# Microstrip C-R Slotted WiFi Antenna Modified for X band Applications

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**Abstract -** *Recent research show that some parameters such as the shape of antenna patch and ground plane when geometrically altered produces changes in the return loss and resonant modes. This paper presents a circular rectangular microstrip antenna modified with the technique of inserting slots in the ground plane in order to alter the specific behavior in the resonant frequencies. The antenna has been designed and simulated using ANSOFT HFSS simulator. It make use of FR4 as substrate with dimensions 50mm×40mm×1.2mm. The circular rectangular antenna resonates at 2.4 and 5.5GHz frequencies for WiFi applications according to IEEE standards, while the modified ground plane version resonates through a band of frequency (9.92-11.46 GHz ) in X band*

***Key Words*: Circular rectangular(C-R) patch, Gain, Microstrip patch antenna, Return loss, VSWR**

## 1. INTRODUCTION

Circular-rectangular microstrip patch antenna has been presented for dual band in wireless communication systems [2]. Microstrip antenna has wide range of application in the field of mobile and satellite communication, RFID (radio frequency identification), GPS (global positioning system) and in radar applications. It is widely used because of its low profile and lightweight. There was a recent development in wireless communication in order to convert IEEE WLAN (wireless local area network) standards in 2.4GHz and 5-6GHz. This paper presents an antenna that can satisfy operations in both these frequency ranges, resonates at 2.4GHz and 5.5GHz.

The modified antenna design is purely for X band applications. X band radar frequency sub-bands are used widely in civil, military and government institutions for weather monitoring, air traffic control defense tracking and vehicle speed detection in law enforcement [1].

## 2. C-R PATCH AND DESIGN GEOMETRY

The basic antenna structure consists of a radiating patch, dielectric substrate and a ground plane. The patch and ground are made of copper. Fig.1 represents the antenna structure with microstrip line feeding technique. Initially circular and rectangular patch are created over the substrate, such that these two antennas are kept one inside the other and are connected using small conducting strips called bridges. These bridges have a great impact in tuning the antenna to the required frequency band. But, in addition to C-R slot two symmetric arcs are also etched from both sides of the circular patch for better accuracy. The required resonance frequencies are obtained by parameter variation such as changing the bridge width or position [2].

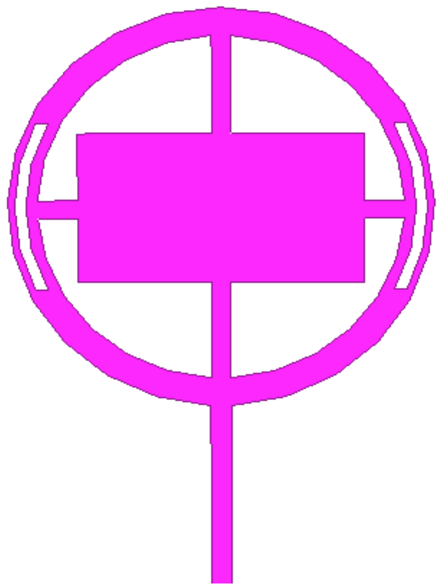

**Fig -1:** Structure of Circular Rectangular Antenna

**Table -1:** Design Geometry of CR Patch

| Antenna | Parameters | Dimensions |
|---|---|---|
| | Resonant Frequency | 2.4 GHz, 5.5GHz |
| | Dielectric Constant | 4.4 |
| Ground /Substrate Plane | Length | 50mm |
| | Width | 40mm |
| Circular patch | Radius of patch | 16.8mm |
| Rectangular patch | Length | 12.5mm |
| | Width | 22.59mm |
| Length of connecting strip | Horizontal strip | 3.25mm |
| | Vertical strip | 8.32mm |
| Feed | Length of strip | 15.25mm |
| | Width of strip | 1.654mm |

The patch antenna shape is etched from the dielectric substrate. The back side of the substrate is used as the ground portion. In this antenna design the width and length of the rectangular patch as well as the radius of the circular patch plays a crucial role in determining the resonant frequency of the system. The values corresponding to these parameters are calculated using the equations given in [3], with 4.4 as the dielectric constant of the substrate. FR4-Eproxy was originally chosen as the substrate as it has a low tangent which will not reduce the antenna efficiency, and has a relatively low dielectric constant. Thick dielectric substrate with low dielectric constant provides better efficiency, larger bandwidth and better radiation, but it is against the low profile concept. Table1 shows the entire dimension details about the C-R antenna design.

