G03: Spectral Signature Based Chipless RFIDs

Arjun Menon Vadakkeveedu, Hari Shankar SK, Sayan Mitra
Poster Proposal for EE2025: Engineering Electromagnetics, 2019

I. Problem Statement

Radio Frequency Identification requires Application Specific Integrated Circuits (ASICs) on both readers and tags, making them expensive when compared to other modes of identification such as optical barcodes. In this poster, we explore if there can be effective low-cost alternatives to optical barcodes that use Radio Frequency Identification Technology.

II. Proposal Description

We present a low-cost alternative to these systems, known as Chipless RFIDs.

In Chipless RFID Systems, the reader (or interrogator) sends a signal towards the tag and analyses the reflected signal. The tags are designed to have a unique reflection pattern, which is used as a signature to identify the tag. Chipless RFIDs may be implemented using Time Domain Reflectometry (TDR) or Frequency Domain Spectral Analysis. In TDR, the interrogator sends a series of pulses and analyses the echoes obtained. The pattern of echoes generated by the tag (reflections occur due to an impedance mismatch at the medium-tag boundary) is used to identify the tag. In order to avoid interference of the reflected signals, the pulses must have large delays between them, or they must be narrow in duration. This implies that the data carrying capacity of TDR-based tags is low.

A Chipless RFID tag that is identified using Frequency Domain Analyses uses resonators to alter the spectral pattern of the input signal upon reflection. By tuning the resonators to predefined frequency ranges, the reflected signal can be made to have a unique distribution of frequency components, which acts as a spectral signature to identify the tag. In comparison to TDR based tags, spectral-signature based tags offer more data-transfer capacity. As a result, the focus of the poster will be on this approach.

There are two popular ways to obtain a unique spectral pattern of the reflected signal: Retransmission and Backscattering. We will be discussing the working principle, tag design and performance for both retransmission and backscattering based chipless RFIDs.

III. Commercial Context

Large Scale Deployment of Chipless RFIDs is possible in environments such as plants, warehouses, supermarkets, and libraries, enabling product identification and tagging processes to be automated.

This would provide a cost-effective and efficient alternative to identification using optical barcodes, a process which requires a human operator.

References

[1] Stevan Preradovic, Isaac Balbin, Nemai Chandra Karmakar and Gerhard F. Swiegers *Multiresonator-Based Chipless RFID Systemfor Low-Cost Item Tracking*
IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 57, NO. 5, MAY 2009

[2] Prasanna Kalansuriya, Nemai Chandra Karmakar and Emanuele Viterbo *On the Detection of Frequency-Spectra-Based Chipless RFID Using UWB Impulsed Interrogation*
IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 60, NO. 12, DECEMBER 2012

[3] Cristian Herrojo, Javier Mata Contreras, Ferran Paredes, Alba Núñez, Eloi Ramon, Ferran Martin *Near-Field Chipless-RFID System With High Data Capacity for Security and Authentication Applications*
IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 65, NO. 12, DECEMBER 2017