INTERNATIONAL STANDARD

ISO/IEC 10373-2

Third edition
2015-01-15

Identification cards — Test methods —

Part 2: Cards with magnetic stripes

Cartes d'identification — Méthodes d'essai —

Partie 2: Cartes à bandeaux magnétiques

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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

ISO/IEC 10373-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology,* Subcommittee SC 17, *Cards and personal identification.*

This third edition cancels and replaces the second edition (ISO/IEC 10373-2:2006), which has been technically revised. It also incorporates the Technical Corrigendum ISO/IEC 10373-2:2006/Cor1:2010.

The user is encouraged to review the entire standard for revisions and updates. The major changes made during this revision are listed below.

— References to ISO/IEC 7811-8 and ISO/IEC 8484 were added.

— Calibration of reference current for ISO/IEC 7811-2 has been added. This will result in a small offset in requirements from the existing 2006 edition but will be equivalent to the requirements as written originally.

— Test densities of 500 ftpi have been changed to 508 ftpi to more closely agree with actual values used.

— Requirements that are different for different base standards have been moved into tables in most cases.

— In 5.5.2.3, Note 2 contained a normative requirement so it was moved out of note.

— The 2 cases of Figure 14 have been combined and a table was given. Conflicting symmetry requirements were resolved by taking T1 = T2 ± 0,02 T1.

— Description of correcting reference values was clarified and terms were deleted since these were not used. Reference to older editions of base standards was deleted.

— Contents of the technical corrigendum have been incorporated.

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

— *Part 1: General characteristics*

— *Part 2: Cards with magnetic stripes*

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

— *Part 5: Optical memory cards*

— *Part 6: Proximity cards*

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— *Part 7: Vicinity cards*

— *Part 8: USB-ICC*

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

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Identification cards — Test methods —

Part 2:
Cards with magnetic stripes

1 Scope

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

This part of ISO/IEC 10373 defines test methods which are specific to magnetic stripe technology.

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

NOTE 2 Test methods described in this part of ISO/IEC 10373 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 1302, *Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation*

ISO 2409, *Paints and varnishes — Cross-cut test*

ISO 3274, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments*

ISO 4288, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture*

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

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 7811-7, *Identification cards — Recording technique — Part 7: Magnetic stripe — High coercivity, high density*

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

ISO/IEC 8484, *Information technology — Magnetic stripes on savingsbooks*

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

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3 Terms and definitions

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

NOTE Static magnetic characteristics definitions were originally derived from IEC 50–221 (which has been replaced by IEC 60050–221) and ISO 31-5:1992 (which has been replaced by IEC 80000–6).

3.1
test method
method for testing characteristics of identification cards for the purpose of confirming their compliance with International Standards

3.2
testably functional
has survived the action of some potentially destructive influence to the extent that

a) any 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) any integrated circuit(s) present in the card continue to show an Answer to Reset response[1)] which conforms to the base standard

c) any contacts associated with any integrated circuit(s) present in the card continue to show electrical resistance and impedance which conform to the base standard

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

e) any contactless integrated circuit(s) in the card continue to operate as intended

3.3
warpage
deviation from flatness

3.4
flux transitions per millimetre
ft/mm
linear recording density applied to a track on a magnetic stripe

3.5
recording
creating a track of flux reversals according to a test method given in this part of ISO/IEC 10373, with the values of all applicable test parameters specified

3.6
encoding
creating a track of flux reversals whose spacing is modified, according to a coding scheme, to represent data

3.7
surface roughness
surface topology of an area of surface, qualified in the International Standards by reference to various resolution determinants and methods of calculation

3.8
amplitude measurements
⟨magnetic stripe⟩ measurement of read-back signal amplitude according to a test method given in this part of ISO/IEC 10373, with the values of all applicable test parameters specified

1) This part of ISO/IEC 10373 does not define any test to establish the complete functioning of integrated circuit(s) cards. The test methods require only that the minimum functionality (testably functional) be verified. This can, in appropriate circumstances, be supplemented by further application-specific functionality criteria which are not available in the general case.

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3.9
flux transition spacing variation
deviation from nominal of measured values of the distance between adjacent flux transitions along a line parallel to the centreline of the encoded track

3.10
magnetic stripe adhesion
strength of the bond between the magnetic stripe and the card

3.11
normal use
use as an identification card according to ISO/IEC 7810, involving equipment processes appropriate to the card technology and storage as a personal document between equipment processes

3.12
static saturation *M(H)* loop
normal hysteresis loop for which the magnetic field strength is cycled between the extremes $-H_{max}$ to $+H_{max}$ at such a low rate of change that the loop is not influenced by the rate of change

3.13
coercivity
$\boldsymbol{H'_{cM} = H'_{cJ}}$
continuously applied magnetic field which reduces the magnetization to zero from a previously saturated state in the opposite direction, measured parallel to the longitudinal axis of the stripe

3.14
remanent coercivity
$\boldsymbol{H_r}$
applied magnetic field which when removed returns the material to a zero magnetization state from a previously saturated state in the opposite direction, measured parallel to the longitudinal axis of the stripe

3.15
Oersted
Oe
Gaussian CGS unit of magnetic field strength which is commonly used in the magnetic recording industry, equal to approximately 79,578 A/m

3.16
static demagnetization
$\boldsymbol{S_{160}}$
reduction in magnetization under the influence of an opposing magnetic field; characterised by $[M_r - M^+(-160)] = M_r$; the average slope of the "demagnetization" quadrant of the static saturation $M(H)$ loop between magnetic field strength values of $H = 0$ and $H = -160$ kA/m

3.17
squareness
$\boldsymbol{SQ}$
ratio of M_r, the value of magnetization (M) at zero magnetic field strength ($H = 0$), to $M(H_{max})$, the value of magnetization at H_{max} obtained from the static saturation $M(H)$ loop

3.18
longitudinal squareness
$\boldsymbol{SQ_{||}}$
squareness of the medium measured parallel to the longitudinal axis of the magnetic stripe

3.19
perpendicular squareness
$\boldsymbol{SQ_{\perp}}$
squareness of the medium measured perpendicular to the plane of the magnetic stripe

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3.20
switching field by derivative
SF_D
width at half height of the differentiated static magnetization curve $M(H)$ divided by the coercivity from the same curve

3.21
switching field by slope
SF_S
difference between the field values at the intercept of the static magnetization $M(H)$ loop, $M(H)$ of $0{,}5M_r$ and $M(H)$ of $-0{,}5M_r$, divided by the coercivity

3.22
angle of maximum squareness
$\Theta(SQ_{max})$
angle between the direction at which the maximum value of squareness is found and the longitudinal axis of the magnetic stripe

3.23
resolution
average signal amplitude at some specified higher recording density divided by the average signal amplitude at some specified lower recording density, multiplied by 100 and expressed as a percentage

3.24
U_{Fi}
magnitude of the individual element at specified frequency of the Fourier spectrum of the entire waveform of the stripe

4 Default items applicable to the test methods

4.1 Test environment

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

4.2 Pre-conditioning

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

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.

4.4 Default tolerance

Unless otherwise specified, a default tolerence 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 for each quantity determined by these test methods shall be stated in the test report.

