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# A Novel Rhombus Shaped Multiband Antenna for Wireless Applications

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**ABSTRACT**- A 30X20X1.6mm$^3$ Novel Rhombus Shaped ring type multiband Antenna was proposed in this paper. The Antenna has 25x15mm$^2$ partial ground inserted below the FR4 Epoxy Substrate to improve performance of Antenna. In addition, we added two rectangle shaped patch structures of dimensions 14X5.5mm$^2$ on both sides of Feed structure to improve S11.The proposed design operates at three bands covering C, X, and Ku band regions. Here we got better S11 at 12.1GHZ which is useful for Radar Applications.

**KEYWORDS**- Structure, S11, Multiband, Patch.

## I. INTRODUCTION

The demand for antennas is growing rapidly as wireless technologies continue to evolve. The evolution of the antenna has led to the development of a wide range of antennas that operate at different frequencies [1-3]. Multiband antennas are antennas that can operate in multiple frequency bands. Their design enables them to effectively transmit and receive signals across a large range of frequencies. There are numerous techniques to design antennas that operate at multiband frequencies, such as fractal, metamaterial, diodes, and DGS structures [4-6]. The coverage of multiple frequency bands allows devices to communicate over different wireless networks without the need for separate antennas for each band. This not only saves space and reduces complexity but also enhances the overall performance of the communication system and increases data rates [7-9]. The play a vital role in enabling seamless connectivity and reliable signal transmission across different frequency bands. In terms of design, multiband antennas can take on various forms, such as patch antennas, dipole antennas, or even more complex structures. The choice of antenna design depends on factors like the desired frequency bands, size constraints, and performance requirements. We have designed a patch antenna of dimensions 30x20x1.6mm3 with a defected ground structure with dimensions of 25x15mm2. The proposed Antenna operates at 7 different frequencies covering three different frequency bands. Two patch structures were created to feed support to the antenna with dimensions of 14x5mm2 each.

## II. DESIGN METHODOLOGY

The multiband antenna mentioned uses FR4 epoxy as its substrate and has dimensions of 30x20x1.6mm3. The ground-plane structure initially had dimensions of 30x20 mm2, but it was later reduced to 25x15mm for better results. To construct the main structure of the antenna, a rectangle with dimensions of 1x12mm2 is created as the feed element. The rectangular feed element is modified by adding a rhombus-shaped ring structure. Subsequently, a second rhombus-shaped ring structure element is added, and eventually a small rhombus-shaped element is added. Then all these structures are combined to form the proposed design. To improve the results, two feed support structures with dimensions 14 x 5.5 mm2 have been put in place on both sides of the antenna.

