International Standard 4057

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Information processing — Data interchange on 6,30 mm (0.25 in) magnetic tape cartridge, 63 bpmm (1 600 bpi) phase-encoded

Traitement de l'information — Cassette de bande magnétique de 6,30 mm (0,25 in) *pour l'échange d'information par codage de phase à* 63 bpmm (1 600 bpi)

Second edition — 1986-07-15

UDC 681.327.64 **Ref. No. ISO 4057-1986 (E)**

Descriptors : data processing, information interchange, magnetic tapes, 6,3 mm magnetic tapes, cassettes for magnetic tapes, equipment specifications, dimensions, testing conditions, operating requirements, recording characteristics, equipment protection, files.

Price based on 33 pages

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.

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 4057 was prepared by Technical Committee ISO/TC 97, *Information processing systems.*

ISO 4057 was first published in 1979. This second edition cancels and replaces the first edition, of which it constitutes a minor revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Printed in Switzerland

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Information processing — Data interchange on 6,30 mm (0.25 in) magnetic tape cartridge, 63 bpmm (1 600 bpi) phase-encoded

1 Scope and field of application

This International Standard specifies the characteristics of a 6,30 mm (0.25 in) magnetic tape cartridge intended for data interchange and physical interchangeability between information processing systems utilizing the ISO 7-bit coded character set (ISO 646), its extensions (ISO 2022) and/or the 8-bit coded character set (ISO 4873).

The cartridge is of the twin-hub coplanar type, loaded with a 6,30 mm (0.25 in) magnetic tape for digital recording using the 63 bpmm[1] (1 600 bpi[2]) phase-encoding method. The tape is transported between hubs by an internal belt capstan to the external drive. No tape driving or position sensing elements penetrate the cartridge. The direction of magnetization is in the longitudinal direction of the tape.

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

NOTE — Numeric values in the SI and/or Imperial measurement system in this International Standard may have been rounded 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 References

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

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

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

3 Definitions

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

3.1 magnetic tape: A tape which accepts and retains magnetic signals intended for input/output and storage purposes of information processing and associated systems.

3.2 Reference Tape Cartridge: A tape cartridge selected for a given property for calibrating purposes.

3.3 secondary reference tape cartridge: A tape cartridge intended for routine calibrating purposes, the performance of which is known and stated in relation to that of the Reference Tape Cartridge.

3.4 Signal Amplitude Reference Tape Cartridge: A reference tape cartridge selected as a standard for signal amplitude and reference field.

NOTE — A Master Standard (Computer Amplitude Reference) Cartridge has been established at the US National Bureau of Standards (NBS). Secondary Standard Signal Amplitude Reference Tape cartridges are available from NBS[3] under Part Number SRM 3216.

1) Bits per millimetre.

2) Bits per inch.

3) NBS, Office of Standard Reference Materials, Room 311, Chemistry Building, Gaithersburg, MD 20899, USA.

3.5 reference field: The minimum field which, when applied to the Signal Amplitude Reference Tape Cartridge, causes a signal output equal to 95 % of the maximum signal output at the specified test packing density (see 4.3.1).

3.6 Test Recording Current: A recording current between 145 % and 155 % of the current required to produce the Reference Field.

3.7 Standard Reference Amplitude (SRA): The average peak-to-peak signal amplitude derived from the Signal Amplitude Reference Tape Cartridge, at a density of 126 ftpmm (3 200 ftpi) using the test recording current (see 3.6). The signal amplitude shall be averaged over 4 000 flux transitions (see 5.3).

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 physical contact with a magnetic head.

3.10 track: A longitudinal area of 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 position which exhibits the maximum free space flux density normal to the tape surface.

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

3.14 Reference Alignment Tape Cartridge: A tape cartridge containing a tape on which continuous information has been recorded.

A Reference Alignment Tape Cartridge is optimized for perpendicularity of the written flux transitions to the cartridge positioning plane.

3.15 typical field: The minimum field 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.

