

# Design and Analysis of Active Integrated Antenna (AIA) for Triband Applications

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**ABSTRACT:** The primary designed passive antenna is capable of supporting for WLAN band at 2.1 GHz, WIFI at 3.7 GHz, Satellite and RADAR at 5 GHz. The antenna with harmonic suppression capability is directly integrated with a amplifier to improve power added efficiency. The antenna is a microstrip patch with harmonic suppressing slits etched on it. The proposed passive patch antenna is integrated with a power amplifier (PA). The antenna has been designated on FR4 substrate. The radiation pattern, return loss, VSWR and Bandwidth of the proposed antenna are simulated and found using HFSS software package.

**KEYWORDS:** Microwave amplifiers, Active integrated antenna slits, Active components

## I. INTRODUCTION

Active Integrated Antenna (AIA) is a direct integration between an antenna and an active circuit such as a power amplifier (PA), low noise amplifier (LNA), or an oscillator [1]. Such integration not only offers reduced circuit size by reducing parts of matching circuits, but also improves the performance of power amplifier when the antenna is designed to have harmonic suppressing capability. The active device in an AIA can be of any kind such as transistors (three-terminal device) or resistors, inductors and any planar antennas such as microstrip patch or microstrip slot antennas can be used as the radiating element.

Initially a single antenna is designed and used for a single application and this makes antenna designers to design a number of antennas. A growing need for portable devices has spawned considerable effort to develop suitable multiband antennas. So multiband antennas are designed, this will operate at multiple frequencies. Multi-frequency antenna has a low frequency operation also has a high frequency bandwidth and operating bandwidth.

## II. RELATED WORK

J.H.Lu and Y.H.Li[1]“Planar Multi-Band T Shaped Monopole Antenna With A Pair Of Mirrored L-Shaped Strips For Wlan/Wimax Operation” *Progress In Electromagnetics Research C*, Vol. 21(2011), 33-44. In this paper, A novel compact design of planar T-shaped monopole antenna with multi-band operation for WLAN/WiMAX system is proposed. By inseting a pair of mirrored L-shaped monopole strips, multi resonant modes close to 2.45/3.5/5.5 GHz band are excited to meet the specifications of WLAN/WiMAX system. And, the obtained impedance bandwidth across the operating bands can reach about 160/1100/2690MHz for the 2.45/3.5/5.5 GHz bands, respectively.

In 2000 Baliarda ,C. P ., J. Romeu and A. Cardama[2] analyzed the behavior the Koch monopole. The results show that as the number of iterations on the small fractal Koch monopole are increased, the Q of the antenna approaches the fundamental limit for small antennas . Compact, low-cost antennas for multiband telematics applications on vehicles are described. The multi frequency band antennas are variations on the printed inverted-F antenna (PIFA) principle. One type of PIFA is a compact variation of a conventional antenna while the other is a novel planar version.

### III. METHODOLOGY

#### Transmission line model

Based on the simplified formulation that has been described, a design procedure is outlined which leads to practical designs of a microstrip antennas. The procedure assumes that the specified information includes the dielectric constant of the substrate ( $\epsilon_r$ ), resonant frequency ( $f_r$ ), and the height of the substrate,  $h$ . The procedure is as follows

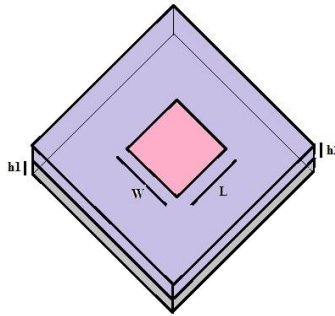


Fig 1. Microstrip patch antenna

Fig 1 shows that For an efficient radiator, a practical width that leads to good radiation efficiencies

$$W = \frac{c}{2 f_r \sqrt{\frac{\epsilon_r + 1}{2}}}$$

Where,

$c$  is the velocity of light,  $3 \times 10^8$  m/s,

$\epsilon_r$  is the dielectric constant of the substrate

$f_r$  is the resonant frequency

Effective Dielectric constant of the microstrip is determined

$$\epsilon_{r_{eff}} = \frac{(\epsilon_r + 1)}{2} + \frac{(\epsilon_r - 1)}{2} \left[ 1 + 12 \frac{h}{W} \right]^{-1/2}$$

Where,

$\epsilon_r$  is dielectric constant of substrate, 4.3 mm

$h$  is the height of the substrate.

$W$  is width of substrate

Once width is found, Extension of the length ( $\Delta L$ ), is determined

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

Where,

$\epsilon_{eff}$  is the effective dielectric constant.

Actual Length of the patch and also the substrate can now be determined by using effective length

$$L_{eff} = \frac{c}{2 f_r \sqrt{\epsilon_{eff}}}$$

$$L = L_{eff} - 2\Delta L$$

Where  $L_{eff}$  is the effective length.

$\Delta L$  is the extension of length.

### Proposed structure of star etch tri band aperture coupled fractal antenna

The proposed fractal antenna uses a combination of aperture coupled technique and fractal geometric approach. The proposed antenna consists of two layers. The top layer contains fractal patch as radiating element. The radiating patch is depicted with complementary minkowski fractal geometry with third order iteration. The 50 ohm micro strip feed-line is excited with a SMA connector. The proposed antenna consists of the FR4 epoxy substrate as a substrate that have a dielectric constant,  $\epsilon_r$  4.4 and  $\epsilon_{eff}$  3.3 with thickness of  $h_1=1.6$ mm.

