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# Dual Polarized MIMO Patch Antenna for Wi-Fi Application

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**ABSTRACT:** Design of dual polarized MIMO patch antenna is proposed to achieve high Gain of about 12dBi.Omni-directional antenna is having same directivity in 360° in Wi-Fi application. The patch antenna is generally used for high directive radiation .The antenna is design for 2.4GHz to 2.5GHz Frequency band. It is design to achieve VSWR 1.6 for full band. Designed patch antenna has FR-4 as a substrate with dielectric constant is 4.2 and thickness 0.8mm. The 50 impedance feed position can be achieved by designing of the square patch with impedance matching method, power divider and including aluminium reflector in the design. Gain can be improve by taking aluminium plate with some particular distance from FR4 substrate. Target gain is 12dBi and for achieving that much gain, various techniques are applied. Two patch element array is used to design 12dBi and simulated in HFSS 15.Patch antenna is basically directional antenna so it can be used in Wi-Fi for having high gain in particular direction. The important advantages of these antennas are simplicity in structure, low cost, and easy to manufacture. This antenna can be applicable to the wireless communication areas such as Wi-Fi [11].

**KEYWORDS**: Multiple Input Multiple Output (MIMO), High Frequency Structure Simulator (HFSS), Impedance, Voltage Standing Wave Ratio (VSWR), Wireless Fidelity (Wi-Fi)

## I. INTRODUCTION

In case of long distance communication, signal fading is a common feature for single-input-single-output (SISO) antenna system. Sometimes the received signal drops below the mean signal level and ultimately the communication is lost. In order to receive the required signal, the power level needs to increase which further invites the interference for other channels. To overcome this problem the best solution is MIMO antenna.

To increase the power level some active devices are used which also introduces some non-linear behaviour of the channel. MIMO antenna system using spatial diversity reception or transmission increases the probability of reception, spectral efficiency and reliability as compared to single-antenna communication systems.

## II. RELATED WORK

In [1] author used meta-material line for feeding, patch is very compact in size but complex also. There are also slot gaped patch antennas, different types of slots are possible like elliptical slot in given [2] and square ring given in [5]. Aperture coupling is used for multiband system. In multiband system antenna can work in two or more bands. In [6] antenna is designed for dual band S-band and X-band. [8] Patch is also designed for the dual band application for cellular system services. Aperture coupling is also used for broadband. In [9] patch is designed by aperture coupling and it is also dual polarized antenna. This type of dual polarized patch antenna is used in cellular services [10]. Main research direction of patch antenna is to reduce complexity and to develop low profile and low cost antenna. These light weighted antennas are used in wireless communication applications. In [7] author is used reduced size of antenna for wireless communication.

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## III. PROPOSED ALGORITHM

Microstrip patch antenna is very popular in Wi-Fi application because of directivity of this antenna and because of directivity it can divert RF energy in particular direction so, it can cover long ranges of coverage area. For obtaining dual polarization two feeds are required that results in horizontal as well as vertical polarization. Here patch antenna has low gain compare to other antennas so, high gain is achieved by computing an array. With array of 2 patch we can achieve 10-11dB gain and my target is to achieve 12dBi gain in 2patch array. With the design of 2 patch array there is another one technique with feeding of coaxial probe in which there is output of 12dBi. That antenna is simulated by ansoft HFSS.This antenna is fabricated with very low cost and also light weight antenna [7]. There is less complexity in fabrication of patch antenna and main advantage of patch antenna is easier way to cover particular area in indoor and outdoor Wi-Fi application [11].

### A. *FEEDING METHOD:*

There are different feeding methods in design of today's microstrip patch antenna for having high gain and also directivity. But in this proposed work microstrip line feeding is used because of there is advantage of less complexity. In microstrip line feed technique impedance matching is required parameter with different methods like power divider and other.

### B. *CALCULATION FOR MICROSTRIP PATCH:*

Aim of the proposed algorithm is to have high gain in particular direction. Generally one patch antenna has maximum gain of 5-6dBi. In proposed work aim is to achieve 12dBi gain with implementing array of two elements. Since it has about 10-11dBi and work is going on 12dBi gain with respective VSWR.

For designing patch and strip lines calculations are needed.

Essential parameter for calculation is

- Frequency f= 2.45GHz
- Dielectric constant $\varepsilon_r$ = 4.2
- Height of substrate $h$ = 0.8 mm

After this calculation all the parameters can be find out and simulate in the software. Basic three parameter is frequency, dielectric constant and height of substrate.

