# HSMP-386x
Surface Mount PIN Diodes

## Data Sheet

Lead (Pb) Free
RoHS 6 fully compliant

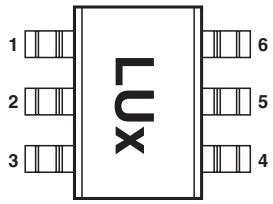
### Description/Applications

The HSMP-386x series of general purpose PIN diodes are designed for two classes of applications. The first is attenuators where current consumption is the most important design consideration. The second application for this series of diodes is in switches where low capacitance is the driving issue for the designer.

The HSMP-386x series Total Capacitance ($C_T$) and Total Resistance ($R_T$) are typical specifications. For applications that require guaranteed performance, the general purpose HSMP-383x series is recommended.

A SPICE model is not available for PIN diodes as SPICE does not provide for a key PIN diode characteristic, carrier lifetime.

### Pin Connections and Package Marking, SOT-363




**Notes:**

1. Package marking provides orientation, identification, and date code.
2. See "Electrical Specifications" for appropriate package marking.

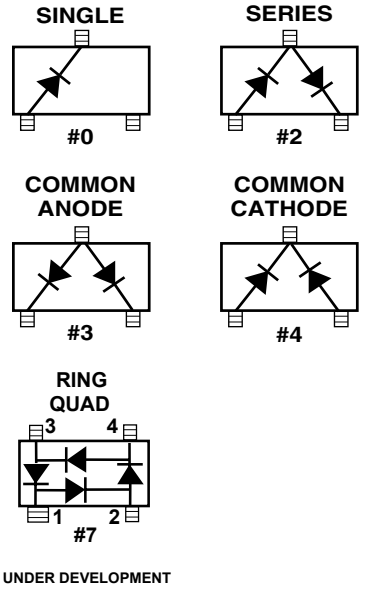
### Features

- Unique Configurations in Surface Mount Packages
  - Add Flexibility
  - Save Board Space
  - Reduce Cost
- Switching
  - Low Distortion Switching
  - Low Capacitance
- Attenuating
  - Low Current Attenuating for Less Power Consumption
- Matched Diodes for Consistent Performance
- Better Thermal Conductivity for Higher Power Dissipation
- Low Failure in Time (FIT) Rate[1]
- Lead-free

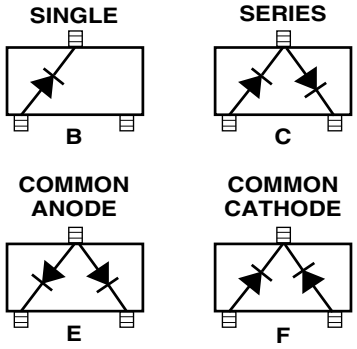
**Note:**

1. For more information see the Surface Mount PIN Reliability Data Sheet.

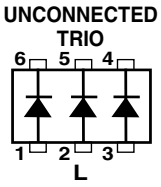
### Package Lead Code Identification, SOT-23, SOT-143 (Top View)




### Package Lead Code Identification, SOT-323 (Top View)




### Package Lead Code Identification, SOT-363 (Top View)




## Absolute Maximum Ratings[1] $T_C$ = +25°C

| Symbol | Parameter | Unit | SOT-23 | SOT-323 |
|---|---|---|---|---|
| $I_f$ | Forward Current (1 µs Pulse) | Amp | 1 | 1 |
| $P_{IV}$ | Peak Inverse Voltage | V | 50 | 50 |
| $T_j$ | Junction Temperature | °C | 150 | 150 |
| $T_{stg}$ | Storage Temperature | °C | -65 to 150 | -65 to 150 |
| $\theta_{jc}$ | Thermal Resistance[2] | °C/W | 500 | 150 |

*ESD WARNING:*
**Handling Precautions Should Be Taken To Avoid Static Discharge.**

Notes:
1. Operation in excess of any one of these conditions may result in permanent damage to the device.
2. $T_C$ = +25°C, where $T_C$ is defined to be the temperature at the package pins where contact is made to the circuit board.

## Electrical Specifications $T_C$ = 25°C, each diode

### PIN General Purpose Diodes, Typical Specifications $T_A$ = 25°C

| Part Number HSMP- | Package Marking Code | Lead Code | Configuration | Minimum Breakdown Voltage $V_{BR}$ (V) | Typical Series Resistance $R_S$ (Ω) | Typical Total Capacitance $C_T$ (pF) |
|---|---|---|---|---|---|---|
| 3860 | L0 | 0 | Single | 50 | 3.0/1.5* | 0.20 |
| 3862 | L2 | 2 | Series | | | |
| 3863 | L3 | 3 | Common Anode | | | |
| 3864 | L4 | 4 | Common Cathode | | | |
| 386B | L0 | B | Single | | | |
| 386C | L2 | C | Series | | | |
| 386E | L3 | E | Common Anode | | | |
| 386F | L4 | F | Common Cathode | | | |
| 386L | LL | L | Unconnected Trio | | | |
| Test Conditions | | | | $V_R = V_{BR}$ Measure $I_R \leq 10$ µA | $I_F$ = 10 mA f = 100 MHz $I_F$ = 100 mA* | $V_R$ = 50 V f = 1 MHz |

