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# Design of A New Universal Reader RFID Antenna Eye-Shaped in UHF Band

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## Abstract

*In this paper, miniaturized reader antenna's Radio Frequency Identification (RFID) are designed, simulated and fabricated using FR4 substrate, by using slots integration on the front and on the back side of the antenna In addition, a parametric study is conducted to facilitate the design and optimization processes , the total area of the achieved antenna is 90.5x99.5x1,58 mm$^3$. Therefore, the proposed antenna is universal for UHF RFID applications worldwide at the UHF band of 860–960 MHz return loss < -10 dB, which covers various RFID bands including North American (902-928 MHz), Chinese (920-925 MHz) and Japanese (952-955 MHz), the average gain is 2.49 dBi in UHF band.*



## 1. Introduction

Radio frequency identification (RFID) technology has been popular and widely adopted for various data collection applications such as warehouse and retail item management [1].

Currently, several frequency bands have been assigned to RFID applications, such as 125 kHz, 13.56 MHz, 420~460 MHz, 840~960 MHz, 2.45GHz, and 5.8 GHz .RFID systems at UHF and ISM bands have become more attractive due to the suitability for long-range applications [2-3], It is a technique used to identify objects. An object can be tagged with an electronic code responding label. An electronic tag consists of an antenna and an integrated circuit. Upon receiving any valid interrogating signal from any interrogating source, such as a reader, the tag will respond according to its designed protocol. The relationship between a tag and a reader is illustrated as figure 1 [4].

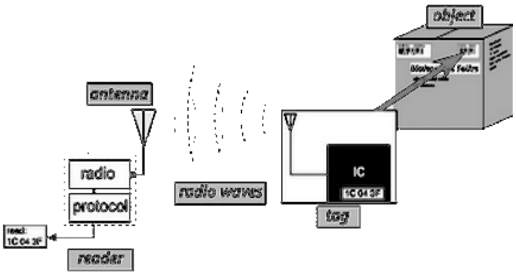


Figure 1. General functioning of a system RFID.

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Therefore, a universal reader antenna with desired performance across the entire UHF RFID band would be beneficial for RFID system configuration and implementation, as well as cost reduction [5-8].

The remainder of this paper is organized as follows. Section 2 describes the geometry of the proposed antenna. The measured results, analysis, and the validation of the proposed antenna in RFID system applications are presented in Section 3. Finally, a conclusion is drawn in Section 4.

## 2. Antenna Configuration and Design

The antenna is mounted on FR4 substrate with permittivity of 4.43, dielectric loss tangent of 0.025 and thickness of 1.58 mm. the total area of the achieved antenna is 90.5 mm (L) * 99.5 mm (W) * 1.58 mm (H). According to the standards ISO 18000 for the standardization of the systems RFID, This antenna is designed in a frequency band around 900 MHz.

The initial design antenna have a simple ground plane as shown in figure below, in the antenna (2) a circular and rectangular slots are added in each side. Finally, including the slots in top layer of the antenna and optimization antenna (3).

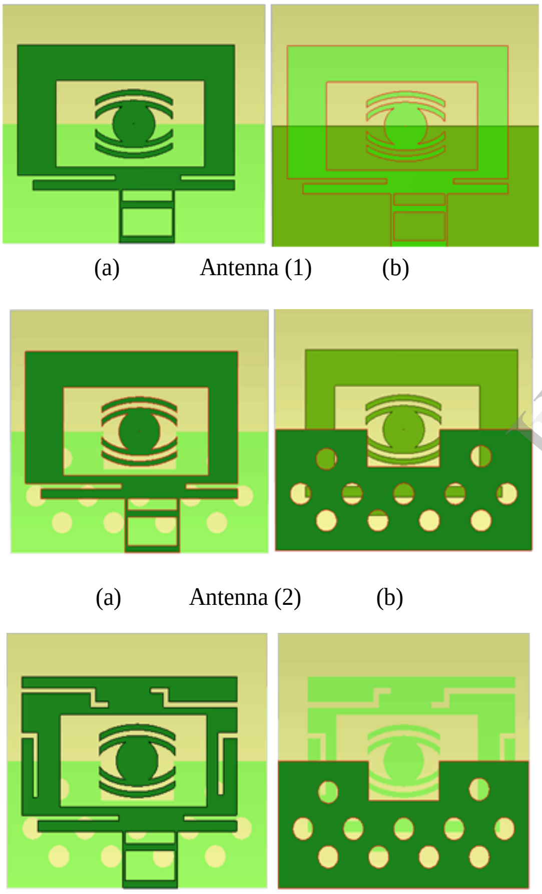



Figure 2. Configuration of the proposed antenna. (a) Top layer. (b) Bottom layer.

