IEC 60034-18-42

Edition 1.1 2020-08
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Rotating electrical machines –
Part 18-42: Partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters – Qualification tests

Machines électriques tournantes –
Partie 18-42: Systèmes d'isolation électrique résistants aux décharges partielles (Type II) utilisés dans des machines électriques tournantes alimentées par convertisseurs de tension – Essais de qualification

This document is a preview generated by EVS

IEC 60034-18-42:2017-02+AMD1:2020-08 CSV(en-fr)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2020 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 Central Office
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.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and definitions clause of IEC publications issued between 2002 and 2015. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

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.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary
67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et définitions des publications IEC parues entre 2002 et 2015. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

This document is a preview generated by EVS

IEC 60034-18-42

Edition 1.1 2020-08
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Rotating electrical machines –
Part 18-42: Partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters – Qualification tests

Machines électriques tournantes –
Partie 18-42: Systèmes d'isolation électrique résistants aux décharges partielles (Type II) utilisés dans des machines électriques tournantes alimentées par convertisseurs de tension – Essais de qualification

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.160.01

ISBN 978-2-8322-8795-8

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.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

This document is a preview generated by EVS

This document is a preview generated by EVS

IEC 60034-18-42

Edition 1.1 2020-08
CONSOLIDATED VERSION

REDLINE VERSION

VERSION REDLINE

colour inside

Rotating electrical machines –
Part 18-42: Partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters – Qualification tests

Machines électriques tournantes –
Partie 18-42: Systèmes d'isolation électrique résistants aux décharges partielles (Type II) utilisés dans des machines électriques tournantes alimentées par convertisseurs de tension – Essais de qualification

This document is a preview generated by EVS

IEC 60034-18-42:2017-02+AMD1:2020-08 CSV(en-fr)

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
2 Normative references 8
3 Terms and definitions 9
4 Machine terminal voltages arising from converter operation 12
5 Electrical stresses in the insulation system of machine windings 16
5.1 General 16
5.2 Voltages stressing the phase to phase insulation 17
5.3 Voltages stressing the phase to ground insulation 17
5.4 Voltages stressing the turn to turn insulation 17
5.4.1 General 17
5.4.2 Random-wound windings 18
5.4.3 Form-wound windings 18
6 Voltage rating for Type II insulation systems 18
7 Stress factors for converter-fed Type II insulation systems 19
8 Qualification tests 21
8.1 General 21
8.2 Qualification tests 21
9 Qualification of mainwall insulation system 22
9.1 General 22
9.2 Test methods 22
9.3 Use of 50 Hz or 60 Hz life data to predict the service life with a converter drive 23
10 Qualification of turn insulation 24
10.1 General 24
10.2 Test methods 25
11 Qualification of the stress control system 26
11.1 General 26
11.2 Test methods 27
12 Preparation of test objects 28
12.1 General 28
12.2 Mainwall specimens 28
12.3 Turn to turn specimens 28
12.4 Stress control specimens 28
13 Qualification test procedures 28
13.1 General 28
13.2 Mainwall insulation 29
13.3 Turn to turn insulation 29
13.4 Stress control system 29
14 Qualification test pass criteria 30
14.1 Mainwall insulation 30
14.2 Turn to turn insulation 30
14.3 Stress control system 30
15 Routine test 31

This document is a preview generated by EVS

16 Optional screening tests 31
17 Analysis, reporting and classification 31
Annex A (informative) Contributions to ageing of the mainwall insulation 32
A.1 Life time consumption of the mainwall insulation 32
A.2 Calculation of the contributions to ageing from a 3-level converter drive 32
A.3 Calculation to derive an equivalent voltage amplitude and frequency 33
Annex B (informative) Examples of circuits for impulse testing 35
B.1 Impulse test circuit using a semiconducting switch 35
B.2 Typical waveform generated from the impulse generator 35
B.3 Alternative impulse test circuit using a semiconducting switch 36
Annex C (informative) Derivation of the short term endurance test voltage 38
Annex D (informative) Derivation of the impulse voltage insulation class for the machine insulation 39
Annex E (normative) Derivation of an IVIC in the absence of a manufacturer's reference life line 43
E.1 Derivation of an IVIC from endurance tests 43
E.1.1 Mainwall insulation 43
E.1.2 Turn insulation 44
E.1.3 Stress control system 44
E.2 Derivation of the IVIC X on the basis of satisfactory service experience 44
E.3 Derivation of an IVIC S on the basis of satisfactory service experience 44
Annex F (informative) Optional screening tests 45
F.1 General 45
F.2 Short term endurance test on the mainwall insulation 45
~~F.3 Voltage withstand test ..... 45~~
Bibliography 46

