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A NOVEL APPROACH FOR SIZE REDUCTION IN RECTANGULAR MICROSTRIP PATCH ANTENNA USING SLOTS FOR GSM APPLICATIONS

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Abstract- *As an important design perspective, the demand of size reduction of low frequency antennas is the main development of communication engineering with integration technology. For this type of purpose, the design is to focus on the reduction of rectangular microstrip patch antenna. In the design, a microstrip patch antenna on a resonant frequency of 3.11GHz without using slots. While using slots the design of the microstrip patch antenna works on a resonant frequency of 0.932GHz. A frequency shift of 3.11GHz to 0.932GHz is observes in this paper. The miniaturization of 89% is the main contribution of this paper, which is very encouraging.*

Keywords: Rectangular Microstrip Patch antenna (RMPA), Return Loss (RL), Miniaturization, Defected Ground structure (DGS).

1. INTRODUCTION

With the advantage of being low cost, low profile, light weight, ease of fabrication, small size and capable of being integrated on planar and non-planar surfaces and as well as VLSI design, the demand of microstrip antennas for wireless based applications for commercial communication increases. The idea of microstrip patch antenna is traced in 1953. In recent years, with the help of low frequency, small size antennas have drawn much interest from researchers[1]. For reducing the size of antenna, many techniques or miniaturization process is being used, such as using of slot on a patch, defected ground structure (DGS), di-electric substrate of high frequency. RMPA is generally having a conducting patch which is made up of PEC as shown in figure 1, printed on a ground substrate[2] [3]. To miniaturize the rectangular microstrip antenna slots are used. The present work deals with the design and analysis of a rectangular microstrip antenna for GSM Communication and applications. Initially the antenna is designed for a resonant frequency of 3.11GHz and while using of slots, the resonant frequency is brought down to 0.932GHz. So, a size reduction of 89% is achieved.

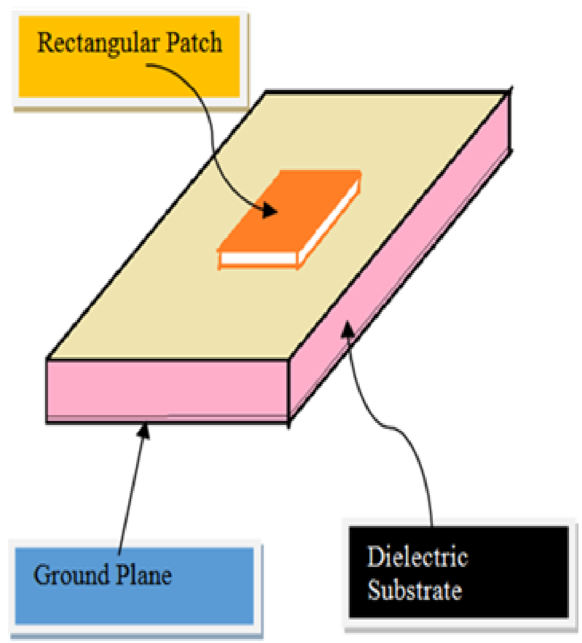

Figure 1: A Basic Rectangular Microstrip Patch antenna

2. DESIGN PROCEDURE, FORMULATION & SIMULATION

A. Desired Parametric Analysis[4]:

a) Calculation of Width(W)

$$W = \frac{1}{2fr\sqrt{\mu\varepsilon}}\sqrt{\frac{2}{\varepsilon r+1}} = \frac{c}{2fr}\sqrt{\frac{2}{\varepsilon r+1}}$$

--- (1)

b) Effective dielectric constant is calculated from:

$$\varepsilon eff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right)$$

--- (2)

c) The actual length of the Patch (L)

$$L = Leff - 2\Delta L$$

--- (3)

Where,

$$Leff = \frac{c}{2fr\sqrt{\varepsilon eff}}$$

--- (4)

d) Calculation of Length Extension

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon eff+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon eff-0.258)\left(\frac{w}{h}+0.8\right)}$$

--- (5)

Where,
c = free space velocity of light,
εr = Dielectric constant of substrate
h = height of dielectric substrate
ΔL= Effective length
Fr= Resonating frequency
L= Length of patch
W= Width of patch
Eeff= Effective dielectric constant

