SLOVENSKI STANDARD
SIST EN IEC 62836:2024

01-junij-2024

Merjenje notranjega električnega polja v izolacijskih materialih - Metoda širjenja tlačnega vala (IEC 62836:2024)

Measurement of internal electric field in insulating materials - Pressure wave propagation method (IEC 62836:2024)

Messung des inneren elektrischen Feldes in Isoliermaterialien - Methode der Druckwellenausbreitung (propagation method) (IEC 62836:2024)

Mesurage du champ électrique interne dans les matériaux isolants - Méthode de l'onde de pression (IEC 62836:2024)

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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

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

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English Version

Measurement of internal electric field in insulating materials - Pressure wave propagation method (IEC 62836:2024)

Mesurage du champ électrique interne dans les matériaux isolants - Méthode de l'onde de pression (IEC 62836:2024)

Messung des inneren elektrischen Feldes in Isoliermaterialien - Methode der Druckwellenausbreitung (IEC 62836:2024)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Ref. No. EN IEC 62836:2024 E

European foreword

The text of document 112/627/FDIS, future edition 1 of IEC 62836, prepared by IEC/TC 112 "Evaluation and qualification of electrical insulating materials and systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62836:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2025-01-03
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2027-04-03

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IEC 62836

Edition 1.0 2024-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

Mesurage du champ électrique interne dans les matériaux isolants – Méthode de l'onde de pression

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 17.220.99, 29.035.01

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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 cancels and replaces IEC TS 62836 published in 2020.

This edition includes the following significant technical changes with respect to IEC TS 62836:

a) addition of Clause 12 for the measurement of space charge distribution in a planar sample;

b) addition of Clause 13 for coaxial geometry samples;

c) addition of Annex D with measurement examples for coaxial geometry samples;

d) addition of a Bibliography;

e) measurement examples for a planar sample have been moved from Clause 12 in IEC TS 62836 to Annex C.

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

Draft	Report on voting
112/627/FDIS	112/632/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.

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, or
- revised.

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INTRODUCTION

High-voltage insulating structures, especially high-voltage DC cables and capacitors etc., are subjected to charge accumulation and this can 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, a standardized procedure for testing how the internal electric field can be characterized has become essential for the materials used for the cables, and even the structure of these cables when considering electrodes or the junction between cables. The measurement of the internal electric field provides a tool for comparing materials and helps 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 document 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 of thickness from 0,5 mm to 5 mm.

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 the pressure wave propagation (PWP) method. It is suitable for a planar and coaxial geometry sample with homogeneous insulating materials of thickness larger or equal to 0,5 mm 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

3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
pressure wave propagation
procedure where a pressure wave is propagated in a material containing electric charges and the induced electric signal from electrodes is measured.

3.1.2
interface charge
net layer of charges between two different materials, either two different insulators or a conductor and an insulator

3.1.3
space charge
net charge inside an insulating dielectric material

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. Figure 1 a) shows the principle and the relation between the current measured with the PWP method and the electric field distribution in the sample without space charge. Figure 1 b) shows the principle and the relation between the current measured with the PWP method and the space charge distribution in the sample without applied voltage. Figure 1 c) shows the measuring schematics of the PWP method. In Figure 1, x_f is the position of pulse front, d_0 is the original thickness of sample, and $d_0 \approx d$ in the case of a narrow pulse.

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 electric 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

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

where

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

d is the thickness of sample;

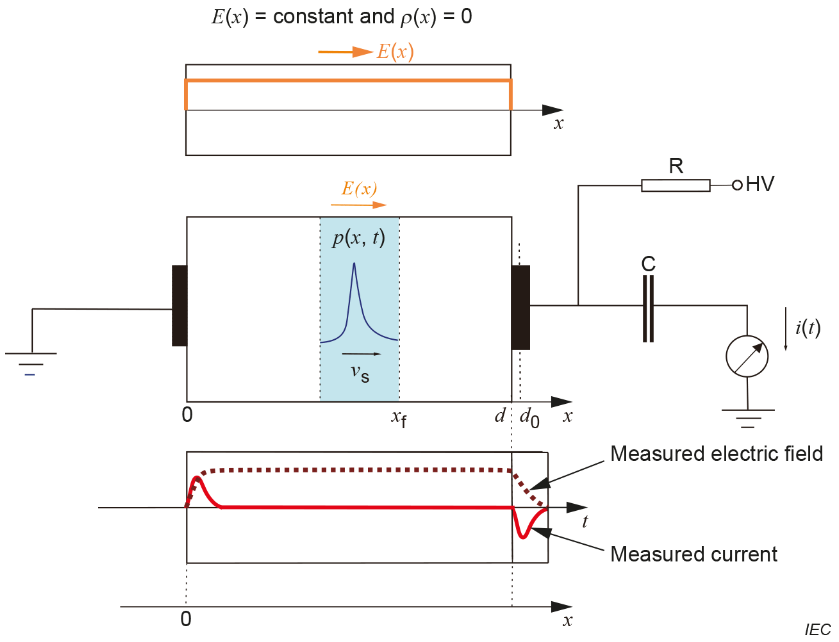
$p(x, t)$ is the pressure wave in the sample, which depends on the electrode materials, dielectric sample material, the condition of coupling on the interface, etc.;

C_0 is the sample capacitance with the action of a pressure wave. The active area is the area on which the pressure wave acts, and it shall be less than the area of the measuring electrode.

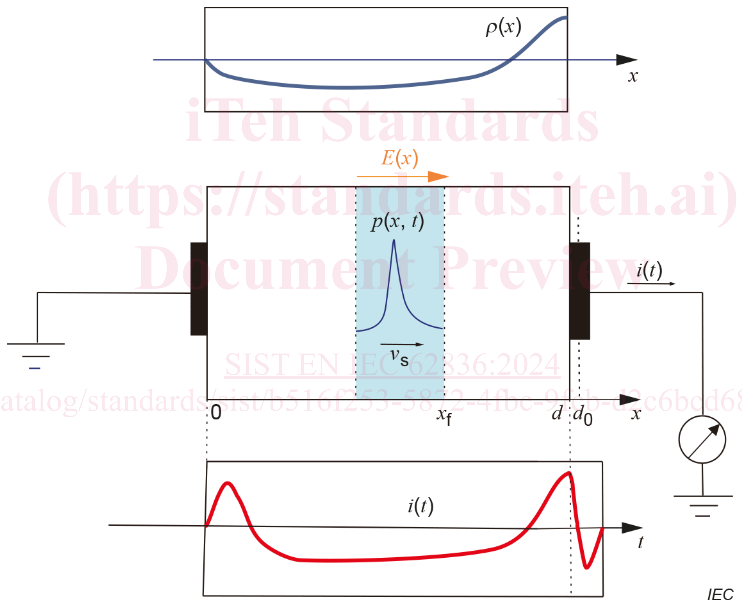
C_0 depends on the thickness of the sample, and its surface area which is equal to the area of action of the pressure wave.

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 thus put outside the integral as it does not depend on positions. However, B depends on the measurement conditions. The measurement is carried out in given environmental conditions so B shall be determined during the calibration in the same conditions (temperature, humidity and pressure). In this document, 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.



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



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