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Design of Rectangular Microstrip Patch Antenna for Wi-Fi

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Abstract*: The robust working and speed of a wireless communication will depend on the speed of the signal we can receive and transmit. Antenna selection can therefore have a significant impact on the working and speed of a wireless link. A microstirp patch antenna has a low profile and weight along with low fabrication cost. In this project, ANSYS HFSS is used to develop and simulate a Microstrip Line Feed Linearly Polarized Rectangular Microstrip Patch Antenna for Wi-Fi at 2.455 GHz.*

Keywords: Wireless communication, Microstrip patch Antenna, Wi-fi, Wireless link, Communication systems

1. Introduction

The performance and advantages of rectangular microstrip patch antennas such as low weight, low profile, and low cost made them the perfect choice for communication systems engineers. They have the capability to integrate with microwave circuits and therefore they are very well suited for applications such as cell devices, WLAN applications, navigation systems and many others .In this synopsis; a compact rectangular microstrip patch antennas are designed using HFSS and tested for Wi-Fi devices at 2.45GHz. The final part of this work has been concentrated on studying an array antenna with two and four elements. The antennas of the design examples of this work has been tested in laboratory.

1.1 Microstrip Patch Antenna

The advantages and performance of rectangular microstrip patch antennas such as low cost, low profile, and low weight make them the perfect choice for a communication systems engineer. A microstrip patch antenna consists of a thin metallic patch placed above a conducting ground-plane. The ground-plane and patch are separated by a dielectric. The conductor of the patch is generally copper and can be made in various shapes. The microstrip patch is generally photo etched on the dielectric substrate. The substrate of the antenna used is often non-magnetic in nature. A range of 2.2 to12 is chosen for the dielectric constant (r ε) of the substrate, this helps in improving the fringing fields that produce radiation, but higher values may be used in special circumstances. A microstrip patch antenna is the most commonly used antenna due its simple geometry. The width thickness and length characterize the antenna. Under operating conditions a microstrip patch antenna is used to send onboard parameters of article to the ground. The purpose is to fabricate and design an microstirp-fed rectangular Patch Antenna and study the antenna parameters over the WI-FI range at a given frequency.

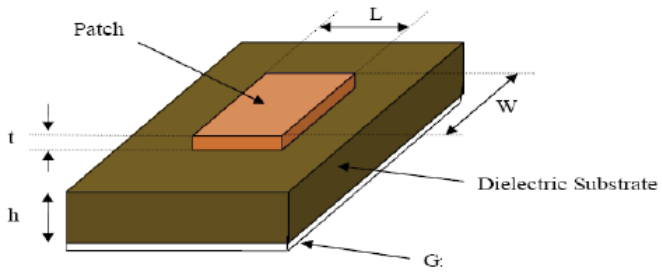

Figure 1: Structure Of Microstrip Patch Antenna

1.2 Advantages of Rectangular Microstrip Antenna

Due to low-profile structure of Microstrip patch antenna it is specially favoured for use in wireless applications. This makes them exceedingly reliable for embedded antennas used for wireless handheld devices like WI-FI tracker, electronic pagers, mobile phones etc. The communicating and remote measuring antennas in defence applications like missiles need to be thin and conformal thus patch antennas are often employed. They also have been used successfully in Satellite communication.

Some of their principal advantages are given below:

- Ease of manufacturing
- When mounted on rigid surfaces they are mechanically robust
- Can be easily conformed to a host due to their low profile planar configuration.
- They can be produced in large quantities due to their low cost of fabrication.
- They allow two type of polarization-Linear and circular.
- They are easily adopted into MICs.
- Can conform to multiple frequency requirements.

1.3 FEEDING TECHNIQUES

There are various methods of driving power(feeding) to Microstrip patch antennas. The 2 main categories of feeding a patch antenna are- non-contacting and contacting. In the non-contacting scheme there is transfer power between the Microstrip line and the radiating patch by using electromagnetic field coupling. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a Microstrip line or a coaxial feed cable. Commonly used feeding techniques are the coaxial probe and Microstrip line which are contacting schemes while

proximity coupling and aperture coupling are without contact. We have employed MICROSTIP LINE Feed Technique , because they have a simple modelling technique, easy to fabrication and provide high impedance matching.

1.4 LINEAR POLARIZATION

Polarization of an antenna is a key characteristic for an antenna to be chosen. Vertical, horizontal or circular polarization are the type of polarizations exhibited in a communication system. An antenna with linear polarization radiates completely in the plane of propagation .While the polarization plane rotates in a corkscrew pattern completing one revolution during one period of the wave in a circularly polarized antenna. When the electric field of the antenna is perpendicular to the Earth's surface then it is said to be vertically polarized (linear) antenna.

