Analysis of Rectangular Shape Microstrip Patch Antenna for Wireless Communications

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Abstract— Compared with traditional antennas, diversity antennas have the advantages of small dimension, small volume, light weight and easy construction, as well as low interference and high performance. After this all the learners are using mobile phones to attend classes and teachers are using cell phones to take web classes. For the above usage we need a fast 5G organization with high bandwidth. This paper proposes a reduced 5G microstrip patch antenna with DGS structure for better detection in 5G wireless applications. The DGS concept is widely used to improve the radiation characteristics of receivers. In the proposed work, a 5G microstrip patch antenna with FR4 substrate having thickness of 0.4 mm and dielectric constant of 4.4 is planned.

Index Terms- Microstrip Patch Antenna, Dielectric Substrate, Bandwidth, Radiation Pattern, 5G.

I. INTRODUCTION

The concept of radiator with alphabet letter E-shape can be created using various slot antenna technologies for WLAN and Wi-Max applications. The frequency range of E-shape microstrip patch antenna for wireless communications is between 1.9 GHz and 2.8 GHz [1]. Low-profile single- and dual-band antenna designs provide a wide bandwidth, feedline endurance, frequency flexibility and beam inspection for Internet of Things applications [2]. Mobile, satellite, adjusting remote controls, various computer linkages, and radar systems are some of the communication systems that use RMPA. Narrow bandwidth is one of the shortcomings of this type of antenna. Its performance is enhanced by the use of multiple antenna methods. It is a direct microstrip patch antenna fabricated directly on a printed circuit board (PCB) with a irradiated patch component and a defect ground structure [3].

To generate multi- and dual-frequency band response, the slots are required to be defected. The ground is carved into the structure [4]. To meet the desired results, rectangular microstrip planar patch E-shape antenna has been designed, fabricated and simulated at 2.8 frequency band [5-6]. Various types of antennas are proposed using circular, triangular and square methods with the aim of reducing the size and improving operational parameters [7]. Butterfly-shaped patch antenna with improved gain for 5G applications reported. Metamaterial is also one of the best methods to improve the directivity and bandwidth of patch antenna for S-band application [8].

II. LITERATURE SURVEY

Smart home gadgets and devices are becoming increasingly popular, and 5G networks are essential to ensure device connectivity and application monitoring. Furthermore, 5G wireless networks are critical to the development of self-driving cars, as they require high throughput and low latency for autonomous driving. With intelligent traffic lights, environment-based objects, and other moving vehicles interacting with the automobile, every millisecond counts to prevent accidents and ensure passenger safety[1]. To achieve this, high speed data rates and sufficient bandwidth are required, which cannot be provided by the current 4G data rate. Therefore, 5G millimeter waves are being used to increase the bandwidth [2]. In this context, a rectangular microstrip patch antenna with good reflection coefficient, high gain and bandwidth was developed. The microstrip patch antenna is an essential component of wireless communications and consists of a ground plane, dielectric substrate, and a thin copper metal patch [3]. Rectangle and circular shapes are the most commonly used shapes for microstrip patch antennas, and in this project, a rectangular shape was chosen. Selecting dielectric materials with low permeability to ensure high efficiency [4-5]. Microstrip patch antennas are widely used in wireless communications applications. Due to their low profile, ease of production, and compatibility with flat circuits. Rectangular microstrip patch antennas, in particular, are frequently used in 5G applications due to their high gain, efficiency, and compatibility with high-frequency bands [6–8].

The world is facing a technological revolution in the 21st century that has ushered in a redefined civilization of global connectivity. Wireless communication is one of the major features of this technological revolution, which has a great impact on our daily lives. To meet the key performance factors of wireless communication such as high data traffic, massive connectivity, low latency of various wireless devices, sub-6 GHz technology is a suitable candidate. Sub-6 GHz wireless bands are allocated for many wireless technologies such as WiMAX, WiFi, 3G, 4G and the most promising 5G applications [9]. Sub-6 GHz has opened the door to a new era of innovation and connectivity that will power cloud computing, smart traffic systems, AI services, automated industrial infrastructure, robotics, HD live streaming, virtual reality, augmented reality, space and astronomy, smart -Enables. home, smart transportation [10], IoT, distance learning and healthcare services especially during the period of global pandemic like COVID-19 [11].

