International Standard

ISO/IEC 24789-2

Second edition
2024-01

Identification cards — Card service life —

Part 2: Methods of evaluation

Cartes d'identification — Durée de vie des cartes —
Partie 2: Méthodes d'évaluation

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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

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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. In the IEC, see www.iec.ch/understanding-standards.

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 second edition cancels and replaces the first edition (ISO/IEC 24789-2:2011), which has been technically revised.

The main changes are as follows:

— all methods have been revised to bring them to the latest technical status;

— additional details are defined in the method ICM adhesion;

— plasticizer changed from DOP to DOTP;

— temperature humidity cycling method is replaced by temperature and exposure with humidity variation;

— temperature and humidity aging followed by peel strength is deleted;

— ID-card static bending stress method is added;

— temperature and humidity induced dye migration method is added to the informative Annex A;

— mechanical life cycle sequence for contactless cards is added to the informative Annex A.

A list of all parts in the ISO/IEC 24789 series can be found on the ISO and IEC websites.

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

Introduction

This document provides methods of evaluation of identification (ID) card service life. These methods of evaluation complement the application profiles and requirements defined in ISO/IEC 24789-1 which are intended to be used by card issuers, card manufacturers and card component suppliers to represent the comparative rigour of various ID card service life applications. They provide a means for ranking and comparing the main factors affecting ID card service life in a manner that is amenable to evaluation using the methods defined or referenced in this document.

NOTE For the convenience of certain users, non-SI equivalents are given for some quantity values where these are in common use in the ID card industry. These equivalents appear in parenthesis and are for information only.

Identification cards — Card service life —

Part 2:
Methods of evaluation

1 Scope

This document provides methods of evaluation for ID-1 identification card service life for the applications provided in ISO/IEC 24789-1.

The listed evaluation methods represent available tests, not mandatory tests. The selection of mandatory tests is listed in ISO/IEC 24789-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 3664, *Graphic technology and photography — Viewing conditions*

ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO/IEC 7811-2, *Identification cards — Recording technique — Part 2: Magnetic stripe: Low coercivity*

ISO/IEC 7811-6, *Identification cards — Recording technique — Part 6: Magnetic stripe: High coercivity*

ISO/IEC 7811-8, *Identification cards — Recording technique — Part 8: Magnetic stripe — Coercivity of 51,7 kA/m (650 Oe)*

ISO 9370, *Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method*

ISO/IEC 10373-1, *Cards and security devices for personal identification — Test methods — Part 1: General characteristics*

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

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO/IEC 14443-1, *Cards and security devices for personal identification — Contactless proximity objects — Part 1: Physical characteristics*

ISO/IEC 24789-1[1)], *Identification cards — Card service life — Part 1: Application profiles and requirements*

IEC 60068-2-78, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

IEC 60454-2, *Pressure-sensitive adhesive tapes for electrical purposes — Part 2: Methods of test*

1) Under preparation. Stage at the time of publication: ISO/IEC FDIS 24789-1.

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO/IEC 24789-1 and the following apply.

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

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

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

3.1 Terms and definitions

3.1.1
card fracture
crack or break in a card whose depth is at least one third of the card thickness

3.1.2
contactless integrated circuit card
card into which integrated circuit and coupling means have been placed, such that the communication to such integrated circuit is done in a contactless manner

3.2 Abbreviated terms

ATQA	Answer To reQuest, Type A
ATQB	Answer To reQuest, Type B
ATR	answer to reset
DICC	dual interface integrated circuit card, as defined in ISO/IEC 10373-1
DOTP	dioctyl terephthalate CAS 6422-86-2
IC	integrated circuit, as defined in ISO/IEC 7816-1
ICC	integrated circuit card, as defined in ISO/IEC 7810
ICM	integrated circuit model
PICC	proximity integrated circuit(s) card or object, as defined in the ISO/IEC 14443 series
PVC	polyvinyl chloride
RH	relative humidity
VICC	vicinity integrated circuit(s) card or object, as defined in the ISO/IEC 15693 series

4 Default items applicable to the evaluation 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 (RH) of 40 % to 60 %.

4.2 Pre-conditioning

Pre-conditioning is mandatory for all test methods. The identification card shall be conditioned in the test environment for 16 h before testing.

4.3 Default tolerance

Unless otherwise specified, a default tolerance of ±5 % shall be applied to the quantity values given to specify the characteristics of the test equipment (for example linear dimensions) and the test method procedures (for example test equipment adjustments).

4.4 Total measurement uncertainty

Total measurement uncertainty shall be reported with the results and is considered when judging conformity. The total measurement uncertainty should be less than 20 % of the permitted tolerance range. JCGM 100 provides guidance for determining and expressing the total measurement uncertainty.

5 Test methods

5.1 Surface abrasion

5.1.1 General

The test simulates mechanical abrasion of the card surface.

5.1.2 Apparatus

5.1.2.1 Abraser, with vacuum pick up or equivalent:

— abrasive wheels pair (TABER® CS-10F); [2)]

— resurfacing disks (TABER® S-11);

— dry soft cloth, or soft brush, or both;

— hole punch or equivalent;

— 500 g total load per wheel (250 g additional – no counter weight wheels);

— clamping ring (outer retaining ring).

5.1.3 Procedure

Prepare test cards that possess all desired information and features.

Use the notch location as per Figure 1 if the area of interest falls in the wheel path. If the area of interest does not fall inside the wheel path in Figure 1 then:

— the card may be moved to a different location on the turntable, so the area of interest is in the wheel path;

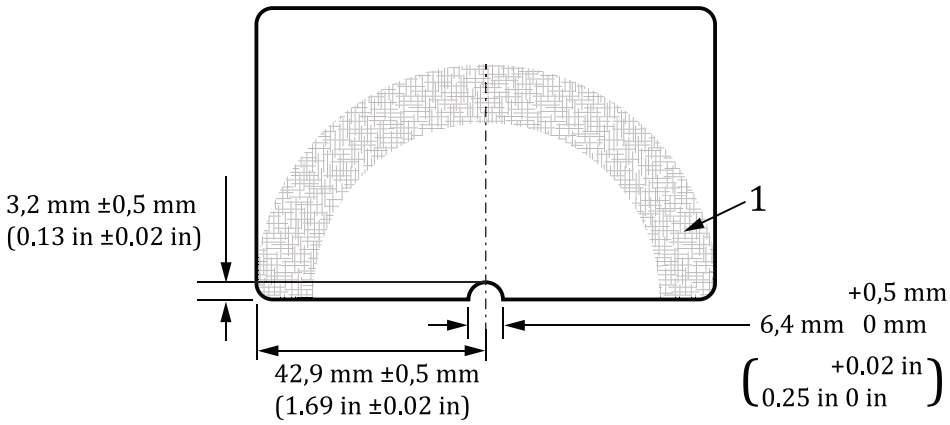
— if only one card is tested, a place holder card shall be used to position the test card on the turntable so the area of interest is abraded with minimal wheel bouncing;

— notches / holes for mounting the cards on the turntable shall be made in one or both cards;

— location of wear pattern tested shall be noted on the test report.

2) TABER® Industries is a trade name of products supplied by TABER® Industries. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to same result.

Dimensions in millimetres



Key

1 abrasive wheel path

Figure 1 — Test card notch location

Resurface the abrasive wheels for 50 cycles before testing begins. Remove all debris from the cards and turntable by cleaning with either a dry soft cloth or soft brush, or both. Avoid direct finger contact with the test cards and abrasion wheels. Replace the S-11 resurfacing disk after a maximum of 10 uses. Use the clamping ring when re-surfacing to avoid damage to vacuum nozzle from contact with the resurfacing disk.

Mount the cards on the turntable using the clamp plate and nut without a rubber pad. Place the abrasive wheels on the cards and lower the vacuum nozzle to 3 mm (0.12 in) above them.

Start the abraser and vacuum.

— The test shall be paused every 50 cycles. The cards shall be cleaned and examined for wear-through.

— Wear-through within 6 mm (0.25 in) of the card edge shall be excluded from the examination.

— The cards and turntable shall be cleaned with a vacuum and either a dry soft cloth or soft brush, or both. Avoid direct finger contact with the test cards and abrasion wheels.

— The abrasive wheels shall be resurfaced at the beginning of each test and again after every 250 cycles.

— The resurfacing is independent of specified cycles or stopping point.

— Stop the test after wear-through of the card feature is observed.

— Figure 2 illustrates 50 cycles before and at the stopping point for a heat transfer film, varnish or similar coating. This will also be the stopping point for dye printing underneath the heat transfer film.

— Figure 3 illustrates 50 cycles before and at the stopping point for resin-based text. Wear-through is defined as the point where any character is no longer legible.

