

### 1.5KE Series



#### Agency Approvals

| AGENCY  | AGENCY FILE NUMBER |
|---|--------------------|
|  | E128662/E230531    |

#### Maximum Ratings and Thermal Characteristics (T<sub>A</sub>=25°C unless otherwise noted)

| Parameter   | Symbol                            | Value      | Unit |
|---|-----------------------------------|------------|------|
| Peak Pulse Power Dissipation by 10/1000µs Test Waveform (Fig.2) (Note 1)              | P <sub>PPM</sub>                  | 1500       | W    |
| Steady State Power Dissipation on Infinite Heat Sink at T <sub>C</sub> =75°C (Fig. 6) | P <sub>D</sub>                    | 6.5        | W    |
| Peak Forward Surge Current, 8.3ms Single Half Sine Wave Unidirectional Only (Note 2)  | I <sub>FSM</sub>                  | 200        | A    |
| Maximum Instantaneous Forward Voltage at 100A for Unidirectional Only (Note 3)        | V <sub>F</sub>                    | 3.5/5.0    | V    |
| Operating Junction and Storage Temperature Range                                      | T <sub>J</sub> , T <sub>STG</sub> | -55 to 175 | °C   |
| Typical Thermal Resistance Junction to Lead   | R <sub>uJL</sub>                  | 15         | °C/W |
| Typical Thermal Resistance Junction to Ambient  | R <sub>uJA</sub>                  | 75         | °C/W |

#### Notes:

1. Non-repetitive current pulse, per Fig. 4 and derated above T<sub>A</sub> = 25°C per Fig. 3.
2. Measured on 8.3ms single half sine wave or equivalent square wave, duty cycle=4 per minute maximum.
3. V<sub>F</sub><3.5V for devices of V<sub>BR</sub> ≤ 200V and V<sub>F</sub><5.0V for devices of V<sub>BR</sub> ≥ 201V.

#### Functional Diagram



#### Description

The 1.5KE Series is designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events.

#### Features

- V<sub>BR</sub>@T<sub>J</sub>=V<sub>BR</sub>@25°C x (1+α T x (T<sub>J</sub>-25)) (α T: Temperature Coefficient)
- Glass passivated chip junction in DO-201 Package
- 1500W peak pulse capability at 10/1000µs waveform, repetition rate (duty cycles):0.01%
- Fast response time: typically less than 1.0ps from 0 Volts to BV min
- Excellent clamping capability
- Typical failure mode is short from over-specified voltage or current
- Whisker test is conducted based on JEDEC JESD201A per its table 4a and 4c
- IEC-61000-4-2 ESD 15kV(Air), 8kV (Contact)
- ESD protection of data lines in accordance with IEC 61000-4-2 (IEC801-2)
- EFT protection of data lines in accordance with IEC 61000-4-4 (IEC801-4)
- Low incremental surge resistance
- Typical I<sub>R</sub> less than 1µA above 13V
- High temperature soldering guaranteed: 260°C/40 seconds / 0.375"/(9.5mm) lead length, 5 lbs., (2.3kg) tension
- Plastic package has underwriters laboratory flammability classification 94V-O
- Matte tin lead-free plated
- Halogen free and RoHS compliant
- 2nd level interconnect is Pb-free per IPC/JEDEC J-STD-609A.01

#### Applications

TVS devices are ideal for the protection of I/O interfaces, V<sub>CC</sub> bus and other vulnerable circuits used in telecom, computer, industrial and consumer electronic applications.

