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Information technology — Automatic identification and data capture techniques — Air interface specification for Mobile RFID interrogators

Technologies de l'information — Techniques d'identification et de captage automatiques des données — Spécification d'interface d'air pour interrogateurs Mobile RFID

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

ISO/IEC 29143 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

Introduction

This International Standard provides an air interface specification for Mobile radio frequency identification (RFID) interrogators that are part of a passive backscatter system. This system comprises one or more mobile interrogators, also known as Mobile RFID interrogators, and an undefined number of tags, also known as labels.

Interrogators are not required to support channel sensing, i.e. do not need to implement Listen Before Talk (LBT), and transmit commands on the off chance under the risk of colliding with one or more peer-interrogators. Moreover, interrogators compliant to this International Standard are not obliged to synchronize by any means (wired or wireless), i.e. no control channel dedicated to coordinating Time Division Multiplexing (TDM) is provided.

Tags are powered by the RF signal provided by the interrogator and respond to an interrogator by modulating the reflection coefficient of its antenna, thereby backscattering data to the interrogator. The working mode adopted by the tags is purely passive, i.e. tags do not actively initiate any kind of RF communication.

In this International Standard, collision arbitration and collision avoidance for Mobile RFID applications are defined by specifying methods aimed at mitigating the impact of emerging collisions and mechanisms used to avoid follow-up collisions.

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning radio-frequency identification technology given in the clauses identified below.

ISO and IEC take no position concerning the evidence, validity and scope of these patent rights.

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The latest information on intellectual property that may be applicable to this International Standard can be found at www.iso.org/patents.

Information technology — Automatic identification and data capture techniques — Air interface specification for Mobile RFID interrogators

1 Scope

This International Standard applies to Mobile radio frequency identification (RFID) interrogator devices used to inventory passive or semi-passive backscatter tags at 860 MHz to 960 MHz in a mobile (non-fixed) application independent from specific communication details, i.e. modulation technique and command set.

Furthermore, the scope of this International Standard is mobile consumer applications, whereas mobile enterprise applications are not covered as long as operating in a closed environment.

An operating environment is considered to be closed if it belongs to a central administrative authority able to guarantee for sufficient isolation, i.e. preventing mobile enterprise interrogator devices from being used outside the dedicated operating environment, and if sufficient spatial separation and/or electromagnetic shielding from adjacent operating environments is provided.

An application is considered a consumer application if at least one of two interacting entities is a private individual (consumer) and the interaction is taking place in the public domain. Consequently, a Mobile RFID consumer application is defined as Mobile RFID equipment (e.g. mobile phones equipped with an RFID interrogator) being used in a consumer application.

NOTE As there is currently no active contribution on Mobile HF interrogators, this International Standard covers only UHF.

This International Standard specifies

— Mobile RFID interrogator media access control,

— interrogator to interrogator and multiple interrogator to tag collision arbitration scheme including interrogator requirements,

— interrogator to interrogator and multiple interrogator to tag collision avoidance scheme, and

— tag memory use for Mobile RFID applications.

This International Standard does not specify

— physical interactions (the signaling layer of the communication link) between interrogators and tags,

— interrogator and tag operating procedures and commands, and

— the collision arbitration algorithm used to singulate (separate to the current response slot) a specific tag in a multiple-tag environment.

NOTE These aspects are addressed by other International Standards.

In particular, this International Standard does not replace any existing RFID air interface specification issued by ISO/IEC but extends the existing methodologies for fixed RFID interrogators with mechanisms addressing

the special challenges of Mobile RFID. The concepts and mechanisms described in this International Standard can be integrated in any existing RFID protocol approved by ISO/IEC for the given frequency range of 860 MHz to 960 MHz (unless explicitly prohibited by such protocol) regardless of the actual command set.

The mechanisms defined by this International Standard can be used for Mobile RFID interrogators used in consumer applications and compliant to ISO/IEC 18000-6.

