

Features

- Formerly a **KEKOVARICON** product
- Two model sizes available - 3255 & 4032
- Operating voltage range (V_{dc}) 14 V to 385 V
- Operating voltage (V_{rms}) 11 V to 300 V
- +85 °C Continuous operating temperature
- UL 94 V-0 Non-flammable thermoplastic encapsulation

- Easily solderable tinned copper sheet
- Available in tape and reel packaging for automatic pick-and-place
- RoHS compliant*

PV Series - Low & Medium Voltage Plastic-Encapsulated Varistors

General Information

The PV series of low and medium voltage plastic-encapsulated varistors is designed to protect electronic equipment against voltage surges in the low and medium voltage region. They offer direct SMD equivalents to leaded disc varistors of 5 and 7 mm sizes. The thermoplastic encapsulation is non-flammable and UL 94 V-0 rated. Contacts are made of tinned copper sheet.

PV series varistors are designed for surface mounting and are available in two model sizes.

These transient voltage suppressors cover an operating voltage V_{rms} from 11 V to 300 V, featuring maximum surge currents from 100 A to 1200 A.

Absolute Maximum Ratings

| Parameter | Value | Units |
|---|--------------|-------|
| Continuous: | | |
| Steady State Applied Voltage | | |
| DC Voltage Range (V_{dc}) | 14 to 385 | V |
| AC Voltage Range (V_{rms}) | 11 to 300*** | V |
| Transient: | | |
| Non-Repetitive Surge Current, 8/20 μ s Waveform (I_{max}) | 100 to 1200 | A |
| Non-Repetitive Surge Energy, 10/1000 μ s Waveform (W_{max}) | 0.6 to 30 | J |
| Operating Ambient Temperature | -40 to +85 | °C |
| Storage Temperature Range | -40 to +125 | °C |
| Threshold Voltage Temperature Coefficient | < +0.05 | %/°C |
| Response Time | < 5 | ns |
| Climatic Category | 40 / 85 / 56 | |

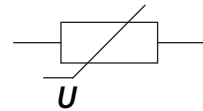
*** Varistors with rated voltages of 11 Vrms to 50 Vrms are non-standard and available only upon request.

Agency Recognition

| Standard | UL 1449 |
|-------------|---------------------------|
| File Number | E326499** |

**Not all rated voltages are UL recognized; check the file for details.

Varistor Symbol



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WARNING Cancer and Reproductive Harm - www.P65Warnings.ca.gov

*RoHS Directive 2015/863, Mar 31, 2015 and Annex.
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Applications

- Electricity meters
- White goods
- Entertainment electronics
- Power supplies
- Distribution panels
- Sensors

