

Specification for pressure-sensitive adhesive tapes for electrical purposes

Part 2. Methods of test

The European Standard EN 60454-2 : 1995 has the status of a British Standard

Committees responsible for this British Standard

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Adhesive Tape Manufacturers' Association
ERA Technology Ltd.
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National foreword

This British Standard has been prepared by Technical Committee GEL/15 and is the English language version of EN 60454-2 *Specification for pressure-sensitive adhesive tapes for electrical purposes Part 2: Methods of test*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 454-2 : 1994, published by the International Electrotechnical Commission (IEC).

Cross-references

Publication referred to	Corresponding British Standard
HD 381 S1 1979 (IEC 589 : 1979)	BS 5591 : 1978 <i>Methods of test for determination of ionic impurities in electrical insulating materials by extraction with liquids</i>
HD 611.2 1992 (IEC 216-2 : 1990)	BS 5691 <i>Guide for the determination of thermal endurance properties of electrical insulating materials Part 2 : 1979 List of materials and available tests</i>
IEC 426 : 1973	BS 5735 : 1979 <i>Test methods for determining electrolytic corrosion with electrical insulating materials</i>
IEC 383 : 1976	BS 572 : 1985 <i>Specification for interchangeable conical ground glass joints</i>
ISO 2194 : 1991	BS 7579 : 1992 <i>Specification for designation and nominal sizes of openings for woven wire cloth, perforated plate and electroformed sheet for industrial screens</i>
ISO 3071 : 1980	BS 3266 : 1981 <i>Methods of test for determination of conductivity, pH, water-soluble matter, chloride and sulphate in aqueous extracts of textile materials</i>

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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English version

Specification for pressure-sensitive adhesive tapes for
electrical purposes
Part 2 : Methods of test
(IEC 454-2 : 1994)

Spécification pour rubans adhésifs sensibles
à la pression à usages électriques
Partie 2: Méthodes d'essai
(CEI 454-2 : 1994)

Bestimmungen für selbstklebende
Isolierbänder für elektrotechnische
Anwendungen
Teil 2: Prüfverfahren
(IEC 454-2 : 1994)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 15C(CO)345, future edition 2 of IEC 454-2, prepared by SC 15C, Specifications, of IEC TC 15, Insulating materials, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60454-2 on 1994-12-06.

The following dates were fixed

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1995-12-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1995-12-01

Annexes designated 'normative' are part of the body of the standard. In this standard, annexes A and ZA are normative. Annex ZA has been added by CENELEC.

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INTRODUCTION

This part of IEC 454 is one of a series which deals with the characteristics of pressure-sensitive adhesive tapes for electrical purposes.

The series consists of three parts:

- Part 1: General requirements (IEC 454-1).
- Part 2: Methods of test (IEC 454-2).
- Part 3: Specifications for individual materials (IEC 454-3).

SPECIFICATION FOR PRESSURE-SENSITIVE ADHESIVE TAPES FOR ELECTRICAL PURPOSES

Part 2: Methods of test

1 Scope

This part of IEC 454 specifies methods of test for pressure-sensitive adhesive tapes for electrical purposes.

2 Normative references

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this part of IEC 454. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 454 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 216-1: 1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 1: General guidelines for ageing procedures and evaluation of test results*

IEC 216-2: 1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 2: Choice of test criteria*

IEC 216-3-1: 1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 3: Instructions for calculating thermal endurance characteristics – Section 1: Calculation using mean values of normally distributed complete data*

IEC 243-1: 1988, *Methods of test for electric strength of solid insulating materials – Part 1: Tests at power frequencies*

IEC 426: 1973, *Test methods for determining electrolytic corrosion with insulating materials*

IEC 454-3: *Specifications for pressure-sensitive adhesive tapes for electrical purposes – Part 3: Specifications for individual materials*

IEC 589: 1977, *Methods of test for the determination of ionic impurities in electrical insulating materials by extraction with liquids*

ISO 383: 1976, *Laboratory glassware – Interchangeable conical ground joints*

ISO 468: 1982, *Surface roughness – Parameters, their values and general rules for specifying requirements*

ISO 683-13: 1986, *Heat-treatable steels, alloy steels and free-cutting steels – Part 13: Wrought stainless steels*

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

ISO 2194: 1991, *Industrial screens – Woven wire cloth, perforated plate and electroformed sheet – Designation and nominal sizes of openings*

ISO 3071: 1980, *Textiles – Determination of pH of the aqueous extract*

ISO 3599: 1976, *Vernier callipers reading to 0,1 and 0,05 mm*

ISO/DIS 10093: *Plastics – Fire tests – Standard ignition sources* (under consideration)

3 Conditioning and specimen preparation

Unless otherwise specified, rolls are to be conditioned for at least 24 h at $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity and all test procedures are to be carried out in this atmosphere.

Remove and discard the three outer turns before taking any test specimens from the conditioned roll. Specimen preparation shall be done with care in a clean environment. Specific specimen preparation details will be included with the appropriate test method.

