SLOVENSKI STANDARD
oSIST prEN IEC 62836:2023

01-julij-2023

Merjenje notranjega električnega polja v izolacijskih materialih - Metoda širjenja tlačnega vala

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

Ta slovenski standard je istoveten z: **prEN IEC 62836:2023**

ICS:

17.220.99	Drugi standardi v zvezi z elektriko in magnetizmom	Other standards related to electricity and magnetism
29.035.01	Izolacijski materiali na splošno	Insulating materials in general

oSIST prEN IEC 62836:2023 **en**

IEC

112/606A/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 62836 ED1**	
DATE OF CIRCULATION: **2023-05-19**	CLOSING DATE FOR VOTING: **2023-08-04**
SUPERSEDES DOCUMENTS: **112/579/CD, 112/602B/CC**	

IEC TC 112 : EVALUATION AND QUALIFICATION OF ELECTRICAL INSULATING MATERIALS AND SYSTEMS

SECRETARIAT: Germany	SECRETARY: Mr Bernd Komanschek
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 15	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

☒ SUBMITTED FOR CENELEC PARALLEL VOTING

Attention IEC-CENELEC parallel voting

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.

The CENELEC members are invited to vote through the CENELEC online voting system.

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Recipients of this document are invited to submit, with their comments, notification of

- any relevant patent rights of which they are aware and to provide supporting documentation,
- any relevant "in some countries" clauses to be included should this proposal proceed. Recipients are reminded that the enquiry stage is the final stage for submitting "in some countries" clauses. See AC/22/2007.

TITLE:

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

PROPOSED STABILITY DATE: 2027

NOTE FROM TC/SC OFFICERS:

This A-version CDV is circulated due to some texts in Figure-7 of 112/606/CDV were missing.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

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IEC 62836 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems. It is an International Standard.

This first edition of IEC 62836 cancels and replaces the first edition of the Technical Specification of IEC TS 62836 published in 2020.

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

Draft	Report on voting
112/XXX/FDIS	112/XXX/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/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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.

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INTRODUCTION

High voltage insulating structures, especially high voltage DC cables and capacitors etc., are subjected to charge accumulation and this may lead 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 avoid risks of breakdown as much as possible. The pressure wave propagation (PWP) method has been used by many 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 throughout the world, it is difficult to compare the measurement results between the different equipment.

The procedure outlined in this Standard provides a reliable point of comparison between different test results carried out by different laboratories in order to avoid interpretation errors. The method is suitable for a planar plaque sample as well as for a coaxial sample, with homogeneous insulating materials. The IEC has established a project team to develop a procedure for the measurement of PWP.

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

1 Scope

This document provides an efficient and reliable procedure to test the internal electric field in the insulating materials used for high-voltage applications, by using of the pressure wave propagation (PWP) method. It is suitable for a planar and/or coaxial geometry sample with homogeneous insulating materials and an electric field higher than 1 kV/mm, but it is also dependent on the thickness of the sample and the pressure wave generator.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms 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 Terms and definitions

3.1.1
pressure wave propagation
PWP
pressure wave that is propagated in a material containing electric charges and measurement of the induced electrical signal from electrodes

3.2 Abbreviated terms

CB	carbon black
EVA	ethylene-vinyl acetate
LDPE	low density polyethylene
LIPP	laser induced pressure pulse
PE	polyethylene
PIPP	piezoelectric induced pressure pulse
PMMA	poly (methyl methacrylate)
PWP	pressure wave propagation
S/N	signal to noise ratio

4 Principle of the method

The principle of the PWP method is shown schematically in Figure 1, which is for a planar sample. Figures 1 a) shows the principle and the relation between the measured current of PWP method and the electrical field distribution in the sample without space charge. Figure 1 b) shows the principle and the relation between the measured current of PWP method and the space charge distribution in the sample without applied voltage. Figure 1 c) show the measuring schematics of PWP method.

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

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

where

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

d is the thickness of sample;

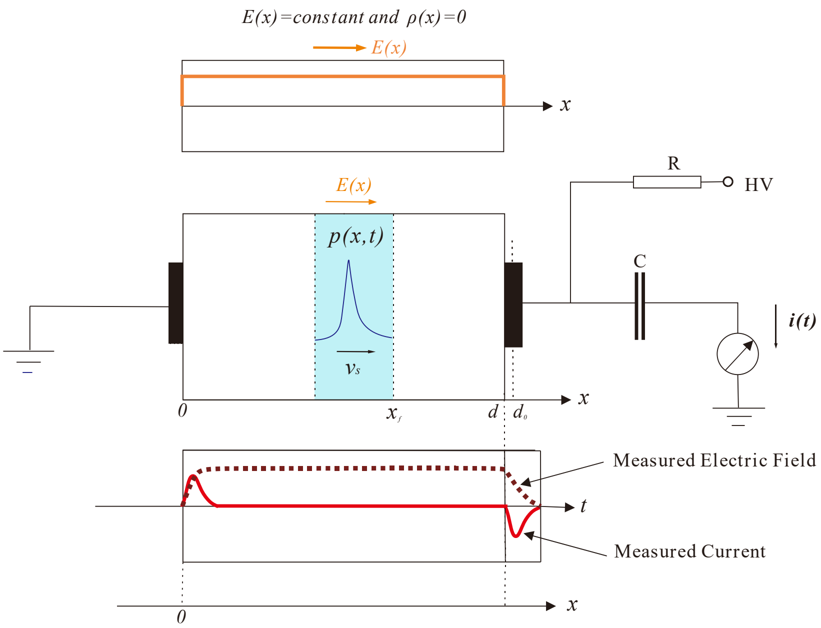
$p(x,\ t)$ is the pressure wave in the sample, which depends on the electrode materials, dielectric sample material, the condition of coupling on the interface, etc.;

