International Journal of Electrical and Computer Engineering (IJECE)
Vol. 4, No. 3, June 2014, pp. 441~446
ISSN: 2088-8708

A Modified Fractal Bow Tie Antenna for an RFID Reader

Chaouki Guesmi, Abdelhak Ferchichi, Ali Gharsallah
Unit of research Circuits and Electronics Systems High Frequency
Faculty of Science, University El Manar, Tunis, Tunisia

Article Info

Article history:

Received Jan 21, 2014
Revised May 10, 2014
Accepted May 26, 2014

Keyword:

Bowtie Antenna
Fractal
Lumped elements
RFID Reader

ABSTRACT

In this paper, fractal Bowtie antennas are proposed. To validate our structure and to develop an analytic method to determine the geometry parameters, the Lumped theory is used. The proposed structure is simulated using CST Microwave Studio and then Compared to the electrical Model. The proposed circuit has the same resonant aspect when comparing to the Bowtie antenna with a much reduced simulation time. The Bowtie antenna has a box with a size of 44 *80 *1.5 mm^3. This antenna will be designed to an RFID Reader that resonates on 2.45 GHz.

Corresponding Author:

Abdelhak Ferchichi,
Unit of research Circuits and Electronics Systems High Frequency,
Faculty of Science, University El Manar, Tunis, Tunisia,
Email: abdelhakferchichi@yahoo.fr

1. INTRODUCTION

The best identification technology wireless son the second world war is radio frequency identification RFID. Comparing with bar codes technology RFID technology is more efficient for many reasons, such as reading distance, tracking capability also is more robust. Today RFID is used in several areas, such as electronic toll collection, anti-theft system in mall, tracking of animal and patient and vehicle security [1].

According to the operating frequency of the reader, RFID systems can be classified into: 125 KHz low frequency band, 13.56 MHz high frequency band, 860 MHz (Ultra High Frequency) UHF band and 2.45-5.8GHz microwave band. UHF and microwave RFID system have several advantage compared LF/HF system. Especially, the commercial use of micro-wave RFID system in the supply chain and identifying persons have become very popular, which gives the reader several type working in this frequency band which is becoming increasingly important. The important requirements for this types of readers is small size antenna, light weight and low profile which are features of microstrip antenna.

The operating principle of the RFID system can be explained as following: when a transponder appears in the operation range of reader, it starts receiving both energy and data from the reader. The rectify circuit in the transponder collects and stores the energy for powering the other circuit in the transponder [3-4]. After collecting enough energy the transponder can operate and send back pre-stored data to reader, like electronic article code or tag ID code. The reader then passed the received response data to a server for system application, such as the request of price and manufacture information of comidities, or user authentication [2].

For height gain and wide bandwidth, fractal technique is effective for these results. It is combination of antenna technology and fractal geometry [5]. The fractal antenna is the same symmetric geometry that repeats over the entire surface. Indeed, this technique was a very broad focus of research. The best known fractal techniques are: Koch curve, Hilbert curve, Helix, Sierpinski carpet/gasket and Minkwoski Ring [6]-

[7]. We can say that the antennas fractal geometry are very complicated and difficult to made, as to the past few years there have been no new fractal structures. While bowtie antennas in addition to light weight, ease of fabrication and reliability possess a wide and ultras wide band.

The management of communication in various applications requires a very advanced identification system. That is why there are having difficulty for simplify the identification process.

In recent years, many studies have been developed to provide an important antenna for RFID applications. In our case, we focus on the RFID Reader antenna where we need to provide a miniaturized structure with acceptable parameters. The publications that have worked on this goal are many we cite some one that we used as a reference: First, S- Kokici and E- Korkmaz design and optimize of Bow-tie optical antennas, in their work, the optical antennas were illuminated by a linearly polarized plane wave perpendicular to the surface of the optical antennas. The simulations frequency range is 250-650 THz, [8]. In [9], D an Yang, H-ch- Yang, J- Zhang, and Y- Li present A novel crossed bowtie dipole (CBD) antenna, the structure is designed to Inmarsat applications, the polarization was circularly. Third, Daotie Li, and Jun-fa-Mao, proposed a novel Koch-like fractal curve to transform ultra-wideband (UWB) bow-tie into so called Koch-like sided fractal bow-tie dipole, [10].

