

## SA 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>                  | 500        | W    |
| Steady State Power Dissipation on Infinite Heat Sink at T <sub>L</sub> =75°C (Fig. 6) | P <sub>D</sub>                    | 3.0        | W    |
| Peak Forward Surge Current, 8.3ms Single Half Sine Wave Unidirectional Only (Note 2)  | I <sub>FSM</sub>                  | 70         | A    |
| Maximum Instantaneous Forward Voltage at 35A 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>θJL</sub>                  | 20         | °C/W |
| Typical Thermal Resistance Junction to Ambient                                        | R <sub>θJA</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 SA 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-15 Package
- 500W 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<sub>A</sub>=25°C unless otherwise noted)

| Part Number (Uni) | Part Number (Bi) | Reverse Stand off Voltage V <sub>R</sub> (V) | Breakdown Voltage V <sub>BR</sub> (Volts) @ I <sub>T</sub> |        | Test Current I <sub>T</sub> (mA) | Maximum Clamping Voltage V <sub>C</sub> @ I <sub>PP</sub> (V) | Maximum Peak Pulse Current I <sub>PP</sub> (A) | Maximum Reverse Leakage I <sub>R</sub> @ V <sub>R</sub> (μA) | Agency Approval  |
|-------------------|------------------|----------------------------------------------|------------------------------------------------------------|--------|----------------------------------|---------------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
|                   |                  |                                              | MIN                                                        | MAX    |                                  |                                                               |                                                |                                                              |                                                                                                     |
| SA5.0A            | SA5.0CA          | 5.0                                          | 6.40                                                       | 7.00   | 10                               | 9.2                                                           | 55.4                                           | 600                                                          | X                                                                                                   |
| SA6.0A            | SA6.0CA          | 6.0                                          | 6.67                                                       | 7.37   | 10                               | 10.3                                                          | 49.5                                           | 600                                                          | X                                                                                                   |
| SA6.5A            | SA6.5CA          | 6.5                                          | 7.22                                                       | 7.98   | 10                               | 11.2                                                          | 45.5                                           | 400                                                          | X                                                                                                   |
| SA7.0A            | SA7.0CA          | 7.0                                          | 7.78                                                       | 8.60   | 10                               | 12.0                                                          | 42.5                                           | 150                                                          | X                                                                                                   |
| SA7.5A            | SA7.5CA          | 7.5                                          | 8.33                                                       | 9.21   | 1                                | 12.9                                                          | 39.5                                           | 50                                                           | X                                                                                                   |
| SA8.0A            | SA8.0CA          | 8.0                                          | 8.89                                                       | 9.83   | 1                                | 13.6                                                          | 37.5                                           | 25                                                           | X                                                                                                   |
| SA8.5A            | SA8.5CA          | 8.5                                          | 9.44                                                       | 10.40  | 1                                | 14.4                                                          | 35.4                                           | 10                                                           | X                                                                                                   |
| SA9.0A            | SA9.0CA          | 9.0                                          | 10.00                                                      | 11.10  | 1                                | 15.4                                                          | 33.1                                           | 5                                                            | X                                                                                                   |
| SA10A             | SA10CA           | 10.0                                         | 11.10                                                      | 12.30  | 1                                | 17.0                                                          | 30.0                                           | 3                                                            | X                                                                                                   |
| SA11A             | SA11CA           | 11.0                                         | 12.20                                                      | 13.50  | 1                                | 18.2                                                          | 28.0                                           | 1                                                            | X                                                                                                   |
| SA12A             | SA12CA           | 12.0                                         | 13.30                                                      | 14.70  | 1                                | 19.9                                                          | 25.6                                           | 1                                                            | X                                                                                                   |
| SA13A             | SA13CA           | 13.0                                         | 14.40                                                      | 15.90  | 1                                | 21.5                                                          | 23.7                                           | 1                                                            | X                                                                                                   |
| SA14A             | SA14CA           | 14.0                                         | 15.60                                                      | 17.20  | 1                                | 23.2                                                          | 22.0                                           | 1                                                            | X                                                                                                   |
| SA15A             | SA15CA           | 15.0                                         | 16.70                                                      | 18.50  | 1                                | 24.4                                                          | 20.9                                           | 1                                                            | X                                                                                                   |
| SA16A             | SA16CA           | 16.0                                         | 17.80                                                      | 19.70  | 1                                | 26.0                                                          | 19.6                                           | 1                                                            | X                                                                                                   |
| SA17A             | SA17CA           | 17.0                                         | 18.90                                                      | 20.90  | 1                                | 27.6                                                          | 18.5                                           | 1                                                            | X                                                                                                   |
| SA18A             | SA18CA           | 18.0                                         | 20.00                                                      | 22.10  | 1                                | 29.2                                                          | 17.5                                           | 1                                                            | X                                                                                                   |
| SA20A             | SA20CA           | 20.0                                         | 22.20                                                      | 24.50  | 1                                | 32.4                                                          | 15.7                                           | 1                                                            | X                                                                                                   |
| SA22A             | SA22CA           | 22.0                                         | 24.40                                                      | 26.90  | 1                                | 35.5                                                          | 14.4                                           | 1                                                            | X                                                                                                   |
| SA24A             | SA24CA           | 24.0                                         | 26.70                                                      | 29.50  | 1                                | 38.9                                                          | 13.1                                           | 1                                                            | X                                                                                                   |
| SA26A             | SA26CA           | 26.0                                         | 28.90                                                      | 31.90  | 1                                | 42.1                                                          | 12.1                                           | 1                                                            | X                                                                                                   |
