

INTERNATIONAL STANDARD



**Electrostatics –
Part 5-1: Protection of electronic devices from electrostatic phenomena –
General requirements**

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INTERNATIONAL STANDARD



**Electrostatics –
Part 5-1: Protection of electronic devices from electrostatic phenomena –
General requirements**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROSTATICS –

**Part 5-1: Protection of electronic devices from
electrostatic phenomena – General requirements**

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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- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

This commented version (CMV) of the official standard IEC 61340-5-1:2024 edition 3.0 allows the user to identify the changes made to the previous IEC 61340-5-1:2016 edition 2.0. Furthermore, comments from IEC TC 101 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

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 61340-5-1 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 2016. This edition constitutes a technical revision.

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

- a) definitions have been added to the document;
- b) updates to product qualification requirements;
- c) subclause 5.3.3 now includes a reference to groundable static control garment systems;
- d) Table 2 was replaced;
- e) subclause 5.3.4.2 was updated to define what an insulator is;
- f) subclause 5.3.4.3 was updated to include a definition for isolated conductor;
- g) Table 3 was updated, technical items added, including a reference to IEC 61340-5-4 for compliance verification testing;
- h) Table 4 was added as a summary of the requirements in IEC 61340-5-3 and to include requirements for compliance verification of packaging;
- i) Annex A was replaced: the former Annex is no longer required. Annex A are examples of tailoring.

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

Draft	Report on voting
101/705A/FDIS	101/710/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/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, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

INTRODUCTION

This part of IEC 61340 covers the requirements necessary to design, establish, implement and maintain an electrostatic discharge (ESD) control program for activities that: manufacture, process, assemble, install, package, label, service, test, inspect, transport, or otherwise handle electrical or electronic parts, assemblies, and equipment susceptible to damage by electrostatic discharges greater than or equal to 100 V human body model (HBM), 200 V charged device model (CDM), and 35 V on isolated conductors. ~~Isolated conductors were historically represented by machine model (MM). The 35 V limit is related to the level achievable using ionizers specified in this document. The MM test is no longer required for qualification of devices, only the HBM and CDM tests are. The MM test is retained in this standard for process control of isolated conductors only.~~ **1**

Any contact and physical separation of materials or flow of solids, liquids, or particle-laden gases can generate electrostatic charges. Common sources of ESD include charged: personnel, conductors, common polymeric materials, and processing equipment. ESD damage can occur when:

- a charged person or object comes into contact with an ESD sensitive device (ESDS);
- an ESDS comes into direct contact with a ~~highly~~ conductive surface while exposed to an electrostatic field;
- a charged ESDS comes into contact with another conductive surface which is at a different electrical potential. This surface ~~may or may not~~ can be grounded or ungrounded.

Examples of ESDS are microcircuits, discrete semiconductors, thick and thin film resistors, hybrid devices, printed circuit boards and piezoelectric crystals. It is possible to determine device and item susceptibility by exposing the device to simulated ESD events. The ESD withstand voltage determined by sensitivity tests using simulated ESD events does not necessarily represent the ability of the device to withstand ESD from real sources at that voltage level. However, the levels of sensitivity are used to establish a baseline of susceptibility data for comparison of devices with equivalent part numbers from different manufacturers. Three different models have been used for qualification of electronic components – HBM, MM, and CDM. In current practice devices are qualified only using HBM and CDM susceptibility tests.

This document covers the ESD control program requirements necessary for setting up a program to handle ESDS, based on the historical experience of both military and commercial organizations. The fundamental ESD control principles that form the basis of this document are as follows.

- Avoid a discharge from any charged, conductive object (personnel and especially automated handling equipment) into the ESDS. This can be accomplished by bonding or electrically connecting all conductors in the environment, including personnel, to a known ground or contrived ground (as on board ship or on aircraft). This attachment creates an equipotential balance between all conducting objects and personnel. Electrostatic protection can be maintained at a potential different from a “zero” voltage ground potential as long as all conductive objects in the system are at the same potential.
- Avoid a discharge from any charged ESD sensitive device. Charging can result from direct contact and separation or it can be induced by an electric field. Necessary insulators in the environment cannot lose their electrostatic charge by attachment to ground. Ionization systems provide neutralization of charges on these necessary insulators (circuit board materials and some device packages are examples of necessary insulators). The ESD hazard created by electrostatic charges on the necessary insulators in the workplace is assessed to ensure that appropriate actions are implemented, according to the risk.

- Once outside of an electrostatic discharge protected area (hereinafter referred to as an EPA) it is generally not possible to control the above items; therefore, ESD protective packaging ~~may~~ can be required. ESD protection can be achieved by enclosing ESD sensitive products in static protective materials, although the type of material depends on the situation and destination. Inside an EPA, static dissipative materials ~~may~~ can provide adequate protection. Outside an EPA, static discharge shielding materials are recommended. Whilst all of these materials are not discussed in this document, it is important to recognize the differences in their application. For more information see IEC 61340-5-3 and IEC TR 61340-5-5 [1]¹.

Each organization has different processes, and so will require a different blend of ESD prevention measures for an optimum ESD control program. Measures should be selected, based on technical necessity, and carefully documented in an ESD control program plan, so that all concerned can be sure of the program requirements.

Training is an essential part of an ESD control program in order to ensure that the personnel involved understand the equipment and procedures they are to use in order to be in compliance with the ESD control program plan. Training is also essential in raising awareness and understanding of ESD issues. Without training, personnel are often a major source of ESD risk. With training, they become an effective first line of defence against ESD damage. Product qualification ensures that equipment sourced for use in the ESD control program meets the technical requirements before it is placed in service.

A product qualification plan details the criteria to be used for selection of ESD control items.

Regular compliance verification checks and tests are essential to ensure that equipment remains effective and that the ESD control program is correctly implemented in compliance with the ESD control program plan.

¹ Numbers in square brackets refer to the bibliography.

ELECTROSTATICS –

Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements

1 Scope

This part of IEC 61340 applies to organizations that: manufacture, process, assemble, install, package, label, service, test, inspect, transport, or otherwise handle electrical or electronic parts, assemblies and equipment with withstand voltages greater than or equal to 100 V human body model (HBM) and 200 V charge device model (CDM) ~~and 35 V for isolated conductors~~. Also, protection from isolated conductors is addressed by limiting the voltage on isolated conductors to less than 35 V. ESDS with lower withstand voltages ~~may~~ can require additional control elements or adjusted limits. Processes designed to handle items that have lower ESD withstand voltage(s) can still claim compliance to this document.

This document provides the requirements for an ESD control program. IEC TR 61340-5-2 [2] provides guidance on the implementation of this document.

This document does not apply to electrically initiated explosive devices, flammable liquids, gases, and powders.

The purpose of this document is to provide the administrative and technical requirements for establishing, implementing, and maintaining an ESD control program (hereinafter referred to as the “program”).

~~NOTE – Isolated conductors were historically represented by MM.~~

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

IEC 61340-4-3, *Electrostatics – Part 4-3: Standard test methods for specific applications – Footwear*

IEC 61340-4-5, *Electrostatics – Part 4-5: Standard test methods for specific applications – Methods for characterizing the electrostatic protection of footwear and flooring in combination with a person*

IEC 61340-4-6, *Electrostatics – Part 4-6: Standard test methods for specific applications – Wrist straps*

IEC 61340-4-7, *Electrostatics – Part 4-7: Standard test methods for specific applications – Ionization*

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

IEC 61340-4-9, *Electrostatics – Part 4-9: Standard test methods for specific applications – Garments*

IEC 61340-5-3, *Electrostatics – Part 5-3: Protection of electronic devices from electrostatic phenomena – Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices*

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

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 <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

NOTE For the purposes of this document “earth” and “ground” have the same meaning.

3.1.1

charged device model

CDM

ESD stress model that approximates the discharge event that occurs when a charged component is quickly discharged to another object at a different electrostatic potential

Note 1 to entry: Charged device model is described in ~~ANSI/ESDA/JEDEC JS-002-2014 [1]~~ IEC 60749-28 [3].

Note 2 to entry: This note only applies to the French language.

3.1.2

common ground point

grounded device or location where the conductors of two or more ESD control items are bonded

3.1.3

common connection point

device or location where the conductors of two or more ESD control items are connected in order to bring the ESD ~~protective~~ control items to the same electrical potential through equipotential bonding

3.1.4

equipotential bonding

electrical connection of ~~conductive parts (or~~ items used to control ESD) so that they are at substantially the same voltage under normal and fault conditions

3.1.5

electrostatic discharge

ESD

rapid transfer of charge between bodies that are at different electrostatic potentials

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

3.1.6

ESD control items

materials or products designed to either prevent the generation of static charge or dissipate static charges that have been generated, or both, so as to prevent damage to ESD sensitive devices

3.1.7

ESD protected area

EPA

area in which an ESDS can be handled with accepted risk of damage as a result of electrostatic discharge or fields

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

3.1.8

ESD sensitive device

ESDS

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

3.1.9

ESD withstand voltage

highest voltage level in an ESD stress model test that does not cause ~~device~~ failure

Note 1 to entry: The device passes all tested lower voltages.

3.1.10

functional ground

terminal used to connect parts to ground for reasons other than safety

3.1.11

human body model

HBM

ESD stress model that approximates the discharge from the fingertip of a typical human being onto a pin of a device with another pin grounded

Note 1 to entry: Human body model is described in IEC 60749-26 [4].

~~Note 2 to entry: This note only applies to the French language.~~

3.12

~~machine model~~

~~MM~~

~~ESD stress model that approximates the discharge to a device pin due to contact of equipment or tools such as those found in the manufacturing line~~

~~Note 1 to entry: Machine model is described in IEC 60749-27 [3].~~

~~Note 2 to entry: This note only applies to the French language.~~

3.1.12

organization

company, group or body that handles ESDS

Note 1 to entry: For the purposes of this document an organization can be an individual person.

3.1.13

protective earth

terminal used to connect parts to earth for safety reasons

3.1.14

unprotected ESDS 2

ESDS without ESD protective packaging or coverings

3.1.15

worksurface 3

surface where any type of work or processing can be performed on an unprotected ESDS

3.2 Abbreviated terms

CDM	charge device model
EPA	electrostatic protected area
ESD	electrostatic discharge
ESDS	ESD sensitive devices
HBM	human body model
MM	machine model
R_g	resistance to ground
R_{gp}	resistance to groundable point
R_{p-p}	resistance point to point
V_{offset}	offset voltage

4 Personnel safety

The procedures and equipment described in this document ~~may~~ can expose personnel to hazardous electrical conditions. Users of this document are responsible for selecting equipment that complies with applicable laws, regulatory codes and both external and internal policy. Users are cautioned that this document cannot replace or supersede any requirements for personnel safety.

Electrical hazard reduction practices shall be exercised and proper grounding instructions for equipment shall be followed.

5 ESD control program

5.1 General

5.1.1 ESD control program requirements

The ESD control program shall include all the administrative and technical requirements of this document. ~~The ESD control program shall document the lowest ESD withstand voltage(s) that can be handled.~~ The organization shall establish, document, implement, maintain, and verify the compliance of the program in accordance with the requirements of this document.

5.1.2 ESD control program manager or coordinator

The organization shall assign ~~a person~~ an ESD control program manager or coordinator with the responsibility for implementing the requirements of this document including establishing, documenting, maintaining, and verifying the compliance of the program. The roles may be delegated to other sub-ordinate personnel appropriate to an organization's requirements, provided the ESD control program manager or coordinator retains managerial responsibility.

5.1.3 Tailoring

~~This standard, or portions of it, may not apply to all applications.~~ It is possible that for some applications, some of the requirements of this document are not applicable. 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 and technical justification, shall be documented. See Annex A for more information. **4**

5.2 ESD control program administrative requirements

5.2.1 ESD control program plan

The ESD control program shall document the lowest ESD withstand voltage(s) that can be handled. By default, the values given in Clause 1 shall apply. The organization shall prepare an ESD control program plan that addresses each of the requirements of the program. Those requirements are:

- training,
- product qualification,
- compliance verification,
- grounding/bonding systems,
- personnel grounding,
- EPA requirements,
- packaging systems,
- marking.

The plan is the principal document for implementing and verifying the program. The goal is a fully implemented and integrated program that conforms to internal quality system requirements. The plan shall apply to all applicable facets of the organization's work.

5.2.2 Training plan

The training plan shall define all personnel that are required to have ESD awareness and prevention training. At a minimum, initial and recurrent ESD awareness and prevention training shall be provided to all personnel who handle or otherwise come into contact with any ESDs. Initial training shall be provided before personnel handle ESD sensitive devices. The type and frequency of ESD training for personnel shall be defined in the training plan. The training plan shall include a requirement for maintaining employee training records and shall document where the records are stored. Training methods and the use of specific techniques are at the organization's discretion. The training plan shall include methods used by the organization to ensure trainee comprehension and training adequacy.

