MICROSTRIP PATCH ANTENNA AT 28GHZ FOR 5G NETWORK SYSTEM

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ABSTRACT
The whole world is revolving around the latest technologies and networks. Which made the generations of networks get updated within short period of time and these changes made the connectivity faster and more responsive. The microstrip patch antenna at 28GHz frequency is designed in the favour of 5G network. The CST software is used for simulation and results were obtained with analysis. The efficiency of the designed antenna is analysed based on the s-parameter (return loss), gain, VSWR, 3D&2D radiation characteristics, Electric and magnetic fields. As we define 5G network as the more responsive, easy connectivity and can handle a greater number of devices at a time with more capacity. The microstrip patch antenna which is designed can be perfectly fitted into a IoT device as it occupies less space and with greater efficiency in a 5G network for a wireless communication. The increased broadband prevalence of next generation of mobile communication, as well as other service applications, will almost certainly rely on new advanced antenna innovations. In this regard, the narrow beam widths commonly associated with antennas operating at higher frequencies have prompted research into the use of advanced multiple-input multiple-output (MIMO) architectural design along with adaptive beamforming.

Keywords: Microstrip patch antenna, 5G Network, multiple-input & multiple-output.

1 Introduction
In recent years, the wireless telecommunications market has emerged as one of the most vibrant and fastest growing segments of the global telecommunications industry. In this regard, the world has witnessed four generations of mobile technology, with each new generation extending capability and improving end-user experience over the preceding generation. In this regard, the global mobile communication system has evolved significantly, beginning with 1G and progressing through several modifications to the emergence of 4G. These versions include a slew of new services, including voice, text, and multi-media [1-5].

The fifth-generation network is expected to greatly improve communication capability by utilising a large amount of spectrum within the metric linear unit wave [6-8]. It is also expected to be capable of providing and supporting extremely high data rates to the full extent of fourth generation capability [9-12]. This necessitates new difficult network requirements as well as changes in antenna design for 5G communication systems to meet the anticipated needs and capabilities.

Many fields, such as realistic extremist high definition, computing, block-chain, and services of a web of things like good cities, good transportation, and good grids, have significantly increased because of the massive increase in mobile information in 5G. As the mobile industry transitions to the milli-meter-wave spectrum, carriers will most likely use the 28, 38, and 73 gigahertz bands that may become available for future technologies.

According to the requirements for 5G, antennas with a low profile (a compact size), a low cost of production, simple installation, satisfied on the placid surface and additionally non-planar surface, naturally sturdy once mounted on a rigid surface, and aligned with a monolithic microwave microcircuit are extremely important. Despite its small information size, the micro strip patch antenna will be an excellent candidate for all higher-than-
necessary applications [13-19].

Antennas for next-generation wireless communication networks are expected to achieve a high-rate while being low in cost, light in weight, and small, with multi-frequency options. They are also said to have high gain for 5G networks to overcome high path loss at mm-wave frequencies. Microstrip antennas, as opposed to other types of antennas, will meet these requirements. However, in their basic form, microstrip antennas have some drawbacks, such as low radiation potency, a small information measure, and surface wave excitation [20-24].

According to the literature review, numerous approaches are being investigated to improve the performance of written circuits and antennas. Defected Ground Structure (DGS) is one of the techniques used by researchers to overcome some of the drawbacks, particularly when designing electrically tiny antennas. On the other hand, researchers around the world are planning antennas with completely different shapes and style techniques for 28GHz and 38GHz communication. The square measures are aimed at antenna arrays, while other researchers continue to work on single-part antennas for similar applications [25-32].

As illustrated in the antennas style, designing high-speed networks for digital media system applications may be a difficult task. Broadband systems are encouraging 5G metrics because they provide high knowledge rates, low energy consumption, and extensive data measures. Such systems and antenna designs have piqued the interest of researchers all over the world.

A tri-band antenna, for example, has been bestowed for higher 5G bands. The antenna's performance was determined to be quite acceptable. However, the optimised style's size is incompatible with mobile devices.

