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Identification cards — Test methods — Part 6: Proximity cards

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Contents

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. 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.

ISO/IEC 10373 consists of the following parts, under the general title *Identification card(s) – Test methods:*

- *Part 1 General characteristics tests*
- *Part 2 Cards with magnetic stripes*
- *Part 3 Integrated circuit(s) cards with contacts and related interface devices*
- *Part 4 Contactless integrated circuit cards*
- *Part 5 Optical memory cards*
- *Part 6 Proximity cards*
- *Part 7 Vicinity cards*

Identification cards — Test methods — Part 6: Proximity cards

1 Scope

This International Standard 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 may be ISO/IEC 7810 or one or more of the supplementary standards that define the information storage technologies employed in identification cards applications.

NOTE 1 Criteria for acceptability do not form part of this International Standard but will be found in the International Standards mentioned above.

NOTE 2 Test methods described in this International Standard are intended to be performed separately. A given card is not required to pass through all the tests sequentially.

This part of ISO/IEC 10373 deals with test methods which are specific to contactless integrated circuit(s) card technology (Proximity cards). Part 1 of the standard, General characteristics, deals with test methods which are common to one or more ICC technologies and other parts deal with other technology-specific tests.

Unless otherwise specified, the tests in this part of ISO/IEC 10373 shall be applied exclusively to Proximity cards defined in ISO/IEC 14443-1 and ISO/IEC 14443-2.

2 Normative reference(s)

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 7810:1995 *Identification cards - Physical characteristics*

ISO/IEC 14443-1 *Identification cards - Proximity integrated circuit(s) cards - Part 1: Physical characteristics*

ISO/IEC 14443-2 *Identification cards - Proximity integrated circuit(s) cards - Part 2: Radio frequency power and signal interface*

ISO/IEC 14443-3 *Identification cards - Proximity integrated circuit(s) cards - Part 3: Initialisation and Anticollision*

IEC 61000-4-2: 1995 *Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques - Clause 2: Electrostatic discharge immunity test*

ISBN 92-67-10188-9, 1993 *ISO Guide to the Expression of Uncertainty in Measurement*

3 Terms and definitions

For the purpose of this International Standard, the following definitions and abbreviations apply:

3.1
Base standard
The standard which the test method is used to verify conformance to.

3.2
DUT
Device under test

3.3
ESD
Electrostatic Discharge

3.4
Normal use
Use as an Identification Card (see clause 4 of ISO/IEC 7810:1995), involving equipment processes appropriate to the card technology and storage as a personal document between equipment processes.

3.5
Testably functional
Surviving the action of some potentially destructive influence to the extent that any integrated circuit(s) present in the card continues to show a response[1] as defined in ISO/IEC 14443-3 which conforms to the base standard.

3.6
Test method
A method for testing characteristics of identification cards for the purpose of confirming their compliance with International Standards.

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

Where pre-conditioning is required by the test method, the identification cards to be tested shall be conditioned to the test environment for a period of 24 h before testing.

[1] This International Standard does not define any test to establish the complete functioning of integrated circuit(s) cards. The test methods require only that the minimum functionality (testably functional) be verified. This may, in appropriate circumstances, be supplemented by further, application specific functionality criteria which are not available in the general case.

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).

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 Guide to the Expression of Uncertainty in Measurement", ISBN 92-67-10188-9, 1993.

5 Static electricity test

The purpose of this test is to check the behaviour of the card IC in relation to electrostatic discharge (ESD) exposure in the test sample. The card under test is exposed to a simulated electrostatic discharge (ESD, human body model) and its basic operation checked following the exposure.

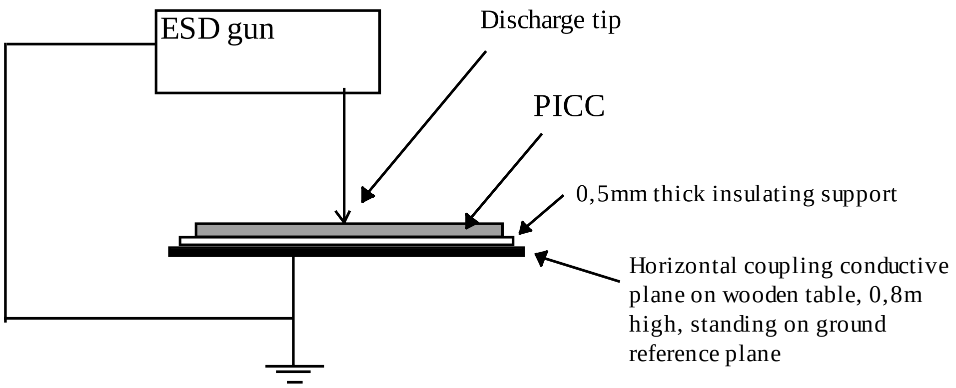


Figure 1 —- ESD test circuit

5.1 Apparatus

Refer to IEC 61000-4-2: 1995.

a) Main specificationsof the ESD generator

- — energy storage capacitance: 150 pF ± 10 %
- — discharge resistance: 330 Ohm ± 10 %
- — charging resistance: between 50 MOhm and 100 MOhm
- — rise time: 0,7 to 1 ns

b) Selected specifications from the optional items

— type of equipment: table top equipment

— discharge method: direct and contact discharge to the equipment under test

— discharge electrodes of the ESD generator: Round tip probe of 8 mm diameter (to avoid breaking the surface label layer of card)

5.2 Procedure

Connect the ground pin of the apparatus to the conductive plate upon which the card is placed.

