TECHNICAL REPORT

ISO/IEC TR 6371

First edition
1989-03-15

Information processing — Interchange practices and test methods for unrecorded instrumentation magnetic tape

Reference number
ISO/IEC/TR 6371 : 1989 (E)

Contents

Annexes

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) together form a system for worldwide standardization as a whole. 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.

The main task of a technical committee is to prepare International Standards but in exceptional circumstances, the publication of a technical report of one of the following types may be proposed:

— type 1, when the necessary support within the technical committee cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development requiring wider exposure;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC/TR 6371, which is a technical report of type 2, was prepared by ISO/IEC JTC 1, *Information technology.*

Introduction

Draft International Standard ISO/DIS 6371 was distributed to ISO member bodies in August 1982 and was approved for issue as an International Standard.

During the preparation of the final text, however, it was found necessary to replace the existing test for surface electrical resistance and, moreover, amendments to the text were necessitated to ensure alignment with related International Standards which at that time were in the course of preparation.

Bearing in mind the need for this document, but also the amount of time that has elapsed since it was approved and the extent to which the original text has been modified, it is considered preferable to make the document available at the present time in the form of a type 2 ISO/IEC Technical Report. It is expected that within two to three years, it will be further revised with a view to its issue as an International Standard.

This page intentionally left blank

Information processing — Interchange practices and test methods for unrecorded instrumentation magnetic tape

1 Scope

1.1 General

This Technical Report specifies the interchange requirements for longitudinally-orientated, unrecorded magnetic tape wound on reels or hubs designed for use in instrumentation-recording applications. Tapes for interchange shall be recorded and played back on equipment conforming to ISO 6068 and to the applicable instructions furnished by the equipment manufacturer.

1.2 Archival tapes

It is recognized that archival interchange tapes, or those produced by systems in use prior to the publication of this Technical Report, may not meet the stringent requirements that follow. Users requiring exchange of standard tapes should verify that the planned interchange of data will be accomplished according to the following standards for tapes, reels, and recorder/reproducers: ISO 1858, ISO 1860, ISO 3802, ISO 6068, and this Technical Report.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1184 : 1983, *Plastics — Determination of tensile properties of films.*

ISO 1858 : 1977, *Information processing — General purpose hubs and reels, with* 76 mm (3 in) *centrehole, for magnetic tape used in interchange instrumentation applications.*

ISO 1860 : 1986, *Information processing — Precision reels for magnetic tape used for interchange instrumentation applications.*

ISO 3802 : 1980, *Information processing — General purpose reels with* 8 mm (5/16 in) *centre hole for magnetic tape for interchange instrumentation applications.*

ISO 6068 : 1985, *Information processing — Recording characteristics of instrumentation magnetic tape (including telemetry systems) — Interchange requirements.*

In case of conflicts between reference documents and this Technical Report, the Technical Report should prevail.

3 Classification of tapes

3.1 Tape type designator

Tape types covered by this Technical Report may be designated in the following form:

TIT-E1-HT1-127(500)-760(2500)-G1

TIT	E	1
Basic indicator (see 3.2)	Magnetic coating characteristic indicator (see 3.3)	Performance class indicator (E magnetic coating only) (see 3.4)

HT 1	127(500)	760(2500)	G1
Base material and thickness indicator (see 3.5)	Width indicator (see 3.6)	Length indicator (see 3.7)	Reel indicator (see 3.8)

3.2 Basic indicator

The basic indicator defines the general application for a particular class of tape as specified herein. The basic indicator is "TIT" for tape, instrumentation type.

3.3 Magnetic coating characteristics indicator

The magnetic coating characteristics indicator defines a coating in terms of its short wavelength recording capabilities:

a) indicator "B" (intermediate resolution) denotes tape intended for use on low-band and intermediate-band recorder/reproducers [having a recorded wavelength not less than 6,1 µm (240 µin)];

b) indicator "E" (high resolution) denotes tape intended for use on wideband recorder/reproducers [having a recorded wavelength down to 1,5 µm (60 µin)].

See ISO 6068 for further information on the types of recorder/reproducers.

3.4 High resolution performance class indicator

High resolution tape (see 3.3) is subclassified as either E1 or E2 depending on its output level uniformity (see 8.5 and 8.6) and dropout performance (see 8.7).

3.5 Base material and thickness indicator

The base material and thickness indicator combines two letters and a number as an indicator. The number indicates whether the back side of the base material has been treated; untreated tape is defined by the number "1" and treated tape is defined by the number "2". The first letter identifies the type of base material, and the second letter indicates the nominal thickness of the base material. The base material is indicated by the letter "H" for polyethylene terephthalate (polyester). Base material of nominal thickness 38,1 µm (0,001 5 in) is defined by the letter "R" and base material of nominal thickness 25,4 µm (0,001 in) is defined by the letter "T".

3.6 Width indicator

The width indicator is the nominal width of the tape in tenths of a millimetre followed in parentheses by its equivalent in thousandths of an inch. For example, tape with a nominal width of 12,7 mm (0,5 in) has the width indicator 127 (500) (see 6.1).

3.7 Length indicator

The length indicator is the nominal length, in metres (feet), of a tape wound on a reel (see 6.3).

3.8 Reel indicator

This symbol identifies the type of reel on which the tape is wound, as follows

Table 1 — Reel indicator

Designator	Definition
G1	General purpose reels conforming to ISO 1858
G2	General purpose reels conforming to ISO 3802
P	Precision reels conforming to ISO 1860

4 Sampling

Sampling schemes and AQL (acceptable quality level) criteria for

a) dimensional requirements;

b) physical requirements;

c) performance requirements;

shall be separately agreed between interchange parties. Each sample tape shall be tested against the above requirements in order to determine compliance or non-compliance of the sampled batch.

5 General requirements

5.1 Materials

The tape shall consist of a layer of ferromagnetic material on a suitable continuous and splice-free, flexible base material and shall have the physical, magnetic and other characteristics as specified herein.

5.2 Toxic compounds

Tape or reel components which may cause bodily harm by contact, inhalation or ingestion shall not be used.

5.3 Flammable materials

Flammable materials which will ignite from a match flame, and when so ignited continue to burn in a still carbon dioxide atmosphere, shall not be part of the magnetic tape.

5.4 Tape reels

Tape reels shall conform to the requirements of ISO 1860 or ISO 1858 or ISO 3802.

5.5 Tape wind

The tape shall be wound with the magnetic coated surface facing the surface of the hub.

5.6 Packaging

It is recommended that each reel of magnetic tape should be enclosed, as a minimum, by an individually sealed polyethylene wrapper packaged in an appropriate container which provides support of the enclosed reel at the hub.

5.7 Environmental conditions

NOTE — Recent research results as reported in annex D suggest that certain points of the following specification may result in an undesirable operating condition. A future revision in this area may be issued.

5.7.1 Standard operating conditions

Temperature range: (see note 1)	10 °C to 40 °C (50 °F to 104 °F)
Relative humidity range: (see note 2)	40 % to 60 %
Barometric pressure:	50 kPa to 106 kPa

5.7.2 Extended operating conditions (see note 3)

Temperature range: (see note 1)	0 °C to 55 °C (32 °F to 131 °F)
Relative humidity range: (see notes 2 and 4)	25 % to 95 %
Barometric pressure:	5 kPa to 106 kPa

5.7.3 Severe operating conditions (see note 4)

Annex C provides guidelines for instrumentation tape use in severe conditions, for example, airborne recording.

5.7.4 Standard shipping and short-term storage

Temperature range: 10 °C to 40 °C (59 °F to 77 °F)

Relative humidity range: 10 % to 40 %
(see note 3)

Barometric pressure: 5 kPa to 106 kPa

5.7.5 Extended shipping and short-term storage
(see note 3)

Temperature range: − 60 °C to + 60 °C
(− 76 °F + 140 °F)

Relative humidity range: 0 % to 95 %
(see notes 2 and 4)

Barometric pressure: 5 kPa to 106 kPa

5.7.6 Recommended long-term storage

Temperature range: 15 °C to 25 °C (59 °F to 77 °F)

Relative humidity range: 10 % to 20 %
(see note 2)

Barometric pressure: 50 kPa to 106 kPa

NOTES

1 These temperatures apply to the air in the immediate vicinity of the tape within the tape transport.

2 Relative humidity values shall be maintained under non-condensing conditions.

3 Extended environments may require component qualification for tape and transport.

4 The deterioration of tape under adverse conditions is progressive (see annex D for further information). Tapes subjected to such conditions for long periods may need additional restrictions (see recommended long-term storage conditions in 5.7.6).

5.8 Test environment

5.8.1 Preliminary conditioning

Individual test clauses may require preliminary conditioning of each reel of tape prior to testing to relieve stresses and establish uniformity. Reels of tape shall be wound and rewound with a tensile force of 0,131 N/mm ± 0,033 N/mm (12 ozf/in ± 3 ozf/in) tape width. The tape shall then be conditioned at 23 °C ± 3 °C (73 °F ± 5 °F), 40 % RH to 60 % RH for a minimum of 24 h, and stored under the same environmental conditions until required for testing.

5.8.2 Standard test environment

During testing, unless otherwise specified, the testing environment shall be

Temperature: 23 °C ± 3 °C (73 °F ± 5 °F)
Relative humidity: 45 % to 55 %
Barometric pressure: 80 kPa to 106 kPa

6 Dimensional requirements

6.1 Tape widths

The standard tape widths shall be as listed in table 2.

Table 2 — Standard tape widths

Standard tape widths	
mm	in
$6{,}30\ ^{0}_{-0{,}06}$	$0{,}248\ ^{0}_{-0{,}002\,5}$
$12{,}70\ ^{0}_{-0{,}10}$	$0{,}500\ ^{0}_{-0{,}004}$
$25{,}40\ ^{0}_{-0{,}10}$	$1{,}000\ ^{0}_{-0{,}004}$
$50{,}80\ ^{0}_{-0{,}10}$	$2{,}000\ ^{0}_{-0{,}004}$

This Technical Report does not at present define performance requirements (see clause 8) for tape widths of 6,30 mm (0,248 in) or 50,80 mm (2,000 in).

6.2 Thickness

Maximum total thickness is a function of standard reel dimensions, length, coating thickness and E value (see 6.4.1).

Table 3a) — Tape length by reel diameters — For reels with 76 mm (3 in) centre hole

(Reels to ISO 1860 or ISO 1858)

Nominal base thickness		Tape perf. class	Reel diameters																	
			203 mm (8 in)			266 mm (10,5 in)			318 mm (12,5 in)			356 mm (14 in)			381 mm (15 in)			406 mm (16 in)		
			Nominal length*)	Minimum actual length**)		Nominal length*)	Minimum actual length**)		Nominal length*)	Minimum actual length**)		Nominal length*)	Minimum actual length**)		Nominal length*)	Minimum actual length**)		Nominal length*)	Minimum actual length**)	
mm	in		m	m	ft	m	m	ft	m	m	ft	m	m	ft	m	m	ft	m	m	ft
0,038	0,001 5	B	365	366	1 200	760	768	2 520	+)	+)	+)	1 520	1 531	5 025	—	—	—	—	—	—
0,025	0,001 0	B	525	527	1 730	1 100	1 105	3 625	+)	+)	+)	2 200	2 204	7 230	—	—	—	—	—	—
0,025	0,001 0	E1 or E2	670	673	2 210	1 400	1 410	4 625	2 190	2 204	7 230	2 800	2 815	9 235	3 290	3 303	10 795	3 800	3 792	12 440

*) These nominal lengths are metric conversions, rounded for convenience of description, of original values in feet.

**) These lengths apply for an E value as specified in 6.4.2.

+) B1/B2 tape not normally available on 318 mm reel.

Table 3b) — Tape length by reel diameters for reels with 8 mm (0,312 5 in) centre hole

(Reels to ISO 3802)

Nominal base thickness		Type perf. class	Reel diameters									
			102 mm (4 in)				127 mm (5 in)		146 mm (5,75 in)		178 mm (7 in)	
			Metal		Plastic							
			Tape lengths									
			min.		min.		min.		min.		min.	
mm	in		m	ft	m	ft	m	ft	m	ft	m	ft
0,038	0,001 5	B	100	330	112	365	180	590	242	795	371	1 220
0,025	0,001 0	B	146	480	161	530	256	840	347	1 140	535	1 755
0,025	0,001 0	E1 or E2	186	610	205	675	274	900	445	1 460	683	2 240

6.3 Length

Tape shall be supplied in the minimum lengths given in table 3.

6.4 *E* value

6.4.1 Definition

***E* value:** The radical distance by which the reel flanges extend beyond the outermost layer of tape wound on a reel.

6.4.2 Requirement

The minimum *E* value shall be 2,54 mm (0,100 in) for reels having a diameter up to and including 203 mm (8 in), and shall be 3,18 mm (0,125 in) for reels having a diameter greater than 203 mm (8 in).

