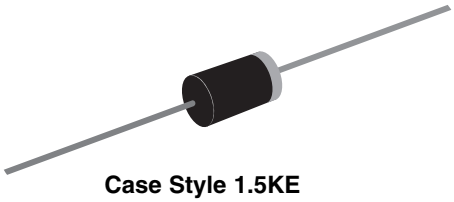
# TRANSZORB® Transient Voltage Suppressors



Case Style 1.5KE

| PRIMARY CHARACTERISTICS | |
|---|---|
| $V_{BR}$ uni-directional | 6.8 V to 540 V |
| $V_{BR}$ bi-directional | 6.8 V to 440 V |
| $P_{PPM}$ | 1500 W |
| $P_D$ | 6.5 W |
| $I_{FSM}$ (uni-directional only) | 200 A |
| $T_J$ max. | 175 °C |

## DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional types, use C or CA suffix (e.g. 1.5KE440CA).

Electrical characteristics apply in both directions.

## FEATURES

- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 1500 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 s
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

Pb e3 RoHS COMPLIANT

## TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

## MECHANICAL DATA

**Case:** Molded epoxy body over passivated junction

Molding compound meets UL 94 V-0 flammability rating

Base P/N-E3 - RoHS compliant, commercial grade

Base P/NHE3 - RoHS compliant, high reliability/automotive grade (AEC Q101 qualified)

**Terminals:** Matte tin plated leads, solderable per J-STD-002 and JESD22-B102

E3 suffix meets JESD 201 class 1A whisker test, HE3 suffix meets JESD 201 class 2 whisker test

**Note:**

- 1.5KE250 ~ 1.5KE540A and 1.5KE250C ~ 1.5KE440CA for commercial grade only

**Polarity:** For uni-directional types the color band denotes cathode end, no marking on bi-directional types

**MAXIMUM RATINGS** ($T_A$ = 25 °C unless otherwise noted)

| PARAMETER | SYMBOL | LIMIT | UNIT |
|---|---|---|---|
| Peak pulse power dissipation with a 10/1000 µs waveform (1) (Fig. 1) | $P_{PPM}$ | 1500 | W |
| Peak pulse current with a 10/1000 µs waveform (1) | $I_{PPM}$ | See next table | A |
| Power dissipation on infinite heatsink at $T_L$ = 75 °C (Fig. 5) | $P_D$ | 6.5 | W |
| Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2) | $I_{FSM}$ | 200 | A |
| Maximum instantaneous forward voltage at 100 A for uni-directional only (3) | $V_F$ | 3.5/5.0 | V |
| Operating junction and storage temperature range | $T_J$, $T_{STG}$ | - 55 to + 175 | °C |

**Notes:**

(1) Non-repetitive current pulse, per Fig. 3 and derated above $T_A$ = 25 °C per Fig. 2

(2) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

(3) $V_F$ = 3.5 V for 1.5KE220 (A) and below; $V_F$ = 5.0 V for 1.5KE250(A) and above

