



BSI Standards Publication

Electrostatics

Part 5-2: Protection of electronic devices from
electrostatic phenomena - User guide

National foreword

This Published Document is the UK implementation of IEC TR 61340-5-2:2018. It supersedes PD CLC/TR 61340-5-2:2008, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/101, Electrostatics.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2018
Published by BSI Standards Limited 2018

ISBN 978 0 580 93967 9

ICS 31.020; 29.020; 17.220.99

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 April 2018.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------



IEC TR 61340-5-2

Edition 2.0 2018-03

TECHNICAL REPORT



**Electrostatics –
Part 5-2: Protection of electronic devices from electrostatic phenomena –
User guide**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 17.220.99; 29.020

ISBN 978-2-8322-5445-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	9
2 Normative references	9
3 Terms, definitions and abbreviated terms	9
3.1 Terms and definitions	9
3.2 Abbreviated terms	9
4 Personnel safety	10
5 ESD control program	10
5.1 General	10
5.1.1 ESD control program requirements	10
5.1.2 ESD coordinator	10
5.1.3 Tailoring	10
5.2 ESD control program administrative requirements	11
5.2.1 ESD control program plan	11
5.2.2 Training plan	13
5.2.3 Product qualification	15
5.2.4 Compliance verification plan	16
5.3 ESD control program technical requirements	20
5.3.1 Grounding/equipotential bonding systems	20
5.3.2 Personnel grounding	22
5.3.3 ESD protected areas (EPA)	26
5.3.4 Packaging electronic products for shipment and storage	61
5.3.5 Marking	65
6 Automated handling equipment (AHE)	68
7 ESD control gloves and finger cots	68
7.1 Introductory remarks	68
7.2 Types	69
7.3 Testing and qualification	70
7.3.1 Properties to test	70
7.3.2 Resistance measurements	70
7.3.3 Charge decay time measurements	72
7.3.4 Product charging test	73
8 Handtools	75
8.1 Introductory remarks	75
8.2 Testing and qualification	75
8.2.1 Qualification criteria	75
8.2.2 Resistance measurement	75
8.2.3 Charge decay	78
Annex A (informative) Example ESD control program plan based on IEC 61340-5-1	81
A.1 Introductory remarks (Not part of the example)	81
A.2 Purpose	81
A.3 Range	81
A.4 Responsibilities	81
A.5 References	81

A.6	Definitions.....	81
A.7	ESD control program plan	81
A.8	Training plan.....	82
A.8.1	Initial training.....	82
A.8.2	Refresher training.....	82
A.9	Product qualification	83
A.10	Compliance verification plan	83
A.11	ESD protected area requirements	83
A.11.1	General requirements	83
A.11.2	Grounding plan.....	84
A.11.3	Personnel grounding plan	84
A.12	Tailoring statement	84
A.13	Work surfaces.....	85
A.14	Packaging.....	85
A.15	Marking.....	85
A.16	Compliance verification procedures	86
A.16.1	Testing of wrist strap connection point.....	86
A.16.2	Checking for static generators	86
A.16.3	Checking isolated conductors	86
Annex B (informative)	ESD control element considerations	87
B.1	General remarks	87
B.2	ESD control footwear and flooring.....	87
B.2.1	General	87
B.2.2	Ionizers	90
B.2.3	Constant monitors	90
Bibliography		92
Figure 1	– Example assessment report showing trend report	19
Figure 2	– Example of individually grounded benches – Recommended.....	21
Figure 3	– Example of a series ground connection of benches – Not recommended.....	22
Figure 4	– Relationship between body voltage and resistance to ground.....	23
Figure 5	– Voltage reading on person walking across grounded conductive floor whilst wearing two heelstraps	25
Figure 6	– Ionization by alpha radiation	45
Figure 7	– Corona ionization – Positive.....	45
Figure 8	– Corona ionization – Negative	45
Figure 9	– ESD sensitive part or assembly.....	66
Figure 10	– Example of a warning label for ESDS	66
Figure 11	– Example of a packaging label.....	67
Figure 12	– ESD control material marking.....	67
Figure 13	– Glove or finger cot resistance testing (as worn).....	71
Figure 14	– Testing glove or finger cot resistance via a wrist strap system.....	72
Figure 15	– Product charging tests	75
Figure 16	– Tool resistance test.....	76
Figure 17	– Tool resistance to ground system.....	77
Figure 18	– Charge decay test.....	79

Figure 19 – Tool CPM waveforms	80
Figure A.1 – Sign indicating special handling conditions	85
Figure A.2 – Label indicating product is ESD sensitive.....	86
Figure B.1 – Voltage generated for three types of footwear all on the same flooring system	90
Table 1 – Types of bands.....	32
Table 2 – Ionizer selection checklist	49
Table A.1 – ESD control program compliance verification requirements	83

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROSTATICS –**Part 5-2: Protection of electronic devices from
electrostatic phenomena – User guide**

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 61340-5-2, which is a Technical Report, has been prepared by IEC technical committee 101: Electrostatics.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

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

This second edition of IEC TR 61340-5-2 has been modified to provide guidance for users of IEC 61340-5-1:2016. The text has been arranged to follow the requirements of

IEC 61340-5-1:2016 as closely as possible as well as providing specific guidance on each of the requirements of IEC 61340-5-1:2016.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
101/532/DTR	101/543/RVDTR

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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

A bilingual version of this publication may be issued at a later date.