Recently, some researchers are using machine learning approaches to design low-cost portable electronic devices for applications like 5G, WiFi, WiMAX, WLAN, etc. [12]. To provide these myriad services, sub-6 GHz 5G has some key features such as massive data rates, myriad connectivity, ultra-low latency, high reliability, wide coverage area, and high mobility [13]. Similarly, due to its properties of very high peak data rates, high mobility and multi-device connectivity, WiMAX technology is widely used. The most popular band of WiMAX is 3.5 GHz (3.3–3.6 GHz) which falls in the sub-6 GHz band [14]. WiMAX technology is widely used for cellular backhaul, broadband Internet, VoIP, interactive gaming, IP Multimedia Subsystem (IMS), etc. Although mm-wave 5G offers much faster data rates with higher spectrum, sub-6 GHz 5G technology is more practical. -Known technology with its wide coverage and implementability. The most popular Sub-6 GHz 5G band (3.3–4.2 GHz) is the 3.5 GHz band. In wireless technology, antennas are the key elements for establishing a communication link. Many researchers around the world are developing different types of antennas. Microstrip patch antennas are the most popular type of antenna due to their important characteristics. Microstrip patch antennas have some desirable features such as simplicity, robustness, compatibility of integration, cost effective, energy efficient, light weight and ease of fabrication. These key characteristics of microstrip patch antennas (MPAs) make them the hot cake of sub-6 GHz wireless communications.

They are being developed by modern day researchers with independent shapes of many designs with respect to their utility and requirement. Various methods are used to design MPAs, among which DGS is one of the popular strategies to enhance the radiation characteristics of MPAs [15–17]. DGS is a very popular technique due to its versatility and freedom of structure. Over the years, various types of antennas have been developed to comply with the increasing demand in many applications of wireless technologies [18].

III. ADVANTAGES OF MICROSTRIP PATCH ANTENNA

1. Microstrip feeding line is easy to fabricate, easy to match with internal position control and easy to model. However, as substrate thickness increases, surface waves and spurious feed radiation increase, limiting the practical design bandwidth.
2. Microstrip antennas are relatively inexpensive to fabricate and design due to their simple 2D physical geometry. These are commonly used at UHF and higher frequencies because the antenna size is directly related to the wavelength at the resonant frequency.

IV. METHODS OF ANALYSIS OF MICROSTRIP PATCH ANTENNA

The most common methods to analyze microstrip patch antennas are the transmission line model, the cavity model, and the full-wave model (originally including the integral/transient method). The power line model is the simplest and provides good physical understanding but is less accurate. The cavitation model is highly accurate and provides a good physical understanding but is inherently complex. Full wave models are very accurate and flexible and can handle single elements, finite and infinite matrices, stacked elements, arbitrary shaped elements, and intersections. There are several methods for analyzing microstrip antennas; The most common is a transmission line (where we assume that the patch is a transmission line or part of a transmission line). The second method is cavity placement (here we assume that the patch is a cavity filled with insulating material). The transmission line method is the easiest way to study microstrip antennas. In this approach, the transmission line model represents a microstrip patch antenna with two slots, separated by a low-impedance transmission line of length L. The results obtained are not the most accurate compared to other methods, but they are good enough.

V. ANTENNA DESIGN

In the suggested design, the microstrip patch antenna was created using CST software. Feed Line Because of their flexibility for multiple frequency operation, circular and rectangular patch antennas are often used for a variety of applications. We increased the design parameters of the microstrip rectangular patch antenna such as substrate width and length to improve the return loss and bandwidth. In the proposed microstrip rectangular patch antenna we have removed the E-shaped patch and used a rectangular patch to increase the directionality and convert the omni-directional antenna into a directional antenna. Therefore the directionality of the microstrip rectangular patch antenna increases.

