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Rectangular Ring Microstrip Patch Antenna for Ultra-wide Band Applications

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ABSTRACT: The printed antenna is one of the best antenna structures, due to its low cost and compact design. In this paper, we present a new approach to improve the radiation effectiveness and the performance of antennas by miniaturization of the size. Indeed, we have studied the performance of ultra wideband antenna which consists of a ring-shaped patch. This study was made for the whole frequency band of UWB ranging from 2.5GHz to 9.4GHz and the geometry of the antenna and the results were obtained using the simulation software CST Studio microwaves. The detailed design and the results are shown and discussed in this paper.

KEYWORDS: Microstrip, Patch, Antenna, Planar, Broadband, Ultra Wide Band.

1 INTRODUCTION

Developments in communication systems Ultra Wide Band (UWB) in recent years have generated significant research activity dedicated to antenna wide bandwidth [1], [7], [9]. This technology is based on signals from the baseband which their band is not limited, of course levels of spectral densities; they must be limited not to interfere with existing systems. As an example, the United States, the Federal Communications Commission (FCC) emission limits -41 dBm / MHz in the band 3 GHz to 10 GHz levels [3], [7]. The FCC defines UWB as any radio technology that has a bandwidth greater than 500 MHz or greater than 25% of its center frequency. The field of UWB transmission technology for wireless data speeds up to several hundred Mbit/s. It comes as a result of development and Bluetooth wireless USB versions. This is a radio technology which is based on the generation of pulses with very short duration that gives rise to spectral components on a very wide frequency band, hence its name [2], [4]. UWB, the issue of useful signals is performed at a level below the level of ambient radio noise (- 41 dB / MHz), which limits the scope to ten meters (in the current regulatory framework proposed by the FCC) and has the advantage of not receiving multiple signals reflected by the obstacles encountered propagation. In other parts of the spectrum, the transmission power can reach - 75 dB / MHz. The UWB signals are digital signals that are modulated by the carrier frequency. Reaserchs are ongoing to define the degree of UWB compatibility with the existing applications. In various studies, the printed monopole antenna has received a great attention due to its wide band, its omnidirectional and its low dimensions [5]. Thus, a major challenge for ultra-wideband communications (UWB) terminals for small or very small, for short range radio and in combination with sensors or networks of information transfer in the context domestic, multimedia or professional. The low power consumption (and thus performance), ease of integration, and especially the cost are essential aspects that are incompatible with the performance [8], [6], [10]-[18].

In this paper, we propose a monopole antenna which consists of a ring-shaped patch fed by a 50Ω impedance feeder. The advantages of this antenna, consists of his small size and simple structure easing the manufacturing. The antenna design was performed using the CST microwaves studio software. The following sections describe the configuration, design and implementation of the proposed antenna.

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2 ANTENNA GEOMETRY

The antenna proposed is composed of a rectangular patch-shaped ring and printed on a substrate (FR4) having a length Lsub = 30mm and Wsub = 20mm width. The relative permittivity of 4.4 and thickness of 1.5 mm. The antenna is fed by a microstrip line of 50Ω, 12mm length and width w = 2.9mm, all placed on a ground plane of 20x10mm2 dimension as shown in Fig.1. Patch ring constitutes the radiating element of the antenna. The design and study of the proposed antenna with a bandwidth of operation below - 10dB, which extends from 2.5 to 9.16GHz, are presented.