| ELECTRICAL CHARACTERISTICS ($T_A$ = 25 °C unless otherwise noted) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| JEDEC TYPE NUMBER | GENERAL SEMICONDUCTOR PART NUMBER | BREAKDOWN VOLTAGE $V_{BR}$ AT $I_T$ (1) (V) | | TEST CURRENT $I_T$ (mA) | STAND-OFF VOLTAGE $V_{WM}$ (V) | MAXIMUM REVERSE LEAKAGE AT $V_{WM}$ $I_D$ (4) (μA) | MAXIMUM PEAK PULSE CURRENT $I_{PPM}$ (2) (A) | MAXIMUM CLAMPING VOLTAGE AT $I_{PPM}$ $V_C$ (V) | MAXIMUM TEMP. COEFFICIENT OF $V_{BR}$ (%/°C) |
| | | MIN. | MAX. | | | | | | |
| 1N6267 | (+)1.5KE6.8 | 6.12 | 7.48 | 10 | 5.50 | 1000 | 139 | 10.8 | 0.057 |
| 1N6267A | (+)1.5KE6.8A | 6.45 | 7.14 | 10 | 5.80 | 1000 | 143 | 10.5 | 0.057 |
| 1N6268 | (+)1.5KE7.5 | 6.75 | 8.25 | 10 | 6.05 | 500 | 128 | 11.7 | 0.061 |
| 1N6268A | (+)1.5KE7.5A | 7.13 | 7.88 | 10 | 6.40 | 500 | 133 | 11.3 | 0.061 |
| 1N6269 | (+)1.5KE8.2 | 7.38 | 9.02 | 10 | 6.63 | 200 | 120 | 12.5 | 0.065 |
| 1N6269A | (+)1.5KE8.2A | 7.79 | 8.61 | 10 | 7.02 | 200 | 124 | 12.1 | 0.065 |
| 1N6270 | (+)1.5KE9.1 | 8.19 | 10.0 | 1.0 | 7.37 | 50 | 109 | 13.8 | 0.068 |
| 1N6270A | (+)1.5KE9.1A | 8.65 | 9.55 | 1.0 | 7.78 | 50 | 112 | 13.4 | 0.068 |
| 1N6271 | (+)1.5KE10 | 9.00 | 11.0 | 1.0 | 8.10 | 10 | 100 | 15.0 | 0.073 |
| 1N6271A | (+)1.5KE10A | 9.50 | 10.5 | 1.0 | 8.55 | 10 | 103 | 14.5 | 0.073 |
| 1N6272 | (+)1.5KE11 | 9.90 | 12.1 | 1.0 | 8.92 | 5.0 | 92.6 | 16.2 | 0.075 |
| 1N6272A | (+)1.5KE11A | 10.5 | 11.6 | 1.0 | 9.40 | 5.0 | 96.2 | 15.6 | 0.075 |
| 1N6273 | (+)1.5KE12 | 10.8 | 13.2 | 1.0 | 9.72 | 5.0 | 86.7 | 17.3 | 0.076 |
| 1N6273A | (+)1.5KE12A | 11.4 | 12.6 | 1.0 | 10.2 | 5.0 | 89.8 | 16.7 | 0.078 |
| 1N6274 | (+)1.5KE13 | 11.7 | 14.3 | 1.0 | 10.5 | 5.0 | 78.9 | 19.0 | 0.081 |
| 1N6274A | (+)1.5KE13A | 12.4 | 13.7 | 1.0 | 11.1 | 5.0 | 82.4 | 18.2 | 0.081 |
| 1N6275 | (+)1.5KE15 | 13.5 | 16.5 | 1.0 | 12.1 | 1.0 | 68.2 | 22.0 | 0.084 |
| 1N6275A | (+)1.5KE15A | 14.3 | 15.8 | 1.0 | 12.8 | 1.0 | 70.8 | 21.2 | 0.084 |
| 1N6276 | (+)1.5KE16 | 14.4 | 17.6 | 1.0 | 12.9 | 1.0 | 63.8 | 23.5 | 0.086 |
| 1N6276A | (+)1.5KE16A | 15.2 | 16.8 | 1.0 | 13.6 | 1.0 | 66.7 | 22.5 | 0.086 |
| 1N6277 | (+)1.5KE18 | 16.2 | 19.8 | 1.0 | 14.5 | 1.0 | 56.6 | 26.5 | 0.088 |
| 1N6277A | (+)1.5KE18A | 17.1 | 18.9 | 1.0 | 15.3 | 1.0 | 59.5 | 25.2 | 0.089 |
| 1N6278 | (+)1.5KE20 | 18.0 | 22.0 | 1.0 | 16.2 | 1.0 | 51.5 | 29.1 | 0.090 |
