

INTERNATIONAL STANDARD

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Information technology — Data interchange on 12,7 mm 128-track magnetic tape cartridges — DLT 3 format

*Technologies de l'information — Échange de données sur cartouches de
bande magnétique de 12,7 mm, 128 pistes — Format DLT 3*



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 JTC1. 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 10090 was prepared by the European Computer Manufacturers Association (as Standard ECMA-209) and was adopted under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

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

Introduction

International Standard ISO/IEC 13421 concerns a magnetic tape cartridge of a type different from that of International Standards ISO 9661 and ISO/IEC 11559. Whilst the magnetic tape is also 12,7 mm wide, it is characterized by the fact that the physical tracks, recorded and read in pairs, constitute two groups, the first recorded and read in forward direction, the second in reverse direction. International Standard ISO/IEC 13962 constitutes a development of the cartridge specified in International Standard ISO/IEC 13421 in that the number of tracks has been raised from 48 to 112, thus raising the total capacity of the cartridge accordingly.

This International Standard specifies a further development of the DLT-formatted cartridges. By raising the number of tracks to 128 and adopting an enhanced format, a further capacity increase is achieved.

Information technology - Data interchange on 12,7 mm 128-track magnetic tape cartridges - DLT 3 format

Section 1: General

1 Scope

This International Standard specifies the physical and magnetic characteristics of a 12,7 mm wide, 128-track magnetic tape cartridge, to enable interchangeability of such cartridges. It also specifies the quality of the recorded signals, a format - called Digital Linear Tape 3 (DLT 3) - and a recording method. Together with a labelling standard, for instance International Standard ISO 1001: 1986, *Information processing - File structure and labelling of magnetic tapes for information interchange*, 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 International 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 entitled to claim 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.

2.3 Receiving systems

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

3 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1302:1992, *Technical drawings - Method of indicating surface texture*.

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 1 640 ftpmm measured over a minimum length of track of 25,4 mm, exclusive of missing pulses.

4.2 azimuth : The angular deviation, in minutes 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 byte : An ordered set of bits acted upon as a unit.

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

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

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

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

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

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

4.11 Entity : A group of ten Logical Blocks treated as a logical unit and recorded on a logical track.

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

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

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

4.15 Logical Block : The two physical blocks simultaneously written on, or read from, the two physical tracks of a logical track.

4.16 logical track : A pair of physical tracks that are written or read simultaneously.

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

4.18 Master Standard Reference Tape : A tape selected as the standard for reference field, signal amplitude, resolution, peakshift, and overwrite characteristics.

NOTE - The Master Standard Reference Tape is maintained by the Quantum Corporation.

4.19 object : A Record or a Tape Mark Block.

4.20 page : A logical division of a physical block.

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

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

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

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

4.25 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.

4.26 Reference Field : The Typical Field of the Master Standard Reference Tape.

4.27 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/DLT1" until the year 2003 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.

4.28 Standard Reference Amplitude (SRA) : The Average Signal Amplitude from the Master Standard Reference Tape when it is recorded with the Test Recording Current at 1 640 ftpmm.

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

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

4.31 Typical Field : In the plot of the Average Signal Amplitude against the recording field at the physical recording density of 1 640 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.

- 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 ZEROs and ONES shown with the most significant bit to the left.

5.2 Dimensions

Unless otherwise stated, all dimensions in the format figures 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)
ECC	Error-Correcting Code
EDC	Error-Detecting Code
EOD	End of Data
EOT	End of Tape
EOTR	End of Track
EW	Early Warning
FCT1	Forward Calibration Track 1
FCT2	Forward Calibration Track 2
RCT1	Reverse Calibration Track 1
RCT2	Reverse Calibration Track 2
2.7 RLL	Run Length Limited (method)
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: $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$
- 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 2 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 %
- wet bulb temperature: 26 °C max.

Tapes intended for archiving data for one year or more shall be stored under the following conditions:

- temperature: 18 °C to 26 °C
- relative humidity: 20 % to 60 %

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 F 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 cartridge shall be coated with a non-ferromagnetic conductive coating.

7.2 Tape length

The length of the tape, measured from BOT to EOT, shall be 355 m minimum and 365 m maximum.

7.3 Width

The width of the tape shall be 12,649 mm $\pm$ 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 tape at any point shall be between 12,0 µm and 14,0 µm.

7.5 Thickness of the base material

The thickness of the base material shall be between 9,0 µm and 11,0 µm.