PV Series - Low & Medium Voltage Plastic-Encapsulated Varistors

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Device Ratings

| Model | 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 |
|---------------|------------------|-----------------|--------------------------|----------------|----------------|--------------------------------|-----------|-----------------------------|-------------------|
| | V | V | V | V | A | J | W | A | pF |
| PV 11 K 3225 | 11 | 14 | 18 | 36 | 2.5 | 0.6 | 0.01 | 100 | 1600 |
| PV 11 K 4032 | 11 | 14 | 18 | 36 | 5 | 1.1 | 0.02 | 250 | 3100 |
| PV 14 K 3225 | 14 | 18 | 22 | 43 | 2.5 | 0.7 | 0.01 | 100 | 1300 |
| PV 14 K 4032 | 14 | 18 | 22 | 43 | 5 | 1.3 | 0.02 | 250 | 2500 |
| PV 17 K 3225 | 17 | 22 | 27 | 53 | 2.5 | 0.9 | 0.01 | 100 | 1050 |
| PV 17 K 4032 | 17 | 22 | 27 | 53 | 5 | 1.6 | 0.02 | 250 | 1900 |
| PV 20 K 3225 | 20 | 26 | 33 | 65 | 2.5 | 1.1 | 0.01 | 100 | 750 |
| PV 20 K 4032 | 20 | 26 | 33 | 65 | 5 | 2.0 | 0.02 | 250 | 1500 |
| PV 25 K 3225 | 25 | 31 | 39 | 77 | 2.5 | 1.2 | 0.01 | 100 | 660 |
| PV 25 K 4032 | 25 | 31 | 39 | 77 | 5 | 2.4 | 0.02 | 250 | 1260 |
| PV 30 K 3225 | 30 | 38 | 47 | 93 | 2.5 | 1.5 | 0.01 | 100 | 580 |
| PV 30 K 4032 | 30 | 38 | 47 | 93 | 5 | 2.8 | 0.02 | 250 | 1050 |
| PV 35 K 3225 | 35 | 45 | 56 | 110 | 2.5 | 1.8 | 0.01 | 100 | 460 |
| PV 35 K 4032 | 35 | 45 | 56 | 110 | 5 | 3.4 | 0.02 | 250 | 850 |
| PV 40 K 3225 | 40 | 56 | 68 | 135 | 2.5 | 2.2 | 0.01 | 100 | 400 |
| PV 40 K 4032 | 40 | 56 | 68 | 135 | 5 | 4.1 | 0.02 | 250 | 720 |
| PV 50 K 3225 | 50 | 65 | 82 | 135 | 5 | 2.5 | 0.10 | 400 | 390 |
| PV 50 K 4032 | 50 | 65 | 82 | 135 | 10 | 6.5 | 0.25 | 1200 | 820 |
| PV 60 K 3225 | 60 | 85 | 100 | 165 | 5 | 3.0 | 0.10 | 400 | 330 |
| PV 60 K 4032 | 60 | 85 | 100 | 165 | 10 | 7.0 | 0.25 | 1200 | 680 |
| PV 75 K 3225 | 75 | 100 | 120 | 200 | 5 | 4.0 | 0.10 | 400 | 270 |
| PV 75 K 4032 | 75 | 100 | 120 | 200 | 10 | 9.0 | 0.25 | 1200 | 550 |
| PV 95 K 3225 | 95 | 125 | 150 | 250 | 5 | 6.0 | 0.10 | 400 | 220 |
| PV 95 K 4032 | 95 | 125 | 150 | 250 | 10 | 11.0 | 0.25 | 1200 | 440 |
| PV 115 K 3225 | 115 | 150 | 180 | 300 | 5 | 6.5 | 0.10 | 400 | 180 |
| PV 115 K 4032 | 115 | 150 | 180 | 300 | 10 | 13.0 | 0.25 | 1200 | 360 |
| PV 130 K 3225 | 130 | 170 | 205 | 340 | 5 | 7.0 | 0.10 | 400 | 160 |
| PV 130 K 4032 | 130 | 170 | 205 | 340 | 10 | 15.0 | 0.25 | 1200 | 320 |
| PV 140 K 3225 | 140 | 180 | 220 | 360 | 5 | 7.5 | 0.10 | 400 | 150 |
| PV 140 K 4032 | 140 | 180 | 220 | 360 | 10 | 18.0 | 0.25 | 1200 | 300 |
| PV 150 K 3225 | 150 | 200 | 240 | 395 | 5 | 9.0 | 0.10 | 400 | 140 |
| PV 150 K 4032 | 150 | 200 | 240 | 395 | 10 | 18.5 | 0.25 | 1200 | 280 |
| PV 175 K 3225 | 175 | 225 | 270 | 455 | 5 | 9.5 | 0.10 | 400 | 120 |
| PV 175 K 4032 | 175 | 225 | 270 | 455 | 10 | 21.0 | 0.25 | 1200 | 250 |
| PV 230 K 3225 | 230 | 300 | 360 | 595 | 5 | 10.0 | 0.10 | 400 | 95 |
| PV 230 K 4032 | 230 | 300 | 360 | 595 | 10 | 23.0 | 0.25 | 1200 | 190 |
| PV 250 K 3225 | 250 | 320 | 390 | 650 | 5 | 11.0 | 0.10 | 400 | 80 |
| PV 250 K 4032 | 250 | 320 | 390 | 650 | 10 | 25.0 | 0.25 | 1200 | 180 |
| PV 275 K 3225 | 275 | 350 | 430 | 710 | 5 | 13.0 | 0.10 | 400 | 75 |
| PV 275 K 4032 | 275 | 350 | 430 | 710 | 10 | 29.0 | 0.25 | 1200 | 160 |
| PV 300 K 3225 | 300 | 385 | 470 | 775 | 5 | 15.0 | 0.10 | 400 | 70 |
| PV 300 K 4032 | 300 | 385 | 470 | 775 | 10 | 30.0 | 0.25 | 1200 | 150 |

