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Information technology — Data interchange on 12,7 mm 36-track magnetic tape cartridges

*Technologies de l'information — Échange de données sur cartouches de
bande magnétique de 12,7 mm, 36 pistes*



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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 14251 was prepared by the European Computer Manufacturers Association (as Standard ECMA-196) 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 an integral part of this International Standard. Annexes H to M are for information only.

Introduction

The following International Standards specify data interchange on 12,7 mm wide magnetic tape cartridges:

ISO/IEC 9661: 1994, *Information technology - Data interchange on 12,7 mm wide magnetic tape cartridges - 18 tracks, 1 491 bytes per millimetre*

ISO/IEC 11559: 1993, *Information technology - Data interchange on 12,7 mm wide 18- track magnetic tape cartridges Extended format*

ISO/IEC 13421: 1993, *Information technology - Data interchange on 12,7 mm, 48-track magnetic tape cartridges - DLT 1 format*

ISO/IEC 13962: 1995, *Information technology - Data interchange on 12,7 mm, 112-track magnetic tape cartridges - DLT 2 format*

This International Standard is related to further developments of cartridges containing 12,7 mm magnetic tape. It incorporates most of the requirements of ISO/IEC 11559, together with extensions and modifications which specify the additional features that allow higher capacities to be achieved.

Two types of cartridge are defined within this International Standard. For one of the types, the requirements for the case and the tape are identical with those in ISO/IEC 11559. The second type conforms to different requirements which are defined in this International Standard. This International Standard also specifies a recording method and format for use with either type.

It is not intended that this International Standard replaces ISO/IEC 11559. Existing cartridges which conform to ISO/IEC 11559 will continue to do so and will not conform to all the requirements of this International Standard. Drives which write and read according to this International Standard may have the ability to accept and read cartridges conforming to ISO/IEC 9661 or ISO/IEC 11559.

Information technology - Data interchange on 12,7 mm 36-track magnetic tape cartridges

Section 1 - General

1 Scope

This International Standard specifies the physical and magnetic characteristics of 12,7 mm wide, 36-track magnetic tape cartridges to enable interchangeability of such cartridges. It also specifies the quality of the recorded signals, the format and the recording method, thus allowing, together with International Standard ISO 1001 or equivalent, full data interchange by means of such magnetic tape cartridges.

This International Standard specifies two types of cartridge which, for the purposes of this International Standard, are referred to as Cartridge System Tape (CST) and Extended Capacity Cartridge System Tape (ECCST), and contain tape of different thicknesses and lengths.

CST cartridges have a nominal uncompressed capacity of approximately 400 Mbytes.

ECCST cartridges have a nominal uncompressed capacity of approximately 800 Mbytes.

This International Standard specifies extensions and modifications to the recorded format that is described in International Standard ISO/IEC 11559.

These extensions and modifications

- increase the number of tracks recorded on the tape from 18 to 36. Actual recordings will be made 18 tracks at a time requiring two complete passes of the tape, one from the beginning of tape to the end of tape and the other from the end of tape to the beginning of tape;

- specify a different method of defining the ECC characters used to detect and correct errors when the data is read from the tape.

2 Conformance

2.1 Magnetic tape cartridge

A magnetic tape cartridge is in conformance with this International Standard if:

- the cartridge meets all the requirements of clauses 6 to 8 for either one of the two types of magnetic tape cartridge;

- the recording on the tape meets the requirements of clauses 9 to 13;

- for each recorded packet the algorithm used for processing the data therein, if Processed Data has been recorded, is defined and the identification is included in Byte 13 of the Packet ID of this packet (see 11.2). This identification shall conform to ISO/IEC 11576.

2.2 Generating system

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 meet the mandatory requirements of this International Standard. A claim of conformance shall state which types of magnetic tape cartridges it is capable of recording, whether or not one, or more, registered algorithms are implemented and, if so, the registered identifiers of all implemented algorithms. It shall also state whether it is capable of generating the optional VOLID Mark information.

2.3 Receiving system

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 the tape according to this International Standard and specifies which of the two types of magnetic tape cartridges it is capable of reading. In particular it shall

- be able to retrieve data from individual packets within the extended blocks;

- be able to recognize that the data has been processed, to identify the algorithm(s) used, restore the data to its original form or to indicate to the host that it cannot do so;

A claim of conformance shall state whether or not one, or more, registered algorithm(s) is (are) implemented and, if so, the registered identifier(s) of all implemented algorithms. It shall also state whether it is capable of using the optional VOLID Mark information.

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/IEC 646: 1991,	<i>Information technology - ISO 7-bit coded character set for information interchange.</i>
ISO 683-13: 1986,	<i>Heat-treatable steels, alloy steels and free-cutting steels - Part 13: Wrought stainless steels.</i>
ISO 1001: 1986,	<i>Information processing - File structure and labelling of magnetic tapes for information interchange.</i>
ISO 1302: 1992,	<i>Technical drawings - Method of indicating surface texture.</i>
ISO/IEC 11576:1994,	<i>Information technology - Procedure for the registration of algorithms for the lossless compression of data.</i>