Apply the discharge successively in normal polarity to each of the 20 test zones shown in Figure 2. Then repeat the same procedure with reversed polarity. Allow a cool-down period between successive pulses of at least 10s.

WARNING - If the card includes contacts, the contacts shall be face up and the zone which includes contacts shall not be exposed to this discharge.

Check that the card remains testably functional (see clause 3) at the end of the test.

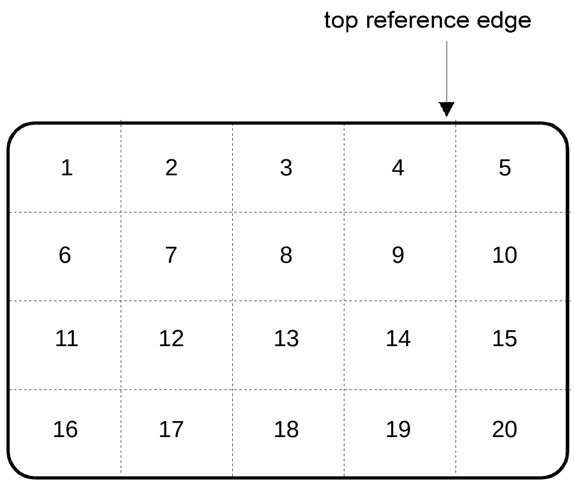


Figure 2 — Test zones on card for ESD test

5.3 Test report

The test report shall state whether the card remains testably functional

6 Test apparatus and test circuits

This clause defines the test apparatus and test circuits for verifying the operation of a PICC or a PCD according to ISO/IEC CD14443-2. The test apparatus includes:

a) **Calibration coil**
b) **Test PCD assembly**
c) **Reference PICCs**
d) **Digital sampling oscilloscope**

These are described in the following clauses.

6.1 Calibration coil

6.1.1 Size of the Calibration coil card

The Calibration coil card shall consist of an area which has the height and width of an ID1 type defined in ISO/IEC 7810 containing a single turn coil concentric with the card outline.

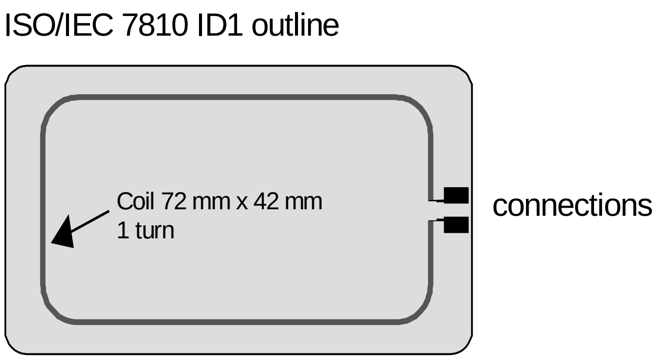


Figure 3 — Calibration coil

6.1.2 Thickness and material of the Calibration coil card

The thickness of the calibration coil card shall be 0,76 mm +/-10%. It shall be constructed of a suitable insulating material.

6.1.3 Coil characteristics

The coil on the Calibration coil card shall have one turn. The outer size of the coil shall be 72 mm x 42 mm with corner radius 5 mm. Relative dimensional tolerance shall be ± 2 %.

NOTE Note: The area over which the field is integrated is 3000 mm^2.

The coil shall be made as a printed coil on PCB plated with 35 µm copper.

Track width shall be 500 µm with a relative tolerance of ± 20 %. The size of the connection pads should be 1,5 mm x 1,5 mm.

NOTE At 13,56 MHz the nominal inductance is 200 nH and the nominal resistance is 0,25 Ohm.

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

The open circuit calibration factor for this coil is 0,32 Volts (rms) per A/m (rms). [Equivalent to 900 mV (peak-to-peak) A/m (rms)]

NOTE The signal on the terminals of the calibration coil should be measured with a high impedance probe which does not load the coil significantly.

6.2 Test PCD assembly

The test apparatus for load modulation shall consist of a 150 mm diameter PCD antenna and two parallel sense coils: sense coil a and sense coil b. The schematic is shown in Figure 4. The sense coils shall be connected such that the signal from one coil is in opposite phase to the other. The 50 Ohm potentiometer 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