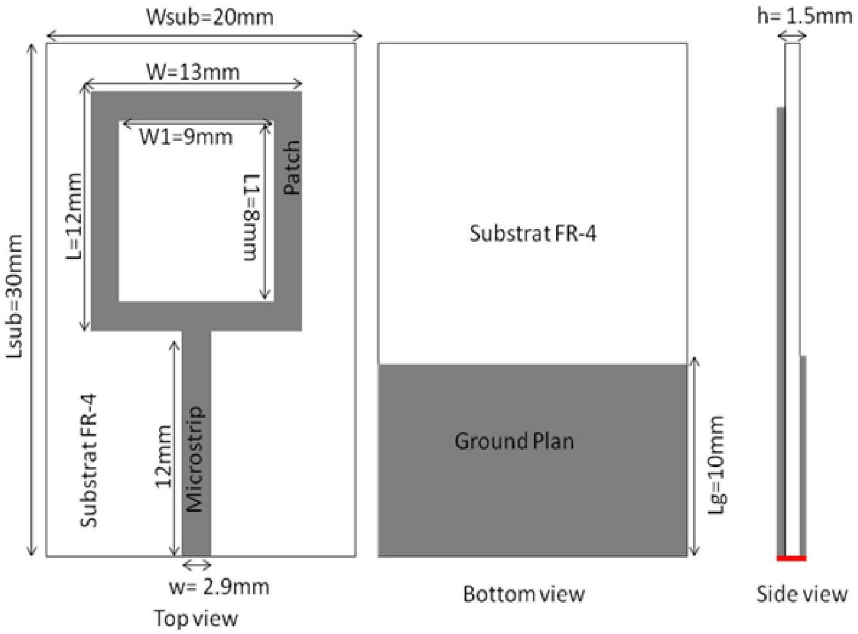


Fig. 1. Geometry of the proposed antenna

3 SIMULATED RESULTS

The simulation gives us three resonance modes centered on 3.17GHz, 6.38GHz and 9 GHz frequencies respectively. and a return loss of -10dB 2.5GHz to 9.16GHz which has a bandwidth for Bluetooth / ISM 2.5/3.5/5.5GHz, WiMAX and WLAN 5.2/5.7 GHz bands, with three resonant modes are mainly excited by the presence of a rectangular patch ring. Fig.2 shows the return loss of the proposed antenna. We note that this is an ultra-wideband antenna with a bandwidth between 2.5GHz and 9.16GHz. Two resonance modes are observed, one centered around 3GHz and the other around 6.2GHz. The presence of these resonances can be explained by the presence of the rectangular ring-shaped patch.

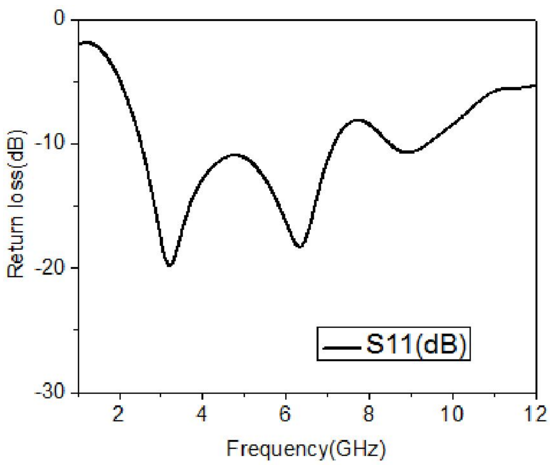


Fig. 2. The return loss S11 of the proposed antenna at L1 = 8 mm, W1=9mm, Lg = 10mm

Fig. 3 shows the variation of the return loss S11 as a function of the width (W1) of the rectangular slot in the center of the patch.

