

## SIOV metal oxide varistors

Leaded varistors, Automotive series

**Series/Type:** B722\*  
**Date:** December 2011

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**Automotive series**
**Construction**

- Round varistor element, leaded
- Coating: epoxy resin (D1: phenolic resin), flame-retardant to UL 94 V-0

**Features**

- High energy absorption, particularly for load dump
- Jump-start strength
- Stable protection level, minimum leakage current
- High resistance to cyclic temperature stress
- PSpice models
- High operating temperature range up to 125 °C

**Delivery mode**

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

**General technical data**

Climatic category	to IEC 60068-1 for D1 types	40/85/56 40/125/56	
Operating temperature	to IEC 61051 for D1 types	-40 ... + 85 -40 ... +125	°C °C
Storage temperature	for D1 types	-40 ... +125 -40 ... +150	°C °C
Electric strength	to IEC 61051	≥ 2.5 (not D1 types)	kV <sub>RMS</sub>
Insulation resistance	to IEC 61051	≥ 100 (not D1 types)	MΩ
Response time		< 25	ns


**Electrical specifications and ordering codes**
**Maximum ratings ( $T_A = 85\text{ °C}$ ,  $T_A = 125\text{ °C}$  for S...D1 types)**

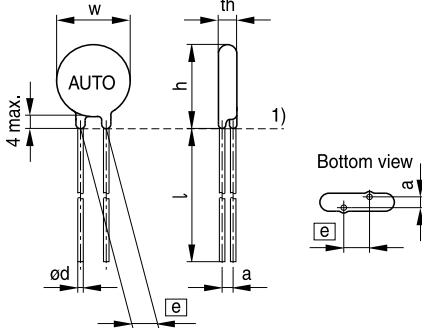
Ordering code	Type (untaped)	$V_{RMS}$ V	$V_{DC}$ V	$i_{max}$ (8/20 $\mu$ s) A	$W_{max}$ (2 ms) J	$P_{max}$ W	$W_{LD}$ (10 x) J
<b>12-V supply systems</b>							
B72207S1140K201	S07K14AUTOS2D1	14	16	250	0.9	0.02	12
B72210S1140K102	S10K14AUTO	14	16	500	2.0	0.05	25
B72210S1140K501	S10K14AUTOS5D1	14	16	500	2.0	0.05	25
B72214S1140K102	S14K14AUTO	14	16	1000	4.0	0.10	50
B72214S1140K501	S14K14AUTOS5D1	14	16	1000	4.0	0.10	50
B72220S1140K102	S20K14AUTO	14	16	2000	12.0	0.20	100
B72210S1170K102	S10K17AUTO	17	20	500	2.5	0.05	25
B72214S1170K102	S14K17AUTO	17	20	1000	5.0	0.10	50
B72220S1170K102	S20K17AUTO	17	20	2000	14.0	0.20	100
<b>24-V supply systems</b>							
B72220S1250K102	S20K25AUTO	25	28	2000	22.0	0.20	100
B72214S1300K102	S14K30AUTO	30	34	1000	9.0	0.10	50
B72220S1300K102	S20K30AUTO	30	34	2000	26.0	0.20	100


**Leaded varistors**
**B722\***
**Automotive series**
**Characteristics (T<sub>A</sub> = 25 °C)**

Ordering code	V <sub>Jump</sub> (5 min) V	V <sub>V</sub> (1 mA) V	ΔV <sub>V</sub> (1 mA) %	V <sub>C,max</sub> (i <sub>C</sub> ) V	i <sub>C</sub> A	C <sub>typ</sub> (1 kHz) nF
<b>12-V supply systems</b>						
B72207S1140K201	25	22	±10	43	2.5	2.3
B72210S1140K102	25	22	±10	43	5.0	5.2
B72210S1140K501	25	22	±10	43	5.0	5.2
B72214S1140K102	25	22	±10	43	10.0	10.0
B72214S1140K501	25	22	±10	43	10.0	10.0
B72220S1140K102	25	22	±10	43	20.0	19.0
B72210S1170K102	30	27	±10	53	5.0	4.4
B72214S1170K102	30	27	±10	53	10.0	8.2
B72220S1170K102	30	27	±10	53	20.0	15.6
<b>24-V supply systems</b>						
B72220S1250K102	40	39	±10	77	20.0	11.1
B72214S1300K102	45	47	±10	93	10.0	5.0
B72220S1300K102	45	47	±10	93	20.0	9.4

**Note:**

- If the maximum loads specified for load dump and jump start are fully utilized, subsequent polarity reversal of the AUTO varistors is inadmissible.
- If the load remains under the maximum ratings, polarity reversal may be admissible. Contact EPCOS for consultancy on this kind of problem.
- Load dump or jump start can decrease the varistor voltage in load direction by max. 15%.
- Load dump: min. time of energy input 40 ms, interval 60 s.


