DESIGN OF A RECONFIGURABLE, MULTI-FREQUENCY & CIRCULARLY POLARIZED MICROSTRIP PATCH ANTENNA

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Abstract

Abstract: In this microstrip antenna design multi frequencies are used. Here working frequencies are 1.9 GHz and 2.0 GHz. Rectangular patch shape technique is used for designing this microstrip antenna. In our model electric field lines, conductance and input resistance have obtained by transmission line model whereas charge distribution, directivity and gains have brought by cavity model of rectangular patch. Correct feeds are applied at various positions and after comparing all the results the best of all will increase the efficiency and gain of microstrip patch antenna by 30-35%. All the results are mathematically calculated and achieved but these results may also be obtained by various designing software like Zeland IE3D software, Ansoft's HFSS software and CST software.

Keywords: *Cavity Model, Feeding Technique, Microstrip Antenna, Rectangular Patch and Transmission Line Model*

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1. INTRODUCTION

Since a very long time man had dreamt of transmitting signals from one place to another. In 1983 by Maxwell's equations electromagnetic waves are discovered which was successfully shown by Hertz in 1887 and presently lots of research was done in this field. There are several ways of communication but radio communication (wireless communication) is the most fascinating and popular system in radio communication presently.

European telecommunication standards institute (ETSI) define a standard set called "Global Systems for Mobile" (GSM) for second generation (2G) digital cellular network used by cellphones.GSM technology provide us various facilities like: network used by cellphones.GSM technology provide us various facilities like: network used by cellphones.GSM technology provide us various facilities like: network used by cellphones.GSM technology provide us various facilities like:

- Text massaging
- Internet service
- Call forwarding & waiting
- Caller ID & encrypted calling service.

In 1999-2000 GSM networks works on 900MHz frequency but nowadays continuously number of customers are increasing so that there is lack of frequency channels. To overcome this problem there are various methodologies are used:

1. Frequency reuse
2. Cell structure
3. Adding micro cells

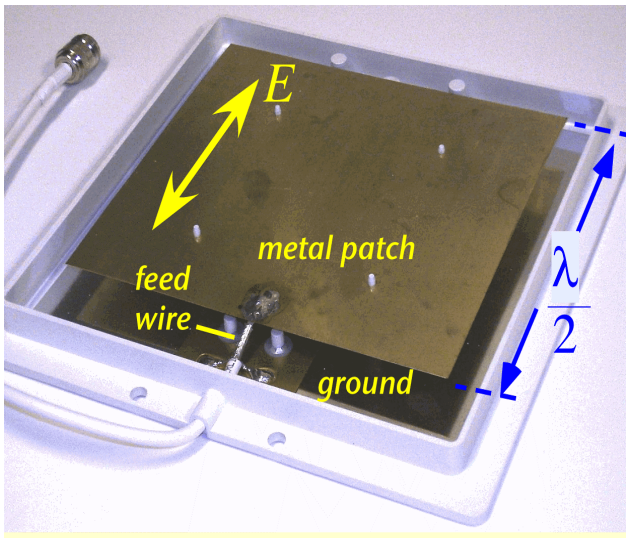

Fig -1: Microstrip Patch Antenna

All these methods are good but not sufficient enough for better performance we need to increase our frequencies. Presently 1.8 GHz and 1.9GHz frequencies are introduced in GSM networks. In this paper I am proposing a Microstrip patch antenna which works on multi frequency 1.9GHz and 2.0 GHz respectively. Our design is reconfigurable and thin for that correct feed position is obtained by impedance matching. I am using IE3D software for simulating the frequency 1.9GHz & 2.0GHz.

2. DESIGNS AND MEASUREMENT

Microstrip antenna is useful in various applications because they are low profile, light in weight and very conformable to surface and having low manufacturing cost using printed circuit technology. For a rectangular Microstrip patch antenna, thicker substrate with low dielectric constant provides very good efficiency and larger bandwidth but size

of the element will be increases means high expenses. Thin substrate and higher dielectric constant need small element size so that efficiency is less and bandwidth is also small.

