Design of a UHF RFID Tag Antenna for RFID-based Blood-bag Management System

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Abstract

In this paper, an UHF RFID tag antenna for RFID-based blood-bag management system is designed and fabricated. The tag antenna consists of a modified dipole antenna with a reflector, and it is considering high permittivity of blood (ε_r=60) in the blood bag. The tag antenna is optimized and fabricated with simulations and tests for the cases with/without the reflector, various distance between the reflector and the dipole tag, and the different widths of the reflector. The input reflection coefficient characteristics and the reading range patterns of the tag antennas are measured.

Keywords : RFID, Tag antenna, Tag for Blood bag with Reflector

1. Introduction

Radio frequency identification (RFID) technology is a relatively new type of automatic identification (Auto-ID) technology, and it uses radio waves to identify physical objects. It can be used to electronically identify, track, and store information about groups of products or individual items for various applications, such as supply chain management (SCM), inventory control, security management, and logistics. The operating frequencies for most RFID systems mainly fall into five categories, namely, low frequency (LF) at 125 or 135 kHz, high frequency (HF) at 13.56 MHz, ultra-high frequency (UHF) at 433MHz and 910 MHz, and microwaves at 2.4 GHz. Currently, UHF RFID technology receives a lot of attention due to long reading range and low-cost tags for item-level RFID applications. The RFID tags are attached on various objects with different shapes and material properties. The performance of UHF and microwave bands tag antenna is influenced by the material properties of objects, such as blood, medicines, or vaccines [1-3].

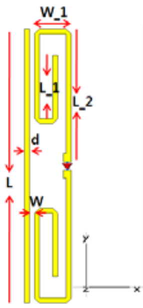
In this paper, we propose an UHF RFID tag antenna for RFID-based blood-bag management system. The tag antenna structure has a modified dipole antenna with a reflector, and is designed with consideration of high permittivity of blood (ε_r=60) in the blood bag. The tag antenna is optimized and fabricated via simulation tests for the cases with/without the reflector, various distance between the reflector and the dipole tag, the different widths of the reflector.

2. Tag antenna design and experimental results

Human blood is usually collected in a round shape plastic blood bag and the blood bags are stored in the refrigerator in the blood bank with a certain temperature. An RFID-based blood bag management system is developed with RFID reader antennas located in sides of the refrigerator.

Figure 1 shows the configuration of an RFID-based blood bag management system and the geometry of a proposed tag antenna attached on a blood bag. In general, dielectric constant of blood ranges from 58 to 62, which is considerably high, compared to that of free space, and the performance of general dipole-type label RFID tags attached on blood bag is deteriorated severely due to the high permittivity of blood in the bag. To alleviate the effect of high permittivity from blood, the location of a tag on the blood bag is determined to be a side of the blood bag with the consideration of the location of the reader antennas. Furthermore, a reflector is added to minimize the effect of high permittivity blood and to increase the directivity of the tag toward the side which has the tag on the bag. A strap type Higgs-2 chip fabricated from Alien Technology Co. is used on the two arms of dipole antenna. The chip impedance is about 11.9-j133.3Ω at 910MHz, and the antenna is matched to the conjugate of the chip impedance.

Figure 1: Configuration of an RFID-based blood bag management system and the geometry of a proposed tag antenna attached on a blood bag.



Parameter	Value
L	82.4mm
L_1	19mm
L_2	39.9mm
W	1.5mm
W_1	11mm
d	1.5mm

Figure 2: Tag antenna parameters.

Design parameters of an optimized tag antenna are presented in Figure 2. *W* is the distance between the dipole antenna and the reflector, and *d* is the width of the reflector. The dimensions of the blood bag are modelled by 110 mm in width, 145 mm in length, and 30 mm in thickness with a dielectric constant of 60. The spacing between the blood bag and the attached tag antenna is set to be 16.5 mm for the simulation.

Input reflection coefficient characteristics of the tag antenna with and without the reflector are compared in Fig. 3. Input reflection coefficient for the tag antenna with the reflector shows -27.8 dB at 910MHz and a bandwidth less than -10 dB is 12 MHz (902~914MHz). Figure 4 shows the radiation patterns of the tag antenna with/without the reflector at 910 MHz.

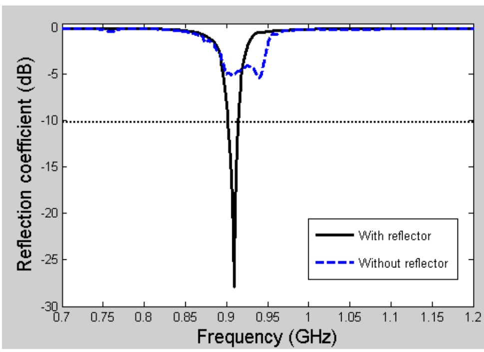


Figure 3: Comparison of input reflection coefficient characteristics of the tag with/without the reflector.

