A CIRCULAR MICROSTRIP PATCH ANTENNA DESIGN FOR 5G PURPOSES

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Abstract

*This paper presents a comprehensive design and analysis of a microstrip circular patch antenna specifically tailored for 5G applications. The antenna is optimized to resonate at 5 GHz, making it suitable for high-speed wireless communication systems. The design incorporates FR4 epoxy as the substrate material, with dimensions of 30 mm × 35 mm × 3.6 mm. The circular patch length is carefully chosen as 7.2 mm to achieve efficient performance.S11 value is to be found as -24.9 dB. The VSWR is found as 1.02.It is nearly ideal. Extensive simulations and measurements are conducted to validate the design, considering parameters such as return loss, radiation pattern, and gain. The proposed antenna design offers compact size, high efficiency, and excellent characteristics for 5G communication systems***.**

Keywords: *Microstrip antenna, circular patch antenna, 5G, FR4 epoxy, resonant frequency*

1. Introduction

The rapid growth of wireless communication systems, particularly with the advent of 5G technology, necessitates the development of compact and efficient antennas. This paper presents a detailed design and analysis of a micro strip circular patch antenna specifically tailored for 5G applications. By optimizing the dimensions and incorporating FR4 epoxy as the substrate material, the antenna achieves resonance at 5 GHz, a commonly used frequency band for 5G networks. circular micro strip patch antenna is a type of antenna that consists of a circular metallic patch printed or etched on one side of a dielectric substrate. It is widely used in various wireless communication systems due to its compact size, low profile. The circular patch is typically made of a conductive material such as copper and is centered on the substrate. The patch dimensions, including the radius and thickness, play a crucial role in determining the resonant frequency and impedance characteristics of the antenna. The dielectric substrate provides mechanical support to the antenna and influences its performance. Commonly used substrate materials include FR-4, Rogers, or ceramic materials. The dielectric constant and thickness of the substrate affect the antenna's impedance matching, bandwidth, and radiation characteristics .It is fed by a transmission line, such as a micro strip line or a coaxial cable. The feeding point is usually located at the center of the patch, where the feed line is connected to the patch through a feedline transition structure .The circular patch antenna typically exhibits a radiation pattern with maximum radiation perpendicular to the substrate plane, resulting in a broadside radiation pattern. However, higher-order modes can also be excited, leading to additional radiation patterns. The dimensions of the circular patch, the dielectric constant of the substrate, and the thickness of the substrate collectively influence the resonant frequency and bandwidth of the antenna. Techniques such as adding slots, using multiple patches, or incorporating impedance matching networks can be employed to enhance the bandwidth.

2. ANTENNA DESIGN

2.1 Substrate Selection :

The choice of substrate material plays a critical role in antenna performance. In this design, FR4 epoxy is selected as the substrate material due to its favorable electrical properties, cost-effectiveness, and ease of fabrication. The substrate dimensions are set to 30 mm (length), 35 mm (width), and 3.6 mm (height).

2.2 Circular Patch Design:

The circular patch is chosen as the radiating element due to its compact size and omni directional radiation characteristics. To achieve resonance at the desired frequency of 5 GHz, the length of the circular patch is carefully optimized to be 7.2 mm, considering the dielectric constant and other factors associated with the FR4 epoxy substrate.

2.3 *Feedline and Ground Plane:*

To excite the circular patch, a microstrip feed line is implemented on the bottom side of the substrate. The feed line is designed to have an impedance matching with the antenna, ensuring efficient power transfer. A copper ground plane is placed on the top side of the substrate, serving to enhance the antenna's performance by providing proper grounding and reducing radiation losses.

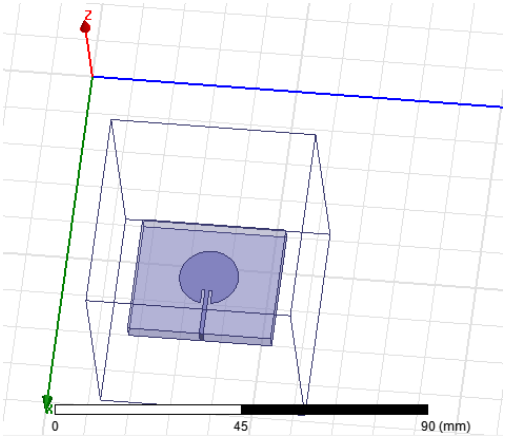

Fig 1. Design of Circular Patch Antenna

3. SIMULATION AND ANALYSIS

The designed antenna was simulated using HFSS. The simulated results show that the antenna resonates at 5 GHz, which is the desired frequency for 5G applications. The return loss (S11) is measured to be -24.9 dB, indicating excellent impedance matching. The voltage standing wave ratio (VSWR) is found to be 1.02, further confirming the good match between the antenna and the transmission line.

