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Square Monopole antenna for Wide band Applications

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Abstract: ***This paper presents the design of a square monopole with sliced semi-circular ground plane. The proposed antenna exhibits ultra wide band characteristics from 2.2GHz to 11.7GHz. The dimensions of the patch are 20x20mm² with a microstrip line feed at one of its corners, yields S_{11} < -10dB, VSWR < 2 when simulated in HFSS 18.0 software. The antenna is fabricated and measured for reflection coefficient, radiation pattern and peak gain.***

Index Terms: modified ground plane, square monopole, ultra wideband antenna, wide band monopole.

I. INTRODUCTION

Wireless communications require antennae with wide band characteristics. Microstrip antennas are widely used in communication systems because of small in size, cost effective and less weight [1]. These suffer from narrow bandwidth. So many researchers attempted to widen the bandwidth using the concept of defected ground structure.

A detailed report on applications of defected ground structures to improve the performance of an antenna is available in open literature [2]. Improvement in the bandwidth is proven for 5G mobile networks [3]. Enhancement of bandwidth can also be achieved using a resonator [4]. Coplanar waveguide fed triangular shaped microstrip antenna with slit on the patch is used for ultra wide band applications [5]. By controlling the resonance frequencies of two radiating elements wide bandwidth can be achieved [6]. A good number of bandwidth enhancement techniques are available in the open source [7]. In this paper a simple square monopole antenna with UWB is designed, fabricated and measured for S_{11}, radiation pattern and peak gain.

II. GROUND PLANE DESIGN OF MONOPOLE

The proposed antenna is a modification to the basic square patch antenna with complete ground plane. The modification is introduced in the ground plane to obtain wide band characteristics. It is fed with a microstrip line at one of its corners.

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Consider case (a) in which a partial rectangular ground plane of length equal to the length of the microstrip line feed and width equal to the width of substrate (60mm). A square slit or cut is introduced in the rectangular ground plane, exactly below the feed to obtain an improvement in the bandwidth.

In case (b), a sliced semi-circular ground plane (peak of the semicircle is clipped off) with a square slit in the ground plane, exactly below the feed line as shown in fig 1. The diameter of the semicircle is less than the width of the substrate and the radius of semicircle after slicing is equal to the length of the feed line. This modification in the ground plane has good improvement in the bandwidth when compared to case (a). Based on the simulated results, a corner fed square patch with sliced semi-circular ground plane and a square slit can act as an ultra wide band antenna.

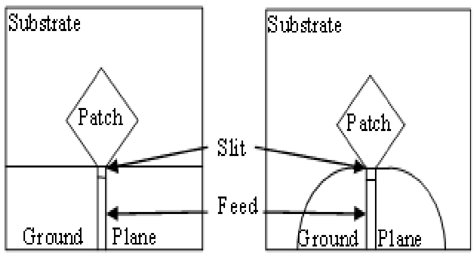

Fig. 1. Modifications introduced in the ground plane.

III. DESIGN OF MONOPOLE

The proposed antenna has been designed on an FR4 epoxy substrate with ε_r=4.4 and thickness of 1.6mm. It has a semi-circular ground plane of radius 23mm with 3mm slicing and a slit of dimensions a x b. The rear view and front view of proposed antenna are shown in fig. 2. The patch antenna has dimensions of 20 x 17.17mm² (17.17mm < 20mm, the difference gets merged into the feed line) microstrip line feed is of 20 x 4 mm². The fabricated square monopole antenna is shown in fig. 3.

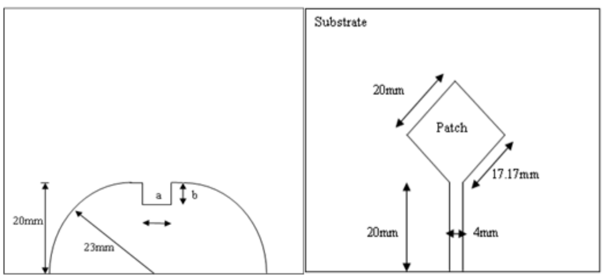

Fig. 2. Rear and front view of the monopole.

