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A Design of New Bluetooth Antenna for RFID Application

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ABSTRACT

This paper covers the design and optimization of new antenna for RFID applications at microwave frequencies. The structure is designed to resonate at 2.45GHz one of the FID frequencies. In fact, the development of RFID antenna is of theoretical significance and practical value for the RFID system. In this chapter, the RFID technology is briefly introduced, and the operating principle of the RFID system is described. An equivalent resonant model is presented based on a model of triangular antenna. Simulation results given by our approach, show that the antenna and its model have the same resonant frequency at 2.45GHz but with a little difference in Bandwidth.

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INTRODUCTION

Radio Frequency Identification is an automatic identification technology of objects. The RFID system is made up of a Reader and a Tag which is attached to objects. The identification does not necessitate a contact between the reader and the tag. The antenna is the main component of RFID system. It represents the channel between the reader and the tag figure (1). As RFID frequencies raise into microwave region, the antenna should be carefully designed in order to reduce the tag size and to maximize the transfer of power into and out of the tag (Amir Galehdar, 2007).

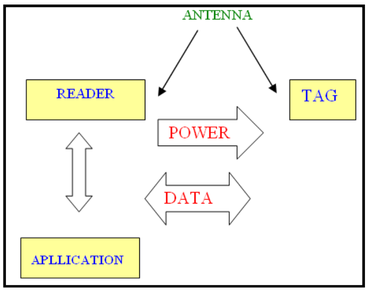

Fig. 1: RFID system

Thus, we should in choosing the antenna considerate some points. First, the type of the antenna should differ from the reader to the tag and from an application to another. Second, the antenna should be small, easy when made and cheap when produced. Third, the RF characteristics of the antenna should be acceptable considering impedance, gain and directivity.

On the one hand, the reduction of the size of the antenna means a possibility to have a small TAG which can be placed anywhere without occupying a large place. On the other hand, one of the important characteristic of RFID system is the readable range R. The readable range is the maximum distance that the Interrogator can read from the TAG. This distance depends essentially on the gain of both the TAG antenna and the reader antenna as shown in the equation 1 (Klaus Finkenzeller, 2003):

$$R = \frac{\lambda_0}{4\pi} \sqrt[4]{\frac{P_1 . G_{reader}^2 . G_T^2}{P_3}} \quad (1)$$

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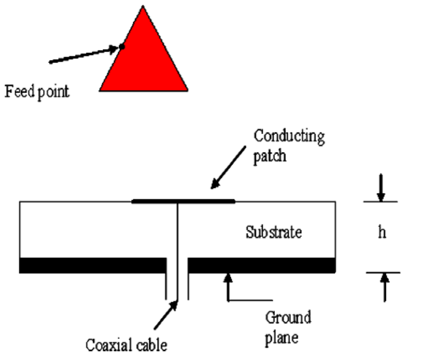
With: P3 = Power received in the TAG
P1 = Power transmitted by the Interrogator
G_{reader} = The Gain of interrogator antenna
G_T = The Gain of TAG antenna
In this paper, we propose a new small tag antenna.

The patch is based on a bow tie antenna. It simulated using Advanced Design System (ADS 2009). The importance of the new patch is that we reduce the original antenna size that resonates at 2.45GHz by more than 70%. In order to validate our work, we simulated an electrical model of the structure and we compare the ADS results of the physical patch.

A bt small antenna:

Geometry of triangular antenna:

Figure (2) shows the geometry of an equilateral triangular microstrip patch on a dielectric substrate with a ground plane. The antenna is mounted on a substrate material with a thickness h=3.2mm, a dielectric constant $\varepsilon_r = 2.6$ and loss tangent (tangδ) = 0.002.



