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DESIGNING G-SHAPED MICROSTRIP PATCH ANTENNA FOR 5G APPLICATION

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Abstract - This paper presents the design and simulation of a G-shaped microstrip antenna operating at 3.7 GHz for 5G applications using ANSYS HFSS software. The antenna is fabricated on a substrate with dimensions 30x60 mm^2. The G-shaped geometry is chosen for its compact size and improved bandwidth characteristics. The design process involves parameter optimization to achieve the desired resonant frequency and impedance matching. ANSYS HFSS simulations are utilized to analyze the antenna's performance in terms of return loss, radiation pattern, 3D polar plot and efficiency. The proposed antenna demonstrates promising characteristics suitable for 5G communication systems, offering wide bandwidth and efficient radiation properties with specific application in the S band frequency range.

***Key Words*:** G-shaped patch antenna, 3D polar plot, 5G, S band, ANSYS HFSS design.

1.INTRODUCTION

Communication is the process of exchanging information, ideas, thoughts, or feelings between individuals or groups through various channels and mediums. It is a fundamental aspect of human interaction and plays a crucial role in everyday life, relationships, businesses, education, politics, and virtually all aspects of society.

An antenna is a device designed to transmit or receive electromagnetic waves. It is a fundamental component of wireless communication systems, including radio, television, cellular networks, satellite communications, and more recently, technologies like Wi-Fi and 5G. Antennas play a crucial role in 5G networks, antennas are essential because they act as an interface between devices and the wireless infrastructure.

Microstrip antennas have emerged as a popular choice for 5G applications due to their compact size, low profile, and versatility. Compared to conventional antenna designs, these printed circuit board (PCB)-based antennas have a number of advantages. Microstrip antennas are perfect for wearable technology, mobile phones, and Internet of Things devices because they are small, affordable, and simple to integrate into modern communication systems.

Unlike various microstrip antenna designs, the G-shaped structure has attracted a lot of interest due to its unique geometry and performance characteristics. The ground plane and radiating element of the G-shaped microstrip antenna are arranged to look like the letter "G." Its tiny size, larger bandwidth, and improved radiation efficiency are only a few advantages of this unique design. Compared with conventional microstrip designs, G-shaped antennas may provide less efficient radiation patterns, mutual coupling, improved impedance matching, and more.

Using ANSYS HFSS software, the main goal of this research is to build and model a G-shaped microstrip antenna operating at 3.7 GHz for 5G applications. The suggested antenna's efficiency, radiation pattern, and return loss will be evaluated using electromagnetic models and parameter.

2. METHODOLOGY

1.Define the Conditions:

- 3.7 GHz operating frequency; FR4 substrate material.
- The substrate measures 30 x 60 mm square units.
- Antenna Type: G - shape microstrip microstrip patch antenna.

2. Creation of Geometry:

- Open ANSYS HFSS and create a new project.
- Create a FR4 substrate with a dimension of 30 x 60 square units in size.
- On the FR4 substrate, construct the G-shaped microstrip patch antenna. Ensure that the patch antenna's dimensions are appropriate for 3.7 GHz operation.

3. Port Configuration:

- Add ports for feeding the antenna. Define the feeding ports with the appropriate excitation (e.g., voltage or current) and impedance (e.g., 50 ohms).

4. Meshing:

- Create a mesh covering the whole structure. To reliably capture details, use fine meshing in close range of the feeding lines and patch antenna edges.

