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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Information processing — Data interchange on 12,7 mm (0.5 in) wide magnetic tape cartridges — 18 tracks, 1 491 data bytes per millimetre (37 871 data bytes per inch)

Traitement de l'information — Échange d'information sur cartouche de bande magnétique de 12,7 mm *de large* (0,5 in) — *18 pistes, 1 491 caractères par millimètre (37 871 caractères par inch)*

Reference number
ISO 9661 : 1988 (E)

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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 preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9661 was prepared by the European Computer Manufacturers Association (as Standard ECMA-120) and was adopted, under a special "fast-track procedure", by Technical Committee ISO/TC 97, *Information processing systems*, in parallel with its approval by the ISO member bodies.

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 processing — Data interchange on 12,7 mm (0.5 in) wide magnetic tape cartridges — 18 tracks, 1 491 data bytes per millimetre (37 871 data bytes per inch)

Section 1 : General

1.1 Scope

This International Standard specifies the physical and magnetic characteristics of a 12,7 mm (0.5 in) wide, 18-track magnetic tape cartridge to enable interchangeability of such cartridges. It also specifies a format and recording method thus allowing, together with ISO 1001 for magnetic tape labelling, full data interchange by means of such magnetic tape cartridges.

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

1.2 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.

1.3 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 646 : 1983, *Information processing — 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 processing interchange.*

ISO 1302 : 1978, *Technical drawings — Method of indicating surface texture on drawings.*

ISO 2022 : 1986, *Information processing — ISO 7-bit and 8-bit coded character sets — Code extension techniques.*

ISO 4873 : 1986, *Information processing — ISO 8-bit code for information interchange — Structure and rules for implementation.*

1.4 Definitions

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

1.4.1 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 (1 in) of tape exclusive of missing pulses.

1.4.2 back surface : The surface of the tape opposite the magnetic coating used to record data.

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

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

1.4.5 Cyclic Redundancy Check Character : A character represented by two bytes, placed at the end of a data block and used for error detection.

1.4.6 data density : The number of 8-bit bytes stored per unit length of tape, expressed in bytes per millimetre (bytes per inch).

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

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

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

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

1.4.11 Master Standard Reference Tape: A tape selected as the standard for Reference Field, Signal Amplitude, Resolution and Overwrite.

NOTE — A Master Standard Reference Tape is being established at the National Bureau of Standards (NBS) for this International Standard.

1.4.12 physical recording density: The number of recorded flux transitions per unit length of track, expressed in flux transitions per millimetre (ftpmm) (flux transitions per inch, [ftpi]).

1.4.13 Postamble: A repeated 9-bit pattern at the end of a Recorded Data block providing electronic synchronization when reading in the reverse direction.

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

1.4.15 Reference Field: The Typical Field of the Master Standard Reference Tape.

1.4.16 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 are being developed at the National Bureau of Standards (NBS) and will be available from the NBS Office of Standard Reference materials, Room B311, Chemistry Building, National Bureau of Standards, Gaithersburg, MA 20899, USA.

It is intended that these be used for calibrating tertiary reference tapes for use in routine calibration.

1.4.17 Standard Reference Amplitude: The Average Signal Amplitude from the Master Standard Reference Tape when it is recorded with the Test Recording Current on the NBS measurement system at 972 ftpmm (24 689 ftpi).

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

1.4.18 Standard Reference Current: The current that produces the Reference Field.

1.4.19 Test Recording Current: The current that is 1,5 times the Standard Reference Current.

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

1.4.21 Typical Field: In the plot of the Average Signal Amplitude against the Recording Field at the physical recording density of 972 ftpmm (24 689 ftpi), the minimum field that causes an Average Signal Amplitude equal to 85 % of the maximum Average Signal Amplitude.

1.5 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.

1.5.1 Cartridge/tape testing environment

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

temperature	: 23 °C ± 2 °C (73 °F ± 4 °F)
relative humidity	: 40 % to 60 %
conditioning period before testing	: 24 h

1.5.2 Cartridge operation environment

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

temperature	: 16 °C to 32 °C (60 °F to 90 °F)
relative humidity	: 20 % to 80 %
wet bulb temperature	: 25 °C max. (78 °F max.)

