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A Novel Circular Patch FSS Microstrip Antenna for C Band Applications

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Abstract—*A low profile and highly selective FSS antenna for C band applications is designed. The proposed design is a circular patch array. The array is of size 3×2. The size of the antenna is 60mm x 60mm x 0.8mm.The substrate is FR4 epoxy with height 0.8mm and permittivity 4.4.The circular patch has radius 7mm with interconnections. The proposed antenna design has dual band characteristics. The resonating frequencies are 5.7 GHz and 6.06 GHz. Considerable gain is achieved at the resonating frequencies. HFSS software is used to simulate the design.*

1. INTRODUCTION

Miniaturization is a recent trend in antenna communication. Nowadays high gain and wider bandwidth are required for modern communication [4]. Microstrip antenna is the best suited for satellite communication. But low bandwidth is the major problem in these antennas. For reducing the size of antennas, designing slot on radiating patch is best idea [2]. Due to larger width of microstrip antennas, bandwidth increases. Slots are designed in the patch where current concentrated region is joined to merge the gain distributed. Efficiency of the antenna increases by increasing bandwidth resulting in a decrease in gain. Frequency of operation is affected by slot length and substrate thickness [5].

Microstrip antennas are low profile, low weight, low fabrication cost and reliable [3]. Defected ground structure is used for size reduction and multiband applications. It increases the gain and suppresses surface wave propagation. Microstrip antenna with circular patch is more simpler than rectangular patch microstrip antennas. Degree of freedom in circular patch microstrip antenna is one but degree of freedom in rectangular patch antenna is two [1]. The radiation of circular patch microstrip antenna is easily controllable and easy to design. At the same frequency the circular patch antenna has 16% reduction in size than rectangular patch microstrip antenna.

2. ANTENNA DESIGN

The size of the antenna is 60mm×60mm with array size of 3×2.The substrate is FR4 epoxy with permittivity 4.4. The height of the substrate is 0.8mm.Interconnected circular patch is laid above FR4 epoxy substrate.FSS concept is used in designing the antenna. FSS is a array of metallic patches which are periodic in nature. It is a thin repetitive surface which operates in radio frequency region. Microstrip line feeding is used for feeding purpose. There are different types of feeding but microstrip line feeding is easy to fabricate. Thicker the substrate with low dielectric constant gives better antenna performance but size of the antenna is larger. Thinner substrates are more suitable for microwave applications. Etching slots inside the patch increases antenna performance

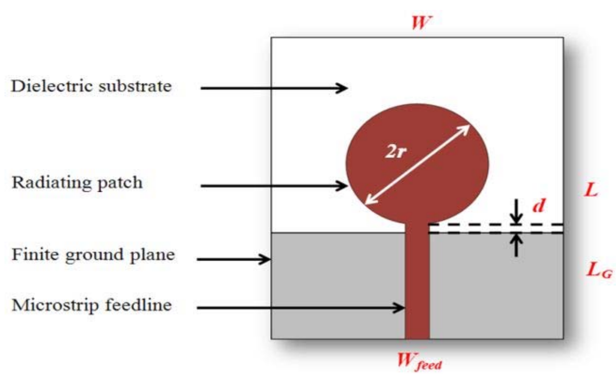

Figure 1. Circular patch with microstrip line feeding

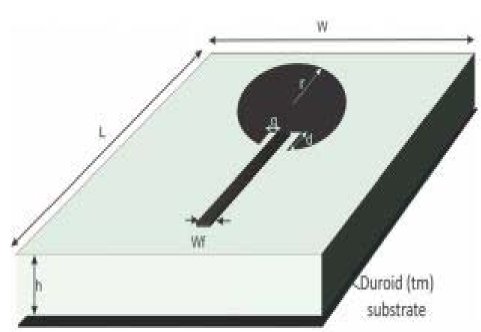

Figure 2. Circular patch with inset feeding

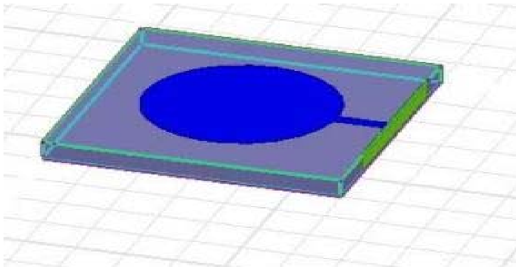

Figure 3. Circular patch unit cell

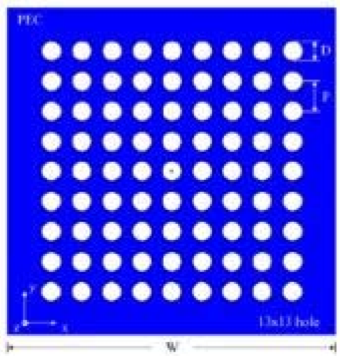

Figure 4. Circular patch FSS array

Figure 1 shows circular patch with microstrip line feeding. Figure 2 shows circular patch with inset feeding. Figure 3 illustrates circular patch unit cell. Figure 4 shows circular patch FSS array. Figure 5 shows the proposed design.

