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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.

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

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

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

International Standard ISO/IEC 117913 was prepared by ECMA (as ECMA-278) 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, B, C and D form a normative part of this International Standard. Annexes E to G are for information only.

Information technology — 12,7 mm 128-track magnetic tape cartridge for information interchange — Parallel serpentine format

Section 1 - General

1 Scope

This International Standard specifies the physical and magnetic characteristics of a magnetic tape cartridge, using a magnetic tape 12,7 mm wide, so as to provide physical interchange of such cartridges between drives. It also specifies the quality of the recorded signals, the recording method and the recorded format known as Parallel Serpentine, thereby allowing data interchange between drives by means of such cartridges. The format supports variable length Logical Records, high speed search, and the use of the algorithm for data compression specified in International Standard ISO/IEC 15200.

Information interchange between systems also requires, at a minimum, agreement between the interchange parties upon the interchange code(s) and the specification of the structure and labelling of the information on the interchanged cartridge.

Together with a standard for volume and file structure, e.g. International Standard ISO 1001, this International Standard provides for full data interchange between data processing systems.

2 Conformance

2.1 Magnetic tape cartridge

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

2.2 Generating system

A generating system shall be in conformance with this International Standard if it generates a tape according to 2.1.

2.3 Receiving system

A receiving system shall be in conformance with this International Standard if it can read all tapes according to 2.1.

3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1001: 1986, *Information processing — File structure and labelling of magnetic tapes for information interchange*.

IEC 60950:1999, *Safety of information technology equipment*.

ISO/IEC 15200:1996, *Information technology— Adaptive Lossless Data Compression algorithm (ALDC)*.

ISO/R 527:1966, *Plastics — Determination of tensile properties*.

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*.

ANSI MH10.8M-1993, *Materials Handling — Unit Loads and Transport Packages — Bar Code Symbols*.

4 Terms and definitions

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

4.1 algorithm: A set of rules for transforming the logical representation of data.

4.2 anhysteretic erase: A process of erasure utilising an alternating magnetic field of decaying level.

- 4.3 **average signal amplitude:** The average peak-to-peak value of the signal output measured over a minimum of 25,4 mm, exclusive of missing pulses.
- 4.4 **azimuth:** The angle, in minutes of arc, of the mean flux transition line of a track from a line normal to the tape Reference Edge.
- 4.5 **back surface:** The surface of the tape opposite the recording surface.
- 4.6 **beginning of partition (BOP):** The point along the length of the tape where recording in any partition begins.
- 4.7 **beginning of tape (BOT):** The point along the length of the magnetic tape, indicated by the start of recorded information.
- 4.8 **cartridge:** A container holding a single supply reel of magnetic tape with an attached leader block at the BOT end.
- 4.9 **cyclic redundancy check (CRC) character:** A four-byte character used for error detection.
- 4.10 **end of tape (EOT):** The point on a track farthest from BOT up to which recording is allowed.
- 4.11 **error-correcting code (ECC):** An algorithm yielding bytes used for error detection and correction.
- 4.12 **error-detecting code (EDC):** An algorithm yielding bytes used for error detection.
- 4.13 **File Mark:** A recorded element requested by a host that marks the end of a host data file or aggregate.
- 4.14 **flux transition position:** The point on the magnetic tape that exhibits the maximum free-space flux density normal to the tape surface.
- 4.15 **flux transition spacing:** The distance along a track between successive flux transitions.
- 4.16 **half-wrap:** A track group recorded in the physical forward or physical reverse direction.
- 4.17 **logical block:** User data or a File Mark that is received as input by the system or that is sent as output from the system.
- 4.18 **logical forward:** The direction of tape motion that results in finding an ascending order of device block identifiers.
- 4.19 **logical reverse:** The direction of tape motion that results in finding a descending order of device block identifiers.
- 4.20 **magnetic tape:** A tape that accepts and retains magnetic signals intended for input, output, and storage of data for information processing.
- 4.21 **mark tach count:** The value of the tach counter that exists at the starting point of an Interblock Gap prior to the first device block of a mark.
- 4.22 **Master Standard Reference Tape:** A tape selected as the standard for Reference Field, signal amplitude, resolution, and broad-band signal-to-noise ratio.
Note - A Master Standard Reference Tape has been established at Imation Corporation.
- 4.23 **physical recording density:** The number of recorded flux transitions per unit length of track expressed in flux transitions per millimetre (ftpm).
- 4.24 **pre-record condition:** The condition of the magnetic tape in preparation for data recording that has been anhyseretically erased and subsequently servo written.
- 4.25 **recorded element:** A File Mark or a logical block.
- 4.26 **Reference Field:** The Typical Field of the Master Standard Reference Tape.
- 4.27 **resync character:** A control character identifying format resynchronisation points in a track. It is intended that read-back circuits be capable of resynchronising operations when such characters are sensed.
- 4.28 **SDM set:** The group of SDM marks delineated by the beginning and end SDM marks, containing any number of included middle SDM marks including zero middle SDM marks.
- 4.29 **Secondary Standard Reference Tape (SSRT):** A tape, the performance of which is known and stated in relation to that of the Master Standard Reference Tape.

