BS EN 61643-311:2013

BSI Standards Publication

Components for low-voltage surge protective devices

Part 311: Performance requirements and test circuits for gas discharge tubes (GDT)

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National foreword

This British Standard is the UK implementation of EN 61643-311:2013. It is identical to IEC 61643-311:2013. Together with BS EN 61643-312:2013 it supersedes BS EN 61643-311:2001, which will be withdrawn on 16 May 2016.

The UK participation in its preparation was entrusted by Technical Committee PEL/37, Surge Arresters — High Voltage, to Subcommittee PEL/37/1, Surge Arresters – Low Voltage.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Date	Text affected

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English version

Components for low-voltage surge protective devices - Part 311: Performance requirements and test circuits for gas discharge tubes (GDT)

(IEC 61643-311:2013)

Composants pour parafoudres basse tension -
Partie 311: Exigences de performance et circuits d'essai pour tubes à décharge de gaz (TDG)
(CEI 61643-311:2013)

Bauelemente für Überspannungsschutzgeräte für Niederspannung -
Teil 311: Leistungsanforderungen sowie Prüfschaltungen und -verfahren für Gasentladungsableiter (ÜsAG)
(IEC 61643-311:2013)

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 61643-311:2013 E

Foreword

The text of document 37B/113/FDIS, future edition 2 of IEC 61643-311, prepared by SC 37B, "Specific components for surge arresters and surge protective devices", of IEC TC 37, "Surge arresters" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61643-311:2013.

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)	2014-02-16
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-05-16

This document partially supersedes EN 61643-311:2001.

EN 61643-311:2013 includes the following significant technical changes with respect to EN 61643-311:2001:

- addition of performance values.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61643-311:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60364-5-51:2005	NOTE	Harmonised as HD 60364-5-51:2009 (modified).
IEC 61180-1:1992	NOTE	Harmonised as EN 61180-1:1994 (not modified).
IEC 61643-312	NOTE	Harmonised as EN 61643-312.
IEC 61643-11:2011	NOTE	Harmonised as EN 61643-11:2012 (modified).
IEC 61643-21:2000 + A1:2008	NOTE	Harmonised as EN 61643-21:2001 (not modified) + A1:2009 (modified)

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60068-2-1	2007	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	2007
IEC 60068-2-20	2008	Environmental testing - Part 2-20: Tests - Test T: Test methods for solderability and resistance to soldering heat of devices with leads	EN 60068-2-20	2008
IEC 60068-2-21 + corr. January	2006 2012	Environmental testing - Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices	EN 60068-2-21	2006
IEC 61000-4-5 + corr. October	2005 2009	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5	2006
ITU-T Recommendation K.20	2011	Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents	-	-

CONTENTS

COMPONENTS FOR LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

Part 311: Performance requirements and test circuits for gas discharge tubes (GDT)

1 Scope

This part of IEC 61643 is applicable to gas discharge tubes (GDT) used for overvoltage protection in telecommunications, signalling and low-voltage power distribution networks with nominal system voltages up to 1 000 V (r.m.s.) a.c. and 1 500 V d.c..They are defined as a gap, or several gaps with two or three metal electrodes hermetically sealed so that gas mixture and pressure are under control. They are designed to protect apparatus or personnel, or both, from high transient voltages. This standard contains a series of test criteria, test methods and test circuits for determining the electrical characteristics of GDTs having two or three electrodes. This standard does not specify requirements applicable to complete surge protective devices, nor does it specify total requirements for GDTs employed within electronic devices, where precise coordination between GDT performance and surge protective device withstand capability is highly critical.

This part of IEC 61643

- does not deal with mountings and their effect on GDT characteristics. Characteristics given apply solely to GDTs mounted in the ways described for the tests;
- does not deal with mechanical dimensions;
- does not deal with quality assurance requirements;
- may not be sufficient for GDTs used on high-frequency (>30 MHz);
- does not deal with electrostatic voltages;
- does not deal with hybrid overvoltage protection components or composite GDT devices.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-1:2007, *Environmental testing – Part 2: Tests. Tests A: Cold*

IEC 60068-2-20:2008, *Environmental testing – Part 2: Tests. Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-21:2006, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*

ITU-T Recommendation K.20:2011, *Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
arc current
current that flows after sparkover when the circuit impedance allows a current to flow that exceeds the glow-to-arc transition current

3.1.2
arc voltage
arc mode voltage
voltage drop across the GDT during arc current flow

Note 1 to entry: See Figure 1a region A.

3.1.3
arc-to-glow transition current
current required for the GDT to pass from the arc mode into the glow mode

3.1.4
current turn-off time
time required for the GDT to restore itself to a non-conducting state following a period of conduction.

Note 1 to entry: This applies only to a condition where the GDT is exposed to a continuous d.c. potential (see d.c. holdover).

3.1.5
d.c. sparkover voltage
d.c. breakdown voltage
voltage at which the GDT transitions from a high-impedance off to a conduction state when a slowly rising d.c. voltage up to 2 kV/s is applied

Note 1 to entry: The rate of rise for d.c. sparkover voltage measurements is usually equal or less 2 000 V/s.

3.1.6
d.c. holdover
state in which a GDT continues to conduct after it is subjected to an impulse sufficient to cause breakdown.

Note 1 to entry: In applications where a d.c. voltage exists on a line. Factors that affect the time required to recover from the conducting state (current turn-off time) include the d.c. voltage and the d.c. current