— Figure 4 illustrates the stopping point for a resin based graphical element (e.g. logo, seal). Wear-through is defined as the point where the element is no longer completely intact or functional.

— The test may be stopped after reaching the limit value of the base standard:

Key

1 wear-through

Figure 2 — 50 cycles before (left) and at (right) stopping point for heat transfer film, varnish or similar coating

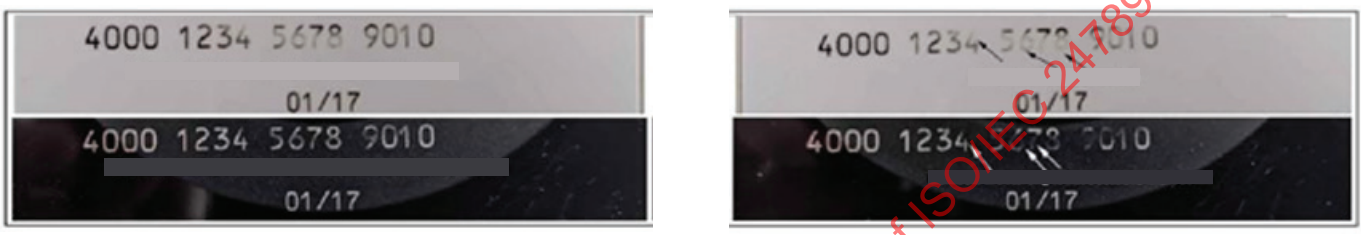


Figure 3 — 50 cycles before (left) and at (right) stopping point for resin-based text

Figure 4 — 50 cycles before (left) and at (right) stopping point for resin based graphical element (e.g. logo, seal)

Test results are affected by alignment of the card and wheels. It is important that the wheels make uniform contact with the card's surface over the width of each wheel.

Test results are affected by roughness of the abrasive wheels.

5.1.4 Test report

Record the number of cycles to stopping point, along with location of wheel path.

Sample images at stopping point should be included in the test report unless security dictates their exclusion. The test report inclusion of a card image at stopping point fulfils the wheel path documentation requirement.

5.2 Magnetic stripe abrasion

5.2.1 General

The test simulates mechanical abrasion of the card surface.

5.2.2 Apparatus

5.2.2.1 Abraser, with vacuum pick up or equivalent

— filler card (card of the same thickness as the card to be abraded);

— resurfacing disks (TABER® S-11);

— 500 g total load per wheel (250 g additional – no counter weight wheels);

— dry soft cleaning cloth or soft brush;

— hole punch or equivalent;

— magnetic stripe read test equipment with the following characteristics:

  — ISO/IEC 10373-2 conformant;

  — capable of reporting average signal amplitude (U_A) on middle third of Track 2 according to ISO/IEC 7811-2, ISO/IEC 7811-6 or ISO/IEC 7811-8.

5.2.3 Procedure

Prepare the card by encoding on Track 2 with a recording density of 8 bpmm (200 ftpi), with a relative tolerance of ±10 %, at a recording current of I_{min}. Use ISO/IEC 7811-2, ISO/IEC 7811-6 or ISO/IEC 7811-8 for the definition and permitted range of I_{min} and ISO/IEC 10373-2 for the method to measure I_{min}.

Create a hole in the card as shown in Figure 5.

Measure the average signal amplitude $U_{A\ initial}$ in the read area shown in Figure 5.

Resurface the abrasive wheels for 50 cycles before testing begins and after every 100 cycles. Clean the cards and turntable using a dry soft cloth or soft brush after the abrasive wheels are resurfaced. Avoid direct finger contact with the cards and abrasion wheels. Complete the procedure for each card to the stopping point before recommencing it with another card.

Mount the card on the turntable without any compliant pad. Add a filler card of the same thickness as the card on the specimen plate so that the abrasive wheels do not bounce when the procedure is in progress. Place the abrasive wheels (with the additional loads) on the card and the vacuum nozzle 6,4 mm (0.25 in) above the cards.

Preset counter to 50 and start the abraser and vacuum. Ensure that the abrasive wheels do not bounce during the test.

Remove the card and clean the magnetic stripe thoroughly, using a clean soft cloth, to remove debris.

NOTE A completely debris-free stripe prevents damage to the magnetic head used to measure the signal amplitude.

Re-measure average signal amplitude (U_A) in the read area shown in Figure 5.

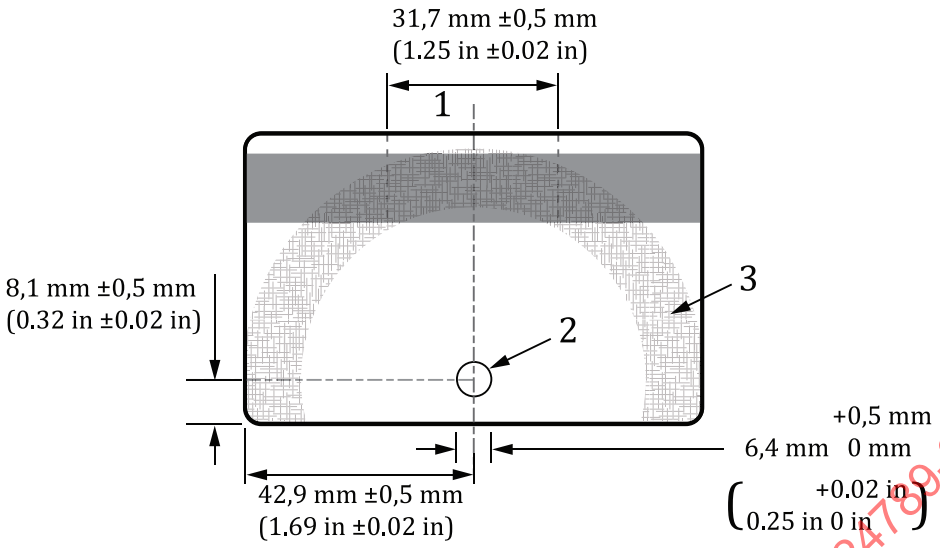
Repeat the sequence. Wheel resurfacing is required every 100 cycles, while U_A measurements are made every 50 cycles. The test may be stopped when the following occur:

— the average signal amplitude (U_A) in the read area is equal to or less than 0,70 $U_{A\ initial}$;

— after 5 000 cycles if U_A remains above 0,70 $U_{A\ initial}$ and the base standard does not specify otherwise.

Record the number of cycles to stopping point for each card tested.

Dimensions in millimetres



Key

1 read area
2 hole
3 abrasive wheel path

Figure 5 — Magnetic stripe read area and hole location

5.2.4 Test report

Report the number of abrasion cycles for each card tested.

NOTE Graphical results (average signal amplitude vs. abraser cycles) have been shown to be useful in showing abrasion characteristics.

5.3 Adhesion of ICM to card — Wrapping test

5.3.1 General

The purpose of this method is to establish that sufficient bond strength exists between the card and the ICM of an IC card with contacts.

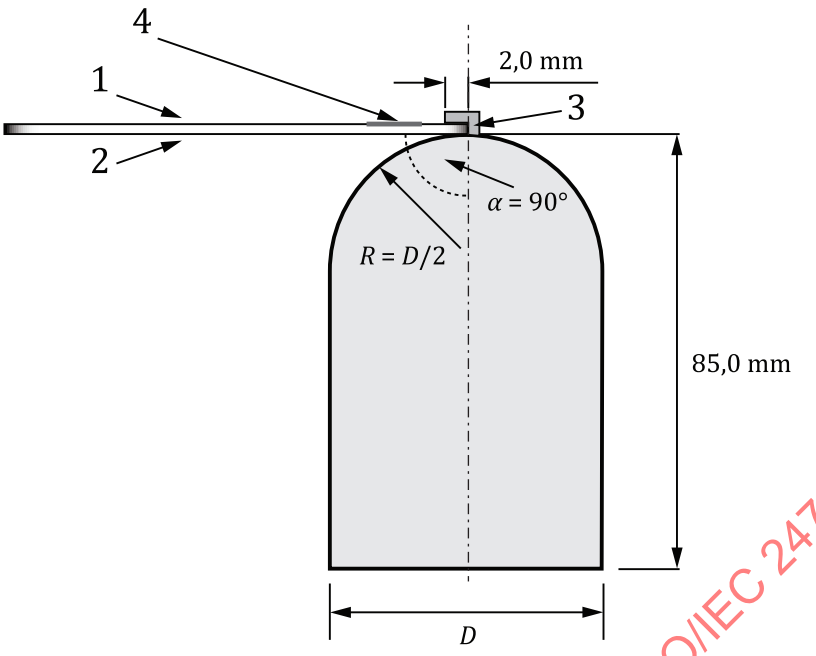
This test is destructive and tested cards are not suitable for further use.