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

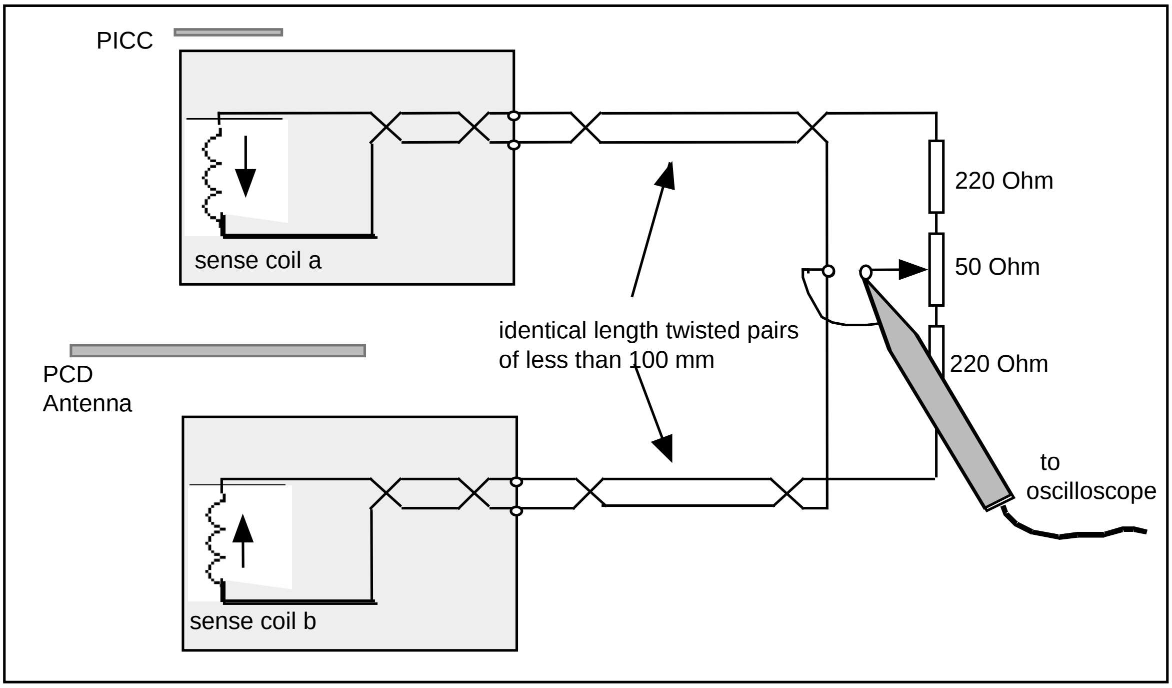


Figure 4 — Load modulation test circuit

6.2.1 Test PCD antenna

The Test PCD antenna shall have a diameter of 150 mm and it's construction shall conform to the drawings in Annex A. The tuning of the antenna may be accomplished with the procedure given in Annex B.

6.2.2 Sense coils

The size of the sense coils shall be 100 mm x 70 mm. The sense coil construction shall conform to the drawings in Annex C.

6.2.3 Assembly of Test PCD

The sense coils and Test PCD antenna 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 in Figure 5.

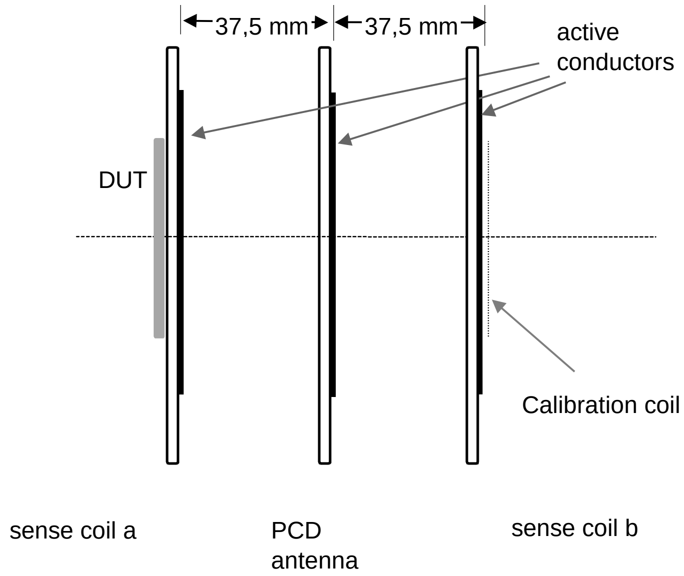


Figure 5 — Test PCD assembly

6.3 Reference PICCs

Reference PICCs are defined to test:

— H_{min} and H_{max} produced by a PCD (under conditions of loading by a PICC)

— the ability of a PCD to power a PICC

— to detect the minimum load modulation signal from the PICC.

6.3.1 Reference PICC for H_{min}, H_{max} and PCD power

The schematic is shown in Annex D. Resistor R1 or R2 may be selected by means of jumper J1. Resonant frequency can be adjusted with CV1.

6.3.2 Reference PICC for load modulation test

The schematic for the load modulation test is shown in Annex E. The load modulation can be chosen to be resistive or capacitive.

This Reference PICC is calibrated by using the Test PCD assembly as follows:

Place the Reference PICC in the position of the DUT. Measure the load modulation signal amplitude as described in clause 7.2.This amplitude should correspond to the minimum amplitude at values of field strength required by the base standard.

6.3.3 Dimensions of the Reference PICC

The reference PICC shall consist of an area containing the coils which has the height and width defined in ISO/IEC 7810 for ID1 type. An area external to this, containing the circuitry which emulates the required PICC functions, shall be appended in such a way as to allow insertion into the test setups described below and so as to cause no interference to the tests. The dimensions shall be as in Figure 6.

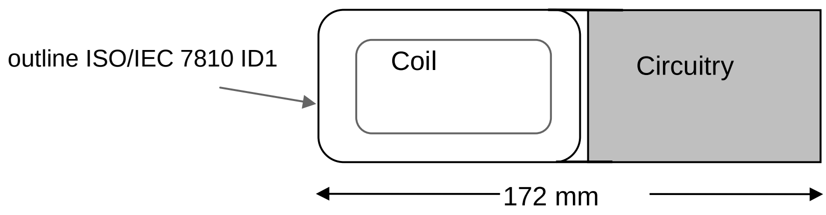


Figure 6 — Reference PICC dimensions

6.3.4 Thickness of the Reference PICC board

The thickness of the reference PICC active area shall be 0,76 mm +/-10%.

6.3.5 Coil characteristics

The coil in the active area of the reference PICC shall have 4 turns and shall be concentric with the area outline.

The outer size of the coils shall be 72 mm x 42 mm with a relative tolerance of ± 2 %.

The coil shall be printed on PCB plated with 35 µm copper.

Track width and spacing shall be 500 µm with a relative tolerance of ± 20 %.

6.4 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 programmes (see Annex F).

