

## PROTECTION PRODUCTS

### Description

The SM series of transient voltage suppressors (TVS) are designed to protect components which are connected to data and transmission lines from voltage surges caused by **ESD** (electrostatic discharge), **EFT** (electrical fast transients), and **lightning**.

TVS diodes are characterized by their high surge capability, low operating and clamping voltages, and fast response time. This makes them ideal for use as board level protection of sensitive semiconductor components. The dual-junction common-anode design allows the user to protect one bidirectional data line or two unidirectional lines. The low profile SOT23 package allows flexibility in the design of "crowded" circuit boards.

The SM series will meet the surge requirements of IEC 61000-4-2 (Formerly IEC 801-2), Level 4, "Human Body Model" for air and contact discharge.

### Features

- ◆ 300 watts peak pulse power ( $t_p = 8/20\mu s$ )
- ◆ Transient protection for data & power lines to  
**IEC 61000-4-2 (ESD) 15kV (air), 8kV (contact)**  
**IEC 61000-4-4 (EFT) 40A ( $t_p=5/50ns$ )**  
**IEC 61000-4-5 (Lightning) 12A ( $t_p=1.2/50\mu s$ )**
- ◆ Protects one bidirectional line or two unidirectional lines
- ◆ Working Voltages: 5V, 12V, 15V, 24 and 36V
- ◆ Low clamping voltage
- ◆ Solid-state silicon avalanche technology

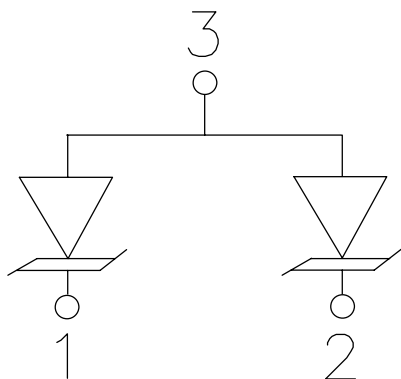
### Mechanical Characteristics

- ◆ JEDEC SOT23 package
- ◆ Molding compound flammability rating: UL 94V-0
- ◆ Marking : Marking Code
- ◆ Packaging : Tape and Reel per EIA 481

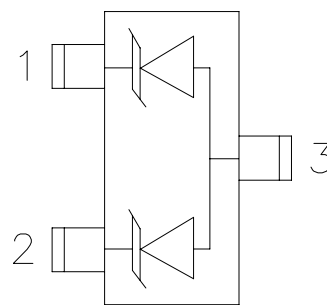
### Applications

- ◆ Cellular Handsets and Accessories
- ◆ Portable Electronics
- ◆ Industrial Controls
- ◆ Set-Top Box
- ◆ Servers, Notebook, and Desktop PC

### Circuit Diagram



### Schematic & PIN Configuration



**SOT23 (Top View)**

**PROTECTION PRODUCTS**
**Absolute Maximum Rating**

| Rating                                  | Symbol        | Value         | Units         |
|-----------------------------------------|---------------|---------------|---------------|
| Peak Pulse Power ( $t_p = 8/20\mu s$ )  | $P_{pk}$      | 300           | Watts         |
| Thermal Resistance, Junction to Ambient | $\theta_{JA}$ | 556           | $^{\circ}C/W$ |
| Lead Soldering Temperature              | $T_L$         | 260 (10 sec.) | $^{\circ}C$   |
| Operating Temperature                   | $T_J$         | -55 to +125   | $^{\circ}C$   |
| Storage Temperature                     | $T_{STG}$     | -55 to +150   | $^{\circ}C$   |

**Electrical Characteristics**
**SM05**

| Parameter                  | Symbol    | Conditions                                           | Minimum | Typical | Maximum | Units   |
|----------------------------|-----------|------------------------------------------------------|---------|---------|---------|---------|
| Reverse Stand-Off Voltage  | $V_{RWM}$ |                                                      |         |         | 5       | V       |
| Reverse Breakdown Voltage  | $V_{BR}$  | $I_t = 1mA$                                          | 6       |         |         | V       |
| Reverse Leakage Current    | $I_R$     | $V_{RWM} = 5V, T=25^{\circ}C$                        |         |         | 20      | $\mu A$ |
| Clamping Voltage           | $V_C$     | $I_{pp} = 1A,$<br>$t_p = 8/20\mu s$                  |         |         | 9.8     | V       |
| Maximum Peak Pulse Current | $I_{pp}$  | $t_p = 8/20\mu s$                                    |         |         | 17      | A       |
| Junction Capacitance       | $C_j$     | Pin 1 to 2<br>$V_R = 0V, f = 1MHz$                   |         |         | 350     | pF      |
| Junction Capacitance       | $C_j$     | Pin 1 to 3 and<br>Pin 2 to 3<br>$V_R = 0V, f = 1MHz$ |         |         | 400     | pF      |

