INTERNATIONAL STANDARD

ISO/IEC 10373-1

Third edition
2020-10

Cards and security devices for personal identification — Test methods —

Part 1: General characteristics

Cartes et dispositifs de sécurité pour l'identification personnelle — Méthodes d'essai —

Partie 1: Caractéristiques générales

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see http://patents.iec.ch).

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and security devices for personal identification*.

This third edition cancels and replaces the second edition (ISO/IEC 10373-1:2006), which has been technically revised. It also incorporates the Amendment ISO/IEC 10373-1:2006/Amd.1:2012. The main changes compared to the previous edition are as follows:

— three electrostatic discharge tests and the mechanical strength of contacts have been added;

— the ultraviolet light and static magnetic fields tests have been removed;

— the peel strength including the edge of the card test has been added; this test differs from the peel strength test by allowing layer bond strength measurement at the card edge and the middle area of the card;

— chemical lists have been revised into tables, which now include the base chemicals for Fuel B and artificial perspiration solutions (a normative reference was provided in the second edition);

— technical changes have been made to the dynamic bending stress calibration method and opacity measurement reporting;

— figures, tables and NOTEs have been revised to facilitate understanding of the tests;

— address for availability of optical reference (ORM7810) media has been changed;

— test methods have been refined and relaxed where technically appropriate.

A list of all parts in the ISO/IEC 10373 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The changes to the last version are a result of industry feedback, harmonisation of standards, and inter-laboratory studies (round robin studies) performed by experts from SC 17's Working Group 1. Additional information has been provided as NOTEs within the test methods

This document defines the ISO/IEC test methods for physical requirements of cards and security devices for personal identification and is utilised by other requirements and test methods. For example, the following ISO/IEC standards refer to this document for one or more test methods.

— ISO/IEC 7501 (all parts)

— ISO/IEC 7811 (all parts)

— ISO/IEC 7812 (all parts)

— ISO/IEC 7813

— ISO/IEC 7816 (all parts)

— ISO/IEC 10373 (all parts)

— ISO/IEC 10536 (all parts)

— ISO/IEC 11693 (all parts)

— ISO/IEC 11694 (all parts)

— ISO/IEC 11695 (all parts)

— ISO/IEC 14443 (all parts)

— ISO/IEC 15693 (all parts)

— ISO/IEC 18013 (all parts)

— ISO/IEC 18328 (all parts)

— ISO/IEC 18745 (all parts)

— ISO/IEC 24789 (all parts)

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Cards and security devices for personal identification — Test methods —

Part 1: General characteristics

1 Scope

This document describes the test methods for characteristics of identification cards according to ISO/IEC 7810 and other standards, such as those listed in the Introduction.

NOTE 1 Criteria for acceptability do not form part of this document but are found in other International Standards including those mentioned in the introduction.

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

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 7816-2, *Identification cards — Integrated circuit cards — Part 2: Cards with contacts — Dimensions and location of the contacts*

ISO/IEC 10373-2, *Identification cards — Test methods — Part 2: Cards with magnetic stripes*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

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

IEC 60749-26, *Semiconductor devices — Mechanical and climatic test methods — Part 26: Electrostatic discharge (ESD) sensitivity testing — Human body model (HBM)*

ANSI/ESDA/JEDEC JS-002, *ESDA/JEDEC Joint Standard For Electrostatic Discharge Sensitivity Testing - Charged Device Model (CDM) - Device Level*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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3.1.1
test method
method for testing characteristics of identification cards for the purpose of confirming their compliance with International Standards

3.1.2
testably functional
having survived the action of some potentially destructive influence to the extent that any:

a) magnetic stripe present on the card shows a relationship between signal amplitudes before and after exposure that is in accordance with the base standard;

b) integrated circuit connected to contacts continues to provide an Answer to Reset response which conforms to the *base standard* (3.1.13);

c) integrated circuit connected to an antenna continues to provide a response to an ATQA (Type A) or ATQB (Type B);

d) other integrated circuit continues to operate as intended;

e) optical memory present in the card continues to show optical characteristics which conform to the base standard

Note 1 to entry: ISO/IEC 7816-2 defines the contacts.

Note 2 to entry: ISO/IEC 14443 (all parts) defines the antenna, ATQA and ATQB.

Note 3 to entry: ISO/IEC 7811 (all parts) defines the magnetic strip.

Note 4 to entry: ISO/IEC 11693 (all parts) defines the optical memory.

3.1.3
warpage
deviation from flatness

3.1.4
embossing relief height
local increase in the height of the card surface produced by the embossing process

3.1.5
peel strength
ability of a card to resist separation of adjacent layers of material in its structure

3.1.6
resistance to chemicals
ability of a card to resist degradation of its performance and appearance as a result of exposure to commonly encountered chemicals

3.1.7
dimensional stability
ability of a card to resist dimensional variation when exposed to defined temperatures and humidity

3.1.8
adhesion or blocking
tendency of cards to stick together when stacked

3.1.9
bending stiffness
ability of a card to resist bending

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3.1.10
dynamic bending stress
cyclically applied bending stress of defined magnitude and orientation relative to the card

3.1.11
dynamic torsional stress
cyclically applied torsional stress of defined magnitude and orientation relative to the card

3.1.12
dual interface chip card
DICC
card or object combining the functionality of a ICC and a PICC

3.1.13
base standard
standard to which the *test method* (3.1.1) is used to verify conformance

3.1.14
electrostatic discharge
ESD
sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown

3.1.15
electrostatic stress
ESS
stress applied to a PICC or VICC by an electrostatic field

3.1.16
electrostatic discharge conductivity
ESDC
ability of a card to conduct or transport *electrostatic discharge* (3.1.14)

3.2 Abbreviated terms

ICC integrated circuit card as defined in ISO/IEC 7810 (all parts)

PICC proximity integrated circuit(s) card or object as defined in ISO/IEC 14443 (all parts)

VICC vicinity integrated circuit(s) card or object as defined in ISO/IEC 15693 (all parts)

4 Default items applicable to the test methods

4.1 Test environment

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

4.2 Pre-conditioning

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

4.3 Selection of test methods

Tests shall be applied as required to test the attributes of the card defined by the relevant base standard

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4.4 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).

4.5 Total measurement uncertainty

The total measurement uncertainty should be reported with the results and be considered when judging conformity. The total measurement uncertainty should be less than 20 % of the permitted tolerance range. ISO/IEC Guide 98 (all parts) provides guidance for determining and expressing the total measurement uncertainty.

5 Test methods

5.1 Card warpage

5.1.1 General

The purpose of this test is to measure the degree of warpage of a card test sample.

5.1.2 Apparatus

The test apparatus shall consist of:

— a flat level rigid plate;

— a suitable measurement device or a gauge with an accuracy of ±0,03 mm (0.0012 in).

5.1.3 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Place the sample card on the level rigid plate of the measuring apparatus. At least three corners of the card shall rest on the plate (warpage of the card in convex form to the plate). Use a suitable measurement device or gauge to determine that no point on the card's surface is at a distance of more than the permitted maximum warpage from the level rigid plate, as shown in Figure 1. The measurement device or gauge shall not change the warpage of the card.

NOTE The point of maximum displacement is not necessarily at the centre of the card.

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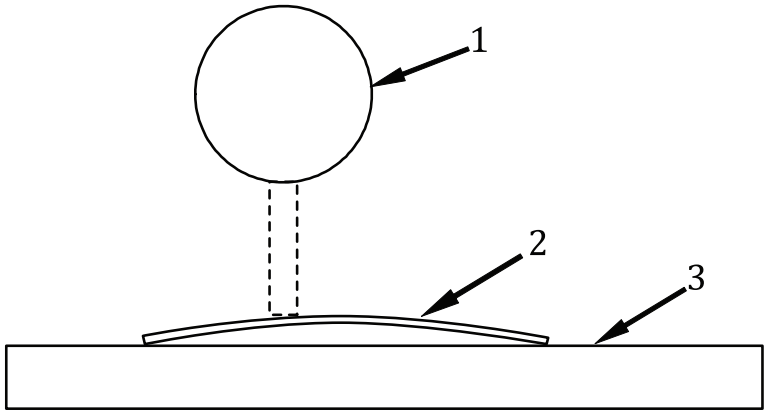

Key

1 measurement device or gauge
2 card
3 level rigid plate

NOTE This figure is not to scale.

Figure 1 — Warpage measurement apparatus

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5.1.4 Test report

The test report shall state if the warpage of the card complies with the requirement and optionally the measured warpage.

5.2 Dimensions of cards

5.2.1 General

The purpose of this test is to measure the height, width and thickness of a card test sample.

5.2.2 Thickness of card measurements

5.2.2.1 Apparatus

The test apparatus shall consist of a micrometer with a flat anvil and spindle whose diameter is within the range of 3 mm to 8 mm (0.12 in to 0.32 in), having a precision of 0,005 mm (0.00020 in) and a pressure range of 0,1 N/mm^2 to 0,4 N/mm^2 (14.5 lbf/in^2 to 58.0 lbf/in^2).

5.2.2.2 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Use the micrometer to measure the thickness of the card at four points, one in each of the four quadrants of the card (see Figure 2 for the location of the quadrants). The measurements shall be made at locations on the card that do not include signature panels, magnetic stripes or contacts (integrated circuit/s cards), or any other raised area.

5.2.2.3 Test report

The test report shall give the maximum and the minimum values of the four measurements.

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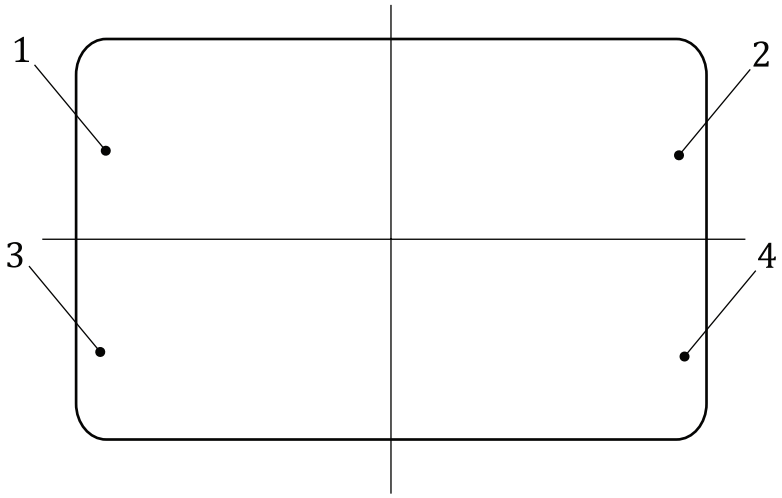

Key

1, 2, 3, 4 quadrant

Figure 2 — Assignment of quadrants

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5.2.3 Height and width of card measurement

5.2.3.1 Apparatus

The following items are required:

— a level horizontal rigid surface having a deviation from flatness not greater than 3,2 µm (0.000128 in) over the width of the card;

— a measuring device with a precision of 2,5 µm (0.0001 in);

— a load of 2,2 N ± 0,2 N (0.495 lbf ± 0.045 lbf).

5.2.3.2 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Place the sample card on the level horizontal rigid surface and flatten it under the load. Measure the height and width of the card. Find the maximum and minimum height and the maximum and minimum width.

5.2.3.3 Test report

The test report shall state whether the card conforms to the base standard and shall record the maximum and minimum values of height and width recorded.

5.3 Peel strength

5.3.1 General

The purpose of this test is to measure the peel strength between card layers.

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5.3.2 Apparatus

The following items are required:

a) sharp cutting knife;

b) pressure sensitive adhesive filament (fibre reinforced) tape or a suitable clamp;

c) tensile tester equipped with chart recorder or equivalent;

d) gripping device;

e) stabilising plate backed with adhesive or adhesive tape is required when the layer being peeled is more than 20 % of the total card thickness.

— the adhesive strength shall be sufficient to ensure that the plate and card do not separate during testing;

— the plate shall not bend during the measurement;

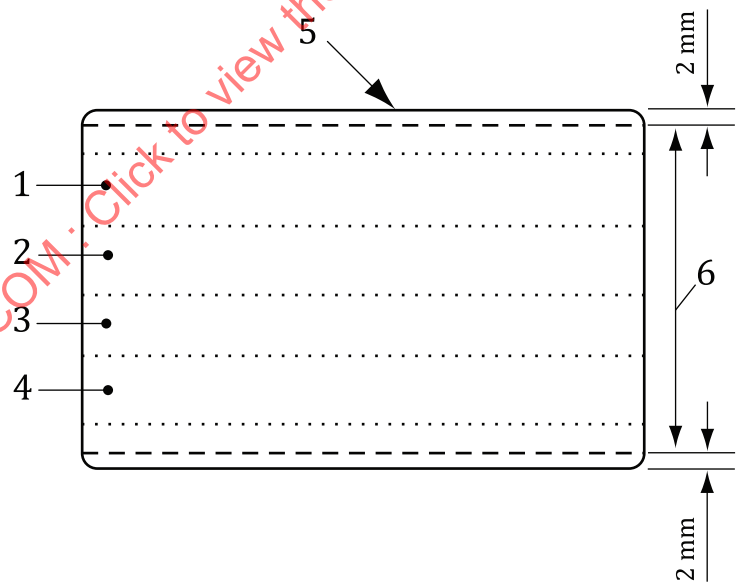
— the size of the plate shall be equal to, or greater than, the size of the card.

EXAMPLE A suitable plate can be a 60 mm × 90 mm × 2 mm aluminium plate backed with adhesive tape.

5.3.3 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Cut the card, or score through the layer, to produce sections of width 10,0 mm ± 0,2 mm (0.390 in ± 0.008 in) as shown in Figure 3.



Key

1 test section 1
2 test section 2
3 test section 3
4 test section 4
5 top reference edge
6 peel strength test area

Figure 3 — Card preparation

Using a sharp knife, cut the layer back from the core approximately 10 mm (0.4 in) and apply the clamp or adhesive tape to the cut back edge of the layer and core as shown in Figure 4.

