BRITISH STANDARD

BS EN 1149-3:2004

Protective clothing — Electrostatic properties —

Part 3: Test methods for measurement of charge decay

The European Standard EN 1149-3:2004 has the status of a British Standard

ICS 13.340.10

British Standards

National foreword

This British Standard is the official English language version of EN 1149-3:2004.

The UK participation in its preparation was entrusted by Technical Committee PH/3, Protective clothing, to Subcommittee PH/3/1, Clothing for protection against general hazards, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

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This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 20, an inside back cover and a back cover.

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EUROPEAN STANDARD

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English version

Protective clothing - Electrostatic properties - Part 3: Test methods for measurement of charge decay

Vêtements de protection - Propriétés électrostatiques - Partie 3: Méthodes d'essai pour la mesure de l'atténuation de la charge

Schutzkleidung - Elektrostatische Eigenschaften - Teil 3: Prüfverfahren für die Messung des Ladungsabbaus

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Content

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Foreword

This document (EN 1149-3:2004) has been prepared by Technical Committee CEN/TC 162 “Protective clothing including hand and arm protection and life jackets”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2004, and conflicting national standards shall be withdrawn at the latest by October 2004.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

Annex A is informative.

EN 1149 consists of the following parts, under the general title "Protective clothing – Electrostatic properties":

— Part 1: Surface resistivity (Test methods and requirements*)*

— Part 2: Test method for measurement of the electrical resistance through a material (vertical resistance)

— Part 3: Test methods for measurement of charge decay

— Part 4[1)]: Garment tests

— Part 5[1)]: Performance requirements

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1) In course of preparation.

Introduction

This European Standard is part of a series of test methods and requirements for electrostatic properties of protective clothing. Different parts are necessary, because of the various fields of application and diverse nature of garment materials.

Two test methods are described for measuring the rate of dissipation of electrostatic charge of garment materials, i.e. the charge decay. In both cases, charge is monitored by observation of the electrostatic field it generates and this is done using non-contacting field measuring instruments. The principal difference between the methods is the technique used to generate the electrostatic charge. Triboelectric charging relies on the charge generated as two materials come into contact, rub together and subsequently separate. Induction charging involves an electrode placed beneath the test surface and is raised to a defined potential. Induced charge on the test material influences the net field that is observed by a field-measuring probe positioned above the test surface.

1 Scope

This European Standard specifies methods for measuring the dissipation of electrostatic charge from the surface of materials for garments. The test methods are applicable to all materials, including homogeneous materials and inhomogeneous materials with surface conducting fibres and core conducting fibres.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 340:2003, *Protective clothing — General requirements.*

EN 1149-1:1995, *Protective clothing — Electrostatic properties — Part 1: Surface resistivity (test methods and requirements).*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions of EN 340:2003 and EN 1149-1:1995 together with the following apply.

3.1
surface conducting fibre
fibre in which the conducting component is exposed at the surface. Depending on the cross-section of the fibre, all or only part of its surface may be conducting

3.2
core conducting fibre
fibre in which the conducting component is completely encapsulated in non-conducting material

3.3
charge decay
migration of charge across or through a material leading to a reduction of charge density or surface potential at the point where the charge was deposited

3.4
Electric field strength

3.4.1
test method 1
$\boldsymbol{E_0}$ - maximum electric field strength after triboelectric charging (kV/m);

$\boldsymbol{E_{30}}$ - electric field strength 30 s after E_0 (kV/m)

3.4.2
test method 2
$\boldsymbol{E_{max}}$ - electric field strength indicated on the recording device with no test specimen present (kV/m);

$\boldsymbol{E_R}$ - maximum electric field strength indicated on the recording device with the test specimen in the measuring position

3.5
half decay time t_{50}
the time taken for the indicated field strength to decay to $E_{max}/2$ (s)

3.6
shielding factor *S*
relationship between E_{max} and E_R calculated as:

$$S = 1 - \frac{E_R}{E_{\max}}$$

4 Test methods

4.1 Sample preparation and conditioning applicable for both test methods

4.1.1 Pre-treatment

The test sample shall be pre-treated according to the specific clothing standard or otherwise shall undergo five cycles of cleaning according to EN 340.