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5 Test methods

5.1 Magnetic stripe area warpage

The purpose of this test is to measure the degree of warpage of a card test sample in the area of the magnetic stripe (see ISO/IEC 7811-2, ISO/IEC 7811-6, ISO/IEC 7811-7, ISO/IEC 7811-8, ISO/IEC 8484).

The method is applicable to both embossed and unembossed cards.

5.1.1 Apparatus

The apparatus is shown in Figure 1. It comprises:

a) a level rigid plate whose surface roughness is not greater than 3,2 µm (130 µin) in accordance with ISO 1302. The plate shall contain an aperture to allow access for a micrometer probe;

b) a dial indicator accurate to within 2,5 µm (98 µin) with a probe whose contact area is a hemisphere with a diameter in the range of 3 mm to 8 mm (0.1 in to 0.3 in). The force exerted by the probe shall be f = 0,6 N ± 0,3 N (0.13 lbf ± 0.07 lbf);

c) a means of applying a force, F = 2,2 N (0.49 lbf), evenly distributed on the front face of the card opposite the magnetic stripe area.

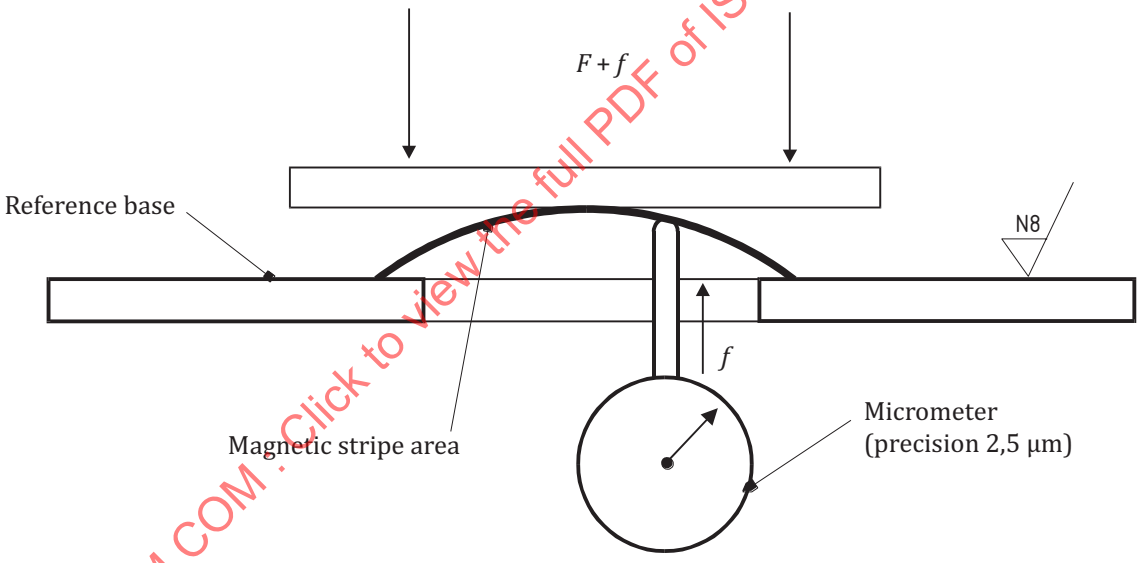

Figure 1 — Measuring arrangement (not to scale)

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5.1.2 Procedure

Place the sample card, front side up, on the level rigid plate. Position the magnetic stripe area to be measured over the aperture.

The load of 2,2 N (0.49 lbf) should be increased by an amount f to compensate for the micrometer force which is acting in the opposite direction to that force.

Apply the force F (+ f) directly over the magnetic stripe area on the front side of the card. Wait 1 minute before making any measurements.

Measure the card stripe area warpage at the nine positions along the stripe as shown in Figure 2. Additional locations shall be measured if the magnetic stripe area warpage appears greater in those areas than in the nine designated areas.

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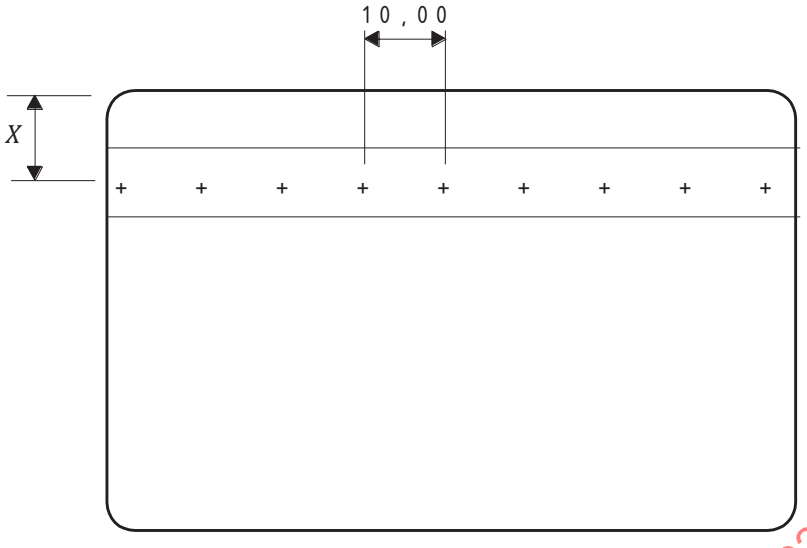

NOTE The value of *X* is given in Table 1.

Figure 2 — Measuring points on the card (dimensions in mm, not to scale)

Table 1 — Position of the line of measuring points

Magnetic stripe area	Dimension *X* (mm)
Tracks 1 and 2	8,00
Tracks 1, 2 and 3	10,70

5.1.3 Test report

The test report shall give the maximum value obtained from the set of nine measurements.

5.2 Height and surface profile of the magnetic stripe

The purpose of this test is to determine the height and flatness of the magnetic stripe of a card test sample (see ISO/IEC 7811-2, ISO/IEC 7811-6, ISO/IEC 7811-7, ISO/IEC 7811-8, and ISO/IEC 8484).

The height of the magnetic stripe is determined by reference to the card and the stripe surface profile.

5.2.1 Apparatus

The following items are required:

a) a profilometer (see Figure 3);

b) a notched rigid metal plate as shown in Figure 4. Any rigid metal can be used to construct the plate, but its thickness shall be adjusted, according to the density of the material, to achieve a weight of 2,2 N ± 0,1 N (0.49 lbf ± 0.02 lbf). All dimensions of the plate shall be ± 0,5 mm (0.02 in) or better.