Whatever advancements are made by released recently wireless technologies, the goal of every wireless communication is to collect data, which is impossible without an antenna, however an antenna plays a fundamental role and can affect the entire system's functionality in terms of bandwidth, beamwidth, and efficiency. With the rapid advancement of wireless communication systems, the leading to improved antenna design characteristics such as antenna size, traffic demand, high data rate, bandwidth, gain, and efficiency grows. These required features lead to various antenna designs to achieve trade-offs in antenna size vs antenna cost, high radiation efficiency and high gain vs low loss, high bandwidth, and high data rate. Numerous microstrip antennas have been designed for various applications, i.e., for WLAN, PCS, 2G, 3G, and for 4G.

The increased demand for telecommunications services is propelling the development of new call-handling technology solutions. Data transfer speed has doubled with each evolution of cellular technologies, as has connection quality and new functions. The fourth generation (4G) technology, which is currently in use, has been available globally since 2009.

The fifth generation (5G) network enables a wide range of new services, including those related to the Internet of Things (IoT) and the smart urban concept. The new technology will make use of low, medium, and high frequency bands, each with its own set of benefits and drawbacks. The wide-scale deployment of a 5G network, on the other hand, necessitates the planning of antenna infrastructure as well as the implementation of innovative technology innovations. Many antennas (other than those used for mobile devices) will be installed inside buildings, especially common carrier buildings such as stadiums, train stations, and shopping malls. It should be noted at this point that antennas assembled near large groups would be thinner than those used in current macro-cell transmission. This is a significant differentiation and a common source of confusion in public debate.

In a traditional antenna system, power is radiated in accordance with the spatial characteristics that have been established. As a result, the area in which users can be found is predefined. In contrast, the power in a 5G antenna is emitted in a specific direction and targeted at specific users or groups of users. To focus on mobile users, radiation patterns directions can change almost inevitably.

2 Characteristics of the 5G System

To meet the growing demands of users, the 5G network employs new technological solutions. As a matter of fact, the new system will be able to handle a growing number of devices while also meeting the higher quality thresholds requirements of modern applications. It is a development of today's 4G networks, incorporating technologies capable of managing rapidly increasing amounts of transmitted data and facilitating data exchange
between an ever-increasing number of IoT devices. As is typical for the introduction of any next-generation network, it is expected that the 5G network will have to cohabit with existing 4G networks until its coverage and functionality can match or surpass such networks.

In addition to the current mobile network operating systems, three additional scenarios for the evolving 5G network are arranged, all of which will be of key significance to users and will differentiate the 5G network from past generations.

The first new interpretation scenario is advanced user broadband, which enables high-speed internet connectivity up to 1gbps and will be the distinguishing feature of this network when compared to existing networks, particularly in the early stages of implementation. This main benefit of the 5G system over existing protocols will improve the performance and accuracy of societal communications.

As an instance, this will enable service providers on the delivery of high-resolution digital media, appealing methods of communication for example, video, enhanced and virtual reality, content transmission from high-resolution cameras.

The second application of 5G networks is centred on massive machine type communications (mMTC), in which 5G will be able to handle many interactions from low-power devices known as the Internet of Things (IoT) to the cellular network. These devices exchange information asynchronously while communicating via the mobile network. This statement suggests support for a wide range of device types, with the caveat that these devices will only use the mobile network on occasion, exchanging small amounts of data.

The third application is ultra-reliable low latency communications (URLLC), which is a technology that provides data exchange over a mobile network with a minimum 1ms latency for critical applications for instance, drone control. Previous generations of mobile networks had higher latency values, which were around 100 milliseconds for 3G networks and around 30 milliseconds for 4G (LTE—Long Term Evolution) networks.

The current state of standardisation of the 5G network calls for it to operate in three frequency bands, namely low, medium, and high. The use case of a particular band is determined by its characteristics, which include two factors in particular: radio signal propagation and spectrum resource capacity. The first factor is related to the physical properties of electromagnetic waves and determines radio transmission range in changing weather conditions as well as radio signal coverage in difficult-to-reach areas (e.g., interiors of buildings). The second factor is the number of RF bands available in each frequency range that can be used by 5G networks. It should be concluded that high bandwidths necessitate a broad radio band, which, as a restricted resource, is subject to rationing, and its use should also account for RF communications systems other than 5G networks, such as TV broadcasts, radio communication for smart home equipment, and so on.

The following three frequency bands are assumed to be used first in a 5G system:

• 694 to 790 MHz (700 MHz band)
• 3400 to 3800 MHz (3.6 GHz band)
• 27.50 to 28.35 GHz (28 GHz band)

The 700 MHz band has good signal transmission and comparatively low attenuation (signal absorption by various obstacles), allowing it to reach vast areas. Because of these characteristics, this band is suitable for mMTC services.

