



## **SIOV metal oxide varistors**

Leaded varistors, AdvanceD, S14 compact series

**Series/Type:** SIOV-S14K\*\*\*E2K11  
**Ordering code:** B72314S2\*\*\*  
Date: April 2022  
Version: 2

### Construction

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

### Features

- High performance with smaller disk diameter
- Wide operating voltage range 130 to 625 V<sub>RMS</sub>
- All types I<sub>n</sub> @ 3 kA = >15 impulses according to UL 1449, 4<sup>th</sup> edition surge current generator (8/20 μs), type 5 listed
- Multiple pulse handling capability

### Approvals

- UL
- CSA
- VDE
- IEC

### Delivery mode

- Bulk (standard), taped versions on reel or in Ammo pack upon request
- For further details refer to chapter "Taping, packaging and lead configuration" for leaded varistors.

### Options

- Alternative kinked types upon request

### General technical data

Climatic category	to IEC 60068-1	40/105/56	
Operating temperature	to IEC 61051	-40 ... +105	°C
Storage temperature		-40 ... +125	°C
Electric strength	to IEC 61051	≥ 2.5	kV <sub>RMS</sub>
Insulation resistance	to IEC 61051	≥ 100	MΩ

**Electrical specifications and ordering codes**

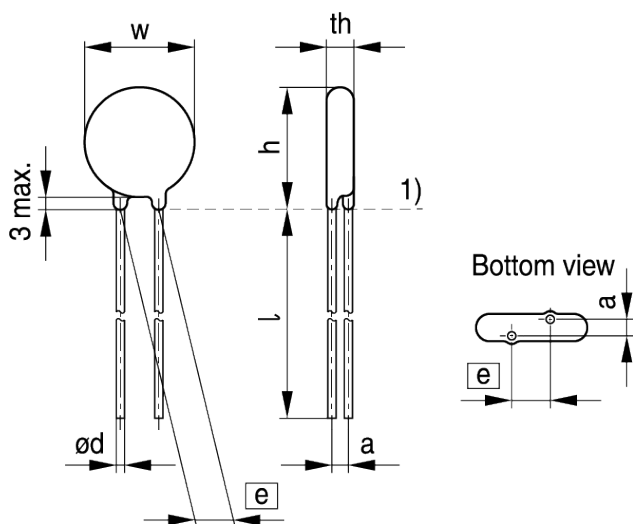
 Maximum ratings ( $T_A = 105\text{ °C}$ )

Ordering code	Type (untaped)	$V_{RMS}$	$V_{DC}$	$i_{max}$ (8/20 $\mu s$ ) 1 time	$I_n^{1)}$ (8/20 $\mu s$ ) 15 times	$W_{max}$ (2 ms)	$P_{max}$
	SIOV-	V	V	A	A	J	W
B72314S2171K101	S14K175E2K11	175	225	6000	3000	70.0	0.60
B72314S2211K101	S14K210E2K11	210	270	6000	3000	80.0	0.60
B72314S2231K101	S14K230E2K11	230	300	6000	3000	90.0	0.60
B72314S2251K101	S14K250E2K11	250	320	6000	3000	100.0	0.60
B72314S2271K101	S14K275E2K11	275	350	6000	3000	110.0	0.60
B72314S2301K101	S14K300E2K11	300	385	6000	3000	125.0	0.60
B72314S2321K101	S14K320E2K11	320	420	6000	3000	136.0	0.60
B72314S2351K101	S14K350E2K11	350	460	5000	3000	136.0	0.60
B72314S2381K101	S14K385E2K11	385	505	5000	3000	136.0	0.60
B72314S2421K101	S14K420E2K11	420	560	5000	3000	136.0	0.60
B72314S2461K101	S14K460E2K11	460	615	5000	3000	150.0	0.60
B72314S2511K101	S14K510E2K11	510	670	5000	3000	165.0	0.60
B72314S2551K101	S14K550E2K11	550	745	5000	3000	180.0	0.60
B72314S2621K101	S14K625E2K11	625	825	5000	3000	200.0	0.60

<sup>1)</sup> Note: Nominal discharge current  $I_n$  according to UL 1449, 4<sup>th</sup> edition.

**Characteristics ( $T_A = 25\text{ °C}$ )**

Ordering code	Type (untaped)	$V_v$ (1 mA)	$\Delta V_v$ (1 mA)	$V_{c,max}$ ( $i_c$ )	$i_c$	$C_{typ}$ (1 kHz)
	SIOV-	V	%	V	A	pF
B72314S2171K101	S14K175E2K11	270	±10	455	50.0	670
B72314S2211K101	S14K210E2K11	330	±10	545	50.0	580
B72314S2231K101	S14K230E2K11	360	±10	595	50.0	530
B72314S2251K101	S14K250E2K11	390	±10	650	50.0	490
B72314S2271K101	S14K275E2K11	430	±10	710	50.0	440
B72314S2301K101	S14K300E2K11	470	±10	775	50.0	400
B72314S2321K101	S14K320E2K11	510	±10	840	50.0	370
B72314S2351K101	S14K350E2K11	560	±10	910	50.0	350
B72314S2381K101	S14K385E2K11	620	±10	1025	50.0	315
B72314S2421K101	S14K420E2K11	680	±10	1120	50.0	290
B72314S2461K101	S14K460E2K11	750	±10	1240	50.0	260
B72314S2511K101	S14K510E2K11	820	±10	1355	50.0	240
B72314S2551K101	S14K550E2K11	910	±10	1500	50.0	215
B72314S2621K101	S14K625E2K11	1000	±10	1650	50.0	200