With certain ICC designs, this test can cause localized detachment of the adhesive near the connection points of the antenna. If the ICM remains firmly attached in all four corners, then this should not be seen as a failure. The visual check shall be done at bending stage.

5.3.2 Apparatus

The test shall be carried out by wrapping the card module side up around a cylinder, with a diameter *D* of 50 mm. See Figure 6.

Dimensions in millimetres



Key

1	card front side	3	jaw
2	card back side	4	location of ICM

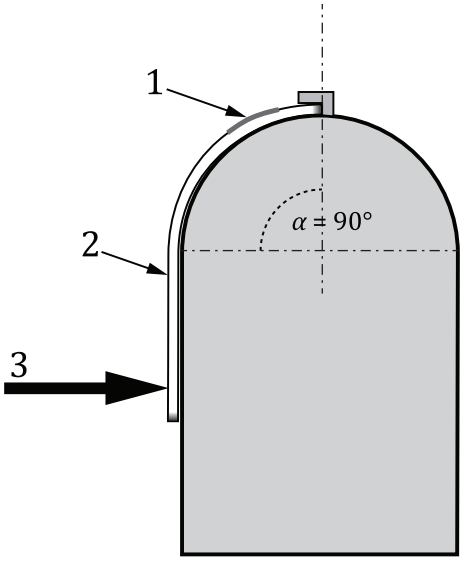
NOTE The rounded part of the apparatus is half a cylinder, not half a sphere

Figure 6 — Wrapping test apparatus with IC card inserted

5.3.3 Procedure

Insert the card in the jaws, contact side up, the ICM being as close as possible to the jaw, but definitely on the radius of the testing device, when wrapped.

Wrap the card 10 times as shown in Figure 7. The time for deforming the card from a fully relaxed to a fully wrapped position shall be between 0,5 s and 2 s. The time for relaxing the card from a fully wrapped to a fully relaxed position shall be between 0,5 s and 2 s.



Key

1 location of ICM
2 card front side
3 force

Figure 7 — Wrapping test apparatus with card being wrapped

5.3.4 Test report

Report if there is detachment of the ICM from the card body.

5.4 Adhesion of ICM to card — Push test

5.4.1 General

The area of the ICM shall be the full visible area of the ICM, not just the metallized area, nor just the adhesive area.

The adhesive between the ICM and the card is a key factor of the ICC's durability and is designed to bond plastic and other materials (card and ICM substrate). Many variables ranging from physical properties of the related substrates, process parameters to end use environment can affect the adhesion.

This test is a destructive test with concentrated pressure on the exposed reverse side of the ICM, opposite to the contacts. The test attempts to push the ICM out of the card.

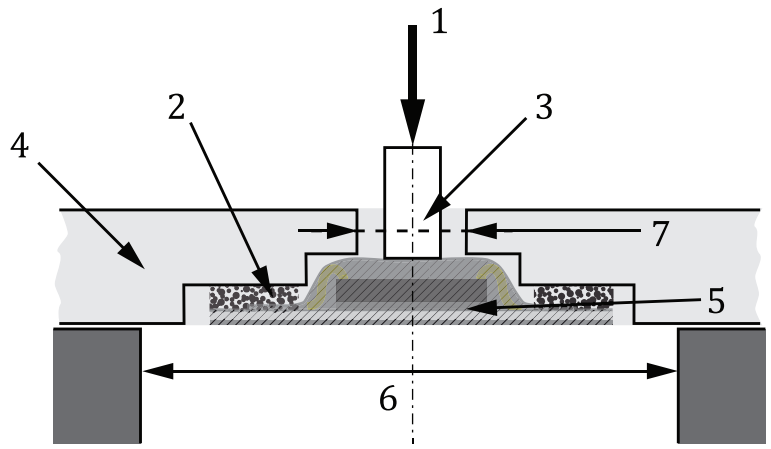
The force is applied directly to the centre of the reverse side of the ICM through an opening in the card. The opening in the card is created specifically for this test.

5.4.2 Apparatus

5.4.2.1 Card holder, to hold the card in a fixed position. The card holder has an opening that is slightly larger than the visible surface of the ICM, to allow pushing the ICM from the card when applying a force from behind.

5.4.2.2 Stamp, connected to a force measurement device. The stamp can move perpendicular to the card's surface and should be able to travel at least 5 mm deeper than the location of the card in the card holder.

The apparatus is shown in Figure 8



Key

1	force applied to the centre of ICM	4	card
2	ICM adhesive	5	ICM
3	stamp with a diameter of 5 mm	6	opening with at least the size of the ICM
		7	milled hole; minimum for hole diameter of the stamp +1 mm

Figure 8 — ICM push test

Certain recent ICM constructions have a very small IC and a very small encapsulation around the IC. When embedding such an ICM into the card, the resulting cavity to hold the IC is probably also very small and a stamp diameter of 5 mm is perhaps too large, as it would not fit into the part of the cavity holding the IC. In such case, stamps with a smaller diameter are permitted.

5.4.3 Procedure

a) Remove the card material covering the backside of the ICM that is not adhered to the ICM. Ensure that the encapsulation of the IC and wire bonds (for wire bonded IC) or the backside of the IC itself (for flip-chip bonded IC) remain undamaged. Use milling or cutting equipment as suitable for the specific card and ICM construction while taking care not to damage the adhesive between the ICM and the card.

b) Determine the centre of the ICM (reverse side).

c) Lower the stamp until it is close above the rear centre of the ICM without touching the ICM or the card with the stamp.

d) Start the force measurement and continue lowering the stamp onto the rear of the ICM with a speed of 30 mm/min.

e) Continue the downward movement of the stamp until one of the following occurs:

   — the ICM detaches at least partially from the card; or

   — the ICM ruptures.

f) Record the maximum force measured.

g) Remove the card and ICM from the test apparatus and observe the ICM and card for the failure mode of the adhesive and record the observation.

Failure modes recommended to distinguish are:

— ICM ruptured;

— ICM detached from the adhesive;

— adhesive detached from the card;

— adhesive split (adhesive can be found on both the detached ICM and the card).

NOTE The test is expected to irreversibly damage the ICM, even if the test is stopped at the minimum required force. No verification of electrical functionality is required as part of this test and damage of the IC and ICM is likely to occur.

5.4.4 Test report

The test report shall report the maximum force measured and the failure mode.

5.5 Adhesion of ICM to card — Pull test

5.5.1 General

The purpose of this test is to provide a means to determine the bond strength between the card and ICM. ICM-to-card adhesion is a function of the card material, ICM, adhesive employed and the assembly process.

5.5.2 Apparatus

5.5.2.1 Force measuring device, which displays maximum force achieved and equipped with grip to affix the test block.

5.5.2.2 Test block, a metal block with one end sized to fit onto the ICM contact surface without overlap and as flat and smooth as the ICM. The block length is sufficient to facilitate the force measuring grip.

5.5.2.3 Card restraint fixture (see Figure 9).

5.5.2.4 Suitable adhesive, for example cyanoacrylate or 2-component epoxy adhesive.

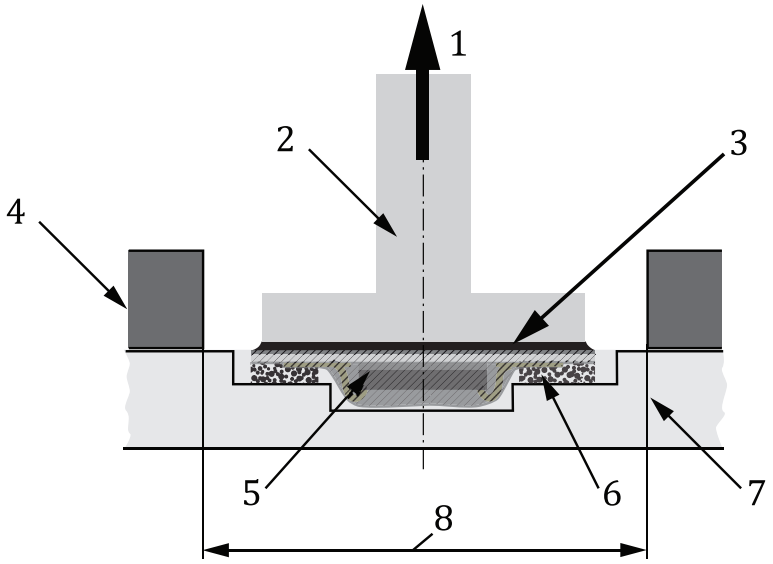
NOTE Carbon steel test blocks and Loctite 380 adhesive have shown to produce sufficient bonding to the ICM.

