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# FABRICATION OF MULTIBAND FRACTAL CPW ANTENNA FOR GPS, WIMAX, AND IMT APPLICATIONS

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## ABSTRACT

Fractal multiband antenna structure fed by coplanar waveguide (CPW) transmission line is designed and analyzed. The final validated circuit is designed on FR4 substrate with a CPW-Fed line which operates in the Global Positioning System (GPS 1.57), Worldwide Interoperability for Microwave Access (Wi-MAX 2.5 — 2.69), and International Mobile Telecommunication (IMT 3.40 — 4.20 GHz). The antenna is fabricated on an economical FR4 dielectric substrate with a thickness of 1.58 mm (h), a relative permittivity of 4.4 (Ɛr), and a loss tangent of 0.025. The entire area of the antenna is 75 x 55 mm2. A 50Ω SMA Connector is used to feed the antenna at the CPW-Fed line manifestly, it has been found that the radiation patterns of the presented antenna are still similar to the bidirectional radiation pattern. The properties of the antennas, for instance, return losses and radiation patterns are validated by using a network analyzer.

**Keywords:** Coplanar Waveguide (CPW), Global Positioning System (GPS), Worldwide Interoperability for Microwave Access (Wi-Max), International Mobile Telecommunications (IMT), Fractal CPW Antenna.

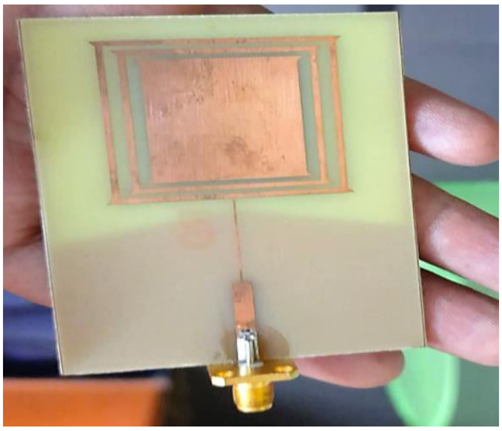
## I. INTRODUCTION

We require an antenna that has a compact size, higher gain, and optimal performance. To meet these requirements, we need a fractal antenna that has not deterministic and smaller in size. To obtain a stable bidirectional radiation pattern and good input impedance matching with a significant bandwidth, we have chosen fractal theory in antenna.

