IEC 60454-2

Edition 3.0 2007-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Pressure-sensitive adhesive tapes for electrical purposes –
Part 2: Methods of test

Rubans adhésifs sensibles à la pression à usages électriques –
Partie 2: Méthodes d'essai

IEC 60454-2:2007

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX X

ICS 17.220.99; 29.035.20

ISBN 978-2-88910-195-5

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRESSURE-SENSITIVE ADHESIVE TAPES FOR ELECTRICAL PURPOSES –

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60454-2 has been prepared by IEC technical committee 15: Solid electrical insulating materials.

This third edition cancels and replaces the second edition published in 1994, and constitutes a technical revision. This revision includes improved text regarding the flame test (Clause 20), the improved text on adhesion (Clause 11) and a new Figures 9a and 9b.

This bilingual version, published in 2010-01, corresponds to the English version.

The text of this standard is based on the following documents:

FDIS	Report on voting
15/377/FDIS	15/387/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 60454 series, under the general title *Pressure-sensitive adhesive tapes for electrical purposes*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

PRESSURE-SENSITIVE ADHESIVE TAPES FOR ELECTRICAL PURPOSES –

Part 2: Methods of test

1 Scope

This part of IEC 60454 specifies methods of test for pressure-sensitive adhesive tapes for electrical purposes.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60216-1:2001, *Electrical insulating materials – Properties of thermal endurance – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2:2005, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60216-3:2006, *Electrical insulating materials – Thermal endurance properties – Part 3: Instructions for calculating thermal endurance characteristics*

IEC 60243-1:1998, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60426:1973, *Test methods for determining electrolytic corrosion with insulating materials*

IEC 60454-3 (all parts), *Pressure-sensitive adhesive tapes for electrical purposes – Part 3: Specifications for individual materials*

IEC 60589:1977, *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 527-3:1995, *Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets*

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

ISO 3071:2005, *Textiles – Determination of pH of the aqueous extract*

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

ISO 10093:1998, *Plastics – Fire tests – Standard ignition sources*

EN 1939:2003, *Self-adhesive tapes – Determination of peel adhesion properties* (The peel adhesion test method of Clause 11 is based on test method A of EN 1939:2003. This standard is the result of the harmonisation of AFERA 5001 and PSTC-1,2,3 and 4, ASTM 3330/D, ASTM 3330/M and agreed by JATMA.)

NOTE EN: European Norm (Europe) – AFERA: Association des fabricants européens de rubans auto-adhésifs – PSTC: Pressure sensitive tape council (USA) – ASTM: American society for testing and materials (USA) – JATMA: Japanese adhesive tapes manufacturers association.

3 Conditioning and specimen preparation

Unless otherwise specified, rolls are to be conditioned for at least 24 h at (23 ± 2) °C and (50 ± 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 ± 5) 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 calipers.

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 calipers 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 calipers so that the scale shaft is in the horizontal plane.

Carefully close the caliper 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 milimetres.

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 milimetres.

6.2.2 Test specimen

One roll of tape.

6.2.3 Procedure

Measure the circumference of the roll C_r in milimetres 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

$$L\,(\text{metres}) = \text{N}\,\frac{C_r + C_o}{2\,000} - \frac{C_o}{1\,000}$$

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

7.1 General

The requirements for individual products are given in IEC 60454-3. The test methods will be selected from those given in this part. When electrolytic corrosion is of significance, i.e. when fine wire approximately 1 mm in diameter or finer is used, the determination is carried out according to IEC 60426.

Where required by IEC 60454-3, the test methods for the determination of conductivity, pH and corrosive sulphur shall be used.

7.2 Preparation of water extract for pH and conductivity determinations

7.2.1 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.

7.2.2 Test piece

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.

7.2.3 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. CO_2 trap).

7.2.4 Quantity

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

7.3 Determination of pH value of water extract

Determine the pH value at a temperature of (23 ± 2) °C according to 8.2 of ISO 3071.

7.4 Determination of conductivity of water extract

7.4.1 Apparatus

The following apparatus is required.

7.4.1.1 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.

7.4.1.2 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.

NOTE 1 It is important that any insulation immersed in the test liquid should not be water absorbent or subject to contamination by aqueous electrolytes.

NOTE 2 The conductivity cell should be easy to clean and free from recesses where impurities can be retained.

NOTE 3 Care should be taken to ensure that the electrodes do not become polarized.

NOTE 4 Platinized platinum electrodes are platinum-coated with platinum black.

7.4.2 Determination of electrical conductivity

7.4.2.1 General

Determination of the conductivity cell constant. If not known, determine the conductivity cell constant K (m^{-1}) using the method specified in IEC 60589.

NOTE For test apparatus, where the cell constant is calibrated into the apparatus electronics, this step is not necessary.

7.4.2.2 Determination of the conductivity of the blank

After thoroughly cleaning the conductivity cell with water as specified in 7.2.3, fill it with water obtained as a result of the blank extraction test, and measure its conductivity G_1 in mS/m at (23 ± 2) °C. The conductivity of the blank in mS/m is then KG_1.

7.4.2.3 Determination of the conductivity of the water extract

Thoroughly rinse the conductivity cell with the extract to be tested, and then fill with the extract. Adjust the temperature to (23 ± 2) °C, maintain for 15 min and then measure the conductivity G_2 in mS/m at that temperature.

The conductivity of the water extract in mS/m is then calculated as $K(G_2 - G_1)$.

NOTE For most purposes, where it is not convenient to test the water extract at (23 ± 2) °C, it is sufficiently accurate to apply the following correction:

$$\text{Conductivity at 23 °C} = \frac{G}{1 + 0{,}02\ (t - 23)}$$

where G is the conductivity obtained when the measurement is made at t °C.

7.4.3 Results

Express the conductivity in mS/m at a temperature of 23 °C.

7.5 Detection of corrosive sulfur

7.5.1 Test specimens

Cut two test specimens, each 100 mm long, from the sample roll.

7.5.2 Apparatus

Three smooth copper rods are required, each approximately 6 mm in diameter and 75 mm long, cleaned and polished with water and silicon carbide powder size 90 µm to 125 µm and wiped clean and dried with cotton wool or filter paper. Finally the rods are washed with a volatile sulfur-free solvent, such as diethyl ether, and allowed to dry.

7.5.3 Method

Handle the copper rods with clean, dry metal forceps. Wind two of the copper rods centrally with approximately 100 mm of tape so that succeeding layers are superimposed one on another. Leave at least 12 mm at each end of the copper rods clear of tape.

NOTE Tapes above 50 mm in width should be slit to allow the copper rods to be bare at each end for the required 12 mm.

Apply the tape to the first rod, adhesive side downwards in contact with the copper, and to the second rod, adhesive side upwards with the tape backing in contact with the copper. Leave the third rod bare to act as a control.

Place each rod in a separate glass-stoppered, chemically cleaned glass tube and maintain them at a temperature of (100 ± 2) °C for 16 h. Take the rods out of the tubes after they have cooled to room temperature.

Remove the tapes, together with any exudations that may have occurred, from the rods. Removal of exudation may be assisted by the use of a solvent but no mechanical abrasive aids shall be employed.