INTERNATIONAL STANDARD

ISO/IEC 15457-2

Second edition
2007-06-15

Identification cards — Thin flexible cards —

Part 2: Magnetic recording technique

Cartes d'identification — Cartes flexibles fines —

Partie 2: Techniques d'enregistrement magnétique

Reference number
ISO/IEC 15457-2:2007(E)

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Contents

Page

Foreword ... iv

1 Scope ... 1

2 Normative references ... 1

3 Terms and definitions ... 2

4 General characteristics ... 4
4.1 Introduction ... 4
4.2 Requirements common to all formats ... 4
4.3 Environmental conditions ... 5

5 Magnetic stripe characteristics ... 5
5.1 Stripe surface ... 5
5.2 Stripe adherence ... 6
5.3 Stripe life ... 6
5.4 Magnetic characteristics ... 7
5.5 Magnetic stripe zone reservation ... 7

6 TFC.0 data recording ... 7
6.1 Magnetic track characteristics ... 7
6.2 Encoding characteristics ... 8

7 TFC.1 data recording ... 9
7.1 Magnetic track characteristics ... 9
7.2 TFC.1-specific stripe requirements ... 10
7.3 Encoding characteristics ... 11

8 TFC.5 data recording ... 12
8.1 Magnetic track characteristics ... 12
8.2 TFC.5-specific stripe requirements ... 12
8.3 Encoding characteristics ... 12

Annex A (normative) **Magnetics classes** ... 14

Annex B (normative) **Encoding classes** ... 16

Bibliography ... 19

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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 15457-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

This second edition cancels and replaces the first edition (ISO/IEC 15457-2:2001), Annex A of which has been technically revised.

ISO/IEC 15457 consists of the following parts, under the general title *Identification cards — Thin flexible cards*:

— *Part 1: Physical characteristics*

— *Part 2: Magnetic recording technique*

— *Part 3: Test methods*

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Identification cards — Thin flexible cards —

Part 2: Magnetic recording technique

1 Scope

Thin flexible cards (TFCs) are used to automate the controls for access to goods or services such as mass transit, highway toll systems, car parks, vouchers and stored value.

For these applications, data can be written and/or read by machines using various recording techniques: magnetic stripe, optical character recognition (OCR), bar code, etc.

This part of ISO/IEC 15457 specifies the magnetic stripe and encoding characteristics of thin flexible cards at two points in the card's life cycle:

— at the point of loading into the card-issuing equipment;

— at the point of issue to the public.

Guidance concerning the storage and usage of finished cards (including magnetic stripe cards) under various environmental conditions is given in ISO/IEC 15457-1.

2 Normative references

The following referenced documents are indispensable for the application 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 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

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

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

ISO/IEC 15457-1, *Identification cards — Thin flexible cards — Part 1: Physical characteristics*

ISO/IEC 15457-3, *Identification cards — Thin flexible cards — Part 3: Test methods*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 15457-1 and the following apply.

3.1
track
area of stripe surface occupied by the data encoded by a single channel of the magnetic recording write/read interface

3.2
central stripe
stripe centred on the widthwise axis of the card

3.3
lateral stripe
any widthwise stripe which is not centred on the widthwise axis of the card

3.4
re-usable card
durable card able to be recovered from the field (generally by automatic equipment operation) and re-issued

3.5
unused unencoded card
card possessing all the components required for its intended purpose, which has not been subjected to any personalisation or testing operation and which has been stored in a clean environment with no more than a 48 h exposure to daylight at temperatures between 5 °C and 30 °C and a humidity between 10 % and 90 % without experiencing thermal shock

3.6
unused encoded card
card according to 3.5 that has only been encoded with all the data required for its intended purpose (e.g. magnetic encoding, printing, etc.)[1)]

3.7
returned card
card according to 3.6 after it has been issued to the card holder and returned for the purpose of testing (e.g. re-usable card returned for possible re-issue)[2)]

3.8
$\boldsymbol{R_a}$, $\boldsymbol{R_z}$
measures of surface irregularity as defined in ISO 4287

3.9
maximum field, H_{max}
maximum absolute magnetic field strength applied as described by the test method

3.10
coercivity, $H_{cM} = H_{cJ}$
continuously applied magnetic field which reduces the magnetisation to zero from a previous maximum magnetisation state in the opposite direction, the quantity of interest being that which is measured parallel to the longitudinal axis of the stripe

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1) The definitions used in ISO/IEC 7811 refer to embossing and electronic encoding, which are not defined in ISO/IEC 15457. However, printing on issue (as opposed to pre-printing) frequently accompanies magnetic encoding in applications of thin flexible cards.

2) In certain applications of thin flexible cards, the purpose of testing returned cards is to establish their suitability to be re-issued for re-use. Such testing is generally done automatically by bulk sorter/encoder equipment.

