

INTERNATIONAL STANDARD

NORME INTERNATIONALE

High-voltage test techniques – Charge-based measurement of partial discharges

**Techniques des essais à haute tension – Mesurages des décharges partielles
fondés sur les charges**

[IEC 60270:2025](https://standards.iteh.ai/standards/iec/330bde4a-6da5-413d-8aff-63b9a97e6378/iec-60270-2025)

<https://standards.iteh.ai/catalog/standards/iec/330bde4a-6da5-413d-8aff-63b9a97e6378/iec-60270-2025>



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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembe
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 It also gives information on projects, replaced and withdrawn publications.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.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

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

Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

FOREWORD.....	6
1 Scope.....	8
2 Normative references.....	8
3 Terms and definitions	9
4 Test circuits and measuring systems.....	14
4.1 General requirements.....	14
4.2 Test circuits for alternating voltages	15
4.3 Measuring systems for apparent charge.....	18
4.3.1 General	18
4.3.2 Coupling device or ‘quadripole’.....	18
4.3.3 Pulse train response of instruments for the measurement of apparent charge	18
4.3.4 Wide-band PD measuring systems	20
4.3.5 Wide-band PD instruments with active integrator	20
4.3.6 Narrow-band PD instruments.....	21
4.4 Requirements for measurements with digital PD-instruments.....	21
4.4.1 General	21
4.4.2 Requirements for measurement of apparent charge q	22
4.4.3 Requirements for measurement of test voltage magnitude and phase.....	22
4.5 Measuring systems for derived quantities	22
4.5.1 Coupling device	22
4.5.2 Instruments for the measurement of pulse repetition rate n	22
4.5.3 Instruments for the measurement of average apparent discharge current I	22
4.5.4 Instruments for the measurement of apparent discharge power P	23
4.6 Instruments for the measurement of the radio disturbance voltage.....	23
4.7 Instrumentation for PD detection >1 MHz.....	23
5 Calibration of a measuring system in the complete test circuit.....	24
5.1 General.....	24
5.2 Calibration procedure	24
6 Calibrators.....	26
6.1 General.....	26
6.2 Calibrators for the calibration of a measuring system in the complete test circuit.....	27
6.3 Calibrators for performance tests on measuring systems.....	28
7 Maintaining the characteristics of calibrators and measuring systems	28
7.1 General.....	28
7.2 Schedule of tests	28
7.3 Maintaining the characteristics of calibrators.....	29
7.3.1 Type tests on calibrators	29
7.3.2 Routine tests on calibrators	29
7.3.3 Performance tests on calibrators	29
7.3.4 Performance checks on calibrators	29
7.3.5 Record of performance.....	30
7.4 Maintaining the characteristics of PD measuring systems.....	30
7.4.1 General	30
7.4.2 Type tests on PD measuring systems	30

7.4.3	Routine tests on measuring systems.....	31
7.4.4	Performance checks on PD measuring systems	31
7.4.5	Checks for additional capabilities of digital measuring systems	32
7.4.6	Record of performance.....	32
8	Partial discharge measurements during tests with alternating voltage	33
8.1	General.....	33
8.2	Conditioning of the test object	33
8.3	Choice of test procedure	33
8.3.1	General	33
8.3.2	Determination of the partial discharge inception and extinction voltages	34
8.3.3	Determination of the partial discharge magnitude at a specified test voltage	34
9	Measuring uncertainty and sensitivity	34
10	External disturbances and interference	35
11	Partial discharge measurements during tests with direct voltage	36
11.1	General.....	36
11.2	PD quantities	36
11.3	Voltages related to partial discharges	37
11.3.1	Partial discharge inception and extinction voltages	37
11.3.2	Partial discharge test voltage	37
11.4	Test circuits and measuring systems	37
11.5	Test procedures with regard to external disturbances.....	37
11.5.1	Choice of test procedures.....	37
11.5.2	Disturbances.....	38
Annex A (normative)	Performance tests on calibrators.....	39
A.1	General.....	39
A.2	Comparison method	41
A.3	Numerical integration method	41
A.4	Passive integration method	43
A.5	Active integration method	44
Annex B (informative)	Test circuits	46
Annex C (informative)	Measurements on test objects with distributed or inductive characteristics such as cables, gas-insulated switchgear, power capacitors, and on test objects with windings: alternative methods	48
C.1	General.....	48
C.2	Attenuation and distortion phenomena	50
C.3	Resonance phenomena, reflections	51
C.4	Location of discharges	51
Annex D (informative)	The use of radio disturbance (interference) meters for the detection of partial discharges.....	52
Annex E (informative)	PD measuring instruments	54
E.1	General concept.....	54
E.2	Correct acquisition of (charge) amplitude and polarity of PD signals.....	57
E.3	Recommendations for recording test voltage, phase angle φ_i and time t_i of occurrence of a PD pulse	58
E.4	Phase-resolved partial discharge (PRPD) pattern display algorithm.....	59

