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S. Djidel, M. Bouamar, and D. Khedrouche



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Performances Study of UWB Monopole Antennas Using Half-Elliptic Radiator Conformed on Elliptical Surface

S.Djidel, M. Bouamar and D. Khedrouche^{a)}

LASS (Laboratoire d'Analyse des Signaux et Systèmes), Department of Electronics, University of M'sila BP.166, Route Ichebilia, M'sila, 28000 Algeria

^{a)} Corresponding author: dkhedrouche@yahoo.com

Abstract. This paper presents a performances study of UWB monopole antenna using half-elliptic radiator conformed on elliptical surface. The proposed antenna, simulated using microwave studio computer CST and High frequency simulator structure HFSS, is designed to operate in frequency interval over 3.1 to 40 GHz. Good return loss and radiation pattern characteristics are obtained in the frequency band of interest. The proposed antenna structure is suitable for ultra-wideband applications, which is, required for many wearable electronics applications.

Keywords: Half-elliptic radiator; Conformal microstrip antenna; Elliptical surface; Ultra wide band (UWB).

PACS: 84.40.Ba, 84.40.Ua, 84.40.Dc, 04.40.Nr.

INTRODUCTION

UWB communication systems can support high data rates with low power consumption and are mainly used for short-range indoor communication systems [1]. Microstrip antenna is essential component of such UWB systems. The choose of the design parameters of microstrip antenna (geometrical shape, dimensions, the physical properties of the materials involved, the feed type and location, height and frequency, etc.) is important because antenna performance depends on these parameters. A microstrip antenna structure consists of very small conducting patch built on a ground plane separated by dielectric substrate. The patch is generally made of conducting material such as copper or gold and can take any possible shape. Moreover, the physical proprieties of the dielectric substrate materials, such as the dielectric constant and loss tangent are important properties of interest to electrical engineers because these two parameters, among others, decide the suitability of a material for a given applications [2, 3]. Microstrip antennas has become an active topic of research in recent years, due to a plethora of reasons, such as low profile, lightweight, low cost, high gain and conformability to curved surfaces [1], [4]. A non planar geometry can offer certain desirable antenna characteristics that are not provided by planar elements. In effect, conformal antennas are essential in applications where the generation of high directional patterns is required over curved surfaces. Applications of conformal microstrip structures include airborne, missile applications and commercial

applications like automatic cruise control for cars. The antennas used for these applications need to have some additional characteristics such as low weight, thin substrate thickness, and flexibility to conform to non-planar surfaces [5-7]. Different antenna designs have been proposed for these applications, they include cylindrical-rectangular patch antenna [8], conformal microstrip patch antenna on conical and spherical surfaces [9-11], circular disc conformed on cylindrical surface [12], and conformal elliptical monopole on cylindrical surfaces [7].

In this paper an UWB Monopole Antenna using half-elliptical radiator conformed on elliptical surface is investigated. The return loss and the radiation pattern are simulated using the CST [13] and HFSS software [14] simulators. The results are discussed and comparisons between the performances of planar and elliptical microstrip antennas are given.

ANTENNA DESIGN

The UWB monopole antenna with half elliptic radiator is shown in Figure 1(a, b), and it is based on the antenna in reference [15]. The patch had minor radius of 12mm and major radius of 22 mm, feed by microstrip line with width of 1.7 mm and length of 5 mm to achieve input impedance of 50Ω . Tapered impedance transformer had upper width of 1.12 mm and length of 3 mm to achieve good matching. The dielectric is a Rogers, RO4350B, with dimension 24 x 30 mm, having thickness $H_s = 0.762$ mm, a permittivity $\epsilon_r = 3.48$ and loss tangent of 0.004, as shown in Figure 1(a). The partial ground plane is chosen with dimension of 24 x 8 mm and square shaped slot with dimension 1 x 1 mm as shown in Figure 1(b).

The proposed antenna is shown in Figure 1(c, d), it consists of the same radiator element in reference [15], but conformed on elliptical substrate, the elliptical substrate had minor radius of $R_{min} = 8$ mm, thickness of H_s and eccentricity of 1.7 as shown in Figure 1(c).

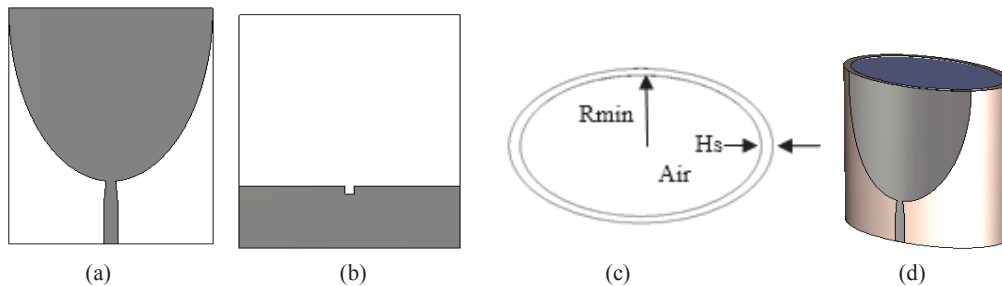


Figure 1. Structure under study. (a) Top view. (b) bottom view. (c) Top view. (d) 3D view.

