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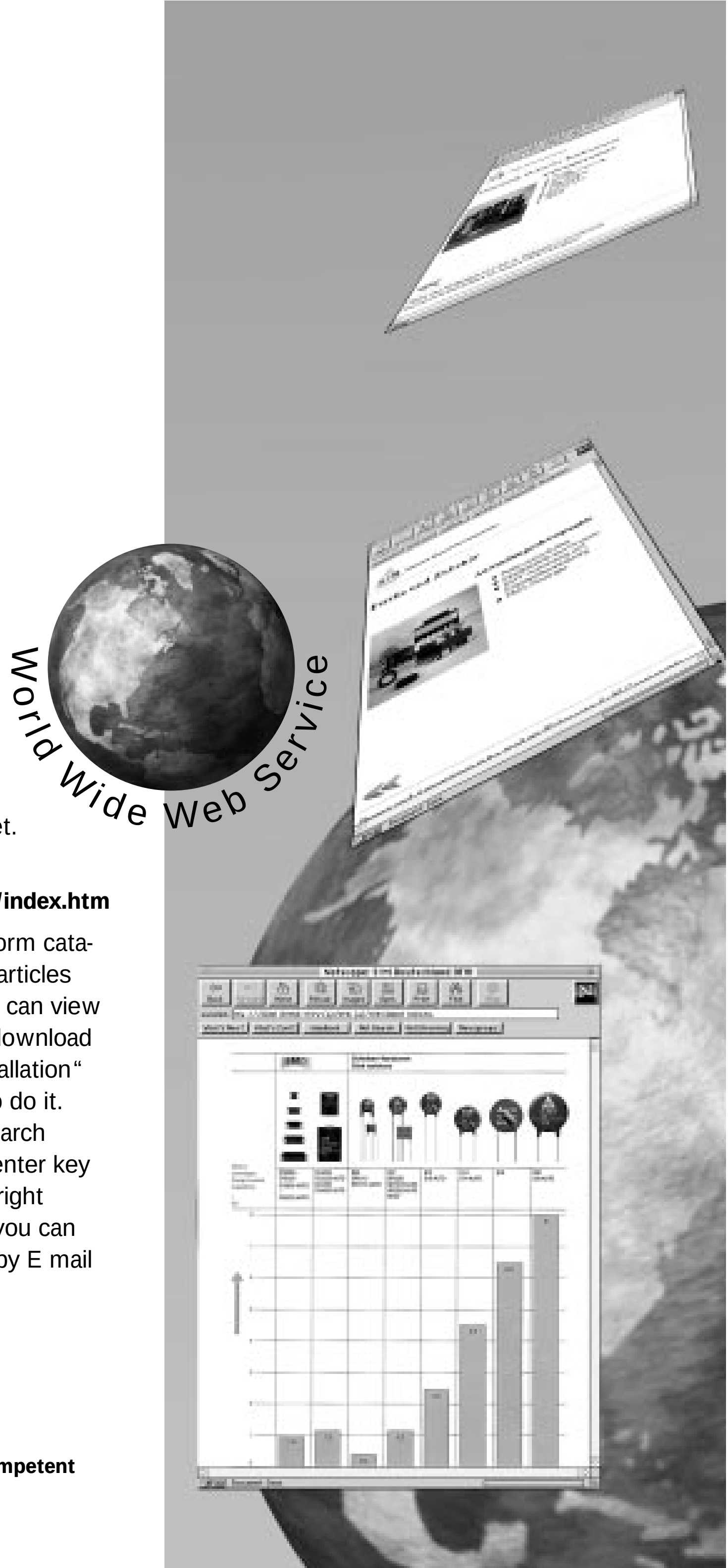

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SMD varistors

				
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Operating voltage V_{RMS}	4 … 14 V	4 … 25 V	4 … 60 V	4 … 60 V
Surge current i_{max}	0,03 kA	0,08 … 0,12 kA	0,15 … 0,2 kA	0,25 … 0,40 kA
Energy absorption W_{max}	0,1 … 0,2 J	0,1 … 0,3 J	0,3 … 1,1 J	0,4 … 2,3 J
Automotive		CN0805 Page 96	CN1206 Page 96	CN1210 Page 96
Operating voltage V_{RMS}		14 V	14 V	14 V
Surge current i_{max}		0,12 kA	0,2 kA	0,4 kA
Energy absorption W_{max}		1,0 J	1,5 J	3,0 J

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SMD varistors

				
Standard	CN1812 Page 90 ff	CN2220 Page 90 ff	CU3225 Page 102 ff	CU4032 Page 102 ff
Operating voltage V_{RMS}	4 … 60 V	4 … 60 V	11 … 300 V	11 … 300 V
Surge current i_{max}	0,5 … 0,8 kA	0,8 … 1,2 kA	0,1 … 0,4 kA	0,25 … 1,2 kA
Energy absorption W_{max}	0,8 … 5,8 J	1,4 … 12,0 J	0,3 … 9,6 J	0,8 … 23,0 J
Automotive	CN1812 Page 96	CN2220 Page 96	CU3225 Page 107	CU4032 Page 107
Operating voltage V_{RMS}	14 V	14 … 30 V	14 … 30 V	14 … 30 V
Surge current i_{max}	0,8 kA	1,2 kA	0,1 kA	0,25 kA
Energy absorption W_{max}	6,0 J	12,0 … 25,0 J	6,0 J	12,0 J
Telecom	CN1812 Page 98			CU4032 Page 109
Operating voltage V_{RMS}	60 … 95 V[1)]			60 … 95 V[1)]
Surge current i_{max}	0,25 … 0,4 kA			1,2 kA
Energy absorption W_{max}	5,0 … 6,0 J			4,8 … 7,6 J

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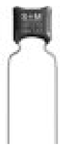
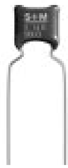
1) All varistors of the standard program are suitable for telecom applications, taking into consideration the selection criteria.

Disk varistors

					
Standard	SR1210 Page 116		SR2220 Page 116	S05 Page 122 ff	S07 Page 122 ff
Operating voltage V_{RMS}	4 … 8 V		4 … 8 V	11 … 460 V	11 … 460 V
Surge current i_{max}	0,25 … 0,4 kA		1,0 … 1,2 kA	0,1 … 0,4 kA	0,25… 1,2 kA
Energy absorption W_{max}	0,4 … 1,0 J		1,4 … 4,2 J	0,3 … 18 J	0,8 … 36 J
Automotive	SR1210 Page 119	SR1812 Page 119	SR2220 Page 119		S07 Page 140
Operating voltage V_{RMS}	14 V	14 V	14 V		14 V
Surge current i_{max}	0,4 kA	0,8 kA	1,2 kA		0,25 kA
Energy absorption W_{max}	3,0 J	6,0 J	12,0 J		12,0 J
Telecom					S07 Page 144
Operating voltage V_{RMS}					60 … 95 V[1)]
Surge current i_{max}					1,2 kA
Energy absorption W_{max}					4,8 … 7,6 J

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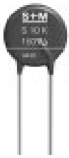
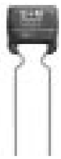
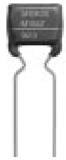
1) All varistors of the standard program are suitable for telecom applications, taking into consideration the selection criteria.

Disk varistors

					
Standard	S10 Page 122 ff	S14 Page 122 ff	S20 Page 122 ff		
Operating voltage V_{RMS}	11 … 680 V	11 … 1100 V	11 … 1100 V		
Surge current i_{max}	0,5 … 2,5 kA	1,0 … 6,0 kA	2,0 … 10,0 kA		
Energy absorption W_{max}	1,7 … 72 J	3,2 … 230 J	10 … 410 J		
Automotive	S10 Page 140	S14 Page 140	S20 Page 140	SHCV-SR1 Page 146	SHCV-SR2 Page 146
Operating voltage V_{RMS}	14 … 17 V	14 … 30 V	14 … 30 V	14 … 20 V	14 … 20 V
Surge current i_{max}	0,5 kA	1,0 kA	2,0 kA	0,8 kA	1,2 kA
Energy absorption W_{max}	25,0 J	50,0 J	100,0 J	6,0 J	12,0 J

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	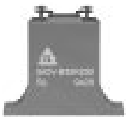	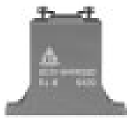	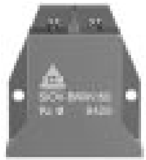	
Block varistors	B32 Page 162 ff	B40 Page 162 ff	B60 Page 162 ff	B80 Page 162 ff
Operating voltage V_{RMS}	130 … 750 V	75 … 750 V	130 … 1100 V	130 … 1100 V
Surge current i_{max}	25 kA	40 kA	70 kA	100 kA
Energy absorption W_{max}	210 … 800 J	190 … 1200 J	490 … 3000 J	660 … 6000 J

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Strap varistors	LS40 Page 168 f		
Operating voltage V_{RMS}	130 … 750 V		
Surge current i_{max}	40 kA		
Energy absorption W_{max}	310 … 1200 J		
PowerDisk		PD80 Page 171 f	
Operating voltage V_{RMS}		1100 V[1]	
Surge current i_{max}		100 kA	
Energy absorption W_{max}		6000 J	
Arrester blocks			E32 Page 173 f
Rated voltage V_R			3 kV, 6 kV[2]
Surge current i_{max}			65 kA[3]

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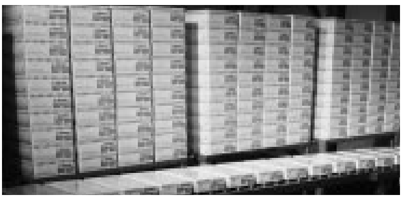

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1 General technical information

1.1 Introduction

Despite its many benefits, one of the few drawbacks of semiconductor technology is the vulnerability of solid-state devices to overvoltages. Even voltage pulses of very low energy can produce interference and damage, sometimes with far-reaching consequences. So, as electronics makes its way into more and more applications, optimum overvoltage or transient suppression becomes a design factor of decisive importance.

SIOV® varistors (**SI**emens Matsushita Metal **O**xide **V**aristors) have shown themselves to be excellent protective devices because of their application flexibility and high reliability. The metal oxide varistor, with its extremely attractive price/performance ratio, is an ideal component for limiting surge voltage and current as well as for absorbing energy.

The S+M product range includes SMDs for surface mounting, radial-lead disks, block varistors, strap-lead varistors and PowerDisk varistors for heavy-duty applications. Special types for automotive electrical systems and for telecom applications round off the product range.

1.2 Definition

Varistors (**Var**iable Res**istors**) are voltage-dependent resistors with a symmetrical *V*/*I* characteristic curve (figure 1) whose resistance decreases with increasing voltage. Connected in parallel with the electronic device or circuit that is to be guarded, they form a low-resistance shunt when voltage increases and thus prevent any further rise in the overvoltage.

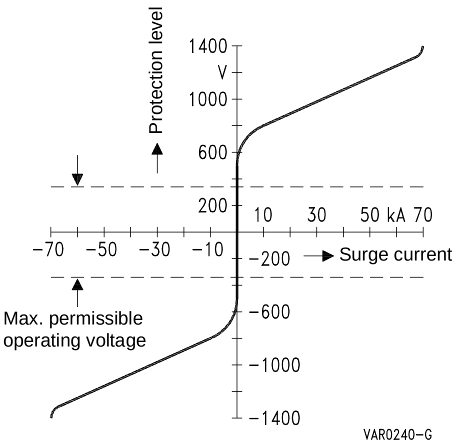

Figure 1 Typical *V*/*I* characteristic curve of a metal oxide varistor on a linear scale, using the SIOV-B60K250 as an example

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The voltage dependence of varistors or VDRs (**V**oltage **D**ependent **R**esistors) is expressed by the nonlinearity exponent α. In metal oxide varistors it has been possible to produce α figures of more than 30. This puts their protection levels in the same region as those of zener diodes and suppressor diodes. Exceptional current handling capability combined with response times of < 25 ns (SMD < 0,5 ns) make them an almost perfect protective device.

1.3 Microstructure and conduction mechanism

Sintering zinc oxide together with other metal oxide additives under specific conditions produces a polycrystalline ceramic whose resistance exhibits a pronounced dependence on voltage. This phenomenon is called the varistor effect.

Figure 2 shows the conduction mechanism in a varistor element in simplified form. The zinc oxide grains themselves are highly conductive, while the intergranular boundary formed of other oxides is highly resistive. Only at those points where zinc oxide grains meet does sintering produce "microvaristors", comparable to symmetrical zener diodes (protection level approx. 3,5 V). The electrical behavior of the metal oxide varistor, as indicated by figure 2, results from the number of microvaristors connected in series or in parallel.

This implies that the electrical properties are controlled by the physical dimensions of the varistor:

- Twice the ceramic thickness produces twice the protection level because then twice as many microvaristors are arranged in series.
- Twice the area produces twice the current handling capability because then twice the number of current paths are arranged in parallel.
- Twice the volume produces almost twice the energy absorption capability because then there are twice as many absorbers in the form of zinc oxide grains.

The series and parallel connection of the individual microvaristors in the sintered body of a SIOV also explains its high electrical load capacity compared to semiconductors. While the power in semiconductors is dissipated almost entirely in the thin p-n junction area, in a SIOV it is distributed over all the microvaristors, i. e. uniformly throughout the component's volume. Each microvaristor is provided with energy absorbers in the form of zinc oxide grains with optimum thermal contact. This permits high absorption of energy and thus exceptionally high surge current handling capability.

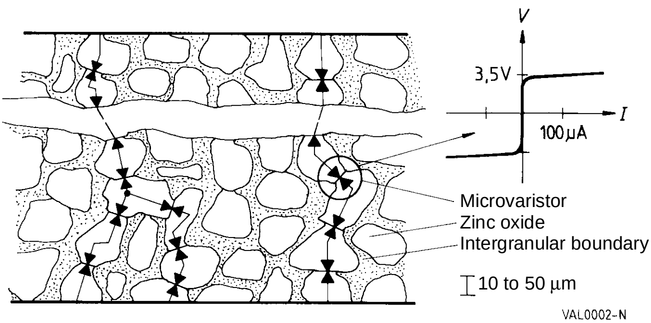


Figure 2 Conduction mechanism in a varistor element

Grain size

For matching very different levels of protection to ceramic thicknesses that are suitable for fabrication, SIOV varistors have to be produced from ceramics with different voltage gradients. The variation of raw materials and sintering control influence the growth of grain size (grain diameter approx. 15 to 100 µm) and thus produce the required specific ceramic voltage (approx. 30 to 200 V/mm). The *V*/*I* characteristic of the individual microvaristors is not affected by this.

Ceramics with a small specific voltage (low-voltage types) cannot handle the same current density as high-voltage types. That explains the differences in surge current, energy absorption and mechanical dimensions within the various type series. The effect of the different grain sizes is most apparent between the voltage classes K40 and K50. For example, the maximum permissible surge current is:

SIOV-S07K40 i_{max} = 250 A
SIOV-S07K50 i_{max} = 1200 A

Multilayer technology overcomes this obstacle by using high-load-capacity fine-grain ceramics even for operating voltages of < 50 V. This permits decidedly higher surge currents with higher non-linearity, i. e. lower protection levels.

1.4 Construction

Sintered metal oxide ceramics are processed on different production lines:

SMD type series CU
The disk-shaped varistor ceramics are fitted with flat metal electrodes (tinned copper alloy) and encapsulated in thermoplast by injection molding.

SMD type series CN
These rectangular multilayer ceramics are electroded on their narrow faces by silver palladium sintered terminations.

Disk types
Here the varistor disk is fitted with leads of tinned copper wire and then the ceramic body is coated with epoxy resin in a fluidized bed.

Block types
The large electromagnetic forces involved in handling currents between 10 and 100 kA call for solid contacting with special electrodes and potting in a plastic housing. Block varistors are electrically and mechanically connected by screw terminals.

Strap types
After contacting of the varistor ceramics with special bolt-holed electrodes, these components are coated with epoxy resin in a fluidized bed.

PowerDisk
High-energy varistors in disk diode cases.

Arrester blocks
Cylindrical varistor ceramics, glass-passivated collar, flame-sprayed electrodes for pressure contacting.

1.5 Equivalent circuits

Figure 3a shows the simplified equivalent circuit of a metal oxide varistor. From this the behavior of the varistor can be interpreted for different current ranges.

Leakage current region (< 10^{-4} A)
In the leakage current region the resistance of an ideal varistor goes towards ∞, so it can be ignored as the resistance of the intergranular boundary will predominate. Therefore $R_B << R_{IG}$. This produces the equivalent circuit in figure 3b:

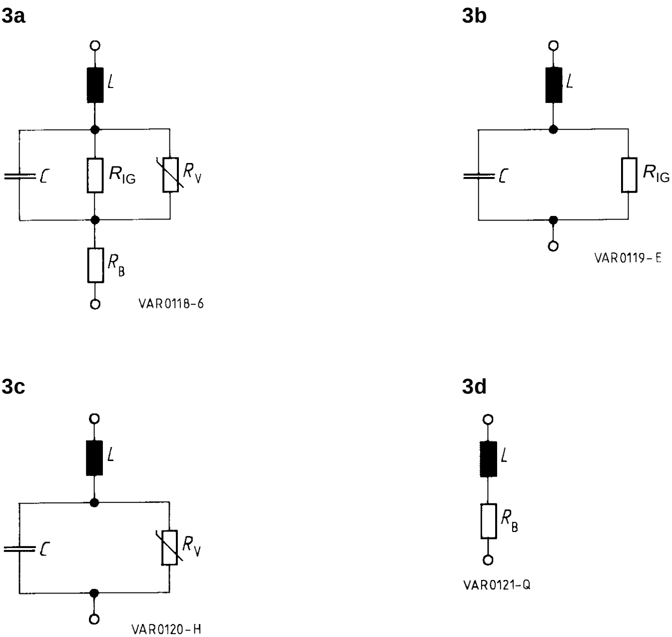
The ohmic resistance R_{IG} determines behavior at small currents, the *V*/*I* curve goes from exponential to linear (downturn region).
R_{IG} shows a distinct temperature dependence, so a marked increase in leakage current must be expected as temperature increases.

Normal operating region (10^{-5} to 10^{3} A)
With $R_V << R_{IG}$ and $R_B << R_V$, R_V determines the electrical behavior (figure 3c). The *V*/*I* curve (figure 5) follows to a good approximation the simple mathematical description by an exponential function (equation 3 in 1.6.1) where $\alpha > 30$, i. e. the curve appears more or less as a straight line on a log-log scale.

High-current region (> 10^{3} A)
Here the resistance of the ideal varistor approaches zero. This means that $R_V << R_{IG}$ and $R_V < R_B$ (figure 3d). The ohmic bulk resistance of ZnO causes the *V*/*I* curve to resume a linear characteristic (upturn region).

Capacitance
Equivalent circuits 3b and 3c indicate the capacitance of metal oxide varistors (see product tables for typical values).
In terms of overvoltage suppression, a high capacitance is desirable because, with its lowpass characteristic, it smooths steep surge voltage edges and consequently improves the protection level.

Lead inductance
The response time of the actual varistor ceramics is in the ps region. In the case of leaded varistors, the inductance of the connecting leads causes the response time to increase to values of several ns. For this reason, all attempts must be made to achieve a mounting method with the lowest possible inductance i. e. shortest possible leads.
Multilayer varistors have considerably shorter response times due to their low-inductance design.



L	Lead inductance (≈ 1 nH/mm)
C	Capacitance
R_{IG}	Resistance of intergranular boundary ($\rho \approx 10^{12}$ to 10^{13} Ωcm)
R_V	Ideal varistor (0 to ∞ Ω)
R_B	Bulk resistance of ZnO ($\rho \approx$ 1 to 10 Ωcm)

Figures 3a – d Equivalent circuits

1.6 *V*/*I* characteristics

1.6.1 Forms of presentation

The *V*/*I* characteristics of metal oxide varistors are similar to those of exponential functions (odd exponents), so it is fairly obvious that the latter should be used to describe them. As the curves are symmetrical, only one quadrant is generally shown for reasons of simplification (figure 4a):

$$I = K\,V^{\alpha} \qquad \alpha > 1 \qquad \text{(equ. 1)}$$

I	Current through varistor
V	Voltage across varistor
K	Ceramic constant (depending on varistor type)
α	Nonlinearity exponent (measure of nonlinearity of curve)

Another possible interpretation of the physical principle underlying these curves is that of a voltage-dependent resistance value, and particularly its rapid change at a predetermined voltage. This phenomenon is the basis of the varistor protection principle (figure 4b):

$$R = \frac{V}{I} = \frac{V}{K\,V^{\alpha}} = \frac{1}{K}\,V^{1-\alpha} \qquad \text{(equ. 2)}$$

Equations 1 and 2 can be shown particularly clearly on a log-log scale, because exponential functions then appear as straight lines:

$$\log I = \log K + \alpha \log V \qquad \text{(equ. 3)}$$

$$\log R = \log\left(\frac{1}{K}\right) + (1-\alpha)\log V \qquad \text{(equ. 4)}$$

This is virtually the only form of presentation used for varistor characteristics (figures 4c and d). A further advantage of the log-log format is the possibility of showing the wide range of the *V*/*I* curve (more than ten powers of 10).

It is evident that the simplified equations 1 to 4 cannot cover the downturn and upturn regions as described in section 1.5. Here, a mathematical description as shown in equation 20 on page 69 is required.

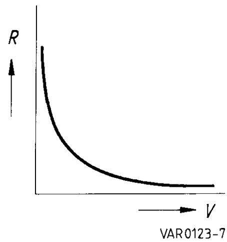
Determining nonlinearity exponent α

Two pairs of voltage/current values (V_1/I_1 and V_2/I_2) are read from the *V*/*I* characteristic of the varistor and inserted into equation 3, solved for α:

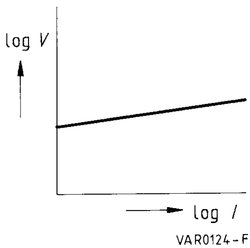
$$\alpha = \frac{\log I_2 - \log I_1}{\log V_2 - \log V_1} \qquad \text{(equ. 5)}$$

4a

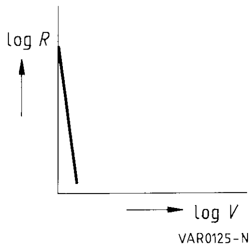
4b



4c



4d



Figures 4a – d Presentation of the *V*/*I* characteristics

1.6.2 Real *V*/*I* characteristic and ohmic resistance

Figure 5 shows a typical *V*/*I* characteristic with SIOV-B60K250 taken as example.

The downturn and upturn regions according to equivalent circuits 3b and d are easy to make out.

Calculating nonlinearity exponent α
Normally α is determined according to equation 5 from the pairs of values for 1 A and 1 mA of the *V*/*I* characteristic. For figure 5 this means:

$$\alpha = \frac{\log I_2 - \log I_1}{\log V_2 - \log V_1} = \frac{\log 1 - \log 10^{-3}}{\log 470 - \log 390} = \frac{0-(-3)}{2{,}67 - 2{,}59} = \frac{3}{0{,}08} \approx 38$$

The *V*/*I* curve of figure 5 is virtually a straight line between 10^{-4} and 10^{3} A, so it is described over a wide range to a good approximation by equation 3. The downturn and upturn regions may be adapted by inserting correction components in equation 3.

Another type of characteristic curve approximation is described in section 3.5

Deriving from figure 5, figure 6 shows the change in static resistance *R* = *V*/*I* for SIOV-B60K250. The resistance is > 1 MΩ in the range of the permissible operating voltage, whereas it can drop by as many as ten powers of 10 in case of overvoltage.

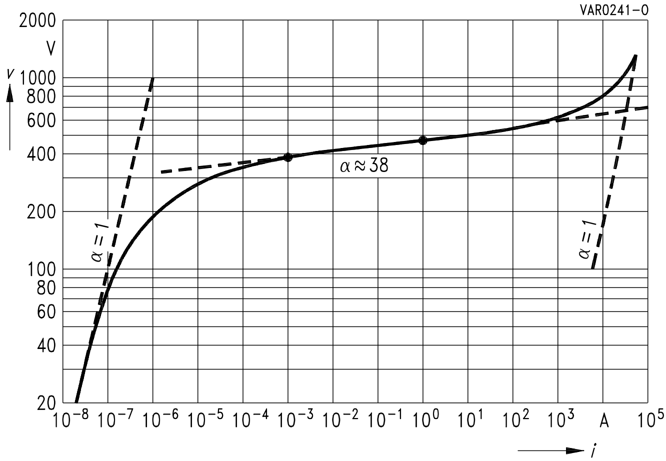


Figure 5 Real *V*/*I* characteristic of a metal oxide varistor with SIOV-B60K250 taken as example

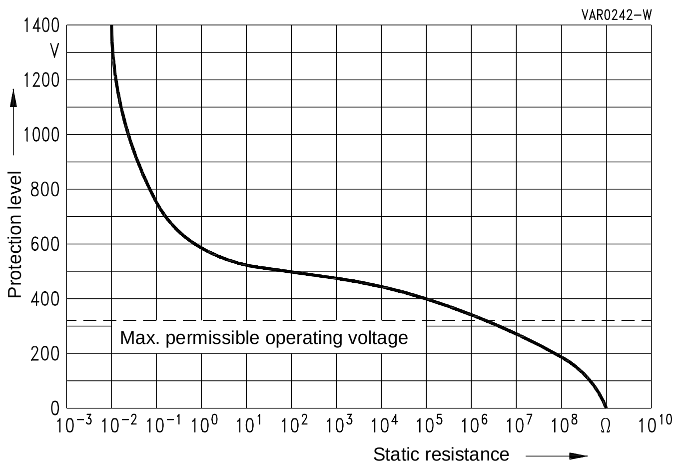


Figure 6 Static resistance of a metal oxide varistor versus protection level with SIOV-B60K250 taken as example

1.6.3 Presentation of tolerance band

The tolerance bands of the individual varistor voltage classes overlap, so their complete presentation in a family of *V*/*I* curves is hard to read. Therefore only the segments that are important for the applications are shown in the product part of the data book. Figure 7 illustrates this in the case of SIOV-S14K14.

Lefthand part of curve (< 1 mA): lower limit of tolerance band
The largest possible leakage current at given operating voltage is shown for each voltage class.

Righthand part of curve (> 1 mA): upper limit of tolerance band
The worst-case voltage drop across the varistor at given surge current is shown.

Related branches are identified by the same maximum AC operating voltage (here “14”).

V/*I* characteristic 1 shows the mean value of the tolerance band between the limits indicated by dashed lines. The mean at 1 mA represents the varistor voltage, in this case 22 V. The tolerance K $\widehat{=}$ ± 10 % refers to this value, so at this point the tolerance band ranges from 19,8 to 24,2 V.

Leakage current at operating voltage:
A maximum permissibe operating voltage of 18 VDC is specified for SIOV-S14K14. For this, depending on where the varistor is in the tolerance band (figure 7a), you can derive a leakage current between $6 \cdot 10^{-6}$ A and $2 \cdot 10^{-4}$ A (region 2). If the varistor is operated at a lower voltage, the figure for the maximum possible leakage current also drops (e. g. to max. $2 \cdot 10^{-6}$ A at 10 VDC).

In the worst case, the peak value of the maximum permissible AC operating voltage ($v = \sqrt{2} \cdot 14 = 19{,}8$ V) will result in an ohmic peak leakage current of 1 mA (point 3).

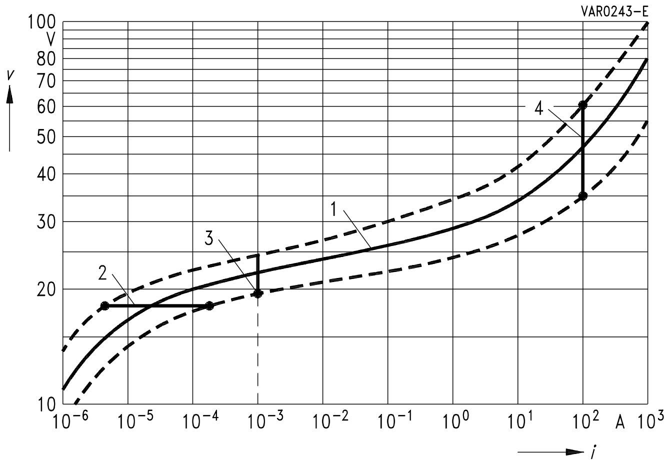
Protection level:
Assuming a surge current of 100 A, the voltage across SIOV-S14K14 will increase to between 35 V and 60 V (region 4), depending on where the varistor is in the tolerance band.

1.6.4 Overlapping *V*/*I* characteristics

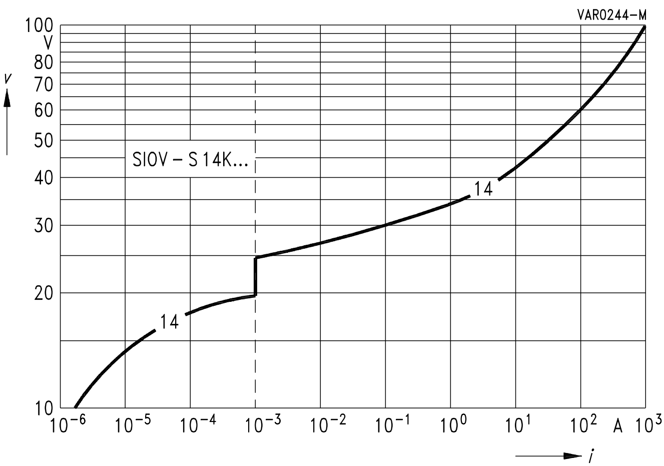
As explained earlier (section 1.3) the differences in non-linearity between voltage classes up to K40 and K50 and above lead to overlapping *V*/*I* curves.

In particular with SIOV-S and SIOV-CU, before selecting voltage rating K40, one should always check whether K50 is not a more favorable solution. Firstly, the protection level is lower for higher surge currents, and secondly, the load capability of K50 is considerably higher for varistors of the same diameter. This consideration does not apply for multilayer varistors SIOV-CN since the same ceramic material is used for all voltage ratings in these components.

7a



7b



Figures 7a and b Tolerance limits of a metal oxide varistor with SIOV-S14K14 taken as example

1.7 Terms and descriptions

1.7.1 Operating voltage

The product tables specify maximum AC and DC operating voltages. These figures should only be exceeded by transients. Automotive types, however, are rated to withstand excessive voltage (jump start) for up to 5 minutes.

The leakage current at specified operating voltage is negligible.

The maximum permissible AC operating voltage is used to classify the individual voltage ratings within the type series.

In most applications the operating voltage is a given parameter, so the varistors in the product tables are arranged according to maximum permissible operating voltage to facilitate comparison between the individual varistor sizes.

1.7.2 Surge current

Short-term current flow – especially when caused by overvoltage – is referred to as surge current.

The maximum surge current that can be handled by a metal oxide varistor depends on amplitude, pulse duration and number of pulses applied over device lifetime. The ability of a varistor to withstand a single pulse of defined shape is characterized by the maximum non-repetitive surge current specified in the product tables (single pulse, $t_r \leq 20$ µs).

If pulses of longer duration or multiple pulses are applied, the surge current must be derated as described in section 1.8.

Maximum surge current

The maximum non-repetitive surge current is defined by an 8/20 µs waveform (rise time 8 µs/decay time to half value 20 µs) according to IEC 60 as shown in figure 8a. This approximates a rectangular wave of 20 µs. The derating curves of the surge current, defined for rectangular waveforms, consequently show a knee between horizontal branch and slope at 20 µs.

1.7.3 Energy absorption

The energy absorption of a varistor is correlated with the surge current by

$$W = \int_{t_0}^{t_1} v(\ )\, i(\ )\, \mathrm{d}t \qquad \text{(equ. 6)}$$

where $v(t)$ is the voltage drop across the varistor during current flow.

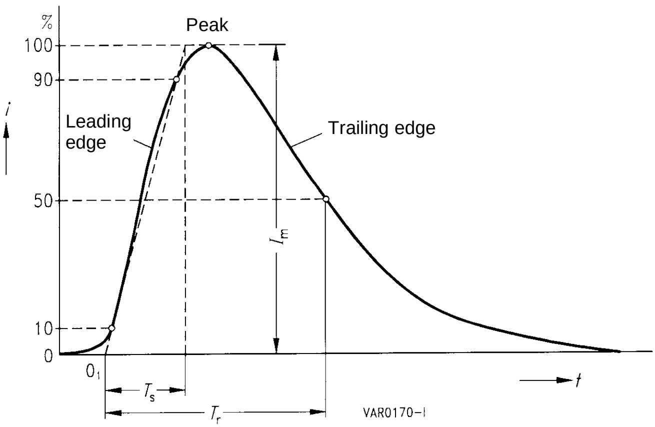
Figure 30 on page 66 illustrates the electrical performance for the absorption of 100 J in the case of SIOV-S20K14AUTO.

Maximum energy absorption

Surge currents of relatively long duration are required for testing maximum energy absorption capability. A rectangular wave of 2 ms according to IEC 60 (figure 8b) is commonly used for this test.

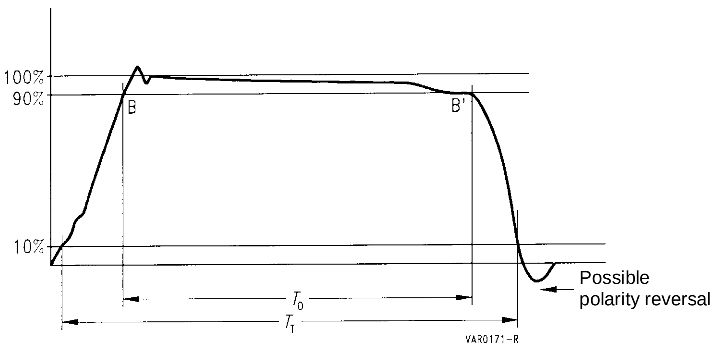
In the product tables the maximum energy absorption is consequently defined for a surge current of 2 ms.

8a



T_S	Rise time in µs
T_r	Decay time to half value in µs
0_1	Nominal start
I_m	Peak value

8b



T_D	Duration of peak value (≈ 2 ms)
T_T	Total duration

Figures 8a and b Surge current waveforms of 8/20 µs and 2 ms to IEC 60 standard

1.7.4 Average power dissipation

If metal oxide varistors are selected in terms of maximum permissible operating voltage, the resulting power dissipation will be negligible.

However, the rated maximum power dissipation must be taken into account if the varistor has not enough time to cool down between a number of pulses occurring within a specified isolated time period.

The examples in the section 3 show the calculation of the minimum time interval in periodic application of energy.

Note:
In applications where a high power dissipation is required, metal oxide varistors must have a high thermal conductivity. Since this is not the case with standard varistors, S+M has developed the PowerDisk for this kind of application.

1.7.5 Varistor voltage

The varistor voltage is the voltage drop across the varistor when a current of 1 mA is applied to the device. It has no particular electrophysical significance but is often used as a practical standard reference in specifying varistors.

1.7.6 Tolerance

Tolerance figures refer to the varistor voltage at 25 °C. As shown by figure 7, the tolerance band for other current values can be larger.

Note:
When the tolerance is examined, the current of 1 mA must only be applied briefly so that the results are not corrupted by warming of the varistor (see temperature coefficient). The current should only flow for 0,2 up to 2,0 s, typical is a duration of 1 s.

1.7.7 Protection level (clamping voltage)

The protection level is the voltage drop across the varistor for surge currents > 1 mA.

The *V*/*I* characteristics show the maximum protection level as a function of surge current (8/20 µs waveform).

In the product tables the protection level for surge currents according to the R10 series (ISO 497) is additionally specified. This is also referred to as clamping voltage.

1.7.8 Capacitance

The product tables specify typical capacitance figures for 1 kHz.

The tabulated values show that metal oxide varistors behave like capacitors with ZnO dielectric. The capacitance rises in proportion to disk area (and thus to current handling capability) and drops in proportion to the distance of the electrodes, i. e. it decreases with increasing protection level.

Capacitance values are not subject to outgoing inspection (except for SHCV and the LC, CC and HC versions of the CN series).

1.7.9 Response behavior, response time

The response time of metal oxide ceramics to voltage transients is in the picosecond region, i. e. comparable to semiconductor protective devices like suppressor diodes.

Higher figures of protection level, which seem to indicate longer response times, are mainly caused by the slightly less non-linear *V*/*I* characteristic compared to that of semiconductors and the voltage drop across the inductance of the leads (typ. 1 nH/mm).

For these reasons a precise response time cannot be stated for varistors without defined test conditions. So published data – in this data book too – are only guidelines.

The *V*/*I* characteristics in this data book have been measured at currents > 1 mA with the standard 8/20 µs waveform (figure 8a). So they allow for the inductive voltage drop across the varistor for the particular d*i*/d*t*.

If surge currents with steep edges are to be handled, one should always design for as low an inductance as possible.

1.7.10 Temperature coefficient

Metal oxide varistors show a negative *TC* of voltage that decreases with increasing current density and is defined for the varistor voltage as follows:

$$|TC| < 0{,}5 \cdot 10^{-3}/K = 0{,}05\%/K = 1\%/\Delta 20\,K \qquad \text{(equ. 7)}$$

An increase in leakage current is consequently noticeable at higher temperatures, especially in the µA region.

Figure 9 shows results for SIOV-S20K275 as an example.

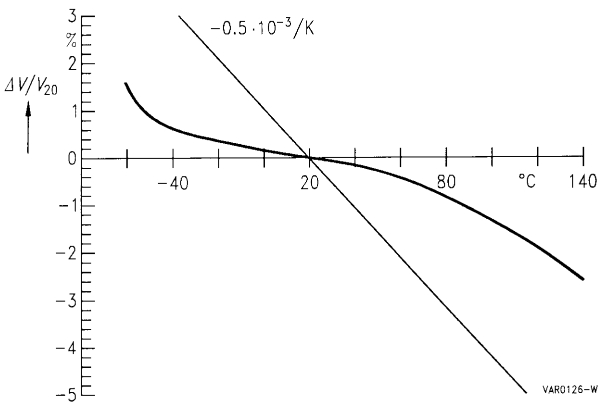


Figure 9 Temperature coefficient of voltage at 1 mA for SIOV-S20K275

1.8 Derating

Derating is the intentional reduction of maximum ratings in the application of a device. With metal oxide varistors derating is of particular interest under the following conditions:

– derating for repetitive surge current and energy absorption,
– derating at increased operating temperatures.

1.8.1 Derating for repetitive surge current

A typical feature of metal oxide varistors is the dependence of the maximum permissible ratings for surge current, and thus for energy absorption, on the number of times this load is repeated during the overall lifetime of the varistor.

The derating for a particular maximum permissible surge current can be derived from the curves for a type series in repetition figures graded 10^x.

The maximum permissible energy absorption can also be calculated from the derating curves by

$W_{max} = v_{max}\, i_{max}\, t_{r\,max}$

1.8.2 Derating at increased operating temperatures

For operating temperatures exceeding 85 °C or 125 °C the following operating conditions of varistors

– voltage
– surge current
– energy absorption
– average power dissipation

have to be derated according to figure 10a or 10b.

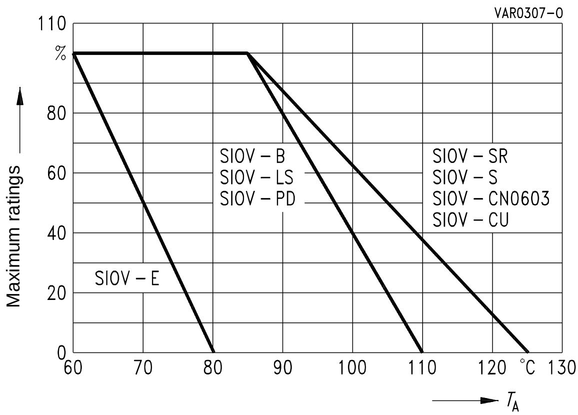
1.9 Operating and storage temperature

The maximum limits of the operating and storage temperature ranges for the individual type series can be deduced from the 100 % and 0 % values in figures 10a and 10b, respectively. For minimum ratings, please refer to the product tables.

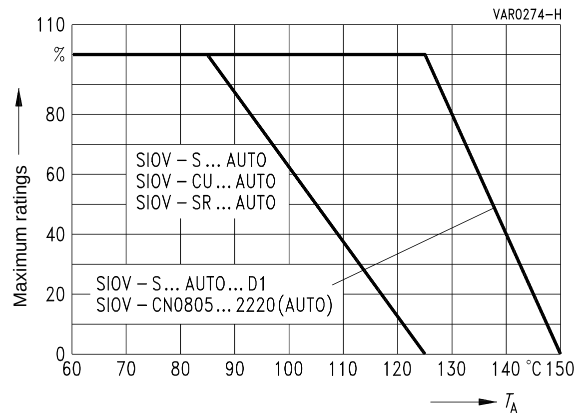
1.10 Climatic categories

As already indicated under “Derating”, limits have to be set for the climatic stress on a varistor (for reasons of reliability and in part because of the temperature dependence of electrical parameters). The limit temperatures according to IEC 68 are stated in the product tables as LCT (**L**ower **C**ategory **T**emperature) and UCT (**U**pper **C**ategory **T**emperature).

10a



10b



Figures 10a and b Temperature derating for operating voltage, surge current, energy absorption and average power dissipation

1.11 Overload response

1.11.1 Moderate overload

Surge currents or continuous overload of up to approx. one and a half times the specified figures can lead to a change in varistor voltage by more than ±10%. In most cases the varistor will not destruct, but there may be an irreversible change in its electrical properties.

1.11.2 Heavy overload

Surge currents far beyond the specified ratings will puncture the varistor element. In extreme cases the varistor will burst.

Excessive steady-state overload fuses the ZnO grains and conducting paths are formed with the bulk resistance of ZnO. The overload can overheat the varistor ceramic to the effect that it becomes unsoldered from the electrodes.

1.12 Design notes

If steep surge current edges are to be expected, you must make sure that your design is as low-inductance as possible (cf 1.7.9).

1.12.1 Physical protection, fuses

Due to the unpredictable nature of transients a varistor may be overloaded although it was carefully selected. Overload may result in package rupture and expulsion of hot material. For this reason the varistor should be physically shielded from adjacent components, e. g. by a suitable metal case.

Fuse protection of varistors against excessive surge current is usually not possible because standard fuses are unable to quench surge currents. But fuses can offer protection against damage caused by follow-on currents. Such follow-on currents flow when a damaged varistor is in low-resistance mode and still connected to power.

When varistors are operated on standard line impedances, nominal fuse currents and varistor type series should be matched as follows:

Type	S05 CU3225	S07 CU4032	S10	S14	S20
Nominal fuse current [A]	≤ 1	≤ 3	≤ 6	≤ 10	≤ 16

Type	B32	B40/LS40	B60	B80/PD80
Nominal fuse current [A]	≤ 50	≤ 80	≤ 125	≤ 160

In applications where the conditions deviate from standard power line impedances, better fuse protection of the varistor can be obtained using thermo-fuses. These thermo-fuses should be in direct thermal contact with the varistor.

1.12.2 Potting and sealing, adhesion

Potting, sealing or adhesive compounds can produce chemical reactions in the varistor ceramic that will degrade its electrical characteristics. Information about this is available on inquiry.

1.12.3 Soldering

Leaded varistors can be soldered by all conventional methods.

Wave and reflow soldering are suitable for SMD varistors. Recommended temperature profiles are shown in figures 11 and 12.

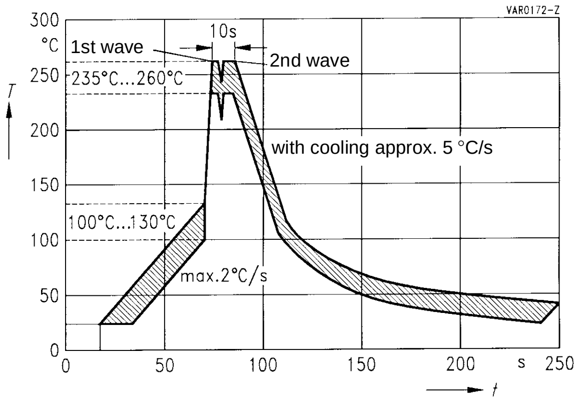


Figure 11 Recommended temperature profile for wave soldering

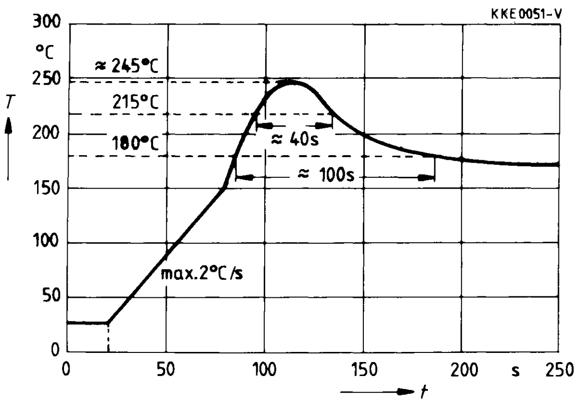


Figure 12 Recommended temperature profile for reflow soldering

1.12.4 Storage of SIOV-CN varistors with AgPd electrodes

The components should be used within six months, if possible. They are to be left in the original packing in order to avoid any soldering problems caused by oxidized terminals.
Storage temperature – 25 to 45 °C.

Max. relative humidity (without condensation): < 75 % annual average,
< 95 % on max. 30 days per annum.

1.12.5 Prior damage

The values specified only apply to varistors which have not been subjected to prior electrical, mechanical or thermal damage.

1.13 Designation system

Varistor = **Var**iable Res**istor**
SIOV = **SI**emens Matsushita Metal **O**xide **V**aristor
SIemens Matsushita Zinc **O**xide **V**aristor
SHCV = **S**iemens Matsushita **H**igh **C**apacitive **V**aristor ("Hicap varistor")

Design	**B** = Block type **CN** = Chip – without encapsulation **CU** = Chip – encapsulated **E** = Arrester block **LS…QP** = Strap type – bolt-holed, square disk – epoxy coated **PD** = PowerDisk **S** = Disk varistor – round **SR** = Disk varistor – rectangular
Area of varistor element Length × width in 1/100 inch	0603 = 6''/100 × 3''/100 = 1,6 mm × 0,8 mm . . . 4032 = 40''/100 × 32''/100 = 10,0 mm × 8,0 mm 1 = 1812 2 = 2220
Rated diameter of varistor disk in mm	05 to 80
Tolerance of varistor voltage (1 mA)	K = ± 10% L = ± 15% M = ± 20% S = Special tolerance
Max. permissible ac operating voltage	4 to 1100 = $V_{RMS\ max.}$
Rated voltage	VR302 = 30 · 10^2 V = 3 kV
Capacitance tolerance (only SHCVs)	M = ± 20%
Capacitance (only SHCVs)	474 = 47 · 10^4 pF = 0,47 µF
Code letter for capacitor ceramic material	X = X7R Z = Z5U

Taping	G = Tape (SMDs are only supplied on tape) G.S. = Tape, crimp style S, S2, S3, S4, S5 (see page 153)
Special codes	AUTO = High energy absorption, high resistance to thermal shock E2 = High-energy varistors AUTO…D1 = High-temperature disk varistors R5 = 5,0 Lead spacing differs from standard R7 = 7,5 Lead spacing differs from standard

Fabrication code: all varistors (except CN) are marked with year/week code.
Example: 9609 = 9th week of 1996

2 Selection procedure

2.1 Overvoltage types and sources

Overvoltages are distinguished according to where they originate.

2.1.1 Internal overvoltages

Internal overvoltages are those overvoltages that originate in the actual system which is to be protected, e. g. through

- inductive load switching
- arcing
- direct coupling with higher voltage potential
- mutual inductive or capacitive interference between circuits
- electrostatic charge
- ESD.

With internal overvoltages the worst-case conditions can often be calculated or traced by a test circuit. This enables the choice of overvoltage protective devices to be optimized.

2.1.2 External overvoltages

External overvoltages are those overvoltages that affect the system which is to be protected from the outside, e. g. as a result of

- line interference
- strong electromagnetic fields
- lightning
- ESD.

In most cases the waveform, amplitude and frequency of occurrence of these transients are not known or, if so, only very vaguely. And this, of course, makes it difficult to design the appropriate protective circuitry.

There have been attempts to define the overvoltage vulnerability of typical supply systems (e. g. industrial, municipal, rural) so that the best possible protective device could be chosen for the purpose. But the scale of local differences makes such an approach subject to uncertainty. So, for reliable protection against transients, a certain degree of “overdesign” must be considered.

Therefore the following figures for overvoltage in 230-V power lines can only be taken as rough guidelines:

- amplitude up to 6 kV
- pulse duration 0,1 µs to 1 ms

Where varistors are operated directly on the line (i. e. without series resistor), normally the type series S20 should be chosen. In systems with high exposure to transients (industrial, mountain locations) block varistors are to be prefered.

Requirements are stipulated in IEC1000-4. Severity levels are specified in the respective product standards (table 1 in 3.2).
Tables 2a and 2b in 3.2.4 show the selection of varistors for surge voltage loads according to IEC1000-4-5 as an example.

2.2 Principle of protection and characteristic impedance

The principle of overvoltage protection by varistors is based on the series connection of voltage-independent and voltage-dependent resistance. Use is made of the fact that every real voltage source and thus every transient has a voltage-independent source impedance greater than zero. This voltage-independent impedance Z_{source} in figure 13 can be the ohmic resistance of a cable or the inductive reactance of a coil or the complex characteristic impedance of a transmission line.

If a transient occurs, current flows across Z_{source} and the varistor that, because $v_{source} = Z_{source} \cdot i$, causes a proportional voltage drop across the voltage-independent impedance. In contrast, the voltage drop across the SIOV is almost independent of the current that flows.

Because

$$v_{SIOV} = \left(\qquad \right) v \qquad \text{(equ. 8)}$$

the voltage division ratio is shifted so that the overvoltage drops almost entirely across Z_{source}. The circuit parallel to the varistor (voltage V_{SIOV}) is protected.

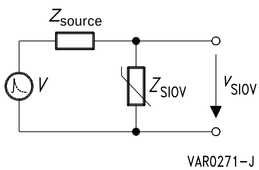
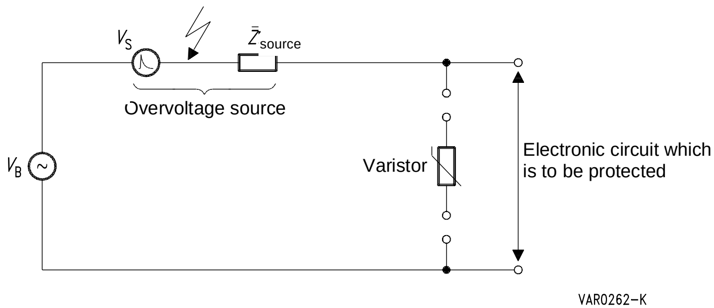


Figure 13 Equivalent circuit in which Z_{source} symbolizes the voltage-independent source impedance

Figure 14 shows the principle of overvoltage protection by varistors:

The intersection of the "load line" of the overvoltage with the *V*/*I* characteristic curve of the varistor is the "operating point" of the overvoltage protection, i. e. surge current amplitude and protection level.



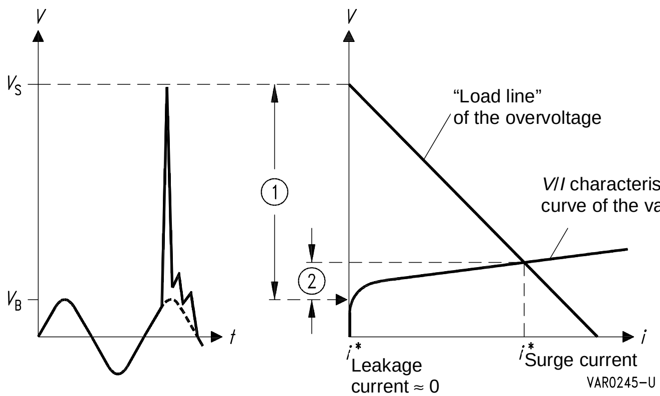


Figure 14 Principle of overvoltage protection by varistors

The overvoltage (1) is clamped to (2) by a varistor.

V_B operating voltage
V_S superimposed surge voltage

For selection of the most suitable protective element, one has to know the surge current waveform that goes with the transient. This is often, and mistakenly, calculated by way of the (very small) source impedance of the line at line frequency. This leads to current amplitudes of unrealistic proportions. Here one has to remember that typical surge current waves contain a large portion of frequencies in the kHz and MHz range, at which the relatively high characteristic impedance of cables, leads etc. determines the voltage/current ratio.

Figure 15 shows approximate figures for the characteristic impedance of a supply line when there are high-frequency overvoltages. For calculation purposes the characteristic impedance is normally taken as being 50 Ω. Artificial networks and surge generators are designed accordingly.