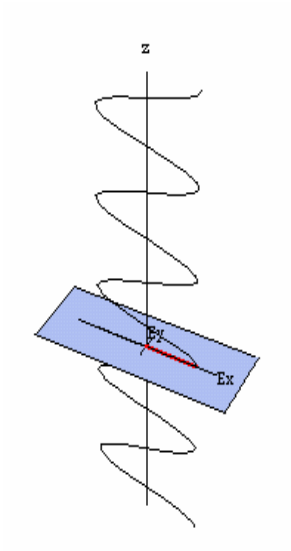

Figure 2: Linear Polarization

2. Proposed Work

Figure 2 shows design & simulation of Rectangular Microstrip patch antenna which support only one frequency. The microstrip antenna is first designed using the estimated values through the required formulas. In simulation of both the patch and the antenna, the proposed values are simulated using the software HFSS. Thus, the characteristics of gain, efficiency etc. are noted. The fabrication process involves PCB development steps. The hardware implementation is followed by testing using VNA

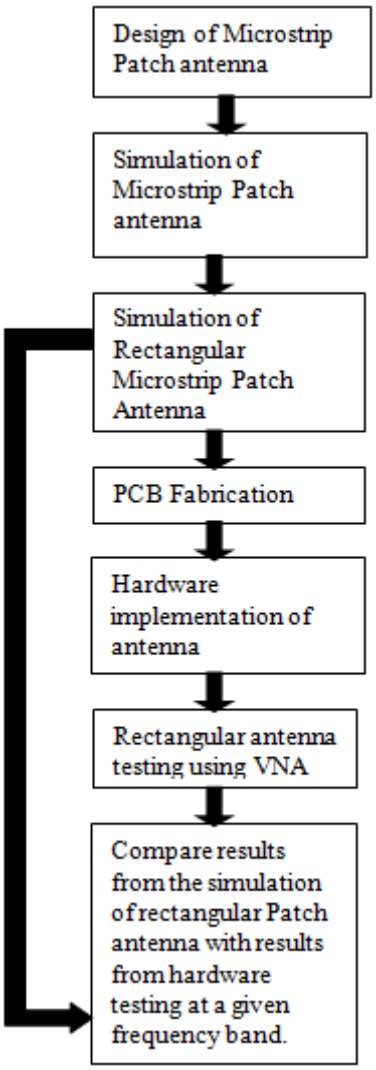

Figure3

In view of the above it will be apparent that, there exists a need of antenna system that enables efficient access of user location as well as wireless communication. For increasing compactness of electronic systems, there is a need of embedding two or more narrowband systems together this can be achieved by an array of antennas. The array of antenna helps in extending the required range of the WI-FI (2.455GHz) network through the required distance. Thus, advancing the usage and providing more user interactions. Therefore, with the proposed frequency the two consecutive antennas should provide the required phase difference between the arrays furthermore making the user to handle the power which needs to be applied. Within these frequency bands, the patch and the antenna, the proposed values are simulated using the software HFSS.

Applications	Type of Band	Frequency
Wi-Fi	S-band	2.455GHz

Table-I

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3. Microstrip Patch Antenna Design And Results

3.1 Design Specifications

Following are the essential parameters for the design of a rectangular Microstrip Patch Antenna:

3.1.1 Frequency of operation (fo):

The sonant frequency of the antenna must be selected appropriately. The resonant frequency selected for my design is 2.455 GHz

a) Dielectric constant of the substrate (εr):

We have selected **FR4** as the dielectric material which has a dielectric constant of 2.455.This value helps in reducing the size of the antenna as a substrate with a higher dielectric value decreases antenna dimensions..

b) Width of antenna (W):

W = 0.04755 m = 47.55 mm (approx.)

c) Effective Length of antenna (Leff):

L_{eff} = 0.0406 m = 40.620 mm (approx.)

d) Length Extension (ΔL):

ΔL = 0.815 mm (approx.)

e) Actual Length of the Patch(L):

L = 392 mm (approx.)

f) Ground Plane Dimensions:

For practical considerations, it is essential to have a finite ground plane. It has been shown by that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater than the patch dimensions by approximately six times the substrate thickness all around the periphery. Hence, for this design, the ground plane dimensions would be given as:

Lg = 48 mm
Wg =56.5 mm

g) Height of dielectric substrate (h):

For the Microstrip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.58 mm.

