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Identification cards — Test methods —

Part 6: Proximity cards

Cartes d'identification — Méthodes d'essai —

Partie 6: Cartes de proximité

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Contents

Page

Foreword........v
1 Scope........1
2 Normative references........1
3 Terms, definitions, symbols and abbreviated terms........2
3.1 Terms and definitions........2
3.2 Symbols and abbreviated terms........3
4 Default items applicable to the test methods........5
4.1 Test environment........5
4.2 Pre-conditioning........5
4.3 Default tolerance........5
4.4 Spurious inductance........6
4.5 Total measurement uncertainty........6
5 Apparatus and circuits for test of ISO/IEC 14443-1 and ISO/IEC 14443-2 parameters........6
5.1 Minimum requirements for measurement instruments........6
5.1.1 Oscilloscope........6
5.2 Calibration coils........6
5.2.1 Size of the calibration coil card........6
5.2.2 Thickness and material of the calibration coil card........7
5.2.3 Coil characteristics........7
5.3 Test PCD assembly........7
5.3.1 Test PCD antenna........8
5.3.2 Sense coils........9
5.3.3 Assembly of Test PCD........9
5.4 Reference PICC........10
5.4.1 Dimensions of the Reference PICC........10
5.4.2 Reference PICC construction........10
5.4.3 Reference PICC resonance frequency tuning........12
5.5 EMD test setup........13
5.5.1 General description........13
5.5.2 Computation of power versus time........13
5.5.3 Noise floor precondition test........14
6 Test of ISO/IEC 14443-1 parameters........14
6.1 PCD tests........14
6.1.1 Alternating magnetic field........14
6.2 PICC tests........15
6.2.1 Alternating magnetic field........15
6.2.2 Static electricity test........16
6.3 PXD tests........17
7 Test of ISO/IEC 14443-2 parameters........18
7.1 PCD tests........18
7.1.1 PCD field strength........18
7.1.2 Void........19
7.1.3 Void........19
7.1.4 Modulation index and waveform........19
7.1.5 Load modulation reception........20
7.1.6 PCD EMD immunity test........21
7.1.7 PCD EMD recovery test........22
7.2 PICC tests........23

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 10373-6:2016
https://standards.iteh.ai/catalog/standards/sist/c9436814-5114-4325-83cc-4dd0ab702226/iso-iec-10373-6-2016

7.2.1 PICC transmission ... 23
7.2.2 PICC EMD level and low EMD time test ... 25
7.2.3 PICC reception ... 26
7.2.4 PICC resonance frequency (informative) ... 27
7.2.5 PICC maximum loading effect ... 28
7.3 Test methods for bit rates of 3*fc*/4, *fc*, 3*fc*/2 and 2*fc* from PCD to PICC ... 29
7.4 PXD tests ... 29

8 Test of ISO/IEC 14443-3 and ISO/IEC 14443-4 parameters ... 29
8.1 PCD tests ... 29
8.2 PICC tests ... 29
8.3 PXD tests ... 29
8.3.1 PCD and PICC Modes ... 29
8.3.2 Automatic mode alternation ... 29

Annex A (normative) Test PCD antennas ... 34

Annex B (informative) Test PCD Antenna tuning ... 43

Annex C (normative) Sense coil ... 45

Annex D (normative) Reference PICCs ... 48

Annex E (normative) Modulation index and waveform analysis tool ... 56

Annex F (informative) Program for the evaluation of the spectrum ... 111

Annex G (normative) Additional PICC test methods ... 117

Annex H (normative) Additional PCD test methods ... 179

Annex I (normative) High bit rate selection test methods for PCD ... 218

Annex J (informative) Program for EMD level measurements ... 232

Annex K (normative) Test methods for bit rates of 3*fc*/4, *fc*, 3*fc*/2 and 2*fc* from PCD to PICC ... 245

Annex L (normative) Frame with error correction test methods ... 331

Bibliography ... 340

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ISO/IEC 10373-6:2016
https://standards.iteh.ai/catalog/standards/sist/c9436814-5114-4325-83cc-4dd0ab702226/iso-iec-10373-6-2016

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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.

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).

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The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

This third edition cancels and replaces the second edition (ISO/IEC 10373-6:2011), which has been technically revised.

