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Design of an H-shaped Microstrip Patch Antenna for Bluetooth Applications

Alak Majumder

Department of ECE,
National Institute of Technology,
Agartala, Tripura, India

ABSTRACT: In this paper, a design of small sized, low profile patch antenna is proposed for BLUETOOTH applications at 2.4GHz frequency with coaxial feeding technique. The patch is H-shaped and different parameters like return loss, VSWR, gain along two directions, radiation pattern in 2-D and 3-D, axial ratio, E and H Field Distributions, Current Distributions are simulated using Ansoft HFSS. The measured parameters satisfy required limits hence making the proposed antenna suitable for BLUETOOTH applications in 2.4GHz band.

KEYWORDS: Patch antenna, Radiation pattern, Return loss, Coaxial fed, Bluetooth.

1 INTRODUCTION

The BLUETOOTH technology provides short range of wireless connections between electronic devices like computers, mobile phones and many others thereby exchanging voice, data and video. The rapid increase in communication standards has led to great demand for antennas with low real estate, low profile and size, low cost of fabrication and ease of integration with feeding network. Microstrip patch antennas are widely used because they are of light weight, compact, easy to integrate and cost effective. However, the serious problem of patch antennas is their narrow bandwidth due to surface wave losses and large size of patch for better performance.

Various techniques like using Frequency Selective Surface[13]-[14], Employing stacked configuration[6], using thicker profile for folded shorted patch antennas[8], use of thicker substrate[10], slot antennas ike U-slot patch antennas together with shorted patch[4], double U-slot patch antenna[5], L-slot patch antenna[8], annular slot antenna[9], double C patch antenna[3], E-shaped patch antenna[2], and feeding techniques like L-probe feed[7], circular coaxial probe feed[1], proximity coupled feed are used to enhance bandwidth of Microstrip patch antenna. The size of feeding patch and thickness of dielectric should be taken care. The techniques to reduce the size of the patch like use of short circuited element [15]-[16], high dielectric constant material [17], slots [10], and resistive loading [19] have been proposed.

But, the choice of slot antenna [20] introduced the drawback of narrow bandwidth and poor circular polarization performance and complex laser cutting of solar cells is required to achieve desired shape during fabrication. Monopole [12], printed monopole [21]-[26], dipole [11] antennas improve the bandwidth to a greater extent. But, monopole antennas are of large size and difficult to build and integrate. Printed monopole antennas also have numerous advantages like low profile, small size, and easy integration but has disadvantage of low broad impedance bandwidth and low omnidirectional radiation pattern. The dipole antennas have large input impedance. So, an impedance matching transformer or balun coil at feed point is required which increases the size of antenna [27]-[33].

In this paper, a compact size patch antenna is proposed with dielectric substrate as FR4 with $\varepsilon r=4.4$ and dimensions are based on resonant frequency. Various attempts are made to adjust the dimensions of the patch to improve the parameters like return loss, VSWR, gain along Θ, Ø directions, radiation pattern in 2-D and 3-D, axial ratio, E and H Field Distributions, Current Distributions using HFSS which is a high performance full wave EM field simulator for arbitrary 3D volumetric passive device modelling that takes advantage of the familiar Microsoft Windows graphical user interface. It integrates simulation,

Corresponding Author: Alak Majumder (majumder.alak@gmail.com)

visualization, solid modelling, and automation in an easy to learn environment where solutions to your 3D EM problems are quickly and accurate obtained. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight to all of the 3D EM problems.

2 DESIGN CONSIDERATION

The design specifications for the proposed antenna are: The proposed structure of the antenna is shown in Fig (1). The antenna is simulated on an FR4 substrate with a dielectric constant of 4.4 and a loss tangent of 0.02. The thickness of the substrate is 6.7 mm. The size of the antenna is 80* 80 mm^2, which is suitable for most Bluetooth devices. Rectangle shaped patches are cut at middle to form H-shaped patch antenna and width of each arm is 25mm.

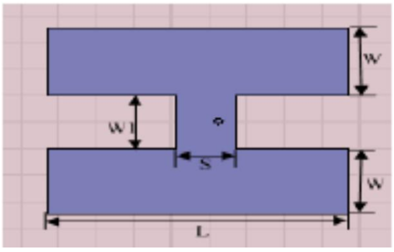


Fig. 1. Geometry of Patch Antenna

A patch can also be fed with a probe through ground plane. The probe position can be inset for matching the patch impedance with the input impedance. This insetting minimizes probe radiation. The ease of insetting and low radiations is advantages of probe feeding as compared to microstrip line feeding. The dimensions of H shaped patch shown in Fig (1) are L=80mm, W=20mm,S=16mm, W1=20mm. These are designed at operating frequency 2.4 GHz.

