



## varistor plus catalog

### Multilayer Varistor Technology

Surface Mount & Leaded Products



SEI electronics inc.

P.O. BOX 58789 ■ Raleigh, NC 27658-8789

Tel. 1-888-sei-sei-sei ■ Fax. 919-850-9504

[www.seiselect.com](http://www.seiselect.com)

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# SEI ELECTRONICS / KEKO VARICON STRATEGIC ALLIANCE

## INTRODUCTION

SEI ELECTRONICS and KEKO VARICON have formed a strategic alliance to jointly promote the sale of transient voltage suppression components throughout North America under a program called Varistor Plus.

The Varistor Plus program combines a unique melding of leading-edge technological development, application engineering support and customer service designed to provide our customers with the best and broadest line of products and services in the industry.

The products offered in the Varistor Plus program include both multilayer and single layer varistors, packaged in EIA standard chip sizes and radial leaded configurations, which virtually cover every board level requirement for standard transient voltage protection. In addition, applications in market segments such as “Automotive,” “Telecom Switches (Line Cards),” “Industrial & Motor Controls” and “AC Power Networks” to name a few, are covered by specific product series designed for these unique transient voltage conditions.

## MULTILAYER PRODUCTS

Low voltage multilayer varistors span a DC voltage range of 3.0 to 125 V<sub>DC</sub>, with energy ratings from 0.05 to 37.8 joules. The wide range of EIA chip sizes, 0603 to 3225, accounts for the exceptionally broad product offering (one of the most extensive in the industry), and radial leaded MLVs are a new addition to the family of TVS protection components. The combination of these devices addresses all but the most extremely damaging transients to semiconductors and/or integrated circuits from: (1) ultra-high voltage, low-energy ESD events, (2) ultra-high voltage, high-energy near lightning strikes, (3) relatively low-to-medium voltage, high-energy inductive load disruptions, and all transient environments in between.

## SINGLE LAYER PRODUCTS

Low-to-medium voltage single layer (SLV) radial leaded discs, commonly known as MOVs, are designed primarily to operate in AC voltage applications. SEI's Varistor Plus products are offered in AC voltages from 11 V to 550 V, energy ratings from 0.6 to 815.0 joules and surge capabilities from 100 to 15,000 amps. Most applications are across AC power lines and protect against line surges generated from load switching, lightning and other forms of high-energy transient events. Please refer to the SEI/KEKO VARICON single layer catalog or contact SEI for any information related to SLV products.

## SPECIALTY PRODUCTS

The SEI Varistor Plus program embraces many specialty TVS products. Specific to the automotive industry, for example, the multilayer AV products offer exceptional electrical characteristics in much smaller packages and much higher levels of reliability than that achieved by typical automotive disc varistors. The multilayer OV (leaded) “dual function” component combines a low voltage varistor and capacitor into a single package for protection against voltage surges and RFI typically encountered in cars.

## KEKO VARICON HISTORY

KEKO VARICON, headquartered in Zuzemberk, Slovenia, has produced over-voltage protection devices for over 10 years. In the late 80s, the company was acquired by Zoran and Angela Zivic from the former ISKRA Group and was named KEKO VARICON (VARI from “VARIstor,” and CON from “CONDensator,” the old term for a capacitor). The ISKRA Group, started in the mid 50s, had previously manufactured both single layer and multilayer ceramic electronic components.

KEKO VARICON's General Manager, Zoran Zivic, has been actively involved in circuit protection developments in both active and passive components and material systems for more than 20 years. Mr. Zivic has written and published a wide variety of technical papers on electrical and electronic protection subjects and currently holds numerous product and material system patents. Considered one of the leading pioneers in developing surface mount protection devices, Zoran Zivic has earned and maintains the role as a technological leader in this industry.

## GENERAL NOTES

SEI's Varistor Plus / KEKO VARICON products have been tested and approved under the following standards:

UL1414, UL1449, CSA 22.2, IEC 1051.2 and CECC 42000.

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## Multilayer Technology

## Varistor Plus

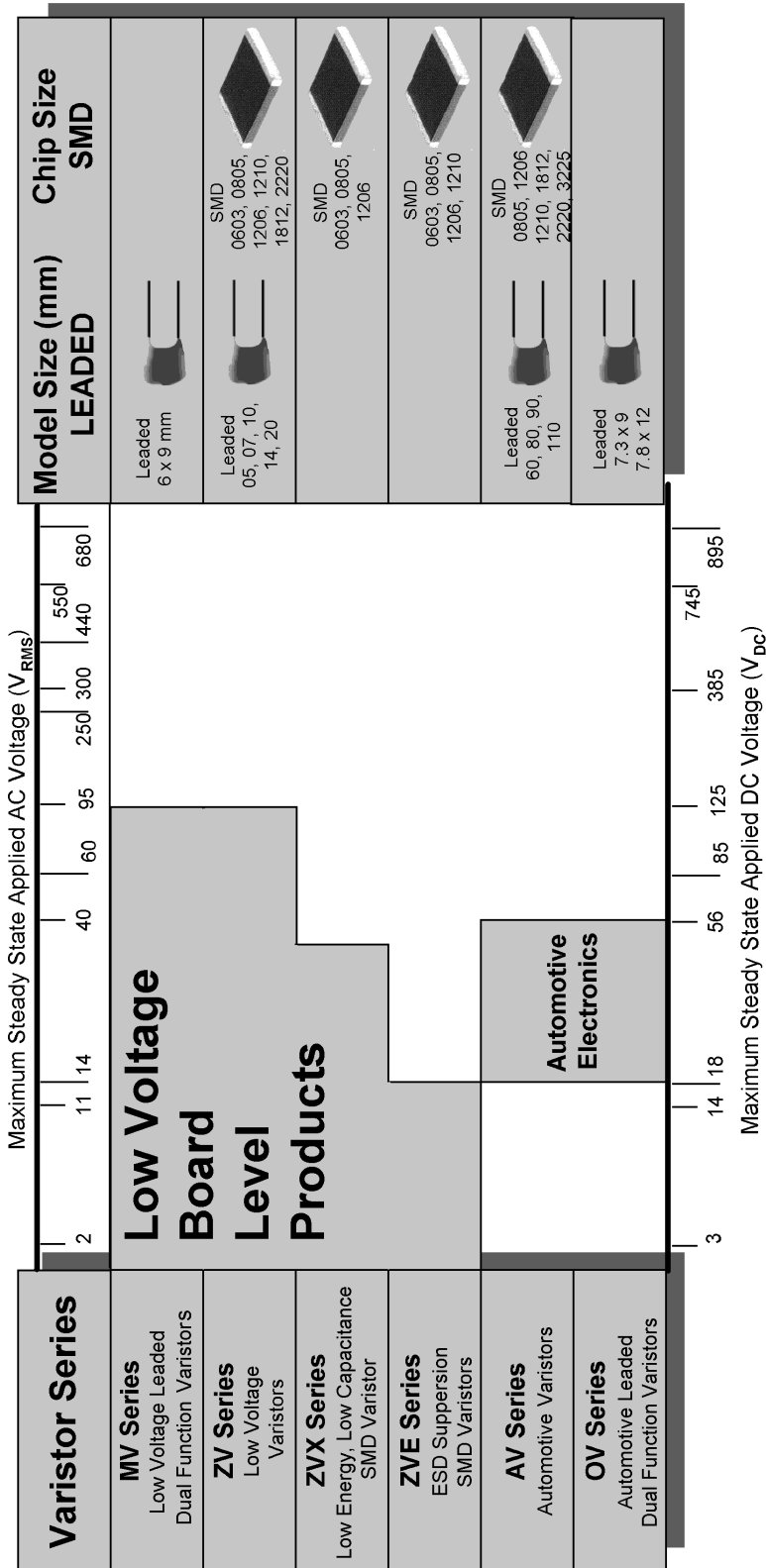
Term	Symbol	Definition
Rated AC Voltage	$V_{RMS}$	Maximum continuous sinusoidal AC voltage (< 5% total harmonic distortion) which may be applied to the varistor at 25°C.
Rated DC Voltage	$V_{DC}$	Maximum continuous DC voltage (< 5% ripple) which may be applied to the varistor at 25°C.
Leakage Current	$I_L$	Current passing through the varistor at rated DC voltage at 25°C or any other specified temperature.
Varistor Voltage	$V_N$	Voltage across the varistor measured at 1mA of DC current.
Clamping Voltage	$V_C$	Maximum peak voltage developed across the varistor when passing an 8/20 $\mu$ s class current pulse.
Class Current	$I_C$	A peak value of current which is 1/10 of the maximum peak current for 100 pulses at two per minute for an 8/20 pulse.
Voltage Clamping Ratio	$V_C / V_{APP}$	A figure of merit measure of the varistor clamping effectiveness as defined by the symbols $V_C / V_{APP}$ , where $V_{APP} = V_{RMS}$ or $V_{DC}$ .
Single Pulse Transient Energy	$W_{MAX}$	Energy which may be dissipated for a single 10/1000 $\mu$ s pulse of a maximum rated current, with rated AC/DC voltage applied, without causing device failure.
Load Dump Transient	$W_{LD}$	Load Dump is a transient that occurs in an automotive environment. It is an exponentially decaying positive voltage that occurs in the event of a battery disconnect while the alternator is still generating charging current, with other loads remaining on the alternator circuit at the time of battery disconnect.
Single Pulse Peak Current	$I_P$	Maximum peak current that may be applied to the varistor for a single 8/20 $\mu$ s pulse, with line voltage applied, without causing device failure.
Average Power Dissipation	$P_{MAX}$	Maximum average dissipated power at 25°C resulting from a group of pulses occurring within a specified isolated time period, without causing device failure.
Capacitance	$C_{(TYP)}$	Capacitance between two terminals of the varistor measured at 1 kHz.
Inductance	$L$	Inductive component of the varistor when measured with a current edge rate (di/dt) of 100mA/ns. Values are typically measured in nanohenries (nH).
Jump Start Transient	$V_{JUMP}$	The jump start transient results from the temporary application of an over-voltage in excess of the rated battery voltage. The circuit power supply may be subjected to a temporary over-voltage condition due to the voltage regulation failing or it may be deliberately generated when it becomes necessary to boost start the car.
Response Time		The time lag between application of a surge and the varistor's "turn-on" conduction action.
Varistor Voltage Temperature Coefficient		$(V_N \text{ at } 85^\circ\text{C} - V_N \text{ at } 25^\circ\text{C}) / ((V_N \text{ at } 25^\circ\text{C}) \times 60^\circ\text{C}) \times 100$

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Insulation Resistance	IR	Minimum resistance between shorted terminals and varistor surface.
Isolation Voltage		The maximum peak voltage that may be applied under continuous operating conditions between the varistor terminations and any conducting mounting surface.
Operating Temperature		The range of ambient temperature for which the varistor is designed to operate continuously, as defined by the temperature limits of its climatic category.
Storage Temperature		Storage temperature range without voltage applied.
Current/Energy Derating		Derating of maximum values when operated above the varistor's rated continuous operating temperature.

## Overview of Protective Devices



Model Size (mm) LEADED	Chip Size SMD
Leaded 6 x 9 mm	
Leaded 05, 07, 10, 14, 20	SMD 0603, 0805, 1206, 1210, 1812, 2220
	SMD 0603, 0805, 1206
	SMD 0603, 0805, 1206, 1210
Leaded 60, 80, 90, 110	SMD 0805, 1206, 1210, 1812, 2220, 3225
Leaded 7.3 x 9 7.8 x 12	

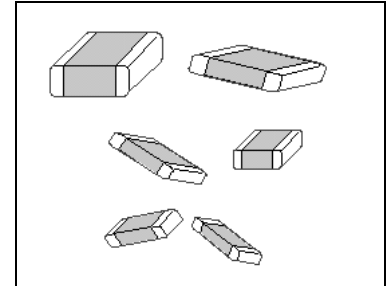
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**Description**

The ZV Series of low voltage varistors is designed to protect sensitive electronics devices against high voltage surges in the low voltage region. They offer excellent transient energy absorption due to improved energy volume distribution and power dissipation. Low voltage varistors cover wide DC operating voltage range from 3V to 125V.

ZV varistors are typically applied to protect integrated circuits and other components at the circuit board level.



**Features**

- Operating voltage range ( $V_{DC}$ ) .....3V to 125V
- Part number voltage range ( $V_{RMS}$ ).....2V to 95V
- Bi-directional, low clamping voltages
- 6 model sizes available....0603, 0805, 1206, 1210, 1812 and 2220
- Broad range of current and energy handling capabilities
- Fast response time
- + 125°C continuous operating temperature
- Dimensional and weight savings on PC board
- AgPd end terminations
- No plastic coating guarantees better flammability rating
- Available in tape and reel for automatic pick and place

**Applications**

- Suppression of inductive switching or other low to medium transient events at the circuit board level
- ESD protection for components sensitive to IEC 1000-4-2, MIL-STD 883C Method 3015.7 and other industry specifications
- Provides on-board transient voltage protection of ICs and transistors
- Used to help achieve electromagnetic compliance of end products
- Replace larger surface mount TVS Zeners in many applications

**Absolute Maximum Ratings**

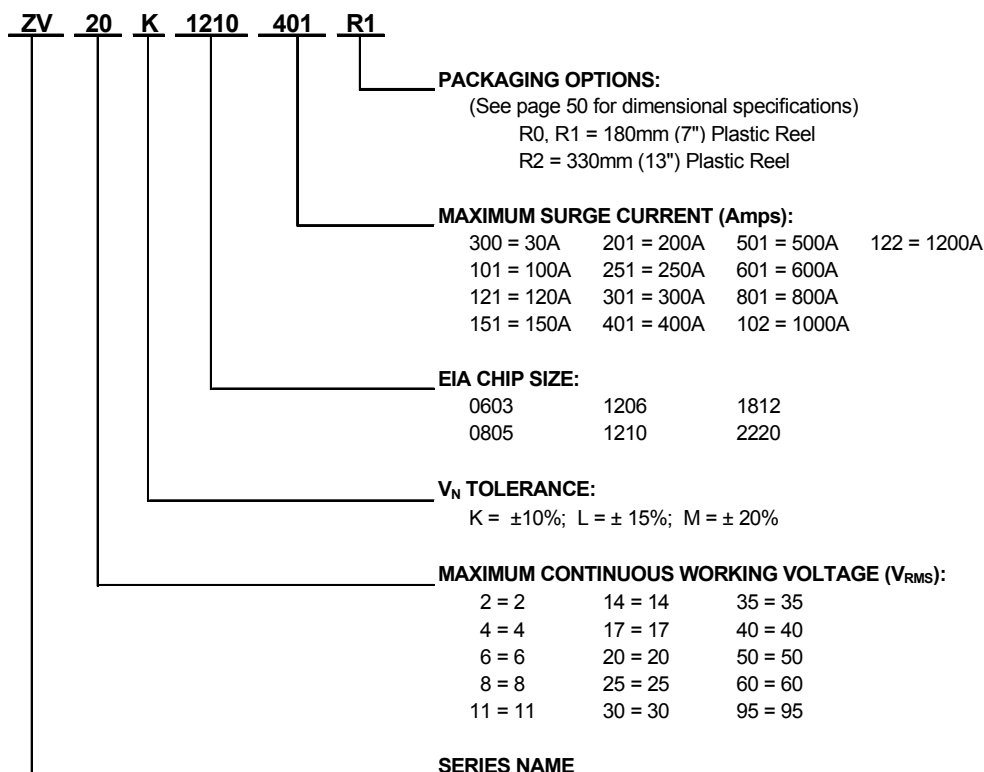
<b>Continuous:</b>	Value
Steady State Applied Voltage:	
DC Voltage Range ( $V_{DC}$ )	3V to 125V
AC Voltage Range ( $V_{RMS}$ )	2V to 95V
<b>Transient:</b>	
Peak Single Pulse Surge Current ( $I_P$ ), 8/20 $\mu$ s Waveform	30A to 1200A
Single Pulse Surge Energy ( $W_{MAX}$ ), 10/1000 $\mu$ s Waveform	0.1J to 12.2J
Operating Ambient Temperature	-55°C to +125°C
Storage Temperature Range	-55°C to +150°C
Threshold Voltage Temperature Coefficient	< - 0.05%/°C
Response Time	< 2ns



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HOW TO ORDER: ZV SERIES (LOW VOLTAGE SMD VARISTORS)



Standard Packaging Options / Quantities

Series	Voltage Range (V <sub>RMS</sub> )	Chip Size									
		0603			0805			1206			
		R0	R1	R2	R0	R1	R2	R0	R1	R2	
		180mm	180mm	330mm	180mm	180mm	330mm	180mm	180mm	330mm	
		7"	7"	13"	7"	7"	13"	7"	7"	13"	
ZV	2 to 14	1000	4000	15000	1000	4000	15000	1000	4000	15000	
	17	1000	3500	14000	1000	3500	14000	1000	2500	14000	
	20 to 40	1000	3500	14000	1000	3500	14000	1000	2500	10000	
	50 to 95	N/A	N/A	N/A	N/A	N/A	N/A	1000	2000	8000	
	Voltage Range (V <sub>RMS</sub> )	1210			1812			2220			
		R0	R1	R2	R0	R1	R2	R0	R1	R2	
		180mm	180mm	330mm	180mm	180mm	330mm	180mm	180mm	330mm	
			7"	7"	13"	7"	7"	13"	7"	7"	13"
		2 to 14	1000	4000	15000	1000	1500	6000	1000	1500	5000
		17	1000	2500	14000	1000	1500	6000	1000	1500	5000
	20 to 40	1000	2500	9000	1000	1000	4000	1000	1000	4000	
	50 to 95	1000	2000	8000	1000	1000	4000	1000	1000	4000	

Note: Chips packaged in plastic embossed tape.

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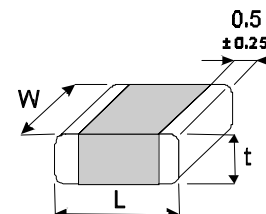
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Device Ratings and Characteristics

ZV 2M 0603 300 -- to ZV 11K 1210 401 --

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> 1 mA	V <sub>C</sub>	I <sub>C</sub> 8/20 μs	W <sub>MAX</sub> 10/1000 μs	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C <sub>(TYP)</sub> 1 kHz	L <sub>(TYP)</sub> 100 mA/nS
Unit of Measure	Volts	Volts	Volts	Volts	Amps	Joules	Watts	Amps	pF	nH
ZV 2M 0603 300 --	2	3	4	10	1	0.1	0.003	30	360	1.0
ZV 4M 0603 300 --	4	5.5	8	14	1	0.1	0.003	30	295	1.0
ZV 6M 0603 300 --	6	8	11	21	1	0.1	0.003	30	260	1.0
ZV 8L 0603 300 --	8	11	15	25	1	0.1	0.003	30	250	1.0
ZV 11K 0603 300 --	11	14	18	33	1	0.2	0.003	30	210	1.0
ZV 14K 0603 300 --	14	18	22	38	1	0.3	0.003	30	195	1.0
ZV 17K 0603 300 --	17	22	27	44	1	0.3	0.003	30	185	1.0
ZV 20K 0603 300 --	20	26	33	54	1	0.3	0.003	30	175	1.0
ZV 25K 0603 300 --	25	31	39	65	1	0.1	0.003	30	165	1.0
ZV 30K 0603 300 --	30	38	47	77	1	0.1	0.003	30	160	1.0
ZV 2 M 0805 101 --	2	3	4	10	1	0.1	0.005	100	1300	1.5
ZV 4 M 0805 101 --	4	5.5	8	14	1	0.1	0.005	100	1100	1.5
ZV 6 M 0805 101 --	6	8	11	21	1	0.2	0.005	100	900	1.5
ZV 8 L 0805 121 --	8	11	15	25	1	0.2	0.005	120	700	1.5
ZV 11 K 0805 121 --	11	14	18	33	1	0.3	0.005	120	500	1.5
ZV 14 K 0805 121 --	14	18	22	38	1	0.4	0.005	120	400	1.5
ZV 17 K 0805 121 --	17	22	27	44	1	0.4	0.005	120	340	1.5
ZV 20 K 0805 121 --	20	26	33	54	1	0.4	0.005	120	300	1.5
ZV 25 K 0805 121 --	25	31	39	65	1	0.2	0.005	120	280	1.5
ZV 30 K 0805 121 --	30	38	47	77	1	0.2	0.005	120	250	1.5
ZV 2 M 1206 151 --	2	3	4	10	1	0.2	0.008	150	5000	1.8
ZV 4 M 1206 151 --	4	5.5	8	14	1	0.3	0.008	150	3500	1.8
ZV 6 M 1206 151 --	6	8	11	21	1	0.5	0.008	150	2600	1.8
ZV 8 L 1206 201 --	8	11	15	25	1	0.6	0.008	200	1950	1.8
ZV 11 K 1206 201 --	11	14	18	33	1	0.6	0.008	200	1300	1.8
ZV 14 K 1206 201 --	14	18	22	38	1	0.6	0.008	200	950	1.8
ZV 17 K 1206 201 --	17	22	27	44	1	0.7	0.008	200	740	1.8
ZV 20 K 1206 201 --	20	26	33	54	1	0.8	0.008	200	620	1.8
ZV 25 K 1206 201 --	25	31	39	65	1	1.0	0.008	200	510	1.8
ZV 30 K 1206 201 --	30	38	47	77	1	1.2	0.008	200	450	1.8
ZV 35 K 1206 121 --	35	45	56	90	1	0.6	0.008	120	400	1.8
ZV 40 K 1206 121 --	40	56	68	110	1	0.8	0.008	120	370	1.8
ZV 50 K 1206 121 --	50	65	82	135	1	0.8	0.008	120	320	1.8
ZV 60 K 1206 121 --	60	85	100	165	1	0.9	0.008	120	290	1.8
ZV 4 M 1210 251 --	4	5.5	8	14	3	0.4	0.010	250	5000	1.8
ZV 6 M 1210 301 --	6	8	11	21	3	0.8	0.010	300	4100	1.8
ZV 8 L 1210 401 --	8	11	15	25	3	1.1	0.010	400	3400	1.8
ZV 11 K 1210 401 --	11	14	18	33	3	1.3	0.010	400	2600	1.8

ZV Series - Low Voltage SMD Varistors				
Chip Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)		
		L	W	t <sub>MAX</sub>
0603	2 - 30	1.60 ± 0.15	0.80 ± 0.10	1.0
0805	2 - 30	2.00 ± 0.20	1.25 ± 0.15	1.0
1206	2 - 60	3.20 ± 0.30	1.60 ± 0.20	1.6
1210	4 - 95	3.20 ± 0.30	2.50 ± 0.25	1.7



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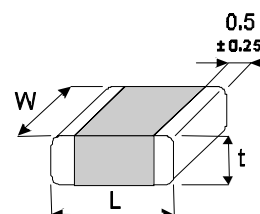
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Device Ratings and Characteristics

ZV 14K 1210 401 -- to ZV 95K 2220 501 --

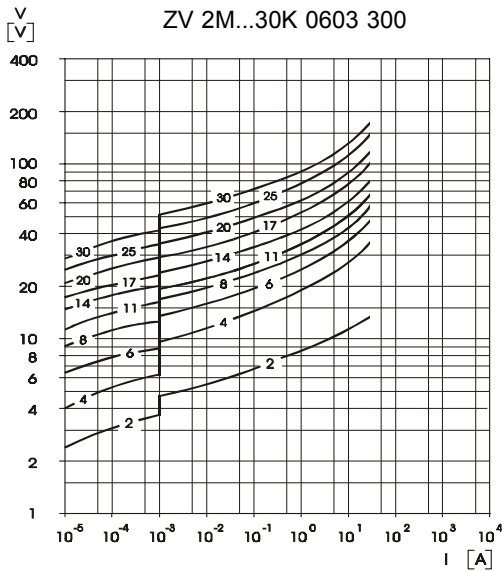
Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> 1 mA	V <sub>C</sub>	I <sub>C</sub> 8/20 μs	W <sub>MAX</sub> 10/1000 μs	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C <sub>(TYP)</sub> 1kHz	L <sub>(TYP)</sub> 100 mA/nS
Unit of Measure	Volts	Volts	Volts	Volts	Amps	Joules	Watts	Amps	pF	nH
ZV 14 K 1210 401 --	14	18	22	38	3	1.6	0.010	400	2150	1.8
ZV 17 K 1210 401 --	17	22	27	44	3	1.8	0.010	400	1800	1.8
ZV 20 K 1210 401 --	20	26	33	54	3	2.0	0.010	400	1500	1.8
ZV 25 K 1210 401 --	25	31	39	65	3	1.8	0.010	400	1350	1.8
ZV 30 K 1210 301 --	30	38	47	77	3	2.1	0.010	300	1100	1.8
ZV 35 K 1210 251 --	35	45	56	90	3	2.2	0.010	250	950	1.8
ZV 40 K 1210 251 --	40	56	68	110	3	2.4	0.010	250	750	1.8
ZV 50 K 1210 251 --	50	65	82	135	3	1.7	0.010	250	650	1.8
ZV 60 K 1210 251 --	60	85	100	165	3	2.2	0.010	250	500	1.8
ZV 95 K 1210 201 --	95	125	150	250	3	2.6	0.010	200	300	1.8
ZV 4 M 1812 501 --	4	5.5	8	14	5	0.8	0.015	500	10000	2.5
ZV 6 M 1812 501 --	6	8	11	21	5	1.0	0.015	500	7500	2.5
ZV 8 L 1812 501 --	8	11	15	25	5	1.9	0.015	500	6500	2.5
ZV 11 K 1812 801 --	11	14	18	33	5	2.0	0.015	800	5100	2.5
ZV 14 K 1812 801 --	14	18	22	38	5	2.4	0.015	800	4000	2.5
ZV 17 K 1812 801 --	17	22	27	44	5	2.8	0.015	800	3500	2.5
ZV 20 K 1812 801 --	20	26	33	54	5	3.0	0.015	800	3000	2.5
ZV 25 K 1812 801 --	25	31	39	65	5	3.9	0.015	800	2500	2.5
ZV 30 K 1812 801 --	30	38	47	77	5	4.4	0.015	800	2000	2.5
ZV 35 K 1812 601 --	35	45	56	90	5	4.2	0.015	600	1450	2.5
ZV 40 K 1812 601 --	40	56	68	110	5	4.8	0.015	600	1100	2.5
ZV 50 K 1812 401 --	50	65	82	135	5	4.8	0.015	400	800	2.5
ZV 60 K 1812 401 --	60	85	100	165	5	5.8	0.015	400	640	2.5
ZV 95 K 1812 301 --	95	125	150	250	5	5.2	0.015	300	450	2.5
Note: 115 & 130 VAC ratings available upon request - contact factory for specifications.										
ZV 4 M 2220 102 --	4	5.5	8	14	10	1.5	0.020	1000	19500	3.0
ZV 6 M 2220 122 --	6	8	11	21	10	3.8	0.020	1200	17000	3.0
ZV 8 L 2220 122 --	8	11	15	25	10	4.3	0.020	1200	16000	3.0
ZV 11 K 2220 122 --	11	14	18	33	10	5.5	0.020	1200	13000	3.0
ZV 14 K 2220 122 --	14	18	22	38	10	6.0	0.020	1200	10000	3.0
ZV 17 K 2220 122 --	17	22	27	44	10	7.5	0.020	1200	8000	3.0
ZV 20 K 2220 122 --	20	26	33	54	10	8.0	0.020	1200	6500	3.0
ZV 25 K 2220 122 --	25	31	39	65	10	9.5	0.020	1200	5000	3.0
ZV 30 K 2220 122 --	30	38	47	77	10	12.2	0.020	1200	4000	3.0
ZV 35 K 2220 102 --	35	45	56	90	10	7.6	0.020	1000	3000	3.0
ZV 40 K 2220 102 --	40	56	68	110	10	9.2	0.020	1000	2200	3.0
ZV 50 K 2220 801 --	50	65	82	135	10	5.8	0.020	800	1500	3.0
ZV 60 K 2220 801 --	60	85	100	165	10	6.2	0.020	800	1400	3.0
ZV 95 K 2220 501 --	95	125	150	250	10	7.4	0.020	500	600	3.0
Note: 115 & 130 VAC ratings available upon request - contact factory for specifications.										