5. Design parameter:

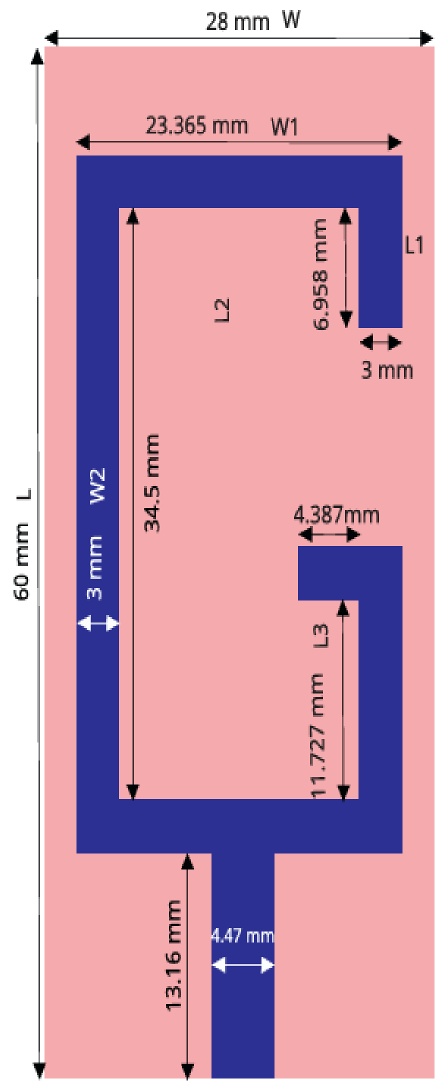

Figure 1 Antenna evolution process

TABLE 1

Design parameter	Optimum value(mm)
Length of the substrate	30
Width of the substrate	60
Width of the patch	3
Length of the transmission line	13.16
Width of the transmission line	4.47
W1	23.365
W2	3
L1	6.958
L2	34.5

6. Simulation Design:

- Establish the simulation configuration by setting the operating frequency to 3.7 GHz.
- Choose the right solver parameters (for example, for the Finite Element Method) and specify convergence requirements.

7. Analysis:

- Execute the simulation and examine the outcomes. Analyze S-metrics (impedance matching, return loss), radiation patterns, 3D polar plots, and antenna efficiency at 3.7 GHz, among other parameters.

3. RESULT AND DISCUSSION

A. Reflection coefficient(dB) of patch antenna

The HFSS 16.0 simulator software was used to analyze the G-shaped microstrip patch antenna. It was found to be resonating at 3.7GHz with a reflection coefficient of -26.3595dB.

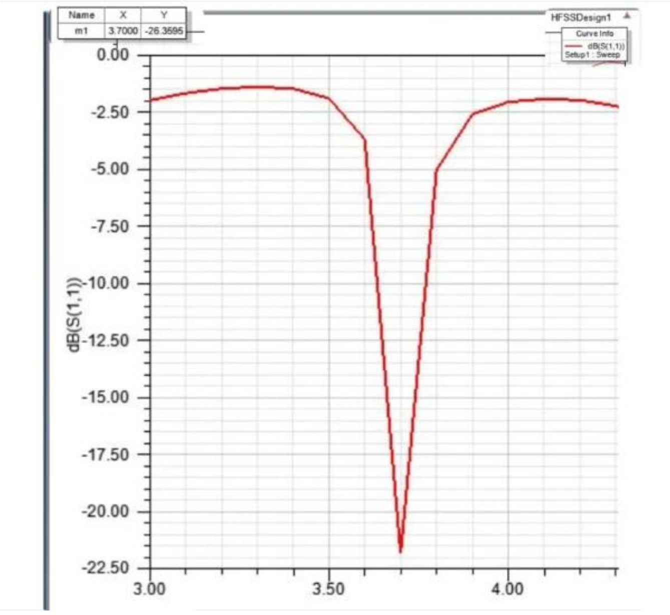

Figure 2 Reflection coefficient (dB) for S band

The prototype microstrip antenna's reflection coefficient for a S band patch antenna which can be used for 5G communication is shown in Figure 1. This is the use of the FR4 substrate material.

B. Radiation pattern for patch antenna

The radiation plots antenna direction is shown in Figure 2. Radiation characteristics with respect to spatial coordinates are contained in the directional pattern. It involves the radiation intensity, the strength of the magnetic or electric field, the antenna's directivity, and the antenna's polarization characteristics.

