

## **SIOV metal oxide varistors**

Leaded varistors, SuperioR-MP, S20 series

**Series/Type:** B722\*  
**Date:** May 2017

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**SuperioR-MP, S20 series**
**Construction**

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

**Features**

- Wide operating voltage range 130 ... 680 V<sub>RMS</sub>
- All types duty cycle @ 6 kV/ 3 kA = >10 pulses, according to IEC 60950-1, Annex Q; IEC 61051-2
- All types I<sub>nom</sub> @ 5 kA = >15 impulses according to UL 1449, 3<sup>rd</sup> edition surge current generator (8/20 μs), type 2 listed
- Multiple pulse handling capability

**Approvals**

- UL
- CSA (all types ≤320 V<sub>RMS</sub>)
- VDE
- IEC

**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**

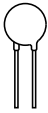
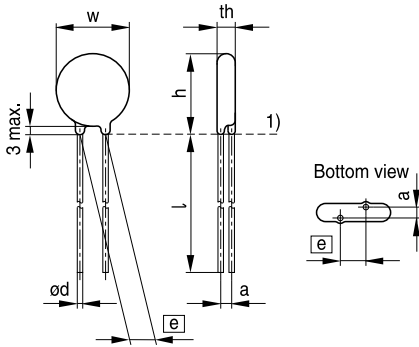
Climatic category	to IEC 60068-1	40/105/56	
Operating temperature	to IEC 61051	-40 ... +105	°C
Storage temperature		-40 ... +125	°C
Electric strength	to IEC 61051	≥ 2.5	kV <sub>RMS</sub>
Insulation resistance	to IEC 61051	≥ 100	MΩ
Response time		< 25	ns


**Electrical specifications and ordering codes**
**Maximum ratings ( $T_A = 105\text{ °C}$ )**

Ordering code	Type (untaped) SIOV-	$V_{RMS}$ V	$V_{DC}$ V	$i_{max}$ (8/20 $\mu$ s) A	$W_{max}$ (2 ms) J	$P_{max}$ W
B72220P3131K101	S20K130E3K1	130	170	12000	135	1.00
B72220P3141K101	S20K140E3K1	140	180	12000	145	1.00
B72220P3151K101	S20K150E3K1	150	200	12000	155	1.00
B72220P3171K101	S20K175E3K1	175	225	12000	180	1.00
B72220P3211K101	S20K210E3K1	210	270	12000	215	1.00
B72220P3231K101	S20K230E3K1	230	300	12000	235	1.00
B72220P3251K101	S20K250E3K1	250	320	12000	255	1.00
B72220P3271K101	S20K275E3K1	275	350	12000	280	1.00
B72220P3301K101	S20K300E3K1	300	385	12000	305	1.00
B72220P3321K101	S20K320E3K1	320	420	12000	330	1.00
B72220P3351K101	S20K350E3K1	350	460	12000	335	1.00
B72220P3381K101	S20K385E3K1	385	505	12000	370	1.00
B72220P3421K101	S20K420E3K1	420	560	12000	405	1.00
B72220P3461K101	S20K460E3K1	460	615	12000	445	1.00
B72220P3511K101	S20K510E3K1	510	670	10000	445	1.00
B72220P3551K101	S20K550E3K1	550	745	10000	490	1.00
B72220P3621K101	S20K620E3K1	625	825	10000	540	1.00
B72220P3681K101	S20K680E3K1	680	895	10000	595	1.00

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

Ordering code	Type (untaped) SIOV-	$V_v$ (1 mA) V	$\Delta V_v$ (1 mA) %	$V_{c,max}$ ( $i_c$ ) V	$i_c$ A	$C_{typ}$ (1 kHz) pF
B72220P3131K101	S20K130E3K1	205	$\pm 10$	340	100	2400
B72220P3141K101	S20K140E3K1	220	$\pm 10$	360	100	2250
B72220P3151K101	S20K150E3K1	240	$\pm 10$	395	100	2050
B72220P3171K101	S20K175E3K1	270	$\pm 10$	455	100	1800
B72220P3211K101	S20K210E3K1	330	$\pm 10$	545	100	1500
B72220P3231K101	S20K230E3K1	360	$\pm 10$	595	100	1400
B72220P3251K101	S20K250E3K1	390	$\pm 10$	650	100	1300
B72220P3271K101	S20K275E3K1	430	$\pm 10$	710	100	1150
B72220P3301K101	S20K300E3K1	470	$\pm 10$	775	100	1050
B72220P3321K101	S20K320E3K1	510	$\pm 10$	840	100	1000
B72220P3351K101	S20K350E3K1	560	$\pm 10$	910	100	900
B72220P3381K101	S20K385E3K1	620	$\pm 10$	1025	100	800
B72220P3421K101	S20K420E3K1	680	$\pm 10$	1120	100	730
B72220P3461K101	S20K460E3K1	750	$\pm 10$	1240	100	660
B72220P3511K101	S20K510E3K1	820	$\pm 10$	1355	100	600
B72220P3551K101	S20K550E3K1	910	$\pm 10$	1500	100	550
B72220P3621K101	S20K620E3K1	1000	$\pm 10$	1650	100	500
B72220P3681K101	S20K680E3K1	1100	$\pm 10$	1815	100	450