4 Definitions

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

- 4.1 algorithm:** A set of rules for transforming the logical representation of data.
- 4.2 algorithmically Processed Data:** Data which has been processed by a defined processing algorithm.
- 4.3 Beginning of Tape (BOT):** The point along the length of the magnetic tape, indicated by the start of recorded information.
- 4.4 byte:** An ordered set of eight bits (9 encoded bits) that are acted upon as a unit.
- 4.5 Cyclic Redundancy Check (CRC) character:** A character represented by two bytes, placed at the end of a byte string and used for error detection.
- 4.6 Data Records**
 - 4.6.1 Processed Data Record (PDR):** The data entity resulting from the application of an algorithm to the Logical Data Record.
 - 4.6.2 Host Data Record:** The data entity originally compiled by the host.
 - 4.6.3 Logical Data Record (LDR):** The data entity received by the system from the host. It may contain one or several Host Data Record(s) depending upon action taken by the host to use extended blocks.
 - 4.6.4 User Data Record (UDR):** The data entity available to the Packet Former.
- When the data has been processed it shall be a PDR.
- When the data has not been processed it shall be a LDR.
- 4.7 End of Tape (EOT):** The point on the tape furthest from BOT up to which recording is allowed.
- 4.8 Error correcting code (ECC):** A mathematical procedure yielding bits used for the detection and correction of errors.
- 4.9 flux transition position:** The point on the magnetic tape that exhibits the maximum free-space flux density normal to the tape surface.
- 4.10 flux transition spacing:** The distance along a track between successive flux transitions.
- 4.11 Frame:** A section across all 18 tracks within a Half-Wrap containing logically related bytes.
- 4.12 logical backwards:** The direction of tape motion that results in finding a descending order of LDRs.
- 4.13 logical forwards:** The direction of tape motion that results in finding an ascending order of LDRs.
- 4.14 magnetic tape:** A tape that accepts and retains magnetic signals intended for input, output, and storage of data for information processing.
- 4.15 Master Standard Reference Tape:** A tape selected as the International Standard for Reference Field, Signal Amplitude, Resolution, and Overwrite.

NOTE 1 - A Master Standard Reference Tape has been established at the US National Institute of Standards and Technology (NIST).

- 4.16 packet:** A UDR with a Packet ID and Packet Trailer added.
- 4.17 Pad byte:** A byte having a bit pattern consisting of eight ZEROs.
- 4.18 physical backward:** The direction of tape motion from EOT to BOT. This will be logical forward for Half-Wrap 2.
- 4.19 physical forward:** The direction of tape motion from BOT to EOT. This will be logical forward for Half-Wrap 1.
- 4.20 physical recording density:** The number of recorded flux transitions per unit length of track, e.g. flux transitions per millimetre (ftpm).
- 4.21 Processed Data:** Data which has been processed by an algorithm.
- 4.22 Secondary Standard Reference Tape:** A tape the performance of which is known and stated in relation to that of the Master Standard Reference Tape.
- NOTE 2 - Secondary Standard Reference Tapes, SRM 3202, have been developed at the National Institute for Standards and Technology (NIST) and are available from the NIST Office of Standard Reference Materials, Room B311, Chemistry Building, National Institute for Standards and Technology, Gaithersburg, Maryland USA 20899 until the year 2004.
It is intended that these be used for calibrating tertiary reference tapes for use in routine calibration.
- 4.23 Standard Reference Amplitude (SRA):** The Average Signal Amplitude from the Master Secondary Reference Tape when it is recorded with the Test Recording Current on the NIST measurement system at 972 ftpmm.
- Traceability to the Standard Reference Amplitude is provided by the calibration factors supplied with each Secondary Reference Tape.
- 4.24 Standard Reference Current:** The current that produces the Reference Field.
- 4.25 Tape Reference Edge:** The Reference Edge of the tape is the bottom edge when viewing the recording side of the tape with the hub end (EOT) of the tape to the observer's right.
- 4.26 Test Recording Current:** The current that is 1,5 times the Standard Reference Current.
- 4.27 track:** A longitudinal area on the tape along which a series of magnetic signals can be recorded.
- 4.28 Typical Field:** In the plot of the Average Signal Amplitude against the Recording Field at the physical recording density of 972 ftpmm, the minimum field that causes an Average Signal Amplitude equal to 85 % of the maximum Average Signal Amplitude.
- 4.29 transformation:** The manipulation of Host Data Records before formatting. It includes the operations of processing, the formation of packets and the concatenation of packets.
- 4.30 Wrap:** A set of 36 tracks, 18 of which are recorded from BOT to EOT and 18 of which are recorded from EOT to BOT in a sequential manner.
- 4.31 Half-Wrap:** A set of 18 tracks which are recorded concurrently in the same direction. The tape contains two Half-Wraps; Half-Wrap 1 is recorded from BOT towards EOT and Half-Wrap 2 is recorded from EOT towards End of Volume (EOV).

5 Conventions and notations

5.1 Representation of numbers

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

- In each field the bytes shall be arranged with Byte 1, the most significant, first. Within each byte the bits shall be arranged with Bit 1, the most significant, first and Bit 8, the least significant bit, last. This order applies to the data, and to the input and output of the error correcting codes and cyclic redundancy codes.
- Letters and digits in parentheses represent numbers in hexadecimal notation.
- The setting of binary bits is denoted by ZERO or ONE.
- Numbers in binary notation and bit combinations are represented by strings of ZEROs and ONES with the most significant bit to the left.

5.2 Names

The names of entities are given with a capital initial letter.

