BS EN 61643-312:2013

BSI Standards Publication

Components for low-voltage surge protective devices

Part 312: Selection and application principles for gas discharge tubes

bsi.

...making excellence a habit.™

National foreword

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 Together with BS EN 61643-311:2013 it supersedes BS EN 61643-311:2001, which will be withdrawn on 16 May 2016.

Corrigendum July 2013 corrects figure references in subclause 8.2.

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.

Published by BSI Standards Limited 2013

ISBN 978 0 580 63625 7

ICS 31.100; 33.040.99

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

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 September 2013.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61643-312

August 2013

ICS 31.100; 33.040.99

English version

Components for low-voltage surge protective devices - Part 312: Selection and application principles for gas discharge tubes
(IEC 61643-312:2013 + corrigendum Jul. 2013)

Composants pour parafoudres basse tension -
Partie 312: Principes de choix et d'application pour les tubes à décharge de gaz
(CEI 61643-312:2013
+ corrigendum Jul. 2013)

Bauelemente für Überspannungsschutzgeräte für Niederspannung -
Teil 312: Auswahl- und Anwendungsprinzipien für Gasentladungsableiter
(IEC 61643-312:2013
+ corrigendum Jul. 2013)

This European Standard was approved by CENELEC on 2013-05-27. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

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 61643-312:2013 E

Foreword

The text of document 37B/114/FDIS, future edition 1 of IEC 61643-312, 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 61643-312:2013.

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)	2014-02-27
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-05-27

This document partially supersedes EN 61643-311:2001.

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 61643-312:2013 + corrigendum July 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 60364-5-51:2001	NOTE	Harmonised as HD 60364-5-51:2006 (modified).
IEC 60068-2-1	NOTE	Harmonised as EN 60068-2-1.
IEC 60068-2-20	NOTE	Harmonised as EN 60068-2-20.
IEC 60068-2-21	NOTE	Harmonised as EN 60068-2-21.
IEC 60721-3-3	NOTE	Harmonised as EN 60721-3-3.
IEC 61643-11	NOTE	Harmonised as EN 61643-11.
IEC 61643-21	NOTE	Harmonised as EN 61643-21.

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	-	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-20	-	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	-
IEC 60068-2-21	-	Environmental testing - Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices	EN 60068-2-21	-
IEC 61643-311	-	Components for low-voltage surge protective devices - Part 311: Performance requirements and test circuits and methods for gas discharge tubes (GDT)	EN 61643-311	-

CONTENTS

1 Scope ... 6
2 Normative references ... 6
3 Terms, definitions and symbols ... 6
3.1 Terms and definitions ... 6
3.2 Symbols ... 10
4 Service conditions ... 10
4.1 General ... 10
4.2 Low temperature ... 10
4.3 Air pressure and altitude ... 10
4.4 Ambient temperature ... 10
4.5 Relative humidity ... 11
5 Mechanical requirements and materials ... 11
5.1 General ... 11
5.2 Robustness of terminations ... 11
5.3 Solderability ... 11
5.4 Radiation ... 11
5.5 Marking ... 11
6 General ... 11
7 Construction ... 12
7.1 Design ... 12
7.2 Description ... 12
7.3 Fail-short (failsafe) ... 13
8 Function ... 14
8.1 Protection principle ... 14
8.2 Operating mode ... 14
8.3 Response behaviour ... 14
8.3.1 Static response behavior ... 14
8.3.2 Dynamic response behavior ... 14
8.4 Fail-short (failsafe) ... 15
9 Applications ... 16
9.1 Protective circuits ... 16
9.1.1 General ... 16
9.1.2 2-point (signal line) protection ... 16
9.1.3 3-point protection ... 17
9.1.4 5-point protection ... 18
9.2 Telephone/fax/modem protection ... 19
9.3 Cable TV/coaxial cable protection ... 19
9.4 AC line protection ... 20
Bibliography ... 21

Figure 1 – Voltage and current characteristics of a GDT ... 8
Figure 2 – Symbol for a two-electrode GDT ... 10
Figure 3 – Symbol for a three-electrode GDT ... 10
Figure 4 – Example of a two-electrode GDT ... 12

Figure 5 – Example of a three-electrode GDT 12
Figure 6 – Failsafe construction of a three-electrode GDT using a solder pill as sensitive spacer 13
Figure 7 – Failsafe construction of a three-electrode GDT, using a plastic foil as sensitive spacer 13
Figure 8 – Typical response behaviour of a 230 V GDT 15
Figure 9 – Spark-over voltages versus response time 15
Figure 10 – Current through the GDT versus response time of fail-short (failsafe) 16
Figure 11 – 2-point (Signal line) protection 17
Figure 12 – 3-point protection using two-electrode GDTs 17
Figure 13 – 3-point protection using three-electrode GDTs 17
Figure 14 – 3-point protection using two-electrode GDTs with fail-short 18
Figure 15 – 3-point protection using three-electrode GDTs with fail-short 18
Figure 16 – 5-point protection using two-electrode GDTs 18
Figure 17 – 5-point protection using three-electrode GDTs 18
Figure 18 – 5-point protection using two-electrode GDTs with fail-short 19
Figure 19 – 5-point protection using three-electrode GDTs with fail-short 19
Figure 20 – Telephone/fax/modem protection using two-electrode GDTs 19
Figure 21 – Telephone/fax/modem protection using three-electrode GDTs 19
Figure 22 – Cable TV/ coaxial cable protection 20
Figure 23 – AC line protection 20

COMPONENTS FOR LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

Part 312: Selection and application principles for gas discharge tubes

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 provides information about the characteristics and circuit applications 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, *Environmental testing – Part 2-1: Tests – Test A: Cold*

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

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

IEC 61643-311, *Components for low-voltage surge protective devices – Part 311: Specification for gas discharge tubes (GDT)*

