# IEC 61340-5-3

Edition 3.0 2022-04
COMMENTED VERSION

# INTERNATIONAL STANDARD



colour inside

## Electrostatics –
## Part 5-3: Protection of electronic devices from electrostatic phenomena – Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices

IEC 61340-5-3:2022-04 CMV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# ELECTROSTATICS –

# Part 5-3: Protection of electronic devices from electrostatic phenomena – Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices

## FOREWORD

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**This commented version (CMV) of the official standard IEC 61340-5-3:2022 edition 3.0 allows the user to identify the changes made to the previous IEC 61340-5-3:2015 edition 2.0. Futhermore, comments from IEC TC 101 experts are provided to explain the reasons of the most relevant changes.**

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

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

IEC 61340-5-3 has been prepared by IEC technical committee 101: Electrostatics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2015. This edition constitutes a technical revision.

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

a) reference to IEC 61340-4-10[1] [1][2] was removed;
b) material resistance property "electrostatic field shielding" was removed;
c) the requirement for electrostatic discharge shielding was changed from 50 nJ to 20 nJ;
d) Table 1 – footnote "b" was changed to mention the two-point probe in IEC 61340-2-3;
e) "shall be marked" was changed to "should be marked" in 7.2.2 and 7.2.3;
f) Table 3 – the classification symbol and the primary function code F was removed;
g) Table A.2 – references to IEC TS 61340-5-4 [2] and IEC TR 61340-5-5 [3] were added;
h) Annex C – guidance regarding electric field shielding was added;
i) Annex D – low charging material property was added.

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

| Draft | Report on voting |
|---|---|
| 101/649/FDIS | 101/660/RVD |

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

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

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

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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



1 Withdrawn.

2 Numbers in square brackets refer to the bibliography.

# INTRODUCTION

Packaging is necessary to protect electrostatic discharge sensitive devices (ESDSs) from static electricity and electrostatic discharge (ESD) damage as well as 1 physical and environmental damage during manufacture, transportation and storage.

# ELECTROSTATICS –

# Part 5-3: Protection of electronic devices from electrostatic phenomena – Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices

## 1 Scope

This part of IEC 61340 defines the ESD protective packaging properties ~~needed~~ required to protect ~~electrostatic discharge~~ ESD sensitive devices (ESDSs) through all phases of production, rework~~/~~ and maintenance, transport and storage. Test methods are referenced to evaluate packaging and packaging materials for these product and material properties. Performance limits are provided.

This document does not address protection from electromagnetic interference (EMI), electromagnetic pulsing (EMP) or protection of ~~volatile materials~~ electrically initiated explosive materials or devices **2**.

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

IEC 61340-4-8, *Electrostatics – Part 4-8: Standard test methods for specific applications – Electrostatic discharge shielding – Bags*

~~IEC 61340-4-10, *Electrostatics – Part 4-10: Standard test methods for specific applications – Two-point resistance measurement*[3] **3**~~

~~IEC 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment) **4**~~

## 3 Terms, definitions and abbreviated terms

### 3.1 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] At the time of writing, it is proposed withdrawing IEC 61340-4-10: 2012 and incorporating the test method into the next edition of IEC 61340-2-3.~~

**3.1.1**
**electrostatic discharge**
**ESD**
rapid transfer of charge between bodies at different electrostatic potentials

~~Note 1 to entry: This note applies to the French language only.~~

**3.1.2**
~~**electrostatic discharge**~~ **ESD sensitive device**
**ESDS**
sensitive device, integrated circuit or assembly that ~~may~~ can be damaged by electrostatic fields or electrostatic discharge

~~Note 1 to entry: This note applies to the French language only.~~

Note 1 to entry: See Clause B.2 and Clause B.3 in Annex B.

**3.1.3**
**ESD protected area**
**EPA**
area in which an ESDS can be handled with acceptable risk of damage caused by electrostatic discharge or fields

SEE: Figure A.1 in Annex A.

**3.1.4**
**unprotected area**
**UPA**
area outside an EPA

~~Note 1 to entry: This note applies to the French language only.~~

SEE: Figure A.1 in Annex A.

**3.1.5**
**intimate packaging**
material which makes contact with an ESDS

**3.1.6**
**proximity packaging**
material not making contact with an ESDS and which is used to enclose one or more devices

**3.1.7**
**secondary packaging**
material used primarily to give additional physical protection to the outside of proximity ~~package~~ packaging

**3.1.8**
**volume resistance**
$R_V$
ratio of a DC voltage (V) applied between two electrodes placed on two (opposite) surfaces of a specimen and the current (A) between the electrodes

Note 1 to entry: Volume resistance is expressed in Ω.

**3.1.9**
**point-to-point resistance**
$R_{p\text{-}p}$
ratio of a DC voltage (V) applied between two electrodes on a surface of a specimen and the current (A) between the electrodes

Note 1 to entry: The electrode configuration for point-to-point resistance measurements is usually a pair of circular faced electrodes with a defined distance apart.

Note 2 to entry: Point-to-point resistance is expressed in Ω.

**3.1.10**
**surface resistance**
$R_S$
ratio of a DC voltage (V) applied between two electrodes in a defined configuration on a surface of a specimen and the current (A) between the electrodes

Note 1 to entry: The electrode configuration for surface resistance measurement is usually a pair of parallel rectangular electrodes or a pair of circular concentric electrodes.

Note 2 to entry: Surface resistance is expressed in Ω.

### 3.2 Abbreviated terms

CDM charged device model
EMI electromagnetic interference
EMP electromagnetic pulsing
EPA ESD protected area
ESD electrostatic discharge
ESDS electrostatic discharge sensitive device
HBM human body model
~~MM~~ ~~Machine model~~ **5**
UPA unprotected area

## 4 Tailoring

This document, or portions thereof, ~~may~~ does not necessarily apply to all applications. Tailoring is accomplished by evaluating the applicability of each requirement for the specific application. Upon completion of the evaluation, requirements may be added, modified or deleted.

Tailoring decisions, including rationale, shall be documented.

## 5 Packaging application requirement

### 5.1 General

Transportation and storage of ESDSs require packaging that provides protection from electrostatic hazards (for example from an electrostatic discharge). Within an EPA in which all ESD risks are well controlled, it is possible that ESD protective packaging ~~may~~ will not be necessary.

### 5.2 Inside an EPA

Packaging used within an EPA shall consist of dissipative or conductive materials for intimate contact.

~~Items sensitive to <100 V human body model (HBM) may need additional protection depending on application and program plan requirements.~~

Additional protection can be necessary for items sensitive to < 100 V for HBM, < 200 V for CDM and < 35 V for isolated conductors, depending on application and program plan requirements. **6**

NOTE Dissipative materials are preferred for intimate packaging in situations where charged device model (CDM) damage is a concern.

### 5.3 Outside an EPA

Transportation and storage of sensitive products outside of an EPA shall ~~require~~ be done in packaging that provides both

a) dissipative or conductive materials for intimate contact,

b) a structure that provides electrostatic discharge shielding.

If electrostatic field shielding materials are used to provide discharge shielding, a material that provides a barrier to current flow should be used in combination with the electrostatic field shielding material.

NOTE Dissipative materials are preferred for intimate packaging in situations where charged device model (CDM) damage is a concern.

## 6 Classification of ESD packaging material properties

### 6.1 General

Materials and ~~packages~~ packaging that are useful in preventing damage to ESD sensitive ~~electronic~~ devices exhibit certain properties. These properties include:

a) resistance properties:
   – conductive;
   – dissipative;
b) shielding properties:
   – electrostatic discharge;
   – electrostatic field;
c) low charging properties:

See Annex D. **7**

### 6.2 Material resistance properties

#### 6.2.1 General

Most standard packaging materials are electrically insulating and insulating materials retain charge. Making the ~~package~~ packaging less insulating provides a path for the charge to dissipate from the ~~package~~ packaging to a material at a lower potential.

Specific ranges of resistance are useful for different purposes. Packaging can be classified by these resistance ranges of the material used in its construction.

#### 6.2.2 Resistance of conductive materials

Conductive materials ~~may~~ can be surface conductive, volume conductive or both.

a) Surface conductive materials

   Surface conductive materials shall have a surface resistance of $< 1 \times 10^4\ \Omega$.

b) Volume conductive materials

   Volume conductive materials shall have a volume resistance of $< 1 \times 10^4\ \Omega$ .

NOTE The thickness of the material ~~might~~ can have a significant influence on the measured value of volume resistance.

~~6.2.3 Resistance of electrostatic field shielding materials~~ 8

~~Within the conductive materials classification, electrostatic field shielding materials shall have a homogeneous layer with a surface resistance of $<1 \times 10^3$ Ω or a volume resistance of $<1 \times 10^3$ Ω.~~

~~Other methods may also define the electrostatic field shielding classification.~~

~~NOTE These resistance values do not necessarily imply EMI/EMP shielding.~~

### 6.2.3 Resistance of dissipative materials

Dissipative materials ~~may~~ can be surface dissipative, volume dissipative or both.

a) Surface dissipative materials

Surface dissipative materials shall have a surface resistance ≥ $1 \times 10^4$ and < $1 \times 10^{11}$ Ω.

b) Volume dissipative materials

Volume dissipative materials shall have a volume resistance ≥ $1 \times 10^4$ and < $1 \times 10^{11}$ Ω.

NOTE The thickness of the material ~~might~~ can have a significant influence on the measured value of volume resistance.

### 6.2.4 Resistance of insulating materials

Electrostatic insulating materials ~~may~~ can be surface insulating, volume insulating or both.

a) Surface insulating materials

Electrostatic surface insulating materials have a surface resistance ≥ $1 \times 10^{11}$ Ω.

b) Volume insulating materials

Electrostatic volume insulating materials have a volume resistance ≥ $1 \times 10^{11}$ Ω.

## 6.3 Material electrostatic shielding properties

NOTE Electrostatic shielding materials protect packaged ~~sensitive electronic items~~ ESDSs from the effects of electrostatic discharges and fields that are external to the ~~package~~ packaging.

### 6.3.1 Electrostatic discharge shielding

Electrostatic discharge shielding packaging is capable of attenuating an electrostatic discharge. The calculated energy allowed inside ~~a static~~ an electrostatic discharge shielding bag shall be less than ~~50~~ 20 nJ 9 when tested according to IEC 61340-4-8 or equivalent test method modified to accommodate the product.

### 6.3.2 Electrostatic field shielding

Electrostatic field shielding packaging is capable of attenuating an electrostatic field.

~~NOTE Classified field-shielding materials can allow current flow through their volume.~~

See Annex C.