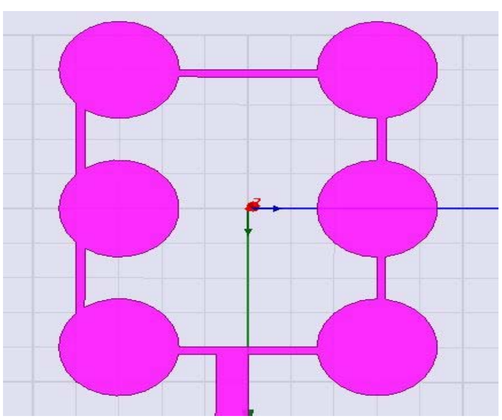

Figure 5. Proposed design

3. SIMULATION RESULTS AND DISCUSSIONS

The size of the antenna is 60mm×60mm with array size of 3×2 and substrate height of 0.8mm.Microstrip line can be treated as a transmission line. If diagonal feeding is used then circular polarization is achieved.

When the load is mismatched, not all of the available power from generator is delivered to load. This called return loss or S_{11}. S_{11}=-10 dB means -3dB is delivered to the load and -7dB is reflected. Figure 6 shows the scattering parameter graph. It exhibits dual band and the resonating frequencies are 5.7 GHz and 6.06 GHz.

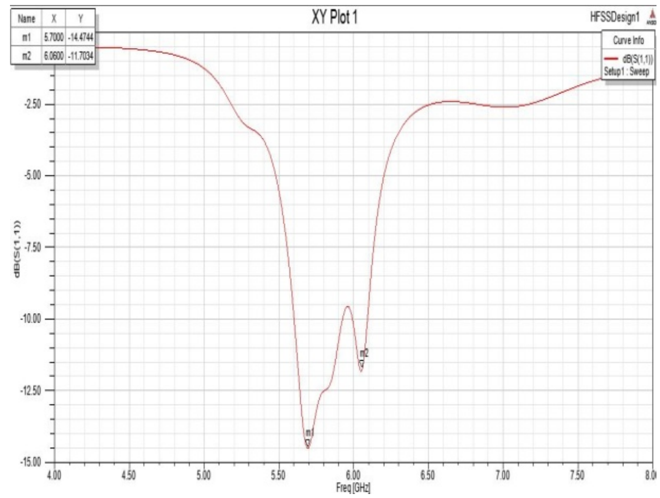

Figure 6. S_{11}graph

In ideal system, VSWR is 1. VSWR below 2 that means impedance is matched properly. When VSWR increases more power is reflected from antenna and transmission is less. Figure 7 shows VSWR graph.

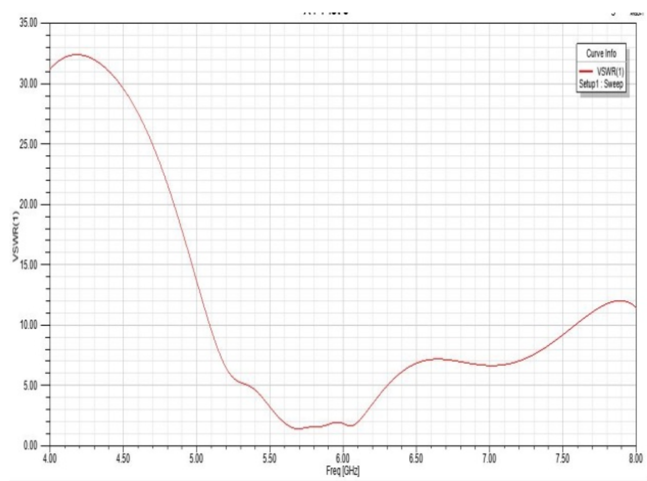

Figure 7. VSWR graph

The radiation pattern of the antenna is a pattern which depicts the Direction in which maximum power of the antenna is radiated in free space. Figure 8 shows 0 and 90 degree radiation pattern at 5.7 GHz. Figure 9 gives 0 and 90 degree radiation pattern at 6.06 GHz.

