BRITISH STANDARD

BS EN 61340-2-1:2002

Electrostatics —

Part 2-1: Measurement methods — Ability of materials and products to dissipate static electric charge

The European Standard EN 61340-2-1:2002 has the status of a British Standard

ICS 17.220.99; 29.020

British Standards

National foreword

This British Standard is the official English language version of EN 61340-2-1:2002. It is identical with IEC 61340-2-1:2002.

The UK participation in its preparation was entrusted to Technical Committee GEL/101, Electrostatics, which has the responsibility to:

— aid enquirers to understand the text;

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

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Summary of pages

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English version

Electrostatics
Part 2-1: Measurement methods - Ability of materials and products to dissipate static electric charge
(IEC 61340-2-1:2002)

Electrostatique
Partie 2-1: MÈthodes de mesure -
CapacitÈ des matÈriaux et des produits ‡ dissiper des charges Èlectrostatiques
(CEI 61340-2-1:2002)

Elektrostatik
Teil 2-1: Messverfahren -
F‰higkeit von Materialien und Erzeugnissen, elektrostatische Ladungen abzuleiten
(IEC 61340-2-1:2002)

This European Standard was approved by CENELEC on 2002-09-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC
European Committee for Electrotechnical Standardization
ComitÈ EuropÈen de Normalisation Electrotechnique
Europ‰isches Komitee f¸r Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 61340-2-1:2002 E

Foreword

The text of document 101/138/FDIS, future edition 1 of IEC 61340-2-1, prepared by IEC TC 101, Electrostatics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61340-2-1 on 2002-09-01.

The following dates were fixed:

ñ latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2003-06-01
ñ latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2005-09-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annexes A and ZA are normative.
Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 61340-2-1:2002 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61340-5-2	NOTE	Harmonized as EN 61340-5-2:2001 (not modified).

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CONTENTS

INTRODUCTION

Measurements of the rate of dissipation of static charge belong to the essential measurement techniques in the field of electrostatics.

For homogeneous conductive materials this property can be evaluated by measuring resistance or resistivity parameters.

For materials in the dissipative or insulative range and especially for high ohmic materials including conductive fibres (e.g. textiles with a metallic grid), resistance measurements may not be reliable enough or may not give enough information and the rate of dissipation of static charge needs to be measured.

For many non-metal materials, such as plastics, the transport of charges is dependent on the applied electrical field strength during the measurement, for example, a measurement of resistance will show a non-linear dependence on applied test voltage. There are also problems with spatial inhomogeneity with measurement methods that use contacting electrodes. These points are covered by measuring the rate of dissipation of charge.

ELECTROSTATICS –

Part 2-1: Measurement methods – Ability of materials and products to dissipate static electric charge

1 Scope

This part of IEC 61340 describes test methods for measuring the rate of dissipation of static charge of insulating and static dissipative materials and products.

It includes a generic description of test methods and detailed test procedures for specific applications.

2 Normative references

The following referenced documents are indispensable for the application 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 61340-5-1:1998, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*[1]

ISO 2859-0:1995, *Sampling procedures for inspection by attributes – Part 0: Introduction to the ISO 2859 attribute sampling system*

ISO/TR 13425:1995, *Guide for the selection of statistical methods in standardization and specification*

3 Definitions

For the purpose of this part of IEC 61340, the following definitions apply.

3.1
charge decay
migration of charge across or through a material leading to a reduction of charge density or surface potential at the area where the charge was deposited

3.2
charge decay time constant
time required for the local charge density or surface potential to fall to 1/e of its initial value (e being the base of the natural logarithms 2,7183)

3.3
charged plate monitor (CPM)
instrument using a charged metal plate of a certain capacitance and geometry which is going to be discharged in order to measure charge dissipation/neutralization properties of products or materials

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1 For the interpretation of this publication see IEC 61340-5-2 given in the bibliography.

3.4
corona
generation of ions of either polarities by a high electric field

3.5
dissipative material
material which allows charge to migrate over its surface and/or through its volume in a time which is short compared to the time scale of the actions creating the charge or the time within which this charge will cause an electrostatic problem

3.6
insulator
material with very low mobility of charge so that any charge on the surface will remain there for a long time

4 Method of measurement of charge decay

4.1 Principles

Two methods are described.

