

# Design and Analysis of Inset Fed Microstrip Patch Antenna for Wireless Application

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**Abstract**— In today's world, the wireless communication is in demand. Wireless technology evolution is on the way by making this our goal, presenting the paper. This paper presents basic concepts and terms of Microstrip patch antenna with inset feed feeding technique. This antenna operating at 2.38 GHz and its design, analysis, and performance are presented. The proposed antenna is capable of transmitting and receiving signal at its operating range. The FEKO Software tool used for design and analysis of the antenna. The return loss, 3D radiation Pattern, VSWR has been estimated. The simulated result of this antenna shows that the designed antenna have proper radiation characteristics at its desired operating frequency. The gain of the proposed antenna is 6.75dB the return loss is -10.6828dB and VSWR is 1.828.

**Key words:** FEKO Tool, Wimax, Microstrip Patch Antenna, Inset Feeding Technique, Return Loss

## I. INTRODUCTION

In today's world, the smart antenna plays an important role in wireless communication like WiMax, the global positioning system (GPS), RFID and WLAN. The antenna requires small, low cost and low profile wireless communication application [7]. Rapid growth in the high density networks in the antenna technology has led to the smaller antenna size, lighter weight, and reconfigurable nature [4]. WiMax is Worldwide Interoperability for Microwave Access. WiMax is one of the hottest wireless technologies. WiMax is a standardized wireless version of Ethernet. WiMax would operate similar to Wi-Fi, but at higher speeds over greater distances and for a greater number of users. WiMax has the ability to provide service even in areas that are difficult for wired infrastructure to reach and the ability to overcome the physical limitations of traditional wired infrastructure. The growth of wireless communication has necessitated the development of efficient systems especially antenna with low return loss and high bandwidth [4]. WiMax refers to interoperable implementations of the IEEE 802.16 family of wireless-networks standards ratified by the WiMax Forum.

With the advancement of wireless communication systems and their miniaturization, antenna design becomes more significant in present days. An antenna is an electrical conductor or a system of conductors which is "that part of transmitting or receiving system that design to radiate or receive electromagnetic waves" [1]. A Microstrip antenna is consisting of the thin metallic conductor which is bonded to the thin grounded dielectric substrate. A Microstrip patch antenna is crucial in many of the modern day's practical applications like that of wireless local area network (WLAN), mobile cellular handsets, Global Position System (GPS) and other upcoming wireless terminals.

This paper presents basic concepts and terms of Microstrip patch antenna with inset feeding technique. Patch antennas have advantages like low cost, low profile, and easy to manufacture and design. It can provide a wide range of antenna responses in terms of the radiation pattern, gain, polarization etc. Using an array of patch antennas can further increase the gain. A comparison between various feeding techniques has been done. Finally, an in-plane inset fed patch antenna at WiMax frequency has been designed and, simulated on the design FEKO software tool for a better understanding of the design parameters of an antenna and their effect on the bandwidth and efficiency.

## II. ANTENNA DESIGN

### A. Microstrip patch antenna

An antenna is electrical conductor or a system of conductors that transmits and/or receives electromagnetic waves. There are different types of microwave antennas, which include Reflector antennas, Horn resonators and Microstrip patch antennas [5]. The Microstrip patch antennas are well known for their performance and their robust design, fabrication and their widespread usage. The advantages of the Microstrip patch antenna have overcome their demerits like extra radiation occurs from its feeds and junctions excitation of surface waves. Patch antennas can easily be designed to have vertical, horizontal, right hand circular (RHCP) or left hand circular (LHCP) polarizations, using multiple feed points, or a single feed-point with asymmetric patch structures [6].

In order to design Microstrip patch antenna, in this paper we have used FEKO tool. This software tool is capable in developing high-power RF and microwave device models. In patch antenna design, here consider important parameters like Antenna shape, Antenna tuning, Voltage standing wave ratio (VSWR) and return loss, Bandwidth, Gain and directivity, Radiation pattern and Diversity, etc

Microstrip Patch Antenna is also called as a printed antenna. Microstrip Patch Antenna is an antenna fabricated using Microstrip techniques on a printed circuit board (PCB) [7]. Microstrip antenna is mostly used at microwave frequencies. The Rectangular Microstrip patch antenna, Microstrip transmission line and ground plane are made of high conductivity metal typically we are using copper material. The figure 1 shows working of Microstrip Patch Antenna;

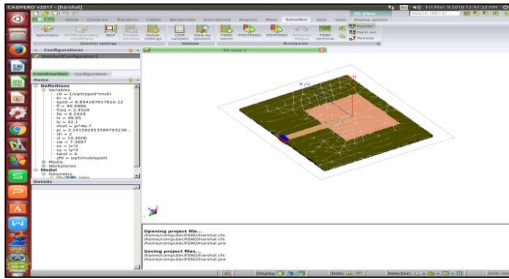


Fig. 1: Microstrip Patch Antenna

Here L represents lengths of patch; W represents widths of patch; and Er represents Dielectric Constant.