5.5.3 Procedure

Place a drop of adhesive on the surface of the ICM. Press the contact surface of the test block on the ICM surface and apply approximately 2 N (0.4 lbf) force on the test block during the curing time of the adhesive.

A clean ICM and test block surface is needed to achieve the optimal bond between the ICM and test block. Allow adhesive to cure before performing the force measurement. Care shall be taken not to influence the test results by adhesive flowing into the gaps between the ICM and the card.

Mount the IC card with the test block attached in the card restraint fixture and affix the force measuring device to the test block. Pull the test block at a rate of 300 mm/min, until separation occurs (after the peak force is achieved).



Key

1	applied force	5	ICM
2	test block affixed to ICM	6	ICM adhesive
3	adhesive for pull test	7	card
4	restraint fixture	8	opening in restraint fixture

Figure 9 — ICM pull test fixture

5.5.4 Test report

Record the peak (maximum) force achieved during the pull. Record whether the ICM was removed in whole or in part or if the test block released from the ICM.

5.6 Plasticised vinyl storage

5.6.1 General

The purpose of this method is to evaluate the card's resistance to the potentially damaging effects of plasticisers. Plasticisers can migrate into the card from adjacent materials and can change the card's physical properties.

5.6.2 Apparatus

5.6.2.1 Two rigid inert sheets, having dimensions that exceed the maximum length and width of the cards to be evaluated. Glass or chrome plated steel are acceptable materials.

5.6.2.2 Soft PVC foils, containing 20 % to 30 % DOTP plasticiser cut, at least, to cover the entire card surface.[3)]

5.6.2.3 Weight, placed on top of one of the rigid inert sheets listed above, applying together with the top rigid inert sheet a uniform pressure of 2,5 kPa ± 0,13 kPa (0.36 PSI ± 0.02 PSI) to the surface of a card placed completely beneath the top rigid inert sheet.

3) DOTP sheets with a DOTP content between 26 % and 30 % can be obtained from Q-Card Company, 301 Reagan Street, Sunbury, PA 17801 Phone 570 286-7447, Fax 570 286 2649, www.q-card.com, in small quantities. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC for this product.

NOTE 1 Test results vary depending upon DOTP content used. Higher DOTP content will degrade susceptible materials faster.

NOTE 2 This pressure would correlate to a combined mass for the weight and top rigid inert sheet of 1 169 +/- 65 g when testing an ID-1 card.

5.6.2.4 Environmental chamber.

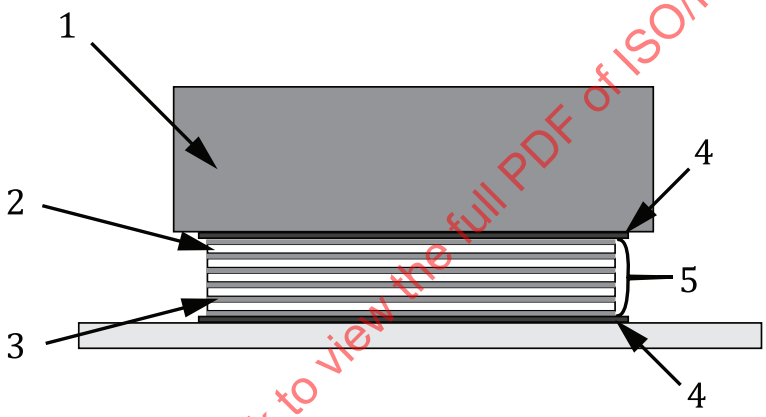
5.6.3 Procedure

The procedure requires a batch of five cards for evaluation. Add placeholder cards in case less than five samples are available for the test.

Starting from the rigid inert sheet, alternately place DOTP sheets and cards to form a stack. All card sides shall be in contact with the surface of a DOTP sheet. DOTP sheets of about 450 µm should be used, or a stack of DOTP sheets giving the same thickness.

Use DOTP sheets only once.

Cover the stack with weight and place all elements as shown in Figure 10 in an environmental chamber set to temperature of 50 °C ± 3 °C for 48 h unless otherwise specified.



Key

1	weight	4	inert rigid sheet
2	card	5	stack of five cards and six plasticised DOTP foils
3	DOTP foil		

Figure 10 — Cards stacked for loading into the environmental chamber

Remove the stack from the chamber and place in the test environment (4.1) and immediately remove the weight from the stack. Allow the stack to cool for 2 h. Separate the plasticised vinyl sheets from the cards.

WARNING — Results obtained with DOTP sheets may not be directly comparable to results obtained with DOP sheets, which were used in the first edition of this document.

5.6.4 Test report

Report visible changes to the card and transfer to DOTP sheets. Report the DOTP percentage by weight.

5.7 Temperature and humidity aging

5.7.1 General

The purpose of this test is to accelerate the aging process of the cards. The rate of humidity penetration increases with higher temperatures. The aging effect can then be evaluated with complementary tests, such as mechanical or thermo-mechanical tests.

This method exposes the card to elevated temperature and humidity. It can be used in conjunction with other methods to evaluate the effect of aging on specified properties of the card.

5.7.2 Apparatus

5.7.2.1 Environmental chamber, as specified in IEC 60068-2-78.

5.7.2.2 Test card holder, constructed in such a way that permits exposure of the humid air to both surfaces of the card and is sufficient to support cards without restricting their movement.

NOTE Stainless steel welded wire cloth has shown to provide proper card support. Other similar materials can be also suitable.

5.7.3 Procedure

Place the sample card on the test card holder in the environmental chamber at RH and a time period according to the defined sequence of the test plan.

Following the exposure, return the sample card to the test environment for 24 h ± 4 h before evaluating the card.

5.7.4 Test report

Report any visual changes after exposure.

5.8 Temperature and exposure with humidity variation

5.8.1 General

The purpose of the test is to saturate the card material at a fixed temperature with water and dry the material in the following step. This procedure first swells and in the second step shrinks the material which induces a significant higher stress compared to a standard RH test (5.7). The defined test parameters (50 °C ±3°C/ 95 % RH ±5% RH followed by 50 °C ±3°C/ 25 % RH ±5% RH) ensure card materials are saturated with water and dried afterwards.

5.8.2 Apparatus

5.8.2.1 Environmental chamber, as specified in IEC 60068-2-78.

5.8.2.2 Test card holder, constructed in such a way that permits exposure of the humid air to both surfaces of the card and is sufficient to support cards without restricting their movement.

5.8.3 Procedure

Place the sample card on the test card holder in the environmental chamber at a temperature of 50 °C, a RH of 95 % and a time period according to the defined sequence of the test plan according to ISO/IEC 24789-1. The dwell time tolerance is ±10 %.

In a second step, place the sample card on the card holder in the environmental chamber at a temperature of 50 °C, a RH of 25 % and a time period according to the defined sequence of the test plan according to ISO/IEC 24789-1.

Following the exposure, return the sample card to the test environment for at least 16 h before evaluating the card.

5.8.4 Test report

Report any visual changes after exposure.

5.9 ID-1 card flexure

5.9.1 General

This test method may be used for in-process card fabrication evaluations or material selections, when the flexure characteristics of a card is desired to be tested and when a card type is suspected of being "brittle" or has experienced early field fractures.

NOTE The flexure characteristic of a card is a function of fabrication process conditions, card materials, card thickness, presence or absence of embossed characters, or presence or absence of surface applied features.

5.9.2 Apparatus

5.9.2.1 Flexure apparatus, described in ISO/IEC 10373-1 (dynamic bending stress) shall be used for this method.

5.9.3 Procedure

Conduct the test with separate samples front side up and back side up.

Set the apparatus to flex the card in the orientation desired. Set the flexure frequency to 1,0 Hz. Mount card in the flexure apparatus and begin flexing the card.

NOTE Card axes A and B are defined in the dynamic bending stress procedure contained in ISO/IEC 10373-1.

Do not allow the card under evaluation to remain under mechanical stress for more than 5 min when not being flexed. The movable jaw shall be positioned in the fully open position when stopped. Cards shall be removed from the apparatus if flexing is stopped for more than 5 min. Flexing shall be restarted within 24 h of removal.

Once cards begin to fracture, the fractures can progress rapidly.

Unless otherwise specified, the stopping point is reached when a combination of five fractures or fewer of at least 13 mm in length is observed.

The test may be stopped after reaching the limit value specified by the base standard, or after 100 000 cycles if the base standard does not provide a limit value.

5.9.4 Test report

Report the following for each card side facing up in the test:

— number of cycles to stopping point to the nearest 1 000 cycles;

— combined length of fractures at stopping point;

— flexure axis;

— description of which card side the fracture occurred.

