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# Frequency-Adaptable Antenna Radiation Pattern for Wireless Applications

Dr. Y. Srinivas
*Professor*
*Department of ECE*
*Vignana Bharathi Institute of Technology*
*Hyderabad-501301, India*
srinivasyerram06@gmail.com

Maram Harika
*Student*
*Department of ECE*
*Vignana Bharathi Institute of Technology*
*Hyderabad-501301, India*
maramharika116@gmail.com

K. Snehitha
*Student*
*Department of ECE*
*Vignana Bharathi Institute of Technology*
*Hyderabad-501301, India*
sweetysnehitha10@gmail.com

M. Vijay
*Student*
*Department of ECE*
*Vignana Bharathi Institute of Technology*
*Hyderabad-501301, India*
motevijaykumar224@gmail.com

***Abstract*** **– A stub-loaded circular radiator on FR-4 epoxy with a thickness of 0.254mm, a frequency (resonant frequency) of 5.4GHZ, and slot etching processes make up the antenna's framework. The proposed antenna is intended to be a small frequency reconfigurable antenna for conformal surfaces and flexible electronics. The proposed antenna has a higher gain than the existing prototype. The performance of the designed antenna at the designated frequency is investigated. These consist of Wi-Fi, Bluetooth, and satellite communications.**

***Keywords***— **Antenna, CPW fed, Wideband, Dual band and Tri-band and Frequency reconfigurability.**

## I. INTRODUCTION

Flexible and conformal surfaces require a changing frequency antenna that is compressed and stabilized. Real-time operation frequency fluctuation is made possible by reconfigurable antennas. They are very useful for developing a communication system that several antennas can use for various objectives. From this angle, several antennas can be replaced by a single adjustable antenna. Both compactness and frequency Constant radiation, wide impedance bandwidth, and reconfigurability. layout, structural integrity, and suggested design characteristics of the antenna.

Most of the developments that are taking place are mostly due to antennas. They provide functionality to a range of devices and are employed for many different applications. Antennas with a wide range of software are growing in popularity. while the development of antenna generation occurs. For fans of a particular time period, antennas that might function well at a variety of frequencies Levels are a fantastic tool.

It has been challenging to turn an antenna into a tool that can be reconfigured by changing the internal structure of the antenna using particular techniques. When designing an antenna, it's crucial to take into account factors like achieving a high-quality benefit, exact performance, a consistent radiation pattern, and exceptional impedance matching. This results in lower costs, weight, volume, and maintenance refill supplies. Two-pin diodes were used to modify the frequency of a tiny antenna [5]– [6]. The former is a stub-loaded circular radiator and is made to function in three modes with three distinct bands, whilst the latter is a rectangular microstrip slot antenna that can operate in multiband frequencies, particularly for WLAN applications.

Additionally, reconfiguration, adaptability, and antenna compactness are highly prized in [7] because smaller antennas significantly minimize the size of electrical systems. Thus, the antennas' tiny size and adaptability make them perfect for today's devices and communication systems in [4]. The recommendation in [9] is for a tri-band antenna fed by CPW. Even though the operational bands were smaller, the results were consistent with the modelling.

A high-gain dual-band frequency reconfigurable antenna was first presented in [10]. Since the high gain required a trade-off rather than an antenna size, it is not appropriate to small devices. In order to accomplish frequency and polarization reconfigurability, varactor diodes were employed [11]. [12] used three small, rectangular patches. Stunting the side patches relative to the centre patch results in a wide bandwidth and two resonant modes at two near frequencies.

## ANTENNA DESIGN

The suggested frequency-reconfigurable antenna design is shown in Fig. 1 (a-b). A thin Rogers RT/duroid 5880(tm) substrate with a resonant frequency of 5.4GHz, a thickness (h) of 0.254mm, a relative permittivity (εr) of 4.4, and a loss tangent (tan) of 0.002 is the substrate to which the antenna is affixed. [7] places a high priority on reconfiguration, adaptability, and antenna compactness since smaller antennas significantly lower the bulk of electronic systems. As a result, the antennas are perfect for today's devices and communication systems due to their small size and adaptability [12]. In [13], a tri-band antenna fed by CPW is advised. Despite having fewer operational bands, the results were consistent with the simulation.

*The Fig. 1 describes:*

Substrate Selection: Rogers RT/5880, which is renowned for its exceptional electrical qualities, such as low loss and good thermal

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stability, will be used for this design. RT/5880's dielectric constant (εr) is normally approximately 2.2, which aids in reaching a greater efficiency and a larger bandwidth for high frequency applications.

