IEC 61340-4-9

Edition 3.0 2024-10
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

Electrostatics –
Part 4-9: Standard test methods for specific applications – Garments – Resistive characterization

IEC 61340-4-9:2024-10 CMV(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 61340-4-9

Edition 3.0 2024-10
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

Electrostatics –
Part 4-9: Standard test methods for specific applications – Garments – Resistive characterization

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 17.200.99, 29.020

ISBN 978-2-8322-9965-4

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

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTROSTATICS –

Part 4-9: Standard test methods for specific applications – Garments – Resistive characterization

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

This commented version (CMV) of the official standard IEC 61340-4-9:2024 edition 3.0 allows the user to identify the changes made to the previous IEC 61340-4-9:2016 edition 2.0. Furthermore, comments from IEC TC 101 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 61340-4-9 has been prepared by IEC technical committee 101: Electrostatics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2016. This edition constitutes a technical revision.

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

a) IEC 61010-1 and IEC 61010-2-030 added as requirements for measurement equipment;
b) testing voltage range for personnel ground path changed from "7 V DC to 30 V DC" to "7 V DC to 100 V DC";
c) cleaning requirements changed from a minimum of five cycles of cleaning to a minimum of three cycles of cleaning;
d) moderate humidity requirements deleted;
e) figures replaced with generic drawings.

The text of this International Standard is based on the following documents:

Draft	Report on voting
101/718/FDIS	101/721/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 61340 provides test methods for evaluating the electrical resistance of garments that contain surface conductive or dissipative components or materials used in the electronics industry for the control of electrostatic discharge. This document defines procedures for measuring electrical resistance, including a system resistance test for garments that provide a ground path for personnel.

Clothing made from synthetic fibres is a common source of electrostatic charge. Wearing an appropriate static control garment over personnel clothing can minimize the effect of this charge. To effectively control electrostatic charges of the static control garments and effectively shield the electrostatic field of personnel clothing, the static control garment should be grounded.

Three categories of garments are considered in this document.

a) A static control garment ~~may~~ can suppress or otherwise affect an electric field from clothing worn underneath the garment without being attached to ground. However, without grounding, a charge ~~may~~ can accumulate on conductive or dissipative elements of a garment, if present, resulting in a charged source.

b) A groundable static control garment ~~may~~ can provide a higher level of suppression when the lower resistance fabric is connected to ground.

c) A groundable static control garment system provides a ground path for a person that suppresses the electrical field from clothing worn underneath the garment and also bonds the skin of the wearer to an identified ground path. Groundable static control garment systems ~~may~~ can also be used in conjunction with a continuous or constant monitoring system in a manner similar to those used in continuous monitoring of wrist straps in an ESD protected area (EPA).

Resistive characterization is only one aspect to consider in evaluating garments for any specific application. To fully characterize a garment, it can be necessary to take into consideration electrical field attenuation, static decay, peak voltage, residual voltage and triboelectric charging ~~may need to be considered~~. Other attributes related to applications and environments, such as cleanroom compatibility, chemical and fire resistance, should be evaluated in the garment selection process but are beyond the scope of this document.

Garments constructed from fabrics made with fibres that are not surface conductive but ~~may~~ can have other related properties that impart some level of electrostatic charge dissipation or suppression when connected to ground, are not specifically measured by the methods provided in this document. This being the case, some garment fabrics and construction ~~may~~ can allow for surface voltage accumulation and charge transfer to occur which ~~may~~ can be detrimental to electronic items.

Alternate methods for evaluating the electrostatic properties of garments are described in IEC TS 61340-4-2 [1][1].

[1] Numbers in square brackets refer to the Bibliography.

ELECTROSTATICS –

Part 4-9: Standard test methods for specific applications – Garments – Resistive characterization

1 Scope

This part of IEC 61340 provides test methods for measuring the electrical resistance of garments used for static control applications. These test methods can be used for evaluating outer garments that are homogenously conductive or homogeneously dissipative, or that utilize surface conductive or surface dissipative components or elements.

NOTE It is possible that the test methods defined in this document ~~may~~ will not be able to measure materials with buried conductive layers.

The resistance point-to-point test method tests the electrical resistance between the two sleeves, any two panels or any two ~~or more~~ electrically interconnected components of the static control garment, including the electrical resistance across the seams and cuffs of the garment as applicable.

An alternate sleeve-to-sleeve test method is ~~allowed~~ described, using clamps to hang a garment.

Static control garments that electrically bond to the wearer and provide a path to ground from the wearer are evaluated using the resistance point-to-point test method, the resistance point-to-groundable point test method, as well as a system test to determine the resistance from the person through the garment to the groundable point of the garment system.

A band resistance measurement test is provided in IEC 61340-4-6 which can be used for garments so equipped with cuffs that are intended to perform the same function as a wrist strap band.

The system test with a person wearing a groundable static control garment system includes the ground cord that connects to the groundable point of the garment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits*

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 61340-4-6, *Electrostatics – Part 4-6: Standard test methods for specific applications – Wrist straps*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
acceptance testing
testing used to confirm to users that products delivered are substantially the same as the samples used to qualify products

3.2
garment system
any electrically interconnected components of a static control apparel

3.3
point-to-point resistance
resistance measured from one point to another on the surface of the same panel or two different panels of a garment

Note 1 to entry: Point-to-point resistance is expressed in Ω.

3.4
static control garment
personnel garment that is designed for electrostatic charge control

3.5
product qualification
testing used to confirm that products comply with the requirements of an ESD control program or other specification

3.6
groundable static control garment
garment that exhibits an electrical resistance from point-to-point and from any point or panel on the garment to the groundable point on the garment

Note 1 to entry: The groundable point ~~may~~ can be a cuff contact to the wearer's skin or a separate dedicated grounding point connector.

3.7
groundable static control garment system
system whereby a garment that is used to establish the primary ground path for a person to the groundable point of the garment and the connection of the garment to ground, typically through a grounding cord

Note 1 to entry: ~~The garment shall also meet all the requirements included in the definition for groundable static control garments.~~ The garment is a groundable static control garment as defined in 3.6, with additional features to enable grounding of the wearer.

4 Atmosphere for conditioning and testing

~~4.1 General~~

The following requirements supersede any other specification relating to the atmosphere for conditioning and testing that ~~may~~ can be given in one or more of the documents referred to in this document.

~~4.2 Low humidity~~

Unless otherwise agreed, the atmosphere for conditioning and testing for laboratory evaluations ~~at low humidity~~ shall be at a temperature of 23 °C ± 2 °C and 12 % ± 3 % relative humidity. The conditioning time prior to testing shall be at least 48 h. 1

~~4.3 Moderate humidity~~

~~The atmosphere for conditioning and testing for laboratory evaluations at moderate humidity shall be at a temperature of 23 °C ± 2 °C and 50 % ± 2 % relative humidity. The conditioning time prior to testing shall be at least 48 h.~~

5 Equipment and materials

~~5.1 Test equipment requirements~~

5.1 Resistance measurement apparatus

5.1.1 General

Electrical equipment for measurement shall comply with the safety requirements of IEC 61010-1 and IEC 61010-2-030. The measurement apparatus, called the meter, whether it is a single meter or collection of instruments, shall be capable of the following.

5.1.2 Product qualification

The meter shall have a circuit voltage while under load of ~~100 V (±5 %)~~ (100 ± 5) V for measurements of 1,0 × 10^6 Ω and above, and ~~10 V (±5 %)~~ (10 ± 0,5) V for measurements ~~less than 1,0 × 10^6 Ω~~ from 1,0 × 10^4 Ω to 1,0 × 10^6 Ω. The meter shall have an open circuit or under load voltage of (10 ± 0,5) V) for measurement from 1,0 × 10^3 Ω to 1,0 × 10^4 Ω. 2

The meter shall be capable of making measurements from 1,0 × 10^3 Ω to 1,0 × 10^{12} Ω.

5.1.3 Acceptance testing

The product qualification meter ~~may~~ can be used for acceptance testing or the following:

The meter shall have an open circuit voltage of ~~100 V (±5 %)~~ (100 ± 5) V for measurements of 1,0 × 10^6 Ω and above, and ~~10 V (±5 %)~~ (10 ± 0,5) V for measurements less than 1,0 × 10^6 Ω.

The meter shall be capable of making measurements from 1,0 × 10^3 Ω to 1,0 × 10^{12} Ω.

In case of disagreement, the meter used for product qualification ~~will~~ shall be used to resolve any disputes.

5.1.4 Ohmmeter for testing personnel ground path

Integrated tester or meter, whether it is a single meter (ohmmeter) or a collection of instruments that are capable of measuring from 5,0 × 10^4 Ω to at least 1,0 × 10^8 Ω with a test voltage from 7 V DC to ~~30~~ 100 V DC open circuit. If the test voltage exceeds 60 V DC, or 35 V DC in wet

locations, the additional safety limits for current and capacitive charge specified in IEC 61010-1 shall be applied.

Both test leads should be capable of being isolated from ground. AC line-powered resistance measuring devices ~~may~~ can give erroneous results due to undefined ground paths. Battery powered equipment is recommended.

5.2 Resistance measurement electrodes

5.2.1 Cylindrical electrodes

A cylindrical 2,5 kg ± 0,25 kg ~~rubber~~ electrode with a diameter of ~~65 mm ± 0,5 mm~~ 63,5 mm ± 1 mm, having a contact of electrically conductive material with a Shore-A ~~(IRHD)~~ durometer hardness between 50 and 70. The resistance between two electrodes should be less than 1,0 × 10^3 Ω when measured at 10 V on a metallic surface.

5.2.2 Clamps~~/~~ or electrodes

The clamps~~/~~ or electrodes shall consist of two flat electrically conductive plates (e.g. stainless steel) with a dimension of approximately 50 mm × 25 mm each. The ~~clamp/~~clamps or electrodes shall be electrically conductive with sufficient compression force to retain and suspend the garment. See Figure 7.

5.2.3 Cuff test fixture

A test fixture comprising an insulative stand and two stainless steel cylinders ~~approximately~~ (25,0 ± 0,5) mm in diameter, with one cylinder fixed to the stand directly above the second. The second cylinder ~~will weigh approximately 0,11 kg~~ shall have a mass of (0,11 ± 0,01) kg and is mounted in a slot in the stand that allows free vertical movement. See Figure 10.

5.2.4 Hand-held electrode

A hand-held electrode, for example stainless steel, brass, copper or other suitable metal round or tubular stock, approximately 25 mm in diameter and 75 mm or greater in length, with provision for connection to the meter (such as a banana plug receptacle or screw connector) attached to one end of the cylinder. See Figure 11.

5.3 Support surface

5.3.1 Insulative support surface

An insulative surface when used for specimen support shall have a surface resistance of greater than 1,0 × 10^{12} Ω when measured in accordance with IEC 61340-2-3. The insulative surface shall be large enough to accommodate the entire garment when it is laid out flat.

5.3.2 Insulative sleeve inserts

Two pieces of insulative material meeting the requirements of 5.3.1 cut into approximately 75 mm by 152 mm strips to slide into the sleeves (and cuffs if so equipped) of garments under test to isolate one side of the sleeve from the other.

5.3.3 Insulative hangers

The points to which the clamps described in 5.2.2 holding a garment under test shall be isolated from ground by a resistance greater than 1,0 × 10^{12} Ω when measured with an instrument meeting the requirements of 5.1.3. Insulating thread ~~may~~ can be used for this purpose.

6 Test procedure

6.1 Sample preparation

6.1.1 General

~~The test samples shall be processed through a minimum of five cycles of the garment manufacturer's prescribed or user defined cleaning process prior to performing laboratory tests.~~

~~6.1.2 Sample size~~

~~Test a minimum of three samples for each style and manufacturer for product qualification. For acceptance testing, the sample size shall be determined by the user.~~

~~6.1.3 Sample sketch~~

Garments can have a temporary finish on them, either a residue from processing treatments or deliberately applied by garment manufacturers, that can reduce electrical resistance. Such finishes shall be removed before proper evaluation of the long-term properties of garments can be made. This can be achieved by processing garments through a minimum of three cycles of the garment manufacturer's specified or user defined cleaning process, prior to performing laboratory tests. **3**

The person performing the tests should examine the garment's construction and make a general sketch showing separate front and back panels used to fabricate the garment. Number the panels for measurement identification purposes from No. 1 to No. n. Identify the sleeves and cuffs as left and right. The groundable points, if they exist, should be shown on the sketch. The sketch should accompany the test results to become part of the test report.

6.1.2 Number of samples

Test a minimum of three samples for each style and manufacturer when using this test method for qualification.

6.2 Humidity requirements

For product qualification, resistance point-to-point, resistance point-to-groundable point and cuff measurements shall be conducted at ~~two~~ humidity conditions according to Clause 4. Humidity conditioning for product qualification of the groundable static control garment system is optional and ~~may~~ can require a walk-in environmental chamber.

~~NOTE Laboratory testing has shown that low and moderate humidity conditions do not have a consequential impact on the electrical resistance measurement of a garment in combination with a person.~~

6.3 Test procedures

6.3.1 General

Subclause 6.3 defines the test methods for measuring the electrical resistance of garments. It includes a resistance point-to-point test and a resistance point-to-groundable point test. The described test procedures ~~may~~ can be used for product qualification and acceptance testing. A system test for a garment that provides a path to ground from a person while being worn is also described.

