

DATA SHEET

# SMV123x Series: Hyperabrupt Junction Tuning Varactors

## Applications

- Low tuning voltage VCOs
- High-Q resonators in wireless system VCOs
- High-volume commercial systems

## Features

- High capacitance ratio
- Low series resistance for low phase noise
- Packages rated MSL1, 260 °C per JEDEC J-STD-020



Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04-0074.



## Description

The SMV123x series of silicon hyperabrupt junction varactor diodes are designed for use in Voltage Controlled Oscillators (VCOs) with a low tuning voltage operation. The low resistance of these varactors makes them appropriate for high-Q resonators in wireless system VCOs to frequencies over 10 GHz. This family of varactors is characterized for capacitance and resistance over temperature.

Table 1 describes the various packages and markings of the SMV123x varactors.

Table 1. Packaging and Marking

|  |                                       |  |  |  |  |                                    |
|--|---------------------------------------|--|--|--|--|------------------------------------|
|  |                                       |  |  |  |  |                                    |
| Single                                     | Single                                | Single   | Common Cathode                                 | Common Anode                                   | Common Cathode                                 | Single                             |
| SC-79<br>Green™                            | SOD-323<br>Green™                     | SOT-23   | SOT-23   | SC-70  | SC-70  | SOD-882<br>Green™                  |
|  |                                       |  |  |  | <b>SMV1231-074</b><br>Marking: JA3             |                                    |
| <b>SMV1231-079LF</b><br>Marking: Cathode   | <b>SMV1231-011LF</b><br>Marking: KA   |  |  |  | <b>SMV1231-074LF</b><br>Green™<br>Marking: KA3 | <b>SMV1231-040LF</b><br>Marking: A |
|  |                                       |  |  |  |  |                                    |
| <b>SMV1232-079LF</b><br>Marking: Cathode   | <b>SMV1232-011LF</b><br>Marking: HC   |  |  |  |  | <b>SMV1232-040LF</b><br>Marking: Y |
|  |                                       | <b>SMV1233-001</b><br>Marking: VP1             | <b>SMV1233-004</b><br>Marking: VP3             |  |  |                                    |
| <b>SMV1233-079LF</b><br>Marking: Cathode   | ◆ <b>SMV1233-011LF</b><br>Marking: DP | <b>SMV1233-001LF</b><br>Green™<br>Marking: DP1 | <b>SMV1233-004LF</b><br>Green™<br>Marking: DP3 |  |  | <b>SMV1233-040LF</b><br>Marking: B |
|  |                                       | <b>SMV1234-001</b><br>Marking: VQ1             | <b>SMV1234-004</b><br>Marking: VQ3             | <b>SMV1234-073</b><br>Marking: VQ9             |  |                                    |
| <b>SMV1234-079LF</b><br>Marking: Cathode   | ◆ <b>SMV1234-011LF</b><br>Marking: DQ | <b>SMV1234-001LF</b><br>Green™<br>Marking: DQ1 | <b>SMV1234-004LF</b><br>Green™<br>Marking: DQ3 | <b>SMV1234-073LF</b><br>Green™<br>Marking: DQ9 |  | <b>SMV1234-040LF</b><br>Marking: G |
|  |                                       | <b>SMV1235-001</b><br>Marking: VR1             | <b>SMV1235-004</b><br>Marking: VR3             |  |  |                                    |
| <b>SMV1235-079LF</b><br>Marking: Cathode   | <b>SMV1235-011LF</b><br>Marking: DR   | <b>SMV1235-001LF</b><br>Green™<br>Marking: DR1 | <b>SMV1235-004LF</b><br>Green™<br>Marking: DR3 |  |  | <b>SMV1235-040LF</b><br>Marking: M |
|  |                                       | <b>SMV1236-001</b><br>Marking: AQ1             | <b>SMV1236-004</b><br>Marking: AQ3             |  |  |                                    |
| ◆ <b>SMV1236-079LF</b><br>Marking: Cathode | <b>SMV1236-011LF</b><br>Marking: EQ   | <b>SMV1236-001LF</b><br>Green™<br>Marking: EQ1 | <b>SMV1236-004LF</b><br>Green™<br>Marking: EQ3 |  |  | <b>SMV1236-040LF</b><br>Marking: R |
|  |                                       | <b>SMV1237-001</b><br>Marking: VT1             |  |  |  |                                    |
|  |                                       | <b>SMV1237-001LF</b><br>Green™<br>Marking: DT1 |  |  |  |                                    |
| Ls = 0.7 nH                                | Ls = 1.5 nH                           | Ls = 1.5 nH                                    | Ls = 1.5 nH                                    | Ls = 1.4 nH                                    | Ls = 1.4 nH                                    | Ls = 0.45 nH                       |