After many optimizations, the final structure shown in figure 3.

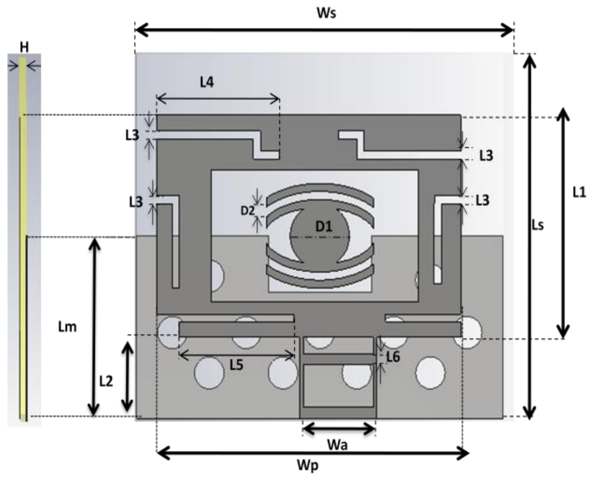



Figure 3. Geometry of the proposed antenna

Table 1. Parameter details of the optimum antenna (all dimensions in mm).

| **Ws** | **Ls** | **L1** | **L2** | **Wa** | **Lm** | **H** | **Wp** |
|---|---|---|---|---|---|---|---|
| 99.5 | 90.5 | 55.1 | 20.1 | 21 | 45.2 | 1.58 | 82.4 |
| **D1** | **D2** | **L3** | **L4** | **L5** | **L6** | | |
| 16 | 2 | 2 | 33 | 31 | 2.7 | | |



It is clearly observed from figure 4 bandwidth is obtained with successive modifications of the initial design.

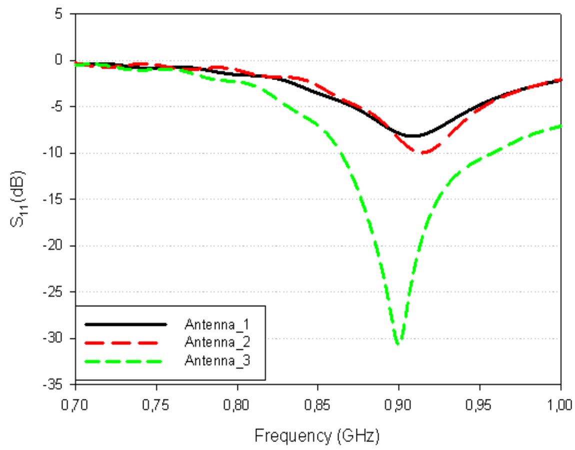
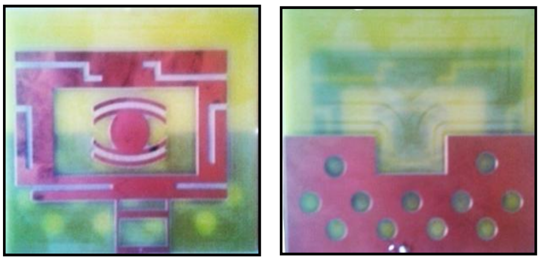



Figure 4. Development of bandwidth.

## 3. Simulated and measured results

### 3.1. S parameters

A prototype of the proposed antenna is fabricated, as shown in figure 5.
The comparison of simulated and measured S-parameter is shown in figure 6 the simulated bandwidth of the antenna is 100 MHz (860-960 MHz), with the condition of reflection coefficient less than -10 dB. These antenna exhibits a simulated -33 dB result, which is better than the antenna prototype measured result. The discrepancy is mainly due to the feeder line and SMA connector.



(a) (b)

Figure 5. Photograph of the fabricated printed RFID antenna with optimal dimensions. (a) Top view. (b) Bottom view.

