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Reconfigurable Antenna for Wi-Fi and 5G Applications using Rogers RT5880

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ABSTRACT

The purpose of this paper is the concept of a reconfigurable antenna is presented. Reconfigurable antennas can provide various functions in operating frequencies, beam pattern, polarization. A reconfigurable antenna is implemented using CST Software. The total size of antenna is 30 X 28.4 mm^2.The reconfigurable antenna operates in frequency band. It is Printed on Rogers RT5880 substrate. The S-Parameters is calculated and is compared with the existing model. We used the commercially available software CST MICROWAVE STUDIO (electromagnetic simulator) which is based on the FDTD method, to simulate the reconfigurable antenna and to determine the electromagnetic characteristics of this antenna (S11, VSWR). The frequency band more than 3.4 GHz and magnitude has been identified as a worthy candidate for 5G communications because of spectrum availability. By using substrate as Rogers RT5880, and we have achieved the requirement frequency band and magnitude which are more than the 3.4 GHz and more than -20dB respectively.

Key words: Reconfigurable Antenna, 5G Technology, Wi-Fi, Rogers RT5880, CST, Copper(annealed).

1. INTRODUCTION

1.1 Reconfigurable Antenna

A reconfigurable antenna is a type of antenna that may be altered to operate at various frequencies, polarizations, radiation patterns, or other properties. The manual or autonomous operation of these antennas allows them to adapt to changing communication requirements or environmental conditions.

Reconfigurable antennas can be made in a variety of methods, such as by modifying the radiating elements' length, shape, or arrangement, or by utilizing electrical or material components that are tunable to alter the antenna's characteristics. Wireless communication systems, satellite communications, radar, and sensing are just a few of the uses for reconfigurable antennas. One advantage of reconfigurable antennas is that they may switch between different operating modes and function in many frequency bands without the need for additional antennas [1]. This can result in less interference, better performance, and more effective use of the available spectrum [3]. However, there are certain disadvantages to reconfigurable antennas, such as higher costs, complexity, and power consumption when compared to regular antennas. The design and optimization of reconfigurable antennas require an understanding of electromagnetics, RF circuits, and control systems [17].

1.2 Wireless Communication

Wireless communication is the process of exchanging information or data across a wireless network between two or more devices [16]. In contrast to wired communication, wireless communication does not require physical cables or wires to transfer information. Instead, wireless communication uses electromagnetic waves to convey data across the air. Wireless communication is a key element of contemporary communication technology that enables mobile communication and information access [2]. Wi-Fi and 5G operate at separate frequencies and have different characteristics from one another.

1.3 5G

The most modern cellular technology, known as 5G, offers connections that are more trustworthy, offer higher data rates, and have lower latency than those of earlier generations. It operates in the low-band (sub-1 GHz), mid-band (1-6 GHz), and high-band (millimetre wave above 24 GHz) frequency ranges [11]. Massive machine-type communications (MTC), improved mobile broadband, and ultra-reliable and low-latency communications are a few of the unique uses that 5G is anticipated to enable.

1.4 Wi-Fi

Devices can connect to the internet or a local area network (LAN) via Wi-Fi, a wireless networking technology. It operates in the unlicensed 2.4 GHz and 5 GHz frequency ranges with a variety of Wi-Fi protocols (such as 802.11n, 802.11ac, and 802.11ax) defining various data speeds and other properties. In homes, businesses, and public spaces, wireless internet connection is typically provided by Wi-Fi [19]. Local wireless networking was made simple for the general public to understand more than 20 years ago with the invention of the term Wi-Fi.

1.5 Rogers RT5880

Rogers RT5880 is a high-frequency laminate material that is often used in reconfigurable antennas. Reconfigurable antennas are those that can be altered or reconfigured to change their radiation patterns or other properties to meet specific needs or conditions. In wireless communication systems, these antennas are widely used to improve performance or enable environment adaption [4]. Rogers RT5880's exceptional dimensional stability, robust thermal conductivity, and low loss make it the ideal material for reconfigurable antennas [11]. The material's low loss properties allow the antenna to operate efficiently even at high frequencies, and its high thermal conductivity enables effective heat dissipation [5]. This is crucial for high-power antennas since they produce a lot of heat. The Rogers RT5880's superior dimensional stability also ensures that, even in difficult climatic conditions, the antenna will continue to function and behave as predicted over time [7]. This is essential for antennas used in outdoor or industrial settings where they might be exposed to inclement weather, high humidity, or other environmental problems [15]. The Rogers RT5880 can easily be used to create reconfigurable antennas because it is compatible with a variety of manufacturing processes, such as conventional PCB fabrication techniques. The antenna's safety and environmental friendliness for use in a variety of applications are further assured by the material's compatibility with both lead-free and lead-containing soldering procedures [9]. Rogers RT5880 is a fantastic material for reconfigurable antennas in general because to its low loss, good thermal conductivity, dimensional stability, and compatibility with various production techniques. The material's enhanced reliability and performance make reconfigurable antennas ideal for use in a variety of wireless communication systems [12].

