IEC 60079-32-2

Edition 1.0 2015-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Explosive atmospheres –
Part 32-2: Electrostatics hazards – Tests

Atmosphères explosives –
Partie 32-2: Dangers électrostatiques – Essais

IEC 60079-32-2:2015-02(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 60079-32-2 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

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

FDIS	Report on voting
31/1164/FDIS	31/1176/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.

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

A list of all parts of the IEC 60079 series, under the general title *Explosive atmospheres*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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- withdrawn,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.

EXPLOSIVE ATMOSPHERES –

Part 32-2: Electrostatics hazards – Tests

1 Scope

This part of IEC 60079 describes test methods concerning the equipment, product and process properties necessary to avoid ignition and electrostatic shock hazards arising from static electricity. It is intended for use in a risk assessment of electrostatic hazards or for the preparation of product family or dedicated product standards for electrical or non-electrical machines or equipment.

The purpose of this part of IEC 60079 is to provide standard test methods used for the control of static electricity, such as surface resistance, earth leakage resistance, powder resistivity, liquid conductivity, capacitance and evaluation of the incendivity of provoked discharges. It is especially intended for use with existing standards of the IEC 60079 series.

NOTE IEC TS 60079-32-1, *Explosive atmospheres – Part 32-1: Electrostatic hazards, guidance*, was published in 2013. This international standard is not intended to supersede standards that cover specific products and industrial situations.

This part of IEC 60079 presents the latest state of knowledge which may, however, slightly differ from requirements in other standards, especially concerning test climates. When a requirement of this standard conflicts with a requirement specified in IEC 60079-0, to avoid the possibility of re-testing previously approved equipment, the requirement in IEC 60079-0 applies only for equipment within the scope of IEC 60079-0. In all other cases, the statements in this part of IEC 60079 apply.

2 Normative references

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

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC TS 60079-32-1, *Explosive atmospheres – Part 32-1: Electrostatic hazards, guidance*

IEC 60093, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*

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

IEC 60243-2, *Electric strength of insulating materials – Test methods – Part 2: Additional requirements for tests using direct voltage*

IEC 60247, *Insulating liquids – Measurement of relative permittivity, dielectric dissipation factor (tan d) and d.c. resistivity*

IEC TS 61241-2-2, *Electrical apparatus for use in the presence of combustible dust – Part 2: Test methods – Section 2: Method for determining the electrical resistivity of dust in layers*

IEC 61340-2-1, *Electrostatics – Part 2-1: Measurement methods – Ability of materials and products to dissipate static electric charge*

IEC 61340-2-3, *Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid planar materials used to avoid electrostatic charge accumulation*

IEC 61340-4-4, *Electrostatics – Part 4-4: Standard test methods for specific applications – Electrostatic classification of flexible intermediate bulk containers (FIBC)*

ISO 14309, *Rubber, vulcanized or thermoplastic – Determination of volume and/or surface resistivity*

ASTM E582, *Standard test method for minimum ignition energy and quenching distance in gaseous mixtures*

EN 1081, *Resilient floor coverings – Determination of the electrical resistance*

EN 1149-3, *Protective clothing – Electrostatic properties Part 3: Test methods for measurement of charge decay.*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
conductive
having a resistivity or resistance below the dissipative range (see 3.4) allowing stray current arcs and electric shocks to occur

Note 1 to entry: Conductive materials or objects are neither dissipative nor insulating and are incapable of retaining a significant electrostatic charge when in contact with earth.

Note 2 to entry: Boundary limits are given in IEC TS 60079-32-1 for the conductive range for solid materials, enclosures, some objects and bulk materials.

Note 3 to entry: Product standards and other standards covering electrostatic properties often include specific definitions of "conductive" which apply only to items covered by those standards and may be different from the definitions given here. See e.g. ISO 8031 and ISO 8330 for hose assemblies, ISO 284 for belts and EN 1149-1, -2, -3 and -5 for protective clothing.

3.2
conductivity (electrical conductivity)
reciprocal of volume resistivity, expressed in siemens per metre (see 3.14)

3.3
conductor
conductive object

3.4
dissipative (electrostatic dissipative)
having an intermediate resistivity or resistance that lies between the conductive and insulating ranges (see 3.1 and 3.7)

Note 1 to entry: Dissipative materials or objects are neither conductive nor insulating but, like conductive items, safely limit contact charging and/or dissipate even the maximum charging currents associated with their designed application when in contact with earth

Note 2 to entry: Boundary limits are given in IEC TS 60079-32-1 for the dissipative range for solid materials, enclosures, some objects and bulk materials.