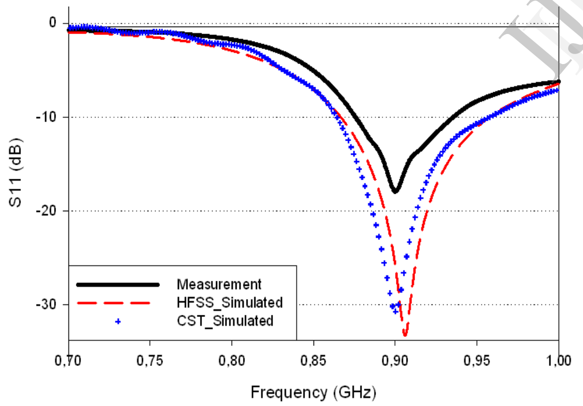
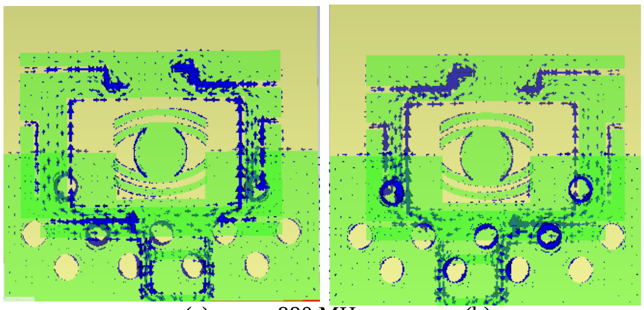


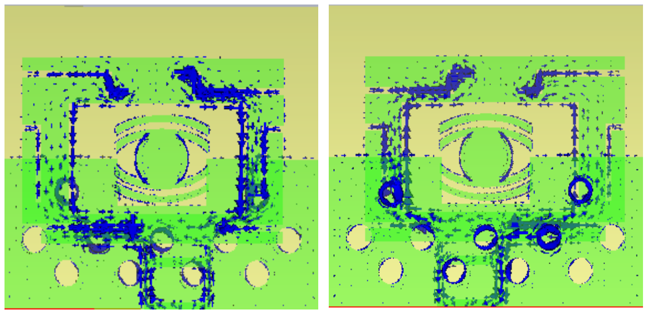

Figure 6. The comparison of simulated and measured S-parameter.

### 3.2. Current distributions of antenna in different frequencies.

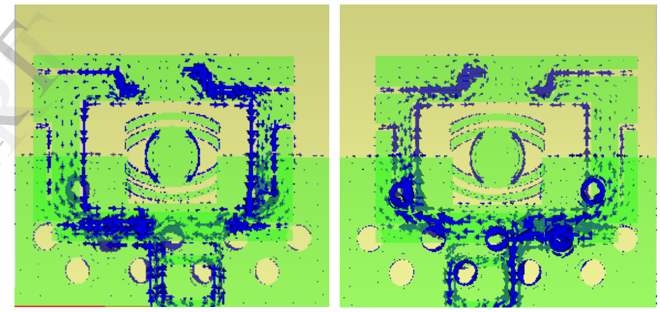
Figure 7 shows the surface current densities for the tree resonant frequencies of 880MHz, 900 MHz and 940 MHz.



(a) 880 MHz (b)



(a) 900 MHz (b)



(a) 940MHz (b)

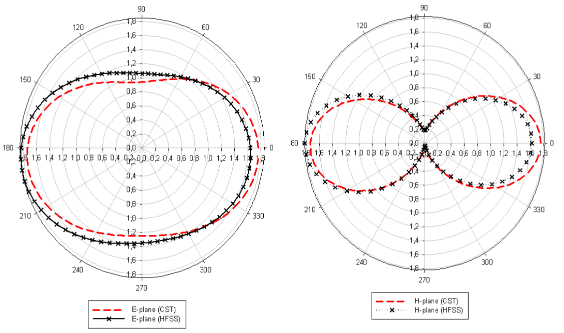
Figure 7. Current distributions marked in blue at 880MHz, 900MHz and 940MHz, (a) Top view. (b) Bottom view.



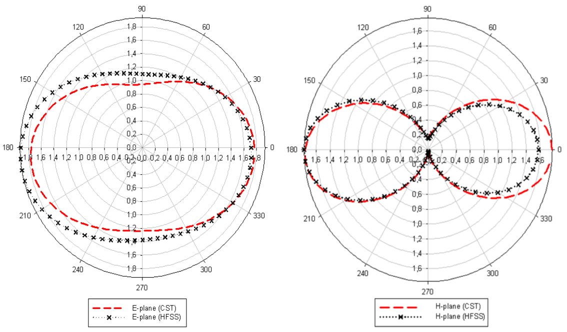
The figure of antenna at the frequency 940 MHz shows stronger surface currents in the circular slots, the surface currents show more density at the five circular [9].

