CHAPTER 6
MULTI BAND MEANDERED STACKED MICROSTRIP FRACTAL ANTENNA

6.1 INTRODUCTION

This chapter presents a multi layered multi band slotted microstrip patch antenna with a probe feeding to the lower patch. This antenna resonates of frequencies from 0.5 to 6.0 GHz. It covers all wireless bands. It gives VSWR less than 2 in the resonant frequencies. This multi band is achieved by using stacked technique with fractal and meandered patch. The lower is ground, Circular shaped meandered patch having FR4 substrate material is in the middle. The slotted patch and fractal patch are in the upper side. This stacked antenna has been simulated by electromagnetic simulator software.

This introduction of a stacked patch in antenna structure associated with multiple layers provides us with few parameters to optimize the antennas broadband behavior. In comparison with previous research, the antenna in this research uses a FR4 substrate material for upper, lower and additional patches. The antenna radiation pattern is useful for LAN protocols in wireless communication broadband applications.

6.2 MEANDER PATCH

Circular patch with five slits as meander patch (A12) is designed in chapter 3. The Circular patch with multi slit as Meander (figure 3.42) having radius, a=47.6 mm, on the FR4 dielectric material $\varepsilon_r =4.4$, substrate thickness, h=3.2 mm. It is giving the results of -10.14 dB at 0.885 GHz, -12.35 dB at 1.82 GHz, -10.74 dB at 2.42 GHz, -13.32 dB at 4.79 GHz, -11.77 dB at 5.23 GHz, and -10 dB at 5.83 GHz. To get required multi band, it is taken for stacking.
6.3 FRACTAL PATCH

Star shaped multisided fractal patch (figure 4.30) is designed with radius, \( a \) is equal to 47.6 mm by assuming resonant frequency, \( f_r \) is equal to 0.9 GHz, \( \varepsilon_r \) is equal to 4.4, \( \sqrt{\varepsilon} \) is equal to 2.09, and thickness \( h \) is equal to 1.6 mm with \( N \) is equal to 16 sides. The simulation result of S-Parameter \( S_{11} \) is, -25dB at 0.99 GHz. It is also added here for stacking to get 0.9 GHz in the final result.

6.4 STACKED PATCHES

This hexagonal shaped fractal patch is already designed in chapter 5, by stacking with circular meander patch to form as stacked patch. It yields multi band operation. Further to get more performances, it is taken for stacking.

6.5 STAR SHAPED FRACTAL, HEXAGONAL FRACTAL STACKED WITH MEANDER PATCH

Stacked with additional patch combining star shaped fractal, hexagonal and meander patch together as antenna (A18) is presented here.

Figure 6.1: Geometry of star shaped fractal stacked with meander
6.5.1 Working principle of multiband antenna

The stack has the structure as shown in figure 6.1. The top patch is star shaped fractal, additional patch is hexagonal fractal and the bottom patch is meander. The side view is shown in figure 6.2.

![Figure 6.2: Side view of stacked antenna with additional patch](image)

It consists of star shape fractal on top, hexagonal fractal as additional, and meandered patch as bottom patch. This stacked antenna attains radiation characteristics with utilizing the coupling between the first radiating element ‘star shaped fractal’ and the second radiating element ‘hexagonal fractal’, when a power is fed to the bottom meandered patch antenna.

![Figure 6.3: S-Parameter results of star shaped fractal stacked with meander](image)
Reflection coefficient vs frequency as S-parameter is shown in this figure 6.3, multi band operation is obtained between 0.5 GHz and 6 GHz for the two patches only, top patch star shape, and bottom patch meander.

![Figure 6.4: Gain of star shaped fractal stacked with hexagonal patch and meander patch](image)

The S-Parameter values of this combined stacked antenna’s simulation and measurement are displayed in the graph of figure 6.3. The solid line indicates measurement and it follows closely to simulation results. The gain vs frequency variation is shown in figure 6.4. The radar plot results of star shaped fractal stacked with hexagonal patch and meander patch showing the radiation pattern in figure 6.5.
Figure 6.5: Radar plot results of star shaped fractal stacked with hexagonal patch and meander patch.

VSWR vs frequency display is given in figure 6.6, which shows less than 2 values are obtained for most of the resonant frequencies.

Figure 6.6: VSWR results of star shaped fractal stacked with hexagonal patch and meander patch
Figure 6.7: S-Parameter results of star shaped fractal stacked with hexagonal patch and meander patch

In this figure 6.7, reflection coefficient vs frequency curve shows the multiband operation with maximum gain, 10 dB return loss. Far field radiation pattern of XZ plane, YZ plane is given in two dimensional view in figure 6.8 and 6.9

Figure 6.8: Radiation pattern of star shaped fractal stacked with hexagonal patch and meander patch in XZ plane
Figure 6.9: Radiation pattern of star shaped fractal stacked with hexagonal patch and meander patch in YZ plane

6.6 SUMMARY

Multi slit circular patch as meandered patch, Star shaped fractal patch resonating frequency at 0.9 GHz, and Hexagonal fractal patch are combined as one antenna by stacking together and designed. This stacked combination antenna gives multiband operation between 0.5 GHz and 6 GHz with maximum gain of 7.74 dB. The simulation and measurement results are in close uniformity.

Microstrip antenna meandered and stacked design and analysis for wireless communication application are given in this chapter. It is concluded that low profile antenna can be utilized for wideband applications with fractal, meandering method and stacking method. The next chapter proposes the conclusion of analysis, design of microstrip antenna by using probe feed multi band stacked methods. The future work of this research is also discussed.