ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-10

for

DATA INTERCHANGE ON PUNCHED TAPE

2nd Edition — July 1970

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BRIEF HISTORY

On April 30, 1965, ECMA adopted their Standard ECMA-6 for a 7 Bit Character Code for Input and Output purposes. In the form adopted, it included no proposals for implementation in media which were deliberately left as the subject for future standards.

This Standard ECMA-10 is directed to a Data Interchange on Punched Tape. It has been adopted by the General Assembly of ECMA on Nov. 30, 1965.

THIS 2nd EDITION SUPERSEDES THE VERSION DATED NOVEMBER 1965.

INTRODUCTION

(i) This Standard relates to punched tape used for data interchange. It does not refer to prefolded tape.

(ii) Only tape with a width of 25,40 mm nominal is considered standard for data interchange.

(iii) Punched tape for data interchange must be straight and its edges parallel. No deformation or notches on the edge of the tape can be permitted.

(iv) This Standard is divided into three parts. The appendices are not part of the Standard.

- Part 1 : Properties of unpunched tape
- Part 2 : Properties of punched tape for data interchange
- Part 3 : Coding on punched tape for data interchange
- Appendix A : Recommendations for the handling of punched tape
- Appendix B : Measurement of Light Transmittance
- Appendix C : Specific test methods

(v) Test Conditions

For the purpose of all measurements the test conditions are:

Relative Humidity: 50% RH $\pm$ 2% RH

Temperature : 23^{o} C $\pm$ 2^{o} C

It is necessary that all paper samples to be tested are freely exposed to the stipulated environment for at least 24 hours prior to any measurements.

1. PROPERTIES OF UNPUNCHED TAPE

1.1 Dimensions

1.1.1 Width

Nominal: 25,40 mm

Tolerance: 95% of the samples $\pm$ 0,05 mm
100% of the samples $\mp$ 0,08 mm

The width is to be measured by an optical method. Care must be taken that the source of illumination does not heat the tape.

1.1.2 Thickness

Nominal: 0,100 mm

Tolerance: 95% of the samples $\pm$ 0,008 mm
100% of the samples $\mp$ 0,010 mm

The thickness should be measured using a micrometer exerting a pressure of 1 kg/cm^2 and having an anvil size of approximately 2 cm^2.

1.2 Dimensional Stability

1.2.1 When the relative humidity is varied from 20% to 75% and also when it is varied from 75% to 20% the maximum variation of the dimension in the cross (transverse) direction shall not exceed 1% of the value measured at 50% RH.

1.2.2 Under the same changes of relative humidity the maximum variation of the dimension in the machine (longitudinal) direction shall not exceed 0,5% of the value measured at 50% RH.

The method of the test should be as described in Appendix C, Section C.1.

1.3 Mechanical Properties

1.3.1 Tensile Strength

Static tensile strength shall be measured in the machine (longitudinal) direction. The mean value shall not be less than 180 N per width of the tape. In addition the arithmetic mean of the results less twice the standard deviation shall not be less than 160 N per width of the tape.

The method of test should be as described in Appendix C, Section C.2.

1.3.2 Internal Tear Resistance

The tear resistance shall not be less than 0,55 N in the machine (longitudinal) direction and not less than 0,55 N in the cross (transverse) direction.

NOTE: The method of the test should be as described in ISO/TC6/339 (or the appropriate ISO Recommendation when available).

1.3.3 Basic Weight

The basic weight should be 76 to 94 g/m^2 and as low as possible within these limits. This refers only to unoiled tape.

The method of the test should be as described in Appendix C, Section C.3.

1.4 Optical Properties

1.4.1 The light transmittance as defined, measured and calculated as described in Appendix B shall not be greater than 50%.

1.4.2 The tape may be of any colour, provided that all the specifications of this Standard are satisfied.

1.4.3 Printing

The tape may be printed on provided that after printing the tape meets all the requirements of this Standard.

1.5 Electrical Properties

1.5.1 Conductivity

For the purpose of sensing the tape shall act substantially as an insulator when placed between low-voltage sensing contacts.

1.6 Chemical Properties

1.6.1 Grit Content

A maximum of 0,04% is permitted.