It also incorporates the Amendments ISO/IEC 10373-6:2011/Amd 1:2012, ISO/IEC 10373-6:2011/Amd 2:2012, ISO/IEC 10373-6:2011/Amd 3:2012, ISO/IEC 10373-6:2011/Amd 4:2012, and the Technical Corrigendum ISO/IEC 10373-6:2011/Cor 1:2013.

ISO/IEC 10373 consists of the following parts, under the general title Identification cards — Test methods:

— *Part 1: General characteristics*

— *Part 2: Cards with magnetic stripes*

— *Part 3: Integrated circuit cards with contacts and related interface devices*

— *Part 5: Optical memory cards*

— *Part 6: Proximity cards*

— *Part 7: Vicinity cards*

— *Part 8: USB-ICC*

— *Part 9: Optical memory cards — Holographic recording method*

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Identification cards — Test methods — Part 6: Proximity cards

1 Scope

ISO/IEC 10373 defines test methods for characteristics of identification cards according to the definition given in ISO/IEC 7810. Each test method is cross-referenced to one or more base standards, which can be ISO/IEC 7810 or one or more of the supplementary standards that define the information storage technologies employed in identification card applications.

NOTE 1 Criteria for acceptability do not form part of ISO/IEC 10373, but will be found in the International Standards mentioned above.

NOTE 2 Test methods defined in this part of ISO/IEC 10373 are intended to be performed separately. A given proximity card or object, or proximity coupling device, is not required to pass through all the tests sequentially.

This part of ISO/IEC 10373 defines test methods which are specific to proximity cards and objects, and proximity coupling devices and proximity extended devices, defined in ISO/IEC 14443-1, ISO/IEC 14443-2, ISO/IEC 14443-3, and ISO/IEC 14443-4.

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ISO/IEC 10373-1 defines test methods which are common to one or more integrated circuit card technologies and other parts deal with other technology-specific tests.

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2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 7810, *Identification cards — Physical characteristics*

ISO/IEC 14443-1:2016, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 1: Physical characteristics*

ISO/IEC 14443-2:2016, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 2: Radio frequency power and signal interface*

ISO/IEC 14443-3:2016, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 3: Initialization and anticollision*

ISO/IEC 14443-4:2016, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 4: Transmission protocol*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test*

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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 14443-1, ISO/IEC 14443-2, ISO/IEC 14443-3, and ISO/IEC 14443-4, and the following apply.

NOTE Elements in bold square brackets **[ ]** are optional definitions.

3.1.1
base standard
standard which the test method is used to verify conformance to

3.1.2
CascadeLevels
number of cascade levels of the PICC

3.1.3
Command Set
set describing the PICC commands during initialization and anticollision

Note 1 to entry: See ISO/IEC 14443-3:2016, 6.4 for PICC Type A and ISO/IEC 14443-3:2016, 7.5 for PICC Type B.

3.1.4
loading effect
change in PCD antenna current caused by the presence of PICC(s) in the field due to the mutual coupling modifying the PCD antenna resonance and quality factor

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3.1.5
mute
no response within a specified timeout, e.g. expiration of FWT

3.1.6
PICC states
different PICC states during initialization and anticollision

Note 1 to entry: See ISO/IEC 14443-3:2016, 6.3 for PICC Type A and ISO/IEC 14443-3:2016, 7.4 for PICC Type B.

3.1.7
scenario
defined typical protocol and application specific communication to be used with the test methods defined in this part of ISO/IEC 10373

3.1.8
Test Initial State
TIS
element from PICC states that is the PICC state before performing a specific PICC command from Command Set

3.1.9
test method
method for testing characteristics of identification cards for the purpose of confirming their compliance with International Standards

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3.1.10
Test Target State
TTS
element from PICC states that is the PICC state after performing a specific PICC command from Command Set

