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Band Width Enhancement of Microstirp Patch Antenna

Atanu Maiti
Student of Electronics and Communication Engineering
ST Thomas' College of Engineering and technology
Kolkata, West Bengal, India

Soumik Das
Student of Electronics and Communication Engineering
ST Thomas' College of Engineering and technology
Kolkata, West Bengal, India

Abstract – **Microstrip patch antenna is very popular now because of ease of its ease of fabrication, compatibility with electronics circuit, low cost, low profile. Although patch antenna has numerous advantages, it has also some drawbacks such as restricted bandwidth, low gain. Different techniques are used to solve these problems. This paper presents designs and stimulation of Micro Strip patch antenna to operate at frequency range 785 Mhz to 1015 Mhz. Two rectangular metal plate with resonating frequencies 850Mhz and 950Mhz respectively is merged with a narrow metal strip. The micro strip patch antenna is analyzed by SONNET that shows wide bandwidth of 450Mhz and % bandwidth is 25.56% of centre frequency.**

Keywords --- component, Microstrip Patch antenna, Radiation pattern, Bandwidth, gain .

I. INTRODUCTION

In this era of wireless communication need of compact antennas is increasing rapidly. Microstrip patch antennas are used in mobile devices, WLAN, satellite communication, Radars, biomedical application, GPS, remote sensing because of its compatibility with electronics circuit, versatile in terms of resonating frequency, mechanically robust, low profile, low cost, light weight. Microstrip patch antenna can have any shape and size, however to simplify analysis and performance patch is generally made in rectangular, square, triangle, circular or other common geometrical shape. Rectangular and square shaped patch antennas are widely used for different purpose.

Inspite of having so many advantages of microstrip patch antenna it has some disadvantages. Bandwidth of a simple geometrical shaped patch antennas are very low. Some times gain of antenna is also very low. There are several techniques those are used to increase bandwidth and gain. One of the popular method is cutting a slot from metal patch. Bandwidth can also be increased by increasing the thickness of substrate. In this paper the patch antenna is designed to for frequency ranged from 785 Mhz to 1.015 Ghz. The metal patch is made of two rectangular shaped metal having resonating frequencies 850Mhz and 950Mhz respectively . These two rectangular metal plates are merged through a metal strip. Proposed metal patch is analyzed by a software tool SONNET because it is a high performance full wave electromagnetic simulator for modeling and simulating antenna and other high frequency instruments. It integrates simulation, visualization, solid modeling and automation in an easy to learn environment where solutions of high frequency antenna and other device problems are quickly and efficiently obtained .

II. ANTENNA STRUCTURE

.Microstrip patch antenna mainly consists of 3 elements, Metal patch, dielectric substrate and ground plane. Ground plane is placed on one side of dielectric substrate and the metal patch is placed at opposite side of dielectric material. The metal patch is generally made of materials those have very high conductivity such as copper , silver, gold etc. Dielectric constant of substrate can vary between 2<ξr<15 depending on the desired frequency and bandwidth of antenna.

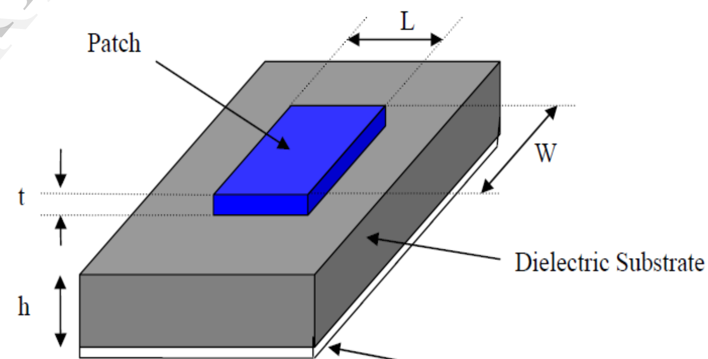

Fig (1)

For good antenna performance ,a low dielectric constant with thick dielectric substrate is desirable, as it provides better radiation, better efficiency and larger bandwidth.

