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Design and Simulate 5G MicroStrip Patch Antenna using MATLAB and CST

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Abstract: This abstract presents the design and analysis of rectangular micro strip patch antenna operating at 34 GHz. The antenna operates at waves having a wavelength of 5.9mm. The rectangular patches were excited using Micro strip line feeds, which provided a wide bandwidth and low return loss. CST simulation software was used to analyze the antenna performance. The VSWR was observed to be 1.066 at 34 GHz. Return loss was observed to be 29.87 dB 34 GHz. Gain was observed to be 6.993 dB for 34 GHz. The proposed rectangular micro strip patch antennas can potentially meet the demands for high data rate, high capacity, and low latency for 5G communication systems.

Keywords: directivity, gain, return loss, bandwidth.

I. CONTENT

INTRODUCTION

5G networks continue their roll-outs across the world and the new mobile internet service is eagerly awaited for a reason. Peak and regular use download speeds as well as other specification of the new service dwarf existing 4G/LTE specs. The service also offers improved latency (the lag from giving an order to a device and the carrying out of that order), increased bandwidth and a much higher number of simultaneous carriers. This improvement is especially crucial for the development of services like autonomous driving and the like [2]. 5G aims at connecting everything. It provides low latency, more stability and faster internet access speed.5g works in K/Ka band from 28GHZ to 60 GHZ.

It also operates in two other bands know as low band and mid band. 1G was the first generation of mobile phones, but it had the disadvantages of having large antenna. 2G was introduced next but it had slow data rate. 3G was the next to be introduced but it had complicated structure and needed large upfront capital. The next generation of mobile phone was 4G, but it had the problem of congestion. So need of 5G was needed. The antenna currently being used in 4G does not use 5G connection to its full potential, hence a newer, better antenna had to be designed. 5G work on mm. frequency waves. For such waves, micro strip patch antenna is the most suitable antenna currently available.

MATERIAL SPECIFICATION AND METHODOLOGY

The micro strip antenna is composed of three layers, from bottom to top: a ground plane, a dielectric plane, and a conductor plane. The most famous type of micro strip antennas –and the antenna that we will construct in this project– is the patch antenna. This antenna takes its name from the conductor plane, when it takes the form of a patch of metal (hence the name).

The patch antenna is a low profile antenna generally used in applications where size, ease of installation, and weight, all play a significant role. It is prevalent in aircraft and satellite applications, indoor wireless applications, and in long distance mobile communication. The patch antenna comes in many shapes and sizes, but it is generally composed of two metallic layers mounted over each other with a dielectric substrate sandwiched between them. The bottom layer is larger and is referred to as the ground plane. The type of the patch antenna is determined by its geometric shape. The most popular forms used are the rectangular and the circular designs, due to their low cross-polarization radiation, and their decent radiation characteristics.

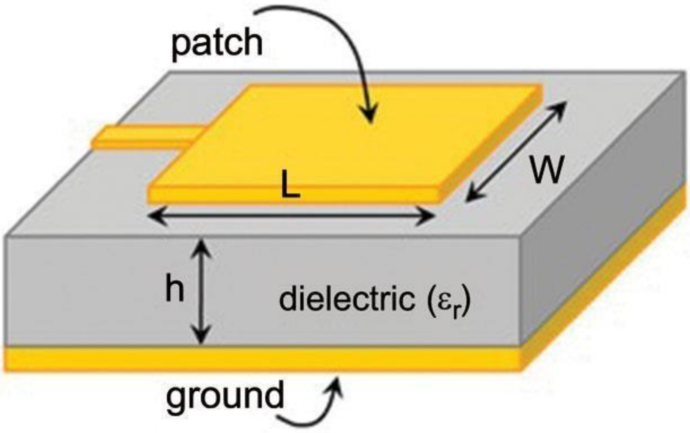

figure 1. microstrip pacth antenna

Ground plane: - It acts as the reflecting surface to the waves that the antenna generates. The ground plane is made up of copper because it needs to have high conductivity to be able to reflect radio waves at high frequency. Dielectric substrate: - A dielectric is a substance with poor electric conductivity. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable for better efficiency, larger bandwidth and better radiation. Metal patch: - The patch's shape is what determines the shape of the induced radio waves. We chose the rectangular shape because it is easy to design and fabricate. It also has a lower VSWR and lower reflection coefficient when compared to other designs.

GOVERNING EQUATIONS AND DESIGN

Length of patch

During antenna design, an important parameter is length of patch. The patch length is usually selected within the range of 0.333 λ0<PL<0.5

$$L = L_{eff} - 2\Delta L$$

Where Leff is effective patch length, ^-L is difference between L and Leff.

Leff: patch's effective length:

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon reff}}$$

Leff is effective length of patch. It is an important parameter that must be calculated.

