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Information technology — Radio frequency identification device conformance test methods —

Part 3: Test methods for air interface communications at 13,56 MHz

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Foreword

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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 or www.iec.ch/members_experts/refdocs).

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This document was prepared by Technical Committee ISO/IEC JTC1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

A list of all parts in the ISO/IEC ISO/IEC 18047 series can be found on the ISO and IEC websites.

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 and www.iec.ch/national-committees.

Introduction

ISO/IEC 18000 defines the air interfaces for radio frequency identification (RFID) devices used in item management applications. ISO/IEC 18000-3 defines the air interface for these devices operating in the 13,56 MHz industrial, scientific, and medical (ISM) band and used in these applications.

Each part of ISO/IEC 18047 contains all measurements required to be made on a product in order to establish whether it conforms to the corresponding part of ISO/IEC 18000. For ISO/IEC 18047-3, each product should be assessed following either the procedure defined for ISO/IEC 18000-3 Mode 1, for Mode 2 or for Mode 3.

Information technology — Radio frequency identification device conformance test methods —

Part 3: Test methods for air interface communications at 13,56 MHz

1 Scope

This document defines test methods for determining the conformance of radio frequency identification devices (tags and interrogators) for item management with the specifications given in ISO/IEC 18000-3. It does not apply to the testing of conformity with regulatory or similar requirements.

The test methods intend to verify the mandatory functions, and any optional functions which are implemented. This can, in appropriate circumstances, be supplemented by further, application-specific functionality criteria that are not available in the general case.

This document includes the following interrogator and tag conformance parameters:

— mode-specific conformance parameters including nominal values and tolerances;

— parameters that apply directly affecting system functionality and inter-operability.

This document does not include the following:

— parameters that are already included in regulatory test requirements;

— high-level data encoding conformance test parameters (these are specified in ISO/IEC 15962).

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

ISO/IEC 19762, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

3 Terms, definitions, symbols and abbreviated terms

3.1 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 https://www.electropedia.org/

3.1.1
loading effect
change in interrogator antenna current caused by the presence of tag(s) in the field due to the mutual coupling modifying the interrogator antenna resonance and quality factor

3.2 Symbols and abbreviated terms

ar	reference tag width
ASK	amplitude shift keying
asp	air spacing
br	reference tag height
ca	calibration coil width
cb	calibration coil height
co	calibration coil corner radius
dis	distance between test interrogator antenna and sense coils
DUT	device under test
fc	frequency of the operating field
fs	frequency of sub-carrier
H_{max}	maximum field strength of the interrogator antenna field
H_{min}	minimum field strength of the interrogator antenna field
ISM	industrial scientific and medical
lx	length of test interrogator assembly connection cable
lya	test interrogator and sense coil PCB width
lyb	test interrogator and sense coil PCB height
lyd	test interrogator coil diameter
lyw	test interrogator coil track width
nr	number of turns of reference tag
oa	calibration coil outline width
ob	calibration coil outline height
PCB	printed circuit board
rs	sense coil corner radius
sa	sense coil width
sb	sense coil height
sr	reference tag track spacing

wr reference tag track width

4 Conformance tests for ISO/IEC 18000-3 — 13,56 MHz

4.1 General

This document specifies a series of tests to determine the conformance of interrogators and tags. The results of these tests shall be compared with the values of the parameters specified in ISO/IEC 18000-3 to determine whether the interrogator-under-test or tag-under-test conforms.

Unless otherwise specified, the tests in this document shall be applied exclusively to RFID tags and interrogators defined in ISO/IEC 18000-3 Mode 1, Mode 2 and Mode 3.

4.2 Default conditions applicable to the test methods

4.2.1 Test environment

Unless otherwise specified, testing shall take place in an environment of temperature 23 °C ± 3 °C and of relative humidity 40 % to 60 %.

4.2.2 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 h before testing.

4.2.3 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).

4.2.4 Spurious inductance

Resistors and capacitors should have negligible inductance.

4.2.5 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.

4.3 Conformance tests for ISO/IEC 18000-3 Mode 1

4.3.1 General

The conformance tests for ISO/IEC 18000-3 mode 1 are described independent of the tag size. For tests of tags smaller or equal to ID-1 (as defined in ISO/IEC 7810) all dimensions shall be as specified in Annex A. Dimensions of larger tags shall be in accordance with Annex B.