Antenna Geometry: Inner1 (8 mm) and Inner2 (6.4 mm) are the measurements that determine the antenna's annular patch. Inner1 and Inner2 are separated by 1.6 mm, forming a ring configuration that improves impedance matching and the bandwidth of the antenna. A larger frequency response can be achieved with this design, which also permits improved radiation properties. The antenna's radiation effectiveness depends on the ground plane, which acts as a reflector and has dimensions of x=5mm and y=11mm. To minimize surface waves and guarantee efficient radiation, it should be bigger than the patch.

Feeding Mechanism: Because microstrip feeds are straightforward and simple to integrate with other circuits, they are frequently utilized. In order to achieve optimal impedance matching and reduce signal reflection, the feed point should be carefully selected.

*HFSS Simulation Configuration:*

• Create a new HFSS project and configure the design environment.

The substrate layer should be created using Rogers RT/5880, and then the ground plane and annular patch should be created using the given measurements.

The proper material qualities should be assigned, such as ideal electric conductor for the ground and dielectric for the substrate.

• To precisely model the antenna's environment, specify the excitation source at the feed point and provide boundary conditions

*Frequency Adaptability:*

Think about including tunable parts like switches or varactor diodes to accomplish frequency adaptability. These components can change the feed mechanism or the patch's effective length, enabling the antenna to function well at a variety of frequencies.

Simulation and Optimization: Run the simulation to examine radiation pattern, gain, and return loss (S11), among other important factors. Adapt the feeding point and dimensions as needed to maximize performance over the intended frequency range. A return loss of less than -10 dB is preferred as an indication of good impedance matching.

*Post-Processing:*

View the radiation patterns and gain plots to assess the antenna's performance after acquiring simulation data. Examine the outcomes to see what needs to be improved, then make the necessary changes.

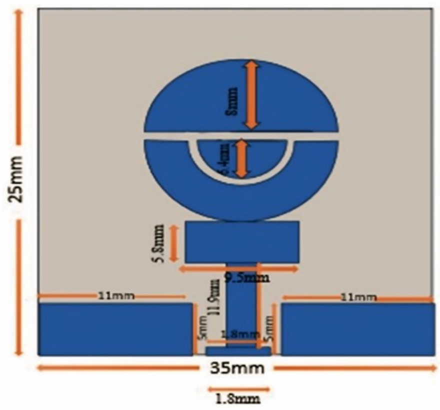


Fig. 1 Antenna Design

Many wireless communication systems, such as satellite communications, mobile phones, and Internet of Things devices, use frequency-adaptable antennas. They can be used in a variety of applications due to their versatility in operating over several frequency bands.

Importance of Deducting Inner2 from Inner1: This process produces a gap that can increase the bandwidth and radiation efficiency of the antenna. This design makes the antenna more versatile for a variety of wireless applications by enabling improved impedance matching and perhaps obtaining a wider frequency response. Additionally, by lowering surface waves, the annular patch design can enhance performance.

*CPW Feed:*

The antenna cannot be excited without the Coplanar Waveguide (CPW) feed. Use the right width and spacing when designing the CPW to guarantee effective power transfer. In order to facilitate efficient coupling, the feed ought to be connected to the inner rings.

Using Ansys HFSS software, we integrated the CPW feed into the circular ring slot antenna. Microstrip antennas employ this feeding method when the ground and signal currents are carved on the same layer. The following steps make up the process involved in doing so: 1. There is ground on both sides of the patch, and by connecting them, we can build a bridge. Next, we give this bridge a perfect boundary. Three rectangles were joined to create this bridge. 2. To finish the building and join the patch to the bridge, a port is positioned in front of the bridge. 3. The port receives excitation. The port receives lumped excitation as an input.

Table:1 Represents the material of substrate

| ANTENNA ELEMENT | MATERIAL | XSIZE | YSIZE | ZSIZE |
|---|---|---|---|---|
| Substrate | ROGERS RT5880LZ | 35 | 25 | 0.254 |
| Airbox | Air | 50 | 50 | 10 |

Table:2 Represents the dimensions of design

## II. RESULTS

*Return Loss:*

A device's or system's ability to match the impedance of a transmission line or load is measured by return loss in HFSS. Usually, it is represented by the S11 parameter, a complex number that characterizes the device's reflection coefficient. A lower return loss value, often measured in decibels (dB), denotes less signal reflection and better matching.