### 3.3. Radiation pattern and gains of reader antenna

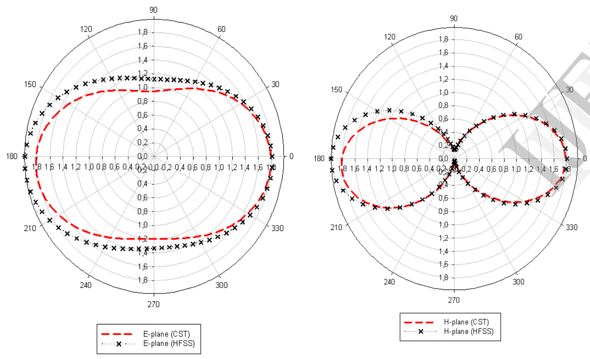
The simulated field E-plane and H-plane radiation patterns of the proposed antenna at the several typical frequencies are plotted in figure 7, respectively. We can see that the simulation results obtained by CST Microwave Studio and Ansoft HFSS software.
The resulting patterns at both of the resonance are almost identical and exhibit broadside radiation pattern as expected of microstrip patch antenna .Furthermore, the peak gain of the antenna is illustrated in figure 8.




880 MHz




900 MHz




940 MHz

Figure 8. Measured radiation patterns of the propose antenna at three frequencies.

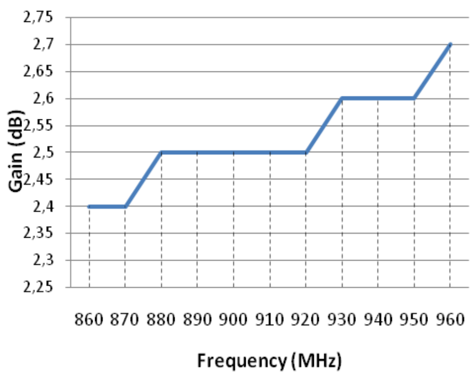



Figure 9. Plot of gain in (dB).

## 4. Conclusion

In this paper, a novel antenna is designed and fabricated by using FR4 substrate is worked at the resonance frequency 900 MHz. The dimensions final of the proposed antenna is 90.5x99.5x1.58 $mm^3$ the antenna is simulated at two softwares CST microwave studio and Ansoft HFSS. Final, a good agreement is found between the simulated and measured.

## 5. References

[1] K. Finkenzeller, *RFID handbook*, 2nd ed. John Wiley and Sons, 2003.

[2] J. Landt, "*The history of RFID*," Potentials, IEEE, vol. 24, no. 4, pp. 8–11, 2005.

[3] Daniel M. Dobkin," *The RF in RFID: UHF RFID in Practice*", second edition 2013.

[4] John Wiley & Sons, "*HANDBOOK OF SMARTN ANTENNAS FOR RFID SYSTEMS*", 2010

[5] Zhi Ning Chen, Fellow, IEEE, Xianming Qing, Member, IEEE, and Hang Leong Chung "*A Universal UHF RFID Reader Antenna" IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES*", VOL. 57, NO. 5, MAY 2009.

[6] T. G. Abo-Elnaga, E. A. F. Abdallah, H. Hennawy,"*Universal UHF RFID Rose Reader Antenna",*PIERS Proceedings, Xi'an, China, March 22-26, 2010.

[7] Ting-Jui Huang and Heng-Tung Hsu," *Log-Periodic Dipole Array with Improved Front-toBack Ratio for Universal UHF RFID Handheld Reader Applications*", IEEE, 978-1-4673-0462-7/12/31.00 ,2012 .

[8] M. S. R. Bashri, M. I. Ibrahimy, S. M. A. Motakabber," *A Planar Wideband Microstrip Patch Antenna for UHF RFID Tag* ",IEEE International Conference on Space Science and Communication (IconSpace), 1-3 July 2013.

[9] X. Li and J. Liao, "*EYE-SHAPED SEGMENTED READER ANTENNA FOR NEAR-FIELD UHF RFID APPLICATIONS* ",Progress In Electromagnetics Research, Vol. 114, 481-493, 2011.