5.2.3 Product qualification plan

~~The organization shall qualify all ESD control items that are selected for use as part of the ESD control program. Tables 2 and 3 list the required product qualification test methods, associated limits for each ESD control item and other requirements as stated in this standard.~~

~~Acceptable evidence of product qualification includes:~~

- ~~a) Product data sheets published by the manufacturer of the ESD control item:
 - ~~1) The data sheet shall reference the required IEC test method for that item.~~
 - ~~2) The data sheet limits shall, at a minimum, comply with the limits for that ESD control item~~~~
- ~~b) Test reports from an independent laboratory: the test report shall reference the applicable IEC test method and the limits shall comply with the limits for that item as specified in this standard.~~

- e) ~~Test reports generated internally by the organization for its own use: the test report shall reference the applicable IEC test method and the limits shall comply with the limits for that item.~~
- d) ~~For ESD control items that were installed by the organization before the adoption of this standard, on-going compliance verification records can be used as evidence of product qualification.~~

~~For ESD control items that are not listed in Tables 2 and 3, but are considered to be a part of the ESD control program, the organization using such items shall qualify these products prior to use. The test method used for product qualification and the user defined acceptance limits for each item shall be documented in the ESD control program plan.~~

A product qualification plan shall be established to ensure the ESD control items selected by the organization meet the requirements identified in Table 2, Table 3 and Table 4 of this document as well as other requirements as stated in this document. This includes the use of the test methods and test limits identified in these tables.

Product qualification shall occur during the initial selection of the ESD control item and before initial use. It may use any of the following qualification methods:

- a) product specification review,
- b) independent laboratory evaluation, or
- c) internal laboratory evaluation.

Independent of the organization's qualification method, qualification records shall include the test method used, the test results obtained from that method, and the test limits. Also, the qualification data shall include the environmental conditioning used during the testing as defined within the test method. The product qualification plan shall also include the location of the qualification records. **5**

Organizations with facilities where the annual minimum relative humidity (RH) is above the environmental conditioning levels identified within the product qualification test method for each ESD control item can use this minimum value to qualify each item used within that facility. However, any ESD control item that leaves these facilities (for example, packaging) shall be qualified using the environmental test requirements within the product qualification test methods identified in Table 2, Table 3, and Table 4 of this document. **6**

Organizations that can verify the use of ESD control items before adopting this document to certify their ESD control program can use compliance verification records to meet product qualification requirements. These records shall cover a minimum of one year and reflect a timeframe immediately before use as product qualification records. These records shall reflect test results that meet the compliance verification test limits identified in Table 2, Table 3 and Table 4 of this document.

The use of compliance verification records for product qualification does not apply when the organization selects a footwear/flooring system as the personnel grounding method. When a footwear/flooring system is selected, it shall be qualified using the environmental test conditioning specified in the test methods identified in Table 2 or by the lowest RH at the facility as described above. Product qualification shall be completed for each footwear and flooring type combination used by the organization. **7**

NOTE IEC TR 61340-5-2 [2] contains guidance for items not listed in Table 2 and Table 3 of this document.

5.2.4 Compliance verification plan

A compliance verification plan shall be established to ensure the organization's fulfilment of the requirements of the plan. Process monitoring (measurements) shall be conducted in accordance with a compliance verification plan that identifies the technical requirements to be verified, the measurement limits and the frequency at which those verifications shall occur. The

compliance verification plan shall document the test methods used for process monitoring and measurements. If the organization uses different test methods to replace those of this document, the organization shall be able to show that the results achieved correlate with the referenced standards. Where test methods are devised for testing items not covered in this document, these shall be adequately documented including corresponding test limits. Compliance verification records shall be established and maintained to provide evidence of conformity to the technical requirements. The compliance verification plan shall document where the records are stored.

The test equipment selected shall be capable of making the measurements defined in the compliance verification plan.

Consideration should be taken regarding the lowest relative humidity levels experienced by the organization; some of the measurements should be made under these conditions.

NOTE Calibration certificates do not ensure test equipment is capable of making the required measurements.

5.3 ESD control program plan technical requirements

5.3.1 General

The subclauses from 5.3.2 to 5.3.6 describe the essential technical requirements used in the development of an ESD control program.

The required limits are based on the test methods or standards listed in Table 1, Table 2, Table 3 and Table 4. ~~The compliance verification plan shall document the methods used to verify the limits. These procedures may or may not be based on the test methods in each table. Test methods and corresponding limits used by the organization that differ from the test methods or references in Tables 1 to 3 shall be documented with a technical justification that supports their use.~~

Some of the technical elements listed in Table 1 to Table 4 do not have a defined lower resistance limit. However, a minimum resistance value ~~may~~ can be required for safety reasons.

~~See relevant~~ National requirements ~~and/or~~ can apply. For more information see the IEC 60364 [6] series, IEC TS 60479-1 [4] [7], IEC TS 60479-2 [8], IEC 61010-1 [9], and IEC 61140 [10] for more information.

5.3.2 Grounding/equipotential bonding systems

In order to eliminate ESD damage, it is necessary to eliminate differences in potential between ESDS and other conductors that ESDS ~~might~~ come into contact with such as personnel, automated handling equipment, fixtures, and mobile equipment. All items that come into contact with ESDS and are capable of conducting electricity shall be connected to ground or electrically bonded in order to eliminate differences in potential. This can be achieved in three different ways:

- Grounding using protective earth

The first and preferred ESD ground is protective earth if available. In this case, the ESD control elements and grounded personnel are connected to protective earth (see Figure 1).

- Grounding using functional ground

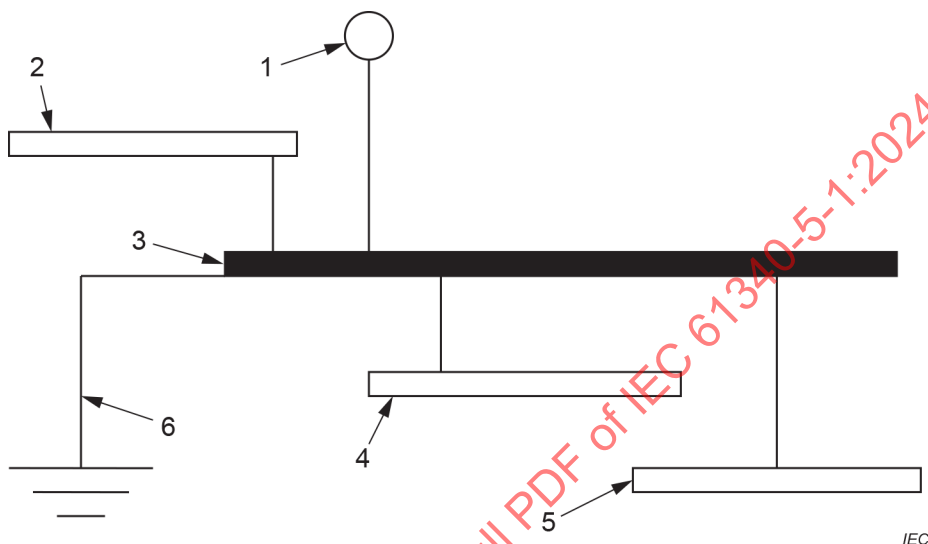
The second acceptable ESD ground is achieved through the use of a functional ground. This conductor can be a ground rod, stake, or a separate wiring system that is bonded to ~~the AC ground~~ protective earth at the main service panel (see Figure 1). In order to eliminate differences in potential between protective earth and the functional ground system, the two systems shall be electrically bonded together where possible.

- Equipotential bonding

If a ground facility is not available, ESD protection can be achieved by connecting all of the ESD control items together at a common connection point (see Figure 2). The maximum resistance between any protective item and the common connection point shall comply with the limits established for the protective items as per Table 2 and Table 3.

Whichever grounding/bonding system is selected, it shall be referred to as “ground” in the remainder of this document.

CAUTION: Electrical wiring systems can be subject to local and national electrical codes and regulatory requirements.

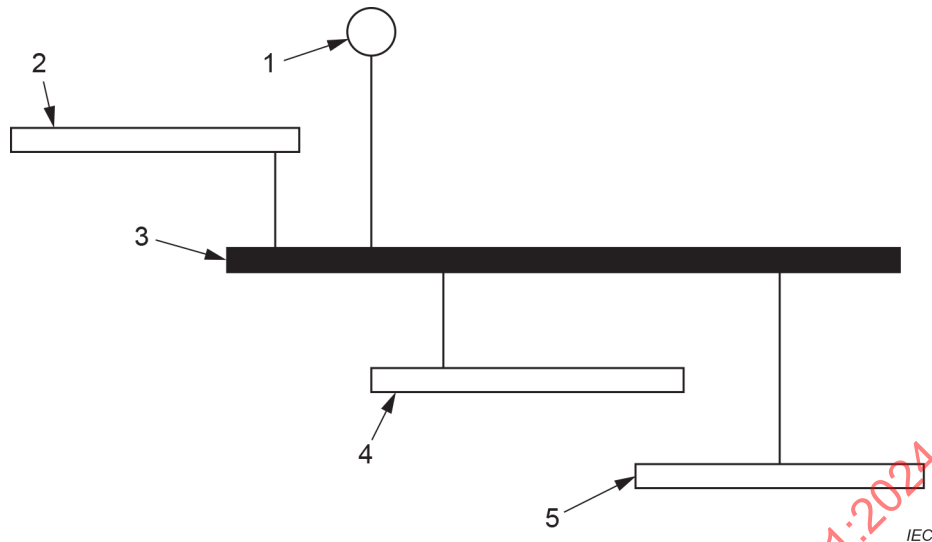


Key

- 1 Wrist strap (band and ground cord)
- 2 Worksurface
- 3 Common ground point
- 4 Floor mat
- 5 Floor
- 6 Protective earth or functional ground (functional ground, if used, shall be bonded to protective earth)

Figure 1 – Schematic of an EPA with a ground reference

CAUTION: Users are advised to consult local and national electrical codes and regulations before making any connections to facility electrical wiring systems.

**Key**

- 1 Wrist strap and cord
- 2 Worksurface
- 3 Common connection point
- 4 Floor mat
- 5 Floor

Figure 2 – Schematic of an equipotential bonding system**Table 1 – Grounding/bonding requirements**

Technical requirement	Grounding method	Test method/standard	Required limit(s)
Grounding/bonding system	Protective earth	~~National electrical system standard~~ Not defined in this document. Additional local requirements can apply.	~~National electrical code limits~~ Not defined in this document. Additional local requirements can apply.
	Functional ground	~~National electrical system standard~~ Not defined in this document. Additional local requirements can apply.	~~National electrical code limits~~ ~~If the national electrical code does not specify a requirement, then~~ The resistance between functional ground and protective earth shall not exceed 25 Ω unless otherwise specified.
	Equipotential bonding	See applicable implementing process from Table 2 and Table 3	See limits for each ESD control item from Table 2 and Table 3

5.3.3 Personnel grounding

All personnel shall be grounded or equipotentially bonded according to the requirements below when handling ESDS. When personnel are seated at ESD protective workstations, they shall be connected to ground via a wrist strap system or groundable static control garment system.

When garments are used to achieve personnel grounding, it shall be documented in the ESD control program plan. The garment shall also meet the groundable static control garment system resistance requirements defined in Table 2 and the groundable static control garment requirements in Table 3. **8**

For standing operations, personnel can be grounded via ~~a wrist strap system or by a footwear flooring system~~ any method from Table 2. When a footwear/flooring system is used, personnel shall wear ~~ESD~~ footwear for ESD control on both feet and the two following conditions shall be met:

- the total resistance of the system (from the person, through the footwear and flooring to ground) shall be less than $1,0 \times 10^9 \Omega$;
- the maximum body voltage generation shall be less than 100 V.

Table 2 – Personnel grounding requirements

Technical requirement	ESD control item	Product qualification		Compliance verification	
		Test method	Limits ^b	Test method	Limits ^b
Personnel grounding	Wrist straps (bands and ground cords)	IEC 61340-4-6	$R < 5 \times 10^6 \Omega$ or user defined value	See wrist strap system	
	Wrist band resistance	IEC 61340-4-6			
		— interior	$\leq 1 \times 10^5 \Omega$	Not applicable	
		— exterior	$\geq 1 \times 10^7 \Omega$	Not applicable	
	Wrist strap system ^a	Not applicable		IEC 61340-4-6 Wrist strap continuity test	$R < 3,5 \times 10^7 \Omega$
	Footwear	IEC 61340-4-3 ^c	$R \leq 1 \times 10^8 \Omega$	See person/footwear system	
	Person/footwear/flooring system	IEC 61340-4-5	$R_g < 1,0 \times 10^9 \Omega$ and absolute value of body voltage $< 100 \text{ V}$ (average of 5 highest peaks)	IEC 61340-4-5	$R_g < 1,0 \times 10^9 \Omega$ ^{d,f}
Person/footwear system	Not applicable		See Annex A ^e	$R_{gp} < 1,0 \times 10^8 \Omega$	
^a For situations where an ESD garment is used as part of the wrist strap grounding path, the total system resistance including the person, garment and grounding cord should be less than $3,5 \times 10^7 \Omega$.					
^b Symbols used in this table: R_g refers to resistance to ground, R_{gp} refers to resistance to groundable point					
^c For the product qualification of footwear, the environmental conditions for testing, using IEC 61340-4-3 should be $(12 \pm 3) \% \text{ RH}$ and $23^\circ \text{C} \pm 2^\circ \text{C}$.					
^d A periodic body voltage generation test should be done to verify the voltage is less than 100 V.					
^e The resistance limit applies to measuring each foot one by one, not two in parallel.					
^f The required limit of $< 1,0 \times 10^9 \Omega$ is the maximum allowed value. The user should establish an upper limit from the resistance values that were measured for product qualification for the footwear and the floor to comply with the $< 100 \text{ V}$ body voltage generation and use these resistances for compliance verification.					

