IEC 61643-311

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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

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COMPONENTS FOR LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

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FOREWORD

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International Standard IEC 61643-311 has been prepared by subcommittee 37B: Specific components for surge arresters and surge protective devices, of IEC technical committee 37: Surge arresters.

This second edition of IEC 61643-311 cancels and replaces the first edition published in 2001. It constitutes a technical revision.

Specific changes with respect to the previous edition are:

– Addition of performance values.

The text of this standard is based on the following documents:

FDIS	Report on voting
37B/113/FDIS	37B/118/RVD

Full information on the voting for the approval of this standard 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.

A list of all parts of IEC 61643 series, under the general title *Components for low-voltage surge protective devices* can be found on the IEC website.

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- withdrawn,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.

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

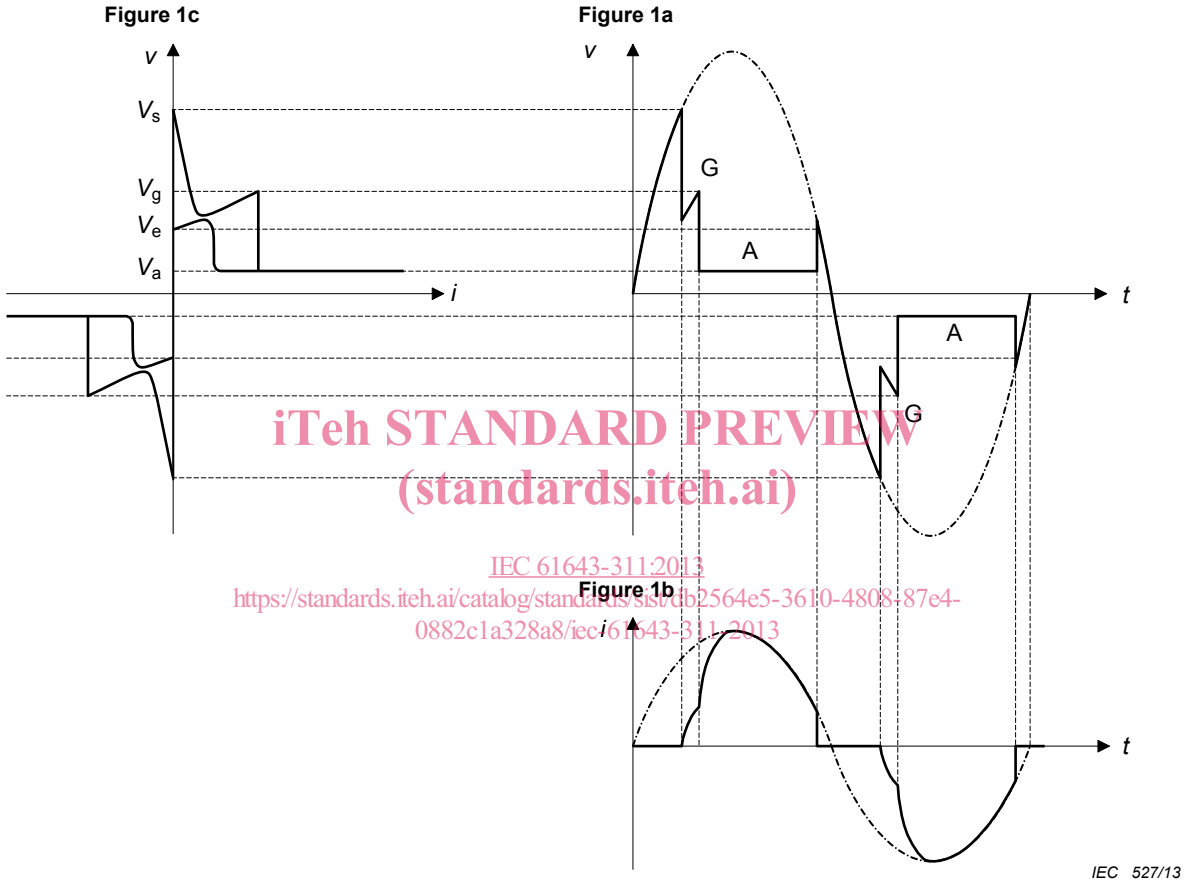
3.1.7
d.c. holdover voltage
maximum d.c. voltage across the terminals of a gas discharge tube under which it may be expected to clear and to return to the high-impedance state after the passage of a surge, under specified circuit conditions

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

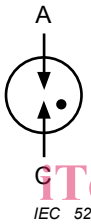


Figure 2 – Symbol for a two-electrode GDT

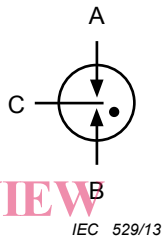


Figure 3 – Symbol for a three-electrode GDT

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.).