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Research Article

# A Compact Circular Polarized Antenna For Fixed Communication Applications

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**ABSTRACT**
A compact Circular polarized rectangular patch antenna has been designed for the Fixed Communication applications in the Ku band with an operating frequency of 15GHz. The patch has been truncated at the diagonal corners to get the circular polarization. Rogers RT Duroid 5880 is taken as substrate material which is having a thickness of 0.508mm and a 50Ω coaxial cable has been used to excite the antenna. The overall dimension of the antenna is 13mm×13mm×0.508mm which is 0.65λ×0.65λ making the proposed antenna a compact one. The Proposed antenna is having an impedance bandwidth of 0.85GHz ranging from 14.61GHz to 15.45GHz with a gain of 7.87dB at the operating frequency of 15GHz. The axial ratio of the antenna at the operating frequency is 1.6dB which indicate the circular polarization. Commercially available 3D simulator Ansys HFSS software has been used to design the proposed antenna.

**Keywords**: Compact, Circular Polarization, Fixed Communication Applications.

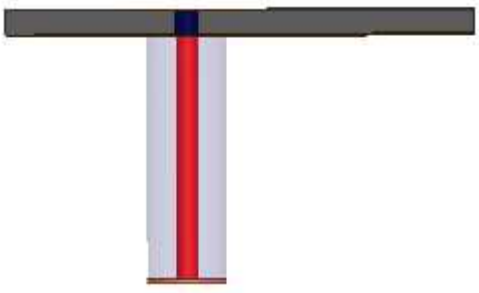
## INTRODUCTION

To meet the requirement of the modern communication systems the need for antennas with compact size and circular polarization is increasing day by day and it has become a challenge for the designers to achieve circular polarization in a compact antenna by maintaining the necessary impedance bandwidth and gain. For Fixed communication application circular polarization is a very essential parameter. It will reduce the signal loss due to polarization mismatch in between the transmitter and receiver antennas. It is also useful in reducing propagation losses. In [1] an antenna with circular polarization has been proposed where the patch is been truncated for getting circular polarization but the antenna is fed with a microstrip feed line which will have low radiation efficiency because of the surface waves produced by the feed line as both the feed line and the radiating patch are on the same surface. In [2] an antenna with circular polarization has been proposed where the authors used two feeds to develop orthogonal modes to achieve circular polarization. But this technique needs two transmitter circuits which will affect the cost of the system. In [3] an antenna with a diagonal slot at the center has been proposed to achieve circular polarization but by adding slot in the radiating patch the radiation pattern of the antenna is not uniform and the power radiated by the antenna is not uniform over the entire region. In this paper, we proposed is a compact circular polarized rectangular patch antenna with an operating frequency of 15GHz. Coax feed has been used to excite the antenna and to achieve circular polarization the radiating patch has been truncated at the two diagonal corners.

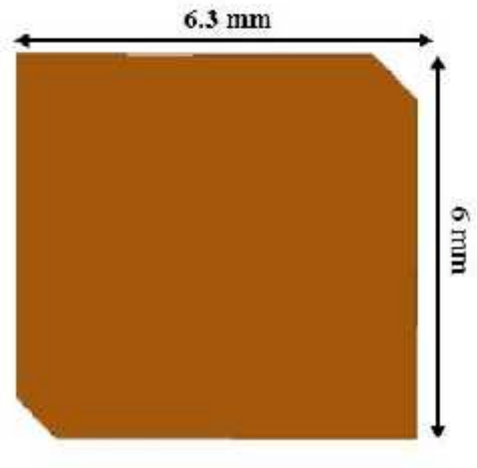
### Development of Proposed Antenna

*Proposed is a compact circular polarized rectangular patch antenna with an operating frequency of 15GHz. Low loss Rogers RT Duroid 5880 material has been used as the substrate material with a thickness of 0.508mm. Substrate has been considered as a square with a side dimension of 13mm. The radiating patch is a rectnagle and is truncated at the corners diagonally by 0.7mm. Proposed antenna is excited with a coax feed whose position is orthogonal to the diagonal truncations.*