**Dimensional drawings**


1) Seating plane to IEC 60717

VAR0408-C-E

**Weight**

Nominal diameter mm	$V_{RMS}$ V	Weight g
14	130 ... 460	1.1 ... 4.5

The weight of varistors in between these voltage classes can be interpolated.

**Dimensions**

Ordering code	[e] ±1 mm	a (typical) mm	$w_{max}$ mm	$th_{max}$ mm	$h_{max}$ mm	$l_{min}$ mm	$d \pm 0.05$ mm
B72314S2171K101	7.5	2.2	13.0	5.1	17.0	25.0	0.8
B72314S2211K101	7.5	1.9	13.0	5.0	17.0	25.0	0.8
B72314S2231K101	7.5	1.7	13.0	5.2	17.0	25.0	0.8
B72314S2251K101	7.5	1.7	13.5	5.4	17.0	25.0	0.8
B72314S2271K101	7.5	1.8	13.5	5.7	17.0	25.0	0.8
B72314S2301K101	7.5	1.9	13.5	5.8	17.0	25.0	0.8
B72314S2321K101	7.5	2.1	13.5	6.0	17.0	25.0	0.8
B72314S2351K101	7.5	2.2	13.5	6.4	17.0	25.0	0.8
B72314S2381K101	7.5	2.4	14.0	7.2	18.0	25.0	0.8
B72314S2421K101	7.5	2.6	14.0	8.0	18.0	25.0	0.8
B72314S2461K101	7.5	2.8	14.0	8.2	18.0	25.0	0.8
B72314S2511K101	7.5	3.1	14.0	8.4	18.0	25.0	0.8
B72314S2551K101	7.5	3.4	14.0	8.6	18.0	25.0	0.8
B72314S2621K101	7.5	3.7	14.0	9.0	18.0	25.0	0.8

**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 <sub>DC</sub> @ 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 $\mu$ s) 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 $\pm 2$ °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.	$ \Delta V/V (1 \text{ mA})  \leq 10\%$
Surge current derating, 8/20 $\mu$ s	10 surge currents (8/20 $\mu$ s), unipolar, interval 30 s, amplitude corresponding to derating curve for 10 impulses at 20 $\mu$ s	$ \Delta V/V (1 \text{ mA})  \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	$ \Delta V/V (1 \text{ mA})  \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 <sub>RMS</sub> , 60 s The varistor is placed in a container holding 1.6 $\pm$ 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	<p>The specimen shall be subjected to:</p> <p>a) dry heat at UCT, 16 h, IEC 60068-2-2, test Ba</p> <p>b) damp heat, 1<sup>st</sup> cycle: 55 °C, 93% r. H., 24 h, IEC60068-2-30, test Db</p> <p>c) cold, LCT, 2 h, IEC 60068-2-1, test Aa</p> <p>d) damp heat, additional 5 cycles: 55 °C/25 °C, 93% r. H., 24 h/cycle, IEC 60068-2-30, test Db.</p> <p>Then the specimen shall be stored at room temperature and normal humidity for 1 to 2 h.</p> <p>Thereafter, the change of <math>V_V</math> shall be measured. Thereafter, insulation resistance <math>R_{ins}</math> shall be measured at <math>V = 500 V</math>.</p>	$ \Delta V/V (1 mA)  \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	$ \Delta V/V (1 mA)  \leq 5\%$ No visible damage
Damp heat, steady state	<p>IEC 60068-2-78, test Ca</p> <p>The specimen shall be subjected to <math>40 \pm 2</math> °C, 90 to 95% r. H. for 56 days without load / with 10% of the maximum continuous DC operating voltage <math>V_{DC}</math>. Then stored at room temperature and normal humidity for 1 to 2 h. Thereafter, the change of <math>V_V</math> shall be measured.</p> <p>Thereafter, insulation resistance <math>R_{ins}</math> shall be measured at <math>V = 500 V</math> (insulated varistors only).</p>	$ \Delta V/V (1 mA)  \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 shall 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 shall 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 shall 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 VV shall be measured and the specimen shall be visually examined.	$ \Delta V/V (1 \text{ mA})  \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	$ \Delta V/V (1 \text{ mA})  \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/s <sup>2</sup> 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.	$ \Delta V/V (1 \text{ mA})  \leq 5\%$ No visible damage
Bump	IEC 60068-2-29, test Eb Pulse duration: 6 ms Max. acceleration: 400 m/s <sup>2</sup> Number of bumps: 4000 Pulse: half sine	$ \Delta V/V (1 \text{ mA})  \leq 5\%$ No visible damage
Fire hazard	IEC 60695-11-5 (needle flame test) Severity: vertical 10 s	5 s max.