4.3.2 Test apparatus and test circuits

4.3.2.1 General

This subclause defines the test apparatus and test circuits for verifying the operation of a tag or an interrogator according to the base standard, ISO/IEC 18000-3. The test apparatus includes:

— calibration coil (see 4.3.2.2);

— test interrogator assembly (see 4.3.2.3);

— reference tag (see 4.3.2.5);

— digital sampling oscilloscope (see 4.3.2.6).

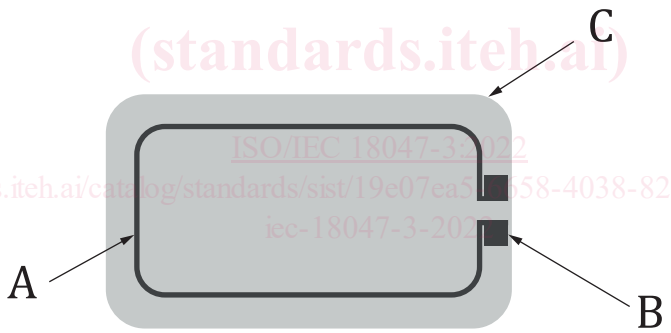
4.3.2.2 Calibration coil

4.3.2.2.1 General

This subclause defines the size, thickness and characteristics of the calibration coil PCB.

4.3.2.2.2 Size of the Calibration coil

The calibration coil PCB consists of an area, which has the height and width defined in Figure 1. Figure 1 shows an example calibration coil containing a single turn coil concentric with the tag outline.



Key

A coil *ca* x *cb*, 1 turn

B connections

C outline *oa* x *ob*

Figure 1 — Example calibration coil

4.3.2.2.3 Thickness and material of the calibration coil substrate

The thickness of the calibration coil PCB shall be 0,76 mm ±10 %. It shall be constructed of a suitable insulating material such as FR4 or equivalent.

4.3.2.2.4 Coil characteristics

The coil on the calibration coil PCB shall have one turn. The outer size of the coil shall be as defined in Figure 1, with a corner radius, *co*.

The coil is made as a printed coil on PCB plated with 35 µm copper. The track width shall be 500 µm ±20 %. The size of the connection pads shall be 1,5 mm × 1,5 mm.

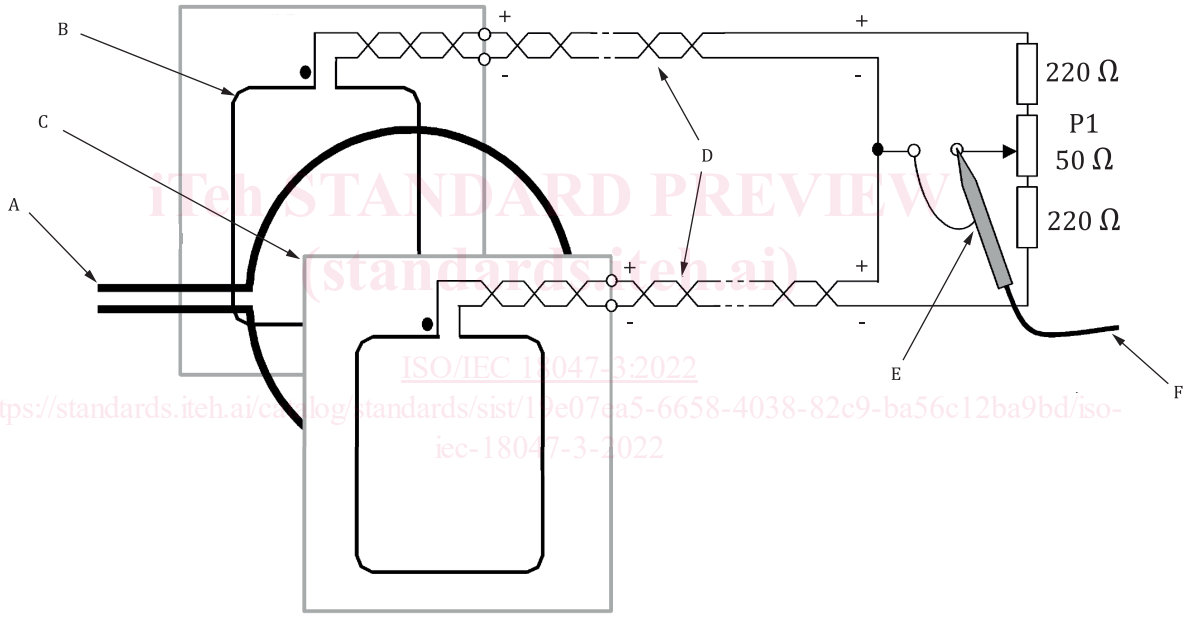
A high impedance oscilloscope probe (e.g. >1 MΩ, <14 pF) shall be used to measure the open circuit voltage in the coil. The resonant frequency of the whole set (calibration coil, connecting leads and probe) shall be above 60 MHz.

