Design and Simulation of Polygon Patch Antenna with Circular Slot

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Abstract

In this paper, a single rectangular microstrip patch antenna with polygon and circular slot is designed. The antenna is designed for C and X band applications. The shape of the antenna is obtained by assigning the coordinate values to each part. A cut is given in the middle of the rectangle and also inside the polygon and circular slot to enhance the performance. Microstrip feed technique is used. In this paper discussed with two different antennas performance had been analyzed.

Keywords— *Microstrip patch antenna, C and X band application, Microstrip feed, communication antenna.*

I. INTRODUCTION

Antenna is a major critical component of the wireless communication system, which is a key building block for constructing every wireless communication systems. Recently there are many advanced technologies in the field of wireless technology. Though there are many types of antennas present, the Microstrip patch antennas are highly used in the wireless communication because they has better gain , bandwidth and easy to design. Microstrip antenna is also known as printed antenna. It plays a vital role in wireless communication field.

Microstrip antennas are simple to construct by using fabrication technique. This type of antennas is now used in designing textile antennas. These antennas consist of a radiating patch on top of the dielectric substrate and also have a ground plane on the bottom side.

Polygon shaped microstrip slot antenna for dual band

In microstrip patch antenna the patch is cut by polygon and circle to gain high efficiency It is capable of producing high Gain and Directivity.

The existing antenna is a square shaped body centered antenna at a size of 80 millimeter on all sides. It is a patch antenna with coaxial feed is operation. The dual bands are achieved by placing ring slot in the conventional polygon microstrip antenna

A new patch antenna which is proposed is a polygon and circular slots and also the cut in the rectangular patch area are subtracted from the microstrip antenna.

II. MATH

The Length and width of the patch is founded by the formula given

1. $L = L_{eff} - 2\Delta L$
2. $W = C/2f_0\sqrt{((\varepsilon r+1)/2)}$

Where,

εr - Represents the real value of the dielectric material used.

L_{eff} - Effective length of the patch

The Change in Length of the Patch is given by the following formula

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

Where,

h - represents the thickness

W - represents the width of the patch

The other formulas used are

$$L_{eff} = C/2f_0\sqrt{\varepsilon_{eff}}$$

$$\varepsilon_{eff} = (\varepsilon_r+1/2) + (\varepsilon_r-1/2)(1+12h/w)$$

III.FR4 EPOXY

The Proposed antenna design is shown in the Fig. 1. The antenna is of polygon and circular slot with a microstrip patch on the bottom. Here the Ground layer is defined as the infinite or boundary less region. The HFSS (High Frequency Structural Simulator) Software is used to design the proposed antenna. In this software the 3D radiation pattern is obtained and the output parameters are easily calculated. The shape of the antenna is obtained by assigning the coordinate values for each part.

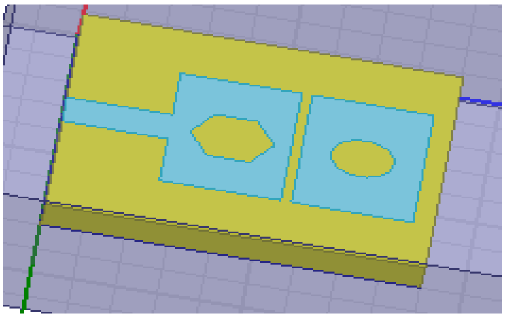


Fig.1. Proposed Antenna Design

A cut is given in the middle in the form of a rectangle shape on layer of the patch. There is only one port P1 placed at the bottom and connected together with the feed. The substrate material used here is FR4 EPOXY which is cheaper material and also easily available.

The height of the substrate layer is equal the conductor material layer. After the designing was completed, the port values are assigned to the antenna. The thickness of the substrate material is 2 millimeter and the conductor material is 35 micron. The adaptive frequency is from 5GHz to 10 GHZ

Result and Discussion

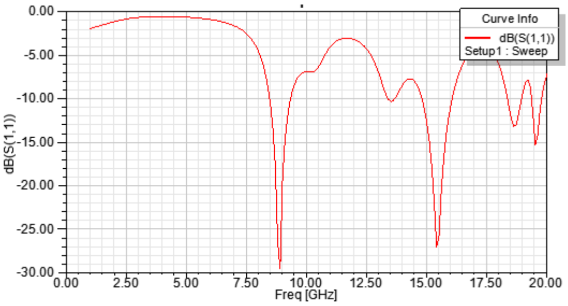


Fig.2. Return Loss of the antenna

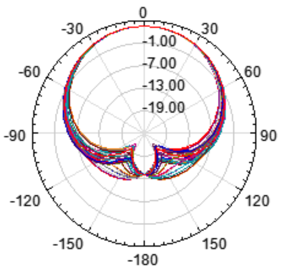


Fig.3. Radiation pattern for FR4 EPOXY

Return loss shows the loss of power returned or reflected back. It shows the backside radiation of the designed antenna. Here the return loss is -30 dB which is greater than the cut off value. So the return loss is very less and there is no backside radiation produced.

