Design of Rectangular Microstrip Patch Antenna for 5G mobile application

S.C.SIVAPRAKASH[1], M.ANIKSHA2, M.AADITHYA3, K.NIVETHA4

[1]Professor, Dept of ECE,K.L.N College of Engineering
[2 3 4] UG Students, Dept of ECE,K.L.N College of Engineering

ABSTRACT:

The objective of this paper is to reduce the size of a rectangular microstrip patch antenna by utilizing a defected ground structure. To reduce the size of antenna, a defected ground structure is introduced in the ground plane to move the frequency from 5.8GHz to 3.5GHz. This 3.5 GHz is an optimum frequency that is used for fifth generation-5G application. The Defected Ground Structure that is used is dumbbell shaped. The size of the ground plane used in this work is 34 × 34 mm^2. The rectangular microstrip patch antenna is designed, and solved by utilizing HFSS (High Frequency Structure Simulator.

***KEYWORDS*: Rectangular Microstrip Patch Antenna (RMPA), Miniaturization,Defected Ground Structure(DGS),5G, 3.5GHz.**

INTRODUCTION:

Microwave components like microstrip patch antenna is so important in wireless communication system .Microstrip patch antenna have better benefits and advantages . Some of the advantages include a)light in weight, b)low volume ,c) Inexpensive, d)low profile ,e)smaller in dimension , and f)ease of fabrication. Inspite of their benefits Microstrip Patch. Antennna has some Limitations, as follows: low efficiency, low return loss, low gain, and narrow bandwidth.
Designers want to design antennas in smaller dimensions with higher efficiency and performance. One of the reasons for miniaturization is lower profile antennas are easier to conceal and transport. Miniaturization of antenna is always a challenge. Miniaturization can be done in following techniques a) Defected Microstrip Structure (DMS) b) Defected Ground Structure (DGS) c) using planar inverted F antenna structure (PIFA) d)using a dielectric substrate of high permittivity,e)using a Magneto-Dielectric Meta-substrate (MDM) ,f)microstrip patch antenna based on metamaterial unit.
Microwave component with Defected Ground Structure (DGS) has been captured attention among all other techniques. Using DGS strengthens antenna parameters and elevates the antenna's performance. The technique DGS compromises action of attaching a simple structure in the ground plane. DGS can be used size reduction of antennas.
If defect is etched into the ground plane of patch antenna, it interrupts the current shield distribution .Because of this, there will be variation in characteristics like inductance and capacitance.The different kind of structures structures that can be introduced in the ground plane like dumbbell, ring shaped,square shaped with U slot.

ANTENNA DESIGN:

ANTENNA WITHOUT DGS:

The idea was to pull off an antenna that performs in a high frequency band in attempt to have reduced size of the microstrip patch. Fig 1 shows the simple antenna structure resonating at 5.8 GHz; this antenna is kept on an FR4 substrate due to its low cost and ease of fabrication. The length (L) and width (W) of the microstrip patch antenna can be calculated by utilizing theoretical equations as follows

$L = 1\ 2fr\ \sqrt{\varepsilon reff}\ \sqrt{\varepsilon 0\mu 0} - 2\Delta L$ (1)

$W = 1\ 2fr\ \sqrt{\varepsilon 0\mu 0}\ 2/(\varepsilon r + 1)$ (2)

In this paper, the proposed rectangular microstrip patch antenna is constructed on an Low cost FR-4 substrate, which has dielectric constant 4.4, loss tangent= 0.025, and substrate thickness =1.6 mm. It encloses the area = 34 × 34 mm^2.
By making use of the HFSS solver, the various parameters of the designed planar antenna are shown in the Fig 1