3.2 Symbols and abbreviated terms

(xxxxx)b	Data bit representations
'XY'	Hexadecimal notation, equal to XY in base 16
ATA(cid)	Answer to ATTRIB, i.e. (mbli+cid CRC_B), with mbli an arbitrary hex value (see ISO/IEC 14443-3:2016, 7.11)
ATTRIB(cid, fsdi)	Default ATTRIB command with PUPI from ATQB, CID = cid and Maximum Frame Size Code value = fsdi, i.e. ('1D' PUPI cid fsdi '01 00' CRC_B)
DUT	Device under test
ESD	Electrostatic Discharge
I(c)$_n$**(**inf **[**,CID = cid**]** **[**,NAD = nad**]** **[**,~CRC**])**	ISO/IEC 14443-4 I-block with chaining bit c∈{1,0}, block number n∈{1,0} and information field inf. By default no CID and no NAD will be transmitted. If CID = cid∈{0...15} is specified, it will be transmitted as second parameter. If NAD = nad∈{0...'FF'} is specified, it will be transmitted as third parameter (or second parameter if no CID is transmitted). If the literal '~CRC' is not specified, a valid CRC corresponding to the type of the PICC will be transmitted by default (i.e. CRC_A or CRC_B)
IUT	Implementation Under Test (ISO/IEC 9646); within the scope of this part of ISO/IEC 10373, IUT represents the PCD under the test
LT	Lower Tester (ISO/IEC 9646), the PICC-emulation part of the PCD-test-apparatus
m	Modulation index
Mute	No response within a specified timeout
N/A	Not applicable
PPS(cid, dri, dsi)	Default PPS request with CID = cid, DRI = dri and DSI = dsi, i.e. ('D' + cid '11' dsi × 4 + dri CRC_A)
R(ACK **[**,CID = cid**]** **[**,~CRC**]**)$_n$	ISO/IEC 14443-4 R(ACK) block with block number n. The definition of the optional CID and ~CRC symbols is as described in the I(c)$_n$ block above
R(NAK **[**,CID = cid**][**,~CRC**]**)$_n$	ISO/IEC 14443-4 R(NAK) block with block number n. The definition of the optional CID and ~CRC symbols is as described in the I(c)$_n$ block above
RATS(cid, fsdi)	Default RATS command with CID = cid and FSDI value = fsdi i.e. ('E0' fsdi × 16 + cid CRC_A)
READY(I)	READY state in cascade level I, I ∈ {1, 2, 3}; e.g. READY(2) is a PICC cascade level 2

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READY*(I) — READY* state in cascade level I, I ∈ {1, 2, 3}; e.g. READY*(2) is a PICC cascade level 2

REQB(N) — REQB command with N as defined in ISO/IEC 14443-3:2016, 7.7

S(WTX)(WTXM [,CID = cid][,~CRC]) — ISO/IEC 14443-4 S(WTX) block with parameter WTXM. The definition of the optional CID and ~CRC symbols is as described in the $I(c)_n$ block above

S(DESELECT **[**,CID = cid**]** **[**,~CRC**]**) — ISO/IEC 14443-4 S(DESELECT) block. The definition of the optional CID and ~CRC symbols is as described in the $I(c)_n$ block above

SAK(cascade) — the SELECT(I) answer with the cascade bit (bit 3) set to (1)b

SAK(complete) — the SELECT(I) answer with the cascade bit (bit 3) set to (0)b

SEL(c) — Select code of level c (i.e. SEL(1) = '93', SEL(2) = '95', SEL(3) = '97')

SELECT(I) — SELECT command of cascade level I, i.e.

SELECT(1) = ('93 70' $UIDTX_1$ BCC CRC_A)

SELECT(2) = ('95 70' $UIDTX_2$ BCC CRC_A)

SELECT(3) = ('97 70' $UIDTX_3$ BCC CRC_A)

SLOTMARKER(n) — Slot-MARKER command with slot number n, i.e. (16 × (n − 1) + 5 CRC_B)

TB-PDU — Transmission Block Protocol Data Unit, which consists of either I-block, R-block or S-block

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TEST_COMMAND1(1) — Default test command consisting of one unchained I-block

NOTE This command depends on the negotiated maximum frame size value of the PICC.

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TEST_COMMAND1(n), n > 1 — Default test command consisting of n chained I-blocks (PCD chaining)

NOTE This command depends on the negotiated maximum frame size value of the PICC.

$TEST_COMMAND1(n)_k$ — INF field of k'th I-block chain of TEST_COMMAND1(n)

NOTE This command depends on the negotiated maximum frame size value of the PICC.

TEST_COMMAND2(n), n > 1 — Default test command which expects a response consisting of n chained I-blocks

NOTE This command depends on the negotiated maximum frame size value of the PCD.

TEST_COMMAND3 — Default test command consisting of one I-block which needs more than FWT time for execution

TEST_RESPONSE1(n) — INF field of the response to TEST_COMMAND1(n)

NOTE This response is assumed to be always unchained.

