ISSN 2582-2659
DOI:https://doi.org/10.31838/NJAP/01.01.03

Research Article

A Compact Triangular Ring Patch Antenna For Radio Location and Fixed Satellite Applications

M. I. AHMED,
Microstrip Department, Electronics Research Institute, Giza, Egypt
Email id: miahmed@eri.sci.eg
Received: 03.01.19, Revised: 03.02.19, Accepted: 03.03.19

ABSTRACT
A compact dual frequency triangular ring patch antenna has been designed for the radiolocation and fixed satellite applications in the X and Ku bands with an operating frequency of 8.55GHz and 19.44GHz. The patch has been considered as triangular ring to get the necessary frequency of operation. Flame Retardant Glass epoxy is taken as substrate material which are having a thickness of 2mm and a 50Ω microstrip line has been used to excite the antenna. Slotted patch technique has been implemented to attain the dual frequency of operation. Proposed antenna work as two radiators of which one is outer perimeter of patch and the other is the inner perimeter. The overall dimension of the antenna is 14.3mm×14.3mm×2mm which is 0.61λ×0.61λ making the proposed antenna a compact one. The Proposed antenna is having dual frequency of operation at the frequencies of 8.55GHz and 19.44GHz with a gain of 6.06dB and 5.82dB respectively. Commercially available 3D simulator Ansys HFSS software has been used to design the proposed antenna.

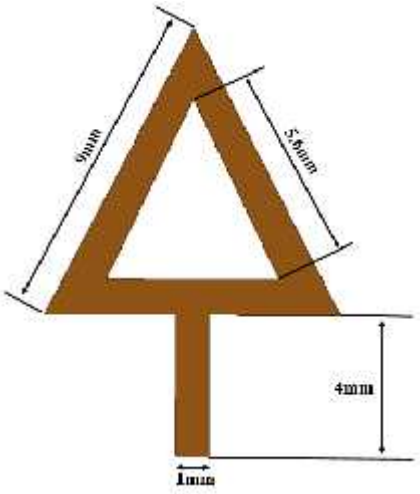
Keywords: Compact, Ring patch, Radio Location Application.

INTRODUCTION
With the rapid development of the technology we need devices with multiple applications and to meet the requirement of the modern communication systems the need for antennas with compact size and multiple frequency of operation is increasing day by day and it has become a challenge for the designers to achieve multiple resonance in a compact antenna by maintaining the necessary impedance bandwidth and gain. For radio location application compactness is a very essential parameter so that the antenna can be carried easily and can be integrated into any system used for the search operations. In [1] an antenna with dual resonance has been proposed where the patch has been shorted with the ground using a via for getting dual resonance but the antenna is fed with a coax feed line which will have low radiation efficiency. In [2] an antenna with two radiating elements placed on the same surface has been proposed where the authors used two feeds to excite two patches for achieving dual resonance. But this technique needs two transmitter circuits which will affect the cost of the system and also the size is very high. In [3] an antenna with a diagonal slot at the center has been proposed to achieve dual resonance 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, A compact dual frequency triangular ring patch antenna has been designed for the radiolocation and fixed satellite applications in the X and Ku bands with an operating frequency of 8.55GHz and 19.44GHz. Strip feed has been used to excite the antenna.

Development of Proposed Antenna
Proposed is A compact dual frequency triangular ring antenna with an operating frequency of 8.55GHz and 19.44GHz. Easily availale Flame Retardant Glass epoxy material has been used as the substrate material with a thickness of 2mm. Substrate has been considered as a square with a side dimension of 14.3mm. The radiating patch is a triangular ring and is fed with a microstrip feed.

(a) Top View of proposed antenna

(b) Bottom View of proposed antenna



(c) Schematic Model of Antenna

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, and current distributions 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 at the two frequencies of 8.55GHz and 19.44GHz. We can also observe that the return loss of the antenna at the operating frequency of 8.55GHz is -19.27dB and at 19.44GHz is 15.37dB. Which represents that the proposed antenna is having a good impedance matching at the required operating frequency.