Length extension:

$$\Delta L = 0.412h\frac{(\varepsilon reff + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon reff - 0.258)(\frac{W}{h} - 0.8)}$$

Width of patch:

$$W = \frac{c}{2f_0\sqrt{\frac{(\varepsilon r+1)}{2}}}$$

Width of ground:

$$W_g = 2 * W$$

Length of ground:

$$L_g = 2 * L$$

Table 1. Values of design parameters of proposed antenna

Parameters	Values in mm
Wavelength(λg)	5.9
ϵeff	2.1
Patch's effective length(Leff)	3
ΔL	0.0789
L of patch	2.84
W of patch	3.20
length of ground(Lg)	6.51
width of ground(Wg)	6.40
Length of substrate	6.51
Width of substrate	6.40

II. RESULTS

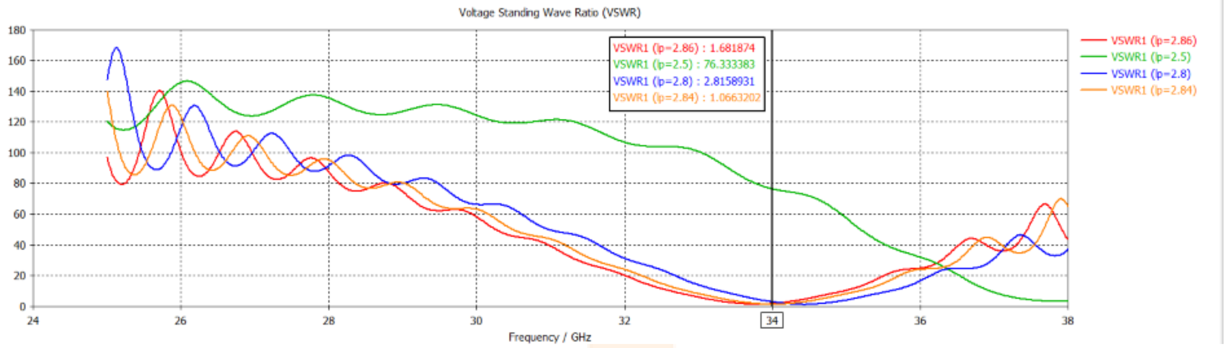

Figure 2. VSWR

The VSWR i.e. the Voltage Standing Wave Ration is 1.066 at 34GHz.

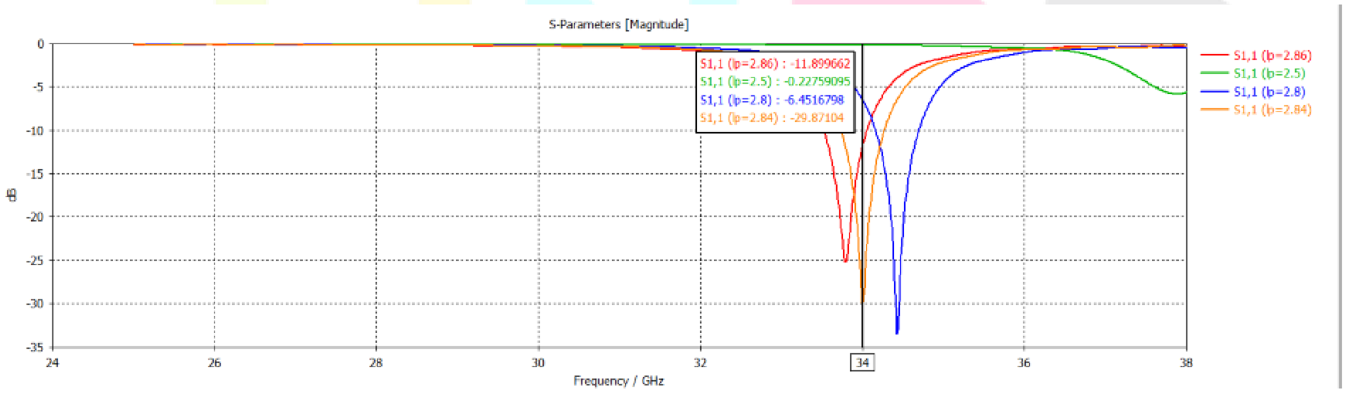

Figure 3. Scattering Parameter

The above figure shows the scattering parameter of the antenna, which is its return loss at 34GHz which is -29.87 dB.