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

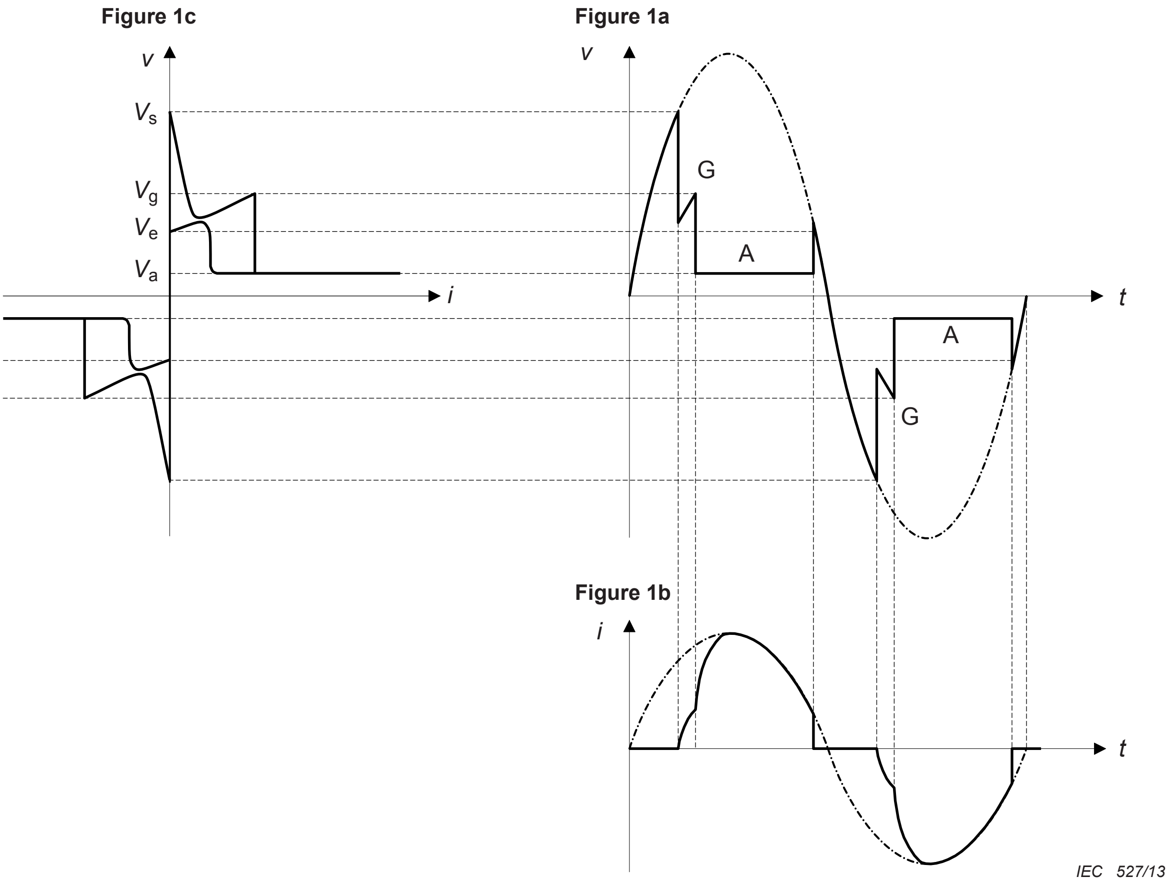
3.1.7
d.c. holdover voltage
maximum d.c. voltage across the terminals of a gas discharge tube under which it may be expected to clear and to return to the high-impedance state after the passage of a surge, under specified circuit conditions

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

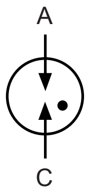
3.1.19
nominal d.c. sparkover voltage
voltage specified by the manufacturer to indicate the target value of sparkover voltages of a particular type of GDT products

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 et 4 500 V

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

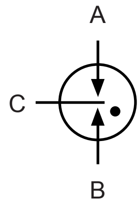
3.1.20
sparkover
breakdown
abrupt transition of the gap resistance from practically infinite value to a relatively low value

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

Figures 2 and 3 show the symbols for two- and three-electrode GDTs.

4 Service conditions

4.1 General

The basic GDT is relatively insensitive to temperature, air pressure and humidity. GDTs fitted with a fail-short mechanism have a lower high temperature rating due to the thermal nature of the fail-short. Manufacturer's guidelines shall be followed when soldering fail-short mechanism GDTs to avoid premature operation of the shorting mechanism. For reference, standardised values and ranges of temperature, air pressure and humidity are given in Subclauses 4.2 to 4.5.

4.2 Low temperature

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.

4.3 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.

4.4 Ambient temperature

For the purposes of Subclause 4.4, 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

4.5 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, 4.4, and pressure, 4.3.

normal range: 5 % to 95 %

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

5 Mechanical requirements and materials

5.1 General

Clause 5 lists standardised requirements for terminations, solderability, radiation and marking. The radiation requirement is a key item to check as GDTs containing radio active elements are still manufactured.

5.2 Robustness of terminations

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

5.3 Solderability

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

5.4 Radiation

Gas discharge tubes shall not contain radioactive material.

5.5 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.

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

Due to the high complexity of the gas discharge physics on which the functioning of the GDTs is based, the performance of the GDTs depends very much on the technical expertise of the manufacturer. Thus the electrical properties and characteristics (tolerances, ignition values, etc.) are varying.

7 Construction

7.1 Design

The GDTs consist of two or more metallic electrodes that are separated by gap(s) in a hermetically sealed envelope containing an inert gas or mixture of gases, usually at less than atmospheric pressure. Some of the gases used are argon, helium, hydrogen, and nitrogen. Electrode spacing is maintained by means of ceramic, glass, or other insulating materials, that may form a part of the sealed envelope. The electrodes are fitted with a variety of terminations suitable for mounting on circuit boards, clip terminals, sockets, or for incorporation in a protector.