**Dimensional drawings**


1) Seating plane to IEC 60717

VAR0401-Y-E

**Weight**

Nominal diameter mm	$V_{RMS}$ V	Weight g
7	14	0.6 ... 0.8
10	14; 17	1.0 ... 2.0
14	14; 17; 30	2.0 ... 4.0
20	14; 17; 25; 30	3.0 ... 6.0

**Dimensions**

Ordering code	$[e] \pm 1$ mm	$a \pm 1$ mm	$w_{max}$ mm	$th_{max}$ mm	$h_{max}$ mm	$l_{min}$ mm	$d \pm 0.05$ mm
<b><math>V_{RMS} = 14 V</math></b>							
B72207S1140K201	5.0	1.3	9.0	3.5	12.5	25.0	0.6
B72210S1140K102	7.5	1.5	13.0	5.0	16.5	25.0	0.8
B72210S1140K501	7.5	1.5	12.0	4.0	16.0	25.0	0.8
B72214S1140K102	7.5	1.5	17.0	5.0	20.5	25.0	0.8
B72214S1140K501	7.5	1.5	16.0	4.0	20.0	25.0	0.8
B72220S1140K102	10.0	1.6	23.0	5.4	27.5	25.0	1.0
<b><math>V_{RMS} = 17 V</math></b>							
B72210S1170K102	7.5	1.6	13.0	5.1	16.5	25.0	0.8
B72214S1170K102	7.5	1.7	17.0	5.1	20.5	25.0	0.8
B72220S1170K102	10.0	1.6	23.0	5.6	27.5	25.0	1.0
<b><math>V_{RMS} = 25 V</math></b>							
B72220S1250K102	10.0	2.9	23.0	6.2	27.5	25.0	1.0
<b><math>V_{RMS} = 30 V</math></b>							
B72214S1300K102	7.5	1.8	17.0	5.3	20.5	25.0	0.8
B72220S1300K102	10.0	3.2	23.0	6.5	27.5	25.0	1.0

For crimp styles S2 and S5 refer to chapter "Taping, packaging and lead configuration".


**Leaded varistors**
**B722\***
**Automotive series**
**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 μs) applied.	To meet the specified value
Max. DC operating voltage	MIL STD 202F, method 108A, UCT, V <sub>DC</sub> , 1000 h	$ \Delta V/V$ (1 mA) $\leq$ 10% No visible damage
Load dump	ISO 7637-1, test pulse 5 ("load dump") (DIN 40 839 Part 1; impulse 5) 7 mm varistors (S07K...AUTO...): 10 × 12 J 10 mm varistors (S10K...AUTO...): 10 × 25 J 14 mm varistors (S14K...AUTO...): 10 × 50 J 20 mm varistors (S20K...AUTO...): 10 × 100 J (minimum 40 ms time of energy input, 60 s interval)	$\Delta V/V$ (1 mA) $\geq$ 15% No visible damage
Jump start	V <sub>DC, load</sub> = V <sub>jump</sub> ; 5 min duration 14 V (S...K14AUTO...); V <sub>jump</sub> = 25 V 17 V (S...K17AUTO...); V <sub>jump</sub> = 30 V 25 V (S...K25AUTO...); V <sub>jump</sub> = 40 V 30 V (S...K30AUTO...); V <sub>jump</sub> = 45 V	$\Delta V/V$ (1 mA) $\geq$ 15% No visible damage
Fast temperature cycling	IEC 60068-2-14, test Na, LCT/UCT, dwell time 15 min, 100 cycles for SIOV...AUTO types and dwell time 15 min, 1000 cycles for SIOV...AUTOD1 types	$ \Delta V/V$ (1 mA) $\leq$ 5% No visible damage
Damp heat	IEC 60068-2-67, test Cy, 85 °C, 85% r. H., V <sub>DC</sub> , 1000 h	$ \Delta V/V$ (1 mA) $\leq$ 10% No visible damage

