Design of 2.4GHz Patch Antenna for WLAN Applications

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Abstract – *In this letter, we introduce a basic microstrip patch antenna for use in IEEE 82.11 b/g/n wireless local area network (WLAN) applications. For short-distance network connectivity, WLAN is the most widely used wireless distribution protocol. This paper defines a high-gain, single-band microstrip antenna with dimensions of 27.9x38x3.6mm^3 and a ground plane. The proposed patch antenna configuration has a return loss of -32.008dB and spans the 2.4GHz frequency band. The simulation was carried out using HFSS and the designed antenna has excellent efficiency and is an excellent solution for WLAN applications.*

Key Words: ISM band, Microstrip line feed, Patch antenna, WLAN.

1.INTRODUCTION

A microstrip patch antenna has two sides: one dielectric side and one ground plane side. The patch's conductors are normally made of copper, but they can also be made of gold and can be of any form. Standard shapes, on the other hand, are commonly used to simplify interpretation and forecast results. The radiating components and feed lines are photo-etched on the dielectric substrate. Radiating patches may be square, oval, rectangular, elliptical, or other irregular shapes. However, owing to their ease of construction and study, cube, rectangular, and circular shapes are the most widely used designs. Microstrip patch antennas have a number of advantages, including:

- Low fabrication costs
- Low profile, low volume
- Mass processing
- Simple feed allows for fast linear and circular polarization.
- Easy MIC integration

Because of their simplicity of construction and manufacturing, patch antennas can be used in a wide range of applications, from military to industrial. Due to rapid advancements in wireless networking, the WLAN plays an important part in short-distance communication, and people can use 3G/4G to access the internet on their mobile devices. Since it is known as the world's most cost-effective high-speed internet access and networking network. Many types of WLAN protocols such as 802.11a, 802.11b, and 802.11g are available on the market. Because of its higher cost, 802.11a is mostly used in business networks. WLAN frequencies covered by the 802.11 community are 2.4 GHz, 3.6 GHz, 4.9 GHz, 5 GHz, and 5.9 GHz.The application can be applied from home networks to big homes, hospitals, food courts, and handheld devices such as smart phones, laptops, and other thanks to recent advancements in WLAN specifications.

This paper describes a new patch antenna architecture for WLAN applications. The proposed architecture would run in the 2.4 GHz frequency band. The patch antenna's overall dimensions are 27.9 x 38 x 3.6mm^3. The patch antenna architecture suggested is for 802.11b/g/n. The below is how the article is structured: Section II explains the theory of antenna architecture and its geometry, Section III explains the patch's observations and discusses them, and Section IV summarizes the paper's conclusion.

1.1 Antenna Design

Figure 1 depicts the proposed rectangular feed patch antenna's geometry. The ground plane, substrate, and patch configuration are the three components that make up the antenna design. The antenna has a 27.9 x 38.0 x 3.6 mm^3 FR4 substrate with a dielectric constant of 4.8 and a loss tangent of 0.001. The antenna feed is provided as a rectangular feed in the patch's centre. Mathematically the antenna dimensions are calculated.

