MINIATURIZATION OF A PASSIVE UHF RFID TAG

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***Abstract*—RFID *(Radio Frequency Identification)* technologies nowadays has become the most used in identification. A miniaturization will introduce this technology to other fields. This paper focus on the miniaturization of the RFID antenna. A theoretical design and simulation for the significant improvement and amelioration in term of miniaturization will be presented.**

1. Introduction

RFID, usually designated by the acronym RFID, is a method for storing and retrieving data remotely using markers called tags or transponders. RFID tags are small objects, which can be embedded in products and even implanted into living organs for animals or human. RFID tags include an antenna associated with an electronic chip that allows them to receive and respond to radio frequency requests emitted from the reader.

LF *(Low Frequency)* tags can only be read at close range and may not perform well when multiple tags are simultaneously present in the reading region. Hence, the intention has turned toward UHF *(Ultra High Frequency)* tag. UHF tags not only give better read range,but also support higher data rates.

In the following section, A theoretical study about the circular loop antenna and miniaturization will be covered. the antenna structure and parameters will be shown later.

1.1. Theoretical and design

The design was started with a loop antenna and a network of adaptation designed. More details about the design is mentioned in [1] where the design is based on a very thin substrate with a copper layer in front side. The structure proposed in [2] consists of a curved electric dipole antenna with inductance track across the dipole for impedance matching purpose. The structure and dimensions of this tag is shown in figure 1. This tag is made of a FR4 substrate thickness h = 1.6 mm and relative dielectric permittivity ϵ_r = 4.4. The tag antenna structure is simulated using CST Studio, the impedance is 1+j152 Ω.

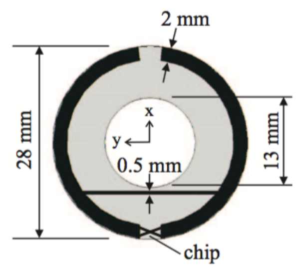

Figure 1. (UHF antenna tag

In order to miniaturize the antenna, internal looping consists of reducing the diameter without affecting the tag length which is proportional to the resonate frequency. as shown in figure 2, the design is based on an electrical dipole antenna with an internal looping to center with a thin inductance for impedance matching purpose. Structure and dimensions of this tag is shown in Figure 2. This tag is made of FR4 substrate, the thickness t = 0.48 mm and dielectric permittivity of Er = 4.4 and thin copper layer of 0.1 mm.

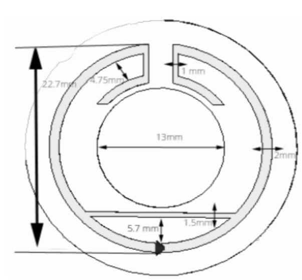

Figure 2. The miniaturized UHF antenna

The previous figure shows a new version of the antenna. Size was reduced about 30% of its initial form in the previous design. The structure goes from 28 mm in diameter to about 22 mm. The diameter can be more optimize with more loops.The New structure allows easy control of resonate frequency. In the following section, detailed demonstration on the advantages and improvements of this new structure that allows us to get more flexibility in terms of the antenna diameter.

1.2. Simulation and results

As shown in figure 2, the size was miniaturized while the performance remains the same. This structure allows us a frequency control.The simulation shows that for a variation of the inner circle length by 2mm leads to 10MHz frequency offset. The value of S-parameters oscillates with a variation of 1db. Figure 3 shows the S-parameters after each cutting process.

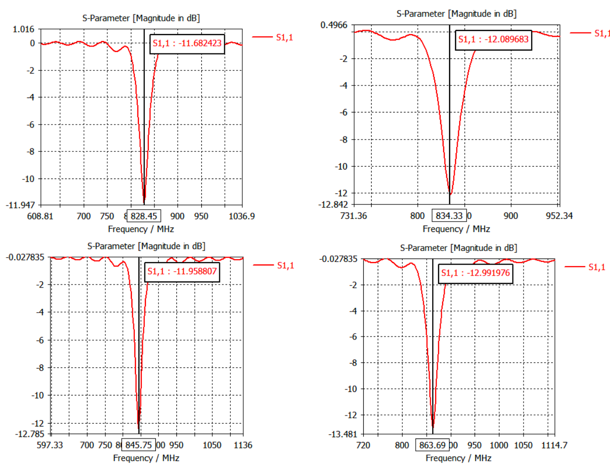

Figure 3. S-Parameters after cutting

The following figures show the main parameters of the looped antenna. S-parameters describe the input-output relationship between ports (or terminals). The system's S11 is about -12db in the frequency range of 867.6 - 867.0 MHz The bandwidth of this design is 11MHz in the range of 860.0 - 871.0 MHz.

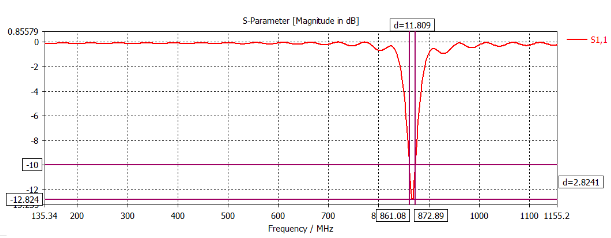

Figure 4. S-parameters

The VSWR (Voltage Standing Wave Ratio) describes the power reflected from the antenna. When VSWR is 1.0, no power is reflected, which is ideal. Always antennas must satisfy a bandwidth requirement that is given in terms of VSWR. For instance, an antenna might claim to operate for VSWR superior to 3.For the antenna proposed, VSWR is 1.5.

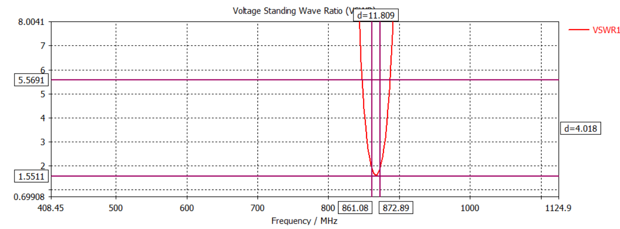

Figure 5. Voltage Standing Wave Ratio

The radiation pattern refers to the directional (angular) dependence of the strength of the radio waves from the antenna or other source. The figure bellow shows a directivity of 1.47dbi.

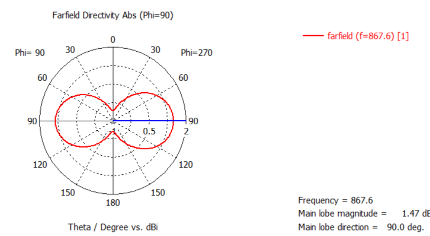

Figure 6. Radiation pattern

2. Conclusion

This design of UHF tag can be used in a variety of RFID system. In this paper the size was reduced from its initial form in the first design. The structure goes from 28 mm in diameter to 22.7 mm, the minimization is around 30%. The diameter can be optimized with more loops.The New structure allows easy control of resonate frequency. The size was miniaturized while the performance remains the same.

References

[1] A SMALL PASSIVE UHF RFID TAG FOR LIVESTOCK IDENTIFICATION
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[2] Investigation on the Deployment of HF and UHF RFID Tag in Livestock Identification Kin Seong Leong*, Mun Leng Ng, and Peter H. Cole Auto-ID Laboratory, School of Electrical and Electronic Engineering The University of Adelaide, SA, Australia. Email: kleong, mng, cole@eleceng.adelaide.edu.au