

## SM Series 400W TVS Diode Array



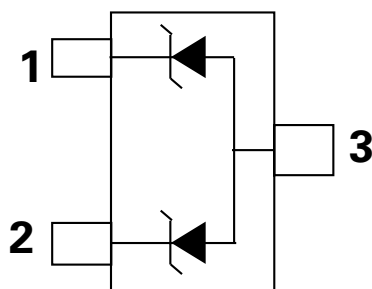
### Description

The SM series TVS Diode Array is designed to protect sensitive equipment from damage due to electrostatic discharge (ESD), electrical fast transients (EFT), and lightning induced surges.

The SM series can absorb repetitive ESD strikes above the maximum level specified in the IEC 61000-4-2 international standard without performance degradation and safely dissipate up to 24A of 8/20us induced surge current (IEC-61000-4-5, 2nd Edition) with very low clamping voltages.

### Pinout and Functional Block Diagram

(AEC-Q101 qualified)



Life Support Note:

#### Not Intended for Use in Life Support or Life Saving Applications

The products shown herein are not designed for use in life sustaining or life saving applications unless otherwise expressly indicated.

### Features

- RoHS compliant and lead-free ( $t_p=8/20\mu s$ , SM05)
- ESD, IEC 61000-4-2,  $\pm 30kV$  contact,  $\pm 30kV$  air
- EFT, IEC 61000-4-4, 50A (5/50ns)
- Lightning, IEC 61000-4-5, 2nd Edition, 24A
- Working voltages: 5V, 12V, 15V, 24V and 36V
- Low clamping voltage
- Low leakage current
- AEC-Q101 qualified (SOT23-3 package)

### Applications

- Industrial Equipment
- Test and Medical Equipment
- Point-of-Sale Terminals
- Motor Controls
- Legacy Ports (RS-232, RS-485)
- Security and Alarm System
- Automotive Electronics

### Additional Information



Datasheet

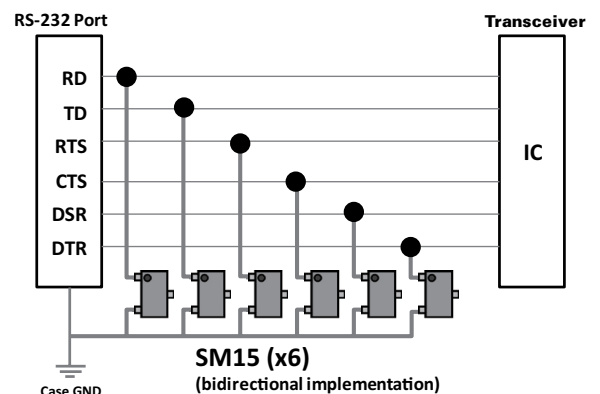


Resources



Samples

### RS-232 Application Example



### Absolute Maximum Ratings

| Symbol     | Parameter                            | Value      | Units |
|------------|--------------------------------------|------------|-------|
| $P_{PK}$   | Peak Pulse Power ( $t_p=8/20\mu s$ ) | 400        | W     |
| $T_{OP}$   | Operating Temperature                | -40 to 125 | °C    |
| $T_{STOR}$ | Storage Temperature                  | -55 to 150 | °C    |

Notes:

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### Thermal Information

| Parameter                                   | Rating     | Units |
|---------------------------------------------|------------|-------|
| Storage Temperature Range                   | -55 to 150 | °C    |
| Maximum Junction Temperature                | 150        | °C    |
| Maximum Lead Temperature (Soldering 20-40s) | 260        | °C    |