III GEOMETTRICAL PARAMETERS OF ANTENNA

The Microstrip patch antenna is represented by 2 slots, which are separated by the transmission line with length L and it is

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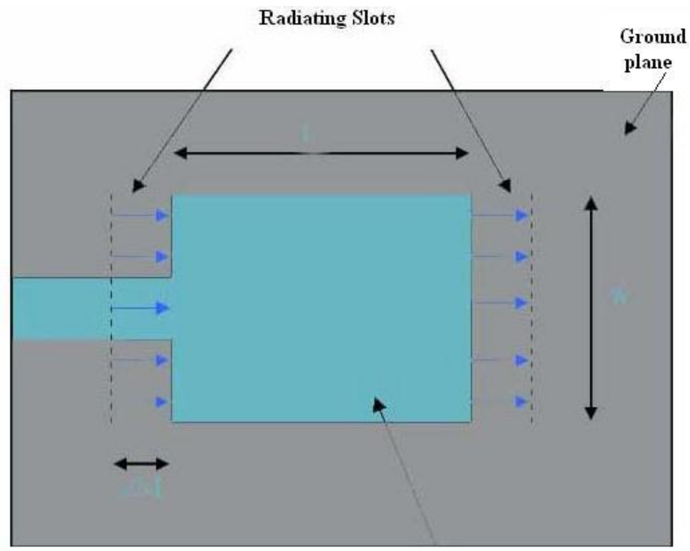
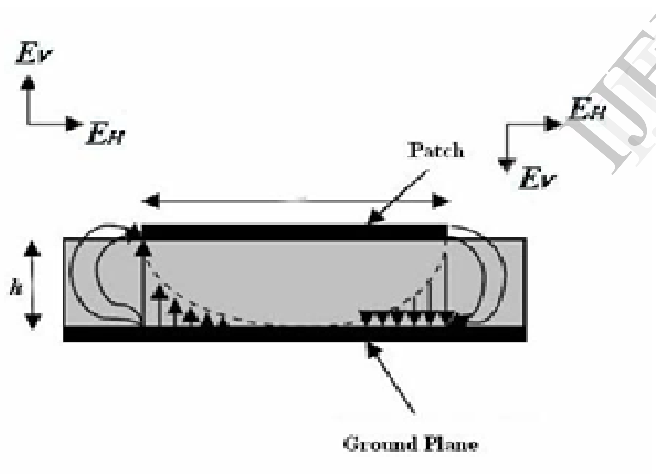
open circuited on the two ends. The width of the structure has a maximum voltage and minimum current as it is an open ended circuit. The tangential and the normal components of the fields at the edges are resolved with respect to the ground plane.



.The usual direction of electric and magnetic fieldare shown Below.



The fringing fields along the width can be modeled as radiating slots and electrically the patch of the microstrip antenna looks greater than its physical dimensions. The dimensions of the patch along its length have now been extended on each end by a distance ΔL, which is given empirically as

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

ΔL is also known as fringe factor.

To design the rectangular patch , following things has to be determined

ϵreff= Effective dielectric constant

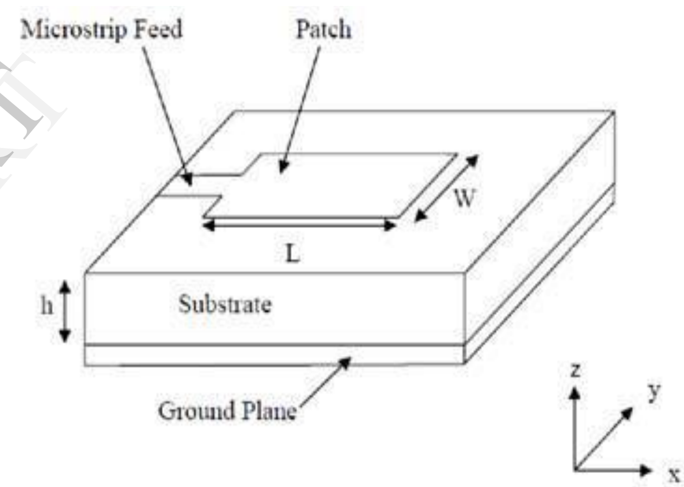
ϵr = Dielectric constant of substrate

h = Height of dielectric substrate

W = Width of the patch

L = Length of the patch

Assume Fig(3),a rectangular microstrip antenna of width *W*, length *L* resting on the height of a substrate *h*. The coordinate axis was selected as the height along *z* direction, length along *x* direction and width along *y* direction.



For a rectangular microstrip patch antenna, the resonance frequency for any TMmn mode is given by as:

$$f_o = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right]^{\frac{1}{2}}$$

Where m and n are modes along L and W respectively**.**
For efficient radiation, the width W is given as:

$$W = \frac{c_o}{2 f_r}\sqrt{\frac{2}{\epsilon_r + 1}}$$

The effective length of the patch Leff can be expressed AS:

$$L_{eff} = L + 2\Delta L$$

For the particular resonate frequency the effective length of the patch is calculated by:

$$L_{eff} = \frac{c}{2 f_o \sqrt{\varepsilon_{reff}}}$$

Extended length ΔL is also known as fringe factor and it is expressed as

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

Effective permittivity can be expressed as

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

Where

$$W/h > 1$$

Desired microstrip patch antenna is made off 2 rectangular metal plate having resonating frequency 850Mhz and 950Mhz. And these two plates are merged by thin metal plate. A microstrip feed is applied at the midpoint of joining metal.