The Pb-free symbol or "LF" in the part number denotes a lead-free, RoHS-compliant package unless otherwise noted as Green™. Tin/lead (Sn/Pb) packaging is not recommended for new designs.



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## Electrical and Mechanical Specifications

The absolute maximum ratings of the SMV123x varactors are provided in Table 2. Electrical specifications are provided in Table 3. Typical capacitance values are listed in Table 4. Typical performance characteristics of the SMV123x varactors are illustrated in Figures 1 through 4.

The SPICE model for the SMV123x varactors is shown in Figure 5 and the associated model parameters are provided in Table 5.

Package dimensions are shown in Figures 6 to 14 (even numbers), and tape and reel dimensions are provided in Figures 7 to 15 (odd numbers).

## Package and Handling Information

Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SMV123x series of varactors are rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. They can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

**Table 2. SMV123x Absolute Maximum Ratings (Note 1)**

| Parameter  | Symbol    | Minimum | Maximum | Units |
|--|-----------|---------|---------|-------|
| Reverse voltage  | $V_R$     |         | 15      | V     |
| Forward current  | $I_F$     |         | 20      | mA    |
| Power dissipation  | $P_{DIS}$ |         | 250     | mW    |
| Operating temperature  | $T_{OP}$  | -55     | +125    | °C    |
| Storage temperature  | $T_{STG}$ | -55     | +150    | °C    |
| Electrostatic discharge:<br>Human Body Model (HBM), Class 1B | ESD       |         | 1000    | V     |

**Note 1:** Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

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**CAUTION:** Although this device is designed to be as robust as possible, electrostatic discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times.

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**Table 3. SMV123x Electrical Specifications (Note 1)**  
 (TOP = 25 °C, Unless Otherwise Noted)

| Part Number | C <sub>T</sub> @ 1 V (pF) |       | C <sub>T</sub> @ 3 V (pF) | C <sub>T</sub> @ 6 V (pF) | C <sub>T</sub> @ 1 V / C <sub>T</sub> @ 3 V (Ratio) |      | C <sub>T</sub> @ 1 V / C <sub>T</sub> @ 6 V (Ratio) |      | Rs @ 3 V, 500 MHz (Ω) |
|-------------|---------------------------|-------|---------------------------|---------------------------|---|------|---|------|-----------------------|
|             | Min.                      | Max.  | Typ.                      | Typ.                      | Min.  | Max. | Min.  | Max. | Typ.                  |
| SMV1231     | 1.43                      | 1.72  | 0.97                      | 0.61                      | 1.5   | 1.8  | 2.5   | 2.8  | 2.90                  |
| SMV1232     | 2.34                      | 2.86  | 1.50                      | 0.94                      | 1.5   | 1.9  | 2.6   | 3.3  | 1.50                  |
| SMV1233     | 3.00                      | 3.60  | 1.80                      | 1.10                      | 1.5   | 1.9  | 2.6   | 3.3  | 1.20                  |
| SMV1234     | 5.85                      | 7.15  | 3.60                      | 2.00                      | 1.6   | 2.0  | 2.8   | 3.4  | 0.80                  |
| SMV1235     | 10.35                     | 12.65 | 6.40                      | 3.60                      | 1.6   | 2.0  | 2.9   | 3.4  | 0.60                  |
| SMV1236     | 15.50                     | 18.50 | 9.20                      | 5.30                      | 1.6   | 2.0  | 3.0   | 3.5  | 0.50                  |
| SMV1237     | 45.00                     | 54.00 | 26.90                     | 14.40                     | 1.6   | 2.0  | 3.0   | 3.5  | 0.40                  |

**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

Tested with -079 package.

