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DESIGN AND SIMULATION OF 5G WIDEBAND WITH U-SLOT PATCH ANTENNA

Kurva Rajashekhar[1], J Himadeep[2], Nausheen Sultana[3]

[1,2]Students from SNIST
[3]Assistant Professor of SNIST

ABSTRACT - This paper deals with design and analysis of U-slot Rectangular microstrip patch antenna with high frequency for 5G applications. The design of U-slot patch antenna consists are substrate, patch, U-slot and coaxial feed. The software: Ansys.Electronics.18.0 is used to design the patch antenna. 28GHz is the Resonant frequency of antenna with wide band width. Antenna parameters like gain, return loss, radiation pattern, and impedance. The substrate of antenna is Roger RO 5880(tm) material which has good mechanical strength and performance. Dielectric constant of the material is 2.2.

KEY WORDS: patch, U-slot, coaxial feed, 28GHz and HFSS

INTRODUCTION

5G Technology is used for high speed data rate and with grater Band width. 5G Technology will be launched 2023 in India. Normally for high speed data rate frequency range is 28GHz to 60GHz. In mobile communication we are using patch antenna because light weight, low volume, compact size, low cost mass production and ease installation. Generally the operation of antenna is Fundamental Mode TM_{10} .The design of microstrip patch antenna is simple. But it has major limitation because it is used for Narrow band width. To overcome this problem we will introduce a slot on patch. We can use any type of slots like U, H, E, L… etc. . For high frequency antenna U and H slot antenna are used. In this project antenna is design with U-slot, So the Resonant frequency is inversely proportional to slot length and the feed line length. By increasing the slot width Band width increases. The high frequency microstrip patch antenna used in satellite communication and Bio-medical radiation. The function of slot antenna is complementary to the Dipole antenna. These slots will create the fringing fields due to that it create the capacitive effect. In this paper discuss about return loss, radiation pattern and impedance.

ANTENNA DESIGN

The substrate of antenna is Roger RO 5880(tm) material which has good mechanical strength and performance. Dielectric constant of the material is 2.2and thickness of substrate is 0.157cm. For high resonant frequency antenna dielectric constant should be low.

The geometry of patch antenna is very easy. Dimensions of antenna calculated with some following specification and Formulae:

Patch Diomensions:

The width of patch antenna is (W_{pat})

$$W_{pat} = \frac{V_{vaccum}}{2f_{reso}} \sqrt{\frac{2}{1+\varepsilon_{re}}}$$

Where $V_{vaccum\ velocity} = 3*10^{10}$ cm/s

$f_{resonance}$ is resonant frequency

ε_{re} is dielectric constant= 2.2

The effective dielectric constant

$$\varepsilon_{effct} = \frac{\varepsilon_{re}+1}{2} + \frac{\varepsilon_{re}-1}{2}\left(1 + \frac{h}{\text{Wpat}}\ 12\right)\frac{-1}{2}$$

h is height of substrate and W_{pat} is patch width

The length of patch is ($_{Leff\ pat}$)

$$\text{Leff patc} = \frac{V_{vaccum\ velocity}}{2f_{resonance}\sqrt{\varepsilon_{effct}}} + 2\Delta L$$

ΔL extension length because of fringing field

$$\Delta L = 0.412h\frac{(\varepsilon_{effct}+0.3)\left(\frac{\text{Wpat}}{h}+0.264\right)}{(\varepsilon_{effct}-0.258)\left(\frac{\text{Wpat}}{h}+0.8\right)}$$

The dimensions of patch are 0424 cm *0.245 cm

Substrate Dimensions:

Substrate width (Y_{sub})

$Y_{subtr} = W_{pat} + 6*h$

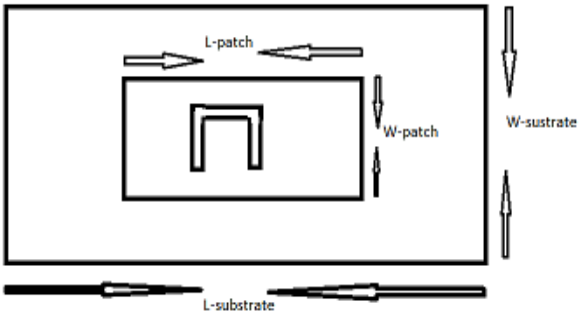
Substrate length (X_{sub})