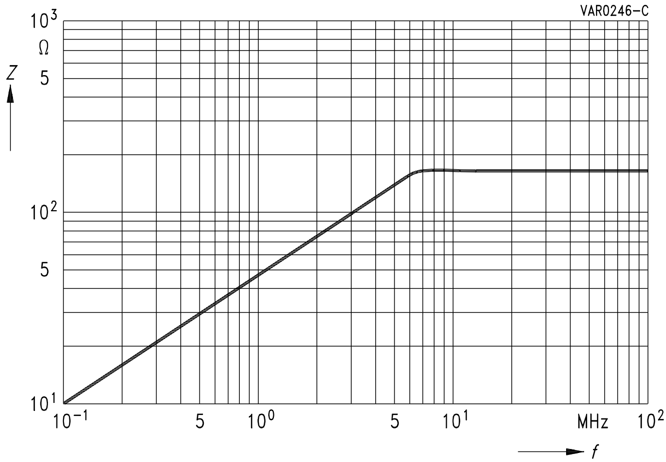


Figure 15 Impedance of a supply line for high-frequency overvoltages

2.3 Areas of application for varistors

A wide selection of components is available to cover very different requirements for protective level and load capability. Straightforward conditions of use and an attractive price/performance ratio have made SIOVs from S+M successful in just about every area of electrical engineering and electronics. The table below summarizes them:

Telecommunications
Private branch exchanges
Telephone subscriber sets
Telephone pushbutton modules
Teleprinters
Answering sets
Power supply units
Transmitting systems
Fax machines
Modem
Cellular (mobile) phones
Cordless phones

Industrial controls
Telemetering systems
Remote control systems
Machine controls
Elevator controls
Alarm systems
Proximity switches
Lighting controls
Power supply units
Ground fault interrupters
Gas heating electronics
Electronic ballasts

Power electronics
Bridge rectifiers
Brake rectifiers
Electric welding
Electric vehicles
Switch-mode power supplies
High-power current converters
DC/AC converters
Power semiconductors

Power engineering
Transformers
Inductors
Motor and generator windings
Transmission line lightning arresters

Automotive electronics
Central protection of automotive electrical systems
Load-dump protection
Anti-skid brake systems
Trip recorders
Radios
Motor controls
Generator rectifiers
Central locking systems
Trip computers
Wiper motors
Power window systems
Airbag electronics
Carphones
Seat memories

Traffic lighting
Traffic signals
Runway lighting
Beacon lights

Medical engineering
Diagnostic equipment
Therapeutic equipment
Power supply units

Data systems
Data lines
Power supply units
Personal computers
Interfaces

Stepped protection
Microelectronics
EMI/RFI suppression
EMP/NEMP protection

Entertainment electronics
Video sets
Television sets
Slide projectors
Power supply units
HIFI equipment

Household electronics
Washer controls
Dimmers
Lamps
Quartz clocks
Electric motor tools
Thermostats

If semiconductor devices like diodes, thyristors and triacs are paralleled with SIOVs for protection, they may do with lower reverse-voltage strength. This leads to a marked cost reduction and can be the factor that really makes a circuit competitive.

2.4 Series and parallel connection

2.4.1 Series connection

SIOV varistors can be connected in series for more precise matching to uncommon voltage ratings or for voltage ratings higher than those available. For this purpose the types selected should be of the same series (i. e. same diameter). The maximum permissible operating voltage in series configuration is produced by adding the maximum DC or AC voltages of the varistors.

2.4.2 Parallel connection

Metal oxide varistors can be connected in parallel in order to achieve higher current load capabilities or higher energy absorption than can be obtained with single components. To this end, the intended operating point in the surge current region (see section 1.5) must be taken into account.

2.4.2.1 Medium operating region

If an operating point is chosen from the derating fields that is in the highly non-linear medium region of the *V*/*I* characteristic (e.g. current of up to 1 kA in figure 46), a current distribution may result that leads to negation of the intended purpose.

Example surge current i^* = 1 A in figure 16:

In the worst case, 2 varistors may have been chosen for parallel connection with the first having a *V*/*I* characteristic curve corresponding to the upper limits and the second having a *V*/*I* characteristic curve corresponding to the lower limits of the tolerance band. From the region boundary a) one can see that then a current of 1 mA flows through the first varistor and a current of 1 A flows through the second varistor. The energy absorptions of the two varistors are in the same ratio. This means that if unselected varistors are used in this current region, current distributions of up to 1000:1 may render the parallel connection useless. In order to achieve the desired results, it is necessary to match voltage and current to the intended operating point.

2.4.2.2 High-current region

In this region, the current values are closer together due to the bulk resistance of the varistors. Region b) in figure 16 shows that in the worst case, the current ratio is approx. 15 kA:40 kA, which is a considerably better result than in the medium operating region. Accordingly, parallel connection can increase the maximum permissible surge current for 2 block varistors, e. g. from 40 kA to 55 kA for B40K275 varistors.

The graphical method in accordance with figure 16 can only provide guideline values, since the deviation of the individual varistors from the standard non-linear values is not taken into consideration. In practice, the individual varistors must be measured for the current region for which parallel operation is envisaged. If this region is within the two upper decades of the maximum surge current, then the varistors should be measured at 1 % of the maximum current in order to prevent the measurement itself reducing the service life of the varistor. Example: using B40K275, maximum permissible surge current 40 kA. The measurement should take place using 400 A with surge current pulse 8/20 µs.

The effort required for measurements of this kind will make the parallel connections an exception. The possibility of using a single varistor with a higher load capacity should always be preferred, in this example this would be a type from the B60, B80 or PD80 series.

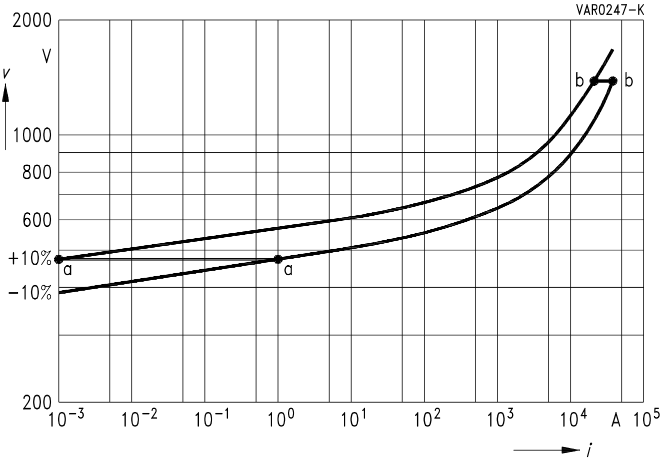


Figure 16 Tolerance band of the SIOV-B40K275

2.5 Selection guide

The choice of a varistor involves three main steps:

- Select varistors that are suitable for the operating voltage.
- Determine the varistor that is most suitable for the intended application in terms of
  a) surge current
  b) energy absorption
  c) average power dissipation
  (for a and b also estimating the number of repetitions).
- Determine the maximum possible voltage rise on the selected varistor in case of overvoltage and compare this to the electric strength of the component or circuit that is to be protected.

To ensure proper identification of circuit and varistor data, the following distinction is made:

– Maximum possible loading of varistor resulting from the electrical specifications of the intended location.
  Identification: *
– Maximum permissible loading of varistor limited by its surge current and absorption capability.
  Identification: max

So the following must always apply:

$i^* \leq i_{max}$ (equu. 9)
$W^* \leq W_{max}$ (equ. 10)
$P^* \leq P_{max}$ (equ. 11)

2.5.1 Operating voltage

Maximum permissible AC and DC operating voltages are stated in the product tables for all varistors. To obtain as low a protection level as possible, varistors must be selected whose maximum permissible operating voltage is the same as or as little as possible above the operating voltage of the application.

Non-sinusoidal AC voltages are compared with the maximum permissible DC operating voltages so that the peak or amplitude of the applied voltage does not exceed the maximum permissible DC voltage.

When selecting, you must allow for the plus tolerance of the operating voltage (European supply systems according to IEC 38: 230 V + 6 % = 244 V, at the latest, from the year 2003 on: 230 V + 10 % = 253 V) because power dissipation in a varistor rises sharply with too high an operating voltage.

Note:
Of course, you may also select any varistor with a higher permissible operating voltage. This procedure is used, for example, when it is more important to have an extremely small leakage current than the lowest possible protection level. In addition, the service life of the varistor is increased. Also the type for the highest operating voltage may be selected in order to reduce the number of types being used for different voltages.

2.5.2 Surge current

Definition of the maximum possible operating voltage in the previous step will have narrowed down the choice of an optimum SIOV to the models of a voltage class (e. g. those whose designation ends in 275 for 230 V + 10 % = 253 V). Then you check, with reference to the conditions of the application, what kind of load the SIOV can be subjected to.

Determining the load on the varistor when limiting overvoltage means that you have to know the surge current which is to be handled.

2.5.2.1 Predefined surge current

Often the surge current is predefined in specifications. After transformation into an equivalent rectangular wave (figure 19, page 46) the suitable varistor type can be selected with the aid of the derating curves.

2.5.2.2 Predefined voltage or network

If the voltage or a network is predefined, the surge current can be determined in one of the following ways:

Simulation

Using the PSpice simulation models of the SIOV varistors, the surge current, waveform and energy content can be calculated without difficulty. In these models, the maximum surge current is deduced for the lower limit of the tolerance band, i. e. setting TOL = – 10.

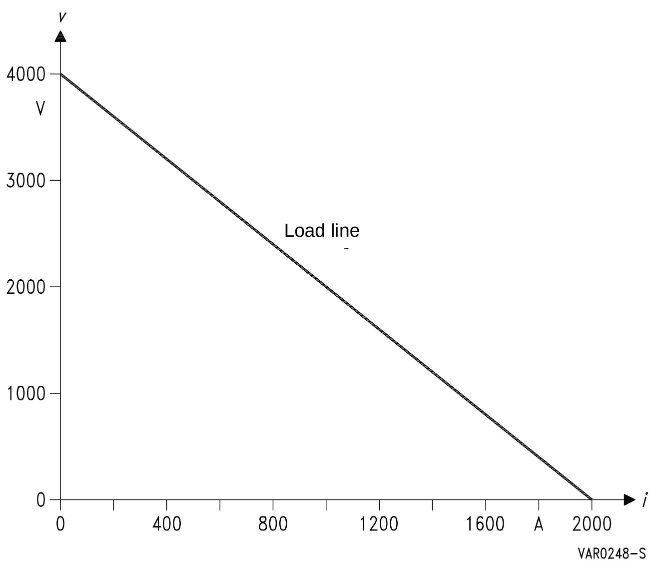
Test circuit

The amplitude and wave form of the surge current can be determined with the aid of a test circuit (example shown in figure 29, page 65). The dynamic processes for overvoltages require adapted measuring procedures.

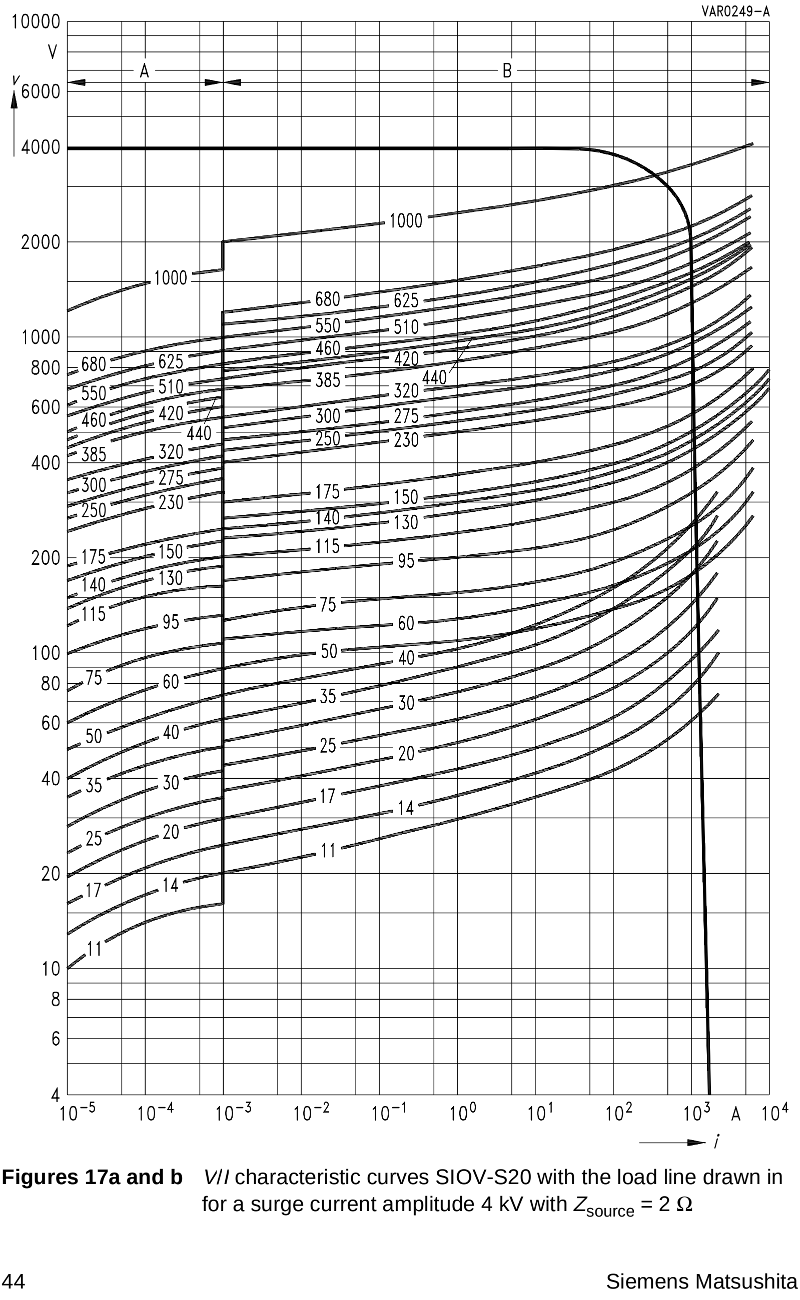
Graphic method

As shown in figure 17, the overvoltage can be drawn into the *V*/*I* characteristic curve fields as a load line (open circuit voltage, short circuit current). At the intersection of this "load line" with the varistor curve selected to suit the operating voltage, the maximum protection level and the corresponding surge current can be read off. The wave form and thus the energy content cannot be determined by this method.
Since the *V*/*I* characteristic curves are drawn in a log-log representation, the "load lines" in figure 17b are distorted to a curve.

17a



17b



Figures 17a and b *V*/*I* characteristic curves SIOV-S20 with the load line drawn in for a surge current amplitude 4 kV with Z_{source} = 2 Ω

Mathematic approximation

The surge current is determined solely from the source impedance of the surge voltage (V_S). By subtracting the voltage drop across the varistor (from the *V*/*I* curve) you can approximate the maximum surge current as follows:

$$i = \frac{V_S - V_{SIOV}}{Z_{source}} \qquad \text{(equ. 12)}$$

See 3.2.4 for an example.

Switching off inductive loads

If the transient problems are caused by switching off an inductor, the “surge current” can be estimated as follows:

The current through an inductance cannot change abruptly, so, when switching off, a current of the order of the operating current must flow across the varistor as an initial value and then decay following an e function. The path taken by the current during this time is referred to as a fly-wheel circuit (see figure 23, page 51).

The time constant $\tau = L/R$ that can be calculated from the inductance and the resistance of the fly-wheel circuit (including varistor resistance) shows how long the current requires to return to the 1/e part (approx. 37%) of its original value. According to theory, τ is also the time that the fly-wheel current must continue to flow at constant magnitude in order to transport the same charge as the decaying current.

So the amplitude of the “surge current” is known, and its duration is approximately τ (figure 18).

τ depends on the value of the inductance and the resistances of the fly-wheel circuit, generally, therefore, on the resistance of the coil and the varistor. The latter is, by definition, dependent on voltage and thus also current and so, for a given current, it has to be calculated from the voltage drop across the varistor (*V*/*I* characteristic).

$$\tau \approx \frac{L}{R_{Cu} + R_{SIOV}} \; [s] \qquad \text{(equ. 13)}$$

L	[H]	Inductance
R_{Cu}	[Ω]	Coil resistance
R_{SIOV}	[Ω]	SIOV resistance at operating current

R_{SIOV} increases as current decreases. So τ is not constant either during a decay process. This dependence can be ignored in such a calculation however.

For comparison with the derating curves of the current you can say that $\tau = t_r$ (see example 3.1).

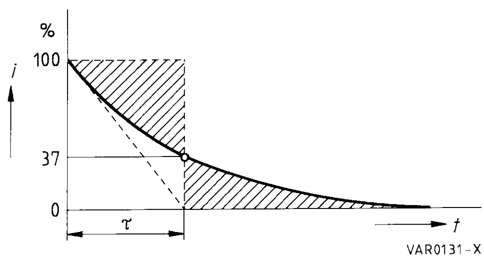


Figure 18 Time constant of fly-wheel circuit

2.5.2.3 Comparison: determined surge current / derating curve

The maximum permissible surge current of the SIOV depends on the duration of current flow and the required number of repetitions. Taking these two parameters, it can be read from the derating curves. It is compared to the maximum possible surge currents in the intended electrical environment of the varistor.

From the derating curves one can obtain maximum figures for rectangular surge current waves. For correct comparison with these maximum permissible values, the real surge current wave (any shape) has to be converted into an equivalent rectangular wave. This is best done graphically by the "rectangle method" illustrated in figure 19.

Keeping the maximum value, you can change the surge current wave into a rectangle of the same area. t^*_r is then the duration of the equivalent rectangular wave and is identical to the "pulse width" in the derating curves. (The period T^* is needed to calculate the average power dissipation resulting from periodic application of energy.)

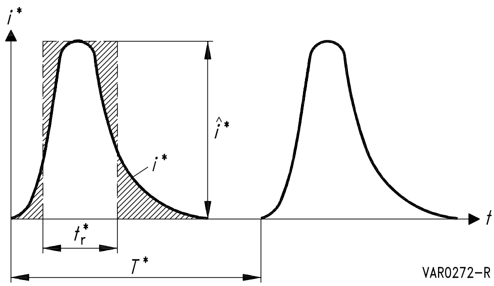


Figure 19 "Rectangle method"

If the pulse load $\int i^* dt$ is known, then t_r can be calculated using the following equation:

$$t^*_r = \frac{\int i^* d\,t}{\hat{i}^*} \qquad \text{(equ. 14)}$$

2.5.3 Energy absorption

When a surge current flows across the varistor, there will be absorption of energy. The amount of energy to be absorbed by the varistor can generally be calculated by equation 6.

Calculation method

Often, the energy absorption can be read directly from a storage oscilloscope or can be calculated from the voltage/current curve using numerical methods. An example for W^* = 100 J is shown in figure 30, page 66.

Simulation

Determination of the energy absorption by simulation (PSpice) is even more convenient.

Graphic method

Otherwise equation 6 can be solved graphically with sufficient accuracy by using the rectangle method. $i^*(t)$ is converted as in figure 19 and multiplied by the highest voltage appearing on the varistor according to equation 15:

		$\hat{v}^*$	[V]	(equ. 15)
$W^* = \hat{v}^* \hat{i}^* t^*_r$	[J]	$\hat{i}^*$	[A]	
		t^*_r	[s]	

$\hat{v}^*$ can either be derived from the *V*/*I* characteristic as the value matching $\hat{i}^*$, or likewise be determined with the aid of an oscilloscope as the maximum voltage drop across the varistor.

Switching off inductive loads

If transients are caused by interrupting the current supply of an inductor, the worst-case principle can be applied to calculate the necessary energy absorption of a varistor. The energy to be absorbed by the varistor cannot be greater than that stored in the inductor:

$W^* = {}^1/_2\, L\, i^{*2}$	[J]	L	[H]	(equ. 16)
		i^*	[A]	

This calculation will always include a safety margin because of losses in other components. See 3.1 for an example.

Discharging of capacitances

The statements made for inductances also apply for capacitances. This means that the load placed on the varistors in many of the tests according to IEC 1000-4-X can be estimated.

Comparison: determined energy input / maximum permissible energy absorption

To check the selection requirement $W^* \leq W_{max}$ (equation 10), you have to determine the maximum permissible energy absorption for the intended varistor. This can be calculated by equation 17 as a function of time the energy is applied (t_r) and the number of repetitions from the derating curves:

$$W_{max} = v_{max}\, i_{max}\, t_{r\,max} \qquad \text{(equ. 17)}$$

v_{max} is derived from the *V*/*I* characteristic of the intended varistor type for the surge current i_{max}. $t_{r\,max}$ can be taken as being the same as t^*_r, because W_{max} is to be calculated for the given time of current flow.

2.5.4 Average power dissipation

The actual power dissipation of a varistor is composed of the basic dissipation P_0 caused by the operating voltage and, possibly, the average of periodic energy absorption. If metal oxide varistors are chosen from the product tables in agreement with the maximum permissible operating voltages, P_0 will be negligible.

Periodic energy absorption produces an average power dissipation of:

$$P^* = \frac{W^*}{T^*} = \frac{v^* \, i^* \, t^*_r}{T^*} \; [\;\;]$$ (equ. 18)

W^*	[J]	i^*	[A]
T^*	[s]	t^*_r	[s]
v^*	[v]		

W^* takes the value of a single absorption of energy.
T^* is the period of figure 19.

By solving this equation for T^* it is possible to calculate the minimum time that must elapse before energy is applied again without exceeding the maximum permissible average power dissipation of the varistor:

$$T_{min} = \frac{W^*}{P_{max}} \; [\;\;]$$ (equ. 19)

W^*	[J]
P_{max}	[W]

Note:
Metal oxide varistors are not particularly suitable for “static” power dissipation, e. g. voltage stabilization. There are other kinds of components, like zener diodes, designed primarily for this kind of application.

The PowerDisk has been specially developed for periodic pulse trains with high continuous load ratings.

2.5.5 Maximum protection level

The maximum possible voltage rise in the event of a current surge is checked with the aid of the *V*/*I* curves or PSpice models. This figure can be read directly from the curve for a given surge current (for worst-case varistor tolerances). If the voltage value thus obtained is higher than acceptable, the following possibilities may assist in reducing the protection level:

- Choose a type with a larger disk diameter
  The protection level is lower for the same surge current because the current density is reduced.
- Better matching to the operating voltage by series connection
  Example: 340 V AC
  Here, according to the first step in selection, a standard SIOV with the end number “385” would normally be chosen. But if two SIOVs with the end number “175” are connected in series, the response of a 350-V varistor is obtained.
- Choose a tighter tolerance band
  A special type is introduced that only utilizes the bottom half of the standard tolerance band for example. This would mean a drop in the protection level by approx. 10 %.
- Insert a series resistor
  This reduces the amplitude of the surge current and thus the protection level of the varistor.

Note:
If the protection level obtained from the *V*/*I* curve is **lower** than required, one can change to a varistor with a higher protection level, i. e. higher end number in its type designation. This has a favorable effect on load handling capability and operating life. The leakage current is further reduced.
If necessary, the number of different types used can be reduced.

2.5.6 Selection by test circuit

The maximum permissible ratings of varistors refer to the amount of energy that will cause the varistor voltage to change by maximally ± 10 %.

Figures 20 and 21 show typical curves for the change in varistor voltage of metal oxide varistors when energy is repeatedly applied through a bipolar or unipolar load. You often find an increase of a few percent to begin with, and for a unipolar load there are also polarization effects. This is seen in figure 22 for the leakage current. Such phenomena have to be considered when interpreting measured results.

So, in test circuits, one starts with determining the varistor voltage for every single type as accurately as possible (at a defined temperature). It is advisable to check the change in varistor voltage from time to time, making sure that the temperature is the same. By extrapolation of the measured results to the intersection with the –10 % line a guide value for the lifetime of varistors is obtained.

Figure 46, for example, can be taken to be measured results that follow curve 1 of figure 20. The mean tends towards the horizontal, corresponding to point 1 in figure 20. Although 100 loads of 500 A (8/20 µs) are the maximum permissible number of load repetitions for S14K150 according to the derating curves, the measured results indicate that a substantially higher number of loads can be handled in individual cases. Figure 46 gives proof of the high reliability of SIOV varistors.

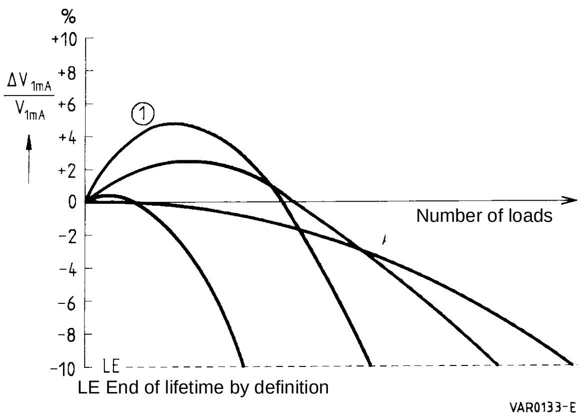


Figure 20 Typical curves for change in varistor voltage when metal oxide varistors are repeatedly loaded

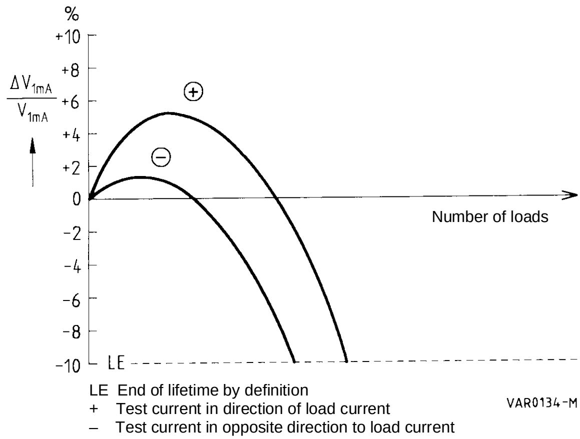


Figure 21 Typical polarization effect for unipolar loading of metal oxide varistors

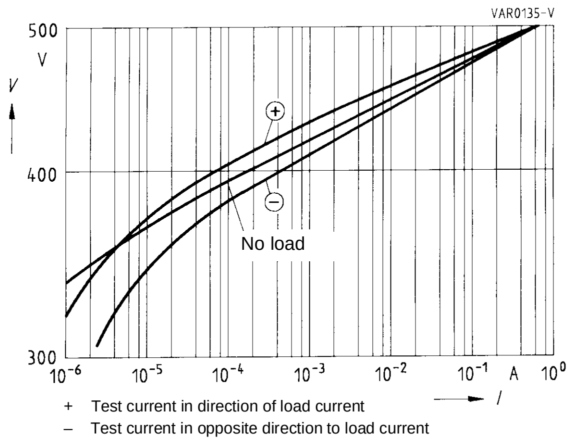


Figure 22 Typical polarization effects of leakage current for unipolar loading of metal oxide varistors

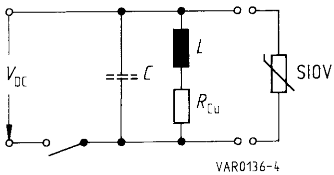
3 Application and design examples

3.1 Switching off inductive loads

The discharge of an inductor produces high voltages that endanger both the contact breaker (switching transistor and the like) and the inductor itself. According to equation 16 the energy stored in the coil is $^1/_2\, L\, i^2$. So, when the inductor is switched off, this energy charges a capacitor in parallel with the inductor (this capacitor can also be the intrinsic capacitance of the coil). Not allowing for the losses, and for $^1/_2\, C\, v^2 = {}^1/_2\, L\, i^2$, the values of figure 23 produce:

$$v^* = \sqrt{\frac{L}{C}} = \sqrt{\frac{0,1}{250 \cdot 10^{-12}}} = 20\,000 \text{ V}$$

To suppress this transient, a varistor is to be connected in parallel with the inductor as a fly-wheel circuit.



V_{DC}	= 24 V
L	= 0,1 H
R_{Cu}	= 24 Ω
I	= 1 A
C	= 250 pF

Required switching rate	= 10^6
Period	= 10 s
Required protection level	< 65 V

Figure 23 Limiting switching transients with a varistor as fly-wheel circuit

Operating voltage

The DC operating voltage is given as 24 V (cf. figure 23). If the possible increase in operating voltage is no more than 2 V, types with a maximum permissible DC operating voltage of 26 V should be chosen from the product tables to arrive at as low a protection level as possible. The types available in this category are

– disks S..K20
– SMDs CU....K20G2, CN....K20G
– hicaps SR.K20M...

Surge current

When it is cut off, the current through an inductor cannot change abruptly, so it flows across the varistor initially with the value of the operating current (here 1 A) , then decaying towards zero following an exponential function.

The simplest ways of determining the current duration are simulation or measurement ($\tau = t^*_r$).

The time constant can also be calculated to an approximation with equation 13.
Here the varistor resistance of voltage class K20 is calculated for 1 A. As the protection levels of the various type series do not differ much, the S10K20 has been chosen arbitrarily to determine the resistance (the voltage is taken from the appropriate *V*/*I* characteristics).

$$R_{SIOV} = \frac{55\ V}{1\ A} = 55\ \Omega$$

So τ according to equation 13 is

$$\tau = t^*_r = \frac{0{,}1\ H}{24\ \Omega + 55\ \Omega} \approx 1{,}3\ ms$$

For S10K20 with t^*_r = 1,3 ms and 10^6 load repetitions, one can derive

$i_{max} = 3\ A > i^* = 1\ A$

from the derating curves.

Taking this result, one should check whether other types with lower current ratings satisfy the selection criterion:

S05K20: $i_{max} = 0{,}5\ A < i^* = 1\ A$
S07K20: $i_{max} = 1{,}4\ A > i^* = 1\ A$

So the selection criterion of equation 9 is met by SIOV-S07K20 and all types with higher current ratings.

If an SMD is to be used, this can be selected from either the SIOV-CU or SIOV-CN ranges.

SIOV-CU: CU4032K20G2 is the electrical equivalent of S07K20.
SIOV-CN: CN1206K20G, with $i_{max} = 1{,}5\ A > i^* = 1\ A$ fulfills the selection criteria.

Energy absorption

The maximum energy absorption capacity of SIOV-S07K20 for t^*_r =1,3 ms, i_{max} = 1,4 A and 10^6 repetitions according to equation 17 is

$W_{max} = v_{max} \cdot i_{max} \cdot t_{r\ max} = 60 \cdot 1{,}4 \cdot 0{,}0013 = 0{,}11$ J (with $t_{r\ max} = t^*_r$ according to 2.5.3)

According to equation 16 the varistor must in the worst case absorb an energy of

$W^* = {}^1/_2\ L\ i^{*2} = {}^1/_2 \cdot 0{,}1\ H \cdot 1\ A^2 = 0{,}05\ J < W_{max} = 0{,}11\ J$

per switching cycle. Thus SIOV-S07K20 and CU4032K20G2 also satisfy the selection requirement of equation 10.

For CN1206K20G the result is $W_{max} = 58 \cdot 1{,}5 \cdot 0{,}0013 = 0{,}11\ J > 0{,}05\ J$.
This varistor is therefore also suitable.

Average power dissipation

According to equation 18, applied energy of 0,05 J every 10 s produces an average power dissipation of

$$P^* = \frac{W^*}{T} = \frac{0{,}05}{10} = 0{,}005\ \mathrm{W}$$

The product table shows a maximum dissipation capability of 0,02 W for SIOV-S07K20 and CU4032K20G2. So on this point too, the choice is correct (equation 11).

For the sake of completeness, the minimum permissible time between two applications of energy is calculated (equation 19):

$$T_{\min} = \frac{W^*}{P_{\max}} = \frac{0{,}05\ \mathrm{J}}{0{,}02\ \mathrm{W}} = 2{,}5\ \mathrm{s}$$

For CN1206K20G, with P_{max} = 0,008 W the result is

$$T_{\min} = \frac{W^*}{P_{\max}} = \frac{0{,}05\ \mathrm{J}}{0{,}008\ \mathrm{W}} = 6{,}2\ \mathrm{s}$$

Maximum protection level

The *V*/*I* curve for S07K20 and/or CU4032K20G2 shows a protection level of 60 V at 1 A for the worst case position in the tolerance field (PSpice supplied by S+M: TOL = +10).
The protection level for CN1206K20G is 55 V.
This means that all three types meet the requirement for a protection level < 65 V.

The hicap varistors SHCV-SR.K20... also satisfy all the selection criteria. Their use can have a positive effect as far as contact erosion and RFI are concerned. They also mean a reduction of the maximum protection level to 50 V.

3.2 CE conformity

A wide range of legislation and of harmonized standards have come into force and been published in the field of EMC in the past few years. In the European Union, the EMC Directive 89/336/EEC of the Council of the European Communites has come into effect on the 1st of January 1996. As of this date, all electronic equipment must comply with the protective aims of the EMC Directive. The conformity with the respective standards must be guaranteed by the **manufacturer or importer** in the form of a declaration of conformity. A CE mark of conformity must be applied to all equipment [1].

As a matter of principle, all electrical or electronic equipment, installations and systems must meet the protection requirements of the EMC Directive and/or national EMC legislation. A declaration of conformity by the manufacturer or importer and a CE mark are required for most equipment. Exceptions to this rule and special rulings are described in detail in the EMC laws.

[1] Kohling, Anton "CE Conformity Marking"
ISBN 3-89578-037-5, Ordering code: A19100-L531-B666

New, harmonized European standards have been drawn up in relation to the EEC's EMC Directive and the national EMC laws. These specify measurement techniques and limit values or severity levels, both for interference emission and for the interference susceptibility (or rather, immunity to interference) of electronic devices, equipment and systems.

The subdivision of the European standards into various categories (cf. table 1) makes it easier to find the rules that apply to the respective equipment.
The generic standards always apply to all equipment for which there is no specific product family standard or dedicated product standard.

Adherence to the standards for electromagnetic compatibility (EMC) is especially important.
These are:

– Interference emission EN 50081
– Immunity to interference EN 50082

Whereas regulations concerning maximum interference emission have been in existence for some time, binding requirements concerning immunity to interference have only come into existence since 1996 for many types of equipment. In this respect, in addition to having an optimum price/performance ratio, SIOV varistors have proved themselves to be a reliable solution for all requirements concerning overvoltages:

- ESD (electrostatic discharge)
- Burst (fast transients)
- Surges, high-energy transients

The basic standards contain information on interference phenomena and general measuring methods.

The following standards and regulations form the framework of the conformity tests:

Table 1

EMC standards		Germany	Europe	International
Generic standards define the EMC environment in which a device is to operate according to its intended use				
Emission	residential industrial	DIN EN 50081-1 DIN EN 50081-2	EN 50081-1 EN 50081-2	—
Susceptibility	residential industrial	DIN EN 50082-1 DIN EN 50082-2	EN 50082-1 EN 50082-2	—

Table 1 (continued)

EMC standards		Germany	Europe	International

Basic standards
describe physical phenomena and measurement techniques

Basic principles		DIN VDE 0843	EN 61000	IEC 1000
Measuring equipment		DIN VDE 0876		CISPR 16-1
Measuring methods	emission susceptibility	DIN VDE 0877	 EN 61000-4-1	CISPR 16-2 IEC 1000-4-1
Harmonics		DIN VDE 0838	EN 60555-2	IEC 1000-3-2
Interference factors e. g.	 ESD EM fields Burst Surge	 DIN VDE 0843-2 DIN VDE 0843-3 DIN VDE 0843-4 DIN VDE 0843-5	 EN 61000-4-2 EN 61000-4-3 EN 61000-4-4 EN 61000-4-5	 IEC 1000-4-2 IEC 1000-4-3 IEC 1000-4-4 IEC 1000-4-5

Product standards
define limit values for emission and susceptibility

EMC standards		Germany	Europe	International
ISM equipment[2)]	emission susceptibility	DIN VDE 0875 T11 1)	EN 55011 1)	CISPR 11 1)
Household appliances	emission susceptibility	DIN VDE 0875 T14-1 DIN VDE 0875 T14-2	EN 55014-1 EN 55014-2	CISPR 14-1 CISPR 14-2
Lighting	emission susceptibility	DIN VDE 0875 T15-1 DIN VDE 0875 T15-2	EN 55015-1 EN 55015-2	CISPR 15 IEC 3439
Radio and TV equipment	emission susceptibility	DIN VDE 0872 T13 DIN VDE 0872 T20	EN 55013 EN 55020	CISPR 13 CISPR 20
High-voltage systems	 emission	 DIN VDE 0873	 EN 55018	 CISPR 18
IT equipment[3)]	emission susceptibility	DIN VDE 0878 DIN VDE 0878	EN 55022 EN 55022	CISPR 22 CISPR 22
Vehicles	emission susceptibility	DIN VDE 0879 DIN VDE 0839	EN 72245	CISPR 25 ISO 11451/S2

1) Is governed by the safety and quality standards of the product families
2) Industrial, scientific and medical devices and equipment
3) Information technology facilities

Table 1 (continued)

The following table shows the most important standards in the field of immunity to interference.

Standard	Test characteristics	Phenomena
Conducted interference		
EN 61000-4-4 IEC 1000-4-4	5/50 ns (single pulse) 15 kHz burst	Burst Cause: switching processes
EN 61000-4-5 IEC 1000-4-5	1,2/50 µs (open-circuit voltage) 8/20 µs (short-circuit current)	Surge (high-energy transients) Cause: lightning strikes mains lines, switching processes
EN 61000-4-6 (ENV 50141) IEC 801-6	1 V, 3 V, 10 V 150 kHz to 80 MHz	High-frequency coupling Narrow-band interference
Field-related interference		
EN 61000-4-3 (ENV 50140) IEC 801-3	3 V/m, 10 V/m 80 to 1000 MHz	High-frequency interference fields
Electrostatic discharge (ESD)		
EN 61000-4-2 IEC 1000-4-2	Up to 15 kV figure 24	Electrostatic discharge

The IEC 1000 or EN 61000 series of standards are planned as central EMC standards into which all EMC regulations (e. g. IEC 801, IEC 555) are to be integrated in the next few years.

3.2.1 ESD

The trend to ever smaller components and lower and lower signal levels increases the susceptibility of electronic circuits to interference due to electrostatic disturbances. Simply touching the device may lead to electrostatic discharge causing function disturbances with far-reaching consequences or to component breakdown. Studies have shown that the human body on an insulated ground surface (e. g. artificial fiber carpeting), can be charged up to 15 kV.
In order to safeguard the immunity to interference and thus ensure CE conformity, measures are needed to prevent damage due to **e**lectro**s**tatic **d**ischarge (ESD). This applies to both the circuit layout and to selection of suitable overvoltage protection.

EN 61000-4-2 describes the test procedures and specifies severity levels:
Figure 24 shows the discharge circuit, figure 25 the waveform of the discharge current with an extremely short rise time of 0,7 to 1,0 ns and amplitudes of up to 45 A. Secondary effects caused by this edge steepness are high electrical and magnetic fields strengths.
In the ESD test, at least 10 test pulses of the polarity to which the device under test is most sensitive are applied.

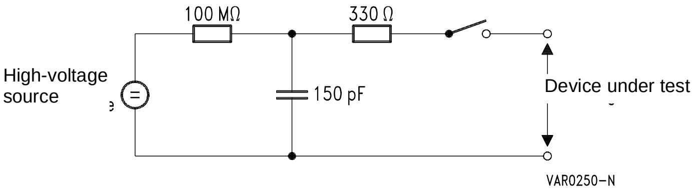


Figure 24 ESD discharge circuit according to EN 61000-4-2

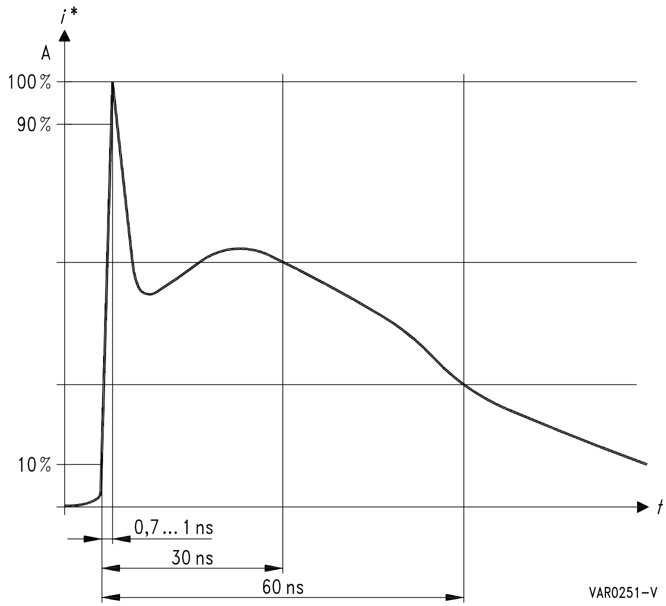


Figure 25 ESD discharge current according to EN 61000-4-2

For this reason, suitable overvoltage protection elements must meet the following requirements:

– response time < 0,5 ns
– bipolar characteristics
– sufficient surge current handling capability
– low protection level

In addition, the following requirements are desirable:

- smallest possible component size
- SMD design
- high capacitance values for RF interference suppression, or low capacitance values for systems with high-speed data transmission rates, respectively
- wide operating voltage range
- high operating temperature

All these requirements are optimally fulfilled by SIOV multilayer varistors (CN series). The extremely low inductance of their construction reduces the response time to < 0,5 ns. Consequently, in order to utilize this advantage to the full, the lowest possible connection inductance is required.

The fields of application are, in particular:

- cordless and cellular phones (“handies”)
- SCART sockets
- data transmission lines
- interfaces such as RS232, CENTRONICS
- PC (keyboard, mouse, printer ports etc.)
- LANs, modems, sensors
- interface circuits

Often, for example in SCART sockets of TV sets and video recorders, signal lines are connected with two Z diodes in serial and opposing polarity and a decoupling capacitor. Replacing these three components by a multilayer varistor leads to considerable cost and space savings (figure 26).

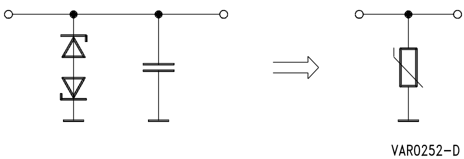


Figure 26 A multilayer varistor can replace three components

The adaptation to the capacitance values of the decoupling capacitor can be achieved by correct selection of the model and/or the voltage class:

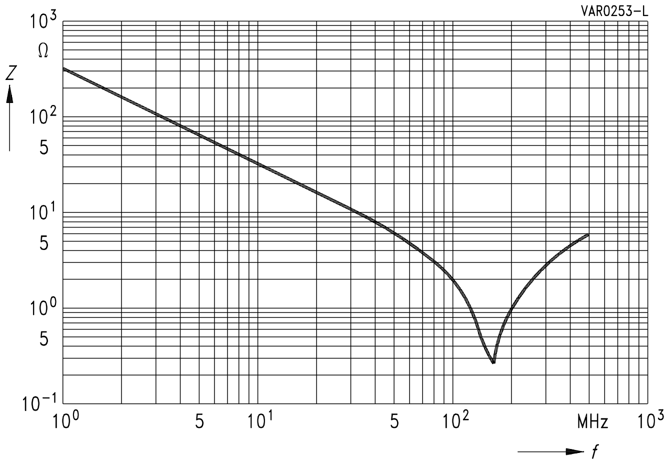
- higher capacitance values are achieved by selecting a larger model,
- lower capacitance values are achieved by selecting a smaller model,
  or, where this is not possible, a higher voltage class.

In addition, multilayer varistors with defined capacitance tolerances are available:

LC	**L**ow **C**apacitance	(C < defined value)
CC	**C**ontrolled **C**apacitance	(C within a defined tolerance band)
HC	**H**igh **C**apacitance	(C > defined value)

Figures 27a and 27 b show the typical RF behavior of multilayer varistors with a capacitance value which remains practically constant over a wide frequency range.

a



b

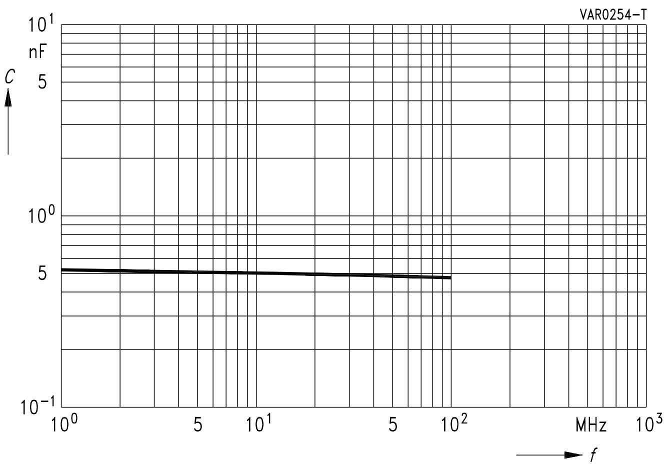


Figure 27 Typical frequency response of the impedance (a) and the capacitance (b), using the multilayer varistor SIOV-CN0805M6G as an example

3.2.2 Energy of an ESD pulse

EN 61000-4-2 specifies 15 kV as the highest charging voltage (severity level 4, air discharge) for the 150 pF discharge capacitor according to figure 7.

This means that the stored energy is

$W^* = 0{,}5 \cdot C \cdot V^2 = 0{,}5 \cdot 150 \cdot 10^{-12} \cdot 15^2 \cdot 10^6 < 0{,}02$ J

The 330-Ω resistor limits the surge current to a maximum of

$$\hat{i}^* = \frac{V^*}{R} = \frac{15\,000\,[\;]}{330\,[\;]} \approx 45 \text{ A}$$

If this surge current is to be handled by a multilayer varistor, then, according to equation 12, the effect of the varistor on this value of the current amplitude is negligible.

For CN0805M6G, for example, this means that:

$$\hat{i}^* = \frac{V_c - V_{SIOV}}{Z_{source}} = \frac{15\,000\,[\;] - 45\,[\;]}{330\,[\;]} \approx 45 \text{ A}$$

By transforming the discharge current (figure 25) into an equivalent rectangular wave, we obtain $t^*_r \approx 40$ ns.

No value can be deduced from the derating curves for such an extremely short current flow time.

The energy absorption of multilayer varistors during ESD discharges lies in the region of µJ.

For the SIOV-CN0805M6G, for example, according to equation 15 this means that:

$W^* = \hat{v}^* \hat{i}^* t^*_r = 45 \cdot 45 \cdot 40 \cdot 10^{-9} = 80$ µJ

Thus one can expect the largest part of the energy content of the ESD pulse to be absorbed by the 330-Ω discharge resistor.

If EN 61000-4-5 (surge voltage) is taken into consideration when selecting the varistor, it can be assumed that, where applicable, ESD specifications are also covered by the varistor. Due to the steep edge of the ESD pulse, the mechanical construction of a device is of great importance for the test result. The ESD varistor selection should therefore always be verified by a test circuit.

3.2.3 Burst

According to EN61000-4-4 (IEC 1000-4-4), burst pulses are low-energy transients with steep edges and high repetition rate. Thus, for equipment to pass burst testing successfully, design and construction are as critical as the choice of the varistor. If EN 61000-4-5 has been taken into account when selecting varistors, they will normally also handle the burst pulse energy without any problems. Due to the steepness of the pulse edges, the varistors must be connected in a way which keeps parasitic circuit inductance low. Our EMC laboratory in Regensburg will carry out tests on request (cf. 3.2.6).

3.2.4 Surge voltages

The immunity to interference against (high-energy) surge voltages is tested in accordance with EN 61000-4-5 (IEC 1000-4-5). The overvoltage is generated using a hybrid generator such as specified in EN 61000-4-5 and is then coupled in via the individual leads of the device under test.

The severity level of the test (i.e. the charging voltage and thus the energy content) is defined in relation to the installation conditions. In most cases, the respective product standards demand 5 positive and 5 negative voltage pulses.

Varistors suitable for 230 V and 400 V mains are given in tables 2a and 2b, in each case as a function of the required severity levels and the source impedance. An impedance of 2 Ω is used in the line-to-line test.

12 Ω is specified for the line-earth test:

The tables show that smaller components may be used.

Note:
Connection of varistors to earth may be subject to restrictions. This must be clarified with the respective authorization offices.

For all lines which do not serve to supply electricity, EN 61000-4-5 specifies 42 Ω as the generator impedance.

The extremely high suitability of SIOV varistors for ensuring immunity to interference can be seen in table 2a:

Even for test severity level 4 (4 kV via 2 Ω), the very cost-efficient model S20 (type S20K275) is adequate. Here the “overvoltage” of 4 kV is reduced to a maximum of 900 V.

Table 2a

		230 V rms					
		Connection via 2 Ω			Connection via 12 Ω		
		10 load cycles			10 load cycles		
Severity level	kV	Type	i_{max} A	v_{max} V	Type	i_{max} A	v_{max} V
1	0,5	Overvoltage protection not required					
2	1	S07K275	135	820	S05K275	28	790
3	2	S10K275	590	920	S07K275	110	830
4	4	S20K275	1560	900	S07K275	270	850

Table 2b

		400 V rms					
		Connection via 2 Ω			Connection via 12 Ω		
		10 load cycles			10 load cycles		
Severity level	kV	Type	i_{max} A	v_{max} V	Type	i_{max} A	v_{max} V
1	0,5	Test makes no sense					
2	1	S05K460	3	1000	S05K460	2	990
3	2	S10K460	360	1430	S05K460	60	1450
4	4	S20K460	1300	1530	S07K460	230	1410

Selection example

How to determine suitable varistors for each case covered by tables 2a and b is demonstrated by the example of the S20K275.

Operating voltage

According to IEC 38, from the year 2003 onwards the operating voltage tolerance in Europe will be 230 V ± 10%, i.e. a maximum operating voltage of 253 V can be expected. This means that only varistors of the voltage classes “K275” (or higher) may be selected.

Surge current

The surge current caused by the hybrid generator depends to a large extent on the load, i.e. on the varistor, in this case. It is easy to determine amplitude and current duration by simulation. Here, one should take into account that the greatest current flows across the varistor whose *V/I* characteristic is at the lower limit of the tolerance band.

In this case, the resulting current amplitude for S20K275 is approx. $\hat{i}^* = 1560$ A, the current duration of the equivalent rectangular wave is < 20 µs. For 10 repetitions, the value of ($t_r \le 20$ µs) i_{max} = 2500 A can be deduced from the derating curve for S20K275.

Since $i_{max} > \hat{i}^*$ the selection criterion for the surge current is fulfilled.

If no simulation is available, then the surge current has to be determined by a test circuit or by mathematical approximation.

The approximation solution (equation 12) results in:

$$i^* = \frac{V_s - V_{SIOV}}{Z_{source}} = \frac{4000 - 750}{2} = 1625\ \text{A} < i_{max}$$

A maximum value of 940 V is obtained from the *V/I* characteristic for the S20K275 at 2000 A; the lower tolerance limit will then be approx. 940 V – 20 %.

The current duration can be estimated on the basis of the fact that the hybrid generator produces a short-circuit surge current wave of 8/20 µs. Under load with a low-resistance varistor one can expect a waveform similar to that of the 8/20 µs wave, whose transformation into an equivalent rectangular wave has a t^*_r < 20 µs. Again this leads to a reading of i_{max} = 2500 A for 10 times in the derating curve. With i^* = 1625 A < i_{max} the selection criterion of equ. 9 is fulfilled. The difference between the results of this calculation and the simulation results is negligible.

Energy absorption

The energy absorption of the S20K275 varistor can be calculated directly by simulation.

It is possible to estimate the value by means of equation 15 (lower tolerance field limit):

$W^* = \hat{v}^*\,\hat{i}^*\,t^*_r = 750 \cdot 1625 \cdot 20 \cdot 10^{-6} = 24$ J

Minimum time interval between energy loads

The minimum time interval between loads to the S20K275 can be deduced from equation 19:

$$T_{min} = \frac{W^*}{P_{max}} = \frac{24\ \mathrm{J}}{1\ \mathrm{W}} = 24\ \mathrm{s}$$

Protection level

The highest possible protection level, which the S20K275 will achieve, can be deduced from the + 10 % tolerance curve simulation. According to table 2a, the maximum voltage v_{max} is 900 V.

Similar results are obtained for a current of approx. 1600 A in the V/I characteristic curve field.

3.2.5 Interference emission

The switching off inductive loads can lead to overvoltages which may become sources of line interference as well as of inductively and/or capacitively coupled interference. This kind of interference can be suppressed using varistors connected as a fly-wheel circuit.

SHCV varistors are especially well-suited for radio-frequency interference suppression.

3.2.6 EMC systems engineering

S+M Components is your competent partner when it comes to solving EMC problems.

Our performance range covers
– systems for measuring and testing EMC
– shielded rooms for EMP measures
– anechoic chambers
– EMC consultation services and planning

For further details, please refer to the EMC Components Data Book (ordering no. B424-P2414-X-X-7600).

3.3 Protection of automotive electrical systems

3.3.1 Requirements

Electronic equipment must work reliably in its electromagnetic environment without, in turn, unduly influencing this environment. This requirement, known as electromagnetic compatibility (EMC), is especially important in automotive electrical systems, where energy of mJ levels is sufficient to disturb or destroy devices that are essential for safety. S+M Components has devised a wide range of special models matched to the particular demands encountered in automotive power supplies:

- extra high energy absorption (load dump)
- effective limiting of transients
- low leakage current
- jump-start capability (no varistor damage at double the car battery voltage)
- insensitive to reverse polarity
- wide range of operating temperature
- high resistance to cyclic temperature stress
- high capacitance for RFI suppression

S+M automotive varistors (SIOV-…AUTO) and SHCVs suit all these demands. They are specified separately in the product tables.