### SM05 Electrical Characteristics ( $T_{OP}=25^{\circ}C$ )

| Parameter                                       | Symbol        | Test Conditions                                          | Min      | Typ  | Max  | Units    |
|-------------------------------------------------|---------------|----------------------------------------------------------|----------|------|------|----------|
| Reverse Standoff Voltage                        | $V_{RWM}$     | $I_R \leq 1\mu A$                                        |          |      | 5.0  | V        |
| Reverse Voltage Drop                            | $V_R$         | $I_R = 1mA$                                              | 6.0      |      |      | V        |
| Leakage Current                                 | $I_{LEAK}$    | $V_R = 5V$                                               |          |      | 1.0  | $\mu A$  |
| Clamp Voltage <sup>1</sup>                      | $V_C$         | $I_{PP}=1A$ , $t_p=8/20\mu s$ , Pin 1 or Pin 2 to Pin 3  |          |      | 9.8  | V        |
|                                                 |               | $I_{PP}=10A$ , $t_p=8/20\mu s$ , Pin 1 or Pin 2 to Pin 3 |          |      | 13.0 | V        |
| Dynamic Resistance <sup>2</sup>                 | $R_{DYN}$     | TLP, $t_p=100ns$ , I/O to GND                            |          | 0.19 |      | $\Omega$ |
| Peak Pulse Current (8/20 $\mu s$ ) <sup>1</sup> | $I_{PP}$      | $t_p=8/20\mu s$                                          |          |      | 24.0 | A        |
| ESD Withstand Voltage <sup>1</sup>              | $V_{ESD}$     | IEC 61000-4-2 (Contact Discharge)                        | $\pm 30$ |      |      | kV       |
|                                                 |               | IEC 61000-4-2 (Air Discharge)                            | $\pm 30$ |      |      | kV       |
| Diode Capacitance <sup>1</sup>                  | $C_{I/O-GND}$ | Reverse Bias=0V, f=1MHz                                  |          |      | 400  | pF       |
|                                                 | $C_{I/O-I/O}$ | Reverse Bias=0V, f=1MHz                                  |          |      | 350  | pF       |

### SM12 Electrical Characteristics ( $T_{OP}=25^{\circ}C$ )

| Parameter                                       | Symbol        | Test Conditions                                          | Min      | Typ  | Max  | Units    |
|-------------------------------------------------|---------------|----------------------------------------------------------|----------|------|------|----------|
| Reverse Standoff Voltage                        | $V_{RWM}$     | $I_R \leq 1\mu A$                                        |          |      | 12.0 | V        |
| Reverse Voltage Drop                            | $V_R$         | $I_R = 1mA$                                              | 13.3     |      |      | V        |
| Leakage Current                                 | $I_{LEAK}$    | $V_R = 12V$                                              |          |      | 1.0  | $\mu A$  |
| Clamp Voltage <sup>1</sup>                      | $V_C$         | $I_{PP}=1A$ , $t_p=8/20\mu s$ , Pin 1 or Pin 2 to Pin 3  |          |      | 18.5 | V        |
|                                                 |               | $I_{PP}=10A$ , $t_p=8/20\mu s$ , Pin 1 or Pin 2 to Pin 3 |          |      | 22.5 | V        |
| Dynamic Resistance <sup>2</sup>                 | $R_{DYN}$     | TLP, $t_p=100ns$ , I/O to GND                            |          | 0.25 |      | $\Omega$ |
| Peak Pulse Current (8/20 $\mu s$ ) <sup>1</sup> | $I_{PP}$      | $t_p=8/20\mu s$                                          |          |      | 17.0 | A        |
| ESD Withstand Voltage <sup>1</sup>              | $V_{ESD}$     | IEC 61000-4-2 (Contact Discharge)                        | $\pm 30$ |      |      | kV       |
|                                                 |               | IEC 61000-4-2 (Air Discharge)                            | $\pm 30$ |      |      | kV       |
| Diode Capacitance <sup>1</sup>                  | $C_{I/O-GND}$ | Reverse Bias=0V, f=1MHz                                  |          |      | 150  | pF       |
|                                                 | $C_{I/O-I/O}$ | Reverse Bias=0V, f=1MHz                                  |          |      | 120  | pF       |