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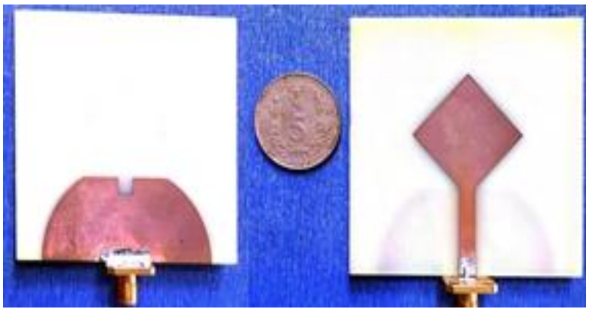

Fig. 3. Rear and front view of printed monopole.

IV. RESULTS AND DISCUSSION

The proposed antenna with slit in rectangular ground plane, sliced semi-circular ground plane and conventional square patch (complete ground plane) are simulated using HFSS 18.0 software. From the simulated results, S_{11} of square patch with sliced semi-circular ground plane with slit exhibits wide band characteristics as shown in fig. 4.

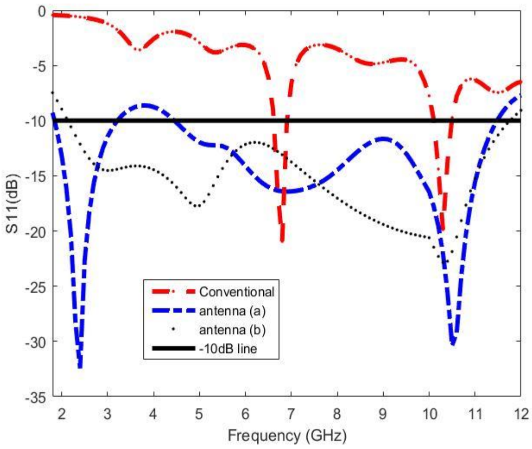

Fig. 4. S_{11} with three different ground planes.

S_{11} of proposed antenna is below -10dB over a band of frequencies from 2.2GHz to 11.7GHz as shown in fig. 5. Measured results shown that, there is a deviation in S_{11}. The deviations in the S_{11} are due to fabrication tolerance and losses in the substrate.

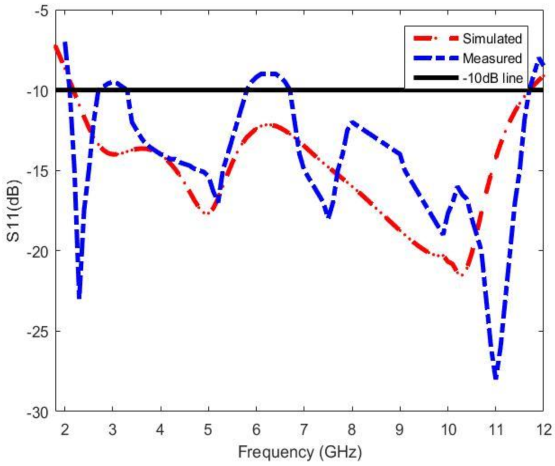

Fig. 5. S_{11} of proposed monopole

A. Effect of Slit dimensions

The antenna is simulated for various dimensions of slit and the results were shown in fig. 5. If the slit dimensions are a=4, b=1 mm then it acts as a single band antenna, for a=5, b=3 then the proposed antenna acts as a wide band antenna with S_{11} close to -10dB in the low frequency region, a=4, b=6 then it acts as a single wide band antenna and when a=4, b=4 then the antenna is an ultra wide band antenna.

The measured radiation pattern at frequencies 5GHz, 7.3GHz, 9GHz and 11GHz are shown in fig. 6. E-plane radiation has directional pattern and H-plane radiation has Omni-directional pattern. At higher frequencies there is a deviation in the radiation pattern. Peak gain of the proposed square monopole antenna is shown in fig. 7.

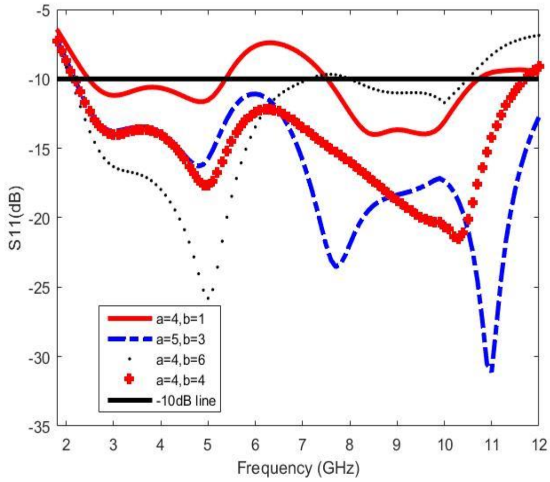

Fig. 5. S_{11} with various slit dimensions.

