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Triple Frequency CPW Fed Fractal Antenna for Wireless Applications

S.Ram Kumar, M.V.S. Prasad

Abstract*: A Triple Frequency CPW feed fractal patch antenna has been designed for the S and C band applications with the operating frequencies of 2.29GHz, 3.46GHz and 5.89GHz. Patch has been etched with slots in a periodic manner which led for the generation of triple band of resonance. Flame Retardant Glass epoxy is taken as substrate material which is having a thickness of 1.6mm and a 50Ω stripline has been used to excite the antenna. Fractal technique has been implemented to attain the triple frequency of operation. The overall dimension of the antenna is 60mm×60mm×1.6mm. The Proposed antenna is having resonance which is covering the S and C band frequencies with a return loss value less than -10dB for entire bandwidth. Commercially available 3D simulator Ansys HFSS software has been used to design the proposed antenna.

Keywords* : Fractal, Triple frequency, edge truncation.

I. INTRODUCTION

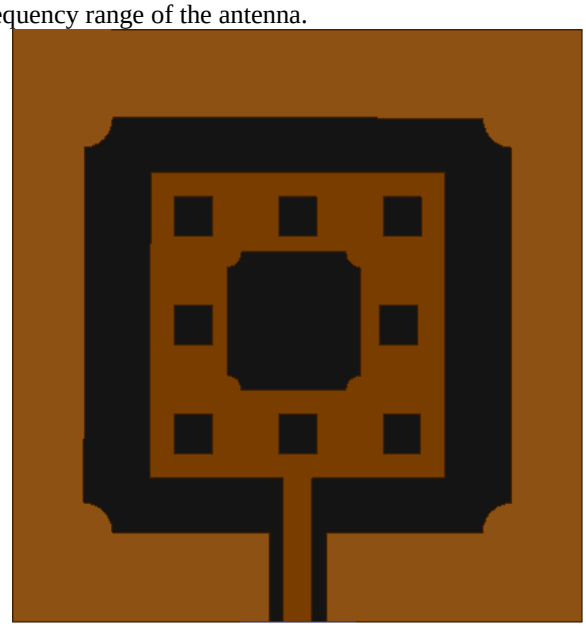
With the advancement of technology usage of Microwave devices has grown in a many fields including medical imaging. Medical Images plays a crucial role in diagnosis of the disease in a very early stages. Microwave devices assists for the development of these medical images. The frequencies of the S-band and C-band are best suited for these devices. Different tissues of the body will give different response for different frequencies. It is necessary for diagnosis of different diseases. For this purpose we need antennas which can radiate at multiple frequencies and with a compact size.

Researchers around the globe proposed many techniques to develop antennas with compact size and multiple resonance. In [1] a U slot antenna with edge truncation has been proposed for 5G communication systems. Here they achieved the triple frequency of operation by implementing the slotting and edge truncation techniques. In [2] the authors presented a triple band slotted patch antenna for maritime applications. Here they achieved the triple frequency of operation by implementing the symmetrical dual slotting technique in a printed monopole antenna. A printed dipole dual frequency patch antenna has been presented in [3]. Here they achieved the dual frequency of operation by taking printed dipole structures as three different arms and with a interconnection between the three arms. Similarly many researchers' proposed different techniques like stacked patch, shorting pin, shorting post defective ground structures in [4-17]

In this paper, Triple Frequency CPW fed fractal Rectangular patch antenna has been designed for the S and C band applications. Fractal antenna technique has been implemented to attain the multiple frequency of operation. Three iterations of the fractal geometry are been taken and the corners of the first and second iteration slots are truncated with a semicircle. Coplanar wave guide feed has been used to excite the antenna and to achieve exact operating frequency the dimensions of the periodic slots and their position with respective to the feed location and patch plays an important role.

II. DEVELOPMENT OF PROPOSED ANTENNA

Proposed is a Triple Frequency Coplanar wave guide fed fractal rectangular patch antenna with an operating frequency ranging in the S and C bands with center frequencies of 2.29GHz, 3.46GHz and 5.89GHz. Flame Retardant Glass epoxy is taken as substrate material which is having a thickness of 1.6mm. Substrate has been considered as a rectangle with a dimension of 60mm×60mm×1.6mm. The basic radiating patch is a rectangle in which periodic slots are been etched which led to the generation of multiple resonance. The dimensions of the various components in the radiating elements after optimization are given as A=60mm, B=39mm, C=31mm, D=11mm, E=4mm and F=6mm. Proposed antenna is excited with a Coplanar wave guide feed whose position is crucial in determining the operating frequency range of the antenna.



