ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 1863

9-TRACK 32 RPmm (800 RPI) MAGNETIC TAPE
FOR INFORMATION INTERCHANGE

1st EDITION

May 1971

BRIEF HISTORY

The ISO Recommendation R 1863, *9 track 32 RPmm (800 RPI) magnetic tape for information interchange*, was drawn up by Technical Committee ISO/TC 97, *Computers and information processing*, the Secretariat of which is held by the American National Standards Institute (ANSI).

Work on this question led to the adoption of Draft ISO Recommendation No. 1863, which was circulated to all the ISO Member Bodies for enquiry in December 1969. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Italy	Switzerland
Belgium	Japan	Turkey
Brazil	Netherlands	U.A.R.
Czechoslovakia	New Zealand	U.S.A.
France	Portugal	U.S.S.R.
Greece	Spain	
Israel	Sweden	

The following Member Bodies opposed the approval of the Draft :

Germany
United Kingdom

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

FOREWORD

I. This ISO Recommendation presents the standard technique for recording the ISO 6 and 7-bit coded character sets for information precessing interchange on 9-track magnetic tape at 32 rows per millimetre (RPmm) [800 rows per inch (RPI)] using the "non-return to zero" (NRZI) recording technique. It is one of a series of ISO Recommendations implementing the ISO 6 and 7-bit codes in media.

In the development of this ISO Recommendation, careful consideration was given to current practices, existing equipment and supplies, and the broadest possible acceptance while providing a basis for future improvement in the use of the medium.

II. In previous standards for the interchange of data on magnetic tape, the problems encountered due to packing density of 8 rows per millimetre (RPmm) [200 rows per inch (RPI)] have not created any serious difficulty with respect to the definitions or the quantitative values assigned to the various parameters.

Some of the difficulties and technical shortcomings which had to be faced in the preparation of this ISO Recommendation are listed below.

(a) The positioning of the data on the tape is very dependent on the particular guidance geometry of the tape transport.

(b) The coating thickness of the tape has an appreciable effect on the position of bits due to the pulse crowding factor on the tape as specified.

(c) The characteristics of the head and in particular the crosstalk factor.

(d) The initial transient conditions as the tape is started from rest.

(e) The problem of defining and utilizing the reference edge.

(f) Speed variations at the time of writing and reading which could also include different nominal speeds.

(g) Timing constraints due to coding and pattern sensitivity.

It is important to recognize, in the light of these difficulties, that the write-check by the control device is the most practical method of measuring the quality of the written tape. This ISO Recommendation therefore includes certain definitions and quantitative values which represent the most meaningful checks that can be provided at the present time.

When magnetic tape is read by the recipient, certain additional factors of tape dynamics will have to be considered.

ISO Recommendation	R 1863	May 1971

9-TRACK 32 RPmm (800 RPI) MAGNETIC TAPE

FOR INFORMATION INTERCHANGE

1. SCOPE

This ISO Recommendation gives specifications relating to format and recording for 9-track 12.7 mm (1/2 in) wide magnetic tape and reels to be used for information interchange among information processing systems, communication systems, and associated equipment utilizing the 7-bit coded character set specified in ISO Recommendation R 646.

NOTES

1. Certain other aspects of coding requirements, such as significance of binary digits, sequence of characters, filling of unused positions and magnetic labelling for use on magnetic tape, are the subject of the following ISO Recommendations :

   — ISO/R 962, *Implementation of the 7-bit coded character set on 9-track 12.7 mm (1/2 in.) magnetic tape;*

   — ISO/R 1001, *Magnetic tape labelling and file structure for information interchange.*

2. Details of unrecorded tape and reels are specified in the complementary ISO Recommendation, R 1864, *Unrecorded magnetic tape for information interchange — 8 and 32 RPmm (200 and 800 RPI), NRZI, and 63 RPmm (1600 RPI), phase-encoded.*

2. DEFINITIONS OF TERMS

NOTE. — The material contained in this section is taken from ISO Recommendation R 1864 for unrecorded magnetic tape.

For the purpose of this ISO Recommendation the following definitions apply :

2.1 *Magnetic tape.* Tape which will accept and retain magnetic signals intended for input, output and storage purposes on computers and associated equipment.

2.2 *Reference tape.* A tape which has been selected for given properties for use in calibration.

2.3 *Secondary reference tape.* A tape intended for routine calibrating purposes, whose performance is known and is stated in relation to that of a reference tape.

