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Information technology — Radio frequency identification device performance test methods —

Part 2: Test methods for interrogator performance

Technologies de l'information — Méthodes d'essai des performances du dispositif d'identification par radiofréquence —

Partie 2: Méthodes d'essai des performances de l'interrogateur

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see http://patents.iec.ch).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO/IEC 18046-2:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— addition of test methods for UHF RFID in the 860-930 MHz in Clause 7.

A list of all parts in the ISO 18046 series can be found on the ISO website.

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

Radio frequency identification (RFID) technology has broad applicability to the automatic identification and data capture (AIDC) industry in item management. As a wireless communication technique based on radio frequency technology, the applications cover multiple levels of the industrial, commercial and retail supply chains. These can include:

— freight containers,

— returnable transport items (RTI),

— transport units,

— product packaging, and

— product tagging.

Performance tests define test methods which deliver results that allow the comparison of different RFID systems, interrogators and tags in order to select among them for use in a particular application.

The performance characteristics of devices (tags and interrogation equipment) can vary drastically due to application factors as well as the particular RFID air interface (frequency, modulation, protocol, etc.) being supported. Of key concern is the matching of the various performance characteristics to the user application. Additionally, in an open environment, users of such technology demand multiple sources for these devices from technology providers. A key challenge is a method of evaluating the differences between various technology providers' products in a consistent and equitable manner.

This document provides a framework for meeting the above noted concerns and challenges. To this end, clear definitions of performance as related to user application of RFID technology in the supply chain are provided. Based on such application-based definitions, test methods are defined with attention to the test parameters required for a consistent evaluation of RFID devices.

Of particular significance, these tests are defined for RFID devices with one antenna. It is common practice to have products with both single and multiple antennae to define an RFID transaction zone sufficient for the application. The defined test methods used are for a single antenna but can equivalently be extended to equipment with multiple antennae, in order to evaluate performance under conditions more closely matching those of a particular application. However, it is important to exercise care in multiple-antenna measurement since multiple antennae can cause antenna-to-antenna interactions, physical packaging limitations, mutual coupling issues, shadowing issues, directivity issues and other impacts, even with respect to interrogators since these can be limited in size, shape and mounting method for many RFID applications.

Information technology — Radio frequency identification device performance test methods —

Part 2:
Test methods for interrogator performance

1 Scope

This document defines test methods for performance characteristics of RFID interrogators and specifies the general requirements and test requirements for interrogators which are applicable to the selection of the devices for an application. The summary of the test reports forms a unified interrogator datasheet.

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 18000-2, *Information technology — Radio frequency identification for item management — Part 2: Parameters for air interface communications below 135 kHz*

ISO/IEC 18000-3, *Information technology — Radio frequency identification for item management — Part 3: Parameters for air interface communications at 13,56 MHz*

ISO/IEC 18000-7, *Information technology — Radio frequency identification for item management — Part 7: Parameters for active air interface communications at 433 MHz*

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 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 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/

4 Symbols and abbreviated terms

4.1 Symbols

E_{THR}	electromagnetic field threshold
$E_{\text{THR Identification}}$	identification electromagnetic field threshold
$E_{\text{THR Read}}$	reading electromagnetic field threshold
$E_{\text{THR Write}}$	writing electromagnetic field threshold
E_{Max}	maximum electromagnetic field exposure
$E_{\text{Max Operating}}$	maximum operating electromagnetic field
E_{Survival}	survival electromagnetic field
$I_{\text{Rejection}}$	interference rejection
D	distance between the tag and the antenna
P_{rcv}	interrogator receiver sensitivity power level
P_{back}	tag backscatter power
P_{TX}	interrogator transmit power
P_{r}	power received on the spectrum analyser
f_{a}	antenna factor of the reference antenna
$\lvert\Delta C\rvert$	loss of cable
F_{f}	field strength
$S_{\text{Directivity}}$	sensitivity directivity
G	antenna gain
f_{tsbl}	frequency tag side band left
f_{tsbr}	frequency tag side band right

4.2 Abbreviated terms

LM	load modulation
EMF	electromagnetic field
DUT	device under test
MPE	maximum permissible human exposure
SAR	specific absorption rate
TE	test equipment
RF	radio frequency

RFID	radio frequency identification
RTI	returnable transport items
UHF	ultra high frequency
AIDC	automatic identification and data capture
BLF	backscatter link frequency
UII	unique item identifier

5 Conditions applicable to the test methods

5.1 Number of interrogators to be tested

All measurements defined in this document shall be performed at least on a single interrogator, but higher sampling numbers can be required for statistical purposes.

5.2 Test environment

Unless otherwise specified, testing shall take place in an air environment of temperature (23 ± 3) °C [(73 ± 5) °F] with relative humidity within the range of 40 % to 60 %.

5.3 RF environment

The tests shall be performed in a known RF environment.

For measurements of propagative UHF interrogators (see ISO/IEC 18000-63 and ISO/IEC 18000-7), an anechoic chamber is the recommended test environment. The size of the anechoic chamber shall be justified based on the dimensions of the test setup.