RESULTS and DISCUSSION

The simulated results are concerning the return loss coefficient (S_{11}) and the radiation pattern, of the microstrip structure of Figure 2, and are performed by HFSS and CST commercial simulators. Figure 2(a) shows the return loss curve of the planar antenna of Figure 1(a). It can be seen from the simulated results that the antenna had

an impedance bandwidth over 3.1 to 40 GHz for ($S_{11} < -10\text{dB}$), and a multi-bands characteristics is observed with 6 resonance frequencies. It is also noted that the results obtained by HFSS are in agreement with those obtained by CST.

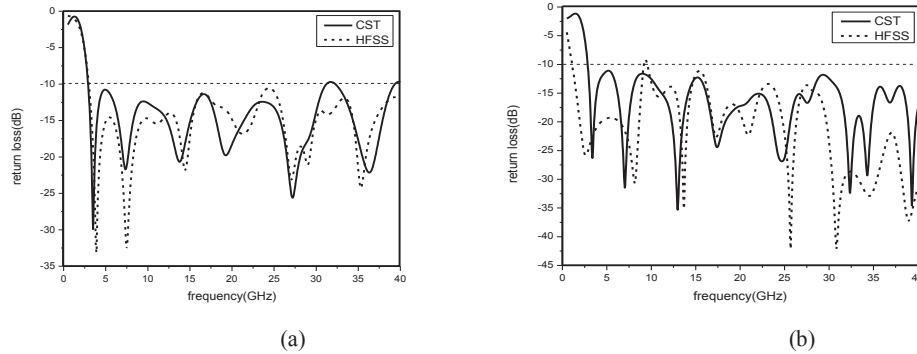


Figure 2. Return loss. (a) Planar Antenna. (b) Elliptical Antenna.

The corresponding return loss for the proposed antenna is illustrated in Figure 2(b). It can be observed that the proposed antenna has an ultra-wide band over 3.1 to up 40 GHz and the reflection coefficient is lowered compared with that of the planar antenna. Thus a better matching is achieved using half-elliptic radiator conformed on elliptical surface. Always from Figure 2(b), we found that the number of resonances is increased and reach the value of 8 which is very suitable for many applications that require multi-band characteristics of microstrip antennas.

The radiation pattern simulations were performed in the $\Phi = 0^\circ$ and $\Phi = 90^\circ$ planes, at frequencies 3.1, 10, 18, and 40 GHz, and are presented in Figures 3, 4, 5 and 6 respectively.

In Figure 3, the radiation pattern of the planar and elliptical antennas at the resonance frequency 3.1GHz are identical, and they are closely the same in the rest resonances frequencies, as illustrated in Figures 4, 5 and 6 respectively. It is also observed that the omni-directional behavior of the half-elliptic radiator antenna under study is maintained in the two planes. It is concluded that the performances of planar antenna is enhanced, without degrading the radiation characteristics, using elliptical surface.

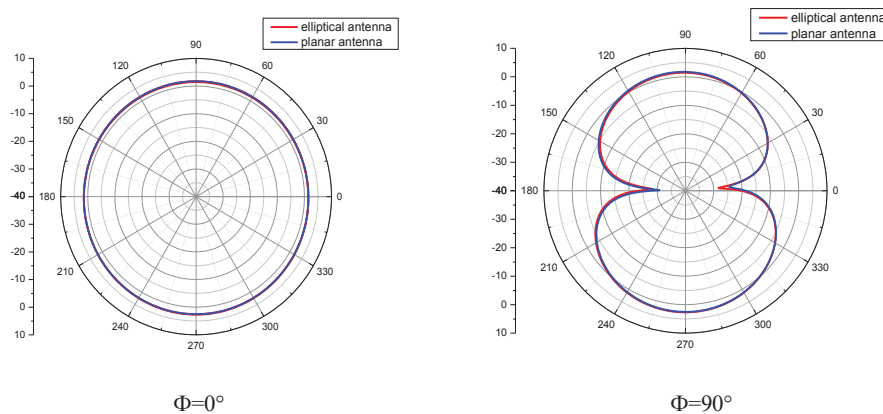


Figure 3. Radiation pattern at $f = 3.1\text{GHz}$.