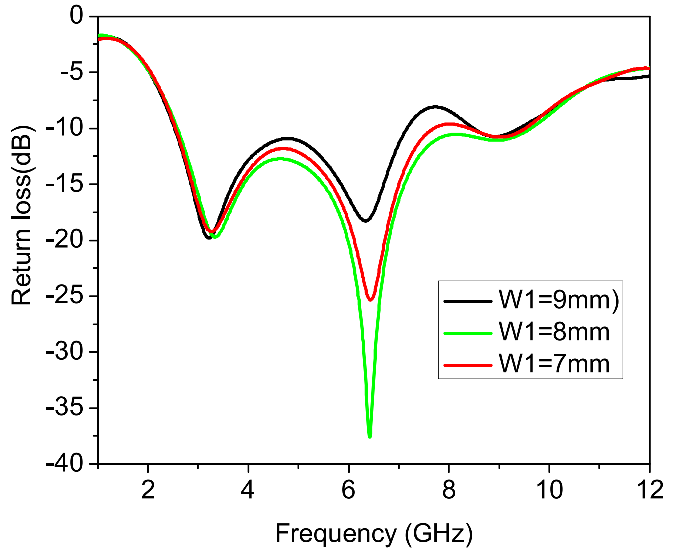


Fig. 3. ***The return loss S11 of the antenna functions W1.***

Fig. 4 shows the variation of the return loss S11 as a function of length L1 of the slit.

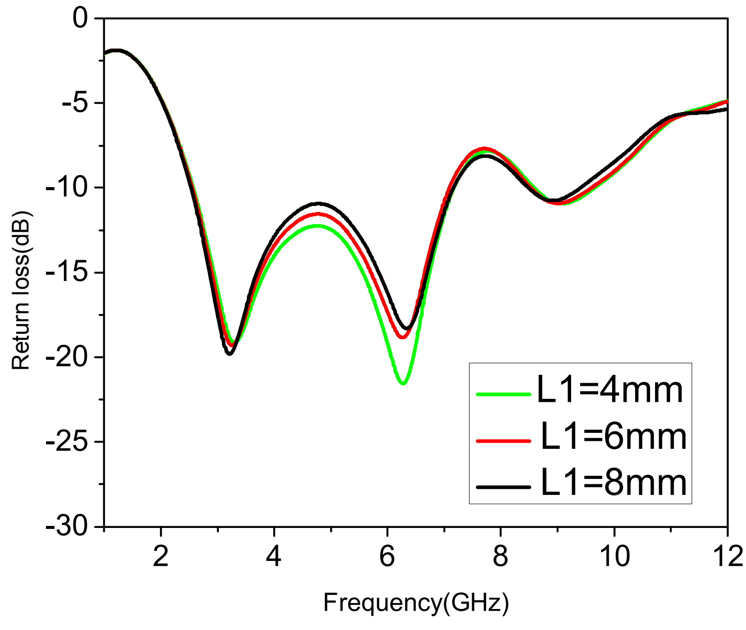


Fig. 4. ***The return loss of the antenna functions (L1)***

The fig. 5 shows the variation of the S11 parameter as a function of the length of the ground plane. Note that the variation of the width (Lg) between 9.5mm and 10.5mm gives a shift of S11 parameter as shown in the figure below.

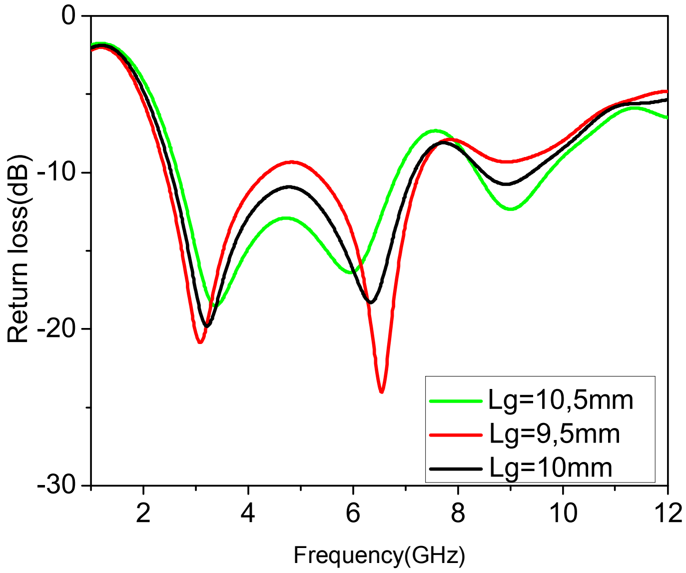


Fig. 5. The reflection coefficients of the antenna functions (Lg)

The fig. 6 presents the proposed antenna gain. The maximum value is obtained at 7GHz. The gain increases steadily from -2 to -5 dB between 2GHz and 7GHz, then decreases steadily until 2dB between 7 and 9 GHz before returning to growth.