3.3.2 Transients

Standard ISO 7637-1 (DIN 40839, part 1), details “Conducted interference on supply lines in 12-V automotive electrical systems”. The toughest test for transient suppression is pulse 5, simulating load dump. This critical fault occurs when a battery is accidentally disconnected from the generator while the engine is running, e. g. because of a loose cable. Voltages of as much as 200 V can result, lasting for a few hundred ms with energy levels of up to 100 J. This worst case can be mastered with SIOV-AUTO varistors of the S20 series. The lower energy pulses 1 to 3 are equally covered.

3.3.3 Fine protection

Electronic components are often far apart, so EMC cannot be implemented with a central suppressor module alone. Instead one has to provide extra fine protection directly on the individual modules. Here energy absorption of a few Joules to some tens of Joules is adequate, meaning that lower rated and thus smaller components can be chosen, like the SMD series SIOV-CU/CN or SHCVs. Figure 28 illustrates a concept for suppression with varistors.

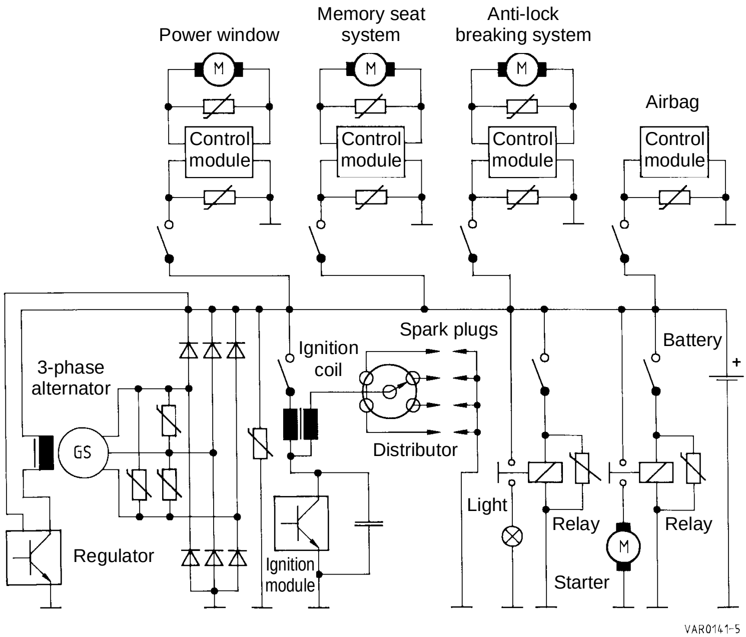


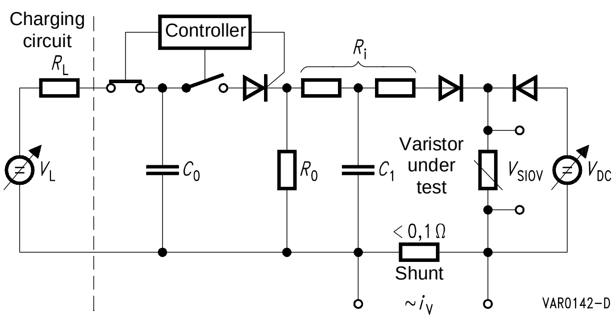
Figure 28 Automotive electrical system, complete EMC concept with varistors

3.3.4 Tests

Maintenance of EMC requirements can be checked with conventional test generators. Figures 29a and b show block diagrams for load dump tests with operating voltage applied. The electrical performance associated with a load dump of 100 J is illustrated in figures 30a to c.

Note

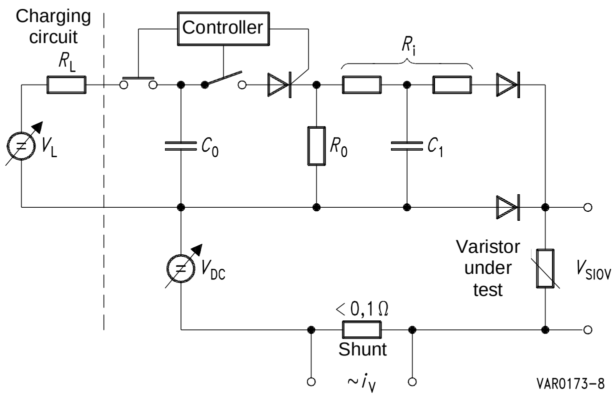
Circuit 29b produces the test pulse according to ISO 7637-1 (DIN 40 839); the 10 % time constant t_d can be set independently of the battery voltage. Note that the maximum discharge current is not limited by the source V_{DC}.



Typical values

C_0	20 … 35 mF
R_0	4 … 10 Ω
C_1	0 … 10 µF
R_i	0,5 … 4 Ω
V_L	0 … 200 V
V_{DC}	12 … 28 V
v_{SIOV}	Protection level of varistor
i_v	Current through varistor

Figure 29a Principle of load dump generator with battery connected in parallel

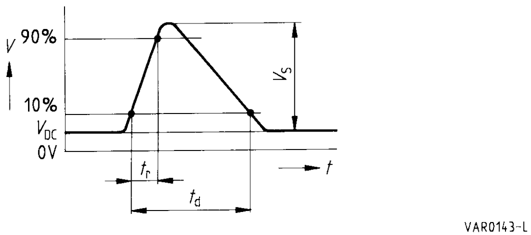


Typical values

C_0	4,7 … 47 mF
R_0	4 … 5 Ω
C_1	47 … 470 µF
R_i	0,5 … 5 Ω
V_L	0 … 200 V
V_{DC}	12 … 28 V
v_{SIOV}	Protection level of varistor
i_v	Current through varistor

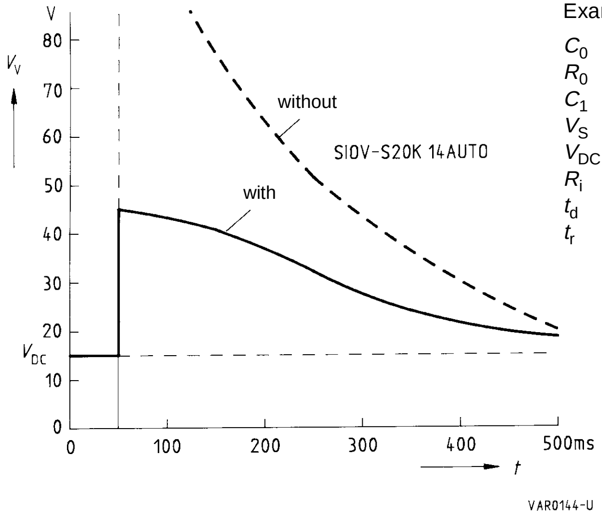
Figure 29b Principle of load dump generator with battery connected in series

30a



Test pulse 5
acc. ISO 7637-1
(DIN 40 839)

30b



Example:

C_0	37,6 mF
R_0	4,6 Ω
C_1	47 µF
V_S	146 V
V_{DC}	14 V
R_i	2 Ω
t_d	400 ms
t_r	0,1 ms

30c

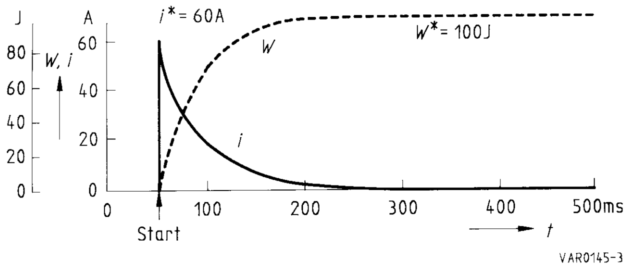


Figure 30a – c Voltage (b), current and energy absorption (c) on SIOV-S20K14AUTO with test pulse 5 (a), load dump generator as in figure 29 b

3.3.5 RFI suppression

The capacitance of varistors alone (some nF) is not enough for RFI suppression. Therefore S+M has developed the high-capacitive varistors SHCV (**S**iemens Matsushita **HiC**ap **V**aristors) that offer transient protection and RFI suppression in very compact form. These components are comprised of a multilayer varistor connected in parallel with a multilayer capacitor. SHCVs are especially suitable for handling RFI from small motors of windscreen wipers, power windows, memory seats, central locking, etc. Figure 31 shows an example of the suppression effect.

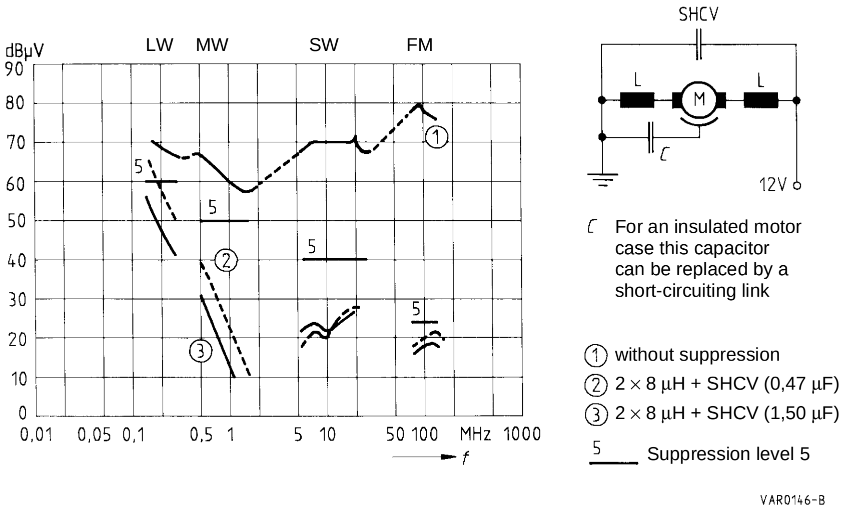


Figure 31 Example of RFI suppression in small motors with chokes and SHCVs (measured to VDE 0879, part 3)

3.4 Telecom

3.4.1 Requirements

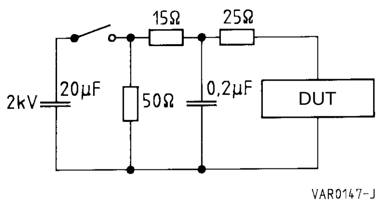
Electromagnetic interference on telecommunications, signal and control lines can be quite considerable as these lines tend to be long and exposed. So the requirements are correspondingly high when it comes to the electromagnetic compatibility of connected components or equipment.

According to the directives of the Deutsche Telekom, the interference or noise immunity of equipment is tested by application of a surge voltage with a wave form according to CCITT and IEC 1000-4-5. Figure 32 shows a simplified circuit diagram. The test is made with five pulses of either polarity, at least 60 s apart. According to equation 12, a voltage of 2 kV produces a surge current amplitude of approx. 45 A. SIOV varistors are capable of handling this surge current (and of absorbing the accompanying energy).

The choice of voltage class will depend on

– minimum required resistance in undisturbed operation
– maximum permissible protection level at 45 A.

Both figures can be derived from the *V*/*I* characteristics. (example of application 3.5.2).



e. g. telephone terminal device

DUT Device under test

Figure 32 Circuit for generating 10/700 µs test pulse to CCITT and IEC 1000-4-5

3.4.2 Telecom varistors

If requirements for minimum resistance and protection level cannot be met by standard types, it is possible to specify an application-oriented type. In such cases the tolerance bandwidth at 1 mA is of no interest, so it is not stated for telecom varistors.

The following special types have gone into wide use:

Design	Type	Ordering code	R_{min} (95 V)	v_{max} (45 A)
Disk	SIOV-S07S60AGS2	Q69X3815	250 kΩ	200 V
SMD	SIOV-CU4032S60AG2	Q69660-M600-S172	250 kΩ	200 V
SMD	SIOV-CN1812S60AG	Q69580-V600-S162	250 kΩ	200 V

Design	Type	Ordering code	R_{min} (150 V)	v_{max} (45 A)
Disk	SIOV-S07S95AGS2	Q69X4574	150 kΩ	270 V
SMD	SIOV-CU4032S95AG2	Q69660-M950-S172	150 kΩ	270 V
SMD	SIOV-CN1812S95AG2	Q69580-V950-S172	150 kΩ	270 V

Contact us if these types do not meet your requirements; we offer design to customer specifications.

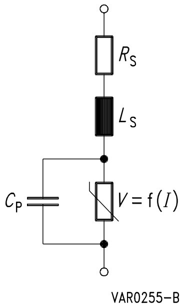
3.5 S+M's PSpice simulation model

3.5.1 Varistor model

The development of an SIOV model for the “PSpice Design Center” circuit simulation program allows varistors to be integrated into the computer-assisted development of modern electronic circuitry.

In the PSpice modelling concept, the varistor is represented by its V/I characteristic curve, a parallel capacitance and a series inductance.

The structure of this equivalent circuit is shown in figure 33.



$V = f(I)$	*V/I* characteristic
C_p	Varistor capacitance
L_s	Series inductance
$R_S = 100\ \mu\Omega$	Series resistance

Figure 33 Varistor model, basic structure

In the model, the *V/I* characteristic curve is implemented by a controlled voltage source $V = f(I)$. An additional series resistance $R_s = 100\ \mu\Omega$ has been inserted In order to prevent the unpermissible state which would occur if ideal sources were to be connected in parallel or the varistor model were to be connected directly to a source.

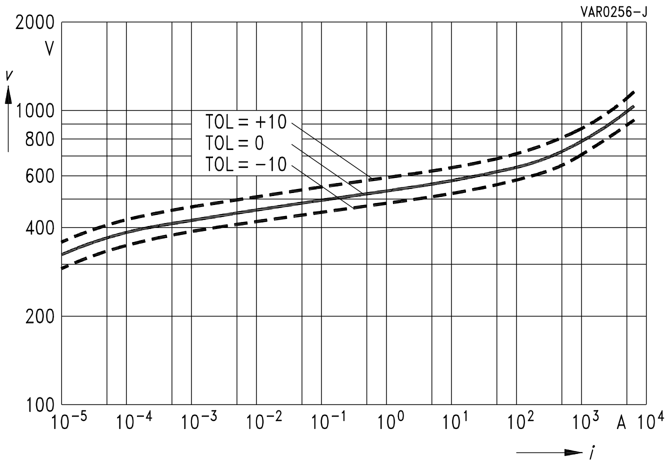
The following approximation is used for the mathematical description:

$$\log V = b1 + b2 \cdot \log(I) + b3 \cdot e^{-\log(I)} + b4 \cdot e^{\log(I)} \qquad I > 0 \qquad \text{(equ. 20)}$$

This means that the characteristic curve for any specific varistor can be described by the parameters b1 … b4. Figure 34 shows the typical V/I characteristic curve for the varistor SIOV-S20K275 and the corresponding parameters b1 … b4.

The tolerance bandwidth of the V/I characteristic curve can be shifted (cf. figure 7) in order to include cases of

- upper tolerance bandwidth limit:
  highest possible protection level for a given surge current, and
- lower tolerance bandwidth limit:
  highest possible (leakage) current for a given voltage.



b1 = 2.7233755
b2 = 0.0258453
b3 = 0.0005746
b4 = 0.0046033

Figure 34 *V/I* characteristic curve of SIOV-S20K275 with tolerance band

In the model, the capacitance values stated in the product tables are used. The dependence of the capacitance on the applied voltage and frequency is extremely low and can be neglected here.

It is not permissible to neglect the inductance of the varistor in applications with steep pulse leading edges. For this reason, it is represented by a series inductance and essentially is determined by the lead inductance. As opposed to this, the internal inductance of the metal oxide varistor may be neglected. The inductance values in the model library are chosen for typical applications, e.g. approx. 13 nH for the S20K275. If longer leads are used, insertion of additional inductances must be considered, if necessary. In the case of disk varistors, the inductance of the leads is approx. 1 nH/mm.

The PSpice simulation models (Version 6.1 for Windows 3.2) can be obtained from S+M together with a data book. Ordering code: B462-P6214-V1-X-7600.

They can also be downloaded from the INTERNET (WWW) under http://www.siemens.de/pr/index.htm.

Limits of the varistor model

For mathematical reasons, the *V/I* characteristic curves are extended in both directions beyond the current range (10 µA up to I_{max}) specified in this data book, and cannot be limited by the program procedure. The validity of the model breaks down if the specified current range is exceeded. For this reason, it is imperative that the user takes consideration of these limits when specifying the task; the upper limit depends on the type of varistor. Values of < 10 µA may lead to incorrect results, but do not endanger the component. In varistor applications, it is only necessary to know the exact values for the leakage current in the < 10 µA range in exceptional cases. As opposed to this, values exceeding the type-specific surge current I_{max}, may lead not only to incorrect results in actual practice but also to destruction of the component. Apart from this, the varistor model does not check adherence to other limit values such as maximum continuous power dissipation or surge current deratings. In addition to carrying out simulation procedures, the adherence to such limits must always be ensured, observing the relevant spec given in the data book.

In critical applications, the simulation result should be verified by a test circuit.

The model does not take into account the low temperature coefficient of the varistors (equ. 7).

3.5.2 Application example

In accordance with CCITT /IEC 1000-4-5, the test pulse 10/700 µs is frequently used to ensure the interference immunity of equipment used in telecommunications applications. Five load pulses of each polarity are required, with a minimum interval of 60 s between loads. This test pulse is defined by the circuit of the test generator and the open-circuit voltage. Figure 32 shows the circuit of the test generator, figure 35 the implementation in PSpice.

In order to achieve an open-circuit voltage of 2 kV, the charging capacitor must be charged to 2,05 kV. In order to prevent an undefined floating of R_{m2}, an additional resistor R_1 = 10 MΩ is inserted at the output end.

The voltage level “K95” is given as an example. The suitability of S10K95 for the test pulses is to be tested.

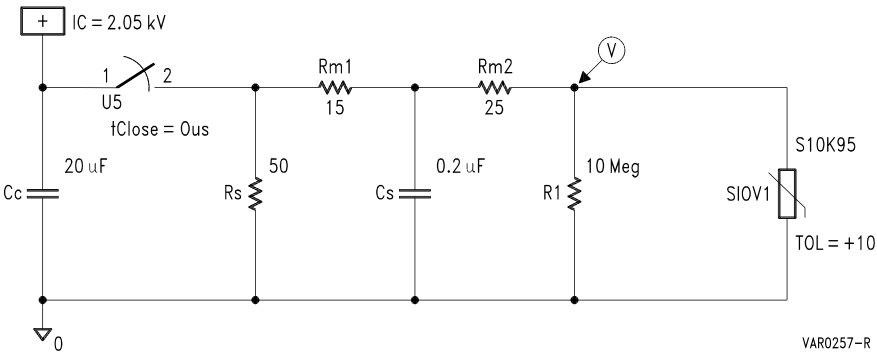


Figure 35 Simulation of the test pulse 10/700 µs applied to the device under test S10K95

For the varistor, the upper characteristic curve tolerance (TOL = +10) limit is used to simulate the worst case i.e. highest possible protection level. It is not considered necessary to model the device to be protected in this diagram, since, in relation to the varistor, this is generally of higher resistance for pulse loads.

Figure 36 shows the curve of the open-circuit voltage (varistor disconnected) and the maximum protection level (with varistor).

Surge current

Figure 37 shows the voltage and current curves, with the $\int i^* d\,t$ included in the drawing.

A maximum current of 44 A can be deduced from the curves.

Then, according to equation 14:

$$t^*_r = \frac{\int i^* d\,t}{\hat{i}^*} = \frac{17\ \text{mAs}}{44\ \text{A}} \approx 386\ \mu\text{s}$$

According to figure 38, the resulting maximum surge current for 10 loads is i_{max} = 48 A > $\hat{i}^*$ = 44 A. The selection criterion of equ. 9 is fulfilled.

Energy absorption

PSpice displays the energy absorption directly as $W^* = \int v^* i^* d\,t$ = 4,2 J.

The resulting permissible time interval between two pulses according to equ. 19 is:

$$T_{min} = \frac{W^*}{P_{max}} = \frac{4{,}2\ \text{J}}{0{,}4\ \text{W}} = 10{,}5\ \text{s}$$

This means that the requirement of a minimum time interval between pulses of 60 s or more is fulfilled.

Highest possible protection level

Figure 36 shows the highest possible protection level to be 260 V. Thus it is possible to reduce the "overvoltage" of 2 kV to 13 % of its value.

Note: The specification stated above can also be met using the specially developed telecom varistors (cf. section 3.4.2).

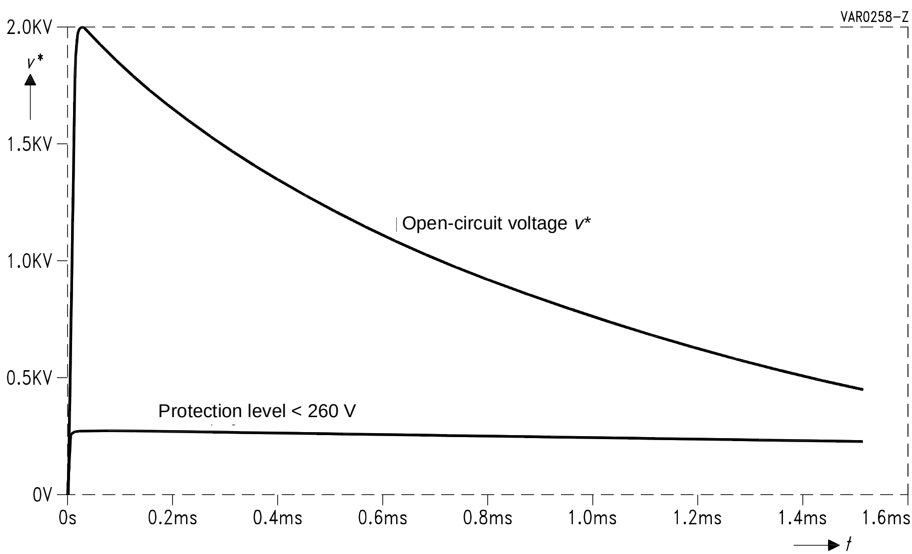


Figure 36 Open-circuit voltage (varistor disconnected) and maximum protection level (with varistor) achieved by the SIOV-S10K95 varistor

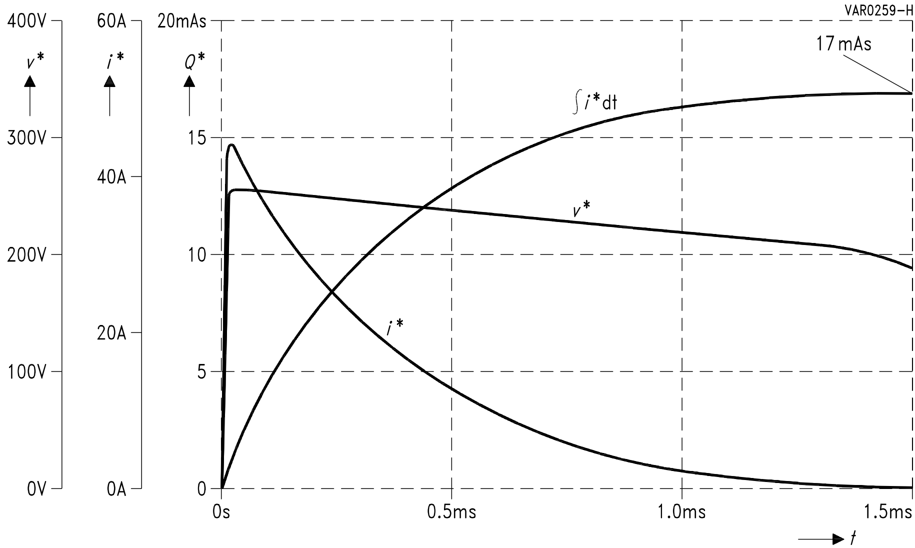


Figure 37 PSpice simulation: voltage, current and $\int i^* d\, t$ curves for the S10K95

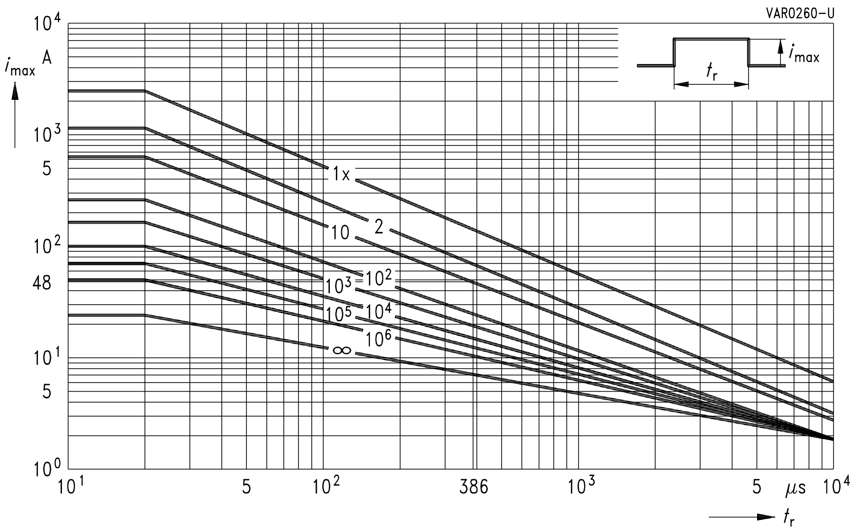


Figure 38 A maximum surge current i_{max} = 48 A (10 times) can be deduced for t^*_r = 386 µs from the derating curves for S10K50 … 320

3.6 High-performance varistors for power electronics

The introduction of the first semiconductor components more than 30 years ago ushered in an era of rapid electronics development. With the emergence of high-performance thyristors, in particular of GTO (Gate Turn Off) thyristors in the mid-eighties, power electronics technology began to establish itself in fields from which it had been excluded up to then: since then, applications in high-performance power converters and pulse-width-modulated inverters for railway vehicles are state-of-the-art.

With the wide distribution of high-performance semiconductors and the compressing of ever higher power ratings into ever smaller volumes, overvoltage protection has also attained a significant role. Admittedly, the risk of damage can be limited by appropriate dimensioning of the individual components. However, in most cases this approach fails due to the over-proportionately increased costs for semiconductor components with higher power ratings. A ratio of ≤ 2,5 has proved to be satisfactory as a safety factor between the maximum overvoltage to be expected and the highest periodic peak inverse voltage (V_{DSM} or V_{RRM}) in many applications. If there is a risk of overvoltages exceeding the level given by the selected safety factor, the use of an overvoltage protection circuit is necessary.

In the field of power electronics, the types of overvoltages can be categorized into the following groups:·

- overvoltages due to carrier storage effect (CSE)
- overvoltages caused by surge voltage waves
- switching transients

RC-elements, protective thyristors and protective diodes as well as voltage-dependent resistors have become the most commonly used protective elements.

Overvoltage protection with varistors

In the early days of power electronics, applications were frequently equipped with selenium overvoltage limiters. These components were available in various plate sizes and the size of the plate was determined by the maximum permissible peak current.

With the introduction of block varistors, components which showed considerably better performance with respect to leakage current and protection level became available.

In some application cases, block varistors in conventional housings still had the disadvantage that their continuous power dissipation capability was lower than that of selenium limiters.

PowerDisk

In order to increase the capability of handling periodic continuous loads, S+M Components has developed the PowerDisk, incorporating SIOV technology into a disk diode housing. The advantages of the construction translate into:

– excellent thermal conductivity
– easy mounting
– mechanical reliability
– high immunity to environmental influences

This means that the same mounting and cooling methods can be used for PowerDisks as for power semiconductors.

The PowerDisk PD80, when cooled on both faces, can dissipate 100 W, fifty times as much as the corresponding block varistor series B80. Upon special request, the PowerDisks can be supplied with the same operating voltages as the type series SIOV-B80. In this data book only the SIOV-PD80K1100 is specified.

Figure 39 shows the typical voltage and current as a function of time for a PowerDisk with 100 W power dissipation.

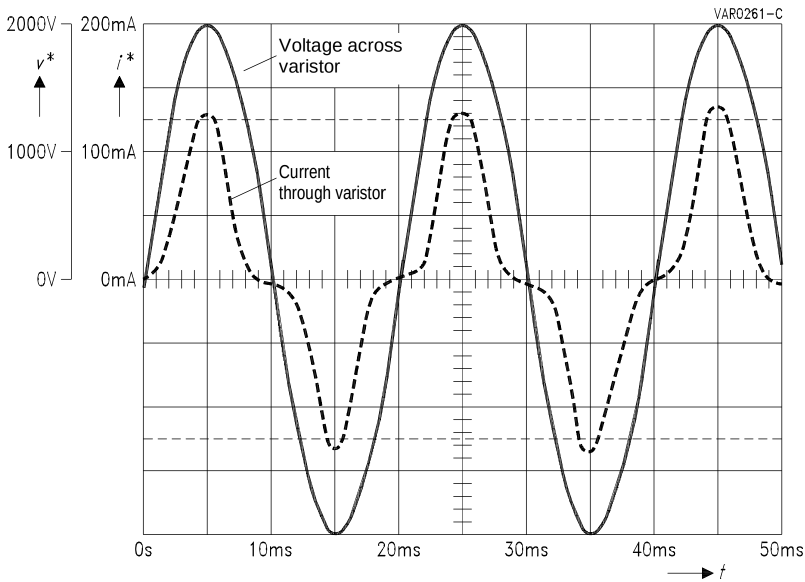


Figure 39 PowerDisk with power dissipation of approx. 100 W

3.7 Combined circuits

3.7.1 Stepped protection

If transient problems cannot be resolved with a single component like a varistor, it is always possible to combine different components and utilize their respective advantages. As an example, figure 40 illustrates the principle of stepped protection of a telemetering line with a gas-filled surge arrester [1], a varistor and a suppressor diode*):

The voltage of 10 kV is limited in three stages

- “coarse” surge arrester
- “standard” varistor
- “fine” suppressor diode, zener diode or filter [2]

to less than 50 V. The series inductors or resistors are necessary to decouple the voltage stages. For more details refer to Siemens publication [3].

Note
According to the specifications in [1] gas-filled surge arresters may not be used on low-impedance supply lines.

A PROTECTOR TESTER is available to test the function state of the above-mentioned protection components. This can be ordered using ordering code B84298-P1-A1.

3.7.2 Protective modules

Application-specific circuits for stepped protection assembled as modules, some incorporating overload protection and remote signaling, are available on the market.

Figures 41 a and b show some practical examples.

[1] Shortform catalog “Gas-Filled Surge Arresters”, ordering no. B448-P4806-X-X-7400
[2] Data book “EMC Components”, ordering no. B424-P2414-X-X-7600
[3] Pigler, Franz “EMV und Blitzschutz leittechnischer Anlagen” (only available in German), ordering no. A19100-L531-F503, ISBN 3-8009-1565-0
*) Not in the S+M range

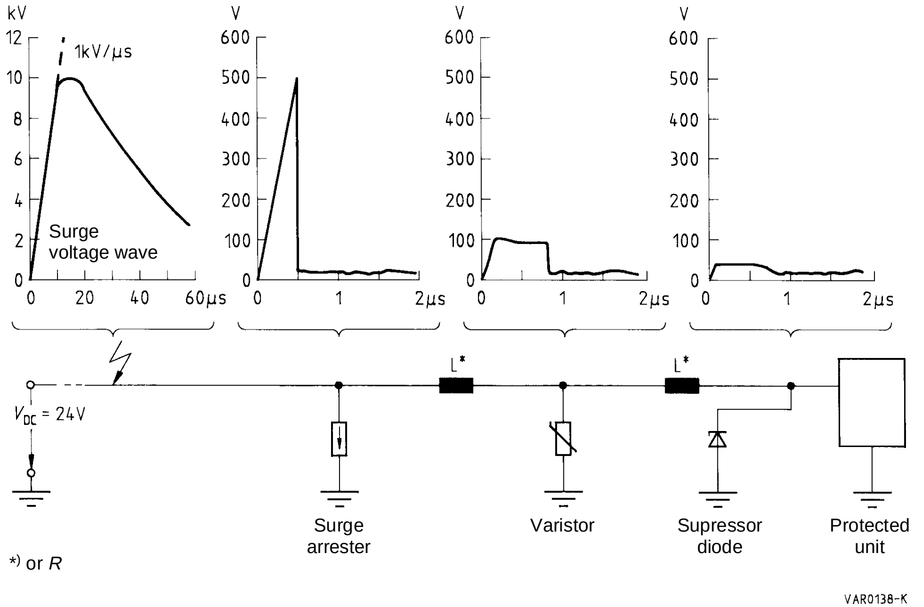
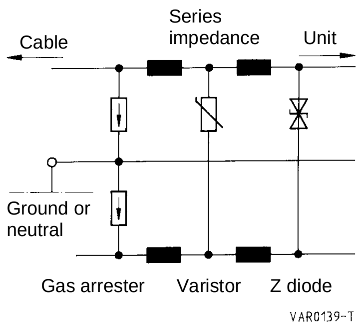
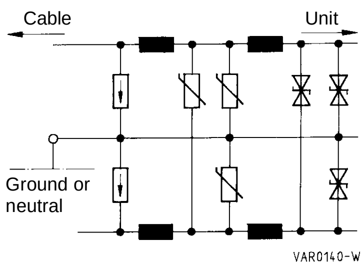


Figure 40 Principle of stepped protection with surge arrester, varistor and suppressor diode

41a



41b



Figures 41a and b Examples of transient protective modules
a) Circuit with coarse protection plus fine transverse voltage protection
b) Circuit with coarse protection plus fine longitudinal voltage and transverse voltage protection

Siemens Matsushita Components

European technology center for
ceramic components

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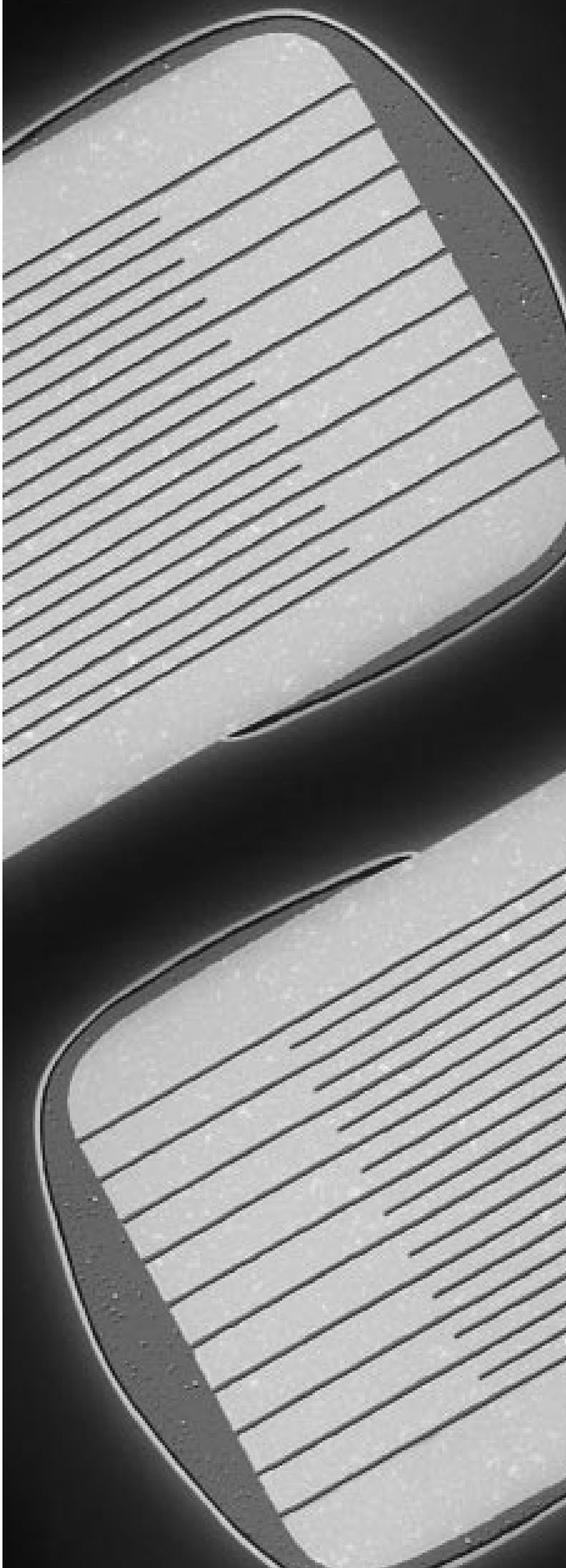


4 Quality

To satisfy the high technical demands of an open world market, S+M Components has set up extensive quality assurance systems. These allow for both general and enhanced requirements of the CECC/IECQ system of quality assessment. The organization of quality assurance complies with the international ISO 9001 standard.

4.1 Quality assurance procedure

SIOV varistors are tested and released by the quality department on the basis of the following criteria: compliance with type specifications, process capability of production equipment as well as accuracy of measuring and test methods and equipment. To ensure a constantly high quality level, the following tests are carried out:

4.1.1 Incoming inspection

The parts and materials required for production are checked for dimensional accuracy and material properties in a prescribed sequence.

4.1.2 Product assurance

All important manufacturing stages are subject to routine monitoring. Each manufacturing stage is followed by a “quality control gate”, i. e. the product is only released for the next stage after passing a corresponding test. The test results are constantly monitored and evaluated and are then used to assess the quality of the manufacturing process itself. The flow chart on page 80 assigns the major quality measures to the different production steps.

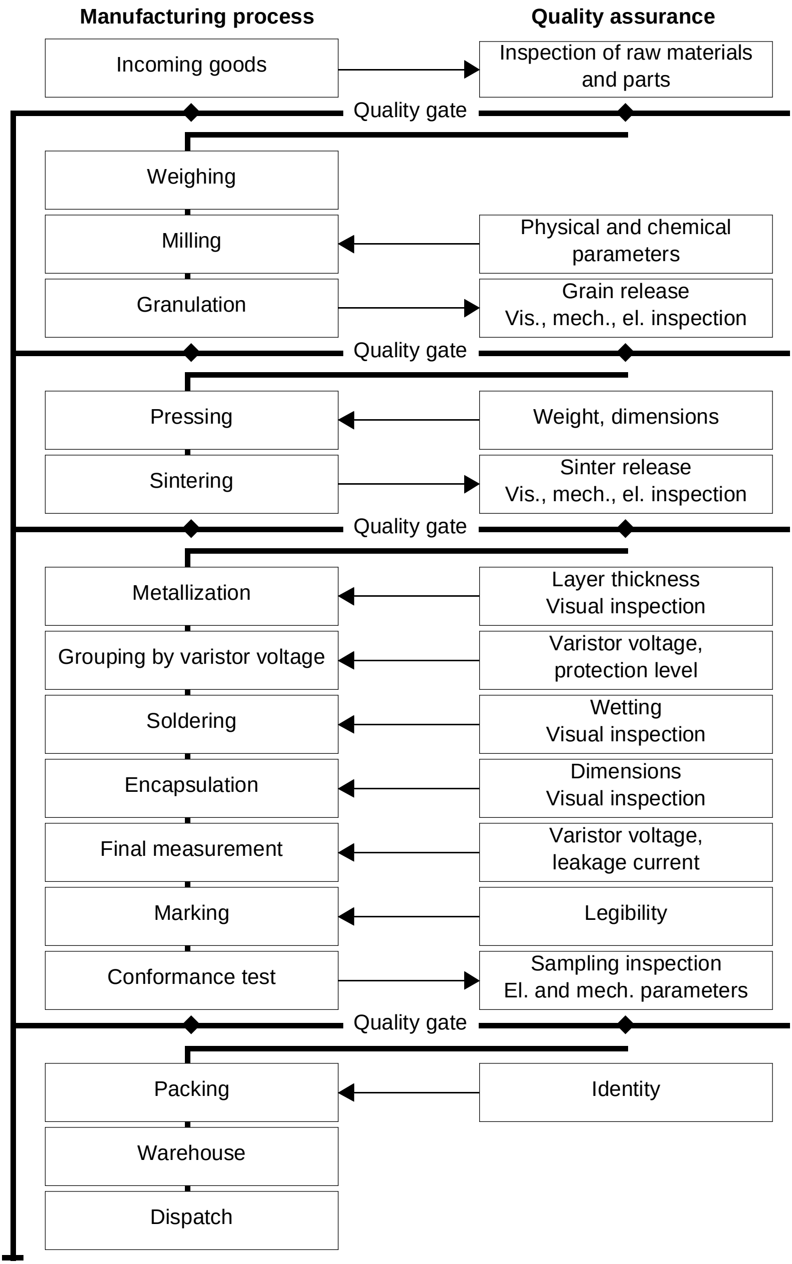
4.1.3 Final inspection

The electrical characteristics, dimensions and material quality of SIOV varistors are checked in a final inspection in accordance with the required specifications.

4.2 AOQ

For SIOV varistors an AOQ (average outgoing quality) figure of < 10 dpm (defectives per million) is given. This value refers to major defects defined as follows (DIN 55 350):

– short circuit
– open circuit
– wrong marking


Manufacturing process
Quality assurance
Incoming goods
Inspection of raw materials and parts
Quality gate
Weighing
Milling
Physical and chemical parameters
Granulation
Grain release
Vis., mech., el. inspection
Quality gate
Pressing
Weight, dimensions
Sintering
Sinter release
Vis., mech., el. inspection
Quality gate
Metallization
Layer thickness
Visual inspection
Grouping by varistor voltage
Varistor voltage, protection level
Soldering
Wetting
Visual inspection
Encapsulation
Dimensions
Visual inspection
Final measurement
Varistor voltage, leakage current
Marking
Legibility
Conformance test
Sampling inspection
El. and mech. parameters
Quality gate
Packing
Identity
Warehouse
Dispatch

4.3 Reliability

4.3.1 Lifetime

The mean life (ML) of SIOV varistors as a function of

– voltage class (i. e. ceramic material)
– ambient temperature
– applied voltage ratio (AVR)

can be derived from figure 42.

There is marked difference between “low-voltage ceramics” (≤ K40) and “high-voltage ceramics” (≥ K50).

AVR is defined as the ratio between intended operating voltage and maximum permissible operating voltage.

$$AVR = \frac{v^*}{v_{max}} \qquad \text{(equ. 21)}$$

Reaching the maximum average power dissipation is defined as the end of useful life. But the varistor is still functional.

The increase in leakage current is, to a good approximation

$$i_L = A + k\sqrt{t} \qquad \text{(equ. 22)}$$

i_L = leakage current at constant voltage
A = factor, dependent on temperature, AVR, geometry, encapsulating material
k = slope coefficient of leakage current over $\sqrt{t}$

Investigations at different temperatures and AVRs show that the logarithm of lifetime is in a linear relation to reciprocal ambient temperature.The slope of this curve is virtually constant for zinc oxide. It can be attributed to activation energy.

The theoretical background of these relations is known as the Arrhenius model. Figure 42 shows evaluation for SIOV varistors.

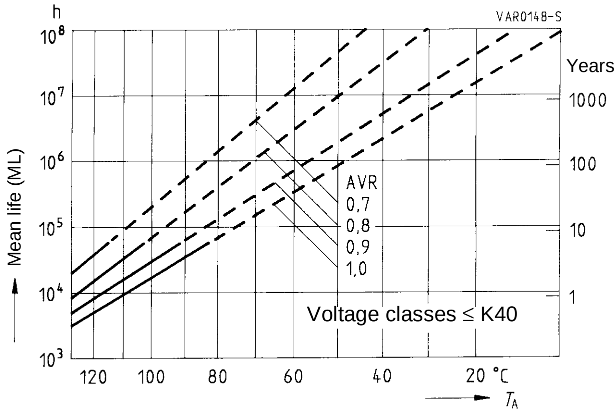
S+M lifetime tests extend over a period of several 10^4 hours. The higher lifetime figures are determined by extrapolation on the Arrhenius model.

4.3.2 Failure rate

The failure rate λ is the reciprocal of mean life in hours, the unit being fit (**f**ailures **i**n **t**ime) = 10^{-9}/h.

$$\lambda[\text{fit}] = \frac{10^9}{\text{ML[h]}} \qquad \text{(equ. 23)}$$

Accordingly, the fit rate can also be derived from the Arrhenius model.



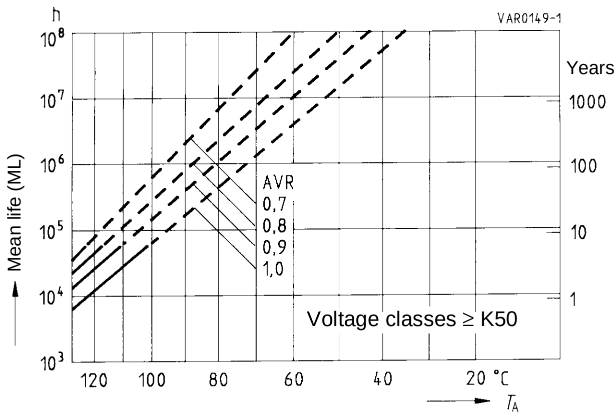


Figure 42 Mean life on Arrhenius model
Applied voltage ratio (AVR) referred to maximum permissible operating voltage

4.4 Tests

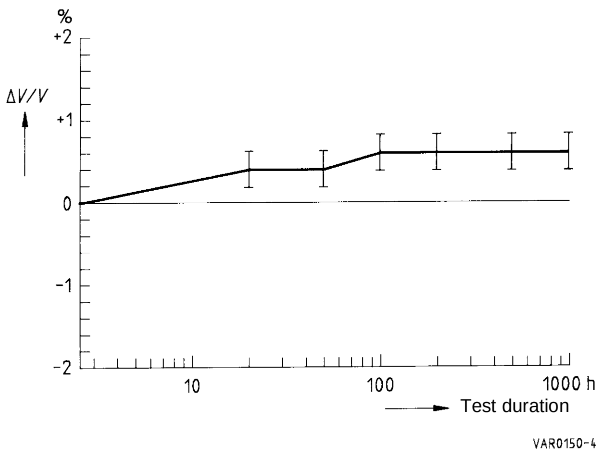
Tests of SIOV disk varistors are made according to IEC 68 and the harmonized system of quality assessment CECC 42 000.

Max. AC operating voltage	CECC 42 000, test 4.20 1000 h at UCT [1]	I Δ *V*/*V* (1 mA) I ≤ 10 %
Surge current derating, 8/20 µs	CECC 42 000, test C 2.1 100 surge currents (8/20 µs), unipolar, interval 30 s, amplitude corr. to derating curve for 20 µs	I Δ *V*/*V* (1 mA) I ≤ 10 % (measured in direction of surge current) No visible damage
Surge current derating, 2 ms	CECC 42 000, test C 2.1 100 surge currents (2 ms), unipolar, interval 120 s, amplitude corr. to derating curve for 2 ms	I Δ *V*/*V* (1 mA) I ≤ 10 % (measured in direction of surge current) No visible damage
Electric strength	CECC 42 000, test 4.7 metal-sphere method	≥ 2,5 kV
Climatic sequence	CECC 42 000, test 4.16 a) dry heat, UCT [1], 16 h b) damp heat, 1st cycle: 55 °C, 93 % RH, 24 h c) cold, LCT [1], 2 h d) damp heat, additional 5 cycles: 55 °C, 93 % RH, 24 h/cycle	I Δ *V*/*V* (1 mA) I ≤ 10 % R_{is} [2] ≥ 1 MΩ
Fast temperature cycling	IEC 68-2-14 test Na, UCT/LCT [1] dwell time 30 min, 5 cycles	I Δ *V*/*V* (1 mA) I ≤ 5 % No visible damage
Damp heat, steady state	IEC 68-2-3 56 days, 40 °C, 93 % RH	I Δ *V*/*V* (1 mA) I ≤ 10 % R_{is} [2] ≥ 1 MΩ
Solderability	IEC 68-2-20 test Ta, method 1, 235 °C, 5 s	Solderable upon delivery and after 6 months storage
Resistance to soldering heat	IEC 68-2-20 test Tb, method 1A 260 °C, 10 s	I Δ *V*/*V* (1 mA) I ≤ 5 %

1) UCT = Upper Category Temperature; LCT = Lower Category Temperature
2) R_{is}: Insulation resistance to CECC 42 000, test 4.8

Tensile strength	IEC 68-2-21, test Ua1 tensile force for wire diameter 0,5 mm 5 N 0,6 mm 10 N 0,8 mm 10 N 1,0 mm 20 N	I Δ *V*/*V* (1 mA) I ≤ 5 % No break of solder joint, no wire break
Vibration	IEC 68-2-6, test Fc frequency range 10 … 55 Hz amplitude: 0,75 mm or 98 m/s^2 duration: 6 h (3 × 2 h) pulse: sine wave	I Δ *V*/*V* (1 mA) I ≤ 5 % No visible damage
Bump	IEC 68-2-29, test Eb pulse duration: 6 ms max. acceleration: 400 m/s^2 number of bumps: 4000 pulse: half sine	I Δ *V*/*V* (1 mA) I ≤ 5 % No visible damage

Figures 43 through 46 are examples of test results showing mean values and distribution.



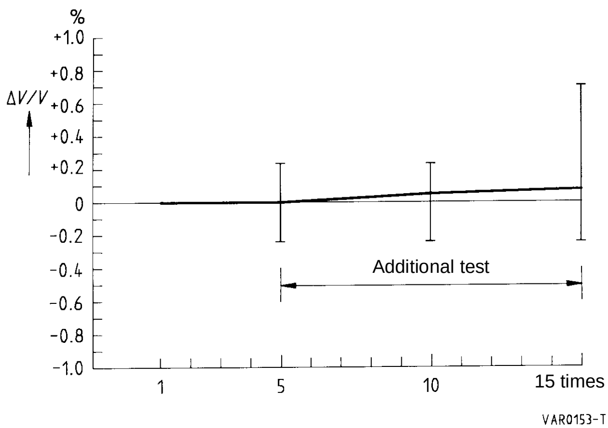
Test method:

The specimens are subjected to 85 °C for 1000 hours with the specified maximum permissible AC voltage applied and then stored at room temperature for 4 hours.

Requirement:

I Δ *V*/*V* (1 mA) I ≤ 10 %

Figure 43 Testing of maximum AC operating voltage on SIOV-S10K130, 13 specimens



Test method:

The temperature cycles below are repeated five times, followed by measurement of the voltage change and examination for mechanical damage.

Additional test:

Another ten cycles.

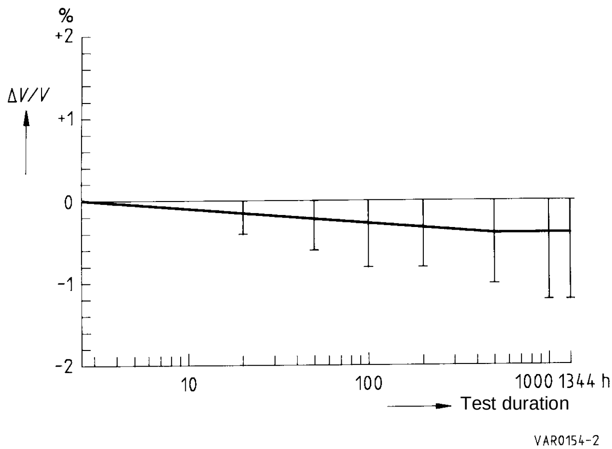
Step	Temp. °C	Time min.
1	– 40	30
2	+ 85	30

Requirement:

$|\Delta V/V\,(1\text{ mA})| \leq 5\,\%$

No visible damage

Figure 44 Temperature cycling test (5 cycles + 10 additional cycles) on SIOV-S10K275, 13 specimens



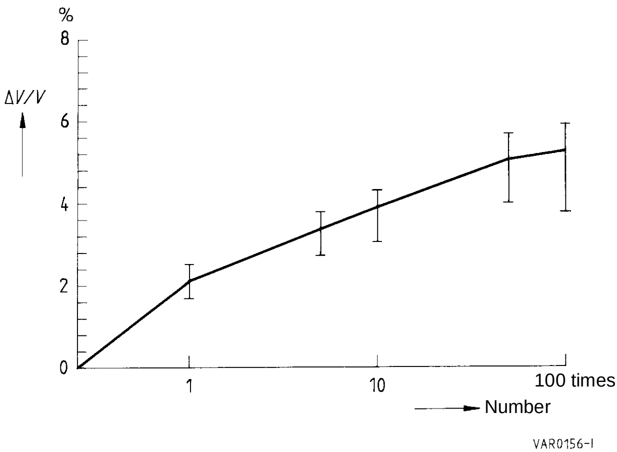
Test method:

The specimens are subjected to 40 °C and 93 % relative humidity for 56 days and then stored at room temperature for 2 hours.

Requirement:

$|\Delta V/V\,(1\text{ mA})| \leq 10\,\%$

Figure 45 Steady-state damp heat test on SIOV-S07K50, 8 specimens



Test method:

The specified surge current is applied 100 times at intervals of 30 s at 25 °C.