The power loss in the signal that is reflected into a load via a transmission line is known as return loss. For an antenna to match well, the return loss must be at least -10dB. Return loss is one metric that illustrates how much power is "lost" to the load and does not return. Thus, the RL is a metric that provides information about how well the transmitter and antenna have matched.

The phase-dependent superposition of two or more emitted signals is the fundamental function of the phased array antenna. When the signals are in phase, they combine to form an amplitude-adding signal. It is found that the return loss at 5.15GHz is -13.0154dB. This is how the return loss is seen:

In Fig.2 the return loss of -13.015dB id detected at 5.15GHZ.

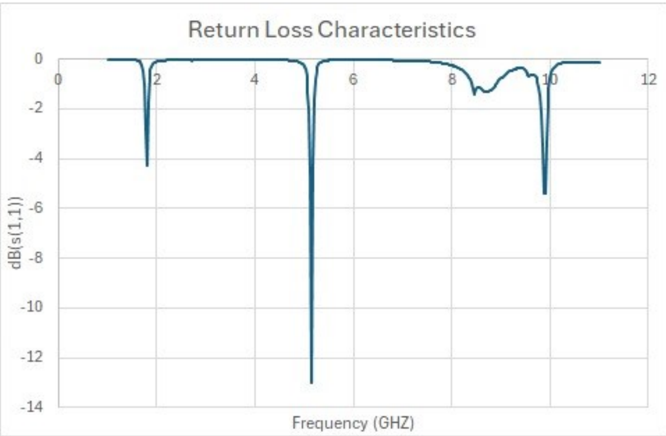


Fig.2 Characteristics of Return Loss

In the above figure 2 the return loss at 5.15GHz, with the X-axis denoting frequency and the Y-axis denoting antenna return loss. The graphic shown illustrates the variation in return loss at various frequencies. Return loss must be at least -10dB for a better matching antenna. Return loss is shown here at -13.015dB. This frequency range is especially well-suited for C-band satellite communications.

*Radiation Pattern:*

An antenna's radiation pattern is a visual depiction of how electromagnetic energy is received or emitted by the antenna in various directions. It is crucial for understanding the performance and behaviour of antennas in various applications.

| Command | Axis | Size-1 | Size-2 |
|---|---|---|---|
| Ground | z | Xsize:35 | Ysize:25 |
| g1 | z | Xsize:5 | Ysize:11 |
| g2 | z | Xsize:5 | Ysize:11 |
| r2 | z | Xsize:5.8 | Ysize:9.5 |
| r3 | z | Xsize:8 | Ysize:16 |
| r4 | z | Xsize:1 | Ysize:22.4 |
| r5 | y | Xsize:0.5 | Ysize:0.5 |
| r6 | y | Xsize:0.5 | Ysize:0.5 |
| r7 | z | Xsize:0.5 | Ysize:3 |
| Probe | x | Ysize:1.8 | Zsize:0.754 |
| Feed | z | Xsize:11.9 | Ysize:1.8 |

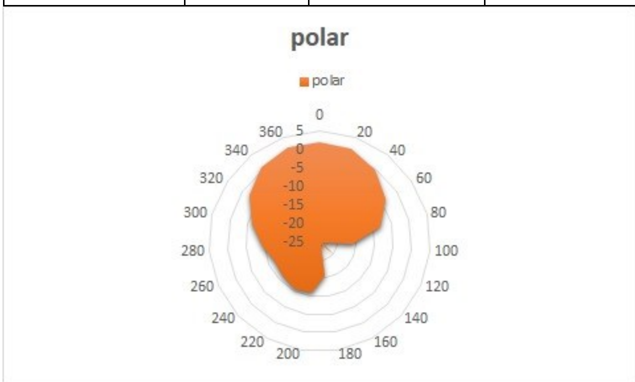


Fig.3 Radiation Pattern

## III. CONCLUSION

An antenna with frequency adaptability is created for wireless applications. The antenna can operate in both the S and C bands. By adjusting the parameters, the six antennas were developed from the basic paper antenna. All of the antennas were examined, and their findings were acquired. Every antenna can produce dual-band, wide-band frequencies. The antenna with the broadest frequency range was chosen and used based on the results. In conclusion, a frequency-adaptable antenna has been developed for use in satellite communications, Wi-Fi devices, weather radar, air traffic control, and aviation radar systems.

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