(a) Top View of proposed antenna

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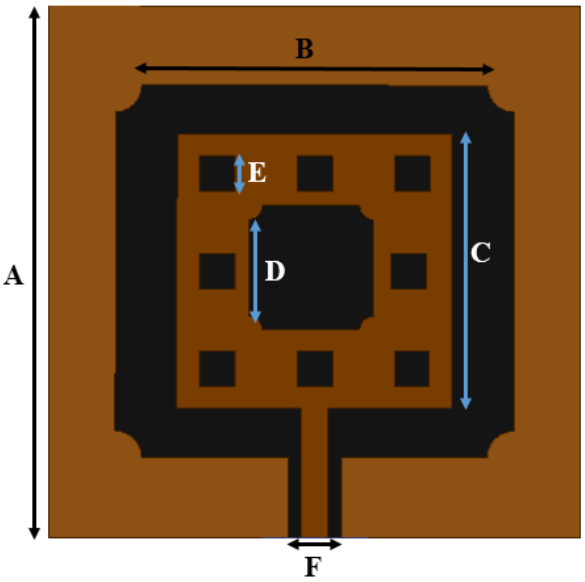
* Correspondence Author
S.Ram Kumar*, Department of E.C.E, University College of Engineering and Technology, Acharya Nagarjuna University, Guntur, A.P, India. Email: rams.mtech@gmail.com
M.V.S. Prasad, Department of E.C.E, R.V.R&J.C College of Engineering, Guntur, A.P, India



(b) Schematic Diagram of antenna

Fig. 1. Proposed antenna

III. 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, and current distributions which are used to verify the performance of the antenna were studied and presented below. Figure 3 below shows the impedance matching plot of the antenna, The image depicts that the antenna is having operating frequency ranging in the S and C bands with center frequencies at 2.29GHz, 3.46GHz and 5.89GHz. We can also observe that the return loss of the antenna at the entire operating frequency is less than -10dB. Which represents that the proposed antenna is having a good impedance matching at the required operating frequency.

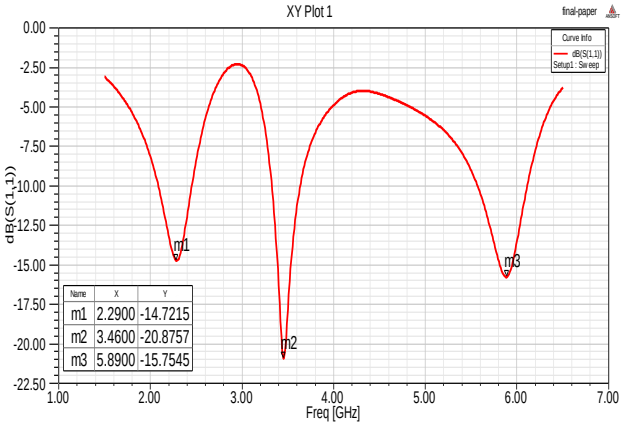


Fig. 3. Return loss

Figure 4 below shows the VSWR plot of the antenna, The image depicts that the VSWR value of the antenna is less than 2dB for the entire operating frequency ranging in the S and C bands with center frequencies at 2.29GHz, 3.46GHz and 5.89GHz. We can also observe that the VSWR of the antenna at the operating frequency range is less than 2dB. Which represents that the proposed antenna is having a good impedance matching at the required operating frequency.