NOTE Pre-treatment is not required for garments not intended to be cleaned in use (e.g. for single use garments).

4.1.2 Atmosphere for conditioning and testing

Unless otherwise specified, the test specimens shall be conditioned for at least 24 hours in an atmosphere of (23 ± 1) °C and (25 ± 5) % relative humidity. Testing shall be performed in the same atmosphere.

4.2 Triboelectric charging (test method 1)

4.2.1 Principle

Test materials are charged by rubbing against cylindrical rods mounted on a vertically running slider. The electrical field strength from the charge generated on the test material is observed and recorded using an electrostatic fieldmeter connected to a graphical recording device.

4.2.2 Equipment

4.2.2.1 General

The test apparatus is shown in Figure 1.

4.2.2.2 Cylindrical rods

Two rods of length (100 ± 5) mm with a circular cross-section of diameter (15,0 ± 0,5) mm are used. The rods are attached to a metal slider in a parallel fashion without freedom of rotation such that the bottom of the first rod is horizontally in line with the top of the second rod and with a distance of (15 ± 1) mm between their nearest edges (see Figure 1).

Two pairs of rods are required, one pair made from high density polyethylene (HDPE) and one pair made from aluminium. The fixture used to attach the rods to the slider shall allow rods to be interchanged.

The HDPE rods shall have a specific gravity of (999 ± 10) kg/m³ and shore hardness D of 63; surface resistance of $\leq 10^6\ \Omega$ and volume resistivity of $\leq 10^6\ \Omega$ cm.

The material for aluminium rods shall be:

AlMgSi(3.3207;6060)

NOTE Producer of the HDPE-material (PE-EL): SIMONA AG, D-55606 Kirn. This information is given for the convenience of users of this standard and does not constitute an endorsement by CEN/TC 162 of the product named. Equivalent products may be used if they can shown to lead to the same results.

4.2.2.3 Slider and support structure

The slider to which the cylindrical rods are attached runs on one or more vertical guide rail(s). The start position of the slider is the highest point on the guide rail(s). The slider is either allowed to fall freely under its own weight, or is driven down the guide rail(s) by a suitable motor. In the former case, a suitable clamp is required to lock the slider in the start position prior to each measurement. The slider, guide rail(s) and support framework shall be of any design that satisfies the requirement of allowing the cylindrical rods to move down at a velocity of (0,20 ± 0,02) m/s in a vertical direction without significant twisting or rotation. All metalwork shall be connected to earth.

4.2.2.4 Specimen clamp and tensioning device

The upper edge of the specimen is clamped to a rigid structure and is tensioned by attaching a free-hanging clamp to the bottom edge. The free-hanging clamp shall be such that the load evenly applied to the full width of the specimen. The fixed clamp shall be metal and shall be connected to earth. The load applied to the test specimen by the bottom clamp shall be (1,30 ± 0,05) N. In case elongation of the test specimen is larger than 5 % then a load of (0,2 ± 0,05) N shall be used.

4.2.2.5 Fieldmeter

An electrostatic fieldmeter meeting at least the following specification is positioned with its sensing aperture (50 ± 5) mm from the plane of the test specimen (see Figure 2) when the slider has decended:

range: at least 1 kV/m to 200 kV/m;

resolution: ≤ 1 kV/m;

response time: ≤ 10 ms;

zero drift: ± 0,5 kV/m (long term) or better.

The fieldmeter shall have an output function that allows connection to a recording device.

NOTE Care should be taken to avoid presence of charged objects that can influence the reading of the fieldmeter.

4.2.2.6 Recording device

A means of recording time related data from the fieldmeter output, preferably in graphic form. The time resolution and response time of the recording device shall be 1 ms or less, and it shall be capable of recording the full range of output from the fieldmeter. Examples of suitable devices include paper chart recorders, storage oscilloscopes, and data-loggers/computers with appropriate software.

4.2.2.7 Static neutraliser

A means of neutralising electrostatic charge on test specimens and HDPE rods prior to measurement, e.g. electric air ionisation.

