On the transformation of symbols and figures to RFID tags

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Abstract
This article discusses the possibility of making unconventional antenna designs for RFID tags based on artistic figures and symbols. Some classical techniques of impedance matching are used in order to match these structures to commercial RFID chips without modifying a lot the shape of the structure. These tags were simulated on HFSS and their read ranges were measured and compared to a conventional antenna design.

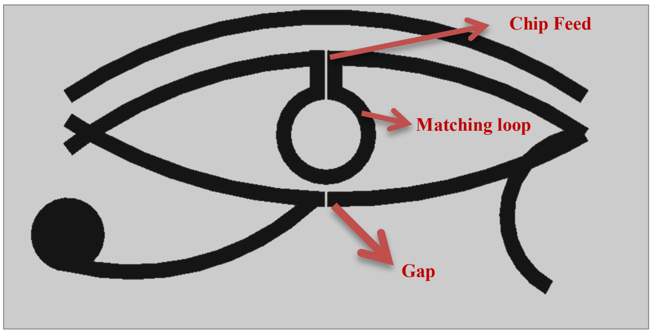
1. Introduction

Radio frequency identification (RFID) is a form of wireless communication that uses radio waves to automatically identify people or track objects. An RFID system consists of readers and tags that communicate with each other by RF signals according to some standards and power regulations[1]. An RFID tag is comprised of an integrated circuit (called an IC or chip) attached to an antenna that is tuned to receive the waves sent by the reader and enables the chip to transmit the identification information back to the reader. For passive RFID, tag antennas collect energy and channel it to the chip to turn it on. The larger the tag antenna's area, the more power it will be able to draw from the field created by the reader and channel toward the tag chip, and therefore the further read range the tag will have.

The majority of RFID tag antenna designs is based on uniform or non-uniform meander line structures [2]. The design goal is to achieve a good impedance matching with the chip and to miniaturize the tag size. While most of UHF RFID tags look very similar, some tags have a very attractive and artistic layouts like [3] where the tag antenna was designed using text as meander lines. This unconventional way of design can give additional value to the RFID tag itself as an untraditional hi-tech advertisement where brand and institutional names or commercial logos can be used to form a radiating element. This work discusses the use of some artistic figures and symbols as tag antennas for the European RFID UHF frequency band. Numerical simulations and measured values of the read range are given for two different structures. Read range performance compared to a conventional structure is also discussed.
The paper is organized as follows. Section 2 introduces the antenna configuration of the proposed structures and the impedance matching technique used in order to match these antennas to commercial RFID chip. In section 3, results for the read range obtained by HFSS simulation are compared to the measured results by Voyantic Tagformance measurement setup. Finally section 4 draws some conclusions.

2. Antenna Configurations

Fig. 1 shows the proposed antenna configurations where the first one represents a pharaonic figure (Horus Eye) and the second one represents the Chinese symbol of friendship. In order to obtain a good impedance matching with the chip, some small modifications on the shape were essential beside the choice of the spot where the IC will be connected.



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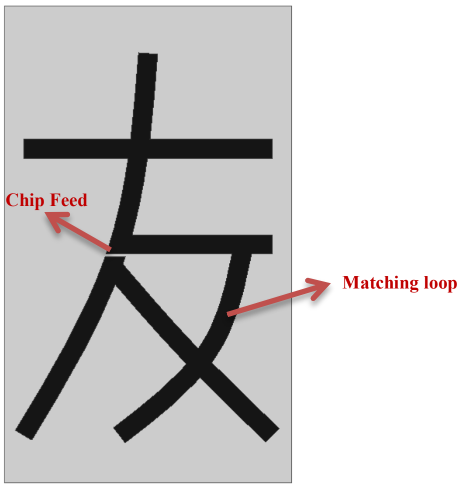

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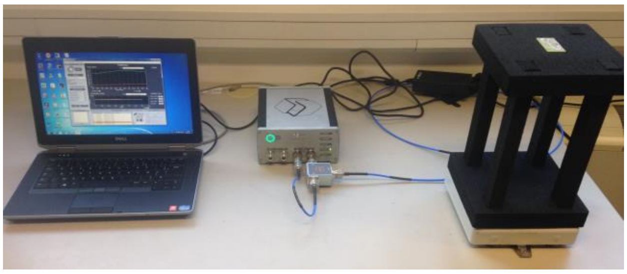
Figure 1. Proposed antenna configurations a) Horus Eye b) Chinese Friendship symbol.