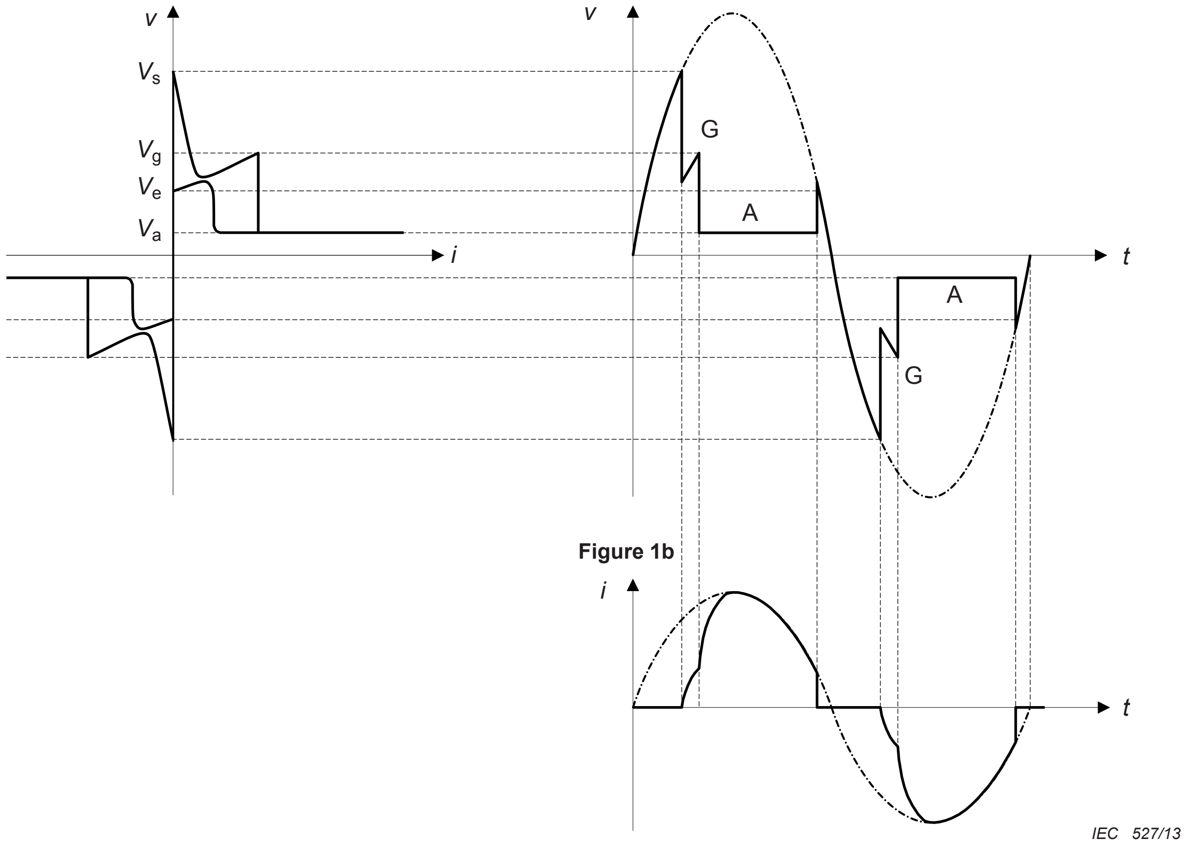
3.1.7
d.c. holdover voltage
maximum d.c. voltage across the terminals of a gas discharge tube under which it may be expected to clear and to return to the high-impedance state after the passage of a surge, under specified circuit conditions

3.1.8
discharge current
current that flows through a GDT after sparkover occurs

Note 1 to entry: In the event that the current passing through the GDT is alternating current, it will be r.m.s. value. In instances where the current passing through the GDT is an impulse current, the value will be the peak value.

3.1.9
discharge voltage
residual voltage of an arrester
peak value of voltage that appears across the terminals of a GDT during the passage of GDT discharge current

3.1.10
discharge voltage current characteristic
V/I characteristic
variation of peak values of discharge voltage with respect to GDT discharge current



Legend

V_s	spark-over voltage	V_a	arc voltage	G	glow mode range
V_{gl}	glow voltage	V_e	extinction voltage	A	arc mode range

Figure 1a – Voltage at a GDT as a function of time when limiting a sinusoidal voltage

Figure 1b – Current at a GDT as a function of time when limiting a sinusoidal voltage

Figure 1c – V/I characteristic of a GDT obtained by combining the graphs of voltage and current

Figure 1 – Voltage and current characteristics of a GDT

3.1.11
extinction voltage
voltage at which discharge (current flow) ceases

3.1.12
fail-short
failsafe
thermally-activated external shorting mechanism

3.1.13
follow on current
current that the GDT conducts from a connected power source after sparkover

Note 1 to entry: The GDT is expected to extinguish after sparkover to avoid overheating

3.1.14
gas discharge tube
GDT
gap, or several gaps with two or three metal electrodes hermetically sealed so that gas mixture and pressure are under control, designed to protect apparatus or personnel, or both, from high transient voltages

3.1.15
glow current
glow mode current
current that flows after breakdown when the circuit impedance limits the follow current to a value less than the glow-to-arc transition current

Note 1 to entry: See Figure 1a region G.

3.1.16
glow-to-arc transition current
current required for the GDT to pass from the glow mode into the arc mode

Note 1 to entry: See Figure 1a region G.

3.1.17
glow voltage
glow mode voltage
peak value of voltage drop across the GDT when a glow current is flowing

Note 1 to entry: See Figure 1a region G.

3.1.18
impulse sparkover voltage
highest value of voltage attained by an impulse of a designated voltage rate-of-rise and polarity applied across the terminals of a GDT prior to the flow of the discharge current

3.1.19
impulse waveshape
outline of an electrical surge designated as *x*/*y* having a rise time of *x* μs and a decay time to half value of *y* μs

3.1.20
nominal alternating discharge current
current which the GDT is designed to conduct for a defined time

Note 1 to entry: For currents with a frequency of 15 Hz to 62 Hz.

3.1.21
nominal d.c. sparkover voltage
voltage specified by the manufacturer to indicate the target value of sparkover voltages of a particular type of GDT products

Note 1 to entry: The nominal value is generally a rounded number such as: 75 V, 90 V, 150 V, 200 V, 230 V, 250 V, 300 V, 350 V, 420 V, 500 V, 600 V, 800 V, 1 000 V, 1 200 V, 1 400 V, 1 800 V, 2 100 V, 2 700 V, 3 000 V, 3 600 V, 4 000 V and 4 500 V.

Note 2 to entry: Values in between should be agreed jointly between the manufacturer and the user.

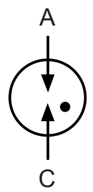
3.1.22
nominal impulse discharge current
peak value of the impulse current with a defined waveshape with respect to time for which the GDT is rated

3.1.23
sparkover
breakdown
abrupt transition of the gap resistance from practically infinite value to a relatively low value

3.1.24
transverse voltage
the difference in the discharge voltages between terminal A and B (see Figure 3) of the gaps assigned to the two conductors of the circuit during the passage of discharge current

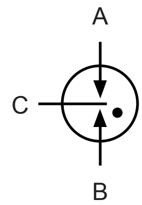
Note 1 to entry: Only for three electrode GDT conducting a longitudinal surge.

3.2 Symbols



IEC 528/13

Figure 2 – Symbol for a two-electrode GDT



IEC 529/13

Figure 3 – Symbol for a three-electrode GDT

4 Service conditions

4.1 Low temperature

The GDT shall be capable of withstanding IEC 60068-2-1, test Aa –40 °C, duration 2 h, without damage. While at –40 °C, the GDT shall meet the d.c. and impulse sparkover requirements of Table 1.

4.2 Air pressure and altitude

Air pressure is 80 kPa to 106 kPa.

These values represent an altitude of +2 000 m to –500 m respectively.