4 Environment and transportation

4.1 Testing environment

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

temperature	: 23 ± 2 °C (73 ± 4 °F)
relative humidity	: 40 % to 60 %
conditioning before testing	: 24 h min.
wet-bulb temperature	: 18 °C max. (64 °F max.)

4.2 Operating environment

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

temperature	: 5 to 45 °C (41 to 113 °F)
relative humidity	: 20 % to 80 %
wet-bulb temperature	: 26 °C max. (79 °F max.)

The temperature shall be measured in the air immediately surrounding the cartridge. Rapid temperature variations should be avoided.

There shall be no deposit of moisture on or in the cartridge.

It is recommended that the cartridge should be conditioned by exposure to the operating environment for a time at least equal to the period during which it has been out of the operating environment (up to a maximum of 8 h). If a user of a cartridge knows or suspects that it has been exposed to a drop in temperature exceeding 17 °C (30 °F) since last used, it is recommended that the tape be rewound one complete cycle on the tape transport before using the cartridge for data interchange.

4.3 Storage environment

During storage it is recommended that recorded cartridges be kept within the following conditions:

temperature	: 5 to 45 °C (41 to 113 °F)
relative humidity	: 20 % to 80 %
wet-bulb temperature	: 26 °C max. (79 °F max.)

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

4.4 Transportation

4.4.1 Transportation environment

During transportation, the cartridge may be exposed to conditions outside the operating environment. It is recommended that the following conditions are not exceeded:

temperature	: −40 to 45 °C (−40 to 113 °F)
relative humidity	: 20 % to 80 %
wet-bulb temperature	: 26 °C max. (79 °F max.)

4.4.2 Transportation procedures

Responsibility for ensuring that adequate precautions are taken during transportation shall be with the sender. For transportation a rigid container free from dust or extraneous matter shall be used. The final package shall have a clean interior and a construction preventing ingress of dust or water. It is recommended that sufficient space be provided between cartridge and outer surface of the final container, so that risk of damage due to stray magnetic fields will be negligible.

4.5 Flammability

Tape or cartridge components shall be made from materials that, if ignited from a match flame, do not continue to burn in a still carbon dioxide atmosphere.

4.6 Toxicity

Tape or cartridge components which may cause bodily harm by contact, inhalation or ingestion during normal use of the cartridge shall not be used.

5 Characteristics of the tape

5.1 Mechanical properties

5.1.1 Tape width

The width of the tape shall be

$6{,}30\ ^{0}_{-0{,}06}$ mm ($0.248\,0\ ^{0}_{-0.002\,5}$ in)

5.1.2 Tape length

The length of the tape between the LP and the EW markers (see 5.1.4) shall be

$91{,}4\ ^{+3{,}1}_{0}$ m ($300\ ^{+10}_{0}$ ft) for standard length (SL) cartridges

and $137{,}2\ ^{+4{,}6}_{0}$ m ($450\ ^{+15}_{0}$ ft) for long length (LL) cartridges.

5.1.3 Tape thickness

Approximate tape thickness shall be 30 µm (0.001 2 in) for the SL cartridge and 20 µm (0.000 8 in) for the LL cartridge.

Absolute limits are controlled through other characteristics of the tape.

5.1.4 Markers

In the tape there shall be a number of markers, the relative positions of which are shown in figure 1.

5.1.4.1 Beginning-of-tape (BOT)

A BOT marker shall be a pair of circular holes punched in the tape. There shall be three such markers, the innermost of which is used for the purpose of identifying the storage position for the cartridge. In the storage position, all of the usable recording area shall be wound on the supply hub and shall be protected by at least one layer of tape. The other two markers are used to ensure reliability of detection.

The diameter of the BOT holes shall be 1,17 ± 0,05 mm (0.046 ± 0.002 in).

5.1.4.2 End-of-tape (EOT)

An EOT marker shall be a single circular hole punched in the tape. There shall be three such markers along a single line. The first to pass the photo sensor during forward operation indicates that the usable recording area has been exceeded. The other two markers are used to ensure the reliability of detection.

