

Identification cards — Test methods —

Part 6: Proximity cards

ICS 35.240.15

National foreword

This British Standard is the UK implementation of ISO/IEC 10373-6:2001+A7:2010. It supersedes BS ISO/IEC 10373-6:2001+A5:2007, which is withdrawn.

ISO/IEC amendments 1:2007, 2:2003, 3:2006, 4:2006, 5:2007 and 7:2010 are appended in National Annex NA due to the technical content of these amendments.

The UK participation in its preparation was entrusted to Technical Committee IST/17, Cards and personal identification.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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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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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.

Attention is drawn to the possibility that some of the elements of this part of ISO/IEC 10373 may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 10373-6 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Identification cards and related devices*.

ISO/IEC 10373 consists of the following parts, under the general title *Identification cards — 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: Close-coupled cards*
- *Part 5: Optical memory cards*
- *Part 6: Proximity cards*
- *Part 7: Vicinity cards*

Annexes A, C and D form a normative part of this part of ISO/IEC 10373. Annexes B, E and F are for information only.

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). ISO/IEC 10373-1, 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 references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 10373. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10373 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 7810:1995, *Identification cards — Physical characteristics*.

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

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

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

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

BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1993, *Guide to the Expression of Uncertainty in Measurement (Gum)*.

3 Terms and definitions, abbreviations and symbols

For the purposes of this part of ISO/IEC 10373, the following terms and definitions and abbreviations apply.

3.1 Terms and definitions

3.1.1

base standard

standard which the test method is used to verify conformance to

3.1.2

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 response¹⁾ as defined in ISO/IEC 14443-3 which conforms to the base standard

NOTE If other technologies exist on the same card they shall be testably functional in accordance with their respective standard.

3.1.3

test method

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

3.2 Abbreviations and symbols

DUT	Device under test
ESD	Electrostatic Discharge
f_c	Frequency of the operating field
f_s	Frequency of the subcarrier
$H_{\max}$	Maximum fieldstrength of the PCD antenna field
$H_{\min}$	Minimum fieldstrength of the PCD antenna field
PCD	Proximity Coupling Device
PICC	Proximity Card

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 Default items applicable to the test methods

4.1 Test environment

Unless otherwise specified, testing shall take place in an environment of temperature $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($73\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$) 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.

4.3 Default tolerance

Unless otherwise specified, a default tolerance of $\pm 5\%$ 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 Gum, 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.

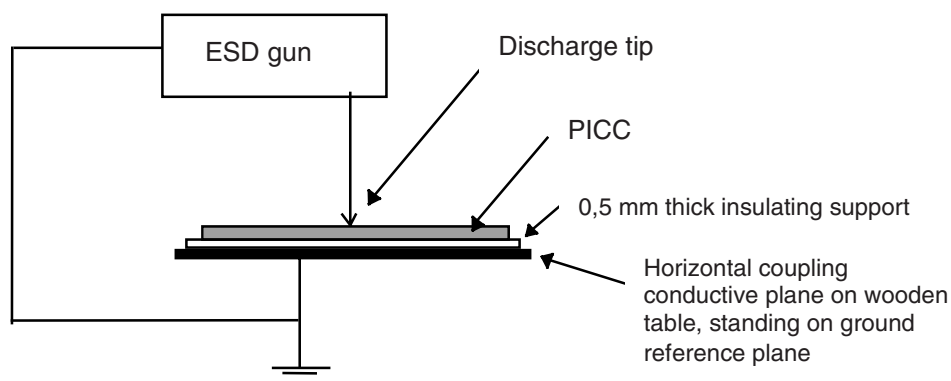


Figure 1 — ESD test circuit

5.1 Apparatus

Refer to IEC 61000-4-2:1995.

- a) Main specifications of 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 10 s.

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.

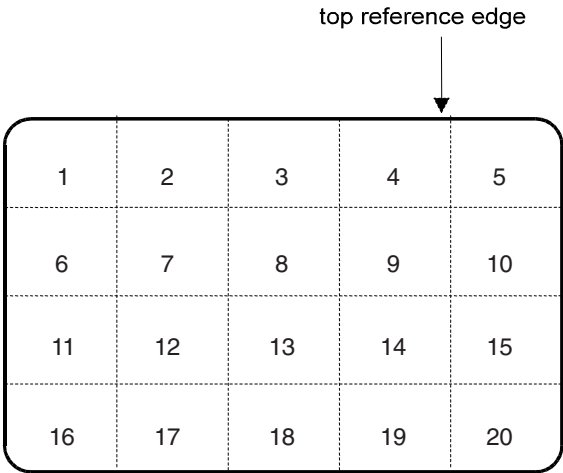


Figure 2 — Test zones on card for ESD test

5.3 Test report

The test report shall state whether or not 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 14443-2. The test apparatus includes:

- Calibration coil (see 6.1)
- Test PCD assembly (see 6.2)
- Reference PICCs (see 6.3)
- Digital sampling oscilloscope (see 6.4)

These are described in the following clauses.

6.1 Calibration coil

This clause defines the size, thickness and characteristics of the 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 ID-1 type defined in ISO/IEC 7810 containing a single turn coil concentric with the card outline.

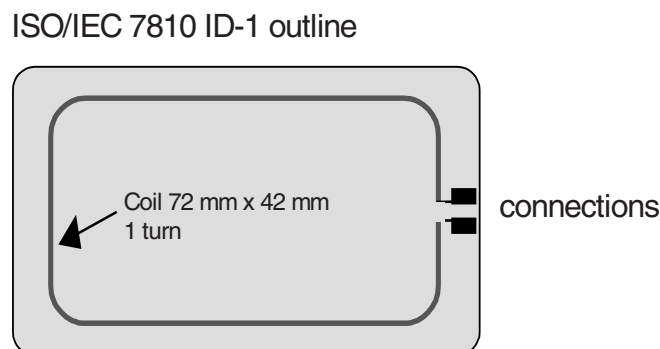


Figure 3 — Calibration coil

6.1.2 Thickness and material of the Calibration coil card

The thickness of the calibration coil card shall be $0,76 \text{ mm} \pm 10 \%$. 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 $72 \text{ mm} \times 42 \text{ mm}$ with corner radius 5 mm . Relative dimensional tolerance shall be $\pm 2 \%$.

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

The coil shall be made as a printed coil on PCB plated with $35 \text{ }\mu\text{m}$ copper. Track width shall be $500 \text{ }\mu\text{m}$ with a relative tolerance of $\pm 20 \%$. The size of the connection pads shall be $1,5 \text{ mm} \times 1,5 \text{ mm}$.

NOTE At $13,56 \text{ MHz}$ the approximate inductance is 200 nH and the approximate resistance is $0,25 \text{ Ohm}$.

A high impedance oscilloscope probe (e.g. $> 1\text{M}\Omega$, $< 14\text{pF}$) 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.

NOTE A parasitic capacitance of the probe assembly of less than 35 pF normally ensures a resonant frequency for the whole set of greater than 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) per A/m (rms)]

6.2 Test PCD assembly

The test PCD assembly shall consist of a 150 mm diameter PCD antenna and two parallel sense coils: sense coil a and sense coil b. The test set-up 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 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.

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

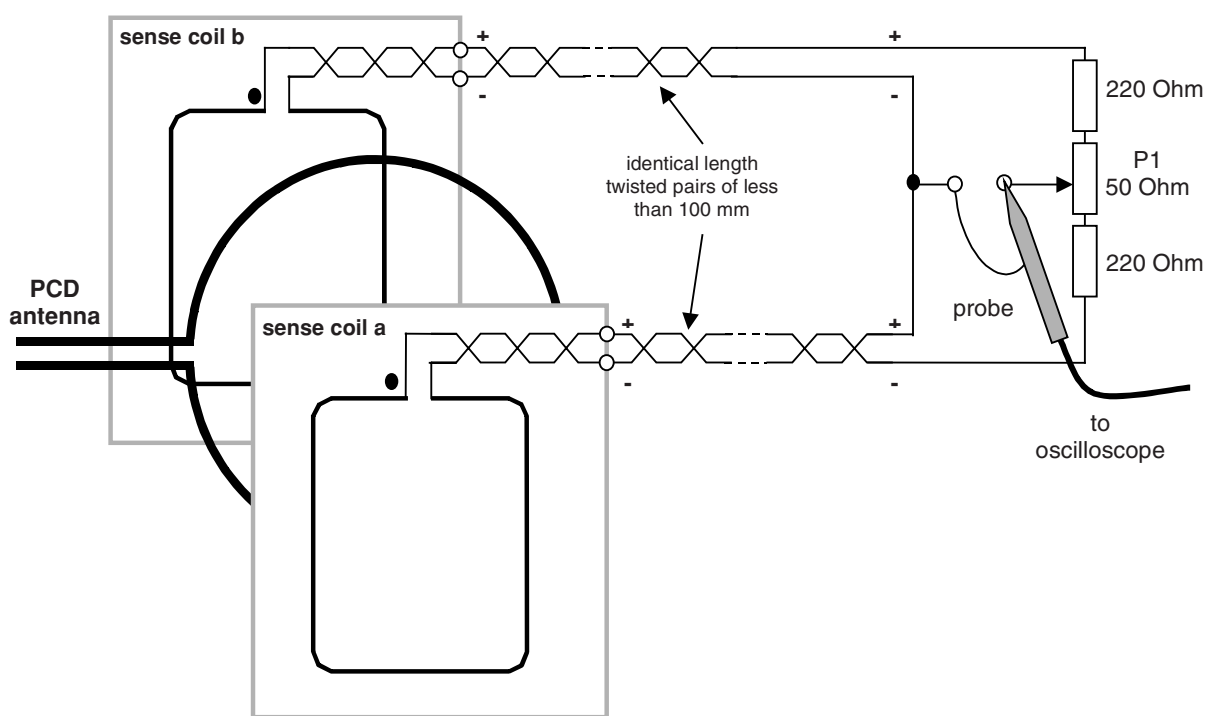


Figure 4 — Test set-up (principle)

6.2.1 Test PCD antenna

The Test PCD antenna shall have a diameter of 150 mm and its 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 $\times$ 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. 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 represent the typical operating distance of the PICC.

