

This paper provides a fundamental analysis of the maximum possible information content and reading range of chipless time-domain reflectometry (TDR) radio frequency identification (RFID). Bits encoded on a tag as well as bits that can be decoded by the reader need to be considered to estimate the information content on a tag. This needs an approach that deals with the entire RFID system. Factors such as insertion loss, reader signal, reading range, and channel properties impact the number of bits that can be decoded by the reader. Taking these parameters into account on their own, we can model the signal properties at the decoder by equations from radar theory such as the Cramer-Rao lower bound. The overall performance of these systems cannot be satisfactorily described by the radar theory, as today's chipless RFID systems use different modulation schemes to increase the information content. Modulation theory can provide a detailed analysis of the modulation schemes depending on the channel and signal properties. This theory influences the tag design and the demodulation algorithms on the decoder, but is not suited to describe the RFID systems as a whole. This paper provides an approach that combines the radar and modulation theories to provide an exhaustive description of chipless TDR RFID communication. The maximum information content obtainable in practice can be estimated with this analysis. The introduced methodology is applied to surface-acoustic wave and ultra-wideband delay-line-based TDR tags. We present the simulations and measurements taken with different tags to show the practical importance of the theoretical findings.