SIOV metal oxide varistors

Housed (ThermoFuse) varistors, AdvanceD series

Series/Type: **T20 series**

Date: January 2018

EPCOS AG is a TDK Group Company.

Construction

- Round varistor element, leaded
- Coating: epoxy resin, flame-retardant to UL 94 V-0
- Terminals: tinned copper wire, metal compound wire
- Housing: thermoplastic, flame-retardant to UL 94 V-0

Features

- Wide operating voltage range 130 … 680 V_{RMS}
- Self-protected under abnormal overvoltage conditions
- High-energy AdvanceD series E2

Approvals

- UL 1449 (file number E321126)
- IEC (certificate number 101-QA-10 IECQ)
- VDE (certificate number 40031102)

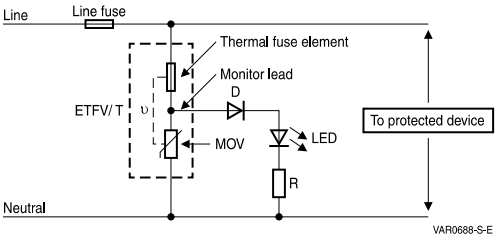
Applications

- Houshold appliances
- Power supply units
- Inverters in solar power systems
- Lighting applications
- Communication and data systems
- Transient voltage surge suppressors (TVSS)
- Electronic metering

Delivery mode

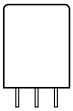
- Tray packing

Typical applications



General technical data

Climatic category	to IEC 60068-1	40/85/56	
Operating temperature	to IEC 61051	−40 ... + 85	°C
Storage temperature		−40 ... + 85	°C
Electric strength	to IEC 61051	≥ 2.5	kV_{RMS}
Insulation resistance	to IEC 61051	≥ 100	MΩ



Electrical specifications and ordering codes

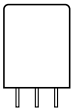
Maximum ratings (T_A = 85 °C)

Ordering code	Type (untaped) SIOV-	V_{RMS} V	V_{DC} V	i_{max} (8/20 µs) A	I_n [1] (8/20 µs) 15 times A	W_{max} (2 ms) J	P_{max} W
B72220T2131K105	T20K130E2	130	170	10000	3000	100	1.0
B72220T2151K105	T20K150E2	150	200	10000	3000	120	1.0
B72220T2171K105	T20K175E2	175	225	10000	3000	135	1.0
B72220T2231K105	T20K230E2	230	300	10000	3000	180	1.0
B72220T2251K105	T20K250E2	250	320	10000	3000	195	1.0
B72220T2271K105	T20K275E2	275	350	10000	3000	215	1.0
B72220T2301K105	T20K300E2	300	385	10000	3000	250	1.0
B72220T2321K105	T20K320E2	320	420	10000	3000	273	1.0
B72220T2351K105	T20K350E2	350	460	10000	3000	223	1.0
B72220T2381K105	T20K385E2	385	505	10000	3000	248	1.0
B72220T2421K105	T20K420E2	420	560	10000	3000	273	1.0
B72220T2461K105	T20K460E2	460	615	10000	3000	300	1.0
B72220T2511K105	T20K510E2	510	670	10000	3000	325	1.0
B72220T2551K105	T20K550E2	550	745	10000	3000	360	1.0
B72220T2621K105	T20K625E2	625	825	10000	3000	400	1.0
B72220T2681K105	T20K680E2	680	895	10000	3000	440	1.0

[1] **Note:** Nominal discharge current I_n according to UL 1449, 4th edition.

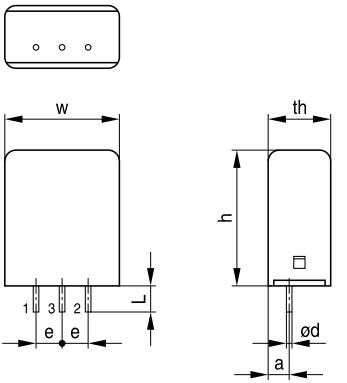
Characteristics (T_A = 25 °C)