Technical requirement	Product qualification		Compliance verification	
	Test method(s)	Required limit(s)	Test method(s)	Required limit(s)
Wrist strap system	IEC 61340-4-6	System resistance <3,5 × 10 ⁷ Ω	IEC TS 61340-5-4 Wrist strap system	System resistance <3,5 × 10 ⁷ Ω
Groundable static control garment system 9	IEC 61340-4-9	System resistance <3,5 × 10 ⁷ Ω	IEC TS 61340-5-4 Groundable static control garment system	System resistance <3,5 × 10 ⁷ Ω
Footwear/flooring ^a systems (shall comply with limits for both system resistance and body voltage)	IEC 61340-4-5	System resistance <1 × 10 ⁹ Ω	IEC TS 61340-5-4 Person-footwear-flooring system	Resistance to groundable point ^b <1 × 10 ⁸ Ω
		absolute value of body voltage < 100 V (average of 5 highest peaks)	IEC TS 61340-5-4 Person-footwear-flooring system	System resistance ^b < 1 × 10 ⁹ Ω
^a A periodic body voltage generation test should be done to verify the voltage is less than 100 V.				
^b The required limit of < 1,0 × 10 ⁹ Ω is the maximum allowed value for the person-footwear-floor system. The user should establish an upper limit for the person-footwear system from the resistance values that were measured for product qualification for the footwear and the floor to comply with the < 100 V body voltage generation, and use this resistance limit for compliance verification.				

5.3.4 ESD protected areas (EPA)

5.3.4.1 Handling ESDS and access to EPA

Handling of ESDS without ESD protective covering or packaging shall be performed in an EPA. The boundaries of the EPA shall be clearly identified as EPA boundaries (e.g. Caution signs indicating the existence of the EPA can be posted and conspicuous to personnel prior to entry to the EPA.)

NOTE An EPA can, for example, consist of a building, an entire room or a single workstation.

Access to the EPA shall be limited to personnel who have completed appropriate ESD training. Untrained individuals shall be escorted by trained personnel while in an EPA.

5.3.4.2 Insulators

~~All non-essential insulators and items (plastics and paper), such as coffee cups, food wrappers and personal items shall be removed from the workstation or any operation where unprotected ESDS are handled.~~

For the purposes of this document, materials and objects with volume resistance and either surface resistance or point-to-point resistance, greater than or equal to $1,0 \times 10^{11} \Omega$, measured in accordance with IEC 61340-2-3, are considered to be insulators. **10**

The organization's ESD control program shall include a plan for handling insulators to mitigate field induced damage. All nonessential insulators shall be separated from any ESDS item by at least 30 cm. Areas can be designated within the EPA to store electrostatic charge generating items provided the areas do not cause any of the requirements below to be exceeded **11**. When qualifying a process to be deployed in an EPA, process essential insulators shall be evaluated in accordance with how the insulators will be used **12**. The ESD threat associated with process essential insulators or electrostatic field sources shall be evaluated to ensure that:

- the electrostatic field at the position where the ESDS are handled shall not exceed 5 000 V/m;

or

- if the electrostatic potential measured at the surface of the process ~~required~~ essential insulator exceeds 2 000 V, the item shall be kept a minimum of 30 cm from the ESDS; and
- if the electrostatic potential measured at the surface of the process ~~required~~ essential insulator exceeds 125 V, the item shall be kept a minimum of 2,5 cm from the ESDS.

~~If the measured electrostatic field or surface potential exceeds the stated limits, ionization or other charge mitigating techniques shall be used.~~

Some of the electrostatic field or potential measurements should be taken at the lowest expected relative humidity experienced by the facility.

The ESD threat associated with process essential insulators after normal handling that could occur during the processing of ESDS items with materials in use in the EPA or other electrostatic field sources shall be evaluated to ensure that the above limits are not exceeded.

NOTE 1 These measurements are made based on the frequency defined in the compliance verification plan.

NOTE 2 An ESD threat is considered a ~~metal to metal~~ contact of the ESDS with a conductive object while the ESDS is in the presence of the field

~~NOTE 3~~ The accurate measurement of electrostatic fields requires that the person making the measurement is familiar with the operation of the measuring equipment. Most handheld meters require that the reading be taken at a fixed distance from the object. They also normally specify that the object has a minimum dimension of fixed size to obtain an accurate reading.

NOTE 3 IEC TR 61340-5-2 [2] provides guidance on actions to take if the measured electrostatic field or surface potential exceeds the stated limits.

5.3.4.3 Isolated conductors

~~When establishing an ESD control plan, if a conductor that comes into contact with an ESDS item cannot be grounded or equipotentially bonded together, then the process shall ensure that the difference in potential between the conductor and the contact of the ESDS item is less than 35 V.~~

~~This can be accomplished by measuring the ESDS item and the conductor by using: a non-contact electrostatic voltmeter or a high impedance contact electrostatic voltmeter.~~

~~NOTE The 35 V limit is related to the level achievable using ionizers specified in this standard.~~

For the purposes of this document, materials and objects with surface resistance, point-to-point resistance or volume resistance less than $1,0 \times 10^4 \Omega$, measured in accordance with IEC 61340-2-3, are considered to be conductors. **13**

An isolated conductor is a conductor with resistance to ground of greater than or equal to $1,0 \times 10^9 \Omega$, measured in accordance with IEC 61340-2-3 from point(s) that can contact ESDS.

Before a conductor that cannot be grounded or equipotentially bonded comes into contact with an ESDS item, the process shall ensure that the potential difference between the isolated conductor and ground is within ± 35 V.

This can be accomplished by measurement of the potential difference between the conductor and ESDS and ground using a non-contact electrostatic voltmeter or a high impedance contact electrostatic voltmeter.

For an isolated conductor that does not come into contact with an ESDS item, the requirements for insulators in 5.3.4.2 shall be met.

NOTE The 35 V limit is related to the level achievable using ionizers selected to achieve the desired performance when used in the process.

5.3.4.4 ESD control items

An EPA shall be established wherever ESD sensitive products are handled without ESD protective covering or packaging. However, there are many different ways to establish an ESD control program. Table 3 lists some optional ESD control items that can be used to control static electricity. For those ESD control items that are selected for use in the ESD control program, the required ranges for that item becomes mandatory.

If the limits in Table 3 are exceeded, the ESD control program shall include a tailoring statement as required by 5.1.3.

Table 3 – EPA technical requirements

EPA requirements	ESD-control item	Product qualification ^a		Compliance verification ^b	
		Test method	Limits ^c	Based on test method	Limits ^c
	Working surfaces, storage racks and trolley ^g	IEC 61340-2-3	$R_{gp} < 1 \times 10^9 \Omega$ $R_{p-p} < 1 \times 10^9 \Omega^f$	IEC 61340-2-3	$R_g < 1 \times 10^9 \Omega$
	Wrist strap bonding point				$R_g < 5 \times 10^6 \Omega$
	Flooring	IEC 61340-4-1 ^{d,e}	$R_{gp} < 1 \times 10^9 \Omega$	IEC 61340-4-1	$R_g < 1 \times 10^9 \Omega$
	Ionization	IEC 61340-4-7	Decay (1 000 V to 100 V and –1 000 V to –100 V) < 20 s Offset voltage < ± 35 V	IEC 61340-4-7	Decay (1 000 V to 100 V and –1 000 V to –100 V) < 20 s or user-defined Offset voltage < ± 35 V
	Seating	IEC 61340-2-3 (resistance to groundable point measurements)	$R_{gp} < 1 \times 10^9 \Omega$	IEC 61340-2-3 (resistance to ground measurements)	$R_g < 1 \times 10^9 \Omega$
	Static control garments	IEC 61340-4-9 or user defined method	$R_{p-p} < 1 \times 10^{11} \Omega$ or user-defined limit	IEC 61340-4-9 or user defined method	$R_{p-p} < 1 \times 10^{11} \Omega$ or user-defined limit
	Groundable static control garments	IEC 61340-4-9	$R_{gp} < 1 \times 10^9 \Omega$	IEC 61340-4-9	$R_{gp} < 1 \times 10^9 \Omega$

^a For product qualification, the environmental conditions for testing should be (12 ± 3) % RH and 23 °C ± 2 °C. When not specified in the referenced IEC standard, the minimum environmental conditioning time for product qualification should be 48 hours.

^b The test methods in the compliance verification column refer to the basic test procedure only. It is not expected that the test method will be followed in its entirety.

^c Symbols used in this table: R_{p-p} refers to point to point resistance, R_g refers to resistance to ground and R_{gp} refers to resistance to groundable point.

^d The maximum test voltage allowed for measuring ESD flooring that should be used for an ESD program complying with this standard is 100 V.

^e If flooring is used for grounding personnel that handle ESDS refer to the system requirements in Table 2.

^f In situations where charged device model (CDM) damage is a concern, a minimum point to point resistance limit of $1 \times 10^9 \Omega$ is recommended.

^g Worksurfaces are defined as any surface on which an unprotected ESD sensitive item is placed.

ESD control item	Product qualification ^a		Compliance verification	
	Test method	Limits	Test method	Limits
Worksurface, storage racks	IEC 61340-2-3	$R_{gp} < 1 \times 10^9 \Omega$ $R_{p-p} < 1 \times 10^9 \Omega^d$	IEC TS 61340-5-4 Worksurfaces	$R_g < 1 \times 10^9 \Omega$
Wrist strap (bands and ground cords)	IEC 61340-4-6	$< 5 \times 10^6 \Omega$	See Table 2	
Wristband	IEC 61340-4-6	Interior $< 1,0 \times 10^5 \Omega$		
		Exterior $> 1,0 \times 10^7 \Omega$		
Mobile equipment	IEC 61340-2-3	$R_{gp} < 1 \times 10^9 \Omega$ $R_{p-p} < 1 \times 10^9 \Omega^d$	IEC TS 61340-5-4 Mobile equipment	$R_g < 1 \times 10^9 \Omega$
Wrist strap bonding point			IEC TS 61340-5-4 Grounding/bonding	$R_g < 5 \times 10^6 \Omega$
Flooring	IEC 61340-4-1 ^{b,c}	$R_{gp} < 1 \times 10^9 \Omega$ $R_{p-p} < 1 \times 10^9 \Omega$	IEC TS 61340-5-4 Flooring	$R_g \times 10^9 \Omega$
Footwear	IEC 61340-4-3	$R \leq 1 \times 10^8 \Omega$	See Table 2	
Ionization	IEC 61340-4-7	Decay (+1 000 V to +100 V and – 1 000 V to – 100 V) < 20 s or user defined Offset Voltage (Peak) $-35 \text{ volts} < V_{\text{offset}}$ $< 35 \text{ volts}$	IEC TS 61340-5-4 Ionization	Decay (+1 000 V to +100 V and – 1 000 V to – 100 V) < 20 s or user defined Offset Voltage (Peak) $-35 \text{ volts} < V_{\text{offset}}$ $< 35 \text{ volts}$
Seating	IEC 61340-2-3	$R_{gp} < 1 \times 10^9 \Omega$	IEC TS 61340-5-4 Seating	$R_g < 1 \times 10^9 \Omega$
Static control garments	IEC 61340-4-9 or user defined method	$R_{p-p} < 1 \times 10^{11} \Omega$ or user defined limit	IEC TS 61340-5-4 Static control garments or user defined method	$R_{p-p} < 1 \times 10^{11} \Omega$ or user defined limit
Groundable static control garments	IEC 61340-4-9	$R_{gp} < 1 \times 10^9 \Omega$	IEC TS 61340-5-4 Groundable static control garments	$R_{gp} < 1 \times 10^9 \Omega$
^a For general product qualification, the environmental conditions for testing shall be $(12 \pm 3) \% \text{ RH}$ and $23^\circ\text{C} \pm 2^\circ\text{C}$. When not specified in the referenced IEC document, the minimum environmental conditioning time for product qualification should be 48 h. ^b The maximum test voltage allowed for measuring ESD flooring that should be used for an ESD program complying with this document is 100 V. ^c If flooring is used for grounding personnel that handle ESDS refer to the system requirements in Table 2. ^d In situations where charged device model (CDM) damage is a concern, a minimum point to point resistance limit of $1 \times 10^4 \Omega$ is recommended.				

5.3.5 Packaging

ESD protective packaging ~~and package marking~~ shall be in accordance with customer contracts, purchase orders, drawing or other documentation. When the contract, purchase order, drawing or other documentation does not define ESD protective packaging, the organization shall define ESD protective packaging requirements for ESDS within the plan based on IEC 61340-5-3. Packaging, when required, shall be defined for all material movement within EPAs, between

EPAs, between job sites, field service operations and to the customer. The requirements of qualification and compliance verification are summarized in Table 4. **14**

Table 4 – Packaging requirements

Technical requirement	ESD Control Item	Product qualification		Compliance verification	
		Test method	Required limits	Test method	Required limits
Packaging	Conductive packaging	IEC 61340-2-3	$R < 1 \times 10^4 \Omega$	IEC TS 61340-5-4 Packaging	$R < 1 \times 10^4 \Omega$
	Dissipative packaging	IEC 61340-2-3	$R \geq 1 \times 10^4 \Omega$ to $< 1 \times 10^{11} \Omega$	IEC TS 61340-5-4 Packaging	$R \geq 1 \times 10^4 \Omega$ to $< 1 \times 10^{11} \Omega$
	Electrostatic discharge shielding (bags only)	IEC 61340-4-8	Energy < 20 nJ	IEC TS 61340-5-4 Packaging ^a	$R < 1 \times 10^{11} \Omega$
^a For intimate packaging only					

5.3.6 Marking

ESDS, system or packaging marking shall be in accordance with customer contracts, purchase orders, drawing or other documentation. When the contract, purchase order, drawing or other documentation does not define ESDS, system or packaging marking, the organization, in developing the ESD control program plan, shall consider the need for marking. If it is determined that marking is required, it shall be documented as part of the plan.