**(a) Top View of proposed antenna**



**(b) Side View of proposed antenna**




**(c) Schematic Model of Patch**
**Fig. 1. Proposed antenna**

## Results and Discussion

Proposed antenna has been modeled and studied using the 3D Model simulator software Ansys HFSS. Various antenna parameters like Return loss, VSWR, Gain, Radiation Pattern, Directivity and axial ratio which are used to verify the performance of the antenna were studied and presented below[4-7]. Figure 3 below shows the impedance matching plot of the antenna, The image depicts that the antenna is radiating in the frequency range of 14.61GHz to 15.45GHz with a operating centre frequency of 15GHz. We can also observe that the return loss of the antenna at the operating frequency is -24dB. Which represents that the proposed antenna is having a good impedance matching at the required operating frequency.

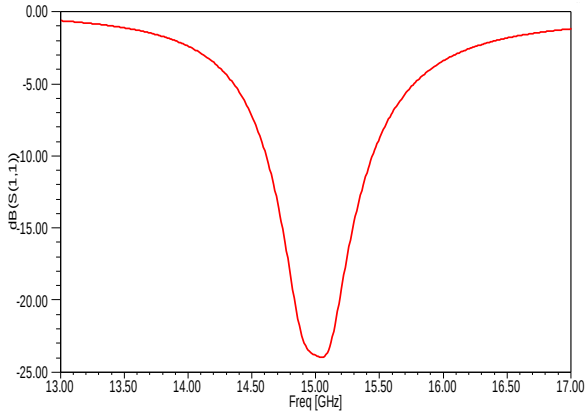



**Fig. 3. Return loss**

Figure 4 below shows the VSWR plot of the antenna, The image depicts that the VSWR value of the antenna is less than 2dB in the entire radiating frequency range of 14.6GHz to 15.4GHz with a operating centre frequency of 15GHz. We can also observe that the VSWR value of the antenna at the operating frequency is 1.12dB. Which represents that the proposed antenna is having a good impedance matching at the required operating frequency.

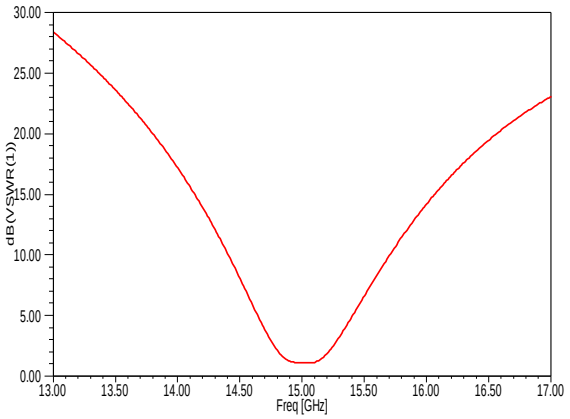



**Fig. 4. VSWR**

Figure 5, 6 and 7 below shows the 3D gain plot, 2D gain plot and the Directivity plot of the proposed antenna at the operating frequency of 15GHz, The image depicts that the gain value of the antenna is 7.87dB and the directivity of the antenna is 7.81dB. Figure 6 represents the two dimensional gain plot of the antenna it shows a uniform distribution of the power in different theta angles without any nulls which is very essential for the fixed communication applications [8,9]. It is also observed that the gain and directivity are nearly equal which represents that the losses in the proposed antenna are very low.