**Note:**

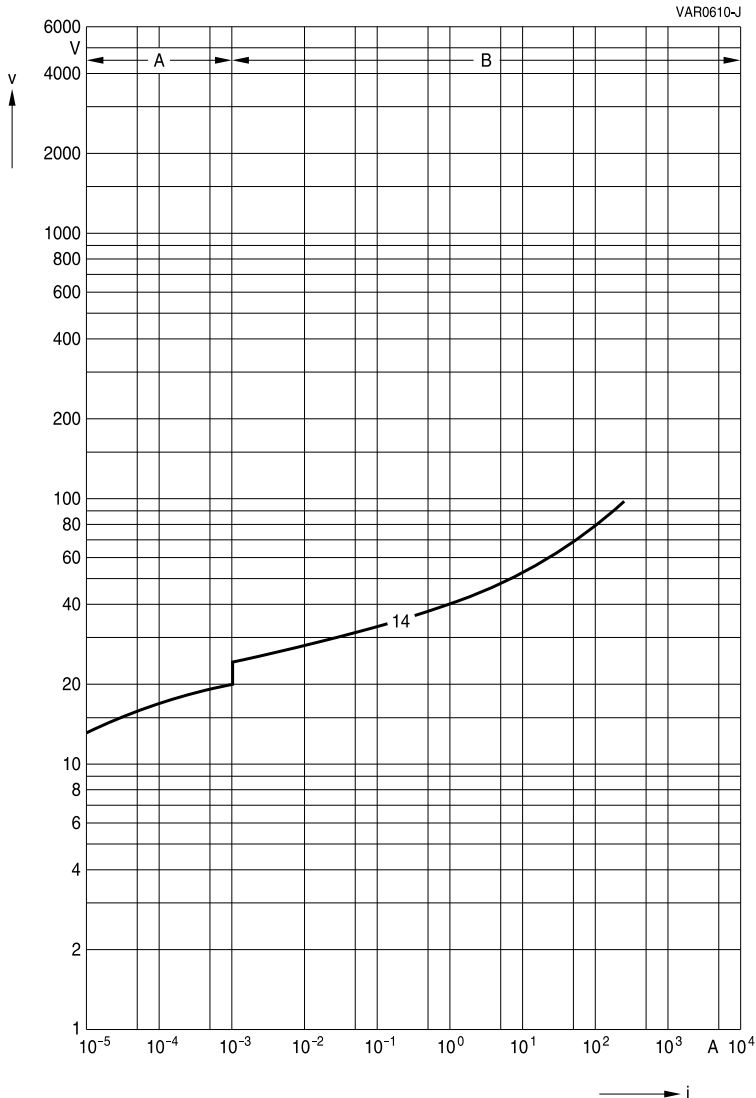
UCT = Upper category temperature

LCT = Lower category temperature



**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

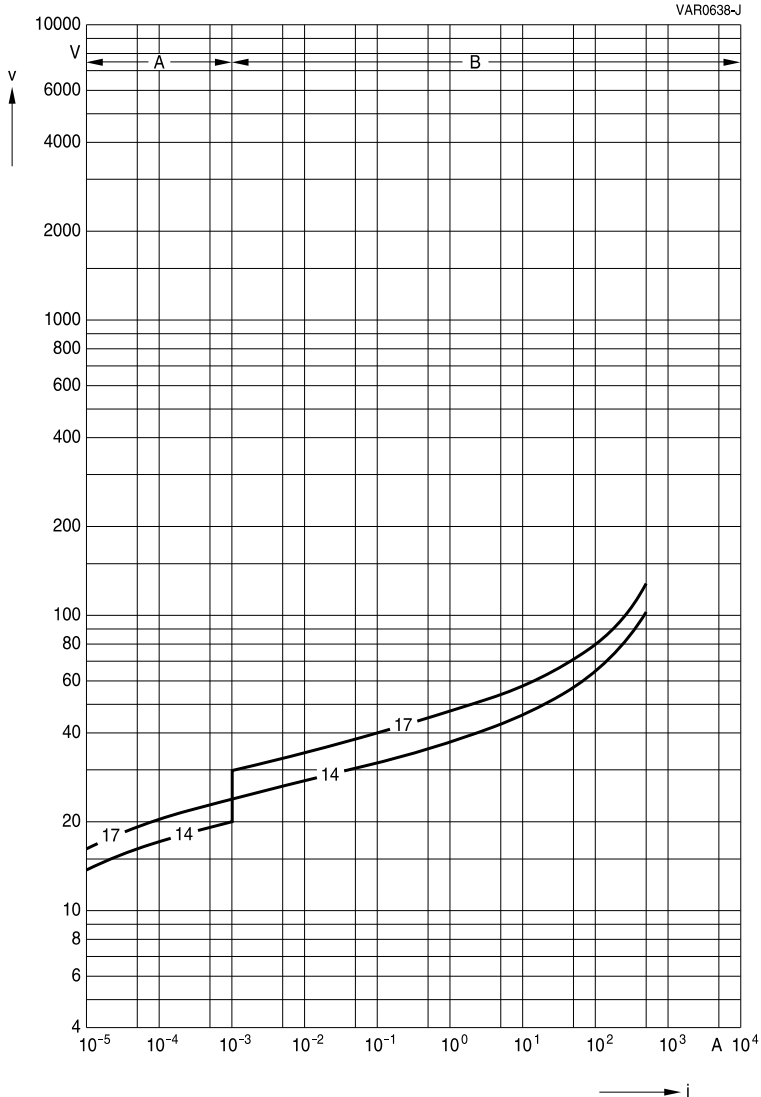


**SIOV-S07 ... D1**



**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



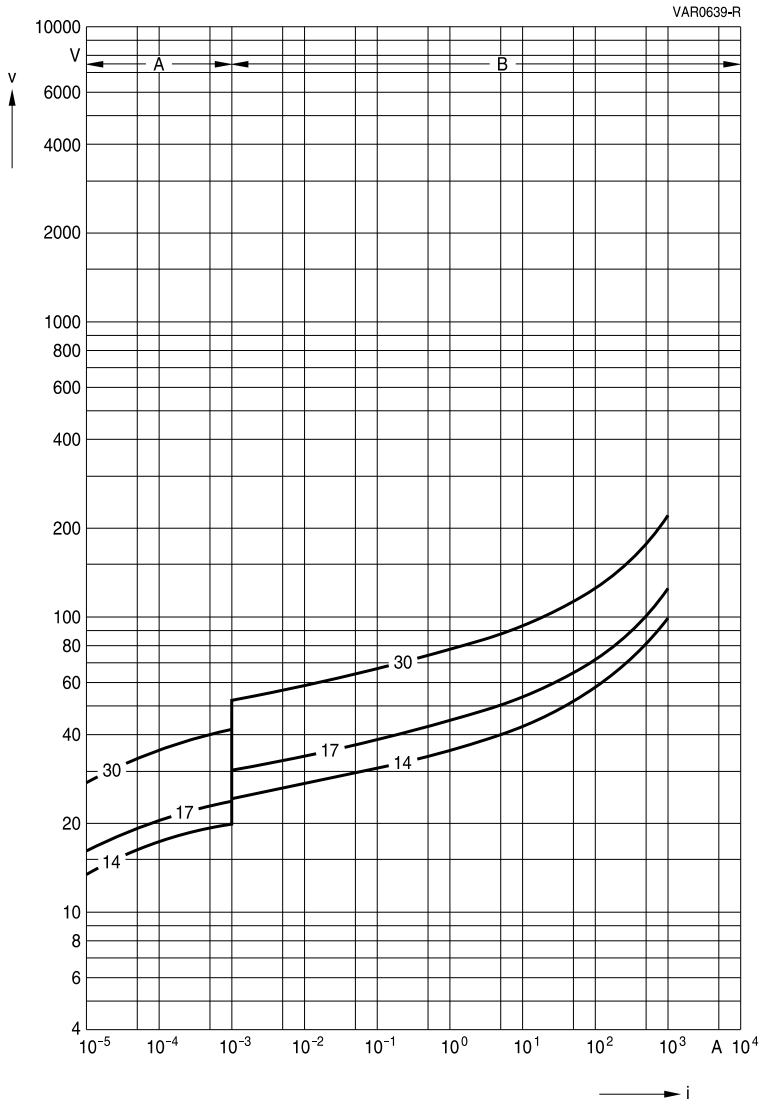