The dielectric constant of the substrate is closely related to the size and bandwidth of the microstrip antenna. A lower dielectric constant produces a larger bandwidth, while the result is a higher dielectric constant. Basic design feature of patch antenna on FR-4 substrate with dielectric constant 4.4 The main advantage of this type of power supply scheme is that the power supply can be placed at any desired location within the patch to match its input impedance. can be placed. This feeding method is easier to make and involves less duplicate radiation.

An antenna is a device that transmits and receives radiated electromagnetic waves. There are several important antenna characteristics to consider when choosing an antenna for our application, as follows:

1. Antenna radiation pattern
2. Refund of damage
3. VSWR

The radiation pattern of an antenna is a graph of the relative field strengths of radio waves emitted by the antenna at different angles. The loss of signal power due to reflection due to imbalance in the transmission line is called return loss. VSWR is the voltage standing wave ratio which is defined as the power reflected from the transmission line. Microstrip patch antennas are increasingly being used because the patches can be printed directly on the circuit board. In the mobile phone market, microstrip antennas are widely used.

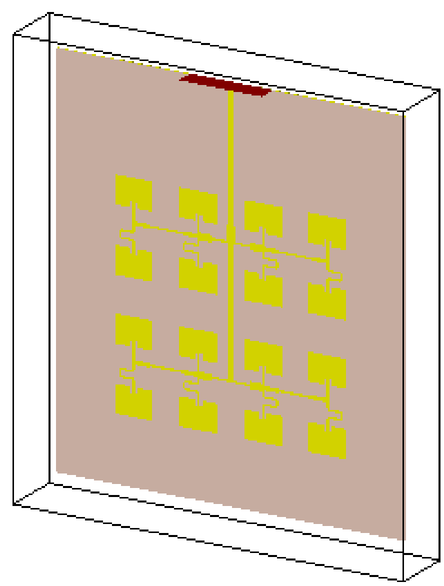

Figure.1. Model of Antenna

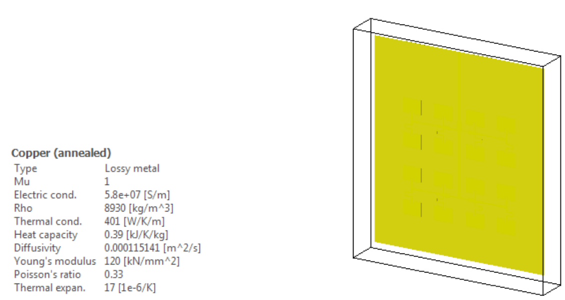

Figure.2. Ground plane of Antenna

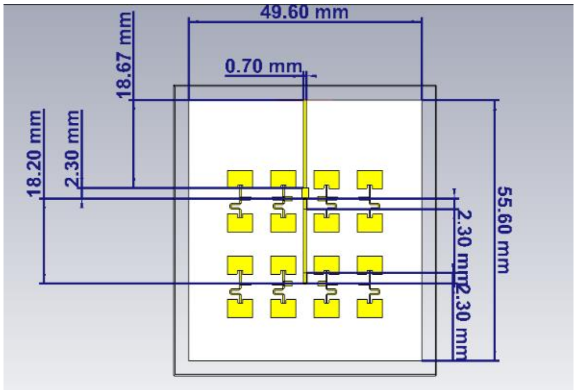

Figure.3. Dimensions of Antenna

VI. RESULT AND DISCUSSION

To get good quality the VSWR should be in the range of 1≈VSWR≈2. (S11) represents the reflection coefficient, sometimes called return loss. Antenna performance generally depends on good reflection coefficient or return loss at least better than -10 dB or -15 dB because the return loss of an antenna is the ratio of incoming power to reflected power. If the reflection coefficient is 0 dB then the antenna radiates no power. Since the antenna has reflected all the power.

