

ANTREX Electronics

Electronic Components Sourcing Information

Product Reference Information

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Note:

This PDF includes an ANTREX product reference cover page.

The original manufacturer datasheet follows from the next page.



Product Profile 2025

Surge Arresters and Switching Spark Gaps



www.tdk-electronics.tdk.com



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Important Notes

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule we are either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether a product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or life-saving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
3. **The warnings, cautions and product-specific notes must be observed.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous)**. Useful information on this will be found in our Material Data Sheets on the Internet (www.tdk-electronics.tdk.com/material). Should you have any more detailed questions, please contact our sales offices.
5. We constantly strive to improve our products. Consequently, **the products described in this publication may change from time to time**. The same is true of the corresponding product specifications. Please check therefore to what extent product descriptions and specifications contained in this publication are still applicable before or when you place an order.

We also **reserve the right to discontinue production and delivery of products**. Consequently, we cannot guarantee that all products named in this publication will always be available.

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6. Unless otherwise agreed in individual contracts, **all orders are subject to our General Terms and Conditions of Supply**.
7. **Our manufacturing sites serving the automotive business apply the IATF 16949 standard**. The IATF certifications confirm our compliance with requirements regarding the quality management system in the automotive industry. Referring to customer requirements and customer specific requirements ("CSR") TDK always has and will continue to have the policy of respecting individual agreements. Even if IATF 16949 may appear to support the acceptance of unilateral requirements, we hereby like to emphasize that **only requirements mutually agreed upon can and will be implemented in our Quality Management System**. For clarification purposes we like to point out that obligations from IATF 16949 shall only become legally binding if individually agreed upon.
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Release 2024-02

Cautions and Warnings

Correct application and strict adherence to the important information listed below will ensure optimum performance for the components specified in this brochure.

Please consult your local TDK sales organization if one or more limits cannot be adhered to.

- Do not continue to use damaged surge arresters.
- Surge arresters must be handled with care and must not be dropped.
- Do not operate surge arresters in power supply networks, whose maximum operating voltage exceeds the minimum sparkover voltage of the surge arresters.
- If the surge arresters are not properly contacted, current load can cause sparks and loud noises.
- Store surge arresters in original packaging only. Do not open the package prior to storage.
- Electromagnetic fields and ionizing radiation may affect the electrical characteristics of the arrester. The impact of such effects (inductive and capacitive field distortion from adjacent components) must be avoided by appropriate circuit design measures.
- Surge arresters may become hot in the event of longer periods of current stress (burn risk). In the event of overload the connectors may fail or the component may be destroyed.
- Leaded and SMD surge arresters should be soldered within 24 months after shipment.
- Operators who suffer from excessive sensitivity to metals should wear light gloves (e.g. cotton gloves) when performing manual assembly operations involving surge arresters.
- Do not continue to use surge arresters whose short-circuit mechanisms have been activated.
- Depending on the sensor material the short-circuit spring does not trigger until 140, 200, 260 or 300 °C is reached (see data sheets). Thermal radiation to adjacent components must be taken into consideration in the circuit design. Depending on the mounting position, the surge arrester may have to be secured by additional mechanical means.
- The follow current must be limited (see data sheets) so that the arrester can be properly extinguished when the surge has decayed. The arrester might otherwise heat up and ignite adjacent components.
- For SMD types the shown SMD pad dimensions represent a safe way to mount the surge absorber and are a recommendation of the manufacturer. During the reflow process it must be assured that no solder material reduces the insulation distance between the pads below the surge absorber.
- Do not continue to use surge arresters with an external short circuit mechanism whose short-circuit mechanisms have been activated.
- Surge arresters should be disposed of in the same way as household-type industrial waste. In individual cases, any specific local legal regulations departing from this rule must be observed.

Surge Arresters



Tried and tested billions of times over

Our customers include many international manufacturers and suppliers of telecommunication systems and manufacturers of surge voltage protection devices and installations. They appreciate our extensive range of types, which enables high flexibility in matching to the most diverse circumstances. They rely on the excellent quality with which we manufacture our arresters in large numbers, more than 400 million items annually.

The development of our surge arresters is based on international standards such as ITU-T, K.12, IEC 61643-311 (EN 61643-311), IEC 61643-11 (EN 61643-11), RUS PE-80/IEEE 465.1 and IEC 61643-21 (EN 61643-21). They are also used to enable modules/equipment to meet various regulatory requirements including ITU K20/K21, IEC 61000-4-5, Telcordia GR974/GR1089.

UL certification

Surge arresters from TDK are recognized to

- UL 497B under UL file E163070
- UL 497 under UL file E214013 and
- UL 1449 under UL file E319264

Surge arresters in brief

Gas-filled surge arresters operate on the gas-physical principle of the highly effective arc discharge. Electrically, surge arresters act as voltage-dependent switches. As soon as the voltage applied to the arrester exceeds the spark-over voltage, an arc is formed in the hermetically sealed discharge region within nanoseconds. The high surge current handling capability and the arc voltage, which is almost independent of the current, short-circuit the overvoltage. When the discharge has died down, the arrester extinguishes and the internal resistance immediately returns to values of several 100 MΩ.

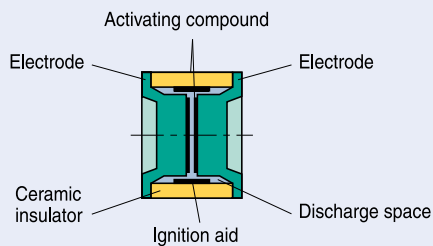
The surge arrester thus meets almost perfectly all requirements made on a protective element. It reliably limits the overvoltage to permissible values, and – under normal operating conditions – the high insulation resistance and the low capacitance contribute to the fact that an arrester has virtually no impact on the system to be protected.

Key characteristics

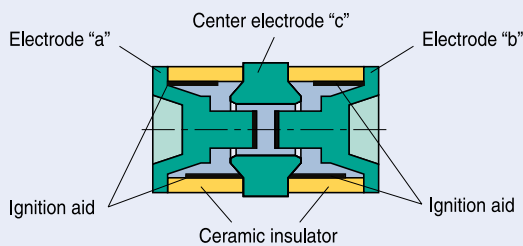
• DC spark-over voltage	70 ... 7500 V
• Impulse discharge current (8/20 μs)	max. 100 kA
• Impulse discharge current (10/350 μs)	max. 100 kA
• Alternating discharge current (1 s)	max. 100 A
• Alternating discharge current (0.2 s)	max. 300 A
• Arc voltage	10 ... 35 V
• Insulation resistance	typ. >10 GΩ
• Capacitance	typ. 1 pF

Construction

Basic construction of 2- and 3-electrode arresters

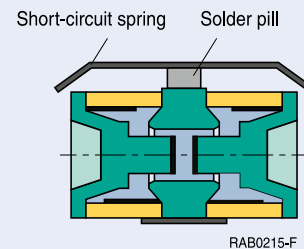


RAB0213-P

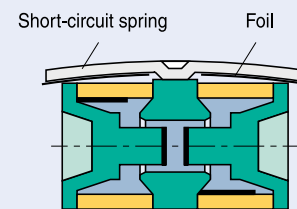


RAB0214-X Figure 1

Basic construction of 3-electrode arresters with failsafe function



RAB0215-F



RAB0312-N

Figure 2

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 surge arresters is based on this requirement.

Our proven technique of connecting insulator and electrode ensures a hermetically sealed discharge space. The type and pressure of the gas in the discharge space can thus be selected to achieve the required performance. Noble gases are predominantly used in gas-filled arresters since they ensure optimum electrical characteristics throughout the useful life of the component. An activating compound is applied to the electron emission surfaces of the electrodes, they themselves separated typically by less than 1 mm, to reduce the work function of the electrons and to guarantee the stability of the ignition voltage even after repeated current loads.

Gas-filled surge arresters feature an optimum balance of size, impulse discharge capability and longer than average service life.

To achieve an excellent response characteristic for fast rise time, an ignition aid is attached to the cylindrical inner surface of the insulator. This speeds up gas discharge by distorting the electric field. Our gas-filled arresters thus feature a fast response characteristic with high reproducibility. The electrical characteristics of the arrester such as DC spark-over voltage, pulsed and AC discharge current handling capability as well as 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.

Variants such as the 3-electrode arrester with an external short-circuit spring offer an additional protection in the event of contact between telecommunications and power lines and overheating. (For further information see page 10.)

Function

Limitation of a sinusoidal overvoltage by a surge arrester

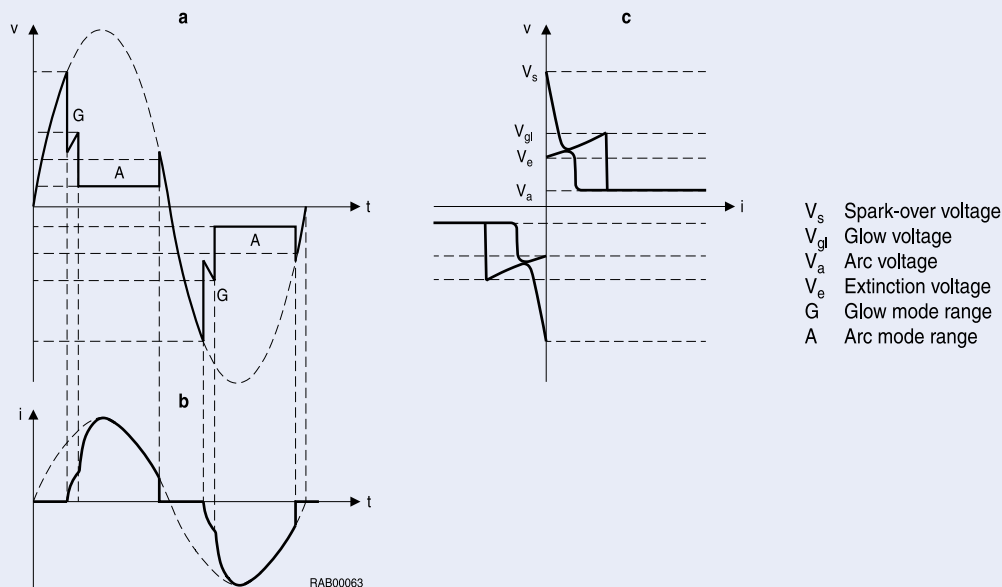


Figure 3

Protection principle

Generally, a spark-over occurs whenever surge voltages exceed the electric strength of a system's insulation. This discharge limits the surge voltage and reduces the interference energy within a short period of time. As the arc with its high current handling capability is ignited, it prevents a further rise in surge voltage due to its low arc voltage of some 10 V. Gas-filled arresters utilize this natural principle of limiting surge voltages.

Operating mode

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

Figure 3a shows the voltage curve at the arrester and **Figure 3b** the current as a function of time when limiting a sinusoidal voltage surge.

Virtually no current flows while the voltage rises to the spark-over voltage V_s of the arrester. 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 overvoltage (i.e. in the second half of the wave), the current through the arrester 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 arrester extinguishes at a voltage V_e .

The V/I characteristic of the surge arrester shown in **Figure 3c** was obtained by combining the graphs of voltage and current as a function of time.

Function

Typical response behavior of a 230-V arrester

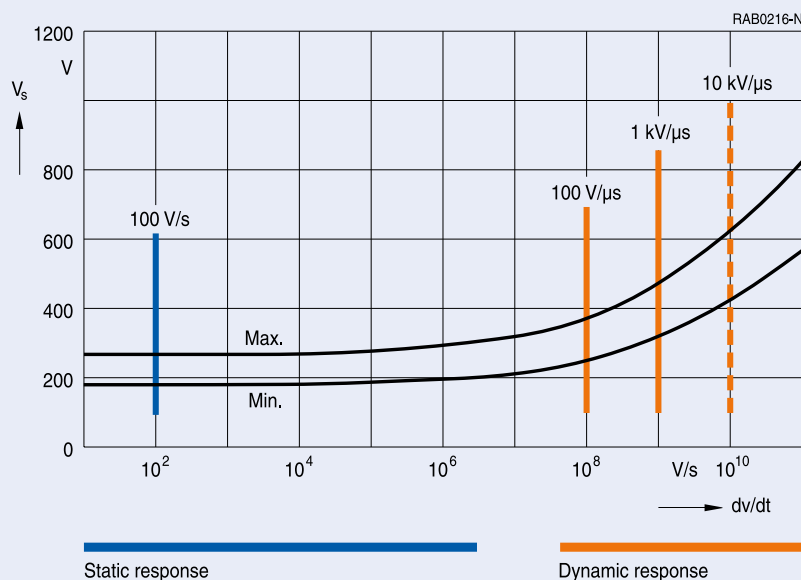


Figure 4

Response behavior

Static response behavior

If a voltage with a low rate of rise (typical 100 V/s) is applied to the arrester, the spark-over voltage V_s 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 DC spark-over voltage V_{sdc} .

Dynamic response behavior

At a fast rate of rise the spark-over voltage V_s of the arrester exceeds V_{sdc} . This effect is caused by the finite time necessary for the gas to ionize. All these dynamic spark-over 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 inner surface of the arrester. 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 V_{si} . Our gas-filled surge arresters are thus independent of permanent pre-ionization in order to reach this characteristic value (V_{si}), which is crucial for evaluating their protection quality in practical applications.

As a result of the harmonization of national and international specifications, the two voltage rates of rise of 100 V/μs and 1 kV/μs (ITU-T, K.12 and IEC 61643-311) are used to evaluate the dynamic characteristic of surge arresters. An example for other rates of rise is shown in **Figure 4**.

Extinguishing characteristics

AC operation:

After the surge has subsided, the arrester normally extinguishes since its arc voltage drops below the minimum value in the subsequent zero crossing of the AC voltage. However, this behavior does not apply to operation with a low-resistance power supply. In this case it is essential to consider the very low internal resistance of the line and of the ignited surge arrester. The maximum permissible follow current of the arrester may be exceeded between the decay of the surge and the subsequent zero crossing. This follow current can reach values up to several 1000 A (refer to page 12).

Note: The follow current must be limited so that the arrester can properly extinguish when the surge has decayed. The arrester might otherwise heat up and ignite adjacent components. It is mandatory to check for flawless extinguishing in the user circuit.

Failsafe characteristic

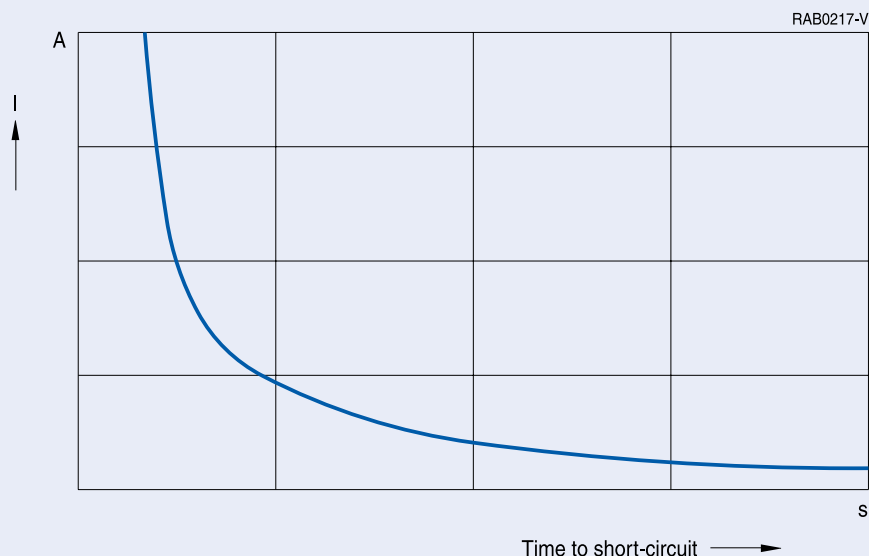


Figure 5

DC operation:

This condition can be found in the protection of telecommunication systems. When continuously operated with DC voltage, the surge arrester must be able to extinguish after the surge has subsided. Surge arresters easily satisfy this requirement when used in communication circuits as these are usually highly resistive throughout. In the case of systems with higher DC voltages or low resistance the arrester's extinguishing characteristics must be examined in each individual case.

The following condition(s) must be achieved in order for the surge arrester to extinguish properly:

- The DC operating voltage is lower than the minimum arc voltage (10 to 35 V depending on the type), or
- the DC operating voltage is lower than the glow voltage (60 to 200 V depending on the type).

In the latter case it must be ensured that the maximum current drawn from the operating voltage source can no longer maintain the arc discharge mode (several 100 mA depending on the type) after the surge has subsided.

Note: The follow current must be limited in both, AC and DC operations, so that the arrester can properly extinguish when the surge has decayed. The arrester might otherwise heat up and ignite adjacent components. It is mandatory to check that the arrester works in all AC or DC applications and extinguishes properly.

Failsafe function

In case of direct contact between power and telecommunication lines, current will flow through the ignited arrester for a long period of time. The arrester then heats up. When this happens, the hardware must be protected from thermal overload. The heating is detected by a failsafe mechanism. The spacer (solder pellet or plastic foil) that 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, to which a bias tension is applied, then drops onto the arrester body and short-circuits the electrodes.

Figure 5 shows a typical short-circuit characteristic as a function of the current flowing through the arrester. This characteristic can be affected by the thermal conductivity of the holder. The coordination between component and package must therefore be subsequently verified by a type test.

Note: The materials used in the sensor to monitor arrester temperature are triggered at temperatures above 200 °C (solder) or 140 °C/260 °C (plastic foil) depending on their composition. The melting temperatures of the solder or plastic foil are up to 300 °C. These temperatures exceed the melting point of standard commercial soft solders used in further processing. This discrepancy must be considered when deciding on the location of the arrester, which may have to be additionally secured by mechanical means. Thermal radiation to adjacent components is another factor of importance.

PSpice Model

PSpice model for surge arresters

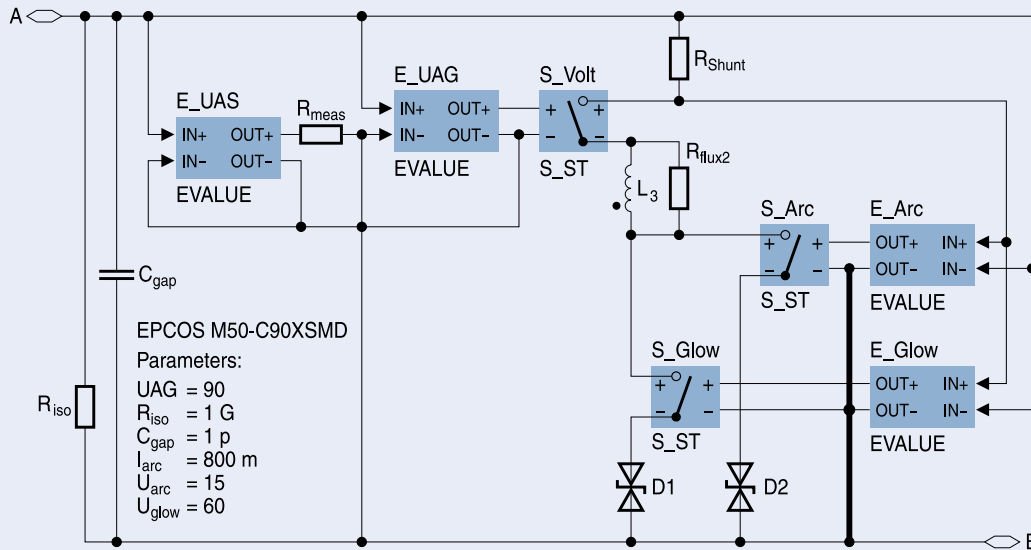


Figure 6

Simulation of surge arrester

PSpice model for surge arresters – analog behavioral model for circuit simulation

Our PSpice model for surge arresters allows users to fit surge arresters into their designs at an early stage of development. Before the first prototype is built the model allows designers to simulate any effects which may occur during normal operation as well as the behavior of the entire circuit under surge. This offers significant advantages such as cost savings and shorter development times for new designs.

A PSpice model is available upon request for every arrester from our product range.

Applications

- Analog circuit simulation
- System design and verification
- Functional verification
- Surge simulation

Notes for Applications with Follow Current

Follow current effect

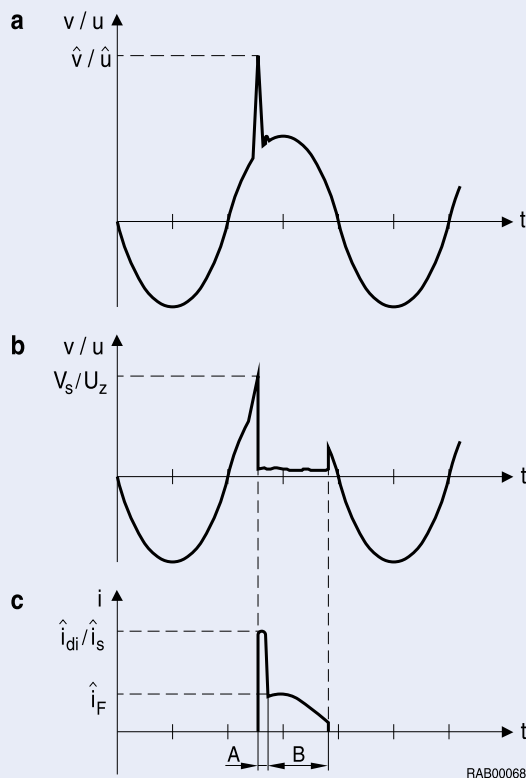


Figure 7

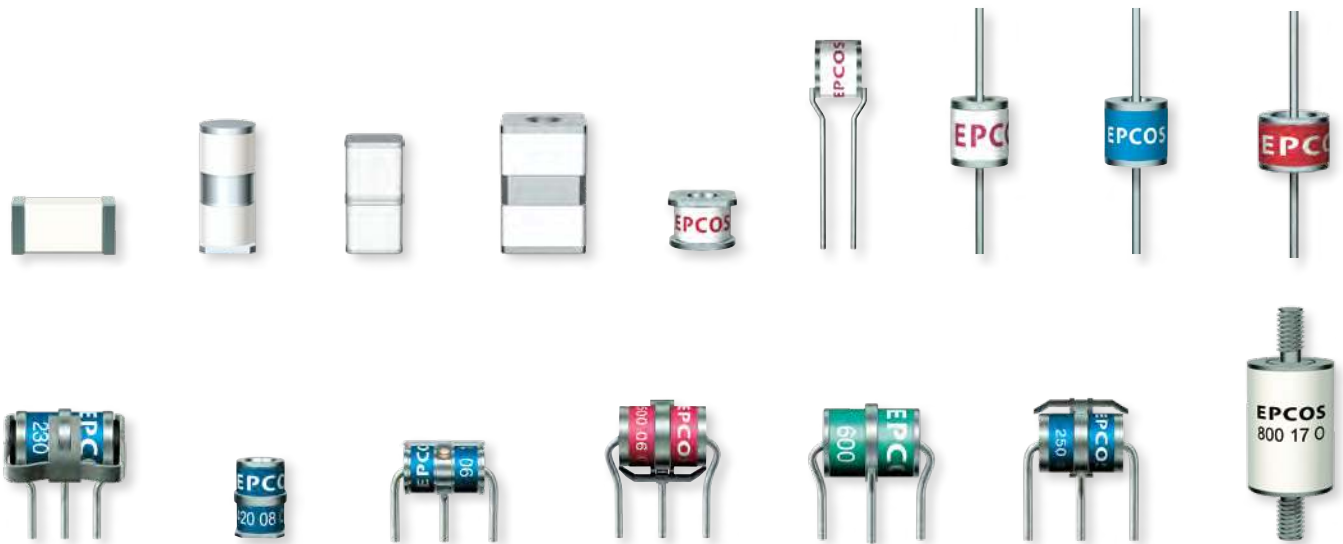
Surge arresters must not be operated directly in power supply networks. (Exception: surge arrester with sufficient follow current capability, see page 57). Because of the extremely low internal resistance of these networks, an excessive current which as a rule exceeds the permissible follow current would flow through the ignited arrester.