## II. COMPONENTS USED

**Antenna main components**

1. Ground plane
2. Dielectric substrate
3. Fractals
4. CPW Feedline



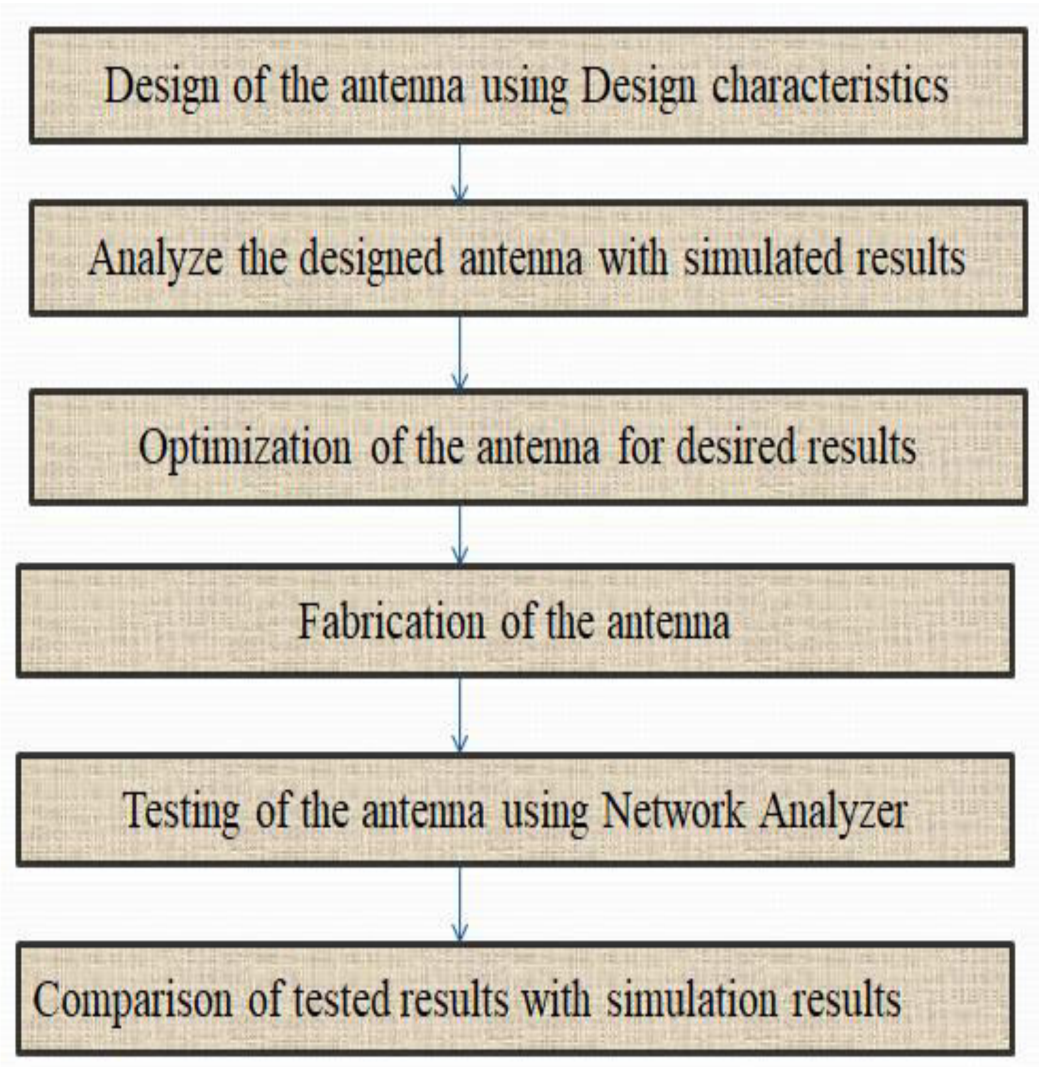
## III. EQUATIONS USED

$$Width = \frac{c}{2f_o\sqrt{\frac{\varepsilon_R+1}{2}}}; \quad \varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right]$$

$$Length = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}\right)$$

The above equations are used for widths and lengths of the antenna are calculated for the different relative permittivity of substrates such as epoxy FR4.
Antenna performance changes by changing the dimensions of the antenna so till we achieve desired antenna parameter values like return losses, gain, and VSWR we change the dimensions of the antenna.

## IV. METHODOLOGY




The above algorithm is followed for designing the Multiband Fractal CPW Antenna For GPS, Wi-MAX, And IMT Applications.

## V. MODELING AND ANALYSIS

Dimensions and the parameter values of an Antenna are shown in the below table:

| Parameters | Values (Unit it mm) |
|---|---|
| $L_{sub}$ | 75 |
| $W_{sub}$ | 55 |
| H | 1.58 |
| T | 0.035 |
| L0 | 34 |
| W0 | 37 |
| Lg | 27.25 |
| Wg | 25 |
| Lf | 5.75 |
| Wf | 4 |
| G | 0.5 |
| W | 5 |
| L1 | 30 |
| W1 | 31 |
| L2 | 26 |
| W2 | 25 |

Table 4.1: Dimensions and Parameters

In our project, Multiband Fractal Antenna design is fed with two different feeding techniques they are, CPW feedline and Microstrip feedline. In that, we obtained better results for the CPW feedline shown in the below figures.