Surge current (8/20 µs): 500 A

Requirement:

I Δ *V*/*V* (1 mA) I ≤ 10 %

Figure 46 Surge current derating test (8/20 µs) on SIOV-S14K150, 13 specimens

4.5 Approvals

SIOV varistors have received the following certification:

Underwriters Laboratories, Inc.

UL 1449 Transient voltage surge suppressors: File E77005 (M)
- SMD types SIOV-CU
- Disk types SIOV-S
- Block types SIOV-B
- Strap types SIOV-LS

UL1414 Across-the-line components: File E77005 (N)
- Type series S05/S07/S10/S14/S20, voltage classes K130 … K300

Canadian Standards Association

Class 2221 01 Accessories and Parts for Electronic Products
Metal oxide varistors, for use as across-the-line transient protectors: File LR 63185
- SMD types SIOV-CU, voltage classes ≥ K130
- Disk types SIOV-S, voltage classes ≥ K115
- Block types SIOV-B, voltage classes ≥ K130
- Strap types SIOV-LS

Schweizerischer Elektrotechnischer Verein SEV

(Swiss Electrotechnical Association)
Protection class 1
Degree of protection IP 00
Test requirement CECC 42 200

Test report no. 90.1 02484.02 of 18 July 1991
Disk types SIOV-S
Block types SIOV-B (except B80)

Certification of manufacturer in accordance with CECC 00114, Part 1

(includes the requirements of EN ISO 9001)

ÖNORM EN ISO 9001: 1994

(Österreichische Vereinigung zur Zertifizierung von Qualitätssicherungssystemen, Austrian Association for Certification of Quality Assurance Systems, Registration no. 523/0).

Design approval according to CECC 42201-004

Disk types SIOV-S

VDE mark of conformity

Proof of approval to use symbol No. 91848, pages 1-4 (up to 3.96: No. 76815 E)

Certification in accordance with CECC 42 000, CECC 42 200, CECC 42 201-004

Disk types SIOV-S

4.6 Environmental protection, hazardous materials

4.6.1 Environmental protection

S+M Components is responsible for protection of the environment in the development, fabrication and use of its products for the intended purpose. S+M Components is very thorough in fulfilling the resulting obligations. Over and above the legal prescriptions, our guiding principle is the corporation’s responsibility towards man and environment.

Responsibility for safety in working with materials that have a potential environmental impact rests with the manager in charge. This involves, in the first place, instructing and informing the staff concerned. A specially trained environmental protection supervisor watches over adherence to regulations, reports on the introduction of processes within an environmental context and on decisions relating to investment (e. g. he ensures that all environmentally associated requirements like filters and sumps have been considered). Advising and informing staff have the highest priority; only in this way all protective measures are known and observed.

All chemicals employed in development and fabrication are examined for environmental compatibility or harmful effects before their use on the basis of DIN safety specifications. Alternatives are devised if risks emerge. The result of this procedure is that today all CFCs as well as all highly toxic materials have been eliminated entirely from the fabrication process.

Dust and vapor generated during fabrication are filtered for disposal. The emission figures of the filters are constantly examined; considerable efforts are undertaken to ensure that these figures are well below the legally prescribed limits. The same applies to the water used in the plant; this water is cleansed using a special waste-water treatment process. Water consumption has been reduced substantially in recent years through the use of cooling water circuits and water recycling.

Waste produced in the fabrication of components is sorted and collected on the spot and recycled by state-of-the-art methods.

The packaging materials used for our components can be fully recycled.

All varistors can be disposed of without any special precautions on dumps intended for industrial waste similar to household refuse.

4.6.2 Hazardous materials

SIOV varistors contain no chemical substances which exceed limit values as named in the following German regulations:·

- Chemikalien-Verbotsverordnung (ChemVerbotsV - Regulation governing forbidden chemicals)
- FCKW-Halon-Verbotsverordnung (FCKW-Halon-VerbotsV – Regulation forbidding the production and use of fluoro-chloro-hydrocarbons, halon and related compounds)

SMD Varistors, CN Standard

Construction

- Rectangular varistor element in multilayer technology, without encapsulation
- Termination: silver palladium

Features

- Electrical equivalents to leaded types SIOV-SR
- Good solderability
- Suitable for ESD protection
- Types with controlled capacitance available
- PSpice models

Taping

- Supply on 8/12/16-mm tape, for tape dimensions see pages 111/112, for reel dimensions and packing units see page 113

Type designation

Detailed description of coding system on page 33

SIOV-CN 1210 M 4 G

- SIOV-CN: S+M metal oxide varistor, Design
- 1210: Size (nominal)
- M: Tolerance of varistor voltage
- 4: Max. AC operating voltage
- G: Taping mode

General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	55/125/56 (55/85/56) – 55 °C + 85 °C (CN0603) + 125 °C (CN0805…2220) 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 55 … + 125 °C (85 °C)	in accordance with CECC 42 000
Storage temperature	– 55 … + 150 °C (125 °C)	
Response time	< 0,5 ns	
Solderability	235 °C, 2 s	in accordance with IEC 68-2-58
Resistance to soldering heat	260 °C, 10 s	in accordance with IEC 68-2-20

Maximum ratings (0603: T_A = 85 °C; 0805 … 2220: T_A = 125 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
CN0603M4G	Q69500-V0040-M060	4	5,5	30	0,1	0,003
CN0805M4G	Q69510-V0040-M062	4	5,5	100	0,1	0,005
CN1206M4G	Q69520-V0040-M062	4	5,5	150	0,3	0,008
CN1210M4G	Q69530-V0040-M062	4	5,5	250	0,4	0,010
CN1812M4G	Q69580-V0040-M062	4	5,5	500	0,8	0,015
CN2220M4G	Q69540-V0040-M062	4	5,5	1000	1,4	0,020
CN0603M6G	Q69500-V0060-M060	6	8	30	0,1	0,003
CN0805M6G	Q69510-V0060-M062	6	8	120	0,2	0,005
CN1206M6G	Q69520-V0060-M062	6	8	200	0,4	0,008
CN1210M6G	Q69530-V0060-M062	6	8	300	0,7	0,010
CN1812M6G	Q69580-V0060-M062	6	8	500	1,0	0,015
CN2220M6G	Q69540-V0060-M062	6	8	1200	3,6	0,020
CN0603K7G	Q69500-V0070-K060	7	9	30	0,1	0,003
CN0603L8G	Q69500-V0080-L060	8	11	30	0,1	0,003
CN0805L8G	Q69510-V0080-L062	8	11	120	0,2	0,005
CN1206L8G	Q69520-V0080-L062	8	11	200	0,5	0,008
CN1210L8G	Q69530-V0080-L062	8	11	400	1,0	0,010
CN1812L8G	Q69580-V0080-L062	8	11	800	1,8	0,015
CN2220L8G	Q69540-V0080-L062	8	11	1200	4,2	0,020
CN0603K11G	Q69500-V0110-K060	11	14	30	0,2	0,003
CN0805K11G	Q69510-V0110-K062	11	14	120	0,2	0,005
CN1206K11G	Q69520-V0110-K062	11	14	200	0,5	0,008
CN1210K11G	Q69530-V0110-K062	11	14	400	1,2	0,010
CN1812K11G	Q69580-V0110-K062	11	14	800	1,9	0,015
CN2220K11G	Q69540-V0110-K062	11	14	1200	5,4	0,020
CN0603K14G	Q69500-V0140-K060	14	18	30	0,2	0,003
CN0805K14G	Q69510-V0140-K062	14	18	120	0,3	0,005
CN1206K14G	Q69520-V0140-K062	14	18	200	0,5	0,008
CN1210K14G	Q69530-V0140-K062	14	18	400	1,5	0,010
CN1812K14G	Q69580-V0140-K062	14	18	800	2,3	0,015
CN2220K14G	Q69540-V0140-K062	14	18	1200	5,8	0,020

Characteristics (T_A = 25 °C)

Type SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	 i A	C_{typ} (1 kHz) pF	L_{typ} nH	Derating curve Page	V/I characteristic Page
CN0603M4G	8	± 20	19	1,0	200	1,0	175	197
CN0805M4G	8	± 20	19	1,0	700	1,5	175	198
CN1206M4G	8	± 20	17	1,0	1500	1,8	177	199
CN1210M4G	8	± 20	17	2,5	5000	1,8	178	200
CN1812M4G	8	± 20	17	5,0	10000	2,5	179	201
CN2220M4G	8	± 20	17	10,0	24000	3,0	181	202
CN0603M6G	11	± 20	27	1,0	200	1,0	175	197
CN0805M6G	11	± 20	27	1,0	600	1,5	176	198
CN1206M6G	11	± 20	25	1,0	1200	1,8	177	199
CN1210M6G	11	± 20	25	2,5	4000	1,8	178	200
CN1812M6G	11	± 20	25	5,0	8000	2,5	179	201
CN2220M6G	11	± 20	25	10,0	20000	3,0	181	202
CN0603K7G	12,5	± 10	27	1,0	200	1,0	175	197
CN0603L8G	15	± 15	33	1,0	150	1,0	175	197
CN0805L8G	15	± 15	33	1,0	500	1,5	176	198
CN1206L8G	15	± 15	30	1,0	1000	1,8	177	199
CN1210L8G	15	± 15	30	2,5	3000	1,8	179	200
CN1812L8G	15	± 15	30	5,0	6000	2,5	180	201
CN2220L8G	15	± 15	30	10,0	16000	3,0	181	202
CN0603K11G	18	± 10	35	1,0	120	1,0	175	197
CN0805K11G	18	± 10	35	1,0	400	1,5	176	198
CN1206K11G	18	± 10	33	1,0	800	1,8	177	199
CN1210K11G	18	± 10	33	2,5	2400	1,8	179	200
CN1812K11G	18	± 10	33	5,0	5000	2,5	180	201
CN2220K11G	18	± 10	33	10,0	12000	3,0	181	202
CN0603K14G	22	± 10	40	1,0	100	1,0	175	197
CN0805K14G	22	± 10	40	1,0	350	1,5	176	198
CN1206K14G	22	± 10	38	1,0	700	1,8	177	199
CN1210K14G	22	± 10	38	2,5	2000	1,8	179	200
CN1812K14G	22	± 10	38	5,0	4500	2,5	180	201
CN2220K14G	22	± 10	38	10,0	10000	3,0	181	202

Maximum ratings (0603: T_A = 85 °C; 0805 … 2220: T_A = 125 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
CN0805K17G	Q69510-V0170-K062	17	22	120	0,3	0,005
CN1206K17G	Q69520-V0170-K062	17	22	200	0,6	0,008
CN1210K17G	Q69530-V0170-K062	17	22	400	1,7	0,010
CN1812K17G	Q69580-V0170-K062	17	22	800	2,7	0,015
CN2220K17G	Q69540-V0170-K062	17	22	1200	7,2	0,020
CN0805K20G	Q69510-V0200-K062	20	26	80	0,3	0,005
CN1206K20G	Q69520-V0200-K062	20	26	200	0,7	0,008
CN1210K20G	Q69530-V0200-K062	20	26	400	1,9	0,010
CN1812K20G	Q69580-V0200-K062	20	26	800	3,0	0,015
CN2220K20G	Q69540-V0200-K062	20	26	1200	7,8	0,020
CN0805K25G	Q69510-V0250-K062	25	31	80	0,3	0,005
CN1206K25G	Q69520-V0250-K062	25	31	200	1,0	0,008
CN1210K25G	Q69530-V0250-K062	25	31	300	1,7	0,010
CN1812K25G	Q69580-V0250-K062	25	31	800	3,7	0,015
CN2220K25G	Q69540-V0250-K062	25	31	1200	9,6	0,020
CN1206K30G	Q69520-V0300-K062	30	38	200	1,1	0,008
CN1210K30G	Q69530-V0300-K062	30	38	300	2,0	0,010
CN1812K30G	Q69580-V0300-K062	30	38	800	4,2	0,015
CN2220K30G	Q69540-V0300-K062	30	38	1200	12,0	0,020
CN1206K35G	Q69520-V0350-K062	35	45	120	0,6	0,008
CN1210K35G	Q69530-V0350-K062	35	45	250	2,0	0,010
CN1812K35G	Q69580-V0350-K062	35	45	500	4,0	0,015
CN2220K35G	Q69540-V0350-K062	35	45	1000	7,7	0,020
CN1206K40G	Q69520-V0400-K062	40	56	120	0,7	0,008
CN1210K40G	Q69530-V0400-K062	40	56	250	2,3	0,010
CN1812K40G	Q69580-V0400-K062	40	56	500	4,8	0,015
CN2220K40G	Q69540-V0400-K062	40	56	1000	9,0	0,020
CN1206K50G	Q69520-V0500-K062	50	65	120	0,8	0,008
CN1210K50G	Q69530-V0500-K062	50	65	200	1,6	0,010
CN1812K50G	Q69580-V0500-K062	50	65	400	4,5	0,015
CN2220K50G	Q69540-V0500-K062	50	65	800	5,6	0,020

Characteristics (T_A = 25 °C)

Type	V_v (1 mA)	ΔV_v (1 mA)	Max. clamping voltage		C_{typ} (1 kHz)	L_{typ}	Derating curve	V/I char-acteristic
			v	i				
SIOV-	V	%	V	A	pF	nH	Page	Page
CN0805K17G	27	± 10	46	1,0	300	1,5	176	198
CN1206K17G	27	± 10	44	1,0	650	1,8	177	199
CN1210K17G	27	± 10	44	2,5	1800	1,8	179	200
CN1812K17G	27	± 10	44	5,0	4000	2,5	180	201
CN2220K17G	27	± 10	44	10,0	9000	3,0	181	202
CN0805K20G	33	± 10	56	1,0	300	1,5	176	198
CN1206K20G	33	± 10	54	1,0	600	1,8	177	199
CN1210K20G	33	± 10	54	2,5	1500	1,8	179	200
CN1812K20G	33	± 10	54	5,0	3000	2,5	180	201
CN2220K20G	33	± 10	54	10,0	7000	3,0	181	202
CN0805K25G	39	± 10	67	1,0	250	1,5	176	198
CN1206K25G	39	± 10	65	1,0	550	1,8	177	199
CN1210K25G	39	± 10	65	2,5	1200	1,8	178	200
CN1812K25G	39	± 10	65	5,0	2500	2,5	180	201
CN2220K25G	39	± 10	65	10,0	5000	3,0	181	202
CN1206K30G	47	± 10	77	1,0	500	1,8	177	199
CN1210K30G	47	± 10	77	2,5	1000	1,8	178	200
CN1812K30G	47	± 10	77	5,0	2000	2,5	180	201
CN2220K30G	47	± 10	77	10,0	4000	3,0	181	202
CN1206K35G	56	± 10	90	1,0	300	1,8	176	199
CN1210K35G	56	± 10	90	2,5	600	1,8	178	200
CN1812K35G	56	± 10	90	5,0	1200	2,5	179	201
CN2220K35G	56	± 10	90	10,0	2500	3,0	181	202
CN1206K40G	68	± 10	110	1,0	250	1,8	176	199
CN1210K40G	68	± 10	110	2,5	500	1,8	178	200
CN1812K40G	68	± 10	110	5,0	1000	2,5	179	201
CN2220K40G	68	± 10	110	10,0	2000	3,0	181	202
CN1206K50G	82	± 10	135	1,0	120	1,8	176	199
CN1210K50G	82	± 10	135	2,5	250	1,8	177	200
CN1812K50G	82	± 10	135	5,0	500	2,5	179	201
CN2220K50G	82	± 10	135	10,0	1000	3,0	180	202

Standard

Maximum ratings (0603: T_A = 85 °C; 0805 … 2220: T_A = 125 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
CN1206K60G	Q69520-V0600-K062	60	85	120	0,9	0,008
CN1210K60G	Q69530-V0600-K062	60	85	200	2,0	0,010
CN1812K60G	Q69580-V0600-K062	60	85	400	5,8	0,015
CN2220K60G	Q69540-V0600-K062	60	85	800	6,8	0,020

Characteristics (T_A = 25 °C)

Type SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	 i A	C_{typ} (1 kHz) pF	L_{typ} nH	Derating curve Page	V/I characteristic Page
CN1206K60G	100	± 10	165	1,0	100	1,8	176	199
CN1210K60G	100	± 10	165	2,5	200	1,8	177	200
CN1812K60G	100	± 10	165	5,0	400	2,5	179	201
CN2220K60G	100	± 10	165	10,0	800	3,0	180	202

Construction

- Rectangular varistor element in multilayer technology, without encapsulation
- Termination: silver palladium

Features

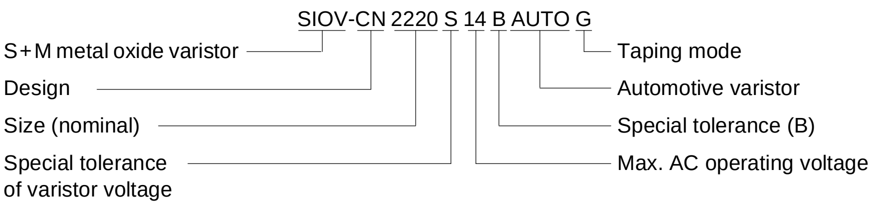
- High energy absorption, particularly in case of load dump
- Jump-start strength
- Stable protection level, minimum leakage current
- High resistance to cyclic temperature stress
- Wide range of operating temperature
- Low inductance (suitable for ESD protection)
- PSpice models

Taping

- Supply on 8/12-mm tape, for tape dimensions see page 112, for reel dimensions and packing units see page 113

Type designation

Detailed description of coding system on page 33



General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	55/125/56 – 55 °C + 125 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 55 … + 125 °C	in accordance with CECC 42 000
Storage temperature	– 55 … + 150 °C	
Response time	< 0,5 ns	
Solderability	235 °C, 2 s	in accordance with IEC 68-2-58
Resistance to soldering heat	260 °C, 10 s	in accordance with IEC 68-2-20

Maximum ratings (T_A = 125 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W	W_{LD} (10x) J
12-V supply systems							
CN0805S14BAUTOG	Q69510-V1140-S262	14	16	120	0,3	0,008	1,0
CN1206S14BAUTOG	Q69520-V1140-S262	14	16	200	0,6	0,008	1,5
CN1210S14BAUTOG	Q69530-V1140-S262	14	16	400	1,6	0,010	3,0
CN1812S14BAUTOG	Q69580-V1140-S262	14	16	800	2,4	0,015	6,0
CN2220S14BAUTOG	Q69540-V1140-S262	14	16	1200	5,8	0,030	12,0
CN2220S14BAUTOE2G2	Q69540-V3140-S272	14	16	1200	5,8	0,030	25,0
24-V supply systems							
CN2220K30AUTOG	Q69540-V1300-K062	30	34	1200	12,0	0,030	12,0

Characteristics (T_A = 25 °C)

Type SIOV-	V_{Jump} (5 min) V	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	 i A	C_{typ} (1 kHz) nF	L_{typ} nH	Der. curve Page	V/I char. Page
12-V supply systems									
CN0805S14BAUTOG	24,5	22	+23/–0	42	1,0	0,4	1,5	176	203
CN1206S14BAUTOG	24,5	22	+23/–0	40	1,0	0,8	1,8	177	203
CN1210S14BAUTOG	24,5	22	+23/–0	40	2,5	1,7	1,8	179	203
CN1812S14BAUTOG	24,5	22	+23/–0	40	5,0	5,6	2,5	180	203
CN2220S14BAUTOG	24,5	22	+23/–0	40	10,0	9,5	3,0	181	203
CN2220S14BAUTOE2G2	24,5	22	+23/–0	40	10,0	15,0	3,0	181	203
24-V supply systems									
CN2220K30AUTOG	50,0	47	± 10	77	10,0	4,0	3,0	181	202

Notes

- 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 S+M Components 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 30 ms, interval 60 s.

Construction

- Rectangular varistor element in multilayer technology, without encapsulation
- Termination: silver palladium

Features

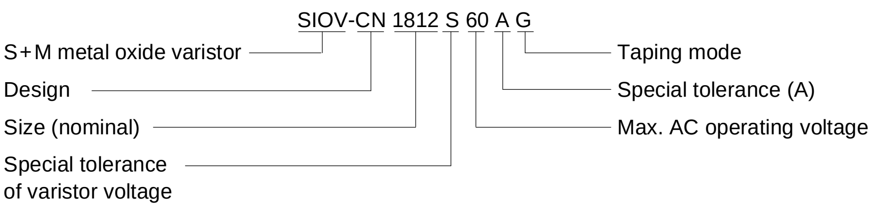
- Suitable for handling the surge current of the 10/700 µs pulse to CCITT and IEC 1000-4-5
- Special types with controlled minimum resistance and protection level available
- Matched to line conditions with or without superimposed ringing voltage
- Good solderability
- Suitable for ESD protection
- PSpice models

Taping

- Supply on 12-mm tape, for tape dimensions see page 112, for reel dimensions and packing units see page 113

Type designation

Detailed description of coding system on page 33



General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	55/85/56 – 55 °C + 125 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 55 … + 125 °C	in accordance with CECC 42 000
Storage temperature	– 55 … + 150 °C	
Response time	< 0,5 ns	
Solderability	235 °C, 2 s	in accordance with IEC 68-2-58
Resistance to soldering heat	260 °C, 10 s	in accordance with IEC 68-2-20

Telecom

Maximum ratings (T_A = 125 °C)

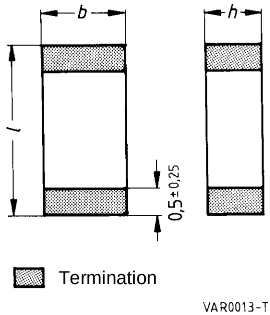
Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
CN1812S60AG	Q69580-V0600-S162	60	85	400	6,0	0,015
CN1812S95AG2	Q69580-V0950-S172	95	125	250	5,0	0,015

Characteristics (T_A = 25 °C)

Type	R_{min}	Max. clamping voltage		C_{typ}	L_{typ}	Derating curve	V/I characteristic
		v	i	(1 kHz)			
SIOV-	kΩ	V	A	pF	nH	Page	Page
CN1812S60AG	250 (95 V)	200	45	400	2,5	179	—
CN1812S95AG2	150 (150 V)	270	45	250	3,0	178	—

Note

All standard varistors are also suitable for telecom applications, provided that the selection criteria are observed.

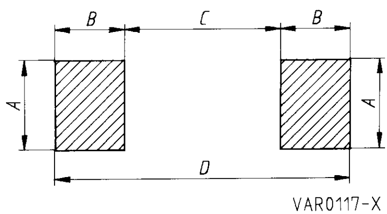


Weight: < 0,2 g

Dimensions

Type	*l* mm	*b* mm	*h* mm
SIOV-CN0603	1,6 ± 0,15	0,80 ± 0,10	1,3 max.
SIOV-CN0805	2,0 ± 0,20	1,25 ± 0,15	1,3 max.
SIOV-CN1206	3,2 ± 0,20	1,60 ± 0,15	1,7 max.
SIOV-CN1210	3,2 ± 0,20	2,50 ± 0,20	1,7 max.
SIOV-CN1812	4,5 ± 0,20	3,20 ± 0,20	2,3 max.
SIOV-CN2220	5,7 ± 0,20	5,00 ± 0,20	1,7 max.

Termination: silver palladium



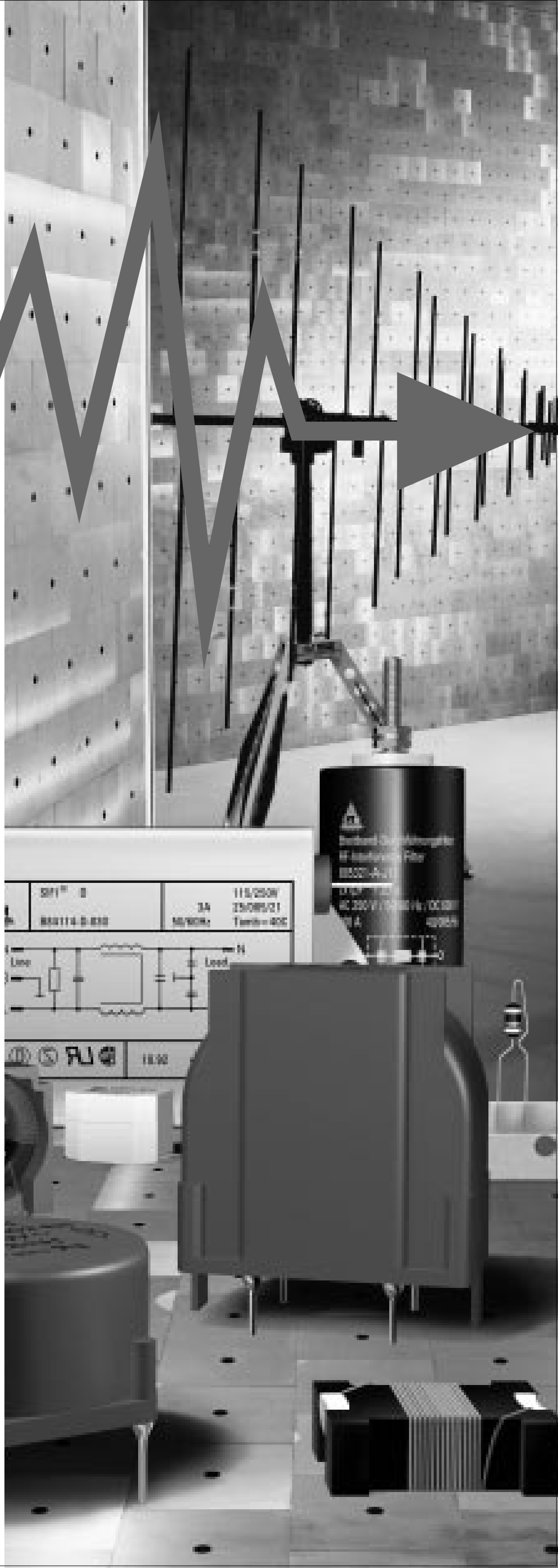
Recommended solder pad layout

Type	*A* mm	*B* mm	*C* mm	*D* mm
SIOV-CN0603	1,0	1,0	0,6	3,0
SIOV-CN0805	1,4	1,2	1,0	3,4
SIOV-CN1206	1,8	1,2	2,1	4,5
SIOV-CN1210	2,8	1,2	2,1	4,5
SIOV-CN1812	3,6	1,5	3,0	6,0
SIOV-CN2220	5,5	1,5	4,2	7,2

S+M COMPONENTS **Siemens Matsushita Components**

Siemens Components Service

Get on the right side of EMC



Completely undisturbed- with the right solutions you're always on the safe side. For really sure suppression of interference we have all the matching components, like converter filters and ring core chokes.

Plus low-price Safe-X capacitors, insensitive to damp, and low-volume data line chokes.

Not forgetting our EMC-lab, featuring the latest technology and at your service for measuring and testing conducted and radiated interference.

Be sure of EMC – with our specialists on your side.

SCS – dependable, fast and competent

Construction

- Cylindrical varistor element, encapsulated
- Encapsulation: thermoplast, flame-retardant to UL 94 V-0
- Termination: tinned copper alloy

Features

- Electrical equivalents to leaded types SIOV-S05/S07
- Good solderability
- PSpice models

Taping

- Supply on 16-mm tape,
  for tape dimensions see page 112,
  for reel dimensions and packing units see page 113

Type designation

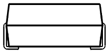
Detailed description of coding system on page 33

SIOV-CU 4032 K 275 G2

- SIOV-CU: S+M metal oxide varistor
- CU: Design
- 4032: Size (nominal)
- K: Tolerance of varistor voltage
- 275: Max. AC operating voltage
- G2: Taping mode

General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 125 °C	
Electric strength	≥ 2,5 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 10 ns	
Solderability	235 °C, 2 s	in accordance with IEC 68-2-58
Resistance to soldering heat	260 °C, 10 s	in accordance with IEC 68-2-20



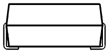
Standard

Maximum ratings (T_A = 85 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
CU3225K11G2	Q69650-M110-K72	11	14	100	0,3	0,01
CU4032K11G2	Q69660-M110-K72	11	14	250	0,8	0,02
CU3225K14G2	Q69650-M140-K72	14	18	100	0,4	0,01
CU4032K14G2	Q69660-M140-K72	14	18	250	0,9	0,02
CU3225K17G2	Q69650-M170-K72	17	22	100	0,5	0,01
CU4032K17G2	Q69660-M170-K72	17	22	250	1,1	0,02
CU3225K20G2	Q69650-M200-K72	20	26	100	0,6	0,01
CU4032K20G2	Q69660-M200-K72	20	26	250	1,3	0,02
CU3225K25G2	Q69650-M250-K72	25	31	100	0,7	0,01
CU4032K25G2	Q69660-M250-K72	25	31	250	1,6	0,02
CU3225K30G2	Q69650-M300-K72	30	38	100	0,9	0,01
CU4032K30G2	Q69660-M300-K72	30	38	250	2,0	0,02
CU3225K35G2	Q69650-M350-K72	35	45	100	1,1	0,01
CU4032K35G2	Q69660-M350-K72	35	45	250	2,5	0,02
CU3225K40G2	Q69650-M400-K72	40	56	100	1,3	0,01
CU4032K40G2	Q69660-M400-K72	40	56	250	3,0	0,02
CU3225K50G2	Q69650-M500-K72	50	65	400	1,8	0,10
CU4032K50G2	Q69660-M500-K72	50	65	1200	4,2	0,25
CU3225K60G2	Q69650-M600-K72	60	85	400	2,2	0,10
CU4032K60G2	Q69660-M600-K72	60	85	1200	4,8	0,25
CU3225K75G2	Q69650-M750-K72	75	100	400	2,5	0,10
CU4032K75G2	Q69660-M750-K72	75	100	1200	5,9	0,25
CU3225K95G2	Q69650-M950-K72	95	125	400	3,4	0,10
CU4032K95G2	Q69660-M950-K72	95	125	1200	7,6	0,25
CU3225K115G2	Q69650-M111-K72	115	150	400	3,6	0,10
CU4032K115G2	Q69660-M111-K72	115	150	1200	8,4	0,25
CU3225K130G2	Q69650-M131-K72	130	170	400	4,2	0,10
CU4032K130G2	Q69660-M131-K72	130	170	1200	9,5	0,25

Characteristics (T_A = 25 °C)

Type SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage *v* V	 *i* A	C_{typ} (1 kHz) pF	Derating curve Page	*V*/*I* char-acteristic Page
CU3225K11G2	18	± 10	36	1,0	1600	182	204
CU4032K11G2	18	± 10	36	2,5	3100	182	205
CU3225K14G2	22	± 10	43	1,0	1300	182	204
CU4032K14G2	22	± 10	43	2,5	2500	182	205
CU3225K17G2	27	± 10	53	1,0	1050	182	204
CU4032K17G2	27	± 10	53	2,5	1900	182	205
CU3225K20G2	33	± 10	65	1,0	750	182	204
CU4032K20G2	33	± 10	65	2,5	1500	182	205
CU3225K25G2	39	± 10	77	1,0	660	182	204
CU4032K25G2	39	± 10	77	2,5	1250	182	205
CU3225K30G2	47	± 10	93	1,0	580	182	204
CU4032K30G2	47	± 10	93	2,5	1050	182	205
CU3225K35G2	56	± 10	110	1,0	460	182	204
CU4032K35G2	56	± 10	110	2,5	850	182	205
CU3225K40G2	68	± 10	135	1,0	400	182	204
CU4032K40G2	68	± 10	135	2,5	720	182	205
CU3225K50G2	82	± 10	135	5,0	300	183	204
CU4032K50G2	82	± 10	135	10,0	530	183	205
CU3225K60G2	100	± 10	165	5,0	250	183	204
CU4032K60G2	100	± 10	165	10,0	480	183	205
CU3225K75G2	120	± 10	200	5,0	210	183	204
CU4032K75G2	120	± 10	200	10,0	430	183	205
CU3225K95G2	150	± 10	250	5,0	135	183	204
CU4032K95G2	150	± 10	250	10,0	260	183	205
CU3225K115G2	180	± 10	300	5,0	110	183	204
CU4032K115G2	180	± 10	300	10,0	220	183	205
CU3225K130G2	205	± 10	340	5,0	100	183	204
CU4032K130G2	205	± 10	340	10,0	200	183	205



Standard

Maximum ratings (T_A = 85 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
CU3225K140G2	Q69650-M141-K72	140	180	400	4,5	0,10
CU4032K140G2	Q69660-M141-K72	140	180	1200	10,0	0,25
CU3225K150G2	Q69650-M151-K72	150	200	400	4,9	0,10
CU4032K150G2	Q69660-M151-K72	150	200	1200	11,0	0,25
CU3225K175G2	Q69650-M171-K72	175	225	400	5,6	0,10
CU4032K175G2	Q69660-M171-K72	175	225	1200	13,0	0,25
CU3225K230G2	Q69650-M231-K72	230	300	400	7,2	0,10
CU4032K230G2	Q69660-M231-K72	230	300	1200	17,0	0,25
CU3225K250G2	Q69650-M251-K72	250	320	400	8,2	0,10
CU4032K250G2	Q69660-M251-K72	250	320	1200	19,0	0,25
CU3225K275G2	Q69650-M271-K72	275	350	400	8,6	0,10
CU4032K275G2	Q69660-M271-K72	275	350	1200	21,0	0,25
CU3225K300G2	Q69650-M301-K72	300	385	400	9,6	0,10
CU4032K300G2	Q69660-M301-K72	300	385	1200	23,0	0,25

Characteristics (T_A = 25 °C)

Type SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage *v* V	 *i* A	C_{typ} (1 kHz) pF	Derating curve Page	*V*/*I* characteristic Page
CU3225K140G2	220	± 10	360	5,0	95	183	204
CU4032K140G2	220	± 10	360	10,0	180	183	205
CU3225K150G2	240	± 10	395	5,0	90	183	204
CU4032K150G2	240	± 10	395	10,0	170	183	205
CU3225K175G2	270	± 10	455	5,0	75	183	204
CU4032K175G2	270	± 10	455	10,0	150	183	205
CU3225K230G2	360	± 10	595	5,0	60	183	204
CU4032K230G2	360	± 10	595	10,0	115	183	205
CU3225K250G2	390	± 10	650	5,0	55	183	204
CU4032K250G2	390	± 10	650	10,0	105	183	205
CU3225K275G2	430	± 10	710	5,0	50	183	204
CU4032K275G2	430	± 10	710	10,0	95	183	205
CU3225K300G2	470	± 10	775	5,0	45	183	204
CU4032K300G2	470	± 10	775	10,0	90	183	205

Construction

- Cylindrical varistor element, encapsulated
- Encapsulation: thermoplast, flame-retardant to UL 94 V-0
- Termination: tinned copper alloy

Features

- High energy absorption, particularly in case of load dump
- Jump-start strength
- Stable protection level, minimum leakage current
- High resistance to cyclic temperature stress
- Good solderability
- Low inductance
- PSpice models

Taping

- Supply on 16-mm tape, for tape dimensions see page 112, for reel dimensions and packing units see page 113

Type designation

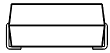
Detailed description of coding system on page 33

SIOV-CU 4032 K 14 AUTO G2

- SIOV-CU: S+M metal oxide varistor
- CU: Design
- 4032: Size (nominal)
- K: Tolerance of varistor voltage
- 14: Max. AC operating voltage
- AUTO: Automotive varistor
- G2: Taping mode

General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 125 °C	
Electric strength	≥ 2,5 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 10 ns	
Solderability	235 °C, 2 s	in accordance with IEC 68-2-58
Resistance to soldering heat	260 °C, 10 s	in accordance with IEC 68-2-20



Maximum ratings (T_A = 85 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W	W_{LD} (10x) J
12-V supply systems							
CU3225K14AUTOG2	Q69650-M1140-K72	14	16	100	0,4	0,01	6
CU4032K14AUTOG2	Q69660-M1140-K72	14	16	250	0,9	0,02	12
CU3225K17AUTOG2	Q69650-M1170-K72	17	20	100	0,5	0,01	6
CU4032K17AUTOG2	Q69660-M1170-K72	17	20	250	1,1	0,02	12
24-V supply systems							
CU3225K30AUTOG2	Q69650-M1300-K72	30	34	100	0,9	0,01	6
CU4032K30AUTOG2	Q69660-M1300-K72	30	34	250	2,0	0,02	12

Characteristics (T_A = 25 °C)

Type SIOV-	V_{Jump} (5 min) V	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	 i A	C_{typ} (1 kHz) nF	Derating curve Page	V/I characteristic Page
12-V supply systems								
CU3225K14AUTOG2	25	22	± 10	43	1,0	1,3	182	204
CU4032K14AUTOG2	25	22	± 10	43	2,5	2,5	182	205
CU3225K17AUTOG2	30	27	± 10	53	1,0	1,1	182	204
CU4032K17AUTOG2	30	27	± 10	53	2,5	1,9	182	205
24-V supply systems								
CU3225K30AUTOG2	50	47	± 10	93	1,0	0,6	182	204
CU4032K30AUTOG2	50	47	± 10	93	2,5	1,1	182	205

Notes

- 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 S+M Components 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 30 ms, interval 60 s.

Construction

- Cylindrical varistor element, encapsulated
- Encapsulation: thermoplast, flame-retardant to UL 94 V-0
- Termination: tinned copper alloy

Features

- Suitable for handling the surge current of the 10/700 µs pulse to CCITT and IEC 1000-4-5
- Special types with controlled minimum resistance and protection level available
- Matched to line conditions with or without superimposed ringing voltage
- Electrical equivalents to leaded telecom types
- Good solderability
- PSpice models

Taping

- Supply on 16-mm tape, for tape dimensions see page 112, for reel dimensions and packing units see page 113

Type designation

Detailed description of coding system on page 33

SIOV-CU 4032 S 95 A G2

- SIOV: S+M metal oxide varistor
- CU: Design
- 4032: Size (nominal)
- S: Special tolerance of varistor voltage
- 95: Max. AC operating voltage
- A: Special tolerance (A)
- G2: Taping mode

General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 150 °C	
Electric strength	≥ 2,5 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 10 ns	
Solderability	235 °C, 2 s	in accordance with IEC 68-2-58
Resistance to soldering heat	260 °C, 10 s	in accordance with IEC 68-2-20

Maximum ratings (T_A = 85 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
CU4032S60AG2	Q69660-M600-S172	60	85	1200	4,8	0,25
CU4032S95AG2	Q69660-M950-S172	95	125	1200	7,6	0,25

Characteristics (T_A = 25 °C)

Type	R_{min}	Max. clamping voltage		C_{typ} (1 kHz)	Derating curve	*V/I* characteristic
		v	*i*			
SIOV-	kΩ	V	A	pF	Page	Page
CU4032S60AG2	250 (95 V)	200	45	480	183	—
CU4032S95AG2	150 (150 V)	270	45	260	183	—

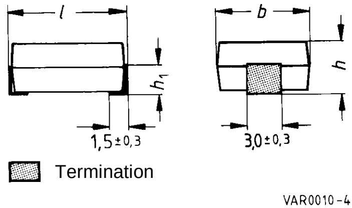
Note

All standard varistors are also suitable for telecom applications, provided that the selection criteria are observed.

Dimensions
Solder Pads

Weight:

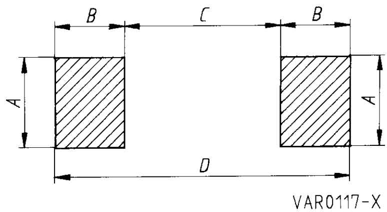
CU3225: approx. 0,5 g
CU4032: approx. 0,8 g



Dimensions

Type	*l* mm	*b* mm	*h* mm	h_1 mm
SIOV-CU3225K11…175	8,0 ± 0,3	6,3 ± 0,3	3,2 ± 0,3	1,7 ± 0,3
SIOV-CU3225K230…300	8,0 ± 0,3	6,3 ± 0,3	4,5 ± 0,3	2,3 ± 0,3
SIOV-CU4032K11…175	10,2 ± 0,3	8,0 ± 0,3	3,2 ± 0,3	1,7 ± 0,3
SIOV-CU4032K230…300	10,2 ± 0,3	8,0 ± 0,3	4,5 ± 0,3	2,3 ± 0,3

Termination: tinned copper alloy



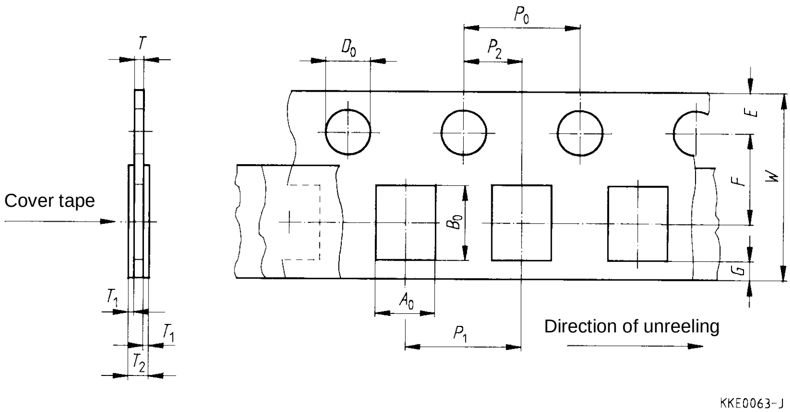
Recommended solder pad layout

Type	*A* mm	*B* mm	*C* mm	*D* mm
SIOV-CU3225K11…175	3,5	2,8	4,5	10,1
SIOV-CU3225K230…300	3,5	2,8	4,5	10,1
SIOV-CU4032K11…175	3,5	2,8	6,5	12,1
SIOV-CU4032K230…300	3,5	2,8	6,5	12,1

SMD varistors are always supplied taped and reeled.

Tape and reel packing comply with the specifications of IEC 286-3.

Cardboard tape



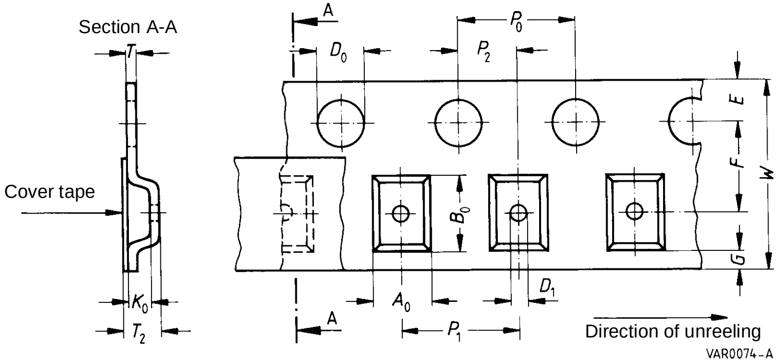
Tape dimensions (in mm)

Tape Size	8 mm 0603	Tolerance
$A_0 \times B_0$ T_2 T	0,95 × 1,80 1,10 0,90	± 0,20 max. max.
D_0	1,50	± 0,10
P_0 P_2 P_1	4,00 2,00 4,00	± 0,10 [1)] ± 0,05 ± 0,10
W E F G	8,00 1,75 3,50 0,75	± 0,30 ± 0,10 ± 0,05 min.

1) ≤ 0,2 mm over 10 sprocket holes

Taping

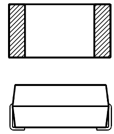
Blister tape

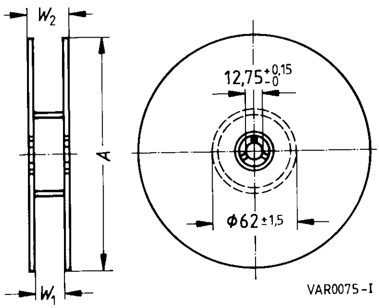


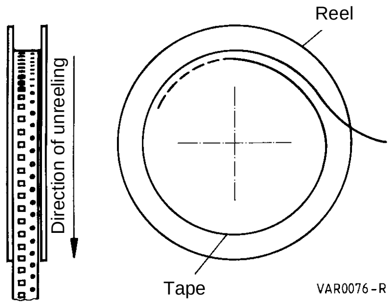
Tape dimensions (in mm)

Tape	8 mm	12 mm		16 mm		Tolerance
Size	0805 1206 1210	1812	2220	3225	4032	
$A_0 \times B_0$	1,60 × 2,40 (0805) 1,90 × 3,50 (1206) 2,80 × 3,50 (1210)	3,5 × 4,8	5,1 × 6,0	7,0 × 8,7	8,6 × 10,6	± 0,20
K_0	1,80	1,80	1,80	5,00	5,00	max.
T_2	2,50	3,00	3,00	5,50	5,50	max.
T	0,30	0,30	0,30	0,30	0,30	max.
D_0	1,50	1,50	1,50	1,50	1,50	+ 0,10/– 0
D_1	1,00	1,50	1,50	1,50	1,50	min.
P_0	4,00	4,00	4,00	4,00	4,00	± 0,10 1)
P_2	2,00	2,00	2,00	2,00	2,00	± 0,05
P_1	4,00	8,00	8,00	12,00	12,00	± 0,10
W	8,00	12,00	12,00	16,00	16,00	± 0,30
E	1,75	1,75	1,75	1,75	1,75	± 0,10
F	3,50	5,50	5,50	7,50	7,50	± 0,05
G	0,75	0,75	0,75	0,75	0,75	min.

1) ≤ ± 0,2 mm over 10 sprocket holes







Reel dimensions

Size	CN0603 CN0805 CN1206 CN1210 … G	CN1812 CN2220 … G	CN … G2	CU3225 CU4032 … G2
A (mm) W_1 (mm) W_2 (mm)	180_{-2} $8{,}4_{+1,5/-0}$ 14,4 max.	180_{-2} $12{,}4_{+1,5/-0}$ 18,4 max.	330_{-2} $8{,}4_{+1,5/-0}$/$12{,}4_{+1,5/-0}$ 14,4 max./18,4 max.	330_{-2} $16{,}4_{+1,5/-0}$ 22,4

Packing units

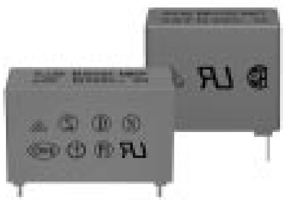
Type	Pieces/reel
CN0603M4-K14G	4000
CN0805M4G-K14G	3000
CN1206M4G-K20G CN1206K25G-K60G	3000 2000
CN1210M4G-K20G CN1210K25G-K60G	3000 2000
CN1812M4G-K14G CN1812K17G-S60AG CN1812S95AG2	1500 1000 3000
CN2220M4G-K17G CN2220K20G-K60G	1500 1000
CU3225…G2	1000
CU4032…G2	1000

S+M COMPONENTS **Siemens Matsushita Components**

EMI suppression capacitors

Play it safe

Whether video recorder, television, refrigerator or toaster – our EMI suppression capacitors do a grand job in every possible kind of entertainment and consumer electronics appliance. They've also proven their worth in switch-mode power supplies for PCs. No wonder, because the advantages of film technology are there to be seen: low cost, no risk of failure through damp, and optimum self-



healing capability. The result – less destruction of equipment and ensuing fires. Plus the line is safeguarded against surges. In this way our capacitors satisfy strict user's need for safety, and the EMC standards too of course.

SCS – dependable, fast and competent

Construction

- Rectangular varistor element in multilayer technology
- Coating: epoxy resin, flame-retardant to UL 94 V-0
- Terminals: tinned copper wire

Features

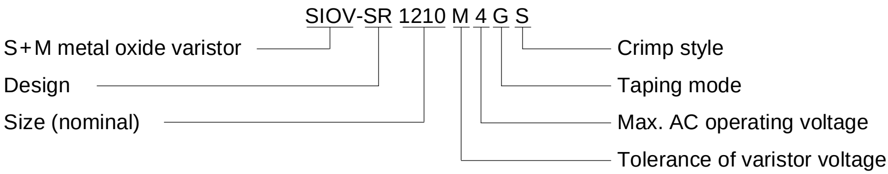
- Electrical equivalents to CN types
- PSpice models

Taping

- All types available on tape,
  for ordering information see page 148 ff

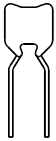
Type designation

Detailed description of coding system on page 33



General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 125 °C	
Electric strength	≥ 1,0 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	



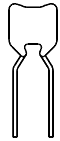
Standard

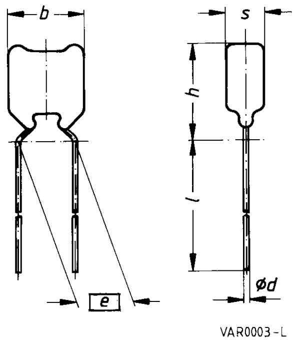
Maximum ratings (T_A = 85 °C)

Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
SR1210M4S	Q69535-R40-M	4	5,5	250	0,4	0,01
SR2220M4S	Q69545-R40-M	4	5,5	1000	1,4	0,02
SR1210M6S	Q69535-R60-M	6	8	300	0,7	0,01
SR2220M6S	Q69545-R60-M	6	8	1200	3,6	0,02
SR1210L8S	Q69535-R80-L	8	11	400	1,0	0,01
SR2220L8S	Q69545-R80-L	8	11	1200	4,2	0,02

Characteristics (T_A = 25 °C)

Type (untaped) SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	i A	C_{typ} (1 kHz) pF	Derating curve Page	V/I characteristic Page
SR1210M4S	8	± 20	17	2,5	5000	178	200
SR2220M4S	8	± 20	17	10,0	24000	181	202
SR1210M6S	11	± 20	25	2,5	4000	178	200
SR2220M6S	11	± 20	25	10,0	20000	181	202
SR1210L8S	15	± 15	30	2,5	3000	179	200
SR2220L8S	15	± 15	30	10,0	16000	181	202





Weight:
SR1210: approx. 0,3 g
SR2220: approx. 0,5 g

Dimensions

Type	e ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-SR1210M4S	5,0	5,5	3,1	6,5	30,0	0,5
SIOV-SR2220M4S	5,0	7,8	3,8	9,0	30,0	0,5
SIOV-SR1210M6S	5,0	5,5	3,1	6,5	30,0	0,5
SIOV-SR2220M6S	5,0	7,8	3,8	9,0	30,0	0,5
SIOV-SR1210L8S	5,0	5,5	3,1	6,5	30,0	0,5
SIOV-SR2220L8S	5,0	7,8	3,8	9,0	30,0	0,5

Construction

- Rectangular varistor element in multilayer technology
- Coating: epoxy resin, flame-retardant to UL 94 V-0
- Terminals: tinned copper wire

Features

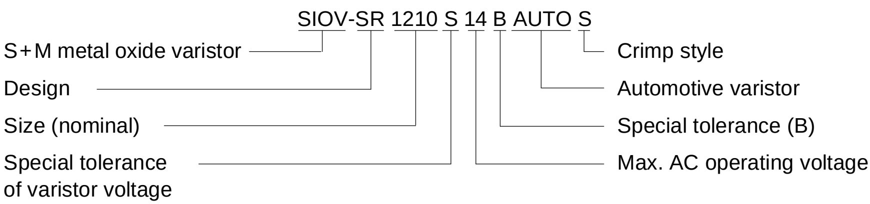
- High energy absorption,
  particularly in case of load dump
- Jump-start strength
- Stable protection level, minimum leakage current
- High resistance to cyclic temperature stress
- PSpice models

Taping

- All types available on tape upon request

Type designation

Detailed description of coding system on page 33



General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 125 °C	
Electric strength	≥ 1,0 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	

Maximum ratings (T_A = 85 °C)

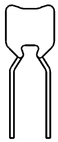
Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W	W_{LD} (10x) J
12-V supply systems							
SR1210S14BAUTOS	Q69535-R1140-S200	14	16	400	1,6	0,010	3
SR1812S14BAUTOS	Q69585-R1140-S200	14	16	800	2,4	0,015	6
SR2220S14BAUTOS	Q69545-R1140-S200	14	16	1200	5,8	0,030	12

Characteristics (T_A = 25 °C)

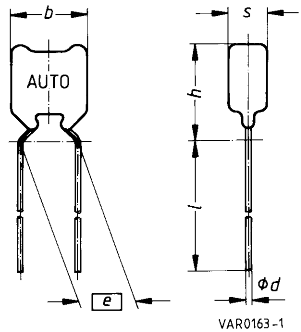
Type (untaped) SIOV-	V_{Jump} (5 min) V	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	i A	C_{typ} (1 kHz) nF	Derating curve Page	V/I characteristic Page
12-V supply systems								
SR1210S14BAUTOS	24,5	22	+ 23/– 0	40	2,5	1,7	179	203
SR1812S14BAUTOS	24,5	22	+ 23/– 0	40	5,0	5,6	180	203
SR2220S14BAUTOS	24,5	22	+ 23/– 0	40	10,0	9,5	181	203

Notes

- 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 S+M Components 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 30 ms, interval 60 s.