**Note:**

UCT = Upper category temperature

LCT = Lower category temperature

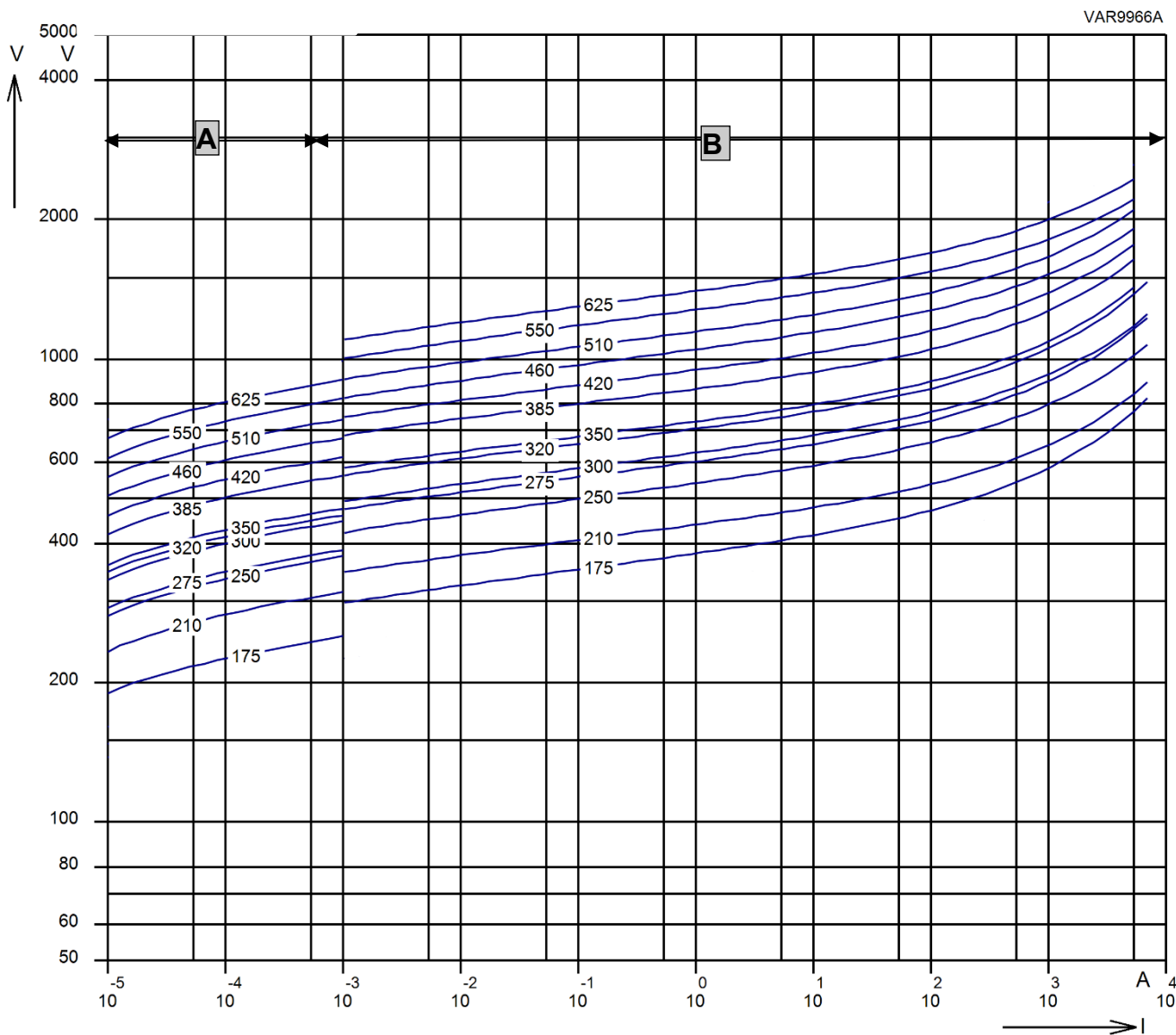
 $R_{ins}$  = Insulation resistance



**v/i characteristics**

$v = f(i)$  - for explanation of the characteristics refer to "General technical information", 1.6.3