The average temperature of the air immediately surrounding the tape shall not exceed 40,5 °C (105 °F).

NOTE — Localized tape temperatures in excess of 49 °C (120 °F) 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 h.

1.5.3 Cartridge storage environment

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

temperature	: 5 °C to 32 °C (40 °F to 90 °F)
relative humidity	: 5 % to 80 %
wet bulb temperature	: 26 °C max. (80 °F max.)

1.5.4 Safety requirements

1.5.4.1 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.

1.5.4.2 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.

1.5.5 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

2.1 Characteristics of the tape

2.1.1 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.

2.1.2 Tape length

The length of the tape shall not be less than 165 m (541 ft).

2.1.3 Tape width

The width of the tape shall be 12,650 mm ± 0,025 mm (0.498 0 in ± 0.001 0 in). 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 (1.0 ozf).

2.1.4 Tape discontinuity

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

2.1.5 Total thickness of tape

The total thickness of the tape at any point shall be between 0,025 9 mm and 0,033 7 mm (1 020 µin and 1 330 µin).

2.1.6 Base material thickness

The thickness of the base material shall be 0,023 4 mm (921 µin) nomimal.

2.1.7 Longitudinal curvature

The radius of curvature of the edge of the tape shall not be less than 33 m (108 ft).

Procedure :

Allow a length of tape of 1 m (39 in) to unroll and assume its natural curvature on a flat smooth surface. Measure the deviation from a 1 m (39 in) chord. The deviation shall not be greater than 3,8 mm (0.150 in). This deviation corresponds to the minimum radius of curvature of 33 m (108 ft) if measured over an arc of a circle.

2.1.8 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 (2.16 ozf). 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.

2.1.9 Cupping

The departure across the width of tape from a flat surface shall not exceed 0,3 mm (0.011 8 in).

Procedure :

Cut a length of tape of 1,0 m ± 0,1 m (39.4 in ± 3.9 in). Condition it for a minimum of 3 h 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 (1 in). Stand the test piece on its end in a cylinder which is at least 25 mm (1 in) high with an inside diameter of 13,0 mm ± 0,2 mm (0.511 8 in ± 0.007 9 in). With the cylinder standing on an optical comparator measure the cupping by aligning the edges of the test piece to the reticle and determining the distance from the aligned edges to the corresponding surface of the test piece at its centre.

2.1.10 Dynamic frictional characteristics

In the tests of 2.1.10.1 and 2.1.10.2 the specified forces of 1,0 N and 1,5 N (3.6 ozf and 5.4 ozf), respectively, comprise both the force component of the dynamic friction and the force of 0,64 N (2.30 ozf) applied to the sample of tape.

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

2.1.10.1 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 (3.6 ozf).

Procedure

a) Wrap a test piece of tape around a 25,4 mm (1 in) diameter circular mandrel with the back surface of the sample facing outward.

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

c) Apply a force of 0,64 N (2.30 ozf) 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.

d) Drive the slide at a speed of 1 mm/s (0.039 in/s).

2.1.10.2 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 1,5 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 :

a) Wind tape on to a spool hub of diameter 50 mm (2 in) to an outside diameter of 97 mm (4 in) with a winding tension of 2,2 N ± 0,2 N (7.91 ozf ± 0.72 ozf).

b) Repeat the following two steps five times:

1) Store for 48 h at a tempeature of 50 °C (122 °F) and a relative humidity of 10 % to 20 %.

2) Condition in the testing environment for 2 h and rewind with a tension of 2,2 N ± 0,2 N (7.91 ozf ± 0.72 ozf).

c) Condition the tape for 48 h at a temperature of 30,5 °C (87 °F) and a relative humidity of 85 %. The tape shall remain in this environment for steps d) and e).

d) Apply a force of 0,64 N (2.30 ozf) to one end of a test piece of tape of not more than 1 m (39 in), taken 1,34 m (52.75 in) from the leader block. Pass the test piece over a ferrite rod of diameter 25,4 mm (1 in) 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 (0.039 in/s).

e) Repeat step d) for a similar test piece taken 4,3 m (14,11 ft) from the junction of the tape with the cartridge hub.