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3.11
longitudinal squareness, $SQ = M_r/M$ (*at* H_{max})
ratio of the value of magnetisation (M_r) at zero magnetic field (H=0) after the application and removal of the maximum field (H_{max}) to the magnetisation (M) at the maximum field applied (H_{max}) measured along the longitudinal axis of the stripe

3.12
switching field by derivative, SF_D
the width at half height of the differentiated static magnetisation curve $M(H)$ divided by the coercivity from the same curve

3.13
switching field by slope, SF_S
$(\ /H_2/-/H_1/)/\ H'_{cM}$, where $M(-/H_1/) = 0{,}5M_r$ and $M(-/H_2/) = -0{,}5\ M_r$; the difference between the field values at the intercept of the static magnetisation $M(H)$ loop with $M(H) = 0{,}5M_r$ and $M(H) = -0{,}5M_r$, divided by the coercivity

3.14
recording technique
technique, such as magnetic or optical encoding, used to store data on the card

3.15
nominal bit density, D_R
encoding density specified for a track

3.16
maximum test current, I_{max}
upper of two test write currents used for testing TFC magnetic stripes

3.17
maximum test density, D_{max}
upper of two test recording densities used for testing TFC magnetic stripes

3.18
minimum test current, I_{min}
lower of two test write currents used for testing TFC magnetic stripes

3.19
minimum test density, D_{min}
lower of two test recording densities used for testing TFC magnetic stripes

3.20
individual signal amplitude, U_i
base-to-peak amplitude of a single readback signal pulse

3.21
average signal amplitude, U_A
arithmetic mean of the absolute values of the individual signal amplitudes found in a readback waveform:

$$U_A = \frac{\sum_{k=1}^{n} U_{ik}}{n}$$ (where n is the number of individual signal amplitudes)

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3.22
modulation, *m*
range of variation of a readback signal defined by

$$m = \frac{U_{\text{imax}} - U_{\text{imin}}}{2 \times U_A}$$

where U_i is the individual readback signal amplitude and U_A is the average readback signal amplitude recorded at D_{max} and I_{max}

4 General characteristics

4.1 Introduction

Three card sizes, TFC.0, TFC.1 and TFC.5, are defined in ISO/IEC 15457-1.

Common physical characteristics and the geometrical and topographical characteristics of each card size are specified in ISO/IEC 15457-1.

In this part of ISO/IEC 15457, the magnetic stripe and track characteristics specific to each size of card are given in separate clauses. Common characteristics are specified in Clause 4. Specifications for the permitted magnetic and encoding characteristics are given in the annexes.

All clauses in all parts of ISO/IEC 15457 apply to finished cards or to the reels/packs from which such cards are taken. Certain clauses however, such as durability, concern the characteristics of the card throughout its life. As a matter of convenience and practicality, certain tests can be carried out on unfinished cards where it can be demonstrated that no significant change in that property can arise during subsequent processing.

4.2 Requirements common to all formats

4.2.1 General requirements

Thin flexible cards may be finished in a variety of ways, according to the requirements of the system in which they are to be used. This part of the standard deals with those which are equipped with a magnetic stripe.

Stripes may be magnetically encoded, in accordance with this part of ISO/IEC 15457.

The addition of a magnetic stripe and the encoding of that stripe shall not affect the continued conformance of the finished cards to the other applicable parts of ISO/IEC 15457.

Magnetic stripes, however presented, shall be free from defects which could interfere with usage, such as joins, discontinuities, loose particles, embedded debris, creases, indentations and high spots. They shall not adhere to, or leave an impression on, the adjacent cards in a reel or pack.

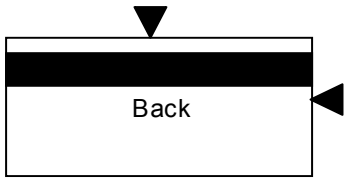
4.2.2 Reference edges

Once identified in accordance with the criteria defined in ISO/IEC 15457-1, the same front and reference edges shall be used exclusively and consistently in applying all relevant parts of ISO/IEC 15457, including this.

NOTE 1 In the case of a central stripe, this constraint results in a unique relationship between reference edges and the beginning of the encoded message.

NOTE 2 For example, in the case of a lateral stripe, this constraint results in the unique relationship between reference edges and stripe shown in Figure 1.

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Reference edges are indicated by the black triangles.

Figure 1 — Reference edges for lateral stripe

4.3 Environmental conditions

4.3.1 Testing environment

The environmental conditions under which the characteristics specified in this part of ISO/IEC 15457 are to be measured are specified in ISO/IEC 15457-3.

4.3.2 Storage environment and packaging

Magnetic stripes shall continue to comply with the requirements of this part of ISO 15457 after storage under the storage environment and packaging conditions specified in ISO/IEC 15457-1.

4.3.3 Usage environment

Magnetic stripes shall remain structurally reliable and usable within the usage environment specified in ISO/IEC 15457-1.

5 Magnetic stripe characteristics

5.1 Stripe surface

5.1.1 Protrusion

In order to accommodate manufacturing processes which apply the magnetic stripe as tape, this part of ISO/IEC 15457 defines two classes of protrusion, as follows.