Reverse voltage V<sub>R</sub> (I<sub>R</sub> = 10 μA) = 15 V minimum

Reverse current I<sub>R</sub> (V<sub>R</sub> = 12 V) = 20 nA maximum

**Table 4. Capacitance vs Reverse Voltage**

| V <sub>R</sub> (V) | C <sub>T</sub> (pF) |         |         |         |         |         |         |
|--------------------|---------------------|---------|---------|---------|---------|---------|---------|
|                    | SMV1231             | SMV1232 | SMV1233 | SMV1234 | SMV1235 | SMV1236 | SMV1237 |
| 0                  | 2.35                | 4.15    | 5.08    | 9.63    | 18.22   | 26.75   | 71.82   |
| 0.5                | 1.87                | 3.22    | 3.95    | 7.53    | 14.12   | 20.61   | 56.10   |
| 1.0                | 1.58                | 2.67    | 3.28    | 6.28    | 11.67   | 17.02   | 46.89   |
| 1.5                | 1.40                | 2.28    | 2.80    | 5.39    | 9.91    | 14.38   | 40.33   |
| 2.0                | 1.22                | 1.97    | 2.41    | 4.68    | 8.52    | 12.29   | 35.13   |
| 2.5                | 1.09                | 1.72    | 2.09    | 4.09    | 7.36    | 10.56   | 30.71   |
| 3.0                | 0.970               | 1.51    | 1.82    | 3.58    | 6.40    | 9.16    | 26.87   |
| 3.5                | 0.882               | 1.35    | 1.62    | 3.15    | 5.62    | 8.04    | 23.57   |
| 4.0                | 0.794               | 1.22    | 1.45    | 2.81    | 4.99    | 7.19    | 20.83   |
| 4.5                | 0.732               | 1.13    | 1.33    | 2.54    | 4.50    | 6.53    | 18.62   |
| 5.0                | 0.683               | 1.05    | 1.24    | 2.32    | 4.11    | 6.01    | 16.87   |
| 5.5                | 0.648               | 0.99    | 1.16    | 2.15    | 3.80    | 5.61    | 15.48   |
| 6.0                | 0.613               | 0.94    | 1.10    | 2.02    | 3.55    | 5.28    | 14.36   |
| 6.5                | 0.590               | 0.90    | 1.05    | 1.90    | 3.34    | 5.02    | 13.46   |
| 7.0                | 0.567               | 0.86    | 1.01    | 1.80    | 3.17    | 4.81    | 12.72   |
| 7.5                | 0.551               | 0.84    | 0.98    | 1.72    | 3.03    | 4.64    | 12.11   |
| 8.0                | 0.534               | 0.81    | 0.96    | 1.65    | 2.91    | 4.49    | 11.61   |
| 9.0                | 0.512               | 0.78    | 0.92    | 1.55    | 2.73    | 4.28    | 10.87   |
| 10.0               | 0.497               | 0.76    | 0.90    | 1.47    | 2.61    | 4.13    | 10.38   |
| 11.0               | 0.492               | 0.75    | 0.88    | 1.42    | 2.53    | 4.02    | 10.06   |
| 12.0               | 0.487               | 0.74    | 0.87    | 1.38    | 2.47    | 3.95    | 9.84    |
| 13.0               | 0.480               | 0.73    | 0.86    | 1.35    | 2.43    | 3.89    | 9.68    |
| 14.0               | 0.472               | 0.73    | 0.85    | 1.33    | 2.40    | 3.84    | 9.56    |
| 15.0               | 0.466               | 0.72    | 0.84    | 1.32    | 2.38    | 3.80    | 9.47    |

