

INTERNATIONAL STANDARD

ISO/IEC
1864

Fourth edition
1992-06-15

**Information technology — Unrecorded 12,7 mm
(0,5 in) wide magnetic tape for information
interchange — 32 ftpmm (800 ftpi), NRZ1,
126 ftpmm (3 200 ftpi) phase encoded and
356 ftpmm (9 042 ftpi), NRZ1**

*Technologie de l'information — Bande magnétique vierge de 12,7 mm
(0,5 in) de large, pour l'échange d'information — 32 ftpmm (800 ftpi),
NRZ1, 126 ftpmm (3 200 ftpi) par codage de phase et 356 ftpmm
(9 042 ftpi), NRZ1*



Reference number
ISO/IEC 1864:1992(E)

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 1864 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Sub-Committee SC 11, *Flexible magnetic media for digital data interchange*.

This fourth edition cancels and replaces the third edition (ISO 1864:1985), of which it constitutes a technical revision.

Annexes A and B form an integral part of this International Standard. Annex C is for information only.

Information technology — Unrecorded 12,7 mm (0,5 in) wide magnetic tape for information interchange — 32 ftpmm (800 ftpi), NRZ1, 126 ftpmm (3 200 ftpi) phase encoded and 356 ftpmm (9 042 ftpi), NRZ1

1 Scope

This International Standard specifies the characteristics of 12,7 mm (0,5 in) wide magnetic tape with reel, to enable magnetic and mechanical interchangeability of such tape between information processing systems.

This International Standard applies solely to magnetic tape for digital recording using the NRZ1 method of recording at 32 ftpmm and 356 ftpmm (800 ftpi and 9 042 ftpi) or the phase-encoded method of recording at 126 ftpmm (3 200 ftpi) in which the direction of magnetization is nominally longitudinal.

NOTE 1 Some numeric values in the SI and/or Imperial measurement system in this International Standard 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 re-converted. The original design was made using the Imperial measurement system.

2 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 indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 209-1:1989, *Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition*.

ISO 468:1982, *Surface roughness — Parameters, their values and general rules for specifying requirements*.

ISO 1863:1990, *Information processing — 9-track, 12,7 mm (0,5 in) wide magnetic tape for information interchange using NRZ1 at 32 ftpmm (800 ftpi) — 32 cpmm (800 cpi)*.

ISO/IEC 3788:1990, *Information processing — 9-track, 12,7 mm (0,5 in) wide magnetic tape for information interchange using phase encoding at 126 ftpmm (3 200 ftpi), 63 cpmm (1 600 cpi)*.

ISO 5652:1984, *Information processing — 9-Track, 12,7 mm (0,5 in) wide magnetic tape for information interchange — Format and recording, using group coding at 246 cpmm (6 250 cpi)*.

ISO 6098:1984, *Information processing — Self-loading cartridges for 12,7 mm (0,5 in) wide magnetic tape*.

ASTM D 2000, *Rubber products in automotive applications, classification system for*.

3 Definitions

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

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

3.2 Master Standard Reference Tape: A tape selected as the standard for signal amplitude.

NOTE 2 A Master Standard Reference Tape has been established at the US National Institute of Standards and

Technology (NIST) for the physical recording densities of 32 ftpmm (800 ftpi) and 126 ftpmm (3 200 ftpi).

A further Master Standard Reference Tape has been established at the NIST for the physical recording density of 356 ftpmm (9 042 ftpi).

3.3 Secondary Standard Reference Tape: A tape for which the magnetic characteristics are known and stated in relation to that of the Master Standard Reference Tape. It is intended that these be used for calibrating tertiary reference tapes for use in routine calibration. See annex B.

NOTE 3 Secondary Standard Reference Tapes are available from the NIST, Office of Standards Reference Materials, Room 205, Building 202, National Institute of Standards Technology, Gaithersburg, MD 20899, USA, under the following part numbers:

SRM 3200 for 32 ftpmm (800 ftpi) and 126 ftpmm (3 200 ftpi)

SRM 6250 for 356 ftpmm (9 042 ftpi)

3.4 Average Signal Amplitude: The average peak-to-peak value of the signal output to the read head when measured over a minimum of 76 mm (3,0 in) of tape.

3.5 Typical Field: In the plot of the Average Signal Amplitude against the recording field at the specified physical recording density, it is the minimum field that causes an Average Signal Amplitude equal to 95 % of the maximum Average Signal Amplitude.

3.6 Reference Field: The typical field of the Master Standard Reference Tape at the specified physical recording density.

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

Traceability to the Standard Reference Current is provided by the calibration factor(s) supplied with each Secondary Standard Reference Tape.