| 1N6278A | (+)1.5KE20A | 19.0 | 21.0 | 1.0 | 17.1 | 1.0 | 54.2 | 27.7 | 0.090 |
| 1N6279 | (+)1.5KE22 | 19.8 | 24.2 | 1.0 | 17.8 | 1.0 | 47.0 | 31.9 | 0.092 |
| 1N6279A | (+)1.5KE22A | 20.9 | 23.1 | 1.0 | 18.8 | 1.0 | 49.0 | 30.6 | 0.092 |
| 1N6280 | (+)1.5KE24 | 21.6 | 26.4 | 1.0 | 19.4 | 1.0 | 43.2 | 34.7 | 0.094 |
| 1N6280A | (+)1.5KE24A | 22.8 | 25.2 | 1.0 | 20.5 | 1.0 | 45.2 | 33.2 | 0.094 |
| 1N6281 | (+)1.5KE27 | 24.3 | 29.7 | 1.0 | 21.8 | 1.0 | 38.4 | 39.1 | 0.096 |
| 1N6281A | (+)1.5KE27A | 25.7 | 28.4 | 1.0 | 23.1 | 1.0 | 40.0 | 37.5 | 0.096 |
| 1N6282 | (+)1.5KE30 | 27.0 | 33.0 | 1.0 | 24.3 | 1.0 | 34.5 | 43.5 | 0.097 |
| 1N6282A | (+)1.5KE30A | 28.5 | 31.5 | 1.0 | 25.6 | 1.0 | 36.2 | 41.4 | 0.097 |
| 1N6283 | (+)1.5KE33 | 29.7 | 36.3 | 1.0 | 26.8 | 1.0 | 31.4 | 47.7 | 0.098 |
| 1N6283A | (+)1.5KE33A | 31.4 | 34.7 | 1.0 | 28.2 | 1.0 | 32.8 | 45.7 | 0.098 |
| 1N6284 | (+)1.5KE36 | 32.4 | 39.6 | 1.0 | 29.1 | 1.0 | 28.8 | 52.0 | 0.099 |
| 1N6284A | (+)1.5KE36A | 34.2 | 37.8 | 1.0 | 30.8 | 1.0 | 30.1 | 49.9 | 0.099 |
| 1N6285 | (+)1.5KE39 | 35.1 | 42.9 | 1.0 | 31.6 | 1.0 | 26.6 | 56.4 | 0.100 |
| 1N6285A | (+)1.5KE39A | 37.1 | 41.0 | 1.0 | 33.3 | 1.0 | 27.8 | 53.9 | 0.100 |
| 1N6286 | (+)1.5KE43 | 38.7 | 47.3 | 1.0 | 34.8 | 1.0 | 24.2 | 61.9 | 0.101 |
| 1N6286A | (+)1.5KE43A | 40.9 | 45.2 | 1.0 | 36.8 | 1.0 | 25.3 | 59.3 | 0.101 |
| 1N6287 | (+)1.5KE47 | 42.3 | 51.7 | 1.0 | 38.1 | 1.0 | 22.1 | 67.8 | 0.101 |
| 1N6287A | (+)1.5KE47A | 44.7 | 49.4 | 1.0 | 40.2 | 1.0 | 23.1 | 64.8 | 0.101 |
| 1N6288 | (+)1.5KE51 | 45.9 | 56.1 | 1.0 | 41.3 | 1.0 | 20.4 | 73.5 | 0.102 |
| 1N6288A | (+)1.5KE51A | 48.5 | 53.6 | 1.0 | 43.6 | 1.0 | 21.4 | 70.1 | 0.102 |
| 1N6289 | (+)1.5KE56 | 50.4 | 61.8 | 1.0 | 45.4 | 1.0 | 18.6 | 80.5 | 0.103 |
| 1N6289A | (+)1.5KE56A | 53.2 | 58.8 | 1.0 | 47.8 | 1.0 | 19.5 | 77.0 | 0.103 |
| 1N6290 | (+)1.5KE62 | 55.8 | 68.2 | 1.0 | 50.2 | 1.0 | 16.9 | 89.0 | 0.104 |
| 1N6290A | (+)1.5KE62A | 58.9 | 65.1 | 1.0 | 53.0 | 1.0 | 17.6 | 85.0 | 0.104 |
| 1N6291 | (+)1.5KE68 | 61.2 | 74.8 | 1.0 | 55.1 | 1.0 | 15.3 | 98.0 | 0.104 |
| 1N6291A | (+)1.5KE68A | 64.6 | 71.4 | 1.0 | 58.1 | 1.0 | 16.3 | 92.0 | 0.104 |
| 1N6292 | (+)1.5KE75 | 67.5 | 82.5 | 1.0 | 60.7 | 1.0 | 13.9 | 109 | 0.105 |
| 1N6292A | (+)1.5KE75A | 71.3 | 78.8 | 1.0 | 64.1 | 1.0 | 14.6 | 104 | 0.105 |

