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IMPROVEMENT OF RECTANGULAR PATCH ANTENNA PERFORMANCE FOR RFID APPLICATIONS

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ABSTRACT

In the present paper, the optimal design of the rectangular patch antenna parameters, excited by a microstrip line having a power port 50 adapted to Ω, are introduced to the requirement of improvement of radiation characteristics namely reflection coefficient, the standing wave ratio (VSWR), the input impedance of the antenna and bandwidth. The design was performed using the simulator HFSS (High Frequency Structure Simulator) based on the resolution of Maxwell's equations for the ticket of the finite element method. The objective of this improved radiation characteristics of the antenna patch is the full performance of this antenna at 0.92 MHz for RFID applications. Simulation results show that the reflection coefficient reaches a level of less -31dB, the standing wave ratio is equal to 1.057, and the bandwidth is about 2.75%.

Keywords: *Antenna Patch, Return Loss, RFID, HFSS*

1. INTRODUCTION

Printed elements antennas "Patch" have the advantages of microstrip lines, light weight, reduced by the technique of printed circuit cost. They can be placed on land or space vehicles, easy to networks of tens or hundreds element, connected directly to the power supply device that goes in the direction of integrating the antenna and power supply [1] - [2].

Diet plays a very important role in the design of patch antennas. It can be made by direct connection to a microstrip line which is the junction point on the axis of symmetry of the element or offset with respect to this axis, [3] or by direct connection to a coaxial line whose central conductor is connected at a point on the axis of symmetry of the element [4].

Radio frequency identification (RFID) is a technology that allows electronic tagging an object, place or person to be automatically identified at a distance without a direct line of sight using an exchange of radio waves. Recently there have been many studies on RFID antennas mostly in the UHF Band [5]-[6], and even as on RFID dual-band antennas [7].

In a previous study [3], the author simulated a patch antenna excited by a microstrip line for RFID applications. He has represented some radiation characteristics of the patch antenna that is the reflection coefficient, the bandwidth and the standing wave ratio.

This paper presents the improvement of radiation characteristics of an antenna rectangular patch fed by a microstrip line with axial notch and compared with those found in the publication [3]. The proposed antenna is adapted to the resonance frequency of 0.92 MHz for RFID applications.

2. RECTANGULAR PATCH

The rectangular antenna configuration is the most widely used. It is very easy to analyze using both the transmission line and cavity models that are more accurate for fin substrates [1].

1.1 Main Design

In its most basic form, a patch antenna

consists of a radiating element and a ground plane separated by a dielectric substrate as shown in figure 1.The patch is usually made of materials such as copper or gold and can take any form geometric (figure 2).

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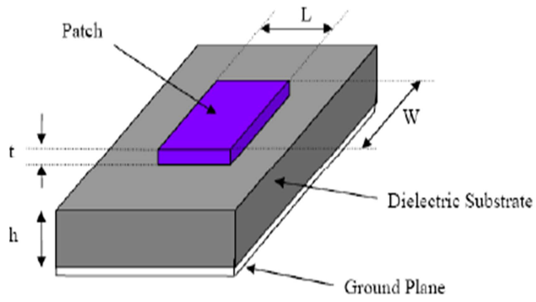

Figure 1: Structure Of A Patch Antenna

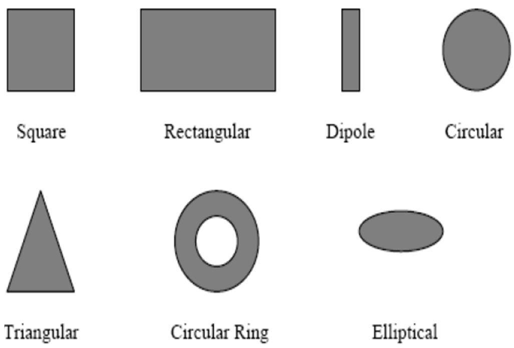

Figure 2: Different Forms Radiating Elements

For a rectangular patch, the length L of the radiating element is generally $\lambda 0/3 < L < \lambda 0 / 2$, where λ0 is the wavelength in free space. The patch is selected to be very thin such that $t << \lambda 0$ (where t is the thickness of the patch). The height h of the dielectric substrate is usually $0.003\ \lambda 0 \leq h \leq 0.05\ \lambda 0$. There are many materials that can be used for the design of microstrip antennas and their dielectric constants are generally in the range of $2.2 \leq \varepsilon r \leq 12$.

2.2 Methods of Analysis

The preferred models for the analysis of microstrip antennas are the transmission line model, the model of the cavity, and the full wave model (which primarily include integral equations / method of moments). The model of the transmission line is the simplest of all and it gives a good physical insight.

The transmission line model is the microstrip antenna by two slots of width W and height h, separated by a transmission line of length L. The microstrip is basically a line non-homogeneous of two dielectric, generally the substrate and air.

