# A Novel Design for C-Slot RMSA Yielding Quadruple Frequency

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## Abstract

*The paper focuses on design of RMSA with an etched C-slot for obtaining Quadruple frequencies at 3.7 GHz, 4.7 GHz, 6.4 GHz and 6.8 GHz. RMSA with dielectric constant* $\varepsilon r = 2.4$*, tangential loss* $(\tan\delta)$ *of 0.001. It is simulated using IE3D, working on Method of Moments for obtaining optimum antenna parameters using Transmission Line Model and incorporating co axial feed. This antenna can be used for Radio astronomy, microwave devices/communications, wireless LAN, most modern radars, communications satellites, satellite television broadcasting & amateur radio.*



## 1. Introduction

In today's world of scaling and reducing the size of devices, microstrip antennas have attracted a lot of attention due to rapid growth in wireless communication area. Several patch antenna designs with single-feed, dual-feed operation have been proposed. The increasing use of microwave mobile communication systems demand antennas for different systems & standards with properties like reduced size, broadband, multiband operation, moderate gain etc.[1],[2] that work in a different range of frequencies. Designed Quadruple frequency Rectangular Microstrip Patch Antenna operates at 3.7GHz, 4.7 GHz, 6.4 GHz and 6.8 GHz each having its own advantages & uses. As the 2.4GHz band used for wireless applications is becoming over crowded, the applications running on those frequencies are moving to higher frequencies so as to have a higher Signal-to-Noise Ratio (SNR). This Antenna can be used for applications such as Wi-Fi access points, microwave ovens, cordless phones, Bluetooth devices & baby monitors. Certain Frequencies are unavailable in certain parts of the world & hence we need antennas operation at multiple frequencies so that the same antenna can be operated at a different frequency for the same operation [2] [7].

The multi-frequency characteristics here are studied using a C & inverted C slot antenna structure. Because of many attractive features of patch antennas these antennas have received over whelming support and are used in most of the practical applications such as mobile phones to Vehicular GPS systems [3].

## 2. Antenna Protocol

Width of the Patch (W).

$$W = \frac{c}{2f\sqrt{\frac{\varepsilon r + 1}{2}}}$$

Effective Dielectric constant of Antenna ($\varepsilon reff$)

$$\varepsilon reff = \frac{\varepsilon r + 1}{2} + \left(\frac{\varepsilon r - 1}{2}\right)\left[1 + \frac{12h}{w}\right]^{-0.5}$$

Effective length of antenna ($Leff$)

$$Leff = \frac{c}{2f\sqrt{\varepsilon reff}}$$

Extended Length of Antenna ($\Delta L$)

$$\Delta L = \frac{h}{2\sqrt{\varepsilon reff}}$$

Length of Antenna (L)

$$Leff = L + 2\Delta L$$

The patch shown is designed using these formulas.