Metallic antennas work effectively at microwave frequencies but have limits due to their limited conductivity at high frequencies. Therefore, it's crucial to locate a metal alternative for various antenna systems [8]. 2-dimensional (2D) materials are being researched as a result of the constraints of metallic devices. One of the most well-known 2D materials that can be utilised as a substrate is Roger RT5880 [14]. A thin laminate with strong chemical resistance and negligible water absorption is Rogers RT/duroid 5880LZ. Applications needing good performance while minimising weight are suitable for this material. Furthermore, even in challenging conditions, significant performance is possible due to its low density and multilayer capacity [6]. There have been many different reconfigurability solutions created, some of which have utilised active localised components including PIN diodes, Varicap diodes, Micro Electro Mechanical Systems (MEMS), and optical switches [16]ss. The flexibility of the substrate is used in many techniques. Reconfigurable aerial systems have been the subject of numerous recent concepts [18]. The ratio of the greatest voltage to the minimum voltage is known as the standing wave pattern ratio (VSWR), which runs the length of a transmission line. It spans from 1 to (plus) infinity and is always positive [10]. Without a piece of slotted line-test equipment, it is challenging to use this word, especially given that the concept of voltage in a microwave structure has multiple interpretations [20].

We introduce a ground-breaking reconfigurable aerial in this study. We obtained frequency and magnitude for the 5G application, were obtained by inserting a metal pad. The simulation of the suggested aerial was done using CST.

2. ANTENNA DESIGNING AND MODEL

2.1 Figures and Tables

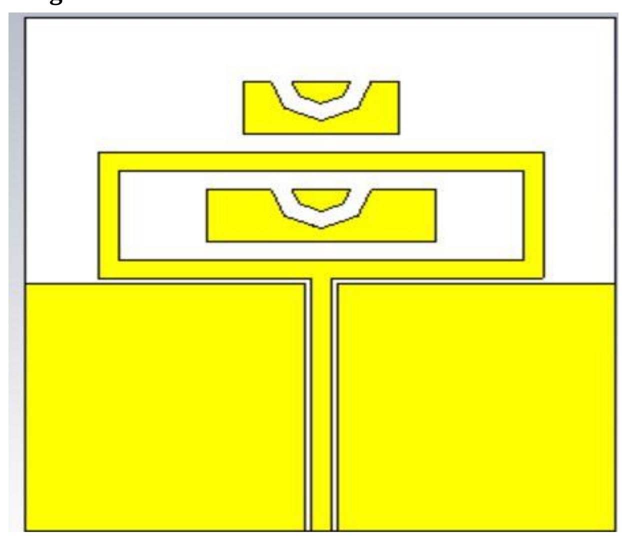

Figure 1: Proposed reconfigurable antenna

Table 1: Dimensions and the reconfigurable antenna parameters

Name	Value
w	28.4
l	30
st	0.508
wg	13.45
lg	14.442
ct	0.035
wr	11
wt	5.2
g	0.358
lm	7.3
f	1
lh	2.15
lr	3

Description:

w=Width of the antenna
l=Length of the antenna
st=Thickness of the substrate
wg=Width of the ground
lg=Length of the ground
ct=Thickness of the copper
wr=Width of the radiator
wt=Extra width of the loop
g=Gap between component
lm=Length of the loop
f=Width of the feedline
lh=Length of the outer radiator
lr= Length of the inner radiator

Figure 1 shows reconfigurable antenna for 5G applications. The graphic depicts the reconfigurable antenna, which is printed on copper and is 30 x 28.40 mm^2. The use of the Roger RT5880 is the major component of this antenna design. To improve the frequency response, the rogers can be employed as a substrate in the antenna design. The Rogers substrate has a thickness of 0.508 mm and a dielectric constant of 2.2. Table 1 shows the dimensions of the antenna design.

For high frequency and broadband applications, Rogers RT5880 laminates are the best choice due to their low dielectric constant and minimal dielectric loss. The PTFE composites' randomly arranged microfibers help to preserve the homogeneity of the dielectric constant.