6.4.3 Test condition

The tape pack shall be wound on a reel of a type listed in table 1 under a tensile force of 0,131 N/mm ± 0,033 N/mm (12 ozf/in ± 3 ozf/in) of tape width.

NOTE — It is current practice in some countries to use a standard tensile force of 0,175 N/mm (16 ozf/in) tape width. Interchange parties should exercise caution when defining tests involving this parameter.

7 Physical requirements

7.1 Yield strength

7.1.1 Requirement

The tensile force at break and/or the 1 % offset yield point (defined in ISO 1184) shall not be less than the value specified in table 4.

Table 4 — Physical requirements

Characteristics	Base material and thickness indicator (see 4.5)		Units
	HR	HT	
Yield strength or breaking force	3,08 (17,6)	2,10 (12,0)	N/mm (lbf/in) tape width
Elongation under stress	0,30	0,50	%

7.1.2 Test procedure

The sample tape shall undergo the preliminary conditioning specified in 5.8. A strip of tape, minimum length 200 mm (8 in), shall be clamped in the grips set for an initial separation of 100 mm (4 in). The test specimen shall be clamped in the testing machine taking care to align the long axis of the specimen with an imaginary line joining the points of attachment of the grips to the machine. The grips shall be tightened evenly and firmly to the degree necessary to prevent slipping of the specimen during the test. The rate of grip separation shall be 0,8 mm/s (2 in/min). Not less than five specimens of a particular type of tape shall be tested. A force-strain diagram shall be obtained. Means shall be provided for calibration of the strain axis. The force corresponding to 1 % offset yield shall equal or exceed the value listed in the table. For a more complete description of standard test procedures, see ISO 1184.

In the event that the breakage of a particular tape occurs prior to reaching the 1 % offset yield point, the load at break shall equal or exceed the value listed in table 4.

NOTE — ISO 1184 describes the determination of tensile properties of films and does not refer specifically to magnetic tape.

7.2 Elongation under stress

7.2.1 Definition

Elongation under stress is defined as the difference between an initially measured unstressed tape length and the final stressed tape length expressed as a percentage of the unstressed tape length.

7.2.2 Requirement

The elongation shall not exceed the value specified in table 4.

7.2.3 Test procedure

The sample tape shall undergo the preliminary conditioning specified in 5.8. Samples at least 600 mm (24 in) long shall be clamped so as to hang in the test area in a standard test environment, for at least 24 h under no externally applied stress before tests are begun. Before any weight is hung on the samples, a mark shall be made approximately 500 mm (20 in) from the point of clamping to serve as a reference point for length measurement before and after stress. The distance between the mark and clamping point shall be measured accurately to the nearest 0,25 mm (0,01 in). A weight shall be attached which applies a tensile force of 0,5 N (2 ozf). The distance shall be taken as the base distance for calculation of residual elongation. When measurement of the base distance has been made, the test shall begin. A weight, which applies a tensile force of 1,75 N/mm (10 lbf/in) of tape width, shall be attached to the tape below the mark at zero time and allowed to hang undisturbed for 180 min ± 30 s, at which time the weight shall be removed from the tape. The tape shall be allowed to hang under its own weight for an additional 180 min ± 30 s. The distance between the mark and the point of clamping shall then be measured to the nearest 0,25 mm (0,01 in) with an applied tensile force of 0,5 N (2 ozf). The difference between the base distance and the final distance shall be expressed as a percentage of the base distance to determine compliance with table 4.

7.3 Transverse curvature (cupping)

7.3.1 Definitions

7.3.1.1 transverse curvature (cupping): The angle formed by the conjunction of lines constructed perpendicular to the edges of the tape when viewed end on.

7.3.1.2 initial cupping: The transverse cupping measured prior to testing under humidifying or desiccating conditions.

7.3.1.3 differential cupping: The arithmetic difference between the transverse curvatures measured on the humidified tape and the desiccated tape.

7.3.2 Requirement

This test is not needed for standard interchange of polyester tapes. If needed by the user, the test procedure and recommanded performance levels appear in annex A.

7.4 Layer-to-layer adhesion and layer delamination

7.4.1 Definition

Layer-to-layer adhesion is defined as the tendency for one layer of tape to adhere to an adjacent layer of tape in the same pack.

7.4.2 Requirement

A sample of tape when conditioned according to the procedure described in 7.4.3, shall exhibit no sticking or layer-to-layer adhesion.

7.4.3 Test procedure

The sample tape shall undergo the preliminary conditioning specified in 5.8. Samples of 900 mm (36 in) in length shall be allowed to hang without bends or kinks in a standard test environment (see 5.8) for at least 24 h under no externally applied stress, before tests are begun.

The sample length shall be fastened at one end, magnetic side down, to a 12,7 mm (0,5 in) diameter hollow tube, approximately 100 mm (4 in) in length with a non-oozing adhesive material. The tube shall be made of a non-oxidizing metal such as brass or corrosion resisting steel and shall have a mass of not less than 15 g (0,5 oz) nor more than 30 g (1,0 oz). The tube shall be mounted in bearings so that it may be rotated freely around its central axis and easily removed from the bearings.

Weights shall be attached to the free end of the tape so as to apply a stress of 40 MPa (5 700 lbf/in^2). A small strip of double coated adhesive tape shall be affixed to the magnetic side of the tape about 25 mm (1 in) above the weight. The tube shall then be slowly and uniformly rotated so that the tape, held in tension by the weight, winds uniformly around the tube into a compact and even roll. The double-coated tape when wound into the test roll acts to secure the roll and prevent its unwinding when the weight is removed.

The tube supporting the rolled tape shall be removed from the winding set-up and subjected to a heat and humidity cycle of 16 h to 18 h at 55 °C ± 3 °C (130 °F ± 5 °F) and 80 % RH to 90 % RH, followed by 4 h at 55 °C ± 3 °C (130 °F ± 5 °F) dry heat (less than 5 % RH). During the humidification and dry heat phase, provision shall be made so that the air surrounding the tube is constantly circulated to assure uniformity of conditions throughout the test area. At the end of the dry heat cycle, the rod shall be removed from the conditioned area and allowed to come to equilibrium in a standard test environment (see 5.8).

To evaluate the tape for layer-to-layer adhesion, the end of the roll on the rod shall be carefully opened and the double-coated tape shall be removed. The rod shall then be held between the thumb and fingers and the untabbed tape shall be observed to note if the first two or three layers loosen up of their own accord; if this occurs, there is no adhesion and the tape has passed the test. If no loosening, or very little loosening of the outermost layer is observed, the free end of the tape shall be unwound slowly until 250 mm (10 in) has been unwound. The free end shall then be allowed to hang and the tape shall be observed to see if it will loosen by itself. If it will not unwind unaided, the tube with the tape hanging freely shall be slowly rotated in the direction of tape unwind. If the tape adheres to itself and refuses to begin to unwind after the rod has been rotated through one-fourth revolution or $\pi/2$ rad (90°), it shall be considered to have failed the test. After the rotation test has been made, the free end of the tape shall be held and the rod allowed to fall, thereby unwinding the tape. The unwound tape shall be checked for evidence of coating delamination and in this way the severity of adhesion is established. Any tape which will not self-unwind after rotating the rod through $\pi/2$ rad (90°) or which shows any delamination except in the 50 mm (2 in) nearest the rod shall be considered as having failed this test.

7.5 Longitudinal curvature

7.5.1 Definition

longitudinal curvature: The deviation of each tape edge from a straight line.

7.5.2 Requirement

The longitudinal curvature of a tape shall not exceed 3,8 mm when measured along a 1 m straight edge. (Alternatively, in inch dimensions, the curvature shall not exceed 0,125 in when measured along a 36 in straight edge.)

NOTE — The longitudinal curvature measurement has a resolution of about 0,4 mm (0,031 25 in).

Table 5 — Maximum moments of inertia for full reels

Nominal tape width	Nominal reel diameter											
	203 mm (8 in)		266 mm (10,5 in)		318 mm (12,5 in)		355 mm (14 in)		381 mm (15 in)		406 mm (16 in)	
	g·m²	lb·ft²	g·m²	lb·ft²	g·m²	lb·ft²	g·m²	lb·ft²	g·m²	lb·ft²	g·m²	lb·ft²
6,30 mm (0,25 in)	2,78	0,066	10,16	0,241	19,72	0,468	29,81	0,707	41,75	0,989	54,27	1,29
12,70 mm (0,50 in)	3,77	0,089	14,57	0,345	28,14	0,667	43,21	1,02	59,78	1,42	77,79	1,84
25,40 mm (1,00 in)	5,73	0,136	23,37	0,554	44,97	1,07	69,99	1,66	95,82	2,27	124,8	2,96
50,80 mm (2,00 in)	9,66	0,229	40,97	0,971	78,63	1,86	123,55	2,93	167,92	3,98	218,86	5,19

7.5.3 Test procedure

Longitudinal curvature shall be determined by constraining a sufficient length of tape to lie in a horizontal plane under a stress of about 0,3 MPa (40 lbf/in²) and measuring the maximum deviation of either tape edge from a straight edge of the specified length. No special preparation of the tape sample is required.

7.6 Abrasivity

7.6.1 Definition

abrasivity: Tendency of the magnetic tape to abrade or wear a tape transport head.

7.6.2 Requirement

Under consideration.

7.6.3 Test procedure

Under consideration.

7.7 Moments of inertia of a full reel of tape

The maximum moments of inertia for full reels of tape are given in table 5.

8 Performance requirements

8.1 Definitions

8.1.1 reference tape: The reference tape is a special unrecorded length of tape used as a reference to establish operating bias current (see 8.1.3), standard record level (see 8.1.4), standard output level (see 8.1.5) and wavelength response (see 8.4) for the reference test recorder used in the tests described herein. The parameters of an operational system calibrated by means of the reference tape are: standard record level (see 8.1.4), standard output level (see 8.1.5), sensitivity (see 8.3), wavelength response (see 8.4), and harmonic distortion (see 8.8).

NOTE — To be established at and/or co-ordinated through a National Standards laboratory. As an interim measure, the reference tape may be one adopted by agreement between interchange parties. When absolute quantitative performance levels and an international source of standard reference types have been adopted, such agreements may be replaced by reference to standard reference tapes.

The reference tape required for tests on high resolution tapes may be different from that required for tests on intermediate resolution tapes. In the following sections, a reference tape shall be taken to mean the one appropriate to the type of tape being tested.

8.1.2 secondary reference tape: The secondary reference tape is an unrecorded length of tape, the magnetic characteristics of which have been calibrated against those of the reference tape.

8.1.3 Operating bias current

(1) For a high resolution tape (type E): Operating bias current is the amplitude of bias current through the recording head which causes a 2 dB fall-off (overbias peak) of the peak output from the reference tape when a 2,0 MHz signal is recorded at standard record level [see 8.1.4 (1)] at a tape speed of 3,048 m/s (120 in/s).

NOTE — This test is applicable to tapes used either in 1,5 or 2,0 MHz wideband DR equipment.

(2) For an intermediate-resolution tape (type B): Operating bias current is the amplitude of bias current through the recording head which causes a 3 dB fall-off (overbias peak) of the peak output from the reference tape when a 250 kHz signal is recorded at standard record level [see 8.1.4 (2)] at a tape speed of 1,524 m/s (60 in/s).

8.1.4 Standard record level

(1) For a high-resolution tape (type E): Standard record level is that input level of a 200 kHz signal recorded on the reference tape at 3,048 m/s (120 in/s) and with operating bias current [see 8.1.3 (1)] such that on playback the output signal has 1 % third-harmonic distortion as measured with a wave analyzer (see ISO 6068, annex A, table 23) with a 3 kHz bandpass and provision for automatic frequency control. The reproduce equalization shall be adjusted as recommended by the recorder manufacturer and correction shall be made for allowable equalization variation.

(2) For an intermediate resolution tape (type B): Standard record level is that input level of a 25 kHz signal recorded on the reference tape at 1,524 m/s (60 in/s) and with operating bias current [see 8.1.3 (2)] such that on playback the output signal has 1 % third-harmonic distortion as measured with a wave analyzer (see ISO 6068, annex A, table 23) with a 3 kHz bandpass and provision for automatic frequency control. The reproduce equalization shall be adjusted as recommended by the recorder manufacturer and correction shall be made for allowable equalization variation.

8.1.5 Standard output level

(1) For a high resolution tape (type E): The standard output level is the reproduce level of a 200 kHz signal recorded on the reference tape at 6 dB below standard record level and with operating bias current [see 8.1.3 (1) and 8.1.4 (1)].

(2) For an intermediate resolution tape (type B): The standard output level is the reproduce level of a 25 kHz signal recorded on the reference tape at 6 dB below standard record level and with operating bias current [see 8.1.3 (2) and 8.1.4 (2)].

8.2 Standard tests

8.2.1 Reference tape system

A reference tape system shall be used for standardized testing (see 8.1.1 and 8.1.2). A reference tape system includes a standard tape and head mounted on a suitable recorder/reproducer. Interchange tapes should perform within the tolerances of table 8 when recorded and played back on a reference system.

