Designing of Printed Monopole Antenna for Micro, Nano and Pico Satellites

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Abstract: In this paper, two printed Monopole Patch Antenna (PMA) with tri band (L & S band) are designed and simulated for micro, Nano and Pico satellites application. These Printed Monopole Antennas with high gain and good radiations pattern for all three frequencies. These PMAs comprises some slots with different shapes which generate three separate resonant modes for the desired tri band operations. Proposed antennas are designed and simulated using ANSYS electronics desktop (HFSS) software.

Index terms: Small satellites, Printed Antenna, Satellite Communication, Slot and Monopole Antennas

I. INTRODUCTION

Recently compact technologies make it convenient to elaborate smaller satellites than those built a decade ago without causing the performances. Small satellites are pleasing because they require less investments, low cost mass production while presenting greater reliability, lower launch costs and greater launch workability. Their use, involving a solitary or a constellation of satellites, comprise earth observation the testing of components, communication and educational applications [2]. Low cost micro, Nano and Pico satellites have enabled unparalleled access to space for smaller institutions and organizations. As the benefits of low cost, small satellites have been realized by more bodies there has been an increase in demand for higher performing small satellite systems [3].

Micro strip patch antennas are used in various wireless applications, being present in missiles, aircrafts, spacecrafts and satellites. As per [1] is lightweight, thin, cheap, easy to fabricate and to polarize circularly and linearly. Micro strip patch antennas are easily combined with feeding networks and impedance matching devices [3].

One attribute of printed antennas is that the antenna dimensions are conditional on the dielectric constants of the enrolled microwave laminates. In many situations, miniaturized radiators can be obtained by using substrates with high dielectric constant. Although, it is well known that these characteristics have the disadvantage of surface waves excitation, which can cause the radiation efficiency of the antenna and degenerate the shape of the radiation pattern and the polarization.

The multiband or broadband antennas have inspired high interest in recent years for application to multimode communication systems. Because of low cost and process simplicity, printed monopole antennas are very commercial candidates for these applications [4]. These printed monopole antennas are very appropriate to be integrated on the circuit board of a communication appliance, leading to the attractive attribute of occupying very small volume of the system and reducing the fabrication cost of the final product. In addition, with the use of this form of printed monopole antennas, a covered antenna for the system can be obtained; that is, there are no extended portions in appearance for the antenna [5]. Lately, the design of dual band or multiband antennas has received the civility of antenna researchers.

II. VARIOUS GEOMETRY OF PRINTED MONOPOLE ANTENNA

Various regular shaped printed monopole antennas such as printed square monopole antenna (PSMA), printed rectangular monopole antenna (PRMA), printed hexagonal monopole antenna (PHMA), printed triangular monopole antenna (PTMA), printed circular monopole antenna (PCMA), and printed elliptical monopole antenna (PEMA) [1] for different feed positions are shown in Fig.1[9]