The arrester no longer extinguishes and can reach very high temperatures.

Varistors connected in series with the arrester are well suited for limiting the follow current. Our metal oxide varistors offer high reliability for this application. The table below shows a selection of these components. To stop the arrester from responding during normal operation, a permissible tolerance of the line voltage of +10% and a possible derating of the arrester of -20% were taken into account.

Line voltage V_{rms} (V)	Follow current arrester		Varistor	
	Type	Ordering code	Type	Ordering code
110	EF270X	B88069X4131S102	S20K150	B72220S0151K101
230	EF470X	B88069X5080S102	S20K250	B72220S0251K101
400	EF800X	B88069X2641S102	S20K460	B72220S0461K101

Note: In the event of particularly frequent and severe surges as well as large fluctuations in line voltage, the dimensioning for each individual combination must be checked.



Surge Protection for Telecom Applications

Telecom Applications

Infrastructure base stations/fixed network

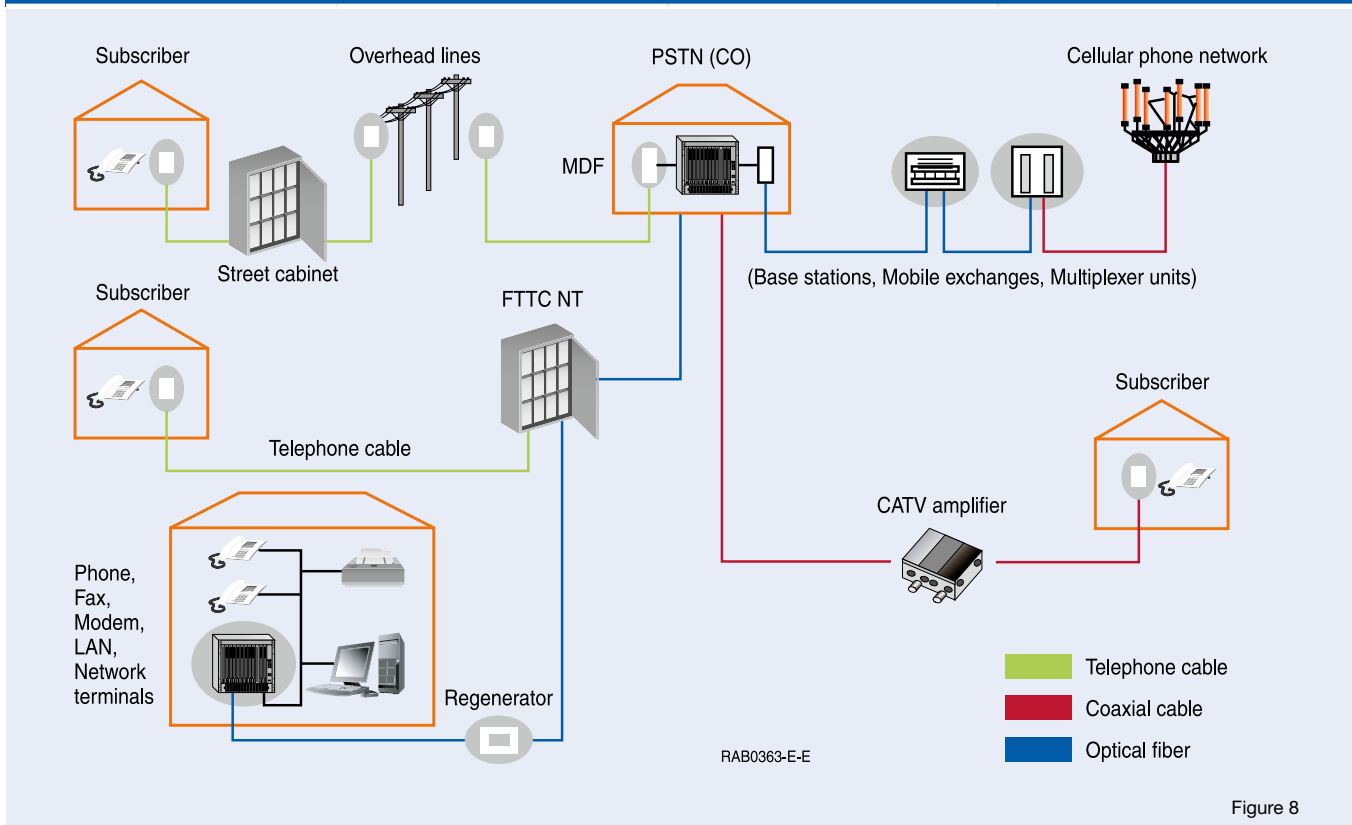


Figure 8

Gas-filled surge arresters are classic components for protection of telecommunication installations. It is essential that IT and telecommunication systems – with their high-grade but sensitive electronic circuits – be protected by arresters. They are thus fitted at the input of the power supply system together with varistors and at the connection points to telecommunication lines. They have become equally indispensable for protecting base stations in mobile telephone systems as well as extensive cable television (CATV) networks with their repeaters and distribution systems.

These protective components are also indispensable in other sectors:

- In AC power transmission systems, where they are often used with current-limiting varistors
- In customer premises equipment such as DSL modems, WLAN routers, TV sets and cable modems
- In air-conditioning equipment

The integral black-box concept offers graduated protection by combining arresters with varistors, PTC thermistors, diodes and inductors to create an ideal solution for many applications.

Basic circuit configurations

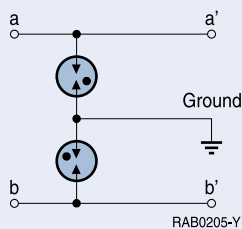


Figure 9

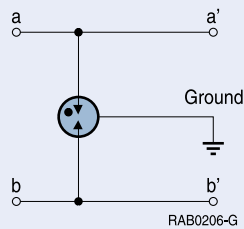


Figure 10

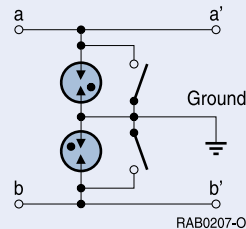


Figure 11

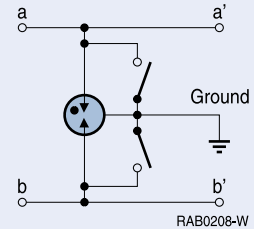


Figure 12

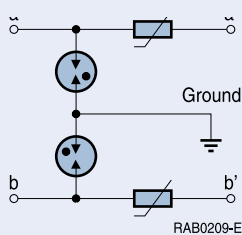


Figure 13

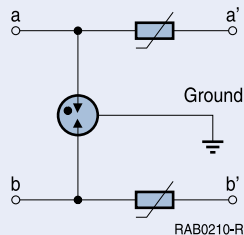


Figure 14

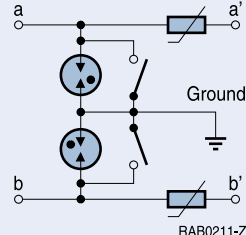


Figure 15

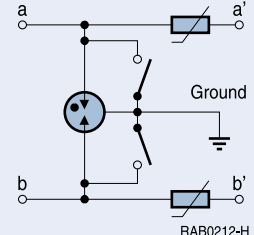


Figure 16

Protective circuits

The following basic circuits illustrate standard configurations for surge arresters used in protection circuits for the telecommunications sector. 3-point protection solutions contain only an arrester whereas 5-point protection solutions make additional use of current-limiting components such as PTC thermistors.

3-point protection

3-point protection circuits are connected between the a/b wires and ground and operate by conducting the voltage surge to ground. Both 2-electrode (**Figure 9**) and 3-electrode arresters (**Figure 10**) are used. Arresters with a failsafe mechanism (**Figures 11** and **12**) represent another alternative. For further information about this variant see page 10.

5-point protection

A 5-point protection circuit contains a current-limiting component, usually a PTC thermistor, in addition to the arrester. The thermistor blocks further current flow through it by assuming a very high resistance in the event of an overcurrent.

Figures 13 and **14** show circuits with 2-electrode and 3-electrode arresters, while **Figures 15** and **16** show variants with a failsafe mechanism (for details refer to page 10). However, it may not always be possible to reset an activated thermistor in systems with constant current feed.

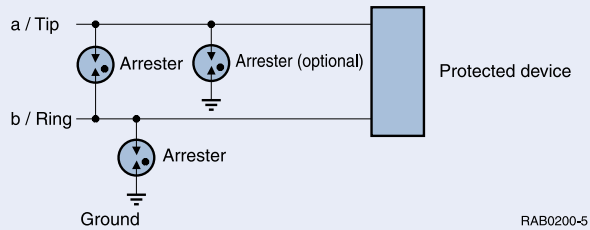
Telecom Applications

Telephone/fax/modem protection

Typical:

- 230-V arrester
- 350-V arrester

Two 2-electrode arresters



One 3-electrode arrester

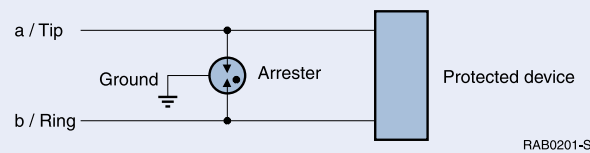


Figure 17

Signal line protection

Typical:

- 75-V arrester
- 90-V arrester
- 230-V arrester

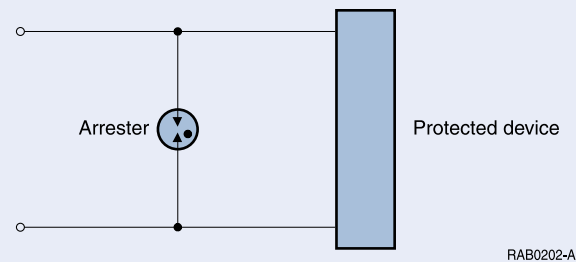


Figure 18

Telephone/fax/modem protection

Telephones, faxes and modems are equipped with sophisticated but sensitive electronics. Typical protection circuits with surge arresters are shown in **Figure 17**. These arresters protect against common-mode interference voltages, i.e. surge voltages that appear in both lines to ground. In the event of an overvoltage, the arrester protects both exchange lines by conducting the surge current away to ground.

Signal line protection

Signal circuits are often run with no ground conductor. A 2-electrode arrester 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 18**). This circuit offers differential-mode protection.

Telecom Applications

Overvoltage protection of Ethernet interfaces

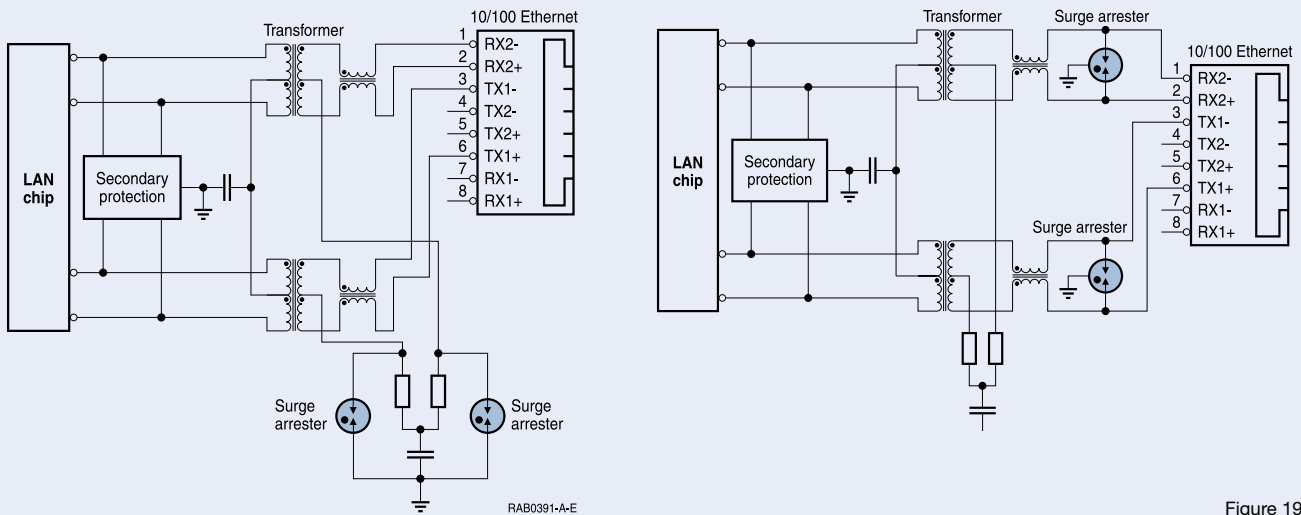


Figure 19

Data line protection (RS485)

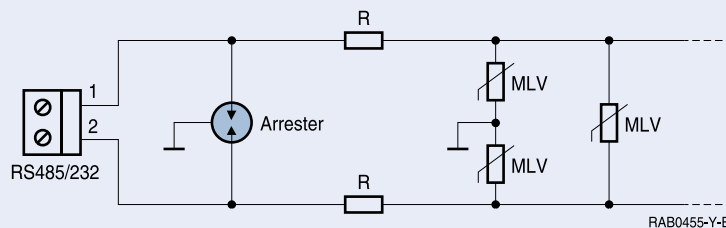


Figure 20

Protection of Ethernet interfaces

Voltage surges in telecommunication systems caused by lightning or line power faults can damage sensitive electronic circuitry.

Protection components are used inside the device interfaces to avoid such damage. TDK offers surge arresters with 2- and 3-electrodes especially designed to protect data interfaces.

The design activities focused on achieving small SMD housing, high current capability, high insulation resistance and low capacity.

Typical applications are Ethernet interfaces in routers and switches, patch panels, modems, PCs and laptops, set-top boxes, IP-TV, CCTV, WLAN-AP.

Examples for the application of surge arresters can be found in **Figure 19**.

Data line protection (RS485)

RS485 interfaces are used for serial data transmissions in a wide range of computer, telecommunications and automation systems. At the receiver, the data signal is determined from the difference between the two signal levels, making data transmission less susceptible to common-mode interference.

A typical circuit for protection against voltage surges consists of a primary side with surge arresters and a secondary side with multilayer varistors (MLV) (see **Figure 20**).

Telecom Applications

CATV/Coax line protection

Typical:

- 145-V arrester
- 150-V arrester
- 230-V arrester

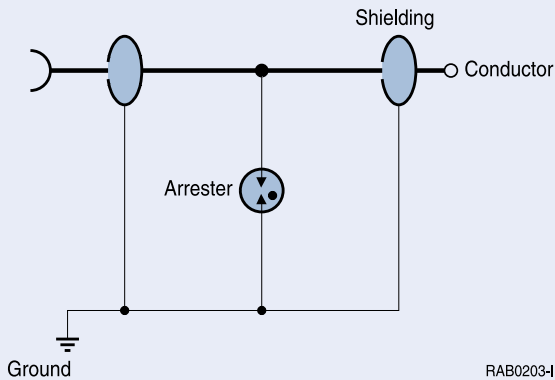


Figure 21

AC line protection

Typical:

- 270-V arrester for 110 VAC
- 470-V arrester for 230 VAC
- 600-V arrester for 230 VAC
- 800-V arrester for 400 VAC

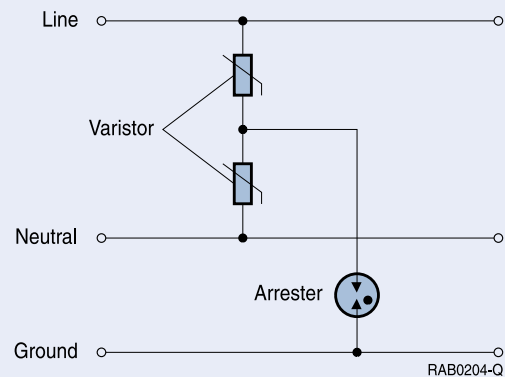


Figure 22

Cable TV/coaxial cable protection

Arresters are particularly well suited for protecting the 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 typ. 0.5 to 1 pF. The arrester 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 21).

AC line protection

Telecommunication installations as well as CATV amplifiers, CB transmitters, home entertainment systems, computers and similar equipment can be exposed to voltage surges via the power network. The combination of a surge arrester and a varistor offers proven protection in these cases. The phase and neutral conductors are connected to ground potential of both protection elements (Figure 22).

TDK arresters can be used in SPDs (surge protective devices), to fulfill IEC 61643-11 class I, II or III requirements. Please refer to chapter *Surge Protection of AC/DC Power Lines*, starting from page 56.

Definitions, Measuring Conditions

Spark-over voltages

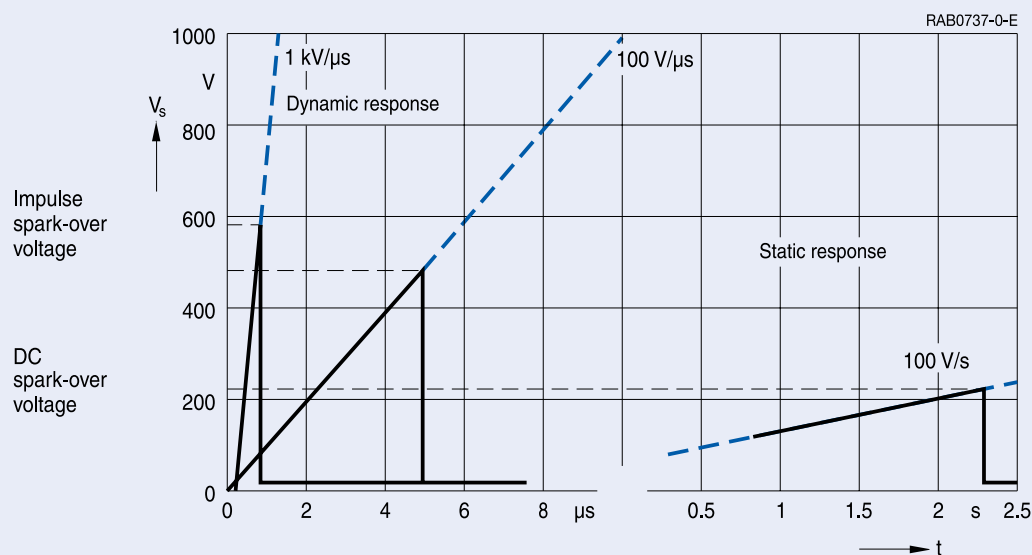


Figure 23

DC spark-over voltage

This voltage is determined by applying a voltage with a low rate of rise $dv/dt = 100 \text{ V/s}$ (Figure 23). Due to the physical phenomenon of a gas discharge the values are subject to statistical variation.

Tolerance

The tolerance in % is generally specified as a percentage of V_{sdCN} . Tolerance specifications take into account individual and batch variations in arrester production.

Impulse spark-over voltage

The impulse spark-over voltage characterizes the dynamic behavior of a surge arrester (Figure 23). The values specified in the product part refer to a voltage rise rate of $dv/dt = 100 \text{ V}/\mu s$ and $1 \text{ kV}/\mu s$.

Definitions, Measuring Conditions

Standard impulse discharge current 8/20 μ s

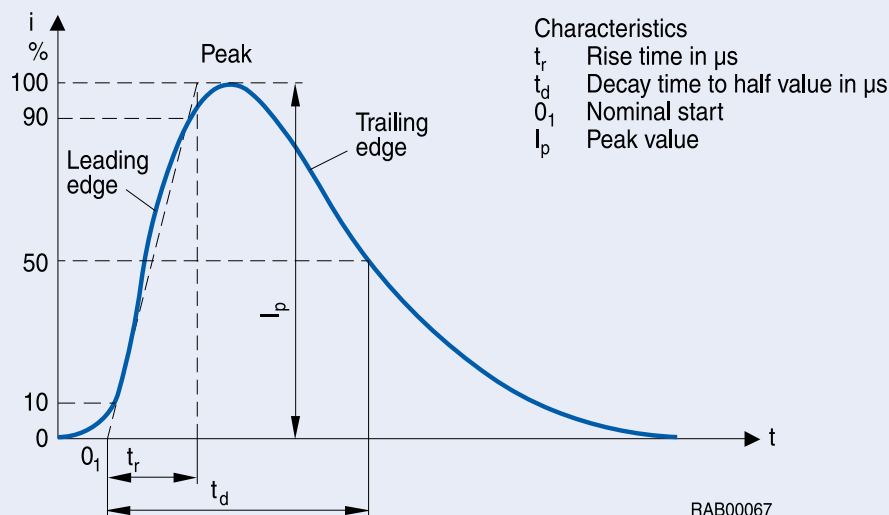


Figure 24

Service life

Alternating discharge current

This is the RMS value of an AC current with a frequency of 15 Hz to 62 Hz, which the gas discharge tube is designed to carry for a defined time.

e.g.

