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Design of Microstrip Patch Antenna for 5G Applications

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ABSTRACT

Millimeter-wave wireless technology (mmWave) has become a part of human life for fast and secure data transmission. This document introduces a 37GHz resonant frequency square microstrip patch antenna for mm Wave wireless communication. The antenna was designed and tested on a Rogers RT5880 board with a relative permittivity of 2.2 and a loss factor of 0.0009. Uses electromagnetic simulation software High Frequency Structure Simulator. The result of this paper shows minimal return loss -0.0812 dB, gain -1.205 dB, and impedance bandwidth 16.22% at 37 GHz resonant frequency. The voltage standing wave ratio (VSWR), radiation pattern has also presented for the proposed antenna which can be strong candidate for 5G mmWave cellular communication.

***Keywords:** Microstrip patch antenna, mm Wave, 5G, Return loss, Wireless communication.*

1. Introduction

Beyond the 4G network, the fifth generation network, which operates in the millimetre wave frequency band, will play an important role in wireless communication. The mobile communication revolution is ranked from 1 to 4G, with each generation outperforming the previous one [1],[2]. Machine-to-machine communication, remote host monitoring, recorded call data transmission, and other functions of 4G technology are common. High energy consumption, connection loss, and low quality and content area are some of the disadvantages of 4G technology, all of which decrease system performance [3],[4]. Every day, a large number of new devices connect to wireless networks [5]. 4G wireless technology will not be able to meet future demand due to the rising proliferation of mobile devices. A connected gadget in mobile communication [6]. To guarantee high data speeds. The mobile communication system must be improved to provide better connectivity and high-quality networks [7].

Microstrip antennas are utilized in a variety of wireless applications, including WLAN, Wi-Fi, Bluetooth, and others [8]. Microstrip patch antennas are becoming increasingly popular because to their several benefits, including small weight, low volume, compatibility with integrated circuits, ease of installation on rigid surfaces, and low cost. Microstrip patch antennas are designed to work in either dual or circular polarisation in dual-band and multi-band applications. These antennas can be found in a variety of handheld communication devices [9]. In 2016, the Federal Communications Commission (FCC) designated three licensed millimetre Wave frequency bands for fifth-generation mobile communication: 27 GHz (27.5 to 28.35 GHz), 37 Hz (37 to 38.6 GHz), and 39 GHz (38.6 to 40 GHz) [10]. Following that, many mm wave frequency bands for fifth generation cellular communication have been proposed, including GHz, 28 GHz, 37 GHz, 60 GHz, 64 GHz, 71 GHz, and 73 GHz [11]-[13]. The FCC has suggested mm wave diapason 37 GHz for 5G wireless networks, Internet of effects, and other advanced diapason base services[14]-[18].

2. Numerical Analysis

A 37 GHz operating recurrence opening square microstrip fix receiving wire has been constructed for 5G cellular communication. According to the transmission line model, the entire schematic measurement for the suggested plan was picked. Eqs. 1 and 2 were used to compute the effective dielectric constant reff and the length expansion. Table 1 lists the dimensions of the planned receiving wire.

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}, W/_h > 1 \quad (1)$$

Where, r is the dielectric constant, w is the radiating patch width, and h is the substrate height. The length of a microstrip patch is calculated as follows:

$$L = Leff - 2\Delta L \quad (2)$$

Finally, the effective length and width of the patch are calculated as,

$$L = \frac{C_0}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L \quad (3)$$

Where, W=width of the patch.

$$W = \frac{C_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad (4)$$

Here, C_o=speed of light, εr=value of the dielectric substrate and Length ΔL.

Parameters	Value (mm)
Width of Substrate	12
Length of Substrate	12
Width of Patch	6
Length of Patch	6
Width of Microstrip line feed	0.64
Length of Microstrip line feed	3
Height of Substrate	0.035

3. Results

As a numerical study, the proposed receiving wire is reenacted using the EM programme HFSS (13.0), which is based on the restricted component method. The return loss, voltage standing wave proportion (VSWR), and pick up and radiation design of this proposed radio line at 37 GHz thunderous recurrence for 5G cellular

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communication have all been investigated. These factors determine how well a receiving wire is executed. The effects of receiving wire parameters on radio wire execution were investigated using a comprehensive parametric approach.

$$\frac{\Delta L}{h} = 0.412\frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)} \quad (5)$$

A. Return loss

Return loss is expressed as (S11). The patch antenna has a return loss of -0 and resonates at 18.56 GHz. Fig.1 shows the 081dB level. Waveguide port configuration was used to derive the S11 parameter.

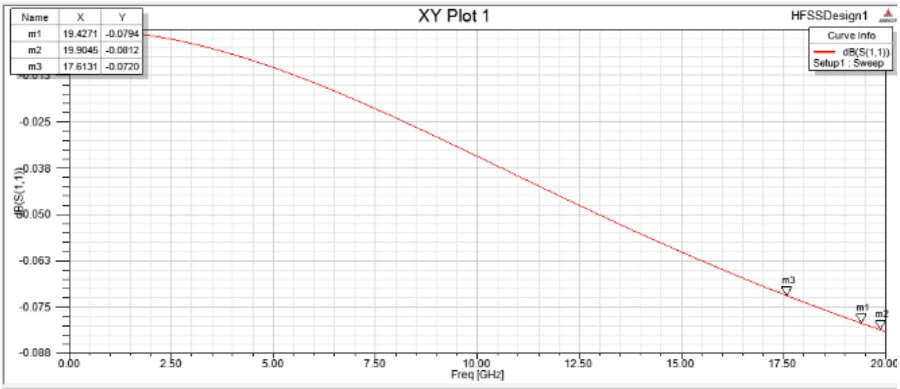

Fig.1. Return Loss

B. VSWR

The HFSS (13.0) programme is used to obtain VSWR recreation results. Standing wave proportion is another term for voltage standing wave proportion. As a result, in shown fig.2, inventors offered a square Microstrip fix receiving wire with a value of 20 at 37GHz.

