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An improved Mini Antenna Designed at 60GHZ for a New Generation Mobile Phone

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Abstract:- Five-generation (5G) communication systems are being required to meet the needs of small, high-speed, and big bandwidth systems [2]. This paper simulates and designs a 60GHZ rectangular micro strip patch antenna. The proposed antenna resonates at 60GHZ with a return loss of -32.126 dB, efficiency of 87.7119%, and gain of 6.96485 dBi. The patch is 2.726 x 2.364 x 0.125 mm. The radiating patch and the 50Ω micro strip feed line are matched using an iset feed transmission line approach. A Roger RT Duroid 5880 substrate, with a height of 0.125mm and a dielectric constant of 2.20 and a loss tangent of 0.0009, was selected in the design. The Advanced Design System (ADS) was used to compute the antenna's parameters and evaluate the results of simulations.

I. INTRODUCTION

We're living in a time of information technology. We're seeing technological advances we weren't expecting in the past, like mobile communication and cellular telephones. In addition, we can always be at the same time connected to friends and relatives through state of the art communication systems like ATMs, credit cards, mobile phones, internet etc. Improved service, error free and reliable communication, reduced transmission losses are among the major advantages of digital wireless communications systems over analogue Wireless Communication. An antenna is a vital element of communication systems[5]. It is therefore of fundamental importance to understand their principles, so that a wide variety of antennas can be found, among other things: loop antenna, slot antenna, hlical antenna, random periodic antenna, patch antenna etc. . The performance of the antenna depends on a number of basic parameters, these design parameters must be taken into account and should allow adjustments as necessary during the development process in respect of the frequency range of operation, polarization, input impedance, radiation patterns, gain or efficiency[1,3]. A common printed resonant antenna for narrow-band microwave wireless communications that call for semi-hemispherical coverage is the micro strip patch antenna. The micro strip patch antenna has received a lot of attention because of its planar configuration and simplicity of integration with micro strip technology. It is frequently employed as a component of an array.Rectangular, circular, ring, triangular, and elliptical are typical geometries for micro strip antennas[8]. Some patch antennas omit a dielectric substrate in favor of suspending a metal patch in the air above a ground plane using dielectric spacers. In order to create a fair trade-off between technological design concerns and commercial criteria—low cost, compact size, radiation, efficiency, antenna gain, broad band performance, and soon—primarily at mill metric wave band, this need generates a number of design obstacles. Rectangular patches, designed to function at 60 GHz for 5G applications, are used as the network feeding element in coplanar micro strep antenna designs.[1,3]

II. REVIEW OF LITERATURE

Deepa Negia.et.al(2017) "Designing of Microstrip Patch Antenna at 60 GHz using StriplineFeeding for Defense Applications" This work presents the design and implementation of a 60GHz rectangular microstrip patch antenna for military applications employing stripline feeding. The suggested antenna is built on a 0.04 mm thick duroid substrate with a dielectric constant of 2.3.For defense applications, the 60 GHz frequency is utilized due to its extremely secure and interference-resistant characteristics. With a 50 W input impedance and an operating frequency of 60 GHz, the return loss is 24.77dB. The suggested antenna's fundamental characteristics, including directivity, gain, return loss, and electric field, are simulated using the Computer Simulation Technology (CST) microwave studio.

Tran Thi Bich Ngoc(2020)" Design Of Microstrip Patch Antenna For 5g Wireless Communication Applications" Designing and simulating a microstrip planar antenna for fifth generation (5G) wireless applications is the aim of this paper[10]. A 50 Ohm microstrip line supplies power to the antenna construction, which is constructed on a low loss RO3003 substrate with a 3.0 relative permittivity. The suggested antenna offered a very broad bandwidth of 2.5 GHz, a low reflection coefficient of -24.3 dB, a high gain of 5.51 dB at 28 GHz (gigahertz) bands, and a generally omnidirectional emission pattern. The substrate's thickness has altered; depending on the thickness value, the resonance frequency can be at either 20/28 GHz or 20/38 GHz, which are both suggested bands for 5G. In this work, industry-standard software CST Microwave Studio has been used for all simulations.

Ghanendra Kumar and Chakresh Kumar(2020)" Design And Analysis Of U-Slot Mircostrip PatchAntenna For Mobile Communication At 60 GHZ" This work proposes a millimeter wave microstrip patch antenna with low loss and good gain. The antenna is made by creating a U-slot in the patch, and a microstrip feed line powers it. This design has

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the benefits of low manufacturing cost and high gain. The size and form of the antenna affect how well they work. The ultimate goal of wireless communication is to deliver fast data even in challenging geographic locations. The goal is to use a high frequency structure simulator (HFSS) to construct a U-slotted patch antenna at a frequency of 60GHz with maximum antenna gain and minimal radiation loss. Because Rogers RT/duroid 5880 has appropriate mechanical and insulating qualities, we shall employ it as the substrate. The height will be 0.508 mm, and the resonant frequency will be 60 GHz.