7.2 Description

The electrical properties of an open gas-discharge path depend greatly on environmental parameters such as gas type, gas pressure, humidity and pollution. Stable conditions can only be ensured if the discharge path is shielded against these environmental influences. The design principle of GDTs is based on this requirement. A proven technique of connecting insulator and electrode ensures hermetic sealing of the discharge space.

The type and pressure of the gas in the discharge space can thus be selected on the basis of optimum criteria. The rare gases argon and neon are predominantly used in gas arresters since they ensure optimum electrical characteristics throughout the entire useful life of the component.

An activating compound is applied to the effective electrode surfaces to enhance the emission of electrons. The electrodes are typically separated by less than 1 mm. The combination of the activation compound and the electrode separation distance lower the electrode work function and increase the ignition voltage stability over repetitive current surges.

To achieve optimal response characteristic at fast rise times, ignition aids are attached to the cylindrical internal surface of the insulator. These ignition aids distort the electric field, which enhances the ionization speed of the gas. The electrical characteristics of the GDT, such as d.c. spark-over voltage, pulsed and a.c. discharge current handling capability as well as its service life, can be optimized to the specific requirements of various systems. This is achieved by varying the gas type and pressure as well as the spacing of the electrodes and the emission-promoting coating of the electrodes.

Figure 4 and Figure 5 show construction examples of two- and three-electrode GDTs.

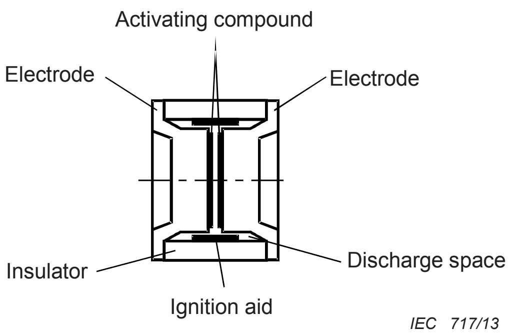


Figure 4 – Example of a two-electrode GDT

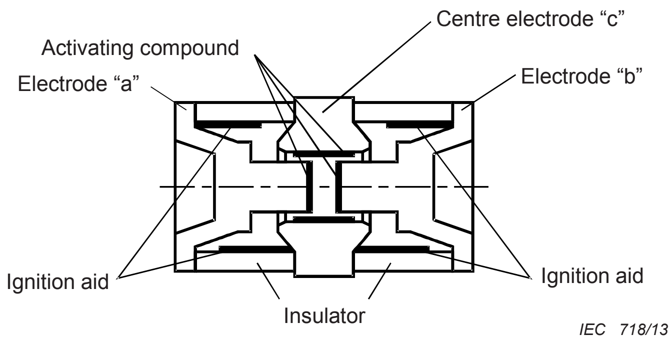


Figure 5 – Example of a three-electrode GDT

7.3 Fail-short (failsafe)

GDTs are usually designed for pulse-shaped loads. If permanent overloads are possible (e.g. mains contact), GDTs with integrated failsafe should be used. This external short-circuit mechanism prevents the generating of excessive thermal energy of the operating GDT by bridging it.

The failsafe mechanism usually consists of a mechanical short-circuit spring and a temperature sensitive spacer, which prevents the bridging of the GDT until a defined temperature is reached.

The fail-short mechanism performance is dependent on its thermal environment. The soldering profile used for the GDT could be critical. Recommendations made by the manufacturer for mounting and processing should be followed. The fail-short spacer, used to keep the switch open, has typical melting temperatures of >200 °C for solder spacer types. For plastic foil spacer types, typical melting temperatures are 140 °C or 260 °C depending on their composition. If an inappropriate soldering profile and mounting arrangement used the spacer will melt and the GDT will be shorted after soldering. When a permanent current overload occurs the GDT temperature rise operates the fail-short switch. Caution should be used in the coordination between the soldering temperature of the GDT to the board and the operating temperature of the fail-short mechanism to avoid desoldering of the GDT. Under current overload conditions the GDT thermal radiation to adjacent components is another factor to be considered.

Failsafe constructions are available for two- and three-electrode GDTs. For three-electrode GDTs two examples are shown in Figures 6 and 7.

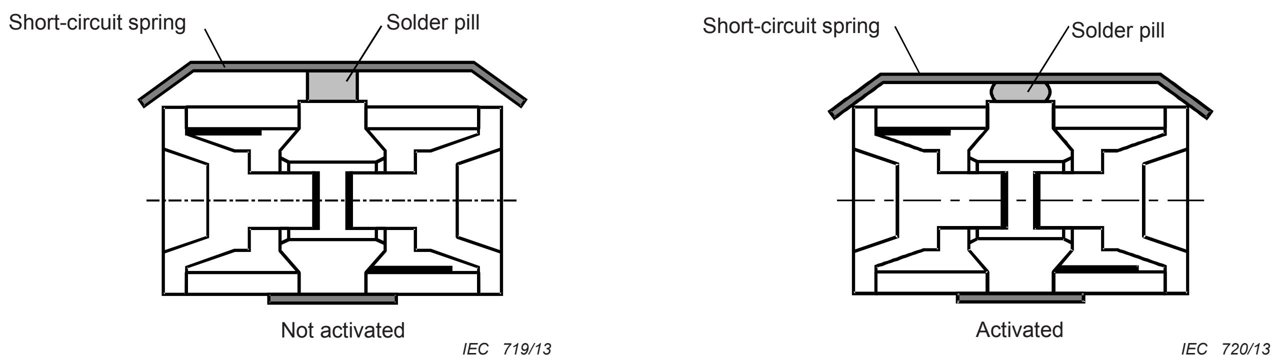


Figure 6 – Failsafe construction of a three-electrode GDT using a solder pill as sensitive spacer