NOTE: Suitable wet digestion processes for determining the grit content are described in

BS 3880, Part II, Appendix B or
ISO/TC97/SC4/WG-3 (USA-15) 125, Paragraph 6.2

1.6.2 Ash Content

A maximum of 1% is permitted.

NOTE: Suitable methods for determining the ash content are described in several national standards, e.g.

NF Q 03-001 Section B
DIN 53 136
BS 3631

1.6.3 Hydrogen Ion Concentration

The pH value should be 6 $\pm$ 1,5 and as high as possible within these limits.

NOTE: Suitable hot extraction methods for determining the pH value are described in several national standards, e.g.

NF Q 03-005
DIN 53 124
BS 2924

1.7 General Quality

1.7.1 Printability

The surface of the tape shall be capable of accepting and retaining printing and normal manuscript, without adverse effect on the legibility of such printing or handwriting.

1.7.2 Defects

The paper tape shall be as free as possible from unbeaten fibres, fluff, dust, slime spots, wrinkles, creases, edge tears, grit and abrasive particles.

The tape shall be free of any holes or translucent spots.

1.7.3 Lubricating additives

Lubricating additives are permitted. The percentage will depend largely on the type of lubricant used. Lubricated tape must adhere to all the other specifications of this Standard.

1.8 Tape Coils

1.8.1 Outer Diameter

The outer diameter of a coil of unpunched tape shall be $200 \begin{smallmatrix} + 3 \\ - 0 \end{smallmatrix}$ mm.

1.8.2 Inner Diameter

The inner diameter of a coil of unpunched tape shall be $51 \begin{smallmatrix} + 1,4 \\ - 0,2 \end{smallmatrix}$ mm.

If the tape is wound on a core, the inner diameter of that core must also be $51 \begin{smallmatrix} + 1,4 \\ - 0,2 \end{smallmatrix}$ mm.

1.8.3 Tightness of Coiling

The coil should be wound evenly and sufficiently tight so that it does not telescope with normal handling.

2. PROPERTIES OF PUNCHED TAPE (at the time of punching)

2.1 Environmental Conditions

It is highly desirable, for physical interchange of punched tapes, that the tape be punched in an environment where the relative humidity is within the range from 40% to 60% RH.

If at the time of punching the environmental conditions are outside of the range stated above, it may prove necessary to make special arrangements between the sender and the recipient in order to ensure satisfactory reading.

2.2 Reference Edge

The reference edge shall be that with three data tracks between it and the feed hole track. If tape is guided from one edge, the reference edge shall be used as the guide edge.

2.3 Dimensions

2.3.1 Distance of the centre of feed holes to reference edge
Nominal: 9,96 mm
Tolerance: $\pm$ 0,10 mm

2.3.2 Feed Hole Diameter

Nominal: 1,170 mm

Tolerance: $^{+\ 0,050}_{-\ 0,025}$ mm

2.3.3 Data Hole Diameter

Nominal: 1,83 mm

Tolerance: $\pm$ 0,05 mm

2.3.4 Track Positioning

If a line is drawn through the centres of the feed holes, then the distance of the centres of the data holes from this line shall be:

$$2,54\ n \pm 0,05 \text{ mm}$$

where n is an integer.

2.3.5 Row Positioning

The distance between two adjacent rows shall be

Nominal : 2,540 mm

Tolerance : $\pm$ 0,075 mm

measured between centres of feed holes.

The permissible spacing error along the feed track between centres of feed holes shall not exceed

$\pm$ 0,25 mm in any span up to 10 spaces (25,40 mm)

$\pm$ 0,63 mm in any span up to 50 spaces (127,00 mm).

The tolerance on alignment on data holes in any one row, measured between the centre of the data hole and a line perpendicular to the reference edge and passing through the centre of the feed hole of that row, shall be:

$\pm$ 0,075 mm

2.4 Other Properties of Punched Tape

2.4.1 Punched tape for data interchange shall be free of overlapped and other joints, splices etc.

2.4.2 Punched tape for data interchange shall be as clean and free from dust etc. as possible. There shall be no translucent spots, or oil deposits from punches.

2.4.3 The edges of data holes and feed holes shall be free of fibres or burrs that could cause errors in reading.

2.5 Leaders and Trailers

In order to facilitate tape handling on reeling equipment each coil of tape carrying data shall have

leaders and trailers. These shall be at least 120 cm in length.