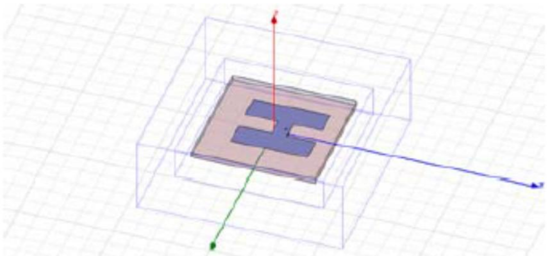


Fig. 2. Ansoft – HFSS Generated Antenna Model

Figure 2 shows the proposed antenna on FR4 Substrate using Ansoft-HFSS.

3 Simulation Results

3.1 Return Losses

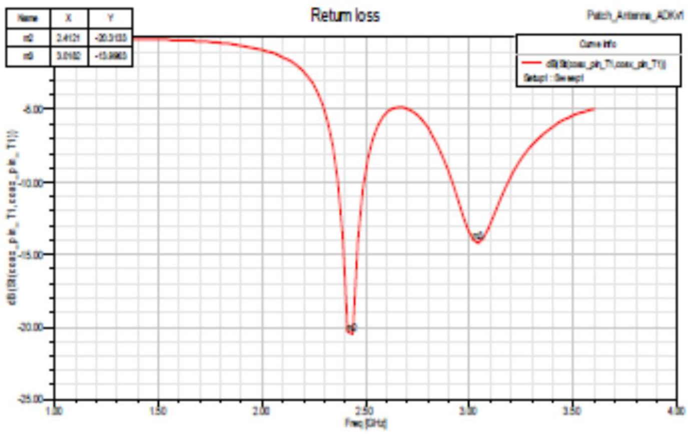


Fig. 3. Return Loss

Figure (3) shows the return loss Curve for the proposed antenna at 2.4 GHz. A return loss of 22.90dB is obtained at desired frequency.

3.2 2D gain & 3D gain totals

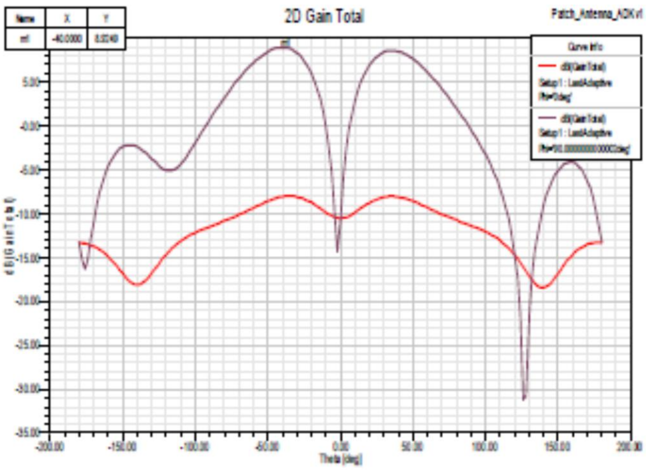


Fig. 4. 2D Gain Total

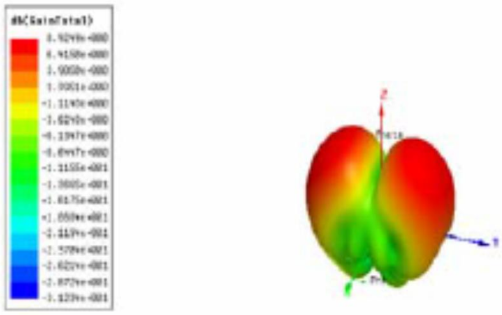


Fig. 5. 3D Gain Total

Figure (4-5) shows the antenna gain in 2D &3D patterns. The gain of proposed antenna at 2.4GHz is obtained as 8.9367dB. The gain above 6dB is acceptable.