**SM15 Electrical Characteristics (T<sub>OP</sub>=25°C)**

| Parameter                                | Symbol               | Test Conditions                                                         | Min  | Typ  | Max  | Units |
|------------------------------------------|----------------------|-------------------------------------------------------------------------|------|------|------|-------|
| Reverse Standoff Voltage                 | V <sub>RWM</sub>     | I <sub>R</sub> ≤ 1 μA                                                   |      |      | 15.0 | V     |
| Reverse Voltage Drop                     | V <sub>R</sub>       | I <sub>R</sub> = 1 mA                                                   | 16.7 |      |      | V     |
| Leakage Current                          | I <sub>LEAK</sub>    | V <sub>R</sub> = 15V                                                    |      |      | 1.0  | μA    |
| Clamp Voltage <sup>1</sup>               | V <sub>C</sub>       | I <sub>PP</sub> = 1A, t <sub>p</sub> = 8/20μs, Pin 1 or Pin 2 to Pin 3  |      |      | 24.0 | V     |
|                                          |                      | I <sub>PP</sub> = 10A, t <sub>p</sub> = 8/20μs, Pin 1 or Pin 2 to Pin 3 |      |      | 30.0 | V     |
| Dynamic Resistance <sup>2</sup>          | R <sub>DYN</sub>     | TLP, t <sub>p</sub> = 100ns, I/O to GND                                 |      | 0.30 |      | Ω     |
| Peak Pulse Current (8/20μs) <sup>1</sup> | I <sub>PP</sub>      | t <sub>p</sub> = 8/20μs                                                 |      |      | 12.0 | A     |
| ESD Withstand Voltage <sup>1</sup>       | V <sub>ESD</sub>     | IEC 61000-4-2 (Contact Discharge)                                       | ±30  |      |      | kV    |
|                                          |                      | IEC 61000-4-2 (Air Discharge)                                           | ±30  |      |      | kV    |
| Diode Capacitance <sup>1</sup>           | C <sub>I/O-GND</sub> | Reverse Bias=0V, f=1MHz                                                 |      |      | 100  | pF    |
|                                          | C <sub>I/O-I/O</sub> | Reverse Bias=0V, f=1MHz                                                 |      |      | 75   | pF    |

**SM24 Electrical Characteristics (T<sub>OP</sub>=25°C)**

| Parameter                                | Symbol               | Test Conditions                                                        | Min  | Typ  | Max  | Units |
|------------------------------------------|----------------------|------------------------------------------------------------------------|------|------|------|-------|
| Reverse Standoff Voltage                 | V <sub>RWM</sub>     | I <sub>R</sub> ≤ 1 μA                                                  |      |      | 24.0 | V     |
| Reverse Voltage Drop                     | V <sub>R</sub>       | I <sub>R</sub> = 1 mA                                                  | 26.7 |      |      | V     |
| Leakage Current                          | I <sub>LEAK</sub>    | V <sub>R</sub> = 24V                                                   |      |      | 1.0  | μA    |
| Clamp Voltage <sup>1</sup>               | V <sub>C</sub>       | I <sub>PP</sub> = 1A, t <sub>p</sub> = 8/20μs, Pin 1 or Pin 2 to Pin 3 |      |      | 36.0 | V     |
|                                          |                      | I <sub>PP</sub> = 5A, t <sub>p</sub> = 8/20μs, Pin 1 or Pin 2 to Pin 3 |      |      | 42.0 | V     |
| Dynamic Resistance <sup>2</sup>          | R <sub>DYN</sub>     | TLP, t <sub>p</sub> = 100ns, I/O to GND                                |      | 0.50 |      | Ω     |
| Peak Pulse Current (8/20μs) <sup>1</sup> | I <sub>PP</sub>      | t <sub>p</sub> = 8/20μs                                                |      |      | 7.0  | A     |
| ESD Withstand Voltage <sup>1</sup>       | V <sub>ESD</sub>     | IEC 61000-4-2 (Contact Discharge)                                      | ±30  |      |      | kV    |
|                                          |                      | IEC 61000-4-2 (Air Discharge)                                          | ±30  |      |      | kV    |
| Diode Capacitance <sup>1</sup>           | C <sub>I/O-GND</sub> | Reverse Bias=0V, f=1MHz                                                |      |      | 65   | pF    |
|                                          | C <sub>I/O-I/O</sub> | Reverse Bias=0V, f=1MHz                                                |      |      | 50   | pF    |

