International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 03 | Mar -2017 www.irjet.net p-ISSN: 2395-0072

DESIGN OF INSET FEED MICROSTRIP PATCH ANTENNA FOR BLUETOOTH APPLICATION.

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Abstract - *Microstrip Patch antennas are widely used in various fields of electromagnetic applications because of its low cost, low profile, easy fabrication and due to its conformability. In this paper an attempt has been made to design a microstrip patch antenna for the Bluetooth applications. The aim of this work is to design an efficient and economical patch antenna for indoor and outdoor uses. The effectiveness of the proposed designs is confirmed through proper simulation results.*

Key Words: **Microstrip Patch Antenna, Inset Feeding, Radiation Pattern, Bluetooth.**

1. INTRODUCTION

With the ever increasing need for portable computing devices and the emergence of many systems, it is important to design a portable and efficient antenna for communication system [1]. The design of an efficient wideband small size antenna, for recent wireless applications, viz Wi-Fi, Bluetooth, etc., is a major challenge [2].Micro strip patch antennas have found extensive application in wireless communication system due to their advantages such as low profile, conformability, low-cost fabrication and ease of integration with feed networks.

The Bluetooth technology provides a means of short range of wireless connections between electronic devices like mobile devices, computers and many others thereby exchanging data voice and video.

This paper presents development of microstrip antenna at frequency of 2.4 GHz for that of Bluetooth application. An antenna is a device used to transform an RF signal, traveling on a conductor, into an electromagnetic wave in free space. Antennas demonstrate a property known as reciprocity, it means that an antenna will maintain the same characteristics regardless if it is transmitting or receiving. Most of the antennas are resonant devices, which operate efficiently over a relatively narrow frequency band [3]. An antenna must be tuned to the same frequency band of the radio system to which it is connected otherwise the reception and the transmission will be mismatched. When a signal is fed into an antenna, the antenna will emit radiation distributed in space in a certain way. A graphical representation of the relative distribution of the radiated power in space is called a radiation pattern [2].The antenna has become a necessity for many applications in recent wireless communication such as WLAN, radar, microwave and space communication.

2. DESIGNING AND CALCULATION OF INSET FEED RECTANGULAR PATCH ANTENNA

A single element rectangular microstrip patch antenna, as shown in the fig1, can be designed for the 2.4GHz resonant frequency using the transmission line model.

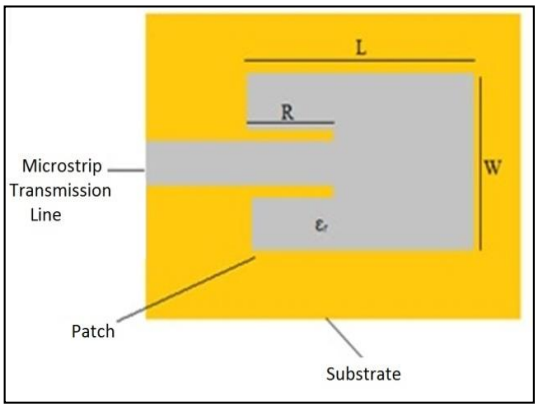

Fig 1: Structure of Inset feed Rectangular Patch Antenna

In this design of rectangular Microstrip Patch Antenna design a dielectric material of FR4 is used with the height of 2.5mm. The designed antenna operates on the specified frequency of f_0=2.4GHZ which is used for Bluetooth application.

Calculation of the inset length of the patch is necessary to calculate, also it is dependent on the width of the patch as well as the operating wavelength. Following are the procedures for calculating the dimensions of the inset feed rectangular patch antenna.

The width "W" and Length "L" of the microstrip patch antenna is given below:

$$W = \frac{\lambda_0}{2}\left(\frac{2}{E_r + 1}\right)^{1/2} \quad (1)$$

$$L = \frac{1}{2\,fr\sqrt{E_{eff}}\sqrt{\mu_0 \in_0}} - 2\Delta L \quad (2)$$

$$\Delta L = 0.412h\frac{(E_{eff} + 0.3)}{(E_{eff} - 0.258)}\frac{(\frac{W}{h} + 0.264)}{(\frac{W}{h} + 0.813)} \quad (3)$$

Where,

$$E_{eff} = \frac{(E_r + 1)}{2} + \frac{(E_r - 1)}{2}\left(1 + 12\frac{W}{h}\right)^{-1/2} \quad (4)$$

The inset length of the patch is calculated by using the width of the patch. The calculation is given by.