Note 3 to entry: Product standards often include specific definitions of "dissipative" which apply only to items covered by those standards and may be different to the definitions given here. See 3.1, Note 3 to entry.

3.5
enclosure
walls, doors, covers, cable glands, rods, spindles, shafts, coatings, etc. which surround and enclose equipment

Note 1 to entry: For electrical equipment, the enclosure is likely to be identical to the enclosure defined in IEC 60079-0.

Note 2 to entry: Flexible Intermediate Bulk Containers (FIBC) and other similar containers are not equipment enclosures and, therefore, are considered separately in IEC TS 60079-32-1.

3.6
hazardous area
area in which flammable or explosive gas/vapour-air or dust-air mixtures are, or can be, present in such quantities as to require special precautions against ignition

Note 1 to entry: See IEC 60079-10-1 and IEC 60079-10-2.

3.7
insulating
having a resistivity or resistance that is higher than the dissipative range (see 3.4)

Note 1 to entry: Insulating materials or objects are neither conductive nor dissipative. Electrostatic charges can accumulate on them and do not readily dissipate even when they are in contact with earth.

Note 2 to entry: Boundary limits are given in IEC TS 60079-32-1 for the insulating range for solid materials, enclosures, some objects and bulk materials. For certain items, special definitions are maintained in other standards.

Note 3 to entry: Product standards and other standards covering electrostatic properties often include specific definitions of "insulating" which apply only to items covered by those standards and may be different to the definitions given here. See 3.1, Note 3 to entry.

Note 4 to entry: The adjective "non-conductive" has often been used as a synonym for insulating. It is avoided in this document as it could be taken to mean either "insulating" or "insulating or dissipative" and this may lead to confusion.

3.8
isolated conductor
conductive object which can accumulate charge due to an earth leakage resistance exceeding the values given in IEC TS 60079-32-1

3.9
leakage resistance (resistance to earth)
resistance expressed in ohms between an electrode in contact with the surface to be measured and earth

Note 1 to entry: The leakage resistance depends upon the volume and/or surface resistivity of the materials and the distance between the chosen point of measurement and earth.

3.10
resistance
quotient of voltage and current flowing through a sample

Note 1 to entry: Depending on the electrodes applied the following resistances are distinguished:

Insulation resistance (ohms), see 3.11

Leakage resistance (ohms), see 3.9

Surface resistance (ohms), see 3.11

Surface resistivity (ohms), see 3.12

Volume resistivity (ohm metres), see 3.14.

3.11
surface resistance
resistance expressed in ohms between two electrodes in contact with the surface to be measured

Note 1 to entry: This definition of surface resistance is not entirely correct as the resistance between two electrodes depends on the volume resistivity of the material under test too. However, surface resistance as defined above has practical significance when evaluating the ability of materials to dissipate charges by conduction.

Note 2 to entry: The surface resistance measured according to 3.11 nearly always decreases with increasing thickness. The amount of decrease is depending on the relationship between surface resistance and volume resistance.

Note 3 to entry: In IEC 60167, the surface resistance is named insulation resistance.

Note 4 to entry: In IEC 60093, the surface resistance is defined as pure surface resistance without any current flowing through the volume.

3.12
surface resistivity
resistance across opposite sides of a surface of unit length and unit width commonly expressed in ohms

Note 1 to entry: Ohms/square is sometimes used but should be avoided as it does not confirm with SI.

Note 2 to entry: The surface resistivity is ten times higher than the surface resistance measured according to 4.2.

3.13
teraohm meter
resistance measuring instrument with an upper measuring range of at least 1 TΩ and a variable measuring voltage up to 1 kV or higher

3.14
volume resistivity
resistance of a body of unit length and unit cross-sectional area expressed in ohm metres measured according to IEC 60093 for insulating materials and IEC TR 61340-2-3 for dissipative materials

4 Test methods

4.1 General

Variations in the results of measuring electrostatic properties of materials are mainly due to variations in the sample (e.g. inhomogeneous surfaces, geometry and the state of the material) rather than uncertainties in voltage, current, electrode geometry or uncertainty of the measuring device. This is because electrostatic properties are strongly influenced by very small differences so that statistical effects play an important role.

For example, in ASTM E582 the minimum ignition energy of an explosive gas atmosphere is defined by 100 or 1 000 non-ignitions. This does not exclude that, nevertheless, the 1 001st trial may ignite. Due to this statistical effect, the accuracy and reproducibility of electrostatic properties is limited by statistical scatter.

Typically, the accuracy and reproducibility of electrostatic measurements is about 20 % to 30 %. This is much higher than for a typical electric measurement which is less than 1 %. For this reason, electrostatic threshold limits contain a certain safety margin to compensate for the occurring statistical scatter.

