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# HIGH GAIN ANTENNAS FOR WLAN APPLICATIONS

**Venkatraman Subramanian, Chirag Dewani, Pratik Parab**

*Student , Department of EXTC, PCE , University of Mumbai*

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**Abstract-** *High gain antennas are best for covering long distance communications applications. Efficient high gain broadband, directive antenna design is a critical issue in wireless communication system design due to unique requirements of point to point communications. Low cost ,efficient and high gain antennas composed of a single feed present an attractive solution for several wireless communication systems. This project describes high gain antenna structures using partially reflecting surface (PRS) layers which can provide more than 10dB gain, less than -20db side lobe level (SLL), less than -20db cross polarization, about 20 db F/B ratio, more than 80 percent antenna efficiency . It will be having gain variation of less than 3db over operating frequency band. This antenna satisfies the requirements of wireless local area network in frequency range 5.725GHz -5.875GHz. The return loss, radiation pattern and critical design parameters are also investigated in detail.*

**Keywords- Side lobe level, Partially reflecting surface, Microstrip line feed, Patch antenna**

## I.INTRODUCTION

Antenna plays a very important role in the field of wireless communications. The various types of antennas are parabolic reflector antenna, patch antenna ,slot antenna. Each antenna has its own properties and applications .Microstrip antennas are widely used in wireless communication applications considering its various advantages being simple in construction, light weight, planar configuration, can be linearly and circularly polarized. But it suffers some disadvantages like having narrow bandwidth and low gain.[1] Due to the rapid developments in wireless communication, the WLAN plays a vital role for short distance communication and also users can access internet in their portable devices by using 3G/4G through the WLAN. Because it is recognized as a cost effective with high speed data connectivity and communication network in the world.[3]-[5] Many types of WLAN standards are available in market such as 802.11a, 802.11b, and 802.11g. The 802.11a usually found in business network due to its higher cost. The 802.11 group announces the WLAN covered frequencies are 2.4 GHz, 3.6 GHz, 4.9 GHz, 5 GHz, and 5.9 GHz. Due to modern developments in WLAN standard, the application can extended from home networks to large buildings, hotels, food courts and also for portable devices like mobile phones, tablets and others.

This paper presents a novel design of a patch antenna for WLAN applications. The proposed design will operate on the frequency of 2.4 GHz range. The entire dimension of the patch antenna is 29.2 x 29.2 x 1.6mm .

The paper is organized as follows: Section II describes the principle of antenna design and its geometry, Section III presents the results of patch and its discussion and section IV describes the conclusion of this paper.

A number of gain enhancement techniques based on Fabry Perot Cavity (FPC) are reported . In these structures, the dielectric layer is placed above a ground plane, which acts as a Partially Reflecting Surface (PRS). Antenna Gain depends on the reflection coefficient of PRS and radiation characteristics. High directivity planar antenna structures for long-range wireless links such as reflect array antennas have been proposed to overcome the low directivity of MSA.

In this paper, MSA array fed constant high gain and low SLL antenna structures using square PPs on superstreet layer are proposed for the 5.725-5.875 GHz ISM band[7].

## II.SELECTION OF PARAMETERS

A.Selection of substrate

For patch antenna design , selection of substrate material is very important. Selection of substrate depends on thickness, dielectric constant and loss tangent. Thicker substrate provide better efficiency ,larger bandwidth but leads to larger element size. In this design substrate is chosen as FR4 with dielectric constant as 4.4 as it is low cost [1].

Microstrip patch antenna is used to send onboard parameters of article to the ground while under operating conditions. The aim of the thesis is to design and fabricate an coaxial feed Patch Antenna and study the effect of antenna dimensions Length (L) , Width (W) and substrate

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parameters relative Dielectric constant (εr), substrate thickness (t) on the Radiation parameters of Bandwidth and Beam-width.