TEST_RESPONSE2(n) — Response to TEST_COMMAND2(n)

NOTE This response depends on the negotiated maximum frame size value of the PCD.

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$TEST_RESPONSE2(n)_k$	INF field of k'th I-block chain of TEST_RESPONSE2(n) NOTE This response depends on the negotiated maximum frame size value of the PCD.
TEST_RESPONSE3	Response I-block to TEST_COMMAND3 NOTE This response is always assumed to be unchained.
TM-PDU	Test Management Protocol Data Unit (ISO/IEC 9646-1, PDU)
t_{START}	Start of PICC transmission
$UIDTX_I$	Transmitted UID 32-bit data at cascade level I (see Table 1)
UT	Upper Tester (ISO/IEC 9646), the master part of the PCD-test-apparatus
UT_APDU	Upper Tester Application Protocol Data Unit: a packet of data to be sent by the PCD to the LT through the RF interface
V_{load}	DC voltage measured at connector CON3 of the Reference PICC
WUPB(N)	WUPB command with N as defined in ISO/IEC 14443-3:2016, 7.7
~X	Bit sequence consisting of the inverted bits of bit sequence X or any other bit sequence different from X
X[[a...b]]	Bit subsequence of bit sequence X consisting of the bits between position a and b included. If a > b then the sequence is empty
X[[n]]	Bit at position n of bit sequence X. First bit is at position 1
X[n]	Byte at position n of bit sequence X. First byte is at position 1 (i.e. X[n] = X[[(n − 1) × 8 + 1...n × 8]])

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Table 1 — Mapping from UID to UIDTX

Cascade level	Single UID PICC	Double UID PICC	Triple UID PICC
$UIDTX_1$	UID0 UID1 UID2 UID3	'88' UID0 UID1 UID2	'88' UID0 UID1 UID2
$UIDTX_2$	—	UID3 UID4 UID5 UID6	'88' UID3 UID4 UID5
$UIDTX_3$	—	—	UID6 UID7 UID8 UID9

4 Default items applicable to the test methods

4.1 Test environment

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

4.2 Pre-conditioning

No environmental pre-conditioning of PICCs or PCDs is required by the test methods in this part of ISO/IEC 10373.

4.3 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).

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4.4 Spurious inductance

Resistors and capacitors should have negligible inductance.

4.5 Total measurement uncertainty

The total measurement uncertainty for each quantity determined by these test methods shall be stated in the test report.

Basic information is given in ISO/IEC Guide 98-3.

5 Apparatus and circuits for test of ISO/IEC 14443-1 and ISO/IEC 14443-2 parameters

This Clause defines the test apparatus and test circuits for verifying the operation of a PICC or a PCD according to ISO/IEC 14443-1 and ISO/IEC 14443-2. The test apparatus includes the following:

— measurement instruments (see 5.1);

— calibration coil (see 5.2);

— Test PCD assembly (see 5.3);

— Reference PICC (see 5.4);

— EMD test setup (see 5.5).

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These are described in the following clauses.

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5.1 Minimum requirements for measurement instruments

5.1.1 Oscilloscope

The digital sampling oscilloscope shall be capable of sampling at a rate of at least 500 million samples per second with a resolution of at least 8 bits at optimum scaling and shall have an overall minimum bandwidth of 250 MHz. 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 software programs (see Annex E and Annex F).

NOTE The overall bandwidth is the combination of oscilloscope and probing system bandwidth.

5.2 Calibration coils

This subclause defines the size, thickness and characteristics of the calibration coils 1 and 2.

Calibration coil 1 shall be used only in Test PCD assembly 1 and calibration coil 2 shall be used only in Test PCD assembly 2.

5.2.1 Size of the calibration coil card

The calibration coil card shall consist of an area which has the height and width of an ID-1 type defined in ISO/IEC 7810 containing a single turn coil concentric with the card outline (see Figure 1).