This proposed rectangular Microstrip patch antenna is designed with a return loss less than -10dB. The inset feed technique is used to fit the matching between the feed line and the patch. The main radiator element of the proposed antenna and the feeder are on the top face of the substrate while the conducting partial ground plane of length L on the bottom face of the substrate.

**B. Design Methodology**

Microstrip Patch Antenna is also known as a printed antenna. The patch is of length L, width W, and sitting on top of a substrate of thickness h with permittivity. The upper face is radiating surface and lower face is acting as a ground [7][9].

The essential parameters for the design are:

- Frequency of operation of = 2.38 GHz
- Dielectric constant of the substrate  $\epsilon_r = 2$
- Height of dielectric substrate h = 2 mm

The first step in designing rectangular microstrip patch antenna is calculating all the parameters with antenna the above specification. Microstrip patch antenna width (W):

$$W = \frac{c}{2f_0 \sqrt{\frac{(\epsilon_r + 1)}{2}}} \dots\dots\dots(1)$$

Effective Dielectric constant:

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[ 1 + 12 \frac{h}{W} \right]^{-2} \dots\dots\dots(2)$$

Effective Length:

$$L_{eff} = \frac{c}{2f_0 \sqrt{\epsilon_{reff}}} \dots\dots\dots(3)$$

Length Extension:

$$\Delta L = 0.412h \frac{(\epsilon_{reff} + 0.3) \left( \frac{W}{h} + 0.264 \right)}{(\epsilon_{reff} - 0.258) \left( \frac{W}{h} + 0.8 \right)} \dots\dots\dots(4)$$

Actual length of Patch:

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

The Calculated parameters are

Sr. No.	Parameters	Dimensions
1	Operating frequency (f)in GHz	2.38
2	Dielectric Constant ( $E_r$ )	2
3	Length of the Patch (ly) in mm	42.1
4	Width of Patch (lx) in mm	49.95
5	Substrate Width (sx) in mm	lx*2
6	Substrate Length (sy) in mm	ly*2
7	Substrate Height (sh) in mm	2

8	Slot Width (sw) in mm	7.3687
9	Slot Length (sl) in mm	14.4606
10	Feed line Length (fl) in mm	46.4968
11	Feed line Width (fw) in mm	6.5429

**C. FEKO tool**

FEKO is a Method of Moments (MoM) tool that can be used to calculate the radiation pattern, impedance and gain of an antenna while mounted on some defined geometry. In addition, it can calculate the isolation or mutual coupling (S12) between pairs of antennas, the near fields around an antenna and the electric currents that flow on an antenna or the surrounding structure.

The basic flow of performing a FEKO analysis consists of

- 1) Building geometry for the antenna in CADFEKO or EDITFEKO.
- 2) Building a geometry to represent surrounding geometry in CADFEKO, EDITFEKO or an external tool.
- 3) Meshing the Created Antenna and Surrounding Geometries.
- 4) Requesting Solution Types and Setting Solution Parameter.
- 5) Running the FEKO solver.
- 6) Read in and interpret results using PostFEKO.

Figure 2 shows the Microstrip patch antenna simulation

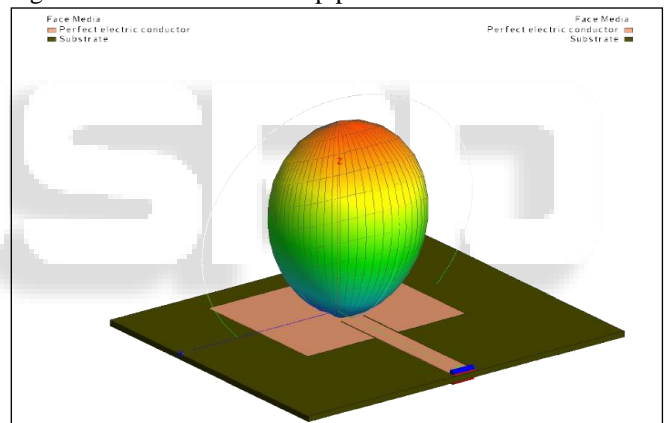


Fig. 2: Radiation pattern

Microstrip antennas can range from a simple pin-fed patch to complex designs incorporating multiple dielectric layers with widely varying electromagnetic properties and complex metallic shapes on different dielectric layers. Typical simulation results of interest include:

- 1) Coupling efficiency between metallic layers
- 2) Near and far-fields
- 3) Current distribution on metallic layers
- 4) Input impedance

FEKO offers all of these capabilities, through its comprehensive, full-wave Method of Moments (MoM) solver. The current distribution on all metallic elements of a Microstrip antenna is calculated, with other antenna characteristic parameters derived from the currents.