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Figure: 4.1 CPW feed

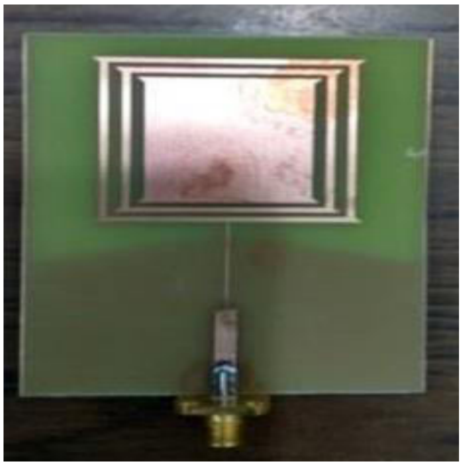

Figure: 4.2 Microstrip feed

**Comparison of CPW and Microstrip line Feed Measured Results**

| | CPW Feed | | | | Microstrip Feed | | | |
|---|---|---|---|---|---|---|---|---|
| Resonant frequency (GHz) | 1.6 | 2.6 | 4.03 | 4.5 | 1.7 | 2.58 | 3.95 | 4.44 |
| Gain(dB) | 2.15 | 2.9 | 4.10 | 3.01 | 2.22 | 2.78 | 3.47 | 2.86 |
| Returnloss(dB) | -18.8 | -25.4 | -12.9 | -22.6 | -11.8 | -28.7 | -18.9 | -26.02 |

Table 4.2 Comparison of the proposed antenna with CPW feed and microstrip feed.