Figure 1 – Voltage impulse waveshape parameters 13
Figure 2 – Waveform representing one complete cycle of the phase to phase voltage at the terminals of a machine fed from a 3-level converter 14
Figure 3 – Jump voltage (U_j or $U_{j\ max}$) at the terminals of a machine fed from a converter drive 15
Figure 4 – Maximum voltage enhancement at the machine terminals at infinite impedance as a function of cable length for various impulse rise times 16
Figure 5 – Example of a random-wound design 17
Figure 6 – Example of a form-wound design 17
Figure 7 – Worst case voltage stressing the turn to turn insulation in a variety of random-wound stators as a function of the rise time of the impulse 18
Figure 8 – Example of a life curve for a Type II mainwall insulation system 24
Figure 9 – Example of a life curve for turn insulation 26
Figure A.1 – Representation of the phase to ground voltage at the terminals of a machine fed from a 3-level converter 32
Figure A.2 – Ratio of the life time consumption (y-axis) of impulse voltage ($U_{pk/pk}$) to fundamental voltage ($U'_{pk/pk}$) expressed as a percentage for various impulse/fundamental frequency ratios (n=10) 34
Figure B.1 – Example of a simple converter voltage simulation circuit 35
Figure B.2 – Typical waveform generated from the impulse generator 36
Figure B.3 – Example of a simple converter voltage simulation circuit 37

This document is a preview generated by EVS

Figure B.4 – Typical waveform generated from the impulse generator 37

Figure E.1 – Reference life line for mainwall insulation 43

Table 1 – Examples of the measured values of characteristics of the terminal voltages for two converter-fed machines 13

Table 2 – Influence of features of the converter drive voltage on acceleration of ageing of components of Type II insulation systems 20

Table A.1 – Contribution to electrical ageing by 1 kHz impulses from a 3-level converter as a percentage of the ageing from the 50 Hz fundamental voltage (endurance coefficient of 10) 33

~~Table D.1 – Phase to ground test voltages according to IVIC for Type II insulation systems ....~~

Table D.1 – IVIC- and test voltage factor definition for Type II insulation systems 40

Table D.~~1~~2 – Impulse voltage insulation classes (IVIC) 41

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ROTATING ELECTRICAL MACHINES –

Part 18-42: Partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters – Qualification tests

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.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60034-18-42 edition 1.1 contains the first edition (2017-02) [documents 2/1854/FDIS and 2/1856/RVD] and its amendment 1 (2020-08) [documents 2/1998/FDIS and 2/2008/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

This document is a preview generated by EVS

International Standard IEC 60034-18-42 has been prepared by IEC Technical Committee 2: Rotating machinery.

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

NOTE A table of cross-references of all TC 2 publications can be found on the IEC TC 2 dashboard on the IEC website.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

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.

This document is a preview generated by EVS

INTRODUCTION

The approval of electrical insulation systems for use in rotating electrical machines fed from voltage converters is set out in two International Standards. These standards separate the systems into those which are not expected to experience partial discharge activity within specified conditions in their service lives (Type I) and those which are expected to experience and withstand partial discharge activity in any part of the insulation system throughout their service lives (Type II). For both Type I and Type II insulation systems, the power drive system integrator (the person responsible for co-ordinating the electrical performance of the entire power drive system) shall inform the machine manufacturer what voltage will appear at the machine terminals in service. The machine manufacturer will then decide upon the severity of the tests appropriate for qualifying the insulation system. For insulation systems which have been qualified through IEC 60034-18-41 or IEC 60034-18-42 for use in converter-fed applications, an impulse voltage insulation class may be derived. This indicates the ability of the insulation to withstand the electric stresses resulting from converter operation. For Type I systems, the severity is based on the impulse rise time and the peak to peak voltage. For Type II systems, the severity is additionally affected by the impulse voltage repetition rate and the fundamental voltage characteristics. After installation of the converter/machine system, it is recommended that the system integrator measures the phase to phase and phase to ground voltages between the terminals and ground to check for compliance.