3. ANTENNA SPECIFICATION

Computer Simulation Technology (CST-MSW) 2010 software is the software for designing and simulating the desired antenna. CST MSW helps in fast and accurate analysis of high frequency devices such as antennas, couplers and filters. Apart from that CST MSW is one of the specialized tool for 3D simulation of high frequency devices or antenna .CST microwave studio is ultimate software to simulate the design, as this software is desirable for 1D, 2D and 3D platform in simulating a full wave simulation and other specifications. [4]

Length of ground= 30mm
Width of ground= 30mm
Length of dielectric substrate= 30mm
Width of dielectric substrate= 30mm
Length of rectangular patch= 22.779mm
Width of rectangular patch= 29.53
Dielectric constant of substrate= 4.3
Height of dielectric substrate= 1.6mm
Free space velocity of light= 2.99*10^8
Resonating frequency= 3.118GHz

4. RESULT

A microstrip patch antenna without slots and with slots is shown in figure 2 and 3. As below in figure 2, the discrete point is taken as (-5,-5).

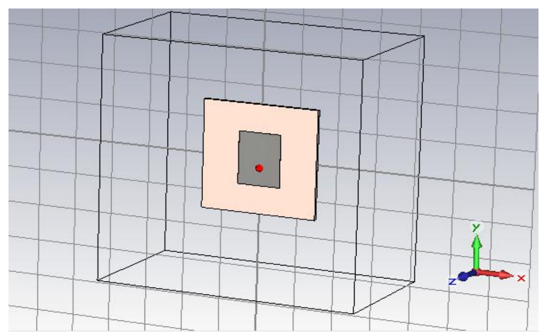

Figure 2: A Rectangular microstrip patch antenna without slots

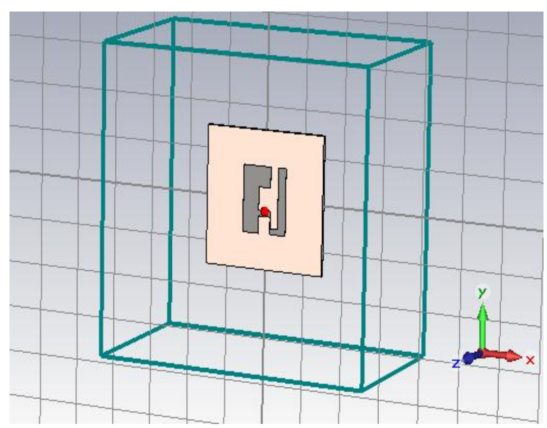

Figure 3: A Rectangular Microstrip Patch Antenna with slots

The return loss of the rectangular microstrip patch antenna without slots and with slots is shown in figure 4 and figure 5

