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Information technology — Automatic identification and data capture techniques — Radio frequency identification device performance test methods

Technologies de l'information — Techniques d'identification automatique et de capture des données — Méthodes d'essai de performance de dispositif d'identification par radiofréquence

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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 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 cancels and replaces ISO/IEC TR 18046:2005, which has been technically revised.

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 RF technology the applications cover multiple levels of the industrial, commercial and retail supply chains. These may include

- freight containers,
- returnable transport items (RTIs),
- transport units,
- product packaging,
- product tagging.

The performance characteristics of devices (tags and interrogation equipment) may vary drastically due to application factors as well as the particular RF 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 International Standard provides a framework for meeting the above noted concern and challenges. To this end, a clear definition of performance as it relates to user application of RFID technology in the supply chain is provided. Based on such application-based definitions, test methods are defined with attention to the test parameters that must be defined and controlled for a consistent evaluation of RFID devices.

It should be noted that the test methods defined in this International Standard form the basic framework for performance evaluation and are not exhaustive. Many applications may require a slightly different set of test conditions to match the use of RFID to the user requirements. The test methods defined herein may be modified to accommodate the specifics of the application as specified by the user.

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 — Automatic identification and data capture techniques — Radio frequency identification device performance test methods

1 Scope

This International Standard defines test methods for performance characteristics of radio frequency identification (RFID) devices (tags and interrogation equipment) for item management, and specifies the general requirements and test requirements for tag and interrogator performance which are applicable to the selection of the 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 18000-1:2004, *Information technology — Radio frequency identification for item management — Part 1: Reference architecture and definition of parameters to be standardized*

ISO/IEC 18000-2:2004, *Information technology — Radio frequency identification for item management — Part 2: Parameters for air interface communications below 135 kHz*

ISO/IEC 18000-3:2004, *Information technology — Radio frequency identification for item management — Part 3: Parameters for air interface communications at 13,56 MHz*

ISO/IEC 18000-4:2004, *Information technology — Radio frequency identification for item management — Part 4: Parameters for air interface communications at 2,45 GHz*

ISO/IEC 18000-6:2004, *Information technology — Radio frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 MHz*

ISO/IEC 18000-7:2004, *Information technology — Radio frequency identification for item management — Part 7: Parameters for active air interface communications at 433 MHz*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
identification range
range at which an RFID system shall reliably identify desired tags under a variety of conditions

NOTE Adapted from ISO/IEC 19762-3:2005.

3.2
identification rate
rate at which an RFID system shall reliably identify desired tags under a variety of conditions

NOTE Adapted from ISO/IEC 19762-3:2005.

3.3
read range
range at which an RFID system may reliably read from desired tags under a variety of conditions

NOTE Adapted from ISO/IEC 19762-3:2005.

3.4
read rate
rate at which an RFID system shall reliably read desired tags under a variety of conditions

NOTE Adapted from ISO/IEC 19762-3:2005.

3.5
write range
range at which an RFID system may reliably write to desired tags under a variety of conditions

NOTE Adapted from ISO/IEC 19762-3:2005.

3.6
write rate
rate at which an RFID system shall reliably write desired tags under a variety of conditions

NOTE Adapted from ISO/IEC 19762-3:2005.

4 Symbols and abbreviated terms

EUT equipment under test

5 General concepts

5.1 Identification

An RFID system for item management must perform a sequence of communication processes within an “open” RF environment to transact the desired data with one or more tags in a potentially large tag population. This process begins with activation and segregation of the desired tags (small population) within the “open” larger population. This process concludes with the establishment of a communication link between the RFID interrogator and the tag allowing transaction (reading and/or writing) of application data. This initial process is described as “Identification”. Identification specifically refers to the process of tag segregation and isolation. This will result in a uniquely addressable means to communicate with a tag (tag ID). Application data has not been accessed.

5.2 Range

An RFID system for item management requires the segregation and transaction of information remotely (i.e. non-line-of-sight). The physical separation between the interrogator and the tag is commonly referred to as range. Range specifically refers to the distance (minimum and maximum) between interrogator antenna and tag(s). For multiple tags, the range will be measured to the geometric centroid of the tag population. Tag density (tags per unit volume) will be specified.