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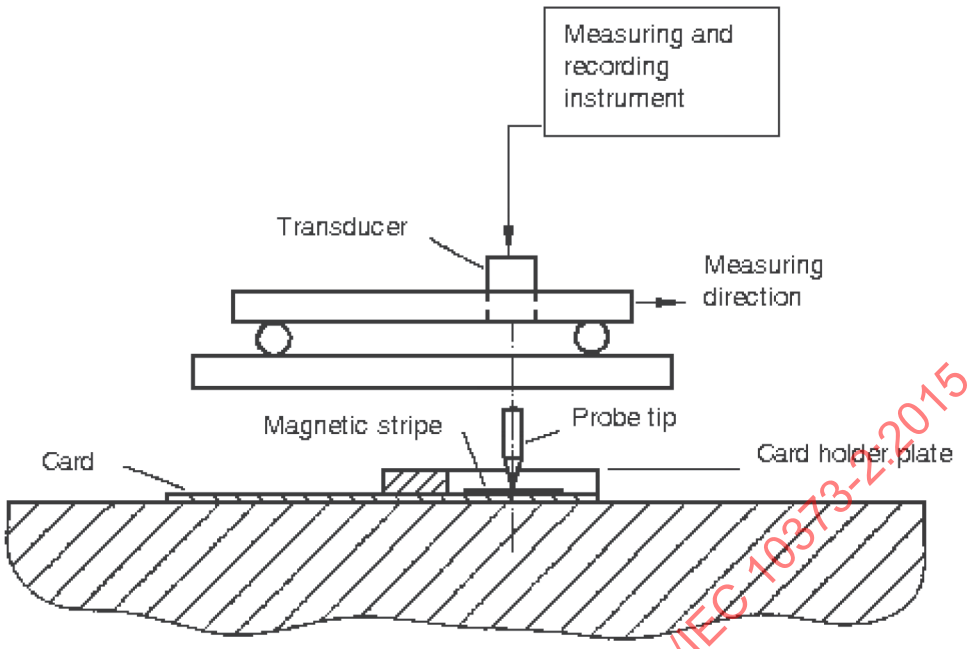

Figure 3 — Measuring device for height and profile of magnetic stripe (not to scale)

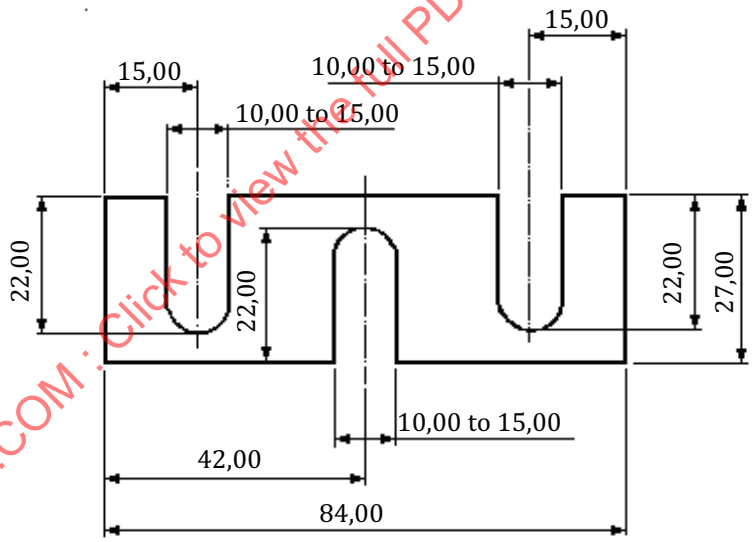

Figure 4 — Card holder plate-contact area (dimensions in mm, not to scale)

5.2.2 Procedure

Hold the card to be tested under the notched rigid metal plate shown in Figure 4.

Measure the height and the surface profile of the magnetic stripe and the surrounding card surface using a measuring recording instrument.

Measure the profile at a maximum speed of 1 mm/s (0.04 in/s) using a probe having a radius of 0,38 mm to 2,54 mm (0.015 in to 0.1 in) applied with a force of 0,5 mN to 6 mN (0.0001 lbf to 0.0013 lbf).

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Take three measurements on each specimen across the width of the stripe. The locations V and Y are defined as the distance of 15 mm ± 2 mm (0.59 in ± 0.08 in) from each end of the card and location X is the centreline of the card (see Figure 5).

Additional areas shall be measured if the height or surface profile deviations appear to be greater in those areas than in the three designated areas.

The starting point for measurement along each line V,X,Y begins 1 mm minimum (0.04 in minimum) above the top edge of the magnetic media and ends 1 mm minimum (0.04 in minimum) below the bottom edge of the magnetic media.

NOTE In preparing the test card for the surface profile measurement, it is helpful to lightly scribe a line, using a sharp knife, parallel to the top reference edge of the card for locating the minimum stripe width *W* on the profile recording.

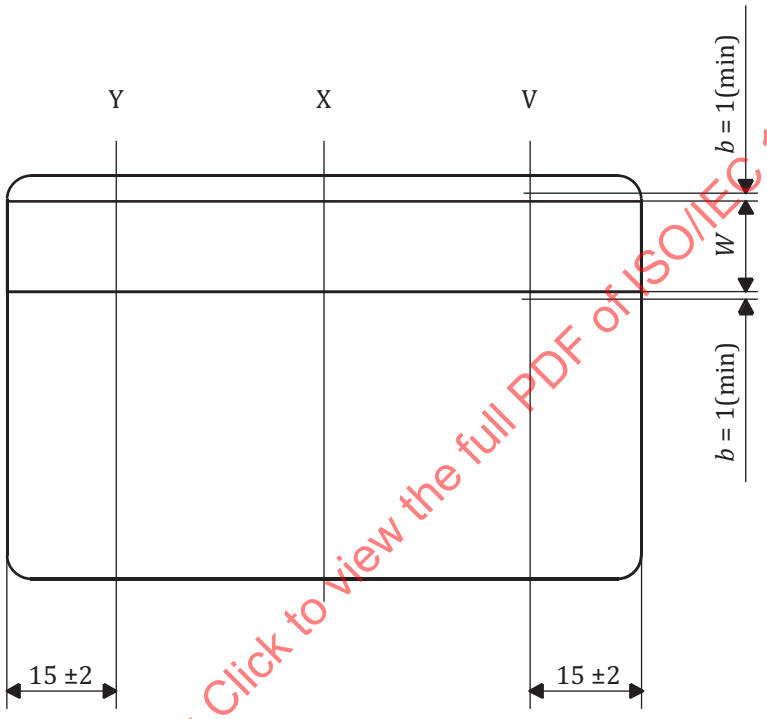

Figure 5 — Magnetic stripe profile measurement location (dimensions in mm, not to scale)

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5.2.3 Expression of results

5.2.3.1 Surface profile of the magnetic stripe

For the measurements along V, X, and Y line (see Figure 5), form a first basic measurement line (see Figure 6 and Figure 7) by connecting the top and bottom points that define the edges of the minimum stripe width. The basic measurement line shall lie within 10° of the chart recording direction.

The maximum vertical deviation (*a*) is the distance between the basic measuring line and the point on the magnetic media furthest away from the basic measurement line. The measurement shall be made perpendicular to the chart recording direction.