Leaders shall be punched with at least 50 feed holes immediately before the data and trailers with at least 50 feed holes immediately following the data.

3. CODING ON PUNCHED TAPE FOR DATA INTERCHANGE

3.1 Code

Data on punched tapes for data interchange shall be encoded using the ECMA 7-bit Coded Character Set (Standard ECMA-6).

3.2 Track Numbering

The data tracks on punched tape shall be numbered consecutively from 1 to 8. Track # 1 shall be the track closest to the reference edge, so that the feed hole track lies between data tracks # 3 and # 4.

3.3 Allocation of Bits to Tracks

3.3.1 Bits

A ONE bit within a coded character shall correspond to a data hole in the punched tape. All ONE bits of a coded character shall be punched in one transverse row.

3.3.2 Parity Bit

In each and every transverse row a parity check bit shall be added to the bits of the coded character. The value of this parity check bit shall be such that overall even parity per row is achieved.

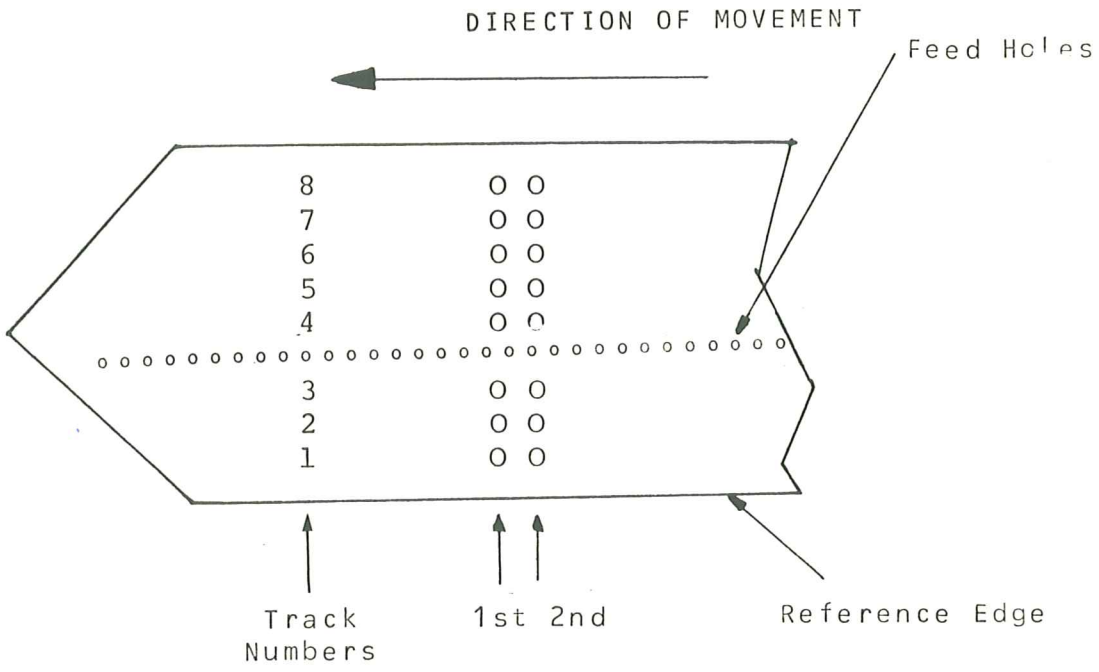
3.3.3 7-bit Coded Characters

The bits within a coded character shall be allocated to the tracks on the tape as follows:

Bit	Track
"P"	8
b_7	7
b_6	6
b_5	5
b_4	4
	feed hole track
b_3	3
b_2	2
b_1	1

"P" indicates the parity check bit.

3.4 Orientation of Data on Punched Tape



With the tape oriented as shown and the observer looking down on to the tape, the direction of forward tape movement is from right to left, and the first character of date (the most significant character as entered from a tapewriter-like device) is the one farthest to the left (1st). The next most significant character follows it (2nd) etc.

Tapes for data interchange shall be marked, or the ends cut, to give a positive indication of the direction of forward tape movement at the time of punching. See also Appendix A.

