INTERNATIONAL STANDARD

ISO/IEC 9661

Second edition
1994-12-15

Information technology — Data interchange on 12,7 mm wide magnetic tape cartridges — 18 tracks, 1 491 data bytes per millimetre

Technologies de l'information — Échange de données sur cartouches de bande magnétique de 12,7 mm *de large — 18 pistes, 1 491 caractères par millimètre*

Reference number
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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. 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.

International Standard ISO/IEC 9661 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 11, *Flexible magnetic media for digital data interchange*.

This second edition cancels and replaces the first edition (ISO 9661:1988).

Annexes C, E, F and G form an integral part of this International Standard. Annexes A, B, D and H are for information only.

Information technology - Data interchange on 12,7 mm wide magnetic tape cartridges - 18 tracks, 1 491 data bytes per millimetre

Section 1 - General

1 Scope

This International Standard specifies the physical and magnetic characteristics of a 12,7 mm wide, 18-track magnetic tape cartridge to enable interchangeability of such cartridges. It also specifies the quality of the recorded signals, the format and recording method thus allowing, together with ISO 1001 for magnetic tape labelling, full data interchange by means of such magnetic tape cartridges.

2 Conformance

A magnetic tape cartridge shall be in conformance with this International Standard if it meets all mandatory requirements specified herein. The tape requirements shall be satisfied throughout the extent of the tape.

3 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 646:1991, *Information technology — ISO 7-bit coded character set for information interchange.*

ISO 683-13:1986, *Heat-treatable steels, alloy steels and free-cutting steels — Part 13: Wrought stainless steels.*

ISO 1001:1986, *Information processing — File structure and labelling of magnetic tapes for information interchange.*

ISO 1302:1992, *Technical drawings — Method of indicating surface texture.*

ISO/IEC 2022:1994, *Information technology — Character code structure and extension techniques.*

ISO/IEC 4873:1991, *Information technology — ISO 8-bit code for information interchange — Structure and rules for implementation.*

4 Definitions

For the purposes of this International Standard, the following definitions apply.

4.1 Average signal amplitude: The average peak-to-peak value of the signal output of the read head measured over a minimum of 25,4 mm of tape exclusive of missing pulses.

4.2 Back surface: The surface of the tape opposite the magnetic coating used to record data.

4.3 Beginning of Tape (BOT): The point along the length of the magnetic tape indicated by the start of the Density Identification Burst.

4.4 Byte: An ordered set of eight bits acted upon as a unit and recorded as a 9-bit pattern.

4.5 Cartridge: A container holding a supply reel of magnetic tape with an attached leader block.

4.6 Cyclic Redundancy Check character: A character represented by two bytes, placed at the end of a Data Block and used for error detection.

4.7 Data density: The number of 8-bit bytes stored per unit length of tape, expressed in bytes per millimetre.

4.8 Error Correcting Code: A mathematical procedure yielding bits used for the detection and correction of errors.

4.9 Flux transition position: That point which exhibits maximum free-space flux density normal to the tape surface.

4.10 Flux transition spacing: The distance along a track between successive flux transitions.

4.11 Magnetic tape: A tape which will accept and retain the magnetic signals intended for input, output and storage purposes on computers and associated equipment.

4.12 Master Standard Reference Tape: A tape selected as the standard for reference field, signal amplitude, resolution and overwrite.

Note - A Master Standard Reference Tape has been established at the National Institute for Standards and Technology (NIST) for this International Standard.

4.13 Physical recording density: The number of recorded flux transitions per unit length of track, expressed in flux transitions per millimetre (ftpmm).

4.14 Postamble: A repeated 9-bit pattern at the end of a recorded Data Block providing electronic synchronization when reading in the reverse direction.

4.15 Preamble: A repeated 9-bit pattern at the beginning of a recorded Data Block providing electronic synchronization when reading in the forward direction.

4.16 Reference field: The typical field of the Master Standard Reference Tape.

4.17 Secondary Standard Reference Tape: A tape the performance of which is known and stated in relation to that of the Master Standard Reference Tape.

Note - Secondary Standard Reference Tapes have been developed at the National Institute for Standards and Technology (NIST) and are available from the NIST Office of Standard Reference Materials, Room 205, Building 202, National Institute of Standards and Technology, Gaithersburg, MA 20899, USA, under reference number SRM 3202, until January 2004.
It is intended that these be used for calibrating tertiary reference tapes for use in routine calibration.