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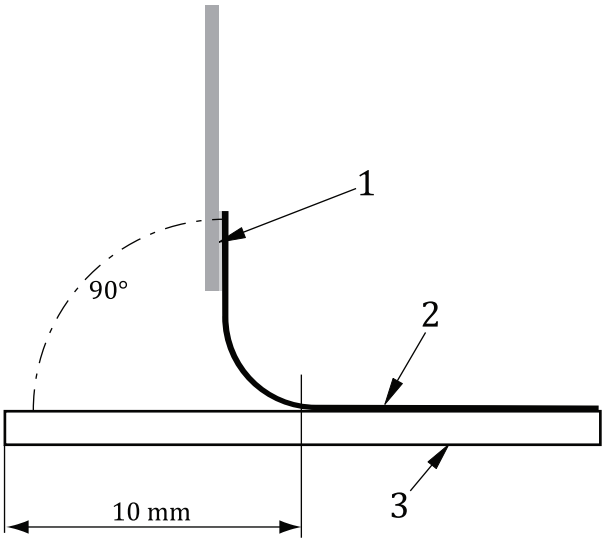


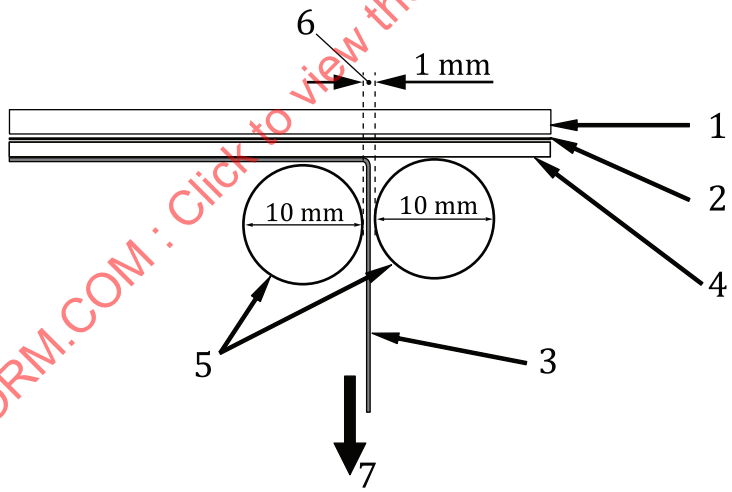
Key

1	apply clamp and/or adhesive tape	3	thicker layer
2	thinner layer		

Figure 4 — Specimen preparation for peel test

If the peeling angle cannot be kept at 90° during the measurement, attach the stabilising plate to the core in advance.

Place the prepared specimen in the tensile tester fixture as shown in Figure 5.



Key

1	stabilising plate	5	diameter rollers
2	double sided adhesive tape	6	gap between rollers
3	thinner layer	7	force *F*
4	thicker layer		

Figure 5 — Specimen mounted in tensile tester

Operate the tensile tester according to the manufacturers' instructions at 300 mm/min (11.8 in/min) to determine the force *F* in N (lbf).

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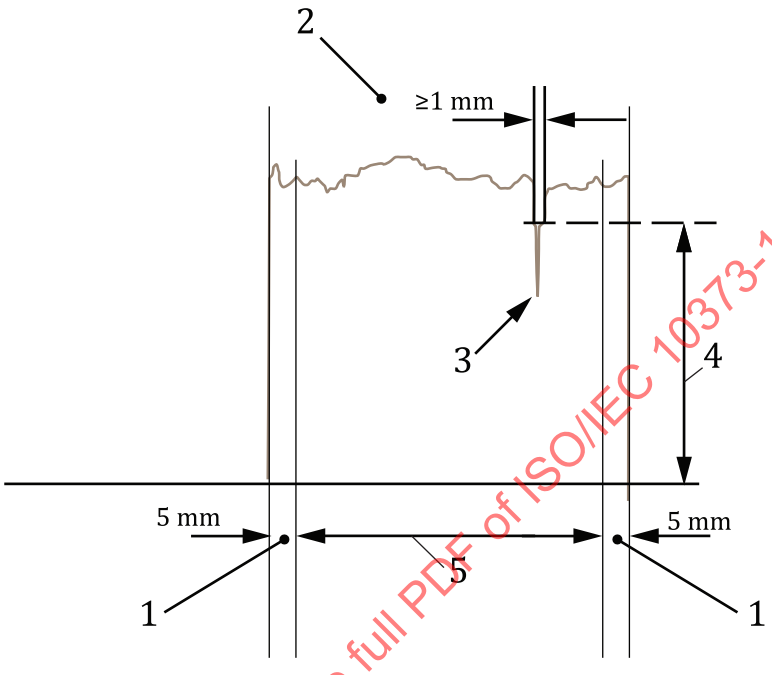
Excluding the first and last 5 mm and any features less than 1 mm in length (spikes) from consideration, find the test strip having the lowest force value, using Figure 6 as a guide. Exclude peel force results from regions of test sections where at least one of the peeled layers is less than 10 mm wide (e.g. in the area of IC contacts).

Divide the measured minimum peel force by the sample width. Record this as the peel strength of the section. The section with the lowest peel strength value shall be recorded as the peel strength of the card.



Key

1	area not used for evaluation	4	minimum value
2	length spike definition	5	measurement area
3	spike		

Figure 6 — Example of force chart recording

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5.3.4 Test report

The test report shall give the peel strength, together with the test strip identifier. It shall also include the chart recording, clearly showing where the recorded minimum value was found, and shall state whether any tearing occurred.

5.4 Peel strength including the edge of the card

5.4.1 General

The purpose of this test is to determine the peel strength at the edge of the card. In addition, this test can be performed in such a manner that the peel strength in the centre of the card is also determined, in which case the values obtained for the centre of the card may be used instead of determining them using 5.3.

5.4.2 Apparatus

The following items are required:

a) sharp cutting knife;

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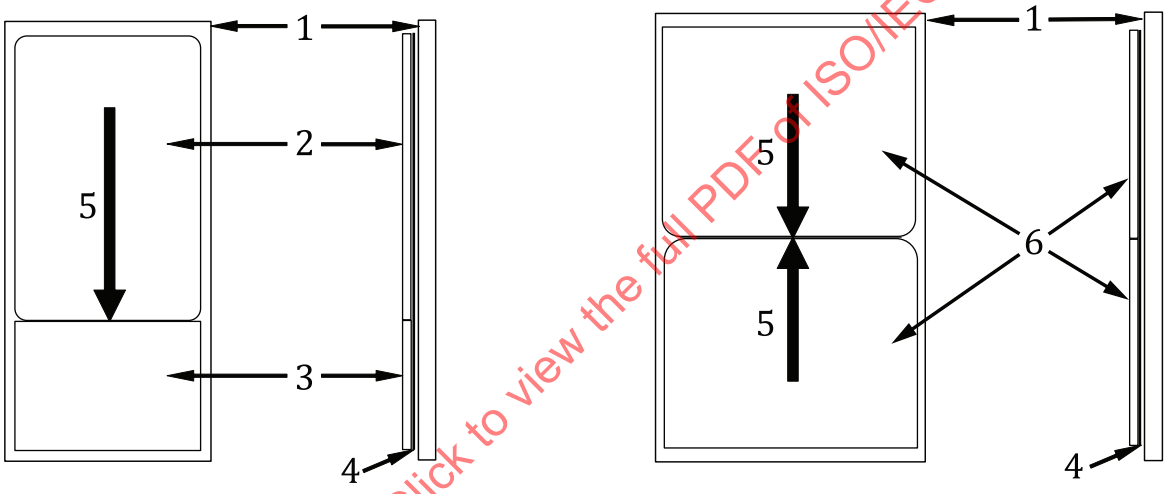
b) pressure sensitive adhesive filament (fibre reinforced) tape and/or a suitable clamp;

c) tensile tester equipped with chart recorder or equivalent;

d) stabilising plate meeting the following requirements:

- the plate design shall ensure that the plate and card do not separate during testing;
- plate and sample shall not bend during the measurement;
- the width of the plate shall be equal to or greater than, the width of the prepared specimen; the length of the plate shall be at least the length of the specimen plus the length of the spacer;
- a spacer with the same thickness as the test specimen, or half of a single card, shall be present immediately following the end of the test specimen as shown in Figure 7.
- the spacer and specimen or card halves shall be in direct contact with each other; or
- the stabilising plate shall have rails along the edges of the specimen to ensure that the assembly of plate and specimen are held at a 90° angle to the peel direction. Rails are shown in Figure 8.



Key

1	stabilising plate	4	double sided adhesive tape
2	specimen	5	peel direction
3	spacer	6	specimen (card halves)

Figure 7 — Stabilising plate (top and side view)

NOTE 1 Unstable peel force plots from the edge peel test can occur when a spacer or specimen is not used against the card edge under test or when insufficient adhesion to the stabilising plate allows card peel torque to flex the card edge.

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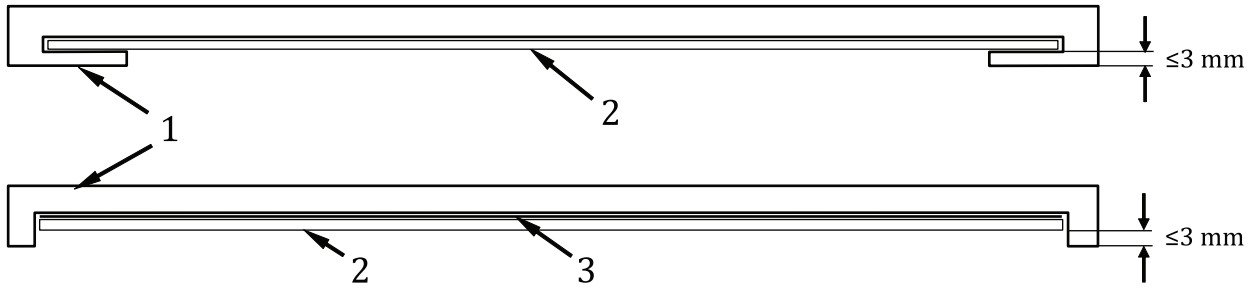


Key

1 stabilising plate with rails
2 specimen
3 double sided adhesive tape

Figure 8 — Rails (end view)

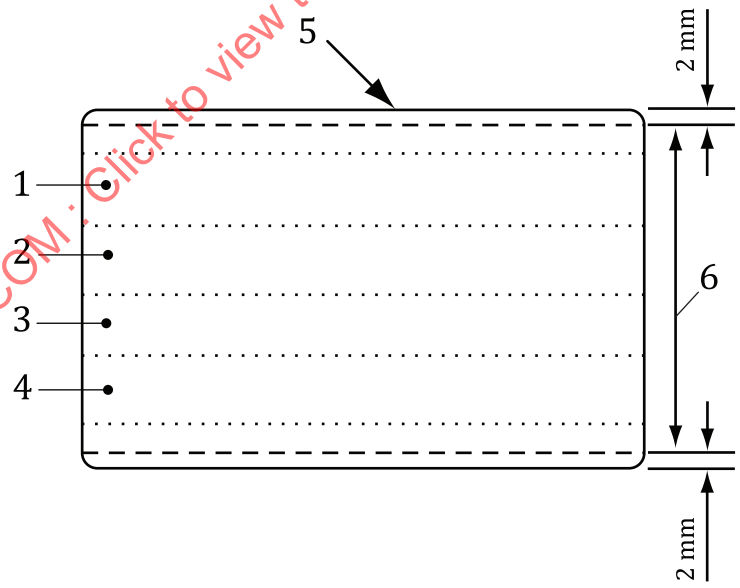
NOTE 2 Clamps that reach into the peel strength test area, depending on their design, limit the potential locations of the test sections.

5.4.3 Procedure

5.4.3.1 General

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Cut the card or score through the layer, to produce sections of 10,0 mm ± 0,2 mm (0.390 in ± 0.008 in) width as shown in Figure 9.



Key

1 test section 1
2 test section 2
3 test section 3
4 test section 4
5 top reference edge
6 peel strength test area

Figure 9 — Card preparation

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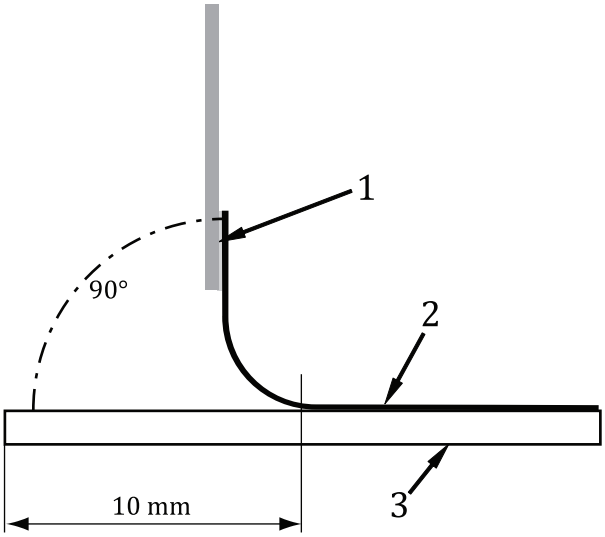
Using a sharp knife, cut the layer back from the core approximately 10 mm (0.4 in). Apply the clamp and/or adhesive tape to the cut back edge of the thinner layer as shown in Figure 10.

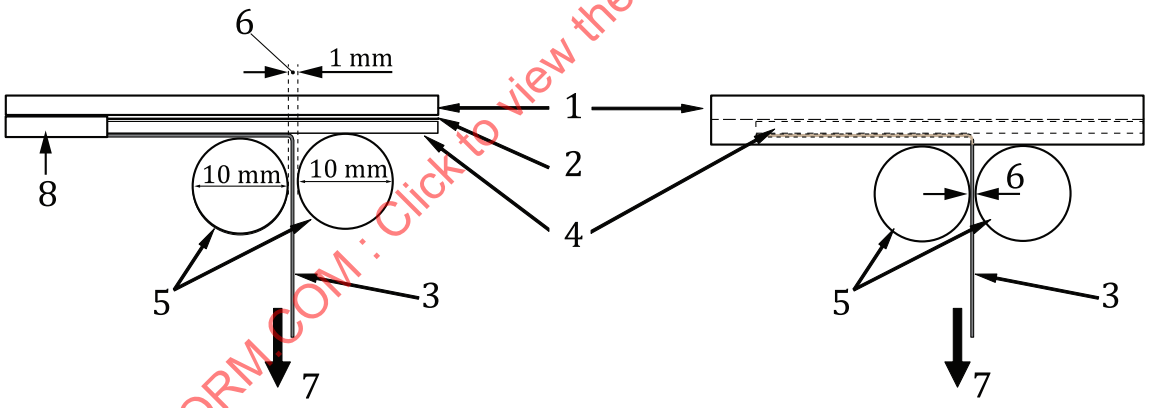


Key

1 apply clamp and/or adhesive tape
2 thinner layer
3 thicker layer

Figure 10 — Specimen preparation for peel test

Place the stabilising plate and prepared specimen in the tensile tester fixture as shown in Figure 11.



Key

1 stabilising plate
2 double sided adhesive tape
3 thinner layer
4 thicker layer
5 diameter rollers
6 gap between roller
7 force *F*
8 space or card halves

Figure 11 — Specimen & stabilising plate mountings in tensile tester

Operate the tensile tester according to the manufacturers' instructions at 300 mm/min (11.8 in/min) to determine the force *F* in N (lbf).

NOTE If the layer tears during testing or the resulting graph contains adjacent positive and negative spikes as shown in the example graph in Figure 12, the test can be performed at 50 mm/min (2 in/min) to reduce these effects. It is possible that results between different peel speeds are not directly comparable. Testing for compliance is performed at 300 mm/min.