APPENDIX A

A.1 Transportation

It is important that tape for data interchange is not damaged or contaminated during transport from one installation to another. It is therefore necessary to provide adequate protection by means of a suitable container. A recommended method comprises a cardboard or plastic box for each single full sized coil or several smaller ones. The lid of the box must fit well and be capable of being sealed with an adhesive tape.

To prevent damaging the tape, it shall be located on a raised boss. The interior of the box shall be free of sharp edges. Metal staples shall not be used. Provision shall be made for labelling the box with the information:

Recipient
Sender
Job reference
etc.

A.2 Storage Conditions

It is desirable that tapes, which are to be read, be reasonably well conditioned to the preferred atmospheric conditions of 50% RH and 23° C temperature. For this reason storing tapes in extreme conditions or heat, moisture or dryness should be avoided. If tape has been adversely effected, it should be borne in mind that a wound coil will take many hours or even several days to reacclimatize itself to the proper conditions.

A.3 Cores

Cores shall be strong enough to maintain the inner diameter of a coil as defined in 1.8.2 during normal practical use.

A.4 Indication of Direction, Titles and Winding of Punched Tape

Tapes for data interchange shall be marked to give a positive indication of the direction of forward movement.

Examples of such markings are preprinted arrows or marks (logo-type, trade mark, etc.), handwritten arrows or marks (tape identification, job number, data, etc.), or a distinctive cut end of tape (point, arrow head, etc.). All such markings shall define the same relative direction.

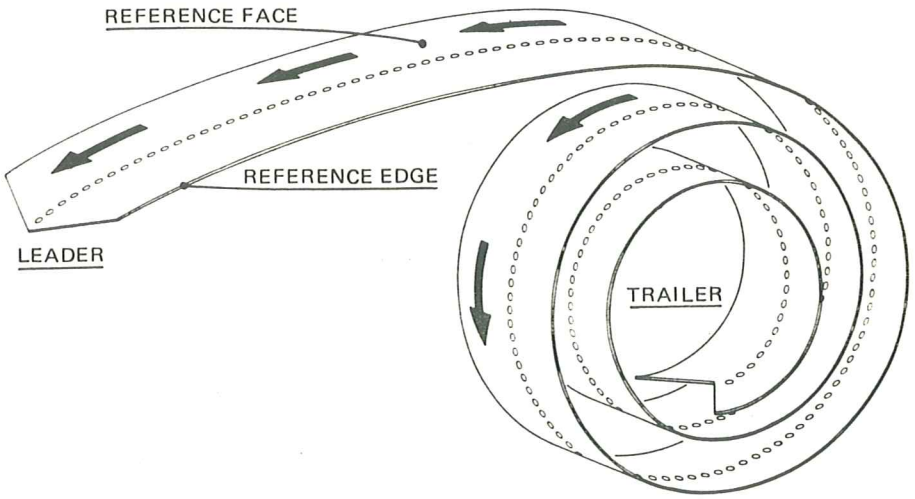
A preferred method is the marking with arrows. These arrows should be printed all along the tape in low-density,

non-abrasive ink, clear of the feed holes, and evenly spaced not more than 20 cm apart along the entire length of the tape.

Any printing or handwriting shall be on the reference face of the tape only. Any caption or title shall be written at the leading end outside the data bearing area of the tape.

The reference face is defined as that side of the tape that the observer looks down on in 3.4.

A coil of punched tape, the first character of data being at the free, outer end shall run counter-clockwise when the reference edge is the one nearest to the observer and the reference face is on the outside of the coil. This method is also called Trailer In-Face Out (or Leader Out-Face Out).



Whilst the above is not mandatory, it is considered desirable in the interests of standardization to recommend strongly to equipment designers to adopt this convention on future punched tape winding equipments.

APPENDIX B

Measurement of Light Transmittance

B.1 Introduction

Characteristically, photoelectric punched tape readers used in data processing equipment are susceptible to the radiation transmitted through and scattered by the tape.

The description in the following paragraphs outlines the general principle of a test device and the test method to be employed when measuring the radiation (light) transmittance of punched tape. Device and test method simulate the more critical factors of typical photo electric tape readers.

For the purpose of this document "light transmittance" is defined by convention as the relationship between the reading obtained from the test device with the tape sample inserted and the reading obtained when no sample is present. The transmittance value is expressed as the percentage ratio of the two readings.