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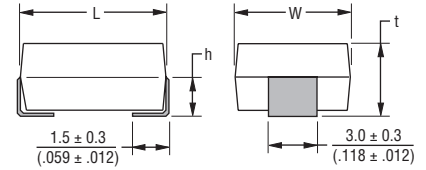
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PV Series - Low & Medium Voltage Plastic-Encapsulated Varistors

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Product Dimensions

| Model | Dimension | | | |
|---------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | $h \pm 0.3$ (.012) | $L \pm 0.5$ (.020) | $W \pm 0.4$ (.016) | $t \pm 0.3$ (.012) |
| PV 11 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 11 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 14 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 14 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 17 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 17 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 20 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 20 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 25 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 25 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 30 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 30 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 35 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 35 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 40 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 40 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 50 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 50 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 60 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 60 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 75 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 75 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 95 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 95 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 115 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 115 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 130 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 130 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 140 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 140 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |



DIMENSIONS: $\frac{\text{MM}}{\text{(INCHES)}}$

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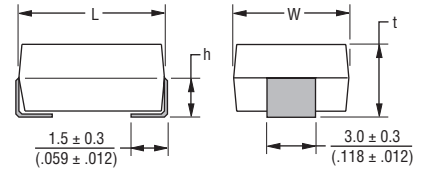
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Product Dimensions (Continued)

| Model | Dimension | | | |
|---------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | $h \pm \frac{0.3}{(.012)}$ | $L \pm \frac{0.5}{(.020)}$ | $W \pm \frac{0.4}{(.016)}$ | $t \pm \frac{0.3}{(.012)}$ |
| PV 150 K 3225 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ |
| PV 150 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 175 K 3225 | $\frac{2.3}{(.091)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{4.7}{(.185)}$ |
| PV 175 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 230 K 3225 | $\frac{2.3}{(.091)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{4.7}{(.185)}$ |
| PV 230 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 250 K 3225 | $\frac{2.3}{(.091)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{4.7}{(.185)}$ |
| PV 250 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 275 K 3225 | $\frac{2.3}{(.091)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{4.7}{(.185)}$ |
| PV 275 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |
| PV 300 K 3225 | $\frac{2.3}{(.091)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{4.7}{(.185)}$ |
| PV 300 K 4032 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.0}{(.315)}$ | $\frac{4.7}{(.185)}$ |



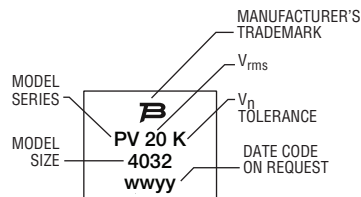
DIMENSIONS: $\frac{\text{MM}}{\text{(INCHES)}}$

How to Order

PV20K3225R2yy

- Series Designator
PV = PV Series
- Max. Continuous Operating Voltage (V_{rms})
K = $\pm 10\%$
- Model Size
• 3225
• 4032
- Packaging
R2 = 330 mm Reel
- Special Requirements
• yy

Typical Part Marking



Instructions for Creating Orderable Part Number:

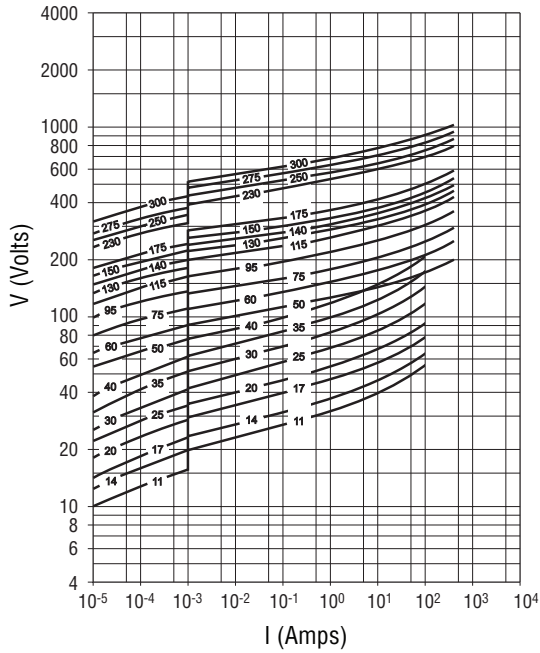
- 1) Start with base part number in characteristics table (example: PV20K3225).
- 2) Add Packaging: R2 (example part number becomes PV20K3225R2).
- 3) Part number can have no spaces or lower case letters.

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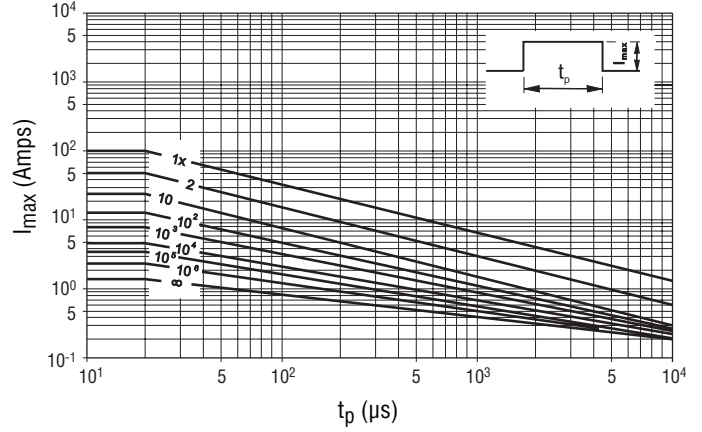
Protection Level

Model Size 3225 - (PV50 ~ PV300)

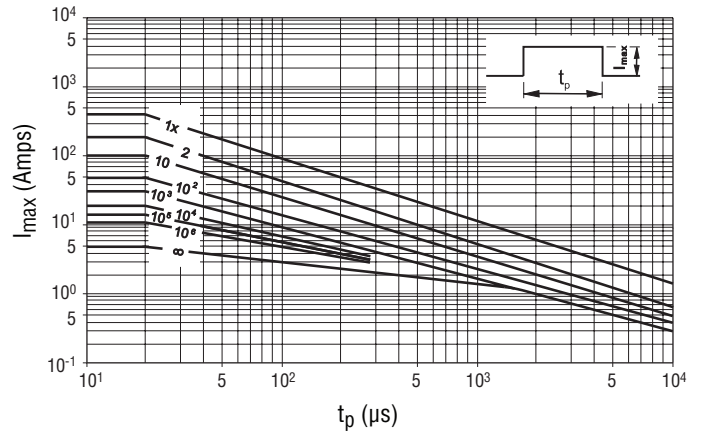


Pulse Rating Curves

Model Size 3225 - (PV11 ~ PV40)



Model Size 3225 - (PV50 ~ PV300)