Step 1: Calculation of the Width (W):

$$W = \frac{c}{2f_{0}\sqrt{\frac{(\varepsilon_r+1)}{2}}}$$

Step 2: Calculation of Effective dielectric constant ( $\varepsilon_{reff}$ )

$$\varepsilon_{reff} = \frac{\varepsilon_{r+1}}{2} + \frac{\varepsilon_{r-1}}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Substituting values of W, h=0.8and $\varepsilon_r$=4.2
Then, effective dielectric constant $\varepsilon_{reff}$ =3.992

Step 3: Calculation of the Effective length ( $L_{eff}$ ):

By putting values of $f_{\circ}$ and $\varepsilon_{reff}$

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

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Step 4: Calculation of the length extension (ΔL):

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

Putting values of h, $\varepsilon_{reff}$ and W, ΔL=0.3709 in above equation

Step 5: Calculation of actual length of patch (L):

By putting both ΔL and $L_{eff}$

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

Putting all the values, final L=29.9mm

## IV. PSEUDO CODE

There are six main steps to creating and solving a proper HFSS simulation.
They are:
Step 1. Create model/geometry
Step 2. Assign boundaries
Step 3. Assign excitations
Step 4. Set up the solution
Step 5. Solve
Step 6. Post-process the results

## V. SIMULATION OF TWO PATCH ARRAY IN HFSS

Design of two element printed dipole antenna using substrate material FR4 with given measured parameters in HFSS is shown in below figures in different views. Here in figure 1, two patch array element is designed and it is top view of design. In figure 2, two lumped ports are used for dual polarization of patch antenna design in HFSS.

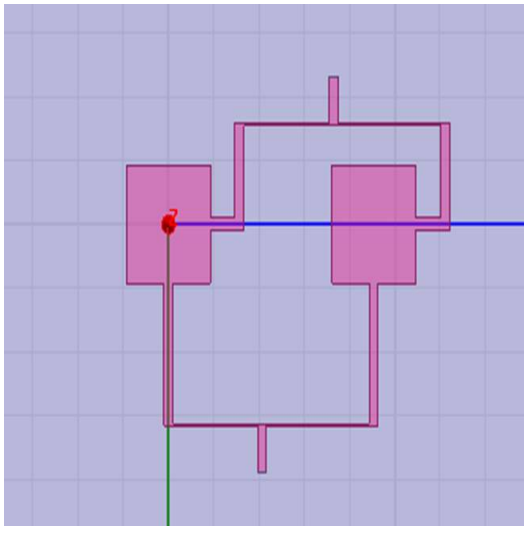

Figure 1: Top view of two patch design

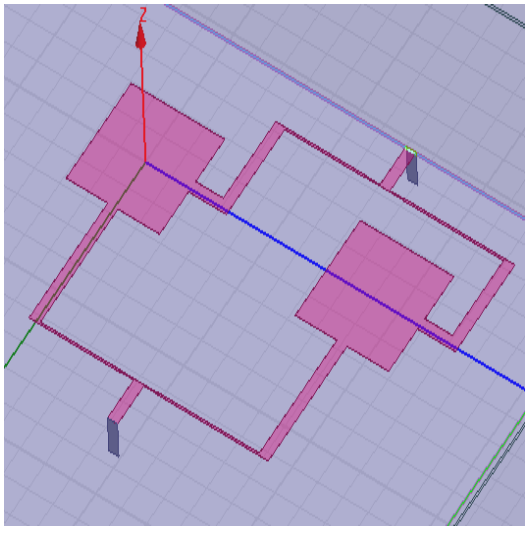

Figure 2: Side view of two patch design

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## VI. SIMULATION RESULTS

Generally, single patch design has 5-6 dB gain but my proposed design target is 12dB which can be achieved by designing of two patch array design. Here in proposed design by the calculation of line impedance and size of patch, result is achieved upto 10.10dB which is shown in figure 3.By applying different gain improvement techniques, gain can be improved upto 12dB and VSWR of this design can be controlled by length and width of the each microstrip line also called impedance.

| Name | Theta | Ang | Mag |
|---|---|---|---|
| m1 | 0.0000 | 0.0000 | 10.1022 |
| m2 | 30.0000 | 30.0000 | 4.9363 |
| m3 | 20.0000 | 20.0000 | 7.9685 |
| m4 | 30.0000 | 30.0000 | 7.5441 |

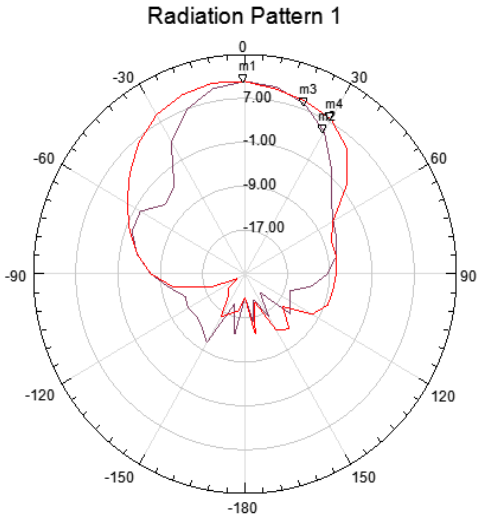


Figure 3-Radiation pattern Gain in dB

## VII. CONCLUSION AND FUTURE WORK

Microstrip patch antenna is very popular in Wi-Fi application because of directivity of this antenna and because of directivity it can divert RF energy in particular direction so, it can cover long ranges of coverage area. For obtaining dual polarization two feeds are required that results in horizontal as well as vertical polarization. Here patch antenna has low gain compare to other antennas so, high gain is achieved by computing an array. With array of 2 patch we can achieve 10-11dB gain and my target is to achieve 12dBi gain in 2patch array. With the design of 2 patch array there is another one technique with feeding of coaxial probe in which there is output of 12dBi. That antenna is simulated by ansoft HFSS.

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