

Chapter 5

Application and Design of Surface Acoustic Wave Based Radio Frequency Identification Tags

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ABSTRACT

This chapter overviews a complementary technology to the integrated circuit based radio frequency identification (RFID)—Surface Acoustic Wave (SAW) based RFID. The fundamental principle and applications of SAW RFID are presented. In order to guarantee the encoding capacity and reliable reading range, the design criteria in coding scheme, tag design and a time domain interrogated reader design are discussed in detail. As an example, a low-cost SAW RFID system applied in poultry farming management is introduced.

INTRODUCTION

Radio frequency identification (RFID) tags have created growing applications for tracking, sensing and identifying various targets in wide-ranging areas. However, the RFID market is currently dominated by integrated circuit (IC) based RFID. SAW RFID first appeared in non-stop road tolling in California(USA) and Oslo(Norway). In recent years, SAW RFID provides some solutions to identify in harsh environments or where long read ranges are

required, where ordinary semiconductor based RFID technologies have been unsuccessfully deployed. And it turns out to be fairly complementary to IC RFID in different applications. As a matter of fact, SAW devices have been mainly used as the radio frequency filters in signal processing devices in military and the radio frequency filters in applications, such as mobile phones and televisions since the invention of the interdigital transducer (IDT) by R.White and F.Voltmer in 1965[1]. In this chapter, a comprehensive comparison between these two technologies is presented. The state-of-the-art of SAW tags system design is also discussed.

DOI: 10.4018/978-1-61520-603-2.ch005

FUNDAMENTAL PRINCIPLE AND STRUCTURE

The operating principle of SAW RFID is shown in Figure 1. An interdigital transducer, reflectors and piezoelectric crystalline material as substrate compose of a SAW tag. As soon as a SAW RFID tag enters the interrogation range of the reader, a RF pulse from reader antenna is received by the tag with an antenna, and then the signal is converted into a surface acoustic wave through the IDT by the inverse piezoelectric effect. The excited SAW propagates with a relatively low velocity compared to the speed of electromagnetic wave (in a factor of 10⁻⁵). Several coding reflectors are located at the SAW propagating path on the tag surface, and each reflector gives rise to a partial reflection of the interrogating pulse. After a certain delay, which is proportional to the distance between the reflectors and the IDT, the reflected SAW is reconverted into an electrical signal by the IDT and is retransmitted by the tag's antenna as a pulse train to the reader. This signal implicates the information about the number and location of reflectors as well as the propagation and reflection properties of the SAW and can be used for extraction of identification code and/or certain sensing parameters.

Because the IDT and reflectors are built on the surface of piezoelectric crystalline materials rather

than silicon, the physical mechanism of operation is based on the acoustic wave propagation and reflection rather than semiconductor. Therefore, SAW RFID is a chipless and passive device (no need for power supply).

COMPARISON BETWEEN TWO KINDS OF RFID

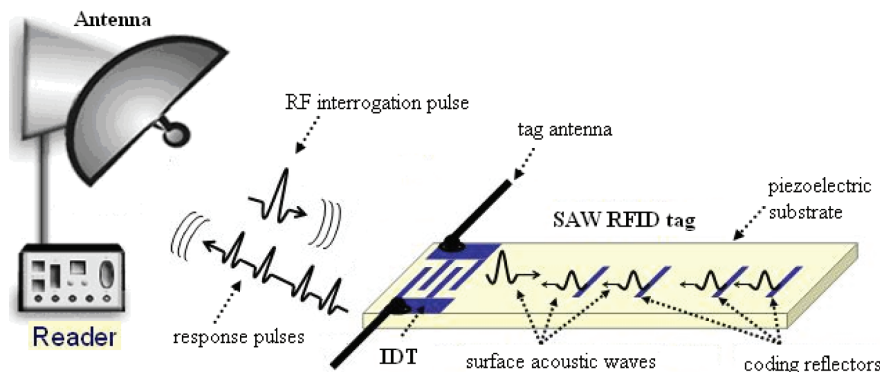
According to the operating principle, there are fundamental differences between SAW tags and IC based RFID. Some specific applications of SAW RFID are introduced.

Merits of SAW RFID

SAW RFID tags are truly passive. By contrast, silicon RFID tags need a very strong powering signal which is rectified to the DC power to operate the IC chip. The unique physics of SAW chips can solve major RFID issues and achieves:

1. The reading signal of SAW tags is about 100 times smaller than IC's[2], and thus, it has stronger capability of a longer reading range, better signal penetration, and tagging on containing cases of metal or liquid. In many applications, the read range of SAW tags is sufficiently large so that passive tags

Figure 1. Fundamental principle of SAW RFID



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