
International Standard **ISO** 3407



3407

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Information processing — Information interchange on 3,81 mm (0.150 in) magnetic tape cassette at 4 cpmm (100 cpi), phase encoded at 63 ftpmm (1 600 ftpi)

Traitement de l'information — Échange d'information sur cassette de bande magnétique de 3,81 mm (0,150 in) à 4 cpmm (100 cpi), enregistrée par codage de phase à 63 ftpmm (1 600 ftpi)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3407 was developed by Technical Committee ISO/TC 97, *Information-processing systems*.

This second edition was submitted directly to the ISO Council, in accordance with clause 6.11.2 of part 1 of the Directives for the technical work of ISO. It cancels and replaces the first edition (i.e. ISO 3407-1976), which had been approved by the member bodies of the following countries:

Australia	Netherlands	Turkey
Bulgaria	New Zealand	United Kingdom
Czechoslovakia	Poland	USA
France	Portugal	USSR
Germany, F.R.	Romania	Yugoslavia
Hungary	Spain	
Italy	Switzerland	

The member bodies of the following countries had expressed disapproval of the document on technical grounds:

Belgium
Japan

Information processing — Information interchange on 3,81 mm (0.150 in) magnetic tape cassette at 4 cpmm (100 cpi), phase encoded at 63 ftpmm (1 600 ftpi)

1 Scope and field of application

This International Standard specifies the characteristics of a 3,81 mm (0.150 in) magnetic tape cassette to provide data interchange and physical interchangeability between information processing systems utilizing the ISO 7-bit coded character set (see ISO 646) and, where required, its extensions (see ISO 2022). The cassette is of the twin hub coplanar type, loaded with a 3,81 mm (0.150 in) wide magnetic tape for digital recording using the 31,5 bits per mm (800 bpi) phase encoding method. The direction of magnetization is in the longitudinal direction of the tape.

NOTES

1 Numeric values in the SI and/or Imperial measurement system in this International Standard may have been rounded, and are therefore consistent with, but not exactly equal to each other. Either system may be used, but the two should be neither intermixed nor converted. The original design was made using the metric measurement system.

2 Throughout the remainder of this International Standard for the sake of simplicity the recording density is stated as 32 bpmm (800 bpi) nominal.

This International Standard applies to cassettes and data used for interchange. Where it applies for testing only, this is specifically stated.

2 References

ISO 646, *Information processing — 7-bit coded character set for information interchange.*

ISO 2022, *Information processing — ISO 7-bit and 8-bit coded character set — Code extension techniques.*

3 Definitions

For the purpose of this International Standard, the following definitions apply:

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

3.2 reference tape cassette: A tape cassette which has been selected for given properties for use in calibration.

3.3 secondary reference tape cassette: A tape cassette intended for routine calibrating purposes, whose performance is known and stated in relation to that of the reference tape cassette.

3.4 reference field: For the specified packing density (see 5.2), the minimum field applied to the signal amplitude reference tape cassette which causes an output signal equal to 95 % of the maximum output.

3.5 test recording current: A recording current between 145 % and 155 % of the current required to produce the reference field.

3.6 signal amplitude reference tape cassette: A reference tape cassette selected as a standard for signal amplitude.

NOTE — A master standard (computer amplitude reference), based on reference tape cassettes and heads, has been established as the result of work by national standardization organizations and national laboratories, coordinated by the U.S. National Bureau of Standards (NBS).

Secondary signal amplitude reference tape cassettes, certified by the National Bureau of Standards, Gaithersburg, Maryland, USA, and the Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany, are available.

NBS certified cassettes are available directly from NBS under the part number SRM 1600. PTB certified cassettes are available through the European Computer Manufacturers Association (ECMA), 114, rue du Rhône, CH—1204 Geneva, Switzerland.

The calibration devices are correlated between NBS and PTB.

3.7 standard reference amplitude: The average peak-to-peak signal amplitude derived from the signal amplitude reference tape cassette, at the density of 63 ftpmm (1 600 ftpi) using the test recording current (see 3.5). The signal amplitude shall be averaged over 4 000 flux transitions.

3.8 average signal amplitude: The average peak-to-peak value of the signal output measured over at least 4 000 flux transitions.

3.9 in contact: An operating condition in which the magnetic surface of a tape is in contact with a magnetic head.

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

3.11 bit density: The number of bit flux transitions per unit length of track.

3.12 position of flux transitions: That point which exhibits the maximum free-space flux density normal to the tape surface.

3.13 leader: Non-magnetic transparent tapes joined to each end of the magnetic tape.

3.14 erasing field: A unidirectional field of sufficient strength to remove the signals from the tape.

3.15 print through: Any unwanted signals induced in one layer of tape by the field of a deliberately recorded signal in an adjacent layer or layers.

3.16 reference alignment cassette: A cassette containing tape on which continuous information has been recorded where the optimum playback head gap alignment does not differ by more than $\pm 3'$ from the vertical on the cassette support plane. [Currently, these cassettes are available with wavelengths of 7,5 μm (265 μin) and 4,75 μm (187 μin), and with longer wavelengths.]

3.17 typical field: The minimum field characteristic of each tape, which, when applied to the tape under test, causes a signal output equal to 95 % of the maximum signal output at the specified test packing density.

3.18 resistance per square: The surface resistance of a square area of any size, measured between electrodes placed on two opposite sides of the square. The unit of measurement is the ohm.

4 Environment and transportation

4.1 Testing environment

Tests and measurements made on the cassette to check the requirements of this International Standard shall be carried out under the following conditions:

temperature: 23 ± 2 °C (73 ± 5 °F);

relative humidity: 40 to 60 %;

conditioning before testing: 24 h minimum.

4.2 Operating environment

Cassettes used for data interchange shall be operated under the following conditions:

temperature: 10 to 45 °C (50 to 113 °F);

relative humidity: 20 to 80 %;

wet bulb temperature: less than 26 °C (79 °F).

The temperature shall be measured in the air immediately surrounding the cassette. Rapid temperature variations should be avoided. There shall be no deposit of moisture on or in the cassette.

4.3 Transportation and storage environment

During transportation and storage, it is recommended that recorded cassettes are kept within the following conditions:

temperature: 4 to 50 °C (40 to 122 °F);

relative humidity: 20 to 80 %;

NOTE — Cassettes which have been exposed to temperatures exceeding the storage temperature range may exhibit degraded performance characteristics. Such cassettes should be subjected to a conditioning period of not less than 24 h within the operating environment prior to use.

4.4 Transportation

Responsibility for ensuring that adequate precautions are taken during shipment shall be with the sender. During transport, the reels of tapes shall be blocked to prevent any tendency to unwind. For transport, a rigid container free from dust or extraneous matter shall be used. The final package must have a clean interior and construction, preventing ingress of dust and water. It is recommended that a space of not less than 80 mm (3.15 in) exists between cassette and outer surface of the final container so that risk of damage due to stray magnetic fields will be negligible.

5 Characteristics of tape

The tape shall consist of a base material (for example 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 magnetic tape shall be continuous and splice-free. Tape or cassette components which will ignite from a match flame and when so ignited will continue to burn in a still carbon dioxide atmosphere shall not be used.