8.2.2 Reference test recorder for high resolution tape

The reference test recorder shall have wideband 2,0 MHz DR capability as defined in ISO 6068.

8.2.3 Reference test recorder for intermediate resolution tape

The reference test recorder shall have intermediate band DR capability as defined in ISO 6068.

8.2.4 Test set-up

Prior to tape testing, the reference tape system shall be set up as follows:

a) The recorder shall be thoroughly cleaned and demagnetized, and the heads shall be adjusted for correct azimuth. Cleanliness is particularly critical in drop-out tests (see 8.7) and it is highly desirable that facilities be provided to clean the tape during record/playback.

b) The tensile force applied to the tape shall be measured to determine that the recorder is in proper adjustment. Unless otherwise specified, the tensile force used in the following tests is the standard tensile force: 0,131 N/mm ± 0,033 N/mm (12 ozf/in ± 3 ozf/in) tape width (but see note following 6.4.3).

c) The record and reproduce head segments and head configuration shall conform to the dimensions specified in ISO 6068 (table 5 or table 8), i.e. using head segments giving a track width of 1,27 mm ± 0,13 mm (0,050 in ± 0,005 in). (Consideration is being given to test requirements for other track widths.)

d) Measurements of high resolution tape samples shall be performed at a tape speed of 3,048 m/s (120 in/s) unless otherwise specified in this Technical Report.

e) Measurements on intermediate resolution tape samples shall be performed at a tape speed of 1,524 m/s (60 in/s) unless otherwise specified in this Technical Report.

f) For all tests, the reference test recorder shall be terminated with its proper load impedance.

g) All test signals shall be sine wave signals.

8.3 Sensitivity

8.3.1 Definition

sensitivity: The output from a tape compared to the output from the reference tape at one specific frequency.

8.3.2 Requirement

The output from the tape under test at any point along its length shall not vary from the standard output level by more than the amount (expressed as a ratio in decibels) specified in table 8.

8.3.3 Test procedure

8.3.3.1 The standard output level applicable to the type of tape under test shall be determined to calibrate the test recorder for sensitivity measurement [see 8.1.5 (1) and 8.5.1 (2)]. The appropriate following procedure shall then be followed.

8.3.3.2 For a high resolution tape (type E): A 200 kHz signal shall be recorded on the tape to be tested at a record level 6 dB below standard record level and with operating bias current [see 8.1.3 (1) and 8.1.4 (1)]. The equalization and reproduce amplifier gain settings shall not be changed from those obtained when establishing the standard output level. This tape shall be reproduced and the output of the recorder measured to determine compliance with table 8.

8.3.3.3 For an intermediate resolution tape (type B): A 25 kHz signal shall be recorded on the tape to be tested at a record level 6 dB below standard record level and with operating bias current [see 8.1.3 (2) and 8.1.4 (2)]. The equalization and reproduce amplifier gain settings shall not be changed from those obtained when establishing the standard output level. This tape shall be reproduced and the output of the recorder measured to determine compliance with table 8.

8.4 Wavelength response

8.4.1 Definition

wavelength response: The output voltage vs. frequency characteristic of a tape when normalized to a specific wavelength and compared with the response of the reference tape.

8.4.2 Requirement

8.4.2.1 High resolution tape, type E

The output at each frequency, when normalized to the output at 15 µm (0,000 6 in) wavelength and compared with the response of the reference tape, shall be within the limits given in table 6.

Table 6 — Output limits

Recorded wavelength µm (0,001 in)	Requirement variation from reference tape dB	Test frequency, kHz, at 3,048 m/s (120 in/s)
3 810 (150)	± 2	0,8
254 (10)	± 2	12
25,4 (1)	± 2	120
6,35 (0,25)	± 2	480
3,18 (0,125)	± 2,5	960
2,54 (0,10)	± 2,5	1 200
2,03 (0,08)	± 3	1 500
1,52 (0,06)	± 3	2 000

8.4.2.2 Intermediate resolution tape, type B

The output at each frequency when normalized to the output at 60 µm (0,002 4 in) wavelength compared with the response of the reference tape, shall be within the limits given in table 7.

Table 7 — Output limits

Recorded wavelength µm (0,001 in)	Requirement variation from reference tape dB	Test frequency, kHz, at 1,524 m/s (60 in/s)
7 620 (300)	± 1	0,2
5 080 (200)	± 1	0,3
1 524 (60)	± 1	1
25,4 (1)	± 2	60
12,7 (0,5)	± 2,5	120
6,1 (0,24)	± 3	250

8.4.3 Test procedure

The procedure specified in 8.3.3 shall be repeated at all frequencies specified in 8.4.2.1 or 8.4.2.2 as appropriate to the tape being tested. The measurements shall be made on a centre track and over the middle portion of the tape length to determine compliance with 8.4.2.1 or 8.4.2.2 as appropriate.

8.5 Output level uniformity — short term

8.5.1 Definition

output level uniformity — short term: The variation from maximum peak output level to minimum peak output level throughout the tape length, measured over any 10 s interval. The peak values shall be obtained by determining the level which contains 95 % of the peaks (see figure 1). The performance of the first and last 1 % of type B tape length and 2 % of type E tape length shall be ignored.

8.5.2 Requirement

The uniformity of the reproduce output at the specified test frequency for a particular type of tape [intermediate resolution (class B) or high resolution (class E1 or E2)] shall be such that the ratio of maximum peak voltage readings to minimum peak voltage readings expressed in decibels does not exceed the value specified in table 8 for the appropriate tape type.

8.5.3 Test procedure

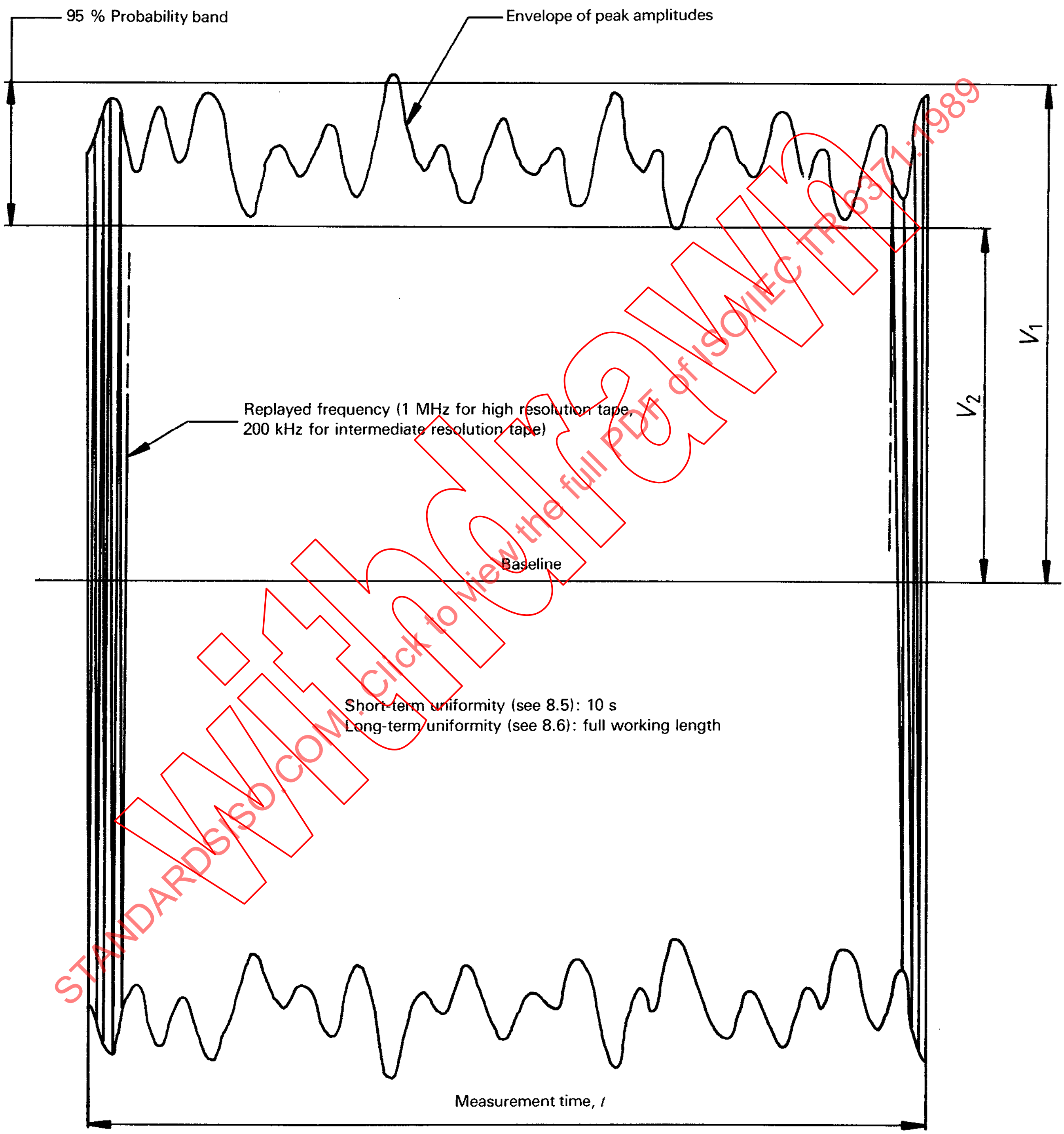
8.5.3.1 For every tape under test

a) Uniformity measurements shall be made on three tracks (a centre track and both edge tracks) at the appropriate tape speed as specified in 8.2.4 d) and 8.2.4 e). The test frequency specified (see 8.5.3.2 and 8.5.3.3) shall be recorded at standard record level and with the bias current adjusted as recommended by the recorder manufacturer, to that value which is optimum for the tape type being tested. The signal shall be recorded over the entire length of tape. Upon playback, the signal level shall be at least 20 dB above the noise level measured as recommended by the recorder manufacturer. The output-reading circuitry shall include a rectifier (AM demodulator) with a peak reading facility. The variation in the peak signal amplitude shall be measured by means of a linear recording oscillograph having a frequency response which is uniform up to at least 200 Hz. Dropout defect areas shall be excluded from this measurement.

b) The tape uniformity, over any 10 second interval, shall be measured by determining the maximum variation in peak output, expressed as a ratio in decibels referred to the maximum peak amplitude. This uniformity test may be performed simultaneously with the output level uniformity — long term (see 8.6) and instantaneous non-uniformity (dropouts) (see 8.7) tests specified herein.

8.5.3.2 For high resolution tape (type E): A 1 MHz signal shall be recorded as specified in 8.5.3.1. Uniformity tests shall be conducted simultaneously with recording, and output level variations occurring in the first and last 2 % of the nominal tape length shall be disregarded.

8.5.3.3 For intermediate resolution tape (type B): A 200 kHz signal be recorded as specified in 8.5.3.1. Uniformity tests shall be conducted simultaneously with recording and output level variations occurring in the first and last 1 % of the nominal length shall be disregarded.



$$\text{Deviation from uniformity} = 20 \log_{10} \frac{V_1}{V_2}, \text{dB}$$

Figure 1 — Replayed waveforms for output level uniformity tests (not to scale)

8.6 Output level uniformity — long term

8.6.1 Definition

output level uniformity — long term: The variation from maximum peak output level to minimum peak output level throughout the tape length. The peak values shall be obtained by determining the level which contains 95 % of the peaks (see figure 1). The first and last 1 % of type B tape length and 2 % of type E tape length shall be ignored.

8.6.2 Requirement

The uniformity of the signal output at the specified test frequency for a particular type of tape [intermediate resolution (class B) or high resolution (class E1 or E2)] shall be such that the ratio of maximum peak voltage readings to minimum peak voltage readings expressed in decibels does not exceed the values specified in table 8 for the appropriate tape type.

8.6.3 Test procedure

8.6.3.1 For either type of tape, the test procedure shall be similar to that specified in 8.5.3.1 a). The tape uniformity shall be measured by determining the variation of the peak output over the specified tape length. This uniformity test may be performed simultaneously with the output level, uniformity — short term (see 8.5) and instantaneous non-uniformity (dropouts) (see 8.7) tests. Dropout defect areas shall be excluded from uniformity measurement.

8.6.3.2 For high resolution tapes (type E), the test procedure shall be the same as that specified in 8.5.3.2.

8.6.3.3 For intermediate resolution tapes (type B), the test procedure shall be the same as that specified in 8.5.3.3.

8.7 Instantaneous non-uniformity (dropouts)

8.7.1 Definition

instantaneous non-uniformity (dropouts): A loss of reproduced signal amplitude which exceeds a specified allowable time duration and percentage decrease in level.

8.7.2 Requirement

The total number of dropouts for any given track on a particular class or type of tape [intermediate resolution (class B) or high resolution (class E1 or E2)] shall not exceed the value specified in table 8 for the appropriate tape type.