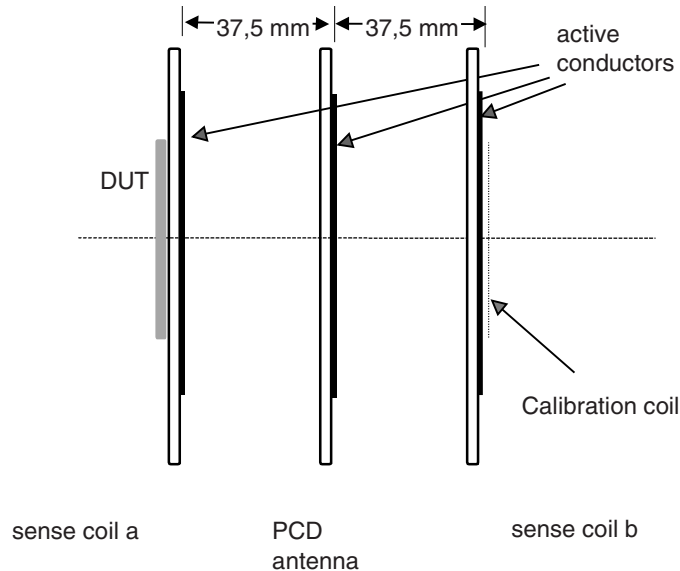


Figure 5 — Test PCD assembly

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)
- to test 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 C2.

6.3.2 Reference PICC for load modulation test

The suggested 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 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 PICCs

The Reference PICCs shall consist of an area containing the coils which has the height and width defined in ISO/IEC 7810 for ID-1 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 set-ups described below and so as to cause no interference to the tests. The dimensions shall be as in figure 6.

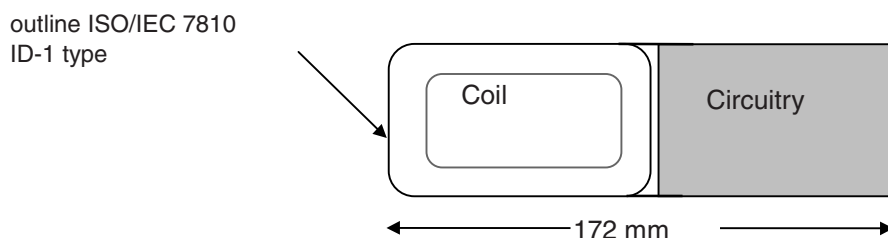


Figure 6 — Reference PICC dimensions

6.3.4 Thickness of the Reference PICCs board

The thickness of the Reference PICCs active area shall be $0,76 \text{ mm} \pm 10 \%$.

6.3.5 Coil characteristics

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

The outer size of the coils shall be $72 \text{ mm} \times 42 \text{ mm}$ with a relative tolerance of $\pm 2 \%$.

The coil shall be printed on PCB plated with $35 \mu\text{m}$ copper.

Track width and spacing shall be $500 \mu\text{m}$ with a relative tolerance of $\pm 20 \%$.

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 $[H_{\min}, H_{\max}]$ as specified in the base standard. Also the functionality of the PICC for Type A and Type B within their corresponding modulation ranges as defined in the base standard shall be determined.

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 RF power delivered by the signal generator to the test 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 digital 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 shorting one sense coil.

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

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

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

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 $fc + fs$ and $fc - fs$ 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 $fc + fs$ and $fc - fs$ and the applied fields and modulations.

8 Functional test - PCD

8.1 PCD field strength

8.1.1 Purpose

This test measures the field strength produced by a PCD with its specified antenna in its operating volume as defined in accordance with the base standard. The test procedure of 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 (Annex D) to 19 MHz.

NOTE The resonance frequency of the Reference 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 into the DUT position on the Test PCD assembly. Switch the jumper to R2 and adjust R2 to obtain $V_{DC} = 3 \text{ V}$ (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 R2 shall not exceed 3 V (dc).

Procedure for $H_{\min}$ test:

1. Calibrate the Test PCD assembly to produce the $H_{\min}$ operating condition on the calibration coil.
2. Tune the Reference PICC (Annex D) to 13,56 MHz.
3. Place the Reference PICC into the DUT position on the Test PCD assembly. Switch the jumper to R2 and adjust R2 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 R2 shall exceed 3 V (dc).

8.1.3 Test report

The test report shall give the dc voltage measured across R2 at $H_{\min}$ and $H_{\max}$ under the conditions applied.

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

With the jumper set to R1 place the Reference PICC (Annex D) into the field with the resonance frequency of the PICC tuned to 19 MHz. Measure the voltage across R1 with a high impedance voltmeter and it shall exceed 3V (dc) within the defined operating volume.

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 the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2.

8.3.2 Test procedure

Position the calibration coil at all positions 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, 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.

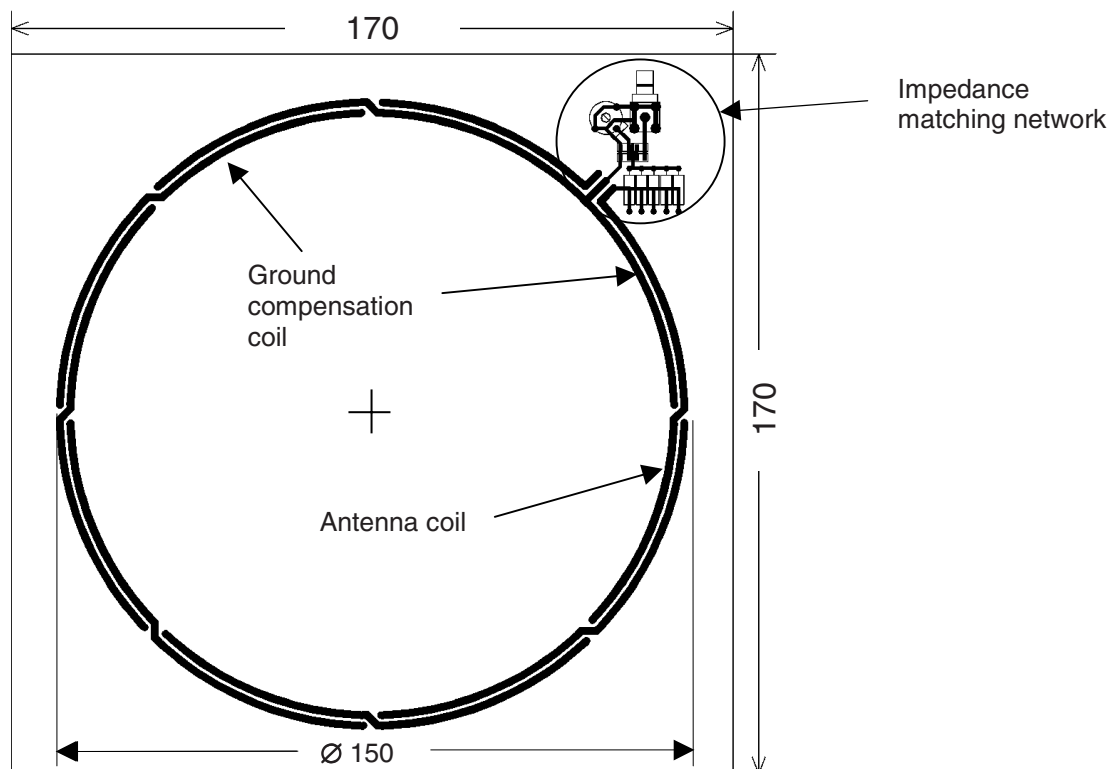
8.4.2 Test procedure

Annex E 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).
The antenna coil track width is 1,8 mm (except for through-plated holes).
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)