7 Functional test - PICC

7.1 Purpose

The purpose of this test is to determine the amplitude of the PICC load modulation signal within the operating field range specified in the base standard.

7.2 Test procedure

Step 1: The load modulation test circuit of Figure 4 and the Test PCD assembly of Figure 5 are used.

Adjust the current in the PCD antenna to the required field strength as measured by the calibration coil. Connect the output of the load modulation test circuit of Figure 4 to a digitizing sampling oscilloscope. The 50 Ohm potentiometer shall be trimmed to minimise the residual carrier. This signal shall be at least 40 dB lower than the signal obtained by shortening one sense coil.

Step 2: The PICC under test shall be placed in the DUT position, concentric with sense coil **a.** The current of the PCD antenna should be re-adjusted to the required field strength.

Display a segment of at least two cycles of the waveform of the subcarrier load modulation f_c on the digital sampling oscilloscope and store the sampled data in a file for analysis by a computer software programme (see Annex F).

Fourier transform exactly two subcarrier cycles of the sampled modulation waveform using suitable computer software. Use a discrete Fourier transformation with a scaling such that a pure sinusoidal signal results in its peak magnitude. To minimize transient effects, avoid a subcarrier cycle immediately following a non-modulating period.

The resulting peak amplitudes of the upper and lower sidebands at $f_c + f_s$ and $f_c - f_s$ shall be above the value defined in the base standard.

A REQA or a REQB command sequence as defined in ISO/IEC 14443-3 shall be sent by the Test PCD to obtain a signal or load modulation response from the PICC.

7.3 Test report

The test report shall give the measured peak amplitudes of the upper and lower sidebands at ($f_c + f_s$) and ($f_c - f_s$).

8 Functional test - PCD

8.1 PCD field strength

8.1.1 Purpose

This test measures the field strength produced by a PCD in the defined operating volume . The test procedure of clause 8.1.2 is also used to determine that the PCD generates a field not higher than the value specified in ISO/IEC 14443-1, in any possible PICC position, by setting H to the required value in steps 1 to 3.

Note: The test takes account of PICC loading of the PCD.

8.1.2 Test procedure

Procedure for H_{max} test:

1. Calibrate the Test PCD assembly to produce the H_{max} operating condition on the calibration coil.

2. Tune the Reference PICC to 19 MHz.

NOTE: The resonance frequency of the test PICC is measured by using an impedance analyser or a LCR-meter connected to a calibration coil. The coil of the test PICC should be placed on the calibration coil as close as possible, with the axes of the two coils being congruent. The resonance frequency is that frequency at which the reactive part of the measured complex impedance is at maximum.

3. Place the Reference PICC (Annex D) into the DUT position on the Test PCD assembly. Switch the jumper to R3 and adjust R3 to obtain 3 V (dc) across it measured with a high impedance voltmeter. Verify the operating field condition by monitoring the voltage on the Calibration coil.

4. Position the Reference PICC within the defined operating volume of the PCD under test. The voltage V_{dc} measured with a high impedance voltmeter across R3 shall not exceed 3 V (dc).

Procedure for $H_{\mathbf{min}}$ test:

1. Calibrate the Test PCD assembly to produce the $H_{\mathbf{min}}$ operating condition on the calibration coil.

2. Tune the Reference PICC to 13,56 MHz.

3. Place the Reference PICC (Annex D) into the DUT position on the Test PCD assembly. Switch the jumper to R3 and adjust R3 to obtain 3 Vdc across it measured with a high impedance voltmeter. Verify the operating field condition by monitoring the voltage on the Calibration coil.

4. Position the Reference PICC within the defined operating volume of the PCD under test. The voltage V_{dc} measured with a high imedance voltmeter across R3 shall exceed 3 V (dc).

8.1.3 Test report

The test report shall note the measured values for V_{dc} at H_{min} and H_{max} under the defined conditions.

8.2 Power transfer PCD to PICC

8.2.1 Purpose

This test is used to determine that the PCD is able to supply a certain power to a PICC placed anywhere within the defined operating volume.

8.2.2 Test procedure

Place the reference PICC into the field with the resonance frequency of the PICC tuned to 13,56 MHz. Measure the voltage across R1 with a high impedance voltmeter and it shall exceed 3V (dc) within the defined operating volume. Repeat the test with the Reference PICC with the resonant circuit tuned to19 MHz.

8.2.3 Test report

The test report shall give the dc voltage measured across R1 within the defined operating volume under the defined conditions.

8.3 Modulation index and waveform

8.3.1 Purpose

This test is used to determine the index of modulation of the PCD field as well as its rise-, fall-, and overshoot values.

8.3.2 Test procedure

Position the Calibration coil anywhere in the defined operating volume, and determine the modulation index and waveform characteristics from the induced voltage on the coil displayed on a suitable oscilloscope.

8.3.3 Test report

The test report shall give the measured modulation index of the PCD field, the rise and fall times and overshoot values as defined in ISO/IEC 14443-2, within the defined operating volume.

8.4 Load modulation reception (informative only)

8.4.1 Purpose

This test may be used to verify that a PCD correctly detects the load modulation of a PICC which conforms to the base standard. It is supposed that the PCD has means to indicate correct reception of the subcarrier produced by a PICC.