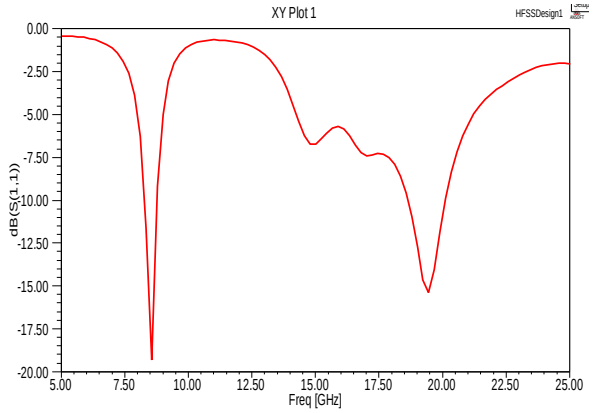


Fig. 3. Return loss

Figure 4 below shows the VSWR plot of the antenna, The image depicts that the VSWR value of the antenna is less than 2dB at the two frequencies of 8.55GHz and 19.44GHz. We can also observe that the VSWR of the antenna at the operating frequency of 8.55GHz is 1.24dB and at 19.44GHz is 1.41dB. Which represents that the proposed antenna is having a good impedance matching at the required operating frequency.

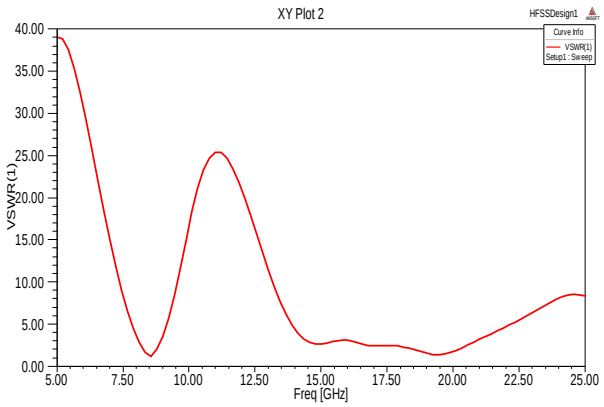


Fig. 4. VSWR

Figures 5 and 6 below shows the gain plot of the proposed antenna at the two operating frequencies of 8.55GHz and 19.44GHz, The image depicts that the gain value of the antenna at the operating frequency of 8.55GHz is 6.06dB and at 19.44GHz is 5.82dB. From the two gain plots of the antenna we can observe that there is a uniform distribution of the power in different theta angles without any nulls which is very essential for Radio Location applications [8,9].

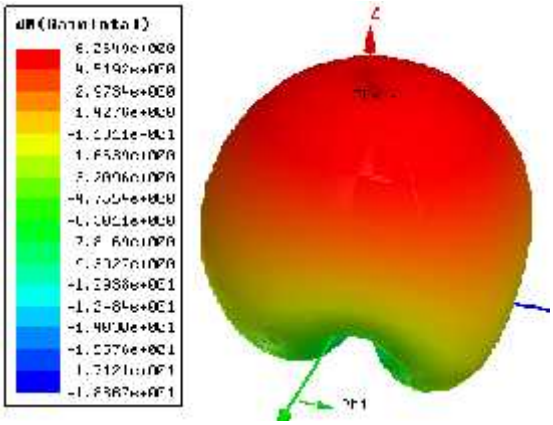


Fig.5. Gain at 8.55GHz

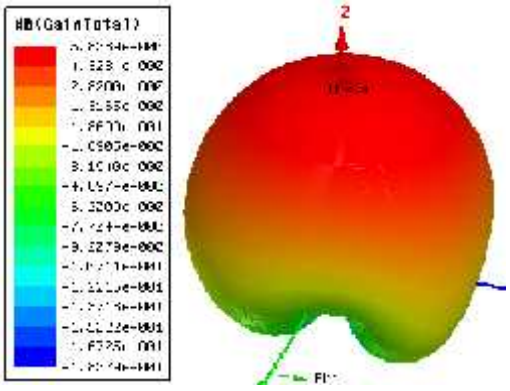
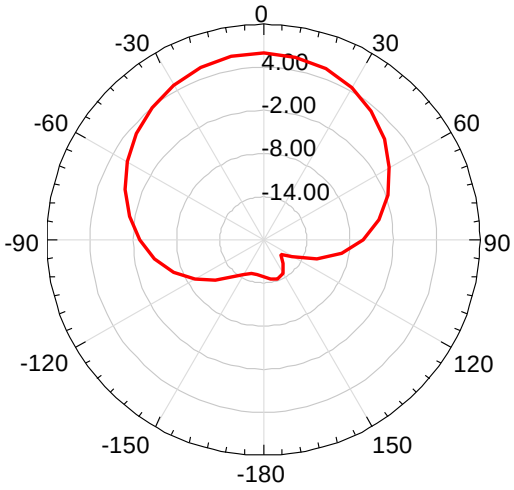