## HSMP-386x Typical Parameters at $T_C = 25°C$

| Part Number HSMP- | Total Resistance $R_T$ (Ω) | Carrier Lifetime t (ns) | Reverse Recovery Time $T_{rr}$ (ns) | Total Capacitance $C_T$ (pF) |
|---|---|---|---|---|
| 386x | 22 | 500 | 80 | 0.20 |
| Test Conditions | $I_F$ = 1 mA<br>f = 100 MHz | $I_F$ = 50 mA<br>$T_R$ = 250 mA | $V_R$ = 10 V<br>$I_F$ = 20 mA<br>90% Recovery | $V_R$ = 50 V<br>f = 1 MHz |

## Typical Performance, $T_C = 25°C$, each diode

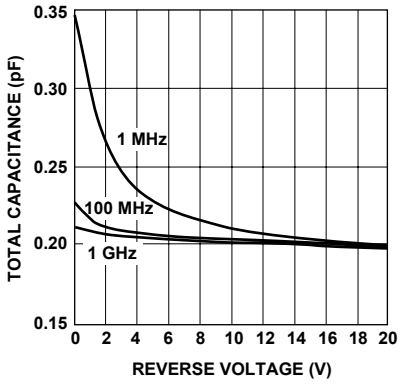



Figure 1. RF Capacitance vs. Reverse Bias.

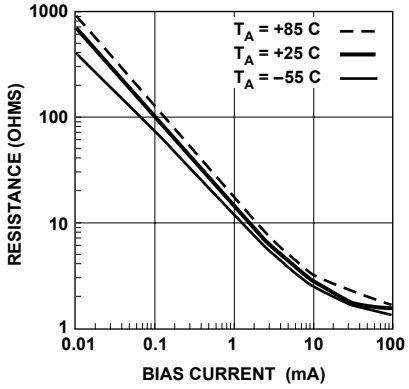



Figure 2. Typical RF Resistance vs. Forward Bias Current.

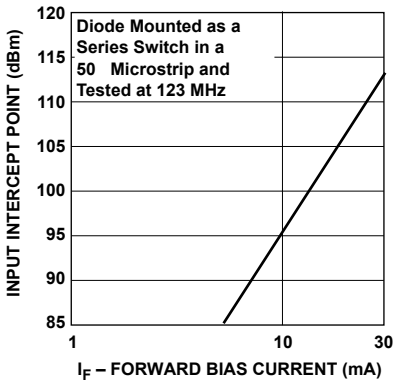



Figure 3. 2nd Harmonic Input Intercept Point vs. Forward Bias Current for Switch Diodes.

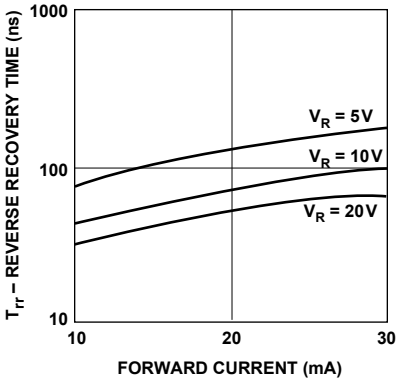



Figure 4. Reverse Recovery Time vs. Forward Current for Various Reverse Voltages.

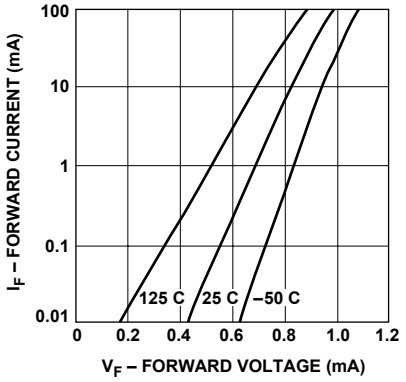
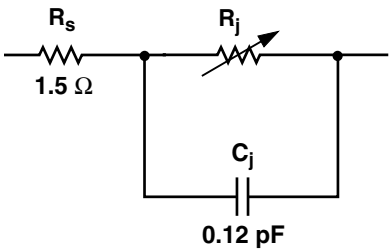



Figure 5. Forward Current vs. Forward Voltage.