**Leaded varistors**
**B722\***
**SuperioR-MP, S20 series**
**Dimensional drawings**


1) Seating plane to IEC 60717

VAR0408-C-E

**Weight**

Nominal diameter mm	$V_{RMS}$ V	Weight g
20	130 ... 680	3.2 ... 10.2

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

**Dimensions**

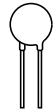
Ordering code	[e] ±1 mm	a ±1 mm	$w_{max}$ mm	$th_{max}$ mm	$h_{max}$ mm	$l_{min}$ mm	d ±0.05 mm
B72220P3131K101	10.0	2.2	22.5	5.1	27.0	25.0	1.0
B72220P3141K101	10.0	2.3	22.5	5.2	27.0	25.0	1.0
B72220P3151K101	10.0	2.4	22.5	5.3	27.0	25.0	1.0
B72220P3171K101	10.0	2.6	22.5	5.5	27.0	25.0	1.0
B72220P3211K101	10.0	2.9	22.5	5.8	27.0	25.0	1.0
B72220P3231K101	10.0	3.1	22.5	6.0	27.0	25.0	1.0
B72220P3251K101	10.0	3.2	22.5	6.1	27.0	25.0	1.0
B72220P3271K101	10.0	3.5	22.5	6.5	27.0	25.0	1.0
B72220P3301K101	10.0	3.8	22.5	6.8	27.0	25.0	1.0
B72220P3321K101	10.0	3.9	22.5	6.9	27.0	25.0	1.0
B72220P3351K101	10.0	4.2	22.5	7.3	27.0	25.0	1.0
B72220P3381K101	10.0	4.8	22.5	8.3	27.5	25.0	1.0
B72220P3421K101	10.0	5.0	22.5	8.6	27.5	25.0	1.0
B72220P3461K101	10.0	5.3	22.5	8.9	27.5	25.0	1.0
B72220P3511K101	10.0	5.6	23.0	9.3	28.0	25.0	1.0
B72220P3551K101	10.0	6.1	23.0	9.8	28.0	25.0	1.0
B72220P3621K101	10.0	6.6	23.0	10.3	28.0	25.0	1.0
B72220P3681K101	10.0	7.2	23.0	10.9	28.0	25.0	1.0


**Leaded varistors**
**B722\***
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**Reliability data**

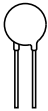
Test	Test methods/conditions	Requirement
Varistor voltage	The voltage between two terminals with the specified measuring current applied is called $V_V$ (1 mA <sub>DC</sub> @ 0.2 ... 2 s).	To meet the specified value
Clamping voltage	The maximum voltage between two terminals with the specified standard 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 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 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 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


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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, 1st cycle: 55 °C, 93% r. H., 24 h, IEC 60068-2-30, 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</math> V.</p>	$ \Delta V/V (1 \text{ mA})  \leq 10\%$ $R_{ins} \geq 100 \text{ M}\Omega$
Rapid change of temperature	IEC 60068-2-14, test Na, LCT/UCT, dwell time 30 min, 5 cycles	$ \Delta V/V (1 \text{ mA})  \leq 5\%$ No visible damage
Damp heat, steady state	IEC 60068-2-78, test Ca  The specimen shall be subjected to $40 \pm 2$ °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).	$ \Delta V/V (1 \text{ mA})  \leq 10\%$ $R_{ins} \geq 100 \text{ M}\Omega$