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

INTRODUCTION

This user guide has been produced for individuals and organizations that are faced with controlling electrostatic discharge (ESD). It provides guidance that can be used for developing, implementing and monitoring an electrostatic discharge control program in accordance with IEC 61340-5-1.

This user guide applies to activities that manufacture, process, assemble, install, package, label, service, test, inspect or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges greater than or equal to 100 V using the human body model (HBM), 200 V charged device model (CDM) or 35 V on isolated conductors. Isolated conductors were historically represented by the machine model (MM). The MM test is no longer used for qualification of devices, only HBM and CDM. The MM is retained in this document for process control of isolated conductors. These three levels were selected for IEC 61340-5-1 as the baseline susceptibility threshold, since a large majority of the ESD products on the market have a sensitivity of greater than 100 V HBM, 200 V CDM and 35 V for isolated conductors. If ESD sensitive devices (ESDS) of less than these values are being handled, additional controls can be implemented or some of the technical control item requirements can be adjusted.

The requirements established for each of the ESD control items are specified for an ESD control program designed for 100 V HBM, 200 V CDM and 35 V for isolated conductors. The 100 V HBM value is predicated on maximum voltage levels attainable on an individual when they are grounded via techniques accepted throughout the electronics industry as outlined in IEC 61340-5-1.

For organizations concerned with charged device model damage, IEC 61340-5-1 establishes requirements concerning the use of insulators in the ESD protected area (EPA) based on maximum electrostatic field limits.

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 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 be grounded.

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 level of sensitivity, determined by test using simulated ESD events, may not necessarily relate to the level of sensitivity in a real life situation. 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 – human body model (HBM), machine model (MM), and charged device model (CDM). In current practice, devices are qualified only using HBM and CDM susceptibility tests.

The general principles described in IEC 61340-5-1 are not limited in their applicability to ESDS with ESD sensitivities defined in IEC 61340-5-1 (e.g. 100 V HBM). For organizations that handle ESDS with withstand voltages higher or lower than those defined in IEC 61340-5-1, the general principles of IEC 61340-5-1 can still be used. The organization can modify some of the required limits specified in Tables 2 to 3 of IEC 61340-5-1:2016. The program documentation identifies the lowest ESDS withstand voltage(s) that can be handled,

and if different to those defined in IEC 61340-5-1, appropriate changes to the limits specified in IEC 61340-5-1 can be made in the program documentation.

The fundamental ESD control principles that form the basis of IEC 61340-5-1 are as follows:

- a) Avoid a discharge from any charged, conductive object (personnel, equipment) into the sensitive device:

It is preferred that all conductors that may come into contact with ESDS including personnel, are bonded or electrically connected to a known ground or contrived ground (as on shipboard or on aircraft). This attachment creates an equipotential balance between all items and personnel. Electrostatic protection can be maintained at a potential different from “zero” voltage ground potential, as long as all items in the system are at the same potential. If a conductor that cannot be grounded (e.g. isolated conductor) comes into contact with an ESDS, the ESD risk should be evaluated and if necessary mitigated.

- b) Avoid a discharge from any charged ESD sensitive device (the charging process that can lead to a discharge can result from direct contact and separation or can be field induced):

Insulators cannot lose their electrostatic charge by grounding. It is preferred that insulators should be removed from the vicinity of ESDS. Some insulators are essential to the process or product and cannot be removed from the vicinity of the ESDS. Ionization or other mitigating techniques can provide neutralization of charges on these essential insulators (circuit board materials and some device packages are examples of essential insulators). Assessment of the ESD hazard created by electrostatic charges on the essential insulators in the work place is done to ensure that appropriate actions are implemented, according to the risk.

- c) Once outside of an electrostatic discharge protected area (hereafter referred to as an EPA) it is generally not possible to control the above items, therefore, ESD protective packaging can be used. 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 provide adequate protection. Outside an EPA, low charging and static discharge shielding materials are recommended. While all of these materials are not discussed in this document, it is important to recognize the differences in their application. Requirements and associated test methods for ESD protective packaging are specified in IEC 61340-5-3.

Each organization has different processes, and so there will be a different blend of ESD prevention measures for an optimum ESD control program. It is vital that these measures are 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.

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.

ELECTROSTATICS –

Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide

1 Scope

This part of IEC 61340, which has been developed to support IEC 61340-5-1, applies to activities 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 HBM, 200 V CDM and 35 V for isolated conductors. Additional control elements or adjusted limits can be applicable for ESDS with lower withstand voltages.

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 61340-5-1:2016, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61340-5-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

3.2 Abbreviated terms

AHE	automated handling equipment
CDM	charged device model
CPM	charged plate monitor
DUT	device under test
EPA	ESD protected area
ESD	electrostatic discharge
ESDS	ESD sensitive device
HBM	human body model
MM	machine model
MVTR	moisture vapour transmission rate