

**ABSTRACT**

Traditionally each antenna operates at a single or dual frequency bands, where different antenna is needed for different applications. This will cause a limited space and place problem. In order to overcome this problem, multiband antenna can be used where a single antenna can operates at many frequency bands. One technique to construct a multiband antenna is by applying microstrip shape into antenna geometry. a modified Auspicious square patch antenna has been designed. For designing this antenna IE3D software is used which is based on MoM technique. The Auspicious microstrip shape is used for designing the proposed antenna. In decomposition algorithm for rectangular shape is cut down from each side of the square patch antenna which shows the 1<sup>st</sup> iteration. The side length of square patch microstrip antenna is 30 mm (without iteration) and after iteration 'indentation' size is 2mm×8mm and square size is 14 mm. This square patch microstrip antenna has scale factor of 2.

**KEYWORDS: :- microstrip antenna, square patch antenna , MoM**

**INTRODUCTION**

In the modern wireless world, the need for smaller, broadband and reliable antennas has been fully demonstrated in current advancements in communication industry and significant growth in wireless communication market and consumer demand. Traditionally Each antenna operates at a single or dual frequency bands, where different antenna is needed for different applications. This will cause a limited space and place problem. Antenna design in this miniaturized world has become a challenging task for engineering and science as it needs to be compact as well as efficient to meets the required conditions. The microstrip patch antenna[1] (MPA) has attracted wide interest due to its important features, such as light weight, low profile, low cost, simple to manufacture and easy to integrate with RF devices. For reducing the size of antenna, microstrip [2] geometries have been introduced. In this paper, a modified auspicious square patch antenna has been designed. And in order to overcome this problem, multiband antenna can be used where a single antenna can operates at many frequency bands. One technique to construct a multiband antenna is by applying microstrip [3] shape into antenna geometry. A modified auspicious square patch antenna has been designed. For designing this antenna IE3D software is used which is based on MoM technique. The Auspicious microstrip shape is used for designing the proposed antenna. In decomposition algorithm for rectangular shape is cut down from each side of the square patch antenna which shows the 1<sup>st</sup> iteration. The side length of square patch microstrip antenna is

30 mm (without iteration) and after iteration 'indentation' size is 2mm×8mm and square size is 14 mm. This square patch microstrip antenna has scale factor of 2.

$$\delta = \frac{h_n}{h_{n+1}}$$

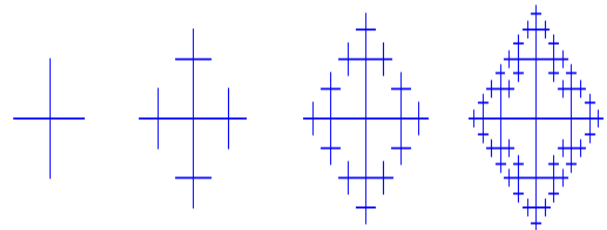
where  $\delta$  = scaling factor of the antenna

$h_n$  = length of the antenna

n = number of iterations

**Antenna Design**

A microstrip is "a rough or fragmented geometric shape" that is generated by starting with a very simple pattern that grows through the application of rules. In many cases the rules to make the figure grow from one stage to next involve taking the original figure and modifying it or adding to it. The process can be repeated recursively an infinite number of times.



*Figure 1.1 Simplest Example of Microstrip  
Geometry*

Microstrip has the following features

- (1) It has a fine structure at arbitrarily small scales.
- (2) It is too irregular to be easily described in traditional Euclidean geometric.
- (3) It is self-similar.
- (4) Simple and recursive.

The latest communication system requires antennas with more bandwidth and smaller dimensions. In order to improve bandwidth and dimensions [4][5], a new square shaped microstrip antenna for wireless communication is designed and simulate that designed Antenna. And a comparative study of the simulated and theoretical results of the designed square shape microstrip antenna [6]. For reducing the size of antenna, microstrip geometries have been introduced in the design of antenna.

