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# SIZE REDUCTION OF A 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. In this work, with the help of rectangular micro strip patch antenna and slots, the size reduction is proposed. In the absence of slots, the structure found to be resonant at 3.11GHz. When the slots are introduced, then frequency shift of 3.11GHz to 1.808GHz is observed. Miniaturization of 72.3% is the main contribution of this paper.. Our present paper deals with the size reduction of microstrip patch antenna on 1.808GHz which is applicable for GSM applications.

**Keywords:** Rectangular microstrip antenna (RMPA), slots, Miniaturization, GSM

## I. INTRODUCTION

Rectangular Micro strip patch antenna has been very popular due to their many advantages, like lightweight, low profile, easy to fabricate, small size and conformable for the planar and non planar surfaces. Ground plane is the plane which consists of plane rectangular sheet or **patch** made up of metal which, mounted over the large sheet of metal[1]. The frequency is inversely proportional to the size of the microstrip patch antenna and due to their lower frequency than microwave and therefore the size which we required does not make sense for microstrip patches [2] [4]. However, it suffers from the narrow impedance bandwidth. Microstrip antenna is being extensively used in hand held because of their small and light enough to be operated while you hold it in your hands and mobile communications devices [3] [5]. To miniaturize the rectangular microstrip antenna paper slots are used [6]. The present work deals with the design and analysis of a rectangular microstrip antenna for GSM

communication and application. Initially the antenna is designed for a resonant frequency of 3.11GHz and while using of slots, the resonant frequency is brought down to 1.808GHz. So, a size reduction of 72.3% is achieved.

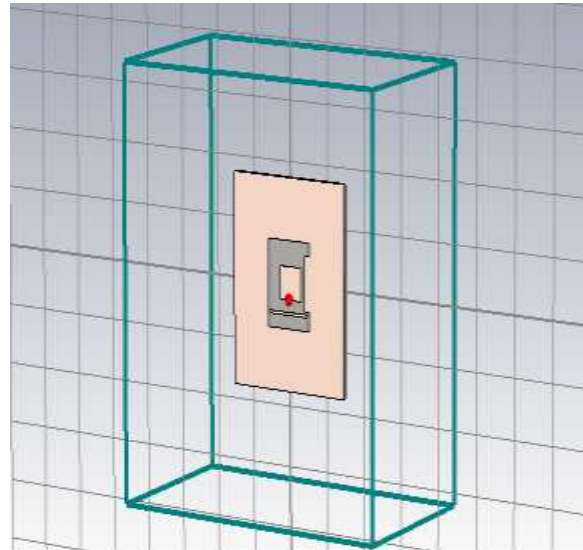


Figure 1: A Rectangular Microstrip Patch Antenna with slots

## II. DESIGN PROCEDURE, FORMULATION & SIMULATION

A. Desired Parametric Analysis[4]:

a) Calculation of Width(W)

$$W = \frac{1}{2fr\sqrt{\mu\epsilon}} \sqrt{\frac{2}{\epsilon r + 1}} = \frac{c}{2fr} \sqrt{\frac{2}{\epsilon r + 1}} \quad \text{--- (1)}$$

b) Effective dielectric constant is calculated from:



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

c) The actual length of the Patch (L)

$$L = L_{eff} - 2\Delta L \quad \text{--- (3)}$$

Where,

$$L_{eff} = \frac{c}{2fr\sqrt{\epsilon_{eff}}} \quad \text{--- (4)}$$

d) Calculation of Length Extension

$$\frac{\Delta L}{h} = 0.412 \frac{(\epsilon_{eff} + 0.3) \left( \frac{w}{h} + 0.264 \right)}{(\epsilon_{eff} - 0.258) \left( \frac{w}{h} + 0.8 \right)} \quad \text{--- (5)}$$

Where,

- c = free space velocity of light,
- $\epsilon r$  = Dielectric constant of substrate
- h = height of dielectric substrate
- $\Delta L$  = Effective length
- Fr = Resonating frequency
- L = Length of patch
- W = Width of patch
- E<sub>eff</sub> = Effective dielectric constant

### III. ANTENNA SPECIFICATION

The antenna is designed and simulated with Computer simulation Technology (CST-MSW) 2010 software [7]. 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 [5].

- Length of ground= 30mm
- Width of ground= 35mm
- Length of dielectric substrate= 30mm
- Width of dielectric substrate= 35mm
- 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=  $2.99 \times 10^8$
- Resonating frequency= 3.118GHz

### IV. RESULTS

Return Loss of the rectangular patch with slots and without slots is given in figure 3 and 5. It is observed from figure 3 that returns loss at 3.11 GHz is -27dB in absence of slots. From figure 4 , It is seen that return los at 1.808GHz is -26dB in presence of slots as shown in figure respectively.

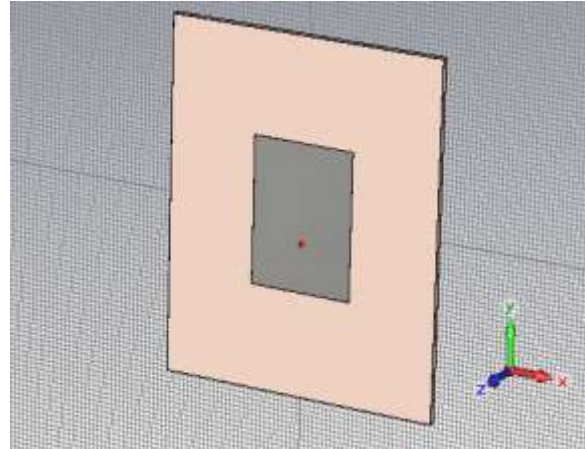


Figure 2: A rectangular Microstrip patch antenna without slots

The dimension of the slots of the rectangular Microstrip patch antenna is as follows-