**SM36 Electrical Characteristics (T<sub>OP</sub>=25°C)**

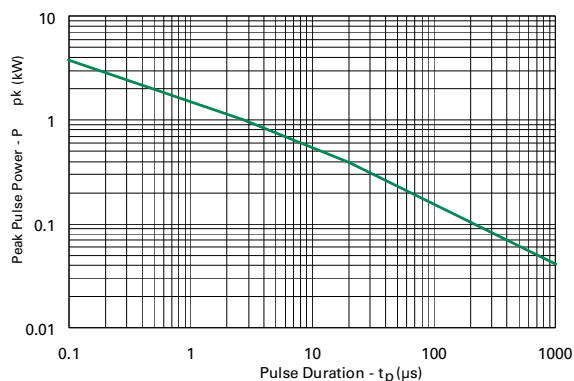
| Parameter                                | Symbol               | Test Conditions                                                        | Min  | Typ  | Max  | Units |
|------------------------------------------|----------------------|------------------------------------------------------------------------|------|------|------|-------|
| Reverse Standoff Voltage                 | V <sub>RWM</sub>     | I <sub>R</sub> ≤ 1 μA                                                  |      |      | 36.0 | V     |
| Reverse Voltage Drop                     | V <sub>R</sub>       | I <sub>R</sub> = 1 mA                                                  | 40.0 |      |      | V     |
| Leakage Current                          | I <sub>LEAK</sub>    | V <sub>R</sub> = 36V                                                   |      |      | 1.0  | μA    |
| Clamp Voltage <sup>1</sup>               | V <sub>C</sub>       | I <sub>PP</sub> = 1A, t <sub>p</sub> = 8/20μs, Pin 1 or Pin 2 to Pin 3 |      |      | 52.0 | V     |
|                                          |                      | I <sub>PP</sub> = 4A, t <sub>p</sub> = 8/20μs, Pin 1 or Pin 2 to Pin 3 |      |      | 62.0 | V     |
| Dynamic Resistance <sup>2</sup>          | R <sub>DYN</sub>     | TLP, t <sub>p</sub> = 100ns, I/O to GND                                |      | 0.65 |      | Ω     |
| Peak Pulse Current (8/20μs) <sup>1</sup> | I <sub>PP</sub>      | t <sub>p</sub> = 8/20μs                                                |      |      | 5.0  | A     |
| ESD Withstand Voltage <sup>1</sup>       | V <sub>ESD</sub>     | IEC 61000-4-2 (Contact Discharge)                                      | ±30  |      |      | kV    |
|                                          |                      | IEC 61000-4-2 (Air Discharge)                                          | ±30  |      |      | kV    |
| Diode Capacitance <sup>1</sup>           | C <sub>I/O-GND</sub> | Reverse Bias=0V, f=1MHz                                                |      |      | 50   | pF    |
|                                          | C <sub>I/O-I/O</sub> | Reverse Bias=0V, f=1MHz                                                |      |      | 40   | pF    |

**Note:**

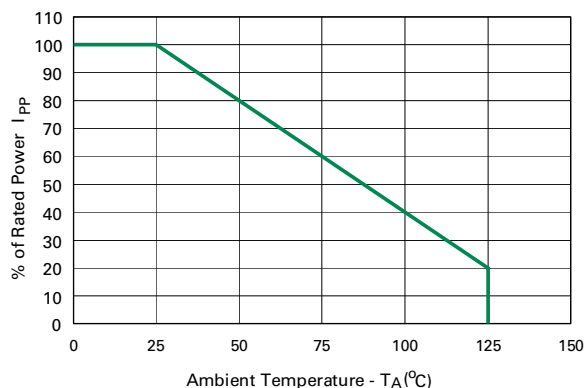
<sup>1</sup> Parameter is guaranteed by design and/or device characterization.

<sup>2</sup> Transmission Line Pulse (TLP) with 100ns width and 200ps rise time.