4.3 Ambient temperature

In this clause, the ambient temperature is the temperature of the air or other media, in the immediate vicinity of the component.

operating range (GDTs without failsafe): –40 °C to +90 °C

operating range (GDTs with failsafe): –40 °C to +70 °C

NOTE This corresponds to class 3K7 in IEC 60721-3-3.

storage range (GDTs without failsafe): –40 °C to +90 °C

storage range (GDTs with failsafe): –40 °C to +40 °C

4.4 Relative humidity

In this clause the relative humidity is expressed as a percentage, being the ratio of actual partial vapour pressure to the saturation vapour pressure at any given temperature, 4.3, and pressure, 4.2.

normal range: 5 % to 95 %

NOTE This corresponds to code AB4 in IEC 60364-5-51

5 Mechanical requirements and materials

5.1 Robustness of terminations

If applicable, the user shall specify a suitable test from IEC 60068-2-21.

5.2 Solderability

Solder terminations shall meet the requirements of IEC 60068-2-20, test Ta, method 1.

5.3 Radiation

Gas discharge tubes shall not contain radioactive material.

5.4 Marking

Legible and permanent marking shall be applied to the GDT as necessary to ensure that the user can determine the following information by inspection:

Each GDT shall be marked with the following information:

– nominal d.c. sparkover voltage;
– date of manufacture or batch number;
– manufacturer name or trademark;
– part number;
– safety approval markings.

NOTE 1 The necessary information can also be coded.

NOTE 2 When the space is not sufficient for printing this data, it should be provided in the technical documentation after agreement between the manufacturer and the purchaser.

6 General

6.1 Failure rates

Sampling size, electrical characteristics to be tested, etc. are covered by the quality assurance requirements, which are not covered by this standard.

6.2 Standard atmospheric conditions

The following tests shall be performed on the GDTs as required by the application. Unless otherwise specified, ambient test conditions shall be as follows:

- temperature: 15 °C to 35 °C;
- relative humidity 25 % to 75 %;

7 Electrical requirements

7.1 General

All electrical requirements in this standard are minimum requirements. Users may specify different values.

7.2 Initial values

7.2.1 Sparkover voltages

The sparkover voltages between electrodes A and C of a two-electrode GDT as shown in Figure 2 or between either line electrode A or B and the earth electrode C of a three-electrode GDT as shown in Figure 3 shall be within the limits shown in Table 1.

Table 1 – DC and impulse sparkover voltage requirements, initial

Preferred d.c. sparkover voltage at 100 V/s A – C or A/B – C	Values of sparkover voltage, initial		
	100 V/s to 2 kV/s		1 kV/µs (99,7 % of measured values)
	Min.	Max	
V	V	V	V
75	57	93	<650
[a] 90/1	72	108	<600
[a] 90/2	72	108	<500
150	120	180	<600
[a] 200/1	160	240	<700
[a] 200/2	160	240	<450
[a] 230/1	184	280	<700
[a] 230/2	184	280	<450
250	200	300	<700
300	240	360	<1 000
[a] 350/1	280	420	<1 000
[a] 350/2	265	455	<800
[a] 420/1	360	520	<1 100
[a] 420/2	360	520	<850
[a] 500/1	400	600	<1200
[a] 500/2	400	600	<900
[a] 600/1	480	720	<1 400
[a] 600/2	480	720	<1 000
800	640	960	<1 600
1 000	800	1 200	<2 000
1 200	960	1 440	<1 600
1 400	1 120	1 680	<2 800
1 800	1 440	2 160	<3 600
2 100	1 680	2 520	<4 000
2 700	2 160	3 240	<4 500
3 000	2 400	3 600	<4 500
3 600	2 900	4 300	<5 000
4 000	3 200	4 800	<5 500
4 500	3 600	5 400	<6 000

[a] Represents different technologies of GDTs.

For three-electrode GDTs the sparkover voltage between the line electrodes A – B shall not be higher than twice of A or B – C or not be less than the minimum d.c. sparkover voltage in Table 1, column 2.

7.2.2 Insulation resistance

The values shall not be less than 1 GΩ.

7.2.3 Capacitance

The values shall not be greater than 20 pF.

7.2.4 Transverse voltage

The transverse voltage for a three-electrode gas discharge tube is the difference in the discharge voltages between terminals a and b of the gaps assigned to the two conductors of the circuit during the passage of discharge current. For a three-electrode GDT the difference in time between the sparkover of the first and second gap shall not exceed 200 ns.

7.2.5 DC holdover

The current turn-off time shall be less than 150 ms, depending upon the d.c. sparkover voltage and the test circuit parameters.

7.3 Requirements after application of load

7.3.1 General

After the tests shown in Table 5, the GDTs shall be within the following limits of sparkover voltage (Table 2) and insulation resistance (see 7.3.3.).

7.3.2 Sparkover voltages

Table 2 – Values of sparkover voltages after the tests of Table 5

Preferred d.c. sparkover voltage at 100 V/s A – C or A/B – C	Values of sparkover voltage after testing		
	100 V/s to 2 kV/s		1 kV/µs
	Min.	Max.	(99,7 % of measured values)
V	V	V	V
75	57	100	<750
[a] 90/1	65	120	<700
[a] 90/2	65	120	<600
150	110	195	<700
[a] 200/1	150	250	<800
[a] 200/2	150	250	<550
[a] 230/1	170	300	<800
[a] 230/2	170	300	<550
250	180	325	<800
300	225	375	<1 300
[a] 350/1	260	455	<1 100
[a] 350/2	265	600	<900
[a] 420/1	360	550	<1 200
[a] 420/2	360	650	<1 000
[a] 500/1	400	650	<1 300
[a] 500/2	400	700	<1 050
[a] 600/1	450	780	<1 500
[a] 600/2	450	800	<1 200
800	600	1 000	<2 000
1 000	750	1 250	<2 500
1 200	900	1 680	<2 500
1 400	1 050	1 750	<3 500
1 800	1 350	2 250	<4 500
2 100	1 550	2 650	<5 000
2 700	2 150	3 350	<5 500
3 000	2 450	3 700	<5 500
3 600	2 550	4 700	<6 000
4 000	2 800	5 200	<6 500
4 500	3 150	5 850	<7 000

[a] Represents different technologies of GDTs.

7.3.3 Insulation resistance

The values shall not be less than 10 MΩ.

NOTE In some countries the insulation resistance shall not be less than 100 MΩ.

7.3.4 AC follow current

In the absence of special requirements, it is recommended that the device be required to extinguish not later than thirty electrical degrees after the first alternating current zero crossing without failure and that subsequent breakdown does not occur.

7.3.5 Fail-short (Failsafe)

For GDTs with an integrated fail-safe feature only.

Alternating currents shall be applied at the specified current of the GDT in accordance with the circuits in Figure 18 and Figure 19.

After the tests, the resistance of the GDTs shall be less than 1 Ω between electrodes A and C of a two-electrode GDT or between either line electrode (A or B) and the earth electrode (C) of a three-electrode GDT.