4.2.2.8 Cleaning agent

An appropriate liquid cleaning agent, is either propan-2-ol or ethanol.

WARNING: Propan-2-ol and ethanol are highly flammable and harmful to health. Avoid breathing the vapour and contact with skin, eyes or clothing.

4.2.3 Specimens

Cut twelve specimens each measuring (50 ± 2) mm $\times$ (300 ± 2) mm from the sample fabric or garment, six cut with the long dimension in the warp or machine direction and six in the weft or width direction. In case the machine direction can not be identified six specimen shall be cut from each of two orthogonal directions. Three specimens in warp and three specimens in weft to be used with HDPE rods and three specimens in warp and three specimens in weft to be used with aluminium rods. Specimen shall not contain seams. Handle the specimens only at the edges to avoid contamination.

4.2.4 Procedure

Clean the cylindrical rods by wiping with a paper tissue moistened with the cleaning agent (4.2.2.7). Allow the cylindrical rods to dry.

Secure one end of the first specimen to the fixed clamp and with the slider in its highest position, pass the free end of the specimen between the two rods. The specimen should contact the first rod on its bottom surface and the second rod on its top surface (see Figure 2). Attach the tensioning device to the free end of the specimen.

Remove any significant residual electrostatic charge from the specimen and rods using the static neutraliser. Ensure that the fieldmeter is showing a zero or near-zero reading.

Start the recording device and release the slider, allowing it to fall, or be driven down so that the specimen rubs over the cylindrical rods.

Stop the recording device 60 s after release of the slider.

From the recording, note the maximum field strength reading and the field strength 30 s after $\boldsymbol{E_0}$.

Remove the specimen and repeat the procedure with remaining specimens.

Repeat the whole procedure with the remaining six specimens but using the other kind of rods.

4.2.5 Calculation and expression of results

Calculate the mean of absolute values of the maximum field strength $\boldsymbol{E_0}$ and the mean of the absolute values of the field strength after 30 s $\boldsymbol{E_{30}}$ for the following groups:

a) three measurements made in the warp or machine direction with the HDPE rods;

b) three measurements made in the weft or width direction with the HDPE rods;

c) three measurements made in the weft or width direction with the aluminium rods;

d) three measurements made in the warp or machine direction with the aluminium rods.

4.3 Induction charging (test method 2)

4.3.1 Principle

Charging of the test specimen is carried out by an induction effect. Immediately under the test specimen, which is horizontally arranged, a field-electrode is positioned, without contacting the specimen. A high voltage is rapidly applied to the field-electrode. If the specimen is conductive, or contains conducting elements, charge of opposite polarity to the field-electrode is induced on the specimen. Field from the field-electrode which impinges on the conducting elements does not pass through the test specimen and the net field is reduced in a way that is characteristic of the material under test. This effect is measured and registered behind the specimen with a suitable field-measuring probe.

As the amount of induced charge on the test specimen increases, the net field registered by the measuring probe decreases. It is this decrease in field that is used to determine the half decay time and the shielding factor.

4.3.2 Equipment

The test apparatus is shown in Figures 3 to 5.

4.3.2.1 Field-electrode

A polished stainless steeldisc, (70 ± 1) mm diameter, fixed to an insulating support. Details are shown in Figure 4.

4.3.2.2 Support ring

A metal ring, (100 ± 1) mm internal diameter, connected to earth and positioned concentric to the field-electrode (4.3.2.1). Details are shown in Figure 4. The distance between the top surface of the field-electrode and the top of the support ring shall be (4,0 ± 0,1) mm.

4.3.2.3 Specimen clamping rings

The specimen is clamped between an outer and an inner ring. The outer ring with (250 ± 1) mm external diameter and (220 ± 1) mm internal diameter is connected to earth and positioned concentric to the field-electrode (4.3.2.1) and support ring (4.3.2.2). The outer ring is flexible and clamps the specimen. Details are shown in Figure 4.

4.3.2.4 Voltage generator

A piezo-electric, or other suitable generator capable of producing a (1 200 ± 50) V step voltage on the field-electrode (4.3.2.1) within 30 µs.