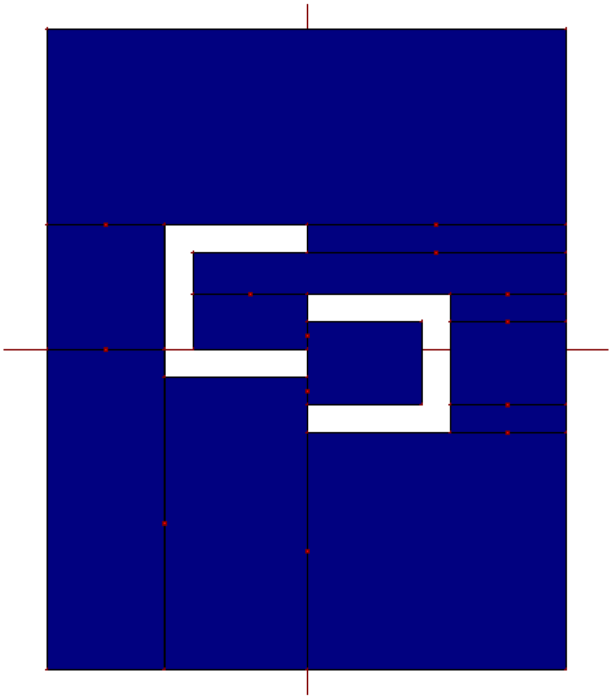

**Figure 1: C slots etched on Rectangular Patch Antenna**

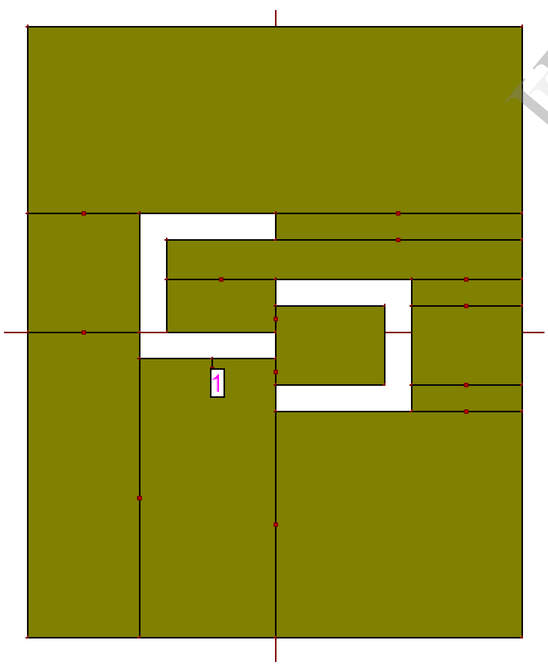


**Figure 2: Patch Antenna (With Feed)**

**Table 1: Optimized Antenna Parameters**

| Antenna Parameter | Value |
|---|---|
| Resonant Frequency | 5GHz |
| Dielectric Constant | 2.4 |
| Thickness (h) | 1.5 mm |
| Length | 17 mm |
| Width | 20.5 mm |

## 3. Simulation Results

The Micro Strip Patch Antenna is designed using IE3D working on Methods of Moment. The Method of Movements for discretizing integral equations in electromagnetics is an extremely powerful and versatile general numerical methodology for electromagnetic field simulation in antenna and scattering applications. It is a numerical computational method of solving linear partial differential equations which have been formulated as integral equations. The antenna feed is a Coaxial Line using SMA connector.



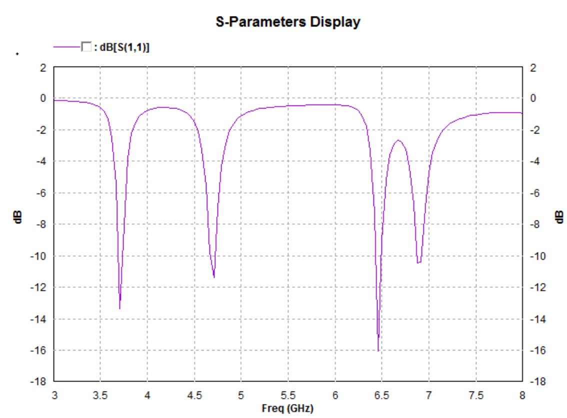


**Figure 3: S Parameters**

Return loss at 3.7 GHz = -13.2 dB
Return loss at 4.8 GHz = -11 dB
Return loss at 6.5 GHz = -16 dB
Return loss at 6.8 GHz = -10.5 dB
The maximum return loss is obtained at 6.5GHz.

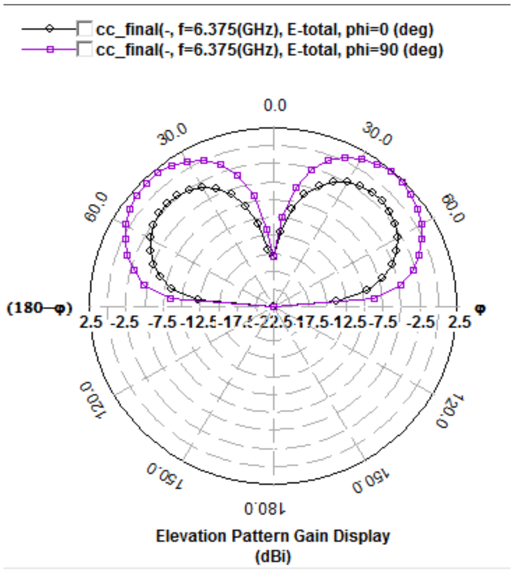


**Figure 4: Elevation Pattern**

The elevation pattern of the antenna shows that the radiation pattern is bidirectional. A bidirectional antenna can be used to transmit a signal to two different receivers at the same time or vice versa, i.e. it can be used to receive a signal from two receivers.