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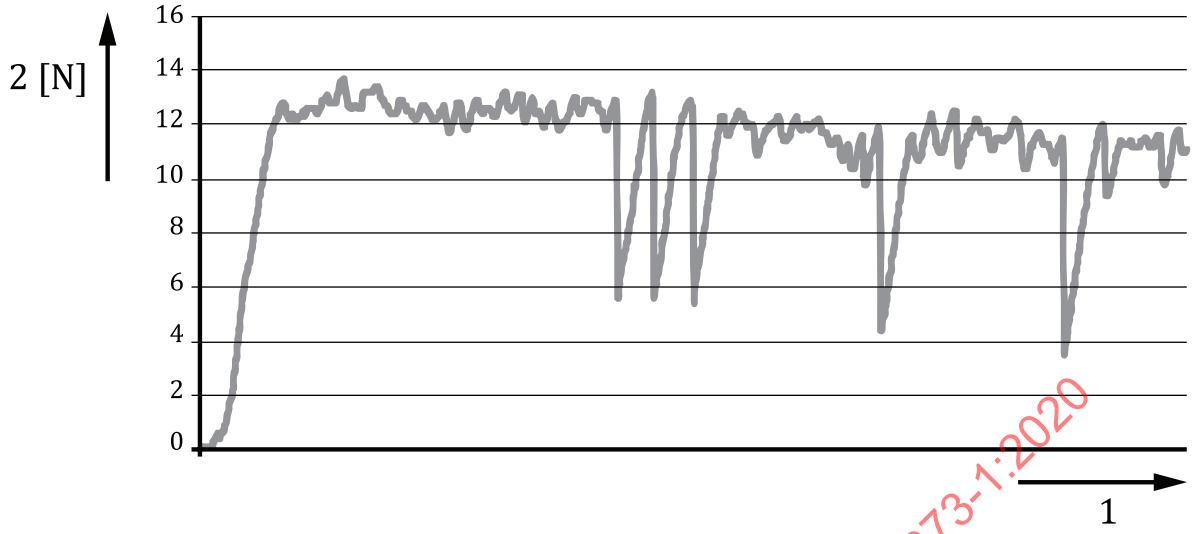

Key

1 deflection 2 force

Figure 12 — Example of adjacent negative and positive spikes

Exclude peel force results from the first 5 mm, the last downward drop at the end of the plot, and any features less than 1 mm in length (spikes) from consideration, using Figure 13 as a guide. Exclude peel force results from regions of test sections where at least one of the peeled layers is less than 10 mm wide (e.g. in the area of IC contacts).

5.4.3.2 Peel strength at the edge of the card

Determine the peel strength at the edge of the card by using the recording between a distance of 5 mm from the edge and the edge of the card as shown by the edge area in Figure 13.

Divide the measured force by the width of the section in mm and record this as the peel strength for the edge area in N/mm (lbf/in).

5.4.3.3 Peel strength in the centre of the card

When available, determine the peel strength in the centre of the card by using the recording between a distance of 5 mm from the beginning of the recording up to a distance of 5 mm from the edge of the card as shown by the centre area in Figure 13.

Divide the measured force by the width of the section in mm and record this as the peel strength for the centre area in N/mm (lbf/in).

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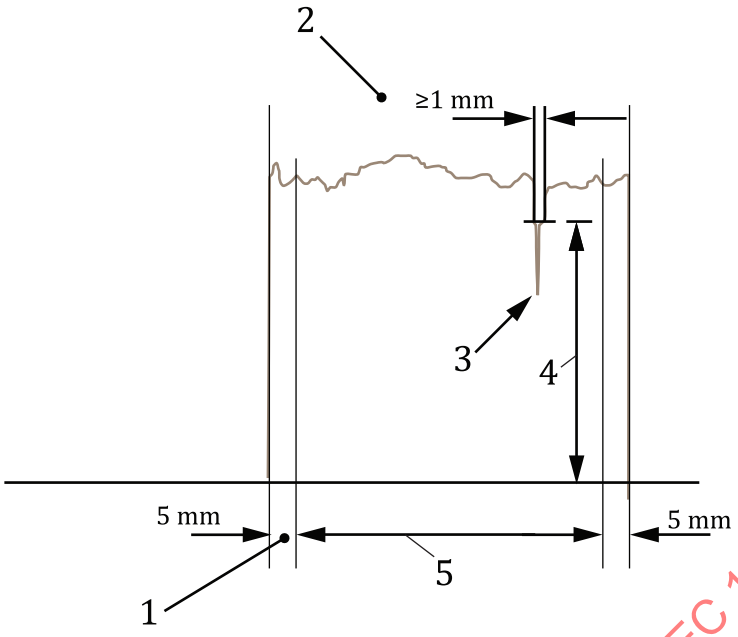

Key

1	area not used for evaluation	4	minimum value
2	length spike definition	5	measurement area
3	spike		

Figure 13 — Example of peel strength chart recording

Dimensions shown in Figure 13 are dimensions on the card.

5.4.4 Test report

The test report shall give the peel strength, together with the test section identifier. It shall also include the chart recording, clearly showing where the recorded minimum value was found, and shall state whether any tearing occurred.

5.5 Resistance to chemicals

5.5.1 General

The purpose of this test is to determine any adverse effects of a range of chemical solutions on a card test sample.

5.5.2 Reagents

5.5.2.1 General

Good laboratory practices should be applied with respect to freshness and non-deterioration of base chemicals and mixtures.

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5.5.2.2 Solutions for short-term test

Table 1 — Short-term reagents

Test solution	Mass %	Chemical	Chemical formula	Minimum assay %
5.5.2.2.a Aqueous salt solution	5,00	sodium chloride	NaCl	98,0
	95,00	water[c]	H_2O	99,9
5.5.2.2.b Simulated vinegar solution	5,00	acetic acid	CH_3COOH	99,0
	95,00	water[c]	H_2O	99,9
5.5.2.2.c Simulated softened water	5,00	sodium carbonate	Na_2CO_3	99,0
	95,00	water[c]	H_2O	99,9
5.5.2.2.d Simulated alcoholic beverage	60,00	ethyl alcohol[b]	CH_3CH_2OH	93,0
	40,00	water[c]	H_2O	99,9
5.5.2.2.e Aqueous sugar solution	10,00	sucrose	$C_{12}H_{22}O_{11}$	98,0
	90,00	water[c]	H_2O	99,9
5.5.2.2.f Fuel B	65,00	2,2,4 trimethyl pentane[a]	$(CH_3)_2CHCH_2C(CH_3)_3$	98,0
	35,00	toluene	$C_6H_5CH_3$	98,0
5.5.2.2.g Simulated anti-freeze	50,00	ethylene glycol	$HOCH_2CH_2OH$	98,0
	50,00	water[c]	H_2O	99,9

[a] Also known as iso-octane.

[b] Denatured alcohol (ethanol with additives to make it poisonous, bad tasting, foul smelling or nauseating to discourage recreational consumption) shall not be used.

[c] Distilled water or water with a purity grade 3 as defined in ISO 3696 shall be used.

5.5.2.3 Solutions for long-term test

a) salt mist;

b) artificial perspiration:

   1) alkaline solution;

   2) acidic solution.

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Table 2 — Long-term reagents

Test solution	Mass %	Chemical	Chemical formula	Minimum assay %
5.5.2.3.a Salt mist	Reference ISO 9227, neutral salt spray (NSS) condition			
5.5.2.3.b.1 Alkaline artificial perspiration (option 1)[a]	0,05	l-histadine monohydrochloride monohydrate	$C_6H_9O_2N_3{\cdot}HCl{\cdot}H_2O$	98,0
	0,50	sodium chloride	NaCl	98,0
	0,50	disodium hydrogen orthophosphate dodecahydrate	$Na_2HPO_4{\cdot}12H_2O$	98,0
	98,95	water[b]	H_2O	99,9
	Add enough 0,1 molar NaOH to reach a pH of 8,00 ± 0,25	0.1 molar sodium hydroxide solution	NaOH	***
or				
5.5.2.3.b.1 Alkaline artificial perspiration (option 2)[a]	0,05	l-histadine monohydrochloride monohydrate	$C_6H_9O_2N_3{\cdot}HCl{\cdot}H_2O$	98,0
	0,50	sodium chloride	NaCl	98,0
	0,25	disodium hydrogen orthophosphate dihydrate	$Na_2HPO_4{\cdot}2H_2O$	98,0
	99,2	water[b]	H_2O	99,9
	Add enough 0,1 molar NaOH to reach a pH of 8,00 ± 0,25	0.1 molar sodium hydroxide solution	NaOH	***
5.5.2.3.b.2 Acidic artificial perspiration	0,05	l-histadine monohydrochloride monohydrate	$C_6H_9O_2N_3{\cdot}HCl{\cdot}H_2O$	98,0
	0,50	sodium chloride	NaCl	98,0
	0,22	sodium dihydrogen orthophosphate dihydrate	$NaH_2PO_4{\cdot}2H_2O$	98,0
	99,23	water[b]	H_2O	99,9
	Add enough 0,1 molar NaOH to reach a pH of 5,50 ± 0,25	0.1 molar sodium hydroxide solution	NaOH	***
*** 0,1 molar sodium hydroxide solution	0,40	sodium hydroxide	NaOH	99,0
	99,60	water[b]	H_2O	99,9

[a] Both alkaline artificial perspiration formulations create the same chemical solution once the components are dissolved in water. The use of either hydrated version of disodium hydrogen orthophosphate is allowed as per the above formulations.

[b] Distilled water or water with a purity grade 3 as defined in ISO 3696 shall be used.

The artificial perspiration solutions shall not be older than 1 week if stored under default conditions and not be older than 30 days if stored below 10 °C.

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5.5.3 Procedure

5.5.3.1 General

Use a different sample card for each test.

Pre-condition the sample card and chemical solutions according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Subject each card to a visual inspection to establish its appearance prior to test and record the results of that examination.

Perform any pre-exposure measurements required by the base standard.

For cards with a magnetic stripe, record each sample card at 20 ft/mm (500 ftpi) using a test recording current of I_{min} (or at the density and test recording current specified in the base standard), read and note the signal amplitude.

Expose the card to the appropriate short-term or long-term solution described in 5.5.2.2 and 5.5.2.3.

Immediately after exposure to Fuel B (5.5.2.2.f), remove the residual chemicals from the surface using absorbent tissue and dry the card for ≥15 min.

Immediately after exposure to aqueous solutions (short-term or long-term solutions), the samples shall be cleaned using distilled water or water of purity grade 3 and an absorbent tissue. This cleaning procedure supersedes any other cleaning procedure that might be defined in any other standard.

Condition the sample card under the test environment defined in 4.1 for 24 h.

Perform any post-exposure measurements required by the base standard within 24 h following completion of the conditioning.

For cards with a magnetic stripe, read the signal amplitude on the apparatus used for the pre-exposure measurements and compare the result with the amplitude obtained at the beginning of the test within 24 h following completion of the conditioning.

Subject the card to a visual inspection to determine the effects of the test on its appearance and record the results of that examination within 24 h following completion of the conditioning.

5.5.3.2 Short-term solutions

Submerge the card for 1 min in one of the solutions listed in Table 1, which shall be at a temperature between 20 °C and 26 °C.

5.5.3.3 Long-term solutions

5.5.3.3.1 Salt mist

Expose the sample card to neutral salt spray for 24 h, using the equipment and procedures defined in ISO 9227.

If the card contains IC contact plates, verify that the ICC is testably functional and measure the surface resistance of the contact plates. If the surface resistance complies with the base standard, 5.5.3.3.2 is not required.

5.5.3.3.2 Salt mist additional cleaning (if required)

If the surface resistance performed in 5.5.3.3.1 is between 500 mΩ and 1 Ω, additional cleaning using a soft white PVC based eraser with calcium carbonate filler e.g. Staedtler Mars 526 50, may be performed.

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After additional cleaning, re-measure the surface resistance of the contact plate for compliance with the base standard.

NOTE Cleaning with the eraser sometimes affects the functionality of the card. This does not constitute a non-conformity.

5.5.3.3.3 Artificial perspiration

Submerge the card for 24 h in one of the artificial perspiration solutions in Table 2, which shall be at a temperature between 20 °C and 26 °C.

5.5.4 Test report

The test report shall state whether the card is testably functional following the test and shall give the results of:

— any pre-exposure and post-exposure tests required by the base standard;

— visual examination.

NOTE For the salt mist test, visible corrosion on contact plates can occur as a result of this test. As long as the surface resistance and functionality requirements are met, this constitutes no functional problem for the card and is solely cosmetic. Determining compliance with a cosmetic requirement after salt mist exposure is not within the scope of this document.

5.6 Card dimensional stability and warpage with temperature and humidity

5.6.1 General

The purpose of this test is to establish whether the dimensions and flatness of a card test sample remain within the requirements of the base standard after exposure to the specified environmental temperature and humidity.

NOTE It is noted that humidity effects can still be observed over far longer periods of exposure.

5.6.2 Procedure

Pre-condition the sample card according to 4.2 before testing.

Place the sample card on a horizontal flat surface and expose it to each of the environments in the sequence listed below for 60 min.

1) −35 °C ± 3 °C (−31 °F ± 5 °F);

2) +50 °C ± 3 °C (+122 °F ± 5 °F) and 95 % ± 5 % relative humidity.

Following each exposure in the sequence, return the sample card to the default test environment described in 4.1 and retain it in this environment for 24 h before measuring its width, height, thickness and warpage.

5.6.3 Test report

The test report shall give the complete set of measured values of the sample card dimensions and card warpage, taken after each sub-cycle of exposure.

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5.7 Adhesion or blocking

5.7.1 General

The purpose of this test is to determine any adverse effects when unembossed card test samples (finished cards) are stacked together.

5.7.2 Procedure

Pre-condition the unembossed sample cards according to 4.2 before testing.

Check whether each of the individual cards can be easily separated by hand.

Stack the cards in groups of five, all in the same orientation with the back sides of the cards down. Apply a uniform pressure of 2,5 kPa ± 0,13 kPa (0.362 ± 0.018 lbf/ft^2) over the top card surface.

Expose the stacked cards to an environment maintained at a temperature of 40 °C ± 3 °C (104 °F ± 5 °F) and a relative humidity of 40 % to 60 % for 48 h.

At the end of the 48 h period, return the stacked cards to the default test environment of 4.1 and immediately check whether individual cards can be easily separated by hand.

Inspect the individual cards for visible deterioration attributable to the test, including any degree of:

— delamination;

— discolouration or colour transfer;

— changes to the surface finish;

— transfer of material from one card to an adjacent card;

— deformation of card when compared to card appearances prior to the test.

5.7.3 Test report

The test report shall state whether the cards were easily separated by hand after preconditioning and after exposure to the test environment. State whether any visible signs of deterioration were found. If any were found, it shall describe their nature and severity.

5.8 Bending stiffness

5.8.1 General

The purpose of this test is to determine whether the bending stiffness of a card test sample lies within the limits set by the base standard.

5.8.2 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Using the apparatus in Figure 14, mount the sample card such that it is firmly clamped along the entire left side, front surface upwards.

Measure h_1 (see Figure 14).

Apply a load F equivalent to 0,7 N (0.16 lbf) within 3 mm (0.12 in) along the entire right side of the card for 1 min.

Measure h_2 (see Figure 15).

