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Design of Hexagonal Microstrip Patch Antenna for Wireless Applications

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ABSTRACT

A microstrip patch antenna plays an important role in wireless communication. Because of its low profile, compact size, lighter in weight and easy of fabrication. In this paper, Hexagonal microstrip patch antenna is designed and the performance was analysed. The substrate is a dielectric material. The proposed design consist of FR4-epoxy dielectric material which having relative permittivity of 4.4 between the patch and ground plane. The antenna parameters such as gain, return loss and radiation pattern has been analysed using HFSS 13.0 software.

Index Terms: Antenna, microstrip patch antenna, Hexagonal patch antenna, feeding.

I. INTRODUCTION

Microstrip antenna was first introduced in the year of 1950s. The purpose of antenna is to transmit or receive electromagnetic waves. The reducing the size of antenna and bandwidth enhancement are the important design issues for real-world applications In recent times lots of studies have been done to improve the performance of an antenna by improving the bandwidth and efficiency of an antenna. The patch can be of various geometrical configuration such as square, rectangular, circular, elliptical, E-shaped, H-shaped etc.

The suggested antenna is largely made up of a conducting channel on one side of a dielectric substrate with a ground plane on the other. The thickness, size, form, and dielectric constant (ϵr) of the substrate material are all measured. it is used to separate the patch and the ground plane is determined on the basis of operating frequency of the patch antenna. They have been widely used for military and civilian application such as satellite communication, global positioning system (GPS), remote sensing, radio frequency identification (RFID), etc. The basic structure of microstrip patch antenna is shown in Fig. 1.

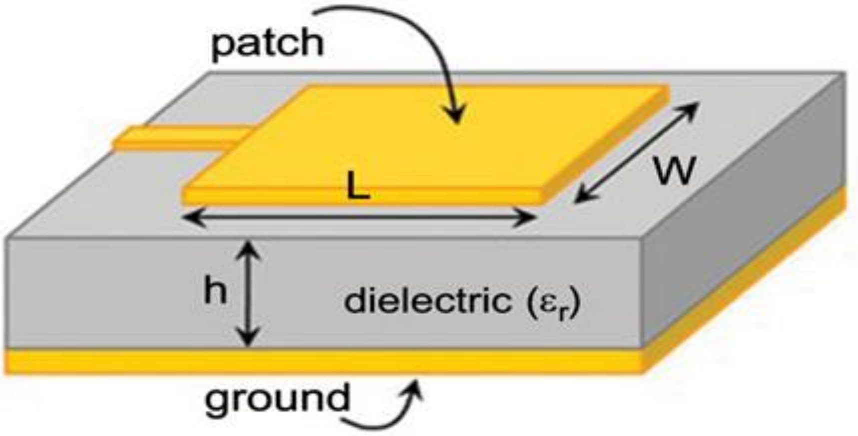

Fig.1.Basic Structure of Microstrip Patch Antenna

Wireless Standards	Frequency
1G analog cellular standard	824-849 MHz 869-895 MHz
2G GSM standards	890-915 MHz; 935-960 MHz
Cellular video	28GHz
Wireless LAN	2.40-2.48 GHz 5.4 GHz band
WAN Networks	60 GHz
Global Positioning System(GPS)	1575 MHz band, 1227 MHz band
Collision Avoidance Radar System	60,77 and 94 GHz band
Automatic Toll Collection System	905 MHz; 5-6GHz
Direct Broadcast Satellite(DBS)	11.7-12.5GHz band

Table 1: Application Area of Microstrip Antenna

A. Hexagonal Patch

The study and the design of Hexagonal patch antenna is presented in this paper is shown in Fig.1. Hexagonal patch is smaller in size when compared to circle and square for a given frequency.

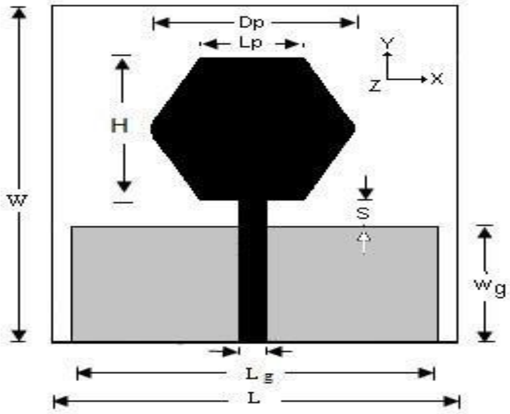

Fig..2..Hexagonal Patch Antenna

B. Feeding Techniques

The efficiency of the antenna is calculated using feedline. There are numerous strategies for feeding the signal into microstrip patch antenna. Some of the popular feeding methods are microstrip line feeds, coaxial probe feeds and aperture coupled feeds.