**D. Inset feed techniques**

There are various fed methods for Microstrip antenna. In this Microstrip antenna instead of using a simple rectangular feed, we have used Inset feed techniques. There are two main advantages of using an Inset feed i.e. it feeds the antenna directly near the centre and secondly it yields high

input impedance [3]. The high input impedance and low output impedance is needed so as to transfer the signal or power from input to the output as in op-amps and also we require high input and low output impedance to avoid or minimize the standing waves.

A feed line is used to excite to radiate by direct or indirect contact. There are many different techniques of feeding and most popular techniques is Inset feed [6]. In this paper Microstrip inset feed patch antenna is to work as both receiving and transmitting antenna.

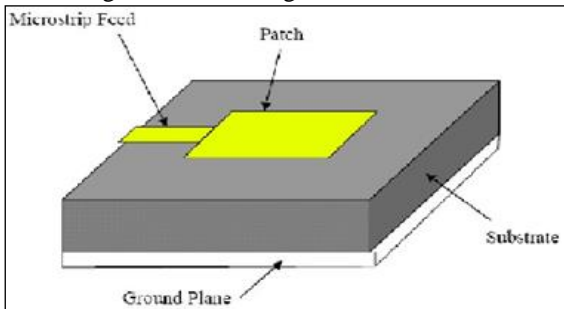


Fig. 3: Inset feed Microstrip Patch Antenna

### III. PERFORMANCE PARAMETERS

Following are some of the performance parameter used to measure the performance of Microstrip patch antennas

#### A. Return loss

The Return Loss parameter indicated the amount of power that is lost to the load and does not return as a reflection. The antenna presented maximum radiation at 2.38 GHz as shown in table 1. It has been observed that by varying position of feed line the level of radiation could be significantly improved. The reason for that is that changing such offset changes the impedance seen by the feeding line. From return loss we can determine whether the antenna is single band or multiband and also we can calculate bandwidth.

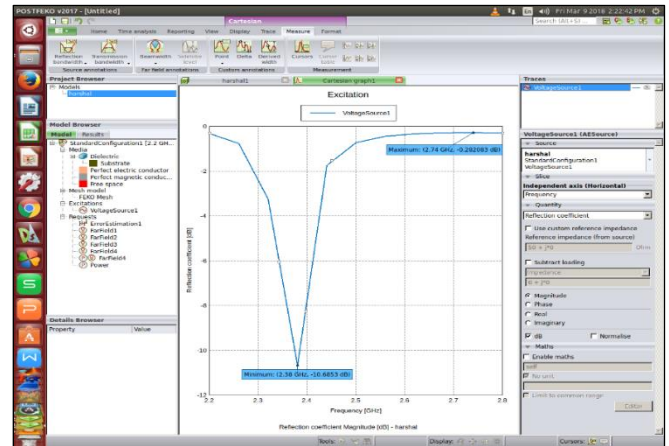
#### B. Radiation pattern

It is radiation properties of the antenna as a function of space coordinates. Radiation pattern is determined in a far field region and is depicted as a function of directional characteristics.

#### C. VSWR

It is a function of the reflection coefficient which describes the power reflected from the antenna. It is always a real and positive number for antennas. The smaller the VSWR, the better the antenna is matched to the transmission line and more power is delivered to the antenna. It is the ratio of the peak amplitude of a standing wave to the minimum amplitude of a standing wave

### IV. RESULT



In this paper we represent the concept of Microstrip patch antennas that helps to designed vertical, horizontal, RHCP or LHCP polarizations, using multiple feed points, or a single feed-point with asymmetric patch structures. Here we use Inset feeding to calculate return loss, radiation pattern, and VSWR. The simulation results of the proposed antenna are illustrated using FEKO software tool. FEKO has a special MoM solver for finite metal objects or slots in the presence of infinite, planar media. This enables the efficient analysis of complex Microstrip antennas.

### V. CONCLUSION

This paper presents design and analysis Microstrip patch antenna which is used at microwave frequencies and return loss less than -10dB. Here we shows that the use of inset feeding technique for designing in Microstrip patch antenna by calculating return loss and VSWR.

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