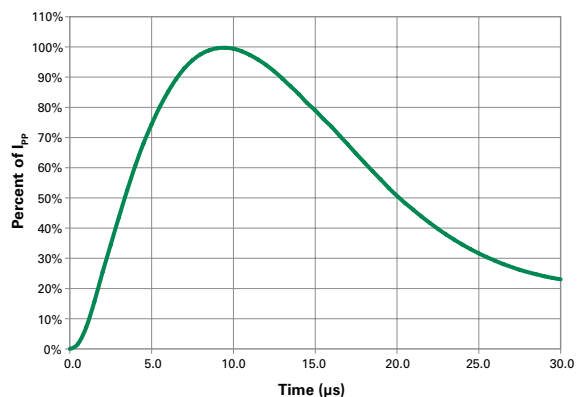
### Non-Repetitive Peak Pulse Power vs. Pulse Time



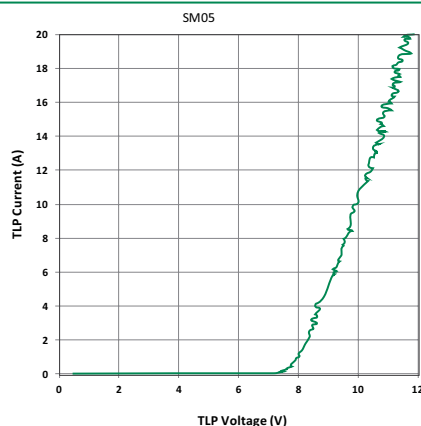
### Power Derating Curve



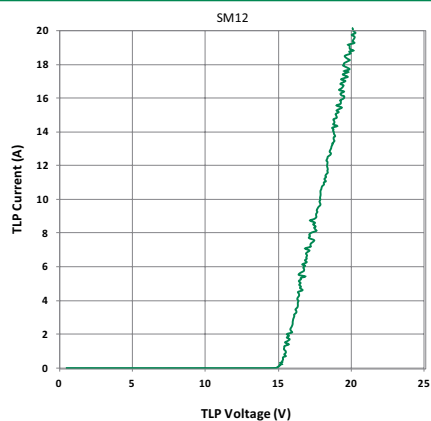
### Pulse Waveform



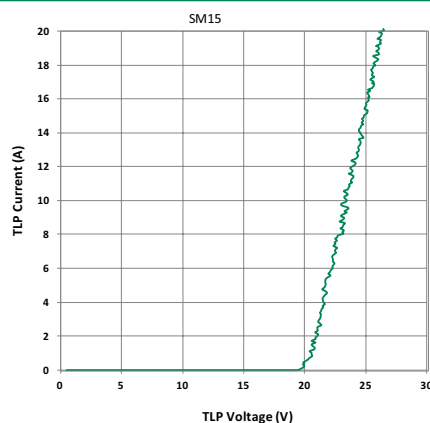
### SM05 Transmission Line Pulsing(TLP) Plot



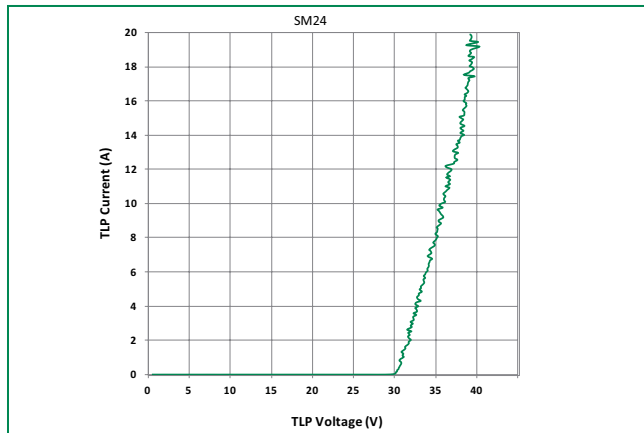
### SM12 Transmission Line Pulsing(TLP) Plot



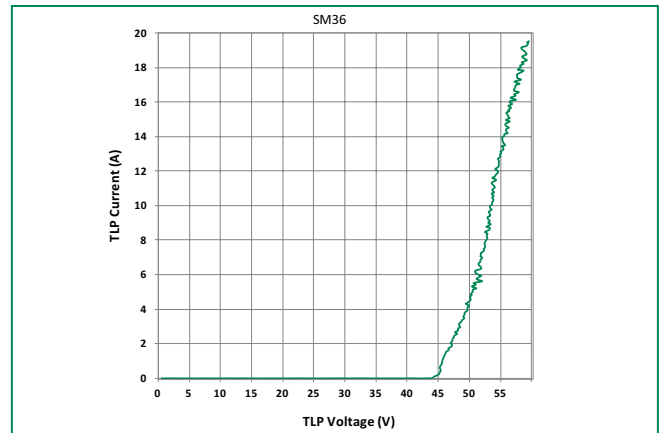
### SM15 Transmission Line Pulsing(TLP) Plot



