IEC TR 61340-1-1

Edition 1.0 2025-05

TECHNICAL REPORT

Electrostatics –
Part 1-1: Electrostatic phenomena – Measurement errors, uncertainties and expression of results

ICS 17.220.99; 29.020

ISBN 978-2-8327-0389-2

IEC TR 61340-1-1:2025-05(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2025 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms and definitions 7
4 Measurement errors 9
4.1 General 9
4.2 Random error 10
4.3 Systematic error 10
4.4 Gross error 10
5 Minimizing errors in practice 11
5.1 Electrical resistance 11
5.1.1 Test setup and procedures 11
5.1.2 Contact resistance 11
5.1.3 Leakage currents 12
5.1.4 Voltage dependence 12
5.1.5 Electrification 13
5.1.6 Practical guidelines 14
5.2 Electrostatic charge 14
5.2.1 Electrometers and nanocoulomb meters 14
5.2.2 Current integration method 15
5.3 Electrostatic voltage 15
5.3.1 General 15
5.3.2 Electrometers 15
5.3.3 Electrostatic voltmeters 15
5.4 Electrostatic field 16
5.5 ESD current 17
5.6 Charge or voltage decay 17
6 Measurement considerations 19
6.1 Calibration and traceability 19
6.2 Verification 20
6.3 Laboratory services 20
7 Uncertainty evaluation 20
7.1 General 20
7.2 Practical approach 21
7.3 Evaluation of data 21
7.3.1 General 21
7.3.2 Combined uncertainty 22
7.3.3 Confidence 22
8 Expression of results 23
8.1 General 23
8.2 Significant digits 23
8.3 Quantity units, symbols, and values 24
8.4 Test report 24
Bibliography 27

Figure 1 – Distribution examples of different errors 9
Figure 2 – Example of systematic error caused by contact resistance 11
Figure 3 – Leakage currents (dashed lines) in different parts of the measurement system 12
Figure 4 – Examples of voltage dependencies 12
Figure 5 – Capacitive loading 13
Figure 6 – Voltage and electrostatic field measurement 16
Figure 7 – Varying capacitance of charged plate can be an error source 18
Figure 8 – Charge decay testing using a step response of electrostatic field 18
Figure 9 – Calibration and traceability 19

Table 1 – Examples of writing units and symbols 24

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTROSTATICS –

Part 1-1: Electrostatic phenomena – Measurement errors, uncertainties and expression of results

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) 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.

IEC TR 61340-1-1 has been prepared by IEC technical committee 101: Electrostatics. It is a Technical Report.

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

Draft	Report on voting
101/728/DTR	101/735/RVDTR

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 Technical Report 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

Measurement in electrostatics poses unique challenges, often requiring the use of high impedance measurement techniques. Electrostatic fields and potentials are challenging to measure without disturbing the actual situation being observed. Additionally, materials used in various applications can have very high electrical resistance above $1 \times 10^9\,\Omega$, complicating measurements due to the low currents that are vulnerable to disturbances.

Electrostatic field meters, high impedance voltmeters and high resistance meters are often used in compliance verification or qualification of electrostatic discharge (ESD) control items. Many meters available in the market offer a user-friendly interface and a digital display, making them easier to operate. However, it is important to note that a friendly user interface does not guarantee accurate measurements without a proper understanding of the factors and sources of errors that can influence the results.

It is important to know the basics of electrostatic theory so that measurement errors and measurement uncertainties can be accurately evaluated. Measurements are incomplete without consideration of error and uncertainty estimation, and this can lead to significant deviations in conclusions.

This document provides practical guidance on how to understand and mitigate different types of measurement errors and how to estimate measurement uncertainties when making measurements according to the test methods of IEC 61340 series documents. This document also includes examples of how to express the results.

ELECTROSTATICS –

Part 1-1: Electrostatic phenomena – Measurement errors, uncertainties and expression of results

1 Scope

This part of IEC 61340 gives guidance on error consideration and uncertainty estimation in electrostatics and ESD control measurements. It provides guidance on minimizing measurement errors and estimating measurement uncertainties using practical methods. The document also outlines how measurement results can be expressed in a test report. It is important to note that this document serves as an informative guideline intended for individuals who already have a solid understanding of the basics of electrostatics theory and measurement techniques.

2 Normative references

There are no normative references in this document.