INTERNATIONAL STANDARD

ISO/IEC 15896

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Information technology — Data interchange on 12,7 mm 208-track magnetic tape cartridges — DLT 5 format

Technologies de l'information — Échange de données sur cartouches de bande magnétique de 12,7 mm*, 208 pistes — Format DLT 5*

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Contents

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 15896 was prepared by *ECMA — European association for standardizing information and communication systems* (as ECMA-259) and was adopted, under a special “fast-track procedure”, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

Annexes A to G form a normative part of this International Standard. Annexes H to L are for information only.

Introduction

This International Standard constitutes a further development of the magnetic tape cartridge specified in International Standard ISO/IEC 15307. The number of tracks is raised to 208. As a result a native capacity of 35 Gbytes or, with compressed data, of typically at least 70 Gbytes is achieved.

Information technology - Data interchange on 12,7 mm 208-track magnetic tape cartridges - DLT 5 format

Section 1 - General

1 Scope

This International Standard specifies the physical and magnetic characteristics of a 12,7 mm wide, 208-track magnetic tape cartridge, to enable physical interchangeability of such cartridges between drives. It also specifies the quality of the recorded signals, a format - called Digital Linear Tape 5 (DLT 5) - and a recording method, thereby allowing data interchange between drives. Together with a labelling standard, for instance International Standard ISO 1001 for Magnetic Tape Labelling, it allows full data interchange by means of such magnetic tape cartridges.

2 Conformance

2.1 Magnetic tape cartridges

A magnetic tape cartridge shall be in conformance with this International Standard if it satisfies all mandatory requirements of this Standard. The tape requirements shall be satisfied throughout the extent of the tape.

2.2 Generating systems

A system generating a magnetic tape cartridge for interchange shall be in conformance with this International Standard if all the recordings that it makes on a tape according to 2.1 meet the mandatory requirements of this International Standard.

In addition, a claim of conformance shall state

- whether or not one, or more registered algorithm(s) are implemented within the system, and are able to compress data received from the host prior to collecting the data into blocks, and
- the registered identification number(s) of the implemented compression algorithm(s) .

2.3 Receiving systems

A system receiving a magnetic tape cartridge for interchange shall be in conformance with this International Standard if it is able to handle any recording made on a tape according to 2.1.

In addition, it shall state

- whether or not one, or more de-compression algorithm(s) are implemented within the system, and are able to be applied to de-compress data prior to making such data available to the host,
- the registered identification number(s) of the implemented compression algorithm(s) .

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

ISO 1001:1986	*Information processing - File structure and labelling of magnetic tapes for information interchange.*
ISO 1302:1992	*Technical drawings - Method of indicating surface texture.*
ISO/IEC 11576:1994	*Information technology - Procedure for the registration of algorithms for the lossless compression of data.*

4 Definitions

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

4.1 **Average Signal Amplitude:** The average peak-to-peak value of the output signal from the read head at the physical recording density of 2 254 ftpmm measured over a minimum length of track of 25,4 mm, exclusive of missing pulses.

4.2 **azimuth:** The angular deviation, in degrees of arc, of the mean flux transition line of the recording made on a track from the line normal to the Reference Edge.

4.3 **back surface:** The surface of the tape opposite the magnetic coating which is used to record data.

4.4 **Beginning-Of-Tape marker (BOT):** A hole punched on the centreline of the tape towards the end nearest to the leader.

4.5 **block:** A set of contiguous bytes recorded on a physical track and considered as a unit.

4.6 **byte:** An ordered set of bits acted upon as a unit.

Note - In this International Standard, all bytes are 8-bit bytes.

4.7 **cartridge:** A case containing a single supply reel of 12,7 mm wide magnetic tape with a leader attached at the outer end.

4.8 **Cyclic Redundancy Check (CRC) character:** A 64-bit character, generated by a mathematical computation, used for error detection.

4.9 **Early Warning (EW):** A signal generated by the drive indicating the approaching end of the recording area.

4.10 **Error-Detecting Code (EDC):** A mathematical computation yielding check bytes used for error detection.

4.11 **End-Of-Tape marker (EOT):** A hole punched on the centreline of the tape towards the end farthest from the leader.

4.12 **Entity:** A group of twenty blocks treated as a logical unit and recorded on a logical track, except Filler Blocks ,if any.

4.13 **Error-Correcting Code (ECC):** A mathematical computation yielding check bytes used for the correction of errors detected by the CRC and the EDC.

4.14 **Envelope:** A group of Entities.

4.15 **Envelope size:** The number of Entities in an Envelope.

4.16 **flux transition position:** The point which exhibits the maximum free-space flux density normal to the tape surface.

4.17 **flux transition spacing:** The distance on the magnetic tape between successive flux transitions.