A = Leakage current, B = Protection level } for worst-case varistor tolerances

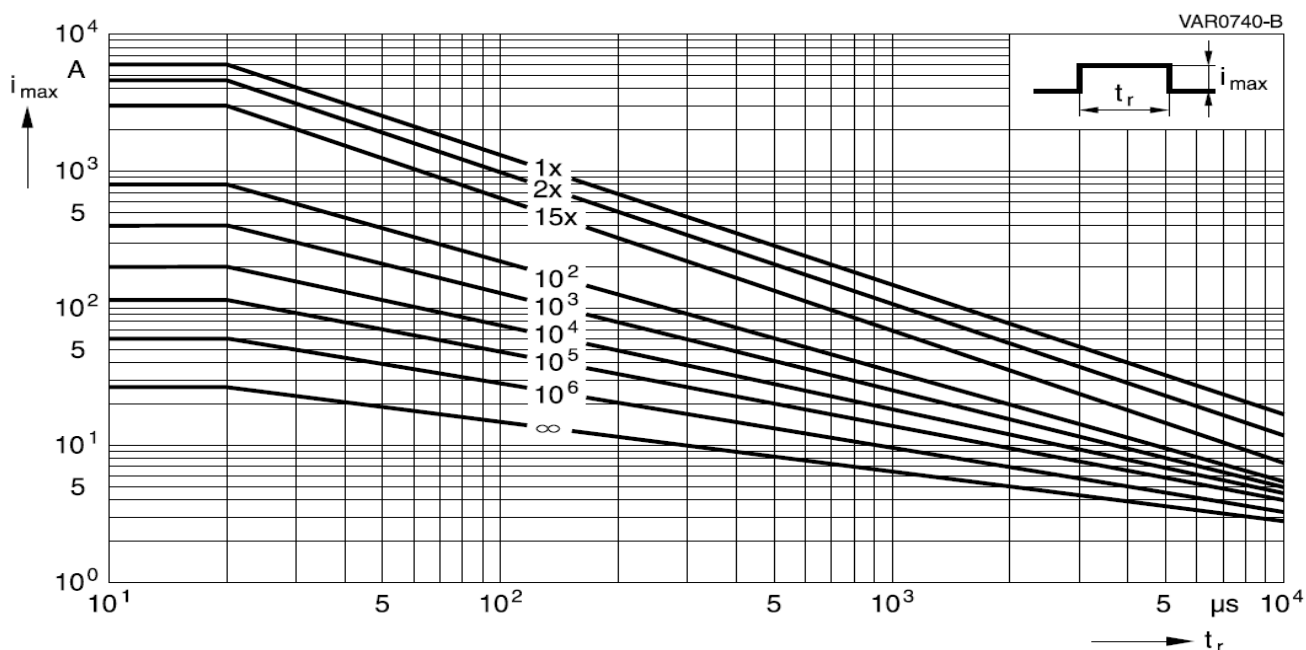


**SIOV-S14 ... E2K11**

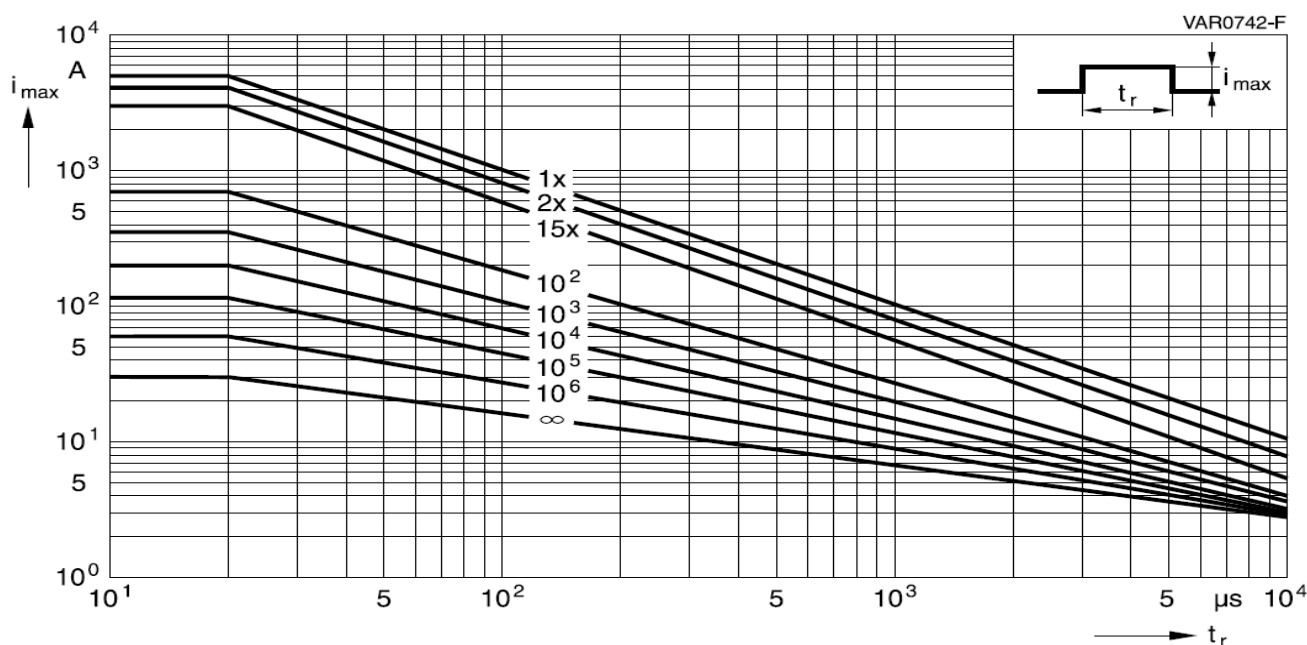
**Derating curves**

Maximum surge current  $i_{max} = f(t_r, \text{pulse train})$

For explanation of the derating curves refer to "General technical information", section 1.8.1



