

RFID-UHF Tag Antenna for e-Healthcare Applications

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Abstract

This paper presents a novel low-cost and flexible passive RFID tag antenna for blood monitoring and tracking, which is in great demand by e-healthcare applications. The tag antenna consists of two compact symmetrical capacitive structures and works at the ultra-high frequency (UHF) European band (865 MHz–868 MHz). Measurement results show that the proposed design has a read range of 2.2 m, which is 4.4 times higher than commercial RFID tag antennas.

1. Introduction

Radio frequency identification (RFID) technology is rapidly developing and is becoming very important for monitoring and tracking applications [1,2,3]. Common applications with this technology include security identification, retail item management, access control, and tracking. Therefore, RFID technology has been found to be of great help in the healthcare sector and, especially for blood management in medical centers [4,5]. It may have some benefits with regards to optical technologies, such as quick response codes (QR) and barcodes [6], since it is possible to increase the automation level of stock, identification, tracking and monitoring tasks and, therefore, reduce possible human intervention errors. Passive tags working at the ultra-high frequency (UHF) European band (865 MHz–868 MHz) can be used for this type of applications. In this paper, a novel compact, low profile and flexible UHF RFID tag antenna for blood tubes tracking and monitoring is presented. While most of commercially available tags are based on inductive designs using the T-match technique, the proposed tag antenna consists of two compact coupled capacitive meandered structures. Due to the high relative permittivity value of the blood, inductive designs tend to have smaller sizes, leading to extra drop in the efficiency of the antenna. On the contrary, the proposed capacitive design exhibits reasonable size for the tube, and it represents a good compromise between compactness and radiation efficiency. In addition, the capacitive tag also presents higher sensitivity to the presence of blood. Thanks to this behavior,

the reading range is increased when the tag antenna is attached to a clinic tube full of blood, while the reading range drastically drops when the tube is empty. The designed tag antenna covers the UHF band, and it is fabricated by using a DuPont™ Kapton polyimide film) [7]. It is expected that the development of this new tag will open new exciting perspectives in the design of future UHF RFID traceability systems for blood monitoring applications.

2. Proposed RFID tag antenna

The structure of the proposed design is depicted in Fig. 1. The tag consists of two symmetrical capacitive pads with two etched meandered substrate arms. Both pads are separated at the center by means of two different gaps s and g , which are placed at the left and right sides, respectively. The IC chip (NXP UCODE G2XL) is mounted across the gap s between the two pads, while the gap g is used to introduce a capacitive behavior to the tag antenna. The structure of the dipole antenna is meandered to achieve a compact design. Due to the good flexibility of the Kapton polyimide, the tag antenna can be easily conformed to the curved shape of the blood tube. The optimized geometrical parameters obtained by using CST Microwave studio are listed in Table. 1.

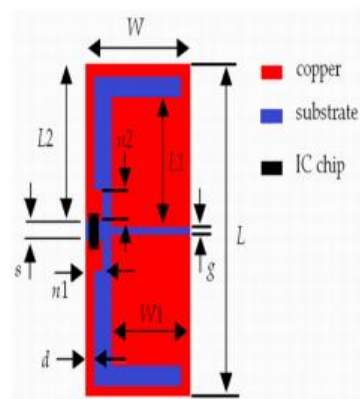


Figure 1: Schematic view of the proposed RFID tag antenna.

TABLE I
DIMENSIONS OF RFID TAG ANTENNA

Parameter	Value (mm)	Parameter	Value (mm)
L	49.5	s	5
W	15	g	2.25
$L1$	18.75	$n1$	5
$W1$	8.5	$n2$	3.5
$L2$	18.25	d	2

3. Results and discussion

Here, we will present only the results of the reading range which is a critical parameter that determines the performance of an RFID tag antenna. The simulated and measured reading ranges obtained for the proposed tag attached to a tube in the frequency range from 0.8 GHz and 0.9 GHz are shown in Fig.2. The measurements include the results obtained for the smallest and largest tube standards manufactured by the Becton Dickinson (BD) Company. It can be observed that the measurements are in good agreement with predictions. The measured reading range reaches a peak value of 2.2 m at the frequency of 867 MHz when the tag is attached to the smallest size tube full of blood, while the largest size tube has a peak value of 2.3 m at 860 MHz. At 867 MHz, the largest size tube presents a reading range of 2.25 m, which is similar to the measured value (2.2 m) for the smallest size tube. For both tube sizes, the reading ranges drastically decrease when the tubes are empty.

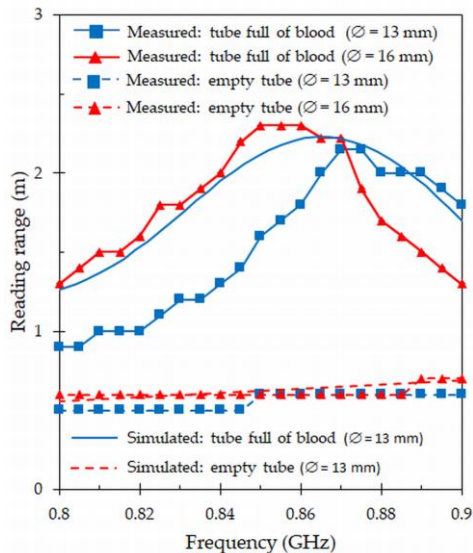


Figure 2: Simulated and measured reading ranges

This confirms that the proposed design can be applied to different tube standards, and that it is possible to detect the

tag at reasonable distances when the tube is full of blood. In addition, in both cases the reading range drastically reduces for empty tubes.

4. Conclusions

In this work, a novel compact and high-performance tag antenna for blood tube traceability applications, working at the European RFID UHF system, is proposed. The proposed tag is based on a capacitive dipole design, which consists of two coupled compact capacitive meandered pads. Results have demonstrated that the new tag attached to a clinic tube full of blood exhibits reading ranges above 2 m. Moreover, its capacitive design has shown a strong sensitivity with the presence of the blood inside the tube. Therefore, reading ranges drastically drop when the tube is empty. This property may be interesting for many tracking applications, since it could reduce the amount of information generated from empty tubes.

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