

TECHNICAL REPORT



Low-voltage surge protective devices –
Part 03: SPD testing guide

Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC TR 61643-03:2024](https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024)

<https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024>



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 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.

IEC Secretariat
3, rue de Varembe
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 It also gives information on projects, replaced and withdrawn publications.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, graphical symbols and the glossary. 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 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

International
Standards
Document Preview
standards.iteh.ai

[IEC TR 61643-03:2024](https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024)

<https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024>

TECHNICAL REPORT



Low-voltage surge protective devices –
Part 03: SPD testing guide

iteh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC TR 61643-03:2024](https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024)

<https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.240.01; 29.240.10

ISBN 978-2-8322-7999-1

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

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	9
4 Correspondence between this document and the tests in IEC 61643-x1	9
5 Probe application – residual voltage measurements	9
5.1 Overview.....	9
5.2 General.....	9
5.3 Guidance for the test arrangement.....	14
5.3.1 General	14
5.3.2 Method 1: Voltage probe placed at a certain distance	14
5.3.3 Method 2: Minimized loop of measurement lines	16
5.3.4 Combination of method 1 and method 2 for pigtail connections	17
6 Insulation resistance and dielectric withstand	19
6.1 General.....	19
6.2 Surfaces which are touchable after installation as for normal use are as follows:	19
6.3 Surfaces on which the SPD can be mounted or it can be in contact with metal surfaces:	20
6.4 Conclusions:	21
6.5 Example of a test-set-up to measure the Insulation Resistance according to 9.3.7 and the Dielectric Withstand according to 9.3.8 of IEC 61643-01:—	22
7 TOV testing	23
7.1 TOV testing of SPDs for AC power systems	23
7.2 TOV testing of SPDs for DC power systems	26
8 Test application to SPDs with multiple components	27
8.1 General.....	27
8.2 Example of a multiple series spark gap with resistive/capacitive trigger control	28
8.3 Example of a series spark gap with resistive/capacitive trigger control and with a parallel connected series connection of GDT + MOV(s)	28
8.4 Example of a 3-electrode GDT with parallel MOV bypass/trigger control	29
8.5 Example of a 4-electrode spark gap with GDT + MOV trigger control	30
8.6 Example of a GDT with parallel connected series connection of GDT + MOV	30
8.7 Example of a 3-electrode spark gap with trigger transformer	31
9 SPD coordination testing	32
9.1 Energy coordination	32
9.2 Let-through energy (LTE) method	32
9.2.1 General	32
9.2.2 Method	34
9.3 Energy and voltage protection coordination method	35
9.3.1 General	35
9.3.2 Coordination criteria	35
9.3.3 Coordination techniques	36
9.3.4 Coordination test	36
10 System level immunity testing.....	40

10.1	General.....	40
10.2	SPD discharge current test under normal service conditions:	40
10.3	Induction test due to lightning currents:.....	40
10.4	Recommended test classification of system level immunity (following IEC 61000-4-5):	40
Annex A (informative) Critical investigation on the impulse current specification for T1 SPDs when testing Metal Oxide Varistors		
A.1	History and background	42
A.2	General information	42
A.3	Test program and instructions	43
A.3.1	Detailed instructions	43
A.4	Details and results of interlaboratory comparison tests	44
A.4.1	Single disc results	45
A.4.2	Double block results	46
A.5	Conclusions from interlaboratory test results.....	47
A.6	Further investigations and comparison tests in CTI	47
A.6.1	Examples.....	48
A.6.2	Overview single disc results.....	49
A.6.3	Overview double block results	49
A.7	Final conclusions	49
Annex B (informative) Illustration of the terms mode of protection, current path and current branch		
B.1	Examples of SPDs with one single mode of protection	51
B.2	Examples of multimode SPDs	52
Bibliography.....		
Figure 1 – 8/20 current impulse and induced voltage		
Figure 2	– Test arrangement A	11
Figure 3	– Test arrangement B	12
Figure 4	– Test arrangement C	13
Figure 5	– Measured voltages of test arrangements A, B and C during 8/20 current application	13
Figure 6	– Routing of the measurement lines of an SPD having a single mode of protection	15
Figure 7	– Wrong routings of the measurement lines	15
Figure 8	– Routing of the measurement lines of a multimode SPD, example 1	16
Figure 9	– Routing of the measurement lines of a multimode SPD, example 2	16
Figure 10	– Example for the application of method 2 at an SPD having a single mode of protection.....	17
Figure 11	– Example for the application of method 1 and method 2 where the SPD is provided with pigtail connections	18
Figure 12	– Wrong routings of the pigtails together with the measurement lines where the SPD is provided with pigtail connections	18
Figure 13	– Examples of a three-phase and single-phase test setup for use in testing SPDs for application in TT systems under TOVs caused by faults in the high (medium) voltage system.....	24
Figure 14	– Example of a three-phase test setup for use in testing SPDs for use in IT systems under TOVs caused by faults in the high (medium) voltage system	25
Figure 15	– Vector diagram for the voltages in the test setup in Figure 14	26

