INTERNATIONAL STANDARD

ISO/IEC 1863

Second edition
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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)

Traitement de l'information — Bande magnétique à 9 pistes de 12,7 mm (0,5 in) *de large, pour l'échange d'information, employant NRZ1 à* 32 ftpmm (800 ftpi) — 32 cpmm (800 cpi)

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 1863 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

This second edition cancels and replaces the first edition (ISO 1863 : 1976), which has been technically revised.

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

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)

1 Scope

This International Standard specifies a format and recording standard for 9-track, 12,7 mm (0,5 in) magnetic tape to be used for data interchange between information processing systems, communication systems, and associated equipment utilizing the 7-bit coded character set (see ISO 646), its extension in ISO 2022 where required, and the 8-bit coded character set (see ISO 4873). Magnetic labelling for use on magnetic tape is the subject of ISO 1001. The magnetic tape and reel to be used shall conform to ISO 1864 and/or ISO 8064.

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 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 646 : 1983, *Information processing — ISO 7-bit coded character set for information interchange.*

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

ISO 1864 : 1985, *Information processing — 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.*

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

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

ISO 8064 : 1985, *Information processing — Reels for* 12,7 mm (0,5 in) *wide magnetic tapes — Sizes 16, 18 and 22.*

3 Definitions

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

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

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

3.3 Master Standard Reference Tape: A reference tape selected as a standard for signal amplitude.

NOTE — A Master Standard Reference Tape has been established by the US National Institute for Standards and Technology (NIST).

3.4 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 available from NIST (Office of Standard Reference Materials, Room B 311, Chemistry Building, NIST, Gaithersburg, Md 20899, USA) under part number SRM 3200.

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

3.5 Typical Field: In the plot of Average Signal Amplitude against recording field at the specified flux transition density, the Typical Field 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 recording density.

3.7 Standard Reference Amplitude: The average peak-to-peak signal amplitude derived from the Master Standard Reference Tape on the NIST measurement system under the recording conditions specified in 5.6.1.

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

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

3.12 physical recording density: The number of recorded flux transitions per unit length of track [ftpmm (ftpi)].

3.13 data density: The number of data characters stored per unit length of tape [cpmm (cpi)].

3.14 skew: Within a row, the maximum displacement of any location from any other location measured as the distance between two perpendiculars to the reference edge through said locations.

4 General requirements

4.1 Operating environment

Tapes 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: not greater than 25 °C (78 °F).

Conditioning before operating: If a tape has been exposed during storage and/or transportation to conditions outside the above values, it should be conditioned for a period of 2 h to 12 h depending upon the extent of exposure.

4.2 Storage and transportation

The recommendations for storage and transportation environment are specified in annex C.

Responsibility for ensuring that adequate precautions against damage are taken during shipment shall be with the sender (see annex C).

4.3 Wind tension

For interchange, the tape winding tension shall be between 2,0 N and 3,6 N (7 ozf to 13 ozf).

5 Recording

5.1 Method of recording

The "non return to zero change-on-ones recording" (NRZ1) method of recording shall be used where a ONE is represented by a change of direction of longitudinal magnetization.

5.2 Density of recording

The nominal density shall be designated by 32 ftpmm (800 ftpi). The actual density shall be 31,5 ftpmm (800 ftpi). The resulting nominal flux transition spacing is 31,75 µm (1 250 µin).

5.3 Average flux transition spacing

The average flux transition spacing shall be within ± 3 % of 31,75 µm (1 250 µin). This average shall be measured over a minimum of $1{,}2 \times 10^5$ successive flux transitions, at the extremes of operating conditions, by reading a tape that has been continuously and evenly recorded at 31,5 ftpmm (800 ftpi) in phase in all tracks.

5.4 Instantaneous flux transition spacing

The instantaneous spacing between flux transitions may be influenced by the reading and writing processes, the pattern recorded (pulse crowding effects) and other factors. Measurements are taken from leading edge to leading edge of flux transitions.

The following conditions shall all be met.

a) The spacing between the first detected bits of successive rows shall be greater than 22,9 µm (900 µin);

b) The spacing between the first detected bit and the last detected bit of a row shall be less than 10,8 µm (425 µin);

c) There shall be a minimum apparent spacing between any bits of successive rows of 11,2 µm (440 µin).

5.5 Static skew

The static skew shall be less than 3,81 µm (150 µin). This condition is required to be satisfied for both flux transition polarities.