6.3.2 Resistance point-to-point

6.3.2.1 Panel-to-panel

Precondition the test samples according to 6.2 as required. Place the garment on an insulative support surface as described in 5.3.1. Place the garment with the front panels opened and laid out as flat as possible (it is possible that larger garments such as overalls ~~may~~ will not allow

this completely). Place the insulative sleeve inserts from 5.3.2 into each sleeve (including the cuff, if so equipped, or leg cuffs of an overall) of the garment under test. Attach test leads from the resistance measuring apparatus (meter) to the electrodes defined in 5.2.1. Place one electrode on a panel of the sample. Place the second electrode on another panel of the same sample. Ensure the panels are on the insulative support surface and do not touch any other part of the garment. Apply 10 V and observe the reading after ~~15~~ 5 s. If the reading is less than $1,0 \times 10^6$ Ω, record the value. If the reading is greater than or equal to $1,0 \times 10^6$ Ω, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Switching the test voltage to 100 V can result in a resistance reading of less than $1,0 \times 10^6$ Ω. When this occurs the reading made with the 100 V test voltage shall be recorded. Repeat for all electrically interconnected components and panels as well as exterior cuff-to-cuff and sleeve-to-sleeve, making sure that the electrodes are directly above the insulative inserts (see Figure 1, Figure 2 and Figure 3). Resistance point-to-point measurements can give variable results depending on the arrangement of the garment under test and location of electrodes on it. For qualification testing, at least three measurements shall be made with the garment arrangement and electrode location re-arranged between each measurement. The result is the highest of the three measured values **4**. Repeat for all test samples.

6.3.2.2 Interior cuff-to-cuff

Some garments ~~may~~ can have an insulative exterior and conductive interior of the cuff or incorporate a wrist strap band or another wrist bonding mechanism or device. Precondition the test samples according to 6.2 as required. Insert the measurement electrodes inside the cuffs or wrist bonding devices (see Figure 4 and Figure 5). Apply 10 V and observe the reading after ~~15~~ 5 s. If the reading is less than $1,0 \times 10^6$ Ω, record the value. If the reading is greater than or equal to $1,0 \times 10^6$ Ω, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Switching the test voltage to 100 V can result in a resistance reading of less than $1,0 \times 10^6$ Ω. When this occurs, the reading made with the 100 V test voltage shall be recorded. Repeat for all test samples.

6.3.2.3 Hanging clamp sleeve-to-sleeve

Precondition the test samples according to 6.2 as required. Hang the garment from each sleeve with electrically isolated clamps (see Figure 6). Place the clamps so that they connect the exterior and the interior of the cuff. The resistance measurement shall be made by ~~applying the voltage lead (positive) to one clamp and attaching the sensor lead (negative)~~ attaching a test lead to one clamp and attaching the other test lead to the other clamp. Apply 10 V and observe the reading after ~~15~~ 5 s. If the reading is less than $1,0 \times 10^6$ Ω, record the value. If the reading is greater than or equal to $1,0 \times 10^6$ Ω, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Switching the test voltage to 100 V can result in a resistance reading of less than $1,0 \times 10^6$ Ω. When this occurs, the reading made with the 100 V test voltage shall be recorded. Repeat for all test samples.

6.3.3 Resistance point-to-groundable point

Precondition the test samples according to 6.2 as required. Place the garment with the front panels opened and laid out as flat as possible (it is possible that larger garments such as overalls ~~may~~ will not allow this completely) on an insulative support surface as described in 5.3.1. Use one electrode as described in 5.2.1 connected to ~~the positive~~ one test lead of the meter. Place the insulative sleeve insert from 5.3.2 into each sleeve of the garment under test. Place the electrode on a cuff (~~or inside as described in 6.3.2.2~~ see 6.3.2.2 for interior cuff-to-cuff measurements), sleeve (directly above the insulative insert) or panel. Connect the ~~negative~~ other test lead of the meter to the garment groundable point. Apply 10 V and observe the reading after ~~15~~ 5 s. If the reading is less than $1,0 \times 10^6$ Ω, record the value. If the reading is greater than or equal to $1,0 \times 10^6$ Ω, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Switching the test voltage to 100 V can result in a resistance reading of less than $1,0 \times 10^6$ Ω. When this occurs, the reading made with the 100 V test voltage shall be recorded. If cuffs are designated as groundable points, measurements shall be made between sleeves and cuffs or between panels and cuffs; see 6.3.2.2 for cuff-to-cuff

measurements. Repeat for all panels, sleeves and cuffs and groundable points (see Figure 8 and Figure 9). Repeat for all test samples.

6.3.4 Cuff measurements

IEC 61340-4-6 provides test methods for the evaluation of wrist strap bands and cuffs. These methods ~~may~~ can be adapted for use in testing garment cuffs or any wrist strap cuff type grounding mechanism that ~~may~~ can be part of a garment and used to bond to the skin of the wearer. The band resistance test procedure described in IEC 61340-4-6 ~~may~~ shall be used to measure the interior resistance of the garment cuff or wrist strap grounding mechanism (see Figure 10).

NOTE Some garments can be used in conjunction with resistance continuous monitoring systems. Garments of this type can have one cuff that provides the skin contact for personnel grounding, and the other cuff is used for monitoring the electrical continuity between the garment and the wearer. The two cuffs are isolated electrically from each other in this type of garment. The manufacturer can be contacted for assistance in measuring this type of garment.

6.3.5 Groundable static control garment system

Users of this document should ensure that garments tested in this procedure meet the grounding requirements at the lowest humidity levels experienced in their facility.

This procedure verifies the resistance path from a person wearing the garment, through the body-garment cuff contacts or wrist strap cuff type grounding mechanism to the ground termination point of the garment grounding wire. Testing in a controlled environment is not a requirement of this subclause. Personnel shall wear the garment under test for a minimum of 10 min prior to testing.

This test is conducted with the meter described in 5.1.4. This test includes the ground cord and wearer's resistance as part of the total system resistance (see Figure 11 and Figure 12). The test can be performed using a proprietary integrated tester (Figure 12) or resistance meter of similar specification (Figure 11). Connect the grounding point of the garment to the tester using the ground cord. Contact is made to the tester via a push button, contact plate (on the integrated tester, Figure 12) or a hand-held electrode (Figure 11). Apply the test voltage and record the result.

7 Product qualification

Table 1 describes the test required, based on the garment that is being qualified. For more information on garments, see Annex A.

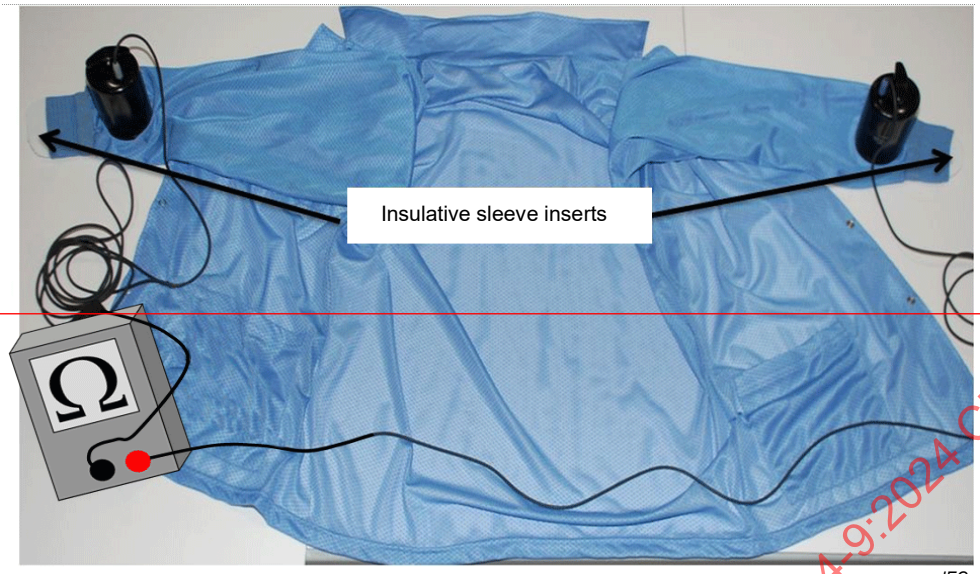
Table 1 – Product qualification 5

~~Garment type~~	~~Qualification testing required~~
~~Static control garment~~	~~Point-to-point resistance (see 6.3.2)~~
~~Groundable static control garment~~	~~Point-to-point resistance~~ ~~Point-to-groundable point panel (if applicable) to groundable point (see 6.3.2 and 6.3.3)~~
~~Groundable static control garment system~~	~~Point-to-point resistance from panel-to-panel~~ ~~Point-to-groundable point panel-to-groundable point (see 6.3.2, 6.3.3 and integrated wrist strap in accordance with IEC 61340-4-6)~~

Garment type	Qualification testing required	Options to comply with testing requirements
Static control garment	Resistance point-to-point (see 6.3.2)	Interior cuff-to-cuff (see 6.3.2.2) – only required if exterior of cuff is insulative and interior is conductive
	Panel-to-panel (see 6.3.2.1) – all garments	Hanging clamp sleeve-to-sleeve (see 6.3.2.3) – can be used as an alternative to panel-to-panel or interior cuff-to-cuff testing
Groundable static control garment	Resistance point-to-point (see 6.3.2)	Interior cuff-to-cuff (see 6.3.2.2) – only required if exterior of cuff is insulative and interior is conductive
	Panel-to-panel (see 6.3.2.1) – all garments	Hanging clamp sleeve-to-sleeve (see 6.3.2.3) – can be used as an alternative to panel-to-panel or interior cuff-to-cuff testing
	Resistance point-to-groundable point (see 6.3.3)	Cuff measurements (see 6.3.4) – can be used as an alternative to the method described in 6.3.2.2 when measuring resistance point-to-groundable point
Groundable static control garment system	Resistance point-to-point (see 6.3.2)	Interior cuff-to-cuff (see 6.3.2.2) – only required if exterior of cuff is insulative and interior is conductive
	Panel-to-panel (see 6.3.2.1) – all garments	Hanging clamp sleeve-to-sleeve (see 6.3.2.3) – can be used as an alternative to panel-to-panel or interior cuff-to-cuff testing
	Resistance point-to-groundable point (see 6.3.3)	Cuff measurements (see 6.3.4) – can be used as an alternative to the method described in 6.3.2.2 when measuring resistance point-to-groundable point
	Total system resistance (see 6.3.5)	

8 Reporting

Record all resistance values. Record the voltage levels, relative humidity and temperature for each test sample. Record the type of test equipment used and test date. See Annex B for an example of a data collection sheet with sketches.



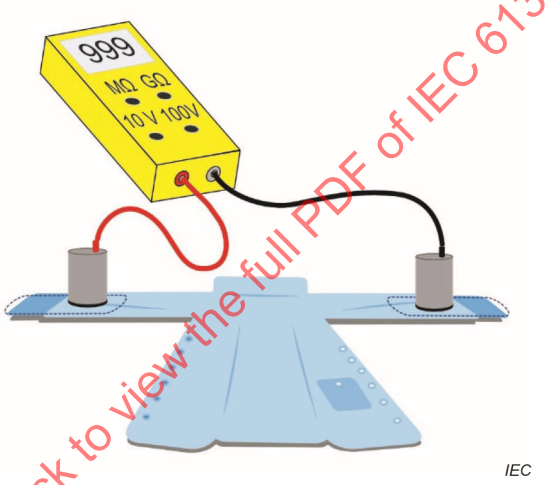
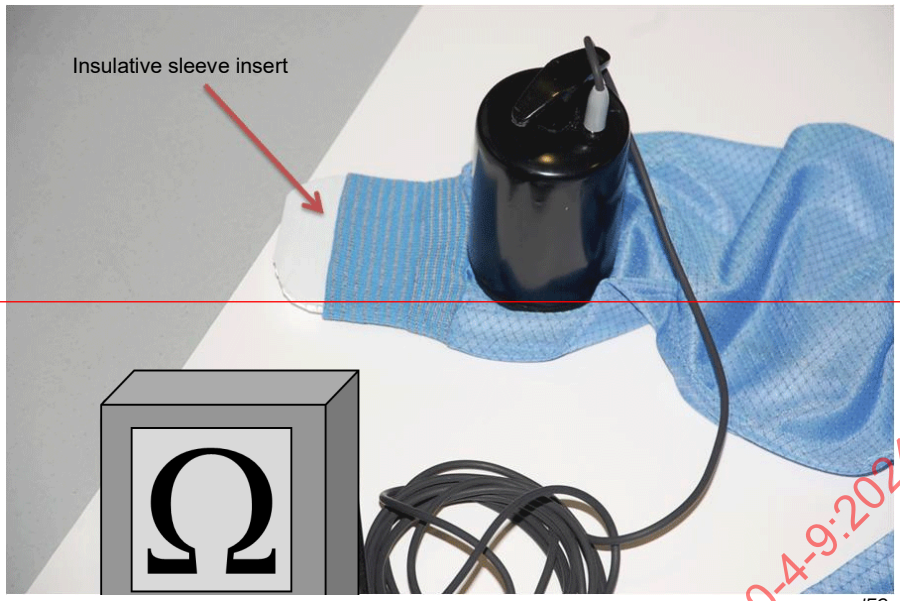
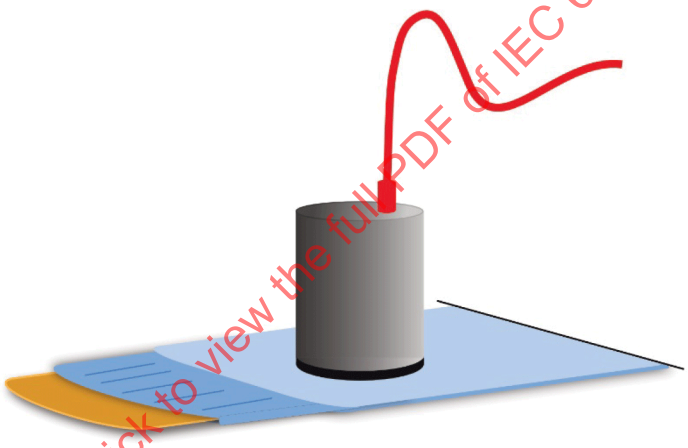


Figure 1 – Test set-up – Resistance point-to-point (sleeve-to-sleeve procedure with insulative sleeve inserts) 6

