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Information technology — Radio frequency identification device performance test methods —

Part 1: Test methods for system performance

Technologies de l'information — Méthodes d'essai des performances du dispositif d'identification par radiofréquence —
Partie 1: Méthodes d'essai des performances du système

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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.

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

This first edition (ISO/IEC 18046-1) cancels and replaces the first edition (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

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 methods can easily be extended from equipment with a single antenna to apply to equipment with multiple antennas, in order to evaluate performance under conditions more closely matching those of a particular application.

Information technology — Radio frequency identification device performance test methods —

Part 1:
Test methods for system performance

1 Scope

This part of ISO/IEC 18046 defines test methods for performance characteristics of RFID systems for item management, and specifies the general requirements and test requirements for systems which are applicable to the selection of devices for an application. 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 Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 2859-4, *Sampling procedures for inspection by attributes — Part 4: Procedures for assessment of declared quality levels*

ISO 2859-10, *Sampling procedures for inspection by attributes — Part 10: Introduction to the ISO 2859 series of standards for sampling for inspection by attributes*

ISO/IEC 19762-3, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 3: Radius frequency identification (RFID)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-3 and the following apply.

3.1
one side antenna(s)
system with one antenna or multiple antennas which are positioned on the same plane and same side in front of the tag

3.2
gate
system with a minimum of two antennas set in parallel vertical plans at a given distance with a tag that moves between these antennas

3.3
tunnel
system with a minimum of three antennas, two of them being set in parallel vertical plans, and one being set in a horizontal plan with a tag that moves between those three antennas

4 Abbreviated terms

D Distance between tag and antenna of interrogator

D_G Distance between antennas for gate configuration

D_{HT} Horizontal distance between antennas for tunnel configuration

EMF Electro Magnetic Field

MPE Maximum Permissive Exposure

SAR Specific Absorption Rate

5 Conditions applicable to the test methods

5.1 Selection of the tests

The system integrators and/or end users will have to select the applicable tests according to a specific application while ignoring the ones which do not apply to this (these) application(s).

5.2 Selection of the devices to be tested

Unless otherwise specified, testing shall be performed on:

- The population of tag to be tested shall be chosen in accordance with ISO/IEC 2859-1, ISO/IEC 2859-4, and ISO/IEC 2859-10.
- The interrogator given for testing.

The equipment shall be the same for all the tests selected for the testing program.

5.3 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 30 % to 60 %.

5.4 RF environment

The tests shall be performed in a known RF environment. RF environment must be measured to operate the test. Spurious transmissions in functional band for the test must be less than –80 dBm.

All measurement shall be done with spectrum analyser and antenna (loop antenna for BF and HF band, and Log periodic antenna or horn for UHF band.

The spectrum analyser must be configured on the RF band and on “Max hold” measurement. The time of measurement must be more than 5 min.

5.5 Pre-conditioning

The RFID System to be tested shall be conditioned to the test environment for a period of 24 hours before testing.

5.6 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).

5.7 Total measurement uncertainty

The total measurement uncertainty for each quantity determined by these test methods shall be stated in the test report in accordance with ISO/IEC Guide 98-3.

5.8 Test Read and Write

The hexadecimal characters written in the user memory shall be alternatively 0xAA and 0x55

Without specific requirement, the user memory addresses used for these tests shall be the first address and the last address. Others addresses could be tested and these addresses shall be noted in the report.

The size and position of data in the memory to be read or written may influence the results and shall therefore be noted.

Measure the maximum read and write rate for the system under test and these rates shall be noted in the report.

5.9 Test speed motion

For all Tests Speed Motion, the unique important factor is that the motion speed be constant within the volume tested. It implies that the tag be moved from outside the reading volume at a constant speed throughout the volume tested.

The interrogator shall be configured to repeat the inventory command. The delay between two inventory commands shall be such that the tag is still in the identification volume (read zone).

5.10 Test mounting material

The tags shall be mounted on the mounting materials for which they are intended for the application. The mounted material attached to the tag shall be considered as integral part of the tag.

5.11 Test communication parameters

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

5.12 Test equipment limits

If the test equipment limits the performance measurement, these limits shall be noted in the test report.

5.13 Human exposure to EMF

High magnetic or electromagnetic field strength shall not exceed the limits of maximum permissible human exposure to EMF,in accordance with local regulations. FCC guidelines for MPE and SAR or EC 1999/519/CE are examples for relevant documents.