7.6 Thickness of the magnetic coating

The thickness of the magnetic coating shall be between 2,0 µm and 3,0 µm.

7.7 Thickness of the back coating

The thickness of the back coating shall be between 0,4 µm and 0,9 µm.

7.8 Discontinuity

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

7.9 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.

7.9.1 Requirement

Any deviation of the Reference Edge from a straight line shall be continuous and shall not exceed 0,038 mm within any 229 mm length of tape.

7.9.2 Procedure

Measure at a tension of $1,39 \text{ N} \pm 0,28 \text{ N}$ 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.

7.10 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.

7.11 Cupping

The departure across the width of the tape from a flat surface shall not exceed 0,76 mm.

Cut a $1,0 \text{ m} \pm 0,1 \text{ m}$ length of tape. Condition it for a minimum of 3 hours 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 $13,0 \text{ mm} \pm 0,2 \text{ mm}$. 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.

7.12 Roughness of the coating surfaces

7.12.1 Roughness of the back coating surface

The back coating surface shall have an arithmetic average roughness R_a between 0,005 µm and 0,025 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.

7.12.2 Roughness of the magnetic coating surface

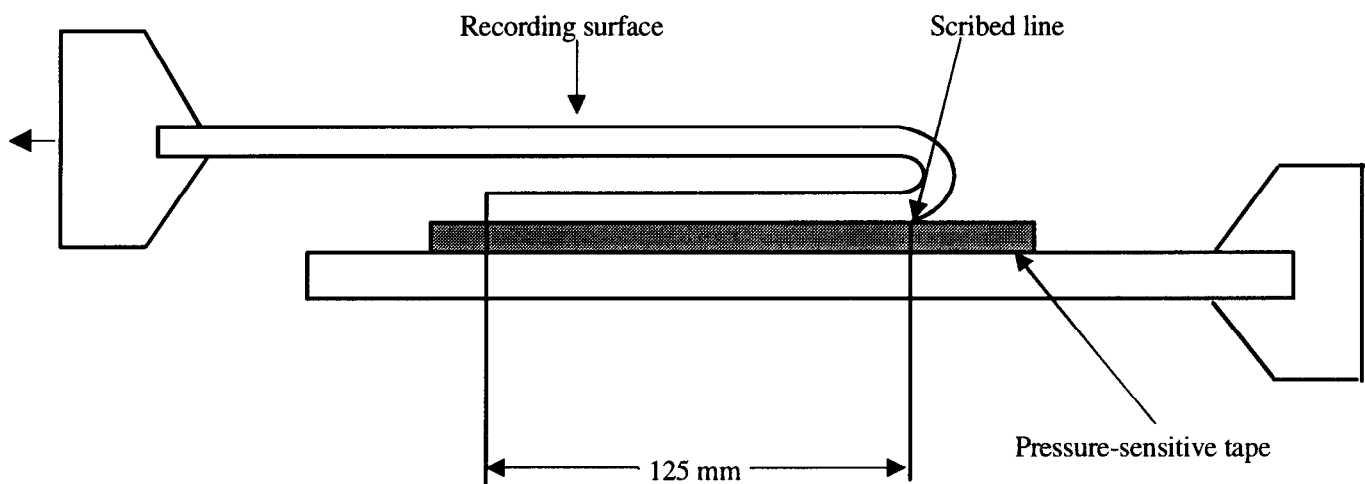
The magnetic coating surface shall have an arithmetic average roughness R_a between 0,005 0 µm and 0,012 5 µm (ISO 1302: N 3). For this measurement, the contacting stylus radius shall be 12,5 µm with a 20 mg load, and a 254 µm cut-off range.

7.13 Coating adhesion

The force required to peel any part of the coating from the tape base material shall not be less than 0,2 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°, 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 0,2 N, the test has failed. If the test piece peels away from the double-sided pressure sensitive tape before the force exceeds 0,2 N, an alternative type of double-sided pressure sensitive tape shall be used.
- v. Repeat i) to iv) for the back coating.



93-0120-A

Figure 1 - Measurement of the coating adhesion

7.14 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.

7.14.1 Requirements

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

7.14.2 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.