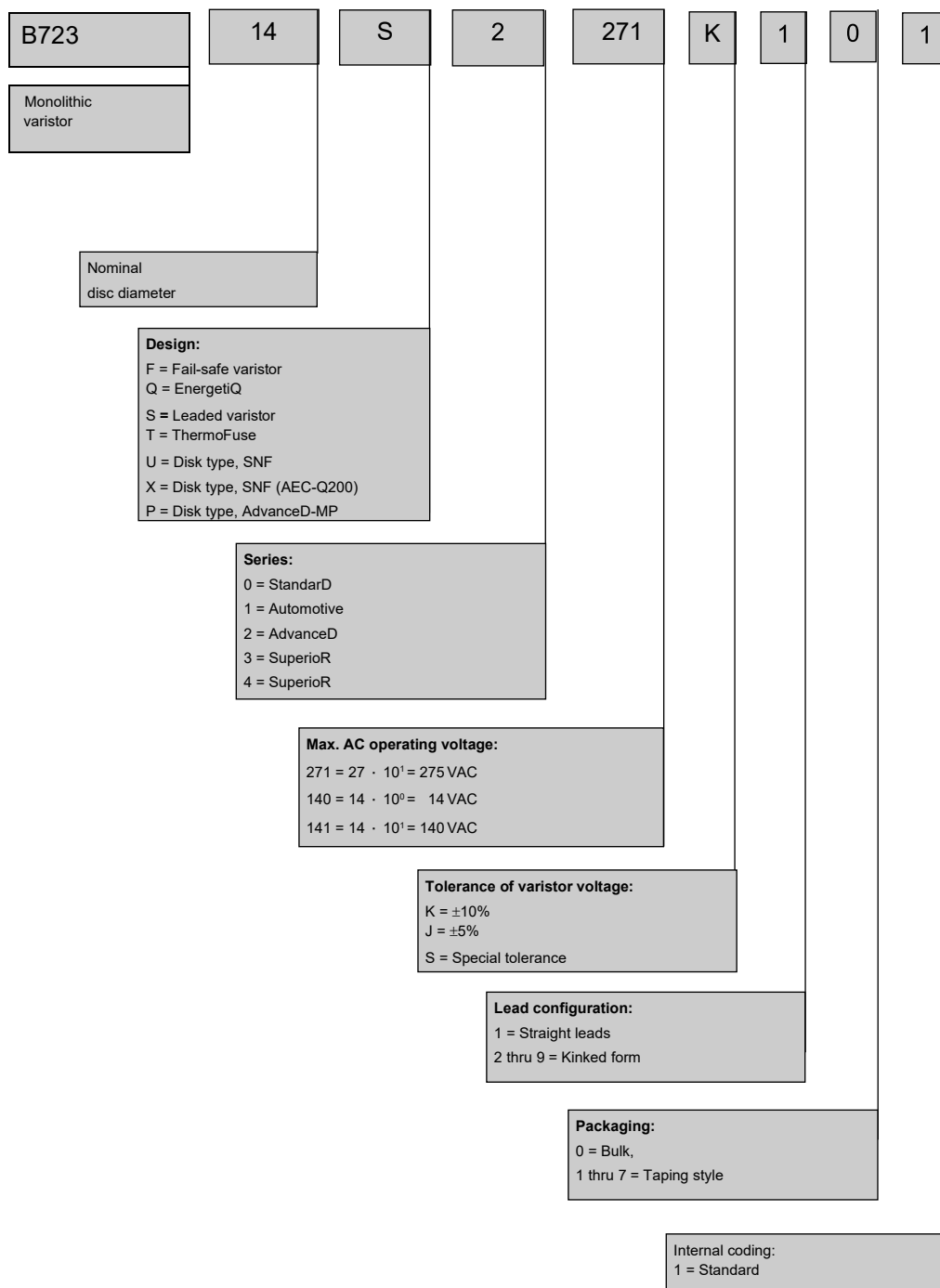
**SIOV-S14K175 ... K320E2K11**



**SIOV-S14K350 ... K625E2K11**

Taping, packaging and lead configuration

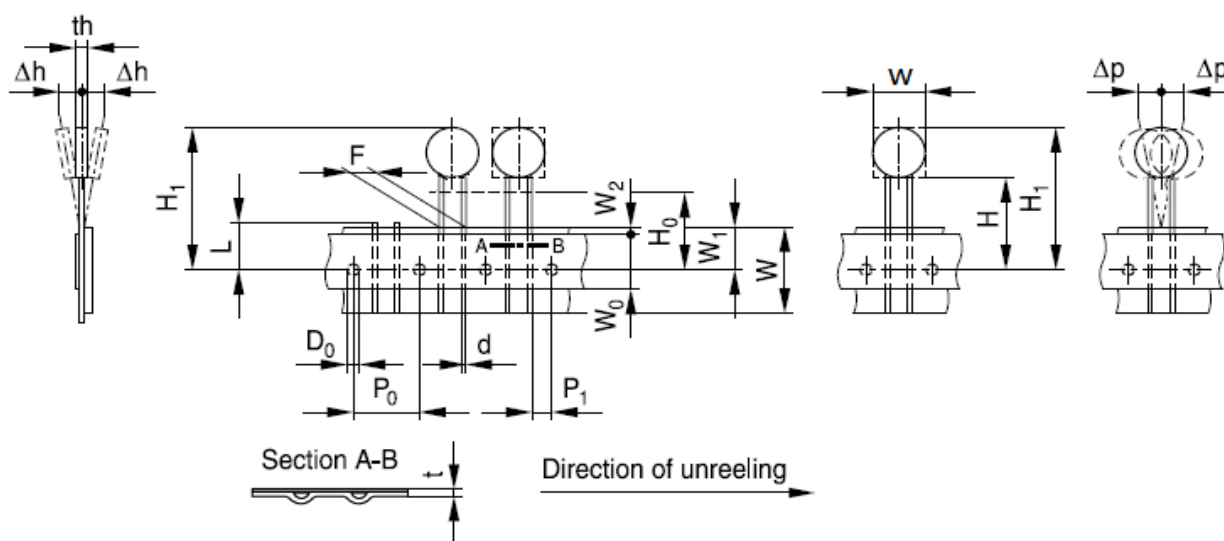
1 EPCOS ordering code system For leaded varistors



