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Stimulation of Micro-strip Patch Antenna Using HFSS

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Abstract - *Wider bandwidth is required in modern wireless communication. Traditionally each antenna operates in a single frequency band, where a different antenna is required for different application. This will occupy more space. This paper presents a comparative study between three multiband antennas – Monopole antenna, PIFA and Fractal antenna. The planar monopole antenna has a simple structure, Omni-directional radiation characteristic, low profile, and lightweight internal antenna. PIFA is one of the most promising antenna types because it is small and has a low profile, making it suitable for mounting on portable equipment. Fractals have self -similar shapes and space filling properties. This property makes the fractal antenna compact and operating in multiband frequencies. The comparison is done in terms multiband radiation and size. The behavior of Micro-strip patch antenna in different atmospheric conditions can be analyzed by varying the values of Di electric Substrates.*

***Key Word**:* Antenna, Monopole, PIFA, Fractal, HFSS.

1. INTRODUCTION

In the last few years, the trend of mobile phone technology has dramatically decreased the weight and size. Due to enhancement in this trend, the antennas used for mobile have to be small, light weighted, low profile and have Omni-directional radiation pattern in horizontal plane.

1.1. PLANAR MONOPOLE ANTENNA

Monopole antenna have been the best whelming choice for use in various automobiles and mobile equipment [4]. The planar monopole antenna is a good candidate for wireless communication because of its simple structure, Omni-directional radiation characteristic, low profile, and light weight internal antenna. It is significant that the designed dual or multi band antenna maintained good radiation efficiency value and constant gain at both bands [2].

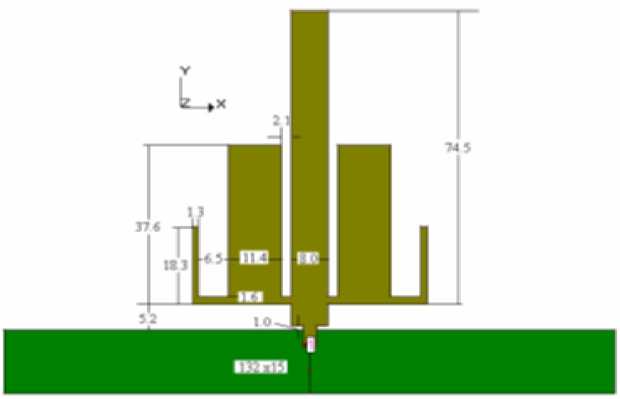


Figure 1. Extended E shape monopole antenna

1.2. PIFA

The Planar Inverted-F antenna (PIFA) is increasingly used in the mobile phone market. The antenna is resonant at a quarter-wavelength (thus reducing the required space needed on the phone), and also typically has good SAR properties. This antenna resembles an inverted F, which explains the PIFA name. The Planar Inverted-F Antenna is popular because it has a low profile and an Omni-directional pattern. The PIFA is shown from a side view in figure [3].

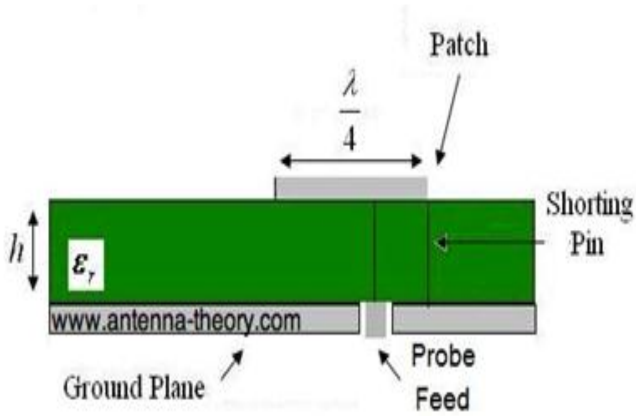


Figure 3. The Planar Inverted-F Antenna (PIFA).