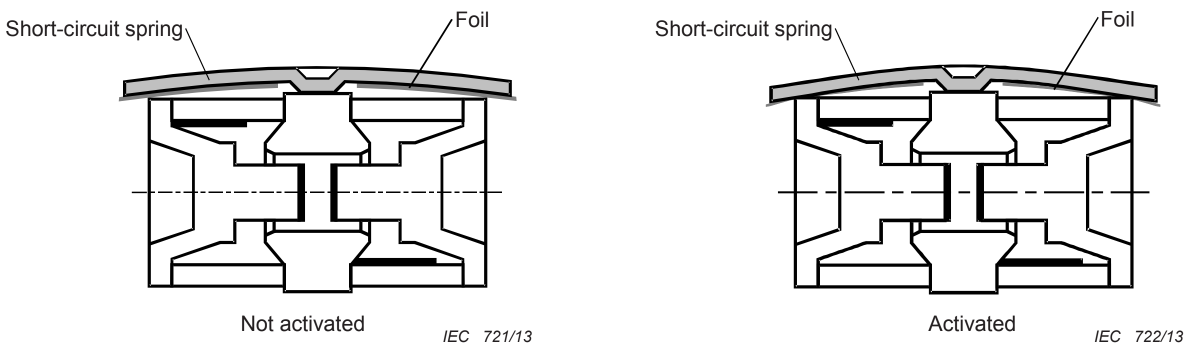


Figure 7 – Failsafe construction of a three-electrode GDT, using a plastic foil as sensitive spacer

8 Function

8.1 Protection principle

Generally, a spark-over occurs whenever surge voltages exceed the electric strength of a system's insulation. To prevent this system sparkover, a GDT with appropriate voltage limiting capabilities needs to be installed. A surge event exceeding the GDT spark-over voltage causes it to conduct, entering first into the glow mode, which in turn begins to limit the surge voltage magnitude. As the current increases the GDT then transitions from the glow mode to its arc mode. This further limits and lowers the surge voltage to around 10 to 35 V depending on the GDT technology. GDTs utilize this natural principle of limiting surge voltages. For the test circuits used to determine the parameters of a GDT see IEC 61643-311.

8.2 Operating mode

A simplified GDT can be compared with a symmetrical low-capacitance switch whose resistance may jump from several GΩ during normal operation to values <1 Ω after ignition caused by a surge voltage. The GDT automatically returns to its original high-impedance state after the surge has subsided.

Figure 1a shows the voltage curve at the GDT and Figure 1b the current as a function of time when limiting a sinusoidal voltage surge. Virtually no current flows during the time that the voltage rises to the spark-over voltage V_s of the GDT. After ignition, the voltage drops to the glow voltage level V_{gl} (70 to 200 V depending on the type, with a current of several 10 mA up to about 1,5 A) in the glow-mode range G. As the current increases further, transition to arc mode A occurs. The extremely low arc voltage V_a of 10 to 35 V typical for this mode is virtually independent of the current over a wide range. With decreasing over-voltage (i.e. in the second half of the wave), the current through the GDT decreases accordingly until it drops below the minimum value necessary to maintain the arc mode. Consequently, the arc discharge stops suddenly and, after passing through the glow mode, the GDT extinguishes at a voltage V_e.

The V/I characteristic of the GDT shown in Figure 1c was obtained by combining the graphs of voltage and current as a function of time.

8.3 Response behaviour

8.3.1 Static response behavior

If a voltage with a low rate of rise (typically 100 V/s) is applied to the GDT, the spark-over voltage Vs will be determined mainly by the electrode spacing, the gas type and pressure, and by the degree of pre-ionization of the enclosed noble gas. This ignition value is defined as the d.c. spark-over voltage.

8.3.2 Dynamic response behavior

At fast rate of rise, the spark-over voltage Vs of the GDT exceeds d.c. spark-over voltage. This effect is caused by the finite time necessary for the gas to ionize. All these dynamic sparkover voltages are subject to considerable statistical variation.

However, the average value of the spark-over voltage distribution can be significantly reduced by attaching the ignition aid to the inside surface of the GDT. This reduces the upper limit of the tolerance field considerably and also limits the spread of the spark-over voltage. The ignition voltage in this dynamic range is defined as the impulse spark-over voltage.

In general the two voltage rates of rise of 100 V/μs and 1 kV/μs are used to evaluate the dynamic characteristic of surge arresters (Figure 8).