**SM12**

| Parameter                  | Symbol    | Conditions                                           | Minimum | Typical | Maximum | Units   |
|----------------------------|-----------|------------------------------------------------------|---------|---------|---------|---------|
| Reverse Stand-Off Voltage  | $V_{RWM}$ |                                                      |         |         | 12      | V       |
| Reverse Breakdown Voltage  | $V_{BR}$  | $I_t = 1mA$                                          | 13.3    |         |         | V       |
| Reverse Leakage Current    | $I_R$     | $V_{RWM} = 12V, T=25^{\circ}C$                       |         |         | 1       | $\mu A$ |
| Clamping Voltage           | $V_C$     | $I_{pp} = 1A,$<br>$t_p = 8/20\mu s$                  |         |         | 19      | V       |
| Maximum Peak Pulse Current | $I_{pp}$  | $t_p = 8/20\mu s$                                    |         |         | 12      | A       |
| Junction Capacitance       | $C_j$     | Pin 1 to 2<br>$V_R = 0V, f = 1MHz$                   |         |         | 120     | pF      |
| Junction Capacitance       | $C_j$     | Pin 1 to 3 and<br>Pin 2 to 3<br>$V_R = 0V, f = 1MHz$ |         |         | 150     | pF      |

**PROTECTION PRODUCTS**
**Electrical Characteristics (Continued)**
**SM15**

| Parameter                  | Symbol    | Conditions                                    | Minimum | Typical | Maximum | Units   |
|----------------------------|-----------|-----------------------------------------------|---------|---------|---------|---------|
| Reverse Stand-Off Voltage  | $V_{RWM}$ |                                               |         |         | 15      | V       |
| Reverse Breakdown Voltage  | $V_{BR}$  | $I_t = 1mA$                                   | 16.7    |         |         | V       |
| Reverse Leakage Current    | $I_R$     | $V_{RWM} = 15V, T=25^{\circ}C$                |         |         | 1       | $\mu A$ |
| Clamping Voltage           | $V_C$     | $I_{PP} = 1A, t_p = 8/20\mu s$                |         |         | 24      | V       |
| Maximum Peak Pulse Current | $I_{PP}$  | $t_p = 8/20\mu s$                             |         |         | 10      | A       |
| Junction Capacitance       | $C_J$     | Pin 1 to 2<br>$V_R = 0V, f = 1MHz$            |         |         | 75      | pF      |
| Junction Capacitance       | $C_J$     | Pin 1 to 3 and 2 to 3<br>$V_R = 0V, f = 1MHz$ |         |         | 100     | pF      |

**SM24**

| Parameter                  | Symbol    | Conditions                                    | Minimum | Typical | Maximum | Units   |
|----------------------------|-----------|-----------------------------------------------|---------|---------|---------|---------|
| Reverse Stand-Off Voltage  | $V_{RWM}$ |                                               |         |         | 24      | V       |
| Reverse Breakdown Voltage  | $V_{BR}$  | $I_t = 1mA$                                   | 26.7    |         |         | V       |
| Reverse Leakage Current    | $I_R$     | $V_{RWM} = 24V, T=25^{\circ}C$                |         |         | 1       | $\mu A$ |
| Clamping Voltage           | $V_C$     | $I_{PP} = 1A, t_p = 8/20\mu s$                |         |         | 43      | V       |
| Maximum Peak Pulse Current | $I_{PP}$  | $t_p = 8/20\mu s$                             |         |         | 5       | A       |
| Junction Capacitance       | $C_J$     | Pin 1 to 2<br>$V_R = 0V, f = 1MHz$            |         |         | 50      | pF      |
| Junction Capacitance       | $C_J$     | Pin 1 to 3 and 2 to 3<br>$V_R = 0V, f = 1MHz$ |         |         | 60      | pF      |