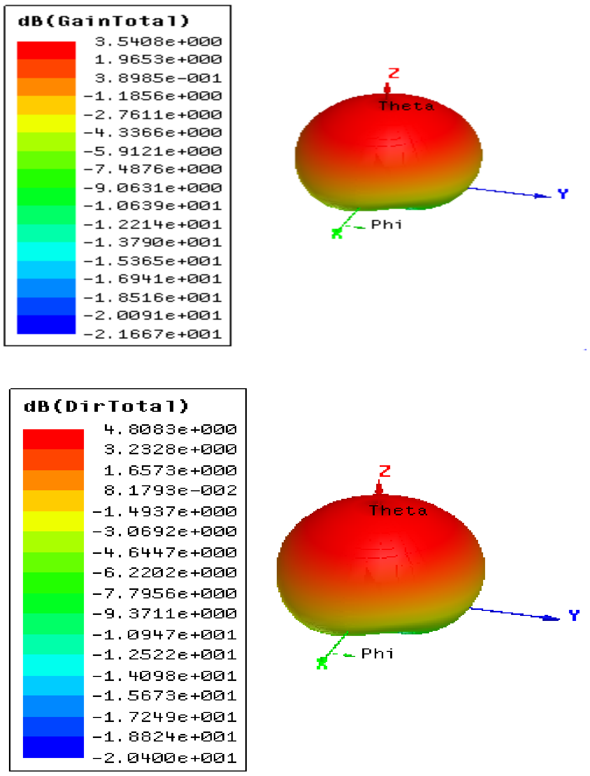


Fig 4. Gain and directivity of FR4

IV.BAKELITE

The Proposed antenna design is double patch polygon and circle shaped microstrip patch antenna. Here the Ground layer is defined as the infinite or boundary less region. The HFSS (High Field Structural Simulator) Software is used to design the proposed antenna. In this software the 3D radiation pattern , output parameters are obtained for the design.

In the same structure only the material is changed. The change in material is BAKELITE and then analyzes the performance. The structural design of Bakelite is shown below

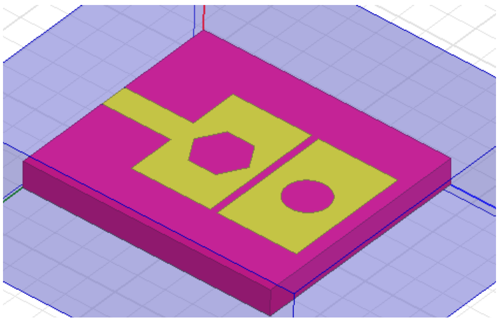


Fig.6. Proposed Antenna Design

The results of the above structure substrate is of Bakelite are shown below

V. RESULT AND DISCUSSION

When the antenna design starts to run, the results obtained are namely the Return Loss, Gain Directivity, Radiation pattern of the antenna and finally the Efficiency respectively. These outputs corresponds the working and efficiency of the antenna designed.

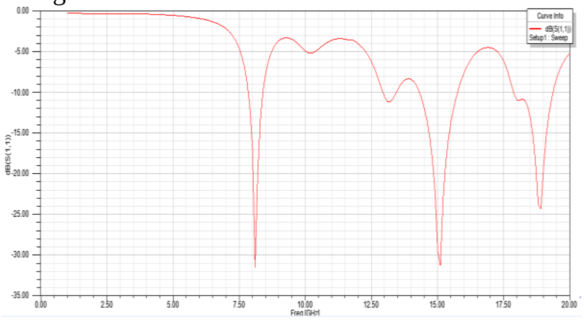


Fig.7. Return Loss of the antenna

Return loss shows the loss of power returned or reflected back. It shows the backside radiation of the designed antenna. Here the return loss is -33 dB at 7.5 GHz, which is greater than the cut off value. So the return loss is very less and there is no backside radiation produced.

It is defined as the performance of the antenna. The performance of the working is given out in percentage value. Here the Efficiency of the antenna is 79.58 %, which is a better efficiency.

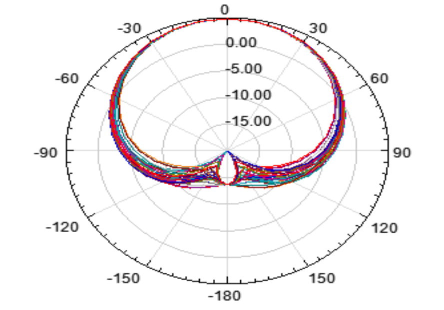
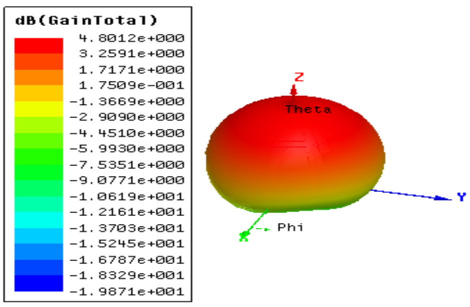


Fig.9. 3D Radiation pattern of Bakelite



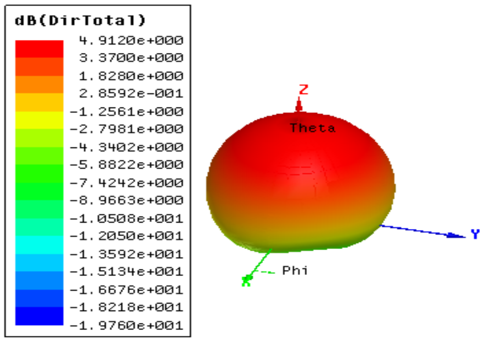


Fig 10. 3D gain and directivity for Bakelite

Comparison between the fr4 epoxy and Bakelite

S.No	Parameters	Fr4	Bakelite
1	Return loss	-30 dB	-33 dB
2	Gain	3.54	4.80
3	Directivity	4.80	4.91
4	Efficiency	77%	79.58%
5	Band	Dual band	Triple band
6	Frequency	8.5GHZ 15.5 GHZ	8.2 GHZ 15.25GHZ 19.34 GHZ

The above parameters are essential for finding the better working of every antenna. The above figures show the pictorial representation of the parameters of the antenna. The antenna works on the C band and X band produces the Broadside radiation pattern

VI. CONCLUSION

A microstrip patch antenna is designed with polygon and circular slot in it. The results of material FR4 EPOXY and BAKELITE are compared in this paper. In future work different materials are used in same antenna design methodology.

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