8 Test and measurement procedures and circuits

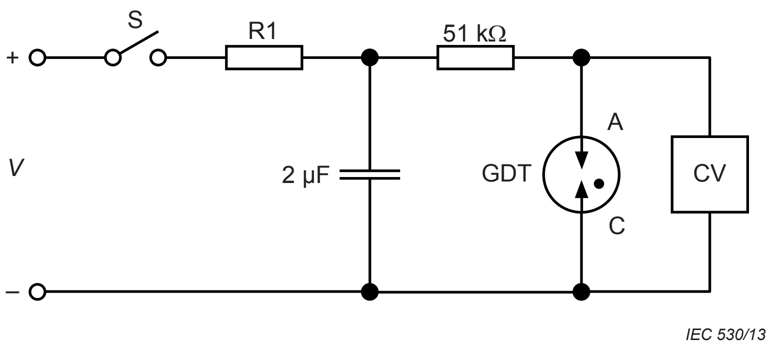
8.1 DC sparkover voltage

The GDT shall be placed in darkness for at least 15 min with no application of energizing voltage supply and tested in this condition using a test circuit as shown in Figure 4 with a voltage rate of rise between 100 V/s to 2 000 V/s. Values of V and R1 are adjusted to give du/dt = 100 V/s to 2 000 V/s, e.g for d.c. sparkover voltage of 230 V, V= 500 V and R1 = 2 MΩ. Two measurement values shall be recorded for each GDT between A and C for each polarity. Time between measurements should be equal to 1 s or more.

NOTE Placing the GDT in darkness for 24 h assures that it is not pre-ionized before the measurement. GDTs that are not pre-ionized may have a slight ignition delay depending on their technology. This is called First-Time-Effect (dark effect) as it only appears at the first out of several ignitions (after the first ignition the GDT is pre-ionized). Depending on the design of a GDT it may stay pre-ionized for a span of time after firing or being exposed to light. In most cases the decay time is less than 15 min.

Each pair of terminals of a three-electrode GDT shall be tested separately with the other terminal unterminated.

All measured values shall meet the limits given in Table 1.



Components

CV crest voltmeter, oscilloscope with impedance higher than 10 MΩ

S switch

V d.c. voltage source

NOTE 1 Avoid oscillating operation.

NOTE 2 With other circuit parameters the rate of rise can be changed up to 2 kV/s. This can be jointly agreed between the manufacturer and the user.

Figure 4 – Circuit for d.c. sparkover voltage test at 100 V/s

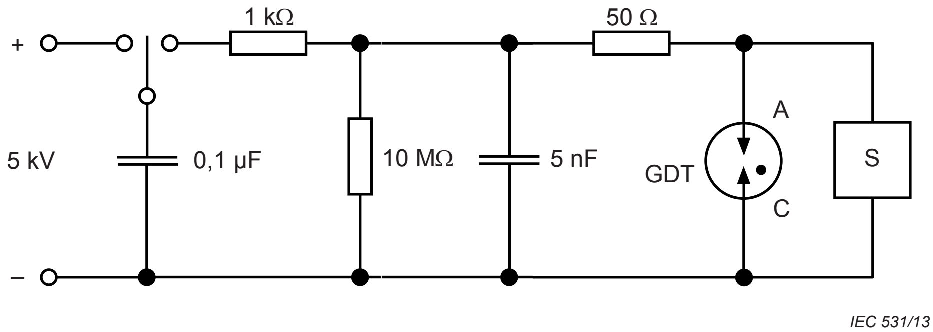
8.2 Impulse sparkover voltage

The GDT shall be placed in darkness for at least 15 min with no application of energizing voltage supply and tested in this condition using a test-circuit as shown in Figure 5. Figure 5 circuit values of d.c. supply voltage, resistor and capacitor shall be adjusted to du/dt = 1 000 V/μs. The values shown in Figure 5 are suitable for GDTs up to 1 000 V d.c. sparkover voltage. The test is performed with a voltage rate of rise of 1 000 V/μs ± 20 %. Two measurement values shall be recorded for each GDT between A and C for each polarity.

The duration of breaks between the measurement shall be at least 1 s.

Each pair of terminals of a three-electrode GDT shall be tested separately with the other terminal unterminated.

All measured values shall meet the limits given in Table 1.



Components

S crest voltmeter, oscilloscope with impedance higher than 10 MΩ

Figure 5 – Circuit for impulse sparkover voltage at 1 000 V/μs

8.3 Insulation resistance

Insulation resistance shall be measured from each terminal to every other terminal of the GDT. For GDTs with a nominal d.c. sparkover voltage of up to and including 150 V, the test is performed using 50 V d.c. For higher nominal d.c. sparkover voltage, the test is performed with 100 V d.c.

All measured values shall meet the requirement of 7.2.2. Terminals of three-electrode GDTs not involved in the measurement shall be left unterminated.

8.4 Capacitance

The capacitance shall be measured once at 1 MHz between all terminals unless otherwise specified.

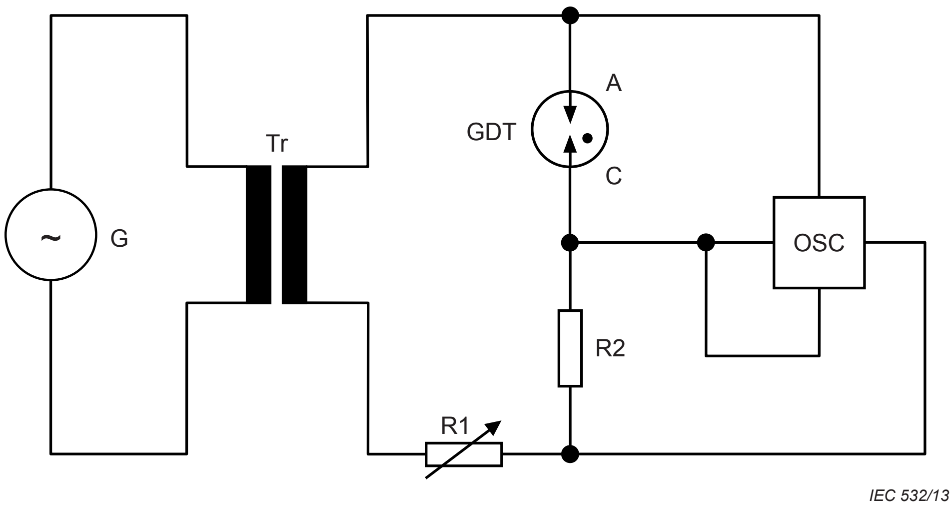
All measured values shall meet the requirement in 7.2.3. Terminals of three-electrode GDTs not involved in the measurement shall be left unterminated.

8.5 Glow-to-arc transition current, glow voltage, arc voltage

The GDT shall be placed in a test circuit as shown in Figure 6.

The r.m.s. voltage of the secondary side of transformer Tr should be a minimum of twice the nominal d.c. sparkover voltage. The peak value of discharge current is approximately twice that of the expected glow-to-arc transition current, however not more than 2 A. The test duration shall be a maximum of 1 s.