This paper is organized as follow, in the first section we will describe an bowtie antenna for an RFID reader. In the second section, a fractal bowtie antenna is designed and simulated by the commercial software (CST MWS). In the third paragraph we build an electrical model to the two structures of bowtie antenna. Finally, we conclude our paper and we suggest some perspectives.

2. BOW TIE ANTENNA FOR AN RFID READER

Although the RFID tag and readers have marked a success either in industries or in scientific publications, but the gain of antennas remains very low, which limits the maximum read range of at least two meters. In addition, the bandwidths are not so broad to cover bands UHF and microwave. In addition, some designs cannot adjust the impedance of the antenna. so we need to develop RFID tags and readers who possess antenna whose gain is greater than a width of classic band and whose operation can cover the UHF and microwave bands in the world entier.de more, have a mechanism enables adjustment of the impedance to increase the degree of freedom.

To solve the problems mentioned above, technology bowtie antenna was among the best solutions.

2.1. Bow Tie Anntenna

Two antennas are placed face to face from their summit with a gap between them is the principle of bowtie antennas. The performance of the bowtie antennas depends on several geometric parameters, such as bowtie size, apex angle, and gap size [11]-[12]. Bowtie antenna polarization can be linear or circular, the impedance of the bowtie antenna can be calculated theoretically by transmission line theory [13], and can be changed by varying the flare angle, which may change the resonant wavelength slightly [14].

More precisely, in our article we propose a bow tie antenna for RFID reader that can solve the problems mentioned

2.2. Geometry

The schematic of the bowtie antenna given in our article is shown in Figure 1. It is a planar antenna consisting of two metal layers is printed on each one of the listed FR4 substrate with permittivity $\varepsilon_r = 4.3$ and loss tangent (tangδ) = 0.025. One of the layers is printed the microwave radiation member and the other to the UWB element. The microwave component is based on two isosceles triangles which are placed in front of their top connected to each other by the RFID chip Intermediate. While the UWB is a modified version of the Crossed Exponential Tapered Slot antenna (XETS) proposed in [15], [16].This last structure given good results for UWB. The two parts of the microwave and UWB antenna must be made with great precision so that minimizes the mutual influence. Thus, the two elements are aligned so that the holes of power each side of the substrate shown in Figure 1.

During the simulation we used a discrete port with an impedance equal to 50 Ω input for UWB. Microwave for harbor we used a lumped element that represents an RFID IC in our proposed antenna.

The geometry bowtie RFID element microwave view in Figure 2 consists of two triangles. In addition, the two elements of our antenna must be very close; in fact, the lines that connect the RFID microwave element with the chip are very thin, very narrow and positioned in a manner that minimizes interference with XETS antenna on the opposite side.

For maximum power transfer to 2.45 GHz, the antenna impedance RFID must be equal to the conjugate of the chip $Z_{(antenna)}$=R x + j Lx.

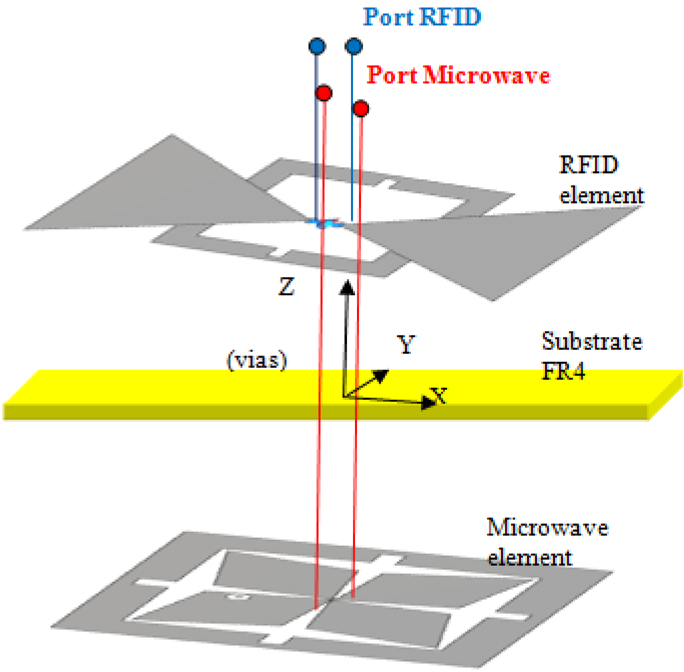

Figure 1. Exploded view of the antenna showing both RFID and UWB faces in addition to the common substrate