2.4 *Reference field.* For any specified packing density, the minimum field applied to the reference tape which causes an output signal equal to 95 % of the maximum output.

2.5 *Reference signal level.* The signal level which is obtained from a reference tape.

2.6 *In contact.* An operating condition in which the oxide side of a tape is in contact with a magnetic head.

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

2.8 *Packing density.* The number of bits of recorded information per unit length of track.

2.9 *Reference edge.* The edge farthest from an observer, or nearest the top of a page, when a tape is lying flat with the oxide side uppermost and the direction of movement for recording from left to right. (See Figures 1 and 2.)

3. REFLECTIVE MARKERS (See Figure 3)

NOTE. – The material contained in this section is taken from ISO Recommendation R 1864 for unrecorded magnetic tape.

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 (e.g. 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 oxide coating, 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 ± 0.5 mm (0.19 ± 0.02 in).

The length of the markers shall be 28 ± 5 mm (1.1 ± 0.2 in).

The thickness of the markers measured after their application to the tape shall be not greater than 0.020 mm (0.0008 in).

The beginning-of-tape reflective marker (BOT) shall be placed 4.6 ± 0.3 m (15 ± 1 ft) from the beginning of the tape and the end-of-tape marker (EOT) shall be placed $7.6^{+1.5}_{0}$ m (25^{+5}_{0} ft) from the end of the tape.

The distance from the outer edge of a marker to the adjacent edge of the tape shall be 0.8 mm (0.03 in) maximum, and the marker shall not protrude beyond the edge of the tape.

The markers shall be free of wrinkles and excessive adhesive. The surface of the reflective markers shall be non-conductive.

NOTE. – It is desirable to employ the thinnest markers which perform satisfactorily to minimize the distortion of layers of tape adjacent to them.

4. DIRECTION OF WIND (See Figure 4)

On a reel of tape used for data interchange, the tape shall be wound with the oxide coating innermost and the reference edge towards the front, i.e. away from the write-enable ring.

NOTE. – This means that the tape will be wound in a clockwise direction from the end (nearest the hub) to the start (outer end) if the reel is viewed from the front.

5. WIND TENSION

For interchange purposes, a tape shall be wound at a tension not less than 1.5 N and not greater than 3 N (5 to 10 ozf approximately).

6. REFERENCE EDGE

The reference edge shall be used for determining the position of the tracks and rows on tape, within the requirements of this ISO Recommendation.

7. TRACK IDENTIFICATION

NOTE. – The contents of this section are in accordance with ISO Recommendation R 962, *Implementation of the 7-bit coded character set on 9-track 12.7 mm (1/2 in) magnetic tape.*

Tracks shall be numbered consecutively, beginning at the reference edge with track No. 1, and shall be assigned as follows :

MT track	1	2	3	4	5	6	7	8	9
Environment bit	E_3	E_1	E_5	P	E_6	E_7	E_8	E_2	E_4
Binary value	2^2	2^0	2^4	P	2^5	2^6	2^7	2^1	2^3

Bit "P" is the parity bit. Row parity is odd.

8. TRACK CONFIGURATION

The written track width shall be 1.09 mm (0.043 in) minimum. The distance from the centreline of any track to the reference edge shall be $0.74 + (n-1)\ 1.397 \pm 0.08$ mm $[0.029 + (n-1)\ 0.055 \pm 0.003$ in] where n is the track number. (See Figures 1 and 2.)

9. DENSITY OF RECORDING

The nominal density shall be 32 rows per millimetre (800 rows per inch) of track.

10. SPACING OF ROWS

The average written row spacing variation allowed should be $\pm 3\%$ of the nominal spacing of 31.75 μm (1 250 μin). The capability of a machine in this respect shall be measured over a distance of 3.8 m (150 in), at the extremes of operating conditions, reading in continuously and evenly recorded tape with 32 in-phase flux-reversals per millimetre (800 per inch) in all tracks.

For the purpose of defining the location of recorded data on the tape, the position of a flux-reversal representing a binary "one" is defined as the point of maximum free-space surface flux density, normal to the tape surface.

11. SKEW

Skew is defined as the deviation of the bits within the recorded row during reading from time coincidence (converted to apparent length) when measured in the control device.

11.1 Static skew

The equipment used for recording tapes at 32 RPmm (800 RPI) must be capable of recording 3.81 μm (150 μin) or less absolute static skew. This capability shall be measured on a tape which has been recorded continuously with 32 in-phase flux-reversals per millimetre (800 per inch) in all tracks. This maximum static deviation within a character is the value of static recorded skew. Both character polarities must meet the criterion.