The voltage current characteristic of a typical GDT is shown in Figure 7, generated by the test circuit of Figure 6 for the positive half cycle.



Components

G generator 50 Hz or 60 Hz

OSC oscilloscope

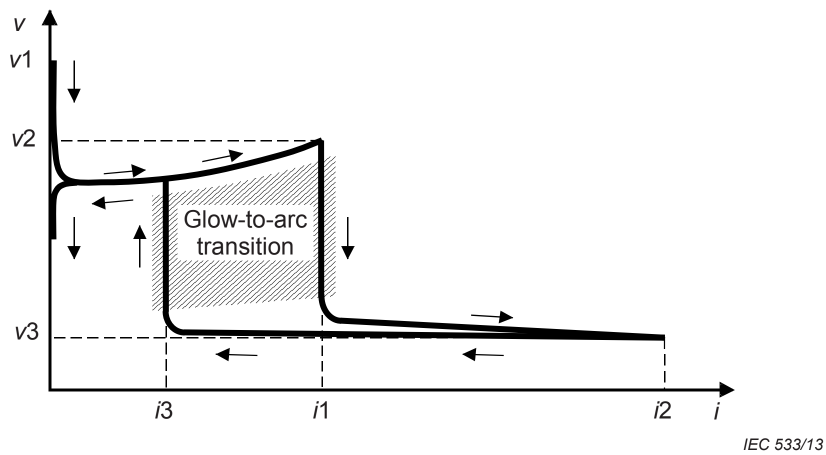
R1 regulating resistor

R2 current sensing resistor

Tr transformer

Figure 6 – Test circuit for glow-to-arc transition current, glow voltage and arc voltage

Voltage-current characteristic u = f(i) (schematic)



Legend

*v*1 d.c. sparkover voltage

*v*2 glow voltage

*v*3 arc voltage

*i*1 glow-to-arc transition current

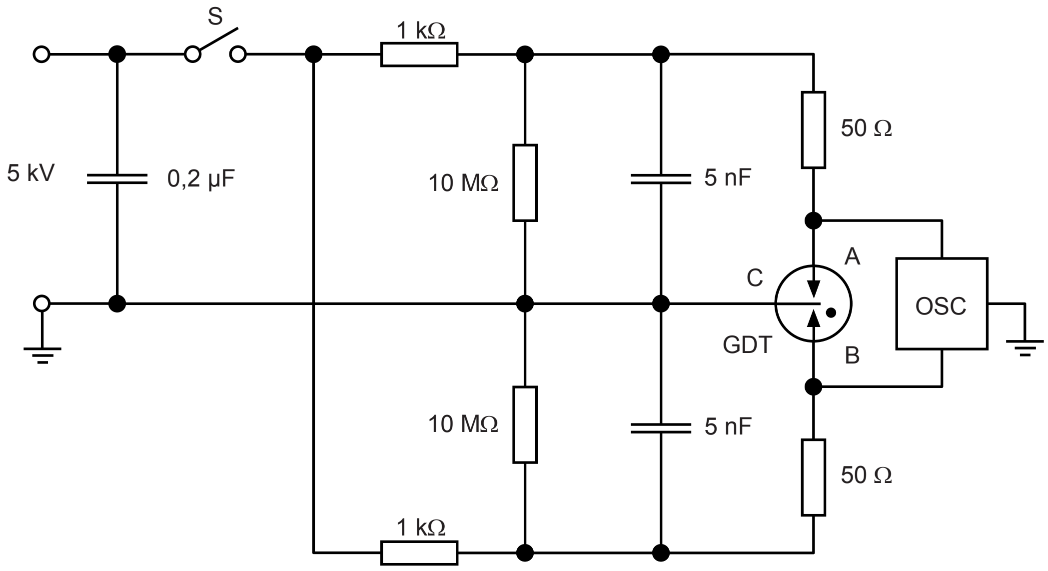
*i*3 arc-to-glow transition current

*i*2 peak current

Figure 7 – Voltage-current characteristic of a typical GDT, suitable for measuring for example the glow-to-arc transition current, glow voltage, and arc voltage

8.6 Transverse voltage

The magnitude and the duration of transverse voltage shall be measured for GDTs with three electrodes, while an impulse voltage having a virtual steepness of impulse wave front of 1 000 V/μs is applied simultaneously to both discharge gaps. Measurement may be made with an arrangement as indicated in Figure 8. The difference in time between the sparkover of the first gap and that of the second shall be determined for each test for both polarities. The maximum time shall be less than specified in 7.2.4.



Component

OSC dual channel oscilloscope

S switch

Figure 8 – Test circuit for transverse voltage

8.7 DC holdover voltage

8.7.1 General

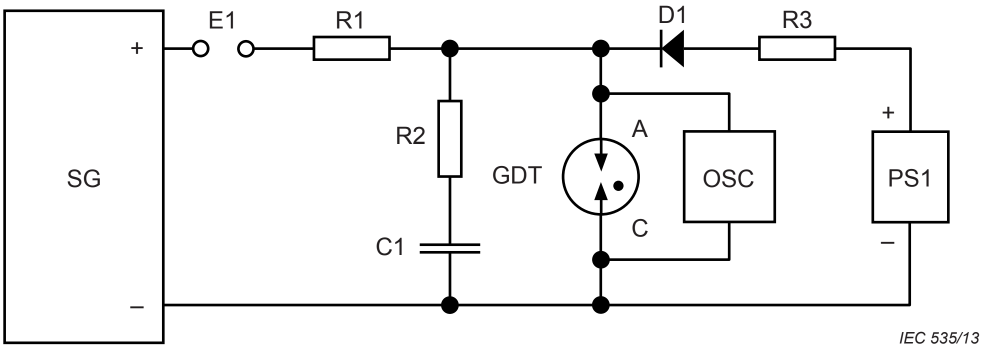
The d.c. holdover voltage of GDTs is dependent upon the test circuits and is therefore application specific. The user and the manufacturer should agree on the special test circuits, the number of tests, test parameters, etc.

The major application of GDTs is the protection of telecommunication equipment. The test circuits shown in Figure 9 and Figure 10 provide examples suitable for breakdown voltages equal or higher than 230 V.

The test shall be conducted using the circuit of Figure 9 or Figure 10. Values of circuit components shall be selected from Table 3 or Table 4. The simultaneous currents that are applied to the gaps of the three-electrode GDT shall have an impulse waveform of 100 A, 10/1 000 µs or 5/320 µs measured through a short-circuit replacing the GDT under test. The polarity of the impulse current through the GDT shall be the same as the current from PS1 and PS2.

For each test condition, measurement of the time of current turn-off shall be made for both polarities of the impulse current. Three impulses in each direction shall be applied at intervals not greater than 1 min, and the time to current turn-off measured for each impulse.