4.3.2.5 Field-measuring probe

A metal disc, (30,0 ± 0,1) mm diameter, surrounded by an earthed guard ring and connected to the charge amplifier. Details are shown in Figures 4 and 5. The distance between the bottom of the field-measuring probe and the top of the support ring (4.3.2.2) shall be (50 ± 1) mm

Charge amplifier (electronic electrometer):

Range	1pC...2nC
Input impedance	> 5 * 10^8 Ω
Resolution	0,05 pC
Rise time	0,2 V/µs
Output voltage	+/- 20 V max

4.3.2.6 Recording device

A means of recording time related data from the field-measuring probe output. The time resolution and response time of the recording device shall be 50µs or less, and it shall be capable of recording the full range of output from the fieldmeter. Examples of suitable devices include paper chart recorders, storage oscilloscopes, and data-loggers/computers with appropriate software.

4.3.2.7 Static neutraliser

A means of neutralising electrostatic charge on test specimens prior to measurement.

4.3.3 Specimen

Cut three specimens each at least 300 mm square from the test sample. Specimen shall not include seams. Alternatively, if an uncut material (garment) shall be tested, then measurements shall be made at three different suitable places on the material (garment). Handle the specimen only at the edges to avoid contamination.

4.3.4 Procedure

4.3.4.1 Determination of the initial maximum field strength without specimen

A control measurement shall be carried out without specimen between field-electrode and field-measuring probe. Start the recording device and switch the voltage generator to apply the step voltage to the field-electrode. The field–measuring probe should show the constant maximum value, E_{max}.

4.3.4.2 Measurement with specimen

Clamp the first test specimen or test area in the specimen clamping ring, and position it with the clamping ring concentric to the specimen support ring. Make the earth connections to the clamping ring.

Remove any significant residual electrostatic charge from the specimen using the static neutraliser. Ensure that the field-measuring probe is showing a zero or near-zero reading.

Start the recording device and switch the voltage generator to apply the step voltage to the field-electrode.

Stop the recording device when the field-measuring probe reading has fallen to at least half of its maximum value or after 30 s, whichever occurs first.

From the recording, note E_R and t_{50}.

Remove the specimen and repeat the procedure with the other two specimens.

4.3.5 Calculation and expression of results

Calculate the mean values of the half decay time, t_{50} and shielding factor, S (see 3.6).

For materials that show no shielding effect, E_R is equal to E_{max} (see Figure 6).

For materials with some shielding effects, E_R is less than E_{max} (see Figure 7). Occasionally, a transient peak will occur at the start of the recorder trace. Such peaks are ignored when calculating E_R.

If $E_R < E_{max}/2$ then t_{50} is recorded as < 0,01 s. If the indicated field has not decayed to $E_{max}/2$ within 30 s, t_{50} is recorded as > 30 s.

5 Reporting

The test report shall include at least the following information:

a) reference to this European Standard;

b) date of testing;

c) atmosphere for conditioning and testing;

d) description and number of test samples and specimens;