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25 °C unless otherwise noted)

| JEDEC TYPE NUMBER | GENERAL SEMICONDUCTOR PART NUMBER | BREAKDOWN VOLTAGE $V_{BR}$ AT $I_T$ (1) (V) | | TEST CURRENT $I_T$ (mA) | STAND-OFF VOLTAGE $V_{WM}$ (V) | MAXIMUM REVERSE LEAKAGE AT $V_{WM}$ $I_D$ (4) (μA) | MAXIMUM PEAK PULSE CURRENT $I_{PPM}$ (2) (A) | MAXIMUM CLAMPING VOLTAGE AT $I_{PPM}$ $V_C$ (V) | MAXIMUM TEMP. COEFFICIENT OF $V_{BR}$ (%/°C) |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN. | MAX. | | | | | | |
| 1N6293 | (+)1.5KE82 | 73.8 | 90.2 | 1.0 | 66.4 | 1.0 | 12.7 | 118 | 0.105 |
| 1N6293A | (+)1.5KE82A | 77.9 | 86.1 | 1.0 | 70.1 | 1.0 | 13.3 | 113 | 0.105 |
| 1N6294 | (+)1.5KE91 | 81.9 | 100.0 | 1.0 | 73.7 | 1.0 | 11.5 | 131 | 0.106 |
| 1N6294A | (+)1.5KE91A | 86.5 | 95.5 | 1.0 | 77.8 | 1.0 | 12.0 | 125 | 0.106 |
| 1N6295 | (+)1.5KE100 | 90.0 | 110 | 1.0 | 81.0 | 1.0 | 10.4 | 144 | 0.106 |
| 1N6295A | (+)1.5KE100A | 95.0 | 105 | 1.0 | 85.5 | 1.0 | 10.9 | 137 | 0.106 |
| 1N6296 | (+)1.5KE110 | 99.0 | 121 | 1.0 | 89.2 | 1.0 | 9.5 | 158 | 0.107 |
| 1N6296A | (+)1.5KE 110A | 105 | 116 | 1.0 | 94.0 | 1.0 | 9.9 | 152 | 0.107 |
| 1N6297 | (+)1.5KE120 | 108 | 132 | 1.0 | 97.2 | 1.0 | 8.7 | 173 | 0.107 |
| 1N6297A | (+)1.5KE120A | 114 | 126 | 1.0 | 102 | 1.0 | 9.1 | 165 | 0.107 |
| 1N6298 | (+)1.5KE130 | 117 | 143 | 1.0 | 105 | 1.0 | 8.0 | 187 | 0.107 |
| 1N6298A | (+)1.5KE130A | 124 | 137 | 1.0 | 111 | 1.0 | 8.4 | 179 | 0.107 |
| 1N6299 | (+)1.5KE150 | 136 | 165 | 1.0 | 121 | 1.0 | 7.0 | 215 | 0.108 |
| 1N6299A | (+)1.5KE150A | 143 | 158 | 1.0 | 128 | 1.0 | 7.2 | 207 | 0.106 |
| 1N6300 | (+)1.5KE160 | 144 | 176 | 1.0 | 130 | 1.0 | 6.5 | 230 | 0.106 |