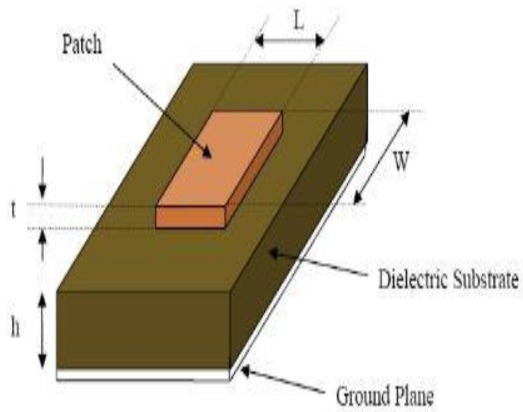


Figure 1. Structure of microstrip patch antenna

B.Feed Position

A patch can be end fed or inset fed. Studies show that inset feed excitation technique provides more enhanced characterstics and much perfect impedance matching as compared to other feed techniques. Current is minimum at the end and maximum at centre. The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. As seen from Figure 1.2, the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane

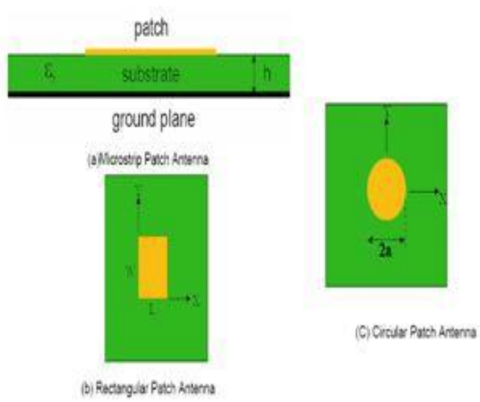


Figure.2. Circular and rectangular patch antennas

C.Polarization and antenna gain common antenna types are linearly polarized and circularly polarized antennas. Linearly polarized antennas achieve long reading range and high power. Circularly polarized antennas deliver less power when compared to linear antennas[6]. We are looking for high gain so gain is the most important parameter in antenna so required gain which is more than 10db in first stage and 15 or more than 15db is required for well operated high gain antenna.

## III. DESIGN PROCEDURE

The geometry of the proposed rectangular feed patch antenna is shown in Fig. 1. The antenna design consists of three elements such as ground plane, substrate and patch design.

The antenna uses FR4 substrate with a dimension of 29.2 x 29.2 x 1.6 mm3, dielectric constant is 4.4 and a loss tangent of 0.001. The antenna feed is given as rectangular feed at the center of the patch. Mathematically the antenna dimensions are calculated.

TO DETERMINE WIDTH ,LENGTH AND HIGHT OF ANTENNA :

- Width:- $$W = \frac{v_0}{2f_r}\sqrt{\frac{2}{\epsilon_r + 1}} \quad (1)$$

The effective dielectric constant is calculated as,

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}} \quad (2)$$

- To obtain ΔL:

$$\Delta L = 0.412h \frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)} \quad (3)$$

- Effective length of the patch is :

$$\frac{v_0}{2f_r\sqrt{\epsilon_{reff}}} \quad (4)$$

The length of the patch is calculated as

- L= Leff−2ΔL (5)

    - Input specifications: W=30mm h=2mm
      L= 27mm

Output specifications *:*

Simulated and measured results verify that the presented antenna is a good solution for WLAN long distance communication applications.

Table1. variation of frequencies with patch length

| Simulation | Width | Length | Height | Frequency |
|---|---|---|---|---|
| 1 | 30 | 27 | 2 | 5Ghz |
| 2 | 30 | 19 | 2 | 7Ghz |
| 3 | 34 | 23 | 2 | 5.8Ghz |
| 4 | 26 | 23 | 2 | 5.6-5.7Ghz |
| 5 | 30 | 23 | 2 | 5.8Ghz |