5.3 Acronyms

BDM	Beginning of Data Mark
BOT	Beginning of Tape
CRC	Cyclic Redundancy Check
CST	Cartridge System Tape
ECC	Error Correction Code
ECCST	Extended Capacity Cartridge System Tape
EDM	End of Data Mark
EOT	End of Tape
EOV	End of Volume
IBG	Interblock Gap
ID	Identifier or Identification
LDR	Logical Data Record
NB-SNR	Narrow Band Signal-to-Noise Ratio
PDR	Processed Data Record
RBW	Resolution Bandwidth
SRA	Standard Reference Amplitude
UDR	User Data Record
VBW	Video Band Width

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 equipment.

6.1 Cartridge/tape testing environment

Unless otherwise stated, tests and measurements made on the tape cartridge 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 period before testing:	24 h

6.2 Cartridge operating environment

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

temperature:	16 °C to 32 °C
relative humidity:	20 % to 80 %
wet bulb temperature:	25 °C max.

The average temperature of the air immediately surrounding the tape shall not exceed 40,5 °C.

NOTE 3 - Localized tape temperatures in excess of 49 °C may cause tape damage.

Conditioning

before operating:	If a cartridge has been exposed during storage and/or transportation to conditions outside the above values, it shall be conditioned for a period of at least 24 h prior to use.
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6.3 Cartridge storage environment

Cartridges used for data interchange shall be stored under the following conditions.

temperature:	5 °C to 32 °C
relative humidity:	5 % to 80 %
wet bulb temperature:	26 °C max.

6.4 Safety requirements

6.4.1 Safeness

The cartridge and its components shall not constitute any safety or health hazard when used in its intended manner or in 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, 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 - Characteristics of the tapes

7 Characteristics of the tapes

There are two types of tapes specified by this International Standard. The tape used in an ECCST cartridge is longer and thinner than that used in a CST cartridge. ECCST cartridges are differentiated from CST cartridges by the larger tape circumference when the tape is completely wound on the supply reel and by the two coloured cartridge case. Where there are differences between the two cartridges, they are denoted in this International Standard.

7.1 Material

The tape shall consist of a base material (oriented polyethylene terephthalate film or its equivalent) coated on one side with a strong yet flexible layer of ferromagnetic material dispersed in a suitable binder. The back surface of CST tape may also be coated with a ferromagnetic or non-ferromagnetic material. ECCST tape shall not be coated on the back surface.

7.2 Tape length

The minimum length of the tape shall be

For CST tape: 165 m

For ECCST tape: 332 m

7.3 Tape width

The width of tape shall be

For CST tape: 12,650 mm $\pm$ 0,025 mm

For ECCST tape: 12,570 mm $\pm$ 0,025 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 Tape discontinuity

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

7.5 Total thickness of tape

The total thickness of the tape shall be in the following ranges

For CST tape: 0,025 9 mm to 0,033 7 mm

For ECCST tape: 0,016 1 mm to 0,018 0 mm

7.6 Base material thickness

The nominal thickness of the base material for the tape shall be

For CST tape: 0,023 4 mm

For ECCST tape: 0,014 2 mm

7.7 Longitudinal curvature

7.7.1 CST tape

The radius of curvature of the edge of the CST tape shall not be less than 33 m.

Procedure:

Allow a 1 m length of tape to unroll and assume its natural curvature on a flat smooth surface. Measure the maximum deviation from the concave edge of the tape to its chord. The deviation shall not be greater than 3,8 mm. This deviation corresponds to the minimum radius of 33 m if measured over an arc of circle.

7.7.2 ECCST tape

The radius of curvature of the edge of the ECCST tape shall not be less than 33,75 m.

Procedure:

Allow a 0,90 m length of tape to unroll and assume its natural curvature on a flat smooth surface. Measure the maximum deviation from the concave edge of the tape to its chord. The deviation shall not be greater than 3,0 mm. This deviation corresponds to the minimum radius of 33,75 m if measured over an arc of circle.

7.8 Out-of-plane distortions

All visual evidence of out-of-plane distortion shall be removed when the tape is subjected to the uniform tension specified below. 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.

For CST tape: 0,6 N

For ECCST tape: 0,4 N

7.9 Cupping

The departure across the width of tape from a flat surface shall not exceed 0,3 mm.

Procedure:

Cut a $1,0 \text{ m} \pm 0,1 \text{ m}$ length of tape. Condition it for a minimum of 3 h in the test environment by hanging it so that the surfaces are freely exposed to the test environment. From the centre portion of the conditioned tape cut a test piece of 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.

7.10 Dynamic frictional characteristics

In the tests of 7.10.1 and 7.10.2 the specified forces of 1,0 N and 1,50 N, respectively, comprise both the force component of the dynamic friction and the force of 0,64 N applied to the test piece of tape.

NOTE 4 - Particular attention should be given to keeping the surfaces clean.

7.10.1 Frictional drag between the recording surface and the back surface

The force required to move the recording surface in relation to the back surface shall not be less than 1,0 N.

Procedure:

- Wrap a test piece of tape around a 25,4 mm diameter circular mandrel with the back surface of the test piece facing outwards in such a manner that the test piece will not slide.
- Place a second test piece of the same type of tape, with the recording surface facing inwards, around the first test piece for a total wrap angle of 90° .
- Apply a force of 0,64 N to one end of the outer test piece. Secure its other end to a force gauge which is mounted on a motorized linear slide.
- Drive the slide at a speed of 1 mm/s.