The width and length of the patch antenna is calculated as,

$$W = L = \frac{c}{2f\sqrt{\varepsilon r}} \qquad (2.1)$$

The feed depth into the patch is given by,

$$C = 0.822 * L/2 \qquad (2.2)$$

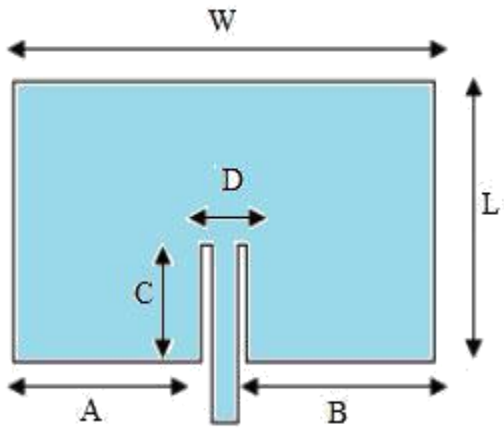

Fig.1 Patch antenna geometry

TABLE 1. The Dimensions of the Patch Antenna

Parameters	W	L	A	B	C	D
Unit (mm)	27.9	38	16	16	10	6

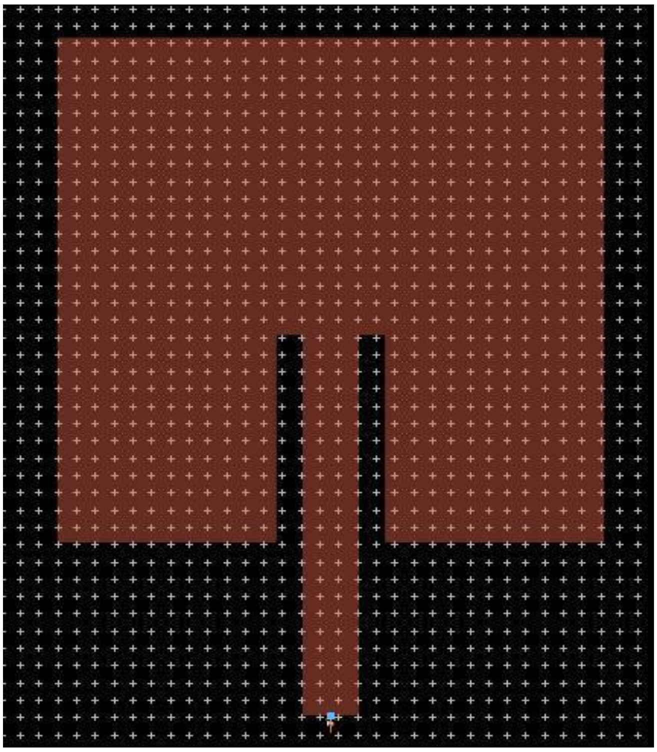

Fig.2 Patch Antenna Design

$$D = W/5 \quad (2.3)$$

$$A = B = 2W/5 \quad (2.4)$$

And the usual method of calculating patch antenna dimensions are given as follows.

For calculating the width,

$$W = \frac{C}{2f}\sqrt{\frac{2}{\varepsilon r+1}} \quad (2.5)$$

The effective dielectric constant is calculated as,

$$\varepsilon reff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left[1+12\,\frac{h}{W}\right]^{-1/2} \quad (2.6)$$

The extended incremental length of the patch is given by,

$$\Delta L = 0.412h\,\frac{\varepsilon reff+0.3\,[\frac{W}{h}+0.264]}{\varepsilon reff+0.258\,[\frac{W}{h}+0.8]} \quad (2.7)$$

Effective length of the patch is;

$$Leff = \frac{C}{2f\sqrt{\varepsilon reff}} \quad (2.8)$$

The length of patch is calculated as,

$$L = Leff - 2\Delta L \quad (2.9)$$

The length of the patch is also calculated as,

$$L = \frac{1}{2f\sqrt{\varepsilon reff}\sqrt{\mu o \varepsilon o}} - 2\Delta L \quad (2.10)$$

A rectangular feed or microstrip line is used as a feeding tool. Since it is also a conducting strip of a narrower diameter than the patch antenna, this feed can be quickly manufactured and will complement the patch. Inset feed, middle feed, and outset feed are the three locations of microstrip line feed. The proposed antenna architecture employs a centre feed, which provides excellent patch matching as well as efficiency.

2. RESULT AND DISCUSSION

The following parameters are needed to investigate the proposed antenna: Radiation pattern and return depletion. The HFSS programme is used to create the antenna configuration. And for the proposed architecture, the momentum microwave optimization is favoured. The patch specification was completed first in the software's corresponding workspace, followed by the substrate editor. The ground plane, substrate, and patch are the three main components of a microstrip antenna. The patch antenna can be conveniently constructed in the workspace using the coordinate values. The return loss is a measure of reflected and forward power which will be denoted by S11. Fig.3 tells the corresponding return loss for the proposed patch antenna.

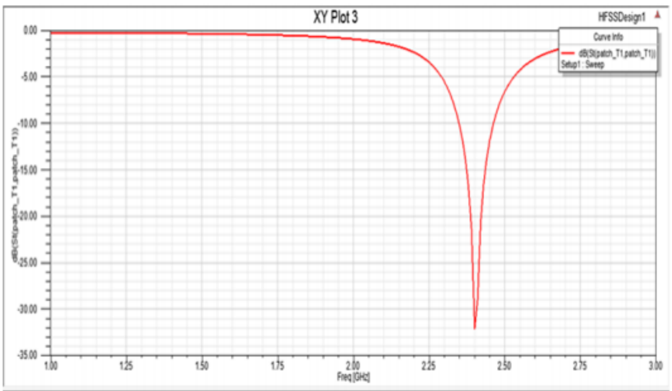

Fig.3 VSWR of Proposed Antenna

TABLE 2. Simulated Result for Proposed Antenna

Frequency	Return Loss	Gain	Directivity
2.4GHz	-32.008dB	4.703dBi	6.782dBi

The antenna has a 2.4GHz frequency with a return loss of -32.008dB and a bandwidth of 2.2 percent at - 10dB, according to the data. At -10dB, the obtained bandwidth ranges from 2.389 GHz to 2.411 GHz. Figure 4 shows the smith map for the designed antenna. Radiation patterns are normally expressed in spherical coordinate systems and are calculated in the far field area.

The radiation pattern describes how the antenna's boundary is propagated in a certain direction. The effect for the antenna radiation pattern as seen in Figure 6. The results demonstrate that the antenna is well-designed in terms of return loss, gain, directivity, and bandwidth. The ability of the antenna power between input and output is referred to as gain. The gain of the proposed antenna is 4.685dBi. The term "directivity" refers to the amount of mandate benefit in a certain direction. In certain cases, the gain is equal to the directivity, which is lower than the directivity. The directivity result is 6.287dBi.