5.10 Cross cut tape test

5.10.1 General

The purpose of this method is to determine the adhesion of surface and near surface features to deeper layers.

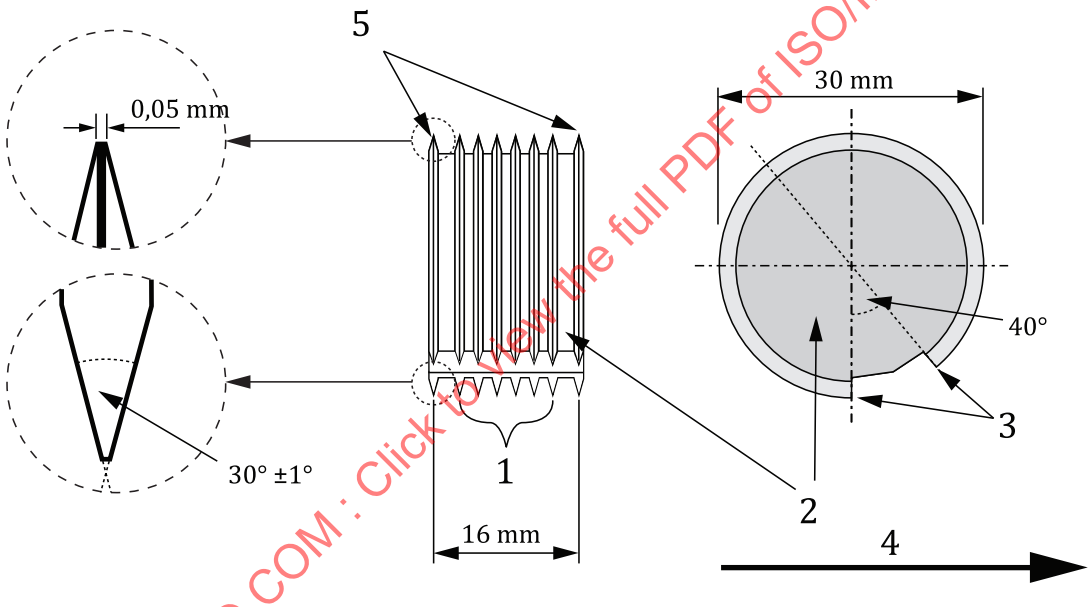
5.10.2 Apparatus

5.10.2.1 Cutting tool, with 30° ± 1° edge. One such tool is specified in Figure 11. Other cutting tools creating similar cuts may be used.

5.10.2.2 A soft brush.

5.10.2.3 Transparent pressure sensitive adhesive tape, 25 mm ± 2 mm wide, with an adhesion strength of 9 N ± 2 N per 25 mm width when tested in accordance with IEC 60454-2.

NOTE 3M Scotch transparent film tape 600 is a compliant pressure sensitive adhesive tape. Note that 3M Scotch crystal clear tape 600 is not compliant.



Key

1 cutting edges
2 blade
3 guide edges
4 cut direction
5 cutting edges

NOTE Drawing not to scale.

The guide edges and the cutting edges shall have the same diameter.

When the cutting edge has worn to 0,1 mm it is necessary to regrind.

Figure 11 — Multiblade cutting tool

5.10.3 Procedure

Before making any cuts, inspect the cutting edge of the blade and maintain its condition by sharpening or replacement. Ensure the blade spacing creates six parallel cuts 1 mm apart.

Place the card on a flat, rigid supporting surface.

With uniform pressure and cutting rate, make six parallel cuts in the first direction of the lattice pattern ensuring the cuts should penetrate through the layer of interest.

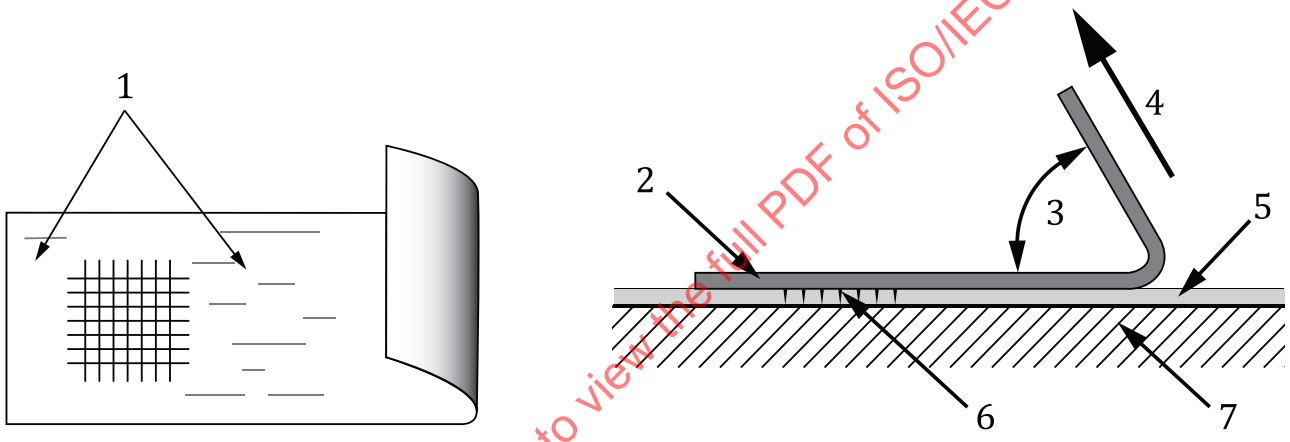
Repeat this operation, making further six parallel cuts, crossing the original cuts at 90° so that the lattice pattern illustrated in Figure 12 is formed.

Repeat the pattern of cuts in at least three different places on the card surface, making sure that surface features known to have less initial adhesion or to be most affected by age and usage (e.g. by embrittlement) are included.

Brush the panel lightly with the soft brush several times backwards and several times forwards along each of the diagonals of the lattice pattern.

Prepare a length of adhesive tape. If beginning a new series of tests, remove two complete laps from a reel of the adhesive tape and discard. Remove an additional length at a steady rate and cut a piece approximately 75 mm long.

Place the centre of the tape over the lattice in a direction parallel to one set of cuts as shown in Figure 12, positioning the adhesive tape and, with a finger, smooth the tape into place over the area of the lattice and at least 20 mm on each side.



Key

1 smoothed down area
2 tape
3 angle of removal 60°
4 force
5 layer of interest
6 cuts
7 card

Figure 12 — Positioning the adhesive tape

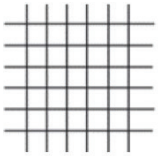
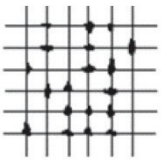
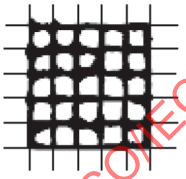
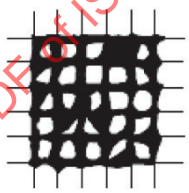
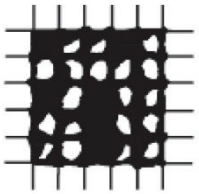
To ensure good contact with the coating, rub the tape firmly with a fingertip. Uniform transparency and darkened colour under the tape is a useful indication of good contact.

Within 5 min of applying the tape, remove the tape by grasping the free end and pulling it off steadily in 0,5 s to 1,0 s at an angle which is as close as possible to 60° (see Figure 12). Retain the tape for reference purposes.

Immediately after removing the tape, examine the lattice area in good lighting using normal or corrected vision. During the examination, rotate the panel so that the viewing and lighting areas are not confined to one direction. It may be useful to examine the tape in a similar manner.

Classify the lattice area by comparison with Table 1 illustrations and the accompanying descriptions.

Table 1 — Classification of lattice pattern

Classification	Description	Appearance of surface of cross cut area from which flaking has occurred (example of six parallel cuts)
0	The edges of the cuts are completely smooth. None of the squares of the lattice is detached.	
1	Detachment of small flakes of the coating at the intersections of the cuts. A cross-cut area not significantly greater than 5 % is affected.	
2	The coating has flaked along the edges and/or at the intersections of the cuts. A cross-cut area significantly greater than 5 %, but not significantly greater than 15 %, is affected.	
3	The coating has flaked along the edges of the cuts partly or wholly in large ribbons, and/or it has flaked partly or wholly different parts of the squares. A cross-cut area significantly greater than 15 %, but not significantly greater than 35 % is affected	
4	The coating has flaked along the edges of the cuts in large ribbons and/or some squares have detached partly or wholly. A cross-cut area significantly greater than 35 %, but not significantly greater than 65 % is affected.	
5	Any degree of flaking that cannot even be classified by classification 4.	