C_0 is the sample capacitance with the action of a pressure wave.

C_0 depends on the thickness of the sample, and its surface area which is equal to the area of action of the pressure wave.

The constant $B = \chi(1 - a/\varepsilon)$ only depends on the characteristics of the dielectric materials. In this formula, χ is the coefficient of compressibility of the material, ε is the permittivity of the material and a is the coefficient of electrostriction of the material. For heterogeneous dielectric materials, B is a function of position. For homogeneous dielectric materials, B is not a function of position and can be put outside of the integral. In this proposition, only homogeneous dielectric materials are considered, so B is a constant.

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



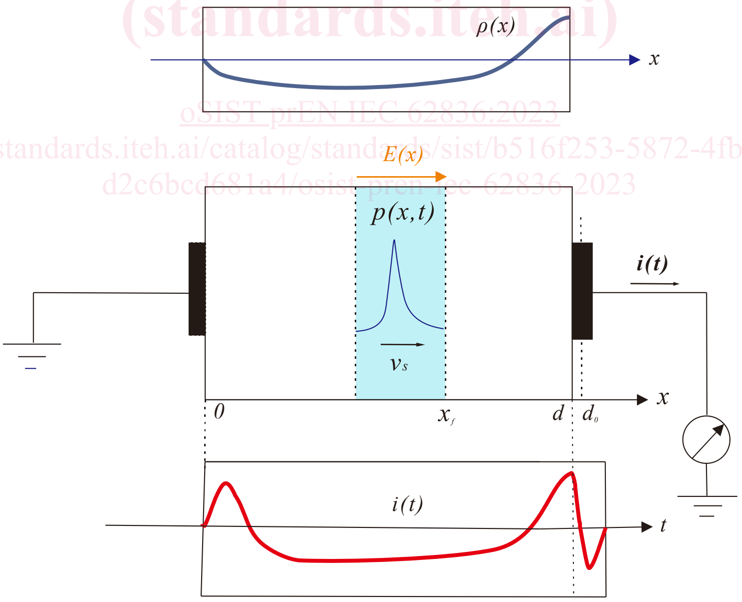
Key

x_f is the position of pulse front

d_0 is the original thickness of sample

$d_0 \approx d$ in the case of a narrow pulse

a) Applied pressure pulse and measure short-circuit current with applied voltage but without space charge



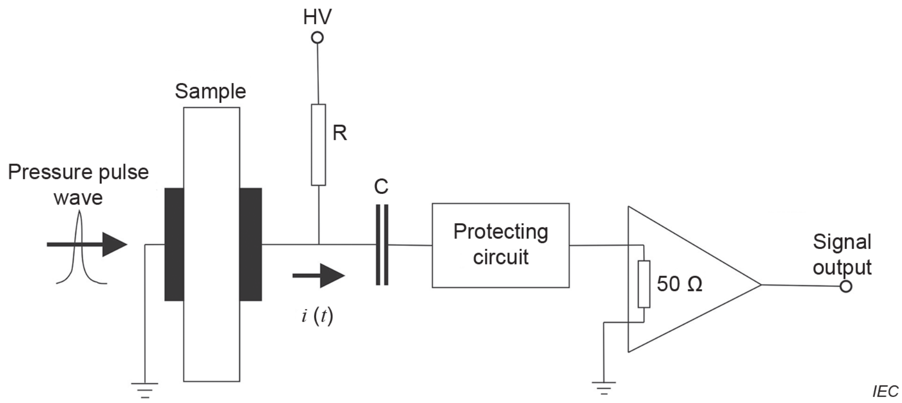
Key

x_f is the position of pulse front

d_0 is the original thickness of sample

$d_0 \approx d$ in the case of a narrow pulse

b) Applied pressure pulse and measured short-circuit current with space charge but without applied voltage



c) Measuring schematics

Figure 1 – Principle of the PWP method

The applied pressure wave can be generated by different techniques, but the same kind of analysis can be done for any of these techniques. The main practical PWP method can be divided into two ways: a pressure pulse is induced by a powerful laser pulse, a technique called LIPP method, and a pressure pulse generated by a piezoelectric device, a technique called PIPP. The sensibility and resolution of the PWP method depends mainly on the amplitude and duration of the pressure pulse. The advantage of the LIPP method is to produce highly sensitive measurements without contact. The advantage of the PIPP method is to obtain the measurement with a high measuring rate and allow a low-cost measurement system.