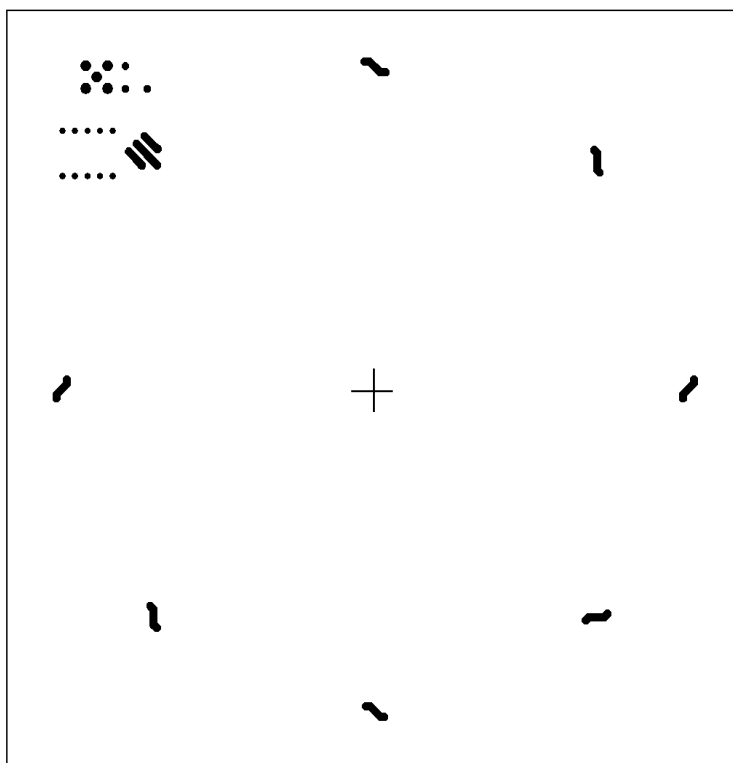


Figure A.2 — PCD Antenna Layout (View from back)

NOTE PCBs and/or Layout may be made available by:

arsenal research
MIFARE® Certification Institute
Faradaygasse 3
A-1030 Vienna
Austria
Phone: +43 50 550-6525
Fax: +43 1 799 19 55
mci@arsenal.ac.at

A.2 Impedance matching network

The antenna impedance (R_{ant} , L_{ant}) is adapted to the signal generator output impedance ($Z=50\text{ Ohm}$) by a matching circuit (see below). The capacitors C1, C2 and C3 have fixed values. The input impedance phase can be adjusted with the variable capacitor C4.

NOTE 1 Care has to be taken to keep maximum voltages and maximum power dissipation within the specified limits of the individual components.

NOTE 2 The linear low distortion variable output 50 Ohm power driver should be capable of emitting Type A and Type B modulations for transmission of REQA/B. For Type B the modulation index should be adjustable in the range of 8 % - 14 %. The output power should be adjustable to deliver H fields in the range of 1,5 A/m – 12 A/m. Care should be taken with the duration of fields above the upper operating range of 7,5 A/m.

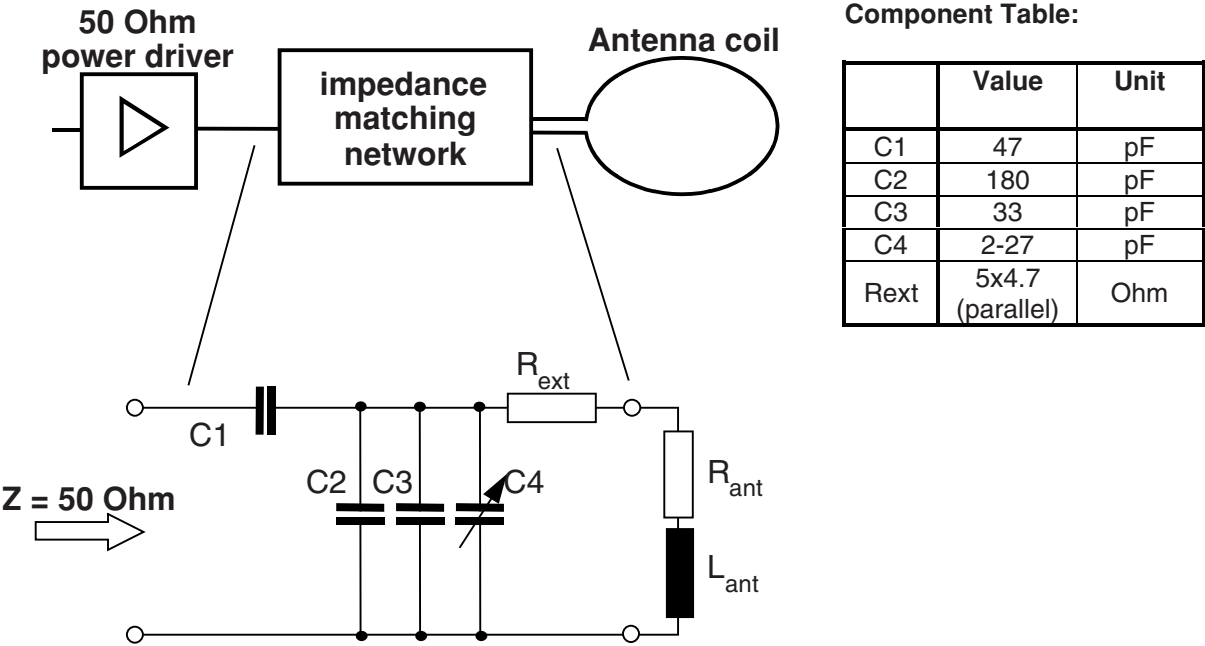


Figure A.3 — Impedance matching network

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 shall be directly connected to the antenna output for the tests.

Step 1:

A high precision resistor of 50 Ohm $\pm 1\%$ (e.g. 50 Ohm BNC resistor) is inserted in the signal line between the signal generator output and an antenna connector. The two probes of the oscilloscope are connected to both sides of the serial reference resistor. The oscilloscope displays a Lissajous figure when it is set in Y to X presentation. The signal generator is set to:

- Wave form: Sinusoidal
- Frequency: 13,56 MHz
- Amplitude: 2V (rms) - 5V (rms)

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

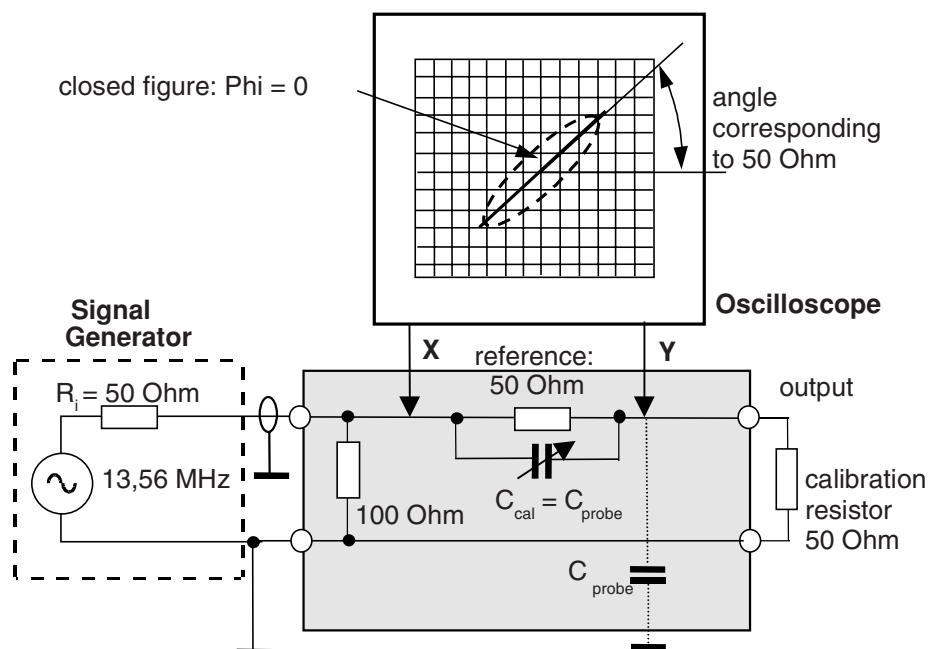


Figure B.1 — Calibration set-up (Step 1)

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 C4 on the antenna board is used to tune the phase to zero.