8.7.3 Test procedure

8.7.3.1 Dropout tests shall be made on three tracks (a centre track and both edge tracks) of a reel of tape at the appropriate tape speed as specified in 8.2.4 d) or 8.2.4 e). The appropriate test frequency specified below shall be recorded at standard record level and with the bias current adjusted as recommended by the recorder manufacturer, to that value which is optimum for the tape type being tested. The signal shall be recorded over the entire length of tape. Upon playback, the signal level shall be at least 20 dB above the noise level measured as recommended by the recorder manufacturer. The dropout measurements may be performed simultaneously with the output level uniformity tests [see also 8.2.4 a)].

8.7.3.2 For high resolution tape (type E), a 1 MHz signal shall be recorded as specified in 8.7.3.1. A count shall be kept of all periods of 10 µs or more during which the reproduce signal amplitude is 50 % or less of the average value. If the dropout duration exceeds 10 µs the dropout count shall be incremented by one for each complete 10 µs. The dropout count shall be conducted simultaneously on a centre track and both edge tracks over the entire length of the tape sample, except that all dropouts occurring in the first and last 2 % of the nominal tape length shall be disregarded.

8.7.3.3 For intermediate resolution tape (type B), a 200 kHz signal shall be recorded as specified in 8.7.3.1. A count shall be kept of all periods of 10 µs or more during which the reproduce signal amplitude is 50 % or less of the average value. If the dropout duration exceeds 10 µs the dropout count shall be incremented by one for each complete 10 µs. The dropout count shall be conducted simultaneously on a centre track and both edge tracks over the entire length of the tape sample, except that all dropouts occurring in the first and last 1 % of the nominal tape length shall be disregarded.

8.8 Harmonic distortion

8.8.1 Definition

harmonic distortion: Spurious multiples of the fundamental frequency contained in the reproduced output signal, which are caused by tape saturation.

8.8.2 Requirement

The third harmonic distortion of a particular type of tape shall not exceed the value specified in table 8.

8.8.3 Test procedure

8.8.3.1 In computing the percentage of third harmonic distortion, correction shall be made for the variation in system response between the fundamental and third harmonic frequencies.

8.8.3.2 High resolution tape. A 200 kHz signal shall be recorded at standard record level and with operating bias current [see 8.1.3 (1) and 8.1.4 (1)]. The tape shall be played back and the third harmonic distortion measured to determine compliance with table 8.

8.8.3.3 Intermediate resolution tape. A 25 kHz signal shall be recorded at standard record level and with operating bias current [see 8.1.3 (2) and 8.1.4 (2)]. The tape shall be played back and the third harmonic distortion measured to determine compliance with table 8.

8.9 Signal-to-noise ratio

8.9.1 Definition

signal-to-noise ratio: A measure of the relative value of the reproduced output signal power from a tape and the wideband noise power (tape and equipment) measured over the system bandwidth.

8.9.2 Requirement

The signal-to-noise ratio of either type of tape shall not be less than the signal-to-noise ratio of the reference tape by more than the value specified in table 8.

8.9.3 Test procedure

For either type of tape, using the appropriate reference tape, the reference test recorder shall be adjusted for the appropriate operating bias current [see 8.1.3 (1) and 8.1.3 (2)] and standard record level [see 8.1.4 (1) and 8.1.4 (2)]. The reproduce equalization shall be adjusted as recommended by the recorder manufacturer. The noise-power spectral density of the tape-reproducer system throughout the nominal bandwidth must be better than that for the tape. The specified frequency (see 8.9.3.1 and 8.9.3.2) shall be recorded and the reproduced output level taken as the signal level. The tape shall then be externally erased. The input signal shall be disconnected and replaced with a load equal to the input impedence of the recorder, and the recorder operated in the record mode. The reproduced noise output level shall be measured without any readjustment of the recorder. The signal-to-noise ratio for the reference tape is the value in decibels of the signal level minus the value of the noise level. The signal-to-noise measurements shall be made utilizing a band pass filter which provides no more than a 3 dB attenuation at the recorder band edge frequencies (at the applicable speed) and has an 18 dB per octave rolloff characteristic. The above measurements shall be repeated (without any recorder adjustment) on the tape being tested to determine the signal-to-noise ratio for the tape under test and hence, by taking the difference, between the two signal-to-noise ratios, compliance with the requirements of table 8.

8.9.3.1 High resolution tape. The test frequency shall be 200 kHz.

8.9.3.2 Intermediate resolution tape. The test frequency shall be 25 kHz.

8.10 Layer-to-layer signal transfer

8.10.1 Definition

layer-to-layer signal transfer: The level of magnetization on an unrecorded layer of tape caused by its proximity to adjacent layers of recorded (i.e. magnetized) tape.

8.10.2 Requirement

The signal resulting from layer-to-layer signal transfer for either type of tape shall be below the signal level by at least the amount (expressed as values in decibels) specified in table 8.

8.10.3 Test procedure

For either type of tape, using the appropriate reference tape, the reference test recorder shall be adjusted for a tape speed of 381 mm/s (15 in/s) and the appropriate operating bias current but no input signal. Ten layers of tape shall be recorded and wound on to a reel. The record level shall be set to 10 dB above standard record level at operating bias current with a 1 000 Hz signal, and one additional layer recorded and wound on to the reel. The record level shall be returned to zero and ten additional layers shall be recorded and wound on the reel. The recorded tape shall then be conditioned at a temperature of 66 °C ± 3 °C (150 °F ± 5 °F) for a period of 4 h. The tape shall then be played back at 381 mm/s (15 in/s); the output level of the recorded signal and the maximum level of the signal resulting from signal transfer shall be measured through a properly terminated filter tuned to the recorded signal frequency and having a 10 Hz passband, to determine compliance with table 8.

8.11 Ease of erasure

8.11.1 Definition

ease of erasure: The ability to effect a specified reduction in the recorded signal level on a tape when the tape is subjected to a specific erase field.

8.11.2 Requirement

An erase field of 80 kA/m (1 000 Oe) shall effect a reduction in recorded signal level of at least the amount (expressed as a ratio in decibels) specified in table 8.

8.11.3 Test procedure

The tape shall be externally erased. A frequency of 1 000 Hz shall be recorded at 381 mm/s (15 in/s) at operating bias current and 10 dB above standard record level. The tape shall then be conditioned at a temperature of 66 °C ± 3 °C (150 °F ± 5 °F) (dry heat) for a period of 4 h. The tape shall be reproduced and the output measured through a properly terminated filter tuned to the recorded frequency and having a 10 Hz passband. The tape shall then be passed through a solenoid producing a 50 Hz or 60 Hz ac field 80 kA/m (1 000 Oe) (peak value) after which the level of the residual signal on playback shall be measured again through the band pass filter tuned to the recorded signal frequency. The ratio in decibels between the recorded signal level and the residual signal level is the effective reduction in signal indicative of ease of erasure.

8.12 Surface electrical resistance

8.12.1 Definition

surface electrical resistance: The surface resistance in ohms of the magnetic coating of the tape as measured between opposite sides of a square area.

8.12.2 Requirement

The surface electrical resistance of the magnetic coating shall not exceed the value specified in table 8.

8.12.3 Test procedure

8.12.3.1 Apparatus

The apparatus for this test shall consist of a temperature and humidity chamber and the apparatus as specified in annex B, or equivalent.

8.12.3.2 Preparation of samples

Samples of tape shall be prepared as specified under preliminary conditioning (see 5.8). Lengths of tape sufficient for this test shall be unwound from the reels and placed in a standard test environment (see 5.8) without kinks or bends and allowed to remain for at least 24 h before test. A minimum of two samples shall be taken from each reel of tape being tested.

8.12.3.3 Procedure

Following pre-conditioning as described in 8.12.3.2, two 12,7 mm (0,5 in) wide layers of the sample tape shall be placed back-to-back between the strip electrodes, as shown in figures 2 and 3, so that the recording surfaces are in contact with all the electrodes. In mounting the specimen for measurement it is important that no conduction paths exist between the electrodes except those through the specimen. To ensure that the length of tape held between each pair of strip electrodes is the same, the specimen shall be placed under 2,2 N ± 0,5 N (0,5 lbf ± 0,1 lbf) tension as it is being clamped.

The width of the test specimen shall be 12,7 mm (0,5 in). If the specimen tape is less than 12,7 mm (0,5 in) wide (e.g. 6.3 mm (0,25 in) wide), two or more samples shall be placed side-by-side to make up a 12,7 mm (0,5 in) specimen. If the tape is 25,4 mm (1,0 in) wide, it may be folded longitudinally with the recording surface outermost to make a 12,7 mm (0,5 in) back-to-back specimen for measurement. Specimens obtained from wider tapes must be cut down to 12,7 mm or 25,4 mm (0,5 in or 1,0 in) width and mounted as described above.

NOTE — Neither the specimen nor the insulating surfaces shall be handled with the bare fingers. The use of clean lint-free gloves is recommended.

Measurements shall be made between each pair of adjacent electrodes. This will produce a total of five readings per specimen. The resistance of the coating shall be determined by means of a guarded circuit, as shown in figure 3, using 500 V ± 10 V potential.

The average value of the five surface resistance measurements shall not exceed the limits shown in table 8.

8.13 Bi-directional performance

8.13.1 Definition

bi-directional performance: The ability of the tape to exhibit similar magnetic and performance characteristics in either direction of motion.

8.13.2 Requirement

When tested as specified, the tape shall meet the requirements of wavelength response (see 8.4.2), sensitivity (see 8.3.2), output level uniformity — short term (see 8.5.2) and output level uniformity — long term (see 8.6.2).

8.13.3 Test procedure

The tape shall be completely rewound on to a reel of the same type as the original, so that the tape ends are reversed. Upon completion of the rewind process, the tape shall be subjected to the tests specified in 8.3.3, 8.4.3, 8.5.3 and 8.6.3, to determine compliance with the requirements therein.

8.14 Environmental performance

8.14.1 Definition

environmental performance: Storage at those extremes of temperature and humidity conditions which do not cause any unacceptable degradation in subsequent tape performance.

8.14.2 Requirement

The tape, when subjected to the temperature and humidity conditions specified, shall meet the requirements for output level uniformity — short term and output level uniformity — long term listed in table 8.

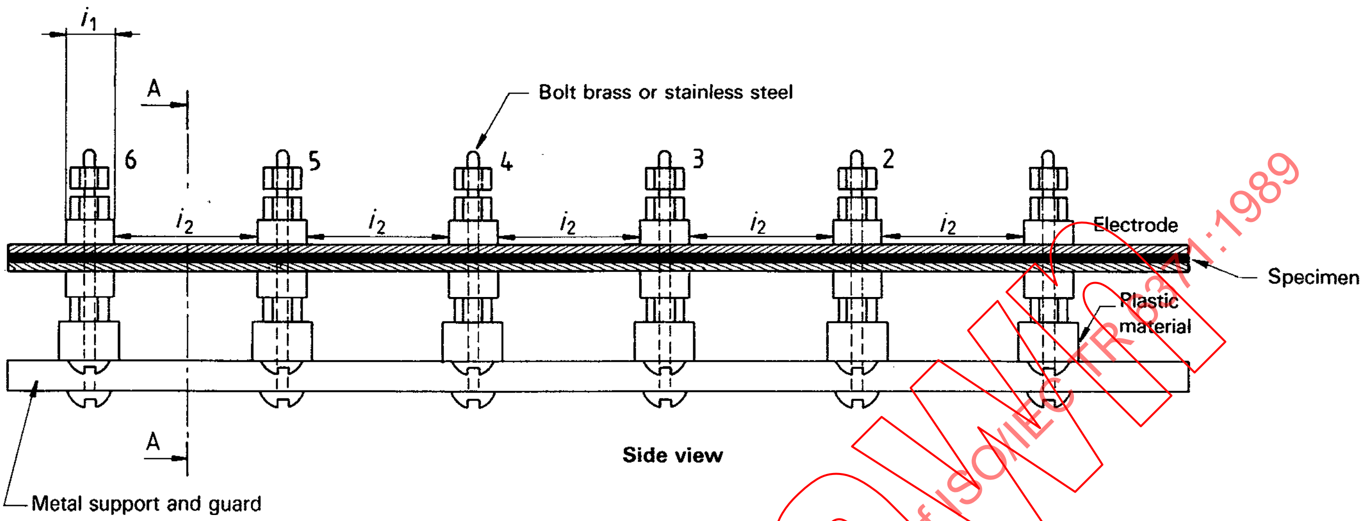
8.14.3 Test procedure

The tape shall be recorded under the conditions specified in 8.5 and 8.6. The tape shall then be subjected to a temperature of 55 °C ± 3 °C (131 °F ± 5 °F) and a relative humidity of 95 % for a period of 24 h. Upon removal from this environment, the tape shall be rewound once at a tensile force of 0,131 N/mm ± 0,033 N/mm (12 ozf/in ± 3 ozf/in) tape width and kept in a standard test environment (see 5.8.2) for a minimum of 24 h. The tape shall then be tested for output level uniformity — short term (see 8.5) and output level uniformity — long term (see 8.6) to determine compliance with table 8. Following these tests, the tape shall then be subjected to a temperature of −12 °C ± 3 °C (+10 °F ± 5 °F) and a relative humidity of less than 25 % for a period of 24 h. Upon removal from this environment, the tape shall be rewound once at standard tensile force of 0,131 N/mm ± 0,033 N/mm (12 ozf/in ± 3 ozf/in) tape width and kept in the standard test environment (see 5.8.2) for a minimum of 24 h. The tape shall again be tested for output level uniformity — short term (see 8.5) and output level uniformity — long term (see 8.6) to determine compliance with table 8 (see note following 6.4.3 on standard tensile force).

