SIZE REDUCTION OF RECTANGULAR MICROSTRIP PATCH ANTENNA FOR GSM APPLICATION

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Abstract - *This paper presents a compact rectangular microstrip patch antenna with slots (a combination of E shaped and T shaped slots) and defected ground structure for 0.9 GHz GSM applications.This rectangular patch is printed on the glass epoxy (FR4 lossy) of dielectric substrate with relative permittivity (€r) of 4.3, thickness of 1.6 mm. In the absence of slots and defected ground structure (DGS), the structure found to resonant at 3 GHz. When the DGS and slots are introduced, a frequency shift of 3.22 GHz to 1.07 GHz is observed. The main contribution of this paper is the miniaturization of 86.72% which is very much encouraging. Other parameters such as directivity, antenna gain, radiation pattern are also analysed.These results can provide useful information in designing safety mobile communication equipment's compliant.*

Key Words: Rectangular microstrip antenna, Defected Ground Structure, Size reduction, Miniaturization.

1.INTRODUCTION

Microstrip antenna is being extensively used in mobile and other hand held communication devices. The microstrip antenna can be fabricated on the same printed circuit board containing the electronic components of the device. This leads to efficient use of the available space and making the device compact. This shows that, in the case of mobile or other small communicating devices, the size of the antenna plays a vital role. So, by reducing the size of antenna [1-2], the overall size of the device can be reduced.

In recent years, as the demand of the small systems have increased, small size antennas at low frequency have drawn much interest from researchers [3]. Many kind of miniaturization techniques, such as using of dielectric substrate of high permittivity [4], slot on the patch, DGS at the ground plane or a combination of them have been proposed and applied to microstrip patch antennas. The other method to miniaturize the microstrip antenna is to modify its geometry using irises [5] or folded structures [6], based on the perturbation effect [7]. In this paper slots and DGS are used to miniaturize the rectangular microstrip antenna.

The rapid development of wireless communication systems has increased the demand for compact microstrip antennas with high gain and wideband operating frequencies. Microstrip patch antenna has advantages such as low profile, conformal, light weight, simple realization process and low manufacturing cost. However, the general microstrip patch antennas have some disadvantages such as narrow bandwidth etc. Enhancement of the performance to cover the demanding bandwidth is necessary [8]. There are numerous and well-known methods to increase the bandwidth of antennas, including increase of the substrate thickness, the use of a low dielectric substrate, the use of various impedance matching and feeding techniques.

A microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate [1]. In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape.

The present work deals with design and analysis of a rectangular compact microstrip antenna for wireless application. In this design, a combination of E shaped and T shaped slots are produced on the patch with some adjustments in the dimensions of ground structure. Initially the antenna is designed for the resonant frequency of 3 GHz and the using DGS and slots the resonant frequency is brought down to 0.9 GHz. So a size reduction of 86.72% is achieved.

I. SIZE REDUCTION OF MICRO STRIP PATCH ANTENNAS

For very low frequencies of MHz range, the size of the microstrip antennas becomes too large to be manageable. Many techniques have been used to reduce the size of antenna, such as

- using dielectric substrates with high permittivity [9],
- applying resistive or reactive loading [10],
- increasing the electrical length of antenna by optimizing its shape [11],
- Utilization of strategically positioned notches on the patch antenna [12].
- Various shapes of slots and slits have been embedded on patch antennas to reducetheir size.

II. ANTENNA DESIGN

The geometry of proposed rectangular microstrip patch antenna (RMPA) with a combination of E shaped and T shaped slots with reduction in the size of ground plane is shown in figure 1. In this design, RMPA is printed on the glass epoxy dielectric substrate of relative permittivity (€*r*) of 4.4 and thickness (h) of 1.6 mm.

Upper and Lower Strips of slot of E shaped are equal in sizeexcept the middle strip and two T shaped slots are mirror to each other as per the middle slot strip of E shaped. Both the T shaped slots are same in size. All the dimensions of the proposed RMPA design are shown in the table 1.

By properly selecting the antenna's geometric parameters and dimension, position and particular shaped, size reduction geometry for GSM application is achieved.

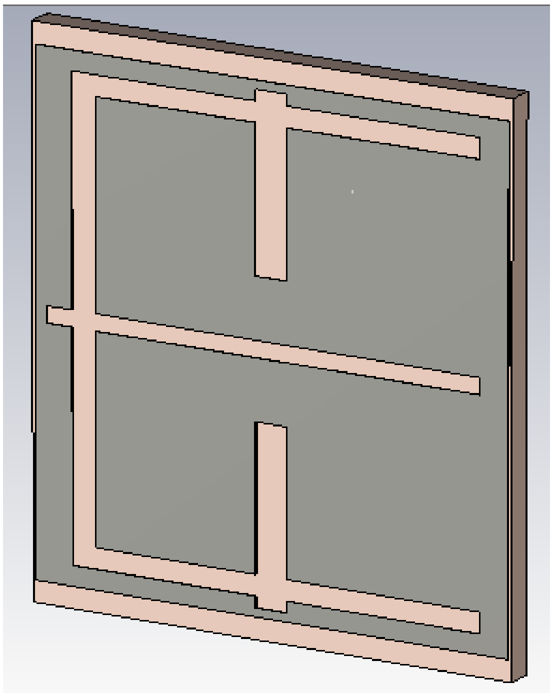


Figure 1: Structure of proposed RMPA.