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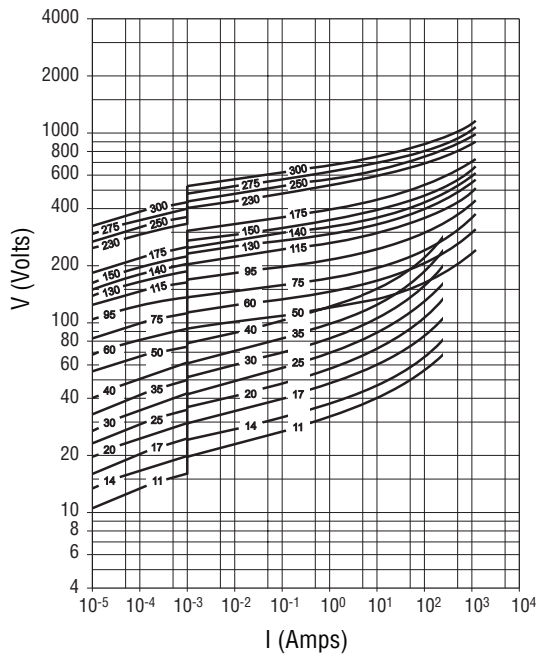
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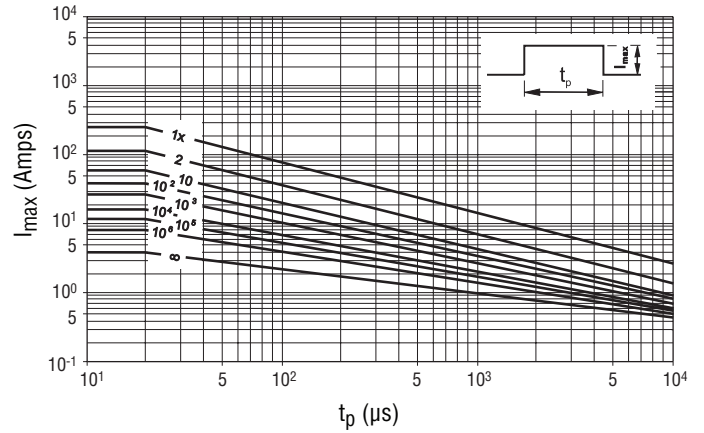
Protection Level

Model Size 4032 - (PV11 ~ PV300)

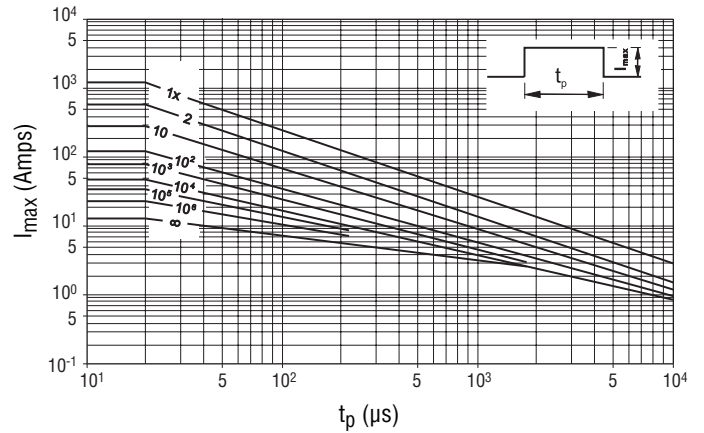


Pulse Rating Curves

Model Size 4032 - (PV11 ~ PV40)



Model Size 4032 - (PV50 ~ PV300)



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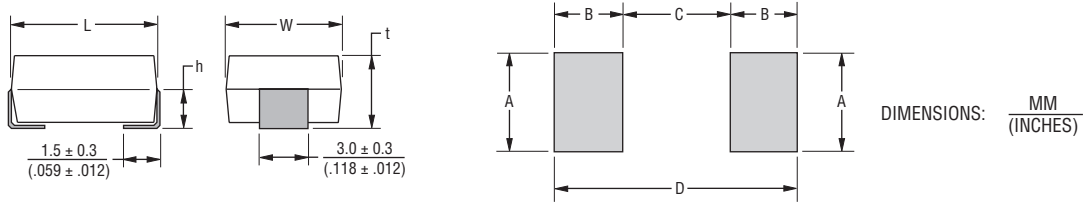
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PV Series - Low & Medium Voltage Plastic-Encapsulated Varistors