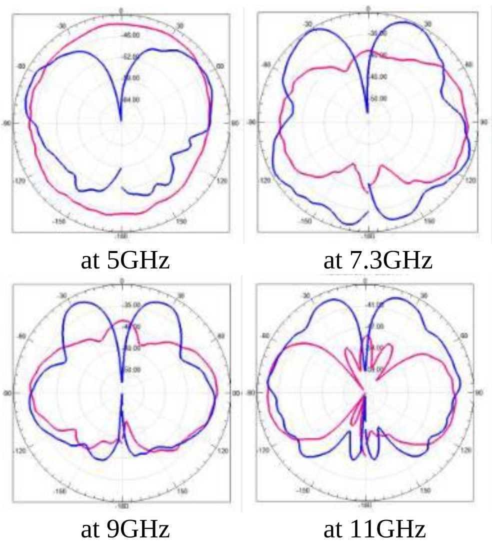

Fig. 6. Pattern in E-plane (blue) and H-plane (red).

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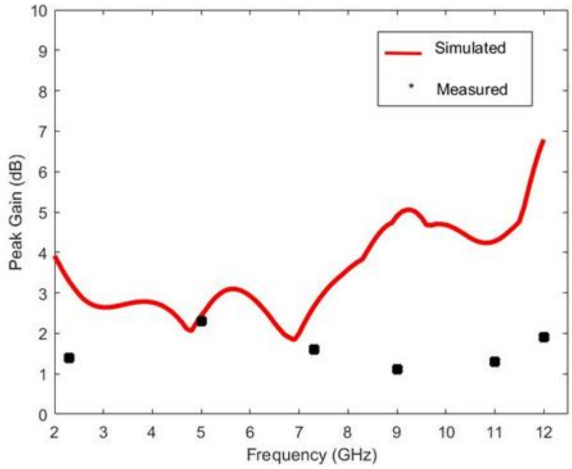

Fig. 7. Peak gain of the square monopole

V. CONCLUSION

A simple square monopole antenna with modified ground plane is designed, simulated and fabricated with optimum slit dimensions. The proposed monopole exhibits UWB characteristics over a band of frequencies from 2.2GHz to 11.7GHz. Measured results are in good agreement with simulated results. Hence it suitable for 2.4GHz, 5GHz Industrial, Scientific and Medical (ISM) bands and microwave X band systems.

REFERENCES

1. C.A. Balanis, Antenna Theory: Analysis and Design. New York, NY: Wiley, 2005.
2. M.K.Khandelwal, B.K. Kanaujia & K. Sachin, "Defected ground structure: Fundamentals, analysis, and applications in modern wireless trends," *Hindawi International Journal of Antennas and Propagation*, volume 2017, Article ID 2018527, 22 pages.
3. K Bouzakraoui, A Mouhsen & M Taouzari, "Bandwidth enhancement of new printed antenna structure for 5G mobile networks applications," *ICIC Express Letters, Part B: Applications*, vol. 9, Issue 7, pp: 615-621, 2018.
4. L Tao, J Xu, H Li, Y Hao, S Huang, M Lei & K Bi, "Bandwidth enhancement of Microstrip Patch Antenna using Complementary Rhombus Resonator," *Wireless Communications and Mobile Computing*, vol. 2018, article no. 6352181.
5. R.M. Elsagheer," Study on bandwidth enhancement techniques of microstrip Antenna," *Journal of Electrical Systems and Information Technology* 3, 527–531, 2016.
6. A. A. Abdelaziz, "Bandwidth Enhancement of Microstrip Antenna," *Progress In Electromagnetics Research*, PIER 63, 311–317, 2006.
7. P.S.A. Razavi, "Bandwidth Enhancement Techniques," Chapter from the book *Trends in Research on Microstrip Antennas*, 2017, DOI: 10.5772/intechopen.70173.

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