## Equivalent Circuit Model

### HSMP-386x Chip*




$R_T = 1.5 + R_j$

$C_T = C_P + C_j$

$R_j = \frac{12}{I^{0.9}}\ \Omega$

I = Forward Bias Current in mA

* See AN1124 for package models

## Typical Applications for Multiple Diode Products

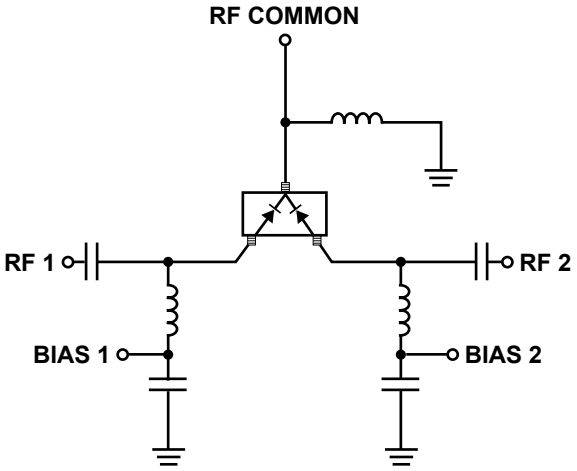



Figure 6. Simple SPDT Switch, Using Only Positive Current.

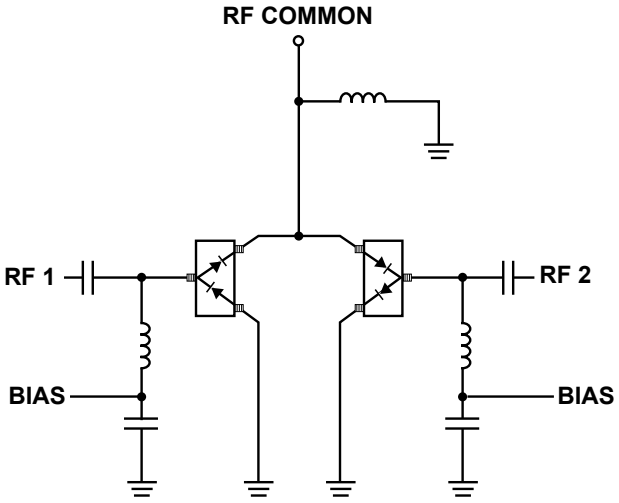



Figure 7. High Isolation SPDT Switch, Dual Bias.

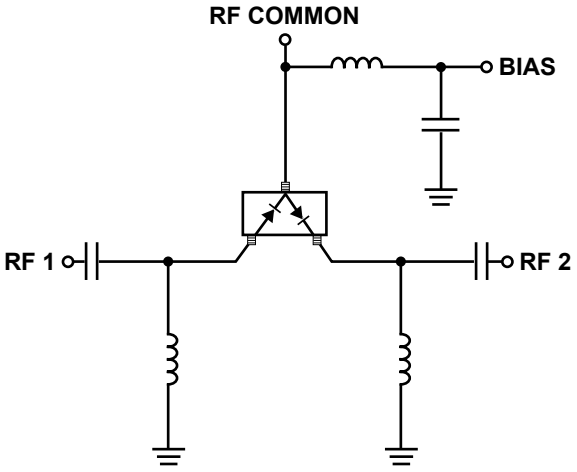



Figure 8. Switch Using Both Positive and Negative Current.

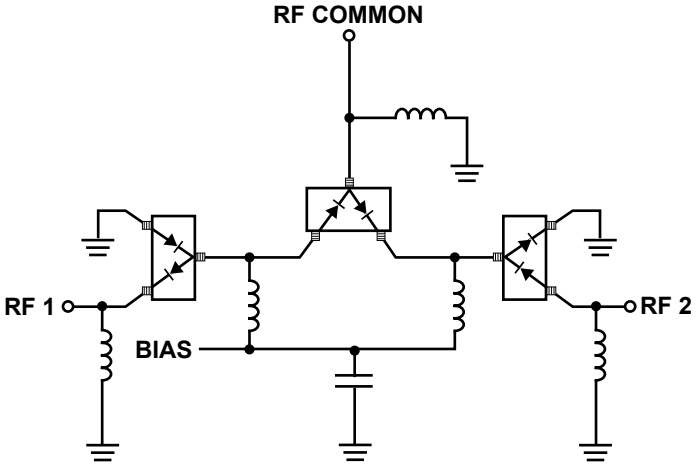



Figure 9. Very High Isolation SPDT Switch, Dual Bias.

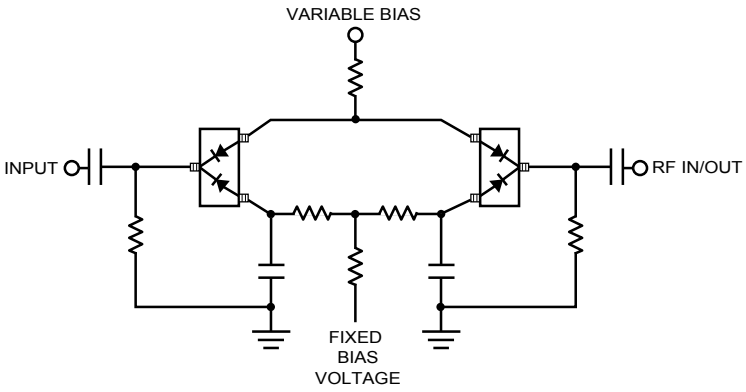



Figure 10. Four Diode $\pi$ Attenuator. See AN1048 for details.