ITU-T K12: 10 operations at 50 Hz, 1 s

RUS PE 80: 11 cycles at 60 Hz (9 cycles at 50 Hz)

Impulse discharge current

This is the peak value of the impulse current, with a wave form defined with reference to the time, for which the gas discharge tube is rated.

Wave form is defined in IEC 62475 as rise time/ decay time to half value (see **Figure 24**), e.g. wave form 8/20 μ s surge current with rise time of 8 μ s and decay time to half value of 20 μ s.

e.g.

ITU-T K12:

- 10 operations with rated discharge current 8/20 μ s
- 1 operation with rated discharge current 10/350 μ s
- 300 operations with rated discharge current 10/1000 μ s

Maximum follow current

For the type series EF (data sheet see page 43) we specify this performance feature as the maximum permissible peak current which may flow from the supply current source through the arrester in the interval between the decay of the surge and the following zero crossing of the AC voltage. This discharge may be repeated ten times with an interval of 30 s.

For notes about power line applications refer to page 12.

Insulation resistance

Ohmic resistance of the non-ignited arrester:

- Requirement of ITU-T K12 $>10^9 \Omega$
- TDK surge arresters¹⁾ $>10^{10} \Omega$

As a rule the arrester is tested with a voltage of 100 V DC. This value is reduced to 50 V DC for types with 90 and 150 V DC.

Capacitance

Self-capacitance of the arrester without holder:

- Requirement of ITU-T K12 $<20 \text{ pF}$
- TDK surge arresters 0.2 ... 3 pF (depending on type)

¹⁾ Unless otherwise specified

Definitions, Measuring Conditions

Return loss, S11

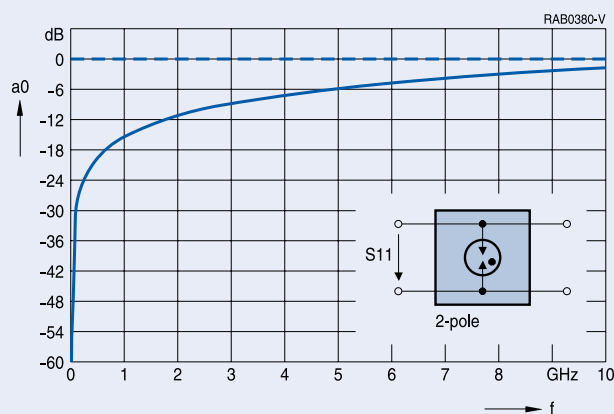


Figure 25

Insertion loss, S21

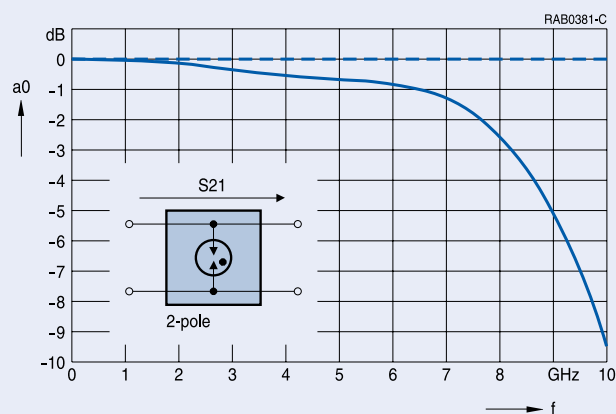


Figure 26

Test configuration for 3-electrode arresters

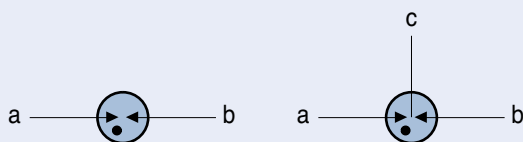
The specified parameters as spark-over voltage, insulation resistance and capacitance refer to the respective measurements between one of the two wire electrodes (a/b) and the center electrode (c).

Unless otherwise specified, the impulse or AC current is applied simultaneously from the two line electrodes to the center electrode with the defined value as the total current through the center electrode (c).

S-parameters

Surge arresters are preferred in high-frequency applications due to their low capacitance and high insulation resistance. The impact of surge arresters on the performance of electrical networks is extremely small. S-parameters can be an essential tool for design. A typical application is shown in **Figure 21**. The most important parameters of such a two-port network are S11 (input return loss) and S21 (insertion loss). Typical behavior of S11 and S21 versus frequency are shown in **Figure 25** and **Figure 26**.

Circuit symbol for 2-electrode and 3-electrode arrester:



a, b Line (tip/ring) electrode
c Center electrode

Overview of Types

2-electrode arresters

										
Type series	S25 / S20	G3 / G41	S30	ES	EM	EHV6	S5B	M5	EC	D06/D08
Discharge class ¹⁾ kA / A	Light-duty types									
	0.5 / –	1 / –	2 / 2	2.5 / 2.5	2.5 / 2.5	3 / –	5 / 5	5 / 5	5 / 5	10 / 10
Dimensions mm (Ø x l)	3.2 x 1.6 x 1.6/ 3.2 x 2.5 x 2.5	2.8 x 3.5/ 4 x 5.1	4.5 x 3.2 x 2.7	4.7 x 4.0	5.5 x 6.0	6 x 7	5.7 x 5 x 5	5 x 5	8 x 6	6.5 x 2.3/ 8 x 2.3
Page	26	27/28	29	30	31	32	33	34	35	36
$V_{sdcN}^{2)} / U_{agN}^{2)}$ V										
75										
90										
140										
150										
200										
230										
250										
260										
300										
350										
400										
420										
470										
500										
600										
800										
900										
1000										
2000										
2500										
3000										
3600										
4000										
4500										
Typical applications	Customer premises equipment such as DSL modems, WLAN routers, TV sets and cable modems.									

Surge arresters are usually classified by their discharge capability.
The overview above relates type series to discharge classes and shows the available voltage ratings.
According to their discharge class the individual type series can be assigned to typical applications.

¹⁾ Surge current: 10 x 8/20 µs wave in total; AC current: 10 x 1 s / 50 Hz in total

²⁾ Nominal DC spark-over voltage

Overview of Types

2-electrode arresters							
							
Type series	N8	A7 / A9	S8A	A8	A83	EF	V1
Discharge class ¹⁾ kA / A	Medium-duty types		Heavy-duty types				
	10 / 10	10 / 10	20 / 20	20 / 20	20 / 20	5 / 5	20 / 20
Dimensions mm (Ø x l)	8 x 6	8 x 8 / 9 x 9	6 x 8.3 x 8.3	8 x 6	8 x 20	8 x 6	11.8 x 17.4
Page	37	41/42	38	39	40	43	44
$V_{sdN}^{(2)}$ (V) $U_{agN}^{(2)}$ (V)							
75							
90							
150							
170							
230							
250							
270							
350							
470							
500							
600							
800							
1000							
1200							
1400							
1500							
1600							
2200							
2500							
3000							
3500							
4500							
5500							
6200							
7500							
Typical applications	Crossover junctions for overhead cables, underground cables, subscriber protection		Overhead lines and installations particularly susceptible to lightning threats, subscriber protection in exposed locations				

Overview of Types

3-electrode arresters

										
Type series	TG3	TQ30F	T4N	TQ9	T9	T3	T8	T2	T6	T2 (US spec.)
Discharge class ¹⁾ kA / A	Light-duty types		Medium-duty types					Heavy-duty types		
	2 / 2	2 / 2	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	20 / 10	20 / 20	20 / 10
Dimensions mm (Ø x l)	6.8 × 3.5	2 × 6.2	14.3 × 8.3	7.6 × 5 × 5	7.6 × 5	8 × 6	10 × 8	10 × 8	11.5 × 9.5	8 × 10
Page	46	46	45	46	47	48	49/50/51	52/53	54	55
$V_{sdnN}^{(2)}$ (V) $U_{agn}^{(2)}$ (V)										
75										
90										
150										
230										
250										
260										
300										
350										
400										
420										
470										
500										
600										
650										
Typical applications	Protection of data lines		Main distributor and subscriber protection in regions with high frequency of lightning strikes	Crossover junctions for overhead cables, underground cables, subscriber protection				Overhead lines and installations particularly susceptible to lightning threats, subscriber protection in exposed locations		

Surge arresters are usually classified by their discharge capability.
The overview above relates type series to discharge classes and shows the available voltage ratings.
According to their discharge class the individual type series can be assigned to typical applications.

¹⁾ Surge current: 10 x 8/20 µs wave in total;
AC current: 10 x 1 s / 50 Hz in total

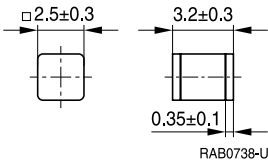
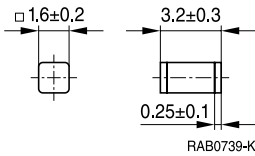
²⁾ Nominal DC spark-over voltage

Designation System

2-electrode arresters				
Example: M51-A350XG				
Type	Dimensions	Discharge class	Page	
G30/ G31	ø 2.8 × 3.5 mm	1 kA / –	27	M5
S20	3.2 × 1.6 × 1.6 mm	0.5 kA / –	26	
S30	4.5 × 3.2 × 2.7 mm	2 kA / 2 A	29	
EHV6	ø 6 × 7 mm	3 kA / –	32	
M5	ø 5 × 5 mm	5 kA / 5 A	34	
S5B	5.7 × 5 × 5 mm	5 kA / 5 A	33	
S8B	6 × 8.4 × 8.4 mm	20 kA / 20 A	38	
N8	ø 8 × 6 mm	10 kA / 10 A	37	
A8/ A83	ø 8 × 6 mm, 8 × 20 mm	20 kA / 20 A	39, 40	
A7/ A9	ø 8 × 8 mm, 9 × 9 mm	10 kA / 10 A	41, 42	
V1	ø 11.8 × 17.4 mm	20 kA / 20 A	44	
Lead styles		without leads	0	1
		straight leads	1	
Internal identification (e.g. -A, -C, -H) V _{sdn} following A or C is specified in V, following H in 100 × V				-A
Nominal DC spark-over voltage (e.g. 90 V, 230 V, 350 V, 600 V)				350
Internal coding			X	X
Taped on reel			G	G
Example: EM350XG				
Type	Dimensions	Discharge class	Page	
ES	ø 4.7 × 4 mm	2.5 kA / 2.5 A	30	EM
EM	ø 5.5 × 6 mm	2.5 kA / 2.5 A · 2 kA / 2 A; 1.5 A	31	
EC, EF	ø 8 × 6 mm	5 kA / 5 A	35, 43	
Nominal DC spark-over voltage (e.g. 90 V, 230 V, 350 V, 400 V, 600 V)				350
Internal coding			X	X
Taped on reel			G	G
3-electrode arresters				
Example: T80-A230XF				
Type	Dimensions	Discharge class	Page	
TG3	ø 3.5 × 6.8 mm	2 kA / 2 A	46	T8
TQ90	7.6 × 5 × 5 mm	10 kA / 10 A	46	
T9	ø 5 × 7.6 mm	10 kA / 10 A	47	
T3	ø 6 × 8 mm	10 kA / 10 A	48	
T8	ø 8 × 10 mm	10 kA / 10 A	49, 50, 51	
T2	ø 8 × 10 mm	20 kA / 10 A	52, 53	
T6	ø 9.5 × 11.5 mm	20 kA / 20 A	54	
T2 (US spec.)	ø 8 × 10 mm	20 kA / 10 A / –	55	
Lead styles		without leads	0	0
		straight leads	1	
		standard	3	
		short leads	5	
Internal identification (e.g. -A, -C)				-A
Nominal DC spark-over voltage (e.g. 90 V, 230 V, 350 V, 600 V)				230
Internal coding			X	X
Position short-circuit spring		undefined	F	F
		on top	F1	
		below	F4	

If the meaning of the other code letters and numbers is unclear to you, inquire at TDK.

2-Electrode Arresters

Light-duty types 1 kA · 3.2 × 2.5 × 2.5 mm				Light-duty types 0.5 kA · 3.2 × 1.6 × 1.6 mm			
S25-... / EIA case size 1210 / Metric 3225				S20-... / EIA case size 1206 / Metric 3216			
SMD  				SMD  			
Type Ordering code	S25-A90X B88069X 2253T253	S20-A140X B88069X 3013T603	S20-A200X B88069X 9731T603	S20-C350X B88069X 3033T603	S20-A470X B88069X 1193T603	S20-A500X B88069X 1513T603	
Nom. DC spark-over voltage V_{sdN}	90	140	200	350	470	500	V
Tolerance of V_{sdN}	±20	±30	±30	-25/+40	±30	±20	%
Impulse spark-over voltage							
@ 100 V/μs 99% of measured values	<500	<800	<700	<900	<1050	<1050	V
@ 100 V/μs typical values	<400	<700	<500	<800	<950	<950	V
@ 1 kV/μs 99% of measured values	<700	<900	<800	<1150	<1200	<1200	V
@ 1 kV/μs typical values	<600	<800	<700	<1000	<1050	<1050	V
Service life							
10 operations 8/20 μs	1	0.5	0.5	0.5	0.5	0.5	kA
10 operations 5/320 μs ¹⁾	–	150	150	150	150	150	A
Insulation resistance	>1	>1	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<0.5	<0.3	<0.3	<0.3	<0.3	<0.3	pF

¹⁾ With test generator 6 kV, 40 Ω

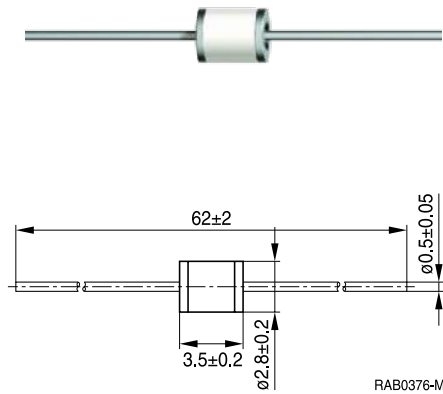
Dimensions in mm

About packing see page 75.

2-Electrode Arresters

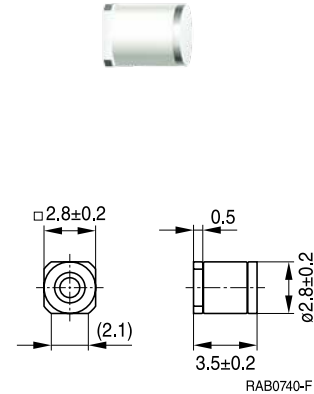
Light-duty types
1 kA · $\varnothing$ 2.8 × 3.5 mm

G31-...



G30-...

SMD



Type Ordering code	G31-A75X B88069X 8091K203	G30-A90XSMD B88069X 4103T203 G31-A90X B88069X 9361K203	G31-A200X B88069X 8801K203	G31-A300X B88069X 2203K203	G31-A400X B88069X 9321K203	G30-A500XSMD B88069X 2243T203 G31-A500X B88069X 2233K203	
Nom. DC spark-over voltage V_{sdN}	75	90	200	300	400	500	V
Tolerance of V_{sdN}	±20	±20	±20	±20	±20	±30	%
Impulse spark-over voltage							
@ 100 V/μs 99% of measured values	<350	<400	<500	<900	<900	<1200	V
@ 100 V/μs typical values	<300	<300	<450	<600	<600	<1000	V
@ 1 kV/μs 99% of measured values	<650	<650	<700	<1200	<1200	<1400	V
@ 1 kV/μs typical values	<600	<600	<650	<800	<850	<1200	V
Service life							
10 operations 8/20 μs	1	1	1	1	1	1	kA
1 operation 8/20 μs	2	2	2	2	2	2	kA
300 operations 8/20 μs	100	100	100	100	100	100	A
200 operations 1.5n F; 10 kV; 20 Ω	500	500	500	500	500	500	A
Insulation resistance	>1	>1	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	pF

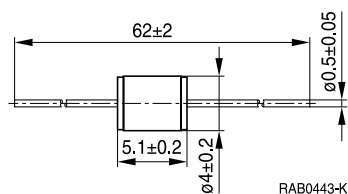
Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Light-duty types
1 kA · $\varnothing$ 4.0 × 5.1 mm

G41-...



Type Ordering code	G41-H30 B88069X4273K103	G41-H36 B88069X4203K103	
Nom. DC spark-over voltage V_{sdN}	3000	3600	V
Tolerance of V_{sdN}	±20	±20	%
Impulse spark-over voltage			
@ 100 V/μs 99% of measured values	<3800	<4600	V
@ 100 V/μs typical values	<3600	<4400	V
@ 1 kV/μs 99% of measured values	<4000	<4800	V
@ 1 kV/μs typical values	<3800	<4600	V
Service life			
10 operations 8/20 μs	1	1	kA
3 operation 8/20 μs	2	2	kA
300 operations 8/20 μs	100	100	A
Insulation resistance	>1	>1	GΩ
Capacitance @ 1 MHz	<0.5	<0.5	pF

Dimensions in mm

About packing see page 75.

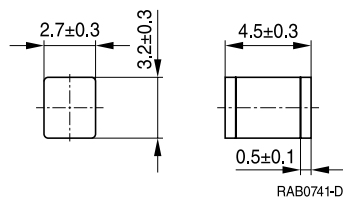
2-Electrode Arresters

Light-duty types

2 kA / 2 A · 4.5 × 3.2 × 2.7 mm

S30-... / EIA case size 1812 / Metric 4532

SMD



Type Ordering code	S30-A75X B88069X 1023T253	S30-A90X B88069X 9231T253	S30-A150X B88069X 6071T253	S30-A230XS B88069X 9801T253	S30-A300XS B88069X 6891T253	S30-A350X B88069X 8361T253	S30-A420XS B88069X 6311T253	S30-A500XS B88069X 1873T253	
Nom. DC spark-over voltage V_{sdN}	75	90	150	230	300	350	420	500	V
Tolerance of V_{sdN}	±30	±30	±30	±30	±30	±25	±25	±20	%
Impulse spark-over voltage									
@ 100 V/μs 99% of measured values	<400	<500	<500	<500	<580	<750	<650	<950	V
@ 100 V/μs typical values	<350	<400	<400	<400	<500	<600	<550	<800	V
@ 1 kV/μs 99% of measured values	<700	<600	<600	<600	<650	<900	<750	<1050	V
@ 1 kV/μs typical values	<650	<500	<500	<500	<550	<750	<600	<900	V
Service life									
10 operations 8/20 μs	3	3	3	1	1	2	1	1	kA
300 operations 8/20 μs	100	100	100	100	100	100	100	100	A
10 operations 5/320 μs ¹⁾	150	150	150	150	150	150	150	150	A
100 operations 10/1000 μs	10	10	10	10	10	10	10	10	A
Insulation resistance	>1	>1	>1	>1	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	pF

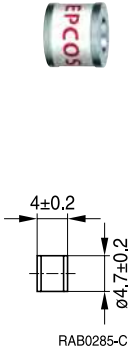
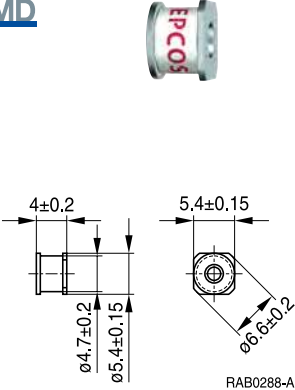
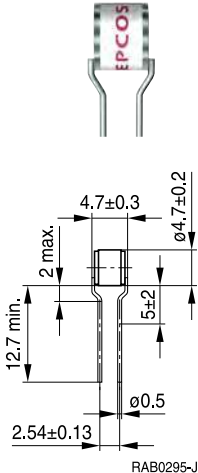
¹⁾ With test generator 6 kV, 40 Ω

Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Light-duty types
2.5 kA / 2.5 A · $\varnothing 4.7 \times 4.7$ mm

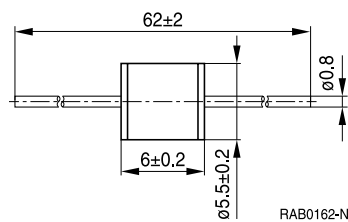
ES...N		ES...SMD				ES...P		
		SMD 						
Type	ES75XSMD	ES90XSMD	ES150XSMD	ES260XP	ES300XN	ES350XN	ES400XSMD	
Ordering code	B88069X 7841T902	B88069X 6241T902 ES90XN B88069X 4421T103 ES90XP B88069X 5151B502	B88069X 6381T902	B88069X 5920B502	B88069X 4190T103 ES300XSMD B88069X 4211T902 ES300XP B88069X 4180B502	B88069X 4951T103 ES350XSMD B88069X 4911T902	B88069X 5591T902	
Nom. DC spark-over voltage V_{sdN}	75	90	150	260	300	350	400	V
Tolerance of V_{sdN}	±25	±20	±20	-15 /+20	±15	±15	±15	%
Impulse spark-over voltage								
@ 100 V/μs 99% of measured values	<500	<450	<500	<500	<500	<530	<800	V
@ 100 V/μs typical values	<450	<300	<450	<450	<450	<450	<750	V
@ 1 kV/μs 99% of measured values	<700	<600	<600	<600	<600	<600	<1000	V
@ 1 kV/μs typical values	<600	<550	<550	<550	<550	<530	<850	V
Service life								
10 operations 8/20 μs	2.5	2.5	2.5	2.5	2.5	2.5	2.5	kA
1 operation 8/20 μs	4	5	5	5	5	5	5	kA
Insulation resistance	>1	>1	>1	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<1	<1	<1	<1	<1	<1	<1	pF

Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Light-duty types 2.5 kA / 2.5 A · ø 5.5 x 6 mm	Light-duty / High-voltage types 2 kA / 2 A · ø 5.5 x 6 mm
EM...	EM1000X / EM2000X



Type Ordering code	EM90X B88069X 0190S102	EM230X B88069X 0900S102	EM300X B88069X 0800S102	EM350X B88069X 0590S102	EM400X B88069X 0200S102	EM1000X B88069X 4651S102	EM2000X B88069X 5600S102	
Nom. DC spark-over voltage V_{sdcN}	90	230	300	350	400	1000	2000	V
Tolerance of V_{sdcN}	±20	±20%	-10/+15	±20	±20	±20	±20	%
Impulse spark-over voltage								
@ 100 V/μs 99% of measured values	<400	<600	<700	<800	<800	<1700	<3400	V
@ 100 V/μs typical values	<330	<550	<600	<700	<750	<1600	<3200	V
@ 1 kV/μs 99% of measured values	<600	<700	<800	<900	<900	<1900	<4100	V
@ 1 kV/μs typical values	<530	<650	<700	<800	<850	<1800	<3800	V
Service life								
10 operations 50 Hz, 1 s	2.5	2.5	2.5	2.5	2.5	2	1.5	A
3 operations 8/20 μs	–	–	–	–	–	2	2	kA
10 operations 8/20 μs	2.5	2.5	2.5	2.5	2.5	–	–	kA
1 operation 10/350 μs	0.5	0.5	0.5	0.5	0.5	–	–	kA
300 operations 10/1000 μs	100	100	100	100	100	100	–	A
Insulation resistance	>1	>1	>1	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<1	<1	<1	<1	<1	<1	<1	pF

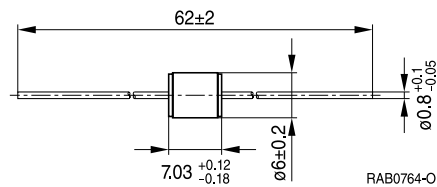
Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Light-duty / High voltage-types
3 kA / – · ø 6 x 7 mm

EHV6*-...