5.6 Signal amplitude

5.6.1 Standard Reference Amplitude

The Standard Reference Amplitude is the average peak-to-peak signal amplitude derived from the Master Standard Reference Tape on the qualified measurement system at the density of 32 ftpmm (800 ftpi) and the recording current I_r of $2{,}1 \times I_f$.

The signal amplitude shall be averaged over 4 000 flux transitions, and shall be measured on the read-while-write pass. The reference current I_f is the minimum current which produces the Reference Field.

5.6.2 Average signal amplitude

The average peak-to-peak output signal amplitude of an interchanged tape at 32 ftpmm (800 ftpi) shall be between 70 % and 115 % of the Standard Reference Amplitude.

Averaging shall be done over a minimum of 4 000 flux transitions which, for the interchange tape, may be segmented into blocks. Averaging shall be done on the first read pass after interchange.

5.6.3 Maximum signal amplitude

An interchanged tape shall contain no flux transition the base-to-peak signal amplitude of which exceeds 120 % of one-half the Standard Reference Amplitude on the first read pass after interchange.

5.6.4 Minimum signal amplitude

An interchanged tape shall contain no flux transition the base-to-peak signal amplitude of which is less than 35 % of one-half the Standard Reference Amplitude on the first read pass after interchange.

5.7 Erasure

5.7.1 Erase direction

When erased, the rim end of the erased area of the tape shall be magnetized so that it is a North-seeking pole and the hub end of the erased area is a South-seeking pole (see annex B).

5.7.2 Erase width

The full width of the tape shall be d.c.-erased in the direction specified in 5.7.1.

5.7.3 Residual signal

The tape shall be erased so that any residual signals, including NRZ1 at 32 ftpmm (800 ftpi) and 356 ftpmm (9 042 ftpi) and phase encoding at 126 ftpmm (3 200 ftpi) are less than 4 % of the Standard Reference Amplitude at 32 ftpmm (800 ftpi).

6 Track configuration

6.1 Number of tracks

There shall be nine tracks.

6.2 Track identification

Tracks shall be numbered consecutively beginning at the reference edge with track 1 (see figure 1).

6.3 Track positions

The distance from the centrelines of the tracks to the reference edge shall be

Track 1: 0,74 mm (0,029 in)
Track 2: 2,13 mm (0,084 in)
Track 3: 3,53 mm (0,139 in)
Track 4: 4,93 mm (0,194 in)
Track 5: 6,32 mm (0,249 in)
Track 6: 7,72 mm (0,304 in)
Track 7: 9,12 mm (0,359 in)
Track 8: 10,52 mm (0,414 in)
Track 9: 11,91 mm (0,469 in)

The tolerance shall be ± 0,08 mm (0,003 in) for all tracks.

6.4 Track width

The width of a written track shall be

1,09 mm min. (0,043 in min.)

7 Data representation

7.1 Coded representation of characters

Characters shall be represented by means of the 7-bit coded character set (see ISO 646), the 8-bit coded character set (see ISO 4873) or, where required, of an extension of the 7-bit coded character set (see ISO 2022).

The bit-to-track allocation shall be as follows:

7.1.1 7-bit coded characters

Binary weight	2^0	2^1	2^2	2^3	2^4	2^5	2^6	–	–
Bit designation	b_1	b_2	b_3	b_4	b_5	b_6	b_7	–	P
Track	2	8	1	9	3	5	6	7	4

Track 7 shall always be recorded with bit ZERO. Bit P in track 4 shall be the parity bit. The parity shall be odd.

7.1.2 8-bit coded characters

Binary weight	2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	–
Bit designation	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	P
Track	2	8	1	9	3	5	6	7	4

Bit P in track 4 shall be the parity bit. The parity shall be odd.

7.2 Representation of binary data

When the coding method requires it, the coded representations recorded in data rows shall be regarded as a set of bit positions, each containing a bit, which can be either a ZERO or a ONE.

The binary weights, bit designations and track allocation shall be given in 7.1.

8 Format of the tape

8.1 Block structure

All data blocks shall consist of a data portion followed by a Cyclic Redundancy Check character (CRC) and a Longitudinal Redundancy Check character (LRC).

8.2 Length of the data portion

The data portion of a data block shall consist of at least 18 characters and at most of 2 048 characters. However, larger blocks may be used by agreement between the interchanging parties.

8.3 Cyclic Redundancy Check character (CRC)

The Cyclic Redundancy Check character, CRC, shall be hardware-generated by shifting serially the relevant bits as specified in annex A through a 9-bit shift register described by the generator polynominal

$$x^9 + x^6 + x^5 + x^4 + x^3 + 1$$

8.4 Longitudinal Redundancy Check character (LRC)

The Longitudinal Redundancy Check character, LRC, shall have a ONE in all tracks in which the longitudinal count would otherwise be odd, else a ZERO.

