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INCREASING RESONANT FREQUENCY OF MICROSTRIP PATCH ANTENNA BY DECREASING THE VALUE OF DIELECTRIC CONSTANT OF SUBSTRATE

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ABSTRACT:

Microstrip patch antenna has some drawbacks of low efficiency, narrow band (<5%), and surface wave losses. In this paper it is shown that we can increase the resonant frequency by decreasing the value of dielectric constant of dielelctric substrate without changing any other parameter. here we have taken the substrate value as 11.8 ,9.8 ,6.8 and 4.8.we have taken 1.5 mm as a substrate height. the simulated results for rectangular microstrip patch antenna are given with the help of feko software for verifying our results.

KEYWORDS:
Microstrip patch antenna,,resonant frequency, substrate

INTRODUCTION:

Because of the booming demand in wireless communication system and UHF applications, microstrip patch antennas have attracted much interest due to their low profile, light weight, ease of fabrication and compatibility with printed circuits. However, they also have some drawbacks, such as narrow bandwidth, low gain spurious feed radiation limited power handling capacity . To overcome their inherent limitation of narrow impedance, bandwidth and low gain, many techniques have been proposed and investigated. When we change the shape of a microstrip antenna and it is covered with a dielectric layer , its properties like resonance frequency, gain are changed which may seriously degrade or upgrade the system performance . Therefore,in order to introduce appropriate correctness in the design of the antenna, it is important to determine the effect of dielectric layer and shapes on the antenna parameter.

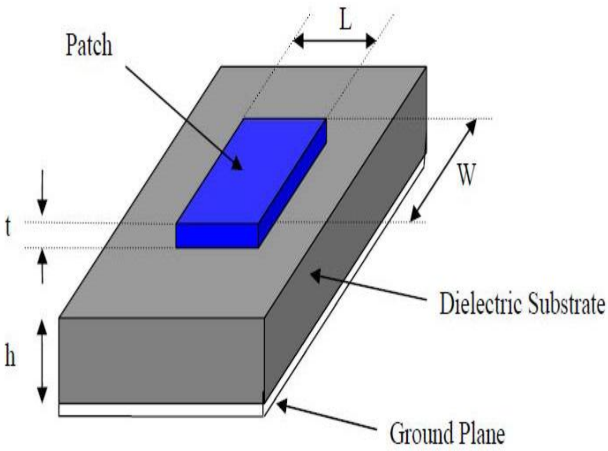

Figure1-Structure of rectangular microstrip patch antenna

Design of microstrip patch antenna

1. *εreff* is calculated as follows

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + \frac{12h}{w}\right]^{1/2}$$

2. ΔL is calculated as below

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

3. *Leff* the effective length of the patch is given by

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

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

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$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{reff}}}$$

5. Considering the rectangular patch Microstrip antenna the resonating frequency for the mode TM*mn* is given by

$$f_0 = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{w}\right)^2\right]$$

m, n are the operating modes of the Microstrip patch antenna, along with *L* – length *W*- width.

6. For the effective radiation the design of the structure is the utmost important aspect and for this the width is calculated as

$$w = \frac{c}{2 f_0}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Design Calculation :

1.Dielectric Constant of the Substrate (εr):

The dielectric material of the Microstrip Patch Antenna is Alumina with εr = 9.8, as this one of the maximum values of the dielectric substrate has been taken in order to reduce the size of the antenna.

2.The frequency of the operation (f0):

The frequency of operation for the Patch antenna design has been selected as 2.1GHz.

3.Height of the dielectric substrate (h):

Microstrip Patch antenna has been designed in order to rule out the conventional antenna as the patch antennas are used in most of the compact devices. Therefore the height of the antenna has been decided as 1.5mm.

The parameters that are decided by default in order to continue to the design process are

Calculation of width:
By the formula

$$Width = \frac{c}{2 f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

With the substituting the values of *c*= 3x108 m/s *fr* = 2.1GHz and *h* = 1.5mm
Width w = 0.0307m = 30.74mm

Calculation of effective dielectric constant:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2}$$

From the equation
With the substituting the values *r*ε= 9.8, *h* = 1.5mm, *w*=30.7mm
Effective Dielectric Constant*reff*ε= 8.89

Calculation of effective length:
From the equation

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

With the values *εreff* = 8.89, *c*= 3x108m/s *fr* = 2.1GHz

Calculation of the length extension(ΔL):
From the equation

$$\Delta L = 0.412h\frac{[\varepsilon_{reff} + 0.3]}{[\varepsilon_{reff} - 0.258]}\frac{\left[\frac{w}{h} + 0.264\right]}{\left[\frac{w}{h} + 0.8\right]}$$