5.14 Test result reporting

Each test result shall include: identification number of tag (UII,Tag ID,.. in relation with air interface standards), type, description, reference number (serial number) of the interrogator, minimum value, maximum value, mean value and standard deviation of the results.

In order to evaluate the results, the interrogator antenna properties, model etc. shall also be specified, as well as the type of interrogator, and type of connection between interrogator and antenna.

The type of command and the number of bits written shall be indicated in the report.

For the tests requiring 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 the test report.

5.15 Tag arrangement

The geometric arrangement of the tags in a population under test may be linear (1D, see Figure 1), array (2D, see Figure 2), or volume (3D, see Figure 3). The spacing of the tags within the defined geometry shall be uniform. Tag spacing shall be measured as the distance between the geometric centroid of each tag. The diagrams below represent the three basic types of tag arrays.

The minimum distance between two tags shall be two times the maximum length of the tag's antenna.

The tag population shall be arranged in a volume smaller than the identification volume (read zone).

Figure 1 — 1D linear tag

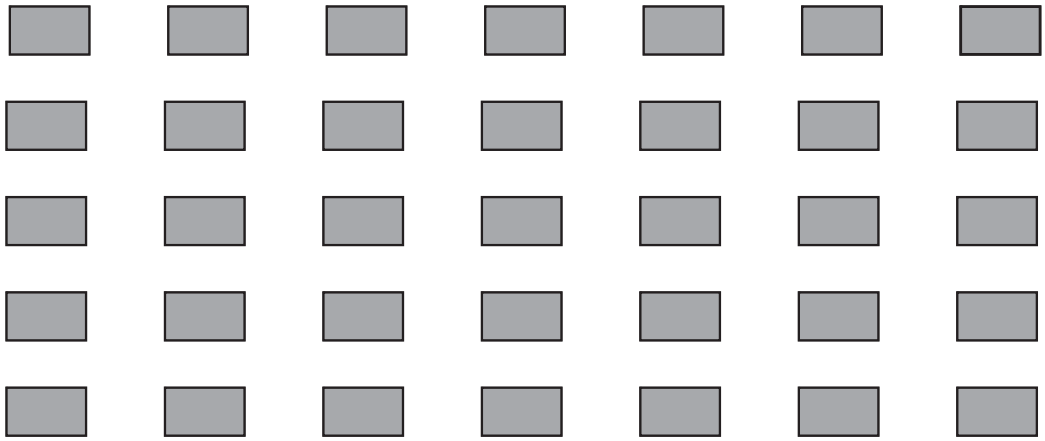

Figure 2 — 2D tag array

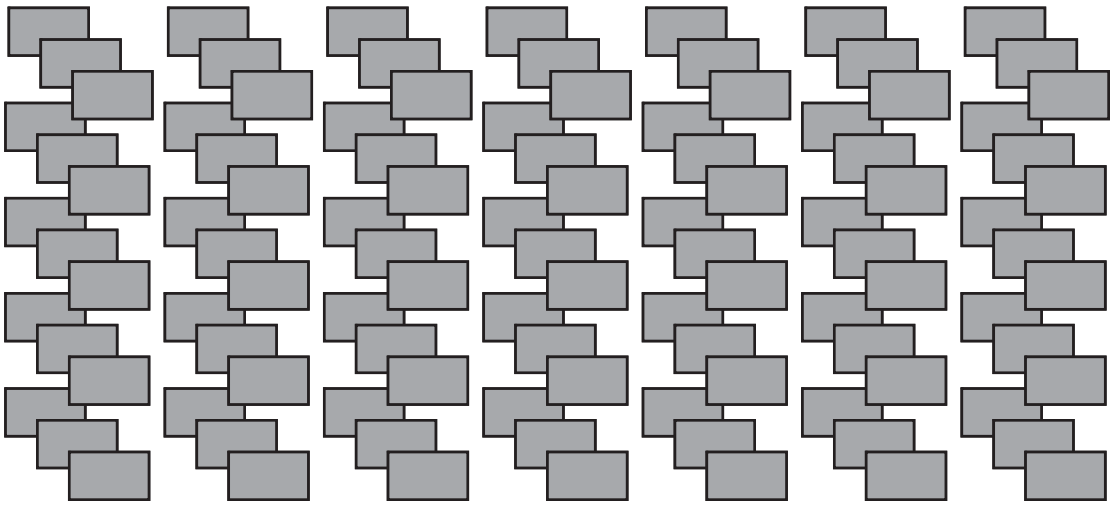

Figure 3 — 3D tag volume

6 Inductive systems

6.1 Portable Interrogator

6.1.1 Operated Range Test

6.1.1.1 Purpose

This test determines the maximum identification distance, read distance and writes distance in front of the antenna of the interrogator.