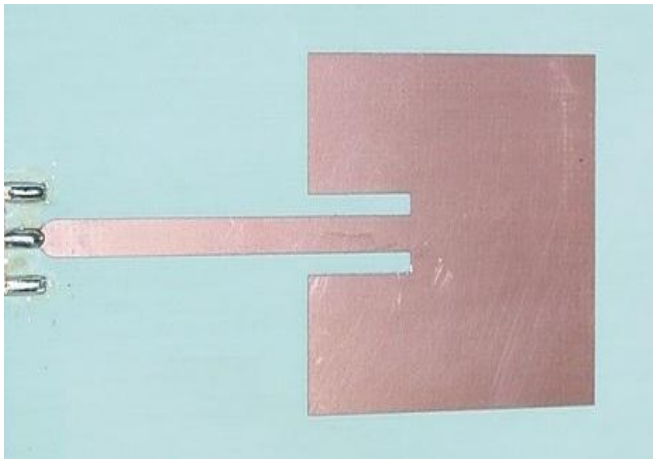

Fig -2: Top View of Rectangular Patch

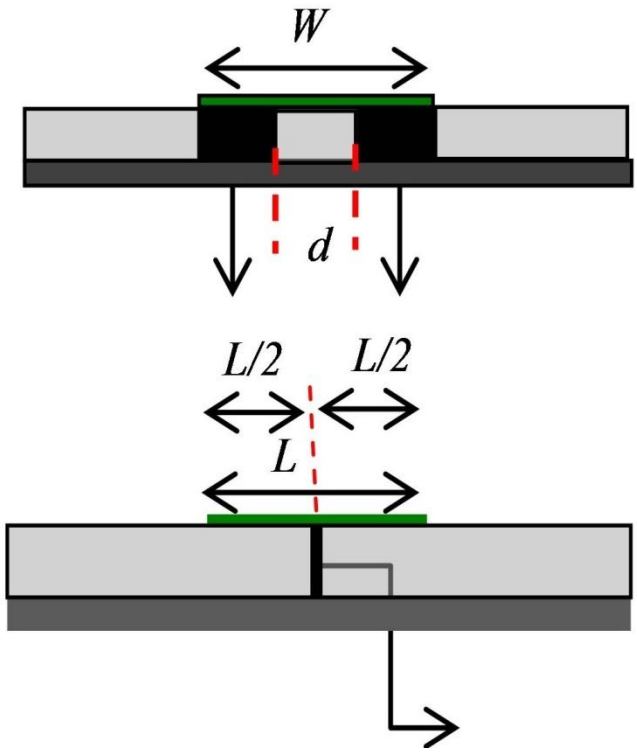

Fig -3: Side View Rectangular Patch

Due to fringing effect the effective electrical length of the patch is greater than the physical length i.e. L_{eff}.>L as shown in figure above.

2.1 Feeding Technique

There are various methods of feeding Microstrip patch antenna. It can be classified into categories:

i. Contacting
ii. Non-contacting

In contacting method the RF power is feeding directly to the patching surface using a connector element example: SMA Connector. In second methodology electromagnetic field coupling transfers the power between the Microstrip line and patch.

Microstrip line feed technique has a conducting strip connected directly to Microstrip patch edge. Coaxial Feed is another but a very common technique of feeding. In this technique the inner conductor of the coaxial connector extends & soldered with patch (radiating). Now the transmission line model is the simplest designed to construct a rectangular patch Microstrip antenna because a parallel-plate transmission line connecting two radiating apertures having width W and height h.