Note - Secondary Standard Reference Tapes can be ordered from the Imation Corporation, 1 Imation Place, Oakdale, MN 55128-3414 under Part Number 84-9802-4185-9. In principle such tapes will be available for a period of 10 years from the publication of

this International Standard. However, by agreement between ECMA and Imation Corporation, this period may be shortened or extended to take account of demands for such SSRTs.

It is intended that these SSRTs be used for calibrating tertiary reference tapes for use in routine calibration.

- 4.30 servo track:** A pre-recorded non-data track that is used by the drive to locate the data recording head at precise locations for recording data.
- 4.31 Standard Reference Amplitude (SRA):** The average signal amplitude from the Master Standard Reference Tape when it is recorded with the Test Recording Current at 2 550 ftpmm. Traceability to the Standard Reference Amplitude is provided by the calibration factors supplied with each Secondary Standard Reference Tape.
- 4.32 Standard Reference Current (I_R):** The current that produces the Reference Field.
- 4.33 Test Recording Current (I_m):** A current whose value is 1,5 times the Standard Reference Current ($I_m = 1,5 \times I_R$).
- 4.34 track:** A longitudinal area on the tape along which a series of magnetic signals can be recorded.
- 4.35 track group:** The set of tracks recorded simultaneously.
- 4.36 trailer:** Data appended to a data entity to provide identification and checking.
- 4.37 Typical Field:** The minimum recording field which, when applied to a magnetic tape, will cause an average signal amplitude equal to 85 % of the maximum average signal amplitude at 2 550 ftpmm recording density.
- 4.38 write equalisation:** An algorithm that linearly transforms an input binary sequence into another binary sequence.

5 Conventions and notations

5.1 Representation of numbers

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

- A measured value is rounded off to the least significant digit of the corresponding specified value. It implies that a specified value of 1,26 with a positive tolerance +0,01, and a negative tolerance -0,02 allows a range of measured values from 1,235 to 1,275.
- In each block and in each field the bytes shall be arranged with Byte 0, the most significant, first. Within each byte the bits shall be arranged with Bit 0, the most significant, first and Bit 7, the least 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 digits 0 and 1 shown with the most significant bit to the left.

5.2 Dimensions

The dimensions in figures 1 to 3 are nominal dimensions. Unless otherwise stated, the dimensions in figures 4 to 21 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

BOP	Beginning of Partition
BOT	Beginning of Tape
BOW	Beginning of half-Wrap mark
BVCR	Beginning of Volume Control Region
CRC	Cyclic Redundancy Check character
DBM	Device Block Map
ECC	Error-Correcting Code
EDC	Error-Detecting Code

EEIU	ECC encoded interleave unit
ELEOP	Early Logical End of Partition
EOD	End of Data mark
EOP	End of Partition
EOT	End of Tape
EOV	End of Volume
EOW	End of half-Wrap mark
EVCR	End of Volume Control Region
FID	Format Identification
IBG	Interblock Gap
LEOP	Logical End of Partition
LP1	Logical Point 1
LP2	Logical Point 2
LP3	Logical Point 3
MIE	Minimum Interleave Element
MIU	Minimum Interleave Unit
MSRT	Master Standard Reference Tape
RLL	Run Length Limited
SAQ	Servo Acquisition Region
SARS	Statistical Analysis and Reporting
SDM	Servo Demark
SECC	Short Error Correction Code
SRA	Standard Reference Amplitude
SSRT	Secondary Standard Reference Tape
VCR	Volume Control Region

6 Environment and safety

Unless otherwise stated, the conditions specified below refer to the ambient conditions in the test or computer room and not to those within the tape drive.

6.1 Cartridge and tape testing environment.

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

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

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: 26 °C max.