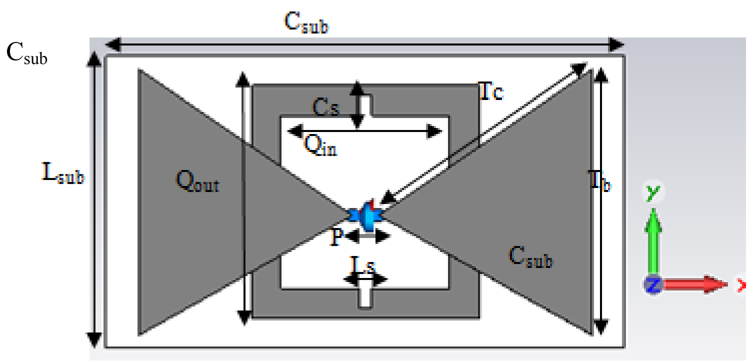

Figure 2. Geometry Bowtie of the RFID face of the hybrid antenna, designed with CST Microwave Studio.

Table 1. Parameter Values of the RFID Element in Millimeters

C_{sub}	L_{sub}	T_c	T_b	Q_{out}
80	44	40	40	35
Q_{in}	**C_s**	**L_s**	**P**	
32	3	2	2	

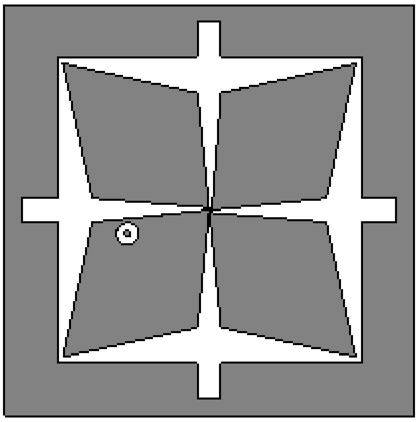

Figure 3. Parameters defining the UWB Element

2.3. Simulation Results

As can be seen, in the simulation results, we obtain a resonant frequency equal to 2.45 GHz which is an RFID frequency. The gain is about 2.85 dB which is acceptable for our application.

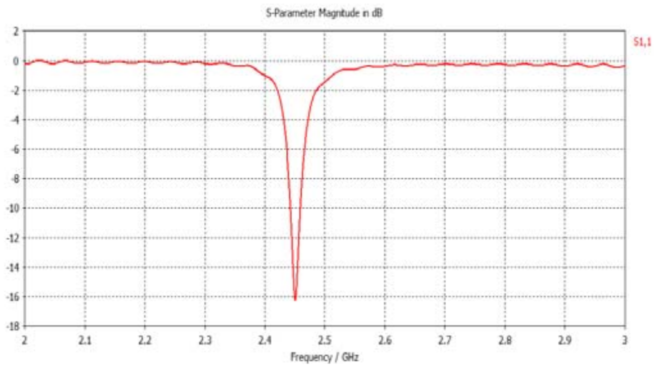

Figure 4. The Return Loss of the proposed antenna

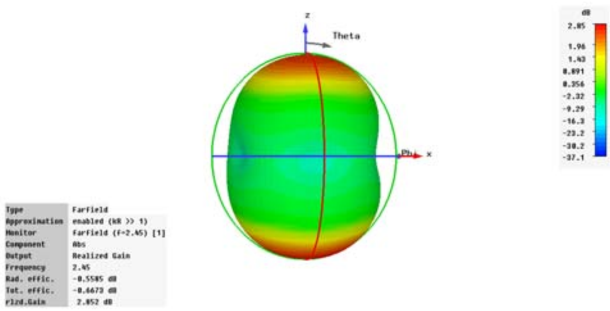

Figure 5. The Gain of our antenna

3. A PROPSED FRACTAL BOW TIE READER ANTENNA

3.1. Fractal Technique

Fractal geometries have been applied in several technologies. Indeed, any self-similar configuration can take the name fractal geometry. The property of thumb is to take the same characteristics of the general structure for each sub section which was well explained by Mandelbrot in 17 [1975]. We can will remake several fractal geometries as sierpenski Koch, Minkowski, Hilbert. The RFID systems and microwave devices well using fractal geometries to improve their characteristics.

3.2. Geometry

This fractal Bow-tie antenna is proposed at the beginning of a couple of similar isosceles triangles by facing the summit, made fractalisation is subtracting a central inverted triangles of each the principals triangles. After subtraction, three equal triangles stay on each side of the structure [18].
Which can be more generalized by applying the sierpenski technology, indeed, the same procedure is repeated to the remaining triangles. The number of triangles Nn, length of a side of triangle Ln and the fractional area An can be calculated after every iteration [19]:

$$N_n = 3^n$$

$$L_n = 1/ 2^n$$

$$A_n = L_n N_n^{\ 2} = (3/4)^n$$

Figure (6) shows fractal antenn Bowtie antenna which used two iterations of Sierpenski which is mounted on substrate FR4 a material having a thickness h = 1.5 mm, a dielectric constant εr = 4.3 and loss tangent (tangδ) = 0.025.

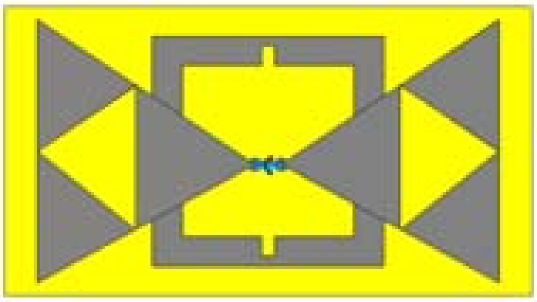

Figure 6. Bowtie Fractal Antenna

3.3. Simulation Results

The simulation results of the proposed fractal antenna give us a resonant frequency equal to 2.45 GHz which is an RFID frequency and a gain about 2.93 dB which is acceptable for our application.

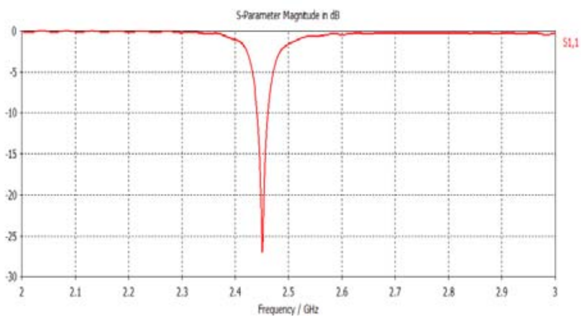

Figure 7. The Return Loss of the Fractal antenna

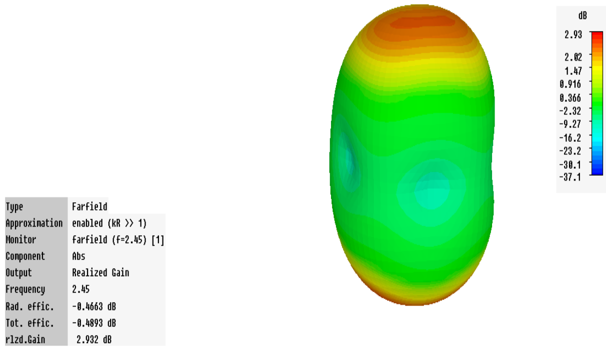

Figure 8. The Gain of fractal antenna

4. CONCLUSION

A Bowtie fractal antenna is developed and proposed in this paper. The antenna is designed to an RFID Reader and it presents many advantageous comparing to a classical Bowtie antenna. The use of a simple and an efficient circuit model was very useful and helps us to do a good analytic study. Besides, the simulation time was reduced which means a fast tools of simulation.

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