In this paper inset feeding method can be used to radiate the power of the proposed antenna and it is easy to implement.

II. DESIGN METHODOLOGY

The following steps is used to design and developing a microstrip patch antenna.

- Step1: Calculate the width of microstrip patch:

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (1)$$

Where,

c =free space velocity of light.

fr = resonating frequency.

ε_r= relative permittivity of substrate.

- Step 2: Effective dielectric constant:

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}[1 + 12\frac{h}{W}]^{-\frac{1}{2}} \qquad (2)$$

Where,

h = Thickness of the substrate.

W= Width of the patch.

- Step 3: Effective length:

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \qquad (3)$$

- Step 4: Extension length:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)} \quad (4)$$

- Step 5: Length of the patch:

$$L = L_{eff} - 2\Delta L \quad (5)$$

- Step 6:Width of the substrate:

$$W_g = 6h + W \quad (6)$$

- Step 7:Length of the substrate:

$$L_g = 6h + L \quad (7)$$

PARAMETER	DIMENSION
Substrate Width(Ws)	80 mm
Substrate Length(Ls)	90 mm
Substrate Height(h)	3.6 mm
Ground Length(Lg)	90 mm
Ground Width(Wg)	80 mm
Operating Frequency(fr)	1.8 GHz
Relative Permitivity (ϵr)	4.4 mm

Table 2: Dimensions of the Antenna

Fig.3 shows the general configuration of proposed hexagonal shaped patch is placed over the substrate having dielectric constant of 4.4 mm and the thickness of substrate is 3.6mm and ground plane is placed on other side of the patch.

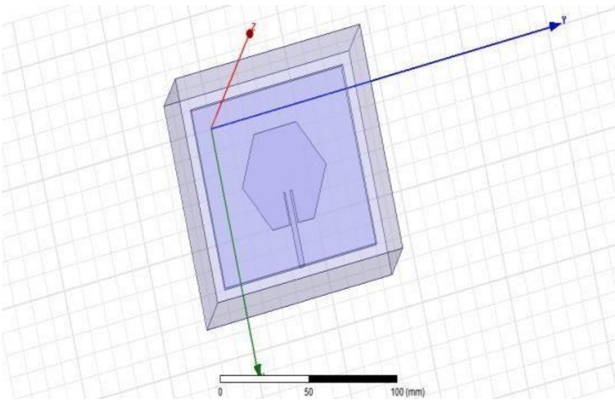

Fig.3.Hexagonal Patch Antenna

III. SIMULATION RESULT

A. Return loss:

In antenna design, return loss is one of the important parameter while designing an antenna is shown in Fig.4 & 5.The simulated results shows the maximum return loss -20 dB at 1.79 GHz and VSWR 1.6 dB at 1.79 GHz, which can cover wireless application.