Ordering code	Type (untaped) SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	$v_{c,max}$ (i_c) V	i_c A	C_{typ} (1 kHz) pF
B72220T2131K105	T20K130E2	205	±10	340	100	1850
B72220T2151K105	T20K150E2	240	±10	395	100	1550
B72220T2171K105	T20K175E2	270	±10	455	100	1350
B72220T2231K105	T20K230E2	360	±10	595	100	940
B72220T2251K105	T20K250E2	390	±10	650	100	940
B72220T2271K105	T20K275E2	430	±10	710	100	850
B72220T2301K105	T20K300E2	470	±10	775	100	780
B72220T2321K105	T20K320E2	510	±10	840	100	720
B72220T2351K105	T20K350E2	560	±10	910	100	660
B72220T2381K105	T20K385E2	620	±10	1025	100	600
B72220T2421K105	T20K420E2	680	±10	1120	100	550
B72220T2461K105	T20K460E2	750	±10	1240	100	500
B72220T2511K105	T20K510E2	820	±10	1355	100	460
B72220T2551K105	T20K550E2	910	±10	1500	100	410
B72220T2621K105	T20K625E2	1000	±10	1650	100	380
B72220T2681K105	T20K680E2	1100	±10	1815	100	340



Dimensional drawings in mm

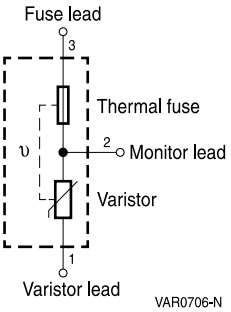
T20, V_{RMS} = 130 ... 420 V



w_{max} = 22
h_{max} = 26
th_{max} = 12
ød = 0.8±0.1
e = 5±0.5
a = 4±0.5
L = 5±0.5

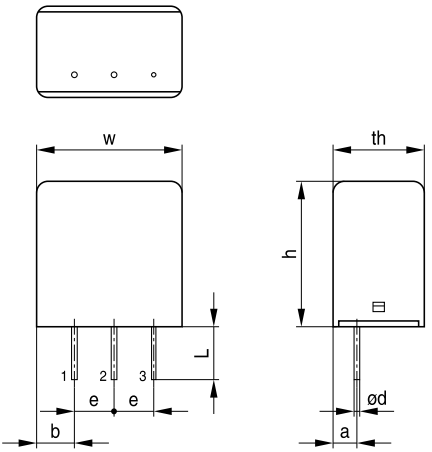
VAR0704-K

Lead configuration



VAR0706-N

T20, V_{RMS} = 460 ... 680 V

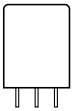


w_{max} = 27.5
h_{max} = 27.5
th_{max} = 13.6 (T20K460...625)
th_{max} = 18.5 (T20K680)
a = 4.2±0.5 (T20K460...625)
a = 4.5±0.5 (T20K680)
b = 7±0.5
e = 7.5±0.5
L = 10±0.5
ød = 1±0.05 (pin1, 2)
ød = 0.8±0.1 (pin3)

VAR0703-J

Weight

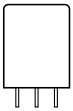
Nominal diameter mm	V_{RMS} V	Weight g
20	130 ... 680	6.2 ... 14



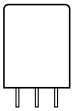
Reliability data

Test	Test methods/conditions	Requirement
Varistor voltage	The voltage between two terminals with the specified measuring current applied is called V_V (1 mA_{DC} @ 0.2 ... 2 s).	To meet the specified value
Clamping voltage	The maximum voltage between two terminals with the specified standard impulse current (8/20 µs) applied.	To meet the specified value
Endurance at upper category temperature	1000 h at UCT After having continuously applied the maximum allowable AC voltage at UCT ±2 °C for 1000 h, the specimen shall be stored at room temperature and normal humidity for 1 to 2 h. Thereafter, the change of V_V shall be measured.	$\lvert\Delta V/V$ (1 mA)$\rvert \leq 10\%$
Surge current derating, 8/20 µs	10 surge currents (8/20 µs), unipolar, interval 30 s, amplitude corresponding to derating curve for 10 impulses at 20 µs	$\lvert\Delta V/V$ (1 mA)$\rvert \leq 10\%$ (measured in direction of surge current) No visible damage
Surge current derating, 2 ms	10 surge currents (2 ms), unipolar, interval 120 s, amplitude corresponding to derating curve for 10 impulses at 2 ms	$\lvert\Delta V/V$ (1 mA)$\rvert \leq 10\%$ (measured in direction of surge current) No visible damage
Electric strength	IEC 61051-1, test 4.9.2 Metal balls method, 2500 V_{RMS}, 60 s The varistor is placed in a container holding 1.6 ±0.2 mm diameter metal balls such that only the terminations of the varistor are protruding. The specified voltage shall be applied between both terminals of the specimen connected together and the electrode inserted between the metal balls.	No breakdown