If, W >> λ_0, then $G_1 = \frac{1}{120}\left(\frac{W}{\lambda_0}\right)$ (5)

If, W <<λ_0, then $G_1 = \frac{1}{90}\left(\frac{W}{\lambda_0}\right)^2$ (6)

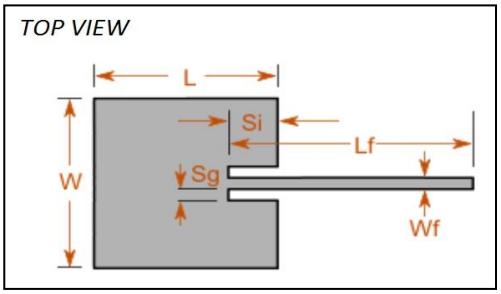

Fig2: Top View of Microstrip Inset feed Rectangular Patch Antenna Structure

The characteristic impedance of Microstrip feeder line is R_{in}

$$R_{in}(y = 0) = \frac{1}{2(G_1 \pm G_2)} \quad (7)$$

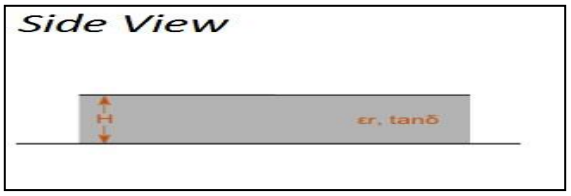

Fig 3: Side View of Microstrip Inset feed Rectangular Patch Antenna Structure

Now inset length (y_0) is calculated by the following equation.

$$R_{in}(y = y_0) = \frac{1}{2(G_1 \pm G_2)}\cos^2\left(\frac{\Pi}{L}y_0\right) \quad (8)$$

The calculated result of Microstrip patch Antenna design parameters are shown in the table 1.

Table 1: Specification for the Inset Feed Rectangular Patch Antenna

Parameters	Units
Operating Frequency(f_0)	2.4 GHz
Ground plane dimension (L X W)	76.37mm x 58.43mm
Patch Length (L)	29.22 mm
Patch Width (W)	38.19 mm
Dielectric Constant(Ɛr)	4.35
Dielectric Material	FR-4
Dielectric Substrate Height(H)	2.5 mm

Table 2: Specification for the Inset Length of Patch

Parameters	Units
Feed Line length (Lf)	34.39 mm
Feed Line Width (Wf)	4.821 mm
Space between feed line and path(Sg)	724.4 µm
Feed inset from edge (Si)	10.39 mm

3. RESULT ANALYSIS FOR INSET FEED RECTANGULAR PATCH ANTENNA

The simulation of purposed inset feed rectangular patch antenna design has been carried out by using Antenna Magus Evaluation software. Fig4. Shows the variation of the Input reflection coefficient vs. frequency curve and Fig5. Shows the Radiation pattern plot of the designed antenna.

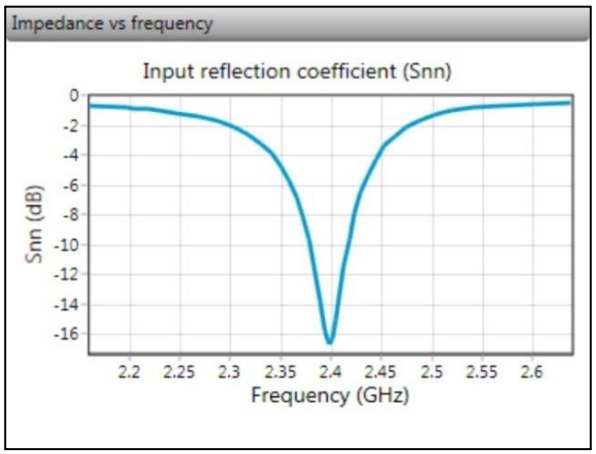

Fig 4. Variation of Input reflection coefficient VS Frequency plot.

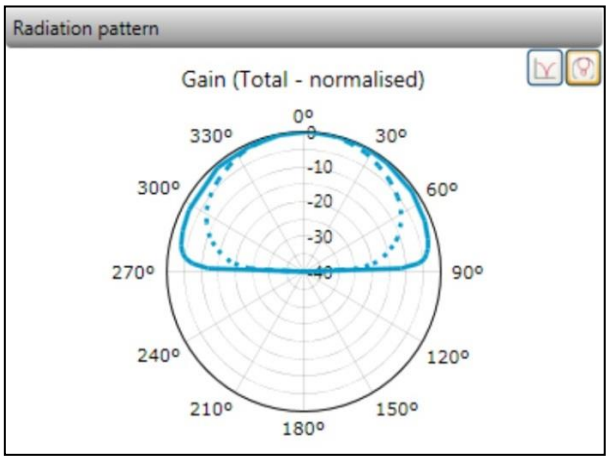

Fig 5. Radiation Pattern Plot of the designed antenna

4. CONCLUSION

A simple and efficeint method of inset feeding has been studied for the impedance matching improvement of the designed antenna. Main objective of this paper is to design a microstrip patch antenna for Bluetooth application with inset feeding techniques. This proposed inset feed rectangular patch antenna is a more conventional approach for the implementation of a Bluetooth application and is a good choice to replace commercially available dipole antenna.

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