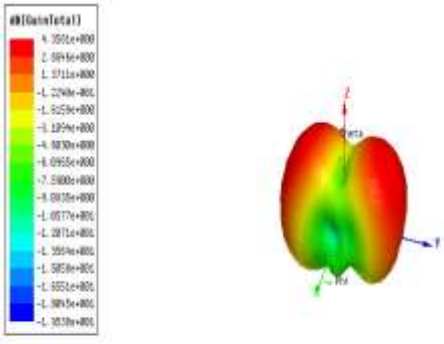


Fig-6: Radiation pattern at 4GHz

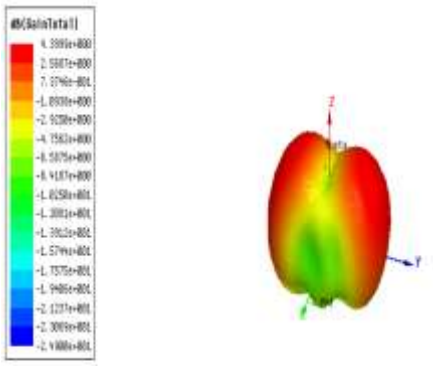


Fig-7: Radiation pattern at 4.45GHz

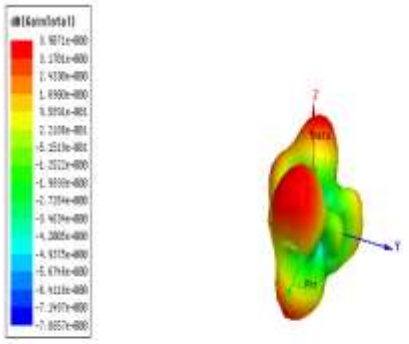


Fig-8: Radiation pattern at 5.6GHz

The results of proposed antenna can be summarized and shown in Table 2.

Table-2: Antenna performance parameters

Resonant Frequency	2.45GHz	4GHZ	4.45GHZ	5.6GHZ
S11(dB)	-21.50	-11	-36	-13.64
VSWR	1.17	1.86	1.10	1.53
Gain(dBi)	2.19	4.35	4.39	3.90
Bandwidth(MHz)	100	40	220	80

4. CONCLUSION

In this paper, the new configuration of pentagonal slot circular patch antenna is designed for S and C band Applications. The circular patch, Pentagonal slot and DGS technique gives the multiband response and resonates in between 2.4-5.6GHz with a gain of 2 to 4dB and VSWR less than 2. The antenna resonating at multiple frequencies are used for Bluetooth, Satellite and WiMAX Applications.

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