4.3.2.3 Test interrogator assembly

4.3.2.3.1 General

The test interrogator assembly for load modulation consists of an interrogator antenna and two parallel sense coils: sense coil A and sense coil B. The test set-up is shown in Figure 2. The sense coils are connected such that the signal from one coil is in opposite phase to the other. The 50 Ω potentiometer P1 serves to fine adjust the balance point when the sense coils are not loaded by a tag or any magnetically coupled circuit. The capacitive load of the probe including its parasitic capacitance shall be less than 14 pF.

The capacitance of the connections and oscilloscope probe should be kept to a minimum for reproducibility.



Key

A interrogator antenna
B sense coil B
C sense coil A
D identical length of twisted pairs of less than *lx* mm
E probe
F to oscilloscope

NOTE The values for the parameters are listed in Table A.2.

Figure 2 — Example test set-up

4.3.2.3.2 Test interrogator antenna

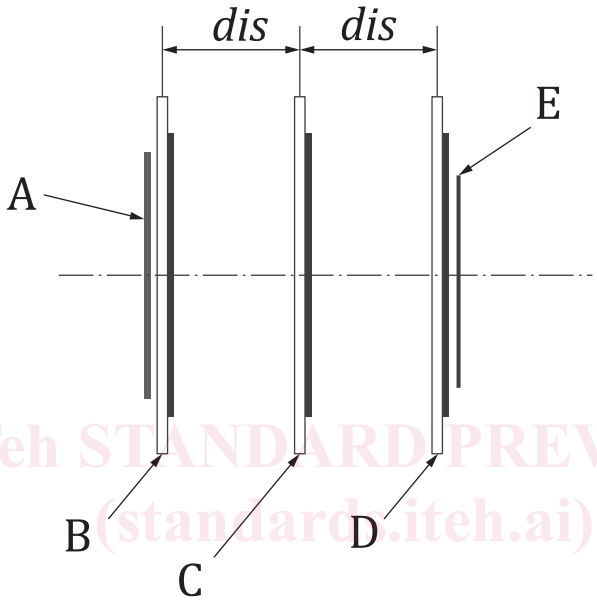
The test interrogator antenna shall have a diameter and a construction conforming to the drawings in Annex C. The tuning of the antenna may be accomplished with the procedure given in Annex D.

4.3.2.3.3 Sense coils

The size and the sense coil construction shall conform to the drawings in Annex E.

4.3.2.4 Assembly of test interrogator

The sense coils and test interrogator antenna shall be assembled parallel to each other. The sense and antenna coils shall be coaxial and the distance between the active conductors shall be as defined in Figure 3. The distance between the coil in the DUT and the coil of the test interrogator antenna shall be equal to the distance between the calibration coil and the coil of the test interrogator antenna.



Key

A DUT
B sense coil A
C interrogator antenna
D sense coil B
E calibration coil

NOTE 1 The asp air spacing avoids parasitic effects such as detuning by closer spacing or ambiguous results due to noise and other environmental effects.

NOTE 2 The values for the parameters are listed in Table A.2.

Figure 3 — Test interrogator assembly

4.3.2.5 Reference tags

4.3.2.5.1 General

Reference tags are defined:

— to test H_{min} and H_{max} produced by an interrogator (under conditions of loading by a tag) and thus to test the ability of an interrogator to power a tag;

— to generate the minimum tag reply load modulation signal.