Type Ordering code	EHV62-H25 B88069X1893T502	EHV62-H30 B88069X4193T502	EHV62-H36 B88069X1683T502	EHV62-H40 B88069X2103T502	EHV62-H45 B88069X1793T502	
Nom. DC spark-over voltage V_{sdcN}	2500	3000	3600	4000	4500	V
Tolerance of V_{sdcN}	±20	±20	±20	±20	±20	%
Impulse spark-over voltage						
@ 100 V/μs 99% of measured values	<3300	<3800	<4350	<5000	<5200	V
@ 100 V/μs typical values	<3000	<3400	<4150	<4600	<4800	V
@ 1 kV/μs 99% of measured values	<3400	<4000	<4500	<5400	<5500	V
@ 1 kV/μs typical values	<3100	<3500	<4300	<4800	<5000	V
Service life						
1 operation 8/20 μs	5	5	5	5	5	kA
3 operation 8/20 μs	3	3	3	3	3	kA
300 operations 8/20 μs	100	100	100	100	100	A
Insulation resistance	>1	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<1	<1	<1	<1	<1	pF

Dimensions in mm

About packing see page 75.

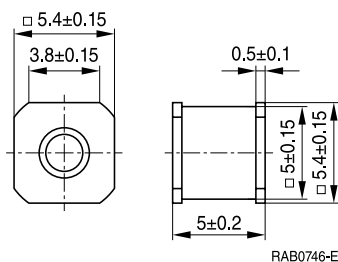
2-Electrode Arresters

Light-duty types

5 kA / 5 A · 5.7 × 5 × 5 mm

S5B-...XHC / EIA case size 2220 / Metric 5750

SMD



Type Ordering code	S5B-A90XHC B88069X5923T902	S5B-A600XHC B88069X4693T602	
Nom. DC spark-over voltage V_{sdcN}	90	600	V
Tolerance of V_{sdcN}	±20	±20	%
Impulse spark-over voltage			
@ 100 V/μs 99% of measured values	<500	<1000	V
@ 100 V/μs typical values	<450	<800	V
@ 1 kV/μs 99% of measured values	<600	<1100	V
@ 1 kV/μs typical values	<550	<900	V
Service life			
10 operations 50 Hz, 1 s	10	5	A
1 operation 50 Hz, 9 cycles	-	65	A
10 operations 8/20 μs	10	6	kA
1 operation 8/20 μs ¹⁾	12	12	kA
1 operation 10/350 μs	1	1	kA
300 operations 8/20 μs	100	100	A
Insulation resistance	>1	>1	GΩ
Capacitance @ 1 MHz	<0.5	<0.6	pF

¹⁾ After loading DC breakdown may exceed initial values but device will remain in a safe mode.

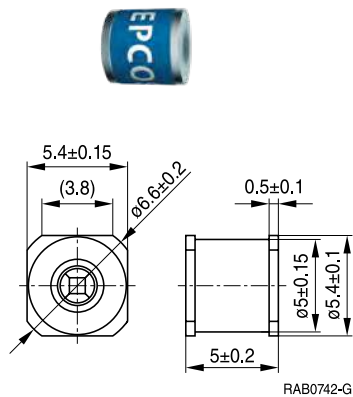
Dimensions in mm

About packing see page 75.

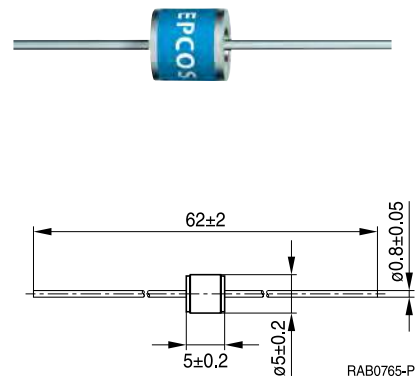
2-Electrode Arresters

Light-duty types 5 kA / 5 A · $\varnothing 5 \times 5$ mm

M50-...



M51-...



Type Ordering code	M50-A75XSMD B88069X7543T902 M51-A75X B88069X6131C102	M50-C90X B88069X1590C253 M50-C90XSMD B88069X1063T902 M51-C90X B88069X5010C102	M50-A230X B88069X4600C253 M50-A230XSMD B88069X5220T902 M51-A230X B88069X2930C102	M50-A350X B88069X4630C253 M50-A350XSMD B88069X3770T902 M51-A350X B88069X4640C102	M50-A600XSMD B88069X3351T902 M51-A600X B88069X4590C102	
Nom. DC spark-over voltage V_{sdN}	75	90	230	350	600	V
Tolerance of V_{sdN}	±20	±20	±20	±20	-5/+30	%
Impulse spark-over voltage						
@ 100 V/μs 99% of measured values	<350	<550	<550	<800	<1350	V
@ 100 V/μs typical values	<300	<500	<500	<750	<1200	V
@ 1 kV/μs 99% of measured values	<650	<600	<650	<900	<1500	V
@ 1 kV/μs typical values	<550	<550	<600	<800	<1350	V
Service life						
10 operations 50 Hz, 1 s	5	5	5	5	5	A
1 operation 50 Hz, 9 cycles	10	10	10	10	10	A
10 operations 8/20 μs	5	5	5	5	5	kA
1 operation 8/20 μs ¹⁾	10	10	10	10	10	kA
1 operation 10/350 μs	0.5	0.5	0.5	0.5	0.5	kA
300 operations 10/1000 μs	100	100	100	100	–	A
Insulation resistance	>1	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<1	<1	<1	<1	<1	pF

¹⁾ After loading DC breakdown may exceed initial values but device will remain in a safe mode.

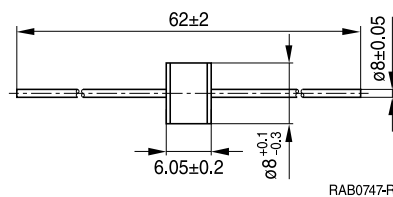
Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Light-duty types
5 kA / 5 A · $\varnothing 8 \times 6$ mm

EC...

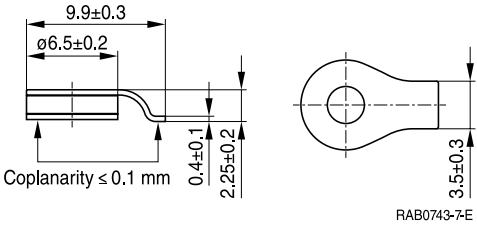
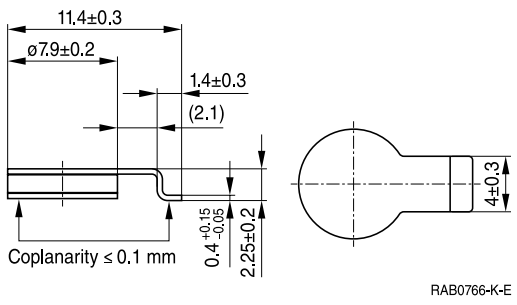


Type Ordering code	EC75X B88069X 0180S102	EC90X B88069X 0720S102	EC150X B88069X 0880S102	EC230X B88069X 0660S102	EC350X B88069X 0810S102	EC600X B88069X 0780S102	
Nom. DC spark-over voltage V_{sdN}	75	90	150	230	350	600	V
Tolerance of V_{sdN}	±20	±20	±20	±15	±15	-10/+20	%
Impulse spark-over voltage							
@ 100 V/μs 99% of measured values	<500	<500	<500	<550	<800	<1200	V
@ 100 V/μs typical values	<400	<450	<450	<500	<700	<1000	V
@ 1 kV/μs 99% of measured values	<700	<600	<650	<700	<900	<1300	V
@ 1 kV/μs typical values	<600	<550	<570	<650	<800	<1100	V
Service life							
10 operations 50 Hz, 1 s	5	5	5	5	5	10	A
1 operation 50 Hz, 9 cycles	20	20	20	20	20	65	A
10 operations 8/20 μs	5	5	5	5	5	5	kA
1 operation 8/20 μs	10	10	10	10	10	10	kA
1 operation 10/350 μs	1	1	1	1	1	1	kA
300 operations 10/1000 μs	100	100	100	100	100	–	A
Insulation resistance	>10	>10	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	pF

Dimensions in mm

About packing see page 75.

2-Electrode Arresters

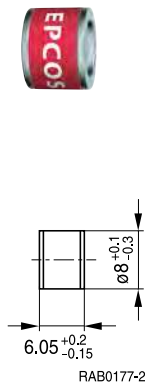
Medium-duty types 10 kA / 5 A · ø 6.5 × 2.3 mm				Medium-duty types 10 kA / 5 A · ø 8 × 2.3 mm			
Flat arresters D06				D08			
  RAB0743-7-E				  RAB0766-K-E			
Type Ordering code	D06-A90SMD B88069X 5183T133	D08-A75SMD B88069X 4863T173	D08-A90SMD B88069X 4653T173	D08-A150SMD B88069X 4873T173	D08-A230SMD B88069X 5243T173	D08-A600SMD B88069X 5233T173	
DC spark-over voltage	90	75	90	150	230	600	V
Tolerance of V _{sdN}	20	20	20	20	20	20	%
Impulse spark-over voltage							
@ 100 V/μs 99% of measured values	400	350	350	450	550	1000	V
@ 100 V/μs typical values	350	300	300	400	500	950	V
@ 1 kV/μs 99% of measured values	600	600	550	600	750	1.250	V
@ 1 kV/μs typical values	550	550	500	550	700	1200	V
Service life							
10 operations 50 Hz, 1s	5	5	5	5	5	5	A
10 operation 8/20 μs	10	10	10	10	10	10	kA
1 operation 8/20 μs	15	15	15	15	20	20	kA
2 operation 10/350 μs	1.5	2.5	2.5	2.5	2.5	2.5	kA
300 operations 10/1000 μs		100	100	100	100	100	A

Dimensions in mm

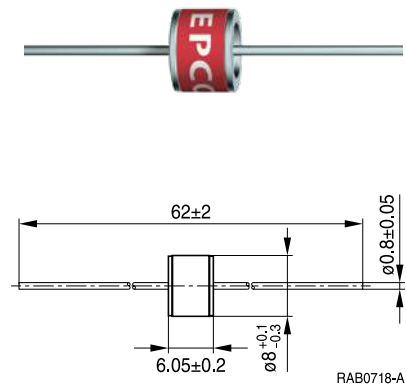
2-Electrode Arresters

Medium-duty types 10 kA / 10 A · $\varnothing 8 \times 6$ mm

N80-...



N81-...



Type Ordering code	N80-C90X B88069X 4890C103 N81-A90X B88069X 4880S102	N80-A230X B88069X 4900C103 N81-A230X B88069X 4930S102	N80-A350X B88069X 4910C103 N81-A350X B88069X 4920S102	N81-A500XG B88069X 4860T502	N80-A600X B88069X 4990C103 N81-A600X B88069X 2830S102	
Nom. DC spark-over voltage V_{sdCN}	90	230	350	500	600	V
Tolerance of V_{sdCN}	±20	±20	±20	±20	±20	%
Impulse spark-over voltage						
@ 100 V/μs 99% of measured values	<500	<500	<700	<900	<1100	V
@ 100 V/μs typical values	<450	<450	<650	<750	<950	V
@ 1 kV/μs 99% of measured values	<600	<700	<900	<1100	<1400	V
@ 1 kV/μs typical values	<550	<600	<800	<900	<1100	V
Service life						
10 operations 50 Hz, 1 s	10	10	10	10	10	A
1 operation 50 Hz, 9 cycles	65	65	65	65	65	A
10 operations 8/20 μs	10	10	10	10	10	kA
1 operation 8/20 μs	12	12	12	12	12	kA
1 operation 10/350 μs	1	1	1	1	1	kA
300 operations 10/1000 μs	100	100	100	–	–	A
Insulation resistance	>10	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	<1.5	pF

Dimensions in mm

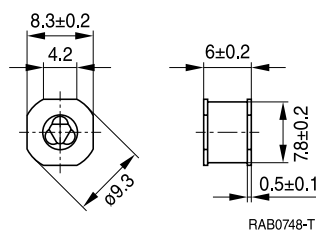
About packing see page 75.

2-Electrode Arresters

Heavy-duty types
20 kA / 20 A · 6 × 8.4 × 8.4 mm

S8A-...XHC

SMD



Type Ordering code	S8A-A75XHC B88069X5733T602	S8A-A90XHC B88069X4693T602	S8A-A150XHC B88069X7373T602	S8A-A230XHC B88069X5783T602	
Nom. DC spark-over voltage V_{sdN}	75	90	150	230	V
Tolerance of V_{sdN}	±20	±20	±20	±20	%
Impulse spark-over voltage					
@ 100 V/μs 99% of measured values	<350	<500	<550	<550	V
@ 100 V/μs typical values	<300	<450	<500	<500	V
@ 1 kV/μs 99% of measured values	<550	<600	<650	<650	V
@ 1 kV/μs typical values	<500	<550	<600	<600	V
Service life					
10 operations 50 Hz, 1 s	20	20	20	20	A
1 operation 50 Hz, 9 cycles	100	100	100	100	A
10 operations 8/20 μs	20	20	20	20	kA
1 operation 8/20 μs	25	25	25	25	kA
1 operation 10/350 μs	2.5	5	2.5	2.5	kA
300 operations 10/1000 μs	100	100	200	200	A
Insulation resistance	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	pF

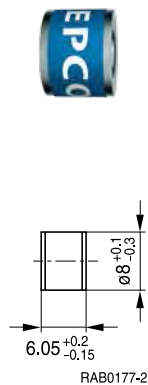
Dimensions in mm

About packing see page 75.

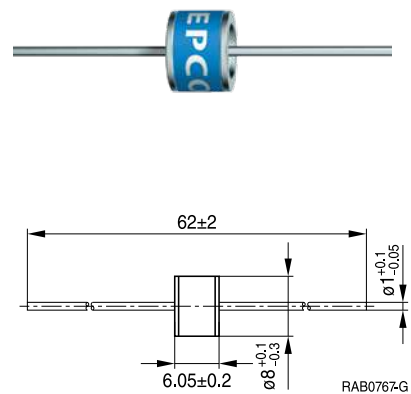
2-Electrode Arresters

Heavy-duty types 20 kA / 20 A · $\varnothing 8 \times 6$ mm

A80-...



A81-...



Type Ordering code	A81-A75X B88069X 3881S102 B88069X 3881T502	A80-C90X B88069X 1410C103 A81-C90X B88069X 1380S102	A80-A230X B88069X 2240C103 A81-A230X B88069X 2250S102	A80-A250X B88069X 2920C103 A81-A250X B88069X 1500S102	A80-A350X B88069X 2230C103 A81-A350X B88069X 2380S102	A80-A600X B88069X 2900C103 A81-A600X B88069X 2880S102	
Nom. DC spark-over voltage V_{sdN}	75	90	230	250	350	600	V
Tolerance of V_{sdN}	±20	±20	±20	±20	±20	±20	%
Impulse spark-over voltage							
@ 100 V/μs 99% of measured values	<350	<500	<500	<550	<700	<1100	V
@ 100 V/μs typical values	<300	<450	<450	<500	<650	<950	V
@ 1 kV/μs 99% of measured values	<650	<600	<650	<700	<900	<1400	V
@ 1 kV/μs typical values	<600	<550	<550	<650	<800	<1100	V
Service life							
10 operations 50 Hz, 1 s	20	20	20	20	20	20	A
1 operation 50 Hz, 9 cycles	100	100	100	100	100	100	A
10 operations 8/20 μs	20	20	20	20	20	20	kA
1 operation 8/20 μs	25	25	25	25	25	25	kA
1 operation 10/350 μs	2.5	2.5	2.5	2.5	2.5	2.5	kA
300 operations 10/1000 μs	200	200	200	200	200	100	A
Insulation resistance	>10	>10	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	pF

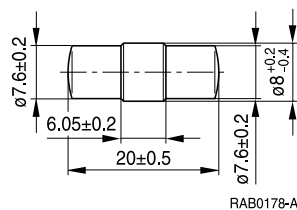
Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Heavy-duty types
20 kA / 20 A · ø 8 × 20 mm

A83-...



Type Ordering code	A83-C90X B88069X 1450C102	A83-A150X B88069X 4350C102	A83-A170X B88069X 4360C102	A83-A230X B88069X 1420C102	A83-A350X B88069X 2860C102	A83-A600X B88069X 2890C102	
Nom. DC spark-over voltage V_{sdN}	90	150	170	230	350	600	V
Tolerance of V_{sdN}	±20	±20	±20	±20	±20	±20	%
Impulse spark-over voltage							
@ 100 V/μs 99% of measured values	<500	<600	<650	<550	<700	<1100	V
@ 100 V/μs typical values	<450	<450	<500	<450	<650	<950	V
@ 1 kV/μs 99% of measured values	<600	<800	<800	<700	<800	<1400	V
@ 1 kV/μs typical values	<550	<600	<600	<550	<700	<1100	V
Service life							
10 operations 50 Hz, 1 s	20	20	20	20	20	20	A
1 operation 50 Hz, 9 cycles	100	100	100	100	100	100	A
10 operations 8/20 μs	20	20	20	20	20	20	kA
1 operation 8/20 μs	25	25	25	25	25	25	kA
1 operation 10/350 μs	2.5	2.5	2.5	2.5	2.5	2.5	kA
Insulation resistance	>10	>10	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	pF

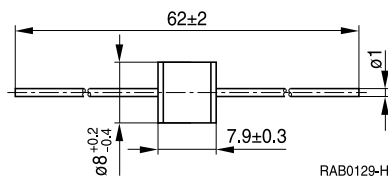
Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Medium-duty / High-voltage types 10 kA / 10 A · $\varnothing 8 \times 8$ mm

A71-...



Type Ordering code	A71-H08X B88069X2140S102	A71-H10X B88069X3820S102	A71-H12X B88069X2090S102	A71-H14X B88069X2180S102	A71-H16X B88069X2610S102	
Nom. DC spark-over voltage V_{sdN}	800	1000	1200	1400	1600	V
Tolerance of V_{sdN}	±15	±15	±20	±20	±20	%
Impulse spark-over voltage						
@ 100 V/μs 99% of measured values	<1100	<1300	<1900	<2100	<2300	V
@ 100 V/μs typical values	<1000	<1200	<1800	<2000	<2200	V
@ 1 kV/μs 99% of measured values	<1200	<1400	<2000	<2200	<2400	V
@ 1 kV/μs typical values	<1100	<1300	<1900	<2100	<2300	V
Service life						
10 operations 50 Hz, 1 s	10	10	10	10	10	A
1 operation 50 Hz, 9 cycles	65	65	65	65	65	A
10 operations 8/20 μs	10	10	10	10	10	kA
1 operation 8/20 μs	15	15	15	15	15	kA
Insulation resistance	>10	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1	<1	<1	<1	<1	pF

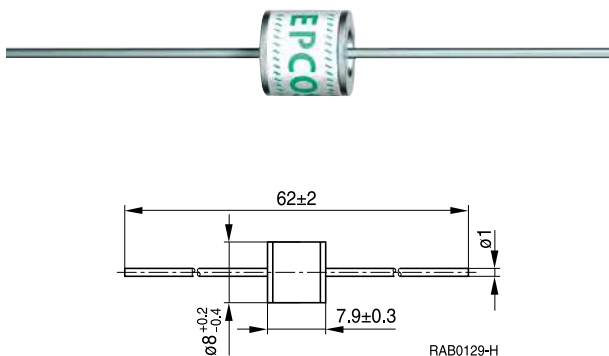
Dimensions in mm

About packing see page 75.

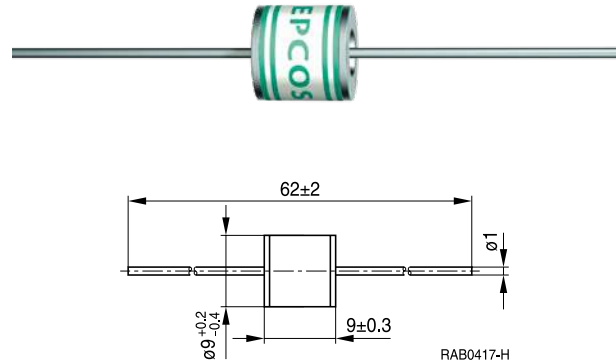
2-Electrode Arresters

Medium-duty / High-voltage types 10 kA / 10 A · $\varnothing 8 \times 8$ mm

A71-...



A91-...