5.3 Rate

An RFID system for item management may (and typically will) encounter multiple tags within a data acquisition session. As many applications require multiple tags to be processed within a fixed amount of time, a performance parameter dealing with “rate” is appropriate. Rate specifically refers to the quantity of tags per unit time. This includes impulse and steady state. Tag population will be both static and dynamic. Tag density (tags per unit volume) will be specified.

5.4 Read

RFID tags contain data. This data represents information about the item associated with the tag whether directly (item attendant) or indirectly (license plate). One of the significant performance characteristics of RFID relates to the ability of retrieving this “item data” in support of various business process requirements. This retrieval process is commonly referred to as “reading” and is separate from the previously described process of “identification”.

Reading tag information assumes that a communication link has been established between the RFID interrogator and the tag. As such the collision arbitration (sometimes referred to as anti-collision) process is not involved. Reading of tag data is a “directed” data transaction with the activated and segregated tag. Reading specifically refers to the process of tag transaction to retrieve information from identified tag population. This process will include both single byte and multiple byte transactions.

5.5 Write

As noted previously, RFID tags contain data. This data represents information about the item associated with the tag whether directly (item attendant) or indirectly (license plate). This information may at times be added and/or modified through the RFID air interface. Should such a capability be available as part of an RFID system, a significant performance characteristic would be the ability of transferring this “item data” from the interrogator into the tag. This process is commonly referred to as “writing” and is the inverse of the previously described process of “reading”.

Writing tag information assumes that a communication link has been established between the RFID interrogator and the tag. As such the collision arbitration (sometimes referred to as anti-collision) process is not involved. Writing of tag data is a “directed” data transaction with the activated and segregated tag. Writing specifically refers to the process of tag transaction to write information into identified tag population. This process will include both single byte and multiple byte transactions. Write with verification will be available.

5.6 Reliable

RFID systems may require extensive dialog between the interrogator and the tag to fully complete the desired transaction with the tag population. It is not uncommon to have dialog errors during wireless communication. Various mechanisms (e.g. checksum, CRC, retransmission, etc.) may be used to ensure the integrity of the transactions. A reliable transaction specifically refers to the assurance that a tag and/or tag population will be identified accurately based on statistical likelihood and a defined confidence level.

5.7 Conditions

RFID systems must perform the required transactions (i.e. identification, reading, or writing) under a variety of environmental and application conditions. Such conditions specifically refer to the following:

— environmental (temperature, humidity, RF spectrum, physical);

— tag population [quantity, density, motion, orientation, mounting material(s)].

6 Requirements

6.1 Introduction

The following section defines the requirements by which RFID systems will be evaluated to describe their performance parameters. It should be noted that there are a number of system and environmental factors which influence and bound the performance characteristics of an RFID system. As referenced, the RFID performance parameters relate to “system” characteristics and thus require both an interrogator as well as tags for their measurement.

6.2 General

An RFID system information transaction volume (range) and/or speed (rate) are defined by many factors. The relevant factors and their form will vary depending on the RFID technology (i.e. inductive or propagative) involved. The following represents some of the relevant factors for the respective system component and environment.

— Interrogator:

  — frequency;

  — power or field strength;

  — antenna directivity (i.e. gain) and polarization or Q factor;

  — receiver sensitivity;

  — modulation characteristic.

— Tag:

  — activation sensitivity (i.e. minimum field strength or power density);

  — antenna directivity (i.e. gain) and polarization or Q factor;

  — modulation characteristic.

— Tag application surface:

  — paper;

  — wood;

  — glass;

  — plastic;

  — metal.

— Application environment:

  — RF reflective and absorptive surfaces;

  — moisture (e.g. humidity, condensation, ice, etc.);

  — chemicals;

  — radio frequency (RF);

  — electrical.

6.3 Test conditions

Given the realities and complexities of such influencing factors, the following defined test methods are constrained to test environments and parameter variations which will allow for a consistent RFID performance characteristic to be measured. Such a measured characteristic may be used for the selection of devices for an application. The general test conditions for short range systems (i.e., under 10 metres) are defined in Table 1 — Short range test conditions below.