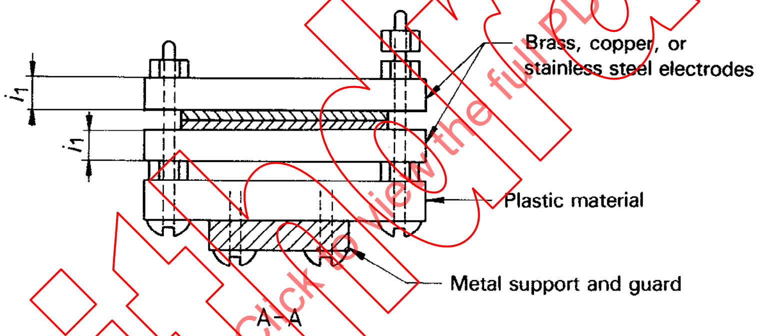
Table 8 — Performance requirements

Characteristic	Magnetic coating characteristic indicator (see 3.3)			Unit
	Intermediate resolution type B	High resolution type E		
Sensitivity[1]	0 ± 2	0 ± 2		Decibel
Wavelength response[1]	See 8.4.2.2	See 8.4.2.1		
Ouput level uniformity		Class E1	Class E2	
Short term — edge tracks	2,5 max.	3,0	2,5 max.	Decibel
Short term — centre tracks	2,5 max.	2,5	2,5 max.	Decibel
Long term — edge tracks	2,0 max.	3,0	2,5 max.	Decibel
Long term — centre tracks	2,0 max.	2,5	2,5 max.	Decibel
Instantaneous non-uniformity (dropouts)				
Centre tracks	66 (20) max.	49 (15)	33 (10) max.	Dropout per 100 m (Dropout per 100 ft)
Edge tracks	82 (25) max.	131 (40)	49 (15) max.	Dropout per 100 m (Dropout per 100 ft)
Harmonic distortion[1]	2,0 max.	2,0 max.		Percent
Signal-to-noise ratio[1]	4 (see 8.8.1)	4 (see 8.8.1)		Decibel
Layer-to-layer signal transfer	40 min. (HT) 46 min. (HR)	40 min.		Decibel
Ease of erasure	60 min.	60 min.		Decibel
Electrical resistance	200 max.	200 max.		Megohm
Bi-directional performance[1]	See 8.12.1	See 8.12.1		
Environmental extremes	See 8.13.1	See 8.13.1		

1) Indicates items calibrated using the reference tape.



Side view



End view

Dimensions	in	mm
i_1	0,250	6,35
i_2	1,000	25,40

Figure 2 — Tape resistance measurement electrodes

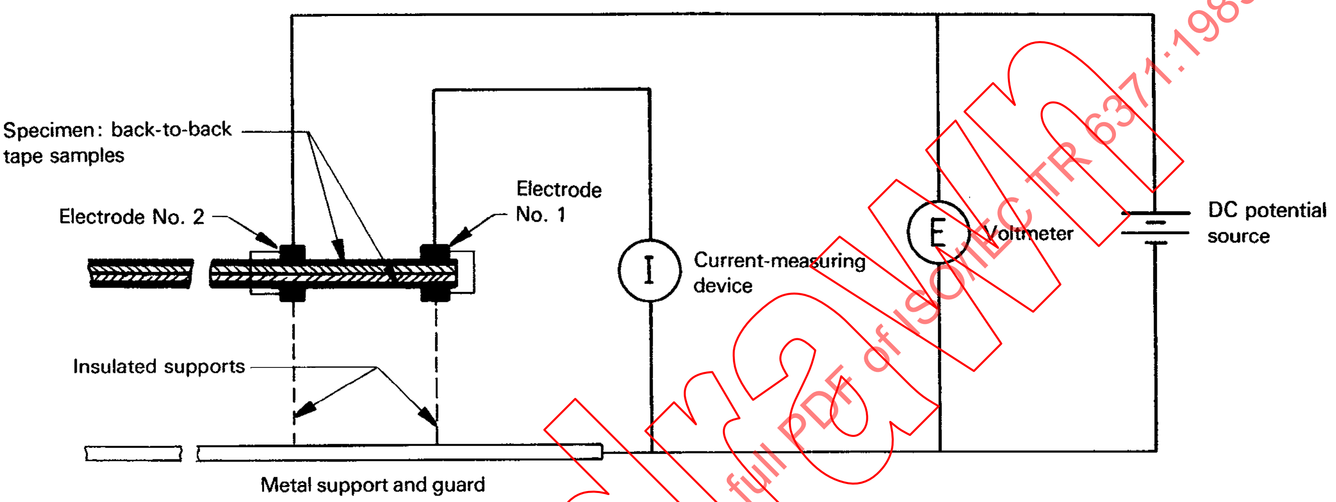


Figure 3 — Tape resistance measurement circuit

Annex A
(informative)

Environmental test for transverse curvature

A.1 Scope

This annex describes an example of apparatus which may be used for the test procedures described in 7.3.

A.2 Humidity chamber

The humidity chamber is made of materials which are non-reactive to water vapour and potassium chloride solution and is constructed so that all joints are sealed tight when the chamber is closed. It consists of two separate compartments each approximately 280 mm × 330 mm × 180 mm (11 in × 13 in × 7 in), one to be used for humidifying conditions, the other for desiccating conditions. The back and front of the compartments are made of a transparent material such as glass. The trays used to hold the chemicals inside the chamber measure approximately 250 mm × 250 mm × 100 mm (10 in × 10 in × 4 in) and are made from aluminium, glass, or any non-reactive material. The trays should be provided with removable perforated aluminium cover plates to permit placing tape holders above the conditioning chemicals with minimum interference with free air circulation. Means are provided for circulating air within each compartment with a velocity of at least 100 mm/s (20 ft/min) across both the conditioning chemicals and the tape holders.

A.3 Tape holders

Each tape holder, when filled, clamps the tape along its longitudinal axis and prevents movement of the longitudinal axis of the tape by positively contacting it, beginning at the end where the cupping is to be measured, and continuing at least 25 mm (1 in) along the tape length. The holder raises the tape at least 3,2 mm (0,125 in) above the holder base plate and should be separated from the adjacent tape holder by at least 16 mm (0,625 in), thus ensuring that there will be no interference to cupping in either direction. In the example, shown in figure 4, this is accomplished by constructing the holder from two pieces of straight rust- or corrosion-resistant wire, the bottom pieces being 3,2 mm (0,125 in) diameter and the top piece being 1,6 mm (0,062 5 in) diameter, 38 mm (1,5 in) length, which are soldered or brazed together at the front tips and then brazed on to a base plate of non-corrosive material. When the tape holders are in place in the chamber compartment and the tapes inserted for measurement, the longitudinal axis of the tapes should be substantially horizontal.

A.4 Humidity stability measuring instrument and illumination

The measuring device should be an optical system with a magnification of from 5 to 25 times, having at least one crosshair which can be referenced to a clinometer or goniometer so as to measure the angle between the crosshair and a reference line, and having a focal length such that it can be focused on the near end of a tape when the tape is mounted in the chamber and the measuring device is placed in front of the chamber. A light source is placed behind the chamber during measurements to outline the tape when viewed through the measuring instrument.

A.5 Test procedure

Subject the sample tape to preliminary conditioning (see 5.8). Hang a 900 mm (36 in) length of tape in the standard test environment (see 5.8) without any externally applied stress and without bends or kinks for at least 24 h.

Take at least five specimens of length 150 mm (6 in). Cut them with scissors into two separate halves of 75 mm (3 in) and mount these halves so that

a) they are clamped backing side down in a horizontal plane;

b) they are held along the longitudinal axis from the end corresponding to the scissors cut for a distance of at least 25 mm (1 in);

c) the edges of the tape have freedom of movement of at least 16 mm (0,625 in) in a vertical direction.

Measure the initial cupping on the clamped end using an optical system which complies with A.4.

Average local irregularities when setting the crosshair for measurement.

Condition one-half of each specimen for at least 16 h in a humidifying atmosphere of 32 °C ± 3 °C (90 °F ± 5 °F) and 85 % RH to 95 % RH. Measure the transverse curvature while the tape is still held under these conditions.

NOTE — The required conditions may be achieved in a closed chamber when it contains a saturated solution of potassium chloride in distilled water (plus an excess of potassium chloride) as the humidifying agent.

Condition the other half of each specimen for at least 16 h in a desiccating atmosphere of 32 °C ± 3 °C (90 ° ± 5 °F) and 10 % to 20 % relative humidity. Measure the transverse curvature while the tape is still held under these conditions.

NOTE — The required conditions may be achieved in a closed chamber when it contains anhydrous calcium chloride with an indicator (or equivalent), in the ratio 3 to 1, as a desiccating agent.

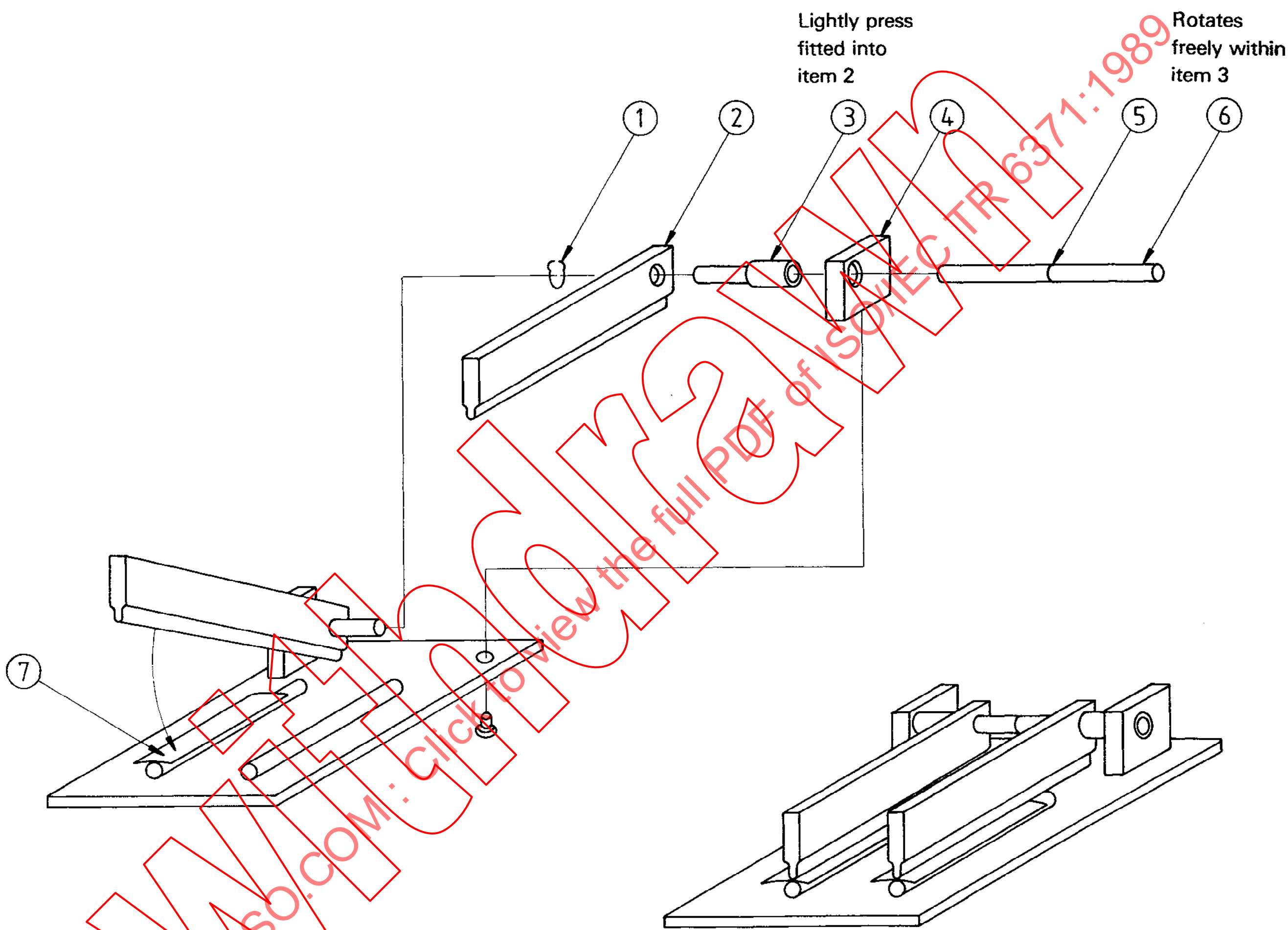
Calculate the differential cupping for each specimen (see 7.3).