Figure 16 – Example of a test setup for use in testing SPDs intended to be connected to a DC system, which is derived from an AC TT system without separation, under TOVs caused by faults in the high (medium) voltage system 27

Figure 17 – Example of a test setup for use in testing SPDs intended to be connected to a DC TT system, which is derived from another earthed DC system, under TOVs caused by faults in the high (medium) voltage system..... 27

Figure 18 – multiple series spark gap with resistive /capacitive trigger control 28

Figure 19 – series spark gap with capacitive trigger control 29

Figure 20 – 3-electrode GDT with parallel MOV bypass/trigger control..... 29

Figure 21 – 4-electrode spark gap with GDT + MOV trigger control..... 30

Figure 22 – GDT with parallel connected series connection of GDT + MOV 31

Figure 23 – 3-electrode spark gap with trigger transformer 31

Figure 24 – LTE – Coordination method with standard pulse parameters 33

Figure 25 – SPDs arrangement for the coordination test 38

Figure 26 – Example of a circuit used to perform discharge current tests under normal service conditions 41

Figure 27 – Example circuit of an induction test due to lightning currents..... 41

Figure B.1 – SPD with one mode of protection comprising one current path and consisting of one current branch 51

Figure B.2 – SPD with one mode of protection comprising three current paths (blue, green, yellow arrows), but consisting of only one current branch..... 52

Figure B.3 – SPD with three modes of protection (L-N, N-PE and L-PE) whereby the mode L-PE is composed of a series connection of the modes L-N and N-PE, the modes of protection L-N and N-PE comprise one current path and consist of one current branch each, the mode of protection L-PE comprises one current path but consists of two current branches (L-N and N-PE) 52

Figure B.4 – SPD with two modes of protection (L-N, N-PE) or three modes of protection (L-N, N-PE, L-PE) as declared by the manufacturer, each mode of protection comprises one current path (blue, green, yellow arrows), but each mode of protection or current path consists of two current branches (e.g. L to common connection point and N to common connection point)..... 53

Figure B.5 – SPD with two modes of protection (L-N, N-PE) or three modes of protection (L-N, N-PE, L-PE) as declared by the manufacturer, each mode of protection comprises two current paths (blue, green, orange arrows)..... 54

Figure B.6 – SPD with two modes of protection (L-N, N-PE) or three modes of protection (L-N, N-PE, L-PE) as declared by the manufacturer and containing three current branches (blue, green, yellow arrows) in total, each mode of protection containing two current branches 54

Table 1 – Correspondence between this document and the IEC 61643-x1 series 9

Table 2 – Values to be calculated 34

Table 3 – Normalised division factors for a CWG 34

Table 4 – Resulting calculation from Table 2 and Table 3 35

Table 5 – Test procedure for coordination 39

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

Part 03: SPD Testing Guide

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> or www.iso.org/patents. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 61643-03 has been prepared by subcommittee 37A: Low-voltage Surge Protective Devices, of IEC technical committee 37: Surge Arrestors. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
37A/XX/DTR	37A/XX/RVDTR

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 Technical Report 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 61643, published under the general title Low-voltage surge protective devices, 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.