2 Conformance

To claim conformance with this International Standard, an interrogator shall comply with all relevant clauses, except those marked as “optional”. Moreover, the interrogator shall also operate within local radio regulations, which may further restrict operation.

To claim conformance with this International Standard, an interrogator shall also fulfill all requirements to claim conformance with the basic air interface specification ISO/IEC 18000-6.

NOTE The basic assumption is that this International Standard cannot be used standalone. It is not intended to encourage usage of a proprietary air interface in combination with the extension defined in this International Standard and allow claiming conformance with this International Standard in that context.

Mobility of the RFID interrogator device is not a requirement for claiming conformance with this International Standard. It is recommended that all RFID interrogators operating in public areas of service, where interrogator to interrogator and multiple interrogators to tag collisions cannot be ruled out by administrative measures such as Time Division Multiplexing or Frequency Division Multiplexing, support the mechanisms specified in this International Standard regardless of the particular usage of the device (fixed, mobile, or both).

Conformance may also require a license from the owner of any intellectual property utilized by this device.

A mobile device shall only activate its RF for RFID capabilities if it is established that it operates according to the RF regulations of the country where it is turned on. For mobile phones this implies that the phone shall derive the country of operation from the network before activating the RF capabilities for RFID.

3 Normative references

The following referenced documents are indispensable for the application 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 18000-6:2010, *Information technology — Radio frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 MHz*

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

RFC 2141, *URN Syntax*, May 1997

RFC 3406, *Uniform Resource Names (URN) Namespace Definition Mechanisms*, October 2002

4 Terms, definitions, symbols, abbreviated terms, and notation

4.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762 (all parts), ISO/IEC 18000-6 and the following apply.

4.1.1
basic air interface
complementary air interface specification that can be used in combination with this International Standard

4.1.2
channel width
extent of a continuous range of frequencies

NOTE The definition can apply for a transmit or a receive channel. It is usually measured in kilohertz. A definition of the term “channel” can be found in ISO/IEC 19762.

4.1.3
contention period
time interval, starting with the first bit of a protocol data unit being transmitted until the reception of the last bit, in which an interrogator command or tag response is vulnerable and can be destroyed due to interference

4.1.4
EPCglobal Application
application whose usage denotes an acceptance of EPCglobal standards and policies

cf. **ISO Application** (4.1.8)

4.1.5
idealized inventory round
sequence of interrogator commands and tag responses leading to a tag detection without anti-collision being applied

NOTE See ISO/IEC 19762 for a definition of the terms “inventory round” and “anti-collision”.

4.1.6
interrogator to interrogator collision
interrogator command transmitted by an interrogator R2 interfering with a tag response to an interrogator command previously issued by a competing interrogator R1, preventing R1 from successfully decoding a valid tag response

NOTE See ISO/IEC 19762 for a definition of the term “collision” in general.

4.1.7
interrogator transmit channel
channel in which interrogator commands are transmitted

NOTE A definition of the term “channel” can be found in ISO/IEC 19762.

4.1.8
ISO Application
application whose MB01 data structure includes a “1” bit in bit 17h and where bits 18h through 1Fh encode an Application Family Identifier (AFI) as defined in ISO/IEC 15961-3

cf. **EPCglobal Application** (4.1.4)

4.1.9
listen before talk
mechanism to determine the current status of occupation of a communication channel by means of channel sensing

4.1.10
MIIM content name
description of the object associated with mobile item identification and management (MIIM) services

EXAMPLE Brand name, company name, food name, movie title, building name.

4.1.11
Mobile RFID
automatic identification and data capture technique supporting the mobile item identification and management (MIIM) technologies of radio frequency identification (RFID)

4.1.12
Mobile RFID interrogator
electronic equipment that retrieves information from radio frequency (RF) tags by transmitting RF signals to and receiving RF signals from the tags

NOTE Also known as a mobile RFID reader.

4.1.13
multiple interrogators to tag collision
collision in which two or more RFID interrogators issue commands in a way that the transmission of the two commands overlap temporarily, preventing the tag(s) from being able to decode a valid interrogator command

NOTE See ISO/IEC 19762 for a definition of the term “collision” in general.