Radiation plot of a microstrip patch antenna A radiation pattern is a graphical representation of how an antenna propagates electromagnetic waves into the surrounding space. The radiation pattern of a microstrip antenna depends on its physical dimensions, the dielectric constant of the substrate, and the frequency of operation. In general, microstrip antennas have a directional radiation pattern with maximum radiation in the direction perpendicular to the patch. The radiation pattern defines the variation of power emitted by an antenna. The antenna gain compared to a theoretical antenna is the ability to emit more or less in any direction.

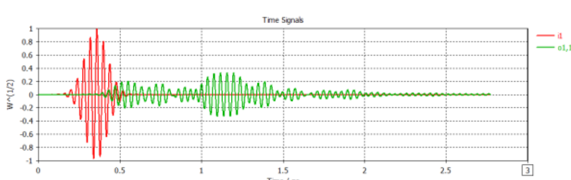

Figure.4. Time signal

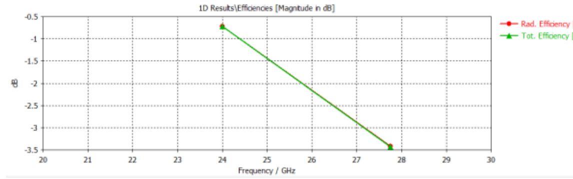

Figure.5. Radiation and total efficiency of Antenna

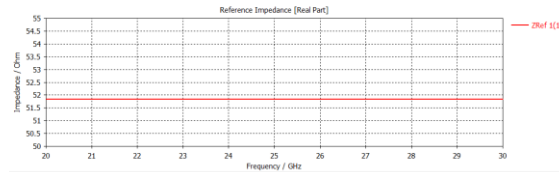

Figure.6. Reference Impedance

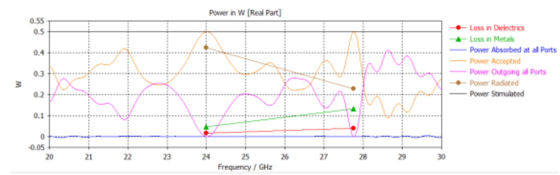

Figure.7. Power in W

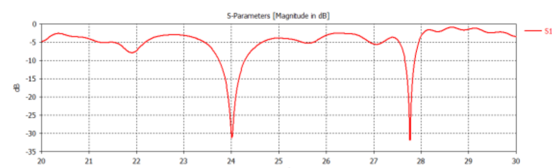

Figure.8. S- Parameter

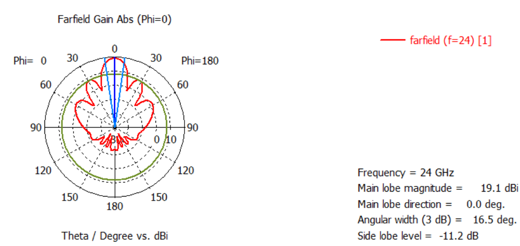

Figure.9. Farfield (f = 24 GHz)

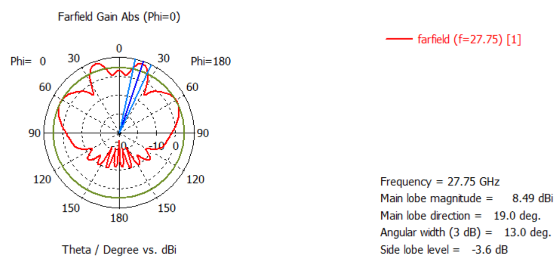

Figure.10. Farfield (f = 27.75 GHz)

CONCLUSION

It is concluded that the desired values of various performance parameters such as bandwidth, gain and return loss can be achieved by using techniques such as fractal geometry and insertion of slots. Some suggestions for future improvement are given such as improvements in the geometry of the fractal structure can be further explored to obtain better results. Various techniques, such as using parasitic patch and reflective layer, replacing the conventional substrate with air substrate, etc., can have a great advantage in achieving the performance parameters of the microstrip antenna. CST simulation results show that the antenna can detect wide-band characteristics with a return loss of -31.00 dB at 24 GHz, -32.50 dB at 27.75 GHz.

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