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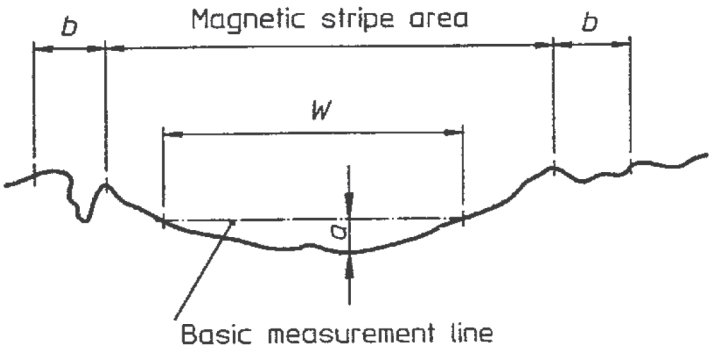


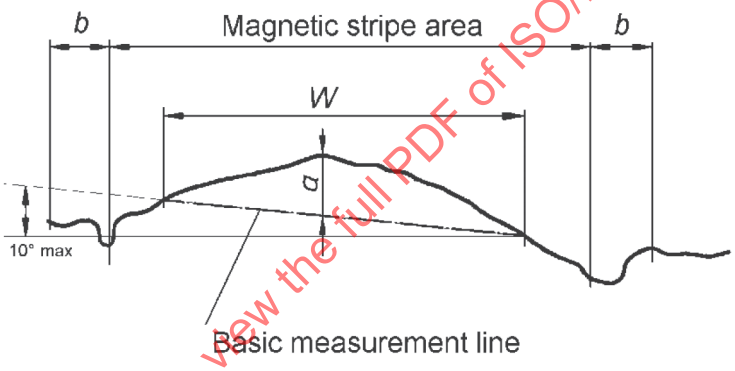
Key

a maximum vertical deviation

b 1 mm (minimum)

W Minimum stripe width as specified in the relevant base standard

Figure 6 — Concave stripe profile



Key

a maximum vertical deviation

b 1 mm (minimum)

W Minimum stripe width as specified in the relevant base standard

Figure 7 — Convex stripe profile

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5.2.3.2 Height of the magnetic stripe

The three measurements along lines V, X, and Y form a basic measurement line by connecting the starting and ending points (see Figure 8 and Figure 9). The basic measurement line shall lie within 10° of the chart recording direction.

The maximal vertical deviation (*h*) is the distance between the basic measurement line and the point on the magnetic media furthest away from the basic measurement line. The measurement shall be made perpendicular to the chart recording direction.

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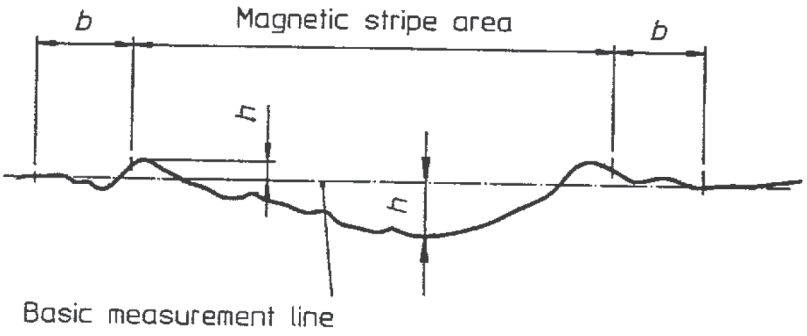
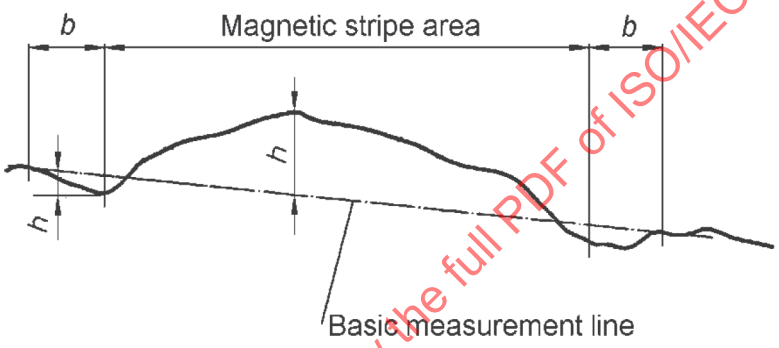


Key

b 1 mm (minimum)

h maximum vertical deviation as specified in the relevant base standard

Figure 8 — Concave stripe profile



Key

b 1 mm (minimum)

h maximum vertical deviation as specified in the relevant base standard

Figure 9 — Convex stripe profile

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5.2.4 Test report

5.2.4.1 Surface profile of the magnetic stripe

The test report shall give the values of the three measurements of maximum vertical deviation (*a*) obtained along lines V, X, and Y.

5.2.4.2 Height of the magnetic stripe

The test report shall give the values of the three measurements of maximum vertical deviation (*h*) obtained along lines V, X, and Y.

5.3 Surface roughness of the magnetic stripe

The purpose of this test is to determine the degree of roughness of the magnetic stripe of a card test sample (see ISO/IEC 7811-2, ISO/IEC 7811-6, ISO/IEC 7811-7, ISO/IEC 7811-8, and ISO/IEC 8484).

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5.3.1 Procedure

The surface roughness of the magnetic stripe shall be measured with a measuring recording instrument as shown in Figure 3. Perform at least three measurements in each direction, traversing those areas where the surface roughness appears worst.

All test conditions specified in 5.2 apply except:

— probe stylus has a radius of 2 µm (79 µin) or 5 µm (197 µin);

— cutoff wavelength and roughness evaluation length shall be chosen in accordance with ISO 3274 and ISO 4288;

— longitudinal and transverse measurements are taken on the stripe.

5.3.2 Test report

The test report shall give the centreline average R_a values of the magnetic stripe roughness obtained by measuring in both longitudinal and transverse directions.

5.4 Wear test for magnetic stripe

The purpose of this test is to determine the signal amplitude of the magnetic stripe of a card test sample after controlled abrasion (see ISO/IEC 7811-2, ISO/IEC 7811-6, ISO/IEC 7811-7, and ISO/IEC 7811-8).

5.4.1 Apparatus

A metal dummy head whose hardness is between 110 HV - 130 HV (Vickers scale) or its equivalent in Rockwell scale. The required dimensions are as shown in Figure 10.

A rigid flat plate capable of holding the card still.

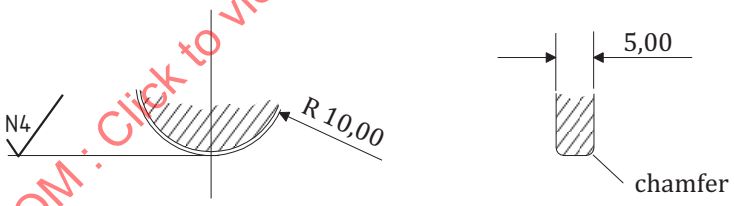

Figure 10 — Dimensions for contact area of dummy head (dimensions in mm, not to scale)

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5.4.2 Procedure

Record the sample card at 20 ft/mm (508 ftpi) using a test recording current of I_{min}, read and note the signal amplitude, measured as specified in the base standard.

Fasten the card, magnetic stripe uppermost, to the flat plate so that the dummy head can traverse the length of the stripe or alternatively, the card can move under the head (see Figure 11). Take care when mounting the card on the rigid flat plate to ensure that the card is held flat and fixed while the tests are performed.

Apply a force of 1,5 N ± 0,2 N (0.34 lbf ± 0.05 lbf) to the head and allow the head to move back and forth at a speed of between 200 mm/s (7.9 in/s) and 500 mm/s (19.7 in/s) for 2 000 cycles, (1 cycle is equivalent to one forward and one backward movement). Read the signal amplitude on the same apparatus and compare the result with the amplitude obtained at the beginning of the test.

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The position of the read and write heads shall be completely contained within the area of the zone of wear from the dummy head.