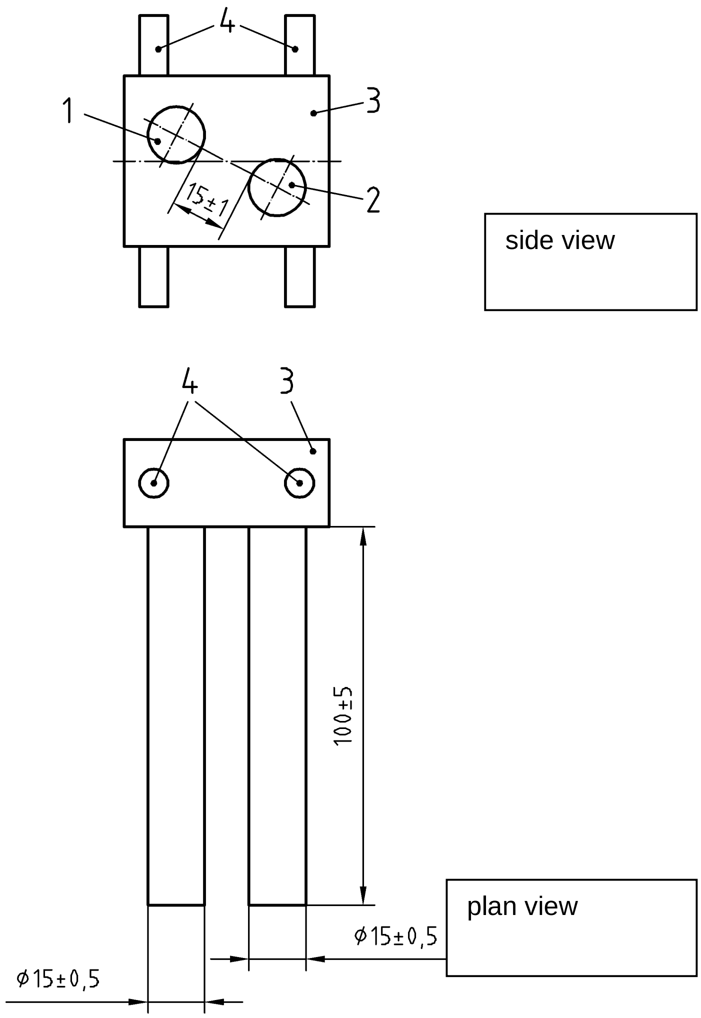
e) test method used;

f) for the triboelectric charging method, the individual and mean values for all parameters included in 4.2.5.

g) for the induction charging method, the individual values of charge decay half time (degree of accuracy: 0,01 s) and shielding factor (degree of accuracy: 0,01 units) for all specimens and the mean values for each sample;

h) any observations or deviations from this European Standard.

Dimensions in millimetres



Key

1 Cylindrical rod

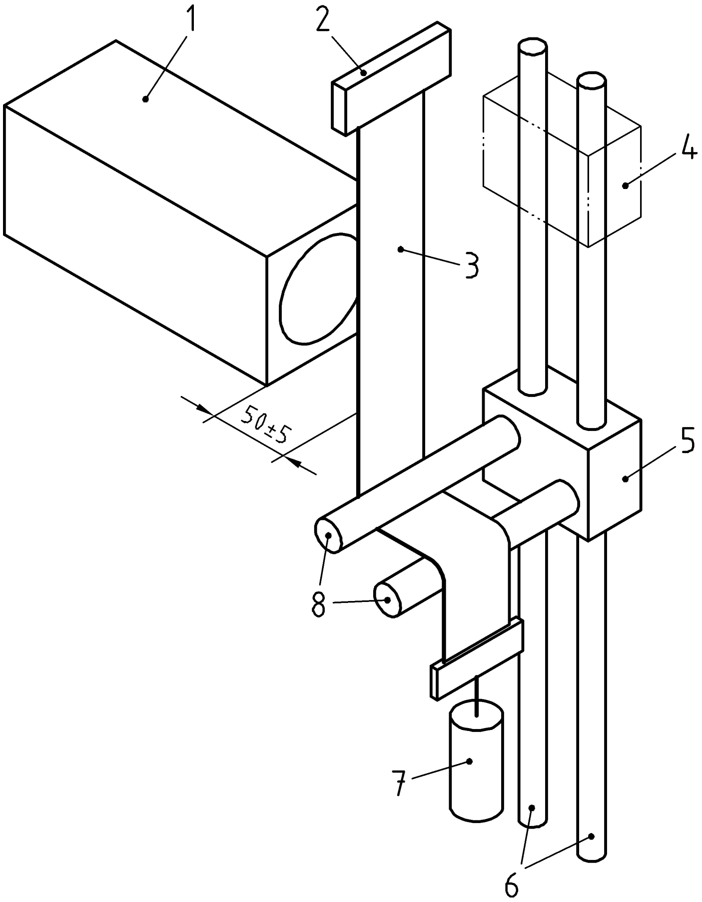
2 Second cylindrical rod

3 Slider

4 Guide rail

Figure 1 — Cylindrical rods mounted on a slider for triboelectric charging test method