# 7 Technical requirements for ESD protective packaging

## 7.1 Packaging and material properties

Table 1 and Table 2 provide test methods for determining material classifications for finished ~~packages~~ packaging and materials. When possible, testing shall be performed on the finished ~~package~~ packaging. When testing cannot be performed on a finished ~~package~~ packaging, the

material classification shall be defined by the bulk material used for the production of the final ~~package~~ packaging.

Other probes (electrodes) may be used providing the results correlate with the specified probes (electrodes). In case of dispute, the probe (electrode) assemblies specified in IEC 61340-2-3 shall be used. **10**

**Table 1 – Test methods for electrostatic protective packaging**

| Material classification | Test method [a] | Method description | Limits |
|---|---|---|---|
| Surface conductive | IEC 61340-2-3 [e] | $R_S$ Surface resistance | < 1 × $10^4$ Ω |
| | IEC 61340-2-3 [b,e] | $R_{p\text{-}p}$ Point-to-point resistance | < 1 × $10^4$ Ω [c] |
| | ~~IEC 61340-4-10 [b]~~ **11** | ~~$R_{p\text{-}p}$ Point-to-point resistance~~ | ~~< 1 × $10^4$ Ω [c,e]~~ |
| Volume conductive | IEC 61340-2-3 [e] | $R_V$ Volume resistance | < 1 × $10^4$ Ω [d] |
| ~~Electrostatic field shielding~~ **12** | ~~IEC 61340-2-3 [e]~~ | ~~$R_S$ Surface resistance~~ | ~~< 1 × $10^3$ Ω~~ |
| | ~~IEC 61340-2-3 [e]~~ | ~~$R_V$ Volume resistance~~ | ~~< 1 × $10^3$ Ω [d]~~ |
| Surface dissipative | IEC 61340-2-3 [e] | $R_S$ Surface resistance | ≥ 1 × $10^4$ to < 1 × $10^{11}$ Ω |
| | IEC 61340-2-3 [b,e] | $R_{p\text{-}p}$ Point-to-point resistance | ≥ 1 × $10^4$ to < 1 × $10^{11}$ Ω [c] |
| | ~~IEC 61340-4-10 [b]~~ | ~~$R_{p\text{-}p}$ Point-to-point resistance~~ | ~~≥ 1 × $10^4$ to < 1 × $10^{11}$ Ω [c]~~ |
| Volume dissipative | IEC 61340-2-3 [e] | $R_V$ Volume resistance | ≥ 1 × $10^4$ to < 1 × $10^{11}$ Ω [d] |
| Surface insulating | IEC 61340-2-3 [e] | $R_S$ Surface resistance | ≥ 1 × $10^{11}$ Ω |
| | ~~IEC 61340-4-10 [b]~~ IEC 61340-2-3 [b,e] | $R_{p\text{-}p}$ Point-to-point resistance | ≥ 1 × $10^{11}$ Ω [c] |
| Volume insulating | IEC 61340-2-3 [e] | $R_V$ Volume resistance | ≥ 1 × $10^{11}$ Ω [d] |

[a] For product qualification of packaging materials, the environmental conditions for preconditioning and testing shall be 23 °C ± 2 °C and 12 % ± 3 % relative humidity. The preconditioning before the measurement shall be ≥ 48 h.

[b] ~~IEC 61340-4-10 describes the $R_{p\text{-}p}$ point-to-point resistance measurement with a twopoint probe.~~
~~IEC 61340-2-3 describes all three test methods $R_S$, $R_V$ and $R_{p\text{-}p}$.~~

IEC 61340-2-3 describes point-to-point resistance measurements using two 2,5 kg electrodes. It also describes a two-point probe for point-to-point resistance measurements for non-planar materials and products with small structures. Either of these two test methods may be used. **13**

[c] The results of a measurement of $R_{p\text{-}p}$ according to IEC 61340-2-3 ~~or IEC 61340-4-10~~ can be different compared to the results of a measurement of $R_S$ according to IEC 61340-2-3 due to the usage of different probes.

[d] The thickness of the material ~~might~~ can have a significant influence on the values of a measured volume resistance. The requirement is the same despite the thickness of the material.

[e] IEC 61340-2-3 describes test methods for the determination of the electrical resistance and resistivity of solid materials in the range from $10^4$ Ω to $10^{12}$ Ω, and refers to other standards for measurements outside this range. However, it is possible that the other test methods referred to ~~may~~ will not be appropriate for measuring packaging materials or products. Therefore, for the purposes stated in this table, any of the ~~concentric ring probe~~ electrodes specified in IEC 61340-2-3 shall be used. The instrumentation used shall be able to measure to below $10^3$ Ω; it is acceptable for the open circuit voltage or voltage under load of the instrumentation used to be less than 10 V.

**Table 2 – Test methods and requirements for electrostatic discharge shielding packaging**

| | Packaging system | |
|---|---|---|
| | **Shielding bags** | **Other ESD shielding packaging design** |
| Test method | IEC 61340-4-8 | User defined |
| Requirement | Energy <~~50~~ 20 nJ **14** | – intimate packaging shall be dissipative or conductive<br>– a barrier layer or a defined air gap attenuating ESD energy shall be included [a] |
| [a] No component of the packaging system shall cause ESD risk when taken within an EPA. | | |

## 7.2 Packaging marking

### 7.2.1 Classification symbol

ESD protective packaging ~~shall~~ should **15** be marked with the ESD classification symbol given in IEC 60417-6202:2013-06 [4] and as shown in Figure 1 or in accordance with customer contracts, purchase orders, drawings or other documentation.


**Figure 1 – Example of packaging label (*Primary function code)**

### 7.2.2 Packaging classification

The primary function code ~~shall~~ should be marked below the ESD classification symbol given in IEC 60417-6202:2013-06 [4] and as shown in Table 3:

S electrostatic discharge shielding;

~~F electrostatic field shielding;~~

C electrostatic conductive;

D electrostatic dissipative.

**Table 3 – Primary function code~~/~~ and ESD classification symbol**

| Primary function code * | Primary function | ESD classification symbol |
|---|---|---|
| S | Electrostatic discharge shielding |   |
| ~~F~~ | ~~Electrostatic field shielding~~ 16 |   |
| C | Electrostatic conductive |   |
| D | Electrostatic dissipative |   |

### 7.2.3 Traceability

Packaging ~~shall~~ should be ~~marked~~ supplied with information that allows traceability to the packaging manufacturer and to the manufacturer's date~~/~~ and lot code information.

~~The date/lot code shall allow traceability to quality control information pertaining to the manufacture of the specific lot of packaging.~~ 17

# Annex A
(informative)

## Guidance on ESD packaging material ~~guidance~~

### A.1 Environment and device sensitivity

#### A.1.1 General

Environment and device sensitivity are two primary considerations for selecting ESD packaging materials.

#### A.1.2 Environment

Since the threat to a sensitive item is usually undetermined when the item is outside ~~an ESD protected area (EPA), electrostatic sensitive devices (ESDS) should be placed in ESD protective packaging whenever the item is in an unprotected area (UPA)~~ an EPA, the ESDS should be placed in ESD protective packaging whenever the item is in a UPA – see Table A.1.

**Table A.1 – Packaging characteristics for environmental consideration**

| Item to be packed | EPA | | UPA | |
|---|---|---|---|---|
| | Intimate | Proximity | Intimate | Proximity |
| ESDS | Electrostatic conductive or dissipative [a] | Electrostatic conductive or dissipative | As for inside EPA and electrostatic discharge shielding [b] | As for inside EPA and electrostatic discharge shielding [c] |

[a] For battery operated ESDSs, the selection of the material or the design of the packaging should ensure that the battery does not become discharged.

[b] Electrostatic discharge shielding property is only ~~needed~~ required when proximity packaging is not electrostatic discharge shielding.

[c] Electrostatic discharge shielding property is only required when intimate packaging is not electrostatic discharge shielding.

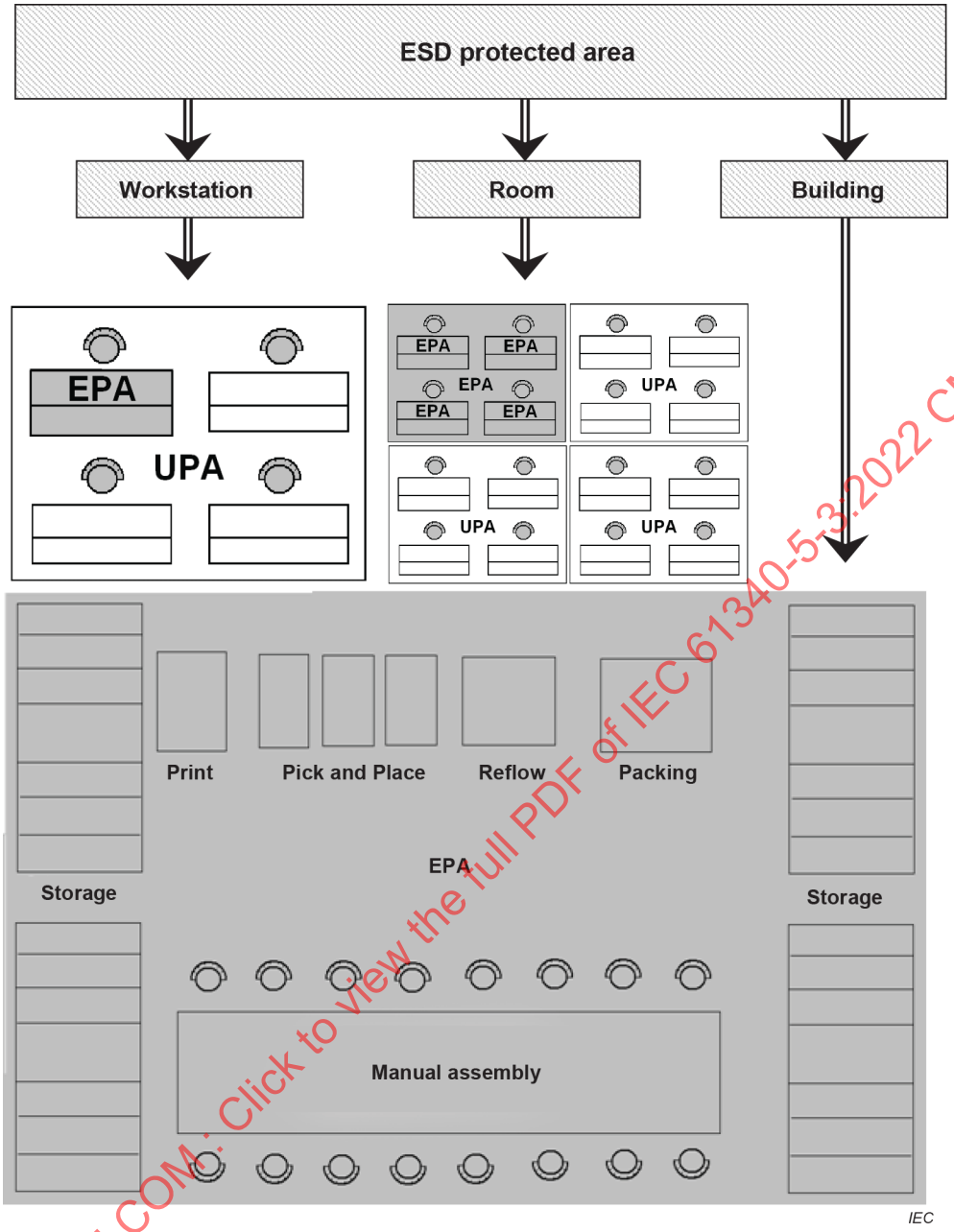


**Figure A.1 – Examples of EPA configurations**

### A.1.3 Device sensitivity

If the sensitivity of the ESDS is unknown and the device is being shipped outside of the EPA, it should be packaged using an electrostatic discharge shielding structure that also provides protection against electrostatic fields (see Annex C).