III. ANTENNA DESIGN

The frequency of operation (fr) of the antennas is a crucial factor in the design of a rectangular patch antenna[4,9]. It must work with 5G apps, which operate at 60 GHz. This paper's design chose 60GHZ as its resonant frequency. The dielectric material chosen for the design has a dielectric constant (εr) of 3, and it is a Roger R03003.The copper (t) is 0.03 mm high and the dielectric (h) is 0.115 mm high.the calculation of the width (*W*) of the micro strip patch antenna, By substituting $v_o = 3 \times 10^8$, $f_r = 60Ghz$, $\varepsilon_r = 3$.

$$W = \frac{3 \times 10^8}{2 \times 60 \times 10^9} \sqrt{\frac{2}{3+1}} = 1.768mm$$

The value of effective dielectric constant (ε_{reff}) can be obtained from eq. (3.4), By substituting $h = 0.115mm$, $W = 1.768mm$, , $\varepsilon_r = 3$

$$\varepsilon_{reff} = \frac{3+1}{2} + \frac{3-1}{2} \frac{1}{\sqrt{1 + 12\left(\frac{0.115}{1.768}\right)}} = 2.749$$

The value of the effective length (L_{reff}) can be obtained by substituting $v_o = 3 \times 10^8$, $f_r = 60\ GHZ$, $\varepsilon_{reff} = 2.74$

$$L_{reff} = \frac{3 \times 10^8}{2 \times 60 \times 10^9 \sqrt{2.749}} = 1.5078\ mm$$

The value of the fringing length (ΔL) can be obtained by substituting $W = 1.768mm, h = 0.115mm, \varepsilon_{reff} = 2.749$

$$\Delta L = 0.412 \times 0.115\ \frac{(2.749 + 0.3)\left(\frac{1.768}{0.115} + 0.264\right)}{(2.749 - 0.258)\left(\frac{1.768}{0.115} + 0.8\right)} = 0.0561mm$$

The width of the inset-fed (wf) can be calculated using the eqs. (3.3), By substituting values of $Z_o = 50\Omega$, $h = 0.115, \varepsilon_r = 3$, $t \ll 0.8wf$.

$$50 = \frac{87}{\sqrt{3 + 1.41}} ln\left(\frac{5.98 \times 0.115}{0.8 \times wf + 0.033}\right)$$

$$wf = 0.2158mm$$

The length inset of the patch for micro strip line (Fi) can be calculated By substituting values $L = 1.5078mm$, $\varepsilon_r = 3$.

$$Fi = 10^{-4}(0.001699 \times 3^7 + 0.13761 \times 3^6 - 6.1783 \times 3^5 + 93.187 \times 3^4 - 682.69 \times 3^3 + 2561.9 \times 3^2 - 4043 \times 3 + 6697) \times \frac{1.5078}{2} = 0.5321mm$$

The length and the width of ground plane can be calculated as following:

$$L_g = 6(0.115) + 1.5078 = 2.1978mm$$

$$W_g = 6(0.115) + 1.768 = 2.458mm$$

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IV. ANTENNA SIMULATION

For 5G applications, this antenna is intended to operate at 60 GHz. The antenna patch is seen in Figure 1; it is an image from the Advanced Design System (ADS).

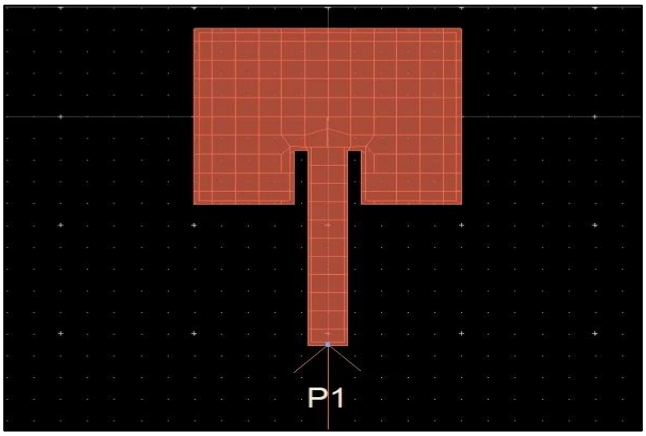

Fig 1: The Patch of the Antenna

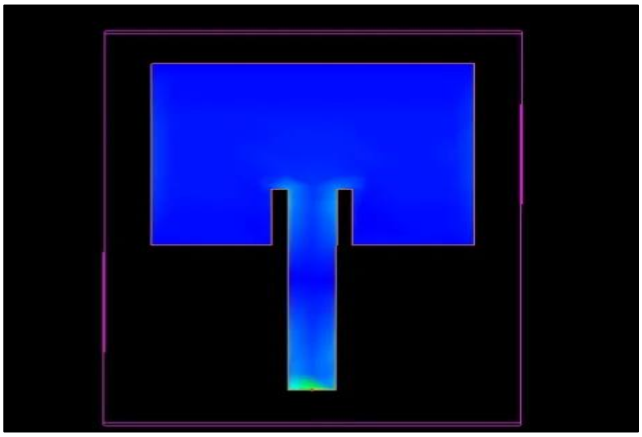

Fig 2: The Upper View of Rectangular Micro Strip Patch Antenna

The graph in Figure 3 displays the return loss (S11) variation as a function of antenna frequency. For a satisfactory operation, it must be less than - 10dB. The frequency band (59.24–60.83 GHz) is displayed by the return loss (S11).

