
**Rubber and plastics hoses and hose
assemblies — Determination of electrical
resistance and conductivity**

*Tuyaux et flexibles en caoutchouc et en plastique — Détermination de
la résistance et de la conductivité électriques*

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 8031 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Hoses (rubber and plastics)*.

This third edition cancels and replaces the second edition (ISO 8031:1993), which has been technically revised (for details, see the Introduction).

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Introduction

This edition of ISO 8031 addresses the problems encountered in field testing and during product acceptance tests in a production facility in following the test procedures specified in the previous edition (ISO 8031:1993) and a more practical approach is suggested. Also, a test procedure for determining electrical continuity between the end fittings of a hose assembly without actually measuring the resistance has been introduced. This test is frequently carried out in the field and in the factory when the product standard does not require the exact electrical resistance to be measured, but only requires verification of electric conductivity between both metal end fittings.

Special test methods to determine the electrical resistance through the hose wall (now required in some product standards for hoses used in explosive atmospheres) have been added.

Some test methods which have been standard practice in the hose industry for some time have now been included, as have several new methods to determine the ability of a hose assembly (with metal end fittings) to dissipate static electric charges when the metal end fitting is connected to earth. A total of four new explanatory sketches are included. The hose and hose assembly product standard applicable will have to specify which method is most suitable for the purpose of verification of the required property.

Annex A, an amended version of informative Annex A, "Recommended terminology and limits for electrical resistance", in ISO 8330:2007, has been included.

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Rubber and plastics hoses and hose assemblies — Determination of electrical resistance and conductivity

1 Scope

This International Standard specifies electrical test methods for rubber and plastics hoses, tubing and hose assemblies to determine the resistance of conductive, antistatic and non-conductive hoses and the electrical continuity or discontinuity between metal end fittings.

NOTE All the test methods described for rubber hoses in this International Standard can also be applied to plastics hoses.

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.

ISO 2878, *Rubber — Antistatic and conductive products — Determination of electrical resistance*

ISO 8330, *Rubber and plastics hoses and hose assemblies — Vocabulary*
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ISO 23529, *Rubber — General procedure for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8330 apply.

4 Measurement of resistance of conductive, antistatic and non-conductive hoses

4.1 General

Rubber hoses may have a conducting lining only or a conducting cover only, or may be manufactured from conducting rubber compounds throughout. A method of test is specified for each of the three possible types of construction.

4.2 Apparatus

The following apparatus is required and shall be basically as described in ISO 2878.

4.2.1 Test instruments

4.2.1.1 To determine the resistance of conductive, antistatic and non-conductive hose¹⁾, the test should preferably be made with an instrument specifically designed for measuring insulation resistance, having a nominal open-circuit voltage of 500 V d.c., or with any other instrument known to give comparable results. The instrument shall be sufficiently accurate to determine the resistance to within $\pm 10\%$ unless specified otherwise. During the test, not more than 3 W shall be dissipated in the specimen, to prevent erroneous results due to effects of temperature. The power dissipated shall be determined by the square of the open-circuit voltage divided by the measured resistance.

The resistance values obtained will vary with the applied voltage, and errors may occur when low test voltages are involved. In cases of dispute, the voltage applied to the test piece shall be not less than 40 V, except where this conflicts with the requirement not to dissipate more than 3 W in the test piece.

4.2.1.2 For tests requiring the measurement of the electrical continuity between end fittings or through continuous internal or external bonded wires, the instrument used shall be an ohmmeter sufficiently accurate to determine the resistance to within $\pm 10\%$.

4.2.1.3 For tests where, according to the product standard, determination of the electrical continuity between the end fittings of a hose assembly is required, without measurement of the actual electrical resistance, a 4,5 V battery in combination with a 4 V (0,3 A) test lamp can be used.