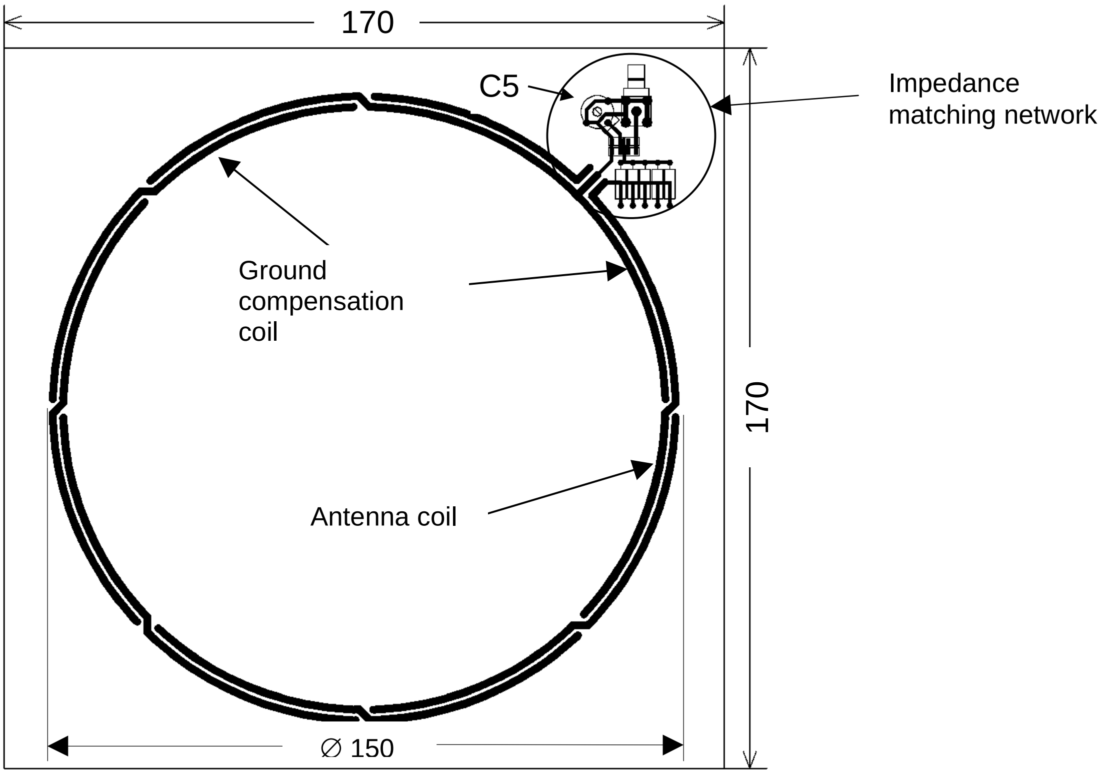
8.4.2 Test procedure

Clause 6.3.2 describes a Reference PICC and calibration procedure which allows the sensitivity of a PCD to load modulation to be assessed. This Reference PICC does not emulate the shunt action of all types of PICC, therefore it shall be calibrated at a given field strength *H* in the Test PCD assembly corresponding to the same value of *H* in which it is to be placed in the PCD field. The latter value of *H* may be measured with the Calibration coil.

Annex A
(normative)

Test PCD Antenna

A.1 Test PCD Antenna layout including impedance matching network



Dimensions in millimetres (Drawings are not to scale).

Note: The antenna coil track width is 1,8 mm.
Starting from the impedance matching network there are crossovers every 45°.
PCB: FR4 material thickness 1,6 mm, double sided with 35 µm copper.

Figure A.1 — Test PCD antenna layout including impedance matching network (View from front)

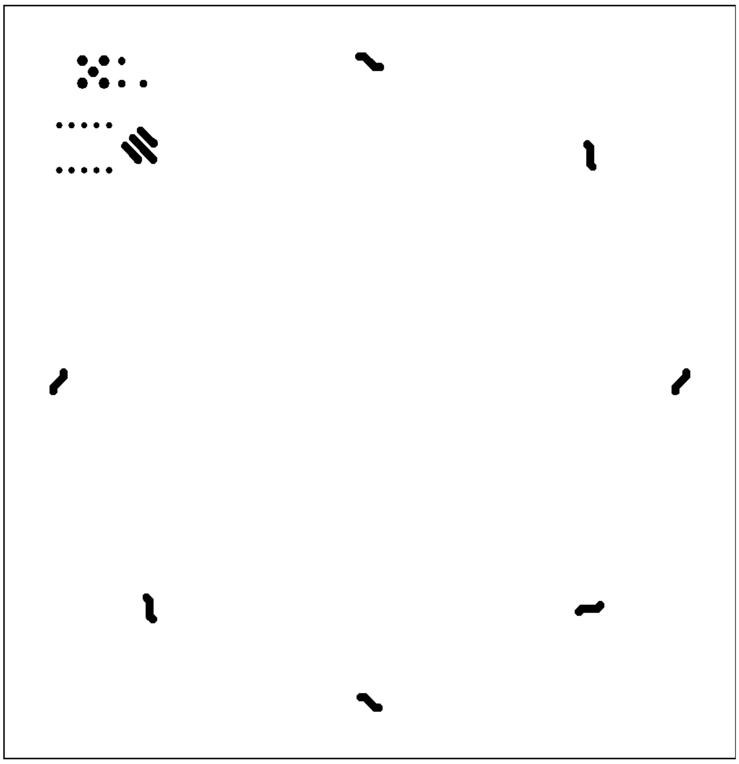
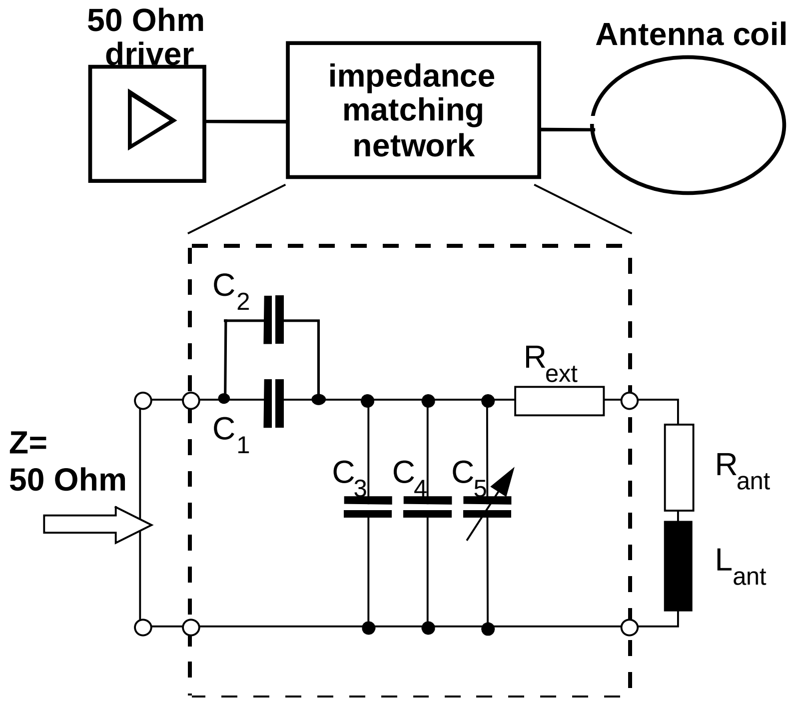


