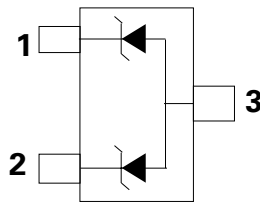


SM Series

General Purpose ESD Protection



Pinout and Functional Block Diagram



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 IEC 61000-4-2 international standard without performance degradation and safely dissipate up to 24A of 8/20 μ s induced surge current (IEC-61000-4-5) with very low clamping voltages.

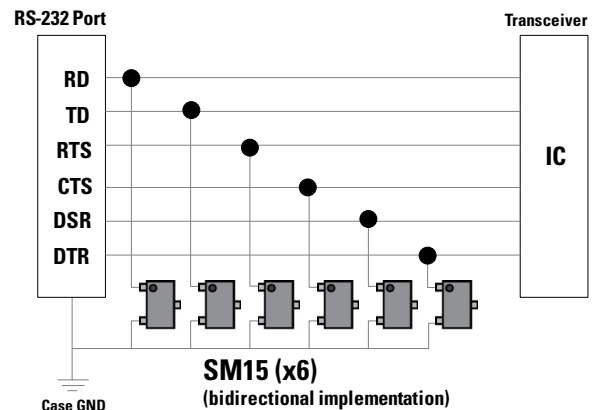
Features & Benefits

- 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 (tP=8/20 μ s, SM05)
- Halogen free, lead free and RoHS compliant
- Working voltages: 5V, 12V, 15V, 24V and 36V
- Low clamping voltage
- Low leakage current
- AEC-Q101 qualified
- Moisture Sensitivity Level(MSL -1)

Applications

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

RS-232 Application Example



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.

SM Series

General Purpose ESD Protection

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 150 | °C |
| T_{STOR} | Storage Temperature | -55 to 150 | °C |

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

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 | μA |
| Clamp Voltage ¹ | 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 ² | R_{DYN} | TLP, $t_p = 100ns$, I/O to GND | | 0.19 | | Ω |
| Peak Pulse Current (8/20 μs) ¹ | I_{PP} | $t_p = 8/20\mu s$ | | | 24.0 | A |
| ESD Withstand Voltage ¹ | V_{ESD} | IEC 61000-4-2 (Contact Discharge) | ± 30 | | | kV |
| | | IEC 61000-4-2 (Air Discharge) | ± 30 | | | kV |
| Diode Capacitance ¹ | $C_{I/O-GND}$ | 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 | μA |
| Clamp Voltage ¹ | 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 ² | R_{DYN} | TLP, $t_p = 100ns$, I/O to GND | | 0.25 | | Ω |
| Peak Pulse Current (8/20 μs) ¹ | I_{PP} | $t_p = 8/20\mu s$ | | | 17.0 | A |
| ESD Withstand Voltage ¹ | V_{ESD} | IEC 61000-4-2 (Contact Discharge) | ± 30 | | | kV |
| | | IEC 61000-4-2 (Air Discharge) | ± 30 | | | kV |
| Diode Capacitance ¹ | $C_{I/O-GND}$ | Reverse Bias=0V, f=1MHz | | | 150 | pF |
| | $C_{I/O-I/O}$ | Reverse Bias=0V, f=1MHz | | | 120 | pF |

SM Series

General Purpose ESD Protection

SM15 Electrical Characteristics ($T_{OP}=25^{\circ}C$)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|---|---------------|---|----------|------|------|----------|
| Reverse Standoff Voltage | V_{RWM} | $I_R \leq 1\mu A$ | | | 15.0 | V |
| Reverse Voltage Drop | V_R | $I_R = 1mA$ | 16.7 | | | V |
| Leakage Current | I_{LEAK} | $V_R = 15V$ | | | 1.0 | μA |
| Clamp Voltage ¹ | V_C | $I_{PP} = 1A, t_p = 8/20\mu s$, Pin 1 or Pin 2 to Pin 3 | | | 24.0 | V |
| | | $I_{PP} = 10A, t_p = 8/20\mu s$, Pin 1 or Pin 2 to Pin 3 | | | 30.0 | V |
| Dynamic Resistance ² | R_{DYN} | TLP, $t_p = 100ns$, I/O to GND | | 0.30 | | Ω |
| Peak Pulse Current (8/20 μs) ¹ | I_{pp} | $t_p = 8/20\mu s$ | | | 12.0 | A |
| ESD Withstand Voltage ¹ | V_{ESD} | IEC 61000-4-2 (Contact Discharge) | ± 30 | | | kV |
| | | IEC 61000-4-2 (Air Discharge) | ± 30 | | | kV |
| Diode Capacitance ¹ | $C_{I/O-GND}$ | Reverse Bias=0V, f=1MHz | | | 100 | pF |
| | $C_{I/O-I/O}$ | Reverse Bias=0V, f=1MHz | | | 75 | pF |

