CTVS –
Ceramic transient voltage suppressors

Leaded transient voltage/RFI suppressors (SHCVs)

Series/Type:

Date: February 2017

EPCOS type designation system for leaded transient voltage/ RFI suppressors

SR	1	S	14	B	M	474	X	G

SR ≙ Leaded, SHCV series

EIA case sizes of used chips:
6 ≙ 12 x 06 / 3.2 x 1.6 mm
1 ≙ 18 x 12 / 4.5 x 3.2 mm
2 ≙ 22 x 20 / 5.7 x 5.0 mm

Varistor voltage tolerance:
K ≙ ±10%
S ≙ Special tolerance

Maximum RMS operating voltage (V_{RMS}):
14 ≙ 14 V
20 ≙ 20 V
35 ≙ 35 V

Special varistor voltage tolerance:
B ≙ Special tolerance

Capacitance tolerance:
M ≙ ±20%

Capacitance value:
474 ≙ $47 \cdot 10^4$ pF ≙ 0.47 µF

Capacitor ceramic:
X ≙ X7R

Taping mode:
G ≙ Taped version
– ≙ Bulk

Leaded transient voltage/RFI suppressors (SHCVs)

SHCV series

Features

- EMI/ RFI noise suppression and transient overvoltage protection integrated in a single component
- Suppression of transients, caused by sudden interruption of currents
- Protection against electrical transients in automotive battery lines (acc. to ISO 7637-2 and ISO 16750-2)
- High capacitance (up to 4.7 µF)
- Low clamping voltage
- RoHS-compatible
- Suitable for lead-free soldering
- PSpice simulation models available

Applications

- RFI noise suppression and transient overvoltage protection on DC lines of small motors, windscreen wipers, window lifters, mirrors, central locking, memory seat, sunroof

Design

- Combination of multilayer RF filter capacitor and multilayer varistor
- Coating: flame-retardant to UL 94 V0, epoxy resin
- Terminals: tinned iron wire, RoHS-compatible

V/I characteristics and derating curves

V/I and derating curves are attached to the data sheet. The curves are sorted by V_{RMS} and then by case size, which is included in the type designation.

General technical data

Maximum RMS operating voltage		$V_{RMS,max}$	14 ... 35	V
Maximum DC operating voltage		$V_{DC,max}$	16 ... 45	V
Maximum surge current	(8/20 µs)	$I_{surge,max}$	100 ... 1200	A
Maximum load dump energy	(10 pulses)	W_{LD}	1.5 ... 12	J
Maximum jump-start voltage	(5 min)	V_{jump}	24.5 ... 45	V
Maximum clamping voltage	(8/20 µs)	$V_{clamp,max}$	38 ... 90	V
Nominal capacitance	(1 kHz, 0.5 V)	C_{nom}	220 ... 4700	nF
Insulation resistance		R_{ins}	≥ 10	MΩ
Response time		t_{resp}	< 25	ns
Operating temperature [1)]		T_{op}	−55/+125	°C
Storage temperature		LCT/UCT	−55/+150	°C

1) Operating temperatures above +85 °C can cause a change in color of the coating material, which has no impact on the reliability of the components.

Electrical specifications and ordering codes

Maximum ratings ($T_{op,max}$ = 125 °C)

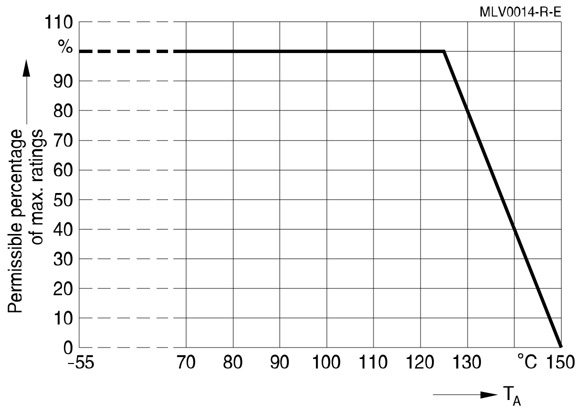
Type	Ordering code	$V_{RMS,max}$ V	$V_{DC,max}$ V	$I_{surge,max}$ (8/20 µs) A	W_{max} (2 ms) mJ	W_{LD} (10 pulses) J	$P_{diss,max}$ mW
SR1S14BM105X	B72587G3140S200	14	16	800	2400	6	15
SR1S14BM155X	B72587H3140S200	14	16	800	2400	6	15
SR1S14BM474X	B72587E3140S200	14	16	800	2400	6	15
SR2S14BM155X	B72547H3140S200	14	16	1200	5800	12	30
SR2S14BM474X	B72547E3140S200	14	16	1200	5800	12	30
SR2S14BM475X	B72547L3140S200	14	16	1200	5800	12	30
SR6K14M224X	B72527C3140K000	14	18	200	500	1.5	8
SR1K20M105X	B72587G3200K000	20	26	800	3000	6	15
SR1K20M155X	B72587H3200K000	20	26	800	3000	6	15
SR1K20M225X	B72587J3200K000	20	26	800	3000	6	15
SR1K20M474X	B72587E3200K000	20	26	800	3000	6	15
SR2K20M105X	B72547G3200K000	20	26	1200	7800	12	30
SR2K20M155X	B72547H3200K000	20	26	1200	7800	12	30
SR2K20M474X	B72547E3200K000	20	26	1200	7800	12	30
SR6K20M105X	B72527G3200K000	20	26	200	700	1.5	8
SR1K30M155X	B72587H3300K000	30	38	800	4200	6	15
SR6K35M105X	B72527G3350K000	35	45	100	400	1.5	8
SR6K35M474X	B72527E3350K000	35	45	100	400	1.5	8

Characteristics (T_A = 25 °C)

Type	V_V (1 mA)	ΔV_V	V_{jump} (5 min)	$V_{clamp,max}$	I_{clamp} (8/20 µs)	C_{nom} (1 kHz, 0.5 V)	ΔC_{nom}
	V	%	V	V	A	nF	%
SR1S14BM105X	22	+23/−0	24.5	40	5	1000	±20
SR1S14BM155X	22	+23/−0	24.5	40	5	1500	±20
SR1S14BM474X	22	+23/−0	24.5	40	5	470	±20
SR2S14BM155X	22	+23/−0	24.5	40	10	1500	±20
SR2S14BM474X	22	+23/−0	24.5	40	10	470	±20
SR2S14BM475X	22	+23/−0	24.5	40	10	4700	±20
SR6K14M224X	22	±10	24.5	38	1	220	±20
SR1K20M105X	33	±10	26	58	5	1000	±20
SR1K20M155X	33	±10	26	58	5	1500	±20
SR1K20M225X	33	±10	26	58	5	2200	±20
SR1K20M474X	33	±10	26	58	5	470	±20
SR2K20M105X	33	±10	26	58	10	1000	±20
SR2K20M155X	33	±10	26	58	10	1500	±20
SR2K20M474X	33	±10	26	58	10	470	±20
SR6K20M105X	33	±10	26	54	1	1000	±20
SR1K30M155X	47	±10	45	77	5	1500	±20
SR6K35M105X	56	±10	45	90	1	1000	±20
SR6K35M474X	56	±10	45	90	1	470	±20

Temperature derating

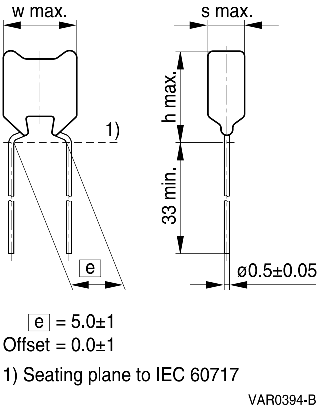
Climatic category: −55/+125 °C



Leaded transient voltage/RFI suppressors (SHCVs)

SHCV series

Dimensional drawing



Dimensions in mm

Type SHCV	w_{max}	h_{max}	s_{max}
SR1 ... 474X	7.3	7.8	3.7
SR1 ... 105X	7.3	7.8	3.7
SR1 ... 155X	7.3	7.8	3.7
SR1 ... 225X	7.3	7.8	4.1
SR2 ... 474X	7.8	9.0	3.6
SR2 ... 105X	7.8	9.0	4.1
SR2 ... 155X	7.8	9.0	4.1
SR2 ... 475X	7.8	9.0	4.1
SR6 ...	6.0	7.5	4.5

Delivery mode

Designation	**Taping mode**	**Ordering code, last two digits**
-	Bulk	B725***********00**
G	Taped on reel	B725***********51**
GA	Taped in AMMO pack	B725***********54**
M14	Lead length 14 mm	B725***********33**

Standard delivery mode for SHCV types is bulk. Taped versions on reel, AMMO pack and special lead length available upon request.
For further information on taping please contact EPCOS.

Packing units for:

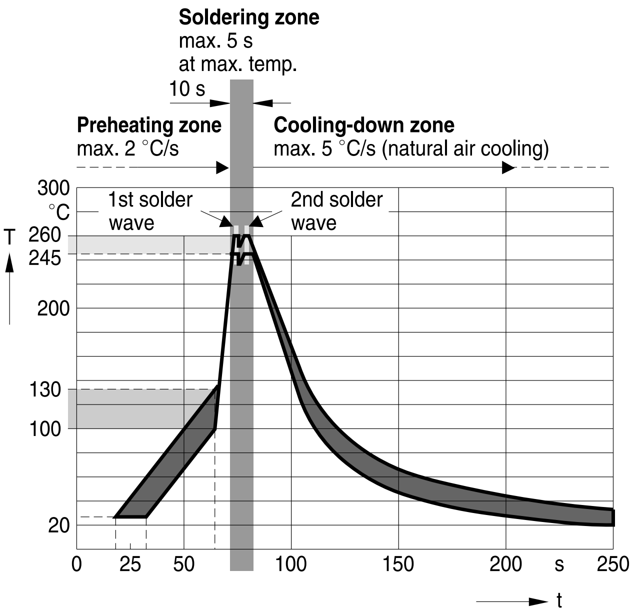
Type	Pieces
SR6	2000
SR1 / SR2	1000

Soldering instructions

Soldering

Components with wire leads such as leaded transient voltage/ RFI suppressors (SHCVs) can be soldered using all conventional methods.

Recommended temperature profile in wave soldering



VAR0623-V-E

Storage

The SHCV type series should be soldered after shipment from EPCOS within the time specified: 24 months.

The parts are to be left in the original packing to avoid any soldering problems caused by oxidized terminals. Storage temperature – 25 to 45 °C.

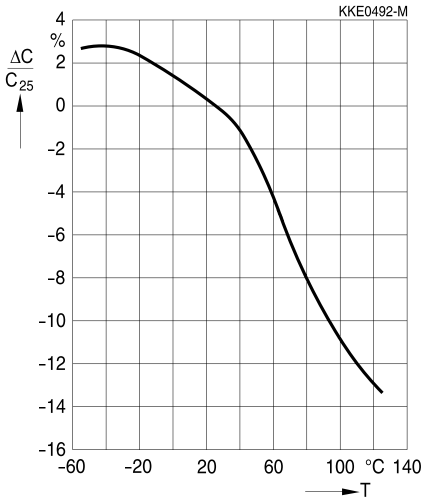
Max. relative humidity (without condensation): < 75% annual average,
< 95% on max. 30 days per annum.

Standards

IEC 60068-2-20

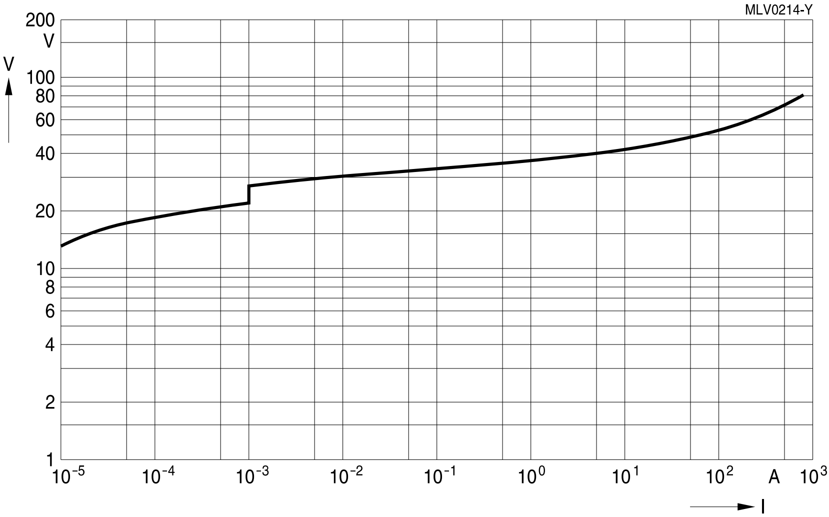
Typical characteristics

Capacitance change $\Delta C/C_{25}$ versus temperature T

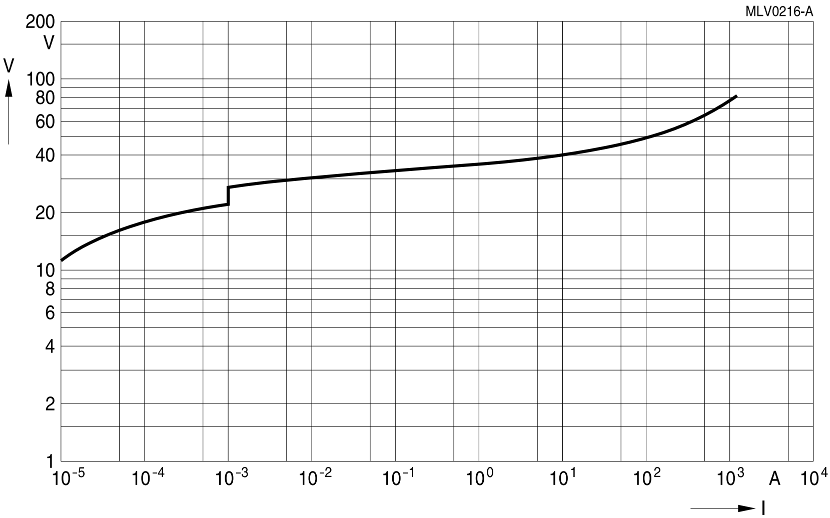


Note:
The capacitance and the dissipation factor shall meet the specified values 1000 hours after the last heat treatment above the curie temperature.

V/I characteristics

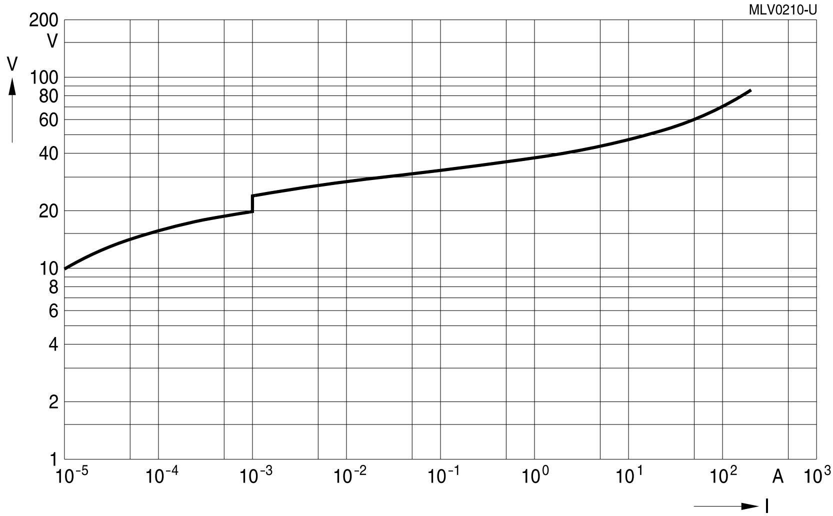


SR1S14B*

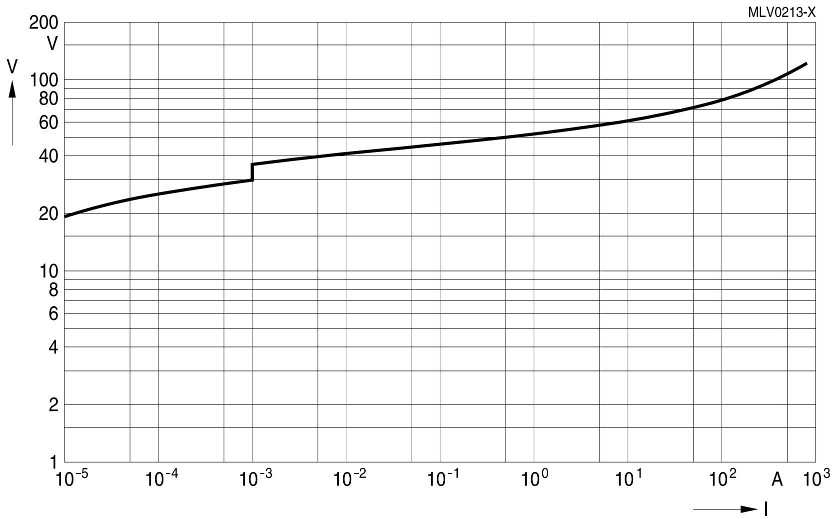


SR2S14B*

V/I characteristics

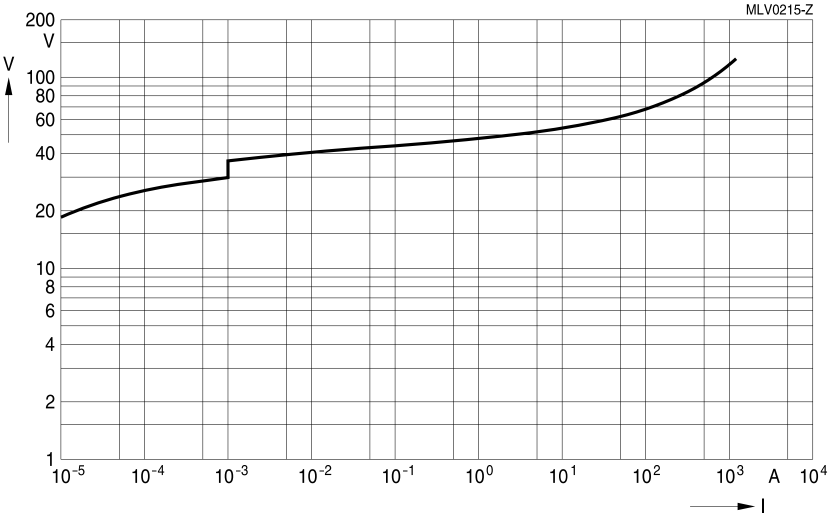


SR6K14*

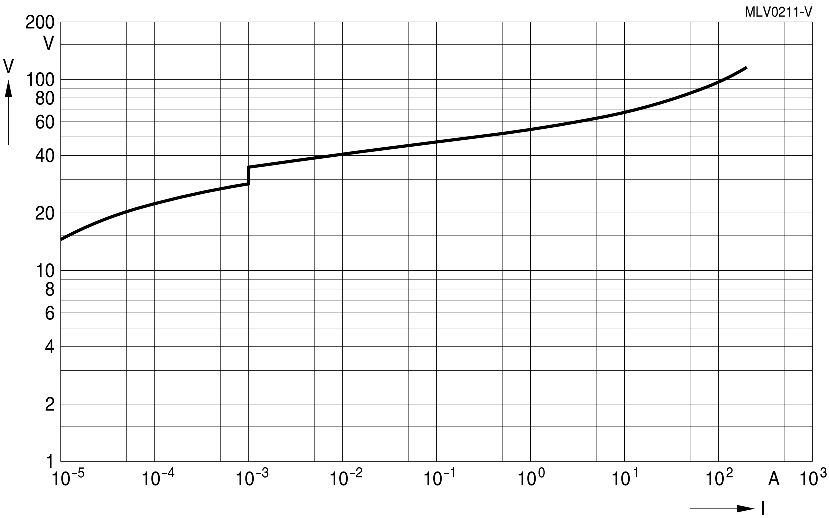


SR1K20*

V/I characteristics

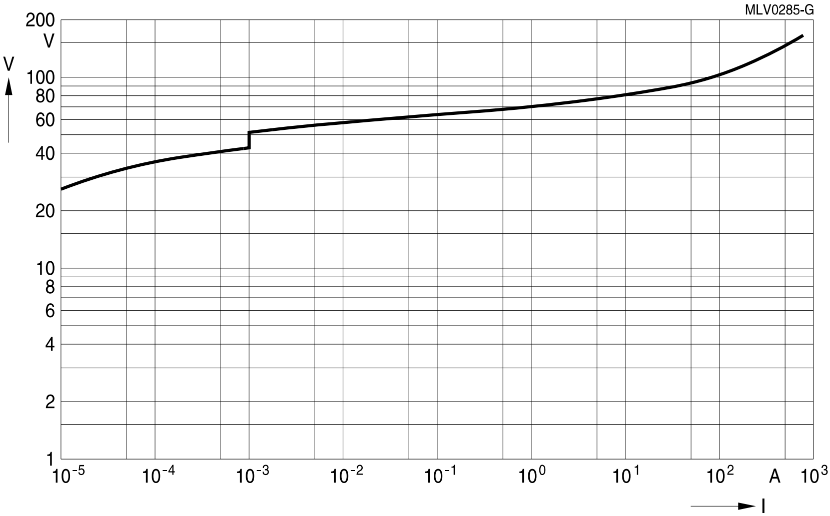


SR2K20*

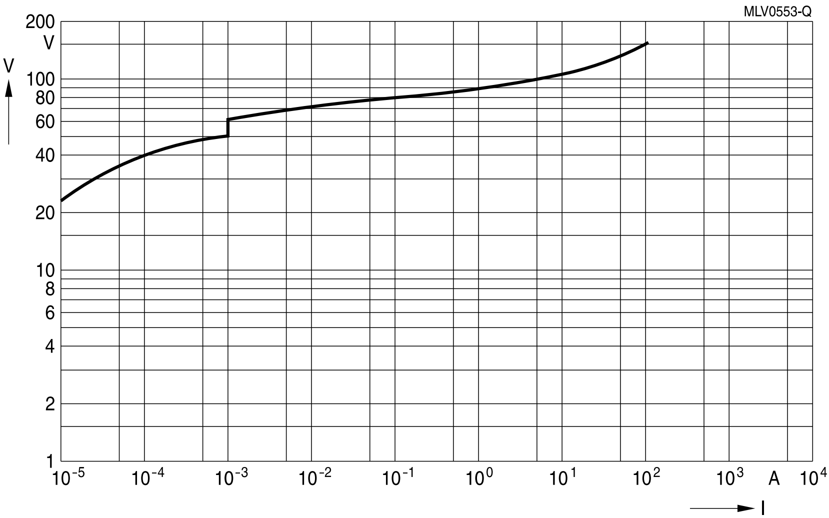


SR6K20*

V/I characteristics



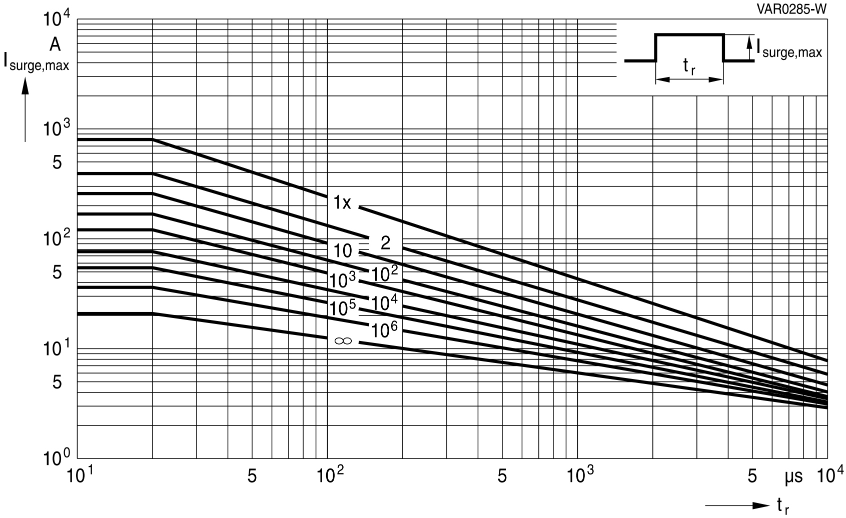
SR1K30*



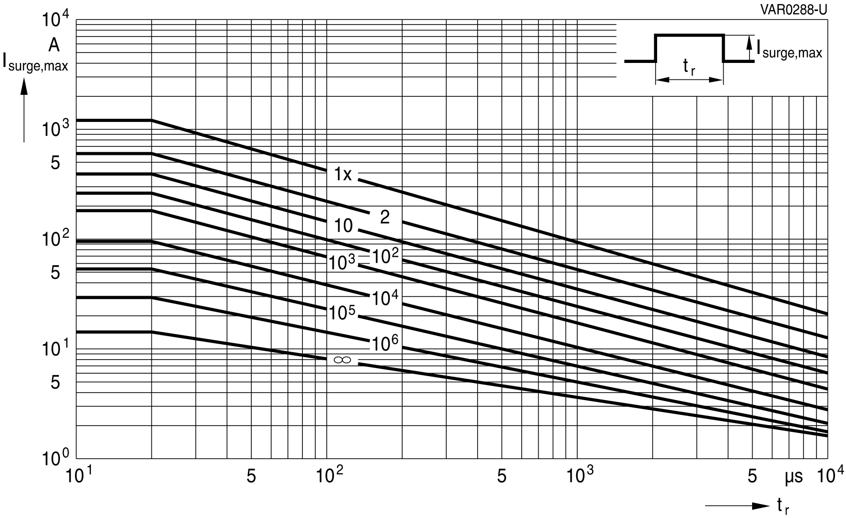
SR6K35*

Derating curves

Maximum surge current $I_{surge,max}$ = f (t_r, pulse train)
For explanation of the derating curves refer to "General technical information", chapter 2.7.1



SHCV-SR1 ...

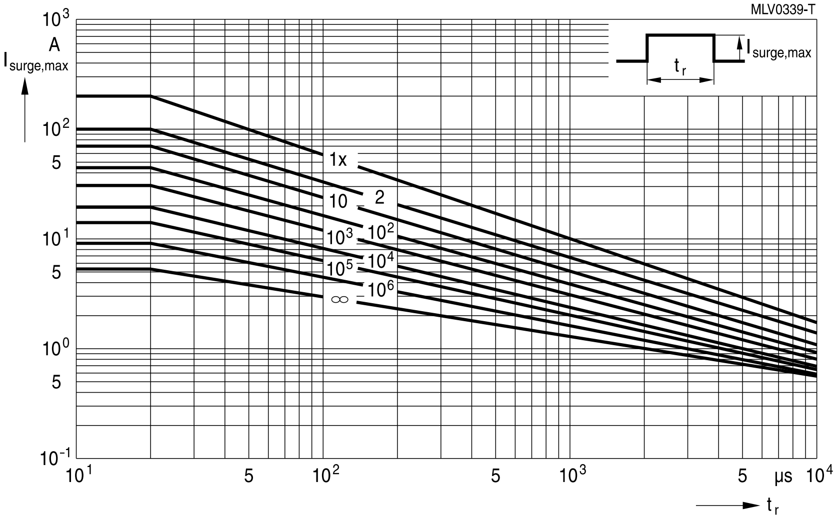


SHCV-SR2 ...

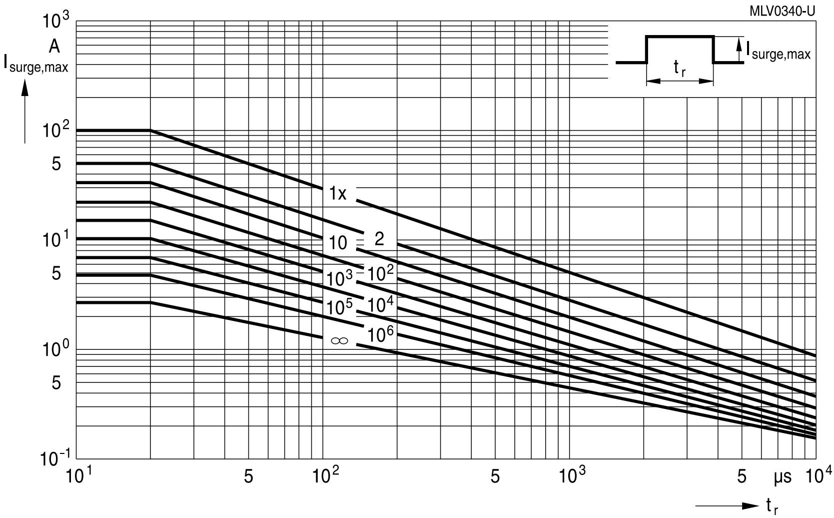
Derating curves

Maximum surge current $I_{surge,max}$ = f (t_r, pulse train)

For explanation of the derating curves refer to "General technical information", chapter 2.7.1



SR6K14 , SR6K20



SR6K35 ...

Symbols and terms

For ceramic transient voltage suppressors (CTVS)

Symbol	Term
$C_{line,max}$	Maximum capacitance per line
$C_{line,min}$	Minimum capacitance per line
$C_{line,typ}$	Typical capacitance per line
C_{max}	Maximum capacitance
C_{min}	Minimum capacitance
C_{nom}	Nominal capacitance
ΔC_{nom}	Tolerance of nominal capacitance
C_{typ}	Typical capacitance
$f_{cut\text{-}off,max}$	Maximum cut-off frequency
$f_{cut\text{-}off,min}$	Minimum cut-off frequency
$f_{cut\text{-}off,typ}$	Typical cut-off frequency
$f_{res,typ}$	Typical resonance frequency
I	Current
I_{clamp}	Clamping current
I_{leak}	Leakage current
$I_{leak,max}$	Maximum leakage current
$I_{leak,typ}$	Typical leakage current
I_{PP}	Peak pulse current
$I_{surge,max}$	Maximum surge current (also termed peak current)
LCT	Lower category temperature
L_{typ}	Typical inductance
$P_{diss,max}$	Maximum power dissipation
P_{PP}	Peak pulse power
R_{ins}	Insulation resistance
R_{min}	Minimum resistance
R_S	Resistance per line
$R_{S,typ}$	Typical resistance per line
T_A	Ambient temperature
T_{op}	Operating temperature
$T_{op,max}$	Maximum operating temperature
T_{stg}	Storage temperature

Leaded transient voltage/RFI suppressors (SHCVs)

SHCV series

Symbol	Term
t_r	Duration of equivalent rectangular wave
t_{resp}	Response time
$t_{resp,max}$	Maximum response time
UCT	Upper category temperature
V	Voltage
$V_{BR,min}$	Minimum breakdown voltage
$V_{clamp,max}$	Maximum clamping voltage
$V_{DC,max}$	Maximum DC operating voltage (also termed working voltage)
$V_{ESD,air}$	Air discharge ESD capability
$V_{ESD,contact}$	Contact discharge ESD capability
V_{jump}	Maximum jump-start voltage
$V_{RMS,max}$	Maximum AC operating voltage, root-mean-square value
V_V	Varistor voltage (also termed breakdown voltage)
V_{LD}	Maximum load dump voltage
V_{leak}	Measurement voltage for leakage current
$V_{V,min}$	Minimum varistor voltage
$V_{V,max}$	Maximum varistor voltage
ΔV_V	Tolerance of varistor voltage
W_{LD}	Maximum load dump energy
W_{max}	Maximum energy absorption (also termed transient energy)
α_{typ}	Typical insertion loss
$\tan \delta$	Dissipation factor
$\boxed{e}$	Lead spacing
≪*≫	Maximum possible application conditions

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

For CeraDiodes

CeraDiode	Semiconductor diode	
C_{max}		Maximum capacitance
C_{typ}		Typical capacitance
I_{BR}	I_R, I_T	(Reverse) current @ breakdown voltage
I_{leak}	I_{RM}	(Reverse) leakage current
I_{PP}	I_P, I_{PP}	Current @ clamping voltage; peak pulse current
P_{PP}	P_{PP}	Peak pulse power
T_{op}		Operating temperature
T_{stg}		Storage temperature
V_{BR}	V_{BR}	(Reverse) breakdown voltage
$V_{BR,min}$		Minimum breakdown voltage
V_{clamp}	V_{cl}, V_C	Clamping voltage
$V_{clamp,max}$		Maximum clamping voltage
V_{DC}	V_{RM}, V_{RWM}, V_{WM}, V_{DC}	(Reverse) stand-off voltage, working voltage, operating voltage
$V_{DC,max}$		Maximum DC operating voltage
$V_{ESD,air}$		Air discharge ESD capability
$V_{ESD,contact}$		Contact discharge ESD capability
V_{leak}	V_{RM}, V_{RWM}, V_{WM}, V_{DC}	(Reverse) voltage @ leakage current
- *)	I_F	Current @ forward voltage
- *)	I_{RM}, $I_{RM,max}$@V_{RM}	(Reverse) current @ maximum reverse stand-off voltage, working voltage, operating voltage
- *)	V_F	Forward voltage

*) Not applicable due to bidirectional characteristics of CeraDiodes.

Cautions and warnings

General

Some parts of this publication contain statements about the suitability of our ceramic transient voltage suppressor (CTVS) components (multilayer varistors (MLVs)), CeraDiodes, ESD/EMI filters, leaded transient voltage/ RFI suppressors (SHCV types)) for certain areas of application, including recommendations about incorporation/design-in of these products into customer applications. The statements are based on our knowledge of typical requirements often made of our CTVS devices in the particular areas. We nevertheless expressly point out that such statements cannot be regarded as binding statements about the suitability of our CTVS components for a particular customer application. As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always incumbent on the customer to check and decide whether the CTVS devices with the properties described in the product specification are suitable for use in a particular customer application.

- Do not use EPCOS CTVS components for purposes not identified in our specifications, application notes and data books.
- Ensure the suitability of a CTVS in particular by testing it for reliability during design-in. Always evaluate a CTVS component under worst-case conditions.
- Pay special attention to the reliability of CTVS devices intended for use in safety-critical applications (e.g. medical equipment, automotive, spacecraft, nuclear power plant).

Design notes

- Always connect a CTVS in parallel with the electronic circuit to be protected.
- Consider maximum rated power dissipation if a CTVS has insufficient time to cool down between a number of pulses occurring within a specified isolated time period. Ensure that electrical characteristics do not degrade.
- Consider derating at higher operating temperatures. Choose the highest voltage class compatible with derating at higher temperatures.
- Surge currents beyond specified values will puncture a CTVS. In extreme cases a CTVS will burst.
- If steep surge current edges are to be expected, make sure your design is as low-inductance as possible.
- In some cases the malfunctioning of passive electronic components or failure before the end of their service life cannot be completely ruled out in the current state of the art, even if they are operated as specified. In applications requiring a very high level of operational safety and especially when the malfunction or failure of a passive electronic component could endanger human life or health (e.g. in accident prevention, life-saving systems, or automotive battery line applications such as clamp 30), ensure by suitable design of the application or other measures (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of such a malfunction or failure. Only use CTVS components from the automotive series in safety-relevant applications.

- Specified values only apply to CTVS components that have not been subject to prior electrical, mechanical or thermal damage. The use of CTVS devices in line-to-ground applications is therefore not advisable, and it is only allowed together with safety countermeasures like thermal fuses.

Storage

- Only store CTVS in their original packaging. Do not open the package prior to processing.
- Storage conditions in original packaging: temperature −25 to +45°C, relative humidity ≤75% annual average, maximum 95%, dew precipitation is inadmissible.
- Do not store CTVS devices where they are exposed to heat or direct sunlight. Otherwise the packaging material may be deformed or CTVS may stick together, causing problems during mounting.
- Avoid contamination of the CTVS surface during storage, handling and processing.
- Avoid storing CTVS devices in harmful environments where they are exposed to corrosive gases for example (SO_x, Cl).
- Use CTVS as soon as possible after opening factory seals such as polyvinyl-sealed packages.
- Solder CTVS components after shipment from EPCOS within the time specified:
  - CTVS with Ni barrier termination, 12 months
  - CTVS with AgPt termination, 6 months
  - SHCV, 24 months

Handling

- Do not drop CTVS components and allow them to be chipped.
- Do not touch CTVS with your bare hands - gloves are recommended.
- Avoid contamination of the CTVS surface during handling.
- Washing processes may damage the product due to the possible static or cyclic mechanical loads (e.g. ultrasonic cleaning). They may cause cracks to develop on the product and its parts, which might lead to reduced reliability or lifetime.

Mounting

- When CTVS devices are encapsulated with sealing material or overmolded with plastic material, electrical characteristics might be degraded and the life time reduced.
- Make sure an electrode is not scratched before, during or after the mounting process.
- Make sure contacts and housings used for assembly with CTVS components are clean before mounting.
- The surface temperature of an operating CTVS can be higher. Ensure that adjacent components are placed at a sufficient distance from a CTVS to allow proper cooling.
- Avoid contamination of the CTVS surface during processing.

Soldering

- Complete removal of flux is recommended to avoid surface contamination that can result in an instable and/or high leakage current.
- Use resin-type or non-activated flux.
- Bear in mind that insufficient preheating may cause ceramic cracks.
- Rapid cooling by dipping in solvent is not recommended, otherwise a component may crack.

Operation

- Use CTVS only within the specified operating temperature range.
- Use CTVS only within specified voltage and current ranges.
- Environmental conditions must not harm a CTVS. Only use them in normal atmospheric conditions. Reducing the atmosphere (e.g. hydrogen or nitrogen atmosphere) is prohibited.
- Prevent a CTVS from contacting liquids and solvents. Make sure that no water enters a CTVS (e.g. through plug terminals).
- Avoid dewing and condensation.
- EPCOS CTVS components are mainly designed for encased applications. Under all circumstances avoid exposure to:
  - direct sunlight
  - rain or condensation
  - steam, saline spray
  - corrosive gases
  - atmosphere with reduced oxygen content
- EPCOS CTVS devices are not suitable for switching applications or voltage stabilization where static power dissipation is required.

This listing does not claim to be complete, but merely reflects the experience of EPCOS AG.

Display of ordering codes for EPCOS products

The ordering code for one and the same EPCOS product can be represented differently in data sheets, data books, other publications, on the EPCOS website, or in order-related documents such as shipping notes, order confirmations and product labels. **The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products**. Detailed information can be found on the Internet under www.epcos.com/orderingcodes

Important notes

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or lifesaving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
3. **The warnings, cautions and product-specific notes must be observed.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous)**. Useful information on this will be found in our Material Data Sheets on the Internet (www.epcos.com/material). Should you have any more detailed questions, please contact our sales offices.
5. We constantly strive to improve our products. Consequently, **the products described in this publication may change from time to time**. The same is true of the corresponding product specifications. Please check therefore to what extent product descriptions and specifications contained in this publication are still applicable before or when you place an order. We also **reserve the right to discontinue production and delivery of products**. Consequently, we cannot guarantee that all products named in this publication will always be available. The aforementioned does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.
6. Unless otherwise agreed in individual contracts, **all orders are subject to the current version of the "General Terms of Delivery for Products and Services in the Electrical Industry" published by the German Electrical and Electronics Industry Association (ZVEI)**.

7. The trade names EPCOS, CeraDiode, CeraLink, CeraPad, CeraPlas, CSMP, CTVS, DeltaCap, DigiSiMic, ExoCore, FilterCap, FormFit, LeaXield, MiniBlue, MiniCell, MKD, MKK, MotorCap, PCC, PhaseCap, PhaseCube, PhaseMod, PhiCap, PowerHap, PQSine, PQvar, SIFERRIT, SIFI, SIKOREL, SilverCap, SIMDAD, SiMic, SIMID, SineFormer, SIOV, ThermoFuse, WindCap are **trademarks registered or pending** in Europe and in other countries. Further information will be found on the Internet at www.epcos.com/trademarks.