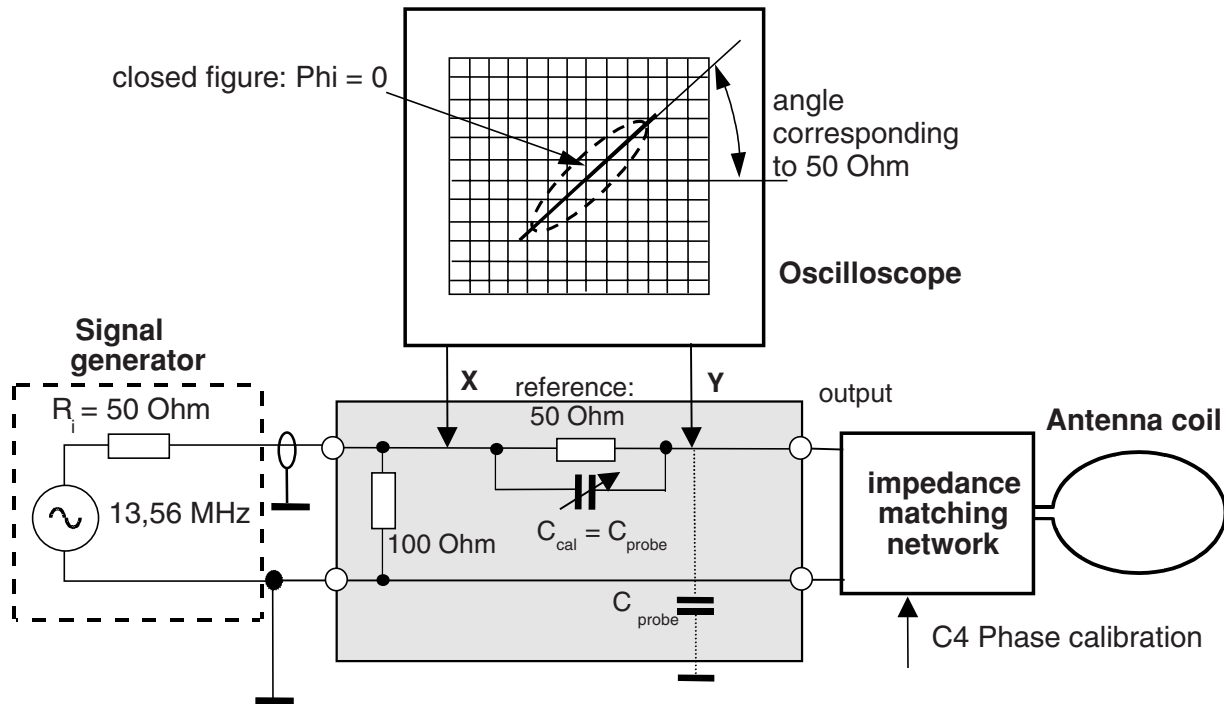
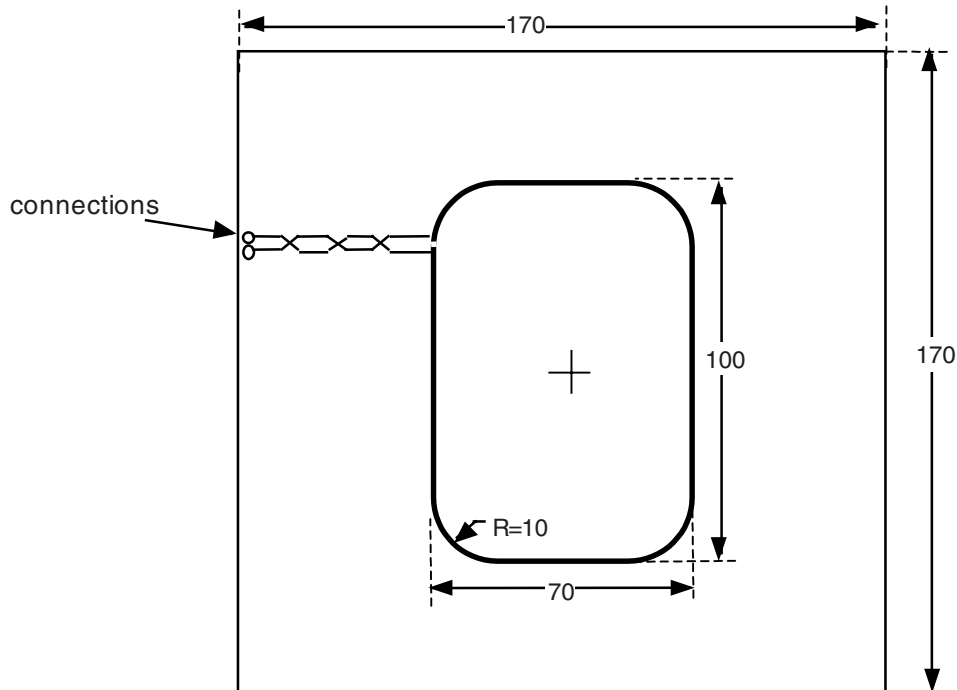


Figure B.2 — Calibration set-up (Step 2)

Annex C (normative)

Sense coil

C.1 Sense coil layout



Dimensions in millimetres (Drawings are not to scale).

The sense coil track width is 0,5 mm with relative tolerance $\pm 20\%$ (except for through-plated holes). Size of the coils refers to the outer dimensions.

PCB: FR4 material thickness 1,6 mm, double sided with 35 μm copper.

Figure C.1 — Layout for sense coils a and b

NOTE PCBs and/or Layout may be made available by:

arsenal research
MIFARE® Certification Institute
Faradaygasse 3
A-1030 Vienna
Austria
Phone: +43 50 550-6525
Fax: +43 1 799 19 55
mci@arsenal.ac.at

C.2 Sense coil assembly

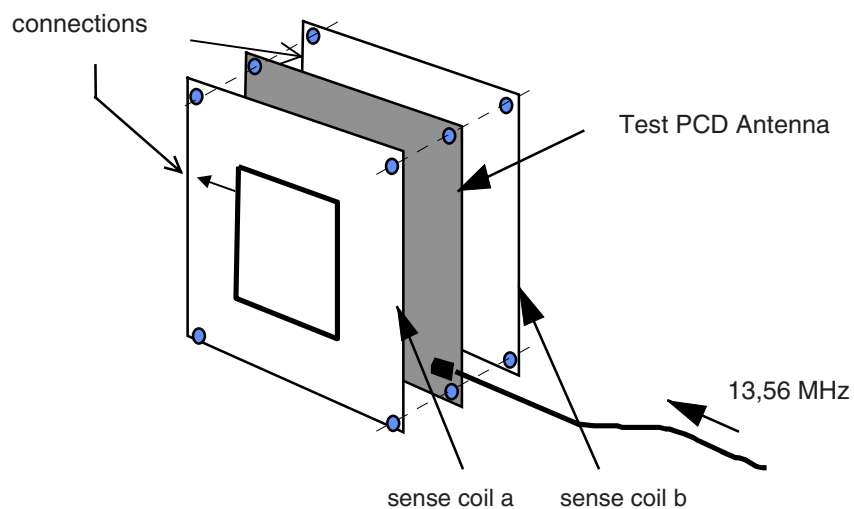
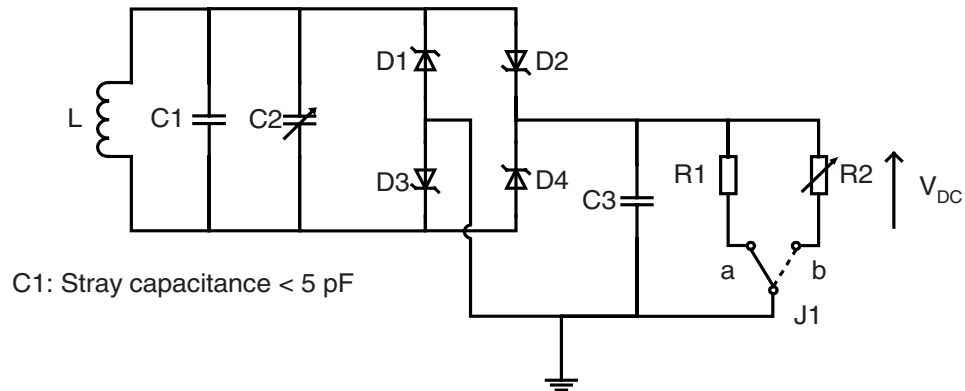


Figure C.2 — Sense coil assembly

Annex D (normative)

Reference PICC for field and power measurements



Component	Value
L (coil)	see 6.3.5
C1	Stray capacitance < 5 pF
C2	6-60 pF
C3	10 nF
D1, D2, D3, D4	see characteristics in table D.1 (BAR 43 or equivalent)
R1	1,8 kOhm
R2	0 - 5 kOhm

