International Journal of Electronics and Electical Engineering

Volume 3 | Issue 2 Article 3

October 2014

DESIGN OF ULTRAWIDEBAND MONOPOLE ANTENNA WITH MINIMUM GROUND PLANE EFFECT

PRAVEEN K P
Department of Electronics and Communication, Karunya University, Coimbatore, India,
kp.praveen2009@gmail.com

T MARY NEEBHA
Department of Electronics and Communication, Karunya University, Coimbatore, India,
neebha@gmail.com

Recommended Citation

K P, PRAVEEN and NEEBHA, T MARY (2014) "DESIGN OF ULTRAWIDEBAND MONOPOLE ANTENNA WITH MINIMUM GROUND PLANE EFFECT," *International Journal of Electronics and Electical Engineering*: Vol. 3 : Iss. 2 , Article 3.
DOI: 10.47893/IJEEE.2014.1133
Available at: https://www.interscience.in/ijeee/vol3/iss2/3

DESIGN OF ULTRAWIDEBAND MONOPOLE ANTENNA WITH MINIMUM GROUND PLANE EFFECT

PRAVEEN K P, T MARY NEEBHA

Department of Electronics and Communication, Karunya University, Coimbatore, India
E-mail: kp.praveen2009@gmail.com

Abstract- A Planar ultra wideband antenna design is analyzed for increased impedance matching in the Ultrawideband (UWB) range (3.1GHz to 10.6GHz). Also the effect of the ground plane is minimized by cutting slot on the ground plane. Impedance matching of Ultrawideband (UWB) antenna can be improved by introducing simple microstrip transitions between the 50-ohm feed line and the printed disc. In this paper a dual step feed is proposed between the feed line and radiator. It also offers a very simple geometry suitable for low cost fabrication and straightforward printed circuit board integration. Here triangle slot is provided on the ground plane in order to reduce the ground plane effect. The radiator used here is elliptical disc.

Keywords- *UltraWideBand ; impedance matching ; monopole elliptical disc antenna*

I. INTRODUCTION

Ultra Wide Band technology is a promising technology mainly used for short range and high speed wireless communications. The frequency band 3.1GHz to 10.6GHz is allocated by the Federal Communications Commission (FCC) for UWB technology in 2002 [1].One of the main component of UWB system is the front-end antenna unit. The main applications of Ultra Wide Band antennas are mine detection, transient radars, indoor wireless radio, medical imaging systems and unexploded ordnance location and identifications. Various types of antenna have been designed for UWB applications, but the planar monopole antenna have been mostly used. This is because of its low cost, low profile, ease of fabrication and compact size. Various types of disc like circular, elliptical, square, rectangular, hexagonal etc. are used [8] ,among these elliptical and hexagonal shaped discs are provided good performance [5], [7].Since using printed structure, it can easily integrate into UWB devices with very low cost. In order to achieve a broad impedance bandwidth, radiator and ground plane shapes as well as the feeding structure should be optimized.

In this paper we mainly discussed how to improve the impedance matching of monopole antenna and then how to reduce the ground plane effects on antenna performance. Here elliptical disc monopole antenna is discussed in order to improve the impedance matching and radiation efficiencies. The good impedance matching can be mainly achieved by providing steps between feed line and disc [2]. Commonly used feeding techniques for antennas are microstrip line feed, coplanar wave guide feeds and slotted structure. In this paper use microstrip line feed since it offers low cost for antenna design, and provide good impedance matching in terms of 50-ohm impedance matching and radiation behavior. The performance of the antenna like impedance matching, radiation behavior and bandwidth are mainly affect the ground plane size and shape. Here only partial ground plane is used and the effect of ground plane on antenna performance can be minimized by cutting slots on the ground plane [3], [4], [6], [9]. Here a triangle slot is cut on the upper edge of the ground plane.

II. ANTENNA DESIGN

The top view of proposed elliptical disc monopole antenna is shown in the Fig1.The antenna is printed on a dielectric substrate with thickness 0.83mm and relative permittivity of 3.38. Antenna consists of an elliptical disc radiator and a microstrip line feed. A dual step transition is provided between the feed line and elliptical disc. The partial ground plane is used and a triangular slot with length ‘la’ and height ‘lb’ is cut on the upper side of the ground plane as shown in the Fig 2.