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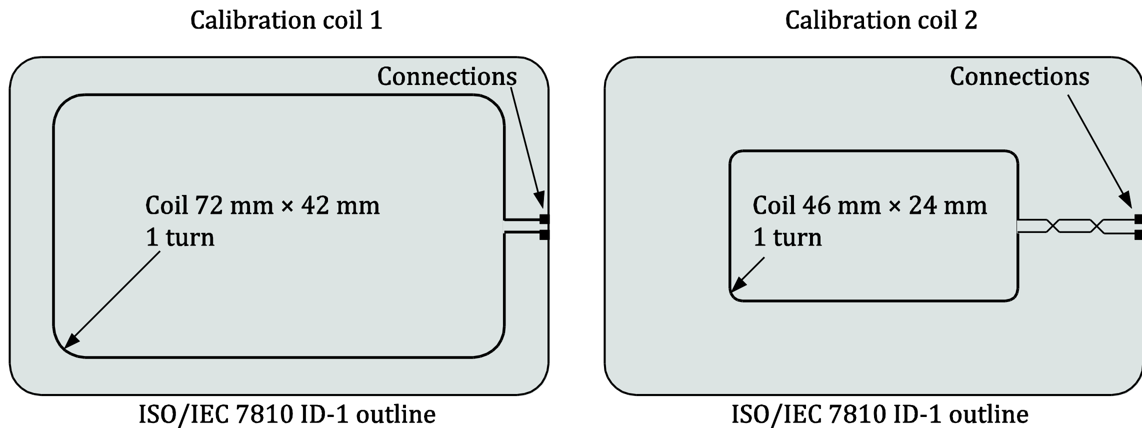

Figure 1 — Calibration coils 1 and 2

5.2.2 Thickness and material of the calibration coil card

The thickness of the calibration coil card shall be less than that of an ID-1 card. It shall be constructed of a suitable insulating material.

5.2.3 Coil characteristics

The coil on the calibration coil card shall have one turn. Relative dimensional tolerance shall be ±2 %.

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The outer size of the calibration coil 1 shall be 72 mm × 42 mm with corner radius 5 mm.

NOTE 1 The area over which the field is integrated is approximately 3 000 mm².

NOTE 2 At 13,56 MHz the approximate inductance is 250 nH and the approximate resistance is 0,4 Ω.

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The open circuit calibration factor for the calibration coil 1 is 0,318 V (rms) per A/m (rms) [Equivalent to 900 mV (peak-to-peak) per A/m (rms)].

The outer size of the calibration coil 2 shall be 46 mm × 24 mm with corner radius 2 mm.

NOTE 3 The area over which the field is integrated is approximately 1 100 mm².

NOTE 4 At 13,56 MHz the approximate inductance is 140 nH and the approximate resistance is 0,3 Ω.

The open circuit calibration factor for the calibration coil 2 is 0,118 V (rms) per A/m (rms) [Equivalent to 333 mV (peak-to-peak) per A/m (rms)].

The coil shall be made as a printed coil on printed circuit board (PCB) plated with 35 µm copper. Track width shall be 500 µm with a relative tolerance of ±20 %. The size of the connection pads shall be 1,5 mm × 1,5 mm.

A high impedance oscilloscope probe with an input admittance equivalent to a parallel capacitance C_p < 14 pF and a parallel resistance R_p > 9 kΩ at 13,56 MHz shall be used to measure the (open circuit) voltage induced in the coil.

The high impedance oscilloscope probe ground connection should be as short as possible, less than 20 mm or coaxial connection.

5.3 Test PCD assembly

Two Test PCD assemblies are defined:

— Test PCD assembly 1 for PICCs of "Class 1", "Class 2" and "Class 3" and for PICCs which do not claim compliance with a class;

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— Test PCD assembly 2 for PICCs of "Class 4", "Class 5" and "Class 6".

Each Test PCD assembly shall consist of a circular Test PCD antenna and two parallel sense coils, sense coil a and sense coil b, as shown in principle by Figure 2. The sense coils shall be connected such that the signal from one coil is in opposite phase to the other. The 10 Ω potentiometer P1 serves to fine adjust the balance point when the sense coils are not loaded by a PICC 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 of the oscilloscope probe should be kept to a minimum for reproducibility.

In order to avoid any unintended misalignment in case of an unsymmetrical set-up the tuning range of the potentiometer P1 is only 10 Ω. If the set-up cannot be compensated by the 10 Ω potentiometer P1, the overall symmetry of the set-up should be checked.

The high impedance oscilloscope probe ground connection should be as short as possible, less than 20 mm or coaxial connection.