Automotive



Weight: < 0,5 g

Dimensions

Type	e ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-SR1210S14BAUTOS	5,0	5,5	3,1	6,5	30,0	0,5
SIOV-SR1812S14BAUTOS	5,0	7,3	3,5	7,8	30,0	0,5
SIOV-SR2220S14BAUTOS	5,0	7,8	3,8	9,0	30,0	0,5

Construction

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

New features

- New high-energy varistors S14/S20 … E2
- PSpice models

Approvals

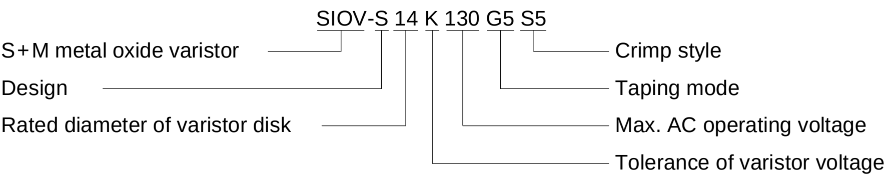
- UL
- CSA (all types ≥ K115)
- SEV
- VDE
- CECC

Taping

- For ordering information see page 148 ff

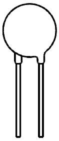
Type designation

Detailed description of coding system on page 33



General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 125 °C	
Electric strength	≥ 2,5 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	

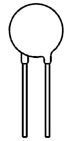


Standard

Maximum ratings (T_A = 85 °C)

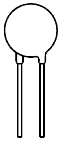
Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
S05K11	Q69X3445	11	14	100	0,3	0,01
S07K11	Q69X3446	11	14	250	0,8	0,02
S10K11	Q69X3455	11	14	500	1,7	0,05
S14K11	Q69X3456	11	14	1000	3,2	0,10
S20K11	Q69X3457	11	14	2000	10,0	0,20
S05K14	Q69X3422	14	18	100	0,4	0,01
S07K14	Q69X3447	14	18[1)]	250	0,9	0,02
S10K14	Q69X3011	14	18[1)]	500	2,0	0,05
S14K14	Q69X3018	14	18[1)]	1000	4,0	0,10
S20K14	Q69X3458	14	18[1)]	2000	12,0	0,20
S05K17	Q69X3423	17	22	100	0,5	0,01
S07K17	Q69X3448	17	22	250	1,1	0,02
S10K17	Q69X3012	17	22	500	2,5	0,05
S14K17	Q69X3019	17	22	1000	5,0	0,10
S20K17	Q69X3459	17	22	2000	14,0	0,20
S05K20	Q69X3424	20	26	100	0,6	0,01
S07K20	Q69X3449	20	26	250	1,3	0,02
S10K20	Q69X3013	20	26	500	3,1	0,05
S14K20	Q69X3020	20	26	1000	6,0	0,10
S20K20	Q69X3460	20	26	2000	18,0	0,20
S05K25	Q69X3425	25	31	100	0,7	0,01
S07K25	Q69X3450	25	31	250	1,6	0,02
S10K25	Q69X3014	25	31	500	3,7	0,05
S14K25	Q69X3021	25	31	1000	7,0	0,10
S20K25	Q69X3461	25	31	2000	22,0	0,20
S05K30	Q69X3426	30	38	100	0,9	0,01
S07K30	Q69X3451	30	38	250	2,0	0,02
S10K30	Q69X3015	30	38	500	4,4	0,05
S14K30	Q69X3022	30	38	1000	9,0	0,10
S20K30	Q69X3462	30	38	2000	26,0	0,20

1) Jump-start strength (max. 24 V, 5 minuts)



Characteristics (T_A = 25 °C)

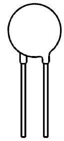
Type (untaped) SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	i A	C_{typ} (1 kHz) pF	Derating curve Page	V/I characteristic Page
S05K11	18	± 10	36	1,0	1600	182	204
S07K11	18	± 10	36	2,5	3100	182	205
S10K11	18	± 10	36	5,0	6800	184	206
S14K11	18	± 10	36	10,0	11000	185	207
S20K11	18	± 10	36	20,0	18000	187	208
S05K14	22	± 10	43	1,0	1300	182	204
S07K14	22	± 10	43	2,5	2500	182	205
S10K14	22	± 10	43	5,0	5200	184	206
S14K14	22	± 10	43	10,0	9000	185	207
S20K14	22	± 10	43	20,0	15000	187	208
S05K17	27	± 10	53	1,0	1050	182	204
S07K17	27	± 10	53	2,5	1900	182	205
S10K17	27	± 10	53	5,0	4000	184	206
S14K17	27	± 10	53	10,0	7000	185	207
S20K17	27	± 10	53	20,0	13000	187	208
S05K20	33	± 10	65	1,0	750	182	204
S07K20	33	± 10	65	2,5	1500	182	205
S10K20	33	± 10	65	5,0	3100	184	206
S14K20	33	± 10	65	10,0	5500	185	207
S20K20	33	± 10	65	20,0	11000	187	208
S05K25	39	± 10	77	1,0	660	182	204
S07K25	39	± 10	77	2,5	1260	182	205
S10K25	39	± 10	77	5,0	2800	184	206
S14K25	39	± 10	77	10,0	4600	185	207
S20K25	39	± 10	77	20,0	8600	187	208
S05K30	47	± 10	93	1,0	580	182	204
S07K30	47	± 10	93	2,5	1050	182	205
S10K30	47	± 10	93	5,0	2150	184	206
S14K30	47	± 10	93	10,0	3500	185	207
S20K30	47	± 10	93	20,0	7200	187	208



Standard

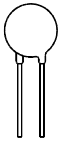
Maximum ratings (T_A = 85 °C)

Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
S05K35	Q69X3427	35	45	100	1,1	0,01
S07K35	Q69X3452	35	45	250	2,5	0,02
S10K35	Q69X3016	35	45	500	5,4	0,05
S14K35	Q69X3023	35	45	1000	10,0	0,10
S20K35	Q69X3463	35	45	2000	33,0	0,20
S05K40	Q69X3428	40	56	100	1,3	0,01
S07K40	Q69X3453	40	56	250	3,0	0,02
S10K40	Q69X3017	40	56	500	6,4	0,05
S14K40	Q69X3024	40	56	1000	13,0	0,10
S20K40	Q69X3464	40	56	2000	37,0	0,20
S05K50	Q69X3429	50	65	400	1,8	0,10
S07K50	Q69X3454	50	65	1200	4,2	0,25
S10K50	Q69X3047	50	65	2500	8,4	0,40
S14K50	Q69X3135	50	65	4500	15,0	0,60
S20K50	Q69X3465	50	65	6500	27,0	1,00
S05K60	Q69X3025	60	85	400	2,2	0,10
S07K60	Q69X3036	60	85	1200	4,8	0,25
S10K60	Q69X3048	60	85	2500	10,0	0,40
S14K60	Q69X3136	60	85	4500	17,0	0,60
S20K60	Q69X3224	60	85	6500	33,0	1,00
S05K75	Q69X3026	75	100	400	2,5	0,10
S07K75	Q69X3037	75	100	1200	5,9	0,25
S10K75	Q69X3049	75	100	2500	12,0	0,40
S14K75	Q69X3137	75	100	4500	20,0	0,60
S20K75	Q69X3225	75	100	6500	40,0	1,00
S05K95	Q69X3027	95	125	400	3,4	0,10
S07K95	Q69X3038	95	125	1200	7,6	0,25
S10K95	Q69X3050	95	125	2500	15,0	0,40
S14K95	Q69X3138	95	125	4500	25,0	0,60
S20K95	Q69X3226	95	125	6500	50,0	1,00



Characteristics (T_A = 25 °C)

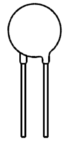
Type (untaped) SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage		C_{typ} (1 kHz) pF	Derating curve Page	*V*/*I* characteristic Page
			v V	*i* A			
S05K35	56	± 10	110	1,0	460	182	204
S07K35	56	± 10	110	2,5	850	182	205
S10K35	56	± 10	110	5,0	1900	184	206
S14K35	56	± 10	110	10,0	3100	185	207
S20K35	56	± 10	110	20,0	6100	187	208
S05K40	68	± 10	135	1,0	400	182	204
S07K40	68	± 10	135	2,5	720	182	205
S10K40	68	± 10	135	5,0	1700	184	206
S14K40	68	± 10	135	10,0	2800	185	207
S20K40	68	± 10	135	20,0	5300	187	208
S05K50	82	± 10	135	5,0	300	183	204
S07K50	82	± 10	135	10,0	530	183	205
S10K50	82	± 10	135	25,0	950	184	206
S14K50	82	± 10	135	50,0	1800	186	207
S20K50	82	± 10	135	100,0	3800	188	208
S05K60	100	± 10	165	5,0	250	183	204
S07K60	100	± 10	165	10,0	480	183	205
S10K60	100	± 10	165	25,0	870	184	206
S14K60	100	± 10	165	50,0	1650	186	207
S20K60	100	± 10	165	100,0	3600	188	208
S05K75	120	± 10	200	5,0	210	183	204
S07K75	120	± 10	200	10,0	430	183	205
S10K75	120	± 10	200	25,0	720	184	206
S14K75	120	± 10	200	50,0	1370	186	207
S20K75	120	± 10	200	100,0	2900	188	208
S05K95	150	± 10	250	5,0	135	183	204
S07K95	150	± 10	250	10,0	260	183	205
S10K95	150	± 10	250	25,0	530	184	206
S14K95	150	± 10	250	50,0	870	186	207
S20K95	150	± 10	250	100,0	1830	188	208



Standard

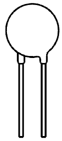
Maximum ratings (T_A = 85 °C)

Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
S05K115	Q69X4318	115	150	400	3,6	0,10
S07K115	Q69X4319	115	150	1200	8,4	0,25
S10K115	Q69X4320	115	150	2500	18,0	0,40
S14K115	Q69X4321	115	150	4500	30,0	0,60
S20K115	Q69X4322	115	150	6500	60,0	1,00
S05K130	Q69X3028	130	170	400	4,2	0,10
S07K130	Q69X3039	130	170	1200	9,5	0,25
S10K130	Q69X3119	130	170	2500	19,0	0,40
S14K130	Q69X3139	130	170	4500	34,0	0,60
S14K130E2	Q69X3747	130	170	6000	50,0	0,60
S20K130	Q69X3227	130	170	8000	74,0	1,00
S20S130BR7	Q69X4379	130	170	8000	70,0	1,00
S20K130E2	Q69X3770	130	170	10000	100,0	1,00
S05K140	Q69X3029	140	180	400	4,5	0,10
S07K140	Q69X3040	140	180	1200	10,0	0,25
S10K140	Q69X3120	140	180	2500	22,0	0,40
S14K140	Q69X3140	140	180	4500	36,0	0,60
S14K140E2	Q69X3748	140	180	6000	55,0	0,60
S20K140	Q69X3228	140	180	8000	78,0	1,00
S20K140E2	Q69X3771	140	180	10000	110,0	1,00
S05K150	Q69X3030	150	200	400	4,9	0,10
S07K150	Q69X3041	150	200	1200	11,0	0,25
S10K150	Q69X3121	150	200	2500	24,0	0,40
S14K150	Q69X3141	150	200	4500	40,0	0,60
S14K150E2	Q69X3749	150	200	6000	60,0	0,60
S20K150	Q69X3229	150	200	8000	85,0	1,00
S20S150BR7	Q69X4380	150	200	8000	78,0	1,00
S20K150E2	Q69X3772	150	200	10000	120,0	1,00
S05K175	Q69X3031	175	225	400	5,6	0,10
S07K175	Q69X3042	175	225	1200	13,0	0,25
S10K175	Q69X3122	175	225	2500	28,0	0,40
S14K175	Q69X3142	175	225	4500	46,0	0,60
S20K175	Q69X3230	175	225	8000	98,0	1,00



Characteristics (T_A = 25 °C)

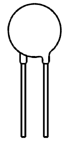
Type (untaped) SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage		C_{typ} (1 kHz) pF	Derating curve Page	*V*/*I* characteristic Page
			v V	*i* A			
S05K115	180	± 10	200	5,0	110	183	204
S07K115	180	± 10	300	10,0	220	183	205
S10K115	180	± 10	300	25,0	445	184	206
S14K115	180	± 10	300	50,0	730	186	207
S20K115	180	± 10	300	100,0	1520	188	208
S05K130	205	± 10	340	5,0	100	183	204
S07K130	205	± 10	340	10,0	200	183	205
S10K130	205	± 10	340	25,0	400	184	206
S14K130	205	± 10	340	50,0	650	186	207
S14K130E2	205	± 10	340	50,0	650	186	207
S20K130	205	± 10	340	100,0	1340	188	208
S20S130BR7	205	+ 8/– 10	325	100,0	1340	188	209
S20K130E2	205	± 10	340	100,0	1340	189	208
S05K140	220	± 10	360	5,0	95	183	204
S07K140	220	± 10	360	10,0	180	183	205
S10K140	220	± 10	360	25,0	370	184	206
S14K140	220	± 10	360	50,0	610	186	207
S14K140E2	220	± 10	360	50,0	610	186	207
S20K140	220	± 10	360	100,0	1240	188	208
S20K140E2	220	± 10	360	100,0	1240	189	208
S05K150	240	± 10	395	5,0	90	183	204
S07K150	240	± 10	395	10,0	170	183	205
S10K150	240	± 10	395	25,0	350	184	206
S14K150	240	± 10	395	50,0	570	186	207
S14K150E2	240	± 10	395	50,0	570	186	207
S20K150	240	± 10	395	100,0	1160	188	208
S20S150BR7	240	+ 2/– 10	360	100,0	1160	188	209
S20K150E2	240	± 10	395	100,0	1160	189	208
S05K175	270	± 10	455	5,0	75	183	204
S07K175	270	± 10	455	10,0	150	183	205
S10K175	270	± 10	455	25,0	300	184	206
S14K175	270	± 10	455	50,0	490	186	207
S20K175	270	± 10	455	100,0	1000	188	208



Standard

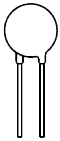
Maximum ratings (T_A = 85 °C)

Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
S05K230	Q69X3032	230	300	400	7,2	0,10
S07K230	Q69X3043	230	300	1200	17,0	0,25
S10K230	Q69X3123	230	300	2500	36,0	0,40
S14K230	Q69X3143	230	300	4500	60,0	0,60
S20K230	Q69X3231	230	300	8000	130,0	1,00
S05K250	Q69X3033	250	320	400	8,2	0,10
S07K250	Q69X3044	250	320	1200	19,0	0,25
S10K250	Q69X3124	250	320	2500	38,0	0,40
S14K250	Q69X3144	250	320	4500	65,0	0,60
S20K250	Q69X3232	250	320	8000	140,0	1,00
S20S250BR7	Q69X4518	250	320	8000	135,0	1,00
S05K275	Q69X3034	275	350	400	8,6	0,10
S07K275	Q69X3045	275	350	1200	21,0	0,25
S10K275	Q69X3125	275	350	2500	43,0	0,40
S14K275	Q69X3145	275	350	4500	71,0	0,60
S14K275E2	Q69X3750	275	350	6000	110,0	0,60
S20K275	Q69X3233	275	350	8000	151,0	1,00
S20S275BR7	Q69X4519	275	350	8000	146,0	1,00
S05K300	Q69X3035	300	385	400	9,6	0,10
S07K300	Q69X3046	300	385	1200	23,0	0,25
S10K300	Q69X3126	300	385	2500	47,0	0,40
S14K300	Q69X3146	300	385	4500	76,0	0,60
S14K300E2	Q69X3753	300	385	6000	125,0	0,60
S20K300	Q69X3234	300	385	8000	173,0	1,00
S10K320	Q69X4746	320	420	2500	50,0	0,40
S14K320	Q69X4327	320	420	4500	84,0	0,60
S14K320E2	Q69X3755	320	420	6000	135,0	0,60
S20K320	Q69X4328	320	420	8000	184,0	1,00



Characteristics (T_A = 25 °C)

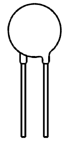
Type (untaped) SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	i A	C_{typ} (1 kHz) pF	Derating curve Page	V/I characteristic Page
S05K230	360	± 10	595	5,0	60	183	204
S07K230	360	± 10	595	10,0	115	183	205
S10K230	360	± 10	595	25,0	230	184	206
S14K230	360	± 10	595	50,0	380	186	207
S20K230	360	± 10	595	100,0	760	188	208
S05K250	390	± 10	650	5,0	55	183	204
S07K250	390	± 10	650	10,0	105	183	205
S10K250	390	± 10	650	25,0	215	184	206
S14K250	390	± 10	650	50,0	350	186	207
S20K250	390	± 10	650	100,0	700	188	208
S20S250BR7	390	+ 6/– 10	620	100,0	700	188	209
S05K275	430	± 10	710	5,0	50	183	204
S07K275	430	± 10	710	10,0	95	183	205
S10K275	430	± 10	710	25,0	195	184	206
S14K275	430	± 10	710	50,0	320	186	207
S14K275E2	430	± 10	710	50,0	320	186	207
S20K275	430	± 10	710	100,0	630	188	208
S20S275BR7	430	+ 6/– 10	680	100,0	630	188	209
S05K300	470	± 10	775	5,0	45	183	204
S07K300	470	± 10	775	10,0	90	183	205
S10K300	470	± 10	775	25,0	180	184	206
S14K300	470	± 10	775	50,0	300	186	207
S14K300E2	470	± 10	775	50,0	300	186	207
S20K300	470	± 10	775	100,0	580	188	208
S10K320	510	± 10	840	25,0	170	184	206
S14K320	510	± 10	840	50,0	280	186	207
S14K320E2	510	± 10	840	50,0	280	186	207
S20K320	510	± 10	840	100,0	540	188	208



Standard

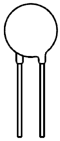
Maximum ratings (T_A = 85 °C)

Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
S05K385	Q69X3700	385	505	400	13,0	0,10
S07K385	Q69X3825	385	505	1200	28,0	0,25
S10K385	Q69X3127	385	505	2500	40,0	0,40
S14K385	Q69X3147	385	505	4500	80,0	0,60
S20K385	Q69X3235	385	505	8000	150,0	1,00
S05K420	Q69X3703	420	560	400	14,0	0,10
S07K420	Q69X3826	420	560	1200	32,0	0,25
S10K420	Q69X3128	420	560	2500	45,0	0,40
S14K420	Q69X3148	420	560	4500	90,0	0,60
S20K420	Q69X3236	420	560	8000	175,0	1,00
S05K440	Q69X4779	440	585	400	16,0	0,10
S07K440	Q69X4780	440	585	1200	34,0	0,25
S10K440	Q69X4781	440	585	2500	47,0	0,40
S14K440	Q69X4782	440	585	4500	95,0	0,60
S20K440	Q69X4784	440	585	8000	185,0	1,00
S05K460	Q69X4702	460	615	400	18,0	0,10
S07K460	Q69X4743	460	615	1200	36,0	0,25
S10K460	Q69X3129	460	615	2500	50,0	0,40
S14K460	Q69X3149	460	615	4500	100,0	0,60
S20K460	Q69X3237	460	615	8000	195,0	1,00
S10K510	Q69X3131	510	670	2500	55,0	0,40
S14K510	Q69X3219	510	670	4500	110,0	0,60
S20K510	Q69X3239	510	670	6500	190,0	1,00
S10K550	Q69X3132	550	745	2500	60,0	0,40
S14K550	Q69X3220	550	745	4500	120,0	0,60
S20K550	Q69X3240	550	745	6500	210,0	1,00
S10K625	Q69X3133	625	825	2500	68,0	0,40
S14K625	Q69X3221	625	825	4500	130,0	0,60
S20K625	Q69X3241	625	825	6500	230,0	1,00



Characteristics (T_A = 25 °C)

Type (untaped) SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	i A	C_{typ} (1 kHz) pF	Derating curve Page	V/I char-acteristic Page
S05K385	620	± 10	1025	5,0	40	183	204
S07K385	620	± 10	1025	10,0	75	183	205
S10K385	620	± 10	1025	25,0	150	185	206
S14K385	620	± 10	1025	50,0	240	187	207
S20K385	620	± 10	1025	100,0	450	189	208
S05K420	680	± 10	1120	5,0	35	183	204
S07K420	680	± 10	1120	10,0	65	183	205
S10K420	680	± 10	1120	25,0	135	185	206
S14K420	680	± 10	1120	50,0	220	187	207
S20K420	680	± 10	1120	100,0	420	189	208
S05K440	715	± 10	1180	5,0	32	183	204
S07K440	715	± 10	1180	10,0	60	183	205
S10K440	715	± 10	1180	25,0	125	185	206
S14K440	715	± 10	1180	50,0	210	187	207
S20K440	715	± 10	1180	100,0	400	189	208
S05K460	750	± 10	1240	5,0	30	183	204
S07K460	750	± 10	1240	10,0	55	183	205
S10K460	750	± 10	1240	25,0	120	185	206
S14K460	750	± 10	1240	50,0	200	187	207
S20K460	750	± 10	1240	100,0	380	189	208
S10K510	820	± 10	1355	25,0	110	185	206
S14K510	820	± 10	1355	50,0	180	187	207
S20K510	820	± 10	1355	100,0	340	190	208
S10K550	910	± 10	1500	25,0	105	185	206
S14K550	910	± 10	1500	50,0	170	187	207
S20K550	910	± 10	1500	100,0	320	190	208
S10K625	1000	± 10	1650	25,0	90	185	206
S14K625	1000	± 10	1650	50,0	150	187	207
S20K625	1000	± 10	1650	100,0	280	190	208



Standard

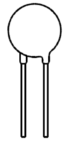
Maximum ratings (T_A = 85 °C)

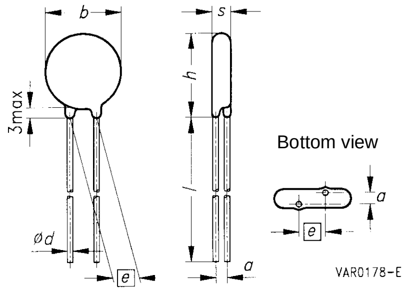
Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
S10K680	Q69X3134	680	895	2500	72,0	0,40
S14K680	Q69X3222	680	895	4500	140,0	0,60
S20K680	Q69X3242	680	895	6500	250,0	1,00
S14K1000[1]	Q69X3223	1100	1465	4500	230,0	0,60
S20K1000[1]	Q69X3243	1100	1465	6500	410,0	1,00

Characteristics (T_A = 25 °C)

Type (untaped) SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	i A	C_{typ} (1 kHz) pF	Derating curve Page	V/I characteristic Page
S10K680	1100	± 10	1815	25,0	85	185	206
S14K680	1100	± 10	1815	50,0	140	187	207
S20K680	1100	± 10	1815	100,0	250	190	208
S14K1000[1]	1800	± 10	2970	50,0	100	187	207
S20K1000[1]	1800	± 10	2970	100,0	170	190	208

1) Operating voltage differs from type designation.

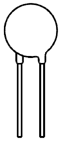




Dimensions

Type	e ± 1 mm	$a \pm 1$ mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-S05K11	5,0	1,2	7,0	3,5	9,5	30,0	0,6
SIOV-S07K11	5,0	1,2	9,0	3,5	11,5	30,0	0,6
SIOV-S10K11	7,5 (5)	1,4 (1,2)	12,5	4,1 (3,7)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K11	7,5	1,4	16,5	4,1	19,0	30,0	0,8
SIOV-S20K11	10,0	1,5	22,5	4,5	26,0	30,0	1,0
SIOV-S05K14	5,0	1,3	7,0	3,6	9,5	30,0	0,6
SIOV-S07K14	5,0	1,3	9,0	3,6	11,5	30,0	0,6
SIOV-S10K14	7,5 (5)	1,5 (1,3)	12,5	4,2 (3,8)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K14	7,5	1,5	16,5	4,2	19,0	30,0	0,8
SIOV-S20K14	10,0	1,6	22,5	4,6	26,0	30,0	1,0
SIOV-S05K17	5,0	1,4	7,0	3,7	9,5	30,0	0,6
SIOV-S07K17	5,0	1,4	9,0	3,7	11,5	30,0	0,6
SIOV-S10K17	7,5 (5)	1,6 (1,4)	12,5	4,3 (3,9)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K17	7,5	1,7	16,5	4,4	19,0	30,0	0,8
SIOV-S20K17	10,0	1,8	22,5	4,8	26,0	30,0	1,0
SIOV-S05K20	5,0	1,2	7,0	3,9	9,5	30,0	0,6
SIOV-S07K20	5,0	1,2	9,0	3,9	11,5	30,0	0,6
SIOV-S10K20	7,5 (5)	1,8 (1,6)	12,5	4,5 (4,1)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K20	7,5	1,9	16,5	4,6	19,0	30,0	0,8
SIOV-S20K20	10,0	2,1	22,5	5,1	26,0	30,0	1,0

Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 152 ff.

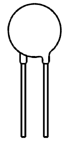


Standard

Dimensions

Type	$e \pm 1$ mm	$a \pm 1$ mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-S05K25	5,0	1,3	7,0	3,6	9,5	30,0	0,6
SIOV-S07K25	5,0	1,3	9,0	3,6	11,5	30,0	0,6
SIOV-S10K25	7,5 (5)	1,6 (1,4)	12,5	4,3 (3,9)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K25	7,5	1,7	16,5	4,4	19,0	30,0	0,8
SIOV-S20K25	10,0	1,8	22,5	4,8	26,0	30,0	1,0
SIOV-S05K30	5,0	1,5	7,0	3,8	9,5	30,0	0,6
SIOV-S07K30	5,0	1,5	9,0	3,8	11,5	30,0	0,6
SIOV-S10K30	7,5 (5)	1,7 (1,5)	12,5	4,4 (4,0)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K30	7,5	1,8	16,5	4,5	19,0	30,0	0,8
SIOV-S20K30	10,0	2,0	22,5	5,0	26,0	30,0	1,0
SIOV-S05K35	5,0	1,6	7,0	3,9	9,0	30,0	0,6
SIOV-S07K35	5,0	1,6	9,0	3,9	11,5	30,0	0,6
SIOV-S10K35	7,5 (5)	1,8 (1,6)	12,5	4,5 (4,1)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K35	7,5	2,0	16,5	4,7	19,0	30,0	0,8
SIOV-S20K35	10,0	2,2	22,5	5,2	26,0	30,0	1,0
SIOV-S05K40	5,0	1,8	7,0	4,1	9,5	30,0	0,6
SIOV-S07K40	5,0	1,8	9,0	4,1	11,5	30,0	0,6
SIOV-S10K40	7,5 (5)	2,1 (1,9)	12,5	4,8 (4,4)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K40	7,5	2,2	16,5	4,9	19,0	30,0	0,8
SIOV-S20K40	10,0	2,4	22,5	5,4	26,0	30,0	1,0
SIOV-S05K50	5,0	1,2	7,0	3,5	9,5	30,0	0,6
SIOV-S07K50	5,0	1,2	9,0	3,5	11,5	30,0	0,6
SIOV-S10K50	7,5 (5)	1,4 (1,2)	12,5	4,1 (3,7)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K50	7,5	1,4	16,5	4,1	19,0	30,0	0,8
SIOV-S20K50	10,0	1,5	22,5	4,5	26,0	30,0	1,0
SIOV-S05K60	5,0	1,2	7,0	3,5	9,5	30,0	0,6
SIOV-S07K60	5,0	1,2	9,0	3,5	11,5	30,0	0,6
SIOV-S10K60	7,5 (5)	1,4 (1,2)	12,5	4,1 (3,7)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K60	7,5	1,5	16,5	4,2	19,0	30,0	0,8
SIOV-S20K60	10,0	1,6	22,5	4,6	26,0	30,0	1,0

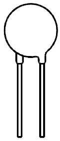
Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 152 ff.



Dimensions

Type	e ± 1 mm	a ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-S05K75	5,0	1,3	7,0	3,6	9,5	30,0	0,6
SIOV-S07K75	5,0	1,3	9,0	3,6	11,5	30,0	0,6
SIOV-S10K75	7,5 (5)	1,5 (1,3)	12,5	4,2 (3,8)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K75	7,5	1,5	16,5	4,2	19,0	30,0	0,8
SIOV-S20K75	10,0	1,6	22,5	4,6	26,0	30,0	1,0
SIOV-S05K95	5,0	1,3	7,0	3,6	9,5	30,0	0,6
SIOV-S07K95	5,0	1,3	9,0	3,6	11,5	30,0	0,6
SIOV-S10K95	7,5 (5)	1,5 (1,3)	12,5	4,2 (3,8)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K95	7,5	1,5	16,5	4,2	19,0	30,0	0,8
SIOV-S20K95	10,0	1,6	22,5	4,6	26,0	30,0	1,0
SIOV-S05K115	5,0	1,5	7,0	3,8	9,5	30,0	0,6
SIOV-S07K115	5,0	1,5	9,0	3,8	11,5	30,0	0,6
SIOV-S10K115	7,5 (5)	1,6 (1,4)	12,5	4,3 (3,9)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K115	7,5	1,7	16,5	4,4	19,0	30,0	0,8
SIOV-S20K115	10,0	1,8	22,5	4,8	26,0	30,0	1,0
SIOV-S05K130	5,0	1,6	7,0	3,9	9,5	30,0	0,6
SIOV-S07K130	5,0	1,6	9,0	3,9	11,5	30,0	0,6
SIOV-S10K130	7,5 (5)	1,8 (1,6)	12,5	4,5 (4,1)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K130	7,5	1,9	16,5	4,6	19,0	30,0	0,8
SIOV-S14K130E2	7,5	1,9	16,5	4,6	19,0	30,0	0,8
SIOV-S20K130	10,0	2,0	22,5	5,0	26,0	30,0	1,0
SIOV-S20S130BR7	7,5	1,8	22,5	4,6	26,0	30,0	0,8
SIOV-S20K130E2	10,0	1,8	22,5	5,0	26,0	30,0	1,0
SIOV-S05K140	5,0	1,7	7,0	4,0	9,5	30,0	0,6
SIOV-S07K140	5,0	1,7	9,0	4,0	11,5	30,0	0,6
SIOV-S10K140	7,5 (5)	1,9 (1,7)	12,5	4,6 (4,2)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K140	7,5	2,0	16,5	4,7	19,0	30,0	0,8
SIOV-S14K140E2	7,5	2,0	16,5	4,7	19,0	30,0	0,8
SIOV-S20K140	10,0	2,1	22,5	5,1	26,0	30,0	1,0
SIOV-S20K140E2	10,0	2,1	22,5	5,1	26,0	30,0	1,0

Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 152 ff.

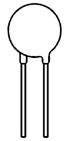


Standard

Dimensions

Type	e ± 1 mm	$a \pm 1$ mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-S05K150	5,0	1,8	7,0	4,1	9,5	30,0	0,6
SIOV-S07K150	5,0	1,8	9,0	4,1	11,5	30,0	0,6
SIOV-S10K150	7,5 (5)	2,0 (1,8)	12,5	4,7 (4,3)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K150	7,5	2,1	16,5	4,8	19,0	30,0	0,8
SIOV-S14K150E2	7,5	2,1	16,5	4,8	19,0	30,0	0,8
SIOV-S20K150	10,0	2,2	22,5	5,2	26,0	30,0	1,0
SIOV-S20S150BR7	7,5	2,0	22,5	4,8	26,0	30,0	0,8
SIOV-S20K150E2	10,0	2,2	22,5	5,2	26,0	30,0	1,0
SIOV-S05K175	5,0	2,0	7,0	4,3	9,5	30,0	0,6
SIOV-S07K175	5,0	2,0	9,0	4,3	11,5	30,0	0,6
SIOV-S10K175	7,5 (5)	2,2 (2,0)	12,5	4,9 (4,5)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K175	7,5	2,2	16,5	4,9	19,0	30,0	0,8
SIOV-S20K175	10,0	2,3	22,5	5,3	26,0	30,0	1,0
SIOV-S05K230	5,0	2,5	7,0	4,8	9,5	30,0	0,6
SIOV-S07K230	5,0	2,5	9,0	4,8	11,5	30,0	0,6
SIOV-S10K230	7,5 (5)	2,7 (2,5)	12,5	5,4 (5,0)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K230	7,5	2,8	16,5	5,5	19,0	30,0	0,8
SIOV-S20K230	10,0	2,9	22,5	5,9	26,0	30,0	1,0
SIOV-S05K250	5,0	2,7	7,0	5,0	9,5	30,0	0,6
SIOV-S07K250	5,0	2,7	9,0	5,0	11,5	30,0	0,6
SIOV-S10K250	7,5 (5)	2,9 (2,7)	12,5	5,6 (5,2)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K250	7,5	3,0	16,5	5,7	19,0	30,0	0,8
SIOV-S20K250	10,0	3,1	22,5	6,1	27,0	30,0	1,0
SIOV-S20S250BR7	7,5	2,9	22,5	5,7	27,0	30,0	0,8
SIOV-S05K275	5,0	2,9	7,0	5,2	9,5	30,0	0,6
SIOV-S07K275	5,0	2,9	9,0	5,2	11,5	30,0	0,6
SIOV-S10K275	7,5 (5)	3,1 (2,9)	12,5	5,8 (5,4)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K275	7,5	3,2	16,5	5,9	19,0	30,0	0,8
SIOV-S14K275E2	7,5	3,2	16,5	5,9	19,0	30,0	0,8
SIOV-S20K275	10,0	3,3	22,5	6,3	27,0	30,0	1,0
SIOV-S20S275BR7	7,5	3,1	22,5	5,9	27,0	30,0	0,8

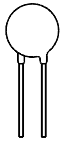
Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 152 ff.



Dimensions

Type	e ± 1 mm	a ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-S05K300	5,0	3,1	7,0	5,4	9,5	30,0	0,6
SIOV-S07K300	5,0	3,1	9,0	5,4	11,5	30,0	0,6
SIOV-S10K300	7,5 (5)	3,4 (3,2)	12,5	6,1 (5,7)	15,0	30,0 (*)	0,8 (0,6)
SIOV-S14K300	7,5	3,4	16,5	6,1	19,5	30,0	0,8
SIOV-S14K300E2	7,5	3,4	16,5	6,1	19,5	30,0	0,8
SIOV-S20K300	10,0	3,6	22,5	6,6	27,0	30,0	1,0
SIOV-S10K320	7,5	3,6	12,5	6,3	15,5	30,0	0,8
SIOV-S14K320	7,5	3,6	16,5	6,3	19,5	30,0	0,8
SIOV-S14K320E2	7,5	3,6	16,5	6,3	19,5	30,0	0,8
SIOV-S20K320	10,0	3,8	22,5	6,8	27,5	30,0	1,0
SIOV-S05K385	5,0	3,9	7,0	6,2	9,5	30,0	0,6
SIOV-S07K385	5,0	3,9	9,0	6,2	11,5	30,0	0,6
SIOV-S10K385	7,5	4,2	12,5	6,9	15,5	30,0	0,8
SIOV-S14K385	7,5	4,2	16,5	6,9	19,5	30,0	0,8
SIOV-S20K385	10,0	4,5	22,5	7,5	27,5	30,0	1,0
SIOV-S05K420	5,0	4,3	7,0	6,6	9,5	30,0	0,6
SIOV-S07K420	5,0	4,3	9,0	6,6	11,5	30,0	0,6
SIOV-S10K420	7,5	4,6	12,5	7,3	15,5	30,0	0,8
SIOV-S14K420	7,5	4,7	16,5	7,4	19,5	30,0	0,8
SIOV-S20K420	10,0	4,8	22,5	7,8	27,5	30,0	1,0
SIOV-S05K440	5,0	4,5	7,0	6,8	9,5	30,0	0,6
SIOV-S07K440	5,0	4,5	9,0	6,8	11,5	30,0	0,6
SIOV-S10K440	7,5	4,8	12,5	7,5	15,5	30,0	0,8
SIOV-S14K440	7,5	4,9	16,5	7,6	19,5	30,0	0,8
SIOV-S20K440	10,0	5,0	22,5	8,0	27,5	30,0	1,0
SIOV-S05K460	5,0	4,7	7,0	7,0	9,5	30,0	0,6
SIOV-S07K460	5,0	4,7	9,0	7,0	11,5	30,0	0,6
SIOV-S10K460	7,5	5,0	12,5	7,7	15,5	30,0	0,8
SIOV-S14K460	7,5	5,1	16,5	7,8	19,5	30,0	0,8
SIOV-S20K460	10,0	5,2	22,5	8,2	27,5	30,0	1,0

Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 152 ff.



Standard

Dimensions

Type	*e* ± 1 mm	*a* ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	*d* mm
SIOV-S10K510	7,5	5,4	12,5	8,1	15,5	30,0	0,8
SIOV-S14K510	7,5	5,5	16,5	8,2	19,5	30,0	0,8
SIOV-S20K510	10,0	5,6	22,5	8,7	27,5	30,0	1,0
SIOV-S10K550	7,5	5,9	12,5	8,6	15,5	30,0	0,8
SIOV-S14K550	7,5	6,0	16,5	8,7	19,5	30,0	0,8
SIOV-S20K550	10,0	6,2	22,5	9,2	27,5	30,0	1,0
SIOV-S10K625	7,5	6,4	12,5	9,1	15,5	30,0	0,8
SIOV-S14K625	7,5	6,5	16,5	9,2	19,5	30,0	0,8
SIOV-S20K625	10,0	6,6	22,5	9,7	27,5	30,0	1,0
SIOV-S10K680	7,5	7,0	12,5	9,7	15,5	30,0	0,8
SIOV-S14K680	7,5	7,1	16,5	9,8	19,5	30,0	0,8
SIOV-S20K680	10,0	7,3	22,5	10,3	27,5	30,0	1,0
SIOV-S14K1000	7,5	11,2	16,5	13,9	20,5	30,0	0,8
SIOV-S20K1000	10,0	11,5	22,5	14,5	28,5	30,0	1,0

Weight

Size	approx.	
S05K11 … 460	0,3 … 1,0 g	The weight of varistors in between these voltage classes can be interpolated.
S07K11 … 460	0,6 … 1,3 g	
S10K11 … 680	1,0 … 4,0 g	
S14K11 … 1000	2,0 … 15,0 g	
S20K11 … 1000	3,0 … 20,0 g	

Construction

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

Features

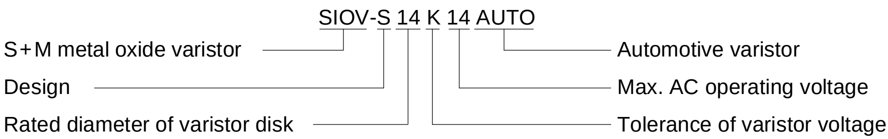
- High energy absorption, particularly in case of load dump
- Jump-start strength
- Stable protection level, minimum leakage current
- High resistance to cyclic temperature stress
- PSpice models
- Types for T_A = 125 °C

Taping

- All types available on tape upon request

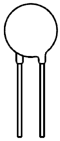
Type designation

Detailed description of coding system on page 33



General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 (D1: 40/125/56) – 40 °C + 85 °C (D1: + 125 °C) 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C (D1: … + 125 °C)	in accordance with CECC 42 000
Storage temperature	– 40 … + 125 °C (D1: … + 150 °C)	
Electric strength	≥ 2,5 kV (not D1)	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ (not D1)	in accordance with CECC 42 000
Response time	< 25 ns	



Automotive

Maximum ratings (T_A = 85 °C, T_A = 125 °C for S…D1)

Type (untaped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W	W_{LD} (10x) J
12-V supply systems							
S07K14AUTOS2D1	Q69X4309	14	16	250	0,9	0,02	12
S10K14AUTO	Q69X3859	14	16	500	2,0	0,05	25
S10K14AUTOS5D1	Q69X4310	14	16	500	2,0	0,05	25
S14K14AUTO	Q69X4482	14	16	1000	4,0	0,10	50
S14K14AUTOS5D1	Q69X4311	14	16	1000	4,0	0,10	50
S20K14AUTO	Q69X3625	14	16	2000	12,0	0,20	100
S10K17AUTO	Q69X4570	17	20	500	2,5	0,05	25
S14K17AUTO	Q69X4325	17	20	1000	5,0	0,10	50
S20K17AUTO	Q69X4569	17	20	2000	14,0	0,20	100
24-V supply systems							
S20K25AUTO	Q69X4885	25	28	2000	22,0	0,20	100
S14K30AUTO	Q69X3889	30	34	1000	9,0	0,10	50
S20K30AUTO	Q69X3803	30	34	2000	26,0	0,20	100

Characteristics (T_A = 25 °C)

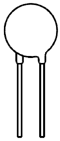
Type (untaped) SIOV-	V_{Jump} (5 min) V	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage v V	i A	C_{typ} (1 kHz) nF	Derating curve Page	V/I characteristic Page
12-V supply systems								
S07K14AUTOS2D1	25	22	± 10	43	2,5	2,5	182	205
S10K14AUTO	25	22	± 10	43	5,0	5,2	184	206
S10K14AUTOS5D1	25	22	± 10	43	5,0	5,2	184	206
S14K14AUTO	25	22	± 10	43	10,0	9,0	185	207
S14K14AUTOS5D1	25	22	± 10	43	10,0	9,0	185	207
S20K14AUTO	25	22	± 10	43	20,0	15,0	187	208
S10K17AUTO	30	27	± 10	53	5,0	4,0	184	206
S14K17AUTO	30	27	± 10	53	10,0	7,0	185	207
S20K17AUTO	30	27	± 10	53	20,0	13,0	187	208
24-V supply systems								
S20K25AUTO	40	39	± 10	77	20,0	10,0	187	208
S14K30AUTO	50	47	± 10	93	10,0	3,5	185	207
S20K30AUTO	50	47	± 10	93	20,0	9,0	187	208

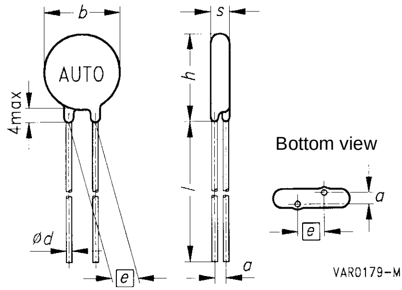
Notes

- 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 S+M Components 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 30 ms, interval 60 s.

Fast temperature cycling	IEC 68-2-14, test Na, UCT/LCT, dwell time 15 min 100 cycles: SIOV-S…AUTO 1000 cycles: SIOV-S…AUTOD1	$\lvert\Delta V/V$ (1 mA)$\rvert \leq$ 10 % No visible damage
Damp heat, steady state	Based on IEC 68-2-3, 85 °C, 85 % r.h., V_{DC}, 1000 h	$\lvert\Delta V/V$ (1 mA)$\rvert$[1] $\leq$ 10 % No visible damage
Max. DC operating voltage	MIL STD 202F, method 108A, UCT, V_{DC}, 1000 h	$\lvert\Delta V/V$ (1 mA)$\rvert$[1] $\leq$ 10 % No visible damage

1) Measured in load direction





Dimensions

Type	e ± 1 mm	a ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-S07K14AUTOS2D1	5,0	1,3	9,0	3,6	13,0	30,0	0,6
SIOV-S10K14AUTO	7,5	1,5	13,5	5,2	17,5	30,0	0,8
SIOV-S10K14AUTOS5D1	7,5	1,5	12,5	4,2	16,0	30,0	0,8
SIOV-S14K14AUTO	7,5	1,5	17,5	5,3	22,0	30,0	0,8
SIOV-S14K14AUTOS5D1	7,5	1,5	16,5	4,2	20,0	30,0	0,8
SIOV-S20K14AUTO	10,0	1,6	24,0	5,6	29,0	30,0	1,0
SIOV-S10K17AUTO	7,5	1,6	13,5	5,3	17,5	30,0	0,8
SIOV-S14K17AUTO	7,5	1,7	17,5	5,4	22,0	30,0	0,8
SIOV-S20K17AUTO	10,0	1,6	24,0	5,8	29,0	30,0	1,0
SIOV-S20K25AUTO	10,0	2,9	24,0	6,2	29,0	30,0	1,0
SIOV-S14K30AUTO	7,5	1,8	17,5	5,8	22,0	30,0	0,8
SIOV-S20K30AUTO	10,0	3,2	24,0	6,5	29,0	30,0	1,0

For crimp styles S2 and S5 see page 153

Weight

Size	approx.
S07	0,6 … 0,8 g
S10	1,0 … 2,0 g
S14	2,0 … 4,0 g
S20	3,0 … 6,0 g

Construction

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

Features

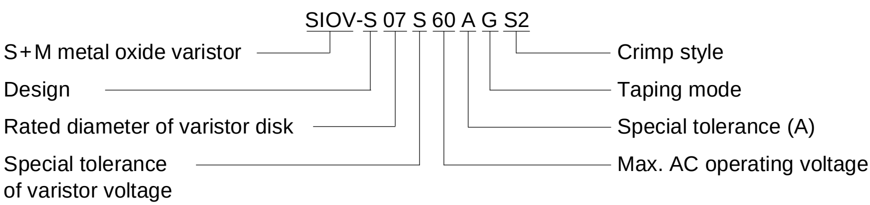
- Suitable for handling the surge current of the 10/700 µs pulse to CCITT and IEC 1000-4-5
- Special types with controlled minimum resistance and protection level available
- Matched to line conditions with or without superimposed ringing voltage
- Electrical SMD equivalents available
- PSpice models

Taping

- Only available on tape

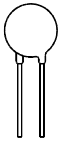
Type designation

Detailed description of coding system on page 33



General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 125 °C	
Electric strength	≥ 2,5 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	



Telecom

Maximum ratings (T_A = 85 °C)

Type (taped) SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
S07S60AGS2	Q69X3815	60	85	1200	4,8	0,25
S07S95AGS2	Q69X4574	95	125	1200	7,6	0,25

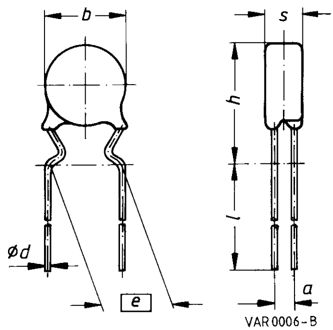
Characteristics (T_A = 25 °C)

Type (taped) SIOV-	R_{min} kΩ	Max. clamping voltage		C_{typ} (1 kHz) pF	Derating curve Page	V/I characteristic Page
		v V	i A			
S07S60AGS2	250 (95 V)	200	45	480	183	—
S07S95AGS2	150 (150 V)	270	45	260	183	—

Note

All standard varistors are also suitable for telecom applications, provided that the selection criteria are observed.

Weight:
S07S60: approx. 0,6 … 0,8 g
S07S95: approx. 0,6 … 0,8 g



Dimensions

Type	e +0,6/-0,1 mm	$a \pm 1$ mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-S07S60AGS2	5,0	1,2	9,0	3,5	13,0	(*)	0,6
SIOV-S07S95AGS2	5,0	1,3	9,0	3,6	13,0	(*)	0,6

For (*) see taping page 152 ff.

Construction

- Combination of a multilayer ceramic capacitor and a multilayer varistor
- Coating: epoxy resin, flame-retardant to UL 94 V-0
- Terminals: tinned copper wire

Features

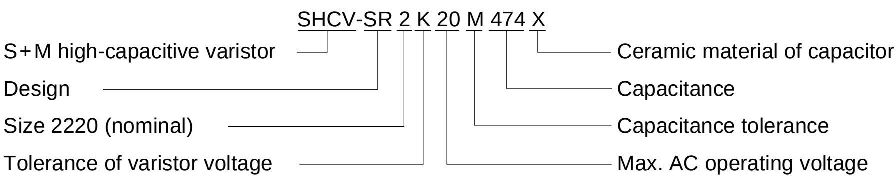
- High capacitance
- Overvoltage protection and RFI suppression provided by a single component
- Load-dump withstand capability
- Jump-start strength
- PSpice models

Taping

- Upon request

Type designation

Detailed description of coding system on page 33



General technical data

Climatic category	X1)	40/85/56	in accordance with IEC 68-1
	Z2)	25/85/56	
LCT	X	– 40 °C	
	Z	– 25 °C	
UCT	X	+ 85 °C	
	Z	+ 85 °C	
Damp heat, steady state (93 % r.h., 40 °C)		56 days	in accordance with IEC 68-2-3
Operating temperature (full load)	X	– 40 … + 85 °C	in accordance with CECC 42 000
	Z	– 25 … + 85 °C	
Storage temperature	X	– 40 … + 125 °C	
	Z	– 25 … + 85 °C	
Electric strength		≥ 1,0 kV	in accordance with CECC 42 000
Insulation resistance		≥ 1,0 GΩ	in accordance with CECC 42 000
Response time		< 25 ns	

1) Ceramic material: X = X7R
2) Ceramic material: Z = Z5U

Maximum ratings (T_A = 85 °C)

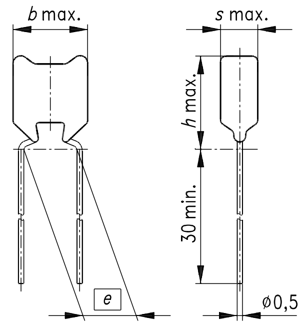
Type (untaped) SHCV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W	W_{LD} (10x) J
SR1S14BM474X	Q69587-E3140-S200	14	16	800	2,4	0,015	6
SR2S14BM474X	Q69547-E3140-S200	14	16	1200	5,8	0,030	12
SR1S14BM105Z	Q69588-G3140-S200	14	16	800	2,4	0,015	6
SR1S14BM155Z	Q69588-H3140-S200	14	16	800	2,4	0,015	6
SR2S14BM105Z	Q69548-G3140-S200	14	16	1200	5,8	0,030	12
SR2S14BM155Z	Q69548-H3140-S200	14	16	1200	5,8	0,030	12
SR1K20M474X	Q69587-E3200-K	20	26	800	3,0	0,015	6
SR2K20M474X	Q69547-E3200-K	20	26	1200	7,8	0,030	12
SR1K20M105Z	Q69588-G3200-K	20	26	800	3,0	0,015	6
SR1K20M155Z	Q69588-H3200-K	20	26	800	3,0	0,015	6
SR2K20M105Z	Q69548-G3200-K	20	26	1200	7,8	0,030	12
SR2K20M155Z	Q69548-H3200-K	20	26	1200	7,8	0,030	12

Characteristics (T_A = 25 °C)

Type (untaped)	V_{Jump} (5 min)	V_v (1 mA)	ΔV_v (1 mA)	Max. clamping voltage		$C \pm 20\%$ (1 kHz)	Derating curve	V/I characteristic
				v	i			
SHCV-	V	V	%	V	A	µF	Page	Page
SR1S14BM474X	24,5	22	+ 23/– 0	40	5,0	0,47	180	203
SR2S14BM474X	24,5	22	+ 23/– 0	40	10,0	0,47	181	203
SR1S14BM105Z	24,5	22	+ 23/– 0	40	5,0	1,00	180	203
SR1S14BM155Z	24,5	22	+ 23/– 0	40	5,0	1,50	180	203
SR2S14BM105Z	24,5	22	+ 23/– 0	40	10,0	1,00	181	203
SR2S14BM155Z	24,5	22	+ 23/– 0	40	10,0	1,50	181	203
SR1K20M474X	26,0	33	± 10	58	5,0	0,47	180	201
SR2K20M474X	26,0	33	± 10	58	10,0	0,47	181	202
SR1K20M105Z	26,0	33	± 10	58	5,0	1,00	180	201
SR1K20M155Z	26,0	33	± 10	58	5,0	1,50	180	201
SR2K20M105Z	26,0	33	± 10	58	10,0	1,00	181	202
SR2K20M155Z	26,0	33	± 10	58	10,0	1,50	181	202

Notes

- 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 S+M Components 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 30 ms, interval 60 s.

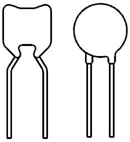


e = 5,0 ± 1
Offset = 0,0 ± 1 VAR0187-D

Weight: approx. 1 g

Dimensions

Type	b_{max} mm	s_{max} mm	h_{max} mm
SHCV-SR1 … 474X	7,3	3,6	7,8
SHCV-SR1 … 105Z	7,3	4,0	7,8
SHCV-SR1 … 155Z	7,3	4,1	7,8
SHCV-SR2 … 474X	7,8	3,6	9,0
SHCV-SR2 … 105Z	7,8	4,0	9,0
SHCV-SR2 … 155Z	7,8	4,1	9,0



Taping

All disk varistors are available on tape. Exception: S10/14/20K320 … K1000.

Tape packaging for lead spacing $\boxed{e}$ = 5 fully conforms to IEC 286-2, while for lead spacings $\boxed{e}$ = 7,5 and 10 the taping mode is based on this standard.

The ordering tables on page 154 ff list all disk types available on tape in detail, i. e. with complete type designation and ordering code. Taping mode and, if relevant, crimp style and lead spacing are coded in the type designation.

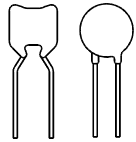
Designation system for taping mode

Type designation untaped	Taped, reel type	Crimp style (if relevant)	Lead spacing (if relevant)
	G G2 G3 see page 150 G4 G5	S S2 S3 see page 153 S4 S5	R5 Lead spacing R7 differs from that of standard version

Example SIOV-S10K250GS3R5

SIOV-S10K250	G	S3	R5
	Taped Reel type I Seating plane height H_0 =16	Crimp style 3	Lead spacing 5,0 (differs from LS 7,5 of standard version S10K250)

The different delivery modes and all variants of reels, tapes and crimp styles are described on the following pages.