Electrode spacing >3 mm, acc. to IEC 60950-1

Type Ordering code	A71-H25X B88069X 2190S102	A71-H35X B88069X 2200S102	A71-H45X B88069X 2590S102	A71-H55X B88069X 2620S102	A91-H62SE B88069X 3103S102	A91-H75SE B88069X 3443S102	
Nom. DC spark-over voltage V_{sdcN}	2500	3500	4500	5500	6200	7500	V
Tolerance of V_{sdcN}	±20	±20	±20	±15	-15/+20	±20	%
Impulse spark-over voltage							
@ 100 V/μs 99% of measured values	<3900	<4900	<5800	<6500	–	–	V
@ 100 V/μs typical values	<3800	<4800	<5700	<6000	–	–	V
@ 1 kV/μs 99% of measured values	<4000	<5000	<6000	<7000	<9000	<10 500	V
@ 1 kV/μs typical values	<3900	<4900	<5800	<6500	<8000	<9500	V
Service life							
10 operations 50 Hz, 1 s	10	10	10	5	–	–	A
1 operation 50 Hz, 9 cycles	20	20	20	10	–	–	A
10 operations 8/20 μs	10	10	10	10	5	5	kA
1 operation 8/20 μs	15	15	15	15	10	10	kA
Insulation resistance	>10	>10	>10	>10	>1	>1	GΩ
Capacitance @ 1 MHz	<1	<1	<1	<1	<1.5	<1.5	pF

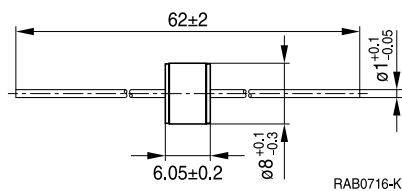
Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Types with follow current limiting
5 kA / 5 A · ø 8 × 6 mm

EF...



Type Ordering code	EF270X B88069X4131S102	EF470X B88069X5080S102	EF800X B88069X2641S102	EF1500X B88069X4301S102	EF2500XS B88069X1583S102	
Nom. DC spark-over voltage V_{sdcN}	270	470	800	1500	2500	V
Tolerance of V_{sdcN}	-15/+25	-15/+25	-15/+25	±20	±20	%
Impulse spark-over voltage						
@ 100 V/μs 99% of measured values	<500	<700	<1200	<1800	<3200	V
@ 100 V/μs typical values	<450	<600	<1000	<1700	<3000	V
@ 1 kV/μs 99% of measured values	<550	<800	<1300	<2000	<3500	V
@ 1 kV/μs typical values	<500	<700	<1100	<1800	<3300	V
Service life						
10 operations 50 Hz, 1 s	5	5	5	5	5	A
1 operation 50 Hz, 9 cycles	65	65	65	35	35	A
10 operations 8/20 μs	5	5	5	5	5	kA
1 operation 8/20 μs	10	10	10	10	10	kA
Max. follow current during one voltage half cycle @ 50 Hz	200	200	200	200	200	A
Insulation resistance	>10	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	<1.5	pF

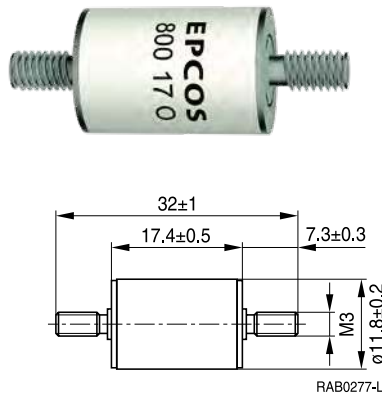
Dimensions in mm

About packing see page 75.

2-Electrode Arresters

Heavy-duty types
20 kA / 20 A · $\varnothing$ 11.8 × 17.4 mm

V10-...



Type Ordering code	V10-H08X B88069X9170C251	V10-H14X B88069X4300C251	V10-H22X B88069X4420CB251	V10-H30X B88069X4330C251	
Nom. DC spark-over voltage V_{sdcN}	800	1400	2200	3000	V
DC spark-over voltage	±20	±20	±20	±25	%
Impulse spark-over voltage					
@ 100 V/μs 99% of measured values	<1000	<1900	<2700	<4500	V
@ 100 V/μs typical values	<900	<1800	<2400	<4300	V
@ 1 kV/μs 99% of measured values	<1200	<2200	<2800	<5000	V
@ 1 kV/μs typical values	<1100	<2000	<2500	<4500	V
Service life					
10 operations 50 Hz, 1 s	20	20	20	20	A
1 operation 50 Hz, 9 cycles	120	120	120	120	A
10 operations 8/20 μs	20	20	20	20	kA
1 operation 8/20 μs	30	30	25	30	kA
1 operation 10/350 μs	5	–	–	–	kA
Insulation resistance	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	pF

Dimensions in mm

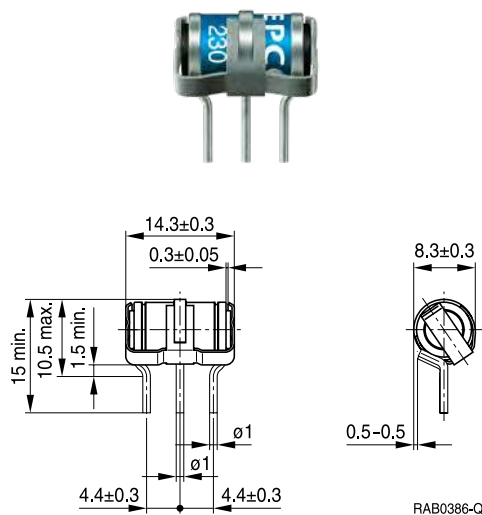
About packing see page 75.

3-Electrode Arresters

Arrester/varistor combination

10 kA / 10 A · ø 8 × 10 mm

T4N-...FV



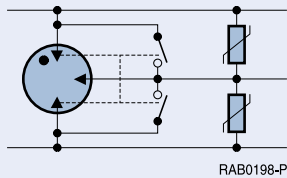
Type	T4N-A90XFV	T4N-A230XFV	
Ordering code	B88069X1953B202	B88069X7480B202	
Nom. DC spark-over voltage V_{sdN}	90	230	V
Tolerance of V_{sdN}	±20	±20	%
Impulse spark-over voltage			
@ 1 kV/μs 99% of measured values	<200	<350	V
@ 1 kV/μs typical values	<170	<320	V
Service life			
10 operations 50 Hz, 1 s	10	10	A
10 operations 8/20 μs	10	10	kA
1 operation 8/20 μs	20	20	kA
Insulation resistance	>0.1	>0.1	GΩ
Capacitance @ 1 MHz	<240	<85	pF

Currents through center electrode, half value through each line electrode.

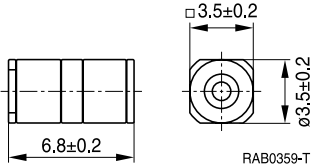
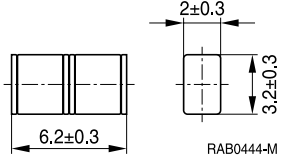
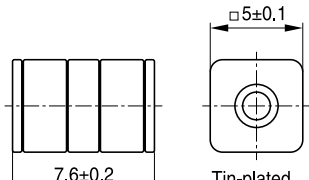
Dimensions in mm

About packing see page 75.

Circuit:



3-Electrode Arresters

Light-duty types 2 kA / 2 A · $\varnothing$ 3.5 × 6.8 mm	Light-duty types 2 kA / 2 A · 2 × 3.2 × 6.2 mm	Medium-duty types 10 kA / 10 A · 7.6 × 5 × 5 mm
TG30-...	TQ30F-...	TQ90-...
SMD 	SMD 	SMD 
 RAB0359-T	 RAB0444-M	 Tin-plated RAB0382-K-E

Type Ordering code	TG30-A90XSMD B88069X9991T203	TG30-A420XSMDS B88069X1833T203	TQ30F-C420 B88069X2713T203	TQ90-A90 B88069X1963T902	
Nom. DC spark-over voltage V_{sdN}	90	420	420	90	V
Tolerance of V_{sdN}	±30	±30	-17/+30	±20	%
Impulse spark-over voltage					
@ 100 V/μs 99% of measured values	<450	<700	<750	<450	V
@ 100 V/μs typical values	<350	<600	<700	<350	V
@ 1 kV/μs 99% of measured values	<650	<800	<870	<650	V
@ 1 kV/μs typical values	<550	<700	<800	<550	V
Service life					
10 operations 50 Hz, 1 s	6	–	2	10	A
1 operation 50 Hz, 0.18 s	–	–	–	–	A
10 operations 8/20 μs	6	2	–	10	kA
1 operation 8/20 μs	–	–	–	–	kA
300 operations 8/20 μs	100	100	–	200	A
10 operations 5/320 μs ¹⁾	150	150	200	150	A
1 operation 10/350 μs	–	–	–	–	kA
300 operations 10/1000 μs	20	–	–	200	A
Insulation resistance	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<1.2	<1.2	<1.2	<1.2	pF

¹⁾ Test generator 6 kV, 10/700 μs, 40 Ω

Currents through center electrode, half value through each line electrode.

Dimensions in mm

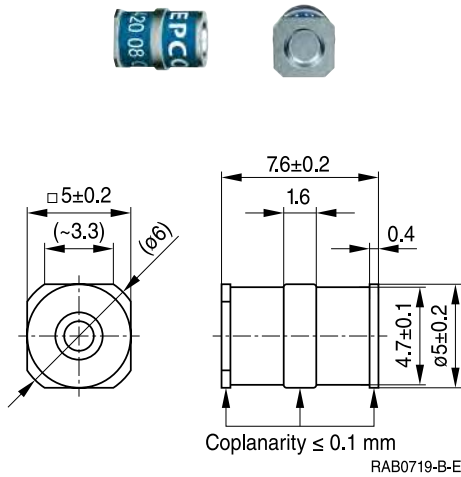
About packing see page 75.

3-Electrode Arresters

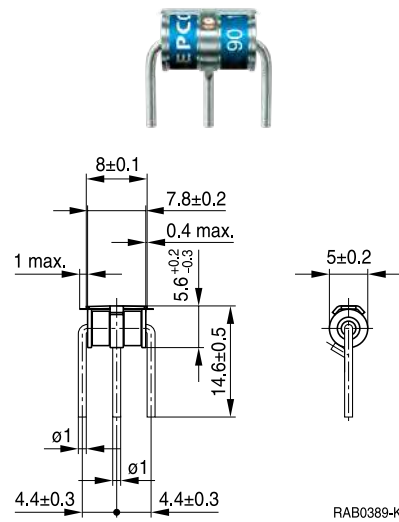
Medium-duty types 10 kA / 10 A · $\varnothing 5 \times 7.6$ mm

T90-...SMD

SMD



T97A-...X1F1



Type Ordering code	T90-A90XSMD B88069X2331T902 T97A-A90X1F1 B88069X1713B502	T90-A230XSMD B88069X6680T902 T97A-A230X1F1 B88069X1743B502	T90-A350XSMD B88069X4030T902	T90-A420XSMD B88069X7041T902 T97A-A420X1F1 B88069X1763B502	
Nom. DC spark-over voltage V_{sdcN}	90	230	350	420	V
Tolerance of V_{sdcN}	±20	±20	±20	±20	%
Impulse spark-over voltage					
@ 100 V/μs 99% of measured values	<450	<600	<850	<850	V
@ 100 V/μs typical values	<350	<550	<750	<750	V
@ 1 kV/μs 99% of measured values	<600	<700	<1000	<1000	V
@ 1 kV/μs typical values	<500	<650	<850	<900	V
Service life					
10 operations 50 Hz, 1 s	10	10	10	10	A
1 operation 50 Hz, 9 cycles	30/40	30/40	40	30/40	A
10 operations 8/20 μs	10	10	10	10	kA
1 operation 8/20 μs	20	20	20	20	kA
1 operation 10/350 μs	2	2.5	2	2	kA
300 operations 10/1000 μs	200	200	200	200	A
Insulation resistance	>1	>1	>1	>1	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	pF

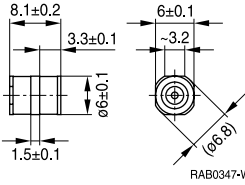
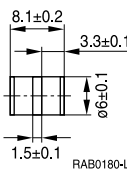
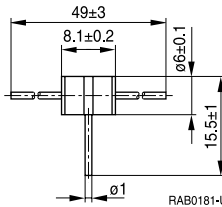
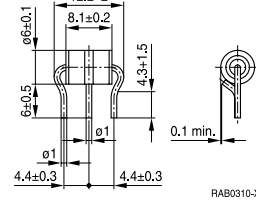
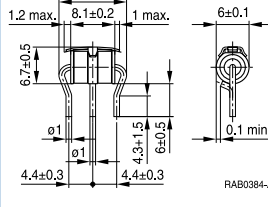
Currents through center electrode, half value through each line electrode.

Dimensions in mm

About packing see page 75.

3-Electrode Arresters

Medium-duty types 10 kA / 10 A · ø 6 × 8 mm

T30-...SMD	T30-...	T31-...	T33-...	T33-...F			
SMD  	 	 	 	 			
Type Ordering code	T30-A90X B88069X 3030C253 T30-A90XSMD B88069X 8561T702 T31-A90X B88069X 2261B252 T33-A90X B88069X 2271B502	T30-A230X B88069X 3060C253 T30-A230XSMD B88069X 6731T702 T31-A230X B88069X 3130B252 T33-A230X B88069X 9800B502 T33-A230XF1 B88069X 9550B502	T30-A250X B88069X 3951C253	T30-A350X B88069X 3180C253 T31-A350X B88069X 3090B252 T33-A350X B88069X 1470B502 T33-A350X8F1 B88069X 9921B502	T30-A420X B88069X 3040C253 T30-A420XSMD B88069X 4961T702	T30-A500X B88069X 3070C253	
Nom. DC spark-over voltage V_{sdN}	90	230	250	350	420	500	V
Tolerance of V_{sdN}	±20	±20	±20	±20	-15/+25	±20	%
Impulse spark-over voltage							
@ 100 V/μs 99% of measured values	<450	<400	<500	<800	<850	<1100	V
@ 100 V/μs typical values	<350	<380	<400	<750	<700	<900	V
@ 1 kV/μs 99% of measured values	<500	<500	<550	<900	<950	<1400	V
@ 1 kV/μs typical values	<480	<430	<450	<850	<850	<1000	V
Service life							
10 operations 50 Hz, 1 s	10	10	10	10	10	10	A
1 operation 50 Hz, 9 cycles	30	30	30	30	30	30	A
10 operations 8/20 μs	10	10	10	10	10	10	kA
1 operation 8/20 μs	12	10	10	10	10	10	kA
1 operation 10/350 μs	5	2	2	2	2	2	kA
Insulation resistance	>10	>10	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	pF

Currents through center electrode, half value through each line electrode.

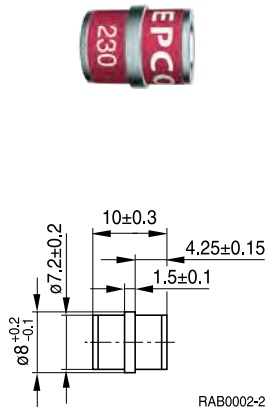
Dimensions in mm

About packing see page 75.

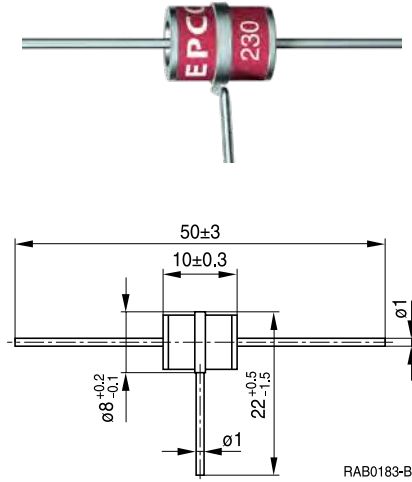
3-Electrode Arresters

Medium-duty types 10 kA / 10 A · $\varnothing 8 \times 10$ mm

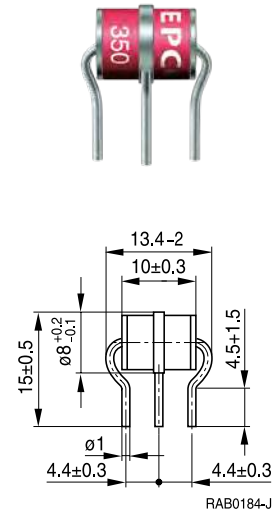
T80-...



T81-...



T83-...



Type Ordering code	T80-A90X B88069X8360C203 T81-A90X B88069X8440B252 T83-A90X B88069X8300B502	T81-A150X B88069X9580B252 T83-A150X B88069X9590B502	T80-A230X B88069X9380C203 T81-A230X B88069X8470B252 T83-A230X B88069X8910B502	T80-A250X B88069X8170C203 T83-A250X B88069X8340B502	
Nom. DC spark-over voltage V_{sdcN}	90	150	230	250	V
Tolerance of V_{sdcN}	±20	±20	±20	±20	%
Impulse spark-over voltage					
@ 100 V/μs 99% of measured values	<400	<450	<450	<500	V
@ 100 V/μs typical values	<300	<400	<400	<450	V
@ 1 kV/μs 99% of measured values	<550	<550	<650	<650	V
@ 1 kV/μs typical values	<500	<500	<600	<600	V
Service life					
10 operations 50 Hz, 1 s	10	10	10	10	A
1 operation 50 Hz, 9 cycles	40	40	40	40	A
10 operations 8/20 μs	10	10	10	10	kA
1 operation 8/20 μs	15	15	15	15	kA
1 operation 10/350 μs	2	2	5	2	kA
300 operations 10/1000 μs	200	200	200	200	A
Insulation resistance	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	pF

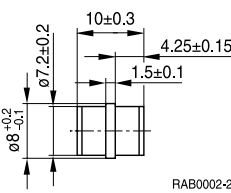
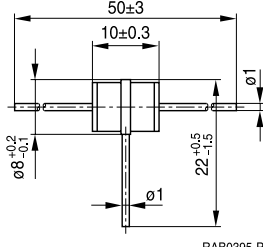
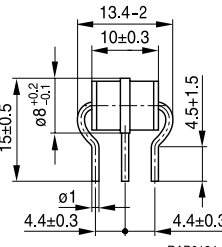
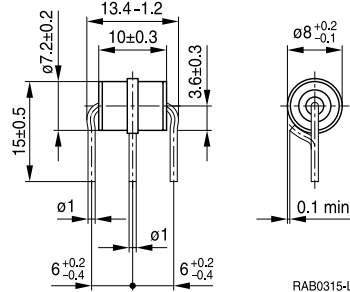
Currents through center electrode, half value through each line electrode.

Dimensions in mm

About packing see page 75.

3-Electrode Arresters

Medium-duty types 10 kA / 10 A · ø 8 × 10 mm

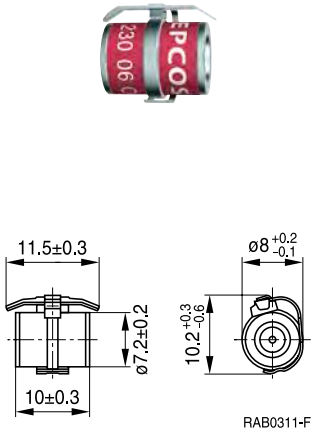
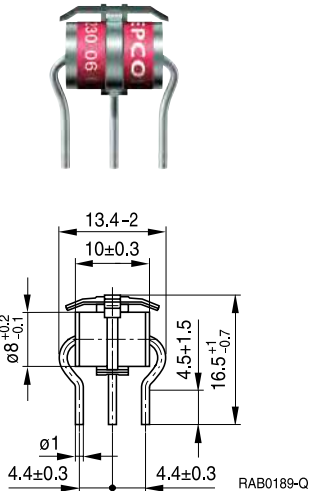
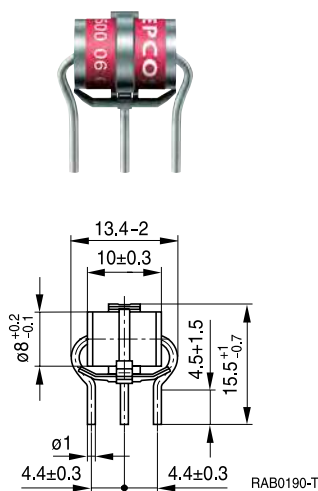
T80-...	T81-...	T83-...	T87-...		
 	 	 	 		
Type Ordering code	T81-A300X B88069X9000B252 T83-A300X B88069X7990B502	T80-A350X B88069X8500C203 T81-A350X B88069X9190B252 T83-A350X B88069X8690B502	T80-A420X B88069X7910C203 T83-A420X B88069X7960B502	T83-C600X B88069X8530B502 T87-C600X B88069X8550B502	
Nom. DC spark-over voltage V_{sdcN}	300	350	420	600	V
Tolerance of V_{sdcN}	±20	±20	±20	-30/+17	%
Impulse spark-over voltage					
@ 100 V/μs 99% of measured values	<700	<700	<850	<900	V
@ 100 V/μs typical values	<600	<600	<700	<800	V
@ 1 kV/μs 99% of measured values	<800	<900	<950	<1100	V
@ 1 kV/μs typical values	<700	<800	<850	<1000	V
Service life					
10 operations 50 Hz, 1 s	10	10	10	10	A
1 operation 50 Hz, 9 cycles	40	40	40	40	A
10 operations 8/20 μs	10	10	10	10	kA
1 operation 8/20 μs	15	15	15	15	kA
1 operation 10/350 μs	2	2	2	2	kA
300 operations 10/350 μs	200	200	200	on request	A
Insulation resistance	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	pF

Currents through center electrode, half value through each line electrode.

Dimensions in mm

About packing see page 75.

3-Electrode Arresters

Medium-duty types / With short-circuit spring 10 kA / 10 A · ø 8 × 10 mm						
T80-...F		T8*-...F1		T8*-...F4		
						
Type	T80-A90XF	T80-A230XF	T80-A250XF	T80-A350XF	T83-A500XF4	
Ordering code	B88069X2391B502 T83-A90XF1 B88069X8430B502 T83-A90XF4 B88069X8350B502 T83-A150XF1 B88069X9930B502	B88069X8380B502 T83-A230XF1 B88069X9420B502 T83-A230XF4 B88069X8870B502 T85-A230XF4 ¹⁾ B88069X9260B502	B88069X8230B502 T83-A250XF4 B88069X8990B502 T83-A260XF4 B88069X8250B502	B88069X8390B502 T83-A350XF1 B88069X9410B502 T83-A350XF4 B88069X9120B502 T85-A350XF4 ¹⁾ B88069X9230B502	B88069X3771B502	
Nom. DC spark-over voltage V _{sdCN}	90/150	230	250/260	350	500	V

¹⁾ Design with shorter lead length.