| 1N6300A | (+)1.5KE160A | 152 | 168 | 1.0 | 136 | 1.0 | 6.8 | 219 | 0.108 |
| 1N6301 | (+)1.5KE170 | 153 | 187 | 1.0 | 138 | 1.0 | 6.1 | 244 | 0.108 |
| 1N6301A | (+)1.5KE170A | 162 | 179 | 1.0 | 145 | 1.0 | 6.4 | 234 | 0.108 |
| 1N6302 | 1.5KE180 | 162 | 198 | 1.0 | 146 | 1.0 | 5.8 | 258 | 0.108 |
| 1N6302A | 1.5KE180A | 171 | 189 | 1.0 | 154 | 1.0 | 6.1 | 246 | 0.108 |
| 1N6303 | 1.5KE200 | 180 | 220 | 1.0 | 162 | 1.0 | 5.2 | 287 | 0.108 |
| 1N6303A | 1.5KE200A* | 190 | 210 | 1.0 | 171 | 1.0 | 5.5 | 274 | 0.108 |
| | 1.5KE220 | 198 | 242 | 1.0 | 175 | 1.0 | 4.4 | 344 | 0.108 |
| | 1.5KE220A* | 209 | 231 | 1.0 | 185 | 1.0 | 4.6 | 328 | 0.108 |
| | 1.5KE250 | 225 | 275 | 1.0 | 202 | 1.0 | 4.2 | 360 | 0.110 |
| | 1.5KE250A | 237 | 263 | 1.0 | 214 | 1.0 | 4.4 | 344 | 0.110 |
| | 1.5KE300 | 270 | 330 | 1.0 | 243 | 1.0 | 3.5 | 430 | 0.110 |
| | 1.5KE300A | 285 | 315 | 1.0 | 256 | 1.0 | 3.6 | 414 | 0.110 |
| | 1.5KE350 | 315 | 385 | 1.0 | 284 | 1.0 | 3.0 | 504 | 0.110 |
| | 1.5KE350A | 333 | 368 | 1.0 | 300 | 1.0 | 3.1 | 482 | 0.110 |
| | 1.5KE400 | 360 | 440 | 1.0 | 324 | 1.0 | 2.6 | 574 | 0.110 |
| | 1.5KE400A | 380 | 420 | 1.0 | 342 | 1.0 | 2.7 | 548 | 0.110 |
| | 1.5KE440 | 396 | 484 | 1.0 | 356 | 1.0 | 2.4 | 631 | 0.110 |
| | 1.5KE440A | 418 | 462 | 1.0 | 376 | 1.0 | 2.5 | 602 | 0.110 |
| | 1.5KE480 | 432 | 528 | 1.0 | 389 | 1.0 | 2.19 | 686 | 0.110 |
| | 1.5KE480A | 456 | 504 | 1.0 | 408 | 1.0 | 2.28 | 658 | 0.110 |
| | 1.5KE510 | 459 | 561 | 1.0 | 413 | 1.0 | 2.06 | 729 | 0.110 |
| | 1.5KE510A | 485 | 535 | 1.0 | 434 | 1.0 | 2.15 | 698 | 0.110 |
| | 1.5KE540 | 486 | 594 | 1.0 | 437 | 1.0 | 1.94 | 772 | 0.110 |
| | 1.5KE540A | 513 | 567 | 1.0 | 459 | 1.0 | 2.03 | 740 | 0.110 |