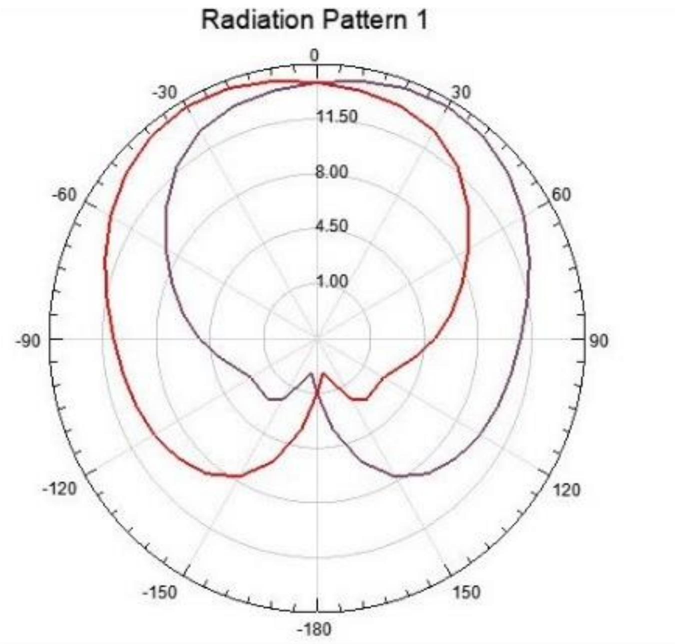

Figure 3 Radiation pattern for microstrip patch antenna.

C. 3D Gain plots of the patch antenna

The figure shows the 3D radiation plot helps in depicting the gain of the antenna as well as directivity of the antenna. Antenna gain is typically expressed in decibels (dB). The maximum gain was observed at 3.7GHz frequency with 7.7772dB. These are used to determine the antenna gain at a particular distance

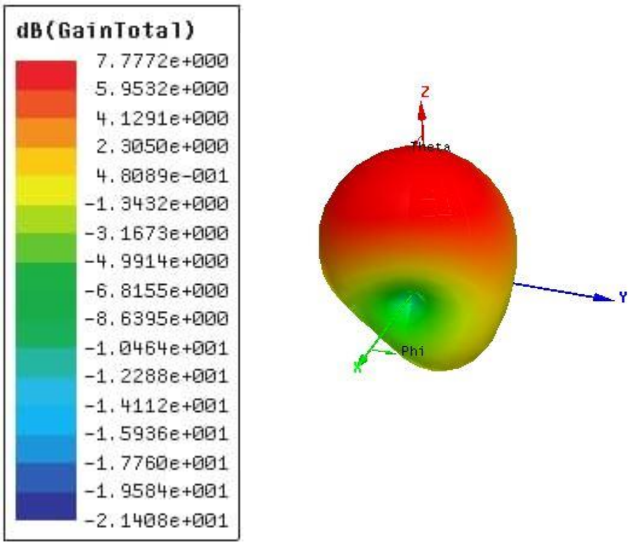

Figure 4 3D Gain polar plot patch antenna

D. Surface current distribution for patch antenna

Current distribution for microstrip antenna at frequency 3.7GHz. The figure shows the current density and flow of e field movement inside the proposed antenna along with density matter.

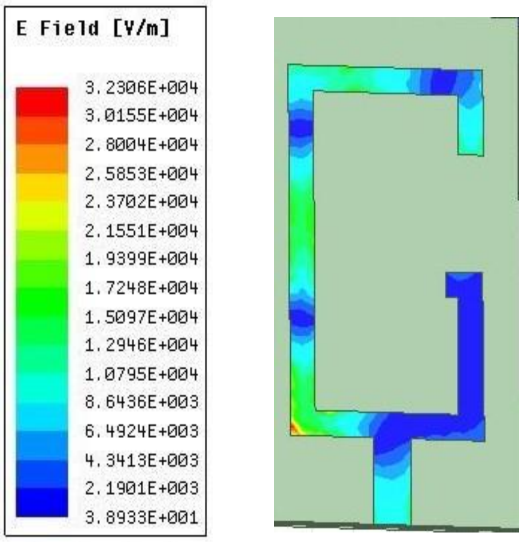

Figure 5 Surface current distribution for patch antenna at 3.7GHz

3. CONCLUSIONS

The design provides the best outcomes and gains, a decent radiation pattern, and aids in understanding the many methods to achieve the desired outcomes. The design miniatures the size of antenna and results in better return loss, bandwidth. This antenna is well suited for 5G communication. Patch antenna produce resonating frequency with adequate bandwidth and better return loss by further incorporating techniques like bandwidth improvement and better reflection coefficient. This work helps to know about how the software HFSS is used in implementation of the design and analysis the results.

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