Note - Localised tape temperatures in excess of 48 °C may cause tape damage.

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

6.3 Cartridge storage environment

Cartridges shall be stored under the following conditions:

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

The stray magnetic field at any point on the tape shall not exceed 4 000 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 E gives some recommendations for transportation.

Section 2 - Requirements for the unrecorded tape

7 Mechanical and electrical requirements

7.1 Material

The tape shall consist of a base material (oriented polyethylene terephthalate film or its equivalent) coated on one surface with a strong yet flexible layer of ferromagnetic material dispersed in a suitable binder. The other surface of the tape may be coated to enhance electrical conduction, tape handling and mechanical properties.

7.2 Tape length

The length of the tape shall be $320 \text{ m} \pm 5 \text{ m}$.

7.3 Width

The width of the tape shall be $12,650 \text{ mm} \pm 0,025 \text{ mm}$.

The width shall be measured across the tape from edge to edge when the tape is under a tension of less than 0,28 N.

7.4 Total thickness

The total thickness of the magnetic tape at any point shall be $17,0 \text{ } \mu\text{m} \pm 1,0 \text{ } \mu\text{m}$.

7.5 Base material thickness

The thickness of the base material shall be $14,2 \text{ } \mu\text{m} \pm 0,7 \text{ } \mu\text{m}$.

7.6 Discontinuity

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

7.7 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.

7.7.1 Requirement

The radius of curvature of the edge of the tape shall be greater than 33,75 m.

7.7.2 Procedure

Allow a 1 m length of tape to unroll and measure its natural curvature on a flat, smooth surface. Measure the deviation from a 1 m chord. The deviation shall not be greater than 3,0 mm within a span of 900 mm. This corresponds to the minimum radius of curvature of 33,75 m when measured over an arc of circle.

7.8 Out-of-Plane distortions

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.

There shall be no visual evidence of out-of-plane distortion when the tape is subjected to a uniform tension of 0,4 N.

7.9 Cupping

Cupping is the departure across the width of the tape (transverse to motion) from a flat surface.

7.9.1 Requirement

There shall be no cupping toward the recording surface of the tape. Cupping away from the recording surface shall be 0,4 mm max.

7.9.2 Procedure

- i. Cut a tape sample at least 1,0 m in length.
- ii. Condition the sample by hanging it so that the coated surface is freely exposed to the test environment for a minimum of 3 h.
- iii. From the centre portion of the tape, cut a sample $0,5 \text{ m} \pm 0,1 \text{ m}$ in length.
- iv. Install the tape sample on a fixture that uses a clamping bar to hold one end of the sample and a 3,5 g tensioning weight to pull the other end of the tape sample across a roller. There shall be a minimum distance of 200 mm between the roller and the clam.
- v. Place the fixture on a 40X microscope stage so that the centre of the fixture is under the microscope. Adjust the microscope to focus on the first edge of the tape, and record the vertical positioning of the focusing adjustment. The microscope focusing adjustment shall be known to $1 \text{ } \mu\text{m}$.
- vi. While positioning the tape laterally under the microscope, use the focusing adjustment to find the point of maximum departure of the tape surface from the reference edge height. Note the vertical height and determine the difference between the first reference of step v and the departed surface height.
- vii. Move the tape under the microscope to view the other reference edge. Adjust the microscope focus and note the focused vertical scope position.
- viii. Calculate cupping as the average of the height departures from the two reference edges determined in steps vi and vii. No individual measurement shall exceed the allowed maximum.

7.10 Coefficient of dynamic friction

The dynamic friction between the recording surface and the back surface is the resistance to motion between the recording surface and the back surface of the tape.

7.10.1 Requirements

The coefficient of dynamic friction between the magnetic surface and the back surface shall be greater than 0,28.

7.10.2 Procedure

- i. Wrap a first piece of tape around a cylinder 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 $F_1 = 0,64 \text{ N}$.
- 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

$$\gamma = \frac{1}{\phi} \times \ln \left(\frac{F_2}{F_1} \right)$$

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

7.11 Coating adhesion

The force required to peel any part of the coating from the tape base material shall not be less than 0,44 N.