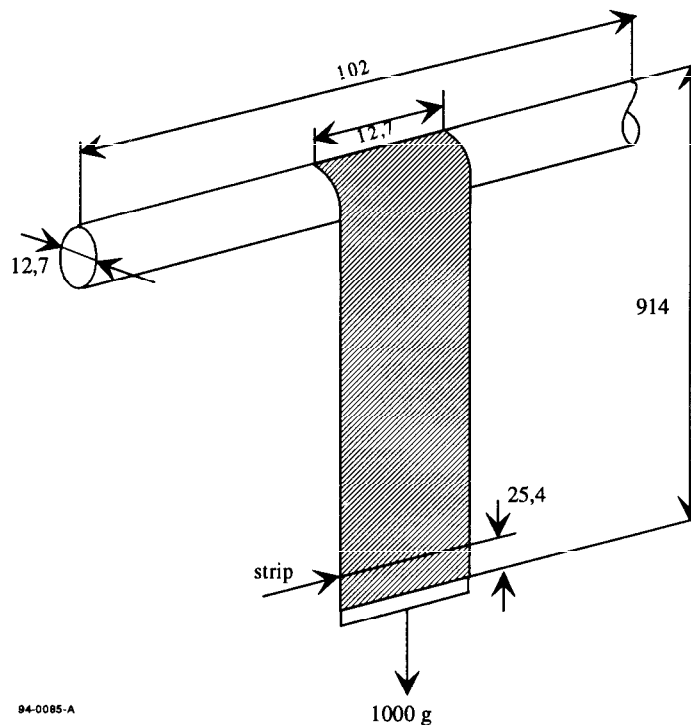


Figure 2 - Measurement of layer-to-layer adhesion

7.15 Modulus of elasticity

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

7.15.1 Requirement

The modulus of elasticity shall be between 5 500 N/mm² and 8 500 N/mm².

7.15.2 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.

7.16 Flexural rigidity

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

7.16.1 Requirement

The flexural rigidity of the tape in the longitudinal direction shall be between $0,5 \times 10^{-3} \text{ N} \cdot \text{mm}$ and $2,9 \times 10^{-3} \text{ N} \cdot \text{mm}$.

7.16.2 Procedure

Calculate the flexural rigidity D from the following equation:

$$D = \frac{E \times t^3}{12} \times (1 - \nu^2)$$

where:

E = modulus of elasticity obtained from 7.15

t = measured thickness of the tape in mm

ν = Poisson's ratio, set to 0,33

7.17 Tensile yield force

The tensile yield force required to elongate the test piece by 3 % shall not be less than 14,7 N.

7.17.1 Procedure

Use a static-weighing-constant-rate-of-grip separation tester capable of indicating the load with an accuracy of 2 %. Clamp a test piece of tape at least 178 mm long with an initial 102 mm separation between the jaws. Elongate the test piece at a rate of 51 mm per minute until a minimum elongation of 10 % is reached. The force required to produce an elongation of 3 % is the tensile yield force.

7.18 Electrical resistance

7.18.1 Requirement

The electrical resistance of any square area of the magnetic coating shall

- be greater than $50 \times 10^6 \Omega$
- not exceed $50 \times 10^{12} \Omega$

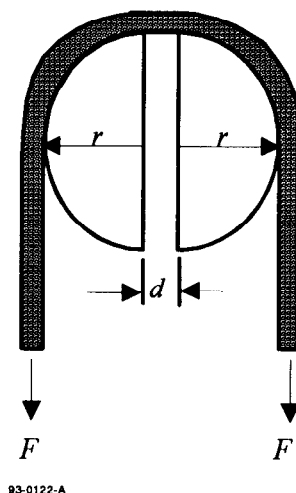
The electrical resistance of any square area of the back coating shall

- not exceed $100 \times 10^6 \Omega$

7.18.2 Procedure

Condition a test piece of tape in the test environment for 24 h. Position the test piece over two 24-carat gold-plated, semi-circular electrodes having a radius $r = 25,4$ mm and a finish of at least N4, so that the recording surface is in contact with each electrode. These electrodes shall be placed parallel to the ground and parallel to each other at a distance $d = 12,7$ mm between their centres. Apply a force F of 1,62 N to each end of the test piece. Apply a d.c. voltage of $100 \text{ V} \pm 10 \text{ V}$ across the electrodes and measure the resulting current flow. From this value, determine the electrical resistance.

Repeat for a total of 5 positions along the test piece and average the 5 resistance readings. For the back coating repeat the procedure with the back surface in contact with the electrodes.



93-0122-A

Figure 3 - Measurement of electrical resistance

When mounting the test piece, make sure that no conducting paths exist between the electrodes except that through the coating under test.

NOTE - Particular attention should be given to keeping the surfaces clean.