Test	Test methods/conditions	Requirement
Solderability	<p>IEC 60068-2-20, test Ta, method 1 with modified conditions for lead-free solder alloys: 245 °C, 3 s:</p> <p>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.</p>	<p>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.</p>
Resistance to soldering heat	<p>IEC 60068-2-20, test Tb, method 1A, 260 °C, 10 s:</p> <p>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.</p> <p>The change of <math>V_V</math> shall be measured and the specimen shall be visually examined.</p>	<p><math> \Delta V/V (1 \text{ mA})  \leq 5\%</math></p> <p>No visible damage</p>
Tensile strength	<p>IEC 60068-2-21, test Ua1</p> <p>After gradually applying the force specified below and keeping the unit fixed for 10 s, the terminal shall be visually examined for any damage.</p> <p>Force for wire diameter:</p> <p>0.6 mm = 10 N 0.8 mm = 10 N 1.0 mm = 20 N</p>	<p><math> \Delta V/V (1 \text{ mA})  \leq 5\%</math></p> <p>No break of solder joint, no wire break</p>


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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

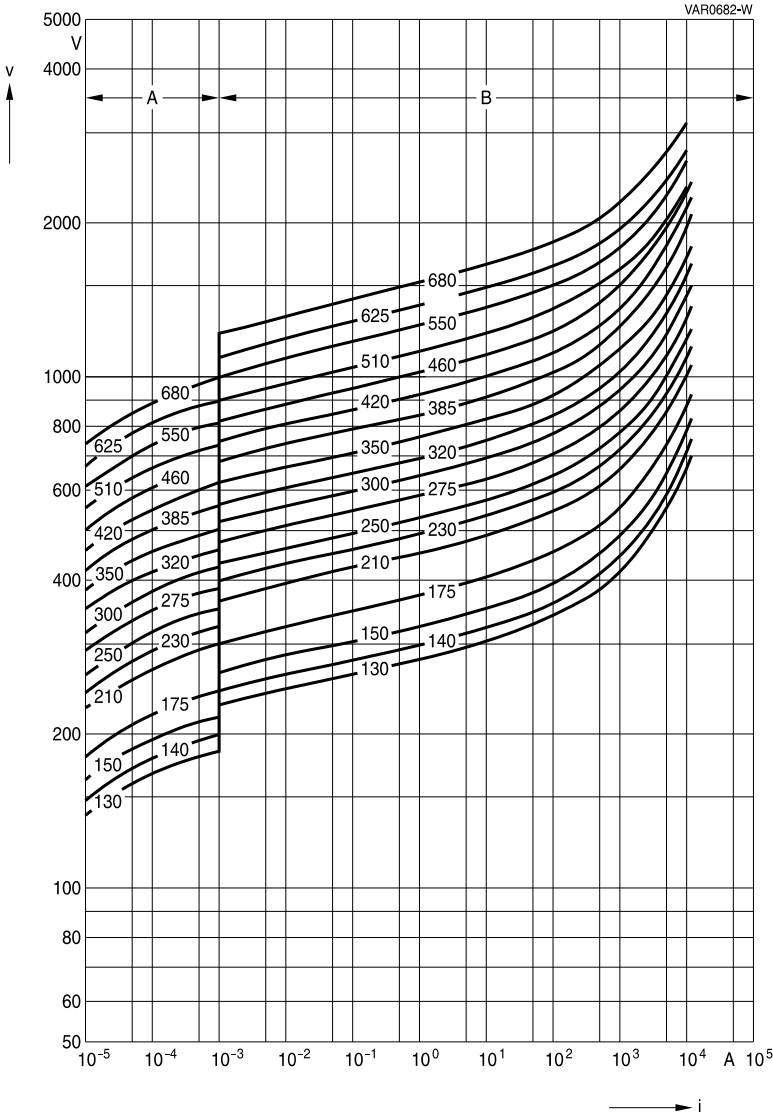
LCT = Lower category temperature

 $R_{ins}$  = Insulation resistance

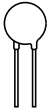


**v/i characteristics**

$v = f(i)$  - 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-S20 ... E3K1**