Further conditioning of test specimens may be required.

4 Determination of thickness

4.1 Test apparatus

A dead-weight thickness gauge having two ground and concentric circular surfaces, flat within 0,001 mm and parallel to within 0,003 mm. The upper surface shall be 6 mm to 8 mm in diameter and the lower surface larger than the upper one. The upper surface shall move on the axis perpendicular to the two faces.

The gauge shall be graduated to read directly to 0,002 mm. The frame of the thickness gauge shall be of such rigidity that a load of 15 N applied to the gauge housing, out of contact with either the weight or the pressure foot spindle, will produce a deflection of the frame not greater than 0,002 mm (as indicated on the thickness gauge). The pressure exerted on the specimen shall be $(50 \pm 5) \text{ kPa}$.

The accuracy of the thickness gauge shall be checked frequently by means of a set of steel gauges; the measuring errors of the thickness gauge shall not exceed 0,005 mm.

4.2 Test specimens

Five specimens, at least 75 mm long, are cut from the roll at intervals not less than 300 mm. The specimen shall be allowed to relax for at least 5 min.

4.3 Procedure

Place the test specimen between the jaws of the thickness gauge in contact with the fixed foot. Take care to ensure that no air bubbles are trapped. Lower the moving pressure foot gently on to the surface of the tape and take the reading on the gauge within 2 s. Read the measurement to the nearest 0,002 mm on the thickness gauge scale.

4.4 Results

Report the central value as well as the maximum and minimum values of the five readings of thickness in millimetres.

5 Determination of width

5.1 Method A

5.1.1 Use a steel rule graduated to 0,5 mm. The total measuring error of the rule shall not exceed 0,1 mm.

5.1.2 A specimen of tape, at least 450 mm long, is removed from the roll and placed adhesive side up on a smooth flat surface. The specimen shall be allowed to relax for at least 5 min.

The width of the relaxed specimen is measured with the adhesive side down to the nearest 0,5 mm using the rule. Ten measurements shall be made, uniformly distributed along the length of the specimen. The width shall be the mean value of the ten measurements.

5.2 Method B

5.2.1 Principle

The adhesive tape roll is placed between the jaws of a pair of callipers.

The width is the perpendicular distance, expressed in millimetres, between the opposite cut edges of the test specimen of adhesive tape. This method may not be suitable for slit or rewound rolls if the turns are not exactly coincident.

5.2.2 Apparatus

Vernier callipers with a scale length not less than the roll width according to ISO 3599.

5.2.3 Test specimen

One roll of tape.

5.2.4 Conditioning

Conditioning shall conform to clause 3 with the exception that it is not necessary to remove any layers unless damaged.

5.2.5 Procedure

Hold the roll so that the cut edges are in a vertical plane. If the outer turns of the tape on the roll have crushed or damaged cut edges, these should be discarded prior to measurement.

Hold the callipers so that the scale shaft is in the horizontal plane.

Carefully close the calliper jaws so as to just touch the cut edges of the outer turns of the roll of tape, taking the following precautions:

- a) do not crush the roll edges;
- b) ensure that calliper jaws are perpendicular to cut edges.

Measure the roll width in millimetres to the nearest 0,1 mm.

Carry out two further measurements at equally spaced intervals around the circumference.

5.2.6 Results

Report the mean value as the width of tape in millimetres.

5.3 Method C

This method will only be used where a very high degree of accuracy is required.

Use a travelling microscope with a vernier control on one axis which has an accuracy of 0,001 mm. Using the specimen obtained and relaxed as in 5.1.2, measure the width to the nearest 0,01 mm, taking ten measurements. The width of the tape is taken as the mean value in millimetres.

6 Determination of roll length

6.1 Principle

The length can be calculated from a measurement of the number of turns of tape on the reel and a measurement of the outer circumference of the tape and the outer circumference of the core. Alternatively, length can be measured directly by using a length sensor that includes a rotating wheel that revolves on the roll of tape as it is being unwound.

For non-extensible tapes the length measured by these methods will be the same as the length after unrolling.

For extensible tapes the length after unrolling will be greater if the tape is stretched irreversibly by unrolling.

6.2 Method A – Measurement of turns method

6.2.1 Apparatus (see figure 1)

- a) A measuring device capable of counting both whole revolutions and part revolutions, continuously driven by a spindle. The spindle has a suitable locking device by means of which a conical shaft can be quickly fitted to suit the internal diameters of cores for the rolls of tape. (For example, for a nominal 25 mm internal diameter core the conical shaft will give a 24,5 mm diameter to 26,5 mm diameter over a shaft length of 50 mm. Alternative size conical shafts would be needed for tapes on a core with significantly different nominal diameters, such as 76 mm.)
- b) Measuring tape. A narrow, flexible, steel tape (6 mm or narrower) calibrated in millimetres.