### Typical Performance Characteristics

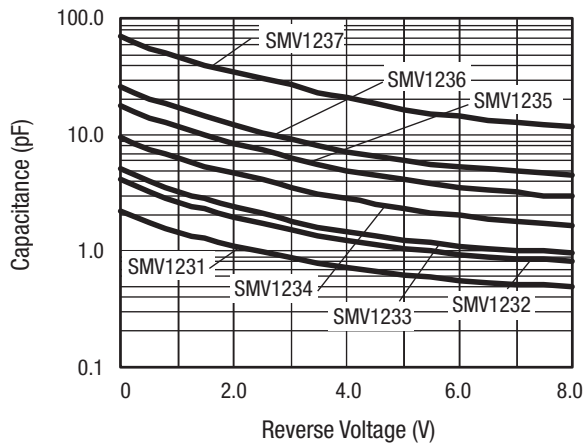


Figure 1. Capacitance vs Reverse Voltage

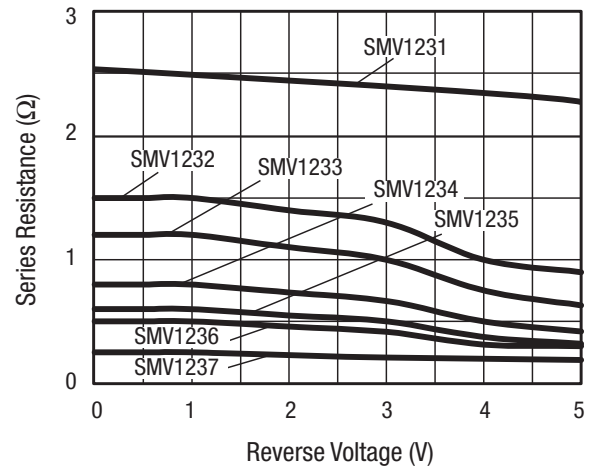


Figure 2. Series Resistance vs Reverse Voltage @ 500 MHz

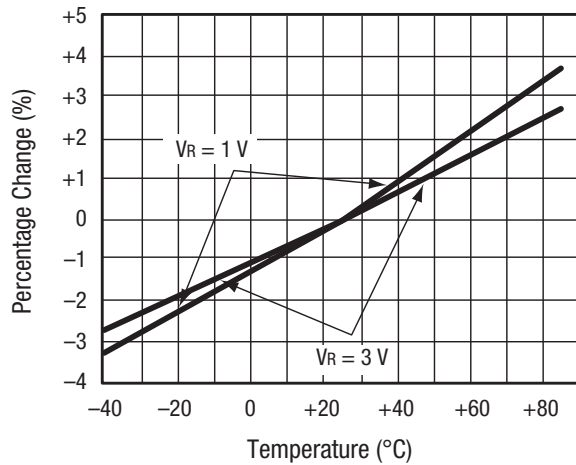


Figure 3. Relative Capacitance Change vs Temperature

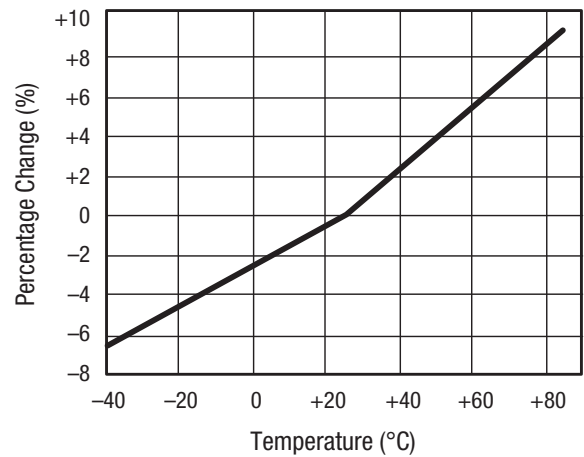


Figure 4. Relative Series Resistance Change vs Temperature @ 500 MHz

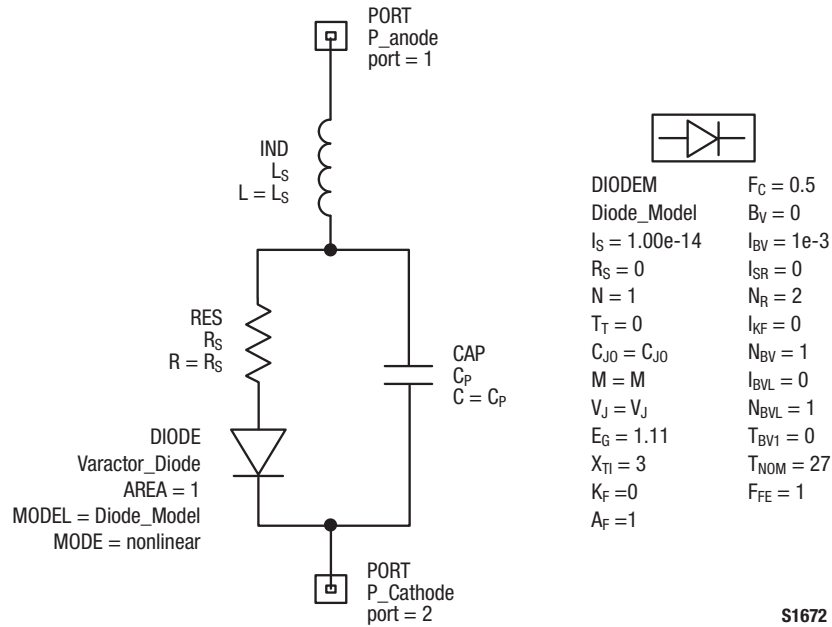


Figure 5. SPICE Model

Table 5. SPICE Model Parameters

| Part Number | C <sub>J0</sub><br>(pF) | V <sub>J</sub><br>(V) | M     | C <sub>P</sub><br>(pF) | R <sub>S</sub><br>(Ω) |
|-------------|-------------------------|-----------------------|-------|------------------------|-----------------------|
| SMV1231     | 1.88                    | 10.13                 | 4.999 | 0.44                   | 2.50                  |
| SMV1232     | 3.43                    | 8.36                  | 4.690 | 0.68                   | 1.50                  |
| SMV1233     | 4.21                    | 11.87                 | 6.430 | 0.81                   | 1.20                  |
| SMV1234     | 8.36                    | 7.95                  | 3.960 | 1.15                   | 0.80                  |
| SMV1235     | 15.85                   | 8.78                  | 4.570 | 2.15                   | 0.60                  |
| SMV1236     | 22.89                   | 9.62                  | 5.230 | 3.59                   | 0.50                  |
| SMV1237     | 61.40                   | 14.51                 | 6.780 | 8.90                   | 0.25                  |

Values extracted from measured performance.

For package inductance (L<sub>s</sub>), refer to Table 1.

For more details, refer to the Skyworks Application Note, *Varactor SPICE Model for Approved RF VCO Applications*, document number 200315.