4.3.2.5.2 Reference tag for interrogator power

The schematic for the power test shall be as defined in Annex F. Power dissipation can be set by the resistor R1 or R2, in order to measure H_{min} and H_{max}, respectively as defined in 4.3.4.1.2. The resonant frequency can be adjusted with C2.

4.3.2.5.3 Reference tag for load modulation reception test

A suggested schematic for the load modulation reception test is shown in Annex G. The load modulation can be chosen to be resistive or reactive.

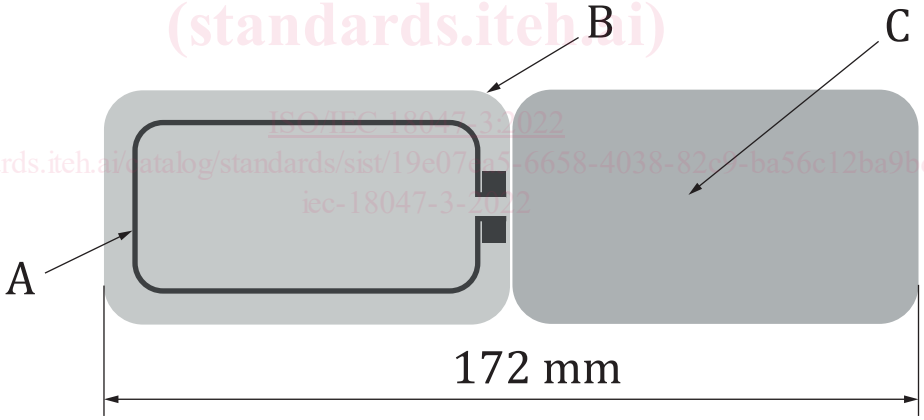
This reference tag is calibrated by using the test interrogator assembly as follows.

The reference tag is placed in the position of the DUT. The load modulation signal amplitude is measured as described in 4.3.3. This amplitude should correspond to the minimum amplitude at all values of field strength required by the base standard, ISO/IEC 18000-3.

4.3.2.5.4 Dimensions of the reference tags

The reference tag which is used for the measurements shall be described in the measurement report. Figure 4 shows as an example an ISO card sized reference tag which consists of an area containing a coil which has the same height and width as those defined in ISO/IEC 7810 for ID-1 type.

An area external to this, containing the circuitry that emulates the required tag functions, is appended so as to allow insertion into the test set-ups described below and so as to cause no interference to the tests.



Key

A coil

B example outline ISO/IEC 7810 ID-1 type

C circuitry

Figure 4 — Example of an ISO card sized reference tag

4.3.2.5.5 Thickness of the reference tag board

The thickness of the reference tag active area shall be 0,76 mm ±10 %.

4.3.2.5.6 Coil characteristics

The coil in the active area of the reference tag shall have nr turns and shall be concentric with the area outline.

The outer size of the coils shall be *ar* x *br*.

The coil is printed on PCB plated with 35 µm copper.

Track width shall be *wr* and spacing shall be *sr*.

NOTE The values for the parameters are listed in Table A.3.

4.3.2.6 Digital sampling oscilloscope

The digital sampling oscilloscope shall be capable of sampling at a rate of at least 100 million samples per second with a resolution of at least 8 bits at optimum scaling. The oscilloscope should have the capability to output the sampled data as a text file to facilitate mathematical and other operations such as windowing on the sampled data using external software programs. An example of the program is shown in Annex H.

4.3.3 Functional test — Tag

4.3.3.1 Purpose

The purpose of this test is to determine the amplitude of the tag load modulation signal within the operating field range (H_{min}, H_{max}) as specified in the base standard, ISO/IEC 18000-3 and the functionality of the tag with the modulation under emitted fields as defined in ISO/IEC 18000-3 parameter table for tag to interrogator link (reference M1-Tag:7).

4.3.3.2 Test procedure

Step 1: Use the load modulation test circuit of Figure 2 and the test interrogator assembly of Figure 3.