11.2 Write quality check

During the writing of a 32 RPmm (800 RPI) interchange tape, the write-check operation will determine bit timing (converted to apparent length) and signal amplitude.

NOTE. – On equipment that is not capable of reading during the write pass, bit timing and signal amplitude may be checked on the first read pass.

(1) *Bit timing* (converted to apparent length)

To determine bit timing, from leading edge to leading edge, the following conditions must be considered together :

(a) The timing between the first detected bit of successive rows is measured greater than a design centre value which shall exceed 22.9 μm (900 μin).

(b) The timing between the first detected bit and the last detected bit of a row is measured less than a design centre value which shall not exceed 10.8 μm (425 μin).

(c) There shall be a minimum apparent space between any bits of successive rows of 11.2 μm (440 μin).

(2) *Signal amplitude*

No "1" bit amplitude level is less than 35 % of the average signal level on the write quality check.

12. BLOCK LENGTH

All blocks for data interchange shall consist of not less than 18 data rows and not more than 2048 data rows and, in addition, a cyclic redundancy check row (see section 13) and a longitudinal check row (see section 14).

13. CYCLIC REDUNDANCY CHECK ROW

At the end of each tape block, a character shall be written on tape for the possible recovery of single track errors. This character shall be called the cyclic redundancy check (CRC) character. In tape mark blocks, zero bits are written in all tracks for the CRC character.

13.1 The track assignments corresponding to positions C_1 to C_9 of a register are the following :

Register position	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
Track	4	7	6	5	3	9	1	8	2

13.2 The CRC character shall be derived as follows :

(1) All data rows in the tape block are added to the CRC register without carry (each bit position is exclusive OR'ed to C_n).

(2) Between additions, the CRC register is shifted one position :

C_1 to C_2 etc., and C_9 to C_1.

(3) If shifting will cause C_1 to become "1", then the bits being shifted into positions C_4, C_5, C_6 and C_7 are inverted.

(4) After the last data row has been added, the CRC register is shifted once more in accordance with paragraphs (2) and (3) above.

(5) 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 all zero bits, in which case the number of data rows is odd.

14. LONGITUDINAL REDUNDANCY CHECK ROW

Following the CRC character, an additional checking character shall be written for the further possible detection of read errors. This character shall be called the longitudinal redundancy check (LRC) character. A longitudinal check bit is written in any track if the longitudinal count is otherwise odd.

15. ERASE

15.1 *Erase direction* : When erased, tape shall be so magnetized that the beginning of tape is a north-seeking pole and the end of tape is a south-seeking pole. (See Figure 3.)

15.2 The full width of the tape is DC erased in the direction specified in clause 15.1.

16. GAPS (See Figures 1 and 2)

16.1 Inter-block gap

The gap shall be

12.7 mm (0.50 in)   minimum;
15   mm (0.6 in)   nominal;
7.6 m   (25 ft)   maximum.

(Gaps depend upon the number of consecutive erase instructions.)

16.2 Initial gaps

The gap between the trailing edge of the BOT marker and the first recorded row shall be 75 mm (3 in) minimum and 7.6 m (25 ft) maximum.

16.3 Cyclic redundancy check row gap

There shall be a gap of 0.127 mm ± 10 % (0.005 in ± 10 %) between the last row of the recorded data and the cyclic redundancy check row. (See section 13.)

16.4 Longitudinal redundancy check row gap

There shall be a gap of 0.127 mm ± 10 % (0.005 in ± 10 %) between the CRC row and the longitudinal check row.

17. METHOD OF RECORDING

The "non-return to zero mark" (NRZI) method of recording shall be used where a "one" is represented by a change of direction of longitudinal magnetization. The recording field shall be not less than 47 % above the reference field.

When erased, tape shall be so magnetized that the beginning of tape is a north-seeking pole and the end of tape is a south-seeking pole. This criterion shall apply also to inter-block gaps. The full width of the tape is DC erased in the specified direction.

18. QUALITY OF RECORDING FOR DATA INTERCHANGE

Information written must be valid at 35 % of the reference signal level, at the time of the first read-after-write. Tape shall not be employed for data interchange where the number of gaps which have been elongated due to erase instruction exceeds two in number or 0.5 % of the total number of blocks written, whichever is the larger.