7.10.2 Frictional drag between the tape recording surface and ferrite after environmental cycling

The force required to move the tape at a point 1,34 m from the leader block of the cartridge shall not be greater than 1,5 N. The force required at a point 4,3 m from the junction of the tape with the cartridge hub shall not exceed 6,0 N.

Procedure:

- a) Wind tape on to a spool hub of diameter 50 mm to an outside diameter of 97 mm with a winding tension of $2,2 \text{ N} \pm 0,2 \text{ N}$ for CST tape and $1,8 \text{ N} \pm 0,2 \text{ N}$ for ECCST tape.
- b) Repeat the following two steps five times:
 - Store for 48 h at a temperature of $50 \text{ }^{\circ}\text{C}$ and a relative humidity of 10 % to 20 %.
 - Condition in the testing environment for 2 h and rewind with a tension of $2,2 \text{ N} \pm 0,2 \text{ N}$ for CST tape and $1,8 \text{ N} \pm 0,2 \text{ N}$ for ECCST tape.
- c) Condition the tape for 48 h at a temperature of $30,5 \text{ }^{\circ}\text{C}$ and a relative humidity of 85 %. The tape shall remain in this environment for steps d) and e).
- d) Apply a force of 0,64 N to one end of a test piece of not more than 1 m, taken 1,34 m from the leader block. Pass the test piece over a ferrite rod of diameter 25,4 mm with the recording surface in contact with the rod for a total wrap angle of 90° .
The rod shall be made from the ferrite specified in annex A. It shall be polished to a roughness value R_a of $0,05 \text{ }\mu\text{m}$ (roughness grade N2, ISO 1302). Pull the other end of the test piece horizontally at 1 mm/s.
- e) Repeat step d) for a similar test piece taken 4,3 m from the junction of the tape with the cartridge hub.

7.11 Coating adhesion

The force required to peel any part of the coating from the tape base material shall not be less than 1,5 N.

Procedure:

- a) 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.
- b) Using a double-sided pressure sensitive tape, attach the full width of the test piece to a smooth metal plate, with the recording surface facing the plate, as shown in figure 1.
- c) 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 m.
- d) Note the force at which any part of the coating first separates from the base material. If this is less than 1,5 N, the test has failed. If the test piece peels away from the double-sided pressure sensitive tape before the force exceeds 1,5 N, an alternative type of double-sided pressure sensitive tape shall be used.
- e) If the back surface of the tape is coated, repeat a) to d) for the back coating.

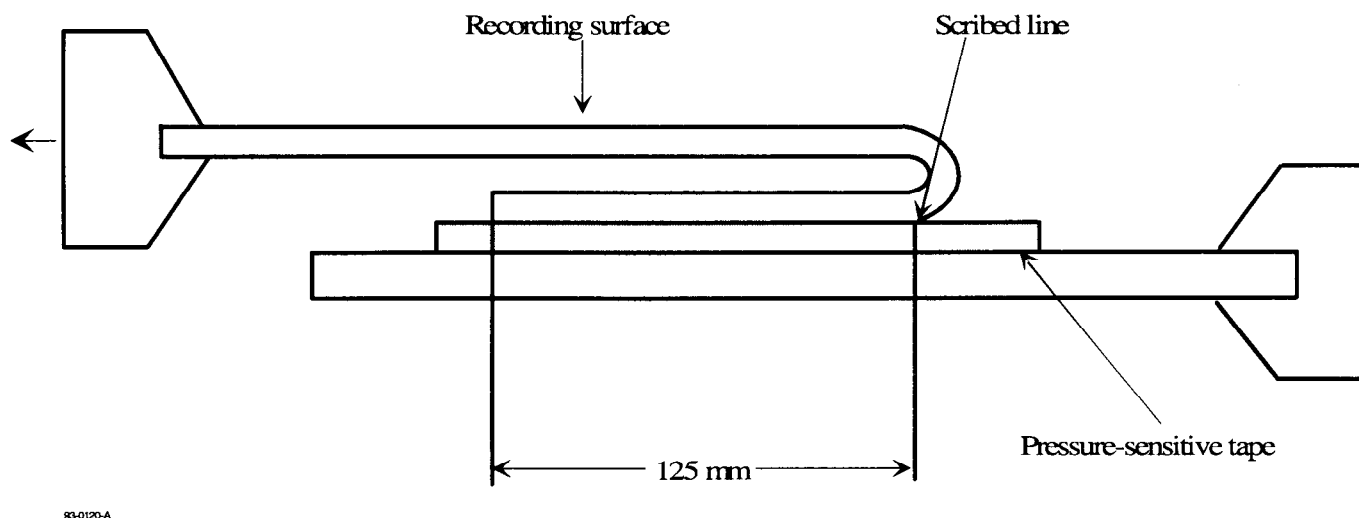


Figure 1 - Coating adhesion test

7.12 Flexural rigidity

The flexural rigidity of the tape in the longitudinal direction shall be

For CST tape	0,06 to 0,16 N·mm ²
For ECCST tape	0,03 to 0,14 N·mm ²

Procedure:

Clamp a 180 mm test piece of tape in a universal testing machine, allowing a 100 mm separation between the machine jaws. Set the jaw separation speed at 5 mm per minute. Plot force against distance. Calculate the flexural rigidity using the slope of the curve between 2,2 N and 6,7 N by the formula

$$E = \frac{\Delta F / WT}{\Delta L / L}$$

$$I = \frac{WT^3}{12}$$

Flexural rigidity = EI

Where

ΔF is the change in force in Newtons

T is the measured thickness in millimetres

W is the measured width in millimetres

$\Delta L/L$ is the change in the length of the test piece between the jaws divided by the original length between the jaws.