5.10.4 Test report

Report grade and test location on the card for each test conducted.

5.11 Additional test methods regarding mechanical strength

Additional test methods to assess the mechanical strength of cards with ICM and contactless integrated circuit cards are described in Annex A. The tests allow the user to define the mechanical performance of cards. The ranking shall be done by the user.

Annex A
(informative)

Additional tests

A.1 General

A.1.1 Overview

The test methods in this annex are a selection of defined procedures for additional testing of special interest. They are add-ons to the mandatory standard tests. The user can select one or more of them to test relevant requirements.

A.1.2 Soiling test

A.1.2.1 General

The purpose of this test method is to evaluate the effect of simultaneous exposure to oils, dirt and abrasion.

A.1.2.2 Apparatus

A.1.2.2.1 160 µm or 180 µm sieve.

A.1.2.2.2 Metal sieve (analytical sieve 63 µm, diameter 200 mm, height 50 mm), according to ISO 3310-1 with cover, or pan bottom (diameter 200 mm, height 50 mm) with cover.

A.1.2.2.3 Vibrating device, containing a level sieve vibrating in a direction perpendicular to the sieve floor with an amplitude of 1,5 mm ± 0,2 mm (0.059 in ± 0.008 in) at a frequency of 45 Hz to 60 Hz;

— weighing device having a precision of 0,05 g;

— double-sided thin adhesive tape having an adhesive that does not contaminate the card surface after removal of the tape.

A.1.2.2.4 270 g ± 10 g of polished solid glass pearls, having a diameter of 7,0 mm ± 0,3 mm (0.275 in ± 0.008 in).

A.1.2.2.5 Soiling mixture ingredients, as follows:

— 8,0 g ± 0,4 g peat, untreated, unfertilised;

— 2,0 g ± 0,1 g quartz sand 40 – 100 mesh ASTM;

— 0,500 g ± 0,025 g activated charcoal powder; (analysis grade activated charcoal at 100 mesh or lower, e.g. Merck no. 102186 or similar);

— 9,00 g ± 0,45 g rac-Glycerol 1-monooleate, technical grade (40 %), CAS no (111-03-5), e.g. Fluka no. 49960;

— 200 µm ± 50 µm thick PVC foil or other plastic film disk with an outer diameter 0 mm to 5 mm smaller than the inner diameter of the sieve or pan.

A.1.2.2.6 Miscellaneous items:

— any commercially available dishwashing detergent;

— a colander;

— double-sided thin adhesive tape having an adhesive that does not contaminate the card surface after removal of the tape;

— weighing device having a precision of 0,05 g.

NOTE The quartz sand required for this test can be obtained from FOGRA, Einsteinring 1a, 85604 Aschheim b München, Germany, email info@fogra.org. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC for this product.

A.1.2.3 Procedure

Prepare the soiling mixture as follows:

Grind reasonably dry peat dust (sphagnum) in an impact mill or similar device for 5 min.

Pass the ground peat dust through the sieve (160 µm or 180 µm).

NOTE 1 Choosing either of these sizes rather than the other will not affect the results of the test.

Dry the sieved peat dust in a ventilated oven at 100 °C or using a desiccant, until weight loss is less than 0,5 percent over a 1 h period.

Mix thoroughly with a blade agitator (paddle mixer)

— 8,0 g ± 0,4 g dried sieved untreated unfertilized peat dust,

— 2,0 g ± 0,1 g quartz sand 40 to 100 mesh ASTM, and

— 0,50 g ± 0,05 g activated charcoal powder, grade: for analysis, e.g. Merck no. 102186.

Add 9,00 g ± 0,45 g rac-Glycerol 1-monooleate, technical grade (40 %), CAS no (111-03-5), e.g. Fluka no. 49960 drop by drop under continuous stirring and continue stirring until mixture is homogenous.

Store the prepared mixture in a non-plastic impermeable container. It is stable for a minimum of 60 days (in default conditions).

Using double-sided adhesive tape, affix three cards, at least 3,0 mm from each other and the sieve or pan wall, to the PVC foil disk.

Place the PVC foil into the sieve or pan bottom as shown in Figure A.1.

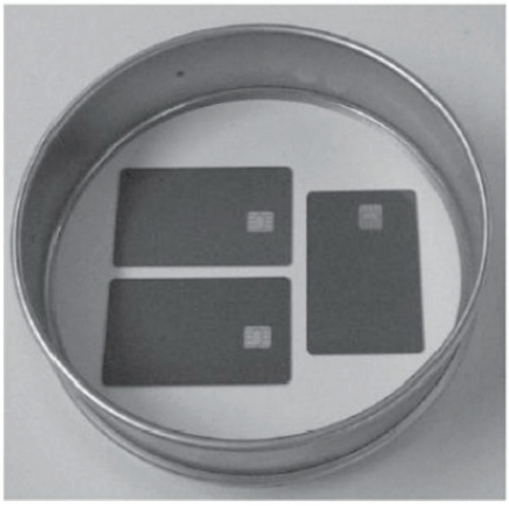


Figure A.1 — Cards and foil positioned in sieve

Add 270 g ± 10 g of glass pearls to the sieve or pan.

Distribute 1,5 g of soiling mixture in various spots in the sieve to keep the soiling mixture from clumping in one location, as shown in Figure A.2.

Figure A.2 — Pearls and soiling mixture added

With its cover in place, secure the sieve to the vibrating device.

Set the amplitude to 1,5 mm and vibrate for 15 min.

Remove the round PVC foil, cards and pearls from the sieve or pan bottom.

Carefully clean the cards with dishwashing soap, and a soft cloth or sponge. Wash the cards to remove as much of the soiling mixture as possible without damaging the card surface.

Dry the cards with a soft, clean towel and then place the cards on a ventilated rack in the test environment (4.1) conditions for 24 h.

It is recommended to clean the pearls with a dishwashing detergent in a colander under tap water and to let them dry at room temperature or under heat. The sieve or pan bottom is cleaned with dishwashing detergent under tap water before drying with a soft cloth. When cleaning the sieves (pans) it is less work to remove

as much soiling mixture as possible with a dry cloth or paper towel before using detergent and water. For a subsequent test, a new PVC foil disk is used.

Report whether a sieve or a pan bottom was used.

Observe whether or not the cards exhibit an even surface abrasion.

NOTE 2 If this is not the case then the test results can be invalid.

A.1.2.4 Test report

Report any visual change (see ISO/IEC 24789-1) to cards after exposure.

A.1.3 ID-1 card static bending stress

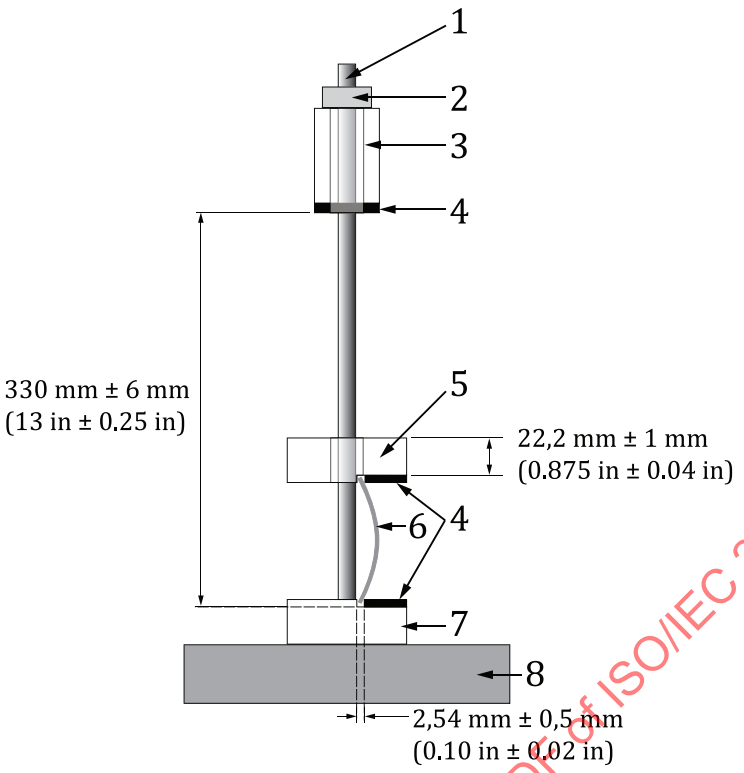
A.1.3.1 General

The purpose of this test is to determine the structural integrity of the card after the static bending stress. This test method may be used for in-process card fabrication evaluations, material selections and when a card type is suspected of being “brittle” or has experienced early field fractures. Card fractures after a stress period can be influenced by the fabrication process conditions, the card materials, their orientation, card thickness, presence or absence of embossed characters and presence or absence of surface features.