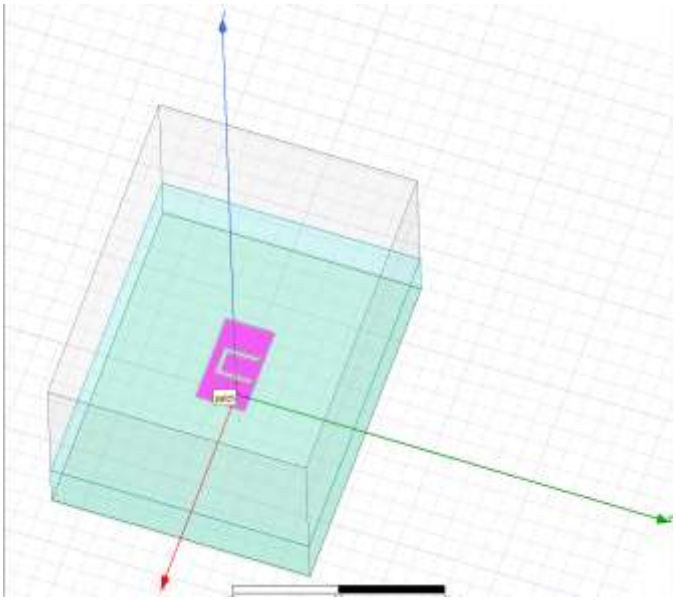
$X_{subtr} = L_{pat} + 6*h$

h is the height of substrate

dimensions of substrate 1.58cm * 1.31cm * 0.157cm

Infinite rectangular ground has same specifications as substrate.



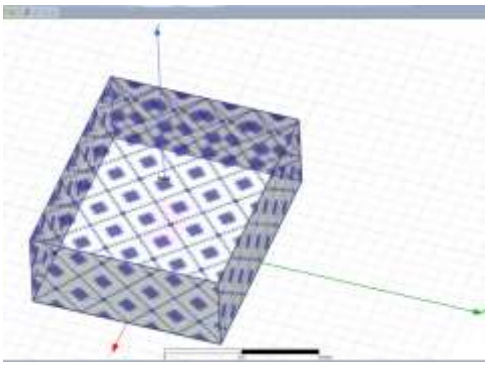


U-slot antenna

Measurments of antenna design

Parameters	Size (cms)
Length of substrate (X_{sub})	1.31
Width of substrate (Y_{sub})	1.58
Height of substrate (h_{sub})	0.157
Length of patch (L_{pat})	0.245
Width of patch (W_{pat})	0.424
Feed point (p)	0.127
Distance between slot and patch (U_{dist})	0.045
Width of slot (U_{xaxis})	0.143
Length of slot (U_{yaxis})	0.183
Thickness of slot (U_{slot})	0.025
Radius of outer coax ($R_{outercoax}$)	0.003
Radius of inner coax ($R_{innercoax}$)	0.0009

Radiation boundary



Results and Conclusion

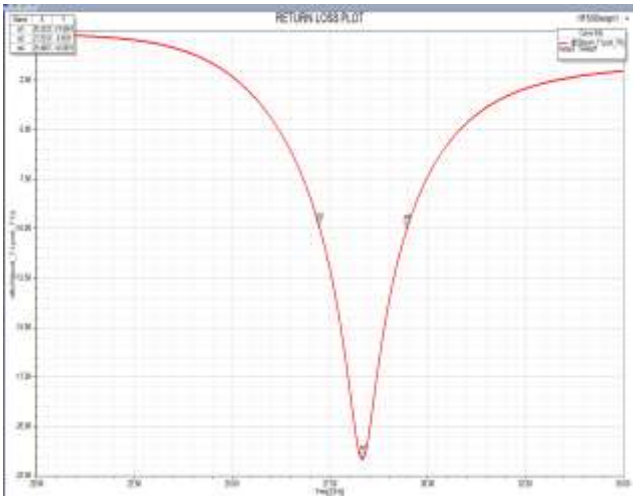
The simulation of u- slot patch antenna is performed by using ANSYS HFSS software.

Antenna parameters like gain, directivity, impedance, radiation pattern, frequency and return loss has been performed. High directivity antenna will have less return loss. Generally return loss should be less than -10 dB. The efficiency of antenna is depends up on return loss and directivity of antenna. The designed antenna 28GHz resonant frequency which is used for transfer of high data rates in 5G application. In simulation impedance matching should occur between feed point and patch. For high resonant frequency slot length should be very less. So U slot length is less compared with the H slot and easy to design compared with H slot.

