Chapter 8
Mastering the Electromagnetic Signature of Chipless RFID Tags

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ABSTRACT

The rapid development in wireless identification devices and subsequent applications is at the origin of intensive investigations in order to fulfill various constraints that can exist when implementing applications in practice. Chipless technologies have many advantages. They are fundamentally wireless and powerless devices, and can be all passive components, which potentially means infinite lifetime. However, chipless technology is still in its infancy age, even if it is the most effective for cost reduction. One of the most important features of chipless is coding capacity and ways to imprint it into the device. This chapter will review and discuss various coding techniques. It will address a comparison of the most relevant coding techniques. For sake of clarity some global parameters that can be used as figure of merit will be introduced and applied to compare different practical chipless tags.

1. INTRODUCTION

The history of Radio Frequency IDentification (RFID), birth and development, are described in several relevant publications (Landt, 2001; Finkenzeller, 2004). The principle of RFID communication was clearly explained in an IRE publication by H. Stockman in 1948 (Stockman, 1948). Even if it is generally said that the first application of RFID is the Identify Friend or Foe (IFF) system introduced by Watson-Watt, the first real device that we can consider as the ancestor of modern tags is the "thing" designed by Leon Theremin (Glinsky, 2005). The later is

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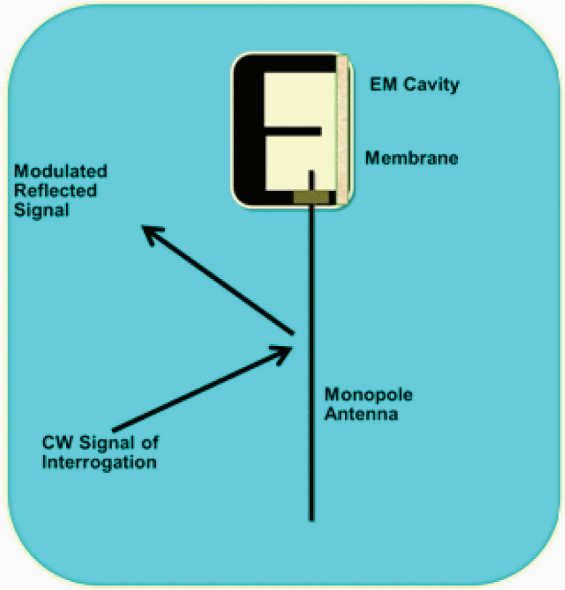
a passive spying device that was embedded in a craved wooden plaque of the US Great Seal and offered by Russians to U.S. Ambassador as a « gesture of friendship » at the end of World War II. The "thing" is composed of an electromagnetic resonant cavity coupled to a monopole antenna. One of the walls of the electromagnetic cavity is transformed into a membrane acting as a microphone. Figure 1 briefly describes the "thing" and its main components.

The communication principle of the "thing" is straightforward. Under a continuous wave (CW) electromagnetic illumination (actually @ 330 MHz) and when the microphone detects some sounds, the resonance frequency of the cavity will change. Consequently, the reflected signal by the monopole antenna will be amplitude modulated by the detected sounds around the "thing".

It is quite amazing to remark that the first RFID device, ever developed, was in the same time a sensor (microphone) and a chipless tag (no IC, neither digital communication protocol). Wireless sensing and chipless tags are currently topics of great interest under consideration in numerous applications where powerless and robustness features are highly desired.

Last decades, roughly since the mid of 1960's, very effective IC based tags have been developed and implemented in numerous applications, from the most simple like the Electronic Surveillance Article (EAS) to the more sophisticated for Internet Of Things application purposes (Giusto, Iera, Morabito & Atzori, 2010). Nowadays the vast majority of RFID tags (or transponders) are usually comprised of an IC chip and an antenna. They are used or under consideration in a large variety of domains and thousands of applications. However, despite the success of IC based tags, there are some drawbacks inherent to their manufacturing process, economic cost, security and privacy of data, electromagnetic and mechanic robustness in specific applications.. On the other hand, IC based tags are often wrongly compared to barcode, which is very challenging when comparing the costs of both identification solutions. Therefore, several research projects have been developed towards the concept of chipless RFID tags with no ICs, known also as RF barcode by some authors (Preradovic, Karmakar & Balbin, 2010). Modern chipless tags have been developed since the mid of 1990's. They are usually passive and exhibit very low cost that is comparable to barcode. On the other hand, contrary to the traditional chip-based tags where the read range is limited by the sensitivity of the tag (i.e. minimum power for chip activation), the read range of the chipless tags is limited by the reader sensitivity leading to larger read range

Figure 1. The «Thing», first RFID chipless tag. operatingo at 330 MHz, it was used as a sound sensor



Perhaps the most known chipless example was introduced by RFSAW® (Hartmann, 2002). Based on the Surface Acoustic Wave (SAW) properties, this tag exploits the properties of the propagation of an acoustic wave on piezoelectric substrate on which reflectors are printed. The implemented reflectors will generate a specific sequence of reflected signals when excited by a short impulse.