7.13 Electrical resistance of coated surfaces

The electrical resistance of any square area of the recording surface shall be within the range

- 105Ω to 5 x 10⁸Ω for non-backcoated tapes.
- 105Ω to 5 x 10⁹Ω for backcoated tapes.

The electrical resistance of any backcoating shall be less than 10⁶Ω.

Procedure:

Condition a test piece of tape to 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 such 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 as shown in figure 2. Apply a force F of 1,62 N to each end of the test piece. Apply a DC voltage of $500 \text{ V} \pm 10 \text{ V}$ across the electrodes and measure the resulting current flow. From this value, determine the electrical resistance.

Repeat for a total of five positions along the test piece and average the five resistance readings. For back-coated tape repeat the procedure with the backcoating in contact with electrodes.

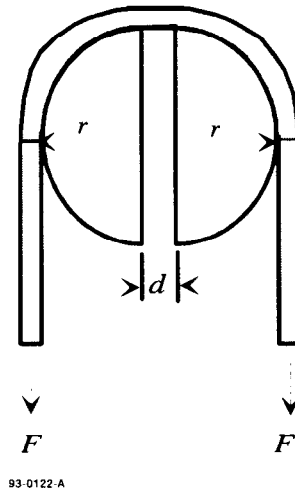


Figure 2 - Electrical resistance test

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

NOTE 5 - Particular attention should be given to keeping the surfaces clean.

7.14 Tape durability

This International Standard does not specify parameters for assessing tape durability. However, a recommended procedure is described in annex K.

7.15 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.

7.16 Tape abrasivity

Tape abrasivity is the tendency of the tape to wear the tape transport and head. The length of the wear pattern on a wear bar shall not exceed $56 \mu\text{m}$ when measured as specified in annex A.

7.17 Accelerated life test

This International Standard does not specify parameters for assessing whether or not a tape withstands long-term storage and extreme environmental operating conditions. However, a recommended procedure is described in annex M.

7.18 Data integrity test

The object of the data integrity test is to demonstrate that the tape will withstand continued tape movement in the drive within the environmentally stressed operating conditions without loss of recorded data. Data is written in the forward direction between BOT and EOT, and then the tape is moved multiple passes the full operating length, after which the data is re-read to check for the generation of errors.

7.18.1 Requirement

There shall be no more than eight additional temporary read errors on any read pass. There shall be no generation of permanent read errors.

7.18.2 Procedure

- Allow cartridges to acclimatize at room temperature and re-tension the tape by driving it one time back and forth between the BOT and EOT to remove any loose wraps.

- b) Place the test hardware and cartridge to be tested in a $30,0\text{ }^{\circ}\text{C} \pm 2,0^{\circ}$, 85 % rh environment for 24 h.
- c) Write Data Blocks containing 32K bytes each on the cartridge from BOT to EOT in the forward direction only. Read the data while writing and save the error information.
- d) File-Protect the cartridge.
- e) From EOT backup the tape 50 Data Blocks and note the Block ID.
- f) Run high-speed passes at 4 m/s to 5 m/s to the Block ID noted in step e). Then do a high-speed rewind to BOT. Repeat this high-speed pass 50 times.
- g) Read the data from the entire tape and save the error information.
- h) Repeat steps f) and g) 4 times for a total of 250 high-speed passes from BOT to the noted Block ID and back to BOT and 5 full length read passes. Save the error information for comparison against the original error information.
- i) Compare the read data results for all five read passes against the original data of step c).

7.19 Pre-recording condition

Prior to recording data for testing purposes, or to testing, erase the tape utilizing alternating magnetic fields of decaying levels (anhysteretic process) to ensure that the remanent magnetic moment of the recording surface does not exceed 20 % of the maximum remanent magnetic moment. Annex B specifies the method of measurement.

In addition, no low density transitions shall be present on the tape and the tape shall have been erased prior to the first time it was used for recording.

7.20 Magnetic recording characteristics

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

When performing these 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 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:	pre-recording condition
– tape speed:	not greater than 2,5 m/s
– read track:	within the written track
– azimuth alignment:	not greater than 6' between the mean write transitions and the read gap
– write gap length:	$1,0\text{ }\mu\text{m} \pm 0,2\text{ }\mu\text{m}$
– write head saturation density:	$0,34\text{ T} \pm 0,03\text{ T}$
– tape tension	
CST tape:	$2,2\text{ N} \pm 0,2\text{ N}$
ECCST tape:	$1,8\text{ N} \pm 0,2\text{ N}$
– recording current:	Test Recording Current

7.20.1 Typical field

The Typical Field of the tape shall be between 90 % and 110 % of the Reference Field.

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

7.20.2 Signal amplitude

The Average Signal Amplitude at the physical recording density of 972 ftpmm shall be between 70 % and 140 % of the SRA.

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

7.20.3 Resolution

The ratio of the Average Signal Amplitude at the physical recording density of 1 458 ftpmm to that at the physical recording density of 972 ftpmm shall be between 80 % 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.