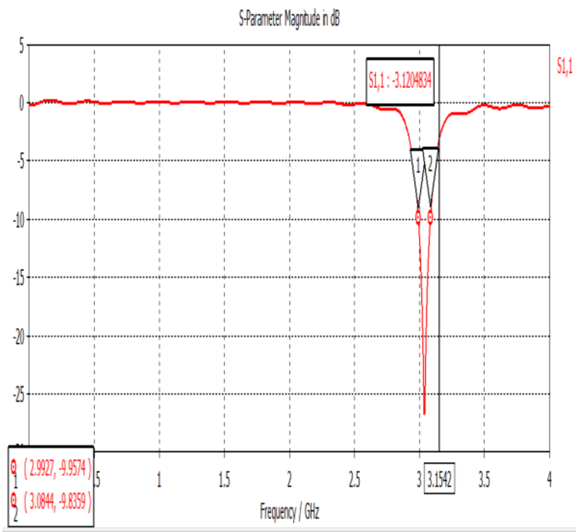

Figure 4: Return Loss without slots

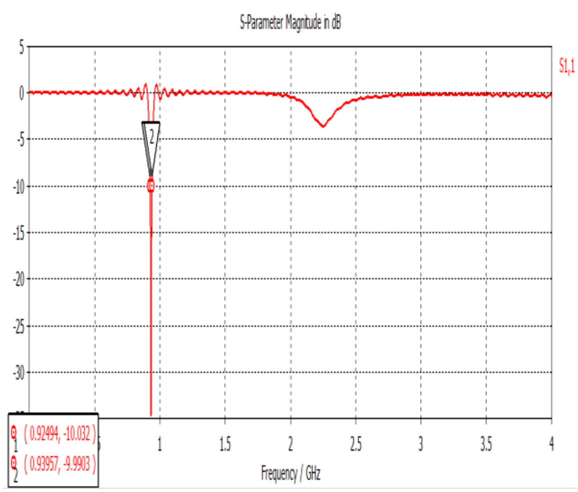

Figure 5 : Return Loss with slots

With the help of three slots, the size reduction from 3.11GHz to 0.932GHz frequency takes place which is used for GSM module and applications. A T- shaped slot is produced on the patch is the slot 1. The length of the upper T-shaped slot is 6mm and the width of the T-shaped slot is 7.5mm. Slot 1 and slot 2 is the combination of the T-shaped slot as shown in figure 5.3.2. The length of lower T-shaped slot is 3.89mm and width is 27mm. And the final slot 3 is produced just below the T-shaped slot whose length is 9.8mm and width is 9.5mm, to get the final result and the final frequency which is 0.932GHz which is used for GSM applications. The measurement of length and width of the following slots is shown in table 1

Table 1: Slots of rectangular microstrip patch antenna

S.no	Components (Slots)	Length	Width
1.	A T- shaped slot	6mm	7.5mm
2.	A lower part of T- shaped slot	3.89mm	27mm
3.	A rectangular slot below the T- shaped slot	9.8mm	9.5mm

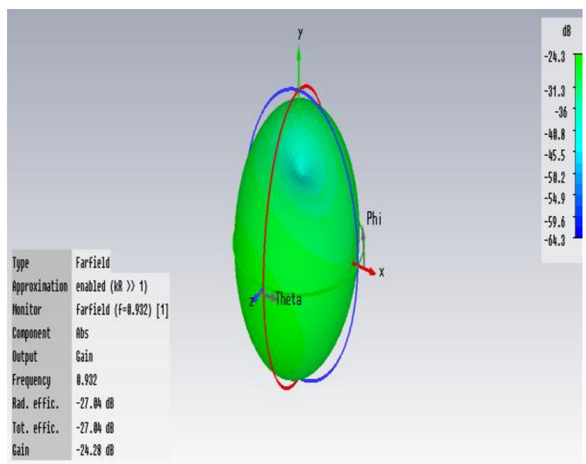

Figure 7: Gain at 0.932GHz

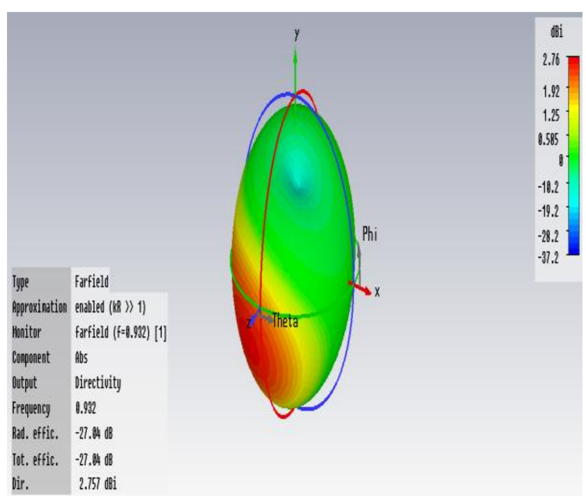

Figure 8: Directivity at 0.932GHz

Gain of a rectangular microstrip patch antenna at 0.932GHz is shown in figure 7 , Directivity of a rectangular microstrip patch antenna at 0.932GHz in figure 8.

5. CONCLUSION

As already discussed above, the purpose of the paper provides a size reduction in rectangular microstrip patch antenna. With the help of slots, the design of rectangular microstrip patch antenna is carried out in this work. Finally a small size and an efficient rectangular microstrip patch antenna at an operating frequency of 0.932GHz . A size reduction of about 89% and shifting of resonant frequency from 3.11GHz to 0.932GHz with -34.71 dB return loss fascinating the antenna to be used for GSM wireless applications.

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