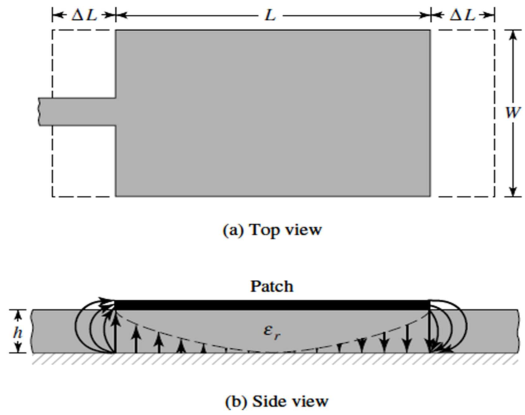

Figure 3: Physical And Effective Lengths Of The Patch Antenna

The electrical behavior can be visualized as of two magnetic surface currents due along radiating edges as seen in Figure 3 (b). These magnetic currents are the result of fringe fields along the radiating edges. The additional length(ΔL), added to the correction due to the fringing fields around the substrate thickness (h). In general, the patch antennas are long structures in the half wave frequency of the fundamental mode, with a length of half-wave patch is [1]:

$$L \cong 0.49\, \lambda_0/\sqrt{\varepsilon_e} \quad (1)$$

With λ_0 is the wavelength in free space and ε_e is the effective permittivity.

To meet the design requirements of different analytical approaches the calculations of the width W is based on the model of the transmission line. For an efficient radiator, a practical width (equation 2) that leads to good yields of radiation:

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r+1}{2}}} \quad (2)$$

Where f_0 is the resonant frequency of the patch antenna.

Because of side effects, electrically the patch of the microstrip antenna is bigger than its physical dimensions. To the main plane (xy plane), the dimensions of the patch along its length, were extended at each end by a distance of ΔL (figure 3 (a)), which is a function of the effective dielectric constant and ε_{reff} aspect ratio(w/h). A very popular relationship and approximate practice for extending the standard duration [8]:

$$L = \frac{c}{2f_0\sqrt{\varepsilon_r}} - 2\Delta L \quad (3)$$

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Where c is the speed of light and ΔL the margin factor is given by the following relation:

$$\Delta L = 0.412h\frac{(\varepsilon_e+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_e-0.258)(\frac{W}{h}+0.8)} \quad (4)$$

The effective dielectric constant (ε_e) is designated as a static value, and they are given by the equation (5) [9]:

$$\varepsilon_e = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}[1 + 12\frac{h}{w}]^{-1/2} \quad (5)$$

2.2.1 Feeding technique

There are many configurations that can be used to feed microstrip antennas. We are interested in feeding the microstrip line because it is easy to manufacture, simple to match by controlling the position key and fairly simple to model. However, as the substrate thickness increases, the surface waves and spurious radiation increase, which is for practical designs limit the bandwidth (usually 2 to 5%). In this type of diet, a conductive strip is connected directly to the edge of the patch. The conductive strip is smaller in width compared to the room and what kind of feeder has the advantage that the feed can be etched on the same substrate to provide a planar structure.

3 PROPOSED ANTENNA AND SIMULATION

4

3.1 Proposed Antenna

The figure 4 shows the proposed antenna using the power supply line with notch, with W is the correction width, and L is the length correction. The width of the feed line and the feed line being inset rated by w_1, w_2 and y_0. The proposed antenna is constructed on a substrate and the substrate layer having a relative permittivity $\varepsilon_r = 4{,}50$and a thickness substrate $h = 1{,}50$ mm.

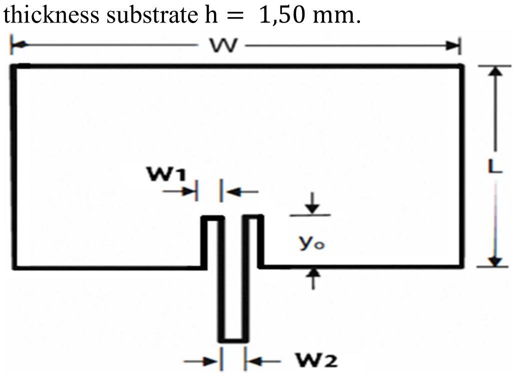

Figure 4: Patch Geometry Proposed

After a laborious optimization patch antenna has been designed to operate at a resonant frequency $f_0 = 920$ MHz and has a dimension of $W = 92$ mm and $L = 75$ mm. The supply line is dimensioned in response, $y_0 = 7$ mm width of the feed line $w_2 = 3$mm and $w_1 = 1$ mm. The patch antenna and the power line are engraved on the same substrate.

4.2 Simulation results

The figure 5 shows the return loss as a function of frequency.