Figure A.2 — PCD Antenna Layout (View from back)

A.2 Impedance matching network

The antenna impedance is adapted to the function generator output impedance (50 Ohm) by a matching circuit (see below). The capacitors C1, C2, C3 and C4 have fixed values. The input impedance phase can be adjusted with the variable capacitor C5.

NOTE Care has to be taken to keep maximum voltages and maximum power dissipation within the specified limits of the individual components.



Component Table:

	Value	Unit
C1	39	pF
C2	8,2	pF
C3	180	pF
C4	33	pF
C5	2-27	pF
Rext	5x4,7 (parallel)	Ohm

Figure A.3 — Impedance matching network

Annex B
(informative)

Test PCD Antenna tuning

The figures below show the two steps of a simple phase tuning procedure to match the impedance of the antenna to that of the driving generator. After the two steps of the tuning procedure the signal generator should be directly connected to the antenna output for the tests.

Step 1:

A high precision resistor of 50 Ohm (e.g. 50 Ohm BNC terminating resistor) is inserted in the ground line between the function generator output and an antenna connector. The two probes of the oscilloscope are connected to the function generator output and in parallel to the serial reference resistor. The oscilloscope displays a Lissajous figure when it is set in Y to X presentation. The function generator is set to:

Wave form: Sinusoidal

Frequency : 13,56 MHz

Amplitude: 2V - 5V

The probe, which is connected in parallel to the reference resistor has a small parasitic capacitance C_{probe}. A calibration capacitance C_{cal} in parallel to the output connector compensates this probe capacitor if $C_{cal} = C_{probe}$. The output is terminated with a second high precision resistor of 50 Ohm (+/-1%) (e.g. 50 Ohm BNC terminating resistor). The probe capacitor is compensated when the Lissajous figure is completely closed.

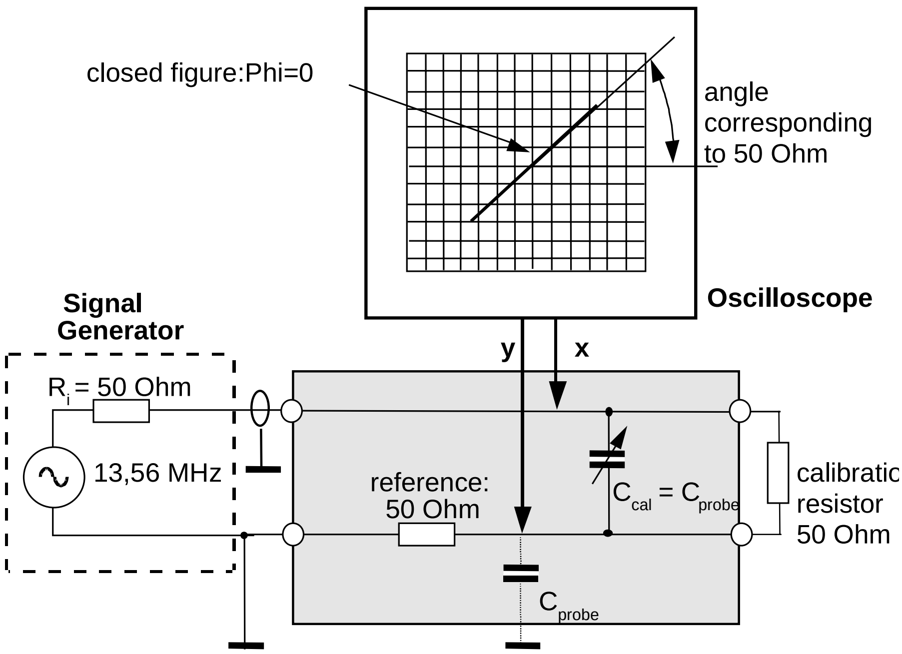


Figure B.1 — Calibration setup (Step 1)

Note: The ground cable has to be run close to the probe to avoid induced voltages caused by the magnetic field.

Step 2:

Using the same values as set for step 1, in the second step the matching circuitry is connected to the antenna output. The capacitor C5 on the antenna board is used to tune the phase to zero.