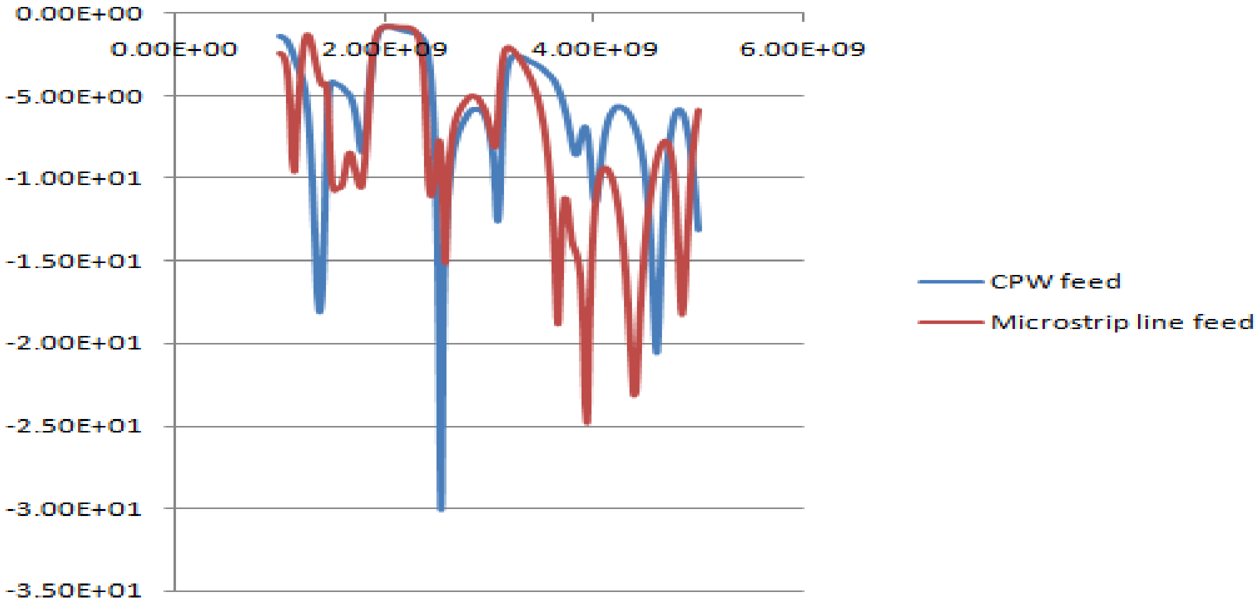


Figure: 4.3 Comparison of CPW and Microstrip line Fed Measured Results

# VI. RESULTS AND DISCUSSION

## COMPARISON OF SIMULATED RESULTS FOR ALL ITERATIONS AND FABRICATED ANTENNA RESULTS

### Return losses

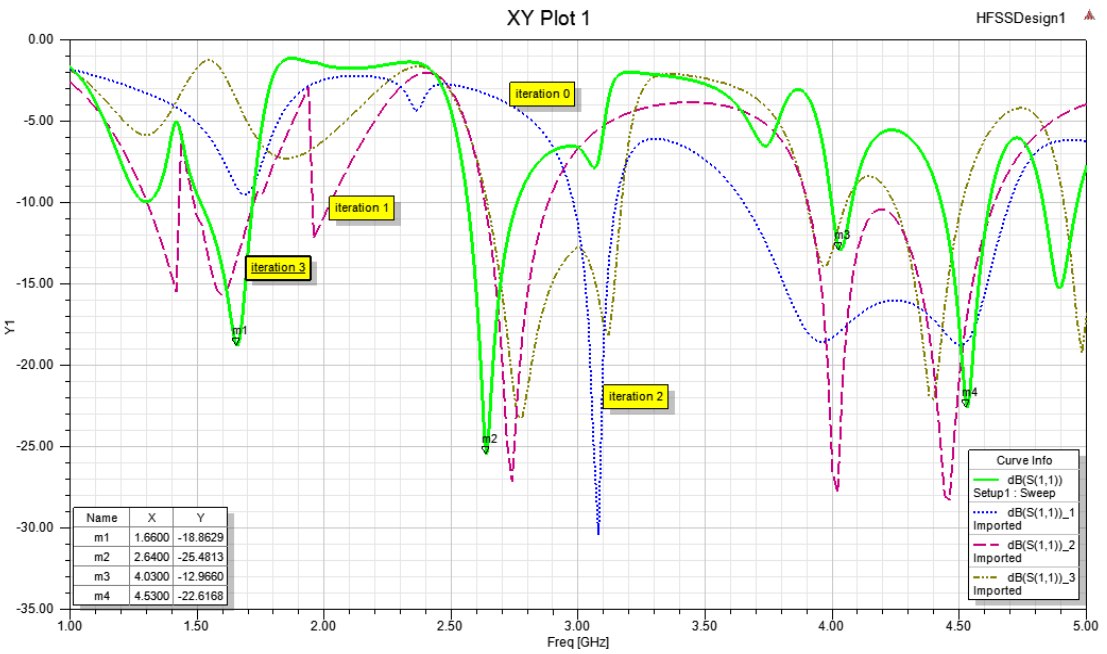


Figure: 5.1 Comparison of simulated Return losses for all iterations in HFSS.


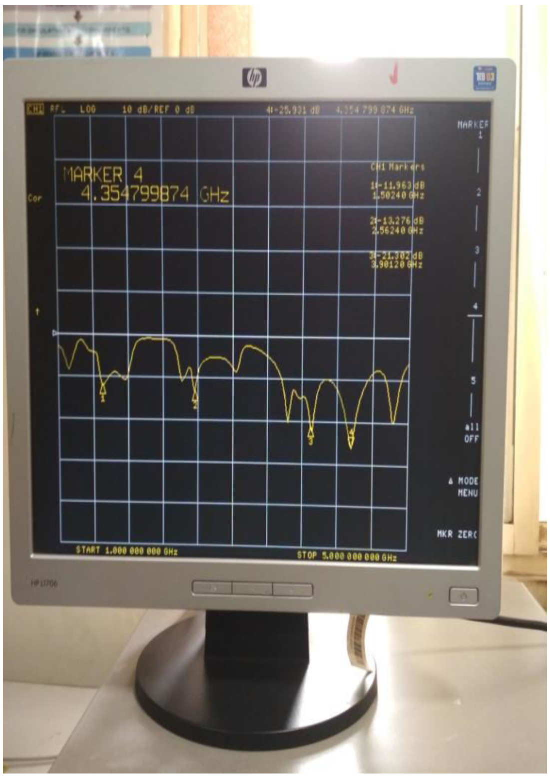

Figure: 5.2 Comparison of CPW and Microstrip line Feed Measured Results in Network Analyzer