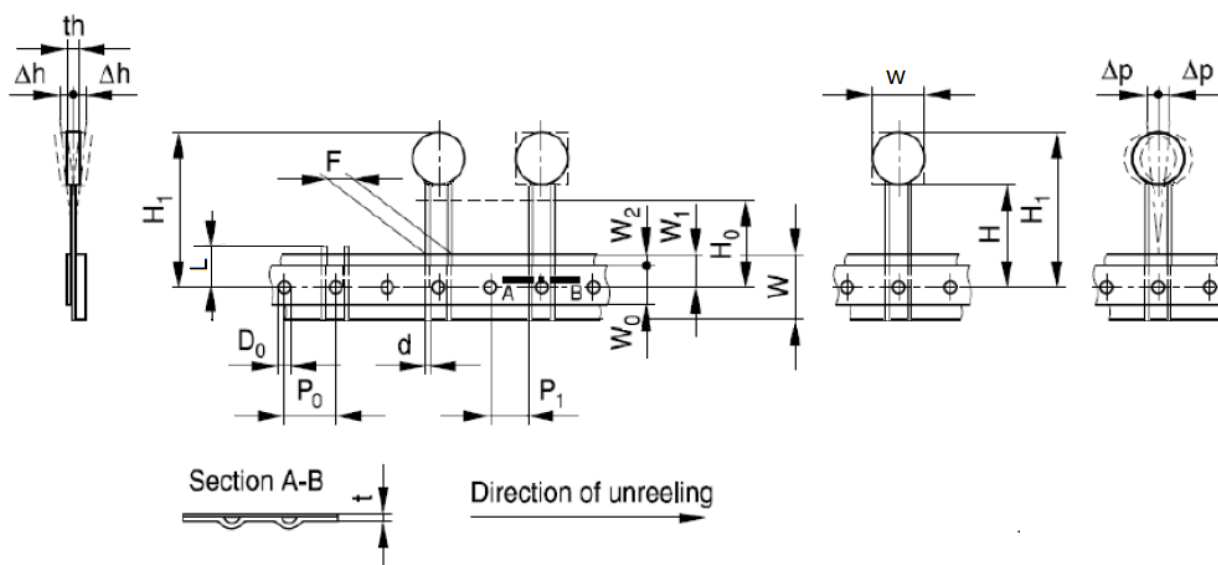
## 2 Taping and packaging of leaded varistors

Tape packaging for lead spacing [e] = 5 fully conforms to IEC 60286-2, while for lead spacings [e] = 7.5 and 10 the taping mode is based on this standard.

