IEC 61340-4-5

Edition 2.0 2018-01
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Electrostatics –
Part 4-5: Standard test methods for specific applications – Methods for characterizing the electrostatic protection of footwear and flooring in combination with a person

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IEC 61340-4-5:2018-01 RLV(en)

Full document details: IEC 61340-4-5 2018 RLV

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 17.220.99; 29.020; 61.060

ISBN 978-2-8322-5278-9

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ELECTROSTATICS –

Part 4-5: Standard test methods for specific applications – Methods for characterizing the electrostatic protection of footwear and flooring in combination with a person

FOREWORD

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International Standard IEC 61340-4-5 has been prepared by IEC technical committee 101: Electrostatics.

This second edition cancels and replaces the first edition published in 2004. This edition constitutes a technical revision.

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

a) normative references have been updated;

b) Figure 2 has been improved and expanded to include actual examples of body voltage recordings, and text has been added to explain how to interpret recordings;

c) an alternative walking pattern has been added in an informative annex.

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

FDIS	Report on voting
101/545/FDIS	101/552/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all the parts in the IEC 61340 series, published under the general title *Electrostatics*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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ELECTROSTATICS –

Part 4-5: Standard test methods for specific applications – Methods for characterizing the electrostatic protection of footwear and flooring in combination with a person

1 Scope

This part of IEC 61340 specifies test methods for evaluating electrostatic protection provided by a system of footwear and flooring in combination with a person.

Test results are valid only for the specific footwear and flooring combination tested.

The test methods are not intended for individual ~~material or system classification~~ product qualification purposes.

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

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

IEC 61340-4-1, *Electrostatics – Part 4-1: Standard test methods for specific applications –* ~~*Electrostatic*~~ *Electrical resistance of floor coverings and installed floors*

ISO 1957, *Machine-made textile floor coverings – Selection and cutting of specimens for physical tests*

3 Terms and definitions

~~For the purposes of this document, the terms and definitions given in IEC 61340-1-2 apply.~~

No terms and definitions are listed in this document.

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

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

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4 Principle

The characterization of a system is achieved by measuring electrical resistance and chargeability of the footwear and flooring in combination with a person. Chargeability is determined using a walking test.

WARNING – Test procedures described in this document ~~may~~ can expose personnel to potentially hazardous electrical conditions. Appropriate electrical hazard reduction practices should be exercised, and proper earthing instructions for the equipment used should be followed when performing tests.

5 Atmosphere for conditioning and testing

The following requirements supersede any other specification for the atmosphere for conditioning and testing that may 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 (23 ± 2) °C and (12 ± 3) % relative humidity. The conditioning time prior to testing shall be at least 48 h. Textile floor coverings are preferably pre-conditioned for at least 24 h at (20 ± 2) °C and (65 ± 3) % relative humidity prior to conditioning and testing.

During pre-conditioning and conditioning, specimens shall be placed on a rack or other suitable support that allows free circulation of air around them.

Whenever tests are made in uncontrolled conditions, for example tests on installed floors, the ambient temperature and relative humidity at the time of measurement shall be recorded.

6 Test methods for footwear and flooring in combination with a person

6.1 Floor covering sampling and specimen preparation for laboratory tests

Sampling and selection of specimens for laboratory tests shall be carried out according to the principles specified in ISO 1957. For the purposes of this document, the general principles of ISO 1957 apply to all types of floor covering. From each sample, select a specimen measuring (2 ± 0,1) m × (1 ± 0,1) m or, in the case of tiles, select sufficient tiles and/or part tiles to make up a single specimen area of (2 ± 0,1) m × (1 ± 0,1) m.

For tests on floor coverings that will be installed with specific earth connections, a groundable point shall be attached to the test specimen in accordance with the manufacturer's instructions, or as otherwise agreed, and in a way that simulates end use earthing methods. For chargeability tests on floor coverings that will be installed without specific earth connections, groundable points shall not be attached to the test specimen.

Sensible electrical resistance measurements cannot be made in the laboratory on floor coverings that will be installed without specific earth connections. Measurement of the electrical resistance of footwear and flooring in combination with a person shall only be made on such floor coverings once installed.

The test specimen shall be mounted or loose-laid on nominal ~~6,3~~ 6 mm tempered or standard hardboard, according to the manufacturer's instructions or as otherwise agreed. When mounted or loose-laid on the hardboard, there shall be a gap of at least 10 mm between each edge of the specimen and the corresponding edge of the hardboard.