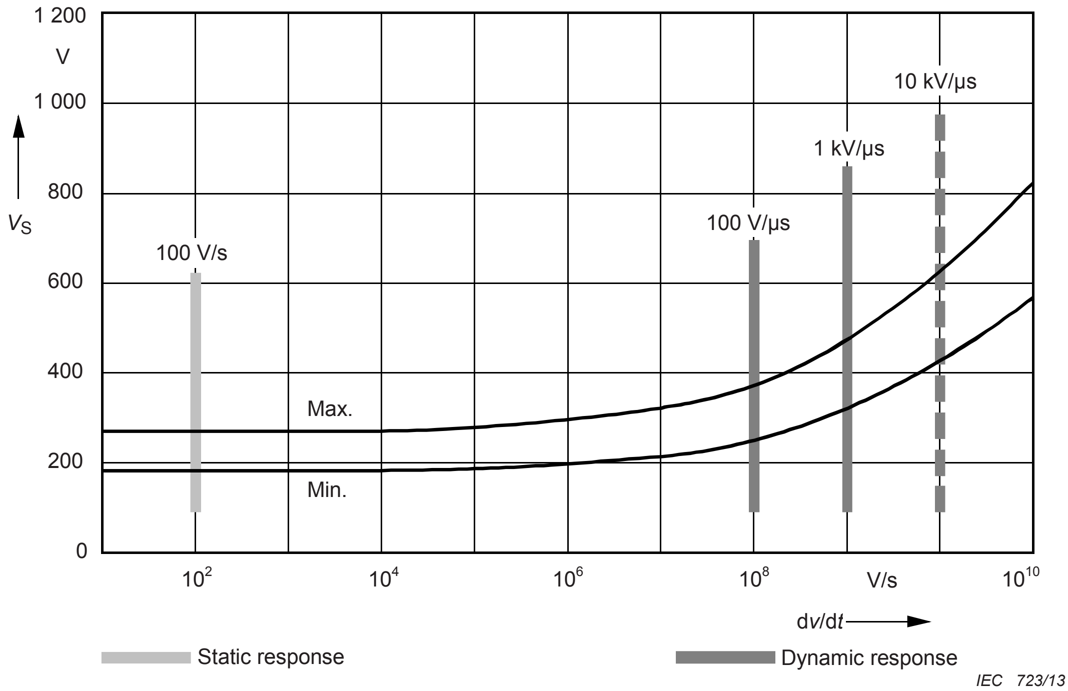


Figure 8 – Typical response behaviour of a 230 V GDT

Figure 9 shows an example of the correlation between the response time and the spark-over voltages.

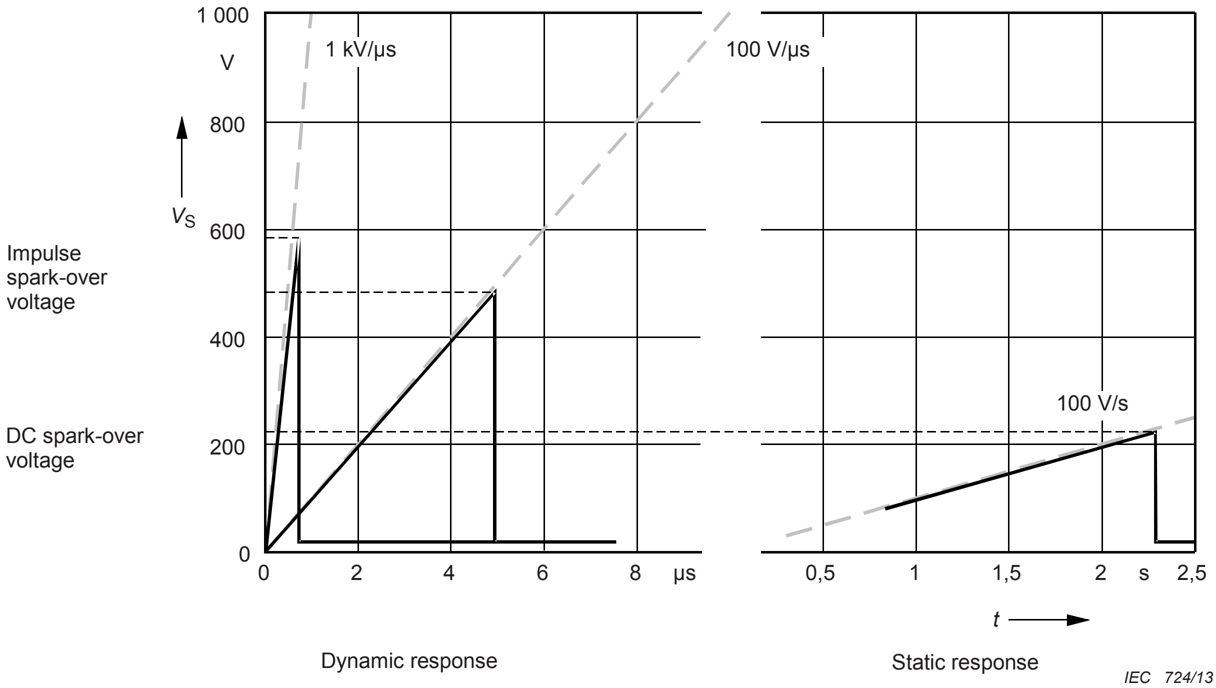


Figure 9 – Spark-over voltages versus response time

8.4 Fail-short (failsafe)

In the case of influences such as a direct contact between the power and telecommunication lines, current will flow through the ignited arrester for a long period of time. The GDT then heats up. When this happens, the hardware must be protected from thermal overload. The heating is detected by a fail-short (failsafe) mechanism. A spacer (solder pellet, plastic foil or mechanical device), which initially keeps the short-circuit spring at a distance from the electrodes, melts at a temperature determined by the choice of material used. The short-circuit spring, which is pre-stressed, then drops onto the electrodes and short-circuits them.

Furthermore, careful consideration must be given to long term power fault events that can cause GDT heating causing loss of the solder connections to the circuit board, before the operating temperature of the fail-short mechanism is reached.

Figure 10 shows a typical short-circuit characteristic as a function of the current flowing through the GDT. This characteristic can be affected by the thermal conductivity of the holder. Therefore the coordination between component and package must be subsequently verified by a type test.

