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MA 5G USING ANSOFT HFSS

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ABSTRACT: *In microwave bands the 5G standers are covered in two bands: Frequency Range 1 (FR1), from 410 MHz to 7125 MHz and Frequency Range 2 (FR2), from 24.25 GHz to 71.0 GHz. In this paper, the antenna design is modified for better return loss(S11) in the frequency spectrum proposed for 5G mobile applications. The proposed antenna can be implemented based on circular patch shape. Various circular slots are provided to improve the S11 and the ground is modified to improve the bandwidth radiation band. The proposed patch is prited on low cost FR-4 substrate with εr=4.4, tanδ=0.02 and dimensions 50mm (Ls) × 50mm (Ws) × 1.6mm (h), while maintaining good performance in terms of gain and efficiency. The proposed antennas have been characterized using the commercially available software Ansoft's HFSS (High frequency structure simulator).*
Keywords*: 5G, Mobile application, return loss, Gain,HFSS.*

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I. INTRODUCTION

1.1 INTRODUCTION

As the development in communication engineering and electronic communicating system, the smaller size and wider bandwidth are key requirement for recent developments in communication system for designing a radiating element (antenna). In communication engineering, 7.0 to 11.2 GHz frequency band is set for X band application. The S-band is part of the microwave band of the electromagnetic spectrum. It is defined by an IEEE for radio waves with frequencies that range from 2 to 4 GHz, crossing the conventional boundary between UHF and SHF at 3.0 GHz. The S band is used by weather radar, and surface ship radar. The C-band is a name given to certain portions of the electromagnetic spectrum, including wavelengths of microwave that are used for long distance telecommunications. C-band (4 to 7 GHz) and its slight variations contain frequency ranges that are used for, some Wi-Fi devices, some cordless telephones, and some weather radar systems. A coplanar patch antenna is a structure in which all the conductors supporting wave propagation are located on the same plane, i.e. generally the top of a dielectric substrate. Coplanar Waveguide is composed of a median metallic strip separated by two narrow slits from an infinite ground plane. The characteristic dimensions of a CPW are the central strip width W and the width of the slots s. The structure is symmetrical along a vertical plane running in the middle of the central strip. A micro strip patch antenna is fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which forms ground plane substrates.

II. EXPERIMENTAL SETUP

2.1 ANTENNA DESIGN

The design is based on transmission line model analysis. In the design process there are three essential parameters that are taken in to consideration: the frequency of operation (*f*), the dielectric constant of the substrate and the height of the dielectric substrate (*h*). In the designing of these antennas three basic parameters are required to be decided, such as thickness of substrate, relative perrmittivity and geometry of the patch. The first step is to select the appropriate substrate and thickness of substrate. Bandwidth and radiation efficiency increase with substrate thickness. Radiation efficiency of the planar patch antenna mainly depends on the dielectric constant or permittivity of the substrate, because permittivity of a substrate affects transmission efficiency. And therefore, low dielectric constant is selected as the antenna gives better efficiency, low losses and higher bandwidth. Thick substrates having low dielectric constant and low dissipation factor give higher efficiency, larger bandwidth, and loosely bound fields for radiation. But, they also have the disadvantage of arriving at large dimensions for the antenna. Rectangular and square patches are the first and probably the most utilized patch conductor geometries. Rectangular patches tend to have the largest impedance bandwidth, simply because they are larger than the other shapes. Square patches can be used to generate circular polarization. In this thesis, the rectangular patch has been selected for the antenna, concerning on the mentioned advantage. But they may not have offer circular polarization. Instead of rectangular patch circular patch is used to have circular polarization. In circular patch the feeding is not easy, so elliptical patch can used. Thus, in this thesis, the substrate that was used in the design process for both Coplanar and Microstrip patch antenna is FR4 Epoxy Glass, which has relative permittivity of 4.4 and substrate height 0.8mm, which in turn fulfill the requirement for low permittivity and high substrate height.