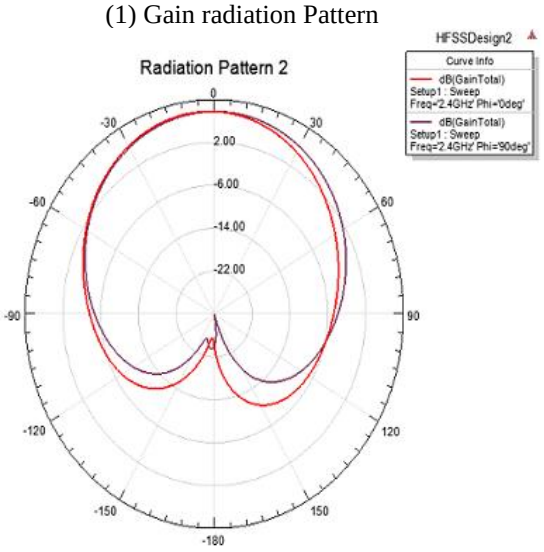
3.2 Simulation Setup and Results

The three essential parameters for the design of a rectangular Microstrip Patch Antenna:

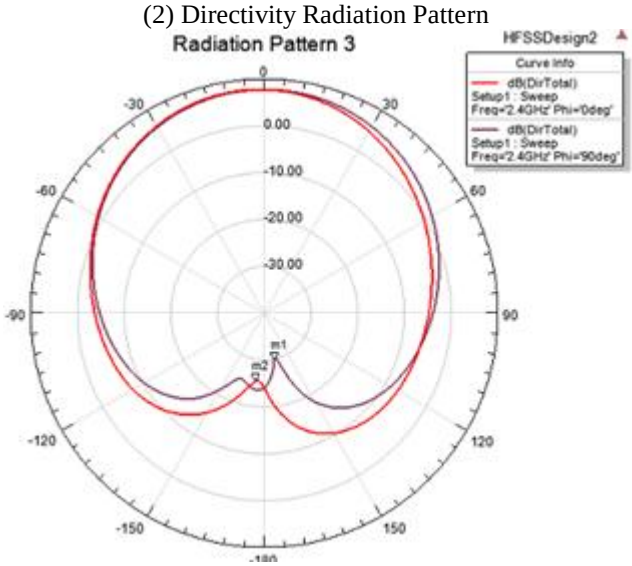
a) *Design of Antenna*

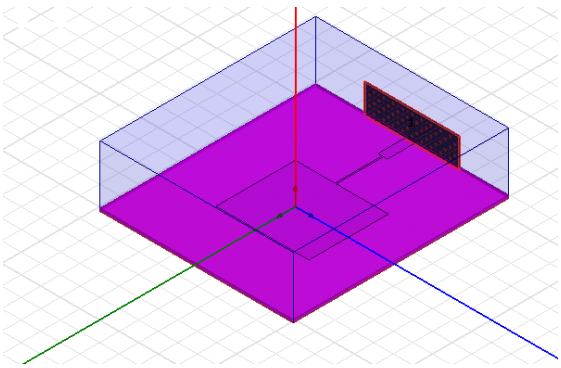
b)Radiation Pattern:

(1) Gain radiation Pattern

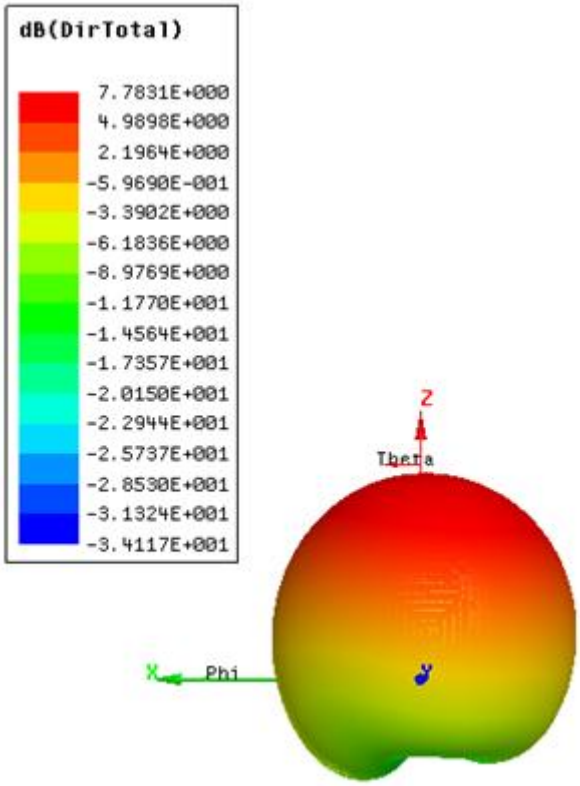


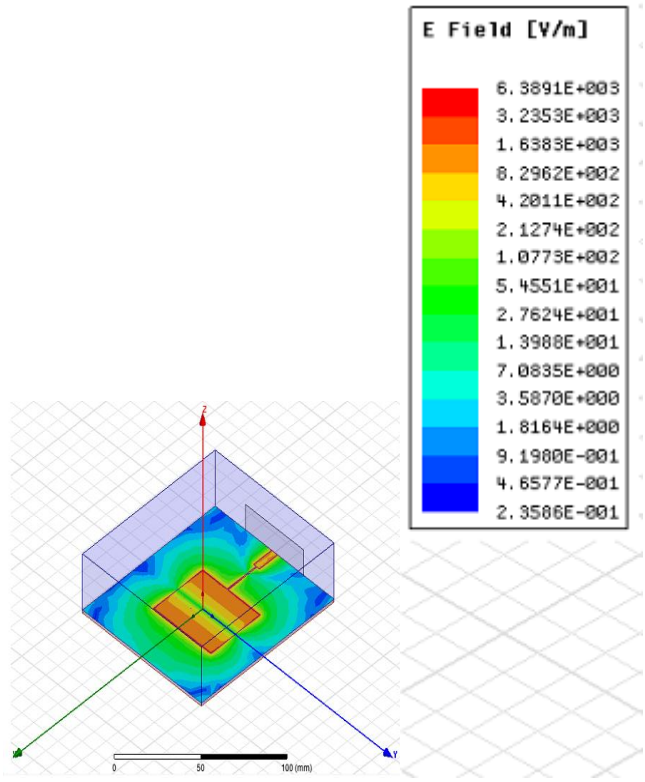
(2) Directivity Radiation Pattern



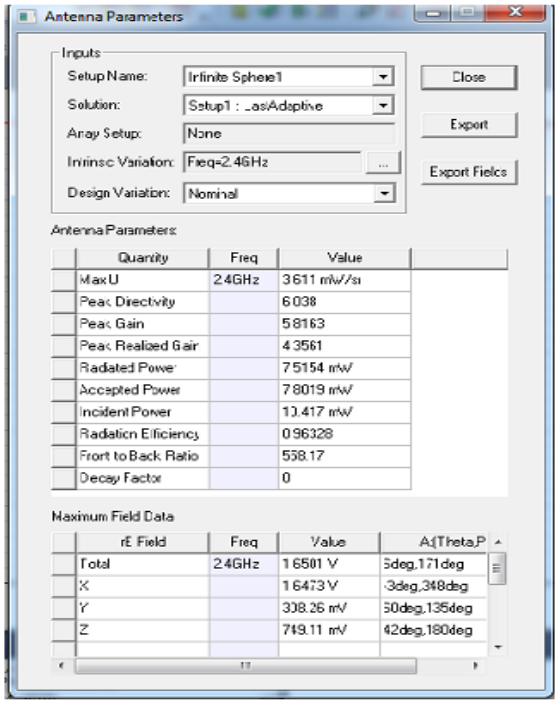


b) 3-D Polar Plot:





c) Antenna Parameters:



d) Current distribution plot:

4. Future Prospects

The future scope of work revolves around with the fabrication of an array of Microstrip Patch Antennas to increase overall gain and improve the signal to noise ratio(SNR). It can be found that the resonant length of the patch can he reduced to a smaller value while maintaining greater bandwidth. The microstrip antenna can be modified to a planar inverted -F antenna (PIFA) for cellular communication purposes.

A further construction of phased arrays of this antenna can be used to reinforce the radiation pattern in the desired direction and suppress it in the undesired direction.

5. Conclusion

In this paper a design for small size patch antenna has been presented along with the development of the Microstrip Patch which correctly functioning code. The designs combine a rectangular microstrip patch with a microsrtip line feeding technique. The use of such an antenna would reduce the size of the wireless navigation setup significantly accompanied by a reduction in fabrication cost of the antenna. Also it is integral with the wireless setup, hence, improving system reliability. Rectangular Microstrip Patch Antenna is a narrowband antenna because of which it has low bandwidth. By increasing the width of the patch the Bandwidth can be increased but the impedance of the patch antenna will also get reduced.

Acknowledgment

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