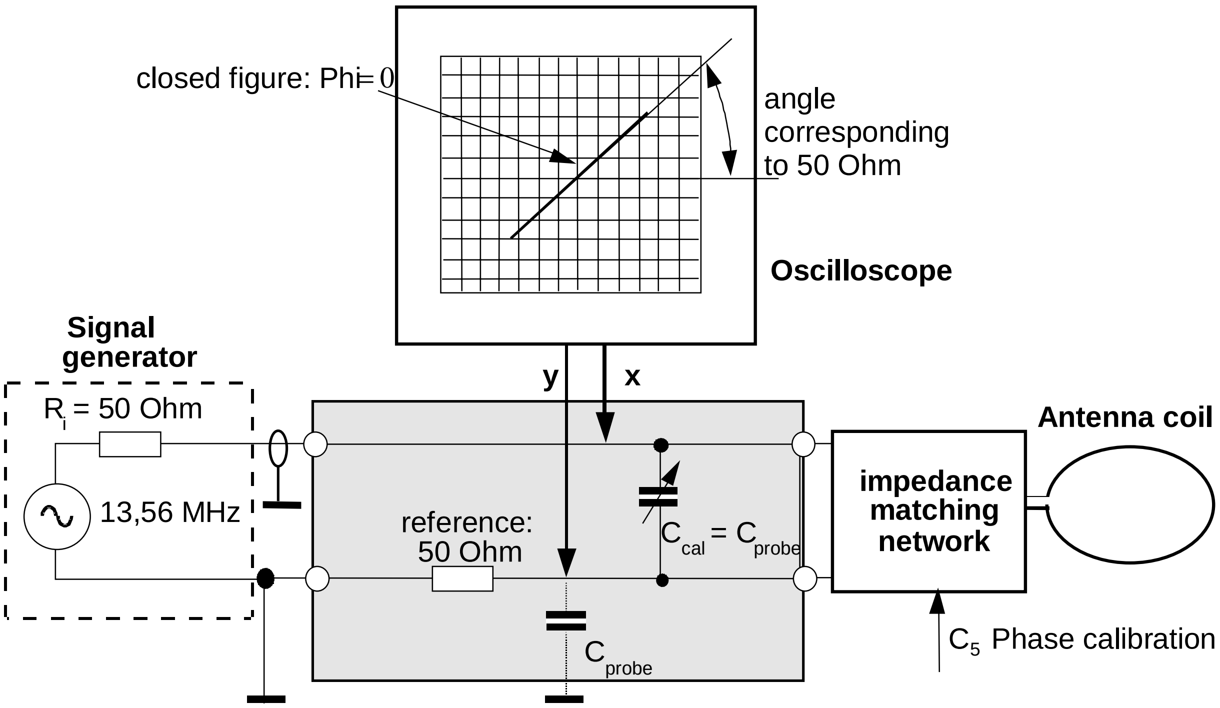
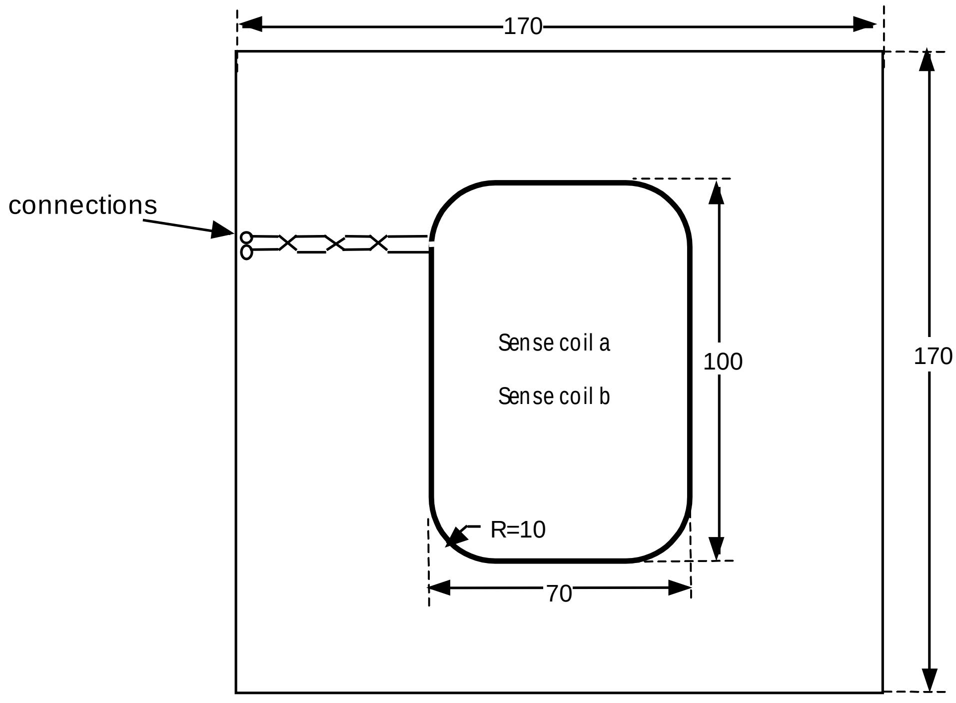


Figure B.2 — Calibration setup (Step 2)

Annex C
(normative)

Sense Coil

C1. Sense coil layout



Dimensions in millimeters (Drawings are not to scale).

Note: PCB of FR4 material thickness 1,6 mm. The coils are made as printed coils plated with 35 µm copper. Sense track width 0,5 mm with relative tolerance ± 20 %. Size of the coils refers to the outer dimensions.