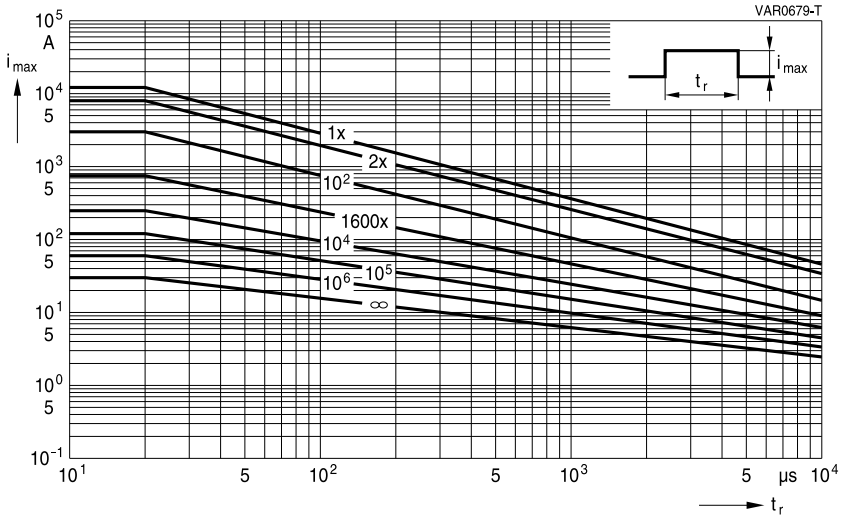
**Leaded varistors**  
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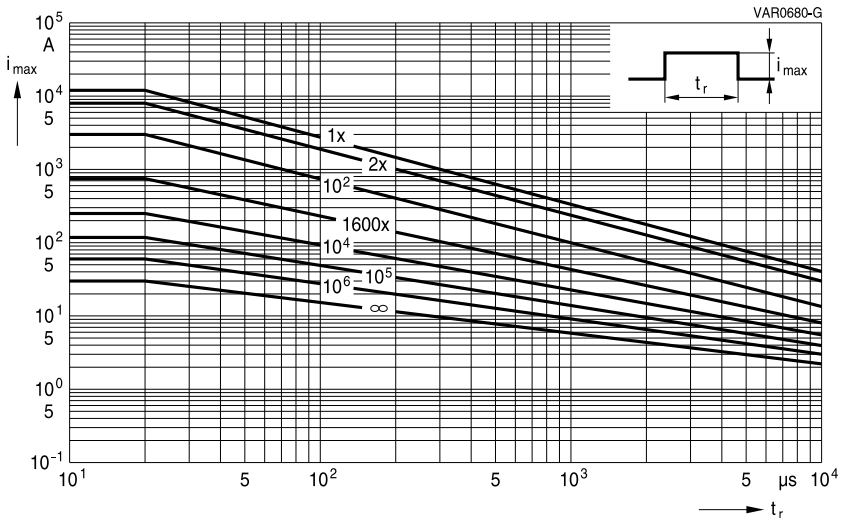
**Derating curves**