IEC 60034-18-41

Type I insulation systems are dealt with in IEC 60034-18-41. These systems are generally used in rotating machines with rated voltage less than 700 V r.m.s. and tend to have random-wound coils. In IEC 60034-18-41, the necessary normative references and definitions are given together with a review of the effects arising from converter operation. Having established the technical basis for the evaluation procedure, the conceptual approach and test programmes are then described.

IEC 60034-18-42

In IEC 60034-18-42, tests are described for qualification of Type II insulation systems. These insulation systems are generally used in rotating machines which have form-wound windings, mostly rated above 700 V r.m.s. The qualification procedure is completely different from that used for Type I insulation systems and involves destructive ageing of test objects under accelerated conditions. The manufacturer requires a life curve (as described in IEC 60034-18-32) for the insulation system that can be interpreted by use of appropriate calculations and/or experimental procedures to provide an estimate of life under the service conditions with converter drive. Great importance is attached to the qualification of any stress control system that is used and testing here should be performed under sinusoidal and repetitive impulse conditions applied separately. If the insulation system can be shown to provide an acceptable life under the specified ageing conditions, it is qualified for use.

This preview is a preview protected by EVS

ROTATING ELECTRICAL MACHINES –

Part 18-42: Partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters – Qualification tests

This document is a preview generated by EVS

1 Scope

This part of IEC 60034 defines criteria for assessing the insulation system of stator/rotor windings of single or polyphase AC machines which are subjected to repetitive impulse voltages, such as those generated by pulse width modulation (PWM) converters, and are expected to experience and withstand partial discharge activity during service. It specifies electrical qualification tests on representative specimens to verify fitness for operation with voltage-source converters. It also describes an additional classification system which defines the limits of reliable performance under converter-fed conditions.

Although this document deals with voltage converters, it is recognised that there are other types of converters that can create repetitive impulse voltages. For these converters, a similar approach to testing can be used.

Qualification of insulation systems may not be required for rotating machines which are only fed from voltage converters for starting and so they are excluded from this document.

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 60034-1:2010, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-18-1:2010, *Rotating electrical machines – Part 18-1: Functional evaluation of insulation systems. General guidelines*

IEC 60034-18-31, *Rotating electrical machines – Part 18-31: Functional evaluation of insulation systems – Test procedures for form-wound windings – Thermal evaluation and classification of insulation systems used in rotating machines*

IEC 60034-18-32, *Rotating electrical machines – Part 18-32: Functional evaluation of insulation systems – Test procedures for form-wound windings – Evaluation by electrical endurance*

IEC 60034-18-41:2014, *Rotating electrical machines – Part 18-41: Partial discharge free (Type I) electrical insulation systems used in rotating electrical machines fed from voltage converters – Qualification and quality control tests*

IEC TS 60034-27, *Rotating electrical machines – Part 27: Off-line partial discharge measurements on the stator winding insulation of rotating electrical machines*

IEC TS 61934, *Electrical insulating materials and systems – Electrical measurement of partial discharges (PD) under short rise time and repetitive voltage impulses*

IEC 62539, *Guide for the statistical analysis of electrical insulation breakdown data*

3 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 http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
partial discharge
PD
electric discharge that only partially bridges the insulation between electrical conductors

Note 1 to entry: It may occur inside or outside the insulation or adjacent to an electrical conductor.

3.2
partial discharge inception voltage
PDIV
lowest voltage at which partial discharges are initiated in the test arrangement when the voltage applied to the test object is gradually increased from a lower value at which no such discharges are observed

Note 1 to entry: With sinusoidal applied voltage, the PDIV is defined as the r.m.s. value of the voltage. With impulse voltages, the PDIV is defined as the peak to peak voltage.

3.3
repetitive partial discharge inception voltage
RPDIV
minimum peak to peak impulse voltage at which more than five PD pulses occur on ten voltage impulses of the same polarity

Note 1 to entry: This is a mean value for the specified test time and a test arrangement where the voltage applied to the test object is gradually increased from a value at which no partial discharges can be detected.

3.4
peak (impulse) voltage
U_p
maximum numerical value of voltage reached during a unipolar voltage impulse (e.g. U_p in Figure 1)

Note 1 to entry: For bipolar voltage impulses, it is half the peak to peak voltage.

3.5
steady state impulse voltage magnitude
U_a
final magnitude of the voltage impulse

SEE: Figure 1.

3.6
voltage overshoot
U_b
magnitude of the peak voltage in excess of the steady state impulse voltage

SEE: Figure 1.

This document is a preview generated by EVS