### SM24 Transmission Line Pulsing (TLP) Plot

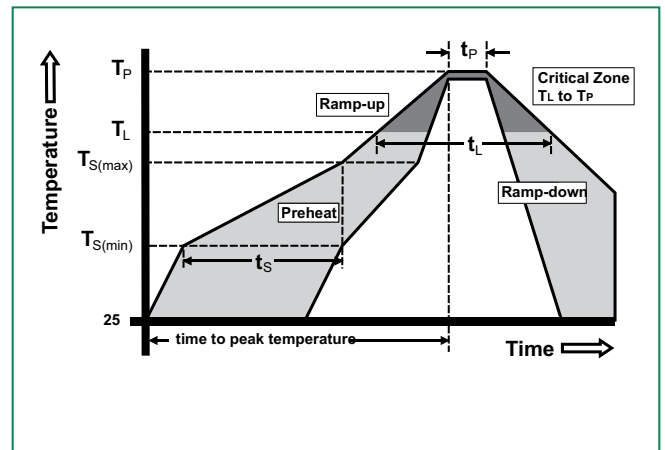


### SM36 Transmission Line Pulsing (TLP) Plot



### Soldering Parameters

|                                                        |                                    |                         |
|--------------------------------------------------------|------------------------------------|-------------------------|
| Reflow Condition                                       |                                    | Pb – 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                   |
|                                                        | - Temperature ( $t_L$ )            | 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                                          |                                    | 260°C                   |



### Ordering Information

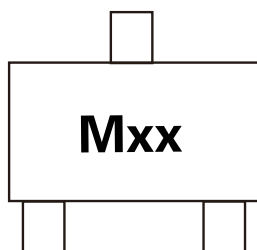
| Part Number | Package | Marking | Min. Order Qty. |
|-------------|---------|---------|-----------------|
| SM05-02HTG  | SOT23-3 | M05     | 3000            |
| SM12-02HTG  | SOT23-3 | M12     | 3000            |
| SM15-02HTG  | SOT23-3 | M15     | 3000            |
| SM24-02HTG  | SOT23-3 | M24     | 3000            |
| SM36-02HTG  | SOT23-3 | M36     | 3000            |

### Product Characteristics

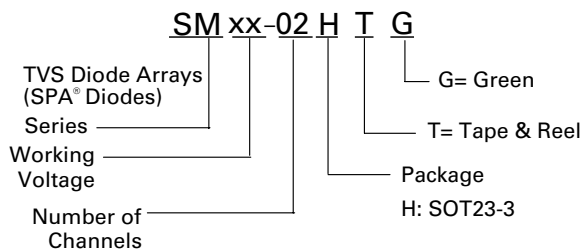
|                            |                         |
|----------------------------|-------------------------|
| <b>Lead Plating</b>        | Matte Tin               |
| <b>Lead Material</b>       | Copper Alloy            |
| <b>Lead Coplanarity</b>    | 0.0004 inches (0.102mm) |
| <b>Substitute Material</b> | Silicon                 |
| <b>Body Material</b>       | Molded Epoxy            |
| <b>Flammability</b>        | UL 94 V-0               |

- Notes :
1. All dimensions are in millimeters.
  2. Dimensions include solder plating.
  3. Dimensions are exclusive of mold flash & metal burr.
  4. Bld is facing up for mold and facing down for trim/form, i.e. reverse trim/form.
  5. Package surface matte finish VDI 11-13.