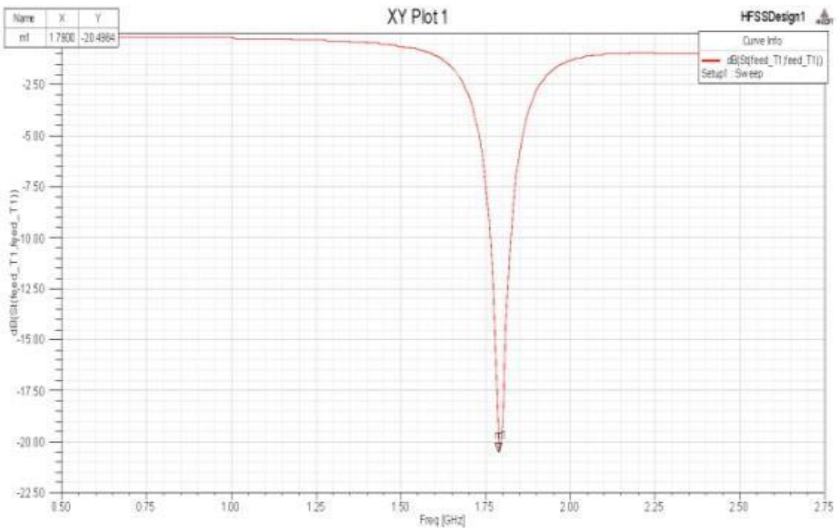

Fig..4.Simulation Result XY Plot 1

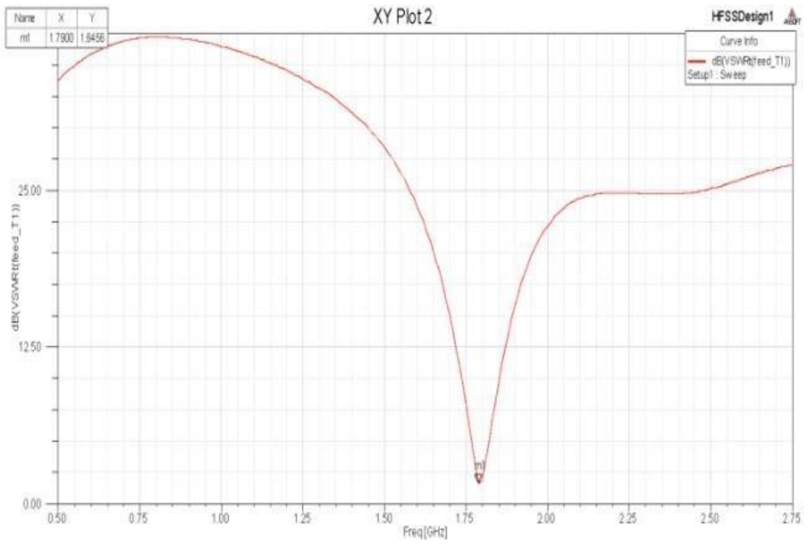

Fig..5.Simulation Result XY Plot 2

B. Radiation Pattern:

The Radiation pattern of the proposed antenna is plotted using HFSS simulation software is shown in Fig.6. In Radiation pattern shows the energy radiated through an antenna.

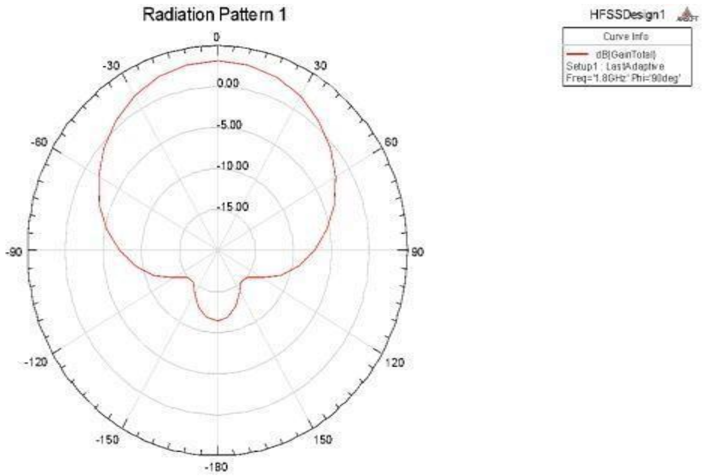

Fig.6.Radiation Pattern

C. Gain

Gain is defined as a conversion of input power into radio waves towards a desired direction. This antenna got a overall gain of 3.21dbi is shown in Fig.7.

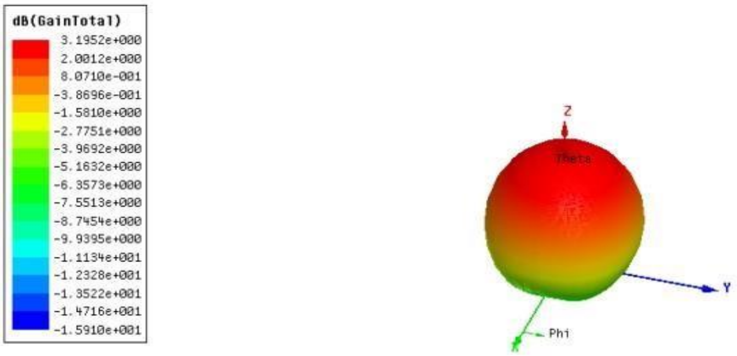

Fig..7. 3D Polar Plot

IV. CONCLUSION

Using the HFSS 13.0 software tool, we evaluated and stimulated a hexagonal microstrip patch antenna with feed line in this research. The proposed antenna was created on a dielectric constant of 4.4 FR4 - EPOXY substrate. The suggested antenna's resonance frequency is 1.8 GHz. The gain of an antenna in the direction of main beam emission is 3.19 dB, and the return loss is -20 GHz. This antenna is suitable for mobile wireless applications. Furthermore, depending on the application, the antenna's performance can be increased.

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