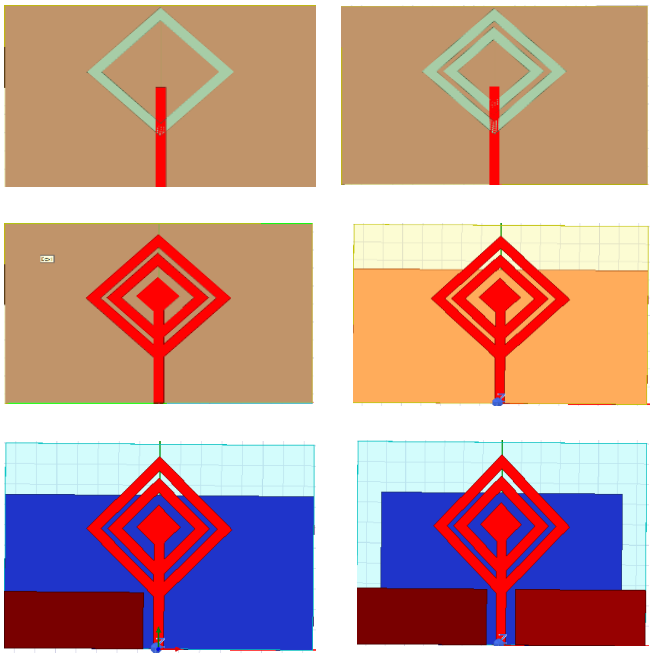

Figure 1: Evolution of Antenna

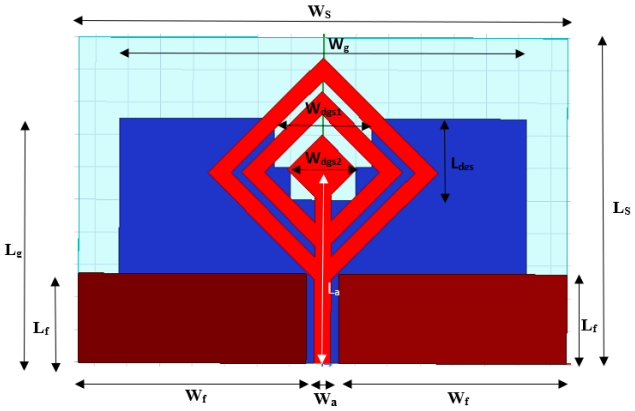


Figure 2: Final design of Antenna

Table 1: parameters and Dimensions of Antenna

| parameter | Dimensions(mm) |
|---|---|
| Length of the substrate ($L_s$) | 20 |
| Length of the feed support element ($L_f$) | 5.5 |
| Length of ground structure ($L_g$) | 15 |
| Length of the antenna ($L_a$) | 12 |
| Width of the substrate (Ws) | 30 |
| Width of the feed support element ($W_f$) | 14 |
| Width of the antenna ($W_a$) | 01 |
| Width of the ground structure ($W_g$) | 25 |
| Width of the defected ground structure 1 ($W_{dgs1}$) | 06 |
| Width of the defected ground structure 2 ($W_{dgs2}$) | 04 |
| Length of the defected ground structure ($L_{dgs}$) | 05 |

## III. RESULTS AND CONCLUSION

The graph between frequency and reflection coefficient (dB) is represented in the below figures. Fig. 2.1 shows three different iterations, and Fig. 2.2 shows the final reflection coefficient result. From the figures we can observe that the antenna is operating at six different frequency bands which cover the C, X, Ku bands with a resonant frequency 12.1GHz where the reflection coefficient< -40dB.

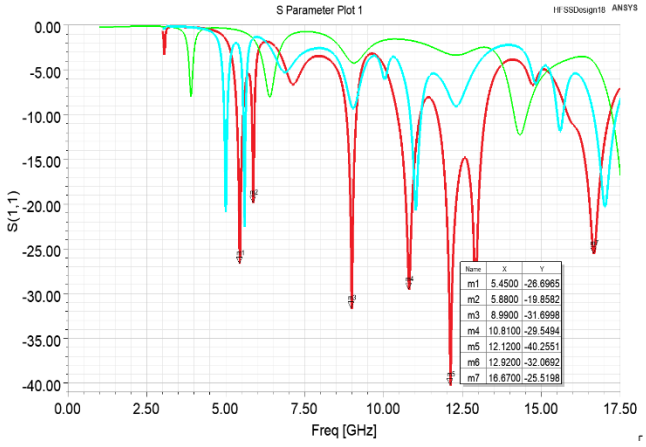


Figure 3: Iterations of reflection co-efficient (S11)

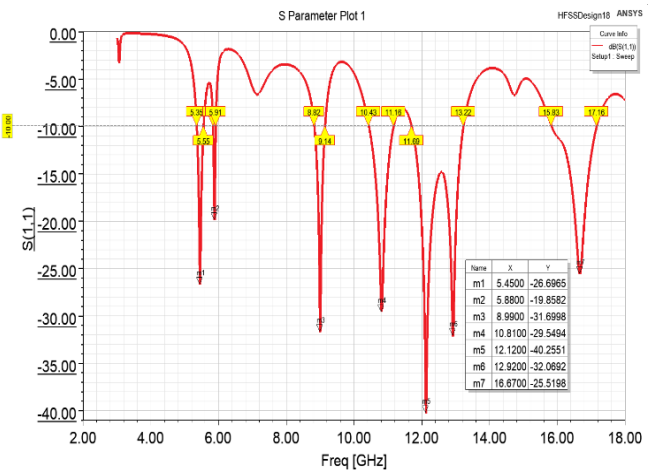


Figure 4: reflection co-efficient (S11) Plot

Figure 3 & figure 4 indicate the graph between frequency and VSWR of the designed antenna. And it has been observed that the antenna's VSWR is less than 2. Figure 5 shows the different iterations of VSWR of the antenna. The final output of VSWR is shown in Figure 6