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Soldering Pad Configuration



| Size | Voltage Range (V) | Dimension | | | | | | | |
|------|-------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------|----------------------|----------------------|-----------------------|
| | | $h \pm \frac{0.3}{(.012)}$ | $L \pm \frac{0.5}{(.020)}$ | $W \pm \frac{0.4}{(.016)}$ | $t \pm \frac{0.3}{(.012)}$ | A | B | C | D |
| 3225 | 11 to 150 | $\frac{1.7}{(.066)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{3.4}{(.134)}$ | $\frac{3.5}{(.138)}$ | $\frac{2.9}{(.114)}$ | $\frac{4.5}{(.177)}$ | $\frac{10.3}{(.406)}$ |
| 3225 | 175 to 300 | $\frac{2.3}{(.091)}$ | $\frac{8.0}{(.315)}$ | $\frac{6.3}{(.248)}$ | $\frac{4.7}{(.185)}$ | $\frac{3.5}{(.138)}$ | $\frac{2.9}{(.114)}$ | $\frac{4.5}{(.177)}$ | $\frac{10.3}{(.406)}$ |
| 4032 | 11 to 300 | $\frac{2.3}{(.091)}$ | $\frac{10.0}{(.394)}$ | $\frac{8.3}{(.327)}$ | $\frac{4.7}{(.185)}$ | $\frac{3.5}{(.138)}$ | $\frac{2.9}{(.114)}$ | $\frac{6.5}{(.256)}$ | $\frac{12.3}{(.484)}$ |

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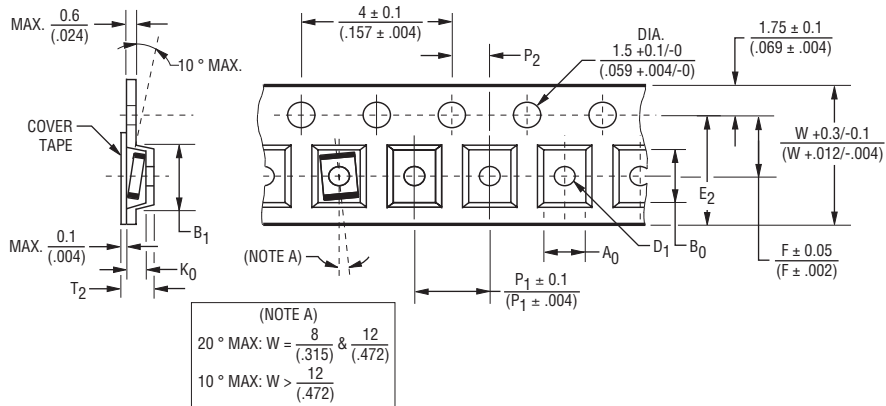
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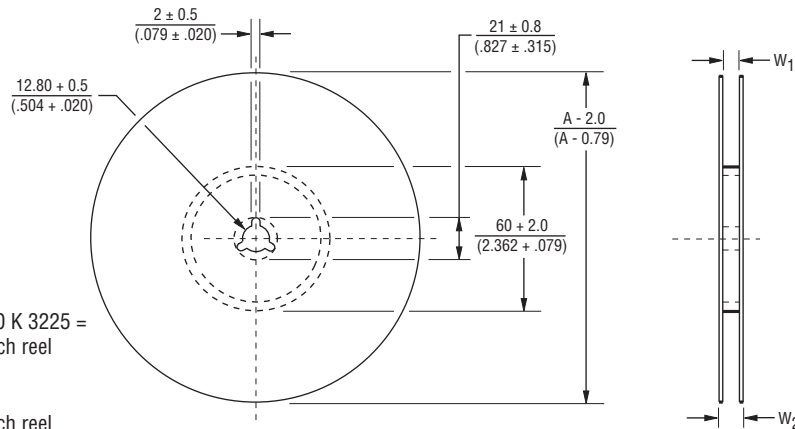
Packaging Specifications