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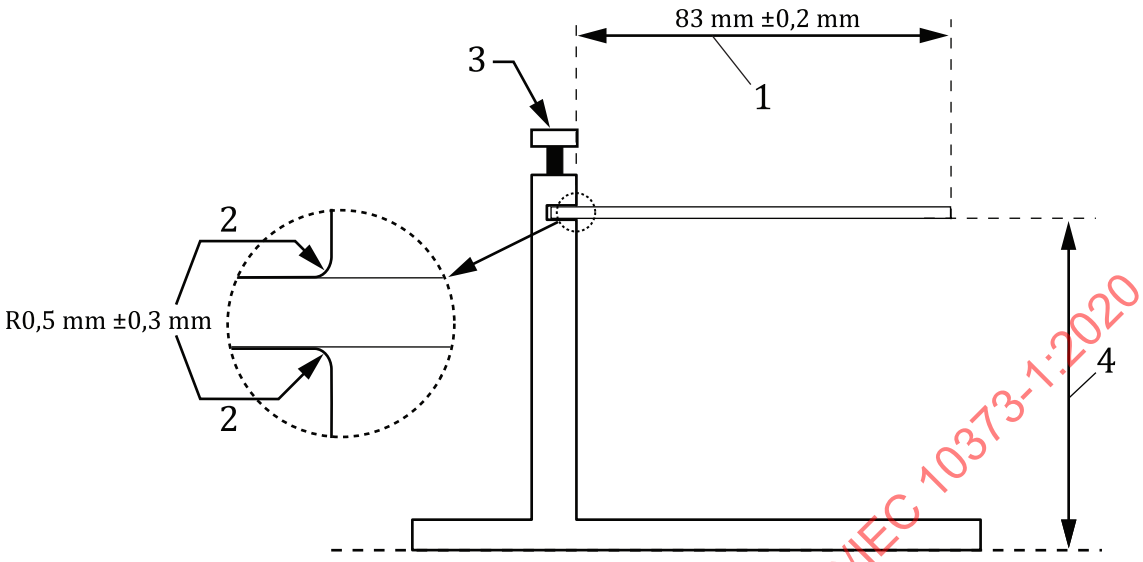
Remove the load *F*.

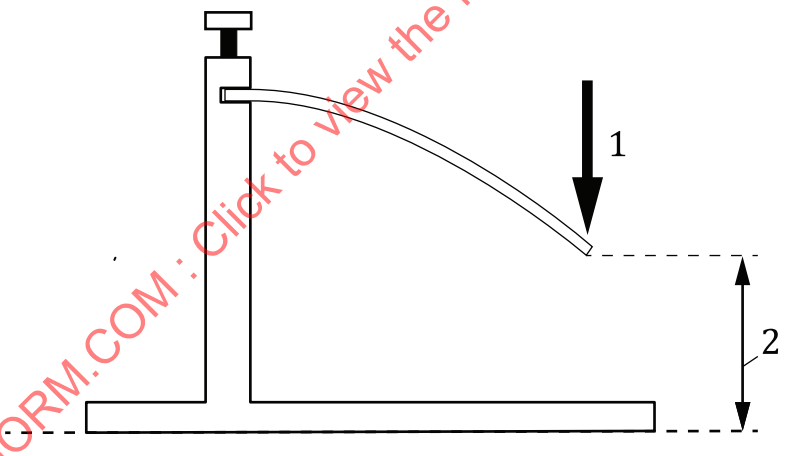
After one minute, measure h_3 (see Figure 16).



Key

1 length clamp to card edge
2 clamp radius
3 clamp card firmly
4 height lower card edge to bottom (h_1)

Figure 14 — Card in clamping device before loading



Key

1 force
2 height lower edge to bottom (h_2)

Figure 15 — Card in clamping device during loading

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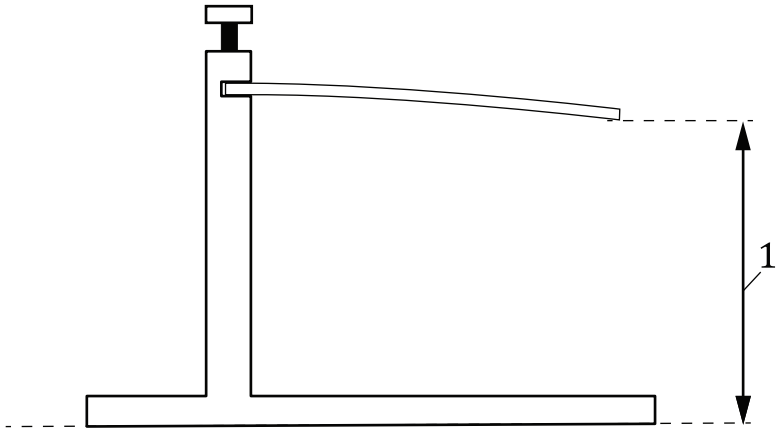

Key

1 height lower card edge to bottom (h_3)

Figure 16 — Card in clamping device after unloading

5.8.3 Test report

The test report shall give the measured values of h_1, h_2 and h_3, together with the calculated values of the deflection ($h_1 - h_2$) under load and the deformation ($h_1 - h_3$) relative to the original condition remaining after removal of the load.

5.9 Dynamic bending stress

5.9.1 General

The purpose of this test is to determine any adverse mechanical or functional effects of bending stress in a card test sample.

NOTE The dynamic bending stress test can cause damage to test apparatus if bending stiffness values are less than 13 mm.

5.9.2 Apparatus

The apparatus used to apply dynamic bending stress to the card under test shall be as shown Figure 17.

The moving part of the apparatus shall move in a sinusoidal manner at a frequency of 0,5 Hz.

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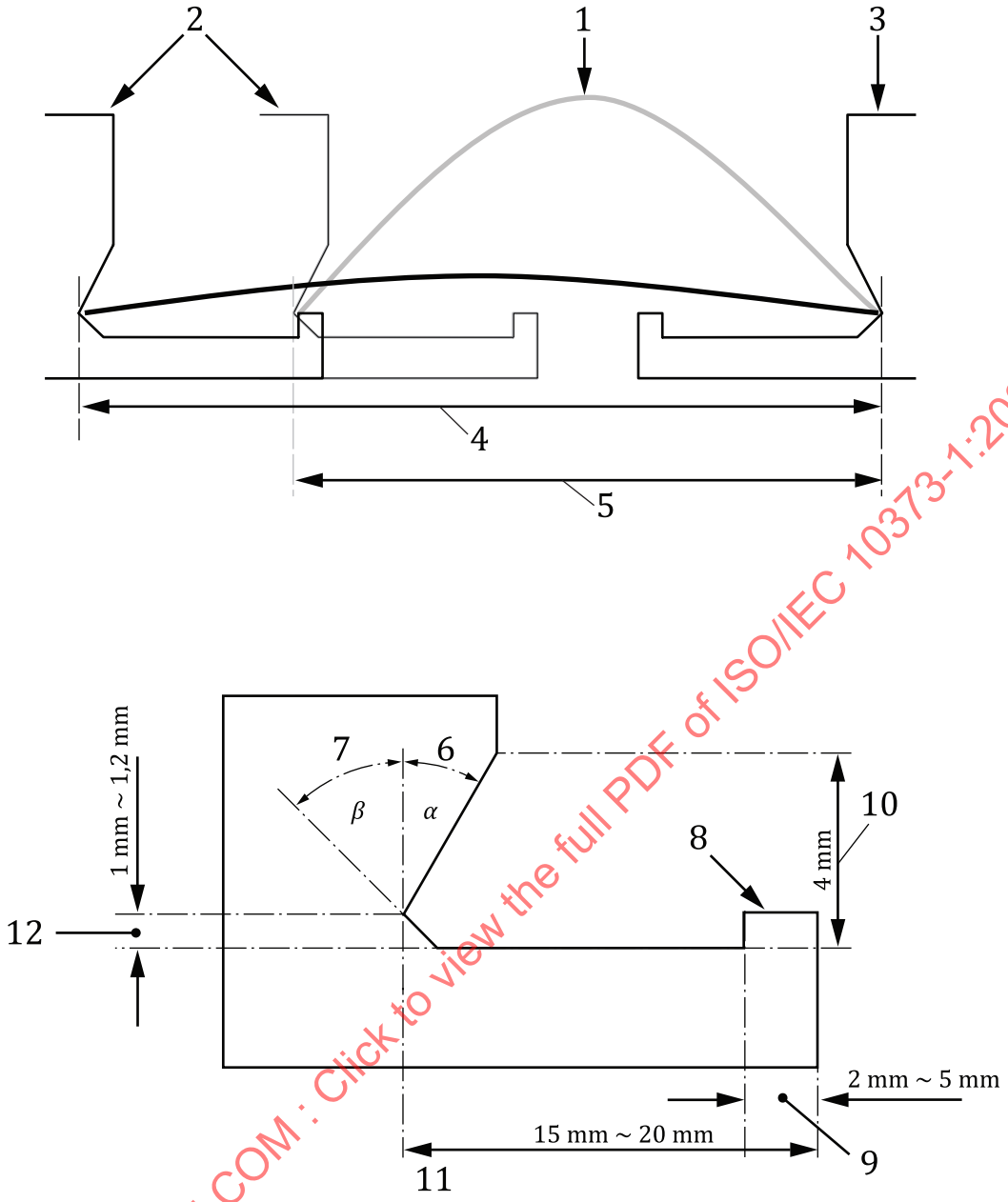

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Key

1	long or short side of the card	7	jaw angle (β)
2	moving jaw	8	optional lip
3	fixed jaw	9	lip width
4	vertex-to-vertex gap at min. deflection (d_v)	10	lip height
5	vertex-to-vertex gap at max. deflection (d_w)	11	jaw width
6	jaw angle (α)	12	jaw height

NOTE α & β = 30° or α & β = 45° or α = 30° & β = 45° (angle tolerance = ±2°).

Figure 17 — Test machine for dynamic bending

NOTE 1 Test apparatus dimensions have been designed to yield equivalent card displacement values referenced in previous editions of this document.

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Equipment manufactured in accordance with previous editions of this document may be used until 2022.

NOTE 2 Lip on jaw is optional. It is designed to prevent undersized cards from bending downward.

5.9.3 Calibration method

The calibration method is intended to standardize card stress at the greatest point of card deflection. Thus the intent to standardize card deflection and stress between testing labs remains consistent with prior editions of this document.

The calibration method is performed by checking:

— the distance between jaws (vertex-to-vertex gap d_v) when the card is at its minimum deflection;

— and the jaw stroke length for maximum flex ($d_v - d_w$).

The minimum flex, vertex-to-vertex jaw gaps, and jaw stroke lengths in Table 3 and Table 4 shall be used.

Table 3 — Bending around axis A dimensions

	Vertex-to-vertex gap for minimum flex (mm) d_v	Jaw stroke length for maximum flex (mm) $d_v - d_w$
$\alpha = \beta = 30$	85,56	11,19
$\alpha = \beta = 45$	85,88	11,51
$\alpha = 30; \beta = 45$	85,68	11,31
Tolerance	±0,05	±0,40

Table 4 — Bending around axis B dimensions

	Vertex-to-vertex gap for minimum flex (mm) d_v	Jaw stroke length for maximum flex (mm) $d_v - d_w$
$\alpha = \beta = 30$	54,11	3,89
$\alpha = \beta = 45$	54,43	4,21
$\alpha = 30; \beta = 45$	54,23	4,01
Tolerance	±0,05	±0,20

NOTE Table 3 and Table 4 are used to ensure equivalent card flexure for all referenced jaw angles (α, β). They are based upon the assumption that cards are of nominal ISO thickness, cards centre themselves at the jaw vertex when the jaws are in their fully open position and that the cards slide into the jaw vertex when at full flex conditions.

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5.9.4 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Check that the card is testably functional.

Place the sample card between the jaws of the test machine shown in Figure 17, positioned such that the bend occurs around axis A (see Figure 18). If the card has contacts then it shall first be positioned with the contacts uppermost.

The equipment is stopped in the minimum flexed position at the end of every set of bending cycles.

Apply one quarter the total number of bendings specified by the base standard or, if no such number is specified, 250 bendings.

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Reposition the card such that the opposite face of the card is uppermost but the bend still occurs around axis A.

Apply the same number of bendings as before.

Reposition the card and reset the test machine such that the original face of the card is uppermost but the bend occurs around axis B (see Figure 18). If the card has contacts then it should be positioned at this point with the contacts uppermost.

Reposition the card such that the opposite face of the card is uppermost but the bend still occurs around axis B.

Apply the same number of bendings as before.

Check that the card is testably functional at the end of the test. It may also be checked at any convenient point during the course of the test.

The time between two sets of bendings, and a set of bendings and completing the testably functional tests of the card shall not exceed 1 h.

If evaluation of the reliability of an interconnection between an antenna and an IC inside the card is desired, then note should be taken that an evaluation after the bending cycles may not reveal all defects.

NOTE The time between two sets of bending cycles is limited to 1 h to reduce the probability of recovery from possible damage to the card and to improve consistency of results.

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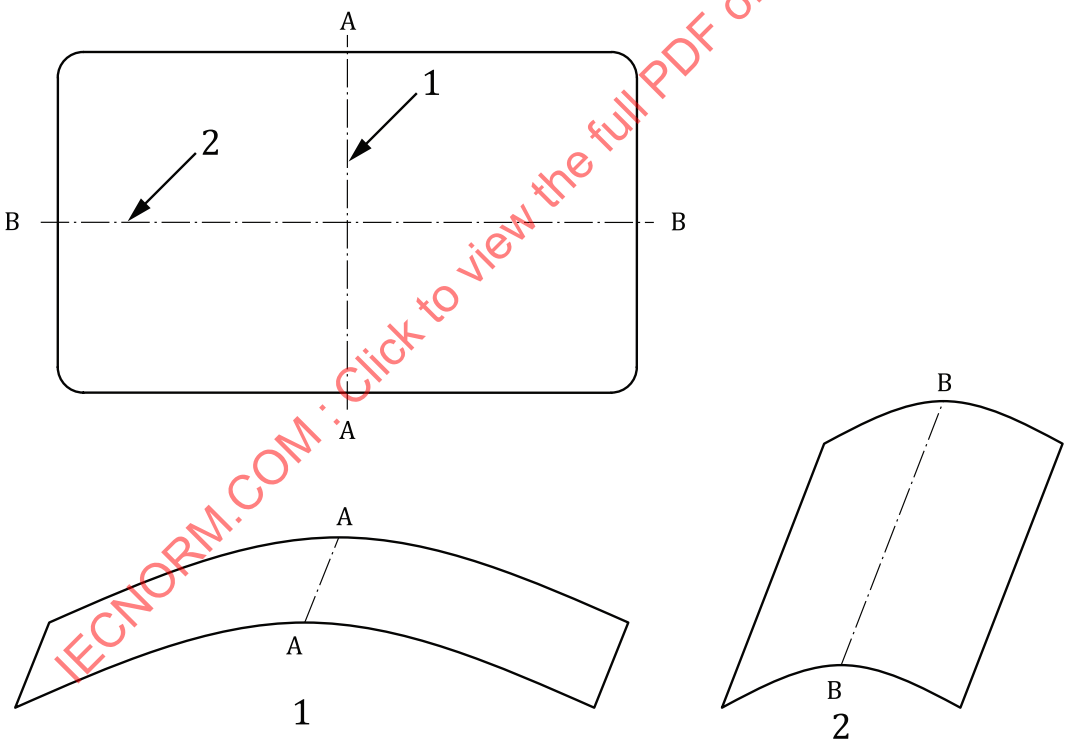

Key

1 axis A

2 axis B

Figure 18 — Definition of axes

5.9.5 Test report

The test report shall state whether or not the card is testably functional at the end of the test.