2.1.11 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 (5.4 ozf).

Procedure:

a) Take a test piece of the tape approximately 380 mm (15 in) long and scribe a line through the recording coating across the width of the tape 125 mm (5 in) from one end.

b) 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 figure 1.

c) 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/min (10 in/min).

d) Note the force at which any part of the coating first separates from the base material. If this is less than 1,5 N (5.4 ozf), the test has failed. If the test piece peels away from the double-sided pressure sensitive tape before the force exceeds 1,5 N (5.4 ozf), an alternative type of double-sided pressure sensitive tape shall be used.

e) If the back surface of the tape is coated, repeat a) to d) for the back coating.

2.1.12 Flexural rigidity

The flexural rigidity of the tape in the longitudinal direction shall be between 0,06 N · mm² and 0,16 N · mm² (0.21 × 10^{-4} lbf · in² and 0.56 × 10^{-4} lbf · in²).

Procedure:

Clamp a 180 mm (7.1 in) test piece of tape in a universal testing machine, allowing a 100 mm (3.9 in) separation between the machine jaws. Set the jaw separation speed at 5 mm/min (0.2 in/min). Plot the force against the distance. Calculate the flexural rigidity using the slope of the curve between 2,2 N and 6,7 N (0.5 lbf and 1.5 lbf) by the formula:

$$E = \frac{\delta F / WT}{\delta L / L}$$

$$I = WT^3/12$$

$$\text{Flexural rigidity} = EI = \frac{\delta F T^2}{12 \delta L / L}$$

where

δF is the change in force in newtons;

T is the measured thickness in millimetres;

W is the measured width in millimetres;

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

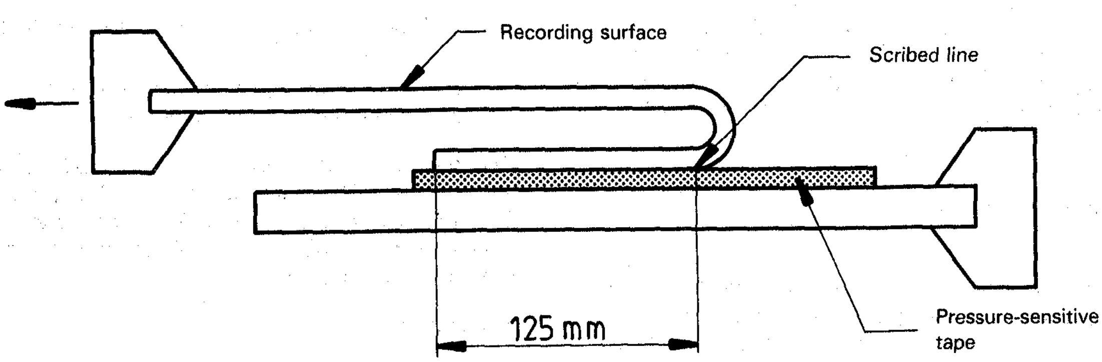


Figure 1 — Coating adhesion

2.1.13 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 in the test environment for 24 h. Position the test piece over two 24-carat gold-plated, semi-circular electrodes having a radius r = 25,4 mm (1 in) and a finish of at least N4, so that the recording surface is in contact with each electrode (see figure 2). These electrodes shall be placed parallel to the ground and parallel to each other at a distance d = 12,7 mm (0.5 in) between their centres. Apply a force F of 1,62 N (0.36 lbf) 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.