## 3. SIMULATED RESULTS

The parameters for the designed WiFi antenna were calculated and simulated. The resonating frequencies 2.4 and 5.5GHz with corresponding values of return loss as -13.91 and -23.56dB is obtained and are shown in Chart 1. The performance of the antenna is described in terms of gain. It gives overall performance of the antenna. The Chart 2 shows the gain of the WiFi antenna. There is no radiation in the backside of substrate because of the presence of ground plane.

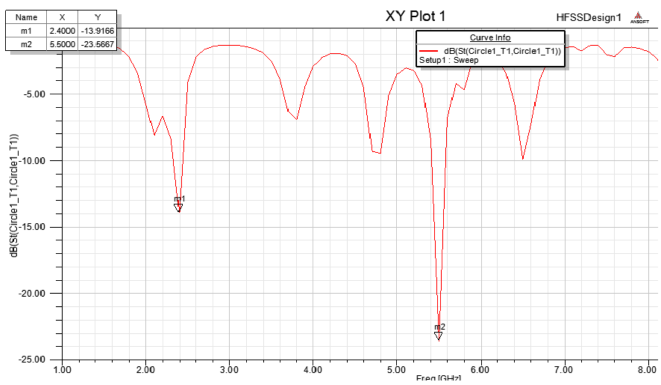


**Chart -1**: Return loss Curve

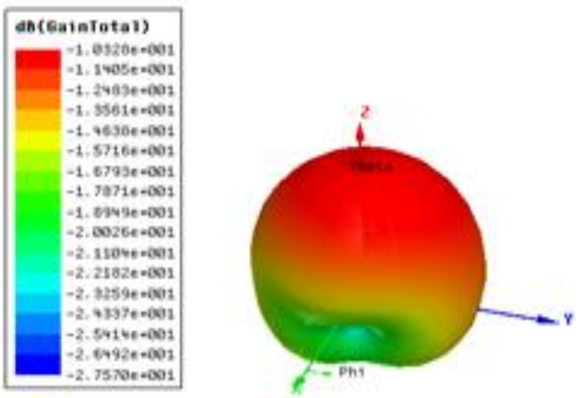


**Chart -2**: Gain Characteristics

## 4. MODIFIED ANTENNA DESIGN AND SIMULATION

The conventional circular rectangular microstrip antenna design is modified by introducing a rectangular slot [4]-[5] on the ground plane, which is expressed in fig.2. Dimension of the slot is given in Table 2.

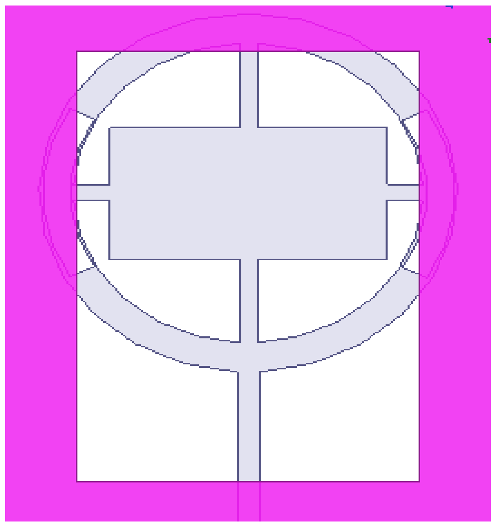

**Fig -2**: Ground Plane of Modified X band Antenna

**Table -2:** Dimension of Etched Slot

| | | |
|---|---|---|
| Rectangular Slot on Ground Plane | Length of Slot | 41 |
| | Width of Slot | 28 |

The introduction of rectangular slot produces two resonating frequencies in X band the 10.20GHz and 11.30GHz corresponding to -17.20 and -20.75dB return loss respectively, with a wide band of application 1.54GHz. Chart 3 represents the return loss characteristics of X band antenna.

