A Novel Leaf Antenna Design for Ultra-Wideband Applications

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Abstract
A novel printed leaf structured antenna for ultra-wideband (UWB) applications is designed in HFSS software, obtained results are presented. The radiating surface is cut like leaf shape over FR4 dielectric substrate backed finite ground plane and power is supplied with a 50 Ω microstrip line. The designed antenna operates over impedance bandwidth (2.9–11.6 GHz) for return loss $S_{11} < -10$ dB. The antenna also shows omni-directional radiation patterns and good gain flatness over the frequency range of interest. The results showing that the proposed antenna performance is suitable for UWB applications.

Keywords: printed leaf structured antenna, omni-directional radiation, ultra-wideband

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INTRODUCTION

As the FCC permitted to use the band 3.1–10 GHz for commercial and academic applications, since then ultrawideband (UWB) technology has attracted the attention of industry and academia.[1] One of the key component in UWB technology is antenna and it affects overall performance. Many kinds of UWB antennas are proposed in literature.[2–5] Following considerations should be considered in designing UWB antenna (i) simple structure, (ii) low profile, (iii) easy manufacturing, (iv) low cost, and (v) impedance matching characteristics over the whole UWB frequency range. Also, it should have a following properties (i) flat gain, (ii) linear phase, and (iii) constant group delay to minimize distortion of transmitted pulses waveforms.[2,3] In current paper, a novel leaf structured printed antenna for UWB applications is presented. In this design, the proposed antenna can operate from 2.9 to 11.6 GHz and shows good radiation pattern performance. This paper is organized as follow, second section presents the configuration of proposed antenna. The simulated and measured results are presented and discussed in third section. Finally, fourthly the conclusions of this work are given.

ANTENNA CONFIGURATION

The proposed antenna structure consists of a leaf-shaped radiating patch over an FR4 dielectric substrate. The radiating patch is feed with a coplanar wave guide feed. Top two-dimensional view of proposed antenna is shown in Figure 1.

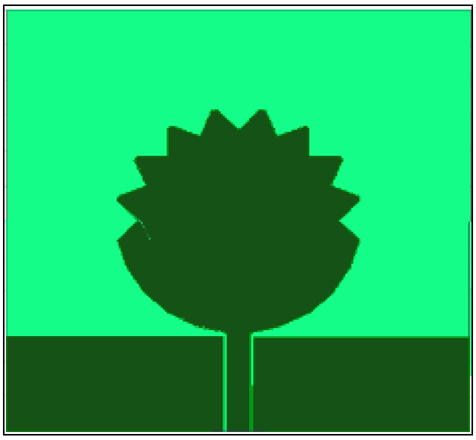

Fig. 1. *Geometry of Moderated Circular Disk Antenna.*

Its structure consists of (i) ground plane of PEC material, (ii) dielectric substrate of FR4 with permittivity 4.4 and loss tangent of 0.0009, and (iii) circular patch of PEC material. The feeding structure is a 50 Ω microstrip feed line with width $W_{feed} = 3.4$ mm and ground plane are printed together on the same side of the dielectric substrate. The ground is designed to be finite for matching purpose and to obtain an UWB bandwidth.[6–8] The ground plane has an area of $W \times L_G = (41 \times 18$ mm).

RESULTS

Return Loss

Simulations have been carried out with the Ansoft high frequency structure simulator (HFSS) software[6] to determine the antenna return loss bandwidth, input impedance, radiation patterns, gain, and transmitted pulses waveform distortion (Figure 2).