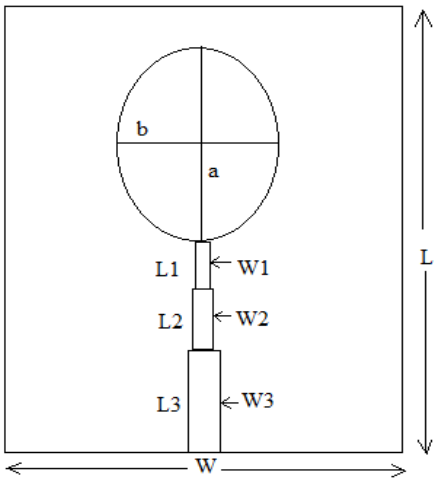


Figure1.Top View of the antenna

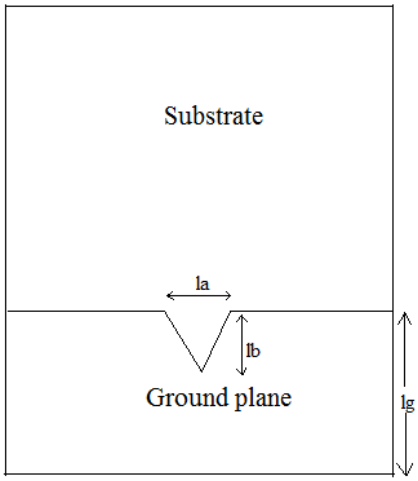


Figure2. Bottom view of the antenna

By optimizing the values of width and length of microstrip line, ground plane size and elliptical disc diameters a good impedance matching can be obtained. Normally ground plane influences the impedance matching and radiation behavior of the antenna. By cutting triangular slot on a ground plane with optimized values this ground plane effect can be reduced. The optimized values of antenna dimensions are shown in the Table1.

Table1. Dimensions of the Monopole Antenna

Dimensions	Millimeter (mm)
Length of the Substrate (L)	35
Width of the Substrate (W)	25
Major Axis of the elliptical Disc (a)	8
Minor Axis of the elliptical Disc (b)	6
Length of the Feed line (L3)	8
Width of the Feed line (W3)	2.4
Length of the First microstrip line (L2)	5
Width of the First microstrip line (W2)	2
Length of the 2nd microstrip line (L1)	3
Width of the 2nd microstrip line (W1)	1.6
Length of the partial ground plane (lg)	13.6
Length of the triangular slot (la)	3.6
Height of the triangular slot (lb)	2.6

III. SIMULATED RESULTS

The elliptical disc monopole antenna is designed and simulated by FEKO software and antenna parameters are analyzed and discussed in the following sections.

A Return Loss

Return loss is an important parameter in the antenna performance; it gives how much power is loss while radiating the antenna .If there is any discontinuity in the transmission line more loss occurs. Return loss(RL) can be expressed in terms of power as given as in (1) :

$$RL\ (dB) = 10\log_{10}(Pi/Pr) \quad (1)$$

Pi is the incident power and Pr is the reflected power. Return loss is mainly expressed in terms of scattering parameters or 'S' parameter .It describes the response of the N-port network. The first number in the subscript of S parameter represents responding port and second number represent incident port. In the case of S11 both responding and incident ports are same; hence it represents how much power is returned back i.e. its return loss. In order to achieve good impedance matching antenna should be matched with transmission line i.e. reduce the power reflected from the antenna and maximize power delivered to the antenna. The S11 parameter of elliptical disc monopole antenna is shown in the Fig3. From the graph it is clear that first resonance is occurring at 3.2 GHz and corresponding S11 value is -48 dB, it indicates good impedance match i.e. good matching between the antenna and transmission line. The frequency at which first resonance value occurred is mainly depends on the size of the elliptical disc. Second resonance value occurred at 7.5GHz and corresponding S11 value is -40.5 GHz.

B Minimizing the Effect of Ground plane

When antenna is fed by microstrip line feed vertical current mode will exited on the radiator.