The first method determines the dissipation of charge deposited on the surface of the material by a corona discharge. The resulting decrease in surface potential is observed using a fieldmeter or other equivalent equipment. This method is applicable to measurement of charge dissipation on surfaces and materials.

The second method determines the dissipation of charge from a charged plate through an object under test by applying a potential to the metallic plate, disconnecting the voltage source and observing the decrease in potential of the plate by means of a fieldmeter or other equivalent equipment. This method is applicable to measurement of charge dissipation via products such as finger cots, gloves and hand tools.

NOTE There are more methods to charge materials other than the charging methods described here (for example tribocharging or inductive charging) but they are not relevant for this standard.

4.2 Environmental conditions

The electrical properties of materials vary with temperature and the absorption of moisture.

The atmosphere for conditioning and testing shall be 23 °C ± 2 °C and 12 % ± 3 % relative humidity. The conditioning time prior to testing shall be at least 48 h, or as otherwise agreed.

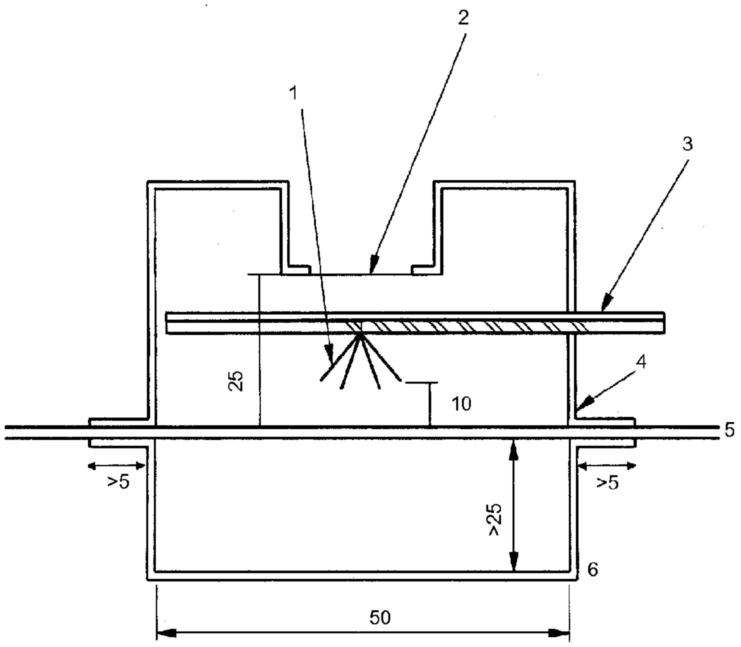
For measurements in practical situations the ambient temperature and relative humidity shall be recorded.

For laboratory measurements, the materials shall be cleaned according to the manufacturer's instructions. The materials used for cleaning and the method shall be reported.

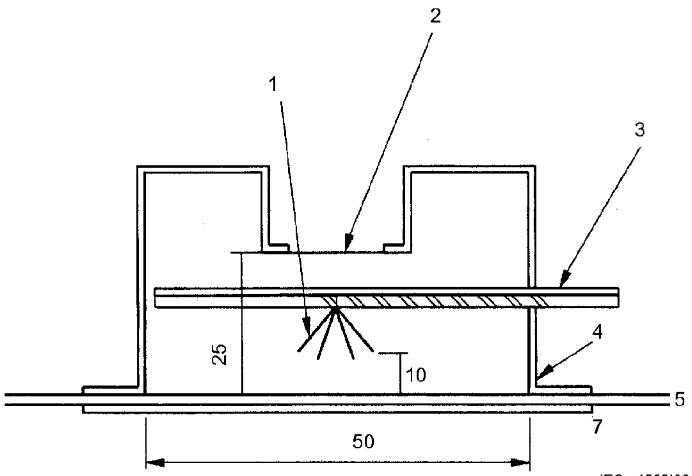
For measurements in practical or installed applications, the materials shall be tested without any “special” cleaning. If cleaning is part of the process, for example, washing of garments, measurements should be taken before and after cleaning, where practical. The materials and the method used for cleaning shall be reported.