Taping modes/reel types

Taped varistors have the letter “G” appended to the type designation.

The different tapes and matching reel types are identified by numbers as shown in the table on page 150.
Types with lead spacing $\boxed{e}$ = 5, reel diameter 360 mm, have the code letter “G” while types with lead spacing $\boxed{e}$ = 7,5 and 10 on 500-mm reels are identified by “G5”.

Versions G2, G3 and G4 are special tapes on 360-mm reels: G2 denotes the seating plane height H_0 = 18 for crimped versions. Tapes G3 and G4 are available on 360-mm reels in case the 500-mm reels are too big for your insertion machine.

Crimp styles

Both crimped and straight leads are standard for taped disk varistors. The leads are differently crimped for technical reasons; the individual crimp styles are denoted by consecutive numbers (S, S2 … S5) as shown in the dimensional drawings on page 153.

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

Example straight leads: S10K250G5
Example crimped leads: S10K250G5S5

Lead spacing

Type series SIOV-S10 is available with two different lead spacings:

$\boxed{e}$ = 5,0 (wire ∅ 0,6 mm)
$\boxed{e}$ = 7,5 (wire ∅ 0,8 mm)

For taped varistors which have another lead spacing than their untaped equivalents, the actual $\boxed{e}$ is appended to type designation.

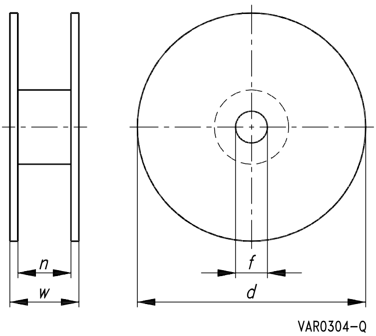
Example: S10K250GS3R5
The standard lead spacing of series SIOV-S10 is $\boxed{e}$ = 7,5. The version with $\boxed{e}$ = 5,0 has the appendix “R5”.

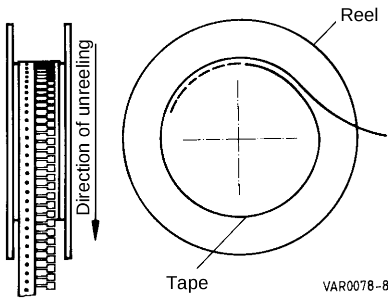
Taping

Assignment of taping mode to reel type

Taping mode	Reel type	Seating plane height H_0 for crimped types mm	Seating plane height H for uncrimped types mm
G[1]	I	16	18
G2	I	18	—
G3	II	16	18
G4	II	18	—
G5	III	16	18

Taping modes G2, G3, G4: delivery upon request.



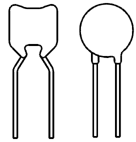


Reel dimensions (in mm)

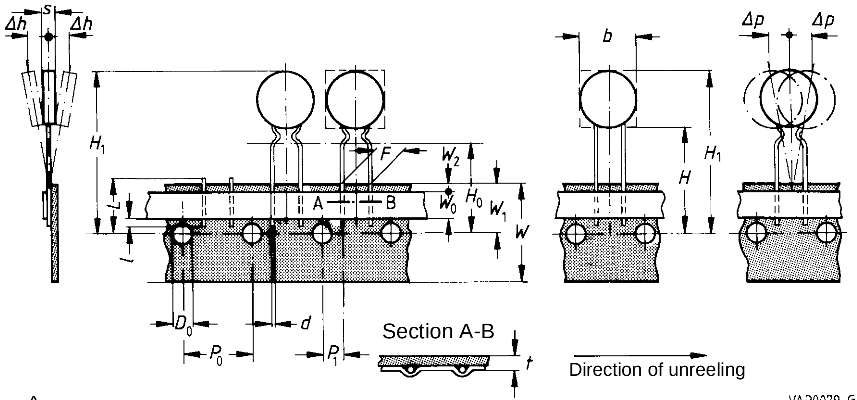
Reel type	*d*	*f*	*n*	*w*
I	360 max.	31 ± 1	approx. 45	54 max.
II	360 max.	31 ± 1	approx. 55	64 max.
III	500 max.	23 ± 1	approx. 59	72 max.

If reel type III is not compatible with insertion equipment because of its large diameter, type series S10 and S14 can be supplied on reel II upon request (taping mode G3).

1) "1" is omitted.

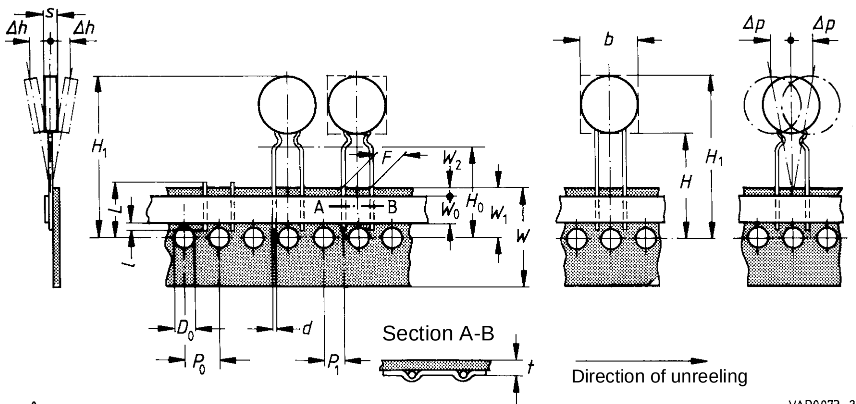


Taping in accordance with IEC 286-2

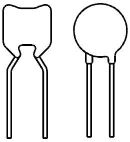


$F \triangleq$ $\boxed{e}$ = 5,0 mm

Taping based on IEC 286-2



$F \triangleq$ $\boxed{e}$ = 7,5 mm and 10 mm

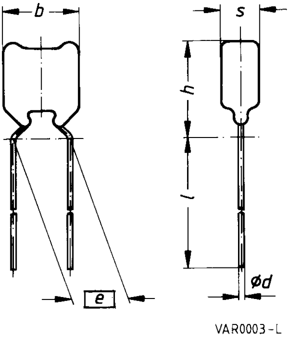


Tape dimensions (in mm)

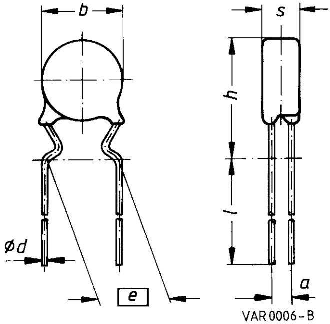
Symbol	e = 5,0	Tolerance	e = 7,5	Tolerance	e = 10,0	Tolerance	Remarks
b		max.		max.		max.	see tables
s		max.		max.		max.	on page 133 ff
d	0,6[1]	± 0,05	0,8	± 0,05	1,0	± 0,05	
P_0	12,7	± 0,2	12,7	± 0,3	12,7	± 0,3	± 1 mm/20 sprocket holes
P_1	3,85	± 0,7	8,95	± 0,8	7,7	± 0,8	
F	5,0	+ 0,6/– 0,1	7,5	± 0,8	10,0	± 1,0	
Δh	0	± 2,0	depends on s		depends on s		measured at
Δp	0	± 1,3	0	± 2,0	0	± 2,0	top of compo-nent body
W	18,0	± 0,5	18,0	± 0,5	18,0	± 0,5	
W_0	5,5	min.	5,5	min.	5,5	min.	Peel-off force ≥ 5 N
W_1	9,0	± 0,5	9,0	+ 0,75/– 0,5	9,0	+ 0,75/– 0,5	
W_2	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]
H_0	16,0 (18,0)	± 0,5	16,0 (18,0)	± 0,5	16,0	± 0,5	[3]
H_1	32,2	max.	45,0	max.	45,0	max.	
D_0	4,0	± 0,2	4,0	± 0,2	4,0	± 0,2	
t	0,9	max.	0,9	max.	0,9	max.	
L	11,0	max.	11,0	max.	11,0	max.	
l	4,0	max.	4,0	max.	4,0	max.	

1) SR 0,5
2) Applies only to uncrimped types
3) Applies only to crimped types (H_0 = 18 upon request)

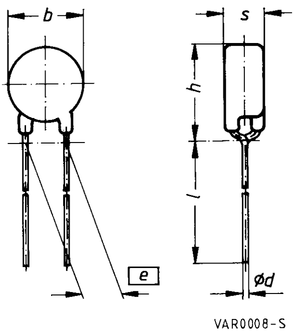
Crimp style S1)



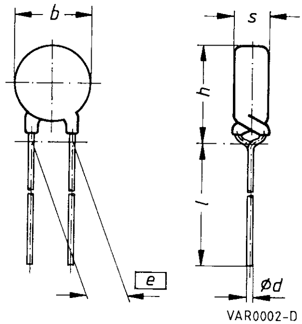
Crimp style S2



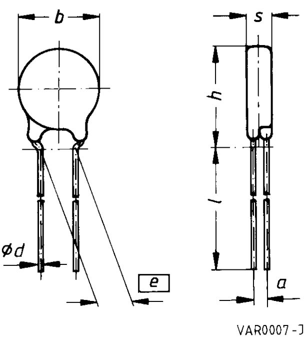
Crimp style S3



Crimp style S4



Crimp style S5

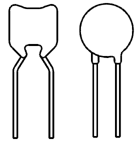


Type	e mm	h_{max} mm
SIOV-SR1210 … S	5,0	6,5
SIOV-S05 … S2	5,0	11,0
SIOV-S05 … S3	5,0	10,0
SIOV-SR2220 … S	5,0	9,0
SIOV-S07 … S2	5,0	13,0
SIOV-S07 … S3	5,0	12,0
SIOV-S10 … S4R5	5,0	15,0
SIOV-S10 … S3R5	5,0	15,0
SIOV-S10 … S5	7,5	17,5
SIOV-S14 … S5	7,5	21,5
SIOV-S20 … S5	10,0	28,5

1) “1” is omitted.

Taping

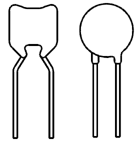
Type	Ordering code	Crimp style	Pieces/reel I
Type series SIOV-SR, crimped leads e = 5,0			
SIOV-SR1210M4GS	Q69535-R40-M52	S	2000
SIOV-SR1210M6GS	Q69535-R60-M52	S	2000
SIOV-SR1210L8GS	Q69535-R80-L52	S	2000
SIOV-SR2220M4GS	Q69545-R40-M52	S	2000
SIOV-SR2220M6GS	Q69545-R60-M52	S	2000
SIOV-SR2220L8GS	Q69545-R80-L52	S	2000
Type series SIOV-S05, straight leads e = 5,0			
SIOV-S05K11G	Q69X4509	—	1500
SIOV-S05K14G	Q69X4860	—	1500
SIOV-S05K17G	Q69X4861	—	1500
SIOV-S05K20G	Q69X4762	—	1500
SIOV-S05K25G	Q69X4757	—	1500
SIOV-S05K30G	Q69X3869	—	1500
SIOV-S05K35G	Q69X4638	—	1500
SIOV-S05K40G	Q69X4862	—	1500
SIOV-S05K50G	Q69X4341	—	1500
SIOV-S05K60G	Q69X4724	—	1500
SIOV-S05K75G	Q69X3885	—	1500
SIOV-S05K95G	Q69X4529	—	1500
SIOV-S05K115G	Q69X4863	—	1500
SIOV-S05K130G	Q69X4864	—	1500
SIOV-S05K140G	Q69X4865	—	1500
SIOV-S05K150G	Q69X4339	—	1500
SIOV-S05K175G	Q69X4866	—	1500
SIOV-S05K230G	Q69X4867	—	1500
SIOV-S05K250G	Q69X4395	—	1500
SIOV-S05K275G	Q69X4490	—	1500
SIOV-S05K300G	Q69X4707	—	1000
Type series SIOV-S05, crimped leads e = 5,0			
SIOV-S05K11GS2	Q69X4388	S2	1500
SIOV-S05K14GS2	Q69X3403	S2	1500
SIOV-S05K17GS2	Q69X4366	S2	1500
SIOV-S05K20GS2	Q69X4465	S2	1500
SIOV-S05K25GS2	Q69X4359	S2	1500
SIOV-S05K30GS2	Q69X4374	S2	1500
SIOV-S05K35GS2	Q69X3864	S2	1500



Type	Ordering code	Crimp style	Pieces/reel I
Type series SIOV-S05, crimped leads *e* = 5,0 (continued)			
SIOV-S05K40GS2	Q69X4577	S2	1500
SIOV-S05K50GS2	Q69X4317	S2	1500
SIOV-S05K60GS2	Q69X4313	S2	1500
SIOV-S05K75GS2	Q69X3719	S2	1500
SIOV-S05K95GS2	Q69X3884	S2	1500
SIOV-S05K115GS2	Q69X4578	S2	1500
SIOV-S05K130GS2	Q69X3892	S2	1500
SIOV-S05K140GS2	Q69X4512	S2	1500
SIOV-S05K150GS2	Q69X4324	S2	1500
SIOV-S05K175GS2	Q69X4579	S2	1500
SIOV-S05K230GS3	Q69X4580	S3	1500
SIOV-S05K250GS3	Q69X3500	S3	1500
SIOV-S05K275GS3	Q69X3900	S3	1500
SIOV-S05K300GS3	Q69X4375	S3	1000
SIOV-S05K385GS3	Q69X3773	S3	1000
SIOV-S05K420GS3	Q69X4884	S3	1000
SIOV-S05K440GS3	Q69X3774	S3	1000
SIOV-S05K460GS3	Q69X3746	S3	1000
Type series SIOV-S07, straight leads *e* = 5,0			
SIOV-S07K11G	Q69X4868	—	1500
SIOV-S07K14G	Q69X4315	—	1500
SIOV-S07K17G	Q69X4869	—	1500
SIOV-S07K20G	Q69X4300	—	1500
SIOV-S07K25G	Q69X4870	—	1500
SIOV-S07K30G	Q69X4304	—	1500
SIOV-S07K35G	Q69X4871	—	1500
SIOV-S07K40G	Q69X4389	—	1500
SIOV-S07K50G	Q69X4872	—	1500
SIOV-S07K60G	Q69X4523	—	1500
SIOV-S07K75G	Q69X4488	—	1500
SIOV-S07K95G	Q69X4542	—	1500
SIOV-S07K115G	Q69X4873	—	1500
SIOV-S07K130G	Q69X3594	—	1500
SIOV-S07K140G	Q69X4874	—	1500
SIOV-S07K150G	Q69X4506	—	1500
SIOV-S07K175G	Q69X4875	—	1500

Taping

Type	Ordering code	Crimp style	Pieces/reel I
Type series SIOV-S07, straight leads e = 5,0 (continued)			
SIOV-S07K230G	Q69X4510	—	1500
SIOV-S07K250G	Q69X4678	—	1500
SIOV-S07K275G	Q69X4314	—	1000
SIOV-S07K300G	Q69X4450	—	1000
Type series SIOV-S07, crimped leads e = 5,0			
SIOV-S07K11GS2	Q69X3802	S2	1500
SIOV-S07K14GS2	Q69X3805	S2	1500
SIOV-S07K17GS2	Q69X3804	S2	1500
SIOV-S07K20GS2	Q69X3624	S2	1500
SIOV-S07K25GS2	Q69X4342	S2	1500
SIOV-S07K30GS2	Q69X4316	S2	1500
SIOV-S07K35GS2	Q69X3843	S2	1500
SIOV-S07K40GS2	Q69X3830	S2	1500
SIOV-S07K50GS2	Q69X3717	S2	1500
SIOV-S07K60GS2	Q69X3706	S2	1500
SIOV-S07S60AGS2	Q69X3815	S2	1500
SIOV-S07K75GS2	Q69X3701	S2	1500
SIOV-S07K95GS2	Q69X3623	S2	1500
SIOV-S07S95AGS2	Q69X4574	S2	1500
SIOV-S07K115GS2	Q69X4469	S2	1500
SIOV-S07K130GS2	Q69X3801	S2	1500
SIOV-S07K140GS2	Q69X4581	S2	1500
SIOV-S07K150GS2	Q69X3807	S2	1500
SIOV-S07K175GS2	Q69X3590	S2	1500
SIOV-S07K230GS3	Q69X3597	S3	1500
SIOV-S07K250GS3	Q69X3806	S3	1500
SIOV-S07K275GS3	Q69X3860	S3	1000
SIOV-S07K300GS3	Q69X3808	S3	1000
SIOV-S07K385GS3	Q69X4900	S3	1000
SIOV-S07K420GS3	Q69X4406	S3	1000
SIOV-S07K440GS3	Q69X3776	S3	1000
SIOV-S07K460GS3	Q69X3769	S3	1000

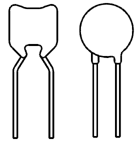


Type	Ordering code	Crimp style	Pieces/reel III
Type series SIOV-S10, straight leads e = 7,5			
SIOV-S10K11G5	Q69X4573	—	1500
SIOV-S10K14G5	Q69X4592	—	1500
SIOV-S10K17G5	Q69X4593	—	1500
SIOV-S10K20G5	Q69X4524	—	1500
SIOV-S10K25G5	Q69X4452	—	1500
SIOV-S10K30G5	Q69X4549	—	1500
SIOV-S10K35G5	Q69X4394	—	1500
SIOV-S10K40G5	Q69X4533	—	1500
SIOV-S10K50G5	Q69X4485	—	1500
SIOV-S10K60G5	Q69X4451	—	1500
SIOV-S10K75G5	Q69X4583	—	1500
SIOV-S10K95G5	Q69X4390	—	1500
SIOV-S10K115G5	Q69X4585	—	1500
SIOV-S10K130G5	Q69X4520	—	1500
SIOV-S10K140G5	Q69X4370	—	1500
SIOV-S10K150G5	Q69X4575	—	1500
SIOV-S10K175G5	Q69X4522	—	1500
SIOV-S10K230G5	Q69X4591	—	1000
SIOV-S10K250G5	Q69X4369	—	1000
SIOV-S10K275G5	Q69X4381	—	1000
SIOV-S10K300G5	Q69X4594	—	1000

Type	Ordering code	Crimp style	Pieces/reel I
Type series SIOV-S10, crimped leads e = 5,0			
SIOV-S10K11GS4R5	Q69X4587	S4	1500
SIOV-S10K14GS4R5	Q69X4340	S4	1500
SIOV-S10K17GS4R5	Q69X4582	S4	1500
SIOV-S10K20GS4R5	Q69X4429	S4	1500
SIOV-S10K25GS4R5	Q69X4557	S4	1500
SIOV-S10K30GS4R5	Q69X3877	S4	1500
SIOV-S10K35GS4R5	Q69X4584	S4	1500
SIOV-S10K40GS4R5	Q69X4430	S4	1500
SIOV-S10K50GS4R5	Q69X4556	S4	1500
SIOV-S10K75GS4R5	Q69X3865	S4	1500
SIOV-S10K95GS4R5	Q69X4586	S4	1500

Type	Ordering code	Crimp style	Pieces/reel I
Type series SIOV-S10, crimped leads e = 5,0 (continued)			
SIOV-S10K115GS4R5	Q69X4605	S4	1500
SIOV-S10K130GS4R5	Q69X4305	S4	1500
SIOV-S10K140GS4R5	Q69X4588	S4	1500
SIOV-S10K150GS4R5	Q69X3881	S4	1500
SIOV-S10K175GS4R5	Q69X4589	S4	1500
SIOV-S10K230GS3R5	Q69X3880	S3	1500
SIOV-S10K250GS3R5	Q69X4337	S3	1500
SIOV-S10K275GS3R5	Q69X3872	S3	1000
SIOV-S10K300GS3R5	Q69X4590	S3	1000

Type	Ordering code	Crimp style	Pieces/reel III
Type series SIOV-S10, crimped leads e = 7,5			
SIOV-S10K11G5S5	Q69X4785	S5	1500
SIOV-S10K14G5S5	Q69X4786	S5	1500
SIOV-S10K17G5S5	Q69X4787	S5	1500
SIOV-S10K20G5S5	Q69X4788	S5	1500
SIOV-S10K25G5S5	Q69X4476	S5	1500
SIOV-S10K30G5S5	Q69X4540	S5	1500
SIOV-S10K35G5S5	Q69X4504	S5	1500
SIOV-S10K40G5S5	Q69X4792	S5	1500
SIOV-S10K50G5S5	Q69X4563	S5	1500
SIOV-S10K60G5S5	Q69X4505	S5	1500
SIOV-S10K75G5S5	Q69X4739	S5	1500
SIOV-S10K95G5S5	Q69X4564	S5	1500
SIOV-S10K115G5S5	Q69X4797	S5	1500
SIOV-S10K130G5S5	Q69X4531	S5	1500
SIOV-S10K140G5S5	Q69X4799	S5	1500
SIOV-S10K150G5S5	Q69X4800	S5	1500
SIOV-S10K175G5S5	Q69X4559	S5	1500
SIOV-S10K230G5S5	Q69X4728	S5	1000
SIOV-S10K250G5S5	Q69X4803	S5	1000
SIOV-S10K275G5S5	Q69X4426	S5	1000
SIOV-S10K300G5S5	Q69X4805	S5	1000



Type	Ordering code	Crimp style	Pieces/reel III
Type series SIOV-S14, straight leads e = 7,5			
SIOV-S14K11G5	Q69X4572	—	1500
SIOV-S14K14G5	Q69X4376	—	1500
SIOV-S14K17G5	Q69X4595	—	1500
SIOV-S14K20G5	Q69X4489	—	1500
SIOV-S14K25G5	Q69X4596	—	1500
SIOV-S14K30G5	Q69X4391	—	1500
SIOV-S14K35G5	Q69X4528	—	1500
SIOV-S14K40G5	Q69X4597	—	1500
SIOV-S14K50G5	Q69X4598	—	1500
SIOV-S14K60G5	Q69X4382	—	1500
SIOV-S14K75G5	Q69X4392	—	1500
SIOV-S14K95G5	Q69X4486	—	1500
SIOV-S14K115G5	Q69X4511	—	1500
SIOV-S14K130G5	Q69X4599	—	1500
SIOV-S14K140G5	Q69X4600	—	1500
SIOV-S14K150G5	Q69X4539	—	1500
SIOV-S14K175G5	Q69X4601	—	1500
SIOV-S14K230G5	Q69X4602	—	1000
SIOV-S14K250G5	Q69X4603	—	1000
SIOV-S14K275G5	Q69X4393	—	1000
SIOV-S14K300G5	Q69X4604	—	1000
Type series SIOV-S14, crimped leads e = 7,5			
SIOV-S14K11G5S5	Q69X4738	S5	1500
SIOV-S14K14G5S5	Q69X4472	S5	1500
SIOV-S14K17G5S5	Q69X4709	S5	1500
SIOV-S14K20G5S5	Q69X4541	S5	1500
SIOV-S14K25G5S5	Q69X4810	S5	1500
SIOV-S14K30G5S5	Q69X4811	S5	1500
SIOV-S14K35G5S5	Q69X4473	S5	1500
SIOV-S14K40G5S5	Q69X4737	S5	1500
SIOV-S14K50G5S5	Q69X4543	S5	1500
SIOV-S14K60G5S5	Q69X4474	S5	1500
SIOV-S14K75G5S5	Q69X4399	S5	1500
SIOV-S14K95G5S5	Q69X4367	S5	1500

Taping

Type	Ordering code	Crimp style	Pieces/reel III
Type series SIOV-S14, crimped leads e = 7,5 (continued)			
SIOV-S14K115G5S5	Q69X4818	S5	1500
SIOV-S14K130G5S5	Q69X4651	S5	1500
SIOV-S14K140G5S5	Q69X4481	S5	1500
SIOV-S14K150G5S5	Q69X4475	S5	1500
SIOV-S14K175G5S5	Q69X4471	S5	1500
SIOV-S14K230G5S5	Q69X4654	S5	1000
SIOV-S14K250G5S5	Q69X4468	S5	1000
SIOV-S14K275G5S5	Q69X4652	S5	1000
SIOV-S14K300G5S5	Q69X4750	S5	1000

SIOV-S20K11 … 300G5 upon request
SIOV-S20K11 … 300G5S5 upon request

Block Varistors

Construction

- Disk-shaped varistor element,
  potted in plastic housing
- Housing flame-retardant to UL 94 V-0
- Screw terminals M4 (SIOV-B32 … 40)
  Screw terminals M5 (SIOV-B60 … 80)

Features

- Heavy-duty varistors (surge current capability up to 100 kA)
- Wide product range
- SIOV-B40 also available without housing (LS40 series)
- PSpice models

Approvals

- UL
- CSA (≥ K130)
- SEV (except SIOV-B80)

Type designation

Detailed description of coding system on page 33

SIOV-B 40 K 275

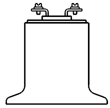
- SIOV-B: S+M metal oxide varistor
- B: Design
- 40: Rated diameter of varistor disk
- K: Tolerance of varistor voltage
- 275: Max. AC operating voltage

General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 110 °C	
Electric strength	≥ 2,5 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	
Max. torque B32/B40 B60/B80	 1,0 Nm 2,5 Nm	

Maximum ratings (T_A = 85 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
B40K75	Q69X3633	75	100	40000	190	1,4
B32K130	Q69X3309	130	170	25000	210	1,2
B40K130	Q69X3634	130	170	40000	310	1,4
B60K130	Q69X3721	130	170	70000	490	1,6
B80K130	Q69X4346	130	170	100000	660	2,0
B32K150	Q69X3324	150	200	25000	240	1,2
B40K150	Q69X3635	150	200	40000	360	1,4
B60K150	Q69X3722	150	200	70000	570	1,6
B80K150	Q69X4347	150	200	100000	800	2,0
B32K230	Q69X3325	230	300	25000	300	1,2
B40K230	Q69X3636	230	300	40000	460	1,4
B60K230	Q69X3723	230	300	70000	730	1,6
B80K230	Q69X4348	230	300	100000	1200	2,0
B32K250	Q69X3310	250	320	25000	330	1,2
B40K250	Q69X3637	250	320	40000	490	1,4
B60K250	Q69X3724	250	320	70000	800	1,6
B80K250	Q69X4349	250	320	100000	1300	2,0
B32K275	Q69X3326	275	350	25000	360	1,2
B40K275	Q69X3638	275	350	40000	550	1,4
B60K275	Q69X3725	275	350	70000	860	1,6
B80K275	Q69X4350	275	350	100000	1400	2,0
B32K320	Q69X4343	320	420	25000	430	1,2
B40K320	Q69X4344	320	420	40000	640	1,4
B60K320	Q69X4345	320	420	70000	1000	1,6
B80K320	Q69X4351	320	420	100000	1600	2,0
B32K385	Q69X3327	385	505	25000	550	1,2
B40K385	Q69X3639	385	505	40000	800	1,4
B60K385	Q69X3726	385	505	70000	1200	1,6
B80K385	Q69X4352	385	505	100000	2000	2,0



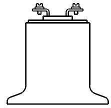
Characteristics (T_A = 25 °C)

Type SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage *v* V	 *i* A	C_{typ} (1 kHz) pF	Derating curve Page	*V*/*I* char-acteristic Page
B40K75	120	± 10	220	300	11000	192	211
B32K130	205	± 10	340	200	4400	191	210
B40K130	205	± 10	340	300	5600	192	211
B60K130	205	± 10	340	500	15000	194	212
B80K130	205	± 10	340	800	28000	195	213
B32K150	240	± 10	395	200	3700	191	210
B40K150	240	± 10	395	300	4800	192	211
B60K150	240	± 10	395	500	12000	194	212
B80K150	240	± 10	395	800	23000	195	213
B32K230	360	± 10	595	200	2500	191	210
B40K230	360	± 10	595	300	3200	193	211
B60K230	360	± 10	595	500	7900	194	212
B80K230	360	± 10	595	800	16000	195	213
B32K250	390	± 10	650	200	2200	191	210
B40K250	390	± 10	650	300	2900	193	211
B60K250	390	± 10	650	500	7100	194	212
B80K250	390	± 10	650	800	14000	195	213
B32K275	430	± 10	710	200	2000	191	210
B40K275	430	± 10	710	300	2700	193	211
B60K275	430	± 10	710	500	6600	194	212
B80K275	430	± 10	710	800	13000	195	213
B32K320	510	± 10	840	200	1700	191	210
B40K320	510	± 10	840	300	2300	193	211
B60K320	510	± 10	840	500	5600	194	212
B80K320	510	± 10	840	800	11000	195	213
B32K385	620	± 10	1025	200	1400	191	210
B40K385	620	± 10	1025	300	1900	193	211
B60K385	620	± 10	1025	500	4600	194	212
B80K385	620	± 10	1025	800	9000	195	213

Maximum ratings (T_A = 85 °C)

Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
B32K420	Q69X3311	420	560	25000	600	1,2
B40K420	Q69X3640	420	560	40000	910	1,4
B60K420	Q69X3727	420	560	70000	1500	1,6
B80K420	Q69X4353	420	560	100000	2200	2,0
B32K440	Q69X4835	440	585	25000	630	1,2
B40K440	Q69X4836	440	585	40000	950	1,4
B60K440	Q69X4837	440	585	70000	1580	1,6
B80K440	Q69X4838	440	585	100000	2350	2,0
B32K460	Q69X3328	460	615	25000	660	1,2
B40K460	Q69X3641	460	615	40000	1000	1,4
B60K460	Q69X3728	460	615	70000	1650	1,6
B80K460	Q69X4354	460	615	100000	2500	2,0
B32K550	Q69X3329	550	745	25000	620	1,2
B40K550	Q69X3642	550	745	40000	960	1,4
B60K550	Q69X3729	550	745	70000	1500	1,6
B80K550	Q69X4355	550	745	100000	3100	2,0
B32K680	Q69X3822	680	895	25000	760	1,2
B40K680	Q69X3823	680	895	40000	1100	1,4
B60K680	Q69X3824	680	895	70000	1800	1,6
B80K680	Q69X4356	680	895	100000	3600	2,0
B32K750	Q69X3632	750	1060	25000	800	1,2
B40K750	Q69X3643	750	1060	40000	1200	1,4
B60K750	Q69X3730	750	1060	70000	2000	1,6
B80K750	Q69X4357	750	1060	100000	4000	2,0
B60K1000[1]	Q69X3731	1100	1465	70000	3000	1,6
B80K1100	Q69X4358	1100	1465	100000	6000	2,0

1) Operating voltage differs from type designation

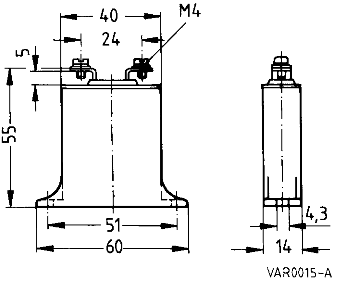


Characteristics (T_A = 25 °C)

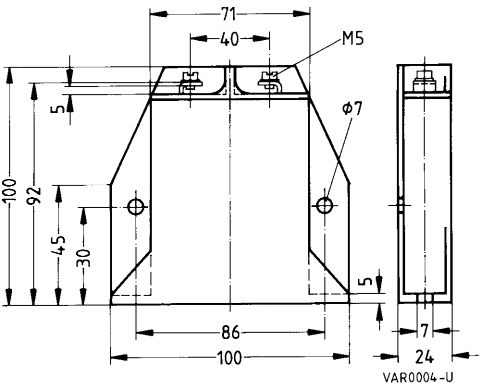
Type SIOV-	V_v (1 mA) V	ΔV_v (1 mA) %	Max. clamping voltage *v* V	 *i* A	C_{typ} (1 kHz) pF	Derating curve Page	*V*/*I* char-acteristic Page
B32K420	680	± 10	1120	200	1300	191	210
B40K420	680	± 10	1120	300	1800	193	211
B60K420	680	± 10	1120	500	4300	194	212
B80K420	680	± 10	1120	800	8500	195	213
B32K440	715	± 10	1180	200	1250	191	210
B40K440	715	± 10	1180	300	1700	193	211
B60K440	715	± 10	1180	500	4100	194	212
B80K440	715	± 10	1180	800	8100	195	213
B32K460	750	± 10	1240	200	1200	191	210
B40K460	750	± 10	1240	300	1600	193	211
B60K460	750	± 10	1240	500	3900	194	212
B80K460	750	± 10	1240	800	7700	195	213
B32K550	910	± 10	1500	200	1000	192	210
B40K550	910	± 10	1500	300	1400	193	211
B60K550	910	± 10	1500	500	3300	195	212
B80K550	910	± 10	1500	800	6500	195	213
B32K680	1100	± 10	1815	200	830	192	210
B40K680	1100	± 10	1815	300	1100	193	211
B60K680	1100	± 10	1815	500	2600	195	212
B80K680	1100	± 10	1815	800	5200	195	213
B32K750	1200	± 10	2000	200	800	192	210
B40K750	1200	± 10	2000	300	1000	193	211
B60K750	1200	± 10	2000	500	2400	195	212
B80K750	1200	± 10	2000	800	4800	195	213
B60K1000	1800	± 10	2970	500	1600	195	212
B80K1100	1800	± 10	2970	800	3200	195	213

Dimensions

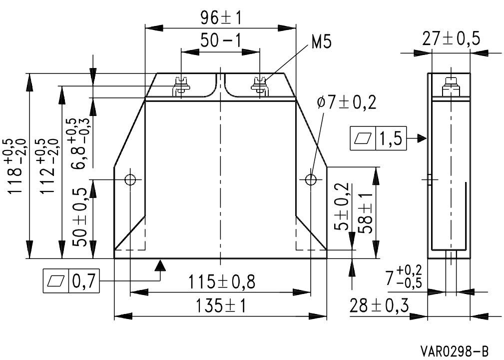
SIOV-B32/-B40



SIOV-B60



SIOV-B80



Weight

Size	approx.
B32	45 g
B40	50 g
B60	250 g
B80	650 g

Dimensions in mm

Strap Varistors

Construction

- Rectangular varistor element as in SIOV-B40
- Coating: epoxy resin, flame-retardant to UL 94 V-0
- Bolt-holed strap terminals for screw fixing or soldering

Features

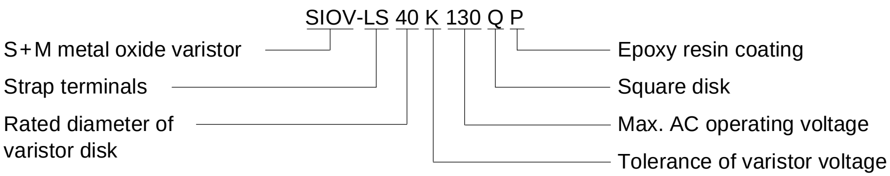
- Electrical equivalents to type series SIOV-B40K130 … 750
- Maximum load capacity with minimum size
- PSpice models

Approvals

- UL (all types)
- CSA (all types)

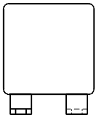
Type designation

Detailed description of coding system on page 33



General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	40/85/56 – 25 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 25 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 25 … + 110 °C	
Electric strength	≥ 2,5 kV	in accordance with CECC 42 000
Insulation resistance	≥ 1,0 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	



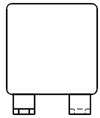
Strap Varistors

Maximum ratings (T_A = 85 °C)

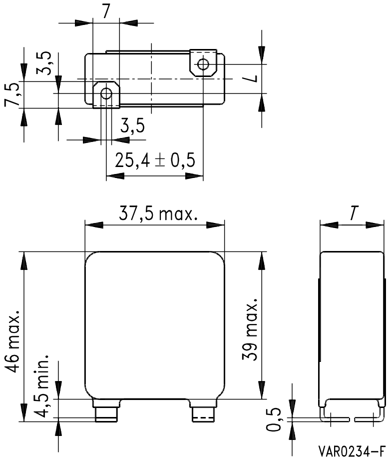
Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
LS40K130QP	Q69X4727	130	170	40000	310	1,4
LS40K150QP	Q69X4662	150	200	40000	360	1,4
LS40K230QP	Q69X4713	230	300	40000	460	1,4
LS40K250QP	Q69X4649	250	320	40000	490	1,4
LS40K275QP	Q69X4722	275	350	40000	550	1,4
LS40K320QP	Q69X4663	320	420	40000	640	1,4
LS40K385QP	Q69X4664	385	505	40000	800	1,4
LS40K420QP	Q69X4497	420	560	40000	910	1,4
LS40K440QP	Q69X4839	440	585	40000	950	1,4
LS40K460QP	Q69X4723	460	615	40000	960	1,4
LS40K550QP	Q69X4717	550	745	40000	960	1,4
LS40K680QP	Q69X4682	680	895	40000	1100	1,4
LS40K750QP	Q69X4683	750	1060	40000	1200	1,4

Characteristics (T_A = 25 °C)

Type	V_v	ΔV_v	Max. clamping voltage		C_{typ}	Derating curve	V/I char-acteristic
SIOV-	(1 mA) V	(1 mA) %	v V	i A	(1 kHz) pF	Page	Page
LS40K130QP	205	± 10	340	300	5600	192	211
LS40K150QP	240	± 10	395	300	4800	192	211
LS40K230QP	360	± 10	595	300	3200	193	211
LS40K250QP	390	± 10	650	300	2900	193	211
LS40K275QP	430	± 10	710	300	2700	193	211
LS40K320QP	510	± 10	840	300	2300	193	211
LS40K385QP	620	± 10	1025	300	1900	193	211
LS40K420QP	680	± 10	1120	300	1800	193	211
LS40K440QP	715	± 10	1180	300	1700	193	211
LS40K460QP	750	± 10	1240	300	1600	193	211
LS40K550QP	910	± 10	1500	300	1400	193	211
LS40K680QP	1100	± 10	1815	300	1100	193	211
LS40K750QP	1200	± 10	2000	300	1000	193	211



Dimensions



Type SIOV	T_{max} mm	$L \pm 1{,}0$ mm
LS40K130QP	8,1	– 3,5
LS40K150QP	8,3	– 3,2
LS40K230QP	9,0	– 2,0
LS40K250QP	9,2	– 1,8
LS40K275QP	9,4	– 1,6
LS40K320QP	9,9	– 1,1
LS40K385QP	10,6	– 0,4
LS40K420QP	10,9	0,0
LS40K440QP	11,1	0,2
LS40K460QP	11,4	0,4
LS40K550QP	12,3	1,2
LS40K680QP	13,5	2,4
LS40K750QP	14,1	3,0

Straight straps upon request

Weight: approx. 20 … 50 g

S+M COMPONENTS **Siemens Matsushita Components**

Big performance ex SCS stock

2,000 PTC thermistors in one go

A hot tip in PTCs for overload protection: our maximum order level of 2,000 pieces. And with more than 50 different models, we've got a lot more to offer too. Operating voltages from 12 to 550 V, rated currents up to 2.5 A, maximum switching currents of 15 A, plus a broad selection of leaded versions and SMDs.

SCS – dependable, fast and competent

PowerDisk

Construction

- High-energy varistor in disk diode case
- Pressure contacts

Features

- Excellent thermal conductivity
- Mechanical reliability
- Insensitive to environmental influences
- Mounting and cooling devices of power semiconductors can be shared
- Other voltage classes upon request
- PSpice models

General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r.h., 40 °C)	25/85/56 – 25 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 25 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 25 … + 110 °C	
Response time	< 25 ns	
Recommended contact pressure	5 … 10 kN	

Maximum ratings (T_A = 85 °C)

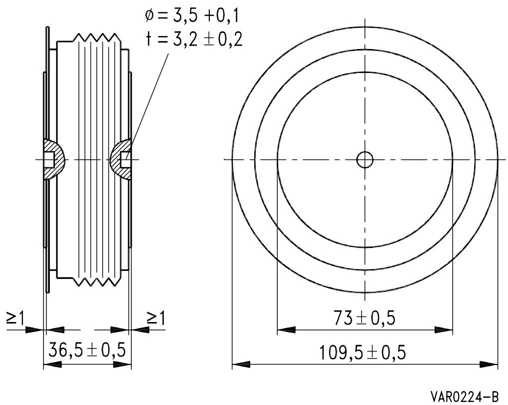
Type SIOV-	Ordering code	V_{RMS} V	V_{DC} V	i_{max} 8/20 µs kA	W_{max} (2 ms) kJ	P_{max} W
PD80K1100	Q69X3756	1100	1465	100	6	100[1)]

1) When sufficiently cooled on both sides

Characteristics (T_A = 25 °C)

Type SIOV-	V_v (1 mA) kV	ΔV_v (1 mA) %	Max. clamping voltage v kV	 i kA	C_{typ} (1 kHz) pF
PD80K1100	1,8	± 10	3	1	3200

Dimensions



Weight: approx. 1,5 kg

Arrester Blocks

Construction

- Passivated collar
- Termination: flame-sprayed
- Pressure contacts

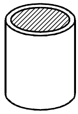
Features

- Suitable for distribution applications (light and normal duty)
- Gapless arrester constructions
- Based on IEC 99-4 and ANSI/IEEE C62.11
- Stackable for higher voltage ratings

General technical data

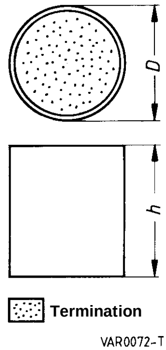
		E32VR302	E32VR602	
Rated voltage	V_R	3	6	kV
Nominal discharge current	I_n	5	5	kA
Residual voltage at I_n	V_{res}	≤ 9,5	≤ 19	kV
Continuous operating voltage	V_c	2,45	4,9	kV
Power dissipation at V_c	P_c	≤ 0,20	≤ 0,39	W
Reference voltage at 1 mA	V_{ref}	≥ 2,8	≥ 5,6	kV
Long-duration current pulse (2 ms)		20 × 150	20 × 150	A
High-current pulse (4/10 µs)[1)]		2 × 65	2 × 65	kA
Operating temperature		– 25 … + 60	– 25 … + 60	°C
Storage temperature		– 25 … + 80	– 25 … + 80	°C

1) Additional coating necessary



Arrester Blocks

Type	Ordering code	Diameter *D* mm	Height *h* mm
E32VR302	Q69X3718	34 ± 1	22 ± 0,6
E32VR602	Q69X3716	34 ± 1	44 ± 0,6

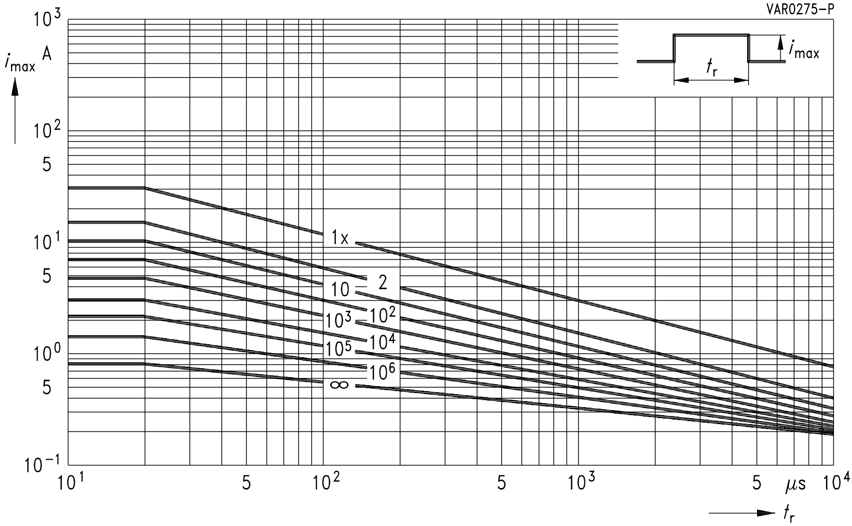


Arrester blocks for high-duty distribution applications (E42VR…)
or other voltage classes and diameters are available upon request.

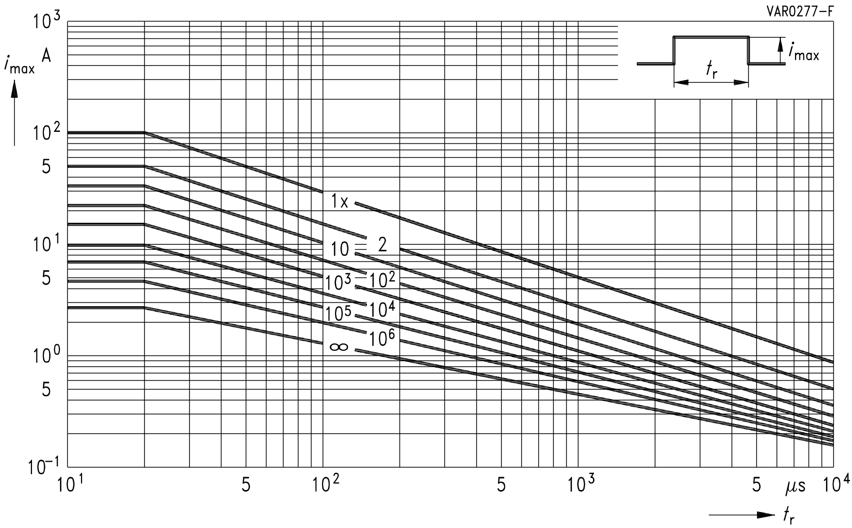
Derating Curves

Maximum surge current

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



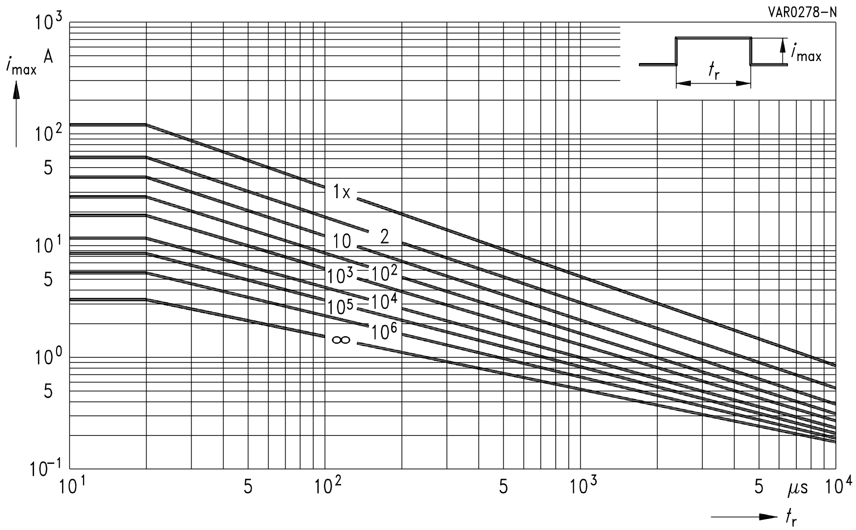
SIOV-CN0603M4G … K14G



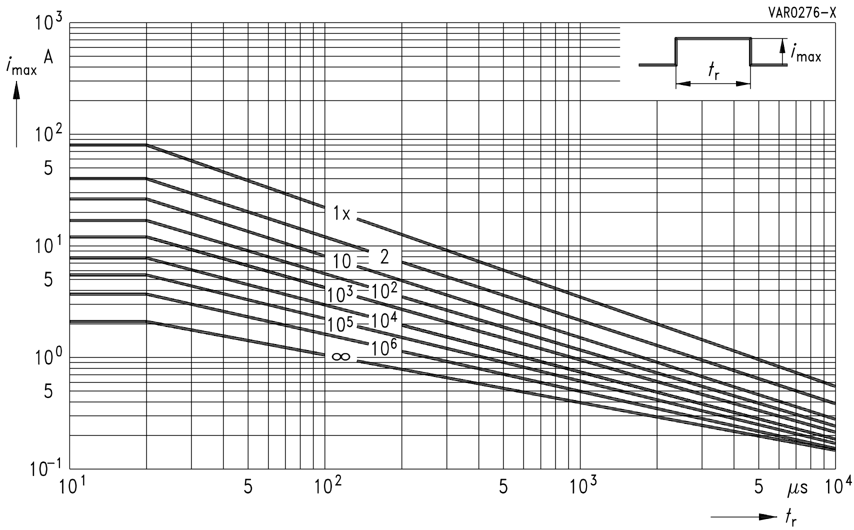
SIOV-CN0805M4G

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



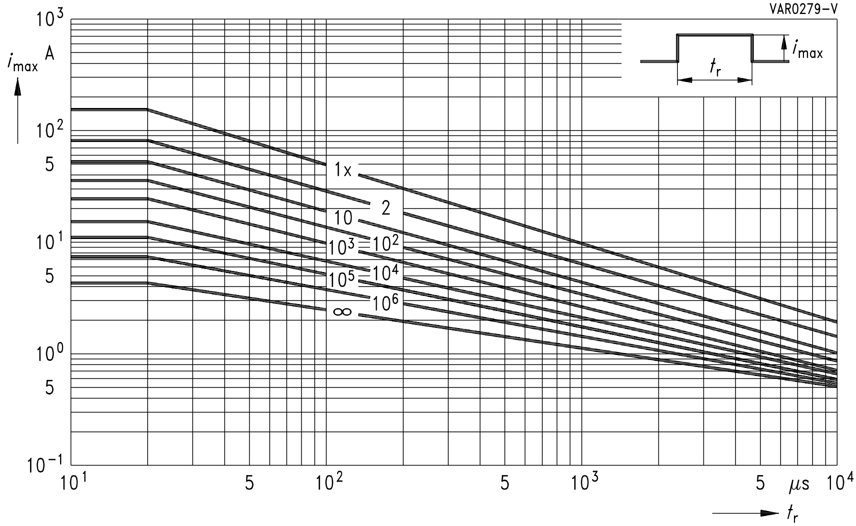
SIOV-CN0805M6G … K17G
SIOV-CN0805S14BAUTOG
SIOV-CN1206K35G … K60G



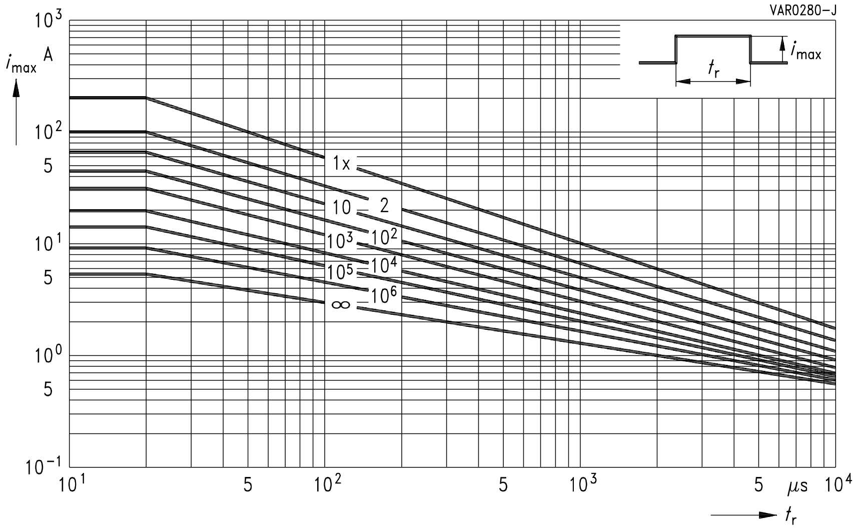
SIOV-CN0805K20G … K25G

Maximum surge current

$i_{max} = f\,(t_r$, pulse train)



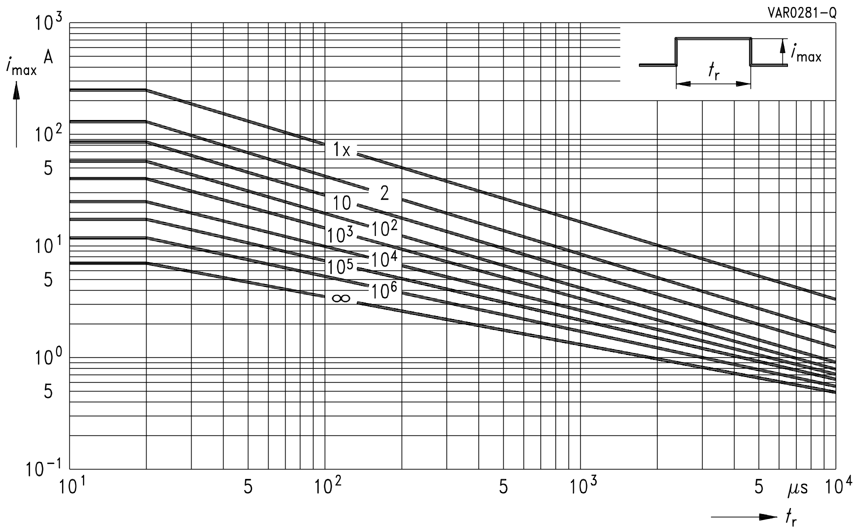
SIOV-CN1206M4G



SIOV-CN1206M6G … K30G
SIOV-CN1206S14BAUTOG
SIOV-CN1210K50G … K60G

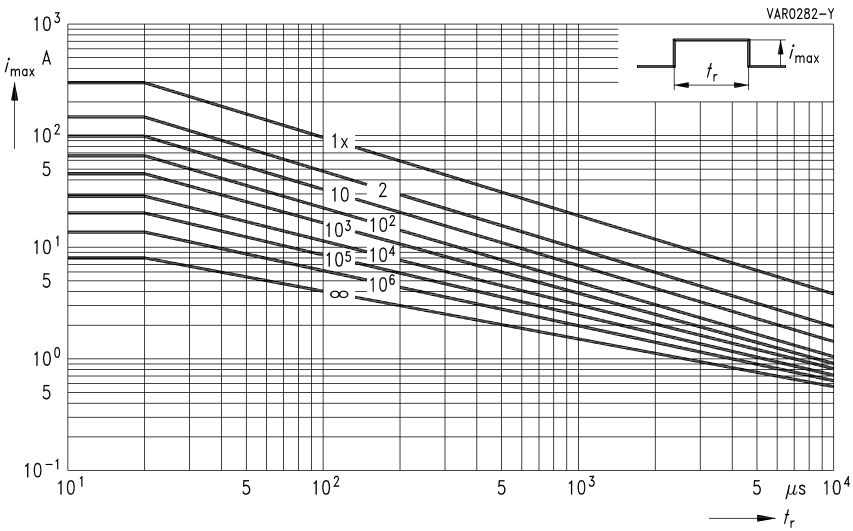
Maximum surge current

$i_{max} = f\,(t_r$, pulse train)