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The hardboard shall be clean, smooth and have a point-to-point resistance of greater than 10^{11} Ω when tested under the environmental conditions specified in Clause 5 and according to the test method specified in IEC 61340-4-1.

Floor finishes shall be tested in conjunction with floor coverings representative of the type for which the finishes are intended. The floor covering shall be prepared and mounted as detailed above. The finish under test shall then be applied to the floor covering in accordance with the manufacturer's instructions or as otherwise agreed. In cases where the manufacturer recommends the use of additional groundable points on the surface of the floor covering, these shall be installed as per the manufacturer's instructions prior to application of the finish, or as otherwise agreed.

~~NOTE~~ Test results can be significantly affected by the presence of dirt or other contaminants on the surface of floor coverings. Any cleaning performed on floor coverings shall be carried out as per the manufacturer's instructions prior to conditioning.

Generally, tests are performed on floor coverings as received, i.e. with finishes and special treatments as appropriate. If the permanency of such finishes and treatments is being investigated, specimens may be submitted to a cleaning process or to practical wear conditions before testing, either for laboratory evaluations or on installed floor coverings.

6.2 Cleaning of footwear for laboratory evaluations and for test on installed floor coverings

6.2.1 General

Test results can be significantly affected by the presence of dirt or other contaminants on the soles of footwear. Any cleaning performed on footwear prior to and during testing shall be as follows. If it is required to test footwear "as received" or "as used", then cleaning shall be omitted from the test procedure.

6.2.2 Cleaning materials

6.2.2.1 Sandpaper

P280 grade sandpaper.

6.2.2.2 Scoured cotton cloth

The cloth shall be free from finish and detergent.

6.2.2.3 Ethanol

Concentration ≥ 95 %.

6.2.3 Cleaning procedure

Scrub the sole of each item of footwear using a piece of scoured cotton (6.2.2.2) wetted with ethanol (6.2.2.3) to remove any chemical substance from the surface.

When using ethanol, personal protective equipment is advised.

When the soles are dry, abrade with a fine sandpaper (6.2.2.1), then remove the dust using a dry piece of scoured cotton. Finally, scrub the sole of each item of footwear again using a fresh piece of scoured cotton wetted with ethanol. This final stage only shall be repeated between each set of measurements. Ensure soles are dry before making measurements.

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6.3 Measurement of electrical resistance

6.3.1 Apparatus

6.3.1.1 Resistance measuring apparatus

6.3.1.1.1 General

A self-contained DC resistance meter (ohmmeter) or DC power supply and current meter in the appropriate configuration for resistance measurement, with a ±10 % accuracy, and fulfilling the following requirements.

~~NOTE~~ For safety reasons, it should be ensured that the maximum current of the measuring circuit does not exceed 5 mA.

6.3.1.1.2 For laboratory evaluations

The apparatus shall have a circuit voltage while under load of 10 V ± 0,5 V for resistance below $1{,}0 \times 10^6\ \Omega$, and 100 V ± 5 V for resistance of $1{,}0 \times 10^6\ \Omega$ and above. The measuring range of the apparatus shall be at least one order of magnitude either side of the expected range of resistance being measured. The apparatus shall be used in a manner that ensures unintended earth paths do not influence measurements.

6.3.1.1.3 For acceptance testing

The apparatus shall have an open circuit voltage of 10 V ± 0,5 V for resistance below $1{,}0 \times 10^6\ \Omega$, and 100 V ± 5 V for resistance of $1{,}0 \times 10^6\ \Omega$ and above. The measuring range of the apparatus shall be at least one order of magnitude either side of the expected range of resistance being measured. The apparatus shall be used in a manner that ensures unintended earth paths do not influence measurements.

Laboratory evaluation equipment as specified in 6.3.1.1.2 may also be used for acceptance testing. In case of dispute, only a laboratory evaluation apparatus shall be used.

6.3.1.2 Hand-held electrode

A stainless steel round stock or tube, approximately 25 mm diameter and 75 mm in length with a banana plug receptacle or screw connector attached to one end of the cylinder.

6.3.2 Test procedure

Wear the test footwear on both feet for at least 10 min prior to the commencement of testing.

Connect the negative lead of the resistance measuring apparatus (6.3.1.1) to the groundable point of the test floor covering (laboratory tests) or to earth (tests on installed floor coverings). Connect the other lead to the hand-held electrode (6.3.1.2). Stand with both feet on the test floor covering and firmly grasp the hand-held electrode – see Figure 1 a) and Figure 1 b).