S.no.	Xmin	Xmax	Ymin	Ymax
<b>SLOT 1</b>	6.75	-4.75	-5	6
<b>SLOT 2</b>	-8	8	-10	-11
<b>SLOT 3</b>	7.8	11	10	-8

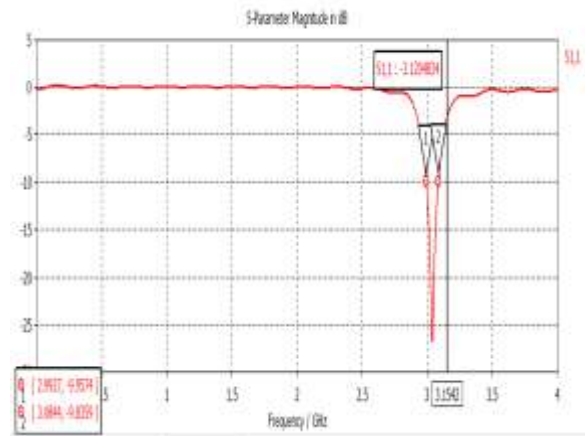


Figure 3: Return Loss without slots

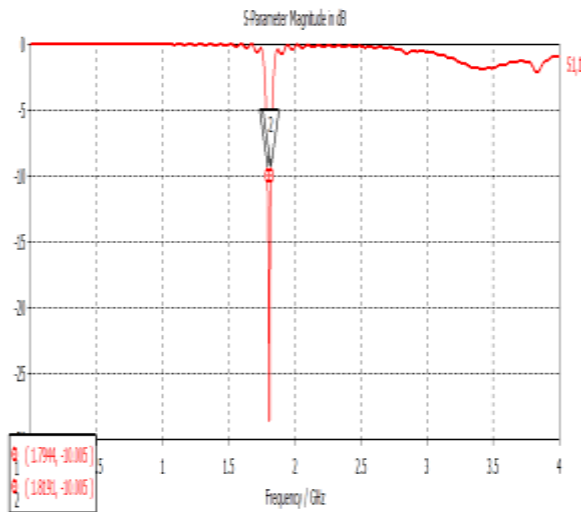


Figure 4: Return Loss with slots

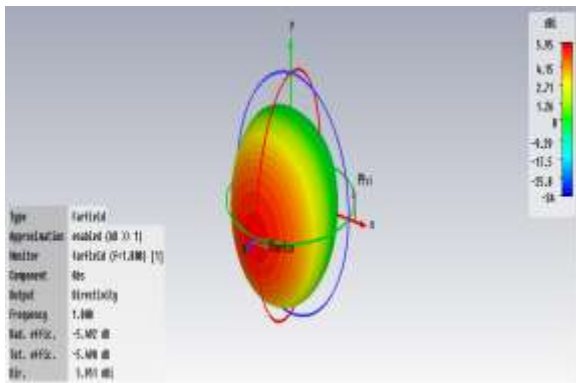


Figure 5: Directivity of Microstrip Patch antenna at 1.808GHz

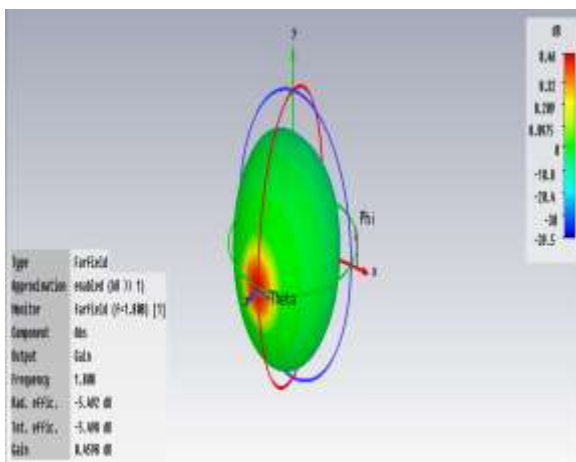


Figure 6: Gain of Microstrip Patch antenna at 1.808GHz

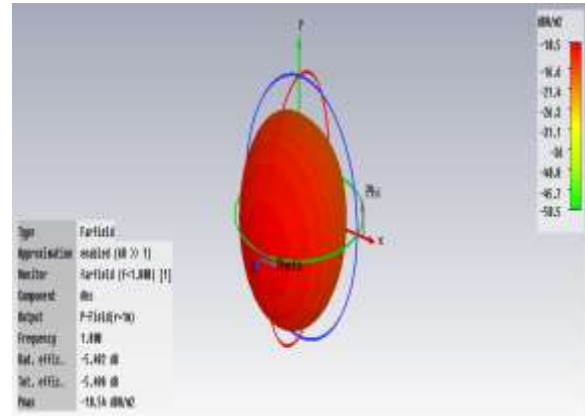


Figure 7: Radiation pattern of a Microstrip Patch antenna

The Directivity of the rectangular microstrip patch antenna at 1.808 GHz is shown in figure 5, the gain of the microstrip patch antenna 1.808GHz is shown in figure 6, Radiation pattern of micro strip patch antenna 1.808GHz is shown in figure 7. The radiation efficiency is 72.3% and VSWR of microstrip patch antenna is 1.077

## V. CONCLUSION

In this paper design of rectangular microstrip patch antenna with slots is carried out. A size reduction of about 72.3% and the shifting of resonant frequency from 3.11GHz to 1.808 GHz with -26dB return loss fascinating the antenna to be used for GSM application.

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