NOTE — If the same specimen is successively conditioned and measured in humidifying then desiccating conditions (or vice versa), only 75 mm (3 in) lengths need be taken.

Record the mean results for all specimens. Clauses A.2 to A.4 describe a form of apparatus which may be used for this test.

A.6 Requirements

The transverse curvature values measured according to the procedure in A.5 shall not exceed 175 mrad (10 degrees) for tapes with either HR or HT base material indicators.



Item	Description
1	Circlip
2	Jaw
3	Pivotal bushing
4	Upright
5	Slot for circlip
6	Inner shaft
7	Magnetic tape

Figure A.1 — Sketch of tape holder for transverse curvature tests

Annex B
(informative)

Surface electrical resistance testing

B.1 Scope

These methods are designed for use in determining insulation and volume resistance and approximate surface resistance of electrical insulating materials together with means of converting the latter two into terms of volume and surface resistivities.

B.2 Apparatus

B.2.1 The apparatus shall consist of suitable electrodes, a source of direct-current potential, a suitable current-indicating amplifier and voltmeter. The latter role may be filled by a galvanometer with suitable shunts and a calibrating resistance, or a megohm bridge together with suitable switches and keys.

B.2.1.1 Electrodes for testing insulation resistance

It is important that good and complete contact be made between the electrodes and the surface of the material on test. For repeated tests at high relative humidities it is essential that the electrode metal(s) be protected against tarnishing. For insulation resistance determinations, the electrode arrangements most commonly used for solid materials are shown in figure B.1 (binding posts), figure B.2 (bar, thin sheets and tapes) and figure B.3 (tapered pins).

B.2.1.2 Electrodes for testing volume and surface resistance

When both the volume and surface resistances are to be measured, there shall be applied to each solid specimen three electrodes designated, respectively, as electrode No. 1, electrode No. 2, and electrode No. 3 (see figure B.4). In the case of a flat specimen, electrode No. 2 shall be in the form of a ring surrounding electrode No. 1 as shown in figure B.4. In the case of tubular specimens, the electrodes shall be applied as shown in figure B.6. For liquid materials the cell should have a guard electrode. However a two-terminal cell may be used provided it is established that the insulation resistance of the insulation between the electrodes is at least 100 times the resistance through the liquid.

B.2.1.3 Electrode materials

The electrode materials shall be corrosion-resistant under the conditions of test.

B.2.1.3.1 Contact or specimen electrode material. Specimen electrodes as shown in figures B.4 to B.7 may be made of silver conductive paint (provided its solvent does not attack the material under test), sprayed metal (provided satisfactory adhesion can be obtained), evaporated metal, metal foil applied with a thin film of petrolatum, silicone grease, or silicone oil (provided the gap can be properly cleaned without disturbing the edges of the adjacent electrodes when surface resistance is to be measured), colloidal graphite (provided it will adhere to the specimen, the specimen does not absorb water readily, and the test is to be made in a dry atmosphere), conductive rubber or mercury (provided care can be taken to eliminate possible toxic effects).

B.2.1.3.2 Conductive paint for specimen electrodes has desirable characteristics, such as giving intimate surface contact with the test surface, and often being sufficiently porous to moisture to permit conditioning. Each application shall be considered for proper choice of material. There should be no adverse interaction between the material and its vehicle, that is, solvent attack, etc. The film must adhere properly to the test surface to give good electrical contact.

B.2.1.3.3 Backing or cell electrode material. The electrode material shall be free of insulating and semi-conducting oxide films. Gold- or silver-plated brass, preferably with a surface flash of rhodium, is highly satisfactory. Nickel is usually satisfactory, but chromium should be avoided. Stainless steel electrodes, above 304 in the type 300 series, are satisfactory.

B.2.1.4 Direct-current potential

The direct current potential source may be a dry or storage battery or a rectified alternating-current voltage supply. When the alternating-current voltage supply is employed, precautions must be observed to maintain a sufficiently constant direct-current voltage with negligible ripple. Unless otherwise specified, the potential shall be 100 V ± 10 V.

B.2.1.5 Measuring equipment

B.2.1.5.1 Voltmeter and current-indicating amplifier, electrometer, or microammeter. The voltmeter shall have a reading error less than ± 2 % of full scale and have a range such that the test voltage reading is greater than one-third of full scale. If possible, the current-indicating amplifier, electrometer or microammeter shall have a sensitivity and ranges such that the reading during measurement shall be greater than one-third full scale. The most sensitive current-indicating amplifiers or electrometers have full scale deflection for 10^{-12} A. Thus a resistance as high as five times 10^{15} Ω can be measured with an accuracy of 10 % using 100 V. Careful static shielding will be required when using an instrument of this sensitivity. For lower resistance a calibrated galvanometer or microammeter can be used to measure the current.

B.2.1.5.2 Galvanometer and calibrated resistance. A galvanometer with proper shunts can be used to compare an unknown resistance with a calibrated resistance. The galvanometer shall have as high a sensitivity as is consistent with reasonable stability of zero. A sensitivity of 10^{-12} A/mrad (1 mm at 1 m scale distance) is sufficient to measure resistance as high as 10^{11} Ω with an accuracy of ± 10 %. It should be well damped. The most convenient shunt is the type known as a universal or Ayrton shunt whereby that fraction of the total current which passes through the galvanometer may be changed without changing the galvanometer damping. The calibrated resistance shall be at least 10^5 Ω. A resistance of 10^6 Ω is preferred. An insulated guarded switch is needed for shorting the specimen.

B.2.1.5.3 Bridge. A bridge method of measuring insulation resistances up to 10^{11} Ω may be used if a high-resistance balance detector, such as a vacuum tube voltmeter, is employed, and the necessary guarding requirements are observed.

B.2.1.6 Switches and keys. All switches and keys shall be suitably insulated and guarded.

B.3 Test specimens

Dimensions for solid insulating materials: for insulation resistance measurements, the specimen may have any practical form but is usually in the form of a sheet, a bar, a tape, a rod, or a tube. For volume and surface resistance measurements, the test specimen shall be in the form of a flat plate or a tube, having dimensions as specified in the specification.

B.4 Procedure

B.4.1 Conditioning of specimens

Determinations of insulation resistance of solid dielectrics shall be made only on specimens which have been kept for a specified time in air at a specified humidity and temperature. These conditions shall be specified in the specification. The specimen shall be kept in the same conditions during the determination. The measurements shall be made without opening the humidity chamber. Where electrode leads pass through the walls of the chamber, care shall be taken to ensure against current leakage at these points by suitable guarding or by passing leads through bushings of wax or other non-wetting materials.

NOTE — Coaxial cables such as Uniradio RG-6A/u (up to 85 °C) or RG-143 (up to 250 °C) may be used for all leads, the braids to be properly terminated at the instrument ground to minimize errors arising from stray capacitances to ground, operator and equipment.

B.4.2 Precautions in mounting specimens

In mounting the specimens for measurement, it is important that there shall be no conductive paths between the electrodes except those through the specimen. For example, the specimens shown in figures B.1, B.2 and B.3 shall be held by one or both edges so that none of the electrodes touches the supports.

B.4.3 Method of measuring resistance

B.4.3.1 Voltmeter-ammeter method

The test potential is applied to the specimen and current-measuring instrument (current-indicating amplifier, electrometer or microammeter) in series. The potential is measured with a suitable voltmeter (see B.2.1.5.1) and the current flowing at the end of a specified electrification time is measured by the current-measuring instrument. The value of the resistance, R, is obtained from the equation

$$R = \frac{E}{I}$$

where

E is the value of the potential applied to the specimen;

I is the current through the specimen at the specified electrification time.

B.4.3.2 Comparison method

B.4.3.2.1 Galvanometer with calibrated resistance. The test potential is applied to the specimen, the calibrated resistance and the galvanometer all connected in series. The shunt is adjusted to give an adequate deflection of the galvanometer and this deflection and the shunt ratio are noted. After setting the shunt ratio to the proper value, the switch across the specimen is closed, leaving only the calibrated resistance in the circuit. The galvanometer deflection and the shunt ratio are then noted. The value of the resistance, R, is computed from the equation

$$R = \left(R_c \times \frac{D}{d} \times \frac{s}{S}\right) - R_c$$

where

R_c is the value of the calibrated resistance;

D is the deflection of the galvanometer when the calibrated resistance only is in the circuit;

d is the deflection of the galvanometer when the calibrated resistance and the specimen are in the circuit;

S is the shunt ratio when the calibrated resistance only is in the circuit;

s is the shunt ratio when the calibrated resistance and the specimen are in the circuit.

Or, if the shunt setting is given in multiplying factors, the formula becomes

$$R = \left(R_c \times \frac{D}{d} \times \frac{F}{f}\right) - R_c$$

where

F is the shunt multiplying factor for the calibrating resistance;

f is the shunt multiplying factor for the specimen.

If the calibrating resistance is so small that the potential source will give too large a deflection of the galvanometer with the smallest shunt ratio (or largest multiplying factor), it is then necessary to calibrate by means of a low potential source. The same measurements shall be made as in the previous cases, but it is now necessary to know the voltage of the calibrating potential, E, and of the measuring potential, e.

Then

$$R = \left(R_c \times \frac{D}{d} \times \frac{s}{S} \times \frac{e}{E}\right) - R_c$$

or

$$R = \left(R_c \times \frac{D}{d} \times \frac{F}{f} \times \frac{e}{E}\right) - R_c$$

B.4.3.2.2 Bridge. The specimen is connected to the measuring terminals of the bridge and the proper potential is applied. The bridge shall be continuously adjusted so that it is in balance at the end of the specified electrification time. The reading of the bridge is then the resistance of the specimen.

B.4.3.3 Precautions in measuring high resistances

In measuring very high resistances it is important that all apparatus between the guard electrode and the terminal of the current measuring instrument be guarded and adequately insulated from guard and ground. The resistance to ground of all connections and apparatus between the current measuring instrument and the guarded electrode, including the surface resistance between the guarded electrode and the guard electrode, must be high enough not to form an appreciable shunt on the current measuring instrument. This means it should be more than 100 times the input resistance of the instrument. For the most sensitive indicating amplifiers or electrometers this input resistance may be $10^{13}\ \Omega$ to $10^{14}\ \Omega$. For a galvanometer it may be only $10^{6}\ \Omega$. For a bridge it should be 100 times the value of the ratio resistance. These values include the resistance from the guarded electrode to the guard electrode when volume and surface resistances are being measured.

NOTE — The insulating supports with assembled cables should be periodically measured for leakage between the measuring electrode and ground. This may be conveniently done by temporarily disconnecting the cable shield and guard electrode from ground and measuring the current flow through the apparatus when the high voltage is connected to the measuring electrode. If the leakage resistance obtained is not beyond the range of the apparatus, the reason for the low value should be determined and corrected.

If it is necessary that one side of the specimens be grounded, then either the potential source or the current measuring instrument must be well insulated from ground. In either case the resistance to ground must be more than 100 times the resistance to be measured.

B.4.3.4 Electrification time

Unless otherwise specified, the electrification time (the elapsed time between the application of the potential and the measurement of the current or resistance) shall be 60 s.

B.4.4 Insulation resistance determination

B.4.4.1 Method

The insulation resistance shall be determined as follows. Connect the measuring leads to adjacent terminals on the specimen and measure the resistance at the specified electrification time. If needed, short the specimen for at least 2 min, reverse the polarity of the potential source and remeasure the resistance.

B.4.4.2 Measurements for insulation resistance

The following measurements shall be made when insulation resistance is to be determined:

B.4.4.2.1 Dimensions of the electrodes (figures B.1, B.2 and B.3).

B.4.4.2.2 Distance between or spacing of the electrodes.

B.4.4.2.3 The insulation resistance between the electrodes.

B.4.4.2.4 The temperature of the material under test.

B.4.4.2.5 The relative humidity of the atmosphere surrounding the material under test.

B.4.4.2.6 Voltage used in measuring.

B.4.4.3 Calculations for insulation resistance

The insulation resistance is the resistance as measured between any two adjacent binding posts of figure B.1, between any two adjacent metal strips of figure B.2, or between the tapered pins of figure B.3. This value should be expressed merely as "insulation resistance". In the case of the metal strips the surface resistance per square may be calculated by the following formula:

$$\sigma = \frac{R' l}{L}$$

where

R' is twice the surface resistance as measured;

l is the average length of the electrodes;

L is the distance between the electrodes.