However, if the sensitivity of the ESDS is known and the ESD threat environment is well understood, the protection level of the packaging may be reduced.

## A.2 Equipotential bonding

While not always recognized as being a packaging consideration, equipotential bonding, or the shunting of leads, can be an effective method to mitigate damage. By placing a conductive shunt across device leads or card connectors, the various parts of the item share the same electrical potential. While not necessarily at ground potential, the fact that parts of the item share the same potential means that damaging current will not flow between them. Shunting has limitations. Energy from direct discharge and electric fields ~~may~~ can impact the item in a manner that does not allow the energy to equalize through the shunt, but instead through the device. ESD protective packaging that offers other protective properties is usually used in conjunction with shunting devices.

## A.3 Dissipative material for intimate contact

To avoid rapid discharge of charged ESDSs due to contact with conductive surfaces leading to charged device ESD risk, dissipative materials are preferred.

## A.4 Packaging from incoming material to the point of use

~~Figure A.1~~ Figure A.2 shows a simplified layout of a generic electronic packaging application. Each area has the recommended ESD packaging material properties noted. As discussed in A.1.3, if the item sensitivity and threats are documented, the level of protective packaging can be reduced after confirming packaging functionality.

NOTE This layout shows an "islands of protection" approach to ESD safeguards. Many manufacturing processes employ a "total factory" approach, where the entire factory is a safeguarded area – see Figure A.1.

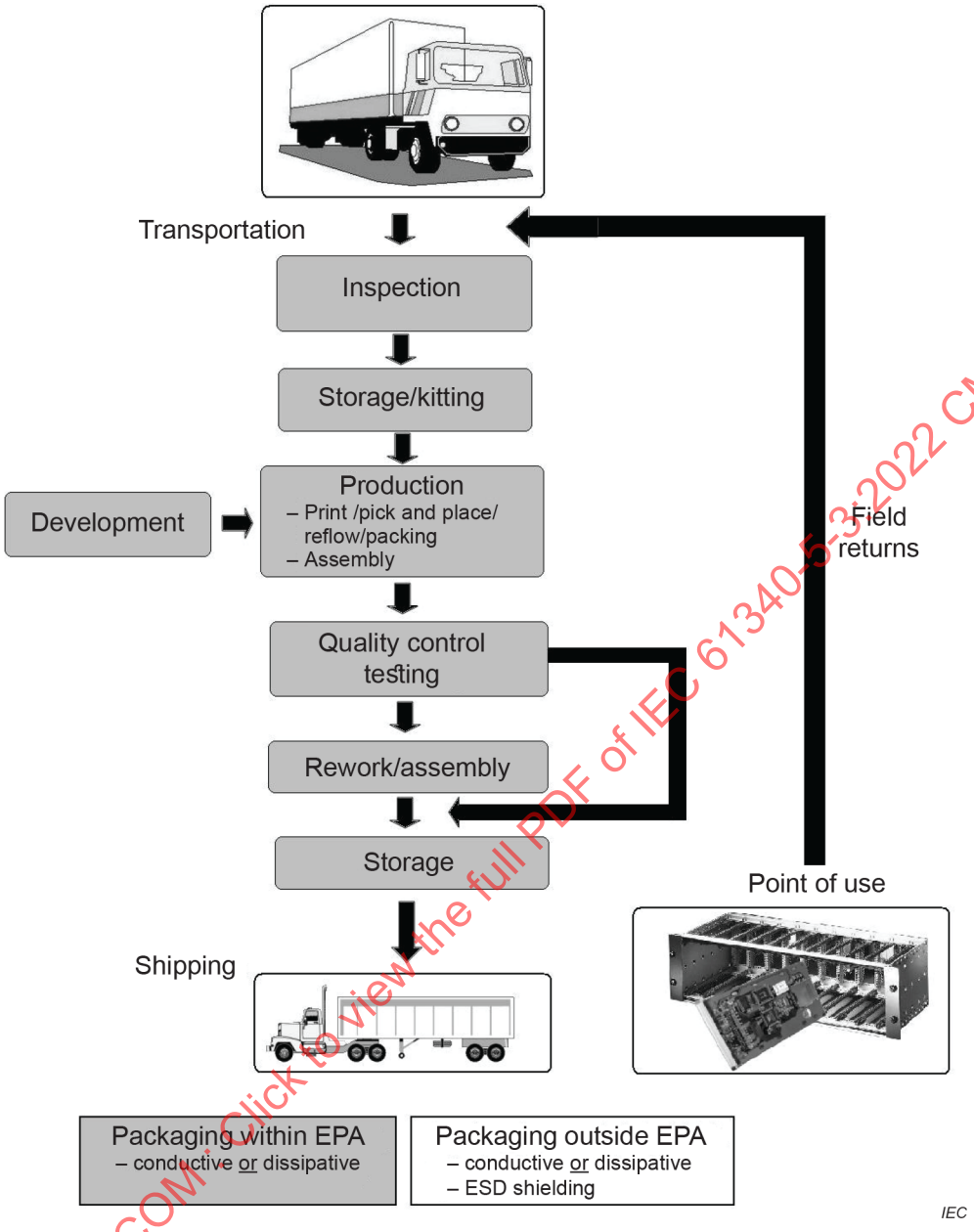


**Figure A.2 – Application of ESD protective packaging**



## A.5 Periodic verification

The static control properties of some packaging materials can deteriorate with time and use.

Periodic verification of static control properties should be considered for re-used materials and for packaging that has been kept in store but not used. 18

## A.6 Examples of measurement procedures for qualification and verification of packaging

**Table A.2 – Examples of qualification and verification of packaging**

| Packaging item | Test method | Product qualification [a] | Test method 19 | Compliance verification |
|---|---|---|---|---|
| Bags | IEC 61340-2-3 | $R_S$<br>Inside and outside ~~layers~~ surfaces<br>$R_V$<br>Inside layers to metal plate | IEC TS 61340-5-4 [2] | $R_S$<br>Inside and outside ~~layers~~ surfaces |
| | IEC 61340-4-8 | Energy bag test [b] | Not applicable | |
| Tote boxes | IEC 61340-2-3 | ~~$R_S$~~<br>~~Inside and outside surfaces~~<br>$R_{p-p}$<br>Inside and outside surfaces<br>$R_V$<br>Inside surface to metal plate | IEC TS 61340-5-4 [2] | $R_{p-p}$<br>Inside and outside surfaces |
| Foams | IEC 61340-2-3 | $R_S$<br>Top and bottom surface<br>$R_V$<br>Top surface to metal plate | IEC TS 61340-5-4 [2] | $R_{p-p}$<br>Top and bottom surfaces |
| Carrier tapes | ~~IEC 61340-4-10~~<br>IEC 61340-2-3 [c] | $R_{p-p}$<br>Inside cavities<br>Cavity to cavity<br>$R_V$<br>Cavity to metal plate | IEC TS 61340-5-4 [2] | $R_{p-p}$<br>Inside cavities |
| Thermoformed and injection moulded trays | ~~IEC 61340-4-10~~<br>IEC 61340-2-3 [c] | $R_{p-p}$<br>Inside cavities<br>Cavity to cavity<br>$R_V$<br>Cavity to metal plate | IEC TS 61340-5-4 [2] | $R_{p-p}$<br>Inside cavities |
| Corrugated cardboard | IEC 61340-2-3 | $R_S$<br>Inside and outside ~~layers~~ surfaces<br>$R_{p-p}$<br>Inside and outside surfaces<br>$R_V$<br>Inside ~~layers~~ surfaces to metal plate | IEC TS 61340-5-4 [2] | $R_S$<br>Inside and outside ~~layers~~ surfaces<br>$R_{p-p}$<br>Inside and outside surfaces |

[a] For product qualification, the environmental conditions for testing should be 23 °C ± 2 °C and 12 % ± 3 % relative humidity.

[b] Only ~~relevant~~ applicable if it is necessary for an ESD discharge shielding bag ~~needs~~ to be qualified.

[c] It ~~may~~ can happen that the two-point probe described in ~~IEC 61340-4-10~~ IEC 61340-2-3 does not fit inside the cavities. Other test methods outside the current scope of this document may ~~then be needed to be used to measure the packaging limits~~ be used to determine compliance with the resistance limits in such cases. See IEC TR 61340-5-5 [3] for guidance.

The compliance verification plan according to IEC 61340-5-1 [5] should document the method used to verify the limits according to the material classification in Table A.2.

IEC TR 61340-5-5 [3] can be used as a guideline for packaging materials such as embossed carrier tapes, trays, tubes (stick magazines), rails and others in backend line processing and parts handling where test methods described in this document are inadequate.

# Annex B
(informative)

# Device damage

## B.1 Damage from ESD

Damage to devices usually occurs in one of two situations:

– electrostatic discharge to a device;
– electrostatic discharge from a charged device.

This distinction is important for packaging considerations because different properties are required to manage each situation. The source of the static electricity needs to be considered and then the path the charge travels to damage the device.

## B.2 Discharge to a device

### B.2.1 ~~Human body model (HBM) [2] and isolated conductors~~ Discharge to device from external objects

Common items that discharge to packaged devices include the human body and conductive objects used to handle ~~packages~~ packaged devices, like conveyors, carts and vehicles. Tribo-electrification is usually the charge source.

Since the discharge must pass through the ~~package~~ packaging to reach the device, the ~~package~~ packaging can be used to protect the device from an ESD event external to the ~~package~~ packaging.