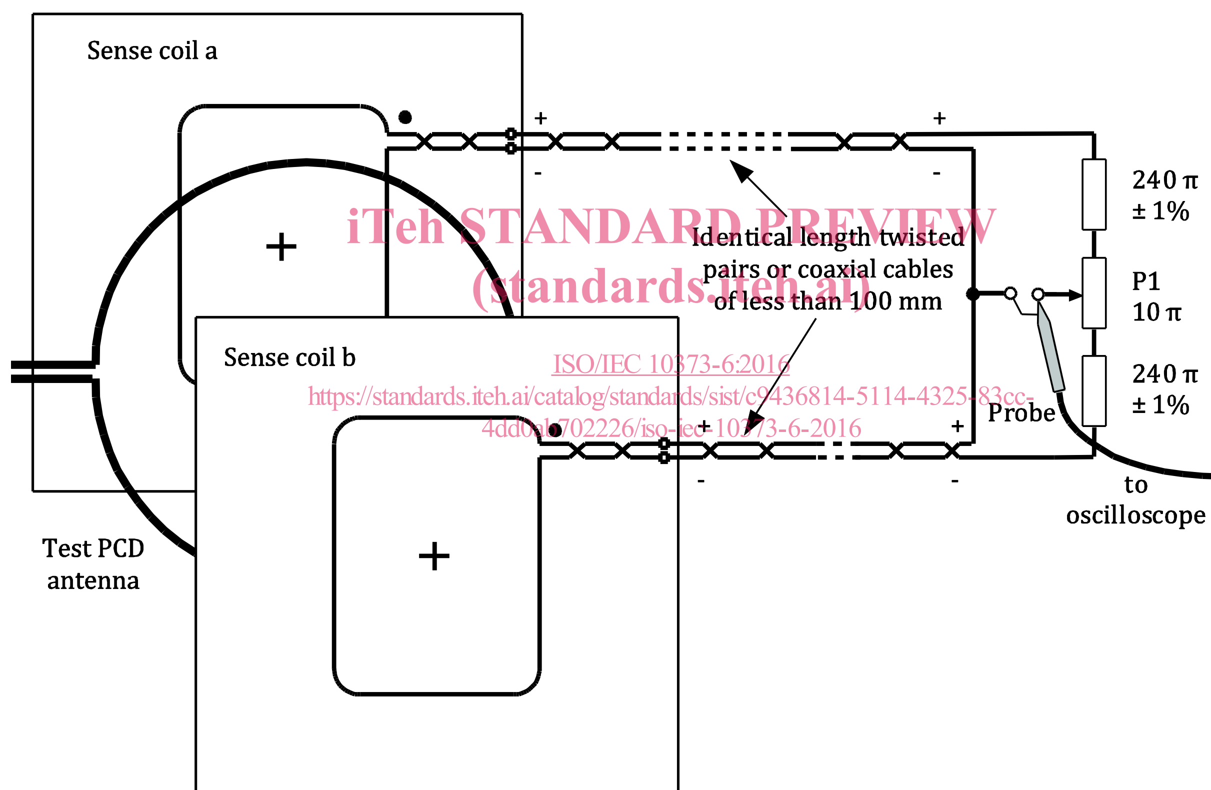

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Figure 2 — Test set-up (principle)

5.3.1 Test PCD antenna

In Test PCD assembly 1 the Test PCD antenna 1 shall have a diameter of 150 mm.

In Test PCD assembly 2 the Test PCD antenna 2 shall have a diameter of 100 mm.

Each Test PCD antenna construction shall conform to the corresponding drawings in Annex A.

The matching of each Test PCD antenna should be accomplished by using an impedance analyzer or a network analyzer or an LCR meter. If either an impedance analyzer or a network analyzer or an LCR meter is not available, then the matching may be accomplished with the procedure given in Annex B.

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5.3.2 Sense coils

In Test PCD assembly 1 the size of the sense coils 1 shall be 100 mm × 70 mm with corner radius 10 mm.

In Test PCD assembly 2 the size of the sense coils 2 shall be 60 mm × 47 mm with corner radius 10 mm.

Each sense coil construction shall conform to the corresponding drawings in Annex C.

5.3.3 Assembly of Test PCD

The sense coils 1 and Test PCD antenna 1 shall be assembled parallel and with the sense and antenna coils coaxial and such that the distance between the active conductors is 37,5 mm as shown in Figure 3, Test PCD assembly 1.

The sense coils 2 and Test PCD antenna 2 shall be assembled parallel and with the sense and antenna coils coaxial and such that the distance between the active conductors is 23 mm as shown in Figure 3, Test PCD assembly 2.