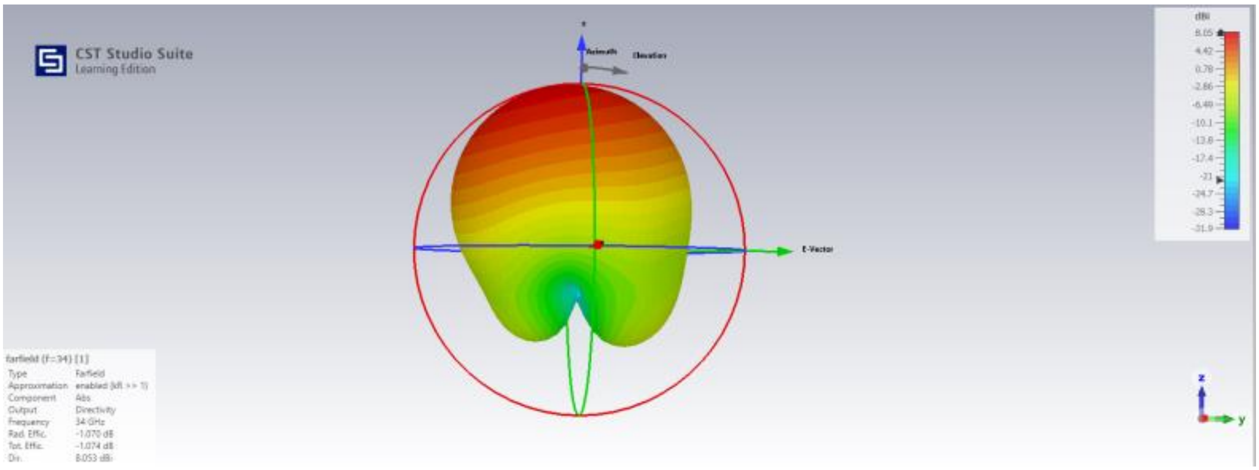

Figure 4. Directivity

The above figure shows us the directivity of the antenna which is 8.053 dBi at 34GHz.

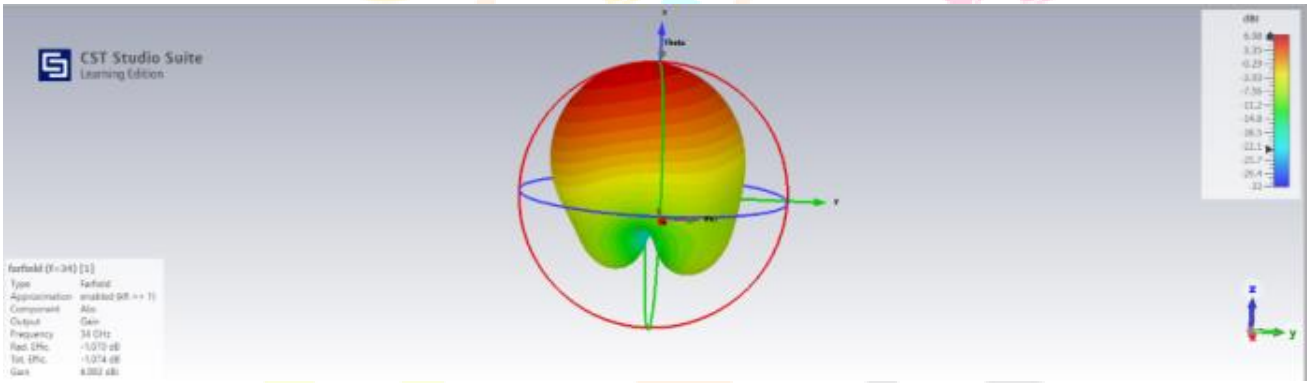

Figure 5. Gain

The above figure shows us the gain of the antenna. The maximum value of gain is 6.993 dBi.

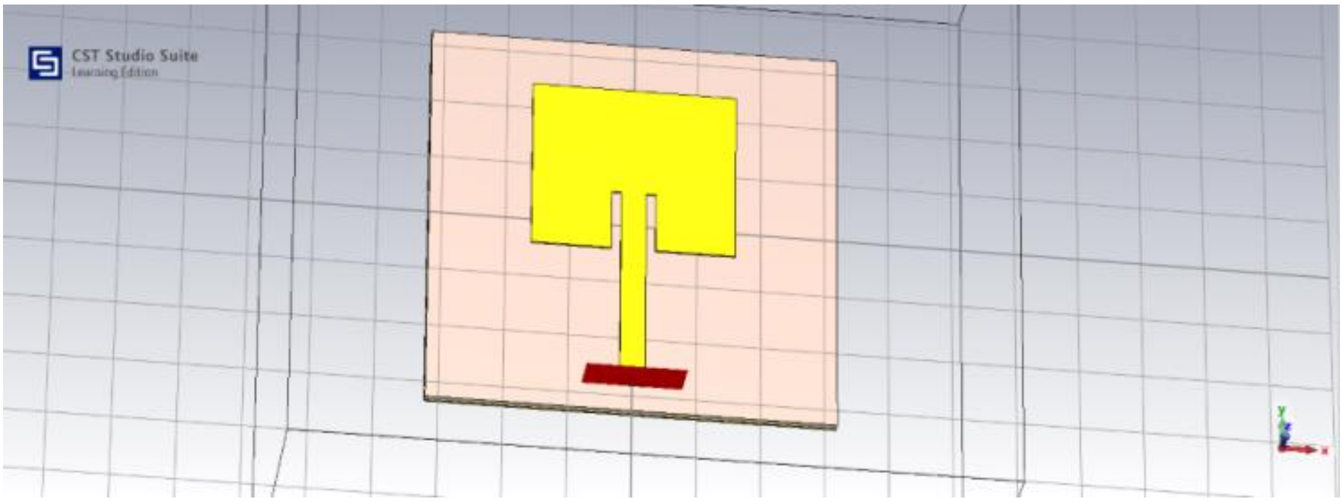

Figure 6. Final design of the Microstrip Patch Antenna

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