Figure C.1 — Sense coil layout

C2. Sense coil assembly

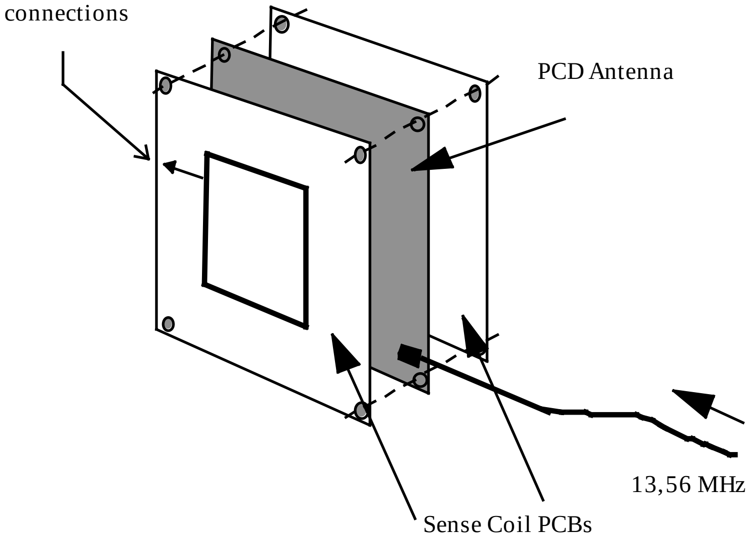
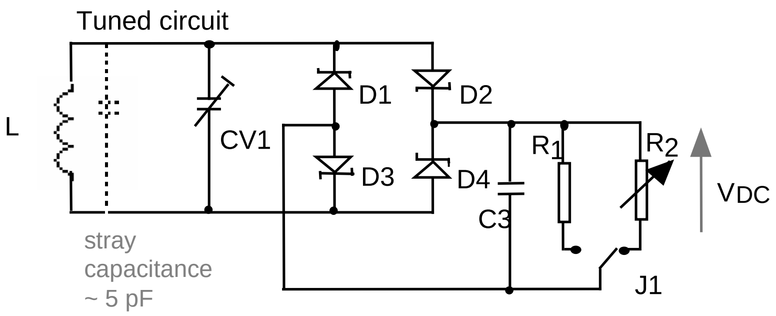


Figure C.2 — Sense coil assembly

Annex D
(normative)

Reference PICC



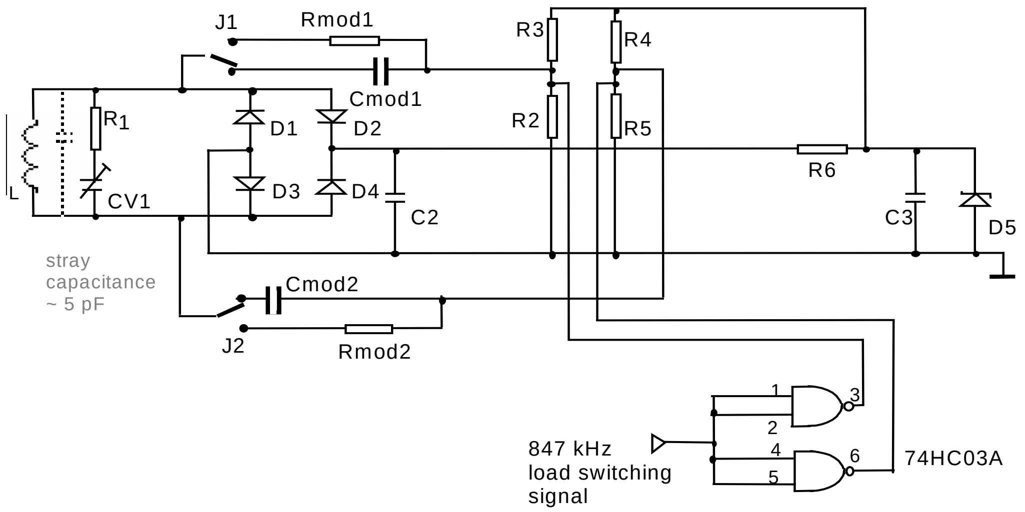
Components list

L (coil)	See 6.3.5
CV1	6-60 pF
C3	10 nF
D1, D2, D3, D4	BAR43 or equivalent
R1	1,8 k Ohm (5 mW)
R2	0 - 5 kOhm

Figure D1 – Circuit diagram for Reference PICC

Annex E
(informative)

Reference PICC for load modulation test



Adjust following components for required emulation:

Component	Function	Value
R1	adjust Q	0 –10 Ohm
CV1	adjust resonance	as required
Cmod1, Cmod2	capacitive modulation	3,3 – 10 pF
Rmod1, Rmod2	resistive modulation	400 Ohm – 12 kOhm
R6	shunt current	10 Ohm – 5 kOhm
D5	shunt voltage	2.7 - 15 V

Components (fixed) list:

Component	Value
R2	1MOhm
R3	1MOhm
R4	1MOhm
R5	1MOhm
D1, D2, D3, D4	BAR43 or equivalent
L	see 6.3.5
CV1	6-60pF
C1	100pF
C2	10nF
74HC03A	open drain output 10 pF max output capacitance to ground

Figure E.1 — Circuit diagram for reference PICC for load modulation test

Annex F
(informative)

Programme for the evaluation of the spectrum

F.1 Programme for the evaluation of the spectrum

The following program gives an example for the calculation of the magnitude of the spectrum from the PICC.

TO BE INCLUDED AFTER FCD