4.18 **logical track:** A group of four physical tracks that are written or read simultaneously.

4.19 **magnetic tape:** A tape that accepts and retains magnetic signals intended for input, output, and storage purposes on computers and associated equipment.

4.20 **Master Standard Reference Tape:** A tape selected as the standard for Reference Field, signal amplitude, resolution, peak shift, and overwrite characteristics.

Note - The Master Standard Reference Tape has been established by the Quantum Corporation.

4.21 **object:** A Record or a page of type Tape Mark.

4.22 **page:** A logical division of a block.

4.23 **physical recording density:** The number of recorded flux transitions per unit length of track, expressed in flux transitions per millimetre (ftpmm).

4.24 **physical track:** A longitudinal area on the tape along which a series of magnetic signals can be recorded.

4.25 **Record:** A collection of User Bytes, the number of which is determined by the host.

4.26 **Reference Edge:** The bottom edge of the tape when viewing the magnetic coating of the tape with the BOT to the left and the EOT to the right of the observer.

4.27 **Reference Field:** The Typical Field of the Master Standard Reference Tape.

4.28 **Secondary Standard Reference Tape:** A tape the characteristics of which are known and stated in relation to those of the Master Standard Reference Tape.

Note - Secondary Standard Reference Tapes can be ordered under Reference "SSRT/DLT4"from Quantum Corporation, 333 South Street, Shrewsbury, Mass. 01545-4195, USA. It is intended that these be used for calibrating tertiary reference tapes for routine calibration.

In principle, these Secondary Standard Reference Tapes will be available for a period of 10 years from the publication of the first version of this International Standard. However, this period may be changed to take into account the demand for such Secondary Standard Reference Tapes.

4.29 Standard Reference Amplitude (SRA): The Average Signal Amplitude from the Master Standard Reference Tape when it is recorded with the Test Recording Current at 2 254 ftpmm.

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

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

4.32 Typical Field: In the plot of the Average Signal Amplitude against the recording field at the physical recording density of 2 254 ftpmm, the minimum field that causes an Average Signal Amplitude equal to 95 % of the maximum Average Signal Amplitude.

5 Conventions and notations

5.1 Representation of numbers

The following conventions and notations apply in this International Standard, unless otherwise stated.

- A measured value is rounded off to the least significant digit of the corresponding specified value. It implies that a specified value of 1,26 with a positive tolerance +0,01, and a negative tolerance -0,02 allows a range of measured values from 1,235 to 1,275.
- In each block and in each field the bytes shall be arranged with Byte 1, the least significant, first. Within each byte the bits shall be arranged with Bit 1, the least significant, first and Bit 8, the most significant bit, last. This order applies to the data, and to the input and output of the error-detecting and error-correcting codes, and to the cyclic redundancy characters.
- Letters and digits in parentheses represent numbers in hexadecimal notation.
- The setting of bits is denoted by ZERO or ONE.
- Numbers in binary notation and bit patterns are represented by strings of 0 and 1 shown with the most significant bit to the left.

5.2 Dimensions

The dimensions in figure 1 to 4 are nominal dimensions. Unless otherwise stated, all dimensions in figures 8 to 23 are in millimetres with a tolerance of ± 50 mm.

5.3 Names

The names of basic elements, e.g. specific fields, are written with a capital initial letter.

5.4 Acronyms

BOT	Beginning of Tape
CF1	Control Field 1
CF2	Control Field 2
CRC	Cyclic Redundancy Check (character)
CT1	Calibration Track 1
CT2	Calibration Track 2
ECC	Error-Correcting Code
EDC	Error-Detecting Code
EOD	End of Data
EOT	End of Tape
EOTR	End of Track
EW	Early Warning
RLL	Run Length Limited
SRA	Standard Reference Amplitude

6 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 drive.

6.1 Cartridge and tape testing environment.

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

- temperature: 23 °C ± 2 °C
- relative humidity: 40 % to 60 %
- conditioning before testing: 24 h

6.2 Cartridge operating environment

Cartridges used for data interchange shall be capable of operating under the following conditions:

- temperature: 10 °C to 40 °C
- relative humidity: 20 % to 80 %
- wet bulb temperature: 25 °C max.

Note - Localized tape temperatures in excess of 49 °C may cause tape damage.

If during storage and/or transportation a cartridge has been exposed to conditions outside the above values, it shall be conditioned before use by exposure to the operating environment for a time equal to, or greater than, the time away from the operating environment up to a maximum of 24 h. There shall be no deposit of moisture on or in the cartridge.

6.3 Cartridge storage environment

Cartridges shall be stored under the following conditions:

- temperature: 16 °C to 32 °C
- relative humidity: 20 % to 80 %

The stray magnetic field at any point on the tape shall not exceed 4000 A/m. There shall be no deposit of moisture on or in the cartridge.