The VSWR (Voltage Standing Wave Ratio) is an important characteristic of communication devices. It gives the measurement of how well an antenna is matched with it feed impedances where the reflection coefficient will be 0. The simulation result for VSWR is shown in Chart 4. This antenna provides the VSWR value is between 1 and 2 for the entire 1.54GHz range, from 9.92-11.46GHz. Hence, the antenna radiates efficiently. The slot provided in the antenna structure act as a radiating notch and provides complete radiation around the antenna structure. Another fundamental parameter of an antenna is its directivity. An antenna that radiate equally in all direction will have zero directionality. The Chart 5 and Chart 6 shows the gain as well as directivity of the simulated X band antenna.

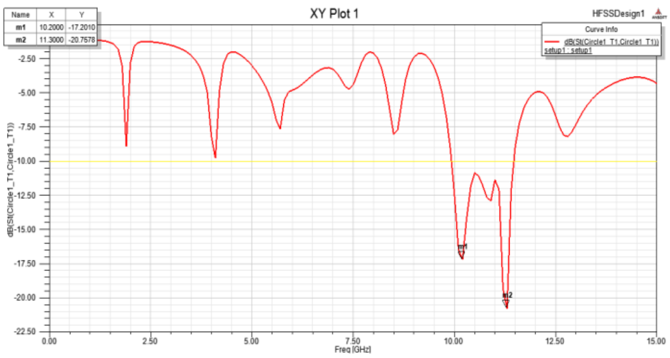


**Chart -3**: Return loss Characteristics

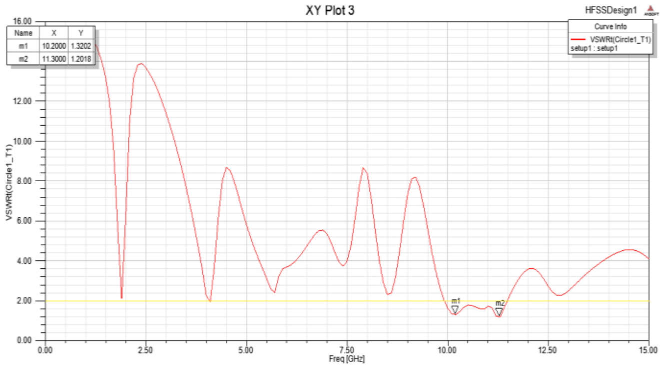


**Chart -4**: VSWR Characteristics

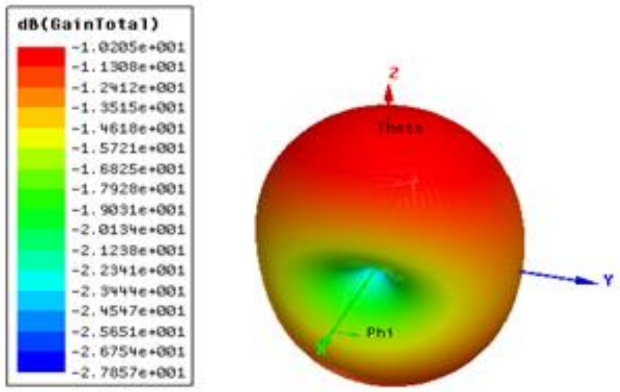


**Chart -5**: Gain

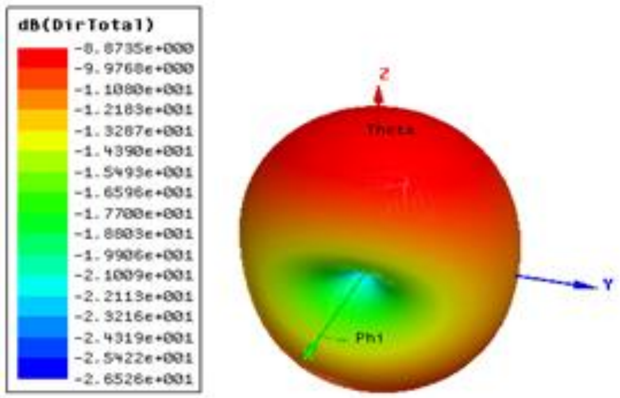


**Chart -6**: Directivity

## 4. CONCLUSIONS

This modified circular rectangular WiFi antenna with a rectangular slot on ground plane provides good performance throughout the 1.54GHz (9.92-11.46GHz) frequency range in terms of return loss, VSWR, gain and directivity. Hence this C-R slot design can be used for different applications in the field of wireless communication or in the field of x band application, this C-R patch can be treated as a versatile design in microstrip patch antenna designing. The gain of the antenna can be further increased by introducing slots on the patch.

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