Dimensions in millimetres



Key

1 Fieldmeter

2 Fixed clamp

3 Test specimen

4 Start position of slider

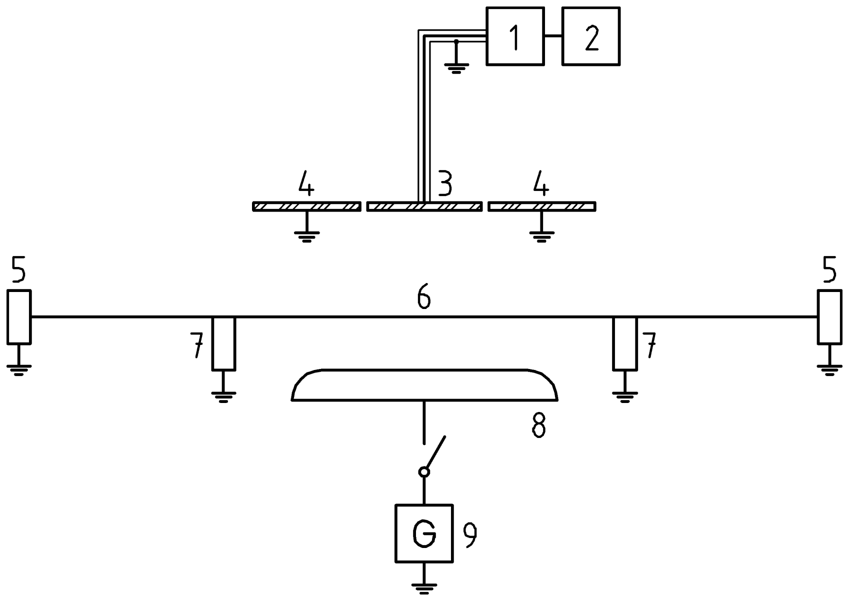
5 Slider in end position

6 Guide rail

7 Tensioning device (weighted clamp)

8 Cylindrical rods

Figure 2 — Example of an equipment for triboelectric charging test method



Key

1 Charge amplifier

2 Recording device

3 Field-measuring probe

4 Guard ring

5 Specimen clamping ring

6 Test specimen

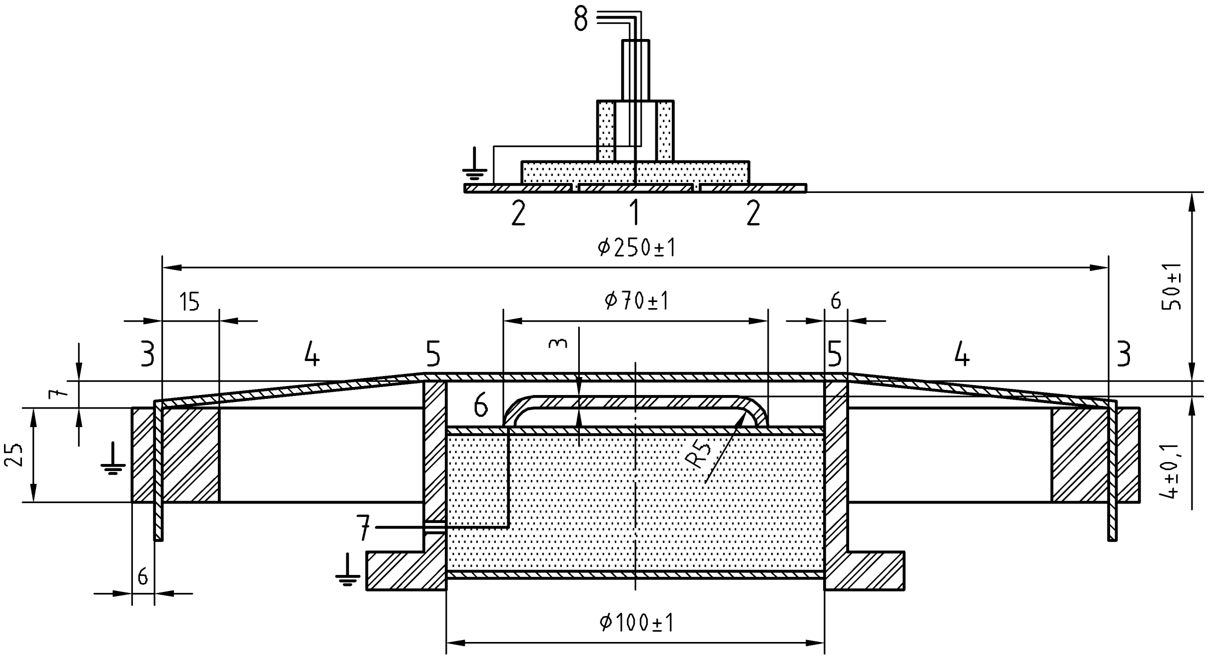
7 Support ring

8 Field-electrode

9 Voltage generator

Figure 3 — Arrangement of equipment for induction charging test method