SM24 Electrical Characteristics ($T_{OP}=25^{\circ}C$)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|---|---------------|--|----------|------|------|----------|
| Reverse Standoff Voltage | V_{RWM} | $I_R \leq 1\mu A$ | | | 24.0 | V |
| Reverse Voltage Drop | V_R | $I_R = 1mA$ | 26.7 | | | V |
| Leakage Current | I_{LEAK} | $V_R = 24V$ | | | 1.0 | μA |
| Clamp Voltage ¹ | V_C | $I_{PP} = 1A, t_p = 8/20\mu s$, Pin 1 or Pin 2 to Pin 3 | | | 36.0 | V |
| | | $I_{PP} = 5A, t_p = 8/20\mu s$, Pin 1 or Pin 2 to Pin 3 | | | 42.0 | V |
| Dynamic Resistance ² | R_{DYN} | TLP, $t_p = 100ns$, I/O to GND | | 0.50 | | Ω |
| Peak Pulse Current (8/20 μs) ¹ | I_{pp} | $t_p = 8/20\mu s$ | | | 7.0 | A |
| ESD Withstand Voltage ¹ | V_{ESD} | IEC 61000-4-2 (Contact Discharge) | ± 30 | | | kV |
| | | IEC 61000-4-2 (Air Discharge) | ± 30 | | | kV |
| Diode Capacitance ¹ | $C_{I/O-GND}$ | Reverse Bias=0V, f=1MHz | | | 65 | pF |
| | $C_{I/O-I/O}$ | Reverse Bias=0V, f=1MHz | | | 50 | pF |

SM36 Electrical Characteristics ($T_{OP}=25^{\circ}C$)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|---|---------------|--|----------|------|------|----------|
| Reverse Standoff Voltage | V_{RWM} | $I_R \leq 1\mu A$ | | | 36.0 | V |
| Reverse Voltage Drop | V_R | $I_R = 1mA$ | 40.0 | | | V |
| Leakage Current | I_{LEAK} | $V_R = 36V$ | | | 1.0 | μA |
| Clamp Voltage ¹ | V_C | $I_{PP} = 1A, t_p = 8/20\mu s$, Pin 1 or Pin 2 to Pin 3 | | | 52.0 | V |
| | | $I_{PP} = 4A, t_p = 8/20\mu s$, Pin 1 or Pin 2 to Pin 3 | | | 62.0 | V |
| Dynamic Resistance ² | R_{DYN} | TLP, $t_p = 100ns$, I/O to GND | | 0.65 | | Ω |
| Peak Pulse Current (8/20 μs) ¹ | I_{pp} | $t_p = 8/20\mu s$ | | | 5.0 | A |
| ESD Withstand Voltage ¹ | V_{ESD} | IEC 61000-4-2 (Contact Discharge) | ± 30 | | | kV |
| | | IEC 61000-4-2 (Air Discharge) | ± 30 | | | kV |
| Diode Capacitance ¹ | $C_{I/O-GND}$ | Reverse Bias=0V, f=1MHz | | | 50 | pF |
| | $C_{I/O-I/O}$ | Reverse Bias=0V, f=1MHz | | | 40 | pF |