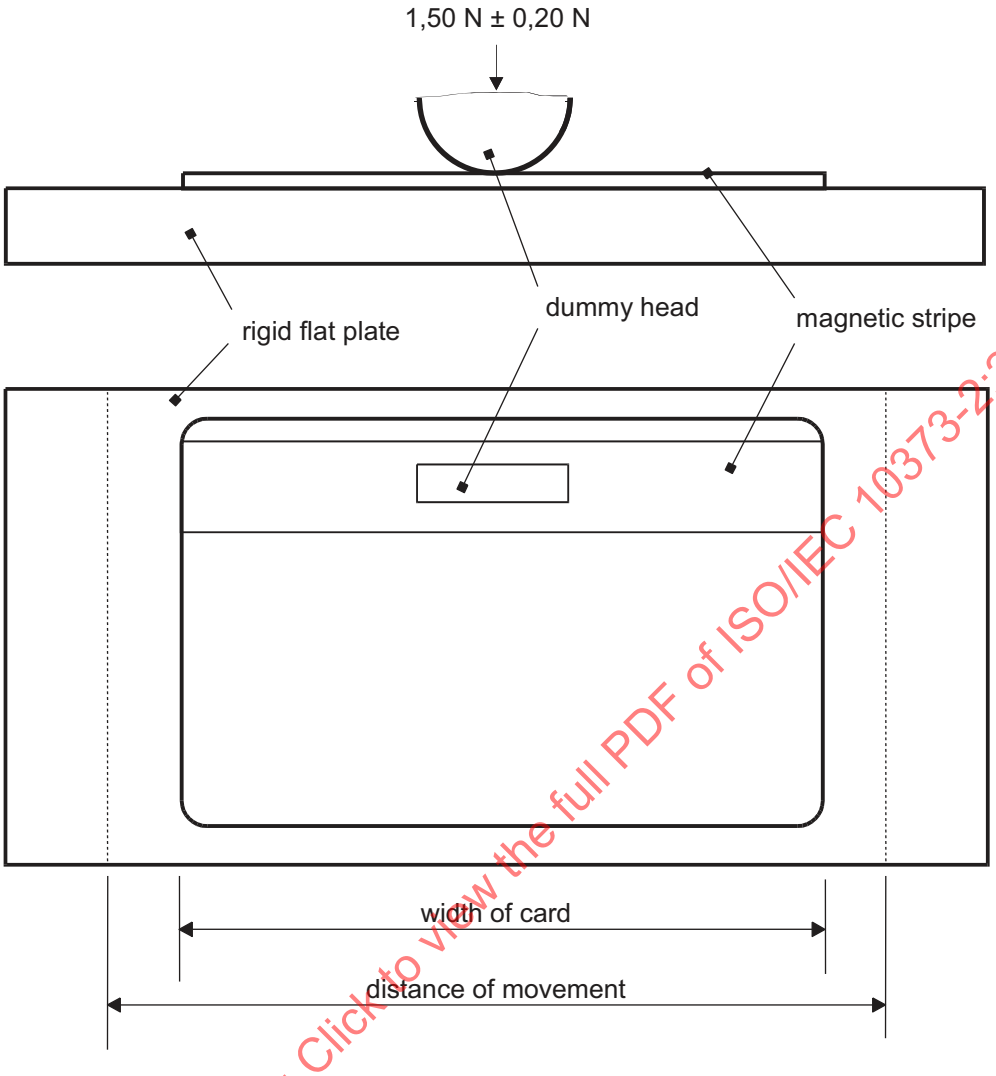

Figure 11 — Dummy head and magnetic stripe (not to scale)

5.4.3 Test report

The test report shall give the values of the signal amplitudes defined in the base standard, measured before and after wear.

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5.5 Amplitude measurements

The purpose of this test is to measure the signal amplitude, resolution, erasure, demagnetization, and waveform characteristics of the magnetic stripe of a card test sample to check conformity with the appropriate base standard as indicated below.

Approximate coercivity	Recording density	Applicable ISO/IEC standard
≤ 35 kA/m (440 Oe)	≤ 12 bpmm (300 bpi)	7811–2, 8484
≥ 80 kA/m (1000 Oe)	≤ 12 bpmm (300 bpi)	7811–6
≥ 80 kA/m (1000 Oe)	40 bpmm (1016 bpi)	7811–7
51,7 kA/m (650 Oe)	≤ 12 bpmm (300 bpi)	7811–8

NOTE Demagnetization and waveform characteristics do not apply to all standards.

5.5.1 Calibration reference

Calibration reference cards shall be selected according to the base standard against which conformance is to be checked:

Reference card	ISO/IEC base standard
RM 7811–2	7811–2, 7811–8, 8484
RM 7811–6	7811–6
RM 7811–7	7811–7

NOTE 1 Secondary Reference cards can be ordered from Q-Card, 301 Reagan Street, Sunbury PA 17801, USA until at least 2018. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO/IEC of the product named.

NOTE 2 Cleaning agents may cause deterioration of the certified properties. Any reference cards so treated can no longer be considered certified and should be destroyed.

5.5.2 Apparatus

A record/read-back system is required which comprises the items and characteristics given in 5.5.2.1, 5.5.2.2, 5.5.2.3, and 5.5.2.4.

5.5.2.1 Mechanical drive

The card shall be held flat during the measurements.

The drive system shall have an average transport speed variation of no more than ± 0,5 % and stable head pressure. If the drive used has a speed variation greater than ± 0,5 %, then the actual speed variation shall be recorded with the test results.

NOTE Variations in speed and head pressure will reduce the accuracy of measurement. In particular, it should be recognized that instantaneous (transient) speed variations will affect the accuracy of individual signal amplitude measurements.

5.5.2.2 Test heads

Test heads shall comprise separate write and read heads constructed in bodies of non-magnetic material, such as brass or aluminium.

To ensure adequate frequency response, the read head shall be constructed of laminated metal with a maximum thickness of 0,18 mm (0.0071 in).