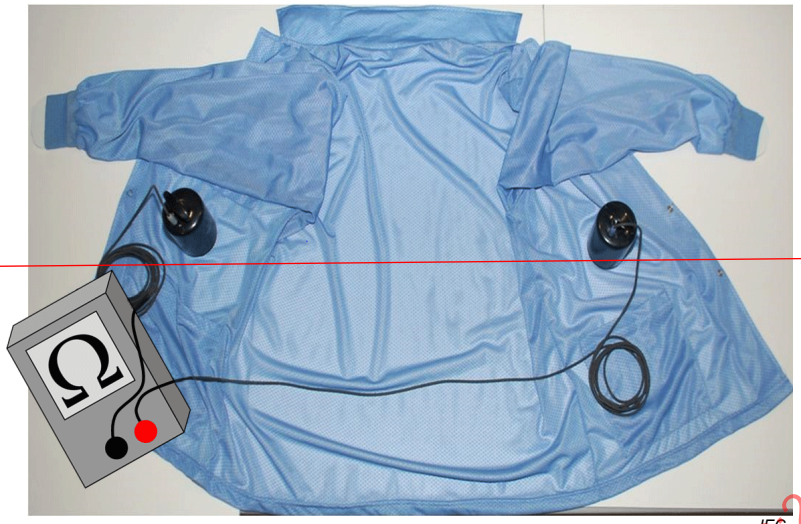


IEC



IEC

Figure 2 – Test set-up – Resistance point-to-point (insulative sleeve insert inserted into sleeve detail)



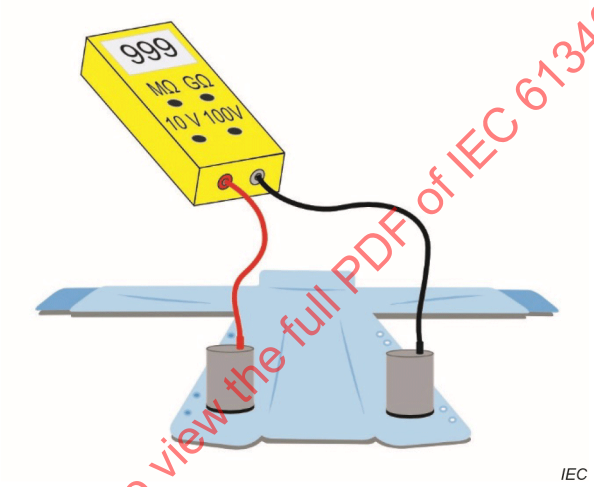
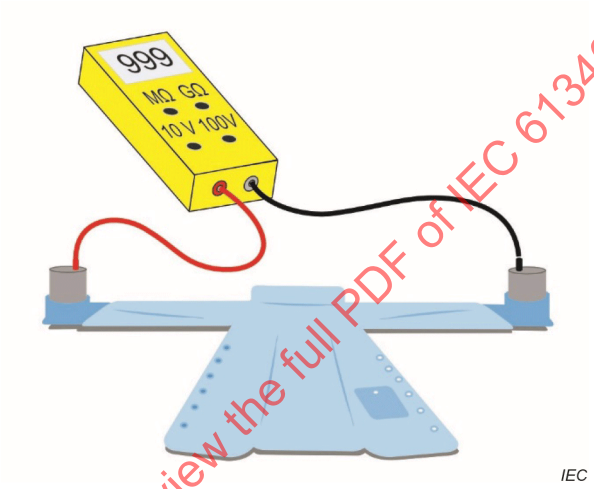


Figure 3 – Test set-up – Resistance point-to-point (panel-to-panel procedure with insulative support surface)

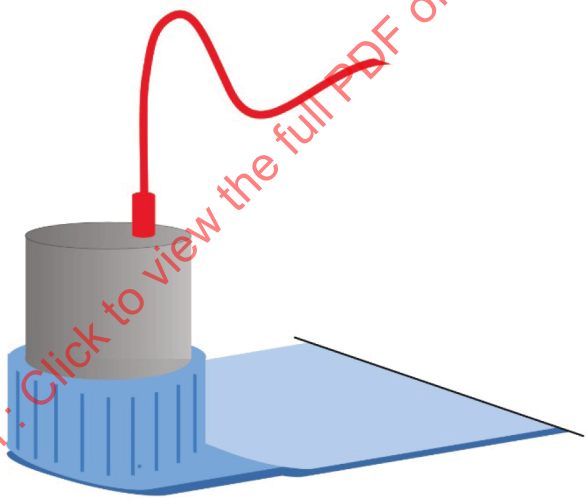
IEC



IEC

Figure 4 – Test set-up – Resistance point-to-point (cuff-to-cuff procedure ~~with insulative sleeve inserts~~)

IEC



IEC

Figure 5 – Test set-up – Resistance point-to-point (electrode inserted into cuff detail)

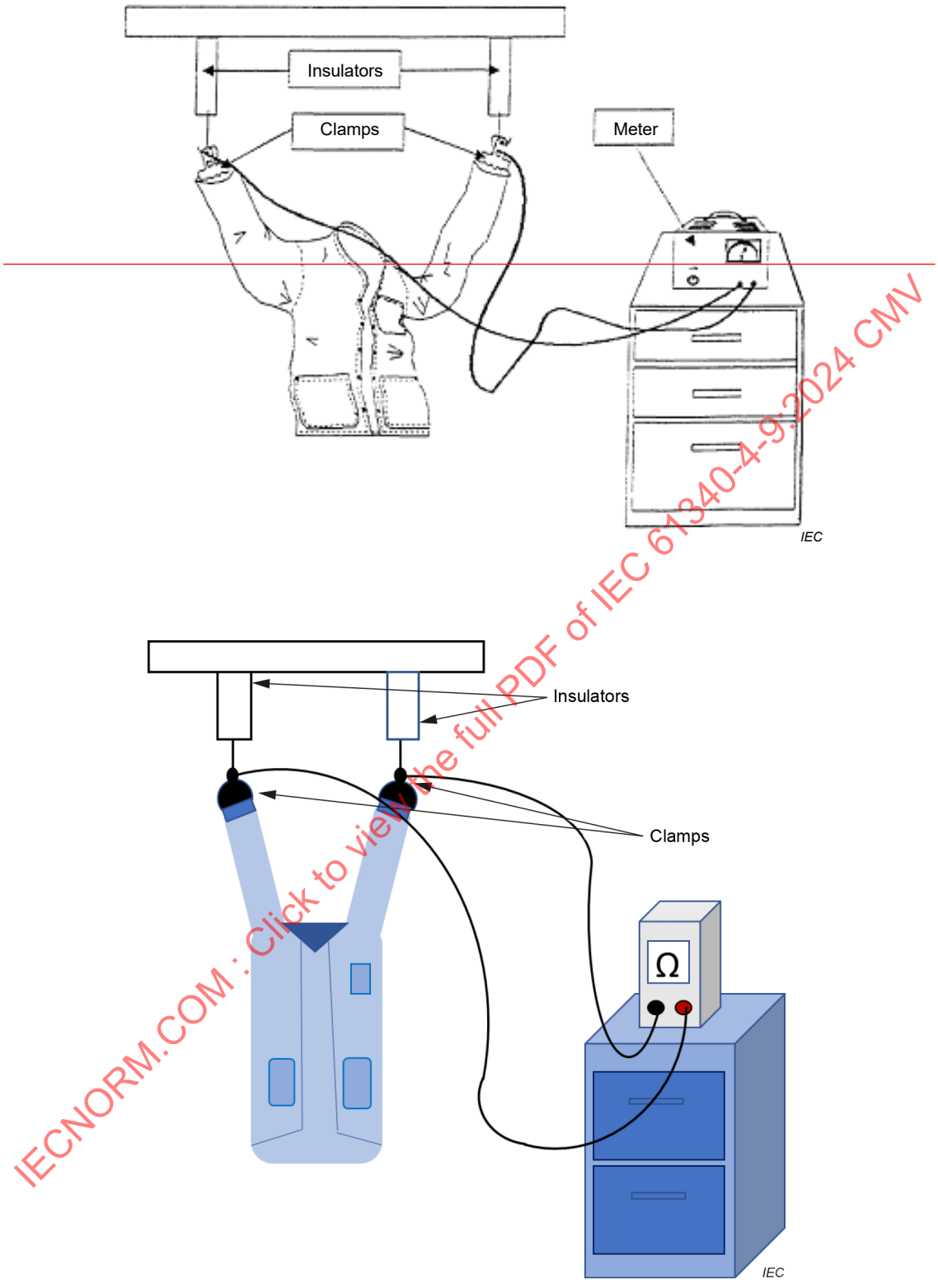


Figure 6 – Test set-up – Resistance point-to-point (hanging clamp sleeve-to-sleeve procedure)

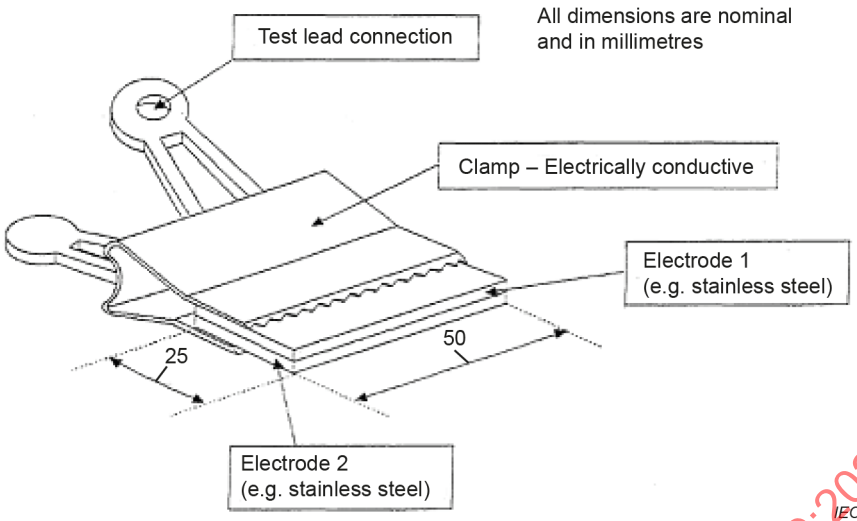
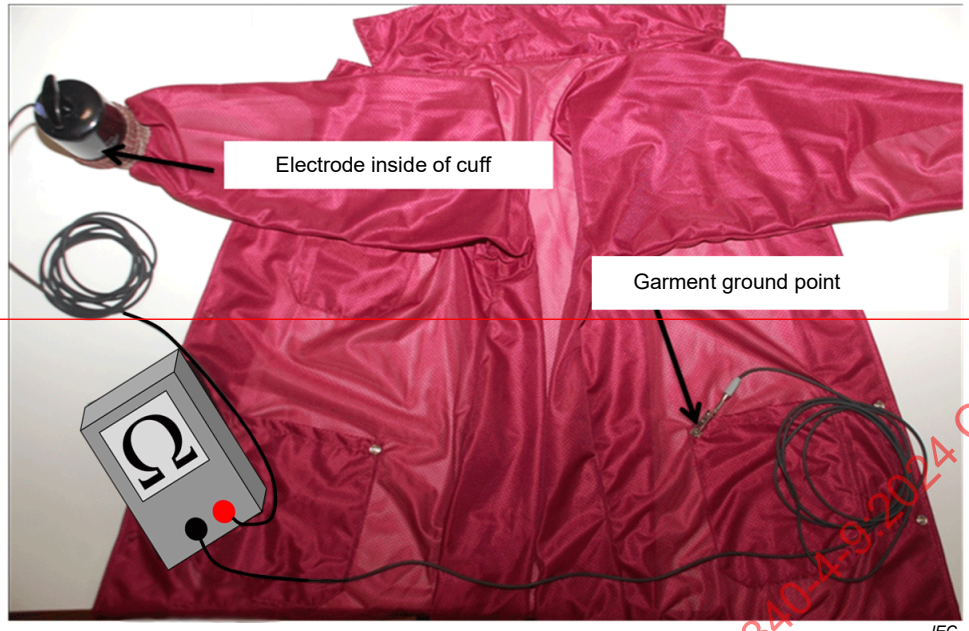


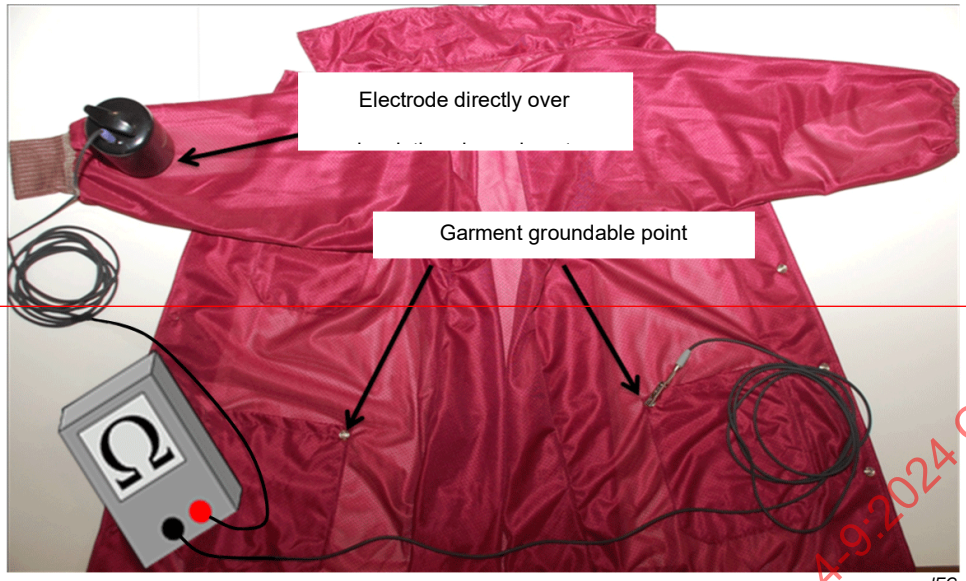
Figure 7 – Clamps~~/~~ or electrodes for hanging garment test



IEC

IEC

Figure 8 – Test set-up – Resistance point-to-groundable point (cuff-to-groundable-point procedure with insulative sleeve inserts)



