INTERNATIONAL STANDARD

ISO/IEC 18046-2

First edition
2011-03-15

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

Reference number
ISO/IEC 18046-2:2011(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

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.

ISO/IEC 18046-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This first edition of ISO/IEC 18046-2, together with ISO/IEC 18046-1 and ISO/IEC 18046-3, will cancel and replace ISO/IEC 18046:2006.

ISO/IEC 18046 consists of the following parts, under the general title *Information technology — Radio frequency identification device performance test methods*:

— *Part 1: Test methods for system performance*

— *Part 2: Test methods for interrogator performance*

— *Part 3: Test methods for tag performance*

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 that deliver results that allow the comparison of different RFID systems, interrogator 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 part of ISO/IEC 18046 provides a framework for meeting the above noted concern 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 having one antenna. It is common practice to have products with both single and multiple antennas 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 antennas, in order to evaluate performance under conditions more closely matching those of a particular application. However care must be exercised in multiple-antenna measurement since multiple antennas 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 part of ISO/IEC 18046 defines test methods for performance characteristics of RFID interrogators for item management, 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 form a unified tag datasheet. It does not apply to testing in relation to regulatory or similar requirements.

2 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 18000-2, *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 18000-6, *Information technology — Radio frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 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 19762 (all parts), *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

ETSI EN 300 330-1, *Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment in the frequency range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 MHz — Part 1: Technical characteristics and test methods*

ETSI EN 300 330-2, *Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment in the frequency range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 MHz — Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive*

47CFR15, *Code of Federal Regulations, Title 47—Telecommunications, Chapter I—Federal Communications Commission — Part 15: Radio frequency devices*, http://www.fcc.gov/oet/info/rules/

3 Terms and definitions

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

4 Symbols and abbreviated terms

$H_{THR\ Identification}$	identification magnetic field threshold
$H_{THR\ Read}$	reading magnetic field threshold
$H_{THR\ Write}$	writing magnetic field threshold
H_{max}	maximum operating magnetic field
$H_{Survival}$	survival magnetic field
Lm	Load Modulation
$E_{THR\ Identification}$	identification electromagnetic field threshold
$E_{THR\ Read}$	reading electromagnetic field threshold
$E_{THR\ Write}$	writing electromagnetic field threshold
$S_{Degradation}$	sensitivity degradation
E_{max}	maximum operating electromagnetic field
$E_{Survival}$	survival electromagnetic field
DUT	device under test
$I_{Rejection}$	interference rejection
G	antenna gain
D	Distance between the tag and the antenna
MPE	Maximum Permissible human Exposure
SAR	Specific Absorption Rate

5 Conditions applicable to the test methods

5.1 Number of interrogator to be tested

Unless otherwise specified, testing shall be performed on 5 randomly chosen interrogators among a population of 20 functional interrogators.

5.2 Test environment

Unless otherwise specified, testing shall take place in air environment of temperature 23 °C ± 3 °C (73 °F ± 5 °F) and of 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 (ISO/IEC 18000-6, ISO/IEC 18000-7) an anechoic chamber is the recommended test environment.

For measurement of inductive interrogators a typical laboratory environment is sufficient, where consideration is given to minimize the impact of electromagnetic sources that may 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 test equipment (e.g. linear dimensions) and the test method procedures (e.g. test equipment adjustments).

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 number of samples, minimum value, maximum value, mean value and standard deviation.

For measurement curves additionally to the curves on minimum value, maximum value, mean value and standard deviation, the individual curves of 5 randomly selected measured devices shall be shown in a figure as well.

5.8 Test communication parameters

All the tests can be done for various communication parameters (forward and return link). The test conditions shall be recorded in the test report.

5.9 Test equipment limits

Test equipment for survivability field maximum level shall be able to handle the maximum level declared by the product vendor. It shall be ensured that the test equipment 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 test equipment 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 516ppm and potentially in opposite directions, the interrogator must function with a tag simulator that may be ±1032ppm (14 kHz) relative to the nominal centre frequency of the interrogator under test.

This frequency adjustment will be 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 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.

The set up of all test equipment 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 test shall be able to receive interrogator commands and transmit tags replies compliant with ISO/IEC 18000-3. The command decoder must 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 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 18000-6 interrogators

The test apparatus and test circuits for ISO/IEC 18000-6 interrogator tests will be the subject of future work and are not covered in this international standard.

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 (±20ppm), which is approximately ±8,7 kHz. Since both the interrogator and the tag may be shifted by 20ppm and potentially in opposite directions, the interrogator must function with a tag simulator that may be ±40ppm (approximately 17,4 kHz) relative to the nominal centre frequency of the interrogator under test.

This frequency adjustment will be 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 set up of all test equipment 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.