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5.10 Dynamic torsional stress

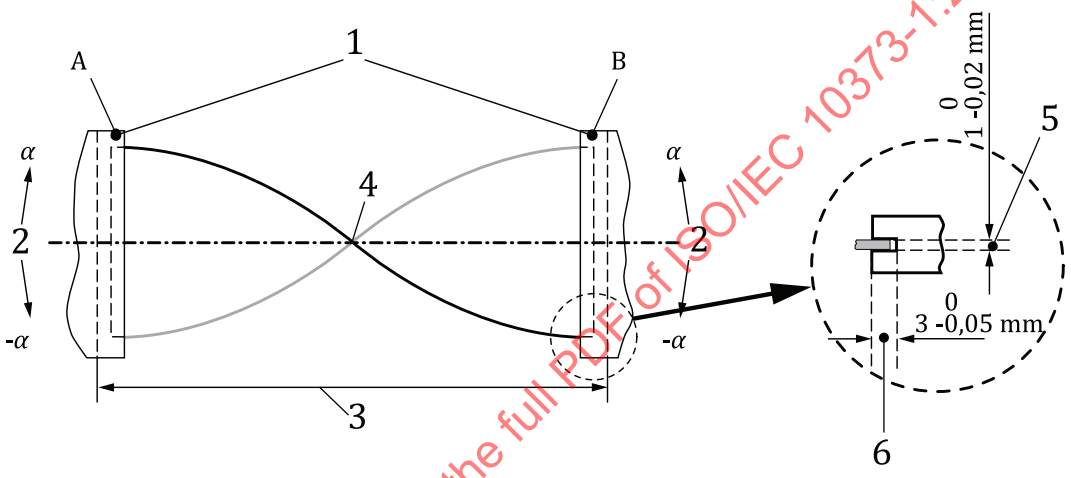
5.10.1 General

The purpose of this test is to determine any adverse mechanical or electrical effects arising from the repeated application of torsional stress to a card test sample.

5.10.2 Apparatus

The apparatus used to apply dynamic torsional stress to the card under test shall be as shown in Figure 19.

The apparatus varies the torsional stress applied in a sinusoidal manner up to a predetermined angular limit, as shown in Figure 20.



Key

1 guide rail
2 angle of rotation
3 guide rail distance
4 card
5 card holding gap thickness
6 card holding gap depth

Figure 19 — Torsion test machine

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5.10.3 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Position the card under test in the torsion test machine shown in Figure 19 so that it is loosely held in the grooves of the two guide rails, adjusting the distance d such that the short side edges of the card may be rotated through an angle up to ±α relative to the neutral position.

Set the test frequency to 0,5 Hz and the angle of rotation α to 15° ± 1° and perform the number of torsion cycles specified by the base standard or, if no such number is specified, 1 000 torsion cycles.

Check that the card is testably functional at the beginning and at the end of the test. It may also be checked during the test after one quarter of the torsion cycles specified in the base standard.

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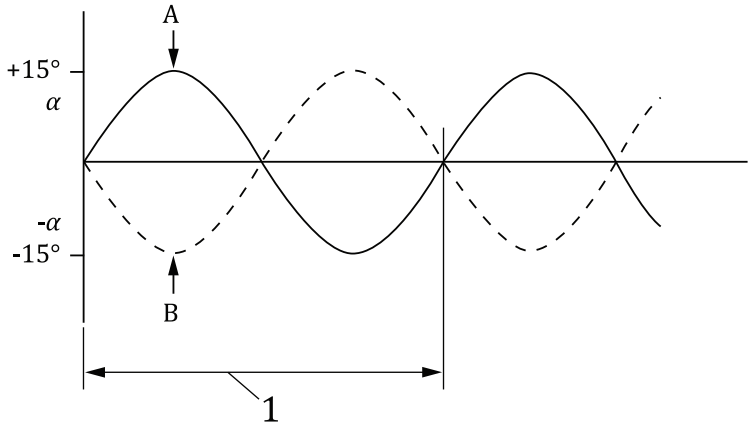

Key

1 one torsion cycle

Figure 20 — Stress cycle function

5.10.4 Test report

The test report shall state whether or not the card is testably functional at the end of the test.

5.11 Opacity

5.11.1 General

The purpose of this test is to determine the opacity of a card test sample in the areas specified by the base standard at two different infrared (IR) wavelengths that are representative of those most commonly employed in applications in which the presence of a card is detected by its attenuation of light transmitted between an emitter and a detector.

NOTE At the time of publication, the most commonly employed IR emitters are GaAlAs (gallium aluminium arsenide) or GaAs (gallium arsenide) light emitting diodes (LEDs) that emit IR light at peak wavelengths nominally at 860 nm and 950 nm respectively.

5.11.2 Apparatus

The test apparatus shall consist of:

a) IR LED emitter and detector pairs with characteristics according to Table 5;

Table 5 — Apparatus specifications

	Wave length	
	Near IR	**Far IR**
Emitter LED minimum radiant power (mW)	50	50
LED peak emission wavelength (nm)	860 ± 10	950 ± 10
LED spectral half band maximum width (nm)	50	50
Detector nominal wavelength for peak sensitivity (nm)	900	900

b) material to block IR light with aperture for both LED and detector as shown in Figure 21;

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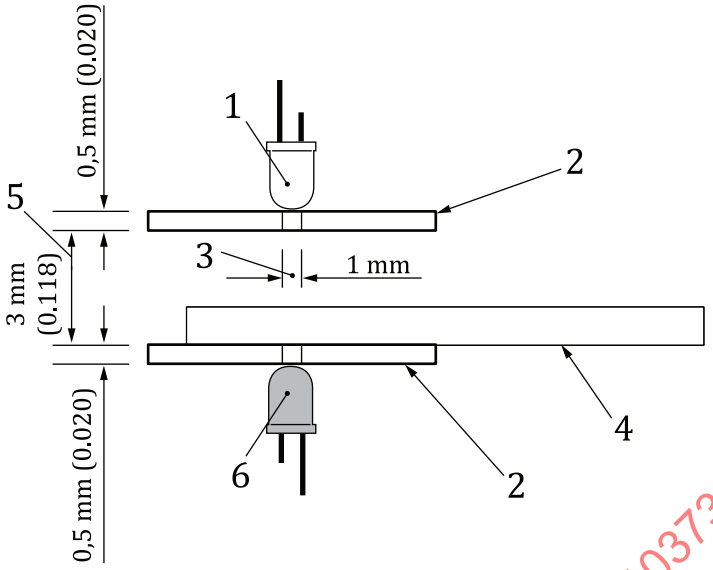
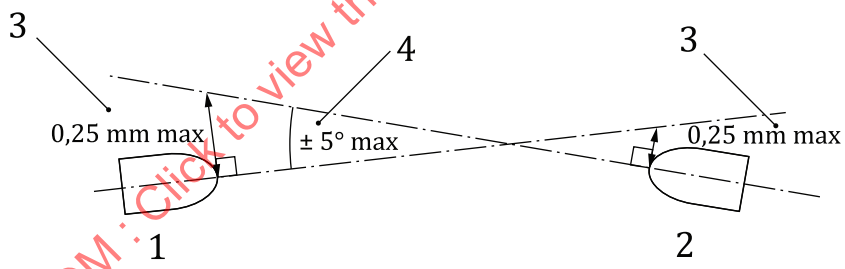


Key

1	IR LED	4	card sample
2	material to block IR light	5	distance IR block material
3	diameter circular aperture	6	detector

Figure 21 — IR LED and detector alignment

c) suitable mount to position IR LED and detector in line, within ± 0,25 mm (0.010 in) and a cone angle of 5° and shield them from ambient light (see Figure 22 for details);



Key

1	IR LED	3	position IR LED, detector
2	detector	4	cone angle

Figure 22 — Alignment detail of source and sensor

d) circuit to control the emitter and provide means to measure the current through the detector as shown in Figure 23.

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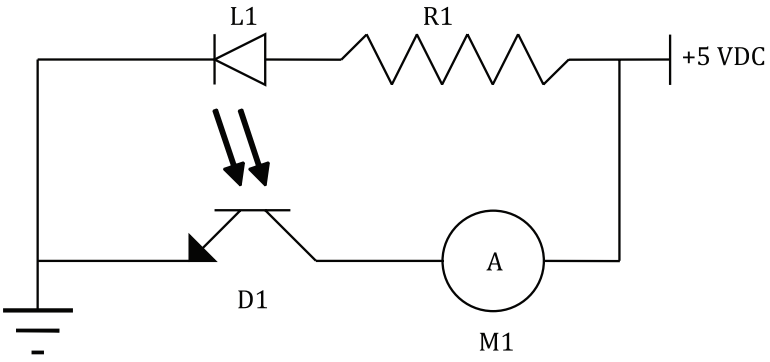

Key

R1 electrical resistance
L1 IR LED
D1 detector
M1 current meter

Figure 23 — Transmission opacity test circuit (for each wavelength)

Select IR LED resistor for a forward current (I_F) not to exceed 90 % of manufacturers maximum rating. A detector current of 5 mA to 15 mA when nothing is between the IR LED and detector is desirable.

5.11.3 Procedure

5.11.3.1 General

Place the ORM7810 reference material, defined by the base standard, between the LED and detector, nearest to the detector. Record the current through the detector, I_{ref}. Move the reference material between the LED and detector to obtain the minimum current. Remove the reference material after calibration.

NOTE The ORM7810 reference material can be obtained from Eclipse Laboratories Inc, 1025 North Hwy 3, Northfield, MN 55057, U.S.A. <www.eclipselaboratories.com>.

5.11.3.2 Measurement

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Position the test card between the LED and detector, nearest to the detector.

Find and record the maximum detector current I_{card} within the areas of the card specified by the base standard for each LED wavelength by moving the card between the LED and detector.

If motorized equipment is used to scan the card, the distance between individual measurement positions should be less than or equal to half the diameter of the aperture. For a continuous scanning method the speed should be less than 0,05 times the aperture diameter divided by the response time of the LED/detector system.

5.11.3.3 Test report

Report the minimum value for I_{ref} and the maximum value for I_{card} for each wavelength.

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5.12 X-rays

5.12.1 General

The purpose of this test is to determine any adverse effects arising from exposure of a card test sample to X-rays.

5.12.2 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Expose each side of the card to X ray radiation with an acceleration voltage of 100 kV, using a tungsten anode, to the dose defined in the standard.

Check that the card remains testably functional following the exposure.

5.12.3 Test report

The test report shall state whether or not the card is testably functional at the end of the test.

5.13 Embossing relief height of characters

5.13.1 General

The purpose of this test is to obtain the overall and the relief height of embossed imprinting characters in a card test sample, such as those defined in ISO/IEC 7811-1.

5.13.2 Apparatus

The test apparatus shall consist of a micrometer with a flat anvil and spindle whose diameter is within the range of 3 mm to 8 mm (0.12 in to 0.32 in), having a precision of 0,005 mm (0.00020 in) and a pressure range of 0,1 N/mm^2 to 0,4 N/mm^2.

5.13.3 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

Use the micrometer to measure the embossed height of any one character.

Calculate relief height by subtracting the thickness of the card, as measured in the relevant quadrant (see Figure 2) from the value of overall height obtained by direct measurement.

5.13.4 Test report

The test report shall give the value of overall and relief height for each character.

5.14 Resistance to heat

5.14.1 General

The purpose of this test is to determine whether the structure of the card remains stable within the requirements of the base standard while exposed to the required temperature. The resistance to heat of the complete card is measured by determining the deformation of the card after being exposed to a certain temperature.

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The deformation of the card (Δh) with reference to a certain temperature is the maximum of the two results obtained with the card being placed into the test apparatus with the card front upwards (Δh_F) and the card back upwards (Δh_B).

5.14.2 Apparatus

The test apparatus shall consist of:

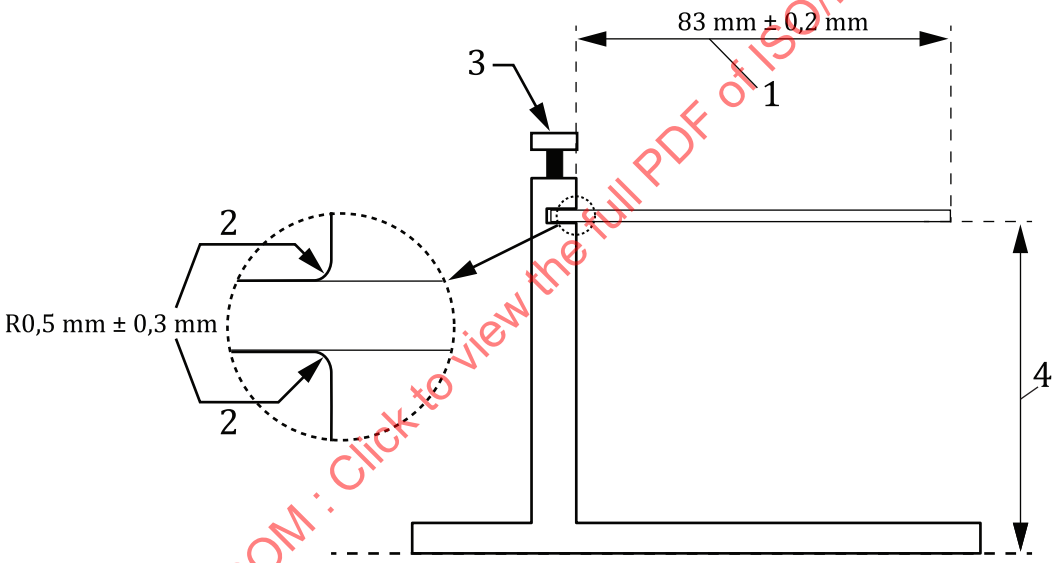
— a climatic chamber or ventilated oven permitting the required temperature and humidity;

— a clamping device able to clamp sample card firmly (see Figure 24).

NOTE A ventilated oven operated in the default test environment at a temperature above 26 °C automatically has a relative humidity below 60 %.

5.14.3 Procedure

Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1. Mount the sample card in the clamping device such that it is clamped along the entire short side, with the front side up. For integrated Circuit Cards with contacts, the card shall be placed such that the contact location is opposite the clamping device. Measure h_1 as shown in Figure 24.



Key

1 length clamp to card edge
2 clamp radius
3 clamp card firmly
4 height lower card edge to bottom (h_1)

Figure 24 — Card in clamping device before exposure to temperature

Place the clamping device with the card into a climatic chamber or oven at the temperature and humidity conditions described in the base standard for a period of 4 h. Ensure that the test card is protected from significant air currents in the chamber.

At the end of the test period, the clamping device with the card is removed from the chamber. After a cooling time of at least 30 min in a test environment conforming to 4.1, measure h_2 as shown in Figure 25.