**Electrical Characteristics** ( $T_A=25^\circ\text{C}$  unless otherwise noted)

| Part Number (Uni) | Part Number (Bi) | Reverse Stand off Voltage $V_R$ (Volts) | Breakdown Voltage $V_{BR}$ (Volts) @ $I_T$ |        | Test Current $I_T$ (mA) | Maximum Clamping Voltage $V_C$ @ $I_{pp}$ (Volts) | Maximum Peak Pulse Current $I_{pp}$ (A) | Maximum Reverse Leakage $I_R$ @ $V_R$ ( $\mu\text{A}$ ) | Agency Approval  |
|-------------------|------------------|---|--|--------|-------------------------|---|---|---|---|
|                   |                  |   | MIN  | MAX    |                         |   |   |   |   |
| 1.5KE6.8A         | 1.5KE6.8CA       | 5.80                                    | 6.45                                       | 7.14   | 10                      | 10.5  | 144.8                                   | 1000  | X   |
| 1.5KE7.5A         | 1.5KE7.5CA       | 6.40                                    | 7.13                                       | 7.88   | 10                      | 11.3  | 134.5                                   | 500   | X   |
| 1.5KE8.2A         | 1.5KE8.2CA       | 7.02                                    | 7.79                                       | 8.61   | 10                      | 12.1  | 125.6                                   | 200   | X   |
| 1.5KE9.1A         | 1.5KE9.1CA       | 7.78                                    | 8.65                                       | 9.50   | 1                       | 13.4  | 113.4                                   | 50  | X   |
| 1.5KE10A          | 1.5KE10CA        | 8.55                                    | 9.50                                       | 10.50  | 1                       | 14.5  | 104.8                                   | 10  | X   |
| 1.5KE11A          | 1.5KE11CA        | 9.40                                    | 10.50                                      | 11.60  | 1                       | 15.6  | 97.4                                    | 5   | X   |
| 1.5KE12A          | 1.5KE12CA        | 10.20                                   | 11.40                                      | 12.60  | 1                       | 16.7  | 91.0                                    | 5   | X   |
| 1.5KE13A          | 1.5KE13CA        | 11.10                                   | 12.40                                      | 13.70  | 1                       | 18.2  | 83.5                                    | 1   | X   |
| 1.5KE15A          | 1.5KE15CA        | 12.80                                   | 14.30                                      | 15.80  | 1                       | 21.2  | 71.7                                    | 1   | X   |
| 1.5KE16A          | 1.5KE16CA        | 13.60                                   | 15.20                                      | 16.80  | 1                       | 22.5  | 67.6                                    | 1   | X   |
| 1.5KE18A          | 1.5KE18CA        | 15.30                                   | 17.10                                      | 18.90  | 1                       | 25.2  | 60.3                                    | 1   | X   |
| 1.5KE20A          | 1.5KE20CA        | 17.10                                   | 19.00                                      | 21.00  | 1                       | 27.7  | 54.9                                    | 1   | X   |
| 1.5KE22A          | 1.5KE22CA        | 18.80                                   | 20.90                                      | 23.10  | 1                       | 30.6  | 49.7                                    | 1   | X   |
| 1.5KE24A          | 1.5KE24CA        | 20.50                                   | 22.80                                      | 25.20  | 1                       | 33.2  | 45.8                                    | 1   | X   |
| 1.5KE27A          | 1.5KE27CA        | 23.10                                   | 25.70                                      | 28.40  | 1                       | 37.5  | 40.5                                    | 1   | X   |
| 1.5KE30A          | 1.5KE30CA        | 25.60                                   | 28.50                                      | 31.50  | 1                       | 41.4  | 36.7                                    | 1   | X   |
| 1.5KE33A          | 1.5KE33CA        | 28.20                                   | 31.40                                      | 34.70  | 1                       | 45.7  | 33.3                                    | 1   | X   |
| 1.5KE36A          | 1.5KE36CA        | 30.80                                   | 34.20                                      | 37.80  | 1                       | 49.9  | 30.5                                    | 1   | X   |
| 1.5KE39A          | 1.5KE39CA        | 33.30                                   | 37.10                                      | 41.00  | 1                       | 53.9  | 28.2                                    | 1   | X   |
| 1.5KE43A          | 1.5KE43CA        | 36.80                                   | 40.90                                      | 45.20  | 1                       | 59.3  | 25.6                                    | 1   | X   |
| 1.5KE47A          | 1.5KE47CA        | 40.20                                   | 44.70                                      | 49.40  | 1                       | 64.8  | 23.5                                    | 1   | X   |
| 1.5KE51A          | 1.5KE51CA        | 43.60                                   | 48.50                                      | 53.60  | 1                       | 70.1  | 21.7                                    | 1   | X   |
| 1.5KE56A          | 1.5KE56CA        | 47.80                                   | 53.20                                      | 58.80  | 1                       | 77.0  | 19.7                                    | 1   | X   |
| 1.5KE62A          | 1.5KE62CA        | 53.00                                   | 58.90                                      | 65.10  | 1                       | 85.0  | 17.9                                    | 1   | X   |