### ANALYSIS AND EXPERIMENTAL RESULTS

As discuss in previous section, **reducing the size of antenna, microstrip geometries have been introduced in the design** of antenna [7]. In this paper, the performance of proposed antenna is influenced by some key design parameters, which can be used to better the radiation pattern and decrease the return loss of this antenna. In decomposition algorithm a rectangular shape is cut down from each side of the square patch antenna which shows the 1<sup>st</sup> iteration. The side length of square patch microstrip antenna is 30 mm (without iteration) and after iteration ‘indentation’ size is 2 mm×8 mm and square size is 14 mm. To iterate the square microstrip antenna scaling factor having value 2.

$$\delta = \frac{h_n}{h_{n+1}}$$

where,  $\delta$ = scaling factor of the antenna  
 $h_n$ = length of the antenna  
 $n$  = number of iteration

For the proposed antenna case  $h_n = 30$  mm (length of the antenna without iteration)

$h_{n+1} = 14$  mm ( length of the antenna after iteration)

$$\delta = \frac{30}{14} \approx 2 \tag{1}$$

Hence the scaling is nearly two of the proposed antenna.

The length of the antenna is L (initially) and the geometrical object obtained at the first iteration. For determining the dimension of self-similar deterministic structure, like the geometries in this article, the self-similar dimension provides an intuitive approach. The dimension D is a solution to the following equation:

$$k_1 \left(\frac{1}{h_1}\right)^D + k_2 \left(\frac{1}{h_2}\right)^D + \dots + k_n \left(\frac{1}{h_n}\right)^D = 1 \tag{2}$$

Where  $K_n$ , is the number of copies of the initiator scaled by  $h_n$ . And D is the width of the indentation

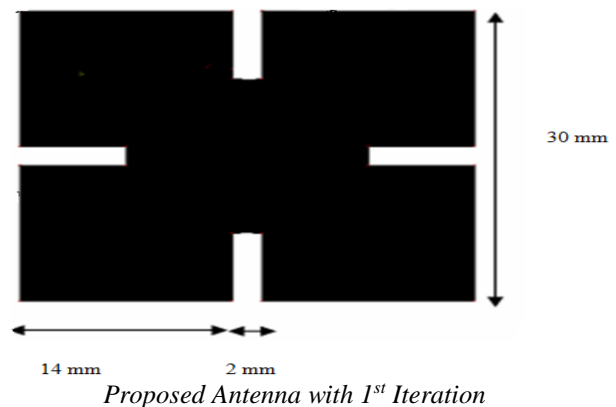
$$D = \frac{-\ln(k_1)}{\ln\left(\frac{1}{h_1}\right)} \tag{3}$$

After iteration in the proposed antenna it consists of four copies of itself, each scaled down by a factor of two

$$D = \frac{-\ln(4)}{\ln\left(\frac{1}{2}\right)} = 2 \tag{4}$$

The coordinate of indentation in square shape to iterate the structure are

- (X, Y) = (-1, 15), (-1, 8), (1, 8), (1, 15)
- (X, Y) = (15, 1), (8, 1), (8, -1), (15, -1)
- (X, Y) = (1, -15), (1, -8), (-1, -8), (-1, -15)
- (X, Y) = (-15, -1), (-8, -1), (-8, 1), (-15, 1)



In first iteration results the return loss, radiation pattern, gain, directivity and VSWR characteristic  
**1.1 Return Loss ( $S_{11}$ )**

Return loss is the ratio, of the amplitude of the reflected wave to the amplitude of the incident wave at the junction of a transmission line and terminating impedance or other discontinuity. The return loss value describes the reduction in the amplitude of the reflected energy, as compared to the forward energy. Figure 1.1 shows the return loss of the proposed antenna with 1<sup>st</sup> iteration.

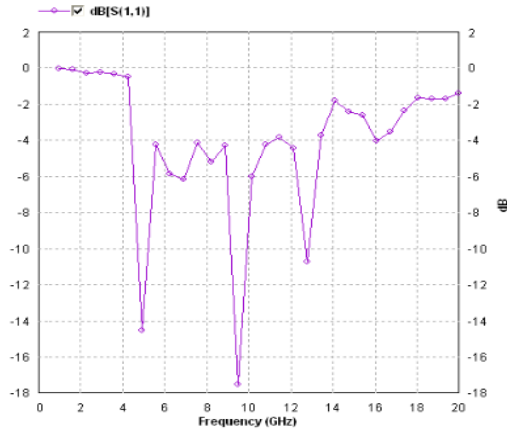


Figure 1.1 The characteristic of the return loss (S11) with 1st Iteration

From figure 1.1 it is shown that the resonant frequencies are 4.9 GHz and 9.5 GHz. At these frequencies the return loss is less than -10 dB. Hence the antenna is best suited for these frequencies.