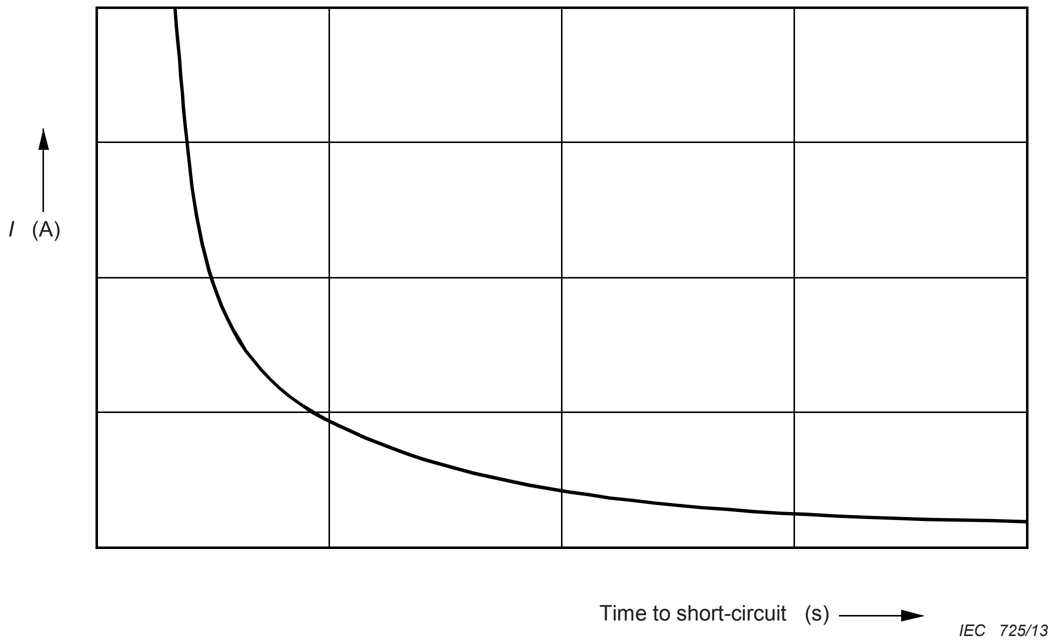


Figure 10 – Current through the GDT versus response time of fail-short (failsafe)

9 Applications

9.1 Protective circuits

9.1.1 General

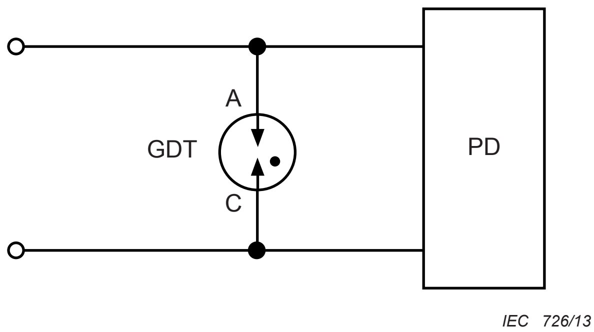
The following basic circuits illustrate standard configurations for GDTs used in protection circuits for the telecommunications sector. 2-point and 3-point protection solutions typically contain GDTs only, whereas 5-point protection solutions can make additional use of current-limiting components such as PTC thermistors, heat coils, fuses, or electronic current limiters.

NOTE 1 Designations a and b define the input side. Designations a' and b' define the protected side.

NOTE 2 In some cases series fuses are used to avoid excessive current flow in front of the GDTs (input side).

9.1.2 2-point (signal line) protection

A 2-point protection circuit is connected between A/C wires and operate by limiting the voltage between A/C and conducting the current from A to C. 2-point (signal) circuits are often run with no ground conductor. A two-electrode GDT circuit located between the two signal lines prevents the formation of large potential differences at the input of the equipment to be protected before they can cause any damage (Figure 11).



Components

PD protected device

Figure 11 – 2-point (Signal line) protection

9.1.3 3-point protection

3-point protection circuits are connected between the a/b wires and ground and operate by conducting voltage surges to ground and conducting voltage surges between a and b. Both two-electrode and three-electrode GDTs are used (Figures 12 and 13).

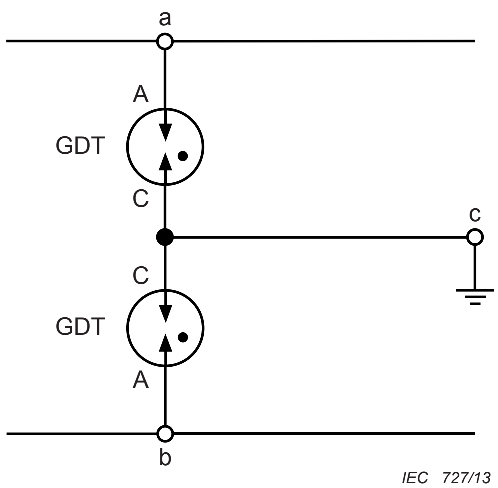


Figure 12 – 3-point protection using two-electrode GDTs

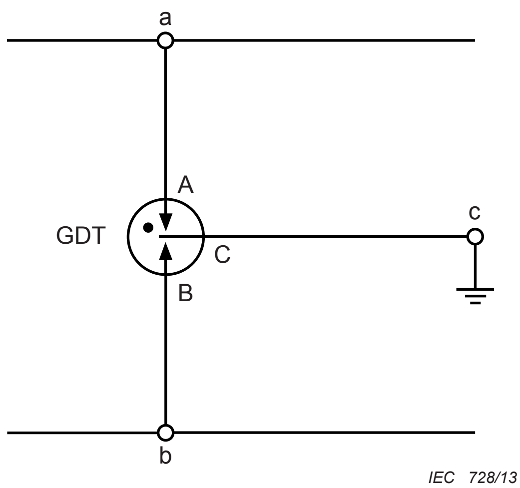
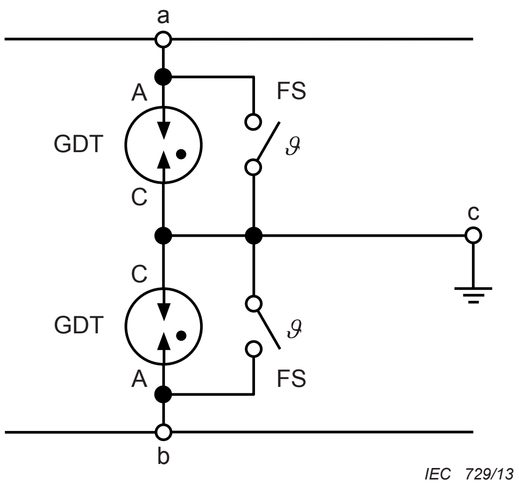


