International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 4 Issue 5, May 2015

Review on Circular Monopole Antenna for UWB Applications

NiveditaSinghal
Electronics and Communication Engineering Deptt
K.I.E.T
MuradNagar, India

***Abstract*—This paper presents a study of a novel monopole antenna for ultra wide-band (UWB) applications. Printed on a dielectric substrate and fed by a 50 Ω micro strip line, a planar circular disc monopole has been demonstrated to provide an ultra wide 10 dB return loss bandwidth with satisfactory radiation properties. The parameters which affect the performance of the antenna in terms of its frequency domain characteristics will investigate.**

***Index Terms*— Circular disc monopole, micro strip line-fed, printed antennas, ultra wideband (UWB).**

- Introduction

With the definition and acceptance of the ultra wide-band (UWB) impulse radio technology in the USA [1], there has been considerable research effort put into UWB radio technology worldwide. However, the non digital part of a UWB system, i.e., transmitting/receiving antennas, remains a particularly challenging topic. A suitable UWB antenna should be capable of operating over an ultra wide bandwidth as allocated by the Federal Communications Commission. At the same time, reasonable efficiency and satisfactory radiation properties over the entire frequency range are also necessary. Another primary requirement of the UWB antenna is a good time domain performance, i.e., a good impulse response with minimal distortion [2].

Conventional UWB antennas in the geometry of either log periodic or spiral tend to be dispersive. They usually radiate different frequency components from different parts of the antenna, which distorts and stretches out the radiated waveform [3]. Recently, several broadband monopole configurations, such as circular, square, elliptical, pentagonal and hexagonal, have been proposed for UWB applications [4]–[7]. These broadband monopoles feature wide operating bandwidths, satisfactory radiation properties, simple structures and ease of fabrication. However, they are not planar structures because their ground planes are perpendicular to the radiators. As a result, they are not suitable for integration with a printed circuit board.

In this paper, a novel design of circular monopole antenna fed by micro strip line is proposed and investigated based on my

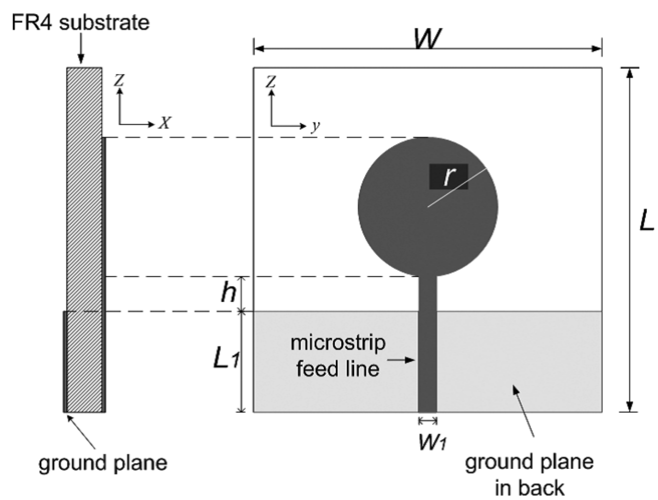

Fig 1. Geometry of Circular Monopole Antenna

previous studies [8], [9]. The parameters which affect the operation of the antenna in terms of its frequency domain characteristics are analyzed both numerically and experimentally in order to understand the operation of the antenna. It has been demonstrated that the optimal design of this type of antenna can achieve an ultra wide bandwidth with satisfactory radiation properties.

The paper is organized in the following sections. Section II discuss about UWB Antenna requirements. Section III describes how to design antenna with the 10 dB return loss bandwidth obtained for an optimal design. Section IV study of
characteristics of antenna. Section V concludes the study.

ISSN: 2278 – 1323

• UWB REQUIREMENTS

By definition, an Ultra Wideband antenna must be operable over the entire 3.1-10.6 GHz frequency range. Therefore, the UWB antenna must achieve almost a decade of impedance bandwidth, spanning 7.5 GHz.