A.1.3.2 Apparatus

A.1.3.2.1 Card impact fixture, see Figure A.3.

Dimensions in millimetres



Key

1	guide shaft	5	upper jaw with bearing jaw weight (815 g ± 25 g)
2	stop collar for weight (sets drop height)	6	test card
3	impact weight (1 350 g ± 50 g)	7	lower jaw (fixed)
4	40-50 durometer rubber pad (shore A)	8	rigid, heavy base

Length of upper and lower jaws shall be at least the card's greatest dimension.

Figure A.3 — Card impact fixture

Stress fixture shall be constructed to cause the card to be bent according to Figure A.4 and Figure A.5.

Dimensions in millimetres

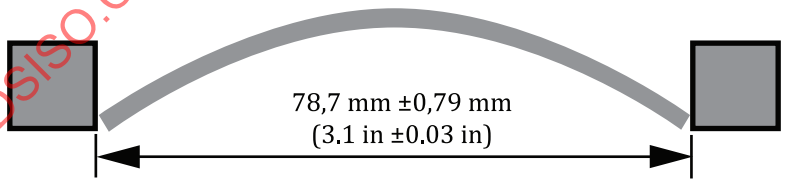


Figure A.4 — Stress fixture — Bending around axis A

Dimensions in millimetres

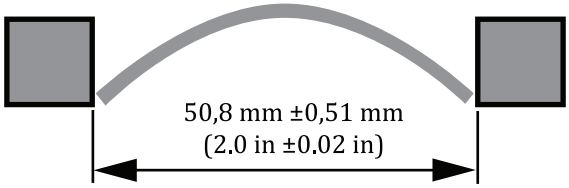


Figure A.5 — Stress fixture — Bending around axis B

A.1.3.3 Procedure

Insert test card in the stress fixture for 24 h unless otherwise specified.

Test results can vary depending on which side of the card is under extension (side up). Thus, it is recommended to conduct the test on separate cards with each side under extension (side up).

Remove the test card from the fixture and immediately force the ends of the cards together in the direction of the stress "bow" by the use of the card impact fixture (see Figure A.4 and Figure A.5). Raise the impact weight to the specified drop height and let the impact weight fall.

WARNING — Use care in operating the card impact fixture to avoid injury. Safety glasses should be worn during this test to prevent eye injury.

It is recommended to test a minimum of 25 cards to account for card to card variation, because significant variations within a card lot have been experienced with this test method.

A.1.3.4 Test report

Report the number of cards tested and number of cards fractured (or broken in pieces) after impact for each side tested.

A.1.4 Temperature and humidity dye migration

A.1.4.1 General

The purpose of this test is to determine the extent of dye migration (blurring) of printed information on a card.

Elevated temperature / humidity can accelerate the dye migration.

A.1.4.2 Apparatus

A.1.4.2.1 Laboratory oven, capable of maintaining 50 °C ± 2 °C (122 °F ± 4 °F).

A.1.4.2.2 Test container, sealable, equipped with a water reservoir above which test cards are mounted in such a way to ensure the cards are not touching each other.

A.1.4.2.3 Test card holder, constructed in such a way that permits exposure of the humid air to both surfaces of the card.

A.1.4.2.4 Potassium sulfate (K_2SO_4).

A.1.4.2.5 Spectrophotometer, with the following characteristics:

— aperture 4 mm to 5,5 mm;

— white base absolute;

— polarized filter;

— D50 light source;

— 2 degree standard observer angle.

NOTE A temperature-controlled and humidity-controlled chamber capable of controlling within ±2 °C (±4 °F) and RH 95 % ±5 % non-condensing on the card surface is used in lieu of the sealable container and potassium sulfate solution. All other test conditions apply.

A.1.4.3 Procedure

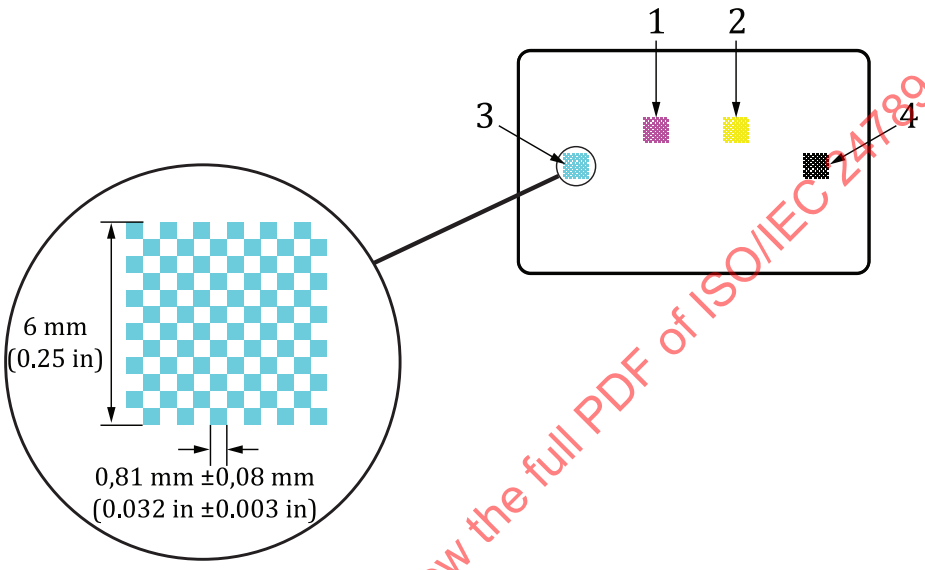
The test cards shall be prepared with the halftone (checkerboard) images as described in Figure A.6 (position of images does not matter, as long as they do not overlap).

Typical colour densities on cards printed for this test are:

Yellow	0,45 to 0,65	Magenta	0,40 to 0,60
Cyan	0,40 to 0,60	Composite black	0,40 to 0,60

The black test area shall be made using the yellow, magenta, cyan (YMC) ribbon (composite black).

Dimensions in millimetres



Key

1	magenta panel	3	cyan panel
2	yellow panel	4	composite black panel

Figure A.6 — Temperature / humidity dye migration test pattern

Prepare a saturated water solution consisting of 12,0 g of K_2SO_4 per 100 g distilled water (saturation is 12,0 g per 100 cm^3 at 25 °C).

Pour the saturated K_2SO_4 solution into the bottom of the test container. The depth of the K_2SO_4 solution should be at least 5 mm (0.2 in) deep. Add an additional 6 g of K_2SO_4 solid per 100 g of the saturated solution. some solid K_2SO_4 will be present in the bottom of the test container. This will ensure a saturated K_2SO_4 solution is present at the elevated test temperatures.

Measure and record the reflection density of the black, yellow, magenta and cyan test areas using the appropriate filters. Measure in the centre of the test area. Record the densities.

NOTE Density measurements taken on areas covered by security features can produce inconsistent results.

Place cards, image side up, in the holder that keeps the cards parallel to the water line. The bottom of the cards should be a minimum of 5 mm (0.2 in) above the K_2SO_4 solution.

Seal the test container and place it into a 50 °C (122 °F) oven for a period of 168 h (7 d). Some solid K_2SO_4 shall remain in the bottom of the test chamber. The K_2SO_4 solution will keep the RH at 95 % ± 5 % and will minimize the possibility of condensing humidity.

Remove the cards from the oven and store in default test environment (4.1) for at least 1 h. Re-measure and record the reflection density of the black, yellow, magenta and cyan test areas using the appropriate filters. Measure in the centre of the test area. Record the densities.

A.1.4.4 Test report

Report the present increase in reflection density of the black, yellow, magenta and cyan test areas.

A.1.5 Xenon arc light exposure

A.1.5.1 General

The purpose of this test sequence is to evaluate the susceptibility of the card to sunlight (either outdoor or indoor through window glass) or indoor conditions depending on whether the window glass filter is used.

a) The procedure can be used as a preconditioning step before, or as a test step in, a sequential test. Cards will be exposed to Xenon arc radiation to accelerate aging of the plastic materials. This aging typically causes plastics to lose ductility and become more susceptible to mechanical failures.

b) The test can also be used as a means for determining discoloration of card materials due to unfiltered sunlight (daylight) in outdoor conditions or due to window glass filtered sunlight in indoor conditions. The filters are introduced below. The test simulates exposure to outdoor or indoor conditions depending on whether the window glass filter is used. This test may not be suitable to accurately determine colour fading; methods like those defined in ISO 12040 can be better suited to accurately determine colour fading caused by light exposure.

A.1.5.2 Apparatus

A.1.5.2.1 Xenon arc test chamber, shall be in accordance with ISO 4892-1, ISO 4892-2 and shall include a xenon-arc lamp with daylight (Method A) or window glass filters (Method B) in accordance with ISO 4892-2.

