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Information technology — Radio frequency identification for item management — Methods for localization of RFID tags

Technologies de l'information — Identification par radiofréquence (RFID) pour la gestion d'objets — Méthodes pour la localisation d'étiquettes RFID

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Technology progress continuously achieves longer read ranges for RFID and in particular UHF RFID. With increasing communication ranges, the actual possible location of a tag around an interrogator gets larger and larger and there is often demand for more precise details on the tag location around the interrogator.

This document addresses tag localization by additionally superimposing a wideband localization signal to the communication between interrogator and tag.

In order to ensure interoperable systems, this document addresses the physical layer, logical layer and details on systems.

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Information technology — Radio frequency identification for item management — Methods for localization of RFID tags

1 Scope

This document defines how to use the RFID air interface standards of the ISO/IEC 18000 series that are based on backscatter technology for localization of RFID tags, specifically tags which are ISO/IEC 18000-4, ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63 and ISO/IEC 18000-64 compliant.

This document specifies the physical and logical requirements for localization. The system comprises interrogators, also known as readers, and tags, also known as labels. An interrogator receives information from a tag by transmitting a modulated RF signal to the tag and the tag responds by modulating the reflection coefficient of its antenna, thereby backscattering an information signal to the interrogator. The modulated RF signal for data exchange is based on the relevant part of the ISO/IEC 18000 series and, in addition, there is a superimposed modulated RF signal with the same or different carrier frequency intended for localization. This document describes the signals required for localization, the method to derive localization information from the signals received by the interrogator and the requirements onto tags and interrogators.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 18000-63, *Information technology — Radio frequency identification for item management — Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C*

ISO/IEC 18047-6, *Information technology — Radio frequency identification device conformance test methods — Part 6: Test methods for air interface communications at 860 MHz to 960 MHz*

ISO/IEC 19762, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
information-bit
single bit of information sent from the tag to the interrogator

Note 1 to entry: Depending on the selected modulation of the backscatter link, an information-bit is represented by multiple modulation-bits.

3.2
modulation-bit
smallest unit in a binary modulated backscatter communication

Note 1 to entry: Depending on the type of modulation, an information-bit is represented by multiple modulation-bits.

Note 2 to entry: In case of ISO/IEC 18000-63 modulations, each modulation bit has the length of Tpri/2.

3.3
Query
command from interrogator-to-tag

Note 1 to entry: This term is explained in more detail in ISO/IEC 18000-63.

4 Conformance

4.1 Claiming conformance

An interrogator or tag shall comply with all relevant clauses of this document, except those marked as “optional”.

4.2 Interrogator conformance and obligations

An interrogator shall implement the mandatory commands defined in this document and conform to ISO/IEC 18000-63.

An interrogator may implement any subset of the optional commands defined in this document.

The interrogator shall not

— implement any command that conflicts with this document, or

— require the use of an optional, proprietary or custom command to meet the requirements of this document.

4.3 Tag conformance and obligations

A tag shall implement the mandatory commands defined in this document for the supported types and conform to ISO/IEC 18000-63.

A tag may implement any subset of the optional commands defined in this document.

A tag shall not

— implement any command that conflicts with this document, or

— require the use of an optional, proprietary or custom command to meet the requirements of this document.

5 Symbols and abbreviated terms

The main symbols and abbreviated terms used in this document are detailed in ISO/IEC 19762. Symbols, abbreviated terms and notation specific to this document are as follows:

BLF	backscatter-link frequency
CW	continuous wave
$\Delta s_{avg}(\tau)$	difference waveform between the averaged waveforms $\Delta s_{avg,1}(\tau) - \Delta s_{avg,0}(\tau)$. This waveform serves as the basis for calculation the ToF between interrogator and tag
$\overline{\Delta IQ}$	averaged delta voltage between the tag's two different modulation states (complex valued)
Δ_{RCS}	delta radar cross section
DUT	device under test
FT	frequency tolerance (of the backscatter link)
G_{0r}	gain of the receiving antenna
G_{0t}	gain of the transmitting antenna
I	in-phase component (real-part of complex value)
$\overline{IQ_{k,m}}$	average IQ voltage during modulation state m and bit number k
k	index of the backscatter modulation-bits, $k = 0, 1, 2...$
$P_{I,min}$	minimum power allowing the DUT tag activation
Q	quadrature-phase component (imaginary-part of complex value)
R=>T	interrogator-to-tag
RCS	radar cross section of tag
RX	receive(d)
$s_{avg,0}(\tau)$	averaged waveform of the RX waveforms, realigned in time, $s'_{RX,k}(\tau)$ of "0"-modulation-bits
$s_{avg,1}(\tau)$	averaged waveform of the RX waveforms, realigned in time, $s'_{RX,k}(\tau)$ of "1"-modulation-bits
$S_{RRSEQ}(\tau)$	cyclic ranging signal in time-domain (one period)
$s_{leakage,RX,k}(\tau)$	part of the RX-signal due to leakage and reflections with the length of one period of the ranging signal, received in time-slot k
$s'_{leakage,RX,k}(\tau)$	part of the RX-signal due to leakage and reflections cyclically rotated
$s_{tag.RX,k}(\tau)$	part of the RX-signal from the active tag with the length of one period of the ranging signal, received in time-slot k
$s'_{tag,RX,k}(\tau)$	part of the RX-signal from the active tag cyclically rotated
$s_{RX,k}(\tau)$	RX-signal with the length of one period of the ranging signal, received in time-slot k
$s'_{RX,k}(\tau)$	RX-signal cyclically rotated
t_{RSEQ}	length of a single period of the ranging signal
T_k	k-th time-segments of the tag's backscattered modulation-bits
T=>R	tag-to-interrogator