7.20.4 Overwrite

Overwrite is the ratio of the Average Signal Amplitude of the residual of the fundamental frequency of a tone pattern after being overwritten at 972 ftpmm to the Average Signal Amplitude of the 972 ftpmm signal. The Average Signal Amplitude of the tone pattern is the peak-to-peak amplitude of the sinusoidal signal with equal rms power.

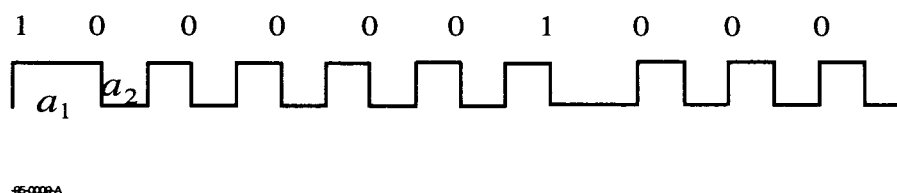
7.20.4.1 Requirement

The overwrite for the tape shall be less than 120 % 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.

7.20.4.2 Procedure:

Record a tone pattern which shall be the following sequence of flux transitions.



where $a_1 = 1,029 \mu\text{m}$
 $a_2 = 0,514 \mu\text{m}$

Figure 3 - Tone Pattern

Record a 972 ftpmm signal over the tone pattern. Measure the Average Signal Amplitude of the residual of the fundamental frequency of the tone pattern (one sixth of the frequency of the 972 ftpmm signal) and the Average Signal Amplitude of the 972 ftpmm signal. Both amplitude measurements shall be made using suitable filters.

7.20.5 Narrow-band signal-to-noise ratio (NB-SNR)

The narrow-band signal-to-noise ratio is the Average Signal Amplitude rms power divided by the average integrated (side band) rms noise power, and is expressed decibels.

7.20.5.1 Requirement

The NB-SNR shall be equal to, or greater than, 30 dB when normalized to a track width of 410 μm . The normalization factor is $\text{dB}(410) = \text{dB}(W) + 10 \log 410/W$, where W is the track width used when measuring $\text{dB}(W)$.

7.20.5.2 Procedure

The NB-SNR shall be measured using a spectrum analyzer with a resolution bandwidth (RBW) of 1 kHz and a video bandwidth (VBW) of 10 Hz. The tape speed shall be 762 mm/s for the frequencies specified below.

The NB-SNR shall be measured as follows

- Measure the read-signal amplitude of the 972 ftpmm signal, taking a minimum of 150 samples over a minimum length of tape of 46 m.
- On the next pass (read only) measure the rms noise power over the same section of tape and integrate the rms noise power (normalizing for the actual resolution bandwidth) over the range from 332 kHz to 366 kHz.

For other tape speeds all frequencies shall be linearly scaled.

7.21 Tape quality

The tape quality (including the effects of exposure to storage and transportation environments) is defined by the testing requirements given in the following clauses. The following conditions shall apply to all quality testing requirements.

- environment: operating environment
- tape condition: pre-recording condition
- tape speed: 2 m/s
- write track width: greater than, or equal, to the read track width
- read track width : $190 \mu\text{m} \pm 2,5 \mu\text{m}$
- physical recording density: 972 ftpmm
- write gap length : $1,0 \mu\text{m} \pm 0,2 \mu\text{m}$

- azimuth alignment : not greater than 6' between the mean write transitions and the read gap
- write head saturation density: $0,34 \text{ T} \pm 0,03 \text{ T}$
- recording current: Test Recording Current
- format: 36 tracks
- tape tension
 - CST tape: $2,2 \text{ N} \pm 0,2 \text{ N}$
 - ECCST tape: $1,8 \text{ N} \pm 0,2 \text{ N}$

7.21.1 Missing pulses

A missing pulse is a loss of read signal amplitude. A missing pulse exists when the base-to-peak read signal amplitude is 25 %, or less, of half the Average Signal Amplitude for the preceding 25,4 mm of tape.

7.21.2 Missing pulse zones

A Missing Pulse Zone begins with a missing pulse and ends when 64 consecutive flux transitions, which are not missing pulses, are detected or a length of 1 mm of tape has been measured.

The Missing Pulse Zone rate shall be less than one in 8×10^6 flux transitions recorded.

7.21.3 Coincident Missing Pulse Zones

For purposes of measuring Coincident Missing Pulse Zones, the 36 tracks are divided into four 9-track groups as shown below. A simultaneous Missing Pulse Zone condition on two or more tracks of a 9-track group is a Coincident Missing Pulse Zone.

The first group shall comprise physical tracks 1, 5, 9, 13, 17, 21, 25, 29, and 33.

The second group shall comprise physical tracks 3, 7, 11, 15, 19, 23, 27, 31, and 35.

The third group shall comprise physical tracks 2, 6, 10, 14, 18, 22, 26, 30, and 34.

The fourth group shall comprise physical tracks 4, 8, 12, 16, 20, 24, 28, 32, and 36.

If a Coincident Missing Pulse Zone occurs at the same time in the first and second group of tracks and the third or fourth group of tracks, it shall be considered as a single Coincident Missing Pulse Zone. Its length shall begin with the start of the earliest Coincident Missing Pulse Zone and terminate with the end of the latest Coincident Missing Pulse Zone.

No tape shall have more than 12 Coincident Missing Pulse Zones.