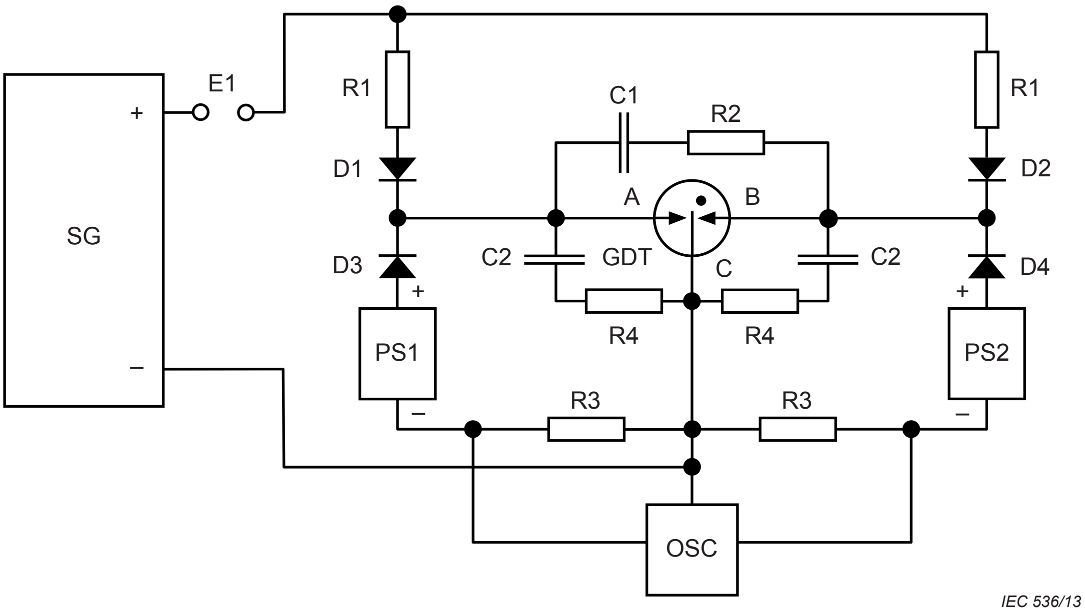
All measured values shall meet the requirements of 7.2.5.



Components

C1	see Table 3
D1	isolation diode or other isolation device
E1	isolation gap or equivalent device
OSC	oscilloscope
PS1	constant voltage d.c. supply or battery
R1	impulse current-limiting resistor or waveshaping network
R2, R3	see Table 3
SG	surge generator, 100 A, 10/1 000 µs

Figure 9 – Test circuit for dc holdover voltage, two-electrode GDTs



Components

C1, C2	see Table 4
E1	isolation gap or equivalent device
OSC	dual channel oscilloscope
PS1, PS2	batteries or d.c. power supplies
R1	impulse current-limiting resistors or wave-shaping networks
R2, R3, R4	see Table 4
SG	surge generator, 100 A per path, 10/1 000 µs

NOTE The polarity of diodes D1 to D4 must be reversed when the polarity of the d.c. power supplies and surge generators is reversed.

Figure 10 – Test circuit for dc holdover voltage, three-electrode GDTs

8.7.2 DC holdover voltage values

Examples for telecommunication applications are given in Table 3 for two-electrode GDTs and in Table 4 for three-electrode GDTs (test circuits as shown in Figure 9 and Figure 10).

Table 3 – Values for different d.c. holdover voltage tests for two-electrode GDTs

Component	Test 1	Test 2	Test 3	Test 4 [b)]
PS1	52 V	80 V	135 V	135 V
R3	200 Ω	330 Ω	1 300 Ω	450 Ω
R2	[a)]	150 Ω	150 Ω	150 Ω
C1	[a)]	100 nF	100 nF	100 nF

[a] Components omitted in this test.

[b] Recommended for ISDN application.

Table 4 – Values for different d.c. holdover voltage tests for three-electrode GDTs

Component	Test 1	Test 2	Test 3	Test 4 [d)]
PS1	52 V	80 V	135 V	135 V
PS2	0 V	0 V	52 V	NA
R3	200 Ω	330 Ω	1300 Ω	450 Ω
R2	[a)]	150 Ω | 272 Ω [b)]	150 Ω | 272 Ω [b)]	150 Ω | 272 Ω [b)]
C1	[a)]	100 nF| 43 nF [b)]	100 nF| 43 nF [b)]	100 nF| 43 nF [b)]
R4 [c)]	136 Ω	136 Ω	136 Ω	136 Ω
C2 [c)]	83 nF	83 nF	83 nF	83 nF

[a] Components omitted in this test.

[b] Optional alternative.

[c] Optional.

[d] Recommended for ISDN application.

8.8 Requirements for current-carrying capacity

8.8.1 General

Table 5 shows different classes of current-carrying capacity.

Table 5 – Different classes of current-carrying capacity

Class	Alternating discharge current for 1 s, 15-62 Hz 10 times	Impulse discharge current		Life test with *n* pulses		
		8/20 μs 10 times [a]	10/350 μs 1 time	Peak value of test current	Current waveshape	
					10/1 000 μs	5/320 μs [b]
	A	kA	kA	A		
1	0,05	0,5	–	1	*n* = 300	–
2	0,1	1,0	–	5		–
3	1,0	1,0	–	10	*n* = 100	–
4	2,5	2,5	0,5	50		
5	5	5	1	100		
6	10	10	2,5	100	*n* = 300	*n* = 500
7	20	10	4	100		
8	20	20	4	200		
9	30	10	4	100		
10	40	20	4	200		

Details shall be agreed jointly between the manufacturer and the user.

[a] The number of applications may be increased, for example 20 times.

[b] Open circuit voltage waveshape 10/700 μs in accordance with IEC 61000-4-5 and ITU-T Recommendation K.20.

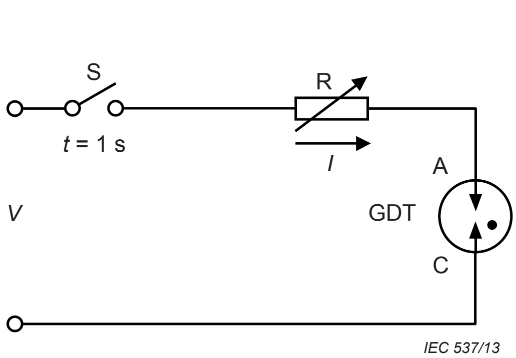
8.8.2 Nominal alternating discharge current

Unused GDTs shall be used and alternating currents applied as specified in Table 5 for the relevant nominal current of the GDT in accordance with the circuits in Figure 11 and Figure 12.

The time between applications should be such as to prevent thermal accumulation in the GDT. The r.m.s. a.c. voltage of the current source shall exceed the maximum d.c. sparkover voltage of the GDT by not less than 50 %.