The RF power delivered by the signal generator to the test interrogator antenna shall be adjusted to produce the required field strength (H_{min} and H_{max}) and modulation waveforms defined in ISO/IEC 18000-3 as measured by the calibration coil without any tag. The output of the load modulation test circuit of Figure 2 is connected to a digital sampling oscilloscope. The 50 Ω potentiometer P1 shall be trimmed to minimize the residual carrier. This signal shall be at least 40 dB lower than the signal obtained by shorting one sense coil.

Step 2: The tag under test shall be placed in the DUT position, concentric with sense coil A. The RF drive into the test interrogator antenna shall be re-adjusted to the required field strength.

Care should be taken to apply a proper synchronization method for low amplitude load modulation.

Exactly two sub-carrier cycles of the sampled modulation waveform shall be Fourier transformed. A discrete Fourier transformation with a scaling such that a pure sinusoidal signal results in its peak magnitude shall be used. To minimize transient effects, a sub-carrier cycle immediately following a non-modulating period should be avoided. In case of two sub-carrier frequencies, this procedure shall be repeated for the second sub-carrier frequency.

The resulting amplitudes of the upper sideband(s) at *fc + fs1* (and *fc + fs2* if both are present) and the lower sideband(s) at *fc - fs1* (and *fc - fs2,* if present) respectively shall be above the value defined in the base standard, ISO/IEC 18000-3.

An appropriate command sequence as defined in the base standard, ISO/IEC 18000-3 shall be sent by the test interrogator to obtain a signal or load modulation response from the tag.

NOTE See ISO/IEC 10373-7 for appropriate command sequence.

4.3.3.3 Test report

The test report shall give the measured amplitudes of the upper sideband(s) at *fc + fs1* (and *fc + fs2,* if present) and the lower sideband(s) at *fc - fs1* (and *fc - fs2*, if present) and the applied fields and modulations. The pass/fail condition is determined by the values defined in ISO/IEC 18000-3 parameter table for tag to interrogator link (reference M1-Tag:7).

4.3.4 Functional test — Interrogator

4.3.4.1 Interrogator field strength and power transfer

4.3.4.1.1 Purpose

This test measures the field strength produced by an interrogator with its specified antenna in its operating volume as defined in accordance with the base standard, ISO/IEC 18000-3. The test procedure of 4.3.4.1.2 is also used to determine that the interrogator with its specified antenna generates a field not higher than the value specified in ISO/IEC 18000-3 parameter table for interrogator to tag link (reference M1-Int:3 for H_{max} and reference M1-Int:3a for H_{min}).

This test shall use a reference tag as defined in Annex F to determine that a specific interrogator to be tested can supply a certain power to a tag placed anywhere within the defined operating volume.

4.3.4.1.2 Test procedure

a) Procedure for H_{max} test:

1) Tune the reference tag to 13,56 MHz.

The resonant frequency of the reference tag is measured by using an impedance analyzer or a LCR-meter connected to a calibration coil. The coil of the reference tag should be placed at a distance of 10 mm from the calibration coil, with the axes of the two coils being congruent. The resonant frequency is that frequency at which the resistive part of the measured complex impedance is at maximum.

2) Set jumper J1 to position b to activate R2 (see Figure F.1).

3) Sweep the reference tag coaxially with the antenna through the defined operating volume of the interrogator under test at a maximum rate of 1 cm/s.

4) The DC voltage (V_{DC}) across resistor R3 (see Annex F) is measured with a high impedance voltmeter and shall not exceed 3 V where the load resistor parallel to the coil L is set to R2 and the field strength equals H_{max}.

b) Procedure for H_{min} test:

1) Tune the reference tag to 13,56 MHz.

2) Set jumper J1 to position a to activate R1 (see Figure F.1).

3) Sweep the reference tag coaxially with the antenna through the defined operating volume of the interrogator under test at a maximum rate of 1 cm/s.

4) The DC voltage (V_{DC}) across resistor R3 is measured with a high impedance voltmeter and shall exceed 3 V where the load resistor parallel to the coil L is set to R1 and the field strength equals H_{min}.

4.3.4.1.3 Test report

The test report shall give the measured values for V_{DC} at H_{min} and H_{max} under the defined conditions. The pass/fail condition is determined by the values defined in ISO/IEC 18000-3 parameter table for interrogator to tag link (reference M1-Int:3 for H_{max} and reference M1-Int:3a for H_{min}).