## Typical Applications for Multiple Diode Products (continued)

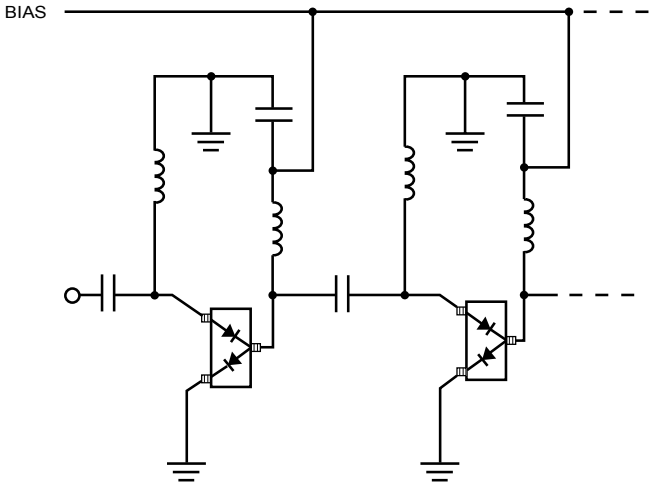



Figure 11. High Isolation SPST Switch (Repeat Cells as Required).

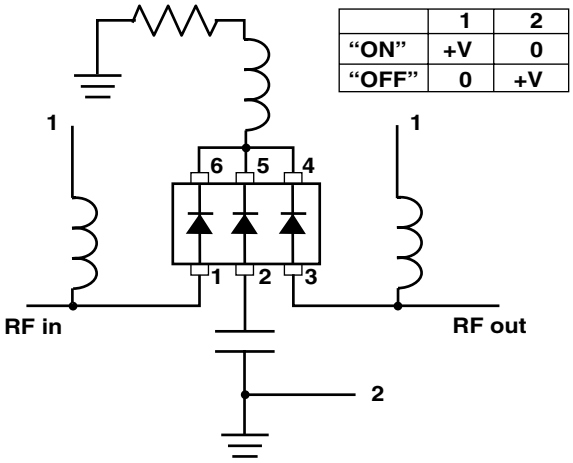



Figure 12. HSMP-386L Unconnected Trio used in a Positive Voltage, High Isolation Switch.

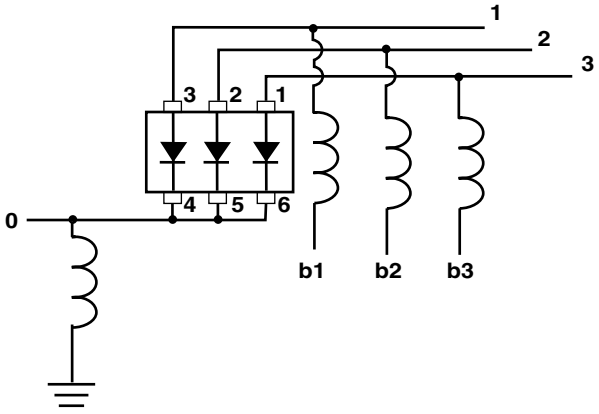



Figure 13. HSMP-386L used in a SP3T Switch.

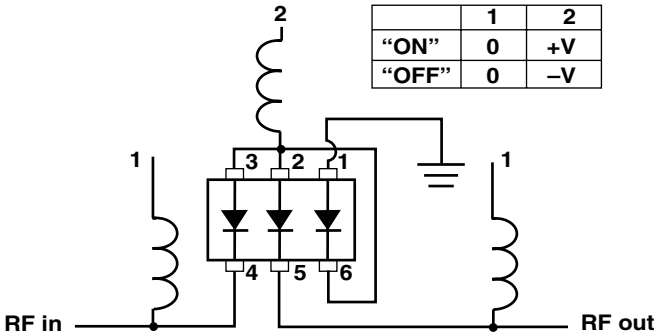



Figure 14. HSMP-386L Unconnected Trio used in a Dual Voltage, High Isolation Switch.

## Ordering Information

Specify part number followed by option. For example:

HSMP - 386x - XXX

- XXX: Bulk or Tape and Reel Option
- 386x: Part Number; x = Lead Code
- HSMP: Surface Mount PIN

### Option Descriptions

-BLKG = Bulk, 100 pcs. per antistatic bag
-TR1G = Tape and Reel, 3000 devices per 7" reel
-TR2G = Tape and Reel, 10,000 devices per 13" reel

Tape and Reeling conforms to Electronic Industries RS-481, "Taping of Surface Mounted Components for Automated Placement."