2. FRACTAL

Fractal antennas are reliable and cost-effective. Fractal antennas allow for multiband capabilities, decreased size, and optimum smart antenna technology. Fractals have self-similar shapes and space filling properties that can be subdivided into parts. This property makes the fractal antenna compact and operating in wideband frequencies. The different fractal elements of the antenna allow it to have different resonances. The presence of discontinuities in the geometry increases the bandwidth and radiation properties of antenna. It also has long electrical lengths that fit into a compact size. There are many mathematical structures that are fractals; e.g. Sierpinski's gasket, Minkowski, Cantor's comb, von Koch's snowflake, the Mandelbrot set, the Lorenz attractor, etc[1].

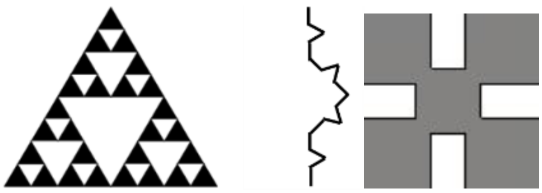


Figure 4. Sierpinski, Koch and Minkowski fractal structures.

3. SIMULATIVE RESULTS OF MONOPOLE, PIFA AND FRACTAL ANTENNA

Monopole, PIFA and Fractal structures are simulated using HFSS(High frequency structure simulator) software. The antenna structures are designed and simulated using FR4 substrate. The relative permittivity and loss tangent thickness of 1.59 mm thick substrate are 4.4 and 0.02 respectively[2]. The structure is fabricated on the one side of the substrate and ground is on the other side of the substrate. The antenna is fed through a 50Ω probe feed at the centre of a 50Ω micro-strip line[2]. simulated structures are given in figures below.

3.1. Monopole antenna:

The proposed antenna consists of a rectangular patch monopole printed antenna in which a slot is cut, and dual-band E-shape patch is placed. The three arms in monopole antenna generates three resonate frequencies to cover 890–960 MHz GSM band, 1710–1880 MHz DCS band, and 2.4–2.5 GHz ISM band. Slots are removed to coincide with central arm to obtain the second structure. Central arm of antenna resonate at GSM, whereas the other two side arms resonate at DCS and ISM band; therefore three bands can be optimized easily. The proposed antennas can easily be fed by using a 50 Ω probe feed. The simulated VSWR is 2 over 890–960 MHz, 1710–1880 MHz, and 2.4–2.5 GHz. The radiation patterns indicate the suitability of these antennas for wireless applications. Monopole antenna has a substrate dimension of 150x105mm^2 and micro-strip line of width 3 mm and a length of 4 mm [2].

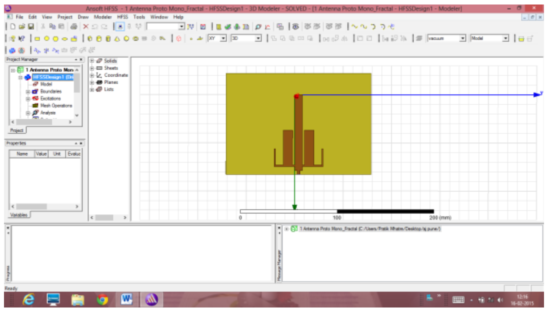


Figure 5. Monopole structure

Monopole is resonating in dual band i.e at 2GHz & 3.25GHz frequency.