### B.2.2 Retained charge on a packaging

~~The package~~ Packaging can gain charge from ESD or tribo-electrification. Where the ~~package~~ packaging exterior is isolated from the ~~package~~ packaging interior and therefore the device, it is possible for charge on the ~~package~~ packaging to discharge to the device as it is removed from the ~~package~~ packaging.

## B.3 Discharge from a floating device (CDM)

### B.3.1 ~~Charged device model (CDM)~~ Discharges from devices in an electric field

If a device is momentarily grounded in the presence of an electric field emanating from an electrostatically charged item, a discharge occurs and the device retains a charge of opposite polarity. When the device contacts an object with a different potential, like a grounded hand removing the device from ~~a package~~ packaging, an electrostatic discharge occurs. Since the electric field passes through the ~~package~~ packaging, the ~~package~~ packaging can be used to protect the device from a field that is external to the ~~package~~ packaging. The ~~package may~~ packaging can also isolate the device from ground.

### B.3.2 ~~Tribo-electrification~~ Discharges from tribo-electrified devices

As a device and ~~package~~ packaging move in relation to each other, charge can accumulate on the ~~package~~ packaging and on the device. When the charged device contacts an object with a different potential, an electrostatic discharge occurs.

Guidance on tribo-electrification test methods and discharge evaluation methods is given in IEC TR 61340-5-5 [3].

# Annex C
(informative)

## Guidance on electric field shielding 20

Exposing an electronic device to a changing electric field can allow an induced current to flow through the electronic device without actually grounding the device. Incorporating the concept of electrostatic field shielding helps to reduce the risk of device damage through this mechanism during transport and storage activities.

While the risk of damage from exposure to changing electric fields is considered low in the practical sense, it is known that high impedance voltage sensitive circuits can be damaged in this way. Providing a means to attenuate electric fields on the exterior of a packaging or container provides protection against this.

The susceptibility of circuits to electrostatic fields and the criteria for materials required for protection are not well understood at this time.

Where this document does not provide a test method or requirements for electrostatic field shielding, the user should determine whether or not their intended packaging configuration provides attenuation of changing electrostatic field strength at the position in the packaging where sensitive items are contained.

# Annex D
(informative)

## Low charging material property 21

Requirements for low charging are not specified in this document at this time, because the measurement is strongly dependent on the application. However, it can be an important consideration for packaging material selection. Users of packaging materials are encouraged to determine the extent that the packaging materials that are selected will charge in the end use environment.

However, the charging is strongly dependent on the material combination and its surface structure properties. Low charging behaviour is not necessarily predicted by surface or volume resistance measurements. Low charging materials are not necessarily dissipative (although many are).

Guidance on measuring chargeability is given in IEC TR 61340-2-2 [6].

## Bibliography

~~IEC 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*~~

[1] IEC 61340-4-10[4], *Electrostatics – Part 4-10: Standard test methods for specific applications – Two-point resistance measurement*

[2] IEC TS 61340-5-4, *Electrostatics – Part 5-4: Protection of electronic devices from electrostatic phenomena – Compliance verification*

[3] IEC TR 61340-5-5, *Electrostatics – Part 5-5: Protection of electronic devices from electrostatic phenomena – Packaging systems used in electronic manufacturing*

[4] IEC 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment)

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

[6] IEC TR 61340-2-2, *Electrostatics – Part 2-2: measurement methods – Measurement of chargeability*



4 Withdrawn.

## List of comments

1 Text was added to emphasize this document is meant for protection from static electricity.

2 To further limit the scope of the document. This document does not address explosive environments.

3 The two point probe test method was withdrawn and now is part of IEC 61340-2-3.

4 Withdrawn as symbols from this document are not used.

5 Machine model is no longer used to characterize ESDS items.

6 This now addresses more than just HBM. Caution was added for CDM devices and isolated conductors. This is now consistent with IEC 61340-5-1.

7 Low charging requirement was added. Please note there are no defined requirements. An Annex D has been added for information on what this means.

8 Field shielding has been removed. Field shielding cannot be defined by resistance alone.

9 Requirement for discharge shielding has been reduced from 50 nJ to 20 nJ. Packaging meeting the 50 nJ requirement will be able to meet this reduced requirement.

10 Other probes are allowed such as parallel bars as long as they can be correlated to defined probes.

11 All references to IEC 61340-4-10 have been removed. IEC 61340-4-10 has been withdrawn. The method has been incorporated into IEC 61340-2-3.

12 Electric field shielding has been removed. Resistance alone does not define field shielding.

13 Explanation of probes that are acceptable. The two point probe is now in IEC 61340-2-3.

14 Requirement change from 50 nJ to 20 nJ. See 6.3.1

15 This was changed from a requirement to a recommendation. Not all programmes need to have a classification symbol on the packaging.

16 Symbol deleted as there is no test for field shielding in this document.

17 The paragraph above was changed to clarify recommended information on packaging. The shall (requirement) was removed and replaced with should (recommendation).

18 This is recommended at this time, however, IEC 61340-5-1 does require compliance verification for ESD control item. This would include packaging.

19 IEC TS 61340-5-4 has compliance verification test methods for packaging. This is a new document that was published in 2021.

20 This section was added to give some information on shielding from electrical fields and why. Currently, a test method does not exist to measure field shielding in a package.

21 Annex D was added to give some direction to what low charging means. A test method for low charging does not exist at this time.

IEC 61340-5-3

Edition 3.0 2022-04

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



## Electrostatics –
## Part 5-3: Protection of electronic devices from electrostatic phenomena – Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices

## Électrostatique –
## Partie 5-3: Protection des dispositifs électroniques contre les phénomènes électrostatiques – Classification des propriétés et des exigences relatives à l'emballage destiné aux dispositifs sensibles aux décharges électrostatiques

IEC 61340-5-3:2022-04(en-fr)

# CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

# ELECTROSTATICS –

# Part 5-3: Protection of electronic devices from electrostatic phenomena – Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices

## FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 61340-5-3 has been prepared by IEC technical committee 101: Electrostatics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2015. This edition constitutes a technical revision.

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

a) reference to IEC 61340-4-10[1] [1][2] was removed;
b) material resistance property "electrostatic field shielding" was removed;

[1] Withdrawn.

[2] Numbers in square brackets refer to the bibliography.

c) the requirement for electrostatic discharge shielding was changed from 50 nJ to 20 nJ;
d) Table 1 – footnote "b" was changed to mention the two-point probe in IEC 61340-2-3;
e) "shall be marked" was changed to "should be marked" in 7.2.2 and 7.2.3;
f) Table 3 – the classification symbol and the primary function code F was removed;
g) Table A.2 – references to IEC TS 61340-5-4 [2] and IEC TR 61340-5-5 [3] were added;
h) Annex C – guidance regarding electric field shielding was added;
i) Annex D – low charging material property was added.

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

| Draft | Report on voting |
|---|---|
| 101/649/FDIS | 101/660/RVD |

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

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

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

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

# INTRODUCTION

Packaging is necessary to protect electrostatic discharge sensitive devices (ESDSs) from static electricity and electrostatic discharge (ESD) damage as well as physical and environmental damage during manufacture, transportation and storage.

# ELECTROSTATICS –

# Part 5-3: Protection of electronic devices from electrostatic phenomena – Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices

## 1 Scope

This part of IEC 61340 defines the ESD protective packaging properties required to protect ESD sensitive devices (ESDSs) through all phases of production, rework and maintenance, transport and storage. Test methods are referenced to evaluate packaging and packaging materials for these product and material properties. Performance limits are provided.

This document does not address protection from electromagnetic interference (EMI), electromagnetic pulsing (EMP) or protection of electrically initiated explosive materials or devices.

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

IEC 61340-4-8, *Electrostatics – Part 4-8: Standard test methods for specific applications – Electrostatic discharge shielding – Bags*

## 3 Terms, definitions and abbreviated terms

### 3.1 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

**3.1.1**
**electrostatic discharge**
**ESD**
rapid transfer of charge between bodies at different electrostatic potentials

**3.1.2**
**ESD sensitive device**
**ESDS**
sensitive device, integrated circuit or assembly that can be damaged by electrostatic fields or electrostatic discharge

Note 1 to entry: See Clause B.2 and Clause B.3 in Annex B.

**3.1.3**
**ESD protected area**
**EPA**
area in which an ESDS can be handled with acceptable risk of damage caused by electrostatic discharge or fields

SEE: Figure A.1 in Annex A.

**3.1.4**
**unprotected area**
**UPA**
area outside an EPA

SEE: Figure A.1 in Annex A.

**3.1.5**
**intimate packaging**
material which makes contact with an ESDS

**3.1.6**
**proximity packaging**
material not making contact with an ESDS and which is used to enclose one or more devices

**3.1.7**
**secondary packaging**
material used primarily to give additional physical protection to the outside of proximity packaging

**3.1.8**
**volume resistance**
$R_V$
ratio of a DC voltage (V) applied between two electrodes placed on two (opposite) surfaces of a specimen and the current (A) between the electrodes

Note 1 to entry: Volume resistance is expressed in Ω.

**3.1.9**
**point-to-point resistance**
$R_{p\text{-}p}$
ratio of a DC voltage (V) applied between two electrodes on a surface of a specimen and the current (A) between the electrodes

Note 1 to entry: The electrode configuration for point-to-point resistance measurements is usually a pair of circular faced electrodes with a defined distance apart.

Note 2 to entry: Point-to-point resistance is expressed in Ω.

**3.1.10**
**surface resistance**
$R_S$
ratio of a DC voltage (V) applied between two electrodes in a defined configuration on a surface of a specimen and the current (A) between the electrodes

Note 1 to entry: The electrode configuration for surface resistance measurement is usually a pair of parallel rectangular electrodes or a pair of circular concentric electrodes.

Note 2 to entry: Surface resistance is expressed in Ω.

### 3.2 Abbreviated terms

CDM charged device model
EMI electromagnetic interference
EMP electromagnetic pulsing
EPA ESD protected area
ESD electrostatic discharge
ESDS electrostatic discharge sensitive device
HBM human body model
UPA unprotected area

## 4 Tailoring

This document, or portions thereof, does not necessarily apply to all applications. Tailoring is accomplished by evaluating the applicability of each requirement for the specific application. Upon completion of the evaluation, requirements may be added, modified or deleted.

Tailoring decisions, including rationale, shall be documented.

## 5 Packaging application requirement

### 5.1 General

Transportation and storage of ESDSs require packaging that provides protection from electrostatic hazards (for example from an electrostatic discharge). Within an EPA in which all ESD risks are well controlled, it is possible that ESD protective packaging will not be necessary.