### 2.1 Taping in accordance with IEC 60286-2 for lead spacing 5.0 mm



### 2.2 Taping based on IEC 60286-2 for lead spacing 7.5 and 10 mm



**2.3 Tape dimensions (in mm)**

Symbol	[e] = 5.0	Tolerance	[e] = 7.5	Tolerance	[e] = 10.0	Tolerance	Remarks
w		max.		max.		max.	see tables in each series under "Dimensions"
th		max.		max.		max.	
d	0.6	±0.05	0.8	±0.05	1.0	±0.05	
F	5.0	+0.6/-0.1	7.5	±0.8	10.0	±0.8	
P <sub>0</sub>	12.7	±0.3	12.7 <sup>1)</sup>	±0.3	12.7	±0.3	± 1 mm/20 sprocket holes
P <sub>1</sub>	3.85	±0.7	8.95	±0.8	7.7	±0.8	
Δh	0	±2.0	depends on th		depends on th		measured at top of component body
Δp	0	±1.3	0	±2.0	0	±2.0	
W	18.0	±0.5	18.0	±0.5	18.0	±0.5	peel-off force ≥ 5 N
W <sub>0</sub>	5.5	min.	11.0	min.	11.0	min.	
W <sub>1</sub>	9.0	±0.5	9.0	+0.75/-0.5	9.0	+0.75/-0.5	
W <sub>2</sub>	3.0	max.	3.0	max.	3.0	max.	
H	18.0	+2.0/-0	18.0	+2.0/-0	18.0	+2.0/-0	2) 3)
H <sub>0</sub>	16.0 (18.0)	±0.5	16.0 (18.0)	±0.5	16.0	±0.5	
H <sub>1</sub>	32.2	max.	45.0	max.	45.0	max.	
D <sub>0</sub>	4.0	±0.2	4.0	±0.2	4.0	±0.2	without lead
t	0.9	max.	0.9	max.	0.9	max.	
L	11.0	max.	11.0	max.	11.0	max.	

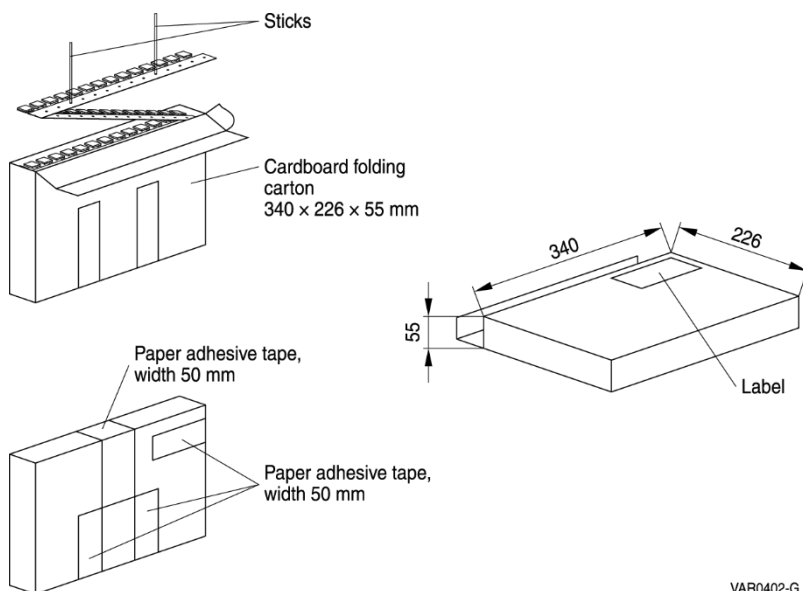
1) Taping with P<sub>0</sub> = 15.0 mm upon request.

2) Applies only to straight types.

3) Applies only to kinked types (H<sub>0</sub> = 18 mm upon request)



### 2.6 Ammo pack dimensions



### 3 Lead configuration

Straight leads are standard for disk varistors. Other lead configurations as kinked style or customer specific lead wire length according to 3.1, 3.2, 3.3 and 3.4 are optional. Kinked leads (non-standard) are differently kinked for technical reasons; the individual kinked styles are denoted by consecutive numbers (S, S2 through S5) as shown in the dimensional drawings below.

The kinked styles of the individual types can be seen from the type designation in the ordering tables.

#### 3.1 Kinked style mode

Example: B72210S0271K[5]01

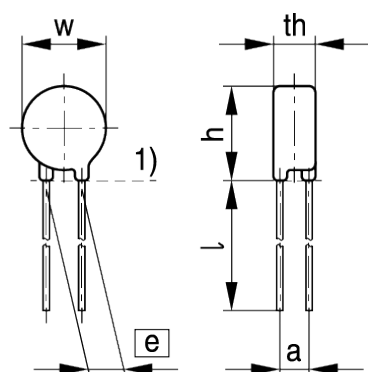
Digit 13

Digit 13 of ordering code	Kinked style	Figure
1	Standard, straight leads	1
2	S2	2
3	S3	3
5	S5	4

### 3.2 Standard leads and non-standard kinked styles

The basic dimensions in figure 1 to 5 are valid for types with either round or square (EnergetiQ series) component head.