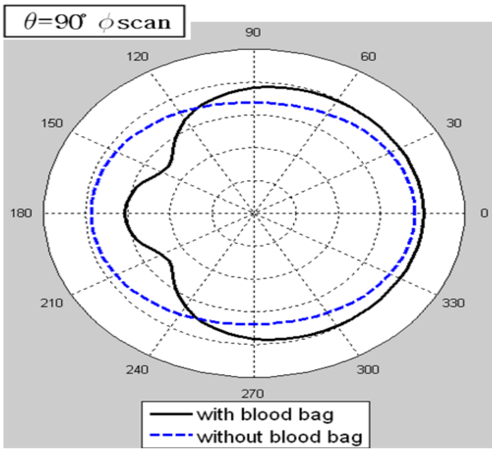
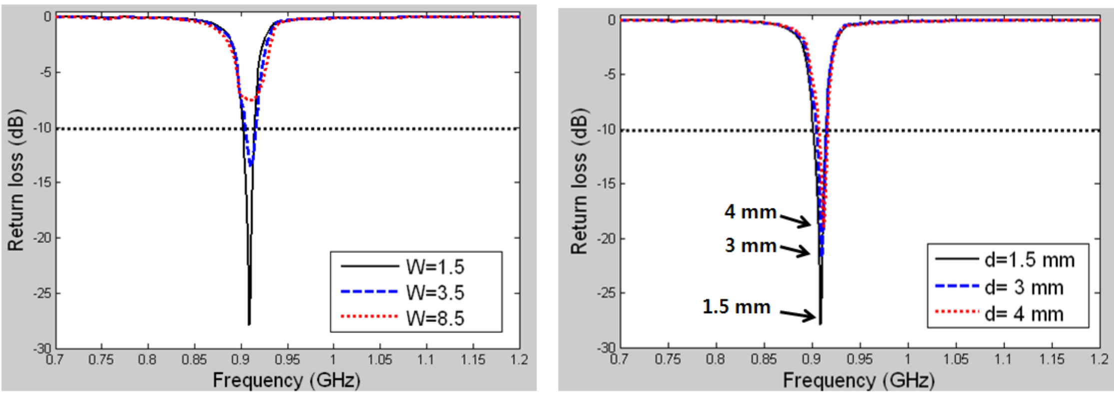


Figure 4: Radiation patterns of the tag with/without the reflector.

Figure 5(a) and (b) present the variation in input reflection coefficient on the distance *W* between the dipole antenna and the reflector, and the reflector width *d*. It is observed that the input reflection coefficient increases as *W* is increased, while the variation of the input reflection coefficient is very little for the reflector width *d*.



(a) (b)

Figure 5: Input reflection coefficient characteristics of the tag with the reflector vs. (a) distance between the dipole antenna and the reflector *W* and (b) reflector width *d*.

Figure 6 shows a fabricated tag antenna etched on 0.04 mm PET film and the dimensions of the tag are 14 mm by 82.4 mm. The simulated and measured input reflection coefficient characteristics are compared in Figure 7 for the tag antenna with and without the blood bag. Figure 8 compared the measured reading range pattern of the tag antenna with/without the reflector with ALR 9900 reader manufactured by Alien Technology Inc. The maximum reading range at 0^o when the tag is located along the reader direction is 86 cm without the reflector and 125 cm with the reflector, respectively.

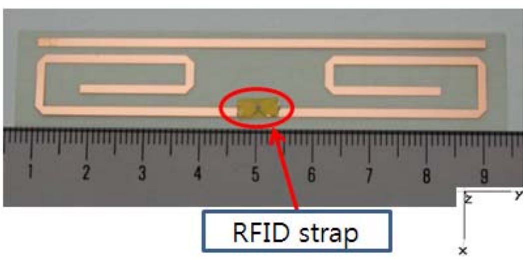


Figure 6: Fabricated tag antenna.

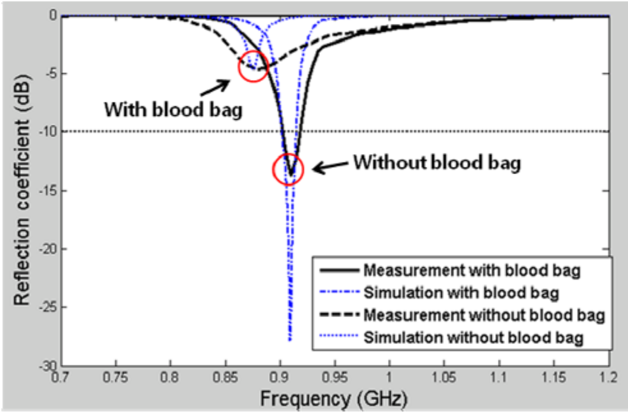


Figure 7: Simulated and measured input reflection coefficient characteristics for the tag antenna with and without the blood bag.

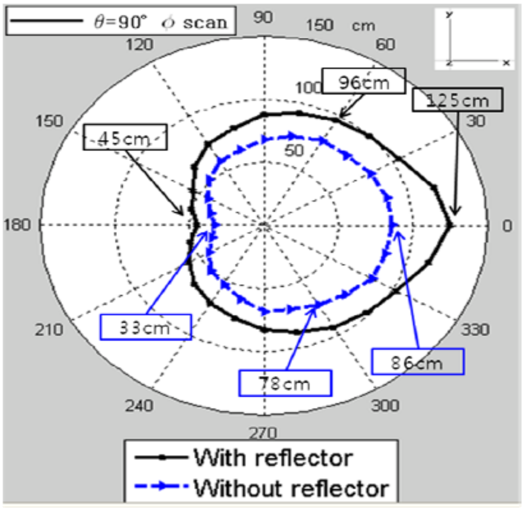


Figure 8: Measured reading range pattern of the tag antenna with/without the reflector.

3. Conclusions

An UHF RFID tag antenna for RFID-based blood-bag management system is designed and fabricated. The proposed tag antenna consists of a modified dipole antenna with a reflector, and it is designed considering high permittivity of blood (ε_r=60). The tag antenna is optimized and fabricated via simulation tests for the cases with/without the reflector, various distance between the reflector and the dipole tag, and the different widths of the reflector. The input reflection coefficient characteristics and the reading range patterns of the tag antennas are measured. The maximum reading range at 0^{o} when the tag is located along the reader direction is 125 cm with the reflector. The proposed tag has been successfully employed to an RFID-based real-time blood-bag management system.

References

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