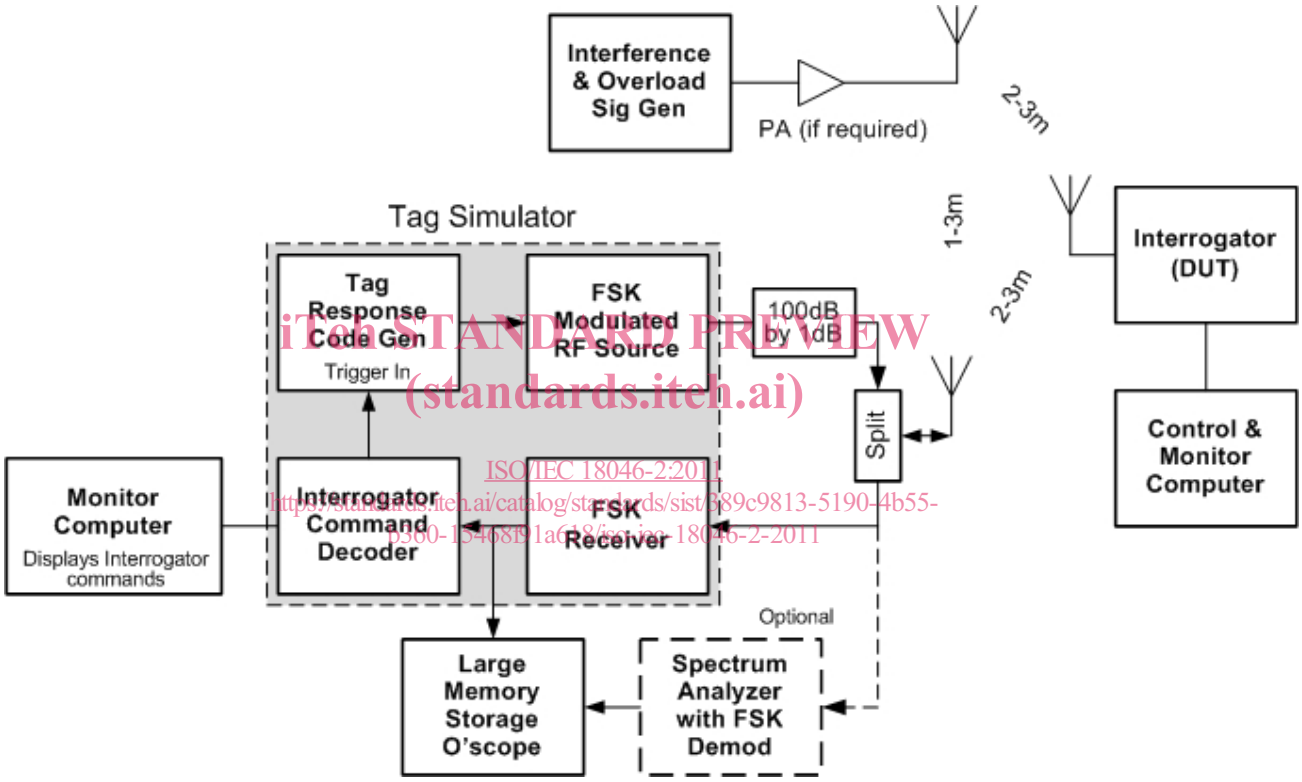

Figure 1 — Test Setup for ISO/IEC 18000-7 Interrogator Measurements

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

Calculation of field strength is as follows:

field strength = 107 + (PR + AF + |LC|)

Where 107 is dB above 1uV at 0dBm, PR = power received on the spectrum analyzer, AF = antenna factor of the reference antenna, and |LC| = loss of cable in dB (absolute value).

Example: PR = -35 dBm, AF = 22dB, LC = |-1,2dB|

FS = 107 + (-35 + 22 + 1,2) = 107 + (-11,8) = 95,2dBuV/m

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

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

The step attenuator shown in the diagram allows adjustment over a 100 dB range in 1 dB steps. The 100 dB of output level change can be adjusted solely using the step attenuator or, as a practical matter, using the level setting capabilities of both the attenuator and the FSK signal source.

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 FSK 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 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 2 meters, minimum, with 3 meters preferred. This will provide sufficient distance to ensure Far Field conditions at the interrogator's location yet not require use of a test site exceeding practical dimensions. A 3 meter test distance is recommended since this is a common regulatory test distance and is also a distance at which many reference antennas have been calibrated for Antenna Factor. This distance also meets the Far Field criteria at a frequency of 433,920 MHz.

7 Functional tests for inductive interrogators as defined in ISO/IEC 18000-2 and ISO/IEC 18000-3

7.1 Interrogator Sensitivity in Listen Mode (Receiving Mode)

7.1.1 Purpose

This test determines the minimum level of modulated carrier at the antenna of the interrogator that can be detected by its receiver.

7.1.2 Test procedure

The Load modulation of the tag simulator is set to the nominal level: 0

The tag simulator is positioned on the axis of the interrogator's antenna. The distance between the tag simulator and the interrogator's antenna (D) is equal to 75 % of the $E_{THR\ identification}$ distance.

Then, the Load modulation is increased from 0 to the level where the interrogator starts to recognize the identification data from the tag simulator.

7.1.3 Test Report

The test report shall give the measured minimum Load modulation Lm interrogator. All parameters shall be recorded according to the example in Table 1