### 5.2 Inside an EPA

Packaging used within an EPA shall consist of dissipative or conductive materials for intimate contact.

Additional protection can be necessary for items sensitive to < 100 V for HBM, < 200 V for CDM and < 35 V for isolated conductors, depending on application and program plan requirements.

NOTE Dissipative materials are preferred for intimate packaging in situations where charged device model (CDM) damage is a concern.

### 5.3 Outside an EPA

Transportation and storage of sensitive products outside of an EPA shall be done in packaging that provides both

a) dissipative or conductive materials for intimate contact,
b) a structure that provides electrostatic discharge shielding.

If electrostatic field shielding materials are used to provide discharge shielding, a material that provides a barrier to current flow should be used in combination with the electrostatic field shielding material.

NOTE Dissipative materials are preferred for intimate packaging in situations where charged device model (CDM) damage is a concern.

## 6 Classification of ESD packaging material properties

### 6.1 General

Materials and packaging that are useful in preventing damage to ESD sensitive devices exhibit certain properties. These properties include:

a) resistance properties:
   – conductive;
   – dissipative;
b) shielding properties:
   – electrostatic discharge;
   – electrostatic field;
c) low charging properties:

See Annex D.

### 6.2 Material resistance properties

#### 6.2.1 General

Most standard packaging materials are electrically insulating and insulating materials retain charge. Making the packaging less insulating provides a path for the charge to dissipate from the packaging to a material at a lower potential.

Specific ranges of resistance are useful for different purposes. Packaging can be classified by these resistance ranges of the material used in its construction.

#### 6.2.2 Resistance of conductive materials

Conductive materials can be surface conductive, volume conductive or both.

a) Surface conductive materials

   Surface conductive materials shall have a surface resistance of $< 1 \times 10^4$ Ω.

b) Volume conductive materials

   Volume conductive materials shall have a volume resistance of $< 1 \times 10^4$ Ω.

NOTE The thickness of the material can have a significant influence on the measured value of volume resistance.

#### 6.2.3 Resistance of dissipative materials

Dissipative materials can be surface dissipative, volume dissipative or both.

a) Surface dissipative materials

   Surface dissipative materials shall have a surface resistance $\geq 1 \times 10^4$ and $< 1 \times 10^{11}$ Ω.

b) Volume dissipative materials

   Volume dissipative materials shall have a volume resistance $\geq 1 \times 10^4$ and $< 1 \times 10^{11}$ Ω.

NOTE The thickness of the material can have a significant influence on the measured value of volume resistance.

#### 6.2.4 Resistance of insulating materials

Electrostatic insulating materials can be surface insulating, volume insulating or both.

a) Surface insulating materials

Electrostatic surface insulating materials have a surface resistance ≥ $1 \times 10^{11}$ Ω.

b) Volume insulating materials

Electrostatic volume insulating materials have a volume resistance ≥ $1 \times 10^{11}$ Ω.

### 6.3 Material electrostatic shielding properties

NOTE Electrostatic shielding materials protect packaged ESDSs from the effects of electrostatic discharges and fields that are external to the packaging.

#### 6.3.1 Electrostatic discharge shielding

Electrostatic discharge shielding packaging is capable of attenuating an electrostatic discharge. The calculated energy allowed inside an electrostatic discharge shielding bag shall be less than 20 nJ when tested according to IEC 61340-4-8 or equivalent test method modified to accommodate the product.

#### 6.3.2 Electrostatic field shielding

Electrostatic field shielding packaging is capable of attenuating an electrostatic field.

See Annex C.

## 7 Technical requirements for ESD protective packaging

### 7.1 Packaging and material properties

Table 1 and Table 2 provide test methods for determining material classifications for finished packaging and materials. When possible, testing shall be performed on the finished packaging. When testing cannot be performed on a finished packaging, the material classification shall be defined by the bulk material used for the production of the final packaging.

Other probes (electrodes) may be used providing the results correlate with the specified probes (electrodes). In case of dispute, the probe (electrode) assemblies specified in IEC 61340-2-3 shall be used.

**Table 1 – Test methods for electrostatic protective packaging**

| Material classification | Test method [a] | Method description | Limits |
|---|---|---|---|
| Surface conductive | IEC 61340-2-3 [e] | $R_S$ Surface resistance | < 1 × $10^4$ Ω |
| | IEC 61340-2-3 [b,e] | $R_{p-p}$ Point-to-point resistance | < 1 × $10^4$ Ω [c] |
| Volume conductive | IEC 61340-2-3 [e] | $R_V$ Volume resistance | < 1 × $10^4$ Ω [d] |
| Surface dissipative | IEC 61340-2-3 [e] | $R_S$ Surface resistance | ≥ 1 × $10^4$ to < 1 × $10^{11}$ Ω |
| | IEC 61340-2-3 [b,e] | $R_{p-p}$ Point-to-point resistance | ≥ 1 × $10^4$ to < 1 × $10^{11}$ Ω [c] |
| Volume dissipative | IEC 61340-2-3 [e] | $R_V$ Volume resistance | ≥ 1 × $10^4$ to < 1 × $10^{11}$ Ω [d] |
| Surface insulating | IEC 61340-2-3 [e] | $R_S$ Surface resistance | ≥ 1 × $10^{11}$ Ω |
| | IEC 61340-2-3 [b,e] | $R_{p-p}$ Point-to-point resistance | ≥ 1 × $10^{11}$ Ω [c] |
| Volume insulating | IEC 61340-2-3 [e] | $R_V$ Volume resistance | ≥ 1 × $10^{11}$ Ω [d] |

[a] For product qualification of packaging materials, the environmental conditions for preconditioning and testing shall be 23 °C ± 2 °C and 12 % ± 3 % relative humidity. The preconditioning before the measurement shall be ≥ 48 h.

[b] IEC 61340-2-3 describes point-to-point resistance measurements using two 2,5 kg electrodes. It also describes a two-point probe for point-to-point resistance measurements for non-planar materials and products with small structures. Either of these two test methods may be used.

[c] The results of a measurement of $R_{p-p}$ according to IEC 61340-2-3 can be different compared to the results of a measurement of $R_S$ according to IEC 61340-2-3 due to the usage of different probes.

[d] The thickness of the material can have a significant influence on the values of a measured volume resistance. The requirement is the same despite the thickness of the material.

[e] IEC 61340-2-3 describes test methods for the determination of the electrical resistance and resistivity of solid materials in the range from $10^4$ Ω to $10^{12}$ Ω and refers to other standards for measurements outside this range. However, it is possible that the other test methods referred to will not be appropriate for measuring packaging materials or products. Therefore, for the purposes stated in this table, any of the electrodes specified in IEC 61340-2-3 shall be used. The instrumentation used shall be able to measure to below $10^3$ Ω; it is acceptable for the open circuit voltage or voltage under load of the instrumentation used to be less than 10 V.

**Table 2 – Test methods and requirements for electrostatic discharge shielding packaging**

| | Packaging system | |
|---|---|---|
| | **Shielding bags** | **Other ESD shielding packaging design** |
| Test method | IEC 61340-4-8 | User defined |
| Requirement | Energy < 20 nJ | – intimate packaging shall be dissipative or conductive<br>– a barrier layer or a defined air gap attenuating ESD energy shall be included [a] |

[a] No component of the packaging system shall cause ESD risk when taken within an EPA.

## 7.2 Packaging marking

### 7.2.1 Classification symbol

ESD protective packaging should be marked with the ESD classification symbol given in IEC 60417-6202:2013-06 [4] and as shown in Figure 1 or in accordance with customer contracts, purchase orders, drawings or other documentation.


**IEC 60417-6202:2013-06**

**Figure 1 – Example of packaging label (*Primary function code)**

### 7.2.2 Packaging classification

The primary function code should be marked below the ESD classification symbol given in IEC 60417-6202:2013-06 [4] and as shown in Table 3:

S electrostatic discharge shielding;

C electrostatic conductive;

D electrostatic dissipative.

**Table 3 – Primary function code and ESD classification symbol**

| Primary function code * | Primary function | ESD classification symbol |
|---|---|---|
| S | Electrostatic discharge shielding |   |
| C | Electrostatic conductive |   |
| D | Electrostatic dissipative |   |

### 7.2.3 Traceability

Packaging should be supplied with information that allows traceability to the packaging manufacturer and to the manufacturer's date and lot code information.

# Annex A
(informative)

# Guidance on ESD packaging material

## A.1 Environment and device sensitivity

### A.1.1 General

Environment and device sensitivity are two primary considerations for selecting ESD packaging materials.

### A.1.2 Environment

Since the threat to a sensitive item is usually undetermined when the item is outside an EPA, the ESDS should be placed in ESD protective packaging whenever the item is in a UPA – see Table A.1.

**Table A.1 – Packaging characteristics for environmental consideration**

| Item to be packed | EPA | | UPA | |
|---|---|---|---|---|
| | Intimate | Proximity | Intimate | Proximity |
| ESDS | Electrostatic conductive or dissipative [a] | Electrostatic conductive or dissipative | As for inside EPA and electrostatic discharge shielding [b] | As for inside EPA and electrostatic discharge shielding [c] |

[a] For battery operated ESDSs, the selection of the material or the design of the packaging should ensure that the battery does not become discharged.

[b] Electrostatic discharge shielding property is only required when proximity packaging is not electrostatic discharge shielding.

[c] Electrostatic discharge shielding property is only required when intimate packaging is not electrostatic discharge shielding.