5.1 Mechanical properties

5.1.1 Tape and leader width and tolerance

The width of tape and leader shall be:

$$3,81 - \begin{matrix} 0 \\ 0,05 \end{matrix} \text{ mm} \quad (0,150 - \begin{matrix} 0 \\ 0,002 \end{matrix} \text{ in})$$

5.1.2 Tape and leader length

5.1.2.1 Tape length

The length of the splice-free tape shall be:

$$86 + \begin{matrix} 4 \\ 0 \end{matrix} \text{ m} \quad (282 + \begin{matrix} 13 \\ 0 \end{matrix} \text{ ft})$$

5.1.2.2 Leader length

The length of the leader tape shall be such that the distance from the cassette face to the beginning of the magnetic tape is 500 ± 50 mm (19.68 ± 2.0 in) when the leader tape is pulled out of the cassette through the opening nearest to the empty reel.

5.1.3 Tape and leader thickness

5.1.3.1 Thickness of tape

The overall thickness of tape (including coating) shall be maximum 19 μm (750 μin), minimum 15 μm (600 μin), with a coating thickness of $5 \pm 1 \mu\text{m}$ ($200 \pm 40 \mu\text{in}$).

5.1.3.2 Thickness of leader

The thickness of the leader shall be 38 μm (1 500 μin) maximum and 28 μm (1 100 μin) minimum.

5.1.4 Markers

5.1.4.1 The magnetic tape shall be provided with a beginning-of-tape and an end-of-tape marker (BOT and EOT).

5.1.4.2 The markers shall be circular holes having a diameter of $0,60 \pm 0,05 \text{ mm}$ ($0.023 7 \pm 0.002 0 \text{ in}$).

5.1.4.3 The distance of the marker centres from the physical beginning and end of the magnetic tape (for BOT and EOT respectively) shall be $450 \pm 30 \text{ mm}$ ($17.7 \pm 1.2 \text{ in}$). The distance between tape centre line and marker centre line shall be less than 0,1 mm (0.003 9 in).

5.1.5 Light transmittance

5.1.5.1 Light transmittance of tape

The tape and the splicing tape shall each have a light transmittance of less than 1 % measured according to annex B.

5.1.5.2 Light transmittance of leader.

The leader tape shall transmit 75 % or more light, measured according to annex B.

5.1.6 Elastoplastic properties

5.1.6.1 The elastic properties of the tape shall be such that when subjected to a tension of 0,5 N (0.112 lbf) for a period of 3 min under any combination of temperature and relative humidity within the ranges given in 4.1, the elongation shall be between 0,08 and 0,50 %.

5.1.6.2 The elastoplastic properties of the tape shall be such that when subjected to a tension of 3 N (0.67 lbf) for a period of 3 min under temperature and humidity conditions as given in 4.1, the (permanent) elongation measured with negligible tension after a second 3 min interval shall be less than 1 %.

5.1.6.3 The elastic properties of the tape shall be such that its tensile yield force, defined as the force required to elongate a sample by 3 %, shall be at least 4,5 N (1.01 lbf).

Procedure: Use a static weighing constant rate of grip separation tester capable of indicating the load to an accuracy of $\pm 2 \%$. Clamp a specimen of tape at least 180 mm (7 in) in

length with an initial 100 mm (4 in) separation between jaws. Elongate the specimen at a rate of 50 mm (2 in) per minute until minimum elongation of 10 % is reached. The force required to produce an elongation of 3 % is the tensile yield force.

5.1.6.4 The elastic properties of the leader shall be such that when subjected to a tension of 1,0 N (0.225 lbf) for a period of 3 min, under temperature and humidity conditions as specified in 4.1 the elongation shall be between 0,08 and 0,50 %.

5.1.7 Longitudinal curvature

There shall be a minimum radius of curvature for the edge of the tape, defined and tested by allowing a 1 m (39 in) length of tape to unroll and assume its natural curvature on a flat surface. The minimum radius shall be 33 m (108 ft) which, if measured over an arc of a circle, corresponds to a deviation of 3,8 mm from a 1 m chord (0.150 in from a 39 in chord).

5.1.8 Tape-to-leader connection

5.1.8.1 Dimensions

If a splicing tape is used it shall not extend more than 18 mm (0.71 in), from the splice between leader and tape and shall not overlap the edges of the leader or tape. No overlap is permitted between leader and tape and any gap shall not exceed 0,5 mm (0.02 in). The thickness of the splicing tape shall be 50 μm (0.002 in) maximum.

5.1.8.2 Tape-to-leader alignment

At the area of the splice, there shall be no lateral discontinuity greater than 50 μm (0.002 in).

5.1.8.3 Strength

After being subjected to a longitudinal static force of 2 N (0.45 lbf) for 24 h under the conditions of 4.2, the connection shall meet the requirements given in 5.1.8.1.

5.1.9 Tensile strength

The tape shall be suitable for use with instruments applying a maximum continuous load of 2 N (0.45 lbf), provided that the requirements of 7.8 are met.

5.1.10 Layer-to-layer adhesion

Layer-to-layer adhesion shall be sufficiently low to meet the test given in annex A.

5.2 Tests of magnetic properties

The magnetic properties of the tape are defined by the testing requirements given below.

5.2.1 Test density

Tape shall be tested at 63 ftpmm (1 600 ftpi) nominal.

5.2.2 Typical field

The typical field of the tape under test shall be within $\pm 20\%$ of the reference field.

5.2.3 Average signal amplitude

When a tape has been recorded with the test recording current, then played back on a system which has been calibrated by means of a signal amplitude reference tape cassette recorded under the same conditions, the average signal amplitude of the tape under test shall be within $\pm \frac{25}{10}\%$ of the standard reference amplitude. When performing this test, the output signal shall be measured on the same relative pass for both tapes; i.e. read-while-write or read-on-first-pass-after-write.

5.2.4 Ease of erasure

When a tape has been recorded with the test recording current, and then passed through a longitudinal steady erasure field of 79 500 A/m (1 000 Oe) the average signal amplitude of the remaining unwanted signal shall not exceed 3 % of the standard reference amplitude. The erasure field shall be reasonably uniform, for example the field in the middle of a solenoid. This measurement shall be made with a band pass filter passing at least the first three harmonics.

5.2.5 Test for drop-outs and drop-ins

These tests shall be carried out in the "in contact" condition and over the entire usable recording area which shall, in length, extend from 350 mm (13.8 in) before the BOT-marker to 350 mm (13.8 in) beyond the EOT-marker, and in width over the track widths as defined in 8.2.

When performing these tests, the output signal shall be measured on the same relative pass for both the signal amplitude reference tape cassette and the tape under test; i.e. read-while-write or read-on-first-pass-after-write.

5.2.5.1 Drop-outs

When a tape has been recorded with the test recording current, any playback signal, when measured base-to-peak, which is less than 50 % of half the standard reference amplitude is considered a drop-out.

5.2.5.2 Drop-ins

When a tape has been recorded with a constant recording current equivalent to the test recording current, any playback signal, when measured base-to-peak, which exceeds 10 % of half the standard reference amplitude is considered a drop-in.

5.2.6 Rejected region

A rejected region is an area of tape extending across the width of either track and not more than 10 mm (0.4 in) in length, which on two consecutive tests exhibits drop-outs or drop-ins.

The acceptable number of rejected regions in an interchange environment is a matter of agreement between interchange parties.

5.2.7 Print-through

A tape for testing shall be written with a suitable pattern using the test recording current rewound and stored for a minimum of 16 h at 60 °C (140 °F). At the end of this period the measured print-through signal shall not exceed 2 % of the standard reference amplitude. As the decay of the print-through signal on a section of tape is extremely rapid after it has been removed from the coil, the time elapsing between the tape leaving the coil and its passing over the test read head shall not exceed 500 ms.

5.3 Electrical surface resistance

The surface resistance of the tape shall not exceed $10^9 \Omega/\text{square}$.