ITeH Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC TR 61643-03:2024](https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024)

<https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024>

INTRODUCTION

It has been assumed in the preparation of this document that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

Throughout this document, when the “IEC 61643-x1 series” is mentioned, it refers to all parts of the IEC 61643 series of standards that deal with testing of SPDs, e.g. IEC 61643-01, IEC 61643-11.

This part of the IEC 61643 series addresses correct test execution and accurate interpretation of measurement results and is also intended to further enhance repeatability and comparability throughout different test laboratories and to establish an acceptable accuracy level for the test results obtained.

The new SPD classification T1 SPD, T2 SPD and T3 SPD is relating to the former test class oriented classification Class I tests, Class II tests and Class III tests.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC TR 61643-03:2024](https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024)

<https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024>

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

Part 03: SPD Testing Guide

1 Scope

This part of IEC 61643, which is a Technical Report, applies to SPD testing in accordance with the IEC 61643-x1 series and for SPD coordination and system level immunity purposes.

It aims to provide guidance and helpful information for correct test execution and accurate interpretation of measurement results. It is also intended to further enhance repeatability and comparability throughout different test laboratories and to establish an acceptable accuracy level for the test results obtained.

The main subjects are:

- Test application
- Test arrangement/setup
- Probe application
- SPD coordination testing
- System level immunity testing

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.

For the purposes of this document the normative references given in IEC 61643-01:—¹ and the following apply.

IEC 61643-01:—, *Low-voltage surge protective devices – Part 01: General requirements and test methods*

IEC 61643-11:—², *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods*

IEC 61643-12:2020, *Low-voltage surge protective devices – Part 12: Surge protective devices connected to low-voltage power systems – Selection and application principles*

IEC 61643-41:—³, *Low-voltage surge protective devices – Part 41: Surge protective devices connected to DC low-voltage power systems – Requirements and test methods*

¹ Under preparation. Stage at the time of publication: IEC/ACDV 61643-01:2023.

² Under preparation. Stage at the time of publication: IEC/ACDV 61643-11:2023.

³ Under preparation. Stage at the time of publication: IEC/ACDV 61643-41:2023.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61543-01:— 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>

4 Correspondence between this document and the tests in IEC 61643-x1

Table 1 provides information on which clauses of this document should apply to certain tests from the IEC 61643-x1 series.

Table 1 – Correspondence between this document and the IEC 61643-x1 series

IEC 61643-03 clause reference	Relevance for test clauses in the IEC 61643-x1 series
5 Probe application – residual voltage measurements	9.1.1, Table 3, pass criterion D 9.3.4 measured limiting voltage, 9.3.5 operating duty test, 9.6.5.3 Measurement of voltage rate of rise du/dt
6 Insulation resistance and dielectric withstand	9.3.7 Insulation resistance 9.3.8 Dielectric withstand
7 TOV testing	9.3.9 Behaviour under temporary overvoltages (TOVs)
7.1 TOV testing of SPDs for AC power systems	IEC 61643-11:—, 9.3.9.101 TOVs caused by faults in the high (medium) voltage system
7.2 TOV testing of SPDs for DC power systems	IEC 61643-41:—, 9.3.9 Behaviour under temporary overvoltages (TOVs)
8 Test application to SPDs with multiple components	General
Annex A Critical investigation on the impulse current specification for T1 SPDs when testing Metal Oxide Varistors	9.1.2 Impulse discharge current

5 Probe application – residual voltage measurements

5.1 Overview

Residual voltages measurements are very sensitive measurements due to the fact that they are carried out at high frequencies in presence of magnetic fields which may strongly interfere with the results of these measurements to such an extent that different measurements from one measurement to another one, or between different testing entities may not be comparable.