4.3 Apparatus for using corona charging

4.3.1 Physical design features



IEC 1581/02



IEC 1582/02

Dimensions in millimetres

Key

1 10 mm diameter circle of corona points

2 Fieldmeter sensing aperture

3 Movable plate:

– insulating plate: to mount corona points (resistance to ground > 10^{14} Ω)

– earthed top surface: to shield fieldmeter

4 Earthed casing

5 Sample

6 Open-shielded backing

7 Earthed backing

NOTE All dimensions are nominal.

Figure 1 – Example of an arrangement for measurement of dissipation of charge using corona charging

A typical arrangement and relevant dimensions of the test apparatus is shown in figure 1. Other equipment giving similar results may be used.

The test aperture for deposition and measurement of deposited charge shall be 50 mm diameter or an equivalent area quasi-square aperture. All the corona points are mounted in a 10 mm diameter circle on a movable plate 10 mm above the centre of the test aperture. The fieldmeter sensing aperture shall be 25 mm above the centre of the test area. When the plate with the corona points is moved fully away, the test area shall be clear up to the plane of the fieldmeter sensing aperture.

4.3.2 Containment of test material

With an installed material, the test aperture in the instrument base plate shall rest directly on its surface. Sheet or flexible materials shall be supported as follows:

a) for testing materials with open backing, the material shall be rested against an earthed metal base plate with an aperture aligned with the instrument test aperture and with width of at least 5 mm extending beyond the aperture. A shield over the reverse side of the test area shall be earthed and be at least 25 mm away over the whole test area;

b) for testing materials against an earthed backing, the material shall be mounted between the base plate and a flat earthed metal plate.

NOTE If charge moves more readily through the bulk test material than across its surface, then placing an earthed metal plate immediately behind the test area may increase the rate of charge dissipation. On the other hand, if charge moves more readily across the surface of the test material, then the rate of charge dissipation may decrease if an earthed metal plate is used because its presence will increase the capacitive loading. To gain a full understanding of charge dissipation from the test material, it is desirable to make measurements both with and without an earthed metal plate backing the test area.

In practical terms, earthed backing represents a material in intimate contact with an earthed surface, for example, a garment fitted close to the body of the wearer, or a work surface on top of a metal bench. Open-backed measurements represent the other practical extreme where materials are separated from earthed surfaces, for example, the bottom edge of a coat or smock which hangs away from the body of the wearer.

4.3.3 Corona charge deposition

Corona charging is achieved with a number of discharge points on a 10 mm diameter circle, 10 mm above the middle of the test area. The exact size and distribution of charge on the material is not well-defined, particularly with the more conductive surfaces, but the arrangement provides a consistent pattern of deposited charge and decay time measurements.

NOTE 1 Typical voltages for corona charging equipments are between 5 kV and 10 kV.

The corona deposition time shall be at least 20 ms in order to achieve an adequate initial peak voltage for measurements. Excessively long deposition times (more than some seconds) may damage the material.

The materials should be tested with positive and negative polarity.

The equipment for charge deposition shall move fully away from the region of fieldmeter observation in less than 20 ms.

NOTE 2 For corona voltages of 7 kV to 8 kV, the initial surface voltage with relatively high insulating materials will be up to about 3 kV. For materials with fast charge decay rates the initial voltage may be much lower – for example only 50 V to 100 V.

4.3.4 Fieldmeter

The fieldmeter shall be a field-mill type of instrument able to measure the surface voltage with an accuracy of ±5 V to below 40 V with a response time (10 % to 90 %) below 10 ms. The stability of the zero shall allow measurement of surface voltage with this accuracy over the longest decay times to be measured.