4.2.1.4 For determination of the electrical resistance through the hose wall (required by some hose product standards for hoses used in explosive atmospheres), the instrument used shall be an ohmmeter with a capacity of $10^{12} \Omega$ and the measurement shall be made at 500 V d.c. The instrument shall be sufficiently accurate to determine the resistance between the lining and the cover as measured through the hose wall to within $\pm 5\%$.

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4.2.2 Electrodes and contacts

4.2.2.1 General

For tests conducted in a laboratory, the equipment described below shall be used. For field tests, and for routine tests and product acceptance tests in a manufacturer's plant, this equipment is not practical, and alternatives may be used as described in 4.6.1, 4.7.1.2 and 4.7.2.3.

Electrodes shall be formed on the surface as bands (25_{-1}^{+2}) mm wide around the circumference by means of a conductive silver lacquer, colloidal graphite or a conductive liquid.

When a conductive liquid is used, the electrode contact area shall be completely wetted and shall remain so until the end of the test. Unless otherwise specified, the conductive liquid shall consist of

- 800 parts by mass of anhydrous poly(ethylene glycol) of relative molecular mass 600;
- 200 parts by mass of water;
- 1 part by mass of wetting agent;
- 10 parts by mass of potassium chloride.

1) See ISO 8330 and Annex A of this International Standard for details of construction.

When a conductive silver lacquer or colloidal graphite is used, the surface resistance between any two points on a sample of the dried film shall not exceed 100 Ω .

Clean metal contacts shall be applied to the electrodes so that the contact area is approximately the same size as, but no greater than, the electrodes, except where otherwise stated.

In the case of hoses of less than 50 mm bore, it is difficult to apply the conducting liquid accurately to the hose bore, and it is preferable to use a brass plug of external diameter equal to or greater than the hose internal diameter (ID), coated with conducting liquid and then pushed 25 mm into the hose.

4.2.2.2 Special electrodes and contacts

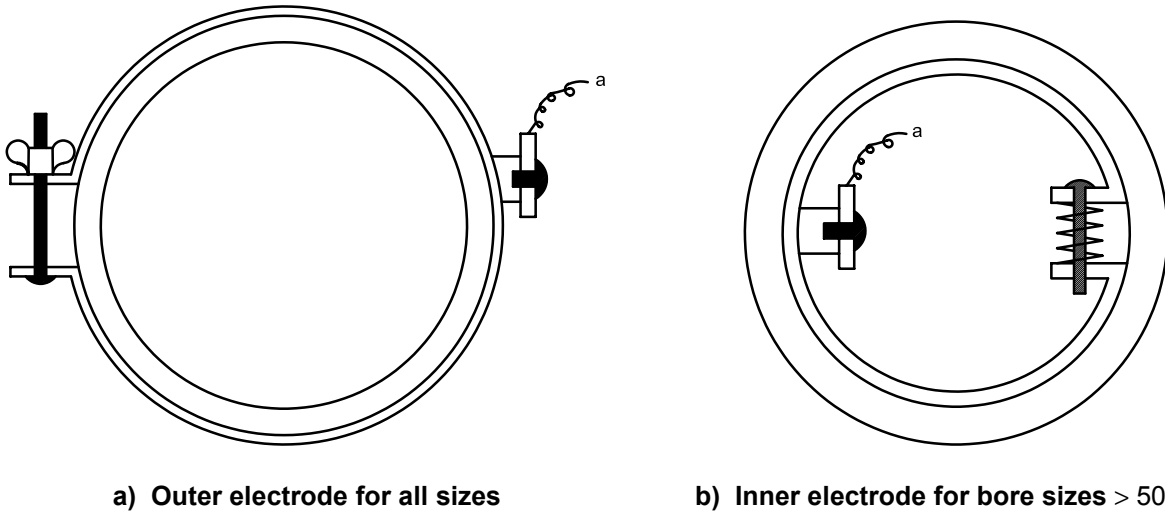
The following special electrodes and contacts shall be used for the determination of the electrical resistance through the hose wall, and other test methods:

- a) Outer electrode: a copper sheet-metal band, of standard width 25 mm, clamped around the outer hose wall (see Figure 1).
- b) Inner electrode:
 - 1) For hoses of less than 50 mm bore size, it is recommended that a tight-fitting brass plug (solid for small bore sizes and hollow for larger sizes), of minimum length $2 \times$ the pitch of the helical wire(s) (for hoses incorporating helical wires) or $0,5 \times$ ID (for hoses without helical wires), be used.
 - 2) For hoses of more than 50 mm bore size, it is recommended that an adjustable copper sheet-metal band, tightly fitting the bore of the hose (expanded against the lining by spring action), of minimum width 25 mm, be used.
- c) Contacts for connecting the electrodes to the ohmmeter should preferably be soldered or brazed to the electrodes to minimize resistance between ohmmeter and electrode (see Figure 1).
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- d) Alternative to b): a 25-mm-wide conducting foam plug completely wetted with a suitable conductive liquid (see 4.2.2.1) of outside diameter slightly larger than the inside diameter of the hose to ensure a snug fit with good electric contact with the hose lining and connected to a suitable insulated conductor (see Figure 3, items 1 and 3). This electrode is recommended for use with hoses with corrugated linings or linings which are less flexible than rubber (i.e. PTFE).
- e) In order to establish good electrical contact with the cover of a corrugated hose, it is recommended that a conducting foam strip 25 mm wide, completely wetted in suitable conductive liquid (see 4.2.2.1), be placed round the full outside circumference of the hose, underneath the electrode described in item a) above.

4.3 Preparation and cleaning for the test

The surfaces of the hose or test piece shall be clean. If necessary, they may be cleaned by rubbing with fuller's earth (magnesium aluminium silicate) and water, washing with distilled water and allowing to dry. Do not use organic materials which attack the rubber or cause it to swell, and do not buff or abrade the test surfaces.

The surface of the hose shall not become deformed either during the application of the contacts or during the test. When using test pieces, the supports shall be outside the test length. When testing a long length of hose, the hose shall be uncoiled and laid straight on polyethylene or another insulating material. Care shall be taken to ensure that the hose is insulated from any leakage path along the length of hose.



a) Outer electrode for all sizes

b) Inner electrode for bore sizes > 50 mm

^a To ohmmeter.

Figure 1 — Examples of inner and outer electrodes as described in 4.2.2.2

4.4 Conditioning

Normally, the articles shall be conditioned for at least 16 h under one of the following sets of standard conditions:

(23 ± 2) °C and (50 ± 5) % relative humidity;

(27 ± 2) °C and (65 ± 5) % relative humidity.

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However, where very long lengths of hose are being tested, it is permissible, by agreement between supplier and customer, to use the conditions prevailing in the factory, warehouse or laboratory, provided that the relative humidity is not greater than 70 %. For testing in the field and for routine and product acceptance tests in a manufacturer's factory of short lengths of hose and hose assemblies, this applies as well.

4.5 Procedure for hoses with conducting lining (on full hose length)

Apply suitable electrodes as specified in 4.2.2 on the inside surface at each end of the hose. The edge of the electrode band shall be coincident with the end of the hose. When using a conductive liquid, care shall be taken to avoid creating a leakage path between the lining and the reinforcement or cover of the hose.

Apply the metal contacts to the electrodes.

Apply the test voltage and measure the resistance (5 ± 1) s after the application of the voltage.

For field tests and routine and product acceptance tests in the factory, the equipment specified in 4.2.2.1 is too complicated and impractical. Instead, clean copper or brass contacts at least 100 mm² in area, shaped to fit the inside surface of the hose lining and held in position manually, can be used. Alternatively, suitable electrodes as described in 4.2.2.2 can be used.