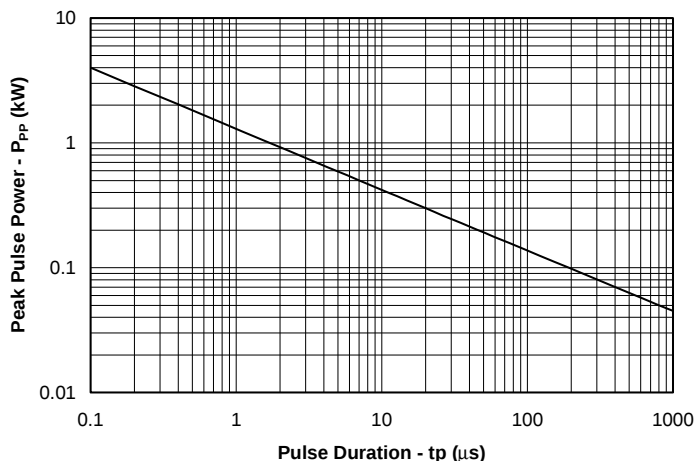
**SM36**

| Parameter                  | Symbol    | Conditions                                    | Minimum | Typical | Maximum | Units   |
|----------------------------|-----------|-----------------------------------------------|---------|---------|---------|---------|
| Reverse Stand-Off Voltage  | $V_{RWM}$ |                                               |         |         | 36      | V       |
| Reverse Breakdown Voltage  | $V_{BR}$  | $I_t = 1mA$                                   | 40      |         |         | V       |
| Reverse Leakage Current    | $I_R$     | $V_{RWM} = 36V, T=25^{\circ}C$                |         |         | 1       | $\mu A$ |
| Clamping Voltage           | $V_C$     | $I_{PP} = 1A, t_p = 8/20\mu s$                |         |         | 60      | V       |
| Maximum Peak Pulse Current | $I_{PP}$  | $t_p = 8/20\mu s$                             |         |         | 4       | A       |
| Junction Capacitance       | $C_J$     | Pin 1 to 2<br>$V_R = 0V, f = 1MHz$            |         |         | 40      | pF      |
| Junction Capacitance       | $C_J$     | Pin 1 to 3 and 2 to 3<br>$V_R = 0V, f = 1MHz$ |         |         | 45      | pF      |

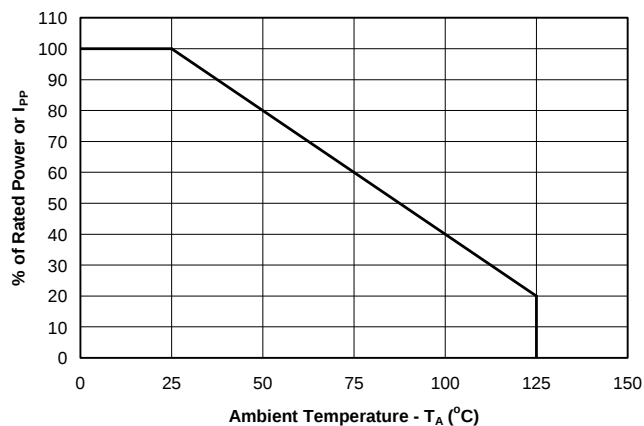
## PROTECTION PRODUCTS

### Typical Characteristics

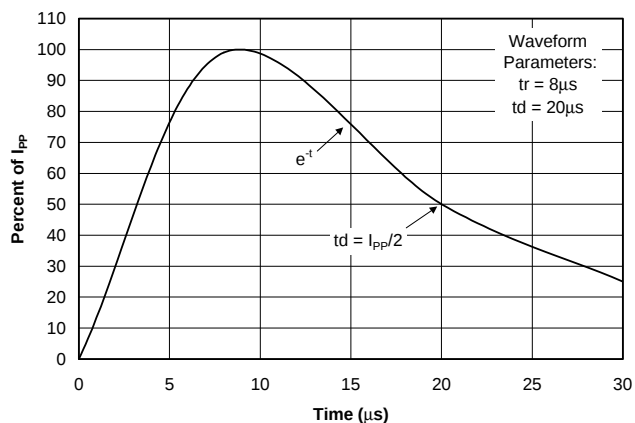
**Non-Repetitive Peak Pulse Power vs. Pulse Time**



