

## **SIOV metal oxide varistors**

Leaded varistors, SuperioR, S25 series

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

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**SuperioR, S25 series**
**Construction**

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

**Features**

- High-energy SuperioR series E4
- Wide operating voltage range 130 ... 750 V<sub>RMS</sub>
- UL approval to UL 1449 (file number E321126 – exception 580 V)
- Very high surge current rating up to 20 kA

**Approvals**

- UL
- CSA
- IEC
- VDE

**Delivery mode**

- Bulk (standard)
- For further details refer chapter "Taping, packaging and lead configuration" for leaded varistors.

**General technical data**

Climatic category	to IEC 60068-1	40/85/56	
Operating temperature	to IEC 61051	-40 ... + 85	°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 ( $T_A = 85\text{ }^\circ\text{C}$ )**

Ordering code	Type (untaped) SIOV-	$V_{RMS}$	$V_{DC}$	$i_{max}$ (8/20 $\mu\text{s}$ )	$W_{max}$ (2 ms)	$P_{max}$
		V	V	A	J	W
B72225S4131K101	S25K130E4R12	130	170	20000	185	1.0
B72225S4141K101	S25K140E4R12	140	180	20000	195	1.0
B72225S4151K101	S25K150E4R12	150	200	20000	215	1.0
B72225S4171K101	S25K175E4R12	175	225	20000	245	1.0
B72225S4231K101	S25K230E4R12	230	300	20000	315	1.0
B72225S4251K101	S25K250E4R12	250	320	20000	345	1.0
B72225S4271K101	S25K275E4R12	275	350	20000	375	1.0
B72225S4301K101	S25K300E4R12	300	385	20000	410	1.0
B72225S4321K101	S25K320E4R12	320	420	20000	445	1.0
B72225S4381K101	S25K385E4R12	385	505	20000	600	1.0
B72225S4421K101	S25K420E4R12	420	560	20000	700	1.0
B72225S4441K101	S25K440E4R12	440	585	20000	710	1.0
B72225S4461K101	S25K460E4R12	460	615	20000	720	1.0
B72225S4511K101	S25K510E4R12	510	670	20000	750	1.0
B72225S4551K101	S25K550E4R12	550	745	20000	780	1.0
B72225S4581K101	S25K580E4R12	580	780	20000	800	1.0
B72225S4621K101	S25K625E4R12	625	825	20000	855	1.0
B72225S4681K101	S25K680E4R12	680	895	20000	940	1.0
B72225S4751K101	S25K750E4R12	750	1060	20000	1025	1.0


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

Ordering code	V <sub>v</sub> (1 mA)	ΔV <sub>v</sub> (1 mA)	V <sub>c,max</sub> (i <sub>c</sub> )	i <sub>c</sub>	C <sub>typ</sub> (1 kHz)
	V	%	V	A	pF
B72225S4131K101	205	±10	340	150	3800
B72225S4141K101	220	±10	360	150	3550
B72225S4151K101	240	±10	395	150	3250
B72225S4171K101	270	±10	455	150	2900
B72225S4231K101	360	±10	595	150	2250
B72225S4251K101	390	±10	650	150	2100
B72225S4271K101	430	±10	710	150	1900
B72225S4301K101	470	±10	775	150	1750
B72225S4321K101	510	±10	840	150	1600
B72225S4381K101	620	±10	1025	150	1250
B72225S4421K101	680	±10	1120	150	1150
B72225S4441K101	715	±10	1180	150	1100
B72225S4461K101	750	±10	1240	150	1050
B72225S4511K101	820	±10	1355	150	950
B72225S4551K101	910	±10	1500	150	860
B72225S4581K101	940	±10	1580	150	830
B72225S4621K101	1000	±10	1650	150	780
B72225S4681K101	1100	±10	1815	150	710
B72225S4751K101	1200	±10	2000	150	650


**Dimensional drawings**


1) Seating plane to IEC 60717

VAR0408-C-E

**Weight**

Nominal diameter mm	$V_{RMS}$ V	Weight g
25	130 ... 750	5.2 ... 22.2

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
B72225S4131K101	12.7	3.4	27.5	5.7	31.0	25.0	1.0
B72225S4141K101	12.7	3.5	27.5	5.8	31.0	25.0	1.0
B72225S4151K101	12.7	3.6	27.5	5.9	31.0	25.0	1.0
B72225S4171K101	12.7	3.8	27.5	6.1	31.0	25.0	1.0
B72225S4231K101	12.7	4.4	27.5	6.7	31.0	25.0	1.0
B72225S4251K101	12.7	4.6	27.5	6.9	31.0	25.0	1.0
B72225S4271K101	12.7	4.9	27.5	7.2	31.0	25.0	1.0
B72225S4301K101	12.7	5.1	27.5	7.4	31.0	25.0	1.0
B72225S4321K101	12.7	5.3	27.5	7.6	31.0	25.0	1.0
B72225S4381K101	12.7	6.0	27.5	8.3	31.5	25.0	1.0
B72225S4421K101	12.7	6.3	27.5	8.6	31.5	25.0	1.0
B72225S4441K101	12.7	6.6	27.5	8.9	31.5	25.0	1.0
B72225S4461K101	12.7	6.8	27.5	9.1	31.5	25.0	1.0
B72225S4511K101	12.7	7.2	27.5	9.5	31.5	25.0	1.0
B72225S4551K101	12.7	7.7	27.5	10.0	32.0	25.0	1.0
B72225S4581K101	12.7	7.9	27.5	10.2	32.0	25.0	1.0
B72225S4621K101	12.7	8.3	27.5	10.6	32.0	25.0	1.0
B72225S4681K101	12.7	8.9	27.5	11.2	32.5	25.0	1.0
B72225S4751K101	12.7	9.4	27.5	11.7	32.5	25.0	1.0


