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COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

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

IEC 61340-5-1:2024-05 CMV(en)

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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.~~

~~c) 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