**SIOV-S10 ... (AUTO)( D1)**





**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

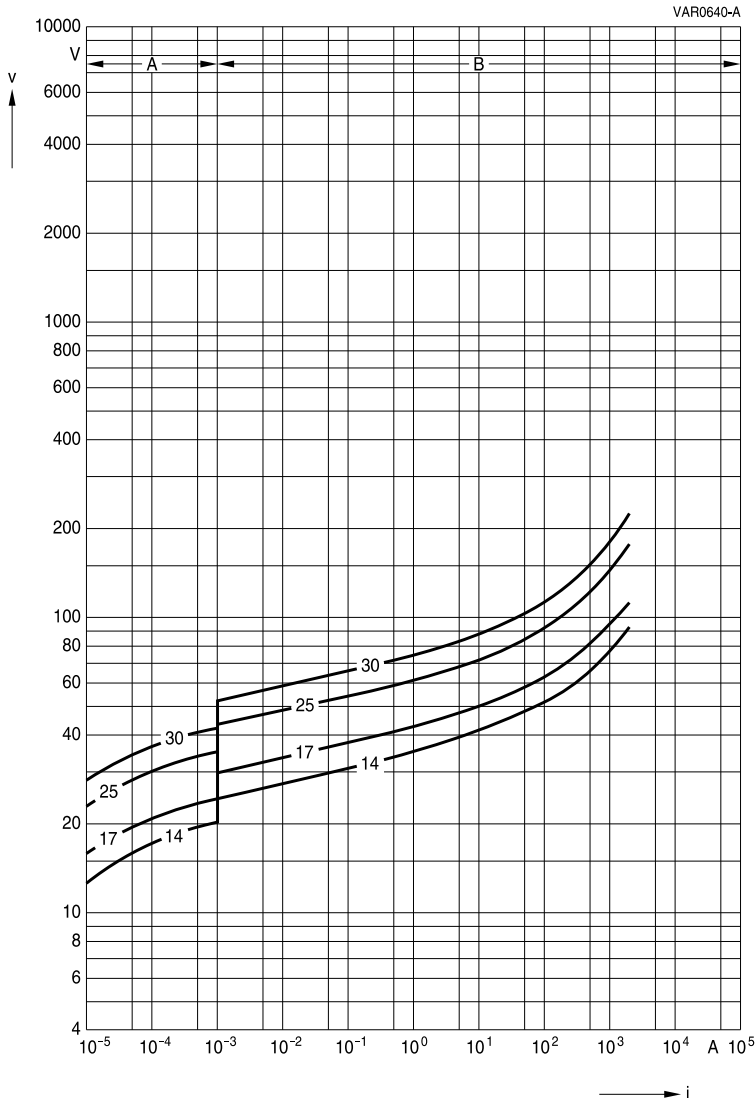


**SIOV-S14 ... (AUTO)( D1)**



**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



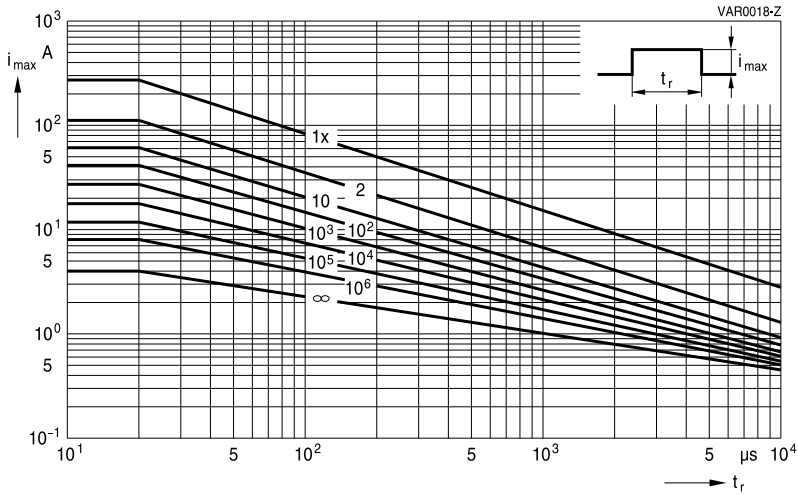
**SIOV-S20 ... AUTO**



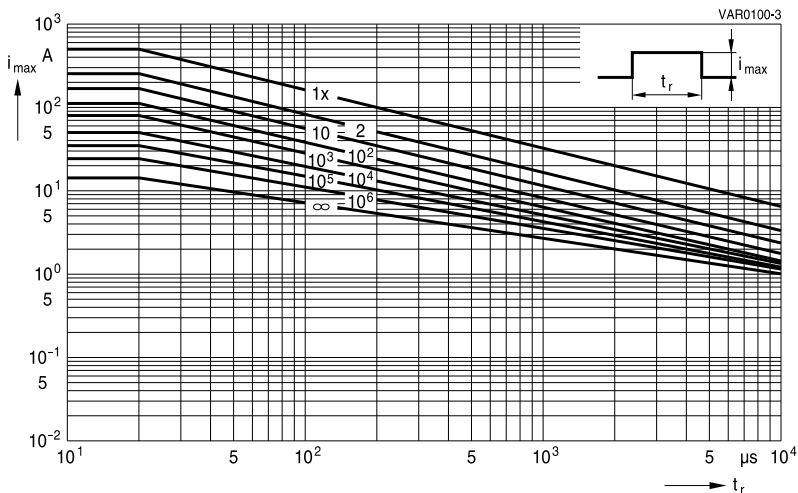