Table 1 — Short range test conditions

Condition	Range	Comment
Distance	0 – 10 metres	3-D (x, y, z)
Tag population	1, 10, 20, 50,100	
Tag geometry	Linear, array, volume	
Tag orientation	0, 30, 60, 90 deg, random	3-D (ψ, θ, ϕ)
Tag volume	0,016, 0,125, 1 m^3	
Tag speed	0, 1, 2, 5, 10 m/s	
Tag mounting material	Paper, wood, glass, plastic, metal	See list below
RF environment	Benign, moderate, congested	WLAN, machinery, etc.
Data transaction	1, 8, 16, 32 bytes	Read and write
Interrogator antenna height	0,5, 1, 2, 3 metres	Distance above ground plane (propagative)

The general test conditions for long range systems (i.e., over 10 metres), such as those systems covered by ISO/IEC 18000-7, are defined in Table 2 — Long range test conditions below:

Table 2 — Long range test conditions

Condition	Range	Comment
Distance	10 – 100 metres	3-D (x, y, z)
Tag population	1, 10, 20, 50,100	
Tag geometry	Linear, array, volume	
Tag orientation	0, 30, 60, 90 deg, random	3-D (ψ, θ, ϕ)
Tag volume	0,016, 0,125, 1 m^3	
Tag speed	0, 1, 2, 5, 10 m/s	
Tag mounting material	Paper, wood, glass, plastic, metal	See list below
RF environment	Benign, moderate, congested	WLAN, machinery, etc.
Data transaction	1, 8, 16, 32 bytes	Read and write
Interrogator antenna height	0,5, 1, 2, 3 metres	Distance above ground plane (propagative)

These test conditions may be modified or extended to represent specific user application requirements. The test methods defined in this document may be performed with test conditions tailored to the specific application to best represent performance of RFID devices in such usage.

Tag mounting material – The list below is a representative list of materials for mounting tag(s) for evaluation. As materials will vary based on supply, such mounting structures shall record the source and physical characteristics (i.e. thickness, finish. size, etc.). Mounting structures for tag(s) shall not place metallic fasteners within 10 cm of tag(s).

— corrugated paper;

— windshield glass;

— particle board;

— plywood;

— plexiglas;

— polypropylene;

— polycarbonate;

— aluminium;

— steel.

The test condition shall utilize a controlled RF environment (i.e. anechoic chamber) when feasible. Use of Open Air Test Sites (OATS) is permissible to accommodate devices where distance and/or movement preclude the use of available anechoic chambers. Annex A defines test sites and general arrangements for measurements involving the use of radiated fields. Annex B defines test extensions and deviations from the base test methods peculiar to long range (i.e. greater than 10 metres) RFID systems.

6.4 Test parameters

6.4.1 Introduction

The defined test conditions include a variety of test parameters that provide a range of conditions for device evaluation. While these parameters shall be used as defined in Table 1 above, these parameters may be varied beyond the defaults listed to accommodate the device evaluation with respect to application requirements. These parameters are described in this section.

6.4.2 Distance

There are four measurable distance elements comprising the range parameter. These are:

— Minimum distance (z axis) – the minimum distance (metres) between the center of interrogator antenna and the centroid of the tag population under test. In the case where there are separate transmit and receive antennae, the maximum of the distances of the two shall be recorded. The z axis is defined to be the vector perpendicular to the plane of the antenna pointing outward toward the peak of the radiated field. This axis shall be oriented parallel to the ground plane for test purposes.

— Maximum distance (z axis) – the maximum distance (metres) between the center of the interrogator antenna and the centroid of the tag population under test. In the case where there are separate transmit and receive antennae, the minimum of the distances of the two shall be recorded. The z axis is defined to be the vector perpendicular to the plane of the antenna pointing outward toward the peak of the radiated field. This axis shall be oriented parallel to the ground plane for test purposes.

— Horizontal distance (x axis) – the maximum distance (metres) across the communication zone for the centroid of the tag population under test. The x axis is defined to be the horizontal vector perpendicular to the z axis and parallel to the ground plane.