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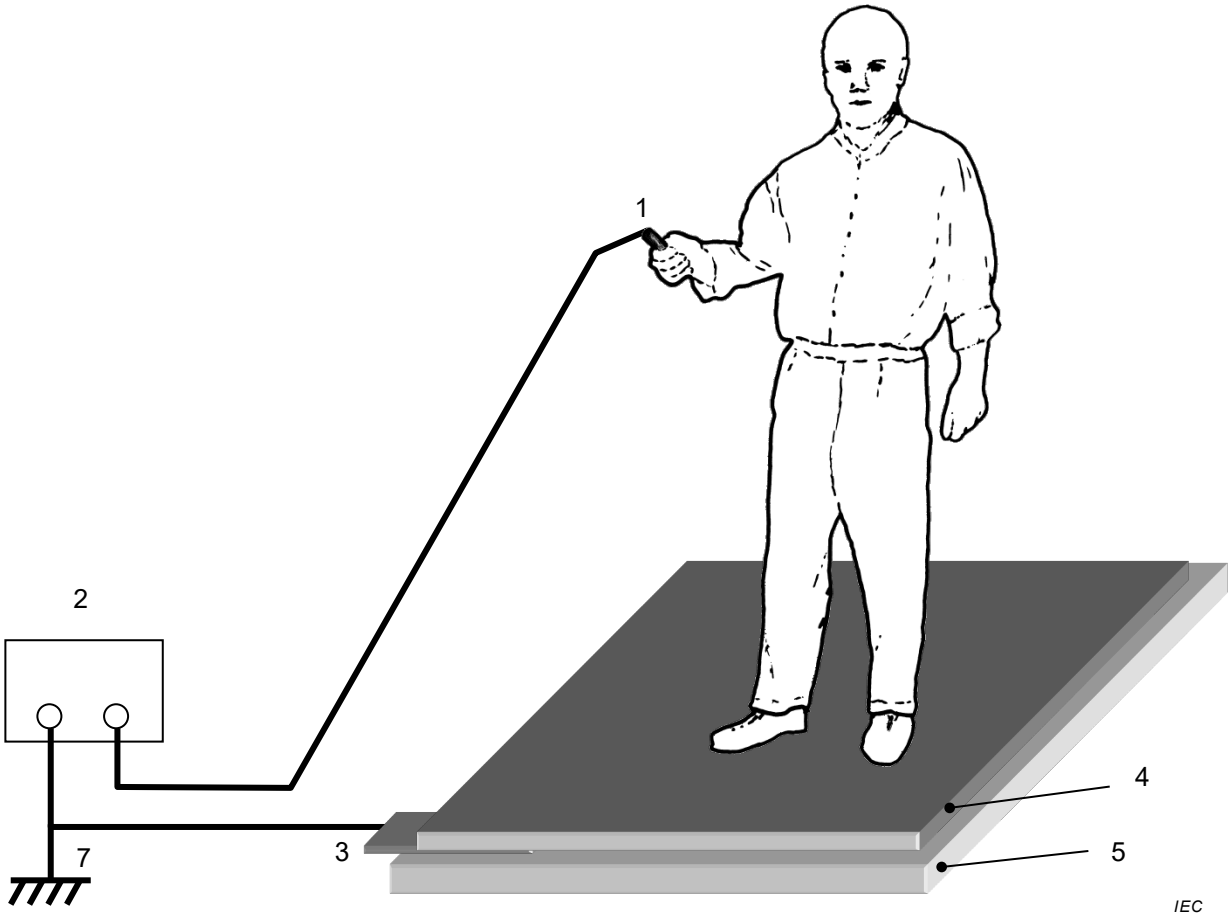