Fin. 2: Triangular Antenna structure

Electrical model of triangular patch:

The recent study work of microstrip patch have demonstrate that the triangular patch have a radiation characteristic similar to a rectangular patch but with a reduced dimensions (Nasimuddin and A.K. Verma Amir, 2004; Geoge, 1996; Xu-Pu zhang and Shum-Shi Zheng, 2002). For this reason, to studies our antenna, we can replace the triangular electrical model by its equivalent electrical rectangular model figure (3).

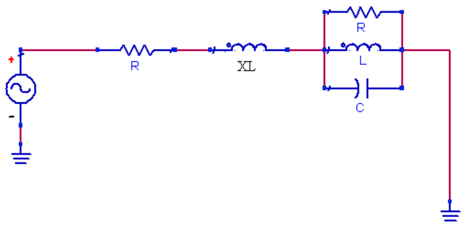


Fig. 3: Electrical model of Triangular antenna .

To calculate the model parameters, we use the formula presented in (Celal YILDIZ and Kerim GÜNEY, 1998) to every triangle.

$$Z_{in} = R + jX \tag{2}$$

$$Z_{in} = \frac{R}{1 + Q_T^2\left[\frac{f}{f_r} - \frac{f_r}{f}\right]} + j\left[X_L - \frac{RQ_T\left[\frac{f}{f_r} - \frac{f_r}{f}\right]}{1 + Q_T^2\left[\frac{f}{f_r} - \frac{f_r}{f}\right]^2}\right]$$

Resonant resistance R:

The resonant resistance is calculated using equation (3) as in (Celal YILDIZ and Kerim GÜNEY, 1998):

$$R = \frac{Q_T H}{\pi f_r \varepsilon_{dyn} \varepsilon_0 A} \cos^2\left(\frac{\pi x_0}{a}\right) \tag{3}$$

f_r : Resonant frequency

Q_T : Quality factor

ε_{dyn}: Dynamic permittivity

X_0 : The distance of the feed point from the edge of the patch.

a: length of triangle
H : thickness of dielectric
A: aire of triangle1

$$Q_T = \left(\frac{1}{Q_R} + \frac{1}{Q_C} + \frac{1}{Q_D} \right)^{-1} \tag{4}$$

$$Q_R = \frac{c_0 \sqrt{\varepsilon_{dyn}}}{4 f_r H} \tag{5}$$

$$Q_D = \frac{1}{Tg\delta} \tag{6}$$

$$Q_c = \frac{0.786 \sqrt{f_r Z_{a0}(W) H}}{p_a} \tag{7}$$

Q_R : Radiation quality factor

Q_D : Losses in the dielectric

Q_C : Losses in the conductor

$$Z_a(w) = \frac{60\pi}{\sqrt{\varepsilon_r}} \left[\frac{W}{2H} + 0.441 + 0.082 \left(\frac{\varepsilon_r - 1}{\varepsilon_r^2} \right) + \frac{(\varepsilon_r + 1)}{2\pi\varepsilon_r} \left(1.451 + Ln\left(\frac{W}{2H} + 0.94 \right) \right) \right] \tag{8}$$

The impedance of an air filled microstrip line

$$Z_{a0}(w) = Z_a(w, \varepsilon_r = 1)$$

$$p_a = \frac{2\pi \left(\frac{W}{H} + \frac{W/(\pi H)}{W/2H + 0.94} \right) \left(1 + \frac{H}{W} \right)}{\left(\frac{W}{H} + \frac{2}{\pi} Ln\left(2\pi \exp\left(\frac{W}{2H} + 0.94 \right) \right) \right)^2}$$

$$W/H > 2 \tag{9}$$

$$\varepsilon_{dyn} = \frac{C_{dyn}(\varepsilon)}{C_{dyn}(\varepsilon_0)} \tag{10}$$