Figure 13 – 3-point protection using three-electrode GDTs

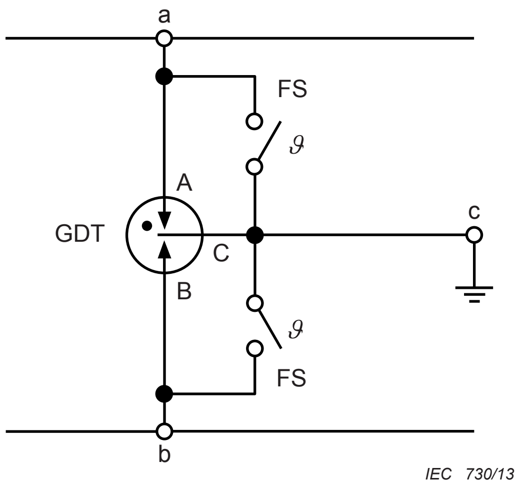
Figures 14 and 15 show another alternative using a GDT with fail-short mechanism



Components

FS fail short (failsafe) mechanism

Figure 14 – 3-point protection using two-electrode GDTs with fail-short



Components

FS fail short (failsafe) mechanism

Figure 15 – 3-point protection using three-electrode GDTs with fail-short

9.1.4 5-point protection

A 5-point protection circuit contains a current-limiting component, usually a PTC thermistor, in addition to the GDT. The thermistor blocks further current flow through it by assuming a very high resistance in the event of an overcurrent (see Figures 16 and 17). However, it may not always be possible to reset an activated thermistor in systems with constant current feed.

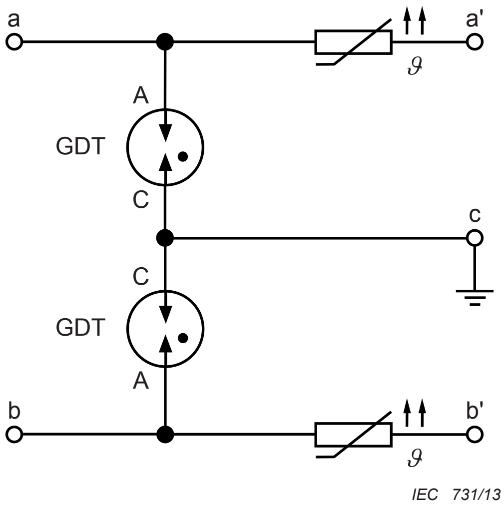


Figure 16 – 5-point protection using two-electrode GDTs

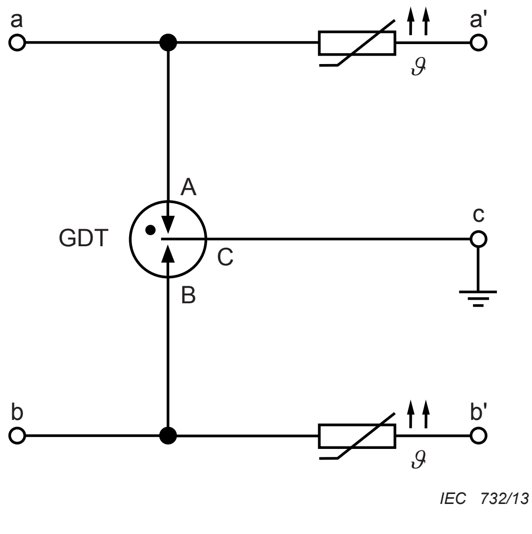
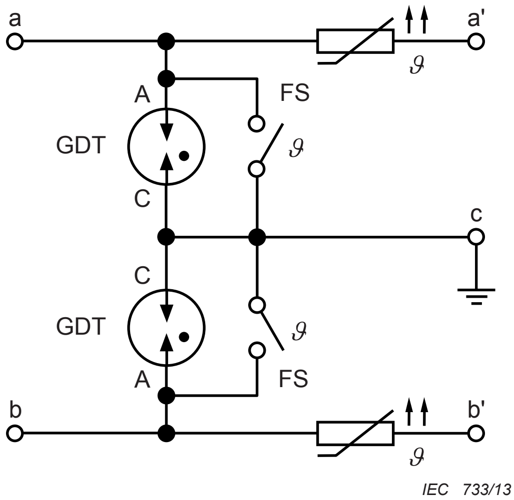


Figure 17 – 5-point protection using three-electrode GDTs

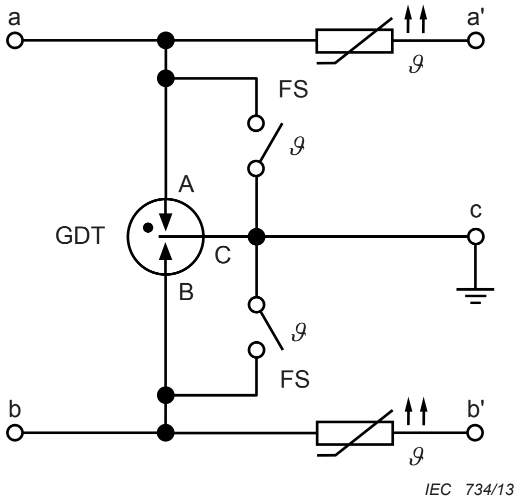
Figures 18 and 19 show another alternative using a GDT with fail-short mechanism