6 Tape cassette

6.1 Identification of cassette sides

6.1.1 The cassette has its two sides distinguished and labelled "A" and "B", respectively, corresponding to tracks No. 1 and No. 2 (see figure 1).

6.1.2 The back surface is provided with two holes whose minimum area, depth and section are indicated in figure 1. Writing on a track is enabled by closing the outer surface of the corresponding hole. When a closing device other than a plug is used, it shall remain attached to the cassette.

6.1.3 The back surface is provided with one slot slightly off-centre (see figure 1).

This slot makes it possible to distinguish between the sides A and B, both visually and mechanically.

6.2 Mechanical characteristics

The mechanical characteristics which define the coplanar tape cassette and which permit physical interchangeability of cassettes on any recorder for data interchange of different manufacture are specified in figures 1 to 6.

6.3 Basic specifications

Furthermore, the following basic specifications apply:

6.3.1 Tape path and guidance

Requirements are shown in figures 2 and 3.

6.3.2 Cassette support planes

The cassette shall be supported by the write/read instrument only by hatched areas in figure 5.

6.3.3 Holes in back surface

The position and dimensions of the holes in the back surface are given in figure 1. The dimensions of the write-enable device, if used, shall be compatible with the hole dimensions as shown in figure 1 and shall be such that it may be installed and removed with reasonable effort and remain seated during normal use. The write-enable device shall not protrude beyond the back surface and it shall not be recessed more than 1 mm (0.039 in). The write-enable device shall at least close the cross-hatched area as shown in figure 1.

6.3.4 Window area

The maximum window area shall be in accordance with the dimensions given in figure 6. The maximum allowable increase in cassette thickness (required, for example, to accommodate marks indicating amount of wound and unwound tape) is given for each support plane.

6.3.5 Withdrawal force

The minimum withdrawal force of the leader tape from the hub attachment shall be a static load of 10 N (2.25 lbf) for a period of 10 min.

6.3.6 Tape winding

The tape shall be wound on the hubs with the magnetic coating out in such a way that, when recording on Track No.1, and looking at label A, the tape is unwound in an anti-clockwise direction.

6.3.7 Friction torque of the full hub

The maximum friction torque of the full hub in the cassette shall be 2×10^{-3} N·m (0.28 ozf·in).

6.3.8 Friction torque of both hubs

The maximum friction torque of both hubs measured in the cassette itself at the nearly full hub shall be $2,7 \times 10^{-3}$ N·m (0.38 ozf·in). With a holdback torque of $0,8 \times 10^{-3}$ N·m (0.11 ozf·in), applied to the nearly empty hub, the required maximum torque to be applied to the nearly full hub shall not exceed $5,5 \times 10^{-3}$ N·m (0.78 ozf·in).

6.3.9 Pressure pad

The cassette shall be provided with a pressure pad to hold the magnetic tape against the write/read head. The pressure of the pad upon the head shall be 0,005 to 0,015 N/mm² (11.6 to 34.8 ozf/in²), when the minimum distance between head and reference line lies between 3,1 mm (0.122 in) and 3,8 mm (0.150 in). This pressure shall be measured on a symmetrically positioned circular cylindrical surface having a radius between 10 mm (0.39 in) and infinity (see figure 2).

Under the above conditions and with $0,8 \times 10^{-3}$ N·m (0.11 ozf·in) holdback torque applied to the nearly empty hub, the required maximum torque applied to the nearly full hub shall not exceed 16×10^{-3} N·m (2.25 ozf·in) to start tape motion, and shall not exceed $12,5 \times 10^{-3}$ N·m (1.78 ozf·in) to continue tape motion.

Measured from the centre line of the cassette, the pressure pad shall extend on both sides of this centre line in the direction of tape travel a minimum of 2,5 mm (0.098 in) and a maximum of 4 mm (0.157 in). Up to the distance of 2,5 mm (0.098 in) the pressure requirements still apply. The pressure pad shall be symmetrically positioned, and the distances between pressure pad and cassette support planes surrounding the reference holes shall not exceed 3,5 mm (0.138 in). Those values shall also be valid in actual working conditions.

No magnetic material may be used for the cassette construction near the position of the write/read head. No screening shield may be used and the pressure pad and its holder shall be of non-magnetic material.

6.3.10 Tape guides

The tape touches the cassette at points on either side of the tape head recesses (indicated by arrows U and L). (See figure 3).

Guides are required at these positions. Between the outer guides (P and S) there shall be a closed construction so as to prevent dust entering the cassette.

The guides indicated by the letter L shall be perpendicular to the lower support plane (see 6.3.2). The guides indicated by the letter U shall be perpendicular to the upper support plane.

6.3.11 Transverse tolerances of tape position

6.3.11.1 Transverse tolerances without tape tension

The extreme position of the tape in the head region when no tape tension is present shall be limited by means incorporated in the cassette. The distance between cassette support planes surrounding the reference holes and those means shall lie between 3,5 mm (0.138 in) and 3,7 mm (0.146 in).

6.3.11.2 Transverse tolerances with tape tension

If the tape is not influenced or touched by any external means (guides, heads, capstans), during wind or rewind, the tape edges shall have a distance $4,1 \pm 0,2$ mm (0.161 ± 0.008 in) from the support plane surrounding the reference holes (see figures 4 and 5). When track No. 1 is being used, the side B outer cassette surface is the reference plane. Conversely, when track No. 2 is being used, the side A outer cassette surface is the reference plane.

6.3.12 Hub diameter

It is recommended that the hub diameter be $21,7 \pm 0,5$ mm (0.855 ± 0.019 in).

6.4 Labelling of tape cassette

6.4.1 Label area

The maximum label area shall be in accordance with the dimensions given in figure 6. The maximum allowable depression in the thickness of the cassette in the label area is given for each support plane.

6.4.2 Interchange

Suitable labels shall be used for marking the contents of the cassette. The use of pencil or erasable material is not allowed. The position and size of labels used shall be less than the provided depression of the label area.

6.4.3 Identification

The label shall have provisions for the identification of owner, manufacturer, cassette side and interchange label. The label shall indicate:

- a) that the cassette is meant for data interchange (clause 1);
- b) the use of track 2 (8.4);
- c) whether 7 or 8 bit coding is used (8.7);
- d) the method of recording.

6.5 Magnetic properties of the cassette housing

The magnetic properties of the cassette housing shall not impede bulk erasure of the tape by an external device.

7 Recording

7.1 Method of recording

The method of recording shall be phase encoding, described as follows:

7.1.1 The tape before the first block, the interblock gaps and that part of the tape following the last block written, shall be erased with the same polarity.

This polarity is such that the beginning of the relevant track is a North-seeking pole.

This erasing process forms part of the recording procedure.

7.1.2 A ZERO bit is defined as a flux transition to the polarity opposite to that of the interblock gap, when reading in the forward direction.

7.1.3 A ONE bit is defined as a flux transition to the polarity of the interblock gap, when reading in the forward direction.

7.1.4 Additional flux transitions shall be written at the nominal midpoints between bit flux transitions as defined in 7.1.2 and 7.1.3 if required, to establish the proper polarity for the succeeding bits. These flux transitions shall be called phase flux transitions.

7.2 Equipment

The equipment and tape used for interchange shall satisfy the requirements of 7.3 to 7.8 inclusive.

All signal measurements are made at a point in the read chain where the amplitude is proportional to the rate of change of flux in the read head.