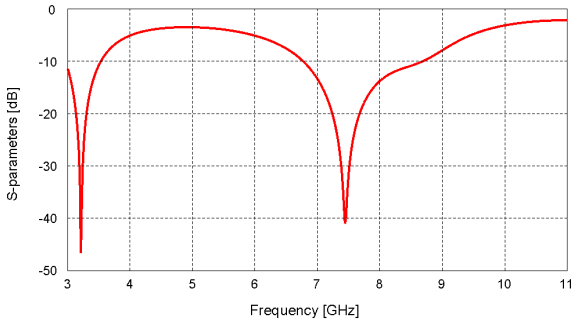


Figure 3. Simulated S11 parameter of antenna

Excitation of first vertical mode depends on dimensions of the radiator, it determines lowest usable frequency and interaction between first and higher order modes decide the highest achievable frequency. The size and shape of the ground plane mainly influence the impedance matching. In order to reduce the effect a triangular slot is cut on the upper side of the ground plane .Fig 4 indicates the S11 parameter of the elliptical disc monopole antenna without slot in the ground plane. In this case if there is any change in ground plane it influences the S11 parameter .From this graph it is clear that when we change the width of the ground plane, frequency at which resonance occurred is changed, if there is no slot in the ground plane. Fig 5 indicates the S11 comparison of antenna for varying the ground plane width with slots in the ground plane. From the graph it is clear that there is no so much difference in the

resonance frequency when changing width of the ground plane

C Radiation Pattern

Radiation pattern gives radiated power variance as a function of direction away from the antenna. This power variation can be calculated in far field or near field. The region close to the antenna is called near field or induction field and region far from the antenna is called far field region or radiation field. Antenna patterns are normally measured in the far field region. The 3-D radiation pattern of the elliptical monopole antenna is given in Fig 6, 7. Since the ground plane is partial antenna radiates below the ground plane also. Fig 6 shows the 3D radiation pattern of antenna at first resonance frequency i.e. 3.2 GHz and Fig 7 shows the 3D radiation pattern of antenna at second resonance frequency i.e.7.5 GHz. Radiations pattern can be drawn in polar plot also as shown in the Fig 8.It gives value of E-field in dB at each angle.

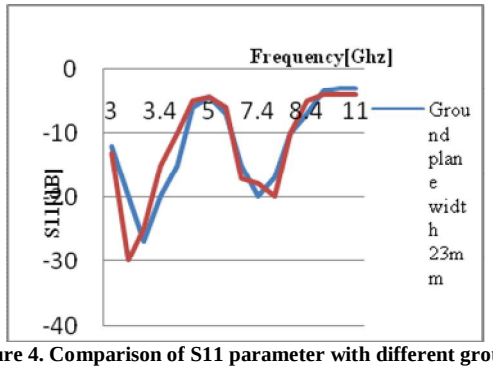


Figure 4. Comparison of S11 parameter with different ground plane without slot

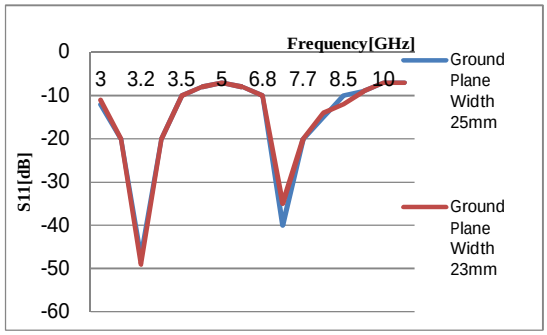


Fig 5. Comparison of S11 parameter with different ground plane with slot

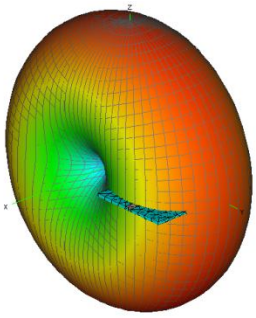


Figure 6. 3-D Radiation pattern at 3.2 GHz

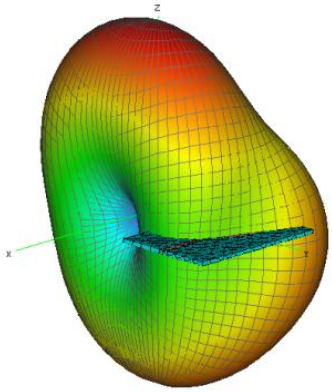
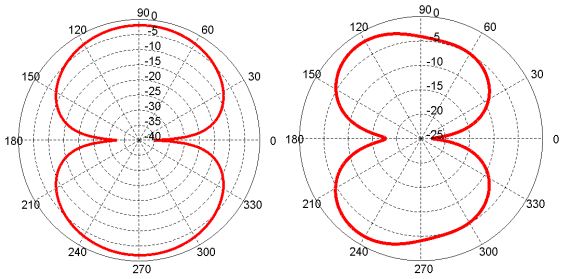