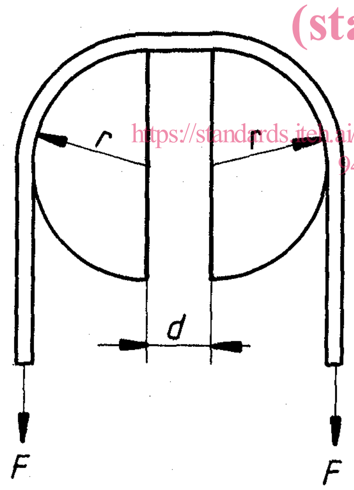


Figure 2 — Position of test piece over two semi-circular electrodes

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.

2.1.14 Tape durability

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

However, a recommended procedure is descibed in annex D.

2.1.15 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.

2.1.16 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 (2 200 µin) when measured as specified in annex C.

2.1.17 Pre-recording condition

Prior to recording data or to testing, the tape shall have been erased using alternating 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.

2.1.18 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 (i.e. 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 (98.47 in/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 (55.1 µin ± 7.9 µin)
write head saturation density	:	0,34 T ± 0,03 T (3 400 gauss ± 300 gauss)
tape tension	:	2,2 N ± 0,2 N (7.91 ozf ± 0.72 ozf)
recording current	:	Test Recording Current

2.1.18.1 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.

2.1.18.2 Signal amplitude

The Average Signal Amplitude at the physical recording density of 972 ftpmm (24 689 ftpi) 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.

2.1.18.3 Resolution

The ratio of the Average Signal Amplitude at the physical recording density of 1 458 ftpmm (37 033 ftpi) to that at the physical recording density of 972 ftpmm (24 689 ftpi) 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.

2.1.18.4 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 (24 689 ftpi) to the Average Signal Amplitude of the 972 ftpmm (24 689 ftpi) signal. The Average Signal Amplitude of the tone pattern is the peak-to-peak amplitude of the sinusoidal signal with equal rms power.

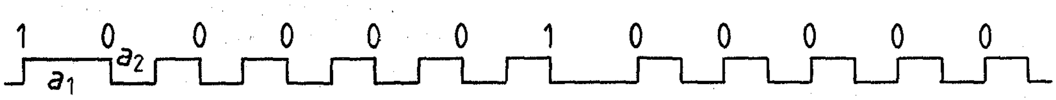
2.1.18.4.1 Requirement

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 (40.512 µin)

a_2 = 0,514 µm (20.236 µin)

Record a 972 ftpmm (24 689 ftpi) 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 (24 689 ftpi) signal] and the Average Signal Amplitude of the 972 ftpmm (24 689 ftpi) signal. Both amplitude measurements should be made using suitable filters.

2.1.18.5 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 decibels.

2.1.18.5.1 Requirement

The NB-SNR ratio shall be equal to, or greater than, 30 dB when normalized to a track width of 410 µm (0.016 14 in). The normalization factor is dB(410) = dB(W) + 10 log 410/W, where W is the track width used when measuring dB(W).

2.1.18.5.2 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 (30 in/s) for the frequencies specified below.

The NB-SNR ratio shall be measured as follows:

a) Measure the read-signal amplitude of the 972 ftpmm (24 689 ftpi) signal, taking a minimum of 150 samples over a minimum length of tape of 46 m (151 ft).

b) 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.

2.1.19 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 (78.7 in/s)
read-track width	: 410 µm (0.016 14 µin)
physical recording density	: 972 ftpmm (24 689 ftpi)
write-gap length	: 1,4 µm ± 0,2 µm (55.1 µin ± 7.9 µin)
azimuth alignment	: not greater than 6′ between the mean write transitions and the read gap
write head saturation	: 0,34 T ± 0,03 T (3 400 gauss ± 300 gauss)
recording current	: Test Recording Current
format	: 18 tracks
tape tension	: 2,2 N ± 0,2 N (7.91 ozf ± 0.72 ozf)

2.1.19.1 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 (1 in) of tape.

2.1.19.2 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 8×10^6 flux transitions recorded.

2.1.19.3 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 pulse missing 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 (541 ft) length of tape shall have more than 12 coincident missing pulse zones.

No coincident missing pulse zone shall exceed 50 mm (2 in).