The essential elements of the test device are

the radiation (light) source
the optical path
the measuring mask
the photo cell
the measuring equipment

B.2 Description of the Test Device

B.2.1 Radiation (light) source

A tungsten lamp is used as the radiation (light) source and should be operated in an under-run state.

The colour temperature should be 2000^{o} K $\pm$ 200^{o} K and a resulting illumination at the surface of the tape sample of about 5000 lux is recommended.

B.2.2 Optical path

The radiation should be perpendicular to the tape sample and be of substantially uniform intensity. Typically the tape sample should be separated from the lamp by a distance of 150 mm.

A diaphragm of the form shown in Figure 1 is recommended in order to sensibly ensure that scattered radiation does not enter the mask area.

B.2.3 Measuring mask geometry

The measuring mask shall be constructed in one piece

according to the drawing shown in Figure 2. A good matt black finish capable of absorbing infra-red radiation is necessary.

Special care must be taken to ensure that the tape sample to be measured is maintained flat in contact with the inner face of the mask.

B.2.4 Photo cell

A flat silicon photocell should be used. Its dimensions must be such that the active area of the photocell exceeds the diameter of the mask orifice. It should be mounted parallel and in close proximity to the outer face of the mask.

B.2.5 Measuring Equipment

The measuring equipment should be connected directly across the photocell to measure the output current. In order to be able to set the measuring equipment to full scale deflection (100%) a shunt potentiometer in the circuit must be provided or a fine adjustment of the lamp power supply voltage is required.

The load impedance across the photocell should be as low as possible and must not exceed 500 Ω . The instrument, which could take the form of a moving coil meter with a full scale deflection of 50 µA, should have a nominal accuracy of ± 1%.

B.3 Test Procedure

B.3.1 For the purpose of the test a sample strip of tape not shorter than 250 mm is used.

- The measuring equipment is set to full scale deflection (100%).
- The sample strip is inserted and 45 observations on different points along the sample are recorded.
- The sample strip is then withdrawn and full scale deflection (100%) is re-checked. If the reading lies outside the range of 99% to 101% the equipment is reset to 100% and a new set of 45 observations is recorded.

B.3.2 A statistical maximum value of light transmittance shall be determined according to the following formula

$$T = \bar{x} + K \cdot \sigma$$

where $\bar{x}$ = mean value of n observations

σ = accurate estimate of the lot standard deviation

K = constant specified by the selected plan of inspection

n = number of observations on the sample specified by the selected plan of inspection.

The T value so calculated is for use where inspection of lots of tape is by variables. Lot quality is judged in terms of percent defective and acceptance is lot by lot.

The plan is based upon single sampling (with σ known) and gives an

Acceptable Quality Level (AQL) of 0,5% defective

and a

Lot Tolerance Percent Defective (LTPD) of 1,62%.

The selected plan has a sample size letter of O and gives the values for

k = 2,33 and
(¤)n = 45

If $T \leq T_{max}$ the lot is accepted,

if $T > T_{max}$ the lot is rejected,

where Tmax = maximum value of transmittance permitted = 50%.

B.4 Guidance on Construction

B.4.1 Experience has shown that a projector lamp is most suited as the radiation source. When selecting a lamp, care must be taken to avoid a lamp with optical inhomogenities in the glass envelope. Also, if mirrors or lenses are used in the optical path they must be placed such that no filament image occurs in the proximity of the mask and photocell area. It is necessary to operate the lamp from a stabilized, regulated power supply.

B.4.2 Special attention must be paid to all surfaces parallel to the optical path and in close proximity to the mask and photocell to avoid reflection of light. Similarly, the method of inserting the paper must ensure that no ambient light leaks through any slot arrangement.