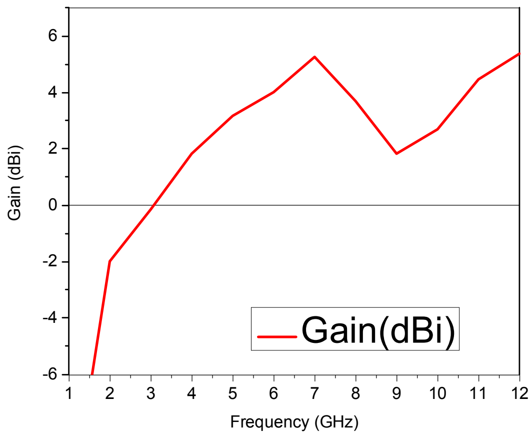
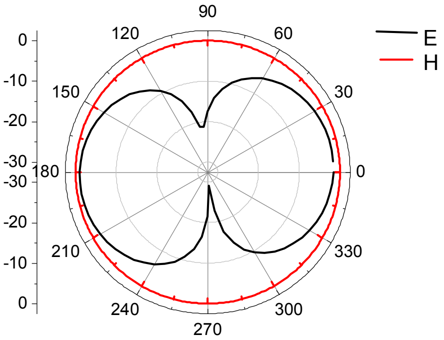
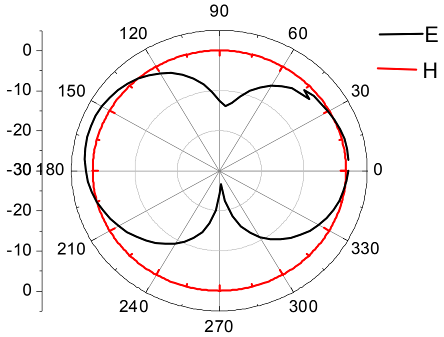


Fig. 6. gain of the proposed antenna

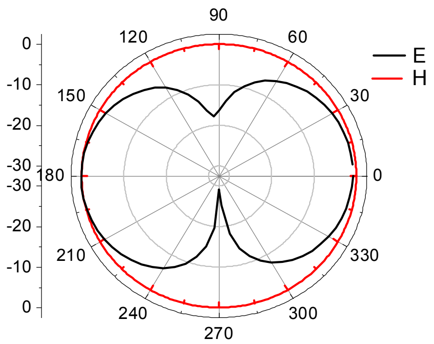
The fig.7 show the different types of radiation patterns for several frequencies: 2.5GHz, 3.17GHz, 6.4GHz and 8.8GHz can be seen that the radiation patterns are almost bidirectional.



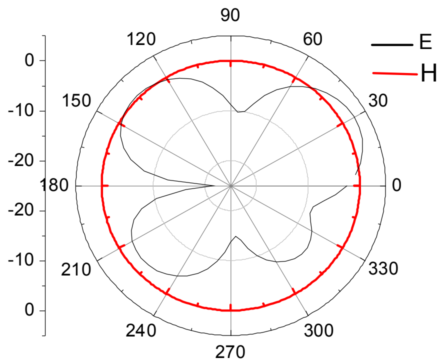
(a) F=2.5GHz



(b) F= 3.1GHz



(c) F=6.4GHZ



(d) F=8.8GHz

Fig. 7. Radiation pattern of the antenna, (a) f = 2.5GHz, (b) f = 3.1GHz, (c) f = 6.4GHz and (d) 8.8GHz

4 CONCLUSION

The rectangular patch antenna ring ultrawide-bandwidth radiating between 2.5GHz and 9.4GHz in order to achieve the operation Bluetooth / ISM, 2.5/3.5 GHz and 5.2/5.7 GHz WiMAX WLAN. Simulation results show diagrams of acceptable radiation and are almost omnidirectional over the entire bandwidth with a significant gain.

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