a) – Laboratory set-up

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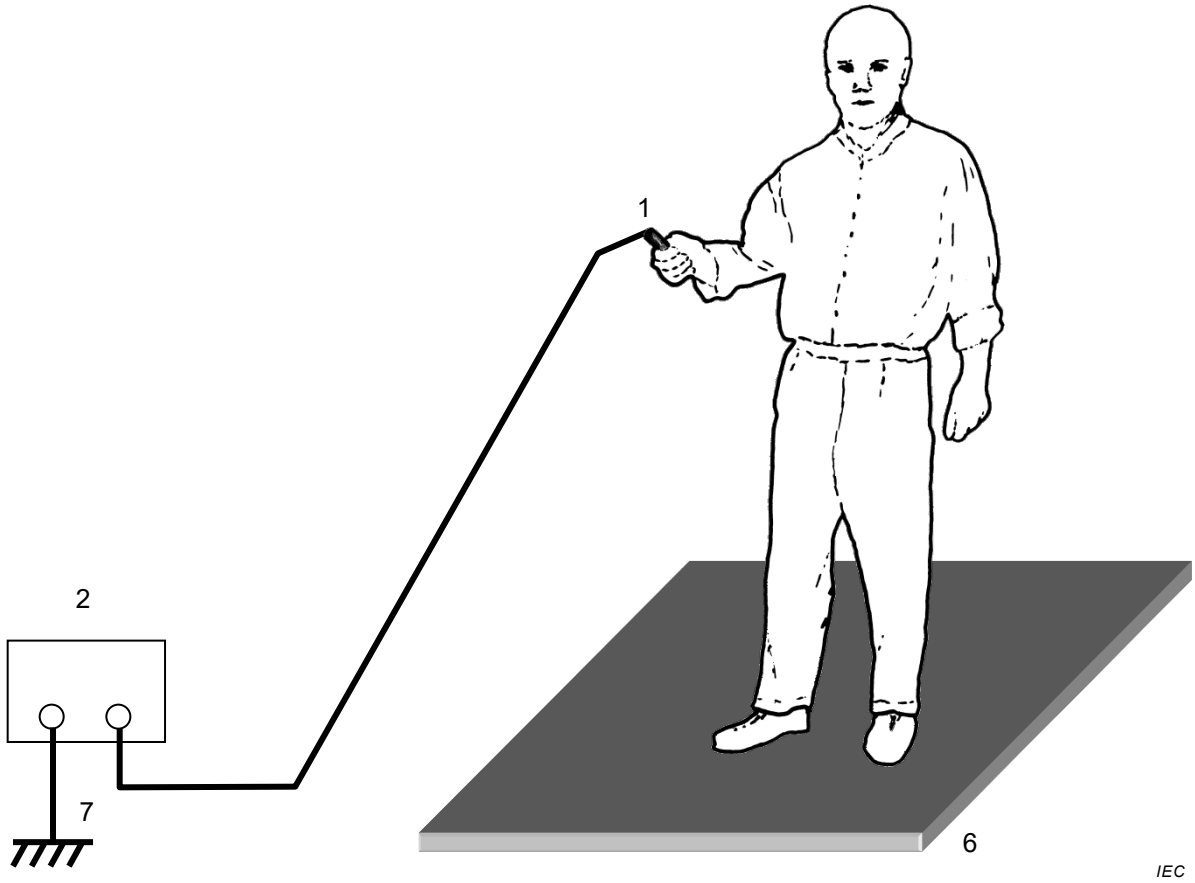

b) – Test set-up for installed flooring

Key

1 hand-held electrode (6.3.1.2)

2 resistance measuring apparatus (6.3.1.1)

3 groundable point (6.1)

4 floor covering under test

5 support material (6.1)

6 installed flooring

7 building earth

Figure 1 – Set-ups for measuring electrical resistance of footwear and flooring in combination with a person

Starting with the voltage set to 10 V, take a reading of the resistance 15 s ± 2 s after applying the test voltage. If the value exceeds 10^6 Ω, select 100 V and repeat the measurement. Record the reading which matches the voltage and resistance range specified in 6.3.1.1. If the resistance falls below 10^6 Ω when making a measurement using 100 V, this reading shall be the one recorded.

Repeat the measuring procedure with only the left foot in contact with the test floor covering and with the right foot held in the air about 150 mm above the floor covering.

Repeat the measuring procedure with only the right foot in contact with the test floor covering and with the left foot held in the air about 150 mm above the floor covering.

For laboratory tests, measurements shall be made at five different locations distributed evenly over the area of the test specimen.

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For tests on installed floor coverings, at least five measurements shall be made for each floor covering material. For large floor areas, at least five measurements per 500 m^2 of each floor covering material shall be made. Where there is evidence of wear, chemical or water spillage or visible dirt, then at least three measurements shall be made on such affected areas.