— Vertical distance (y axis) – the maximum distance (metres) through the communication zone for the centroid of the tag population under test. The y axis is defined to be the vertical vector perpendicular to the z axis and perpendicular to the ground plane.

Figures 1 and 2 depict the general arrangement and relationship of the four distance elements of the range parameter. Note that the inner shaded region represents the measured effective communication zone from which the desired measurable performance parameter (i.e. range) is calculated. The outer shaded region represents the physical volume that a tag population may move through for the measured communication zone (i.e. inner region).

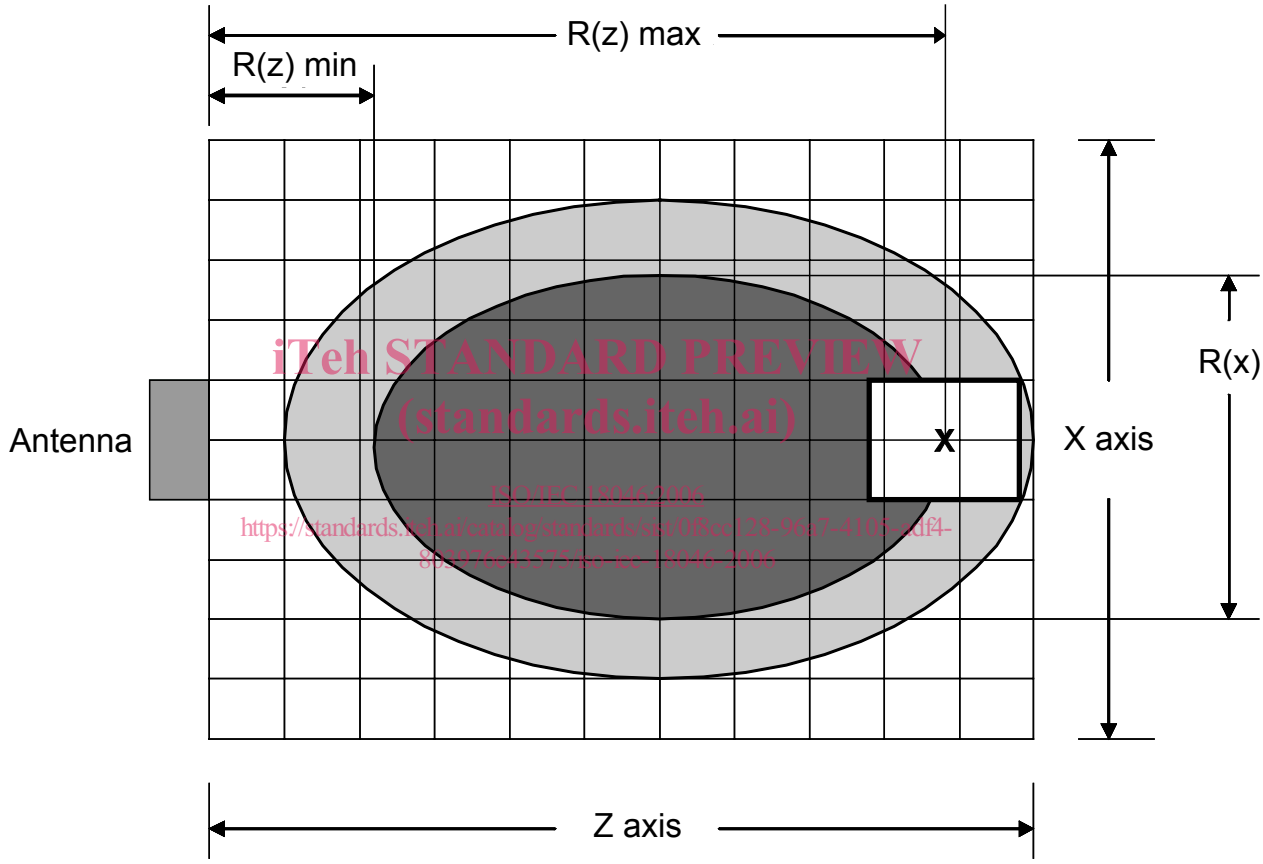

Figure 1 — Top down view of communication zone