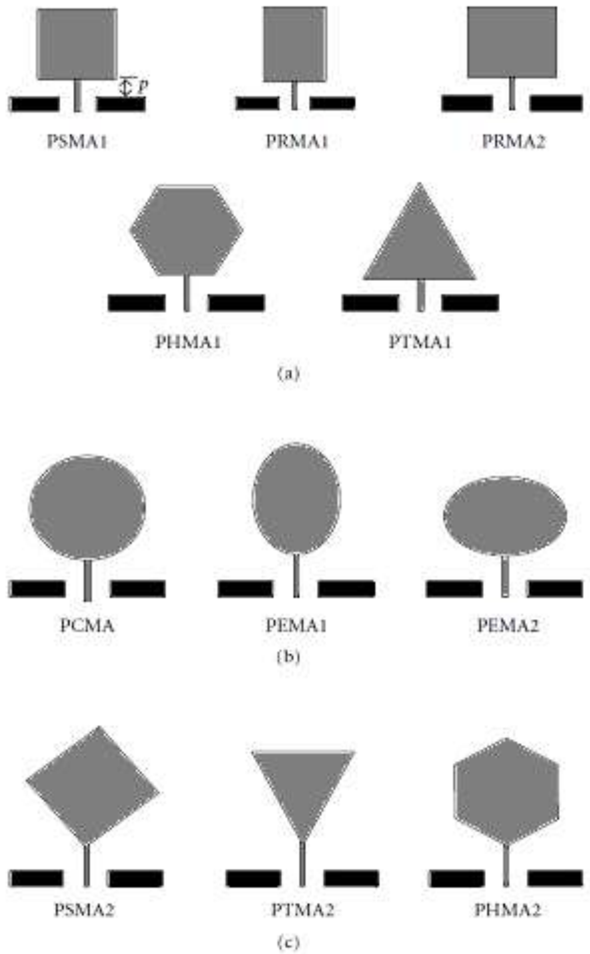

Fig. 1. Various regular shaped PMAs with different feed configurations

III. DEFECTED GROUND STRUCTURE

Deliberately created defects in the form of etched out patterns on the ground plane of micro strip circuits and transmission. The term Defected Ground Structure (DGS), specifically implies a single or very limited number of defects. The antenna designers initially employed DGS underneath printed feed lines to suppress higher harmonics. Various DGS geometries can be used on the radiator as well as on the ground plane to enhance the gain and bandwidth[9]. The DGSs refer to certain compact geometrical shapes and they are realized in the form of defects on the ground plane of printed circuits. The DGS may either comprise a single defect (unit cell), or it may contain a number of periodic and aperiodic configurations. A DGS is characterized by its stop band behavior within which it impedes the propagation of electromagnetic (EM) waves through the substrate containing the DGS over a range of frequencies. DGS technique can be majorly used for WiMAX, WLAN, WCDMA applications.

IV. ANTENNA DESIGN

In this section, procedure of a simple strip printed monopole antenna for tri band Applications. Figure 1 shows three different configurations of Printed Monopole Antenna.