**1.1.2 Radiation Pattern**

As in last parameter return loss is less than, and in radiation patterns of an antenna provide the information that describes how the antenna directs the energy it radiates. All antennas, if 100% efficient will radiate the same total energy for equal input power regardless of pattern shape. Radiation patterns are generally presented on a relative power dB scale.

**1.1.2.1 Elevation Radiation pattern**

Figure 4.2 shows the elevation radiation pattern of the gain at resonant frequency 4.9 GHz. The gain is 4.2 dBi.

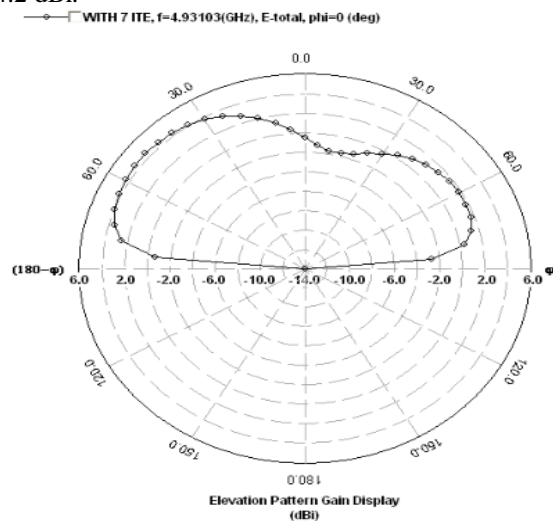


Figure 1.2 Elevation Radiation Pattern at Resonant Frequency 4.9 GHz

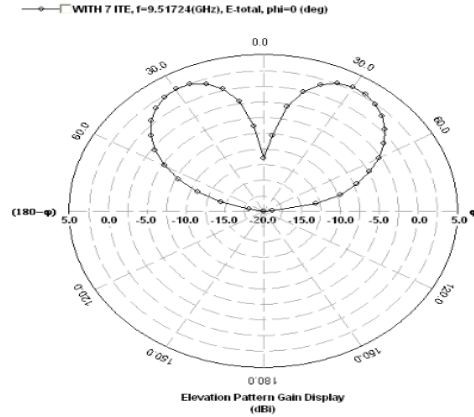


Figure 1.3 Elevation Radiation Pattern at Resonant Frequency 9.5 GHz

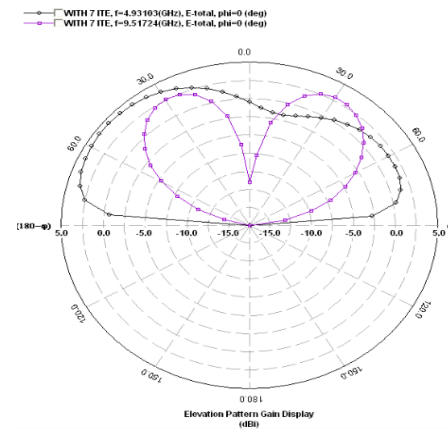


Figure 1.4 Elevation Radiation Pattern at both Resonant Frequencies

**1.1.2.2 Azimuth radiation pattern:**

Figure 4.5 and Figure 4.6 show the azimuth radiation pattern of the antenna at resonant frequencies 4.9 GHz and 9.5 GHz respectively.