Class 1: The maximum protrusion of the magnetic stripe surface above the surface of the base material shall not be less than 0 µm and shall not be greater than 12 µm.

Class 2: The maximum protrusion of the magnetic stripe surface above the surface of the base material shall not be less than 0 µm and shall not be greater than 25 µm.

Class 2 protrusion is permited on TFC.1 cards with paper or composite substrates only.

5.1.2 Profile deviation

The straight line deviation of the profile across stripes greater than 3 mm shall be less than 8 µm.

5.1.3 Roughness

The roughness of the magnetic stripe surface, measured along lines parallel to the height and width dimensions, shall be in accordance with Table 1.

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Table 1 — Stripe roughness

Dimensions in micrometres

Encoding density	R_a(max)	R_z(max)
$\leqslant$ 3 bits/mm	$\leqslant$ 1,6	$\leqslant$ 10
$>$ 3 bits/mm	$\leqslant$ 1,4	$\leqslant$ 8

5.1.4 Stripe area warpage

The maximum deformation of the card material due to the application of the magnetic stripe shall be such that, when the card is laid on its back on a flat surface and a force of 2,2 N is applied uniformly on its front, the maximum perpendicular distance which can be measured from any point on the magnetic stripe to the flat surface does not exceed 80 µm.

5.1.5 Stripe area curl

The curl of a single card shall not exceed 1 mm when a force of 4,9 N is applied to an area between the lower edge of the magnetic stripe and the lower edge of the card when the card is laid on its front on a flat surface (see Figure 2).

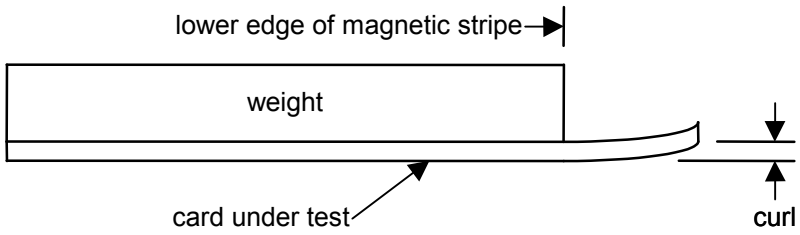


Figure 2 — Curl of the stripe area

5.2 Stripe adherence

The magnetic stripe shall remain firmly fixed to the card material during the lifetime of the card.

It shall not be possible to remove the magnetic stripe without stripping off part of the card material.

Adhesion of the magnetic stripe material to the card surface shall be such that, regardless of the means employed to detach it, the stripe cannot be removed intact.

Furthermore, the removal of any portion of the magnetic stripe shall result in visually detectable damage to the card surface.

5.3 Stripe life

5.3.1 Stripe wear

After being subjected to the appropriate wear test, the worn portion of the magnetic stripe shall remain in compliance with the performance characteristics given in A.1 for returned cards.

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5.3.2 Other requirements

All magnetic stripes, shall resist deterioration from exposure to light and other environmental factors encountered in normal use.

Where abnormally demanding conditions of use are likely to affect life expectancy, these shall be taken into account when selecting suitable materials and methods of manufacture.

5.4 Magnetic characteristics

Magnetic characteristics are grouped into three classes, specified in Annex A.

Classes L and H may be used for any TFC format.

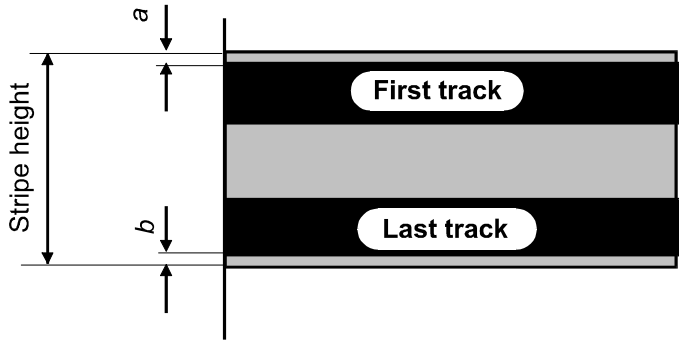
Class S may be used only in existing applications that use the TFC.0 format.

5.5 Magnetic stripe zone reservation

The magnetic stripe area shall extend over the full width of the back of the card.

The location and size of the magnetic stripe results directly from the tracks to be used (track heights and locations are defined in the following clauses).

Except if stated otherwise for a specific card format and track location, the stripe height shall cover an area which includes all the tracks used and extends beyond their top and bottom boundaries by at least 0,8 mm, as shown in Figure 3.