**Standard, straight leads**

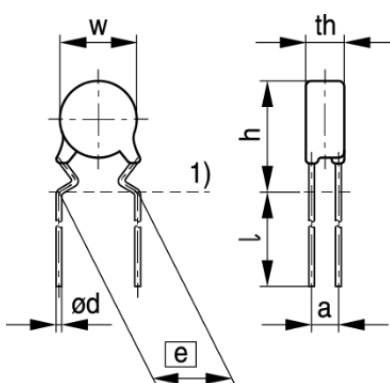


1) Seating plane to IEC 717

VAR0586-W-E

**Figure 1**

**Non-standard, kinked style S2**

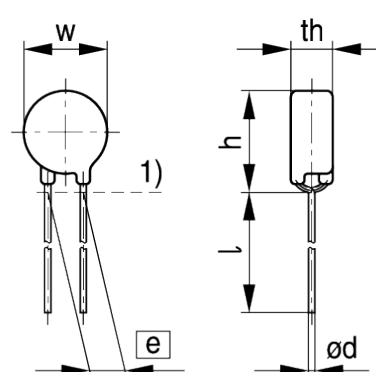


1) Seating plane to IEC 60717

VAR0411-F-E

**Figure 2**

**Non-standard, kinked style S3**

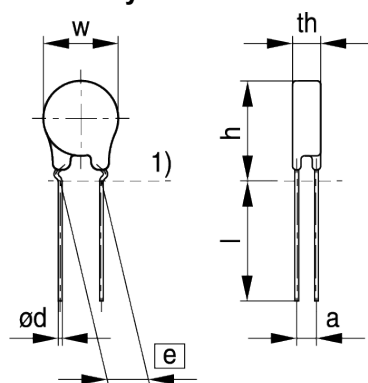


1) Seating plane to IEC 60717

VAR0396-R-E

**Figure 3**

**Non-standard, kinked style S5**



1) Seating plane to IEC 60717

VAR0726-M-E

**Figure 4**



### 3.3 Trimmed leads (non-standard)

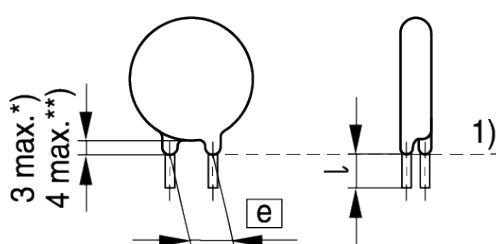
Varistors with cut leads available upon request.

Lead length tolerances:

Straight leads                    +/-0.8 mm

Kinked leads                    +/-0.5 mm

Minimum lead length        3.0 mm



1) Seating plane to IEC 60717

\*) For round component head

\*\*\*) For EnergetiQ series, square component head

VAR0642-U-E

## Cautions and warnings

### General

1. TDK Electronics metal oxide varistors (SIOVs) 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 TDK Electronics during the design-in-phase.
2. Ensure suitability of SIOVs through reliability testing during the design-in phase. The 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 TDK Electronics 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 the 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 the SIOVs. Use SIOVs only in normal atmospheric conditions. Avoid use in the presence of deoxidizing gases (chlorine gas, hydrogen sulfide gas, ammonia gas, sulfuric acid gas, etc), corrosive agents, humid or salty conditions, Avoid contact with any liquids and solvents.

## 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 $i_c$ DC operating voltage
$V_{DC}$	Maximum jump start voltage
$V_{jump}$	Maximum voltage
$V_{max}$	Operating voltage
$V_{op}$	AC operating voltage, root-mean-square value
$V_{RMS}$	Root-mean-square value of max. DC operating voltage incl. ripple current
$V_{RMS,op,max}$	Super imposed surge voltage
$V_{surge}$	Varistor voltage
$V_V$	Tolerance of varistor voltage
$\Delta V_V$	Maximum load dump
$W_{LD}$	Maximum energy absorption
$W_{max}$	Maximum energy absorption
[e]	Lead spacing

All dimensions are given in mm.

The commas used in numerical values denote decimal points.

## Display of ordering codes for TDK Electronics products

The ordering code for one and the same product can be represented differently in data sheets, data books, other publications, on the company 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.tdk-electronics.tdk.com/orderingcodes](http://www.tdk-electronics.tdk.com/orderingcodes).

## 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](http://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. The aforementioned does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.

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.

## Important notes

8. The trade names EPCOS, CarXield, CeraCharge, CeraDiode, CeraLink, CeraPad, CeraPlas, CSMP, CTVS, DeltaCap, DigiSiMic, ExoCore, FilterCap, FormFit, LeaXield, MiniBlue, MiniCell, MKD, MKK, ModCap, MotorCap, PCC, PhaseCap, PhaseCube, PhaseMod, PhiCap, PowerHap, PQSine, PQvar, SIFERRIT, SIFI, SIKOREL, SilverCap, SIMDAD, SiMic, SIMID, SineFormer, SIOV, ThermoFuse, WindCap, XieldCap 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](http://www.tdk-electronics.tdk.com/trademarks).

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