4.1.14
object directory service
service to provide a mapping relationship between mobile item identification (MII) for something physical or virtual and its corresponding associated information

4.1.15
protocol data unit
any kind of data package transmitted by RFID interrogators or RFID tags, i.e. interrogator commands and tag responses

4.1.16
receive channel
channel in which the tag response is received

NOTE Can be equal to **interrogator transmit channel** (4.1.7). A definition of the term “channel” can be found in ISO/IEC 19762.

4.1.17
receiver timeout
ending of receiver active time triggered by the tag state machine due to inactivity on the communication channel or due to absence of valid RF modulation, encoding or message structure

4.1.18
singulated
⟨one tag in a population of tags⟩ having sent back its response without interference from another tag

NOTE 1 A singulated tag is the result of singulation.

NOTE 2 See also ISO/IEC 19762.

4.1.19
tag anti-collision
process used to prepare for dialogue between an interrogator and one or more RF tags out of the total number of RF tags responding to a request command

4.1.20
tag on tag collision
interference of two or more concurrent tag responses in a way that no valid response can be decoded by the RFID interrogator

NOTE See ISO/IEC 19762 for a definition of the term “collision” in general.

4.2 Symbols

P_{thres} power threshold value used to detect interfering interrogators

W_{Size} moving average filter window size

4.3 Abbreviated terms

CP	contention period
DIM	dense interrogator mode
LBT	listen before talk
MIIM	mobile item identification and management
MinWaitTime	minimum retransmission wait time
MaxWaitTime	maximum retransmission wait time
ODS	object directory service
PDU	protocol data unit
RX	receive
TX	transmit
UII	unique item identifier
URI	uniform resource identifier

4.4 Notation

For the purposes of this document, the following notational conventions apply.

$xxxx_2$ binary notation

$xxxx_h$ hexadecimal notation

Furthermore, the intended usage of the terms “positive” and “negative” in the context of describing the output of specified blocks is as follows.

positive binary 1

negative binary 0

Moreover, parameters are always written in italic font, e.g. *parameter1*.

5 Overview

This International Standard specifies mandatory interrogator transmitter properties, which are defined in Clause 6, a mandatory specification of the media access method for Mobile RFID interrogators in Clause 7, mandatory and optional tag memory structures in Clause 8, optional command extensions introduced for the special purpose of Mobile RFID applications in Clause 9, and a number of informative annexes providing additional non-mandatory information useful for the implementation of this International Standard, which are Annex A to Annex F.

Due to the lack of a dedicated control channel for Mobile RFID interrogators no explicit synchronization of two or more interrogators can be established. Additionally, implicit synchronization as achieved by applying Carrier Sensing or Listen Before Talk is basically not applicable to mobile applications due to the lack of suitable listen thresholds. In general, key figures like the number of active mobile devices at a certain location and the specific local arrangement, e.g. distance to the tagged object(s), possible movement of the involved entities and direction of the antennas are not known in advance. Mobile RFID applications are likely to be more complex and less predictable than fixed applications which results in a demand for additional collision avoidance and collision arbitration mechanisms aimed especially on the requirements of Mobile RFID scenarios.

In contrast to fixed RFID applications, where only Tag on Tag collisions have to be resolved by the anti-collision mechanism of the air interface specification, three different types of collisions need to be addressed for Mobile RFID scenarios. Please refer to Annex A for a detailed overview about possible communication errors in Mobile RFID environments.

This International Standard provides a set of simple, robust and effective mechanisms for implementing media access control for Mobile RFID interrogators. All different types of possible collisions are addressed by reducing the probability of unwanted interference and/or providing mechanisms to recover from possible collisions.

The air interface specification for Mobile RFID interrogators described in this International Standard cannot be used on its own but builds upon an existing RFID command set for fixed RFID that is used as a fundament for the mechanisms described in this International Standard. Suitable air interface specifications for this purpose, e.g. ISO/IEC 18000-6 Type C, are provided by ISO and can be found on the internet at www.iso.org.