This clause intends to provide guidelines on testing techniques for making correct residual voltages measurements to limit these deviations and discrepancies.

5.2 General

According to the induction law, an alternating magnetic field induces a voltage into a conductor loop. The induced voltage depends on the loop size and the frequency and the amount of magnetic field. The intensity of a magnetic field decreases with increasing distance to its source.

The residual voltage is measured with 8/20 current impulses. The magnetic field generated by this 8/20 current impulse induces a voltage into the loop build up by the voltage measurement lines that are connected to the device under test. This voltage is added to the voltage drop between the two points where the measurement lines are connected to. This induced voltage depends on and is directly proportional to the size of the loop build by the voltage measurement lines and to the peak value of the 8/20 current impulse and may have values of several 10 V up to some kV. The wave shape of the induced voltage follows the derivative di/dt of the 8/20 current impulse and reaches its maximum at the beginning of the 8/20 current impulse. A zero crossing and therefore 0 V occurs at the crest value of the 8/20 current impulse. A typical waveshape of the induced voltage is shown in Figure 1.

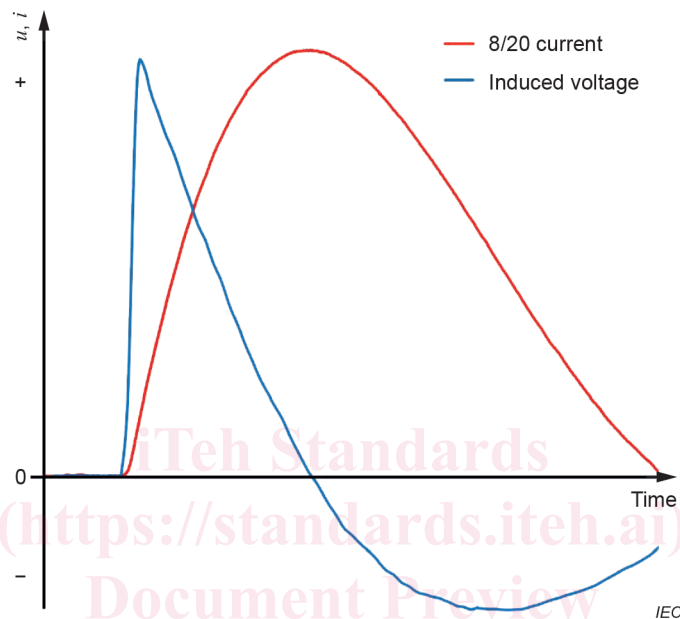


Figure 1 – 8/20 current impulse and induced voltage

In general, the test procedure to measure the residual voltage with 8/20 current impulses requires the connection of the voltage measuring system as close as possible to the SPD. This is caused by the fact that a voltage drop occurs along the length of a conductor when a current flows through. This voltage drop also influences the measured voltage between the two points to which the measurement lines are connected.

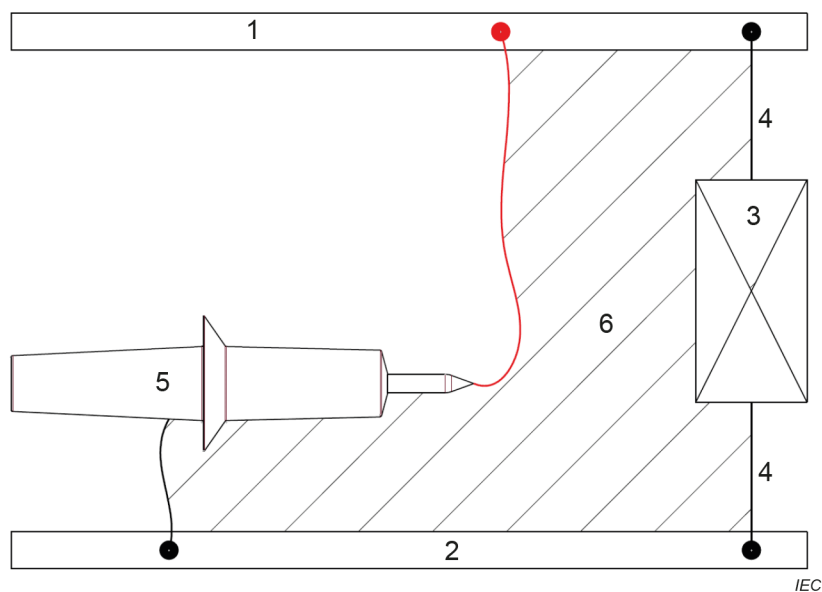
To show the influence of the loop size of the voltage measurement lines and the voltage drop of the conductors to the test sample when the 8/20 current impulse flows, three test arrangements are assumed.