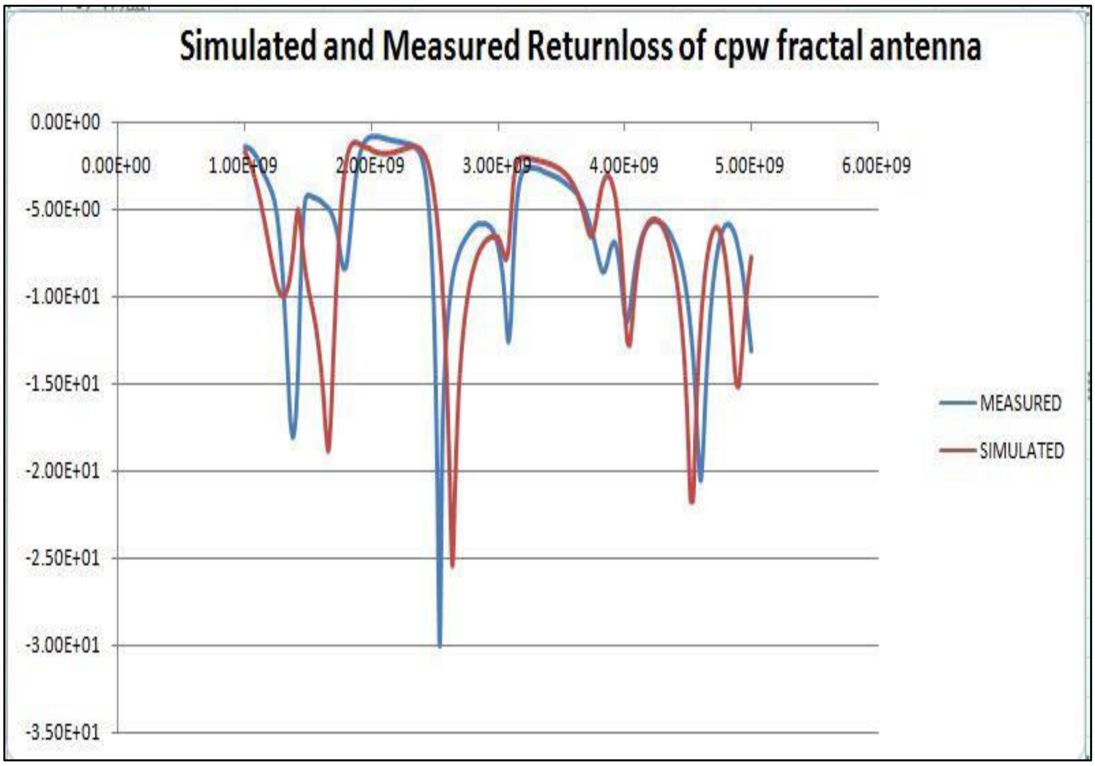


Figure: 5.3 Comparison of simulated and measured Return losses of CPW Feed Fractal Antenna