It may be difficult to understand that the occurring statistical scatter cannot be minimized by improving the quality of the tests. Nevertheless, one has to accept this situation, remembering that electrostatic tests contain adequate safety margins just to compensate for this effect.

Fabrication processes (e.g. moulding, extrusion, etc.) can change the electrostatic properties of materials. It is, therefore, recommended to test finished products, where possible, rather than the materials from which the products are made.

To obtain comparable results all over the world for laboratory measurements, the samples should be acclimated and measured at the stated relative humidity and temperature (mostly for at least 24 h at (23 ± 2) °C and (25 ± 5) % relative humidity). In countries which may experience lower or higher humidity and temperature levels, an additional value at the local higher or lower relative humidity and temperature may be reasonable (e.g. (40 ± 2) °C and (90 ± 5) % relative humidity for tropical climates and (23 ± 2) °C and (15 ± 5) % relative humidity for countries with very cold climates).

In order to exclude measurement errors caused by different hysteresis behaviour of the material's moisture, the sample should be dried at first and hereafter acclimated to the specific climate.

In some other standards, e.g. IEC 60079-0, different limit values based on measurement taken at 50 % RH or 30 % RH have been specified in the past in the absence of an effective dehumidified test chamber. Experience shows that measurement results in this climate are not obtained with the same degree of consistency as those measured according to this standard. However, it may be necessary to use the climate specified in other standards in order to maintain continuity for previously evaluated equipment.

It may be that it is difficult to apply the exact test methods specified in this standard to all types of equipment and in all situations. If this is the case, the test report shall clearly state which parts of this standard have been applied in their entirety and which parts of this standard have been applied in part. This shall be accompanied by a technical justification of why the standard could not be applied in its entirety and the equivalence of any other methods that have been applied compared with the methods specified in this standard.

CAUTION: The test methods specified in this standard involve the use of high voltage power supplies and in some tests flammable gases that may present hazards if handled incorrectly. Users of this standard are encouraged to carry out proper risk assessments and pay due regard to local regulations before undertaking any of the test procedures.

4.2 Surface resistance

4.2.1 General

Surfaces which have a sufficiently low surface resistance as defined in 3.11 cannot be electrostatically charged when in contact with earth. For this reason, surface resistance is a basic electrostatic property concerning the ability of materials to dissipate charge by conduction. As surface resistances usually increase with decreasing relative humidity, a low relative humidity is necessary during measuring to replicate worst case conditions.

IEC 60093 and IEC TR 61340-2-3 describe methods for measuring surface and volume resistance and resistivity of solid planar materials. IEC 61340-4-10 is an alternative method for measuring surface resistance. However, often these methods cannot be applied because of the size and shape of materials, especially when incorporated into equipment and apparatus. For this reason, the test method for resistance measurements for non-planar materials and products with small structures specified in IEC 61340-2-3, or the following method may be used as a suitable alternative.

4.2.2 Principle

The surface is contacted with two conductive electrodes of defined length and distance and the resistance between both electrodes is measured. As high resistances usually decrease with increasing voltage, the applied voltage shall be increased to at least 500 V, preferably 1 000 V, at very high resistances.

NOTE Latest knowledge indicates that it may be advantageous to measure high resistances at 10 kV. However, in this case sparking has to be prevented, for example by an insulating foam between the electrodes, and the acceptance criteria have to be modified.

When thin insulating layers are backed with a more conductive material, the applied voltage can burn through to the material below, and the results obtained are inconclusive.

4.2.3 Apparatus

The measuring apparatus according to IEC 60079-0 consists of two parallel electrodes with the dimensions given in Figure 1. This may be realized by electrodes painted with silver paint through a suitable stencil, soft conductive rubber strip electrodes on spring-mounted metal tongues or conductive foam strips mounted on an insulating support.

Dimensions in millimetres

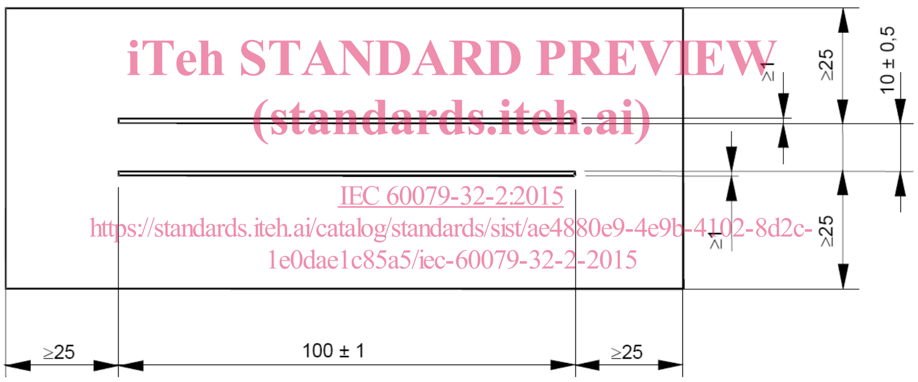

Figure 1 – Test sample with applied electrodes (dimensions in mm)

NOTE 1 The surface resistance is dependent upon the electrode configuration.