4.18 Standard reference amplitude: The average signal amplitude from the Master Standard Reference Tape when it is recorded with the test recording current on the NIST measurement system at 972 ftpmm.

Traceability to the standard reference amplitude is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

4.19 Standard reference current: The current that produces the reference field.

4.20 Test recording current: The current that is 1,5 times the standard reference current.

4.21 Track: A longitudinal area on the tape along which a series of magnetic signals may be recorded.

4.22 Typical field: In the plot of the average signal amplitude against the recording field at the physical recording density of 972 ftpmm, the minimum field that causes an average signal amplitude equal to 85 % of the maximum average signal amplitude.

5 Environment and safety

Unless otherwise stated, the conditions specified below refer to the ambient conditions in the test or computer room and not to those within the tape equipment.

5.1 Cartridge/Tape testing environment

Unless otherwise stated, tests and measurements made on the tape cartridge to check requirements of this International Standard shall be carried out under the following conditions:

temperature:	23 °C ± 2 °C
relative humidity:	40 % to 60 %
conditioning period before testing:	24 hours.

5.2 Cartridge operation environment

Cartridges used for data interchange shall be capable of operating under the following conditions:

temperature:	16 °C to 32 °C
relative humidity:	20 % to 80 %

wet bulb temperature:	25 °C max.

The average temperature of the air immediately surrounding the tape shall not exceed 40,5 °C.

Note - Localized tape temperatures in excess of 49 °C may cause tape damage.

Conditioning before operating: If a cartridge has been exposed during storage and/or transportation to conditions outside the above values, it shall be conditioned for a period of at least 24 hours.

5.3 Cartridge storage environment

Cartridges used for data interchange shall be stored under the following conditions.

temperature:	5 °C to 32 °C
relative humidity:	5 % to 80 %
wet bulb temperature:	26 °C max.

5.4 Safety requirements

5.4.1 Safety

The cartridge and its components shall not constitute any safety or health hazard when used in its intended manner or in any foreseeable misuse in an information processing system.

5.4.2 Flammability

The cartridge and its components shall be made from materials which, if ignited from a match flame, do not continue to burn in a still carbon dioxide atmosphere.

5.5 Transportation

This International Standard does not specify parameters for the environment in which cartridges should be transported. Annex A gives some recommendations for transportation.

Section 2 - Tape requirements

6 Characteristics of the tape

6.1 Material

The tape shall consist of a base material (oriented polyethylene terephthalate film or its equivalent) coated on one side with a strong, yet flexible layer of ferromagnetic material dispersed in a suitable binder. The back surface of the tape may also be coated with a ferromagnetic or non-ferromagnetic material.

6.2 Tape length

The length of the tape shall not be less than 165 m.

6.3 Tape width

The width of the tape shall be 12,650 mm ± 0,025 mm. The width shall be measured across the tape from edge-to-edge when the tape is under a tension of less than 0,28 N.

6.4 Tape discontinuity

There shall be no discontinuities in the tape such as those produced by tape splicing or perforations.

6.5 Total thickness of tape

The total thickness of the tape at any point shall be between 0,0259 mm and 0,0337 mm.

6.6 Base material thickness

The thickness of the base material shall be 0,0234 mm nominal.

6.7 Longitudinal curvature

The radius of curvature of the edge of the tape shall not be less than 33 m.

Procedure

Allow a length of tape of 1 m to unroll and assume its natural curvature on a flat smooth surface. Measure the deviation from a 1 m chord. The deviation shall not be greater than 3,8 mm. This deviation corresponds to the minimum radius of curvature of 33 m if measured over an arc of circle.

6.8 Out-of-plane distortions

All visual evidence of out-of-plane distortion shall be removed when the tape is subjected to a uniform tension of 0,6 N. Out-of-plane distortions are local deformations which cause portions of the tape to deviate from the plane of the surface of the tape. Out-of-plane distortions are most readily observed when the tape is lying on a flat surface under no tension.

6.9 Cupping

The departure across the width of tape from a flat surface shall not exceed 0,3 mm.