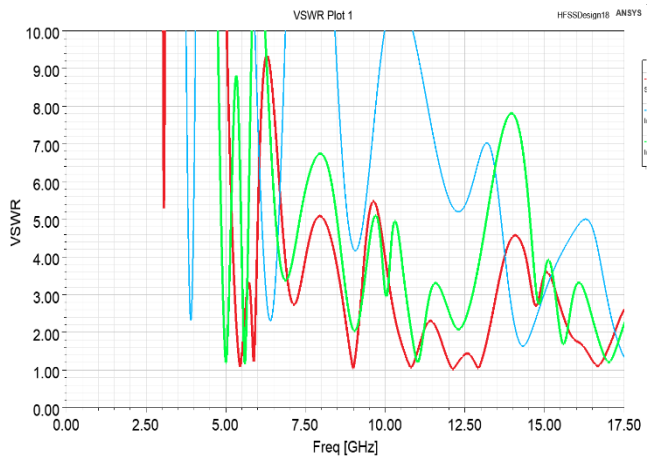


Figure 5: Iterations of VSWR plot

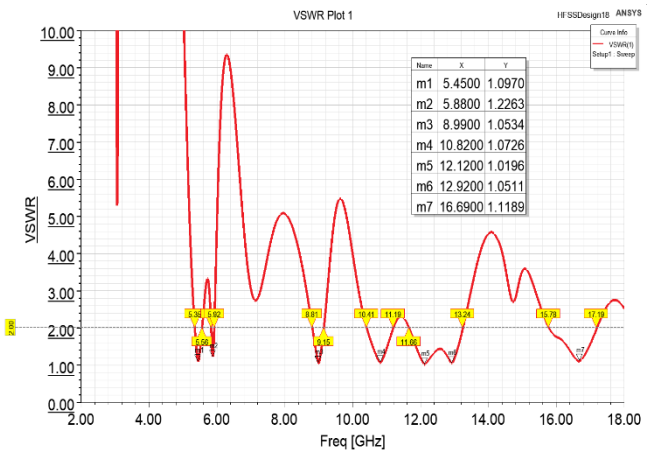


Figure 6: VSWR Plot

Below figures 7, represents the Gain plot of the antenna. Different iterations are considered and the final picture resembles the final Gain plot in which We've got a gain of 3.3dB

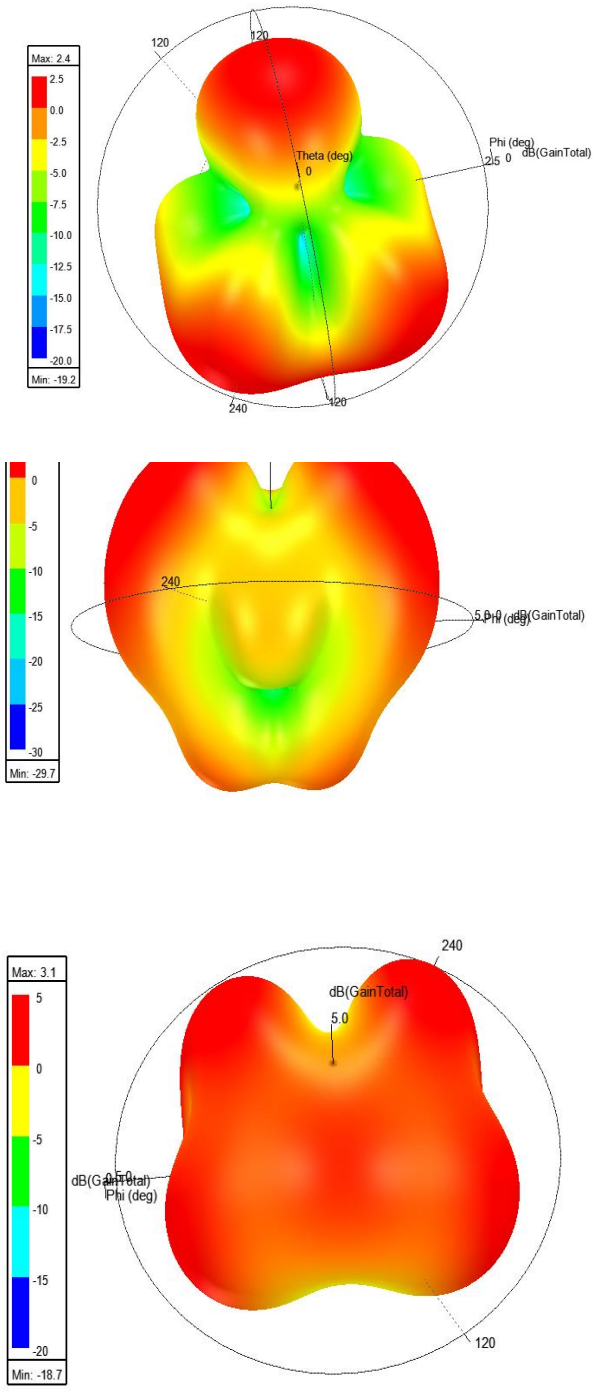


Figure 7: Iterations of Gain Plot

The figures 8 shown represents the E-Plane co-pole & cross-pole plots of the antenna.