$a \geqslant 0{,}8$ mm; $b \geqslant 0{,}4$ mm

Figure 3 — Minimum stripe area

6 TFC.0 data recording

6.1 Magnetic track characteristics

6.1.1 Number of tracks

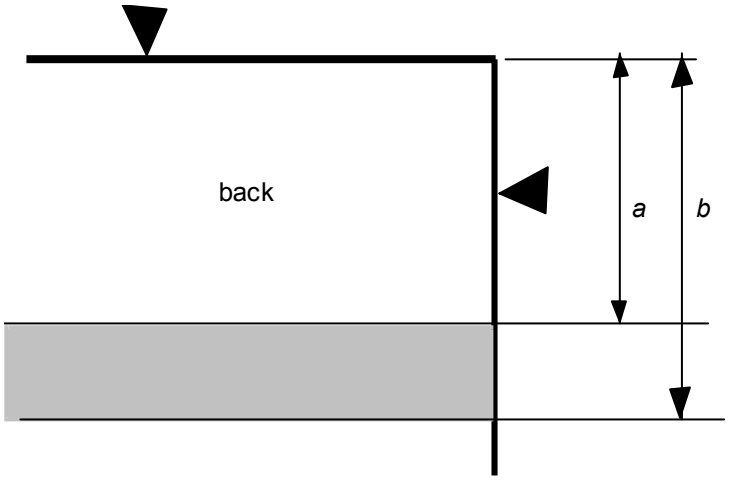
TFC.0 cards shall have a single central track.

6.1.2 Position of track

The position of the stripe shall be as shown in Figure 4. The track shall occupy the full height of the stripe.

NOTE In practice, the height of the written track (i.e. the height of the write head track) is greater than the height of the stripe upon which it is written. Consequently, the track height is determined by the stripe height.

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For type A stripes, *a* = 14,20 mm minimum / 14,30 mm maximum; *b* = 15,80 mm minimum / 15,90 mm maximum.
For type B stripes, *a* = 12,60 mm minimum / 12,90 mm maximum; *b* = 17,60 mm minimum / 17,90 mm maximum.

Figure 4 — TFC.0 track position

6.2 Encoding characteristics

6.2.1 Encoded data

The central track is designated for read and write functions.

6.2.2 Encoding method and bit density

TFC.0 cards shall be encoded at a bit density of either 1,35 bits/mm or 3 bits/mm, using either the F/2F or split phase encoding method (see Annex B).

6.2.3 Encoding zone

Stripe areas within 1,5 mm of either edge of the card are not included in the encoding zone and may be filled with zeroes. Within the remaining zone, the message shall be encoded with its start nearest the reference edge of the card.

The encoding zone shall allow the recording of

— at least 8 leading and trailing zero bits for synchronisation purposes,

— application data.

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7 TFC.1 data recording

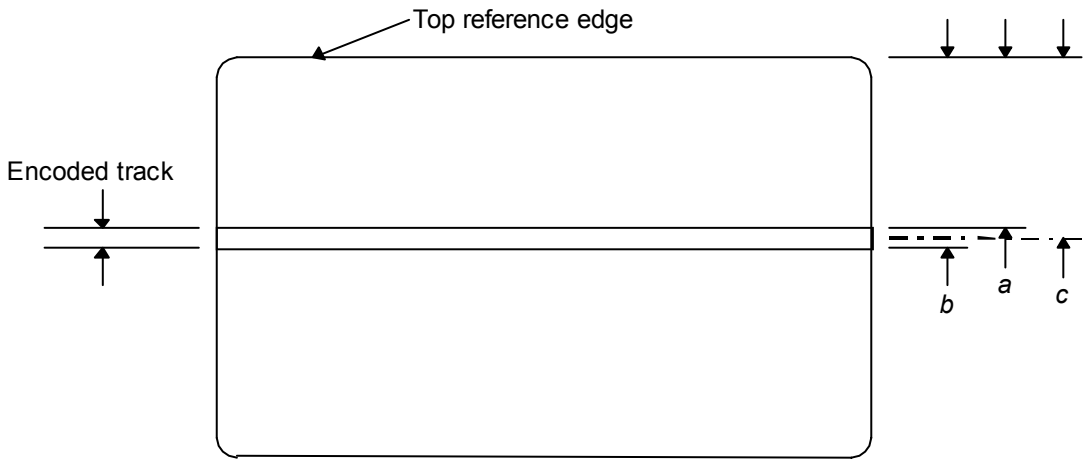
7.1 Magnetic track characteristics

7.1.1 Number of tracks

TFC.1 cards shall be encoded with either a single track, centrally or laterally placed, or up to four lateral tracks.

7.1.2 Position of central track

The position of the single central track shall be as shown in Figure 5.