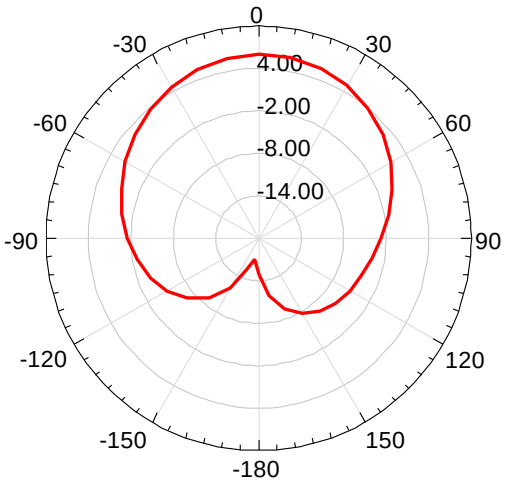
Fig. 6. Gain at 19.44GHz

Elevation plan and Azimuthal plan patterns of the proposed antenna at the two operating frequencies of 8.55GHz and 19.44GHz are shown below in Figures 7 and 8. Both the patterns are having uniform distribution of the power in different theta

angles without any nulls which is very essential for the radio Location applications for proper planning of the antenna coverage area.

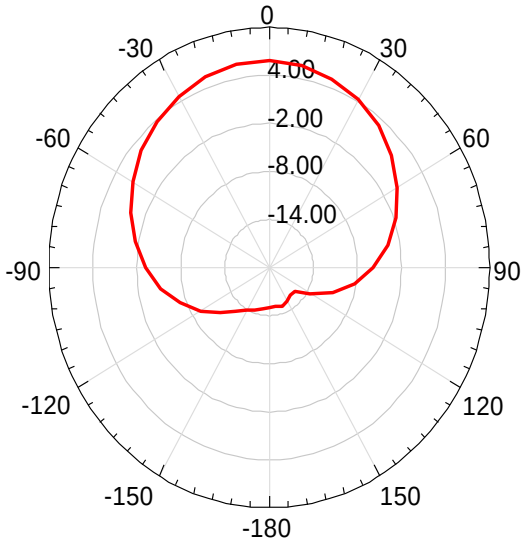


(a) Elevation Plane

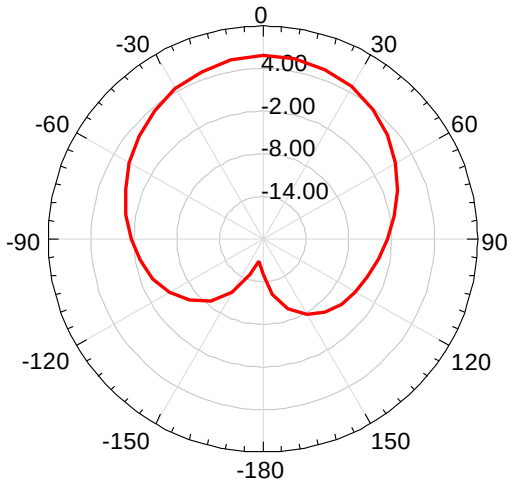


(b) Azimuthal Plane

Fig. 7. Radiation Pattern at 8.55GHz



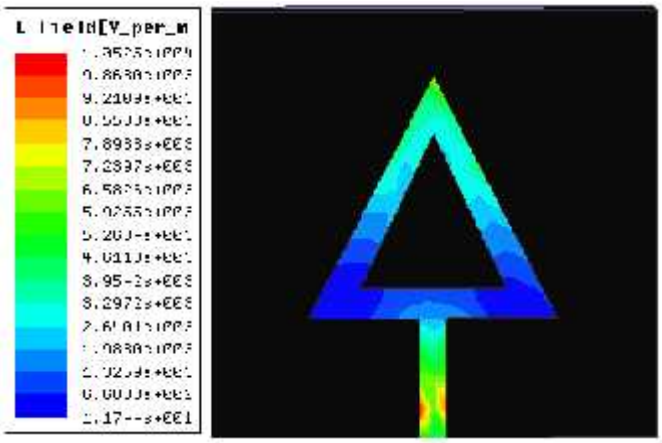
(a) Elevation Plane



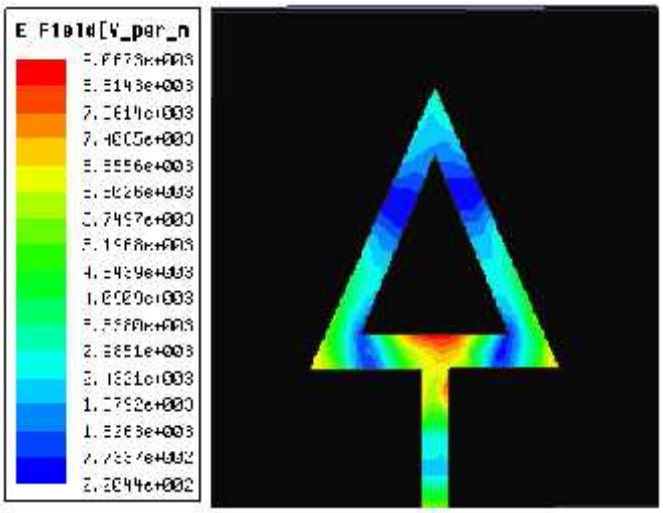
(b) Azimuthal Plane

Fig. 8. Radiation Pattern at 19.44GHz

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 different for different frequency of operation.



(a) at 8.55GHz



(b) at 19.44GHz

Fig. 9. Current distributions of the patch

Conclusion

A compact dual frequency triangular ring patch antenna has been designed for the radiolocation and fixed satellite applications in the X and Ku bands with an operating frequency of 8.55GHz and 19.44GHz. The patch has been considered as triangular ring to get the necessary frequency of operation. Flame Retardant Glass epoxy is taken as substrate material which are having a thickness of 2mm and a 50Ω microstrip line has been used to excite the antenna. Slotted patch technique has been implemented to attain the dual frequency of operation. Proposed antenna work as two radiators of which one is outer perimeter of patch and the other is the inner perimeter. The overall dimension of the antenna is 14.3mm×14.3mm×2mm which is 0.61λ×0.61λ making the proposed antenna a compact one. The Proposed antenna is having dual frequency of operation at the frequencies of 8.55GHz and 19.44GHz with a gain of 6.06dB and 5.82dB respectively.

References