Annexe A (normative)

Test methods 15

The operator shall stand with one foot on the conductive footwear electrode. The hand contact plate shall be pressed to verify that the person/footwear system resistance is within acceptable parameters (see Figure A.1). The test shall be repeated for the other foot. The test apparatus can be an integrated, commercially available tester or other instrumentation that is capable of measuring resistance from $5,0 \times 10^4 \Omega$ to at least $1,0 \times 10^9 \Omega$. The tester open circuit voltage is typically between 9 V d.c. and 100 V d.c.

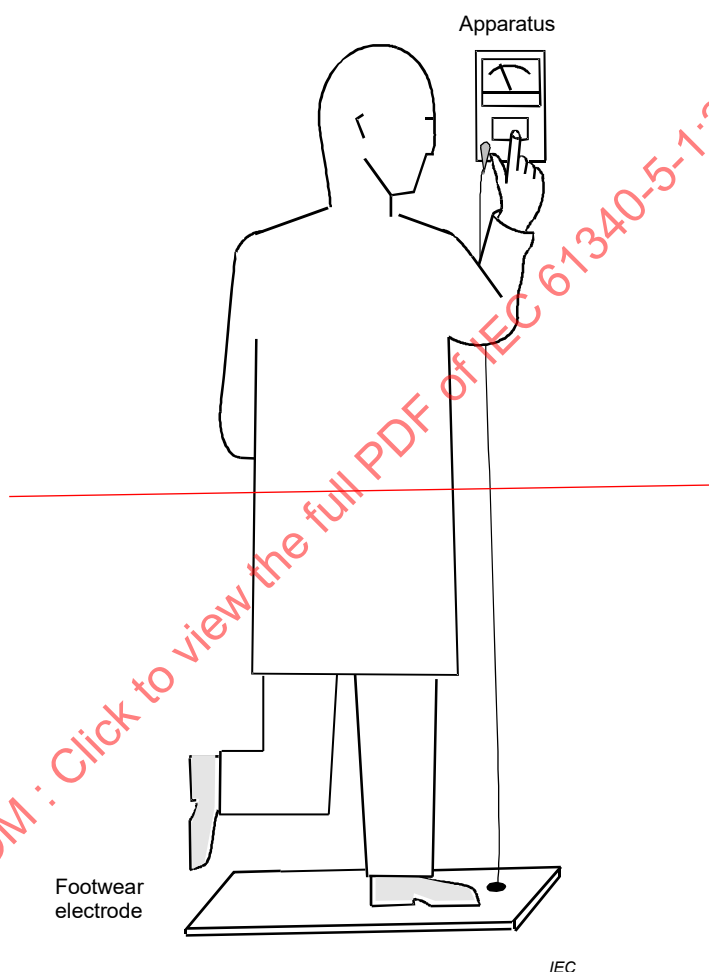


Figure A.1 — Footwear functional testing (example)

Annex A (informative)

Tailoring examples 16

Tailoring allows users of IEC 61340-5-1 to modify or delete a requirement of the document if the user can provide justification and technical rationale for the deviation or exclusion. Tailoring as described in 5.1.3 requires that tailoring statements are documented, and are typically added to an organization's ESD control program plan, and include the requirement(s) of IEC 61340-5-1 that are excluded or modified as well as the technical justification or rationale for the change.

The use of tailoring statements by an organization to deviate from or exclude a requirement from IEC 61340-5-1 in an ESD control program plan is often misunderstood by both the organization and those trying to determine compliance with the document. This most often evolves from a misunderstanding of what is or is not a requirement within the document. In the tailoring examples provided below, the affected requirement within IEC 61340-5-1 includes the word 'shall' or 'mandatory'. Tailoring statements derived by the organization to address where and how the program deviates from IEC 61340-5-1 requirements (see 5.1.3) shall include the requirement within the document that is affected and the technical rationale for the exclusion or deviation from the requirement.

a) Examples of acceptable tailoring statements and rationale:

– Example 1

Tailoring statement: The upper resistance to ground limit for worksurfaces used within cleanroom EPAs is less than $1,0 \times 10^{10} \Omega$ instead of $1,0 \times 10^9 \Omega$ as required for product qualification and compliance verification.

IEC 61340-5-1 requirement affected: Table 3, product qualification and compliance verification 'resistance to groundable resistance' and 'resistance to ground' maximum resistance limit of $1,0 \times 10^9 \Omega$ as tested using IEC 61340-5-3 and IEC TS 61340-5-4, respectively. Also, in 5.2.3 (product qualification plan) and 5.3.4 (compliance verification plan), the required test limits provided in Table 2, Table 3, and Table 4 shall be met.

Technical rationale for deviation: The organization has a cleanliness requirement for multiple cleanrooms where ESDS items are handled. The worksurface materials meeting cleanliness requirements within these cleanrooms have resistance (resistance to ground) values that exceed $1,0 \times 10^9 \Omega$ but are less than $1,0 \times 10^{10} \Omega$. By ensuring these worksurfaces and personnel are properly grounded, all ESDS items and personnel will be at the same electrical potential, which the organization has verified with documented measurements. The manufacturing process in the cleanrooms where these worksurfaces are used is controlled, and yield rates for the end products produced have been acceptable since the initial installation.

– Example 2

Tailoring statement: The pulsed DC ceiling-mounted room ionization system utilized in this EPA will have Offset Voltage (Peak): $-250 \text{ V} < V_{\text{offset}} < 250 \text{ V}$.

IEC 61340-5-1 requirement affected: Table 3, Product Qualification and Compliance Verification Ionization Offset Voltage (Peak): $-35 \text{ V} < V_{\text{offset}} < 35 \text{ V}$.

Technical rationale for deviation: The ESD sensitivity of wafers in front-end manufacturing operations is significantly lower than after the dies are separated. A ceiling-based room ionization system is used in the EPA's covered in this ESD Control plan. The purpose of this system is primarily for contamination control. It will be utilized for reducing the charge on the many process essential insulators typically present in any wafer fabrication facility. A wide-coverage (versus point-of-use) ionization system is critical in any wafer fabrication facility to reduce electric fields on the many process essential insulators. In limited critical operations where a tighter offset is deemed required by engineering or the ESD program manager, peak ionizer offset voltage maximum specification is $\pm 35 \text{ V}$.

b) Examples of unacceptable or unnecessary tailoring statements and rationale

– Example 1

Tailoring statement: Seating as an ESD control item is not required because all personnel shall wear a grounded wrist strap when seated inside an EPA.

IEC 61340-5-1 requirement affected: Subclause 5.3.3 (personnel grounding), states: "When personnel are seated at ESD protective workstations, they shall be connected to ground via a wrist strap system or groundable static control garment system."

Why is this tailoring statement unnecessary? The document does not require ESD protective seating. ESD protective seating is one of many 'optional' ESD control items for EPAs provided in Table 3 of the document. The actual requirement is for seated personnel to be connected to a grounded wrist strap, and this is independent of whether ESD protective seating is used.

– Example 2

Tailoring statement: Nonessential insulators are not allowed inside the organization's EPAs in designated areas.

IEC 61340-5-1 requirement affected: Subclause 5.3.4.2 (insulators), first paragraph, second sentence: "All nonessential insulators shall be separated from any ESDS item by at least 30 cm".

Why is this tailoring statement unnecessary? By not allowing nonessential insulators inside EPAs, the IEC 61340-5-1 requirement to ensure all nonessential insulators are separated from ESDS items by 30 cm is met. As a result, no tailoring statement is required.

– Example 3

Tailoring statement: The lower resistance to ground limit for worksurfaces used within the EPAs is greater than $1,0 \times 10^5 \Omega$ instead of 0Ω as required.

IEC 61340-5-1 requirement affected: Table 3, product qualification and compliance verification 'resistance to groundable point' and 'resistance to ground' minimum resistance limit of 0Ω as tested using IEC 61340-2-3 and IEC TS 61340-5-4, respectively. Also, in 5.2.3 (product qualification plan) and 5.2.4 (compliance verification plan), the required test limits provided in Table 3 shall be met.

Why is this tailoring statement unnecessary? The lower limit established is within the limits of IEC 61340-5-1. Since it is within the limits, tailoring is not required. This lower limit will be the requirement of this facility.

Bibliography

- ~~[1] ANSI/ESDA/JEDEC JS-002-2014, ESDA/JEDEC Joint Standard for Electrostatic Device Sensitivity Testing – Charged Device Model (CDM) – Device Level~~
- [1] IEC TR 61340-5-5, *Electrostatics – Part 5-5: Protection of electronic devices from electrostatic phenomena – Packaging systems used in electronic manufacturing*
- [2] IEC TR 61340-5-2, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*
- [3] IEC 60749-28, *Semiconductor devices – Mechanical and climatic test methods – Part 28: Electrostatic discharge (ESD) sensitivity testing – Charged device model (CDM) – device level*
- [4] IEC 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part 26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*
- [5] IEC 60749-27, *Semiconductor devices – Mechanical and climatic test methods – Part 27: Electrostatic discharge (ESD) sensitivity testing – Machine model (MM)*
- [6] IEC 60364 (all parts), *Low-voltage electrical installations*
- [7] IEC TS 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
- [8] IEC TS 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
- [9] IEC 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
- [10] IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

List of comments

- 1 The Machine Model is not used for device qualification anymore. Charge Device Model more accurately describes metal to metal contact with devices. Isolated conductors have been in the standard for the last two editions and the reference to Machine Model is not needed.
- 2 This definition is added to differentiate between an ESDS item outside the packaging vs a device that has no ESD protection designed into the device.
- 3 For surfaces not explicitly covered in the standard, any surface where unprotected ESDS items are handled must meet the requirements of this standard. For example, conveyor belts are not explicitly stated in Table 3 but if an unprotected device is placed on it, then it is a work surface.
- 4 Tailoring is often confused. Annex A is added to illustrate some examples of what tailoring is and what is not.
- 5 This requirement is added to ensure testing was done with the correct test method and correct environment. It is no longer acceptable for a product data sheet to simply state that the material conforms to a particular standard without the test report.
- 6 Qualification can now be done at the lowest RH level that is present at the facility. This only applies to ESD control items that remain in the facility. Packaging, for example, that leaves the facility must still be qualified in according to the standard that applies including the environmental conditioning.
- 7 Body voltage measurements are required for footwear/flooring systems. That measurement is not part of a compliance verification plan. This has lead to some confusion and the standard now makes it clear.
- 8 A groundable static control garment system will connect a person to the grounding system. This is moved from Table 3 to Table 2. Table 2 are the requirements for grounding personal.
- 9 A groundable static control garment system is now in Table 2 with personal grounding requirements.
- 10 Insulators were not defined in edition 2. This is added to define what is considered an insulator for this document.
- 11 Insulators are allowed in an EPA as long as they do not cause excessive fields where the ESDS item is handled.
- 12 Only materials used within a process need to be evaluated with insulators. Materials not found in the process or used in the process are not to be used to charge insulators.
- 13 What is considered an isolated conductor was not clear. This defines what is an isolated conductor for this document.
- 14 Table 4 is new to this edition. It is a summary of requirements for packaging.
- 15 This annex is deleted as the test method is now in IEC TS 61340-5-4.
- 16 This annex is added to show examples of what tailoring is and when tailoring is not needed.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrostatics –

**Part 5-1: Protection of electronic devices from electrostatic phenomena –
General requirements**

Électrostatique –

**Partie 5-1: Protection des dispositifs électroniques contre les phénomènes
électrostatiques – Exigences générales**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROSTATICS –

**Part 5-1: Protection of electronic devices from
electrostatic phenomena – General requirements**

FOREWORD

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IEC 61340-5-1 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 2016. This edition constitutes a technical revision.

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

- a) definitions have been added to the document;
- b) updates to product qualification requirements;
- c) subclause 5.3.3 now includes a reference to groundable static control garment systems;
- d) Table 2 was replaced;

- e) subclause 5.3.4.2 was updated to define what an insulator is;
- f) subclause 5.3.4.3 was updated to include a definition for isolated conductor;
- g) Table 3 was updated, technical items added, including a reference to IEC 61340-5-4 for compliance verification testing;
- h) Table 4 was added as a summary of the requirements in IEC 61340-5-3 and to include requirements for compliance verification of packaging;
- i) Annex A was replaced: the former Annex is no longer required. Annex A are examples of tailoring.

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

Draft	Report on voting
101/705A/FDIS	101/710/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/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, or
- revised.

INTRODUCTION

This part of IEC 61340 covers the requirements necessary to design, establish, implement and maintain an electrostatic discharge (ESD) control program for activities that: manufacture, process, assemble, install, package, label, service, test, inspect, transport, or otherwise handle electrical or electronic parts, assemblies, and equipment susceptible to damage by electrostatic discharges greater than or equal to 100 V human body model (HBM), 200 V charged device model (CDM), and 35 V on isolated conductors. The 35 V limit is related to the level achievable using ionizers specified in this document.

Any contact and physical separation of materials or flow of solids, liquids, or particle-laden gases can generate electrostatic charges. Common sources of ESD include charged: personnel, conductors, common polymeric materials, and processing equipment. ESD damage can occur when:

- a charged person or object comes into contact with an ESD sensitive device (ESDS);
- an ESDS comes into direct contact with a conductive surface while exposed to an electrostatic field;
- a charged ESDS comes into contact with another conductive surface which is at a different electrical potential. This surface can be grounded or ungrounded.