SIOV-CN1210M4G
SIOV-CN1210K35G … K40G

SIOV-CN1812S95AG2
SIOV-SR1210M4S

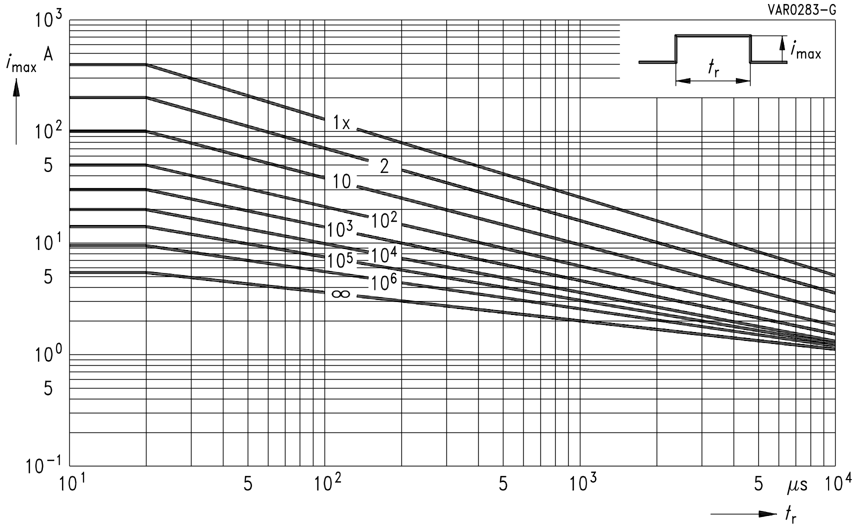


SIOV-CN1210M6G
SIOV-CN1210K25G … K30G

SIOV-SR1210M6S

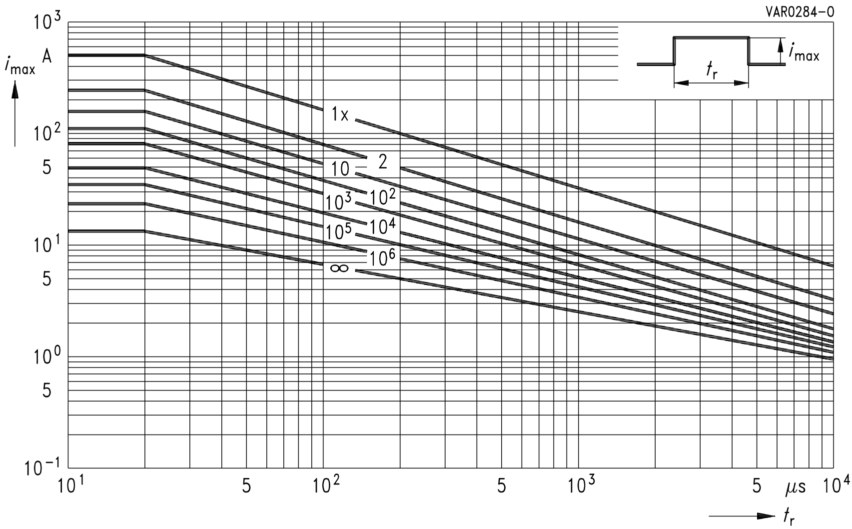
Maximum surge current

$i_{max} = f\,(t_r$, pulse train)



SIOV-CN1210L8G … K20G
SIOV-CN1812K50G … K60G
SIOV-CN1812S60AG

SIOV-CN1210S14BAUTOG
SIOV-SR1210L8S
SIOV-SR1210S14BAUTOS

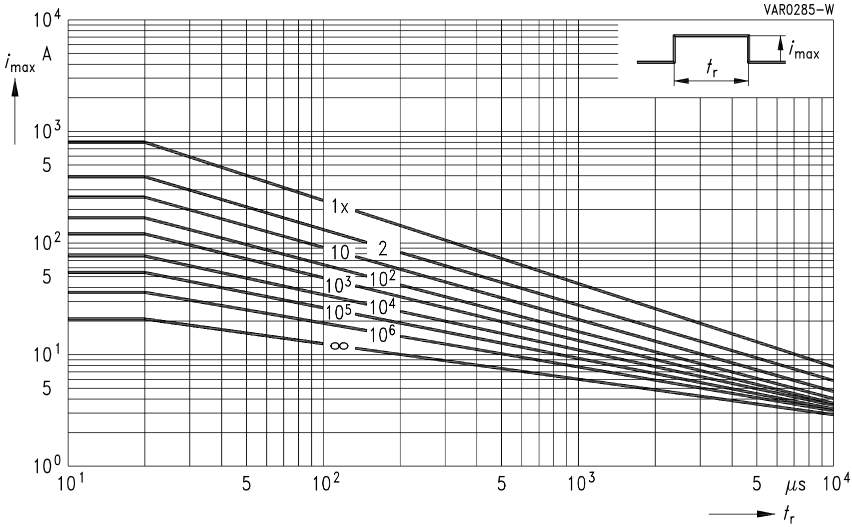


SIOV-CN1812M4G … M6G

SIOV-CN1812K35G … K40G

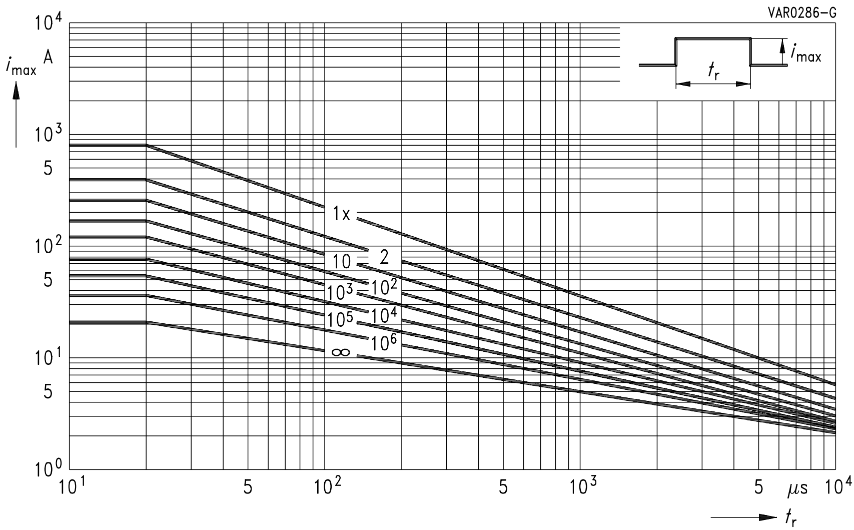
Maximum surge current

$i_{max} = f\,(t_r$, pulse train)



SIOV-CN1812L8G … K30G
SIOV-CN1812S14BAUTOG
SIOV-SR1812S14BAUTOS

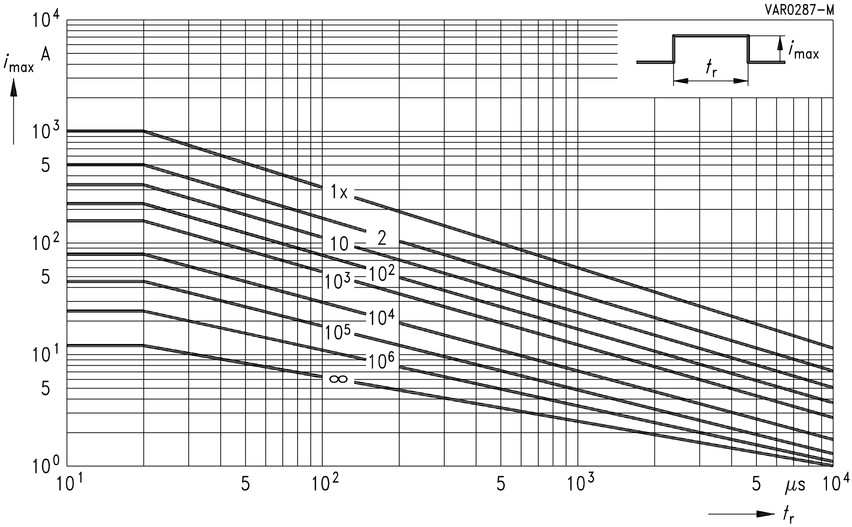
SHCV-SR1 … X/Z



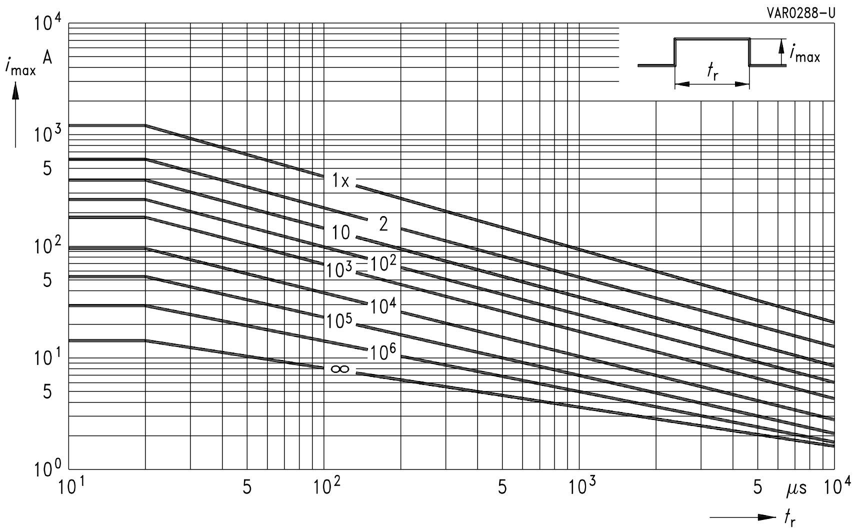
SIOV-CN2220K50G … K60G

Maximum surge current

$i_{max} = f(t_r$, pulse train)



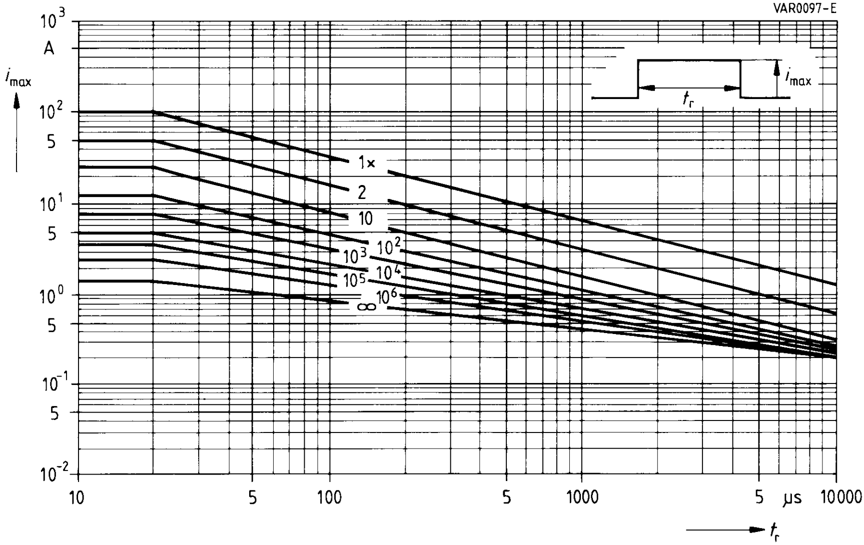
SIOV-CN2220M4G **SIOV-CN2220K35G … K40G** **SIOV-SR2220M4S**



SIOV-CN2220M6G … K30G **SIOV-CN2220S14BAUTOG** **SIOV-CN2220K30AUTOG**
SIOV-SR2220M6S … L8S **SIOV-CN2220S14BAUTOE2G2** **SIOV-SR2220S14BAUTOS**
SHCV-SR2 … X/Z

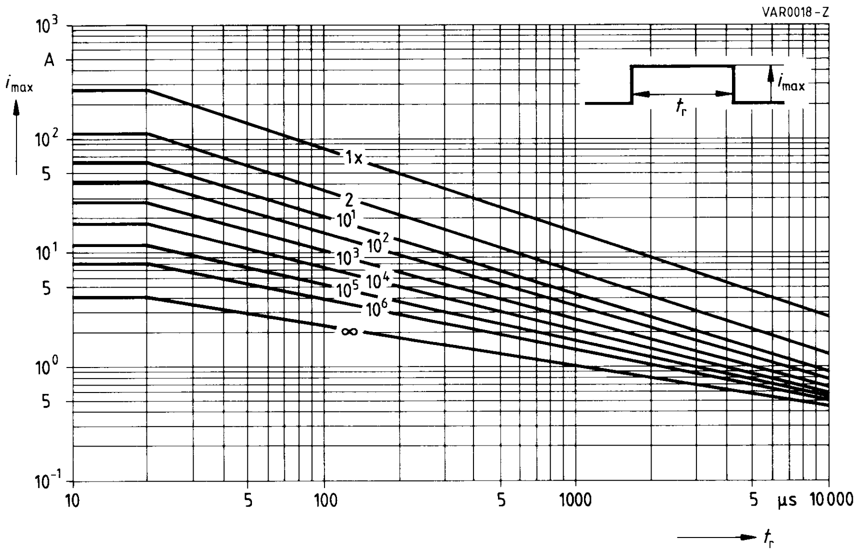
Maximum surge current

$i_{max} = f(t_r$, pulse train)



SIOV-S05K11 … K40

SIOV-CU3225K11G2 … K40G2
SIOV-CU3225K14AUTOG2 … K30AUTOG2

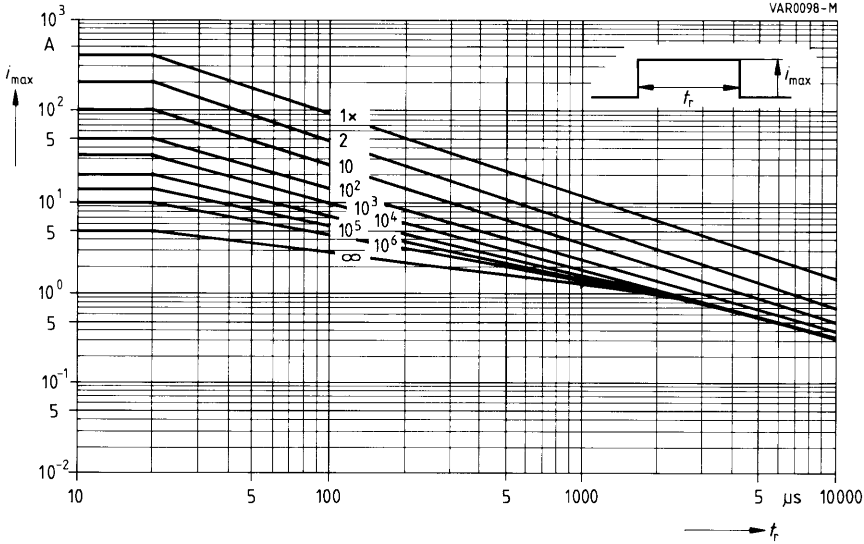


SIOV-S07K11 … K40
SIOV-S07K14AUTOS2D1

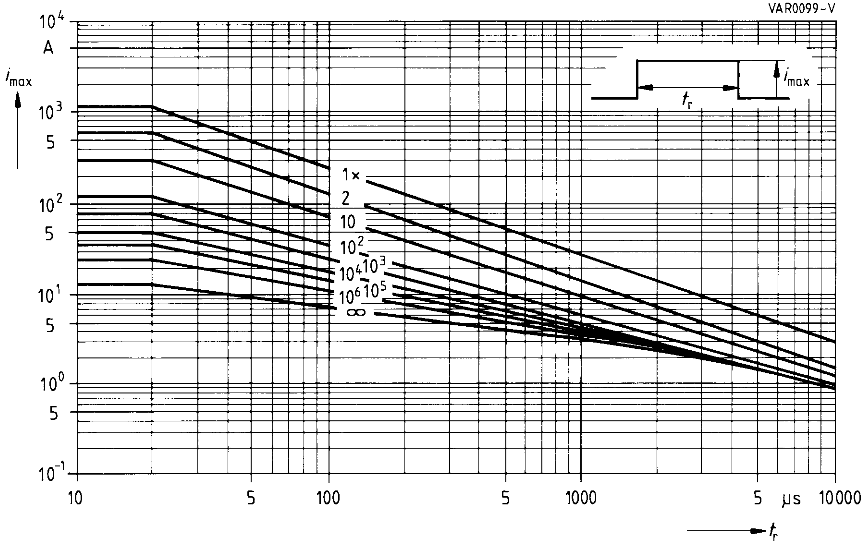
SIOV-CU4032K11G2 … K40G2
SIOV-CU4032K14AUTOG2 … K30AUTOG2

Maximum surge current

$i_{max} = f\,(t_r$, pulse train)



SIOV-S05K50 … K460
SIOV-CU3225K50G2 … K300G2

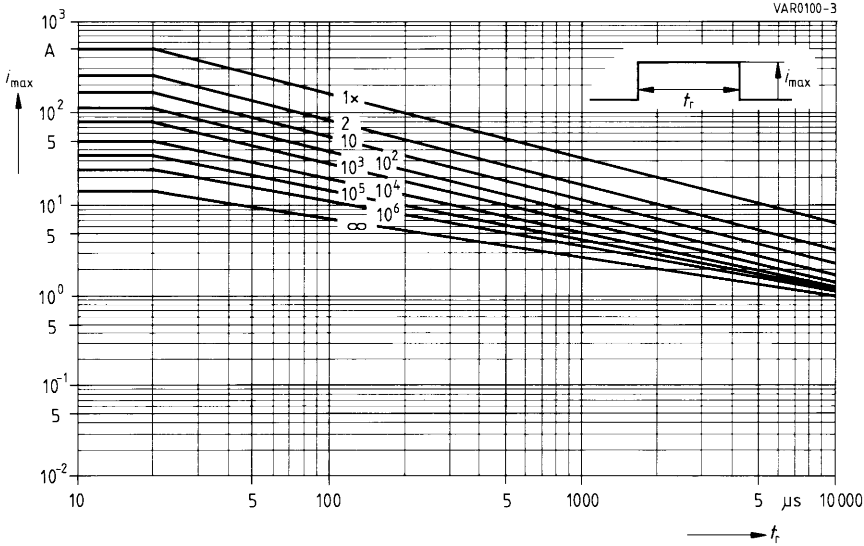


SIOV-S07K50 … K460
SIOV-S07S60AGS2/95AGS2

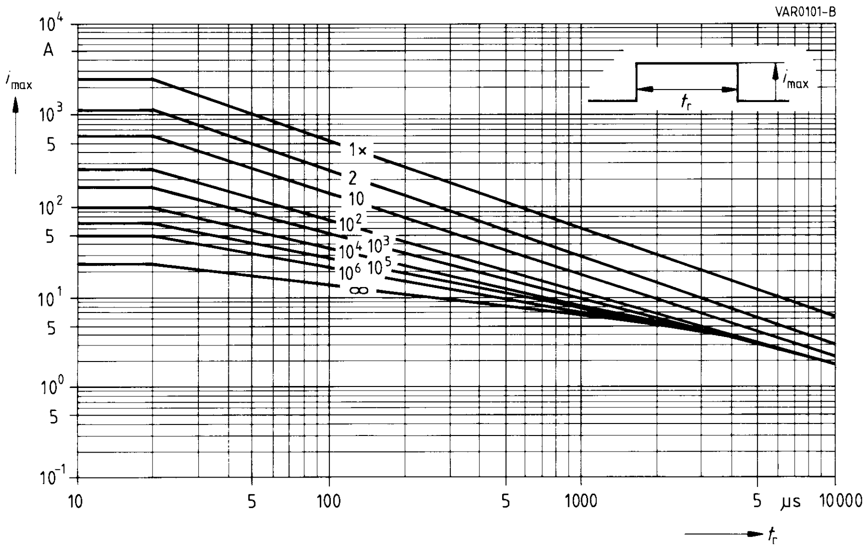
SIOV-CU4032K50G2 … K300G2
SIOV-CU4032S60AG2/S95AG2

Maximum surge current

$i_{max} = f$ (t_r, pulse train)



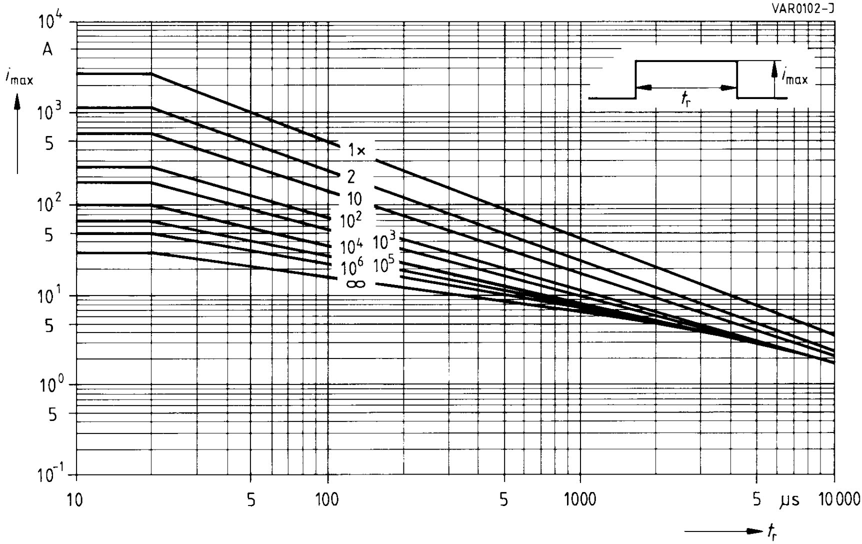
SIOV-S10K11 … K40
SIOV-S10K14AUTO … K17AUTO
SIOV-S10K14AUTOS5D1



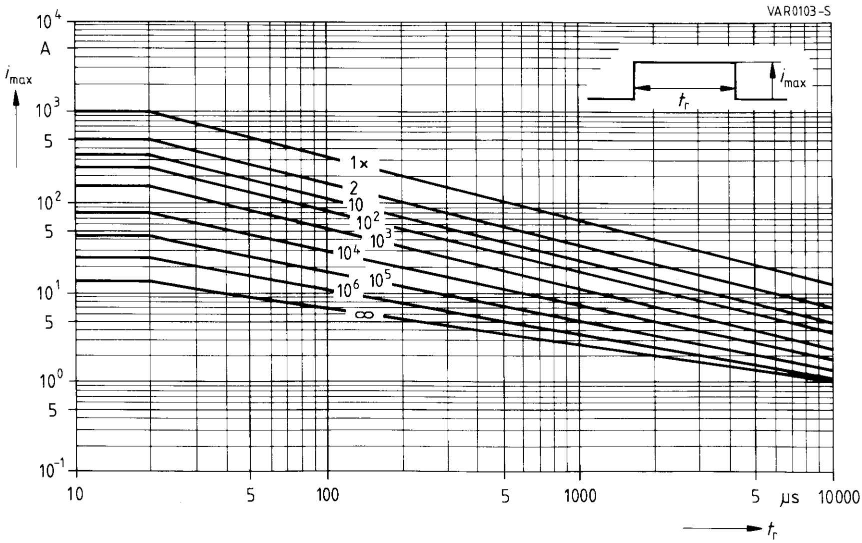
SIOV-S10K50 … K320

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



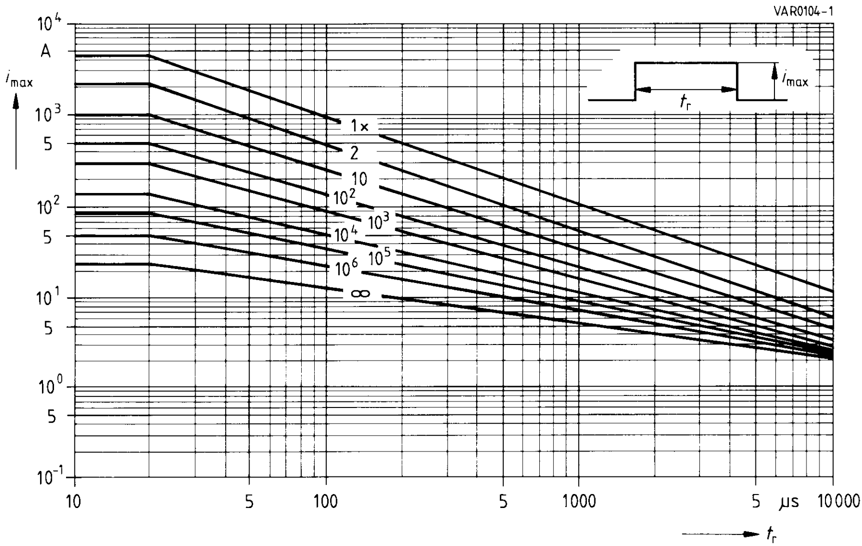
SIOV-S10K385 … K680



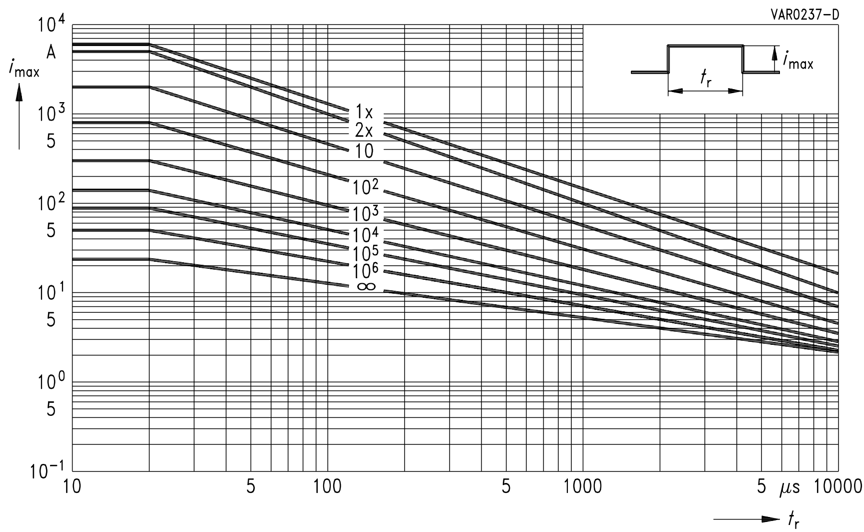
SIOV-S14K11 … K40
SIOV-S14K14AUTO … K30AUTO
SIOV-S14K14AUTOS5D1

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



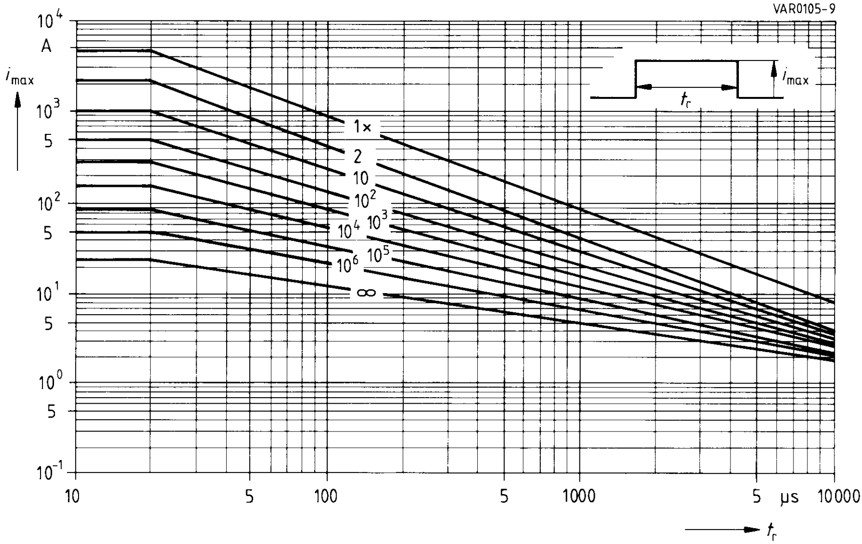
SIOV-S14K50 … K320



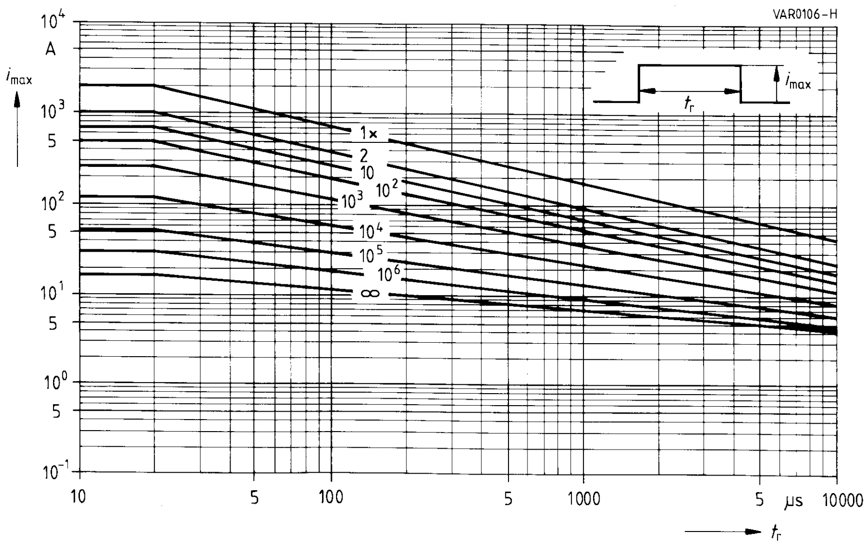
SIOV-S14K130E2 … K320E2

Maximum surge current

$i_{max} = f\,(t_r$, pulse train)



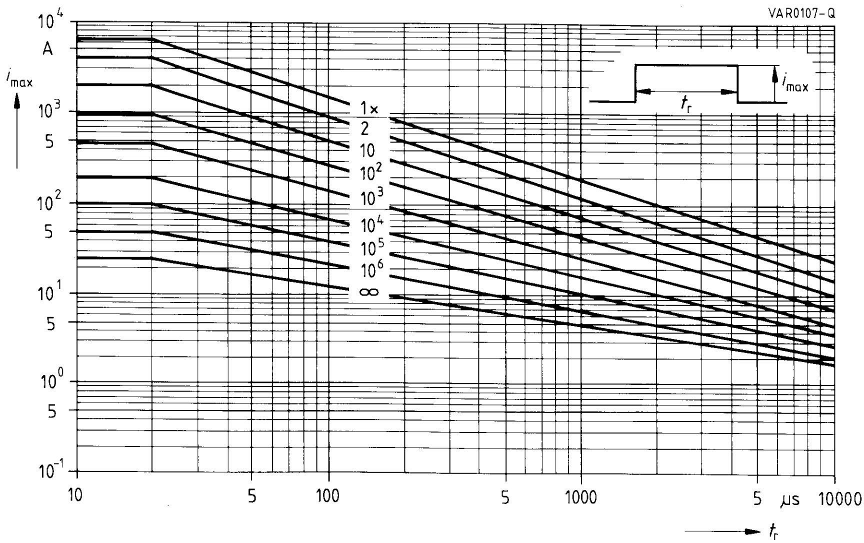
SIOV-S14K385 … K1000



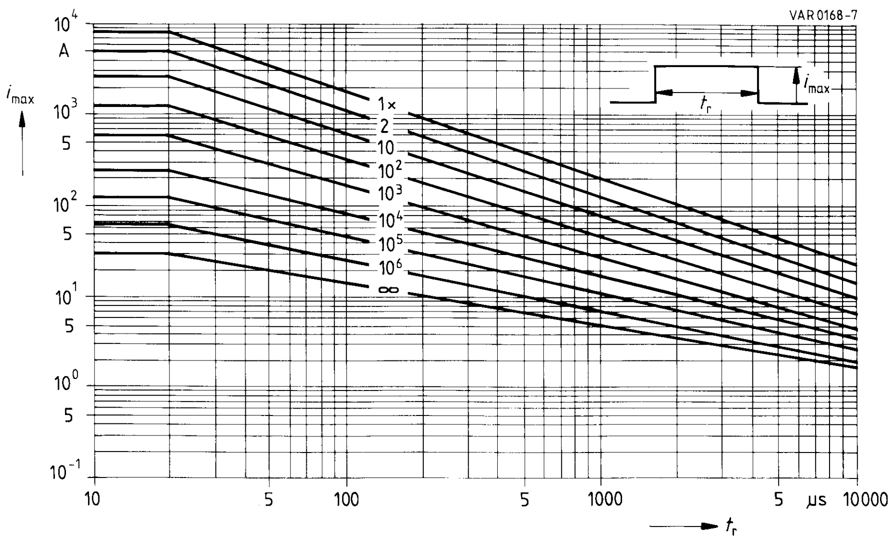
SIOV-S20K11 … K40
SIOV-S20K14AUTO … K30AUTO

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



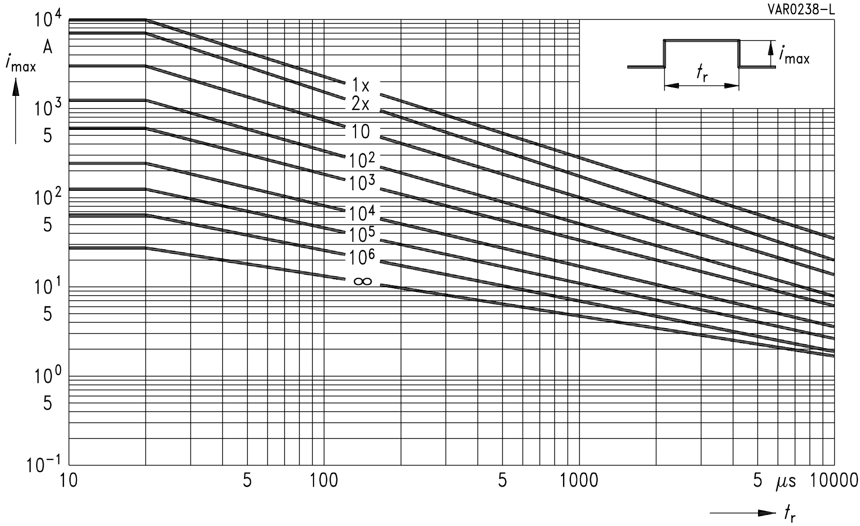
SIOV-S20K50 … K115



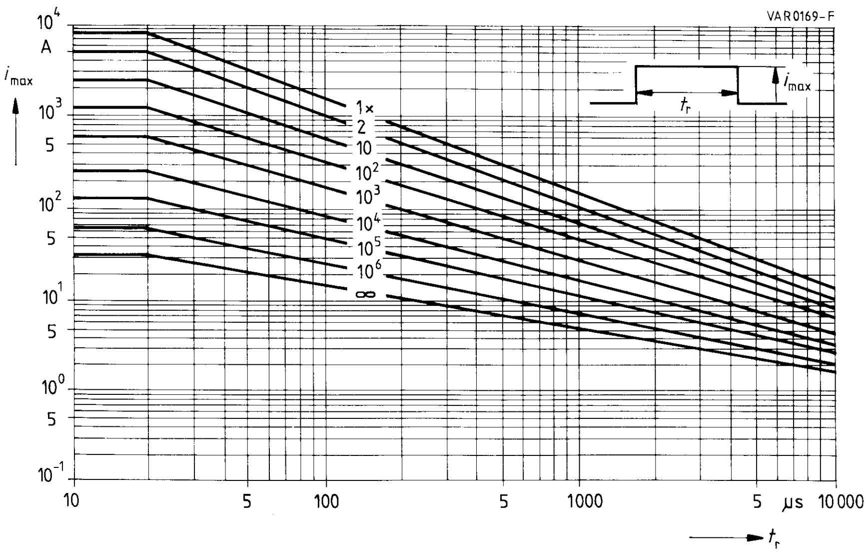
SIOV-S20K130 … K320
SIOV-S20S130BR7 … S275BR7

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



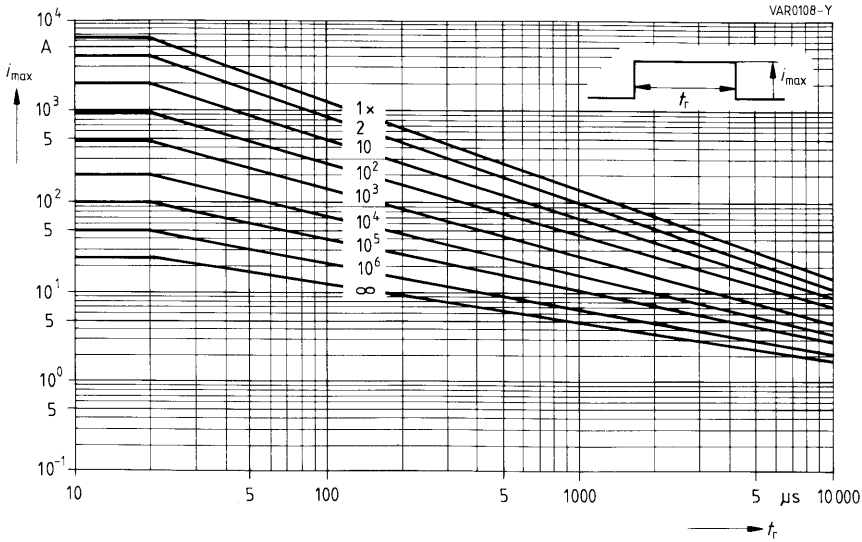
SIOV-S20K130E2 … K150E2



SIOV-S20K385 … K460

Maximum surge current

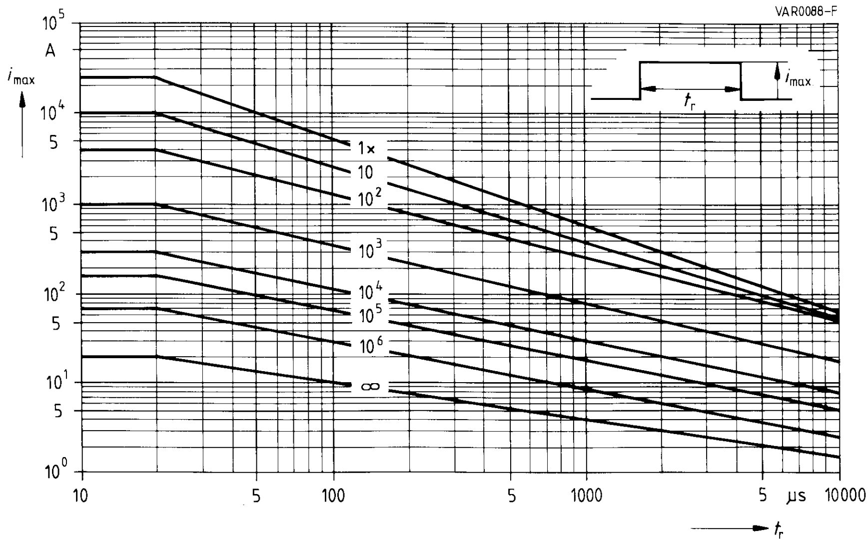
$i_{max} = f(t_r, \text{pulse train})$



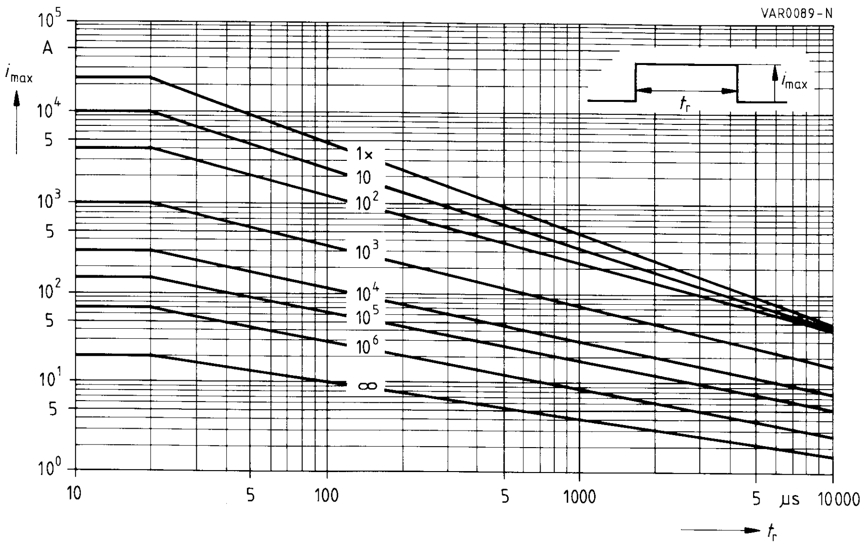
SIOV-S20K510 … K1000

Maximum surge current

$i_{max} = f\,(t_r$, pulse train)



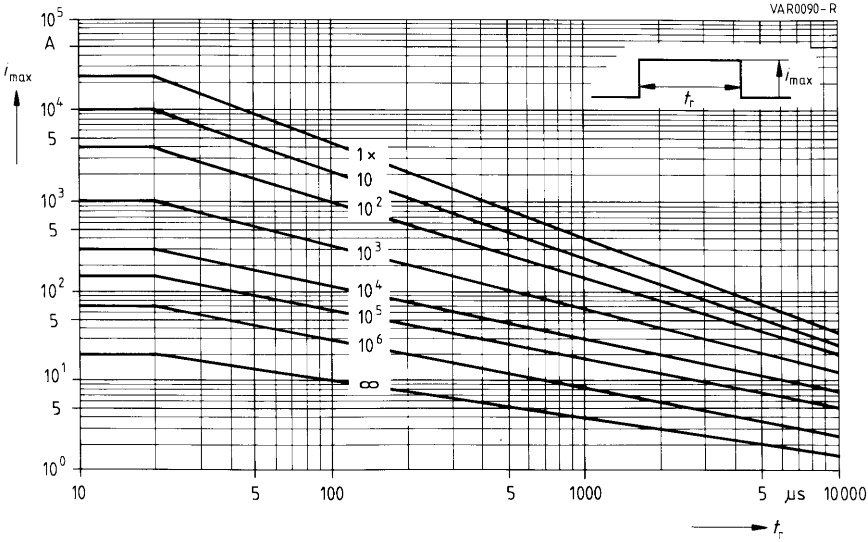
SIOV-B32K130 … K150



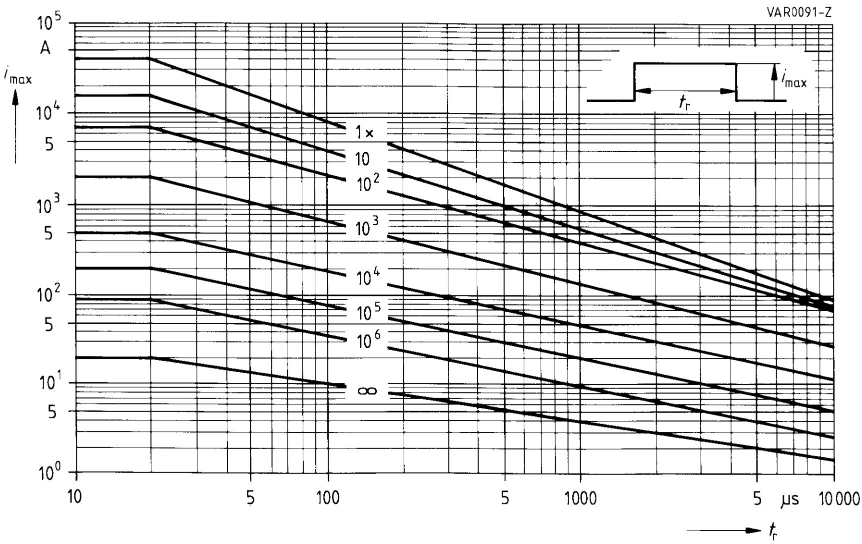
SIOV-B32K230 … K460

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



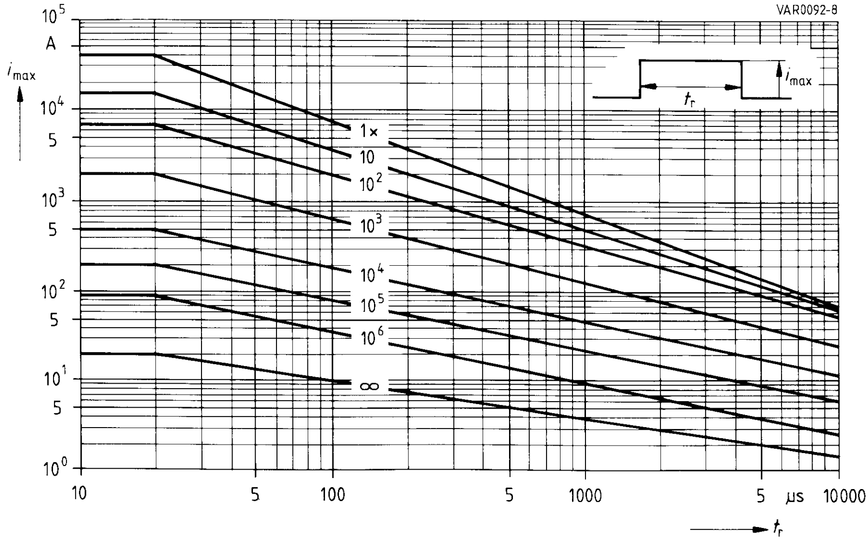
SIOV-B32K550 … K750



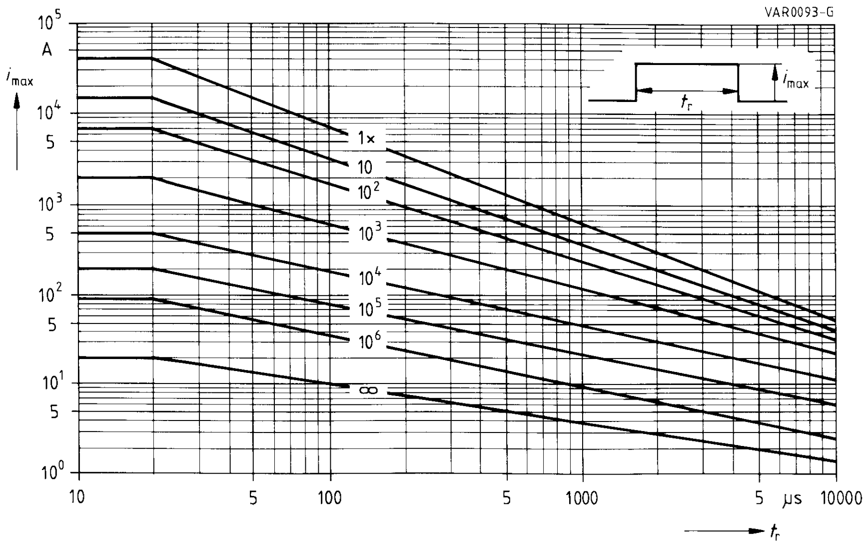
SIOV-B40K75 … K150
SIOV-LS40K130QP … K150QP

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



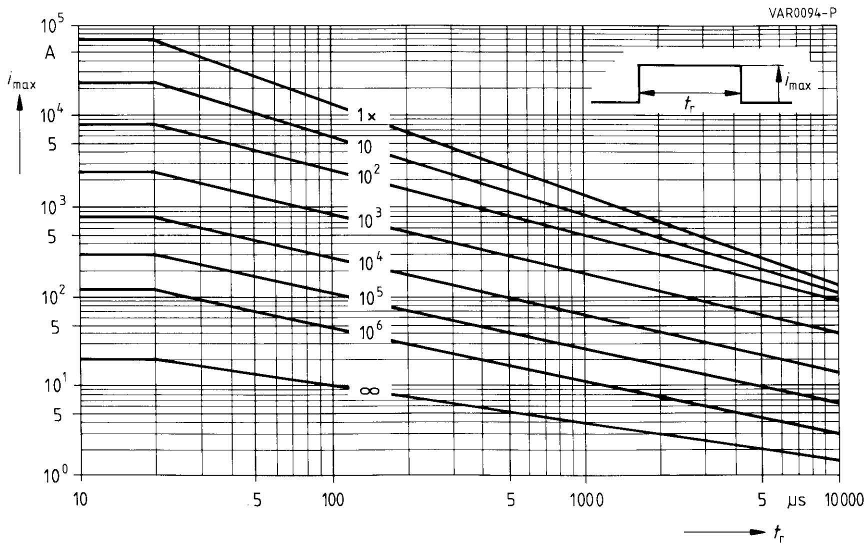
SIOV-B40K230 … K460
SIOV-LS40K230QP … K460QP



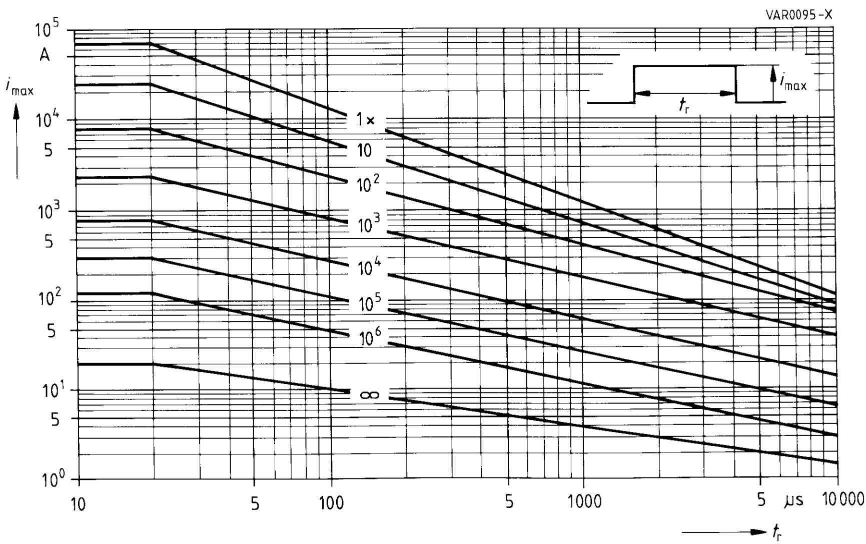
SIOV-B40K550 … K750
SIOV-LS40K550QP … K750QP

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



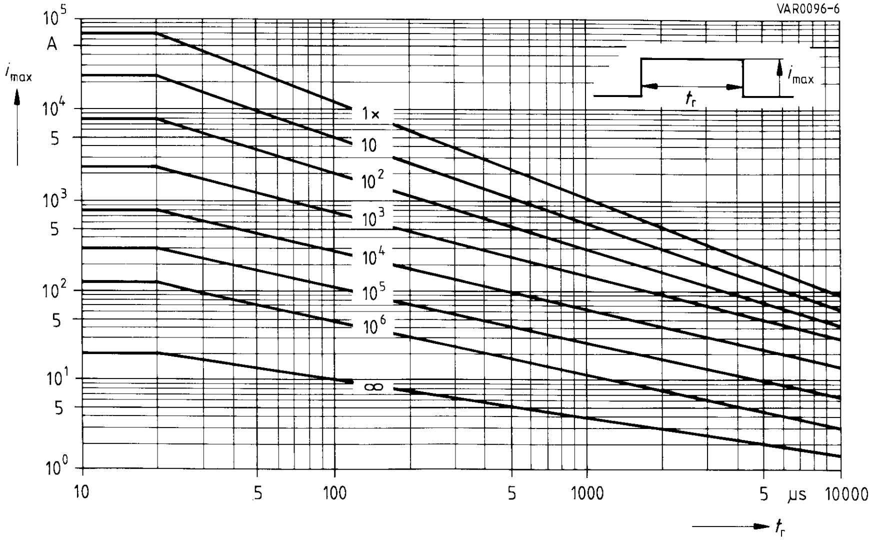
SIOV-B60K130 … K150



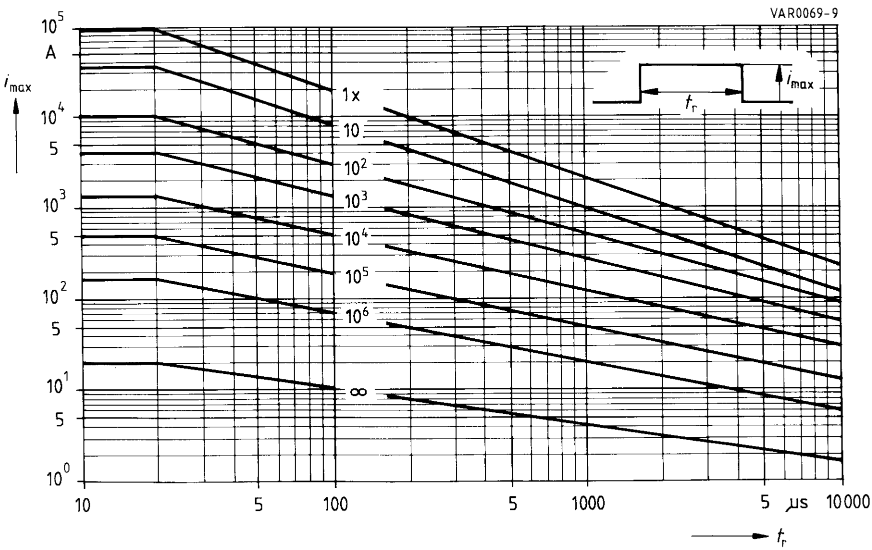
SIOV-B60K230 … K460

Maximum surge current

$i_{max} = f\ (t_r$, pulse train)



SIOV-B60K550 … K1000



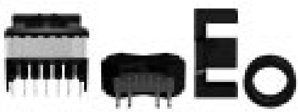
SIOV-B80K130 … K1100

Siemens Matsushita Components

Ferrites and inductive
components in modern
office communications

The little things that do so much

In the multimedia age, ferrites and inductive components often play a key role. In the switch-mode power supplies of PCs ETD cores ensure interference-free transmission of power. Ring and E cores in energy-saving lamps provide pleasant lighting. Interface transformers in ISDN systems satisfy the high demands of CCITT standards. And ultra-flat planar transformers supply units and installations with the necessary power.