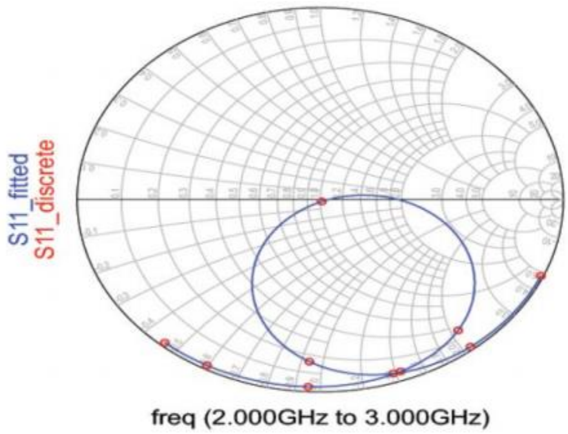

Fig.4 Smith Chart For Designed Antenna

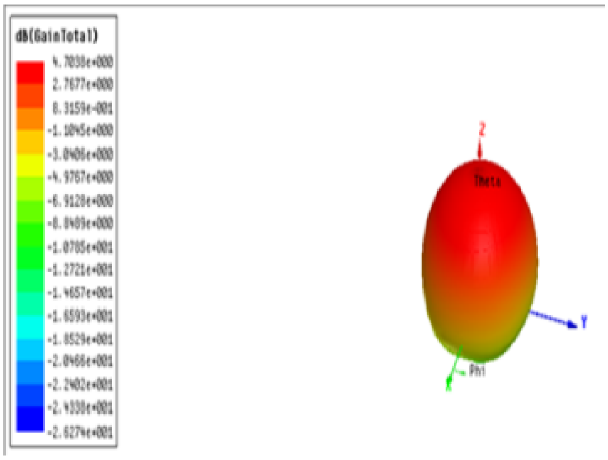

Fig.5 Gain of Antenna

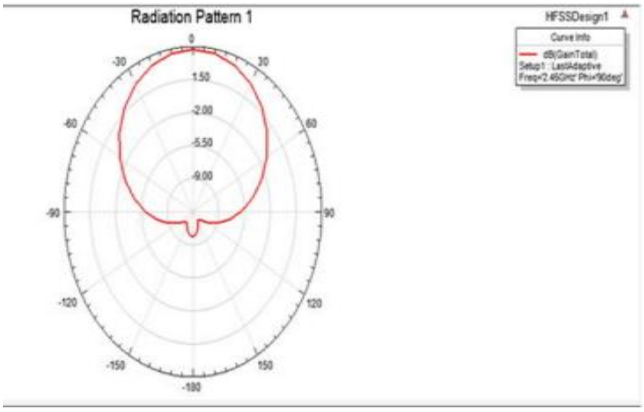

Fig.6 Radiation Pattern

3. ALGORITHM

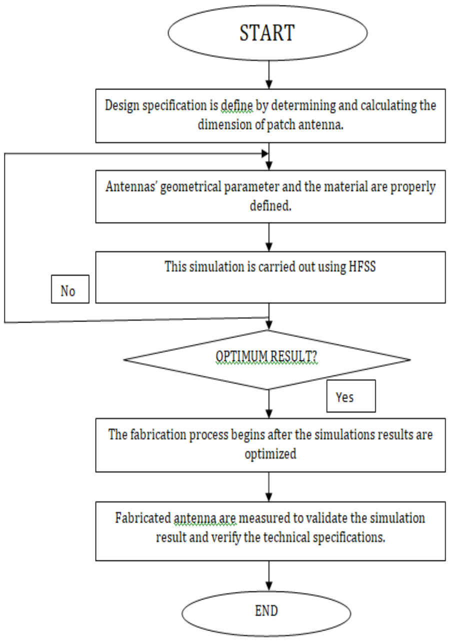

Fig.7 Algorithm

The algorithm shown in Figure 7 is explained as follows:

1) Design specification is define by determining and calculating the dimension of patch antenna means we have to take proper values for our patch antenna to get good results.

2)In next step we have to take right parameters. Parameters should be correct.

3) After taking parameters or after choosing right parameters then we can do simulation using HFSS software.

4)After than we either get our optimum result or the failed one. If we don't get right result then we again have to check for dimension and for parameters as well.

5)The fabrication process begins after the simulations results are optimized.

6)Fabricated antenna are measured to validate the simulation result and verify the technical specifications.

7)So we can after getting satisfying result we can further move to fabrications process.

4. CONCLUSIONS

In this project, we are using a microstrip patch antenna because of its low volume, thin profile configuration, and lightweight. But there are some drawback of this antenna-like narrow bandwidth, low gain, and low efficiency. To overcome this drawback we are using different shapes of the defective ground structure. Hence by introducing defective ground structures in different ways, the performance of the planar antenna was improved to achieve good impedance matching, compactness of structure.

5. REFERENCES

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