No Coincident Missing Pulse Zone shall exceed 50 mm.

Section 3 - Cartridge

8 Dimensional and mechanical characteristics of the cartridge

The two cartridges defined by this International Standard, the CST and the ECCST, are very similar in their dimensional and mechanical characteristics. Requirements in this section shall apply to both types unless a specific difference is noted.

The cartridges shall consist of the following elements:

- a case,
- a reel for the magnetic tape,
- a magnetic tape wound on the hub of the reel,
- a locking mechanism for the reel,
- a write-inhibit mechanism,
- a leader block,
- a latching mechanism for the leader block.

Dimensional characteristics are specified for those parameters deemed mandatory for interchange and compatible use of the cartridge. Where there is freedom of design, only the functional characteristics of the elements described are indicated. In the enclosed drawings a typical implementation is represented in third angle projection. Figures 4 to 20 show a typical implementation.

Where they are purely descriptive, the dimensions are referred to three Reference Surfaces A, B, and C forming a geometrical trihedral (see figure 4). Where the dimensions are related to the position of the cartridge in the drive, they may be referred to another surface of the cartridge. Figures 4 to 14 show the dimensions of the empty case.

Figure 4	is a general view of the whole cartridge.
Figure 5	shows the front side of the case which lies on Reference Surface A.
Figure 6	shows the top side of the case.
Figure 7	shows the rear side of the case.
Figure 8	shows the bottom side of the case which lies in Reference Surface C.
Figure 9	shows the side of the case which lies in Reference Surface B.
Figure 10	shows an enlarged view of a part of figure 5.
Figure 11	shows an enlarged cross-section of a location notch.
Figure 12	shows an enlarged cross-section of a detail of the opening of the case.
Figure 13	shows the bottom side of the case.
Figure 14	shows an enlarged cross-section of the recessed area.
Figure 15	shows an enlarged partial cross-section of the cartridge in hand.
Figure 16	shows the same cross-section as figure 15 but of a cartridge in the drive.
Figure 17	shows schematically the teeth of the toothed rim.
Figure 18	shows two views and an enlarged cross-section of the leader block.
Figure 19	shows the fixation of the tape to the leader block.
Figure 20	shows the leader block inserted in the case.

8.1 Overall dimensions (figure 4)

The overall dimensions of the case shall be

$$l_1 = 125,00 \text{ mm} \pm 0,32 \text{ mm}$$

$$l_2 = 109,00 \text{ mm} \pm 0,32 \text{ mm}$$

$$l_3 = 24,50 \text{ mm} \begin{array}{l} + 0,50 \text{ mm} \\ - 0,32 \text{ mm} \end{array}$$

The corners of the case shall be rounded off as specified by

$$r_1 = 3,00 \text{ mm max.}$$

$$r_2 = 4,00 \text{ mm max.}$$

$$r_3 = 3,00 \text{ mm max.}$$

8.2 Write-inhibit mechanism (figures 4 and 5)

The write-inhibit mechanism shall have a flat surface identified by a visual mark, e.g. a white spot, when in the position in which writing is inhibited.

The flat surface shall be accessible through a window in the front side of the case. The location and dimensions of the window are specified by

$$l_4 = 11,80 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_5 = 15,60 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_6 = 7,40 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_7 = 12,00 \text{ mm} \pm 0,25 \text{ mm}$$

In the write-inhibit position the flat surface of the write-inhibit mechanism shall be behind this window at a distance

$$l_8 = 2,55 \text{ mm min.}$$

from the front side of the case.

In the write-enable position this surface shall be within 0,25 mm of the front side of the case.

The force required for the operation of the write-inhibit mechanism shall be in the range

$$2 \text{ N to } 9 \text{ N}$$

when applied tangentially to the surface of the case.

This International Standard does not prescribe the actual implementation of the write-inhibit mechanism. For example, it can be a rotatable or a slidable element. The implementation may require a larger or additional window but shall not impair the integrity of the case against potential contaminants.

8.3 Label area(s) of the rear side (figures 6 and 7)

On the rear side of the case there shall be one or two label areas, provided to hold labels. Either implementation of the cartridge satisfies the requirements of this International Standard.

8.3.1 Implementation of a single label area

The label area shall be specified by

$$l_9 = 7,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{10} = 80,00 \text{ mm} \begin{matrix} + 0,30 \text{ mm} \\ - 0,16 \text{ mm} \end{matrix}$$

$$l_{11} = 12,30 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{12} = 0,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$r_4 = 1,00 \text{ mm max.}$$

l_{74} , l_{75} , l_{76} are not specified.

8.3.2 Implementation for two label areas

The label areas shall be specified by

l_9 is not specified

$$l_{10} = 80,00 \text{ mm} \begin{matrix} + 0,30 \text{ mm} \\ - 0,16 \text{ mm} \end{matrix}$$

$$l_{11} = 12,30 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{12} = 0,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{74} = 17,55 \text{ mm} \pm 0,13 \text{ mm}$$

$$l_{75} = 21,97 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{76} = 2,41 \text{ mm} \pm 0,13 \text{ mm}$$

$$r_4 = 1,00 \text{ mm max.}$$

8.4 Label area of the top side (figure 6)

On the top side of the case there shall be a label area, recessed by $0,50 \text{ mm} \pm 0,25 \text{ mm}$, specified by l_9 , l_{10} , l_{12} and in addition by

$$l_{13} = 31,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{14} = 75,00 \text{ mm} \begin{matrix} + 0,30 \text{ mm} \\ - 0,16 \text{ mm} \end{matrix}$$