6.4 Measurement of chargeability

6.4.1 Apparatus

6.4.1.1 Body voltage measuring system

An electrostatic voltmeter, a hand-held electrode (6.3.1.2) and an autographic recorder meeting the following requirements:

a) input resistance of electrostatic voltmeter ≥ 10^{14} Ω;

b) input capacitance of electrostatic voltmeter, hand-held electrode and connecting leads ≤ 30 pF;

c) system response time shall be such that full-scale deflection on the recorder is reached within 0,25 s;

d) system resolution shall be at least one-tenth of the voltage level concerned; for example, for the comfort of personnel, body voltages of several kilovolts are considered, in which case the resolution of the measuring system shall be 0,1 kV; in the electronics industry, body voltages of 100 V are considered, in which case the resolution of the measuring system shall be 10 V;

e) system accuracy of ±10 %.

6.4.1.2 Ionizing source

Capable of eliminating electrostatic charge from the surface of footwear and floor covering specimens.

~~NOTE~~ All relevant safety precautions and regulations should be observed.

6.4.2 Test procedure

6.4.2.1 General

For laboratory evaluations on floor coverings that will be installed with specific earth connections, measurements shall be made on specimens fitted with suitable groundable points (see 6.1) and connected to earth. When carrying out laboratory evaluations on floor coverings that will be installed without specific earth connections, groundable points shall not be attached to test specimens, which shall remain isolated from earth whilst measurements are made.

For laboratory evaluations, the procedures described in 6.4.2.2 to 6.4.2.5 inclusive shall be carried out three times for each combination of footwear and floor covering to be tested.

For tests on installed floor coverings, the procedures described in 6.4.2.2 to 6.4.2.5 inclusive shall be carried out at least five times for each combination of footwear and floor covering to be tested. For large floor areas, procedures 6.4.2.2 to 6.4.2.5 inclusive shall be carried out at least five times per 500 m^2 of each floor covering material. Where there is evidence of wear, chemical or water spillage or visible dirt, then at least three of these measurements shall be made on such affected areas. For verification of the body voltage measurement system, see Annex A.

6.4.2.2 Discharging test items

Eliminate any residual electrostatic charge on the footwear and floor covering using the ionizing source (6.4.1.2). Loose-laid specimens for laboratory evaluations shall be discharged

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on both sides before re-positioning them carefully without sliding on the support material (6.1).

6.4.2.3 Donning footwear

The operative shall don the footwear whilst sitting on a nearby seat. The operative shall be earthed and the soles of the footwear discharged using the ionizing source (6.4.1.2). The operative then stands on the floor covering without sliding.

Footwear shall be fastened securely as in normal use.

6.4.2.4 Zeroing the system

The operative shall take hold of the hand-held electrode connected to the body voltage measuring system (6.4.1.1) and shall momentarily touch an earth bonding point to zero the system.

6.4.2.5 Walking

There are many ways one could choose to walk. The walking pattern described here simulates forward and backward movements typical of workers in a number of disciplines. However, other walking patterns are acceptable (see Annex B) assuming that they simulate actual walking patterns in the intended installation.

Users of this test method should choose a walking pattern typical of the majority of the workers within the intended installation.

If no other walking pattern is specified, the following shall be used.

The operative shall walk on the floor covering at a rate of two steps per second whilst maintaining the body facing in the same direction throughout the test. The operative shall cover as much of the test area as possible by walking forwards and backwards, but avoiding scuffing or pivoting. The test area is the whole area of the floor covering specimen for laboratory evaluations, or an equivalent size area of installed flooring. The stepping action shall maintain the sole of the footwear parallel to the floor covering specimen at all times while lifting the footwear between 50 mm and 80 mm. For laboratory evaluations, the operative shall not come closer than 0,5 m to the wall, or any object in the room, and shall continue walking until the peak voltage ceases to rise, or for 60 s, whichever occurs first.

After walking, the operative shall remove the footwear and, if required, clean the soles (6.2).

6.4.3 Calculation and expression of results

For each walking measurement, the arithmetic mean of the five highest valleys and the arithmetic mean of the five highest peaks shall be calculated (see Figure 2). The results shall be expressed in relation to the voltage of concern and the resolution of the measuring system. For example, for personnel comfort, the results may be expressed in kilovolts to the nearest 0,1 kV, or for the electronics industry, the results may be expressed in volts to the nearest 10 V.