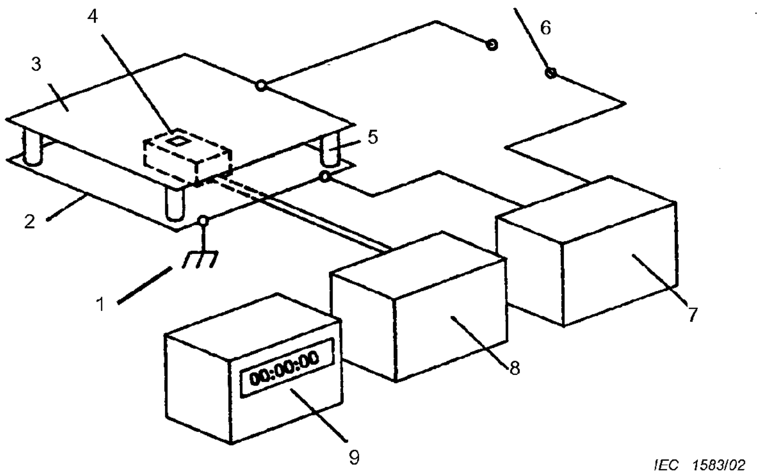
During corona charge deposition and decay time measurement, the fieldmeter sensing aperture shall be well shielded from any connections or surfaces associated with corona high voltage supplies. There shall be no insulating materials around the region between the fieldmeter and the test aperture during the operation of the fieldmeter.

Any residual ionization shall contribute less than 10 V to measurement of surface voltage (excess ionization may be removed, for example, by using an air dam). This may be tested by measurements on a fully conducting test surface.

4.4 Apparatus for using a charged metal plate

4.4.1 Physical design features

The basic arrangement and relevant dimensions of the test apparatus is shown in figure 2.



Key

1 Ground
2 Grounded surface
3 Conductive plate
4 Probe
5 Insulator (resistance to ground > 10^{14} Ω)
6 Switch
7 High-voltage power supply – current limited
8 Fieldmeter or equivalent
9 Discharge timer

Figure 2 – Charged plate monitor components[2]

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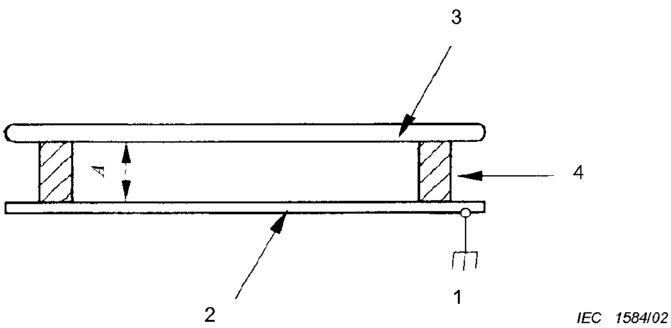
2 If the different components are integrated into one instrument, this is referred to as a charged plate monitor (CPM).

The instrument to measure the charge dissipation of objects under test is the charged plate monitor (see figure 2). The conductive plate shall be 150 mm × 150 mm with a capacitance of 20 pF ± 2 pF when mounted in the test fixture. The wire between the switch and the plate shall be as short as possible.

There shall be no objects grounded or otherwise closer than dimension A of figure 3 of the conductive plate, except the supporting insulators or plate contacts as shown in figure 3. The resistance to ground of the insulators shall be $>10^{14}$ Ω. Dimension A is selected to achieve the desired capacitance. The isolated conductive plate, when charged to the desired test voltage, shall not discharge more than 10 % of the test voltage within 5 min. The response time of the monitoring device shall be sufficient to accurately measure charging plate voltages.

NOTE The capacitance of the plate and the wires should be determined according to A.5.

