DESIGN AND FABRICATION OF MICROSTRIP PATCH ANTENNA AT 2.4 G Hz FOR WIRELESS APPLICATION

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Abstract

Out of the different types of antennas, Micro strip patch antenna has gained much attention of research community because of its low profile, low weight, light and compact, simple and inexpensive to manufacture using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces hence, suitable for wireless communication applications. However, micro strip patch antennas have the limitation of low efficiency, Low power-handling capability, spurious feed radiation and very narrow frequency bandwidth, which is typically only a small fraction of operating frequency. In this work techniques like defected ground and patch structure has been used for the enhancement of the gain and bandwidth. The proposed antenna is simulated and has analyzed in HFSS software. The antenna has a gain of up to 5.58 dB, a perfect voltage standing wave ratio (VSWR) of 1.08, a high fractional bandwidth of 160 MHz with -28.1975 of S_{11}, which makes it function well in wireless applications.

Keywords: High Frequency Structure Simulator (HFSS), Microstrip Patch Antenna (MPA), Wireless application

I. INTRODUCTION

Communication among the humans was first introduced by sound through voice, thereafter various other methods came into existence such as, drums, flags, pigeon and smoke signals were used for sending information for long distance. Day by day rapid development in technologies of electronic gadgets that reduces the effort of human beings, several investigations have been performed all over the world. Consequently, swift developments in the field of communication are being reported for over haul distance communication.

The basic geometry of microstrip patch antenna is shown in Figure 1. It consists of a radiating patch on one side of dielectric substrate and a ground plane on the other sideof the substrate. Normally, the patch is made of copper or gold and can assume virtually in any shape. Some popular shapes are square, circular, triangular, semicircular, sectoral, and annular ring as shown in Fig 1.2. The dimensions of the patch directly affect the wavelength of radiating signal. The operating frequency of patch antenna mainly depends upon the length (L), width (W), height (h), and dielectric constant (εr) of material used. Ideally, for better fringe field of microstrip patch antenna, dielectric constant of substrate should be low ($2 \le \varepsilon r \le 12$)

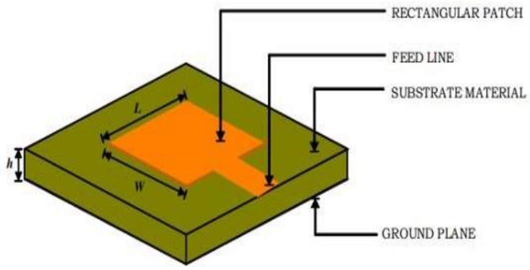

Figure 1: Basic geometry of microstrip patch antenna

Microstrip patch antenna can be excited using different feeding techniques. One of the important feeding techniques is coaxial feed and advantages of this type of feeding technique are easy to match and low spurious radiation. Another one is the microstrip line feed with advantages such as monolithic, easy to fabricate, easy to match by controlling, and insert position. Third one is the proximity coupled feed with advantages such as, no direct contact between feed and patch and can have large effective thickness for patch substrate. The last one is the aperture coupled feeding technique with the advantages such as, use of two substrate avoids deleterious effectof a high dielectric constant substrate on the bandwidth and efficiency. In this type of feeding technique there is no radiation from the feed and active devices since a ground plane separates them from the radiating patch. In this work, the experimental and simulated investigations towards the developments of microstrip patch antennas for 2.4G Hz Wi-Fi application will be developed.

II. LITERATURE REVIEW/BACKGROUND

Researchers have proposed a number of methods for improving gain, efficiency, and bandwidth while maintaining desirable radiation properties.
Some of the techniques for improving performance of microstrip patch antenna includes:

1. Applying a parasitic patch to the antenna [1].
2. Applying differently shaped and sized slots [2] [3].

III. OBJECTIVES

The objective of our project is to develop a 2.4GHz microstrip antennas with following considerations:

1. To design and fabricate microstrip antennas for modern 2.4GHz wireless application.
2. To improve the S_{11} of microstrip antenna.
3. To increase the gain of microstrip antenna.

IV. METHODOLOGY

The steps carried out to design the desired microstrip patch antenna are shown in the figure 2.