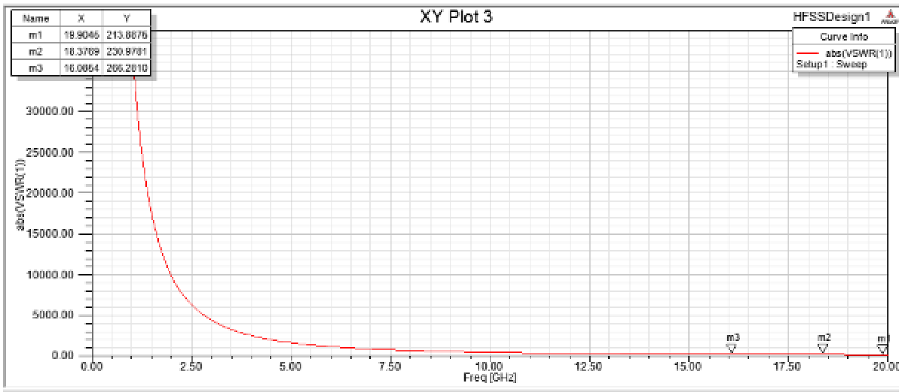

Fig.2. VSWR

C. Radiation Pattern

Figures 3 and 4 demonstrate a 3D and 2D radiation design for a tall -1.205 dB pick up, respectively. Because this radiation design reveals the amount of control radiated by radio wire, tall pick up is really important for 5G distant framework.

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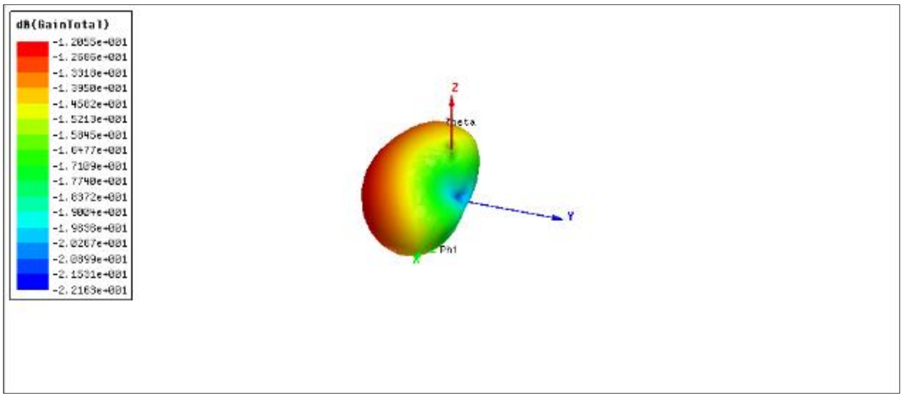

Fig.3. Plot of 3D Radiation Pattern

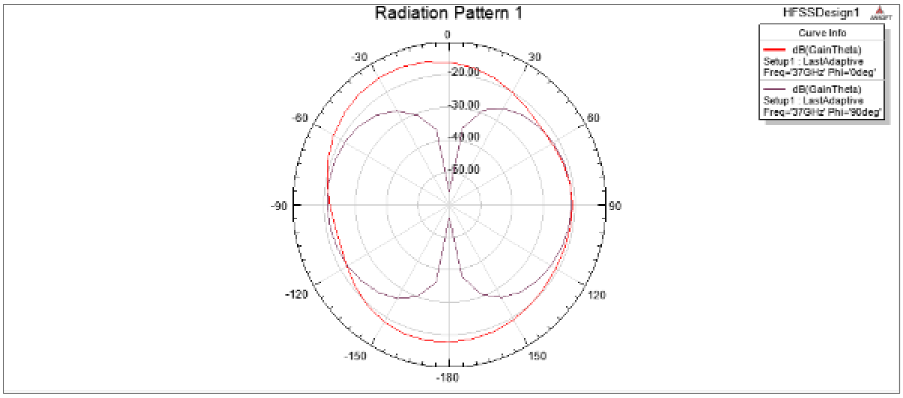

Fig.4. Plot of 2D Radiation Pattern with phi=90 deg and phi=0 deg

4. Conclusion

At 37 GHz thunderous recurrence, a single band microstrip fix receiving wire for 5G wireless communication has been proposed and analysed. Return misery, gain, impedance transmission capacity, VSWR, and radiation design have all been investigated in relation to radio wire execution. At 37 GHz thunderous recurrence, the outcome appears to be a return disaster of -0.0812 dB, pick up of -1.205 dB, and impedance transfer speed of 16.22 percent. For next-generation 5G cellular connection, the proposed microstrip fix receiving wire is quite practical.

Declarations

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Consent for publication

Authors declare that they consented for the publication of this research work.

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