6.2.2 Test specimen

One roll of tape.

6.2.3 Procedure

Measure the circumference of the roll C_r in millimetres by means of a steel tape. Apply the tape to the roll like a belt.

Mount the roll on the conical shaft of the counter. Set the counter to zero and pull the tape from the roll in a direction perpendicular to the spindle. Remove all the tape from the core and record the number of revolutions (to the nearest tenth of a revolution) as read from the counter when the last turn of tape has left the core: N turns.

Measure the circumference of the core: C_o mm.

6.2.4 Results

Calculate the length (L) of the tape as follows:

$$L \text{ (metres)} = N \frac{C_r + C_o}{2\,000}$$

If the length of tape in contact with the core is not to be included in the total length, then:

$$L \text{ (metres)} = N \frac{C_r + C_o}{2\,000} - C_o$$

6.3 Method B – length sensor method

6.3.1 Apparatus (see figure 2)

A measuring device capable of measuring the length of a roll of tape in metres by using a calibrated rotating wheel which rolls, with low torque and contact pressure, against the circumference of the tape as it unwinds. The apparatus includes a spindle for mounting the tape, a length sensor, a read-out system and a rotating wind-up roll that can be used to unwind, either manually or automatically, the roll of tape.

6.3.2 *Test specimen*

One roll of tape.

6.3.3 *Procedure*

Mount the roll on the shaft adjacent to the sensor. Position the roll and length sensor so that the sensor is in contact with the circumference of roll and the leading end of the roll is directly under the sensor. Set the sensor to zero and manually pull the leading edge of the tape and fix it to the wind-up roll. At the start of unwinding, ensure that the length sensor maintains good contact with the roll and does not slip or bind. On completion of unwinding, take the reading of the length sensor.

6.3.4 *Results*

Report the length in metres as recorded on the read-out.

7 **Corrosion-related properties**

The requirements for individual products are given in IEC 454-3. The test methods will be selected from those given in this part. When electrolytic corrosion is of significance, i.e. when fine wire of approximately 1 mm diameter or finer is used, the determination is carried out according to IEC 426.

Where required by IEC 454-3 the test methods for the determination of conductivity, pH and corrosive sulphur shall be used.

7.1 *Preparation of water extract for pH and conductivity determinations*

7.1.1 *Precautions*

Avoid contamination of the material during storage, sampling, preparation of test pieces and testing.

Ensure that the sample roll and the material taken therefrom are not contaminated by the atmosphere, particularly the atmosphere of a chemical laboratory, or by contact with bare hands, and that the implements used for cutting or handling the test piece are chemically clean.

7.1.2 *Test pieces*

Cut strips of tape, each approximately 25 mm × 6 mm, from the sample roll.

If a strip is folded, it shall be folded adhesive surface outwards.

7.1.3 *Method*

Use water having a conductivity not greater than 0,2 mS/m. Make a blank test of the extraction vessel before each extraction, and if the resultant conductivity exceeds 0,2 mS/m repeat the test with the same extraction vessel. Change the vessel if the second result also exceeds this value.

Prepare the extract by putting a ratio of 1 g of tape to 100 ml of water into a borosilicate glass (high chemical resistance glass) or quartz flask fitted with a reflux condenser of the same quality glass or quartz. Use an apparatus with interchangeable conical ground-glass joints complying with the requirements of ISO 383.

Boil the water gently for 60 min, except in the case of cellulose acetate film tape for which the period should be 10 min, taking care that the material is not charred. Allow it to cool as rapidly as possible, taking precautions against admission of carbon dioxide (e.g. CO₂ trap).

7.1.4 *Quantity*

Sufficient quantity of extracts should be prepared so that pH and conductivity are measured on separate portions of the extracts.

7.2 *Determination of pH value of water extract*

Determine the pH value at a temperature of (23 ± 2) °C according to 7.2.2 of ISO 3071.

7.3 *Determination of conductivity of water extract*

7.3.1 *Apparatus*

The following apparatus is required.

7.3.1.1 A suitable conductivity cell which may consist of two inert electrodes, e.g., platinized platinum maintained at a fixed distance apart and adequately insulated from each other.

7.3.1.2 A measuring instrument capable of measuring conductance or admittance with an accuracy of 5 % and a minimum reading of 1 μS in the frequency range 50 Hz to 3 000 Hz at a voltage not exceeding 100 V; alternatively, resistance may be measured to the same accuracy.

NOTES

- 1 It is important that any insulation immersed in the test liquid should not be water absorbent or subject to contamination by aqueous electrolytes.
- 2 The conductivity cell should be easy to clean and free from recesses where impurities can be retained.
- 3 Care should be taken to ensure that the electrodes do not become polarized.
- 4 Platinized platinum electrodes are platinum coated with platinum black.

7.3.2 *Determination of electrical conductivity*

Determination of the conductivity cell constant. If not known, determine the conductivity cell constant K (m⁻¹) using the method specified in IEC 589.