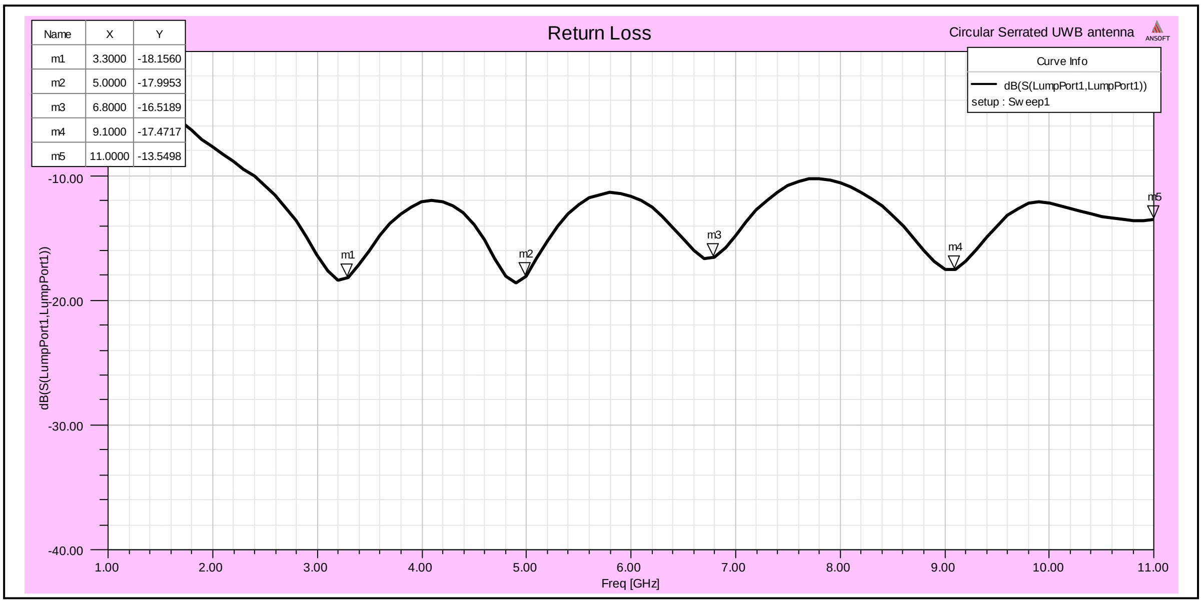

***Fig. 2.** Return Loss.*

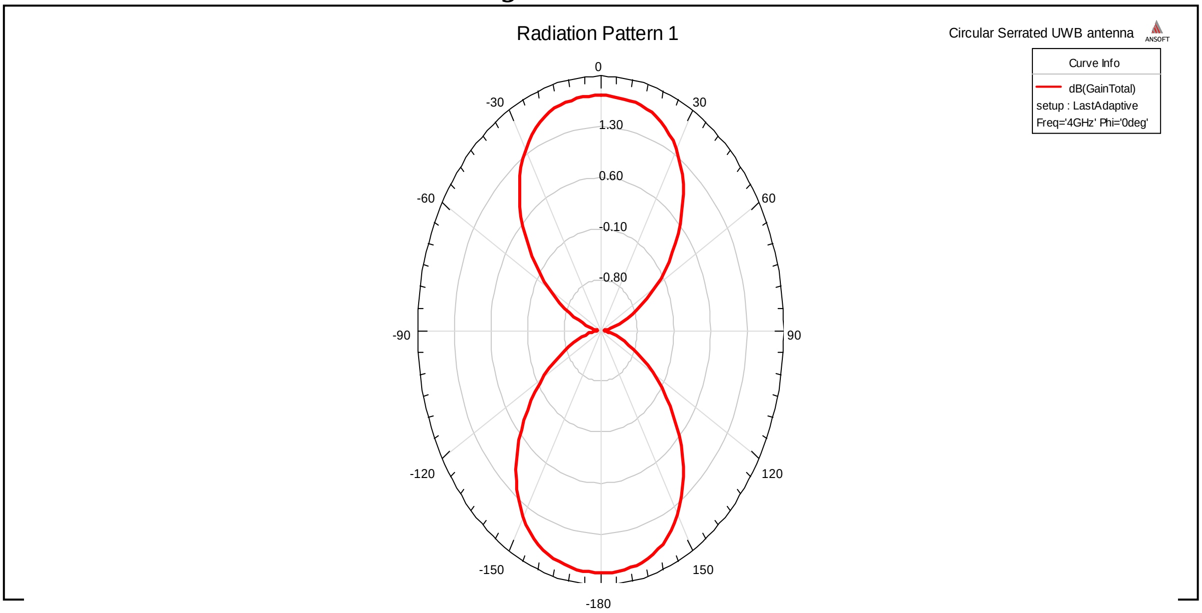

***Fig. 3.** Radiation Pattern.*

Radiation Patterns

The simulated radiation patterns (Figure 3) of the proposed printed monopole antenna at 3, 6.7, 10, and 11.2 GHz along both X–

Z plane (H-plane) and Y–Z plane (E-plane) are illustrated in Figures 4 and 5, respectively. The results show that the radiation pattern is quite stable as the frequency changes with a nearly omni-directional radiation patterns in the H-plane and the monopole-like radiation patterns in the E-plane.

Simulated Gain

The gain of the proposed antenna in the boresight direction is also studied using Ansoft HFSS and presented in Figure 6. The antenna gain varies from 3.6 to 5.9 dB over the operating UWB frequency range. It can be concluded that the gain variation is less than 2.5 dB over the entire operating frequency range from 3 to 11 GHz (Figure 7).