7.3 Density of recording

7.3.1 The density of recording is 32 bpmm (800 bpi) nominal (see clause 1).

7.3.2 The long-term average bit spacing is the spacing between bit flux transitions that have been recorded continuously at a nominal density of 32 ftpmm (800 ftpi) and shall be measured over a length of tape of not less than 3,81 m (12.5 ft).

The long-term average bit spacing shall be within $\pm 4\%$ of the nominal spacing of 31,75 μm (1 250 μin).

7.3.3 The short-term average bit spacing referred to a particular bit spacing is the average of the preceding four bit spacings.

The short-term average bit spacing shall be within the limits of $\pm 5\%$ of the long-term average bit spacing.

In addition, the short-term average bit spacing shall not change at a rate greater than 2 % per bit.

7.4 Flux transition spacing

7.4.1 The spacing between successive data bit flux transitions shall not differ by more than 10 % from the preceding bit spacing.

7.4.2 The spacing between a phase flux transition and the preceding data bit flux transition shall be between 45 and 55 % of the preceding bit spacing.

7.5 Signal amplitude

7.5.1 Average signal amplitude

7.5.1.1 The average peak-to-peak signal amplitude of the interchanged tape cassette at 63 ftpmm (1 600 ftpi) shall not deviate by more than + 50 %, - 35 % from the standard reference amplitude. Averaging shall be done over a minimum of 4 000 flux transitions, which for the interchange cassette may be segmented into blocks.

7.5.1.2 The average peak-to-peak signal amplitude at 32 ftpmm (800 ftpi) nominal shall be less than twice the standard reference amplitude.

7.5.1.3 Averaging shall be done on the first-read-pass-after-interchange.

7.5.2 Minimum signal amplitude

No tape cassettes intended for interchange shall contain any adjacent flux transitions whose base-to-peak signal amplitude is less than 35 % of half of the standard reference amplitude.

This check is to be made during read-while-write or read-on-first-pass-after-write.

7.6 Number of elongated gaps

The number of gaps which have been elongated (see 8.11.4) due to erase instructions is a matter of agreement between interchange parties, but it is recommended that this number does not exceed 2, or alternatively 1 % of the total number of blocks written, whichever figure is larger.

7.7 Alignment error

When adjusted for maximum output, the azimuth angles for a reference alignment cassette, and the information to be interchanged, shall not differ by more than $\pm 15'$.

7.8 Tape winding torque

The take-up torque shall be at least 3×10^{-3} N·m (0.43 ozf·in). The maximum continuous value of the take-up tape tension shall be constant or decrease with increasing reel diameter and shall not exceed 0,5 N (0.113 lbf). The above values apply during winding, re-winding, recording and playback.

7.9 Residuals of previous recordings

In the zone of the tape in which the outer edges of the tracks are allowed to vary (see 8.2.2), there can be residuals of previous recordings.

8 Format

8.1 Number of tracks

There shall be two tracks.

8.2 Track dimensions

8.2.1 Track width

The track-width shall be 1,45 mm (0.057 in) nominal.

8.2.2 Distances between tape centre line and track edges

The distance between the centre line of the tape and the outer edges of the tracks shall be between 1,830 mm (0.072 in) and 1,905 mm (0.075 in). The distance between the tape centre line and the inner edges of the tracks shall be between 0,37 mm (0.015) and 0,51 mm (0.020 in).

8.3 Track designation

8.3.1 With side "A" up the designation of the two tracks is as follows:

When the tape moves from left to right with the magnetic surface facing the observer, and with the leader of side A to the right, the bottom track is designated track No. 1 and the upper track is designated track No. 2 (see figure 1).

8.3.2 The recording starts with track No. 1; at its conclusion the cassette may be turned over and the recording can be continued with track No. 2.

8.4 Use of tracks

The use of track No. 1 is reserved for data interchange. The use of track No. 2 is to be indicated on the label. If it is not used in the same way as track No. 1, reading of track No. 2 requires agreement between sender and recipient of the cassette.

8.5 Location of characters on the tracks

Each character is located in a byte (octet) of eight bit-positions along the track numbered from 1 to 8 in order of recording.

8.6 Sequence of recording

The least significant bit is recorded first. The information to be interchanged is recorded serially by bit and by character.

Bit-positions:

... 4 3 2 1 8 7 6 5 4 3 2 1 8 7 6 5 4 3 2...

Forward tape motion:



Resulting recording direction:



8.7 Code

The characters are represented by means of the ISO 7-bit coded character set (see ISO 646) and, where required, of its extensions (see ISO 2022).

8.7.1 Recording of 7-bit coded characters

Each 7-bit coded character is recorded in bit-positions 1 to 7 of a byte; bit-position 8 is recorded with value ZERO. The relationship is as follows:

Bits of the 7-bit combination:	0	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁
Bit-position in the byte:	8	7	6	5	4	3	2	1

8.7.2 Recording of 8-bit coded characters

Each 8-bit coded character is recorded in bit-positions 1 to 8 of a byte. The relationship is as follows:

Bits of the 8-bit combination:	b ₈	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁
Bit-position in the byte:	8	7	6	5	4	3	2	1

8.8 Sequence of characters

The sequence of characters from start to finish of a block shall correspond to the normal left to right sequence of a written line.

8.9 Data block

A data block shall consist of a preamble, data and a postamble. The data portion of a data block including the CRC (see 8.13) shall contain a minimum of 32 bits and a maximum of 2 064 bits.

8.10 Control block

A control block (known as a tape mark) shall consist of a preamble, two bytes of eight ZERO bits each, and a postamble.

8.11 Gaps

8.11.1 Integrity of gaps

The gaps shall be DC erased. Immediately before and after each block there shall be a length of at least 2,5 mm (0.10 in) in which, exclusive of residual edge signals, there is no flux discontinuity capable of producing a read signal of more than 10 % of half of the standard reference amplitude. In the remaining part of the gap there shall be no more than seven flux transitions.

8.11.2 Interblock gaps

The interblock gap, defined as the distance between two successive data blocks, shall have a minimum length of 17,8 mm (0.70 in), a nominal length of 20,3 mm (0.80 in) and a maximum length of 250 mm (9.84 in). Any gap in excess of 400 mm (15.5 in) shall be considered as the end of data on this track.

8.11.3 Initial gap

The gap between the BOT marker and the first data block shall be 33 mm (1.30 in) minimum and 250 mm (9.84 in) maximum.

8.11.4 Elongated gap

A gap is an elongated gap if its length is between 50 mm (1.97 in) and 250 mm (9.84 in).

8.11.5 Trailer gap

The gap following the last block shall have a minimum length of 17,8 mm (0.70 in). At least 17,8 mm (0.70 in) of this gap shall lie within the tested area (see 5.2.5).

8.12 Preamble and postamble

8.12.1 Preamble

Immediately preceding data in each block, the preamble "10101010" shall be written. When reading in the forward direction, the first flux transition shall be a ZERO transition.

8.12.2 Postamble

Immediately following data in each block, the postamble "10101010" shall be written. When reading in the forward direction, the first flux transition shall be a ZERO transition.