For measurement of inductive interrogators, a typical laboratory environment is sufficient, where consideration is given to minimize the impact of electromagnetic sources that can influence the results.

5.4 Pre-conditioning

Where pre-conditioning is required by the test method, the identification interrogators to be tested shall be conditioned to the test environment for a period of 24 hours before testing.

5.5 Default tolerance

Unless otherwise specified, a default tolerance of ±5 % shall be applied to the quantity values given to specify the characteristics of the TE (e.g. linear dimensions) and the test method procedures (e.g. TE adjustments).

For power values represented in dB or dBm, the tolerance shall be ±0,5 dB.

NOTE ±0,5 dB is approximately ±12 % of the non-logarithmics value.

5.6 Total measurement uncertainty

The total measurement uncertainty for each quantity determined by these test methods shall be stated in the test report.

NOTE Basic information is given in ISO/IEC Guide 98-3.

5.7 Test result reporting

Each test result shall be reported with the DUTs tested. For statistical evaluation, optionally, the minimum value, maximum value, mean value and standard deviation may be reported as well.

5.8 Test communication parameters

All of the tests may be carried out for various communication parameters (forward and return link). The test conditions shall be recorded in the test report.

5.9 TE limits

TE for survival field maximum level shall be able to handle the maximum level declared by the product vendor. It shall be ensured that the TE is not limiting the performance measurement.

5.10 Human exposure to EMF

High magnetic or electromagnetic field strength may exceed the limits of maximum permissible human exposure to EMF, which should be considered accordingly. FCC guidelines for MPE and SAR or EC 1999/519/CE are examples for relevant documents.

6 Setup of TE for interrogator test

6.1 Test apparatus and test circuits for ISO/IEC 18000-3 interrogators

The specification for ISO/IEC 18000-3 tags and interrogators specifies an operating frequency of 13,56 MHz ± 7 kHz. Since both the interrogator and the tag may be shifted by 516 ppm and potentially in opposite directions, it is necessary for the interrogator to function with a tag simulator that may be ±1032 ppm (±14 kHz) relative to the nominal centre frequency of the interrogator under test.

This frequency adjustment is made using only the tag simulator's signal source since there might be no convenient way to adjust the frequency of the interrogator being evaluated. The relative interrogator to tag frequency shift is still achieved using this method.

For convenience in setting up the signal source in the tag simulator, use a low carrier frequency at 13,546 MHz, a nominal centre frequency at 13,560 MHz, and a high carrier frequency at 13,574 MHz for all frequency offset tests.

Unless defined differently in the test description, the set up of all TE shall be in an anechoic chamber or some other fully characterized and controlled location that is free from interference sources and propagation influences, such as significant signal reflections, absorptions, or blockages.

Unless otherwise specified, all the tests should be run using a known reference antenna attached to the tag simulator.

The tag simulator used for these tests shall be able to receive interrogator commands and transmit tag replies in conformance with ISO/IEC 18000-3. The command decoder needs to provide a signal to trigger a properly timed response from the code generator so that the entire assembly acts as a tag simulator.

The output of the decoder in the tag simulator is also connected to a computer and appropriate monitoring software so that it can display the tag commands as received from the interrogator being tested in order to confirm that it is sending correct commands.

The timing of the interrogator's transmitted signal and modulation can be monitored using the output of the tag simulator's receiver attached to a storage scope that has sufficient memory depth to allow the capture of complete interrogator/tag transactions.

The interrogator is connected to a control and monitoring computer that allows issuing of wakeup and command transmissions. This software should also provide a display of decoded data received by the interrogator to confirm that it is able to properly decode and output received tag responses.

Unless otherwise specified, the recommended test distance between the interrogator's location and the reference antenna attached to the tag simulator should be 75 % of the maximum working distance which can be obtained with the interrogator under test and the tag simulator.

6.2 Test apparatus and test circuits for ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63, ISO/IEC 18000-64 interrogators

The test apparatus and test circuits for ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63, ISO/IEC 18000-64 interrogator tests are defined in 8.1.

6.3 Test apparatus and test circuits for ISO/IEC 18000-7 interrogators

The specification for ISO/IEC 18000-7 tags and interrogators specifies an operating frequency of 433,920 MHz (±20 ppm), which is approximately ±8,7 kHz. Since both the interrogator and the tag may be shifted by 20 ppm and potentially in opposite directions, the interrogator needs to function with a tag simulator that may be ±40 ppm (approximately 17,4 kHz) relative to the nominal centre frequency of the interrogator under test.

This frequency adjustment is made using only the tag simulator's signal source since there may be no convenient way to adjust the frequency of the interrogator being evaluated. The relative interrogator to tag frequency shift is still achieved using this method.

For convenience in setting up the signal source in the tag simulator, use a low carrier frequency at 433,900 MHz, a nominal centre frequency at 433,920 MHz, and a high carrier frequency at 433,940 MHz for all frequency offset tests.