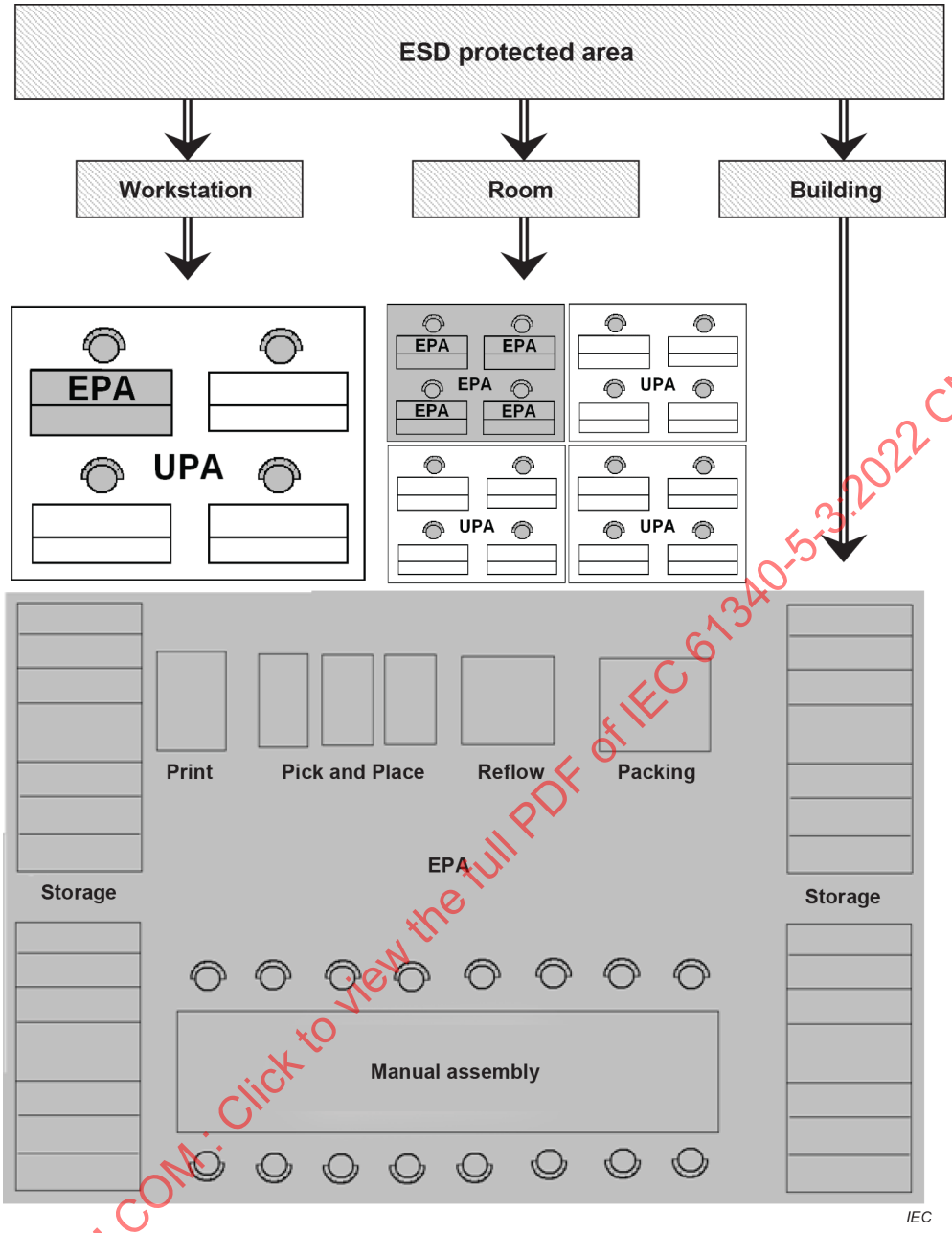


**Figure A.1 – Examples of EPA configurations**

### A.1.3 Device sensitivity

If the sensitivity of the ESDS is unknown and the device is being shipped outside of the EPA, it should be packaged using an electrostatic discharge shielding structure that also provides protection against electrostatic fields (see Annex C).

However, if the sensitivity of the ESDS is known and the ESD threat environment is well understood, the protection level of the packaging may be reduced.

## A.2 Equipotential bonding

While not always recognized as being a packaging consideration, equipotential bonding, or the shunting of leads, can be an effective method to mitigate damage. By placing a conductive shunt across device leads or card connectors, the various parts of the item share the same electrical potential. While not necessarily at ground potential, the fact that parts of the item share the same potential means that damaging current will not flow between them. Shunting has limitations. Energy from direct discharge and electric fields can impact the item in a manner that does not allow the energy to equalize through the shunt, but instead through the device. ESD protective packaging that offers other protective properties is usually used in conjunction with shunting devices.

## A.3 Dissipative material for intimate contact

To avoid rapid discharge of charged ESDSs due to contact with conductive surfaces leading to charged device ESD risk, dissipative materials are preferred.

## A.4 Packaging from incoming material to the point of use

Figure A.2 shows a simplified layout of a generic electronic packaging application. Each area has the recommended ESD packaging material properties noted. As discussed in A.1.3, if the item sensitivity and threats are documented, the level of protective packaging can be reduced after confirming packaging functionality.

NOTE This layout shows an "islands of protection" approach to ESD safeguards. Many manufacturing processes employ a "total factory" approach, where the entire factory is a safeguarded area – see Figure A.1.

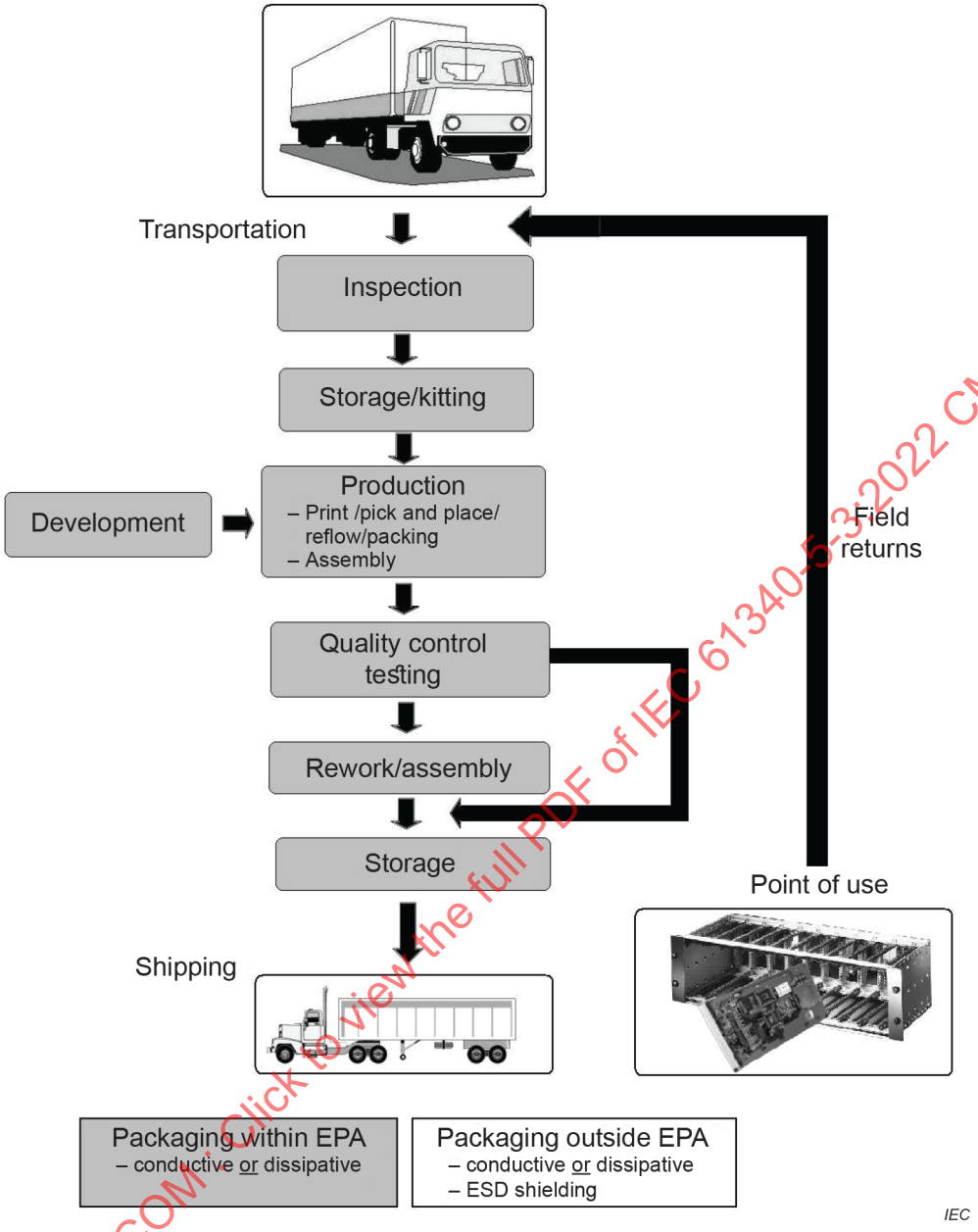


**Figure A.2 – Application of ESD protective packaging**



## A.5 Periodic verification

The static control properties of some packaging materials can deteriorate with time and use.

Periodic verification of static control properties should be considered for re-used materials and for packaging that has been kept in store but not used.

## A.6 Examples of measurement procedures for qualification and verification of packaging

**Table A.2 – Examples of qualification and verification of packaging**

| Packaging item | Test method | Product qualification [a] | Test method | Compliance verification |
|---|---|---|---|---|
| Bags | IEC 61340-2-3 | $R_S$<br>Inside and outside surfaces<br>$R_V$<br>Inside layers to metal plate | IEC TS 61340-5-4 [2] | $R_S$<br>Inside and outside surfaces |
| | IEC 61340-4-8 | Energy bag test [b] | Not applicable | |
| Tote boxes | IEC 61340-2-3 | $R_{p-p}$<br>Inside and outside surfaces<br>$R_V$<br>Inside surface to metal plate | IEC TS 61340-5-4 [2] | $R_{p-p}$<br>Inside and outside surfaces |
| Foams | IEC 61340-2-3 | $R_S$<br>Top and bottom surface<br>$R_V$<br>Top surface to metal plate | IEC TS 61340-5-4 [2] | $R_{p-p}$<br>Top and bottom surfaces |
| Carrier tapes | IEC 61340-2-3 [c] | $R_{p-p}$<br>Inside cavities<br>Cavity to cavity<br>$R_V$<br>Cavity to metal plate | IEC TS 61340-5-4 [2] | $R_{p-p}$<br>Inside cavities |
| Thermoformed and injection moulded trays | IEC 61340-2-3 [c] | $R_{p-p}$<br>Inside cavities<br>Cavity to cavity<br>$R_V$<br>Cavity to metal plate | IEC TS 61340-5-4 [2] | $R_{p-p}$<br>Inside cavities |
| Corrugated cardboard | IEC 61340-2-3 | $R_S$<br>Inside and outside surfaces<br>$R_{p-p}$<br>Inside and outside surfaces<br>$R_V$<br>Inside surfaces to metal plate | IEC TS 61340-5-4 [2] | $R_S$<br>Inside and outside surfaces<br>$R_{p-p}$<br>Inside and outside surfaces |

[a] For product qualification, the environmental conditions for testing should be 23 °C ± 2 °C and 12 % ± 3 % relative humidity.

[b] Only applicable if it is necessary for an ESD discharge shielding bag to be qualified.

[c] It can happen that the two-point probe described in IEC 61340-2-3 does not fit inside the cavities. Other test methods outside the current scope of this document may be used to determine compliance with the resistance limits in such cases. See IEC TR 61340-5-5 [3] for guidance.