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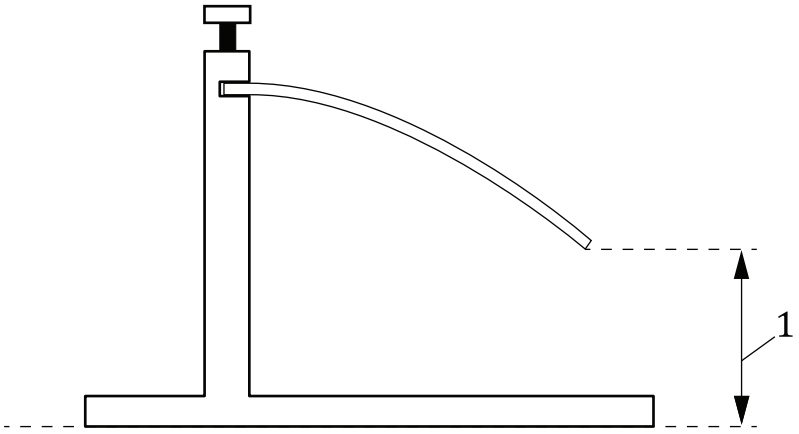

Key

1 height lower card edge to bottom (h_2)

Figure 25 — Card in clamping device after exposure to temperature

Calculate Δh_F: $\Delta h_F = h_1 - h_2$.

Repeat the entire procedure with a second card of the same quality, this time with the back side up and calculate Δh_B: $\Delta h_B = h_1 - h_2$.

Determine the maximum deflection Δh i.e. Δh = Maximum($|\Delta h_F|$,$|\Delta h_B|$).

Check the cards visually for delamination and discoloration.

5.14.4 Test report

The test report shall give the maximum deflection Δh and shall state whether delamination or discoloration occurred on the test card.

5.15 Surface distortions, raised areas and depressed areas

Surface distortions, raised areas and depressed areas (except for embossed characters) shall be measured with the same apparatus and procedures as given for height and surface profile of the magnetic stripe in ISO/IEC 10373-2.

6 Test methods for ICCs

6.1 Conventions for electrical measurements on ICCs with contacts

Potential differences are defined with respect to the electrical ground contact of the ICC and currents flowing to the ICC are considered positive.

6.2 Apparatus for measurements on ICCs with contacts

6.2.1 Default ICC holder, reference axes and default measurement position

When required by the test-method, the ICC shall be positioned in the default measurement position as subsequently defined.

The default measurement position requires the ICC to be positioned in an ICC-holder and flattened by a flattening plate. All measurements using this default measurement position shall be relative to the reference axes defined in Figure 26.

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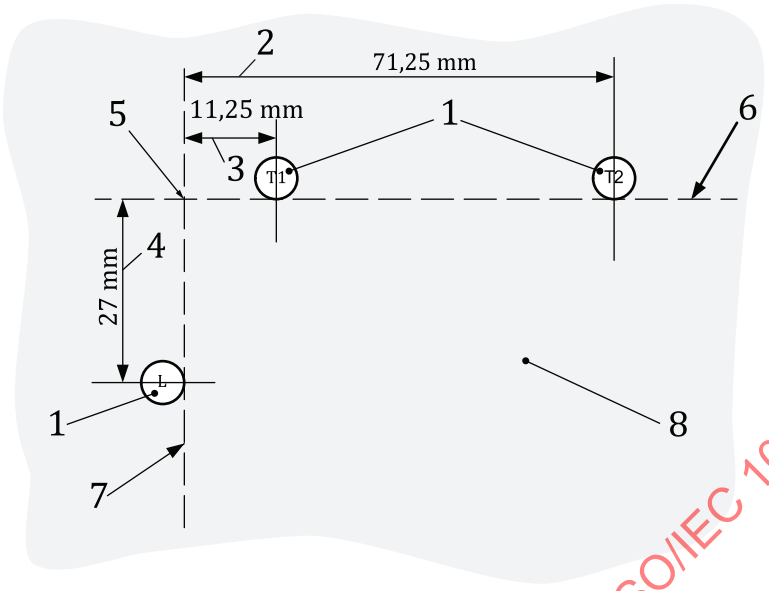
6.2.2 Default ICC holder and reference axes

The default ICC holder shall comply with Figure 26.



Key

1	metal cylinder	5	O Reference
2	distance to holder edge	6	X-Axis Reference
3	distance to holder edge	7	Y-Axis Reference
4	distance to holder edge	8	level grid plate

L, T1 and T2 shall be metal cylinders, having a diameter of 5 mm ± 0,1 mm, a surface roughness Ra < 5 µm, mounted on a level rigid plate with a surface roughness Ra < 5 µm.

Figure 26 — ICC-holder

6.2.3 Flattening plate

The flattening plate shall comply with Figure 27 and shall apply a force of 2,2 N ± 0,2 N to the surface of the card.

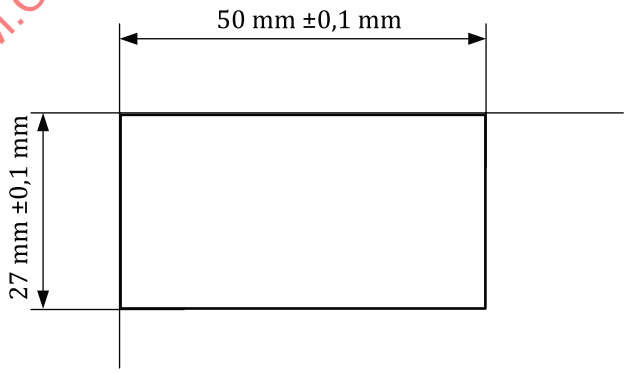


Figure 27 — Flattening plate

6.2.4 Default Measurement Position

The ICC and the flattening plate shall be mounted on the ICC-holder as shown in Figure 28.

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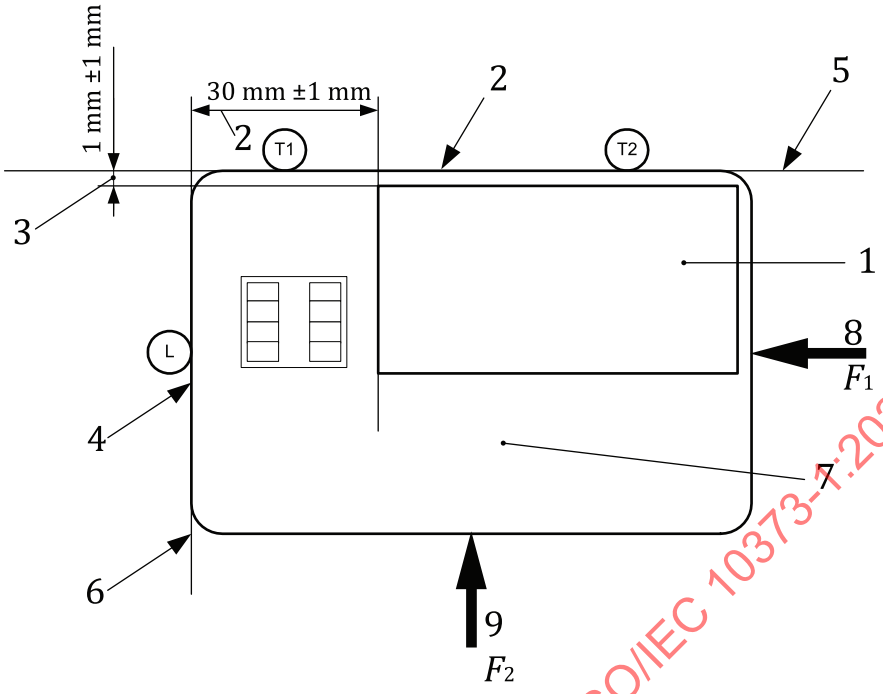

Key

1 flatting plate (FP)
2 distance FP edge to card edge
3 distance FP top edge to card top edge
4 left card edge
5 X-Axis$_{Reference}$
6 Y-Axis$_{Reference}$
7 front side
8 force to the right edge of card (F_1 = 1 N to 2 N)
9 force to the bottom edge of card (F_2 = 2 N to 4 N)

Figure 28 — Position of ICC and flattening plate on ICC-holder

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6.3 Dimension and location of contacts for ICCs with contacts

6.3.1 General

The purpose is to determine the compliance of the dimensions and the location of the ICC's contacts with ISO/IEC 7816-2.

6.3.2 Apparatus

The test apparatus shall consist of:

— an ICC-holder and a flattening plate compliant with 6.2.1;

— any device capable of executing the procedure below with the defined accuracy

6.3.3 Procedure

a) Mount the ICC in the default measurement position as defined in 6.2.4.

b) Construct two lines parallel to the X-Axis$_{Reference}$ and two lines parallel to the Y-Axis$_{Reference}$ on the ICC surface, forming the minimum contact area C1 as defined in ISO/IEC 7816-2 with an accuracy of equal to or better than ±0,01 mm.

c) Check if the rectangular area enclosed by the four lines is completely covered by contact metallization and note the result.

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d) Check if the metallization within the rectangular area enclosed by the four lines is connected to metallization in any other minimum contact area and note the result.

e) Repeat b) to d) for the minimum contact areas C2 to C8.

6.3.4 Test report

The test report shall state for each observed minimum contact area, whether it is completely covered by contact metallization and if it is connected to metallization in any other minimum contact area.

6.4 Mechanical strength of contacts

6.4.1 General

The purpose of this test is to determine any adverse effects arising from the application of mechanical stress as specified in the base standard, in the contact area of a card IC module.

NOTE Information contained in the ISO/IEC 7816-1 base standard might move to ISO/IEC 7810 in future due to changes in the structure of standards for physical requirements.

6.4.2 Apparatus

The test apparatus shall consist of:

— an ICC holder and flattening plate conforming to 6.2;

— an assembly that applies the force given in the base standard to a round steel (or similar material with at least equivalent hardness) ball or tip with a diameter given in the base standard;

— a flat rigid positioning template; see Figure 30 for an illustration of the positioning template.

See Figure 29 for an illustration of the apparatus.

If no base standard applies, the ball diameter shall be 1 mm and the force shall be 1,5 N ± 0,05 N.

NOTE Stainless steel balls of 1 mm diameter for ball point pens are available in the market, which fulfil this purpose.

The exact shape of the assembly is left to the individual test lab as long as the total force applied is as specified.

Manual or automatic jigs may be used, e.g. tensile testers. The resulting test force shall be as specified. Spring mechanisms are not a stable solution for the requirements of this test.

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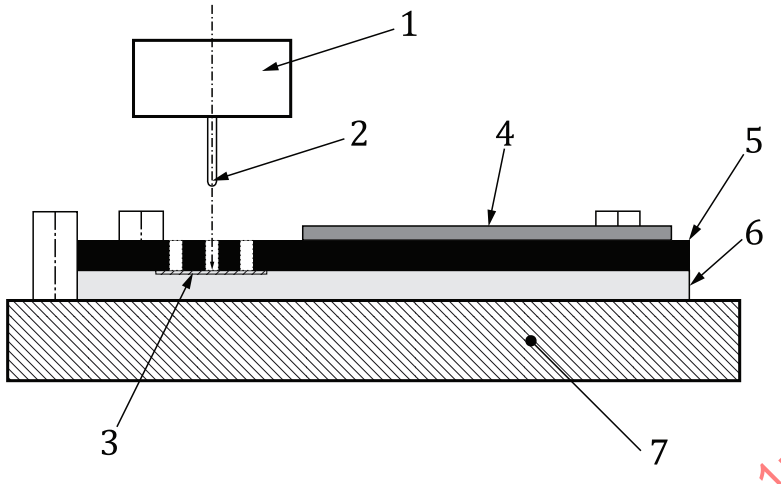

Key

1 assembly (example)
2 stainless steel ball or tip
3 IC card contact area
4 default flattening plate
5 positioning template
6 ID-1 card, contacts up
7 default ICC holder

Figure 29 — Default ICC holder and flattening plate with positioning template and steel ball or round tip assembly

Figure 30 — Positioning template

Length and width of positioning template are identical to ID-1 card dimensions and tolerances as defined in ISO/IEC 7810. The template contains 9 round holes with a diameter of 1,5 mm ± 0,05 mm. 8 holes are located at the centre point of each ISO/IEC 7816-2 contact. The 9th hole is located in the geometrical centre of the other 8 holes.

Six contacts alternative — as there are cards in the market with 6 contacts, the mechanical strength of contacts procedures shall apply correspondingly. The centre (7th) hole shall be in the geometrical centre of the 6 ISO/IEC 7816-2 contacts.

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6.4.3 Procedure

Subject each contact to a visual inspection to establish its appearance prior to testing and any existing visual damage.

Mount the ICC card in the default measurement position as defined in 6.2.4 but with the positioning template between the sample card and the flattening plate.

Lower the assembly with a maximum speed of 1 mm per second until the specified force is applied to the contact for 1 min. Raise the assembly and repeat this step on the remaining 8 (6) positioning template holes.

6.4.4 Test report

Unless specified otherwise by the base standard, state if the IC module is testably functional. If visual changes in appearance have occurred, the surface profile of the contacts according to ISO/IEC 7810 shall still be fulfilled.

6.5 ESD — Electrostatic discharge for ICC contact cards

6.5.1 General

The test method specified in the IEC 60749-26 shall be used to test conformance with the static electricity requirements of the base standard.

Non-connected contacts shall not be stressed.

6.5.2 Test report

The test report shall state whether or not the card under test remained testably functional following the exposure.

6.6 ESS — Electrostatic stress for PICC and VICC

6.6.1 General

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

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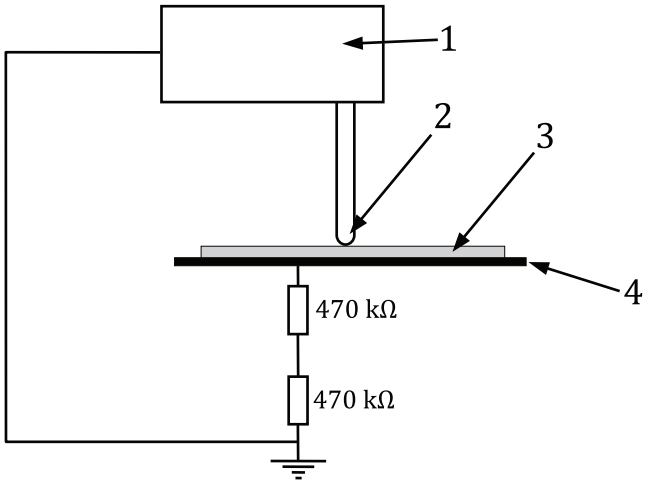

Key

1	ESD gun	3	PICC or VICC
2	discharge tip	4	plane

NOTE The plane is a horizontal coupling conductive plane on a wooden table, standing on a ground reference plane.

Figure 31 — ESD test circuit

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6.6.2 Apparatus

The test apparatus is as follows. Refer to IEC 61000-4-2.

a) main specifications of the Electrostatic gun:

- energy storage capacitance: 150 pF with a tolerance of ± 10 %;
- discharge resistance: 330 Ω with a tolerance of ± 10 %;
- charging resistance: between 50 MΩ and 100 MΩ;
- rise time: 0,7 ns to 1 ns;

b) selected specifications from the optional items:

- type of equipment: table top equipment;
- discharge method: direct application of air discharge to the equipment under test;
- discharge electrodes of the ESD generator: Round tip probe of 8 mm diameter.

6.6.3 Test procedure

Connect the ground pin of the apparatus to the conductive plate upon which the PICC or VICC is placed (see Figure 31).