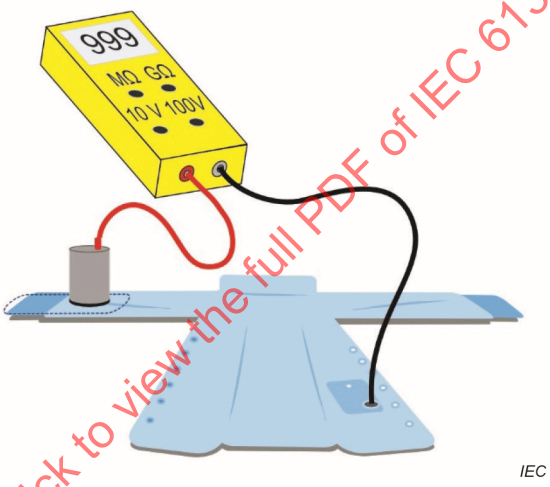


Figure 9 – Test set-up – Resistance point-to-groundable point (sleeve-to-groundable-point procedure with insulative sleeve inserts)

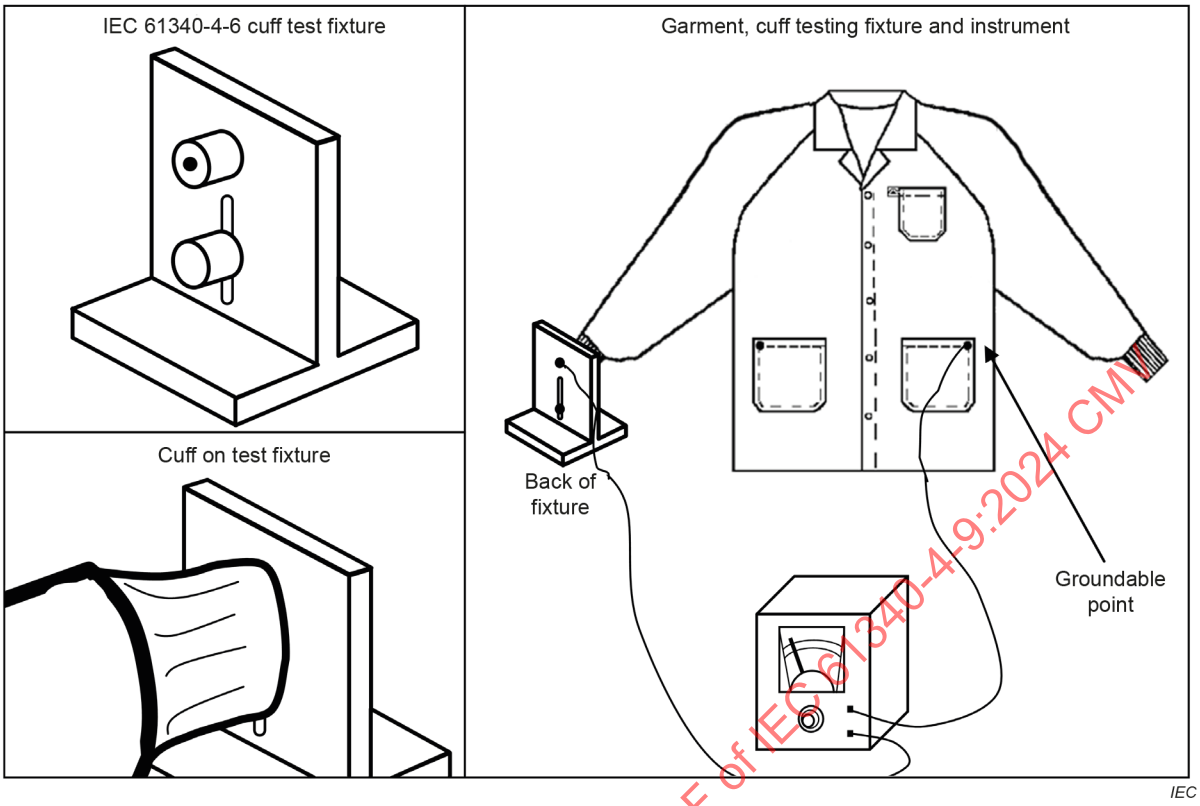


Figure 10 – Groundable garment cuff test

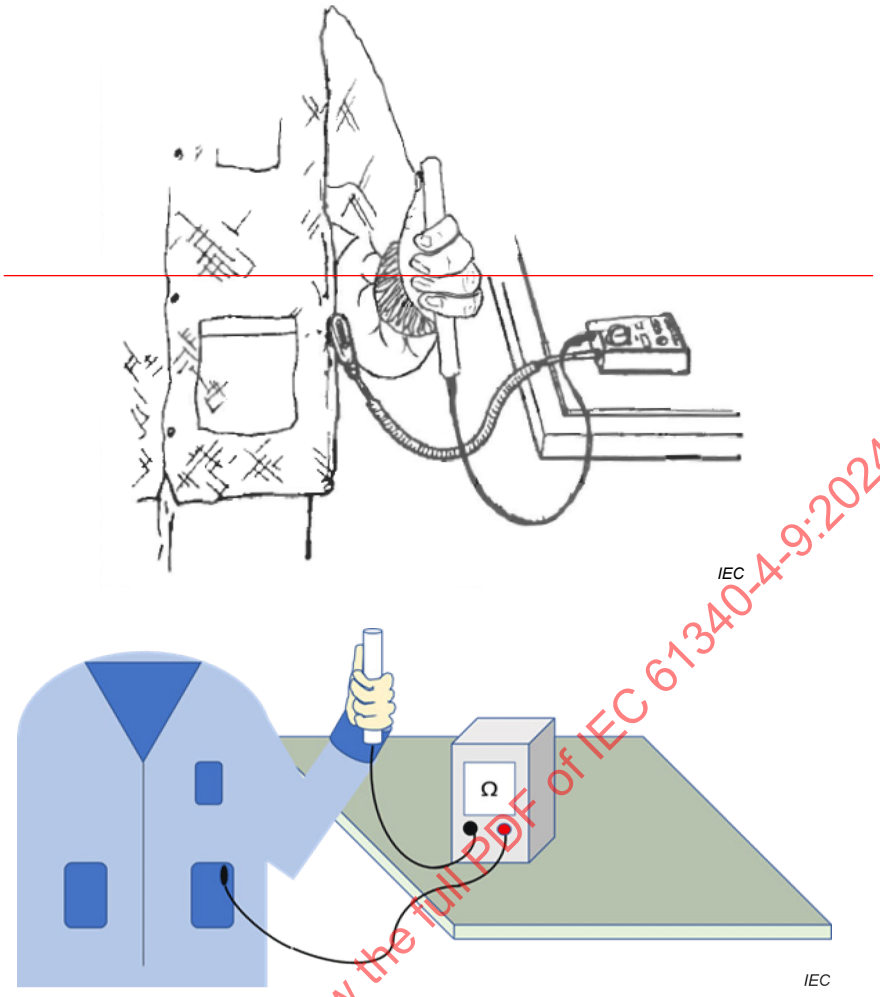


Figure 11 – Test set-up – Groundable static control garment system resistance (groundable garment in combination with a person using a meter and hand-held electrode)

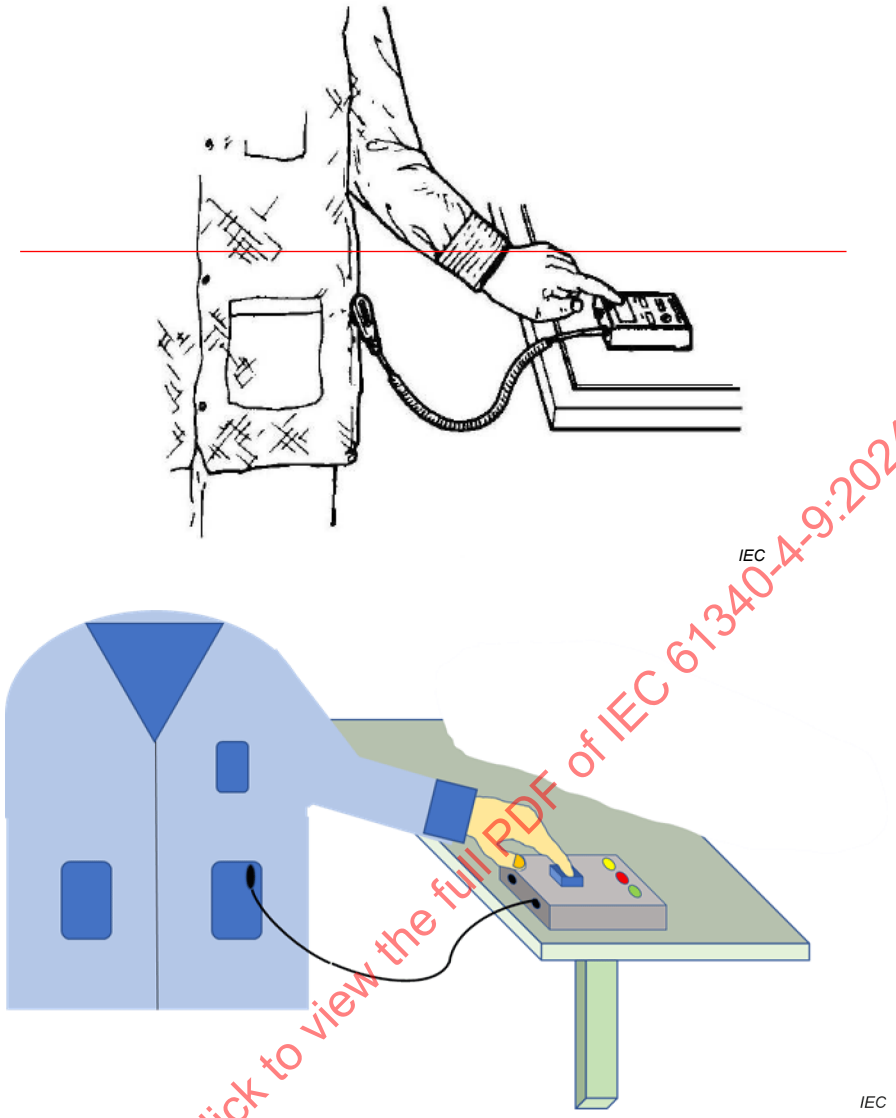


Figure 12 – Test set-up – Groundable static control garment system resistance (groundable garment in combination with a person using an integrated tester)

Annex A
(informative)

Garment types and resistance values

Table A.1 provides a list of garment types and resistance values.

Table A.1 – Garment types and resistance values

Common industry description/Use of garment system	Garment type	Test procedure	Recommended resistance values
Garments with some electrical field suppression properties	Static control garment	Resistance point-to-point	< $1{,}0 \times 10^{11}$ Ω
Garments with a designated groundable point	Groundable static control garment	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
Garment in continuous electrical path with a person; however, not the primary ground path	Groundable static control garment	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
Grounded with dual paths to ground via continuous monitoring equipment that requires two separate paths to ground	Groundable static control garment system (garment in combination with person)	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
		Integrated wrist strap in accordance with IEC 61340-4-6	< $3{,}5 \times 10^{7}$ Ω
Grounded through a single wire constant monitor system	Groundable static control garment system (garment in combination with person)	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
		Integrated wrist strap in accordance with IEC 61340-4-6	< $3{,}5 \times 10^{7}$ Ω
Garment used as primary grounding path for personnel	Groundable static control garment system (garment in combination with person)	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
		Integrated wrist strap in accordance with IEC 61340-4-6	< $3{,}5 \times 10^{7}$ Ω

The values in Table A.1 are for information only. For required limits see the latest edition of IEC 61340-5-1 [2].

Annex B
(informative)

Data collection sheet (example)

GARMENT EVALUATION TEST

Resistive characterization

Manufacturer:_____

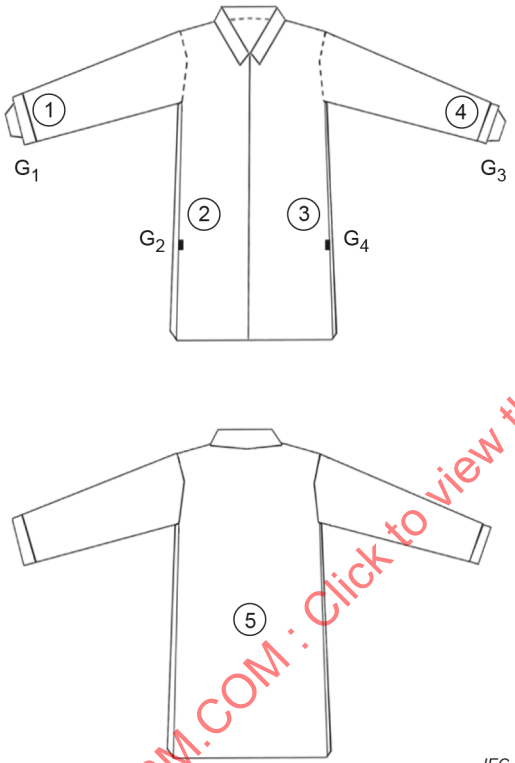
Style:_____

Product N°:_____

Procedure:_____

Date:_____

Test conditions and equipment[a]		**Report N°**
Environment	~~Moderate~~ Condition one (C1)	~~Low~~ Condition two (C2)
Humidity		
Temperature		
Electrode		
Equipment		
Voltage		



G1 and G3:

Cuff or wrist strap type grounding mechanism

G2 and G4:

Ground cord type grounding mechanism

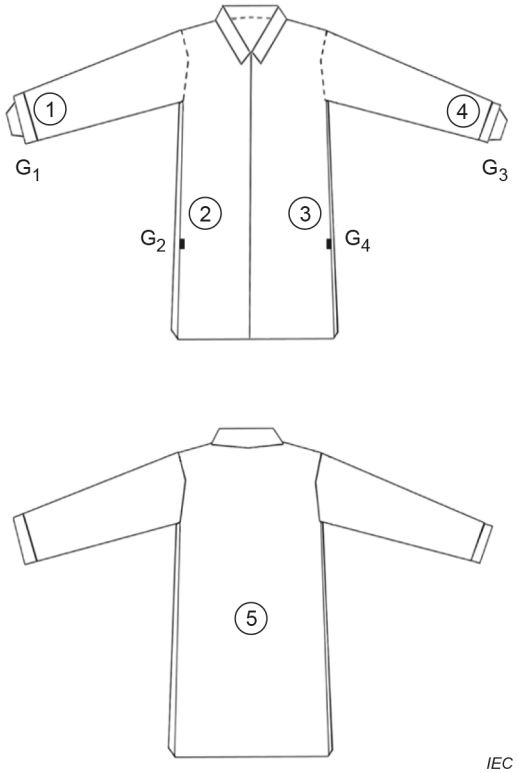
STATIC CONTROL GARMENT

Point-to-point	Sample N°		Sample N°		Sample N°	
	~~Moderate~~ C1	~~Low~~ C2	~~Moderate~~ C1	~~Low~~ C2	~~Moderate~~ C1	~~Low~~ C2
1 – 2						
1 – 3						
1 – 4						
1 – 5						
2 – 3						
2 – 4						
2 – 5						
3 – 4						
3 – 5						
4 – 5						

GROUNDABLE STATIC CONTROL GARMENT

Point-to-ground	~~Moderate~~ C1	~~Low~~ C2	~~Moderate~~ C1	~~Low~~ C2	~~Moderate~~ C1	~~Low~~ C2
1 – G4						
2 – G4						
3 – G4						
4 – G4						

[a] Only one condition is required.