B.4.5 Volume and surface resistance determination

B.4.5.1 Method

The volume resistance shall be measured using a completely guarded circuit. Electrode No. 1 shall be used as the guarded electrode and shall be connected to the current measuring instrument; electrode No. 2 shall be used as the guard electrode and shall be connected to the junction between the current-measuring instrument and the potential source, and electrode No. 3 shall be used as the unguarded electrode and shall be connected to the other terminal of the potential source. If a bridge is used, electrodes Nos. 1 and 3 shall be connected to the measuring terminals and electrode No. 2 connected to the guard terminal.

B.4.5.2 Precautions in measuring volume resistance

In measuring the volume resistance it is important that the current flow between the guarded electrode and the guard electrode shall be negligible. The current through the specimen divides between this path and that through the current-measuring instrument and only the flow through the current-measuring instrument is measured. In order that the error resulting from this source shall be less than 1 %, the insulation resistance between the guarded electrode and the guard electrode shall be more than 100 times the resistance of the current-measuring instrument. For the most sensitive indicating amplifiers a resistance of $10^{14}\ \Omega$ may be required between the guard and the guarded electrodes.

B.4.5.3 Measurements for volume resistivity

The following measurements shall be made when volume resistivity is to be determined by means of the specimens shown in figures B.4, B.5, B.6 and B.7.

B.4.5.3.1 Areas of the guarded electrodes corrected with sufficient accuracy for gap width between the guard and guarded electrodes for the following electrode systems are:

B.4.5.3.1.1 For flat circular electrodes (figures B.4 or B.5) the effective area is

$$A_{\text{effective}} = \frac{\pi}{4}(d_{\text{effective}})^2$$

$$d_{\text{effective}} = D_1 + l_g \text{ (if } l_g < 1{,}66\,\delta\text{) or}$$
$$= D_1 + 1{,}66\,\delta \text{ (if } l_g > 1{,}66\,\delta\text{)}$$

where

$A_{\text{effective}}$ is the effective area of measuring electrode No. 1;

$d_{\text{effective}}$ is the effective diameter of measuring electrode No. 1;

l_g is the gap or linear separation between measuring and guard electrodes (between Nos. 1 and 2);

δ is the thickness of the specimen;

D_1 is the outside diameter of measuring electrode No. 1.

Dimensions in inches

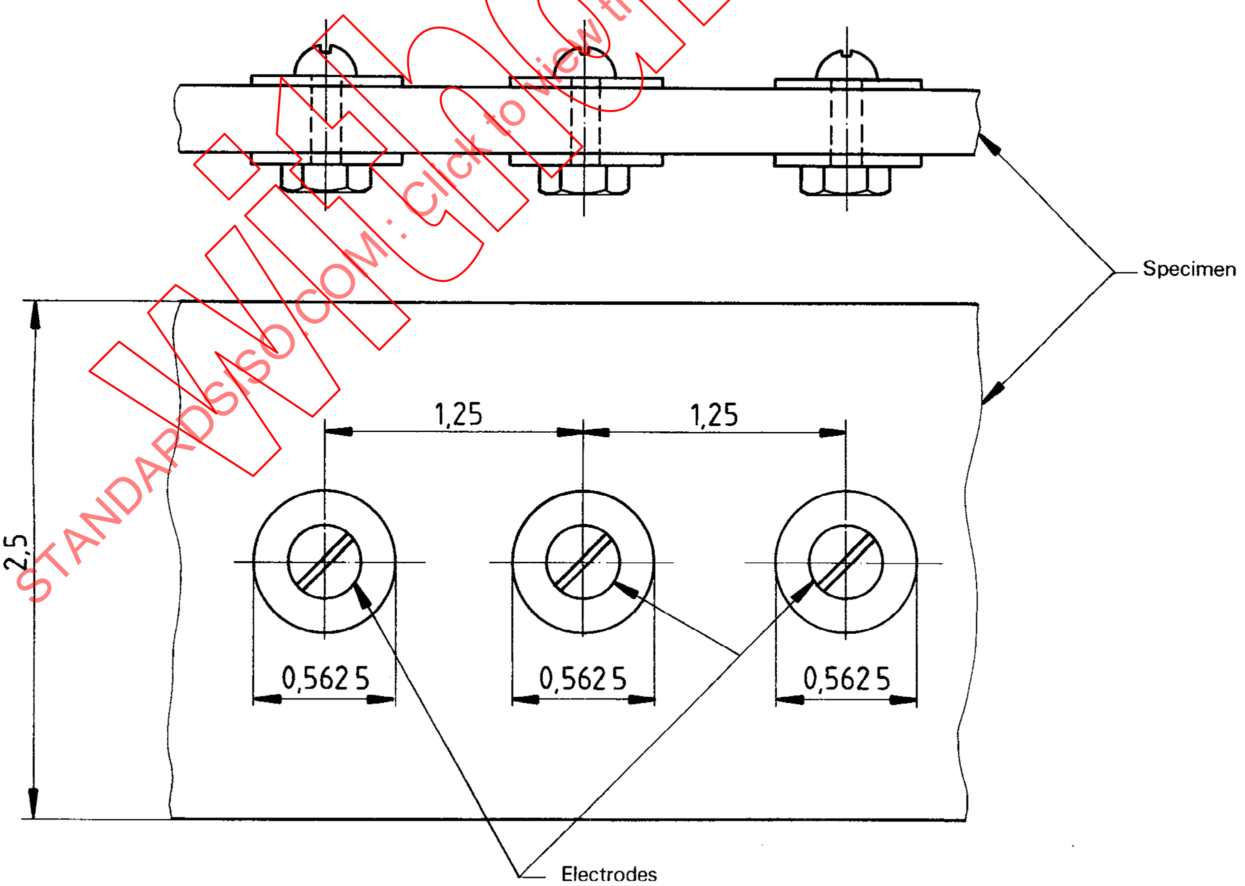


Figure B.1 — Application of binding-post electrodes to flat, solid specimens

B.4.5.3.1.2 For flat rectangular electrodes (figures B.4 or B.5) the effective area is

$$A_{\text{effective}} = (L + l_g)(b + l_g) \text{ (if } l_g \leqslant 1{,}66\,\delta\text{) or}$$
$$= (L + 1{,}66\,\delta)(b + 1{,}66\,\delta) \text{ (if } l_g > 1{,}66\,\delta\text{)}$$

where

L is the length of measuring electrode No. 1;

b is the width of measuring electrode No. 1.

B.4.5.3.1.3 For tubular electrodes (figures B.6 or B.7) the width becomes the effective circumference of the tube (figure B.6):

$$p = (L + l_g)(\pi D_0) \text{ (if } l_g \leqslant 1{,}66\,\delta\text{) or}$$
$$= (L + 1{,}66\,\delta)(\pi D_0) \text{ (if } l_g > 1{,}66\,\delta\text{)}$$

D_0 is the effective diameter of the tube,

where

$$D_0 = \frac{D_1 + D_2}{2}$$

D_1 is the average inside diameter of tube;

D_2 is the average outside diameter of tube.

B.4.5.3.2 Thickness of the specimen.

B.4.5.3.3 Conditioning treatment to which the specimen was exposed.

B.4.5.3.4 Applied voltage.

B.4.5.3.5 Volume resistance.

B.4.5.3.6 Temperature of the material under test.

B.4.5.3.7 Relative humidity of the air surrounding the material under test.

B.4.5.3.8 Volume resistivity, ϱ, which shall be calculated from the volume resistance and reported in terms of ohms centimetres as follows:

$$\varrho = \frac{A}{\delta} \times R$$

where

R is the volume resistance as measured by the instrument;

A is the effective area, calculated as shown for the electrode system;

δ is the average thickness of the specimen.

B.4.6 Surface resistance determination

B.4.6.1 Method

The surface resistance shall be measured using the completely guarded circuit. Electrode No. 1 shall be used as the guarded electrode and connected to the current measuring instrument; electrode No. 3 shall be used as the guard electrode and connected to the junction between the current measuring instrument and the potential source; electrode No. 2 shall be used as the unguarded electrode and connected to the other terminal of the potential source. If a bridge is used, electrodes Nos. 1 and 2 shall be connected to the measuring terminals and electrode No. 3 shall be connected to the guard terminal.

B.4.6.2 Precautions in measuring surface resistance

The precautions needed for measuring surface resistance are the same as for measuring volume resistance (see paragraph B.4.5.2).

B.4.6.3 Measurements for surface resistivity

The following measurements shall be made when surface resistivity is to be determined by means of the specimens shown in figures B.4, B.5, B.6 and B.7.

B.4.6.3.1 Surface resistance. The effective perimeter and gap are given with sufficient accuracy for the following electrode systems by

B.4.6.3.1.1 Flat circular electrodes (figures B.4 or B.5):

$$p = \pi D_0$$

where

p is the effective diameter of electrode system;

D_0 is the effective diameter of electrode No. 1

$$= \frac{D_1 + D_2}{2} = D_1 + l_g$$

D_1 is the outside diameter of electrode No. 1;

D_2 is the inside diameter of electrode No. 2;

l_g is the gap or linear distance between electrodes No. 1 and No. 2 (approximately twice the specimen thickness, but not exceeding 0,25 in).

B.4.6.3.1.2 Flat rectangular electrodes (figures B.4 or B.5):

$$p = 2(L + l_g) + 2(b + l_g)$$

where

L and b are the length and width, respectively, of the measuring electrode No. 1;

l_g has the same meaning as in B.4.6.3.1.1.

B.4.6.3.1.3 Tubular electrodes (figures B.6 or B.7):

$$p = 2\pi D_2$$

where

p is the gap or linear distance between electrodes No. 1 and No. 2;

D_2 is the average outside diameter of the tube.

NOTE — When the tube is tapered the perimeters shall be calculated separately for each gap and the values added to give the total perimeter p.

B.4.6.3.2 Distance between electrodes No. 1 and No. 2.

B.4.6.3.6 Average perimeter.

B.4.6.3.4 Conditioning treatment to which the specimen was exposed.

B.4.6.3.5 Temperature of the material under test.

B.4.6.3.6 Relative humidity of air surrounding the material under test.

B.4.6.3.7 Applied voltage.

B.4.6.3.8 Surface resistivity, ϱ, in ohms, which shall be calculated from the surface resistance as follows:

$$\varrho = \frac{p}{l_g} R_s$$

where

p is the effective perimeter, calculated as shown for the electrode system;

l_g is the gap;

R_s is the surface resistance as measured by the instrument.

B.5 Test report

The test report shall include the following information:

a) a reference to this Technical Report;

b) an identification of the magnetic tape tested;

c) the measured resistance, in ohms;

d) the type and dimensions of the electrodes with their spacing, if determined;

e) the volume resistivity, in ohms centimetres, if determined;

f) the surface resistivity, in ohms, if determined;

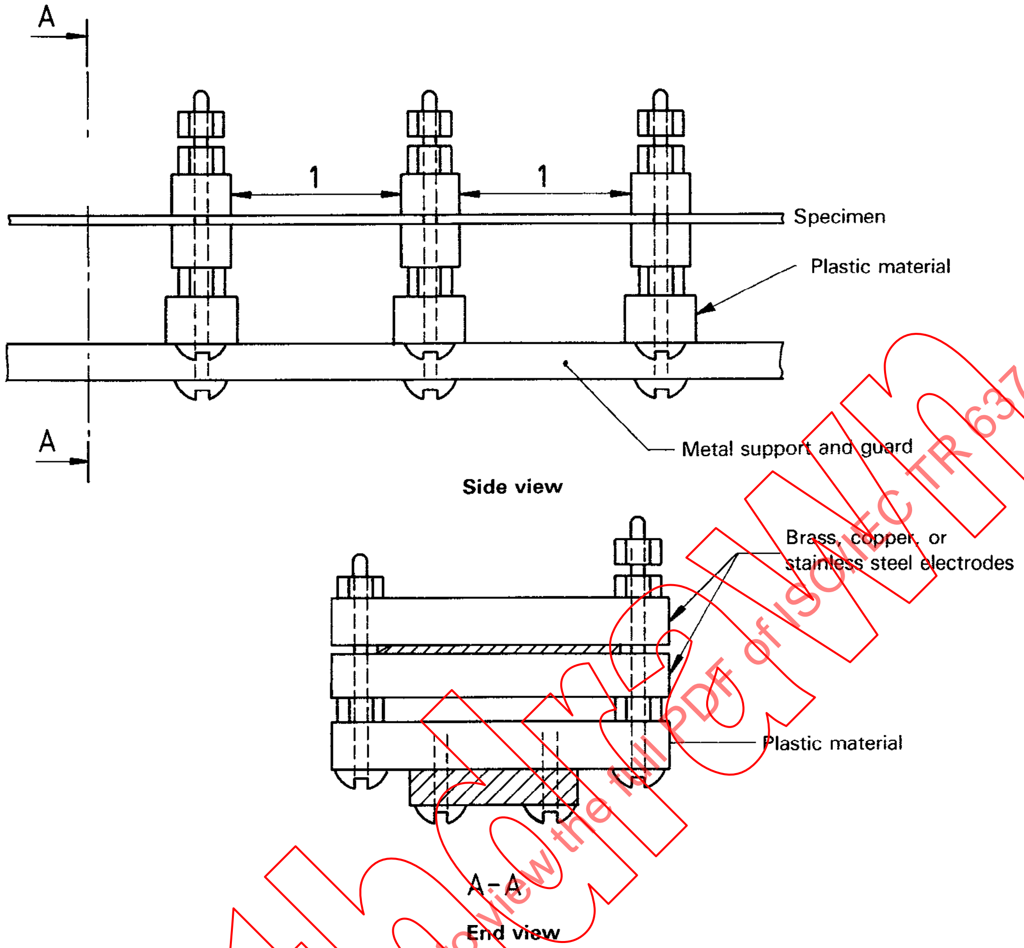
g) the duration and type of conditioning (temperature and relative humidity) to which the specimen was subjected prior to measurement;

h) the temperature of the specimen at time of test;

i) the relative humidity of the air surrounding the specimen at time of measurement;

j) the voltage used.