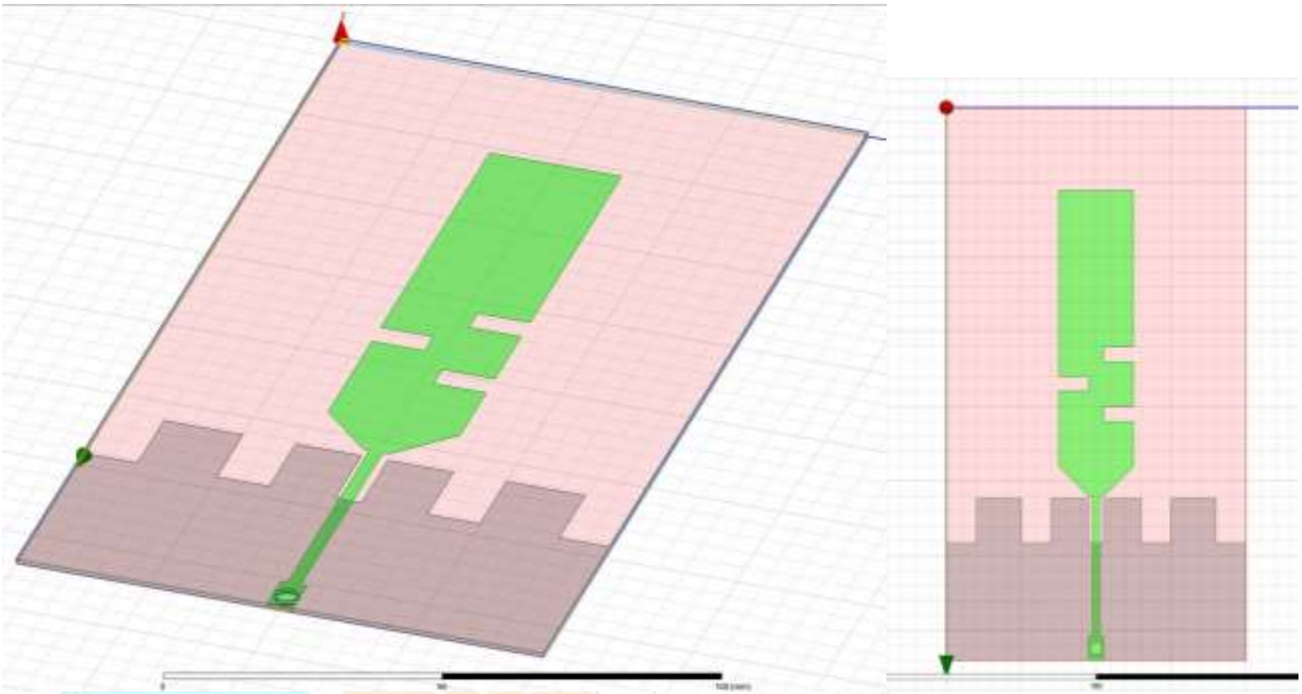

Figure 1 Slotted PRMA

Micro strip slot antenna comprises of a slot in the ground plane fed by a Micro strip line. The slot may have the shape of a rectangle or a circle or any other as required to radiate in a desired manner Figure 1 is a strip monopole antenna excited by a 50- micro strip line with a truncated optimum ground plane. Ground plane is a crucial factor for these printed monopoles. The antenna performance significantly varies for infinite to finite ground plane transition. When the ground plane is truncated, the current distribution on the ground plane at the radiating frequency becomes more significant. This influences the radiation characteristics of the antenna to a great extent.

Table 1: Antenna Parameters

Structure	Dimension
Substrate	L_S = 185mm W_S = 100mm T = 0.8mm
Ground	L_g = 54mm W_g = 100mm
Patch	L_p = 102mm W_p = 25mm
Slot of Patch	L_{Sp} = 5mm W_{Sp} = 10mm

V. SIMULATED RESULTS

Proposed Antenna is Designed and Simulated in ANSYS HFSS. Figure 2 shows the S parameter of PRMA which is shown in figure 1. Here PRMA is resonating at three different frequencies which are **1.2 GHz, 1.6 GHz and 2.34 GHz**. Also Gain, Radiation Pattern, Current distributions are shown below.