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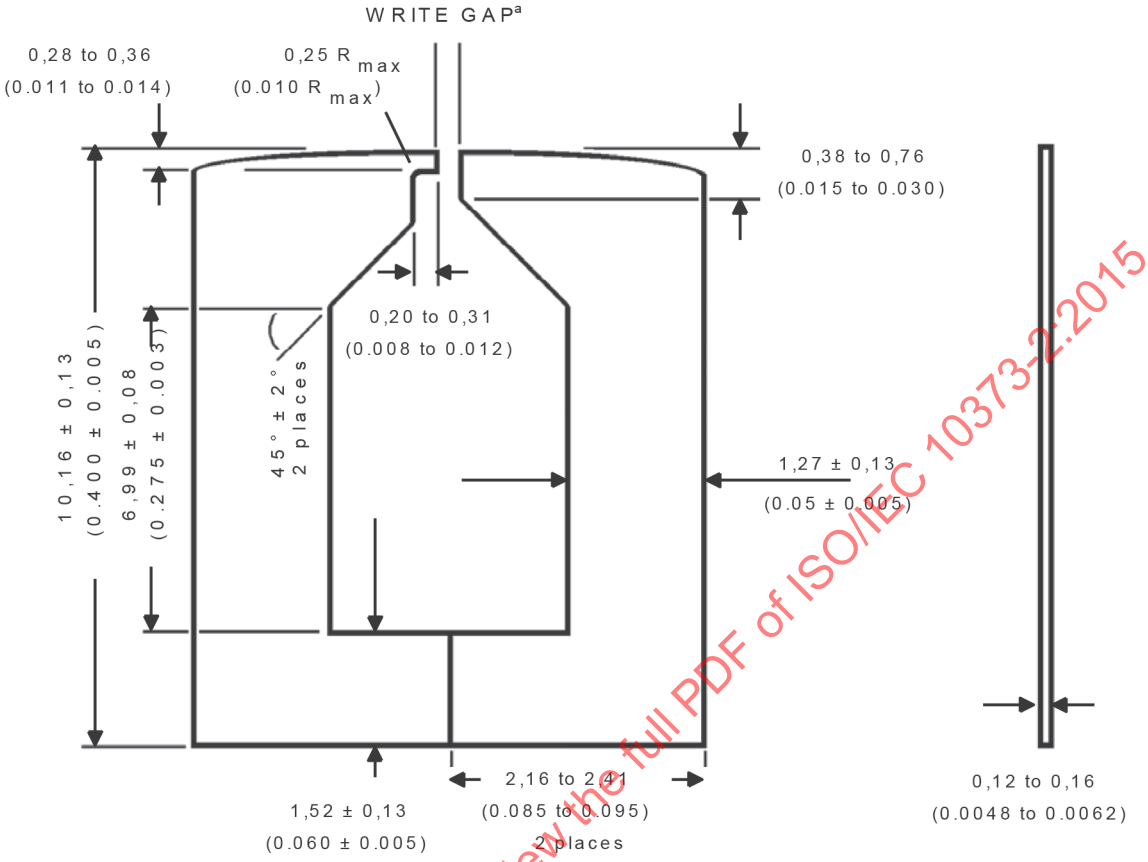
The write head core shall be constructed of metal laminations conforming to Figure 12. The front gap material shall be beryllium copper, free from ferromagnetic impurities. Wear resistant coatings shall not be used (see Annex A).



a See Table 2 for value.

Figure 12 — Test write head laminations (dimensions in mm (inch), not to scale)

Coils of 100 turns shall be wound on each leg of the write head core in no more than 2 layers, with all four leads terminating in external leads, as shown in Figure 13.

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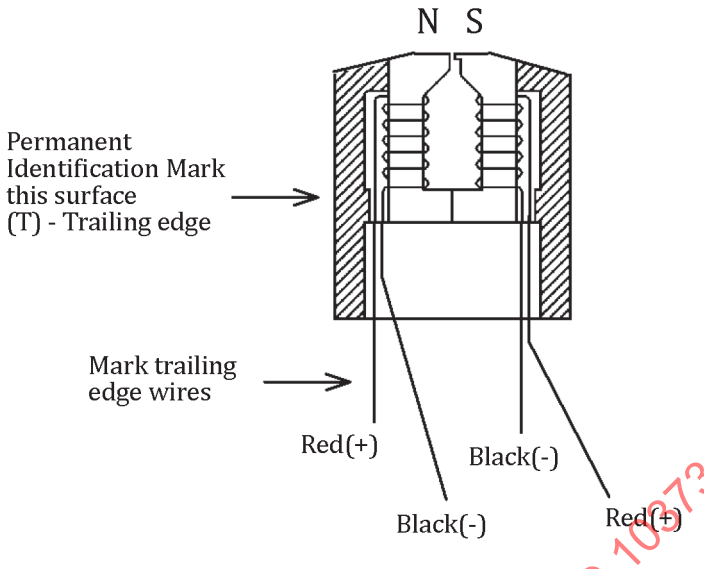

Figure 13 — Test write head coil connections (not to scale)

Gap and track widths etc. are given in Table 2. All the quantities in the table shall be measured optically.

Table 2 — Test heads specification

Head function	Read		Write		
Base standard	ISO/IEC 7811-2 ISO/IEC 7811-6 ISO/IEC 7811-8 ISO/IEC 8484	ISO/IEC 7811-7	ISO/IEC 7811-2 ISO/IEC 7811-8 ISO/IEC 8484	ISO/IEC 7811-6	ISO/IEC 7811-7
Lamination thickness	0,18 mm maximum (0.0071 in maximum)		see Figure 12		
Radius of curvature†	19 mm ± 10 % (0.75 in ± 10 %) for a new head. A flat area at the gap is permitted.				
Width of contact with stripe	2,8 mm to 3,5 mm (0.11 in to 0.14 in)				
Width of magnetic core	1,4 mm ± 10 % (0.055 ± 10 %)	0,5 mm ± 10 % (0.02 in ± 10 %)	2,79 mm minimum (0.110 in minimum)		1,0 mm minimum (0.04 in minimum)
Gap	12,7 µm ± 10 % (0.0005 in ± 10 %)	6 µm ± 10 % (236 uin ± 10 %)	0,025 mm ± 10 % (0.001 in ± 10 %)	0,051 mm ± 10 % (0.002 in ± 10 %)	0,025 mm ± 10 % (0.001 in ± 10 %)
Saturation induction			0,8 T minimum (8 kgauss minimum)	2,3 T minimum (23 kgauss minimum)	
† The size of the test head flat area influences its ability to maintain good contact with the magnetic stripe. Recalibration will be necessary as the test head wears.					

The heads shall be mounted such that they are mechanically independent from each other and such that the azimuth error is less than 10 minutes. They shall be aligned such that the centreline of the read track lies within ± 0,15 mm of the centreline of the written track.

The force on the heads shall be set to the minimum amount required to achieve the maximum output from the reference card at the time of calibration but shall not exceed 7 N (1.6 lbf).

NOTE A typical head force is 3 N (0.7 lbf).

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5.5.2.3 Write head drive

The waveform of the recording current I, at nominal recording densities of 8 ft/mm (200 ftpi) and 20 ft/mm (508 ftpi), shall be as shown in Figure 14. The current waveform shall remain within the limits shown as broken lines.

Variable in Figure 14	Requirement for ISO/IEC 7811-2, 7811, 7811–8, 8484	Requirement for ISO/IEC 7811-7
a	0,05 (T_1 + T_2)	0,10 (T_1 + T_2)
b	0,15 (T_1 + T_2)	0,35 (T_1 + T_2)
c	0,30 (T_1 + T_2)	0,10 (T_1 + T_2)
d	1,02 I	1,02 I
e	0,98 I	0,98 I
f	0,90 I	0,90 I
Symmetry	$T_1 = T_2 \pm 0{,}05\ T_1$	$T_1 = T_2 \pm 0{,}02\ T_1$

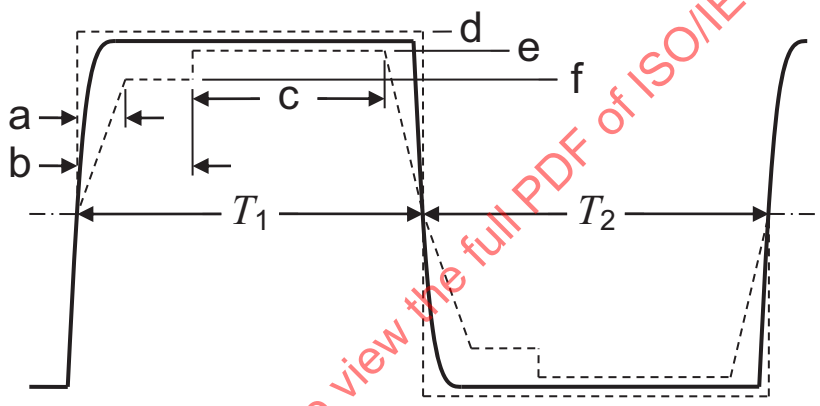

Figure 14 — Recording current waveform

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5.5.2.4 Reading sub-system

The effective remanence of the read head when connected to the read-back sub-system shall not reduce the average signal amplitude of the reference card being used by more than 5 % after 5 successive read-only passes.