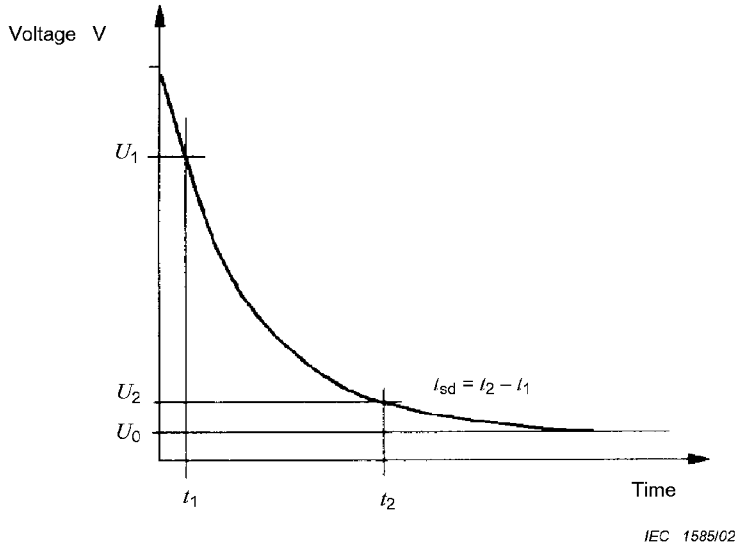


Key
1 Ground
2 Grounded surface
3 150 mm × 150 mm conductive plate
4 Insulator

Figure 3 – Charged plate detail

4.4.2 Charge decay time measurements (t_{sd})

The charge decay time is the period to reduce the initial voltage potential U_1 on the charged plate to a defined lower voltage level U_2, for example it is measured from 1 000 V to 100 V for positive or negative polarity (see figure 4).



NOTE The decay curve may or may not go down to 0 V.

Figure 4 – Charge decay time (t_{sd}) and offset voltage (U_0)

5 Sampling

Sampling shall be carried out according to ISO 2859-0 or another sampling plan defined for specific applications.

Annex A
(normative)

Test methods and procedures

The test methods and procedures described in this annex are primarily intended for use in conjunction with IEC 61340-5-1. The general principles may have relevance to other applications.

A.1 Charge decay test for textile materials

For charge-decay tests on textile materials, the corona charging method shall be used.

A.1.1 Test surface preparation

The test sample presented for test shall be big enough to completely cover the test fixture and shall be clean and free from loose dust.

Remove any loose dust by gentle brushing or blowing with clean dry air. If the surface is obviously contaminated, either test an alternative area of the material or make measurements with the contamination present and report the condition of testing 'as received'.

For laboratory measurements, the materials shall be cleaned according to the manufacturer's instructions. The materials used for cleaning and the method shall be reported.

For measurements in practical or installed applications, the materials shall be tested without any "special" cleaning. If cleaning is part of the process, for example, washing of garments, measurements should be taken before and after cleaning where practical. The materials and the method used to clean shall be reported.

Avoid contamination of samples by handling samples only by tweezers or with gloved hands.

A.1.2 Testing

Rest the test aperture on the surface to be tested, set up appropriate charging conditions and make the required number of charge-decay measurements.

The test equipment shall remain steady and undisturbed on the surface for the duration of each measurement.

NOTE Movement of the test equipment relative to the surface can cause tribocharging which will affect observations.

Make measurements with both positive and negative polarities.

Make measurements on sheet and film materials, both with open-shielded backing and with an earthed surface backing.

At least three measurements shall be made for each set of test conditions with each sample. The time between measurements shall be such that the surface voltage falls to below 5 % of the initial voltage.

All measurements shall be made on different locations.

A.1.3 Results

The charge decay time values are the measured times for the surface voltage to fall from the starting voltage to a defined value.

Charge-decay time values quoted shall be the average of the values measured under the test conditions, which provides the longest decay times.

If it is not possible to achieve the required initial surface voltage with a corona voltage of at least 7 kV, then this fact shall be recorded together with the actual surface voltage achieved.

A.1.4 Test report

The test report shall include at least the following information:

- test results (all values plus charge decay time according to A.1.3);
- number of samples tested;
- date and time of measurements;
- description and/or identification of material tested;
- charging conditions used (for example, polarity, corona voltage, charging duration, electrode dimensions, time between tests);
- whether the sample is supported with an open backing or an earthed backing surface;
- temperature and relative humidity at time of measurements and duration of conditioning for standard laboratory measurements;
- identification of instrumentation used and date of most recent as well as next calibration.

A.2 Charge-decay test via gloves and finger cots

For charge-decay tests on gloves and finger cots, a charged plate monitor and a wrist strap according to IEC 61340-5-1 shall be used. For the following procedure, all technical values shall be observed within 10 %, or as otherwise agreed.