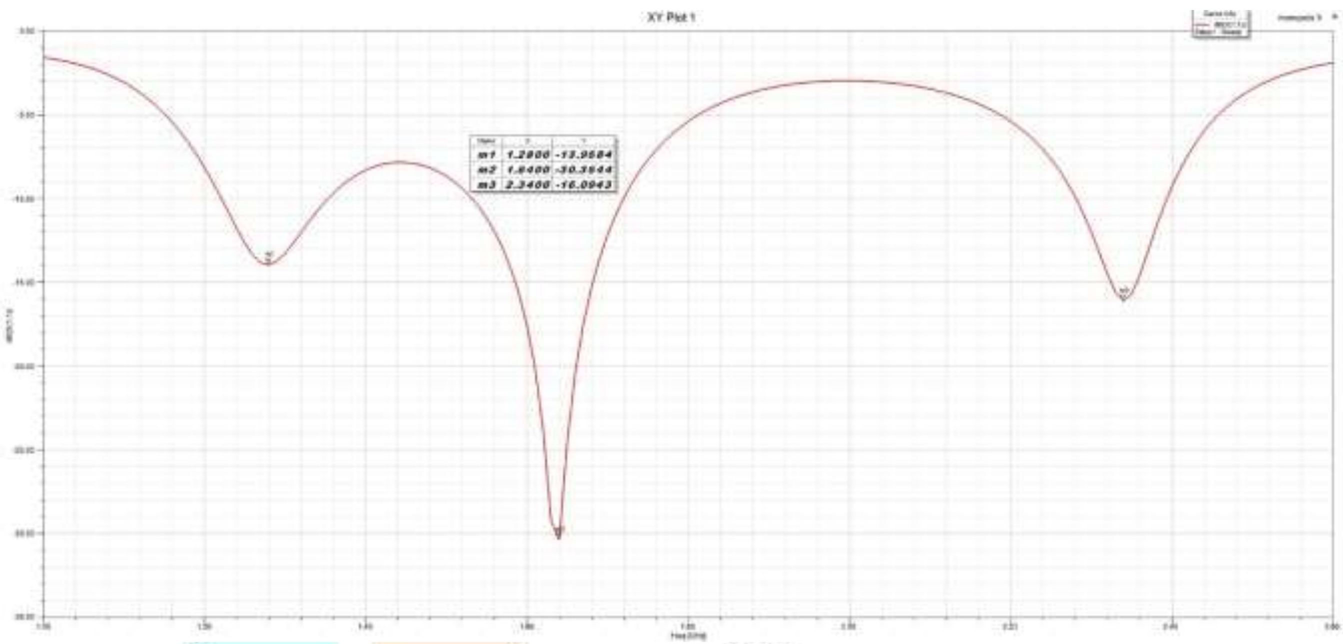

Figure 2 S Parameter of PRMA

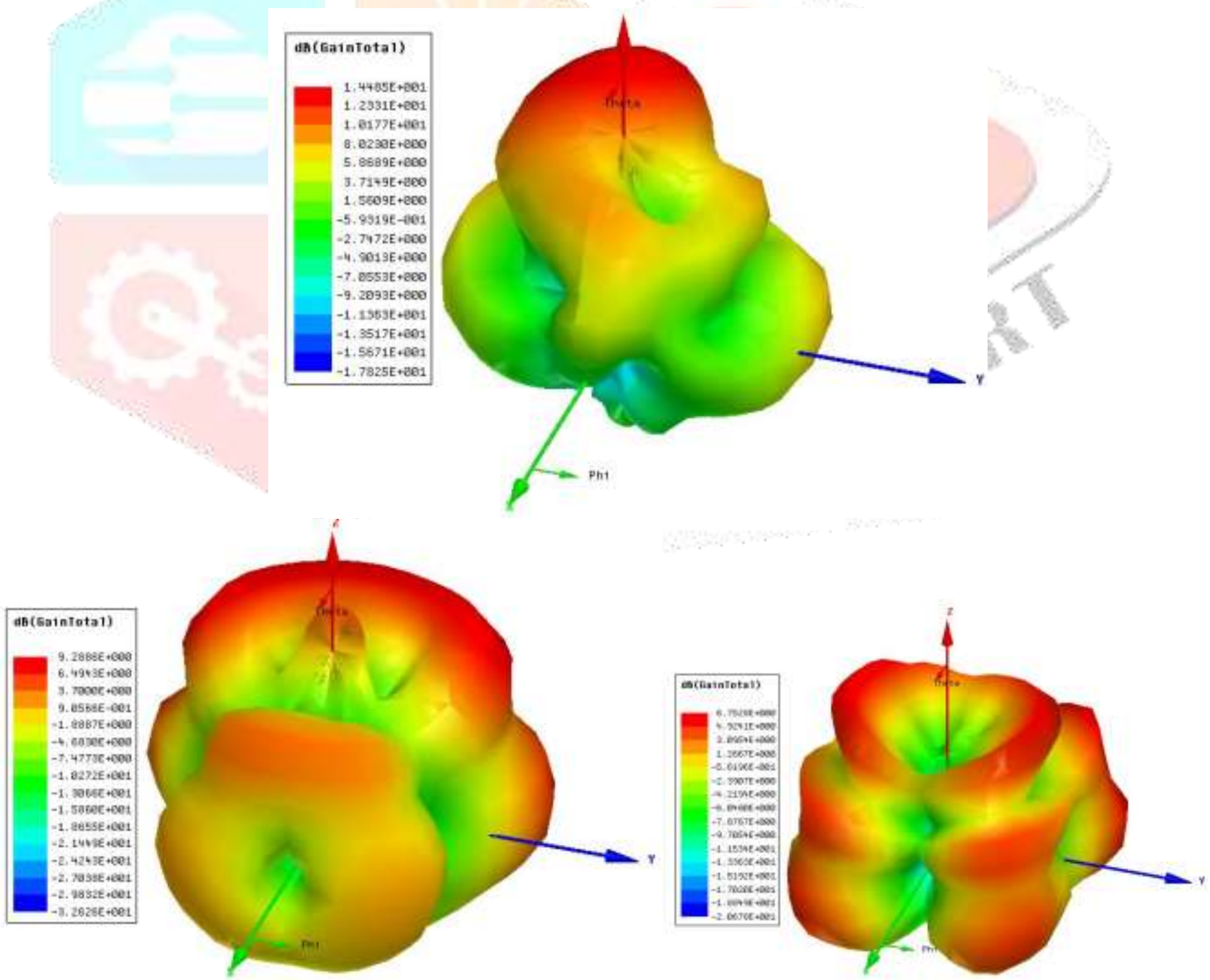

Figure 3 Gain of PRMA at three frequencies