The diameter of the EOT holes shall be 1,17 ± 0,05 mm (0.046 ± 0.002 in).

5.1.4.3 Load-point (LP)

The LP marker shall be a single circular hole punched in the tape to indicate the beginning of the usable recording area in the forward direction.

The diameter of the LP hole shall be 0,58 ± 0,05 mm (0.023 ± 0.002 in) or 1,17 ± 0,05 mm (0.046 ± 0.002 in).

5.1.4.4 Early-warning (EW)

The EW marker shall be a single circular hole punched in the tape for the pupose of indicating the approaching end of the usable recording area in the forward direction. Recording shall stop before the EOT marker is sensed.

The diameter of the EW marker shall be 0,58 ± 0,05 mm (0.023 ± 0.002 in) or 1,17 ± 0,05 mm (0.046 ± 0.002 in).

5.1.5 Light transmittance

The tape shall have a light transmittance of less than 0,5 % measured according to annex A.

5.1.6. Tensile yield force

The tensile yield force of the tape, defined as the force required to elongate a sample by 3 %, shall be not less than 13,4 N (3 lbf) for the SL cartridge and 6,7 N (1.5 lbf) for the LL cartridge.

The elongation shall be measured with a static weighing tester capable of indicating the force to an accuracy of ± 2 % with a constant rate of grip separation. A specimen of tape of at least 178 mm (7 in) shall be clamped with an initial separation of 102 mm (4 in) between the jaws. This specimen shall be elongated at a rate of 51 mm/min until an elongation of at least 10 % is reached. The tensile yield force is the force required to produce the elongation of 3 %.

5.1.7 Layer-to-layer adhesion

Layer-to-layer adhesion shall be sufficiently low to meet the requirements of the test specified in annex B.

5.1.8 Cupping

Cupping, i.e. the departure across a tape (transversely to the tape motion) from a flat surface, shall not exceed 0,12 mm (0.005 in) in the SL cartridge or 0,38 mm (0.015 in) in the LL cartridge.

A length of tape of 6,3 mm (0.25 in) shall be cut and placed concave side down on a flat surface. Measurement shall be made at least 1 h after cutting.

5.1.9 Leaders and splices

The cartridge shall contain no splices or spliced-in leaders.

5.1.10 Tape wind

The tape shall be wound on the hubs with the magnetic coating on the outside, and in such a way that during forward read/write operations the tape is unwound in a counter-clockwise direction viewed from above as shown in figure 2.

5.2 Electrical surface resistance

The electrical resistance of the magnetic surface of any square sample of tape shall be within the range of

5×10^5 to 10^9 Ω

measured between electrodes placed on two opposite sides of the square, using a voltage of 500 ± 10 V.

5.3 Magnetic properties

The magnetic properties of the tape are defined by the testing requirements given in this sub-clause. When performing the tests, the output or resultant signal shall be measured on the same relative pass for both the Signal Amplitude Reference Tape and the tape under test (i.e. read-while-write, or on equipment without read-while-write capability on the first forward-read pass) on the same equipment.

5.3.1 Test density

Tape shall be tested at 126 ftpmm (3 200 ftpi) nominal.

5.3.2 Typical field

The typical field of the tape under test shall be within ± 20 % of the Reference Field.

5.3.3 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 Cartridge recorded under the same conditions, the Average Signal Amplitude of the tape under test shall be within $^{+\ 25}_{-\ 10}$ % of the Standard Reference Amplitude.

The output signal from the tape under test shall be mesured on track 1 (see 8.1).

5.3.4 Erasure

5.3.4.1 Ease of erasure

When a tape has been recorded with the Test Recording Current, and then passed through a longitudinal steady erasure field of up to 79 500 A/m 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.

5.3.4.2 Erasure direction

The tape shall be magnetized so that the beginning of tape is a North-seeking pole.

5.3.5 Tests for drop-outs and drop-ins

These tests shall be carried out in the in-contact condition and over the entire tested recording area (see 5.3.7) using the Test Recording Current. The track location shall be as defined in 8.2.