8.13 Cyclic redundancy check (CRC)

The last two characters in the data portion of a data block shall be cyclic redundancy check (CRC). The 16-bit CRC shall be written in each data block following the data and immediately preceding the postamble. The polynomial generating the CRC is expressed as:

$$X^{16} + X^{15} + X^2 + 1$$

Dimensions in millimetres

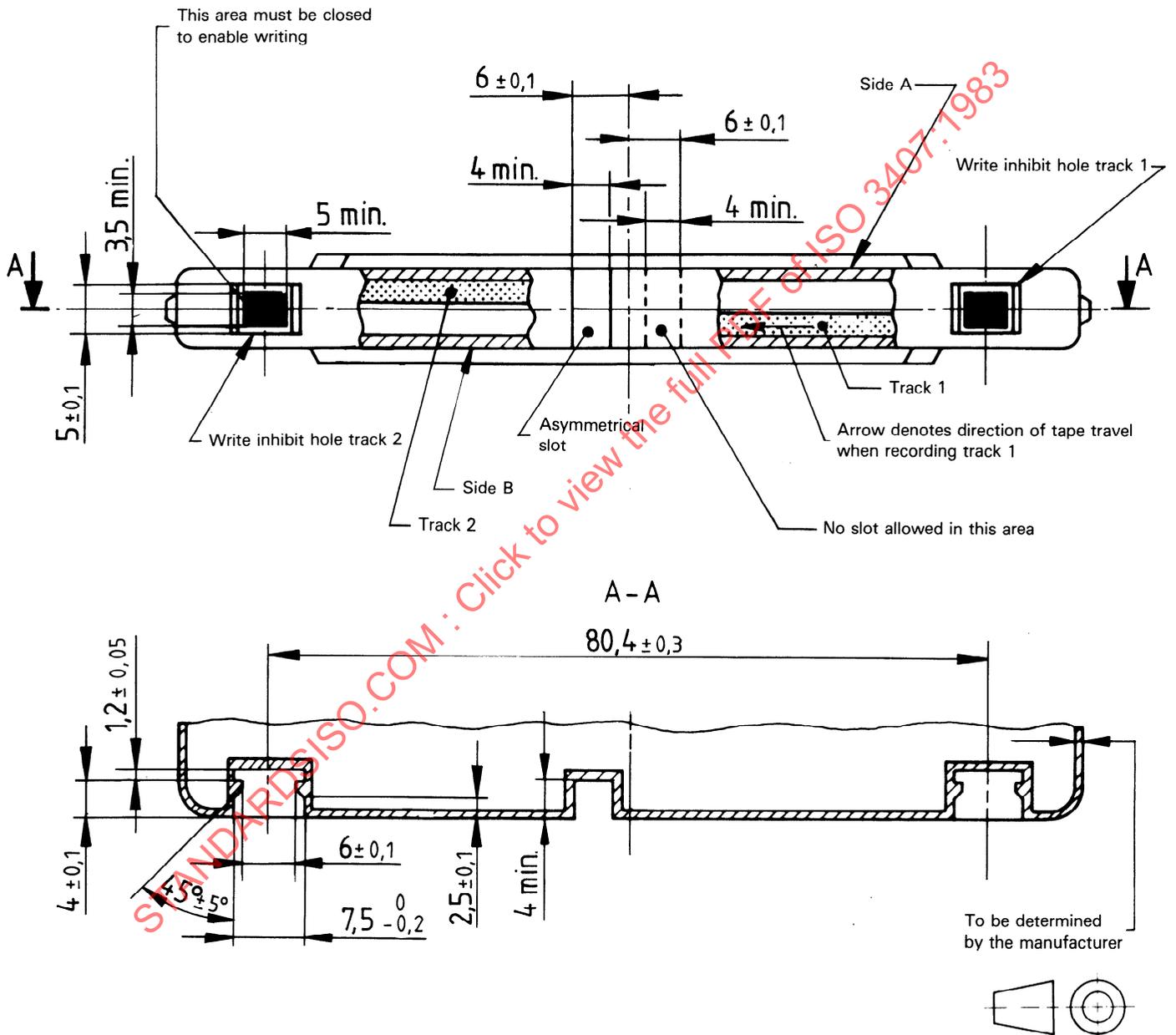


Figure 1a — Sides, tracks, holes and asymmetrical slot

Dimensions in inches

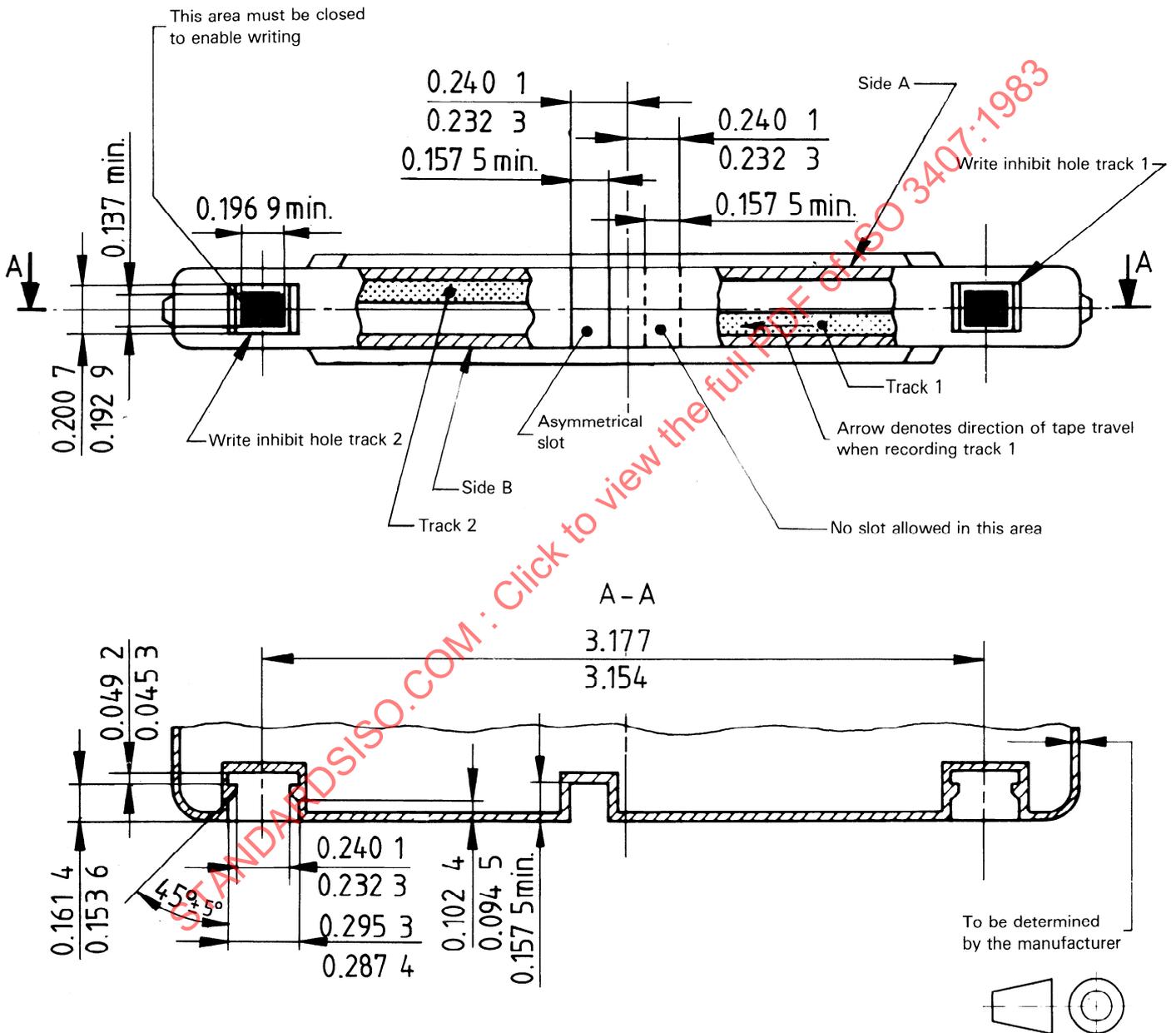


Figure 1b — Sides, tracks, holes and asymmetrical slot

Dimensions in millimetres

Shaded areas in figure 2 define openings over the full height of the cassette aperture, unobstructed by fixed members, except for areas covered by the magnetic tape and pressure pad.