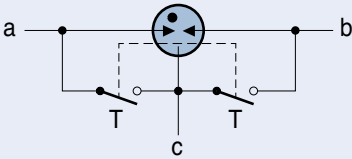
Dimensions in mm

About packing see page 75.

Variants ...F1 and ...F4 show the most common positions for the short-circuit spring. The electrical characteristics are the same as those given for the corresponding types without a short-circuit spring on pages 49 and 50. Alternative voltages, lead configurations and spring positions on request.

Circuit:

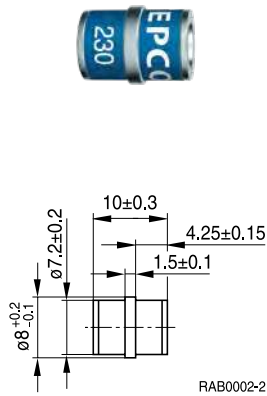
- a, b Line (tip/ring) electrode
- c Center electrode
- T Temperature-controlled short-circuit mechanism



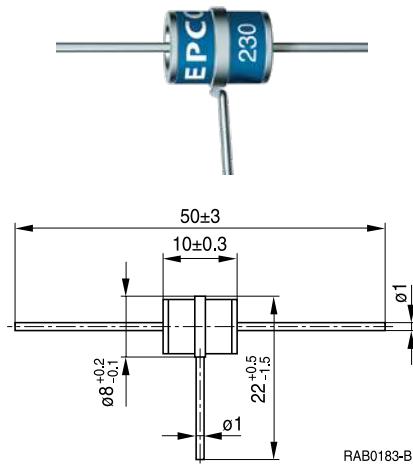
3-Electrode Arresters

Heavy-duty types 20 kA / 10 A · $\varnothing 8 \times 10$ mm

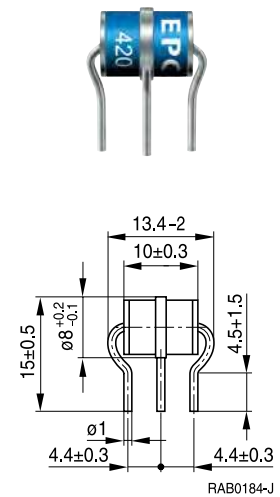
T20-...



T21-...



T23-...



Type Ordering code	T20-A230X B88069X8710C203 T21-A230X B88069X8920B252 T23-A230X B88069X8740B502	T20-A250X B88069X8810C203 T21-A250X B88069X8800B252 T23-A250X B88069X8840B502	T20-A350X B88069X7320C203 T21-A350X B88069X5120B252 T23-A350X B88069X7200B502	T20-A420X B88069X7820C203 T23-A420X B88069X8070B502	
Nom. DC spark-over voltage V_{sdN}	230	250	350	420	V
Tolerance of V_{sdN}	±20	±20	±20	-17/+30	%
Impulse spark-over voltage					
@ 100 V/μs 99% of measured values	<400	<500	<650	<750	V
@ 100 V/μs typical values	<350	<400	<550	<700	V
@ 1 kV/μs 99% of measured values	<500	<600	<700	<850	V
@ 1 kV/μs typical values	<450	<550	<600	<800	V
Service life					
10 operations 50 Hz, 1 s	10	10	10	10	A
1 operation 50 Hz, 9 cycles	50	50	50	50	A
10 operations 8/20 μs	20	20	20	20	kA
1 operation 8/20 μs	25	25	25	25	kA
1 operation 10/350 μs	5	5	5	2	kA
300 operations 10/1000 μs	200	200	200	on request	A
Insulation resistance	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	pF

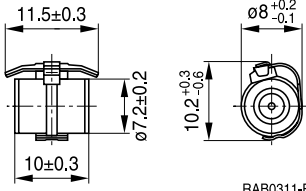
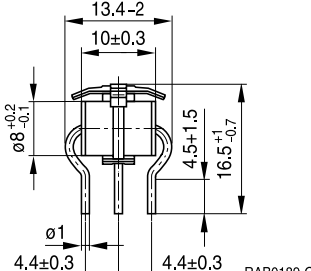
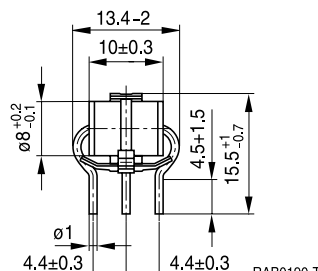
Currents through center electrode, half value through each line electrode.

Dimensions in mm

About packing see page 75.

3-Electrode Arresters

Heavy-duty types / With short-circuit spring
20 kA / 10 A · ø 8 × 10 mm

T20-...F	T23-...F1	T23-...F4			
  RAB0311-F	  RAB0189-Q	  RAB0190-T			
Type Ordering code	T20-A230XF B88069X8720B502 T23-A230XF1 B88069X8680B502 T23-A230XF4 B88069X8750B502 T25-A230XF1 ¹⁾ B88069X8630B502	T23-A250XF1 B88069X9810B502 T23-A250XF4 B88069X8860B502	T23-A350XF1 B88069X7240B502 T23-A350XF4 B88069X7000B502	T20-A420XF B88069X7580B502 T23-A420XF1 B88069X6210B502 T23-A420XF4 B88069X7140B502	
Nom. DC spark-over voltage V _{sdcN}	230	250	350	420	V

¹⁾ Design with shorter lead length.

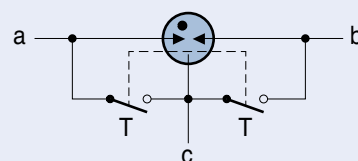
Dimensions in mm

About packing see page 75.

Variants ...F1 and ...F4 show the most common positions for the short-circuit spring. The electrical characteristics are the same as those given for the corresponding types without a short-circuit spring on page 52. Alternative voltages, lead configurations and spring positions on request.

Circuit:

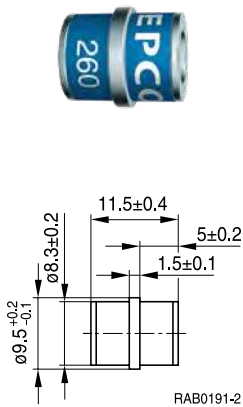
a, b Line (tip/ring) electrode
c Center electrode
T Temperature-controlled short-circuit mechanism



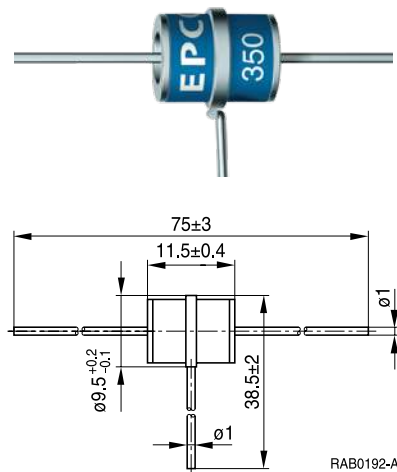
3-Electrode Arresters

Heavy-duty types
20 kA / 20 A · ø 9.5 × 11.5 mm

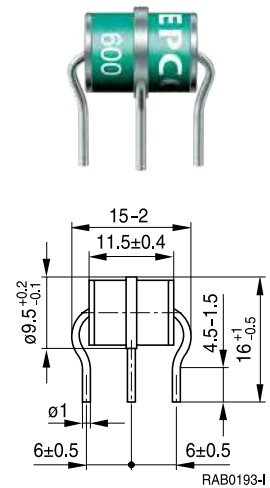
T60-...



T61-...



T63-...



Type Ordering code	T60-A260X B88069X7120C203	T60-C350X B88069X7450C502 T61-C350X B88069X7700B102 T63-C350X B88069X7460B102	T60-A420X B88069X6980C203	T61-C600X B88069X8820B102 T63-C600X B88069X8830B252	T61-C650X B88069X7230B102 T63-C650X B88069X6990B102	
Nom. DC spark-over voltage V_{sdcN}	260	350	420	600	650	V
DC spark-over voltage	210 ... 310	300 ... 500	330 ... 600	420 ... 700	500 ... 800	%
Impulse spark-over voltage						
@ 100 V/μs 99% of measured values	<600	<800	<750	<900	<1100	V
@ 100 V/μs typical values	<550	<700	<650	<800	<1000	V
@ 1 kV/μs 99% of measured values	<650	<900	<850	<1000	<1350	V
@ 1 kV/μs typical values	<600	<800	<750	<900	<1100	V
Service life						
10 operations 50 Hz, 1 s	20	20	20	20	20	A
1 operation 50 Hz, 9 cycles	130	130	130	130	130	A
10 operations 8/20 μs	20	20	20	20	20	kA
1 operation 8/20 μs	40	40	40	40	40	kA
1 operation 10/350 μs	–	5	–	5	5	kA
Insulation resistance	>10	>10	>10	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	<1.5	<1.5	<1.5	pF

Currents through center electrode, half value through each line electrode.

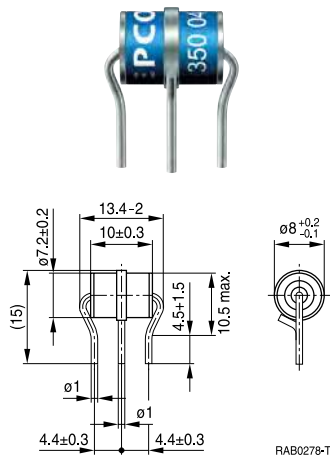
Dimensions in mm

About packing see page 75.

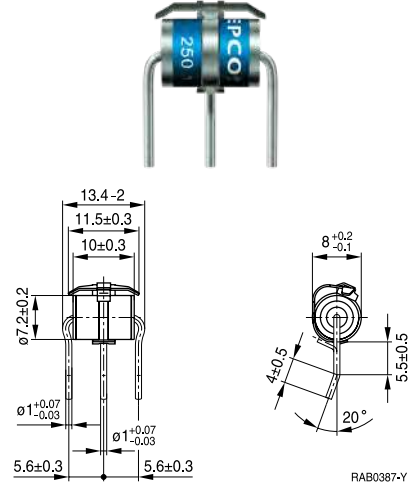
3-Electrode Arresters

Types conforming to US specifications

T23-C350XS



T2B-A350XF1



Type	T23-C350XS ¹⁾	T2B-A350XF1 ²⁾	
Ordering code	B88069X8160B502	B88069X3741B502	
Nom. DC spark-over voltage V_{sdN}	350	350	V
DC spark-over voltage	300 ... 500	±20	%
Impulse spark-over voltage			
@ 100 V/μs 99% of measured values	<650	<750	V
@ 100 V/μs typical values	<550	–	V
@ 1 kV/μs 99% of measured values	<800	<900	V
@ 1 kV/μs typical values	<750	<800	V
Service life			
60 operations 50 Hz, 1 s	–	2	A
10 operations 50 Hz, 1 s	10	–	A
5 operations 50 Hz, 1 s	–	20	A
1 operation 50 Hz, 9 cycles	130	130	A
10 operations 8/20 μs	20	20	kA
1 operation 8/20 μs	25	–	kA
100 operations 10/1000 μs	–	200	A
400 operations 10/1000 μs	1000	1000	A
1500 operations 10/1000 μs	–	20	A
DC hold-over voltage	<150 @ 150 V / 200 mA	<150 @ 135 V / 1300 Ω	ms
Insulation resistance	>10	>10	GΩ
Capacitance @ 1 MHz	<1.5	<1.5	pF

¹⁾ Designed for RUS PE80 Heavy duty

²⁾ Designed for Telcordia GR974-CORE

Currents through center electrode, half value through each line electrode.

Dimensions in mm

About packing see page 75.



Surge Protection of AC/DC Power Lines

Overvoltage Protection of AC Power Lines

Lightning protection acc. to IEC 61643-11

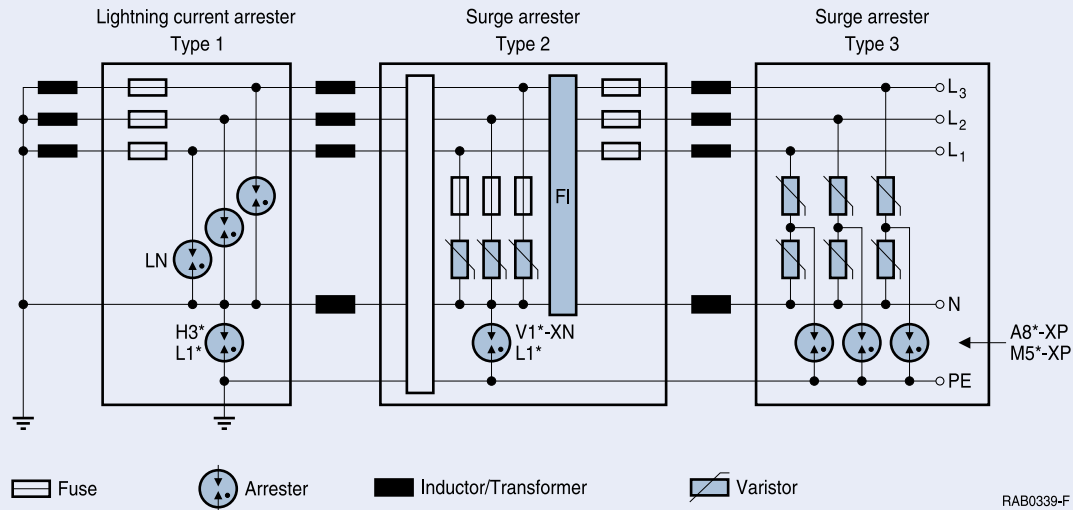


Figure 27

Electrical and electronic systems in building installations and also in power supplies for industrial or telecom installations may be exposed to considerable voltage surges due to direct lightning strikes or interference in the immediate vicinity.

Our surge arresters enable protection modules to be constructed with different protection classes for both L-N and N-PE applications.

L-N arresters

For protection of L-N networks it should be noted that that extremely high currents can flow through the low-resistance AC networks. To ensure that the arresters will extinguish them safely, TDK has designed special stacked arresters for this application.

N-PE arresters

In TT and TN-C-S systems, the so called N-PE arrester is positioned between neutral and protective ground where it is exposed to the sum of the lightning surge currents from all discharge lines. This means that – depending on the classification of the building to the lightning classes defined by DIN VDE 0185-305 – it must carry a direct lightning current of 50, 75 or 100 kA of waveform 10/350 μ s and additionally inductive coupled currents with a waveform of 8/20 μ s and a maximum value of up to 150 kA. The IEC 61643-11 standard specifies a test program which includes both wave-

forms as well as a sinusoidal follow current of up to 100 A that may occur in the event of operation. The limitation of this follow current to the duration of a halfwave, known as its lightning-current discharge capability, is a key characteristic of the arrester.

The different protection classes are defined as follows:

Class I

Protection against direct lightning strike. This is tested in accordance with IEC 61643-11 by means of the “operation duty test” with I_N of the wave form 8/20 μ s and additionally with the impulse current I_{imp} of the wave form 10/350 μ s (additional duty test).

Class II

Protection against induced/injected surges and interference from distant lightning strikes. The components are tested in accordance with IEC 61643-11 – the so-called “operation duty test” – with I_N of the wave form 8/20 μ s and additionally with I_{max} with the wave form 8/20 μ s.

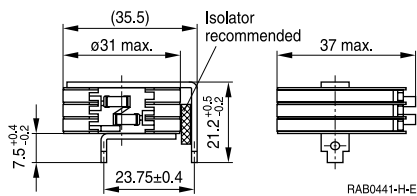
Class III

Class III protection modules are used essentially for protecting terminal equipment. They reduce voltage surges to a level that is harmless to the electrical terminal equipment. These surge arresters are tested with a loading of the wave form 8/20 μ s in accordance with IEC 61643-11.

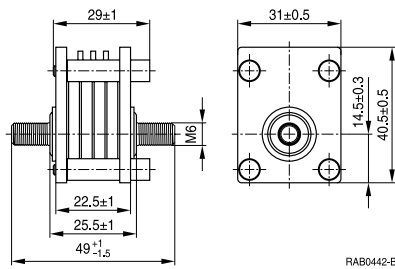
AC Power Line Protection, L-N

Protection class I & II

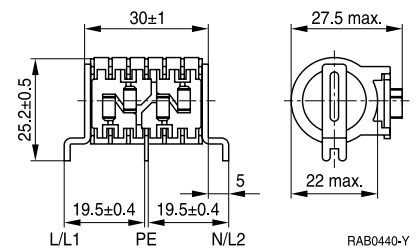
LN30B-...



LN30T6-...



LNP20C-...



Type Ordering code	LN30B-A1800AC-3C B88069X3643B201	LN30T6-A2000AC-4C upon request	LNP20C-A1800AC-6C upon request	
Class	I & II	I	I & II	
Application for	L-N	L-N	L-PE / N-PE	
Nom. DC spark-over voltage V_{sdCN}	1800	–	–	V
DC spark-over voltage	>600	>700	>600	V
Front of wave spark-over voltage @ 1.2/50 μ s, 6 kV U_p	<2500	<2500	<2500	V
Class I				
Max. continuous operating voltage @ 50/60 Hz U_c	275	440	250	V
Nominal discharge current 8/20 μ s I_n	25	25	8	kA
Impulse current 10/350 μ s I_{imp}	25	25	8	kA
Follow current @ 50/60 Hz I_f	6000	10000	1000	A
Class II				
Max. continuous operating voltage @ 50/60 Hz U_c	275	–	250	V
Nominal discharge current 8/20 μ s I_n	25	–	8	kA
Max. discharge current 8/20 μ s I_{max}	40	–	16	kA
Follow current @ 50/60 Hz I_f	6000	–	1000	A
AC discharge current (TOV at 1200 V, connected N-PE) 1 operation 50 Hz, 0.2 s	–	–	–	A
Max. temporary over voltage (max. 5 s) for L-N	440	440	440	V
Insulation resistance	>10	>1	>1	G Ω

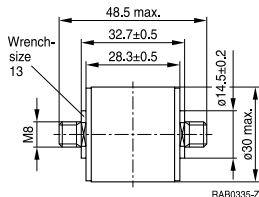
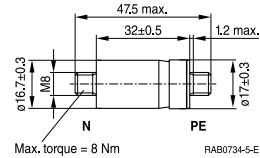
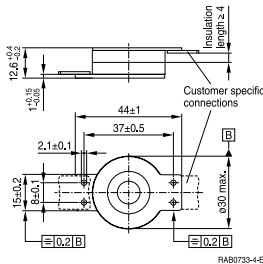
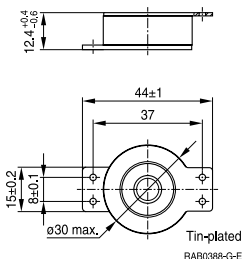
Arresters are designed in accordance with IEC 61643-11.

Dimensions in mm

About packing see page 75.

AC Power Line Protection, N-PE

Protection class I

H38M-...		H28T32-A1000P1		D3E13M-...		L1B-...	
  Wrench size 13 RAB0335-Z		  Max. torque = 8 Nm RAB0734-5-E		  RAB0733-4-E		  Tin-plated RAB0388-G-E	
Type	H38M-A800XP1	H28T32-A1000P1	D3E13M-A800P1	L1B-A800XP1			
Ordering code	B88069X3993B201	B88069X7733B601	B88069X7533B401	B88069X6551B401			
Class	I	I	I	I			
Application for	N-PE	N-PE	N-PE	N-PE			
Nom. DC spark-over voltage V_{sdCN}	800	1000	800	800		V	
DC spark-over voltage	>600	>800	>480	>600		V	
Front of wave spark-over voltage @ 1.2/50 μ s, 6 kV U_p	<1500	<1900	<1500	<1500		V	
Class I							
Max. continuous operating voltage @ 50/60 Hz U_c	255	440	264	264		V	
Nominal discharge current 8/20 μ s I_n	100	100	100	50		kA	
Impulse current 10/350 μ s I_{imp}	100	100	100	50		kA	
Follow current @ 50/60 Hz I_f	100	100	100	100		A	
Class II							
Max. continuous operating voltage @ 50/60 Hz U_c	–	–	–	–		V	
Nominal discharge current 8/20 μ s I_n	–	–	–	–		kA	
Max. discharge current 8/20 μ s I_{max}	–	–	–	–		kA	
Follow current @ 50/60 Hz I_f	–	–	–	–		A	
AC discharge current (TOV at 1200 V, connected N-PE) 1 operation 50 Hz, 0.2 s	300	300	300	300		A	
Insulation resistance	>1	>1	>1	>1		G Ω	

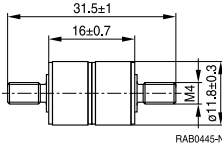
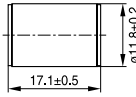
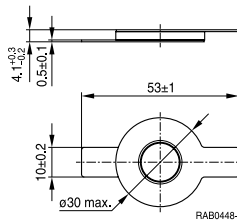
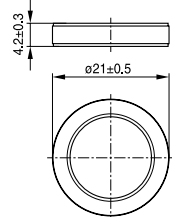
Arresters are designed in accordance with IEC 61643-11.

Dimensions in mm

About packing see page 75.