5.3.5.1 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 35 % of half the Standard Reference Amplitude is a drop-out (see 5.3.6).

5.3.5.2 Drop-ins

When a tape has been erased 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 a drop-in (see 5.3.6).

5.3.6 Rejected Regions

A Rejected Region is an area of tape extending across the width of a track and not more than 25,4 mm (1 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.

5.3.7 Tested recording area

The tested recording area is the part of the tape tested according to 5.3.1 to 5.3.6. In forward direction, it begins at least 686 mm (27 in) before the LP marker and ends at least 991 mm (39 in) after the EW marker (see figure 1) and extends across the width of the tracks (see figure 10).

6 Characteristics of the cartridge

6.1 General description

The cartridge shall be of coplanar design with the tape and hubs completely enclosed by the casing, except for belt capstan and head openings. The drive shall be by means of a tensioned belt which is driven by the internal belt capstan which receives motion from an external motor (see figure 2). Tape guides are located inside the cartridge. A clear plastic top allows visual monitoring of the tape and does not extend beyond the base except at the notches.

6.1.1 Dimension

The dimensions of the cartridge shall be as shown in figure 3.

6.1.2 Cartridge positioning planes

The cartridge shall be referenced to the read/write machine only in the cross-hatched areas shown in figure 4. The application of forces suggested in figure 4 is one method of ensuring conformity of the cartridge to the positioning plane.

6.1.3 Attachment

The ends of the tape shall not be attached to the hubs.

6.1.4 Mounting position

It shall be possible to mount the cartridge in the read/write machine in one position only; to ensure this the cartridge has the following asymmetrical features (see figure 3):

a) a projection in one guide slot;

b) the guide slots are accessible on the head opening edge only.

6.1.5 Light-sensing

The cartridge shall contain optical elements to permit photoelectric detection of the tape markers (see figure 5).

The total light transmittance of both cover windows, including the effects of reflection from the mirror surface, from a 2 000 ± 200 K tungsten filament lamp and from a 940 ± 50 nm LED light source, sensed by a silicon phototransistor, shall be at least 50 % (see annex A).

6.1.6 Cartridge-in-position sensing

The cartridge shall have a solid area on the front surface which is dimensioned as shown in figure 6 to be used for mechanically sensing that the cartridge is in position for writing and reading.

6.1.7 Cartridge door

The cartridge shall have a door for protection of the tape during storage and transportation. Requirements for opening the door are shown in figure 7.

6.2 File protection

The cartridge shall have a rotatable plug located as shown in figure 6 to prevent writing or erasing the tape.

6.3 Physical labels

6.3.1 Location and size

The rear surface of the cartridge (i.e. the side opposite the exposed tape) and a part of the top side of the cartridge may be used for labels. The rear surface area allows the label to be read when in a stacked or inserted position. The position and size of the label shall be within the provided label area as shown in figure 8.

6.3.2 Interchange

Suitable labels shall be used for marking the contents of cartridges. The use of pencil or erasable material is not allowed.

6.4 Tape guides

The tape shall be guided by two tape guides contained within the cartridge (see figure 9). The drive shall not contain any elements that might restrict the tape path in the transverse direction.

6.5 Speeds

The cartridge may be used at any tape speed up to 2,28 m/s (90 in/s).

6.6 Driving force

The tangential force required at the external driving surface of the belt capstan to maintain a constant operating speed shall be 0,98 ± 0,27 N (3.5 ± 1.0 ozf). The external radial load applied to the belt capstan when making this measurement shall be 5,6 ± 0,6 N (20 ± 2 ozf).

6.7 Total inertia

The total equivalent mass of all moving cartridge elements, measured at the external driving surface of the capstan, shall be 0,022 kg max. (0.002 ozf·s^2/in max.).

6.8 Dynamic response

6.8.1 Definition

The speed response of tape motion to a step driving function applied to the belt capstan.

6.8.2 Requirement

The natural resonant frequency shall be at least 60 Hz.