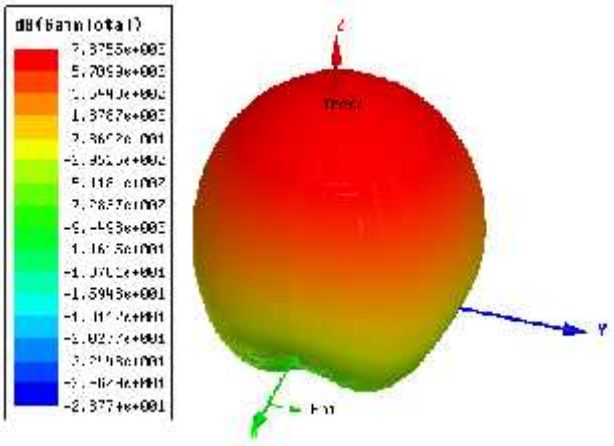


**Fig.5. Gain at 15GHz**

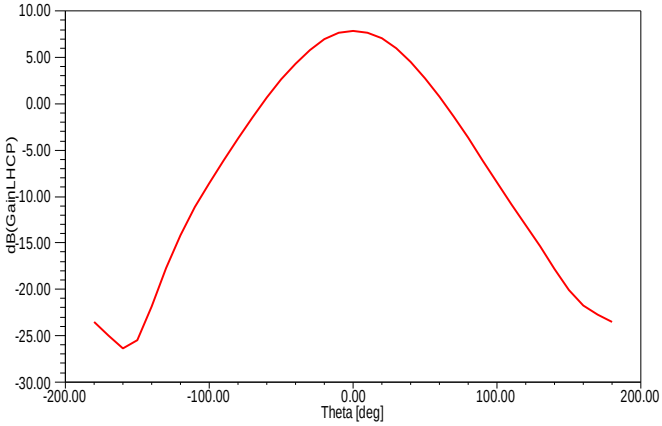



**Fig. 6. Gain at 15GHz**

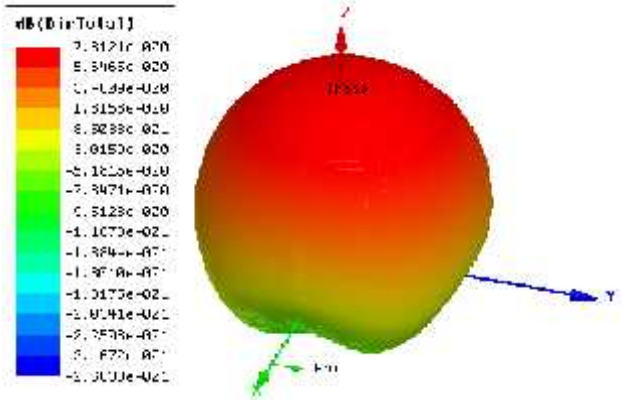


**Fig.7. Directivity at 15GHz**

Elevation plan and Azimuthal plan patterns of the proposed antenna at the operating frequency of 15GHz are shown below in Figures 8 and 9. Both the patterns are having uniform distribution of the power in different theta angles without any nulls which is very essential for the fixed communication applications for proper planning of the antenna coverage area.

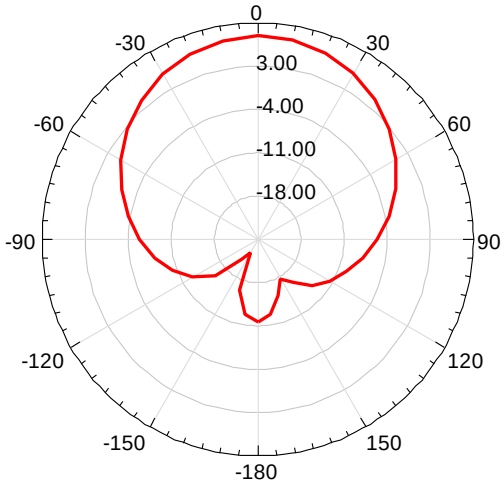



**Fig. 10. Elevation Plane Patterns**

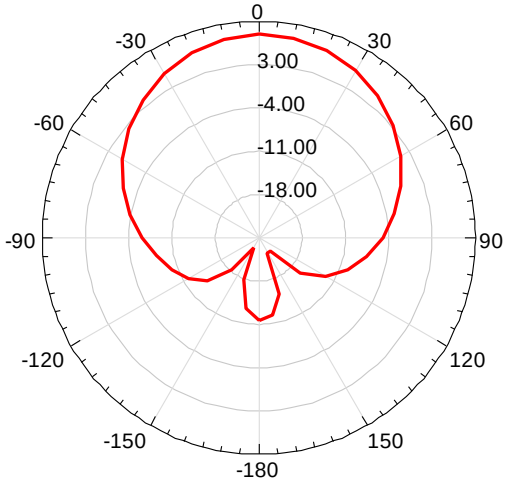



**Fig. 11. Azimuthal Plane Patterns**

Figure 10 below shows the Axial ratio pattern of the proposed antenna at the operating frequency of 15GHz. The axial ratio value is 1.6dB at $0^0$ which represents that the antenna is having circular polarization at the operating frequency.