Results of simulations based on calculation:- Gain:- around 10db

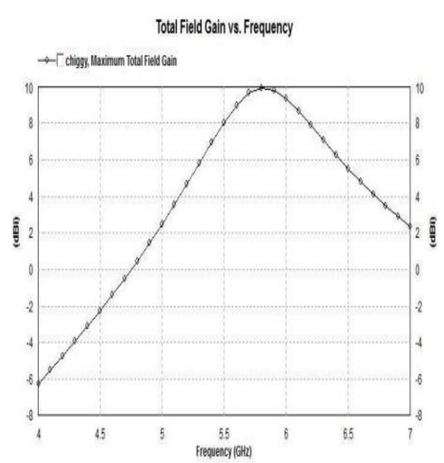


Figure.3. Gain versus frequency graph of rectangular patch S(1,1) graph :-

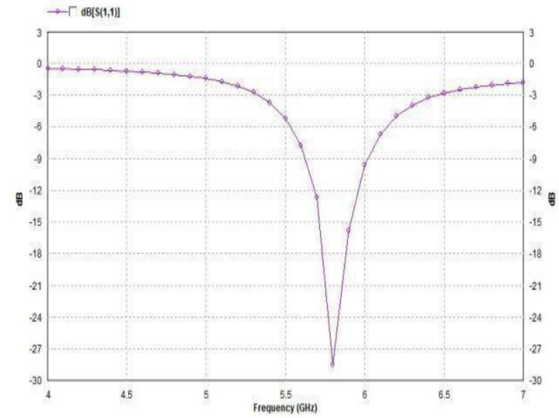


Figure.4. Return loss of rectangular patch

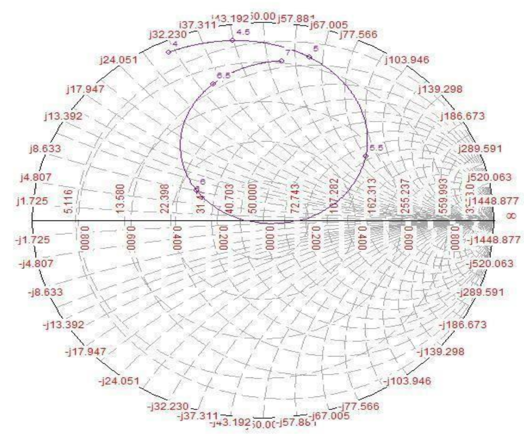

Figure5. VSWR of rectangular patch

## IV. ANALYSIS AND DISCUSSIONS ON PRS LAYER

After simulating the antenna with pre calculated width ,height , length and other required parameters we are getting gain around 10db , VSWR is less than 2 in required frequency rage but for high gain antenna we proposed that 15 or more than 15db of gain is required so we need to add PRS layer above the antenna so we can increase the gain of antenna as per our requirements.

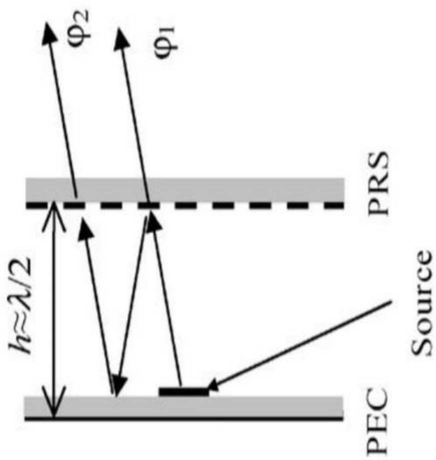


Figure6. PRS Layer

The PRS layer is a partially reflecting surface which is placed above certain height above the base (normally ƛ/2).When the antenna radiates some of the rays are reflected and some of the rays are refracted.

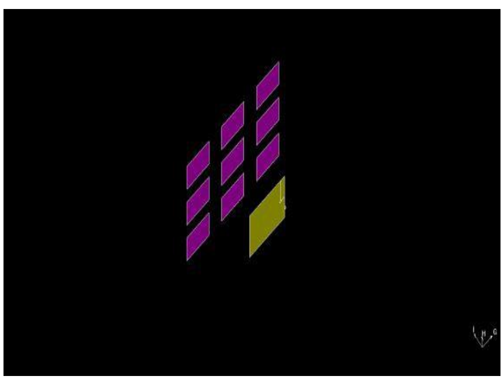

Figure7.3D model of 3X3 SPPA after placing PRS layer

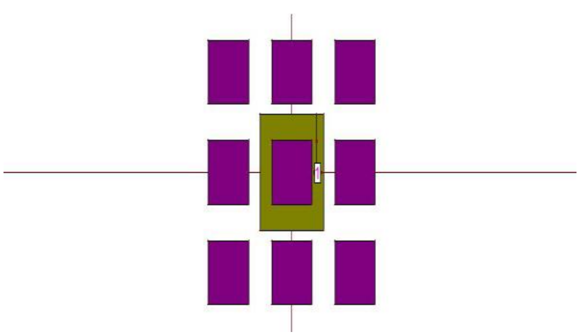

Figure8. 3X3 SPPA on a superstrate layer (top view)