| SA28A             | SA28CA           | 28.0                                         | 31.10                                                      | 34.40  | 1                                | 45.4                                                          | 11.2                                           | 1                                                            | X                                                                                                   |
| SA30A             | SA30CA           | 30.0                                         | 33.30                                                      | 36.80  | 1                                | 48.4                                                          | 10.5                                           | 1                                                            | X                                                                                                   |
| SA33A             | SA33CA           | 33.0                                         | 36.70                                                      | 40.60  | 1                                | 53.3                                                          | 9.6                                            | 1                                                            | X                                                                                                   |
| SA36A             | SA36CA           | 36.0                                         | 40.00                                                      | 44.20  | 1                                | 58.1                                                          | 8.8                                            | 1                                                            | X                                                                                                   |
| SA40A             | SA40CA           | 40.0                                         | 44.40                                                      | 49.10  | 1                                | 64.5                                                          | 7.9                                            | 1                                                            | X                                                                                                   |
| SA43A             | SA43CA           | 43.0                                         | 47.80                                                      | 52.80  | 1                                | 69.4                                                          | 7.3                                            | 1                                                            | X                                                                                                   |
| SA45A             | SA45CA           | 45.0                                         | 50.00                                                      | 55.30  | 1                                | 72.7                                                          | 7.0                                            | 1                                                            | X                                                                                                   |
| SA48A             | SA48CA           | 48.0                                         | 53.30                                                      | 58.90  | 1                                | 77.4                                                          | 6.6                                            | 1                                                            | X                                                                                                   |
| SA51A             | SA51CA           | 51.0                                         | 56.70                                                      | 62.70  | 1                                | 82.4                                                          | 6.2                                            | 1                                                            | X                                                                                                   |
| SA54A             | SA54CA           | 54.0                                         | 60.00                                                      | 66.30  | 1                                | 87.1                                                          | 5.9                                            | 1                                                            | X                                                                                                   |
| SA58A             | SA58CA           | 58.0                                         | 64.40                                                      | 71.20  | 1                                | 93.6                                                          | 5.4                                            | 1                                                            | X                                                                                                   |
| SA60A             | SA60CA           | 60.0                                         | 66.70                                                      | 73.70  | 1                                | 96.8                                                          | 5.3                                            | 1                                                            | X                                                                                                   |
| SA64A             | SA64CA           | 64.0                                         | 71.10                                                      | 78.60  | 1                                | 103.0                                                         | 5.0                                            | 1                                                            | X                                                                                                   |
| SA70A             | SA70CA           | 70.0                                         | 77.80                                                      | 86.00  | 1                                | 113.0                                                         | 4.5                                            | 1                                                            | X                                                                                                   |
| SA75A             | SA75CA           | 75.0                                         | 83.30                                                      | 92.10  | 1                                | 121.0                                                         | 4.2                                            | 1                                                            | X                                                                                                   |
| SA78A             | SA78CA           | 78.0                                         | 86.70                                                      | 95.80  | 1                                | 126.0                                                         | 4.0                                            | 1                                                            | X                                                                                                   |
| SA85A             | SA85CA           | 85.0                                         | 94.40                                                      | 104.00 | 1                                | 137.0                                                         | 3.7                                            | 1                                                            | X                                                                                                   |
| SA90A             | SA90CA           | 90.0                                         | 100.00                                                     | 111.00 | 1                                | 146.0                                                         | 3.5                                            | 1                                                            | X                                                                                                   |
| SA100A            | SA100CA          | 100.0                                        | 111.00                                                     | 123.00 | 1                                | 162.0                                                         | 3.1                                            | 1                                                            | X                                                                                                   |
| SA110A            | SA110CA          | 110.0                                        | 122.00                                                     | 135.00 | 1                                | 177.0                                                         | 2.9                                            | 1                                                            | X                                                                                                   |
| SA120A            | SA120CA          | 120.0                                        | 133.00                                                     | 147.00 | 1                                | 193.0                                                         | 2.6                                            | 1                                                            | X                                                                                                   |
| SA130A            | SA130CA          | 130.0                                        | 144.00                                                     | 159.00 | 1                                | 209.0                                                         | 2.4                                            | 1                                                            | X                                                                                                   |
| SA150A            | SA150CA          | 150.0                                        | 167.00                                                     | 185.00 | 1                                | 243.0                                                         | 2.1                                            | 1                                                            | X                                                                                                   |
| SA160A            | SA160CA          | 160.0                                        | 178.00                                                     | 197.00 | 1                                | 259.0                                                         | 2.0                                            | 1                                                            | X                                                                                                   |
| SA170A            | SA170CA          | 170.0                                        | 189.00                                                     | 209.00 | 1                                | 275.0                                                         | 1.9                                            | 1                                                            | X                                                                                                   |
| SA180A            | SA180CA          | 180.0                                        | 200.00                                                     | 221.00 | 1                                | 289.0                                                         | 1.7                                            | 1                                                            | X                                                                                                   |