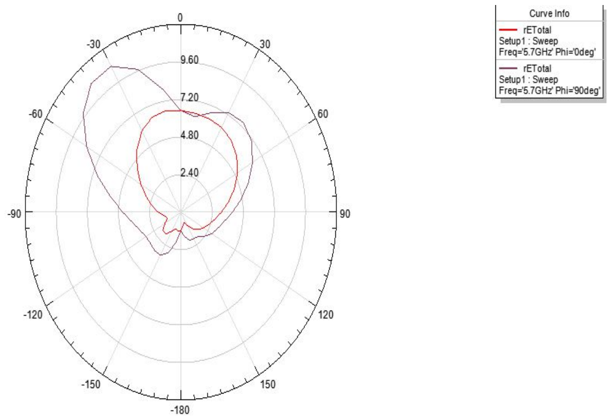

Figure 8. 0 and 90 degree radiation pattern at 5.7 GHz

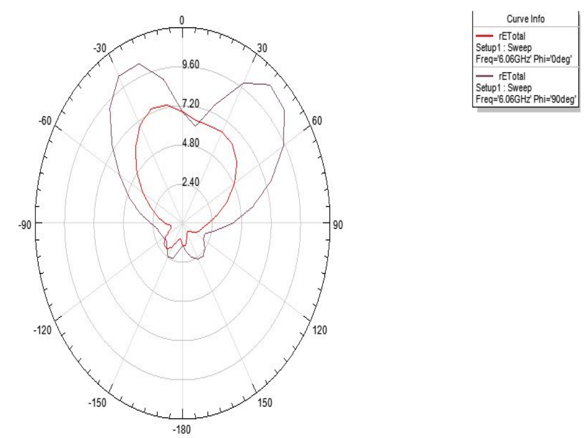

Figure 9. 0 and 90 degree radiation pattern at 6.06 GHz

Gain of an antenna describes how the input power is converted to radio waves. It relates antenna directivity and electrical efficiency. Figure 10 shows the 3D polar plot of gain at 5.7 GHz and figure 11 shows the 3D polar plot of gain at 6.06 GHz.

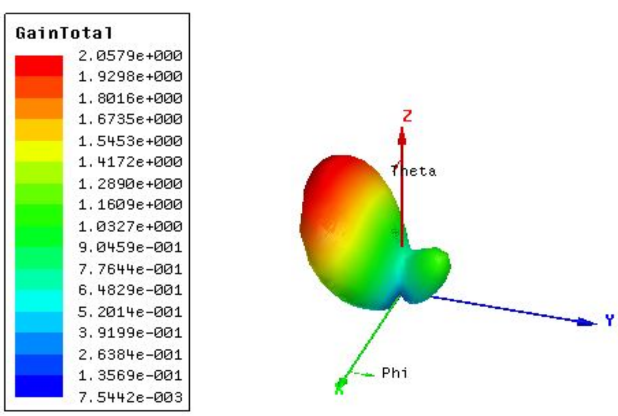

Figure 10. 3D polar plot of gain at 5.7 GHz

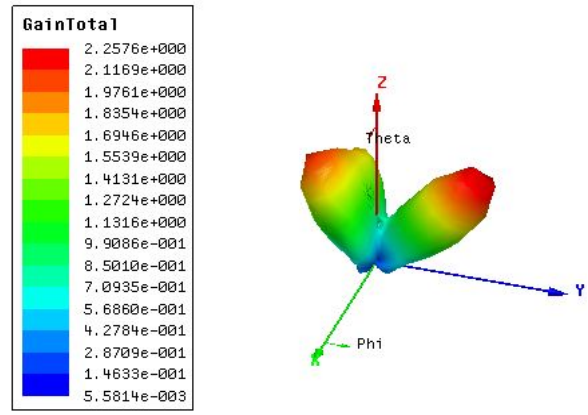

Figure 11. 3D polar plot of gain at 6.06 GHz

4. CONCLUSION

A low profile, light weight antenna is designed to fulfill c band applications. The selectivity is high and utilizes low power. A desired gain of 2.05 dBi is obtained at 5.7 GHz and 2.25 dBi is obtained at 6.06 GHz. The designed antenna has considerable bandwidth and VSWR is below 2 and it is more suitable for C band applications.

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