## Assembly Information

### SOT-323 PCB Footprint

Recommended PCB pad layouts for the miniature SOT packages are shown in Figures 15, 16, 17. These layouts provide ample allowance for package placement by automated assembly equipment without adding parasitics that could impair the performance.

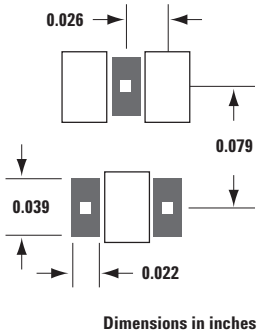



**Figure 15. Recommended PCB Pad Layout for Avago's SC70 3L/SOT-323 Products.**

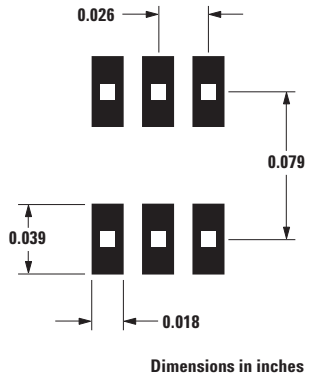



**Figure 16. Recommended PCB Pad Layout for Avago's SC70 6L/SOT-363 Products.**

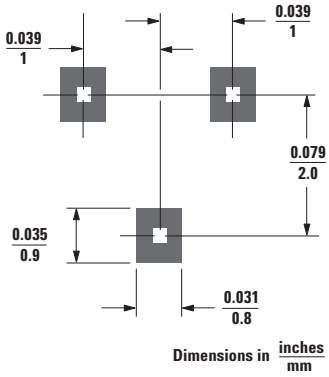



**Figure 17. Recommended PCB Pad Layout for Avago's SOT-23 Products.**

## SMT Assembly

Reliable assembly of surface mount components is a complex process that involves many material, process, and equipment factors, including: method of heating (e.g., IR or vapor phase reflow, wave soldering, etc.) circuit board material, conductor thickness and pattern, type of solder alloy, and the thermal conductivity and thermal mass of components. Components with a low mass, such as the SOT package, will reach solder reflow temperatures faster than those with a greater mass.

Avago's diodes have been qualified to the time-temperature profile shown in Figure 18. This profile is representative of an IR reflow type of surface mount assembly process.

After ramping up from room temperature, the circuit board with components attached to it (held in place with solder paste) passes through one or more preheat zones. The preheat zones increase the temperature of the board and components to prevent thermal shock and begin evaporating solvents from the solder paste. The reflow zone briefly elevates the temperature sufficiently to produce a reflow of the solder.

The rates of change of temperature for the ramp-up and cool-down zones are chosen to be low enough to not cause deformation of the board or damage to components due to thermal shock. The maximum temperature in the reflow zone ($T_{MAX}$) should not exceed 260°C.

These parameters are typical for a surface mount assembly process for Avago diodes. As a general guideline, the circuit board and components should be exposed only to the minimum temperatures and times necessary to achieve a uniform reflow of solder.