Dimensions in millimetres



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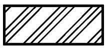
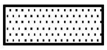

Metal


High insulating material

1 Field-measuring probe

2 Guard ring

3 Specimen clamping ring

4 Test specimen

5 Support ring

6 Field-electrode

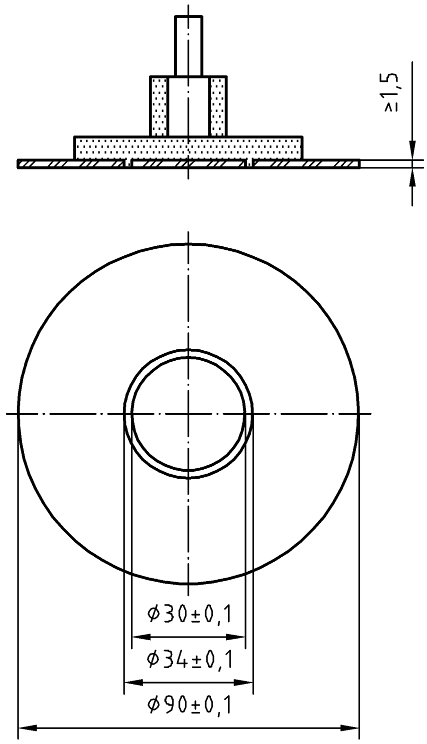
7 Electric wire, connection to voltage generator

8 Electric wire, connection to charge amplifier

Figure 4 — Induction charging test method dimensions of field-electrode, field-measuring probe, specimen clamping ring and distances