Examples of ESDS are microcircuits, discrete semiconductors, thick and thin film resistors, hybrid devices, printed circuit boards and piezoelectric crystals. It is possible to determine device and item susceptibility by exposing the device to simulated ESD events. The ESD withstand voltage determined by sensitivity tests using simulated ESD events does not necessarily represent the ability of the device to withstand ESD from real sources at that voltage level. However, the levels of sensitivity are used to establish a baseline of susceptibility data for comparison of devices with equivalent part numbers from different manufacturers. Three different models have been used for qualification of electronic components – HBM, MM, and CDM. In current practice devices are qualified only using HBM and CDM susceptibility tests.

This document covers the ESD control program requirements necessary for setting up a program to handle ESDS, based on the historical experience of both military and commercial organizations. The fundamental ESD control principles that form the basis of this document are as follows.

- Avoid a discharge from any charged, conductive object (personnel and especially automated handling equipment) into the ESDS. This can be accomplished by bonding or electrically connecting all conductors in the environment, including personnel, to a known ground or contrived ground (as on board ship or on aircraft). This attachment creates an equipotential balance between all conducting objects and personnel. Electrostatic protection can be maintained at a potential different from a “zero” voltage ground potential as long as all conductive objects in the system are at the same potential.
- Avoid a discharge from any charged ESD sensitive device. Charging can result from direct contact and separation or it can be induced by an electric field. Necessary insulators in the environment cannot lose their electrostatic charge by attachment to ground. Ionization systems provide neutralization of charges on these necessary insulators (circuit board materials and some device packages are examples of necessary insulators). The ESD hazard created by electrostatic charges on the necessary insulators in the workplace is assessed to ensure that appropriate actions are implemented, according to the risk.

- Once outside of an electrostatic discharge protected area (hereinafter referred to as an EPA) it is generally not possible to control the above items; therefore, ESD protective packaging can be required. ESD protection can be achieved by enclosing ESD sensitive products in static protective materials, although the type of material depends on the situation and destination. Inside an EPA, static dissipative materials can provide adequate protection. Outside an EPA, static discharge shielding materials are recommended. Whilst all of these materials are not discussed in this document, it is important to recognize the differences in their application. For more information see IEC 61340-5-3 and IEC TR 61340-5-5 [1]¹.

Each organization has different processes, and so will require a different blend of ESD prevention measures for an optimum ESD control program. Measures should be selected, based on technical necessity, and carefully documented in an ESD control program plan, so that all concerned can be sure of the program requirements.

Training is an essential part of an ESD control program in order to ensure that the personnel involved understand the equipment and procedures they are to use in order to be in compliance with the ESD control program plan. Training is also essential in raising awareness and understanding of ESD issues. Without training, personnel are often a major source of ESD risk. With training, they become an effective first line of defence against ESD damage. Product qualification ensures that equipment sourced for use in the ESD control program meets the technical requirements before it is placed in service.

A product qualification plan details the criteria to be used for selection of ESD control items.

Regular compliance verification checks and tests are essential to ensure that equipment remains effective and that the ESD control program is correctly implemented in compliance with the ESD control program plan.

¹ Numbers in square brackets refer to the bibliography.

ELECTROSTATICS –

Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements

1 Scope

This part of IEC 61340 applies to organizations that: manufacture, process, assemble, install, package, label, service, test, inspect, transport, or otherwise handle electrical or electronic parts, assemblies and equipment with withstand voltages greater than or equal to 100 V human body model (HBM) and 200 V charge device model (CDM). Also, protection from isolated conductors is addressed by limiting the voltage on isolated conductors to less than 35 V. ESDS with lower withstand voltages can require additional control elements or adjusted limits. Processes designed to handle items that have lower ESD withstand voltage(s) can still claim compliance to this document.

This document provides the requirements for an ESD control program. IEC TR 61340-5-2 [2] provides guidance on the implementation of this document.

This document does not apply to electrically initiated explosive devices, flammable liquids, gases, and powders.

The purpose of this document is to provide the administrative and technical requirements for establishing, implementing, and maintaining an ESD control program (hereinafter referred to as the “program”).

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

IEC 61340-4-3, *Electrostatics – Part 4-3: Standard test methods for specific applications – Footwear*

IEC 61340-4-5, *Electrostatics – Part 4-5: Standard test methods for specific applications – Methods for characterizing the electrostatic protection of footwear and flooring in combination with a person*

IEC 61340-4-6, *Electrostatics – Part 4-6: Standard test methods for specific applications – Wrist straps*

IEC 61340-4-7, *Electrostatics – Part 4-7: Standard test methods for specific applications – Ionization*

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

IEC 61340-4-9, *Electrostatics – Part 4-9: Standard test methods for specific applications – Garments*

IEC 61340-5-3, *Electrostatics – Part 5-3: Protection of electronic devices from electrostatic phenomena – Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices*

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

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 <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

NOTE For the purposes of this document “earth” and “ground” have the same meaning.

3.1.1

charged device model

CDM

ESD stress model that approximates the discharge event that occurs when a charged component is quickly discharged to another object at a different electrostatic potential

Note 1 to entry: Charged device model is described in IEC 60749-28 [3].

Note 2 to entry: This note only applies to the French language.

3.1.2

common ground point

grounded device or location where the conductors of two or more ESD control items are bonded

3.1.3

common connection point

device or location where the conductors of two or more ESD control items are connected in order to bring the ESD control items to the same electrical potential through equipotential bonding

3.1.4

equipotential bonding

electrical connection of items used to control ESD so that they are at substantially the same voltage under normal and fault conditions

3.1.5

electrostatic discharge

ESD

rapid transfer of charge between bodies that are at different electrostatic potentials

3.1.6**ESD control items**

materials or products designed to either prevent the generation of static charge or dissipate static charges that have been generated, or both, so as to prevent damage to ESD sensitive devices

3.1.7**ESD protected area****EPA**

area in which an ESDS can be handled with accepted risk of damage as a result of electrostatic discharge or fields

3.1.8**ESD sensitive device****ESDS**

sensitive device, integrated circuit or assembly that can be damaged by electrostatic discharge

3.1.9**ESD withstand voltage**

highest voltage level in an ESD stress model test that does not cause failure

Note 1 to entry: The device passes all tested lower voltages.

3.1.10**functional ground**

terminal used to connect parts to ground for reasons other than safety

3.1.11**human body model****HBM**

ESD stress model that approximates the discharge from the fingertip of a typical human being onto a pin of a device with another pin grounded

Note 1 to entry: Human body model is described in IEC 60749-26 [4].

3.1.12**organization**

company, group or body that handles ESDS

Note 1 to entry: For the purposes of this document an organization can be an individual person.

3.1.13**protective earth**

terminal used to connect parts to earth for safety reasons

3.1.14**unprotected ESDS**

ESDS without ESD protective packaging or coverings

3.1.15**worksurface**

surface where any type of work or processing can be performed on an unprotected ESDS

3.2 Abbreviated terms

CDM charge device model

EPA electrostatic protected area

ESD electrostatic discharge

ESDS ESD sensitive devices

HBM	human body model
MM	machine model
R_g	resistance to ground
R_{gp}	resistance to groundable point
R_{p-p}	resistance point to point
V_{offset}	offset voltage

4 Personnel safety

The procedures and equipment described in this document can expose personnel to hazardous electrical conditions. Users of this document are responsible for selecting equipment that complies with applicable laws, regulatory codes and both external and internal policy. Users are cautioned that this document cannot replace or supersede any requirements for personnel safety.

Electrical hazard reduction practices shall be exercised and proper grounding instructions for equipment shall be followed.

5 ESD control program

5.1 General

5.1.1 ESD control program requirements

The ESD control program shall include all the administrative and technical requirements of this document. The organization shall establish, document, implement, maintain, and verify the compliance of the program in accordance with the requirements of this document.

5.1.2 ESD control program manager or coordinator

The organization shall assign an ESD control program manager or coordinator with the responsibility for implementing the requirements of this document including establishing, documenting, maintaining, and verifying the compliance of the program. The roles may be delegated to other sub-ordinate personnel appropriate to an organization's requirements, provided the ESD control program manager or coordinator retains managerial responsibility.

5.1.3 Tailoring

It is possible that for some applications, some of the requirements of this document are not applicable. Tailoring is accomplished by evaluating the applicability of each requirement for the specific application. Upon completion of the evaluation, requirements may be modified, or deleted. Tailoring decisions, including rationale and technical justification, shall be documented. See Annex A for more information.

5.2 ESD control program administrative requirements

5.2.1 ESD control program plan

The ESD control program shall document the lowest ESD withstand voltage(s) that can be handled. By default, the values given in Clause 1 shall apply. The organization shall prepare an ESD control program plan that addresses each of the requirements of the program. Those requirements are:

- training,
- product qualification,

- compliance verification,
- grounding/bonding systems,
- personnel grounding,
- EPA requirements,
- packaging systems,
- marking.

The plan is the principal document for implementing and verifying the program. The goal is a fully implemented and integrated program that conforms to internal quality system requirements. The plan shall apply to all applicable facets of the organization's work.

5.2.2 Training plan

The training plan shall define all personnel that are required to have ESD awareness and prevention training. At a minimum, initial and recurrent ESD awareness and prevention training shall be provided to all personnel who handle or otherwise come into contact with any ESDS. Initial training shall be provided before personnel handle ESD sensitive devices. The type and frequency of ESD training for personnel shall be defined in the training plan. The training plan shall include a requirement for maintaining employee training records and shall document where the records are stored. Training methods and the use of specific techniques are at the organization's discretion. The training plan shall include methods used by the organization to ensure trainee comprehension and training adequacy.

5.2.3 Product qualification plan

A product qualification plan shall be established to ensure the ESD control items selected by the organization meet the requirements identified in Table 2, Table 3 and Table 4 of this document as well as other requirements as stated in this document. This includes the use of the test methods and test limits identified in these tables.

Product qualification shall occur during the initial selection of the ESD control item and before initial use. It may use any of the following qualification methods:

- a) product specification review,
- b) independent laboratory evaluation, or
- c) internal laboratory evaluation.

Independent of the organization's qualification method, qualification records shall include the test method used, the test results obtained from that method, and the test limits. Also, the qualification data shall include the environmental conditioning used during the testing as defined within the test method. The product qualification plan shall also include the location of the qualification records.

Organizations with facilities where the annual minimum relative humidity (RH) is above the environmental conditioning levels identified within the product qualification test method for each ESD control item can use this minimum value to qualify each item used within that facility. However, any ESD control item that leaves these facilities (for example, packaging) shall be qualified using the environmental test requirements within the product qualification test methods identified in Table 2, Table 3, and Table 4 of this document.

Organizations that can verify the use of ESD control items before adopting this document to certify their ESD control program can use compliance verification records to meet product qualification requirements. These records shall cover a minimum of one year and reflect a timeframe immediately before use as product qualification records. These records shall reflect test results that meet the compliance verification test limits identified in Table 2, Table 3 and Table 4 of this document.

The use of compliance verification records for product qualification does not apply when the organization selects a footwear/flooring system as the personnel grounding method. When a footwear/flooring system is selected, it shall be qualified using the environmental test conditioning specified in the test methods identified in Table 2 or by the lowest RH at the facility as described above. Product qualification shall be completed for each footwear and flooring type combination used by the organization.

NOTE IEC TR 61340-5-2 [2] contains guidance for items not listed in Table 2 and Table 3 of this document.

5.2.4 Compliance verification plan

A compliance verification plan shall be established to ensure the organization's fulfilment of the requirements of the plan. Process monitoring (measurements) shall be conducted in accordance with a compliance verification plan that identifies the technical requirements to be verified, the measurement limits and the frequency at which those verifications shall occur. The compliance verification plan shall document the test methods used for process monitoring and measurements. If the organization uses different test methods to replace those of this document, the organization shall be able to show that the results achieved correlate with the referenced standards. Where test methods are devised for testing items not covered in this document, these shall be adequately documented including corresponding test limits. Compliance verification records shall be established and maintained to provide evidence of conformity to the technical requirements. The compliance verification plan shall document where the records are stored.

The test equipment selected shall be capable of making the measurements defined in the compliance verification plan.

Consideration should be taken regarding the lowest relative humidity levels experienced by the organization; some of the measurements should be made under these conditions.

NOTE Calibration certificates do not ensure test equipment is capable of making the required measurements.

5.3 ESD control program plan technical requirements

5.3.1 General

The subclauses from 5.3.2 to 5.3.6 describe the essential technical requirements used in the development of an ESD control program.

The required limits are based on the test methods or standards listed in Table 1, Table 2, Table 3 and Table 4.

Some of the technical elements listed in Table 1 to Table 4 do not have a defined lower resistance limit. However, a minimum resistance value can be required for safety reasons.

National requirements can apply. For more information see the IEC 60364 [6] series, IEC TS 60479-1 [4] [7], IEC TS 60479-2 [8], IEC 61010-1 [9], and IEC 61140 [10] for more information.

5.3.2 Grounding/equipotential bonding systems

In order to eliminate ESD damage, it is necessary to eliminate differences in potential between ESDS and other conductors that ESDS come into contact with such as personnel, automated handling equipment, fixtures, and mobile equipment. All items that come into contact with ESDS and are capable of conducting electricity shall be connected to ground or electrically bonded in order to eliminate differences in potential. This can be achieved in three different ways:

- Grounding using protective earth

The first and preferred ESD ground is protective earth if available. In this case, the ESD control elements and grounded personnel are connected to protective earth (see Figure 1).