For bidirectional type having V<sub>R</sub> of 10 volts and less, the I<sub>R</sub> limit is double.

For parts without A, the V<sub>BR</sub> is + 10% and V<sub>C</sub> 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 ( $I_R$ )

**$V_C$  Clamping Voltage** – Peak voltage measured across the suppressor at a specified  $I_{PPM}$  (peak impulse current)

**$I_R$  Reverse Leakage Current** – Current measured at  $V_R$

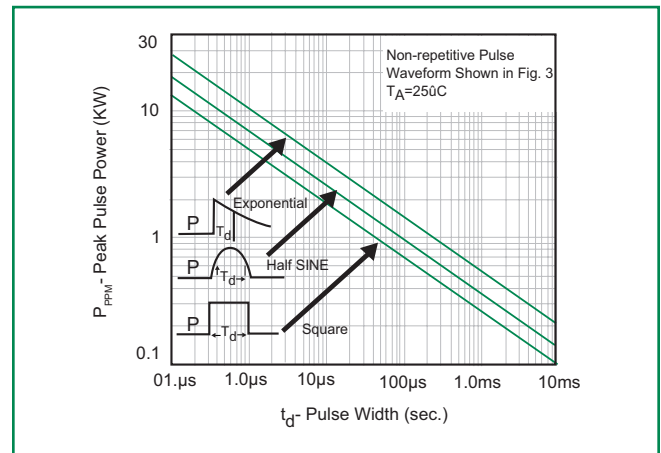
**$V_F$  Forward Voltage Drop for Uni-directional**