8.5 Gaps

8.5.1 Initial gap

Between the hub end of the BOT marker and the first recorded character of the first block there shall be a gap with a length of 76 mm min. (3 in min.) and 7 600 mm max. (300 in max.). It shall be erased in accordance with 5.7.

8.5.2 Interblock gap

The length of interblock gaps shall be

- 15 mm nom. (0,6 in nom.)
- 12,7 mm min. (0,5 in min.)
- 7 600 mm max. (300 in max.).

This gap shall be erased in accordance with 5.7. The actual gap length depends on the number of consecutive erase instructions.

8.5.3 CRC gap

There shall be a gap of 0,127 mm ± 0,013 mm (0,005 in ± 0,000 5 in) between the last recorded data character and the CRC.

8.5.4 LRC gap

There shall be a gap of 0,127 mm ± 0,013 mm (0,005 in ± 0,000 5 in) between the CRC and the LRC characters.

8.6 Tape Mark

The Tape Mark shal be a control block comprising

- a row with ONEs in tracks 2, 3 and 8 and erasure in tracks 1, 4, 5, 6, 7 and 9;
- a CRC gap;
- a CRC character containing only ZEROs;
- an LCR gap;
- an LCR character.

A Tape Mark shall be separated from other blocks by an interblock gap. The use of Tape Marks is specified in ISO 1001.

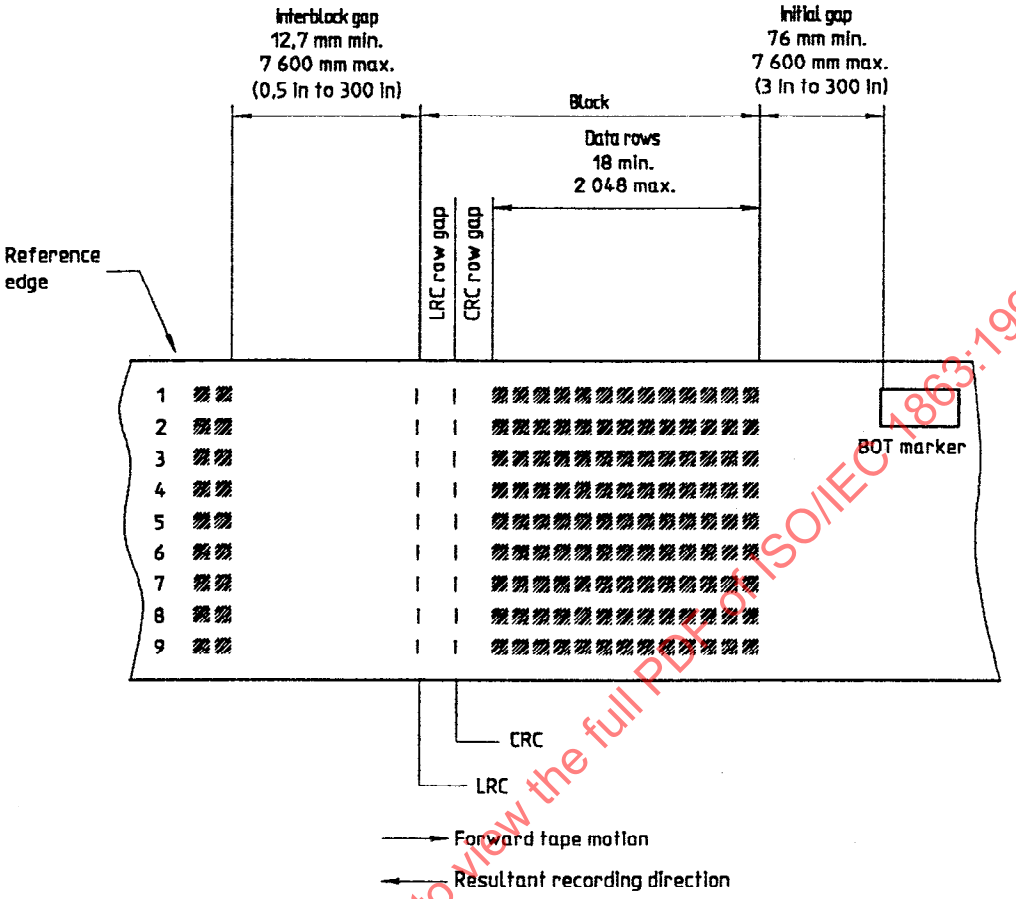
9 Quality of recording for data interchange

Tape shall not be used for data interchange where the number of gaps which have been elongated due to erase instructions exceed two in number or 0,5 % of the total number of blocks written, whichever is the larger.