| 1.5KE68A          | 1.5KE68CA        | 58.10                                   | 64.60                                      | 71.40  | 1                       | 92.0  | 16.5                                    | 1   | X   |
| 1.5KE75A          | 1.5KE75CA        | 64.10                                   | 71.30                                      | 78.80  | 1                       | 103.0   | 14.8                                    | 1   | X   |
| 1.5KE82A          | 1.5KE82CA        | 70.10                                   | 77.90                                      | 86.10  | 1                       | 113.0   | 13.5                                    | 1   | X   |
| 1.5KE91A          | 1.5KE91CA        | 77.80                                   | 86.50                                      | 95.50  | 1                       | 125.0   | 12.2                                    | 1   | X   |
| 1.5KE100A         | 1.5KE100CA       | 85.50                                   | 95.00                                      | 105.00 | 1                       | 137.0   | 11.1                                    | 1   | X   |
| 1.5KE110A         | 1.5KE110CA       | 94.00                                   | 105.00                                     | 116.00 | 1                       | 152.0   | 10.0                                    | 1   | X   |
| 1.5KE120A         | 1.5KE120CA       | 102.00                                  | 114.00                                     | 126.00 | 1                       | 165.0   | 9.2                                     | 1   | X   |
| 1.5KE130A         | 1.5KE130CA       | 111.00                                  | 124.00                                     | 137.00 | 1                       | 179.0   | 8.5                                     | 1   | X   |
| 1.5KE150A         | 1.5KE150CA       | 128.00                                  | 143.00                                     | 158.00 | 1                       | 207.0   | 7.3                                     | 1   | X   |
| 1.5KE160A         | 1.5KE160CA       | 136.00                                  | 152.00                                     | 168.00 | 1                       | 219.0   | 6.9                                     | 1   | X   |
| 1.5KE170A         | 1.5KE170CA       | 145.00                                  | 162.00                                     | 179.00 | 1                       | 234.0   | 6.5                                     | 1   | X   |
| 1.5KE180A         | 1.5KE180CA       | 154.00                                  | 171.00                                     | 189.00 | 1                       | 246.0   | 6.2                                     | 1   | X   |
| 1.5KE200A         | 1.5KE200CA       | 171.00                                  | 190.00                                     | 210.00 | 1                       | 274.0   | 5.5                                     | 1   | X   |
| 1.5KE220A         | 1.5KE220CA       | 185.00                                  | 209.00                                     | 231.00 | 1                       | 328.0   | 4.6                                     | 1   | X   |
| 1.5KE250A         | 1.5KE250CA       | 214.00                                  | 237.00                                     | 263.00 | 1                       | 344.0   | 4.4                                     | 1   | X   |
| 1.5KE300A         | 1.5KE300CA       | 256.00                                  | 285.00                                     | 315.00 | 1                       | 414.0   | 3.7                                     | 1   | X   |
| 1.5KE320A         | 1.5KE320CA       | 273.00                                  | 304.00                                     | 336.00 | 1                       | 441.0   | 3.5                                     | 1   | X   |
| 1.5KE350A         | 1.5KE350CA       | 300.00                                  | 332.00                                     | 368.00 | 1                       | 482.0   | 3.2                                     | 1   | X   |
| 1.5KE400A         | 1.5KE400CA       | 342.00                                  | 380.00                                     | 420.00 | 1                       | 548.0   | 2.8                                     | 1   | X   |
| 1.5KE440A         | 1.5KE440CA       | 376.00                                  | 418.00                                     | 462.00 | 1                       | 602.0   | 2.5                                     | 1   | X   |
| 1.5KE480A         | 1.5KE480CA       | 408.00                                  | 456.00                                     | 504.00 | 1                       | 658.0   | 2.3                                     | 1   | X   |
| 1.5KE510A         | 1.5KE510CA       | 434.00                                  | 485.00                                     | 535.00 | 1                       | 698.0   | 2.1                                     | 1   | X   |
| 1.5KE530A         | 1.5KE530CA       | 451.00                                  | 503.50                                     | 556.50 | 1                       | 725.0   | 2.1                                     | 1   | X   |
| 1.5KE540A         | 1.5KE540CA       | 460.00                                  | 513.00                                     | 567.00 | 1                       | 740.0   | 2.0                                     | 1   | X   |
| 1.5KE550A         | 1.5KE550CA       | 468.00                                  | 522.50                                     | 577.50 | 1                       | 760.0   | 2.0                                     | 1   | X   |
| 1.5KE600A         | 1.5KE600CA       | 512.00                                  | 570.00                                     | 630.00 | 1                       | 828.0   | 1.8                                     | 1   |   |