- Grounding using functional ground

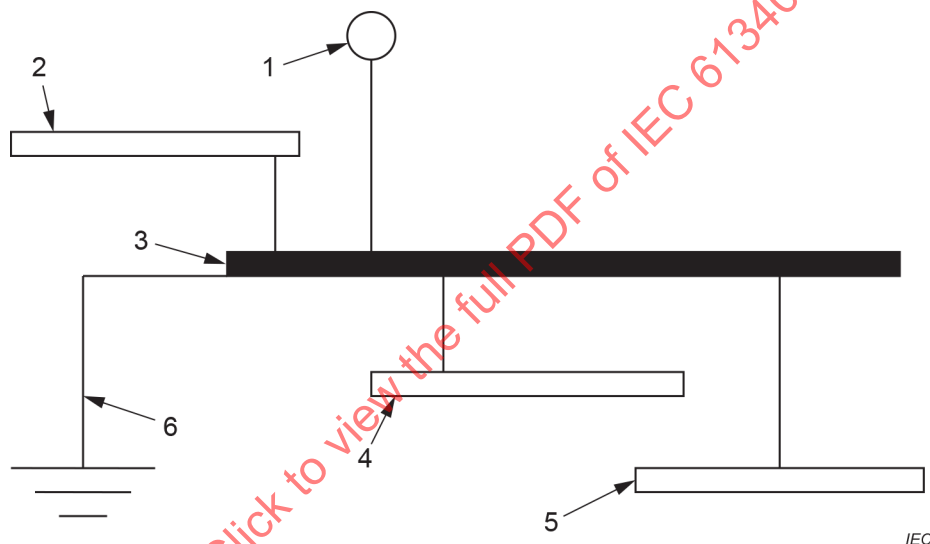
The second acceptable ESD ground is achieved through the use of a functional ground. This conductor can be a ground rod, stake, or a separate wiring system that is bonded to protective earth at the main service panel (see Figure 1). In order to eliminate differences in potential between protective earth and the functional ground system, the two systems shall be electrically bonded together where possible.

- Equipotential bonding

If a ground facility is not available, ESD protection can be achieved by connecting all of the ESD control items together at a common connection point (see Figure 2). The maximum resistance between any protective item and the common connection point shall comply with the limits established for the protective items as per Table 2 and Table 3.

Whichever grounding/bonding system is selected, it shall be referred to as “ground” in the remainder of this document.

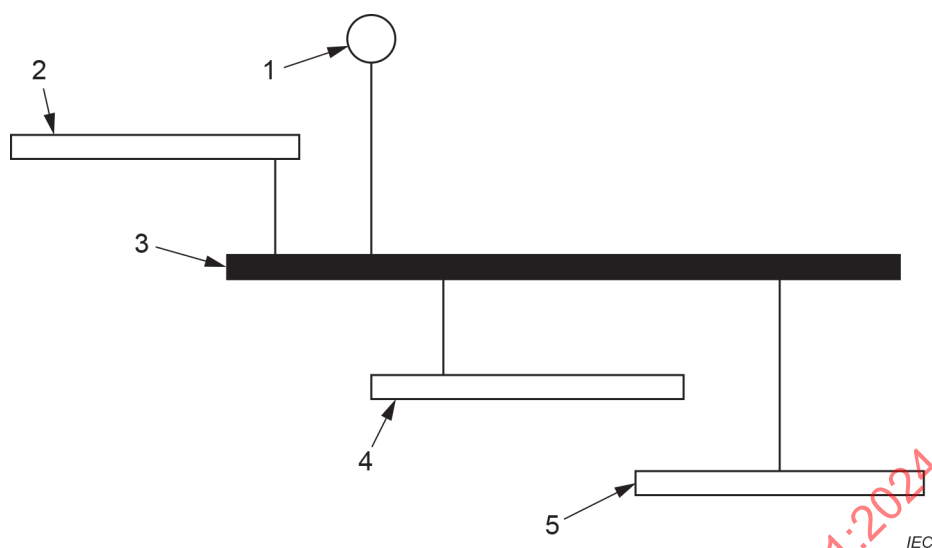
CAUTION: Electrical wiring systems can be subject to local and national electrical codes and regulatory requirements.



Key

- 1 Wrist strap (band and ground cord)
- 2 Worksurface
- 3 Common ground point
- 4 Floor mat
- 5 Floor
- 6 Protective earth or functional ground (functional ground, if used, shall be bonded to protective earth)

Figure 1 – Schematic of an EPA with a ground reference



Key

- 1 Wrist strap and cord
- 2 Worksurface
- 3 Common connection point
- 4 Floor mat
- 5 Floor

Figure 2 – Schematic of an equipotential bonding system

Table 1 – Grounding/bonding requirements

Technical requirement	Grounding method	Test method/standard	Required limit(s)
Grounding/bonding system	Protective earth	Not defined in this document. Additional local requirements can apply.	Not defined in this document. Additional local requirements can apply.
	Functional ground	Not defined in this document. Additional local requirements can apply.	The resistance between functional ground and protective earth shall not exceed 25 Ω unless otherwise specified.
	Equipotential bonding	See applicable implementing process from Table 2 and Table 3	See limits for each ESD control item from Table 2 and Table 3

5.3.3 Personnel grounding

All personnel shall be grounded or equipotentially bonded according to the requirements below when handling ESDS. When personnel are seated at ESD protective workstations, they shall be connected to ground via a wrist strap system or groundable static control garment system.

When garments are used to achieve personnel grounding, it shall be documented in the ESD control program plan. The garment shall also meet the groundable static control garment system resistance requirements defined in Table 2 and the groundable static control garment requirements in Table 3.

For standing operations, personnel can be grounded via any method from Table 2. When a footwear/flooring system is used, personnel shall wear footwear for ESD control on both feet and the two following conditions shall be met:

- the total resistance of the system (from the person, through the footwear and flooring to ground) shall be less than $1,0 \times 10^9 \Omega$;
- the maximum body voltage generation shall be less than 100 V.

Table 2 – Personnel grounding requirements

Technical requirement	Product qualification		Compliance verification	
	Test method(s)	Required limit(s)	Test method(s)	Required limit(s)
Wrist strap system	IEC 61340-4-6	System resistance <3,5 × 10 ⁷ Ω	IEC TS 61340-5-4 Wrist strap system	System resistance <3,5 × 10 ⁷ Ω
Groundable static control garment system	IEC 61340-4-9	System resistance <3,5 × 10 ⁷ Ω	IEC TS 61340-5-4 Groundable static control garment system	System resistance <3,5 × 10 ⁷ Ω
Footwear/flooring ^a systems (shall comply with limits for both system resistance and body voltage)	IEC 61340-4-5	System resistance <1 × 10 ⁹ Ω	IEC TS 61340-5-4 Person-footwear-flooring system	Resistance to groundable point ^b <1 × 10 ⁸ Ω
		absolute value of body voltage < 100 V (average of 5 highest peaks)	IEC TS 61340-5-4 Person-footwear-flooring system	System resistance ^b < 1 × 10 ⁹ Ω

^a A periodic body voltage generation test should be done to verify the voltage is less than 100 V.

^b The required limit of < 1,0 × 10⁹ Ω is the maximum allowed value for the person-footwear-floor system. The user should establish an upper limit for the person-footwear system from the resistance values that were measured for product qualification for the footwear and the floor to comply with the < 100 V body voltage generation, and use this resistance limit for compliance verification.

5.3.4 ESD protected areas (EPA)

5.3.4.1 Handling ESDS and access to EPA

Handling of ESDS without ESD protective covering or packaging shall be performed in an EPA. The boundaries of the EPA shall be clearly identified as EPA boundaries (e.g. Caution signs indicating the existence of the EPA can be posted and conspicuous to personnel prior to entry to the EPA.)

NOTE An EPA can, for example, consist of a building, an entire room or a single workstation.

Access to the EPA shall be limited to personnel who have completed appropriate ESD training. Untrained individuals shall be escorted by trained personnel while in an EPA.

5.3.4.2 Insulators

For the purposes of this document, materials and objects with volume resistance and either surface resistance or point-to-point resistance, greater than or equal to $1,0 \times 10^{11} \Omega$, measured in accordance with IEC 61340-2-3, are considered to be insulators.

The organization's ESD control program shall include a plan for handling insulators to mitigate field induced damage. All nonessential insulators shall be separated from any ESDS item by at least 30 cm. Areas can be designated within the EPA to store electrostatic charge generating items provided the areas do not cause any of the requirements below to be exceeded. When qualifying a process to be deployed in an EPA, process essential insulators shall be evaluated in accordance with how the insulators will be used. The ESD threat associated with process essential insulators or electrostatic field sources shall be evaluated to ensure that:

- the electrostatic field at the position where the ESDS are handled shall not exceed 5 000 V/m;

or

- if the electrostatic potential measured at the surface of the process essential insulator exceeds 2 000 V, the item shall be kept a minimum of 30 cm from the ESDS; and
- if the electrostatic potential measured at the surface of the process essential insulator exceeds 125 V, the item shall be kept a minimum of 2,5 cm from the ESDS.

Some of the electrostatic field or potential measurements should be taken at the lowest expected relative humidity experienced by the facility.

The ESD threat associated with process essential insulators after normal handling that could occur during the processing of ESDS items with materials in use in the EPA, or other electrostatic field sources shall be evaluated to ensure that the above limits are not exceeded.

NOTE 1 These measurements are made based on the frequency defined in the compliance verification plan.

NOTE 2 An ESD threat is considered a contact of the ESDS with a conductive object while the ESDS is in the presence of the field

The accurate measurement of electrostatic fields requires that the person making the measurement is familiar with the operation of the measuring equipment. Most handheld meters require that the reading be taken at a fixed distance from the object. They also normally specify that the object has a minimum dimension of fixed size to obtain an accurate reading.

NOTE 3 IEC TR 61340-5-2 [2] provides guidance on actions to take if the measured electrostatic field or surface potential exceeds the stated limits.

5.3.4.3 Isolated conductors

For the purposes of this document, materials and objects with surface resistance, point-to-point resistance or volume resistance less than $1,0 \times 10^4 \Omega$, measured in accordance with IEC 61340-2-3, are considered to be conductors.

An isolated conductor is a conductor with resistance to ground of greater than or equal to $1,0 \times 10^9 \Omega$, measured in accordance with IEC 61340-2-3 from point(s) that can contact ESDS.

Before a conductor that cannot be grounded or equipotentially bonded comes into contact with an ESDS item, the process shall ensure that the potential difference between the isolated conductor and ground is within ± 35 V.

This can be accomplished by measurement of the potential difference between the conductor and ESDS and ground using a non-contact electrostatic voltmeter or a high impedance contact electrostatic voltmeter.

For an isolated conductor that does not come into contact with an ESDS item, the requirements for insulators in 5.3.4.2 shall be met.

NOTE The 35 V limit is related to the level achievable using ionizers selected to achieve the desired performance when used in the process.

5.3.4.4 ESD control items

An EPA shall be established wherever ESD sensitive products are handled without ESD protective covering or packaging. However, there are many different ways to establish an ESD control program. Table 3 lists some optional ESD control items that can be used to control static electricity. For those ESD control items that are selected for use in the ESD control program, the required ranges for that item becomes mandatory.

If the limits in Table 3 are exceeded, the ESD control program shall include a tailoring statement as required by 5.1.3.

Table 3 – EPA technical requirements

ESD control item	Product qualification ^a		Compliance verification	
	Test method	Limits	Test method	Limits
Worksurface, storage racks	IEC 61340-2-3	$R_{gp} < 1 \times 10^9 \Omega$ $R_{p-p} < 1 \times 10^9 \Omega^d$	IEC TS 61340-5-4 Worksurfaces	$R_g < 1 \times 10^9 \Omega$
Wrist strap (bands and ground cords)	IEC 61340-4-6	$< 5 \times 10^6 \Omega$	See Table 2	
Wristband	IEC 61340-4-6	Interior $< 1,0 \times 10^5 \Omega$		
		Exterior $> 1,0 \times 10^7 \Omega$		
Mobile equipment	IEC 61340-2-3	$R_{gp} < 1 \times 10^9 \Omega$ $R_{p-p} < 1 \times 10^9 \Omega^d$	IEC TS 61340-5-4 Mobile equipment	$R_g < 1 \times 10^9 \Omega$
Wrist strap bonding point			IEC TS 61340-5-4 Grounding/bonding	$R_g < 5 \times 10^6 \Omega$
Flooring	IEC 61340-4-1 ^{b,c}	$R_{gp} < 1 \times 10^9 \Omega$ $R_{p-p} < 1 \times 10^9 \Omega$	IEC TS 61340-5-4 Flooring	$R_g \times 10^9 \Omega$
Footwear	IEC 61340-4-3	$R \leq 1 \times 10^8 \Omega$	See Table 2	
Ionization	IEC 61340-4-7	Decay (+1 000 V to +100 V and – 1 000 V to – 100 V) < 20 s or user defined Offset Voltage (Peak) –35 volts < V_{offset} < 35 volts	IEC TS 61340-5-4 Ionization	Decay (+1 000 V to +100 V and – 1 000 V to – 100 V) < 20 s or user defined Offset Voltage (Peak) –35 volts < V_{offset} < 35 volts
Seating	IEC 61340-2-3	$R_{gp} < 1 \times 10^9 \Omega$	IEC TS 61340-5-4 Seating	$R_g < 1 \times 10^9 \Omega$
Static control garments	IEC 61340-4-9 or user defined method	$R_{p-p} < 1 \times 10^{11} \Omega$ or user defined limit	IEC TS 61340-5-4 Static control garments or user defined method	$R_{p-p} < 1 \times 10^{11} \Omega$ or user defined limit
Groundable static control garments	IEC 61340-4-9	$R_{gp} < 1 \times 10^9 \Omega$	IEC TS 61340-5-4 Groundable static control garments	$R_{gp} < 1 \times 10^9 \Omega$

^a For general product qualification, the environmental conditions for testing shall be $(12 \pm 3) \% \text{ RH}$ and $23^\circ\text{C} \pm 2^\circ\text{C}$. When not specified in the referenced IEC document, the minimum environmental conditioning time for product qualification should be 48 h.