In order to increase the performance of antenna such as gain and efficiency, an air gap substrate of  $h_2 = 1$  mm thickness with Dielectric constant,  $\epsilon_r$  1 is inserted between top layer and bottom layer. The air gap is used to avoid coupling problems between the aperture slot on ground plane and the fractal patch on the top layer due to improper alignment between them. The top layer and bottom layer substrate dimensions are 80mmx70mm and the total thickness of the existing antenna is 2.6 mm with air gap.

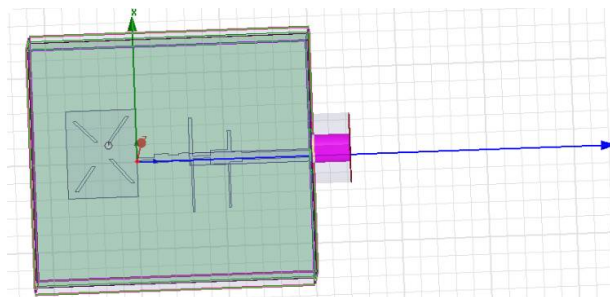


Fig 2 star etch tri band aperture coupled fractal antenna

Figure 2 shows top view of the proposed aperture coupled fractal antenna . Here, radiating patch is designed using fractal approach.

The figure shows various iteration of fractal antenna based Serpinski approach. This antenna is operated at Tri band frequencies 2.1, 3.7GHz and 5GHz. This Tri band frequency response depends on iterations, islands-spaces and perturbation dimensions. The figure shows first iteration of MIB based fractal antenna this gives reduction in patch area is 49.39%.The figure shows second iteration of MIB based fractal antenna. This gives reduction in patch area is 61.737%. The figure shows third iteration of MIB based fractal antenna. This gives reduction in patch area is 64.556%. Fig 4.d. shows fourth order iteration of MIB. This gives reduction in patch area is 65.33%. If iteration order increases, the resonance frequency, return loss, VSWR, directivity and gain are improved. Also bandwidth improved in higher frequency and reduced in lower frequency. This proposed fourth order iteration of MIB aperture coupled fractal antenna used in WLAN and Wi-Fi applications.

### IV. SOFTWARE USED

HFSS is a high-performance full-wave electromagnetic(EM) field simulator for arbitrary 3D volumetric passive device modeling that takes advantage of the familiar Microsoft Windows graphical user interface. It integrates simulation, visualization, solid modeling, and automation in an easy-to-learn environment where solutions to your 3D EM problems are quickly and accurately obtained. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight to all of your 3D EM problems. Ansoft HFSS can be used to calculate parameters such as S-Parameters, Resonant Frequency, and Fields.HFSS is an interactive simulation system whose basic mesh element is a tetrahedron. This allows you to solve any arbitrary 3D geometry, especially those with complex curves and shapes, in a fraction of the time it would take using other techniques. In industry, Ansoft HFSS is the tool of choice for high-productivity research, development, and virtual prototyping.

### V. RESULTS AND EXPRESSIONS

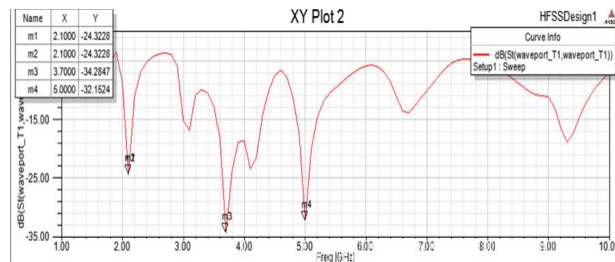


Fig 3 Return Loss

Fig 3 shows that in telecommunications, return loss is the loss of power in the signal returned by a discontinuity in a transmission line or optical fiber.

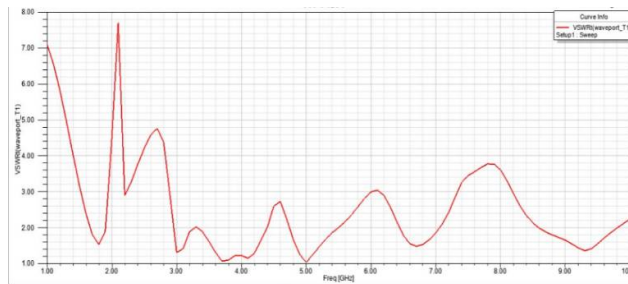


Fig 4 VSWR

Fig 4 shows that that the function of the reflection coefficient, which describes the power reflected from the antenna. The minimum VSWR is 1.0

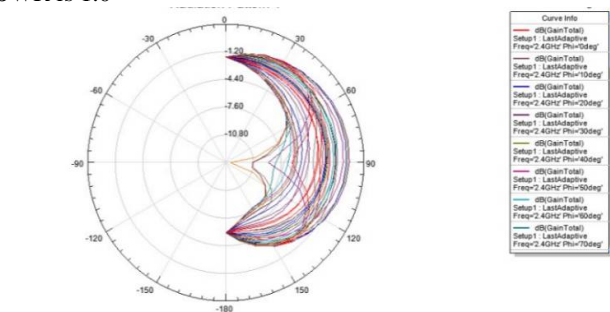


Fig 5 Radiation Pattern

Fig 5 shows that The power pattern is usually plotted on a logarithmic scale or more commonly in decibels(dB).

## V. CONCLUSION

Star etch tri band aperture coupled fractal antenna is designed. The parameters Return loss, VSWR, Radiation pattern are determined.

The return loss for frequency 2.1 GHz, 3.7 GHz and 5 GHz is -24.181, 34.932 and -33.5 respectively.

The VSWR for frequency 2.1 GHz, 3.7 GHz and 5 GHz is 1.09 and 0.8 respectively.

## REFERENCES

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