**Notes:**

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE CA62.35

(4) For bi-directional types with $V_R$ 10 V and less the $I_D$ limit is doubled

* Bi-directional versions are UL approved under component across the line protection, ULV1414 file number E108274 (1.5KE200CA, 1.5KE220CA)

(+) Underwriters laboratory recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B and file number E136766 for both uni-directional and bi-directional devices

| THERMAL CHARACTERISTICS ($T_A$ = 25 °C unless otherwise noted) | | | |
|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **VALUE** | **UNIT** |
| Typical thermal resistance, junction to ambient | $R_{\theta JA}$ | 75 | °C/W |
| Typical thermal resistance, junction to lead | $R_{\theta JL}$ | 15.4 | |

| ORDERING INFORMATION (Example) | | | | |
|---|---|---|---|---|
| **PREFERRED P/N** | **UNIT WEIGHT (g)** | **PREFERRED PACKAGE CODE** | **BASE QUANTITY** | **DELIVERY MODE** |
| 1.5KE6.8A-E3/54 | 0.968 | 54 | 1400 | 13" diameter paper tape and reel |
| 1.5KE6.8AHE3/54 (1) | 0.968 | 54 | 1400 | 13" diameter paper tape and reel |

**Note:**

(1) Automotive grade AEC-Q101 qualified

## RATINGS AND CHARACTERISTICS CURVES
($T_A$ = 25 °C unless otherwise noted)

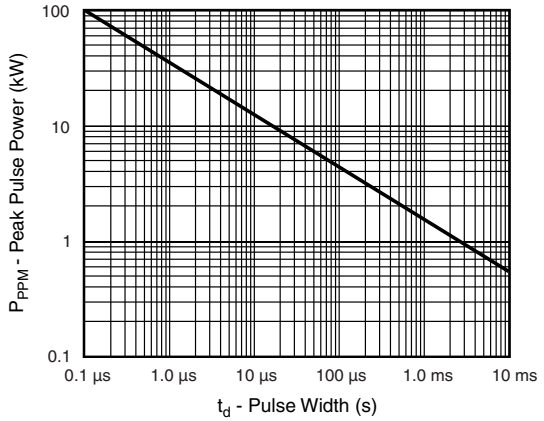



Figure 1. Peak Pulse Power Rating Curve

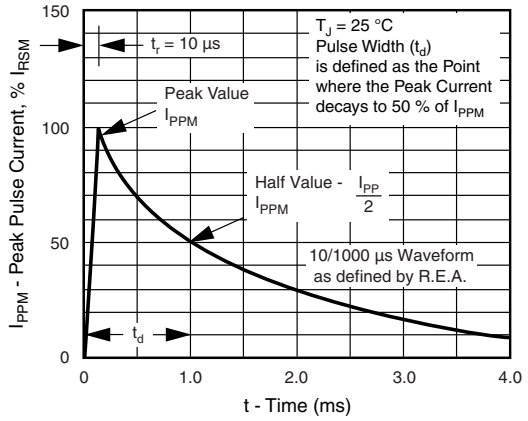



Figure 3. Pulse Waveform

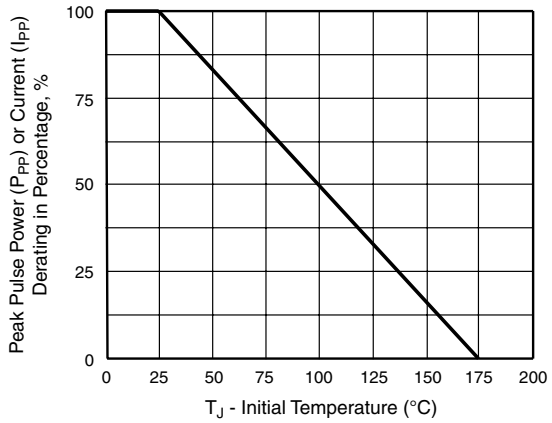



Figure 2. Pulse Power or Current vs. Initial Junction Temperature

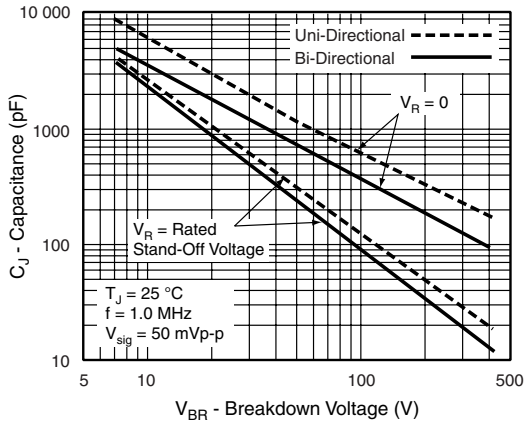



Figure 4. Typical Junction Capacitance

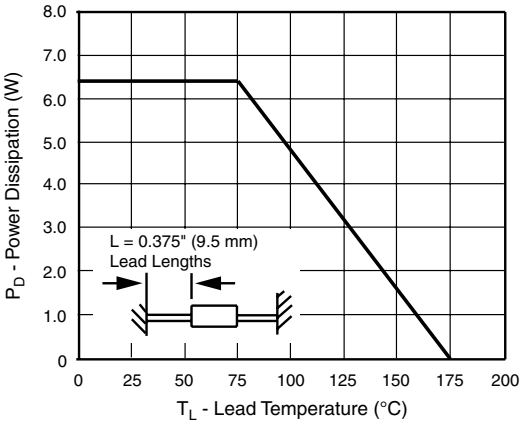



Figure 5. Power Derating Curve

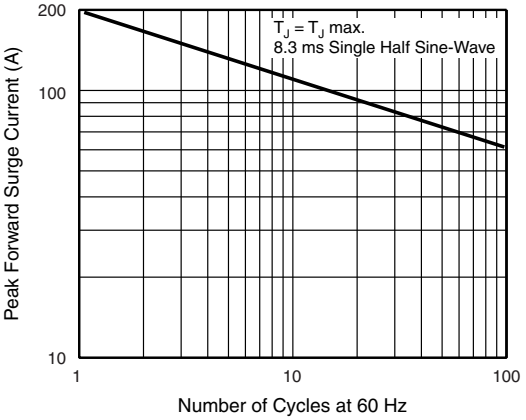



Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional only

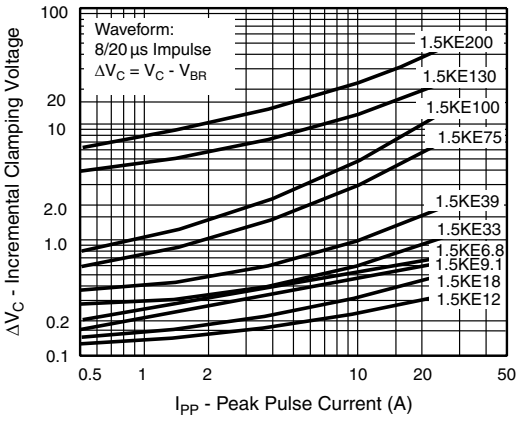



Figure 7. Incremental Clamping Voltage Curve (Uni-Directional)

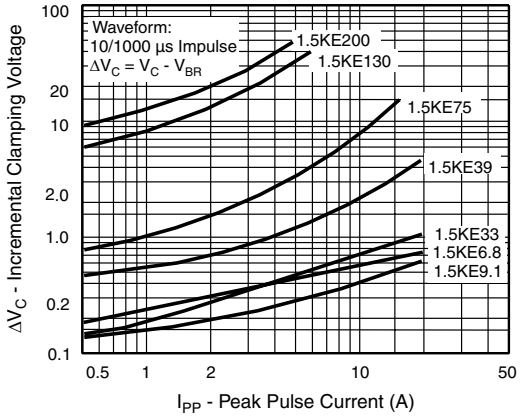



Figure 8. Incremental Clamping Voltage Curve (Uni-Directional)

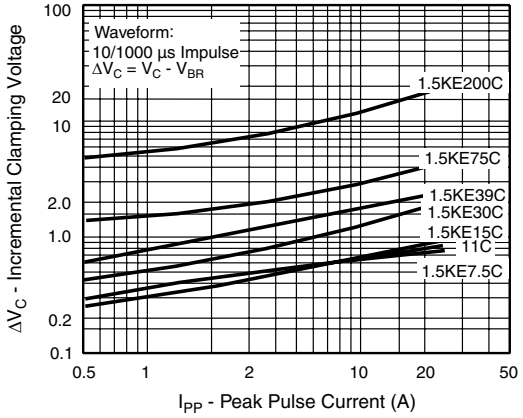



Figure 9. Incremental Clamping Voltage Curve (Bi-directional)