However, the 700 MHz band alone may not be able to provide mobile phone users with broadband internet access (eMBB) because it does not support MIMO, which might increase the size of each cell site.

Also, it can be used in conjunction with the bands mentioned below, which have abundant wavelength resources. This way of operating enhances the effectiveness of signal transmission from the user to the access point (i.e., “upstream”).

3 Antenna Design

In this paper, the antenna is designed at 28GHz operating frequency in favour of 5G network technology. such
that the antenna can provide services even to dead ends and with unusual requirements to manage the performance of antenna and its communication system.

The microstrip patch antenna as shown in fig.1 is designed and simulated using time-domain solver of CST microwave studio suite. The antenna is simulated under PML boundary conditions. The simulations are shown in figure 4 to 9. The S-parameter is -30 dB for the operating frequency of 28 GHz is represented in figure 4 and the VSWR is represented in figure 5. The three-dimensional (3D) radiation pattern and two-dimensional (2D) radiation characteristics are represented in figure 6 & 7, respectively. the radiation pattern shows that the main lobe direction is 53.0 degrees with a magnitude of 0.288 dB. The simulated gain observed in the conventional antenna is 5.173 dB. The field distributions of E-field and H-field are shown in figure 8 and 9, respectively. The Surface current and Current density of the antenna are shown in figure 10 and 11. The current field for the antenna is represented in figure 12. The energy concentrated more on the edges of the feed and radiating element are from E and H field distributions.

![Fig. 1. Design of microstrip patch Antenna](image)

**Table 1: Parameters of Microstrip Patch Antenna**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Wg-Ground Plate Width</th>
<th>Lg-Ground Plate Length</th>
<th>W-Microstrip Width</th>
<th>L-Microstrip length</th>
<th>Y-Insert Length</th>
<th>Wf-Width of Microstrip Feed</th>
<th>G-Pitch Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units (mm)</td>
<td>11.25</td>
<td>13</td>
<td>9.50</td>
<td>5.20</td>
<td>1.00</td>
<td>0.77</td>
<td>0.15</td>
</tr>
</tbody>
</table>

4 Results and Discussion

The results are secured with the help of multiple comparative parameters such as S-parameter (return loss), Voltage Standing Wave Ratio (VSWR), 3D and 2D radiation characteristics, E-field (Electric field), H-field (Magnetic field) as shown in the figures for better efficiency and its performance of the designed antenna in 5G network atmosphere.
Fig. 2. Return Loss for microstrip patch antenna

Fig. 3. Voltage Standing Wave Ratio for microstrip patch antenna

Fig. 4. 3D pattern for microstrip patch antenna

Fig. 5. Radiation Pattern for microstrip patch antenna
Fig. 6. Electric Field for microstrip patch antenna

Fig. 7. Magnetic Field for microstrip patch antenna

Fig. 8. Surface current for microstrip patch antenna
Hence, the results were obtained and concluded from the analysis and comparisons made among all the parameters which will affect the antenna efficiency and its performance in ground reality. The designed microstrip patch antenna has designated to the 5G Network applications as the results achieved meets the requirements of the 5G network environment for wireless communication. This is because of the operating frequency, which is chosen, and the obtained return loss witnessed the ideal design to proceed further.

Table-2: Return loss, gain, E-field, M-field:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Operating Frequency</th>
<th>gain</th>
<th>Return loss</th>
<th>E-field</th>
<th>M-field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td>28 GHz</td>
<td>5.173 dB</td>
<td>-30 dB</td>
<td>96.6e+03 V/M</td>
<td>224.4 A/M</td>
</tr>
</tbody>
</table>

5 Conclusion

In this paper, designed and analyzed the next generation 5G technology antenna using microstrip antenna. The antenna operates at 27.5 GHz to 28.5 GHz with a bandwidth of 1 GHz, the centre frequency of operation is 28 GHz. The proposed 5G antenna with gain of 5.173 dB at 28GHz which is best suitable for outdoor
communications. The parameters like return loss, VSWR, Gain, Bandwidth and Beam width are analyzed in this work through simulation of commercially available simulation tool. All the simulation results show that the antenna is best suitable for 5G applications. This work is further enhanced to fabrication and validation of results for practicality.

References


