IEC

IEC 60034-27-2

Edition 1.0 2023-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Rotating electrical machines –
Part 27-2: On-line partial discharge measurements on the stator winding insulation

Machines électriques tournantes –
Partie 27-2: Mesurages en fonctionnement des décharges partielles effectués sur le système d'isolation

IEC 60034-27-2:2023-12(en-fr)

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 It also gives information on projects, replaced and withdrawn publications.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. 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 22 300 terminological entries in English and French, with equivalent terms in 19 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. 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 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 60034-27-2

Edition 1.0 2023-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Rotating electrical machines –
Part 27-2: On-line partial discharge measurements on the stator winding insulation

Machines électriques tournantes –
Partie 27-2: Mesurages en fonctionnement des décharges partielles effectués sur le système d'isolation

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.160.01 ISBN 978-2-8322-7873-4

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

ROTATING ELECTRICAL MACHINES –

Part 27-2: On-line partial discharge measurements on the stator winding insulation

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 60034-27-2 has been prepared by IEC technical committee 2: Rotating machinery. It is an International Standard.

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

Draft	Report on voting
2/2153/FDIS	2/2166/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 60034 series, published under the general title *Rotating electrical machines*, 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,
- replaced by a revised edition, or
- amended.

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

Partial Discharge (PD) on-line measurement of rotating electrical machines has gained widespread acceptance as it could reveal the presence of localized weak points of the stator insulation system and also various arcing and sparking phenomena. Nevertheless, it has emerged from several studies that not only are there many different methods of measurement in existence, but also the criteria and methods of analysing and finally assessing the measured data are often very different and not really comparable. Consequently, there is a need to have an International Standard (IS) to give defined guidelines to the users of on-line PD measurements to assess the condition of their insulation systems.

On-line PD measurements are recorded with the rotating electrical machine experiencing all of the operating stresses; thermal, electrical, environmental and mechanical. Due to the realistic stress impact on the winding during measurement and due to the fact that the measurement is performed during all kinds of normal operation like base load and peak load, PD on-line testing could identify changes of the winding insulation system at a premature stage and enables real-time condition assessment as part of predictive maintenance strategies.

PD trend evaluation and comparisons with machines of similar design and similar insulation system measured under similar conditions, using the same measuring equipment, are recommended to ensure reliable assessment of the condition of the stator winding insulation. The trending information provides a good measure for early indication of a change in insulation condition. This gives time for planning further standstill examination in terms of visual inspection and off-line testing during next inspection outage.

This document does not deal with on-line PD measurements on converter driven electrical machines because different measuring techniques are needed to distinguish between noise from the converter and PD from the winding.

Limitations:PD on-line tests on stator windings produce comparative, rather than absolute measurements. This creates a fundamental limitation for the interpretation of PD data. Therefore, acceptance criteria with simple limits for new or rewound stator windings cannot be established as the following reasons demonstrate:

– There are many types of PD sensors as well as recording and analysing instruments. Generally, they are incompatible and will produce different results for the same PD activity.
– Even with the same measuring system, the high frequency partial discharge pulses will interact with the winding capacitance and inductance on their way from point of origin to the measuring point, e.g. at the winding terminals. Thus, PD measurements taken at machines with different winding design and rating produce different PD results, even though the actual type of PD source is the same.
– Different types of winding defects produce different PD magnitudes and have different impact on insulation destruction. There is no strong correlation between high PD and high risk of insulation failure.
– PD activity may occur close or far from the PD sensor. In general, if the PD source is inside the winding coils far away from the PD sensor, it will produce a smaller response at the PD sensor at the terminals compared to a PD source at the phase connections nearby due to pulse attenuation.

Users should also be aware that there is no evidence that the time to failure of the stator winding insulation can be estimated using any PD quantity, alone or even in combination. In order to more comprehensively describe the condition of the stator insulation, PD measurements are required to be supplemented by other electrical tests. Also, determining the root cause of an insulation deterioration process using PD pattern recognition, especially if more than one process is occurring, is still somewhat subjective, although the digital analysing technology is evolving rapidly.

Noise and disturbance from electrical environment have a great impact to on-line PD measurement. Cross-coupling of PD and noise between different phases can make objective interpretation of the test results difficult. Therefore, different analogue and digital noise suppression techniques are used to improve PD measuring sensitivity and PD analysing tools.