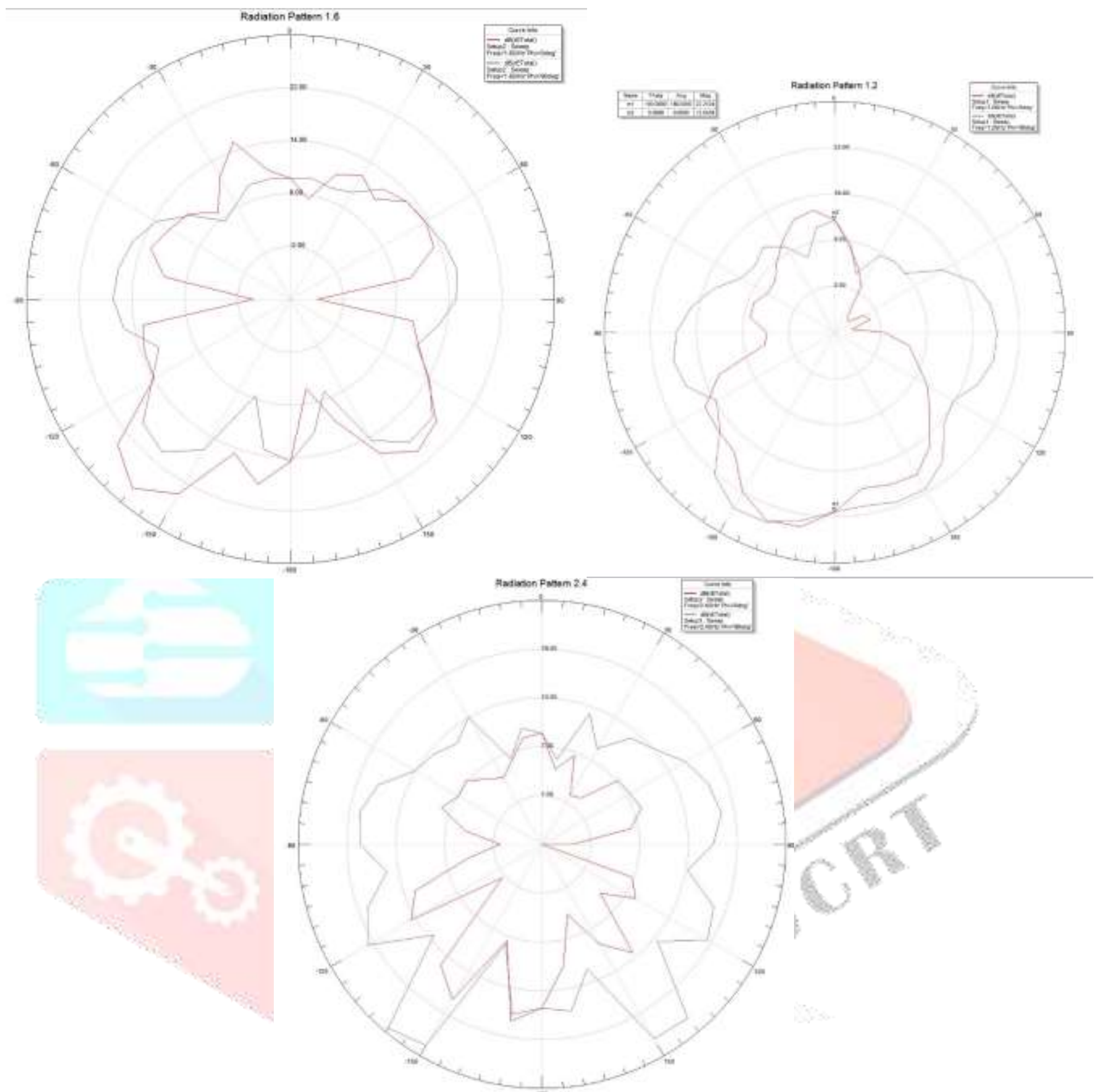

Figure 4 Radiation Patterns of PRMA at three frequencies

The simulated results of proposed antenna are shown. Figure 3 shows Gain at all three frequencies, Figure 4 is about Radiation Patterns and Figure 5 shows Current distributions. Gain of Antenna is 14 dB-7dB at all frequency bands.