## 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**

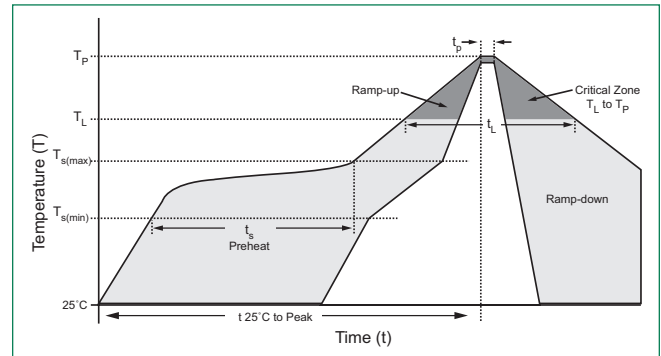


**Figure 7 - Maximum Non-Repetitive Forward Surge Current Uni-Directional Only**



## 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     |

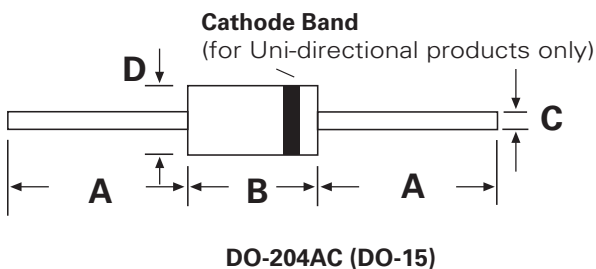
## Physical Specifications

|                 |                                                                      |
|-----------------|----------------------------------------------------------------------|
| <b>Weight</b>   | 0.015oz., 0.4g                                                       |
| <b>Case</b>     | JEDEC DO-204AC (DO-15) 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          | 0.230  | 0.300 | 5.80        | 7.60 |
| C          | 0.028  | 0.034 | 0.71        | 0.86 |
| D          | 0.104  | 0.140 | 2.60        | 3.60 |

### Part Numbering System

**SAxxxXXX**

**OPTION CODE:**

**BLANK** Reel Tape  
**-B** Bulk Packaging

**TYPE CODE:**

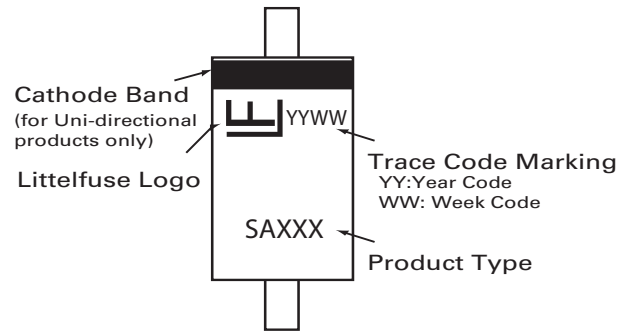
**A** Uni-Directional (5%  $V_{BR}$  Voltage Tolerance)  
**CA** Bi-Directional (5%  $V_{BR}$  Voltage Tolerance)

**V<sub>BR</sub> VOLTAGE CODE**

(Refer to the Electrical Characteristics table)

**SERIES CODE**

### Part Marking System



### Packaging

| Part Number | Component Package | Quantity | Packaging Option | Packaging Specification |
|-------------|-------------------|----------|------------------|-------------------------|
| SAxxxXX     | DO-204AC          | 4000     | Tape & Reel      | EIA STD RS-296          |
| SAxxxXX-B   | DO-204AC          | 1000     | Bulk             | Littelfuse Spec.        |

### Tape and Reel Specification