Figure 8: E-Plane co-pole & cross-pole plots

In the below figures 9, H-Plane co-pole & cross-pole plots of the antenna are represented.

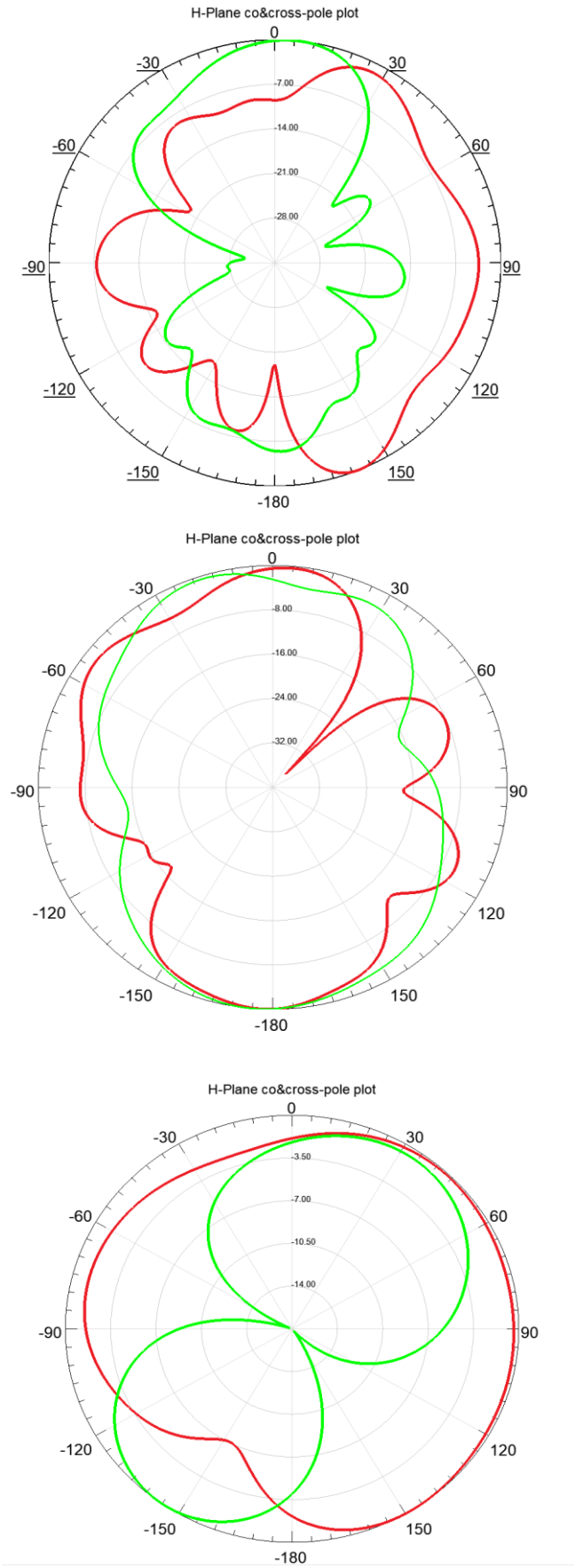


Figure 9: H-Plane co-pole & cross-pole plots

## IV. CONCLUSION

A novel rhombus shaped ring like structure antenna which operates at three different frequency bands is discussed in this paper. The proposed model operates at 5.45, 5.88 (C-band), 8.99, 10.43 – 11.16 GHz (X band), 11.69 – 13.22 GHz & 15.83 – 17.16 GHz (Ku band) and the antenna got better results at 12.1 GHz frequency. The reflection co-efficient S11 is less than -10dB and VSWR is less than 2 at all the above-mentioned frequency bands and we got maximum Gain of 3.3dB. The proposed antenna design can be used for radar applications, weather monitoring systems, satellite communications and.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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