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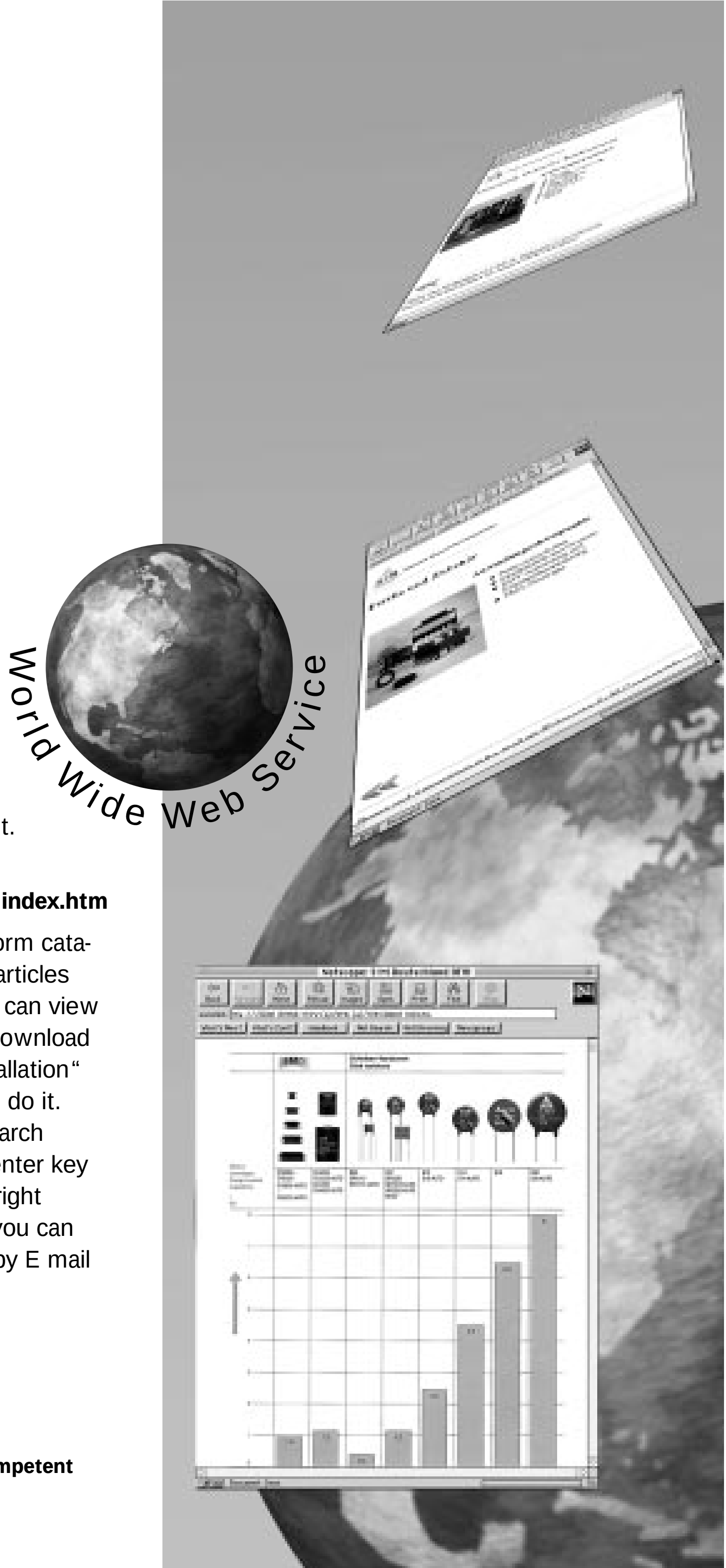

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SIOV
Metal Oxide Varistors

All SIOV varistors presented in this data book are manufactured by Siemens Matsushita Components GmbH & Co. KG in Deutschlandsberg (Styria, Austria).

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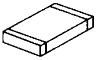
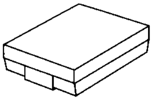
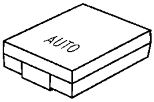
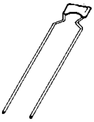
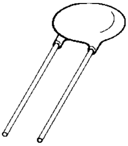
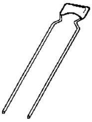
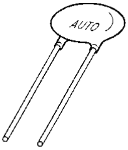
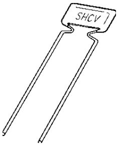
Type Survey

SMD varistors

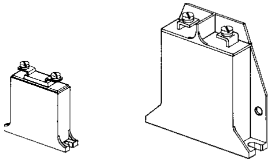
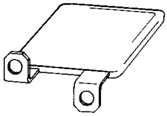
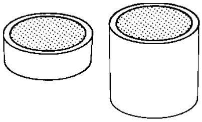
Symbol	Standard models 1)				Automotive models 1)				
									
Type	CN121	CN222	CU322	CU403	CN121	CN181	CN222	CU322	CU403
Operating voltage V_{RMS} 1000 – 100 – 10 –	8 4	8 4	300 11	300 230 TELECOM 60 11	14	14	14	30 17 14	30 17 14
Surge current (kA)	0.25	1.0	0.4 ··· 0.1	1.2 ··· 0.25	0.25	0.5	1.0	0.1	0.25
Energy absorption (J)	0.7 ··· 0.3	4.0 ··· 1.5	9.6 ··· 0.3	23 ··· 0.8	3	6	12	6	12
Available on tape (V class)	8 ··· 4	8 ··· 4	300 ··· 11	300 ··· 11	14	14	14	30 ··· 14	30 ··· 14

1)The range of SMD varistors has been extended:
Type series CN0805, CN1206, CN1210, CN1812, CN2220; voltage range 4 to 60 V_{RMS} (5 to 85

Disk varistors

Standard models								Automotive models							
															
SR	SR	S0	S0	S1	S1	S1	S2	SR12	SR18	SR22	S10	S14	S20	SHCV	SHCV
8 4	8 4	460 11	460 11	680 230 TELECOM 60 11	1100	460 130	1100	14	14	14	17 14	30 17 14	30 25 17 14	20 14	20 14
0.2 5	1.0	0.4 … 0.1	1.2 … 0.2	2.5 … 0.5	4.5 … 1.0	6.5	8.0 … 2.0	0.25	0.5	1.0	0.5	1.0	2.0	0.5	1.0
0.7 … 0.3	4.0 … 1.5	18 … 0.3	36 … 0.8	72 … 1.7	23 0 …	18 0 …	410 … 10.	3	6	12	25	50	100	6	12
8 … 4	8 … 4	30 0 …	30 0 …	30 0 …	30 0 …	30 0 …		14	14	14	17 … 14	30 … 14		20 … 14	20 … 14

Type Survey

Symbol	Block varistors					Strap varistors	Arrester blocks
							
Type	B25	B32	B40	B60	B80	LS40	E32
Operating voltage V_{RMS} 1000 – 100 – 10 –	420 250 130 75	750 75	750 75	1100 75	1100 130	750 130	3500 1150
Surge current (kA)	15	25	40	70	100	40	65 1)
Energy absorption (J)	350 … 85	800 … 120	1200 … 190	3000 … 320	6000 … 660	1200 … 310	2800 … 930

---

1) High-current pulse (4/10 µs)

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.

Components of this kind from Siemens Matsushita range from surface-mount types through radially leaded versions (disk-type) to block models for heavy duty. The selection is rounded off by special designs for automotive electrical systems and telecommunication applications.

1.2 Definition

Varistors (**Var**iable Res**istors**) are voltage-dependent resistors with a symmetrical V/I characteristic curve 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.

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 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 1 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 1, 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.

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- 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.

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 specific 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 characteristic of the individual microvaristors is not affected by this.

Ceramics with a small specific voltage (low-voltage types) cannot be loaded the same as high-voltage types. That explains the differences in surge current, energy absorption and mechanical dimensions within the various type series. This shows most clearly between the voltage classes K40 and K50, for example for the maximum permissible surge current:

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

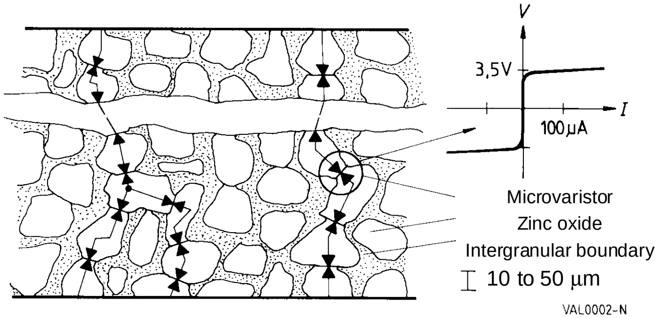


Figure 1
Conduction mechanism in varistor element

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.

1.5 Equivalent circuits

Figure 2a shows the simplified equivalent circuit of a metal oxide varistor. From this the behavior of the varistor can be interpreted for the different current ranges.

Leakage current region ($< 10^{-4}$ A)
In the range of leakage current 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 2b:

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 2c). The *V/I* curve (figure 4) 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 2d). The ohmic bulk resistance of ZnO causes the *V/I* curve to resume a linear characteristic (upturn region).

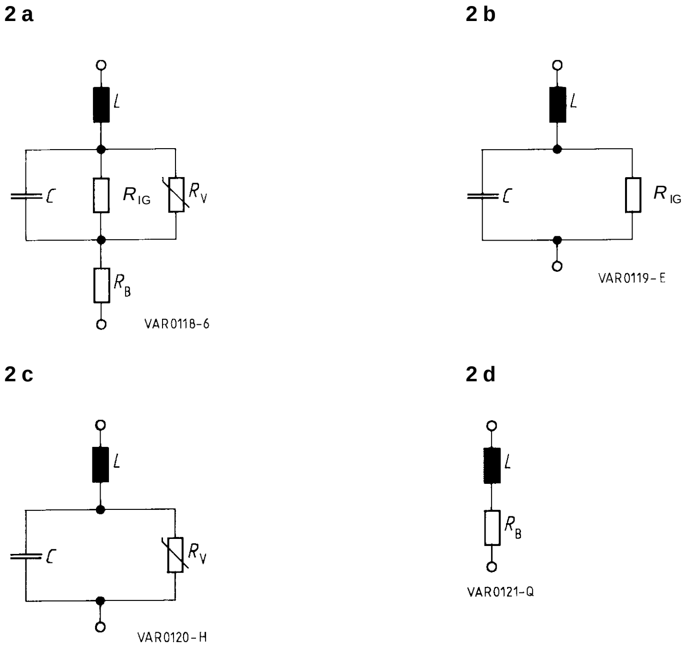
Capacitance

Equivalent circuits 2b and 2c indicate the relatively high capacitance of metal oxide varistors (see product tables for typical values). This capacitance excludes the possibility of using varistors in high-frequency systems.

In terms of overvoltage suppression however, a high capacitance is desirable because, with its low-pass characteristic, it smooths steep surge voltage edges and consequently improves the protection level.

Lead inductance

The response time of the varistor ceramic itself is in the picosecond region. The lead inductance of the terminals, however, increases response time to values of a few nanoseconds. So designs should always aim at minimizing lead lengths in order to keep inductance as low as possible.


2 a **2 b** **2 c** **2 d**

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 2a – 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 3a):

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

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 3b):

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

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

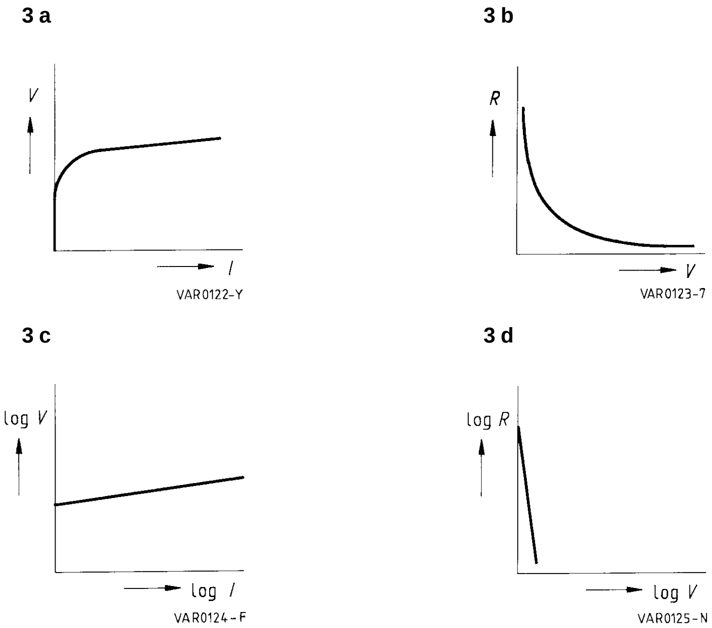
$$\log I = \log K + \alpha \log V \qquad \text{(equ. 3)}$$

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

This is virtually the only form of presentation used for varistor characteristics (figures 3c and 3d). 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).

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

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



Figures 3a – d
Presentation of the *V*/*I* characteristics

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

Figure 4 shows a typical *V*/*I* characteristic with SIOV-B60K250 taken as example.

The downturn and upturn regions according to equivalent circuits 2b and 2d 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 4 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 4 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 possibly have to be compensated by correcting additives in equation 3.

Deriving from figure 4, figure 5 shows the change in static resistance $R = V/I$ for SIOV-B60K250. The resistance is > 1 MΩ in the range of operating voltage, whereas it can drop by as many as ten powers of 10 for overvoltage, which is therefore "short-circuited".

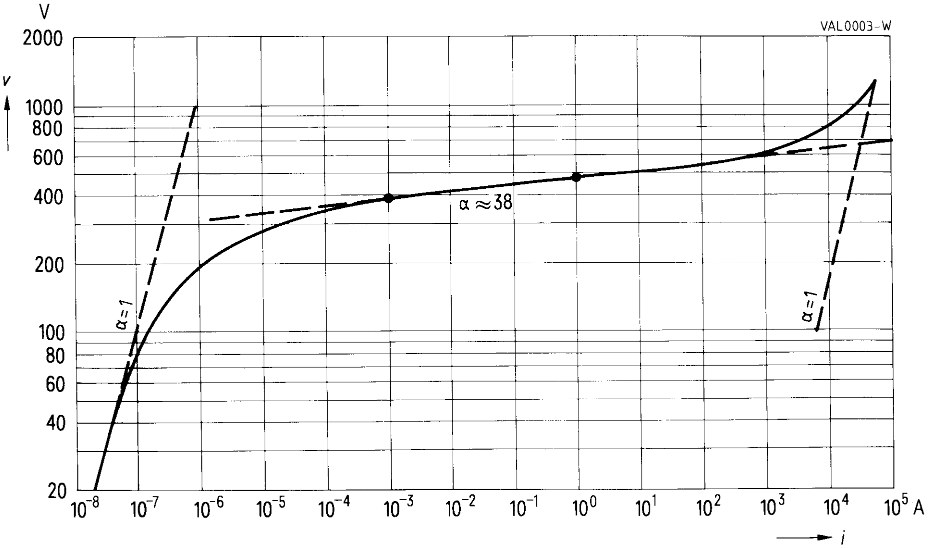


Figure 4
Real *V/I* characteristic of a metal oxide varistor with SIOV-B60K250 taken as example

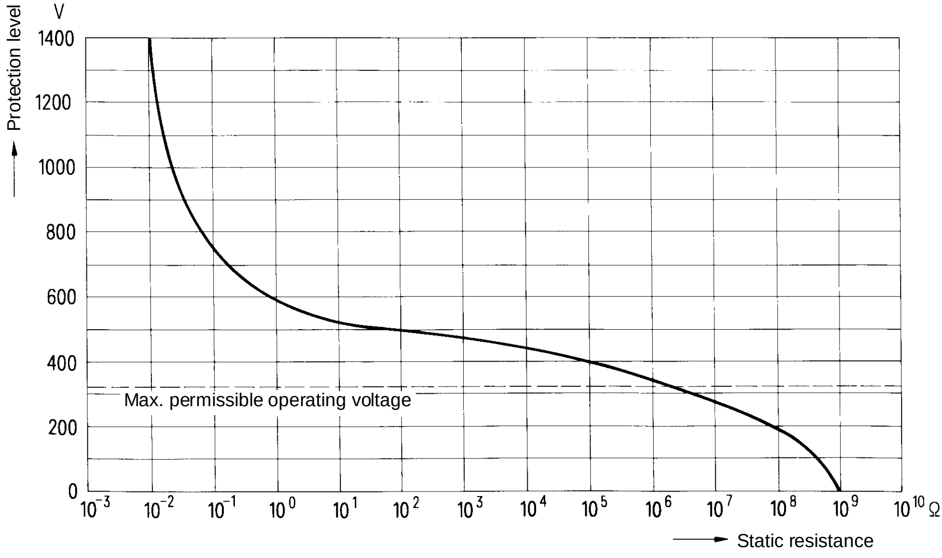


Figure 5
Static resistance of a metal oxide varistor versus protection level with SIOV-B60K250 taken as example

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 becomes unclear. Therefore only the segments that are important for the user are shown in the product part of the data book. Figure 6 illustrates this in the case of SIOV-S14K14.

Lefthand part of curve: lower limit of tolerance band
The largest possible leakage current at given operating voltage can be directly read for the worst case of the varistor in the tolerance band.

Righthand part of curve: upper limit of tolerance band
The largest possible protection level at a given surge current can be directly read for the worst case of the varistor in the tolerance band.

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 $\triangleq$ ±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 6a), you can derive a leakage current between $6 \cdot 10^{-6}$ A and $2 \cdot 10^{-4}$ A (band 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).

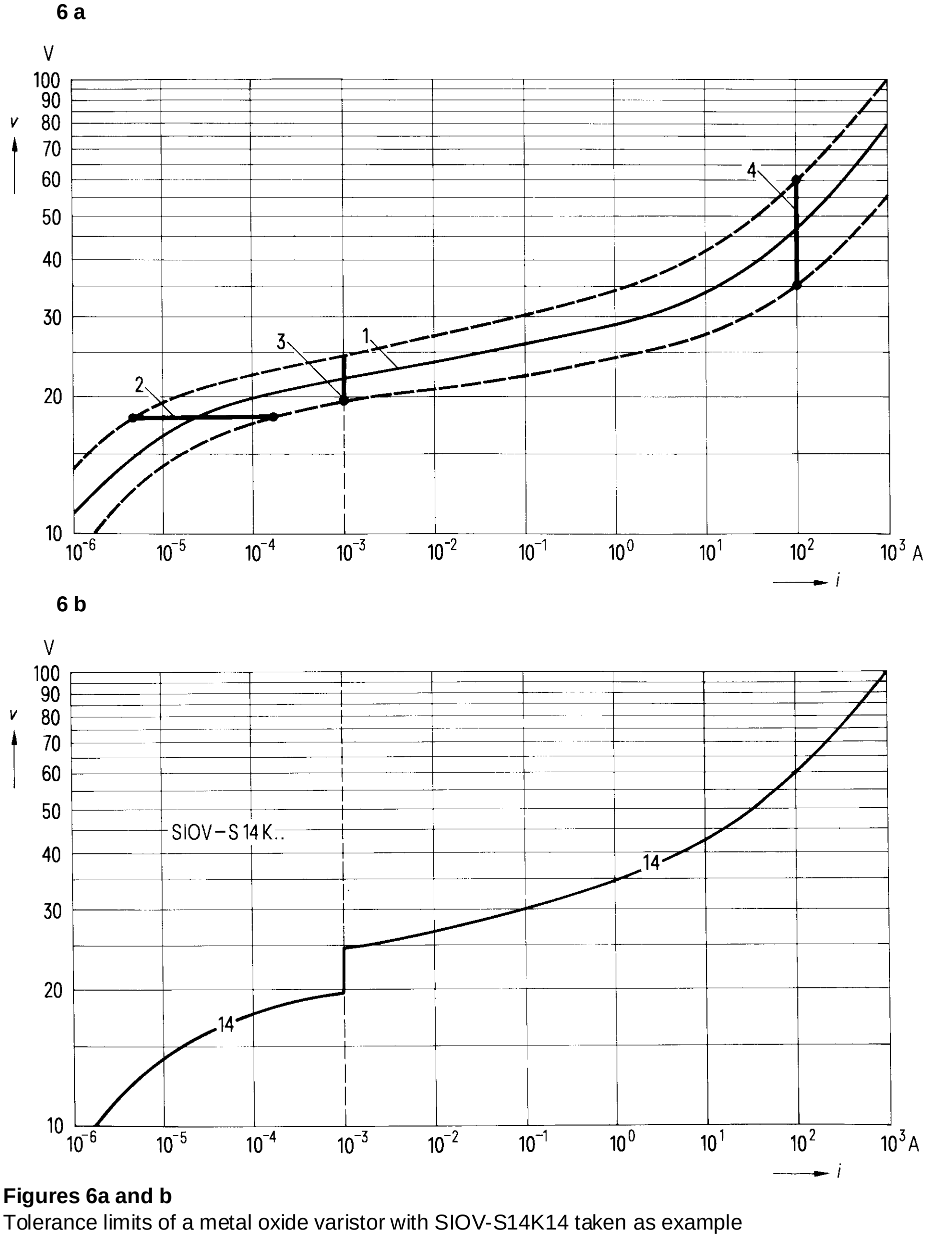
Protection level:
Assuming a surge current of 100 A, the voltage across SIOV-S14K14 will increase to between 35 V and 60 V (band 4), depending on where the varistor is in the tolerance band.

The *V/I* characteristics are only shown as far as 10^{-5} A because there can be considerable errors when measuring smaller currents.

1.6.4 Overlapping *V/I* characteristics

The curves overlap section by section between the voltage ratings L8/K11 and K40/K50. The reason for this are varistor ceramics of different nonlinearity, as described in section 1.3.

Especially before choosing voltage rating K40 therefore, you should always consider whether K50 might not be the better solution. On the one hand the protection level is lower for larger surge currents, and on the other hand the current handling capability of K50 is decidedly greater for the same diameter.



Figures 6a 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, of course, are an exception to this as these models must withstand full jump-start voltage 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.

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 7a. 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:

$$W = \int_{t0}^{t1} v(t)\, i(t)\, dt \qquad \text{(equ. 6)}$$

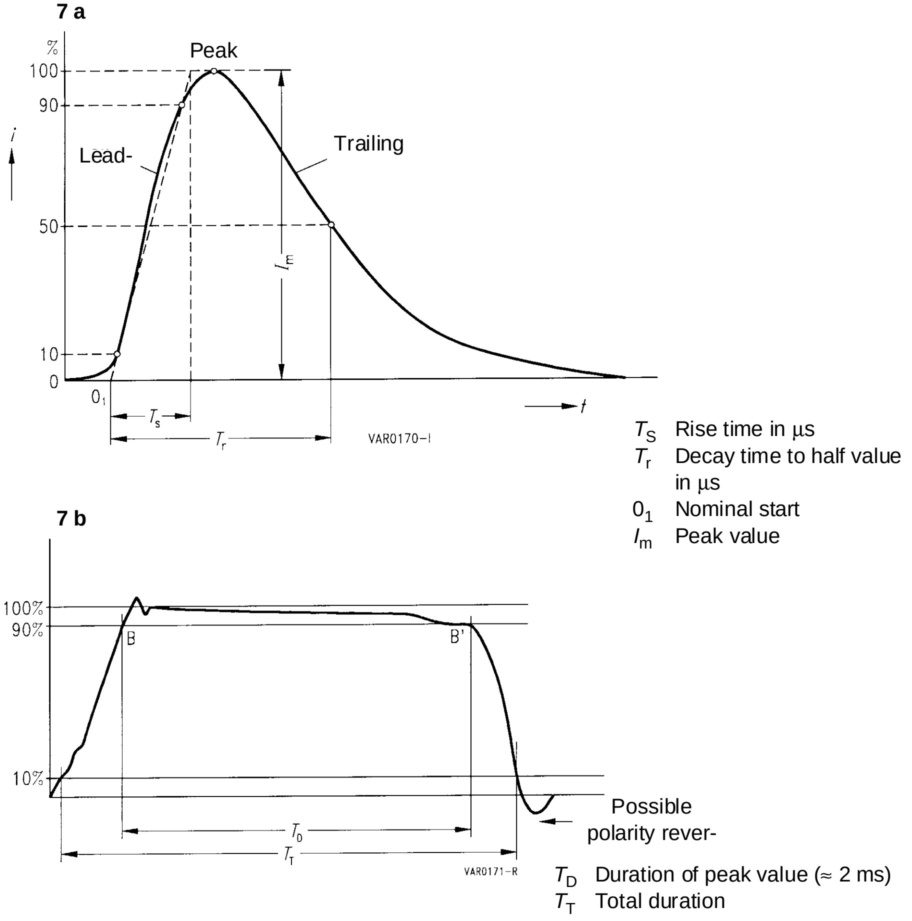
where $v(t)$ is the voltage drop across the varistor during current flow.

Figure 26 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 7 b) is commonly used for this test.

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



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

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

Figures 7a 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 chapter „Application and Selection“ show the calculation of the minimum time interval in periodic application of energy.

Note
Metal oxide varistors are less suitable – because of physical factors – for repetitive dissipation of substantial amounts of average power. Semiconductor devices like zener diodes and silicon carbide varistors are preferable here.

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 6, 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 slight dependence on frequency (approx. 10% lower at 100 kHz) is negligible.

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 disk thickness, i.e. it decreases with increasing protection level.

Capacitance values are not subject to outgoing inspection.

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 7a). So they allow for the inductive voltage drop across the varistor for the particular $\mathrm{d}i/\mathrm{d}t$.

If surge currents with steep edges are to be handled, you 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 8 shows results for SIOV-S20K275 as an example.

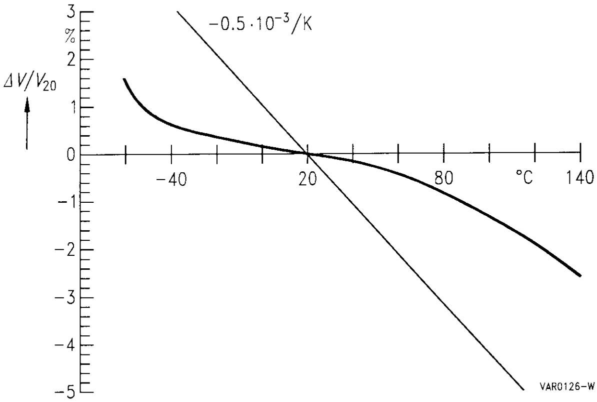


Figure 8
Temperature coefficient of voltage at 1 mA for SIOV-S20K275

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

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

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

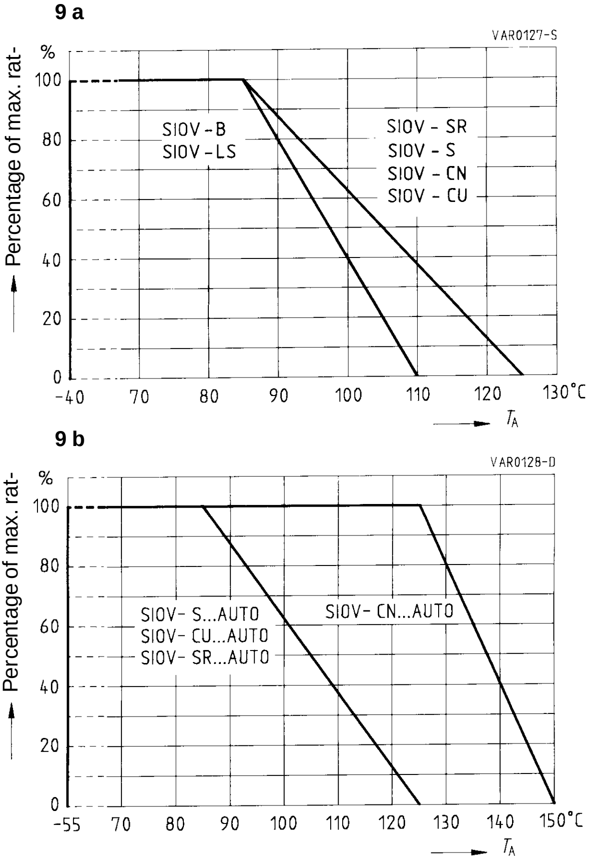
have to be derated according to figure 9a or 9b.

1.9 Operating and storage temperature

The ranges of operating and storage temperature for different type series can be derived from figures 9a and 9b for 100% and 0% values.

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).



Figures 9a 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 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 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 should 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 resistor 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 series	S05 CU3225	S07 CU4032	S10	S14	S18	S20
Nominal fuse current [A]	≤ 1	≤ 3	≤ 6	≤ 10	≤ 12	≤ 16

If the power source impedance is relatively high and the fault current through the varistor after an overload or during continuous overload is too low to blow a fuse, the power dissipated may cause overheating which may lead to fires. In this case a thermal protection device should be used to break the circuit.

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 IR reflow soldering are suitable for SMD varistors. Recommended temperature profiles are shown in figures 10 and 11.

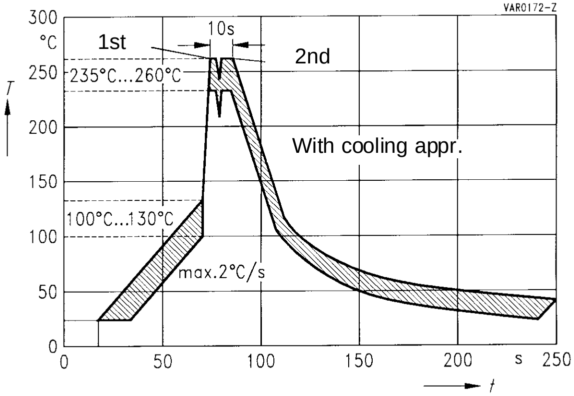


Figure 10
Recommended temperature profile for wave soldering

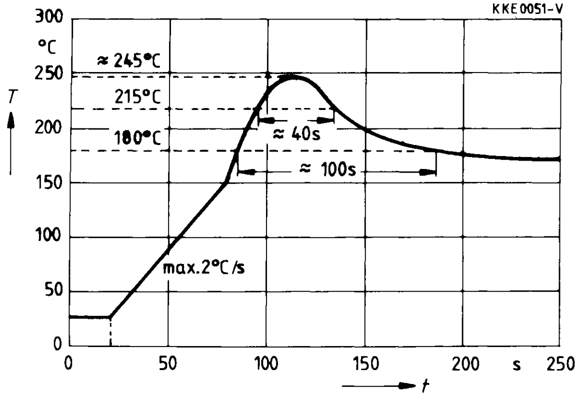


Figure 11
Recommended temperature profile for infrared reflow soldering

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 … + 45 °C
Max. relative humidity (without condensation):
< 75 °C annual average, < 95% on max. 30 days per annum.

1.13 Designation system

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	**CN** = Chip – without encapsulation **CU** = Chip – encapsulated **SR** = Disk varistor – rectangular **S** = Disk varistor – round **B** = Block varistor **LS...QP** = Strap varistor – square disk, epoxy coated, bolt-holed terminals **E** = Arrester block
Area of varistor element Length × width in 1/100 inch	1210 = 12/100 × 10/100 = 3.2 mm × 2.5 mm 1812 = 18/100 × 12/100 = 4.5 mm × 3.2 mm 2220 = 22/100 × 20/100 = 5.7 mm × 5.0 mm 3225 = 32/100 × 25/100 = 8.0 mm × 6.3 mm 4032 = 40/100 × 32/100 = 10 mm × 8.0 mm 1 = 1812 (only SHCVs) 2 = 2220 (only SHCVs)
Rated diameter of varistor disk	05 … 80
Tolerance of varistor voltage (1 mA)	J = ± 5% K = ± 10% L = ± 15% M = ± 20% S…B = Special tolerance (B specifies special tolerance)
Max. permissible AC operating voltage	4 … 1100 = 4 … 1100 $V_{\mathrm{RMS\,max}}$
Varistor voltage	V202 = $V_{\mathrm{V}} = 20 \cdot 10^2$ V = 2.0 kV V612 = $V_{\mathrm{V}} = 61 \cdot 10^2$ V = 6.1 kV
Tolerance of capacitance (only SHCVs)	M = ± 20%
Capacitance (only SHCVs)	474 = $47 \cdot 10^4$ pF = 0.47 µF
Code letter for capacitor ceramic (only SHCVs)	X = X7R Z = Z5U
Taping	G = Taped (SMDs only on tape) G.S. = Taped, crimp style S, S2, S3, S4, S5 (see page 110)
Special codes	AUTO = High energy absorption, high resistance to thermal shock R5 = LS 5.0 (differs from standard) R7 = LS 7.5 (differs from standard)

Manufacturing code: all varistors (except CN) are marked with year/week code.
Example: 8909 = 9th week 1989

2 Application and selection

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.

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.

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 too uncertain. So, for reliable protection against transients, a certain degree of "overdesign" has to be put up with (see example in 2.6.2).

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), the type series S18 or S20 should be chosen, while in systems that are especially vulnerable (industrial, in mountains) block varistors are preferable. For design notes see page 26.

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 12 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 $v_{\text{source}} = Z_{\text{source}} \cdot i$, 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

$$v_V = \left(\frac{Z_V}{Z_{\text{source}} + Z_V} \right) v \qquad \text{(equ. 8)}$$

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

For selection of the most suitable protective element, you have to know something about the surge current waveform that goes with the transient. This is often, and mistakenly, calculated by way of the (very small) characteristic impedance of the line at line frequency. This leads to current amplitudes of unrealistic proportions. Here you have to remember that typical surge current waves contain a large portion of frequencies in the kHz and MHz range at which the characteristic impedance of the line is significantly higher.

Figure 13 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.

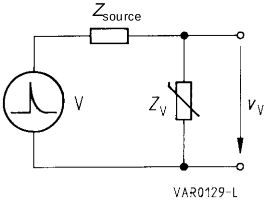


Figure 12
Equivalent circuit in which Z_{source} symbolizes the voltage-independent source impedance

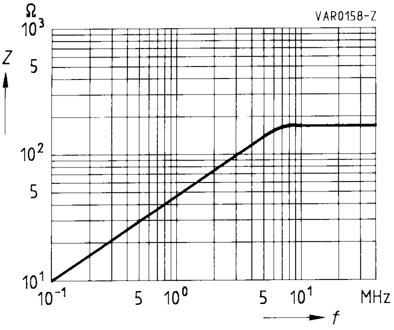


Figure 13
Impedance of a supply line for high-frequency overvoltages

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

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

Data systems
Transmission lines
Power supply units
Personal computers

Power electronics
Bridge rectifiers
Brake rectifiers
Electric welding
Electric vehicles
Switch-mode power supplies

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

Stepped protection
Microelectronics
EMI/RFI suppression
EMP/NEMP protection

Entertainment electronics
Video sets
Television sets
Slide projectors
Power supply units

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 to handle higher surge current or levels of energy. A distinction has to be made between two ranges of surge current.

Normal operating region

According to the definition in 1.5, the surge currents here are of such an order that the bulk resistance of the zinc oxide does not yet become noticeable. The currents looked at are thus substantially less than the maximum permissible ratings. So the purpose of parallel connection in this range of current is not to increase surge strength but simply energy-absorption capability. The cases concerned are consequently those where relatively small surge currents contain high levels of energy, ie flow correspondingly longer.

If unselected varistors are connected in parallel in this region, the result can be current-sharing ratios up to 1000 : 1.

Example S14K14, Fig. 6a:
One varistor is on the upper limit of the tolerance band with its *V/I* curve and the other on the lower limit. For a surge current of 1 A for example, ie protection level 25 V, 1 A flows practically alone across the varistor at the lower tolerance limit, while the 1 mA across the other varistor is negligible. The distribution of energy absorption is correspondingly unfavorable. So parallel connection makes no sense.

Narrowing the tolerance band would produce better results. For this the varistors have to be measured and matched to the expected surge current. The somewhat elaborate procedure involved means that the use of parallel circuits to enhance energy absorption tends to be an exception to the rule.

High surge current region

Here parallel connection can serve to increase the maximum permissible surge current. The bulk resistances that now take effect improve the current-sharing ratio, because the varistor that handles the larger current tends to be driven into the upturn region. So the higher voltage drop on it shifts the current to the varistor in parallel.

From Fig. 6a it is possible to see that at 1080 A for example, ie protection level 55 V, the current-sharing ratio in the worst case is only 1000 A : 80 A. This is an improvement compared to the normal operating region, but still far from satisfactory.

So the measuring effort involved and low efficiency limit the use of parallel circuits to exceptional cases. It is always preferable to use a varistor with a higher rating. This is now possible in practically all applications following the introduction of the SIOV-B80 series.

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:

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

When estimating the loading of a varistor, one should always assume the worst case (e.g. the varistor will have to absorb the entire stored magnetic energy of a coil $1/2\ L\ i^2$ when it is switched). Such a calculation will always include an extra safety margin because of losses in other components of the circuit.

2.5.1 Operating voltage

Maximum permissible AC and DC operating voltages are stated in the product tables for all varistors. To arrive at 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: 230 V + 6 % = 244 V to IEC 38) because power dissipation in a varistor rises sharply with operating voltage.

Note

Any varistor with a higher voltage rating may be selected of course. This procedure is followed, for instance, when an extremely small leakage current is more important than the lowest protection level. This also increases the mean operating life of the varistor (see figure 29).

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 250 for 230 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. According to the explanation of the principle of protection with varistors (2.2), the question here is therefore what surge current is driven by a transient through the series circuit of voltage-independent resistor and varistor.

Graphic method

The problem is solved most easily in graphic fashion. Draw the load line of the transient (open-circuit voltage, short-circuit current) in the family of *V/I* curves. Where this line intersects the *V/I* curve you can read off the surge current together with the protection level (see example in 2.6.2 and figure 21).

On a linear scale the load lines would be straight, but as the *V/I* curves are in log-log format the load lines become curves.

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 2.6.2. for an example.

Switching of 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, 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 free-wheeling circuit (see figure 19).

The time constant $\tau = L/R$ that can be calculated from the inductance and the resistance of the free-wheeling 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 free-wheeling 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 14).

τ depends on the size of the inductance and the resistances of the free-wheeling 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).

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

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 2.6.1).

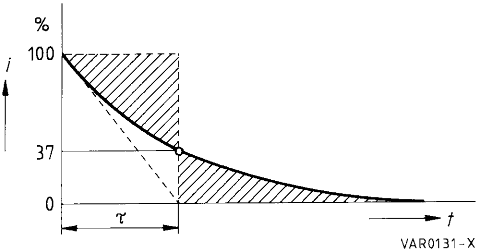


Figure 14
Time constant of free-wheeling circuit

Testing

If there is the possibility of working with a test circuit, the surge current can be determined with the aid of a low-inductance test shunt (example in figure 25).

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 derived 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 you 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 15.

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.)

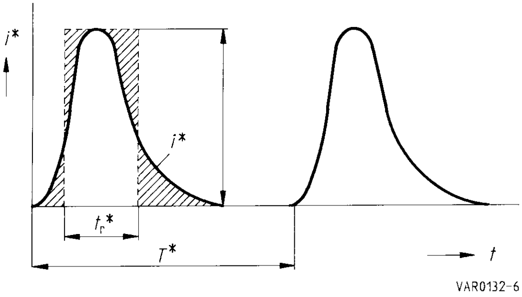


Figure 15
"Rectangle method"

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.

Often – as shown for $W^* = 100$ J in figure 26 – the energy absorption can be read directly from a storage oscilloscope or determined numerically from the voltage and current.

Graphic method

Otherwise equation 6 can be solved graphically with sufficient accuracy by using the rectangle method. $i\,(t)$ is converted as in figure 15 and multiplied by the highest voltage appearing on the varistor according to equation 14:

		v^*	[V]	(equ. 14)
$W^* = v^*\ i^*\ t^*_{\mathrm{r}}$	[J]	i^*	[A]	
		t^*_{r}	[s]	

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

Switching of 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 capacity for 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. 15)
		i^*	[A]	

The equation will always include a safety margin because of losses in other components.

Comparison: determined energy input / maximum permissible energy absorption

To check the selection requirement $W^* \leq W_{\mathrm{max}}$ (equation 10), you have to determine the maximum permissible energy absorption for the intended varistor. This can be calculated by equation 16 as a function of time the energy is applied (t_{r}) and the number of repetitions from the derating curves:

$$W_{\mathrm{max}} = v_{\mathrm{max}}\ i_{\mathrm{max}}\ t_{\mathrm{r\ max}} \qquad \text{(equ. 16)}$$

v_{max} is derived from the *V/I* characteristic of the intended varistor type for the surge current i_{max}. $t_{\mathrm{r\ max}}$ 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:

$$P^* = \frac{W^*}{T^*} = \frac{v^* \, i^* \, t^*_\mathrm{r}}{T^*} \quad [\mathrm{W}]$$

W^* [J] i^* [A] (equ. 17)
T^* [s] t^*_r [s]
v^* [V]

W^* takes the value of a single absorption of energy.
T^* is the period of figure 15.

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:

$$T_\mathrm{min} = \frac{W^*}{P_\mathrm{max}} \quad [\mathrm{s}]$$

W^* [J] (equ. 18)
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.

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. 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 you connect two SIOVs with the end number "175" in series, you get the response of a model for 350 V.
- 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, you 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.

2.5.6 Selection by test circuit

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

Figures 16 and 17 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 18 for the leakage current. Such phenomena have to be considered when interpreting measured results.

So, in test circuits, the varistor voltage for every single type has to be determined as accurately as possible (at a defined temperature). Check the change in varistor voltage from time to time, making sure that the temperature is the same. Extrapolation of the measured results to –10% gives you a guide value for component lifetime.

Figure 33, for example, can be taken as a measured curve for such a test circuit. The mean tends towards the horizontal, corresponding to point 1 in figure 16. 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 curves can be interpreted such that a substantially higher number of loads is permissible. These reserves are proof of the high reliability of SIOV varistors.

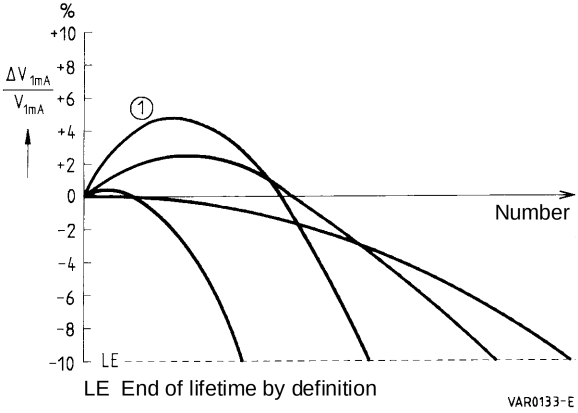
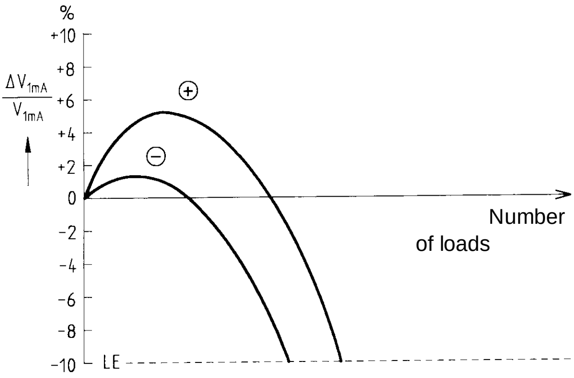
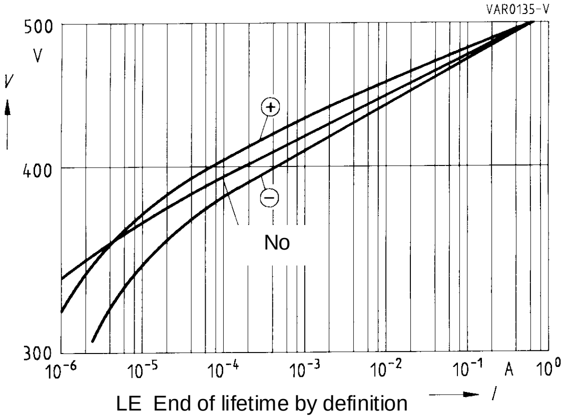


Figure 16
Typical curves for change in varistor voltage when metal oxide varistors are repeatedly loaded



LE End of lifetime by definition
+ Test current in direction of load current

Figure 17
Typical polarization effect for unipolar loading of metal oxide varistors



LE End of lifetime by definition
+ Test current in direction of load current

Figure 18
Typical polarization effects of leakage current for unipolar loading of metal oxide varistors

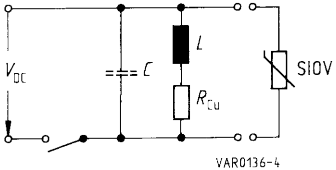
2.6 Application and design examples

2.6.1 Switching of 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 15 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 inherent 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 19 produce:

$$v^* = \; i^* \sqrt{\frac{L}{C}} = 1 \; \sqrt{\frac{0.1}{250 \cdot 10^{-12}}} = \; 20\,000 \text{ V}$$

To suppress this transient, a varistor is to be connected in parallel with the inductor as a free-wheeling 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 19
Limiting switching transients with a varistor as free-wheeling circuit

Operating voltage

The DC operating voltage is given as 24 V. 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....K20
- 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 currrent (here 1 A) , then decaying towards zero following an e function.

The duration of current flow is best determined with the aid of an oscilloscope ($\tau = t^*_r$).

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).

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

So τ according to equation 13 is

$$\tau \approx t^*_r = \frac{0.1\ \mathrm{H}}{24\ \Omega + 55\ \Omega} \approx 1.3\ \mathrm{ms}$$

For S10K20 with t^*_r = 1.3 ms and 10^6 load repetitions, you can derive

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

from the derating curves.

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

S05K20: $i_{\mathrm{max}} = 0.5\ \mathrm{A} < i^* = 1\ \mathrm{A}$
S07K20: $i_{\mathrm{max}} = 1.4\ \mathrm{A} > i^* = 1\ \mathrm{A}$

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

Energy absorption

The maximum energy absorption capacity of SIOV-S07K20 for t^*_r =1.3 ms and 10^6 repetitions according to equation 16 is

$W_{\mathrm{max}} = v_{\mathrm{max}} \cdot i_{\mathrm{max}} \cdot t_{\mathrm{r\,max}} = 60 \cdot 1 \cdot 0.0013 = 78\ \mathrm{mJ}$ (with $t_{\mathrm{r\,max}} = t^*_r$ according to 2.5.3)

According to equation 15 the varistor must in the worst case absorb an energy of

$W^* = 1/2\ L\ i^{*2} = 1/2 \cdot 0.1\ \mathrm{H} \cdot 1\ \mathrm{A}^2 = 0.05\ \mathrm{J} < W_{\mathrm{max}} = 0.078\ \mathrm{J}$

per switching cycle. Thus SIOV-S07K20 also satisfies the selection requirement of equation 10.

Average power dissipation

According to equation 17, applied energy of 0.05 J every 10 s produces an average power dissipation of

$$P^* = \frac{W^*}{T^*} = \frac{0.05}{10} = 0.005 \text{ W}$$

The product table shows a maximum dissipation capability of 0.02 W for SIOV-S07K20. So on this point too, the choice is right (equation 11).

For the sake of completeness, the minimum permissible time between two applications of energy is calculated (equation 18):

$$T_{\text{min}} = \frac{W^*}{P_{\text{max}}} = \frac{0.05 \text{ J}}{0.02 \text{ W}} = 2.5 \text{ s}$$

Maximum protection level

The V/I characteristic for S07K20 shows that the voltage at 1 A (with worst-case varistor tolerances) increases to 60 V. This means that the requirement for a protection level of < 65 V is also fulfilled.

So SIOV-S07K20 is the component selected.

There is also an electrically equivalent SMD model (CU4032K20G).

The hicap varistors SHCV-SR2K20... 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.

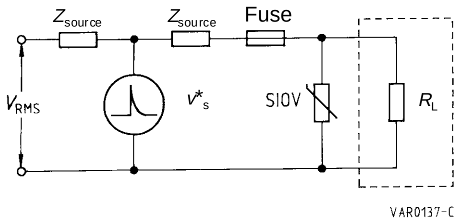
2.6.2 Transient suppression in 230-V systems

As shown in figure 20, the varistor must be connected in parallel with the load that is to be protected.

Operating voltage

In line with IEC 38, Europe is presently converting its 220-V supply systems (GB: 240 V) to 230 V + 6%/– 10%. Only the upper tolerance limit, i.e. 244 V, is of interest when selecting a varistor. So, as in 2.5.1, a type with the voltage class K250 has to be chosen. The varistor is to be operated directly on the line, i.e. without a series resistor, so at least type series SIOV-S18 is necessary according to 2.1.2. Thus a choice is made between the types

S18K250	B25K250
S20K250	B32K250
	B40K250/LS40K250QP
	B60K250
	B80K250



Operating voltage	V_{RMS}	= 230 V + 6/– 10%
Surge voltage amplitude	v^*_s	= 6 kV (100 times)
Surge current duration (rectangular)	t^*_r	= 80 µs
Characteristic impedance	Z_{source}	= 50 Ω
Electric strength of unit	v_{is}	= 2 kV

Figure 20
Transient suppression in 230-V system

Surge current

In a graphic solution according to 2.5.2, the load line for 6 kV, Z_{source} = 50 Ω, i.e. 120 A short-circuit currrent, is plotted on the family of *V/i* curves. The choice of curves is in fact arbitrary, because the curves of the various type series (for the same voltage class) hardly differ. Here, to begin with, is a look at the suitability of SIOV-S18K250.

Figure 21 shows the load line in the SIOV-S18 type series. The intersection produces the voltage drop and the current flow across S18K250, i.e. 100 A at 640 V.

The mathematic approximation shows:

Short-circuit current: 120 A
Voltage drop across S18K250 at 120 A: 650 V

According to equation 12:

$$i^* = \frac{6000 - 650}{50} = \frac{5350}{50} = 107 \text{ A}$$

So, with sufficient accuracy, the surge current amplitude can be assumed to be 100 A.

For comparison with the derating curves for surge current, it is also necessary to know the waveform of the surge current. Calculation on the basis of the waveform of the surge voltage is barely possible for real purposes, because the surge current wave that appears is influenced by a number of parameters that are difficult to express in mathematic terms.

For this example therefore, a waveform will be assumed that, after conversion as in figure 15, produces an equivalent rectangular wave with $t^*_r = 80\,\mu s$. This is used to examine whether SIOV-S18K250 can withstand a surge current of 100 A, rectangular wave 80 µs, one hundred times. The derating curves for S18K250 in this case show

$i_{max} = 300\ A > i^* = 100\ A$

In other words, S18K250 is overrated.

With the next smaller types:

SIOV-S14K250:	$i_{max} = 160\ A > i^* = 100\ A$
SIOV-S10K250:	$i_{max} = \ \ 90\ A < i^* = 100\ A$

So S14K250 also satisfies the selection criterion of equation 9.

Since at least type series SIOV-S18 should be chosen for direct line operation (see 2.1.2), we stick to this series. Moreover, there will be an extra safety margin.

Energy absorption of SIOV-S18K250

The energy absorption of the varistor is directly correlated with the surge current. So this also satisfies the selection criterion $W_{max} > W^*$. For the sake of completeness, this can be checked:

$W^* = v^* \cdot i^* \cdot t^*_r = 640\ V \cdot 100\ A \cdot 80 \cdot 10^{-6}\ s \approx 5\ J$

$W_{max} = v_{max} \cdot i_{max} \cdot t_{r\,max} = 640\ V \cdot 300\ A \cdot 80 \cdot 10^{-6}\ s \approx 15\ J$

Average power dissipation of SIOV-S18K250

Transients introduced on power lines are very rarely periodic, which makes calculation of the minimum permissible time interval between two absorption processes unnecessary. To complete the procedure, equation 18 nevertheless shows:

$$T_{min} = \frac{W^*}{P_{max}} = \frac{5}{1.0} = 5\ s$$

Maximum protection level

The maximum protection level of S18K250 at 100 A was determined as 640 V in conjunction with the surge current. This level is far below the electric strength (2 kV) of the unit to be protected.

Consequently SIOV-S18K250 satisfies all selection criteria.

Note

Figure 21 shows that all higher voltage classes up to S18K460 (protection level 1300 V at 100 A) also meet the requirements. It might therefore be appropriate, from the point of view of reducing the diversity of models, to choose S18K440, because then three-phase applications of 400 V could also be covered.

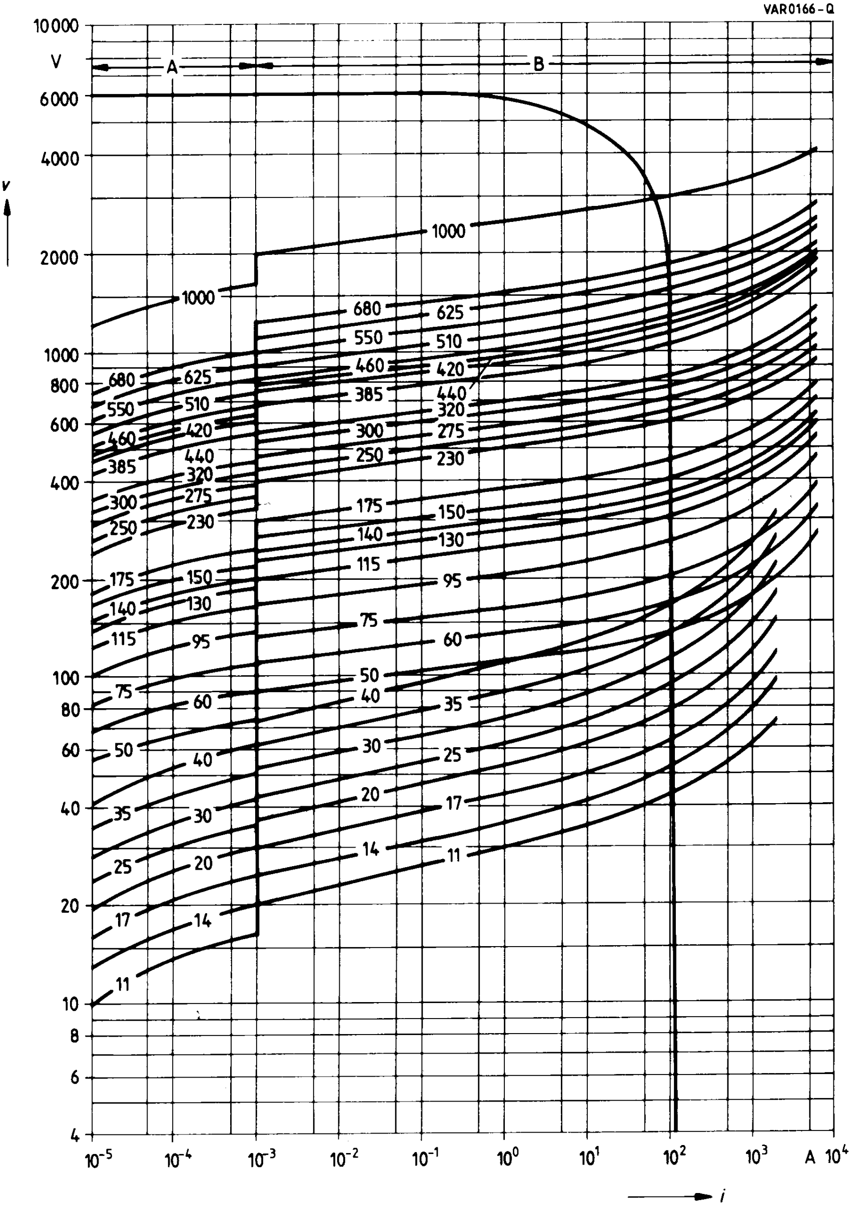


Figure 21
Load line on V/i characteristics for SIOV-S18K130 … 460

2.7 Combined circuits

2.7.1 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 22 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 isolate the different potentials. 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.

2.7.2 Protective modules

Application-specific circuits for stepped protection are obtainable ready assembled as modules (incorporating overload protection and remote signaling, if required).

Figures 23 a and b show some practical examples.

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[1] Shortform catalog "Gas-Filled Surge Arresters", ordering no. B6-P4801-X-X-7400

[2] Shortform catalog "EMC Components", ordering no. B4-P2402-X-X-7400; data book "EMC Components", ordering no. B4-P2406-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

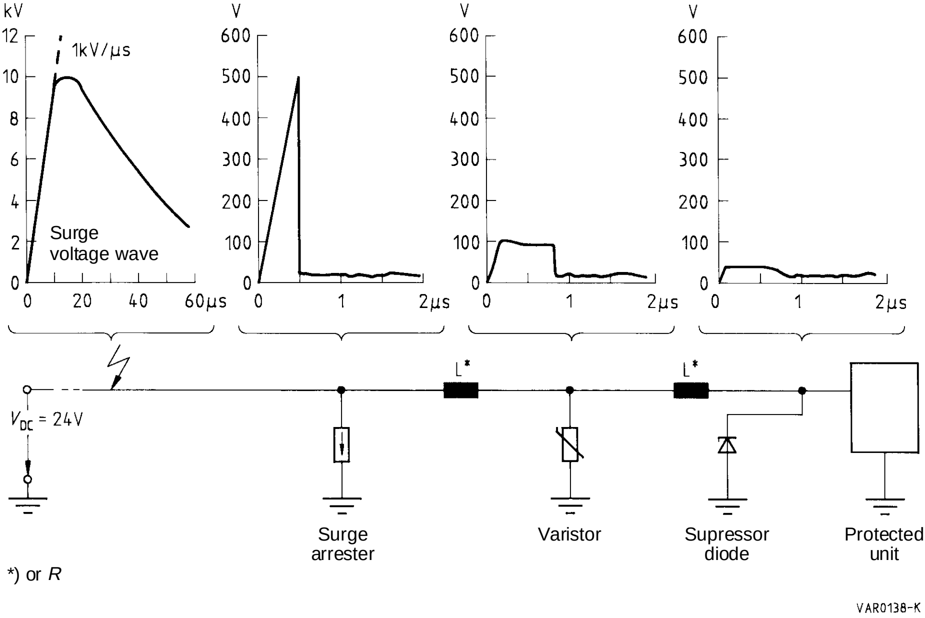
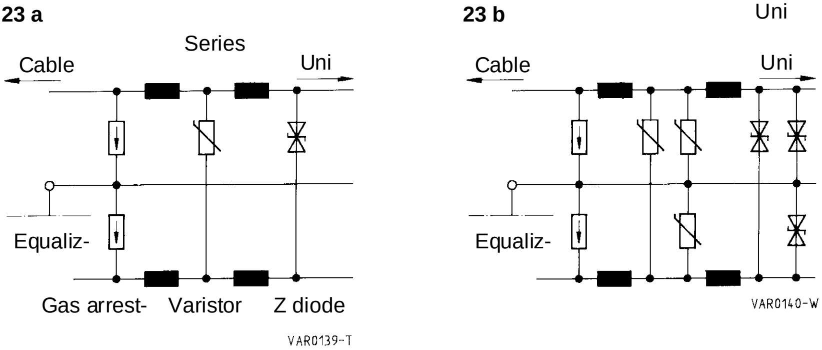


Figure 22
Principle of stepped protection with surge arrester, varistor and suppressor diode



Figures 23a 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

3 Application-specific varistors

3.1 Automotive varistors

3.1.1 Requirements on automotive electrical systems

Electronic equipment must work reliably in its electromagnetic environment without itself 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. Siemens Matsushita has devised a wide range of special models matched to the particular demands encountered in automotive power supplies:

- high energy absorption
- effective limiting of transients
- low leakage current
- jump-start strength (no varistor damage at double the operating 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.

3.1.2 Transients

Standard 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 partially discharged battery is accidentally disconnected from the generator while the engine is still running, e.g. because of a cable break. Voltages of as much as 200 V can then appear 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. So the lower energy pulses 1 to 4 are also covered by these.

3.1.3 Extra fine protection

Electronic components are often far apart, so EMC cannot be implemented with a central suppressor module alone. Instead you have to provide extra fine protection directly on the individual components. 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 S10K14AUTO series or SHCVs. Figure 24 illustrates a concept for suppression with varistors.

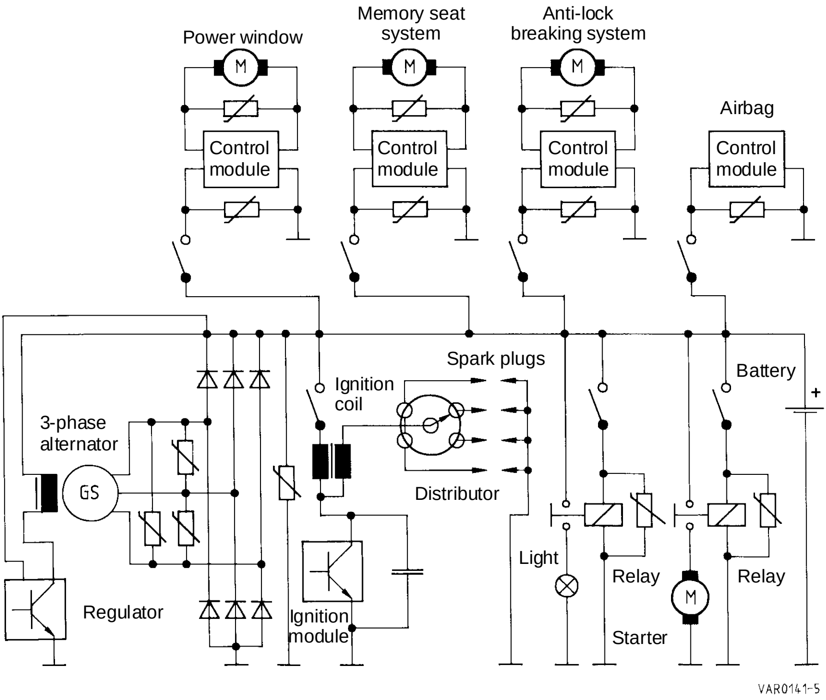
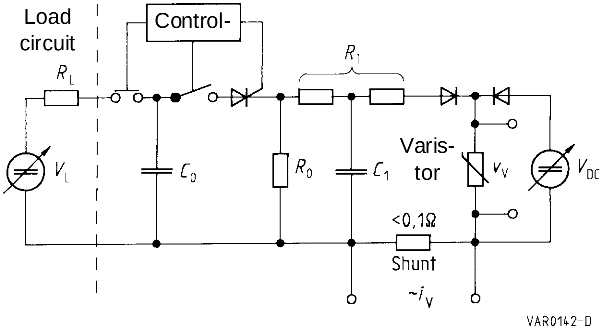


Figure 24
Automotive electrical system, complete EMC concept with varistors

3.1.4 Tests

Maintenance of EMC requirements can be checked with conventional test generators. Figures 25a and b show block diagrams for load dump investigations with operating voltage applied. The electrical performance associated with a load dump of 100 J is illustrated in figures 26 a–c.

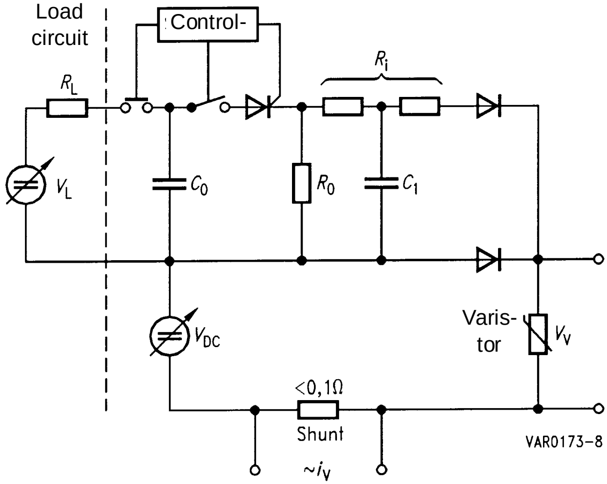
Note
Circuit 25b produces the test pulse according to DIN 40 839; the 10% time constant t_d (figure 26 a) can be set independently of the battery voltage. Note that the maximum discharge current is not limited by the source V_{DC}.



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_V	Protection level of varistor
i_V	Current through varistor

Figure 25a
Principle of load dump generator with battery connected in parallel

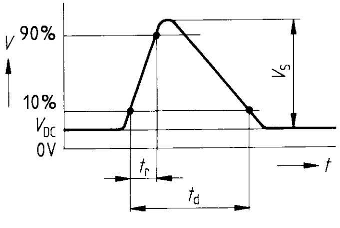


Typical values

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_V	Protection level of varistor
i_V	Current through varistor

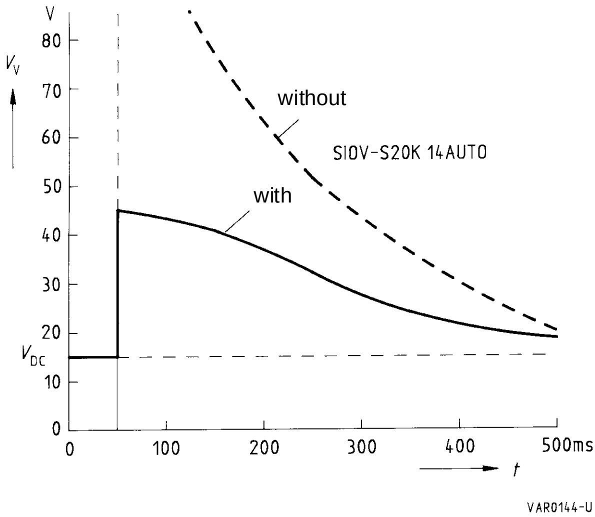
Figure 25b
Principle of load dump generator with battery connected in series

26 a



Test pulse 5
to
DIN 40 839

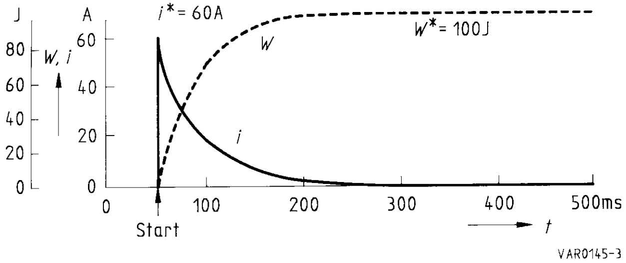
26 b



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

26 c



Figures 26 a – c
Voltage (b), current and energy absorption (c) on SIOV-S20K14AUTO with test pulse 5 (a); load dump generator as in figure 25b

3.1.5 RFI suppression

The capacitance of varistors alone (some nF) is not enough for RFI suppression. For which reason 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. In these components there is 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 27 shows an example of the suppression effect.

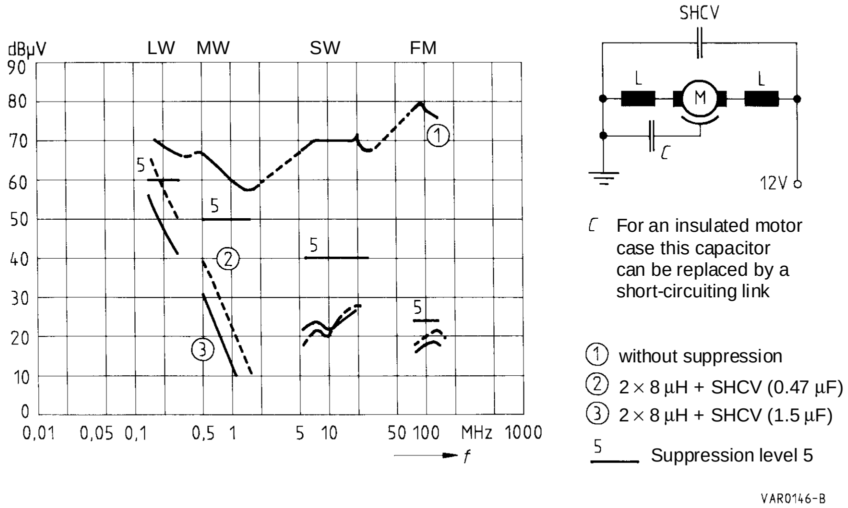


Figure 27
Example of RFI suppression in small motors with chokes and SHCVs
(measured to VDE 0879, part 3)

3.2 Telecom varistors

3.2.1 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.

According to the directives of the Central Telecommunications Engineering Office (Fernmeldetechnisches Zentralamt FTZ) of Germany’s telecommunications administration, the interference or noise immunity of equipment is tested by application of a surge voltage with a 10/700 µs waveform, which can be generated by a discharge circuit as in figure 28. The test is made with five pulses of each 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 suitable for clamping this surge current (and thus for 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.

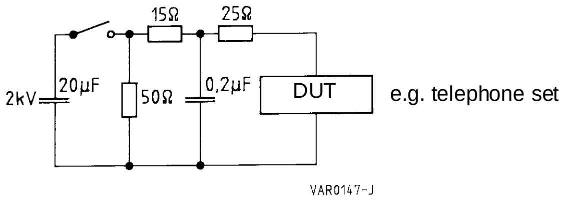


Figure 28
Circuit for generating 10/700 µs test pulse
to FTZ directives

3.2.2 Special models

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

The following special models have gone into wide use:

Model	Type	Ordering code	R_{min} (95 V)	v_{max} (45 A)
Disk	SIOV-S07S60AGS2	Q69X3815	250 kΩ	200 V
SMD	SIOV-CU4032S60AG	Q69660-M600-S162	250 kΩ	200 V
			R_{min} (150 V)	v_{max} (45 A)
Disk	SIOV-S07S95AGS2	Q69X4574	150 kΩ	270 V
SMD	SIOV-CU4032S95AG	Q69660-M950-S162	150 kΩ	270 V

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

SIOV varistors meet the generic specifications of Germany's telecommunications administration for electrical components in telecom installations.

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 seqence.

4.1.2 Product assurance

All important manufacturing stages are subject to routine monitoring. Each manufacturing stage is followed by a socalled "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 assigns the major quality measures to the different production steps.

4.1.3 Final inspection

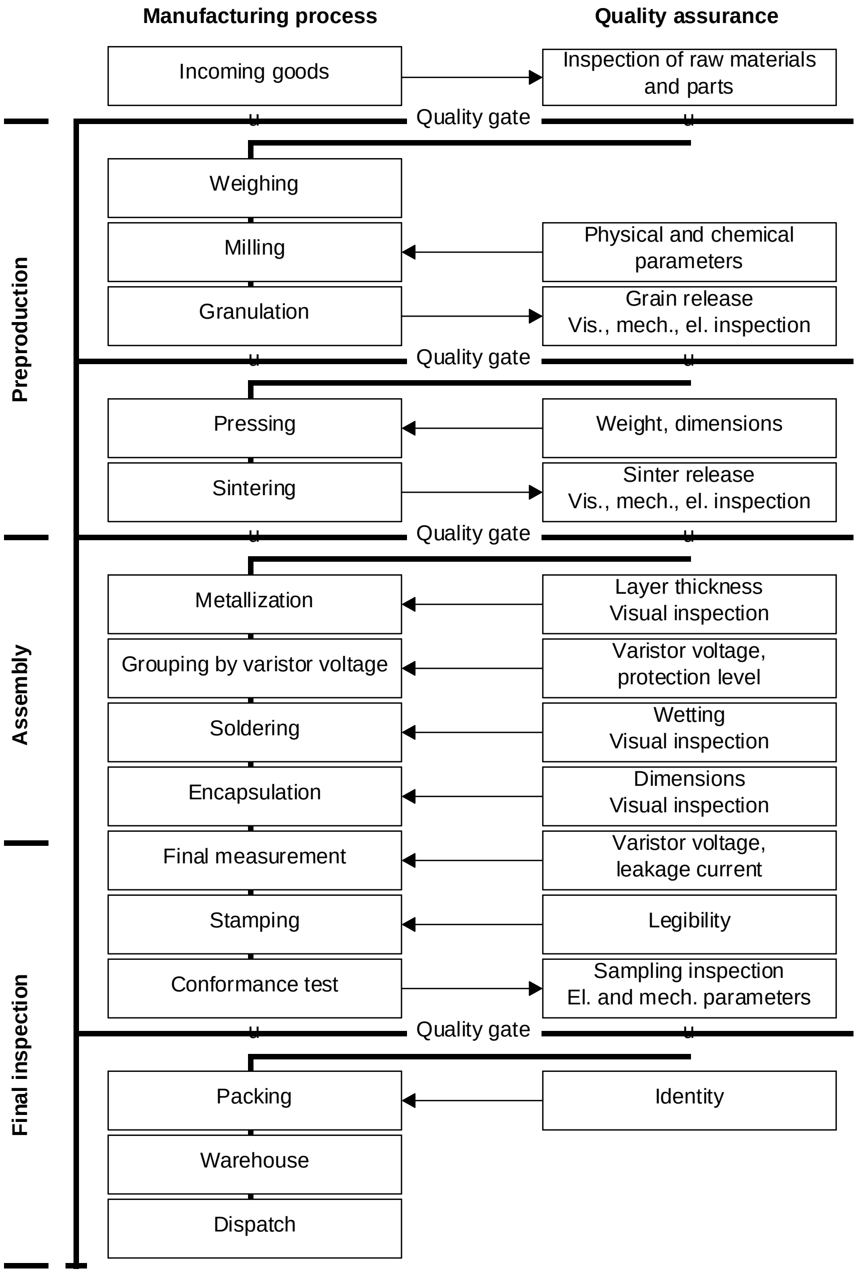
SIOV varistors are subjected to both a visual and an electrical final inspection to check their finish and electrical characteristics in accordance with the relevant specifications.

4.2 AOQ / ppm concept

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

- short circuit
- open circuit
- wrong marking

Together with customers, Siemens Matsushita undertakes quality optimization by the ppm concept, i.e. cooperation on defect analysis with the aim of reducing component defects which are critical in application to ppm (parts per million) levels.


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
Stamping
Legibility
Conformance test
Sampling inspection
El. and mech. parameters
Quality gate
Packing
Identity
Warehouse
Dispatch
Preproduction
Assembly
Final inspection

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 29.

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.

$$AVR = \frac{v^*}{v_{\mathrm{ma}}} \qquad \text{(equ. 19)}$$

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

$$i_{\mathrm{L}} = A + k\sqrt{t} \qquad \text{(equ. 20)}$$

i_{L} = leakage current at constant voltage
A = constant, 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 29 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

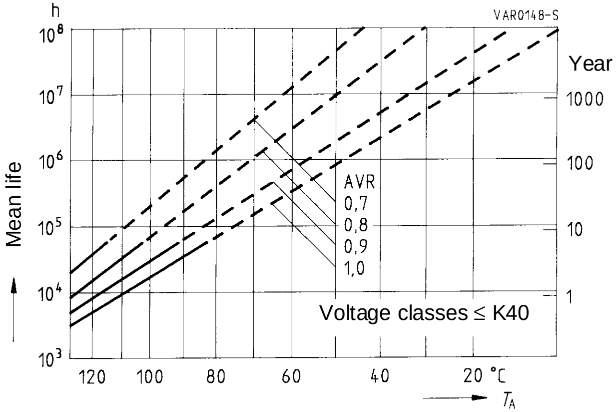
The failure rate λ is the reciprocal of mean life in hours, the unit being fit (**f**ailures **i**n **t**ime) = 10^{-9}/h.

$$\lambda = \frac{1}{\mathrm{ML}} \quad \text{[fit]} \qquad \text{(equ. 21)}$$

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

The mean time between failures (MTBF) corresponds to mean life :

MTBF = ML (equ. 22)



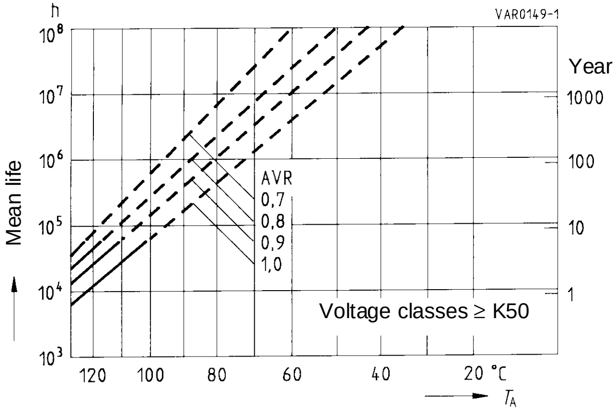


Figure 29
Mean life on Arrhenius model
Applied voltage ratio (AVR) referred to maximum permissibe operating voltage

4.4 Tests

Tests of SIOV disks 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)	$\mid \Delta V/V\ (1\ \mathrm{mA}) \mid \leq 10\%$
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	$\mid \Delta V/V\ (1\ \mathrm{mA}) \mid \leq 10\%$ (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	$\mid \Delta V/V\ (1\ \mathrm{mA}) \mid \leq 10\%$ (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	$\mid \Delta V/V\ (1\ \mathrm{mA}) \mid \leq 10\%$ R_{is} 2) ≥1 MΩ
Fast temperature cycling	IEC 68-2-14 test Na, UCT/LCT 1) dwell time 30 min 5 cycles (automotive: 12 cycles)	$\mid \Delta V/V\ (1\ \mathrm{mA}) \mid \leq 5\%$ No visible damage
Damp heat, steady state	IEC 68-2-3 56 days, 40 °C, 93% RH	$\mid \Delta V/V\ (1\ \mathrm{mA}) \mid \leq 10\%$ R_{is} 2) ≥1 MΩ
Solderability	IEC 68-2-20 test Ta, method 1, 235 °C, 5 s SMD: IEC 68-2-58	Solderable upon delivery and after 6 months storage
Resistance to soldering heat	IEC 68-2-20 test Tb, method 1A 260 °C, 10 s	$\mid \Delta V/V\ (1\ \mathrm{mA}) \mid \leq 5\%$

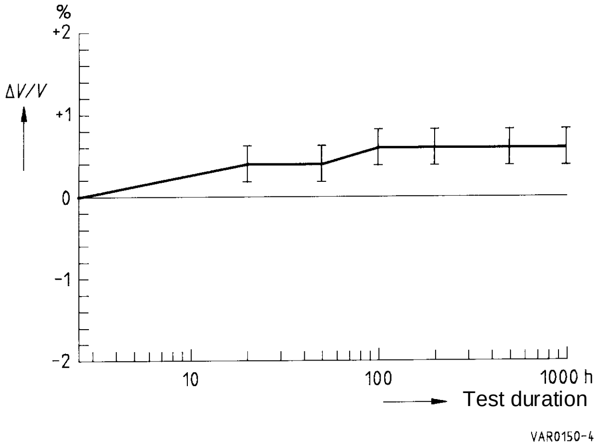
1) UCT = Upper Category Temperature; LCT = Lower Category Temperature

2) R_{is}: Insulation resistance to CECC 42 000, test 4.8

Quality tests, continued

Tensile strength	CECC 42 000, test 4.11, Ua tensile force for wire diameter 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 bumbs: 4000 pulse: half sine	I Δ V/V (1 mA) I ≤ 5% No visible damage

Figures 30 through 33 are examples of test results showing mean values and distribution.



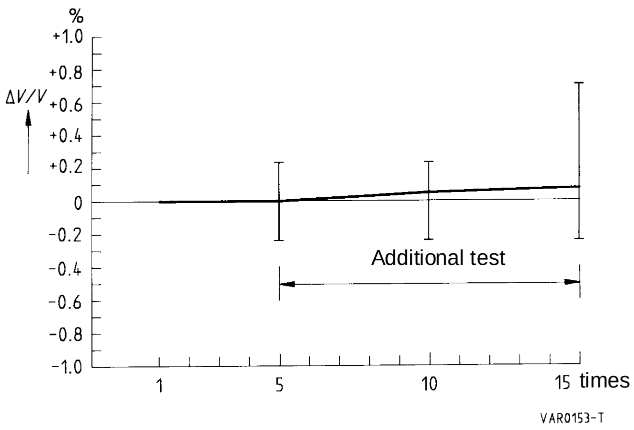
Test method:

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 30
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.

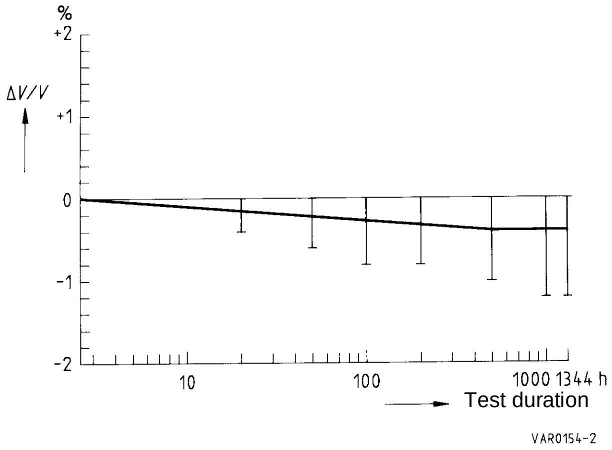
Step	Temp. °C	Time min.
1	– 40	30
2	+ 85	30

Requirement:

I Δ *V*/*V* (1 mA) I ≤ 5%

No visible damage

Figure 31
Temperature cycling test (5 cycles + 10 additional cycles) on SIOV-S10K275, 13 specimens



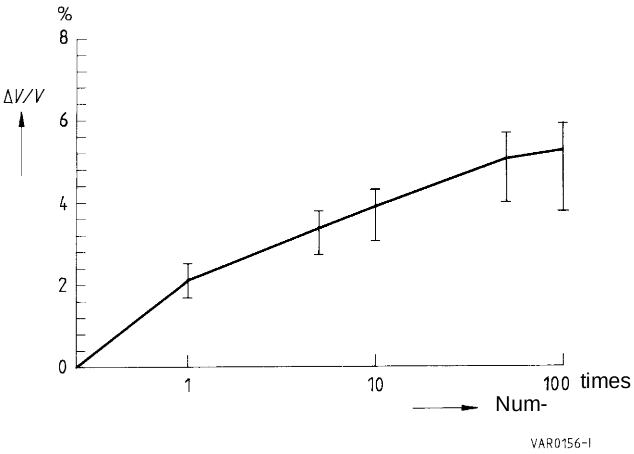
Test method:

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

Requirement:

I Δ *V*/*V* (1 mA) I ≤ 10%

Figure 32
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:

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

Figure 33
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)
  All SMD types SIOV-CU
  All disk types SIOV-S
  All block types SIOV-B
  All 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
  All SMD types SIOV-CU, voltage classes ≥ K130
  All disk types SIOV-S, voltage classes ≥ K115
  All block types SIOV-B, voltage classes ≥ K130
  All strap types SIOV-LS

Schweizerischer Elektrotechnischer Verein SEV

Protection class 1
Degree of protection IP 00
Test requirement CECC 42 200

Test report no. 90.1 02484.01 of 17 July 1991
  All disk types SIOV-S (except S18)
  All block types SIOV-B (except B80)

CECC 42 201-004

Qualification Approval
Certificate no. 101/QA/1
Manufacturer’s registration no. F101
  All standard disk types SIOV-S (except S18)

VDE Testing and Certification Institute

Approval no. 76815 E
  All standard disk types SIOV-S (except S18)

CECC 00 114, Part 1

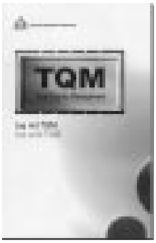
Certificate of Approval of Manufacturer
This certificate also covers the requirements of
EN 29 001
ISO 9001

Siemens Matsushita Components

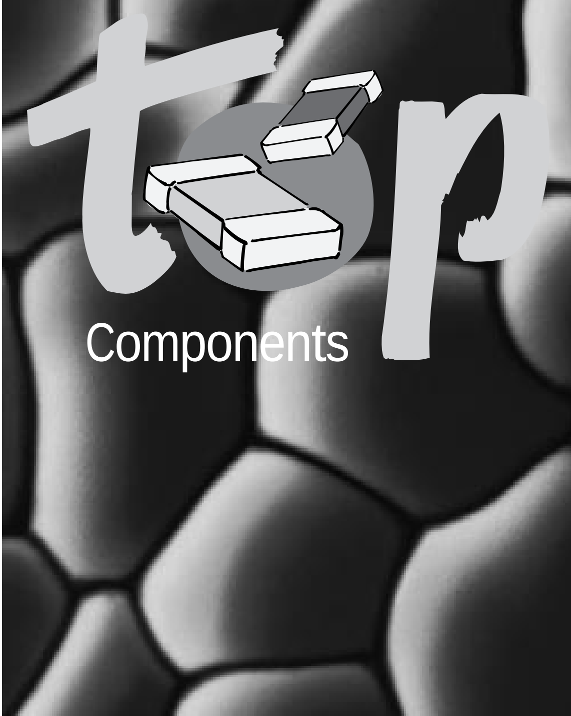
Quality without compromises

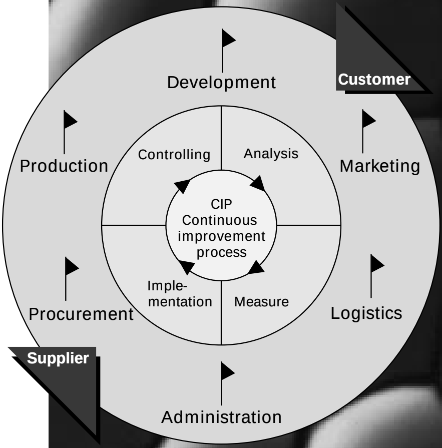
top with TQM

We’re not satisfied until you are. So our quality demands are quite tough. And they don’t start in production, they span the whole field from development to despatch. To watch over it all we implemented Total Quality Management, a system aimed at continuous improvement – in everything. That includes true-to-schedule delivery and service readiness, ISO 9000 for all plants, modern QA, commitment to the environment in manufacturing, materials and packing plus constant training of employees. All embedded in *top*, the worldwide quality campaign of the Siemens organization.

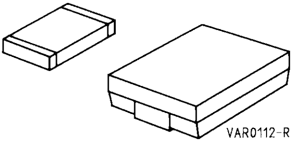


More about “top with TQM“ in this brochure!





SCS – dependable, fast and competent



Construction

CN:

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

CU:

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

Features

- Electrical equivalents to leaded types SIOV-SR/S05/S07
- Good solderability
- Low inductance
- Suitable for telecom applications
- Special types for automotive applications available (refer to page 73 ff)

Approvals (CU)

- UL-E77005 [M/N]
- CSA-LR63185
  All types K ≥130

Taping

- Supply on 8/12/16-mm tape,
  for tape dimensions see page 78,
  for reel dimensions and packing units see page 79

Type designation

Detailed description of coding system on page 28

SIOV-CN 1210 M 4 G

S+M metal oxide varistor — SIOV

Design — CN

Area of varistor element — 1210

Tolerance — M

Max. AC operating voltage — 4

Taped — G

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power dissipation
		V_{RMS}	V_{DC}	i_{max} 8/20 µs	W_{max} (2 ms)	P_{max}
		V	V	A	J	W
SIOV-CN1210M4G 1)	Q69530-V40-M62	4	5.5	250	0.3	0.01
SIOV-CN2220M4G 1)	Q69540-V40-M62	4	5.5	1000	1.5	0.02
SIOV-CN1210M6G 1)	Q69530-V60-M62	6	8	250	0.5	0.01
SIOV-CN2220M6G 1)	Q69540-V60-M62	6	8	1000	2.8	0.02
SIOV-CN1210L8G 1)	Q69530-V80-L62	8	11	250	0.7	0.01
SIOV-CN2220L8G 1)	Q69540-V80-L62	8	11	1000	4.0	0.02
SIOV-CU3225K11G	Q69650-M110-K62	11	14	100	0.3	0.01
SIOV-CU4032K11G	Q69660-M110-K62	11	14	250	0.8	0.02
SIOV-CU3225K14G	Q69650-M140-K62	14	18	100	0.4	0.01
SIOV-CU4032K14G	Q69660-M140-K62	14	18	250	0.9	0.02
SIOV-CU3225K17G	Q69650-M170-K62	17	22	100	0.5	0.01
SIOV-CU4032K17G	Q69660-M170-K62	17	22	250	1.1	0.02
SIOV-CU3225K20G	Q69650-M200-K62	20	26	100	0.6	0.01
SIOV-CU4032K20G	Q69660-M200-K62	20	26	250	1.3	0.02
SIOV-CU3225K25G	Q69650-M250-K62	25	31	100	0.7	0.01
SIOV-CU4032K25G	Q69660-M250-K62	25	31	250	1.6	0.02
SIOV-CU3225K30G	Q69650-M300-K62	30	38	100	0.9	0.01
SIOV-CU4032K30G	Q69660-M300-K62	30	38	250	2.0	0.02
SIOV-CU3225K35G	Q69650-M350-K62	35	45	100	1.1	0.01
SIOV-CU4032K35G	Q69660-M350-K62	35	45	250	2.5	0.02
SIOV-CU3225K40G	Q69650-M400-K62	40	56	100	1.3	0.01
SIOV-CU4032K40G	Q69660-M400-K62	40	56	250	3.0	0.02
SIOV-CU3225K50G	Q69650-M500-K62	50	65	400	1.8	0.10
SIOV-CU4032K50G	Q69660-M500-K62	50	65	1200	4.2	0.25
SIOV-CU3225K60G	Q69650-M600-K62	60	85	400	2.2	0.10
SIOV-CU4032K60G	Q69660-M600-K62	60	85	1200	4.8	0.25
SIOV-CU4032S60AG 2)	Q69660-M600-S162	60	85	1200	4.8	0.25
SIOV-CU3225K75G	Q69650-M750-K62	75	100	400	2.5	0.10
SIOV-CU4032K75G	Q69660-M750-K62	75	100	1200	5.9	0.25

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1) The range of SMD varistors has been extended:
Type series CN0805, CN1206, CN1210, CN1812, CN2220; voltage range 4 to 60 V_{RMS} (5 to 85 V_{DC}).
For detailed data see data book supplement "SMD Varistors in Multilayer Technology“, edition 11.94.

2) Telecom varistor, see also page 54

Characteristics (T_A = 25 °C)

Varistor voltage	Tolerance	Max. clamping voltage		Capacitance typ.	Derating curves	V/I characteristic
V_V (1 mA) V	ΔV_V (1 mA) %	v V	i A	C (1 kHz) pF	Page	Page
8	M = ± 20	17	2.5	5000	80	83
8	M = ± 20	17	10.0	24000	82	84
11	M = ± 20	27	2.5	4000	80	83
11	M = ± 20	27	10.0	20000	82	84
15	L = ± 15	35	2.5	3000	80	83
15	L = ± 15	35	10.0	16000	82	84
18	K = ± 10	36	1.0	1600	80	83
18	K = ± 10	36	2.5	3100	80	84
22	K = ± 10	43	1.0	1300	80	83
22	K = ± 10	43	2.5	2500	80	84
27	K = ± 10	53	1.0	1050	80	83
27	K = ± 10	53	2.5	1900	80	84
33	K = ± 10	65	1.0	750	80	83
33	K = ± 10	65	2.5	1500	80	84
39	K = ± 10	77	1.0	660	80	83
39	K = ± 10	77	2.5	1250	80	84
47	K = ± 10	93	1.0	580	80	83
47	K = ± 10	93	2.5	1050	80	84
56	K = ± 10	110	1.0	460	80	83
56	K = ± 10	110	2.5	850	80	84
68	K = ± 10	135	1.0	400	80	83
68	K = ± 10	135	2.5	720	80	84
82	K = ± 10	135	5.0	300	81	83
82	K = ± 10	135	10.0	530	81	84
100	K = ± 10	165	5.0	250	81	83
100	K = ± 10	165	10.0	480	81	84
not specified		200	45.0	480	81	–
120	K = ± 10	200	5.0	210	81	83
120	K = ± 10	200	10.0	430	81	84

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power dissipation
		V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
SIOV-CU3225K95G	Q69650-M950-K62	95	125	400	3.4	0.10
SIOV-CU4032K95G	Q69660-M950-K62	95	125	1200	7.6	0.25
SIOV-CU4032S95AG[1]	Q69660-M950-S162	95	125	1200	7.6	0.25
SIOV-CU3225K115G	Q69650-M111-K62	115	150	400	3.6	0.10
SIOV-CU4032K115G	Q69660-M111-K62	115	150	1200	8.4	0.25
SIOV-CU3225K130G	Q69650-M131-K62	130	170	400	4.2	0.10
SIOV-CU4032K130G	Q69660-M131-K62	130	170	1200	9.5	0.25
SIOV-CU3225K140G	Q69650-M141-K62	140	180	400	4.5	0.10
SIOV-CU4032K140G	Q69660-M141-K62	140	180	1200	10.0	0.25
SIOV-CU3225K150G	Q69650-M151-K62	150	200	400	4.9	0.10
SIOV-CU4032K150G	Q69660-M151-K62	150	200	1200	11.0	0.25
SIOV-CU3225K175G	Q69650-M171-K62	175	225	400	5.6	0.10
SIOV-CU4032K175G	Q69660-M171-K62	175	225	1200	13.0	0.25
SIOV-CU3225K230G	Q69650-M231-K62	230	300	400	7.2	0.10
SIOV-CU4032K230G	Q69660-M231-K62	230	300	1200	17.0	0.25
SIOV-CU3225K250G	Q69650-M251-K62	250	320	400	8.2	0.10
SIOV-CU4032K250G	Q69660-M251-K62	250	320	1200	19.0	0.25
SIOV-CU3225K275G	Q69650-M271-K62	275	350	400	8.6	0.10
SIOV-CU4032K275G	Q69660-M271-K62	275	350	1200	21.0	0.25
SIOV-CU3225K300G	Q69650-M301-K62	300	385	400	9.6	0.10
SIOV-CU4032K300G	Q69660-M301-K62	300	385	1200	23.0	0.25

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[1] Telecom varistor, see also page 54

Characteristics (T_A = 25 °C)

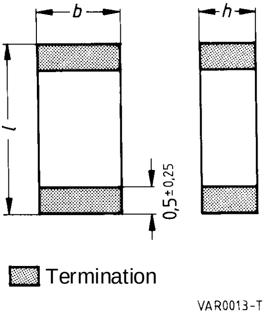
Varistor voltage V_V (1 mA) V	Tolerance ΔV_V (1 mA) %	Max. clamping voltage v V	 i A	Capacitance typ. C (1 kHz) pF	Derating curves Page	V/I characteristic Page
150	K = ± 10	250	5.0	135	81	83
150	K = ± 10	250	10.0	260	81	84
not specified		270	45.0	260	81	–
180	K = ± 10	300	5.0	110	81	83
180	K = ± 10	300	10.0	220	81	84
205	K = ± 10	340	5.0	100	81	83
205	K = ± 10	340	10.0	200	81	84
220	K = ± 10	360	5.0	95	81	83
220	K = ± 10	360	10.0	180	81	84
240	K = ± 10	395	5.0	90	81	83
240	K = ± 10	395	10.0	170	81	84
270	K = ± 10	455	5.0	75	81	83
270	K = ± 10	455	10.0	150	81	84
360	K = ± 10	595	5.0	60	81	83
360	K = ± 10	595	10.0	115	81	84
390	K = ± 10	650	5.0	55	81	83
390	K = ± 10	650	10.0	105	81	84
430	K = ± 10	710	5.0	50	81	83
430	K = ± 10	710	10.0	95	81	84
470	K = ± 10	775	5.0	45	81	83
470	K = ± 10	775	10.0	90	81	84

General technical data

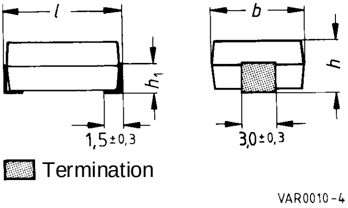
Climatic category LCT UCT Damp heat, steady state (93 % r. h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature (full load)	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 125 °C	
Electric strength	> 2.5 kV (only CU)	in accordance with CECC 42 000
Insulation resistance	> 1 GΩ (only CU)	in accordance with CECC 42 000
Response time	< 1 ns	
Solderability	235 °C, 2 s (CN) 215 °C, 3 s (CU)	in accordance with IEC 68-2-58
Resistance to soldering heat	260 °C, 10 s (CN) 260 °C, 10 s (CU)	
Weight (approx.) CN1210 CN2220 CU3225 CU4032	 0.06 g 0.2 g 0.5 g 0.8 g	

Cleaning
Fluorinated and chlorinated hydrocarbons are recommended as cleaning agents.

SIOV-CN

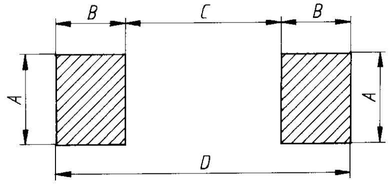


SIOV-CU



Dimensions

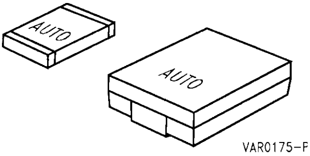
Type	l mm	b mm	h mm	h_1 mm
SIOV-CN1210M4G	3.2 ± 0.2	2.5 ± 0.2	0.75 ± 0.15	–
SIOV-CN1210M6G, L8G	3.2 ± 0.2	2.5 ± 0.2	1.1 ± 0.2	–
SIOV-CN2220M4G, M6G, L8G	5.7 ± 0.2	5.0 ± 0.2	1.1 ± 0.2	–
SIOV-CU3225K11 … 175G	8.0 ± 0.3	6.3 ± 0.3	3.2 ± 0.3	1.7 ± 0.3
SIOV-CU3225K230 … 300G	8.0 ± 0.3	6.3 ± 0.3	4.5 ± 0.3	2.3 ± 0.3
SIOV-CU4032K11 … 175G	10.0 ± 0.3	8.0 ± 0.3	3.2 ± 0.3	1.7 ± 0.3
SIOV-CU4032K230 … 300G	10.0 ± 0.3	8.0 ± 0.3	4.5 ± 0.3	2.3 ± 0.3



Recommended solder pad layout

Type	A mm	B mm	C mm	D mm
CN1210	2.8	1.2	2.1	4.5
CN2220	5.5	1.5	4.2	7.2
CU3225	3.5	2.8	4.5	10.1
CU4032	3.5	2.8	6.5	12.1

Construction



CN:

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

CU:

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

Features

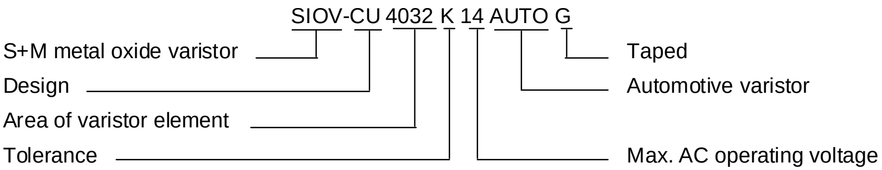
- High energy absorption, particularly in case of load dump
- Jump-start strength
- Stable protection level, minimum leakage current
- High resistance to cyclic temperature stress
- Wide range of operating temperature
- Low inductance

Taping

- Supply on 8/12/16-mm tape, for tape dimensions see page 78, for reel dimensions and packing units see page 79

Type designation

Detailed description of coding system on page 28



Maximum ratings (T_A = 85 °C for CU; T_A = 125 °C for CN)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power dissipation	Load dump
		V_{RMS}	V_{DC}	i_{max} 8/20 µs	W_{max} (2 ms)	P_{max}	W_{LD} (10×)
SIOV-		V	V	A	J	W	J
12-V supply systems							
CN1210S14BAUTOG	Q69530-V1140-S262	14	16	250	0.8	0.01	3
CN1812S14BAUTOG	Q69580-V1140-S262	14	16	500	1.7	0.015	6
CN2220S14BAUTOG	Q69540-V1140-S262	14	16	1000	3.6	0.03	12
CU3225K14AUTOG	Q69650-M1140-K62	14	16	100	0.4	0.01	6
CU4032K14AUTOG	Q69660-M1140-K62	14	16	250	0.9	0.02	12
CU3225K17AUTOG	Q69650-M1170-K62	17	20	100	0.5	0.01	6
CU4032K17AUTOG	Q69660-M1170-K62	17	20	250	1.1	0.02	12
24-V supply systems							
CU3225K30AUTOG	Q69650-M1300-K62	30	34	100	0.9	0.01	6
CU4032K30AUTOG	Q69660-M1300-K62	30	34	250	2.0	0.02	12

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.

Characteristics (T_A = 25 °C)

Jump start	Varistor voltage	Tolerance	Max. clamping voltage		Capacitance, typ.	Derating curves	V/I characteristic
V_{JUMP} (max. 5 minutes) V	V_V (1 mA) V	ΔV_V (1 mA) %	v V	i A	C (1 kHz) nF	Page	Page
24.5	22 … 27	SB1) = + 23/–0	40	2.5	1.7	80	83
24.5	22 … 27	SB1) = + 23/–0	40	5	5.6	82	84
24.5	22 … 27	SB1) = + 23/–0	40	10	9.5	82	84
25	22	K = ± 10	43	1.0	1.3	80	83
25	22	K = ± 10	43	2.5	2.5	80	84
30	27	K = ± 10	53	1.0	1.1	80	83
30	27	K = ± 10	53	2.5	1.9	80	84
50	47	K = ± 10	93	1.0	0.6	80	83
50	47	K = ± 10	93	2.5	1.1	80	84

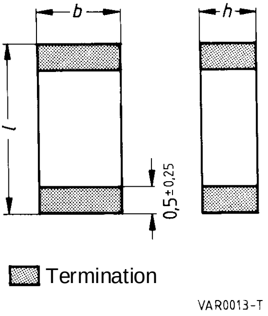
---

1) Special tolerance “B”, here 22 … 27 V

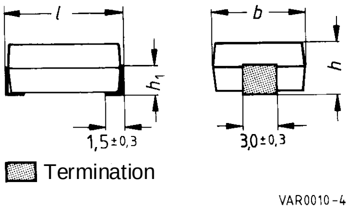
General technical information

Climatic category	55/125/56 (CN) 55/85/56 (CU)	in accordance with IEC 68-1
LCT	– 55 °C	
UCT	+ 125 °C (CN) + 85 °C (CU)	
Damp heat, steady state (93 % r. h., 40 °C)	56 days	in accordance with IEC 68-2-3
Operating temperature (full load)	– 55 … + 125 °C (CN) – 55 … + 85 °C (CU)	in accordance with CECC 42 000
Storage temperature	– 55 … + 150 °C (CN) – 55 … + 125 °C (CU)	
Electric strength	> 2.5 kV (only CU)	in accordance with CECC 42 000
Insulation resistance	> 1 GΩ (only CU)	in accordancee with CECC 42 000
Response time	< 1 ns	
Solderability	235 °C, 2 s (CN) 215 °C, 3 s (CU)	in accordance with IEC 68-2-58
Resistance to soldering heat	260 °C, 10 s (CN) 260 °C, 10 s (CU)	
Weight (approx.)		
CN1210	0.06 g	
CN1812	0.1 g	
CN2220	0.2 g	
CU3225	0.5 g	
CU4032	0.8 g	

SIOV-CN … AUTOG

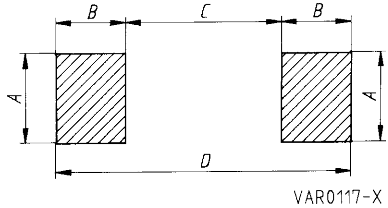


SIOV-CU … AUTOG



Dimensions

Type SIOV-	*l* mm	*b* mm	*h* mm	h_1 mm
CN1210S14BAUTOG	3.2 ± 0.2	2.5 ± 0.2	1.1 ± 0.2	–
CN1812S14BAUTOG	4.5 ± 0.2	3.2 ± 0.2	1.1 ± 0.2	–
CN2220S14BAUTOG	5.7 ± 0.2	5.0 ± 0.2	1.1 ± 0.2	–
CU3225K14 … 30AUTOG	8.0 ± 0.3	6.3 ± 0.3	3.2 ± 0.3	1.7 ± 0.3
CU4032K14 … 30AUTOG	10.0 ± 0.3	8.0 ± 0.3	3.2 ± 0.3	1.7 ± 0.3

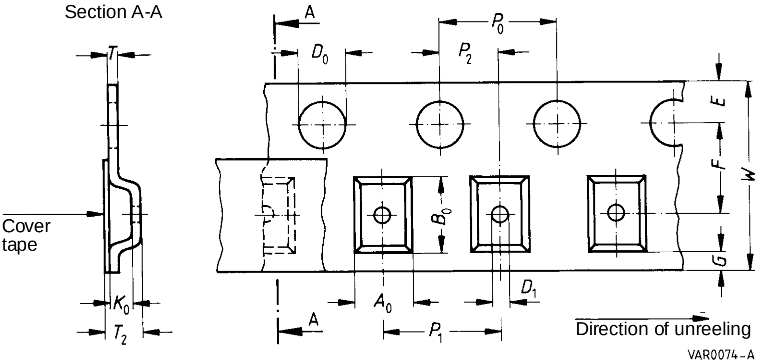


Recommended solder pad layout

Type	*A* mm	*B* mm	*C* mm	*D* mm
CN1210	2.8	1.2	2.1	4.5
CN1812	3.6	1.5	3.0	6.0
CN2220	5.5	1.5	4.2	7.2
CU3225	3.5	2.8	4.5	10.1
CU4032	3.5	2.8	6.5	12.1

SMD varistors are always supplied taped and reeled.

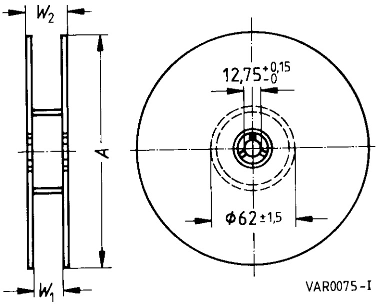
Tape and reel packing comply with the specifications of IEC 286-3.

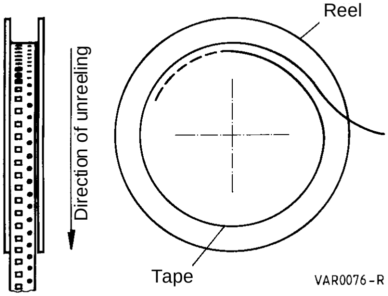


Tape dimensions (in mm)

Tape	8 mm	12 mm		16 mm		Tolerance
Size	CN1210	CN1812	CN2220	CU3225	CU4032	
$A_0 \times B_0$	2.8 × 3.5	3.5 × 4.8	5.1 × 6.0	7.0 × 8.7	8.6 × 10.6	± 0.2
K_0	1.3	1.3	1.3	5.0	5.0	max.
T_2	2.5	2.5	2.5	5.5	5.5	max.
T	0.3	0.3	0.3	0.3	0.3	
D_0	1.5	1.5	1.5	1.5	1.5	+ 0.1/– 0
D_1	1.0	1.5	1.5	1.5	1.5	min.
P_0	4.0	4.0	4.0	4.0	4.0	± 0.1 ^{1})
P_2	2.0	2.0	2.0	2.0	2.0	± 0.05
P_1	4.0	8.0	8.0	12.0	12.0	± 0.1
W	8.0	12.0	12.0	16.0	16.0	± 0.3
E	1.75	1.75	1.75	1.75	1.75	± 0.1
F	3.5	5.5	5.5	7.5	7.5	± 0.05
G	0.75	0.75	0.75	0.75	0.75	min.

1) ≤ ± 0.2 mm over 10 sprocket holes



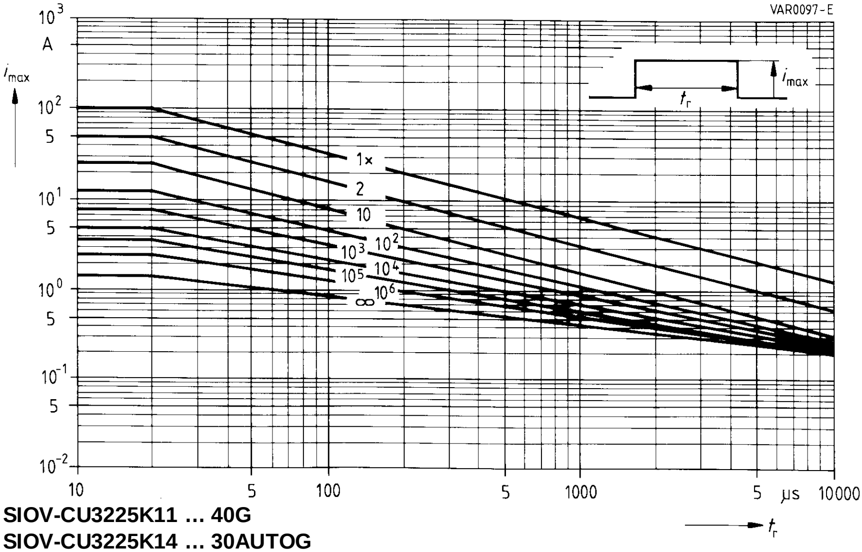


Reel dimensions and packing units

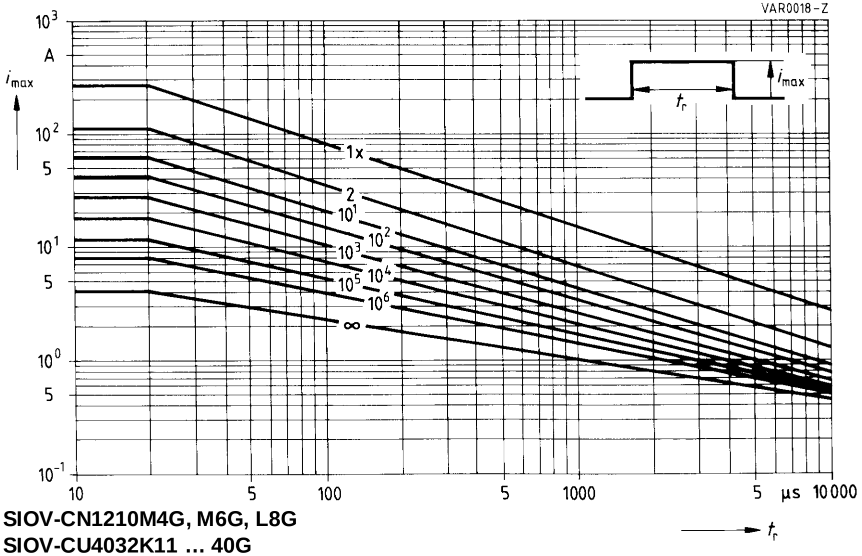
Size	CN1210	CN1812	CN2220	CU3225	CU4032
A W_1 W_2	180_{-2} $8.4_{+1.5/-0}$ 14.4 max.	180_{-2} $12.4_{+1.5/-0}$ 18.4 max.	180_{-2} $12.4_{+1.5/-0}$ 18.4 max.	330_{-2} $16.4_{+1.5/-0}$ 22.4 max.	330_{-2} $16.4_{+1.5/-0}$ 22.4 max.
Pieces/reel	3000	1500	1500	1000	1000

Derating curves (maximum surge current)

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



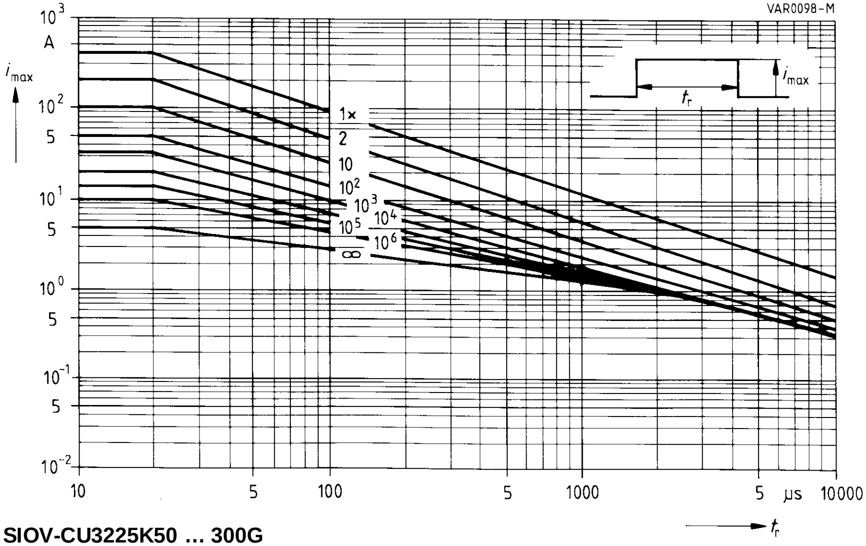
SIOV-CU3225K11 … 40G
SIOV-CU3225K14 … 30AUTOG



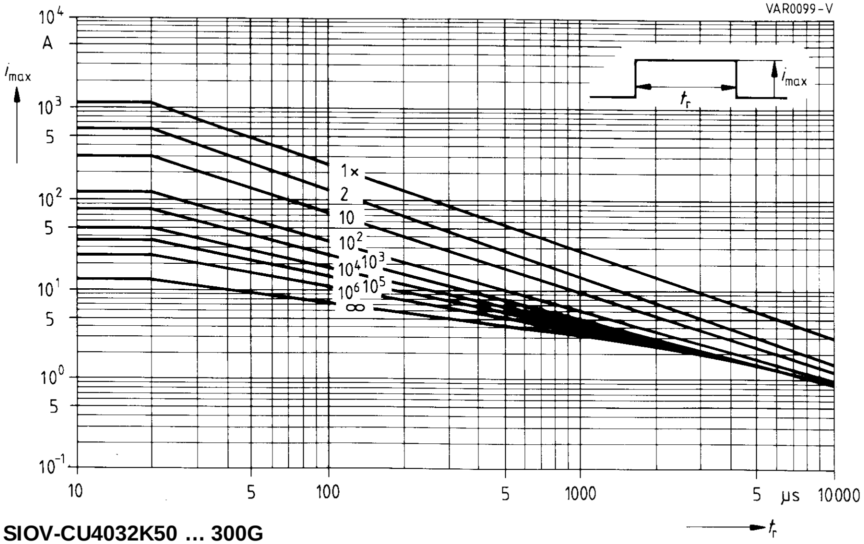
SIOV-CN1210M4G, M6G, L8G
SIOV-CU4032K11 … 40G
SIOV-CN1210S14BAUTOG
SIOV-CU4032K14 … 30AUTOG

Derating curves (maximum surge current)

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



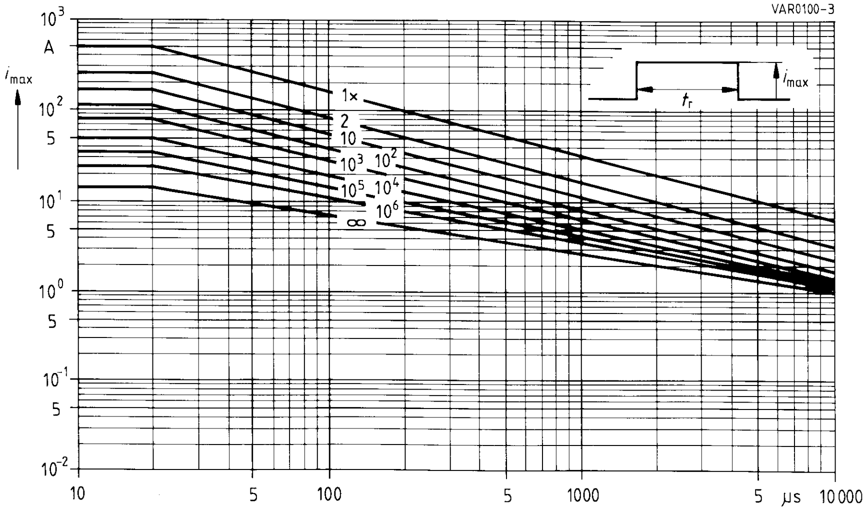
SIOV-CU3225K50 … 300G



SIOV-CU4032K50 … 300G
SIOV-CU4032S60/95AG

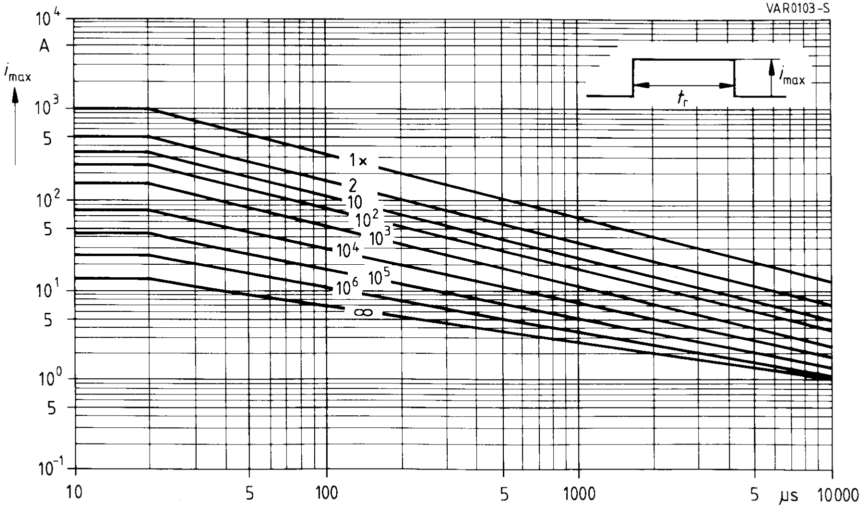
Derating curves (maximum surge current)

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



SIOV-CN1812S14BAUTOG

$\longrightarrow t_r$



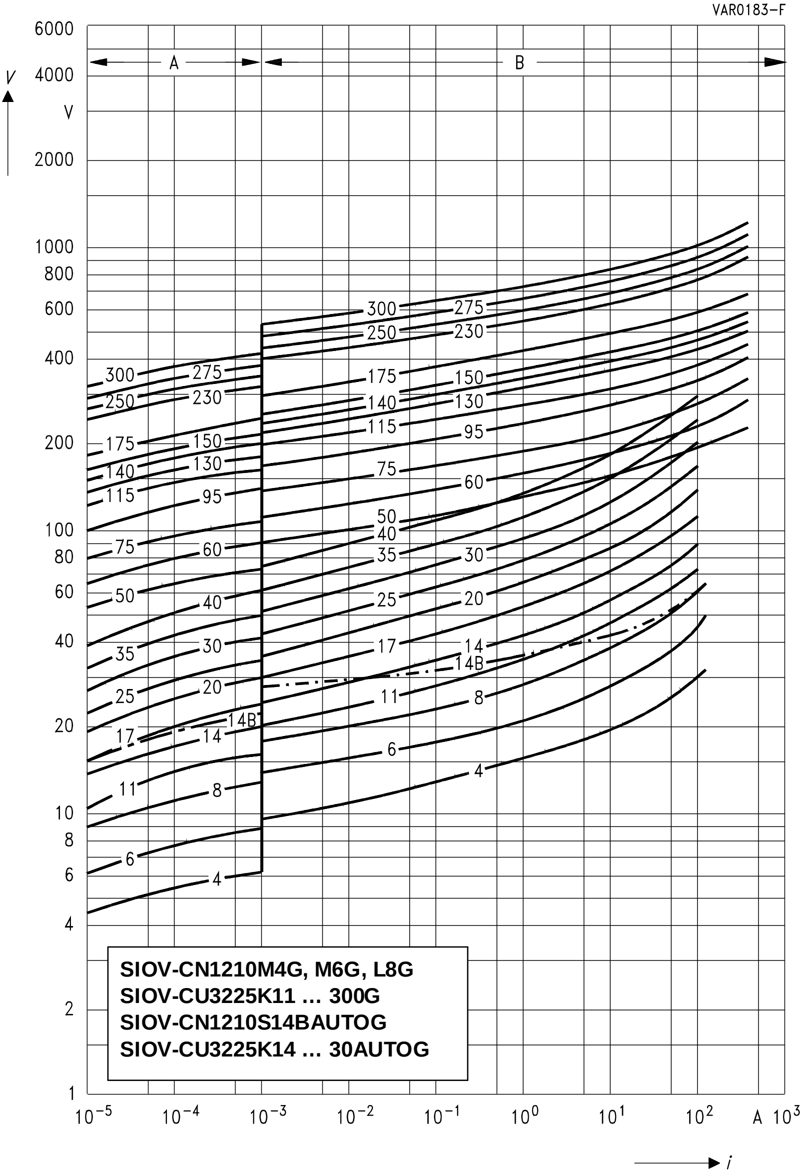
SIOV-CN2220M4G, M6G, L8G
SIOV-CN2220S14BAUTOG

$\longrightarrow t_r$

***V/I* characteristics**

v = *f* (*i*)

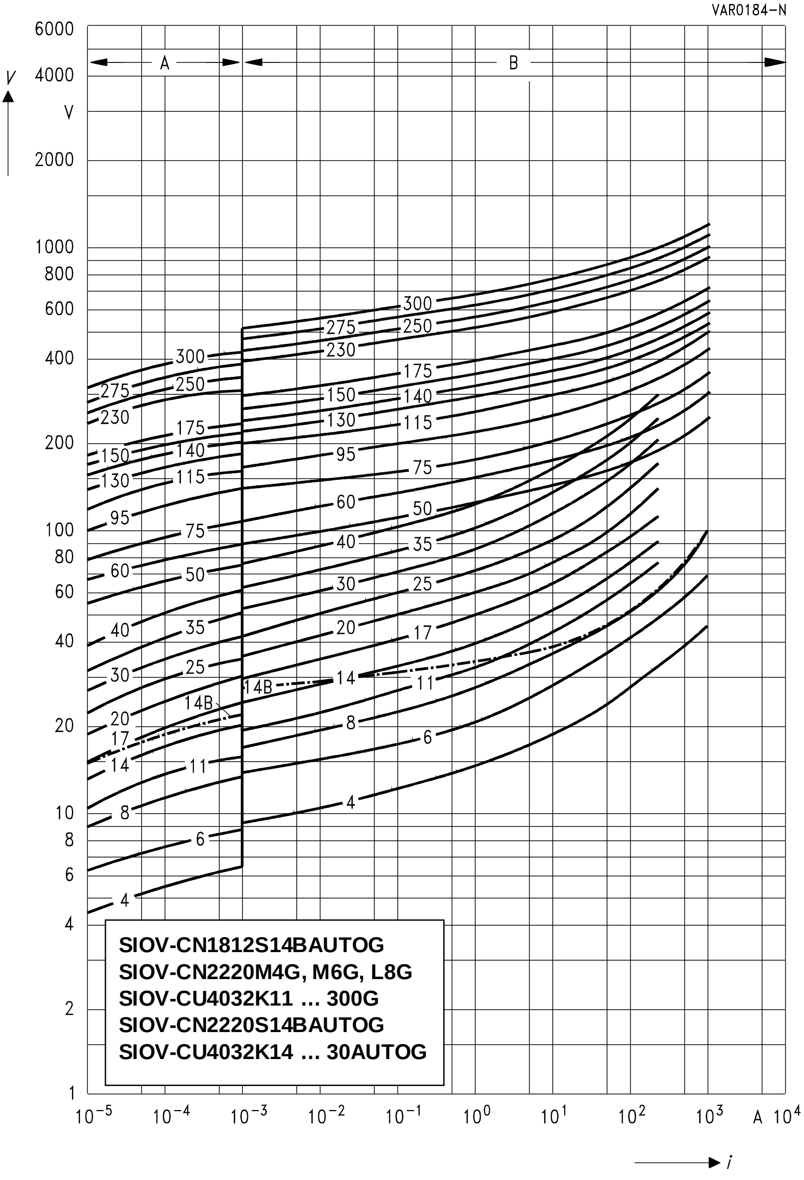
A = Leakage current for worst-case
B = Protection level varistor tolerances



V/*I* characteristics

$v = f(i)$

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



SIOV-CN1812S14BAUTOG
SIOV-CN2220M4G, M6G, L8G
SIOV-CU4032K11 … 300G
SIOV-CN2220S14BAUTOG
SIOV-CU4032K14 … 30AUTOG

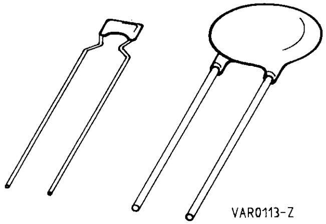
Construction

SR:

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

S:

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



New features

- Types S20K130 … 460 with enhanced performance
- New voltage class K440 for three-phase applications to IEC 38
- Special types for telecom applications

Approvals

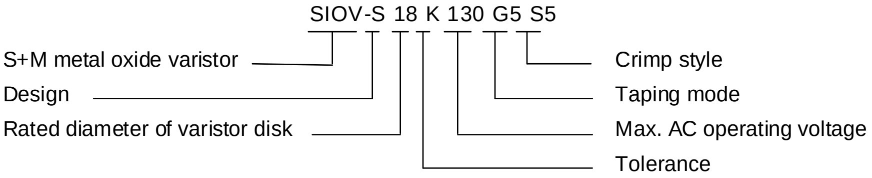
- UL-E77005 [M/N]
- CSA-LR63185: all types ≥ K115
- SEV 91.1 02484.01: all types except SIOV-S18
- VDE 76815 E: all types except SIOV-S18

Taping

- All types ≤ K300 (except S20) also available on tape, for ordering information see page 105 ff

Type designation

Detailed description of coding system on page 28



Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage V_{RMS} V	V_{DC} V	Surge current i_{max} 8/20 µs A	Energy absorption W_{max} (2 ms) J	Power dissipation P_{max} W
SIOV-SR1210M4S	Q69535-R40-M	4	5.5	250	0.3	0.01
SIOV-SR2220M4S	Q69545-R40-M	4	5.5	1000	1.5	0.02
SIOV-SR1210M6S	Q69535-R60-M	6	8	250	0.5	0.01
SIOV-SR2220M6S	Q69545-R60-M	6	8	1000	2.8	0.02
SIOV-SR1210L8S	Q69535-R80-L	8	11	250	0.7	0.01
SIOV-SR2220L8S	Q69545-R80-L	8	11	1000	4.0	0.02
SIOV-S05K11	Q69X3445	11	14	100	0.3	0.01
SIOV-S07K11	Q69X3446	11	14	250	0.8	0.02
SIOV-S10K11	Q69X3455	11	14	500	1.7	0.05
SIOV-S14K11	Q69X3456	11	14	1000	3.2	0.10
SIOV-S20K11	Q69X3457	11	14	2000	10.0	0.20
SIOV-S05K14	Q69X3422	14	18	100	0.4	0.01
SIOV-S07K14	Q69X3447	14	18	250	0.9	0.02
SIOV-S10K14	Q69X3011	14	18	500	2.0	0.05
SIOV-S14K14	Q69X3018	14	18	1000	4.0	0.10
SIOV-S20K14	Q69X3458	14	18	2000	12.0	0.20
SIOV-S05K17	Q69X3423	17	22	100	0.5	0.01
SIOV-S07K17	Q69X3448	17	22	250	1.1	0.02
SIOV-S10K17	Q69X3012	17	22	500	2.5	0.05
SIOV-S14K17	Q69X3019	17	22	1000	5.0	0.10
SIOV-S20K17	Q69X3459	17	22	2000	14.0	0.20
SIOV-S05K20	Q69X3424	20	26	100	0.6	0.01
SIOV-S07K20	Q69X3449	20	26	250	1.3	0.02
SIOV-S10K20	Q69X3013	20	26	500	3.1	0.05
SIOV-S14K20	Q69X3020	20	26	1000	6.0	0.10
SIOV-S20K20	Q69X3460	20	26	2000	18.0	0.20
SIOV-S05K25	Q69X3425	25	31	100	0.7	0.01
SIOV-S07K25	Q69X3450	25	31	250	1.6	0.02
SIOV-S10K25	Q69X3014	25	31	500	3.7	0.05
SIOV-S14K25	Q69X3021	25	31	1000	7.0	0.10
SIOV-S20K25	Q69X3461	25	31	2000	22.0	0.20

The dimensions of the varistors listed above are given on page 99.

Characteristics (T_A = 25 °C)

Varistor voltage V_V (1 mA) V	Tolerance ΔV_V (1 mA) %	Max. clamping voltage v V	 i A	Capacitance typ. C (1 kHz) pF	Derating curves Page	V/I characteristic Page
8	M = ± 20	17	2.5	5000	129	136
8	M = ± 20	17	10.0	24000	131	137
11	M = ± 20	27	2.5	4000	129	136
11	M = ± 20	27	10.0	20000	131	137
15	L = ± 15	35	2.5	3000	129	136
15	L = ± 15	35	10.0	16000	131	137
18	K = ± 10	36	1.0	1600	128	136
18	K = ± 10	36	2.5	3100	129	137
18	K = ± 10	36	5.0	6800	130	138
18	K = ± 10	36	10.0	11000	131	139
18	K = ± 10	36	20.0	18000	134	140
22	K = ± 10	43	1.0	1300	128	136
22	K = ± 10	43	2.5	2500	129	137
22	K = ± 10	43	5.0	5200	130	138
22	K = ± 10	43	10.0	9000	131	139
22	K = ± 10	43	20.0	15000	134	140
27	K = ± 10	53	1.0	1050	128	136
27	K = ± 10	53	2.5	1900	129	137
27	K = ± 10	53	5.0	4000	130	138
27	K = ± 10	53	10.0	7000	131	139
27	K = ± 10	53	20.0	13000	134	140
33	K = ± 10	65	1.0	750	128	136
33	K = ± 10	65	2.5	1500	129	137
33	K = ± 10	65	5.0	3100	130	138
33	K = ± 10	65	10.0	5500	131	139
33	K = ± 10	65	20.0	11000	134	140
39	K = ± 10	77	1.0	660	128	136
39	K = ± 10	77	2.5	1250	129	137
39	K = ± 10	77	5.0	2800	130	138
39	K = ± 10	77	10.0	4600	131	139
39	K = ± 10	77	20.0	8600	134	140

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage V_{RMS} V	V_{DC} V	Surge current i_{max} 8/20 µs A	Energy absorption W_{max} (2 ms) J	Power dissipation P_{max} W
SIOV-S05K30	Q69X3426	30	38	100	0.9	0.01
SIOV-S07K30	Q69X3451	30	38	250	2.0	0.02
SIOV-S10K30	Q69X3015	30	38	500	4.4	0.05
SIOV-S14K30	Q69X3022	30	38	1000	9.0	0.10
SIOV-S20K30	Q69X3462	30	38	2000	26.0	0.20
SIOV-S05K35	Q69X3427	35	45	100	1.1	0.01
SIOV-S07K35	Q69X3452	35	45	250	2.5	0.02
SIOV-S10K35	Q69X3016	35	45	500	5.4	0.05
SIOV-S14K35	Q69X3023	35	45	1000	10.0	0.10
SIOV-S20K35	Q69X3463	35	45	2000	33.0	0.20
SIOV-S05K40	Q69X3428	40	56	100	1.3	0.01
SIOV-S07K40	Q69X3453	40	56	250	3.0	0.02
SIOV-S10K40	Q69X3017	40	56	500	6.4	0.05
SIOV-S14K40	Q69X3024	40	56	1000	13.0	0.10
SIOV-S20K40	Q69X3464	40	56	2000	37.0	0.20
SIOV-S05K50	Q69X3429	50	65	400	1.8	0.10
SIOV-S07K50	Q69X3454	50	65	1200	4.2	0.25
SIOV-S10K50	Q69X3047	50	65	2500	8.4	0.40
SIOV-S14K50	Q69X3135	50	65	4500	15.0	0.60
SIOV-S20K50	Q69X3465	50	65	6500	27.0	1.00
SIOV-S05K60	Q69X3025	60	85	400	2.2	0.10
SIOV-S07K60	Q69X3036	60	85	1200	4.8	0.25
SIOV-S07S60AGS2 1)	Q69X3815	60	85	1200	4.8	0.25
SIOV-S10K60	Q69X3048	60	85	2500	10.0	0.40
SIOV-S14K60	Q69X3136	60	85	4500	17.0	0.60
SIOV-S20K60	Q69X3224	60	85	6500	33.0	1.00
SIOV-S05K75	Q69X3026	75	100	400	2.5	0.10
SIOV-S07K75	Q69X3037	75	100	1200	5.9	0.25
SIOV-S10K75	Q69X3049	75	100	2500	12.0	0.40
SIOV-S14K75	Q69X3137	75	100	4500	20.0	0.60
SIOV-S20K75	Q69X3225	75	100	6500	40.0	1.00

The dimensions of the varistors listed above are given on page 100.

1) Telecom varistor (only available on tape); see also page 54.

Characteristics (T_A = 25 °C)

Varistor voltage V_V (1 mA) V	Tolerance ΔV_V (1 mA) %	Max. clamping voltage v V	 i A	Capacitance typ. C (1 kHz) pF	Derating curves Page	V/I characteristic Page
47	K = ± 10	93	1.0	580	128	136
47	K = ± 10	93	2.5	1050	129	137
47	K = ± 10	93	5.0	2150	130	138
47	K = ± 10	93	10.0	3500	131	139
47	K = ± 10	93	20.0	7200	134	140
56	K = ± 10	110	1.0	460	128	136
56	K = ± 10	110	2.5	850	129	137
56	K = ± 10	110	5.0	1900	130	138
56	K = ± 10	110	10.0	3100	131	139
56	K = ± 10	110	20.0	6100	134	140
68	K = ± 10	135	1.0	400	128	136
68	K = ± 10	135	2.5	720	129	137
68	K = ± 10	135	5.0	1700	130	138
68	K = ± 10	135	10.0	2800	131	139
68	K = ± 10	135	20.0	5300	134	140
82	K = ± 10	135	5.0	300	128	136
82	K = ± 10	135	10.0	530	129	137
82	K = ± 10	135	25.0	950	130	138
82	K = ± 10	135	50.0	1800	132	139
82	K = ± 10	135	100.0	3800	133	140
100	K = ± 10	165	5.0	250	128	136
100	K = ± 10	165	10.0	480	129	137
not specified		200	45.0	480	129	–
100	K = ± 10	165	25.0	870	130	138
100	K = ± 10	165	50.0	1650	132	139
100	K = ± 10	165	100.0	3600	133	140
120	K = ± 10	200	5.0	210	128	136
120	K = ± 10	200	10.0	430	129	137
120	K = ± 10	200	25.0	720	130	138
120	K = ± 10	200	50.0	1370	132	139
120	K = ± 10	200	100.0	2900	133	140

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power dissipation
		V_{RMS}	V_{DC}	i_{max} 8/20 µs	W_{max} (2 ms)	P_{max}
		V	V	A	J	W
SIOV-S05K95	Q69X3027	95	125	400	3.4	0.10
SIOV-S07K95	Q69X3038	95	125	1200	7.6	0.25
SIOV-S07S95AGS2 [1]	Q69X4574	95	125	1200	7.6	0.25
SIOV-S10K95	Q69X3050	95	125	2500	15.0	0.40
SIOV-S14K95	Q69X3138	95	125	4500	25.0	0.60
SIOV-S20K95	Q69X3226	95	125	6500	50.0	1.00
SIOV-S05K115	Q69X4318	115	150	400	3.6	0.10
SIOV-S07K115	Q69X4319	115	150	1200	8.4	0.25
SIOV-S10K115	Q69X4320	115	150	2500	18.0	0.40
SIOV-S14K115	Q69X4321	115	150	4500	30.0	0.60
SIOV-S20K115	Q69X4322	115	150	6500	60.0	1.00
SIOV-S05K130	Q69X3028	130	170	400	4.2	0.10
SIOV-S07K130	Q69X3039	130	170	1200	9.5	0.25
SIOV-S10K130	Q69X3119	130	170	2500	19.0	0.40
SIOV-S14K130	Q69X3139	130	170	4500	34.0	0.60
● SIOV-S18K130	Q69X4538	130	170	6500	68.0	1.00
SIOV-S20K130	Q69X3227	130	170	8000	74.0	1.00
● SIOV-S20S130B	Q69X4397	130	170	8000	70.0	1.00
SIOV-S20S130BR7	Q69X4379	130	170	8000	70.0	1.00
SIOV-S05K140	Q69X3029	140	180	400	4.5	0.10
SIOV-S07K140	Q69X3040	140	180	1200	10.0	0.25
SIOV-S10K140	Q69X3120	140	180	2500	22.0	0.40
SIOV-S14K140	Q69X3140	140	180	4500	36.0	0.60
● SIOV-S18K140	Q69X4623	140	180	6500	72.0	1.00
SIOV-S20K140	Q69X3228	140	180	8000	78.0	1.00
SIOV-S05K150	Q69X3030	150	200	400	4.9	0.10
SIOV-S07K150	Q69X3041	150	200	1200	11.0	0.25
SIOV-S10K150	Q69X3121	150	200	2500	24.0	0.40
SIOV-S14K150	Q69X3141	150	200	4500	40.0	0.60
● SIOV-S18K150	Q69X4535	150	200	6500	79.0	1.00
SIOV-S20K150	Q69X3229	150	200	8000	85.0	1.00

The dimensions of the varistors listed above are given on page 101.

● Not for new design

[1] Telecom varistor (only available on tape); see also page 54.

Characteristics (T_A = 25 °C)

Varistor voltage V_V (1 mA) V	Tolerance ΔV_V (1 mA) %	Max. clamping voltage v V	 i A	Capacitance typ. C (1 kHz) pF	Derating curves Page	V/I characteristic Page
150	K = ± 10	250	5.0	135	128	136
150	K = ± 10	250	10.0	260	129	137
not specified		270	45.0	260	129	–
150	K = ± 10	250	25.0	530	130	138
150	K = ± 10	250	50.0	870	132	139
150	K = ± 10	250	100.0	1830	133	140
180	K = ± 10	300	5.0	110	128	136
180	K = ± 10	300	10.0	220	129	137
180	K = ± 10	300	25.0	445	130	138
180	K = ± 10	300	50.0	730	132	139
180	K = ± 10	300	100.0	1520	133	140
205	K = ± 10	340	5.0	100	128	136
205	K = ± 10	340	10.0	200	129	137
205	K = ± 10	340	25.0	400	130	138
205	K = ± 10	340	50.0	650	132	139
205	K = ± 10	340	100.0	1310	133	140
205	K = ± 10	340	100.0	1340	134	141
205	S = + 8/– 10	325	100.0	1340	134	142
205	S = + 8/– 10	325	100.0	1340	134	142
220	K = ± 10	360	5.0	95	128	136
220	K = ± 10	360	10.0	180	129	137
220	K = ± 10	360	25.0	370	130	138
220	K = ± 10	360	50.0	610	132	139
220	K = ± 10	360	100.0	1210	133	140
220	K = ± 10	360	100.0	1240	134	141
240	K = ± 10	395	5.0	90	128	136
240	K = ± 10	395	10.0	170	129	137
240	K = ± 10	395	25.0	350	130	138
240	K = ± 10	395	50.0	570	132	139
240	K = ± 10	395	100.0	1130	133	140
240	K = ± 10	395	100.0	1160	134	141

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power dissipation
		V_{RMS}	V_{DC}	i_{max} 8/20 µs	W_{max} (2 ms)	P_{max}
		V	V	A	J	W
● nSIOV-S20S150B	Q69X4398	150	200	8000	78.0	1.00
SIOV-S20S150BR7	Q69X4380	150	200	8000	78.0	1.00
SIOV-S05K175	Q69X3031	175	225	400	5.6	0.10
SIOV-S07K175	Q69X3042	175	225	1200	13.0	0.25
SIOV-S10K175	Q69X3122	175	225	2500	28.0	0.40
SIOV-S14K175	Q69X3142	175	225	4500	46.0	0.60
● nSIOV-S18K175	Q69X4624	175	225	6500	91.0	1.00
SIOV-S20K175	Q69X3230	175	225	8000	98.0	1.00
SIOV-S05K230	Q69X3032	230	300	400	7.2	0.10
SIOV-S07K230	Q69X3043	230	300	1200	17.0	0.25
SIOV-S10K230	Q69X3123	230	300	2500	36.0	0.40
SIOV-S14K230	Q69X3143	230	300	4500	60.0	0.60
● nSIOV-S18K230	Q69X4625	230	300	6500	120.0	1.00
SIOV-S20K230	Q69X3231	230	300	8000	130.0	1.00
SIOV-S05K250	Q69X3033	250	320	400	8.2	0.10
SIOV-S07K250	Q69X3044	250	320	1200	19.0	0.25
SIOV-S10K250	Q69X3124	250	320	2500	38.0	0.40
SIOV-S14K250	Q69X3144	250	320	4500	65.0	0.60
● nSIOV-S18K250	Q69X4626	250	320	6500	130.0	1.00
SIOV-S20K250	Q69X3232	250	320	8000	140.0	1.00
● nSIOV-S20S250B	Q69X4516	250	320	8000	135.0	1.00
SIOV-S20S250BR7	Q69X4518	250	320	8000	135.0	1.00
SIOV-S05K275	Q69X3034	275	350	400	8.6	0.10
SIOV-S07K275	Q69X3045	275	350	1200	21.0	0.25
SIOV-S10K275	Q69X3125	275	350	2500	43.0	0.40
SIOV-S14K275	Q69X3145	275	350	4500	71.0	0.60
● nSIOV-S18K275	Q69X4627	275	350	6500	140.0	1.00
SIOV-S20K275	Q69X3233	275	350	8000	151.0	1.00
● nSIOV-S20S275B	Q69X4517	275	350	8000	146.0	1.00
SIOV-S20S275BR7	Q69X4519	275	350	8000	146.0	1.00

The dimensions of the varistors listed above are given on page 102.

● n Not for new design

Characteristics (T_A = 25 °C)

Varistor voltage V_V (1 mA) V	Tolerance ΔV_V (1 mA) %	Max. clamping voltage v V	 i A	Capacitance typ. C (1 kHz) pF	Derating curves Page	V/I characteristic Page
240	S = + 2/– 10	360	100.0	1160	134	142
240	S = + 2/– 10	360	100.0	1160	134	142
270	K = ± 10	455	5.0	75	128	136
270	K = ± 10	455	10.0	150	129	137
270	K = ± 10	455	25.0	300	130	138
270	K = ± 10	455	50.0	490	132	139
270	K = ± 10	455	100.0	980	133	140
270	K = ± 10	455	100.0	1000	134	141
360	K = ± 10	595	5.0	60	128	136
360	K = ± 10	595	10.0	115	129	137
360	K = ± 10	595	25.0	230	130	138
360	K = ± 10	595	50.0	380	132	139
360	K = ± 10	595	100.0	740	133	140
360	K = ± 10	595	100.0	760	134	141
390	K = ± 10	650	5.0	55	128	136
390	K = ± 10	650	10.0	105	129	137
390	K = ± 10	650	25.0	215	130	138
390	K = ± 10	650	50.0	350	132	139
390	K = ± 10	650	100.0	680	133	140
390	K = ± 10	650	100.0	700	134	141
390	S = + 6/– 10	620	100.0	700	134	142
390	S = + 6/– 10	620	100.0	700	134	142
430	K = ± 10	710	5.0	50	128	136
430	K = ± 10	710	10.0	95	129	137
430	K = ± 10	710	25.0	195	130	138
430	K = ± 10	710	50.0	320	132	139
430	K = ± 10	710	100.0	610	133	140
430	K = ± 10	710	100.0	630	134	141
430	S = + 6/– 10	680	100.0	630	134	142
430	S = + 6/– 10	680	100.0	630	134	142

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power disipation
		V_{RMS}	V_{DC}	i_{max} 8/20 µs	W_{max} (2 ms)	P_{max}
		V	V	A	J	W
SIOV-S05K300	Q69X3035	300	385	400	9.6	0.10
SIOV-S07K300	Q69X3046	300	385	1200	23.0	0.25
SIOV-S10K300	Q69X3126	300	385	2500	47.0	0.40
SIOV-S14K300	Q69X3146	300	385	4500	76.0	0.60
● n SIOV-S18K300	Q69X4628	300	385	6500	160.0	1.00
SIOV-S20K300	Q69X3234	300	385	8000	173.0	1.00
SIOV-S10K320	Q69X4746	320	420	2500	50.0	0.40
SIOV-S14K320	Q69X4327	320	420	4500	84.0	0.60
● n SIOV-S18K320	Q69X4629	320	420	6500	170.0	1.00
SIOV-S20K320	Q69X4328	320	420	8000	184.0	1.00
SIOV-S05K385	Q69X3700	385	505	400	13.0	0.10
SIOV-S07K385	Q69X3825	385	505	1200	28.0	0.25
SIOV-S10K385	Q69X3127	385	505	2500	40.0	0.40
SIOV-S14K385	Q69X3147	385	505	4500	80.0	0.60
● n SIOV-S18K385	Q69X4630	385	505	6500	140.0	1.00
SIOV-S20K385	Q69X3235	385	505	8000	150.0	1.00
SIOV-S05K420	Q69X3703	420	560	400	14.0	0.10
SIOV-S07K420	Q69X3826	420	560	1200	32.0	0.25
SIOV-S10K420	Q69X3128	420	560	2500	45.0	0.40
SIOV-S14K420	Q69X3148	420	560	4500	90.0	0.60
● n SIOV-S18K420	Q69X4631	420	560	6500	160.0	1.00
SIOV-S20K420	Q69X3236	420	560	8000	175.0	1.00
SIOV-S05K440	Q69X4779	440	585	400	16.0	0.10
SIOV-S07K440	Q69X4780	440	585	1200	34.0	0.25
SIOV-S10K440	Q69X4781	440	585	2500	47.0	0.40
SIOV-S14K440	Q69X4782	440	585	4500	95.0	0.60
● n SIOV-S18K440	Q69X4783	440	585	6500	170.0	1.00
SIOV-S20K440	Q69X4784	440	585	8000	185.0	1.00
SIOV-S05K460	Q69X4702	460	615	400	18.0	0.10
SIOV-S07K460	Q69X4743	460	615	1200	36.0	0.20
SIOV-S10K460	Q69X3129	460	615	2500	50.0	0.40
SIOV-S14K460	Q69X3149	460	615	4500	100.0	0.60
● n SIOV-S18K460	Q69X4632	460	615	6500	180.0	1.00
SIOV-S20K460	Q69X3237	460	615	8000	195.0	1.00

The dimensions of the varistors listed above are given on page 103.

● n Not for new design

Characteristics (T_A = 25 °C)

Varistor voltage	Tolerance	Max. clamping voltage		Capacitance typ.	Derating curves	V/I characteristic
V_V (1 mA) V	ΔV_V (1 mA) %	v V	i A	C (1 kHz) pF	Page	Page
470	K = ± 10	775	5.0	45	128	136
470	K = ± 10	775	10.0	90	129	137
470	K = ± 10	775	25.0	180	130	138
470	K = ± 10	775	50.0	300	132	139
470	K = ± 10	775	100.0	570	133	140
470	K = ± 10	775	100.0	580	134	141
510	K = ± 10	840	25.0	170	130	138
510	K = ± 10	840	50.0	280	132	139
510	K = ± 10	840	100.0	530	133	140
510	K = ± 10	840	100.0	540	134	141
620	K = ± 10	1025	5.0	40	128	136
620	K = ± 10	1025	10.0	75	129	137
620	K = ± 10	1025	25.0	150	131	138
620	K = ± 10	1025	50.0	240	132	139
620	K = ± 10	1025	100.0	440	133	140
620	K = ± 10	1025	100.0	450	135	141
680	K = ± 10	1120	5.0	35	128	136
680	K = ± 10	1120	10.0	65	129	137
680	K = ± 10	1120	25.0	135	131	138
680	K = ± 10	1120	50.0	220	132	139
680	K = ± 10	1120	100.0	410	133	140
680	K = ± 10	1120	100.0	420	135	141
715	K = ± 10	1180	5.0	32	128	136
715	K = ± 10	1180	10.0	60	129	137
715	K = ± 10	1180	25.0	125	131	138
715	K = ± 10	1180	50.0	210	132	139
715	K = ± 10	1180	100.0	390	133	140
715	K = ± 10	1180	100.0	400	135	141
750	K = ± 10	1240	5.0	30	128	136
750	K = ± 10	1240	10.0	55	129	137
750	K = ± 10	1240	25.0	120	131	138
750	K = ± 10	1240	50.0	200	132	139
750	K = ± 10	1240	100.0	370	133	140
750	K = ± 10	1240	100.0	380	135	141

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage V_{RMS} V	V_{DC} V	Surge current i_{max} 8/20 µs A	Energy absorption W_{max} (2 ms) J	Power dissipation P_{max} W
SIOV-S10K510	Q69X3131	510	670	2500	55.0	0.40
SIOV-S14K510	Q69X3219	510	670	4500	110.0	0.60
SIOV-S20K510	Q69X3239	510	670	6500	190.0	1.00
SIOV-S10K550	Q69X3132	550	745	2500	60.0	0.40
SIOV-S14K550	Q69X3220	550	745	4500	120.0	0.60
SIOV-S20K550	Q69X3240	550	745	6500	210.0	1.00
SIOV-S10K625	Q69X3133	625	825	2500	68.0	0.40
SIOV-S14K625	Q69X3221	625	825	4500	130.0	0.60
SIOV-S20K625	Q69X3241	625	825	6500	230.0	1.00
SIOV-S10K680	Q69X3134	680	895	2500	72.0	0.40
SIOV-S14K680	Q69X3222	680	895	4500	140.0	0.60
SIOV-S20K680	Q69X3242	680	895	6500	250.0	1.00
SIOV-S14K1000 [1])	Q69X3223	1100	1465	4500	230.0	0.60
SIOV-S20K1000 [1])	Q69X3243	1100	1465	6500	410.0	1.00

The dimensions of the varistors listed above are given on page 104.

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[1]) Operating voltage differs from type designation.

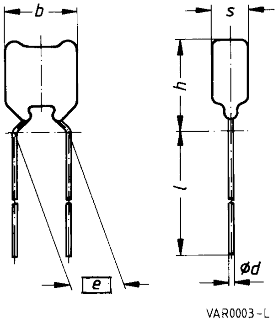
Characteristics (T_A = 25 °C)

Varistor voltage	Tolerance	Max. clamping voltage		Capacitance typ.	Derating curves	V/I characteristic
V_V (1 mA) V	ΔV_V (1 mA) %	v V	i A	C (1 kHz) pF	Page	Page
820	K = ± 10	1355	25.0	110	131	138
820	K = ± 10	1355	50.0	180	132	139
820	K = ± 10	1355	100.0	340	133	140
910	K = ± 10	1500	25.0	105	131	138
910	K = ± 10	1500	50.0	170	132	139
910	K = ± 10	1500	100.0	320	133	140
1000	K = ± 10	1650	25.0	90	131	138
1000	K = ± 10	1650	50.0	150	132	139
1000	K = ± 10	1650	100.0	280	133	140
1100	K = ± 10	1815	25.0	85	131	138
1100	K = ± 10	1815	50.0	140	132	139
1100	K = ± 10	1815	100.0	250	133	140
1800	K = ± 10	2970	50.0	100	132	139
1800	K = ± 10	2970	100.0	170	133	140

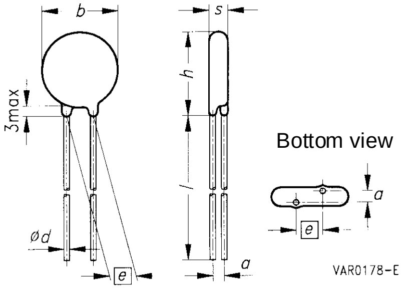
General technical data

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 (full load)	– 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 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	
Weight (approx.) SR1210 SR2220 S05K11 … 460 S07K11 … 460 S10K11 … 680 S14K11 … 1000 S18K130 … 460 S20K11 … 1000	 0.3 g 0.5 g 0.3 … 1.0 g 0.6 … 1.3 g 1.0 … 4.0 g 2.0 … 15.0 g 3.0 … 8.0 g 3.0 … 20.0 g	The weight of varistors in between these voltage classes can be interpolated.

SIOV-SR



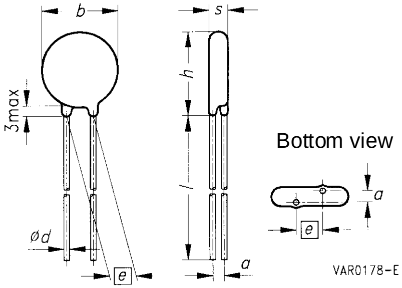
SIOV-S



Dimensions

Type	$\boxed{e}$ ± 1 mm	$a \pm 1$ mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-SR1210M4S	5.0	0	5.0	3.1	6.5	30.0	0.5
SIOV-SR2220M4S	5.0	0	7.5	3.8	9.0	30.0	0.5
SIOV-SR1210M6S	5.0	0	5.0	3.1	6.5	30.0	0.5
SIOV-SR2220M6S	5.0	0	7.5	3.8	9.0	30.0	0.5
SIOV-SR1210L8S	5.0	0	5.0	3.1	6.5	30.0	0.5
SIOV-SR2220L8S	5.0	0	7.5	3.8	9.0	30.0	0.5
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
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

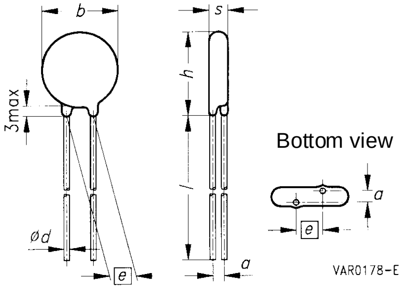
Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 108 ff.



Dimensions

Type	$\boxed{e} \pm 1$ mm	$a \pm 1$ mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
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	9.5	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-S07S60AGS2	5.0	1.2	9.0	3.5	13.0	– (*)	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
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

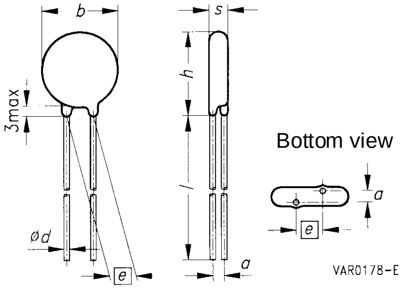
Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 108 ff.



Dimensions

Type	$\boxed{e}$ ± 1 mm	a ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
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-S07S95AGS2	5.0	1.3	9.0	3.6	13.0	– (*)	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-S18K130	10.0	2.0	20.5	5.0	24.0	30.0	1.0
SIOV-S20K130	10.0	2.0	22.5	5.0	26.0	30.0	1.0
SIOV-S20S130B	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-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-S18K140	10.0	2.1	20.5	5.1	24.0	30.0	1.0
SIOV-S20K140	10.0	2.1	22.5	5.1	26.0	30.0	1.0
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-S18K150	10.0	2.2	20.5	5.2	24.0	30.0	1.0
SIOV-S20K150	10.0	2.2	22.5	5.2	26.0	30.0	1.0

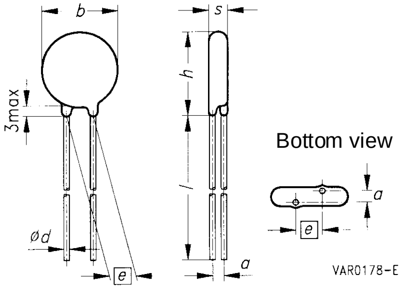
Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 108 ff.



Dimensions

Type	$\boxed{e}$ ± 1 mm	a ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SIOV-S20S150B	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-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-S18K175	10.0	2.3	20.5	5.3	24.0	30.0	1.0
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-S18K230	10.0	2.9	20.5	5.9	24.0	30.0	1.0
SIOV-S20K230	10.0	2.9	22.5	5.9	27.0	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-S18K250	10.0	3.1	20.5	6.1	24.0	30.0	1.0
SIOV-S20K250	10.0	3.1	22.5	6.1	27.0	30.0	1.0
SIOV-S20S250B	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-S18K275	10.0	3.3	20.5	6.3	24.0	30.0	1.0
SIOV-S20K275	10.0	3.3	22.5	6.3	27.0	30.0	1.0
SIOV-S20S275B	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

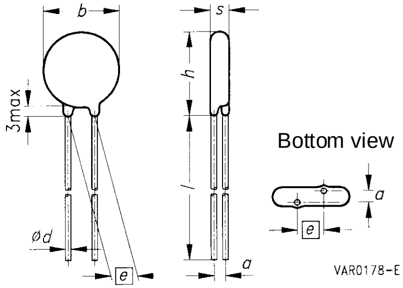
Dimensions in ( ) apply to the taped version with 5 mm lead spacing. For (*) see “Taping”, page 108 ff.



Dimensions

Type	$\boxed{e}$ ± 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	19.0	30.0	0.8
SIOV-S18K300	10.0	3.6	20.5	6.6	24.0	30.0	1.0
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-S18K320	10.0	3.8	20.5	6.8	25.0	30.0	1.0
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-S18K385	10.0	4.5	20.5	7.5	25.0	30.0	1.0
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-S18K420	10.0	4.8	20.5	7.8	25.0	30.0	1.0
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-S18K440	10.0	5.0	20.5	8.0	25.0	30.0	1.0
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-S18K460	10.0	5.2	20.5	8.2	25.0	30.0	1.0
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 108 ff.



Dimensions

Type	$\boxed{e}$ ± 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

All disk varistors from voltage class M4 through K300 (except type series SIOV-S20) are available on tape.

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 111 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 page 107 G4	S S2 S3 page 110 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 the opposite page.
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 110 .

The crimp styles of the individual types can be seen from the type designation in the 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)

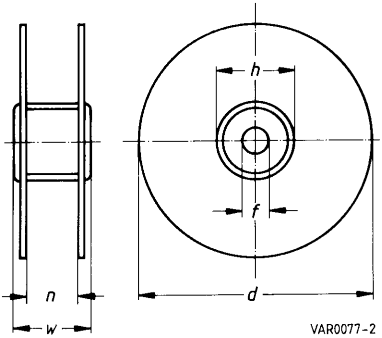
For taped varistors which have another lead spacing than their untaped equivalents, the actual $\boxed{e}$ is appended to type designation.

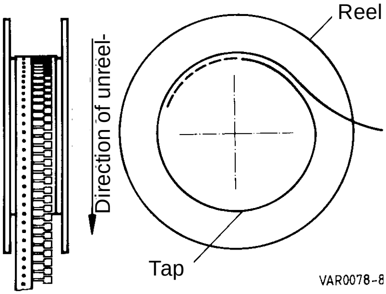
Example: S10K250GS3R5
The standard lead spacing of series SIOV-S10 is $\boxed{e}$ = 7.5. The version with $\boxed{e}$ = 5.0 has the appendix "R5".

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 upon request.





Reel dimensions (in mm)

Reel type	*d*	*f*	*h*	*n*	*w*
I	360 max.	30 ± 1	80 min.	46	52 max.
II	360 max.	30 ± 1	80 min.	54	62 max.
III	500 max.	22 ± 1	125 min.	50	67 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).

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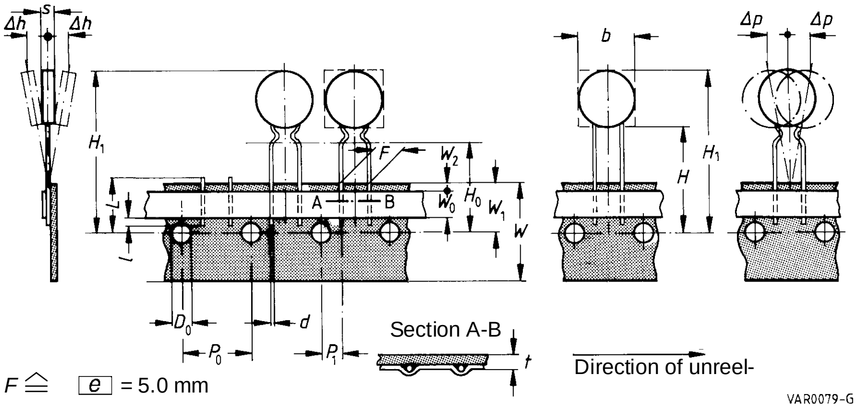
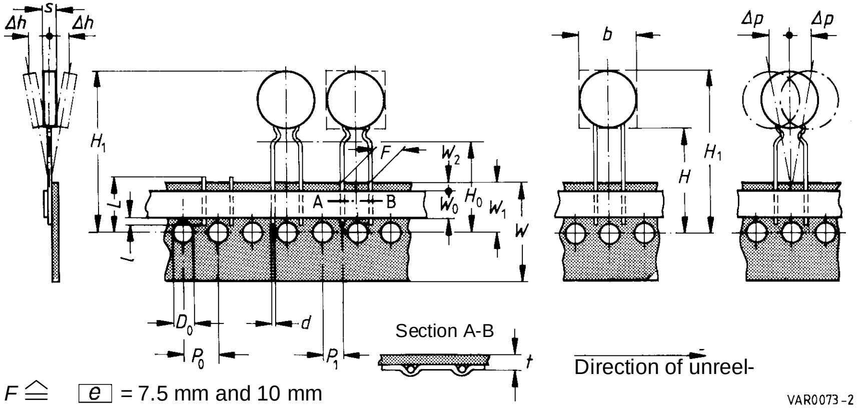
1) “1” is omitted

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	$\boxed{e}$ = 5.0	Tolerance	$\boxed{e}$ = 7.5	Tolerance	$\boxed{e}$ = 10.0	Tolerance	Remarks
b		max.		max.		max.	see tables on page 99 ff
s		max.		max.		max.	
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 top of component body
Δp	0	± 1.3	0	± 2.0	0	± 2.0	
W	18.0	± 0.5	18.0	± 0.5	18.0	± 0.5	
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.	

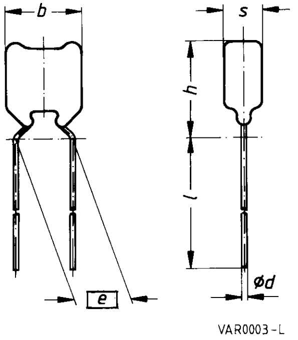
1) Type series SR: 0.5 mm

2) Applies only to uncrimped types

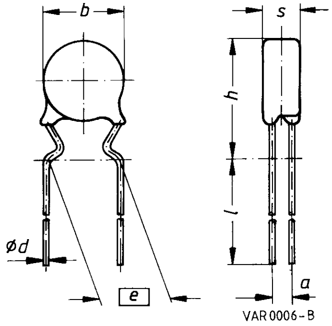
3) Applies only to crimped types (H_0 = 18 upon request)

Disk Varistors
Taping

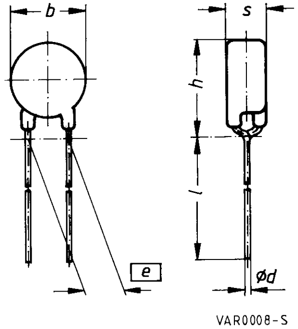
Crimp style S 1)



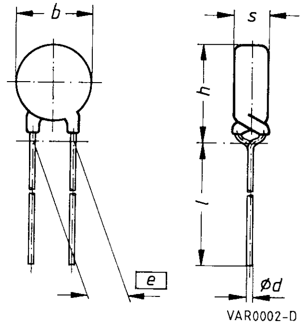
Crimp style S2



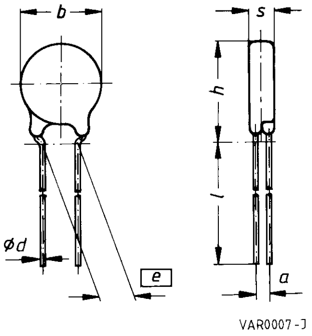
Crimp style S3



Crimp style S4



Crimp style S5



Type	$\boxed{e}$ mm	h_{max} mm
SIOV-SR1210…S	5	6.5
SIOV-S05…S2	5	11.0
SIOV-S05…S3	5	10.0
SIOV-SR2220…S	5	9.0
SIOV-S07…S2	5	13.0
SIOV-S07…S3	5	12.0
SIOV-S10…S4R5	5	15.0
SIOV-S10…S3R5	5	15.0
SIOV-S10…S5	7.5	17.5
SIOV-S14…S5	7.5	21.5
SIOV-S18…S5	10	25.0

1) “1” is omitted

Type	Ordering code	Crimp style	Pieces/reel	Reel type
Type series SIOV-SR, crimped leads $\boxed{e}$ = 5				
SIOV-SR1210M4GS	Q69535-R40-M52	S	2000	I
SIOV-SR1210M6GS	Q69535-R60-M52	S	2000	I
SIOV-SR1210L8GS	Q69535-R80-L52	S	2000	I
SIOV-SR2220M4GS	Q69545-R40-M52	S	2000	I
SIOV-SR2220M6GS	Q69545-R60-M52	S	2000	I
SIOV-SR2220L8GS	Q69545-R80-L52	S	2000	I
Type series SIOV-S05, straight leads $\boxed{e}$ = 5				
SIOV-S05K11G	Q69X4509	–	1500	I
SIOV-S05K14G	Q69X4860	–	1500	I
SIOV-S05K17G	Q69X4861	–	1500	I
SIOV-S05K20G	Q69X4762	–	1500	I
SIOV-S05K25G	Q69X4757	–	1500	I
SIOV-S05K30G	Q69X3869	–	1500	I
SIOV-S05K35G	Q69X4638	–	1500	I
SIOV-S05K40G	Q69X4862	–	1500	I
SIOV-S05K50G	Q69X4341	–	1500	I
SIOV-S05K60G	Q69X4724	–	1500	I
SIOV-S05K75G	Q69X3885	–	1500	I
SIOV-S05K95G	Q69X4529	–	1500	I
SIOV-S05K115G	Q69X4863	–	1500	I
SIOV-S05K130G	Q69X4864	–	1500	I
SIOV-S05K140G	Q69X4865	–	1500	I
SIOV-S05K150G	Q69X4339	–	1500	I
SIOV-S05K175G	Q69X4866	–	1500	I
SIOV-S05K230G	Q69X4867	–	1500	I
SIOV-S05K250G	Q69X4395	–	1500	I
SIOV-S05K275G	Q69X4490	–	1500	I
SIOV-S05K300G	Q69X4707	–	1500	I
Type series SIOV-S05, crimped leads $\boxed{e}$ = 5				
SIOV-S05K11GS2	Q69X4388	S2	1500	I
SIOV-S05K14GS2	Q69X3403	S2	1500	I
SIOV-S05K17GS2	Q69X4366	S2	1500	I
SIOV-S05K20GS2	Q69X4465	S2	1500	I
SIOV-S05K25GS2	Q69X4359	S2	1500	I
SIOV-S05K30GS2	Q69X4374	S2	1500	I
SIOV-S05K35GS2	Q69X3864	S2	1500	I
SIOV-S05K40GS2	Q69X4577	S2	1500	I
SIOV-S05K50GS2	Q69X4317	S2	1500	I
SIOV-S05K60GS2	Q69X4313	S2	1500	I
SIOV-S05K75GS2	Q69X3719	S2	1500	I
SIOV-S05K95GS2	Q69X3884	S2	1500	I

Type	Ordering code	Crimp style	Pieces/reel	Reel type
Type series SIOV-S05, crimped leads $\boxed{e}$ = 5 (continued)				
SIOV-S05K115GS2	Q69X4578	S2	1500	I
SIOV-S05K130GS2	Q69X3892	S2	1500	I
SIOV-S05K140GS2	Q69X4512	S2	1500	I
SIOV-S05K150GS2	Q69X4324	S2	1500	I
SIOV-S05K175GS2	Q69X4579	S2	1500	I
SIOV-S05K230GS3	Q69X4580	S3	1500	I
SIOV-S05K250GS3	Q69X3500	S3	1500	I
SIOV-S05K275GS3	Q69X3900	S3	1500	I
SIOV-S05K300GS3	Q69X4375	S3	1500	I
Type series SIOV-S07, straight leads $\boxed{e}$ = 5				
SIOV-S07K11G	Q69X4868	–	1500	I
SIOV-S07K14G	Q69X4315	–	1500	I
SIOV-S07K17G	Q69X4869	–	1500	I
SIOV-S07K20G	Q69X4300	–	1500	I
SIOV-S07K25G	Q69X4870	–	1500	I
SIOV-S07K30G	Q69X4304	–	1500	I
SIOV-S07K35G	Q69X4871	–	1500	I
SIOV-S07K40G	Q69X4389	–	1500	I
SIOV-S07K50G	Q69X4872	–	1500	I
SIOV-S07K60G	Q69X4523	–	1500	I
SIOV-S07K75G	Q69X4488	–	1500	I
SIOV-S07K95G	Q69X4542	–	1500	I
SIOV-S07K115G	Q69X4873	–	1500	I
SIOV-S07K130G	Q69X3594	–	1500	I
SIOV-S07K140G	Q69X4874	–	1500	I
SIOV-S07K150G	Q69X4506	–	1500	I
SIOV-S07K175G	Q69X4875	–	1500	I
SIOV-S07K230G	Q69X4510	–	1500	I
SIOV-S07K250G	Q69X4678	–	1500	I
SIOV-S07K275G	Q69X4314	–	1000	I
SIOV-S07K300G	Q69X4450	–	1000	I
Type series SIOV-S07, crimped leads $\boxed{e}$ = 5				
SIOV-S07K11GS2	Q69X3802	S2	1500	I
SIOV-S07K14GS2	Q69X3805	S2	1500	I
SIOV-S07K17GS2	Q69X3804	S2	1500	I
SIOV-S07K20GS2	Q69X3624	S2	1500	I
SIOV-S07K25GS2	Q69X4342	S2	1500	I
SIOV-S07K30GS2	Q69X4316	S2	1500	I
SIOV-S07K35GS2	Q69X3843	S2	1500	I
SIOV-S07K40GS2	Q69X3830	S2	1500	I
SIOV-S07K50GS2	Q69X3717	S2	1500	I

Type	Ordering code	Crimp style	Pieces/reel	Reel type
Type series SIOV-S07, crimped leads $\boxed{e}$ = 5 (continued)				
SIOV-S07K60GS2	Q69X3706	S2	1500	I
SIOV-S07S60AGS2	Q69X3815	S2	1500	I
SIOV-S07K75GS2	Q69X3701	S2	1500	I
SIOV-S07K95GS2	Q69X3623	S2	1500	I
SIOV-S07S95AGS2	Q69X4574	S2	1500	I
SIOV-S07K115GS2	Q69X4469	S2	1500	I
SIOV-S07K130GS2	Q69X3801	S2	1500	I
SIOV-S07K140GS2	Q69X4581	S2	1500	I
SIOV-S07K150GS2	Q69X3807	S2	1500	I
SIOV-S07K175GS2	Q69X3590	S2	1500	I
SIOV-S07K230GS3	Q69X3597	S3	1500	I
SIOV-S07K250GS3	Q69X3806	S3	1500	I
SIOV-S07K275GS3	Q69X3860	S3	1000	I
SIOV-S07K300GS3	Q69X3808	S3	1000	I
Type series SIOV-S10, straight leads $\boxed{e}$ = 7.5				
SIOV-S10K11G5	Q69X4573	–	1500	III
SIOV-S10K14G5	Q69X4592	–	1500	III
SIOV-S10K17G5	Q69X4593	–	1500	III
SIOV-S10K20G5	Q69X4524	–	1500	III
SIOV-S10K25G5	Q69X4452	–	1500	III
SIOV-S10K30G5	Q69X4549	–	1500	III
SIOV-S10K35G5	Q69X4394	–	1500	III
SIOV-S10K40G5	Q69X4533	–	1500	III
SIOV-S10K50G5	Q69X4485	–	1500	III
SIOV-S10K60G5	Q69X4451	–	1500	III
SIOV-S10K75G5	Q69X4583	–	1500	III
SIOV-S10K95G5	Q69X4390	–	1500	III
SIOV-S10K115G5	Q69X4585	–	1500	III
SIOV-S10K130G5	Q69X4520	–	1500	III
SIOV-S10K140G5	Q69X4370	–	1500	III
SIOV-S10K150G5	Q69X4575	–	1500	III
SIOV-S10K175G5	Q69X4522	–	1500	III
SIOV-S10K230G5	Q69X4591	–	1000	III
SIOV-S10K250G5	Q69X4369	–	1000	III
SIOV-S10K275G5	Q69X4381	–	1000	III
SIOV-S10K300G5	Q69X4594	–	1000	III

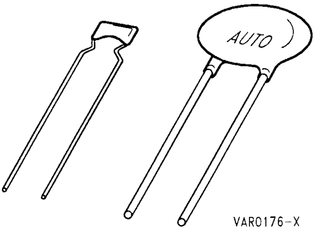
Disk Varistors
Taping

Type	Ordering code	Crimp style	Pieces/reel	Reel type
Type series SIOV-S10, crimped leads $\boxed{e}$ = 5				
SIOV-S10K11GS4R5	Q69X4587	S4	1500	I
SIOV-S10K14GS4R5	Q69X4340	S4	1500	I
SIOV-S10K17GS4R5	Q69X4582	S4	1500	I
SIOV-S10K20GS4R5	Q69X4429	S4	1500	I
SIOV-S10K25GS4R5	Q69X4557	S4	1500	I
SIOV-S10K30GS4R5	Q69X3877	S4	1500	I
SIOV-S10K35GS4R5	Q69X4584	S4	1500	I
SIOV-S10K40GS4R5	Q69X4430	S4	1500	I
SIOV-S10K50GS4R5	Q69X4556	S4	1500	I
SIOV-S10K75GS4R5	Q69X3865	S4	1500	I
SIOV-S10K95GS4R5	Q69X4586	S4	1500	I
SIOV-S10K115GS4R5	Q69X4605	S4	1500	I
SIOV-S10K130GS4R5	Q69X4305	S4	1500	I
SIOV-S10K140GS4R5	Q69X4588	S4	1500	I
SIOV-S10K150GS4R5	Q69X3881	S4	1500	I
SIOV-S10K175GS4R5	Q69X4589	S4	1500	I
SIOV-S10K230GS3R5	Q69X3880	S3	1500	I
SIOV-S10K250GS3R5	Q69X4337	S3	1500	I
SIOV-S10K275GS3R5	Q69X3872	S3	1000	I
SIOV-S10K300GS3R5	Q69X4590	S3	1000	I
Type series SIOV-S10, crimped leads $\boxed{e}$ = 7.5				
SIOV-S10K11G5S5	Q69X4785	S5	1500	III
SIOV-S10K14G5S5	Q69X4786	S5	1500	III
SIOV-S10K17G5S5	Q69X4787	S5	1500	III
SIOV-S10K20G5S5	Q69X4788	S5	1500	III
SIOV-S10K25G5S5	Q69X4476	S5	1500	III
SIOV-S10K30G5S5	Q69X4540	S5	1500	III
SIOV-S10K35G5S5	Q69X4504	S5	1500	III
SIOV-S10K40G5S5	Q69X4792	S5	1500	III
SIOV-S10K50G5S5	Q69X4563	S5	1500	III
SIOV-S10K60G5S5	Q69X4505	S5	1500	III
SIOV-S10K75G5S5	Q69X4739	S5	1500	III
SIOV-S10K95G5S5	Q69X4564	S5	1500	III
SIOV-S10K115G5S5	Q69X4797	S5	1500	III
SIOV-S10K130G5S5	Q69X4531	S5	1500	III
SIOV-S10K140G5S5	Q69X4799	S5	1500	III
SIOV-S10K150G5S5	Q69X4800	S5	1500	III
SIOV-S10K175G5S5	Q69X4559	S5	1500	III
SIOV-S10K230G5S5	Q69X4728	S5	1000	III
SIOV-S10K250G5S5	Q69X4803	S5	1000	III
SIOV-S10K275G5S5	Q69X4426	S5	1000	III
SIOV-S10K300G5S5	Q69X4508	S5	1000	III

Type	Ordering code	Crimp style	Pieces/reel	Reel type
Type series SIOV-S14, straight leads $\boxed{e}$ = 7.5				
SIOV-S14K11G5	Q69X4572	–	1500	III
SIOV-S14K14G5	Q69X4376	–	1500	III
SIOV-S14K17G5	Q69X4595	–	1500	III
SIOV-S14K20G5	Q69X4489	–	1500	III
SIOV-S14K25G5	Q69X4596	–	1500	III
SIOV-S14K30G5	Q69X4391	–	1500	III
SIOV-S14K35G5	Q69X4528	–	1500	III
SIOV-S14K40G5	Q69X4597	–	1500	III
SIOV-S14K50G5	Q69X4598	–	1500	III
SIOV-S14K60G5	Q69X4382	–	1500	III
SIOV-S14K75G5	Q69X4392	–	1500	III
SIOV-S14K95G5	Q69X4486	–	1500	III
SIOV-S14K115G5	Q69X4511	–	1500	III
SIOV-S14K130G5	Q69X4599	–	1500	III
SIOV-S14K140G5	Q69X4600	–	1500	III
SIOV-S14K150G5	Q69X4539	–	1500	III
SIOV-S14K175G5	Q69X4601	–	1500	III
SIOV-S14K230G5	Q69X4602	–	1000	III
SIOV-S14K250G5	Q69X4603	–	1000	III
SIOV-S14K275G5	Q69X4393	–	1000	III
SIOV-S14K300G5	Q69X4604	–	1000	III
Type series SIOV-S14, crimped leads $\boxed{e}$ = 7.5				
SIOV-S14K11G5S5	Q69X4738	S5	1500	III
SIOV-S14K14G5S5	Q69X4472	S5	1500	III
SIOV-S14K17G5S5	Q69X4709	S5	1500	III
SIOV-S14K20G5S5	Q69X4541	S5	1500	III
SIOV-S14K25G5S5	Q69X4810	S5	1500	III
SIOV-S14K30G5S5	Q69X4811	S5	1500	III
SIOV-S14K35G5S5	Q69X4473	S5	1500	III
SIOV-S14K40G5S5	Q69X4737	S5	1500	III
SIOV-S14K50G5S5	Q69X4543	S5	1500	III
SIOV-S14K60G5S5	Q69X4474	S5	1500	III
SIOV-S14K75G5S5	Q69X4399	S5	1500	III
SIOV-S14K95G5S5	Q69X4367	S5	1500	III
SIOV-S14K115G5S5	Q69X4818	S5	1500	III
SIOV-S14K130G5S5	Q69X4651	S5	1500	III
SIOV-S14K140G5S5	Q69X4481	S5	1500	III
SIOV-S14K150G5S5	Q69X4475	S5	1500	III
SIOV-S14K175G5S5	Q69X4471	S5	1500	III
SIOV-S14K230G5S5	Q69X4654	S5	1000	III
SIOV-S14K250G5S5	Q69X4468	S5	1000	III
SIOV-S14K275G5S5	Q69X4652	S5	1000	III
SIOV-S14K300G5S5	Q69X4750	S5	1000	III

Type	Ordering code	Crimp style	Pieces/reel	Reel type
Type series SIOV-S18, straight leads $\boxed{e}$ = 10				
n SIOV-S18K130G5	Q69X4876	–	1000	III
n SIOV-S18K140G5	Q69X4877	–	1000	III
n SIOV-S18K150G5	Q69X4878	–	1000	III
n SIOV-S18K175G5	Q69X4879	–	1000	III
n SIOV-S18K230G5	Q69X4880	–	750	III
n SIOV-S18K250G5	Q69X4881	–	750	III
n SIOV-S18K275G5	Q69X4882	–	750	III
n SIOV-S18K300G5	Q69X4883	–	750	III
Type series SIOV-S18, crimped leads $\boxed{e}$ = 10				
n SIOV-S18K130G5S5	Q69X4655	S5	1000	III
n SIOV-S18K140G5S5	Q69X4828	S5	1000	III
n SIOV-S18K150G5S5	Q69X4656	S5	1000	III
n SIOV-S18K175G5S5	Q69X4830	S5	1000	III
n SIOV-S18K230G5S5	Q69X4831	S5	750	III
n SIOV-S18K250G5S5	Q69X4832	S5	750	III
n SIOV-S18K275G5S5	Q69X4833	S5	750	III
n SIOV-S18K300G5S5	Q69X4834	S5	750	III

n Not for new design



Construction

SR:

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

S:

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

Features

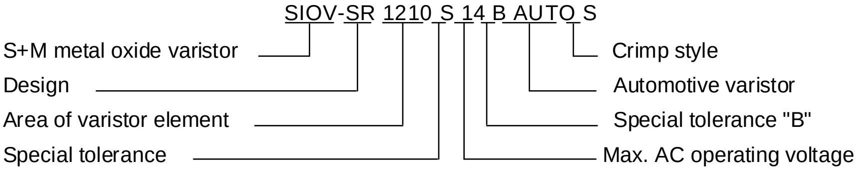
- High energy absorption, particularly in case of load dump
- Jump-start strength
- Stable protection level, minimum leakage curent
- High resistance to cyclic temperature stress

Taping

- All types available taped and reeled upon request

Type designation

Detailed description of coding system on page 28



Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power dissipation	Load dump
		V_{RMS}	V_{DC}	i_{max} 8/20 µs	W_{max} (2 ms)	P_{max}	W_{LD} (10×)
SIOV-		V	V	A	J	W	J
12-V supply systems							
SR1210S14BAUTOS	Q69535-R1140-S200	14	16	250	0.8	0.01	3
SR1812S14BAUTOS	Q69585-R1140-S200	14	16	500	1.7	0.015	6
SR2220S14BAUTOS	Q69545-R1140-S200	14	16	1000	3.6	0.03	12
S10K14AUTO	Q69X3859	14	16	500	2	0.05	25
S14K14AUTO	Q69X4482	14	16	1000	4	0.1	50
S20K14AUTO	Q69X3625	14	16	2000	12	0.2	100
S10K17AUTO	Q69X4570	17	20	500	2.5	0.05	25
S14K17AUTO	Q69X4325	17	20	1000	5	0.1	50
S20K17AUTO	Q69X4569	17	20	2000	14	0.2	100
24-V supply systems							
S20K25AUTO	Q69X4885	25	28	2000	22	0.2	100
S14K30AUTO	Q69X3889	30	34	1000	9	0.1	50
S20K30AUTO	Q69X3803	30	34	2000	26	0.2	100

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.

Characteristics (T_A = 25 °C)

Jump start	Varistor voltage	Tolerance	Max. clamping voltage		Capaci-tance, typ.	Derating curves	V/I characteristic
V_{JUMP} (max. 5 minutes) V	V_V (1 mA) V	ΔV_V (1 mA) %	v V	i A	C (1 kHz) nF	Page	Page
24.5	22 … 27	SB1) = + 23/– 0	40	2.5	1.7	129	136
24.5	22 … 27	SB1) = + 23/– 0	40	5	5.6	130	137
24.5	22 … 27	SB1) = + 23/– 0	40	10	9.5	131	137
25	22	K = ± 10	43	5	5.2	130	138
25	22	K = ± 10	43	10	9.0	131	139
25	22	K = ± 10	43	20	15.0	134	140
30	27	K = ± 10	53	5	4.0	130	138
30	27	K = ± 10	53	10	7.0	131	139
30	27	K = ± 10	53	20	13.0	134	140
40	39	K = ± 10	77	20	10	134	140
50	47	K = ± 10	93	10	3,5	131	139
50	47	K = ± 10	93	20	9	134	140

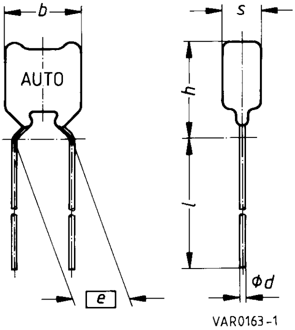
---

1) Special tolerance "B", here 22 … 27 V

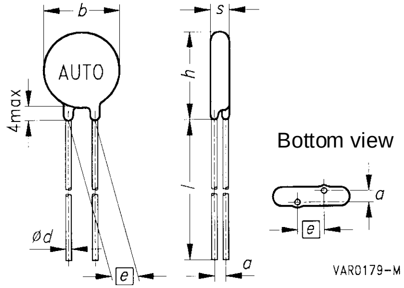
General technical data

Climatic category LCT UCT Damp heat, steady state (93 % r. h., 40 °C)	55/85/56 – 55 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature (full load)	– 55 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 55 … + 125 °C	
Electric strength	> 2.5 kV	in accordance with CECC 42 000
Insulation resistance	> 1 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	
Weight (approx.)		
SR1210	0.3 g	
SR1812	0.4 g	
SR2220	0.5 g	
S10	1 … 2 g	
S14	2 … 4 g	
S20	3 … 6 g	

SIOV-SR…AUTO



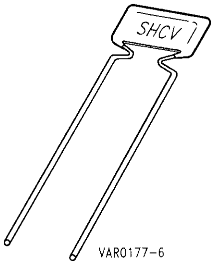
SIOV-S…AUTO



Dimensions

Type SIOV-	$\boxed{e}$ ± 1 mm	a ± 1 mm	b_{max} mm	s_{max} mm	h_{max} mm	l_{min} mm	d mm
SR1210S14BAUTOS	5.0	0	5.0	3.1	6.5	30.0	0.55
SR1812S14BAUTOS	5.0	0	7.0	3.5	7.8	30.0	0.55
SR2220S14BAUTOS	5.0	0	7.5	3.8	9.0	30.0	0.55
S10K14AUTO	7.5	1.5	13.5	5.2	17.5	30.0	0.8
S14K14AUTO	7.5	1.5	17.5	5.3	22.0	30.0	0.8
S20K14AUTO	10.0	1.6	24.0	5.6	29.0	30.0	1.0
S10K17AUTO	7.5	1.6	13.5	5.3	17.5	30.0	0.8
S14K17AUTO	7.5	1.7	17.5	5.4	22.0	30.0	0.8
S20K17AUTO	10.0	1.8	24.0	5.8	29.0	30.0	1.0
S20K25AUTO	10.0	2.9	24.0	6.2	29.0	30.0	1.0
S14K30AUTO	7.5	1.8	17.5	5.8	22.0	30.0	0.8
S20K30AUTO	10.0	3.2	24.0	6.5	29.0	30.0	1.0

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

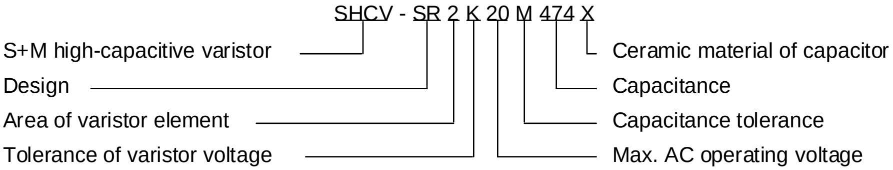
- High capacitance
- Overvoltage protection and RFI suppression provided by a single component
- Load-dump withstand capability
- Jump-start strength

Taping

- Upon request

Type designation

Detailed description of coding system on page 28



SHCV - SR 2 K 20 M 474 X

S+M high-capacitive varistor
Design
Area of varistor element
Tolerance of varistor voltage
Ceramic material of capacitor
Capacitance
Capacitance tolerance
Max. AC operating voltage

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power dissipation	Load dump
		V_{RMS}	V_{DC}	i_{max} 8/20 µs	W_{max} (2 ms)	P_{max}	W_{LD} (10×)
SHCV-		V	V	A	J	W	J
SR1S14BM474X	Q69587-E3140-S200	14	16	500	1.7	0.015	6
SR1S14BM105Z	Q69588-G3140-S200	14	16	500	1.7	0.015	6
SR1S14BM155Z	Q69588-H3140-S200	14	16	500	1.7	0.015	6
SR2S14BM474X	Q69547-E3140-S200	14	16	1000	3.6	0.03	12
SR2S14BM105Z	Q69548-G3140-S200	14	16	1000	3.6	0.03	12
SR2S14BM155Z	Q69548-H3140-S200	14	16	1000	3.6	0.03	12
SR1K20M474X	Q69587-E3200-K	20	26	500	2.5	0.015	6
SR1K20M105Z	Q69588-G3200-K	20	26	500	2.5	0.015	6
SR1K20M155Z	Q69588-H3200-K	20	26	500	2.5	0.015	6
SR2K20M474X	Q69547-E3200-K	20	26	1000	5.5	0.03	12
SR2K20M105Z	Q69548-G3200-K	20	26	1000	5.5	0.03	12
SR2K20M155Z	Q69548-H3200-K	20	26	1000	5.5	0.03	12

Notes

- If the maximum loads specified for load dump and jump start are fully utilized, subsequent polarity reversal of the SHCV 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.

Characteristics (T_A = 25 °C)

Jump start	Varistor voltage	Tolerance	Max. clamping voltage		Capaci-tance	Derating curves	V/i cha-racteristic
V_{JUMP} (max. 5 min-utes)	V_V (1 mA) V	ΔV_V (1 mA) %	v V	i A	C ± 20% (1 kHz) µF	Page	Page
24.5	22 … 27	SB[1]) = + 23/– 0	40	5	0.47	130	143
24.5	22 … 27	SB[1]) = + 23/– 0	40	5	1.0	130	143
24.5	22 … 27	SB[1]) = + 23/– 0	40	5	1.5	130	143
24.5	22 … 27	SB[1]) = +23/–0	40	10	0.47	131	143
24.5	22 … 27	SB[1]) = +23/–0	40	10	1.0	131	143
24.5	22 … 27	SB[1]) = +23/–0	40	10	1.5	131	143
26	33	K = ± 10	58	5	0.47	130	143
26	33	K = ± 10	58	5	1.0	130	143
26	33	K = ± 10	58	5	1.5	130	143
26	33	K = ± 10	58	10	0.47	131	143
26	33	K = ± 10	58	10	1.0	131	143
26	33	K = ± 10	58	10	1.5	131	143

---

[1]) Special tolerance "B", here 22 … 27 V

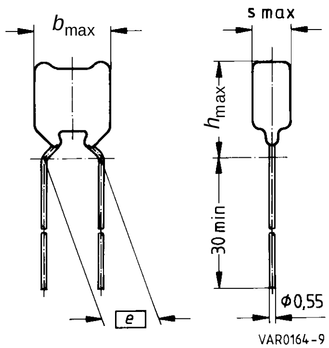
General technical data

Climatic category	X[1]	40/85/56	in accordance with IEC 68-1
	Z[2]	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		> 2.5 kV	in accordance with CECC 42 000
Insulation resistance		> 1 GΩ	in accordance with CECC 42 000
Response time		< 25 ns	
Weight (approx.)		1 g	

[1] Ceramic material: X = X7R

SHCV-	s_{max}
SR…474X	3.6
SR…105Z	4.0
SR…155Z	4.1

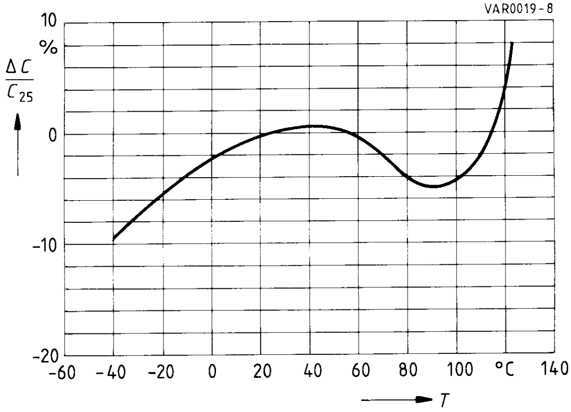
SHCV-	b_{max}	h_{max}
SR1…	7.3	7.8
SR2…	7.8	9.0



e = 5.0 ± 1
Offset = 0.0 ± 1

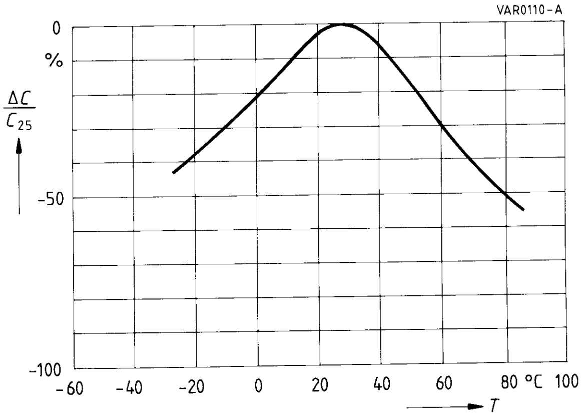
Dimensions in mm

Typical capacitance change as per EIA RS198B



SHCV-SR … X

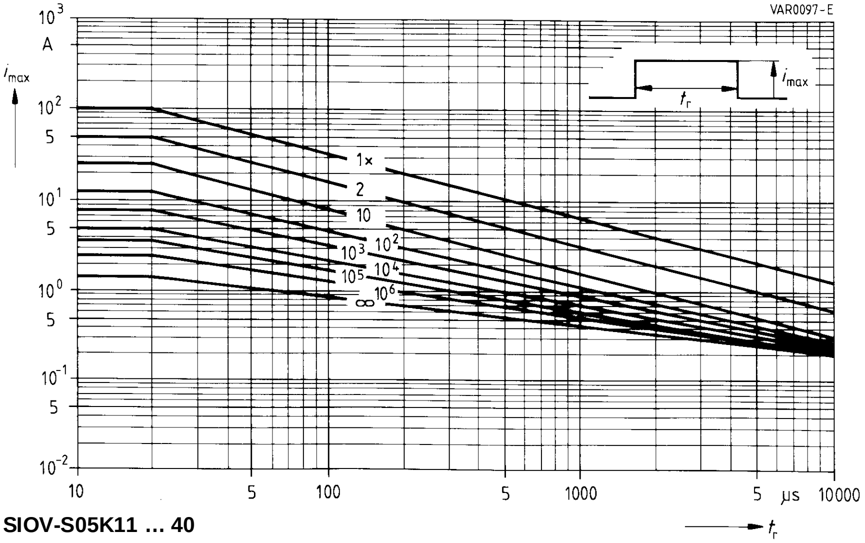
Typical capacitance change as per IEC 384-9



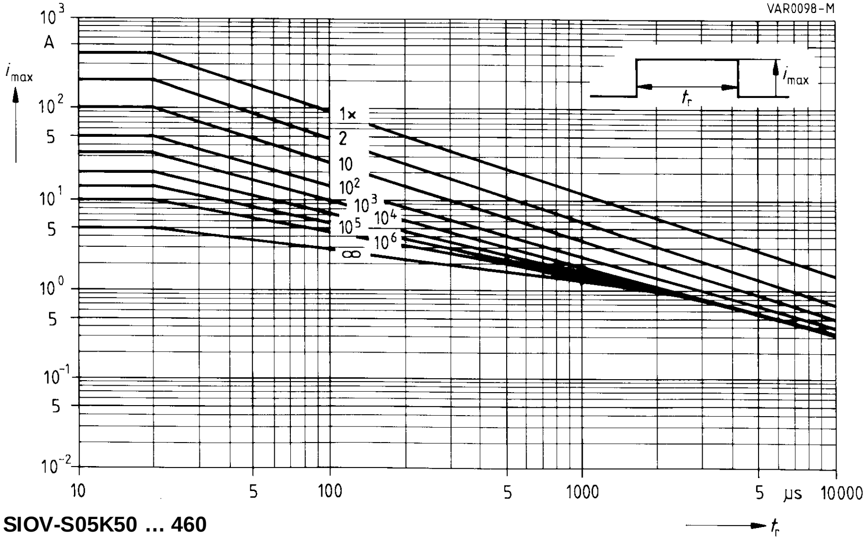
SHCV-SR … Z

Derating curves (maximum surge current)

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



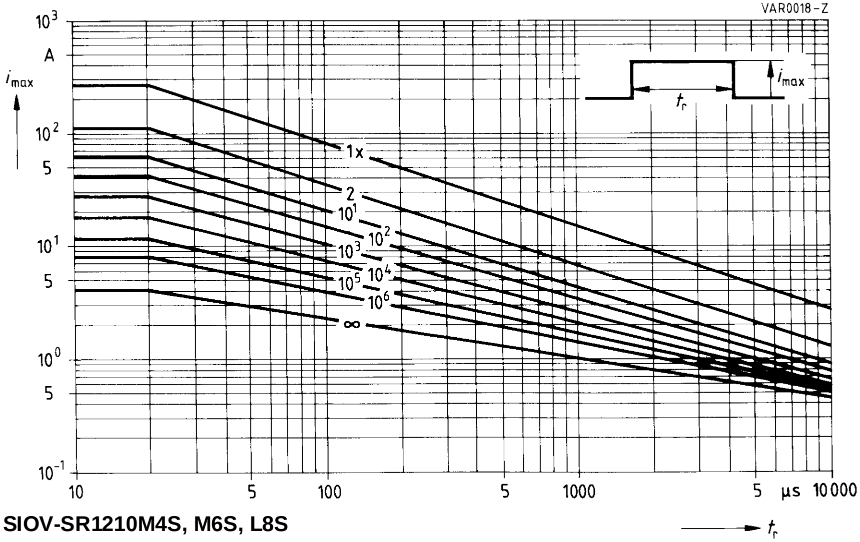
SIOV-S05K11 … 40



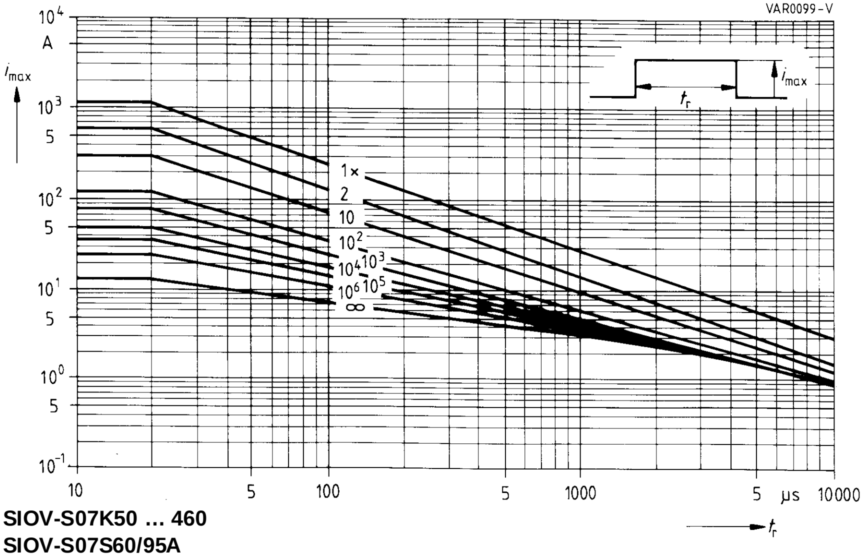
SIOV-S05K50 … 460

Derating curves (maximum surge current)

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



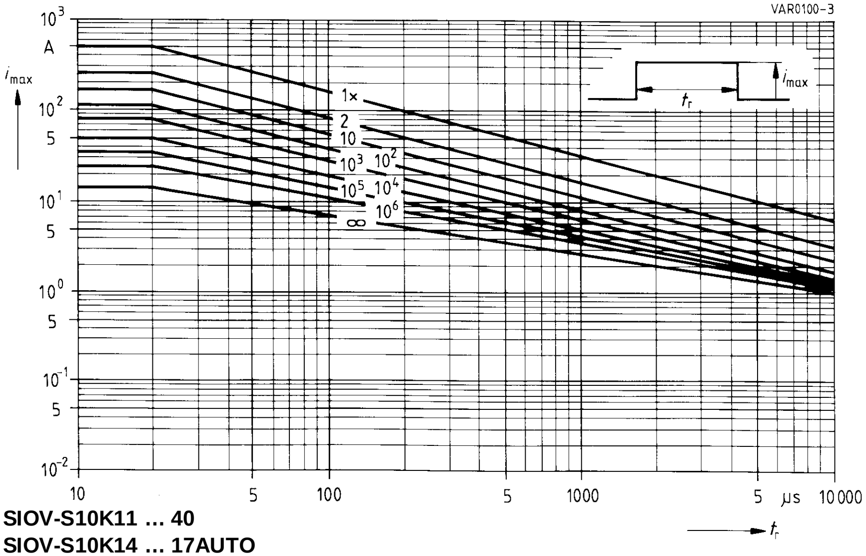
SIOV-SR1210M4S, M6S, L8S
SIOV-S07K11 ... 40
SIOV-SR1210S14BAUTOS



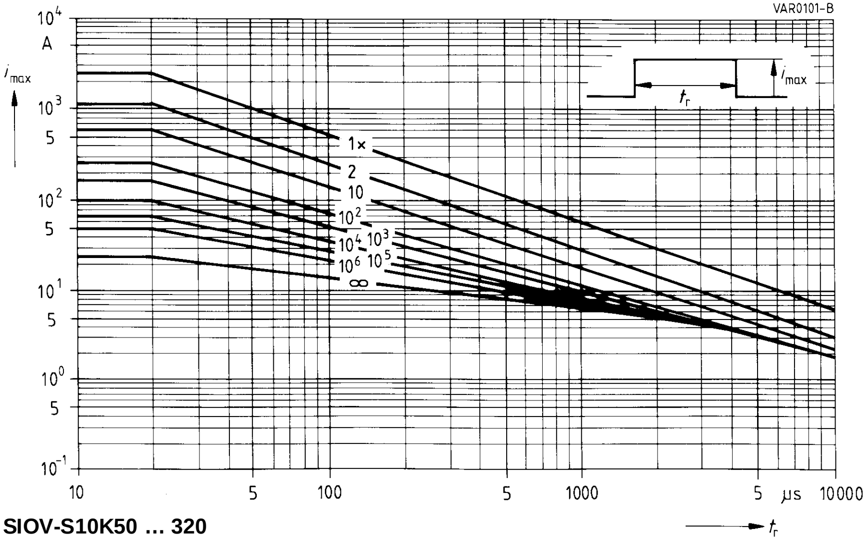
SIOV-S07K50 ... 460
SIOV-S07S60/95A

Derating curves (maximum surge current)

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



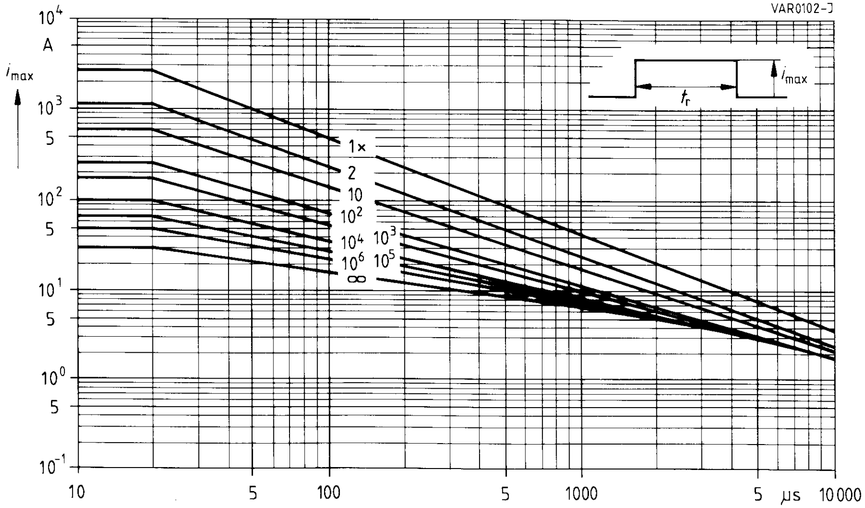
SIOV-S10K11 ... 40
SIOV-S10K14 ... 17AUTO
SIOV-SR1 ... X/Z
SIOV-SR1812S14BAUTOGS



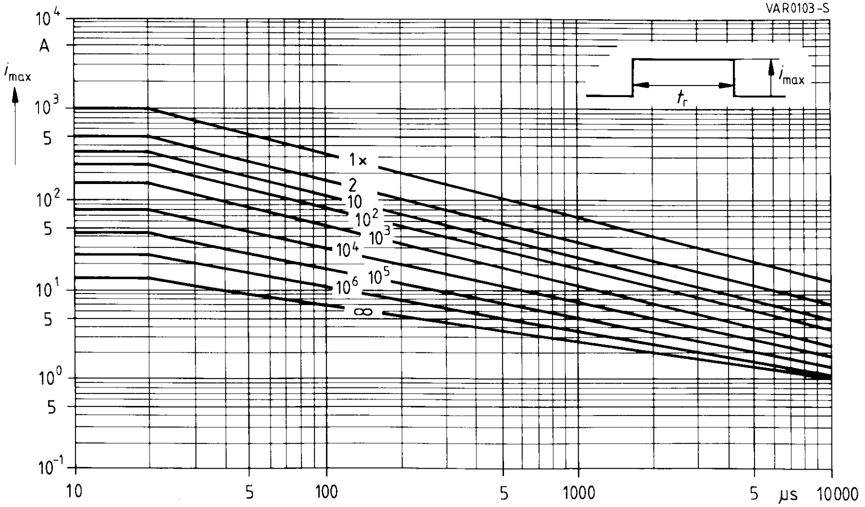
SIOV-S10K50 ... 320

Derating curves (maximum surge current)

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



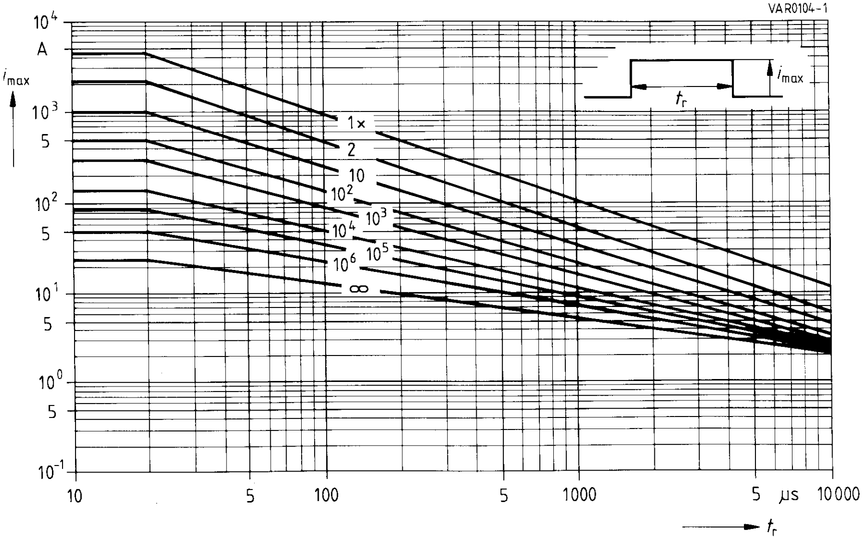
SIOV-S10K385 … 680



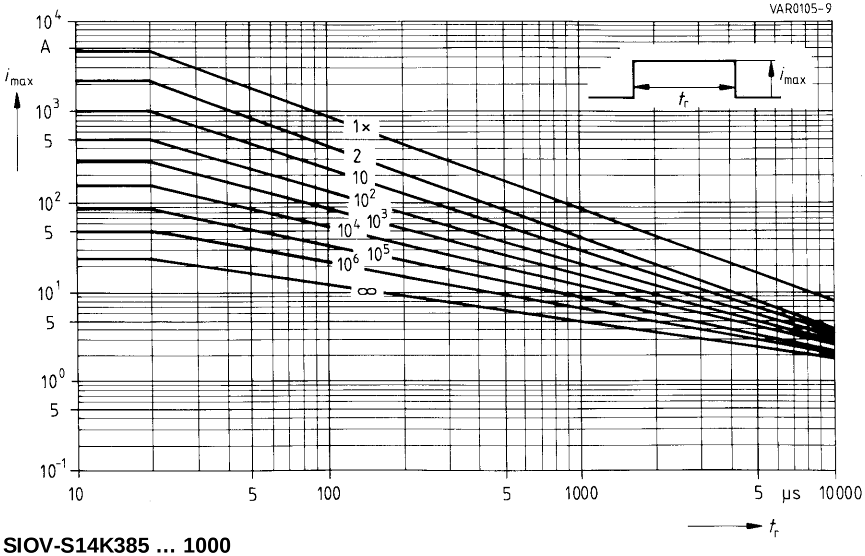
SIOV-SR2220M4S, M6S, L8S
SIOV-S14K11 … 40
SIOV-S14K14 … 30 AUTO
SIOV-SR2220S14BAUTOS
SHCV-SR2 … X/Z

Derating curves (maximum surge current)

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



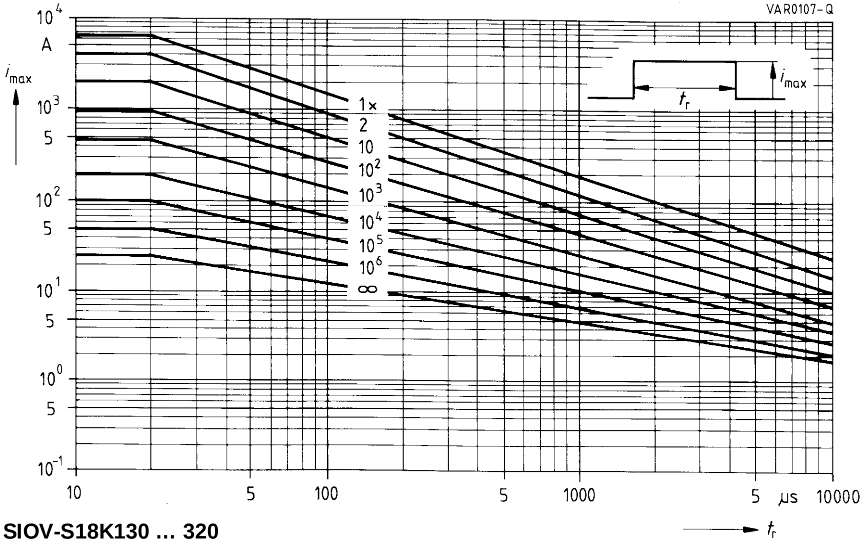
SIOV-S14K50 … 320



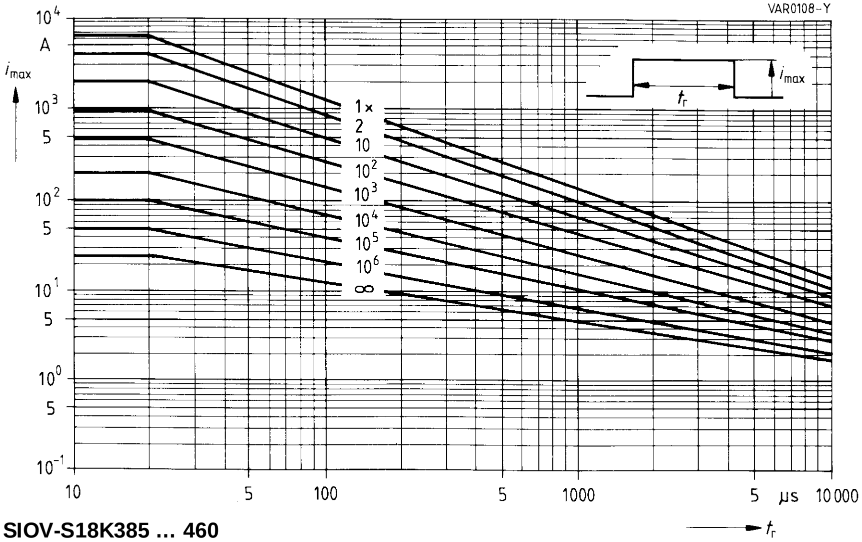
SIOV-S14K385 … 1000

Derating curves (maximum surge current)

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



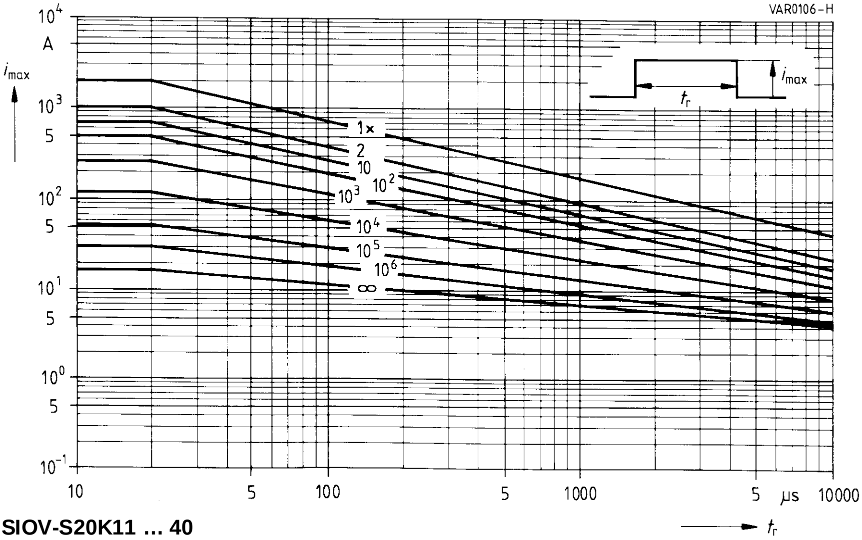
SIOV-S18K130 ... 320
SIOV-S20K50 ... 115



SIOV-S18K385 ... 460
SIOV-S20K510 ... 1000

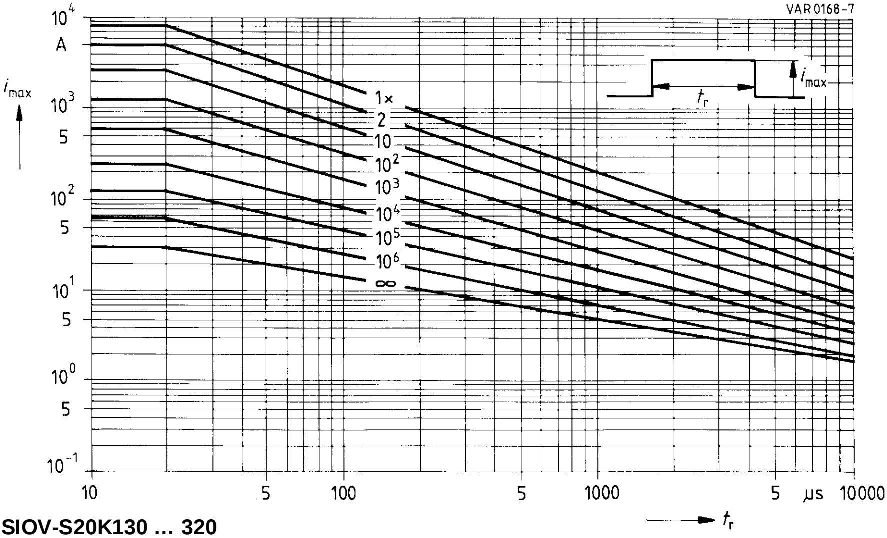
Derating curves (maximum surge current)

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



SIOV-S20K11 ... 40

SIOV-S20K14 ... 30AUTO

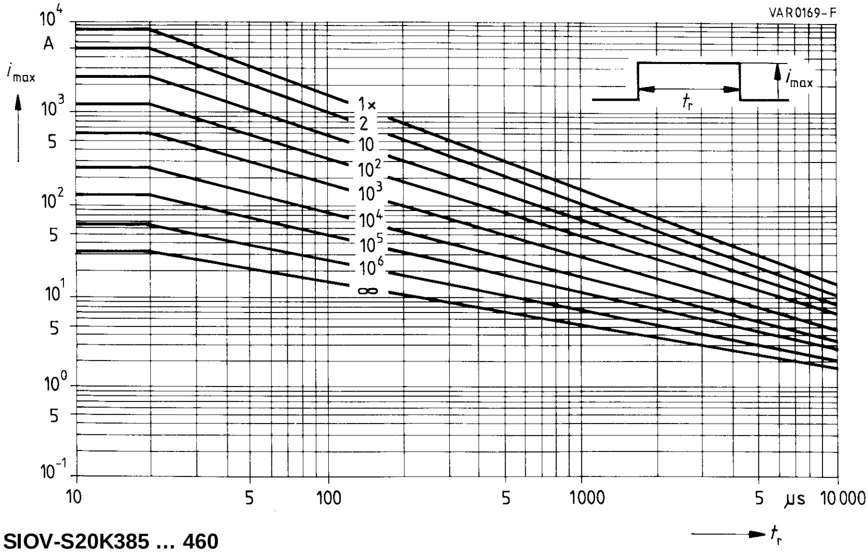


SIOV-S20K130 ... 320

SIOV-S20S130 ... 275B (R7)

Derating curves (maximum surge current)

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

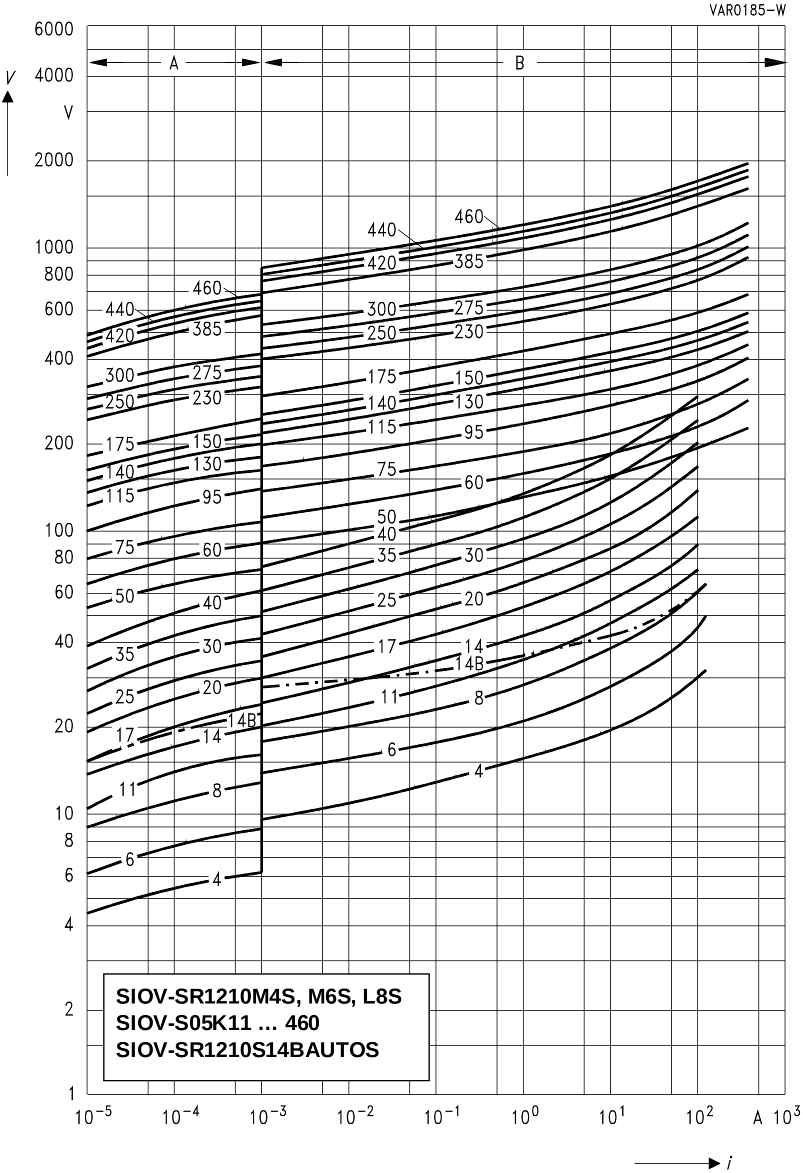


SIOV-S20K385 … 460

V/*I* characteristics

v = *f* (*i*)

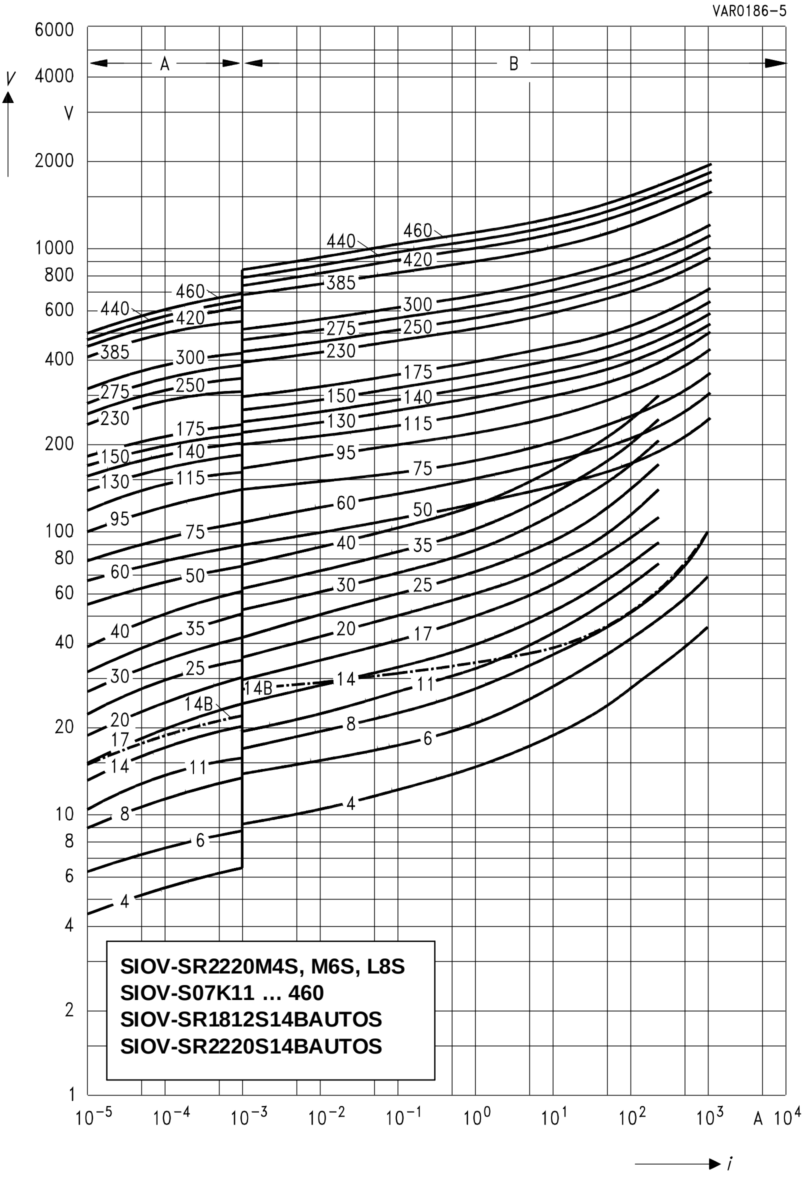
A = Leakage current for worst-case
B = Protection level varistor tolerances



V/*I* characteristics

v = *f* (*i*)

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

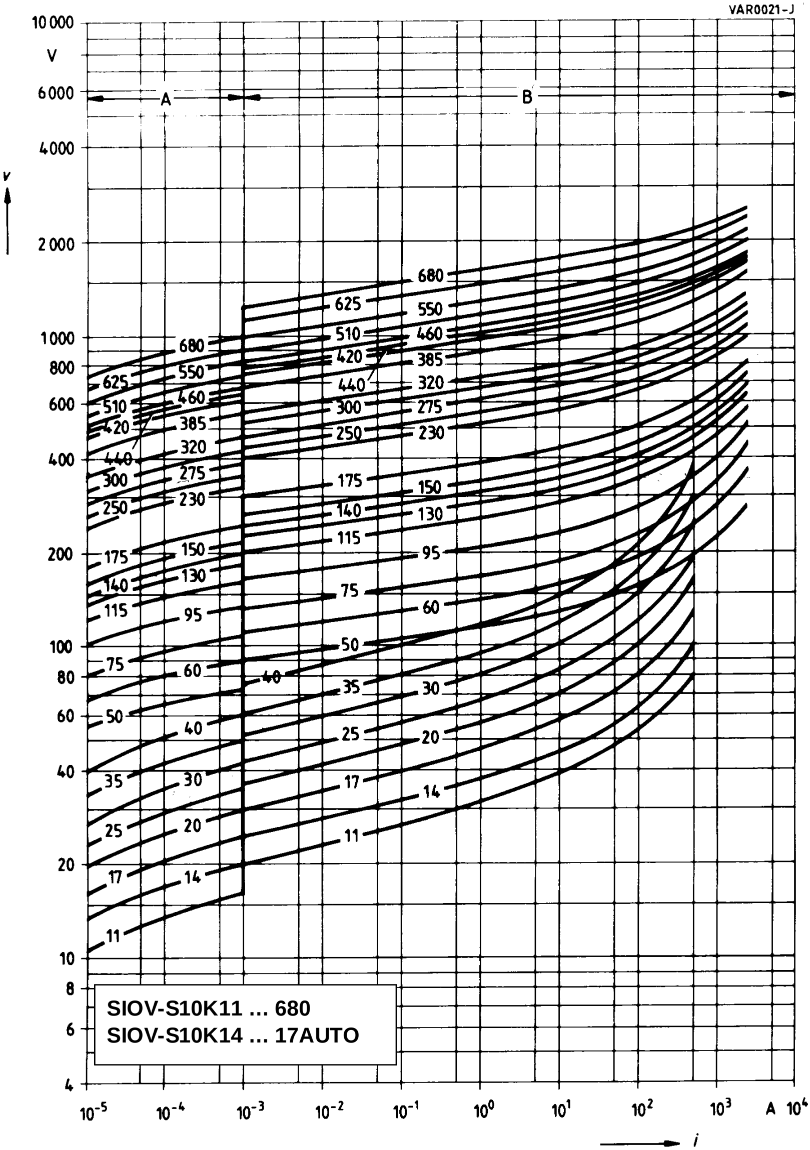


SIOV-SR2220M4S, M6S, L8S
SIOV-S07K11 … 460
SIOV-SR1812S14BAUTOS
SIOV-SR2220S14BAUTOS

V/*I* characteristics

v = *f* (*i*)

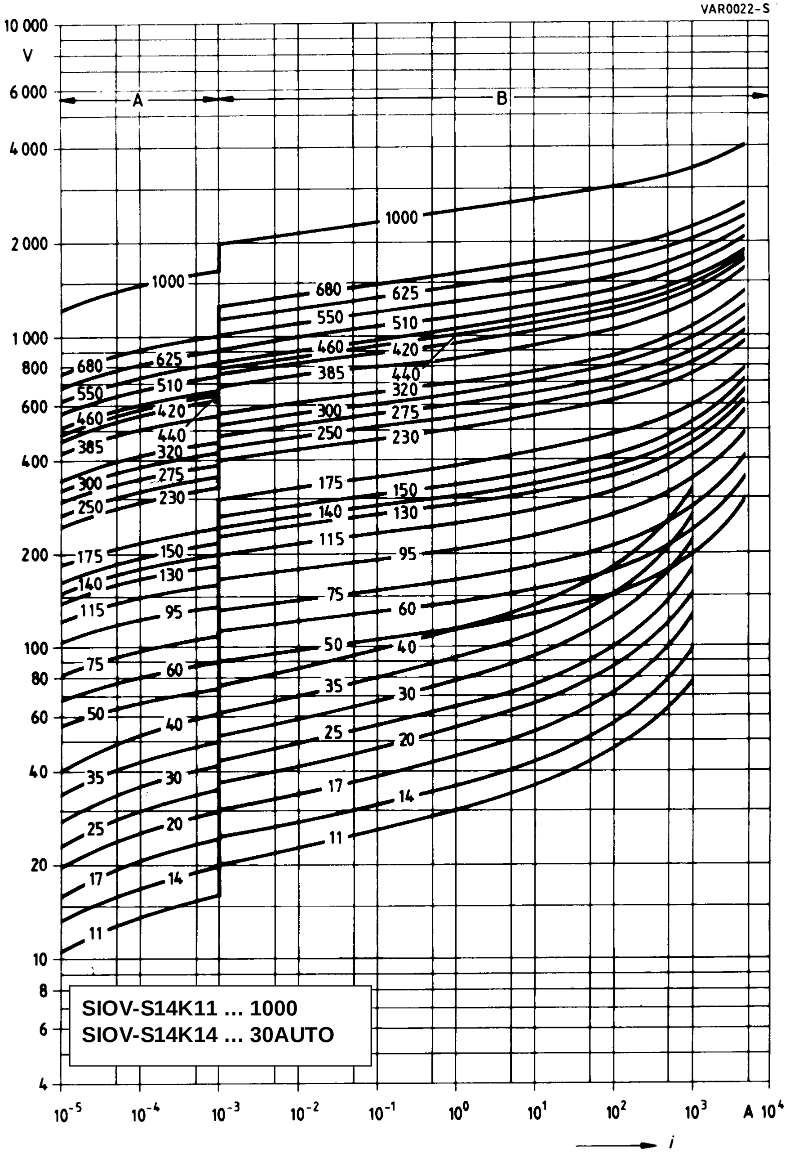
A = Leakage current for worst-case
B = Protection level varistor tolerances



V/*I* characteristics

v = *f* (*i*)

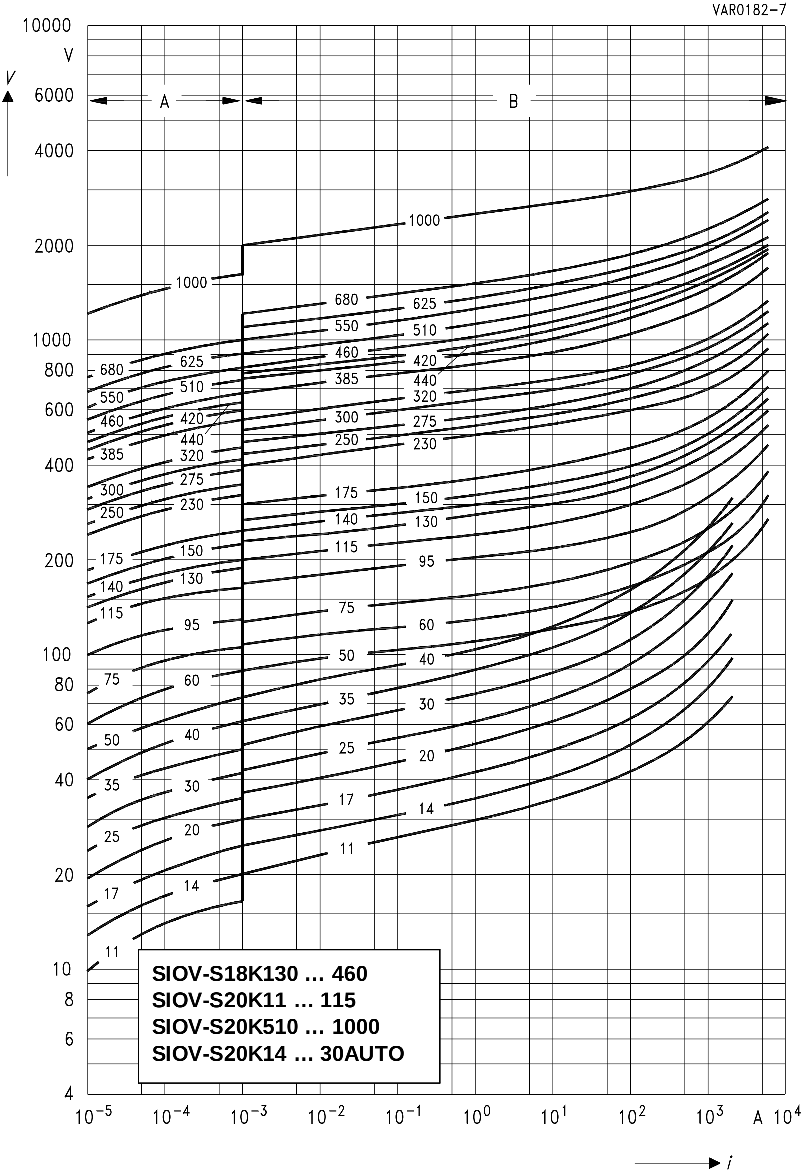
A = Leakage current for worst-case
B = Protection level varistor tolerances



V/*I* characteristics

v = *f* (*i*)

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

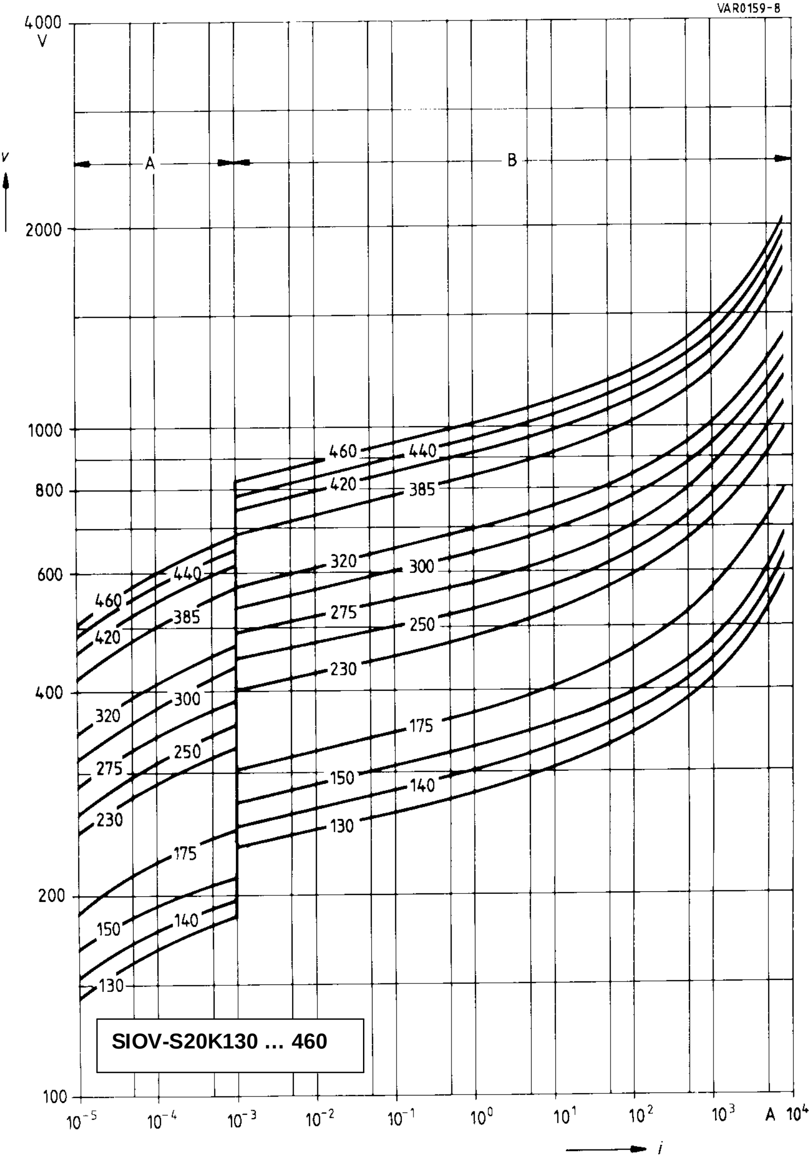


SIOV-S18K130 … 460
SIOV-S20K11 … 115
SIOV-S20K510 … 1000
SIOV-S20K14 … 30AUTO

V/*I* characteristics

v = *f* (*i*)

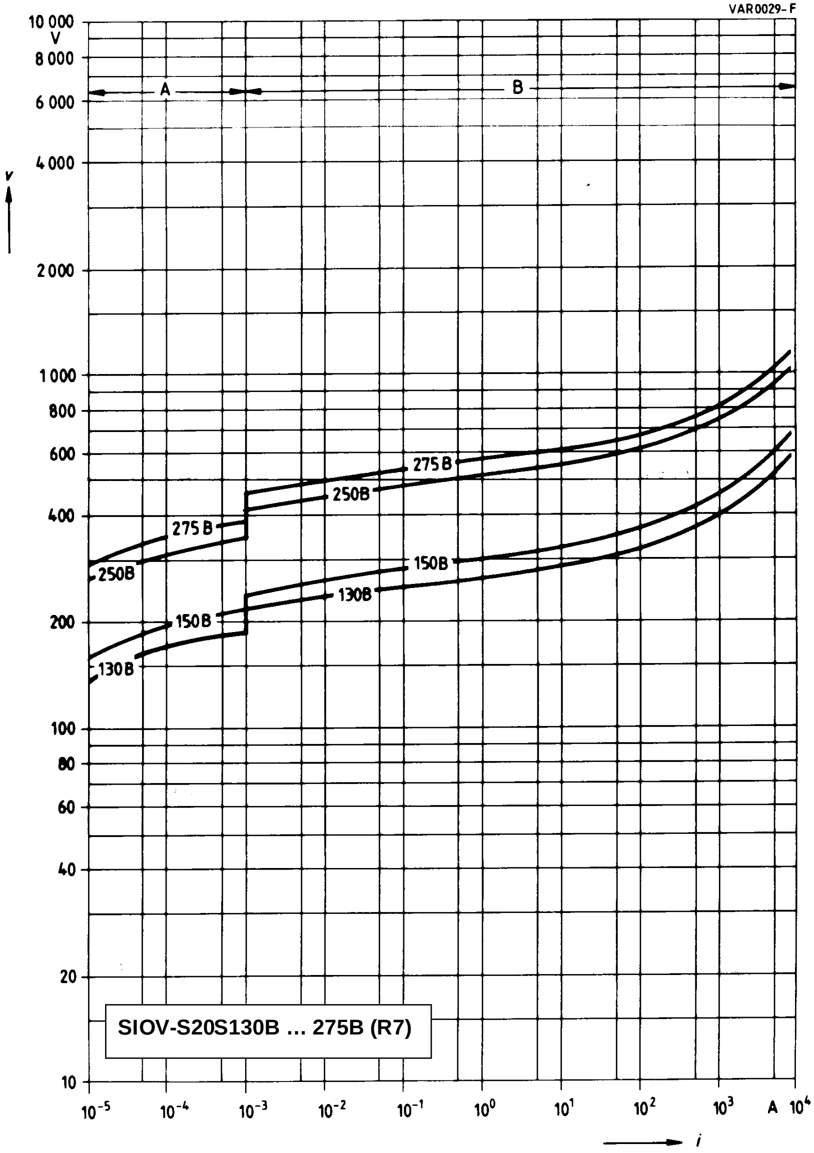
A = Leakage current for worst-case
B = Protection level varistor tolerances



V/*I* characteristics

v = *f* (*i*)

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

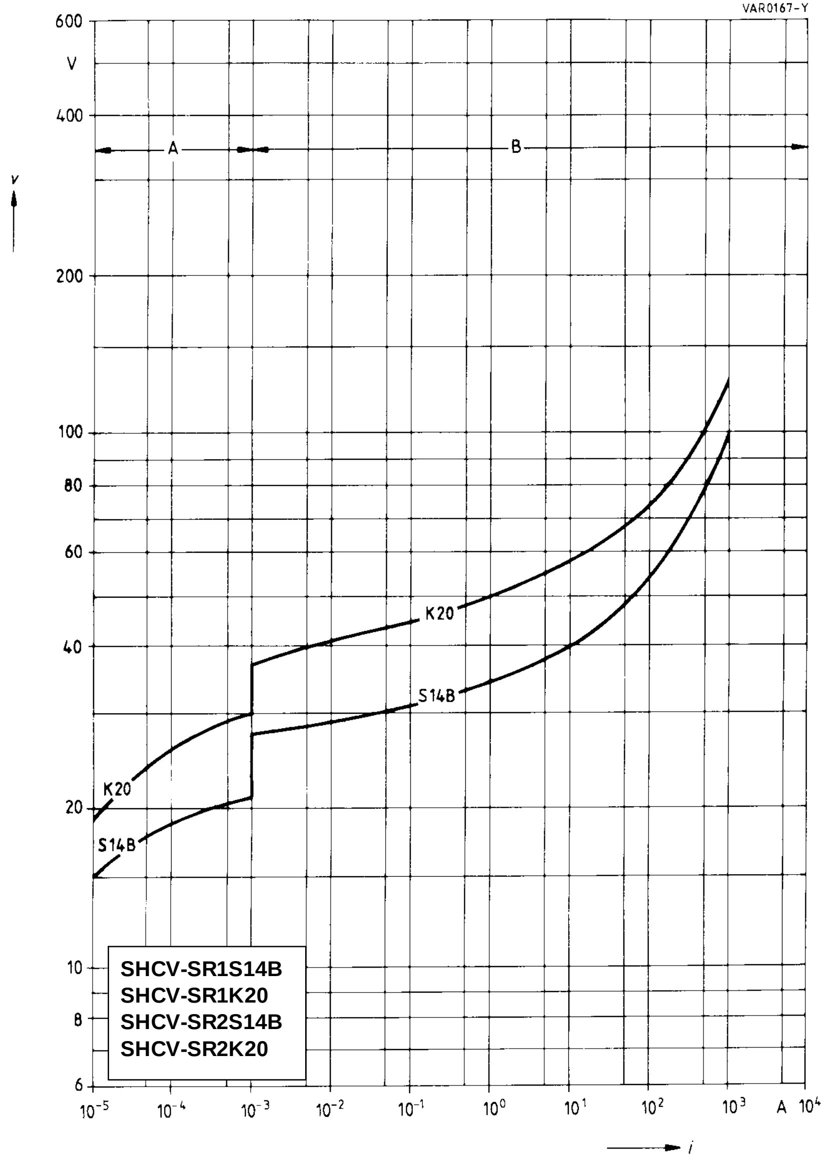


SIOV-S20S130B … 275B (R7)

V/*I* characteristics

v = *f* (*i*)

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



Siemens Matsushita Components

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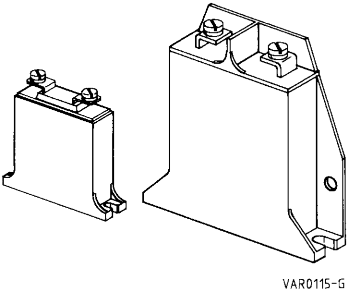
Block Varistors



Construction

- Disk-shaped varistor element, potted in plastic housing
- Housing flame-retardant to UL 94 V-0
- Screw terminals M4 (SIOV-B25 … 40)
  Screw terminals M5 (SIOV-B60 … 80)

Features

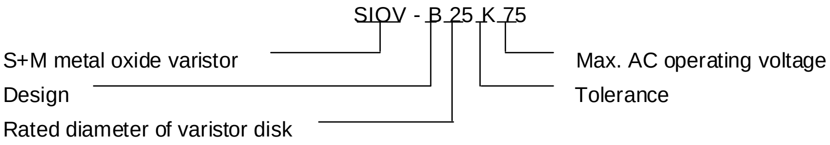
- Heavy-duty varistors
  (surge current capability up to 100 kA)
- Wide product range
- SIOV-B40 also available without housing
  (LS40 series)

Approvals

- UL-E77005 [M/N]
  All types
- CSA-LR63185
  All types ≥ K130
- SEV 91.1 02484.01
  All types except SIOV-B80

Type designation

Detailed description of coding system on page 28



SIOV - B 25 K 75

S+M metal oxide varistor

Design

Rated diameter of varistor disk

Max. AC operating voltage

Tolerance

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage		Surge current	Energy absorption	Power dissipation
		V_{RMS} V	V_{DC} V	i_{max} 8/20 µs A	W_{max} (2 ms) J	P_{max} W
SIOV-B25K75	Q69X3644	75	100	15000	85	1.0
SIOV-B32K75	Q69X3645	75	100	25000	120	1.2
SIOV-B40K75	Q69X3633	75	100	40000	190	1.4
SIOV-B60K75	Q69X3720	75	100	70000	320	1.6
SIOV-B25K130	Q69X3249	130	170	15000	140	1.0
SIOV-B32K130	Q69X3309	130	170	25000	210	1.2
SIOV-B40K130	Q69X3634	130	170	40000	310	1.4
SIOV-B60K130	Q69X3721	130	170	70000	490	1.6
SIOV-B80K130	Q69X4346	130	170	100000	660	2.0
SIOV-B32K150	Q69X3324	150	200	25000	240	1.2
SIOV-B40K150	Q69X3635	150	200	40000	360	1.4
SIOV-B60K150	Q69X3722	150	200	70000	570	1.6
SIOV-B80K150	Q69X4347	150	200	100000	800	2.0
SIOV-B32K230	Q69X3325	230	300	25000	300	1.2
SIOV-B40K230	Q69X3636	230	300	40000	460	1.4
SIOV-B60K230	Q69X3723	230	300	70000	730	1.6
SIOV-B80K230	Q69X4348	230	300	100000	1200	2.0
SIOV-B25K250	Q69X3250	250	320	15000	200	1.0
SIOV-B32K250	Q69X3310	250	320	25000	330	1.2
SIOV-B40K250	Q69X3637	250	320	40000	490	1.4
SIOV-B60K250	Q69X3724	250	320	70000	800	1.6
SIOV-B80K250	Q69X4349	250	320	100000	1300	2.0
SIOV-B32K275	Q69X3326	275	350	25000	360	1.2
SIOV-B40K275	Q69X3638	275	350	40000	550	1.4
SIOV-B60K275	Q69X3725	275	350	70000	860	1.6
SIOV-B80K275	Q69X4350	275	350	100000	1400	2.0
SIOV-B32K320	Q69X4343	320	420	25000	430	1.2
SIOV-B40K320	Q69X4344	320	420	40000	640	1.4
SIOV-B60K320	Q69X4345	320	420	70000	1000	1.6
SIOV-B80K320	Q69X4351	320	420	100000	1600	2.0
SIOV-B32K385	Q69X3327	385	505	25000	550	1.2
SIOV-B40K385	Q69X3639	385	505	40000	800	1.4
SIOV-B60K385	Q69X3726	385	505	70000	1200	1.6
SIOV-B80K385	Q69X4352	385	505	100000	2000	2.0

Characteristics (T_A = 25 °C)

Varistor voltage V_V (1 mA) V	Tolerance ΔV_V (1 mA) %	Max. clamping voltage v V	i A	Capacitance typ. C (1 kHz) pF	Derating curves Page	V/I characteristic Page
120	K = ± 10	220	150	5500	157	163
120	K = ± 10	220	200	8000	158	164
120	K = ± 10	220	300	11000	159	165
120	K = ± 10	220	500	26000	161	166
205	K = ± 10	340	150	2500	157	163
205	K = ± 10	340	200	4400	158	164
205	K = ± 10	340	300	5600	159	165
205	K = ± 10	340	500	15000	161	166
205	K = ± 10	340	800	28000	162	167
240	K = ± 10	395	200	3700	158	164
240	K = ± 10	395	300	4800	159	165
240	K = ± 10	395	500	12000	161	166
240	K = ± 10	395	800	23000	162	167
360	K = ± 10	595	200	2500	158	164
360	K = ± 10	595	300	3200	160	165
360	K = ± 10	595	500	7900	161	166
360	K = ± 10	595	800	16000	162	167
390	K = ± 10	650	150	1250	157	163
390	K = ± 10	650	200	2200	158	164
390	K = ± 10	650	300	2900	160	165
390	K = ± 10	650	500	7100	161	166
390	K = ± 10	650	800	14000	162	167
430	K = ± 10	710	200	2000	158	164
430	K = ± 10	710	300	2700	160	165
430	K = ± 10	710	500	6600	161	166
430	K = ± 10	710	800	13000	162	167
510	K = ± 10	840	200	1700	158	164
510	K = ± 10	840	300	2300	160	165
510	K = ± 10	840	500	5600	161	166
510	K = ± 10	840	800	11000	162	167
620	K = ± 10	1025	200	1400	158	164
620	K = ± 10	1025	300	1900	160	165
620	K = ± 10	1025	500	4600	161	166
620	K = ± 10	1025	800	9000	162	167

Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage V_{RMS} V	V_{DC} V	Surge current i_{max} 8/20 µs A	Energy absorption W_{max} (2 ms) J	Power dissipation P_{max} W
SIOV-B25K420	Q69X3306	420	560	15000	350	1.0
SIOV-B32K420	Q69X3311	420	560	25000	600	1.2
SIOV-B40K420	Q69X3640	420	560	40000	910	1.4
SIOV-B60K420	Q69X3727	420	560	70000	1500	1.6
SIOV-B80K420	Q69X4353	420	560	100000	2200	2.0
SIOV-B32K440	Q69X4835	440	585	25000	630	1.2
SIOV-B40K440	Q69X4836	440	585	40000	950	1.4
SIOV-B60K440	Q69X4837	440	585	70000	1580	1.6
SIOV-B80K440	Q69X4838	440	585	100000	2350	2.0
SIOV-B32K460	Q69X3328	460	615	25000	660	1.2
SIOV-B40K460	Q69X3641	460	615	40000	1000	1.4
SIOV-B60K460	Q69X3728	460	615	70000	1650	1.6
SIOV-B80K460	Q69X4354	460	615	100000	2500	2.0
SIOV-B32K550	Q69X3329	550	745	25000	620	1.2
SIOV-B40K550	Q69X3642	550	745	40000	960	1.4
SIOV-B60K550	Q69X3729	550	745	70000	1500	1.6
SIOV-B80K550	Q69X4355	550	745	100000	3100	2.0
SIOV-B32K680	Q69X3822	680	895	25000	760	1.2
SIOV-B40K680	Q69X3823	680	895	40000	1100	1.4
SIOV-B60K680	Q69X3824	680	895	70000	1800	1.6
SIOV-B80K680	Q69X4356	680	895	100000	3600	2.0
SIOV-B32K750	Q69X3632	750	1060	25000	800	1.2
SIOV-B40K750	Q69X3643	750	1060	40000	1200	1.4
SIOV-B60K750	Q69X3730	750	1060	70000	2000	1.6
SIOV-B80K750	Q69X4357	750	1060	100000	4000	2.0
SIOV-B60K1000 1)	Q69X3731	1100	1465	70000	3000	1.6
SIOV-B80K1100 2)	Q69X4358	1100	1465	100000	6000	2.0

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1) Operating voltage differs from type designation.

2) Also available as PowerDisk varistor, type SIOV-PD80K1100 (high-energy varistor in ceramic power diode case). For detailed technical data see data book supplement "SIOV Metal Oxide Varistors - PowerDisk“, edition 2.95.

Characteristics (T_A = 25 °C)

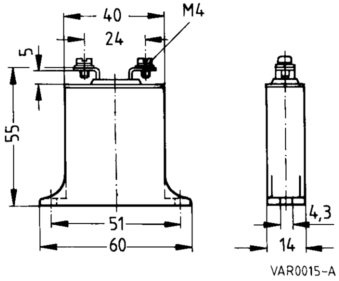
Varistor voltage V_V (1 mA) V	Tolerance ΔV_V (1 mA) %	Max. clamping voltage v V	i A	Capacitance typ. C (1 kHz) pF	Derating curves Page	V/I characteristic Page
680	K = ± 10	1120	150	690	157	163
680	K = ± 10	1120	200	1300	158	164
680	K = ± 10	1120	300	1800	160	165
680	K = ± 10	1120	500	4300	161	166
680	K = ± 10	1120	800	8500	162	167
715	K = ± 10	1180	200	1250	158	164
715	K = ± 10	1180	300	1700	160	165
715	K = ± 10	1180	500	4100	161	166
715	K = ± 10	1180	800	8100	162	167
750	K = ± 10	1240	200	1200	158	164
750	K = ± 10	1240	300	1600	160	165
750	K = ± 10	1240	500	3900	161	166
750	K = ± 10	1240	800	7700	162	167
910	K = ± 10	1500	200	1000	159	164
910	K = ± 10	1500	300	1400	160	165
910	K = ± 10	1500	500	3300	162	166
910	K = ± 10	1500	800	6500	162	167
1100	K = ± 10	1815	200	830	159	164
1100	K = ± 10	1815	300	1100	160	165
1100	K = ± 10	1815	500	2600	162	166
1100	K = ± 10	1815	800	5200	162	167
1200	K = ± 10	2000	200	800	159	164
1200	K = ± 10	2000	300	1000	160	165
1200	K = ± 10	2000	500	2400	162	166
1200	K = ± 10	2000	800	4800	162	167
1800	K = ± 10	2970	500	1600	162	166
1800	K = ± 10	2970	800	3200	162	167

General technical data

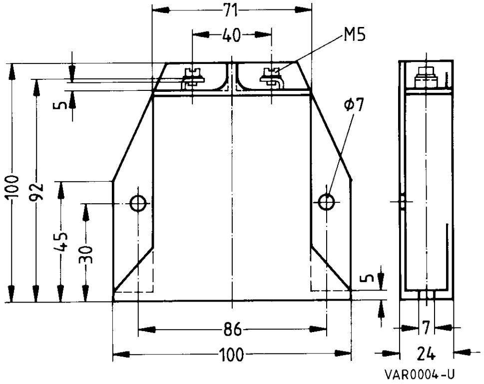
Climatic category LCT UCT Damp heat, steady state (93 % r. h., 40 °C)	40/85/56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature (full load)	– 40 … + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 … + 110 °C	
Electric strength	> 2.5 kV	in accordance with CECC 42 000
Insulation resistance	> 1 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	
Weight (approx.) B25 B32 B40 B60 B80	 40 g 45 g 50 g 250 g 650 g	
Max. torque B25/B32/B40 B60/B80	 1.0 Nm 2.5 Nm	

Dimensions

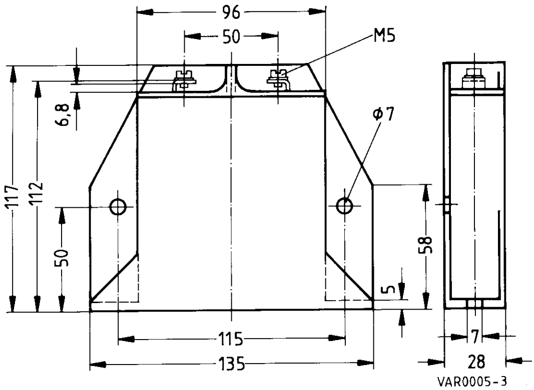
SIOV-B25/-B32/-B40



SIOV-B60



SIOV-B80



Dimensions in mm

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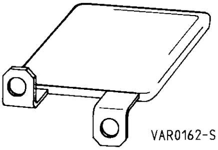
- ▶ MKPs in stacked-film technology: 300 types, 160 to 1000 V, 1.5 nF to 1 µF
- ▶ Interference suppression: 150 types with a wide choice of ratings for different applications – X2 with small dimensions, Safe-X for maximum security against active flammability (X2) and Y for suppressing common-mode interference (Y2)

SCS – dependable, fast and competent

Strap Varistors

Construction



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

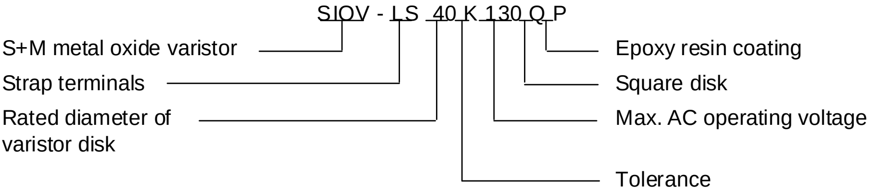
Features

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

Approvals

- UL-E77005 [M/N]
  All types
- CSA-LR63185
  All types

Type designation
Detailed description of coding system on page 28



Maximum ratings (T_A = 85 °C)

Type	Ordering code	Operating voltage V_{RMS} V	V_{DC} V	Surge current i_{max} 8/20 µs A	Energy absorption W_{max} (2 ms) J	Power dissipation P_{max} W
SIOV-LS40K130QP	Q69X4727	130	170	40000	310	1.4
SIOV-LS40K150QP	Q69X4662	150	200	40000	360	1.4
SIOV-LS40K230QP	Q69X4713	230	300	40000	460	1.4
SIOV-LS40K250QP	Q69X4649	250	320	40000	490	1.4
SIOV-LS40K275QP	Q69X4722	275	350	40000	550	1.4
SIOV-LS40K320QP	Q69X4663	320	420	40000	640	1.4
SIOV-LS40K385QP	Q69X4664	385	505	40000	800	1.4
SIOV-LS40K420QP	Q69X4497	420	560	40000	910	1.4
SIOV-LS40K440QP	Q69X4839	440	585	40000	950	1.4
SIOV-LS40K460QP	Q69X4723	460	615	40000	960	1.4
SIOV-LS40K550QP	Q69X4717	550	745	40000	960	1.4
SIOV-LS40K680QP	Q69X4682	680	895	40000	1100	1.4
SIOV-LS40K750QP	Q69X4683	750	1060	40000	1200	1.4

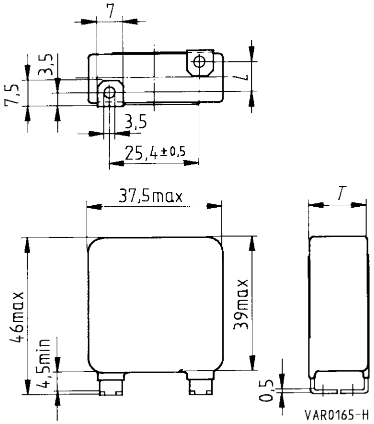
Characteristics (T_A = 25 °C)

Varistor voltage V_V (1 mA) V	Tolerance ΔV_V (1 mA) %	Max. clamping voltage v V	 i A	Capacitance typ. C (1 kHz) pF	Derating curves Page	V/I characteristic Page
205	K = ± 10	340	300	5600	159	165
240	K = ± 10	395	300	4800	159	165
360	K = ± 10	595	300	3200	160	165
390	K = ± 10	650	300	2900	160	165
430	K = ± 10	710	300	2700	160	165
510	K = ± 10	840	300	2300	160	165
620	K = ± 10	1025	300	1900	160	165
680	K = ± 10	1120	300	1800	160	165
715	K = ± 10	1180	300	1700	160	165
750	K = ± 10	1240	300	1600	160	165
910	K = ± 10	1500	300	1400	160	165
1100	K = ± 10	1815	300	1100	160	165
1200	K = ± 10	2000	300	1000	160	165

General technical data

Climatic category	25/85/56	in accordance with IEC 68-1
LCT	– 25 °C	
UCT	+ 85 °C	
Damp heat, steady state (93 % r. h., 40 °C)	56 days	in accordance with IEC 68-2-3
Operating temperature (full load)	– 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 GΩ	in accordance with CECC 42 000
Response time	< 25 ns	
Weight (approx.)	20 … 50 g	

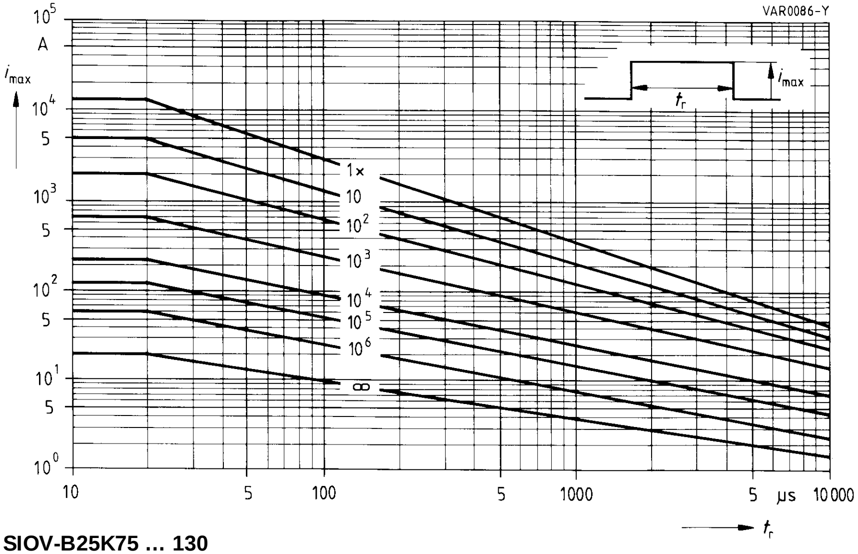
Dimensions



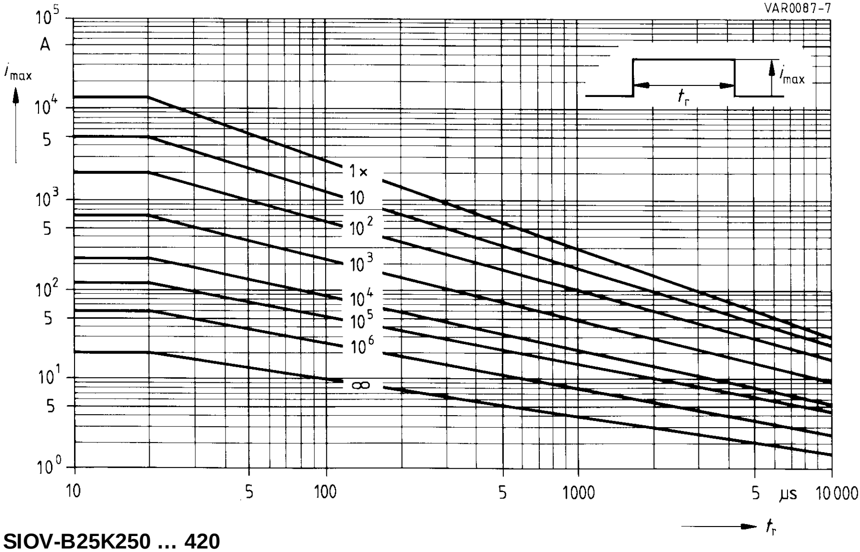
Type SIOV-	T_{max} mm	$L \pm 1.0$ mm
LS40K130QP	8.1	– 3.5
LS40K150QP	8.3	– 3.2
LS40K230QP	9.0	– 2.0
LS40K250QP	9.2	– 1.8
LS40K275QP	9.4	– 1.6
LS40K320QP	9.9	– 1.1
LS40K385QP	10.6	– 0.4
LS40K420QP	10.9	0.0
LS40K440QP	11.1	0.2
LS40K460QP	11.4	0.4
LS40K550QP	12.3	1.2
LS40K680QP	13.5	2.4
LS40K750QP	14.1	3.0

Derating curves (maximum surge current)

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



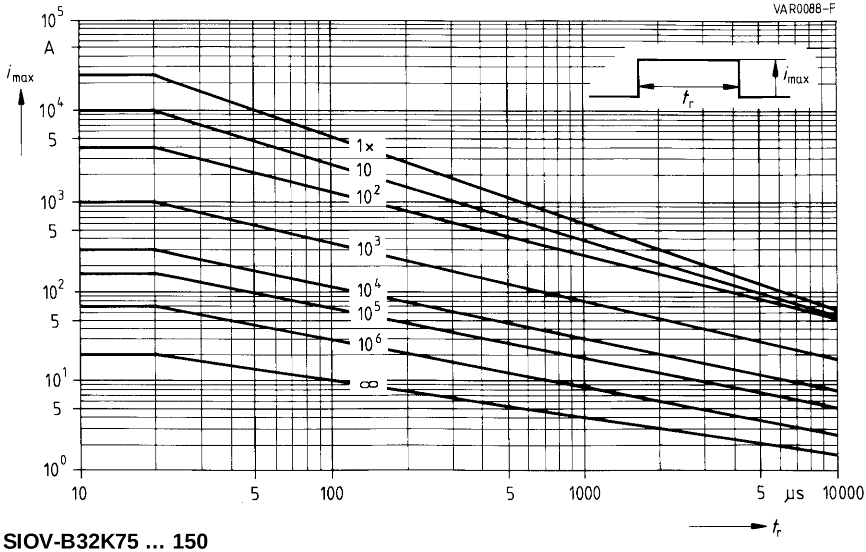
SIOV-B25K75 … 130



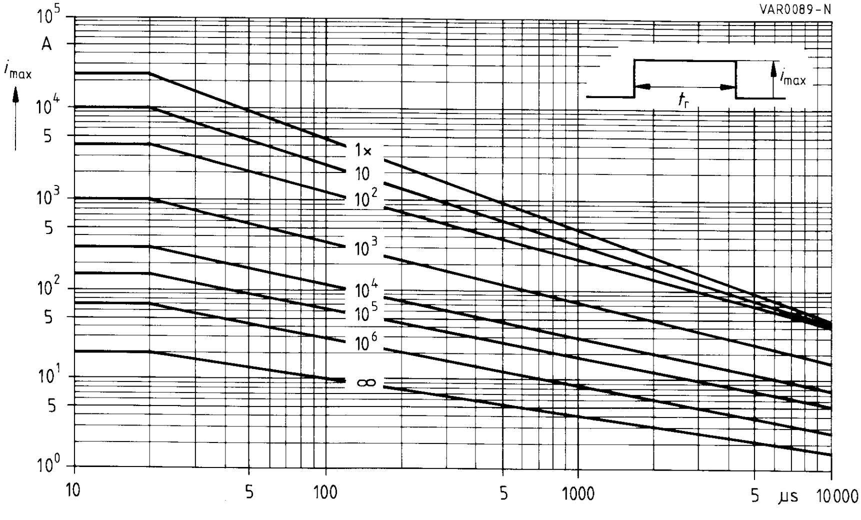
SIOV-B25K250 … 420

Derating curves (maximum surge current)

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



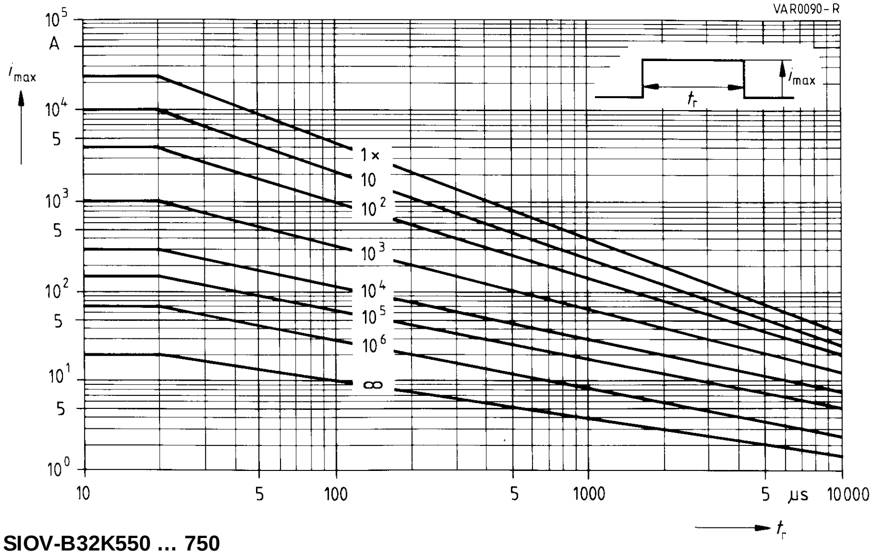
SIOV-B32K75 … 150



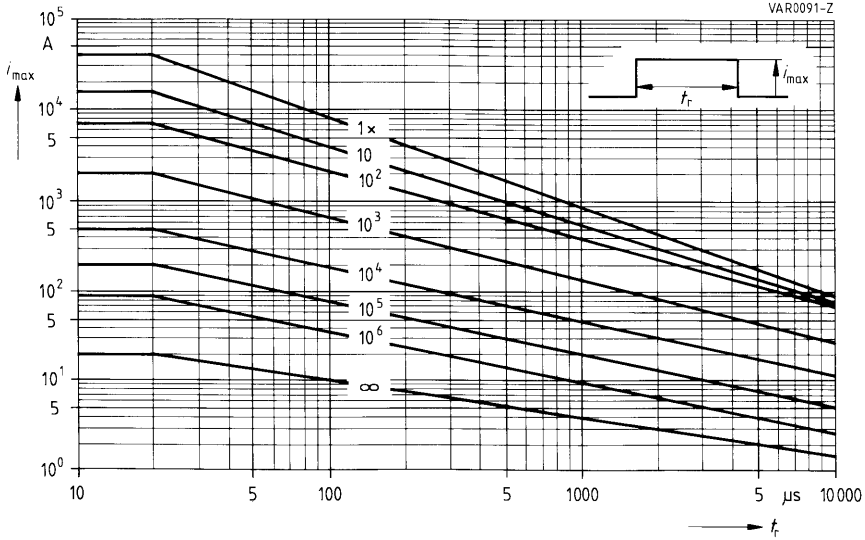
SIOV-B32K230 … 460

Derating curves (maximum surge current)

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



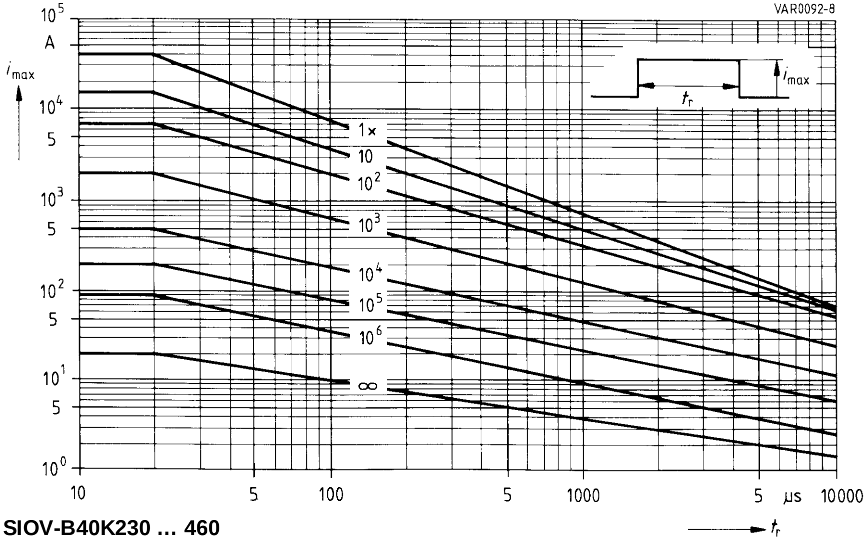
SIOV-B32K550 … 750



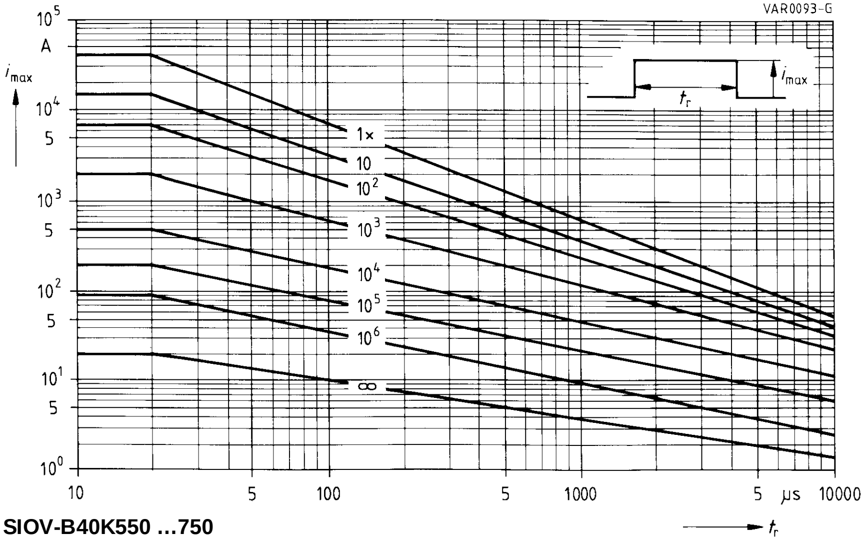
SIOV-B40K75 … 150
SIOV-LS40K130 … 150QP

Derating curves (maximum surge current)

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



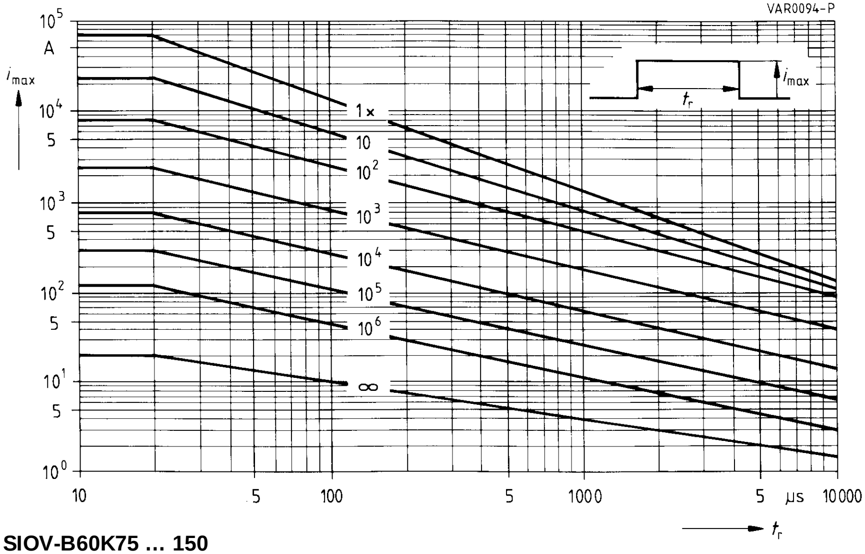
SIOV-B40K230 … 460
SIOV-LS40K230 … 460QP



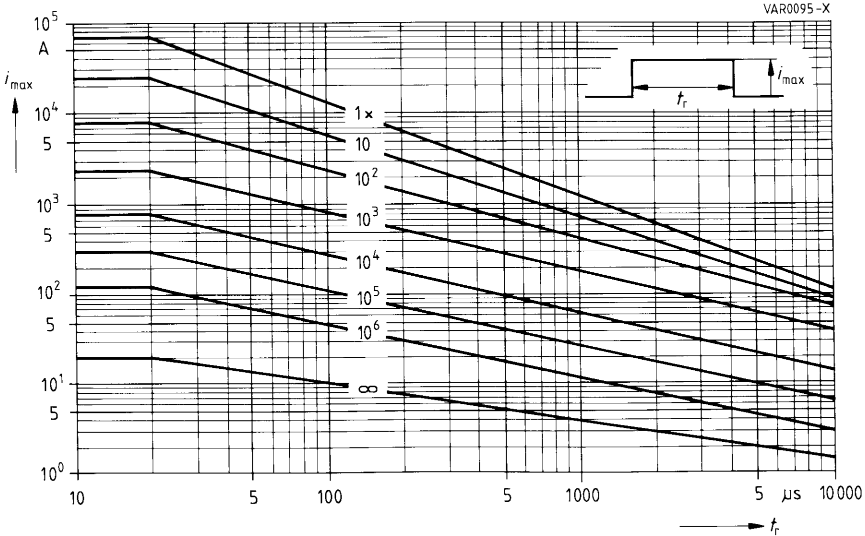
SIOV-B40K550 …750
SIOV-LS40K550 … 750QP

Derating curves (maximum surge current)

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



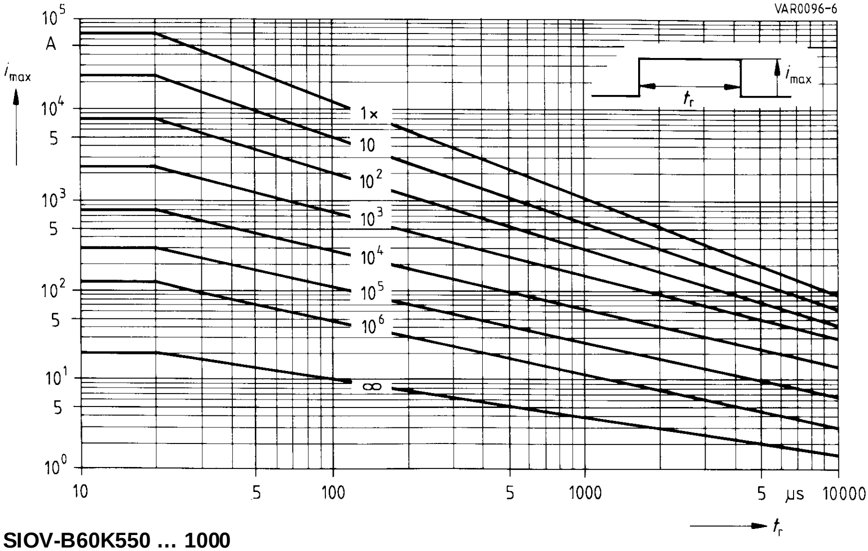
SIOV-B60K75 … 150



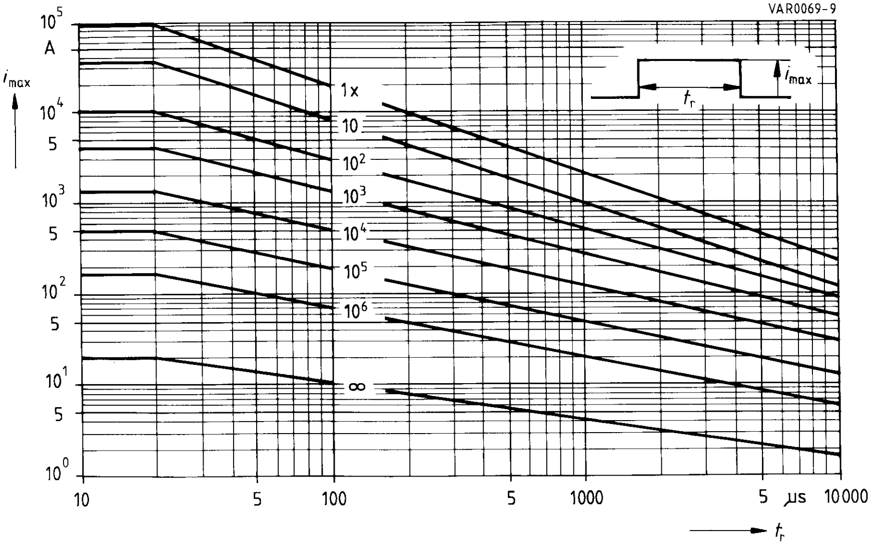
SIOV-B60K230 … 460

Derating curves (maximum surge current)

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



SIOV-B60K550 … 1000

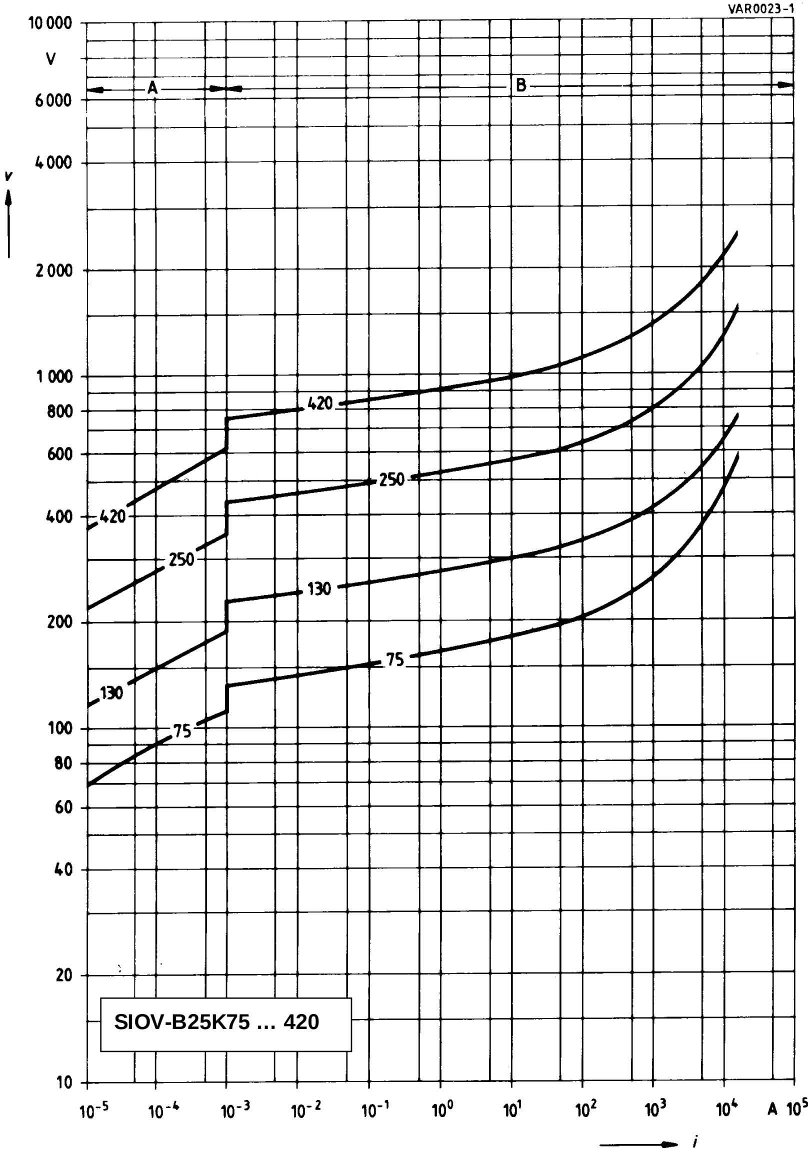


SIOV-B80K130 … 1100

V/I characteristics

v = *f* (*i*)

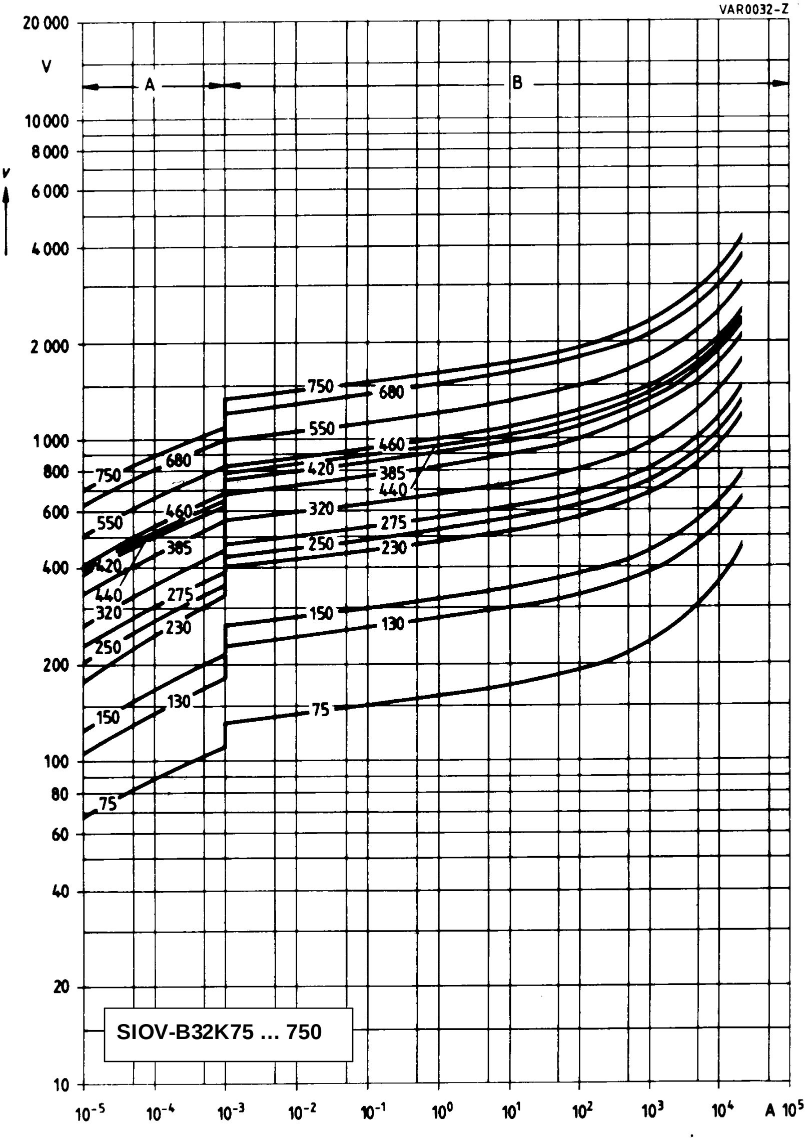
A = Leakage current for worst-case
B = Protection level varistor tolerances



V/*I* characteristics

v = *i* (*i*)

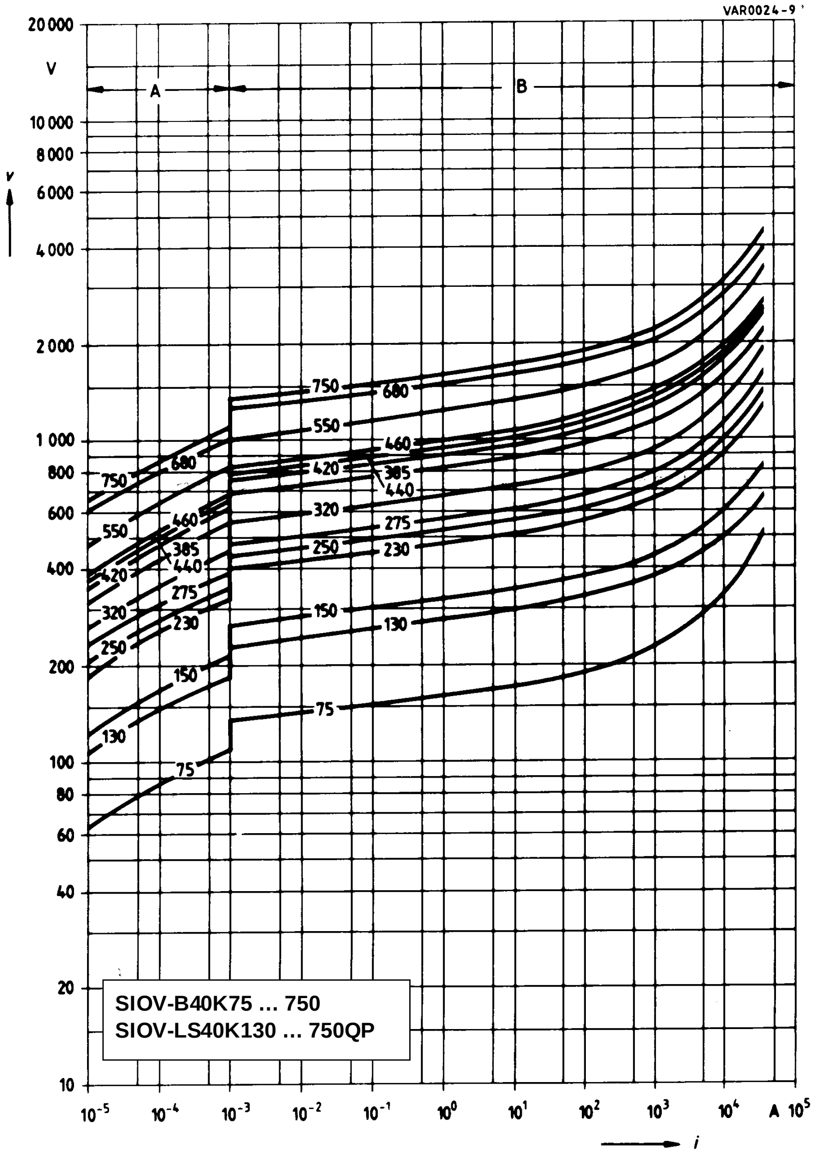
A = Leakage current for worst-case
B = Protection level varistor tolerances



V/*I* characteristics

$v = f(i)$

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

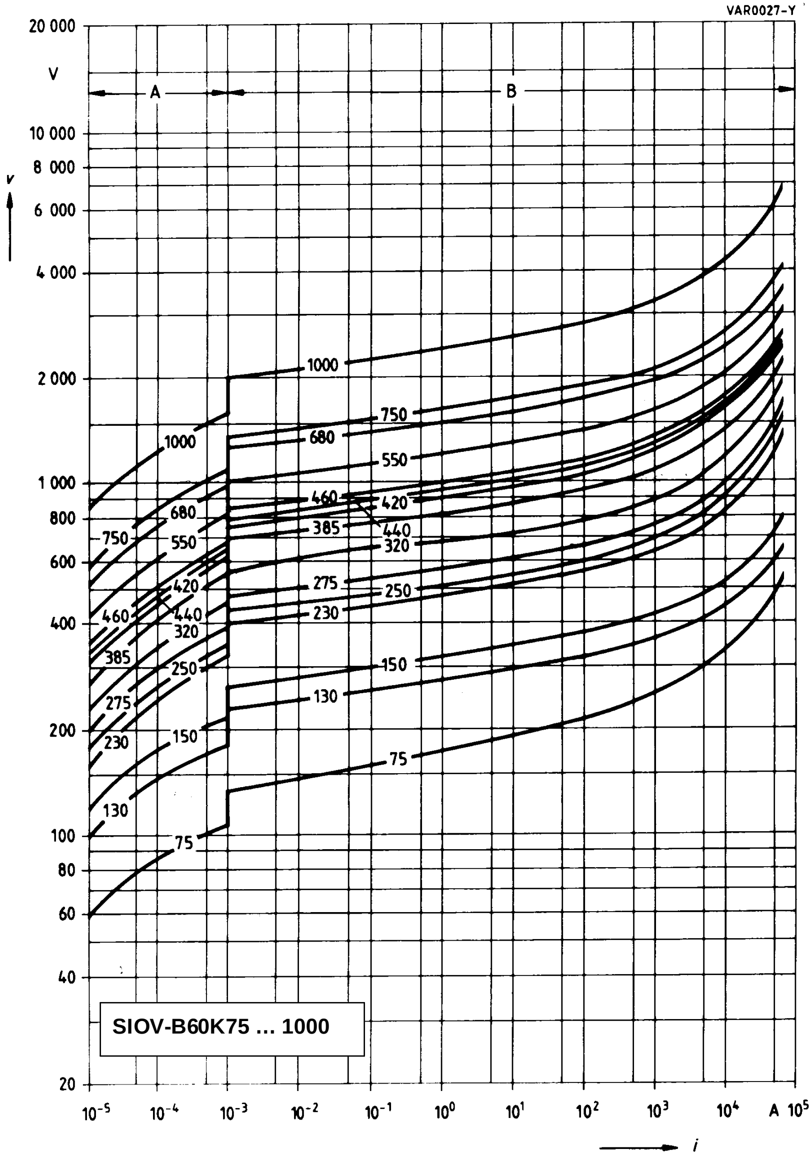


SIOV-B40K75 … 750
SIOV-LS40K130 … 750QP

V/*I* characteristics

v = *f* (*i*)

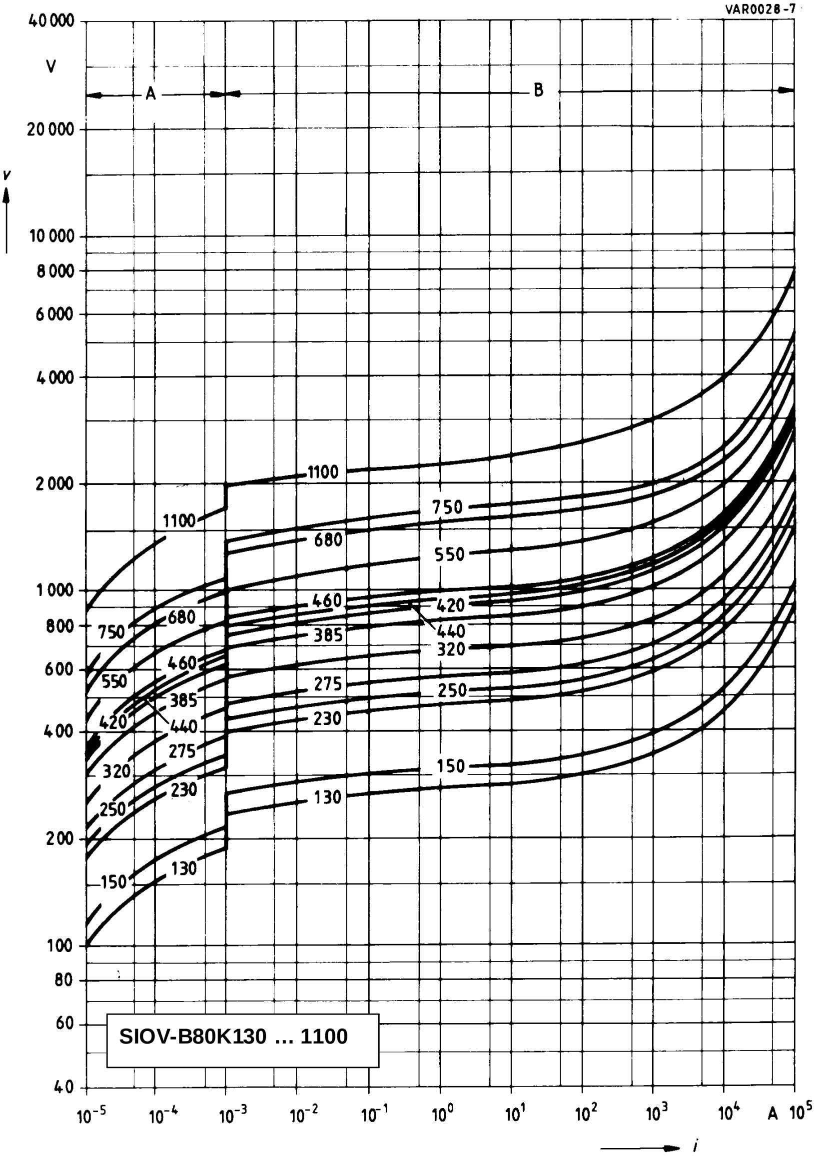
A = Leakage current for worst-case
B = Protection level varistor tolerances



V/*I* characteristics

$v = f(i)$

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



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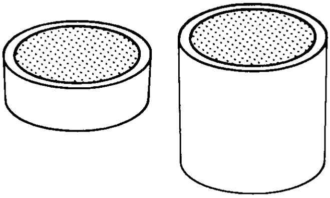
Arrester Blocks

Construction

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

Features

- Stackable for higher voltage



	SIOV-	E32KV202	E32KV612	
Max. continuous operating voltage	COV_{max}	1,15	3,5	kV
Varistor voltage (1 mA)	V_V	2,0 ± 10%	6,1 ± 10%	kV
Max. protection level (5 kA)	V_s	4,2	12,5	kV
Max. high-current surge (4/10 µs)	i_{max}	65	65	kA
Max. long-wave current (2 ms)	i_{Lmax}	150	150	A
Max. energy absorption (2 ms)	W_{max}	930	2800	J

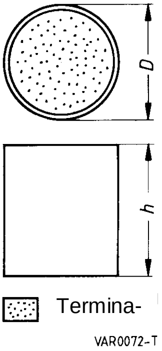
- **Note**

The electrical performance of arrester blocks can also be obtained by connecting block or strap varistors in series (see 2.4.1).

Arrester Blocks

Type SIOV-	Ordering code	*D* mm	*h* mm
E32KV202	Q69X4546	34,0 ± 1,0	11,5 ± 1,0
E32KV612	Q69X4396	34,0 ± 1,0	34,0 ± 1,0

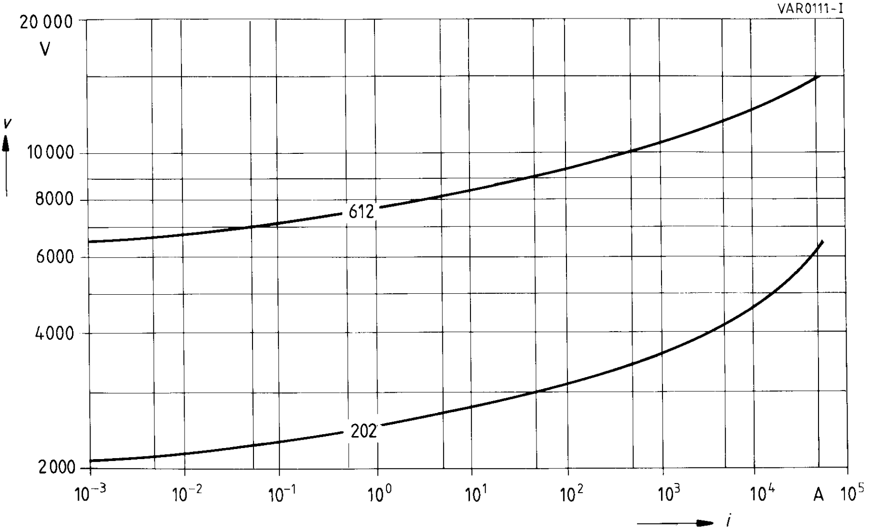
Other types uon request



V/I characteristics

v = *f* (*i*)

Protection level for worst-case varistor tolerances



SIOV-E32KV202
SIOV-E32KV612