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-S20K130 ... K320E3K1**



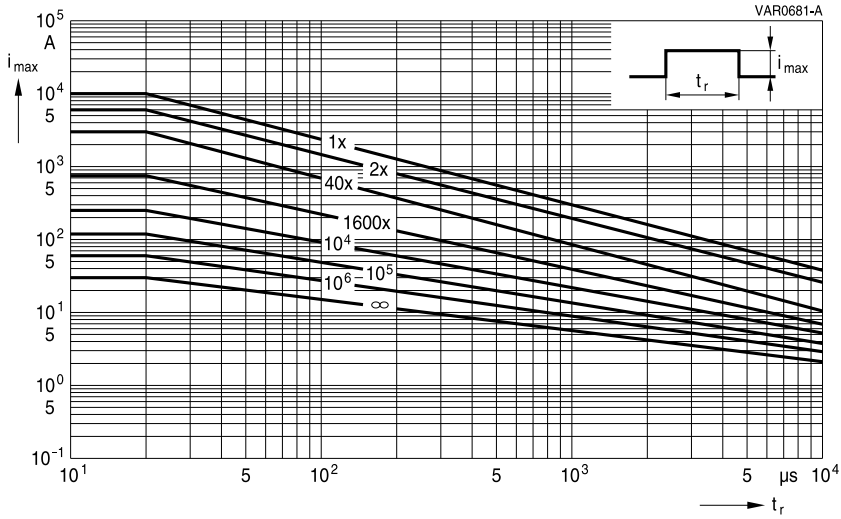
**SIOV-S20K350 ... K460E3K1**



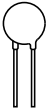
**Derating curves**

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-S20K510 ... K680E3K1**



**Leaded varistors**

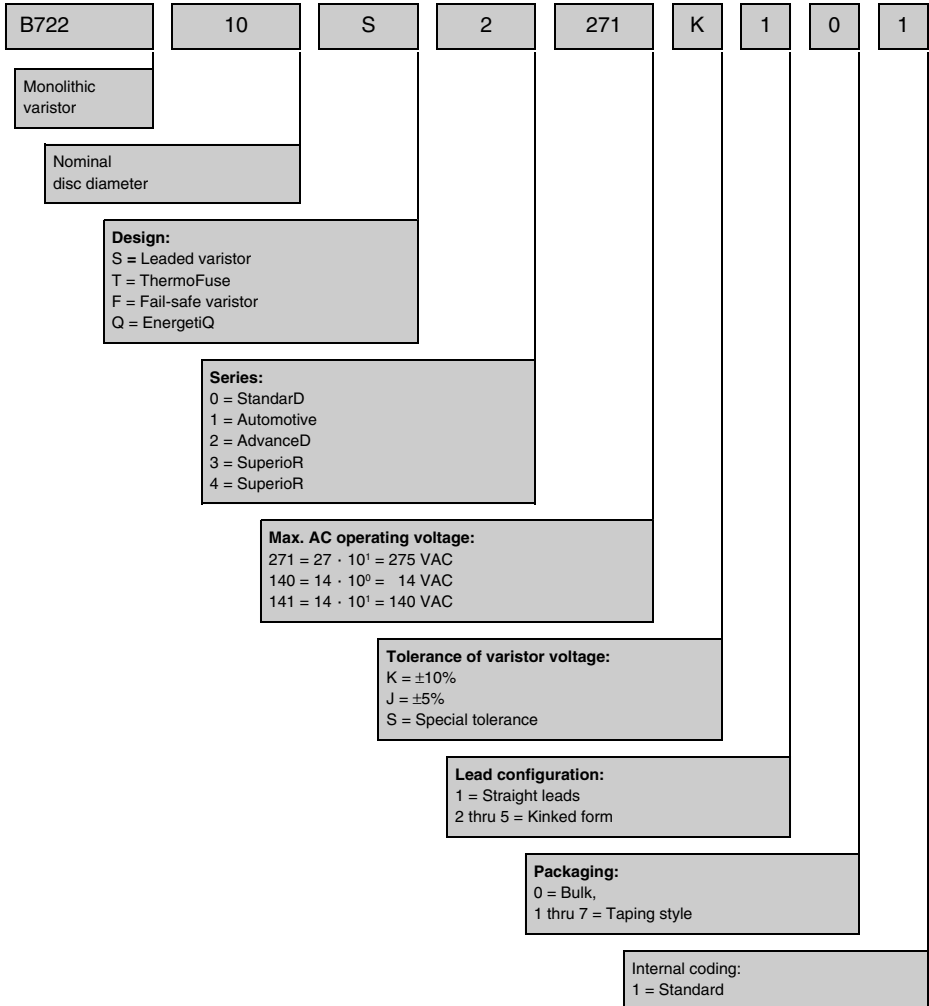
**B722\***

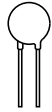
**SuperioR-MP, S20 series**

**Taping, packaging and lead configuration**

**1 EPCOS ordering code system**

**For leaded varistors**

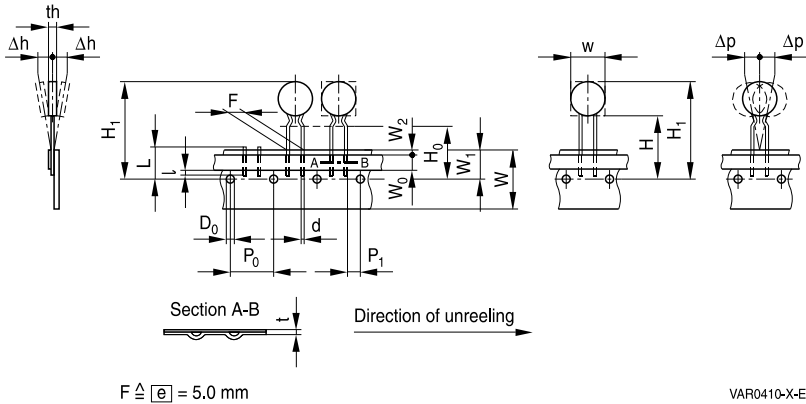




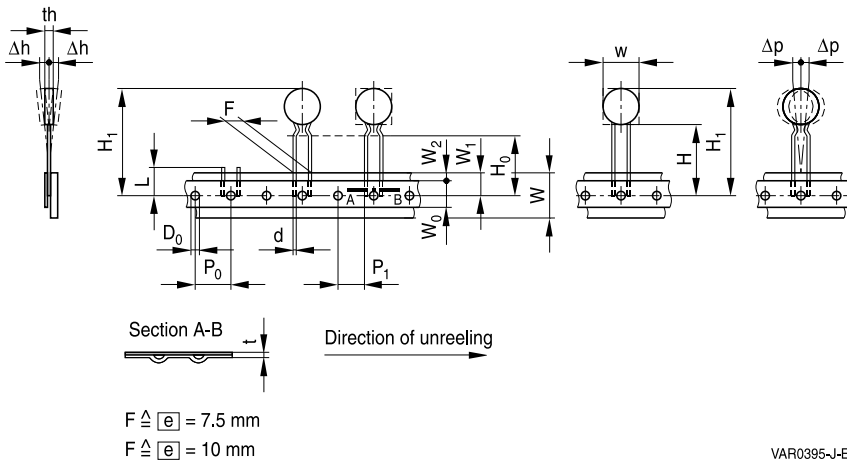
## 2 Taping and packaging of leaded varistors