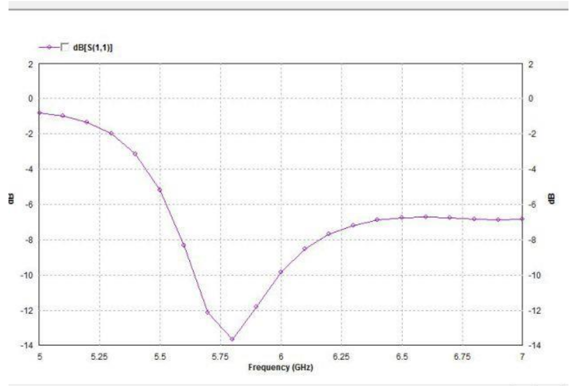


Figure9. Return loss of 3X3 SPPA

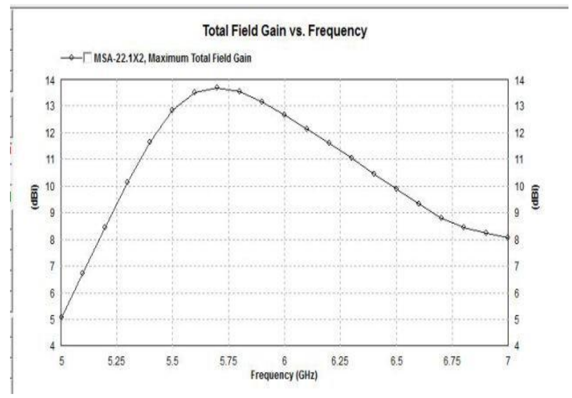


Figure10. Total gain versus frequency graph of 3X3 SPPA

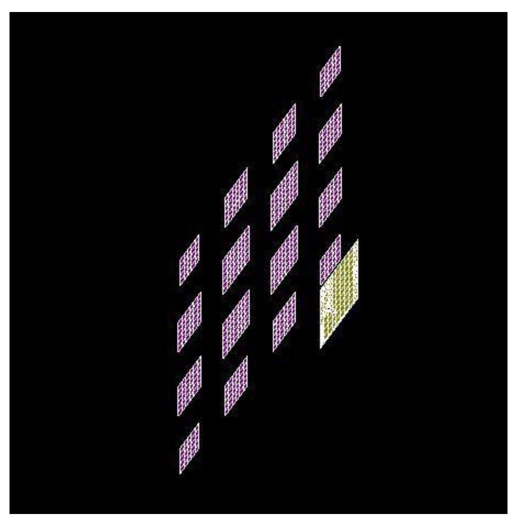

Figure11.3D model of 4X4 SPPA after placing PRS layer

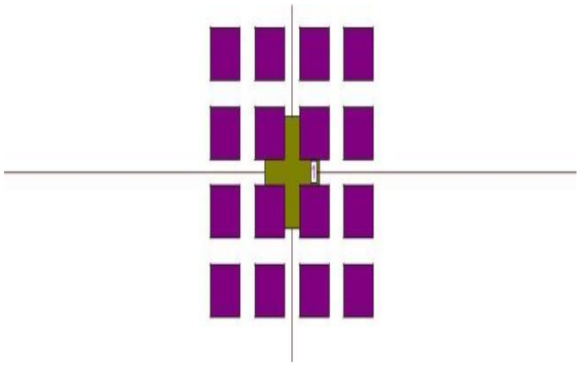

Figure12.4X4 SPPA on a superstrate layer

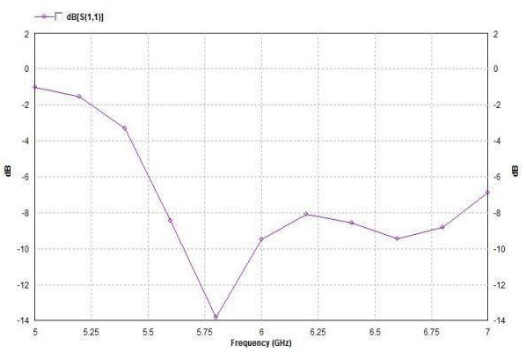


Figure13. Return loss of 4X4 SPPA

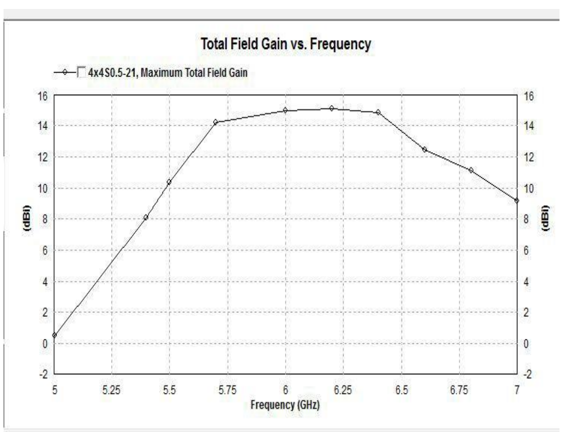


Figure14. Total gain versus frequency graph of 4X4 SPPA

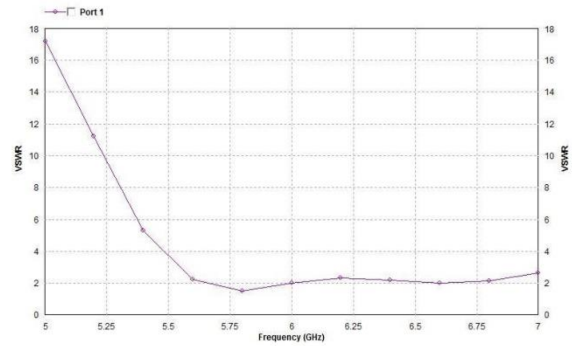


Figure15. VSWR versus frequency graph of 4X4 SPPA

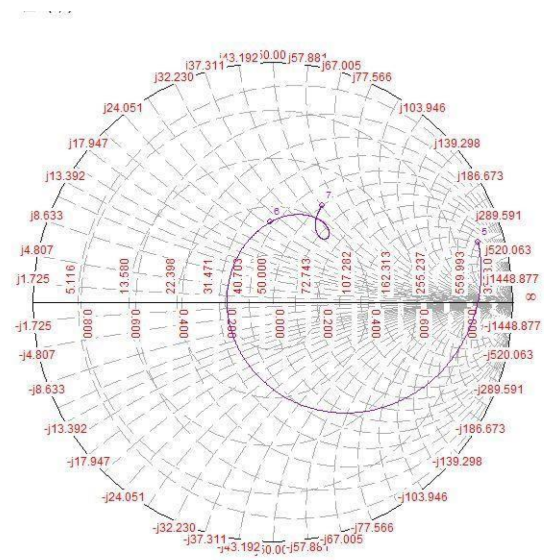

Figure16. VSWR of 4X4 SPPA

Table2. Various parameters of antenna

| Antenna | Gain | BW | Center Frequency |
|---|---|---|---|
| MSA | 4dB | 0.66 | 3GHz |
| PRS | 10dB | 0.52 | 5.8GHz |
| 3x3 | 13.5dB | 0.34 | 5.8GHz |
| 4x4 | 14.5dB | 0.34 | 5.75GHz |

## V. ACKNOWLEDGEMENT

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## VI. CONCLUSION

WLAN is a promising technology for short distance communication. In this paper, a novel 5.8GHz patch antenna for WLAN application has been demonstrated. Optimizations of structures are carried out using Zeland IE3D 14.0 software. IE3D is a Method-of-Moment (MOM) non-uniform meshing simulator. High gain, low side lobe level antenna with feed patch array and parasitic patch array on a superstrate layer is proposed for wireless application. The structure provides design flexibility as the desired gain can be obtained by using different square patch arrays The structure provides uniform gain with more than 10 dB gain variation over the frequency range 5.725-5.875GHz. Future work will focuses on fabrication and testing with performance comparison of simulation and fabrication results.

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