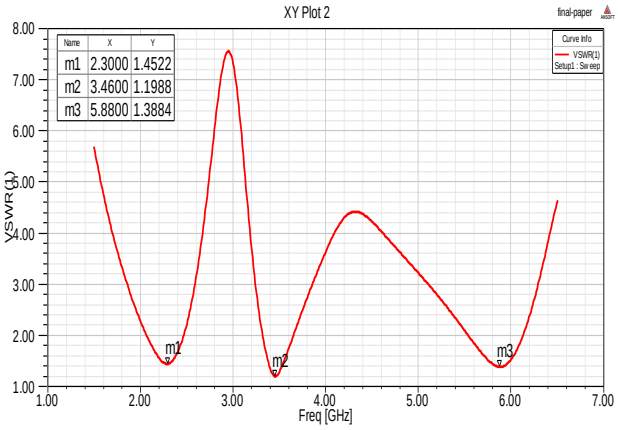


Fig. 4. VSWR

Figures 5, 6 and 7 below shows the gain plot of the proposed antenna at three intermediate operating frequencies of 2.29GHz, 3.46GHz and 5.89GHz.

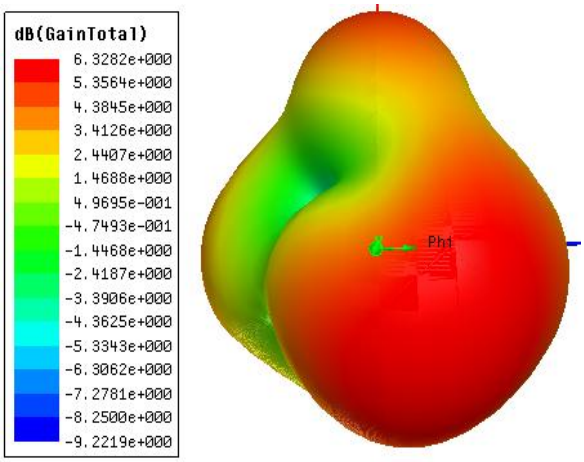


Fig.5. Gain at 2.29GHz

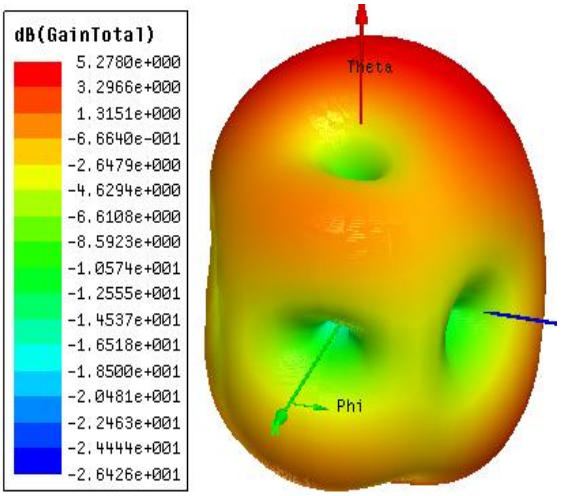


Fig. 6. Gain at 3.46 GHz

The image depicts that the gain value of the antenna at the operating frequency of 2.29GHz is 6.32dB, 3.46GHz is 5.27dB and at 5.89GHz is 6.79dB. From the three gain plots of the antenna we can observe that there is a considerable amount of antenna radiation at all three frequencies. Which is also been observed from the current fields generated in the radiating patch which are shown in the figure 8 below.

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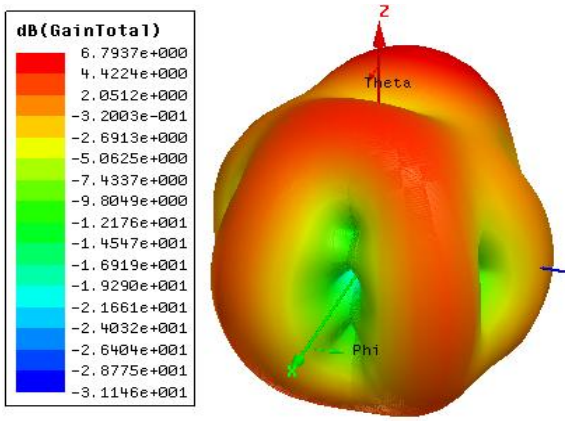
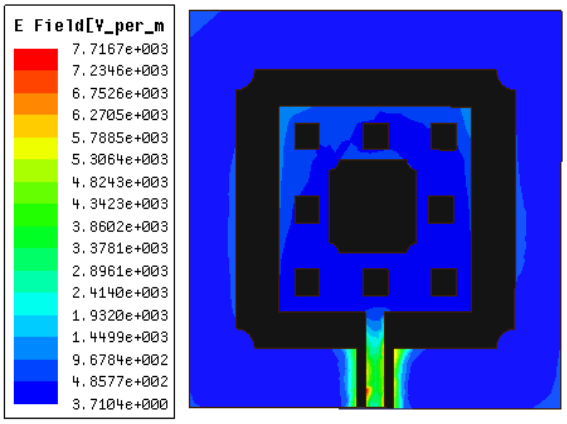
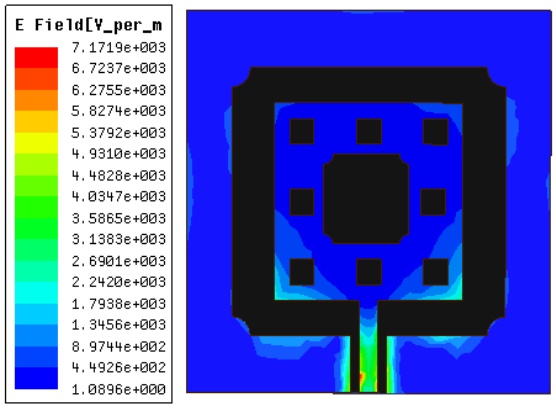