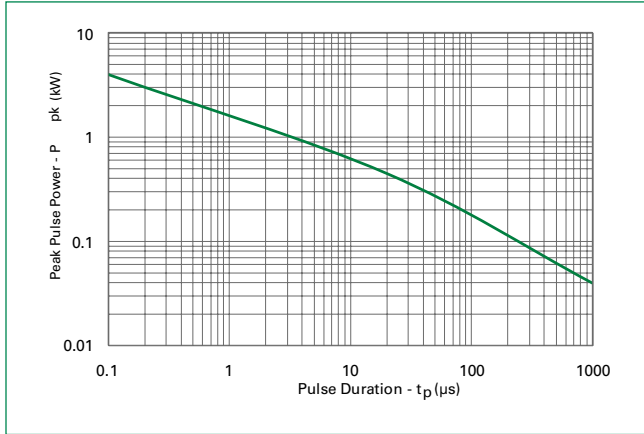
Note:
¹ Parameter is guaranteed by design and/or component characterization.

² Transmission Line Pulse (TLP) with 100ns width, 2ns rise time, and average window $t_1=70ns$ to $t_2=90ns$

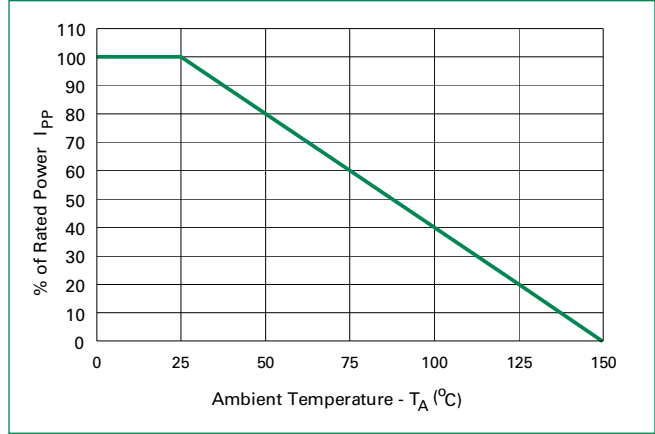
SM Series

General Purpose ESD Protection

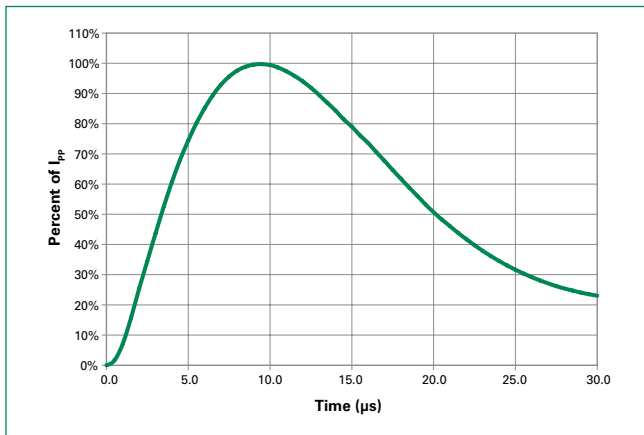
Non-Repetitive Peak Pulse Power vs. Pulse Time