Procedure

- 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.
- 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.
- Fold the test piece over 180 °, adjacent to, and parallel with, the scribed line. Attach the metal plate and the free end of the test piece to the jaws of a universal testing machine and set the speed of the jaw separation to 254 mm per min.
- Note the force at which any part of the coating first separates from the base material. If this is less than 0,44 N, the tape has failed the test. If the test piece peels away from the double-sided pressure sensitive tape before the force exceeds 0,44 N, an alternative type of double-sided pressure sensitive tape shall be used.
- Repeat i to iv for the back coating, if any.

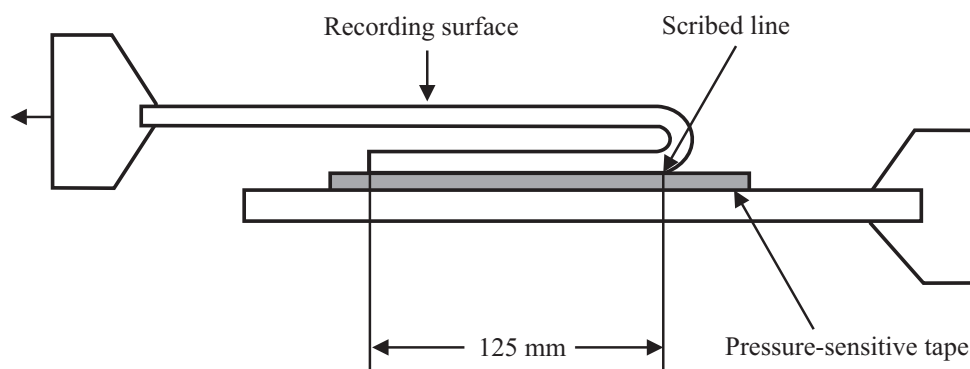


Figure 1 - Measurement of the coating adhesion

7.12 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.

7.12.1 Requirements

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

7.12.2 Procedure

- 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.
- The dimensions of the cylinder shall be:
 - diameter: 12,7 mm
 - length: 102 mm
- Attach a mass of 1 000 g to the opposite end of the tape.
- Attach, 25,4 mm above the mass, a narrow strip of double-sided adhesive tape to the magnetic coating.
- 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.
- 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.

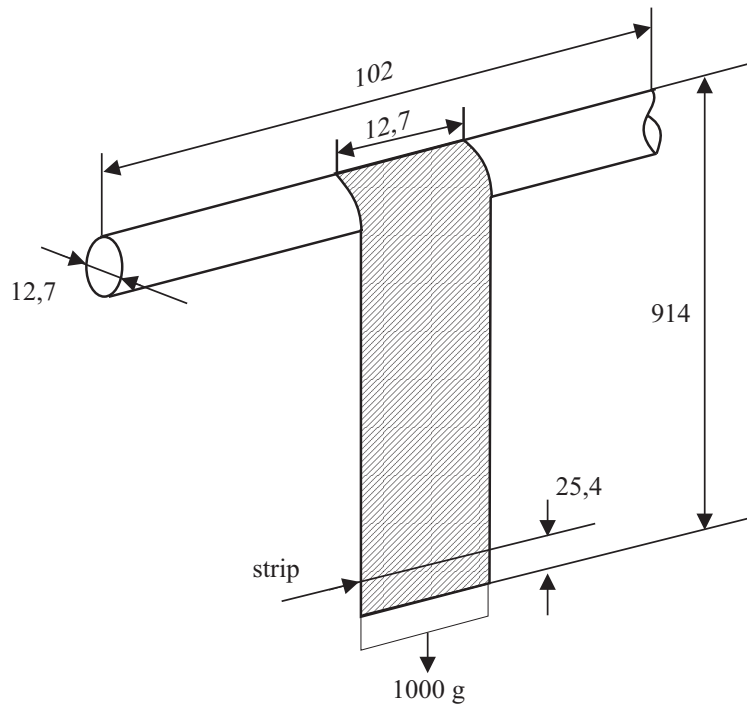


Figure 2 - Measurement of layer-to-layer adhesion

7.13 Electrical resistance

7.13.1 Requirement

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

- be greater than $1 \times 10^6 \Omega$
- not exceed $10 \times 10^{12} \Omega$

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

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

7.13.2 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 $1,62 \text{ N} \pm 0,41 \text{ N}$ to each end of the test piece. Apply a d.c. 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 5 positions along the test piece and average the 5 resistance readings. For back-coated tape repeat the procedure with the back surface in contact with the electrodes.