Fig. 7. Gain at 5.89GHz

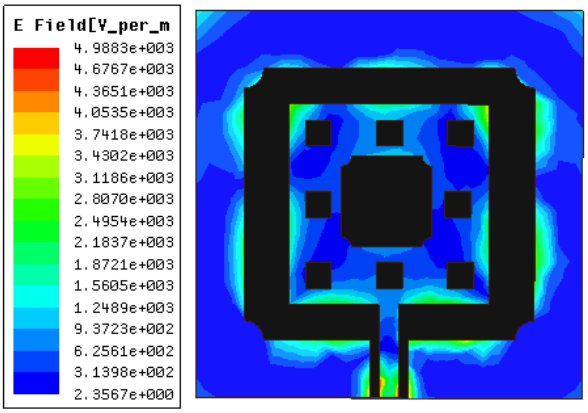


(a) at 2.29GHz



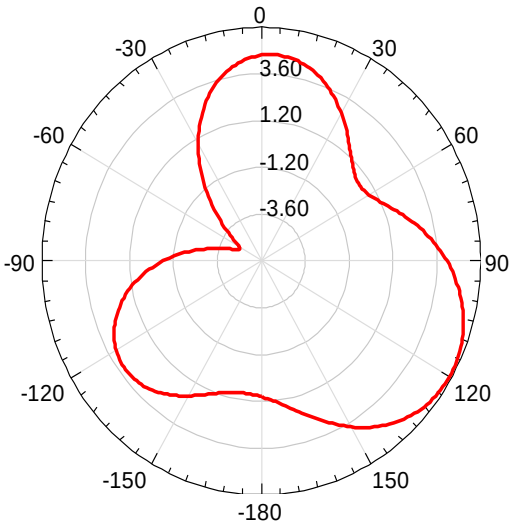
(b) at 3.46GHz

Elevation plan and Azimuthal plan patterns of the proposed antenna at the three operating frequencies of 2.29GHz, 3.46GHz and 5.89GHz are shown below in Figures 9, 10 and 11.