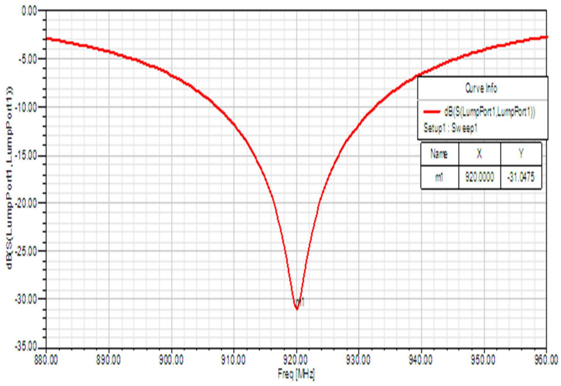

Figure 5: Return Loss In DB

We see that the reflection coefficient S11 Reach a value of less than-31dB in the resonant frequency which is implies that the antenna is well suited. So the patch antenna has been sized to operated at the frequency $f_0 = 0.92$ GHz with a bandwidth of 2.75%.

The standing wave ratio (VSWR) is shown in Figure 6 depending on the frequency. The result and the order of 1.057 which shows that this is a relatively better result compared to the value obtained in [3].

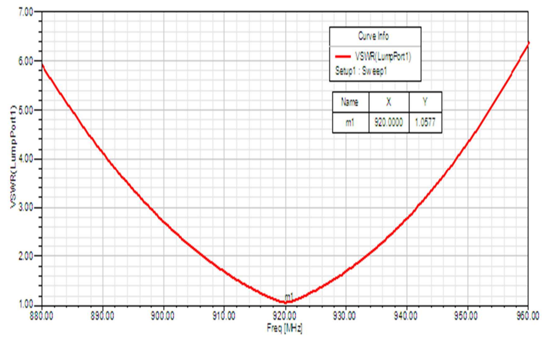

Figure 6: Standing Wave Ratio (VSWR)

The figure 7 shows the relation between the input impedance and frequency and it is found that the center frequency input impedance is equal to $Zin = (51.287 - j2.531)\,\Omega$.

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Table 1: Comparison Of Results

	Reference [3]	this work
S_{11} (dB)	- 23.06	-31.04
Z_{in} (Ω)	57.444 $+j2.147$	51.287 $-j2.531$
VSWR	1.155	1. 057
Bandwidth(%)	2.42	2.74

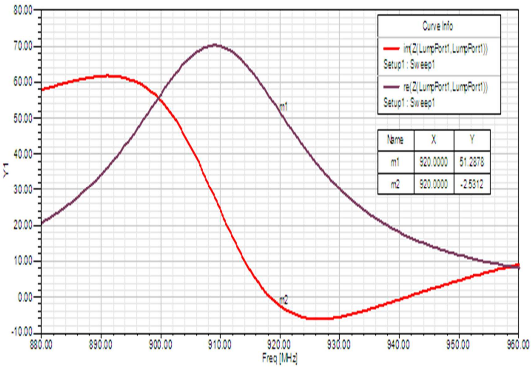

Figure 7: Input Impedance of The Antenna Given

Table 1 summarizes the comparison between the results obtained in our work and that found in [3] in the resonance frequency $f_0 = 0.92GHz$.

4 CONCLUSION

Sizing and the improvement of patch antenna has been done in this article, the results obtained after optimization using HFSS software are developed with respect to the reference [3], we obtain a reflection coefficient S11 -31dB a bandwidth of about 25 MHz (2.74%) and a standing wave ratio of 1.057 at the resonance frequency of .92 GHz 0. therefore, the antenna is proposed a simple structure which can be easily manufactured with a low cost, for applications (RFID).

REFERENCES:

[1] Constantine A. Balanis, Antenna Theory Analysis and Design, John Wiley & Sons, New Jersey, Canada, 2005.chapitre 14.

[2] Paul.f.combes,Micro-Ondes:2.Circuits Passifs, Propagation, Antennes, Dunod, Paris,1997.Chapitre 15.

[3] Indra Surjati, Yuli KN and Arky Astasari,″ Microstrip Patch Antenna Fed by Inset Microstrip Line For Radio Frequency Identification (RFID)″, *International Symposium on Electromagnetic Compatibility*, April 12 - 16, 2010, Beijing, China.

[4] A.B. Mutiara, R. Refianti, Rachmansyah," Design Of Microstrip Antenna For Wireless Communication At 2.4 GHZ". *Journal of Theoretical and Applied Information Technology*, 30th November 2011. Vol. 33 No.2

[5] K. V. Seshagiri Rao, Pavel V. Nikitin, and Sander F. Lam," Antenna Design for UHF RFID Tags: A Review and a Practical Application", IEEE *transactions on antennas and propagation*, VOL. 53, NO. 12, december 2005.

[6] Xingyu Zhang and Anping Zhao," Design of a Miniaturized Broadband Tag Antenna for UHF RFID", *PIERS Proceedings*, Moscow, Russia, August 18-21, 2009.

[7] Gi-Hyun Hwang and Dae-Ki Kang," Systematic Design of High-Performance Smart Card with HF/UHF Dual-Band RFID Tag1", *International Journal of Smart Home* Vol. 6, No. 2, April, 2012.

[8] E. O. Hammerstad, "Equations for Microstrip Circuit Design" *Proc. Fifth European Microwave Conf.*, pp. 268–272, September 1975.

[9] C. A. Balanis, Advanced Engineering Electromagnetics, JohnW iley & Sons, New York, 1989.