ZV Series - Low Voltage SMD Varistors				
Chip Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)		
		L	W	t <sub>MAX</sub>
1210	4 - 95	3.20 ± 0.30	2.50 ± 0.25	1.7
1812	4 - 95	4.50 ± 0.35	3.20 ± 0.30	1.8
2220	4 - 95	5.70 ± 0.40	5.00 ± 0.40	1.8

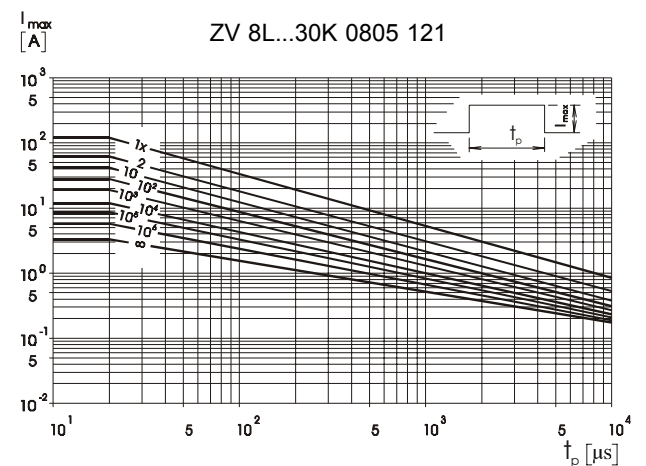
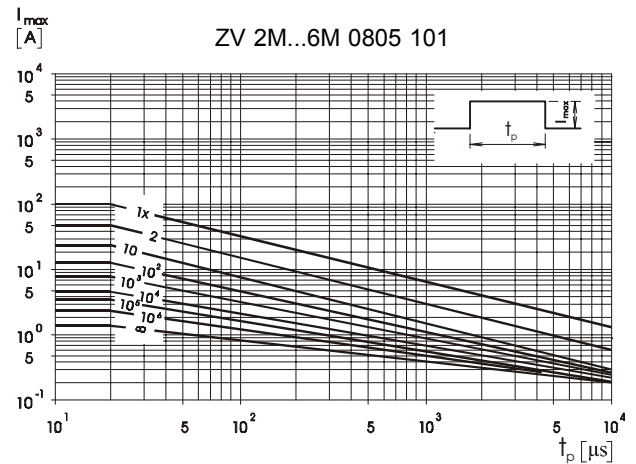
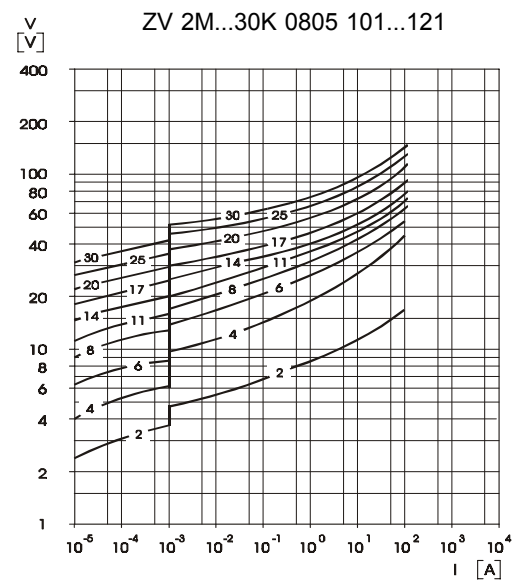
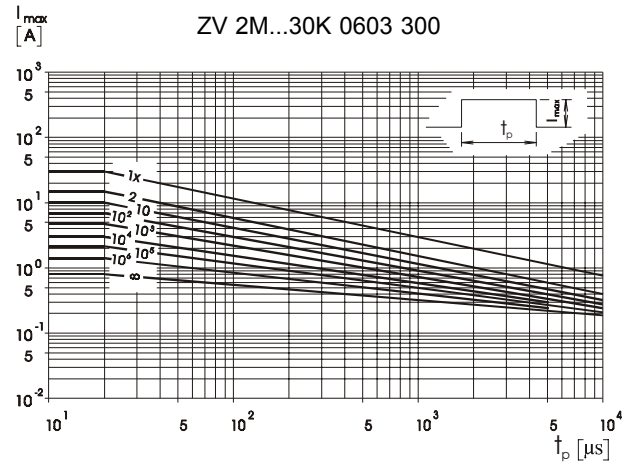


Performance Characteristics

Voltage/Current Curves

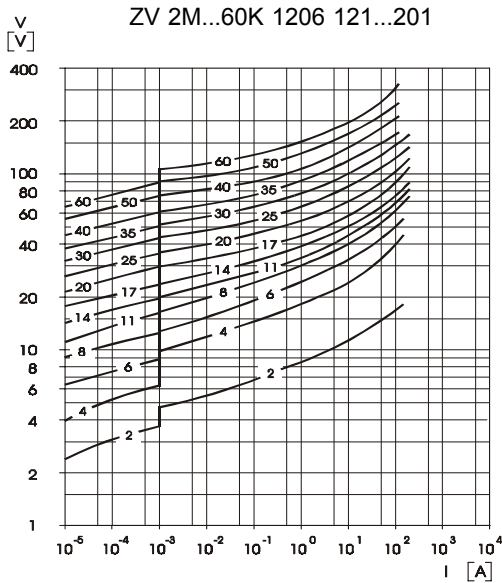


Pulse Rating Curves

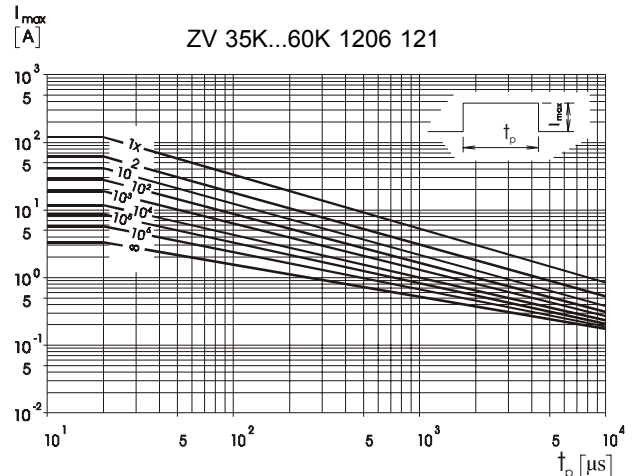
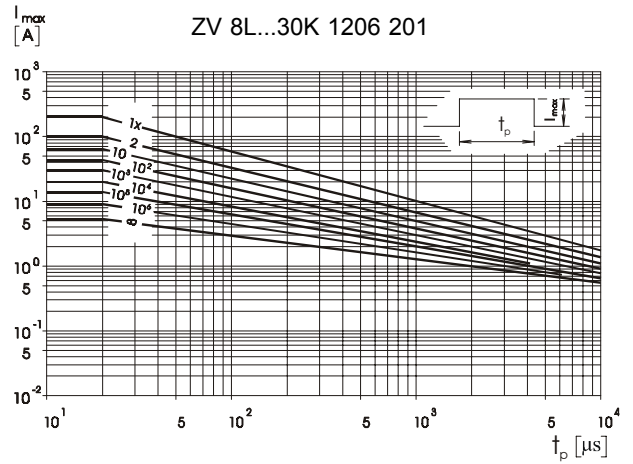
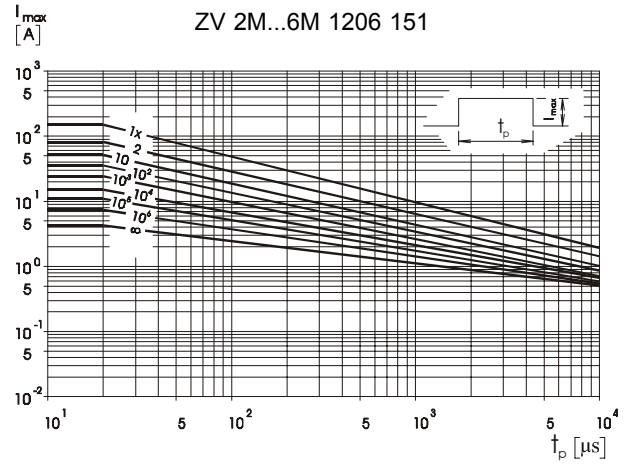


Performance Characteristics

Voltage/Current Curves

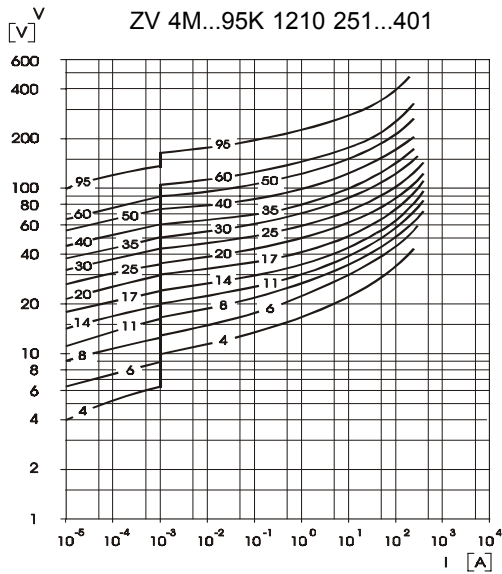


Pulse Rating Curves

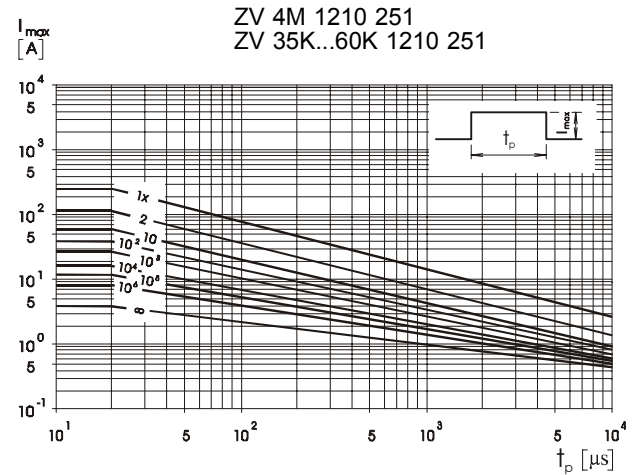


Performance Characteristics

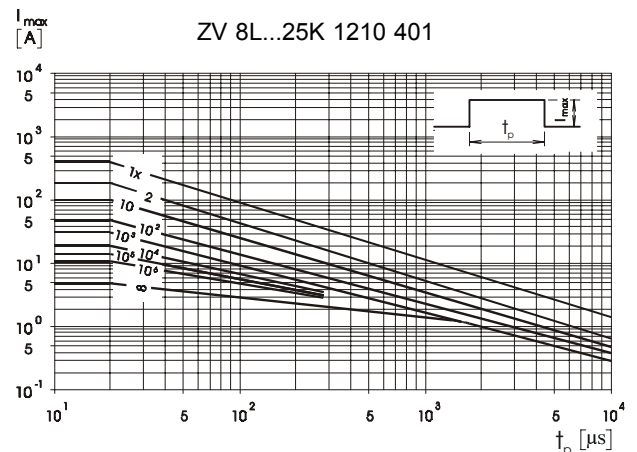
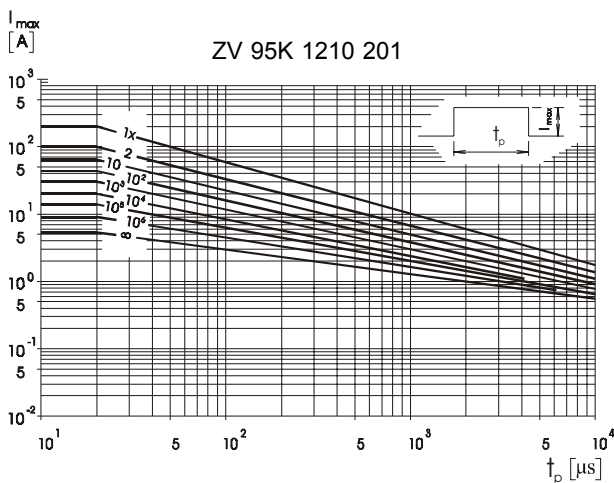
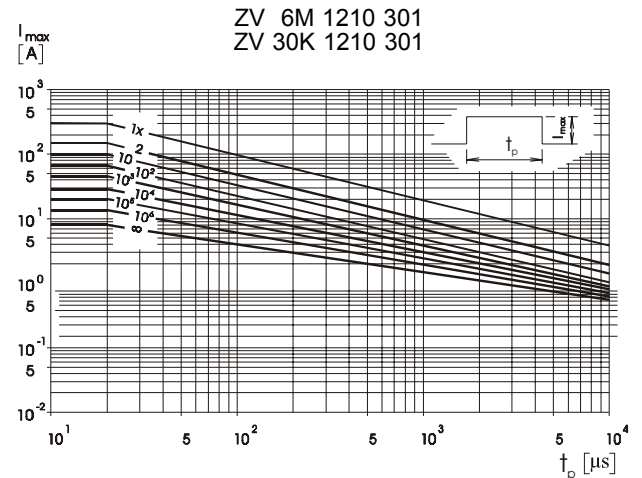
Voltage/Current Curves



Pulse Rating Curves

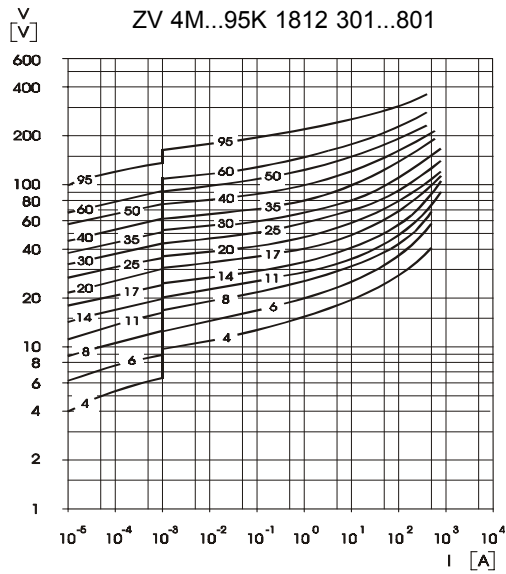


Pulse Rating Curves

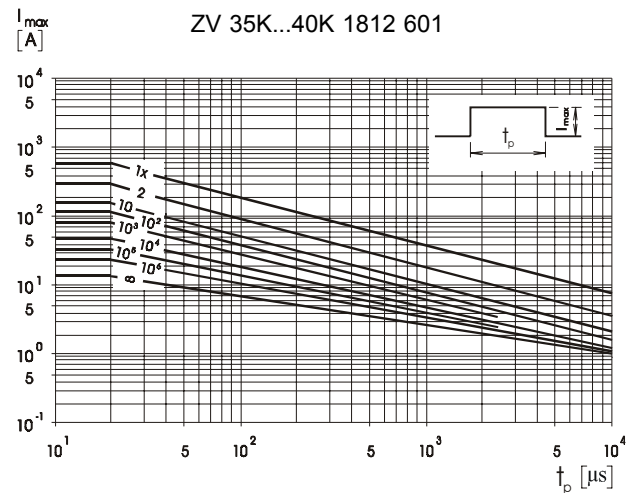
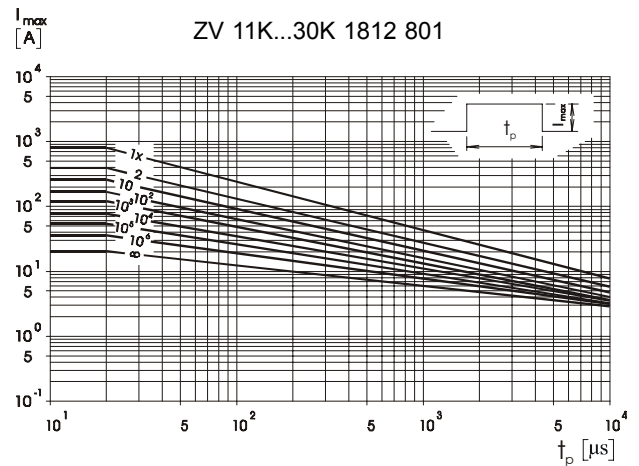


Performance Characteristics

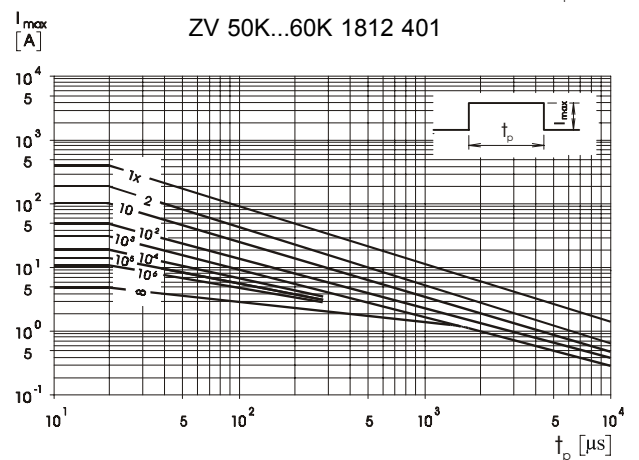
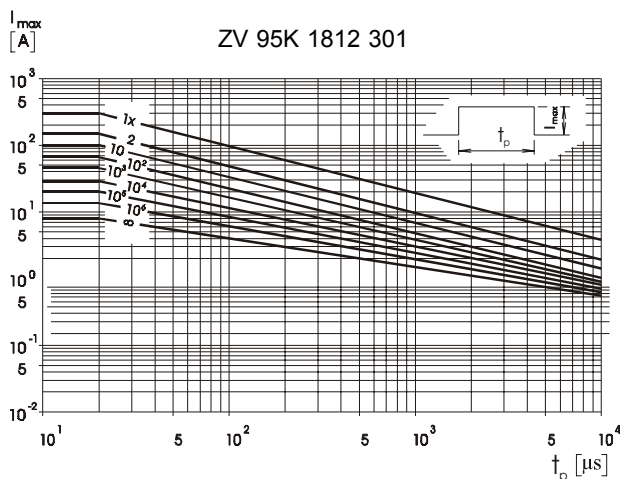
Voltage/Current Curves



Pulse Rating Curves



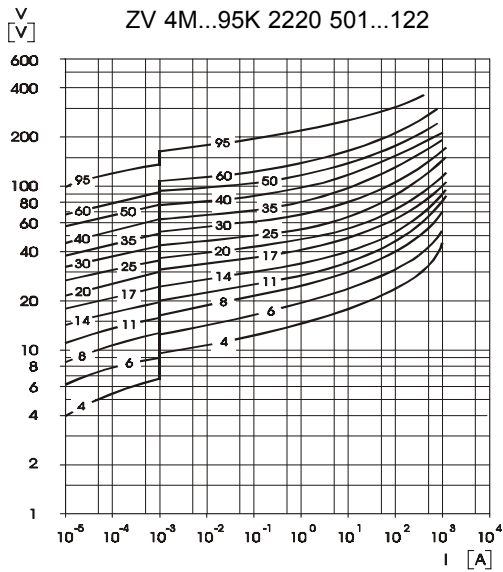
Pulse Rating Curves



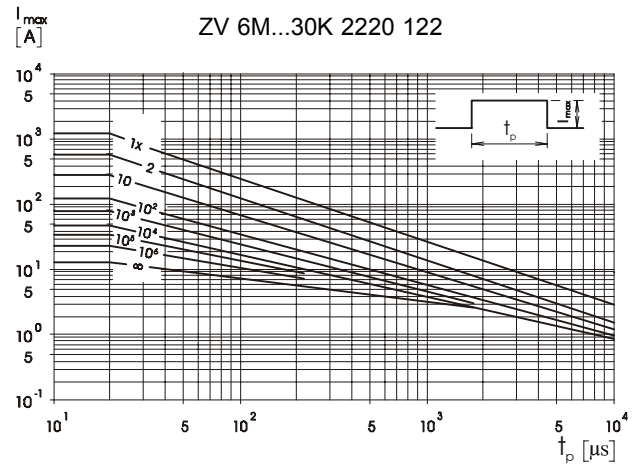


Performance Characteristics

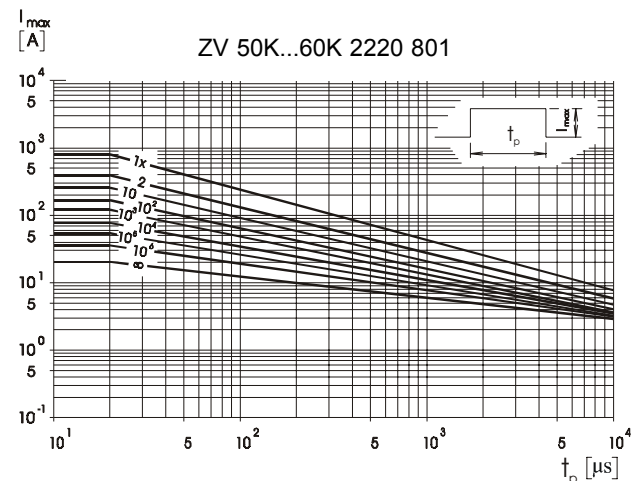
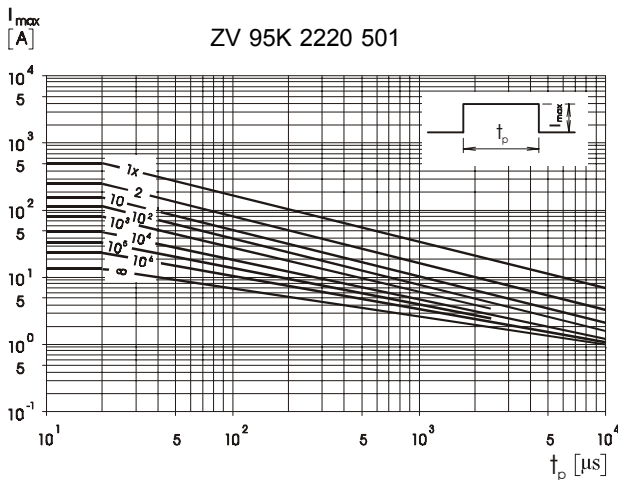
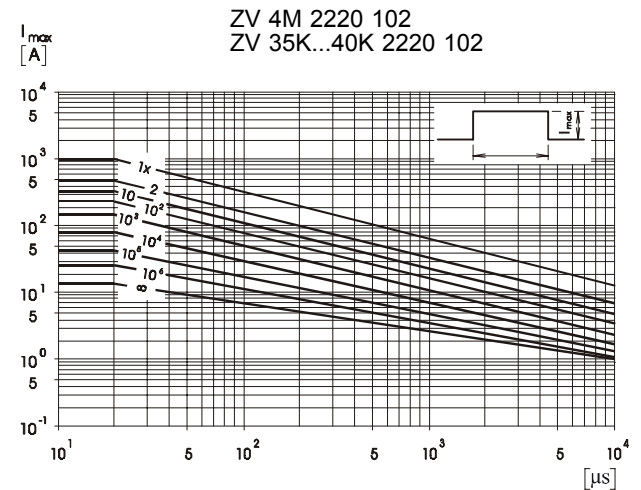
Voltage/Current Curves



Pulse Rating Curves



Pulse Rating Curves





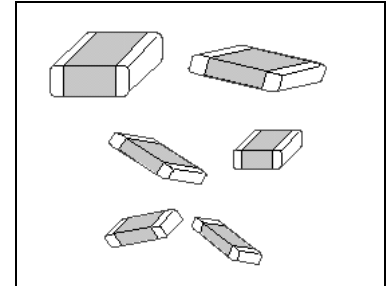
**Multilayer Technology**

**Varistor Plus**

**Description**

The ZVX Series are low-energy (0.1 joules) varistor chips, designed specifically for the protection of I/O line drivers and other sensitive semiconductor gates from the damaging effects of high voltage, low-energy transients such as ESD events. Unlike other competitive low-energy varistors, however, the ZVX Series offers all the protection features of standard varistor chips, and exceptionally low values of capacitance. In these applications, as the frequency of data transfer increases, lower capacitance is required to eliminate possible skewing of the data signals due to capacitive loading.

In most cases, the 1KHz capacitance values of the ZVX Series are less than one half that of the competition. Further, this series is offered in 0603, 0805 and 1206 sizes, with an expanded range of voltages from 3V to 38Vdc. The ZVX Series offers a circuit design engineer the greatest range of high-frequency, low-energy SMD varistor chips available in the marketplace today.



