IEC 62631-3-3

Edition 1.0 2015-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Dielectric and resistive properties of solid insulating materials – Part 3-3: Determination of resistive properties (DC methods) – Insulation resistance

Propriétés diélectriques et résistives des matériaux isolants solides – Partie 3-3: Détermination des propriétés résistives (méthodes en courant continu) – Résistance d'isolement

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DIELECTRIC AND RESISTIVE PROPERTIES OF SOLID INSULATING MATERIALS –

Part 3-3: Determination of resistive properties (DC methods) – Insulation resistance

FOREWORD

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International Standard IEC 62631-3-3 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

This first edition cancels and replaces the first edition of IEC 60167, published in 1964, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the first edition of IEC 60167:

a) IEC 60167 has been completely revised, both editorially and technically, and incorporated into the new IEC 62631 series;
b) test methods have been updated to current day state of the art.

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

FDIS	Report on voting
112/341/FDIS	112/352/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 in the IEC 62631 series, published under the general title *Dielectric and resistive properties of solid insulating materials*, 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 website 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- withdrawn,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.

DIELECTRIC AND RESISTIVE PROPERTIES OF SOLID INSULATING MATERIALS –

Part 3-3: Determination of resistive properties (DC methods) – Insulation resistance

1 Scope

This part of IEC 62631 covers methods of test for the determination of the insulation resistance of electrical insulating materials or insulating systems by applying DC voltage.

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 60212, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60216-4-1, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens – Single-chamber ovens*

ISO 2339, *Taper pins, unhardened*

ISO 3465, *Hand taper pin reamers*

3 Terms and definitions

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

3.1
electrode arrangement
arrangement of two electrically conductive bodies in contact with the surface and the bulk volume of a test specimen

3.1.1
tapered pin electrodes
electrode arrangement using tapered pin electrodes

Note 1 to entry: See Figure 1.

3.1.2
bar electrodes
electrode arrangement using bar electrodes

Note 1 to entry: See Figure 2.