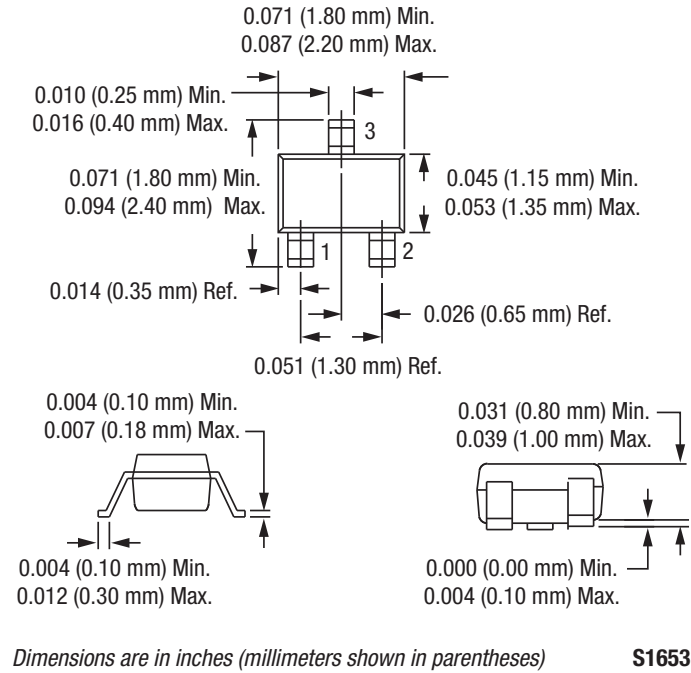
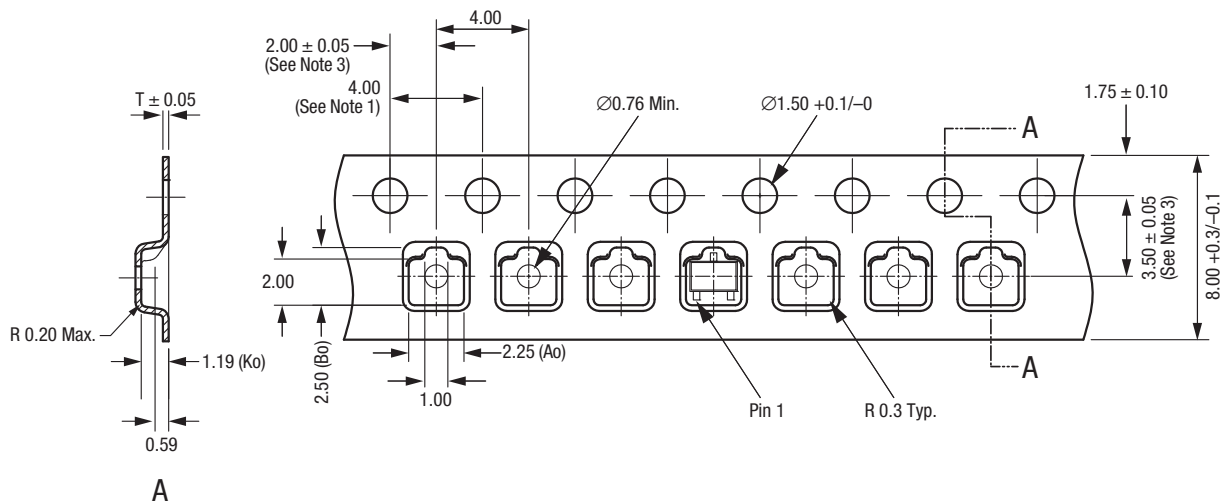


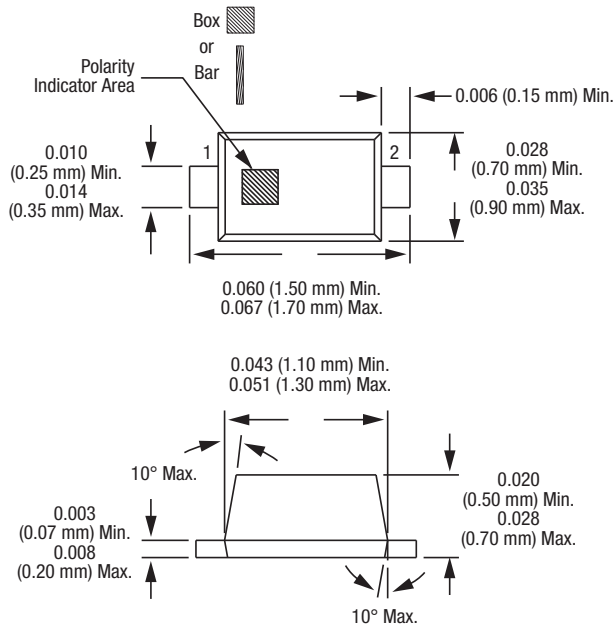
Figure 6. SC-70 Package Dimensions



- Notes:
1. Sprocket hole pitch cumulative tolerance  $\pm 0.2$ .
  2. Carrier tape: black conductive polystyrene.
  3. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.
  4. Cover tape material: transparent conductive PSA with 9.2 mm width.
  5. All measurements are in millimeters.