6.8.3 Procedure

A drive capable of producing a pronounced overshoot of the tape speed should be used. The drive servo should be critically damped so that the overshoot observed is not that of the drive. The reciprocal of the time measured between the first two overspeed peaks is the natural resonant frequency.

6.9 Tape tension

6.9.1 Definitions

6.9.1.1 tape tension: The resultant force in the longitudinal direction of the tape on a cross-section of the tape taken through the tape perpendicular to the longitudinal direction.

6.9.1.2 instantaneous tension: The force as measured at the cross-section of the tape located at the head position of the free tape path and averaged over 10 ms.

6.9.1.3 average tension (at a point along the length of the tape): The average value of instantaneous tension measured over 1 m (3 ft) of tape symmetrically located around that point.

6.9.1.4 dynamic tape tension (at a point along the length of the tape): The maximum variation of instantaneous tension over the 1 m (3 ft) of tape symmetrically located around that point.

6.9.1.5 transverse tape tension variation: That variation across the tape produced by the difference in free tape path length between the two edges of the tape.

6.9.2 Requirements

6.9.2.1 Value of instantaneous tension

a) In the testing environment the instantaneous tension at any point along the length of the tape between LP and EW shall be between 0,28 N (1.0 ozf) and 0,98 N (3.5 ozf).

b) In the operating environment the instantaneous tension shall be between 0,14 N (0.5 ozf) and 1,12 N (4.0 ozf). When the temperature is brought back to that of the testing environment the requirements of a) shall be met.

6.9.2.2 Value of dynamic tension

The dynamic tension at any point along the length of the tape between LP and EW shall not exceed 0,21 N (0.75 ozf).

6.9.2.3 Requirement for transverse tension variation

The test rod shall not deviate from the horizontal by more than 4° at any point along the length of tape from LP to EW.

6.9.3 Procedures

For test procedures see annex C.

6.10 Drive ratio

The ratio of the tape speed to the surface speed of the external driving surface of the belt capstan shall be 0,76 ± 0,02.

6.11 Tape path length increase

The cartridge shall be used with drives causing a tape path length increase of 0,38 mm (0.015 in) to 1,40 mm (0.055 in).

NOTE — The tape path length is the length of the straight tangent common to the tape guides when the cartridge is not mounted in the drive. It is measured between the two contact points with the guides. When the cartridge is mounted in the drive, the head and/or other parts of the drive provoke an increase of this tape path length which affects the initial tape tension. To ensure reliable reading or writing immediately after mounting a cartridge in a drive, the tape path increase should be the same on all drives.

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 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 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 cartridge used for interchange shall satisfy the requirements of 7.3 to 7.5 inclusive. All signal measurements are made at a point in the read chain where the amplitude is proportional to the rate of change of the flux induced in the read head. For the purpose of relating bit spacing along the tape to cartridge driving speed, the ratio of tape speed to the surface speed of the capstan shall be assumed to be exactly 0,76.

7.3 Density of recording

7.3.1 The density of recording shall be 63 bpmm (1 600 bpi) nominal.

7.3.2 The long-term average bit spacing shall be the spacing between bit flux transitions that have been recorded continuously at a nominal density of 63 bpmm (1 600 bpi) and shall be measured over a length of tape of not less than 3,81 m (150 in).

It shall be within ± 3 % of the nominal bit spacing of 15,9 µm (625 µin).

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

It shall be within ± 7 % 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 bit flux transitions without an intervening phase flux transition shall be between 88 % and 105 % of the short-term average bit spacing. The spacing between successive bit flux transitions with an intervening phase flux transition shall be between 95 % and 112 % of the short-term average bit spacing.

7.4.2 The spacing between a bit flux transition and any adjacent phase flux transition shall be between 44 % and 56 % of the short-term average bit spacing.

7.5 Signal amplitude

7.5.1 Average Signal Amplitude

The average peak-to-peak signal amplitude of the interchanged tape cartridge at 126 ftpmm (3 200 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 cartridge may be segmented into blocks.