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

19. DATA CONTENT

All 256 bit combinations are permissible in the eight data tracks of each row.

20. CONTROL CHARACTERS

For the purpose of separating data, a single row control block (known as a Tape Mark) shall be allowed. This block shall be accompanied by a longitudinal check row. The Tape Mark shall be represented by "1" bits in tracks 2, 3 and 8 only. The CRC character for Tape Mark blocks shall contain all zero bits.
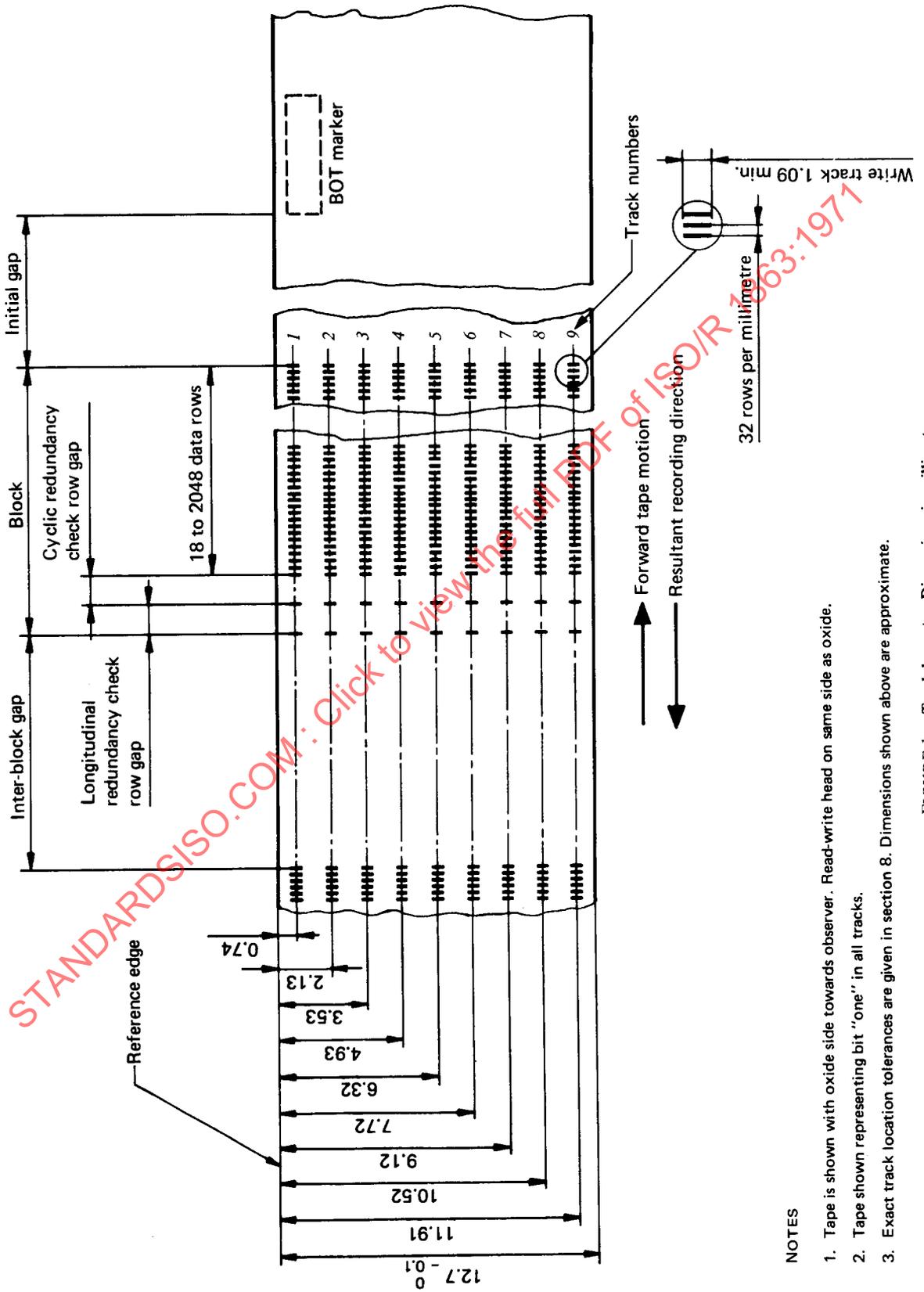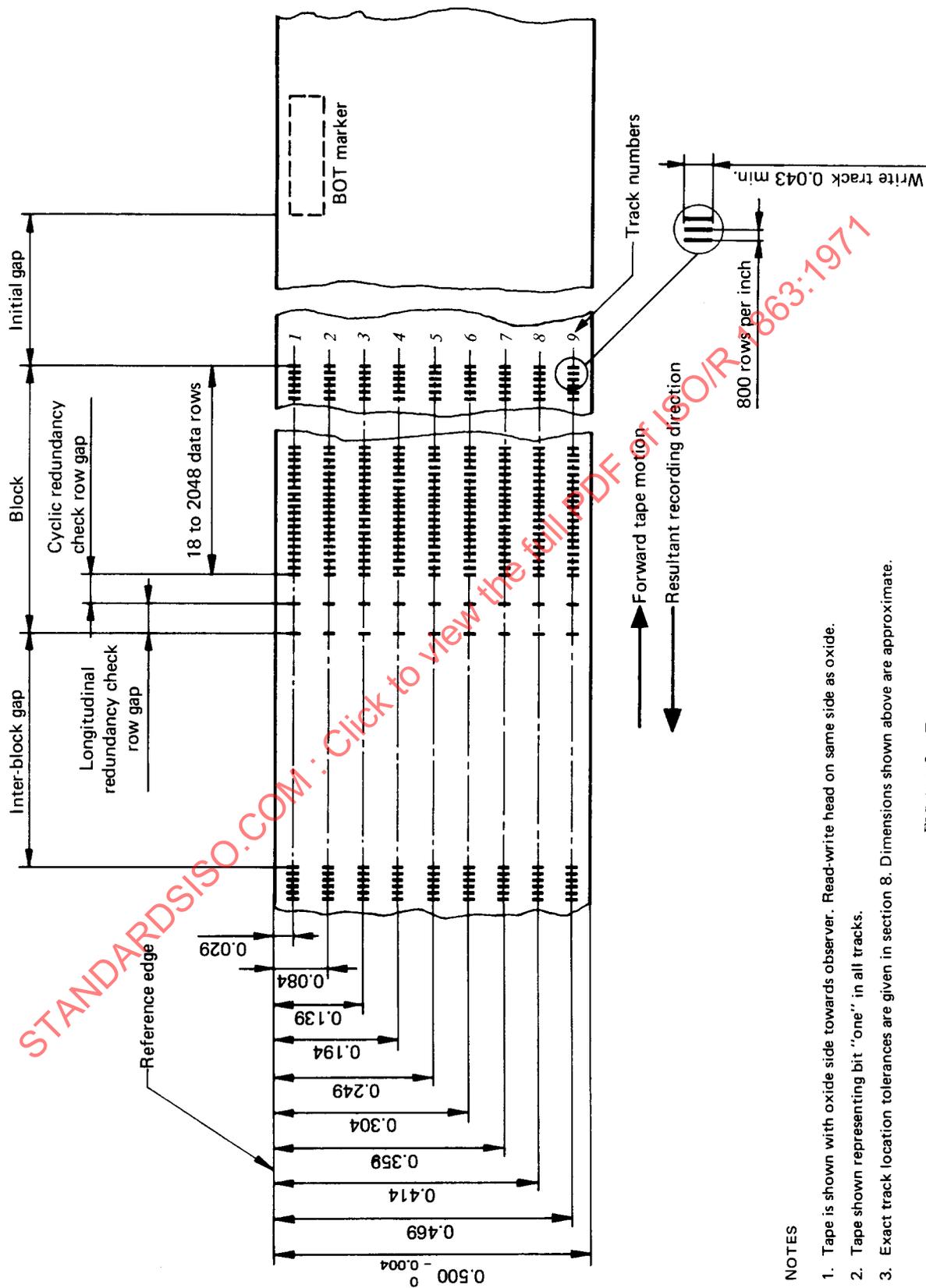
FIGURE 1 – Track layout – Dimensions in millimetres

NOTES

1. Tape is shown with oxide side towards observer. Read-write head on same side as oxide.

2. Tape shown representing bit "one" in all tracks.

3. Exact track location tolerances are given in section 8. Dimensions shown above are approximate.

FIGURE 2 — Track layout — Dimensions in inches

NOTES

1. Tape is shown with oxide side towards observer. Read-write head on same side as oxide.

2. Tape shown representing bit "one" in all tracks.

3. Exact track location tolerances are given in section 8. Dimensions shown above are approximate.