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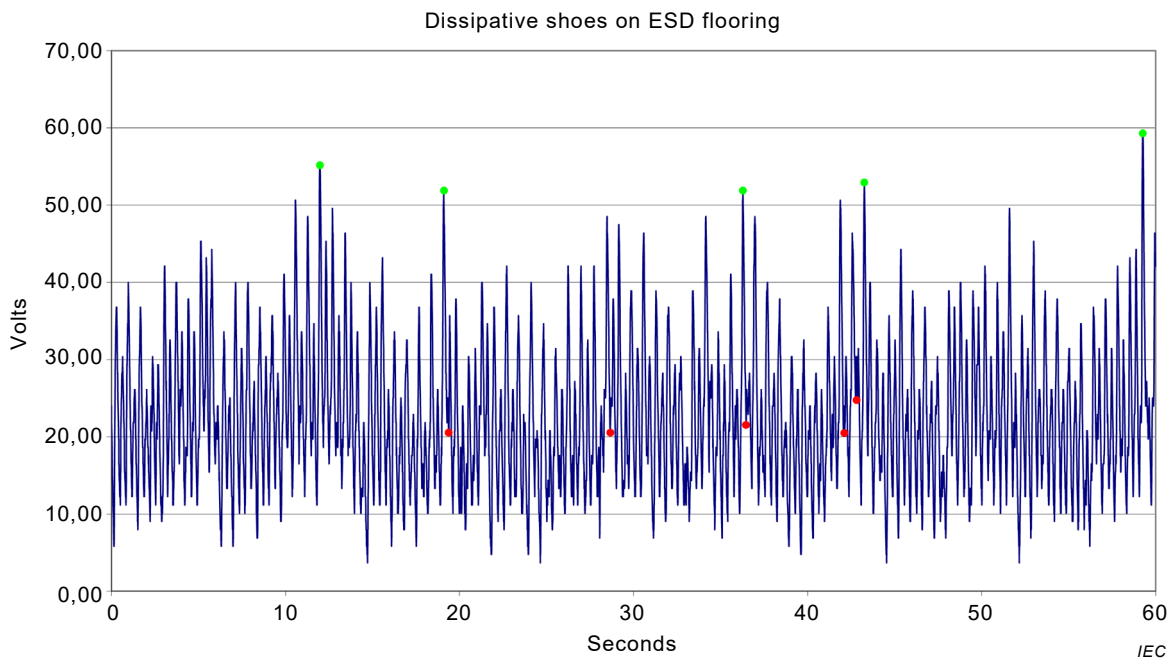
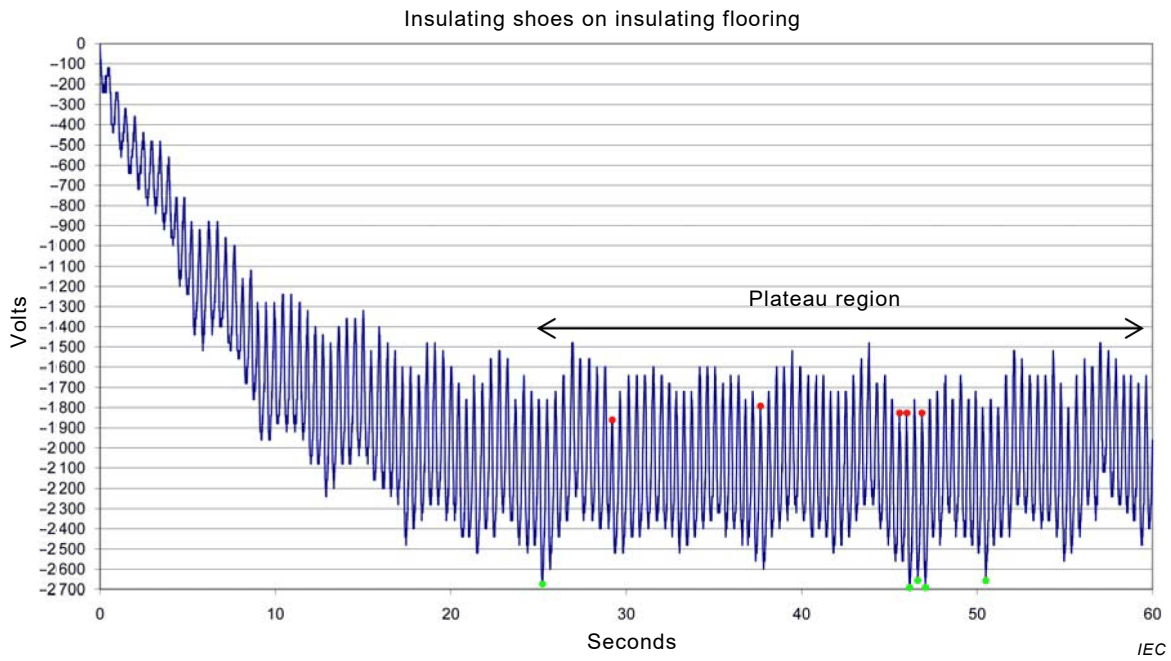


