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Designing Of Microstrip Patch Antenna for Bluetooth Applications

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ABSTRACT:
Here we have designed and simulated the rectangular patch antenna operating at 2.4 GHz, which follows the standards of ISM band, using FEM based EM simulator software - Ansys High-Frequency Structure Simulator (HFSS). The dielectric substrate FR4 Epoxy has been used here which is frequently used in microstrip patch antenna to achieve better gain, bandwidth and also to enhance overall efficiency of antenna. We have analyzed the return loss, VSWR, radiation pattern and other parameters of the two microstrip patch antenna and then concluded the results.

Keywords: HFSS, Microstrip patch antenna, Rectangular patch, FR4 Epoxy, Bluetooth

I. INTRODUCTION

The requirement for microstrip antennas has escalated with the expansion of the mobile and wireless technologies and play a very wide role in communication system devices. The rectangular microstrip patch antennas have also become one of the most commonly used antennas in radar applications. This is due to their suitability to be embedded in portable devices. Because of their various advantages like their structure, ease of fabrication and integration with microwave integrated circuits, they have attracted a lot of attention.

In the market, various forms of antennas are available which can be used for different purposes and which have different usability, for example, wide antenna which are used in space crafts and auto-mobiles, aperture antenna used in Flush-mounted applications and air-craft, lens antennaused for very highfrequency applications, etc.Micro strip patch antennas are used in space-craft, satellites, missiles, cars, mobile phones etc.

Micro strip patch antenna are low profile antennas with many advantages over other such antennas. They are light weight, arecost efficient, portable, can be fabricated easily and are suitable for other electronics devices.

Geometric shape of amicrostrip antenna comprises a very thin metallic strip placed on a ground plane with a di-electric material in-betweenand a radiating element on the dielectric substrate and on the other side a ground plane, as illustrated in Fig 1. There are several categories of the microstrip patch antenna, likea circular, a square, triangular, hexagon, etc., but the most common is rectangular element micro strip.

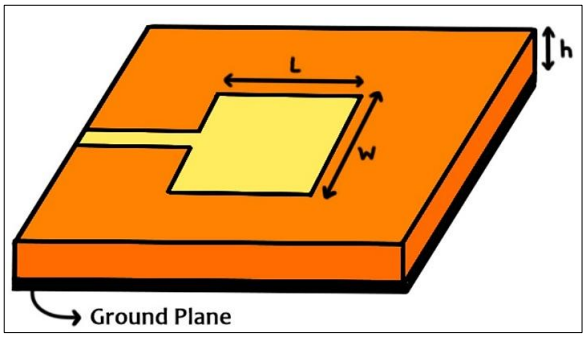

Fig.1. Rectangular Patch Antenna

II. FEEDING TECHNIQUES OF MICROSTRIP ANTENNA

There are many methods to power-up a patch antenna. The feeding techniques are categorized in twomethods:

• Category contacting:Into a radiating patch, element such as a microstrip line is connected which provides a feeding to the patch antenna.

• Without contact category: Through electromagnetic field coupling power is transferred between the microstrip line and a radiating element.

II.I. COAXIAL PROBE FEEDING TECHNIQUE

Here we have employed the most famous feeding technique for the microstrip patch antenna, i.e., coaxial probe feeding technique (Fig.2). Since we are following the ISM band with the range of 2.4

GHz – 2.45 GHz and high operating frequency, use of transmission line is not possible.

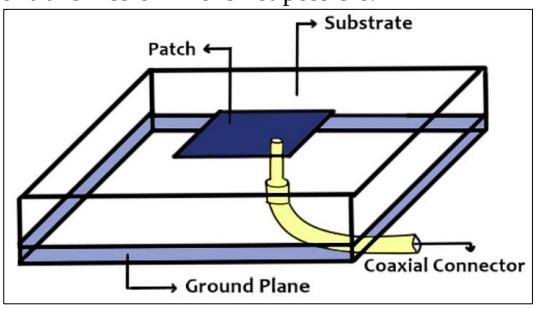

Fig.2. Coaxial Probe Feeding

In this, the inner conductor of the coaxialconnector extends throughout the dielectric and issoldered to the radiating patch, while the outerconductor is coupled to the ground plane.

III. DESIGNING OF RECTANGULARMICROSTRIP PATCHANTENNA

This rectangular microstrip antenna is devisedon Ansoft High-Frequency Structure Simulator (HFSS) software for Industrial, Scientific and Medical (ISM)band communication applications, which is operating at a frequency of 2.4 GHz. The proposed rectangular patch antenna has been created using the substrate Fr_4 Epoxy with dielectric equal toε_r = 4.4 and height of substrate (h) = 1.6 mm.

The Fig. 3 below shows the simulatedrectangular microstrip antennain proper dimensions made practically on HFSS software.

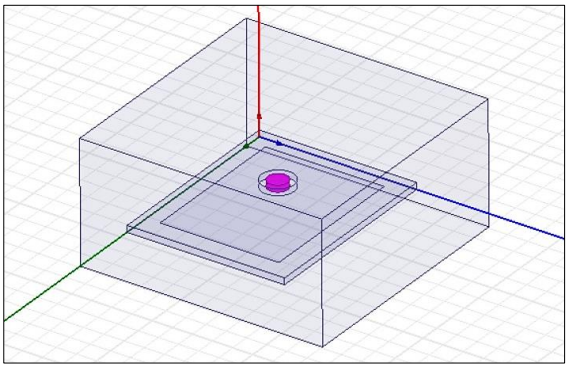

Fig.3. Rectangular microstrip antenna on HFSS Software

The basic steps for the development of rectangular patch antenna are:

Step 1: A parameter Width of the radiating rectangular microstrip antenna is enumerated from this equation:

$$W_p = \frac{c}{2f_r\sqrt{(\varepsilon_r+1)/2}} \quad (1)$$

where,
c is the speed of light, $(3 \times 10^{11}$ m/s).
f_r is the operating frequency.
ε_r is the dielectric constant of the substrate

Step 2: Effective Dielectric constant of the rectangular microstrip antennaisdetermined as:

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[\frac{1}{\sqrt{1+\frac{2h}{W}}}\right] \quad (2)$$

Step 3: The effective length is specified at the resonance frequency:

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_e}} \quad (3)$$

Step 4: Extension length of the rectangular microstrip antenna is calculated through this equation:

$$\Delta L = 0.412h_p \times \frac{((\varepsilon_e + 0.3) \times \left(\frac{W}{h_p} + 0.264\right))}{((\varepsilon_p - 0.258) \times \left(\frac{W}{h_p} + 0.813\right))}$$

*Step 5:*The length " L" of the PRA is calculates as:

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

On the basis of these equations(i.e., 1-5), the dimensions of the mentioned antennas are found as listed in the Table-1 below.

TABLE-1
DIMENSIONS OF THE ANTENNA

PARAMETERS	VALUES
Resonance Frequency (f_r)	2.4 GHz
Dielectric Constant (ε_r)	4.4
Patch dimension (L_p, W_p)	38.01 mm, 29.42 mm
Microstrip Dimension (L_m, W_m, h_m)	47.61 mm, 39.02 mm, 1.6 mm
Ground Dimension (L_g, W_g)	47.61 mm, 39.02 mm
Feeding points (X_f, Y_f)	14.75 mm, 14.75 mm

IV. RESULTS AND ANALYSIS

This antenna is designed and optimized with the aid of Ansoft HFSS. The patch dimension is W_p= 38.01 mm,L_p= 29.42 mm. The feed dimension is X_f= 14.75 mm,Y_f= 14.75 mm. The ground plane length and width are calculated as L_g= 47.61 mm and W_g= 31.86 mm respectively. The proposed rectangular patch antenna is designed using Ansoft HFSS software ADS.

The S-parameter (return loss), VSWR and 3D Polar Plot of the proposed antenna arediscussed here.

IV.I. RETURN LOSS

Return loss simulation result of the schematic model of rectangular microstrip patch antenna simulated on HFSS software is shown in Fig.4.
It is clear from the figure that the patch resonates at 2.4 GHz and has minimum loss at the resonant frequency of -23.99dB.

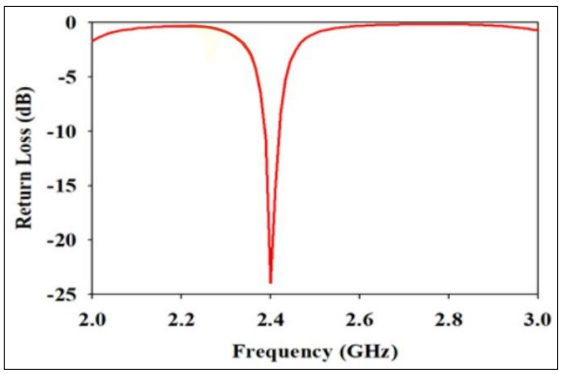

Fig.4. Return Loss

IV.II. VOLTAGE STANDING WAVE RATIO (VSWR)

The parametervoltage standing wave ratio(VSWR)is a measure which defines how much reflection we have got through the system. In other words, it numerically describes how well the antenna is impedance matched to the radio.VSWRmust be less than 2; it would be best if it comes around 1.For this antenna (Fig.5), the VSWR reading is 1.13.

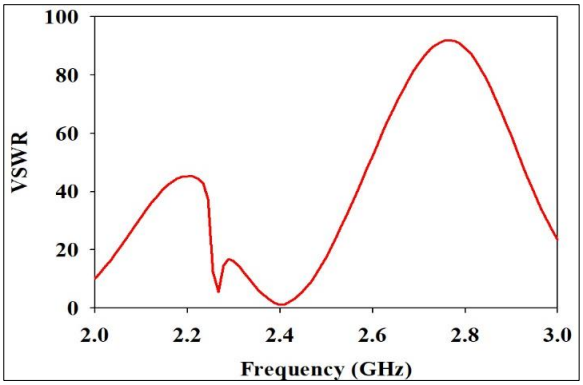

Fig.5. Voltage Standing Wave Ratio (VSWR)

IV.III. 3D POLAR PLOT

From polar plot it is clear that the radiations are along Z direction.The radiation pattern ofrectangular microstrip antenna is depicted below (Fig .6). We are getting one lobe (main lobe) which corresponds to the theoretical radiation pattern of patch antenna radiant.

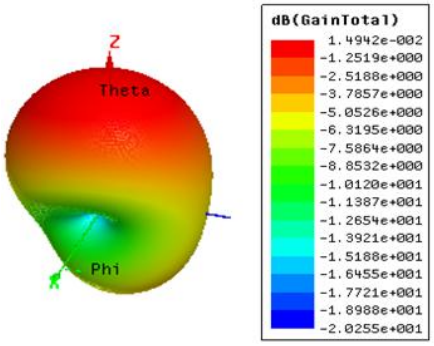

Fig.6. 3D Polar Plot of rectangular patch antenna

V.CONCLUSION

The conception and simulation of anISM band based rectangular microstrip patch antenna is presented in this paper. This antenna has a lucid structure which can easily be incorporated in any miniature devices. Results show that at operating frequency of 2.4 GHz, we have obtained a return loss of – 23.99 dB, through which we can observe thatmeasured and simulate results are in good agreement. Measured results show good impedance matching as well. From above it is clear that the antenna will work good in ISM band for Bluetooth and other Mobile applications.

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