Procedure

Cut a length of tape of 1,0 m ± 0,1 m . Condition it for a minimum of 3 hours in the test environment by hanging it so that the coated surface is freely exposed to the test environment. From the centre portion of the conditioned tape cut a test piece of length 25 mm. Stand the test piece on its end in a cylinder which is at least 25 mm high with an inside diameter of 13,0 mm ± 0,2 mm. With the cylinder standing on an optical comparator measure the cupping by aligning the edges of the sample to the reticle and determining the distance from the aligned edges to the corresponding surface of the test piece at its centre.

6.10 Dynamic frictional characteristics

In the tests of 6.10.1 and 6.10.2 the specified forces of 1,0 N and 1,50 N, respectively, comprise both the force component of the dynamic friction and the force of 0,64 N applied to the test piece of tape.

NOTE - Particular attention should be given to keeping the surfaces clean.

6.10.1 Frictional drag between the recording surface and the tape back surface

The force required to move the recording surface in relation to the back surface shall not be less than 1,0 N.

Procedure

i) Wrap a test piece of tape around a 25,4 mm diameter circular mandrel with the back surface of the test piece facing outward.

ii) Place a second test piece of tape, with the recording surface facing in, around the first test piece for a total angle of wrap of 90°.

iii) Apply a force of 0,64 N to one end of the outer test piece of tape. Secure its other end to a force gauge which is mounted on a motorized linear slide.

iv) Drive the slide at a speed of 1 mm/s.

6.10.2 Frictional drag between the tape recording surface and ferrite after environmental cycling

The force required to move the tape at a point 1,34 m from the leader block of the cartridge shall not be greater than 1,50 N. The force required at a point 4,3 m from the junction of the tape with the cartridge hub shall not exceed the first force by more than a factor of 4.

Procedure

i) Wind tape on to a spool hub of diameter 50 mm to an outside diameter of 97 mm with a winding tension of 2,2 N ± 0,2 N.

ii) Repeat the following two steps five times:

   a) Store for 48 hours at a temperature of 50 °C and a relative humidity of 10 % to 20 %.

   b) Acclimatize in the testing environment for 2 hours and rewind with a tension of 2,2 N ± 0,2 N.

iii) Condition the tape for 48 hours at a temperature of 30,5 °C and a relative humidity of 85 %. The tape shall remain in this environment for steps iv) and v).

iv) Apply a force of 0,64 N to one end of a test piece of tape of not more than 1 m, taken 1,34 m from the leader block. Pass the test piece over a ferrite rod of diameter 25,4 mm with the recording surface in contact with the rod for a total angle of wrap of 90°.

The rod shall be made from the ferrite specified in annex C. It shall be polished to a roughness value r_a of 0,05 µm (roughness grade N2, ISO 1302). Pull the other end of the test piece horizontally at 1 mm/s.

v) Repeat step iv) for a similar test piece taken 4,3 m from the junction of the tape with the cartridge hub.

6.11 Coating adhesion

The force required to peel any part of the coating from the tape base material shall not be less than 1,5 N.

Procedure

i) Take a test piece of the tape approximately 380 mm long and scribe a line through the recording coating across the width of the tape 125 mm from one end.

ii) Using a double-sided pressure sensitive tape, attach the full width of the test piece to a smooth metal piece plate, with the recording surface facing the plate, as shown in the figure below.

iii) Fold the test piece over 180°, attach the metal plate and the free end of the test piece to the jaws of a universal testing machine and set the speed of the jaw separation to 254 mm per min.

iv) Note the force at which any part of the coating first separates from the base material. If this is less than 1,5 N, the test has failed. If the test piece peels away from the double-sided pressure sensitive tape before the force exceeds 1,5 N, an alternative type of double-sided pressure sensitive tape shall be used.

v) If the back surface of the tape is coated, repeat i) to iv) for the back coating.