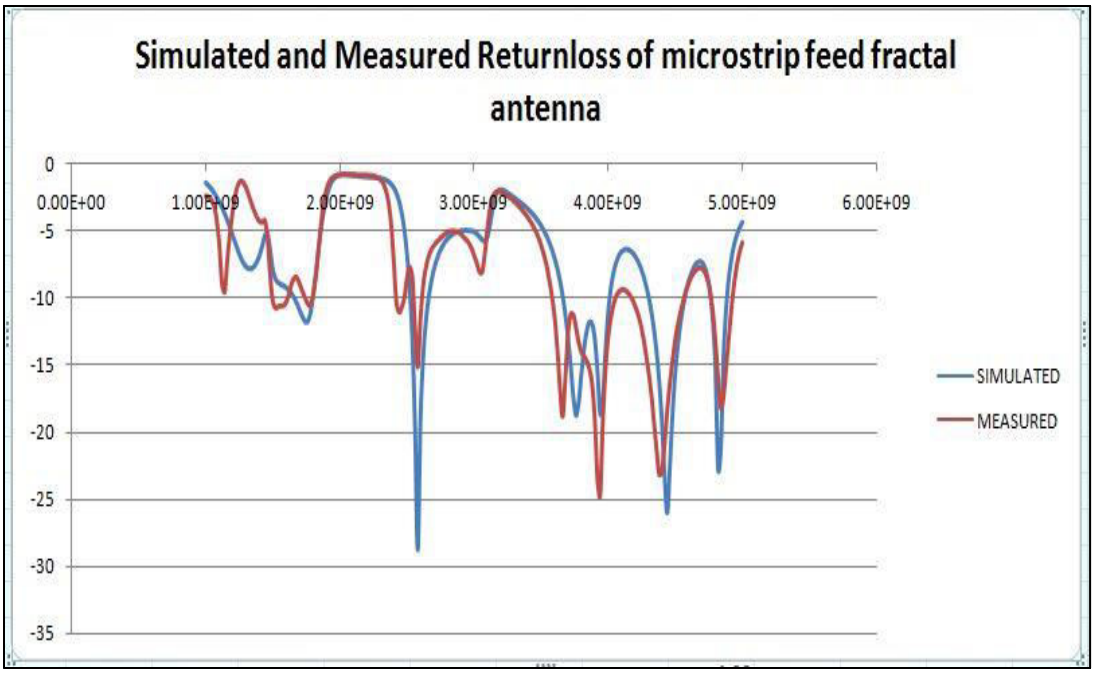


Figure: 5.4 Comparison of simulated And Measured Return losses Microstrip Feed Fractal Antenna

In the graphs, corresponding to 1.66 GHz, 2.64 GHz, 4.03 GHz, and 4.53 GHz frequencies no cusp is observed so near to that frequency one cusp is present. So that vertical value is measured which is reflection coefficient which was observed as 19.003

dB, -25.44 dB, -12.95 dB, and -22.62 dB respectively. It is close to that ideal reflection coefficient value. So Antenna radiation is good.