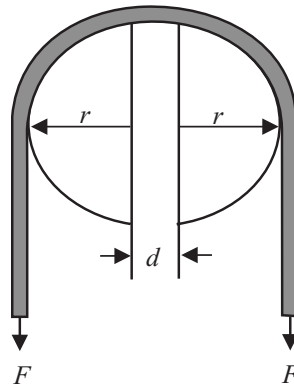


Figure 3 - Measurement of electrical resistance

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.

7.14 Abrasivity

Tape abrasivity is the tendency of the tape to wear the tape transport. When measured according to annex A, the depth of the wear pattern on the wear bar shall not exceed 35 μm .

7.15 Friction characteristics after stress

Friction is the force required to move the tape recording surfaces near the leader block end and near the hub end over a ferrite surface when measured after stress.

7.15.1 Requirements

The force required to move the tape at the leader block end shall not exceed 1,50 N. The maximum force required at the hub end shall not exceed the smaller of 6,0 N or ten times the value measured at the leader block end.

7.15.2 Procedure

- Wind a sample of tape on a 50 mm diameter spool hub to an outside diameter of 99 mm. The wind tension shall be 1,4 N;
- Store at 50 °C, 10 % to 20 % relative humidity for 48 h;
- Acclimatise at 23 °C for 2 h. Then reapply the wind tension to 1,4 N by unwinding and rewinding tape;
- Repeat steps ii and iii five times for a total of 240 h at 50 °C;
- Acclimatise the tape for 48 h at 30,5 °C, 85 % relative humidity. At that environment measure the force required to pull the recording surface over 90 ° of a polished ferrite rod of 25,4 mm diameter made of the material specified in annex A.
- Pull the sample over the rod at 1,0 mm/s while exerting a force of 0,64 N at the other end. Take force measurements with the tape sample near the outer diameter end and near the hub.

Note - The rod shall have been polished to a roughness value N2 (ISO 1302) or smoother.

7.16 Surface roughness

The surface roughness of the magnetic coating is the root mean square (RMS) of the surface topography.

7.16.1 Requirement

The surface roughness shall be between 4 nm and 7 nm.

7.16.2 Procedure

Use a WYKO 3D Profiler with a 512 by 512 pixel array detector and 20X magnification, or equivalent. Take the average of at least three samples.

7.17 Inhibitor tape

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

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: anhyseretically erased
- Tape speed: 2,00 m/s $\pm$ 0,05 m/s
- Read track: within the written track
- Azimuth alignment: 6 ' max. between the mean write transitions and the read gap
- Write gap length: 0,9 μ m $\pm$ 0,1 μ m
- Write head saturation density: 8 000 G $\pm$ 800 G
- Tape tension: 1,4 N $\pm$ 0,2 N
- Recording current: Test Recording Current (I_m)
- Physical recording densities: $1f = 2\,550$ ftpmm
 $4f = 10\,200$ ftpmm

The method of recording shall be as defined in clause 11.

8.1 Typical Field

The Typical Field 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.

8.2 Signal amplitude

The Average Signal Amplitude at the physical recording density of 2 550 ftpmm shall be between 75 % and 125 % 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 2 550 ftpmm to that at the physical recording density of 4 000 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.

8.4 Broad-band signal-to-noise ratio (BBSNR)

The BBSNR is the ratio of average signal power to average integrated broad band (floor) noise power.

8.4.1 Requirement

The BBSNR of the tape shall not be lower than that of the Master Standard Reference Tape by more than 2,8 dB.

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

The noise level of the measuring system shall be well below the noise level of the tape under test.

8.4.2 Procedure

- i. Record a signal on the track at 2 550 ftpmm;
- ii. Measure the signal power, averaging a minimum of 100 samples over 50 m of tape;

- iii. Measure the noise power of the written signal over a 300 kHz to 1 500 kHz bandwidth;
- iv. Calculate the BBSNR as the average signal power divided by the integrated noise power, converted to dB using the equation $BBSNR = 10 \times \log_{10} (S/N)$.

9 Tape quality

The quality of the tape (including the effects of exposure to storage and shipping environments) shall be defined by the testing requirements given in the following paragraphs. The following conditions shall apply to all quality testing requirements:

- Tape condition: pre-record condition
- Tape speed: 2,00 m/s $\pm$ 0,05 m/s
- Write-track width: 35 μ m min.
- Read-track: 35 μ m
- Azimuth alignment: 6 ' max. between the mean write transitions and the read gap
- Write-gap length: 0,9 μ m $\pm$ 0,1 μ m
- Write head saturation density: 8 000 G $\pm$ 800 G
- Tape tension: 1,4 N $\pm$ 0,2 N
- Recording current: Test Recording Current (I_m)
- Recording density: 2 550 ftpmm

9.1 Missing pulse

A missing pulse is a loss of read signal amplitude detected after writing at the physical recording density of 2 550 ftpmm. A missing pulse shall exist when the base-to-peak read signal amplitude is 25 % or less of half of the average signal amplitude (peak-to-peak) for the preceding 25,4 mm of tape.