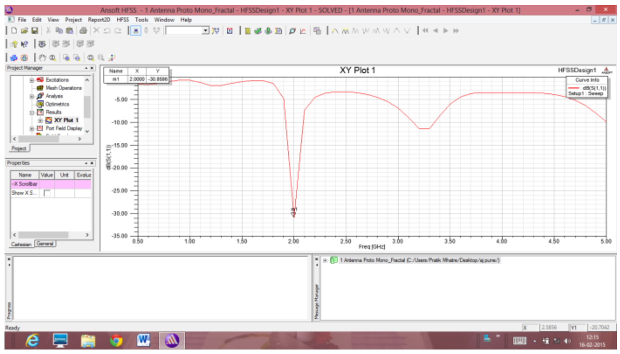
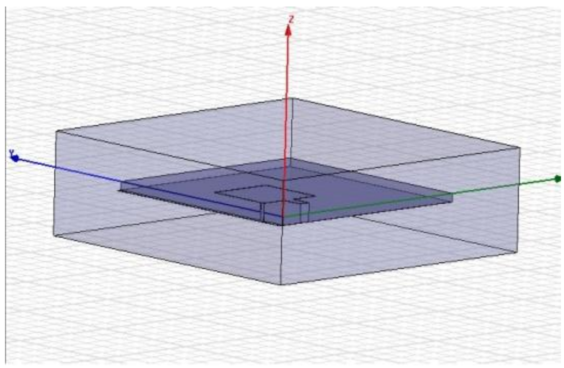


Figure 6. Monopole antenna's Rectangular plot.

3.2. PIFA Antenna:

In modern era, a demand has increased to design antennas having multiband and wideband characteristics for mobile terminals. This paper expresses the bandwidth of a Planar Inverted F Antenna. Here, the antenna is built on a small ground plane size of 60mm x 60mm. In this paper, Planar Inverted F Antenna with a radiating patch of fixed dimensions of 15.3mm x 15.3mm and shorting pin of 1mm with different di electrics [8].



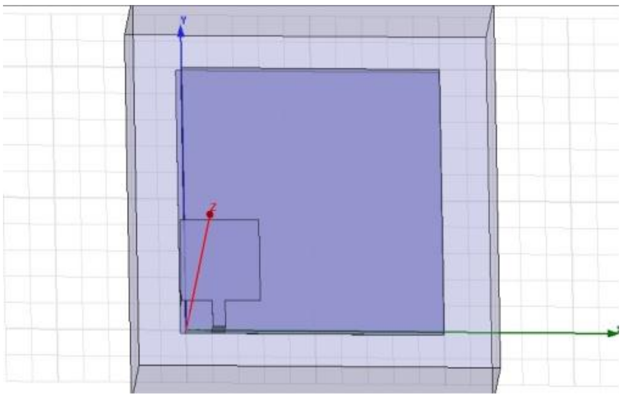


Figure 7. PIFA antenna

PIFA is resonating in dual band i.e in 2.2GHz & 8GHz frequency.

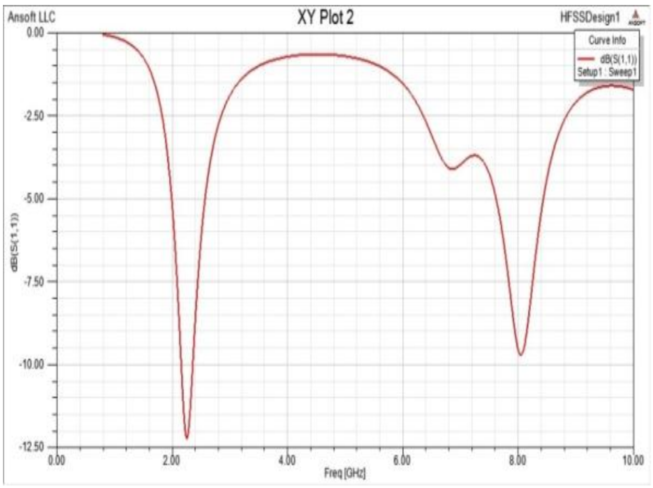


Figure 8. PIFA and its Rectangular plot

3.3. Fractal antenna:

Fractal antennas have the characteristic of radiating in multiple frequencies through the property of self-similarity that fractal shapes possess. By connecting fractal shaped antennas, wideband coverage can be achieved. Micro-strip patch antennas with Minkowski fractal geometry can be tuned, by design, to work exactly at the bands of interest, through judicious choice of the fractal designs and iteration. Minkowski Fractal antenna has substrate dimension of 50x50mm, Gnd dimension of 50x9mm and patch of 39x28mm with different di electric substrates[4].

