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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Wearable electronic devices and technologies – Part 201-3: Electronic textile – Determination of electrical resistance of conductive textiles under simulated microclimate

Technologies et dispositifs électroniques prêts-à-porter – Partie 201-3: Textile électronique – Détermination de la résistance électrique des textiles conducteurs sous microclimat simulé

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Part 201-3: Electronic textile – Determination of electrical resistance of conductive textiles under simulated microclimate

FOREWORD

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

FDIS	Report on voting
124/136/FDIS	124/142/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 parts in the IEC 63203 series, published under the general title *Wearable electronic devices and technologies*, 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- withdrawn,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
- amended.

WEARABLE ELECTRONIC DEVICES AND TECHNOLOGIES –

Part 201-3: Electronic textile – Determination of electrical resistance of conductive textiles under simulated microclimate

1 Scope

This part of IEC 63203-201 specifies a test method for determination of the electrical resistance of conductive fabrics under simulated microclimate within clothing. The microclimate is the climate of the small air layer between the skin and clothing having a specific temperature and humidity. This test method can be applied to conductive fabrics including multilayer assemblies for use in clothing.

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.

ISO 139, *Textiles – Standard atmospheres for conditioning and testing*

ISO 11092:2014, *Textiles – Physiological effects – Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*

ISO 21232:2018, *Textiles – Determination of moisturizing effect of textile materials by measurement of microclimate between textiles and simulated human skin using sweating guarded hotplate*

EN 16812:2016, *Textiles and textile products – Electrically conductive textiles – Determination of the linear electrical resistance of conductive tracks*

3 Terms and definitions

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

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

3.1
textile-based electrically conductive track
electrically conductive part of the textile having a length (L) to width (W) ratio of minimum 10 to 1

[SOURCE: EN 16812:2016, 3.1, modified – Note 1 to entry has been deleted.]

3.2
linear electrical resistance
R_L
electrical resistance per unit length of a track

Note 1 to entry: Linear electrical resistance is expressed in ohm per metre.

[SOURCE: EN 16812:2016, 3.3, modified – Note 1 to entry has been added.]

3.3
microclimate
climate of the small air layer (between the skin and the clothing or between textiles and sweating guarded-hotplate)

Note 1 to entry: This microclimate has specific temperature and humidity characteristics. Simulated microclimate is the climate of the air layer between fabric and sweating guarded-hotplate.

[SOURCE: ISO 21232:2018, 3.2, modified – A hyphen has been added to the term "sweating guarded hotplate" and the second sentence in the note has been added.]

3.4
water-vapour resistance including air layer
R_{et_al}
water-vapour pressure difference between the two faces of a material (separated from each other by 5 mm) divided by the resultant evaporative heat flux per unit area in the direction of the gradient

Note 1 to entry: Water-vapour resistance is measured under the simulated state in which the air layer exists between the skin and clothing.

Note 2 to entry: Water-vapour resistance including air layer is expressed in square metres pascal per watt.

[SOURCE: ISO 21232:2018, 3.3]

4 Principle of test

Clothing comfort depends on the environmental conditions (humidity, temperature) of the microclimate between the skin and the fabrics when clothing is worn. The e-textile system made of conductive fabrics is in direct contact with human skin so that the electrical resistance of conductive fabrics is affected by the microclimate between human skin and fabric. Therefore, this test method can perform the combined measurement of electrical resistance using the measurement principle of the four-wire Kelvin method and a DC current source, under a simulated microclimate.

5 Test equipment

5.1 Sweating guarded-hotplate

For the test device, the sweating guarded-hotplate (see Figure 1), specified in ISO 11092:2014, is used. The upper part is a measuring unit with temperature and water supply control and the lower part is a thermal guard with temperature control.

5.2 Device including temperature and humidity sensor with set-up of the four electrode – four wire method

5.2.1 The device shall be made of electrically non-conductive material. The device is used to create space for the air layer between hotplate and specimen. The sensor inside the device measures the microclimate between hotplate and specimen, specified in ISO 21232:2018 (see Figure 2).

5.2.2 An electrical current source, a voltage-meter and contacting electrodes measure electrical resistance. Electrodes shall be arranged for using the set-up of the four electrode – four wire method on the device and shall cover the whole width of the textile-based electrically conductive track, specified in EN 16812:2016, 6.2 (see Figure 2 and Figure 3). The electrodes shall be placed parallel to each other and they shall be movable forwards and backwards.