9.1.1 Requirement

The average missing pulse rate shall be less than one missing pulse for each 5×10^6 flux transitions recorded. In addition, no single track shall have a mean missing pulse separation less than $2,5 \times 10^5$ flux transitions recorded.

9.1.2 Procedure

- i. While reading the signal of single tracks, observe and count all missing pulses. When a missing pulse is detected, a second missing pulse shall not be counted until 48 consecutive missing pulse-free flux transitions are read. If a missing pulse persists for a distance of 0,7 mm, another missing pulse shall be counted.
- ii. Calculate the missing pulse rate by dividing the number of missing pulses counted by the total number of flux transitions recorded on the tape.
- iii. Calculate the mean missing pulse separation for each individual track by dividing the number of flux transitions recorded on a track by the number of missing pulses on the same track.
- iv. The average missing pulse rate shall be the total number of flux transitions recorded on tape divided by the number of missing pulses counted.

9.2 Coincident missing pulse

A coincident missing pulse is a simultaneous missing pulse condition on five or more tracks of a sixteen-track group. A coincident missing pulse shall be counted as a single event regardless of length. There are eight sixteen-track groups in the format, as shown in table 2. (See 13.5.)

9.2.1 Requirement

No cartridge shall have more than 10 coincident missing pulses. No coincident missing pulse shall be longer than 25 mm.

9.2.2 Procedure

- i. While reading the signals of a sixteen-track group, observe and count all coincident missing pulses.
- ii. Measure the length of each coincident missing pulse from the start of the earliest event to the completion of the last event.

9.3 Missing pulse density

Missing pulse density is the number of tracks within a sixteen-track group that contain missing pulses in a given section of tape. A section of tape for a 16-track group for this requirement shall be a tape length of 0,7 mm.

9.3.1 Requirement

There shall be no events as defined in the following procedure for a cartridge.

9.3.2 Procedure

- i. While reading the signals of a 16-track group, observe for the occurrence of a missing pulse longer than 0,16 mm and start counting the tracks of the 16-track group that have missing pulses during the subsequent 8 sections;
- ii. Count the number of tracks that have missing pulses over the first 2 sections and also over the first 8 sections. An event shall be having 5 or more error tracks in the first 2 sections, or 13 or more error tracks in the 8 sections.

9.4 Tape durability

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

Section 3 - Mechanical specifications of the tape cartridge

10 General

The tape cartridge shall consist of the following elements

- a case,
- a reel for the magnetic tape,
- a locking mechanism for the reel,
- a magnetic tape wound on the hub of 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 21 show a typical implementation.

Where they are purely descriptive, the dimensions refer to three reference surfaces; A, B, and C which form 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.

- | | |
|-----------|---|
| Figure 4 | shows a general view of the whole cartridge. |
| Figure 5 | shows the top side of the case. |
| Figure 6 | shows the front side of the case. |
| Figure 7 | shows the rear side of the case. |
| Figure 8 | shows the bottom side of the case. |
| Figure 8a | shows an enlarged partial view of figure 8. |
| Figure 9 | shows the side of the case. |
| Figure 10 | shows an enlarged cross-section of leader block opening. |
| Figure 11 | shows an enlarged view of a location notch. |
| Figure 12 | shows a detail view of the opening in the case. |
| Figure 13 | shows an enlarged partial cross-section of the cartridge in the non-operating position. |
| Figure 14 | shows an enlarged view of the cartridge button. |
| Figure 15 | shows the same cross-section as figure 15 but of a cartridge in the operating position. |
| Figure 16 | shows schematically the teeth of the toothed rim. |
| Figure 17 | shows two views of the leader block. |
| Figure 18 | shows the attachment of the tape to the leader block. |
| Figure 19 | shows the leader block inserted into the case. |

10.1 Overall dimensions (figures 5 and 7)

The overall dimensions of the cartridge shall be

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

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

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

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

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

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

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

10.2 Write-inhibit mechanism (figures 5 and 6)

The write-inhibit mechanism shall have a flat surface identified by a visual mark, such as 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 shall be 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.