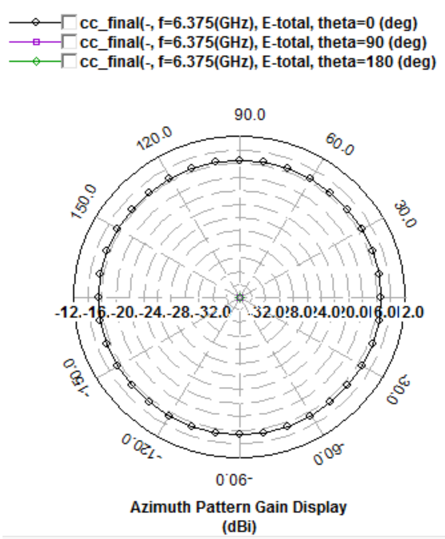


**Figure 5: Azimuth Pattern**

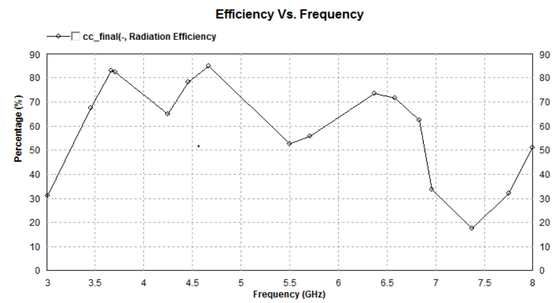


**Figure 6: Radiation Efficiency**

The maximum radiation efficiency of the antenna is found to be 82%



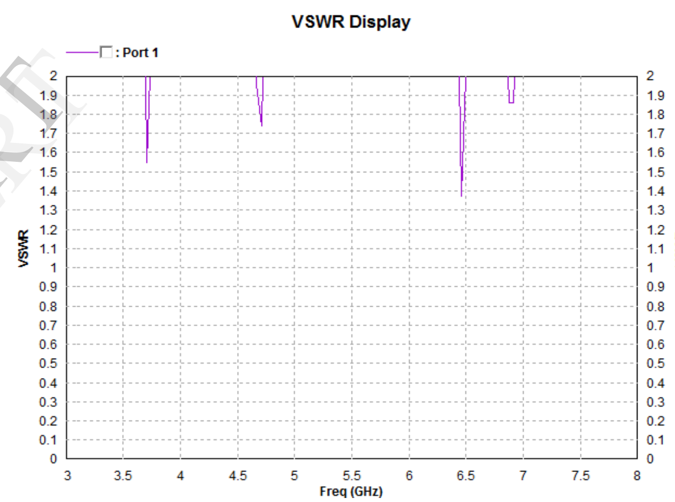


**Figure 7: VSWR**

The VSWR for the specified antenna protocol is found out to be below 2 and hence it is ideal for practical implementation in communication systems.

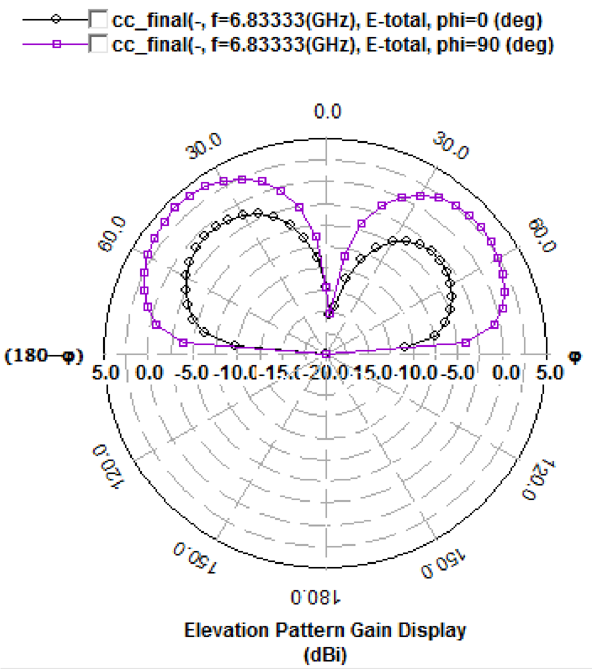


**Figure 8: Elevation Pattern at 6.8GHz**

## 4. Conclusion

In this paper, the slots enable the antenna to operate at quadruple frequencies, thus suitable for more than one application in communication systems. The gain achieved is 6.2dB which is a necessity for an efficient system. The Directivity achieved is around 9.3 and hence we have an advantage of two beams with good directivity and linear polarization.

## 5. Reference

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