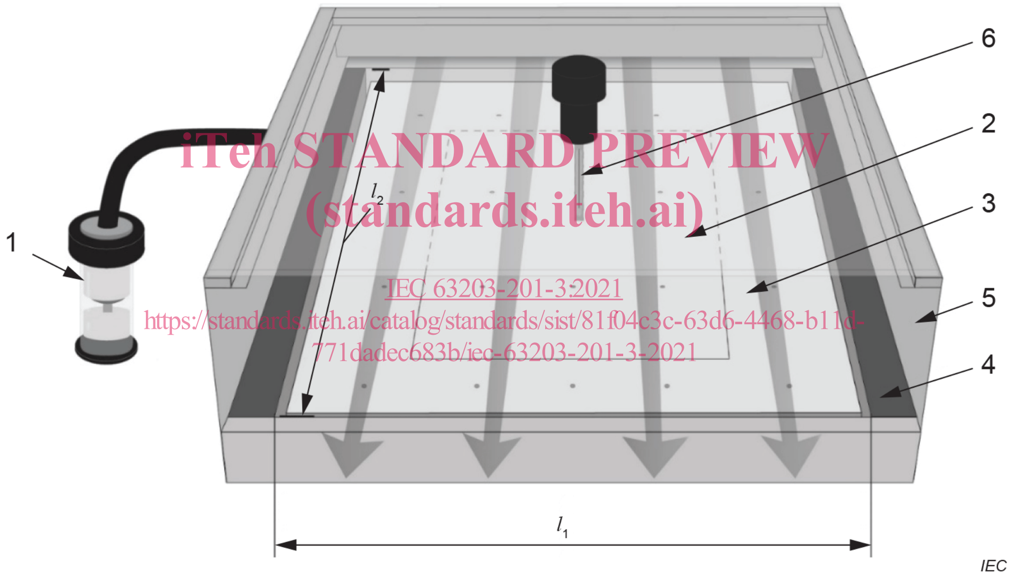
5.2.3 The specimen is fixed by magnets in the device. The diameter and thickness of the magnet are (5,0 ± 0,2) mm and (3,0 ± 0,1) mm, respectively. The magnetic flux density shall be higher than 0,3 T. The interval between magnets shall be less than 50 mm in the test device (see Figure 2).

5.3 Membranes

A water-vapour permeable but liquid-water impermeable membrane shall meet the requirements specified in ISO 11092:2014, 7.1.2.1 or in ISO 21232:2018, 5.4.

5.4 Test enclosure of the sweating guarded-hotplate

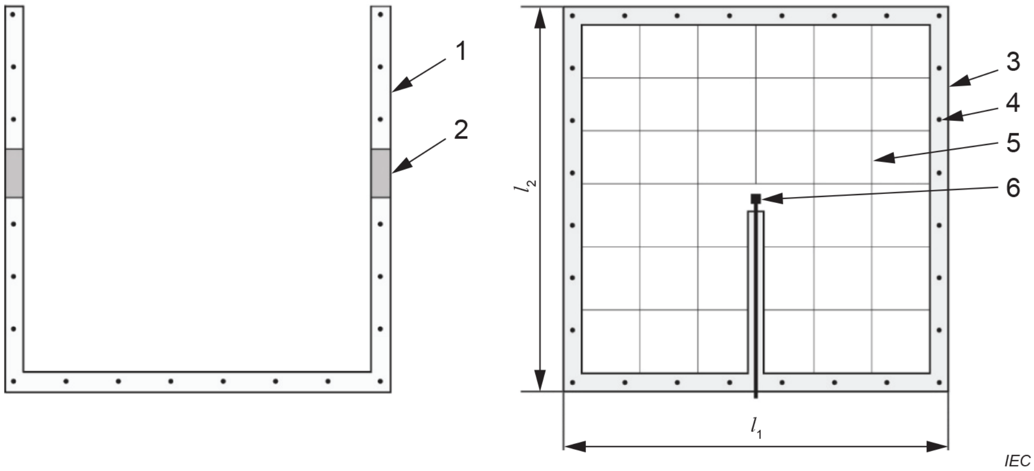
The requirements specified in ISO 11092:2014, 5.3 shall be met.



