16 Bit Retransmission Based Chipless RFID Tag

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BTP Track: Research

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Student's Declaration

I hereby declare that the work presented in the report entitled **"16-Bit Retransmission Based Chipless RFID Tag"** submitted by me for the partial fulfillment of the requirements for the degree of *Bachelor of Technology* in *Electronics and Communication Engineering* at Indraprastha Institute of Information Technology, Delhi, is an authentic record of my work carried out under guidance of **Dr M.S Hashmi**. Due acknowledgements have been given in the report to all material used. This work has not been submitted anywhere else for the reward of any other degree.

.... **Date: 26th November 2018**
Sambhav Malhotra

Certificate

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

....
Date: 26th November 2018
Dr M. S. Hashmi

Abstract

A 16-bit Chipless RFID tags have been proposed in this report. The design will be fabricated on a Rogers RT 5880 board with a dielectric constant of 2.2 and a loss tangent of 0.0009. The tag is based on the concept of re-transmission and therefore require an external set of monopole patch antennas as part of the system. The design employ the use of L resonators with various,defined lengths which in turn resonate at different frequencies. The presence or absence of a resonator at a particular frequency is encoded as a 1 or 0. These tags are intended to solve some of the issues that are faced by the conventional passive RFID and the main focus has been replacement of the barcode which is a smart retail usecase.

Keywords: Chipless RFID tags,Retransmission, L Resonator, RCS

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Contents

Chapter 1

Motivation and Research Problem

A Radio Frequency Identification System or RFID for short, employs the uses radio waves to read data encoded on a tag, which is placed at a certain distance . The conventional RFID system that is in use today has numerous benefits like Non line of sight(NLOS) reading and longer reading range. Furthermore, it does not require human assistance, which is not the case for something like the barcode technology. An RFID tag consists of three major components. First is an Application Specific Integrated Circuit,or ASIC which is used to store and process information by modulating or demodulating the interrogation signal received from the reader. Second component is some method to collect DC power from the signal received. This is especially needed for the passive RFID tags which have no power source of their own and therefore require power from an external source. The third component is an antenna which can be used which would be needed to receive and transmit signals from the tag.

In recent works, the advantages of conventional RFID can be seen in areas of item tracking. But the cost of the ASIC in the RFID increases the size and also the cost of the tag. This makes it useful only for tagging of costly items [6]. This means it is still not viable to replace the current technology used for item tracking, which is the barcode. This is where the domain of Chipless RFID comes in. Chipless RFID,as the name suggests, does not have an integrated circuit and therefore we are able to reduce the cost and size of the overall tag, which was an issue with the conventional RFID tags. Chipless RFID tags are also easier to fabricate than Chip based RFID tags. [4]. Chipless RFID tags are broadly divided into 2 groups: Re-transmission based tags and Back-scattering based tags [5]. Retransmission tags use the method of conventional RFID by using one antenna to capture the interrogation from the RFID reader and another antenna to transmit the encoded signal back from the tag. [3]- [2]. In backscattering tags, there is no need for antennas since the reader works with the signal that is reflected off the chipless tag.

The motivation for this BTP was to increase the number of bits encoded on the chipless RFID tag. This is done to provide a unique ID to more number of users. Furthermore, chipless RFID shares the same features of silicon based RFID tags such as longer reading range and NLOS reading, which brings the technology a step closer to replacing the barcode.

Chapter 2

Research Approach and Work Done

2.0.1 The tags and the L resonator

The resonant frequency of a half wavelength L-resonator with length L can be calculated by [1]-

$$f = \frac{c}{2L}\sqrt{\frac{2}{\epsilon_r + 1}} \tag{2.1}$$

Where c is the speed of light in free space

ϵ_r is the relative permittivity of the substrate

L is the length of L-resonator.

If this resonator is placed on a metallic patch, it will give a signature at a frequency which is determined by the equation given above. If we place N number of such resonators of varying lengths, then there are N different frequencies which show up in the frequency spectrum. . The frequency signatures will be independent of each other and therefore if there is a requirement of removing a frequency signature, we can do that by removing the L resonator. These frequency signatures can be used to encode data on the tag. This requires no ASIC or extra circuitry like in the case of conventional RFID.