With the values from *h, w* and *εreff* the ***ΔL*** is being calculated as 0.6mm
ΔL= 0.64mm

Calculation of length of the patch:
By the equation

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

Where *ΔL*= 0.6mm, *Leff* = 23.9mm
L = 22.67mm

Now we have to change the value of dielectric substrate without changing the other parameter, then we get the following results

1. ***εr= 11.8   fr =1.93ghz***
2. ***εr= 9.8   fr =2.1ghz***

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3. ***εr= 6.8*** ***fr =2.5ghz***
4. ***εr= 4.8*** ***fr =2.93ghz***

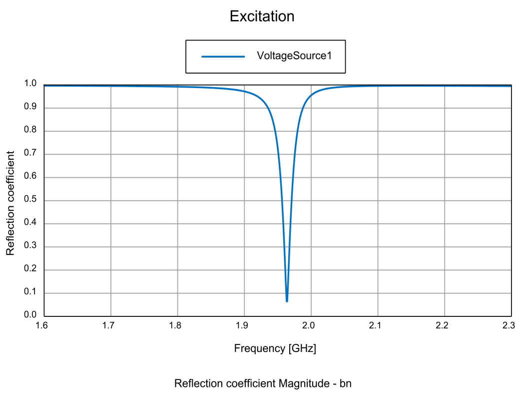

Fig1. εr= 11.8

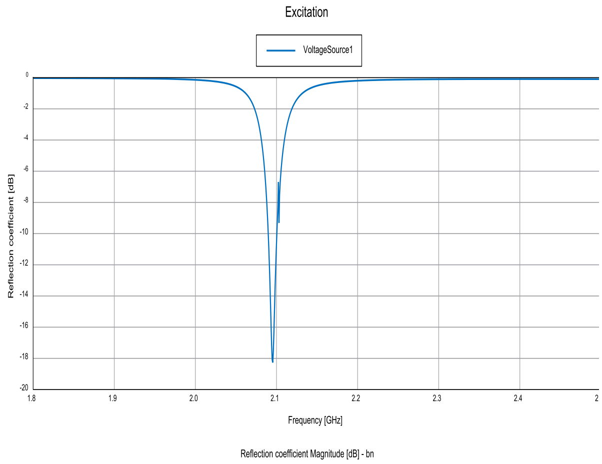

Fig2. εr= 9.8

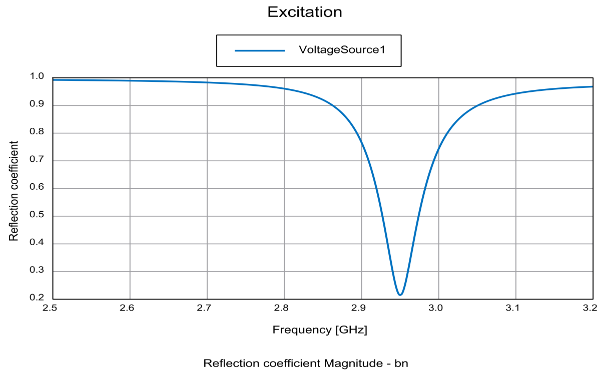

Fig3. εr= 6.8

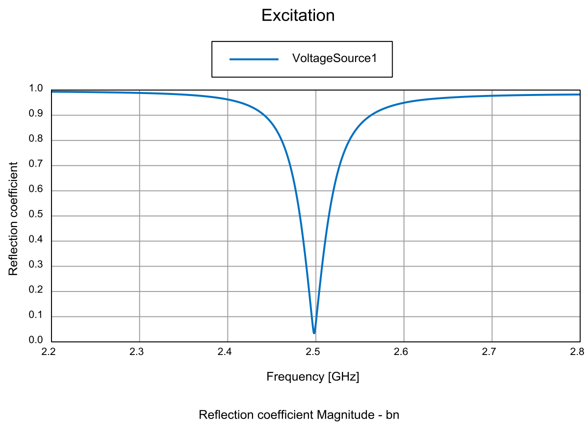

Fig4. εr= 4.8

CONCLUSION :

In the above work we have found that by changing the value of dielectric substrate and keeping other parameters constant, it is seen that as the value of dielectric constant of substrate decreases ,then the resonant frequency increases.on the other hand by increasing the value of dielectric constant , the resonant frequency of patch antenna decreases.it suggests that compactness of microstrip patch antenna can be achieved.this concept is used in designing miniaturized microstrip patch antenna.further the broadband antennas can be designed by loading the Q factor of resonant frequency of patch antenna.

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