6 Transmitter

6.1 Introduction

Mobile RFID interrogators that declare conformance to ISO/IEC 29143 shall comply with 6.2 and all mandatory sub-clauses.

Subclause 6.2 contains all parameters mandatory for mobile UHF interrogators that declare conformance to ISO/IEC 29143. Other frequency bands are currently not supported.

6.2 Mobile UHF Transmitter

6.2.1 Frequency Parameters

6.2.1.1 Frequency Band

The frequency band to be used by Mobile RFID interrogators shall be selected according to local regulations.

Channel access and channel utilization shall be done as specified in Table 1.

In case one or more dedicated channels are available to Mobile RFID within local regulations, such channels shall be accessed by applying LBT unless channel sensing is not required by local regulations. As long as

LBT is supported, Dense Interrogator Mode shall not be mandatory. If a dedicated channel is used for Mobile RFID the media access method specified in Clause 7 shall be mandatory for mobile interrogators.

If no dedicated channels are assigned to Mobile RFID, transmit channels shall be selected according to local regulations (e.g. 4 channel transmit scheme for Europe) and LBT or Frequency Hopping may be applied in accordance to local regulations. Furthermore, the following rules apply:

— In case of Receive Channel Widths of less than 600 kHz, where Receive Channels (RX Channels) are the channels where the tag response is received, see Figure 1, the media access method specified in Clause 7 shall be mandatory if LBT is not used. If Listen Before Talk is used, usage of the media access method specified in Clause 7 is recommended but not mandatory for mobile interrogators.

— If the width of all utilized Receive Channels is greater or equal 600 kHz, Dense Interrogator Mode shall be mandatory, i.e. the spectrum mask specified in Figure 3 applies. If LBT is not used, the media access method specified in Clause 7 shall be mandatory for mobile interrogators. In any other case, usage of the media access method specified in Clause 7 is recommended for mobile interrogators but remains an optional feature.

NOTE 1 Transmit and Receive Channel may be identical, e.g. In-channel backscatter.

NOTE 2 When operating in Dense Interrogator Mode further restrictions regarding signaling may be specified by the basic air interface specification, e.g. ISO/IEC 18000-6 C.

NOTE 3 LBT may always be used regardless of the application of the media access method specified in Clause 7 to identify the least used channel.

Table 1 — UHF Channel Access and Utilization

Dedicated Channel for Mobile RFID available	RX Channel Width (for tag response)	Listen Before Talk (LBT), see NOTE 2	Frequency Hopping (FH), see NOTE 3	Dense Interrogator Mode (DIM)	Commanded Tag Response Format	MAC according Clause 7
Yes	X	X	X	No (NOTE 1)	Not restricted	Mandatory
No	<600 kHz	Yes	No	Not applicable	Not restricted	Recommended
		No	Yes	Not applicable	Not restricted	Mandatory
		No	No	Not applicable	Not restricted	Mandatory
No	≥600 kHz	Yes	No	Yes	Subcarrier	Recommended
		No	Yes	Yes	Subcarrier	Mandatory
		No	No	Yes	Subcarrier	Mandatory

X Don't care

NOTE 1 DIM shall be required if LBT is not applicable due to local regulations.

NOTE 2 Under LBT regulations, the MAC method according Clause 7 is used within dwell time after carrier sensing and first time communication.

NOTE 3 Under FH regulations, the MAC method according Clause 7 is used in the first channel within dwell time and repeated after the channel is changed every dwell time interval.

The RX Channel width in Table 1 shall be defined between the upper edge of the lower frequency band allowed for transmit and the lower edge of the upper frequency band allowed for transmit. Examples are shown in Figure 1 and Figure 2.