6.1.1.2 Test set-up

Figure 4 below shows the test set-up for range measurement:

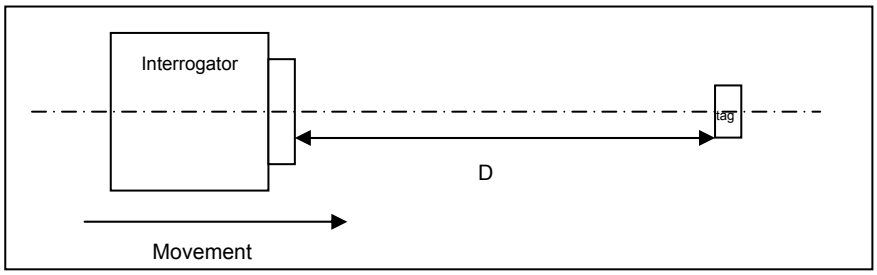

Figure 4 — Test setup for Operated Range Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The interrogator will be fixed on a mobile part of the test bench.

The tag will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.1.1.3 Test procedure

6.1.1.3.1 Test procedure for identification and read range

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

1- The interrogator shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the tag.
2- The interrogator shall be moved closer to the tag by the following step:
   - 0.5 cm step if D < 10 cm.
   - 1 cm step if 10 cm ≤ D ≤ 50 cm.
   - 2 cm step if D > 50 cm.
3- The Inventory command or Read command (as applicable) shall be sent by the interrogator and the existence of a communication link shall be verified.
4- If the communication link does not exist, the step 2 shall be repeated.
5- If the communication link exists, the reading command shall be sent 5 times without move the reader.
6- If one out of the 5 communication links does not exist, then the step 2 shall be repeated.
7- If the communication link exists for each of the 5 tests then the distance D shall be noted in the report as the “IDENTIFICATION_RANGE” or “READ_RANGE” (as applicable).

6.1.1.3.2 Test procedure for write range

The interrogator shall be set in relation to the tag and in accordance with radio frequency recommendation.

1- The interrogator shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the tag.
2- The interrogator shall be moved closer to the tag by the following step:
   - 0.5 cm step if D < 10 cm.
   - 1 cm step if 10 cm ≤ D ≤ 50 cm.
   - 2 cm step if D > 50 cm.

3- The writing command shall be sent by the interrogator with hexadecimal characters 0xAA.
4- The reading command shall be sent to verify that the correct data is written.
5- If the correct data is not read, the step 2 shall be repeated.
6- If the correct data is read, the writing command shall be sent by the interrogator with hexadecimal characters 0x55.
7- The reading command shall be sent to verify that the correct data is written.
8- If the correct data is not read, the step 2 shall be repeated.
9- If the correct data is read, the step 3 shall be repeated. This step shall be repeated 5 times.
10- If the writing command is valid for each of the 5 tests then the distance shall be noted in the report as the “WRITE_RANGE”.

6.1.1.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.
The results of the test shall be recorded according to Table 1

Table 1 — Parameters that shall be recorded for this measurement

Test Results					
EUT	Tag 1	Tag 2	Tag 3	Tag 4	…
IDENTIFICATION_RANGE : **Or** **READ_RANGE** **Or** **WRITE_RANGE**	**xx.x cm**	**xx.x cm**	**xx.x cm**	**xx.x cm**	**xx.x cm**

6.1.2 Operated Volume Test

6.1.2.1 Purpose

This test determines maximum identification volume, read volume and write volume in front of the antenna of the interrogator.

6.1.2.2 Test set-up

Figure 5 shows the test set-up for identification volume, read volume and write volume measurement:

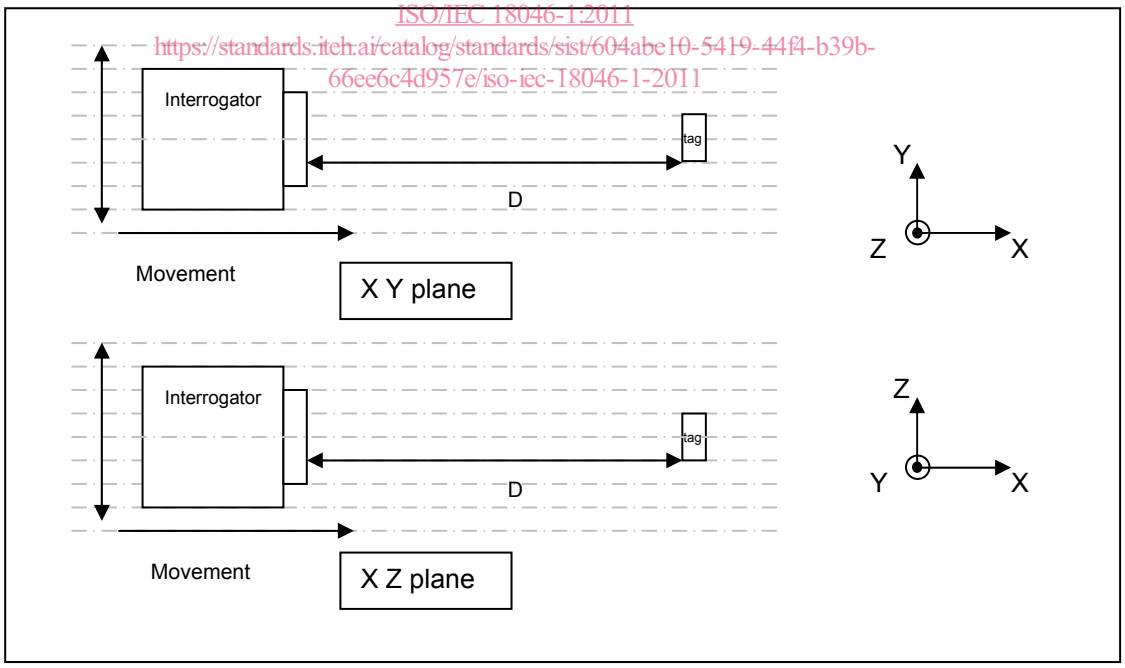

Figure 5 — Test setup for Operated Volume Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The interrogator will be fixed on a mobile part of the test bench.

The tag will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.1.2.3 Test procedure

6.1.2.3.1 Test procedure for identification and read volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

1- The interrogator shall be placed on X axis at a distance of 30% 50% and 80% of the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable) as defined in § 6.1.1.3.1,
2- For each X axis distance, the interrogator shall be moved in steps as specified below in both positive and negative Y and Z directions..
   The interrogator shall be moved along the Y and Z axis by the following step:
   - 0.5 cm step if D < 10 cm.
   - 1 cm step if 10 cm ≤ D ≤ 50 cm.
   - 2 cm step if D > 50 cm.
3- The identification or reading (as applicable) command shall be sent
4- Repeat step 2 until the identification rate or read drops to zero
5- Noting identification rate or read success (as applicable) at each step before drops to zero, Repeat step 2

6.1.2.3.2 Test procedure for write volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

1- The interrogator shall be placed on X axis at a distance of 30% 50% and 80% of the "WRITE_RANGE" as defined in § 6.1.1.3.2,
2- For each X axis distance, the interrogator shall be moved in steps as specified below in both positive and negative Y and Z directions until the identification rate or read drops to zero.
   The interrogator shall be moved along the Y and Z axis by the following step:
   - 0.5 cm step if D < 10 cm.
   - 1 cm step if 10 cm ≤ D ≤ 50 cm.
   - 2 cm step if D > 50 cm.
3- The writing command shall be sent by the interrogator with appropriate value defined in part 5.
4- The reading command shall be sent to verify that the correct data is written.
5- Repeat step 2 until the write drops to zero.
6- Noting identification write success at each step before drops to zero, Repeat step 2

6.1.2.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.
The results of the test shall be recorded according to Table 2.

Example of graph results is shown in Figure 6.

Table 2 — Parameters that shall be recorded for this measurement

Operated Volume Test					
Test Results: EUT 1					
Identification rate / Read / Write success	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO
Distance on X axis :	**xx.x cm**	**xx.x cm**	**xx.x cm**	**xx.x cm**	**xx.x cm**
X = 30%					
Identification rate success / Read success / Write success			**Y**		**Z**
YES/NO			Yy		Zz
YES/NO			Yy		Zz
…			…		…
X = 50%					
Identification rate success / Read success / Write success			**Y**		**Z**
YES/NO			Yy		Zz
YES/NO			Yy		Zz
…			…		…
X = 80%					
Identification rate success / Read success / Write success			**Y**		**Z**
YES/NO			Yy		Zz
YES/NO			Yy		Zz
…			…		…