- Initially, the resonating frequency of an antenna must be known as it decides application for which antenna has to be used. The substrate material and its height on which antenna is fabricated plays a very important role in deciding its parameters.
- Antenna performance is good when thick and low value dielectric constant substrates are used; However, this increases the size of the antenna element. On the other hand, thin substrates with higher dielectric constant are desirable for microwave circuitry as they bind fields and minimize undesired radiations and lead to smaller element sizes. However, antenna using these substrates provides low values of antenna parameters. Since, in wireless applications microstrip antennas are integrated with circuits, so a compromise has to be reached between good antenna performance and circuit design.
- The other factors that are taken into consideration while choosing substrate are its availability and cost. The substrate materials used will be FR4 with εr = 4.4, height, h = 1.6 mm, and thickness of the copper clad, t = 0.06 mm.
- For the input values of resonant frequency, dielectric constant and height of substrate, the values of the antenna dimensions like patch length, width, feed length and point etc., are calculated using the design equations. The calculated values are taken as the initial inputs to design antenna that can be simulated in software like ANSYS HFSS. ANSYS HFSS (High frequency structure simulator) which is a 3D

electromagnetic (EM) simulation software have been used for designing and simulating.

- The parametric study of the antenna physical dimensions which affects the antenna parameters like gain, return loss, and electric field distribution will be performed. The physical dimensions which give the best values of the antenna parameters is selected to design the antenna.
- After getting the measured results from the network analyzer, the data will be saved for validation and data analytics.

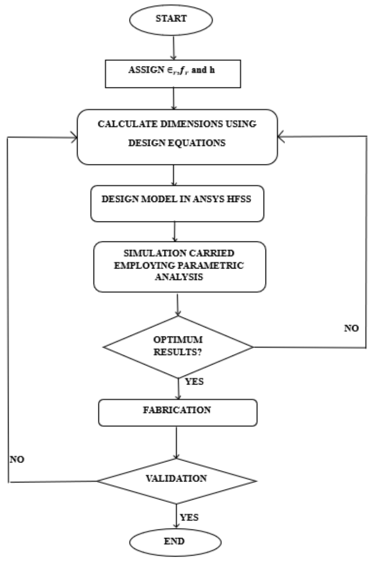

Figure 2: Methodology of Microstrip Antenna Design

V. RESULT AND DISCUSSION

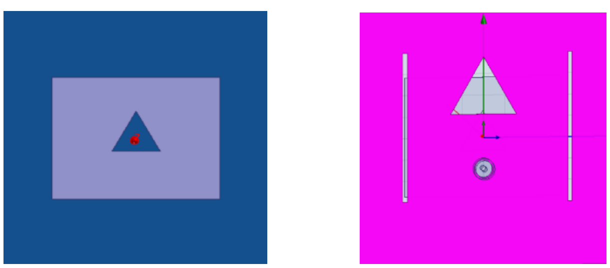

Fig 3: Top and Bottom view of proposed antenna

Table 1: Physical dimension of proposed antenna

Parameter	Dimension of patch	Dimension of substrate	Dimension of ground	Feed position
Calculated in (mm)	28*37	60*60	60*60	-7.25,0,-0.06