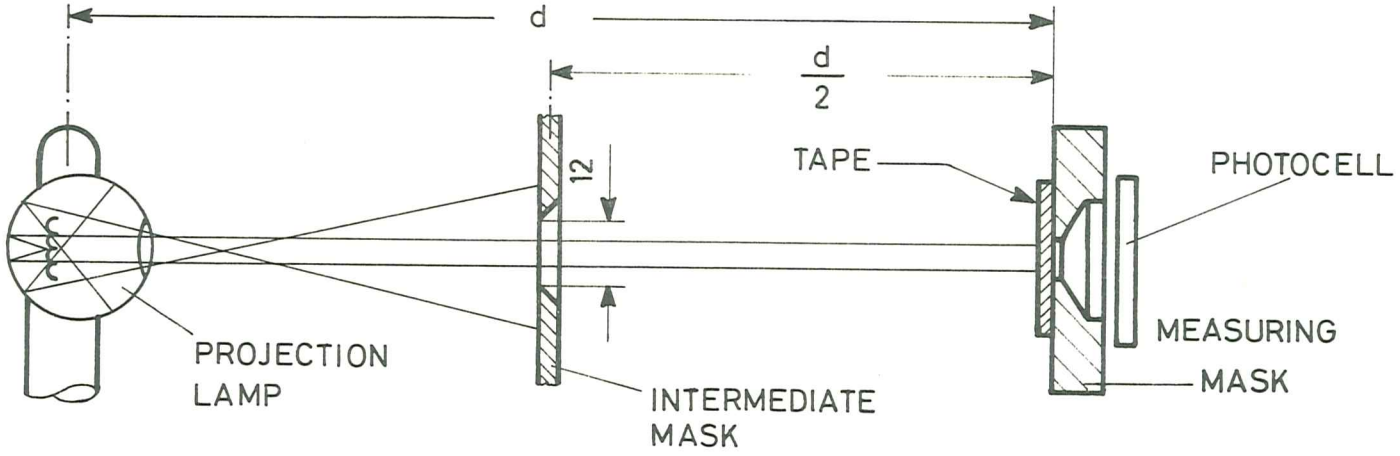
B.4.3 The accuracy of the measurement is dependent not only on attaining the dimensional tolerances shown in Figure 2 but also on the subsequent coating of the surfaces with a high quality optical matt black paint. Chemical methods are unlikely to prove satisfactory. The mask should be checked after coating to ensure that the small hole remains in tolerance. The method of holding the sample must be such that the tape is maintained flat in contact with the face of the mask. However, it must allow the sample to be moved without physical damage or distortion.

¤ References: A.H. Bowker
H.P. Goode
"Sampling Inspection by Variables"
Mc Graw-Hill 1952

B.4.4 The photocell must be mounted with care, taking special precaution that the photocell leads do not interfere with the mounting arrangement. It is advisable that the face of the photocell presses slightly on the outer face of the mask.

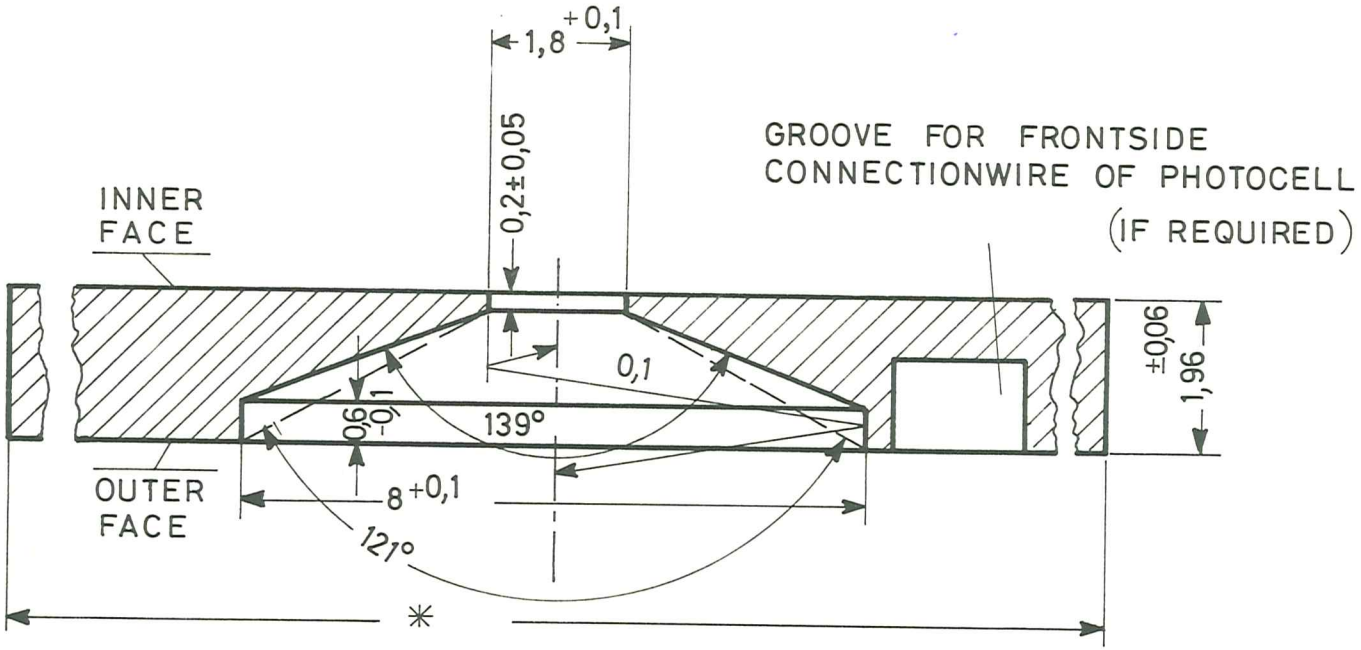
B.4.5 The possibility of inserting an opaque object and a filter glass before the measuring mask should be incorporated in the device. If the filter glass is such that a reading of approximately 50% results, the accuracy of the test device in the area of 0% and 50% transmittance can be verified periodically.