G1 and G3:

Cuff or wrist strap type grounding mechanism

G2 and G4:

Ground cord type grounding mechanism

GROUNDABLE STATIC CONTROL GARMENT						
5 – G4						
5 – G2						
4 – G2						
3 – G2						
2 – G2						
1 – G2						
GROUNDABLE STATIC CONTROL GARMENT SYSTEM						
Cuff to ground	Interior	Exterior	Interior	Exterior	Interior	Exterior
G1-G2						
G3-G4						
Person to ground	Right	Left	Right	Left	Right	Left

TEST CONDITION AMBIENT

Humidity:_____

Temperature:_____

Test equipment:_____

Comments: _

Submitted by:

Bibliography

[1] IEC TS 61340-4-2, *Electrostatics – Part 4-2: Standard test methods for specific applications – Electrostatic properties of garments*

[2] IEC 61340-5-1, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

List of comments

1 The two humidity conditions are reduced to one. The low humidity condition is considered the worst case situation.

2 Tolerance is replaced with values instead of percentages.

3 Requirement for washing cycles before testing is included. This is to ensure any temporary finish on the garment is removed.

4 Multiple measurements are added to ensure that the testing does not have any errors. Garments may not always make good contact with the electrodes.

5 Table 1 is updated to define the testing methods for each garment type. It lists the sections where the test procedures are located in the document and options to meet the requirements.

6 Drawings are updated to show generic garments and meters.

_____

IEC 61340-4-9

Edition 3.0 2024-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electrostatics –
Part 4-9: Standard test methods for specific applications – Garments – Resistive characterization

Électrostatique –
Partie 4-9: Méthodes d'essai normalisées pour des applications spécifiques – Vêtements – Caractéristiques résistives

IEC 61340-4-9:2024-10(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTROSTATICS –

Part 4-9: Standard test methods for specific applications – Garments – Resistive characterization

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61340-4-9 has been prepared by IEC technical committee 101: Electrostatics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2016. This edition constitutes a technical revision.

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

a) IEC 61010-1 and IEC 61010-2-030 added as requirements for measurement equipment;
b) testing voltage range for personnel ground path changed from "7 V DC to 30 V DC" to "7 V DC to 100 V DC";

c) cleaning requirements changed from a minimum of five cycles of cleaning to a minimum of three cycles of cleaning;

d) moderate humidity requirements deleted;

e) figures replaced with generic drawings.

The text of this International Standard is based on the following documents:

Draft	Report on voting
101/718/FDIS	101/721/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 61340 provides test methods for evaluating the electrical resistance of garments that contain surface conductive or dissipative components or materials used in the electronics industry for the control of electrostatic discharge. This document defines procedures for measuring electrical resistance, including a system resistance test for garments that provide a ground path for personnel.

Clothing made from synthetic fibres is a common source of electrostatic charge. Wearing an appropriate static control garment over personnel clothing can minimize the effect of this charge. To effectively control electrostatic charges of the static control garments and effectively shield the electrostatic field of personnel clothing, the static control garment should be grounded.

Three categories of garments are considered in this document.

a) A static control garment can suppress or otherwise affect an electric field from clothing worn underneath the garment without being attached to ground. However, without grounding, a charge can accumulate on conductive or dissipative elements of a garment, if present, resulting in a charged source.

b) A groundable static control garment can provide a higher level of suppression when the lower resistance fabric is connected to ground.

c) A groundable static control garment system provides a ground path for a person that suppresses the electrical field from clothing worn underneath the garment and also bonds the skin of the wearer to an identified ground path. Groundable static control garment systems can also be used in conjunction with a continuous or constant monitoring system in a manner similar to those used in continuous monitoring of wrist straps in an ESD protected area (EPA).

Resistive characterization is only one aspect to consider in evaluating garments for any specific application. To fully characterize a garment, it can be necessary to take into consideration electrical field attenuation, static decay, peak voltage, residual voltage and triboelectric charging. Other attributes related to applications and environments, such as cleanroom compatibility, chemical and fire resistance, should be evaluated in the garment selection process but are beyond the scope of this document.

Garments constructed from fabrics made with fibres that are not surface conductive but can have other related properties that impart some level of electrostatic charge dissipation or suppression when connected to ground, are not specifically measured by the methods provided in this document. This being the case, some garment fabrics and construction can allow for surface voltage accumulation and charge transfer to occur which can be detrimental to electronic items.

Alternate methods for evaluating the electrostatic properties of garments are described in IEC TS 61340-4-2 [1][1].

1 Numbers in square brackets refer to the Bibliography.

ELECTROSTATICS –

Part 4-9: Standard test methods for specific applications – Garments – Resistive characterization

1 Scope

This part of IEC 61340 provides test methods for measuring the electrical resistance of garments used for static control applications. These test methods can be used for evaluating outer garments that are homogenously conductive or homogeneously dissipative, or that utilize surface conductive or surface dissipative components or elements.

NOTE It is possible that the test methods defined in this document will not be able to measure materials with buried conductive layers.

The resistance point-to-point test method tests the electrical resistance between the two sleeves, any two panels or any two electrically interconnected components of the static control garment, including the electrical resistance across the seams and cuffs of the garment as applicable.

An alternate sleeve-to-sleeve test method is described, using clamps to hang a garment.

Static control garments that electrically bond to the wearer and provide a path to ground from the wearer are evaluated using the resistance point-to-point test method, the resistance point-to-groundable point test method, as well as a system test to determine the resistance from the person through the garment to the groundable point of the garment system.

A band resistance measurement test is provided in IEC 61340-4-6 which can be used for garments so equipped with cuffs that are intended to perform the same function as a wrist strap band.

The system test with a person wearing a groundable static control garment system includes the ground cord that connects to the groundable point of the garment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits*

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

IEC 61340-4-6, *Electrostatics – Part 4-6: Standard test methods for specific applications – Wrist straps*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
acceptance testing
testing used to confirm to users that products delivered are substantially the same as the samples used to qualify products

3.2
garment system
any electrically interconnected components of a static control apparel

3.3
point-to-point resistance
resistance measured from one point to another on the surface of the same panel or two different panels of a garment

Note 1 to entry: Point-to-point resistance is expressed in Ω.

3.4
static control garment
personnel garment that is designed for electrostatic charge control

3.5
product qualification
testing used to confirm that products comply with the requirements of an ESD control program or other specification

3.6
groundable static control garment
garment that exhibits an electrical resistance from point-to-point and from any point or panel on the garment to the groundable point on the garment

Note 1 to entry: The groundable point can be a cuff contact to the wearer's skin or a separate dedicated grounding point connector.

3.7
groundable static control garment system
system whereby a garment that is used to establish the primary ground path for a person to the groundable point of the garment and the connection of the garment to ground, typically through a grounding cord

Note 1 to entry: The garment is a groundable static control garment as defined in 3.6, with additional features to enable grounding of the wearer.

4 Atmosphere for conditioning and testing

The following requirements supersede any other specification relating to the atmosphere for conditioning and testing that can be given in one or more of the documents referred to in this document.

Unless otherwise agreed, the atmosphere for conditioning and testing for laboratory evaluations shall be at a temperature of 23 °C ± 2 °C and 12 % ± 3 % relative humidity. The conditioning time prior to testing shall be at least 48 h.

5 Equipment and materials

5.1 Resistance measurement apparatus

5.1.1 General

Electrical equipment for measurement shall comply with the safety requirements of IEC 61010-1 and IEC 61010-2-030. The measurement apparatus, called the meter, whether it is a single meter or collection of instruments, shall be capable of the following.

5.1.2 Product qualification

The meter shall have a circuit voltage while under load of (100 ± 5) V for measurements of $1,0 \times 10^6$ Ω and above, and (10 ± 0,5) V for measurements from $1,0 \times 10^4$ Ω to $1,0 \times 10^6$ Ω. The meter shall have an open circuit or under load voltage of (10 ± 0,5) V) for measurement from $1,0 \times 10^3$ Ω to $1,0 \times 10^4$ Ω.

The meter shall be capable of making measurements from $1,0 \times 10^3$ Ω to $1,0 \times 10^{12}$ Ω.

5.1.3 Acceptance testing

The product qualification meter can be used for acceptance testing or the following:

The meter shall have an open circuit voltage of (100 ± 5) V for measurements of $1,0 \times 10^6$ Ω and above, and (10 ± 0,5) V for measurements less than $1,0 \times 10^6$ Ω.

The meter shall be capable of making measurements from $1,0 \times 10^3$ Ω to $1,0 \times 10^{12}$ Ω.

In case of disagreement, the meter used for product qualification shall be used to resolve any disputes.

5.1.4 Ohmmeter for testing personnel ground path

Integrated tester or meter, whether it is a single meter (ohmmeter) or a collection of instruments that are capable of measuring from $5,0 \times 10^4$ Ω to at least $1,0 \times 10^8$ Ω with a test voltage from 7 V DC to 100 V DC open circuit. If the test voltage exceeds 60 V DC, or 35 V DC in wet locations, the additional safety limits for current and capacitive charge specified in IEC 61010-1 shall be applied.

Both test leads should be capable of being isolated from ground. AC line-powered resistance measuring devices can give erroneous results due to undefined ground paths. Battery powered equipment is recommended.

5.2 Resistance measurement electrodes

5.2.1 Cylindrical electrodes

A cylindrical 2,5 kg ± 0,25 kg electrode with a diameter of 63,5 mm ± 1 mm, having a contact of electrically conductive material with a Shore-A durometer hardness between 50 and 70. The resistance between two electrodes should be less than $1,0 \times 10^3$ Ω when measured at 10 V on a metallic surface.

5.2.2 Clamps or electrodes

The clamps or electrodes shall consist of two flat electrically conductive plates (e.g. stainless steel) with a dimension of approximately 50 mm × 25 mm each. The clamps or electrodes shall be electrically conductive with sufficient compression force to retain and suspend the garment. See Figure 7.

5.2.3 Cuff test fixture

A test fixture comprising an insulative stand and two stainless steel cylinders (25,0 ± 0,5) mm in diameter, with one cylinder fixed to the stand directly above the second. The second cylinder shall have a mass of (0,11 ± 0,01) kg and is mounted in a slot in the stand that allows free vertical movement. See Figure 10.

5.2.4 Hand-held electrode

A hand-held electrode, for example stainless steel, brass, copper or other suitable metal round or tubular stock, approximately 25 mm in diameter and 75 mm or greater in length, with provision for connection to the meter (such as a banana plug receptacle or screw connector) attached to one end of the cylinder. See Figure 11.

5.3 Support surface

5.3.1 Insulative support surface

An insulative surface when used for specimen support shall have a surface resistance of greater than $1,0 \times 10^{12}$ Ω when measured in accordance with IEC 61340-2-3. The insulative surface shall be large enough to accommodate the entire garment when it is laid out flat.

5.3.2 Insulative sleeve inserts

Two pieces of insulative material meeting the requirements of 5.3.1 cut into approximately 75 mm by 152 mm strips to slide into the sleeves (and cuffs if so equipped) of garments under test to isolate one side of the sleeve from the other.

5.3.3 Insulative hangers

The points to which the clamps described in 5.2.2 holding a garment under test shall be isolated from ground by a resistance greater than $1,0 \times 10^{12}$ Ω when measured with an instrument meeting the requirements of 5.1.3. Insulating thread can be used for this purpose.

6 Test procedure

6.1 Sample preparation

6.1.1 General

Garments can have a temporary finish on them, either a residue from processing treatments or deliberately applied by garment manufacturers, that can reduce electrical resistance. Such finishes shall be removed before proper evaluation of the long-term properties of garments can be made. This can be achieved by processing garments through a minimum of three cycles of the garment manufacturer's specified or user defined cleaning process, prior to performing laboratory tests.

The person performing the tests should examine the garment's construction and make a general sketch showing separate front and back panels used to fabricate the garment. Number the panels for measurement identification purposes from No. 1 to No. n. Identify the sleeves and cuffs as left and right. The groundable points, if they exist, should be shown on the sketch. The sketch should accompany the test results to become part of the test report.

6.1.2 Number of samples

Test a minimum of three samples for each style and manufacturer when using this test method for qualification.

6.2 Humidity requirements

For product qualification, resistance point-to-point, resistance point-to-groundable point and cuff measurements shall be conducted at humidity conditions according to Clause 4. Humidity conditioning for product qualification of the groundable static control garment system is optional and can require a walk-in environmental chamber.

6.3 Test procedures

6.3.1 General

Subclause 6.3 defines the test methods for measuring the electrical resistance of garments. It includes a resistance point-to-point test and a resistance point-to-groundable point test. The described test procedures can be used for product qualification and acceptance testing. A system test for a garment that provides a path to ground from a person while being worn is also described.