Dimensions in inches



NOTE — For rigid specimens, the metal support and accompanying methyl methacrylate insulators may be eliminated and the specimen supported by its leads. The bars shall have tinfoil wrapped around them and, after the bars have been clamped on to the specimen, tinfoil shall be pressed down with a thin tool along the edge of the bar to ensure intimate contact with the insulation.

Figure B.2 — Application of strip electrodes to flexible tapes and flat solid surfaces

Dimensions in inches

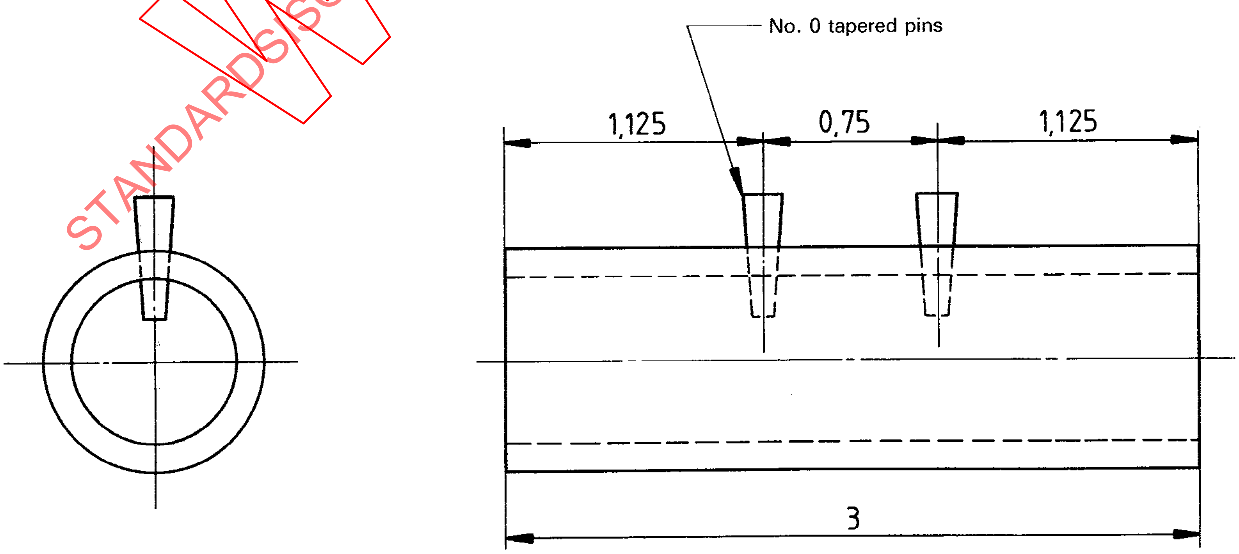


Figure B.3 — Application of tapered pin electrodes to tubular specimens

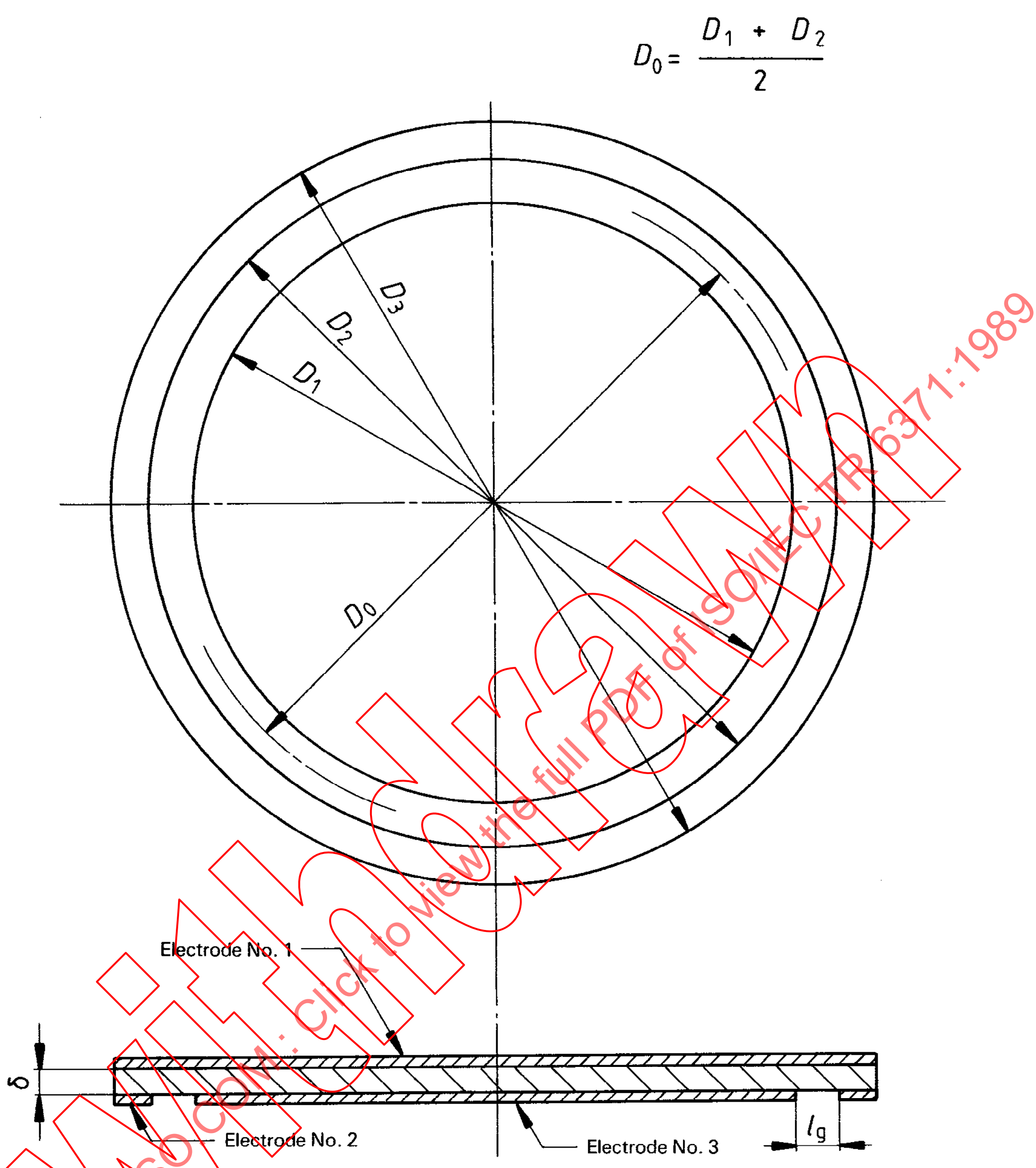


Figure B.4 — Flat specimen for measurement of volume resistance perpendicular to the specimen face and surface resistance

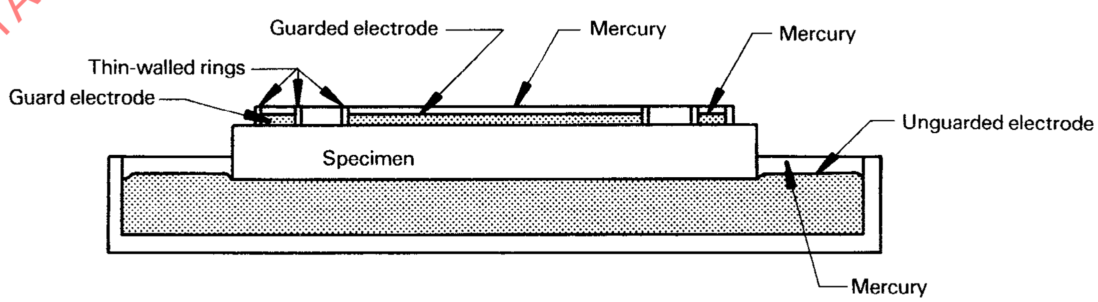


Figure B.5 — Application of mercury electrodes to flat, solid specimens

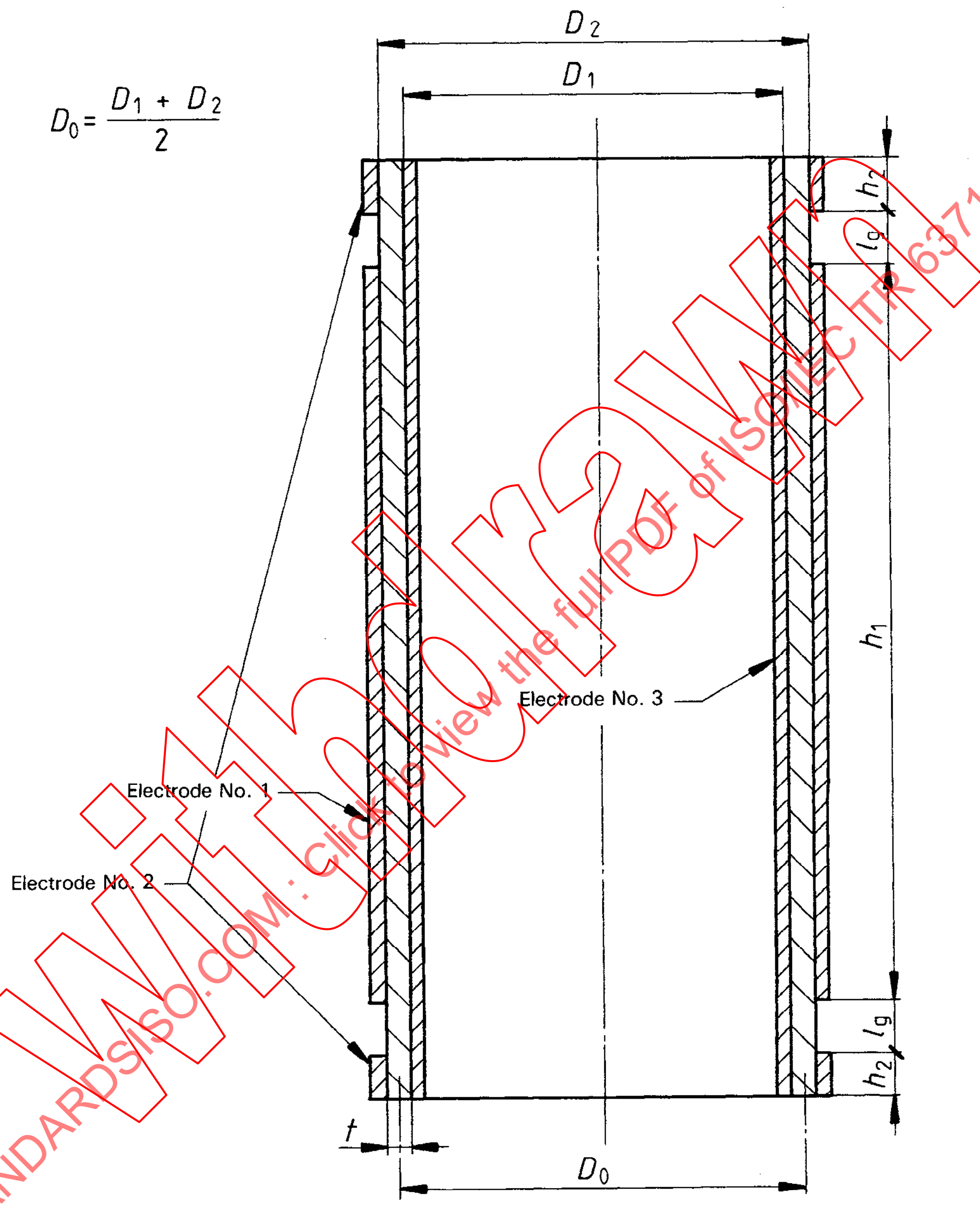


Figure B.6 — Tubular specimen for measurement of volume resistance perpendicular to the specimen wall and surface resistance