**Derating curves**

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-S07K14AUTOS2D1**



**SIOV-S10K14AUTO ... K17AUTO**

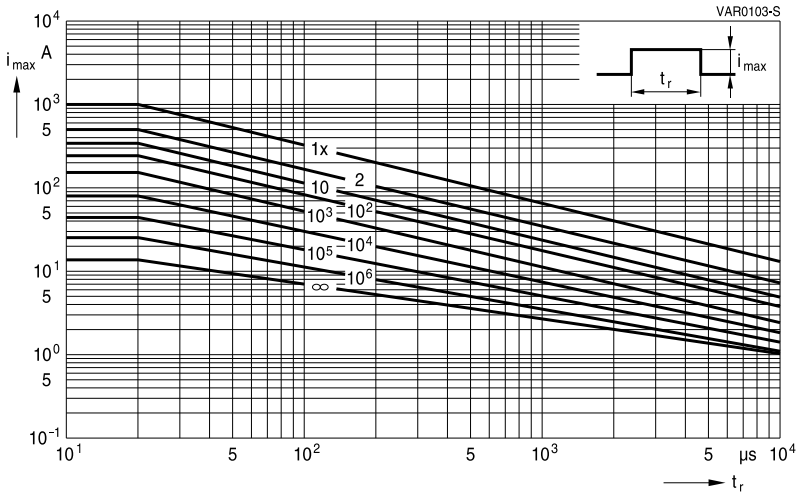
**SIOV-S10K14AUTOS5D1**



**Derating curves**

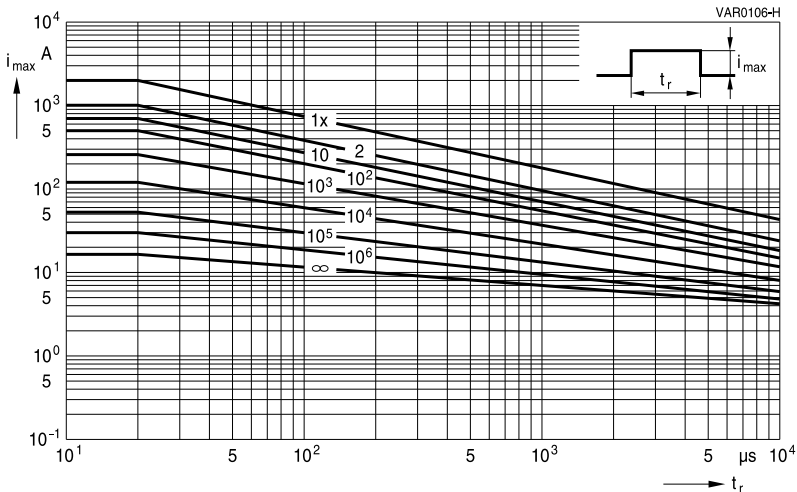
Maximum surge current  $i_{max} = f(t_r, \text{pulse train})$