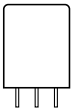
Test	Test methods/conditions	Requirement
Climatic sequence	The specimen shall be subjected to: a) dry heat at UCT, 16 h, IEC 60068-2-2, test Ba b) damp heat, 1st cycle: 55 °C, 93% r. H., 24 h, IEC 60068-2-30, test Db c) cold, LCT, 2 h, IEC 60068-2-1, test Aa d) damp heat, additional 5 cycles: 55 °C/25 °C, 93% r. H., 24 h/cycle, IEC 60068-2-30, test Db. Then the specimen shall be stored at room temperature and normal humidity for 1 to 2 h. Thereafter, the change of V_V shall be measured. Thereafter, insulation resistance R_{ins} shall be measured at V = 500 V.	$\lvert\Delta V/V\ (1\ mA)\rvert \leq 10\%$ $R_{ins} \geq 100\ M\Omega$
Rapid change of temperature	IEC 60068-2-14, test Na, LCT/UCT, dwell time 30 min, 5 cycles	$\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$ No visible damage
Damp heat, steady state	IEC 60068-2-78, test Ca The specimen shall be subjected to 40 ±2 °C, 90 to 95% r. H. for 56 days without load / with 10% of the maximum continuous DC operating voltage V_{DC}. Then stored at room temperature and normal humidity for 1 to 2 h. Thereafter, the change of V_V shall be measured. Thereafter, insulation resistance R_{ins} shall be measured at V = 500 V (insulated varistors only).	$\lvert\Delta V/V\ (1\ mA)\rvert \leq 10\%$ $R_{ins} \geq 100\ M\Omega$



Test	Test methods/conditions	Requirement
Solderability	IEC 60068-2-20, test Ta, method 1 with modified conditions for lead-free solder alloys: 245 °C, 3 s: After dipping the terminals to a depth of approximately 3 mm from the body in a soldering bath of 245 °C for 3 s, the terminals shall be visually examined.	The inspection must be carried out under adequate light with normal eyesight or with the assistance of a magnifier capable of giving a magnification of 4 to 10 times. The dipped surface must be covered with a smooth and bright solder coating with no more than small amounts of scattered imperfections such as pinholes or un-wetted or de-wetted areas. These imperfections must not be concentrated in one area.
Resistance to soldering heat	IEC 60068-2-20, test Tb, method 1A, 260 °C, 10 s: Each lead shall be dipped into a solder bath having a temperature of 260 ±5 °C to a point 2.0 to 2.5 mm from the body of the specimen, be held there for 10 ±1 s and then be stored at room temperature and normal humidity for 1 to 2 h. The change of V_V shall be measured and the specimen shall be visually examined.	$\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$ No visible damage
Tensile strength	IEC 60068-2-21, test Ua1 After gradually applying the force specified below and keeping the unit fixed for 10 s, the terminal shall be visually examined for any damage. Force for wire diameter: 0.6 mm = 10 N 0.8 mm = 10 N 1.0 mm = 20 N	$\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$ No break of solder joint, no wire break



Test	Test methods/conditions	Requirement
Vibration	IEC 60068-2-6, test Fc, method B4 Frequency range: 10 … 55 Hz Amplitude: 0.75 mm or 98 m/s² Duration: 6 h (3 · 2 h) Pulse: sine wave After repeatedly applying a single harmonic vibration according to the table above. The change of V_V shall be measured and the specimen shall be visually examined.	$\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$ No visible damage
Bump	IEC 60068-2-29, test Eb Pulse duration: 6 ms Max. acceleration: 400 m/s² Number of bumps: 4000 Pulse: half sine	$\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$ No visible damage
Fire hazard	IEC 60695-11-5 (needle flame test) Severity: vertical 10 s	5 s max.