Annex F (informative) Alternative methods of PD detection	61
F.1 General.....	61
F.2 Electromagnetic detection	61
F.3 Acoustic detection	61
F.4 Chemical detection.....	61
F.5 Optical detection	62
Annex G (informative) Disturbances – Interference and noise	63
G.1 Sources of disturbances	63
G.2 Detecting disturbances	63
G.3 Disturbance levels.....	64
G.4 Suggestions for reducing disturbances	64
G.4.1 Basic earthing, bonding, and filtering	64
G.4.2 Balanced circuits.....	64
G.4.3 Electronic signal processing	65
G.5 Further interference mitigation methods	66
Annex H (informative) Evaluation of PD test results during tests with direct voltage	67
Bibliography	69
Figure 1 – Basic partial discharge test circuits	16
Figure 2 – Test circuit for measurement at a bushing tap	17
Figure 3 – Test circuit for measuring self-excited test objects	17
Figure 4 – Correct relationship between amplitude and frequency to minimize integration errors for a wide-band system	19
Figure 5 – Connections for the calibration of the complete test arrangement	25
Figure 6 – Output waveform of the calibrator step voltage generator	26
Figure 7 – Minimum realistic specified PD magnitude versus noise level	35
Figure A.1 – Measurement of calibrator characteristics	39
Figure A.2 – Indicative range of applicability for different methods	40
Figure A.3 – Performance test of calibrator using the numerical integration method.....	41
Figure A.4 – Calibration pulses $u_m(t)$ of a typical calibrator using integration resistances $R_m = 33 \, \Omega$ and $R_m = 200 \, \Omega$ respectively ($q = 100 \, \text{pC}$)	42
Figure A.5 – Performance test of calibrator using the passive integration method	43
Figure A.6 – Performance test of calibrator using the active integration method	44
Figure C.1 – Partial discharge measurements in different test objects versus frequency	49
Figure D.1 – CISPR radio disturbance meter readings	53
Figure E.1 – Block diagram of an analog PD instrument equipped with an electronic integrator.....	54
Figure E.2 – Block diagrams of digital PD instruments	55
Figure E.3 – Conceptual diagram of phase-resolved PD pattern (PRPD)	56
Figure E.4 – Detection of PD pulse amplitude and polarity	58
Figure E.5 – Examples of some phase-resolved PRPD patterns	60
Figure H.1 – Display modes of apparent pulses against measuring time	67
Figure H.2 – Histograms of PD pulse count n against apparent charge intervals	68

Table 1 – Pulse train response of PD instruments.....	19
Table 2 – Tests required for calibrators	30
Table 3 – Tests required for measuring systems.....	32
Table A.1 – Three methods for determining PD calibrator output charge	40
Table C.1 – PD measurement application areas with selected references.....	49

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 60270:2025](https://standards.iteh.ai/catalog/standards/iec/330bde4a-6da5-413d-8aff-63b9a97e6378/iec-60270-2025)

<https://standards.iteh.ai/catalog/standards/iec/330bde4a-6da5-413d-8aff-63b9a97e6378/iec-60270-2025>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HIGH-VOLTAGE TEST TECHNIQUES – CHARGE-BASED
MEASUREMENT OF PARTIAL DISCHARGES**

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 60270 has been prepared by IEC technical committee 42: High-voltage and high-current test techniques. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2000 and Amendment 1:2015. This edition constitutes a technical revision.

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

- a) Title modified.
- b) Use with alternating voltages up to 500 Hz or with direct voltage.
- c) Clear focus on charge-based partial discharge measurements.
- d) Streamlined performance checks for partial discharge measurement system components.
- e) Improved normative Annex A for performance tests on calibrators.
- f) Revised and new informative Annexes.