Figure D.1 — Circuit diagram for Reference PICC

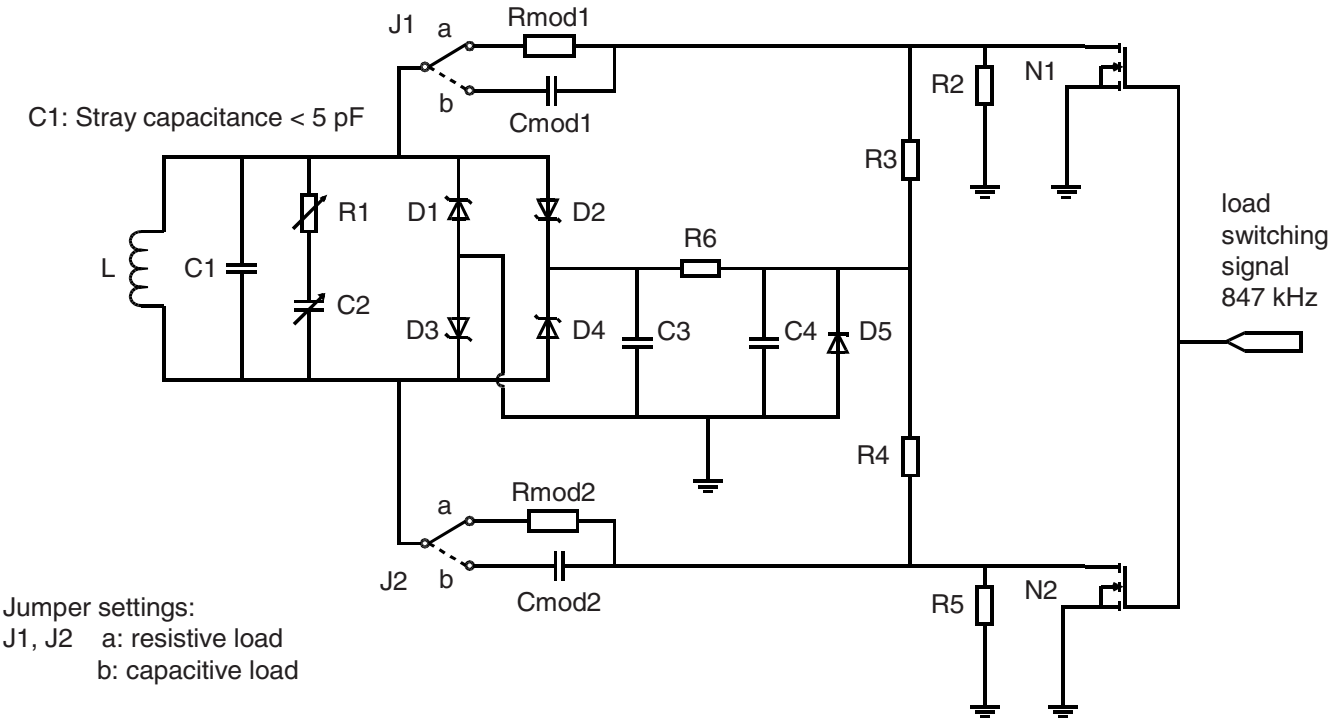
Table D.1 — Specification of basic characteristics of D1, D2, D3, D4

Symbol	Test Condition at $T_j = 25\text{ °C}$	Typ.	Max.	Unit
V_F	$I_F = 2\text{ mA}$		0,33	V
C	$V_R = 1\text{ V}$, $F = 1\text{ MHz}$	7		pF
t_{rr}	$I_F = 10\text{ mA}$, $I_R = 10\text{ mA}$, $I_{rr} = 1\text{ mA}$		5	ns

V_F Forward voltage drop
 V_R Reverse voltage
 I_F Forward current
 I_R Reverse current
 t_{rr} Reverse recovery time
 I_{rr} Reverse recovery current
 T_j Junction temperature
 F Frequency
 C Junction capacitance

Annex E
(informative)

Reference PICC for load modulation test



Adjust following components for required emulation:

Component	Function	Value
R1	adjust Q	0 –10 Ohm
C2	adjust resonance	as required
Cmod1, Cmod2	capacitive modulation	between 3,3 pF and 10 pF
Rmod1, Rmod2	resistive modulation	between 400 Ohm and 12 kOhm
R6	shunt current	between 10 Ohm and 5 kOhm
D5	shunt voltage	between 2,7 V and 15 V

Components (fixed) list:

Component	Value
R2, R3, R4, R5	1 MOhm
D1, D2, D3, D4	as defined in Annex D, table D.1
L	see 6.3.5
C1	Stray capacitance < 5 pF
C2	6-60 pF
C3	100 pF
C4	10 nF
N1, N2	N-MOS transistor; 10 pF max output capacitance to ground

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

Annex F (informative)

Program for the evaluation of the spectrum

The following program written in C language gives an example for the calculation of the magnitude of the spectrum from the PICC.

```

/*****
/**** This program calculates the fourier coefficients      ***
/**** of load modulated voltage of a PICC according      ***
/**** the ISO/IEC 10373-6 Test methods                    ***
/**** The coefficient are calculated for the frequencies:  ***
/**** Carrier:      13.5600 MHz                          ***
/**** Upper sideband: 14.4075 MHz                        ***
/**** Lower sideband: 12.7125 MHz                        ***
/****
/**** Input:                                              ***
/**** File in CSV Format containing a table of two        ***
/**** columns (time and test PCD output voltage vd, clause 7) ***
/****
/**** data format of input-file:                          ***
/**** -----                                             ***
/**** - one data-point per line:                          ***
/****   {time[seconds], sense-coil-voltage[volts]}        ***
/**** - contents in ASCII, no headers                    ***
/**** - data-points shall be equidistant time            ***
/**** - minimum sampling rate: 100 MSamples/second       ***
/**** - modulation waveform centred                      ***
/****   (max. tolerance: half of subcarrier cycle)       ***
/****
/**** "screen-shot of centred modulation-waveform        ***
/****   with 4 subcarrier cycles":                        ***
/****
/**** XXXXXXXXXXXX   xxxx   xxxx   xxxx   xxxXXXXXXXXXXXXX ***
/**** XXXXXXXXXXXX   xxxx   xxxx   xxxx   xxxXXXXXXXXXXXXX ***
/**** XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX ***
/**** XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX ***
/**** XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX ***
/**** XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX ***
/**** XXXXXXXXXXXX   xxxx   xxxx   xxxx   xxxXXXXXXXXXXXXX ***
/**** XXXXXXXXXXXX   xxxx   xxxx   xxxx   xxxXXXXXXXXXXXXX ***
/**** |-----cc-----|
/****
/**** example for spreadsheet file (start in next line): ***
/****   (time)      (voltage)                             ***
/**** 3.00000e-06,1.00                                     ***
/**** 3.00200e-06,1.01                                     ***
/**** .....                                               ***
/****
/**** RUN:                                                 ***
/**** Modtst [filename1[.csv] ... filename[.csv] ]        ***
/****
#include <stdio.h>
#include <conio.h>
#include <string.h>
#include <math.h>
#define MAX_SAMPLES 5000

float pi; /* pi=3.14.... */

/* Array for time and sense coil voltage vd */
float vtime[MAX_SAMPLES]; /* time array

```

```
float vd[MAX_SAMPLES];    /* Array for different coil voltage */

/*****
***   Read CSV File   Function   ***
***                                     ***
***   Description:   ***
***   This function reads the table of time and sense coil ***
***   voltage from a File in CSV Format   ***
***                                     ***
***   Input: filename   ***
***                                     ***
***   Return: Number of samples (sample Count)   ***
***           0   if an error occurred   ***
***                                     ***
***   Displays Statistics:   ***
***                                     ***
***   Filename, SampleCount, Sample rate, Max/Min Voltage   ***
*****/

int readcsv(char* fname)
{
    float a,b;
    float max_vd,min_vd;
    int i;
    FILE    *sample_file;

    /***** Open File *****/
    if (!strchr(fname, '.'))    strcat(fname, ".csv");

    if ((sample_file = fopen(fname, "r"))== NULL)
    {
        printf("Cannot open input file %s.\n",fname);
        return 0;
    }

    /***** Read CSV File *****/
    max_vd=-1e-9F;
    min_vd=-max_vd;
    i=0;

    while (!feof(sample_file))
    {
        if (i>=MAX_SAMPLES)
        {
            printf("Warning: File truncated !!!\n");
            printf("To much samples in file %s\b\n",fname);
            break;
        }
        fscanf(sample_file,"%f,%f\n", &a, &b);
        vtime[i] = a;
        vd[i] = b;
        if (vd[i]>max_vd) max_vd=vd[i];
        if (vd[i]<min_vd) min_vd=vd[i];
        i++;
    }
    fclose(sample_file);

    /***** Displays Statistics *****/
    printf("\n*****\n");

    printf("\nStatistics: \n");
    printf("  Filename      : %s\n",fname);
    printf("  Sample count: %d\n",i);
    printf("  Sample rate  : %1.0f MHz\n",1e-6/(vtime[1]-vtime[0]));
    printf("  Max(vd)      : %4.0f mV\n",max_vd*1000);
    printf("  Min(vd)      : %4.0f mV\n",min_vd*1000);
    return i;
}/**** End ReadCsv *****/
```

```

/*****
/****      DFT : Discrete Fourier Transformation      ****
/*****
/****      Description:                               ****
/****      This function calculate the Fourier coefficient ****
/****
/****      Input: Number of samples                   ****
/****      Global Variables:                         ****
/****
/****      Displays Results:                         ****
/****
/****      Carrier coefficient                       ****
/****      Upper sideband coefficient                 ****
/****      Lower sideband coefficient                 ****
/****
/*****
void dft(int count)
{
    float c0_real,c0_imag,c0_abs,c0_phase;
    float c1_real,c1_imag,c1_abs,c1_phase;
    float c2_real,c2_imag,c2_abs,c2_phase;
    int    N_data,center,start,end;
    float w0,wu,wl;

    int i;

    w0=(float)(13.56e6*2.0)*pi; /* carrier      13.56 MHz */
    wu=(float)(1.0+1.0/16.0)*w0; /* upper sideband 14.41 MHz */
    wl=(float)(1.0-1.0/16.0)*w0; /* lower sideband 12.71 MHz */

    c0_real=0; /* real part of the carrier fourier coefficient */
    c0_imag=0; /* imag part of the carrier fourier coefficient */
    c1_real=0; /* real part of the up. sideband fourier coefficient */
    c1_imag=0; /* imag part of the up. sideband fourier coefficient */
    c2_real=0; /* real part of the lo. sideband fourier coefficient */
    c2_imag=0; /* imag part of the lo. sideband fourier coefficient */

    center=(count+1)/2; /* center address */

    /***** signal selection *****/

    /* Number of samples for two subcarrier periods */

    N_data=(int)(0.5+16.0F/(vtime[2]-vtime[1])/13.56e6F);
    /* Note: (vtime[2]-vtime[1]) are the scope sample rate */

    start=center-N_data;
    end=center+N_data-1;

    /***** DFT *****/
    for( i=start;i<=end;i++)
    {
        c0_real=c0_real+vd[i]*(float)cos(w0*vtime[i]);
        c0_imag=c0_imag+vd[i]*(float)sin(w0*vtime[i]);
        c1_real=c1_real+vd[i]*(float)cos(wu*vtime[i]);
        c1_imag=c1_imag+vd[i]*(float)sin(wu*vtime[i]);
        c2_real=c2_real+vd[i]*(float)cos(wl*vtime[i]);
        c2_imag=c2_imag+vd[i]*(float)sin(wl*vtime[i]);
    }

    /***** DFT scale *****/
    c0_real=2.0F*c0_real/(float)(2*N_data);
    c0_imag=2.0F*c0_imag/(float)(2*N_data);
    c1_real=2.0F*c1_real/(float)(2*N_data);
    c1_imag=2.0F*c1_imag/(float)(2*N_data);
    c2_real=2.0F*c2_real/(float)(2*N_data);
    c2_imag=2.0F*c2_imag/(float)(2*N_data);