7.19 Inhibitor tape

This International Standard does not specify parameters for assessing whether or not a tape is an inhibitor tape. However, annex J gives further information on inhibitor tapes.

7.20 Abrasivity

Tape abrasivity is the tendency of the magnetic coating to wear the magnetic heads.

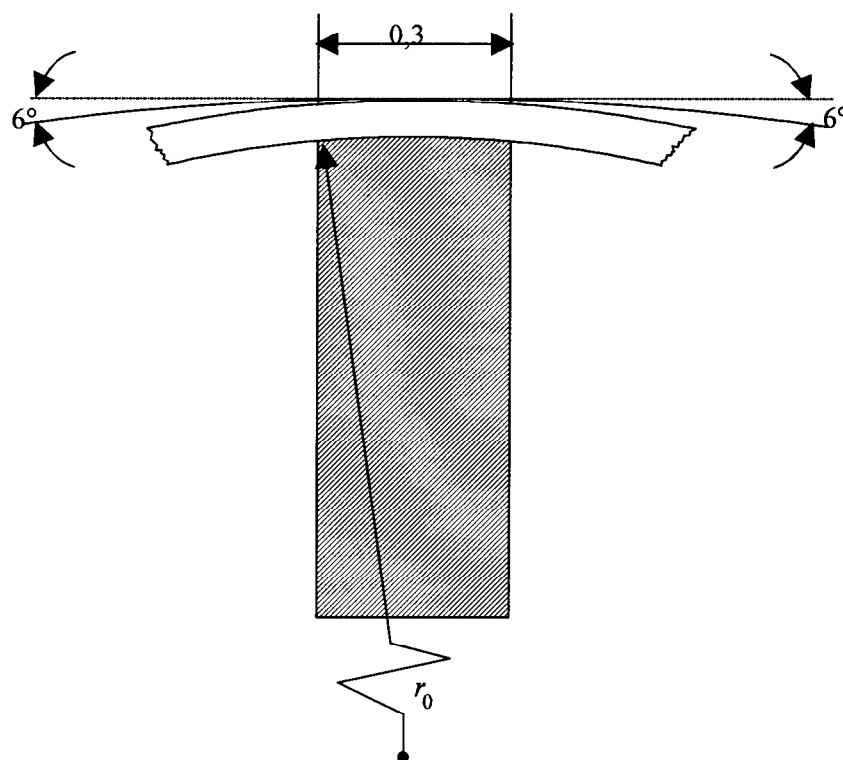
7.20.1 Requirement

The depth of the wear pattern in a ferrite wear bar shall be less than $1,27\ \mu\text{m}$.

7.20.2 Procedure

A test piece 61 m in length shall be passed for 100 passes (50 cycles) over a rectangular bar of manganese zinc ferrite. The bar shall be 0,3 mm wide and its top surface shall be rounded off with a radius $r_0 = 5\ \text{mm}$. The tape speed shall be 2,54 m/s, the tension shall be nominally 1,3 N and the wrap angle shall be 12° . The wear depth is measured with a profilometer across the width of the tape path.

NOTE - Manganese zinc ferrite should be available from Philips Ceramic Division in Saugerties (NY) under order part number 3H7.



94-0085-A

Figure 4 - Measurement of abrasivity (not to scale)

7.21 Light transmittance of the tape and the leader

The light transmittance of the tape and the leader shall be less than 5 % when measured according to the method specified in annex A.

7.22 Coefficient of dynamic friction

The coefficient of dynamic friction is measured between the surfaces of the tape, and calcium titanate ceramic.

7.22.1 Requirements

Between the magnetic surface and the back surface : greater than 0,20

Between the magnetic surface and other surfaces: 0,10 to 0,40

Between the back surface and calcium titanate: 0,10 to 0,25

7.22.2 Procedure for the measurement of the friction between the magnetic surface and the back surface

- i. Wrap a first piece of tape around a calcium titanate ceramic cylinder ($R_a = 0,05 \mu\text{m}$) of diameter 25,4 mm and wrap it with a total wrap angle of more than 90° with the back surface outwards.
- ii. Wrap a second test piece, with the magnetic surface inwards, around the first test piece with a total wrap angle of 90° .
- iii. Exert on one end of the outer test piece a force of $F_1 = 0,54 \text{ N}$.
- iv. Attach the other end to a force gauge mounted on a linear slide.
- v. Drive the slide at a speed of 1 mm/s, measure the force F_2 required.
- vi. Calculate the coefficient of dynamic friction γ from the equation

$$\gamma = \ln \frac{F_2}{F_1} \times \frac{1}{\pi}$$

where π is the value of the wrap angle in radians.

