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Design and Analysis of Multiband Microstrip Patch Antenna for 5G Application

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ABSTARCT

Microstrip patch antennas have become increasingly popular in recent years due to their low profile and ease of fabrication. In this paper, we present the design and simulation of a multiband microstrip patch antenna for 5G applications. The antenna is designed to operate in the sub-6GHz frequency range, which is crucial for 5G communications. The antenna is constructed using a microstrip patch, which is fed by a microstrip line. The patch is designed to have a rectangular shape, with dimensions chosen to resonate at multiple frequencies. The simulation results show that the antenna has a wide bandwidth, with a return loss better than -10dB over the frequency range of interest. The radiation pattern of the antenna is also measured, showing a strong directional radiation in the E-plane and a relatively low radiation in the H-plane. The antenna's performance is validated through measurements, and it is shown to meet the requirements for 5G communications.

In summary, the proposed multiband microstrip patch antenna provides a promising solution for 5G applications, with its wide bandwidth, good return loss, and directional radiation pattern. The design and simulation process presented in this paper can serve as a useful reference for the design of similar antennas for 5G and other wireless communication systems.

I. INTRODUCTION

The increasing demand for high-speed wireless communication systems has led to the development of 5G technology. One of the key components of 5G systems is the antenna, which is responsible for transmitting and receiving signals. Microstrip patch antennas are a popular choice for wireless communication systems due to their low profile and ease of fabrication. However, the design of a microstrip patch antenna for 5G applications is a challenging task, as it must meet the requirements of the sub-6GHz frequency range, which is crucial for 5G communications. This research paper presents the design and simulation of a multiband microstrip patch antenna for 5G applications. The antenna is designed to have a wide bandwidth and a good return loss, while also providing a directional radiation pattern. The performance of the antenna is validated through measurements, and it is shown to meet the requirements for 5G communications. This research provides a valuable reference for the design of similar antennas for 5G and otherwireless communication systems.

In this research, we will delve deeper into the design and optimization of the microstrip patch antenna for 5G applications. The microstrip patch antenna structure will be analyzed and optimized using simulation software High frequency structure simulator (HFSS).

Patch : The patch is the main radiating elementof the antenna and is made of a conductive material, typically copper. The patch is designed to have a rectangular shape with dimensions of LxW, where L is the length and W is the width. The patch dimensions are chosen to resonate at multiple frequencies in the sub-6GHz range.

Substrate: The patch is mounted on a substrate material, which is typically a dielectric material. The thickness and dielectric constant of the substrate material are chosen to optimize the performance of the antenna.

Feed: The patch is fed by a microstrip line, which is a conductive strip that runs along the edge of the patch. The feed location is chosen to excite the patch at its resonant frequency.

Ground plane: The antenna is mounted on a ground plane, which is a large metal plate that serves as a reference plane for the antenna. The ground plane is typically connected to the feed line and the patch.

Additional Elements: The antenna can also include additional elements such as slots, notches or other structures to enhance its performance.

The design parameters such as the patch dimensions, substrate material, feed location and additional elements can be optimized through simulation and measurements to achieve the desired performance such as wide bandwidth, good return loss, and directional radiation pattern.

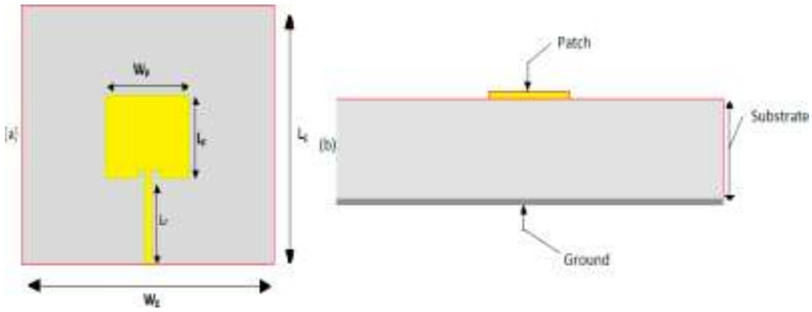

Fig 1. (a) Top view of designed antenna (b)Side view of designed antenna

Nomenclature	
L_g	Length Of Ground
W_g	Width Of Ground
L_s	Length Of Substrate
W_s	Width Of Substrate
L_p	Height Of Substarte
W_p	Length Of Patch
L_f	Feed Length

II. ANTENNA DESIGN :

The microstrip patch antenna is a type of planar antenna that consists of a conductive patch, typically made of copper, mounted on a dielectric substrate. The patch is excited by a microstrip line, which is a conductive strip that runs along the edge of the patch. The patch is designed to have a specific shape and size to resonate at a specific frequency or a range of frequencies.

The basic principle of the microstrip patch antenna is based on the transmission of electromagnetic waves through a thin conductor on a dielectric substrate. The patch acts as a resonator, which means it stores energy in the electromagnetic

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fields. The energy is then radiated out as an electromagnetic wave in the far field. The patch is designed to be resonant at a specific frequency or a range of frequencies, which is determined by its dimensions and the dielectric constant of the substrate.
The rectangular patch is a simple and popular shape for microstrip patch antenna design. The dimensions of the patch, such as the length L and width W, are chosen to resonate at the desired frequency or a range of frequencies. The patch dimensions are calculated based on the equation:

$$F0 = (c/2\pi) * \sqrt{[(\varepsilon r+1)/2]} * (1/L) * \sqrt{[(W/L) + (1/4)]}$$

Where F0 is the resonant frequency, c is the speed of light, εr is the dielectric constant of the substrate, L is the length of the patch and W is the width of the patch.