Table -1:: Dimension of RMPA

Component	Dimension
Length of the rectangular patch	29.56 mm
Width of the rectangular patch	36.86 mm
Length of the ground plane	25 mm
Width of the ground plane	29 mm
Width of upper and lower strip of E shaped slot	1.5 mm
Length of upper and lower strip of E shaped slot	25.5 mm
Width of middle strip of E shaped slot	1.2 mm
Length of middle strip of E shaped slot	27.1 mm
Width of the T shaped slot	2 mm
Length of the T shaped slot	12.8 mm

T shaped slots is combined with lower and upper strips of E shaped slot. All the three strips of E shaped slot is connected with rectangular shaped slot of dimension 34 mm X 1.5 mm at the left side.

III. RESULTS AND DISCUSSION

The proposed RMPAis designed and simulated using the CST Microwave Software [13]. Figure 2 shows the simulated return loss of the proposed RMPA with a combination of E shaped and T shaped slot. The achieved simulated return loss of the proposed RMPA is -23.6dB at a frequency 0.904 GHz having the lower frequency (f_L) of 0.899GHZ and higher frequency (f_H) of 0.906GHz.

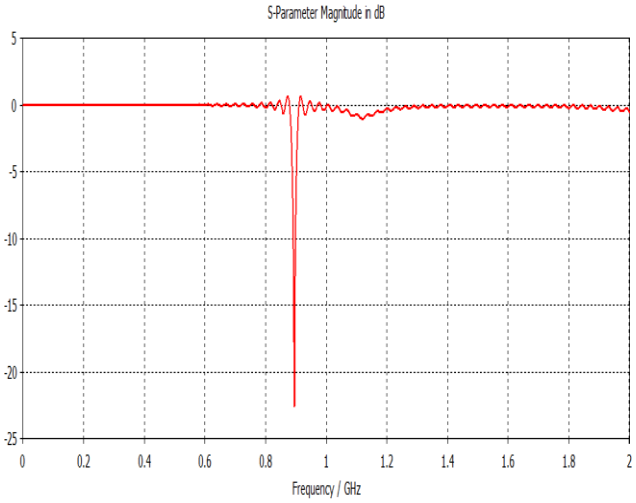


Figure 2: Simulated return loss ofproposed CSRRs with human head model at 0.9 GHz.

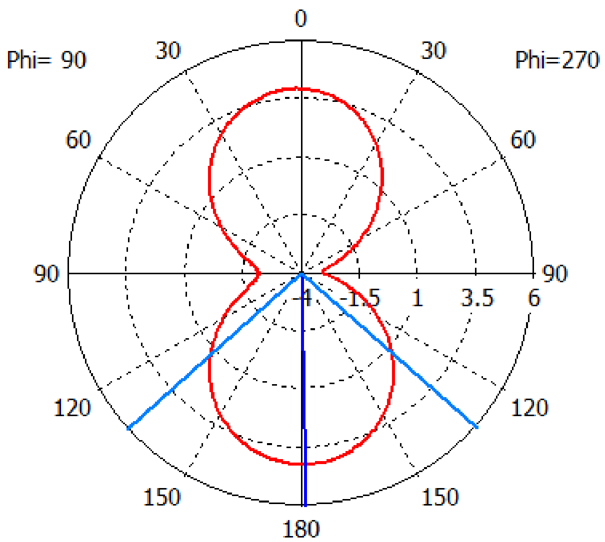
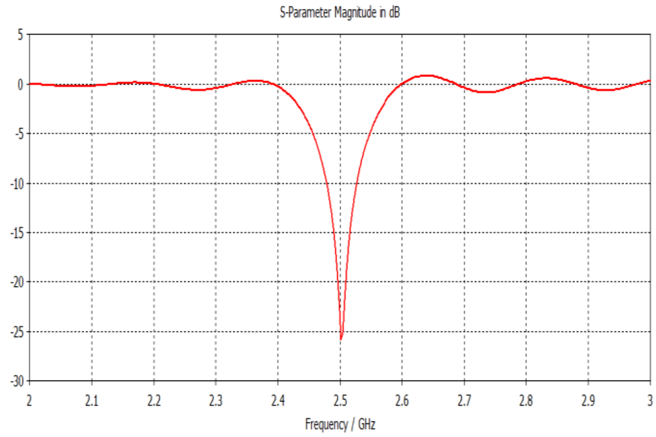


Figure 3: Simulated radiation pattern result of the proposed RMPA at 0.9GHz.

The 2D radiation patterns of proposed RMPA at a frequency of 0.9GHZin polar plot is shown in figure 3. The radiation efficiency and directivity at resonant frequency of 0.9 GHz are 81.23% and 4.2dBi respectively.

Simulated return loss of proposed RMPA without slots and no change in the dimensions in ground plane is shown in the figure 4. From the figure 4, it's clear that the resonant frequency was achieved that is 2.5 GHz but after producing the E shaped and T shaped slots and reduction in size of ground plane on the dimensions of 2.5 GHz antenna , the frequency is shifted from 2.5 GHz to 0.9 GHz. In this way, with the particular dimensions, slots and defect in ground plane, the size reduction was achieved at the 0.9 GHz resonant frequency. Because size of antenna is now reduced from 80.18 mm X 102.38 mm to 29.56 mm X 36.86 mm.



IV. CONCLUSION

A configuration of rectangular microstrip patch antenna with a combination of E shaped slots and two T shaped slots with defected ground structure on the FR4 lossy substratefor GSM applicationhas been investigated. It has been observed that return loss of the antenna is -23 dB at a resonant frequency of 900MHz with proper dimension of design. It is also investigated that a reduction of 86.72 % was achieved in antenna size when compared with an antenna of the same resonant frequency.This work is thus a motivation towards applications where theoverall volume of the structure is an important factor, such as mobile terminals etc.

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