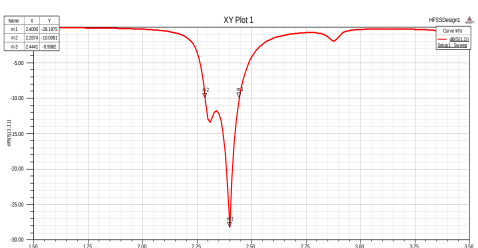

Fig 4: Return loss of MPA

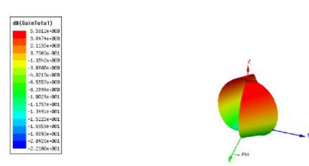

Fig 5: Gain of MPA

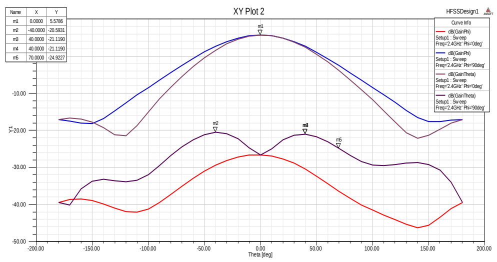

Fig 6: Co and cross pole polarization

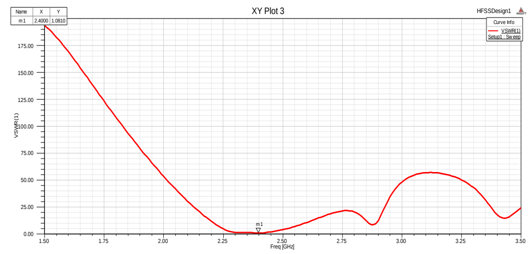

Fig 7: Gain of MPA

The simulated reflection coefficient of the proposed antenna has a S11 in dB and is depicted in Figure 4. For S11 to be considered good, it needs to be greater than -10 dB. The suggested antenna has a resonant frequency of exactly 2.4 GHz with a reflection coefficient of –28.1975 dB; the simulated impedance bandwidth is around 160 MHz (2.44–2.28GHz). As the simulated MPA has S11 below the -10 dB area, this value for the reflection coefficient indicates good matching. The maximum possible gain is 5.581 dB at the resonant frequency of 2.4 GHz, as illustrated in Figure 5.

- **Fabricated Microstrip Patch Antenna**

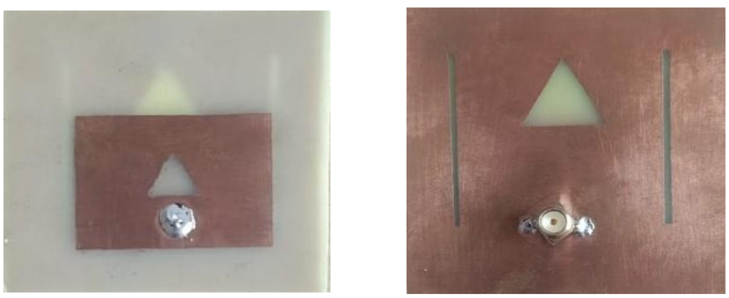

Fig 8: Top and Bottom view of fabricated MPA

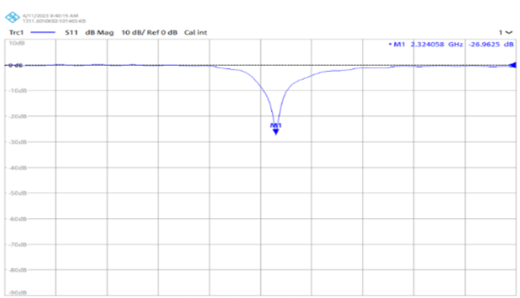

Fig 9: Return loss –S11

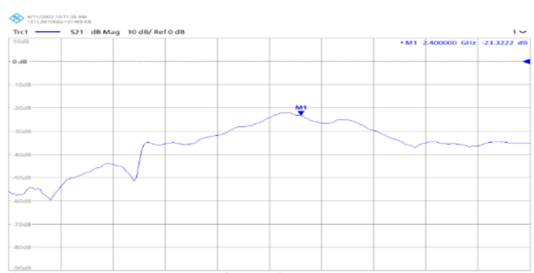

Fig 10: Normalized gain S_{21}

Table 2: Comparison of proposed design

Parameter	Proposed Work	Existing work [6]
Gain	5.343 dB	4.26 dB

VI. CONCLUSION AND FUTURE WORK

The design of a coaxial feed rectangular microstrip patch antenna with slots on ground and patch structure that resonates at 2.4 GHz has been implemented. ANSYS HFSS was employed for the design process, simulation, and optimization of the proposed antenna. The suggested antenna has a resonant frequency of exactly 2.4 GHz with a reflection coefficient of -28.1975 dB. As the simulated MPA has S11 below the -10 dB area, this value for the reflection coefficient indicates good matching. The maximum possible gain is 5.58 dB at the resonant frequency of 2.4 GHz.

New techniques should be explored to reduce the size of the microstrip patch antennas to suit more practical applications. Metamaterial is a promising candidate since it can reduce the size greatly. Bandwidth of microstrip antenna can be increased by using some special methods like defected ground plane strategy, stacked patches, parasitic patch. Gain and the power handling ability of antenna can be improved by making an antenna array.

VII. REFERENCES

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