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



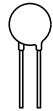

**2.3 Tape dimensions (in mm)**

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	$\pm 0.05$	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

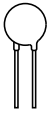
3) Applies only to crimped types (H<sub>0</sub> = 18 upon request)



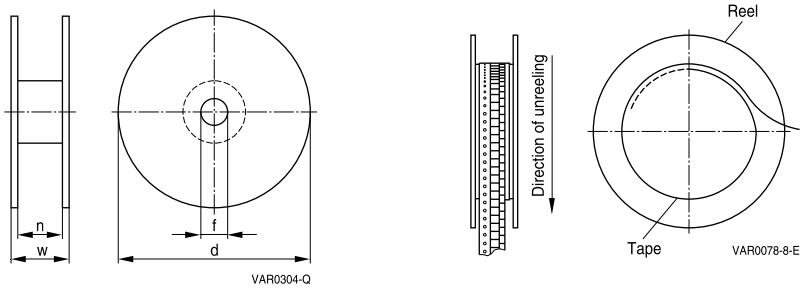
## 2.4 Taping mode

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

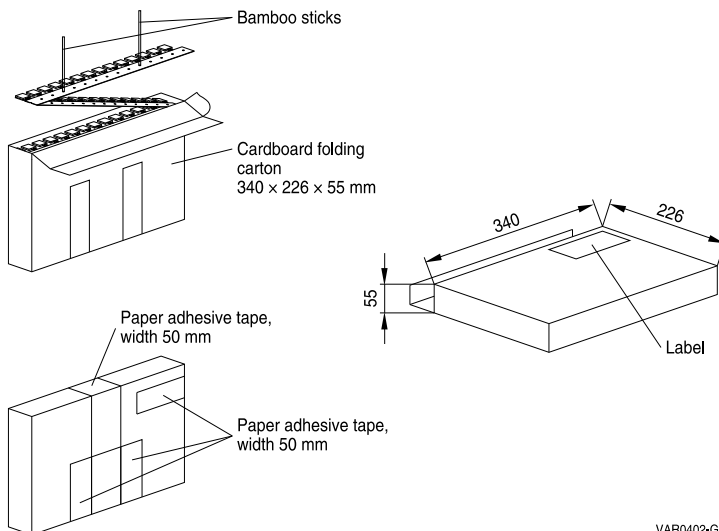


### Dimensions (in mm)

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

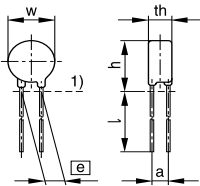
Example: B72210S0271K **5**01

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

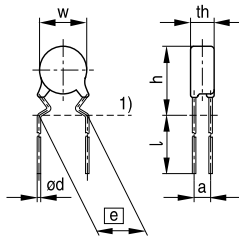
##### Standard, straight leads



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

**Figure 1**

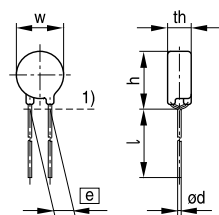
##### Non-standard, crimp style S2



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

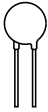
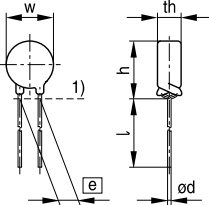
**Figure 2**

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



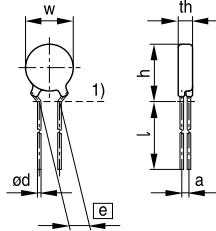
1) Seating plane to IEC 60717  
VAR0396-R-E

**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)

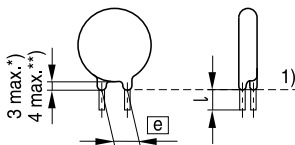
Varistors with cut leads available upon request.

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

\*) For round component head

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

VAR0642-U-E

**Figure 6**





### 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.

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## Important notes

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