6.3.2 Resistance point-to-point

6.3.2.1 Panel-to-panel

Precondition the test samples according to 6.2 as required. Place the garment on an insulative support surface as described in 5.3.1. Place the garment with the front panels opened and laid out as flat as possible (it is possible that larger garments such as overalls will not allow this completely). Place the insulative sleeve inserts from 5.3.2 into each sleeve (including the cuff, if so equipped, or leg cuffs of an overall) of the garment under test. Attach test leads from the resistance measuring apparatus (meter) to the electrodes defined in 5.2.1. Place one electrode on a panel of the sample. Place the second electrode on another panel of the same sample. Ensure the panels are on the insulative support surface and do not touch any other part of the garment. Apply 10 V and observe the reading after 5 s. If the reading is less than $1{,}0 \times 10^6$ Ω, record the value. If the reading is greater than or equal to $1{,}0 \times 10^6$ Ω, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Switching the test voltage to 100 V can result in a resistance reading of less than $1{,}0 \times 10^6$ Ω. When this occurs the reading made with the 100 V test voltage shall be recorded. Repeat for all electrically interconnected components and panels as well as exterior cuff-to-cuff and sleeve-to-sleeve, making sure that the electrodes are directly above the insulative inserts (see Figure 1, Figure 2 and Figure 3). Resistance point-to-point measurements can give variable results depending on the arrangement of the garment under test and location of electrodes on it. For qualification testing, at least three measurements shall be made with the garment arrangement and electrode location rearranged between each measurement. The result is the highest of the three measured values. Repeat for all test samples.

6.3.2.2 Interior cuff-to-cuff

Some garments can have an insulative exterior and conductive interior of the cuff or incorporate a wrist strap band or another wrist bonding mechanism or device. Precondition the test samples according to 6.2 as required. Insert the measurement electrodes inside the cuffs or wrist bonding devices (see Figure 4 and Figure 5). Apply 10 V and observe the reading after 5 s. If the reading is less than $1{,}0 \times 10^6$ Ω, record the value. If the reading is greater than or equal to $1{,}0 \times 10^6$ Ω, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Switching the test voltage to 100 V can result in a resistance reading of less than $1{,}0 \times 10^6$ Ω. When this occurs, the reading made with the 100 V test voltage shall be recorded. Repeat for all test samples.

6.3.2.3 Hanging clamp sleeve-to-sleeve

Precondition the test samples according to 6.2 as required. Hang the garment from each sleeve with electrically isolated clamps (see Figure 6). Place the clamps so that they connect the exterior and the interior of the cuff. The resistance measurement shall be made by attaching a test lead to one clamp and attaching the other test lead to the other clamp. Apply 10 V and observe the reading after 5 s. If the reading is less than $1,0 \times 10^6$ Ω, record the value. If the reading is greater than or equal to $1,0 \times 10^6$ Ω, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Switching the test voltage to 100 V can result in a resistance reading of less than $1,0 \times 10^6$ Ω. When this occurs, the reading made with the 100 V test voltage shall be recorded. Repeat for all test samples.

6.3.3 Resistance point-to-groundable point

Precondition the test samples according to 6.2 as required. Place the garment with the front panels opened and laid out as flat as possible (it is possible that larger garments such as overalls will not allow this completely) on an insulative support surface as described in 5.3.1. Use one electrode as described in 5.2.1 connected to one test lead of the meter. Place the insulative sleeve insert from 5.3.2 into each sleeve of the garment under test. Place the electrode on a cuff (see 6.3.2.2 for interior cuff-to-cuff measurements), sleeve (directly above the insulative insert) or panel. Connect the other test lead of the meter to the garment groundable point. Apply 10 V and observe the reading after 5 s. If the reading is less than $1,0 \times 10^6$ Ω, record the value. If the reading is greater than or equal to $1,0 \times 10^6$ Ω, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Switching the test voltage to 100 V can result in a resistance reading of less than $1,0 \times 10^6$ Ω. When this occurs, the reading made with the 100 V test voltage shall be recorded. If cuffs are designated as groundable points, measurements shall be made between sleeves and cuffs or between panels and cuffs; see 6.3.2.2 for cuff-to-cuff measurements. Repeat for all panels, sleeves and cuffs and groundable points (see Figure 8 and Figure 9). Repeat for all test samples.

6.3.4 Cuff measurements

IEC 61340-4-6 provides test methods for the evaluation of wrist strap bands and cuffs. These methods can be adapted for use in testing garment cuffs or any wrist strap cuff type grounding mechanism that can be part of a garment and used to bond to the skin of the wearer. The band resistance test procedure described in IEC 61340-4-6 shall be used to measure the interior resistance of the garment cuff or wrist strap grounding mechanism (see Figure 10).

NOTE Some garments can be used in conjunction with resistance continuous monitoring systems. Garments of this type can have one cuff that provides the skin contact for personnel grounding, and the other cuff is used for monitoring the electrical continuity between the garment and the wearer. The two cuffs are isolated electrically from each other in this type of garment. The manufacturer can be contacted for assistance in measuring this type of garment.

6.3.5 Groundable static control garment system

Users of this document should ensure that garments tested in this procedure meet the grounding requirements at the lowest humidity levels experienced in their facility.

This procedure verifies the resistance path from a person wearing the garment, through the body-garment cuff contacts or wrist strap cuff type grounding mechanism to the ground termination point of the garment grounding wire. Testing in a controlled environment is not a requirement of this subclause. Personnel shall wear the garment under test for a minimum of 10 min prior to testing.

This test is conducted with the meter described in 5.1.4. This test includes the ground cord and wearer's resistance as part of the total system resistance (see Figure 11 and Figure 12). The test can be performed using a proprietary integrated tester (Figure 12) or resistance meter of similar specification (Figure 11). Connect the grounding point of the garment to the tester using the ground cord. Contact is made to the tester via a push button, contact plate (on the integrated tester, Figure 12) or a hand-held electrode (Figure 11). Apply the test voltage and record the result.

7 Product qualification

Table 1 describes the test required, based on the garment that is being qualified. For more information on garments, see Annex A.

Table 1 – Product qualification

Garment type	Qualification testing required	Options to comply with testing requirements
Static control garment	Resistance point-to-point (see 6.3.2)	Interior cuff-to-cuff (see 6.3.2.2) – only required if exterior of cuff is insulative and interior is conductive
	Panel-to-panel (see 6.3.2.1) – all garments	Hanging clamp sleeve-to-sleeve (see 6.3.2.3) – can be used as an alternative to panel-to-panel or interior cuff-to-cuff testing
Groundable static control garment	Resistance point-to-point (see 6.3.2)	Interior cuff-to-cuff (see 6.3.2.2) – only required if exterior of cuff is insulative and interior is conductive
	Panel-to-panel (see 6.3.2.1) – all garments	Hanging clamp sleeve-to-sleeve (see 6.3.2.3) – can be used as an alternative to panel-to-panel or interior cuff-to-cuff testing
	Resistance point-to-groundable point (see 6.3.3)	Cuff measurements (see 6.3.4) – can be used as an alternative to the method described in 6.3.2.2 when measuring resistance point-to-groundable point
Groundable static control garment system	Resistance point-to-point (see 6.3.2)	Interior cuff-to-cuff (see 6.3.2.2) – only required if exterior of cuff is insulative and interior is conductive
	Panel-to-panel (see 6.3.2.1) – all garments	Hanging clamp sleeve-to-sleeve (see 6.3.2.3) – can be used as an alternative to panel-to-panel or interior cuff-to-cuff testing
	Resistance point-to-groundable point (see 6.3.3)	Cuff measurements (see 6.3.4) – can be used as an alternative to the method described in 6.3.2.2 when measuring resistance point-to-groundable point
	Total system resistance (see 6.3.5)	

8 Reporting

Record all resistance values. Record the voltage levels, relative humidity and temperature for each test sample. Record the type of test equipment used and test date. See Annex B for an example of a data collection sheet with sketches.

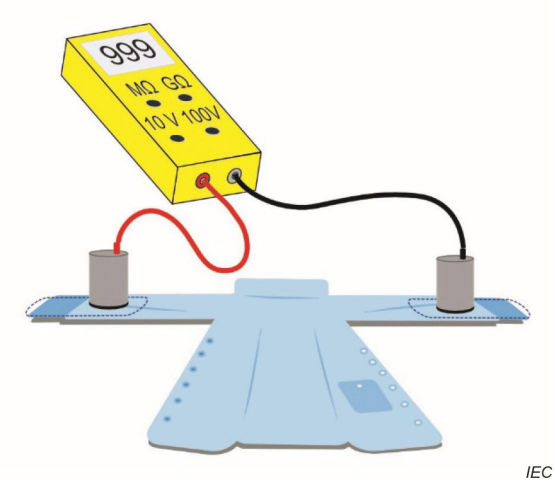


Figure 1 – Test set-up – Resistance point-to-point (sleeve-to-sleeve procedure with insulative sleeve inserts)

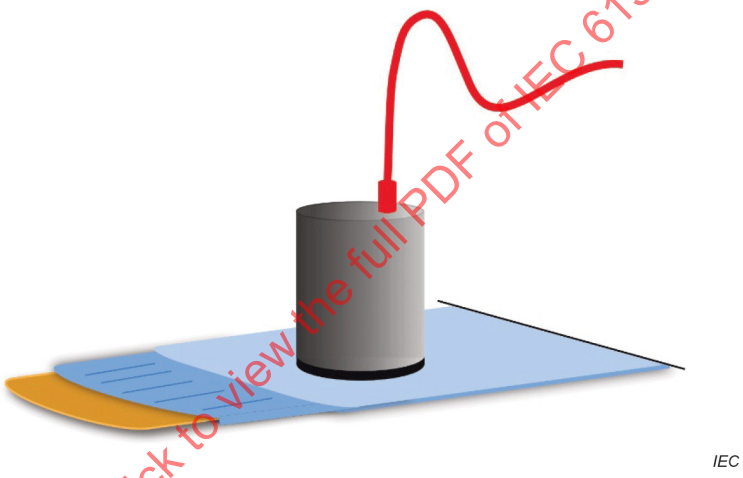


Figure 2 – Test set-up – Resistance point-to-point (insulative sleeve insert inserted into sleeve detail)

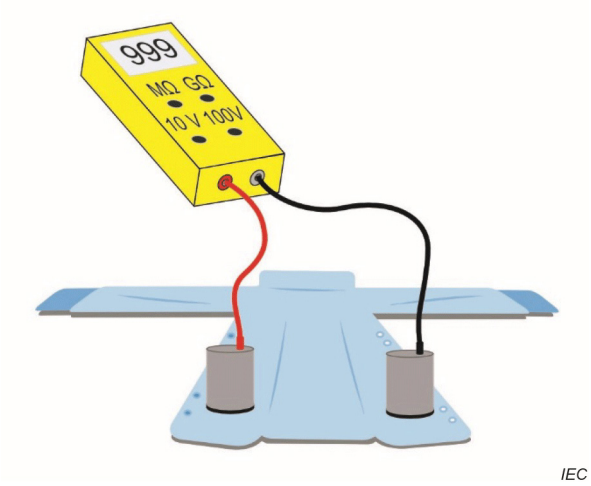


Figure 3 – Test set-up – Resistance point-to-point (panel-to-panel procedure with insulative support surface)

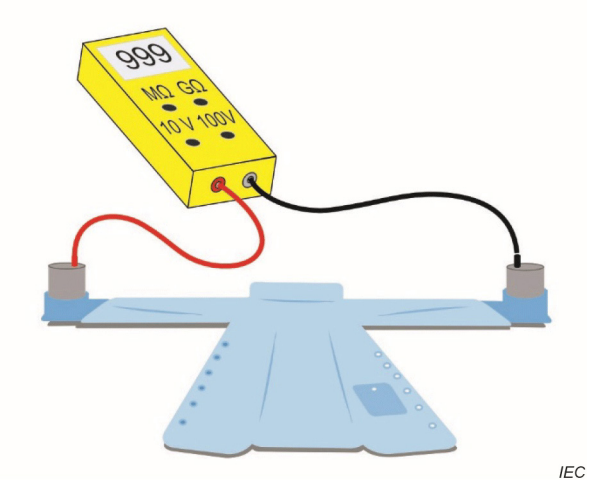


Figure 4 – Test set-up – Resistance point-to-point (cuff-to-cuff procedure)

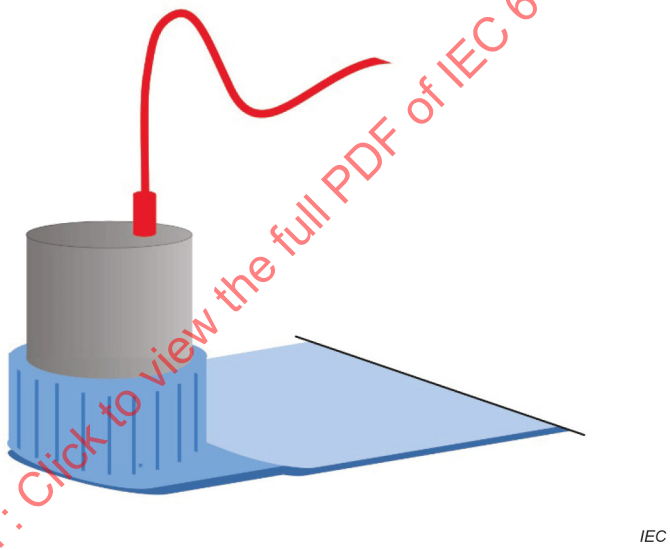


Figure 5 – Test set-up – Resistance point-to-point (electrode inserted into cuff detail)