<table>
<tr><th>Test</th><th>Test methods/conditions</th><th>Requirement</th></tr>
<tr><td>Abnormal overvoltage test</td><td>The device is designed to meet the limited current abnormal overvoltage condition, outlined in section 39.4 of UL 1449, 4th edition.
Detailed test voltage applied onto the device for different types as in the following table:
<table><tr><th>Type</th><th>Device rating V AC</th><th>Test voltage V AC</th></tr><tr><td>T20K130E2</td><td>130</td><td>260</td></tr><tr><td>T20K150E2</td><td>150</td><td>300</td></tr><tr><td>T20K175E2</td><td>175</td><td>350</td></tr><tr><td>T20K230E2</td><td>230</td><td>415</td></tr><tr><td>T20K250E2</td><td>250</td><td>500</td></tr><tr><td>T20K275E2</td><td>275</td><td>480</td></tr><tr><td>T20K300E2</td><td>300</td><td>600</td></tr><tr><td>T20K320E2</td><td>320</td><td>600</td></tr><tr><td>T20K350E2</td><td>350</td><td>600</td></tr><tr><td>T20K385E2</td><td>385</td><td>600</td></tr><tr><td>T20K420E2</td><td>420</td><td>600</td></tr><tr><td>T20K460E2</td><td>460</td><td>690</td></tr><tr><td>Type</td><td>Device rating V DC</td><td>Test voltage V DC[1)]</td></tr><tr><td>T20K510E2</td><td>670</td><td>780</td></tr><tr><td>T20K550E2</td><td>745</td><td>860</td></tr><tr><td>T20K625E2</td><td>825</td><td>950</td></tr><tr><td>T20K680E2</td><td>895</td><td>1040</td></tr></table></td><td>None of the following phenomena shall be observed, or this specimen will be judged as failed part:
1. Emission of flame, molten metal, glowing or flaming particles through any openings (pre-existing or created as a result of the test) in the product.
2. Charring, glowing, or flaming of the supporting surface, tissue paper, or cheesecloth.
3. Ignition of the enclosure.
4. Creation of any openings in the enclosure that result in accessibility of live parts, when evaluated in accordance with accessibility of live parts test in section 58.2 of UL1449, 4th edition.</td></tr>
</table>

Note:

UCT = Upper category temperature

LCT = Lower category temperature

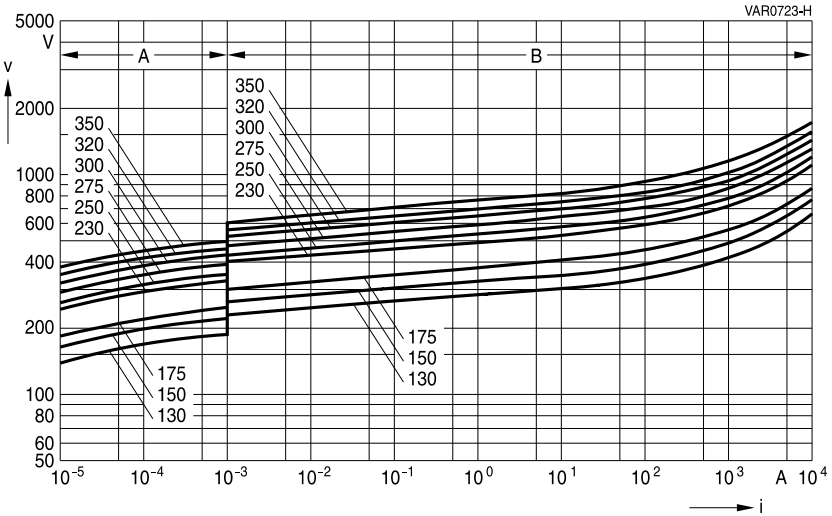
R_{ins} = Insulation resistance

All electrical tests should be performed between pin 1 and pin 3.

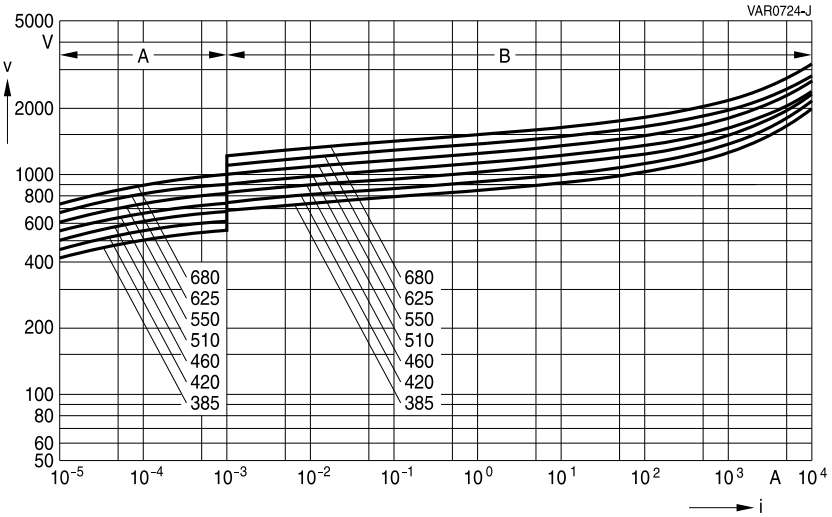
1) For types T20K510E2 to T20K680E2 the testing for UL 4th edition approval was conducted exclusively according to the test methods specified for photovoltaic systems applications. The test voltage for T20K510E2 to T20K680E2 in above table is the maximum DC long-duration test overvoltage for the device. Overstress above the listed test voltage may cause permanent damage to the device.