Dimensions in millimetres

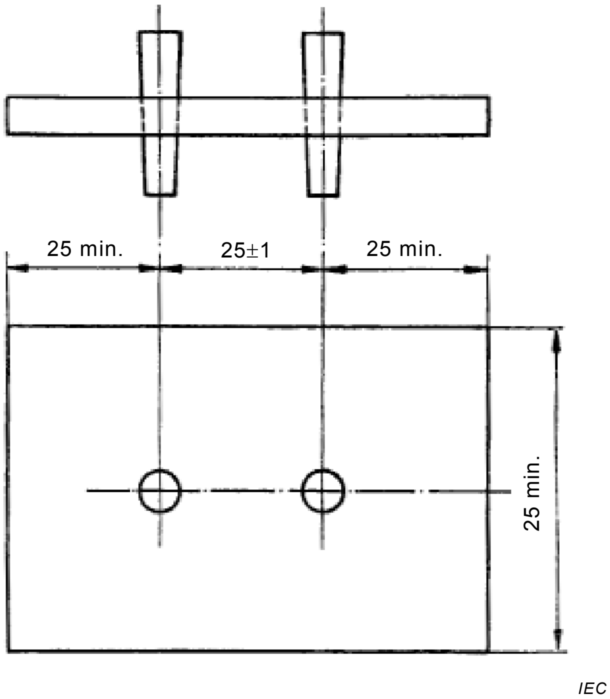

Figure 1a – Test specimen arrangement for plates

Dimensions in millimetres

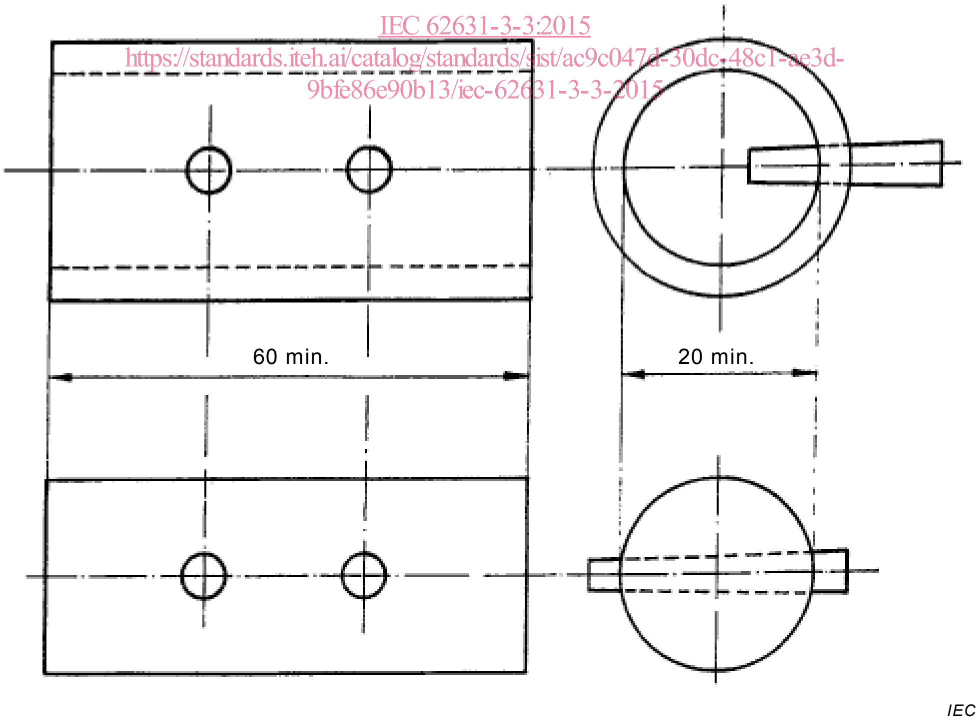

Figure 1b – Test specimen arrangement for pipes and rods

Figure 1 – Pin electrode arrangements

Dimensions in millimetres

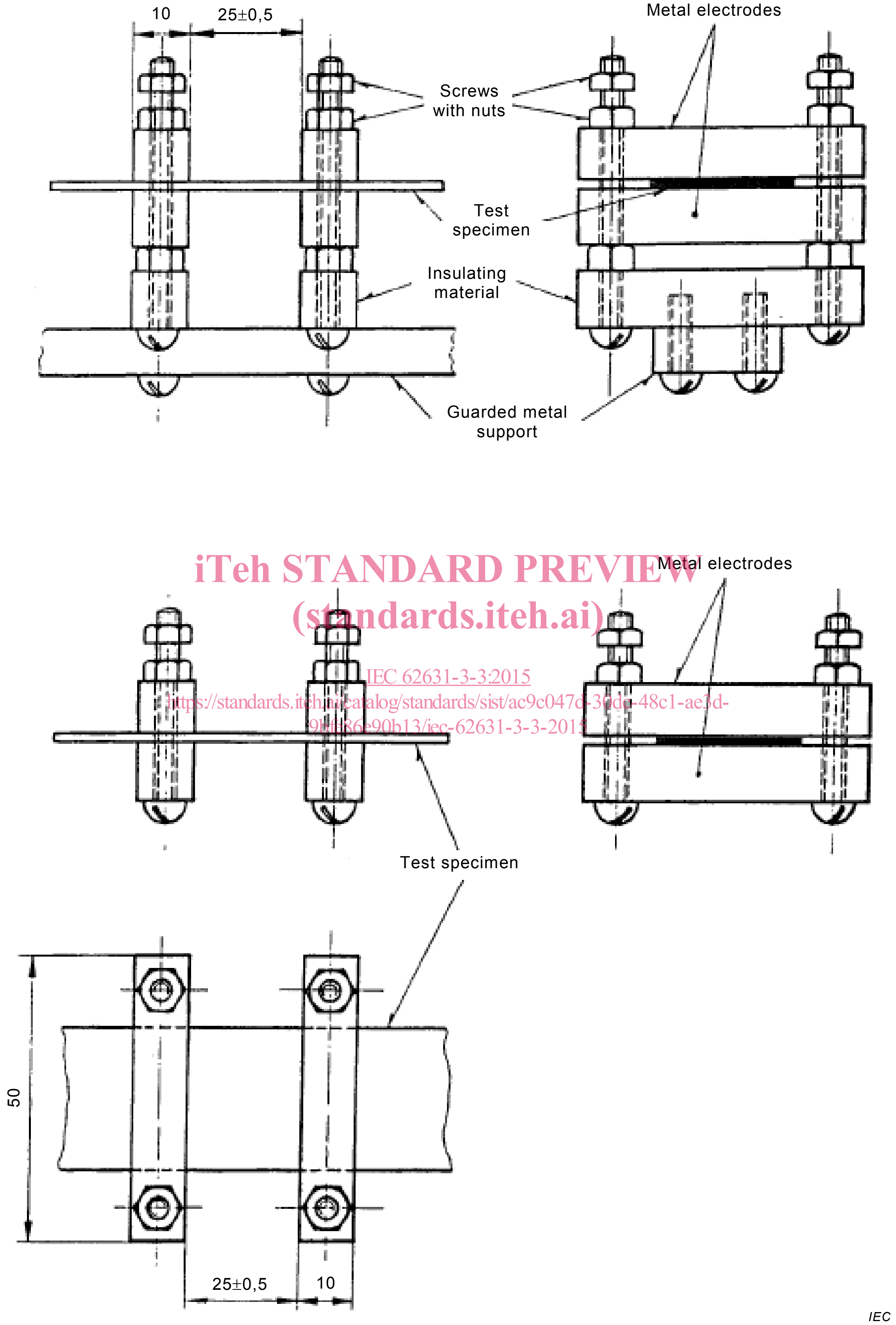

Figure 2 – Bar electrode arrangement

3.2
measured resistance
ratio of DC voltage applied to an electrode arrangement in contact with a test specimen to the current between them measured with sufficient precision

Note 1 to entry: A Wheatstone bridge may also be used to compare the measured resistor with a standard resistor. However, Wheatstone bridges are not commonly used anymore.

Note 2 to entry: According to IEC 60050-121[1] [1]: Electromagnetism, "conductivity" is defined as "scalar or tensor quantity the product of which by the electric field strength in a medium is equal to the electric current density" and "resistivity" as "the inverse of the conductivity when this inverse exists". Measured in this way, the insulating resistance is an average of the integrated resistivity over possible heterogeneities in the volume incorporated in the measurement; it includes the effect of possible polarization phenomena at the electrodes.

3.3
insulation resistance
R_I
measured resistance between any electrode arrangement defined by this standard

Note 1 to entry: Dependent on the electrode arrangement used it is designated as R_{IT} or R_{IR}, with insulation resistance, R_I expressed by the unit Ω.

3.3.1
$\boldsymbol{R_{IT}}$
insulation resistance between tapered pin electrodes
measured resistance using the tapered pin electrode arrangement in contact with a test specimen defined by this standard

Note 1 to entry: Tapered pin electrodes are mainly in contact with the bulk volume of the test specimen but the surface also contributes to the measured insulation resistance.

3.3.2
$\boldsymbol{R_{IB}}$
insulation resistance between bar electrodes
measured resistance using the bar electrode arrangement in contact with a test specimen defined by this standard

Note 1 to entry: Bar electrodes are mainly in contact with the surface of the test specimen but the bulk volume also contributes to the measured insulation resistance.

4 Significance

Insulating materials are used in general to electrically isolate components of an electrical system from each other and from earth. Solid insulating materials can also provide mechanical support. For these purposes it is generally desirable to have the insulation resistance as high as possible, consistent with acceptable mechanical, chemical and heat resistance properties.

Insulation resistance R_I is defined in this standard in two distinct ways: between tapered pin electrodes R_{IT}, and between bar electrodes R_{IB}.

