IEC/TR 62836

Edition 1.0 2013-09

TECHNICAL REPORT

colour inside

Measurement of internal electric field in insulating materials – Pressure wave propagation method

IEC/TR 62836:2013(E)

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

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
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 corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you 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It also gives information on projects, replaced and withdrawn publications.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 on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

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: csc@iec.ch.

IEC/TR 62836

Edition 1.0 2013-09

TECHNICAL REPORT

colour inside

Measurement of internal electric field in insulating materials – Pressure wave propagation method

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE M

ICS 17.220.99; 29.035.01

ISBN 978-2-8322-1102-1

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

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

MEASUREMENT OF INTERNAL ELECTRIC FIELD IN INSULATING MATERIALS – PRESSURE WAVE PROPAGATION METHOD

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 63836, which is a technical report, has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
112/258/DTR	112/263/RVC

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

The committee has decided that the contents of this publication 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.

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

INTRODUCTION

High-voltage insulating cables, especially high-voltage d.c. cables, are subject to charge accumulation and thus to electrical breakdown if the electric field produced by the charges exceeds the electrical breakdown threshold. With the trend to multiply power plants, especially green power plants such as wind or solar generators, more cables will be used for connecting these power plants to the grid and share the electric energy between countries. Therefore the materials for the cables, and even the structure of these cables when considering electrodes or the junction between cables, need a standardized procedure for testing how the internal electric field can be characterized. The measurement of the internal electric field would give a tool for comparing materials and help to establish thresholds on the internal electric field for high voltage applications in order to limit as much as possible breakdown risks. The pressure wave propagation (PWP) method has been used by several researchers to measure the space charge distribution and the internal electric field distribution in insulators. However, since experimental equipment, with slight differences, is developed independently by researchers over the world, it is difficult to compare the measuring results between the different researchers.

The procedure outlined in this technical report would give a reliable point of comparison between different test results carried out by different laboratories and avoid interpretation errors. The IEC has established a project team to develop a procedure to evaluate PWP measurement. The method will be verified in a Round Robin test. Once, having received reliable experience, this report is intended later to be upgraded to a technical specification in order to establish a specified way to estimate fairly the performance of a PWP measurement.

MEASUREMENT OF INTERNAL ELECTRIC FIELD IN INSULATING MATERIALS – PRESSURE WAVE PROPAGATION METHOD

1 Scope

IEC/TR 62836, which is a technical report, contains an efficient and reliable procedure to test the internal electric field in the insulating materials used for high-voltage applications using the pressure wave propagation (PWP) method. It is suitable for a sample with homogeneous insulating materials and an electric field higher than 1 kV/mm, but it is also depended on the thickness of sample and the pressure wave generator.

2 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply.

2.1 Terms and definitions

2.1.1
pressure wave propagation
PWP
propagation of wave generated by the action of a pressure pulse

2.2 Abbreviations

LIPP laser induced pressure pulse

PIPP piezoelectric induced pressure pulse

3 Principle of the method

The principle of the PWP method is shown schematically in Figure 1.

The space charge in the dielectric and the interface charge are forced to move by the action of a pressure pulse wave. The charge displacement then induces an electrical signal in the measuring circuit which is an image of the charge distribution in the short-circuit current measurement condition. The expression for the short-circuit signal is

$$i(t) = C_0 \int_0^d \mathrm{B}\, E(x) \frac{\partial p(x,t)}{\partial t} dx \qquad (1)$$

where

$E(x)$ is the electric field distribution in the sample;

d is the thickness of sample;

$p(x, t)$ is the pressure pulse wave in the sample, which depends on the electrode materials, dielectric sample material, the condition of coupling on the interface, etc.;

C_0 is the sample capacitance without the action of pressure pulse wave.

C_0 depends on the thickness of sample, and its surface area which is equal to the area of action of pressure pulse wave. The constant $\mathrm{B} = x\,(1 - a/\varepsilon)$ only depends on the characteristics of the dielectric materials. For heterogeneous dielectric materials, B is a function of space. For homogeneous dielectric materials, B is not a function of space and can be put in front of the integral. In this proposition, only homogeneous dielectric materials are considered, B is a constant.

In Equation (1), the electric field distribution can be obtained if it is deconvolved.