A.2.1 Test procedure for the charge-decay properties of finger cots as worn

1) Put on a wrist strap and connect it to ground.
2) Perform the null test as described in clause A.4.
3) Charge a CPM up to 1 000 V.
4) Touch the charged plate with the test finger without a finger cot (wearing a wrist strap), lift the finger up after 2 s and do not put it down again; measure the decay time from 1 000 V to 100 V as a reference test.

5) Put on a finger cot.
6) Charge a CPM up to 1 000 V.
7) Touch the charged plate with the test finger wearing a finger cot (wearing a wrist strap), lift the finger up after 2 s and do not put it down again.
8) Measure the decay time to 100 V.
9) Repeat steps 6) to 8) twice to have three test results.

NOTE If the reading after lifting the finger up is significantly higher than at the null test, there is no real discharge of the probe. The voltage is just increasing since the capacitance between the finger and the plate is decreasing (charge suppression).

A.2.2 Test procedure for the charge decay properties of gloves as worn

1) Put on a wrist strap and connect it to ground.
2) Perform the null test as described in clause A.4.
3) Charge a CPM up to 1 000 V.
4) Touch the charged plate with the hand flat, without gloves (wearing a wrist strap), lift the hand up after 2 s and do not put it down again; measure the decay time from 1 000 V to 100 V as a reference test.
5) Put on a glove.
6) Charge a CPM up to 1 000 V.
7) Touch the charged plate with the hand flat, wearing a glove (wearing a wrist strap), lift the hand up after 2 s and do not put it down again.
8) Measure the decay time to 100 V.
9) Repeat steps 6) to 8) twice to have three test results.

NOTE If the reading after lifting the hand up is significantly higher than at the null test, there is no real discharge of the probe. The voltage is just increasing since the capacitance between the hand and the plate is decreasing (charge suppression).

A.2.3 Test report

The test report shall include at least the following information:

- test results (all three separately);
- date and time of measurements;
- description and/or identification of material tested;
- conditions used (for example, polarity, voltage, time between tests);
- temperature and relative humidity at time of measurements and duration of conditioning for standard laboratory measurements;
- identification of instrumentation used.

A.3 Charge-decay test for tools

For charge-decay tests on tools (for example, screwdriver or pliers), a charged plate monitor and a wrist strap according to IEC 61340-5-1 shall be used. For the following procedure all technical values shall be observed within 10 % or as otherwise agreed.

A.3.1 Test procedure for the charge-decay properties of tools

1) Put on a wrist strap and connect it to ground.
2) Perform the null test as described in clause A.4.
3) Charge a CPM up to 1 000 V.
4) Touch the charged plate with the hand without a tool (wearing a wrist strap), lift the hand up after 2 s and do not put it down again; measure the decay time from 1 000 V to 100 V as a reference test.
5) Take the tool under test in the hand.
6) Charge a CPM up to 1 000 V.
7) Touch the charged plate with the tool in the hand (wearing a wrist strap), lift the tool up after 2 s and do not put it down again.
8) Measure the decay time to 100 V.
9) Repeat steps 6) to 8) twice to have three test results

NOTE If the reading after lifting the tool up is significantly higher than at the null test, there is no real discharge of the probe. The voltage is just increasing since the capacitance between the tool and the plate is decreasing (charge suppression).

A.3.2 Test report

The test report shall include at least the following information:

– test results (all three separately);
– date and time of measurements;
– description and/or identification of the tool tested;
– test conditions used (for example, polarity, voltage, time between tests);
– temperature and relative humidity at time of measurements and duration of conditioning for standard laboratory measurements;
– identification of instrumentation used.

A.4 Null test for CPM

1) Ground and zero the CPM.
2) Touch the plate of the CPM with the item to be tested in the same way as for the real test. Be careful only to touch it and do not rub the item across the CPM.
3) Isolate the plate.
4) Raise the item to be tested from the plate.
5) Read the voltage on the plate.
6) This is the voltage generated by the separation of the item to be tested from the plate. This shall be noted in the final report.

NOTE Voltage readings may be affected by triboelectrification. This procedure will determine if tribocharging is making a significant contribution to the voltage values. The voltage of the null test should be reported with the test data.