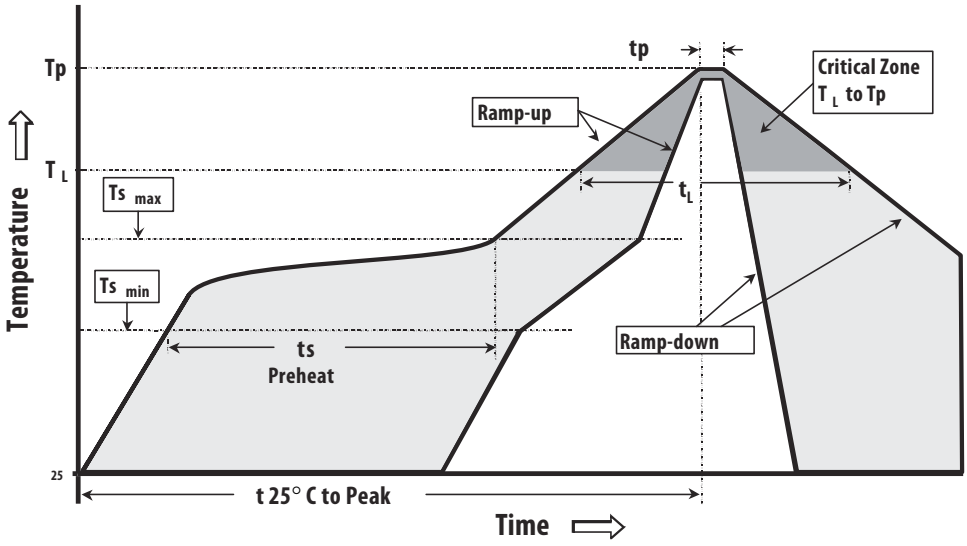



**Figure 18. Surface Mount Assembly Profile.**

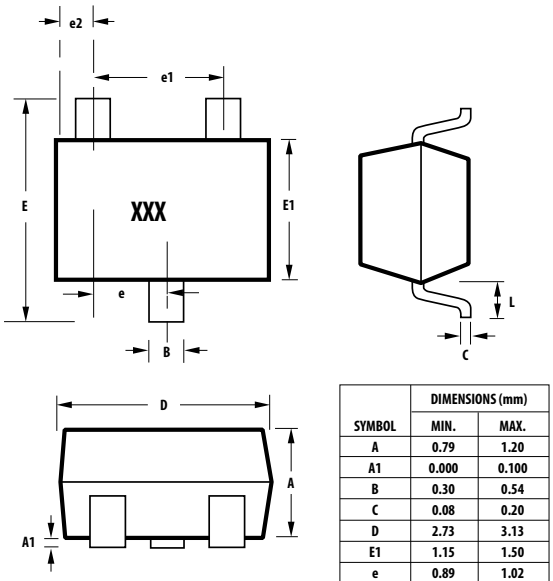
## Lead-Free Reflow Profile Recommendation (IPC/JEDEC J-STD-020C)

| Reflow Parameter | | Lead-Free Assembly |
|---|---|---|
| Average ramp-up rate (Liquidus Temperature ($T_{S(max)}$ to Peak) | | 3°C/ second max |
| Preheat | Temperature Min ($T_{S(min)}$) | 150°C |
| | Temperature Max ($T_{S(max)}$) | 200°C |
| | Time (min to max) ($t_S$) | 60-180 seconds |
| Ts(max) to TL Ramp-up Rate | | 3°C/second max |
| Time maintained above: | Temperature ($T_L$) | 217°C |
| | Time ($t_L$) | 60-150 seconds |
| Peak Temperature ($T_p$) | | 260 +0/-5°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 | | 8 minutes max |

Note 1: All temperatures refer to topside of the package, measured on the package body surface

## Package Dimensions

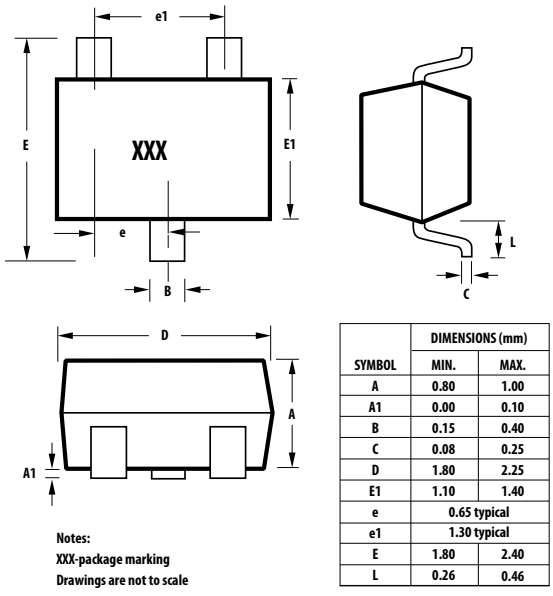
### Outline 23 (SOT-23)




| SYMBOL | DIMENSIONS (mm) | |
|---|---|---|
| | MIN. | MAX. |
| A | 0.79 | 1.20 |
| A1 | 0.000 | 0.100 |
| B | 0.30 | 0.54 |
| C | 0.08 | 0.20 |
| D | 2.73 | 3.13 |
| E1 | 1.15 | 1.50 |
| e | 0.89 | 1.02 |
| e1 | 1.78 | 2.04 |
| e2 | 0.45 | 0.60 |
| E | 2.10 | 2.70 |
| L | 0.45 | 0.69 |

Notes:
XXX-package marking
Drawings are not to scale

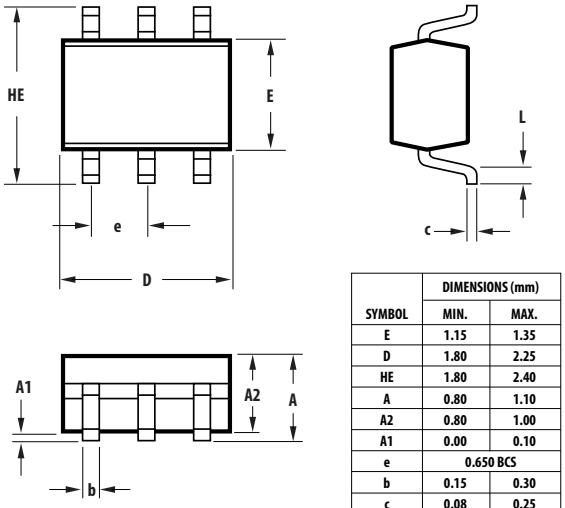
### Outline SOT-323 (SC-70, 3 Lead)




| SYMBOL | DIMENSIONS (mm) | |
|---|---|---|
| | MIN. | MAX. |
| A | 0.80 | 1.00 |
| A1 | 0.00 | 0.10 |
| B | 0.15 | 0.40 |
| C | 0.08 | 0.25 |
| D | 1.80 | 2.25 |
| E1 | 1.10 | 1.40 |
| e | 0.65 typical | |
| e1 | 1.30 typical | |
| E | 1.80 | 2.40 |
| L | 0.26 | 0.46 |