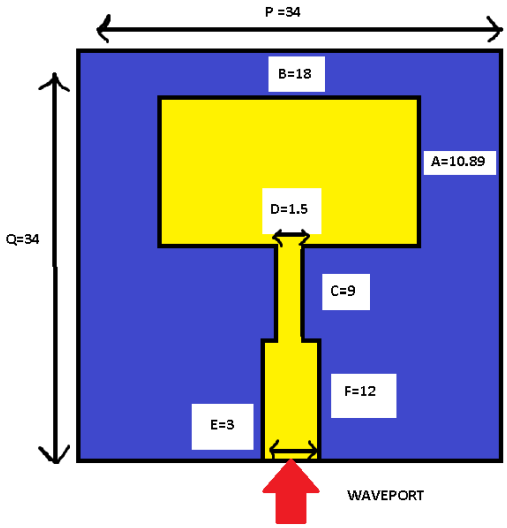
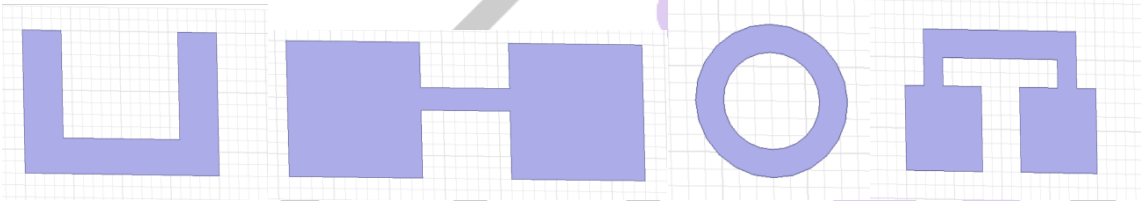


Fig1-Front view of the Proposed Antenna[all measurements in mm]

ANTENNA WITH DGS:
Here are some of the dgs structures.In this paper,we used dumbbell shaped dgs.



i)semi square-shaped ii)dumbbell iii)ring shaped iv)square shape with u slot

Fig. 2 shows the DGS structure consisting of a dumbbell which is introduced to the ground plane resonating at 3.5GHz .

By altering the size of dumbbell structure, resonance frequency shifts from one place to another.After many optimizations done in HFSS, the DGS dimensions are shown in Fig2. DGS is carried out by applying various structures in the ground plane, which interrupts the current distribution. T. Energy is occupied around the defected ground structure. As a conclusion, the resonance frequency can shift from 5.8GHz to 3.5GHz.

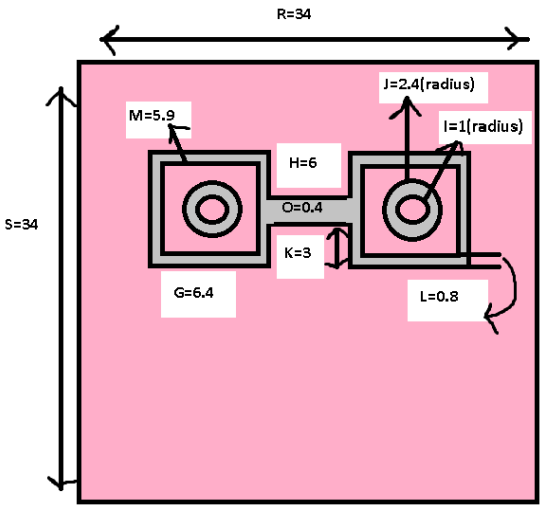
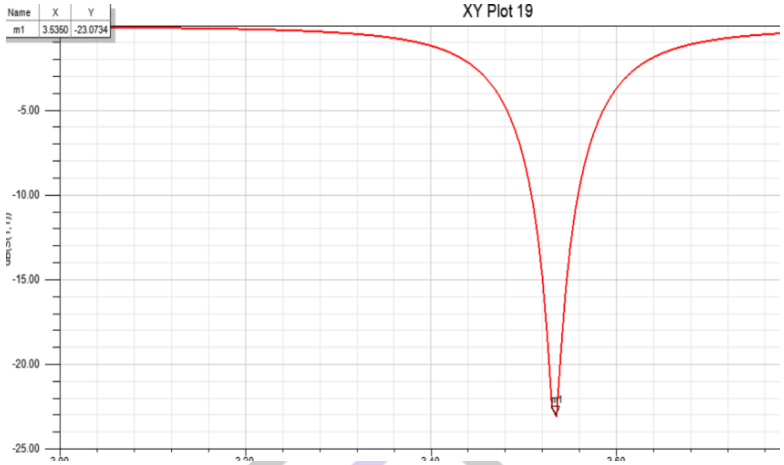