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$$C_{dyn}(\varepsilon) = \frac{\varepsilon_0 \varepsilon_r A}{H \gamma_n \gamma_m} + \frac{1}{2\gamma_n}\left(\frac{\varepsilon_{reff}(\varepsilon_r, H, W)}{c_0 Z(\varepsilon_r = 1, H, W)} - \frac{\varepsilon_0 \varepsilon_r A}{H}\right)$$

$$\gamma_j = \begin{cases} 1, & j = 0 \\ 2, & j \neq 0 \end{cases} \quad (11)$$

$$Z(W, H, \varepsilon_r = 1) = \frac{377}{2\pi} Ln\left(\frac{f(w_H)}{w_h} + \sqrt{1 + (\frac{2}{W_H})^2}\right) \quad (12)$$

$$f(W/H) = 6 + (2\pi - 6)\exp\left(-\left(\frac{30.666}{W_H}\right)^{0.758}\right) \quad (13)$$

Capacitance C, Inductance L:

To determine the capacitance C we use the formula of. C_{dyn}.

To determine L, we know that:

$$\omega_{res} = 2\pi f_r \quad (14)$$

$$\omega_{res} = \frac{1}{\sqrt{LC}} \Rightarrow L = \frac{1}{\omega_{res}^2 C} \quad (15)$$

Inductive reactance of Coax:

Inductive reactance of Coax is calculated via the equation below:

$$X_L = \frac{377\, fH}{c_0} Ln\left(\frac{c_0}{\pi f d_0 \sqrt{\varepsilon_0}}\right) \quad (16)$$

The model is simulated and then compared to physical patch. The results are represented in figure (4). The triangular patch and its electrical model present a resonant frequency about 2.45GHz but with a difference in Band width because of the difference between calculated and simulated losses. The gain and directivity equal respectively 8.1dB and 8.2dB.

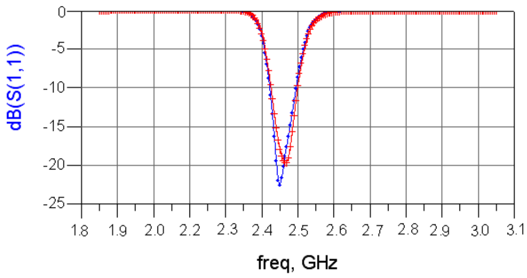

Fig. 4: Return loss of both physical and model of triangular patch

Geometry of proposed bow tie antenna:

The proposed patch is constituted of four triangle patches disposed on planar structure figure (5).

This structure is inspired from the bow tie patch antenna. Only one transmission line links the four triangles. The patch is mounted on a dielectric with a thickness h = 0.65mm and permittivity $\varepsilon_r = 2{,}3$.

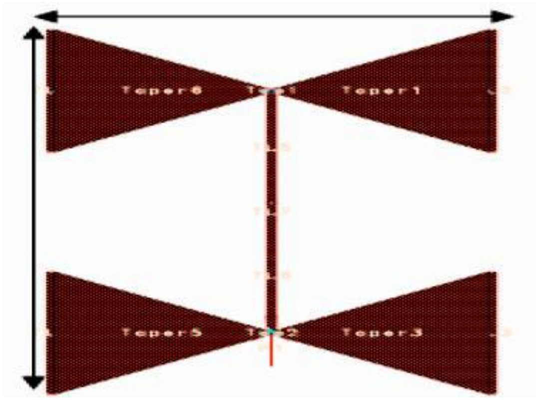

Fig. 5: Proposed bow tie antenna structure.

Electrical model:

To analyze this antenna, an electrical model is developed. The model is inspired from the electrical model of triangular patch described by Nasimuddin and A. K. Verma in [3] where they replaced the triangular patch by its equivalent rectangular patch and then they built the triangular electrical model. The transmission line is also modeled by an RLC circuit. The electrical model is represented in figure (6).