```

```

/***** absolute fourier coefficient *****/
c0_abs=(float)sqrt(c0_real*c0_real + c0_imag*c0_imag);
c1_abs=(float)sqrt(c1_real*c1_real + c1_imag*c1_imag);
c2_abs=(float)sqrt(c2_real*c2_real+c2_imag*c2_imag);

/***** Phase of fourier coefficient *****/
c0_phase=(float)atan2(c0_imag,c0_real);
c1_phase=(float)atan2(c1_imag,c1_real);
c2_phase=(float)atan2(c2_imag,c2_real);

/***** Result Display *****/
printf("\n\nResults: \n");

printf("Carrier ");
printf("Abs: %7.3fmV ",1000*c0_abs);
printf("Phase: %3.0fdeg\n",c0_phase/pi*180);

printf("Upper sideband ");
printf("Abs: %7.3fmV ",1000*c1_abs);
printf("Phase: %3.0fdeg\n",c1_phase/pi*180);

printf("Lower sideband ");
printf("Abs: %7.3fmV ",1000*c2_abs);
printf("Phase: %3.0fdeg\n\n",c2_phase/pi*180);
printf("\n*****\n");
return;
} /***** End DFT *****/

/***** MAIN Program *****/
/*****
int main(unsigned short paramCount,char *paramList[])
{
    char fname[256];
    unsigned int i,sample_count;
    pi = (float)atan(1)*4; /* calculate pi */

    printf("\n*****\n");
    printf("\n**** ISO/IEC 10373-6 PICC Test-Program ****\n");
    printf("\n**** Version: 1.1 JUL 2000 ****\n");
    printf("\n*****\n");
    /***** No Input Parameter *****/
    if (paramCount==1)
    {
        printf("\nCSV File name :");
        scanf("%s",fname);
        if (!strchr(fname, '.')) strcat(fname, ".csv");
        if (!(sample_count=readcsv(fname))) return;

        dft(sample_count);
    }
    else
    {
        /***** Input Parameter Loop *****/
        for (i=1;i<paramCount;i++)
        {
            strcpy(fname,paramList[i]);

            if (!strchr(fname, '.')) strcat(fname, ".csv");
            if (!(sample_count=readcsv(fname))) break;
            dft(sample_count);
        }
    }
    return;
} /***** End Main *****/
```

National Annex NA (normative)
ISO/IEC amendments to BS ISO/IEC 10373-6:2001

This National Annex NA reproduces ISO/IEC amendments 1:2007, 2:2003, 3:2006, 4:2006, 5:2007 and 7:2010.

blank

Identification cards — Test methods —

Part 6:

Proximity cards

AMENDMENT 1: Protocol test methods for
proximity cards

Cartes d'identification — Méthodes d'essai —

Partie 6: Cartes de proximité

*AMENDEMENT 1: Méthodes d'essai du protocole pour cartes de
proximité*



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NOTE The table of contents is given for convenience only and should not be inserted in the amended standard.

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.

Amendment 1 to ISO/IEC 10373-6:2001 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

Identification cards — Test methods —

Part 6: Proximity cards

AMENDMENT 1: Protocol test methods for proximity cards

Page 1, Clause 2

Add the following to the list of normative references:

“ISO/IEC 14443-4, *Identification cards — Contactless integrated circuit(s) cards — Proximity cards — Part 4: Transmission protocol*”

Page 2, Clause 3

Replace the first sentence with the following:

“For the purposes of this document, the terms, definitions, abbreviations and symbols given in ISO/IEC 14443-2, ISO/IEC 14443-3, ISO/IEC 14443-4 and the following apply.

NOTE Elements in bold square brackets [] are optional.”

Page 2, Subclause 3.1

Add the following terms and definitions:

3.1.4

CascadeLevels

number of cascade levels of the PICC

3.1.5

Command Set

set describing the PICC commands during initialization and anticollision

NOTE See ISO/IEC 14443-3:2001, 6.3 for PICC type A and ISO/IEC 14443-3:2001, 7.5 for PICC type B.

3.1.6

Mute

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

3.1.7

PICC States

different PICC states during initialization and anticollision

NOTE See ISO/IEC 14443-3:2001, 6.2 for PICC type A and ISO/IEC 14443-3:2001, 7.4 for PICC type B.

3.1.8

Scenario

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

3.1.9

Test Initial State

TIS

element from PICC States that is the PICC state before performing a specific PICC command from Command Set

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

Page 2, Subclause 3.2

Add the following alphabetically to the list of abbreviations and symbols:

ATA(cid)	Answer to ATTRIB, i.e. (mbli+cid CRC_B), with mbli an arbitrary hex value (see ISO/IEC 14443-3:2001, 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)
SELECT(l)	SELECT command of cascade level l, 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)
READY(l)	READY state in cascade level l, l ∈ {1, 2, 3}; i. e. READY(2) is a PICC cascade level 2
READY*(l)	READY* state in cascade level l, l ∈ {1, 2, 3}; i. e. READY*(2) is a PICC cascade level 2
REQB(s)	REQB command with slot parameter s, s codes N as defined in ISO/IEC 14443-3:2001, 7.7.4 i.e. ('05 00' s CRC_B)
WUPB(s)	WUPB command with slot parameter s, s codes N as defined in ISO/IEC 14443-3:2001, 7.7.4 i.e. ('05 00' 8+s CRC_B)
SLOTMARKER(n)	Slot-MARKER command with slot number n, i.e. (16*(n-1)+5 CRC_B)
RATS(cid, fsdi)	Default RATS command with CID=cid and FSDI value = fsdi i.e. ('E0' fsdi*16+cid CRC_A)
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)
SEL(c)	Select code of level c (i.e. SEL(1) = '93', SEL(2) = '95', SEL(3) = '97')
SAK(cascade)	the SELECT(l) answer with the cascade bit (bit 3) set to 1
SAK(complete)	the SELECT(l) answer with the cascade bit (bit 3) set to 0
UIDTX _n	transmitted UID 32-bit data at cascade level n (see Table 1 — Mapping from UID to UIDTX)
WUPB(s)	WUPB command with slot parameter s, s codes N as defined in ISO/IEC 14443-3:2001, 7.7.4 i.e. ('05 00' 8+s CRC_B)

$\sim X$	Bit sequence consisting of the inverted bits of bit sequence X or any other bit sequence different from X.
$X[[n]]$	Bit at position n of bit sequence X. First bit is at position 1
$X[[a..b]]$	Bit subsequence of bit sequence X consisting of the bits between position a and b included. If $a > b$ then the sequence is empty
$X[n]$	Byte at position n of bit sequence X. First byte is at position 1 (i.e. $X[n] = X[[(n-1)*8+1..n*8]]$)
$X[a..b]$	Bit subsequence of bit sequence X consisting of the bits between position $a*8$ and $b*8$, with bit $b*8$ not included. (i.e. $X[a..b] = X[[(a-1)*8+1..(b-1)*8+1]]$)
$I(c)_n(\text{inf } [,CID=cid] [,NAD=nad] [,~CRC])$	ISO/IEC 14443-4 I-Block with chaining bit $c \in \{1,0\}$, block number $n \in \{1,0\}$ and information field inf. By default no CID and no NAD will be transmitted. If $CID=cid \in \{0...15\}$ is specified, it will be transmitted as second parameter. If $NAD=nad \in \{0...'FF'\}$ is specified it will be transmitted as third parameter. 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).
$R(ACK [,CID=cid] [,~CRC])_n$	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.
$S(WTX)(n [,CID=cid] [,~CRC])$	ISO/IEC 14443-4 S(WTX) block with parameter $WTXM = n$. 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.
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
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 I-block depends on the negotiated maximum frame size value of the PICC
TEST_RESPONSE1(n)	INF field of the response to TEST_COMMAND1(n). This response is assumed to be always unchained.
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_RESPONSE2(n)	Response to TEST_COMMAND2(n) Note: This I-block depends on the negotiated maximum frame size value of the PCD.
TEST_RESPONSE2(n) _k	INF field of k'th I-block chain of TEST_RESPONSE2(n) Note: This I-block depends on the negotiated maximum frame size value of the PCD.
TEST_COMMAND3	Default test command consisting of one I-block which needs between $n*FWT$ and $(n+1)*FWT$ time for execution
TEST_RESPONSE3	Response I-block to TEST_COMMAND3. This response is always assumed to be unchained.