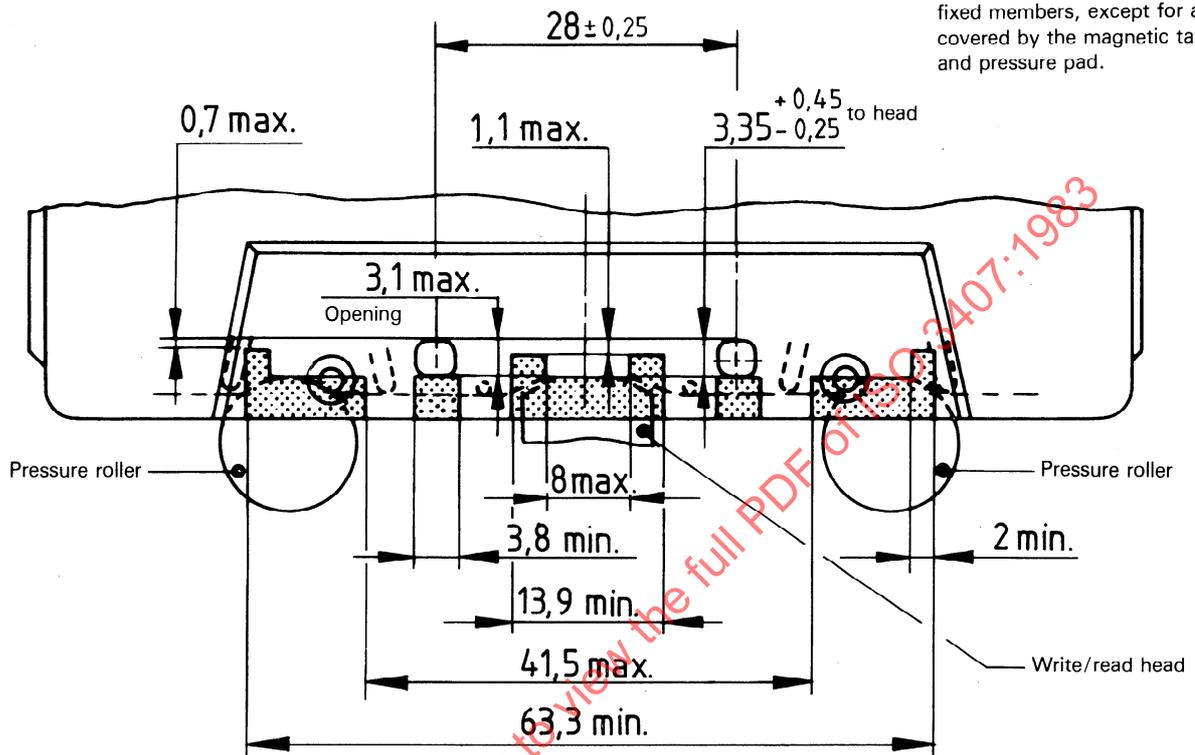


Figure 2a — Position of heads

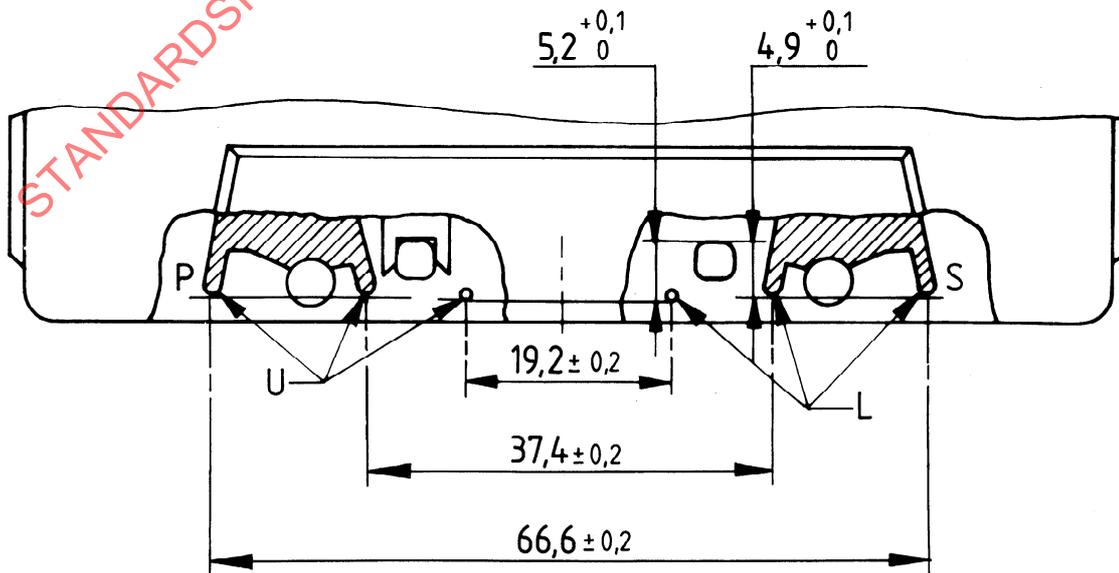


Figure 3a — Tape guides in cassette

Dimensions in inches

Shaded areas in figure 2 define openings over the full height of the cassette aperture, unobstructed by fixed members, except for areas covered by the magnetic tape and pressure pad.