7.22.3 Procedure for the measurement of the friction between the magnetic surface or the back surface and calcium titanate ceramic

- i. Wrap a piece of tape around a calcium titanate ceramic cylinder ($R_a = 0,05 \mu\text{m}$) of diameter 25,4 mm and wrap it with a total wrap angle of 90° with the magnetic surface or the back surface, as appropriate, inwards.
- ii. Exert on one end of the test piece a force of $F_1 = 0,54 \text{ N}$.
- iii. Attach the other end to a force gauge mounted on a linear slide.
- iv. Drive the slide at a speed of 1 mm/s, measure the force F_2 required.
- v. Calculate the coefficient of dynamic friction γ from the equation

$$\gamma = \ln \frac{F_2}{F_1} \times \frac{1}{\pi}$$

where π is the value of the wrap angle in radians.

NOTE - Calcium titanate ceramic should be available from Philips Ceramic Division in Saugerties (NY) under order part Ca Ti.

8 Magnetic recording characteristics

The magnetic recording characteristics shall be defined by testing the requirements given below.

When performing the tests, the output or resultant signal shall be measured on the same relative pass for both a tape calibrated to the Master Standard Reference Tape and the tape under test (read-while-write, or on equipment without read-while-write capability, on the first forward-read-pass) on the same equipment.

The following conditions shall apply to the testing of all magnetic recording characteristics, unless otherwise noted.

- Tape condition: a.c. erased to 2 % or less of the Average Signal Amplitude
- Tape speed: 2,79 m/s
- Read track: within the written track
- Gap alignment: within 5' between the mean write transitions and the read gap
- Write gap length: $2,0 \mu\text{m} \pm 0,3 \mu\text{m}$
- Write gap width: $0,216 \text{ mm} \pm 0,010 \text{ mm}$

- Read gap length: $0,36 \mu\text{m} \pm 0,10 \mu\text{m}$
- Read gap width: $45,7 \mu\text{m} \pm 5,0 \mu\text{m}$
- Tape tension: $1,14 \text{ N} \pm 0,14 \text{ N}$
- Recording current: Test Recording Current
- Physical recording densities: $2f = 1\,640 \text{ ftpmm} \pm 33 \text{ ftpmm}$, corresponding to $2,292 \text{ MHz} \pm 2 \%$
 $1f = 820 \text{ ftpmm} \pm 16 \text{ ftpmm}$, corresponding to $1,146 \text{ MHz} \pm 2 \%$
- Bandwidth of the read amplifier: $3,2 \text{ MHz}$

8.1 Typical Field

The Typical Field shall be between 75 % and 125 % of the Reference Field.

Traceability to the Reference Field is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

8.2 Signal amplitude

The Average Signal Amplitude shall be between 85 % and 115 % of the SRA.

Traceability to the SRA is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

8.3 Resolution

The ratio of the average signal amplitude at the physical recording density of 1 640 ftpmm to that at the physical recording density of 820 ftpmm shall be between 90 % and 120 % of the same ratio for the Master Standard Reference Tape.

Traceability to the resolution of the Master Standard Reference Tape is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

8.4 Overwrite

Overwrite is the ratio of the residual signal of the average signal amplitude recorded at 820 ftpmm after being overwritten at 1 640 ftpmm to the average signal amplitude of the 820 ftpmm signal.

8.4.1 Requirement

The overwrite for the tape shall be less than 110 % of the overwrite for the Master Standard Reference Tape.

Traceability to the overwrite of the Master Standard Reference Tape is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

8.5 Peak shift

Peak shift is measured as the time displacement from nominal of the ONEs transitions in the recorded pattern 110110110....

8.5.1 Requirement

For a peak shift ratio of $n \%$ of the Master Standard Reference Tape, the measured peak shift ratio shall be between $(n-2) \%$ and $(n+2) \%$.

Traceability to the peak shift ratio of the Master Standard Reference Tape is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

8.5.2 Procedure

The time interval measurements shall be averaged over 250 ONE-ONE-ZERO patterns taken at a sampling rate of 96 times $2f$.

The time between adjacent peaks in the ONE-ONE interval is denoted as t_1 . The time between the last ONE in the ONE-ONE interval to the last ONE in the following ONE-ONE interval is denoted as t_0 .

$$\text{Peak shift} = \frac{3t_1 - t_0}{2t_0} \times 100 \%$$