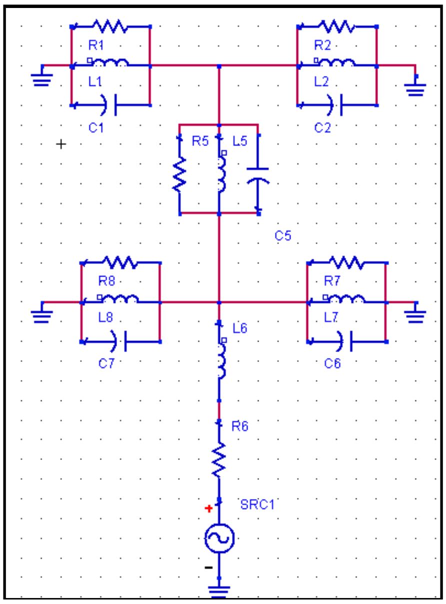

Fig. 6: Electrical model of proposed bow tie antenna .

The RLC parameters are calculated using the formulas developed in section 1.

RESULTS AND DISCUSSION

Dimensions:

The proposed patch is designed to resonate at 2.45GHz (one of the RFID frequencies). The ordinary dimension of an antenna is about 5.8cm × 5.8cm. The dimension of the present antenna is about 10.4mm×6.2mm which means that the dimensions of antennas are reduced by more than 70%. Hence we can obtain a very small tag with a good characteristic.

Return loss:

The return loss is shown in figure (7). The resonant frequency is 2.45 GHz. The antenna represents a band width about 80 MHz which is acceptable to RFID system. The magnitude |S11| attainted 25dB.

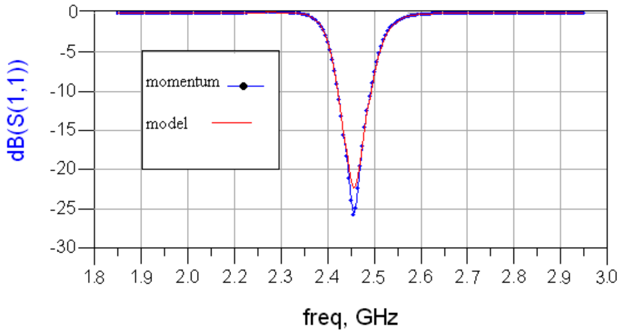

Fig. 7: Return loss of both physical and model of proposed bow tie antenna.

Gain and Directivity:

As the readable rang R depends on and directivity, we should guarantee suitable ones. For our proposed bow tie antenna, the gain and the directivity are successively 2.1dB and 5.2dB which are acceptable parameters to an RFID system.

Finally, when we compare physical patch and electrical model we can see that the resonant frequency is the same and there is a little difference in band width due to the difference in losses between theory and real.

Conclusion:

The reduction of antenna and tag size is of great interest for many applications. In this way, many techniques are applied to propose a very small patch. On the one hand, in this paper we think that reducing antenna size by more than 70% is very important. On the other hand, ameliorating antenna parameters and decreasing antenna cost are our priorities in our future research.

REFERENCES

Amir Galehdar, V. David Thiel and G. Steven O'Keefe, 2007. "Antenna Efficiency Calculations for Electrically Small, RFID Antennas", IEEE Antenna Wireless Propagation Letters, 6: 156-159.

Klaus Finkenzeller, 2003. "RFID HANDBOOK," Second Edition.

Nasimuddin and A.K. Verma Amir, 2004. "Fast and accurate model for analysis of equilateral triangular patch antenna," Journal of Microwaves and Optoelectronics, 3: 99-110.

Celal YILDIZ, Kerim GÜNEY, 1998. "Simple model for the impedance of rectangular microstrip antenna", journal of engineering sciences, pp: 733-738.

Geoge, J., M. Deopukumar,, C.K. Aanadan, P. Mohanan and K.G. Nair, 1996. New compact microstrip antenna, Electron let, 32(6): 508-509.

Xu-Pu zhang, Shum-Shi Zheng, 2002. Resonant frequency and dual-frequency operation of a bow-tie microstrip antenna, IEEE AP-S Int Symp, 2: 60-63.