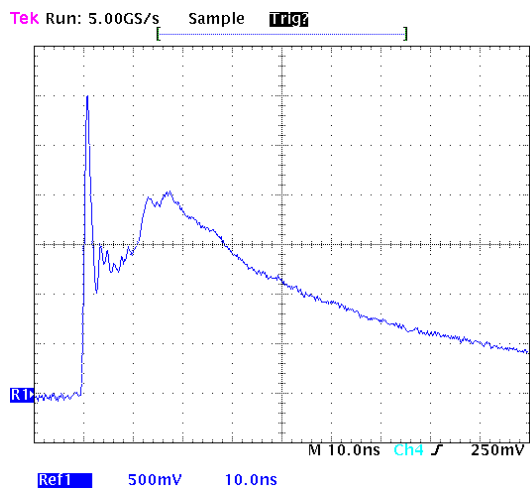
**Power Derating Curve**



**Pulse Waveform**



**ESD Pulse Waveform (Per IEC 61000-4-2)**



**IEC 61000-4-2 Discharge Parameters**

| Level | First Peak Current (A) | Peak Current at 30 ns (A) | Peak Current at 60 ns (A) | Test Voltage (Contact Discharge) (kV) | Test Voltage (Air Discharge) (kV) |
|-------|------------------------|---------------------------|---------------------------|---------------------------------------|-----------------------------------|
| 1     | 7.5                    | 4                         | 8                         | 2                                     | 2                                 |
| 2     | 15                     | 8                         | 4                         | 4                                     | 4                                 |
| 3     | 22.5                   | 12                        | 6                         | 6                                     | 8                                 |
| 4     | 30                     | 16                        | 8                         | 8                                     | 15                                |

## PROTECTION PRODUCTS

### Applications Information

#### Device Connection Options

The SM series is designed to protect one bidirectional or two unidirectional data or I/O lines operating at 5 to 36 volts. Connection options are as follows:

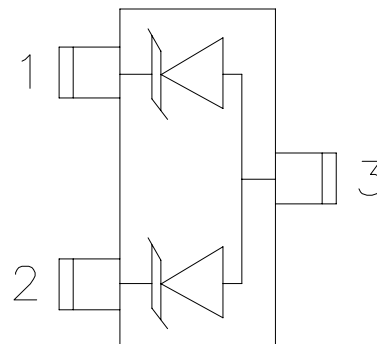
- **Bidirectional:** Pin 1 is connected to the data line and pin 2 is connected to ground (Since the device is symmetrical, these connections may be reversed). For best results, the ground connection should be made directly to a ground plane on the board. The path length should be kept as short as possible to minimize parasitic inductance. Pin 3 is not connected.
- **Unidirectional:** Data lines are connected to pin 1 and pin 2. Pin 3 is connected to ground. For best results, this pin should be connected directly to a ground plane on the board. The path length should be kept as short as possible to minimize parasitic inductance.

#### Circuit Board Layout Recommendations for Suppression of ESD.

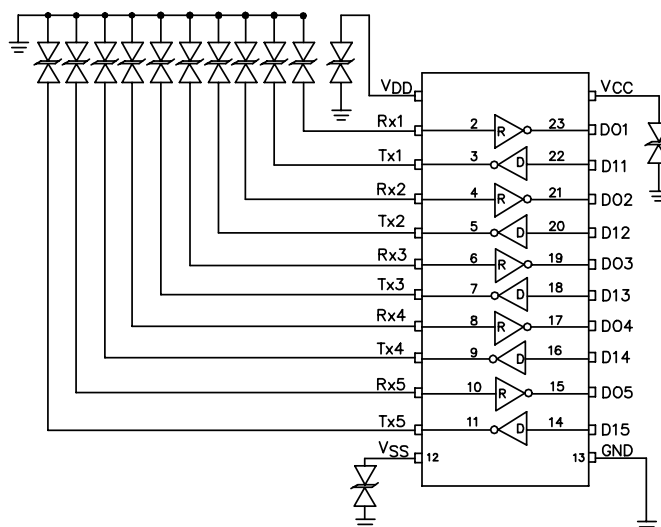
Good circuit board layout is critical for the suppression of fast rise-time transients such as ESD. The following guidelines are recommended (Refer to application note SI99-01 for more detailed information):

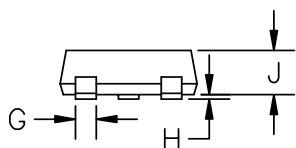
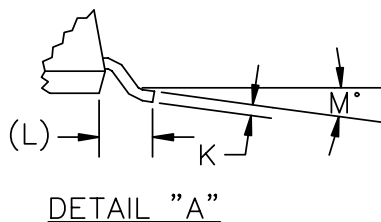
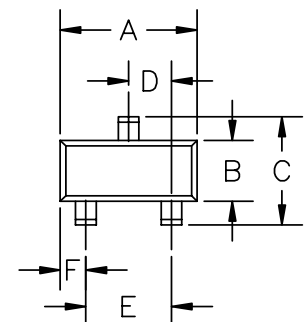
- Place the TVS near the input terminals or connectors to restrict transient coupling.
- Minimize the path length between the TVS and the protected line.
- Minimize all conductive loops including power and ground loops.
- The ESD transient return path to ground should be kept as short as possible.
- Never run critical signals near board edges.
- Use ground planes whenever possible.