Term	Central track
a	25,59 mm maximum
b	28,39 mm minimum
c	26,99 mm nominal

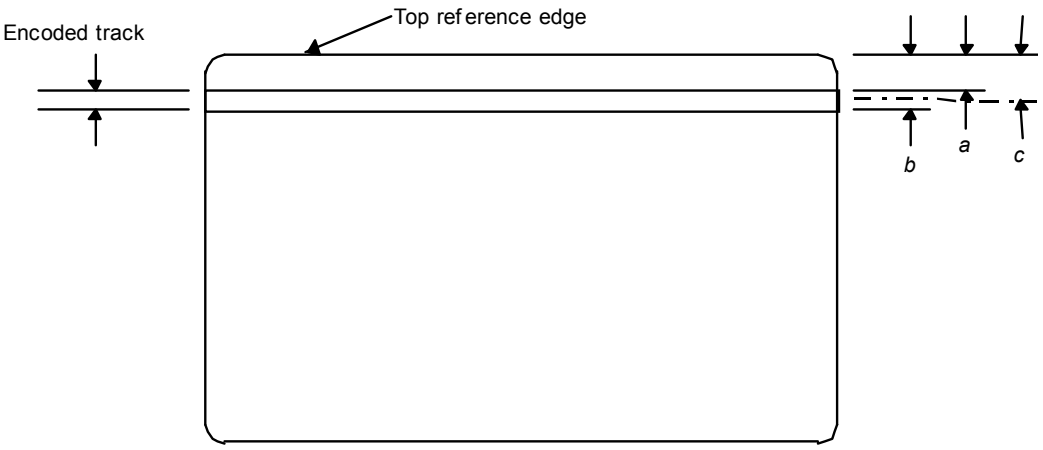
Figure 5 — Position for TFC.1 central track

7.1.3 Position of multiple tracks

The position of multiple lateral tracks shall be as shown in Figure 6.

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Term	Track 1	Track 2	Track 3	Track 4
a		8,33 mm minimum	11,63 mm minimum	15,82 mm minimum
	5,79 mm maximum	9,09 mm maximum	12,65 mm maximum	16,21 mm maximum
b	8,33 mm minimum	11,63 mm minimum	15,19 mm minimum	18,75 mm minimum
	9,09 mm maximum	12,65 mm maximum	15,82 mm maximum	19,51 mm maximum
c	7,06 mm nominal	10,36 mm nominal	13,92 mm nominal	17,48 mm nominal

Figure 6 — Positions of multiple TFC.1 lateral tracks

7.1.4 Position of single lateral track

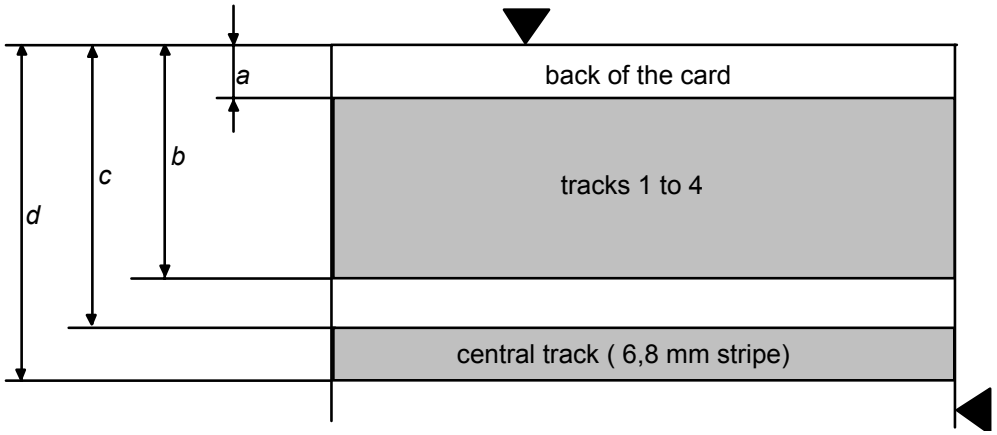
A single lateral track shall be placed as shown for any of the three tracks shown in Figure 6.

7.2 TFC.1-specific stripe requirements

The stripe zone reservation shall not be violated by printing or any other machine process after the TFC card has been issued to the public. The area occupied by unused tracks may, however, be preprinted or printed on issue if required.

Consequent upon the stripe zone definition (see 7.3), the minimum stripe zone capable of accomodating all possible tracks on the same card is as shown in Figure 7.

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a = 5,39 mm; *b* = 19,68 mm; *c* = 23,59 mm; *d* = 30,59 mm

NOTE The largest minimum stripe zone reservation, making full provision for future track positions (such as track 0 located between the top reference edge and the lateral track 1), extends from the top edge down to the lower boundary of the central stripe.

Figure 7 — TFC.1 stripe zone reservation

7.3 Encoding characteristics

7.3.1 Encoded data

The central track and all lateral tracks are designated for read and write functions.

7.3.2 Encoding method and encoding density

Tracks on TFC.1 cards shall be encoded using the F/2F encoding method (see Annex B), at 3 bits/mm, 6 bits/mm or 8,3 bits/mm. It is permitted to used different densities for different tracks.on the same card.

7.3.3 Encoding zone

Stripe areas within 2,9 mm of either edge of the card are not included in the encoding zone and may be filled with zeroes. Within the remaining zone, the message shall be encoded with its start nearest the reference edge of the card.

The encoding zone shall allow the recording of

— at least 10 leading and trailing zero bits for synchronisation purposes,

— application data.

Optionally, the portion of the track designated as the maximum usable bits zone may be divided into multiple independent encoding zones called “blocks”. Where such independent blocks are written within this area, each shall have its own leading and trailing zeroes.

NOTE The encoding of independent blocks may cause spurious readback signals to be written in the gap between the blocks.