The dimensional tolerance shall be better than ± 0,5 mm. The distance between the coil in the DUT and the calibration coil shall be equal with respect to the coil of the Test PCD antenna.

NOTE These distances are chosen to offer a strong and homogenous magnetic field in the DUT position.

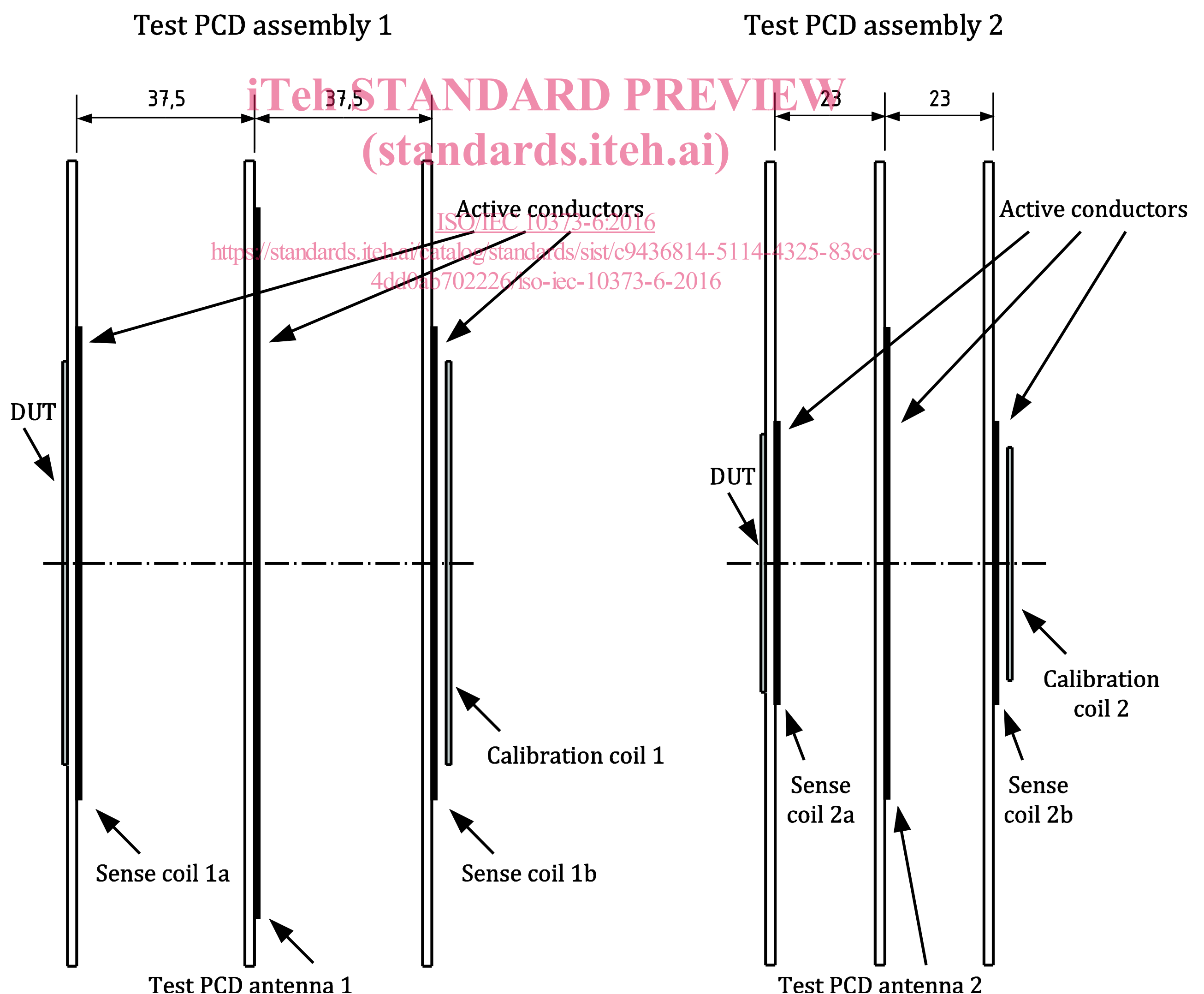

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Figure 3 — Test PCD assembly 1 and Test PCD assembly 2

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