7.5.2 Maximum signal amplitude

The peak-to-peak signal amplitude at 63 ftpmm (1 600 ftpi) shall be less than three times the Standard Reference Amplitude.

7.5.3 Minimum signal amplitude

No tape when interchanged shall contain any adjacent flux transitions whose peak-to-peak signal amplitude is less than 20 % of the Standard Reference Amplitude.

7.6 Azimuth alignment

When adjusted for maximum output, the read azimuth angles for a reference alignment cartridge and for the interchange cartridge shall not differ by more than ± 10 min of arc.

8 Format

8.1 Number of tracks

There shall be up to four tracks numbered 1 to 4. Each track is a data track and shall be independent of the other tracks. Individual read/write units may provide one, two, or four tracks. Track 1 shall be readable on all units. Track 2 shall be readable on either two or four track units (i.e. track positions, track widths, and erased areas shall be compatible between units with a varying number of tracks). Track designations are shown in figure 10.

8.2 Track location and widths

Track locations and widths are shown in figure 10. The nominal track width is 1,22 mm (0.048 in). The nominal spacing between track centrelines is 1,63 mm (0.064 in).

8.3 Use of tracks

Each track shall be written serially starting near the BOT and continuing towards the EOT, with a rewind to BOT before initiating writing on the next track. All tracks are primarily data tracks; however, if one or more tracks are used for other than data, track 1 shall always be a data track.

8.4 Location of characters on the tracks

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

8.5 Sequence of recording

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

byte

Bit positions ... 4321 | 87654321 | 8765432...

Forward tape motion →

Resulting recording direction ←

8.6 Code

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

8.6.1 Recording of 7-bit coded characters

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

8.6.2 Recording of 8-bit coded characters

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

Bits of the 8-bit combination	a_8	a_7	a_6	a_5	a_4	a_3	a_2	a_1
Bit-position in the byte	8	7	6	5	4	3	2	1

8.7 Sequence of characters

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

8.8 Data block

A data block shall consist of a preamble, data, CRC and a postamble. The data part of a data block shall contain a minimum of 6 bytes and a maximum of 2 048 bytes.

8.9 Control block

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

8.10 Gaps

8.10.1 Integrity of gaps

The gaps shall be erased by a constant erasing field. Immediately before and after each block there shall be a length of at least 2,3 mm (0.09 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 the Standard Reference Amplitude.

In the remaining part of the gap one burst of spurious transitions can be tolerated, provided that the total number of spurious transitions is at most seven.

8.10.2 Interblock gaps

The interblock gap, i.e. the distance between two successive data blocks, shall have a minimum length of 30,5 mm (1.2 in) and a maximum length of 1 219 mm (48 in). Any gap in excess of 1 981 mm (78 in) shall be considered end of data on this track.

8.10.3 Initial gap

The gap between the LP marker and the first bit of the first data block shall be at least 152 mm (6 in).

8.10.4 Gap polarity

The polarity of all gaps shall be in the direction specified in 5.3.4.2.

8.11 Preamble and postamble

8.11.1 Preamble

Immediately preceding data in each block, the preamble consisting of 15 ZEROs and 1 ONE shall be written. When reading in the forward direction, the first flux transition shall be a ZERO transition. The preamble may be used to establish a timing sequence so that the data can be read in the forward direction.

8.11.2 Postamble

Immediately following data and the CRC in each block, the postamble consisting of 1 ONE and 15 ZEROs shall be written. When reading in the forward direction, the first flux transition shall be the ONE transition. The postamble may be used to establish a timing sequence so that the data can be read in the reverse direction.

8.12 Cyclic Redundancy Check (CRC)

The 16-bit CRC shall be written in each data block following the data and immediately preceding the postamble. It shall be recorded in two bytes with the least significant bit recorded first. The polynomial generating the CRC is

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

8.13 Usable recording area

All data to be interchanged shall be written within the usable recording area, which, in forward direction, extends from at least 152 mm (6 in) after the LP marker to at most 914 mm (36 in) after the EW marker (see figure 1).

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