8.5 Case opening (figures 5, 6 and 10)

The case shall have an opening for the tape in which the leader block can be inserted (see also figure 18). This opening shall be specified by

$$l_{15} = 4,70 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{16} = 14,90 \text{ mm} \pm 0,32 \text{ mm}$$

$$l_{17} = 7,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{18} = 87,10 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{19} = 4,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$r_5 = 4,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$\alpha = 50^\circ \pm 1^\circ$$

Moreover, figure 10 shows at a larger scale the details of the configuration of the case opening as seen at the right-hand side of figure 5.

$$l_{61} = 3,4 \text{ mm} \pm 0,5 \text{ mm}$$

$$l_{62} = 16,9 \text{ mm} \pm 0,5 \text{ mm}$$

$$l_{63} = 3,0 \text{ mm} \pm 0,5 \text{ mm}$$

$$l_{64} = 11,6 \text{ mm} \pm 0,5 \text{ mm}$$

$$\omega_1 = 1^\circ \pm 30'$$

$$\omega_2 = 20^\circ \pm 2^\circ$$

8.6 Locating notches (figures 8, 9 and 11)

There shall be two locating notches open towards the bottom side. These location notches shall be specified by

$$l_{20} = 106,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{21} = 5,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{22} = 7,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{23} = 104,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{24} = 2,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$\beta = 1^\circ 30' \pm 30'$$

$$\gamma = 2^\circ 0' \pm 30'$$

8.7 Locating areas (figure 8)

The bottom side of the case shall have three circular locating areas a_1 , a_2 , and a_3 which shall lie in the same horizontal plane within 0,25 mm.

Areas a_1 and a_2 shall have a diameter of $10,00 \text{ mm} \pm 0,25 \text{ mm}$. The position of their centre shall be specified by

$$l_{25} = 108,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{26} = 3,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{27} = 105,50 \text{ mm} \pm 0,25 \text{ mm}$$

Area a_3 shall have a diameter of $14,00 \pm 0,25 \text{ mm}$. The position of its centre shall be specified by

$$l_{28} = 31,25 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{29} = 54,50 \text{ mm} \pm 0,25 \text{ mm}$$

8.8 Inside configuration of the case around the case opening (figures 8 and 12)

Figures 8 and 12 show the inside configuration of the case around the opening of the case. This configuration shall be defined as follows (see also 8.10)

$$l_{30} = 3,30 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{31} = 18,40 \text{ mm} \pm 0,25 \text{ mm}$$

$$r_6 = 1,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$r_7 = 1,50 \text{ mm} \pm 0,25 \text{ mm}$$

The oblique edge of the case shall be tangential to the arc of a circle defined by r_6 at an angle

$$\lambda = 40^\circ 0' \pm 30'$$

8.9 Other external dimensions of the case (figure 9)

The external form of the case shall be further specified by

$$l_{32} = 113,2 \text{ mm} \pm 0,3 \text{ mm}$$

$$l_{33} = 26,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$r_8 = 145,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$r_9 = 145,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$\delta = 30^\circ 0' \pm 30'$$

8.10 Central window (figure 8)

The bottom side of the case shall have a central window. The location of its centre shall be specified by l_{29} and

$$l_{34} = 61,00 \text{ mm} \pm 0,25 \text{ mm}$$

Its diameter shall be

$$d_1 = 43,5 \text{ mm} \pm 2,0 \text{ mm}$$

The angle with its apex at the centre of this window and formed by the two lines tangential to the parts shown in figure 8 in cross-section shall be

$$\theta = 16^\circ 0' \pm 30'$$

8.11 Stacking ribs (figures 7 and 8)

The bottom side of the case shall have two parallel stacking ribs. Their dimensions shall be

$$l_{35} = 5,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{36} = 1,00 \text{ mm} \pm 0,16 \text{ mm}$$

$$l_{37} = 74,50 \text{ mm} \pm 0,25 \text{ mm}$$

Their locations shall be

$$l_{38} = 31,25 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{39} = 7,50 \text{ mm} \pm 0,32 \text{ mm}$$

$$l_{40} = 79,50 \text{ mm} \pm 0,25 \text{ mm}$$

8.12 Recessed area (figures 13 and 14)

The bottom of the case of the ECCST cartridge shall have a recessed area whose dimensions shall be

$$l_{67} = 61,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{68} = 5,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{69} = 0,45 \text{ mm} \begin{matrix} + 0,10 \text{ mm} \\ - 0,20 \text{ mm} \end{matrix}$$

$$\mu_6 = 2,0^\circ \text{ max.}$$

$$r_{16} = 0,25 \text{ mm max.}$$

$$r_{17} = 0,10 \text{ mm max.}$$

Its location shall be defined by l_{20} and, in addition

$$l_{70} = 16,50 \text{ mm} \pm 0,25 \text{ mm}$$

This area is not defined for the CST cartridge.

8.13 Flexibility of the case

The flexibility of the top and bottom sides of the case (see figure 4) is the amount of deflection observed when they are submitted to a perpendicular force f .

8.13.1 Requirements

The amount of deflection d shall meet the following requirements

Deflection of the top side

$$0,0256 f \leq d \leq 0,38 + 0,054 f$$