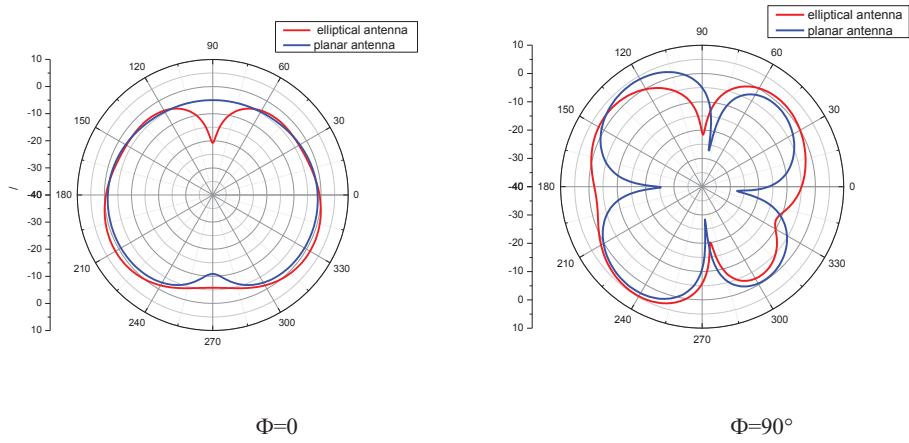


Figure 4. Radiation pattern at $f = 10\text{GHz}$.

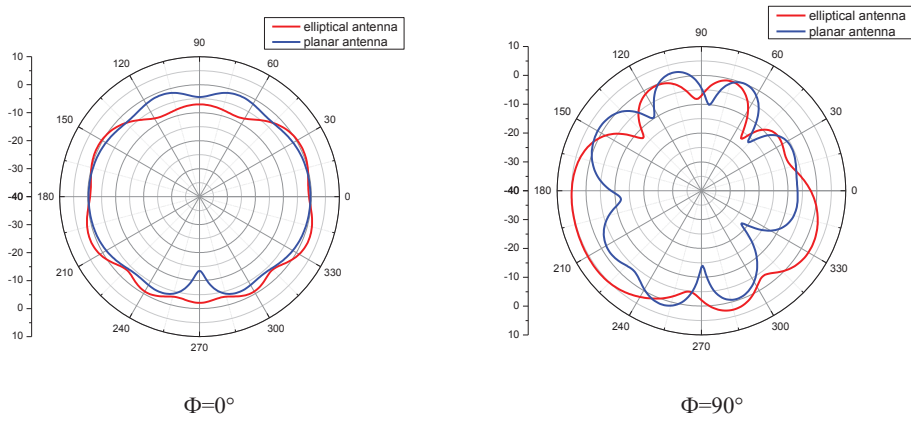


Figure 5. Radiation pattern at $f = 18\text{GHz}$.

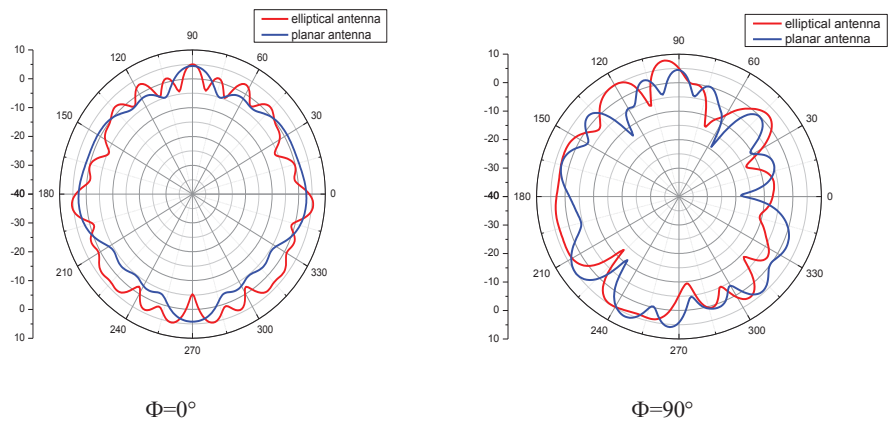


Figure 6. Radiation pattern at $f = 40\text{GHz}$.

CONCLUSION

In This paper, UWB Monopole Antenna using half-elliptical radiator conformed on elliptical surface is presented. The results demonstrate that the proposed antenna has an ultra-wide bandwidth over 3.1 to up 40 GHz. We also demonstrate that the performances of planar antenna, such as the return loss and bandwidth, are enhanced without altering the other parameters such as radiation pattern. The dimensions of the planar microstrip antenna are also reduced to a minimum size using an elliptical surface. We can conclude that the proposed UWB antenna structure is well suitable for conformal packaging and wearable electronics applications.

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