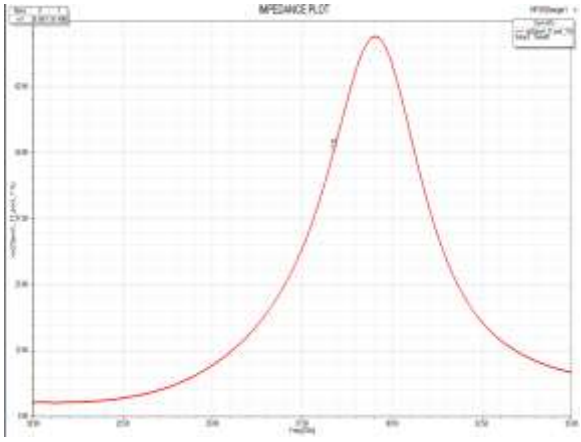
Return Loss plot

Return loss is a effectiveness of power deliver from transmission line to the load such as antenna. Let input power P_{in} and reflected power P_{ref}. Then the ratio of P_{in}/P_{re} should have maximum positive value for load and line matched. Return loss should be less then -10dB for efficient antenmna.

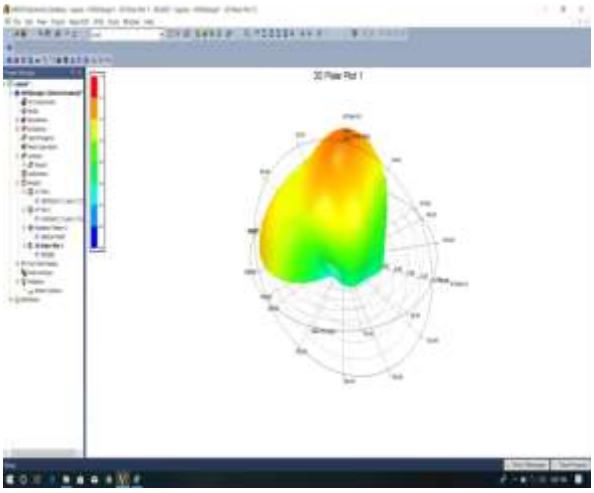
$$RL = 10\log_{10}(P_{in}/P_{ref})$$



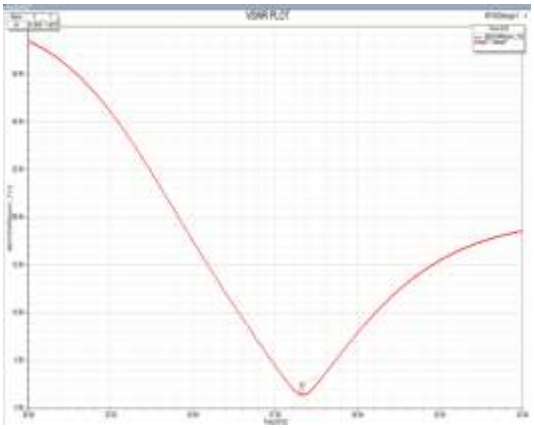
Impedance plot



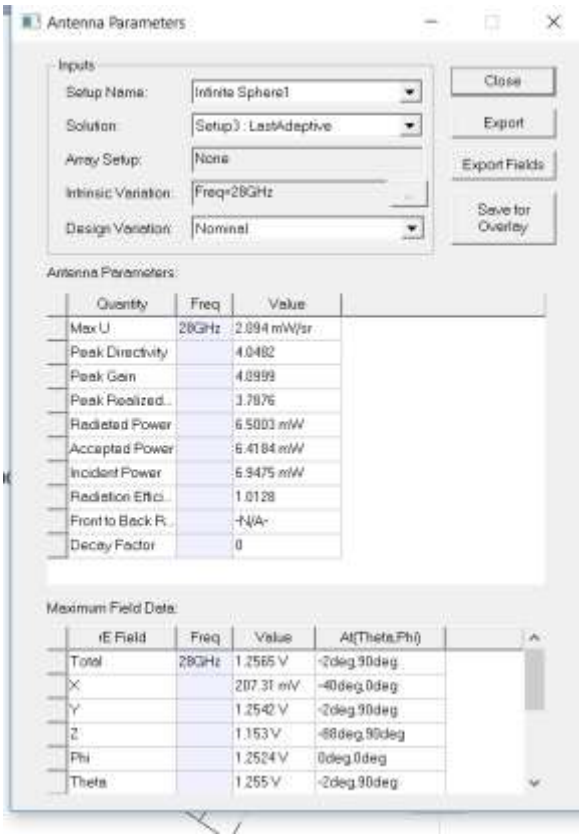
3D Polar plot



VSWR PLOT



Parameters of antenna



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