3.3 VSWR

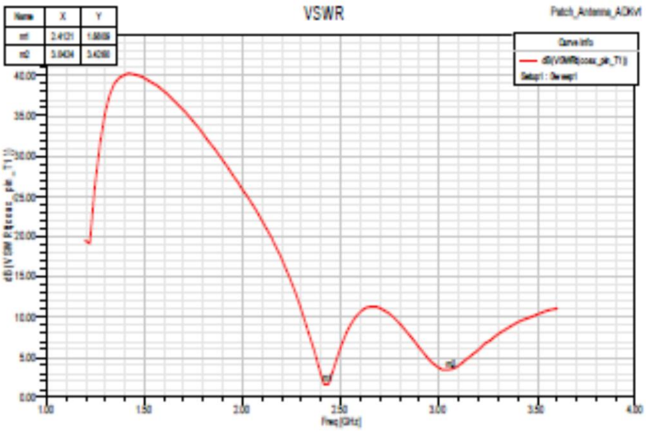
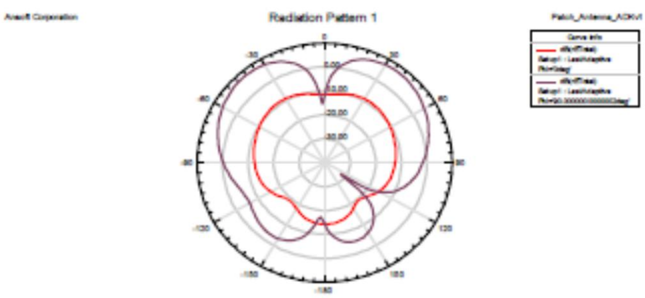


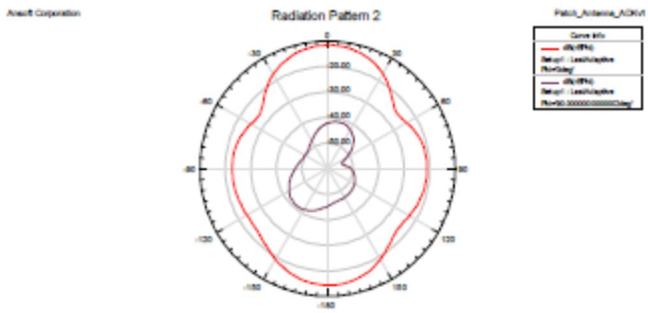
Fig. 6. VSWR

The VSWR for the proposed antenna is less than the 2dB. The obtained value is 1.5089 from Fig 6.

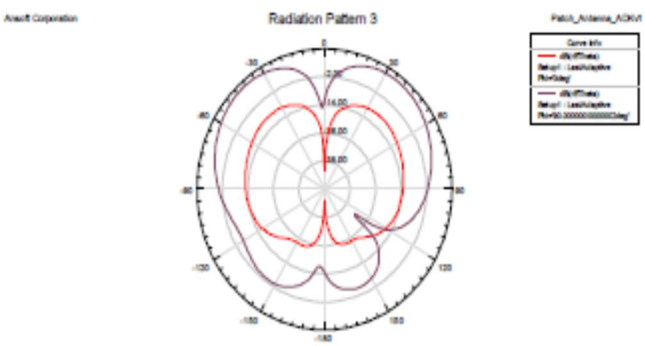
3.4 Radiation patterns



(a)



(b)



(C)

Fig. 7. (a) Gain in Total; (b) Gain Along Phi; (c) Gain Along Theta

Since a Micro strip patch antenna radiates normal to its patch surface, the elevation pattern for ϕ = 0 and ϕ = 90 degrees would be important. The radiation pattern for proposed microstrip patch antenna for gain-Total, phi and theta at 0deg and 90deg is presented in figure 7(a), 7(b) and 7(c).

3.5 AXIAL RATIO

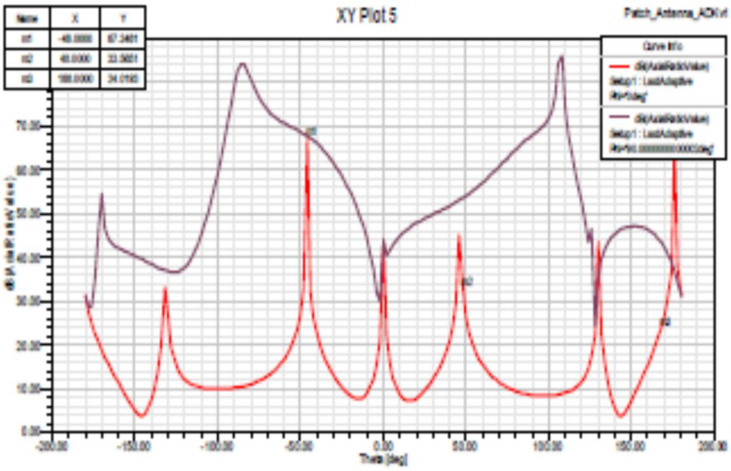
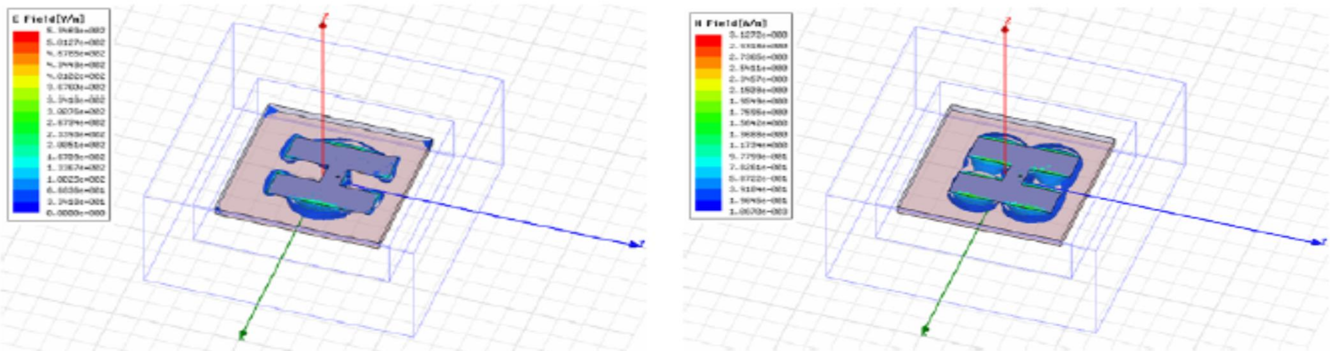