Figure 7. 3-D Radiation pattern at 7.5GHz

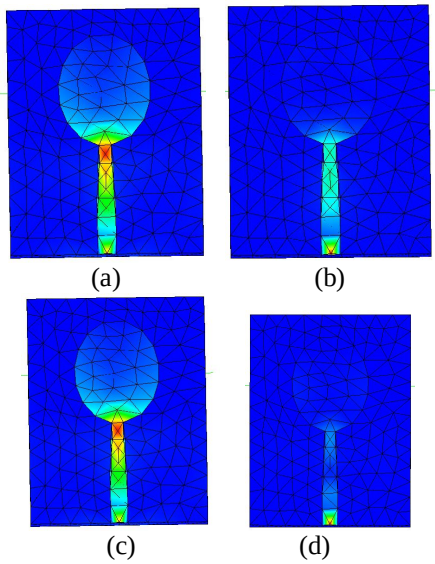


(a) **(b)**

Figure 8. X-Y pattern in polar plot at (a) 3.2GHz (b)7.5GHz

D Current Distribution

The total current distribution on the antenna is the superposition of the characteristic currents with appropriate weighting coefficients .The current distribution of elliptical monopole antenna is varied at each frequency. At resonance frequency maximum current is distributed across the antenna compared with other frequencies. Comparison between the current distribution of resonance frequencies and other frequencies as shown in Fig 9.Resonance frequencies are 3.2 GHz and 7.5GHz , in these frequencies more current is distributed compared with other frequencies like 5GHz and 11 GHz.



(a) (b)

(c) (d)

Figure 9. Current Distribution at various frequencies(a) 3.2GHz (b) 5GHz (c) 7.5GHz (d) 11 GHz

IV. CONCLUSION

Elliptical disc monopole antenna for UWB application were designed and analyzed. By using a dual step feed between the feed line and elliptical disc, better impedance matching can be obtained in the UWB range. Further improvement can be obtained by providing additional steps between the feed line and disc. Effect of ground plane is reduced by cutting slot on the upper side of the ground plane.

REFERENCES

[1] K. Siwiak, "Ultra-wide band radio: Introducing a new technology," in *Proc. IEEE Veh. Technol. Conf.*, May 2001, vol. 2, pp. 1088–1093

[2] Mohamed Nabil Srifi, Symon K. Podilchak, Mohamed Essaaidi, Yahia M. M. Antar "Compact Disc Monopole Antennas for Current and Future Ultrawideband (UWB) Applications" IEEE transc. On antennas and propagation, vol. 59, no. 12, december 2011

[3] Y. Lu1 Y. Huang, H.T. Chattha Y. Shen "Technique for minimising the effects of ground plane on planar ultra-wideband monopole antennas" IET Microw. Antennas Propag., 2012, Vol. 6, Iss. 5, pp. 510–518

[4] Hiroyuki Kobayashi, Takayuki Sasamori, Teruo Tobana and Kohshi Abe "Printed Circular Disc Monopole Antennas with Notched Ground Plane" International Symposium on Antennas and Propagation— ISAP 2006

[5] Y. Y. Sun, S. W. Cheung, and T. I. Yuk "Planar Monopole Ultra-wideband Antennas with Different Radiator Shapes for Body-centric Wireless Networks" Progress In Electromagnetic Research Symposium Proceedings, KL, MALAYSIA, March, 2012

[6] L. Liu, S. W. Cheung, and T. I. Yuk "Bandwidth Improvements Using Ground Slots for Compact UWB Microstrip-fed Antennas" Progress In Electromagnetics Research Symposium Proceedings, Suzhou, China, Sept. 12-16, 2011

[7] Cemin Zhang and Aly E. Fathy "Development of an Ultra-wideband Elliptical Disc Planar Monopole Antenna with Improved Omni-Directional Performance Using a Modified Ground"2006

[8] K. P. Ray" Design Aspects of Printed Monopole Antennas for Ultra-Wide Band Applications" International Journal of Antennas and Propagation Volume 2008, Article ID 713858

[9] X. L. Bao and M. J. Ammann "Printed UWB Antenna with Coupled Slotted Element for Notch-Frequency Function" International Journal of Antennas and Propagation Volume 2008, Article ID 713921