v/i characteristics

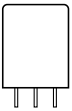
v = f (i) for explanation of the characteristics refer to "General technical information", chapter 1.6.3
A = Leakage current, B = Protection level } for worst-case varistor tolerances



SIOV-T20K130E2 ... T20K350E2

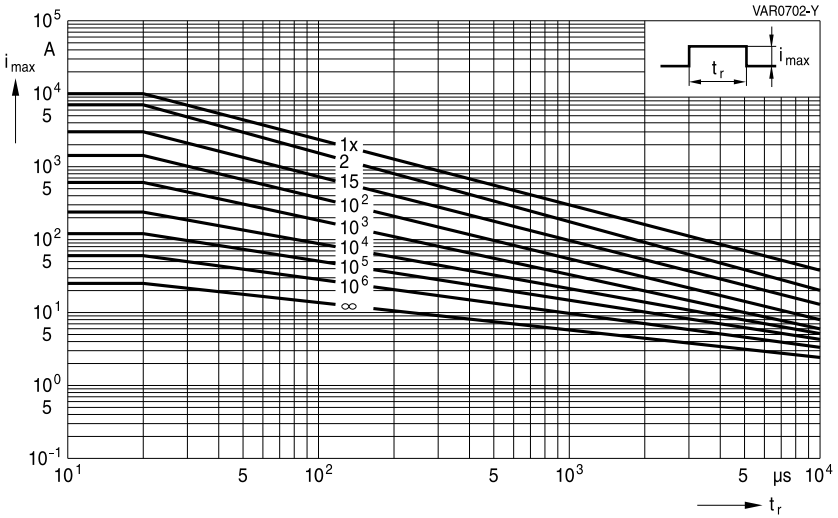


SIOV-T20K385E2 ... T20K680E2

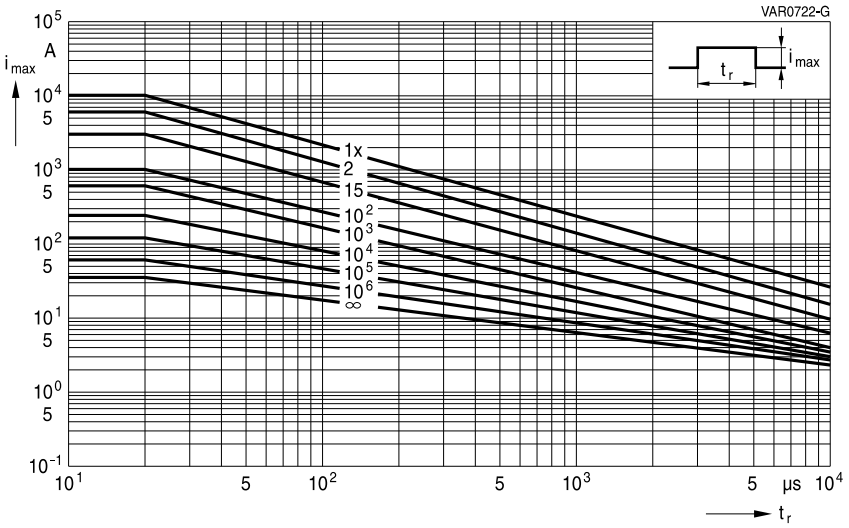


Derating curves

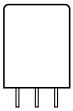
Maximum surge current $i_{max} = f(t_r$, pulse train)
For explanation of the derating curves refer to "General technical information", section 1.8.1



SIOV-T20K130E2 ... T20K320E2



SIOV-T20K350E2 ... T20K680E2



Cautions and warnings

General

1. EPCOS metal oxide varistors are designed for specific applications and should not be used for purposes not identified in our specifications, application notes and data books unless otherwise agreed with EPCOS during the design-in-phase.
2. Ensure suitability of SIOVs through reliability testing during the design-in phase. SIOVs should be evaluated taking into consideration worst-case conditions.
3. For applications of SIOVs in line-to-ground circuits based on various international and local standards there are restrictions existing or additional safety measures required.