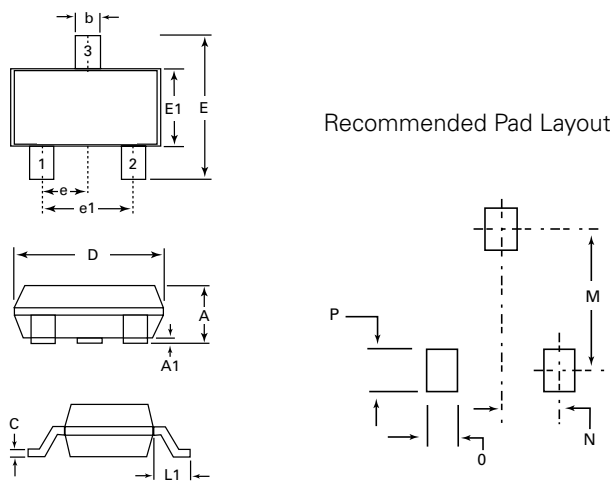
## Part Marking System



## Part Numbering System

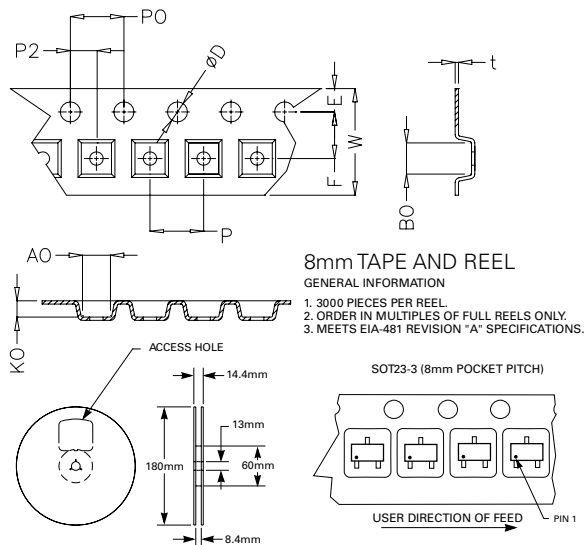


## Package Dimensions — SOT23-3



| Package   | SOT23-3     |      |           |         |
|-----------|-------------|------|-----------|---------|
| Pins      | 3           |      |           |         |
| JEDEC     | TO-236      |      |           |         |
|           | Millimeters |      | Inches    |         |
|           | Min         | Max  | Min       | Max     |
| <b>A</b>  | 0.89        | 1.12 | 0.035     | 0.044   |
| <b>A1</b> | 0.01        | 0.1  | 0.0004    | 0.004   |
| <b>b</b>  | 0.3         | 0.5  | 0.012     | 0.020   |
| <b>c</b>  | 0.08        | 0.2  | 0.003     | 0.008   |
| <b>D</b>  | 2.8         | 3.04 | 0.110     | 0.120   |
| <b>E</b>  | 2.1         | 2.64 | 0.083     | 0.104   |
| <b>E1</b> | 1.2         | 1.4  | 0.047     | 0.055   |
| <b>e</b>  | 0.95 BSC    |      | 0.038 BSC |         |
| <b>e1</b> | 1.90 BSC    |      | 0.075 BSC |         |
| <b>L1</b> | 0.54 REF    |      | 0.021 REF |         |
| <b>M</b>  |             | 2.29 |           | .090    |
| <b>N</b>  |             | 0.95 |           | 0.038   |
| <b>O</b>  |             | 0.78 |           | .030TYP |
| <b>P</b>  |             | 0.78 |           | .030TYP |

## Embossed Carrier Tape & Reel Specification — SOT23-3



| Symbol    | Millimetres |      | Inches |       |
|-----------|-------------|------|--------|-------|
|           | Min         | Max  | Min    | Max   |
| <b>E</b>  | 1.65        | 1.85 | 0.065  | 0.073 |
| <b>F</b>  | 3.40        | 3.60 | 0.134  | 0.142 |
| <b>P2</b> | 1.90        | 2.10 | 0.075  | 0.083 |
| <b>D</b>  | 1.40        | 1.60 | 0.055  | 0.063 |
| <b>P0</b> | 3.90        | 4.10 | 0.154  | 0.161 |
| <b>W</b>  | 7.70        | 8.30 | 0.303  | 0.327 |
| <b>P</b>  | 3.90        | 4.10 | 0.154  | 0.161 |
| <b>A0</b> | 3.05        | 3.25 | 0.120  | 0.128 |
| <b>B0</b> | 2.67        | 2.87 | 0.105  | 0.113 |
| <b>K0</b> | 1.12        | 1.32 | 0.044  | 0.052 |
| <b>t</b>  | 0.22        | 0.24 | 0.009  | 0.009 |

# Mouser Electronics

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