Another consideration that must be taken into account is group delay. Group delay is given by the derivative of the unwrapped phase of an antenna. If the phase is linear throughout the frequency range, the group delay will be constant for the frequency range.

This is an important characteristic because it helps to indicate how well a UWB pulse will be transmitted and to what degree it may be distorted or dispersed. It is also a parameter that is not typically considered for narrowband antenna design because linear phase is naturally achieved for narrowband resonance.

Radiation pattern and radiation efficiency are also significant characteristics that must be taken into account in antenna design. A nearly omni-directional radiation pattern is desirable in that it enables freedom in the receiver and transmitter location. This implies maximizing the half power beam-width and minimizing directivity and gain. Conductor and dielectric losses should be minimized in order to maximize radiation efficiency. Low loss dielectric must be used in order to maximize radiation efficiency. High radiation efficiency is imperative for an ultra wideband antenna because the transmit power spectral density is excessively low. Therefore, any excessive losses incurred by the antenna could potentially compromise the functionality of the system.

For specific IC radio applications in this research, the UWB antenna requirements can be summarized in the following table:

VSWR Bandwidth	3.1 – 10.6 GHz
Radiation Efficiency	High (>70%)
Phase	Nearly linear; constant group delay
Radiation Pattern	Omnidirectional
Directivity and Gain	Low
Half Power Beamwidth	Wide (> 60 °)
Physical Profile	Small, Compact, Planar

Table 1

• ANTENNA DESIGN

The proposed monopole antenna is illustrated in Fig. 1.

A circular disc monopole with a radius of r and a 50 micro strip feed line are printed on the same side of the dielectric substrate. L and W denote the length and the width of the dielectric substrate, respectively. The width of the micro strip feed line is fixed at to achieve 50 impedance. On the other side of the substrate, the conducting ground plane with a length of only covers the section of the micro strip feed line. h is the height of the feed gap between the feed point and the ground plane.

The simulations will perform using the IE3D software or HFSS software.

IE3D- Mentor's full wave 3D electromagnetic analysis functionality addresses the needs of the industry's most advanced designer of high performance electronic products. The integral equations are formulated with a full dyadic Green's function and the matrix elements are computed completely numerical in the spatial domain. IE3D can model truly arbitrary 3D metal structures; since 2006 also finite 3D dielectric volumes can be modeled with a volume integral equations (VIE) approach.

IE3D SSD is ideally suited for the design of monolithic microwave integrated circuits (MMICs), radio – frequency integrated circuits (RFICs), high–temperature superconducting (HTS) circuits, radio-frequency identification (RFID) antennas, patch antennas, slot antennas, wire antennas, and most other RF and wireless antennas.

HFSS- HFSS software is the industry-standard simulation tool for 3D full wave electromagnetic field simulation and is essential for the design of high frequency and high speed component design. This software automatically divides the geometric model into a large number of tetrahedron, where a single tetrahedron is a four sided pyramid. This collection of tetrahedron is referred to as the finite element mesh. Each element can contain a different material. Therefore, the interface between two different materials must coincide with element boundaries. The value of a vector field quantity (such as the H-field or E – field) at points inside each tetrahedron is interpolated from the vertices of the tetrahedron. The field inside each tetrahedron is interpolated from these nodal values. By representing field quantities in this way, the system can transform Maxwell's equation into matrix equations that are solved using traditional numerical method.

ISSN: 2278 – 1323

With HFSS, engineers can extract scattering matrix parameters(S, Y, Z parameters), visualize 3D electromagnetic fields (near and far field) . Each HFSS solver is based on a powerful, automated solution process where you are only required to specify geometry, material properties and the desired output. From there HFSS will automatically generate an appropriate, efficient and accurate mesh for solving the problem using the problem using the selected solution technology.