## Gain plot

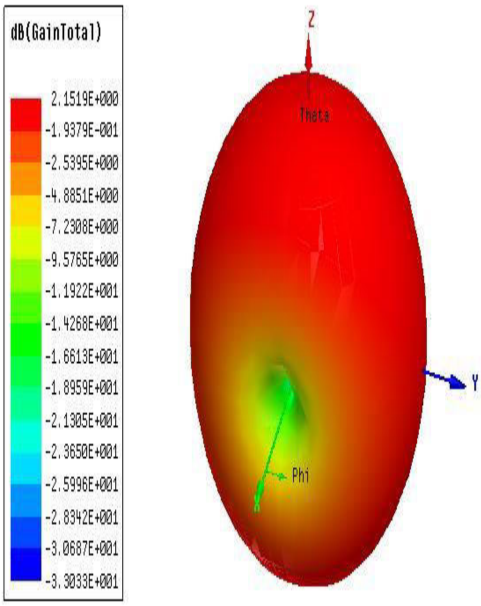


Figure 5.5: Gain at 1.66GHz

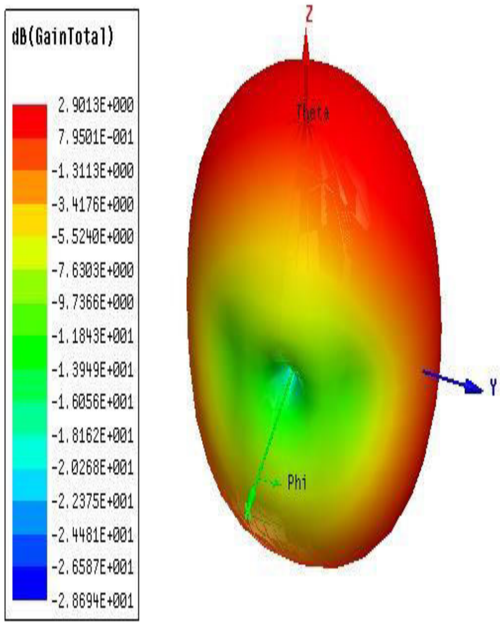


Figure 5.6: Gain at 2.6 GHz

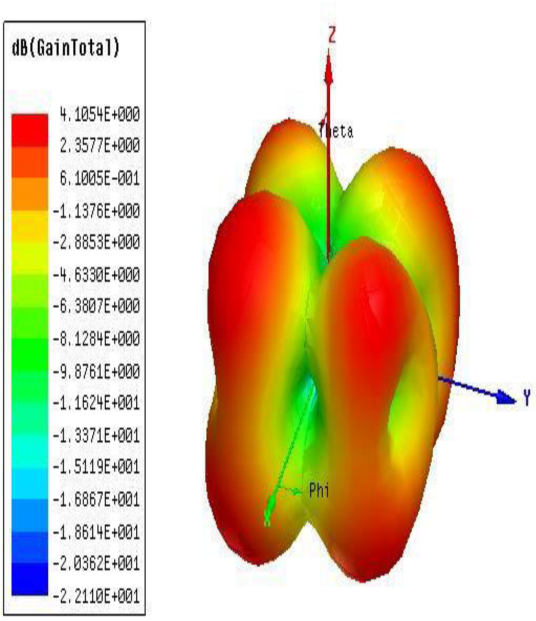


Figure 5.7: Gain at 4.03 GHz

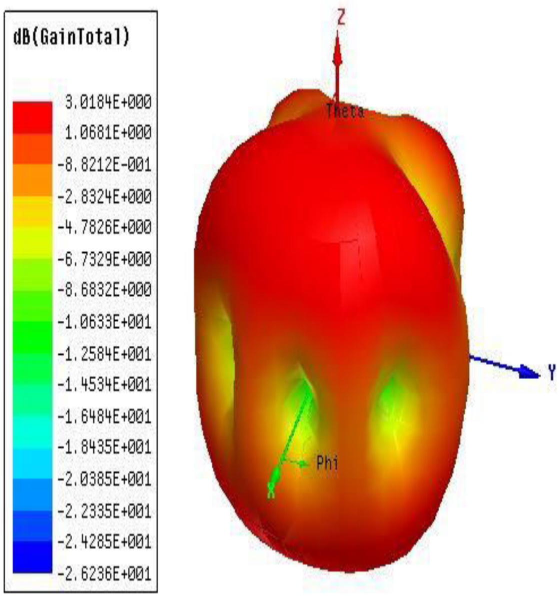


Figure 5.8: Gain at 4.54 GHz

In this spherical coordinate system, the gain is calculated by observing at the z-axis. Gain is observed at 2.15 dB at 1.66 GHz, 2.901 dB at 2.64 GHz, 4.105 at 4.03 GHz, and 3.018 dB at 4.54 GHz. These are various results calculated from the graphs.

## VII. CONCLUSION

In this project, we have validated a simulation of a rectangular patch and Several Iterations Fractal antennas using CPW feed line and Microstrip feed line. To validate these antenna structures we have used HFSS. This Fractal Antenna is designed for GPS, WIMAX, and IMT Applications frequency bands. This antenna structure has a stable bidirectional radiation pattern and significant bandwidth. For the designed Fractal antenna, return losses and gains are observed. The antenna gain below 5dB is obtained for all frequency bands. Compared measured results of the proposed antenna with simulated results. Compared to the microstrip feed antenna, better results have obtained with the CPW feed antenna.

## VIII. REFERENCES

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