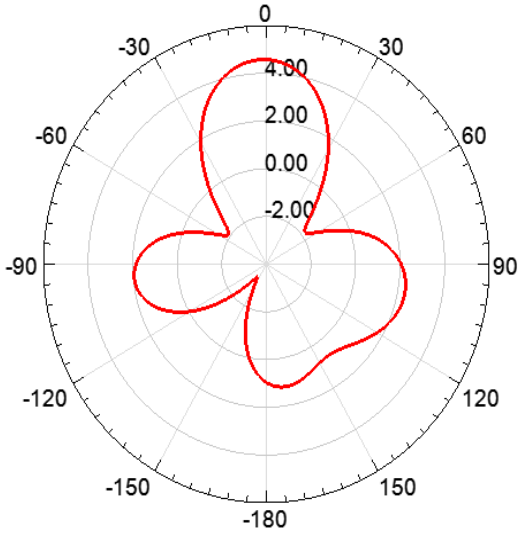


(C) at 5.89GHz

Fig. 8. Current distributions of the patch

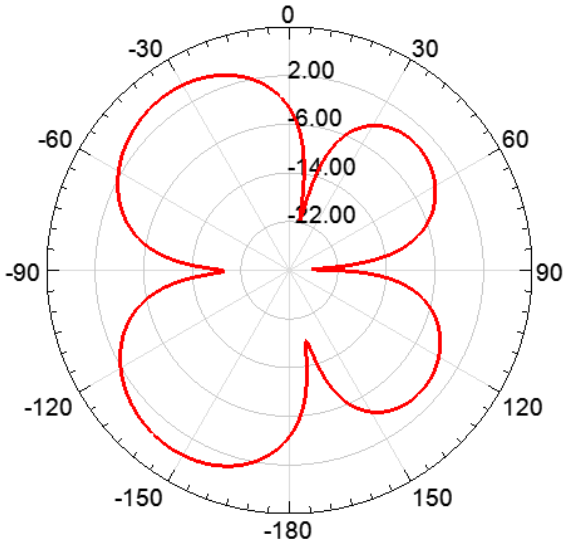


(a) Elevation Plane

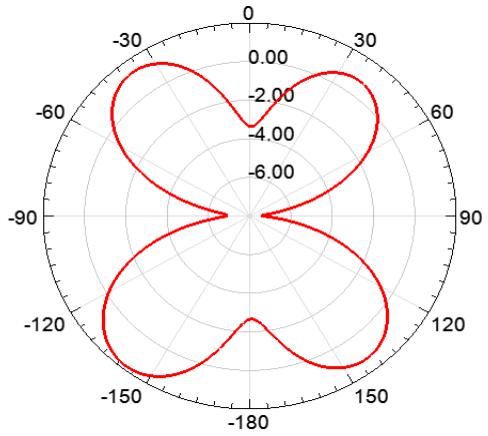


(b) Azimuthal Plane

Fig. 9. Radiation Pattern at 2.29GHz

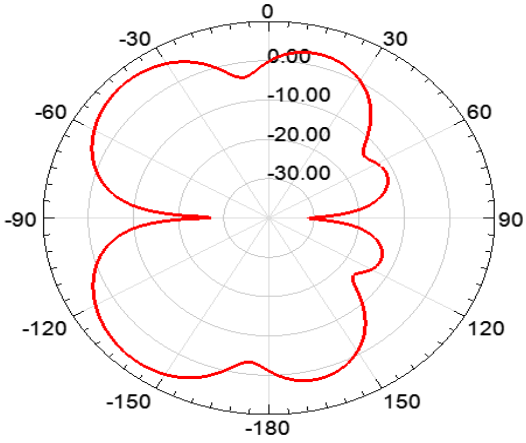


(a) Elevation Plane

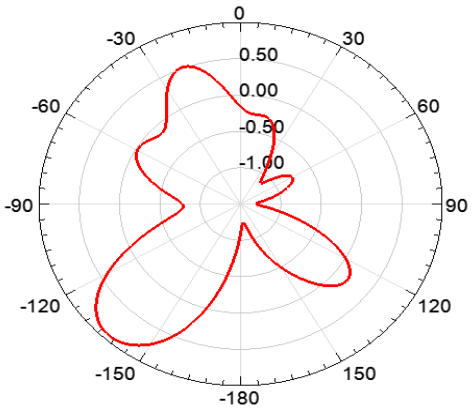


(b) Azimuthal Plane

Fig. 10. Radiation Pattern at 3.46GHz



(a) Elevation Plane



(b) Azimuthal Plane

Fig. 11. Radiation Pattern at 5.89GHz

IV. CONCLUSION

A Triple Frequency CPW feed fractal patch antenna has been designed for the S and C band applications with the operating frequencies of 2.29GHz, 3.46GHz and 5.89GHz. Patch has been etched with slots in a periodic manner which led for the generation of triple band of resonance. Flame Retardant Glass epoxy is taken as substrate material which is having a thickness of 1.6mm and a 50Ω stripline has been used to excite the antenna. Fractal technique has been implemented to attain the triple frequency of operation. The overall dimension of the antenna is 60mm×60mm×1.6mm. The Proposed antenna is having resonance which is covering the S and C band frequencies with a return loss value less than -10dB for entire bandwidth. Commercially available 3D simulator Ansys HFSS software has been used to design the proposed antenna.

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