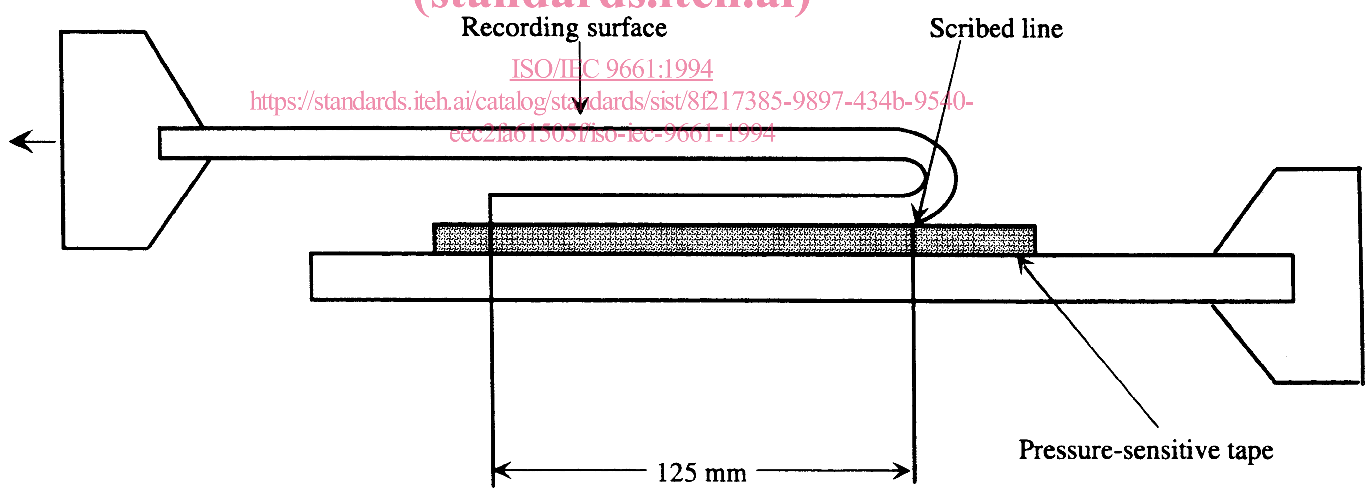


Figure 1 - Coating adhesion

6.12 Flexural rigidity

The flexural rigidity of the tape in the longitudinal direction shall be between 0,06 N·mm^2 and 0,16 N·mm^2.

Procedure

Clamp a 180 mm test piece of tape in a universal testing machine, allowing a 100 mm separation between the machine jaws. Set the jaw separation speed at 5 mm per minute. Plot force against distance. Calculate the flexural rigidity using the slope of the curve between 2,2 N and 6,7 N by the formula:

$$E = \frac{dF / WT}{dL / L}$$

$$I = WT^3 / 12$$

Flexural rigidity $= EI$

where :

δF = change in force in N

T = measured thickness in mm

W = measured width in mm

$\delta L/L$ = change in lenght of test piece between the jaws divided by the original length between the jaws.

6.13 Electrical resistance of coated surfaces

The electrical resistance of any square area of the recording surface shall be within the range:

- $10^5\ \Omega$ to $5 \times 10^8\ \Omega$ for non-backcoated tapes;
- $10^5\ \Omega$ to $5 \times 10^9\ \Omega$ for backcoated tapes.

The electrical resistance of any backcoating shall be less than $10^6\ \Omega$.

Procedure

Condition a test piece of tape to the test environment for 24 hours. Position the test piece over two 24-carat gold-plated, semi-circular electrodes having a radius r = 25,4 mm and a finish of at least N4, so that the recording surface is in contact with each electrode. These electrodes shall be placed parallel to the ground and parallel to each other at a distance d = 12,7 mm between their centres. Apply a force F of 1,62 N to each end of the test piece. Apply a d.c. voltage of 500 V ± 10 V across the electrodes and measure the resulting current flow. From this value, determine the electrical resistance.

Repeat for a total of five positions along the test piece and average the five resistance readings. For back-coated tape repeat the procedure with the backcoating in contact with the electrodes.

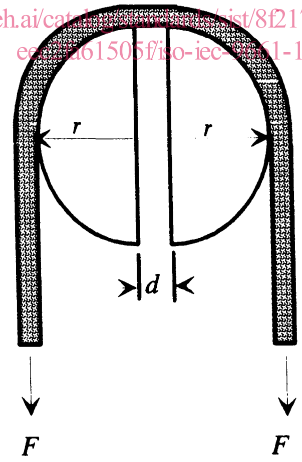


Figure 2 - Position of test piece over two semi-circular electrodes

When mounting the test piece, make sure that no conducting paths exist between the electrodes except that through the coating under test.