One of the most famous techniques of matching antennas to RFID chip is the T-match method[4] where the chip is connected to a small loop in order to compensate the capacitive part of the chip while the rest of the structure acts as radiating arms. For the first structure (Horus Eye), the eye circle serves as a matching loop and a small gap of 0.3 mm was added to the structure in order separate the radiating arms as shown in figure 1. For the Chinese symbol structure, the feeding spot for the chip was chosen in a way that the right part of the structure acts as a loop while the rest as the radiating arms. In both cases a part of the structure acts as a matching loop which means that other shapes may need other technique for impedance matching in order to avoid significant modifications to the structure.

3. Simulation and Measurements

The antennas were simulated on HFSS and optimized to match Monza-6 RFID chip. The prototypes were then realized on FR4 substrates of 1.6 mm thickness and tested using Voyantic Tagformance measurement system as shown in figure 2. The performance of the proposed structures was then compared to a conventional meander design having similar size as the proposed structures of 15 cm^2 and matched to the same IC.



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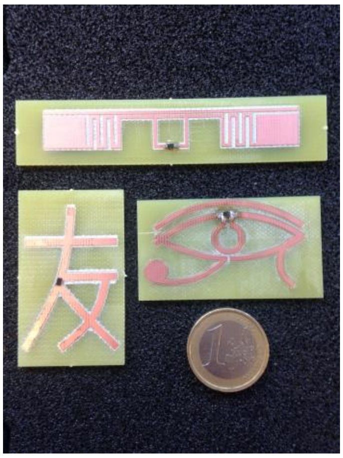

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Figure 2. a) Measurement setup b) Prototypes of the proposed structures and a conventional design of meander tag.

Figure 3 shows a comparison between the read range measured and simulated for each tag where the proposed structures achieved a read range between 5 to 7 meters while the conventional meander design achieved higher performance of 12 m. This lack of performance is due to the fact that the proposed structures have lower directivity and impedance matching than the conventional antenna design. However, a read range performance of 5 to 7 meters can be suitable for a lot of applications.

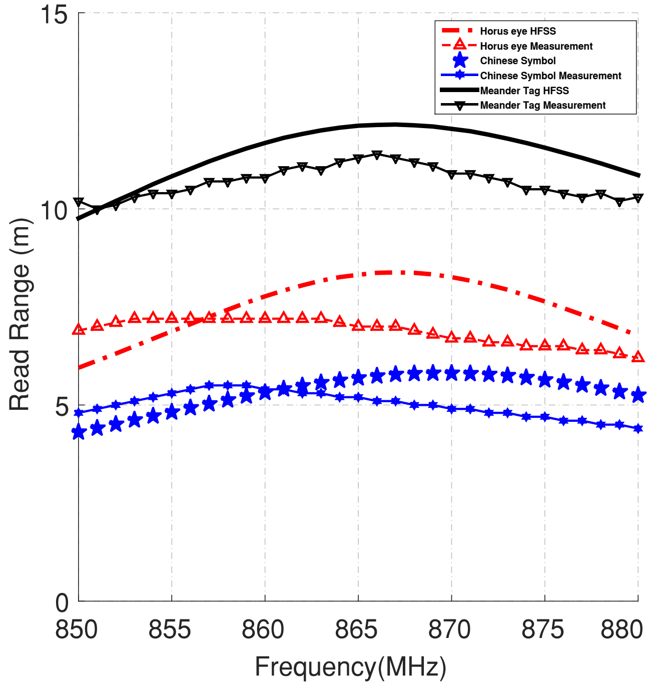

Figure 3. Comparison between the read-range measured and simulated for each tag.

4. Conclusion

This work presented a new antenna design configuration for RFID tags based on artistic figures and symbols. Simple impedance matching technique was used while maintaining the main structure shape which affects the tag performance compared to a conventional design. The proposed structures have a read range performance between 5 to 7 meters.

5. References

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