• ANTENNA CHARACTERISTICS

For circular disc monopole, the ground plane serves as an impedance matching circuit. Consequently, it tunes the input impedance and hence the 10 dB return loss bandwidth by changing the feed gap [10], [11].
Another two important design parameters that affect the antenna performance are the width of the ground plane and the dimension of the disc. The effects of these two parameters can be well explained by investigating the current distributions of the antenna.
Current Distribution- On the ground plane, the current is mainly distributed on the upper edge along the -direction. That means the portion of the ground plane close to the disc acts as the part of the radiating structure. Consequently, the performance of the antenna is critically dependent on the width of the ground plane [8], [9]. However, it also leads to a disadvantage, i.e., when this type of antenna is integrated with printed circuit board, the RF circuitry can't be very close to the ground plane.

• CONCLUSION

The circular monopole antenna has been has been studied to provide a return loss in excess of 10db over an extremely wide frequency range. The antenna has been proposed for future wideband data systems, especially multi band systems and combinations of these systems. Work is continuing on this element in regard to downsizing, pattern stability with change of frequency, the use of dielectric and reactive loading and folding.

• FUTURE WORK

UWB antenna with small size is always desirable for the WPAN applications, especially for mobile and portable devices. Future research may focus on finding out new methods to further reducing the sizes of UWB circular monopole antenna.

Due to the collocation of UWB system with frequency bands reserved for other wireless systems, sometimes the UWB device may be required to provide filtering in those bands to avoid potential interference. UWB circular monopole with band rejection properties can be an objective of future work.

• REFERENCES

[1] *FCC Report and Order for Part 15 Acceptance of Ultra Wideband (UWB) Systems from 3.1 –10.6 GHz*, FCC, Washington, DC, 2002.

[2] S. Licul, J. A. N. Noronha,W. A. Davis, D. G. Sweeney, C. R. Anderson,and T. M. Bielawa, "A parametric study of time-domain characteristics of possible UWB antenna architectures," in *Proc. Vehicular TechnologyConf.*, vol. 5, Oct. 6–9, 2003.

[3] H. G. Schantz, "Ultra wideband technology gains a boost from new antennas," *Antenna Syst. Technol.*, vol. 4, no. 1, Jan./Feb. 2001.

[4] M. J. Ammann and Z. N. Chen, "Wideband monopole antennas for multi-band wireless systems," *IEEE Antennas Propag. Mag.*, vol. 45, no. 2, Apr. 2003.

[5] N. P. Agrawall, G. Kumar, and K. P. Ray, "Wide-band planar monopole antennas," *IEEE Trans Antennas Propag.*, vol. 46, no. 2, Feb. 1998.

[6] E. Antonino-Daviu, M. Cabedo-Fabre's, M. Ferrando-Bataller, and A. Valero-Nogueira, "Wideband double-fed planar monopole antennas," *Electron. Lett.*, vol. 39, no. 23, Nov. 2003.

[7] Z. N. Chen, M. Y.W. Chia, and M. J. Ammann, "Optimization and comparison of broadband monopoles," *Proc. Inst. Elect. Eng. Microw. AntennasPropag.*, vol. 150, no. 6, Dec. 2003.

[8] J. Liang, C. C. Chiau, X. Chen, and C. G. Parini, "Analysis and design of UWB disc monopole antennas," in *Proc. Inst. Elect. Eng. Seminaron Ultra Wideband Communications Technologies and System Design*, Queen Mary, University of London, U.K., Jul. 2004, pp. 103–106.

[9] "Printed circular disc monopole antenna for ultra wideband applications," *Electron. Lett.*, vol. 40, no. 20, Sep. 2004.

[10] *User's Manual*, vol. 4, CST-Microwave Studio, 2002.

[11] Z. Chen, X. Wu, H. Li, N. Yang, and M. Y. W. Chia, "Considerations for source pulses and antennas in UWB radio systems," *IEEE Trans.Antennas Propag.*, vol. 52, no. 7, pp. 1739–1748, Jul. 2004.

ISSN: 2278 – 1323