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8 TFC.5 data recording

8.1 Magnetic track characteristics

8.1.1 Number of tracks

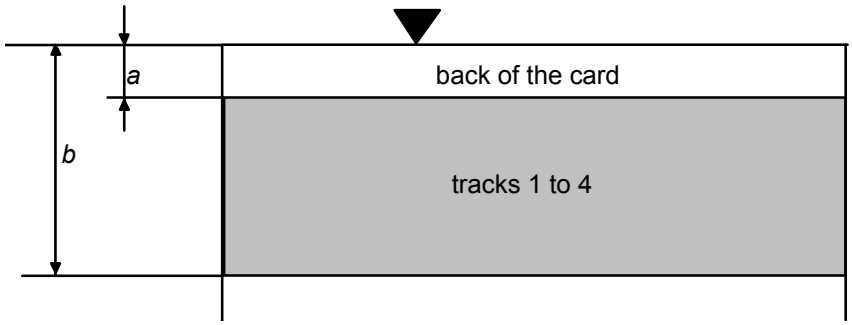
TFC.5 cards shall have up to four lateral tracks.

8.1.2 Position of tracks

The positions of the tracks shall be as shown in Figure 6.

8.2 TFC.5-specific stripe requirements

When all four tracks are used, the position of the magnetic stripe shall be as shown in Figure 8.



a = 5,39 mm; *b* = 19,68 mm

Figure 8 — Stripe position and height for four tracks

8.3 Encoding characteristics

8.3.1 Encoded data

All four tracks are designated for read and write functions.

8.3.2 Encoding method and encoding density

Tracks on TFC.5 cards shall be encoded using the F/2F encoding method (see Annex B), at 3 bits/mm, 6 bits/mm or 8,3 bits/mm. It is permitted to used different densities for different tracks on the same card.

8.3.3 Encoding zones

Stripe areas within 2,9 mm of either edge of the card, or within 1,5 mm of perforation lines A and C, are not included in the encoding zones and may be filled with zeroes. Within the two remaining zones, corresponding to part 1 and part 2 of the card (see ISO/IEC 15457-1), the message shall be encoded with its start nearest the reference edge of the card.

The content of each encoding zone shall be as follows.

— Part 1: The application data shall be preceded and followed by at least 21 zero bits for synchronisation purposes.

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— Part 2: The application data shall be preceded and followed by at least 21 zero bits for synchronisation purposes.

Where a stub exists it shall be filled with zero bits or direct current erased.

Optionally, the portions of the track designated as the maximum usable bits zone may be divided into multiple independent encoding zones called “blocks”. Where such independent blocks are written within this area, each shall have its own leading and trailing zeroes.

NOTE The encoding of independent blocks may cause spurious readback signals to be written in the gap between the blocks.

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Annex A
(normative)

Magnetics classes

This annex specifies the magnetic characteristics of magnetic stripes which are designated, in the ISO/IEC 15457 classification scheme, as classes S, L, and H.

Class S is defined purely in support of existing applications and should not be used for new applications.

A.1 Signal amplitude requirements

A.1.1 New, unused unencoded cards

The requirements for signal amplitude characteristics of new, unused, unencoded magnetic stripes shall be as shown in Table A.1.

Table A.1 — Signal and noise requirements

Symbol(1)	Test density(2)	Test current(2)	Class S	Class L	Class H
U_{A1}	D_{min}	I_{min}	$0{,}4\ U_R \leqslant U_{A1}$ $U_{A1} \leqslant 0{,}65\ U_R$	$0{,}8\ U_R \leqslant U_{A1}$ $U_{A1} \leqslant 1{,}3\ U_R$	$0{,}8\ U_R \leqslant U_{A1}$ $U_{A1} \leqslant 1{,}2\ U_R$
U_{i1}	D_{min}	I_{min}	$U_{i1} \leqslant 0{,}7\ U_R$	$U_{i1} \leqslant 1{,}36\ U_R$	$U_{i1} \leqslant 1{,}26\ U_R$
U_{A2}	D_{min}	I_{max}	$0{,}4\ U_R \leqslant U_{A2}$	$0{,}8\ U_R \leqslant U_{A2}$	$0{,}8\ U_R \leqslant U_{A2}$
U_{A3}	D_{max}	I_{max}	$0{,}7\ U_{A2} \leqslant U_{A3}$	$0{,}7\ U_{A2} \leqslant U_{A3}$	$0{,}7\ U_{A2} \leqslant U_{A3}$
U_{i2}	D_{max}	I_{max}	$0{,}33\ U_R \leqslant U_{i2}$	$0{,}65\ U_R \leqslant U_{i2}$	$0{,}65\ U_R \leqslant U_{i2}$
M (3)	D_{max}	I_{max}	$\leqslant 0{,}15$	$\leqslant 0{,}15$	$\leqslant 0{,}15$
U_{A4}	0 (dc)	I_{min}	$U_{A4} \leqslant 0{,}02\ U_R$	$U_{A4} \leqslant 0{,}03\ U_R$	$U_{A4} \leqslant 0{,}03\ U_R$
U_{i4}	0 (dc)	I_{min}	$U_{i4} \leqslant 0{,}03\ U_R$	$U_{i4} \leqslant 0{,}05\ U_R$	$U_{i4} \leqslant 0{,}05\ U_R$
U_{A5}	0 (dc)	I_d	not specified	not specified	$0{,}8\ U_R \leqslant U_{A5}$
U_{i5}	0 (dc)	I_d	not specified	not specified	$0{,}7\ U_R \leqslant U_{i5}$
U_{A6}	3 (75)	I_{max}	not specified	not specified	not specified
U_{i6} (4)	3 (75)	I_{max}	not specified	not specified	$U_{i6} \leqslant 0{,}07 U_{A6}$