Fig 2-Back view of Proposed Antenna [all measurements in mm]

SIMULATION MEASUREMENT OF ANTENNA WITH DEFECTED GROUND STRUCTURE:

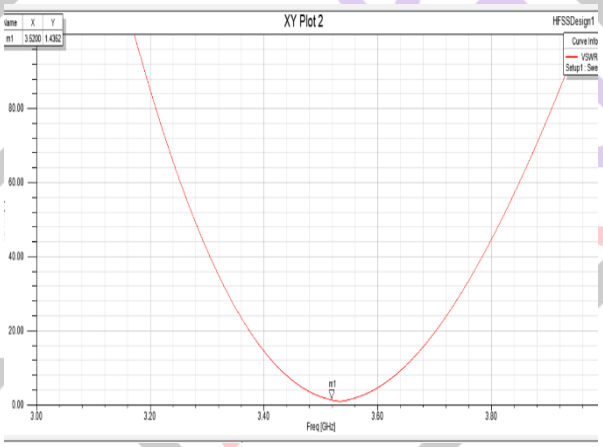
1. RETURN LOSS:

The simulated return loss of the final design of the proposed antenna is showing resonance frequency at 3.5 GHz with a return loss less than -23dB.The above results are attained by hfss software.



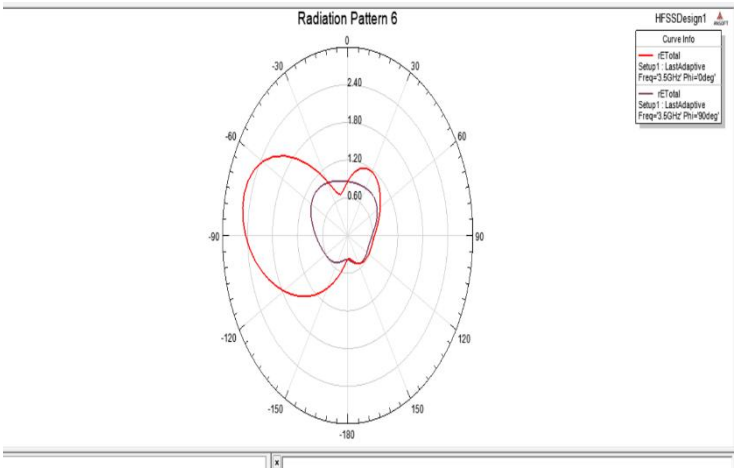
2. VSWR:

The portion of mismatch between an antenna and the feedline linking to it is known as voltage standing wave ratio. The lower the VSWR is, the greater the antenna is. The range of VSWR for basic rectangular microstrip patch antenna will be between 1 and 2. The VSWR obtained is 1.43.



3. RADIATION PATTERN:

The diagrammatical model called antenna pattern shows radiation of energy to space the radiation pis also a reception pattern. Because it express the receiving properties of the antenna. The radiation pattern also can be defined as a graphical illustration of far field. Above figure shows the radiation pattern obtained for the antenna



CONCLUSIONS:

In this work, By utilizing defected ground structure ,we have constructed a rectangular microstrip patch antenna in reduced dimensions. At first, the proposed antenna without DGS is resonated at 5.8 GHz.The frequency is changed from 5.8 to 3.5GHz. The resonance frequency is shifted by rising the antenna electrical length with DGS. After completion, we have compared the simulated and measured results. A miniature rectangular microstrip patch antenna has been designed, simulated, and can be used for 5G applications.

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