Users of PD measurement should be aware that, due to the principles of the method, not all insulation-related problems in stator windings can be detected by measuring on-line PD activity, e.g. insulation failures involving continuous leakage currents due to conductive paths between different electrical potential of the insulation system or fine main insulation cracks with too small PD activity compared to normal delamination PD or pulse-less discharge phenomena.

ROTATING ELECTRICAL MACHINES –

Part 27-2: On-line partial discharge measurements on the stator winding insulation

1 Scope

This part of IEC 60034-27 deals with on-line PD measurements and provides a common basis with standardized procedures if possible for:

- measuring techniques and instruments;
- the arrangement of the installation;
- normalization and sensitivity assessment;
- measuring procedures;
- noise reduction;
- the documentation of results;
- the interpretation of results;

with respect to partial discharge on-line measurements on the stator winding insulation of non-converter driven rotating electrical machines with rated voltage of 3 kV and up. This document covers PD measuring systems and methods detecting electrical PD signals. The same measuring devices and procedures can also be used to detect electrical sparking and arcing phenomena.

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 60034-27-1:2017, *Rotating electrical machines – Part 27-1: Off-line partial discharge measurements on the winding insulation*

IEC 60034-27-3, *Rotating electrical machines – Part 27-3: Dielectric dissipation factor measurement on stator winding insulation of rotating electrical machines*

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60270:2000, *High-voltage test techniques – Partial discharge measurements*

IEC 62271-1, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

IEC TS 62478, *High voltage test techniques – Measurement of partial discharges by electromagnetic and acoustic methods*

ISO 8528-9: *Reciprocating internal combustion engine driven alternating current generating sets – Part 9: Measurement and evaluation of mechanical vibrations*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 60270 apply, together with the following.

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

3.1
partial discharge
PD
localized electrical discharge that only partially bridges the insulation between conductors and which can or cannot occur adjacent to a conductor

3.2
on-line measurement
measurement taken with the rotating electrical machine in operation

3.3
off-line measurement
measurement taken with the rotating electrical machine at standstill, the machine being disconnected from the power system

Note 1 to entry: The necessary test voltage is applied to the winding from a separate voltage source.

3.4
conductive slot coating
conductive paint or tape layer in intimate contact with the groundwall insulation in the slot portion of the coil side, often called 'semiconductive' coating

Note 1 to entry: This coating together with adequate slot design provides electrical contact to the stator core, without shorting the core laminations.

3.5
stress control coating
paint or tape on the surface of the groundwall insulation that extends beyond the conductive slot portion coating in high-voltage stator bars and coils

Note 1 to entry: The stress control coating reduces the electric field stress along the winding overhang to below a critical value that would initiate PD on the surface. The stress control coating overlaps the conductive slot portion coating to provide electrical contact between them.

3.6
corona discharge
visible partial discharge adjacent to the surface of a bare conductor or the surface of an insulation of a conductor

3.7
slot discharges
discharges that occur between the outer surface of the slot portion of a coil or bar and the earthed core laminations due to high electrical field strength

3.8
vibration sparking
interrupted surface currents between the outer surface of the slot portion of a bar and the earthed core laminations due to axially induced voltages on the conductive slot coating combined with bar vibrations

3.9
internal discharges
discharges that occur within the mainwall insulation

3.10
surface discharges
discharges that occur on the surface of the insulation or on the surface of winding components in the winding overhang or the active part of the machine winding

3.11
pulse magnitude distribution
number of pulses within a series of equally-spaced windows of pulse magnitude during a predefined measuring time

3.12
pulse phase distribution
number of pulses within a series of equally-spaced windows of phase during a predefined measuring time

3.13
phase resolved partial discharge pattern
PRPD
PD distribution map of PD magnitude and number of PD pulses versus AC cycle phase position, for visualization of the PD behaviour during a predefined measuring time

3.14
PD sensor
general type of transducer, which can be used to detect PD signals from the machine winding

Note 1 to entry: A PD sensor typically consists of a high voltage coupling capacitor of low inductance design and a low voltage coupling device in series.

3.15
coupling device
usually an active or passive four-terminal network that converts the input currents to output voltage signals

Note 1 to entry: These signals are transmitted to the measuring device by a transmission system. The frequency response of the coupling device is normally chosen at least so as to efficiently prevent the test voltage frequency and its harmonics from reaching the measuring device.

3.16
resistance temperature detector
RTD
temperature detector inserted into the stator winding, usually between the top and bottom bar or between embedded coil sides in a given slot