The slope of the saturation curve shall not be positive between I_{min} and I_{max}.

(1) The measured quantities represented by *U* symbols are defined in clause 3 but this should be read in conjunction with the test methods (see ISO/IEC 15457-3) for a complete understanding.

(2) These quantities are defined in the test methods (see ISO/IEC 15457-3).

(3) This requirement may be applied if required by the application. It is additional to those which correspond to the requirements for ID-1 cards (see ISO/IEC 7811-2 and ISO/IEC 7811-6).

(4) This requirement applies only to plastic TFC substrates (see ISO/IEC 15457-1). For other substrates, it is recommended that a limiting value be agreed between supplier and customer.

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A.1.2 Unused, encoded cards

$0{,}64\ U_R \leqslant U_i \leqslant 1{,}36\ U_R$

NOTE This criterion may also be applied to re-usable cards on the point of re-issue following "refreshment" of their encoding.

A.1.3 Returned cards

$0{,}52\ U_R \leqslant U_i \leqslant 1{,}36\ U_R$

NOTE The requirements above specify the interchange signal amplitude limits for each of the encoded track locations at the specified bit densities. Signal amplitude requirements specified in Table A.1 reflect the magnetic media limits at the specified recording frequency and recording test currents.

A.2 Static magnetic characteristics

If the application demands specification of static characteristics of magnetic stripes, they shall be as shown in Table A.2 or, for more demanding applications, as shown in Annex D of ISO/IEC 7811-6:2001.

Table A.2 — Static magnetic characteristics

Quantity(1)	Class S	Class L	Class H
Coercivity H_{cM} kA/m	19 – 22,5	22,5 – 32	200 – 335
Squareness SQ	$\geqslant 0{,}7$	$\geqslant 0{,}7$	$\geqslant 0{,}8$
Switching Field SF_D	$\leqslant 0{,}7$	$\leqslant 0{,}7$	$\leqslant 0{,}7$
Switching Field SF_S	not specified	not specified	$\leqslant 0{,}5$
(1) These quantities are open to different interpretations and will also vary in value under different conditions and method of measurement. To establish compliance with this standard, only the exact interpretations and conditions of measurement defined in ISO/IEC 15457-3 shall be used.			

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Annex B
(normative)

Encoding classes

This annex defines the magnetic encoding methods and characteristics specified for use on TFC magnetic stripes in the main body of this part of ISO/IEC 15457.

B.1 Encoding methods

One of the following methods of encoding shall be used on TFC stripes.

NOTE For new applications F/2F is recommended.

B.1.1 F/2F

An F/2F bitstream is constructed from an NRZ bitstream as follows:

— polarity reversals are inserted at the equally spaced bit boundaries;

— additional polarity reversals are inserted at the midpoint of each ‘1’ bit.

NOTE F/2F is polarity insensitive, i.e. the directions of the transitions have no significance.

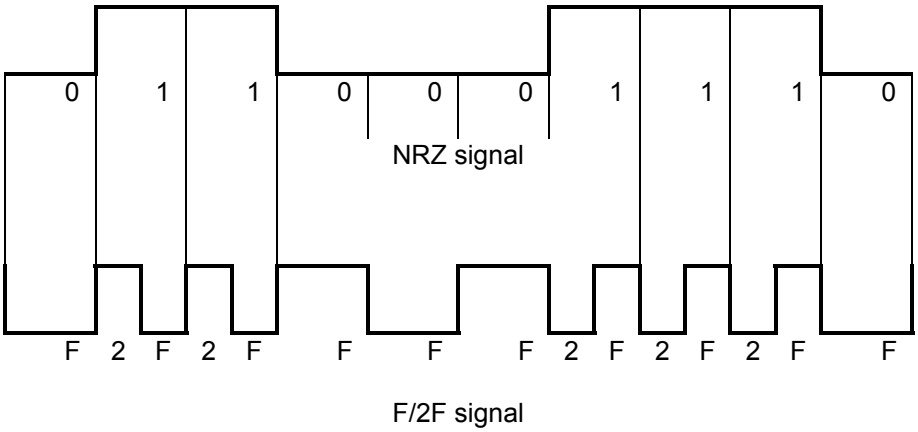


Figure B.1 — F/2F encoding

B.1.2 Split phase

A split phase bitstream is constructed from an NRZ bitstream as follows:

— equally spaced polarity reversals are inserted, one for each bit, with opposite polarity for ‘0’ and ‘1’ bits;

— additional polarity reversals are inserted as necessary midway between the ‘bit’ reversals.