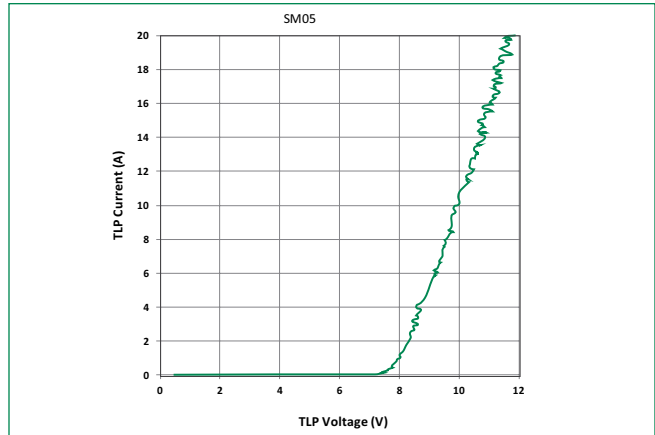
Power Derating Curve



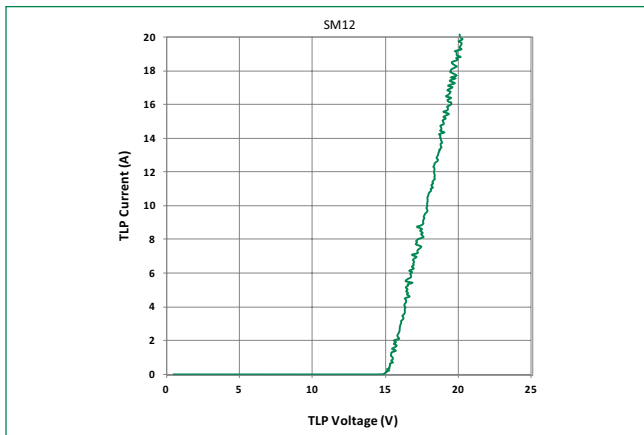
8/20μs Pulse Waveform



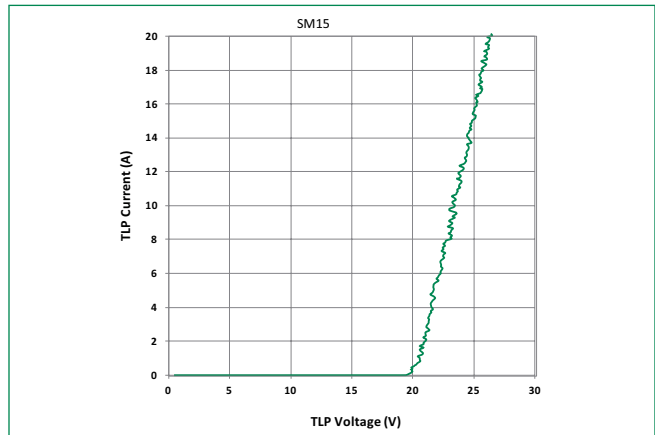
SM05 Transmission Line Pulsing (TLP) Plot



SM12 Transmission Line Pulsing (TLP) Plot



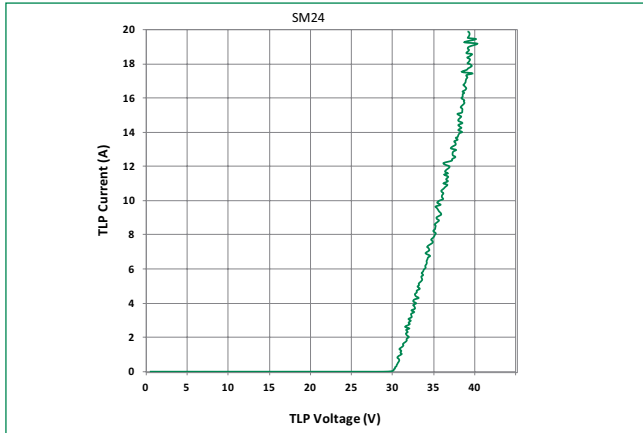
SM15 Transmission Line Pulsing (TLP) Plot