2.2 DESIGN STEPS:

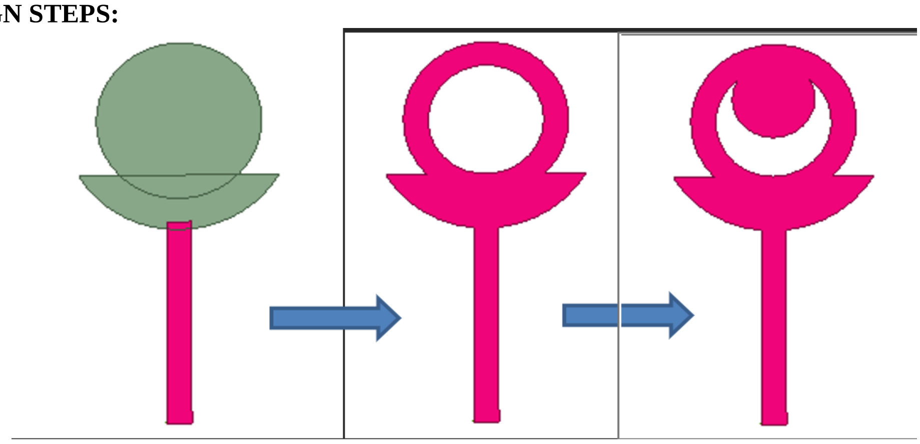

Fig 1: Layout of elliptical patch antenna

2.3 FINAL DESIGN:

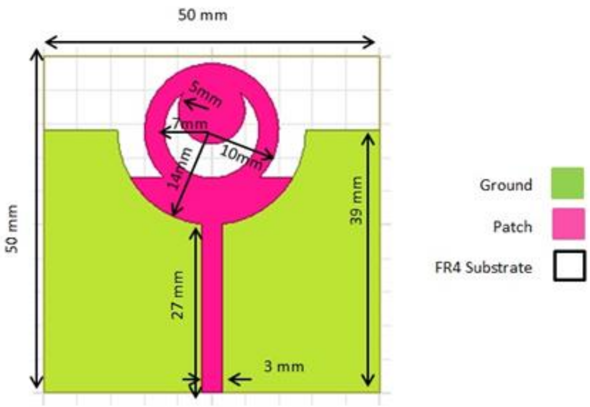

Fig 2: 5G Antenna using HFSS

III. CALCULATIONS

3.1 Calculation of the width (W):

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

Here
c = speed of light = c =3 x 10^{11} mm/s
εr = relative permittivity
W = width of patch

Calculation of the Effective Dielectric Constant:

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

Where ,
ε_{eff}=effective permittivity
ε_r= relative permittivity
h = substrate thickness
W = width of patch

3.2 Calculation of the Effective length:

$$L_{eff} = \frac{0.5c}{2f_0\sqrt{\varepsilon_{eff}}}$$

Where,
L_{eff} = effective length

3.3 Calculation of the length extension ΔL:

$$\Delta L = 0.412h\left(\frac{\left(\varepsilon_{eff}+0.3\right)\left(\frac{w}{h}+0.264\right)}{\left(\varepsilon_{eff}-0.288\right)\left(\frac{w}{h}+0.8\right)}\right)$$

Where,
ΔL is the length extension because of fringing field.

3.4 Calculation of the radius of the antenna:

$$a = \frac{F}{\sqrt{1+\frac{2h}{\pi\epsilon_r F}\left[ln\left(\frac{\pi F}{2h}\right)+1.78\right]}}, where\ F = \frac{\lambda}{\sqrt{\epsilon_r}}$$

3.5 Calculation of the ground plane dimensions:

The transmission line model even though is applicable to infinite ground planes only but for practical considerations, a finite ground plane is used. However, size of ground plane should be greater than the patch dimensions by approximately six times the substrate thickness all around the periphery so that results are similar to the one using infinite ground plane. The ground plane dimensions are calculated as:

L_g= 6h+L
W_g= 6h+W

Where,
h = substrate thickness
L = length of patch
W = width of patch
L_g = length of ground
W_g =width of ground

3.6 ANTENNA PARAMETERS:

The design parameters of the proposed DEAF Antenna layouts is tabulated below:

Parameters	**5G ANTENNA**
Length of the substrate	50mm
Width of the substrate	50mm
Height of the substrate	1.6mm
Effective length	λ/2mm
Operating frequency	6.38GHz

Table1: Design Parameters of 5G Antenna

IV. RESULTS AND DISCUSSIONS

In this work a 5G antenna design and simulated. The simulation results are as follows:

4.1 RETURN LOSS:

The S parameter S_{11} represents the return loss of a device. The return loss in an antenna gives power loss in the signal when returned which is caused due to load mismatch with transmission line impedance. The return loss value should be less than 10 dB. Fig 3 shows the return loss S11 of introduced antenna design.