1. E. Kusuma Kumari, A.N.V.Ravi Kumar. (2017). Wideband High-Gain Circularly Polarized Planar Antenna Array for L Band Radar. IEEE International Conference on Computational Intelligence And Computing Research, Tamilnadu College of Engineering. Tamil Nadu.
2. E. Kusuma Kumari, A.N.V.Ravi Kumar. (2017). Development of an L Band Beam Steering Cuboid Antenna Array. IEEE International Conference on Computational Intelligence And Computing Research, Tamilnadu College of Engineering. Tamil Nadu.
3. Sunkaraboina Sreenu, Vadde Seetharama Rao. (2017). Stacked Microstrip Antenna For Global Positioning System. IEEE International Conference on Computational Intelligence And Computing Research, Tamilnadu College of Engineering. Tamil Nadu.
4. Rao N.A, Kanapala S. (2018). Wideband Circular Polarized Binomial Antenna Array for L-Band Radar. Panda G., Satapathy S., Biswal B., Bansal R. (eds) Microelectronics, Electromagnetics and Telecommunications. Lecture Notes in Electrical Engineering, vol 521. Springer, Singapore
5. Kanapala S, Rao N.A. (2018). Beam Steering Cuboid Antenna Array for L Band RADAR. Panda G., Satapathy S., Biswal B., Bansal R. (eds) Microelectronics, Electromagnetics and Telecommunications. Lecture Notes in Electrical Engineering, vol 521. Springer, Singapore.
6. Sunkaraboina Sreenu, P. Gnanasivam, M. Sekhar (2018). Circular polarised Antenna Array for C Band Applications. Journal of Advanced Research in Dynamical & Control Systems, Vol. 10, 14-Special Issue.
7. K. Ashwini, M. Sekhar, Sunkaraboina Sreenu. (2018). Mutual Coupling Reduction Using Meander Square EBG Structures for C-Band Radars. Journal of Advanced Research in Dynamical & Control Systems, Vol. 10, 12-Special Issue.
8. Sekhar M, S Naga Kishore B, Siddaiah P. (2014). Triple Frequency Circular Patch Antenna. IEEE International Conference on Computational Intelligence And Computing Research, Park College Of Engineering And Tekhnology. Tamil Nadu.
9. J Lavanya, S Nagakishore Bhavanam, Vasujadevi Midasala "Design of Spiral Antenna for Multiband Applications" International Journal of Innovative Technology and Exploring Engineering, Volume-8 Issue-5 March, 2019.