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

Page 24

Add the following annex after Annex F:

Annex G (normative)

Additional PICC test methods

G.1 PICC-test-apparatus and accessories

This clause defines the test apparatus and test circuits for verifying the operation of a PICC according to ISO/IEC 14443-3:2001. The test apparatus includes:

- Calibration coil (see 6.1 of ISO/IEC 10373-6)
- Test PCD assembly (see 6.2 of ISO/IEC 10373-6)
- Digital sampling oscilloscope (see 6.4 of ISO/IEC 10373-6)

Care shall be taken to ensure that the results are not affected by the RF performance of the test circuits.

G.1.1 Emulating the I/O protocol

The PICC-test-apparatus shall be able to emulate the protocol type A, type B, which are required to test a PICC.

G.1.2 Generating the I/O character timing in reception mode

The PICC-test-apparatus shall be able to generate the I/O bit stream according to ISO/IEC 14443-3:2001. Timing parameters: start bit length, guard time, bit width, request guard time, start of frame width, end of frame width shall be configurable.

G.1.3 Measuring and monitoring the RF I/O protocol

The PICC-test-apparatus shall be able to measure and monitor the timing of the logical low and high states of the RF Input/Receive line relative to the CLK frequency. The PICC-test-apparatus shall be able to monitor the PICC subcarrier.

G.1.4 Protocol Analysis

The PICC-test-apparatus shall be able to analyse the I/O-bit stream in accordance with protocol type A and type B as specified in ISO/IEC 14443-3,4 and extract the logical data flow for further protocol analysis.

G.1.5 RFU fields

RFU fields should be constantly monitored during the testing and shall always be verified to contain the assigned default value. A test shall fail and the tested PICC declared non-compliant in case an RFU field is not set to its default value at any time.

G.1.5.1 RFU values

Functional fields should be constantly monitored during the testing and shall always be verified to contain only functional values documented in the standard or proprietary values documented in the standard. A test shall fail and the tested PICC be declared non-compliant in case a functional field is not set to said values (and thus is set to an RFU or restricted value) at any time.

G.1.5.2 Timing measurements

The PICC-test-apparatus shall continuously monitor the following frame format and timing values:

For PICC Type A:

- Frame delay time PCD to PICC (see ISO/IEC 14443-3:2001, 6.1.2)
- Frame formats (see ISO/IEC 14443-3:2001, 6.1.5)
- Frame waiting time (see ISO/IEC 14443-4:2001, 7.2)

For PICC Type B:

- Character, frame format and timing (see ISO/IEC 14443-3:2001, 7.1)
- Frame waiting time (see ISO/IEC 14443-4:2001, 7.2)

A test shall fail and the tested PICC be declared non-compliant in case one of the listed timing constraints is violated.

G.1.5.3 Timing measurement report

Fill out Table G.30 — Type A specific timing table for PICC type A and/or Table G.31 — Type B specific timing table for PICC type B with the measure timing values

G.2 Relationship of test methods versus base standard requirement

Tests in “Table G.1 — Test methods for logical operation of the PICC type A protocol” shall apply to Type A PICCs.

Tests in “Table G.2 — Test methods for logical operation of the PICC type B protocol” shall apply to Type B PICCs.

Tests in “Table G.3 — Test methods for logical operation of PICC of type A/B” shall apply both to Type A and Type B PICCs.

The ISO/IEC 14443-4:2001 PICC should also comply with ISO/IEC 14443-3:2001 and should be subjected to both the part 3 and part 4 tests for the applicable Type.

A PICC compliant with ISO/IEC 14443-3:2001 but not with ISO/IEC 14443-4:2001 and in ACTIVE or ACTIVE* state (see G.3.4.7, G.3.4.12 and G.4.4.6) may respond with any frame (including mute) to frames not related to ISO/IEC 14443-3:2001.

Table G.1 — Test methods for logical operation of the PICC type A protocol

Test method from ISO/IEC 10373-6		Corresponding requirement	
Clause	Name	Base standard	Clause(s)
G.3.2	Polling	ISO/IEC 14443-3:2001	5
G.3.4	Testing of the PICC type A state transitions	ISO/IEC 14443-3:2001	6.2, 6.3,6.4
G.3.5	Handling of type A anticollision	ISO/IEC 14443-3:2001	6.3.2
G.3.6	Handling of RATS	ISO/IEC 14443-4:2001	5.6.1
G.3.7	Handling of PPS request	ISO/IEC 14443-4:2001	5.6.2
G.3.8	Handling of FSD	ISO/IEC 14443-4:2001	5.1

Table G.2 — Test methods for logical operation of the PICC type B protocol

Test method from ISO/IEC 10373-6		Corresponding requirement	
Clause	Name	Base standard	Clause(s)
G.4.2	Polling	ISO/IEC 14443-3:2001	5
G.4.3	PICC Reception	ISO/IEC 14443-3:2001	7.1
G.4.4	Testing of the PICC Type B State Transitions	ISO/IEC 14443-3:2001	7.4 – 7.12
G.4.5	Handling of type B anticollision	ISO/IEC 14443-3:2001	7.4 – 7.12
G.4.6	Handling of ATTRIB	ISO/IEC 14443-3:2001	7.10
G.4.7	Scenario 31 Handling of Maximum Frame Size	ISO/IEC 14443-3:2001	7.10.4

Table G.3 — Test methods for logical operation of PICC of type A/B

Test method from ISO/IEC 10373-6		Corresponding requirement	
Clause	Name	Base standard	Clause(s)
G.5.2	PICC reaction to ISO/IEC 14443-4 Scenarios	ISO/IEC 14443-4:2001	7
G.5.3	Handling of PICC error detection	ISO/IEC 14443-4:2001	7
G.5.4	PICC reaction on CID	ISO/IEC 14443-4:2001	7.1.1.2
G.5.5	PICC reaction on NAD	ISO/IEC 14443-4:2001	7.1.1.3

G.3 Test method for initialisation of the PICC of type A

G.3.1 Introduction

The tests in this chapter determine whether a PICC of type A conforms to the ISO/IEC 14443-3 standard and the activation sequence of ISO/IEC 14443-4:2001, 5.

G.3.2 Scenario 1: Polling

G.3.2.1 Scope

This test is to determine the behaviour of the PICC type A on receiving REQA commands according to ISO/IEC 14443-3:2001, 5.

G.3.3 Procedure

Perform the following steps for 3 different operating fields of 1,5, 4,5 and 7,5 A/m:

- 1: Place the PICC into the field and adjust it.
- 2: Switch the RF operating field off for a minimum time for resetting a PICC (see ISO/IEC 14443-3:2001/Amd.1, 5.4).
- 3: Switch the RF operating field on.
- 4: Do delay of 5 ms and send a valid REQA Command frame.
- 5: Record the presence and the content of the PICC response.
- 6: Switch the RF operating field off for a minimum time for resetting a PICC (see ISO/IEC 14443-3:2001/Amd.1, 5.4).
- 7: Switch the RF operating field on.
- 8: Wait 5 ms and send a valid REQB Command frame (using type B modulation and bit coding).
- 9: Wait 5 ms and send a valid REQA Command frame.
- 10: Record the presence and the content of the PICC response.

G.3.3.1 Test report

Fill the appropriate row in "Table G.32 — Reported Results for type A specific test methods" according to the test results as follows:

Explanation	Test result
If the PICC's response is a valid ATQA in steps 5 and 10	Pass
If the PICC's response isn't a valid ATQA in steps 5 or 10	Fail

G.3.4 Testing of the PICC type A state transitions

G.3.4.1 Scope

These tests verify the correct implementation of the PICC type A state machine as described in ISO/IEC 14443-3:2001, 6.2.