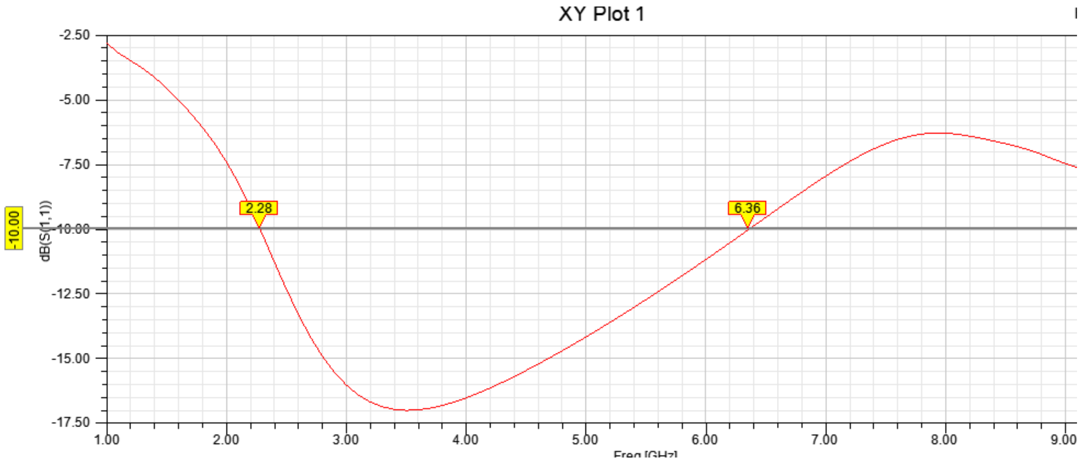

Fig 3: Return Loss (S11)

4.2 RADIATION PATTERN:
A radiation pattern defines the variation of power radiated by an antenna as a function of the direction away from the antenna. The radiation pattern at phi=0^0 , 90^0 is represented in figure4 and the frequency of 6.38GHz.

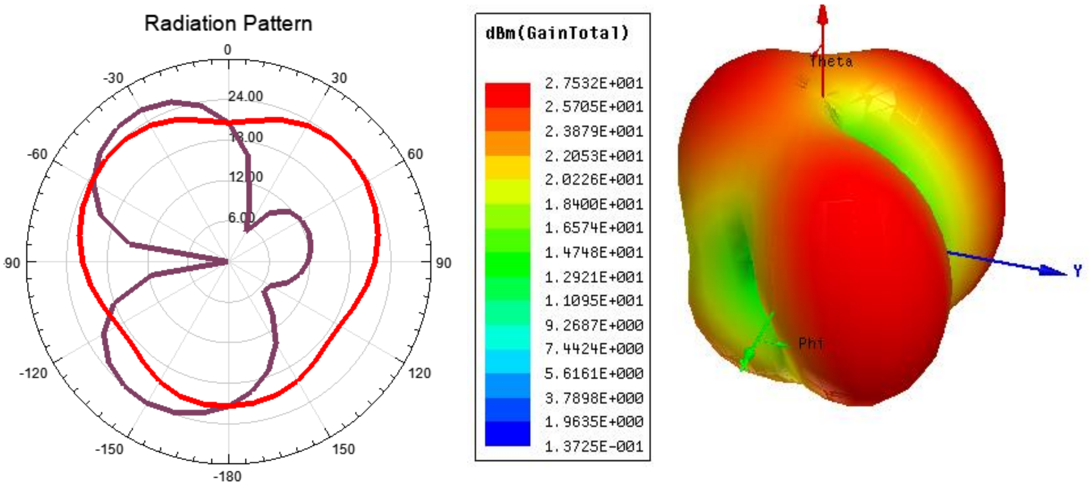

Fig 4: 3D and 2D Radiation plots

The bandwidth of the band is 4.1 GHz. The radiation pattern of 2 D and 3D plots are shows the dipole radiation pattern. From the above results the Return loss S11, give radiation band. It is ranging from 2.28 to 6.38 GHz.

V. CONCLUSION

In this work a microstrip patch antenna is designed, simulated and simulated results recorded. In this work the, the antenna is successfully radiating in the Sub6 band of the 5G communication. The proposed antenna has FR4 substrate. The final design has dimensions of 50X50 mm^2, it radiates in 2.28 to 6.38 GHz successfully. The radiating band covers the S-bad and C- band applications. It also includes ISM bands. The S band consists of the mobile, blue-tooth and Wi-Fi applications. The c-band is a commercial band, that consist satellite applications.

5.1 Future scope of the proposed work:

The proposed work can be further developed by changing the substrates of different constant material constants. The elliptical antenna can be replaced with different shapes. Other ground structures are can be used to improve the bandwidths. The reconfigurable antenna can be obtained by adding resonators with PIN diode or Varactor. This can be used to design Rectenna (Rectifier-antenna) and other applications.

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