INTERNATIONAL STANDARD

ISO/IEC 18046-3

Third edition
2020-10

Information technology — Radio frequency identification device performance test methods —

Part 3: Test methods for tag performance

Technologies de l'information — Méthodes d'essai des performances du dispositif d'identification par radiofréquence —
Partie 3: Méthodes d'essai des perfomances du tag

Reference number
ISO/IEC 18046-3:2020(E)

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

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 https://patents.iec.c).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 third edition cancels and replaces the second (ISO/IEC 18046-3:2012), which has been technically revised.

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

— Change of the frequency range to 860 MHz to 930 MHz, as no countries, including Japan, support a frequency in the 930 MHz to 960 MHz range anymore;

— Adaptation of the test method for 860 MHz to 930 MHz band based on 10 years experience of the use of this document.

A list of all parts in the ISO/IEC 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 3:
Test methods for tag performance

1 Scope

This document defines test methods for performance characteristics of RFID tags for item management and specifies the general requirements and test requirements for tags which are applicable to the selection of devices for an application. The summary of the test reports forms a unified tag 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 18000-6, *Information technology — Radio frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 MHz General*

ISO/IEC 18000-61, *Information technology — Radio frequency identification for item management — Part 61: Parameters for air interface communications at 860 MHz to 960 MHz Type A*

ISO/IEC 18000-62, *Information technology — Radio frequency identification for item management — Part 62: Parameters for air interface communications at 860 MHz to 960 MHz Type B*

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 18000-64, *Information technology — Radio frequency identification for item management — Part 64: Parameters for air interface communications at 860 MHz to 960 MHz Type D*

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 18047-2, *Information technology — Radio frequency identification device conformance test methods — Part 2: Test methods for air interface communications below 135 kHz*

ISO/IEC 18047-6:2017, *Information technology — Radio frequency identification device conformance test methods — Part 6: Test methods for air interface communications at 860 MHz to 960 MHz*

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

λ	wavelength
BLF	backscatter link frequency
BW	bandwidth
D	distance between the tag and the antenna
E	electric field
E_{Max}	maximum operating electromagnetic field
E_{Survival}	survival electromagnetic field
$E_{\text{THR Identification}}$	identification electromagnetic field threshold
$E_{\text{THR Read}}$	reading electromagnetic field threshold
$E_{\text{THR Write}}$	writing electromagnetic field threshold
f_{c}	center frequency
F_{Res}	resonant frequency
f_{tsbr}	frequency tag side band right (frequency of the right side band of the tag spectrum)
f_{tsbl}	frequency tag side band left (frequency of the left side band of the tag spectrum)
G	antenna gain
H_{T}	magnetic field strength
$H_{\text{THR Identification}}$	identification magnetic field threshold
$H_{\text{THR Read}}$	reading magnetic field threshold
$H_{\text{THR Write}}$	writing magnetic field threshold
H_{Max}	maximum operating magnetic field
H_{Survival}	survival magnetic field
$I_{\text{Rejection}}$	interference rejection
M	number of subcarrier cycles per symbol
P_{Max}	maximum operating power of tag
P_{Survival}	survival electromagnetic power of tag

$P_{Rejection}$	interference power
P_{Min}	minimum power operation threshold
$P_{Min,Fade}$	maximum fade rate
P_{Rcv}	interrogator sensitivity
P_{Back}	backscatter power at tag position
Q	quality factor
$RTcal$	interrogator to tag calibration symbol
$S_{Degradation}$	sensitivity degradation
$S_{Directivity}$	sensitivity directivity
$TRcal$	tag to interrogator calibration symbol
U_{RHTA}	peak-peak value of the voltage drop at external serial measurement resistor

NOTE Minimum power operation threshold, P_{Min}, is defined as the minimum power received by the isotropic antenna from the E-field required for the tag to turn-on.