Components

FS fail short (failsafe) mechanism

Figure 18 – 5-point protection using two-electrode GDTs with fail-short



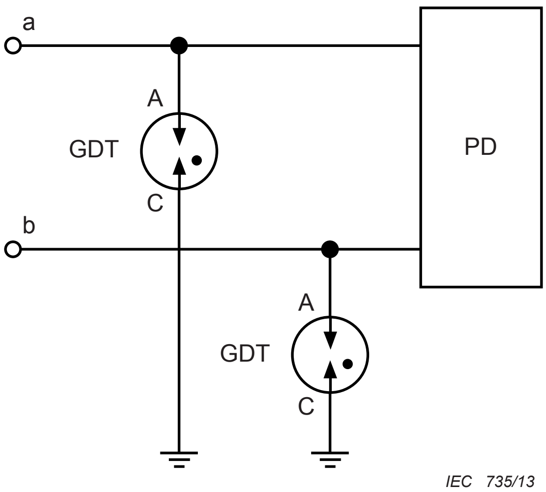
Components

FS fail short (failsafe) mechanism

Figure 19 – 5-point protection using three-electrode GDTs with fail-short

9.2 Telephone/fax/modem protection

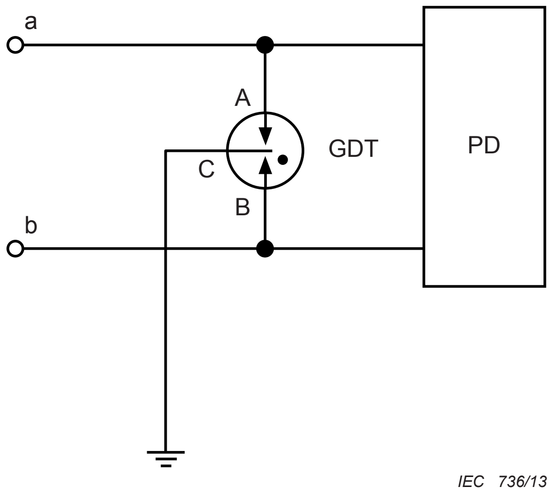
Telephones, faxes and modems are increasingly being equipped with sophisticated electronics. Typical circuits used to protect them with GDTs are shown in Figures 20 and 21. In the event of an overvoltage, the GDT protects both exchange lines by conducting the surge current away to ground.



Components

a tip
b ring
PD protected device

Figure 20 – Telephone/fax/modem protection using two-electrode GDTs



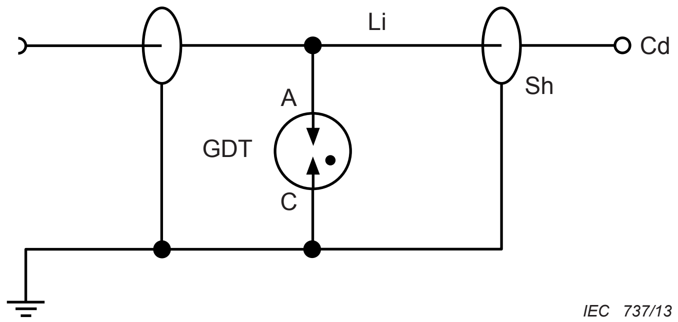
Components

a tip
b ring
PD protected device

Figure 21 – Telephone/fax/modem protection using three-electrode GDTs

9.3 Cable TV/coaxial cable protection

GDTs are particularly well suited for protecting coaxial cables frequently laid in CATV networks, as they do not disturb the system even at high frequencies thanks to their low self-capacitance of typically 0,5 to 1 pF. The GDT is contained in the coaxial protection module where it is connected between the central conductor and the shielding. It is recommended to ground either the shielding or the housing of the protection module, depending on the application (Figure 22).



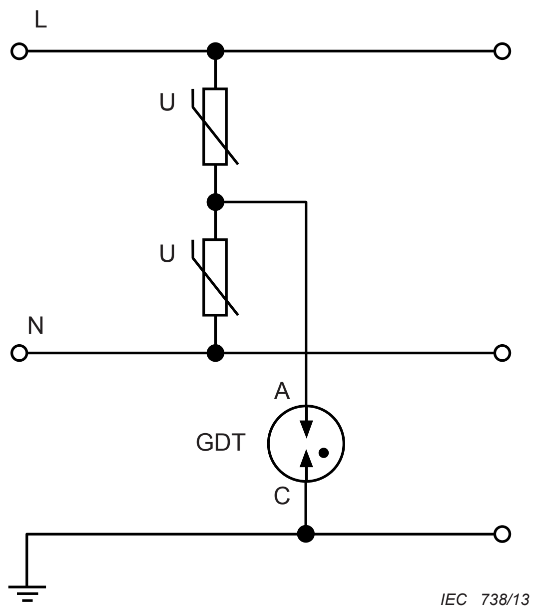
Components

Cd	conductor
Li	line / coax line
Sh	shielding

Figure 22 – Cable TV/ coaxial cable protection

9.4 AC line protection

Telecommunications installations as well as CATV amplifiers, CB transmitters, home entertainment systems, computers and similar equipment can be exposed to voltage surges conducted via the power network. The combination of a GDT and a varistor offers proven protection in these cases. The phase and neutral conductors are connected to ground potential of both protection elements (Figure 23).



Components

L	line
N	neutral

Figure 23 – AC line protection

Bibliography

IEC 60364-5-51:2005, *Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment – Common rules*

IEEE C62.45, *IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits,* 2002

DIN VDE 0845-1, *Protection of telecommunication systems against lightning, electrostatic discharges and overvoltages from electric power installations,* 1987

Environmental tests

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

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

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

IEC 60721-3-3, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 3: Stationary use at weatherprotected locations*

GDT component tests besides IEC 61643-311

IEEE C62.31, *IEEE Standard Test Specifications for Gas-Tube Surge-Protective Device Components,* 2006

ITU-T Recommendation K.12 (05/2010), *Characteristics of gas discharge tubes for the protection of telecommunications installations*

RUS, *Specification for Gas Tube Surge Arresters* (RUS Bulletin 345-83, PE 80, July 1979)

SPD tests

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

IEC 61643-21, *Low voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*

____

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.

...making excellence a habit.™