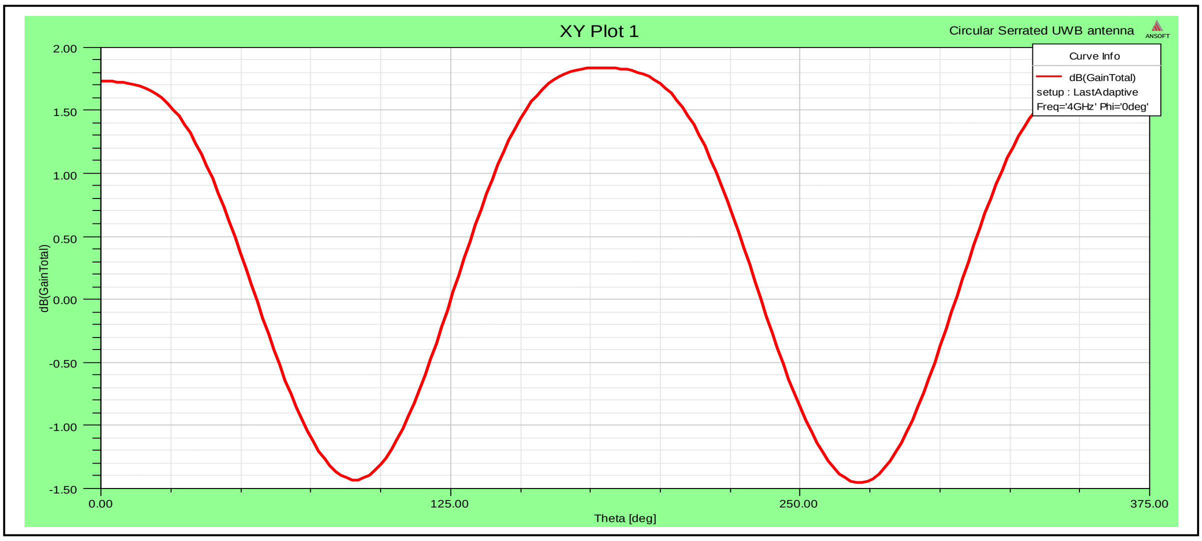

Fig. 4. *2D Gain.*

Voltage Standing Wave Ratio (VSWR)