^b The maximum test voltage allowed for measuring ESD flooring that should be used for an ESD program complying with this document is 100 V.

^c If flooring is used for grounding personnel that handle ESDS refer to the system requirements in Table 2.

^d In situations where charged device model (CDM) damage is a concern, a minimum point to point resistance limit of $1 \times 10^4 \Omega$ is recommended.

5.3.5 Packaging

ESD protective packaging shall be in accordance with customer contracts, purchase orders, drawing or other documentation. When the contract, purchase order, drawing or other documentation does not define ESD protective packaging, the organization shall define ESD protective packaging requirements for ESDS within the plan based on IEC 61340-5-3. Packaging, when required, shall be defined for all material movement within EPAs, between EPAs, between job sites, field service operations and to the customer. The requirements of qualification and compliance verification are summarized in Table 4.

Table 4 – Packaging requirements

Technical requirement	ESD Control Item	Product qualification		Compliance verification	
		Test method	Required limits	Test method	Required limits
Packaging	Conductive packaging	IEC 61340-2-3	$R < 1 \times 10^4 \Omega$	IEC TS 61340-5-4 Packaging	$R < 1 \times 10^4 \Omega$
	Dissipative packaging	IEC 61340-2-3	$R \geq 1 \times 10^4 \Omega$ to $< 1 \times 10^{11} \Omega$	IEC TS 61340-5-4 Packaging	$R \geq 1 \times 10^4 \Omega$ to $< 1 \times 10^{11} \Omega$
	Electrostatic discharge shielding (bags only)	IEC 61340-4-8	Energy < 20 nJ	IEC TS 61340-5-4 Packaging ^a	$R < 1 \times 10^{11} \Omega$
^a For intimate packaging only					

5.3.6 Marking

ESDS, system or packaging marking shall be in accordance with customer contracts, purchase orders, drawing or other documentation. When the contract, purchase order, drawing or other documentation does not define ESDS, system or packaging marking, the organization, in developing the ESD control program plan, shall consider the need for marking. If it is determined that marking is required, it shall be documented as part of the plan.

Annex A (informative)

Tailoring examples

Tailoring allows users of IEC 61340-5-1 to modify or delete a requirement of the document if the user can provide justification and technical rationale for the deviation or exclusion. Tailoring as described in 5.1.3 requires that tailoring statements are documented, and are typically added to an organization's ESD control program plan, and include the requirement(s) of IEC 61340-5-1 that are excluded or modified as well as the technical justification or rationale for the change.

The use of tailoring statements by an organization to deviate from or exclude a requirement from IEC 61340-5-1 in an ESD control program plan is often misunderstood by both the organization and those trying to determine compliance with the document. This most often evolves from a misunderstanding of what is or is not a requirement within the document. In the tailoring examples provided below, the affected requirement within IEC 61340-5-1 includes the word 'shall' or 'mandatory'. Tailoring statements derived by the organization to address where and how the program deviates from IEC 61340-5-1 requirements (see 5.1.3) shall include the requirement within the document that is affected and the technical rationale for the exclusion or deviation from the requirement.

a) Examples of acceptable tailoring statements and rationale:

– Example 1

Tailoring statement: The upper resistance to ground limit for worksurfaces used within cleanroom EPAs is less than $1,0 \times 10^{10} \Omega$ instead of $1,0 \times 10^9 \Omega$ as required for product qualification and compliance verification.

IEC 61340-5-1 requirement affected: Table 3, product qualification and compliance verification 'resistance to groundable resistance' and 'resistance to ground' maximum resistance limit of $1,0 \times 10^9 \Omega$ as tested using IEC 61340-5-3 and IEC TS 61340-5-4, respectively. Also, in 5.2.3 (product qualification plan) and 5.3.4 (compliance verification plan), the required test limits provided in Table 2, Table 3, and Table 4 shall be met.

Technical rationale for deviation: The organization has a cleanliness requirement for multiple cleanrooms where ESDS items are handled. The worksurface materials meeting cleanliness requirements within these cleanrooms have resistance (resistance to ground) values that exceed $1,0 \times 10^9 \Omega$ but are less than $1,0 \times 10^{10} \Omega$. By ensuring these worksurfaces and personnel are properly grounded, all ESDS items and personnel will be at the same electrical potential, which the organization has verified with documented measurements. The manufacturing process in the cleanrooms where these worksurfaces are used is controlled, and yield rates for the end products produced have been acceptable since the initial installation.

– Example 2

Tailoring statement: The pulsed DC ceiling-mounted room ionization system utilized in this EPA will have Offset Voltage (Peak): $-250 \text{ V} < V_{\text{offset}} < 250 \text{ V}$.

IEC 61340-5-1 requirement affected: Table 3, Product Qualification and Compliance Verification Ionization Offset Voltage (Peak): $-35 \text{ V} < V_{\text{offset}} < 35 \text{ V}$.

Technical rationale for deviation: The ESD sensitivity of wafers in front-end manufacturing operations is significantly lower than after the dies are separated. A ceiling-based room ionization system is used in the EPA's covered in this ESD Control plan. The purpose of this system is primarily for contamination control. It will be utilized for reducing the charge on the many process essential insulators typically present in any wafer fabrication facility. A wide-coverage (versus point-of-use) ionization system is critical in any wafer fabrication facility to reduce electric fields on the many process essential insulators. In limited critical operations where a tighter offset is deemed required by engineering or the ESD program manager, peak ionizer offset voltage maximum specification is $\pm 35 \text{ V}$.

b) Examples of unacceptable or unnecessary tailoring statements and rationale

– Example 1

Tailoring statement: Seating as an ESD control item is not required because all personnel shall wear a grounded wrist strap when seated inside an EPA.

IEC 61340-5-1 requirement affected: Subclause 5.3.3 (personnel grounding), states: "When personnel are seated at ESD protective workstations, they shall be connected to ground via a wrist strap system or groundable static control garment system."

Why is this tailoring statement unnecessary? The document does not require ESD protective seating. ESD protective seating is one of many 'optional' ESD control items for EPAs provided in Table 3 of the document. The actual requirement is for seated personnel to be connected to a grounded wrist strap, and this is independent of whether ESD protective seating is used.

– Example 2

Tailoring statement: Nonessential insulators are not allowed inside the organization's EPAs in designated areas.

IEC 61340-5-1 requirement affected: Subclause 5.3.4.2 (insulators), first paragraph, second sentence: "All nonessential insulators shall be separated from any ESDS item by at least 30 cm".

Why is this tailoring statement unnecessary? By not allowing nonessential insulators inside EPAs, the IEC 61340-5-1 requirement to ensure all nonessential insulators are separated from ESDS items by 30 cm is met. As a result, no tailoring statement is required.

– Example 3

Tailoring statement: The lower resistance to ground limit for worksurfaces used within the EPAs is greater than $1,0 \times 10^5 \Omega$ instead of 0Ω as required.

IEC 61340-5-1 requirement affected: Table 3, product qualification and compliance verification 'resistance to groundable point' and 'resistance to ground' minimum resistance limit of 0Ω as tested using IEC 61340-2-3 and IEC TS 61340-5-4, respectively. Also, in 5.2.3 (product qualification plan) and 5.2.4 (compliance verification plan), the required test limits provided in Table 3 shall be met.

Why is this tailoring statement unnecessary? The lower limit established is within the limits of IEC 61340-5-1. Since it is within the limits, tailoring is not required. This lower limit will be the requirement of this facility.

Bibliography

- [1] IEC TR 61340-5-5, *Electrostatics – Part 5-5: Protection of electronic devices from electrostatic phenomena – Packaging systems used in electronic manufacturing*
 - [2] IEC TR 61340-5-2, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*
 - [3] IEC 60749-28, *Semiconductor devices – Mechanical and climatic test methods – Part 28: Electrostatic discharge (ESD) sensitivity testing – Charged device model (CDM) – device level*
 - [4] IEC 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part 26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*
 - [5] IEC 60749-27, *Semiconductor devices – Mechanical and climatic test methods – Part 27: Electrostatic discharge (ESD) sensitivity testing – Machine model (MM)*
 - [6] IEC 60364 (all parts), *Low-voltage electrical installations*
 - [7] IEC TS 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
 - [8] IEC TS 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
 - [9] IEC 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
 - [10] IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*
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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

ÉLECTROSTATIQUE –

Partie 5-1: Protection des dispositifs électroniques contre les phénomènes électrostatiques – Exigences générales

AVANT-PROPOS

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L'IEC 61340-5-1 a été établie par le comité d'études 101 de l'IEC: Électrostatique. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition parue en 2016. Cette édition constitue une révision technique.

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

- a) des définitions ont été ajoutées au document;
- b) les exigences de qualification produit ont été mises à jour;
- c) le 5.3.3 inclut désormais une référence aux systèmes de vêtements de contrôle des DES pouvant être reliés à la terre;
- d) le Tableau 2 a été remplacé;
- e) le 5.3.4.2 a été mis à jour pour définir ce qu'est un isolant;
- f) le 5.3.4.3 a été mis à jour pour inclure une définition de ce qu'est un conducteur isolé;
- g) le Tableau 3 a été mis à jour, des éléments techniques ont été ajoutés, y compris une référence à l'IEC 61340-5-4 pour les essais de vérification de conformité;
- h) le Tableau 4 a été ajouté pour récapituler les exigences de l'IEC 61340-5-3 et inclure les exigences relatives à la vérification de la conformité des emballages;
- i) l'Annexe A a été remplacée, l'ancienne annexe n'étant plus nécessaire. L'Annexe A donne des exemples d'adaptation.

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

Projet	Rapport de vote
101/705A/FDIS	101/710/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.

Ce 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/publications.

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

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- reconduit,
- supprimé, ou
- révisé.

INTRODUCTION

La présente partie de l'IEC 61340 couvre les exigences nécessaires à la conception, à l'établissement, à la mise en œuvre et à la maintenance d'un programme de maîtrise des décharges électrostatiques (DES) pour les activités concernant: la fabrication, le traitement, l'assemblage, l'installation, l'emballage, l'étiquetage, l'entretien, l'essai, l'examen, le transport ou bien la manipulation des pièces, des ensembles et des équipements électriques ou électroniques susceptibles d'être endommagés par des décharges électrostatiques supérieures ou égales à 100 V sur le modèle du corps humain (HBM, *Human Body Model*), 200 V sur le modèle de dispositif chargé (CDM, *Charged Device Model*) et 35 V sur les conducteurs isolés. La limite de 35 V se rapporte au niveau réalisable en utilisant les ioniseurs spécifiés dans le présent document.

Tout contact et toute séparation physique de matériaux ou flux de solides, liquides ou gaz chargés de particules peuvent produire des charges électrostatiques. Des sources courantes de DES comprennent: le personnel, les conducteurs, les matériaux polymères courants et le matériel de traitement. Les DES peuvent engendrer des dommages quand:

- une personne ou un objet chargé entre en contact avec un dispositif sensible aux DES (ESDS, ESD Sensitive device);
- un ESDS entre en contact direct avec une surface conductrice alors qu'il est exposé à un champ électrostatique;
- un ESDS chargé entre en contact avec une autre surface conductrice qui est à un potentiel électrique différent. Cette surface peut être mise à la terre ou non.

Les microcircuits, les semiconducteurs discrets, les résistances à couche rigide et mince, les dispositifs hybrides, les cartes de circuits imprimés et les cristaux piézoélectriques constituent des exemples d'ESDS. Il est possible de déterminer la susceptibilité du dispositif et de l'élément en exposant le dispositif à des événements DES simulés. La tension de tenue aux DES, déterminée par l'essai de sensibilité utilisant des événements DES simulés, ne représente pas nécessairement l'aptitude du dispositif à résister aux DES issues de sources réelles à ce niveau de tension. Cependant, les niveaux de sensibilité sont utilisés afin d'établir une référence pour les données de susceptibilité lors de la comparaison de dispositifs qui possèdent des références de pièce équivalentes provenant de différents fabricants. Trois modèles différents ont été utilisés pour la qualification des composants électroniques (HBM, MM et CDM). En pratique, les dispositifs sont qualifiés uniquement par le biais d'essais de susceptibilité HBM et CDM.

Le présent document couvre les exigences du programme de maîtrise des DES nécessaires à l'établissement d'un programme pour la manipulation des ESDS, en se fondant sur l'expérience historique d'organisations tant militaires que commerciales. Les principes fondamentaux de maîtrise des DES qui constituent la base du présent document sont les suivants.

- Éviter une décharge de tout objet chargé, conducteur (personnel et en particulier les équipements de manutention automatisée) dans l'ESDS. Cela peut être réalisé en reliant ou en raccordant électriquement tous les conducteurs de l'environnement, y compris le personnel, à une terre existante ou provoquée (comme à bord d'un navire ou d'un avion). Cette fixation crée un équilibre équipotentiel entre tous les objets conducteurs et le personnel. La protection électrostatique peut être maintenue à un potentiel différent d'un potentiel de terre de tension "zéro" tant que tous les objets conducteurs du système sont au même potentiel.