a) – Positive polarity body voltage recording



b) – Negative polarity body voltage recording

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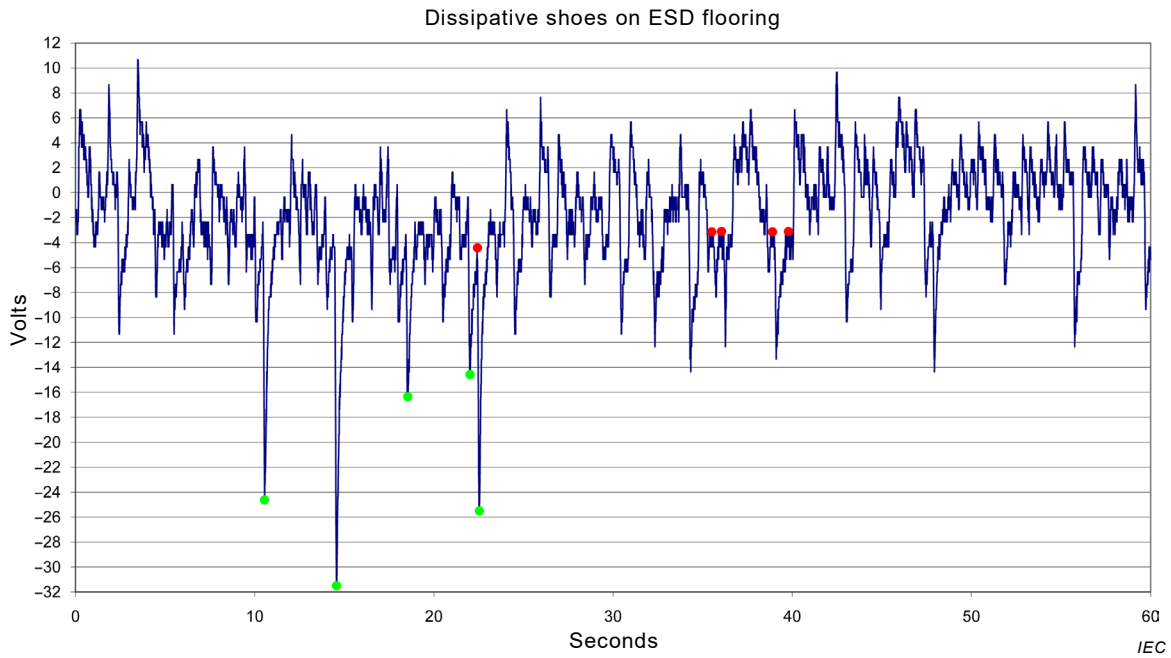

c) – Body voltage recording with positive and negative data points

Key

- ● five highest peaks
- ● five highest valleys

Figure 2 – Examples of body voltage recordings showing points used in calculating mean values

In footwear/flooring systems where there is minimal charge dissipation from the operator, average body voltage tends to increase at the start of the test but after some time reaches a plateau, as shown in the example in Figure 2 a) and Figure 2 b). In cases such as this, the highest valleys and highest peaks means shall be taken from the plateau region.

In footwear/flooring systems where minimal charge is generated, or in which there is significant charge dissipation, the measured body voltage can change polarity, as shown in the example in Figure 2 c). It is clear in this example that the magnitude of the negative peaks is greater than the magnitude of the positive peaks. Therefore, the five highest negative valleys and five highest negative peaks shall be taken.

In cases where there are both positive and negative data points in one recording, and there is no clear difference in the magnitude of positive and negative data point, arithmetic means shall be calculated for the five highest positive valleys, the five highest positive peaks, the five highest negative valleys and the five highest negative peaks.