Key

1	water dosing device	4	measuring table
2	measuring unit	5	hotplate duct
3	thermal guard	6	air velocity sensor

Figure 1 – Sweating guarded-hotplate



Key

1 upper frame

2 electrodes

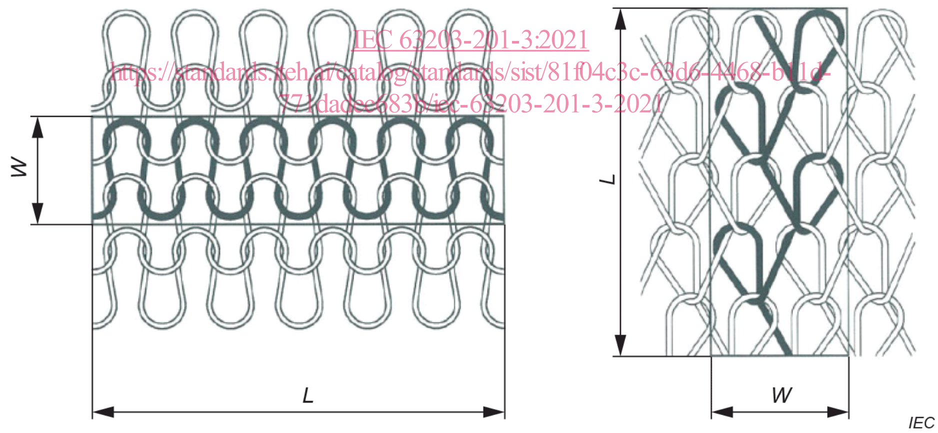
3 lower frame

4 magnets for fixing specimens

5 grid

6 temperature and humidity sensor

Figure 2 – Device including temperature and humidity sensor with set-up of four electrode – four wire method



[SOURCE: ISO 8388:1998, 3.1.2 and 3.5.2][1]

Figure 3 – Example of textile-based electrically conductive track

6 Test specimens

6.1 Number of test specimens

Test three specimens per sample and then calculate the arithmetic mean and the percentage coefficient of variation (CV %). If the CV % is greater than 5 %, test two more specimens and then calculate the arithmetic mean and the CV %.

1 Reproduced (from ISO 8388:1998, 3.1.2 and 3.5.2), with the permission of ISO.

6.2 Dimension of specimens

The specimen shall be large enough to completely cover the surfaces of the measuring unit and the thermal guard.

6.3 Conditioning

Before testing, condition the specimens for at least 24 h at (20 ± 2) °C and (65 ± 4) % relative humidity (RH) in accordance with ISO 139.

7 Test procedure

7.1 Preparation of textile-based electrically conductive track contact points for necessary measurement stability

The preparation of textile-based electrically conductive track points as defined in EN 16812:2016 shall be applied.

7.2 Specimen mounting on measuring unit

7.2.1 Cover the measuring unit (5.1) with a membrane (5.3).

7.2.2 The specimen shall be flat and straight on the grid of lower frame. Fix the specimen by using magnets between the lower and the upper frames of the device (5.2). Establish a tight contact between the electrode and the textile-based electrically conductive track in order to reduce contact resistance.

7.2.3 Place the specimen-mounted device on the covered measuring unit. The device shall fit tightly into the measuring table.

7.3 Determination of the apparatus constant R_{et0_al} and measurement of water-vapour resistance including air layer R_{et_al} and RH)

The R_{et_al} and RH measurement of the test specimen by the sweating guarded-hotplate shall conform to testing conditions and procedures of ISO 21232:2018. See Annex A for an example of test results.

7.4 Determination of linear electrical resistance

7.4.1 Determine the distance (d) between the voltage measurement electrodes (see Figure 2).

7.4.2 Measurement of the linear electrical resistance shall conform to procedures of EN 16812:2016. Apply a suitable current (I), and measure the resistance (R) continuously until R_{et_al} reaches steady-state and R becomes stable.

7.4.3 The calculation of R_L of EN 16812:2016, 8.5.1 shall be followed.

7.4.4 Perform the same measurements for the other two specimens.

7.4.5 Calculate the arithmetic mean of R_L and the standard deviation for the sample, to three significant digits. See Annex A for an example of test results.

8 Test report

The test report shall include the following information:

a) the number and date of this document;
b) identification of the test lab;
c) identification of the sample and material including the direction of the track with respect to the fabric structure, if applicable;
d) number of specimens;
e) type, manufacturer and specification of the equipment used (voltage meter and current supply);
f) type of membrane used;
g) arithmetic mean and standard deviation for R_{et_al} and RH;
h) linear resistance R_L, in ohm per metre;
i) arithmetic mean per sample
j) standard deviation and CV % between specimens
k) any deviation from the specified procedure in this document;
l) date of test;
m) other remarks and observations.