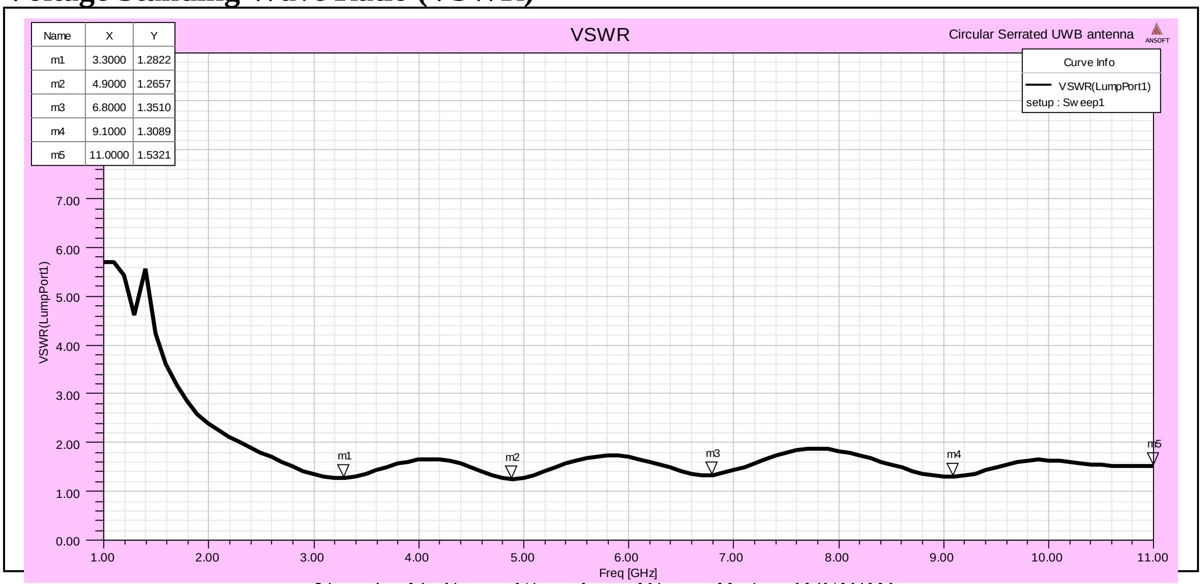

Fig. 5. *Voltage Standing Wave Ratio (VSWR).*

Field Radiation Pattern

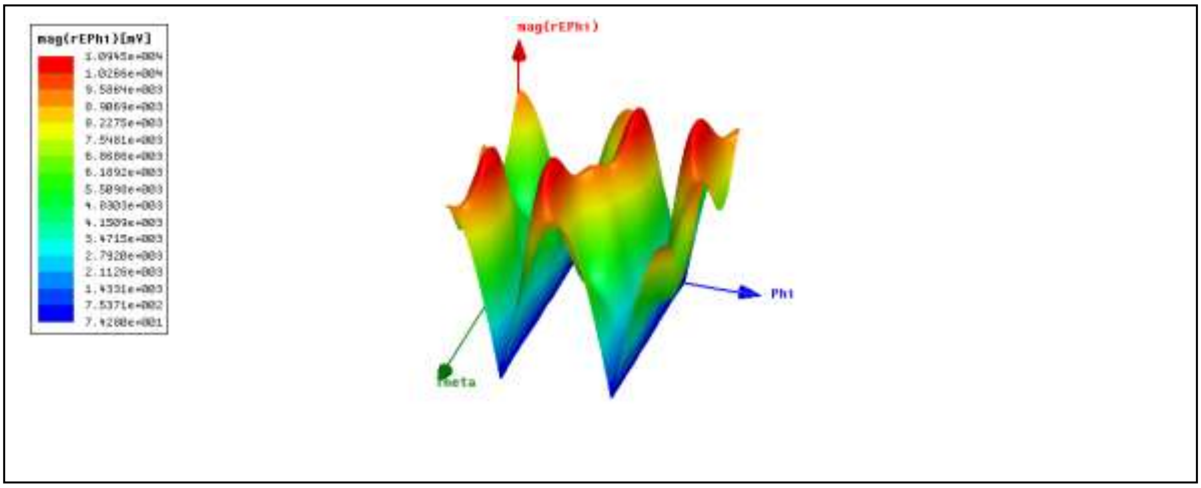

Fig. 6. *E Field Pattern.*

Field Radiation Pattern

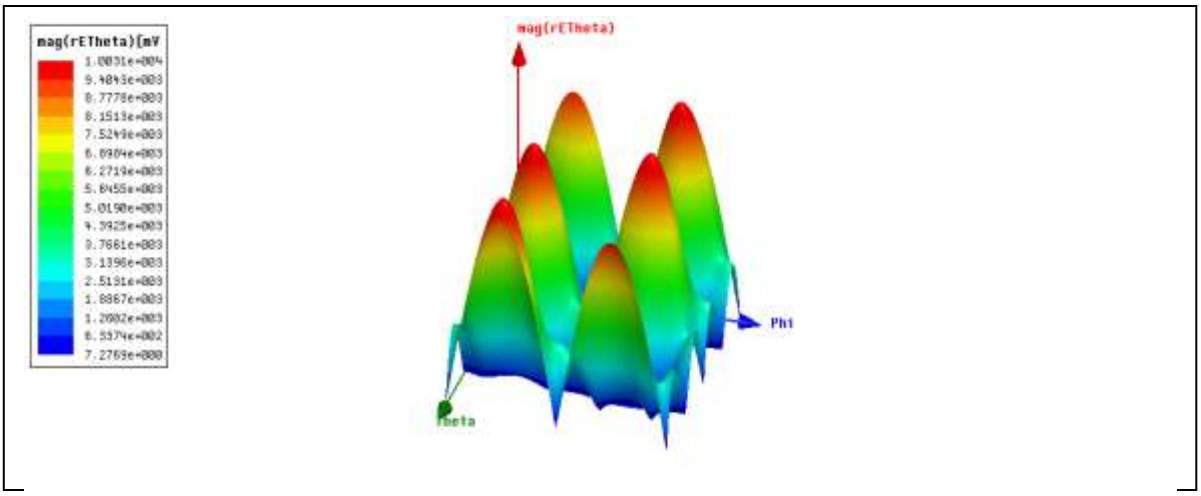

Fig. 7. *H Field Pattern.*

CONCLUSION

In this paper, we presented a novel monopole antenna for UWB applications. The antenna return loss bandwidth is from 2.9 to 11.6 GHz covering the whole UWB frequency band. The proposed antenna satisfied the bandwidth required for UWB applications.

The simulated radiation patterns show good monopole-like patterns and the gain variation is less than 2.5 dB over the frequency band. Good linear phase response, constant group delay characteristics, and small pulse distortion in time-domain were observed.

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