3.8 Test Recording Current: The current that is k times the Standard Reference Current, where k equals:

2,0 to 2,2 at 32 ftpmm (800 ftpi)

1,75 to 1,85 at 126 ftpmm (3 200 ftpi)

1,35 to 1,45 at 356 ftpmm (9 042 ftpi)

3.9 Standard Reference Amplitude; SRA: The Average Signal Amplitude from the Master Standard Reference Tape when it is recorded with the appropriate Test Recording Current at one of the specified physical recording densities.

Traceability to the Standard Reference Amplitude is provided by the calibration factor(s) supplied with each Secondary Standard Reference Tape.

3.10 reference edge: The edge furthest from an observer when the tape is lying flat with the magnetic surface uppermost and the direction of movement for recording is from left to right.

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

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

3.13 row: Nine transversely-related locations (one in each track) in which bits are recorded.

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

3.15 physical recording density: The number of recorded flux transitions per unit length of track (ftpmm or ftpi).

3.16 data density: The number of data characters stored per unit length of tape (cpmm or cpi).

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

3.18 oxide coating to brass and chrome: The resistance of the tape oxide coating to motion on brass (chrome).

3.19 oxide coating to tape back surface: The resistance of the tape oxide coating to motion on the tape back surface.

3.20 tape back surface to stainless steel: The resistance of the tape back surface to motion on stainless steel.

3.21 rubber to tape back surface: The resistance of the tape back surface to motion on rubber.

4 Environment

The conditions specified below refer to the ambient conditions in the test or computer room and not to those within the tape drive equipment.

4.1 Testing environment

Unless otherwise stated, all measurements made on a tape to check compliance with the requirements of this International Standard and all tests

prescribed for a tape in this International Standard shall be carried out under the environmental conditions of $23\text{ °C} \pm 2\text{ °C}$ ($73\text{ °F} \pm 4\text{ °F}$) and relative humidity 40 % to 60 %, after at least 24 h of conditioning in the same environment.

4.2 Operating environment

The operating temperature shall be within the range 16 °C to 32 °C (60 °F to 90 °F) and the relative humidity 20 % to 80 %. Operation near the extremes of these ranges can result in degraded performance. The wet bulb temperature shall not exceed 25 °C (78 °F).

4.3 Storage environment

During storage, it is recommended that the tapes are kept within the following conditions:

4.3.1 Unrecorded tape

temperature: 5 °C to 48 °C (40 °F to 120 °F)

relative humidity: 20 % to 80 %

wet bulb temperature: not greater than 26 °C (80 °F)

4.3.2 Recorded tape

temperature: 5 °C to 32 °C (40 °F to 90 °F)

relative humidity: 20 % to 80 %

wet bulb temperature: not greater than 26 °C (80 °F)

5 Characteristics of the tape

5.1 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. If the tape is also coated on the rear surface, the coating shall be non-ferromagnetic.

5.2 Width

The width of the tape shall be $12,7^{+0,0}_{-0,1}\text{ mm}$ ($0,500^{+0,000}_{-0,004}\text{ in}$).

5.3 Total tape thickness

The total tape thickness, at any point, shall be $0,048\text{ mm} \pm 0,008\text{ mm}$ ($0,0019\text{ in} \pm 0,0003\text{ in}$).

5.4 Base material thickness

The base material thickness shall be $0,038\text{ mm}$ ($0,0015\text{ in}$) nominal.

5.5 Coating thickness

The coating thickness shall not exceed $0,015\text{ mm}$ ($0,0006\text{ in}$).

5.6 Length

The normal minimum length of tape is 732 m (2 400 ft) splice-free. If the length of the tape is less than 732 m (2 400 ft), the actual length shall be stated. Maximum tape length is limited by thickness, E value (see 5.7), moment of inertia and reel dimensions.

5.7 E value

The E value is the radial distance by which the reel flanges extend beyond the outermost layer of a tape which has been wound at a tension of 2 N to 3,6 N (7 ozf to 13 ozf) on the specified reel. The minimum E value shall be 3,2 mm (0,125 in).

When the tape is used with a self-loading cartridge (see ISO 6098), the E value shall satisfy:

$$6,3\text{ mm (0,25 in)} \leq E \leq 15,9\text{ mm (0,625 in)}$$

5.8 Elastoplastic properties

The elastoplastic properties of the tape shall be such that when the tape is subjected to a tension of 30 N (108 ozf) for a period of 3 min under any combination of temperature and relative humidity within the ranges of 10 °C to 50 °C (50 °F to 122 °F) and 20 % to 80 % relative humidity, the permanent elongation measured with negligible tension after a second 3 min interval is less than 1,0 %.