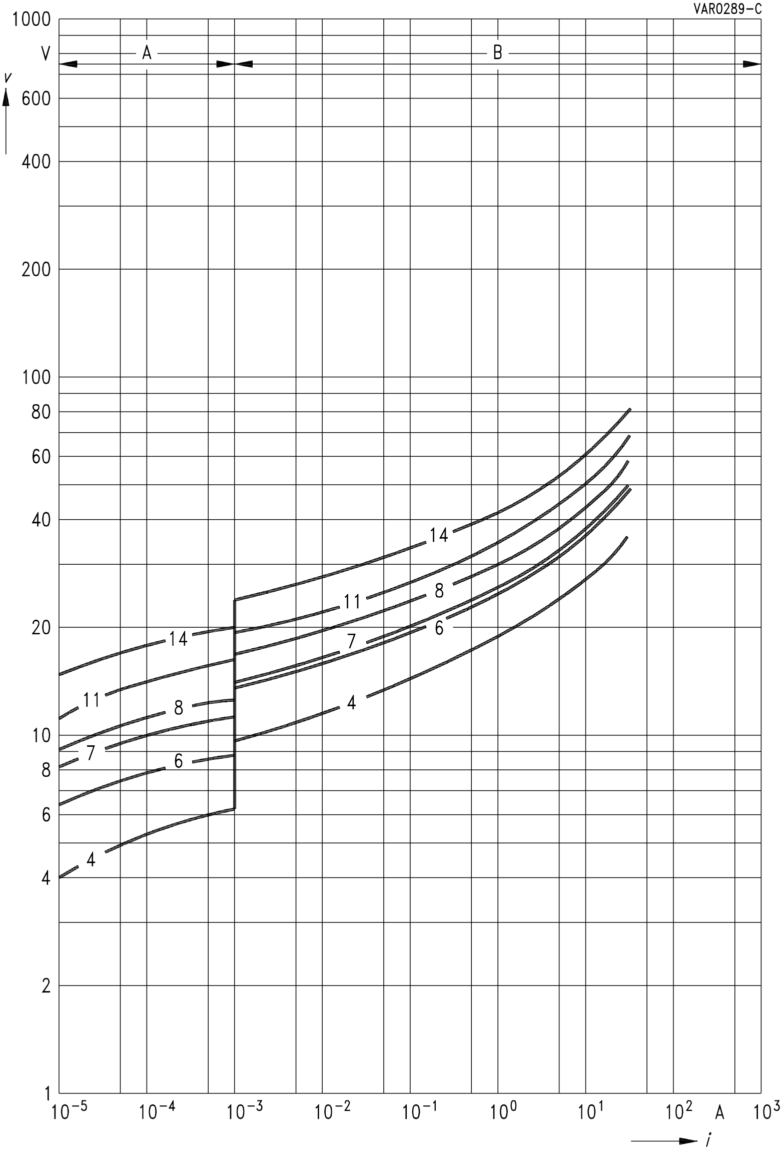
For application-specific products and inductive components design you can count on the support of our I.F.C. KNOW-HOW CENTER, right from the initial engineering phase.

SCS – dependable, fast and competent

V/*I* Characteristics

v = *f* (*i*)

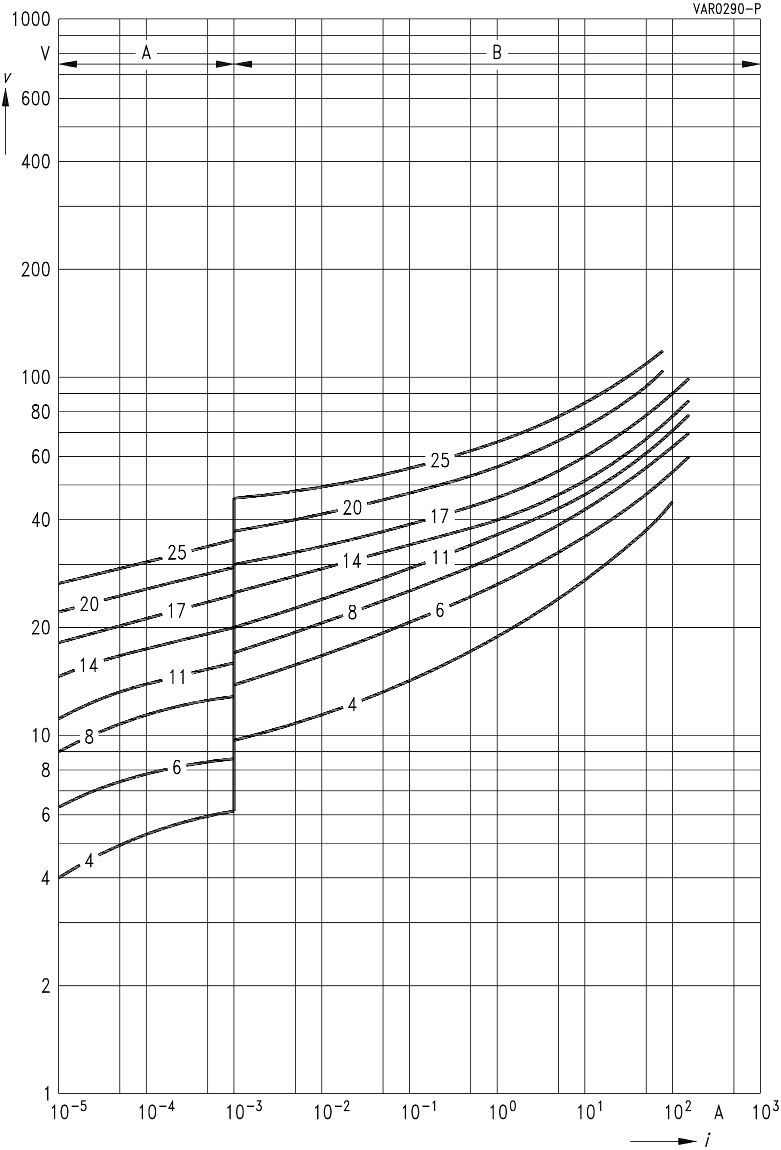
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-CN0603M4G … K14G

v = *f* (*i*)

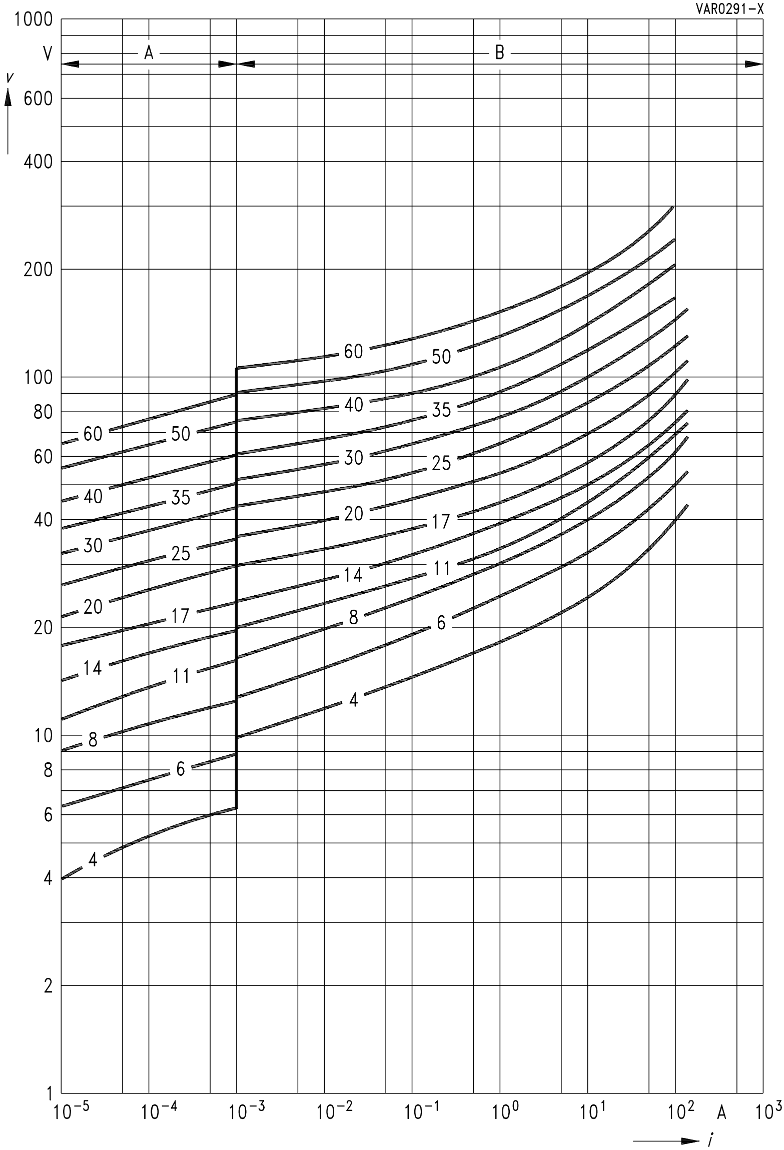
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-CN0805M4G … K25G

v = *f* (*i*)

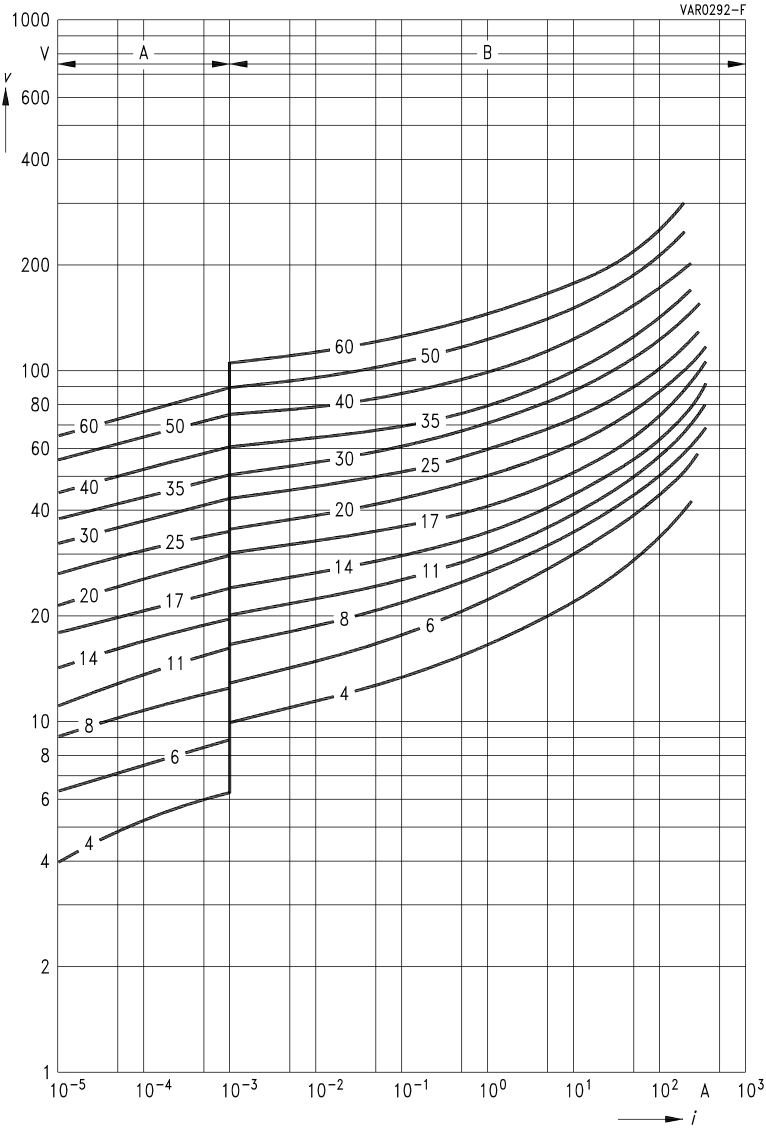
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-CN1206M4G … K60G

v = *f* (*i*)

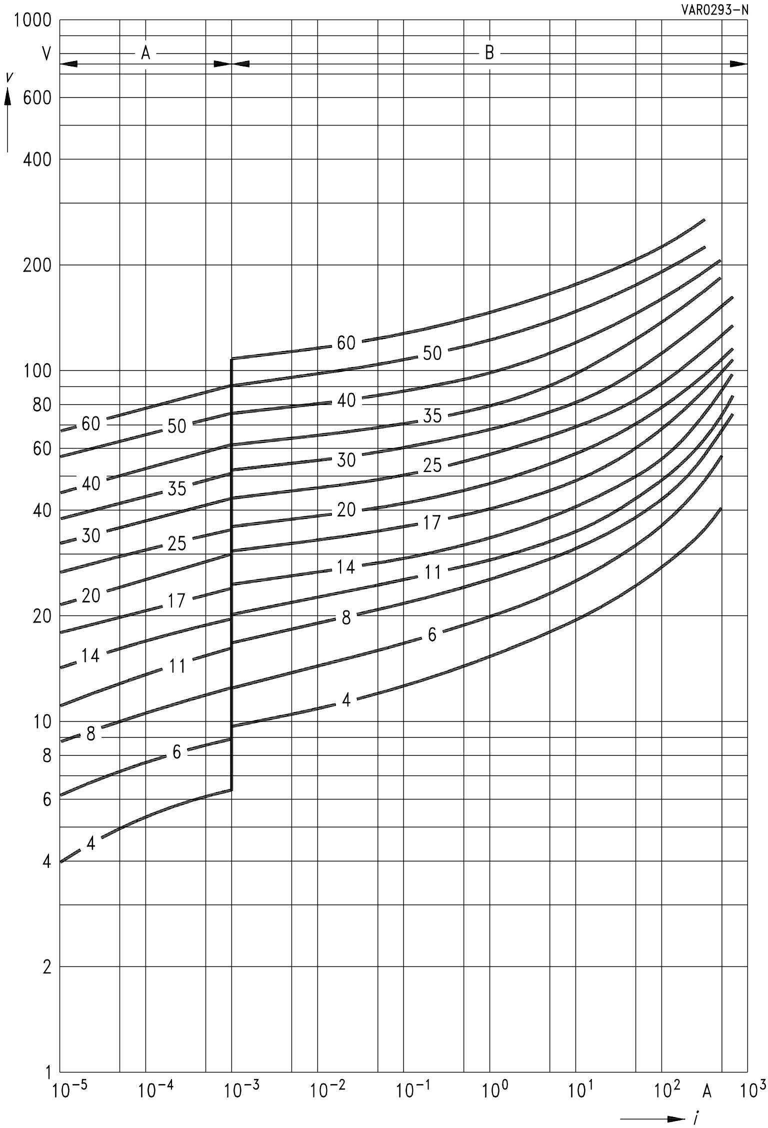
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-CN1210M4G … K60G
SIOV-SR1210M4S, M6S, L8S

v = *f* (*i*)

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

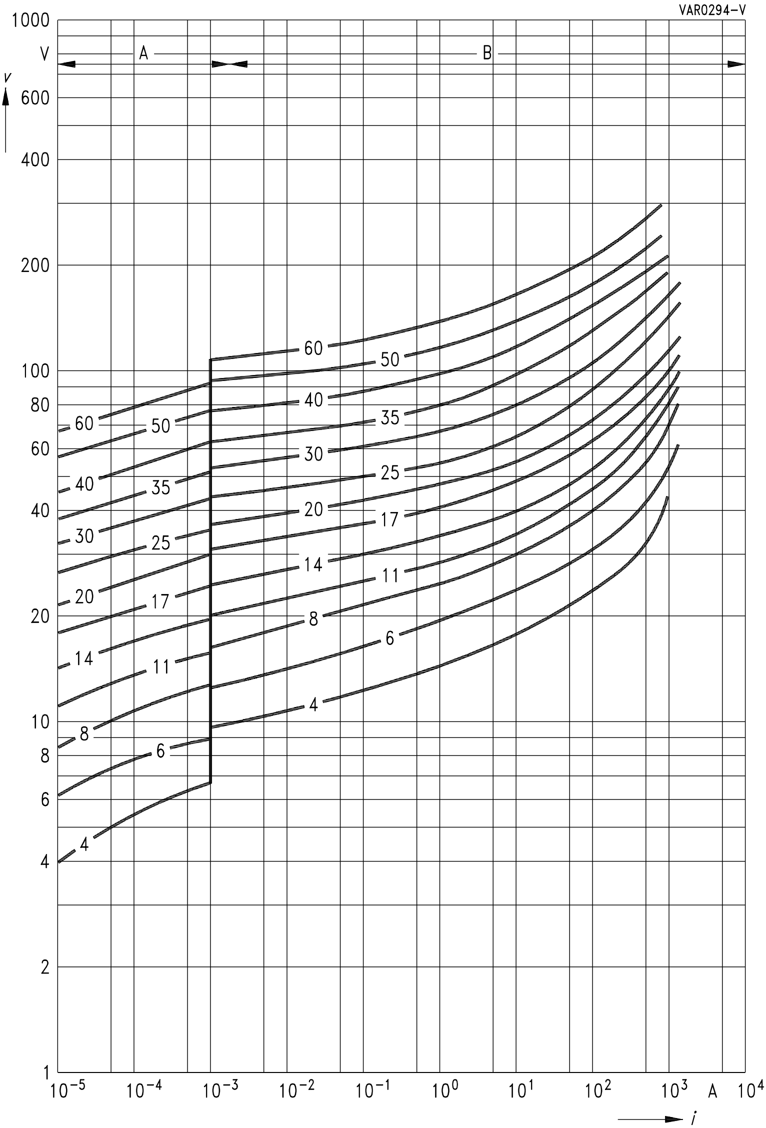


SIOV-CN1812M4G … K60G
SHCV-SR1K20M … X/Z ≙ 1812

V/*I* Characteristics

v = *f* (*i*)

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

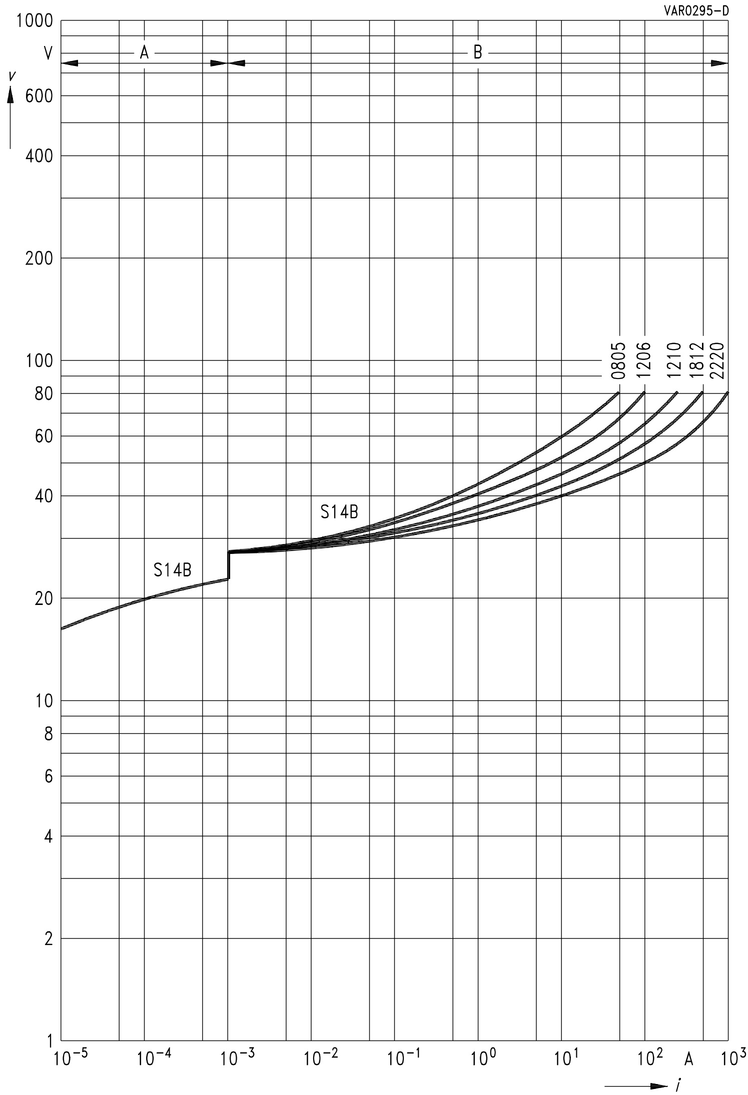


SIOV-CN2220M4G … K60G
SIOV-CN2220K30AUTOG

SHCV-SR2K20M … X/Z ≙ 2220
SIOV-SR2220M4S, M6S, L8S

v = *f* (*i*)

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



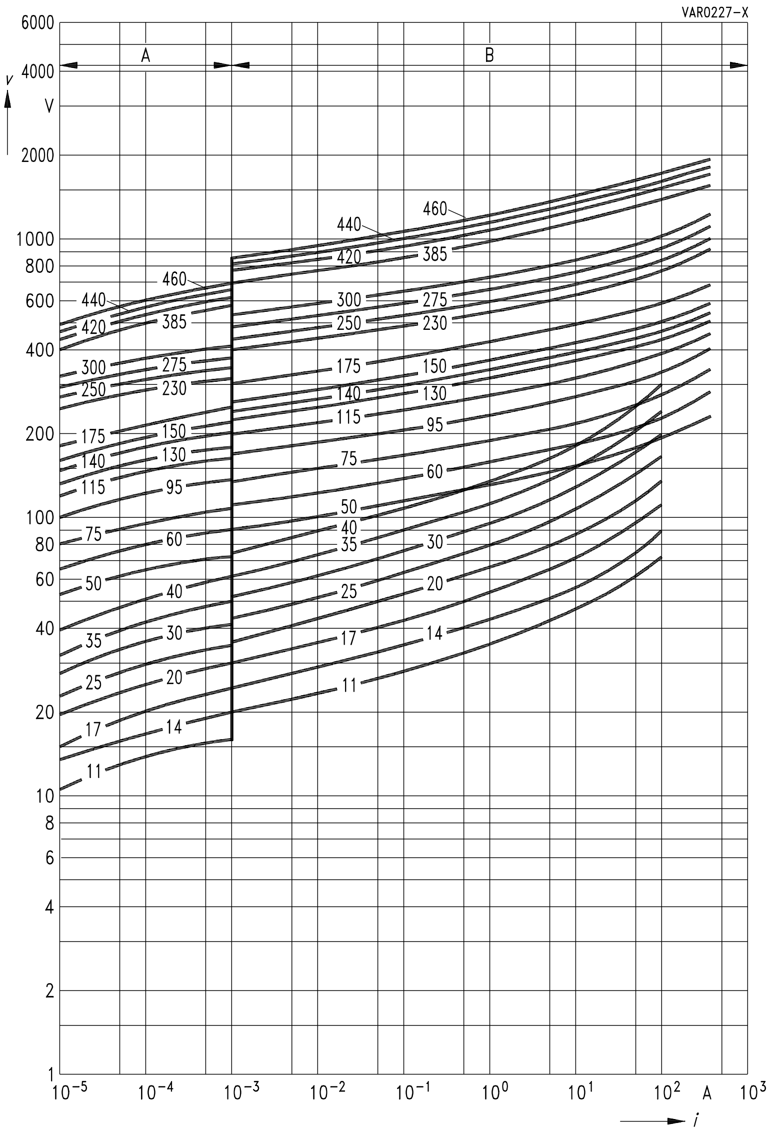
SIOV-CN0805S14BAUTOG … CN2220S14BAUTOG
SIOV-SR1210S14BAUTOS … SR2220S14BAUTOS
SHCV-SR1S14B … X/Z ≙ 1812

SIOV-CN2220S14BAUTOE2G2

SHCV-SR2S14B … X/Z ≙ 2220

v = *f* (*i*)

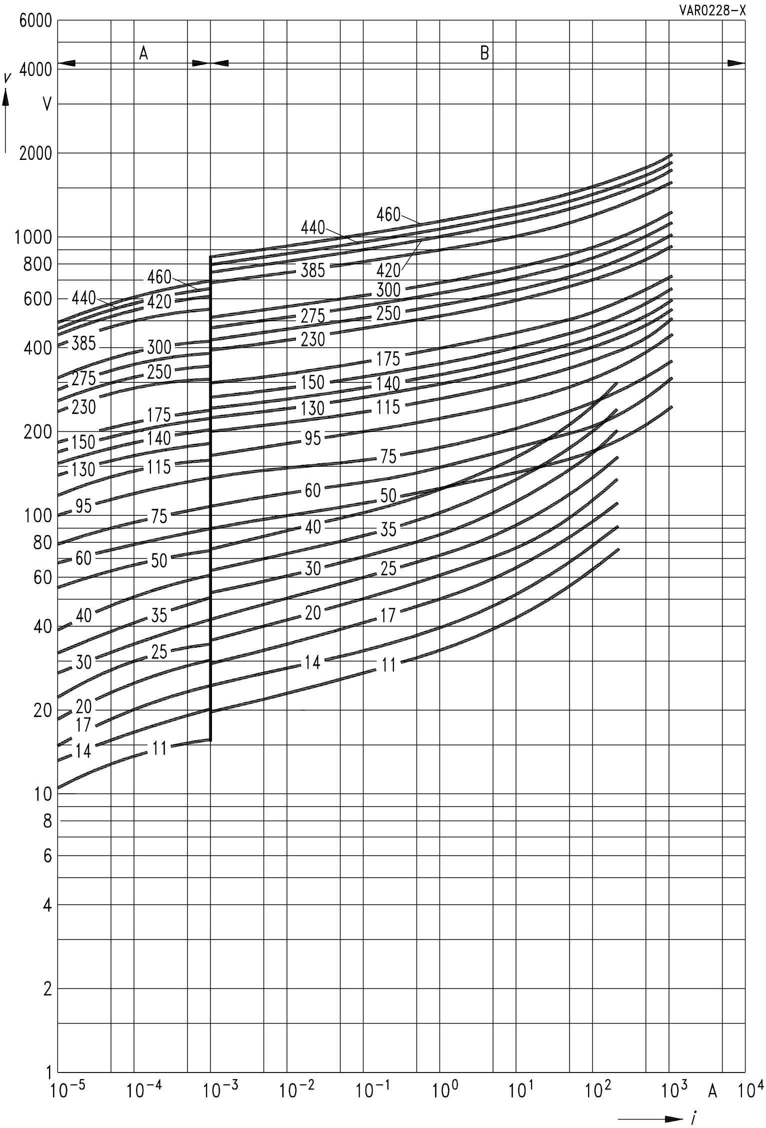
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-S05 …
SIOV-CU3225 … (AUTO)G2

$v = f\,(i)$

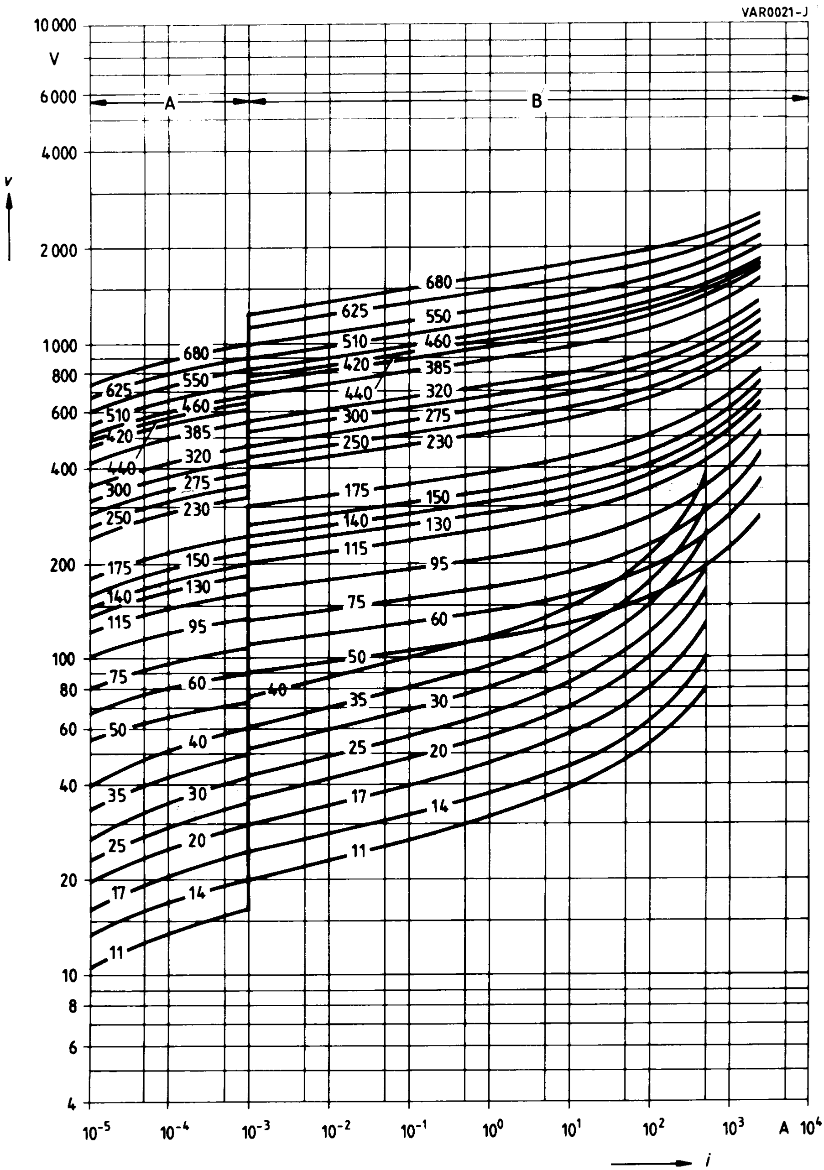
A = Leakage current   for worst-case
B = Protection level   varistor tolerances



SIOV-S07 … (D1)
SIOV-CU4032 … (AUTO)G2

v = *f* (*i*)

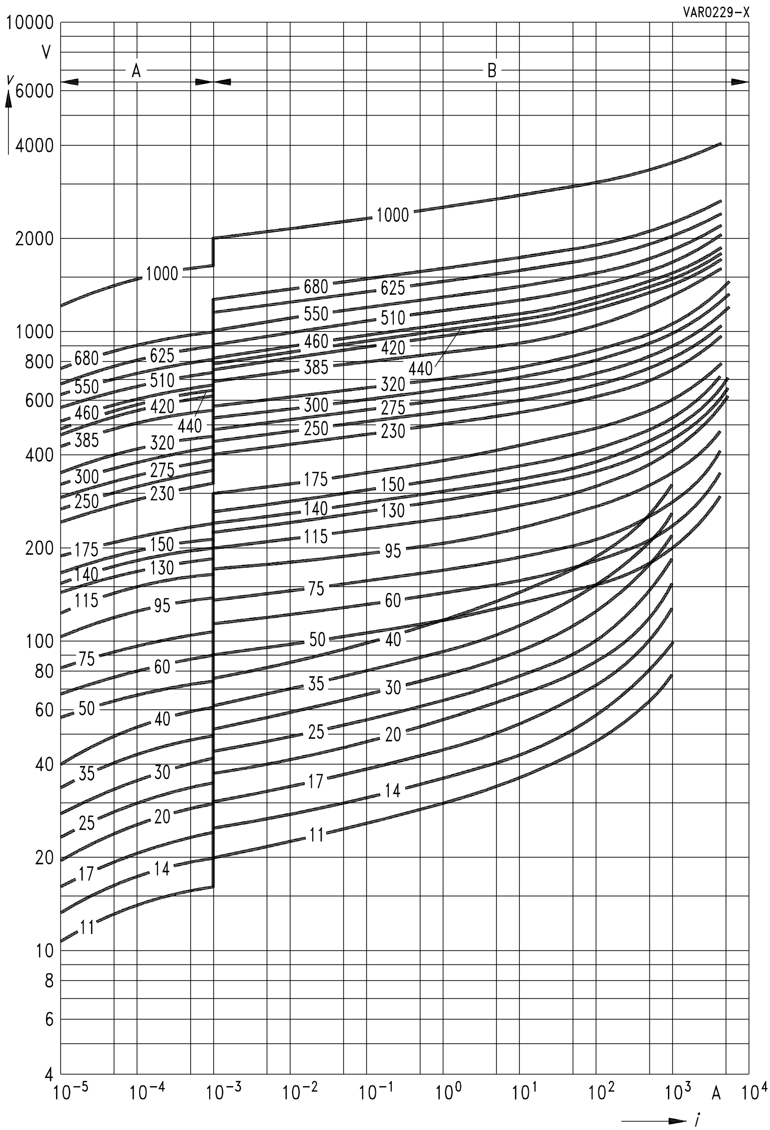
A = Leakage current   for worst-case
B = Protection level   varistor tolerances



SIOV-S10 … (AUTO) (D1)

v = *f* (*i*)

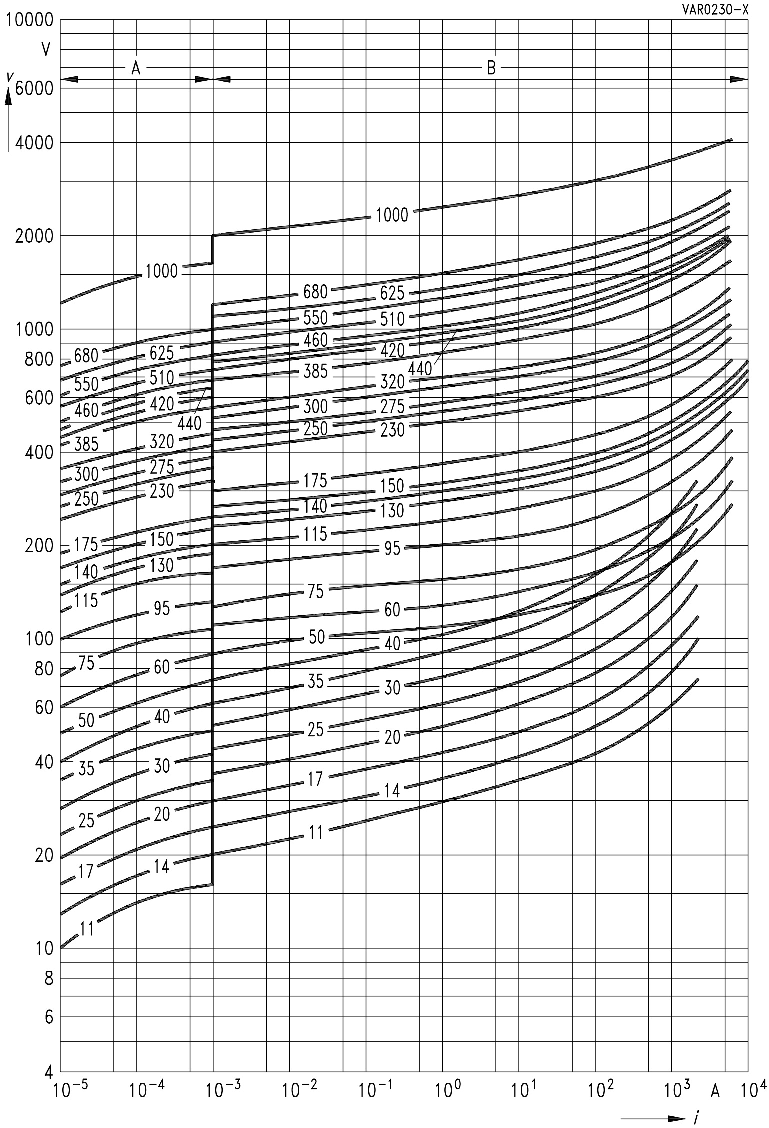
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-S14 … (AUTO) (D1)
SIOV-S14 … (E2)

v = *f* (*i*)

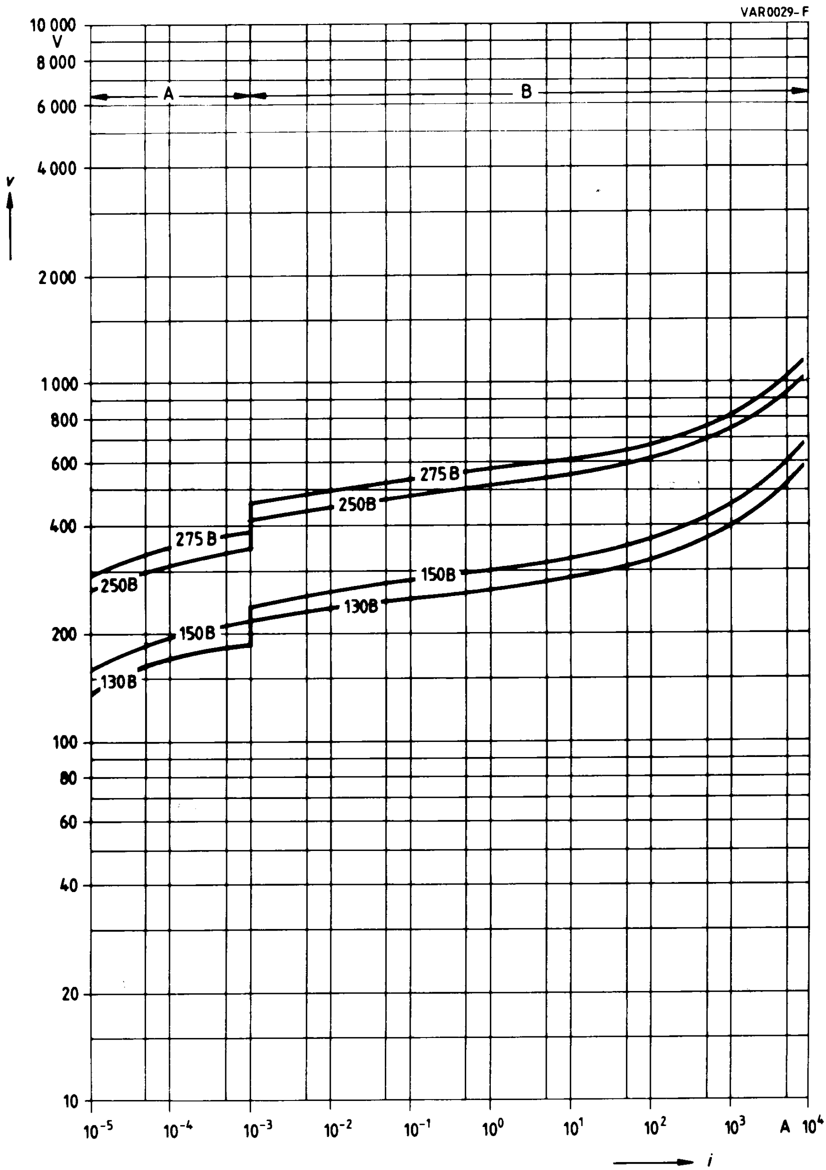
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-S20 … (AUTO)
SIOV-S20 … (E2)

v = *f* (*i*)

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

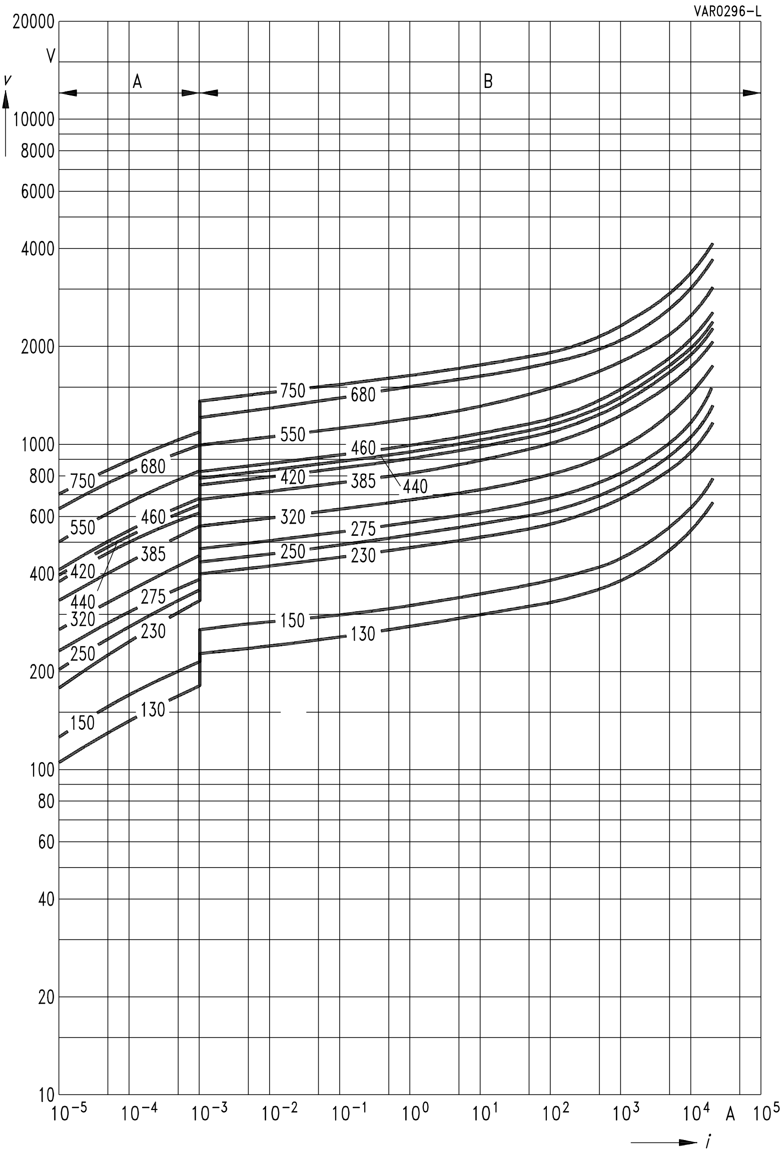


SIOV-S20S130BR7 … S275BR7

V/I Characteristics

$v = f(i)$

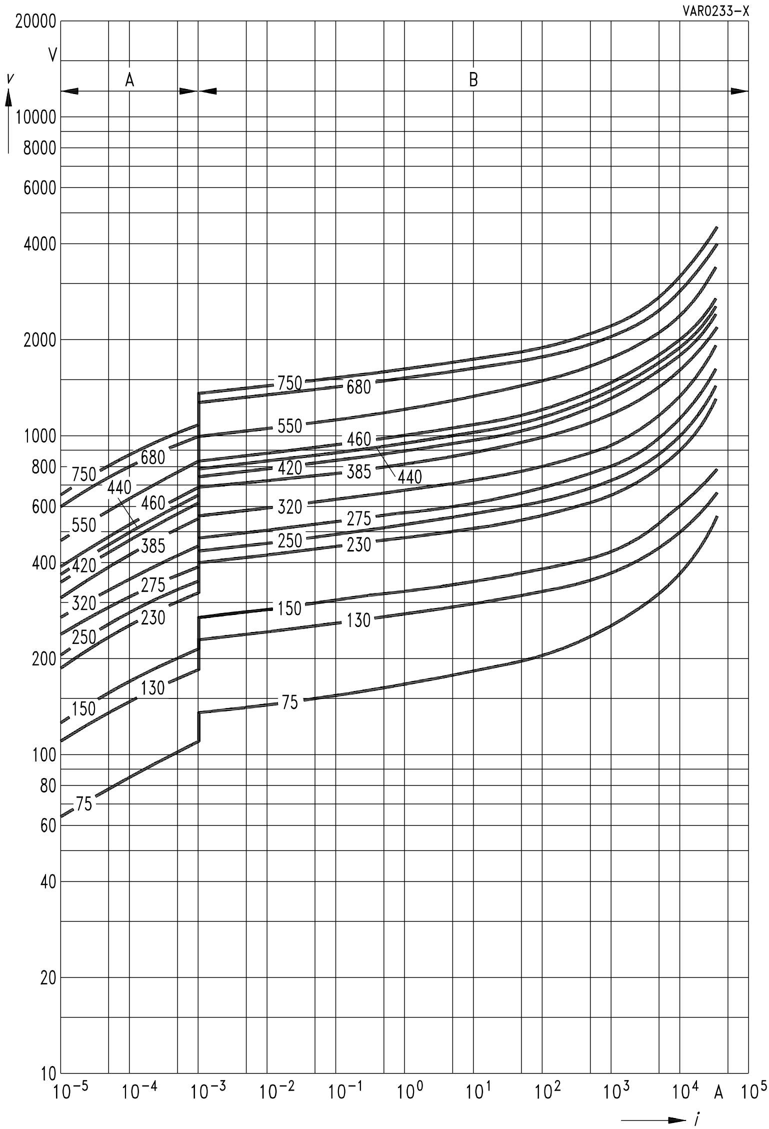
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-B32K130 … K750

v = *f* (*i*)

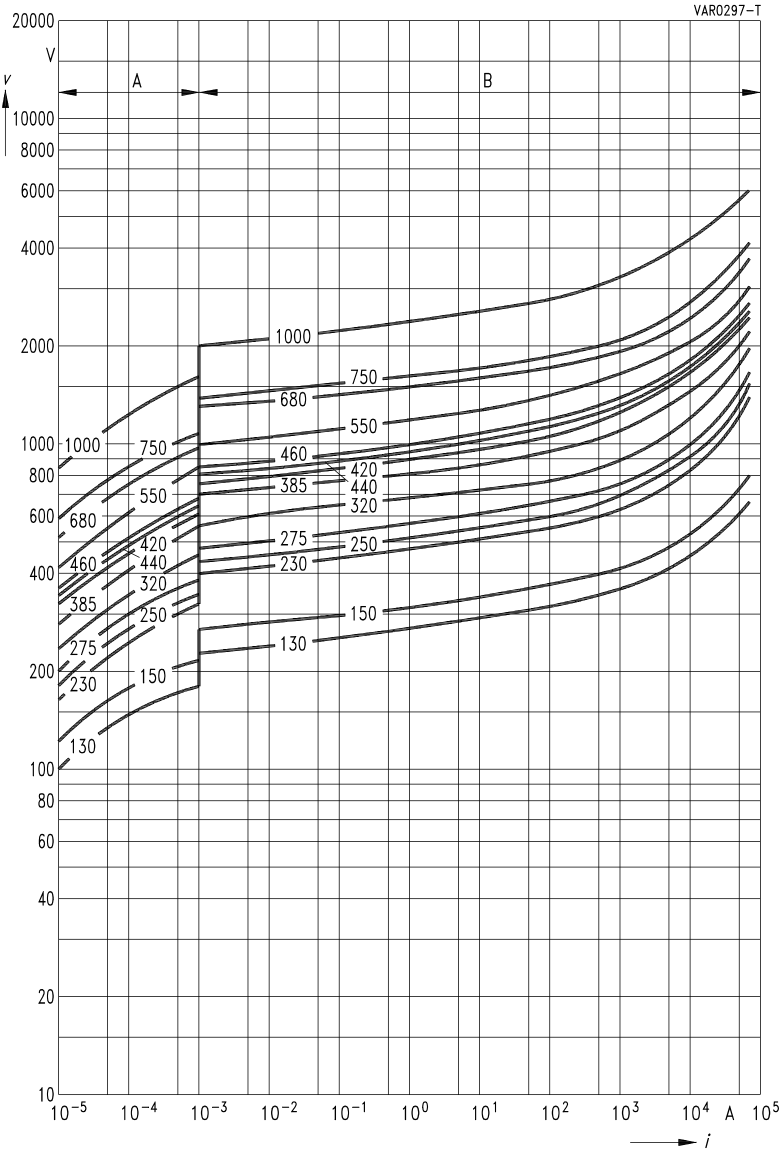
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-B40K75 … K750
SIOV-LS40K130QP … K750QP

$v = f(i)$

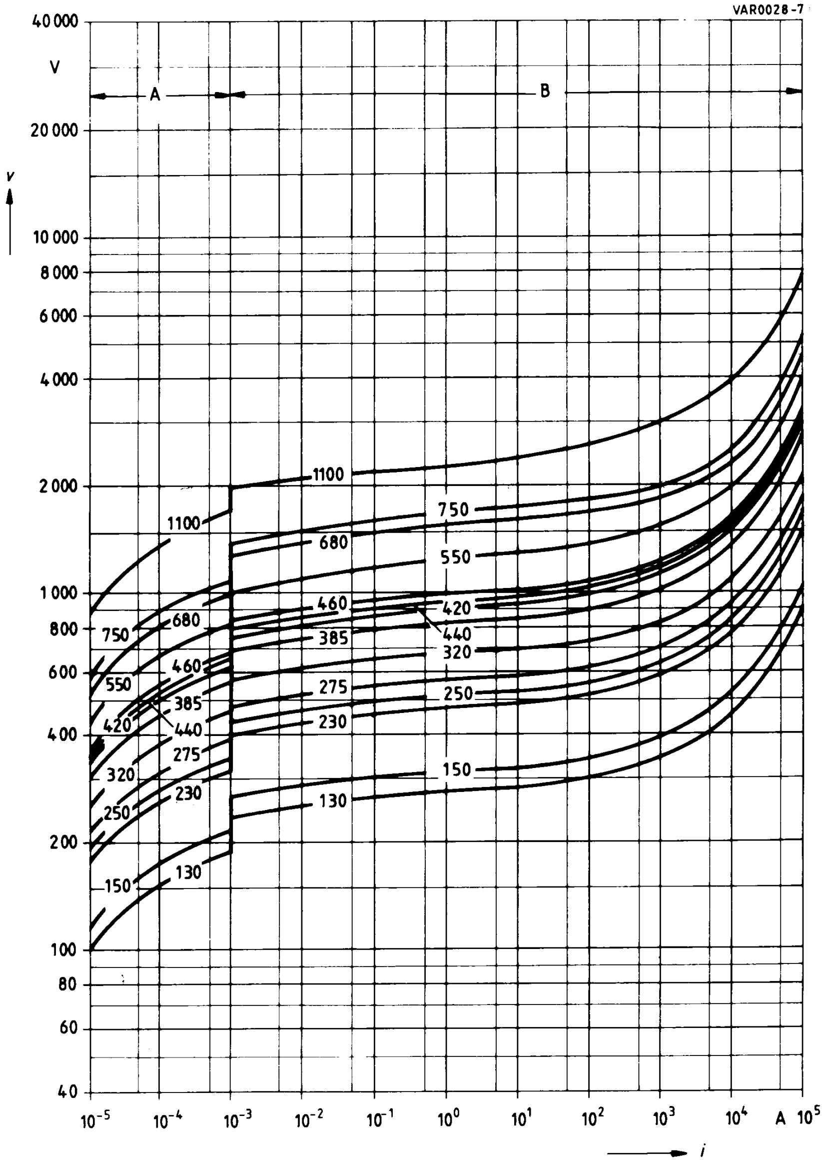
A = Leakage current for worst-case
B = Protection level varistor tolerances



SIOV-B60K130 … K1000

v = *f* (*i*)

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



SIOV-B80K130 … K1100

Symbols and Terms

C_{typ}	Typical capacitance
i	Current
i_{max}	Maximum surge current
L_{typ}	Typical inductance
P_{max}	Maximum average power dissipation
R_{min}	Minimum resistance
T_A	Ambient temperature
t_r	Duration of equivalent rectangular wave
v	Voltage
V_{DC}	DC operating voltage
V_{Jump}	Maximum jump start voltage
V_{RMS}	AC operating voltage, root-mean-square value
V_V	Varistor voltage
ΔV_V	Tolerance of varistor voltage
W_{LD}	Maximum load dump
W_{max}	Maximum energy absorption
$\boxed{e}$	Lead spacing

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