The compliance verification plan according to IEC 61340-5-1 [5] should document the method used to verify the limits according to the material classification in Table A.2.

IEC TR 61340-5-5 [3] can be used as a guideline for packaging materials such as embossed carrier tapes, trays, tubes (stick magazines), rails and others in backend line processing and parts handling where test methods described in this document are inadequate.

# Annex B
(informative)

# Device damage

## B.1 Damage from ESD

Damage to devices usually occurs in one of two situations:

– electrostatic discharge to a device;
– electrostatic discharge from a charged device.

This distinction is important for packaging considerations because different properties are required to manage each situation. The source of the static electricity needs to be considered and then the path the charge travels to damage the device.

## B.2 Discharge to a device

### B.2.1 Discharge to device from external objects

Common items that discharge to packaged devices include the human body and conductive objects used to handle packaged devices, like conveyors, carts and vehicles. Tribo-electrification is usually the charge source.

Since the discharge must pass through the packaging to reach the device, the packaging can be used to protect the device from an ESD event external to the packaging.

### B.2.2 Retained charge on a packaging

Packaging can gain charge from ESD or tribo-electrification. Where the packaging exterior is isolated from the packaging interior and therefore the device, it is possible for charge on the packaging to discharge to the device as it is removed from the packaging.

## B.3 Discharge from a floating device (CDM)

### B.3.1 Discharges from devices in an electric field

If a device is momentarily grounded in the presence of an electric field emanating from an electrostatically charged item, a discharge occurs and the device retains a charge of opposite polarity. When the device contacts an object with a different potential, like a grounded hand removing the device from packaging, an electrostatic discharge occurs. Since the electric field passes through the packaging, the packaging can be used to protect the device from a field that is external to the packaging. The packaging can also isolate the device from ground.

### B.3.2 Discharges from tribo-electrified devices

As a device and packaging move in relation to each other, charge can accumulate on the packaging and on the device. When the charged device contacts an object with a different potential, an electrostatic discharge occurs.

Guidance on tribo-electrification test methods and discharge evaluation methods is given in IEC TR 61340-5-5 [3].

# Annex C
(informative)

## Guidance on electric field shielding

Exposing an electronic device to a changing electric field can allow an induced current to flow through the electronic device without actually grounding the device. Incorporating the concept of electrostatic field shielding helps to reduce the risk of device damage through this mechanism during transport and storage activities.

While the risk of damage from exposure to changing electric fields is considered low in the practical sense, it is known that high impedance voltage sensitive circuits can be damaged in this way. Providing a means to attenuate electric fields on the exterior of a packaging or container provides protection against this.

The susceptibility of circuits to electrostatic fields and the criteria for materials required for protection are not well understood at this time.

Where this document does not provide a test method or requirements for electrostatic field shielding, the user should determine whether or not their intended packaging configuration provides attenuation of changing electrostatic field strength at the position in the packaging where sensitive items are contained.

# Annex D
(informative)

## Low charging material property

Requirements for low charging are not specified in this document at this time, because the measurement is strongly dependent on the application. However, it can be an important consideration for packaging material selection. Users of packaging materials are encouraged to determine the extent that the packaging materials that are selected will charge in the end use environment.

However, the charging is strongly dependent on the material combination and its surface structure properties. Low charging behaviour is not necessarily predicted by surface or volume resistance measurements. Low charging materials are not necessarily dissipative (although many are).

Guidance on measuring chargeability is given in IEC TR 61340-2-2 [6].

# Bibliography

[1] IEC 61340-4-10[3], *Electrostatics – Part 4-10: Standard test methods for specific applications – Two-point resistance measurement*

[2] IEC TS 61340-5-4, *Electrostatics – Part 5-4: Protection of electronic devices from electrostatic phenomena – Compliance verification*

[3] IEC TR 61340-5-5, *Electrostatics – Part 5-5: Protection of electronic devices from electrostatic phenomena – Packaging systems used in electronic manufacturing*

[4] IEC 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment)

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

[6] IEC TR 61340-2-2, *Electrostatics – Part 2-2: measurement methods – Measurement of chargeability*



3 Withdrawn.

# SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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# ÉLECTROSTATIQUE –

# Partie 5-3: Protection des dispositifs électroniques contre les phénomènes électrostatiques – Classification des propriétés et des exigences relatives à l'emballage destiné aux dispositifs sensibles aux décharges électrostatiques

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La Norme internationale IEC 61340-5-3 a été établie par le comité d'études 101 de l'IEC: Electrostatique. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition parue en 2015. Cette édition constitue une révision technique.

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

a) la référence à l'IEC 61340-4-10[1] [1][2] a été supprimée;
b) la propriété de résistance des matériaux "blindage contre les champs électrostatiques" a été supprimée;
c) l'exigence relative au blindage contre les décharges électrostatiques qui était de 50 nJ est désormais fixée à 20 nJ;
d) la note b) du Tableau 1 a été modifiée de manière à mentionner la sonde à deux points de l'IEC 61340-2-3;
e) les expressions "doit figurer" et "doivent figurer" ont été remplacées par l'expression "il convient d'apposer" en 7.2.2 et en 7.2.3;
f) dans le Tableau 3, le symbole de classification et le code de fonction primaire F ont été supprimés;
g) dans le Tableau A.2, des références à l'IEC TS 61340-5-4 [2] et à l'IEC TR 61340-5-5 [3] ont été ajoutées;
h) l'Annex C, Recommandations relatives au blindage contre les champs électriques, a été ajoutée;
i) l'Annex D, Propriété des matériaux à faible charge, a été ajoutée.

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

| Projet | Rapport de vote |
|---|---|
| 101/649/FDIS | 101/660/RVD |

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

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

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

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

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

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.



1 Supprimée.

2 Les chiffres entre crochets renvoient à la Bibliographie.

# INTRODUCTION

L'emballage est nécessaire pour protéger les dispositifs sensibles aux décharges électrostatiques (ESDS, *Electrostatic Discharge Sensitive Device*) contre les dommages liés à l'électricité statique et aux décharges électrostatiques (DES), et contre les dommages physiques et environnementaux au cours de la fabrication, du transport et du stockage.

# ÉLECTROSTATIQUE –

# Partie 5-3: Protection des dispositifs électroniques contre les phénomènes électrostatiques – Classification des propriétés et des exigences relatives à l'emballage destiné aux dispositifs sensibles aux décharges électrostatiques

## 1 Domaine d'application

La présente partie de l'IEC 61340 définit les propriétés des emballages de protection contre les DES qui sont exigées pour protéger les dispositifs sensibles aux DES (ESDS) pendant toutes les phases de production, de retouche et maintenance, de transport et de stockage. Des méthodes d'essai sont citées pour évaluer les emballages et les matériaux d'emballage par rapport aux propriétés de ces produits et matériaux. Des limites de performance sont données.

Le présent document ne traite pas de la protection contre le brouillage électromagnétique (EMI, *Electromagnetic Interference*) et les impulsions électromagnétiques (EMP, *Electromagnetic Pulsing*) ni de la protection des matériaux ou dispositifs explosifs à amorçage électrique.

## 2 Références normatives

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

IEC 61340-2-3, *Electrostatique – Partie 2-3: Méthodes d'essais pour la détermination de la résistance et de la résistivité des matériaux solides destinés à éviter les charges électrostatiques*

IEC 61340-4-8, *Electrostatique – Partie 4-8: Méthodes d'essai normalisées pour des applications spécifiques – Blindage contre les décharges électrostatiques – Sacs*

## 3 Termes, définitions et abréviations

### 3.1 Termes et définitions

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

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

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

**3.1.1**
**décharge électrostatique**
**DES**
transfert rapide de charges électriques entre des corps à des potentiels électrostatiques différents

**3.1.2**
**dispositif sensible aux DES**
**ESDS**
dispositifs sensibles, circuit intégré ou assemblage qui peuvent être endommagés par des champs électrostatiques ou des décharges électrostatiques

Note 1 à l'article: Voir l'Article B.2 et l'Article B.3 à l'Annex B.

Note 2 à l'article: L'abréviation "ESDS" est dérivée du terme anglais développé correspondant "ESD sensitive device".

**3.1.3**
**zone protégée contre les DES**
**EPA**
zone dans laquelle un ESDS peut être manipulé avec un risque tolérable de dommages causés par des champs ou des décharges électrostatiques

Note 1 à l'article: L'abréviation "EPA" est dérivée du terme anglais développé correspondant "ESD protected area".

VOIR: Figure A.1 à l'Annex A.

**3.1.4**
**zone non protégée**
**UPA**
zone située à l'extérieur d'une EPA

Note 1 à l'article: L'abréviation "UPA" est dérivée du terme anglais développé correspondant "unprotected area".

VOIR: Figure A.1 à l'Annex A.

**3.1.5**
**emballage de contact**
matériau qui est en contact avec l'ESDS

**3.1.6**
**emballage de proximité**
matériau qui n'est pas en contact avec l'ESDS, qui est utilisé pour envelopper un ou plusieurs dispositifs

**3.1.7**
**emballage secondaire**
matériau qui est essentiellement utilisé pour procurer une protection physique supplémentaire à l'extérieur de l'emballage de proximité

**3.1.8**
**résistance volumique**
$R_V$
rapport d'une tension (V) en courant continu appliquée entre deux électrodes placées sur deux surfaces (opposées) d'une éprouvette et le courant (A) entre les électrodes

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

**3.1.9**
**résistance point à point**
$R_{p\text{-}p}$
rapport d'une tension (V) en courant continu appliquée entre deux électrodes placées sur la surface d'une éprouvette et le courant (A) entre les électrodes

Note 1 à l'article: La configuration des électrodes utilisées pour les mesurages de la résistance point à point est habituellement une paire d'électrodes circulaires placées face à face et séparées l'une de l'autre par une distance définie.

Note 2 à l'article: La résistance point à point est exprimée en Ω.

**3.1.10**
**résistance superficielle**
$R_S$
rapport d'une tension (V) en courant continu appliquée entre deux électrodes placées selon une configuration définie sur la surface d'une éprouvette et le courant (A) entre les électrodes

Note 1 à l'article: La configuration des électrodes utilisées pour le mesurage de la résistance superficielle est habituellement une paire d'électrodes rectangulaires parallèles ou une paire d'électrodes concentriques circulaires.

Note 2 à l'article: La résistance superficielle est exprimée en Ω.