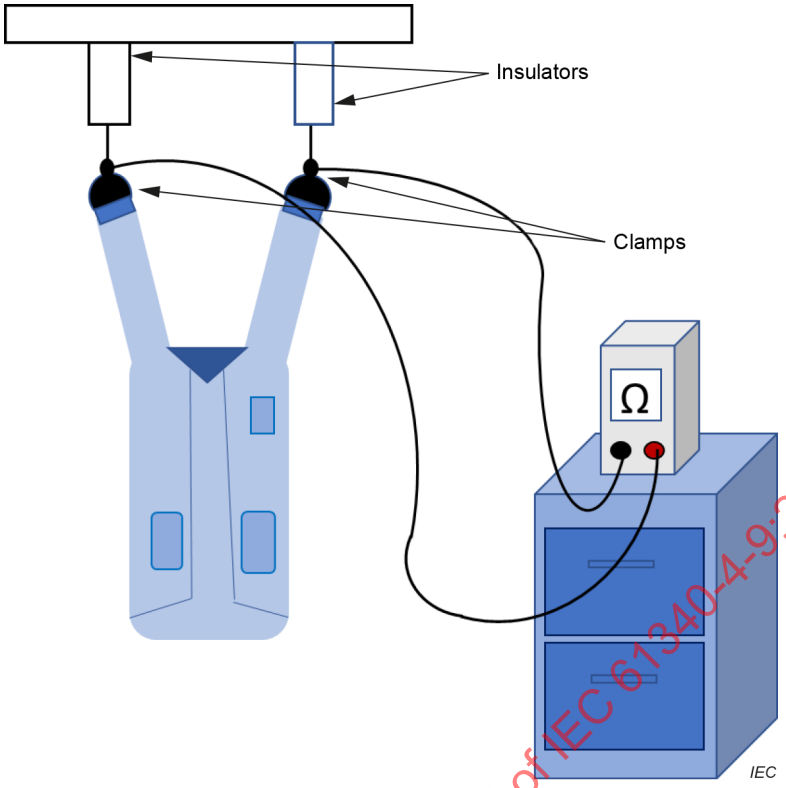


Figure 6 – Test set-up – Resistance point-to-point (hanging clamp sleeve-to-sleeve procedure)

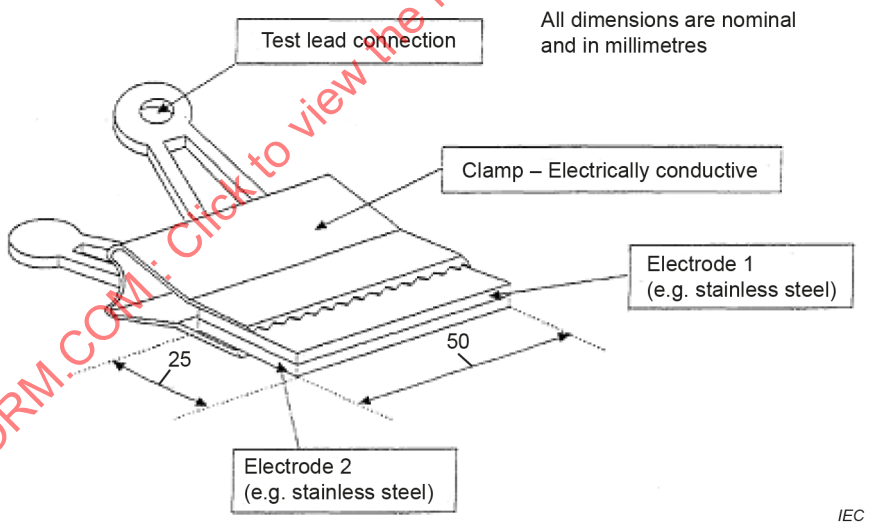


Figure 7 – Clamps or electrodes for hanging garment test

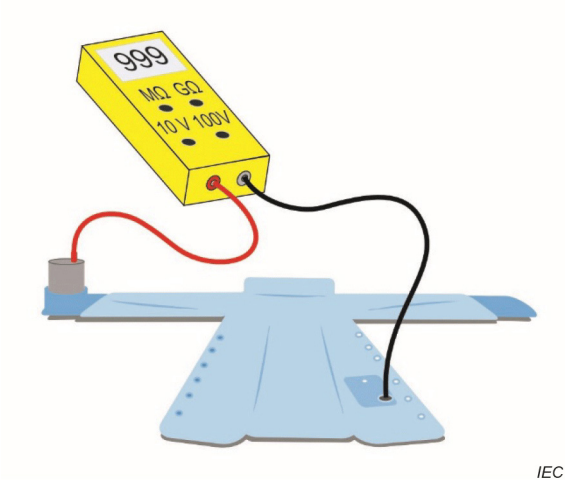


Figure 8 – Test set-up – Resistance point-to-groundable point (cuff-to-groundable-point procedure with insulative sleeve inserts)

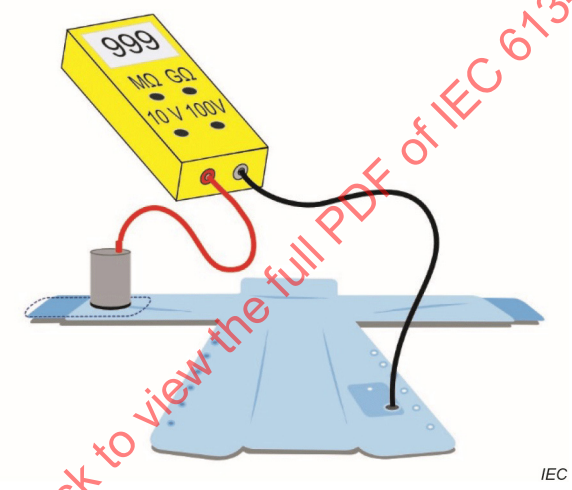


Figure 9 – Test set-up – Resistance point-to-groundable point (sleeve-to-groundable-point procedure with insulative sleeve inserts)

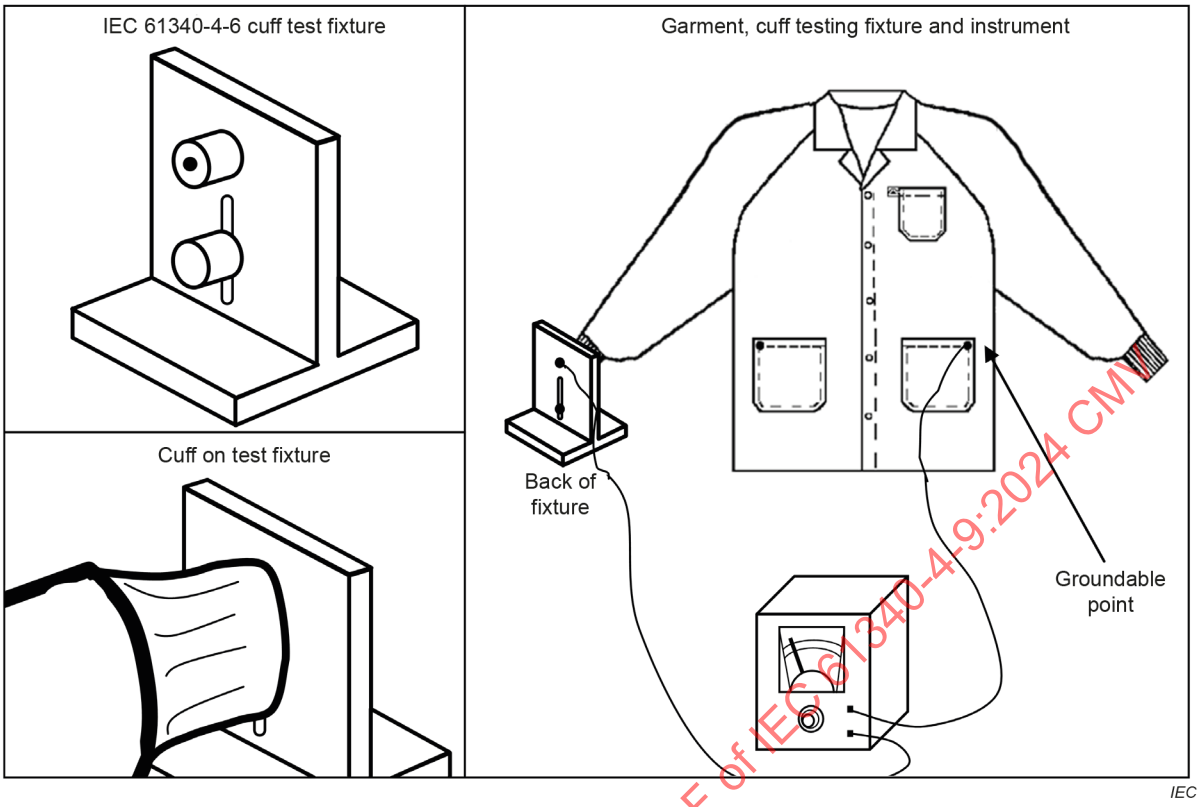


Figure 10 – Groundable garment cuff test

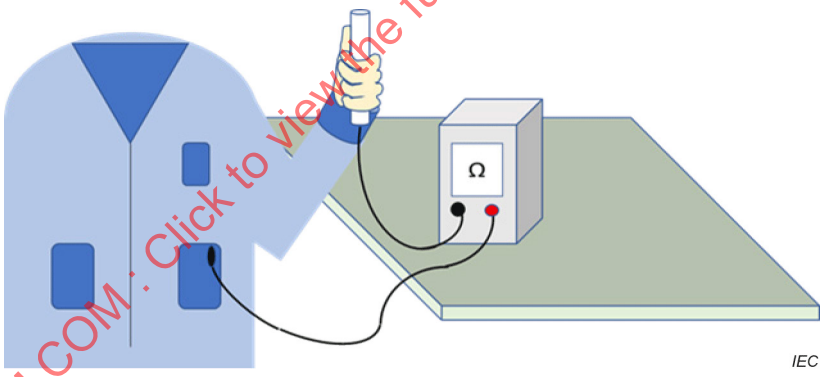


Figure 11 – Test set-up – Groundable static control garment system resistance (groundable garment in combination with a person using a meter and hand-held electrode)

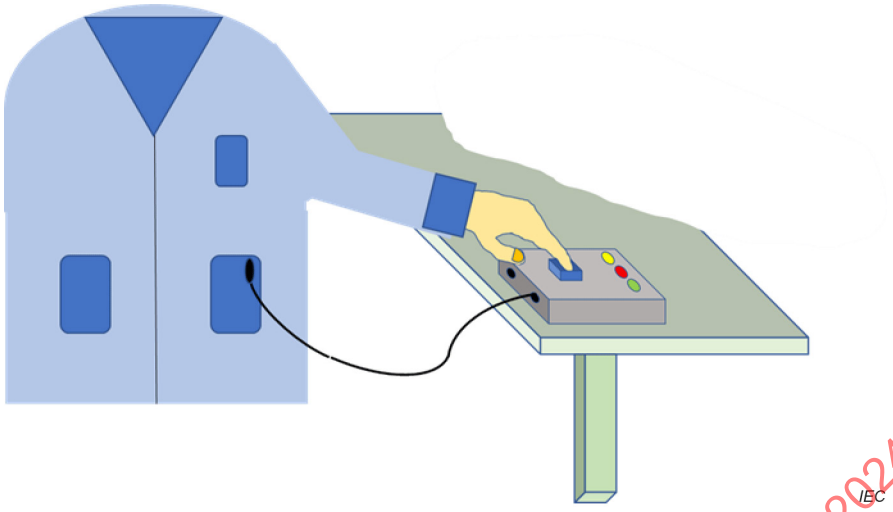


Figure 12 – Test set-up – Groundable static control garment system resistance (groundable garment in combination with a person using an integrated tester)

Annex A
(informative)

Garment types and resistance values

Table A.1 provides a list of garment types and resistance values.

Table A.1 – Garment types and resistance values

Common industry description/Use of garment system	Garment type	Test procedure	Recommended resistance values
Garments with some electrical field suppression properties	Static control garment	Resistance point-to-point	< $1{,}0 \times 10^{11}$ Ω
Garments with a designated groundable point	Groundable static control garment	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
Garment in continuous electrical path with a person; however, not the primary ground path	Groundable static control garment	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
Grounded with dual paths to ground via continuous monitoring equipment that requires two separate paths to ground	Groundable static control garment system (garment in combination with person)	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
		Integrated wrist strap in accordance with IEC 61340-4-6	< $3{,}5 \times 10^{7}$ Ω
Grounded through a single wire constant monitor system	Groundable static control garment system (garment in combination with person)	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
		Integrated wrist strap in accordance with IEC 61340-4-6	< $3{,}5 \times 10^{7}$ Ω
Garment used as primary grounding path for personnel	Groundable static control garment system (garment in combination with person)	Resistance point-to-point and resistance point-to-groundable point	< $1{,}0 \times 10^{9}$ Ω
		Integrated wrist strap in accordance with IEC 61340-4-6	< $3{,}5 \times 10^{7}$ Ω

The values in Table A.1 are for information only. For required limits see the latest edition of IEC 61340-5-1 [2].