- Éviter une décharge de tout dispositif sensible aux DES qui est chargé. La charge peut résulter d'un contact direct et d'une séparation, ou peut être induite par un champ électrique. Les isolants nécessaires dans l'environnement ne peuvent pas perdre leur charge électrostatique par liaison à la terre. Les systèmes d'ionisation assurent une neutralisation des charges sur ces isolants nécessaires (les matériaux de cartes de circuits et certains emballages de dispositifs constituent des exemples d'isolants nécessaires). Le danger de DES provoqué par les charges électrostatiques sur les isolants nécessaires sur le lieu de travail est évalué pour s'assurer que les actions adéquates sont mises en œuvre, en fonction du risque.
- À l'extérieur d'une zone protégée contre les décharges électrostatiques (ci-après dénommée EPA, *Electrostatic discharge Protected Area*), il n'est généralement pas possible de contrôler les éléments ci-dessus; de ce fait, un emballage de protection contre les DES peut être exigé. La protection contre les DES peut être effectuée en enfermant les produits sensibles aux DES dans des matériaux de protection contre les décharges électrostatiques, bien que le type de matériau dépende de la situation et de la destination. À l'intérieur d'une EPA, les matériaux antistatiques peuvent procurer une protection adéquate. À l'extérieur d'une EPA, les matériaux de blindage contre les décharges électrostatiques sont recommandés. Alors que tous ces matériaux ne sont pas examinés dans le présent document, il est important de reconnaître les différences concernant leur application. Pour plus d'informations, se reporter à l'IEC 61340-5-3 et l'IEC TR 61340-5-5 [1]¹.

Dans la mesure où chaque organisation possède des processus distincts, un ensemble différent de mesures de prévention contre les DES est nécessaire pour accomplir un programme de maîtrise des DES optimal. Il convient de choisir ces mesures en se fondant sur la nécessité technique et de les documenter avec soin dans le cadre d'un plan de programme de maîtrise des DES, de telle sorte que toutes les parties concernées puissent être sûres des exigences du programme.

La formation constitue une partie essentielle du programme de maîtrise des DES qui permet de s'assurer que le personnel concerné a une bonne connaissance de l'équipement ainsi que des procédures qu'il doit utiliser afin de respecter le plan du programme de maîtrise des DES. La formation joue également un rôle important pour accroître la sensibilisation aux problématiques des DES et leur compréhension. Sans formation, le personnel constitue souvent une source majeure de risque de DES. En suivant une formation, le personnel devient une première ligne efficace de défense contre les dommages liés aux DES. La qualification produit permet de s'assurer que l'équipement destiné à être utilisé dans le cadre du programme de maîtrise des DES satisfait aux exigences techniques avant de le mettre en service.

Un plan de qualification produit décrit les critères à utiliser pour le choix des éléments de maîtrise des DES.

Des vérifications de la conformité et des essais réguliers sont essentiels pour s'assurer que l'équipement demeure efficace, mais également que le programme de maîtrise des DES est mis en œuvre de manière correcte conformément au plan du programme de maîtrise des DES.

¹ Les chiffres entre crochets renvoient à la Bibliographie.

ÉLECTROSTATIQUE –

Partie 5-1: Protection des dispositifs électroniques contre les phénomènes électrostatiques – Exigences générales

1 Domaine d'application

La présente partie de l'IEC 61340 s'applique aux organisations concernant: la fabrication, le traitement, l'assemblage, l'installation, l'emballage, l'étiquetage, l'entretien, l'essai, l'examen, le transport ou bien la manipulation des pièces, des ensembles et des équipements électriques ou électroniques qui présentent des tensions de tenue supérieures ou égales à 100 V sur le modèle du corps humain (HBM) et 200 V sur le modèle de dispositif chargé (CDM). En outre, la protection des conducteurs isolés est procurée en limitant la tension sur les conducteurs isolés à moins de 35 V. Les ESDS qui présentent des tensions de tenue inférieures peuvent exiger des éléments de maîtrise supplémentaires ou des limites adaptées. Les processus conçus pour manipuler des éléments qui présentent une ou plusieurs tensions de tenue aux DES inférieures peuvent toujours être déclarés conformes au présent document.

Le présent document fournit les exigences relatives à un programme de maîtrise des DES. L'IEC TR 61340-5-2 [2] fournit des recommandations pour la mise en œuvre du présent document.

Le présent document ne s'applique pas aux dispositifs explosifs à déclenchement électronique ni aux liquides, gaz et poudres inflammables.

L'objectif du présent document est de fournir les exigences administratives et techniques pour l'établissement, la mise en œuvre et la maintenance d'un programme de maîtrise des DES (ci-après dénommé "programme").

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, *Électrostatique – 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 61340-4-1, *Électrostatique – Partie 4-1: Méthodes d'essai normalisées pour des applications spécifiques – Résistance électrique des revêtements de sol et des sols finis*

IEC 61340-4-3, *Électrostatique – Partie 4-3: Méthodes d'essai normalisées pour des applications spécifiques – Chaussures*

IEC 61340-4-5, *Électrostatique – Partie 4-5: Méthodes d'essai normalisées pour des applications spécifiques – Méthodes de caractérisation de la protection électrostatique des chaussures et des revêtements de sol par rapport à une personne*

IEC 61340-4-6, *Électrostatique – Partie 4-6: Méthodes d'essai normalisées pour des applications spécifiques – Bracelets de conduction dissipative*

IEC 61340-4-7, *Électrostatique – Partie 4-7: Méthodes d'essai normalisées pour des applications spécifiques – Ionisation*

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

IEC 61340-4-9, *Électrostatique – Partie 4-9: Méthodes d'essai normalisées pour des applications spécifiques – Vêtements*

IEC 61340-5-3, *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 TS 61340-5-4, *Electrostatics – Part 5-4: Protection of electronic devices from electrostatic phenomena – Compliance verification* (disponible en anglais seulement)

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 <https://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <https://www.iso.org/obp>

NOTE Pour les besoins du présent document, les termes "terre" et "masse" ont la même signification.

3.1.1

modèle de dispositif chargé CDM

modèle de contraintes DES qui se rapproche de l'événement de décharge qui survient lorsqu'un composant chargé est déchargé rapidement sur un autre objet qui possède un potentiel électrostatique différent

Note 1 à l'article: Le modèle de dispositif chargé est décrit dans l'IEC 60749-28 [3].

Note 2 à l'article: L'abréviation "CDM" est dérivée du terme anglais développé correspondant "charged device model".

3.1.2

point de terre commun

dispositif ou emplacement relié à la terre où sont reliés les conducteurs de deux éléments de maîtrise des DES ou plus

3.1.3

point commun de connexion

dispositif ou emplacement où sont reliés les conducteurs de deux éléments de maîtrise des DES ou plus de manière à porter les éléments de maîtrise des DES au même potentiel électrique à travers une liaison équipotentielle

3.1.4

liaison équipotentielle

connexion électrique d'éléments utilisés pour la maîtrise des DES de sorte qu'ils soient pratiquement à la même tension dans des conditions normales ou de défaut

3.1.5**décharge électrostatique****DES**

transfert rapide de charges entre des corps qui ont des potentiels électrostatiques différents

3.1.6**éléments de maîtrise des DES**

matériaux ou produits conçus pour empêcher la production de charges électrostatiques ou dissiper des charges électrostatiques qui ont été produites, ou les deux, dans le but de prévenir l'endommagement de dispositifs sensibles aux DES

3.1.7**zone protégée contre les DES****EPA**

zone où un ESDS peut être manipulé avec un risque toléré de dommages résultant d'une décharge ou de champs électrostatiques

3.1.8**dispositif sensible aux DES****ESDS**

dispositif sensible, circuit intégré ou assemblage qui peut être endommagé par des décharges électrostatiques

Note 1 à l'article: L'abréviation "ESDS" est dérivée du terme anglais développé correspondant "ESD sensitive device".

3.1.9**tension de tenue aux DES**

niveau maximal de tension dans un essai de modèle de contraintes DES qui n'entraîne pas de défaillance

Note 1 à l'article: Le dispositif résiste à toutes les tensions d'essai plus faibles.

3.1.10**borne de terre fonctionnelle**

borne utilisée pour relier des parties à la terre pour des raisons autres que la sécurité

3.1.11**modèle du corps humain****HBM**

modèle de contraintes DES qui se rapproche de l'événement de décharge qui survient entre la pulpe du doigt d'un être humain type placée sur une broche d'un dispositif et une autre broche mise à la terre

Note 1 à l'article: Le modèle du corps humain est décrit dans l'IEC 60749-26 [4].

3.1.12**organisation**

société, groupe ou entité qui gère les ESDS

Note 1 à l'article: Pour les besoins du présent document, une organisation peut être un individu.

3.1.13**borne de terre de sécurité**

borne utilisée pour relier des parties à la terre pour des raisons de sécurité

3.1.14**ESDS non protégé**

ESDS sans revêtement ni emballage de protection contre les DES

3.1.15

surface de travail

surface où tout type de travail ou de traitement peut être effectué sur un ESDS non protégé

3.2 Abréviations

CDM (Charge Device Model)	modèle de dispositif chargé
EPA (Electrostatics Protected Area)	zone protégée contre les décharges électrostatiques
DES	décharge électrostatique
ESDS (ESD sensitive devices)	dispositifs sensibles aux DES
HBM (human body model)	modèle du corps humain
MM (machine model)	modèle de machine
R_g	résistance à la terre
R_{gp}	résistance au point de mise à la terre
R_{p-p}	résistance point à point
V_{offset}	tension offset

4 Sécurité du personnel

Les procédures et l'équipement décrits dans le présent document peuvent exposer le personnel à des conditions électriques dangereuses. Il appartient aux utilisateurs du présent document de choisir un matériel qui satisfait aux lois, aux codes réglementaires, ainsi qu'aux politiques extérieures et intérieures en vigueur. Les utilisateurs sont avertis que le présent document ne peut pas remplacer ni annuler les exigences relatives à la sécurité du personnel.

Des pratiques de réduction du danger électrique doivent être mises en œuvre, et les instructions de mise à la terre adéquates pour l'équipement doivent être suivies.

5 Programme de maîtrise des DES

5.1 Généralités

5.1.1 Exigences du programme de maîtrise des DES

Le programme de maîtrise des DES doit inclure l'ensemble des exigences administratives et techniques du présent document. L'organisation doit établir, documenter, mettre en œuvre, assurer la maintenance et vérifier la conformité du programme selon les exigences du présent document.

5.1.2 Gestionnaire ou coordinateur du programme de maîtrise des DES

L'organisation doit désigner un gestionnaire ou coordinateur du programme de maîtrise des DES qui a la responsabilité de mettre en œuvre les exigences du présent document, notamment d'établir, de documenter, d'assurer la maintenance et de vérifier la conformité du programme. Les rôles peuvent être délégués à un autre personnel subalterne adapté aux exigences d'une organisation, à condition que le gestionnaire ou coordinateur du programme de maîtrise des DES conserve la responsabilité managériale.

5.1.3 Personnalisation

Pour certaines applications, il est possible que certaines des exigences du présent document ne s'appliquent pas. Une personnalisation est réalisée en évaluant l'applicabilité de chaque exigence par rapport à l'application spécifique. À l'issue de l'évaluation, des exigences peuvent être modifiées ou supprimées. Les décisions de personnalisation, y compris les justificatifs et les justifications techniques, doivent être documentées. Pour plus d'informations, se reporter à l'Annexe A.

5.2 Exigences administratives du programme de maîtrise des DES

5.2.1 Plan du programme de maîtrise des DES

Le programme de maîtrise des DES doit documenter la ou les tensions de tenue aux DES les plus basses qui peuvent être traitées. Par défaut, les valeurs données à l'Article 1 doivent s'appliquer. L'organisation doit élaborer un plan de programme de maîtrise des DES qui couvre chacune des exigences du programme. Ces exigences sont:

- la formation;
- la qualification produit;
- la vérification de conformité;
- les systèmes de mise à la terre/liaison;
- la mise à la terre du personnel;
- les exigences relatives à l'EPA;
- les systèmes d'emballage;
- le marquage.

Le plan constitue le document principal pour la mise en œuvre et la vérification du programme. L'objectif est d'élaborer un programme entièrement mis en œuvre et intégré qui satisfait aux exigences du système de qualité interne. Le plan doit s'appliquer à l'ensemble des facettes pertinentes des travaux de l'organisation.

5.2.2 Plan de formation

Le plan de formation doit déterminer l'ensemble du personnel qui doit recevoir des formations de sensibilisation et prévention concernant les DES. Au minimum, une formation initiale et récurrente de sensibilisation et de prévention concernant les DES doit être fournie à l'ensemble du personnel qui manipule ou entre en contact avec tout ESDS. La formation initiale doit être prodiguée avant que le personnel ne manipule des dispositifs sensibles aux DES. Le type et la fréquence des formations du personnel aux DES doivent être déterminés dans le plan de formation. Le plan de formation doit inclure une exigence pour la conservation des rapports de formation des employés et doit indiquer l'endroit où sont stockés ces rapports. Les méthodes de formation et l'utilisation de techniques spécifiques sont à la discrétion de l'organisation. Le plan de formation doit inclure les méthodes utilisées par l'organisation pour vérifier la compréhension des stagiaires et l'adéquation des formations.

5.2.3 Plan de qualification produit

Un plan de qualification produit doit être établi pour s'assurer que les éléments de maîtrise des DES choisis par l'organisation satisfont aux exigences identifiées dans le Tableau 2, le Tableau 3 et le Tableau 4 du présent document ainsi qu'à d'autres exigences spécifiées dans le présent document. Cela comprend l'utilisation des méthodes d'essai et des limites d'essai identifiées dans ces tableaux.