The specified a.c. discharge current and duration shall be measured with the GDT replaced with a short-circuit. For a three-electrode GDT, a.c. discharge currents each having the value specified in Table 5 shall be discharged simultaneously from each electrode to the common electrode (see Figure 12).

On completion of the specified number of current applications, the GDT shall be allowed to cool to ambient temperature. Within 1 h of the last current application, test to the requirements of Table 2 and 7.3.3. A retest is permitted 24 h after the last current application, if necessary.



Components

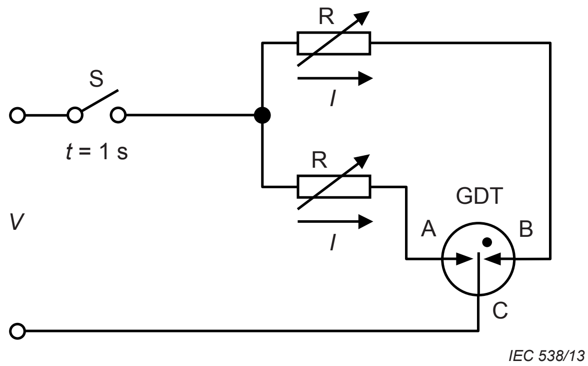
I nominal alternating current

R load resistor (*U*/*I*)

S switch

V a.c. voltage, 15 Hz – 62 Hz

Figure 11 – Circuit for nominal alternating discharge current, two-electrode GDTs



Components

I nominal alternating current

R load resistor (*U*/*I*)

S switch

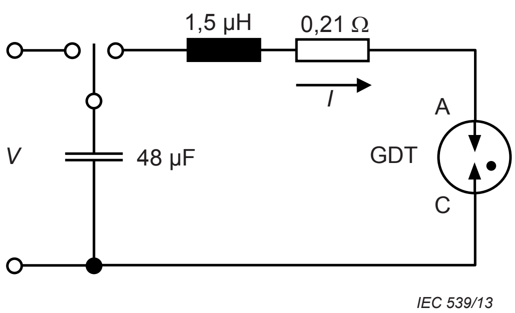
V a.c. voltage, 15 Hz – 62 Hz

Figure 12 – Circuit for nominal alternating discharge current, three-electrode GDTs

8.8.3 Nominal impulse discharge current, waveshape 8/20

Unused GDTs shall be used and impulse discharge current applied as specified in Table 5. An example of a test circuit generating a waveshape 8/20 for a two-electrode GDT is shown in Figure 13. The time between applications should be such as to prevent thermal accumulation in the GDT. The specified nominal impulse discharge current and duration shall be measured with the GDT replaced with a short-circuit. For three-electrode GDTs, nominal impulse discharge currents each having the value specified in Table 5 shall be discharged simultaneously from each electrode to the common electrode (circuit Figure 14).

On completion of the specified number of current applications, the GDT shall be allowed to cool to ambient temperature. Within 1 h of the last current application, test to the requirements of Table 2 and 7.3.3. A retest is permitted 24 h after the last current application if necessary.

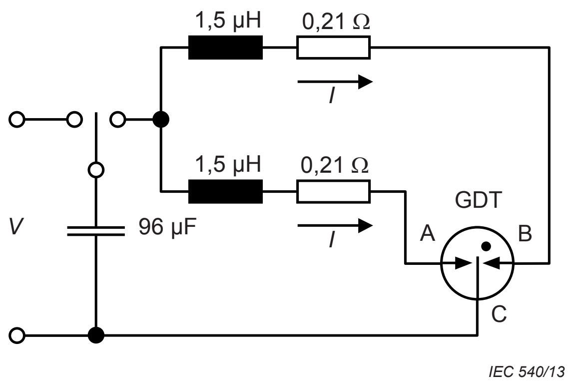


Components

V 5 kV d.c. voltage

I peak value 10 kA, waveshape 8/20

Figure 13 – Circuit for nominal impulse discharge current, two-electrode GDTs



Components

V 5 kV d.c. voltage

I peak value 10 kA per path, waveshape 8/20

Figure 14 – Circuit for nominal impulse discharge current, three-electrode GDTs

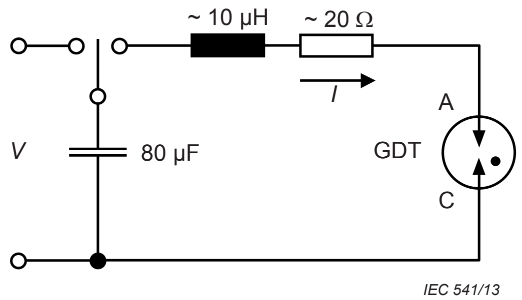
8.8.4 Life test with impulse currents, waveshape 10/1 000

Unused GDTs shall be used and impulse currents shall be applied as specified in Table 5 for the relevant nominal current of the GDT. Half the specified number of tests shall be carried out with one polarity followed by half with the opposite polarity. Alternatively, half the GDTs in a sample size may be tested with one polarity and the other half with the opposite polarity. The pulse repetition rate should be such as to prevent thermal accumulation in the GDT.

The voltage of the source shall exceed the maximum impulse sparkover voltage of the GDT by not less than 50 %. The specified impulse current and waveshape shall be measured with the GDT replaced by a short-circuit. For three-electrode GDTs, independent impulse currents each having the value specified in Table 5 shall be discharged simultaneously from each electrode to the common electrode.

Examples for test circuits generating an impulse current of 100 A peak, waveshape 10/1 000 are shown in Figure 15 and Figure 16.

The GDT shall be tested after each passage of impulse current or at less frequent intervals if agreed between the manufacturer and the user to determine its ability to satisfy the requirements of Table 2 and 7.3.3.