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



**SIOV-S14K14AUTO ... K30AUTO**

**SIOV-S14K14AUTOS5D1**



**SIOV-S20K14AUTO ... K30AUTO**



**Leaded varistors**

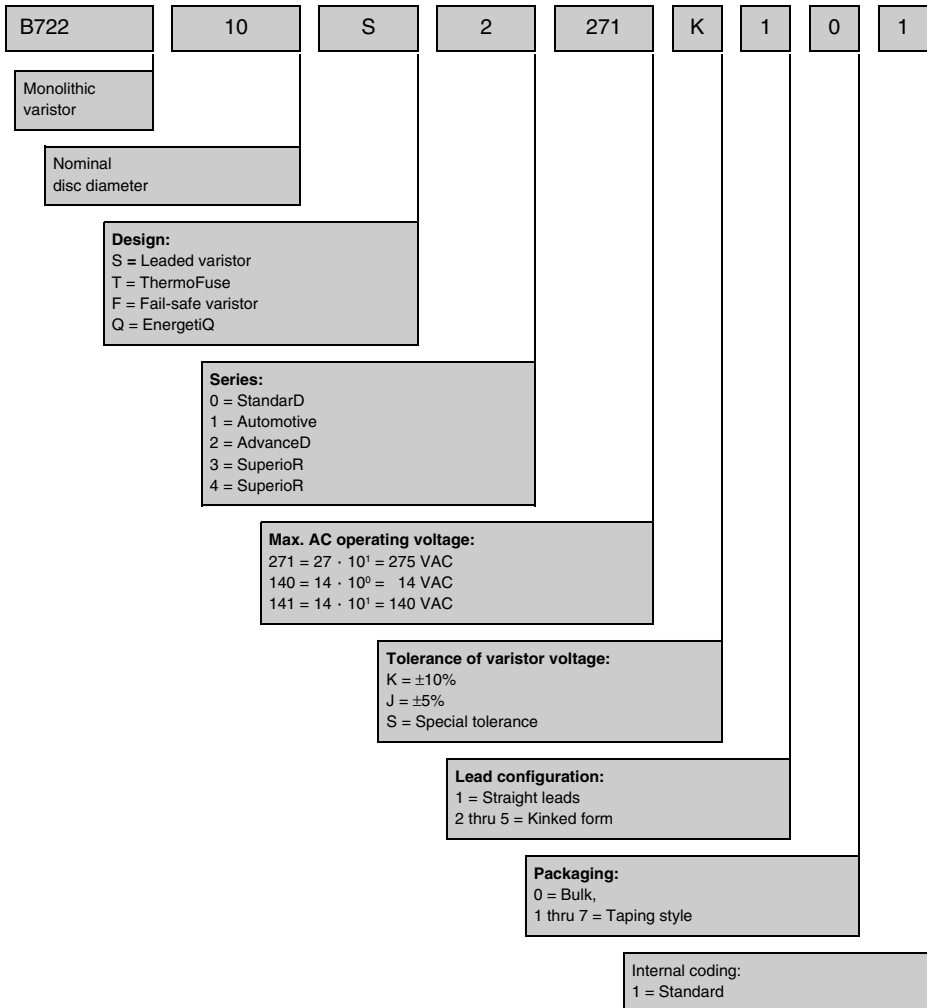
**B722\***

**Automotive series**

**Taping, packaging and lead configuration**

**1 EPCOS ordering code system**

**For leaded varistors**





**Leaded varistors**

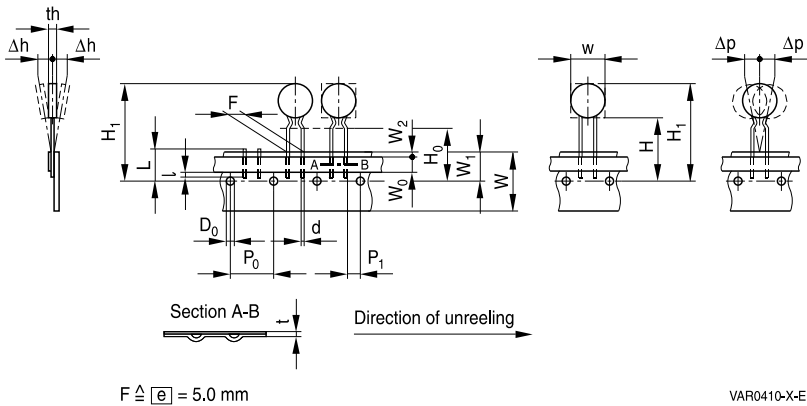
**B722\***

**Automotive series**

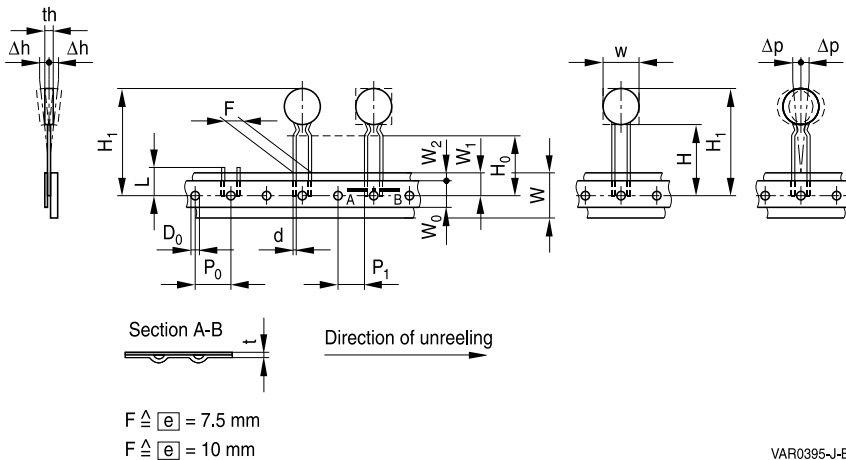
**2 Taping and packaging of leaded varistors**

Tape packaging for lead spacing  $\boxed{e}$  = 5 fully conforms to IEC 60286-2, while for lead spacings  $\boxed{e}$  = 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	$\pm 0.05$	0.8	$\pm 0.05$	1.0	$\pm 0.05$	
P <sub>0</sub>	12.7	$\pm 0.3$	12.7 <sup>1)</sup>	$\pm 0.3$	12.7	$\pm 0.3$	$\pm 1$ mm/20 sprocket holes
P <sub>1</sub>	3.85	$\pm 0.7$	8.95	$\pm 0.8$	7.7	$\pm 0.8$	
F	5.0	$+0.6/-0.1$	7.5	$\pm 0.8$	10.0	$\pm 0.8$	measured at top of component body
$\Delta h$	0	$\pm 2.0$	depends on s		depends on s		
$\Delta p$	0	$\pm 1.3$	0	$\pm 2.0$	0	$\pm 2.0$	
W	18.0	$\pm 0.5$	18.0	$\pm 0.5$	18.0	$\pm 0.5$	Peel-off force $\geq 5$ N