The resolution of the read-back sub-system shall be between 85 % and 100 % when testing on the reference card using a test recording current of I_{max} (see 5.5.3.3) and test recording densities of:

Test recording densities	ISO/IEC base standard
8 ft/mm (200 ft/in) and 20 ft/mm (508 ft/in)	7811–2, 7811–6, 7811–8, 8484
20 ft/mm (508 ft/in) and 40 ft/mm (1016 ft/in)	7811–7

It shall comprise:

a) a linear amplifier

The amplifier shall be without automatic gain control and with noise less than 0,5 % of U_R (see 5.5.3.2) and a frequency response that is flat within ± 0,2 dB between frequencies corresponding to positions 2 and 3 of Figure 15.

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This range corresponds to the characteristics of the bandpass of the filter described in c) below. Outside this range, the response may not rise.

b) display and measurement means

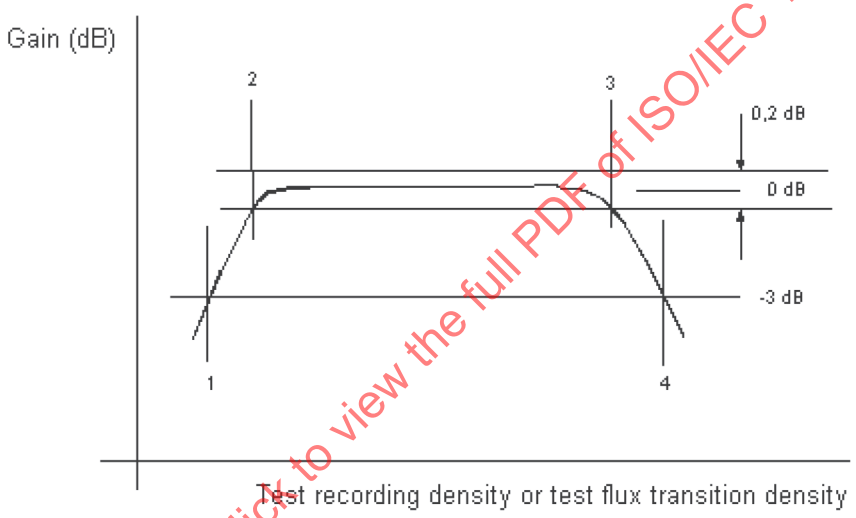
Equipment such as a storage oscilloscope for determining the amplitudes of the signal peaks.

c) a bandpass filter

This filter shall be used for all measurements except Erasure (U_{A4}) and Extra Pulse (U_{i4}).

The upper and lower band edges of the filter shall show a second order response (slope 12 dB/octave). The passband response shall be flat within a 0,2 dB wide band from frequencies corresponding to 0,25 cycles/mm (0,5 ft/mm) to 10,5 cycles/mm (21 ft/mm). Figure 15 shows the required characteristic.

The filter response shall continue downward for at least one decade after the band edges and shall not rise more than −40 dB outside this one decade range. Other filtering functions outside the one decade ranges may be used.



Position	Test recording density		Test flux transition density	
Base standard	ISO/IEC 7811-2 ISO/IEC 7811-6 ISO/IEC 7811-8 ISO/IEC 8484	ISO/IEC 7811-7	ISO/IEC 7811-2 ISO/IEC 7811-6 ISO/IEC 7811-8 ISO/IEC 8484	ISO/IEC 7811-7
	Cycles/mm (cycles/in)		Ft/mm (ft/in)	
1	0,009 (0.23)		0,018 (0.46)	
2	0,025 (0.63)		0,05 (1.27)	
3	10,5 (267)	28 (711)	21 (533)	56 (1422)
4	30 (762)	80 (2032)	60 (1524)	160 (4064)

Figure 15 — Filter characteristic

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5.5.3 Procedure

The entire sequence of measurements shall be performed on the same equipment and under the same conditions.

All measurements shall be performed while reading in the same direction as recording and shall be taken after the same number of passes.

5.5.3.1 Determine the flux/current characteristic of the test write head

Characterize the write head to find the relationship between flux output and write current in the following manner.

For each current amplitude (I), note the corresponding flux amplitude (F) using the apparatus described in Figure 16.

The voltage/current linearity of the current source shall be better than ± 2 %.

The loss of the integrator = 2000π × RC approximately 6283 × RC shall be at least 200.

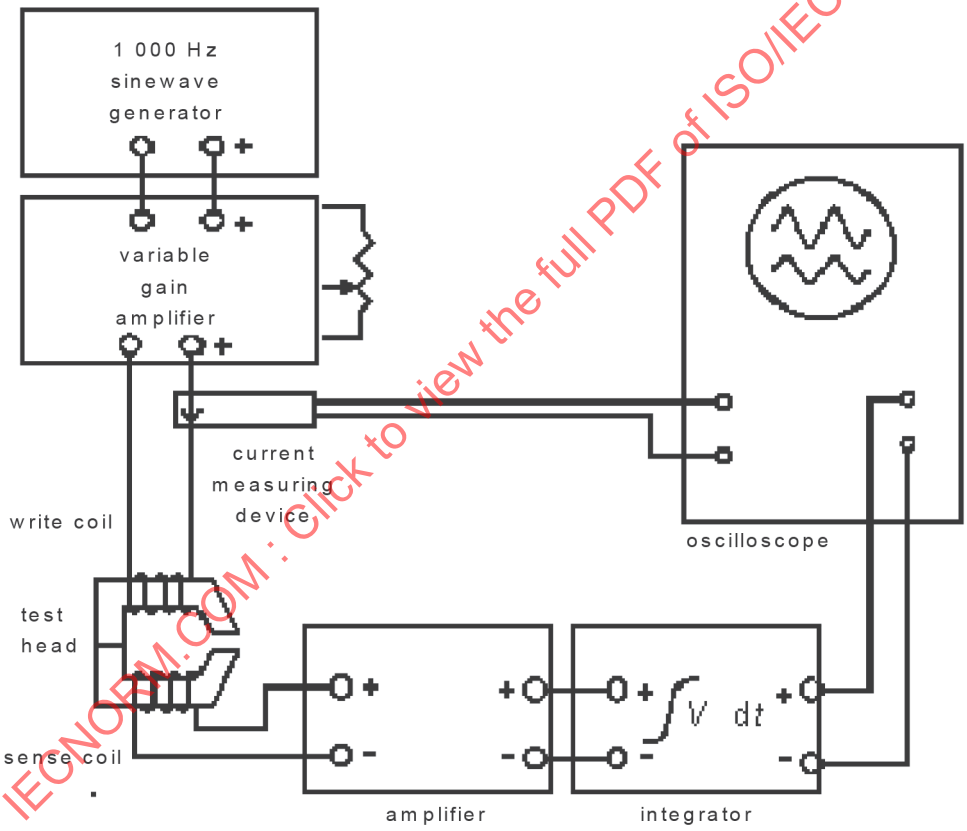

Figure 16 — Typical head characterization test setup

5.5.3.2 Determine U_{max} and I_R from the reference card

Draw the saturation curve to determine the maximum signal amplitude (U_{max}) and reference current (I_R) using the reference card (see 5.5.1) and calibration test recording density appropriate to the base

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standard. For each current amplitude, note the corresponding value of the average signal amplitude of the reference card.