B.4.6 The test device should be cleaned periodically and accumulated paper dust removed.



d = approx. 150 mm

FIG. 1 MEASURING DEVICE (DIAGRAM)



* DETERMINED BY USER

FIG. 2 MEASURING MASK

APPENDIX C

C.1 Measurement of Dimensional Stability

The measurement of the change in planar dimensions of the material, e.g. paper, (from which the tape is produced) as a result of changes in the ambient relative humidity.

C.1.1 The necessary apparatus is to be enclosed in a suitable chamber inside which the ambient atmosphere can be controlled.

C.1.2 All measurement of length of test pieces to be made without disturbing the ambient test atmosphere.

C.1.3 Atmosphere conditions.

C.1.3.1 Upper relative humidity: 75% RH $\pm$ 2% RH.

Lower relative humidity: 20% RH $\pm$ 2% RH.

C.1.3.2 Temperature: 23^{o} C $\pm$ 2^{o} C

C.1.3.3 Speed of flow of conditioned air over surface of test pieces to be not less than 1,5 m/min.

C.1.4 Test Apparatus and Test Conditions.

C.1.4.1 Width of strip:		Not less than 15 mm
C.1.4.2 Length of strip:		Not less than 100 mm
C.1.4.3 Duration of test:		Condition for 1/2 hour after required ambient atmospheric conditions have been attained.
C.1.4.4 Load on strip:	(i)	Not greater than 0,196 N per 25,4 mm width of strip.
	(ii)	No tensile load to be applied to strip during conditioning period.
C.1.4.5 Precision of Measurement:		Position of movable end of test piece to be measured to $\pm$ 0,01% of nominal length of test piece.
C.1.4.6 Number of tests required:		At least 10 in the specified direction.

C.1.5 Test Report:

a) Mean change in length of strips arising from the change in ambient relative humidity from 20% RH to 75% RH, expressed as a percentage of the length of the test piece at 50% RH.

b) Standard Deviation of the change in length.

c) Number of strips tested.

d) Width of strips tested.

e) Mean $\pm 2\sigma$

C.2 Determination of Static Tensile Strength (¤)

C.2.1 This test shall be performed on a pendulum or strain gauge instrument. The test is required in the machine direction only and the following test parameters will apply:

(1) Width of strip:	Not less than 16 mm
(2) Length of strip:	180 mm
(3) Speed of lower clamp:	Operate the tester so that the average time for the completion of the test will be not less than 5 seconds and not greater than 20 seconds.
(4) Number of readings required:	At least 10 strips shall be broken.
(5) Units:	Tensile strength shall be expressed as the load in newtons required to break a strip of tape 25,4 mm wide.

C.2.2 Test Report:

a) Mean tensile strength

b) Standard deviation

c) Number of strips tested

d) Width of strips tested

e) Mean minus twice the standard deviation.