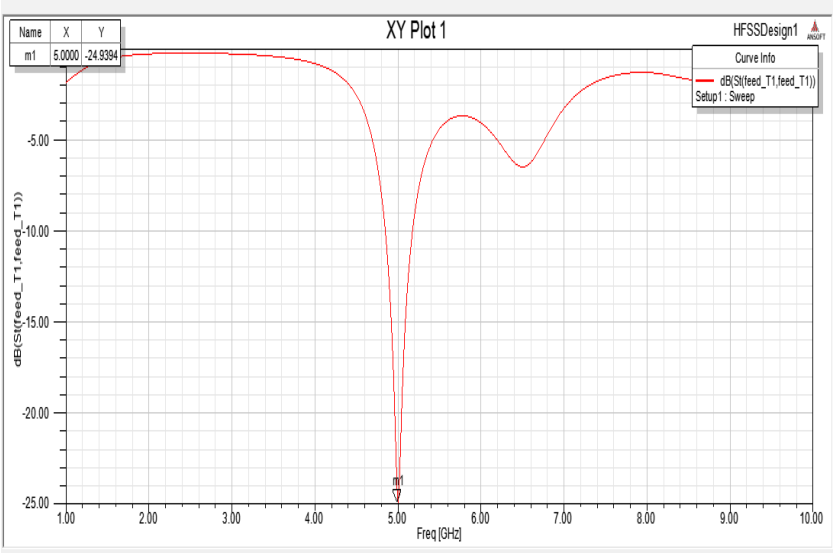

Fig 2. Return loss of the antenna

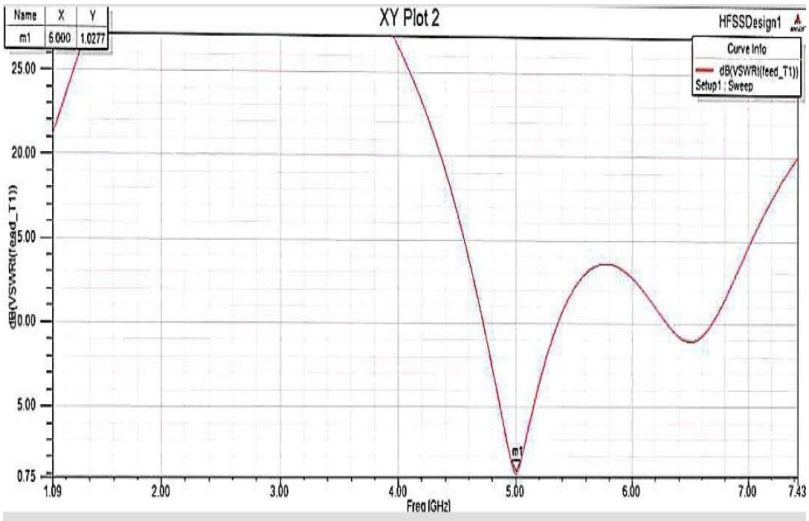

Fig 3. VSWR of the Antenna

In this antenna VSWR Value is 1.02 which symbolizes it is ideal. The radiation pattern of the designed antenna was analyzed to determine its radiation characteristics. The antenna exhibits a broadside radiation pattern, with maximum radiation perpendicular to the substrate plane. The radiation pattern is uniform and has a high gain in the desired direction, making it suitable for 5G applications and bandwidth is found to be 300 MHz.

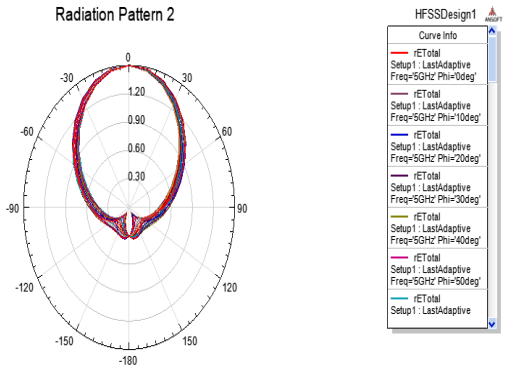

FIG 4. Radiation Pattern at Various Angle

Table 1 . Dimensions of Circular Patch Antenna

DIMENSIONS	**VALUE (mm)**
Ls – Length of substrate	30
Ws- Width of Substrate	35
Rp- Radius of patch	7.2
Hs- Height of Substrate	3.6

4. CONCLUSION

In this paper, a microstrip circular patch antenna designed for 5G applications has been presented. The antenna operates at a resonant frequency of 5 GHz and exhibits excellent impedance matching with a return loss (S11) of -24.9 dB and a voltage standing wave ratio (VSWR) of 1.02. The radiation pattern analysis confirms the suitability of the antenna for 5G communication systems. The compact size, low profile, and ease of fabrication make the proposed antenna an attractive choice for 5G applications

5. REFERENCES

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