10.3 Label areas of the rear side (figures 5 and 7)

On the rear side of the case there shall be two label areas, provided to hold labels

The label area shall be specified by

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

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

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

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

$$l_{71} = 17,55 \text{ mm} \pm 0,13 \text{ mm}$$

$$l_{72} = 2,41 \text{ mm} \pm 0,13 \text{ mm}$$

$$l_{73} = 21,97 \text{ mm} \pm 0,25 \text{ mm}$$

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

A label bearing a letter J and its associated bar code, and complying with the requirements of annex B, shall be affixed in the area having dimension l_{71} and l_{11} .

10.4 Label area on the top side (figure 5)

On the top side of the case there shall have two label areas, recessed by $0,50 \text{ mm} \pm 0,25 \text{ mm}$.

The first label area shall be specified by l_9 , l_{10} and in addition by

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

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

The second label area shall be specified by l_9 , l_{10} and in addition by

$$l_{70} = 11,43 \text{ mm} \pm 0,13 \text{ mm}$$

$$l_{79} = 2,50 \text{ mm} \pm 0,25 \text{ mm}$$

10.5 Case opening (figures 5, 6 and 10)

The case shall have an opening for the tape into which the leader block can be inserted (see also figure 19). 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.

$$l_{61} = 3,9 \text{ mm} \pm 0,5 \text{ mm}$$

$$l_{62} = 16,9 \text{ mm} \begin{matrix} +0,5 \text{ mm} \\ -0,4 \text{ mm} \end{matrix}$$

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

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

$$\omega_1 = 1^\circ 0' \pm 30'$$

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

10.6 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

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

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

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

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

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

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

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

10.7 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 $14,00 \text{ mm} \pm 0,25 \text{ mm}$. The position of its centre shall be specified by

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

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

10.8 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 10.10)

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

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

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

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

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

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

10.9 Other external dimensions of the case (figure 9)

The external form of the case shall be further specified by

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

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

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

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

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

10.10 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

$$d_1 = 43,50 \text{ mm} \begin{matrix} +2,00 \text{ mm} \\ -0,25 \text{ mm} \end{matrix}$$

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

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

10.11 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 location shall be

$$l_{38} = 31,00 \text{ mm} \pm 0,25 \text{ mm}$$

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

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

10.12 Recessed area (figure 8a)

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

$$l_{55} = 0,45 \text{ mm} \begin{matrix} + 0,10 \text{ mm} \\ - 0,05 \text{ mm} \end{matrix}$$

$$l_{67} = 5,00 \text{ mm} \pm 0,13 \text{ mm}$$

$$l_{68} = 16,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{69} = 61,55 \text{ mm} \pm 0,20 \text{ mm}$$

$$\mu_5 = 2,0^\circ \text{ max.}$$

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

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

Its location shall be defined by l_{20} .

10.13 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 .

10.13.1 Requirements

The amount of deflection d shall meet the following requirements

Deflection of the top side

$$d \leq 0,38 + 0,054 F$$

Deflection of the bottom side

$$d \leq 0,38 + 0,040 F$$

where

d is the measured deflection in millimetres, and

$$4,5 \text{ N} \leq F \leq 54,0 \text{ N}$$

10.13.2 Procedure

The flexibility of the case shall be measured in a universal testing machine operating in the compression mode. A suitable load cell shall be used for the test. Apply a single point load with a radius of $10 \text{ mm} \pm 1 \text{ mm}$ on the bottom and subsequently on the top of the cartridge at the points shown in figure 6 and figure 8, and specified by

$$l_{65} = 86,9 \text{ mm nominal}$$

$$l_{66} = 54,5 \text{ mm nominal}$$

10.14 Tape reel (figures 13 to 15)

Figures 13 to 15 show the tape reel mounted within the case. Figure 13 specifies the different dimensions of the reel when the cartridge is in hand, figure 15 when it is within the drive. For the sake of clarity of the drawing the stacking ribs are not shown in figures 13 and 15.

10.14.1 Locking mechanism (figures 13 and 14)

This International Standard does not specify the actual implementation of the locking mechanism. However functionally it shall satisfy the following requirements in the locked position:

- the angular resolution shall not be greater than 6° ;
- the reel shall not rotate by more than 10° when a torque not greater than $0,32 \text{ N}\cdot\text{m}$ is applied in the direction that will cause the tape to unwind.