A.5 Method for verification of the capacitance of an isolated conductive plate

The measurement of the capacitance of an isolated conductive plate shall either be made using a suitable capacitance meter, by measuring the charge on it or by using the charge sharing method.

A.5.1 Measuring the charge

This method for measuring the capacitance of an isolated conductive plate (including the wires) to within an accuracy of 5 % requires a voltage source and a coulomb meter. The capacitance of the plate is determined from the equation:

$$C = Q/V \qquad (A.1)$$

where

Q is the charge on the plate in coulombs (C);

V is the voltage on the plate in volts (V);

C is the capacitance of the plate in farads (F).

The voltage on the plate is determined by charging it with a known voltage V, and the charge Q on the plate is measured by discharging into a coulomb meter. The ratio of these two measured numbers, as shown by the above equation, gives the capacitance of the isolated conductive plate.

If the capacitance is in the range of 20 pF ± 2 pF, it is convenient to use 100 V for the value V. 100 V on a conductive plate with a capacitance of 20 pF results in a charge of 2 nC on the plate.

A.5.1.1 Equipment

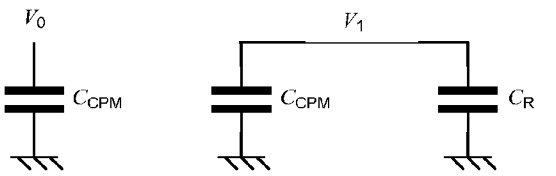
- A d.c. voltage source of 100 V ± 20 %, and measured to ±2 %, with a current limit of 100 µA.
- A coulomb meter with a resolution of 0,02 nC on a suitable scale (for example, 3 nC full scale).

A.5.1.2 Procedure

Charge the plate (see figure 3) to V by momentarily touching it with the probe from the voltage source. Remove the charge on the plate by touching it with the probe from the coulomb meter and record the charge reading. Repeat the experiment 10 times to determine average values and standard deviation. The standard deviation should be less than 0,5 pF.

A.5.2 Charge-sharing method for measuring capacitance

The principle of the charge sharing method for measuring the capacitance of a CPM is to connect the monitor plate, at a known potential, to a reference capacitor that is much larger than the capacitance expected for the CPM itself. Charge will be shared between the reference capacitor and the CPM in the same ratio as their respective capacitances. For example, if the CPM has a capacitance of 20 pF and the reference capacitor is 2 nF then 0,99 % of the total charge will remain on the CPM and 99,01% will be transferred to the reference capacitor. For practical purposes, if a reference capacitor is used that is at least 100 times larger than the capacitance expected for the CPM, then it can be assumed all the charge is transferred to the reference capacitor. By measuring the potential difference across the reference capacitor the amount of charge can be determined. From this result and the known potential to which the CPM was originally charged it is simple to calculate the capacitance of the CPM, thus:



The total charge, Q, originally stored on the charged plate monitor is equal to:

$$Q = V_0 \times C_{CPM} \tag{A.2}$$

If part of the charge is transferred to the reference capacitor, C_R, we have

$$Q = (V_1 \times C_R) + (V_1 \times C_{CPM}) = V_1 \times (C_R + C_{CPM}) \tag{A.3}$$

Since the total charge remains equal, we have:

$$V_0 \times C_{CPM} = V_1 \times (C_R + C_{CPM}) = V_1 \times C_R\,(1 + C_{CPM}/C_R) \tag{A.4}$$

If $C_R >> C_{CPM}$, C_{CPM}/C_R can be neglected in reference to 1. So the capacitance of the charged plate monitor can be calculated from:

$$C_{CPM} = V_1/V_0 \times C_R. \tag{A.5}$$

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 61340-5-1 + corr. February	1998 1999	Electrostatics Part 5-1: Protection of electronic devices from electrostatic phenomena - General requirements	EN 61340-5-1 + corr. April	2001 2001
ISO 2859-0	1995	Sampling procedures for inspection by attributes Part 0: Introduction to the ISO 2859 attribute sampling system	-	-
ISO/TR 13425	1995	Guide for the selection of statistical methods in standardization and specification	-	-

Bibliography

IEC 61340-5-2:1999, *Electrostatics – Protection of electronic devices from electrostatic phenomena – User guide*

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