NOTE 2 This electrode configuration is also used e.g. in IEC 60167.

Non-homogeneous materials, particularly fabrics, may give different results when measured in different directions. Using a concentric ring electrode system, as described in IEC 61340-2-3 or ISO 14309, can avoid this issue.

Soft conductive rubber strip electrodes are preferred over silver paint electrodes to limit unwanted chemical surface interaction.

In case of uneven samples, silver paint electrodes are preferred over soft electrodes because of their better adoption to the uneven sample geometry.

The >25 mm criterion for the area around the electrodes as given in Figure 1 applies to test sheets only, it may be ignored in the case of real products.

The electrodes are connected to a teraohm meter. A guard shield electrode may be placed over the electrodes to minimise electric noise. During the test, the voltage shall be sufficiently steady so that the charging current due to voltage fluctuation will be negligible compared with the current flowing through the test sample.

The accuracy of the teraohm meter shall be regularly tested with several resistances of known value in the interval 1 MΩ to 1 TΩ. The teraohm meter shall read the resistance within its stated accuracy. The geometry of conductive rubber or foam electrodes shall also be regularly checked by measuring their imprint. If the electrode force to reach the minimum resistance is higher than 20 N, the rubber electrodes shall be replaced by softer ones.

4.2.4 Test sample

The surface resistance shall be measured on the parts of the actual specimen if size permits, or on a test sample comprising a rectangular plate with dimensions in accordance with Figure 1. The test sample shall have an intact clean surface. As some solvents may leave conductive residues on the surface or may adversely affect the electrostatic properties of the surface, it is best to clean the surface with a brush only. This is especially important in cases where the surface is treated with special antistatic agents.

If, however, fingerprints or other dirt is visible on the surface and no special antistatic agents are used on the surface the test sample shall be cleaned with 2-propanol (isopropyl alcohol) or any other suitable solvent that will not affect the material of the test sample and the electrodes, and then dried in air.

It shall then be conditioned for at least 24 h at (23 ± 2) °C and (25 ± 5) % relative humidity without being touched again by bare hands. In the case of enclosures for electrical equipment, the climate given in IEC 60079-0 and a test voltage of 500 V shall be used to be compatible with historic measurements.

4.2.5 Procedure

The measurement procedure is as follows:

1) Carry out the test under the same climate as the pre-conditioning.
2) Place the sample on an insulation pad with a surface resistance exceeding 10 TΩ.
3) Place the electrodes on the surface of the sample.
4) Apply a force of 20 N on the electrodes (not necessary in the case of painted electrodes).
5) Apply a measuring voltage of (10 ± 0,5) V for (15 ± 5) s between the electrodes.
6) Measure the resistance between both electrodes and record the value at the end of the measuring time.

   NOTE 1 Starting with low measuring voltage is necessary to avoid damage of the electrodes caused by high currents when measuring low resistance samples.

7) If the resistance is between 1 MΩ and 10 MΩ, the measuring voltage shall be increased to (100 ± 5) V for (15 ± 5) s. Resistances between 10 MΩ and 100 MΩ shall be measured with (500 ± 25) V for (65 ± 5) s. In case of surface resistances exceeding 100 MΩ apply a voltage of at least (500 ± 25) V, preferably (1 000 ± 50) V, for (65 ± 5) s.

   NOTE 2 In IEC 60079-0, one voltage of 500 V is applied.

   NOTE 3 In IEC 61340-4-1, 100 V is applied for resistances between 1 MΩ and 100 GΩ, and 500 V for even higher ones. In IEC 61340-2-3, 100 V is applied for all resistances above 1 MΩ. As high resistances usually decrease with increasing voltage and needs a longer time for stable results, measuring of high resistances at the stated higher voltages and measuring times is recommended.

8) Repeat the measurement nine times at different places on the same sample or using additional samples, unless either the sample is too small for this to be practical, or the range of the results is within ±10 %. In this case, a lower number of repeats is acceptable. However, there should be a minimum of 3 tests in total.