

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrostatics –

Part 2-3: Methods of test for determining the resistance and resistivity of solid materials used to avoid electrostatic charge accumulation

Électrostatique –

Partie 2-3: Méthodes d'essais pour la détermination de la résistance et de la résistivité des matériaux solides destinés à éviter les charges électrostatiques



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2016 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrostatics –

Part 2-3: Methods of test for determining the resistance and resistivity of solid materials used to avoid electrostatic charge accumulation

Électrostatique –

Partie 2-3: Méthodes d'essais pour la détermination de la résistance et de la résistivité des matériaux solides destinés à éviter les charges électrostatiques

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 17.220.99; 29.020

ISBN 978-2-8322-3475-4

Warning! Make sure that you obtained this publication from an authorized distributor.

Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	7
4 Conditioning and test environment	9
5 Selection of test method	9
6 Resistance measurements for solid conductive materials	10
7 Resistance measurements for solid insulating materials	10
8 Resistance measurements for planar electrostatic dissipative materials (used to avoid electrostatic charge accumulation).....	10
8.1 Instrumentation	10
8.1.1 General.....	10
8.1.2 Instrumentation for laboratory evaluation.....	10
8.1.3 Instrumentation for acceptance testing	10
8.1.4 Instrumentation for compliance verification (periodic testing)	11
8.2 Electrode assemblies	11
8.2.1 General.....	11
8.2.2 Assembly for the measurement of surface resistance.....	11
8.2.3 Assembly for the measurement of volume resistance	12
8.2.4 Assembly for the measurement of resistance to ground/groundable point and point-to-point resistance	12
8.2.5 Test support.....	13
8.3 Sample preparation and handling.....	13
8.4 Test procedures.....	14
8.4.1 Surface resistance measurements.....	14
8.4.2 Volume resistance measurements	14
8.4.3 Resistance to groundable point measurements.....	15
8.4.4 Point-to-point resistance measurements	16
9 Conversion to resistivity values.....	17
9.1 Surface resistivity ρ_s	17
9.2 Volume resistivity ρ_v	17
10 Resistance measurements for non-planar materials and products with small structures	18
10.1 General considerations	18
10.2 Equipment	18
10.2.1 Probe.....	18
10.2.2 Sample support surface	20
10.2.3 Resistance measurement apparatus.....	20
10.2.4 Test leads.....	21
10.3 Test procedure.....	22
11 Repeatability and reproducibility	22
12 Test report	23
Annex A (normative) System verification	25
A.1 System verification for surface resistance measurements	25

A.1.1	Fixture and procedure for lower resistance range	25
A.1.2	Fixture and procedure for upper resistance range and determination of electrification period.....	26
A.2	System verification for volume resistance measurements	27
A.2.1	Fixture and procedure for lower resistance range	27
A.2.2	Fixture and procedure for upper resistance range and determination of electrification period.....	27
A.3	System verification for resistance measurements for non-planar materials and products with small structures	27
A.3.1	Verification fixtures	27
A.3.2	Verification procedure	28
Figure 1	– Example of an assembly for the measurement of surface and volume resistance.....	12
Figure 2	– Example of an assembly for the measurement of resistance to ground/groundable point and point-to-point resistance	13
Figure 3	– Basic connections of the electrodes for surface resistance measurements	14
Figure 4	– Basic connections of the electrodes for volume resistance measurements	15
Figure 5	– Principle of resistance to groundable point measurements.....	16
Figure 6	– Principle of point-to-point measurements.....	17
Figure 7	– Configuration for the conversion to surface or volume resistivity	18
Figure 8	– Two-point probe configuration	20
Figure 9	– Probe to instrumentation connection.....	21
Figure 10	– Spring compression for measurement	22
Figure A.1	– Lower resistance range verification fixture for surface resistance measurements.....	25
Figure A.2	– Upper resistance range verification fixture for surface resistance measurements.....	26
Figure A.3	– Resistance verification fixture	28
Table 1	– Material for two-point probe.....	19

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROSTATICS –

**Part 2-3: Methods of test for determining the resistance
and resistivity of solid materials used
to avoid electrostatic charge accumulation**

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61340-2-3 has been prepared by IEC technical committee 101: Electrostatics.

This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) a distinction has been introduced between instrumentation used for laboratory evaluations, instrumentation used for acceptance testing and instrumentation used for compliance verification (periodic testing);

- b) an alternative electrode assembly is described, which can be used on non-planar products or when the dimensions of the product under test are too small to allow the larger electrode assembly to be used;
- c) the formulae for calculating surface and volume resistivity have been modified to correspond with common industry practice in the main areas of application for the IEC 61340 series.

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

CDV	Report on voting
101/470/CDV	101/494/RVC

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 the parts in the IEC 61340 series, published under the general title *Electrostatics*, 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.

INTRODUCTION

Measurements of resistances and related calculations of resistivities belong to the fundamental objectives of electrical measuring techniques along with measurements of voltage and current.

Resistivity is the electrical characteristic having the widest range, extending over some thirty orders of magnitude from the most conductive metal to almost perfect insulators.

The basis is Ohm's law and is valid for DC current and instantaneous values of AC current in electron conductors (metals, carbon, etc.). Values of resistance measurements using AC current can be influenced by capacitive/inductive reactance, depending on the frequency. Thus, existing national and international standards dealing with resistance measurements of solid materials normally require the application of DC current.

Most non-metal materials such as plastics are classified as polymers and ion conductors. The transport of charges can be dependent upon the applied electrical field strength during the measurement. Beside the measuring current, there exists a charging current that polarizes and/or electrostatically charges the material, indicated by an asymptotic decay of the measuring current with time and causing an apparent change in resistance. If this effect is observed, it will be advisable to repeat the measurement immediately after a definite electrification time has elapsed using the reverse polarity for the measuring current and averaging both obtained values.

ELECTROSTATICS –

Part 2-3: Methods of test for determining the resistance and resistivity of solid materials used to avoid electrostatic charge accumulation

1 Scope

This part of IEC 61340 describes test methods for the determination of the electrical resistance and resistivity of solid materials used to avoid electrostatic charge accumulation, in which the measured resistance is in the range $10^4 \Omega$ to $10^{12} \Omega$.

It takes account of existing IEC/ISO standards and other published information, and gives recommendations and guidelines on the appropriate method.

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 62631-3-1, *Dielectric and resistive properties of solid insulating materials – Part 3-1: Determination of resistive properties (DC Methods) – Volume resistance and volume resistivity – General method*

IEC 62631-3-2, *Dielectric and resistive properties of solid insulating materials – Part 3-2: Determination of resistive properties (DC Methods) – Surface resistance and surface resistivity*

IEC 62631-3-3, *Dielectric and resistive properties of solid insulating materials – Part 3-3: Determination of resistive properties (DC Methods) – Insulation resistance*

ISO 1853, *Conducting and dissipative rubbers, vulcanized or thermoplastic – Measurement of resistivity*

ISO 2951, *Rubber, vulcanized or thermoplastic – Determination of insulation resistance*

ISO 3915, *Plastics – Measurement of resistivity of conductive plastics*

ISO 7619-1, *Rubber, vulcanized or thermoplastic – Determination of indentation hardness – Part 1. Durometer method (Shore hardness)*

3 Terms and definitions

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

3.1

electrode

conductor of defined shape, size and configuration being in contact with the specimen to be measured