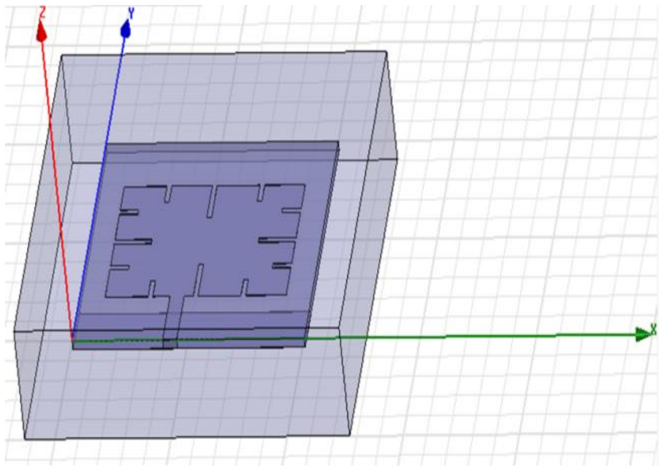


Figure 9. Minkowski fractal antenna.

Minkowski fractal resonate in dual band i.e at 2.2GH & 8.2GHz.

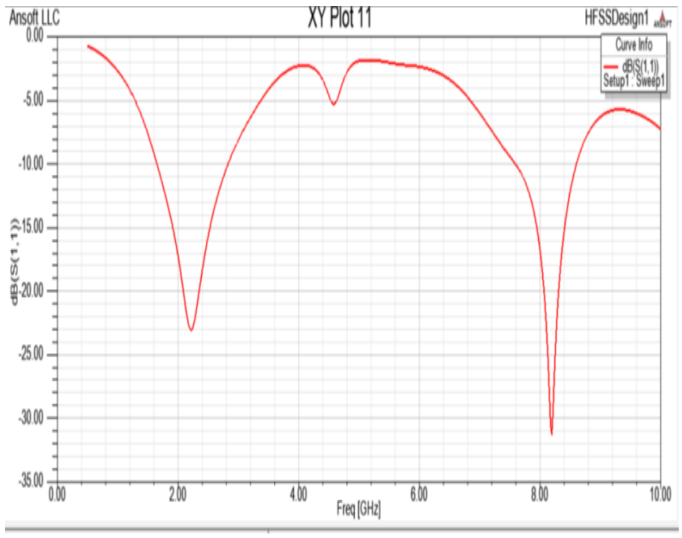


Figure 10. Minkowski Fractal antenna's Rectangular plot.

Table 1. Comparison between Monopole, PIFA and Fractal antenna.

Parameter	Monopole	PIFA	Fractal
Height	planar	Height is varied to increase bandwidth using shorting pin or plate	planar with Fractals & Calculated cuts
Radiation	End-fire	Broadside	Broadside (Omnidirec

			tional)
Frequency	2GHz & 3.25GHz	2.2GHz & 8GHz	2.2GH & 8.2GHz
Bandwidth	20% increase (120Mhz)	40%increase (200Mhz)	15% increase (100 MHZ)
Dimensions (SIZE)	Monopole antenna has a substrate dimension of 150x105mm	15.3x15.3mm and shorting pin of 1mm	50x50mm

Parameter	Monopole	PIFA	Fractal
Size	Large	Small	Medium
Height	Medium	Medium	Small
Radiation	Multiband	Single	Multiband
Bandwidth	Small	Large	wide

4. CONCLUSION

This paper analyses the three antennas Monopole, PIFA and Fractal on the basis of size, height, radiation, frequency, bandwidth parameter. Both monopole and fractal resonate in multiband but since fractal also has small size compared to other two. Fractal is the best option for wireless application. PIFA should have better bandwidth in only two bands but fractional should have better bandwidth in all multi-bands. The antenna analysis is carried out in different layers by varying the di electric values of both substrate & radiation box. It is observed that a fractal antenna performs better in different atmospheric conditions.

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