**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	<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.</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 (insulated varistors only).</p>	$ \Delta V/V (1 \text{ mA})  \leq 10\%$ $R_{ins} \geq 100 \text{ M}\Omega$


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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>





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 <sub>v</sub> shall be measured and the specimen shall be visually examined.	ΔV/V (1 mA)  ≤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	ΔV/V (1 mA)  ≤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

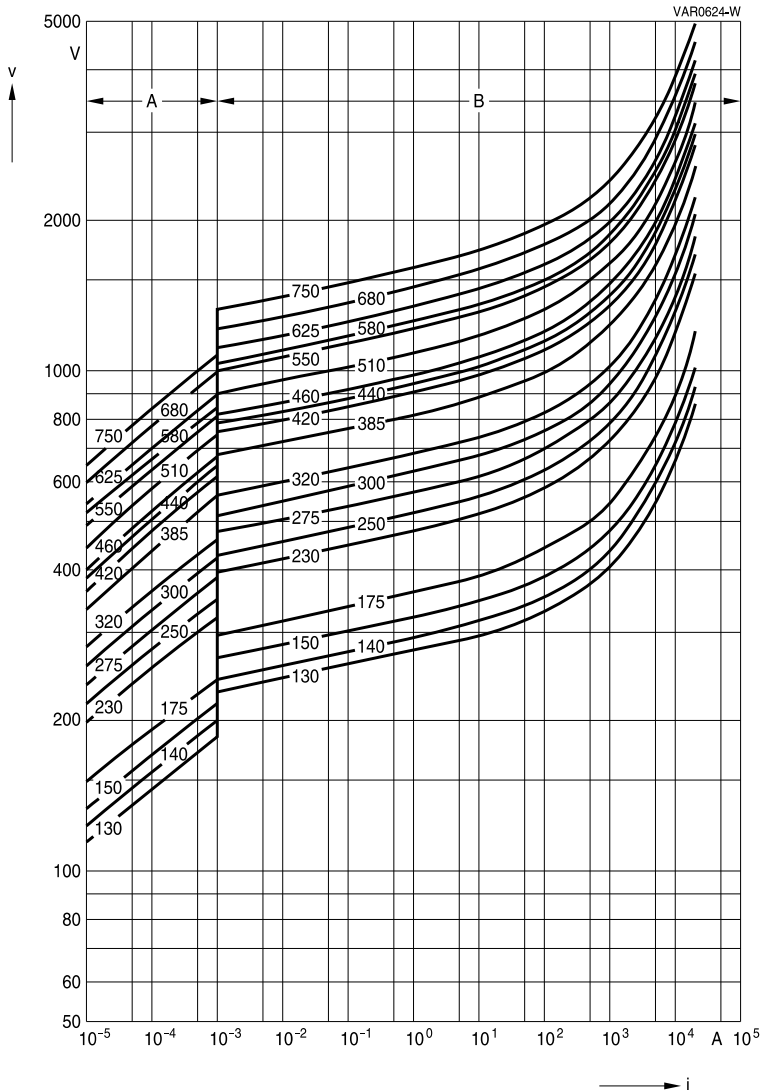
LCT = Lower category temperature

 R<sub>ins</sub> = 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-S25 ... E4R12**



**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-S25 ... E4R12**



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**Taping, packaging and lead configuration**

**1 EPCOS ordering code system**

**For leaded varistors**

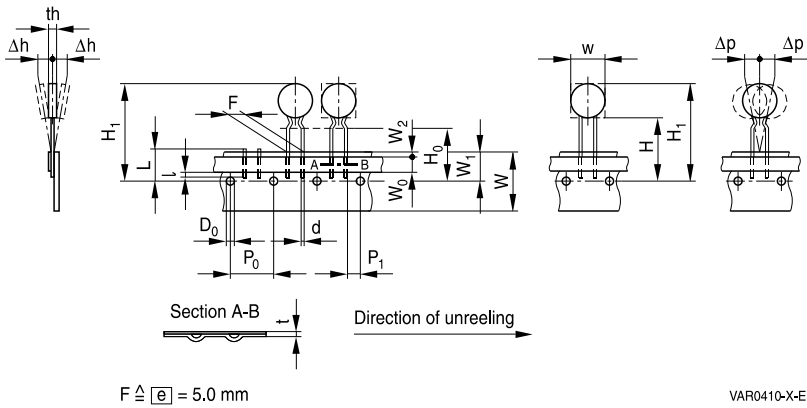




## 2 Taping and packaging of leaded varistors

Tape packaging for lead spacing  $\boxed{e}$  = 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



VAR0402-G





### 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

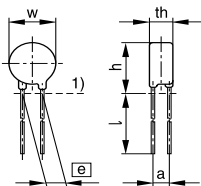
Example: B72210S0271K **5**01

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**

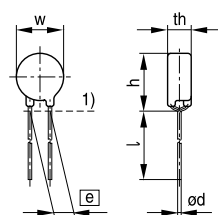
##### Non-standard, crimp style S2



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:  $-25\text{ °C} \dots +45\text{ °C}$ ,  
 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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