Apply the discharge successively in normal polarity to each of the 20 test zones shown in Figure 32 ensuring that the discharge tip is not applied within 6 mm of the card perimeter (see the dashed boundary line in Figure 32) and allowing a cool-down period between successive pulses of at least 10 s.

Repeat the procedure with reversed polarity.

WARNING — If the PICC or VICC includes contacts, the contacts shall face up and the zone which includes contacts shall not be exposed to this discharge.

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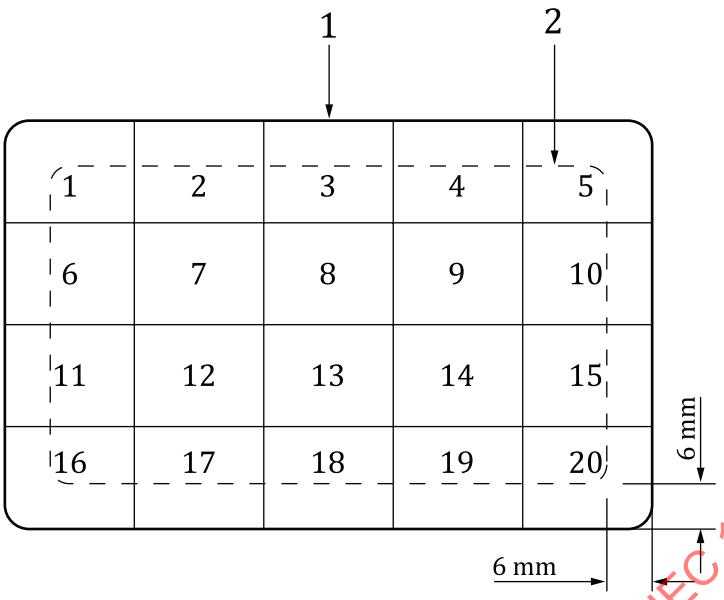
Check that the PICC or VICC remains testably functional at the end of the test.



Key

1 top reference edge

2 dashed boundary line of the positioning area of the discharge tip

Figure 32 — Test zones on PICC or VICC for ESD test

6.6.4 Test report

The test report shall state whether or not the PICC or VICC remains testably functional.

6.7 Electrical resistance of contacts of ICCs with contacts

6.7.1 General

The purpose of this test is to determine the surface resistance of the ICC contact surface

6.7.2 Apparatus

The test apparatus shall consist of an ohmmeter with a range from 10 mΩ to 2 Ω having an accuracy of ±2 mΩ and test prods as defined in Figure 33. The measurement current shall be less than or equal to 100 mA and the measurement voltage shall be less than or equal to 20 mV.

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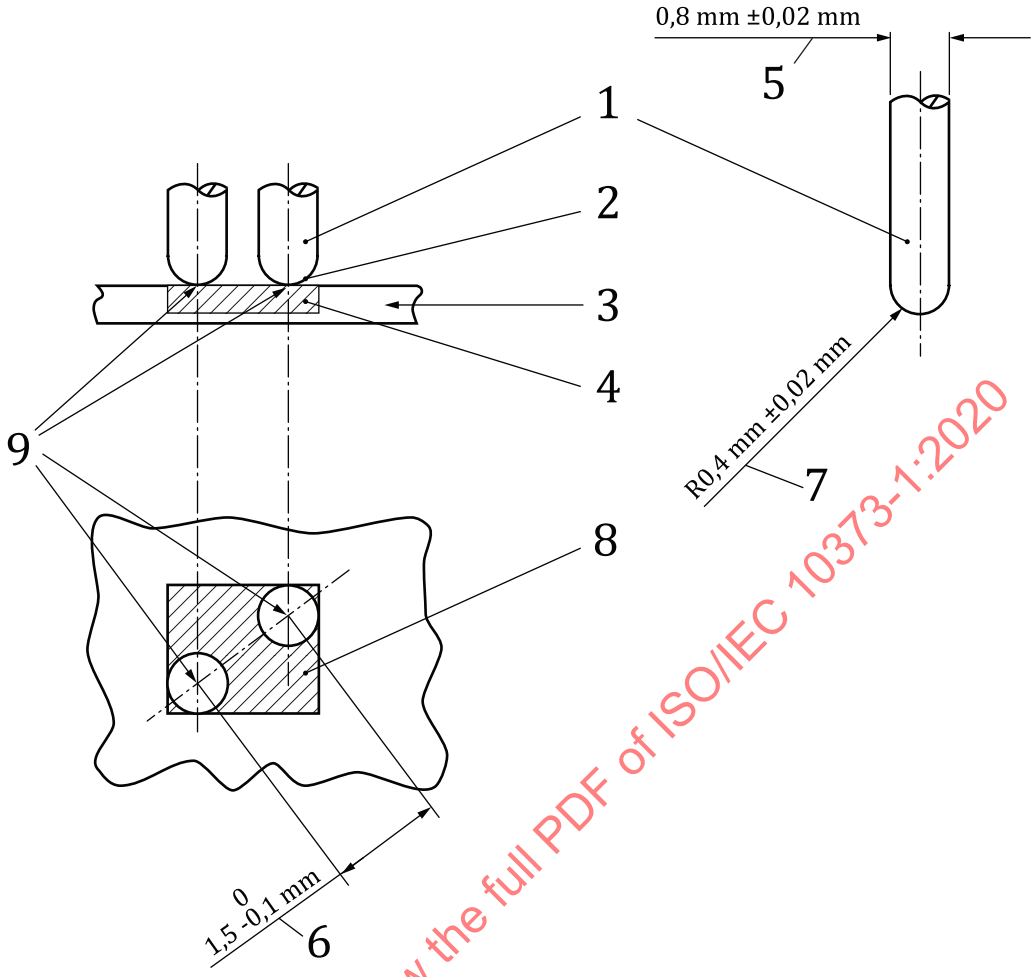

Key

1 test prod
2 pin tip gold plated surface
3 card
4 card contact
5 diameter test prod
6 measuring distance between 2 test prods
7 radius test prod
8 minimum rectangular surface area
9 measuring point

NOTE Applied force per test prod = 0,50 N ± 0,1 N.

Figure 33 — Test prods

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6.7.3 Procedure

Place the ICC on a flat hard surface.

Apply the two test prods to each present minimum contact area as defined in ISO/IEC 7816-2.

Measure the electrical resistance between the two test-prods for each present minimum contact area.

Start applying the measurement voltage after making mechanical contact.

6.7.4 Test report

Report the resistance values for each measured minimum contact area.

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6.8 Additional test methods regarding electrostatic effects

Additional test methods to simulate various types of electrostatic effects are described in Annex A and Annex B.

6.9 Surface profile of contacts of ICCs with contacts

6.9.1 General

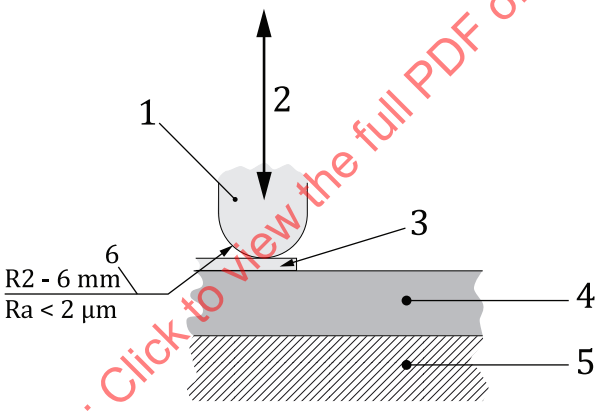
The purpose is to determine the difference in thickness between the ICC's contacts and the adjacent ICC surface to verify compliance with the requirements for the surface profile of contacts in ISO/IEC 7816-1.

6.9.2 Apparatus

The test apparatus shall consist of:

— an ICC-holder and a flattening plate conforming to 6.2.2 and 6.2.3, respectively;

— a measurement device capable of measuring the perpendicular distance between the upper surface of the level rigid plate of the ICC-holder and the upper surface of an ICC placed on the ICC-holder with an accuracy of ±0,01 mm. The area of measurement shall be 2,5 mm wider in all directions than the area covered by the contact metallization of the ICC to be tested. The measurement tip shall be as shown in Figure 34.



Key

1	measurement tip	4	ICC
2	direction of measurement	5	ICC holder level rigid plate
3	ICC contact	6	radius test prod

Figure 34 — Measurement tip

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6.9.3 Procedure

The positioning tolerance of the measurement tip relative to the measurement line in the procedure below shall not exceed 0,5 mm.

a) Mount the ICC in the default measurement position as defined in 6.2.4.

b) Construct a measurement line on the surface of the ICC along the centreline of the minimum contact areas C1 and C5, beginning and ending at a distance of 2 mm of the metallized contact surface (see Figure 35).

c) Measure the distance between the level rigid plate and the start and endpoint of the measurement line and calculate the arithmetic average of the two distances, subsequently called "base thickness".

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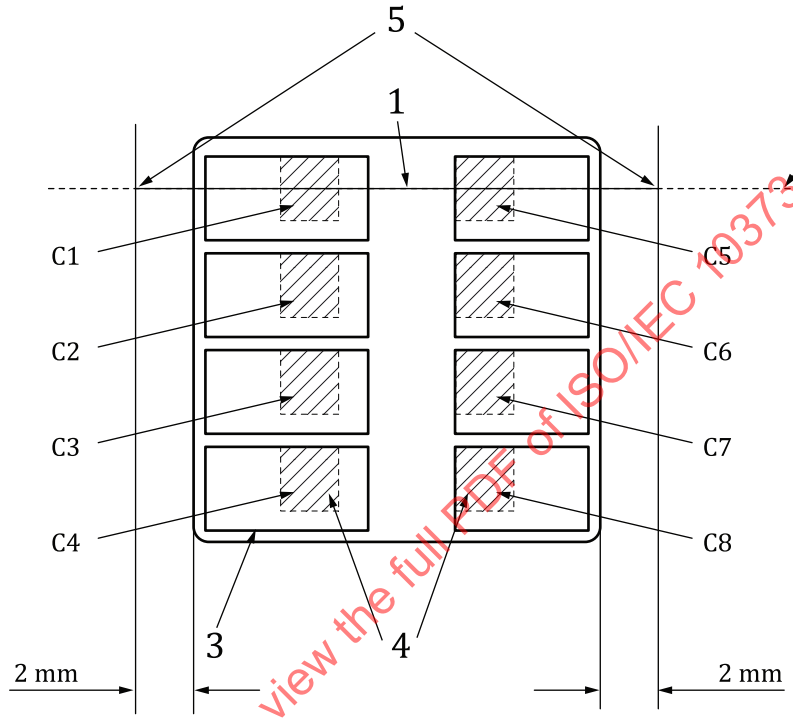
d) Determine the minimum and maximum distance between the level rigid plate and all points on the surface of the ICC along the measurement line.

e) Calculate the difference between the base thickness and the maximum and minimum distance determined under d) in such a way that a distance higher than the base thickness results in a positive value and a distance below in a negative.

f) Repeat b) to e) for the centrelines of the contacts C2 and C6, C3 and C7 and, if present, C4 and C8.

g) Determine the minimum and maximum value of all values determined under e).



Key

1 line of measurement
2 centreline minimum contact areas C1/C5
3 physical contacts
4 minimum contact areas
5 begin, end of measurement line

Figure 35 — Measurement line across contacts C1 and C5

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6.9.4 Test report

Report the minimum and maximum value determined in the procedure, step g) and the radius of the measurement tip used.

6.10 ICC — Mechanical strength: 3 wheel test for ICCs with contacts

6.10.1 General

The purpose of this test is to determine the mechanical reliability of an ICC by using a mechanical arrangement of three wheels to exert cyclical stress onto the contact area.

6.10.2 Apparatus

The principle of the apparatus is shown in Figure 36. It comprises three wheels, one above and two below the ICC. The ICC is moved cyclically between the three wheels, so that the contact area is

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repeatedly exposed to the forces exerted by the wheels. This does not imply that either the card or the wheels must remain stationary relative to the observer during the test, but only that the arrangement of wheels moves relative to the card.

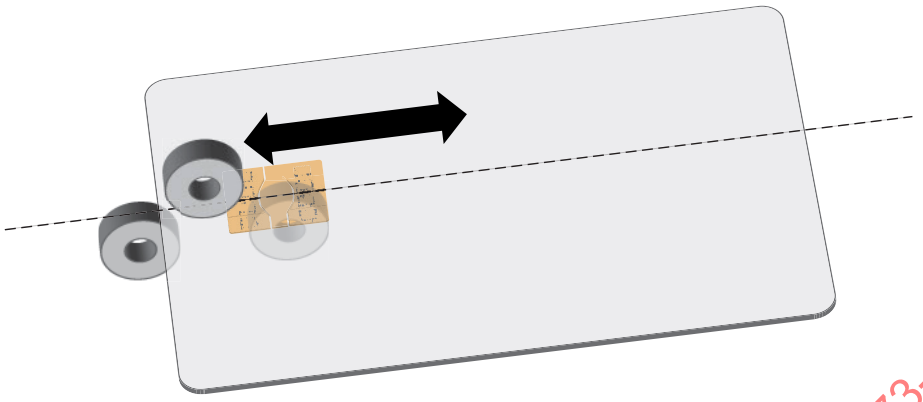

Figure 36 — 3 wheel test principle

The apparatus shall comprise three wheels mounted as shown in Figure 37. Wheels W2 and W3 are fixed. Wheel W1 can move in the direction perpendicular to the surface of the ICC with a maximum error of ±5° and applies a force *F* as shown in Figure 37 to the surface of the ICC. The force *F* shall be applied by means of a static weight (in contrast to the dynamic stress that would be applied by a spring, stepper motor or pneumatic cylinder) fixed above wheel W1 such that the force direction shall pass through the axis of wheel W1. The resulting downward movement of wheel W1 shall be limited, so that in the resting position without a card present, the distance between Axis B in Figure 37 and the surface of wheel W1 shall be within a range of 4,0 mm to 4,5 mm.

The magnitude of the force F shall be that value defined by the base standard or, if the base standard does not define a value, 8,0 N ± 0,5 N.