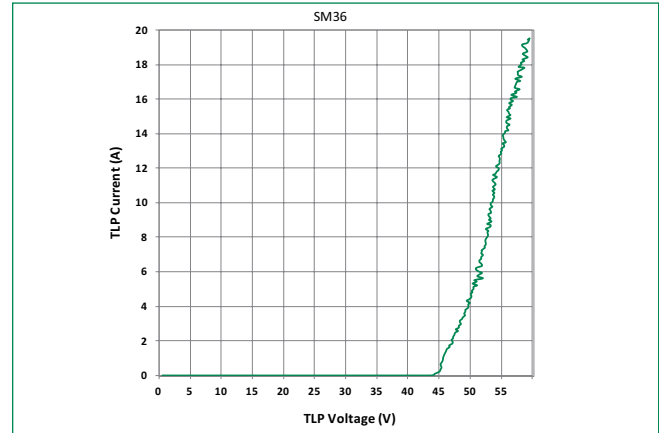
SM Series

General Purpose ESD Protection

SM24 Transmission Line Pulsing(TLP) Plot

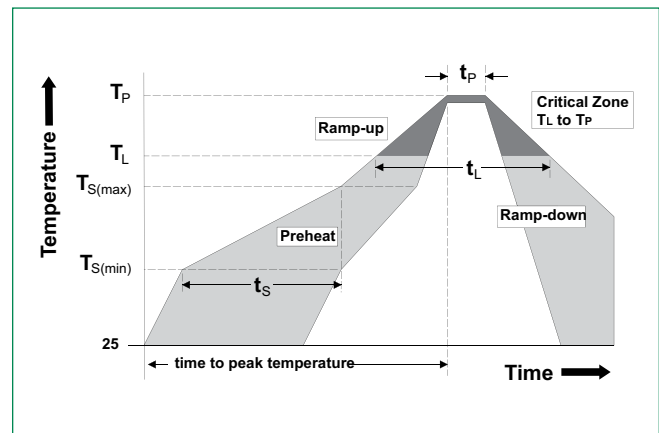


SM36 Transmission Line Pulsing(TLP) Plot



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_p) | 60 – 120 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 ^{+0/-5} °C |
| Time within 5°C of actual peak Temperature (t_p) | | 30 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

| | |
|---------------------------|--|
| Lead Plating | Matte Tin |
| Lead Material | Copper Alloy |
| Lead Coplanarity | 0.004 inches(0.102mm) |
| Substrate material | Silicon |
| Body Material | Molded Compound |
| Flammability | UL Recognized compound meeting flammability rating V-0 |

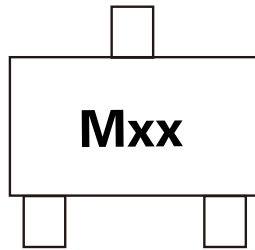
Notes :

- All dimensions are in millimeters
- Dimensions include solder plating.
- Dimensions are exclusive of mold flash & metal burr.

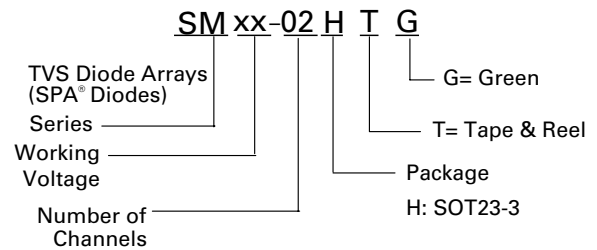
SM Series

General Purpose ESD Protection

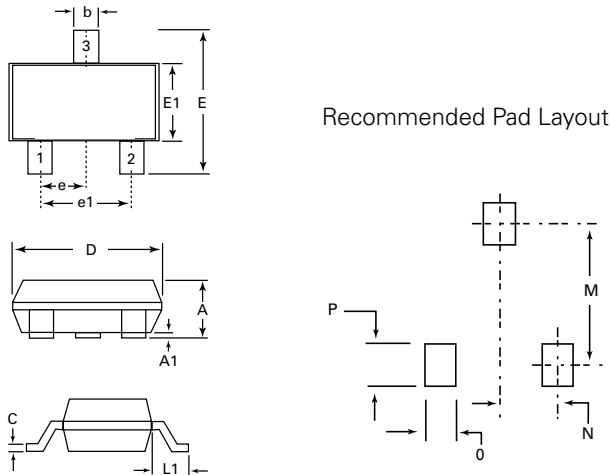
Part Marking System



Part Numbering System

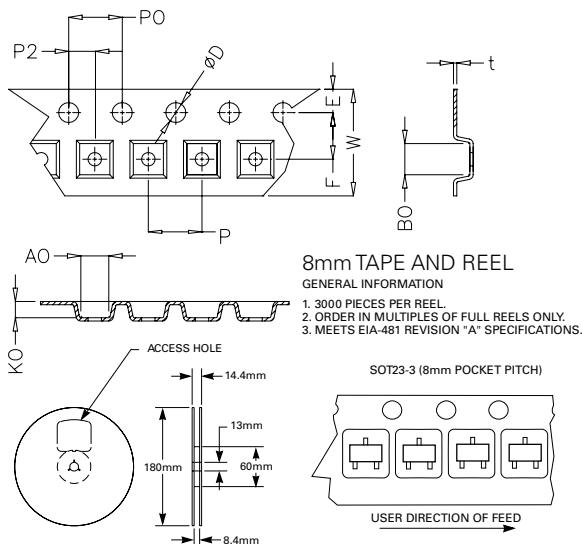


Package Dimensions – SOT23-3



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

Embossed Carrier Tape & Reel Specification – SOT23-3



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

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