AC Power Line Protection, N-PE

Protection class I & II

H12-...	V13-...		D3B-...		D20-...	
  RAB0445-N	  RAB0275-V		  RAB0448-Q		  Tin-plated RAB0362-W-E	
Type	H12T22M-A700P	V13-A500XN	V13-A800XN	D3B-A700XP	D20-A800XP	
Ordering code	B88069X8463B162	B88069X6940B401	B88069X4380B152	B88069X2513B401	B88069X7691B301	
Class	I & II	I & II	I & II	I & II	I & II	
Application for	N-PE	N-PE	N-PE	N-PE	N-PE	
Nom. DC spark-over voltage V_{sdCN}	700	500	800	700	800	V
DC spark-over voltage	600 ... 900	500 ... 850	>600	>550	>600	V
Front of wave spark-over voltage U_p @ 1.2/50 μ s, 6 kV	<1500	<1300	<1500	<1500	<1500	V
Class I						
Max. continuous operating voltage @ 50/60 Hz U_c	275	255	255	264	264	V
Nominal discharge current 8/20 μ s I_n	80	40	40	30	30	kA
Impulse current 10/350 μ s I_{imp}	50	12	25	25	25	kA
Follow current @ 50/60 Hz I_f	100	100	100	100	100	A
Class II						
Max. continuous operating voltage @ 50/60 Hz U_c	275	255	255	264	264	V
Nominal discharge current 8/20 μ s I_n	80	40	40	30	30	kA
Max. discharge current 8/20 μ s I_{max}	100	60	60	40	40	kA
Follow current @ 50/60 Hz I_f	100	100	100	100	100	A
AC discharge current (TOV at 1200 V, connected N-PE) 1 operation 50 Hz, 0.2 s	300	300	300	300	300	A
Insulation resistance	>1	>1	>1	>1	>1	G Ω

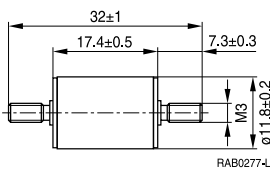
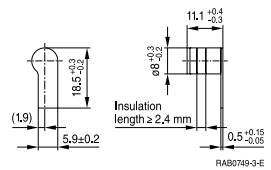
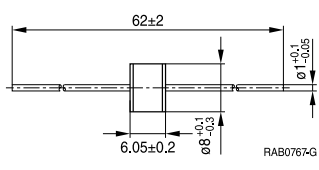
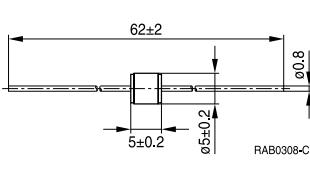
Arresters are designed in accordance with IEC 61643-11.

Dimensions in mm

About packing see page 75.

AC Power Line Protection, N-PE

Protection class II & III

V10...	H08...	A8...	M51-...		
 	 	 	 		
Type Ordering code	V10-A500X B88069X4400B152 V13-A500X B88069X4390B152	H08B11M-A800P2 upon request	A80-A800XP B88069X5691C103 A81-A800XP B88069X5701S102	M51-A800XP B88069X4781S102 B88069X4781T502	
Class	II	II	II & III	II & III	
Application for	N-PE	N-PE	N-PE	N-PE	
Nom. DC spark-over voltage V_{sdcN}	500	800	800	800	V
DC spark-over voltage	400 ... 600	>600	>600	>600	V
Front of wave spark-over voltage @ 1.2/50 µs, 6 kV U_p	<1500	<1500	<1500	<1500	V
Class II					
Max. continuous operating voltage @ 50/60 Hz U_c	255	255	255	255	V
Nominal discharge current 8/20 µs I_n	20	20	10	3	kA
Max. discharge current 8/20 µs I_{max}	40	40	20	3	kA
Follow current @ 50/60 Hz I_f	100	100	100	5	A
AC discharge current (TOV at 1200 V) 1 operation 50 Hz, 0.2 s	300	–	–	–	A
Insulation resistance	>1	>1	>1	>1	GΩ

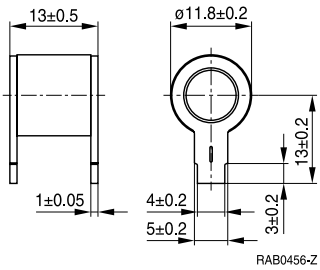
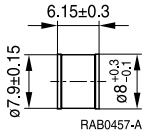
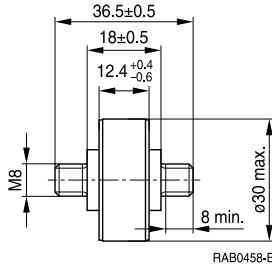
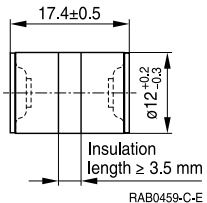
Arresters are designed in accordance with IEC 61643-11

Dimensions in mm

About packing see page 75.

AC Power Line Protection, N-PE

Protection class I, II & III Surge arresters with varistors in series

V87A-...		A80-...	L18A-...	V13M-...	
  RAB0456-Z		  RAB0457-A	  RAB0458-B	  RAB0459-C-E	
Type	V87A-A300XSPD	A80-A900XPD	L18A-A3000XPD	V13M-H40XPD	
Ordering code	B88069X2453B251	B88069X2523C103	B88069X9471B122	B88069X3313B152	
Class	I, II & III (with varistor in series)	II (with varistor in series)	I & II (with varistor in series)	II (with varistor in series)	
Application for	N-PE	N-PE	N-PE	N-PE	
Nom. DC spark-over voltage V_{sdcN}	300	900	3000	4000	V
DC spark-over voltage	225 ... 375	>700	2700 ... 3900	>3200	V
Front of wave spark-over voltage @ 1.2/50 μ s, 6 kV U_p	<900	<1700	<4500	<5500	V
Class I					
Max. continuous operating voltage @ 50/60 Hz U_c	110	–	1000	–	V
Nominal discharge current 8/20 μ s I_n	20	–	50	–	kA
Impulse current 10/350 μ s I_{imp}	12.5	–	35	–	kA
Class II					
Max. continuous operating voltage @ 50/60 Hz U_c	110	255	1000	440	V
Nominal discharge current 8/20 μ s I_n	20	10	50	15	kA
Maximum discharge current 8/20 μ s I_{max}	40	20	100	30	kA
Insulation resistance	>1	>1	>1	>1	G Ω
Class III					
Max. continuous operating voltage @ 50/60 Hz U_c	110	–	–	–	
Limiting voltage at combination wave generator, 1.2/50 μ s, 6 kV; 8/20 μ s, 3 kA U_p	<650	–	–	–	

Arresters are designed in accordance with IEC 61643-11.

Overvoltage Protection of DC Power Networks

Typical protection circuit

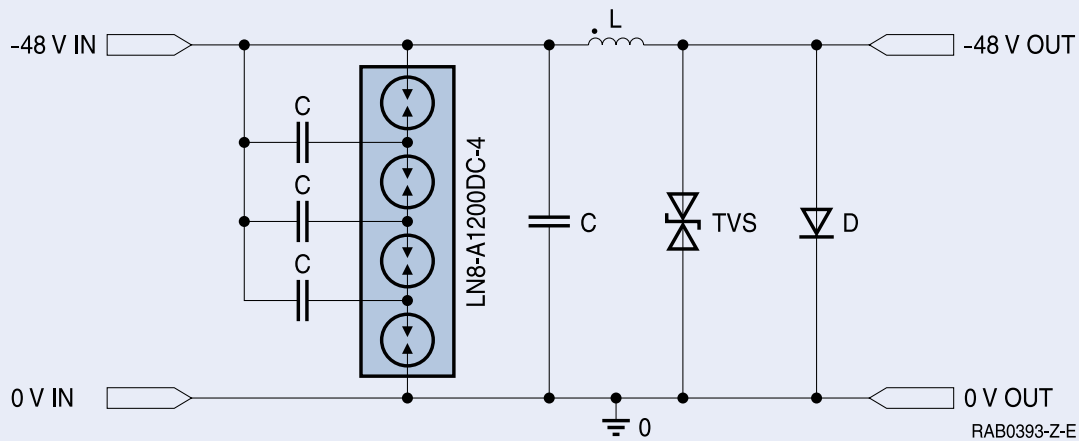


Figure 28

The overvoltage protection of DC power networks is a very sophisticated challenge. These networks, which are able to provide short circuit currents of 30 A or more, can be efficiently protected by the gas-filled stacked arresters of the LN8 series.

For this application it is important that, after the external interference surge has subsided, the arc extinguishes safely. This can only be guaranteed if the arc voltage of the arrester is higher than the DC operating voltage. Connecting stacked arresters in series raises the arc voltage to the required value. The number of arc chambers will determine the maximum DC operating voltage. Unfortu-

nately, the series connection also leads to increased impulse breakdown voltages, an effect that can be minimized by parallel connection of capacitors. The remaining residual voltages can then easily be reduced to small harmless values with a secondary protection circuit.

The LN8 series of surge arresters enables DC power networks to be protected up to 72 V. With an extremely low capacitance of less than 1 pF at 1 MHz and a high insulation resistance of more than 10 GΩ at 100 V DC, these RoHS-compatible SMD components have negligible parasitic impact on the network.

DC Power Line Protection

Stacked surge arresters

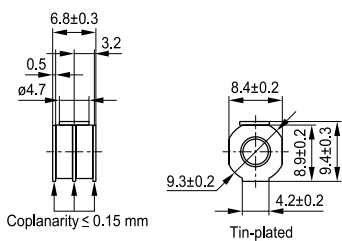
10 kA • 8.4 × 16.3 mm

LN8-... / LN8A-...

SMD



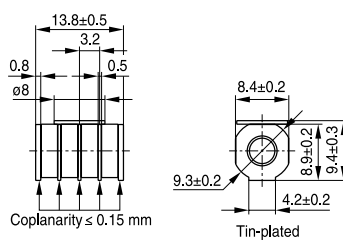
LN8A-...



SMD



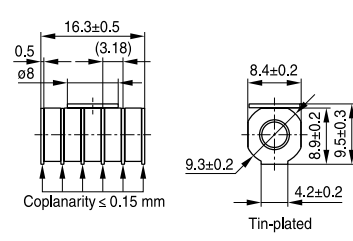
LN8A-...



SMD



LN8A-...



Type Ordering code	LN8-A450DC-2 ¹⁾ B88069X1983B102 LN8A-A450DC-2 B88069X1883B302	LN8-A1200DC-4 ¹⁾ B88069X1993B501 LN8A-A1200DC-4 B88069X2003B302	LN8-A1400DC-5 ¹⁾ B88069X1123B501 LN8A-A1400DC-5 B88069X1003B302	
DC spark-over voltage	450	1200	1400	V
Tolerance V_{sdcN}	±30	±30	±30	%
Front of wave spark-over voltage @ 1.2/50 μ s, 6 kV	<1100	<2000	<2300	V
Front of wave spark-over voltage @ 1.2/50 μ s, 6 kV	See DC power protection circuit ①	See DC power protection circuit ②	See DC power protection circuit ③	
Initial	<780	<850	<900	V
After service life	<1200	<1600	<1500	V
DC operating voltage	24 +25%	48 +20%	60 +20%	V
Service life				
10 operations 8/20 μ s	10	20	20	kA
10 operations 10/350 μ s	–	4	4	kA
100 operations 10/350 μ s	–	500	500	A
300 operations 10/1000 μ s	100	100	100	A
Insulation resistance	>10	>10	>10	G Ω
Capacitance @ 1 MHz	<1	<1	<1	pF

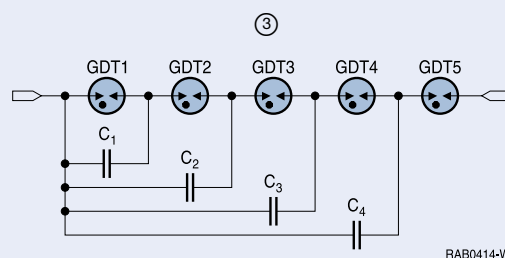
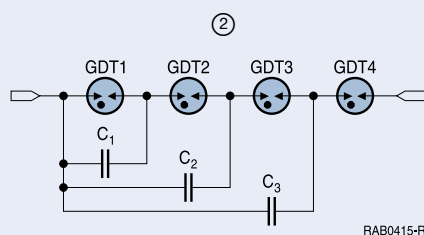
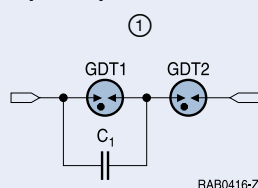
¹⁾ LN8-... types are without assembly disk. Dimensional drawings upon request.

Arresters are designed in accordance with IEC 61643-11

Dimensions in mm

About packing see page 75.

DC power protection circuit





Switching Spark Gaps

Switching Spark Gaps



The principle of gas discharge is used not only for overvoltage protection but also in switching applications. Unlike surge arresters, switching spark gaps are active components that work reliably even after igniting hundreds of thousands of times. They can be used in all applications where high voltage pulses are generated, for example to ignite modern high-pressure gas discharge lamps such as xenon lamps in automotive headlights.

Ignition performance is determined to a large degree by the properties of the switching component. An extremely fast switch is called for, which operates virtually without loss and with high insulation resistance in the non-conducting state. It should also be as compact as possible, rugged, highly reliable, and capable of operating over a wide temperature range.

Switching spark gaps from TDK make use of the advantages of arc discharge: The enormous speed at which the arc is formed (<50 ns) as well as the high current carrying capability allow the generation of short pulses of some $10\text{ }\mu\text{s}$ duration with extremely high current or voltage rise times and low power loss. Insulation resistance in a non-conducting state is determined by the extremely low leakage currents and is in the $\text{M}\Omega$ range.

The construction of our switching spark gaps as well as the high quality of the manufacturing processes (ISO TS 16949) satisfy the strict requirements set by the automobile industry for component reliability. Our switching spark gaps have already proven their worth to ignite xenon headlights for more than 25 years.

Switching Spark Gaps

Circuit example for CAS02X

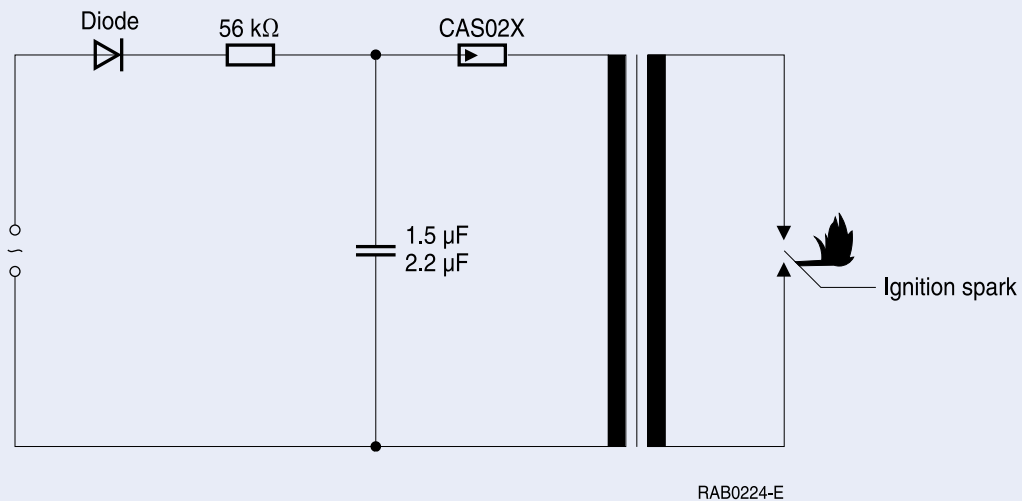


Figure 29

General technical information

The basic circuit of a pulse igniter contains a charging resistor, an ignition capacitor, a spark gap and a high-voltage transformer as shown in **Figure 29** and **Figure 30**.

When the ignition voltage of the spark gap is reached, the energy stored in the capacitor is discharged across the primary side of the transformer to generate the required high-voltage pulses on the secondary side. Their amplitude is determined by the ignition voltage of the spark gap, the selected capacitance and by the winding ratio of the transformer. The repetition frequency can be set by selecting a suitable charging resistor.

The construction of gas-filled switching spark gaps is similar to that of a surge arrester with two electrodes (see page 7). The electrical properties required for switching applications and the long switching life are set by matching design features such as the spacing and shape of the electrodes, the electrode activating compound, the type and pressure of the gas filling as well as the number, type and position of the ignition aids. The rugged hard-solder connection between the electrodes and the ceramic insulator ensures the high reliability demanded for a wide temperature range.

Type series CAS02X

Application: igniters for gas cookers and central heating systems.

Principle: The switching spark gap generates the current pulse for the ignition transformer on the primary side. This in turn generates the high voltage required to ignite the gas mixture, typically 12 kV, on the secondary side through its winding ratio.

Switching Spark Gaps

Basic circuit of pulse igniter for HID lamps

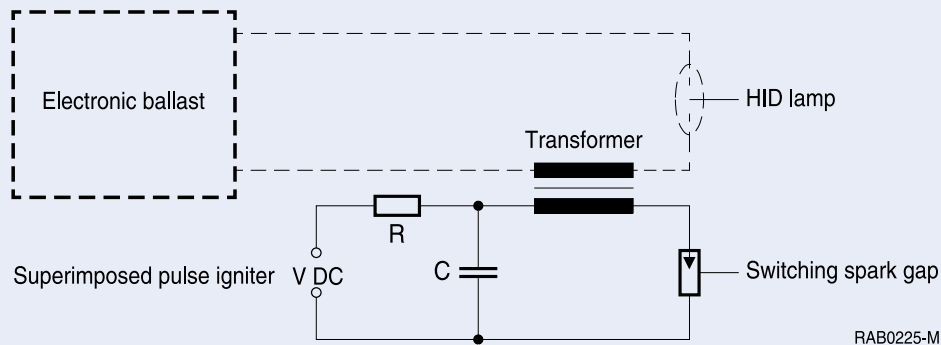


Figure 30

Characteristics

Switching time	<50 ns
Switching current, peak value (depending on type)	<1000 A
Energy per discharge (depending on type)	<200 mJ
Service life (switch operations) ¹⁾	10 ⁵ ... 10 ⁶
Arc voltage	10 ... 50 V

Type series SSG

Application: igniters for cold and hot ignition of high-pressure and ultra-high-pressure gas discharge lamps for video and data projectors, general illumination (e.g. stadium and studio lighting, lighting effects for goods in stores), special applications (endoscopy).

Principle: The high-voltage pulses generated in the ignition circuit are superposed onto the lamp operating voltage supplied by the ballast. The low losses of switching with spark gaps mean that ignition circuits can be dimensioned so that only a few pulses – in some cases just one – suffice to ignite a high-pressure gas discharge lamp.

Type series FS

Application: igniters in xenon discharge lamps for automotive headlights as well as in auxiliary lighting used in construction and mining.

Feature: The FS series is designed for use over a wide temperature range of –40 to +170 °C with a relatively tight range of breakdown voltages. Normally one pulse is sufficient to ignite a gas discharge lamp.

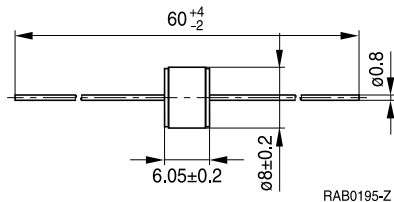
Principle: as for the SSG.

¹⁾The number of switching operations and the breakdown voltage during component service life are largely determined by ignition circuit parameters, i.e. by the capacitance of the ignition capacitor as well as the primary inductance of the high-voltage transformer. Because the layout of the circuits depends on the user, these values have not been included in the table. Data sheets with values for switching operations and breakdown voltages obtained from standardized test circuits are available upon request.

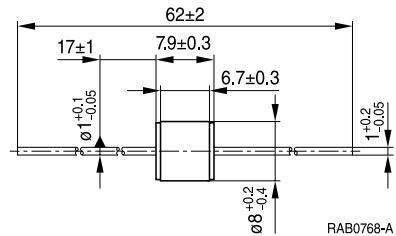
Switching Spark Gaps

Commodity series

CAS...



SSG...



Type series Ordering code	CAS02X-68 B88069X0680T502	SSG3CX-1 B88069X5903S102	SSG5CX-1 B88069X5913S102	
Nominal breakdown voltage	230	3000	5000	V
Static breakdown voltage, initial ¹⁾	200 ... 255	2550 ... 3540	4000 ... 6000	V
Breakdown voltage, during lifetime ¹⁾	–	2400 ... 3600	3750 ... 6250	V
Breakdown time	–	≤ 50	≤ 50	ns
Switching operations @ 25 °C ²⁾	2,000,000	1,000,000	100,000	
Approx. discharge peak current ²⁾	300	50	30	A
Operating temperature	–20 ... +125	0 ... +100	0 ... +100	°C
Insulation resistance	>100	>100	>100	MΩ

¹⁾ Ionized

²⁾ Test circuit on request.

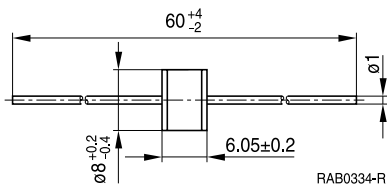
Dimensions in mm

About packing see page 75.

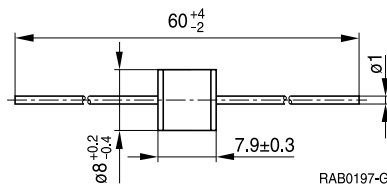
Switching Spark Gaps

High-performance series

FS...



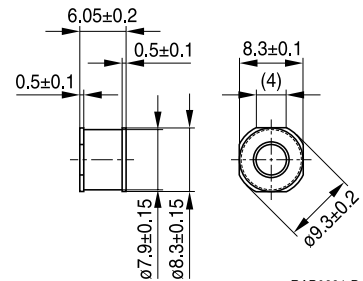
RAB0334-R



RAB0197-G

FS...SMD

SMD



RAB0291-D

Type Ordering code	FS06CX-1NG B88069X6923T502	FS08CX-1GH B88069X5873T502	FS08HF1BSMD B88069X5543T602	FS1.8CX-1JG B88069X7703T502	FS5.5CX-1 B88069X5893S102	
Nominal breakdown voltage	600	800	800	1850	5000	V
Static breakdown voltage, initial ¹⁾	560 ... 680	704 ... 896	704 ... 896	1440 ... 2160	4850 ... 6150	V
Breakdown voltage, during lifetime ¹⁾	540 ... 700	680 ... 920	680 ... 920	1350 ... 2250	4000 ... 6600	V
Breakdown time	<50	<50	<50	<50	<50	ns
Switching operations @ 25 °C ²⁾	40,000	100,000	340,000	200,000	500,000	
Approx. discharge peak current ²⁾	1000	650	500		200	A
Operating temperature	-40 ... +125	-40 ... +150	-40 ... +170	0 ... +100	-40 ... +125	°C
Insulation resistance	>100	>100	>100	>100	>100	MΩ

¹⁾ Ionized

²⁾ Test circuit on request.