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

Tape



Reel



PV 11 K 3225 ~ PV 150 K 3225 = 1,500 pieces per 13-inch reel

All other models = 1,000 pieces per 13-inch reel

| Dimension | Model Size | |
|--------------------------|------------------------|-----------------------|
| | 3225 | 4032 |
| Size | $\frac{7}{(.276)}$ | $\frac{8.6}{(.339)}$ |
| A ₀ | $\frac{7.8}{(.307)}$ | $\frac{10.8}{(.425)}$ |
| B ₀ | $\frac{3.7}{(.146)}$ | |
| K ₀ MAX. | $\frac{12.1}{(.476)}$ | |
| B ₁ MAX. | $\frac{1.5}{(.059)}$ | |
| D ₁ DIA. MAX. | $\frac{14.25}{(.561)}$ | |
| e ₂ | $\frac{12}{(.472)}$ | |

| Dimension | Model Size | |
|---------------------|--|------|
| | 3225 | 4032 |
| P ₁ | $\frac{7.5}{(.295)}$ | |
| F | $\frac{16.0}{(.630)}$ | |
| W | $\frac{9.5}{(.374)}$ | |
| T ₂ MAX. | $\frac{16.4 + 2}{(.646 + .079)}$ | |
| W ₁ | $\frac{22.4}{(.882)}$ | |
| W ₂ MAX. | $\frac{15.9}{(.626)}$ to $\frac{19.4}{(.764)}$ | |
| A DIA. | $\frac{330}{(12.992)}$ | |

DIMENSIONS: $\frac{\text{MM}}{\text{(INCHES)}}$

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Soldering Recommendations for SMD Components

Popular soldering techniques used for surface mounted 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 | RoHS Compliant |
|------------------------------|--------------------|-------------------------------------|----------------|
| Ag/Pd | PV Series...R1 | Pb-containing soldering | Yes |
| Barrier Type End Termination | PV Series...N R1 | Pb-containing and Pb-free soldering | Yes |
| NiSn End Termination | PV Series ...Ni R1 | Pb-containing 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 with an epoxy adhesive. When all components on the PCB have been positioned and an appropriate amount of time is allowed for adhesive curing, the completed assembly is then placed on a conveyor and run through a single, 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 (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. The 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 keep 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 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 a chlorine content > 0.2 wt. % are NOT RECOMMENDED. The 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. Wave and Reflow soldering conditions for SMD varistors with Pb-containing solders are shown on the next page 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 the hot PCB to cool to less than 50 °C before cleaning.

Soldering Recommendations for SMD Components (Continued)

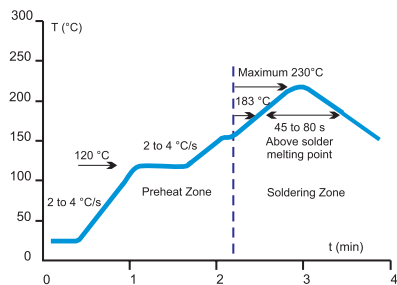


Fig. 1. Infrared Reflow Temperature Profile for Pb-containing Soldering

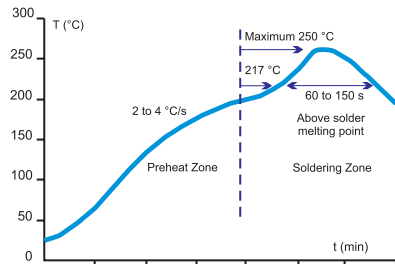


Fig. 2. Reflow Temperature Profile for Pb-free Soldering

Inspection Criteria

When Infrared Reflow processes are used, the inspection criteria to determine acceptable solder joints will depend on several key variables, principally termination material process profiles.

Solder Test 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 performed on each production lot. Test results and accompanying samples are retained for a minimum of two (2) years. The solderability of a specific lot can be checked at any time within this period, should a customer require this information.

Rework Criteria - Soldering Iron

Unless absolutely necessary, the use of soldering irons is NOT recommended for reworking varistors encapsulated in plastic. 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 plastic
- 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.