W <sub>0</sub>	5.5	min.	11.0	min.	11.0	min.	
W <sub>1</sub>	9.0	$\pm 0.5$	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)	$\pm 0.5$	16.0 (18.0)	$\pm 0.5$	16.0	$\pm 0.5$	
H <sub>1</sub>	32.2	max.	45.0	max.	45.0	max.	
D <sub>0</sub>	4.0	$\pm 0.2$	4.0	$\pm 0.2$	4.0	$\pm 0.2$	without lead
t	0.9	max.	0.9	max.	0.9	max.	
L	11.0	max.	11.0	max.	11.0	max.	
l	4.0	max.					

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

2) Applies only to uncrimped types

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



## 2.4 Taping mode

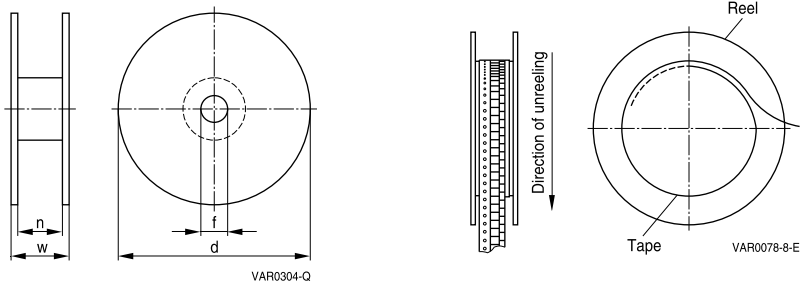
Example: B72210S0271K1 5 1  
|  
Digit 14

Digit 14	Taping mode	Reel type	Seating plane height H <sub>0</sub> for crimped types mm	Seating plane height H for uncrimped types mm	Pitch distance P <sub>0</sub> mm
0	–	Bulk	–	–	–
1	G	I	16	18	12.7
2	G2	I	18	–	12.7
3	G3	II	16	18	12.7
4	G4	II	18	–	12.7
5	G5	III	16	18	12.7
6	GA	Ammo pack	16	18	12.7
7	G2A	Ammo pack	18	–	12.7
<b>Internal coding for special taping</b>					
	G6	III	18	–	12.7
	G10	II	16	18	15.0
	G11	II	18	–	15.0
	G10A	Ammo pack	16	18	15.0
	G11A	Ammo pack	18	–	15.0