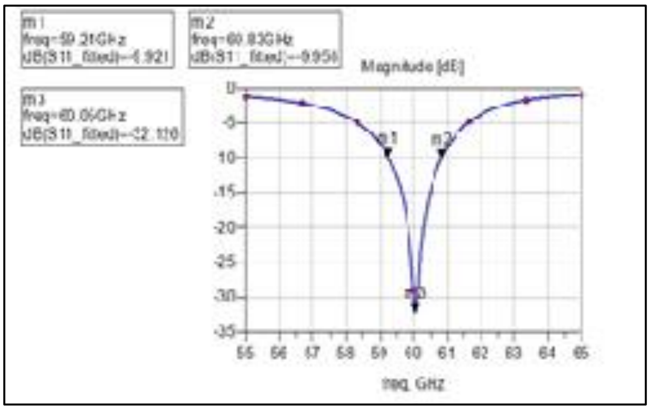

Fig 3: Return Loss (S11) Variation as a Function of Antenna Frequency

The power reflected from the antenna is specified by the reflection coefficient, which is a function of the VSWR. The VSWR value should be in the range of 1 to 2 for a feasible operation. The VSWR value of the proposed micro strip patch antenna at 60 GHz is 1.73.

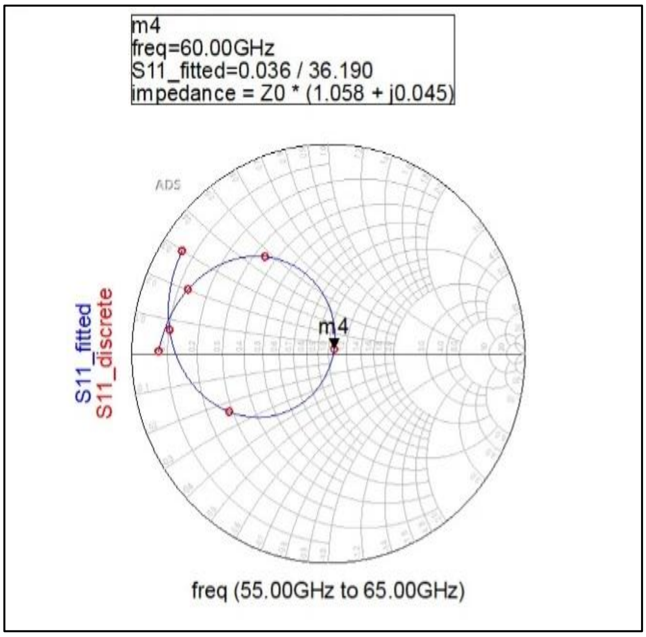

Fig 4: The Variation of Input Impedance with Frequency

The figure depicts the three-dimensional representation of the radiation pattern at 60 GHz for a rectangular microstrip patch antenna.

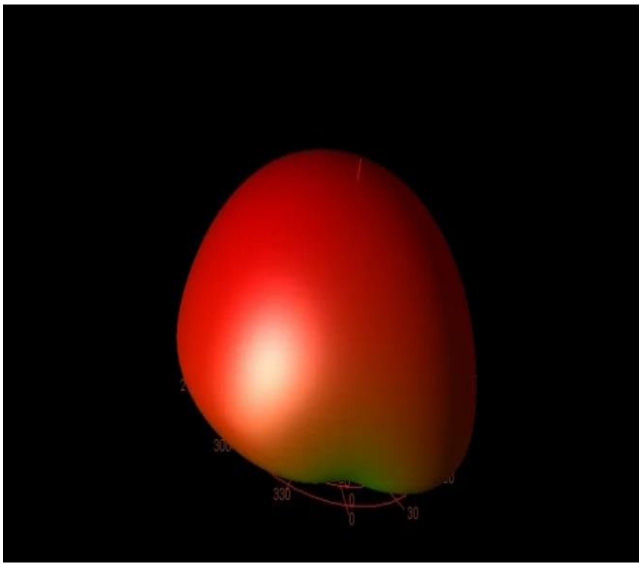

Fig 5: Radiation Pattern of the Designed Antenna

V. CONCLUSION

The present paper proposes the design and modeling of a 60 GHz micro strip patch antenna. When this antenna is simulated using an ADC, the results indicate that the return loss is 32.123 dB, the gain is 6.97238 dBi, and the directivity is 7.56351 dBi. These findings suggest that the developed antenna might be beneficial for the new mobile generation.

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