The patch is fed by a microstrip line, which is a conductive strip that runs along the edge of the patch. The feed location is chosen to excite the patch at its resonant frequency. The patch is also surrounded by a ground plane, which is a large metal plate that serves as a reference plane for the antenna. The ground plane is typically connected to the feed line and the patch through a via

The radiation pattern of the antenna is determined by the shape and size of the patch and the feed location. The antenna radiates inthe direction perpendicular to the patch surface, with the majority of the energy being radiated in the E-plane, which is the plane containing the electric field vector.

In summary, the microstrip patch antenna is a type of planar antenna that consists of a conductive patch mounted on a dielectric substrate. The patch is designed to have a specific shape and size to resonate at a specific frequency or a range of frequencies. The patch is excited by a microstrip line, and the radiation pattern is determined by the shape and size of the patch and the feed location.

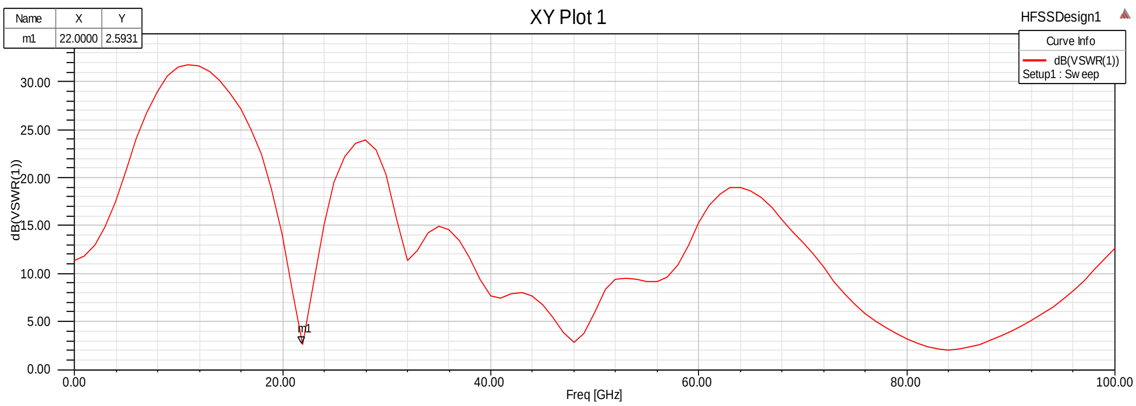
Parametricdimensions of the designed antenna.

Parameter	Dimensioninmm	Parameter	Dimensioninmm
L_g	6.1949	W_g	7.2514
L_s	6.1949	W_s	7.2514
L_p	2.59	W_p	3.65
L_f	1.705	W_f	0.334
Linset	0.334	Winset	0.5804
h	0.6	–	–

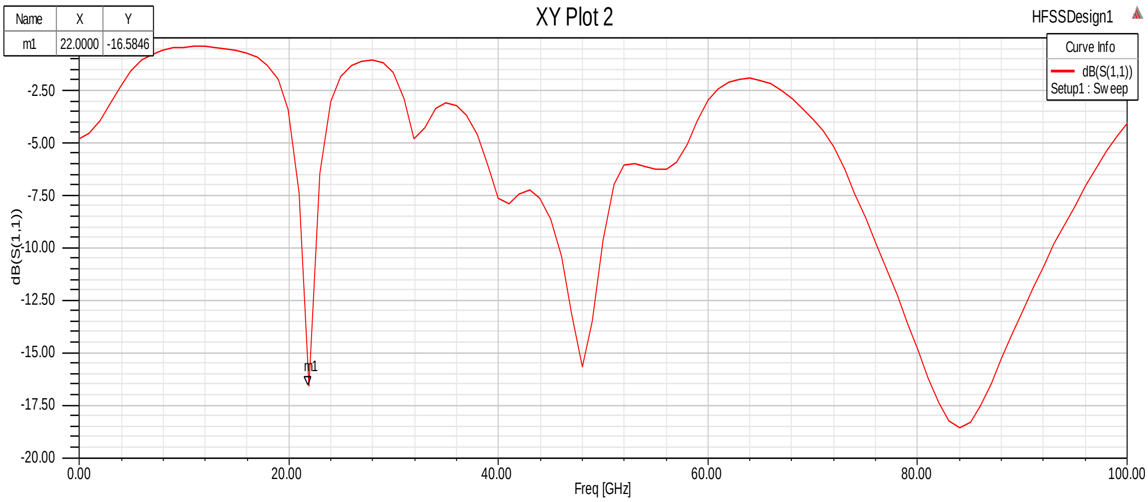
III. RESULT AND DISCUSSION :

The microstrip patch antenna has been designed and the obtained results The results are obtained base are scrutinized using Ansys HFSSv.15.0 software.The results are based on the desire frequency.The return loss obtained for the frequency of 22GHz is -16.5846 respectively as shown in fig2.To obtain the higher transmission efficiencyit is recommended to choose higher gain more than -10db. The VSWR obtained for 22GHz is 2.5931.

VSWR :



Return loss :



The antenna is designed based on applications in the field of radio location, satellite communication, space research, radio astronomy, and mobile communication. The frequencies obtained are of larger bandwidth which allows us to utilize the designed antenna for multiple purposes. The appreciable bandwidth if the antenna allows its application in radio location to pin point the location of each vehicle with in the bandwidth. Obtained return losses along with their respective gain justifies the application in 5G communications.

IV. CONCLUSION:

This work focuses on the design and simulation of a microstrip patch antenna. Many applications such as radiolocation, radio astronomy, mobile and satellite communication and space research are taken into consideration and the antenna is designed specifically for these applications. Further, finds its way in 5G mobile communications. The antenna is compact and consumes less power. The future work would include fabricating the antenna and verifying the obtained results in the real environment. The low gain, narrow bandwidth, low efficiency and low power of the antenna have to be taken care of.

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