Test recording densities	ISO/IEC base standard
8 ft/mm (200 ft/in)	7811–2, 7811–6, 7811–8, 8484
20 ft/mm (508 ft/in)	7811–7

Before recording at each current amplitude, erase the card with high frequency alternating current. The degree of erasure shall be sufficient to ensure that the average remaining signal is less than 0,05 U_R.

This calibration process (which determines the values of U_R and I_R from the Reference Card) shall be performed such that the recording pass across the Reference Card is directly followed by the read pass.

Perform the calibration process at least three times. If output variation is greater than 2 % (i.e. ± 1 %), repeat the calibration procedure.

NOTE 1 Any contact by write or read heads after the recording pass, before the reading pass occurs, may affect the resulting value of U_R.

NOTE 2 The user is advised to check the accuracy of the Reference Card periodically by comparing the signal output amongst five certified Reference Cards.

5.5.3.3 Derive the reference values

Calculate the reference signal amplitude (U_R) and test recording currents (I_{min} and I_{max}) for the secondary reference card as follows. Correction factors are supplied by the provider of secondary reference cards.

a) U_R = (secondary reference maximum amplitude) * (amplitude correction factor)

amplitude correction factor = (primary standard amplitude) / (secondary reference amplitude)

b) I_R = (secondary reference current) * (current correction factor)

secondary reference current = current when U is 80 % of secondary reference maximum

current correction factor = (primary standard current) / (secondary reference current)

c) F_R = reference flux when current is I_R.

d) I_{min} and I_{max} current values depend on the base standard:

ISO/IEC base standard	I_{min} = current flux level of	I_{max} = current flux level of
7811–2, 8484	3,5 × F_R	5,0 × F_R
7811–6	2,8 × F_R	3,5 × F_R
7811–7	2,2 × F_R	2,5 × F_R
7811–8	6,5 × F_R	8,0 × F_R

5.5.3.4 Measure the card under test

Record and read the card under test under the various test conditions defined by the base standard.

Erase the card under test with high frequency alternating current before testing and before each individual test except for erasure and extra pulse. The degree of erasure shall be sufficient to ensure that the average remaining signal is less than 0,05 U_R

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Do not erase the card between the two recordings of any overwriting tests that specifically require a comparison between signal amplitudes before and after overwriting.

Prior to erasing the card under test for erasure and extra pulse measurement, record it with the value of I_{max} appropriate to the base standard and a test density of:

Test recording densities	ISO/IEC base standard
8 ft/mm (200 ft/in)	7811–2, 7811–6, 7811–8, 8484
20 ft/mm (508 ft/in)	7811–7

Prior to performing the test for demagnetization against the requirements in the base standard, record the card with the value of I_{min} appropriate to the base standard at a test density:

Test recording densities	ISO/IEC base standard
20 ft/mm (508 ft/in)	7811–6
40 ft/mm (1016 ft/in)	7811–7

5.5.4 Test report

The test report shall give the values measured for the quantities defined by the base standard.

In addition to the total measurement uncertainty associated with each quantity, it shall also state the measured speed variation of the drive if greater than ± 0,5 % and whether the test heads include wear resistant coatings.

5.6 Flux transition spacing variation

The purpose of this test is to determine the variation in flux transition positions on an encoded card test sample (see ISO/IEC 7811-2, ISO/IEC 7811-6, ISO/IEC 7811-7, ISO/IEC 7811-8, and ISO/IEC 8484).

5.6.1 Apparatus

The apparatus for measuring transition to transition spacing variation shall conform to 5.5.2.1 and 5.5.2.4. It shall also conform to those parts of 5.5.2.2 relevant to the read head.

Specifically, the apparatus shall maintain a ± 0,5 % positional accuracy at 40 ft/mm (1016 ftpi) for all speeds of operation while testing and shall be so constructed that it is protected from debris and contamination.

The read head shall be aligned such that the centreline of the read track lies within ± 0,15 mm of the centreline of the written track under test.

NOTE Either the head or the card position may be measured while holding the other stationary.

Figure 17 shows a block schematic of the apparatus.

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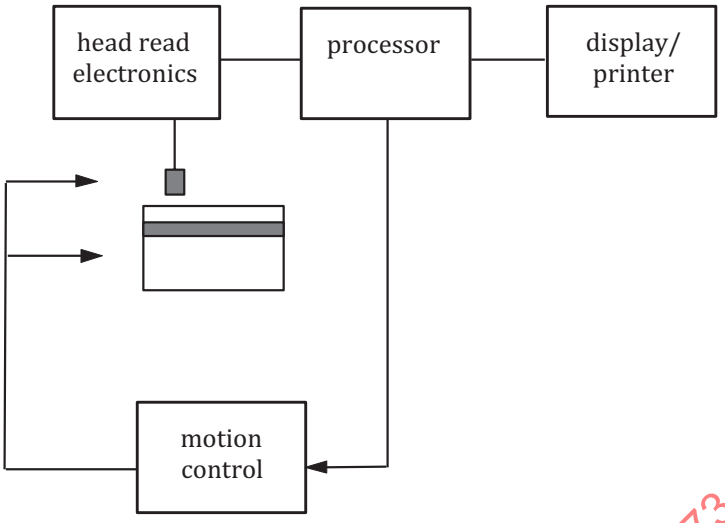

Figure 17 — Example measurement schematic

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5.6.2 Procedure

Place the test specimen card in the apparatus.

The force on the head shall be set to the minimum amount required to achieve the maximum output from the card under test at the time of measurement but shall not exceed 7 N (1.6 lbf).

Activate the apparatus and obtain distance measurements between adjacent signal peaks.

5.6.3 Test report

The test report shall give the measured values of the quantities defined by the base standard, together with the total measurement uncertainty of each.

5.7 Magnetic stripe adhesion

The purpose of this test is to determine the degree of adhesion between the magnetic stripe and the body of a card test sample (see ISO/IEC 7811-2, ISO/IEC 7811-6, ISO/IEC 7811-7, ISO/IEC 7811-8, and ISO/IEC 8484).

5.7.1 Apparatus

The following items are required:

— single blade cutting tool as defined in ISO 2409:2007;

— transparent adhesive tape with an adhesive strength as specified in ISO 2409:2007, 3.5, tested in accordance with IEC 60454-2 and no more than 20 mm wide;

— card holder comprising a rigid rectangular metal plate with a rectangular aperture of 25 mm × 50 mm.

5.7.2 Procedure

Make two cuts in the stripe about 20 mm (0.75 in) long that intersect near the middle of the stripe with an angle of about 20° to 45°. When making the cuts, use the side of the card holder and cut through the stripe to the card in one steady motion.

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