6.4 Safety

6.4.1 Safeness

The cartridge and its components shall not constitute any safety or health hazard when used in the intended manner, or through any foreseeable misuse in an information processing system.

6.4.2 Flammability

The cartridge and its components shall be made from materials which, if ignited from a match flame, and when so ignited do not continue to burn in a still carbon dioxide atmosphere.

6.5 Transportation

This International Standard does not specify parameters for the environment in which cartridges should be transported. Annex H gives some recommendations for transportation.

Section 2 - Requirements for the unrecorded tape

7 Mechanical and electrical requirements

7.1 Material

The tape shall consist of a base material (oriented polyethylene terephthalate film or its equivalent) coated on one surface with a strong yet flexible layer of ferromagnetic material dispersed in a suitable binder. The other surface of the tape shall be coated with a non-ferromagnetic conductive coating.

7.2 Tape length

The length of the tape from the leader splice to the hub shall be 557 m ± 5 m.

7.3 Width

The width of the tape shall be 12,649 mm ± 0,010 mm.

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.

7.4 Total thickness

The total thickness of the magnetic tape at any point shall be between 8,3 µm and 9,3 µm.

7.5 Discontinuity

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

7.6 Longitudinal curvature

The longitudinal curvature is measured as the departure of the Reference Edge of the tape from a straight line along the longitudinal dimension of the tape in the plane of the tape surface.

7.6.1 Requirement

Any deviation of the Reference Edge from a straight line shall be continuous and shall not exceed 0,076 mm within any 229 mm length of tape.

7.6.2 Procedure

Measure at a tension of 1,39 N ± 0,28 N in a test fixture equipped with two guides spaced at 229 mm. The two guides shall be spring-loaded to position the Reference Edge of the tape against two edge control surfaces. Measure the maximum deviation of the Reference Edge of the tape from the line drawn between the two control surfaces.

7.7 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. 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.

7.8 Cupping

The departure across the width of the tape from a flat surface shall not exceed 2,54 mm.

Cut a 1,0 m ± 0,1 m length of tape. Condition it for a minimum of 3 h in the test environment by hanging it so that both surfaces are freely exposed to the test environment. From the centre portion of the conditioned tape cut a test piece of approximately 25 mm length. Stand the test piece on its end in a cylinder which is at least 25 mm high with an inside diameter of 13,0 mm ± 0,2 mm. 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.

7.9 Roughness of the coating surfaces

7.9.1 Roughness of the back coating surface

The back coating surface shall have an arithmetic average roughness R_a between 0,003 µm and 0,018 µm (ISO 1302:N 2). This measurement shall be made using a contacting stylus of radius 12,5 µm with a 20 mg load, and a 254 µm cut-off range.

7.9.2 Roughness of the magnetic coating surface

The magnetic coating surface shall have an arithmetic average roughness R_a between 0,003 µm and 0,008 µm (ISO 1302: N 3). For this measurement, the contacting stylus radius shall be 12,5 µm with a 20 mg load, and a 254 µm cut-off range.

7.10 Coating adhesion

The force required to peel any part of the coating from the tape base material shall not be less than 0,4 N.

Procedure

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

ii. Using a double-sided pressure sensitive tape, attach the full width of the test piece to a smooth metal plate, with the magnetic coating (recording surface) facing the plate, as shown in figure 1.

iii. Fold the test piece over 180°, adjacent to, and parallel with, the scribed line. 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 per min.

iv. Note the force at which any part of the coating first separates from the base material. If this is less than 0,4 N, the tape has failed the test. If the test piece peels away from the double-sided pressure sensitive tape before the force exceeds 0,4 N, an alternative type of double-sided pressure sensitive tape shall be used.

v. Repeat i) to iv) for the back coating.

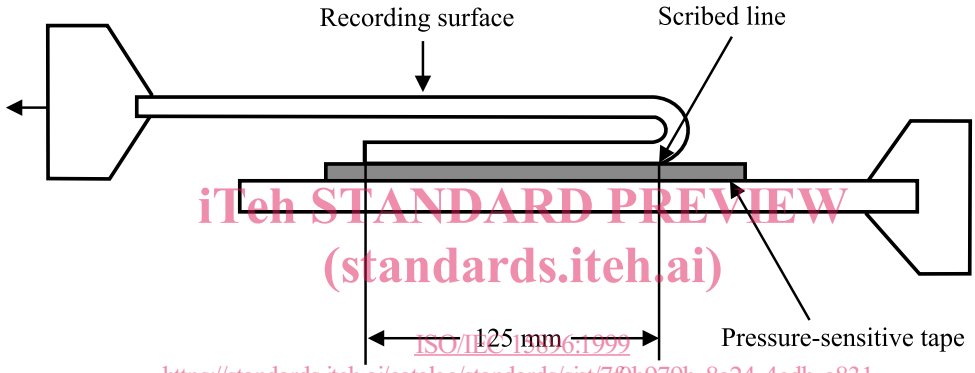

Figure 1 - Measurement of the coating adhesion

7.11 Layer-to-layer adhesion

Layer-to-layer adhesion refers to the tendency of a layer, when held in close proximity to the adjacent layer, to bond itself to an adjacent layer so that free and smooth separation of the layers is difficult.