**Features**

- Operating voltage range ( $V_{RMS}$ ) .....2V to 30V
- Part number voltage range ( $V_{DC}$ ).....3V to 38V
- +125C continuous operating temperature
- Bi-directional, low clamping voltages
- Exceptionally low capacitance ratings
- 3 model sizes available....0603, 0805, 1206
- Dimensional and weight savings on PC board
- AgPd end terminations
- Non-coated chips guarantee excellent flammability rating
- Available in tape and reel for automatic pick and place

**Applications**

- ESD protection for components sensitive to IEC 1000-4-2, MIL-STD 883C Method 3015.7 and other industry specifications
- Excellent for I/O line protection, operating at high-speed data transfer rates, due to very low capacitance values
- Replaces larger surface mount TVS diodes in many applications

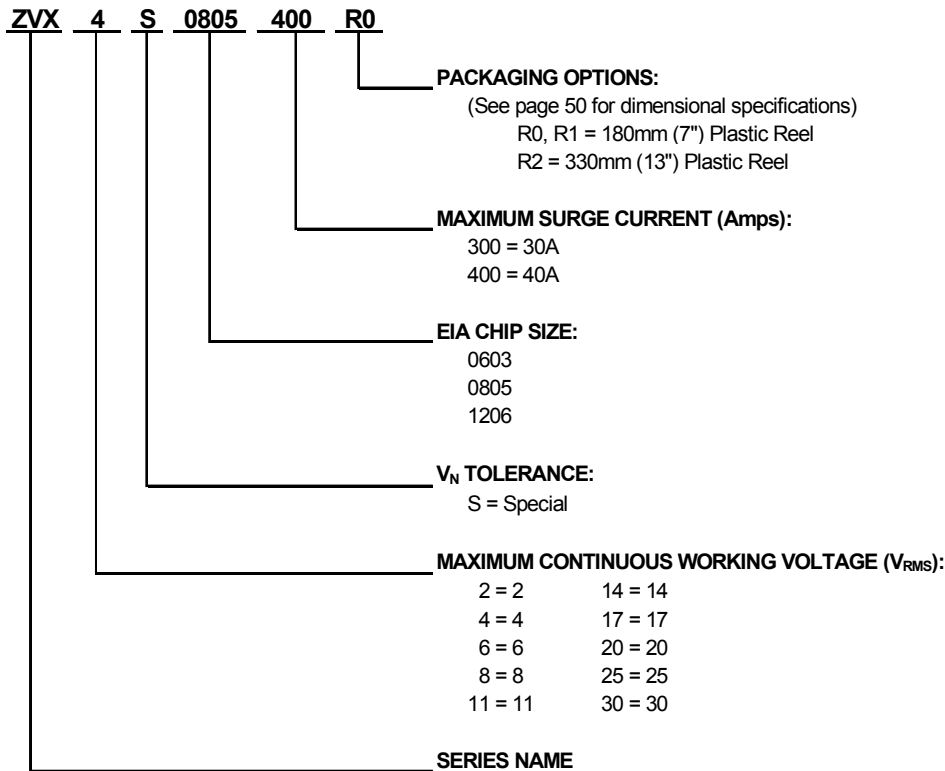
**Absolute Maximum Ratings**

<b>Continuous:</b>	Value
Steady State Applied Voltage:	
DC Voltage Range ( $V_{DC}$ )	3V to 38V
AC Voltage Range ( $V_{RMS}$ )	2V to 30V
<b>Transient:</b>	
Single Pulse Surge Current ( $I_P$ ), 8/20 $\mu$ s Waveform	30A to 40A
Single Pulse Energy Absorption ( $W_{MAX}$ ), 10/1000 $\mu$ s Waveform	0.1J
Operating Ambient Temperature	-55°C to +125°C
Storage Temperature Range	-55°C to +150°C
Threshold Voltage Temperature Coefficient	< - 0.05%/°C
Response Time	< 2ns

Multilayer Technology

Varistor Plus

HOW TO ORDER: ZVX SERIES (LOW ENERGY, LOW CAPACITANCE SMD VARISTORS)



Standard Packaging Options / Quantities

Series	Voltage Range (V <sub>RMS</sub> )	Chip Size								
		0603			0805			1206		
		R0	R1	R2	R0	R1	R2	R0	R1	R2
		180mm	180mm	330mm	180mm	180mm	330mm	180mm	180mm	330mm
		7"	7"	13"	7"	7"	13"	7"	7"	13"
ZVX	2 to 14	1000	4000	15000	1000	4000	15000	1000	4000	15000
	17	1000	3500	14000	1000	3500	14000	1000	2500	14000
	20 to 30	1000	3500	14000	1000	3500	14000	1000	2500	10000

Note: Chips packaged in plastic embossed tape.

Multilayer Technology

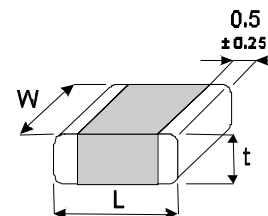
Varistor Plus

Device Ratings and Characteristics

ZVX 2S 0603 300 -- to ZVX 30S 1206 400 --

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> 1 mA	V <sub>C</sub>	I <sub>C</sub> 8/20 μs	W <sub>MAX</sub> 10/1000 μs	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C <sub>(TYP)</sub> 1kHz	L <sub>(TYP)</sub>
										100 mA/nS
Unit of Measure	Volts	Volts	Volts	Volts	Amps	Joules	Watts	Amps	pF	nH
ZVX 2S 0603 300 --	2	3.3	4.1-6.0	10	1	0.1	0.003	30	200	1.0
ZVX 4S 0603 300 --	4	5.6	7.6-9.3	15.5	1	0.1	0.003	30	165	1.0
ZVX 6S 0603 300 --	6	9	11.0-14.0	20	1	0.1	0.003	30	145	1.0
ZVX 8S 0603 300 --	8	12	14.0-18.3	25	1	0.1	0.003	30	135	1.0
ZVX 11S 0603 300 --	11	14	16.5-20.3	40	1	0.1	0.003	30	120	1.0
ZVX 14S 0603 300 --	14	18	22.9-28.0	38	1	0.1	0.003	30	110	1.0
ZVX 17S 0603 300 --	17	22	25.2-31.3	48	1	0.1	0.003	30	100	1.0
ZVX 20S 0603 300 --	20	26	31.0-38.0	58	1	0.1	0.003	30	100	1.0
ZVX 25S 0603 300 --	25	30	37.0-46.9	65	1	0.1	0.003	30	90	1.0
ZVX 30S 0603 300 --	30	38	42.3-51.7	77	1	0.1	0.003	30	80	1.0
ZVX 2S 0805 400 --	2	3.3	4.1-6.0	10	1	0.1	0.005	40	500	1.5
ZVX 4S 0805 400 --	4	5.6	7.6-9.3	15.5	1	0.1	0.005	40	340	1.5
ZVX 6S 0805 400 --	6	9	11.0-14.0	20	1	0.1	0.005	40	290	1.5
ZVX 8S 0805 400 --	8	12	14.0-18.3	25	1	0.1	0.005	40	275	1.5
ZVX 11S 0805 400 --	11	14	16.5-20.3	30	1	0.1	0.005	40	200	1.5
ZVX 14S 0805 400 --	14	18	22.9-28.0	40	1	0.1	0.005	40	165	1.5
ZVX 17S 0805 400 --	17	22	25.2-31.3	48	1	0.1	0.005	40	145	1.5
ZVX 20S 0805 400 --	20	26	31.0-38.0	58	1	0.1	0.005	40	140	1.5
ZVX 25S 0805 400 --	25	30	37.0-46.9	65	1	0.1	0.005	40	110	1.5
ZVX 30S 0805 400 --	30	38	42.3-51.7	77	1	0.1	0.005	40	100	1.5
ZVX 2S 1206 400 --	2	3.3	4.1-6.0	10	1	0.1	0.008	40	840	1.8
ZVX 4S 1206 400 --	4	5.6	7.6-9.3	15.5	1	0.1	0.008	40	720	1.8
ZVX 6S 1206 400 --	6	9	11.0-14.0	20	1	0.1	0.008	40	620	1.8
ZVX 8S 1206 400 --	8	12	14.0-18.3	25	1	0.1	0.008	40	540	1.8
ZVX 11S 1206 400 --	11	14	16.5-20.3	30	1	0.1	0.008	40	500	1.8
ZVX 14S 1206 400 --	14	18	22.9-28.0	40	1	0.1	0.008	40	250	1.8
ZVX 17S 1206 400 --	17	22	25.2-31.3	48	1	0.1	0.008	40	210	1.8
ZVX 20S 1206 400 --	20	26	31.0-38.0	58	1	0.1	0.008	40	200	1.8
ZVX 25S 1206 400 --	25	30	37.0-46.9	65	1	0.1	0.008	40	180	1.8
ZVX 30S 1206 400 --	30	38	42.3-51.7	77	1	0.1	0.008	40	165	1.8

ZVX Series - Low Voltage SMD Varistors				
Chip Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)		
		L	W	t <sub>MAX</sub>
0603	2 - 30	1.60 ± 0.15	0.80 ± 0.10	0.9
0805	2 - 30	2.00 ± 0.20	1.25 ± 0.15	1.0
1206	2 - 30	3.20 ± 0.30	1.60 ± 0.20	1.0



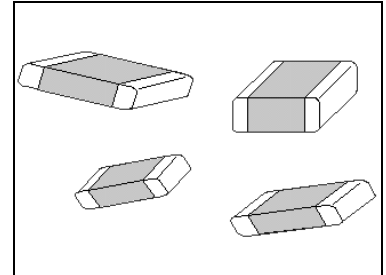
**Multilayer Technology**

**Varistor Plus**

**Description**

ZVE surface mounted varistors are designed to suppress ESD events, including those specified in IEC1000-4-2 or other standards used for Electromagnetic Compliance testing. The ZVE Series is typically applied to protect integrated circuits and other components at the circuit board level operating at 18 V<sub>DC</sub> or less.

Fabrication method, design and materials of these devices result in low capacitance characteristics suitable for high-frequency attenuation / low-pass filter circuit functions, providing suppression and filtering in a single device.



**Features**

- Operating voltage range (V<sub>DC</sub>)....0V to 18V
- Part number voltage range (V<sub>RMS</sub>)....0V to 14V
- Rated for ESD (IEC-1000-4-2)
- Fast response time
- Bi-directional, low clamping voltages
- 4 model sizes available .....0603, 0805, 1206, 1210
- Characterized for low inductance and capacitance
- + 125°C continuous operating temperature
- Dimensional and weight savings on PC board
- AgPd end terminations
- No plastic coating guarantees better flammability rating
- Available in tape and reel for automatic pick and place

**Applications**

- Protection of components and circuits sensitive to ESD transients occurring on power, control and signal lines
- Suppression of ESD events such as specified in IEC 1000-4-2 or MIL-STD 883C, Method 3015.7 for Electromagnetic Compliance (EMC)
- Used for port and I/O interface protection in mobile communication, computer/EDP products, medical products, hand held / portable devices and industrial equipment

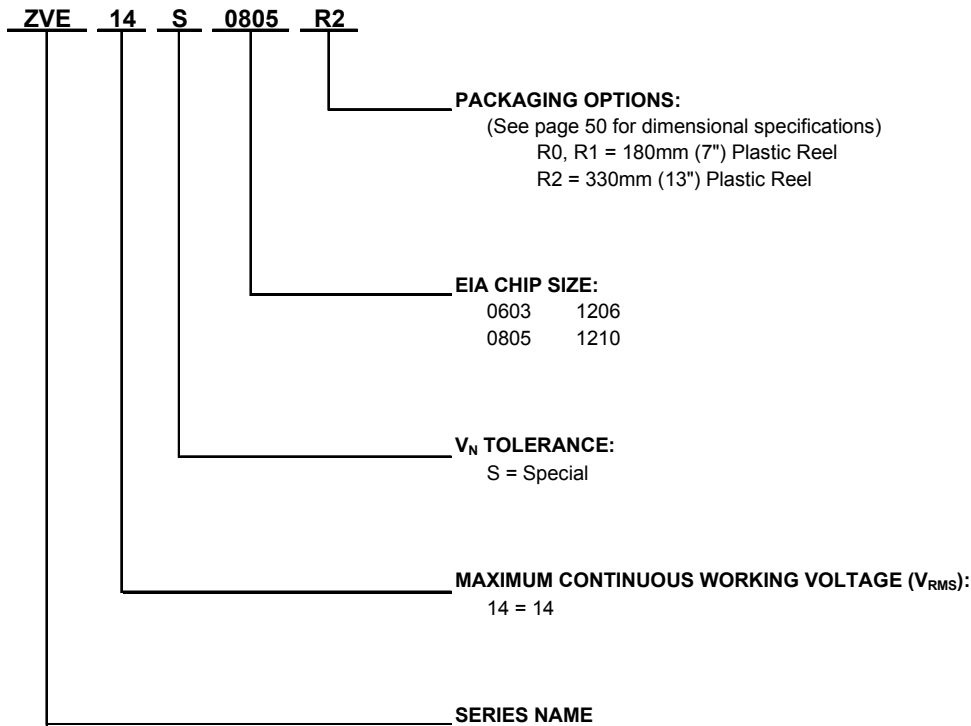
**Absolute Maximum Ratings**

<b>Continuous:</b>	Value
Steady State Applied Voltage:	
DC Voltage Range (V <sub>DC</sub> )	≤ 18V
AC Voltage Range (V <sub>RMS</sub> )	≤ 14V
<b>Transient:</b>	
Peak Single Pulse Surge Current (I <sub>p</sub> ), 8/20 μs Waveform	20A, 30A
Single Pulse Surge Energy (W <sub>MAX</sub> ), 10/1000 μs Waveform	0.05J to 0.1J
Operating Ambient Temperature	-55°C to + 125°C
Storage Temperature Range	-55°C to + 150°C
Threshold Voltage Temperature Coefficient	< - 0.05%/°C
Response Time	< 1ns

Multilayer Technology

Varistor Plus

HOW TO ORDER: ZVE SERIES (ELECTROSTATIC DISCHARGE SMD VARISTORS)



Standard Packaging Options / Quantities

Series	Voltage Range ( $V_{RMS}$ )	Chip Size					
		0603			0805		
		R0	R1	R2	R0	R1	R2
		180mm	180mm	330mm	180mm	180mm	330mm
		7"	7"	13"	7"	7"	13"
	14	1000	4000	15000	1000	4000	15000
ZVE	Voltage Range ( $V_{RMS}$ )	1206			1210		
		R0	R1	R2	R0	R1	R2
		180mm	180mm	330mm	180mm	180mm	330mm
		7"	7"	13"	7"	7"	13"
	14	1000	4000	15000	1000	4000	15000

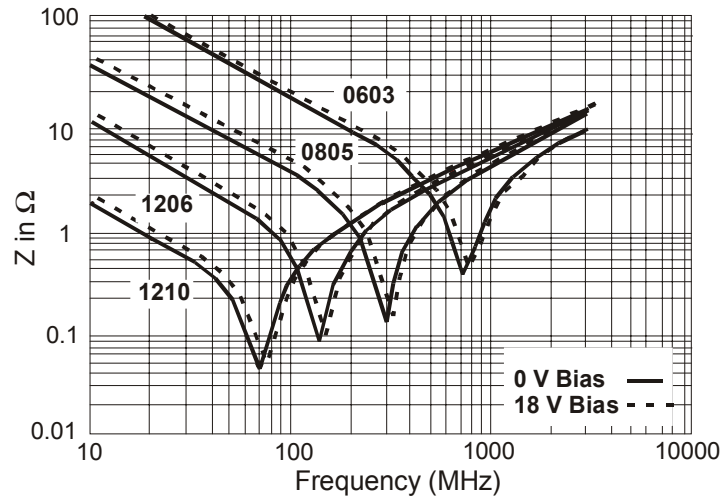
Note: Chips packaged in plastic embossed tape.

Device Ratings and Characteristics

ZVE 14 S 0603 -- to ZVE 14 S 1210 --

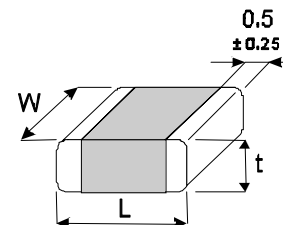
Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> 1 mA	V <sub>C</sub> 8/20 μs	I <sub>C</sub> 8/20 μs	W <sub>MAX</sub> 10/1000 μs	P <sub>MAX</sub>	C <sub>(TYP)</sub> 1MHz	L <sub>(TYP)</sub> 100 mA/nS
Unit of Measure	Volts	Volts	Volts	Volts	Amps	Joules	Watts	pF	nH
ZVE 14 S 0603 --	14	18	22 to 28	50	2	0.05	0.003	75	< 1.0
ZVE 14 S 0805 --	14	18	22 to 28	50	2	0.10	0.004	100	< 1.5
ZVE 14 S 1206 --	14	18	22 to 28	50	2	0.10	0.004	200	< 1.8
ZVE 14 S 1210 --	14	18	22 to 28	50	2	0.10	0.004	400	< 3.5

Performance Characteristics



Capacitance - Frequency Characteristics

ZVE Series - ESD Suppression SMD Varistors				
Chip Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)		
		L	W	t <sub>MAX</sub>
0603	14	1.60 ± 0.15	0.80 ± 0.10	0.9
0805	14	2.00 ± 0.20	1.25 ± 0.15	0.9
1206	14	3.20 ± 0.30	1.60 ± 0.20	1.2
1210	14	3.20 ± 0.30	2.50 ± 0.25	1.2

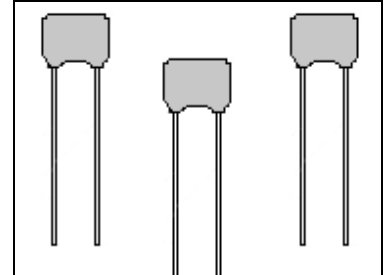


**Multilayer Technology**

**Varistor Plus**

**Description**

The ZV Series of low voltage leaded multilayer varistors (MLVs) is designed to protect sensitive electronics devices operating in the low voltage region against high voltage/current surges. They offer excellent transient energy absorption due to improved energy volume distribution and power dissipation. Low voltage MLVs cover a wide DC operating voltage range from 3V to 56V.



**Features**

- Operating voltage range ( $V_{DC}$ ) .....3V to 56V
- Part number voltage range ( $V_{RMS}$ ) .....2V to 40V
- 5 model sizes available .....05, 07, 10, 14, 20
- Bi-directional, lower clamping voltages than disc type varistors
- Broad range of current and energy handling capabilities
- +125°C continuous operating temperature
- Dimensional and weight savings on PC board
- Available with straight or crimped leads
- Available in tape and reel for automatic insertion

**Applications**

- Suppression of inductive switching or other transient events at the circuit board level
- Provides on-board transient voltage protection for ICs and transistors
- Used to help achieve electromagnetic compliance of end products
- Replace larger TVS Zener diodes in many applications

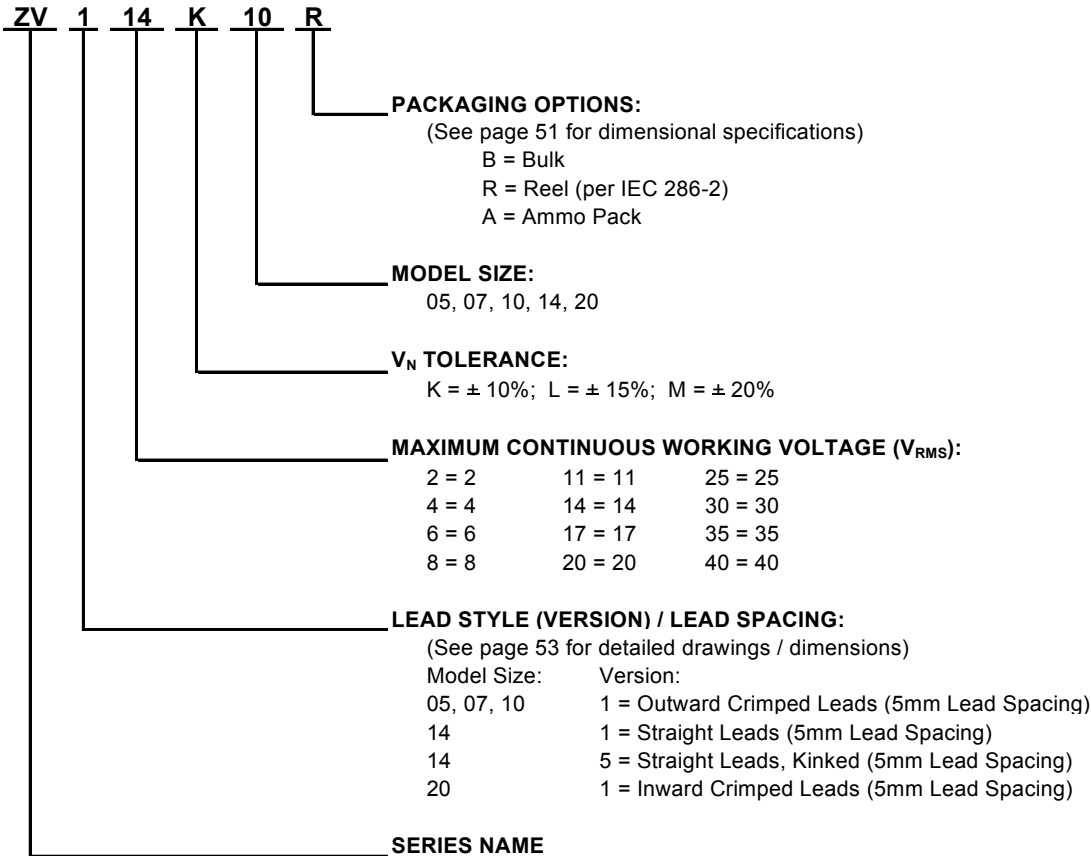
**Absolute Maximum Ratings**

<b>Continuous:</b>	Value
Steady State Applied Voltage:	
DC Voltage Range ( $V_{DC}$ )	3V to 56V
AC Voltage Range ( $V_{RMS}$ )	2V to 40V
<b>Transient:</b>	
Peak Single Pulse Surge Current ( $I_P$ ), 8/20 $\mu$ s Waveform	100A to 2000A
Single Pulse Surge Energy ( $W_{MAX}$ ), 10/1000 $\mu$ s Waveform	0.1J to 37.8J
Operating Ambient Temperature	-40°C to +125°C
Storage Temperature Range	-40°C to +150°C
Threshold Voltage Temperature Coefficient	< - 0.05%/°C
Insulation Resistance	> 1G $\Omega$
Isolation Voltage Capability	> 1kV
Response Time	< 25ns

Multilayer Technology

Varistor Plus

HOW TO ORDER: ZV SERIES (LOW VOLTAGE LEADED VARISTORS)



Standard Packaging Options / Quantities

Series	Voltage Range (V <sub>RMS</sub> )	Model Size	Packaging Options		
			B = Bulk; R = Reel; A = Ammo Pack		
			B	R	A
ZV	2 to 40	05	2000	2000	2000
	2 to 40	07	2000	2000	2000
	2 to 40	10	1000	1000	1000
	2 to 40	14	700	1000	1000
	2 to 40	20	500	800	800



Multilayer Technology

Varistor Plus

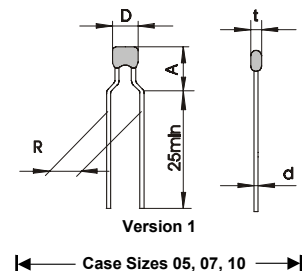
Device Ratings and Characteristics

ZV 2M 05 - to ZV 40K 10 -

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> @ 1 mA	V <sub>C</sub>	I <sub>C</sub>	W <sub>MAX</sub> 10/1000 μs	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C <sub>(TYP)</sub> 1kHz
Unit of Measure	Volts	Volts	Volts	Volts	Amps	Joules	Watts	Amps	pF
ZV 2 M 05 -	2	3	4	10	1	0.1	0.005	100	1300
ZV 4 M 05 -	4	5.5	8	14	1	0.1	0.005	100	1100
ZV 6 M 05 -	6	8	11	21	1	0.2	0.005	100	900
ZV 8 L 05 -	8	11	15	25	1	0.2	0.005	100	700
ZV 11 K 05 -	11	14	18	33	1	0.3	0.005	100	500
ZV 14 K 05 -	14	18	22	38	1	0.4	0.005	100	400
ZV 17 K 05 -	17	22	27	44	1	0.5	0.005	100	340
ZV 20 K 05 -	20	26	33	54	1	0.6	0.005	100	300
ZV 25 K 05 -	25	31	39	65	1	0.7	0.005	100	510
ZV 30 K 05 -	30	38	47	77	1	0.9	0.005	100	450
ZV 35 K 05 -	35	45	56	90	1	1.2	0.005	100	410
ZV 40 K 05 -	40	56	68	110	1	1.4	0.005	100	370
ZV 2 M 07 -	2	3	4	10	2.5	0.2	0.008	200	5000
ZV 4 M 07 -	4	5.5	8	14	2.5	0.3	0.008	200	4300
ZV 6 M 07 -	6	8	11	21	2.5	0.5	0.008	200	3200
ZV 8 L 07 -	8	11	15	25	2.5	0.6	0.008	250	1950
ZV 11 K 07 -	11	14	18	33	2.5	0.8	0.008	250	1300
ZV 14 K 07 -	14	18	22	38	2.5	0.9	0.008	250	950
ZV 17 K 07 -	17	22	27	44	2.5	1.2	0.008	250	740
ZV 20 K 07 -	20	26	33	54	2.5	1.4	0.008	250	620
ZV 25 K 07 -	25	31	39	65	2.5	1.6	0.008	250	1150
ZV 30 K 07 -	30	38	47	77	2.5	2.2	0.008	250	950
ZV 35 K 07 -	35	45	56	90	2.5	2.6	0.008	250	950
ZV 40 K 07 -	40	56	68	110	2.5	3.2	0.008	250	750
ZV 4 M 10 -	4	5.5	8	14	5	0.4	0.010	300	5000
ZV 6 M 10 -	6	8	11	21	5	0.8	0.010	300	4100
ZV 8 L 10 -	8	11	15	25	5	1.1	0.010	500	3400
ZV 11 K 10 -	11	14	18	33	5	1.7	0.010	500	2600
ZV 14 K 10 -	14	18	22	38	5	2.2	0.010	500	2150
ZV 17 K 10 -	17	22	27	44	5	2.6	0.010	500	1800
ZV 20 K 10 -	20	26	33	54	5	3.2	0.010	500	1500
ZV 25 K 10 -	25	31	39	65	5	3.8	0.010	500	1350
ZV 30 K 10 -	30	38	47	77	5	4.4	0.010	500	1100
ZV 35 K 10 -	35	45	56	90	5	5.4	0.010	500	1000
ZV 40 K 10 -	40	56	68	110	5	6.4	0.010	500	820

ZV Series - Low Voltage Leaded Varistors						
Model Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)				
		D <sub>MAX</sub>	h/A <sub>MAX</sub>	R	d	t <sub>MAX</sub> *
05	2 - 40	5	7	5	0.6	4.5
07	2 - 40	7	9	5	0.6	4.5
10	4 - 40	7	9	5	0.6	4.5

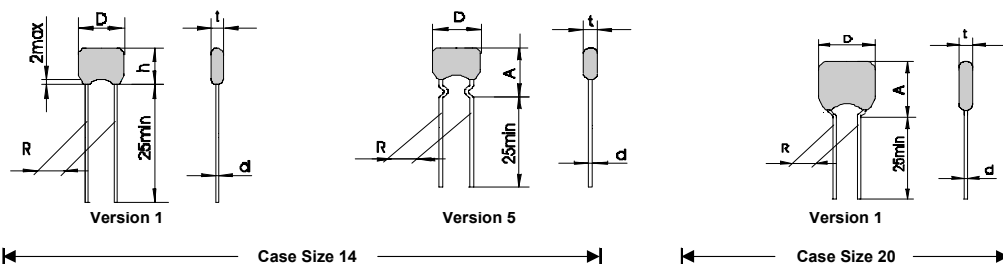
\* Thickness dimensions on 2 - 17 V<sub>RMS</sub> devices are typically 3.5 mm



Device Ratings and Characteristics

ZV 4M 14 - to ZV 40K 20 -

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> @ 1 mA	V <sub>C</sub>	I <sub>C</sub>	W <sub>MAX</sub> 10/1000 μs	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C (TYP) 1kHz
Unit of Measure	Volts	Volts	Volts	Volts	Amps	Joules	Watts	Amps	pF
ZV 4 M 14 -	4	5.5	8	14	10	0.8	0.015	500	10000
ZV 6 M 14 -	6	8	11	21	10	1.0	0.015	500	7500
ZV 8 L 14 -	8	11	15	25	10	1.9	0.015	800	6500
ZV 11 K 14 -	11	14	18	33	10	3.3	0.015	1000	5100
ZV 14 K 14 -	14	18	22	38	10	4.2	0.015	1000	4000
ZV 17 K 14 -	17	22	27	44	10	5.2	0.015	1000	3500
ZV 20 K 14 -	20	26	33	54	10	6.4	0.015	1000	3000
ZV 25 K 14 -	25	31	39	65	10	7.2	0.015	1000	2500
ZV 30 K 14 -	30	38	47	77	10	9.4	0.015	1000	2000
ZV 35 K 14 -	35	45	56	90	10	10.2	0.015	1000	1450
ZV 40 K 14 -	40	56	68	110	10	13.4	0.015	1000	1100
ZV 4 M 20 -	4	5.5	8	14	20	1.5	0.020	1000	19500
ZV 6 M 20 -	6	8	11	21	20	3.8	0.020	1000	17000
ZV 8 L 20 -	8	11	15	25	20	4.3	0.020	1500	16000
ZV 11 K 20 -	11	14	18	33	20	10.5	0.020	2000	13000
ZV 14 K 20 -	14	18	22	38	20	12.0	0.020	2000	10000
ZV 17 K 20 -	17	22	27	44	20	14.2	0.020	2000	8000
ZV 20 K 20 -	20	26	33	54	20	18.2	0.020	2000	6500
ZV 25 K 20 -	25	31	39	65	20	22.4	0.020	2000	5000
ZV 30 K 20 -	30	38	47	77	20	25.8	0.020	2000	4000
ZV 35 K 20 -	35	45	56	90	20	33.4	0.020	2000	3000
ZV 40 K 20 -	40	56	68	110	20	37.8	0.020	2000	2200

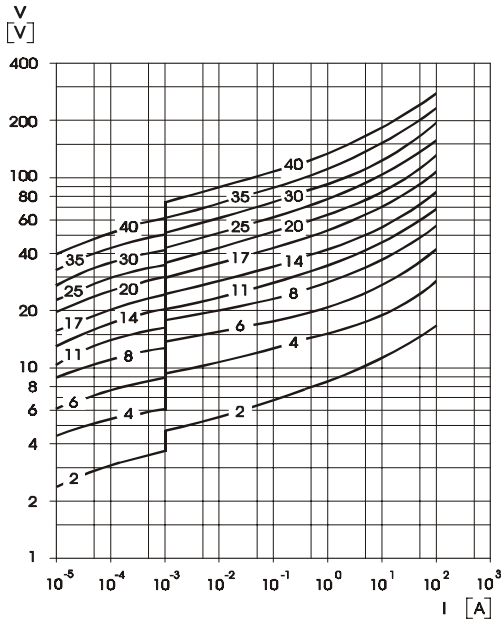


ZV Series - Low Voltage Leaded Varistors						
Model Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)				
		D <sub>MAX</sub>	h/A <sub>MAX</sub>	R	d	t <sub>MAX</sub> *
14	4 - 40	8	12	5	0.6	4.5
20	4 - 40	9	12	5	0.6	4.5

\* Thickness dimensions on 2 - 17 V<sub>RMS</sub> devices are typically 3.5 mm

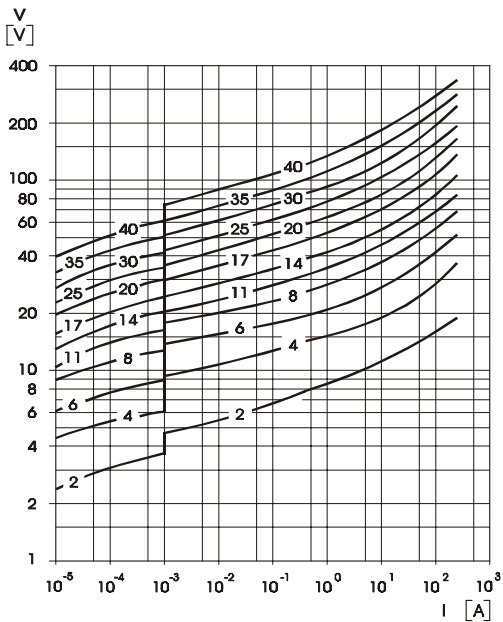
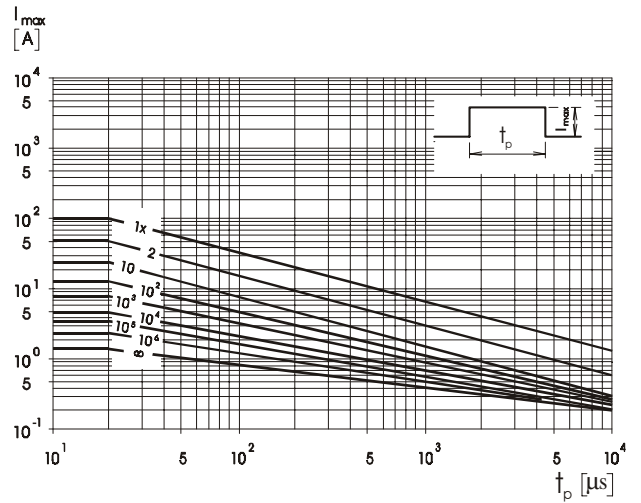
Performance Characteristics

Voltage/Current Curves

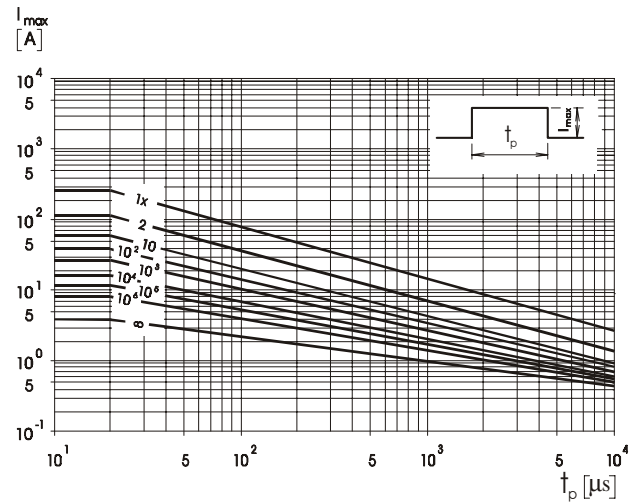


ZV 2M...40K 05

Pulse Rating Curves



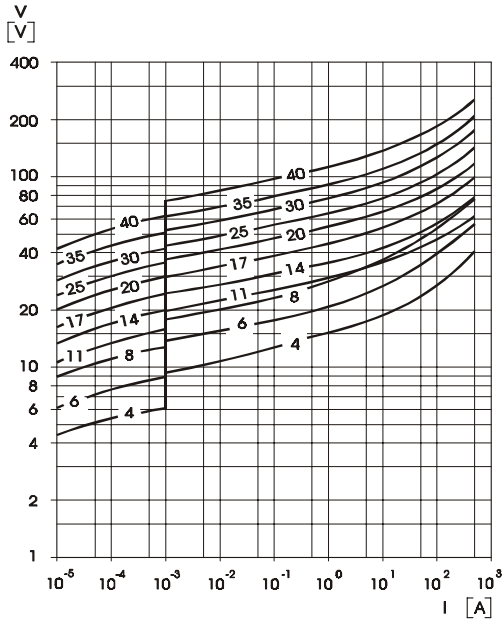
ZV 2M...40K 07



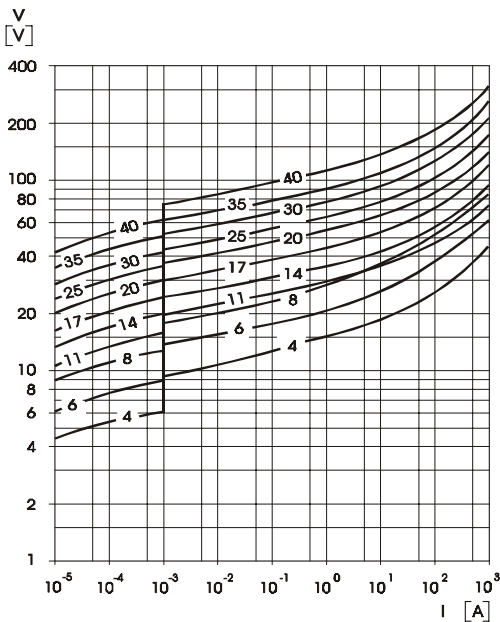
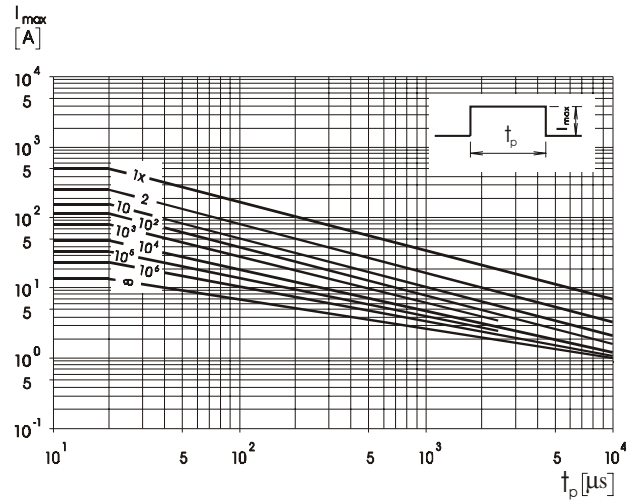
Performance Characteristics

Voltage/Current Curves

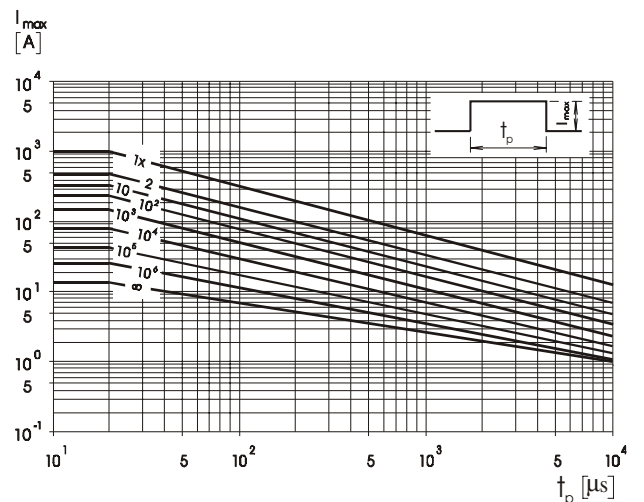
Pulse Rating Curves



ZV 4M...40K 10

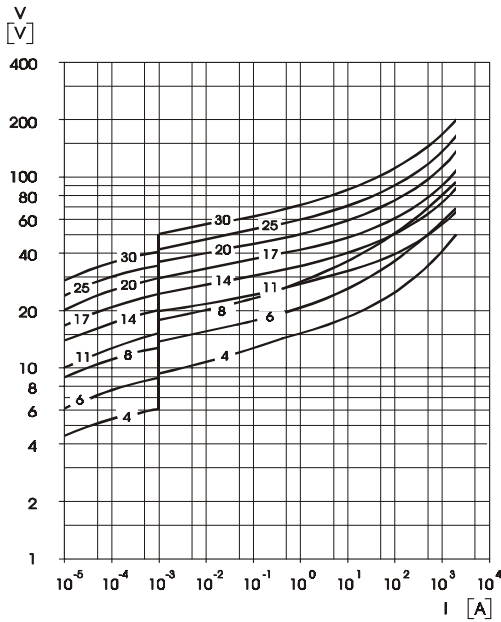


ZV 4M...40K 14



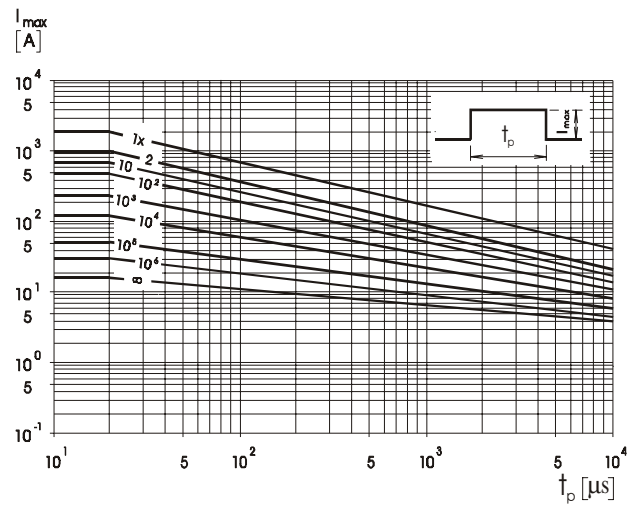
Performance Characteristics

Voltage/Current Curves



ZV 4M...40K 20

Pulse Rating Curves

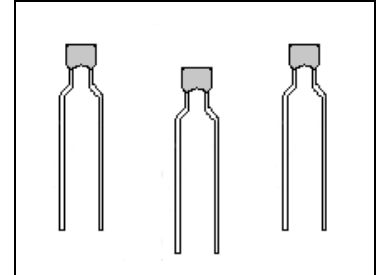


**Description**

MV Series varistors/suppressors are dual function devices that protect electronic equipment operating in the low voltage region against voltage surges and high-frequency noise, replacing two components: a low voltage varistor and a capacitor.

The MV Series incorporates a varistor function in the DC voltage range from 3V to 125V and the function of a high-frequency by-pass capacitor operating in the capacitance range from 10 nF to 1000 nF. They are intended for protection of all sensitive electronic devices experiencing both voltage transients and high-frequency noise produced by electromechanical devices such as buzzers, relays, etc.

MV varistors/suppressors are square shaped components with in-line leads, which require at least 30% less mounting space than the two components they replace.



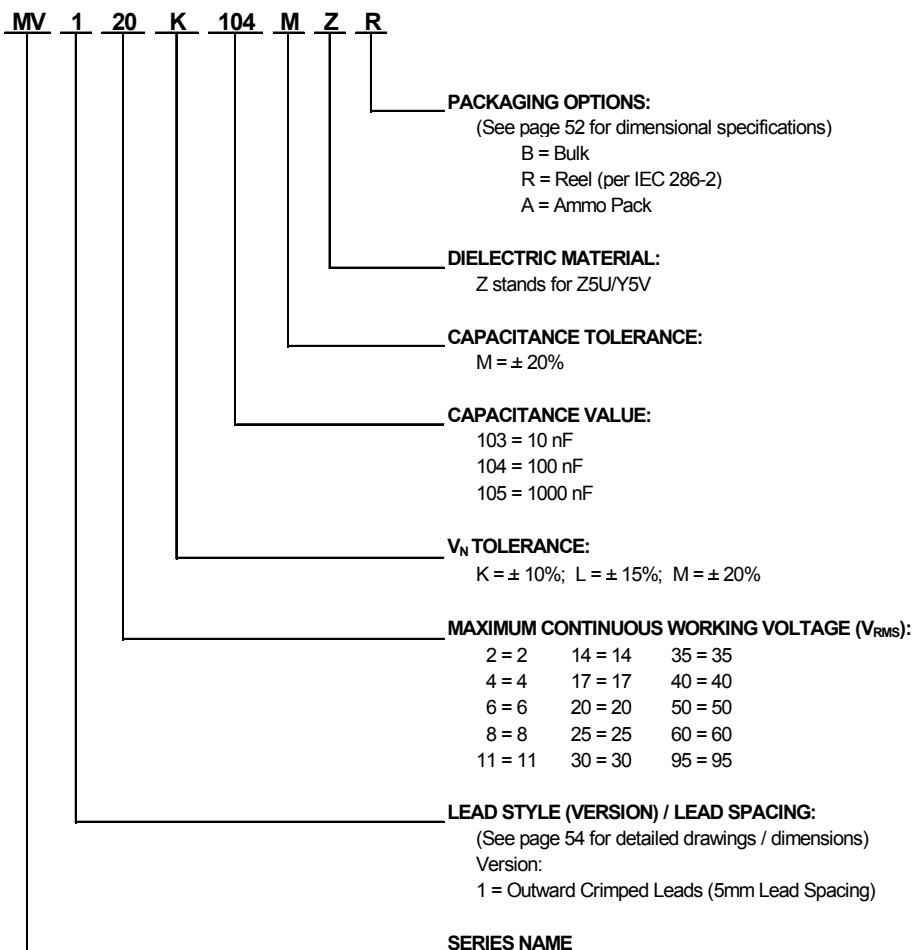
**Features**

- Operating voltage range ( $V_{DC}$ ).....3V to 125V
- Part number voltage range ( $V_{RMS}$ ).....2V to 95V
- Capacitance range C (@1 kHz) .....10 nF to 1000 nF
- Capacitor temperature characteristics ..... Z5U/Y5V
- Protects against voltage transients and suppresses high-frequency interference
- Dimensional and weight savings on PC board
- One model size available ..... 6 x 9 mm
- In-line leads
- Available with crimped leads
- Available in tape and reel for automatic pick and place

**Absolute Maximum Ratings**

<b>Continuous:</b>	Value
Steady State Applied Voltage:	
DC Voltage Range ( $V_{DC}$ )	3V to 125V
AC Voltage Range ( $V_{RMS}$ )	2V to 95V
<b>Transient:</b>	
Single Pulse Surge Current ( $I_P$ ), 8/20 $\mu$ s Waveform	150A
Single Pulse Energy Absorption ( $W_{MAX}$ ), 10/1000 $\mu$ s Waveform	0.1J to 2.5J
Capacitance Range	10nF to 1000nF
Capacitor Temperature Characteristics	Z5U or Y5V
Operating Ambient Temperature	-40°C to +85°C
Storage Temperature Range	-40°C to +125°C
Threshold Voltage Temperature Coefficient	< - 0.05%/°C
Insulation Resistance	> 1G $\Omega$
Isolation Voltage Capability	> 1kV
Response Time	< 25ns

**HOW TO ORDER: MV SERIES (LOW VOLTAGE, DUAL FUNCTION LEADED DEVICES)**



**Standard Packaging Options / Quantities**

Series	Voltage Range (V <sub>RMS</sub> )	Model Size	Packaging Options		
			B = Bulk	R = Reel	A = Ammo Pack
			B	R	A
MV	2 to 95	6 x 9mm	2000	2000	2500

# MV Series – Low Voltage Leaded Dual Function Varistors/ RFI Suppressors



Multilayer Technology

Varistor Plus

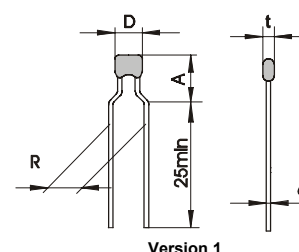
## Device Ratings and Characteristics

### MV 2 M 103 MZ - to MV 20 K 105 MZ -

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> @ 1 mA	V <sub>C</sub> @ 1 A	W <sub>MAX</sub> 10/1000 μs	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C (TYP) @1 kHz
Unit of Measure	Volts	Volts	Volts	Volts	Joules	Watts	Amps	nF
MV 2 M 103 MZ -	2	3	4	10	0.1	0.01	150	10
MV 2 M 104 MZ -	2	3	4	10	0.1	0.01	150	100
MV 2 M 105 MZ -	2	3	4	10	0.1	0.01	150	1000
MV 4 L 103 MZ -	4	5.5	8	14	0.2	0.01	150	10
MV 4 L 104 MZ -	4	5.5	8	14	0.2	0.01	150	100
MV 4 L 105 MZ -	4	5.5	8	14	0.2	0.01	150	1000
MV 6 L 103 MZ -	6	8	11	21	0.2	0.01	150	10
MV 6 L 104 MZ -	6	8	11	21	0.2	0.01	150	100
MV 6 L 105 MZ -	6	8	11	21	0.2	0.01	150	1000
MV 8 L 103 MZ -	8	11	15	25	0.3	0.01	150	10
MV 8 L 104 MZ -	8	11	15	25	0.3	0.01	150	100
MV 8 L 105 MZ -	8	11	15	25	0.3	0.01	150	1000
MV 11 K 103 MZ -	11	14	18	35	0.8	0.01	150	10
MV 11 K 104 MZ -	11	14	18	35	0.8	0.01	150	100
MV 11 K 105 MZ -	11	14	18	35	0.8	0.01	150	1000
MV 14 K 103 MZ -	14	18	22	38	0.9	0.01	150	10
MV 14 K 104 MZ -	14	18	22	38	0.9	0.01	150	100
MV 14 K 105 MZ -	14	18	22	38	0.9	0.01	150	1000
MV 17 K 103 MZ -	17	22	27	49	1.1	0.01	150	10
MV 17 K 104 MZ -	17	22	27	49	1.1	0.01	150	100
MV 17 K 105 MZ -	17	22	27	49	1.1	0.01	150	1000
MV 20 K 103 MZ -	20	26	33	54	1.3	0.01	150	10
MV 20 K 104 MZ -	20	26	33	54	1.3	0.01	150	100
MV 20 K 105 MZ -	20	26	33	54	1.3	0.01	150	1000

Other capacitance values >1000nF are also available. Contact factory.

MV Series - Low Voltage Leaded Dual Function Varistors / RFI Suppressors						
Model Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)				
		D <sub>MAX</sub>	h/A <sub>MAX</sub>	R	d	t <sub>MAX</sub>
6 x 9 mm	2 - 95	6	9	5	0.6	5.5





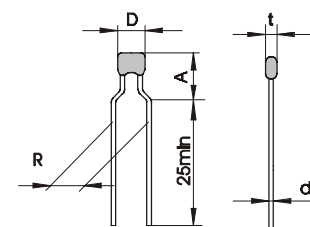
Device Ratings and Characteristics

MV 25 K 103 MZ - to MV 95 K 105 MZ -

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> @ 1 mA	V <sub>C</sub> @ 1 A	W <sub>MAX</sub> 10/1000 μs	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C (TYP) @1 kHz
Unit of Measure	Volts	Volts	Volts	Volts	Joules	Watts	Amps	nF
MV 25 K 103 MZ -	25	31	39	65	1.7	0.01	150	10
MV 25 K 104 MZ -	25	31	39	65	1.7	0.01	150	100
MV 25 K 105 MZ -	25	31	39	65	1.7	0.01	150	1000
MV 30 K 103 MZ -	30	38	47	77	2.0	0.01	150	10
MV 30 K 104 MZ -	30	38	47	77	2.0	0.01	150	100
MV 30 K 105 MZ -	30	38	47	77	2.0	0.01	150	1000
MV 35 K 103 MZ -	35	45	56	90	2.2	0.01	150	10
MV 35 K 104 MZ -	35	45	56	90	2.2	0.01	150	100
MV 35 K 105 MZ -	35	45	56	90	2.2	0.01	150	1000
MV 40 K 103 MZ -	40	56	68	110	2.3	0.01	150	10
MV 40 K 104 MZ -	40	56	68	110	2.3	0.01	150	100
MV 40 K 105 MZ -	40	56	68	110	2.3	0.01	150	1000
MV 50 K 103 MZ -	50	65	82	135	2.3	0.01	150	10
MV 50 K 104 MZ -	50	65	82	135	2.3	0.01	150	100
MV 50 K 105 MZ -	50	65	82	135	2.3	0.01	150	1000
MV 60 K 103 MZ -	60	85	100	165	2.3	0.01	150	10
MV 60 K 104 MZ -	60	85	100	165	2.3	0.01	150	100
MV 60 K 105 MZ -	60	85	100	165	2.3	0.01	150	1000
MV 95 K 103 MZ -	95	125	150	250	2.5	0.01	150	10
MV 95 K 104 MZ -	95	125	150	250	2.5	0.01	150	100
MV 95 K 105 MZ -	95	125	150	250	2.5	0.01	150	1000

Other capacitance values >1000nF are also available. Contact factory.

MV Series - Low Voltage Leaded Dual Function Varistors / RFI Suppressors						
Model Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)				
		D <sub>MAX</sub>	h/A <sub>MAX</sub>	R	d	t <sub>MAX</sub>
6 x 9 mm	2 - 95	6	9	5	0.6	5.5

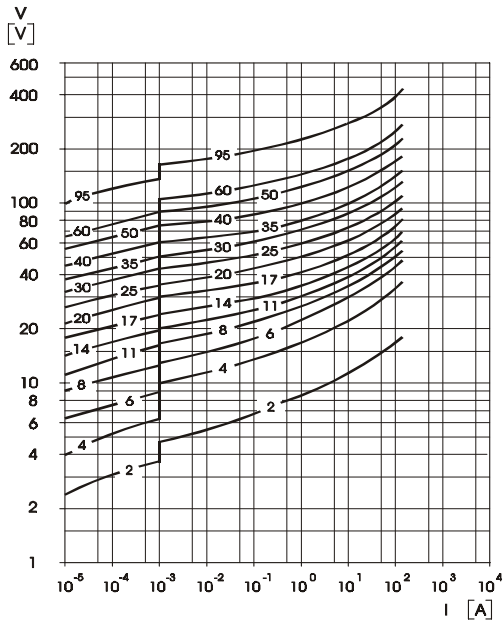


Version 1

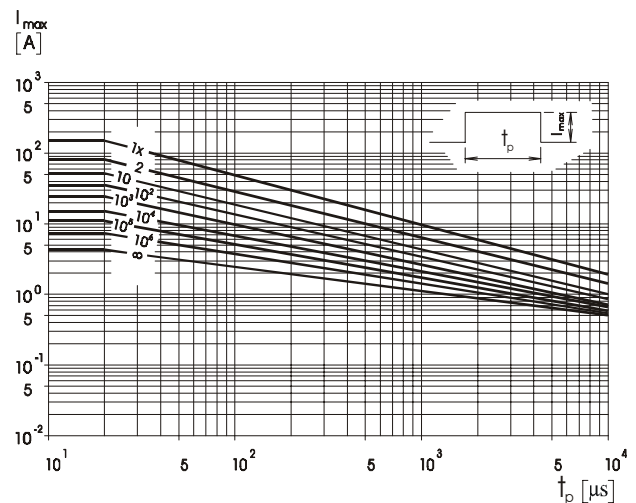
Performance Characteristics

Voltage/Current Curves

Pulse Rating Curves

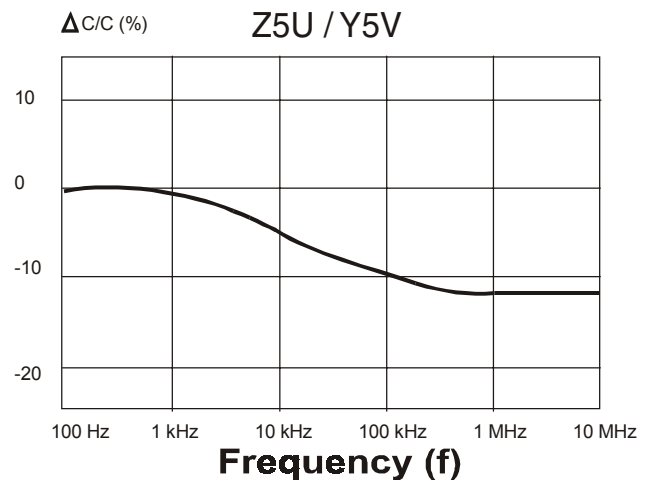
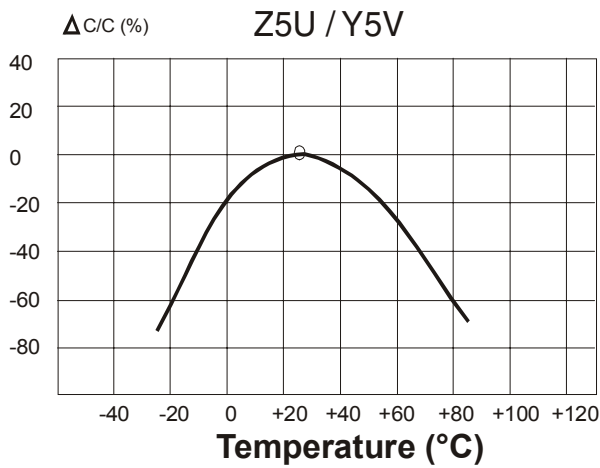


ML 2M...95K 103  
104 MZ  
105



Capacitance - Temperature Characteristics

Capacitance - Frequency Characteristics



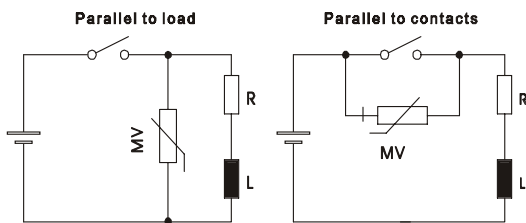
**Application Information**

**Typical Applications:**

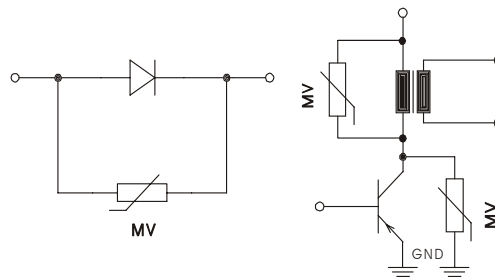
- \* Electrostatic Surge Absorption
- \* Relay Surge Suppression Effect and Relay Reset Time
- \* Piezoelectric Buzzer Shock Noise Absorption

**Application Circuits:**

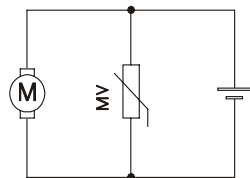
(a) Eliminating sparks from relay circuits  
(there is no delay in operating time)



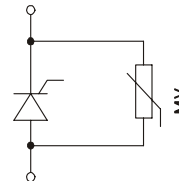
(e) Protecting semiconductive components including transistors and diodes



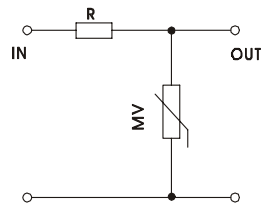
(b) Eliminating noise from micromotors



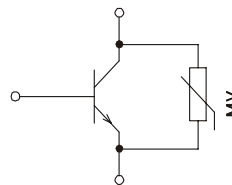
(f) Improved thyristor configuration  
Eliminating vibration better than conventional circuits



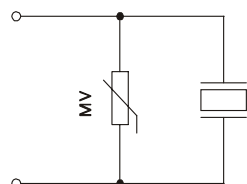
(c) Stabilizing voltages and absorbing line surges



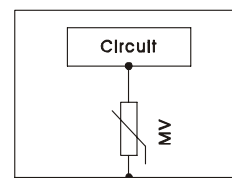
(g) Elimination of over-shooting from transistors



(d) Absorbing shock noise of piezoelectric alarms



(h) Elimination of static electricity from circuits



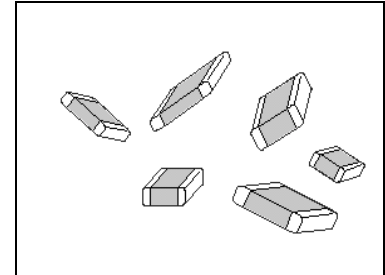
**Multilayer Technology**

**Varistor Plus**

**Description**

Almost all electronic systems in internal-combustion powered vehicles, e.g, anti-lock brakes, direct ignition, airbag control, wiper motors, etc. are susceptible to damage from destructive voltage transients.

AV varistors are TVS chips that have suppression characteristics enabling protection from -55°C to 125°C. These multilayer varistors offer excellent transient energy absorption in a small package due to improved internal energy distribution. AV Series parts require significantly smaller space and pad area than silicon TVS diodes, offering greater circuit board layout flexibility for designer.



**Features**

- Power supply voltages ( $V_{DC}$ ).....12V, 24V and 42V
- Operating voltage range ( $V_{DC}$ ).....16V to 42V
- Part number voltage range ( $V_{RMS}$ )...14V to 35V
- Broad range of current and energy handling capabilities
- 6 model sizes available...0805, 1206, 1210, 1812, 2220, 3225
- + 125°C continuous operating temperature
- No plastic coating guarantees better flammability rating
- Dimensional and weight savings on PC board
- Ultra-low inductance, leadless chip guarantees the fastest response time to transient surges
- AgPd end terminations
- Available in tape and reel for automatic pick and place

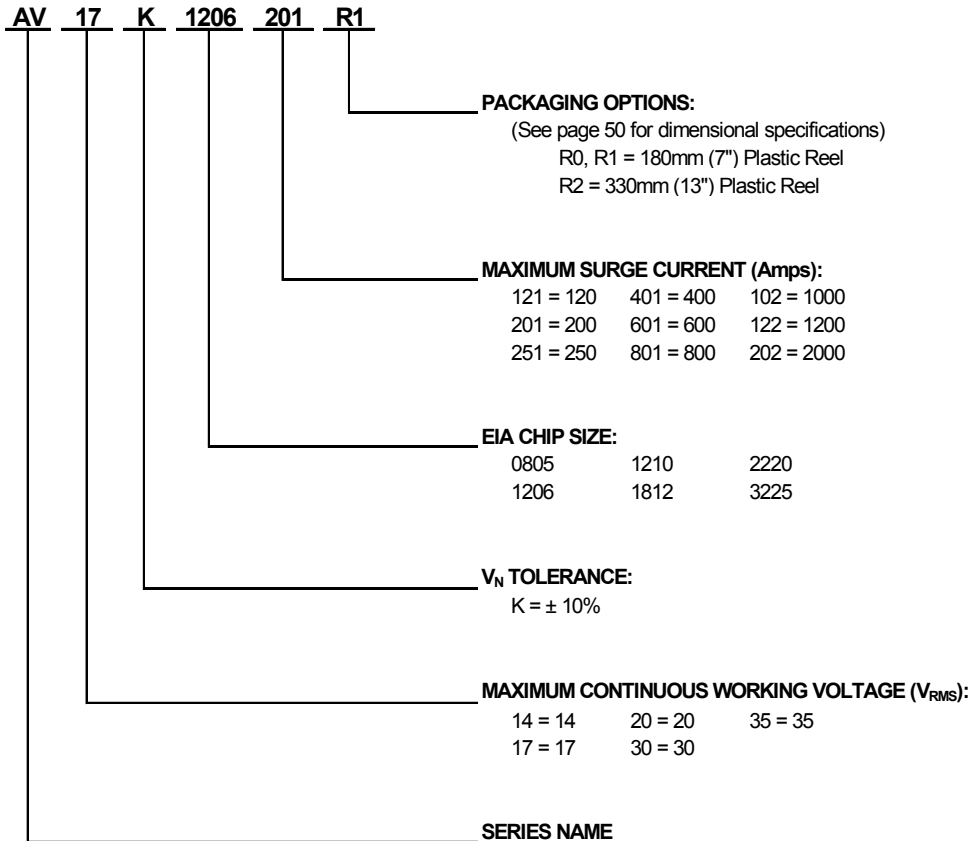
**Absolute Maximum Ratings**

<b>Continuous:</b>	Value
Steady State Applied Voltage:	
DC Voltage Range ( $V_{DC}$ )	16V to 42V
<b>Transient:</b>	
Load Dump Energy ( $W_{LD}$ )	1J to 50J
5 Minute Jump Start Capacity ( $V_{JUMP}$ )	24.5V to 59V
Peak Single Pulse Surge Current ( $I_P$ ), 8/20 $\mu$ s Waveform	120A to 2000A
Single Pulse Surge Energy ( $W_{MAX}$ ), 10/1000 $\mu$ s Waveform	0.3J to 17J
Operating Ambient Temperature	-55°C to +125°C
Storage Temperature Range	-55°C to +150°C
Threshold Voltage Temperature Coefficient	< - 0.05%/°C
Response Time	< 2ns

Multilayer Technology

Varistor Plus

HOW TO ORDER: AV SERIES (AUTOMOTIVE SMD VARISTORS)



Standard Packaging Options / Quantities

Series	Voltage Range (V <sub>RMS</sub> )	Chip Size									
		0805			1206			1210			
		R0	R1	R2	R0	R1	R2	R0	R1	R2	
		180mm	180mm	330mm	180mm	180mm	330mm	180mm	180mm	330mm	
		7"	7"	13"	7"	7"	13"	7"	7"	13"	
AV	14	1000	3500	15000	1000	2500	15000	1000	2500	15000	
	17	1000	3500	14000	1000	2500	14000	1000	2500	14000	
	20 to 35	1000		14000	1000	2500	10000	1000	2500	9000	
			1812			2220			3225		
			R0	R1	R2	R0	R1	R2	R0	R2	
			180mm	180mm	330mm	180mm	180mm	330mm	180mm	330mm	
			7"	7"	13"	7"	7"	13"	7"	13"	
		14	1000	1500	6000	1000	1000	4000	1000	1500	
		17	1000	1500	6000	1000	1000	4000	1000	1500	
		20 to 35	1000	1000	4000	1000	1000	4000	1000	1500	

Note: Chips packaged in plastic embossed tape.

Multilayer Technology

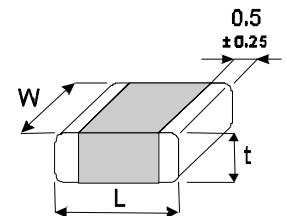
Varistor Plus

Device Ratings and Characteristics

AV 14 K 0805 121 - - to AV 30 K 3225 202 - -

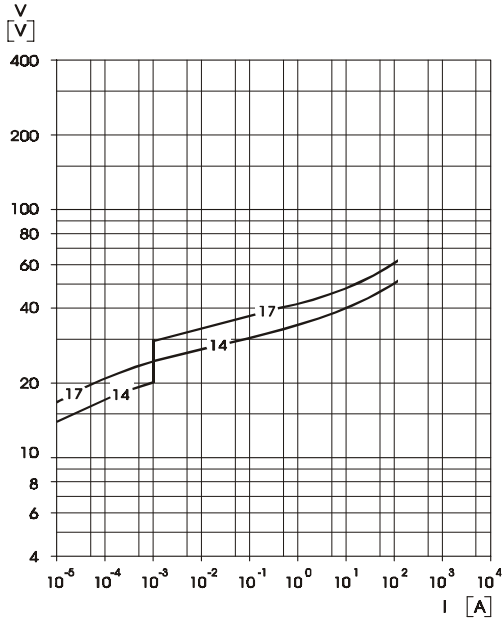
Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> 1 mA	V <sub>JUMP</sub> 5 min	V <sub>C</sub>	I <sub>C</sub> 8/20 μs	I <sub>P</sub> 8/20 μs	W <sub>MAX</sub> 10/1000 μs	W <sub>LD</sub> 10 x	P <sub>MAX</sub>	C (TYP) 1 kHz
Unit of Measure	Volts	Volts	Volts	Volts	Volts	Amps	Amps	Joules	Joules	Watts	pF
<b>12V Power Supply</b>											
AV 14 K 0805 121 - -	14	16	24	24.5	40	1	120	0.3	1	0.008	400
AV 17 K 0805 121 - -	17	20	27	30	44	1	120	0.5	1	0.008	370
AV 14 K 1206 201 - -	14	16	24	24.5	40	1	200	0.6	1.5	0.008	1000
AV 17 K 1206 201 - -	17	20	27	30	44	1	200	1.1	1.5	0.008	810
AV 14 K 1210 401 - -	14	16	24	24.5	40	2.5	400	1.6	3	0.010	2350
AV 17 K 1210 401 - -	17	20	27	30	44	2.5	400	1.8	3	0.010	2000
AV 14 K 1812 801 - -	14	16	24	24.5	40	5	800	2.4	6	0.015	4500
AV 17 K 1812 801 - -	17	20	27	30	44	5	800	2.9	6	0.015	3800
AV 14 K 2220 122 - -	14	16	24	24.5	40	10	1200	5.8	12	0.030	10000
AV 14 K 2220 202 - -	14	16	24	24.5	40	10	2000	6.0	25	0.030	12000
AV 17 K 2220 202 - -	17	20	27	30	44	10	2000	7.2	25	0.030	8000
AV 14 K 3225 202 - -	14	16	24	24.5	40	10	2000	12.5	50	0.040	8300
AV 17 K 3225 202 - -	17	20	27	30	44	10	2000	13.8	50	0.040	6600
<b>24V Power Supply</b>											
AV 20 K 1206 201 - -	20	26	33	30	54	1	200	1.6	1.5	0.008	780
AV 30 K 1206 201 - -	30	34	47	50	77	1	200	2.0	1.5	0.008	530
AV 20 K 1210 401 - -	20	26	33	30	54	2.5	400	1.9	3	0.010	1650
AV 30 K 1210 401 - -	30	34	47	50	77	2.5	400	2.3	3	0.010	1100
AV 20 K 1812 801 - -	20	26	33	30	54	5	800	3.0	6	0.015	3300
AV 30 K 1812 801 - -	30	34	47	50	77	5	800	3.8	6	0.015	2200
AV 30 K 2220 122 - -	30	34	47	50	77	10	1200	12.0	12	0.030	6500
AV 20 K 2220 202 - -	20	26	33	30	54	10	2000	8.0	25	0.030	7000
AV 30 K 2220 202 - -	30	34	47	50	77	10	2000	12.0	25	0.030	4400
AV 20 K 3225 202 - -	20	26	33	30	54	10	2000	15.0	50	0.040	5500
AV 30 K 3225 202 - -	30	34	47	50	77	10	2000	17.0	50	0.040	3300
<b>42V Power Supply</b>											
AV 35 K 1206 121 - -	35	42	56	59	90	1	120	0.6	1.5	0.008	400
AV 35 K 1210 251 - -	35	42	56	59	90	3	250	2.2	3.0	0.010	950
AV 35 K 1812 601 - -	35	42	56	59	90	5	600	4.2	6.0	0.015	1500
AV 35 K 2220 102 - -	35	42	56	59	90	10	1000	7.6	12.0	0.020	3000

AV Series - Automotive SMD Varistors							
Chip Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm) 12 & 24V Power supply			Dimensions (mm) 42V Power supply		
		L	W	t <sub>MAX</sub>	L	W	t <sub>MAX</sub>
0805	14 - 17	2.00 ± 0.20	1.25 ± 0.15	1.0			
1206	14 - 30	3.20 ± 0.30	1.60 ± 0.15	1.2	3.2 ± 0.30	1.6 ± 0.20	1.2
1210	14 - 30	3.20 ± 0.30	2.50 ± 0.20	1.3	3.2 ± 0.30	2.5 ± 0.25	1.4
1812	14 - 30	4.50 ± 0.35	3.20 ± 0.30	1.2	4.5 ± 0.35	3.20 ± 0.30	1.6
2220	14 - 30	5.70 ± 0.40	5.00 ± 0.40	1.2	5.7 ± 0.40	5.00 ± 0.40	1.6
3225	14 - 30	8.00 ± 0.50	6.30 ± 0.40	1.6			



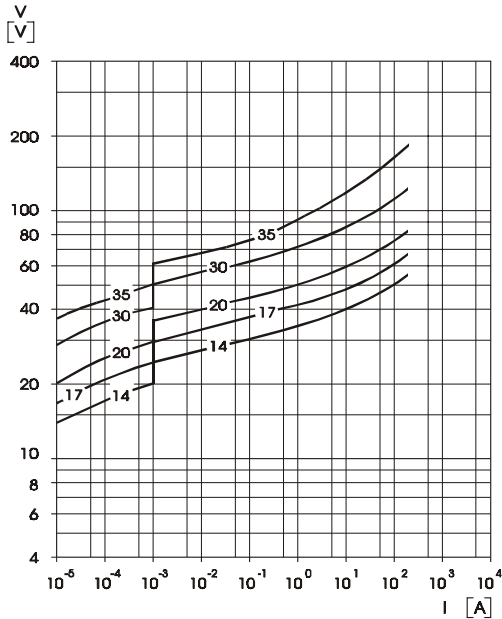
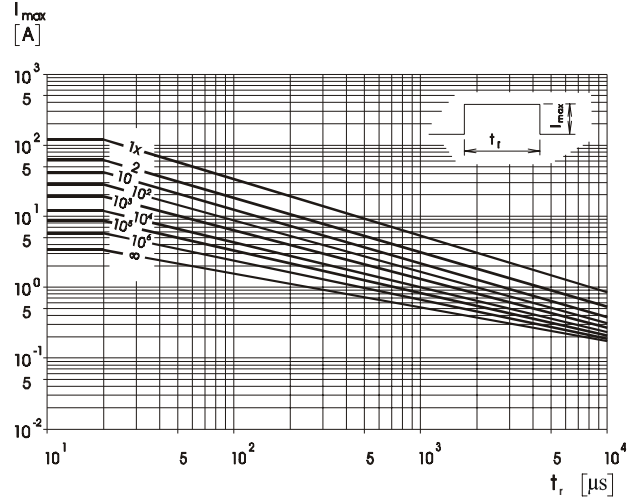
Performance Characteristics

Voltage/Current Curves

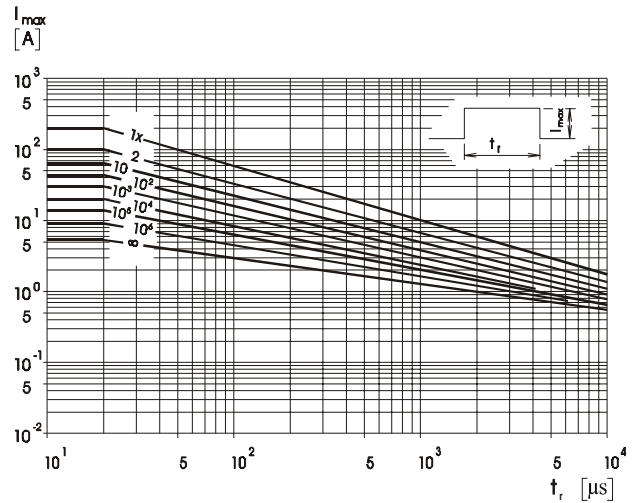


AV 14K...17K 0805 121

Pulse Rating Curves



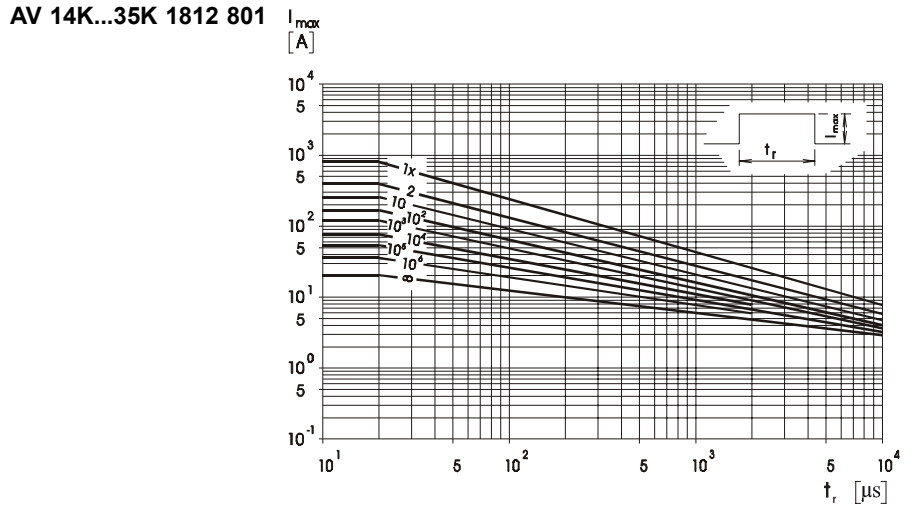
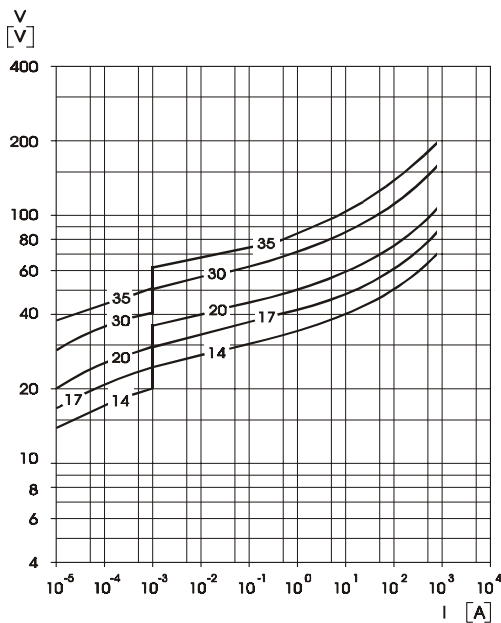
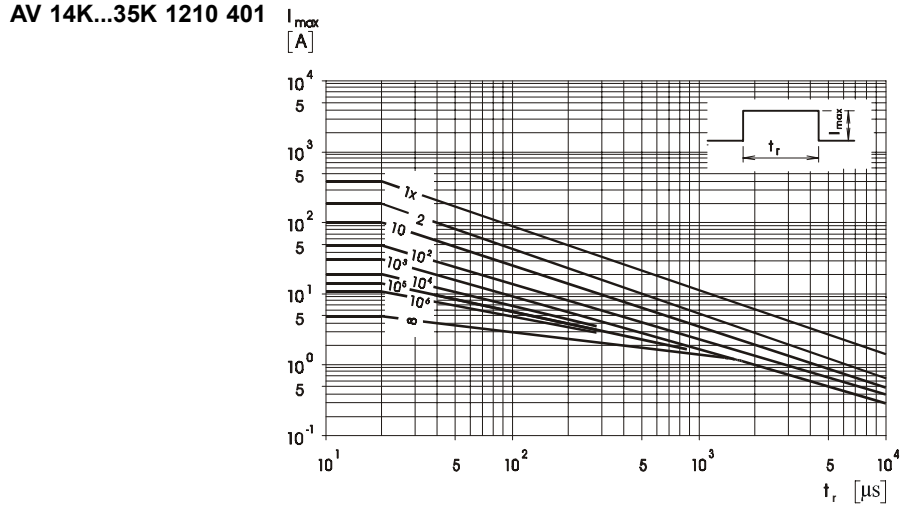
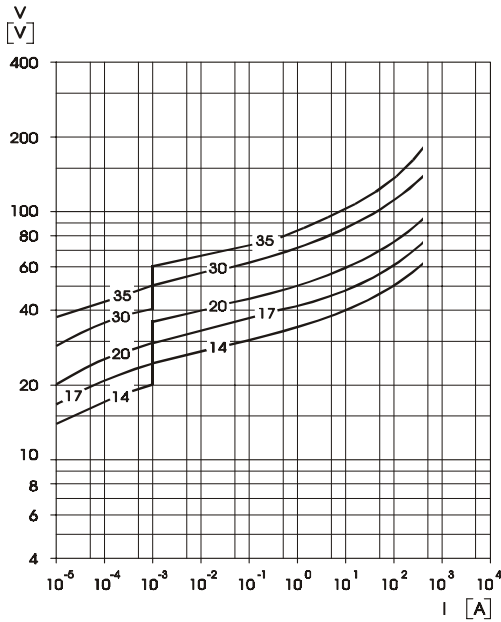
AV 14K...35K 1206 201



Performance Characteristics

Voltage/Current Curves

Pulse Rating Curves

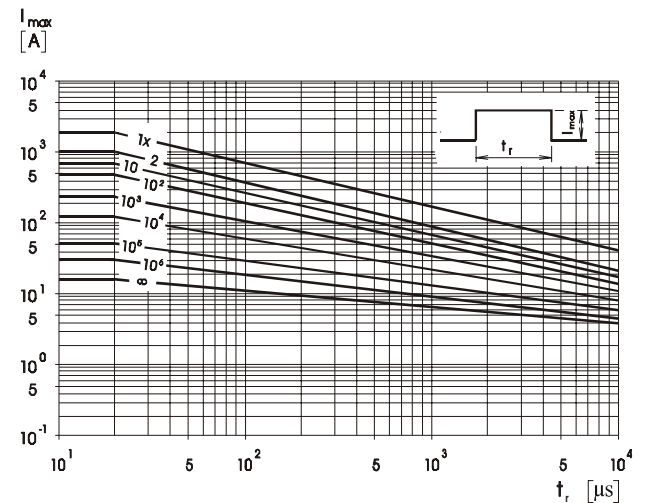
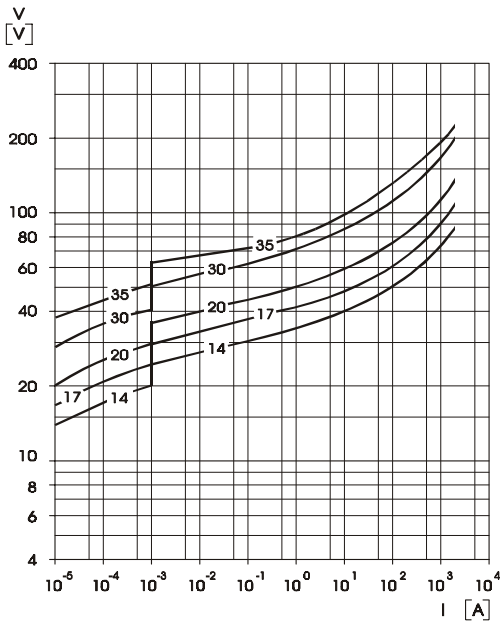
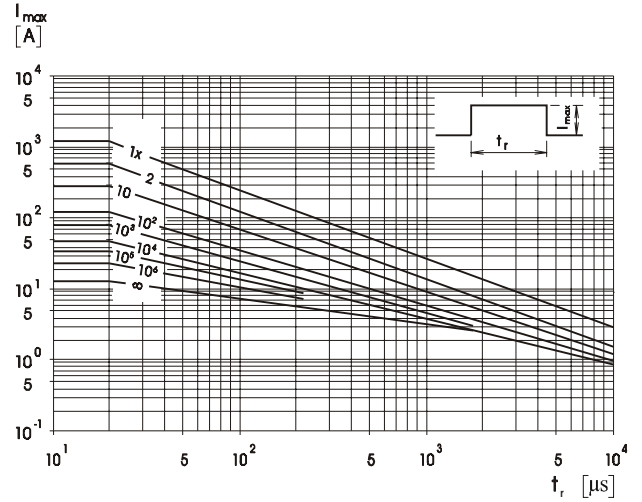
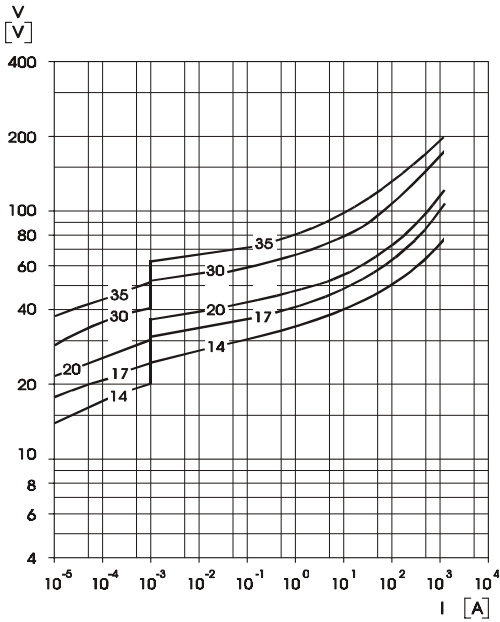




Performance Characteristics

Voltage/Current Curves

Pulse Rating Curves



Multilayer Technology

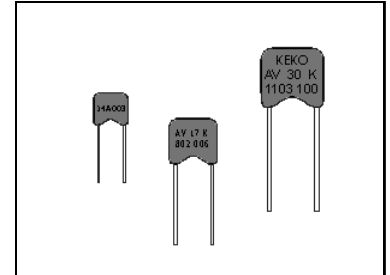
Varistor Plus

Description

Almost all electronic systems in internal-combustion powered vehicles, e.g., anti-lock brakes, direct ignition, airbag control, wiper motors, etc. are susceptible to damage from destructive voltage transients.

SEI/KEKO's AV Series of leaded automotive varistors includes both multilayer and single layer components, defined by  $W_{LD}$  capability. Multilayer devices are intended for  $W_{LD}$  applications requiring  $\leq 50$  Joules of energy, and single layer discs are for  $W_{LD}$  applications requiring  $\geq 50$  Joules of energy.

Automotive multilayer varistors offer excellent transient energy absorption due to improved internal energy distribution. Compared to an equivalent automotive disc varistor, they offer better electrical characteristics in a much smaller size. Automotive disc varistors are specifically designed and used in applications requiring higher levels of  $W_{LD}$  energy absorption, which MLV devices are incapable of handling.



Features

- Power supply voltages ( $V_{DC}$ ).....12V, 24V and 42V
- Operating voltage range ( $V_{DC}$ ).....16V to 42V
- Part number voltage range ( $V_{RMS}$ )...14V to 35V
- Broad range of current and energy handling capabilities realized with either type of construction
- MLV varistors: +125°C continuous operating temperature for  $W_{LD} \leq 50J$
- SLV varistors: +85°C continuous operating temperature for  $W_{LD} \geq 50J$
- In-line leads on automotive MLV varistors
- Available in tape and reel for automatic insertion equipment

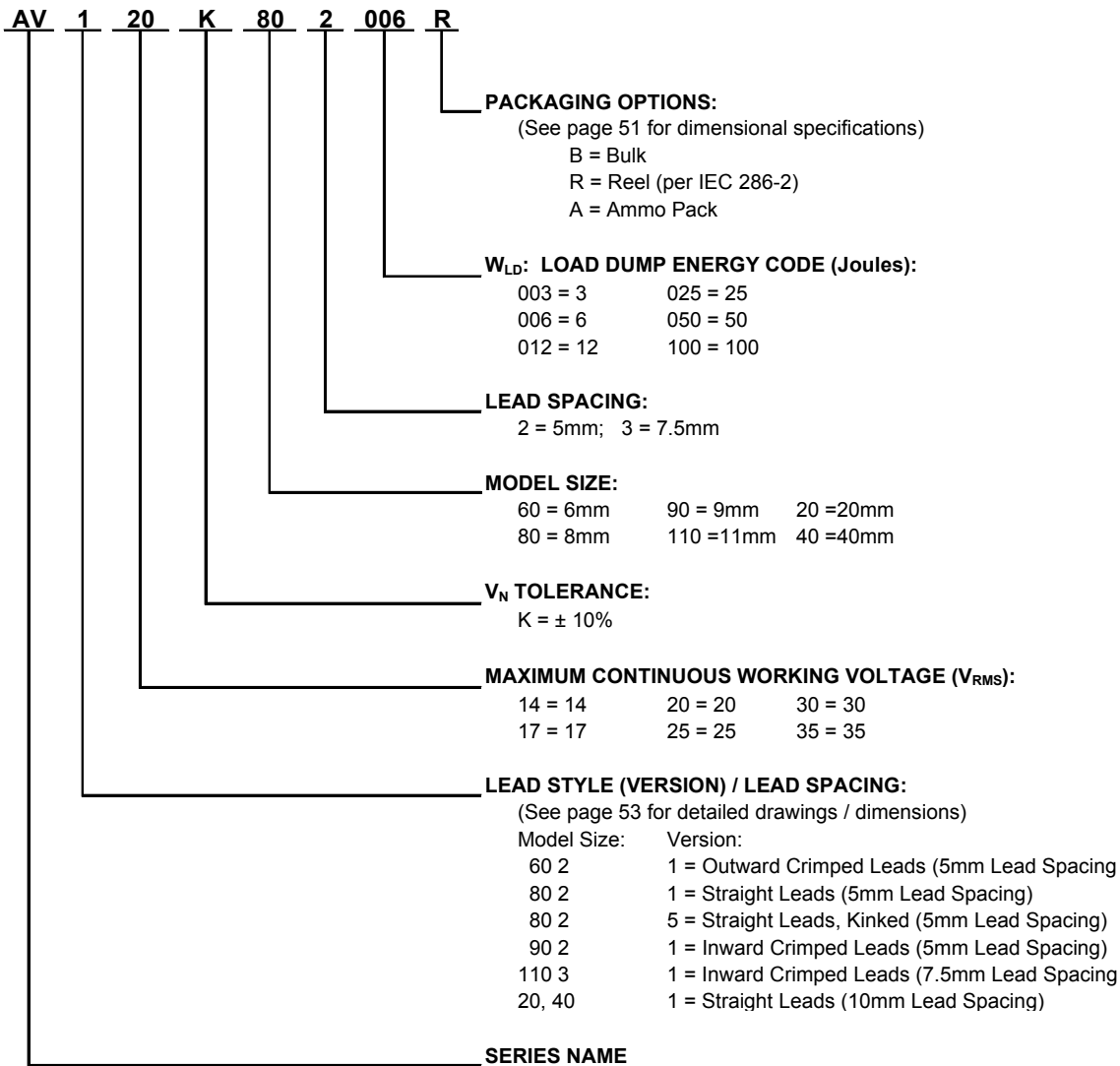
Absolute Maximum Ratings

Continuous:	Value
Steady State Applied Voltage: ( $V_{RMS}$ )	14V to 35V
DC Voltage Range ( $V_{DC}$ )	16V to 42V
Transient:	
Load Dump Energy ( $W_{LD}$ )	3J to 100J
5 Minute Jump Start Capacity ( $V_{JUMP}$ )	24.5V to 59V
Peak Single Pulse Surge Current ( $I_P$ ), 8/20 $\mu s$ Waveform	400A to 2000A
Single Pulse Surge Energy ( $W_{MAX}$ ), 10/1000 $\mu s$ Waveform	1.6J to 76J
MLV Operating Ambient Temperature for $W_{LD} \leq 50J$	-40°C to +125°C
MLV Storage Temperature Range for $W_{LD} \leq 50J$	-40°C to +150°C
SLV Operating Ambient Temperature for $W_{LD} \geq 50J$	-40°C to +85°C
SLV Storage Temperature Range for $W_{LD} \geq 50J$	-40°C to +125°C
Threshold Voltage Temperature Coefficient	< - 0.05%/°C
Insulation Resistance	> 1G $\Omega$
Response Time	< 25ns
MLV Climatic Category for $W_{LD} \leq 50 J$ - MLV	40/125/56
SLV Climatic Category for $W_{LD} \geq 50 J$ - SLV	40/85/56

Multilayer Technology

Varistor Plus

HOW TO ORDER: AV SERIES (AUTOMOTIVE LEADED VARISTORS)



Standard Packaging Options / Quantities

Series	Voltage Range (V <sub>RMS</sub> )	Model Size Lead Spacing	Packaging Options		
			B = Bulk R = Reel A = Ammo Pack		
			B	R	A
AV	14 to 35	60 2	1500	2000	2000
	14 to 35	80 2	1000	1500	1500
	14 to 35	90 2	1000	1500	1500
	14 to 20	110 3	700	1000	1000
	25 to 35	20	400	700	800
	25 to 35	40	400	700	800

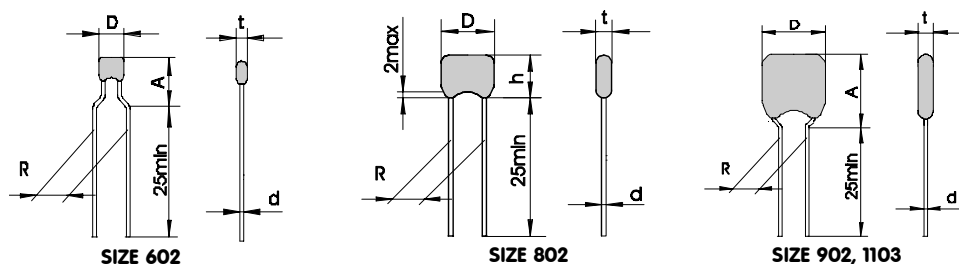
Multilayer Technology

Varistor Plus

Device Ratings and Characteristics

AV 14 K 602 003 - to AV 17 K 1103 050 -

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> @ 1 mA	V <sub>JUMP</sub> 5 min	V <sub>C</sub>	I <sub>C</sub>	I <sub>P</sub> 8/20 μs	W <sub>MAX</sub> 10/1000 μs	W <sub>LD</sub> 10 x	P <sub>MAX</sub>	C (TYP) 1kHz
Unit of Measure	Volts	Volts	Volts	Volts	Volts	Amps	Amps	Joules	Joules	Watts	pF
<b>12V Power Supply</b>											
AV 14 K 602 003 -	14	16	24	24.5	40	2.5	400	1.6	3.0	0.010	2500
AV 17 K 602 003 -	17	20	27	30	44	2.5	400	1.8	3.0	0.010	2000
AV 14 K 802 006 -	14	16	24	24.5	40	5	800	2.4	6.0	0.015	4600
AV 17 K 802 006 -	17	20	27	30	44	5	800	2.9	6.0	0.015	4000
AV 14 K 902 012 -	14	16	24	24.5	40	5	1200	4.4	12.0	0.030	10500
AV 14 K 902 025 -	14	16	24	24.5	40	10	2000	6.0	25.0	0.080	22000
AV 17 K 902 025 -	17	20	27	30	44	10	2000	7.2	25.0	0.080	18000
AV 14 K 1103 050 -	14	16	24	24.5	40	10	2000	13.2	50.0	0.040	29000
AV 17 K 1103 050 -	17	20	27	30	44	10	2000	15.8	50.0	0.040	24000



Model Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)				
		D <sub>MAX</sub>	h/A <sub>MAX</sub>	R	d	t <sub>MAX</sub>
60 2	14 - 35	7.0	7.0	5.0	0.6	4.5
80 2	14 - 35	8.0	9.0	5.0	0.6	4.5
90 2	14 - 35	9.0	12.0	5.0	0.6	4.5
110 3	14 - 35	11.0	12.0	7.5	0.6	6.5

Multilayer Technology

Varistor Plus

Device Ratings and Characteristics

AV 20 K 602 003 - to AV 35 K 40 100 -

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> @ 1 mA	V <sub>JUMP</sub> 5 min	V <sub>C</sub>	I <sub>C</sub>	I <sub>P</sub> 8/20 μs	W <sub>MAX</sub> 10/1000 μs	W <sub>LD</sub> 10 x	P <sub>MAX</sub>	C (TYP) 1kHz
Unit of Measure	Volts	Volts	Volts	Volts	Volts	Amps	Amps	Joules	Joules	Watts	pF

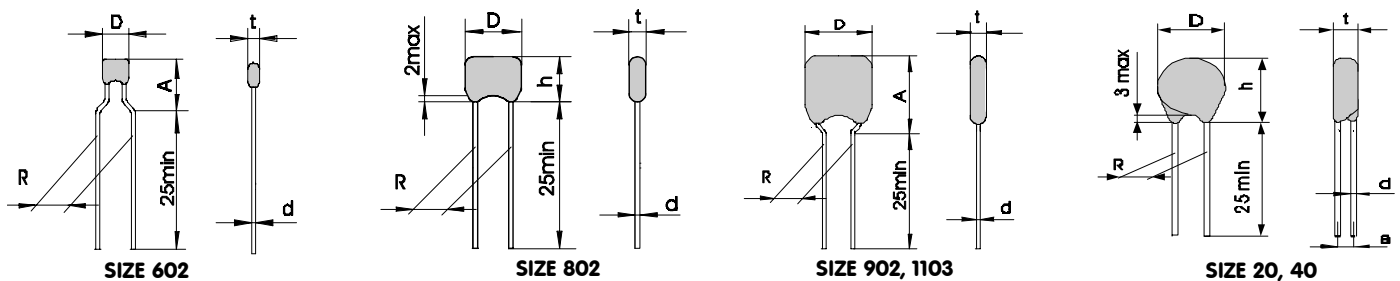
24V Power Supply

AV 20 K 602 003 -	20	26	33	30	54	2.5	400	1.9	3.0	0.010	1800
AV 30 K 602 003 -	30	34	47	50	77	2.5	400	2.3	3.0	0.010	1300
AV 20 K 802 006 -	20	26	33	30	54	5	800	3.0	6.0	0.015	3500
AV 30 K 802 006 -	30	34	47	50	77	5	800	3.8	6.0	0.015	2000
AV 20 K 902 025 -	20	26	33	30	54	10	2000	9.0	25.0	0.080	7500
AV 30 K 902 025 -	30	34	47	50	77	10	2000	18.0	25.0	0.080	16000
AV 20 K 1103 050 -	20	26	33	30	54	10	2000	17.0	50.0	0.100	18000

AV 25 K 20 050 -	25	28	39	40	77	20	2000	28.0	50.0	0.200	14000
AV 30 K 20 050 -	30	34	47	50	93	20	2000	34.0	50.0	0.200	13500
AV 25 K 40 100 -	25	28	39	40	77	20	2000	50.0	100.0	0.300	28000
AV 30 K 40 100 -	30	34	47	50	93	20	2000	60.0	100.0	0.300	26000

42V Power Supply

AV 35 K 602 003 -	35	42	56	59	90	2.5	400	2.6	3	0.010	1000
AV 35 K 802 006 -	35	42	56	59	90	5	800	4.8	6	0.015	1500
AV 35 K 902 025 -	35	42	56	59	90	10	2000	20.0	25	0.080	12800
AV 35 K 40 050 -	35	42	56	59	110	20	2000	41.0	50	0.200	12000
AV 35 K 40 100 -	35	42	56	59	110	20	2000	76.0	100	0.300	23000

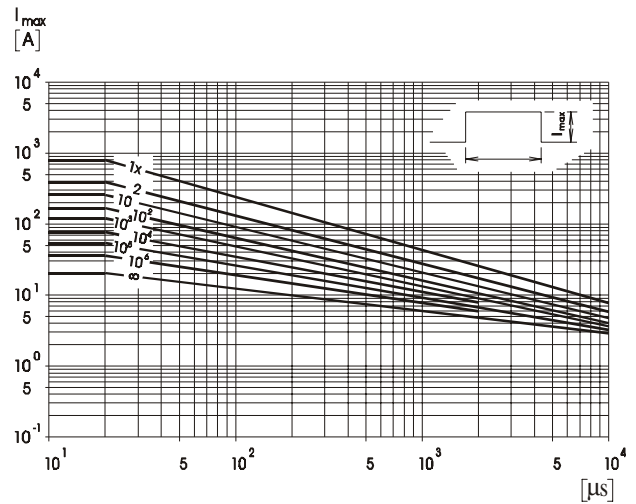
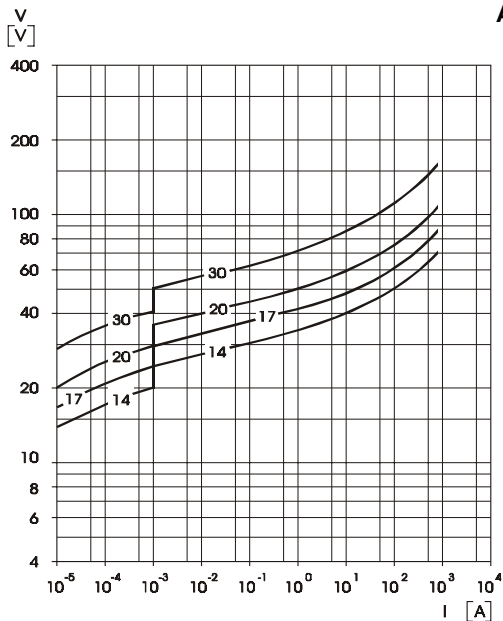
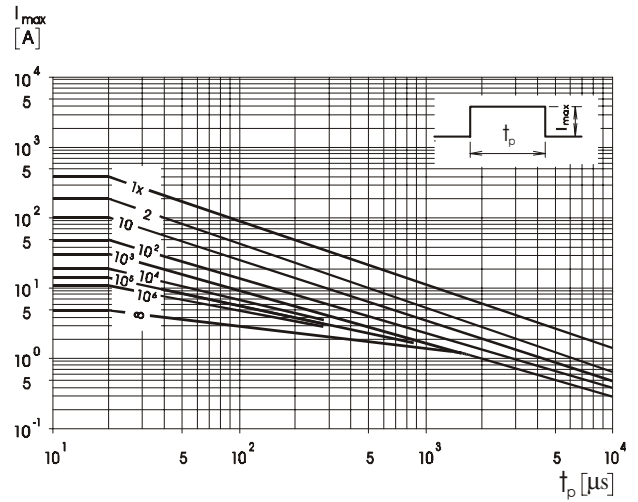
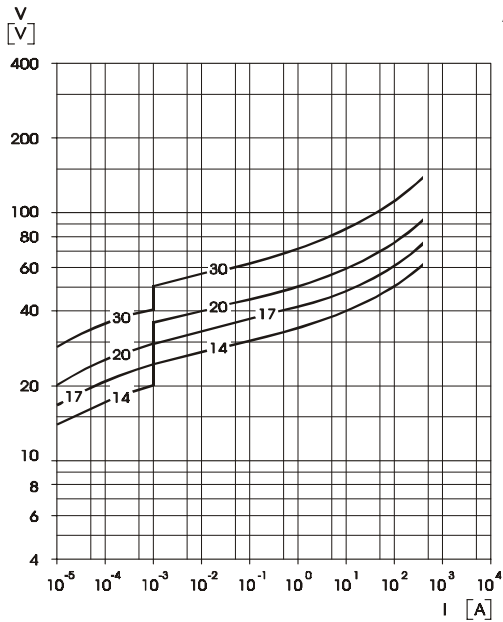


Model Size	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)				
		D <sub>MAX</sub>	h/A <sub>MAX</sub>	R	d	t <sub>MAX</sub>
60 2	14 - 35	7.0	7.0	5.0	0.6	4.5
80 2	14 - 35	8.0	9.0	5.0	0.6	4.5
90 2	14 - 35	9.0	12.0	5.0	0.6	4.5
110 3	14 - 35	11.0	12.0	7.5	0.6	6.5
20	25 - 35	22.5	24.0	10.0	1.0	4.5
40	25 - 35	22.5	24.0	10.0	1.0	5.6

Performance Characteristics

Voltage/Current Curves

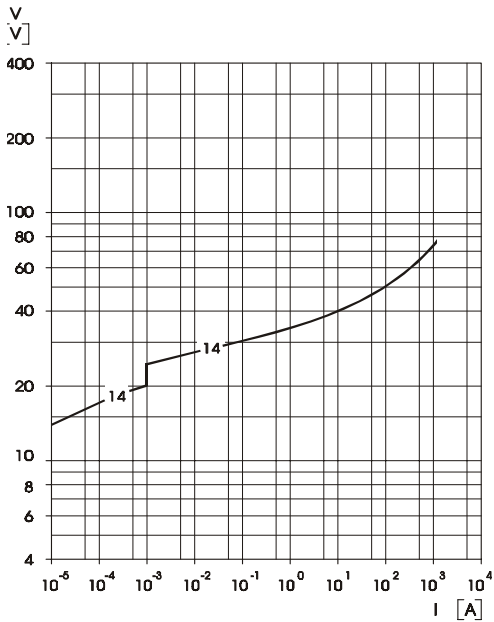
Pulse Rating Curves



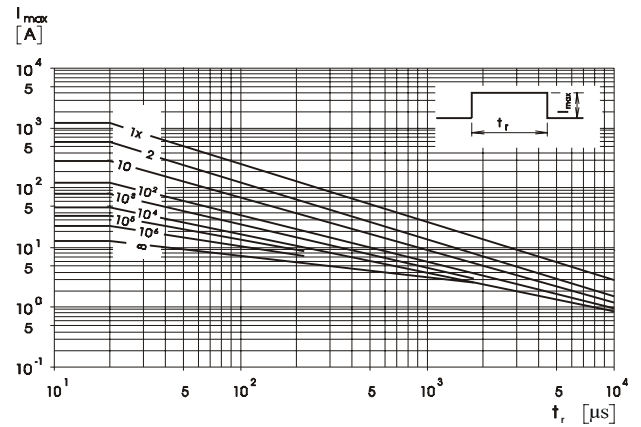
Performance Characteristics

Voltage/Current Curves

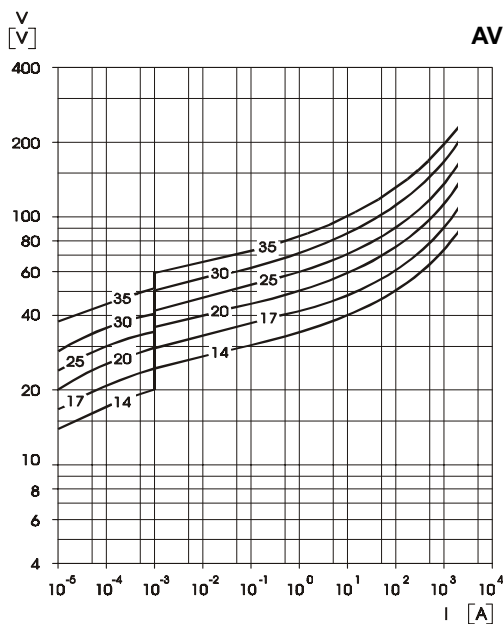
Pulse Rating Curves



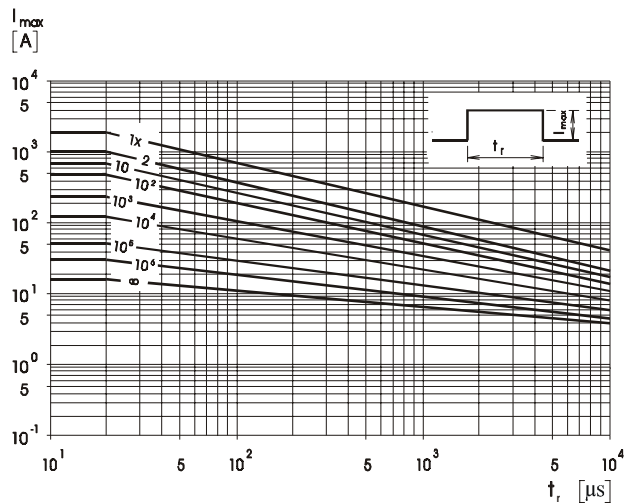
AV 14K 902 012



902  
AV 14K...35K 1103 025...050



20  
AV 25K...35K 40 050...100



**Multilayer Technology**

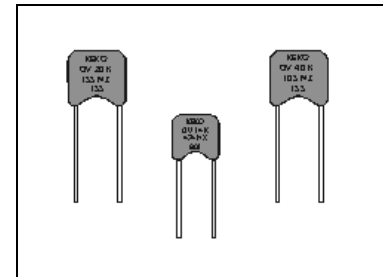
**Varistor Plus**

**Description**

The OV Series varistor/suppressor is a dual function device that protects against transient voltages and radio-frequency noise generated within 12V<sub>DC</sub> and 24V<sub>DC</sub> vehicle power systems. This component replaces two components: a low voltage varistor and a capacitor.

The OV Series incorporates a varistor function in automotive applications and a radio-frequency filter operating in the capacitance range from 0.47 μF to 1.5 μF. These components are designed for protection of all sensitive electronics circuits from both voltage transients and high-frequency noise produced by electromechanical devices such as relays, electric motors, etc.

OV varistor/suppressors are square-shaped components with in-line leads, which require at least 30% less mounting space than the two components they replace.



**Features**

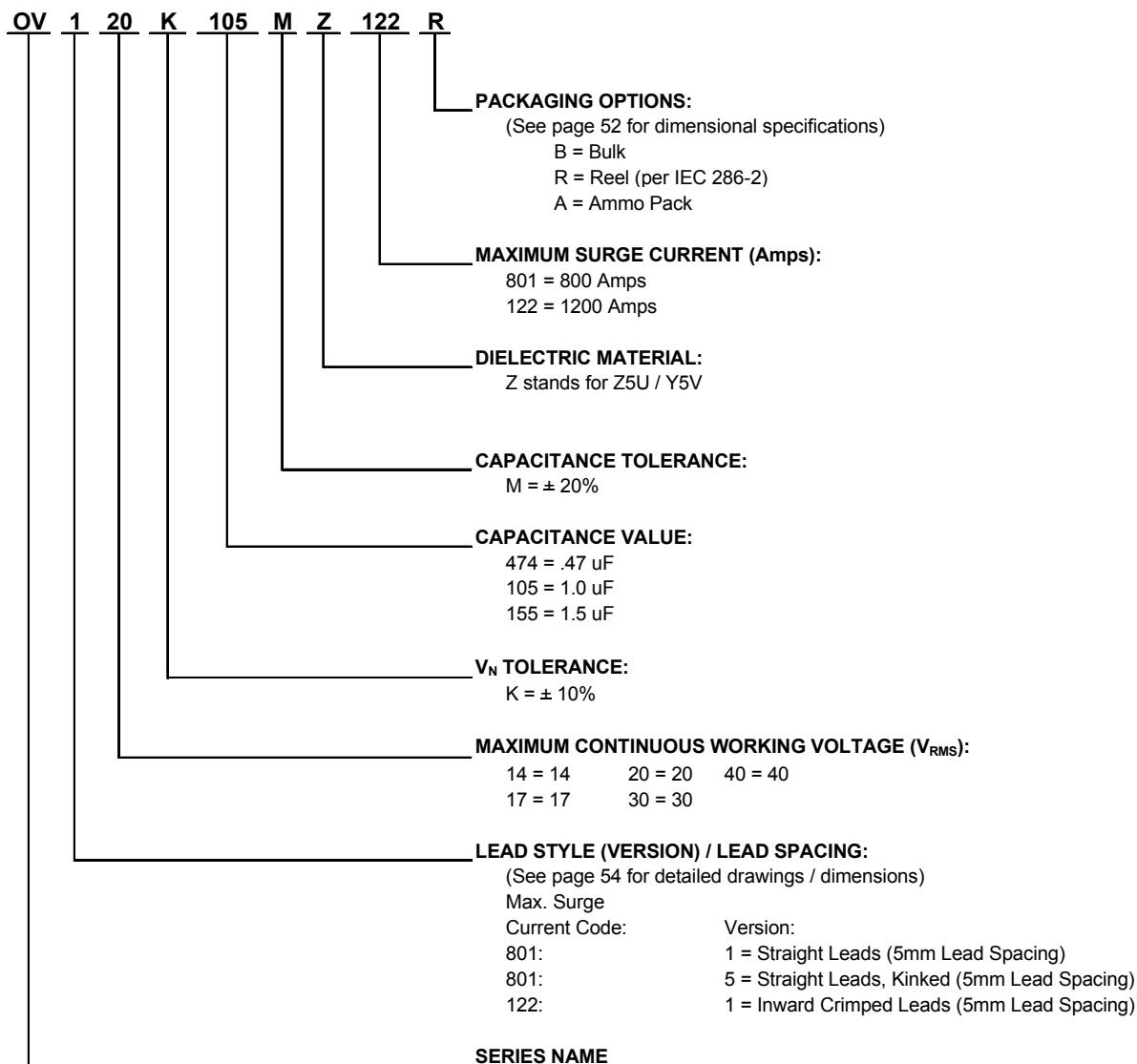
- Power supply voltages (V<sub>DC</sub>).....12V and 24V
- Operating voltage range (V<sub>DC</sub>).....16V to 56V
- Part number voltage range (V<sub>RMS</sub>).....14 to 40V
- Capacitance range (μF).....0.47 to 1.5
- Capacitor temperature characteristics ..... Z5U/Y5V
- Protects against voltage transients and suppresses radio-frequency interference
- Dimensional and weight savings on PC board
- 2 model sizes available..... 7.3 x 9.0 and 7.8 x 12 mm
- In-line leads
- Available with straight or crimped leads
- Available in tape and reel for automatic insertion equipment

**Absolute Maximum Ratings**

<b>Continuous:</b>	Value
Steady State Applied Voltage: DC Voltage Range (V <sub>DC</sub> )	16V to 56V
<b>Transient:</b>	
Load Dump Energy (W <sub>LD</sub> )	6J to 12J
5 Minute Jump Start Capacity (V <sub>JUMP</sub> )	24.5V to 71V
Peak Single Pulse Surge Current (I <sub>P</sub> ), 8/20 μs Waveform	800A to 1200A
Single Pulse Surge Energy (W <sub>MAX</sub> ), 10/1000 μs Waveform	2.4J to 13.3J
Operating Ambient Temperature	-40°C to +85°C
Storage Temperature Range	-40°C to +125°C
Threshold Voltage Temperature Coefficient	< - 0.05%/°C
Insulation Resistance	> 1GΩ
Isolation Voltage Capability	> 1kV
Response Time	< 25ns



**HOW TO ORDER: OV SERIES (AUTOMOTIVE, DUAL FUNCTION LEADED DEVICES)**



**Standar**

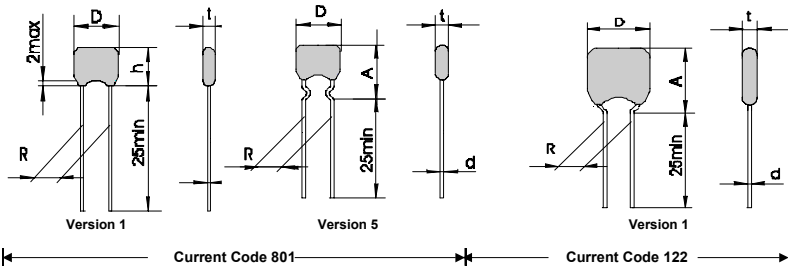
Series	Voltage Range (V <sub>RMS</sub> )	Current Code	Packaging Options		
			B = Bulk   R = Reel   A = Ammo Pack		
			B	R	A
OV	14 to 40	801	1500	1500	1500
	14 to 40	122	1500	1500	1500

**Device Ratings and Characteristics**

**OV 14 K 474 MZ 801 - to OV 17 K 155 MZ 122 -**

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> @ 1 mA	V <sub>JUMP</sub> 5 min	V <sub>C</sub>	I <sub>C</sub>	W <sub>MAX</sub> 10/1000 μs	W <sub>LD</sub> 10 x	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C (TYP) @1 kHz
Unit of Measure	Volts	Volts	Volts	Volts	Volts	Amps	Joules	Joules	Watts	Amps	μF
<b>12V Power Supply</b>											
OV 14 K 474 MZ 801 -	14	16	24	24.5	40	5	2.4	6	0.015	800	0.47
OV 17 K 474 MZ 801 -	17	20	27	30	44	5	2.8	6	0.015	800	0.47
OV 14 K 105 MZ 801 -	14	16	24	24.5	40	5	2.4	6	0.015	800	1.00
OV 17 K 105 MZ 801 -	17	20	27	30	44	5	2.8	6	0.015	800	1.00
OV 14 K 155 MZ 801 -	14	16	24	24.5	40	5	2.4	6	0.015	800	1.50
OV 17 K 155 MZ 801 -	17	20	27	30	44	5	2.8	6	0.015	800	1.50
OV 14 K 474 MZ 122 -	14	16	24	24.5	40	10	5.8	12	0.030	1200	0.47
OV 17 K 474 MZ 122 -	17	20	27	30	44	10	7.4	12	0.030	1200	0.47
OV 14 K 105 MZ 122 -	14	16	24	24.5	40	10	5.8	12	0.030	1200	1.00
OV 17 K 105 MZ 122 -	17	20	27	30	44	10	7.4	12	0.030	1200	1.00
OV 14 K 155 MZ 122 -	14	16	24	24.5	40	10	5.8	12	0.030	1200	1.50
OV 17 K 155 MZ 122 -	17	20	27	30	44	10	7.4	12	0.030	1200	1.50

Other capacitance values are also available.



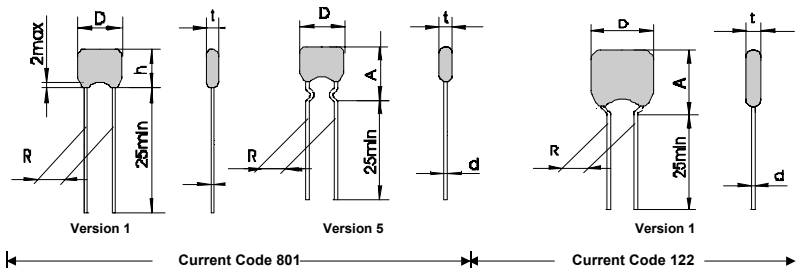
OV Series - Automotive Leaded Dual Function Varistors / RFI Suppressors						
Current Code	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)				
		D <sub>MAX</sub>	h/A <sub>MAX</sub>	R	d	t <sub>MAX</sub>
801	14 - 40	7.5	9	5	0.6	5.5
122	14 - 40	8	12	5	0.6	5.5

Device Ratings and Characteristics

OV 20 K 474 MZ 801 - to OV 40 K 155 MZ 122 -

Catalog Number	V <sub>RMS</sub>	V <sub>DC</sub>	V <sub>N</sub> @ 1 mA	V <sub>JUMP</sub> 5 min	V <sub>C</sub>	I <sub>C</sub>	W <sub>MAX</sub> 10/1000 μs	W <sub>LD</sub> 10 x	P <sub>MAX</sub>	I <sub>P</sub> 8/20 μs	C (TYP) @1 kHz
Unit of Measure	Volts	Volts	Volts	Volts	Volts	Amps	Joules	Joules	Watts	Amps	μF
<b>24V Power Supply</b>											
OV 20 K 474 MZ 801 -	20	26	33	26	54	5	3.2	6	0.015	800	0.47
OV 30 K 474 MZ 801 -	30	38	47	50	77	5	4.5	6	0.015	800	0.47
OV 40 K 474 MZ 801 -	40	56	68	71	110	5	5.0	6	0.015	800	0.47
OV 20 K 105 MZ 801 -	20	26	33	26	54	5	3.2	6	0.015	800	1.00
OV 30 K 105 MZ 801 -	30	38	47	50	77	5	4.5	6	0.015	800	1.00
OV 40 K 105 MZ 801 -	40	56	68	71	110	5	5.0	6	0.015	800	1.00
OV 20 K 155 MZ 801 -	20	26	33	26	54	5	3.2	6	0.015	800	1.50
OV 30 K 155 MZ 801 -	30	38	47	50	77	5	4.5	6	0.015	800	1.50
OV 40 K 155 MZ 801 -	40	56	68	71	110	5	5.0	6	0.015	800	1.50
OV 20 K 474 MZ 122 -	20	26	33	26	54	10	7.8	12	0.030	1200	0.47
OV 30 K 474 MZ 122 -	30	38	47	50	77	10	13.0	12	0.030	1200	0.47
OV 40 K 474 MZ 122 -	40	56	68	71	110	10	13.3	12	0.030	1200	0.47
OV 20 K 105 MZ 122 -	20	26	33	26	54	10	7.8	12	0.030	1200	1.00
OV 30 K 105 MZ 122 -	30	38	47	50	77	10	13.0	12	0.030	1200	1.00
OV 40 K 105 MZ 122 -	40	56	68	71	110	10	13.3	12	0.030	1200	1.00
OV 20 K 155 MZ 122 -	20	26	33	26	54	10	7.8	12	0.030	1200	1.50
OV 30 K 155 MZ 122 -	30	38	47	50	77	10	13.0	12	0.030	1200	1.50
OV 40 K 155 MZ 122 -	40	56	68	71	110	10	13.3	12	0.030	1200	1.50

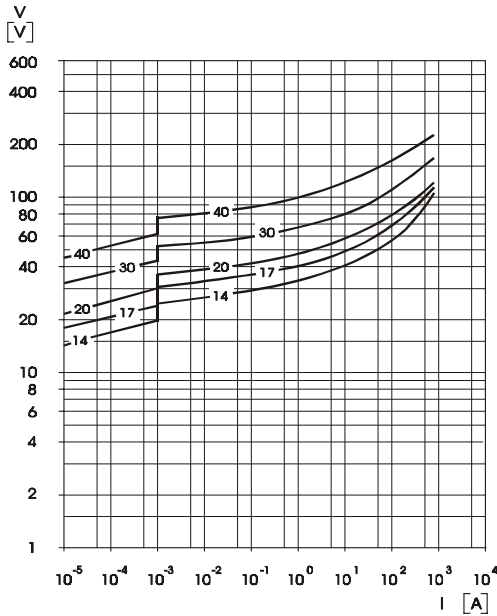
Other capacitance values are also available.



OV Series - Automotive Leaded Dual Function Varistors / RFI Suppressors						
Current Code	Voltage Range (V <sub>RMS</sub> )	Dimensions (mm)				
		D <sub>MAX</sub>	h/A <sub>MAX</sub>	R	d	t <sub>MAX</sub>
801	14 - 40	7.5	9	5	0.6	5.5
122	14 - 40	8	12	5	0.6	5.5

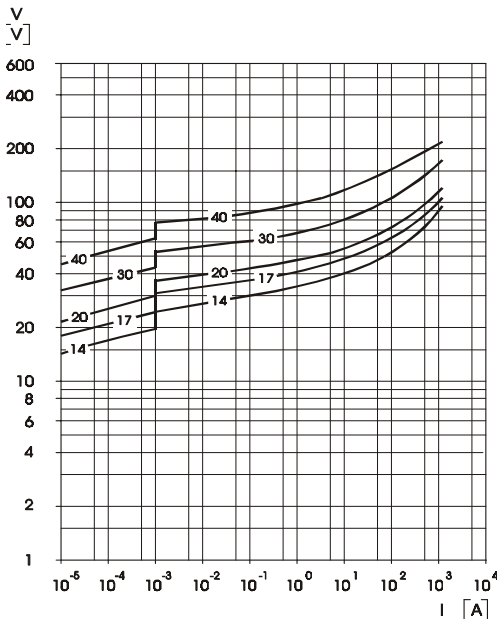
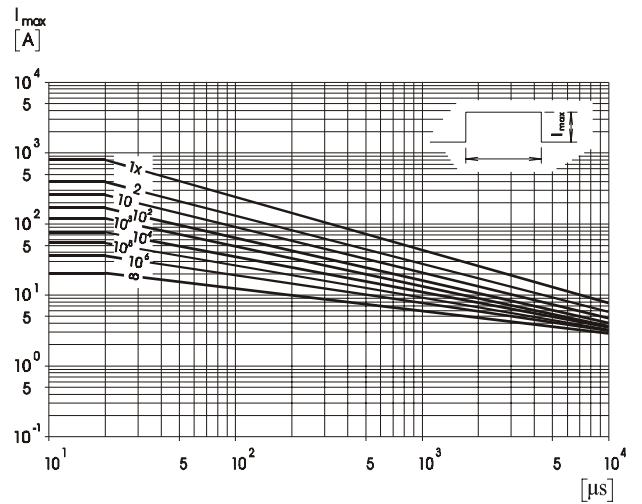
Performance Characteristics

Voltage/Current Curves

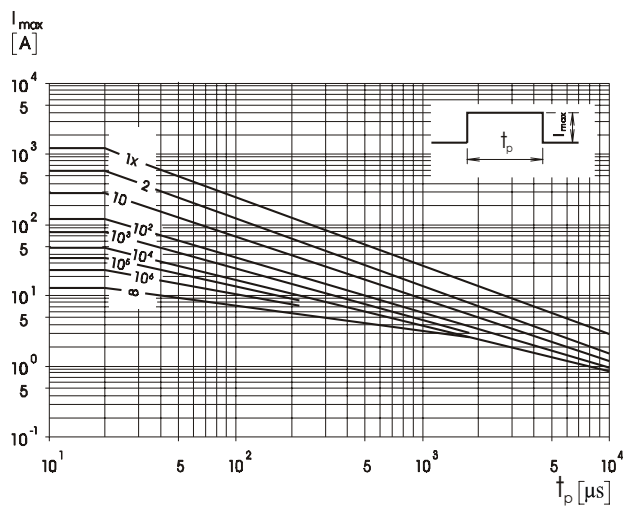


474 MZ  
OV 14K...40K 105 MZ 801  
155 MZ

Pulse Rating Curves



474 MZ  
OV 14K...40K 105 MZ 122  
155 MZ



## **Packaging / Marking Information**

### **SMD Chips (ZV, ZVX, ZVE, AV) Series**

- Tape & Reel Specifications
- Case Size Dimensions
- Recommended Soldering Pad Dimensions

### **Leaded Devices (ZV, AV, MV, OV) Series**

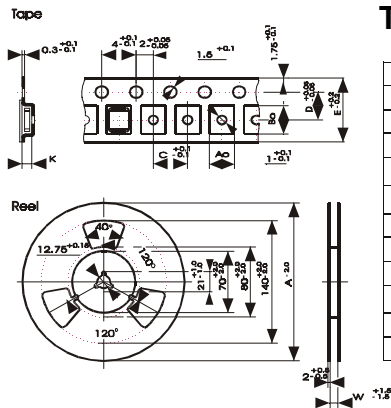
- Tape & Reel Specifications
- Ammo Pack Dimensions
- Lead Style Information
- Marking Information

Multilayer Technology

Varistor Plus

Tape & Reel Specification

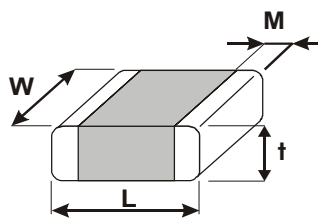
Conforms to IEC Publication 286-2



Tape / Reel Dimensions

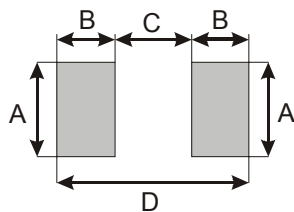
PARAMETERS	CASE SIZE						
	0603	0805	1206	1210	1812	2220	3225
$A_0$	1.2 (0.047)	1.6 (0.063)	1.9 (0.075)	2.9 (0.114)	3.75 (0.148)	5.6 (0.220)	7.0 (0.276)
$B_0$	1.9 (0.075)	2.4 (0.094)	3.75 (0.148)	3.7 (0.146)	5.0 (0.197)	6.25 (0.246)	8.7 (0.343)
C	4.0 (0.157)	4.0 (0.157)	4.0 (0.157)	4.0 (0.157)	8.0 (0.315)	8.0 (0.315)	12.0 (0.472)
D	3.5 (0.138)	3.5 (0.138)	3.5 (0.138)	3.5 (0.138)	5.5 (0.217)	5.5 (0.217)	7.5 (0.295)
E	8.4 (0.331)	8.4 (0.331)	8.4 (0.331)	8.4 (0.331)	12.4 (0.488)	12.4 (0.488)	16.4 (0.646)
$K_{MAX}$	1.1(0.043)	1.1(0.043)	1.8 (0.071)	2.0 (0.079)	2.0 (0.079)	2.0 (0.079)	3.7 (0.146)
W	8.4 (0.331)	8.4 (0.331)	8.4 (0.331)	8.4 (0.331)	12.4 (0.488)	12.4 (0.488)	16.4 (0.646)
A	180/330 (7/13)	180/330 (7/13)	180/330 (7/13)	180/330 (7/13)	180/330 (7/13)	180/330 (7/13)	330 (13)

Case Size Dimensions



Size	Length (L)		Width (W)		Thickness (t)		Land Length (M)	
	mm	(inches)	mm	(inches)	mm	(inches)	mm	(inches)
0603	1.6 ± 0.15	(0.063 ± 0.006)	0.80 ± 0.10	(0.031 ± 0.004)	1.0 max.	(0.040 max.)	0.5 ± 0.25	(.020 ± 0.01)
0805	2.0 ± 0.20	(0.079 ± 0.008)	1.25 ± 0.15	(0.049 ± 0.006)	1.1 max.	(0.043 max.)	0.5 ± 0.25	(.020 ± 0.01)
1206	3.2 ± 0.30	(0.126 ± 0.012)	1.60 ± 0.20	(0.063 ± 0.008)	1.6 max.	(0.063 max.)	0.5 ± 0.25	(.020 ± 0.01)
1210	3.2 ± 0.30	(0.126 ± 0.012)	2.50 ± 0.25	(0.100 ± 0.010)	1.8 max.	(0.070 max.)	0.5 ± 0.25	(.020 ± 0.01)
1812	4.5 ± 0.35	(0.177 ± 0.014)	3.20 ± 0.30	(0.126 ± 0.012)	1.9 max.	(0.075 max.)	0.5 ± 0.25	(.020 ± 0.01)
2220	5.7 ± 0.40	(0.224 ± 0.016)	5.00 ± 0.40	(0.197 ± 0.016)	1.9 max.	(0.075 max.)	0.5 ± 0.25	(.020 ± 0.01)
3225	8.0 ± 0.50	(0.315 ± 0.020)	6.30 ± 0.40	(0.248 ± 0.016)	2.0 max.	(0.079 max.)	0.5 ± 0.25	(.020 ± 0.01)

Recommended Soldering Pad Dimensions



Size	RECOMMENDED PAD DIMENSION			
	A	B	C	D
	mm (in.)	mm (in.)	mm (in.)	mm (in.)
0603	1.0 (0.039)	1.0 (0.039)	1.0 (0.039)	3.0 (0.118)
0805	1.4 (0.055)	1.2 (0.047)	1.0 (0.039)	3.4 (0.134)
1206	1.8 (0.071)	1.2 (0.047)	2.1 (0.083)	4.5 (0.177)
1210	2.8 (0.110)	1.2 (0.047)	2.1 (0.083)	4.5 (0.177)
1812	3.6 (0.142)	1.5 (0.059)	3.0 (0.118)	6.0 (0.236)
2220	5.5 (0.217)	1.5 (0.059)	4.2 (0.165)	7.2 (0.283)
3225	6.8 (.268)	1.5 (0.059)	6.5 (.256)	9.5 (0.374)

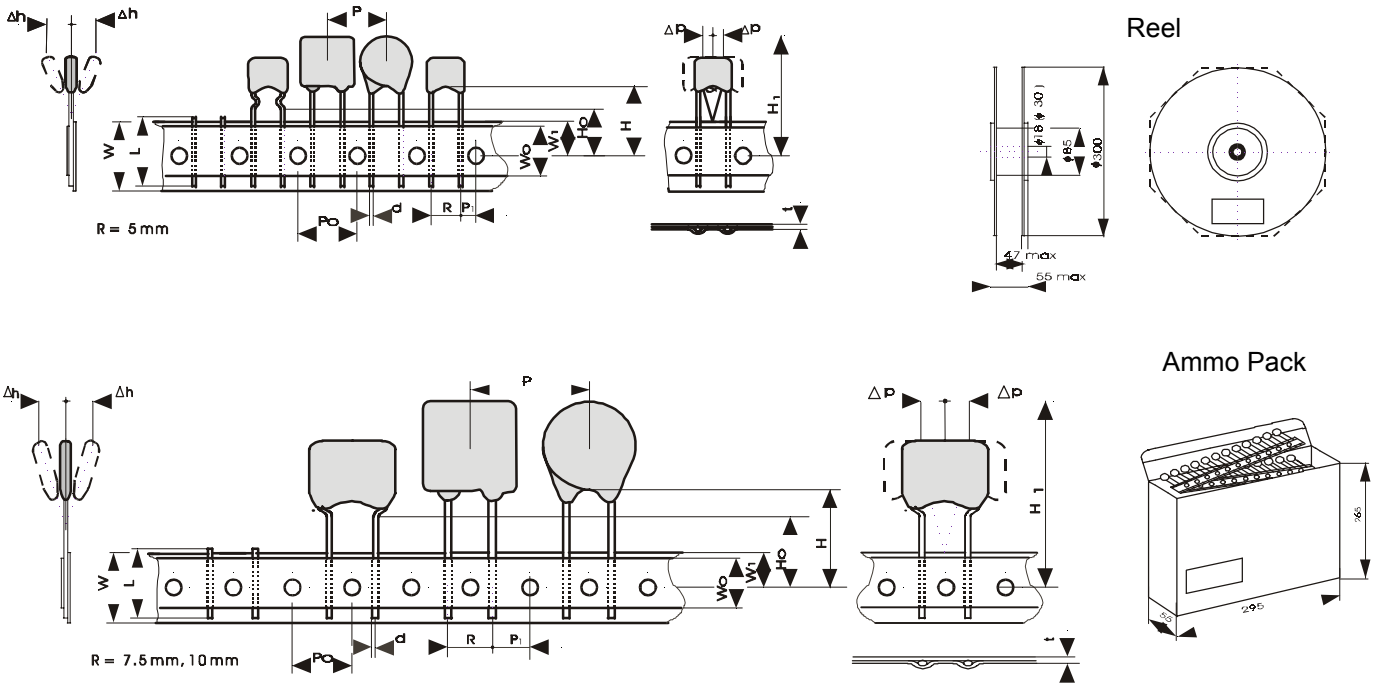
Multilayer Technology

Varistor Plus

Tape & Reel Specification

Ammo Pack Dimensions

Conforms to IEC Publication 286-2



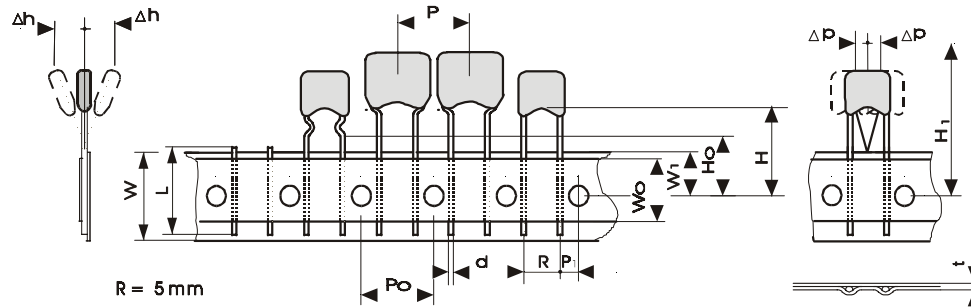
Symbol	Parameters	Series	Model Size				
		ZV	05	07	10	14	20
		AV	602 / 802 / 902			903 / 1103	
W	Tape Width		18 +1.0/-0.5 (0.71 +0.04/-0.02)	18 +1.0/-0.5 (0.71 +0.04/-0.02)	18 +1.0/-0.5 (0.71 +0.04/-0.02)	18 +1.0/-0.5 (0.71 +0.04/-0.02)	18 +1.0/-0.5 (0.71 +0.04/-0.02)
W <sub>0</sub>	Hold Down Tape Width		12 Min. (0.47 Min.)	12 Min. (0.47 Min.)	12 Min. (0.47 Min.)	12 Min. (0.47 Min.)	12 Min. (0.47 Min.)
W <sub>1</sub>	Hold position		9 +0.75/0.5 (0.35 +0.03/0.02)	9 +0.75/0.5 (0.35 +0.03/0.02)	9 +0.75/0.5 (0.35 +0.03/0.02)	9 +0.75/0.5 (0.35 +0.03/0.02)	9 +0.75/0.5 (0.35 +0.03/0.02)
t	Total Tape Thickness		0.9 Max. (0.04 Max.)	0.9 Max. (0.04 Max.)	0.9 Max. (0.04 Max.)	0.9 Max. (0.04 Max.)	0.9 Max. (0.04 Max.)
P	Pitch of Component		12.7 +/- 1.0 (0.5 +/- 0.04)	12.7 +/- 1.0 (0.5 +/- 0.04)	12.7 +/- 1.0 (0.5 +/- 0.04)	12.7 +/- 1.0 (0.5 +/- 0.04)	12.7 +/- 1.0 (0.5 +/- 0.04)
P <sub>0</sub>	Feed Hold Pitch		12.7 +/- 0.2 (0.5 +/- 0.01)	12.7 +/- 0.2 (0.5 +/- 0.01)	12.7 +/- 0.2 (0.5 +/- 0.01)	12.7 +/- 0.2 (0.5 +/- 0.01)	12.7 +/- 0.2 (0.5 +/- 0.01)
P <sub>1</sub>	Feed Hold Center to Pitch		3.81 +/- 0.7 (0.15 +/- 0.03)	3.81 +/- 0.7 (0.15 +/- 0.03)	8.89 +/- 0.8 (0.35 +/- 0.03)	8.89 +/- 0.8 (0.35 +/- 0.03)	7.62 +/- 0.8 (0.30 +/- 0.03)
R	Lead Spacing		5.08 +0.6/-0.1 (0.2 +0.02/-0.004)	5.08 +0.6/-0.1 (0.2 +0.02/-0.004)	7.62 +0.6/-0.1 (0.3 +0.02/-0.004)	7.62 +0.6/-0.1 (0.3 +0.02/-0.004)	10.16 +0.6/-0.1 (0.4 +0.02/-0.004)
ΔP	Component Alignment		+/- 1.3 Max. (+/- 0.05 Max.)	+/- 1.3 Max. (+/- 0.05 Max.)	+/- 2.0 Max. (+/- 0.08 Max.)	+/- 2.0 Max. (+/- 0.08 Max.)	+/- 2.0 Max. (+/- 0.08 Max.)
Δh	Component Alignment		+/- 2.0 Max. (+/- 0.08 Max.)	+/- 2.0 Max. (+/- 0.08 Max.)	Depends on t <sub>max</sub>	Depends on t <sub>max</sub>	Depends on t <sub>max</sub>
d	Wire Diameter		0.6 +/- 0.05 (0.024 +/-0.002)	0.6 +/- 0.05 (0.024 +/-0.002)	0.8 +/- 0.05 (0.031 +/-0.002)	0.8 +/- 0.05 (0.031 +/-0.002)	0.8 +/- 0.05 (0.031 +/-0.002)
D <sub>0</sub>	Feed Hold Diameter		4 +/- 0.2 (0.16 +/-0.01)	4 +/- 0.2 (0.16 +/-0.01)	4 +/- 0.2 (0.16 +/-0.01)	4 +/- 0.2 (0.16 +/-0.01)	4 +/- 0.2 (0.16 +/-0.01)
H	Height from Tape Center		18 +2.0/-0.0 (0.71 +/-0.0)	18 +2.0/-0.0 (0.71 +/-0.0)	18 +2.0/-0.0 (0.71 +/-0.0)	18 +2.0/-0.0 (0.71 +/-0.0)	18 +2.0/-0.0 (0.71 +/-0.0)
H <sub>0</sub>	Seating Plane Height		16 +/- 0.5 (0.63 +/- 0.02)	16 +/- 0.5 (0.63 +/- 0.02)	16 +/- 0.5 (0.63 +/- 0.02)	16 +/- 0.5 (0.63 +/- 0.02)	16 +/- 0.5 (0.63 +/- 0.02)
H <sub>1</sub>	Component Height		32.2 Max. (1.27 Max.)	32.2 Max. (1.27 Max.)	38.5 Max. (1.52 Max.)	40.0 Max. (1.57 Max.)	46.5 Max. (1.83 Max.)
L	Length of Clipped Lead		11 Max. (0.43 Max.)	11 Max. (0.43 Max.)	11 Max. (0.43 Max.)	11 Max. (0.43 Max.)	11 Max. (0.43 Max.)

Legend: mm (inch)

Tape & Reel Specification

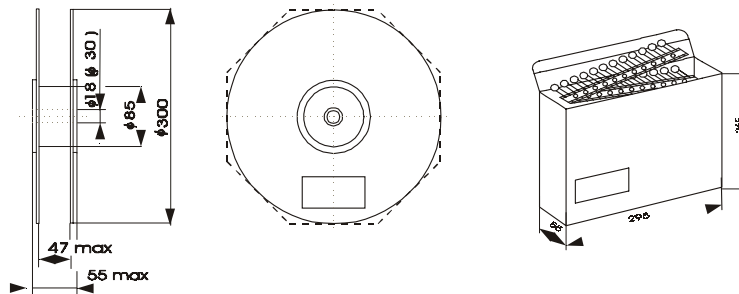
Ammo Pack Dimensions

Conforms to IEC Publication 286-2



Reel

Ammo Pack



Symbol	Parameters	Model Sizes	
		MV	OV
		6 x 9 mm	7.3 x 9.0 / 7.8 x 12 mm
<b>W</b>	Tape Width	18 +1.0/-0.5 (0.71 +0.04/-0.02)	18 +1.0/-0.5 (0.71 +0.04/-0.02)
<b>W<sub>0</sub></b>	Hold Down Tape Width	12 Min. (0.47 Min.)	12 Min. (0.47 Min.)
<b>W<sub>1</sub></b>	Hold position	9 +0.75/0.5 (0.35 +0.03/0.02)	9 +0.75/0.5 (0.35 +0.03/0.02)
<b>t</b>	Total Tape Thickness	0.9 Max. (0.04 Max.)	0.9 Max. (0.04 Max.)
<b>P</b>	Pitch of Component	12.7 +/- 1.0 (0.5 +/- 0.04)	12.7 +/- 1.0 (0.5 +/- 0.04)
<b>P<sub>0</sub></b>	Feed Hold Pitch	12.7 +/- 0.2 (0.5 +/- 0.01)	12.7 +/- 0.2 (0.5 +/- 0.01)
<b>P<sub>1</sub></b>	Feed Hold Center to Pitch	3.81 +/- 0.7 (0.15 +/- 0.03)	3.81 +/- 0.7 (0.15 +/- 0.03)
<b>R</b>	Lead Spacing	5.08 +0.6/-0.1 (0.2 +0.02/-0.004)	5.08 +0.6/-0.1 (0.2 +0.02/-0.004)
<b>ΔP</b>	Component Alignment	+/- 1.3 Max. (+/- 0.05 Max.)	+/- 1.3 Max. (+/- 0.05 Max.)
<b>Δh</b>	Component Alignment	+/- 2.0 Max. (+/- 0.08 Max.)	+/- 2.0 Max. (+/- 0.08 Max.)
<b>d</b>	Wire Diameter	0.6 +/- 0.05 (0.024 +/-0.002)	0.6 +/- 0.05 (0.024 +/-0.002)
<b>D<sub>0</sub></b>	Feed Hold Diameter	4 +/- 0.2 (0.16 +/-0.01)	4 +/- 0.2 (0.16 +/-0.01)
<b>H</b>	Height from Tape Center to Component Base	18 +2.0/-0.0 (0.71 +/-0.0)	18 +2.0/-0.0 (0.71 +/-0.0)
<b>H<sub>0</sub></b>	Seating Plane Height	16 +/- 0.5 (0.63 +/- 0.02)	16 +/- 0.5 (0.63 +/- 0.02)
<b>H<sub>1</sub></b>	Component Height	32.2 Max. (1.27 Max.)	32.2 Max. (1.27 Max.)
<b>L</b>	Length of Clipped Lead	11 Max. (0.43 Max.)	11 Max. (0.43 Max.)



Lead Style (Version) / Lead Spacing

Product Series / Range	Dimensions			Version 1	Version 5
	R	h	A		
	mm (inch)	mm (inch)	mm (inch)		
ZV 2M...40K 05	5 (0.197)		7 (0.276)		
ZV 2M...40K 07	5 (0.197)		8 (0.315)		
ZV 4M...40K 10	5 (0.197)		9 (0.354)		
AV 14K...30K 602 003	5 (0.197)		8 (0.315)		
ZV 4M...40K 14	5 (0.197)	9 (0.354)	12 (0.472)		
AV 14K...30K 802 006	5 (0.197)	9 (0.354)	12 (0.472)		
ZV 4M...40K 20	5 (0.197)		12 (0.472)		
AV 14K...30K 902 012...025	5 (0.197)		12 (0.472)		
AV 14K...30K 1103 50	7.5 (0.295)		12 (0.472)		
AV25...35K 20...40 050...100	10 (0.394)	24 (0.945)			

For additional lead styles (i.e., clipped leads, crimped leads), contact factory.

Lead Style (Version) / Lead Spacing

Type	R (mm)	h (mm)	A (mm)	Version 1	Version 5
95K 103 MV 2M...95K 104 MZ 95K 105	5 (0.197)		9 (0.354)		
474 MZ OV 14K...40K 105 MZ 801 155 MZ	5 (0.197)	9 (0.354)	12 (0.472)		
474 MZ OV 14K...40K 105 MZ 122 155 MZ	5 (0.197)		12 (0.472)		

For additional lead styles (i.e., clipped leads, crimped leads), contact factory.

**Leaded Varistor Marking**

**ZV Series:**

**For Model Sizes 05, 07**

**14 Z 5**

- 14 =  $V_{RMS}$
- Z = First Letter of Series
- 5 = Model Size

**For Model Size 10**

**ZV 40**

**K 10**

- ZV = Series Name
- 40 =  $V_{RMS}$
- K =  $V_N$  Tolerance
- 10 = Model Size

**For Model Sizes 14, 20**

**KEKO**

**ZV 11**

**K 20**

- KEKO = Tradename
- ZV = Series Name
- 11 =  $V_{RMS}$
- K =  $V_N$  Tolerance
- 20 = Model Size

**AV Series:**

**For Model Size 602**

**20 A 003**

- 20 =  $V_{RMS}$
- A = First Letter of Series
- 003 =  $W_{LD}$  Code: 3 Joules

**For Model Size 802**

**AV 17 K**

**802 006**

- AV = Series Name
- 17 =  $V_{RMS}$
- K =  $V_N$  Tolerance
- 802 = Model Size
- 006 =  $W_{LD}$  Code: 6 Joules

**For Model Sizes 902, 1103**

**KEKO**

**AV 30 K**

**1103 050**

- KEKO = Tradename
- AV = Series Name
- 30 =  $V_{RMS}$
- K =  $V_N$  Tolerance
- 1103 = Model Size
- 050 =  $W_{LD}$  Code: 50 Joules

**For Model Sizes 20, 40**

**KEKO**

**AV 25 K**

**20 050**

- KEKO = Tradename
- AV = Series Name
- 25 =  $V_{RMS}$
- K =  $V_N$  Tolerance
- 20 = Model Size
- 050 =  $W_{LD}$  Code: 50 Joules

**Leaded Varistor Marking**

**MV Series:**

**For Model Size 6 x 9mm**

**MV 14 K**

**103 Z**

MV = Series Name

14 =  $V_{RMS}$

K =  $V_N$  Tolerance

103 = Capacitance Code

Z = Dielectric Code: Z for Z5U/Y5V

**OV Series:**

**For Model Sizes 7.3 x 9 & 7.8 x 9mm**

**KEKO**

**OV 20 K**

**474 MZ**

**122**

KEKO = Tradename

OV = Series Name

20 =  $V_{RMS}$

K =  $V_N$  Tolerance

474 = Capacitance Code

M = Capacitance Tolerance

Z = Dielectric Code: Z for Z5U/Y5V

122 = Current Code: 801 for 800A  
122 for 1200A

## **Application Notes**

**Reliability Testing Procedures**

**SMD Soldering Recommendations**

Reliability Testing Procedures

Reliability Parameter	Test	Tested according to	Condition to be satisfied after testing
AC/DC Bias Reliability	AC/DC Life Test	CECC 42000, Test 4.20 or IEC 1051-1, Test 4.20. 1000 h at UCT	$ DV_n/V_n @ 1 \text{ mA}  < 10\%$ $R > 10 \text{ MW}$
Pulse Current Capability	$I_{MAX}$ 8/20 $\mu\text{s}$	CECC 42000, Test C 2.1 or IEC 1051-1, Test 4.5. 10 pulses in the same direction at 2 pulses per minute at maximum peak current for 10 pulses	$ DV_n/V_n @ 1 \text{ mA}  < 10\%$ no visible damage
Pulse Energy Capability	$W_{MAX}$ 10/1000 $\mu\text{s}$	CECC 42000, Test C 2.1 or IEC 1051-1, Test 4.5. 10 pulses in the same direction at 1 pulse every minute at maximum peak current for 10 pulses	$ DV_n/V_n @ 1 \text{ mA}  < 10\%$ no visible damage
Isolation Voltage Capability	Isolation Voltage	CECC 42000, Test 4.7 or IEC 1051-1, Test 4.8. Metal Ball method, 1 minute AC at isolation voltage	>1000V
Environmental and Storage Reliability	Climatic Sequence	CECC 42000, Test 4.16 or IEC 1051-1, Test 4.17. a) Dry heat, 16 h, UCT, Test Ba, IEC 68-2-2 b) Damp heat, cyclic, the first cycle: 55°C, 93% RH, 24 h, Test Db 68-2-4 c) Cold, LCT, 2 h, Test Aa, IEC 68-2-1 d) Damp heat, cyclic, remaining 5 cycles: 55°C, 93% RH, 24 h /cycle, Test Bd, IEC 68-2-30	$ DV_n/V_n @ 1 \text{ mA}  < 10\%$ $R > 10 \text{ MW}$
	Thermal Shock	CECC 42000, Test 4.12, Test Na, IEC 68-2-14 5 cycles UCT/LCT, 30 minutes	$ DV_n/V_n @ 1 \text{ mA}  < 10\%$ no visible damage
	Steady State Damp Heat	CECC 42000, Test 4.17, Test Ca, IEC 68-2-3 56 days, 40°C, 93% RH	$ DV_n/V_n @ 1 \text{ mA}  < 10\%$ $R > 10 \text{ MW}$
Mechanical Reliability	Solderability	CECC 42000, Test 4.10.1., Test Ta, IEC 68-2-20 solder bath method, 235°C $\pm$ 5°C, 2 s	Solderable at shipment and after 6 months of storage
	Resistance to Soldering Heat	CECC 42000, Test 4.10.2., Test Tb, IEC 68-2-20 260°C $\pm$ 5°C, 10 s	$ DV_n/V_n @ 1 \text{ mA}  < 5\%$
	Robustness of Termination	CECC 42000, Test 4.11 Test Ua, IEC 68-2-21	$ DV_n/V_n @ 1 \text{ mA}  < 5\%$
	Vibration	CECC 42000, Test 4.15., Test Fc, IEC 68-2-6, Frequency range 10 to 55 Hz Amplitude 0.75 mm or 98 m/s <sup>2</sup> Total duration 6 h (3 x 2 h) Waveshape - half sine	$ DV_n/V_n @ 1 \text{ mA}  < 10\%$ no visible damage
	Mechanical Shock	CECC 42000, Test 4.14, Test Ea, IEC 68-2-27 Acceleration = 490 m/s <sup>2</sup> , Pulse duration = 11 ms, Waveshape - half sine Number of shocks = 3 x 6	$ DV_n/V_n @ 1 \text{ mA}  < 10\%$ no visible damage
Fire Hazard	Flammability Test	CECC 42000, Test 4.18.1 or IEC 695-2-2 Needle Flame Test, 10 s	Maximum 5 s

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## Multilayer Technology

## Varistor Plus

### GENERAL COMMENTS

Popular soldering techniques used for surface mount components are Wave, Infrared and Vapor Phase Reflow processes.

### WAVE SOLDERING

This process is generally associated with discrete components mounted on the underside of printed circuit boards or for large top-side components with bottom-side mounting tabs to be attached, such as the frames of transformers, relays, connectors, etc. SMD varistors to be wave soldered are first glued to the circuit board, usually by an epoxy adhesive. When the PCB has been fully populated and an appropriate time is allowed for adhesive curing, the completed assembly is then placed on a conveyor and run through a single or double wave process.

### INFRARED AND VAPOR PHASE

These reflow processes are typically associated with top-side component placement. This technique utilizes a mixture of adhesive and solder compounds (and sometimes fluxes) that are blended into a paste. The paste is then screened onto PCB soldering pads specifically designed to accept a particular sized SMD component. Recommended solder paste wet layer thickness is 25 to 40 micrometers. Once the circuit board is fully populated with SMD components, it is placed in a reflow environment, either a heating tunnel or vapor phase chamber, where the paste is heated to slightly above its eutectic temperature. When the solder paste reflows, the SMD components are attached to the solder pads.

### SOLDER FLUXES

Solder fluxes are generally applied to populated circuit boards to prevent oxides from forming during the heating process and to facilitate the flowing of the solder. Solder fluxes can be either a part of the solder paste compound or can be separate materials, usually fluids. Recommended fluxes are:

- Non-activated (R) fluxes, whenever possible
- Mildly activated (RMA) fluxes of class L3CN (e.g., Multicore No Clean, Low Residue X33F8S-07i flux)
- Class ORLO (e.g., Kester VOC Free, No Clean 977 flux)

Activated (RA), water soluble or strong acidic fluxes with chlorine content > 0.2 wt.% are **NOT RECOMMENDED**. Use of such fluxes could create high leakage current paths along the body of the varistor components.

When a flux is applied prior to wave soldering, it is important to completely dry any residual flux solvents prior to the soldering process.

### THERMAL SHOCK

To avoid the possibility of generating stresses in the varistor chip due to thermal shock, a preheat stage to within 100 C of the peak soldering process temperature is recommended. Additionally, SMD varistors should not be subjected to a temperature gradient greater than 4 C/sec, with an ideal gradient being 2 C/sec. Peak temperatures should be controlled. Examples for soldering conditions for SMD varistors are shown in Fig.1 through 3.

Whenever several different types of SMD components are being soldered, each having a specific soldering profile, the soldering profile with the least heat and the minimum amount of heating time is recommended. Once soldering has been completed, it is necessary to minimize the possibility of thermal shock by allowing a hot PCB to cool to less than 50 C before cleaning.

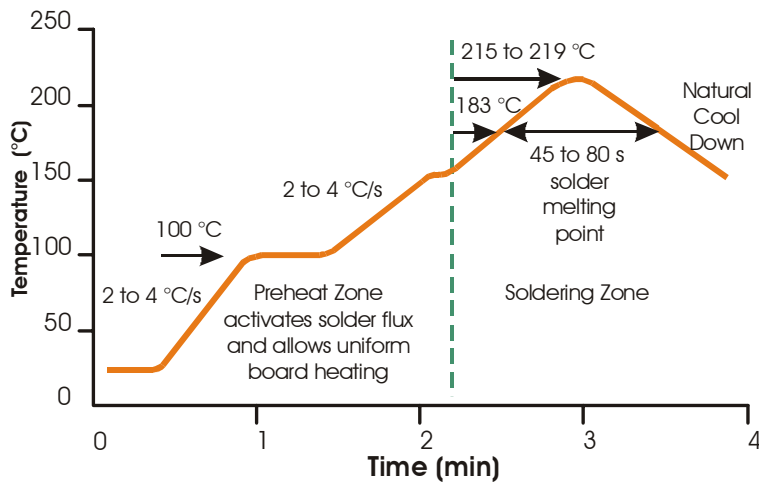


Fig. 1. Infrared Reflow Temperature Profile

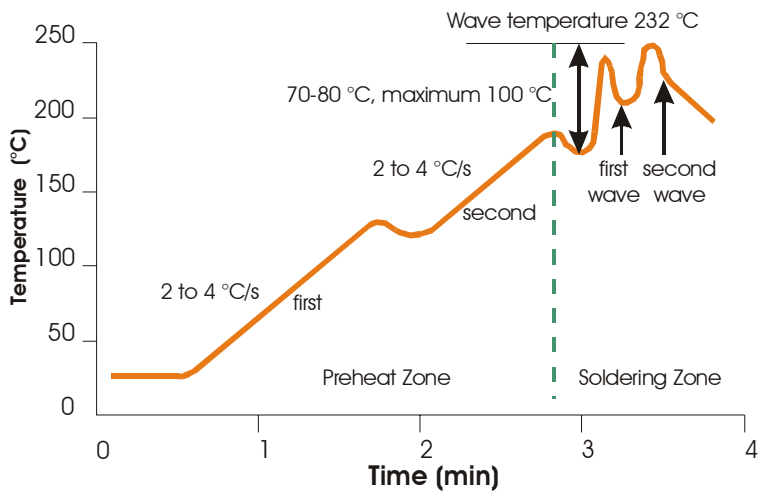


Fig. 2. Wave Soldering Temperature Profile

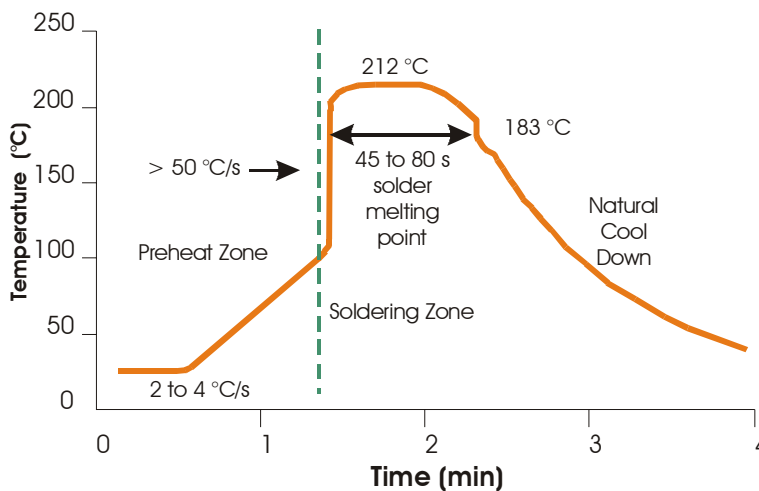


Fig. 3. Vapour Phase Temperature Profile



## INSPECTION CRITERIA FOR WAVE AND REFLOW PROCESSES

The inspection criteria to determine acceptable solder joints, when Wave, Infrared or Vapor Phase Reflow processes are used, will depend on several key variables, principally termination materials and process profiles.

### WAVE AND IR REFLOW: Silver/Palladium (AgPd) and Nickel-Barrier (NiSn) Terminations

Typical “before” and “after” soldering results are given in Fig. 4. Both nickel-barrier and silver/palladium terminated varistors form a reliable electrical contact and metallurgical bond between the end terminations and the solder pads. The bond between these two metallic surfaces is exceptionally strong and has been tested by both vertical pull and lateral (horizontal) push tests. The results, in both cases, exceed established industry standards for adhesion.

The solder joint *appearance* of a nickel-barrier terminated versus a silver/palladium terminated varistor will be slightly different. Solder forms a metallurgical junction with the thin tin-alloy (over the nickel-barrier layer), and due to its small volume “climbs” the outer surface of the termination, forming a classical meniscus. Due to the surface tension characteristics of silver/palladium terminations, the meniscus will be slightly lower. This optical appearance difference should be taken into consideration when programming visual inspection of the PCB after soldering.

### VAPOR PHASE REFLOW: Silver/Palladium (AgPd) Terminations

When the peak soldering temperature of a Vapor Phase Reflow process is less than 210 C, a phenomenon known as “mirror” or “negative” meniscus results. Solder forms a metallurgical junction with the entire volume of the end termination, i.e., it diffuses from pad to end termination across the inner side, forming a “mirror” or “negative” meniscus. The height of the solder penetration can be clearly seen on the end termination (see Fig. 5) and is always higher than 30% of the chip height.

### VAPOR PHASE REFLOW: Nickel-Barrier (NiSn) Terminations

Similar to the explanation given above for solder climbing, the outer surface of the electro-plated tin-alloy layer (over the nickel-barrier layer) of the termination, a classical meniscus is formed as demonstrated in Fig. 5.

### Silver/Palladium (AgPd) & Nickel-Barrier (NiSn) End Terminations

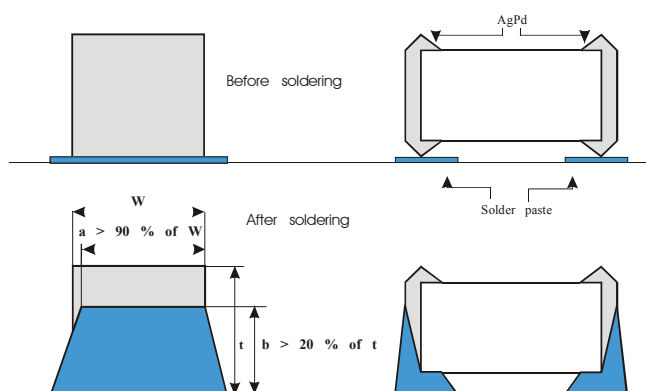


Fig. 4. Soldering Criterion in Case of Wave and IR Reflow Soldering

Silver/Palladium (AgPd) End Termination & Nickel-Barrier End Termination

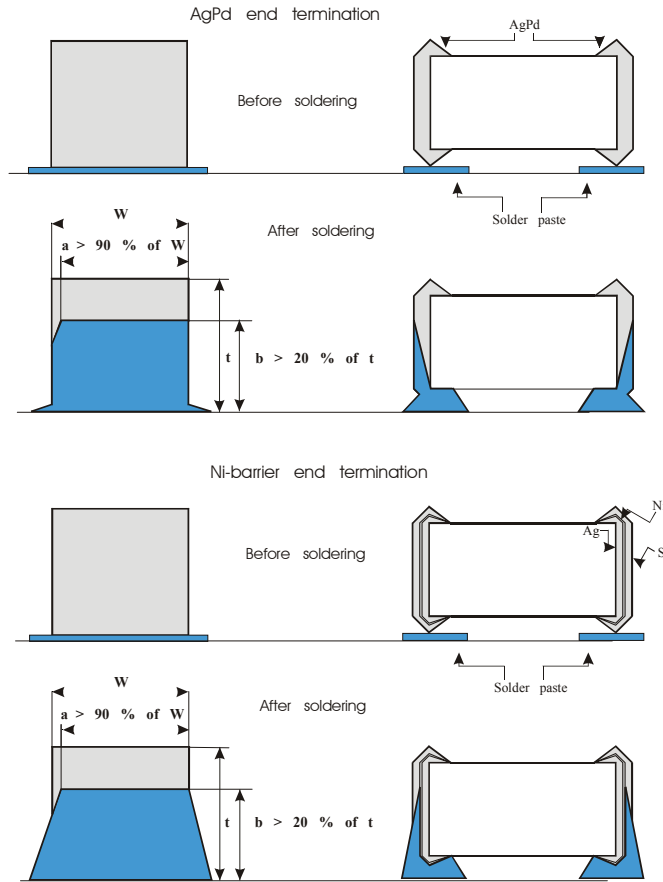


Fig. 5. Soldering Criterion in case of Vapor Soldering

SILVER/PALLADIUM (AgPd) TERMINATIONS

KEKO-VARICON chip varistors with AgPd terminations have soldering performances very close to Ni-barrier terminations. A comparison of soldering curves typical of each type of termination material is shown in the chart below, entitled Soldering Temperature-Time Characteristics

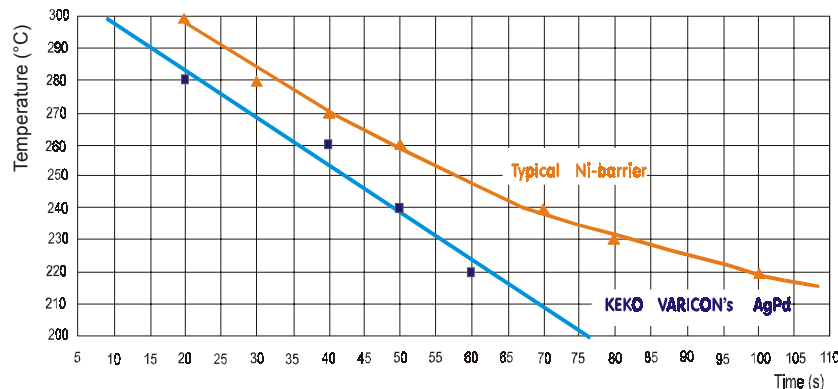


Fig. 6. Soldering Temperature -Time Characteristics

**Multilayer Technology**

**Varistor Plus**

**ENVIRONMENTALLY FRIENDLY**

Since the application of AgPd terminations on KEKO-VARICON chips does not require the use of problematic nickel and tin-alloy electroplating processes, these varistors are truly considered *environmentally friendly*.

**SOLDER TESTS AND RETAINED SAMPLES**

Solder tests are performed on each production lot as shown in the following chart. Test results and accompanying samples are retained for a minimum of two (2) years. Solderability of a specific lot can be checked at any time within this period should a customer require this information.

Test Parameter	Resistance to Flux	Solderability	Static Leaching	Dynamic Leaching
Soldering method	Dipping	Dipping	Dipping	Dipping with agitation
Flux	L3CN ORLO	L3CN, ORLO, R	L3CN, ORLO, R	L3CN, ORLO, R
Solder	62Sn/36 Pb/2 Ag	62Sn/36 Pb/2 Ag	62Sn/36 Pb/2 Ag	62Sn/36 Pb/2 Ag
Soldering temperature (C)	235 ± 5	235 ± 5	260 ± 5	235 ± 5
Soldering time	2	2	10	>15
Burn-in Conditions	V <sub>DC</sub> max, 48 h	-	-	-

Acceptance criterion	V <sub>N</sub> < 5% I <sub>DC</sub> must stay unchanged	> 95% of end terminal must be covered by solder	> 95% of end terminal must be covered by solder	> 95% of end terminal must be covered by solder

**REWORK CRITERIA – SOLDERING IRON**

Unless absolutely necessary, the use of soldering irons is NOT recommended for reworking varistor chips. If no other means of rework is available, the following criteria must be strictly followed:

- Do not allow the tip of the iron to directly contact the top of the chip
- Do not exceed the following soldering iron specifications:
  - Output Power: 30 Watts maximum
  - Temperature of Soldering Iron Tip: 280 C maximum
  - Soldering Time: 10 Seconds maximum

**STORAGE CONDITIONS**

SMD varistors should be used within 1 year of purchase to avoid possible soldering problems caused by oxidized terminals. The storage environment should be controlled, with humidity less than 40%. Varistor chips should always be stored in their original packaged unit.

Where varistor chips have been in storage for more than 1 year, and where there is evidence of solderability difficulties, KEKO-VARICON can “refresh” the terminations to eliminate these problems.

SEI electronics inc.

P.O. BOX 58789 ■ Raleigh, NC 27658-8789

Tel. 1-888-sei-sei-sei ■ Fax. 919-850-9504

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