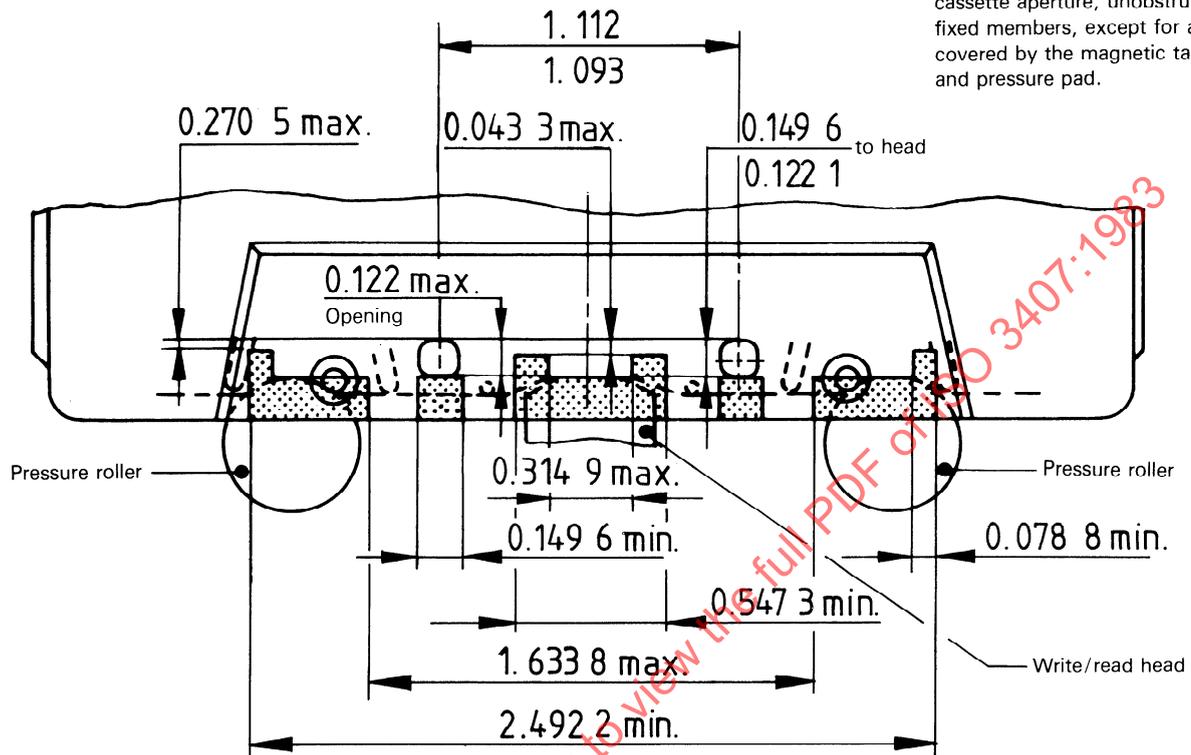


Figure 2b — Position of heads

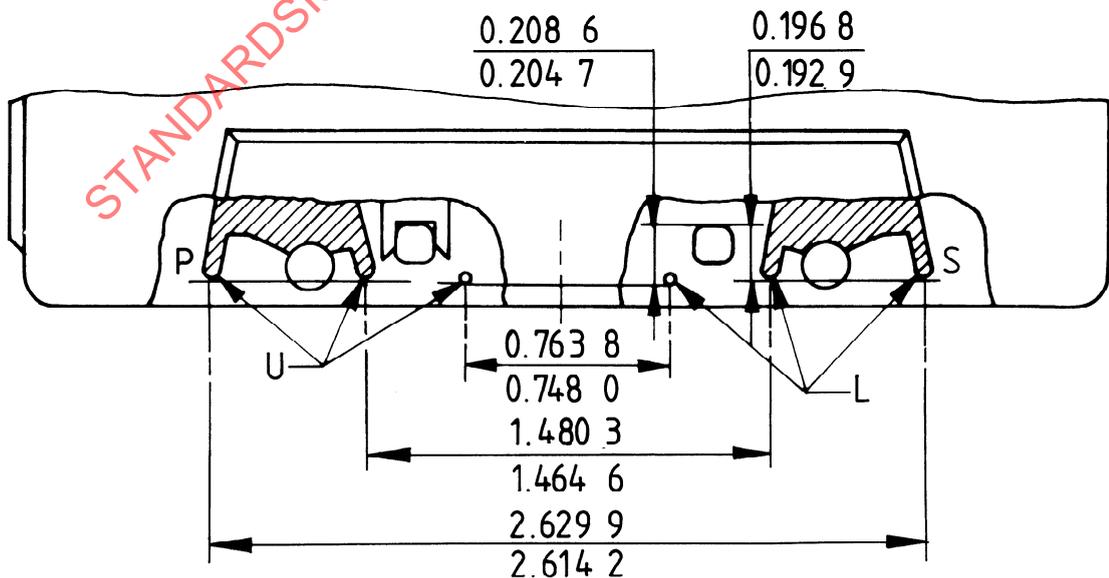


Figure 3b — Tape guides in cassette

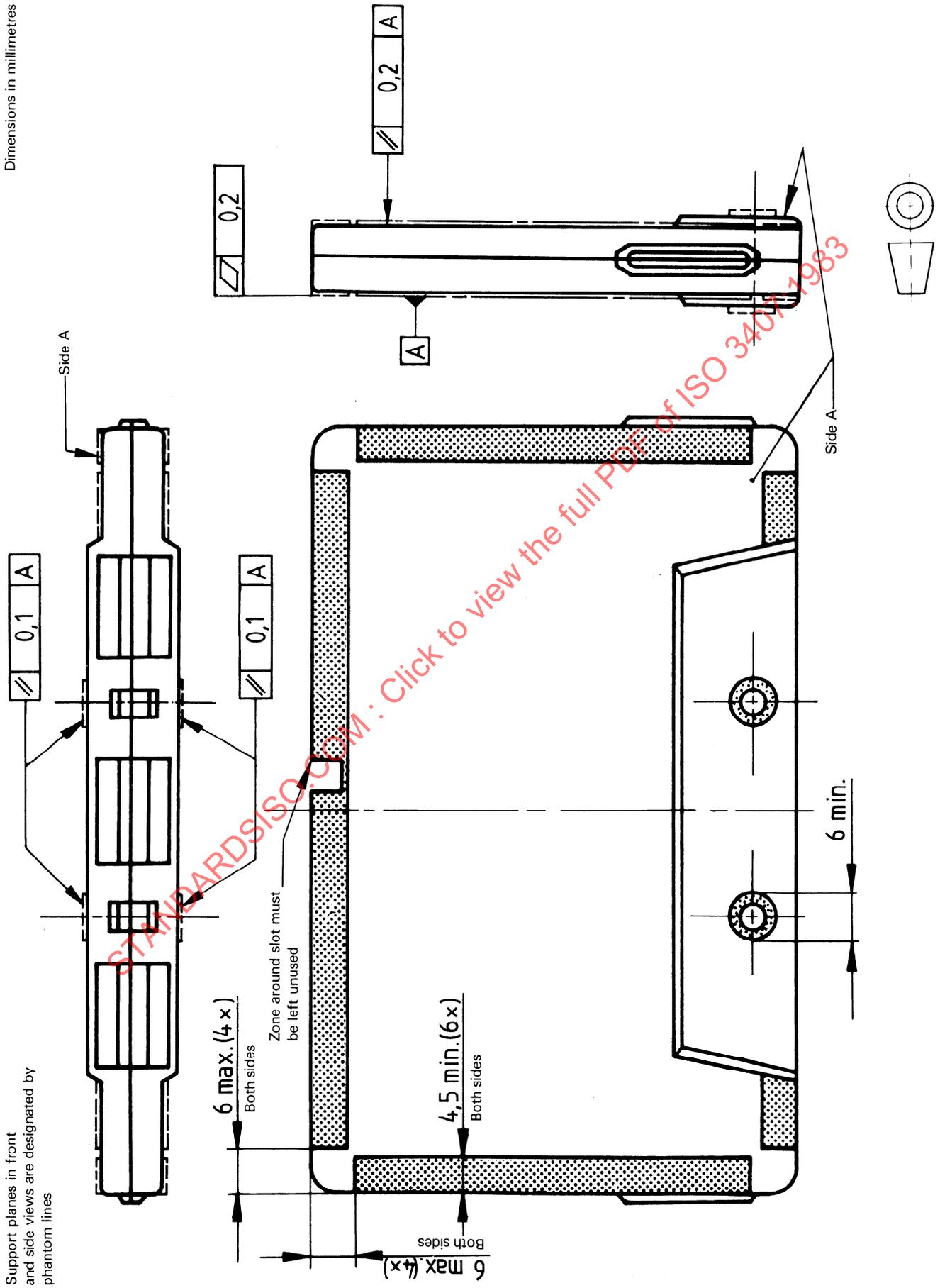


Figure 5a — Cassette support planes

Dimensions in inches