5.9 Longitudinal curvature

There shall be a minimum radius of curvature for the edge of the tape, defined and tested by allowing a 1 m (36 in) length of the tape to unroll and assume its natural curvature on a flat surface. The minimum radius shall be 33 m (108 ft). If measured over an arc of a circle, this corresponds to a deviation of 3,8 mm (1/8 in) from a 1 m (36 in) chord.

5.10 Tape wind

Tape shall be wound, with its magnetic surface toward the reel hub, in a clockwise direction; i.e. when the reel is viewed from the front, the loose end of the tape hangs from the right side of the reel. Tape shall be wound with a tension of 2 N to 3,6 N (7 ozf to 13 ozf) (see figure 2).

5.11 Magnetic properties

The magnetic properties of the tape are not defined here by B-H loops or similar parameters, but are defined by the testing procedures given in 5.13 and 5.15.

5.12 Test density

For the purpose of testing tape in accordance with this International Standard, the physical recording density shall be 32 ftpmm, 126 ftpmm or 356 ftpmm (800 fpi, 3 200 fpi or 9 042 fpi). The flux transitions shall be uniformly spaced. The flux transition spacing and the track configuration shall conform to ISO 1863, ISO 3788 or ISO 5652 as appropriate.

5.13 Typical Field

The Typical Field of the tape under test shall be within ± 20 % of the Reference Field for a physical recording density of 32 ftpmm (800 fpi) or 126 ftpmm (3 200 fpi) and within ± 15 % of the Reference Field for a physical recording density of 356 ftpmm (9 042 fpi).

5.14 Average Signal Amplitude

When read back on a system, each channel of which has been calibrated relative to the SRA, the Average Signal Amplitude shall be within ± 10 % of the SRA at 32 ftpmm (800 fpi), within ± 25 % at 126 ftpmm (3 200 fpi) and within ± 40 % at 356 ftpmm (9 042 fpi).

This test shall be conducted on the read-while-write pass for both tapes.

NOTE 4 It has been observed that the Average Signal Amplitude level at 356 ftpmm (9 042 fpi) can vary along the length of tape. This effect is termed "tilt" and is the subject of an investigation to determine its magnitude. Results indicate that a variation of 20 % can be expected. The effect of such variations is included in the specified tolerance on Average Signal Amplitudes.

5.15 Ease of erasure

When a tape has been recorded according to any of the conditions specified in 5.13 and then passed through a longitudinal unidirectional steady field of 79 500 A/m (1 000 Oe), the remaining Average Signal Amplitude shall not exceed 4 % of the SRA for that density.

The erasure field shall be reasonably uniform, such as that in the middle of a solenoid.

5.16 Test for missing pulses and extra pulses

These tests shall be carried out in the in-contact condition and over the entire tested area, which shall extend from 0,2 m (8 in) before the BOT reflective marker to 3,0 m (10 ft) beyond the EOT reflective marker (see figure 1).

When performing the tests in 5.16.1 and 5.16.2, the output or resultant signal shall be measured on the same relative pass for both the Master Standard Reference Tape and the tape under test, i.e. read-while-write or read-on-first-pass-after-write. The SRA shall be measured at the appropriate density.

5.16.1 Missing pulses

When a tape has been recorded on all tracks as specified in 5.12 and 5.13, and is played back on a system, each channel of which has been calibrated as in 5.14, a missing pulse shall be either:

- at 32 ftpmm (800 fpi), any signal from any track having a base-to-peak amplitude less than 50 % of half the SRA;
- at 126 ftpmm (3 200 fpi), any pair of consecutive output pulses from any track together having a peak-to-peak amplitude less than 35 % of the SRA;
- at 356 ftpmm (9 042 fpi), any signal from any track having a base-to-peak amplitude less than 35 % of half the SRA;

5.16.2 Extra pulses

Following DC-erasure of the tape on the machine used for conducting the missing pulse test as described in 5.16.1, any signal from any track when measured base-to-peak which exceeds 10 % of half the SRA shall be an extra pulse.

5.16.3 Allowable number of missing pulses and extra pulses

The allowable number of missing pulses and of extra pulses is not specified by this International Standard, but is a matter for agreement between interchange parties.

NOTE 5 It is considered impractical to specify this number for the following reasons:

- the performance of test equipment for magnetic tape is not uniform but depends on such things as tape tension, head design, and the method of guidance employed;
- different machines and systems of programming vary in their ability to tolerate missing and extra pulses on tapes.

5.17 Reflective markers

Each reel of tape shall be furnished with two photo-reflective markers, each consisting of, or equivalent to, a transparent plastic base with a metallic (for example, vaporized aluminium) coating sandwiched between the base and a thin layer of low cold flow thermal setting adhesive.