Notes:
XXX-package marking
Drawings are not to scale

### Outline 363 (SC-70, 6 Lead)

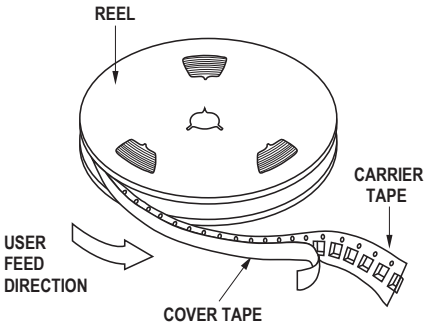



| SYMBOL | DIMENSIONS (mm) | |
|---|---|---|
| | MIN. | MAX. |
| E | 1.15 | 1.35 |
| D | 1.80 | 2.25 |
| HE | 1.80 | 2.40 |
| A | 0.80 | 1.10 |
| A2 | 0.80 | 1.00 |
| A1 | 0.00 | 0.10 |
| e | 0.650 BCS | |
| b | 0.15 | 0.30 |
| c | 0.08 | 0.25 |
| L | 0.10 | 0.46 |

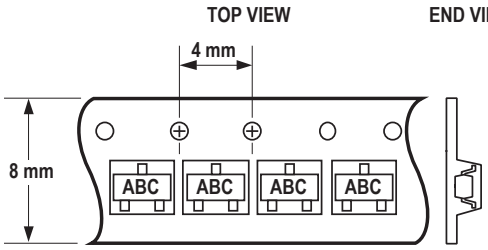
## Package Characteristics

Lead Material ..... Copper (SOT-323/363); Alloy 42 (SOT-23)
Lead Finish ..... Tin 100% (Lead-free option)
Maximum Soldering Temperature ..... 260°C for 5 seconds
Minimum Lead Strength ..... 2 pounds pull
Typical Package Inductance ..... 2 nH
Typical Package Capacitance ..... 0.08 pF (opposite leads)

## Device Orientation

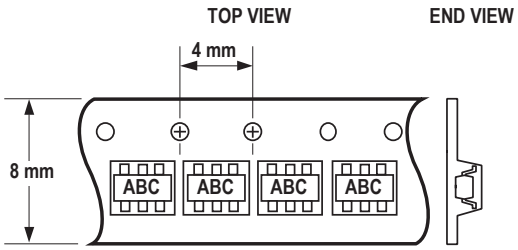



### For Outlines SOT-23, -323




Note: "AB" represents package marking code.
"C" represents date code.

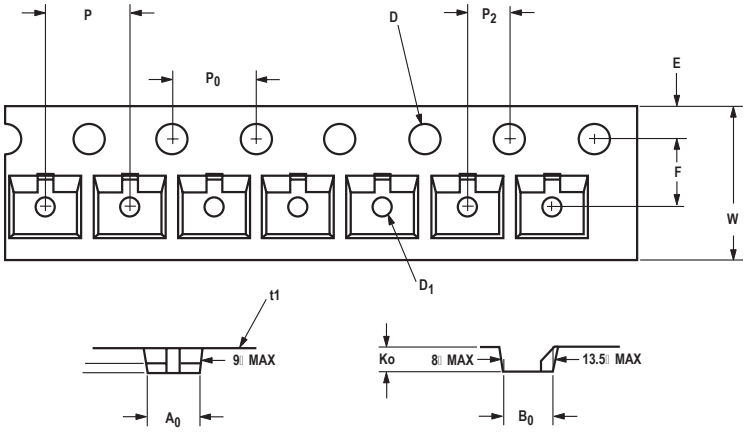
### For Outline SOT-363




Note: "AB" represents package marking code.
"C" represents date code.