Support planes in front and side views are designated by phantom lines

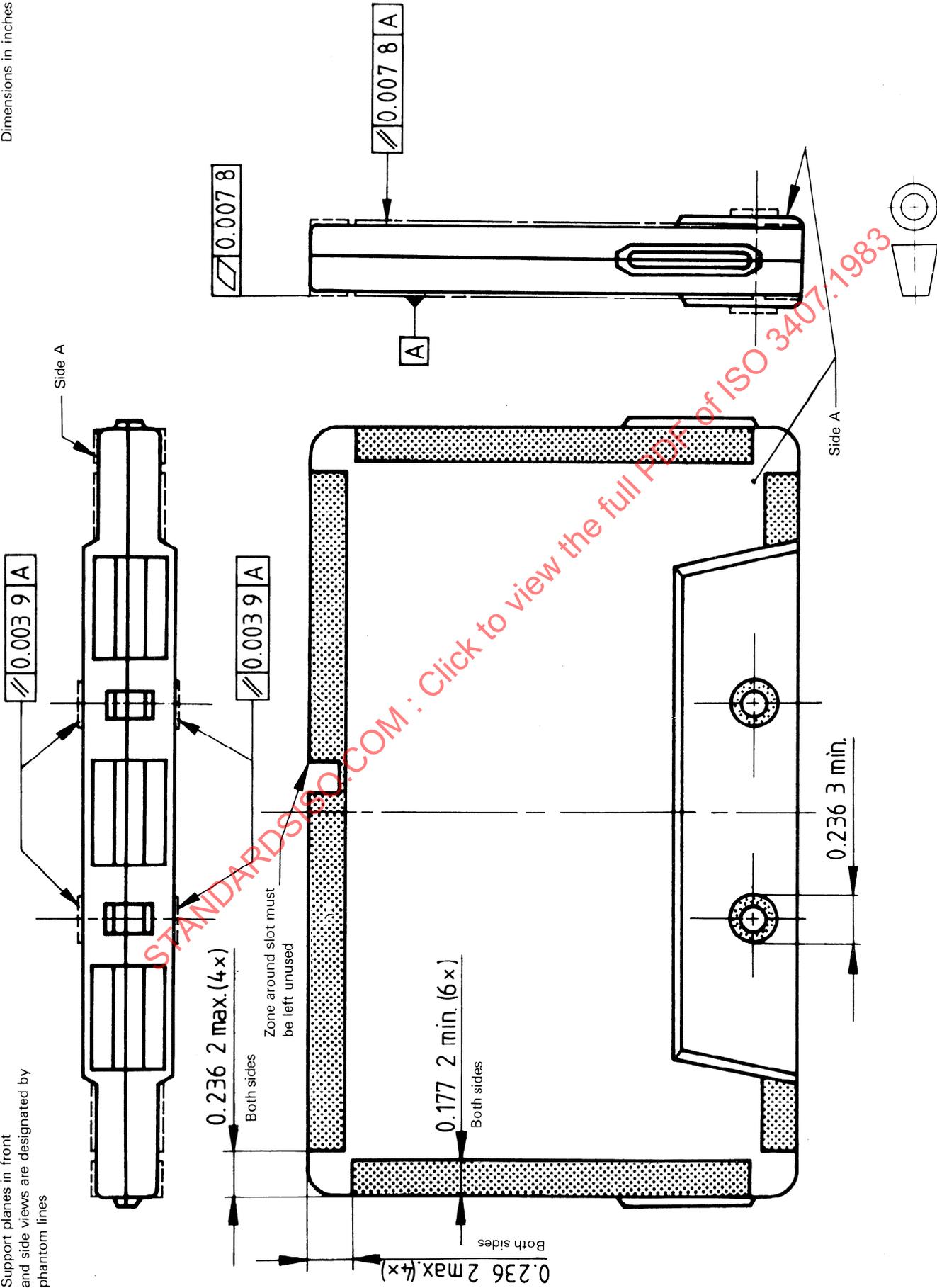


Figure 5b — Cassette support planes

Dimensions in millimetres

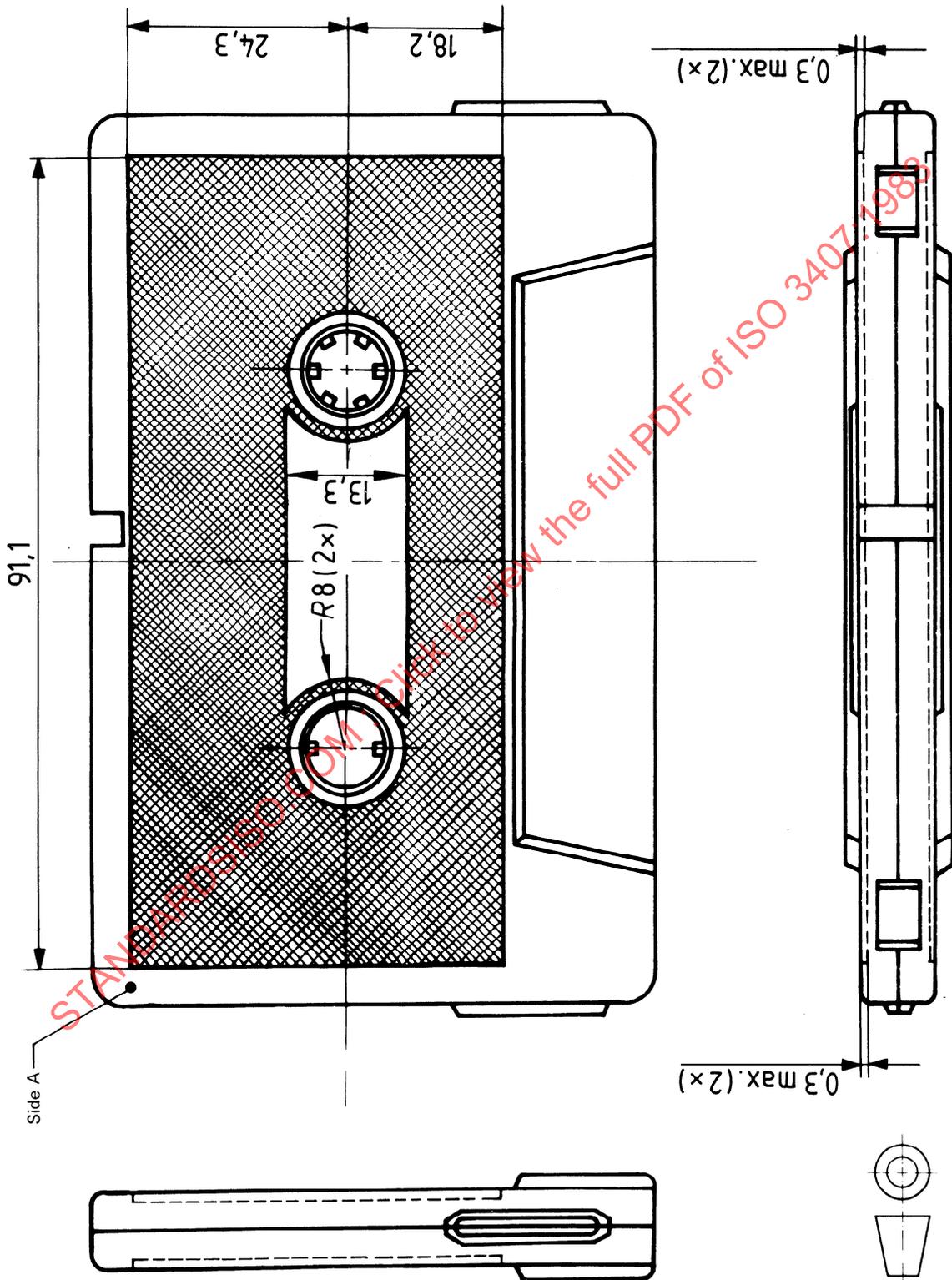


Figure 6a — Maximum label and window area dimensions