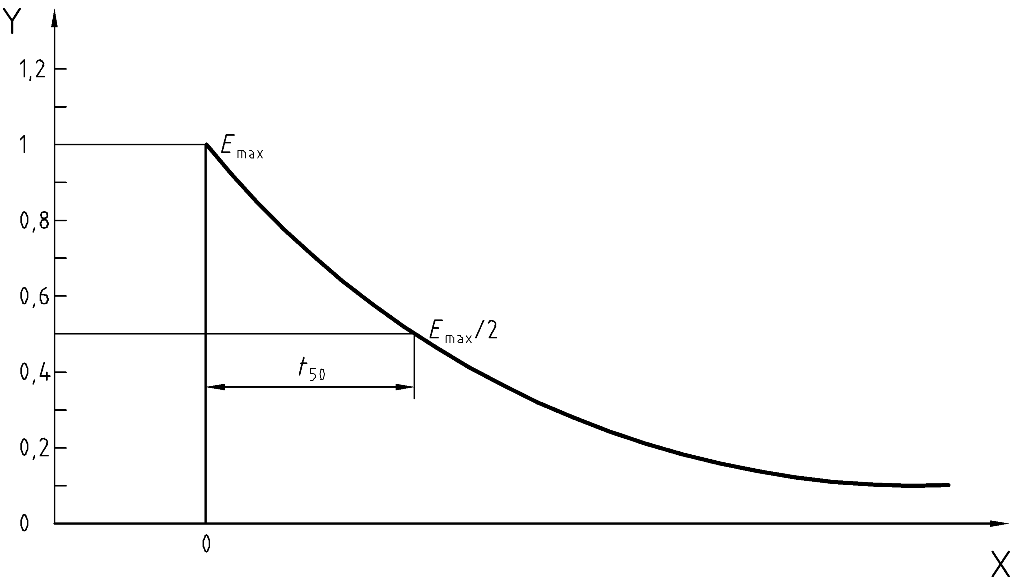
Dimensions in millimetres

side view



bottom view

Figure 5 — Field measuring probe

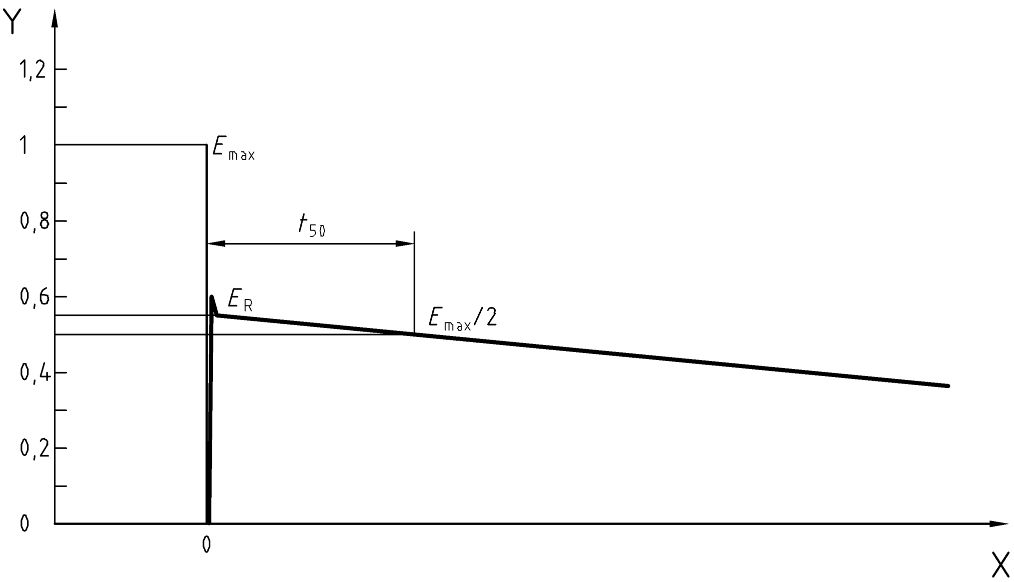


Key

X Time

Y Field strength (relative units)

Figure 6 — Example of a decay measurement record for dissipative material without shielding effect



Key

X Time

Y Field strength (relative units)

Figure 7 — Example of decay measurement record for material with shielding effect

Annex A
(informative)

Explanatory notes

A.1 As mentioned in the scope and annex A of EN 1149-1:1995 surface resistance measurements are not meaningful for special materials, e.g. for fabrics with core conducting fibres. For the assessment of such (inhomogeneous) materials a different test like a charge decay test needs to be standardized. In order to select reliable test methods the results of a European research project were evaluated and led to the proposed two test methods in this standard. Both test are applicable for assessing material for electrostatic dissipative protective clothing to avoid incendiary discharges. Assuming proper earthing as in EN 1149-1 both test methods can be used successfully with the appropriate acceptance criteria to detect electrostatic "safe" garment materials. This statement is based on results from experiments with incendiary discharges using many different fabrics in the most easily ignitable mixture of hydrogen gas and air.

NOTE Although charge decay for both test methods is monitored by observation of the change in measured field, the physical mechanisms involved are different in each case and so there is not necessarily a correlation between the results of the two methods or other charge decay test methods.

A.2 Comparison of results between two laboratories show differences of less than a factor of eight for test method 1. An interlaboratory trial for method 2 using 5 different materials and 5 participating labs in 3 different locations showed a repeatability and reproducibility standard deviation as follows:

Parameter	**S**
Repeatability standard deviation, s_r	0,004
Reproducibility standard deviation, s_R	0,009
	t_{50}
Repeatability variance	30 %
Reproducibility variance	40 %

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 89/686/EEC.

WARNING : Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

The clauses of this standard are likely to support requirements of Directive: 89/686/EEC, Annex II, clause 2.6.

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

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