## Tape Dimensions and Product Orientation

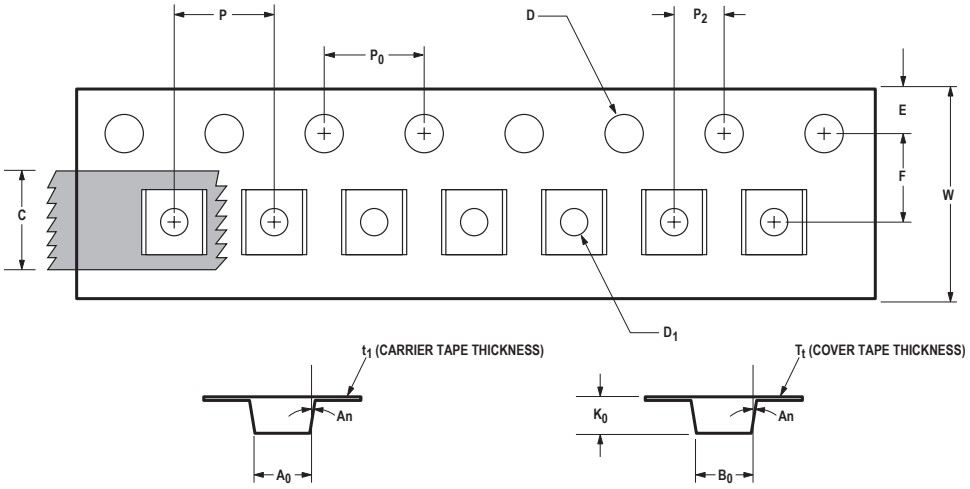
### For Outline SOT-23




| DESCRIPTION | | SYMBOL | SIZE (mm) | SIZE (INCHES) |
|---|---|---|---|---|
| CAVITY | LENGTH | $A_0$ | 3.15 ± 0.10 | 0.124 ± 0.004 |
| | WIDTH | $B_0$ | 2.77 ± 0.10 | 0.109 ± 0.004 |
| | DEPTH | $K_0$ | 1.22 ± 0.10 | 0.048 ± 0.004 |
| | PITCH | P | 4.00 ± 0.10 | 0.157 ± 0.004 |
| | BOTTOM HOLE DIAMETER | $D_1$ | 1.00 + 0.05 | 0.039 ± 0.002 |
| PERFORATION | DIAMETER | D | 1.50 + 0.10 | 0.059 + 0.004 |
| | PITCH | $P_0$ | 4.00 ± 0.10 | 0.157 ± 0.004 |
| | POSITION | E | 1.75 ± 0.10 | 0.069 ± 0.004 |
| CARRIER TAPE | WIDTH | W | 8.00 + 0.30 - 0.10 | 0.315 + 0.012 - 0.004 |
| | THICKNESS | t1 | 0.229 ± 0.013 | 0.009 ± 0.0005 |
| DISTANCE BETWEEN CENTERLINE | CAVITY TO PERFORATION (WIDTH DIRECTION) | F | 3.50 ± 0.05 | 0.138 ± 0.002 |
| | CAVITY TO PERFORATION (LENGTH DIRECTION) | $P_2$ | 2.00 ± 0.05 | 0.079 ± 0.002 |

## Tape Dimensions and Product Orientation

**For Outlines SOT-323, -363**




| DESCRIPTION | | SYMBOL | SIZE (mm) | SIZE (INCHES) |
|---|---|---|---|---|
| CAVITY | LENGTH | $A_0$ | 2.40 ± 0.10 | 0.094 ± 0.004 |
| | WIDTH | $B_0$ | 2.40 ± 0.10 | 0.094 ± 0.004 |
| | DEPTH | $K_0$ | 1.20 ± 0.10 | 0.047 ± 0.004 |
| | PITCH | P | 4.00 ± 0.10 | 0.157 ± 0.004 |
| | BOTTOM HOLE DIAMETER | $D_1$ | 1.00 + 0.25 | 0.039 + 0.010 |
| PERFORATION | DIAMETER | D | 1.55 ± 0.05 | 0.061 ± 0.002 |
| | PITCH | $P_0$ | 4.00 ± 0.10 | 0.157 ± 0.004 |
| | POSITION | E | 1.75 ± 0.10 | 0.069 ± 0.004 |
| CARRIER TAPE | WIDTH | W | 8.00 ± 0.30 | 0.315 ± 0.012 |
| | THICKNESS | $t_1$ | 0.254 ± 0.02 | 0.0100 ± 0.0008 |
| COVER TAPE | WIDTH | C | 5.4 ± 0.10 | 0.205 ± 0.004 |
| | TAPE THICKNESS | $T_t$ | 0.062 ± 0.001 | 0.0025 ± 0.00004 |
| DISTANCE | CAVITY TO PERFORATION (WIDTH DIRECTION) | F | 3.50 ± 0.05 | 0.138 ± 0.002 |
| | CAVITY TO PERFORATION (LENGTH DIRECTION) | $P_2$ | 2.00 ± 0.05 | 0.079 ± 0.002 |
| ANGLE | FOR SOT-323 (SC70-3 LEAD) | An | 8°C MAX | |
| | FOR SOT-363 (SC70-6 LEAD) | | 10°C MAX | |

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

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