Fig. 8. Axial Ratio

Axial ratio which is the ratio of the major axis to the minor axis of the polarization ellipse where the resulting pattern is an oscillating pattern is obtained as in Fig 8.

3.6 FIELD DISTRIBUTIONS



(a) (b)

Fig. 9. (a) E – Field Distribution; (b) H – Field Distribution

The effect produced by an electric charge that exerts a force on charged objects is the E-Field and its distribution in the patch is as shown in Fig 9(a). The measured intensity of a magnetic field in the patch is shown in Fig 9(b).

3.7 CURRENT DISTRIBUTION

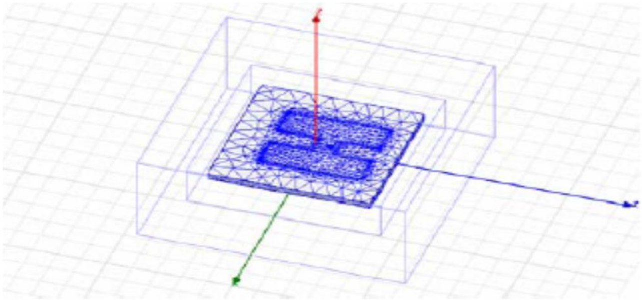
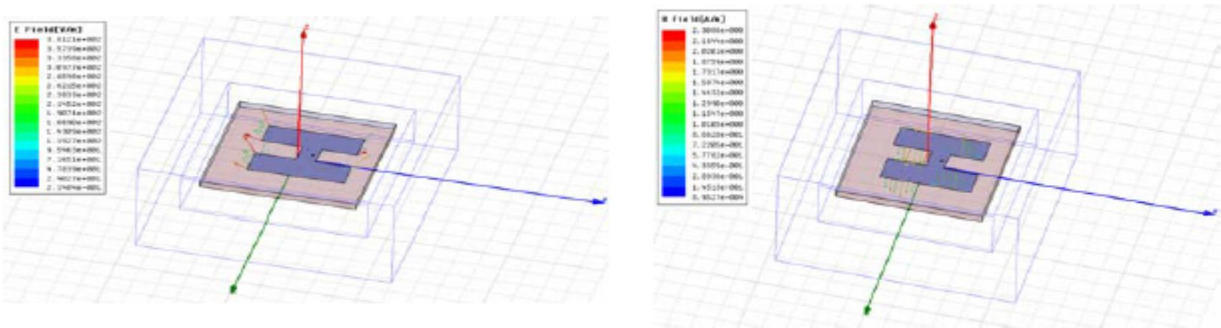


Fig. 10. Mess Pattern

The triangles show the current distribution. Here the numbers of triangles inside the patch are more than those on the substrate i.e. the current distribution in the patch is more when compared to that inside the substrate in Fig10.

3.8 FIELD VECTORS



(a) (b)

Fig. 11. (a) E – Field Vector; (b) H – Field Vector

The E-Field Vector and H-Field vectors of proposed patch antenna are obtained as shown in Fig 11(a) and 11(b).

4 CONCLUSION

Finally, the optimum dimension of circular polarized patch antenna on FR4 substrate for BLUETOOTH applications has been investigated. The performance properties are analysed for the optimized dimensions and the proposed antenna works well at the required 2.4GHz BLUETOOTH frequency band.

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