Dimensions in mm

About packing see page 75.

Triggered Switching Spark Gaps

Typical circuit for shock wave lithotripsy

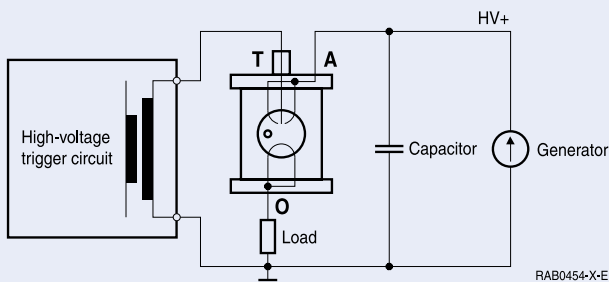


Figure 31



©: EDAP TMS, 37 years of innovation in non-invasive therapies

To generate short high-energy current impulses, TDK offers the triggered spark gaps of the TF series. A high voltage capacitance with a typical electrical strength of approximately 22 kV is discharged with currents of up to 10 kA. A typical application for this kind of high-energy discharge current is the method of extracorporeal shock wave therapy (ESWT) or extracorporeal shock wave lithotripsy (ESWL) for medical purposes. For this application the capacitance, with typical values of between 100 nF and 1.2 μ F, is discharged across an inductance of a coil with a membrane (electro-dynamic principle), or across a spark gap immersed in an electrolyte fluid (spark plug principle). The mechanical impulse wave is focused onto the specified object (e.g. a kidney stone) in order to disintegrate it.

TDK offers various types for this purpose with different self-breakdown voltages and trigger designs. A triggered switching spark gap enables the main discharge of the capacitance to be controlled for voltages below the self-breakdown voltage. Typically the trigger voltage is between about 30% and 80% of the self-breakdown voltage. The advantage of triggered operation is that it controls the discharge voltage of the capacitor and, in the case of ESWT, it enables the medical treatment to start with low current impulses which can subsequently be increased.

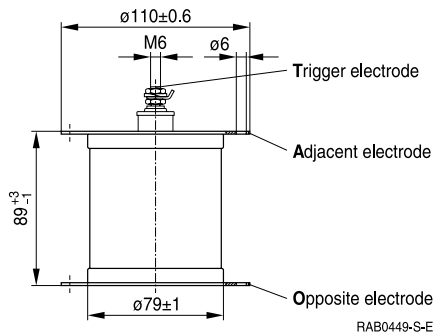
General technical information

A typical circuit for creating a high energy surge impulse is shown in **Figure 31**. The capacitance C is charged by means of a generator and then at the required frequency the discharge to the switching spark gap is triggered by the trigger circuit. For high capacitances the switching spark gaps are triggered at a rate of 2 Hz. Under the conditions defined in the data sheet, a service life of between two and four million operations can be achieved.

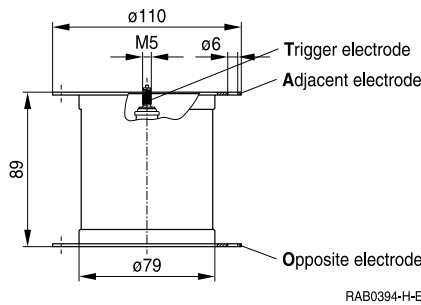
Triggered Switching Spark Gaps

Triggered switching spark gaps

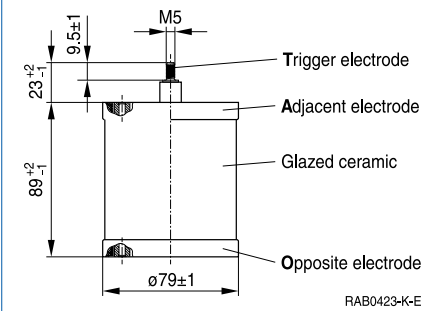
TF25E/ TF32E



TF26/ TF28



TF20R



Type	TF25E	TF26	TF28	TF20R	TF32E	
Ordering code	B88069X1093B011	B88069X9601B011	B88069X9091B011	B88069X4393B011	B88069X1443B011	
Self breakdown voltage	25	26	28	20	32	kV
Tolerance of SBV	±10	±10	±10	±10	±10	%
Triggered breakdown voltage, initial	8 ... 19	8.5 ... 21	8.5 ... 22	7 ... 16	10 ... 22	kV
Triggered breakdown voltage, during lifetime	8 ... 16	9.5 ... 21	10 ... 22	7.5 ... 14.5	10 ... 20	kV
Switching operations @ 2 Hz	4,000,000	2,000,000	2,000,000	2,000,000	4,000,000	
Discharge capacitance	1.2	1.2	1.2	0.1	1.2	μF
Open-circuit peak trigger voltage	>15	>15	>15	>15	>15	kV
Trigger peak current	5 ... 20	~ 5	~ 5	~ 10	5 ... 20	A
Breakdown time	<50	<50	<50	<50	<50	ns
Insulation resistance	>100	>100	>100	>100	>100	MΩ

Dimensions in mm

About packing see page 75.

Display of ordering codes for TDK products

The ordering code for one and the same TDK product can be represented differently in data sheets, data books, other publications, on the TDK website, or in order-related documents such as shipping notes, order confirmations and product labels. **The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products.**

Detailed information can be found on the Internet at <https://www.tdk-electronics.tdk.com/orderingcodes>.

Quality



No compromises

With our quality management (QM) system, and with a company wide zero-defect campaign based on the “Six Sigma” method, we are consistently improving our process control and, as a result, the quality of our products. Numerous awards illustrate how much customers appreciate this strict approach to quality.

Today, increasingly demanding quality requirements are passed along through the entire production chain. Tougher quality standards are becoming increasingly relevant to the company's key markets, which include the automobile industry, information and communications technology as well as industrial and consumer electronics.

International QM system standards

Manufacturers insist that their suppliers run QM systems that cover every function within the company and are precisely aimed at reliably controlling its processes and improving them continuously. These requirements are laid down in the international QM system standards ISO 9001 and ISO/TS 16949.

Certification to ISO 9001 and ISO/TS 16949

Our quality policy stipulates that our QM system must satisfy the requirements of the most demanding international standards in any particular case. Our factories and their supporting sites are therefore audited regularly by external third parties in order to maintain certification to ISO 9001 and ISO/TS 16949. The QM system is continuously monitored

and systematically developed within the company. We do not accept any compromises with regard to quality, which means that we constantly strive for ongoing improvement in a continuous process, whereas process control is the key to business success. It is the only way to ensure products and services of the highest quality and thus customer satisfaction.

Quality monitoring

100% test

Arresters and spark gaps are individually tested for correct operation before dispatch.

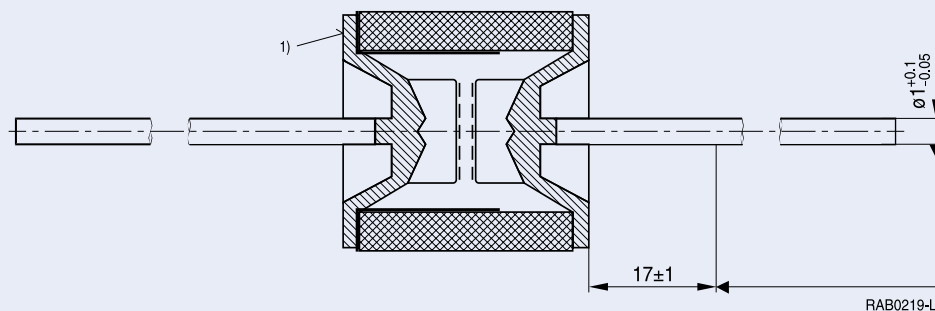
Sampling inspections

In our quality tests, we apply sampling inspections based on the following internationally recognized standard: ANSI Z 1.4, normal inspection level II.

These quality monitoring processes are applied within the scope of statistical process control (SPC) to the process steps, the type and delivery inspections as well as the reliability inspections. Our delivery inspection (including simulation of the customer's incoming inspection) operates with the test features V_{sdc} and R_{ins} unless otherwise agreed. For our outgoing quality inspection we practice AQL 0.65 or better. The average outgoing quality (AOQ) is measured regularly in ppm and evaluated on the basis of these values.

For switching spark gaps, application oriented lifetime tests are carried out (see individual data sheets).

Arresters with tin-plated surface



1) Thickness of tin plating measured on one point in the middle of the flange.

Figure 32

Reliability inspections

The following tests are carried out on the basis of the international standards IEC or DIN EN 60068:

- Lifetime tests (switching spark gaps)
- Temperature cycling tests:

Arresters	−40 °C ... +90 °C
Switching spark gaps	−40 °C ... +125 °C
- Humidity tests (relative humidity = 93%)
- Continuous shock tests ($a = 400 \text{ ms}^{-2}$)
- Vibration tests ($f = 10$ to 500 Hz)
- Tension/bending tests of the lead wires
- Torsional strength tests of the lead wires
- Solderability tests
- Inspection of mechanical dimensions

The frequency and stress parameters used in these tests depend on the component types.

The product and dispatch packaging is monitored to DIN EN 24180 (strain, vibration and impact tests) as well as by means of transport tests performed under practical conditions.

Electrical stress

In the most international specifications, the failure modes for surge arresters are determined. Other failure modes are as follows:

- Nominal discharge current and nominal alternating discharge current
 Failure criteria:
 Total failure
 Failures due to variations:

	Short circuit
$V_{\text{sdc}} < 0.7 \times V_{\text{sdcN}}$	
$V_{\text{sdc}} > 1.3 \times V_{\text{sdcN}}$	
 - Single-discharge current and alternating discharge current
 Failure criteria:
 Total failure
 Failures due to variations:

	Short circuit
$V_{\text{sdc}} < 0.5 \times V_{\text{sdcN}}$	
$V_{\text{sdc}} > 1.5 \times V_{\text{sdcN}}$	
- Permissible failure rate: $\leq 5\%$

Layer thickness test of electrolytic surfaces

The electrolytic layers of the surge arresters and switching spark gaps are monitored during the manufacturing process at the measuring point shown in **Figure 32**.

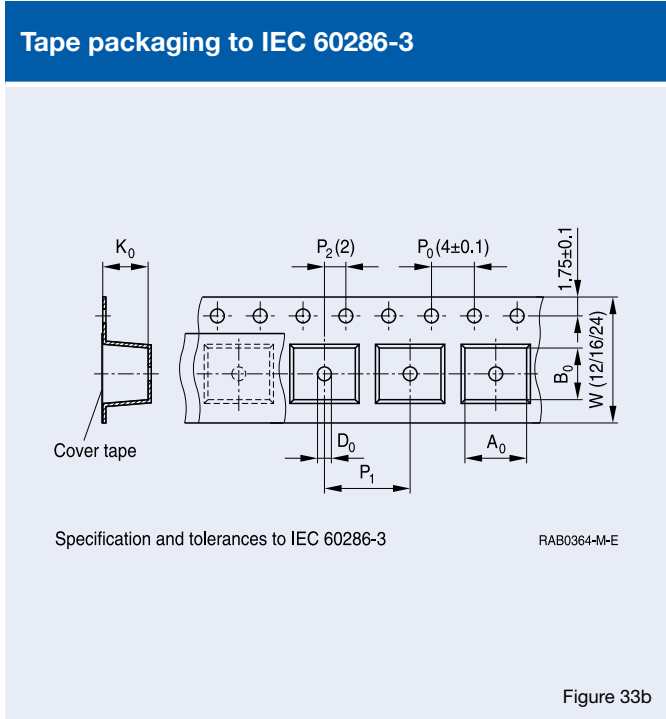
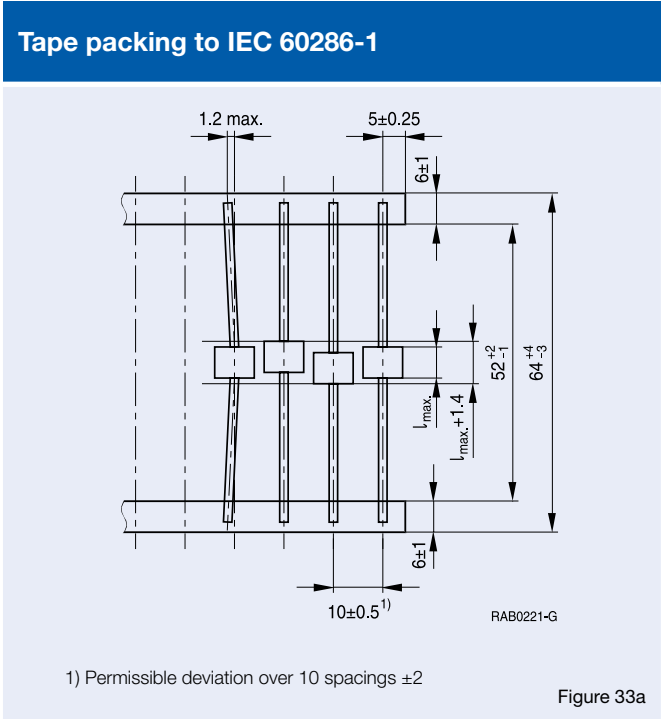
Climatic framework conditions

The diverse requirements profiles for surge arresters and switching spark gaps are used to derive various temperature ranges for operation and storage. Due to their predominant use in telecom applications arresters have to comply with ITU-T, K.12, unless otherwise specified.

For switching spark gaps, the standards of the automotive industry are generally applied.

Temperature values are given in the product part of this brochure or in data sheets which are available at <https://www.tdk-electronics.tdk.com/en/arresters>.

Taping and Packing



Packing

Surge arresters and switching spark gaps are supplied in various types of packing and packing units. These are encoded in the last four digits of ordering codes.

Depending on the design, 2-electrode arresters with a terminal wire are preferably supplied taped to IEC 60286-1.

The wire length available for processing in taped arresters is correspondingly reduced (see **Figure 33a**).

In general unleaded arresters are delivered in plastic tapes to IEC 60286-3 (see **Figure 33b**).

Ordering code system

Ordering code: B88069X1234 **S 102**

Packing

A = AMMO packing on request
B = Blister tray
C = Bulk packing
S = Strip
T = Standard tape

Packing unit

Code	Pieces	Code	Pieces
101	10	252	250
102	10 (on 5 strips)	253	2500
103	1000	352	350
202	200	403	4000
203	2000	502	500
251	25	902	900

Mounting Instructions

Bending lead wires

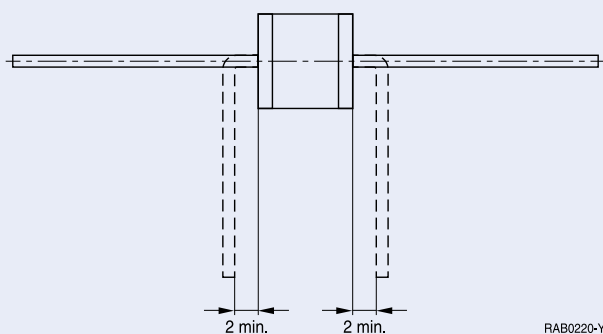


Figure 34

Bending and truncating lead wires

The processing of surge arresters may involve the bending or truncating of lead wires. It is then absolutely necessary to ensure that the metal-ceramic compound (electrodes/ceramic insulator) is not subject to mechanical stress and that no sudden stress affects the ceramic.

A minimum spacing of 2 mm must be observed between the body and the bend point (**Figure 34**). This ensures that the strength at the welding point between wire and electrode is not diminished.

The bending pattern of surge arresters from TDK may differ from that described above.

Recommended soldering profiles: Wave soldering

Soldering profile applied to a single soldering process.

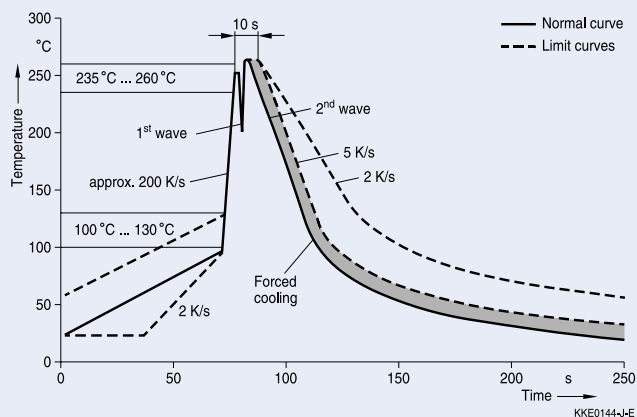


Figure 35

TDK surge arresters are designed for the requirements of lead-free soldering.

Soldering temperature profiles are according to JEDEC J-STD-020D and IEC 60068-2-58 recommendations.

Solder	Solder bath temperature	Dwell time
Sn 95.5/Ag3.8/Cu 0.7	263 (±3) °C	<3 s

Notes:

Soldering surge arresters with a failsafe mechanism needs to be examined individually.

- Recommended storage temperature +5 ... +35 °C
- Relative humidity 45 ... 80%
- Maximum storage period 2 years

Mounting Instructions

Recommended soldering profiles: Reflow soldering

Temperature rise rate: 3 °C/s

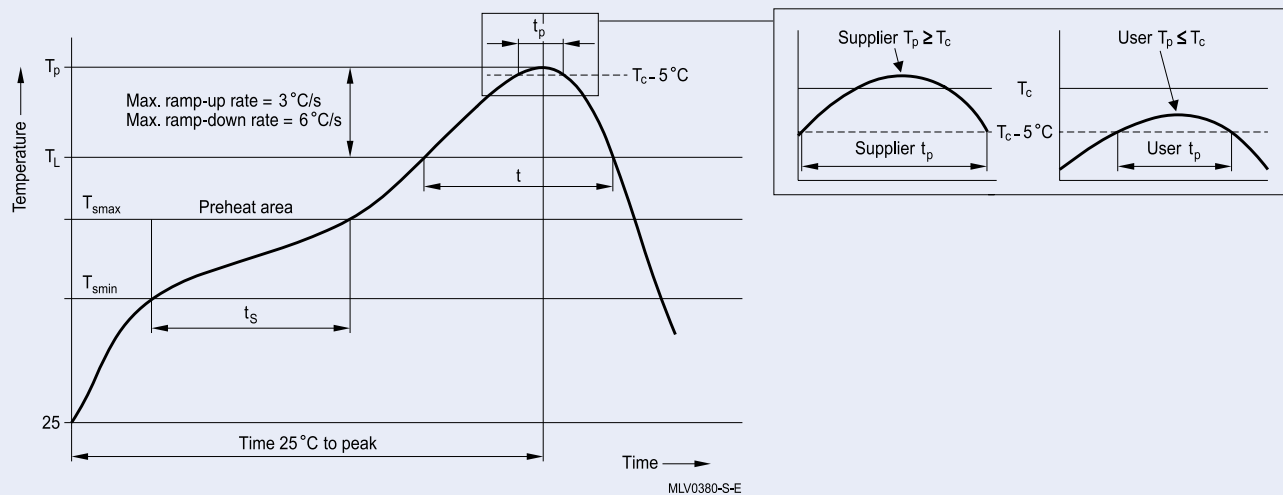


Figure 36

Reflow profile features		Sn-Pb eutectic assembly	Pb-free assembly	
Preheat and soak				
Temperature min.	T_{smin}	100	150	°C
Temperature max.	T_{smax}	150	200	°C
Time	t_{smin} to t_{smax}	60 ... 120	60 ... 120	s
Average ramp-up rate	T_L to T_p	3 max.	3 max.	°C/s
Liquidous temperature	T_L	183	217	°C
Time at liquidous	t_L	60 ... 150	60 ... 150	s
Peak package body temperature ¹⁾	T_p	For users T_p must not exceed the classification temperature. For suppliers T_p must equal or exceed the classification temperature.		°C
Classification temperature ²⁾	T_c	220 ... 235	245 ... 260	°C
Time within 5 °C of specified classification temperature (T_c)	t_p ²⁾	20 ³⁾	30 ³⁾	s
Average ramp-down rate	T_p to T_L	6 max.	6 max.	°C/s
Time 25 °C to peak temperature		6 max.	8 max.	min

¹⁾ Tolerance for peak profile temperature (T_p) is defined as a supplier minimum and a user maximum.

²⁾ Depending on package thickness. For details refer to JEDEC J-STD-020D.

³⁾ Tolerance for time at peak profile temperature (T_p) is defined as a supplier minimum and a user maximum.

Environmental Protection



Global environment management

With our global environmental management in accordance with ISO 14001 we are protecting the environment to the same high standard in all parts of the world.

The same requirements are placed on every site; external institutes ensure, at regular intervals, that they are being observed.

As well as satisfying both statutory requirements and those imposed by the relevant authorities, our environmental management system aims to utilize natural resources efficiently. For that reason, we use our technological expertise to design and manufacture our electronic components in the most environmentally compatible way possible. We are continuously optimizing our products and processes in order to use materials in a way that minimizes the impact on resources, to use substitutes for hazardous materials wherever possible, and to reduce waste to a minimum.

Material data sheets

An obligatory list of materials and substances has its foundations in our quality management system, and this guarantees that a consistent procedure is applied to all our products. We are, moreover, active in a large number of

committees, working groups and commissions associated with the electronics industry, with the aim of pushing forward the standardization of material data sheets for electronic components. The materials contained in our products are listed in detail on these material data sheets, so that customers, in turn, can satisfy the environmental requirements imposed upon them.

Material data sheets for TDK products can be found at www.tdk-electronics.tdk.com/material.

Substances in components regulated by law (RoHS)

Although components are not directly covered by Directive 2011/65/EU (RoHS), we observe this directive on the basis of the current state of knowledge. With due consideration to the exemptions defined in the Annex III to 2011/65/EU, all our products are free¹⁾ of:

- Cadmium and cadmium compounds
- Hexavalent chromium
- Mercury and mercury compounds
- PBBs and PBDEs
- Lead and lead compounds.

¹⁾ "free" means that the substances listed in para. 4 of directive 2011/65/EU may be contained in the homogeneous material less than 0.1%.