4.2 Abbreviated terms

C	directional coupler
CW	continuous wave
DUT	device under test
EMF	electro magnetic field
FCC	federal communications commission
FR	fade rate
FSK	frequency shift keying
ITF	interrogator talk first
L	length
LM	load modulation
MPE	maximum permissible human exposure
NP0	negative-positive 0 ppm/°C
PCB	printed circuit board
PIE	pulse interval encoding
PR-ASK	phase reversal amplitude shift keying
UHF	ultra high frequency
RF	radio frequency

RX	receive antenna
SAR	specific absorption rate
TE	test equipment
TX	transmit antenna
UII	unique item identifier
V	voltage
VSWR	voltage standing wave ratio

5 Conditions applicable to the test methods

5.1 Number of tags to be tested

All measurements defined in this document may be performed on a single tag, but higher sampling numbers may be required for measurement campaigns for statistical purpose.

5.2 Test environment

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

5.3 RF environment

The tests shall be performed in a known RF environment.

For measurements of propagative UHF tags an anechoic chamber is the recommended test environment (see ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63 or ISO/IEC 18000-64).

For measurements of inductive tags at frequencies below 30 MHz, 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 tags 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).

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 98-3:2008.

5.7 Test result reporting

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

5.8 Test mounting material

For UHF tags, the tests may be performed with or without applied mounting material. When the mounting material is defined by the tag manufacturer, the tests shall be performed with the specified mounting material and in the free air.

If the dielectric parameter or other critical parameters of material are known, then they should be specified in the test report.

5.9 Test communication parameters

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

5.10 Test equipment limitations

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.

5.11 Human exposure to EMF

High magnetic or electromagnetic field strength may exceed the limits of MPE to EMF. This should be taken into account as necessary.

NOTE FCC guidelines for MPE and SAR or EC 1999/519/CE are examples of relevant documents.

6 Setup of test equipment for tag test

6.1 Test apparatus and test circuits for ISO/IEC 18000-2 tags

This clause defines the test apparatus and test circuits for verifying the operation of a tag according to the base standard ISO/IEC 18000-2. The test setups used shall be as described in ISO/IEC 18047-2.

6.2 Test apparatus and test circuits for ISO/IEC 18000-3 tags

This clause defines the test apparatus and test circuits for verifying the operation of a tag according to the base standard ISO/IEC 18000-3. The test setups described in ISO/IEC/TR 18047-3 may be used.

As the test apparatus described in ISO/IEC/TR 18047-3 is only designed for a magnetic field strength up to 5 A/m, the test setups as described in Annex B may be used for magnetic field strength exceeding 5 A/m.

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

6.3.1 Propagative UHF tags measurement

6.3.1.1 General

This clause defines the test apparatus and test circuits for verifying the operation of a tag according to the base standards ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63 and ISO/IEC 18000-64. The test setup used for measurements of propagative UHF tags shall be as shown in 6.3.1.2. Alternatively, the test setup described in ISO/IEC 18047-6 may be used.

6.3.1.2 Setup of the devices

The test setup shall use either a bistatic test setup, as in Figure 1, or a monostatic test setup, as in Figure 2. It shall be ensured that the test equipment (TE) receiver is sensitive enough to not limit the measurements.

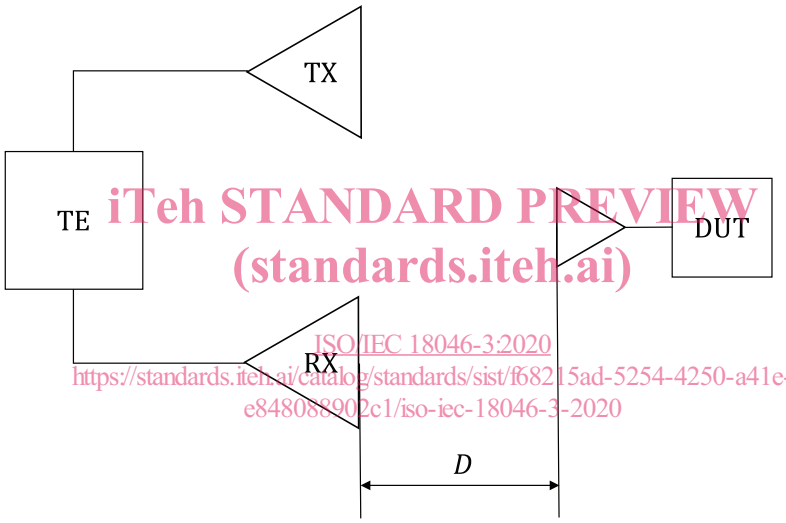

Figure 1 — Bistatic test setup

In Figure 1, RX is the receive antenna, TX is the transmit antenna and TE is the test equipment.