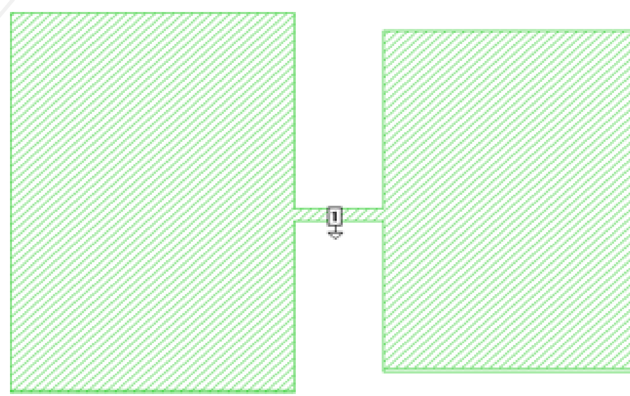
Dielectric constant of substrate	2.7
Operating frequency	750Mhz-1100Mhz
Thickness of substrate(h)	2cm
Feeding Method	Co-axial probe feed
Gain	8.6 - 5.6dB
Metal used for patch	Copper

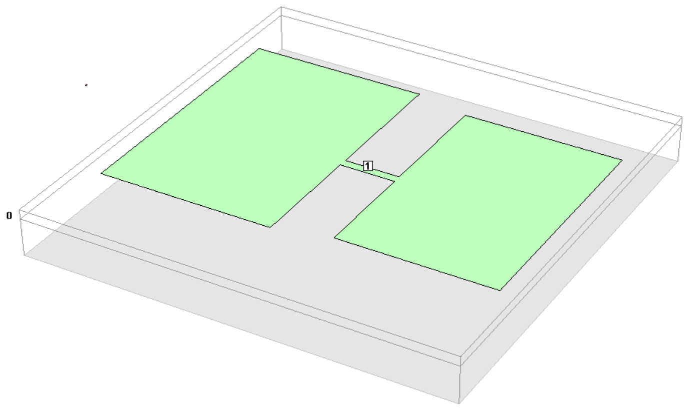
Parameters	Freq=950Mhz	Freq=850Mhz
Width (W)	11.608	12.97
Effective length(Leff)	10.33	11.504
Fringe factor (ΔL)	0.9604	0.967
Actual length(L)	8.41	9.57
Permittivity	2.7	2.7
Effective permittivity	2.3353	2.353

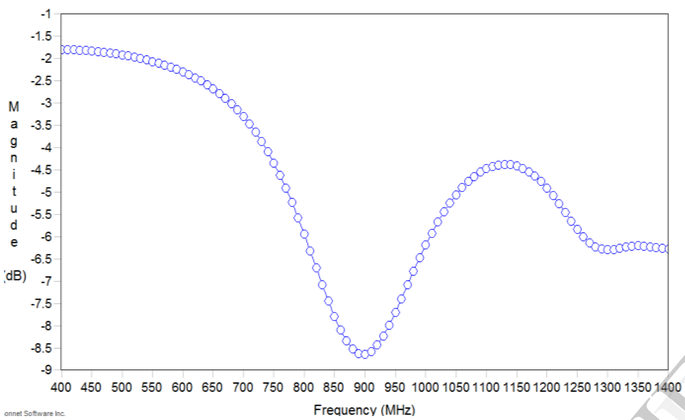
IV SOFTWARE ANALYSIS

This microstrip patch antenna model is analyzed by SONNET. SONNET is a high frequency full wave electromagnetic field. It integrates simulation, visualization , solid modeling, and automation in an easy-to-learn environment where solutions to your 3D EM problems are quickly and accurately obtained.

The patch antenna is shown in below figure. It consists of patch elements on one side of a dielectric substrate and a planar ground on the other side.







IV. SIMULATION RESULTS

In the above figure maximum gain 8.7dB is achieved at 900Mhz frequency.

Centre frequency	900Mhz
Bandwidth	230Mhz
%Bandwidth	25.56%

IV: CONCLUSION

Probe fed patch antenna has been designed in this paper where two metal patches with different resonating frequencies is merged and analyzed by SONNET. The output graphs shows bandwidth of the designed patch is significantly larger compared to individual patch . This microstrip patch antenna has successfully achieved 25.56% bandwidth of centre frequency 900Mhz.

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