7.11.1 Requirements

There shall be no evidence of delamination or other damage to the coatings.

7.11.2 Procedure

i. Fasten one end of a 914 mm length of tape, magnetic coating inwards, to a horizontally mounted stainless steel cylinder with a low cold-flow adhesive material.

ii. The dimensions of the cylinder shall be:

- diameter: 12,7 mm
- length: 102 mm

iii. Attach a mass of 1 000 g to the opposite end of the tape.

iv. Attach, 25,4 mm above the mass, a narrow strip of double-sided adhesive tape to the magnetic coating.

v. Slowly rotate the cylinder, so that the tape winds uniformly around it into a compact and even roll. The double-sided tape secures the end and prevents unwinding when the mass is removed.

vi. The cylinder with the tape shall then be exposed to the following temperature and humidity cycle:

Time	Temperature	RH
16 h to 18 h	54 °C	85 %
4 h	54 °C	10 % or less
1 h to 2 h	21 °C	45 %

vii. Open the end of the roll and remove the double-sided adhesive tape.

viii. Release the free end of the tape.

ix. The outer one or two wraps shall spring loose without adhesion.

x. Hold the free end of the tape and allow the cylinder to fall, thereby unwinding the tape.

xi. The tape shall show no coating delamination, except for the 51 mm of tape nearest to the cylinder.

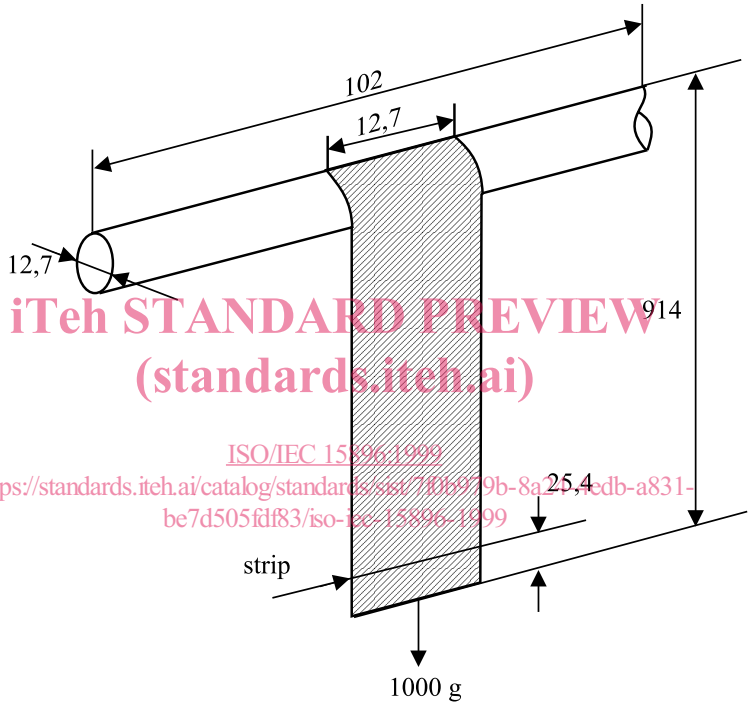

Figure 2 - Measurement of layer-to-layer adhesion

7.12 Modulus of elasticity

The modulus of elasticity (Young's modulus) is the ratio of stress to strain in the longitudinal direction.

7.12.1 Requirement

The modulus of elasticity shall be between 4 900 N/mm^2 and 11 700 N/mm^2.

7.12.2 Procedure

Clamp a test piece of tape at least 178 mm in length with an initial 102 mm separation between the jaws of a universal testing machine with a nominal crosshead speed of 3 mm per minute. Calculate the modulus using the chord of the curve between the force at 0 % and 1 % elongation.

7.13 Flexural rigidity

Flexural rigidity is the ability of the tape to resist bending in the longitudinal direction.

7.13.1 Requirement

The flexural rigidity of the tape in the longitudinal direction shall be between 2 x 10^{-7} N · mm and 8 x 10^{-7} N · mm.

7.13.2 Procedure

Calculate the flexural rigidity *D* from the following equation: