PROTECTIVE DEVICES Catalogue

KEKO

VARICON

2008/2009

Electronic version - .pdf

...not the biggest, simply the best!

Terminology

Term	Symbol	Definition
Rated AC Voltage	V_{rms}	Maximum continuous sinusoidal AC voltage (< 5% total harmonic distortion) which may be applied to the component under continuous operating conditions at 25 °C
Rated DC Voltage	V_{dc}	Maximum continuous DC voltage (< 5 % ripple) which may be applied to the component under continuous operating conditions at 25 °C
Supply Voltage	V	The voltage by which the system is designated and to which certain operating characteristics of the system are referred; V_{rms} = 1,1 x V
Leakage Current	I_{dc}	The current passing through the varistor at V_{dc} and at 25 °C or at any other specified temperature
Varistor Voltage	V_n	Voltage across the varistor measured at a given reference current I_n
Reference Current	I_n	Reference current = 1 mA DC
Clamping Voltage Protection Level	V_c	The peak voltage developed across the varistor under standard atmospheric conditions, when passing an 8/20 µs 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 the 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 $V_{dc)}$
Jump Start Transient	V_{jump}	The jump start transient results from the temporary application of an overvoltage in excess of the rated battery voltage. The circuit power supply may be subjected to a temporary overvoltage condition due to the voltage regulation failing or it may be deliberately generated when it becomes necessary to boost start the car.
Rated Single Pulse Transient Energy	W_{max}	Energy which may be dissipated for a single 10/1000 µs pulse of a maximum rated current, with rated AC voltage or rated DC voltage also applied, without causing device failure
Load Dump Transient	**WLD**	Load Dump is a transient which occurs in automotive environment. It is an exponentially decaying positive voltage which occurs in the event of a battery disconect while the alternator is still generating charging current with other loads remaining on the alternator circuit at the time of battery disconnect.
Rated Peak Single Pulse Transient Current	I_{max}	Maximum peak current which may be applied for a single 8/20 µs pulse, with rated line voltage also applied, without causing device failure
Rated Transient Average Power Dissipation	**P**	Maximum average power which may be dissipated due to a group of pulses occurring within a specified isolated time period, without causing device failure at 25 °C
Capacitance	**C**	Capacitance between two terminals of the varistor measured at 1 kHz
Non-linearity Exponent	α	A measure of varistor nonlinearity between two given operating currents, I_n and I_1, as described by I = k V exp(a), where : - k is a device constant, - $I_1 < I < I_n$ and - $a = \log (I_1 / I_n)/\log(V_1/V_n) = 1/\log(V_1/V_n)$, where : - I_n is reference current (1 mA) and V_n is varistor voltage - $I_1 = 10\ I_n$, V_1 is the voltage measured at I_1
Response Time	t_r	The time lag between application of a surge and varistor's "turn-on" conduction action
Varistor Voltage Temperature Coefficient	**TC**	(V_n at 85°C - V_n at 25 °C) / (V_n at 25 °C) x 60 °C) x 100
Insulation Resistance	**IR**	Minimum resistance between shorted terminals and varistor surface
Isolation Voltage		The maximum peak voltage which 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
Climatic Category	**LCT/UCT/DHD**	UCT = Upper Category Temperature - the maximum ambient temperature for which a varistor has been designed to operate continuously, LCT = Lower Category Temperature - the minimum ambient temperature at which a varistor has been designed to operate continuously DHD = Dump Heat Test Duration
Storage Temperature		Storage temperature range without voltage applied
Current/Energy Derating		Derating of maximum values when operated above UCT (85 °C for PV and 125 °C for DV)

Contents :

Ordering information

PV 20 K 3225 R2 yy

PV - Series Name : DV, PV
20 - V_{rms}
K - V_n Tolerance : K = ± 10 %,
3225 - Model Size : 3225, 4032
R2 - Packaging : R2 = Reel 330 mm
yy - Special requirements

DV 20 K 3225 N R2 yy

PV - Series Name : DV, PV
20 - V_{rms}
K - V_n Tolerance : K = ± 10 %,
3225 - Model Size : 3225, 4032
N - Barrier type end terminations suitable for Pb-free reflow soldering
- (no letter) AgPd end terminations suitable for Pb reflow soldering
R2 - Packaging : R2 = Reel 330 mm
yy - Special requirements

Varistor Marking for PV Series

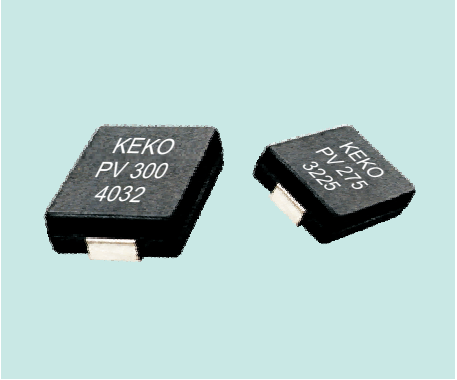
KEKO
PV 20 K
3225

KEKO - Tradename
PV - Series Name
20 - V_{rms}
K - V_n Tolerance
3225 - Model Size

LOW & MEDIUM VOLTAGE PLASTICS-ENCAPSULATED VARISTORS
PV SERIES

Description

PV Series of low & medium voltage plastics-encapsulated varistors is designed to protect electronic equipment against high voltage surges in the low & medium voltage region. They offer direct SMD equivalents to leaded disc varistors of size 5 and 7 mm. Thermoplastic encapsulation is non-flammable according to standard UL 94 V-0. Contacts are made of tinned copper sheet.



PV varistors are designed for surface mounting and are available in two model sizes. These transient voltage suppressers cover operating voltage V_{rms} from 11 V to 300 V, featuring maximum surge currents from 100 A to 1200 A.

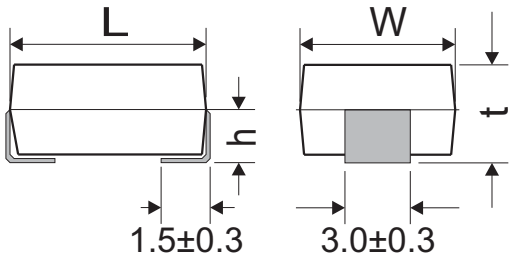
Features

- Fully Lead-free component
- Operating voltage range V_{dc} .....14 V to 385 V
- Operating voltage V_{rms} .....11 V to 300 V
- 2 Model sizes available .....3225 and 4032
- + 85 °C continuous operating temperature
- Dimensional and weight savings on the board
- Easy solderable tinned copper sheet
- Non-flammable thermoplastic encapsulation according to standard UL 94 V -0
- Available in tape and reel for automatic pick and place
- c UL us UL1449 & CSA C22.2 File E221545 Section 3.

Absolute Maximum Ratings

	Units	Value
Continuous :		
Steady State Applied Voltage :		
DC Voltage Range (V_{dc})	V	14 to 385
AC Voltage Range (V_{rms})	V	11 to 300
Transient :		
Non-Repetitive Surge Current, 8/20 µs Waveform, (I_{max})	A	100 to 1200
Non-Repetitive Surge Energy, 10/1000 µs Waveform (W_{max})	J	0,6 to 30
Operating Ambient Temperature	°C	-40 to +85
Storage Temperature Range	°C	-40 to +125
Threshold Voltage Temperature Coefficient	%/°C	< +0.05
Response Time	ns	< 5
Climatic Category		40 / 85 / 56

Device Ratings and Characteristics



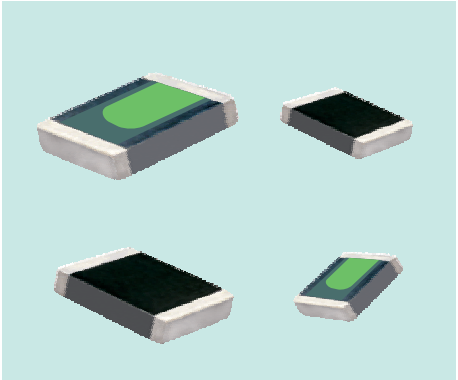
PV 11 K 3225.....PV 300 K 4032

Type	V_{rms}	V_{dc}	V_n @ 1 mA	V_c	I_c	W_{max} 10/1000 µs	P max	I_{max} 8/20 µs	C_{typ} @ 1 kHz	h ± 0,3	L ± 0,5	W ± 0,4	t ± 0,3
	V	V	V	V	A	J	W	A	pF	mm	mm	mm	mm
PV 11 K 3225	11	14	18	36	2,5	0,6	0.01	100	1600	1,7	8,0	6,3	3,4
PV 11 K 4032	11	14	18	36	5	1,1	0.02	250	3100	2,3	10,0	8,0	4,7
PV 14 K 3225	14	18	22	43	2,5	0,7	0.01	100	1300	1,7	8,0	6,3	3,4
PV 14 K 4032	14	18	22	43	5	1,3	0.02	250	2500	2,3	10,0	8,0	4,7
PV 17 K 3225	17	22	27	53	2,5	0,9	0.01	100	1050	1,7	8,0	6,3	3,4
PV 17 K 4032	17	22	27	53	5	1,6	0.02	250	1900	2,3	10,0	8,0	4,7
PV 20 K 3225	20	26	33	65	2,5	1,1	0.01	100	750	1,7	8,0	6,3	3,4
PV 20 K 4032	20	26	33	65	5	2,0	0.02	250	1500	2,3	10,0	8,0	4,7
PV 25 K 3225	25	31	39	77	2,5	1,2	0.01	100	660	1,7	8,0	6,3	3,4
PV 25 K 4032	25	31	39	77	5	2,4	0.02	250	1260	2,3	10,0	8,0	4,7
PV 30 K 3225	30	38	47	93	2,5	1,5	0.01	100	580	1,7	8,0	6,3	3,4
PV 30 K 4032	30	38	47	93	5	2,8	0.02	250	1050	2,3	10,0	8,0	4,7
PV 35 K 3225	35	45	56	110	2,5	1,8	0.01	100	460	1,7	8,0	6,3	3,4
PV 35 K 4032	35	45	56	110	5	3,4	0.02	250	850	2,3	10,0	8,0	4,7
PV 40 K 3225	40	56	68	135	2,5	2,2	0.01	100	400	1,7	8,0	6,3	3,4
PV 40 K 4032	40	56	68	135	5	4,1	0.02	250	720	2,3	10,0	8,0	4,7
PV 50 K 3225	50	65	82	135	5	2,5	0,10	400	390	1,7	8,0	6,3	3,4
PV 50 K 4032	50	65	82	135	10	6,5	0,25	1200	820	2,3	10,0	8,0	4,7
PV 60 K 3225	60	85	100	165	5	3,0	0,10	400	330	1,7	8,0	6,3	3,4
PV 60 K 4032	60	85	100	165	10	7,0	0,25	1200	680	2,3	10,0	8,0	4,7
PV 75 K 3225	75	100	120	200	5	4,0	0,10	400	270	1,7	8,0	6,3	3,4
PV 75 K 4032	75	100	120	200	10	9,0	0,25	1200	550	2,3	10,0	8,0	4,7
PV 95 K 3225	95	125	150	250	5	6,0	0,10	400	220	1,7	8,0	6,3	3,4
PV 95 K 4032	95	125	150	250	10	11,0	0,25	1200	440	2,3	10,0	8,0	4,7
PV 115 K 3225	115	150	180	300	5	6,5	0,10	400	180	1,7	8,0	6,3	3,4
PV 115 K 4032	115	150	180	300	10	13,0	0,25	1200	360	2,3	10,0	8,0	4,7
PV 130 K 3225	130	170	205	340	5	7,0	0,10	400	160	1,7	8,0	6,3	3,4
PV 130 K 4032	130	170	205	340	10	15,0	0,25	1200	320	2,3	10,0	8,0	4,7
PV 140 K 3225	140	180	220	360	5	7,5	0,10	400	150	1,7	8,0	6,3	3,4
PV 140 K 4032	140	180	220	360	10	18,0	0,25	1200	300	2,3	10,0	8,0	4,7
PV 150 K 3225	150	200	240	395	5	9,0	0,10	400	140	1,7	8,0	6,3	3,4
PV 150 K 4032	150	200	240	395	10	18,5	0,25	1200	280	2,3	10,0	8,0	4,7
PV 175 K 3225	175	225	270	455	5	9,5	0,10	400	120	2,3	8,0	6,3	4,7
PV 175 K 4032	175	225	270	455	10	21,0	0,25	1200	250	2,3	10,0	8,0	4,7
PV 230 K 3225	230	300	360	595	5	10,0	0,10	400	95	2,3	8,0	6,3	4,7
PV 230 K 4032	230	300	360	595	10	23,0	0,25	1200	190	2,3	10,0	8,0	4,7
PV 250 K 3225	250	320	390	650	5	11,0	0,10	400	80	2,3	8,0	6,3	4,7
PV 250 K 4032	250	320	390	650	10	25,0	0,25	1200	180	2,3	10,0	8,0	4,7
PV 275 K 3225	275	350	430	710	5	13,0	0,10	400	75	2,3	8,0	6,3	4,7
PV 275 K 4032	275	350	430	710	10	29,0	0,25	1200	160	2,3	10,0	8,0	4,7
PV 300 K 3225	300	385	470	775	5	15,0	0,10	400	70	2,3	8,0	6,3	4,7
PV 300 K 4032	300	385	470	775	10	30,0	0,25	1200	150	2,3	10,0	8,0	4,7

MEDIUM VOLTAGE VARICONS®
DV SERIES

Description

DV Series of medium voltage varicons is designed to protect electronic equipment against high voltage surges in the medium voltage region. They offer excellent transient energy absorption due to improved energy volume distribution and power dissipation. Compared to other medium voltage SMD varistors DV Varicons have very low profile.



DV varicons are designed for surface mounting and are available in two model sizes. These transient voltage suppressers cover operating voltage V_{rms} from 11 V to 300 V, featuring maximum surge currents from 400 A to 1200 A.

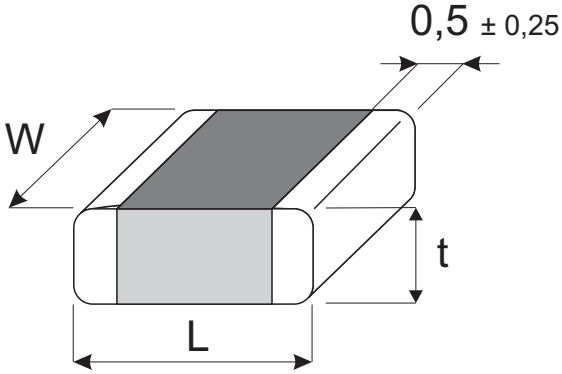
Features

- *Fully lead-free component*
- *Operating voltage range V_{dc} .....14 V to 385 V*
- *Operating voltage V_{rms} .....11 V to 300 V*
- *2 Model sizes available .....3225 and 4032*
- *Broad range of current and energy handling capabilities*
- *Leadless chip form - zero inductance guaranteeing the fastest speed of response to transient surges*
- *+ 125 °C continuous operating temperature*
- *Insensitive to water cleaning procedures and to humidity corresponding to climatic category 55/125/56*
- *Dimensional and weight savings on the board - low profile medium voltage SMD varistor*
- *No packaging improves the flammability rating*
- *Available in tape and reel for automatic pick and place*

Absolute Maximum Ratings

	Units	Value
Continuous :		
Steady State Applied Voltage :		
DC Voltage Range (V_{dc})	V	14 to 385
AC Voltag e Range (V_{rms})	V	11 to 300
Transient :		
Non-Repetitive Surge Current, 8/20 µs Waveform, (I_{max})	A	100 to 1200
Non-Repetitive Surge Energy, 10/1000 µs Waveform (W_{max})	J	0,6 to 30
Operating Ambient Temperature	°C	-55 to +125
Storage Te mperature Range	°C	-55 to +150
Threshold Voltage Temperature Coefficient	%/°C	< +0.05
Response Time	ns	< 5
Climatic Category		55 / 125 / 56

Device Ratings and Characteristics



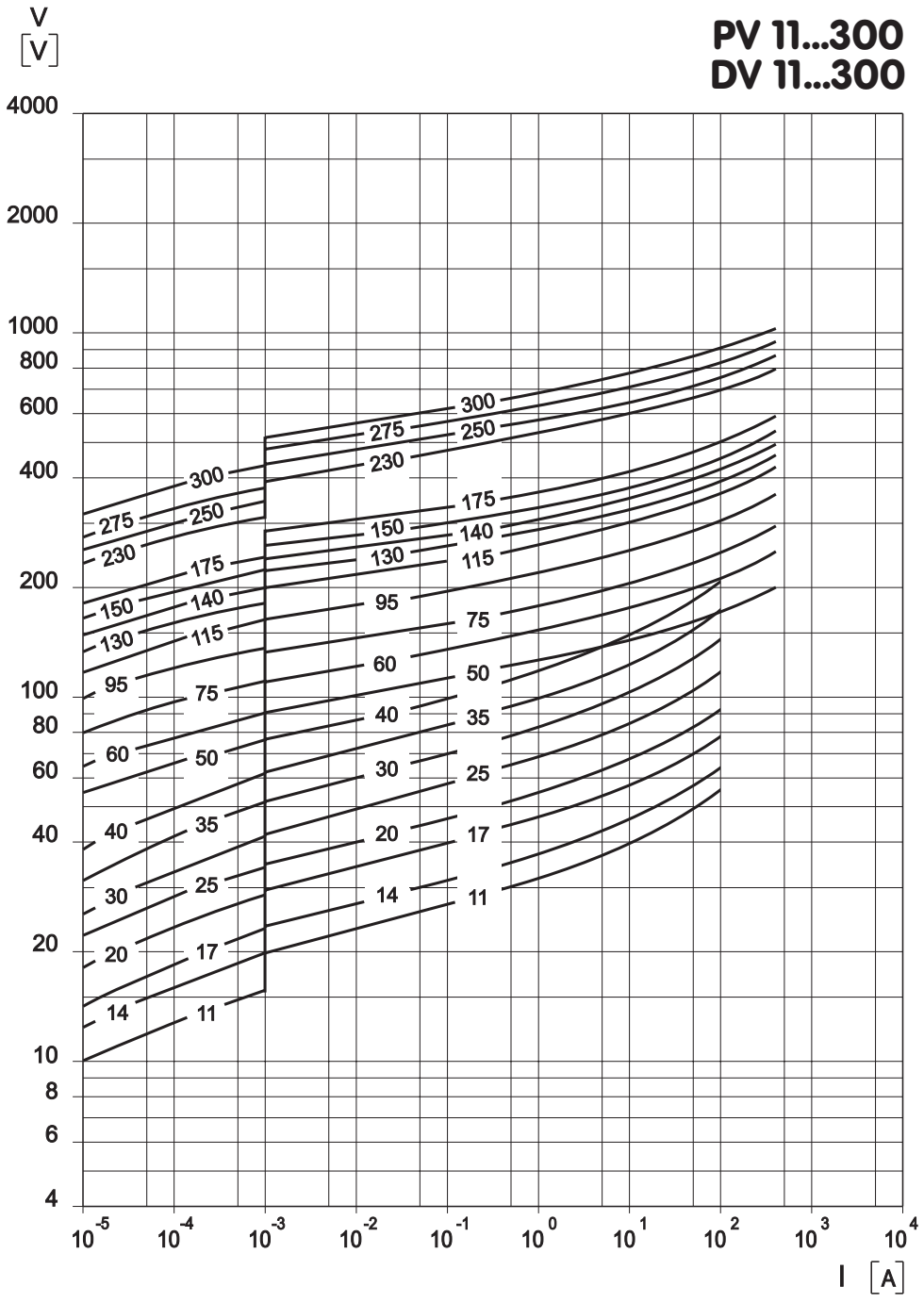
DV 11 K 3225.....DV 300 K 4032

Type	V_{rms} V	V_{dc} V	V_n @ 1 mA V	V_c V	I_c A	W_{max} 10/1000 µs J	P max W	I_{max} 8/20 µs A	C @ 1 kHz pF	L ± 0,5 mm	W ± 0,4 mm	t max mm
DV 11 K 3225	11	14	18	36	2,5	0,6	0.01	100	2500	8,0	6,3	1,4
DV 11 K 4032	11	14	18	36	5	1,1	0.02	250	4300	10,0	8,0	1,4
DV 14 K 3225	14	18	22	43	2,5	0,7	0.01	100	2200	8,0	6,3	1,6
DV 14 K 4032	14	18	22	43	5	1,3	0.02	250	3500	10,0	8,0	1,6
DV 17 K 3225	17	22	27	53	2,5	0,9	0.01	100	1750	8,0	6,3	1,8
DV 17 K 4032	17	22	27	53	5	1,6	0.02	250	3000	10,0	8,0	1,8
DV 20 K 3225	20	26	33	65	2,5	1,1	0.01	100	1650	8,0	6,3	1,8
DV 20 K 4032	20	26	33	65	5	2,0	0.02	250	2300	10,0	8,0	1,8
DV 25 K 3225	25	31	39	77	2,5	1,2	0.01	100	1500	8,0	6,3	2,0
DV 25 K 4032	25	31	39	77	5	2,4	0.02	250	1900	10,0	8,0	2,0
DV 30 K 3225	30	38	47	93	2,5	1,5	0.01	100	1000	8,0	6,3	2,0
DV 30 K 4032	30	38	47	93	5	2,8	0.02	250	1600	10,0	8,0	2,0
DV 35 K 3225	35	45	56	110	2,5	1,8	0.01	100	800	8,0	6,3	2,0
DV 35 K 4032	35	45	56	110	5	3,4	0.02	250	1400	10,0	8,0	2,0
DV 40 K 3225	40	56	68	135	2,5	2,2	0.01	100	700	8,0	6,3	2,0
DV 40 K 4032	40	56	68	135	5	4,1	0.02	250	1200	10,0	8,0	2,0
DV 50 K 3225	50	65	82	135	5	2,5	0,10	400	400	8,2	6,3	2,0
DV 50 K 4032	50	65	82	135	10	6,5	0,25	1200	580	10,0	8,0	2,0
DV 60 K 3225	60	85	100	165	5	3,0	0,10	400	300	8,2	6,3	2,0
DV 60 K 4032	60	85	100	165	10	7,0	0,25	1200	530	10,0	8,0	2,0
DV 75 K 3225	75	100	120	200	5	4,0	0,10	400	240	8,2	6,3	2,0
DV 75 K 4032	75	100	120	200	10	9,0	0,25	1200	480	10,0	8,0	2,0
DV 95 K 3225	95	125	150	250	5	6,0	0,10	400	210	8,2	6,3	2,0
DV 95 K 4032	95	125	150	250	10	11,0	0,25	1200	310	10,0	8,0	2,0
DV 115 K 3225	115	150	180	300	5	6,5	0,10	400	200	8,2	6,3	2,0
DV 115 K 4032	115	150	180	300	10	13,0	0,25	1200	270	10,0	8,0	2,0
DV 130 K 3225	130	170	205	340	5	7,0	0,10	400	150	8,2	6,3	2,0
DV 130 K 4032	130	170	205	340	10	15,0	0,25	1200	250	10,0	8,0	2,0
DV 140 K 3225	140	180	220	360	5	7,5	0,10	400	180	8,2	6,3	2,0
DV 140 K 4032	140	180	220	360	10	18,0	0,25	1200	240	10,0	8,0	2,0
DV 150 K 3225	150	200	240	395	5	9,0	0,10	400	150	8,2	6,3	2,0
DV 150 K 4032	150	200	240	395	10	18,5	0,25	1200	220	10,0	8,0	2,0
DV 175 K 3225	175	225	270	455	5	9,5	0,10	400	130	8,2	6,3	2,0
DV 175 K 4032	175	225	270	455	10	21,0	0,25	1200	200	10,0	8,0	2,0
DV 230 K 3225	230	300	360	595	5	10,0	0,10	400	110	8,2	6,3	2,0
DV 230 K 4032	230	300	360	595	10	23,0	0,25	1200	170	10,0	8,0	2,0
DV 250 K 3225	250	320	390	650	5	11,0	0,10	400	100	8,2	6,3	2,0
DV 250 K 4032	250	320	390	650	10	25,0	0,25	1200	160	10,0	8,0	2,0
DV 275 K 3225	275	350	430	710	5	13,0	0,10	400	90	8,2	6,3	2,0
DV 275 K 4032	275	350	430	710	10	29,0	0,25	1200	150	10,0	8,0	2,0
DV 300 K 3225	300	385	470	775	5	15,0	0,10	400	85	8,2	6,3	2,0
DV 300 K 4032	300	385	470	775	10	30,0	0,25	1200	140	10,0	8,0	2,0

Model Size 3225

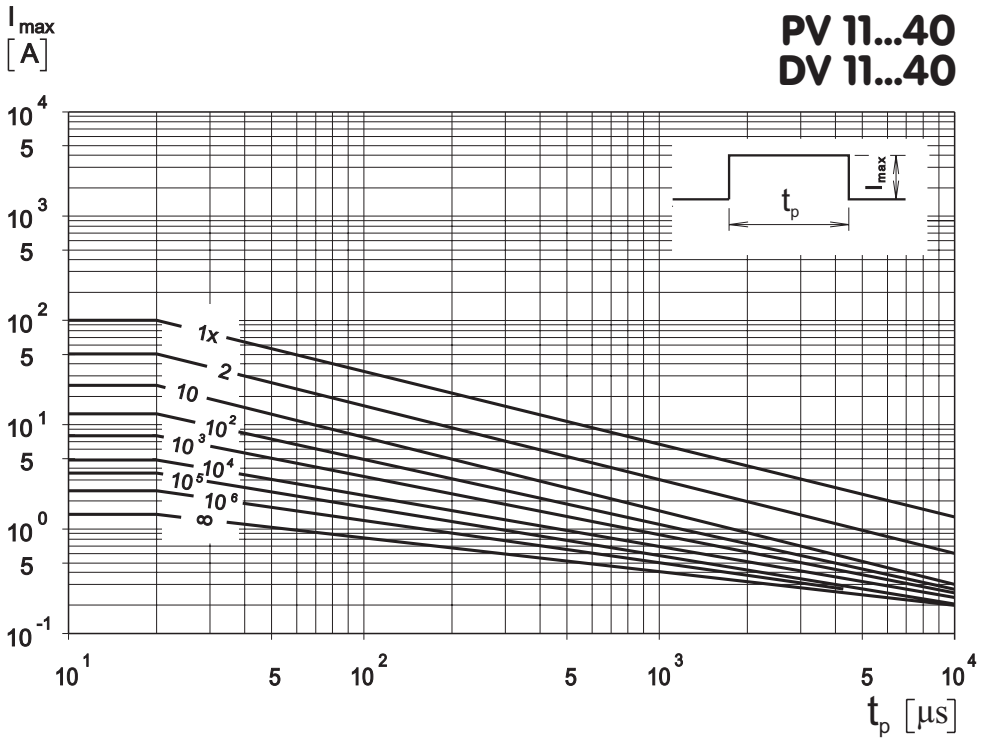
Protection Level

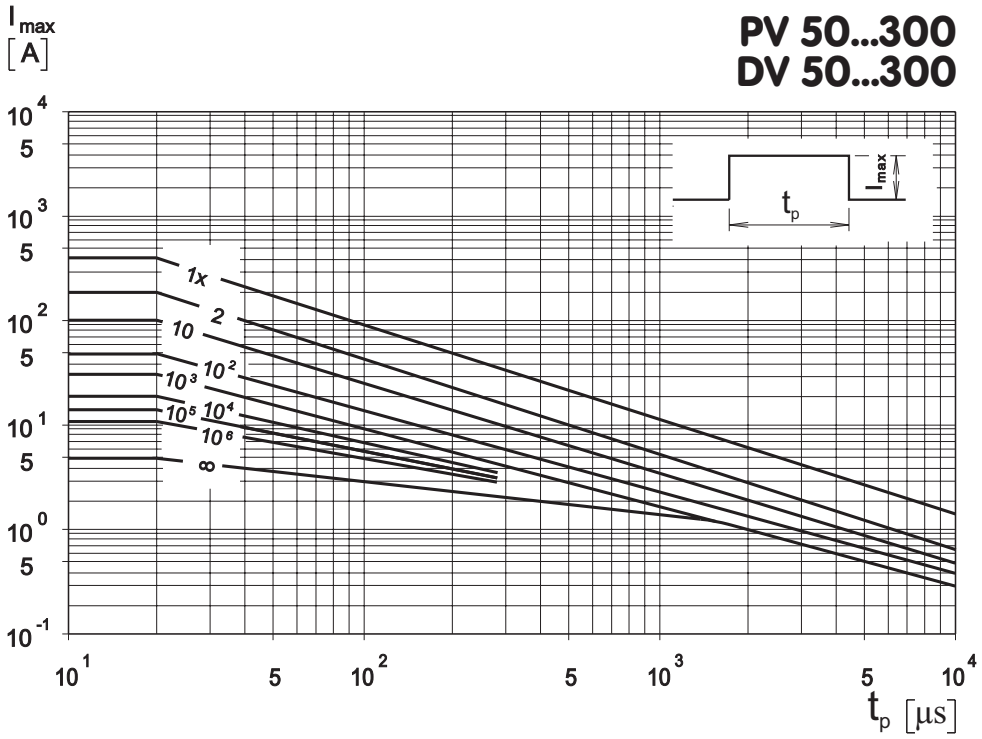
with the worst-case condition
in the tolerance region



Model Size 3225

Pulse Rating Curves

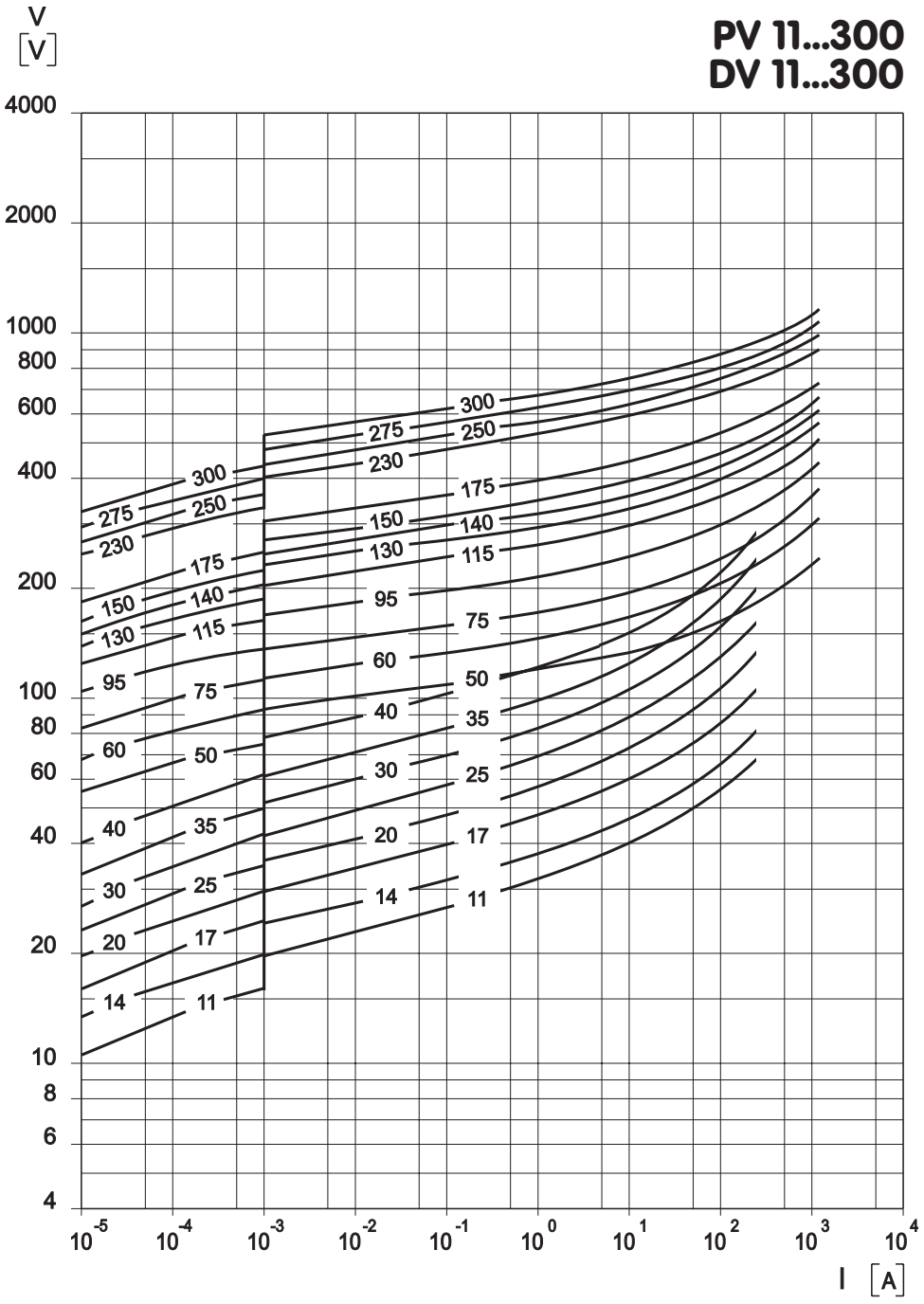




Model Size 4032

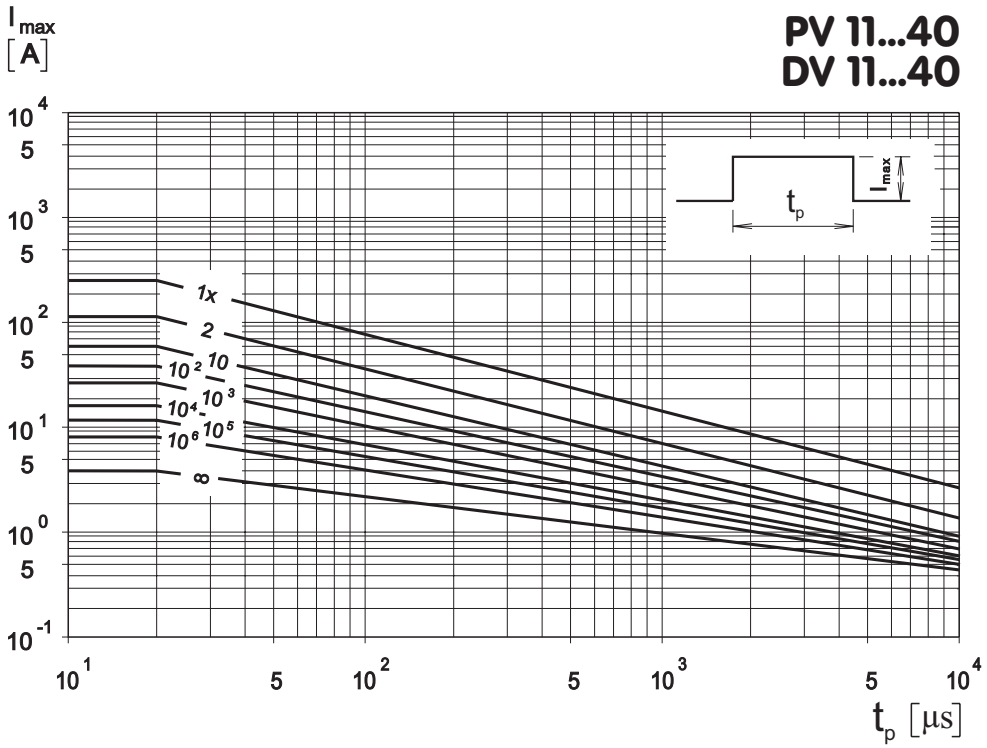
Protection Level

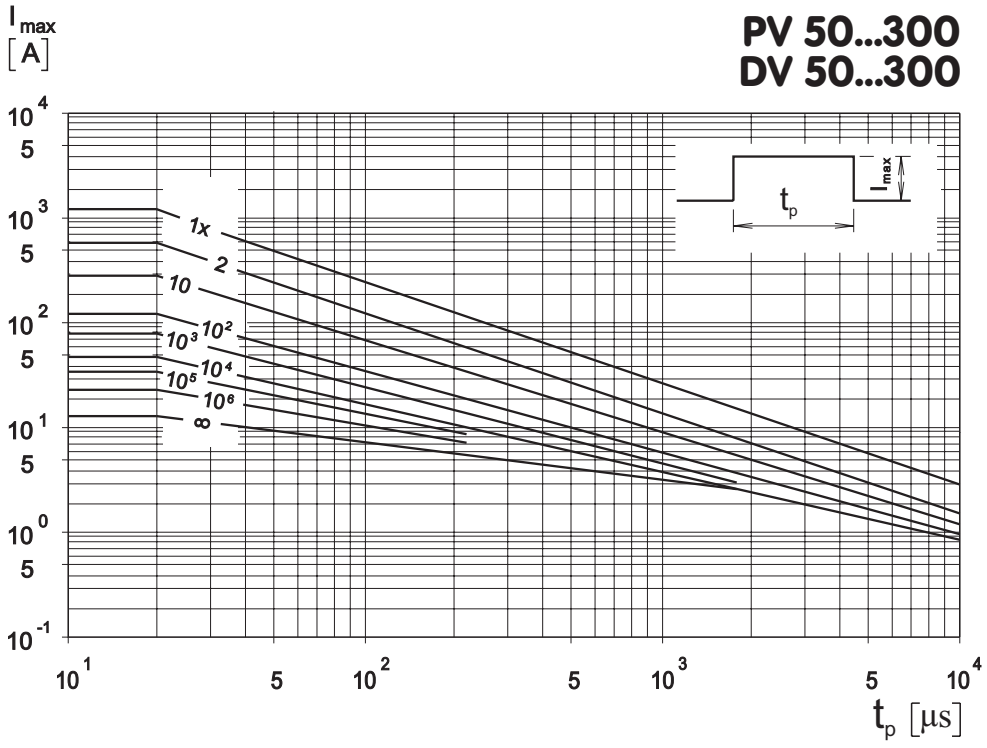
with the worst-case condition
in the tolerance region



Model Size 4032

Pulse Rating Curves





SOLDERING RECOMMENDATIONS

Popular soldering techniques used for surface mount components are Wave and Infrared Reflow processes. Both processes can be performed with Pb-containing or Pb-free solders. The termination options available for these soldering techniques are AgPd and Barrier Type End Terminations.

End termination	Designation	Recommended and Suitable for	Component RoHS Compliant
Ag/Pd	Series(ZV,AV,DV,C,...).....R1	Pb-containing soldering	Yes
Barrier Type End Termination	Series(ZV,AV,DV,C,...).....N R1	Pb-contaning and Pb-free soldering	Yes

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 Reflow Soldering - these reflow processes are typically associated with top-side component placement. This technique utilizes a mixture of adhesive and solder compounds (an 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 100 to 300 μm. Once the circuit board is fully populated with SMD components, it is placed in a reflow environment, 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 clean 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
- Class ORLO

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.

Solders - recommended solders are Pb-free (Sn96 / Cu0,4-0,8/ Ag3-4) or Pb-containing (62Sn / 36Pb / 2Ag) ones.

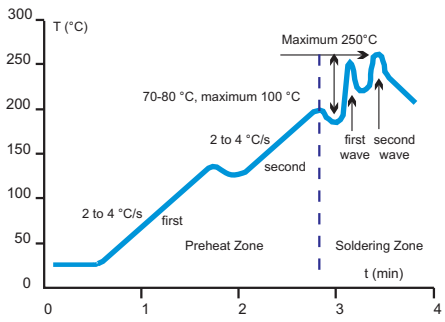


Fig. 1. Wave Soldering Temperature Profile for Pb-free and Pb-containing Soldering

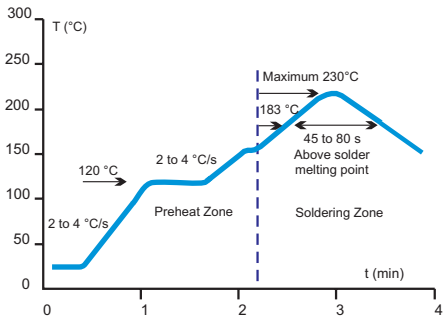


Fig. 2. Infrared Reflow Temperature Profile for Pb-containing Soldering

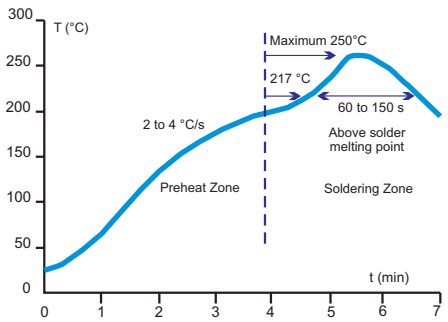


Fig. 3. Reflow Temperature Profile for Pb-free Soldering

Thermal Shock - to avoid the possibility of generating stresses in the varistor chip due to thermal shock, a preheat stage to within 100 ^{0}C of the peak soldering process temperature is recommended. Additionally, SMD varistors should not be subjected to a temperature gradient greater than 4 ^{0}C/sec, with an ideal gradient being 2 ^{0}C/sec. Peak temperatures should be controlled. Wave and Reflow soldering conditions for SMD varistors with Pb-containing solders are shown in Fig. 1 and 2 respectively, while Wave and Reflow soldering conditions for SMD varistors with Pb-free solders are shown in Fig. 1 and 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 ^{0}C before cleaning.

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

Pb-contining Wave and IR Reflow Soldering - typical "before" and "after" soldering results for Silver/Palladium (AgPd) and Barrier Type End Terminations are given in Fig. 4. Both barrier type 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 barrier type terminated versus a silver/palladium terminated varistor will be slightly different. Solder forms a metallurgical junction with the thin tin-alloy (over the barrier layer), and due to its small volume "climbs" the outer surface of the termination, forming a classical meniscus. Due 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.

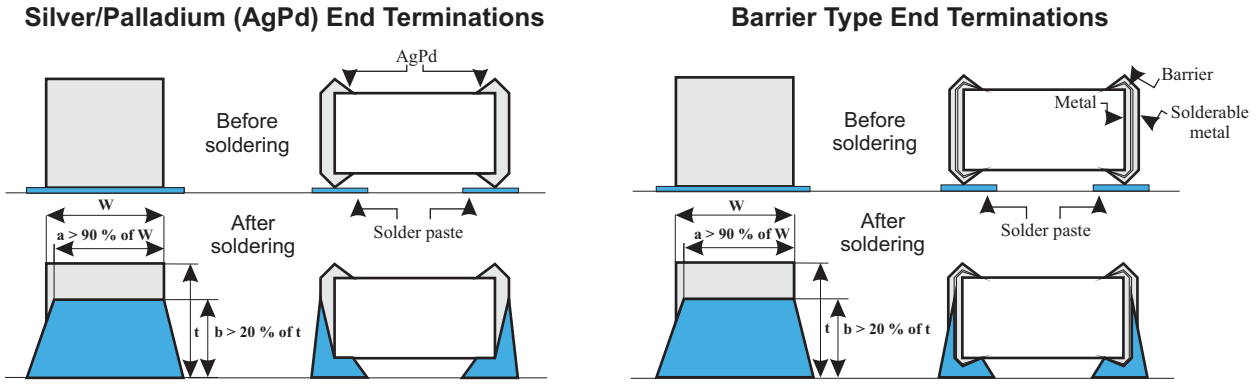


Fig. 4. Soldering Criterion in case of Wave and IR Reflow Pb-containing Soldering

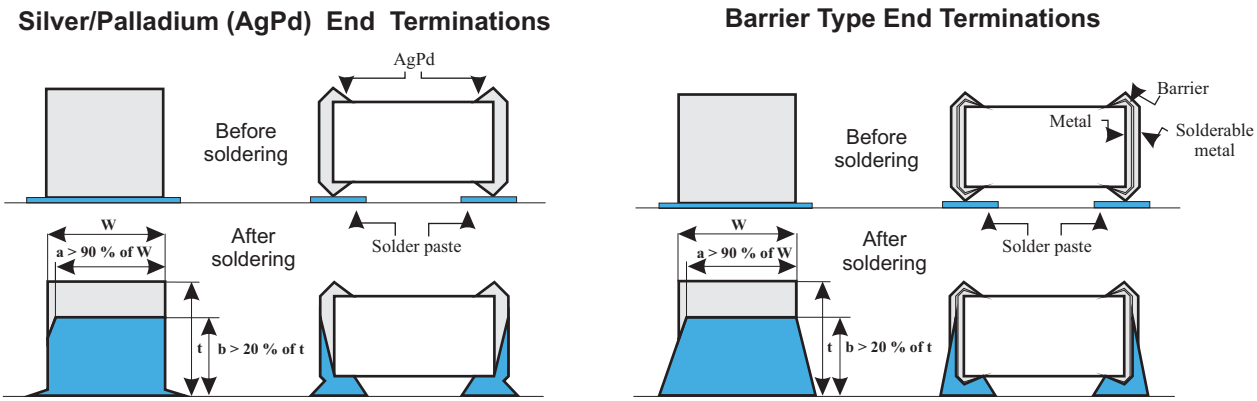


Fig. 5. Soldering Criterion in case of Wave and IR Reflow Pb-free Soldering

Pb-free Wave and IR Reflow Soldeirng - typical “before” and “after” soldering results for Silver/Palladium (AgPd) and Barrier Type End Terminations are given in Fig. 5. Barrier type varistor terminations provide standard meniscus and are recommended for Pb-free soldering.

A phenomenon known as “mirror” or “negative” meniscus results will appear in case of Silver/Palladium termiinated varistors. 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 and is always higher than 30% of the chip height.

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

Solder Tests and Retained Samples - reflow soldering test based on J-STD-020D.1 and soldering test by dipping based on IEC 60068-2 for Pb-free solders are preformed 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 (simulation of Reflow Soldering)	Dynamic leaching (simulation of Wave Soldering)
Soldering method	dipping	dipping	dipping	dipping with agitation
Flux	L3CN, ORL0	L3CN, ORL0, R	L3CN, ORL0, R	L3CN, ORL0, R
Pb Solder	96,5Sn / 3,5Ag			
Pb Soldering temperature (^{0}C)	235 ± 5	235 ± 5	260 ± 5	235 ± 5
Pb-FREE Solder	Sn96 / Cu0,4-0,8 / 3-4Ag			
Pb-FREE Soldering temperature (^{0}C)	250 ± 5	250 ± 5	280 ± 5	250 ± 5
Soldering time (s)	2	2	10	> 15
Burn-in conditions	Vdcmax, 48 h	-	-	-
Acceptance criterion	dVn < 5 %, Idc must stay unchanged	> 95 % of end termination must be covered by solder	> 95 % of end termination must be intact and covered by solder	> 95 % of end termination must be intact and 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:

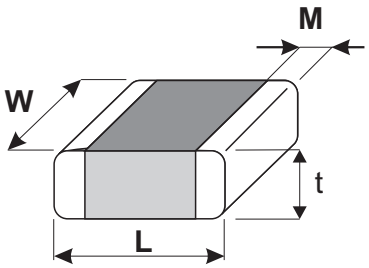
Output Power:	30 Watts maximum
Temperature of Soldering Iron Tip:	280 °C maximum
Soldering Time:	10 Seconds maximum

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% and temperature between -25 and 45 °C. Varistor chips should always be stored in their original packaged unit.

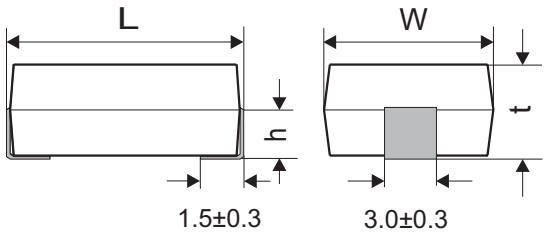
Where varistor chips have been in storage for more than 1 year, and where there is evidence of solderability difficulties, KEKO-VARICON can “refresh” the terminations to eliminate these problems.

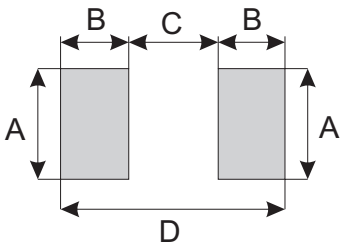
Soldering Pad Configuration

DV Series



PV Series





DV

Size	Voltage range (V)	L ± 0,5 (mm)	W ± 0,4 (mm)	M ± 0,25 (mm)	tmax (mm)	A (mm)	B (mm)	C (mm)	D (mm)
3225	11 to 300	8,0	6,3	0,5	2,0	6,8	1,5	6,5	9,5
4032	11 to 300	10,0	8,0	0,5	2,0	6,8	1,5	8,7	11,7

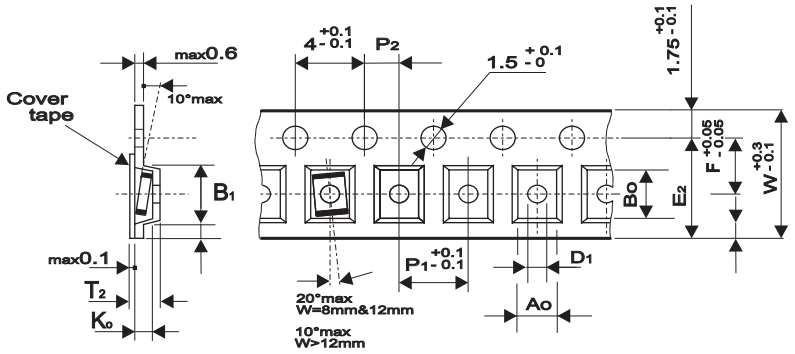
PV

Size	Voltage range (V)	L ± 0,5 (mm)	W ± 0,4 (mm)	h ± 0,3 (mm)	t ± 0,3 (mm)	A (mm)	B (mm)	C (mm)	D (mm)
3225	11 to 175	8,0	6,3	1,7	3,2	3,5	2,8	4,5	10,1
3225	230 to 300	8,3	6,3	2,3	4,5	3,5	2,8	4,5	10,0
4032	11 to 175	10,2	8,0	1,7	3,2	3,5	2,8	6,5	12,1
4032	230 to 300	10,2	8,0	2,3	4,5	3,5	2,8	6,5	12,1

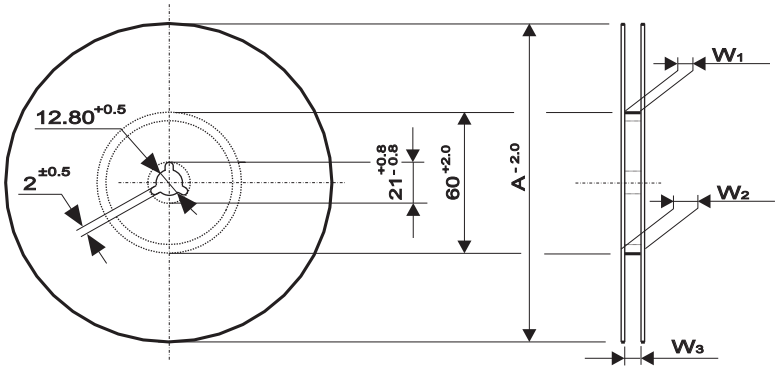
Tape and Reel Specification

Conforms to IEC Publication 286 - 3 Ed.4 : 2007-06

Tape



Reel



Variable dimensions

Tape Size		16 mm	
Size	**Units**	**3225**	**4032**
Ao	(mm)	7	8,6
Bo	(mm)	8,7	10,8
Ko max	(mm)	3,7	3,7
B1 max	(mm)	12,1	12,1
D1 min	(mm)	1,5	1,5
E2 min	(mm)	14,25	14,25
P1	(mm)	12	12
F	(mm)	7,5	7,5
W	(mm)	16,0	16,0
T2 max	(mm)	9,5	9,5
W1	(mm)	16,4+2	16,4+2
W2 max	(mm)	22,4	22,4
W3	(mm)	15,9...19,4	15,9...19,4
A	(mm)	330	330

Package units

Series	Chip Size	
	3225	**4032**
DV	1500	1500
PV < 175	1500	1000
PV > 175	1000	1000

Reliability Testing Procedures

Varistor testing procedures comply with CECC 42200, IEC 1051-1,2 and AEC-Q200.
Testing results are available upon customer request. Special tests can be performed upon customer request.

Reliability Parameter	Test	Tested according to	Condition to be satisfied after testing
AC/DC Bias Reliability	AC/DC Life Test	CECC 42200, Test 4.20 or IEC 1051-1, Test 4.20., AEC-Q200 Test8 - 1000 h at UCT	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 %
Pulse Current Capability	I_{max} 8/20 µs	CECC 42200, 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	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 % no visible damage
Pulse Energy Capability	W_{max} 10/1000 µs	CECC 42200, Test C 2.1 or IEC 1051-1, Test 4.5. 10 pulses in the same direction at 1 pulse every 2 minutes at maximum peak current for 10 pulses	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 % no visible damage
WLD Capability	WLD x 10	ISO 7637, Test pulse 5, 10 pulses at rate 1 per minute	$\lvert\delta V_n$ (1 mA)$\rvert$ < 15 % no visible damage
Vjump Capability	V_{jump} 5 min	Increase of supply voltage to V ≥ V_{jump} for 1 minute	$\lvert\delta V_n$ (1 mA)$\rvert$ < 15 % no visible damage
Environmental and Storage Reliability	Climatic Sequence	CECC 42200, 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	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 %
	Thermal Shock	CECC 42200, Test 4.12,Test Na,IEC 68-2-14, AEC-Q200 Test16, 5 cycles UCT/LCT, 30 minutes	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 % no visible damage
	Steady State Damp Heat	CECC 42200, Test 4.17, Test Ca, IEC 68-2-3,AEC-Q200 Test 6, 56 days, 40 °C, 93 % RH. AEC-Q200 Test7 : Bias,Rh,T all at 85.	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 %
	Storage Test	IEC 68-2-2, Test Ba, AEC-Q200 Test3, 1000 h at maximum storage temperature	$\lvert\delta V_n$ (1 mA)$\rvert$ < 5 %
Mechanical Reliability	Solderability	CECC 42200, Test 4.10.1., Test Ta, IEC 68-2-20 solder bath and reflow method	Solderable at shipment and after 2 year of storage, criteria > 95 % must be covered by solder for reflow meniscus
	Resistance to Soldering Heat	CECC 42200, Test 4.10.2., Test Tb, IEC 68-2-20 solder bath and reflow method	$\lvert\delta V_n$ (1 mA)$\rvert$ < 5 %
	Terminal Strength	JIS-C-6429, App. 1, 18N for 60 s - same for AEC-Q200 Test22	no visual damage
	Board Flex	JIS-C-6429, App. 2, 2 mm min AEC-Q200 Test21 - Board flex: 2mm flex min..	$\lvert\delta V_n$ (1 mA)$\rvert$ < 2 % no visual damage
	Vibration	CECC 42200, Test 4.15., Test Fc, IEC 68-2-6, AEC-Q200 Test14. Frequency range 10 to 55 Hz (AEC : 10-2000Hz) Amplitude 0.75 m/s² or 98 m/s² (AEC :5g's for 20minutes) Total duration 6 h (3 x 2 h) (AEC : 12cycles each of 3 directions) Waveshape - half sine	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 % no visible damage
	Mechanical Shock	CECC 42200, Test 4.14, Test Ea, IEC 68-2-27, AEC-Q200 Test13. Acceleration = 490 m/s² (AEC : MIL-STD-202-Method 213), Pulse duration = 11 ms, Waveshape - half sine Number of shocks = 3 x 6	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 % no visible damage
Electrical Transient Conduction	ISO-7637-1 Pulses	AEC-Q200 Teat30 : Test pulses 1 to 3. Also other pulses - freestyle.	$\lvert\delta V_n$ (1 mA)$\rvert$ < 10 % no visible damage

Protective Device Programme

Leaded Varistors

- **AV Series** - Leaded(TH) Automotive Varistors
- **ZV Series** - Leaded(TH) Low Voltage Varistors
- **CV Series** - Medium Voltage Disc Varistors
- **CV+ Series** - Extended Medium Voltage Disc Varistors
- **SV Series** - Special Medium Voltage Varistors
  - *Standard Types*
  - *Full Custom Parameter Designed Types*

High Energy Varistors

- **ZOV Series** - Square Shaped High Energy Varistors
  - *Standard Types*
  - *Full Custom Parameter Designed Types*
  - *Stacked High Energy Varistor Blocks*
- **ZOVR Series** - Round Shaped High Energy Varistors
- **ZOVS Series** - Stacked High Energy Varistors

SMD Varistors

- **PV Series** - SMD Plastic Encapsulated Varistors
- **DV Series** - Low Profile Medium Voltage SMD Varistors

SMD Varicons

- **ZV Series** - SMD Low Voltage Varicons
- **ZVE Series** - ESD Suppression Varicons
- **ZVX Series** - Low Capacitance & Low Energy Varicons
- **AV Series** - SMD Automotive Varicons

Dual Function Varicons

- **MV Series** - Dual Function Low Voltage Varicons (SMD and TH)
- **OV Series** - Dual Function Automotive Varicons (SMD and TH)

Ceramic Capacitors

- **KM Series** - RFI Suppression Capacitors
- **KZ Series** - Safety Capacitors
- **KV Series** - High Voltage Capacitors
- **C Series** - SMD multilayer Capacitors
- **CL Series** - Leaded(TH) multilayer Capacitors

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