ToF	time of flight
τ	time within a signal of the length of a ranging signal's single period $0 \le \tau < t_{RSEQ}$
TX	transmit(ted)

6 Ranging requirements

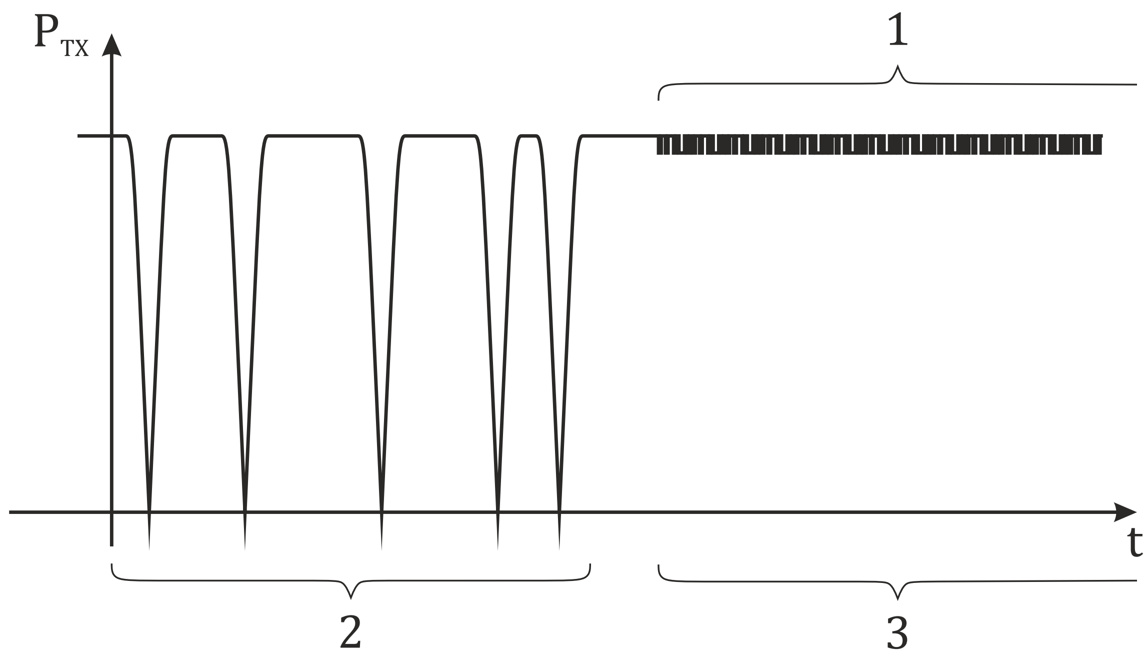
6.1 Overview of the ranging method

The ranging principle is intended to be used in backscatter-based RFID systems. It uses a wideband-signal, superimposed onto the interrogator's signal during tag-to-interrogator (also known as reader) (T=>R) communication. The interrogator uses signal processing on the received signal to determine the distance between tag and interrogator when interrogating the tag. The tag may implement commands and/or operational modes, enhancing the accuracy of the ranging. Ranging in general works with regular tags as e.g. tags compliant to ISO/IEC 18000-63, however some tag designs can have limitations in range and accuracy. The requirements within this document ensure a certain minimum ranging performance for different tag- and interrogator vendors.

6.2 Description of operating procedure

The ranging is based on ToF measurements of the round-trip time from interrogator to tag and back to interrogator. As typical RFID tags work with rather low link data rates (e.g. up to 640 kBits/s for ISO/IEC 18000-63 tags) and allow timing variations of several microseconds, ToF cannot be used directly. Using a wideband interrogator signal and measuring the delay of the received echo does not give usable results either, as the echo is dominated by multiple other contributions (e.g. antenna coupling, other tags).

Figure 1 shows an example for the ranging signal, being transmitted after a ISO/IEC 18000-63 Query command during the time a response from the tag is expected.



Key

1 ranging signal

2 Query sequence

3 response from tag expected

Figure 1 — Superimposed ranging signal

The superimposed periodic signal $S_{RRSEQ}(\tau)$ shall have a periodicity not longer than the time of a single modulation-bit of the tag's backscatter signal. Due to data encoding, a modulation-bit can have a shorter length than an information-bit, depending on the chosen T=>R modulation. Additionally, the timing tolerance of the modulation-bit has to be taken into account. Figure 2 shows an example of the backscattered information bit-sequence "01" with Miller 4-encoding applied. Here, each information-bit consists of 8 modulation-bits. For ISO/IEC 18000-63 tags, the maximum length of one period of the ranging signal $S_{RRSEQ}(\tau)$, denoted by the time t_{RSEQ}, can be expressed by $t_{RSEQ} \leq \frac{1 - f_T}{2 f_{BL}}$, with f_{BL} as the backscatter-link frequency (BLF) and f_T as the tag's allowed frequency tolerance (FT) defined by ISO/IEC 18000-63.