For bidirectional type having  $V_R$  of 10 volts and less, the  $I_R$  limit is double.

For parts without A, the  $V_{BR}$  is  $\pm 10\%$  and  $V_C$  is 5% higher than with A parts.

**I-V Curve Characteristics**



- $P_{PPM}$  Peak Pulse Power Dissipation** – Max power dissipation
- $V_R$  Stand-off Voltage** – Maximum voltage that can be applied to the TVS without operation
- $V_{BR}$  Breakdown Voltage** – Maximum voltage that flows through the TVS at a specified test current ( $I_T$ )
- $V_C$  Clamping Voltage** – Peak voltage measured across the suppressor at a specified  $I_{ppm}$  (peak impulse current)
- $I_R$  Reverse Leakage Current** – Current measured at  $V_R$
- $V_F$  Forward Voltage Drop for Uni-directional**

**Ratings and Characteristic Curves ( $T_A = 25^\circ\text{C}$  unless otherwise noted)**

**Figure 1 - TVS Transients Clamping Waveform**



**Figure 2 - Peak Pulse Power Rating**



continues on next page.

**Ratings and Characteristic Curves** ( $T_A=25^\circ\text{C}$  unless otherwise noted) (Continued)

**Figure 3 - Pulse Derating Curve**



**Figure 4 - Pulse Waveform**



**Figure 5 - Typical Junction Capacitance**



**Figure 6 - Steady State Power Derating Curve**



**Figure 7 - Maximum Non-Repetitive Peak Forward Surge Current Uni-Directional Only**



**Soldering Parameters**

|  |                                    |                         |
|--|------------------------------------|-------------------------|
| Reflow Condition                                       |                                    | Lead-free assembly      |
| Pre Heat   | - Temperature Min ( $T_{s(min)}$ ) | 150°C                   |
|  | - Temperature Max ( $T_{s(max)}$ ) | 200°C                   |
|  | - Time (min to max) ( $t_s$ )      | 60 – 180 secs           |
| Average ramp up rate (Liquidus Temp ( $T_L$ ) to peak) |                                    | 3°C/second max          |
| $T_{s(max)}$ to $T_L$ - Ramp-up Rate                   |                                    | 3°C/second max          |
| Reflow   | - Temperature ( $T_L$ ) (Liquidus) | 217°C                   |
|  | - Time (min to max) ( $t_s$ )      | 60 – 150 seconds        |
| Peak Temperature ( $T_p$ )                             |                                    | 260 <sup>+0/-5</sup> °C |
| Time within 5°C of actual peak Temperature ( $t_p$ )   |                                    | 20 – 40 seconds         |
| Ramp-down Rate   |                                    | 6°C/second max          |
| Time 25°C to peak Temperature ( $T_p$ )                |                                    | 8 minutes Max.          |
| Do not exceed  |                                    | 280°C                   |



**Flow/Wave Soldering (Solder Dipping)**

|                           |            |
|---------------------------|------------|
| <b>Peak Temperature :</b> | 265°C      |
| <b>Dipping Time :</b>     | 10 seconds |
| <b>Soldering :</b>        | 1 time     |

**Physical Specifications**

|                 |  |
|-----------------|--|
| <b>Weight</b>   | 0.045oz., 1.2g   |
| <b>Case</b>     | JEDEC DO-201 molded plastic body over passivated junction. |
| <b>Polarity</b> | Color band denotes the cathode except Bipolar.             |
| <b>Terminal</b> | Matte Tin axial leads, solderable per JESD22-B102.         |

**Environmental Specifications**

|                            |             |
|----------------------------|-------------|
| <b>High Temp. Storage</b>  | JESD22-A103 |
| <b>HTRB</b>                | JESD22-A108 |
| <b>Temperature Cycling</b> | JESD22-A104 |
| <b>H3TRB</b>               | JESD22-A101 |
| <b>RSH</b>                 | JESD22-B106 |

**Dimensions**



| Dimensions | Inches |       | Millimeters |      |
|------------|--------|-------|-------------|------|
|            | Min    | Max   | Min         | Max  |
| A          | 1.000  | -     | 25.40       | -    |
| B          | 0.285  | 0.375 | 7.20        | 9.50 |
| C          | 0.038  | 0.042 | 0.96        | 1.07 |
| D          | 0.190  | 0.210 | 4.80        | 5.30 |

**Part Numbering System**



**Part Marking System**



**Packaging**

| Part Number  | Component Package | Quantity | Packaging Option | Packaging Specification |
|--------------|-------------------|----------|------------------|-------------------------|
| 1.5KExxxXX   | DO-201            | 1200     | Tape & Reel      | EIA STD RS-296          |
| 1.5KExxxXX-B | DO-201            | 500      | BULK             | Littelfuse Spec.        |

**Tape and Reel Specification**



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