Note - Particular attention should be given to keeping the surfaces clean.

6.14 Tape durability

This International Standard does not specify parameters for assessing tape durability.

However, a recommended procedure is described in annex D.

6.15 Inhibitor tape

This International Standard does not specify parameters for assessing whether or not a tape is an inhibitor tape.

However, annex B gives further information on inhibitor tapes.

6.16 Tape abrasivity

Tape abrasivity is the tendency of the tape to wear the tape transport. The length of the wear pattern on a wear bar shall not exceed 56 µm when measured as specified in annex C.

6.17 Pre-recording condition

Prior to recording data or to testing, the tape shall have been erased using alternating magnetic fields of decaying levels (anhysteretic process) to ensure that the remanent magnetic moment of the recording surface does not exceed 20 % of the maximum remanent magnetic moment. Annex E specifies the method of measurement.

In addition no low density transitions shall be present on the tape.

6.18 Magnetic recording characteristics

The magnetic recording characteristics shall be as defined by the testing requirements given below.

When performing these tests, the output or resultant signal shall be measured on the same relative pass for both a tape calibrated to the Master Standard Reference Tape and the tape under test (read-while-write or first forward-read-pass) on the same equipment.

The following conditions shall apply to the testing of all magnetic recording characteristics, unless otherwise stated:

- tape condition : pre-recording condition
- tape speed : not greater than 2,5 m/s
- read-track : within the written track
- azimuth alignment : not greater than 6' between the mean write transitions and the read gap
- write-gap length : 1,4 µm ± 0,2 µm
- write head saturation density : 0,34 T ± 0,03 T
- tape tension : 2,2 N ± 0,2 N
- recording current : test recording current

6.18.1 Typical field

The typical field of the tape shall be between 90 % and 110 % of the reference field.

Traceability to the reference field is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

6.18.2 Signal amplitude

The average signal amplitude at the physical recording density of 972 ftpmm shall be between 70 % and 140 % of the standard reference amplitude.

Traceability to the standard reference amplitude is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

6.18.3 Resolution

The ratio of the average signal amplitude at the physical recording density of 1 458 ftpmm to that at the physical recording density of 972 ftpmm shall be between 80 % and 120 % of the same ratio for the Master Standard Reference Tape.

Traceability to the resolution of the Master Standard Reference Tape is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

6.18.4 Overwrite

Overwrite is the ratio of the average signal amplitude of the residual of the fundamental frequency of a tone pattern after being overwritten at 972 ftpmm to the average signal amplitude of the 972 ftpmm signal. The average signal amplitude of the tone pattern is the peak-to-peak amplitude of the sinusoidal signal with equal rms power.

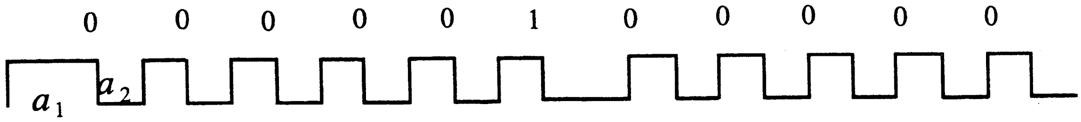
6.18.4.1 Requirement

The overwrite for the tape shall be less than 120 % of the overwrite for the Master Standard Reference Tape.

Traceability to the overwrite of the Master Standard Reference Tape is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

Procedure

Record a tone pattern which shall be the following sequence of flux transitions:



where: a_1 = 1,029 µm
a_2 = 0,514 µm

Record a 972 ftpmm signal over the tone pattern. Measure the average signal amplitude of the residual of the fundamental frequency of the tone pattern (one sixth of the frequency of the 972 ftpmm signal) and the average signal amplitude of the 972 ftpmm signal. Both amplitude measurements should be made using suitable filters.

6.18.5 Narrow-Band Signal-to-Noise Ratio (NB-SNR)

The narrow-band signal-to-noise ratio is the average signal amplitude rms power divided by the average integrated (side band) rms noise power, and is expressed in dB.

6.18.5.1 Requirement

The NB-SNR ratio shall be equal to, or greater than, 30 dB when normalized to a track width of 410 µm. The normalization factor is dB(410) = dB(W) + 10 log 410/W, where W is the track width used when measuring dB(W).