Reliability Testing Procedures

Varistor test procedures comply with CECC 42200, IEC 1051-1/2 (and AEC-Q200, if applicable). Test 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 Test 8 - 1000 h at UCT | $ ΔV_N (1 \text{ mA}) < 10 \%$ |
| Pulse Current Capability | $I_{\text{max}} 8/20 \mu\text{s}$ | 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 | $ ΔV_N (1 \text{ mA}) < 10 \%$ no visible damage |
| Pulse Energy Capability | $W_{\text{max}} 10/1000 \mu\text{s}$ | 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 | $ ΔV_N (1 \text{ mA}) < 10 \%$ no visible damage |
| WLD Capability | WLD x 10 | ISO 7637, Test pulse 5, 10 pulses at rate of 1 per minute | $ ΔV_N (1 \text{ mA}) < 15 \%$ no visible damage |
| V_{jump} Capability | V _{jump} 5 min. | Increase of supply voltage to $V \geq V_{\text{jump}}$ for 1 minute | $ ΔV_N (1 \text{ mA}) < 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, 16h, 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 | $ ΔV_N (1 \text{ mA}) < 10 \%$ |
| | Thermal Shock | CECC 42200, Test 4.12, Test Na, IEC 68-2-14, AEC-Q200 Test 16, 5 | $ ΔV_N (1 \text{ mA}) < 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 Test 7: Bias, Rh, T all at 85. | $ ΔV_N (1 \text{ mA}) < 10 \%$ |
| | Storage Test | IEC 68-2-2, Test Ba, AEC-Q200 Test 3, 1000 h at maximum storage temperature | $ ΔV_N (1 \text{ mA}) < 5 \%$ |

Continued on Next Page

Reliability Testing Procedures (Continued)

| Reliability Parameter | Test | Tested According to | Condition to be Satisfied after Testing |
|--|------------------------------|--|---|
| 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 years 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 nad reflow method | $ \delta V_n (1 \text{ mA}) < 5 \%$ |
| | Terminal Strength | JIS-C-6429, App. 1, 18N for 60 sec. - same for AEC-Q200 Test 22 | No visual damage |
| | Board Flex | JIS-C-6429, App. 2, 2 mm min. AEC-Q200 test 21 - Board flex: 2 mm flex min. | $ \delta V_n (1 \text{ mA}) < 2 \%$ No visible damage |
| | Vibration | CECC 42200, Test 4.15, Test Fc, IEC 68-2-6, AEC-Q200 Test 14 Frequency range 10 to 55 Hz (AEC: 10-2000 Hz) Amplitude 0.75 m/s ² or 98 m/s ² (AEC: 5 g for 20 minutes) Total duration 6 h (3x2 h) (AEC: 12 cycles each of 3 directions) Waveshape - half sine | $ \delta V_n (1 \text{ mA}) < 2 \%$ No visible damage |
| | Mechanical Shock | CECC 42200, Test 4.14, Test Ea, IEC 68-2-27, AEC-Q200 Test 13. Acceleration = 490 m/s ² (AEC: MIL-STD-202-Method 213), Pulse duration = 11 ms, Waveshape - half sine; Number of shocks = 3x6 | $ \delta V_n (1 \text{ mA}) < 10 \%$ No visible damage |
| Electrical Transient Conduction | ISO-7637-1 Pulses | AEC-Q200 Test 30: Test pulses 1 to 3. Also other pulses - freestyle. | $ \delta V_n (1 \text{ mA}) < 10 \%$ No visible damage |

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Users should verify actual device performance in their specific applications.

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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 operation 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; $V_{rms} = 1.1 \times V$ |
| 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 | V_c | The peak voltage developed across the varistor under standard atmospheric conditions, when passing an 8/20 μs class current pulse |
| Protection Level | | |
| 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 μs 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 | 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 |
| Transient Energy | | |
| Load Dump Transient | WLD | Load Dump is a transient which occurs in automotive environments. It is an exponentially decaying positive voltage which 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. |
| Rated Peak Single Pulse..... | 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 |
| Transient Current | | |
| Rated Transient Average | 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 |
| Power Dissipation | | |
| Capacitance..... | C | Capacitance between two terminals of the varistor measured @ 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_r 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 | TC | $(V_n @ 85 \text{ °C} - V_n @ 25 \text{ °C}) / (V_n @ 25 \text{ °C}) \times 60 \text{ °C} \times 100$ |
| Coefficient | | |
| 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 | LCT & UCT = Lower and Upper Category Temperature - the minimum and maximum ambient temperatures for 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 |

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