Storage

1. Store SIOVs only in original packaging. Do not open the package prior to processing.
2. Recommended storage conditions in original packaging:
   Storage temperature: −25 °C ... +45 °C,
   Relative humidity: <75% annual average,
   <95% on maximum 30 days a year.
   Dew precipitation: is to be avoided.
3. Avoid contamination of an SIOV's during storage, handling and processing.
4. Avoid storage of SIOVs in harmful environments that can affect the function during long-term operation (examples given under operation precautions).
5. The SIOV type series should be soldered after shipment from EPCOS within the time specified:

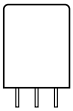
SIOV-S, -Q, -LS, -B, -SNF	24 months
ETFV/ T series, -CU	12 months.

Handling

1. SIOVs must not be dropped.
2. Components must not be touched with bare hands. Gloves are recommended.
3. Avoid contamination of the surface of SIOV electrodes during handling, be careful of the sharp edge of SIOV electrodes.

Soldering (where applicable)

1. Use rosin-type flux or non-activated flux.
2. Insufficient preheating may cause ceramic cracks.
3. Rapid cooling by dipping in solvent is not recommended.
4. Complete removal of flux is recommended.
5. Temperatures of all preheat stages and the solder bath must be strictly controlled especially for T series (T14 and T20).



Mounting

1. Potting, sealing or adhesive compounds can produce chemical reactions in the SIOV ceramic that will degrade the component's electrical characteristics.
2. Overloading SIOVs may result in ruptured packages and expulsion of hot materials. For this reason SIOVs should be physically shielded from adjacent components.

Operation

1. Use SIOVs only within the specified temperature operating range.
2. Use SIOVs only within the specified voltage and current ranges.
3. Environmental conditions must not harm SIOVs. Use SIOVs only in normal atmospheric conditions. Avoid use in deoxidizing gases (chlorine gas, hydrogen sulfide gas, ammonia gas, sulfuric acid gas etc), corrosive agents, humid or salty conditions.Contact with any liquids and solvents should be prevented.

Display of ordering codes for EPCOS products

The ordering code for one and the same EPCOS product can be represented differently in data sheets, data books, other publications, on the EPCOS 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 under www.epcos.com/orderingcodes

Symbols and terms

Symbol	Term
C	Capacitance
C_{typ}	Typical capacitance
i	Current
i_c	Current at which $V_{c, max}$ is measured
I_{leak}	Leakage current
i_{max}	Maximum surge current (also termed peak current)
I_{max}	Maximum discharge current
I_n	Nominal discharge current to UL 1449
LCT	Lower category temperature
L_{typ}	Typical inductance
P_{max}	Maximum average power dissipation
R_{ins}	Insulation resistance
R_{min}	Minimum resistance
T_A	Ambient temperature
t_r	Duration of equivalent rectangular wave
UCT	Upper category temperature
v	Voltage
V_{clamp}	Clamping voltage
$v_{c, max}$	Maximum clamping voltage at specified current i_c
V_{DC}	DC operating voltage
V_{jump}	Maximum jump start voltage
v_{max}	Maximum voltage
V_{op}	Operating voltage
V_{RMS}	AC operating voltage, root-mean-square value
$V_{RMS, op, max}$	Root-mean-square value of max. DC operating voltage incl. ripple current
V_{surge}	Super imposed surge voltage
V_V	Varistor voltage
ΔV_V	Tolerance of varistor voltage
W_{LD}	Maximum load dump
W_{max}	Maximum energy absorption
e	Lead spacing

All dimensions are given in mm.
The commas used in numerical values denote decimal points.

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.

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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.

Important notes

8. The trade names EPCOS, CeraCharge, CeraDiode, CeraLink, CeraPad, CeraPlas, CSMP, CTVS, DeltaCap, DigiSiMic, ExoCore, FilterCap, FormFit, LeaXield, MiniBlue, MiniCell, MKD, MKK, MotorCap, PCC, PhaseCap, PhaseCube, PhaseMod, PhiCap, PowerHap, PQSine, PQvar, SIFERRIT, SIFI, SIKOREL, SilverCap, SIMDAD, SiMic, SIMID, SineFormer, SIOV, ThermoFuse, WindCap are **trademarks registered or pending** in Europe and in other countries. Further information will be found on the Internet at www.tdk-electronics.tdk.com/trademarks.

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