A.1.5.2.2 Black-standard thermometer (BST) or a black panel thermometer (BPT), in accordance with ISO 4892-1 and ISO 4892-2.

A.1.5.2.3 Device, to determine the spectral irradiance and the radiant exposures in the band pass of 300 nm to 800 nm, or a spectral irradiance in the band pass of 300 nm to 400 nm or a spectral irradiance at 340 nm or a spectral irradiance at 420 nm according to ISO 9370;

A.1.5.2.4 Specimen holders, according to ISO 4892-2:2013, 4.6 with a stainless steel or aluminium backing.

A.1.5.3 Procedure

Mount the cards in the test chamber with the card surface of interest exposed.

Close the chamber to prevent leakage. Expose the cards to the Xenon arc for 24 h unless specified otherwise, under outdoor conditions (Test Cycle A according to Table A.1) or indoor conditions (Test Cycle B according to Table A.2).

NOTE The resulting irradiance depends on the type and age of the optical system and can cause variation in the results.

Remove the cards from the test chamber and allow them to cool to default temperature for at least 1 h prior to evaluation.

If used as a preconditioning test, continue with the remaining test procedures.

The evaluation shall be according to ISO 24789-1.

Table A.1 — Test cycle A

Test cycle A: Exposure using daylight filters according to ISO 4892-2					
Irradiance			Black standard temperature [°C][a]	Chamber temperature [°C]	Relative humidity (RH) %[b]
Broadband UV 300-400 nm [W/m^2]	Narrowband 340 nm [W/(m^2·nm)]	Wideband 300-800 nm [W/m^2]			
60 ± 2	0,51 ± 0,02	550 ± 55	50 ± 3	35 ± 3	30 ± 10
[a] If a black panel sensor is used, the set point temperature shall be 47 °C with allowable fluctuation ±3 °C.					
[b] Recommended for chambers that control these parameters. If other values are used, they shall be included in the test report. For instruments without chamber air temperature or RH control, these parameters are allowed to find their own level.					

Table A.2 — Test Cycle B

Test Cycle B: Exposure using window glass filters according to ISO 4892-2						
Irradiance				Black standard temperature [°C][a]	Chamber temperature [°C]	Relative humidity (RH) %[b]
Broadband UV 300-400 nm [W/m^2]	Narrowband 340 nm [W/(m^2·nm)]	Narrowband 420 nm [W/(m^2·nm)]	Wideband 300 nm to 800 nm [W/m^2]			
50 ± 2	0,35 ± 0,02	1,1 ± 0,02	550 ± 55	50 ± 3	35 ± 3	30 ± 10
[a] If a black panel sensor is used, the set point temperature shall be 47 °C with allowable fluctuation ±3 °C.						
[b] Recommended for chambers that control these parameters. If other values are used, they shall be included in the test report. For instruments without chamber air temperature or RH control, these parameters are allowed to find their own level.						

A.1.5.4 Test report

Unless specified otherwise by the base standard the test report shall:

a) Describe the exposure test conducted in accordance with A.1.4 including the following:
   - A description of the exposure device and radiation (light) source, including
     - the type of device and radiation (light) source,
     - a description of the filters used,
     - if required, the irradiance at the specimen surface (including the passband in which the radiation was measured), and
     - recommended to include the number of hours that the filters and the radiation (light) source had been used prior to beginning the exposure (if recorded).
   - the type of black temperature sensor used;
   - a complete description of the method used (Test Cycle A or Test Cycle B);
   - a description of the method used to mount the specimens in the exposure frame, including a description of any material used as backing for the test specimens;
   - a description of the radiometer used for measuring the radiant exposure, if used;
   - the date of the exposure test.

b) record any colour change observations and method of evaluation;
   - visual;
   - colour difference ΔE(00) *Lab* or ΔE *Lch* measured according to ISO 13655 without polarized filter using CIE 2000 *L*a*b** or *L*C*h** with standard illuminant D50 according to ISO 3664 and 2° observer;

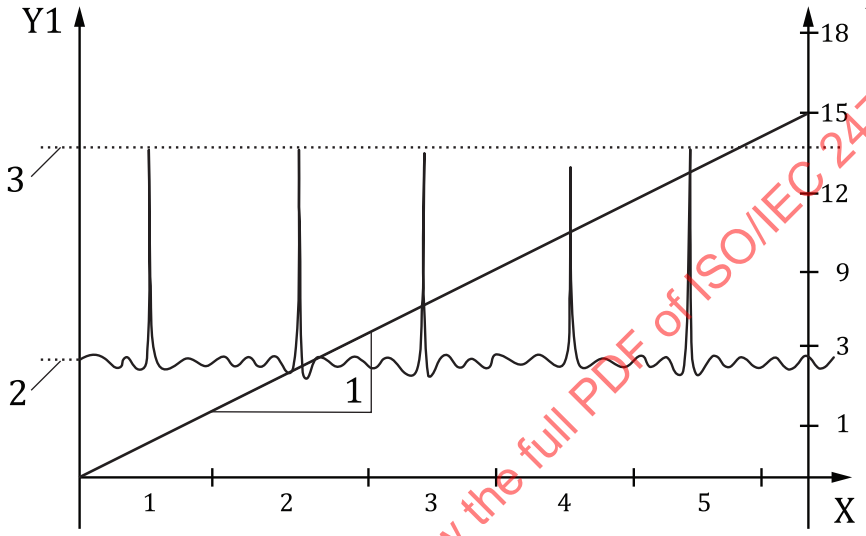
c) record whether or not the cards remain testably functional according to ISO/IEC 10373-1 following application of the procedure and report the version of the colour difference measurement method used.

A.1.6 Mechanical life cycle sequence for contactless cards

A.1.6.1 General

The purpose of the test is to calculate an expected yearly failure rate of a semiconductor package in a contactless integrated circuit card. The main component for the failure of a contactless integrated circuit card in the field is the applied mechanical stress. The described test simulates the mechanical stress in the field and provides a calculation of projected field failure rate for contactless integrated circuit card.

The mechanical stress model is shown in Figure A.7.



Key

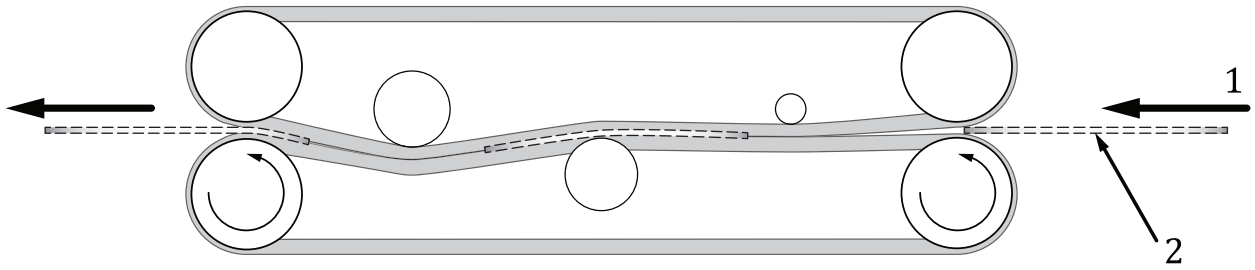
X	loading time in years	1	ƛ1 constant failure rate / year in %
Y1	field load	2	usage base load (roller test)
Y2	failure rate in %	3	mechanical over stress peak (3 wheel)

Figure A.7 — Stress model

A.1.6.2 Apparatus

A.1.6.2.1 Roller tester

The roller stress simulates the mechanical base load stress that a contactless integrated circuit card is exposed to in the field under standard conditions. Figure A.8 shows the principle of the apparatus.



Key

1 transport direction

2 contactless card

Figure A.8 — Principle roller tester

The contactless integrated circuit card is fed through the bending machine with transport belts, first in order to produce a curvature of the width of the card ("Axis A flexure" direction as defined in ISO/IEC 10373-1), followed by producing a curvature of the height of the card ("Axis B flexure" direction as defined in ISO/IEC 10373-1). The bending amplitude is defined by the position of two adjustable rollers.

The length of the transport belt is "Axis A flexure" 310 mm, "Axis B flexure" 295 mm. The diameter of the belt shall be 3 mm and the material shall be TPU [4] Figure A.9 shows the transport parallel to longitudinal axis. Rollers (R1, R2) are variable in Z-position to adjust the bending amplitude.

Figure A.10 shows the transport transverse to longitudinal axis. Rollers (R1, R2) are variable in Z-position to adjust the bending amplitude.

4) "Polycord Rundriemen"belts have been found suitable for this method. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC for this product.