C.3 Determination of Paper Substance (¤¤)

C.3.1 Definition

Substance: The mass of a paper, expressed in grammes per square metre (g/m^2), determined under standard test con-

¤ Based on ISO DR 1924

¤¤ Based on ISO R 536

ditions.

C.3.2 Principle

The area of the test pieces and their mass are measured and the mass per square metre is calculated, all measurements being made on conditioned test pieces.

Note: - Alternatively, the mass per square metre may be determined for other conditions, e.g.:

a) "oven dry": measurements of area are made in the conditioned state and the mass is determined after oven drying, according to ISO Recommendation R 287 "Method for the Determination of Moisture Content of Paper (Oven-drying Method)",

b) "as taken": measurements of area are made on test pieces cut out and weighed without previous conditioning.

When the specimens have to be taken from a reel, they should be cut at such a depth that they are not affected by any abnormal gain or loss of moisture compared with the remainer of the unit.

C.3.3 Apparatus

C.3.3.1 Cutting device. The cutting device should normally be capable of repeatedly cutting out test pieces whose area, in at least 95 cases out of 100, falls to the nearest 1% of a known area. This should be checked frequently by the method given in C.3.3.3.1 below and, provided that the above accuracy is attained, the mean area obtained in these check tests should be used for calculating substance.

With certain types of paper it will be found, after carrying out this determination of area, that test pieces cannot be cut with the accuracy just defined and, in such cases, the area of every test piece should be determined individually (see C.3.3.3).

C.3.3.2 Weighing device. The weighing device should be accurate enough, over the range of mass for which it is used, to measure always to the nearest 0,5% of the actual mass. It should be sensitive enough to detect a change of $\pm$ 0,2% of the mass to be weighed and, if the device is of the direct reading type it should be graduated so that readings may be taken to this degree of accuracy. For checking of the weighing device, see C.3.3.3.2.

Special sheet-weighing devices, designed to weigh test pieces of a given size and indicating substance in grammes per square metre, may be used, provided that the above conditions are fulfilled and that the area of each test piece in a single weighing is not less than 500 cm^2 (see C.3.4 and C.3.5.2).

When in use, the weighing device should be shielded from air currents.

C.3.3.3 Calibration of apparatus

C.3.3.3.1 Checking of cutting device. The area cut should be checked frequently by measuring 20 test pieces and calculating their areas (see paragraph 2 of C.3.4). The cutting accuracy specified in C.3.3.1 is attained when the standard deviation of the individual areas is below 0,5% of the mean area, in which case this mean area should be used for calculating substance in subsequent tests. If the standard deviation exceeds this value, the area of every test piece should be determined individually.

C.3.3.3.2 Checking of weighing device. The weighing device should be checked frequently by applying accurately measured masses with both increasing and decreasing loads.

C.3.4 Procedure

At least 20 test pieces in all are taken from at least five conditioned specimens, if possible the same number from each specimen, each test piece having an area of not less than 500 cm^2. The area of test piece is determined by calculation from measurements taken to the nearest 0,5 mm. If the accuracy of the cutting device does not satisfy the requirements of C.3.3.1, the dimensions of each test piece should be measured.

Weigh each test piece.

C.3.5 Calculation and Expression of Results

The results are expressed in g/m^2 to three significant figures.

C.3.5.1 Using the procedure in C.3.4, the substance of each test piece is calculated according to the following formula:

$$X = \frac{m}{A} \cdot 10\,000$$

where X = substance (g/m^2)

m = mass of the testpiece (g)

A = area of the test piece (cm^2)

C.3.5.2 If a calibrated sheet - weighing device as described in C.3.3.2 is used, then the substance is given by the following formula:

$$X = \frac{A'}{A} \cdot X'$$

where X = substance (g/m^2)

X' = indicated substance of the test piece (g/m^2)

A' = area of test piece for which the device is calibrated (cm^2)

A = area of weighed test piece (cm^2).

C.3.5.3 Calculate the mean of the results.

C.3.6 Test Report

The test report should state the following results :

a) mean of the substance

b) number of tests

c) standard deviation ¤

If specimens have been taken from more than one position across a reel or sheet and information on substance variation is required, the above results should be reported for each position separately.

¤ It is suggested that, in addition, the accuracy of the mean (confidence limits), at the 95% probability level, should be quoted for information.