6.18.5.2 Procedure

The NB-SNR ratio shall be measured using a spectrum analyzer with a resolution bandwidth (RBW) of 1 kHz and a video bandwidth (VBW) of 10 Hz. The tape speed shall be 762 mm/s for the frequencies specified below.

The NB-SNR ratio shall be measured as follows:

i) Measure the read-signal amplitude of the 972 ftpmm signal, taking a minimum of 150 samples over a minimum length of tape of 46 m.

ii) On the next pass (read only) measure the rms noise power over the same section of tape and integrate the rms noise power (normalizing for the actual resolution bandwidth) over the range from 332 kHz to 366 kHz.

For other tape speeds all the frequencies shall be linearly scaled.

6.19 Tape quality

The tape quality (including the effects of exposure to storage and transportation environments) is defined by the testing requirements given in the following clauses. The following conditions shall apply to all quality testing requirements:

– environment	: operating environment
– tape condition	: pre-recording condition
– tape speed	: 2 m/s
– read-track width	: 410 µm
– physical recording density	: 972 ftpmm
– write-gap length	: 1,4 µm ± 0,2 µm
– azimuth alignment	: not greater than 6' between the mean write transitions and the read gap
– write head saturation density	: 0,34 T ± 0,03 T
– recording current	: test recording current
– format	: 18 tracks
– tape tension	: 2,2 N ± 0,2 N

6.19.1 Missing pulses

A missing pulse is a loss of read signal amplitude. A missing pulse exists when the base-to-peak read signal amplitude is 25 %, or less, of half the average signal amplitude for the preceding 25,4 mm of tape.

6.19.2 Missing pulse zones

A missing pulse zone begins with a missing pulse and ends when 64 consecutive flux transitions are detected or a length of 1 mm of tape has been measured.

The missing pulse zone rate shall be less than one in 8 x 10^6 flux transitions recorded.

6.19.3 Coincident missing pulse zones

There are two 9-track groups in the 18-track format. One group comprises the odd-numbered tracks, the other group comprises the even-numbered tracks. A simultaneous missing pulse zone condition on two or more tracks of a 9-track group is a coincident missing pulse zone.

If a coincident missing pulse zone occurs at the same time in both groups of tracks, it shall be considered as a single coincident missing pulse zone. Its length shall begin with the start of the earliest coincident missing pulse zone and terminate with the end of the latest coincident missing pulse zone.

No 165 m length of tape shall have more than 12 coincident missing pulse zones.

No coincident missing pulse zone shall exceed 50 mm.

Section 3 - Cartridge requirements

7 Dimensional and mechanical characteristics of the cartridge

The cartridge shall consist of the following elements:

- a case;
- a reel for the magnetic tape;
- a magnetic tape wound on the hub of the reel;
- a locking mechanism for the reel;
- a write-inhibit mechanism;
- a leader block;
- a latching mechanism for the leader block.

Dimensional characteristics are specified for those parameters deemed mandatory for interchange and compatible use of the cartridge. Where there is freedom of design, only the functional characteristics of the elements described are indicated. In the figures a typical implementation is presented. Third angle projection is used.

Where they are purely descriptive the dimensions are referred to three reference surfaces A, B and C forming a geometrical trihedral (see figure 3). Where the dimensions are related to the position of the cartridge in the drive, they may be referred to another surface of the cartridge. Figure 4 to 11 show the dimensions of the empty case.

Figure 3	is a general view of the whole cartridge;
Figure 4	shows the front side of the case which lies on reference surface A;
Figure 5	shows the top side of the case;
Figure 6	shows the rear side of the case;
Figure 7	shows the bottom side of the case which lies in reference surface C;
Figure 8	shows the side of the case which lies in reference surface B;
Figure 9	shows an enlarged view of a part of figure 4;
Figure 10	shows an enlarged cross-section of a location notch;
Figure 11	shows an enlarged cross-section of a detail of the opening of the case;
Figure 12	shows an enlarged partial cross-section of the cartridge in hand;
Figure 13	shows the same cross-section as figure 12 but of the cartridge in the drive;
Figure 14	shows schematically the teeth of the toothed rim;
Figure 15	shows two views and an enlarged cross-section of the leader block;
Figure 16	shows the fixation of the tape to the leader block, and
Figure 17	shows the leader block inserted in the case.