Test arrangement A is given in Figure 2 and shows a large loop size of the voltage measurement lines that are connected far from the test sample.

Test arrangement B is given in Figure 3 and shows a smaller loop size of the voltage measurement lines that are connected directly to the test sample.

Test arrangement C is given in Figure 4 and shows a loop size as small as possible of the voltage measurement lines that are twisted and connected directly to the test sample.

Figure 5 shows the measured voltage time behaviour of the test arrangements A, B and C during 8/20 current application when the device under test is a voltage limiting SPD.

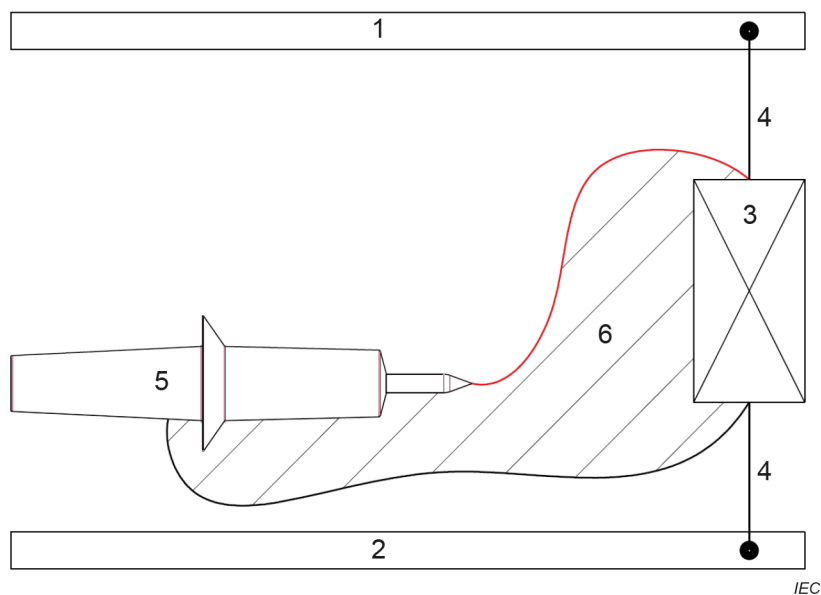
**Key**

- 1 HV output connection of impulse current generator
- 2 Ground connection of impulse current generator
- 3 Device under test (SPD)
- 4 Conductor to connect the SPD to the impulse current generator
- 5 Voltage probe
- 6 Loop area created by the voltage measurement lines (hash shaded area)

Figure 2 – Test arrangement A

[IEC TR 61643-03:2024](https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024)

<https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024>



IEC

Key

- 1 HV output connection of impulse current generator
- 2 Ground connection of impulse current generator
- 3 Device under test (SPD)
- 4 Conductor to connect the SPD to the impulse current generator
- 5 Voltage probe
- 6 Loop area created by the voltage measurement lines (hash shaded area)

Figure 3 – Test arrangement B

[IEC TR 61643-03:2024](https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024)

<https://standards.iteh.ai/catalog/standards/iec/734171c4-428e-4df4-b51a-3201566b9f89/iec-tr-61643-03-2024>