Reflective markers shall be placed on the side of the tape which does not carry the magnetic surface, and they shall be on opposite edges of the tape with the beginning-of-tape reflective marker (BOT) on the reference edge.

The width of the markers shall be $4,8 \text{ mm} \pm 0,5 \text{ mm}$ ($0,19 \text{ in} \pm 0,02 \text{ in}$).

The length of the markers shall be $28 \text{ mm} \pm 5 \text{ mm}$ ($1,1 \text{ in} \pm 0,2 \text{ in}$).

The thickness of the markers, measured after their application to the tape, shall be not greater than $0,020 \text{ mm}$ ($0,0008 \text{ in}$).

The beginning-of-tape reflective marker (BOT) shall be placed $4,9 \text{ m} \pm 0,6 \text{ m}$ ($16 \text{ ft} \pm 2 \text{ ft}$) from the beginning of the tape and the end-of-tape marker (EOT) shall be placed $7,6 \text{ m} \begin{smallmatrix} +22,9 \\ -0,0 \end{smallmatrix}$ ($25 \text{ ft} \begin{smallmatrix} +75 \\ -0 \end{smallmatrix}$) from the end of the tape and such that the tested area is at least $720,6 \text{ m}$ ($2\,363 \text{ ft}$) in length.

The distance from the outer edge of a marker to the adjacent edge of the tape shall be $0,8 \text{ mm}$ max. ($0,031 \text{ in}$ max.) and the marker shall not protrude beyond the edge of the tape.

The markers shall be free of wrinkles and excessive adhesive.

NOTE 6 It is desirable that the thinnest markers be employed which perform satisfactorily in minimizing the distortion of the layers of tape adjacent to them.

5.18 Cupping

Cupping is the departure across the width of tape from a flat surface. The maximum cupping of a $6,35 \text{ mm}$ ($0,25 \text{ in}$) long length of tape shall not exceed $0,25 \text{ mm}$ ($0,010 \text{ in}$) when placed concave side down on a smooth, flat surface. The time between cutting and the measurement should be 1 h .

5.19 Opacity

Opacity is a characteristic which limits the amount of transmission of light through the tape. The tape opacity shall not be less than 95% over the wavelength range from $0,4 \mu\text{m}$ to $1,5 \mu\text{m}$ ($16 \mu\text{in}$ to $59 \mu\text{in}$).

5.20 Resistance

The electrical resistance of the magnetic surface shall be within the range of $5 \times 10^5 \Omega$ to $5 \times 10^8 \Omega$.

5.21 Reflectivity

5.21.1 Marker reflectivity

The photo-reflective marker shall possess a reflectivity of at least 90% compared to a reference standard, at a 60° angle of incidence of light and over the range of wavelengths from $0,4 \mu\text{m}$ to $1,5 \mu\text{m}$ ($16 \mu\text{in}$ to $59 \mu\text{in}$).

The reference standard shall be constructed from a piece of aluminium Al-Mg 1 Si Cu (see ISO 209-1) with a flat face dimension of 30 mm ($1,2 \text{ in}$) by 5 mm ($0,20 \text{ in}$) with a surface roughness R_a (arithmetical mean deviation) between $0,008 \mu\text{m}$ ($0,32 \mu\text{in}$) and $0,016 \mu\text{m}$ ($0,63 \mu\text{in}$) (see ISO 468). The standard should be resurfaced periodically to prevent a reflectivity shift due to oxidation.

5.21.2 Tape backing reflectivity

The tape backing shall possess a reflectivity not exceeding 30% of that of the reference standard when measured under the conditions specified in 5.21.1.

5.22 Dynamic frictional characteristics

The force specified in 5.22.1.1, 5.22.2.1, 5.22.3.1 and 5.22.4.1 shall be the sum of the forces exerted by the 65 g ($2,3 \text{ oz}$) mass and the dynamic friction.

5.22.1 Oxide coating to brass and chrome

5.22.1.1 Requirement

The force shall be $1,28 \text{ N}$ max. ($4,6 \text{ ozf}$ max.).

5.22.1.2 Procedure

The sample shall be pulled at 50 mm (2 in) per minute over a brass (chrome) cylinder (90-degree wrap) of diameter 25 mm (1 in) with a 65 g ($2,3 \text{ oz}$) mass on the other end of the tape. The force versus time (or force versus distance) shall be plotted. Particular attention should be given to keeping the samples clean and maintaining the brass (chrome) cylinder finish [$0,13 \mu\text{m}$ to $0,26 \mu\text{m}$ ($5 \mu\text{in}$ to $10 \mu\text{in}$) peak-to-peak].

5.22.2 Oxide coating to tape back surface

5.22.2.1 Requirement

The force shall be $0,78 \text{ N}$ min. ($2,8 \text{ ozf}$ min.).