### 3.2 Abréviations

| | |
|---|---|
| CDM (Charged Device Model) | modèle de dispositif chargé |
| EMI (Electromagnetic Interference) | brouillage électromagnétique |
| EMP (Electromagnetic Pulse) | impulsion électromagnétique |
| EPA (ESD Protected Area) | zone protégée contre les DES |
| DES | décharge électrostatique |
| ESDS (Electrostatic Discharge Sensitive Device) | dispositif sensible aux décharges électrostatiques |
| HBM (Human Body Model) | modèle du corps humain |
| UPA (Unprotected Area) | zone non protégée |

## 4 Personnalisation

Le présent document, ou certaines parties de celui-ci, ne couvrent pas forcément toutes les applications. Une personnalisation est réalisée en évaluant l'applicabilité de chaque exigence par rapport à l'application spécifique. A l'issue de l'évaluation, des exigences peuvent être ajoutées, modifiées ou supprimées.

Les décisions de personnalisation, y compris les justifications, doivent être documentées.

## 5 Exigence relative à l'application des emballages

### 5.1 Généralités

Le transport et le stockage des ESDS exigent un emballage qui assure une protection contre les dangers électrostatiques (à la suite d'une décharge électrostatique, par exemple). A l'intérieur d'une EPA, où tous les risques liés aux DES sont bien maîtrisés, les emballages de protection contre les DES peuvent ne pas être nécessaires.

### 5.2 A l'intérieur d'une EPA

Les emballages utilisés à l'intérieur d'une EPA doivent être réalisés en matériaux dissipatifs ou conducteurs pour le contact direct.

Une protection supplémentaire peut être nécessaire pour les éléments sensibles à < 100 V pour les HBM, à < 200 V pour les CDM et à < 35 V pour les conducteurs isolés, en fonction des exigences relatives à l'application et au plan de programme.

NOTE Les matériaux dissipatifs sont privilégiés pour l'emballage de contact lorsqu'un endommagement du modèle de dispositif chargé (CDM) constitue une préoccupation.

### 5.3 A l'extérieur d'une EPA

Les produits sensibles à l'extérieur d'une EPA doivent être transportés et stockés dans un emballage qui possède les caractéristiques suivantes:

a) des matériaux dissipatifs ou conducteurs sont utilisés pour le contact direct;

b) une structure assure un blindage contre les décharges électrostatiques.

Si des matériaux de blindage contre les champs électrostatiques sont utilisés pour constituer un blindage contre les décharges, il convient d'utiliser un matériau qui assure une barrière contre la circulation du courant en combinaison avec le matériau de blindage contre les champs électrostatiques.

NOTE Les matériaux dissipatifs sont privilégiés pour l'emballage de contact lorsqu'un endommagement du modèle de dispositif chargé (CDM) constitue une préoccupation.

## 6 Classification des propriétés des matériaux d'emballage contre les DES

### 6.1 Généralités

Les matériaux et emballages utiles pour empêcher l'endommagement des dispositifs sensibles aux DES présentent certaines propriétés. Ces propriétés sont:

a) les propriétés de résistance:
   – des matériaux conducteurs;
   – des matériaux dissipatifs;
b) les propriétés de blindage:
   – contre les décharges électrostatiques;
   – contre les champs électrostatiques;
c) les propriétés à faible charge.

Voir l'Annex D.

### 6.2 Propriétés de résistance des matériaux

#### 6.2.1 Généralités

La plupart des matériaux d'emballage normalisés sont des isolants électriques, et les matériaux isolants conservent la charge. Diminuer les propriétés isolantes de l'emballage procure un chemin pour dissiper la charge de l'emballage vers un matériau dont le potentiel est inférieur.

Des plages de résistance spécifiques sont utiles à différents titres. L'emballage peut être classé en fonction des plages de résistance du matériau constitutif utilisé.

#### 6.2.2 Résistance des matériaux conducteurs

Les matériaux conducteurs peuvent être conducteurs en surface et/ou conducteurs volumiques.

a) Matériaux conducteurs en surface

   Les matériaux conducteurs en surface doivent posséder une résistance superficielle < $1 \times 10^4$ Ω.

b) Matériaux conducteurs volumiques

Les matériaux conducteurs volumiques doivent posséder une résistance volumique $< 1 \times 10^4$ Ω.

NOTE L'épaisseur du matériau peut avoir une incidence significative sur la valeur mesurée de la résistance volumique.

### 6.2.3 Résistance des matériaux dissipatifs

Les matériaux dissipatifs peuvent être dissipatifs en surface et/ou dissipatifs volumiques.

a) Matériaux dissipatifs en surface

Les matériaux dissipatifs en surface doivent posséder une résistance superficielle $\geq 1 \times 10^4$ et $< 1 \times 10^{11}$ Ω.

b) Matériaux dissipatifs volumiques

Les matériaux dissipatifs volumiques doivent posséder une résistance volumique $\geq 1 \times 10^4$ et $< 1 \times 10^{11}$ Ω.

NOTE L'épaisseur du matériau peut avoir une incidence significative sur la valeur mesurée de la résistance volumique.

### 6.2.4 Résistance des matériaux isolants

Les matériaux isolants électrostatiques peuvent être isolants en surface et/ou isolants volumiques.

a) Matériaux isolants en surface

Les matériaux isolants en surface électrostatiques possèdent une résistance superficielle $< 1 \times 10^{11}$ Ω.

b) Matériaux isolants volumiques

Les matériaux isolants volumiques électrostatiques possèdent une résistance superficielle $\geq 1 \times 10^{11}$ Ω.

## 6.3 Propriétés de blindage électrostatique des matériaux

NOTE Les matériaux de blindage électrostatique protègent les ESDS sous emballage contre les effets des décharges électrostatiques et des champs électrostatiques qui sont externes à l'emballage.

### 6.3.1 Blindage contre les décharges électrostatiques

Les emballages qui assurent un blindage contre les décharges électrostatiques sont capables d'atténuer les décharges électrostatiques. L'énergie calculée admise à l'intérieur d'un sac de blindage contre les décharges électrostatiques doit être inférieure à 20 nJ lors de l'essai selon l'IEC 61340-4-8 ou selon une méthode d'essai équivalente qui a été modifiée pour s'adapter au produit.

### 6.3.2 Blindage contre les champs électrostatiques

Les emballages qui assurent un blindage contre les champs électrostatiques sont capables d'atténuer les champs électrostatiques.

Voir l'Annex C.

# 7 Exigences techniques pour les emballages de protection contre les DES

## 7.1 Propriétés de l'emballage et des matériaux

Le Tableau 1 et le Tableau 2 indiquent des méthodes d'essai afin de déterminer la classification des matériaux pour les matériaux et les emballages finis. Dans la mesure du possible, les

essais doivent être réalisés sur l'emballage fini. Lorsque les essais ne peuvent pas être réalisés sur un emballage fini, la classification des matériaux doit être définie selon le matériau en vrac utilisé pour la production de l'emballage final.

Il est permis d'utiliser d'autres sondes (électrodes) sous réserve que les résultats soient cohérents avec ceux obtenus à l'aide des sondes (électrodes) spécifiées. En cas de litige, les ensembles de sondes (électrodes) spécifiés dans l'IEC 61340-2-3 doivent être utilisés.

**Tableau 1 – Méthodes d'essai pour les emballages de protection électrostatique**

| Classification des matériaux | Méthode d'essai [a] | Description de la méthode | Limites |
|---|---|---|---|
| Conducteurs en surface | IEC 61340-2-3 [e] | $R_S$ Résistance superficielle | < $1 \times 10^4$ Ω |
| | IEC 61340-2-3 [b,e] | $R_{p\text{-}p}$ Résistance point à point | < $1 \times 10^4$ Ω [c] |
| Conducteurs volumiques | IEC 61340-2-3 [e] | $R_V$ Résistance volumique | < $1 \times 10^4$ Ω [d] |
| Dissipatifs en surface | IEC 61340-2-3 [e] | $R_S$ Résistance superficielle | ≥ $1 \times 10^4$ à < $1 \times 10^{11}$ Ω |
| | IEC 61340-2-3 [b,e] | $R_{p\text{-}p}$ Résistance point à point | ≥ $1 \times 10^4$ à < $1 \times 10^{11}$ Ω [c] |
| Dissipatifs volumiques | IEC 61340-2-3 [e] | $R_V$ Résistance volumique | ≥ $1 \times 10^4$ à < $1 \times 10^{11}$ Ω [d] |
| Isolants en surface | IEC 61340-2-3 [e] | $R_S$ Résistance superficielle | ≥ $1 \times 10^{11}$ Ω |
| | IEC 61340-2-3 [b,e] | $R_{p\text{-}p}$ Résistance point à point | ≥ $1 \times 10^{11}$ Ω [c] |
| Isolants volumiques | IEC 61340-2-3 [e] | $R_V$ Résistance volumique | ≥ $1 \times 10^{11}$ Ω [d] |

[a] Pour la qualification produit des matériaux d'emballage, une température de 23 °C ± 2 °C et une humidité relative de 12 % ± 3 % doivent être utilisées comme conditions environnementales lors du préconditionnement et des essais. Avant de procéder aux mesurages, un préconditionnement d'une durée ≥ 48 h doit être réalisé.

[b] L'IEC 61340-2-3 décrit les mesurages de la résistance point à point à l'aide de deux électrodes de 2,5 kg. Elle décrit également une sonde à deux points pour les mesurages de la résistance point à point des matériaux et produits non planaires qui possèdent de petites structures. L'une de ces deux méthodes d'essai peut être utilisée.

[c] Du fait de l'utilisation de sondes d'essai différentes, les résultats d'un mesurage de $R_{p\text{-}p}$ selon l'IEC 61340-2-3 peuvent être différents de ceux obtenus lors du mesurage de $R_S$ selon l'IEC 61340-2-3.

[d] L'épaisseur du matériau peut avoir une incidence significative sur les valeurs de la résistance volumique mesurée. L'exigence demeure la même, quelle que soit l'épaisseur du matériau.

[e] L'IEC 61340-2-3 décrit des méthodes d'essai pour la détermination de la résistance électrique et de la résistivité des matériaux solides dans la plage comprise entre $10^4$ Ω et $10^{12}$ Ω, ; elle cite d'autres normes pour les mesurages réalisés en dehors de cette plage. Toutefois, les autres méthodes d'essai citées peuvent ne pas convenir au mesurage des matériaux ou produits d'emballage. Par conséquent, pour les besoins indiqués dans ce tableau, l'une des électrodes spécifiées dans l'IEC 61340-2-3 doit être utilisée. L'instrumentation utilisée doit être capable de mesurer des valeurs inférieures à $10^3$ Ω; il est toléré que la tension en circuit ouvert ou en charge de l'instrumentation utilisée soit inférieure à 10 V.