The setup of all TE shall be in an anechoic chamber or some other fully characterized and controlled location that is free from interference sources and propagation influences, such as significant signal reflections, absorptions, or blockages.

Unless otherwise specified, all the tests should be run using a known reference antenna attached to the tag simulator through a splitter/combiner of a known loss as shown in Figure 1.

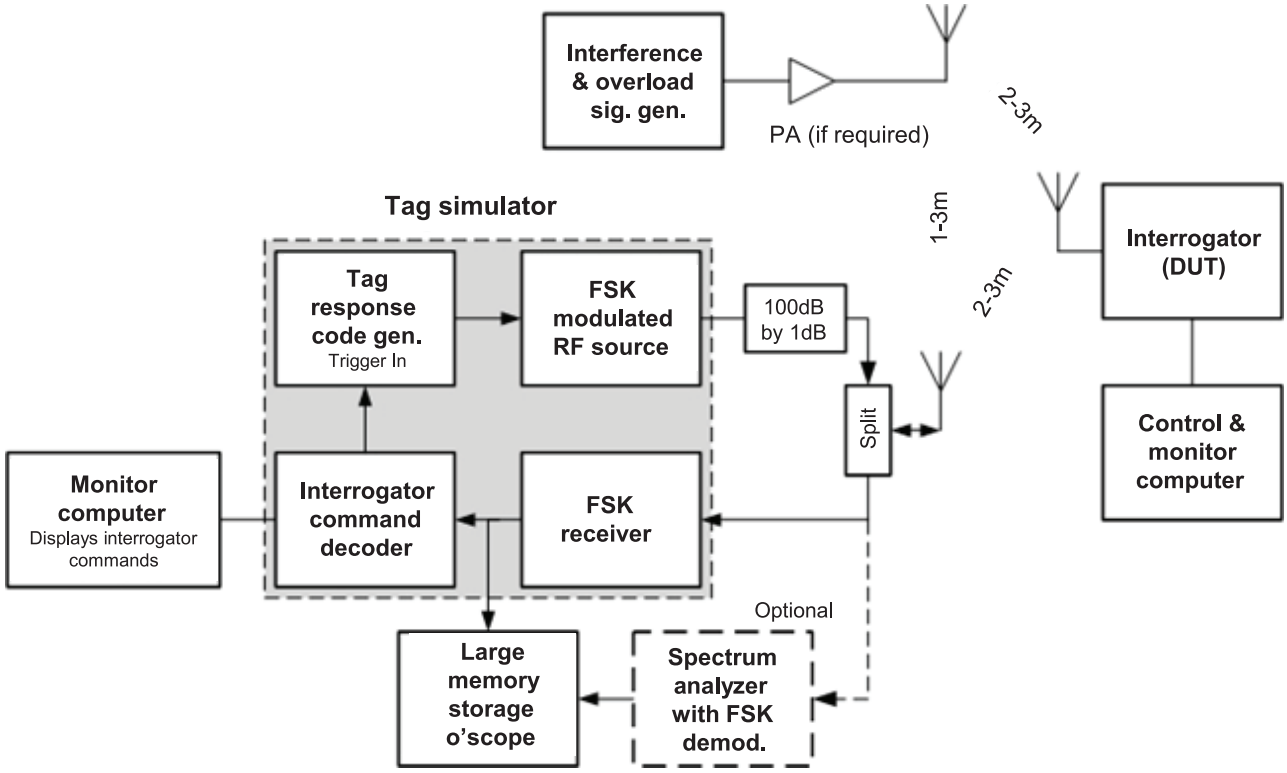

Figure 1 — Test setup for ISO/IEC 18000-7 interrogator measurements

A second reference antenna is located in the place of the interrogator at its test location and shall be connected to a spectrum analyser at the beginning of testing with the tag simulator's signal source set to 0 dBm output to establish the field strength, F_f, at the test site where the interrogator will be placed.

Calculation of field strength is as follows:

$$F_f = 107 + (P_r + f_a + |\Delta C|)$$

where

107 is dB above 1 uV at 0 dBm,

P_r is the power received on the spectrum analyser,

f_a is the antenna factor of the reference antenna, and

$|\Delta C|$ is the loss of cable in dB (absolute value).

EXAMPLE $P_r = -35$ dBm, $f_a = 22$ dB, $\Delta C = |-1{,}2$ dB|

$$F_f = 107 + (-35 + 22 + 1{,}2) = 107 + (-11{,}8) = 95{,}2\text{dBuV/m}$$

The field strength at 0 dBm reference level shall be used during interrogator sensitivity testing.

The tag simulator used for these tests consists of a code generator conforming to ISO/IEC 18000-7, an FSK modulated 433,920 MHz signal source, an FSK 433,920 MHz receiver, and a decoder conforming to ISO/IEC 18000-7. The decoder needs to provide a signal to trigger a properly timed response from the code generator so that the entire assembly acts as a tag simulator.