G.3.4.2 General test outline

For an exhaustive test of the PICC type A state machine the correctness of every possible state transition at every state shall be verified. Verifying a specific state using a specific state transition will be done as follows:

First, reset the PICC and place it in the test initial state (TIS). This is one of the states from StateSet where the transitions (T) have to be verified. Then execute a transition (T) from TransitionSet. After execution of the state transition, check if the PICC is in the expected target state TTS. There is a difficulty in how to perform this check, because it is impossible to directly inspect the state machine of the PICC. The solution to this problem is to make some additional state transitions and checking the answer of the PICC. The transitions for this purpose are selected in such way that the state can be determined from the PICC answers as precisely as possible.

G.3.4.2.1 Functions for putting the PICC in the Test Initial State (TIS)

Putting the PICC into the State TIS will be done by a sequence of transition commands specified in the following table. The general method is as follows:

In order to put the PICC into State TIS, lookup the corresponding state transition sequence in Table G.4 — State Transition Sequence Table. Then successively apply the state transitions described in the State Transition Sequence column by looking up the corresponding commands in Table G.5 — State Transition Table. Always check the content and integrity of the PICC response.

Table G.4 — State Transition Sequence Table

TIS	State Transition Sequence
POWER_OFF	---
IDLE	POWER_OFF → IDLE
READY(1)	POWER_OFF → IDLE → READY(1)
READY(2)	POWER_OFF → IDLE → READY(1) → READY(2)
READY(3)	POWER_OFF → IDLE → READY(1) → READY(2) → READY(3)
ACTIVE	POWER_OFF → IDLE → READY(1) → ... → READY(CascadeLevels) → ACTIVE
PROTOCOL	POWER_OFF → IDLE → READY(1) → ... → READY(CascadeLevels) → ACTIVE → PROTOCOL
HALT	POWER_OFF → IDLE → READY(1) → ... → READY(CascadeLevels) → ACTIVE → HALT
READY*(1)	POWER_OFF → IDLE → READY(1) → ... → READY(CascadeLevels) → ACTIVE → HALT → READY*(1)
READY*(2)	POWER_OFF → IDLE → READY(1) → ... → READY(CascadeLevels) → ACTIVE → HALT → READY*(1) → READY*(2)
READY*(3)	POWER_OFF → IDLE → READY(CascadeLevels) → ACTIVE → HALT → READY*(1) → READY*(2) → READY*(3)
ACTIVE*	POWER_OFF → IDLE → READY(1) → ... → READY(CascadeLevels) → ACTIVE → HALT → READY*(1) → ... → READY*(CascadeLevels) → ACTIVE*

Table G.5 — State Transition Table

State → Next State	PICC-test-apparatus	PICC
POWER_OFF → IDLE	Power On (RF Field on) → ←	Mute
IDLE → READY(1)	REQA → ←	ATQA
READY(1) → READY(2)	SELECT(1) → ←	SAK (cascade)
READY(2) → READY(3)	SELECT(2) → ←	SAK (cascade)
READY(CascadeLevels) → ACTIVE	SELECT (CascadeLevels) → ←	SAK (complete)
ACTIVE → PROTOCOL	RATS(0,0) → ←	ATS
ACTIVE → HALT	HLTA → ←	Mute
HALT → READY*(1)	WUPA → ←	ATQA
READY*(1) → READY*(2)	SELECT(1) → ←	SAK (cascade)
READY*(2) → READY*(3)	SELECT(2) → ←	SAK(cascade)
READY*(CascadeLevels) → ACTIVE*	SELECT (CascadeLevels) → ←	SAK (complete)

G.3.4.2.2 Functions for checking the validity of the test target state (TTS)

The following table describes the state transitions, which are used to check whether the PICC is in the state S. The content of the PICC answer (i.e. ATQA, SAK, ...) should be thoroughly checked for ISO conformance. Please note, that these tests may cause the PICC to change state.

The READY(n)/ READY*(n) states and the ACTIVE/ACTIVE* states cannot be distinguished with one test run. In order to distinguish the ""-states from the non-""-states perform the following steps:

- 1: Rerun the test a second time, without checking the TTS.
- 2: Send REQA command. The PICC response shall be Mute.
- 3: Send REQA command.
- 4: If the PICC response is Mute then the PICC state was a ""-state.
- 5: Else the PICC was a non-""-state.

The HALT state cannot be distinguished from READY*(n) state and from ACTIVE* state with one test run. In order to distinguish the HALT state perform the following steps:

- 1: Rerun the test a second time, without checking the TTS.
- 2: Send WUPA command. The PICC response shall be ATQA.

Table G.6 — Checking the TTS

State S	PICC-test-apparatus	PICC
IDLE	REQA → ←	ATQA
READY(n), n < CascadeLevels	SELECT (n) → ←	SAK (cascade)
READY(n), n = CascadeLevels	SELECT (n) → ←	SAK (complete)
ACTIVE	RATS (0,0) → ←	ATS
PROTOCOL	I(0) ₀ (TEST_COMMAND1(1)) → ←	I(0) ₀ (TEST_RESPONSE1(1))
HALT	REQA → ← WUPA → ←	Mute ATQA
READY*(n), n < CascadeLevels	SELECT (n) → ←	SAK (cascade)
READY*(n), n = CascadeLevels	SELECT (n) → ←	SAK (complete)
ACTIVE*	RATS(0,0) → ←	ATS

G.3.4.3 Scenario 2: Behaviour of the PICC type A in the IDLE state

G.3.4.3.1 Scope

This test is to determine the behaviour of the PICC type A in the IDLE state according to ISO/IEC 14443-3:2001, 6.2.2.

G.3.4.3.2 Procedure

Perform the following steps for every row of Table G.7 — Transitions from IDLE state:

- 1: Put the PICC into IDLE state.
- 2: Perform the state transition by sending the command as indicated in the PICC-test-apparatus column.
- 3: Check if the PICC response is as indicated in the PICC column.
- 4: If the PICC response is not Mute, check that the Frame Delay Time of the PICC conforms with the value indicated in the FDT column.
- 5: Check if the PICC is in the state TTS.

Table G.7 — Transitions from IDLE state

Transition	PICC-test-apparatus	PICC	FDT	TTS
REQA	REQA → ←	ATQA	1172/fc	READY(1)
WUPA	WUPA → ←	ATQA	1236/fc	READY(1)
HLTA	HLTA → ←	Mute		IDLE
AC	('93' NVB UIDTX ₁ [[1..n ₁]]) ^a → ←	Mute		IDLE
nAC	('93' NVB ~UIDTX ₁ [[1..n ₁]]) ^a → ←	Mute		IDLE
SELECT	SELECT(1) → ←	Mute		IDLE
nSELECT	('93 70' ~UIDTX ₁ [[1..32]] BCC CRC_A) → ←	Mute		IDLE
RATS	RATS(0,0) → ←	Mute		IDLE
PPS	PPS(0,0,0) → ←	Mute		IDLE
ISO/IEC 14443-4 command	I(0) ₀ (TEST_COMMAND1(1)) → ←	Mute		IDLE
DESELECT	S(DESELECT) → ←	Mute		IDLE
Error condition	('26') ^b → ←	Mute		IDLE
^a Let $1 \leq n_1 \leq 32$ ^b The value is sent in a standard frame and not in a short frame				

G.3.4.3.3 Test report

Fill the appropriate row in "Table G.32 — Reported Results for type A specific test methods" according to the test results as follows:

Explanation	Test result
If the PICC responded as indicated in the procedure	Pass
Any other case	Fail

G.3.4.4 Scenario 3: Behaviour of the PICC type A in the READY(1) state

G.3.4.4.1 Scope

This test is to determine the behaviour of the PICC type A in the READY state on cascade level 1 according to ISO/IEC 14443-3:2001, 6.2.3.

G.3.4.4.2 Procedure

Perform the following steps for all PICCs and every row of Table G.8 — Transitions from READY(1) state:

- 1: Put the PICC into READY(1) state.
- 2: Perform the state transition by sending the command as indicated in the PICC-test-apparatus column.
- 3: Check if the PICC response is as indicated in the PICC column.
- 4: If the PICC response is not Mute, check that the Frame Delay Time of the PICC conforms with the value indicated in the FDT column.
- 5: Check if the PICC is in the state TTS.

Table G.8 — Transitions from READY(1) state

Transition	PICC-test-apparatus	PICC	FDT	TTS
REQA	REQA → ←	Mute		IDLE
WUPA	WUPA → ←	Mute		IDLE
HLTA	HLTA → ←	Mute		IDLE
AC (split at 0-bit)	('93' NVB UIDTX ₁ [[1..n ₁]]) ^a → ←	if n ₁ =32 then (BCC) else (UIDTX ₁ [[n ₁ +1..32]] BCC) ^a	1172/fc	READY(1)
AC (split at 1-bit)	('93' NVB UIDTX ₁ [[1..n ₂]]) ^b → ←	if n ₂ =32 then (BCC) else (UIDTX ₁ [[n ₂ +1..32]] BCC) ^b	1236/fc	READY(1)
nAC (wrong UID)	('93' NVB ~UIDTX ₁ [[1..n ₃]]) ^f → ←	Mute		IDLE
SELECT	SELECT(1) → ←	SAK ^d	FDT ^c	TTS ^e
nSELECT (wrong UID)	('93 70' ~UIDTX ₁ BCC CRC_A) → ←	Mute		IDLE