NOTE 1 Determination of R_{IT} and R_{IB} on one and the same insulating material does not lead to comparable results.

Both are to be regarded as technical useful quantities, characterizing the overall resistive properties of an electrical insulating material or a product made from it. Insulation resistance contains both, volume resistance (see IEC 62631-3-1[2]) and surface resistance (see IEC 62631-3-2[3]) in differing portions, dependent on the specimen under test and its condition.

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1 Numbers in square brackets refer to the Bibliography.

NOTE 2 In the past, resistance measured between specified line electrodes had also been designated as insulating resistance. This kind of resistance can be found as surface resistance between line electrodes R_{SD} in IEC 62631-3-2.

To achieve comparable results, insulating resistance shall be measured under fixed geometrical conditions, as stipulated in this standard. Under these conditions, it may be used to compare different insulating materials or products, considering that this approach only permits a simplified classification.

NOTE 3 Insulating resistance R_I defined by this standard is not identical with the resistances between conducting bodies within electric equipment, separated by electrical insulating materials. However, it can be useful for basic design considerations.

5 Method of test

5.1 General

The measurement of insulation resistances shall be carried out carefully and with due consideration for the electric properties of the measuring circuit as well as the specific electric properties of the material.

To carry out the test, in most cases the use of high voltages is necessary. Care shall be taken, to prevent from electric shock.

Polarization effects may influence the measurement. Therefore it is not acceptable to achieve the measured resistance twice in two consecutive experiments without a sufficient space of time in between.

NOTE For materials with an insulating resistance of not more than 10^{12} Ω, a period of 1 h after voltage application might be sufficient.

5.2 Test conditions

5.2.1 Voltage

The measuring voltage shall preferably be

10 V, 100 V, 500 V, 1 000 V, 10 000 V.

Other voltages may be applicable. If not otherwise stipulated, a voltage of 100 V shall be used.

NOTE 1 Partial discharges can lead to erroneous measurements when a specific inception voltage is exceeded. In air, below 340 V no partial discharges will occur.

NOTE 2 The ripple of the voltage source is important. A typical value for 100 V is $<5 \times 10^{-5}$ peak to peak.

5.2.2 Electrode material

Stainless steel with the composition as given in Table 1, shall be used as the electrode material. Other materials are acceptable if their equivalence has been proven.

Table 1 – Composition of electrode steel

Chemical elements	Content %
C	Max. 0,07
Si	Max. 1,00
Mn	Max. 2,00
P	Max. 0,045
S	Max. 0,015
N	Max. 0,11
Cr	17,00 to 19,50

NOTE This steel is known as X5CrNi18-10, as stipulated in EN 10088-2[4].The grade is also known as material number 1.4301. A similar grade with slightly other composition is known as AISI 304. For further information see [5] and [6].

When using bar electrodes for the determination of insulating resistance, in case of rigid test specimen, a tin foil (99 % tin) shall be used to provide proper contact.

5.3 Equipment

5.3.1 General

Care should be taken that the insulating resistance is not negatively influenced by parasitic resistances parallel to the electrode arrangement, such as the resistance of test supports or cable isolation.

To prevent measuring errors for measured resistances higher than 10^{10} Ω, shielded cables and shielded measuring cabinets shall be used.

5.3.2 Accuracy

Any suitable equipment may be used. The measuring device should be capable of determining the unknown resistance with an overall accuracy of at least:

- ±10 % for resistance below 10^{10} Ω,
- ±20 % for resistance between 10^{10} Ω and 10^{14} Ω,
- ±50 % for values higher than 10^{14} Ω.

5.3.3 Voltage source

A source of very steady direct voltage is required. This can be provided either by batteries or by rectified and stabilized power supply. The degree of stability required is such that the change in current due to any change in voltage is negligible compared with the current to be measured.

5.4 Calibration

The equipment shall be calibrated in the magnitude of the volume resistance measured.

NOTE Calibration resistors in the range up to 100 TΩ are commercially available.