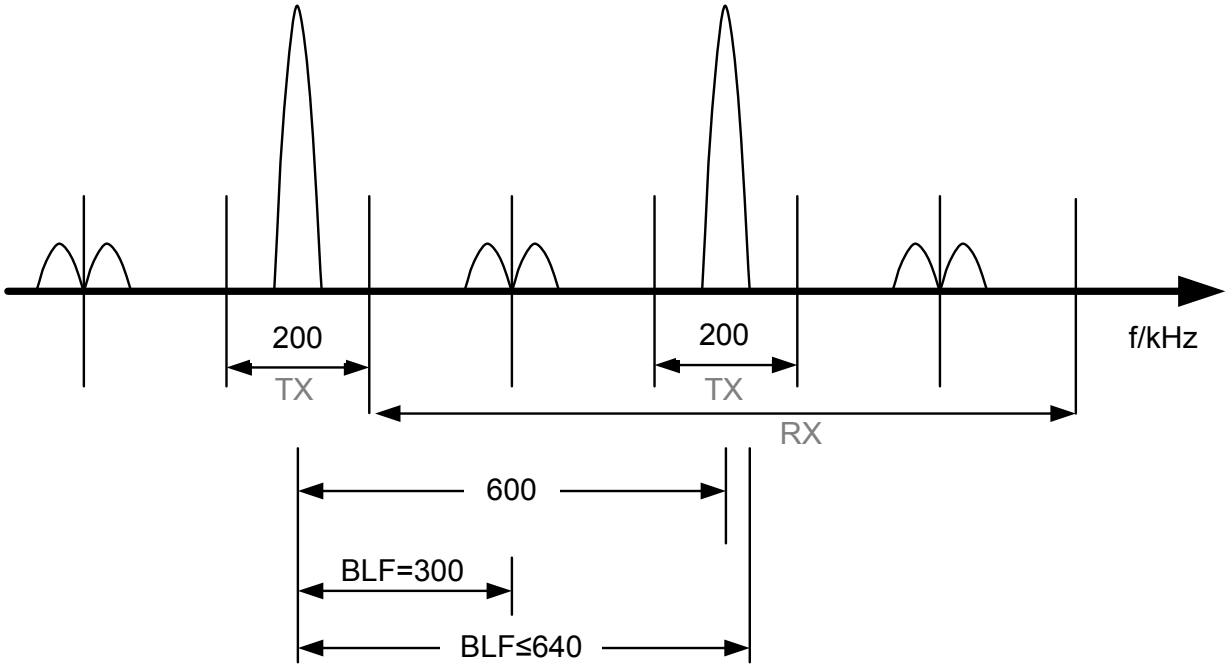

Figure 1 — Example 1 of Possible Transmit and Receive Channel Allocation (e.g. Europe, Korea)

NOTE In Figure 1, the approach of alternative-channel backscatter is shown. In that case the tag response occupies 4 Receive Channels adjacent to the Transmit Channel. Channel width is 200 kHz as according channel plan.

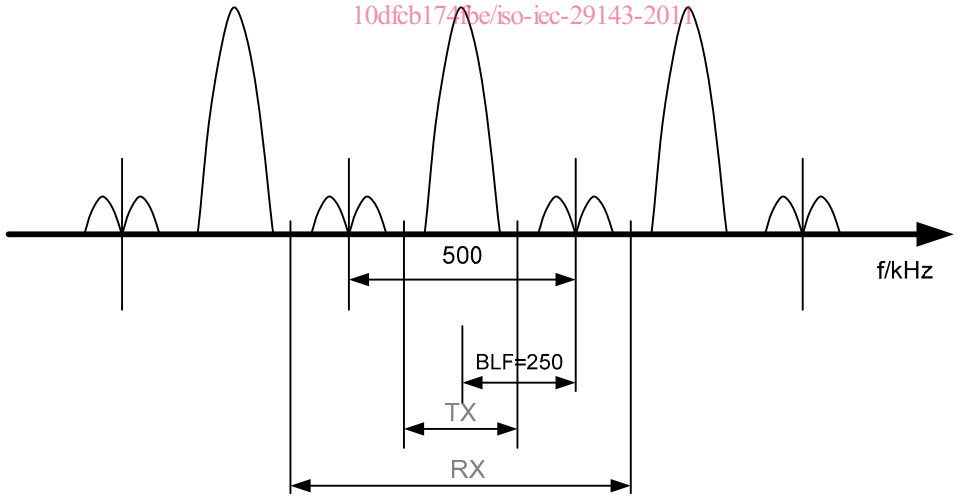

Figure 2 — Example 2 of Possible Transmit and Receive Channel Allocation (e.g. US)