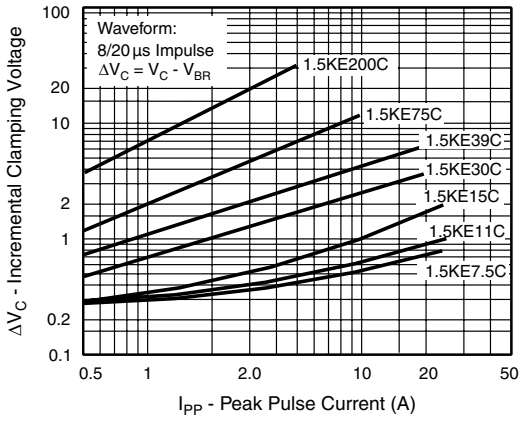



Figure 10. Incremental Clamping Voltage Curve (Bi-Directional)

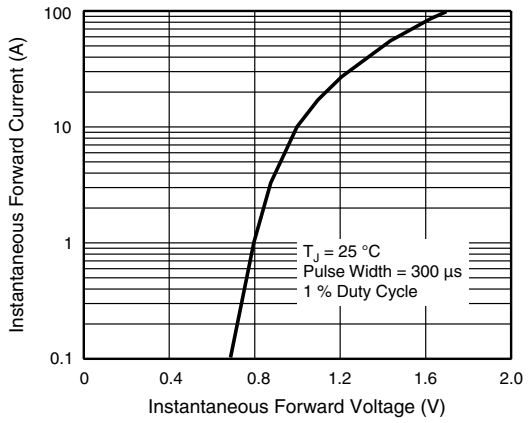



Figure 11. Instantaneous Forward Voltage Characteristics Curve

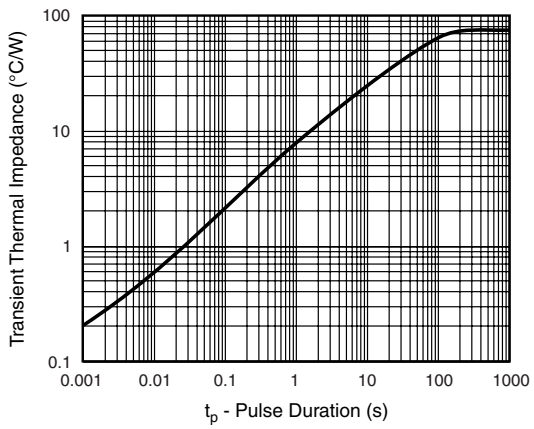
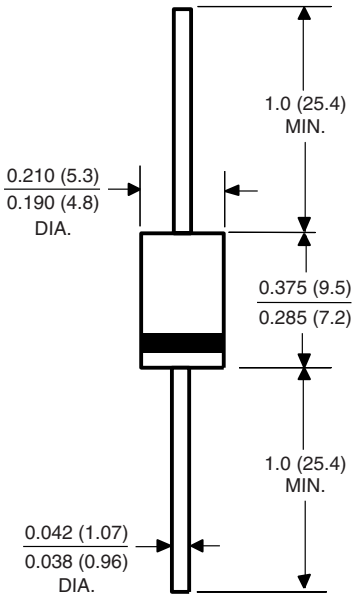



Figure 12. Typical Transient Thermal Impedance

**PACKAGE OUTLINE DIMENSIONS** in inches (millimeters)

**Case Style 1.5KE**




## APPLICATION NOTES

- This series of Silicon Transient Suppressors is used in applications where large voltage transients can permanently damage voltage-sensitive components.

- The TVS diode can be used in applications where induced lightning on rural or remote transmission lines presents a hazard to electronic circuitry (ref: R.E.A. specification P.E. 60).

- This Transient Voltage Suppressor diode has a pulse power rating of 1500 W for 1 ms. The response time of TVS diode clamping action is effectively instantaneous (1 x $10^{-9}$ s bi-directional); therefore, they can protect integrated circuits, MOS devices, hybrids, and other voltage sensitive semiconductors and components. TVS diodes can also be used in series or parallel to increase the peak power ratings.

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