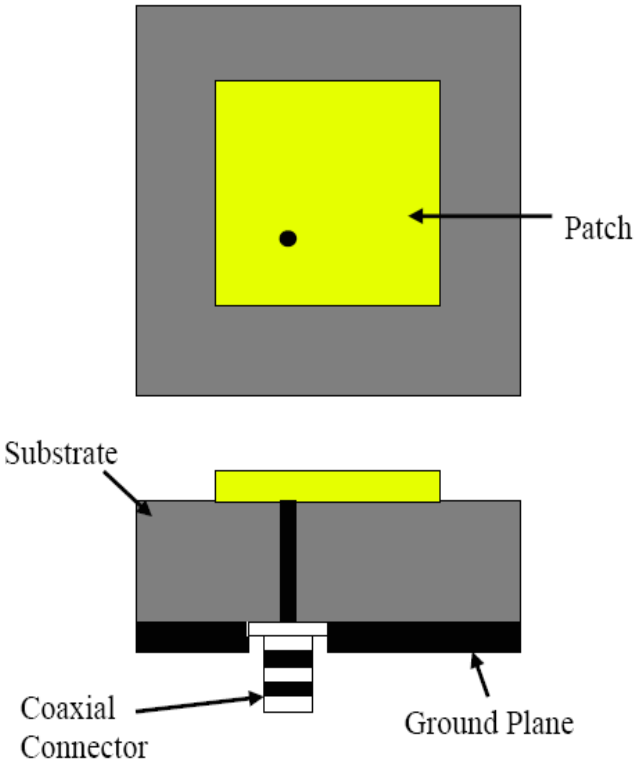

Fig -4: Microstrip Probe feeding

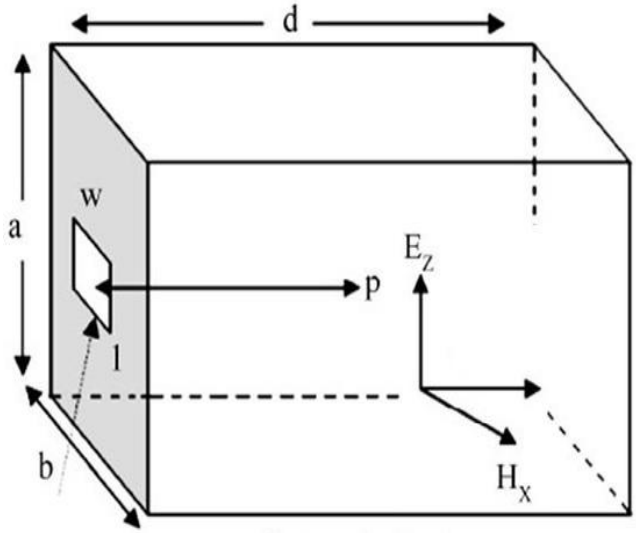

Fig -5: Rectangular Transmission Line Model

In the above figure Z is the direction of propagation. Basically transmission line approach is not perfect due to low versatility but it provides a good physical insight into the nature of the rectangular antenna and field distribution for all TM modes.

The slot shows very high impedance from both sides of the transmission line so that we assume that this structure is having highly resonant characteristics which depend on its length L and propagation direction Z. We know that $L_{eff.} > L$ thus the resonance condition is $\beta(n)L_{eff.} > n.\frac{\pi}{2}$ where, n=1,2,…, all depends upon $L_{eff.}$, not on physical length L. so that effective patch length is

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

For effective length $L_{eff.} = L + 2\Delta L$…….....(2)

So that Length of patch is

$$L = \frac{1}{2f_r\sqrt{\varepsilon_0\mu_0}\sqrt{\varepsilon_{reff}}} - 2\Delta L \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

And resonant frequency for TM001 mode

$$f_r = \frac{c}{2L_{eff.}\sqrt{\varepsilon_{reff.}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Antenna polarization is generally determined by three basic parameters:

i. Axial ratio
ii. Tilt angle
iii. Rotation

When axial ratio is zero then polarization is linear and quality of polarization depends upon the cross polarization for perfect circular polarization axial ratio should be one (unity). Microstrip patch is widely used radiators for circular polarization. There are basically two types of excitation technique for circular polarization in Microstrip patch antenna.