7 Test report

The test report shall include at least the following information:

a) reference to this document;

b) all the information necessary for complete identification of test samples;

c) identification of instrumentation used;

d) date of testing;

e) atmosphere for pre-conditioning, conditioning and testing as follows:

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- for laboratory evaluations: temperature and relative humidity during pre-conditioning (if used), conditioning and testing, and the duration of any pre-conditioning and conditioning;
- for tests on installed floors: temperature and relative humidity during testing;

f) details of any cleaning or finishing procedures for both footwear and floor covering materials;

g) details of procedures and materials used to fix specimens to hardboard;

h) details of procedures and materials used to fix groundable points to specimens;

i) type of measurement: electrical resistance or chargeability;

j) for chargeability, the pattern and rate of walking;

k) all individual results for each type of measurement on each specimen;

l) average of all results for each type of measurement on each sample;

m) any operations not specified in this document, or in any standard to which normative reference is made, or regarded as optional, which might have affected the results.

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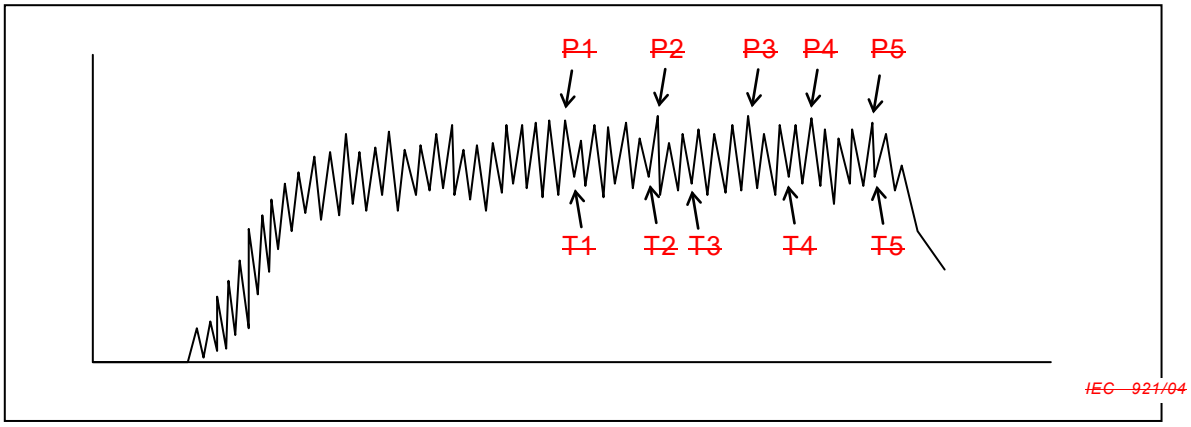

Figure 2a – Positive polarity body voltage recording

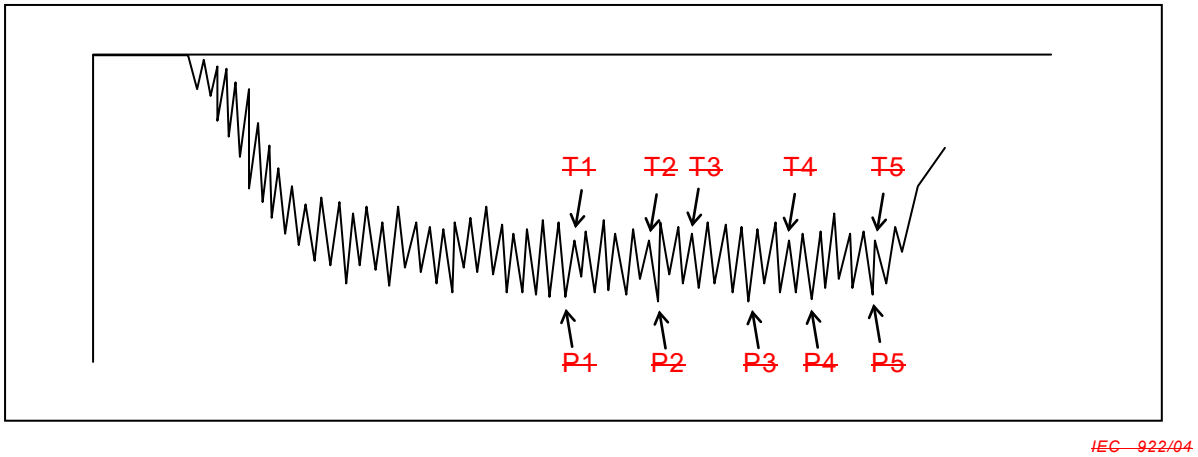

Figure 2b – Negative polarity body voltage recording

Key

P1 to P5: five highest peaks

T1 to T5: five highest valleys

Figure 2 – Typical body voltage recordings showing points used in calculating mean values

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