NOTE Split phase is polarity sensitive, i.e. the directions of the transitions are significant.

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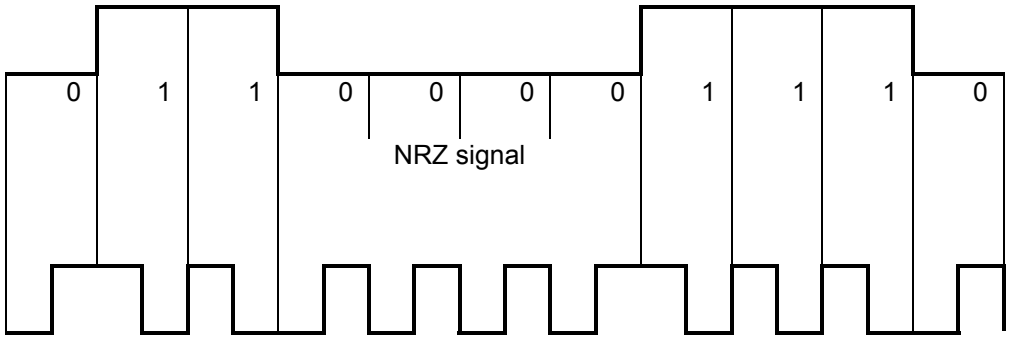


Figure B.2 — Split phase encoding

B.2 Encoding bit densities

TFC encoding bit densities shall be one of the following:

— 1,35 bits/mm (34 bits/in) ± 5 %;

— 3 bits/mm (75 bits/in) ± 5 %;

— 6 bits/mm (150 bits/in) ± 8 %;

— 8,3 bits/mm (210 bits.in) ± 8 %.

B.2.1 Transition angle

The encoded transitions shall be perpendicular to the widthways reference edge of the card to within the following tolerances:

— for 1,35 bits/mm average bit density: ± 1,3°;

— for 3 bits/mm average bit density: ± 0,8°;

— for 6 bits/mm average bit density: ± 0,5°;

— for 8,3 bits/mm average bit density: ± 0,5°.

B.2.2 Flux transition spacing

Flux transition spacing for 3 bits/mm shall conform to the requirements given in ISO/IEC 7811-2 (class L or class S) or ISO/IEC 7811-6 (class H) for track 2.

Flux transition spacing for 8,3 bits/mm shall conform to the requirements given in ISO/IEC 7811-2 (class L or class S) or ISO/IEC 7811-6 (class H) for track 3.

For nominal bit densities of 1,35 bits/mm and 6 bits/mm, the flux transition spacing variations shall be as shown in Table B.1 for unused encoded cards and in Table B.2 for returned cards.

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Table B.1 — Flux transition spacing variation for unused encoded cards

Term	Description	Requirement	Variation
B_a	Average length between clocking flux transitions	$0,95/D_R \leqslant B_a \leqslant 1,05/D_R$	± 5 %
B_{in}	Individual length between clocking flux transitions	$0,93/D_R \leqslant B_{in} \leqslant 1,07/D_R$	± 7 %
B_{in+1}	Adjacent bit-to-bit variation	$0,90B_{in} \leqslant B_{in+1} \leqslant 1,10B_{in}$	± 10 %
S_{in}	Subinterval length	$0,45/D_R \leqslant S_{in} \leqslant 0,55/D_R$	± 10 %
S_{in+1}	Adjacent subinterval length	$0,44B_{in} \leqslant S_{in+1} \leqslant 0,56B_{in}$	± 12 %
B_{in+1} or S_{in+1} is the length between flux transitions immediately following and adjacent to B_{in}.			

Table B.2 — Flux transition spacing variation for returned cards

Term	Description	Requirement	Variation
B_a	Average length between clocking flux transitions	$0,95/D_R \leqslant B_a \leqslant 1,05/D_R$	± 5 %
B_{in}	Individual length between clocking flux transitions	$0,85/D_R \leqslant B_{in} \leqslant 1,15/D_R$	± 15 %
B_{in+1}	Adjacent bit-to-bit variation	$0,85B_{in} \leqslant B_{in+1} \leqslant 1,15B_{in}$	± 15 %
S_{in}	Subinterval length	$0,40/D_R \leqslant S_{in} \leqslant 0,60/D_R$	± 20 %
S_{in+1}	Adjacent subinterval length	$0,35B_{in} \leqslant S_{in+1} \leqslant 0,65B_{in}$	± 30 %
B_{in+1} or S_{in+1} is the length between flux transitions immediately following and adjacent to B_{in}.			
NOTE This table shows only the limits within which cards will function normally and does not imply any guarantee of flux transition spacing during valid term for issued card.			

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Bibliography

[1] IEC 50(221), *International Electrotechnical Vocabulary — Chapter 221: Magnetic materials and components*

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