i. Dual fed patch
ii. Single fed patch

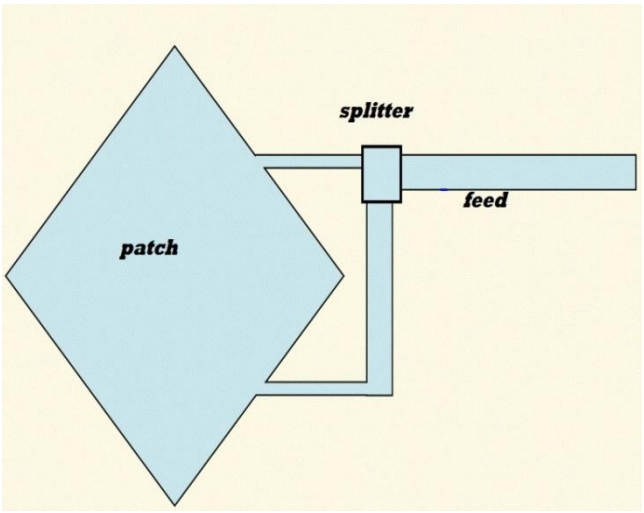

Fig -6: Dual Feed patching

A connector is connected at feed point it may be co-axial feed connector or SMA feed connector. In single fed patch there is less need of splitter where as in dual fed patch splitter is used.

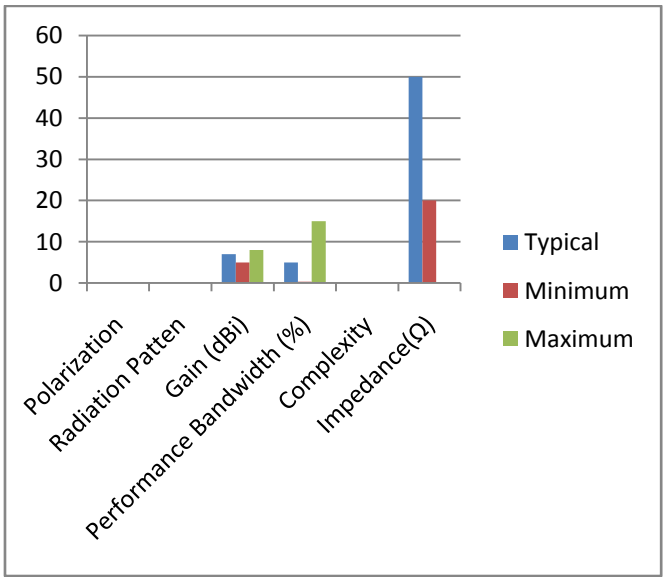

Chart -1: Comparison chart of various parameters with in microstrip patch antenna

Table -1: Quick Summary of Patch Antenna

Quantity	Typical	Minimum	Maximum
Polarization	linear		
Radiation Patten	Single broadside lobe		
Gain (dBi)	7	5	8
Performance Bandwidth (%)	5	0.3	15
Complexity	Moderate		
Impedance(Ω)	**50**	**20**	**≈ 300**

Dual circular polarization has also been achieved using a singly fed triangular or Pentagonal Microstrip antenna. The radiation efficiency will be 70%. Once the dimensions are obtained the antenna can be simulated on a commercially available IE3D EM simulator. And further optimization and fine tuning of dimensions can be carried out to bring the resonance back at the desired frequency with acceptable return loss. Layout generation can be done in interlaced or AutoCAD software for preparing the mask. Once the mask is pointed on a transparent sheet, the patch can be fabricated using conventional photolithography process. The return loss for the patch antenna can be measured on a network Analyzer. The E-plane and H-plane patterns can be measured in a far-field test set up (preferably in an anechoic chamber) with a standard gain antenna as a transmitting antenna and the Antenna under test as a receiving antenna mounted on a pedestal.

3. CONCLUSIONS

Finally 2G spectrums (900MHz-1800MHz) and 3G (1800MHz-2000MHz) spectrums are used by old generation handset antenna but my proposed antenna design is capable of working in both frequencies weather its belongs to 2G or 3G spectrums simultaneously. My multi frequency antenna design is capable of handling two different frequencies simultaneously but in future advancement it's also possible to design an penta frequency (900MHz/1800MHz/1900MHz/ 2000MHz and 2200MHz) operated antenna also.

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BIOGRAPHIES

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