The Rogers has a dissipation factor of 0.0009 at 10GHz and a dielectric constant of 2.2. It is isotropic and has a low moisture absorption rate. The advantages of rogers are beneficial for increasing configuration and frequency. Some of them have uniform electrical properties over a wide frequency range and are machine-cuttable, shareable, and easily formed. The rogers are resistant to the etching or plate edge and hole chemicals and solvents. It contains a rogers component, which is well-known and great for wet environments. The minimal electrical loss of the reinforced PTFE material enhanced the substrate performance. This paper introduces a novel reconfigurable antenna.

The antenna is printed on a Rogers RT5880 substrate with a 2.2 dielectric constant and a thickness of 0.508 mm. It is 30x28.4 mm2 in size. The antenna is moved between frequency 4.88 GHz and magnitude -32.013dB for 5G applications using a copper pad and rogers as a substrate. CST Microwave Studio is used to run the simulation.

3. RESULTS AND DISCUSSIONS

3.1 S1,1-Parameter

The ratio of the incident wave to the reflected wave at the antenna input is known as the reflection coefficient. It is governed by Zin, the antenna's input impedance, and Ic, the transmission line Z0's characteristic impedance, so that:

$$\Gamma = \frac{Z_{in} - Z_o}{Z_{in} + Z_o}$$

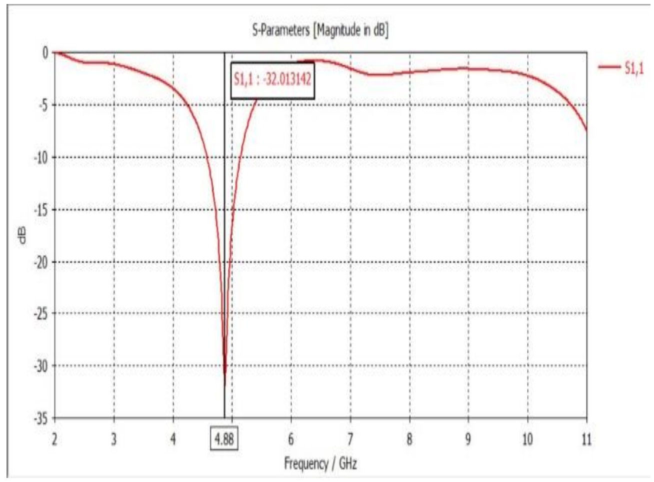

Figure 2: Parameter of the reconfigurable antenna

Figure 2 shows the S1,1 parameter of the reconfigurable antenna and we obtained here frequency 4.88 GHz, and magnitude -32.013142 dB respectively.

3.2 VSWR

The voltage standing wave ratio, which is determined by the reflection coefficient module, is another way to explain the adaptation. VSWR has a range of values from 1 to ∞.

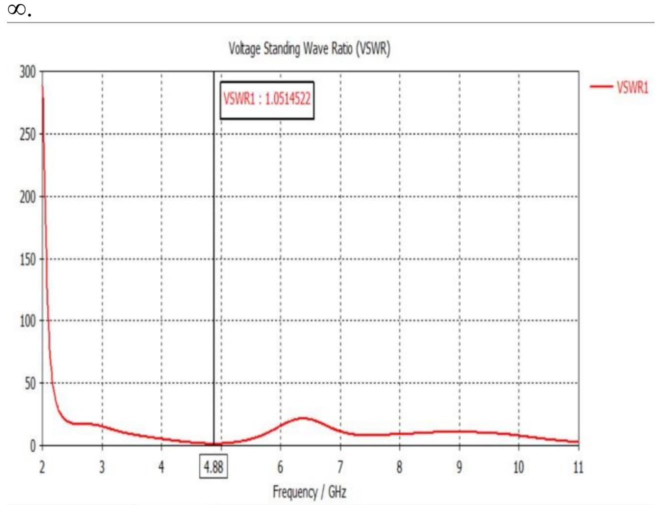

Figure 3: Voltage standing wave ratio

The Figure 3 shows the voltage standing wave ratio. and VSWR1 indicating that the antenna is an excellent fit.

4. CONCLUSION

Reconfigurable antenna is implemented and the parametric analysis is done and is compared with the existing system. The S-Parameter analysis is done on all the conditions and magnitude is achieved less than -20db which is the acceptable range for GHz applications. The antenna is printed on a Rogers RT5880 substrate with a thickness of 0.508 mm and a dielectric constant of 2.2. It is 30x28.4 mm2 in size. The antenna of frequency 4.88 GHz that corresponds to 5G application is switched using a copper plate. Through the use of CST Microwave Studio, the simulation is run.

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