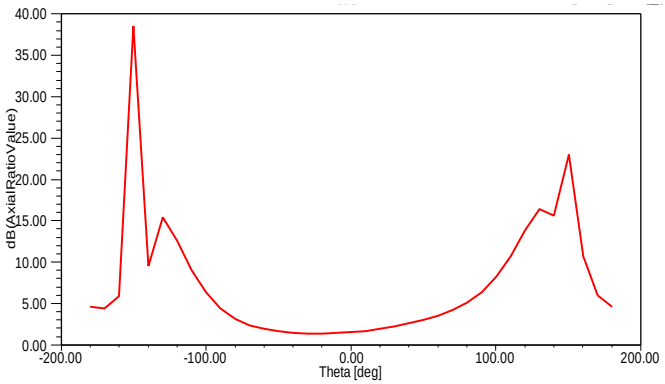



**Fig. 10. Axial Ration at 3.5GHz**

The radiation of the antenna depends on the current fields generated in the radiating patch which are shown in the figure 11 below. We can observe that the intensity of the current field is minimum at the center of the patch and maximum at the edges. Figure 12 above shows the smith chart plot of the antenna.

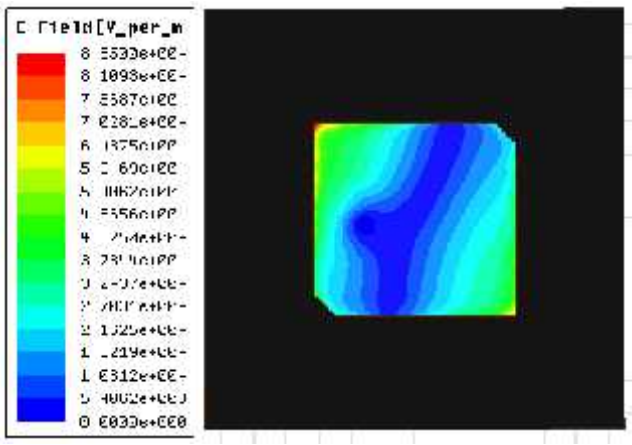


**Fig. 11. Current distribution of the patch**

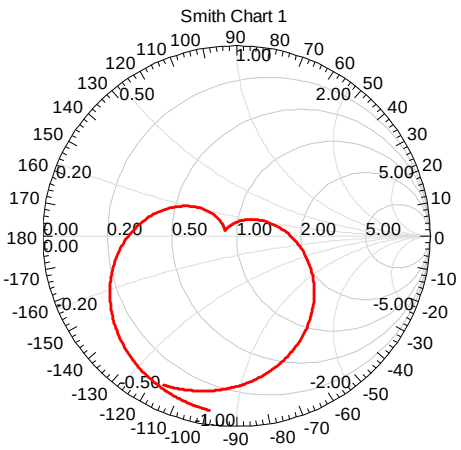



**Fig. 12. Smith Chart**

## Conclusion

A compact Circular polarized rectangular patch antenna has been designed for the Fixed Communication applications in the Ku band with an operating frequency of 15GHz. The patch has been truncated at the diagonal corners to get the circular polarization. Rogers RT Duroid 5880 is taken as substrate material which is having a thickness of 0.508mm and a 50Ω coaxial cable has been used to excite the antenna. The overall dimension of the antenna is 13mm×13mm×0.508mm which is 0.65λ×0.65λ making the proposed antenna a compact one. The Proposed antenna is having an impedance bandwidth of 0.85GHz ranging from 14.61GHz to 15.45GHz with a gain of 7.87dB at the operating frequency of 15GHz. The axial ratio of the antenna at the operating frequency is 1.6dB which indicate the circular polarization.

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