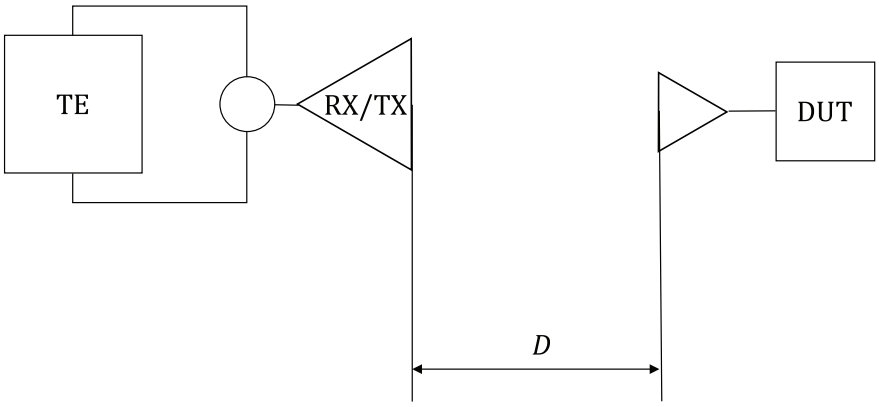

Figure 2 — Monostatic test setup

In Figure 2, the same antenna is used as RX and TX.

6.3.1.3 DUT placement

The DUT shall be placed in the far field according to Figure 1 or Figure 2. The distance, *D*, shall be at least as caluclated using Formula (1):

$$D = \frac{2L^2}{\lambda} \tag{1}$$

where

λ is the wavelength, and

L is the maximum dimension of the test antenna.

6.3.1.4 Antenna polarization and requirements

For propagative UHF tests, a linear or circular polarized antenna shall be used, except when testing tags that have more than one antenna or for sensitivity degradation measurements, in which case a circular polarized antenna shall be used.

The circular polarized antenna shall have an axial ratio that is less than 1 dB over the frequency and orientation ranges of the testing.

Antennae used together in one measurement setup shall have the same gain with a VSWR <1:2.

6.3.1.5 Test setup for interference rejection measurements of propagative UHF tags

Figure 3 and Figure 4 show the test setup arrangements for interference rejection measurements:

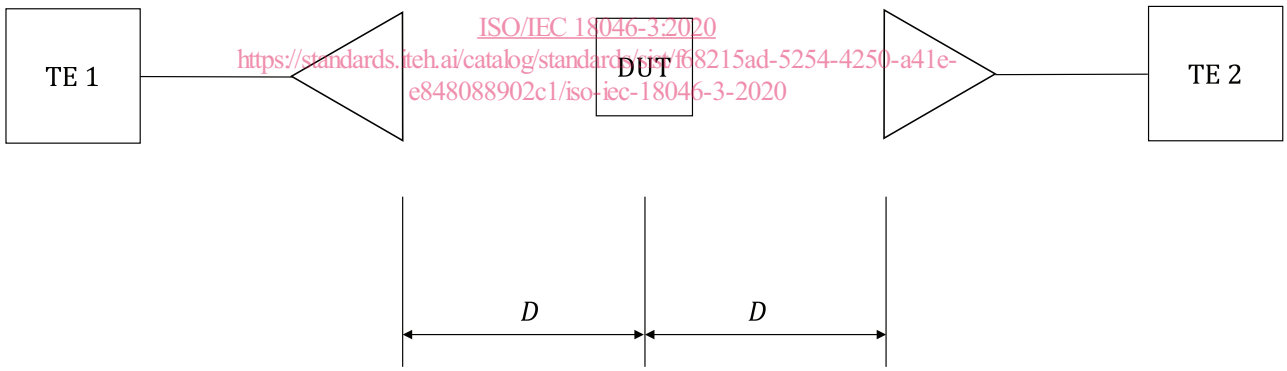

Figure 3 — Test setup for interference rejection measurement

In Figure 3, TE 1 represents the desired RF generator test equipment and TE 2 represents the interferer RF generator test equipment.