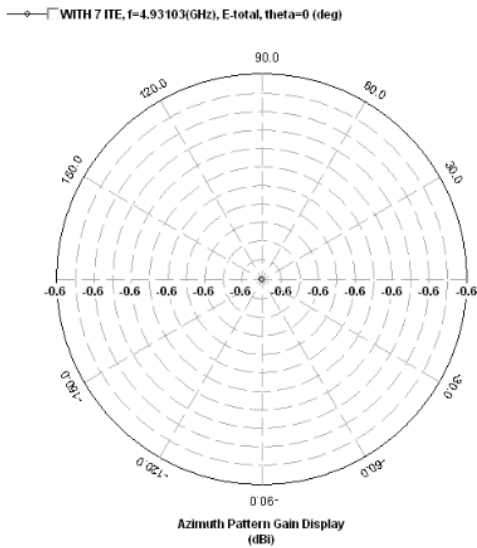


Figure 1.5 Azimuth Radiation Pattern for 4.9 GHz

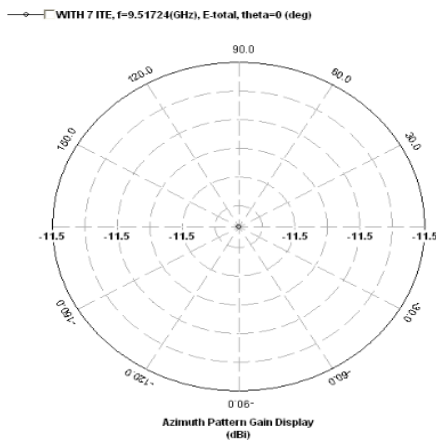


Figure 1.6 Azimuth Radiation Pattern for 9.5 GHz

The bandwidth (BW) of the antenna is the difference of upper cut off frequency and lower cut off frequency

$$BW = f_h - f_l \tag{5}$$

$$BW = 5.25 - 4.75 = .5 \text{ GHz} = 500 \text{ MHz}$$

% bandwidth is define as

$$\% BW = \frac{f_h - f_l}{f_0} \times 100\% \tag{6}$$

$$\% BW = \frac{5.25 - 4.75}{4.9} \times 100\% = \frac{.5}{4.9} \times 100\% = 10.2\%$$

Where  $f_0$ = operating frequency (resonant frequency)

$f_h$ = upper cut-off frequency

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$f_l$  = lower cut-off frequency

The power gain of the antenna for this frequency is 5 dBi and the directivity is 7.5 dBi.

$$G = kD \tag{7}$$

Where G is the gain of the antenna, k is efficiency coefficient, and D is directivity.

$$k = 5/7.5 = .666$$

So that the efficiency of the antenna at 4.9 GHz is 66.6%

### 1.2 For Resonant Frequency 9.5 GHz

The bandwidth of the antenna = 10.00-9.00 = 1 GHz  
% bandwidth of the antenna

$$\% BW = \frac{10 - 9}{9.5} \times 100\% = \frac{1}{9.5} \times 100\% = 10.5\%$$

The power gain of the antenna for this frequency is 6.4 dBi and the directivity is 9.5 dBi.

$$G = kD$$

Where G is the gain of the antenna, k is efficiency coefficient, and D is directivity

$$k = 6.4/9.6 = .673$$

So that the efficiency of the antenna at 9.5 GHz is 67.3%

### 1.3 Total Field Gain With Respect to Frequency

Figure 4.9 shows the gain 5 dBi and 6.4 dBi at resonant frequencies 4.9 GHz and 9.5 GHz respectively.

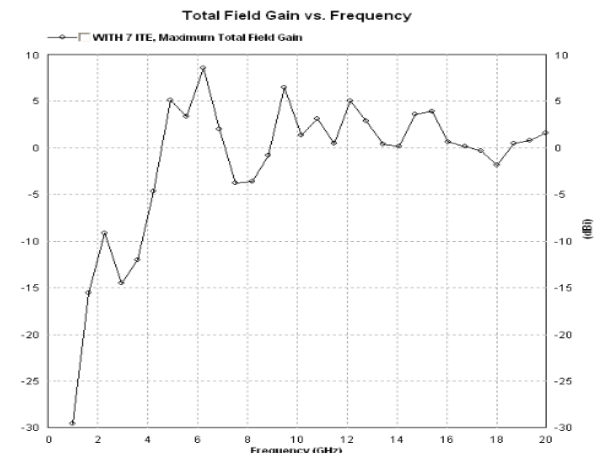


Figure 1.7 Total Field Gain of the Antenna

## CONCLUSIONS

The new square shaped microstrip antenna's results show that antenna resonates at two different frequencies for 1<sup>st</sup> iteration. As figure 1.1 shows resonant frequencies for 1<sup>st</sup> iteration are 4.9 GHz and 9.5 GHz. The results show that as the iteration increases the resonant frequency tends to shift toward lower frequency side and number of bands are also increased The % bandwidths for 1<sup>st</sup> iteration are

10.2% at 4.9 GHz and 10.5% at 9.5 GHz. The directivity for 1<sup>st</sup> iteration is 7.5 dB and 9.5 dB for resonant frequencies 4.9 and 9.5 GHz respectively. The VSWR for proposed antenna at resonant frequency 4.9 and 9.5 GHz have the value 1.4 and 1.5 respectively.

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