4.6 Procedure for hoses with conducting cover

4.6.1 Method for full hose lengths

Apply electrodes as specified in 4.2.2.1 on the outside surface at each end of the hose.

Apply the metal contacts.

Apply the test voltage and measure the resistance (5 ± 1) s after the application of the voltage.

For field tests and routine and product acceptance tests in the factory, the equipment specified in 4.2.2.1 is too complicated and impractical. Instead, clean copper or brass contacts at least 100 mm^2 in area, shaped to fit the outside surface of the hose cover and held in position manually, can be used. Alternatively, suitable electrodes as described in 4.2.2.2 can be used.

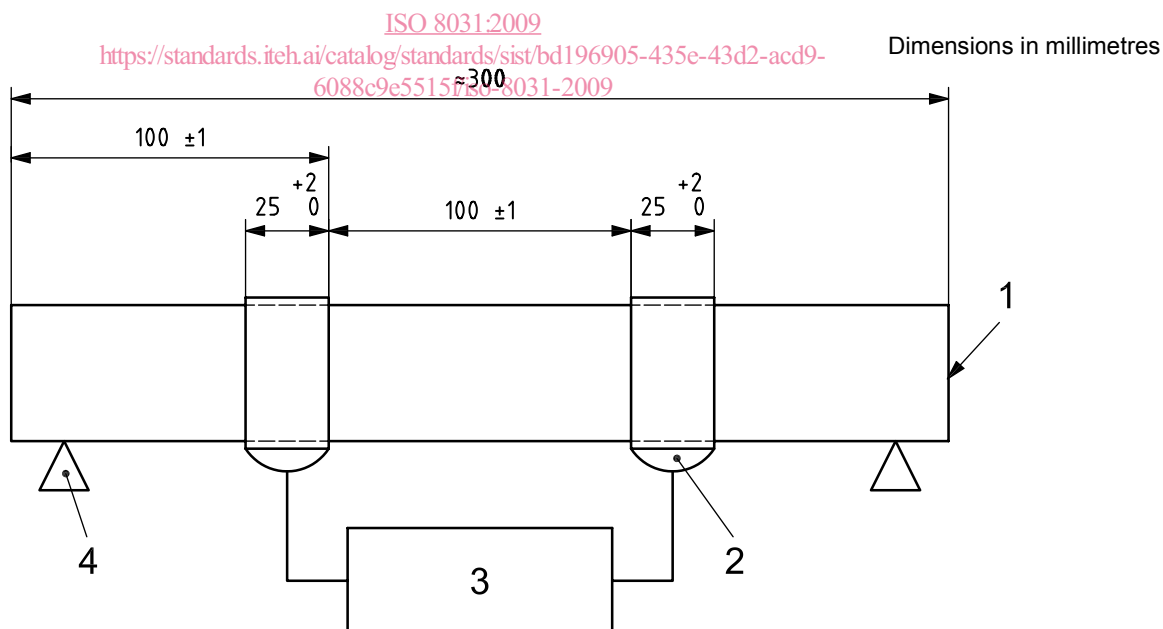
4.6.2 Method for test pieces as tested in the laboratory

4.6.2.1 Test pieces

Prepare the test pieces by cutting five lengths of hose approximately 300 mm long from samples taken at random from a production run. Condition the test pieces in accordance with 4.4.

Position electrodes as specified in 4.2.2.1 symmetrically along the test piece so that the distance between their nearest edges is (100 ± 1) mm (see Figure 2).

Ensure that contact is maintained with the electrodes around the circumference and that the contact pieces are sufficiently long for the two free ends to be held securely by a tensioning clip (see Figure 2) such that the fit of the electrodes is as tight as possible, consistent with the means employed.



Key

- 1 test piece
- 2 metallic foil contact pieces wrapped around conducting electrodes and held by clips
- 3 500 V d.c. insulation tester
- 4 insulated support or clamp

Figure 2 — Electrodes and contacts for testing as described in 4.6.2.1