No permanent parity errors whilst writing are permissible in the data to be interchanged.

10 Erasure of ID bursts

The use of tapes recorded at 63 cpmm (1 600 cpi) and 246 cpmm (6 250 cpi) for recording at 32 cpmm (800 cpi) presents a difficulty in that the identification burst on such a tape extends from a minimum of 43,2 mm (1,7 in) before the trailing edge of the BOT marker. To ensure proper working of the 32 cpmm (800 cpi) system, it is necessary for the burst to be erased, either by the system itself or by bulk erasure.



Note - Tape is shown with magnetic surface towards observer. Read-write head on same side as magnetic surface.

Figure 1 — Track layout

Annex A
(normative)

CRC register

A.1 Generation

Consider the contents of a 9-position register to be C_1 to C_9 with the following track assignments:

Register position: C_1 C_2 C_3 C_4 C_5 C_6 C_7 C_8 C_9

Track number: 4 7 6 5 3 9 1 8 2

The CRC character shall be derived as follows:

a) all data rows in the block are added to the CRC register without carry (exclusive OR);

b) between additions, the CRC register is shifted by one position: C_1 to C_2, etc., and C_9 to C_1;

c) if shifting will cause C_1 to contain ONE, then the bits being shifted into positions C_4, C_5, C_6, and C_7 are inverted;

d) after the bits of last data character have been added, if shifting will cause C_1 to become ONE, then the CRC register is shifted once more in accordance with b) and c);

e) to write the CRC character on tape, the contents of all positions except C_4 and C_6 are inverted. The parity of the CRC character will be odd if the number of data characters within the block is even, and even if the number of data characters within the block is odd. The CRC character may contain only ZEROs, in which case the number of data characters is odd.

A.2 CRC register

When reading, the CRC register is controlled as it was for writing until the last data character has been added and the final shift made. The CRC character on tape is then added to the register.

To test for an error, the register is read out inverting all positions except C_4 and C_6. If the masked output of any position is a ONE, an error has been detected.

To determine whether the errors occurred in a single track, and if so, which, an error pattern (EP) must be generated. This pattern must then be compared with the error indicating pattern in the CRC register.

Consider the contents of a 9-position EP register to be E_1 to E_9 corresponding to C_1 to C_9 of the CRC register. The error pattern may be constructed as follows:

a) whenever a character parity error is detected for a data character or for the CRC character, a ONE is added without carry to E_9 (exclusive OR);

b) between the reading of characters, the EP register is shifted by one position: E_1 to E_2, etc., and E_9 to E_1;

c) if shifting will cause E_1 to contain ONE, then the bits being shifted into positions E_4, E_5, E_6 and E_7 are inverted.

To determine the track in error, a series of comparisons is made between the contents of the EP register and the CRC register. The CRC register, read out through the mask which inverts all positions except C_4 and C_6 is compared with the EP register.

The first comparison is direct: E_1 to C_1, E_2 to C_2, etc. If all positions match, the error was in the track associated with C_9 (track 2).

The CRC register is then shifted once, according to A.1 b) and A.1 c) between each comparison. This is continued until a match is obtained or until a maximum of nine comparisons (eight shifts) have been made. The track in error corresponds to C_9 through C_1 for a match on the first through ninth comparison respectively.

There are two conditions for the final contents of the CRC register for which an uncorrectable error has been detected and for which an incorrect track-in-error indication will be obtained if comparisons are made. These are as follows:

a) C_1 to C_9 contain ZEROs;

b) C_4 to C_6 contain ZEROs, all other positions containing ONEs (the read-out mask).

If a track-in-error indication is obtained, the error block may be re-read. The output of the track in error is then inverted whenever the parity of a character is incorrect.

Annex B
(informative)

Determination of the erase magnetic field direction

B.1 Principle

The beginnings of a correctly erased tape must exhibit a North-seeking pole (see 5.7.1). When the point of a compass needle which normally indicates North is placed in close proximity to the rim end of a correctly erased tape, the needle will be deflected away from the tape.

B.2 Method of test

A section of the erased area of the tape shall be cut in such a way that the end toward the rim end of the tape is identifiable. This end of the cut section is brought as close as possible to the compass needle and the presence or absence of deflection of the needle away from the tape is determined.