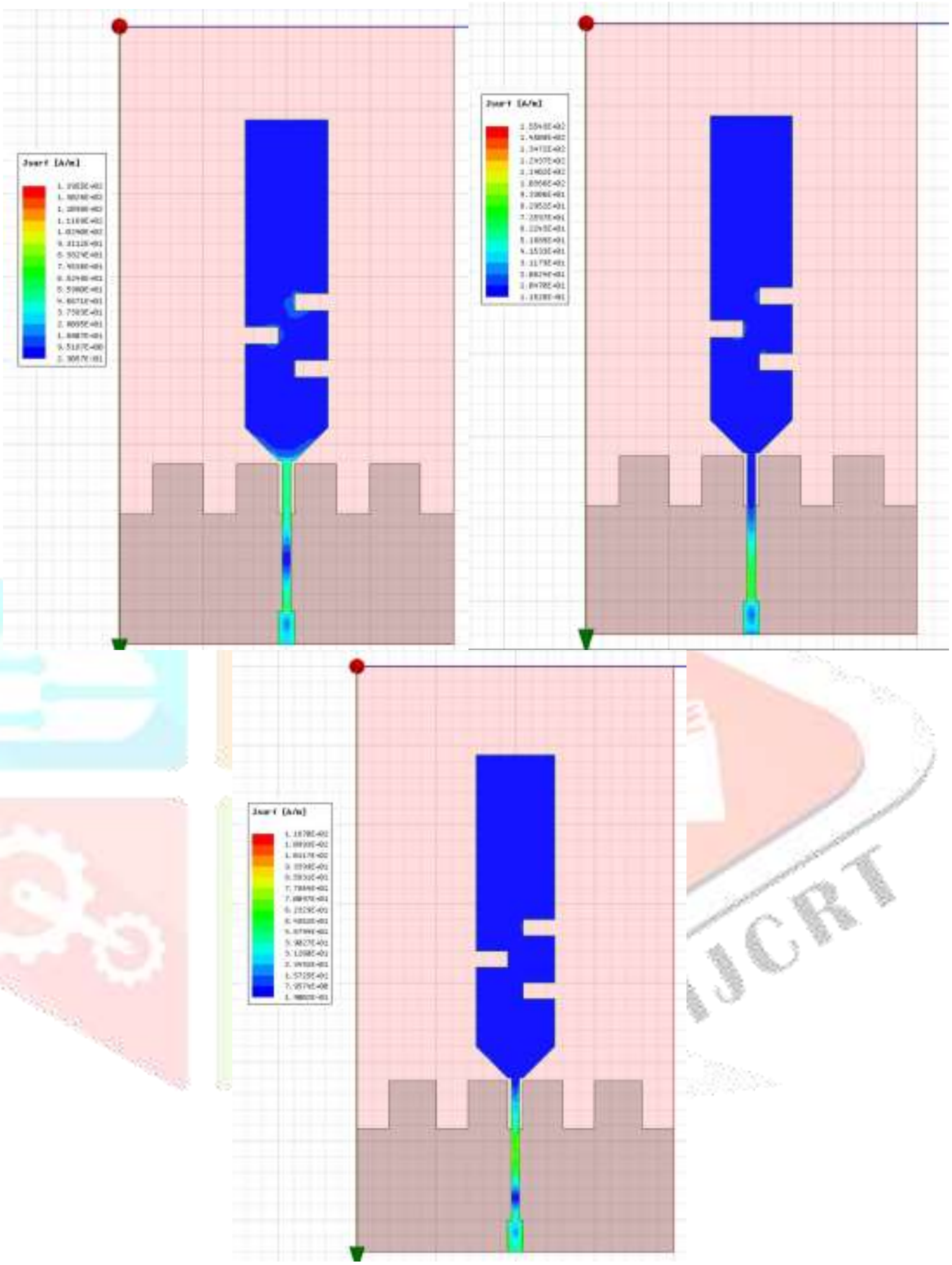

Figure 5 Current distributions of PRMA at three frequencies

VI. CONCLUSION

Tri-band operation of a novel Slotted printed monopole antenna has been proposed. Sufficient bandwidth, gain, and better radiation patterns are shown. The current distribution characteristic of the monopole patch has been studied, which in turn affects the other performance parameter of the antenna. To improve the impedance bandwidth slit in the ground plane and slots in monopole patch has been introduced. Large effects of varying monopole parameters and ground-plane sizes on the antenna's resonant frequencies and impedance bandwidths have also can see.

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REFERENCES

[1] C. A. Balanis, Antenna Theory: Analysis and Design. New York: Harper and Row, 1982

[2] Islam, M. T., Samsuzzaman, M., Kibria, S., & Cho, M. (2014, December). Development of S band antenna for Nanosatellite. In *Applied Electromagnetics (APACE), 2014 IEEE Asia-Pacific Conference on* (pp. 16-19). IEEE.

[3] Sreeja, T. K., Arun, A., & Kumari, J. J. (2012, December). An S-band micro-strip patch array antenna for nano-satellite applications. In *Green Technologies (ICGT), 2012 International Conference on* (pp. 325-328). IEEE.

[4] Suraj, P., & Gupta, V. R. (2009). Analysis of a Rectangular Monopole Patch Antenna. *International Journal of Recent Trends in Engineering*, *2*(5), 106-109.

[5] Y.-L. Kuo and K.-L. Wong, "Printed Double-T monopole antenna for 2.4/5.2 GHz dual-band WLAN operations," IEEE Trans. Antennas Propag., vol. 51, no. 9, pp. 2187–2192, Sep. 2003.

[8]Ray, K. P. (2008). Design aspects of printed monopole antennas for ultra-wide band applications. International Journal of Antennas and Propagation, 2008.

[9]Patil, R. R., & Singh, B. PRINTED MONOPOLE ANTENNA TECHNOLOGY FOR WIDEBAND APPLICATIONS.2015

[10]Pan, C. Y., Horng, T. S., Chen, W. S., & Huang, C. H. (2007). Dual wideband printed monopole antenna for WLAN/WiMAX applications. IEEE Antennas and Wireless Propagation Letters, 6, 149-151.