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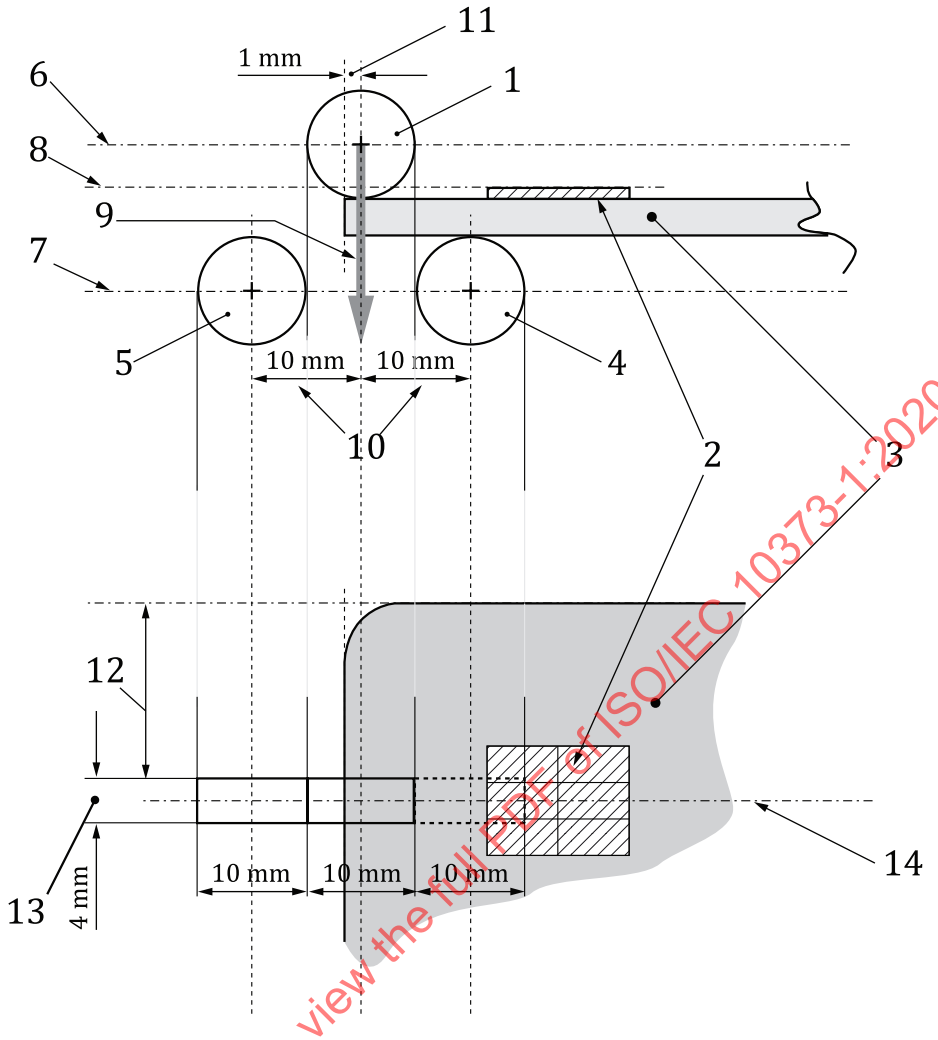

Key

1	wheel W1	8	axis C — centreline of contacts
2	ICC contacts	9	force
3	ICC	10	distance centre W1 to centre W2, W3
4	wheel W2	11	centre W1 to card edge
5	wheel W3	12	dimension *d*
6	axis A — centreline wheel W1	13	width wheels
7	axis B — centreline wheel W2, W3	14	axes A, B, C

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Figure 37 — Location of the wheels and initial position of the ICC

The method by which the ICC is held in position shall be such that it does not prevent deformation of the ICC during testing.

The wheels shall have a chamfer and run on low-friction bearings, e.g. ball bearings.

NOTE 1 The following ball bearing definition defines suitable wheels: ball bearing type 623ZZ.

The part of the ICC moving over W2 shall be free to bend.

Dimension *d* in Figure 37 shall be such that the distance between the centreline axis of the contacts present on the ICC (axis C in Figure 37 and Figure 38) and the plane defined by the centreline axes of

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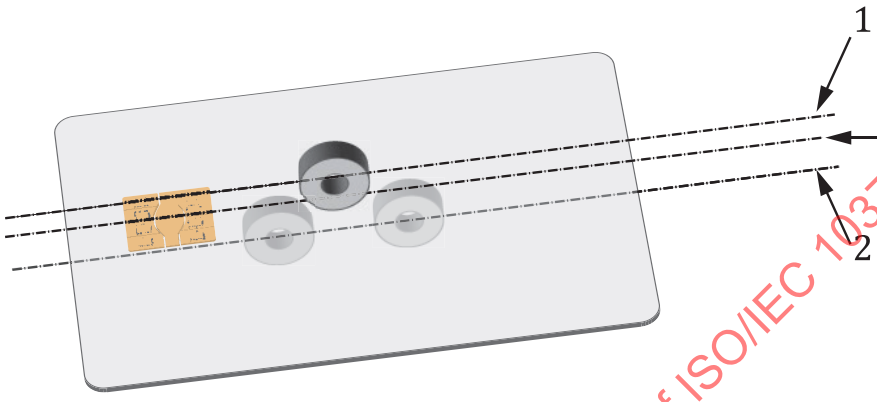
the wheel W1 (axis A in Figure 37 and Figure 38), and the wheels W2 and W3 (Axis B in Figure 37 and Figure 38) does not exceed 0,5 mm, measured above and below any of the three wheels.

NOTE 2 "above" and "below" here refer to positions at perpendicular displacements from the plane of the ICC surface.

NOTE 3 Based on an ICC having minimum contacts as defined in ISO/IEC 7816-2, dimension *d* would be:

Contact side facing upwards: 20,62 mm for an ICC with 6 contacts and 21,89 mm for an ICC with 8 contacts.

Contact side facing downwards: 29,36 mm for an ICC with 6 contacts and 28,09 mm for an ICC with 8 contacts.



Key

1 axis A — centreline wheel W1
2 axis B — centreline wheel W2, W3
3 axis C — centreline of contacts

Figure 38 — Location of axes A, B and C

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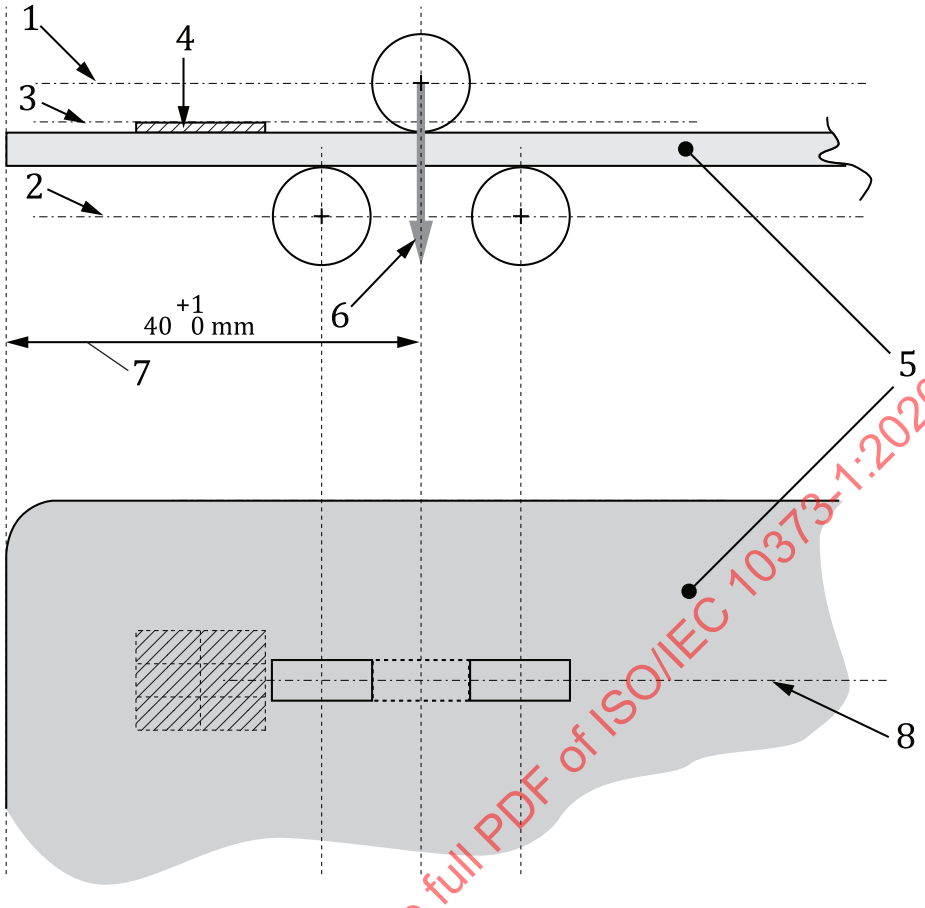

Key

1	axis A — centreline wheel W1	5	ICC
2	axis B — centreline wheel W2, W3	6	force *F*
3	axis C — centreline of contacts	7	centreline wheel W1 to card edge
4	ICC contacts	8	axes A, B, C

Figure 39 — Inserted position of the ICC

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6.10.3 Procedure

During all movements inside the apparatus as described below, the speed of the ICC shall not exceed 100 mm/s.

During all movements the angle between axis C and the plane defined by axis A and axis B shall not exceed 2°.

a) Pre-condition the sample card according to 4.2 before testing and conduct the test under the test environment defined in 4.1.

b) Verify that the IC module remains testably functional.

c) Insert the ICC into the apparatus in the initial position with the contacts facing upwards as shown in Figure 37.

d) Move the ICC within the apparatus into the inserted position as shown in Figure 39.

e) Withdraw the ICC to the initial position.

NOTE Steps c) to e) are defined as one cycle.

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f) Repeat c) to e) for a total number of cycles defined by the base standard with a frequency of 0,5 Hz. or, if the base standard does not define the number of cycles, for 50 cycles.

g) Insert the ICC into the apparatus in the initial position, but with the contacts facing downwards.

h) Move the ICC within the apparatus into the inserted position.

i) Withdraw the ICC to the initial position.

j) Repeat g) to i) for a total number of cycles defined by the base standard with a frequency of 0,5 Hz. or, if the base standard does not define the number of cycles, for 50 cycles.

k) Check if the IC module remains testably functional and note the result.

6.10.4 Test report

The report shall state if the IC module remains testably functional.

The report shall also state the number of cycles conducted, and the force exerted by the centre wheel.

NOTE Acceptance criteria are to be defined by the parties involved.

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Annex A
(informative)

Electrostatic discharge conductivity of cards

A.1 Test method 1

A.1.1 Introduction and summary

This quantitative method to determine a card's conductivity for ESD uses an IEC 61000-4-2 compliant discharge generator and a current probe connected to a digital oscilloscope to measure the electrical charge conducted by a card in different contact scenarios.

This is achieved through recording the current curve of the discharge and from that calculating the charge transmitted by the card.

To take account of capacitive and inductive effects of the test fixture, firstly a calibration run is made to determine a scale with 0 % equivalent to only air being between the discharge electrodes and 100 % equivalent to a conductor with 0 Ω resistance inserted between the electrodes.

To measure a card's conductivity, it is placed between the grid electrodes and the ESD is applied to one set of electrodes and is then conducted to some extent by the card to the grounded set of electrodes. The current flowing from the grounded set of grid contacts into ground is measured and recorded using the current probe connected to the oscilloscope.

A range of grid contact combinations is tested. To ensure each of the measurements is on a scale from 0 % to 100 %, each selected grid contact combination is firstly calibrated to 0 % when open and 100 % when shortened before the measurement is made with the card between the grid contacts.

From the recording of the discharge curve through the card for each contact scenario the transmitted charge is calculated and expressed as a percentage between 0 % and 100 % at a certain discharge voltage.

A.1.2 Apparatus

A.1.2.1 General

The apparatus consists of:

— ESD pulse generator, compliant with IEC 61000-4-2;

— a contact grid comprising of a contact plate with distinct contact fields on the surface in accordance with A.1.2.2;

— a digital storage oscilloscope with a minimum bandwidth of 200 MHz;

— a current probe with a minimum bandwidth of 60 MHz and a maximum pulse current rating of at least 250 A peak and a rise time of less than 6 ns;

— means of integrating a current curve recorded by the oscilloscope.

A.1.2.2 Contact grid

The test grid shall consist of a non-conductive baseplate with 6 conductive contact areas on its surface.

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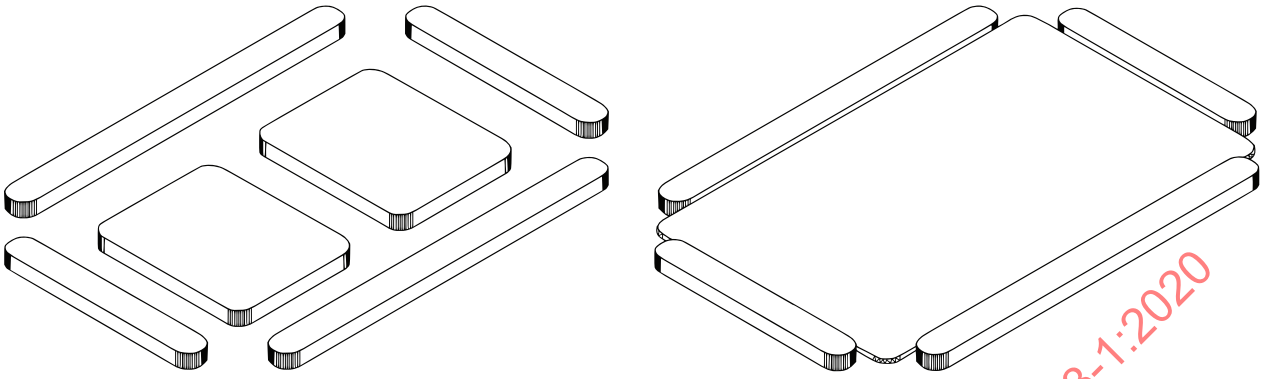
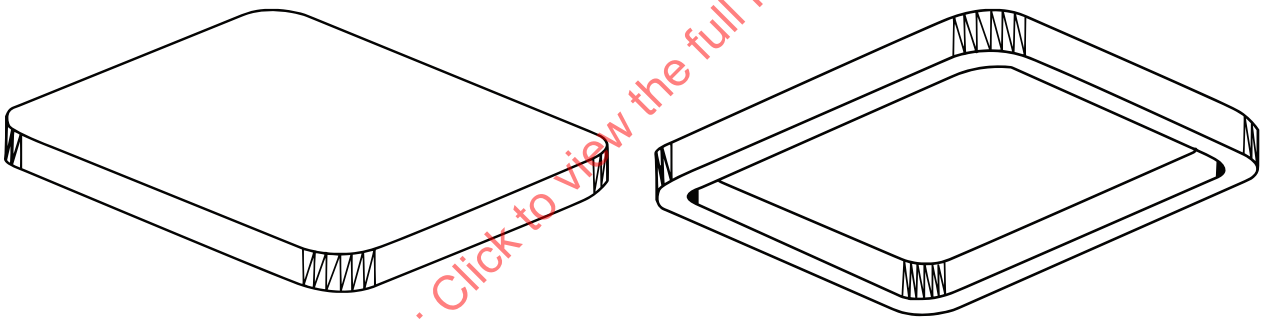
The 4 outer contacts are arranged in a rectangular form around a card position with two more centre contacts touching the side of the card facing downwards, as illustrated in Figure A.1. The surface of the centre contacts is located app 2 mm below the surface of the outer contacts.



a) Contact arrangement without card **b) Contact arrangement with card inserted**

Figure A.1 — Contact arrangement

The contacts shall be made of metal and be 3 mm thick with a thickness tolerance of ±0,2 mm. Seen from the top the individual contacts shall be flat. From the bottom the contacts shall be milled out to leave a remaining thickness of 0,5 mm in the centre of the contact, with a 2 mm wide edge with the full 3 mm thickness. See Figure A.2.



a) Contact plate see from top **b) Contact plate seen from bottom**

Figure A.2 — Contact plate

The horizontal and vertical dimensions of the contacts and their arrangement are defined in Figure A.3.

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