## 2.5 Reel dimension

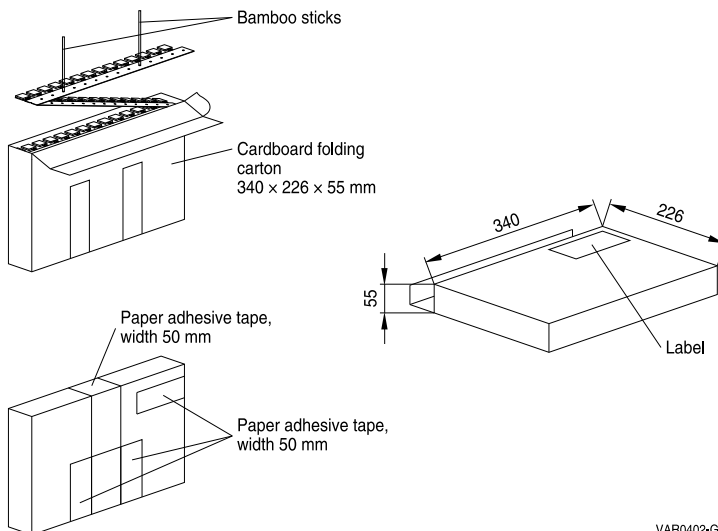


### Dimensions (in mm)

Reel type	d	f	n	w
I	360 max.	31 ±1	approx. 45	54 max.
II	360 max.	31 ±1	approx. 55	64 max.
III	500 max.	23 ±1	approx. 59	72 max.

If reel type III is not compatible with insertion equipment because of its large diameter, nominal disk diameter 10 mm and 14 mm can be supplied on reel II upon request (taping mode G3).

## 2.6 Ammo pack dimensions





### 3 Lead configuration

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

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

#### 3.1 Crimp style mode

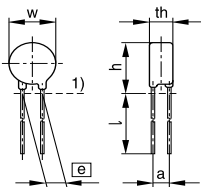
Example: B72210S0271K **5**01

Digit 13

Digit 13 of ordering code	Crimp style	Figure
1	Standard, straight leads	1
2	S2	2
3	S3	3
4	S4	4
5	S5	5
Available upon request		
Internal coding	—	6

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

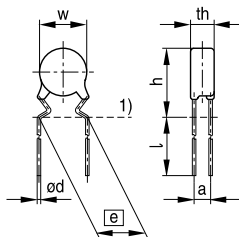
##### Standard, straight leads



1) Seating plane to IEC 717  
VAR0586-W-E

**Figure 1**

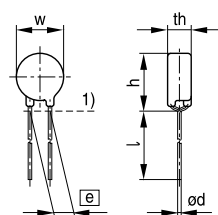
##### Non-standard, crimp style S2



1) Seating plane to IEC 60717  
VAR0411-F-E

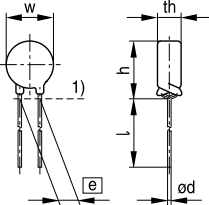
**Figure 2**

##### Non-standard, crimp style S3

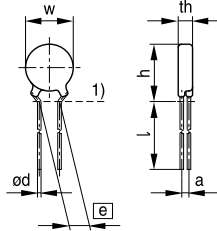


1) Seating plane to IEC 60717  
VAR0396-R-E

**Figure 3**


**Non-standard, crimp style S4**


1) Seating plane to IEC 60717  
VAR0404-W-E

**Non-standard, crimp style S5**


1) Seating plane to IEC 60717  
VAR0412-N-E

**Figure 4**
**Figure 5**

### 3.3 Component height ( $h_{max}$ ) for crimped versions (non-standard)

Due to technical reasons the component height ( $h_{max}$ ) increases if a crimp is added. The maximum height of the crimped component can be found in the table below.

Nominal diameter mm	$V_{RMS}$ V	Crimp style	$e$ mm	$h_{max}$ mm
5	11 ... 175	S2	5.0	10.0
5	210 ... 460	S3	5.0	10.0
7	11 ... 175	S2	5.0	12.0
7	210 ... 460	S3	5.0	12.0
10	11 ... 300	S5	7.5	15.5
10	320 ... 460	S3/S5	7.5	16.5
10	510	S3/S5	7.5	17.5
10	Automotive	S5	7.5	17.0
10	Automotive (D1 types)	S5	7.5	16.0
10	11 ... 175	S4	5.0	16.5
10	210 ... 460	S3	5.0	16.5
14	11 ... 300	S5	7.5	20.0
14	320 ... 460	S3/S5	7.5	20.0
14	510	S3/S5	7.5	21.5
14	Automotive	S5	7.5	21.0
14	Automotive (D1 types)	S5	7.5	20.0
20	11 ... 320	S5	10.0	27.0
20	385 ... 510	S5	10.0	27.5



### 3.4 Trimmed leads (non-standard)

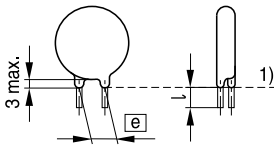
Varistors with cut leads available upon request.

Lead length tolerances:

Straight leads  $\pm 1.0$  mm

Crimped leads  $\pm 0.8$  mm

Minimum lead length 3.5 mm



1) Seating plane to IEC 60717

VAR0642-U-E

**Figure 6**



## 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 before storage.
2. Storage conditions in original packaging:  
Storage temperature:  $-25^{\circ}\text{C} \dots +45^{\circ}\text{C}$ ,  
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 within the time specified:  
SIOV-S, -Q, -LS, -B, -SFS 24 months  
ETFV 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.



### 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.


**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 to IEC 61643-1
$I_{nom}$	Nominal discharge current to IEC 61643-1
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
$\Delta V_V$	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.

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