6.2.1.2 Frequency Accuracy

The tolerance of transmit frequency for Mobile RFID shall be set to less than ±8ppm for temperatures between -25°C and +40°C and less than ±10ppm for the extended temperature range of –40°C to +65°C, unless specified differently by local regulations.

6.2.2 Output Power Parameters

6.2.2.1 Maximum Output Power

The maximum interrogator output power shall be selected in accordance with local regulations.

An interrogator output EIRP of less than 23dBm is recommended for preventing Mobile RFID signals from interfering with fixed RFID systems.

6.2.2.2 Spectrum Mask

Interrogators that are claimed to operate according to this International Standard shall meet the local regulations for out-of-channel and out-of-band spurious radio-frequency emissions.

Interrogators shall only support Tari ≥ 12.5 µs, whereas additionally the tolerance according to ISO/IEC 18000-6 shall apply.

Interrogators that are claimed to operate in Dense Interrogator Environments, in addition to meeting the local regulations, shall also meet the Transmit Mask shown in Figure 3.

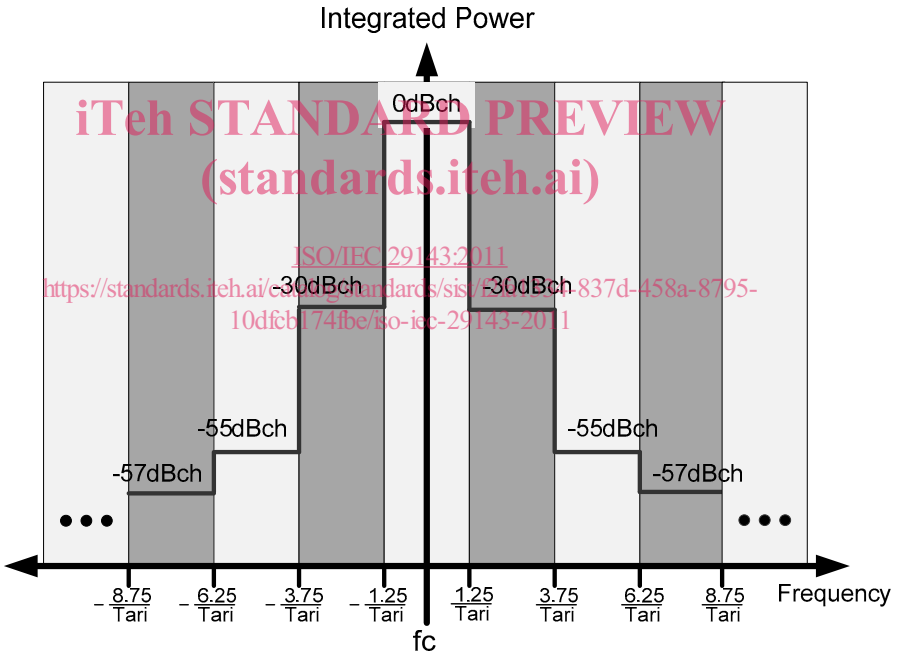

Figure 3 — UHF Transmit Mask for Mobile RFID Interrogators

For an interrogator transmitting random data in channel R, and any other channel S≠R, the ratio of the integrated power P() in channel S to that in channel R shall not exceed the specified values:

|R – S| = 1: 10log10(P(S) / P(R)) < –30 dB

|R – S| = 2: 10log10(P(S) / P(R)) < –55 dB

|R – S| > 2: 10log10(P(S) / P(R)) < –57 dB

Where P() denotes the total integrated power in the specified channel.