#### Device Schematic & Pin Configuration

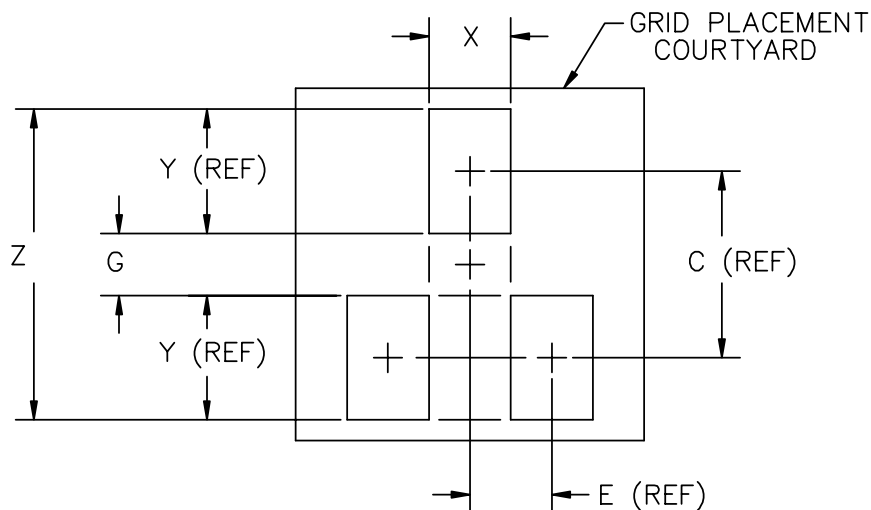


#### RS-232 Transceiver Protection Example



**PROTECTION PRODUCTS**
**Outline Drawing - SOT23**


| DIMENSIONS [1]   |        |      |      |      | NOTE |
|------------------|--------|------|------|------|------|
| DIM <sup>N</sup> | INCHES |      | MM   |      |      |
|                  | MIN    | MAX  | MIN  | MAX  |      |
| A                | .110   | .119 | 2.8  | 3.04 | —    |
| B                | .047   | .055 | 1.20 | 1.40 | —    |
| C                | .083   | .104 | 2.10 | 2.64 | —    |
| D                | .035   | .040 | 0.88 | 1.02 | —    |
| E                | .070   | .081 | 1.78 | 2.05 | —    |
| F                | .017   | .024 | .44  | .60  | —    |
| G                | .014   | .020 | .37  | .51  | —    |
| H                | .0005  | .004 | .013 | 0.10 | —    |
| J                | .034   | .040 | .87  | 1.02 | —    |
| K                | .003   | .007 | .085 | .180 | —    |
| L                | —      | .022 | —    | 0.55 | REF  |
| M                | 0      | 8°   | 0    | 8°   | —    |

**Land Pattern - SOT23**


| DIMENSIONS       |        |     |      |      |      |
|------------------|--------|-----|------|------|------|
| DIM <sup>N</sup> | INCHES |     | MM   |      | NOTE |
|                  | MIN    | MAX | MIN  | MAX  |      |
| C                | —      | .09 | —    | 2.20 | —    |
| E                | —      | .04 | —    | .95  | —    |
| G                | .03    | .04 | .80  | 1.00 | —    |
| X                | .03    | .04 | .80  | 1.00 | —    |
| Y                | —      | .06 | —    | 1.40 | —    |
| Z                | .14    | .15 | 3.40 | 3.60 | —    |

Note 1 : Grid placement courtyard is 8 x 8 elements (4mm x 4mm) in accordance with the international grid detailed in IEC Publication 97.

**PROTECTION PRODUCTS****Marking Codes**

| <b>Part Number</b> | <b>Marking Code</b> |
|--------------------|---------------------|
| SM05               | M05                 |
| SM12               | M12                 |
| SM15               | M15                 |
| SM24               | M24                 |
| SM36               | M36                 |

**Ordering Information**

| <b>Part Number</b> | <b>Working Voltage</b> | <b>Qty per Reel</b> | <b>Reel Size</b> |
|--------------------|------------------------|---------------------|------------------|
| SM05.TC            | 5V                     | 3,000               | 7 Inch           |
| SM05.TG            | 5V                     | 10,000              | 13 Inch          |
| SM12.TC            | 12V                    | 3,000               | 7 Inch           |
| SM12.TG            | 12V                    | 10,000              | 13 Inch          |
| SM15.TC            | 15V                    | 3,000               | 7 Inch           |
| SM15.TG            | 15V                    | 10,000              | 13 Inch          |
| SM24.TC            | 24V                    | 3,000               | 7 Inch           |
| SM24.TG            | 24V                    | 10,000              | 13 Inch          |
| SM36.TC            | 36V                    | 3,000               | 7 Inch           |

**Contact Information**

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