The button of the locking mechanism shall be made of nylon 6/6 with $2\% \pm 1\%$ molybdenum disulphide. Its dimensions shall be

$$d_7 = 2,0 \text{ mm} \pm 0,5 \text{ mm}$$

$$d_8 = 10,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$\rho = 15^\circ \pm 2^\circ$$

10.14.2 Axis of rotation of the reel

The axis of rotation of the reel shall be perpendicular to plane P (see figure 15 and 10.14.7) and shall pass through the centre of the central windows as specified by l_{29} and l_{34} . (See figure 8.)

10.14.3 Metallic insert (figures 13 and 15)

The reel shall have a metallic insert made of stainless steel (ISO 683/XII, type 3 or 7). It shall withstand a pull out force of 300 N min. Its dimensions shall be

$$d_2 = 35,00 \text{ mm} \begin{matrix} +0,20 \text{ mm} \\ -1,20 \text{ mm} \end{matrix}$$

$$d_3 = 11,15 \text{ mm} \pm 0,05 \text{ mm}$$

$$e_1 = 1,51 \text{ mm} \pm 0,10 \text{ mm}$$

Its central opening (diameter d_3) shall be concentric with the axis of rotation of the reel within 0,15 mm.

The metallic insert shall be parallel to plane P within 0,15 mm.

10.14.4 Toothed rim (figure 16)

The reel shall have a toothed rim accessible through the central window, and having the dimensions

$$d_4 = 36,00 \text{ mm} \begin{matrix} +0,50 \text{ mm} \\ -0,00 \text{ mm} \end{matrix}$$

$$d_5 = 41,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$\psi = 11^\circ 3' \pm 5'$$

10.14.5 Hub of the reel (figure 13)

The hub of the reel shall have a diameter

$$d_6 = 50,0 \text{ mm} \begin{matrix} +0,0 \text{ mm} \\ -0,2 \text{ mm} \end{matrix}$$

Further dimensions of the hub shall be

$$l_{41} = 13,05 \text{ mm} \pm 0,20$$

when measured at the hub surface, and

$$r_{10} = 0,08 \text{ mm max.}$$

The hub shall meet the following requirements

- the straightness of the hub surface shall be within 0,04 mm,
- the perpendicularity to the plane P through the pitch line of the teeth of the rim (see 10.14.7) shall be within 0,07 mm,
- the ratio of the difference in the diameters d_6 of any two sections (perpendicular to the axis) to the distance between these sections shall not exceed 0,003 8,
- the rate of change across the width of the hub surface shall not exceed 0,025 mm per mm,
- the total runout of the hub related to the cylinder perpendicular to the circular pitch line (see 10.14.7) of the teeth of the toothed rim shall not exceed 0,2 mm total indicator reading.

10.14.6 Relative positions

10.14.6.1 With the cartridge held in the hand (figure 13)

- the distance of the tip of the button of the locking mechanism to Reference Surface C shall be

$$l_{42} = 1,90 \text{ mm} \begin{matrix} +1,40 \text{ mm} \\ -0,90 \text{ mm} \end{matrix}$$

- the distance from the bottom surface of the metallic insert to Reference Surface C shall be

$$l_{43} = 0,4 \text{ mm} \begin{matrix} +1,0 \text{ mm} \\ -0,5 \text{ mm} \end{matrix}$$

10.14.6.2 Whether the cartridge is in the hand or in the drive (figures 13 and 15)

- the distance from the bottom surface of the metallic insert to plane P shall be

$$l_{44} = 2,27 \text{ mm} \pm 0,12 \text{ mm}$$

- the distance of the inside of the lower flange of the reel to plane P shall be

$$l_{45} = 0,650 \text{ mm} \begin{matrix} +0,127 \text{ mm} \\ -0,090 \text{ mm} \end{matrix}$$

10.14.6.3 With the cartridge in the drive (figure 15)

- the distance from the tip of the button of the locking mechanism to Reference Surface C shall be

$$l_{46} = 8,1 \text{ mm} \pm 0,2 \text{ mm}$$

- the force required to move the button into this position shall not exceed 12,25 N,

- the distance from the centreline of the tape to Reference Surface C shall be

$$l_{47} = 12,25 \text{ mm nominal}$$

- the distance from the Reference Surface C to plane P (see 10.14.7) shall be

$$l_{60} = 5,04 \text{ mm} \pm 0,20 \text{ mm}$$