Two designs have been proposed in the BTP report to Both of these Chipless RFID tags have been designed for the frequency range of 3-6 GHz, which is part of the Ultra-Wideband(UWB) group of 3.1-10.6 GHz, according to International Telecommunication Union(ITU).

2.0.2 Chipless Tag

The 16 bit retransmission based chipless RFID tag has been shown in Fig 2.1. The tag has been designed using ADS 2017. It shows 16 resonators with 8 resonators on one side of the transmission line and 8 resonators on the other side of the transmission line. The S parameter results have been provided in Fig 2.2 which show 16 resonances which can be used to encode 16 bits of data.

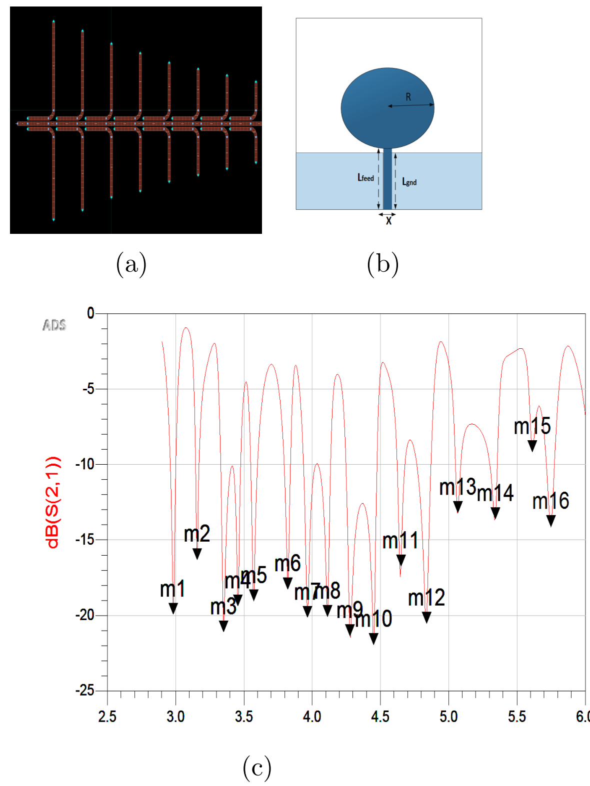

Figure 2.1: (a) 16 bit Chipless TAG (b) Circular Patch antenna (c) S-Parameter response showing 16 resonances

Table 2.1: Patch antenna design parameters

Parameter	
Length of Feeding line	8.2 mm
Width of Feeding line	3.85 mm
Length of Ground Plane	7.65 mm
Radius of Circle	13.9 mm
Height of substrate	1.524 mm
Loss tangent of substrate	0.0009

2.0.3 Chipless RFID Antenna

A circular patch antenna, shown in Fig. 2.1 , has been utilized in this paper for receiving the interrogating signal from the reader and retransmission of the data encoded on the tag. A UWB circular microstrip patch antenna has the advantage that its simple to design and has a high bandwidth. The antenna has been designed using CST Microwave Studio and implemented on a Rogers 5880 board. All the dimensions of the antenna for the proposed 3-6GHz frequency range is also mentioned in Table 2.1

Chapter 3

Conclusion and Future Work

3.0.1 Conclusion

The motivation for working on these designs stems from research done in the field of conventional RFID and how it can replace the barcode in the application of item and human tracking. RFID offers a lot of features like a longer reading range, non-human assistance and better data encoding capacity. But better data encoding capacity involved a microchip which makes the cost of the RFID expensive. It also makes the fabrication process complicated. This is where the research of Chipless RFID steps in. They can be easily design and fabricated for use in item tracking like products in the supermarket and might find use in wearables for human beings too including domains like IOT.

This report presents a 16 bit Chipless RFID tag design which will be fabricated on a Rogers RT 5880 board with a dielectric constant of 2.2. These design uses L resonators with uniform difference in lengths, which produce frequency signatures independent of each other. The presence of absence of an L resonator is encoded as 1 and 0 respectively. These 16 bits have been encoded in a small bandwidth compared to many other configurations [4].

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