INTERNATIONAL STANDARD

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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,	*Information technology - ISO 7-bit coded character set for information interchange.*
ISO 683-13: 1986,	*Heat-treatable steels, alloy steels and free-cutting steels - Part 13: Wrought stainless steels.*
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 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 (ftpmm).

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.

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 ± 0,025 mm
For ECCST tape: 12,570 mm ± 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 m ± 0,1 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 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.

7.10 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:

a) 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.

b) 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°.

c) 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.

d) 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 N ± 0,2 N for CST tape and 1,8 N ± 0,2 N for ECCST tape.

b) Repeat the following two steps five times:

   – Store for 48 h at a temperature of 50 °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 N ± 0,2 N for CST tape and 1,8 N ± 0,2 N for ECCST tape.

c) Condition the tape for 48 h at a temperature of 30,5 °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 Ra of 0,05 µm (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.