Annex B
(informative)

Data collection sheet (example)

GARMENT EVALUATION TEST

Resistive characterization

Manufacturer:_____

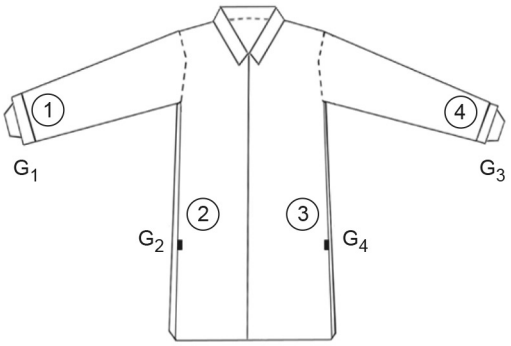
Style:_____

Product N°:_____

Procedure:_____

Date:_____

Test conditions and equipment[a]		**Report N°**
Environment	Condition one (C1)	Condition two (C2)
Humidity		
Temperature		
Electrode		
Equipment		
Voltage		



IEC

G1 and G3:

Cuff or wrist strap type grounding mechanism

G2 and G4:

Ground cord type grounding mechanism

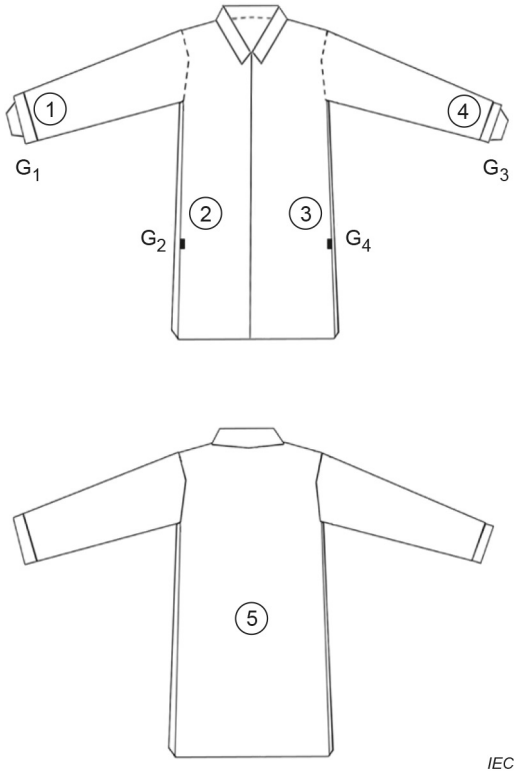
STATIC CONTROL GARMENT

Point-to-point	**Sample N°**		**Sample N°**		**Sample N°**	
	C1	C2	C1	C2	C1	C2
1 – 2						
1 – 3						
1 – 4						
1 – 5						
2 – 3						
2 – 4						
2 – 5						
3 – 4						
3 – 5						
4 – 5						

GROUNDABLE STATIC CONTROL GARMENT

Point-to-ground	C1	C2	C1	C2	C1	C2
1 – G4						
2 – G4						
3 – G4						
4 – G4						

[a] Only one condition is required.



G1 and G3:

Cuff or wrist strap type grounding mechanism

G2 and G4:

Ground cord type grounding mechanism

GROUNDABLE STATIC CONTROL GARMENT						
5 – G4						
5 – G2						
4 – G2						
3 – G2						
2 – G2						
1 – G2						
GROUNDABLE STATIC CONTROL GARMENT SYSTEM						
Cuff to ground	Interior	Exterior	Interior	Exterior	Interior	Exterior
G1-G2						
G3-G4						
Person to ground	Right	Left	Right	Left	Right	Left

TEST CONDITION AMBIENT

Humidity:_____

Temperature:_____

Test equipment:_____

Comments: _

Submitted by:

Bibliography

[1] IEC TS 61340-4-2, *Electrostatics – Part 4-2: Standard test methods for specific applications – Electrostatic properties of garments*

[2] IEC 61340-5-1, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

_____

ÉLECTROSTATIQUE –

Partie 4-9: Méthodes d'essai normalisées pour des applications spécifiques – Vêtements – Caractéristiques résistives

AVANT-PROPOS

1) La Commission Électrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. À cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
9) L'IEC attire l'attention sur le fait que la mise en application du présent document peut entraîner l'utilisation d'un ou de plusieurs brevets. L'IEC ne prend pas position quant à la preuve, à la validité et à l'applicabilité de tout droit de brevet revendiqué à cet égard. À la date de publication du présent document, l'IEC n'avait pas reçu notification qu'un ou plusieurs brevets pouvaient être nécessaires à sa mise en application. Toutefois, il y a lieu d'avertir les responsables de la mise en application du présent document que des informations plus récentes sont susceptibles de figurer dans la base de données de brevets, disponible à l'adresse https://patents.iec.ch. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets.

L'IEC 61340-4-9 a été établie par le comité d'études 101 de l'IEC: Electrostatique. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition parue en 2016. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) l'IEC 61010-1 et l'IEC 61010-2-030 ont été ajoutées comme exigences pour les appareils de mesure;

b) la plage de tensions d'essai pour le chemin de mise à la terre du personnel est passée de "7 V à 30 V en courant continu" à "7 V à 100 V en courant continu";

c) les exigences de nettoyage sont passées de cinq cycles de nettoyage au minimum à trois cycles de nettoyage au minimum;

d) les exigences concernant l'humidité modérée ont été supprimées;

e) les figures ont été remplacées par des dessins génériques.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
101/718/FDIS	101/721/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 61340, publiées sous le titre général *Électrostatique*, se trouve sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé, ou
- révisé.

IMPORTANT – Le logo "colour inside" qui se trouve sur la page de couverture de ce document indique qu'il contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer ce document en utilisant une imprimante couleur.

INTRODUCTION

La présente partie de l'IEC 61340 fournit des méthodes d'essai pour évaluer la résistance électrique des vêtements qui comportent des composants ou des matériaux à surface conductrice ou dissipative, utilisés dans l'industrie électronique pour le contrôle des décharges électrostatiques. Le présent document définit les procédures pour mesurer la résistance électrique, notamment un essai de résistance du système pour les vêtements qui fournissent un chemin de mise à la terre au personnel.

Les vêtements en fibres synthétiques constituent une source courante de charges électrostatiques. Le port d'un vêtement de contrôle des décharges électrostatiques (DES) adapté sur les habits du personnel peut réduire l'effet de telles charges. Afin de contrôler efficacement les charges électrostatiques des vêtements de contrôle des DES et de procurer un blindage efficace des habits du personnel contre les champs électrostatiques, il convient de relier le vêtement de contrôle des DES à la terre.

Trois catégories de vêtements sont prises en considération dans le présent document.

a) Un vêtement de contrôle des DES peut supprimer ou modifier le champ électrique des habits portés sous le vêtement de contrôle des DES, sans être relié à la terre. Cependant, sans mise à la terre, des charges peuvent s'accumuler sur les éléments conducteurs ou dissipatifs d'un vêtement, le cas échéant, ce qui entraîne l'apparition d'une source chargée.

b) Un vêtement de contrôle des DES pouvant être relié à la terre peut procurer un meilleur niveau de suppression du champ électrique lorsque le tissu de résistance inférieure est relié à la terre.

c) Un système de vêtement de contrôle des DES pouvant être relié à la terre assure une liaison à la terre du personnel, en supprimant le champ électrique des habits portés sous le vêtement de contrôle des DES et en reliant également la peau de l'utilisateur à un chemin de mise à la terre identifié. Les systèmes de vêtements de contrôle des DES pouvant être reliés à la terre peuvent également être utilisés conjointement avec un système de surveillance continue ou constante comparable à ceux utilisés pour la surveillance continue des bracelets de conduction dissipative dans une zone de protection électrostatique (EPA, *ESD Protected Area*).

Les caractéristiques résistives ne sont pas le seul aspect à prendre en considération lors de l'évaluation des vêtements pour des applications spécifiques. Pour spécifier les caractéristiques complètes d'un vêtement, il peut être nécessaire de tenir compte de l'affaiblissement du champ électrique, de la décroissance des charges statiques, de la tension de crête, de la tension résiduelle et de la charge triboélectrique. Il convient d'évaluer d'autres attributs liés aux applications et aux environnements, comme la compatibilité avec les salles blanches, la résistance chimique et la résistance au feu, dans le cadre du processus de sélection du vêtement, mais ces attributs ne relèvent pas du domaine d'application du présent document.

Les vêtements fabriqués à partir de tissus composés de fibres dont la surface n'est pas conductrice, mais qui peuvent posséder d'autres propriétés associées qui procurent un certain niveau de dissipation ou de suppression des charges électrostatiques lorsqu'ils sont reliés à la terre, ne sont pas spécifiquement mesurés selon les méthodes indiquées dans le présent document. Cela étant, certains tissus et certaines structures de vêtements peuvent permettre l'accumulation de tension en surface et un transfert de charge qui peuvent être préjudiciables aux éléments électroniques.

D'autres méthodes d'évaluation des propriétés électrostatiques des vêtements sont décrites dans l'IEC TS 61340-4-2 [1][1].

[1] Les chiffres entre crochets renvoient à la Bibliographie.

ÉLECTROSTATIQUE –

Partie 4-9: Méthodes d'essai normalisées pour des applications spécifiques – Vêtements – Caractéristiques résistives

1 Domaine d'application

La présente partie de l'IEC 61340 fournit des méthodes d'essai pour mesurer la résistance électrique des vêtements utilisés pour des applications de contrôle des DES. Ces méthodes d'essai peuvent être utilisées pour évaluer des vêtements extérieurs conducteurs de façon homogène ou dissipatifs de façon homogène, ou qui comportent des composants ou des éléments à surface conductrice ou dissipative.

NOTE Il est possible que les méthodes d'essai spécifiées dans le présent document ne permettent pas le mesurage des matériaux à couches conductrices enfouies.

La méthode d'essai de résistance point à point évalue la résistance électrique entre les deux manches, entre deux pièces ou entre deux composants interconnectés électriquement du vêtement de contrôle des DES, notamment la résistance électrique à travers les coutures et les bords-côtes du vêtement, selon le cas.

Une autre méthode d'essai manche à manche est décrite, en utilisant des pinces pour accrocher un vêtement.

Les vêtements de contrôle des DES qui sont reliés électriquement à l'utilisateur et lui fournissent une liaison à la terre sont évalués selon la méthode d'essai de résistance point à point, la méthode d'essai de résistance point à point de mise à la terre, ainsi que par un essai du système pour déterminer la résistance depuis la personne à travers le vêtement jusqu'au point de mise à la terre du système de vêtement.

L'IEC 61340-4-6 décrit un essai de mesure de résistance de la bande, qui peut être utilisé pour les vêtements qui comportent des bords-côtes destinés à remplir la même fonction qu'un bracelet de conduction dissipative.

L'essai du système réalisé avec une personne portant un système de vêtement de contrôle des DES pouvant être relié à la terre inclut le cordon de terre, qui se raccorde au point de mise à la terre du vêtement.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 61010-1, *Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 1: Exigences générales*

IEC 61010-2-030, *Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 2-030: Exigences particulières pour les appareils équipés de circuits d'essai ou de mesure*

IEC 61340-2-3, *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*

IEC 61340-4-6, *Électrostatique – Partie 4-6: Méthodes d'essai normalisées pour des applications spécifiques – Bracelets de conduction dissipative*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse https://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

3.1
essais de réception
essais utilisés pour confirmer aux utilisateurs que les produits livrés sont pratiquement identiques aux échantillons utilisés pour la qualification des produits

3.2
système de vêtement
tout ensemble de composants électriquement interconnectés qui composent un vêtement de contrôle des DES

3.3
résistance point à point
résistance mesurée entre un point et un autre point à la surface d'une même pièce ou de deux pièces différentes d'un vêtement

Note 1 à l'article: La résistance point à point est exprimée en Ω.

3.4
vêtement de contrôle des DES
vêtement destiné au personnel conçu pour contrôler les charges électrostatiques

3.5
qualification de produit
essais utilisés pour confirmer que les produits sont conformes aux exigences d'un programme de contrôle des décharges électrostatiques (DES) ou d'une autre spécification

3.6
vêtement de contrôle des DES pouvant être relié à la terre
vêtement qui présente une résistance électrique point à point, ainsi qu'entre un point ou une pièce du vêtement et le point de mise à la terre sur le vêtement

Note 1 à l'article: Le point de mise à la terre peut être un contact par bande sur la peau de la personne qui le porte ou un point de raccordement à la terre distinct spécifique.

3.7
système de vêtement de contrôle des DES pouvant être relié à la terre
système dans lequel un vêtement est utilisé pour établir le chemin de mise à la terre primaire pour une personne jusqu'au point de mise à la terre sur le vêtement et le raccordement du vêtement à la terre, généralement au moyen d'un cordon de terre

Note 1 à l'article: Le vêtement est un vêtement de contrôle des DES pouvant être relié à la terre comme cela est défini en 3.6, qui présente des caractéristiques supplémentaires pour permettre la mise à la terre de la personne qui le porte.

4 Atmosphère pour le conditionnement et les essais

Les exigences suivantes annulent toutes les autres spécifications concernant l'atmosphère pour le conditionnement et les essais qui peuvent être données dans un ou plusieurs documents cités en référence dans le présent document.

Sauf accord contraire, l'atmosphère utilisée pour le conditionnement et les essais réalisés dans le cadre des évaluations en laboratoire doit se trouver à une température de 23 °C ± 2 °C avec 12 % ± 3 % d'humidité relative. Le conditionnement avant les essais doit durer 48 h au minimum.

5 Équipement et matériaux

5.1 Appareil de mesure de la résistance

5.1.1 Généralités

Les appareils électriques de mesurage doivent satisfaire aux exigences de sécurité de l'IEC 61010-1 et de l'IEC 61010-2-030. L'appareil de mesure, appelé téraohmmètre, qu'il s'agisse d'un téraohmmètre unique ou d'un ensemble d'instruments, doit être capable de réaliser ce qui suit.

5.1.2 Qualification de produit

Le téraohmmètre doit avoir une tension de circuit sous charge de (100 ± 5) V pour les mesurages de résistances supérieures ou égales à $1,0 \times 10^6$ Ω, et de (10 ± 0,5) V pour les mesurages de résistances de $1,0 \times 10^4$ Ω à $1,0 \times 10^6$ Ω. Le téraohmmètre doit avoir une tension en circuit ouvert ou sous charge de (10 ± 0,5) V) pour les mesurages de $1,0 \times 10^3$ Ω à $1,0 \times 10^4$ Ω.

Le téraohmmètre doit pouvoir réaliser des mesurages de $1,0 \times 10^3$ Ω à $1,0 \times 10^{12}$ Ω.

5.1.3 Essais de réception

L'appareil de mesure de la qualification de produit peut être utilisé pour les essais de réception ou comme suit:

Le téraohmmètre doit avoir une tension en circuit ouvert de (100 ± 5) V pour les mesurages de résistances supérieures ou égales à $1,0 \times 10^6$ Ω, et de (10 ± 0,5) V pour les mesurages de résistances inférieures à $1,0 \times 10^6$ Ω.

Le téraohmmètre doit pouvoir réaliser des mesurages de $1,0 \times 10^3$ Ω à $1,0 \times 10^{12}$ Ω.

En cas de litige, le téraohmmètre utilisé pour la qualification du produit doit être utilisé pour résoudre les différends.