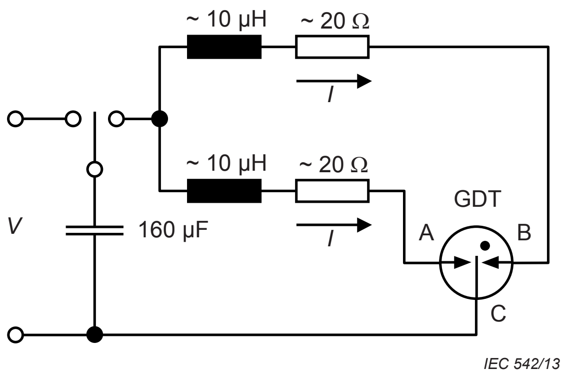


Components

V 2 kV d.c. or as necessary

I peak value 100 A, waveshape 10/1 000

Figure 15 – Circuit for life test with impulse current, two-electrode GDTs



Components

V 2 kV d.c. or as necessary

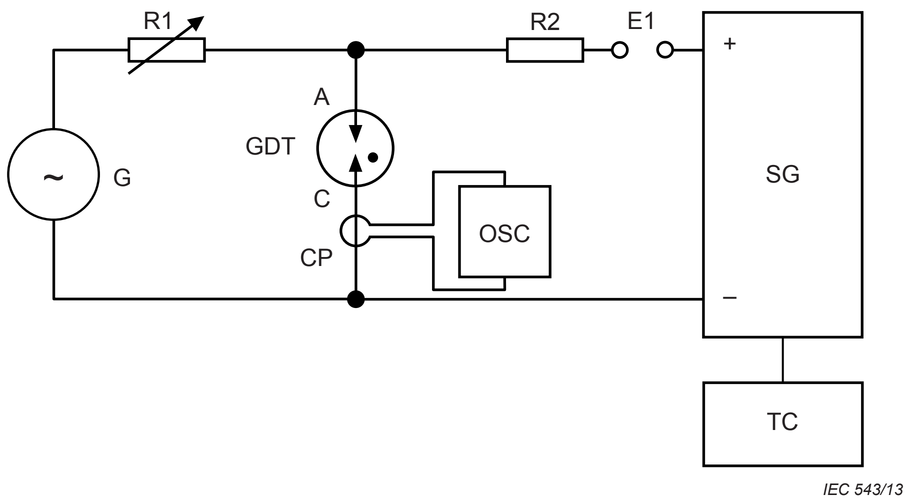
I peak value 100 A per path, waveshape 10/1 000

Figure 16 – Circuit for life test with impulse current, three-electrode GDTs

On completion of the specified number of impulse current application, the GDT shall be allowed to cool to ambient temperature. Within 1 h of the last current application, test to the requirements of Table 2 and 7.3.3 and d.c. holdover test. A retest is permitted 24 h after the last current application if necessary.

8.8.5 AC follow current

Unused GDTs shall be used and applied to an ac source of 50 Hz or 60 Hz as shown in Figure 17. The open-circuit rms ac voltage shall be agreed jointly between the manufacturer and the user, according to the field of application. Preferred values are 25 V, 120 V, 208 V, 240 V, or 480 V. The power frequency source current shall be resistance-limited to approximate unity power-factor conditions. This ac source shall have the capability to provide a follow current when conduction is initiated within the device by a secondary source of impulse current applied at thirty electrical degrees or less after the zero value of the ac source. The impulse current shall be unidirectional and of the same polarity as the applied half cycle of the ac source. The impulse should be of sufficient amplitude and time duration to ensure that the device is put into the arc mode conducting state. The maximum current, which the device will extinguish without failure, defines the maximum alternating follow-current capability.



Components

CP current probe
E1 isolation gap or equivalent device
G 50 Hz or 60 Hz source
OSC dual channel oscilloscope
R1 limiting resistor
R2 isolation resistor
SG surge generator
TC phase, arm and trigger circuitry

NOTE 1 Reactance of 50 Hz or 60 Hz source << R1.

NOTE 2 R2 must be sufficiently large to cause prompt extinguishing of the isolation gap.

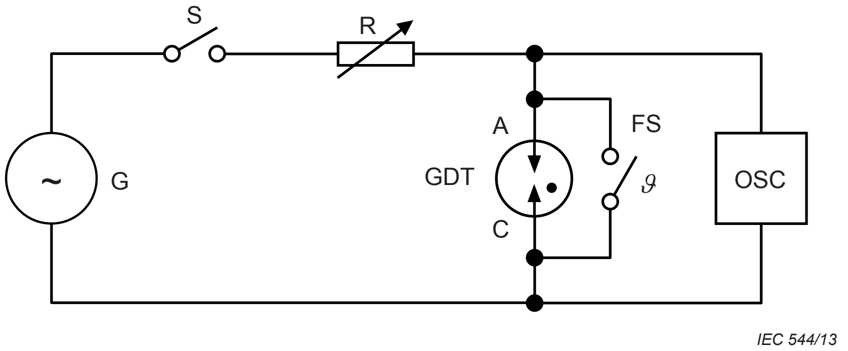
NOTE 3 Surge protections of 50 Hz or 60 Hz supply may be necessary.

Figure 17 – Test circuit for alternating follow current

8.9 Fail-short (failsafe)

For GDTs with an integrated fail-safe feature only.

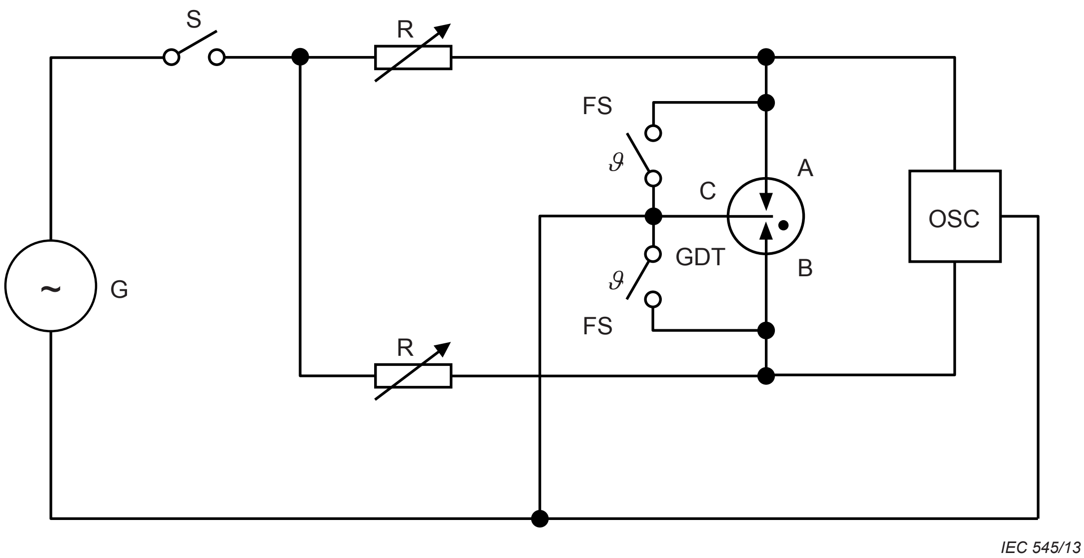
An alternating current shall be applied to unused GDTs which are capable to lead to a thermal overload (rise of temperature), causing the fail-short mechanism to operate and to short circuit the device. The performance regarding alternating current against duration until the fail-short mechanism operates should be specified by the manufacturer. The detailed test procedure and the requirements for passing the test, shall be agreed jointly between the manufacturer and the user, according to the field of application. The test circuits are shown in Figure 18 and Figure 19.



Components

FS fail-short (failsafe) mechanism
G generator 50 Hz or 60 Hz
OSC oscilloscope
R variable resistor
S switch

Figure 18 – Test circuit for fail-short (failsafe), two-electrode GDTs



Components

FS fail-short (failsafe) mechanism
G generator 50 Hz or 60 Hz
OSC oscilloscope
R variable resistor
S switch

Figure 19 – Test circuit for fail-short (failsafe), three-electrode GDTs

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