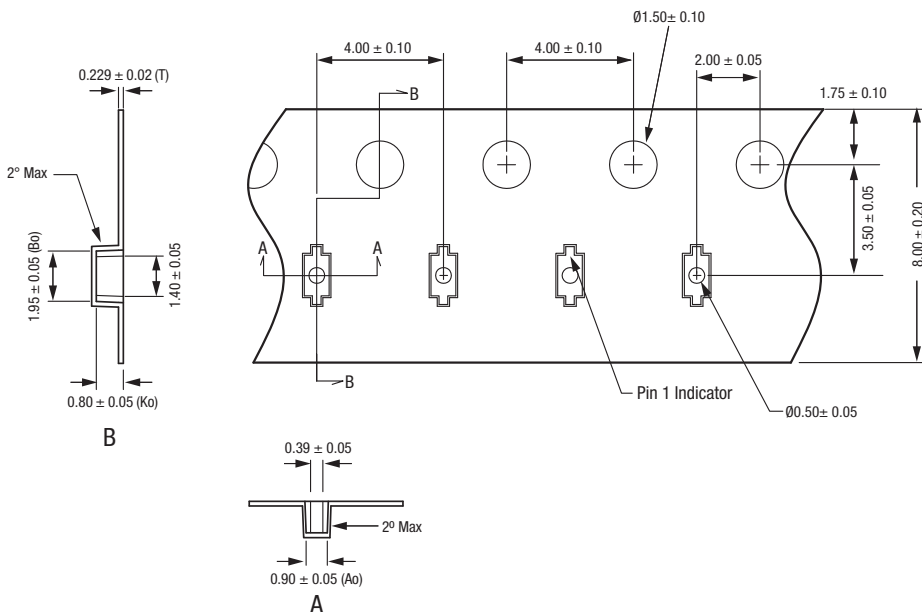
S1685c

Figure 7. SC-70 Tape and Reel Dimensions



Dimensions are in inches (millimeters shown in parentheses) S1652

Figure 8. SC-79 Package Dimensions

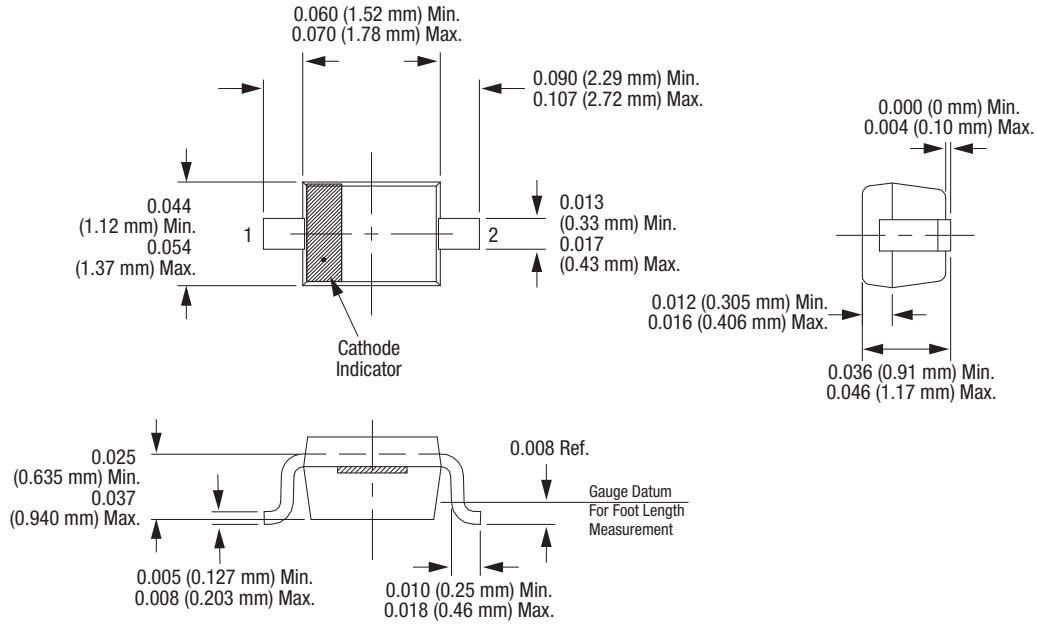


- Notes:
1. Carrier tape: black conductive polycarbonate or polystyrene.
  2. Cover tape material: transparent conductive PSA.
  3. Cover tape size: 5.4 mm width.
  4. ESD-surface resistivity is  $\leq 1 \times 10^8$  Ohms/square per EIA, JEDEC TNR Specification.
  4. All measurements are in millimeters.

S2929

Figure 9. SC-79 Tape and Reel Dimensions

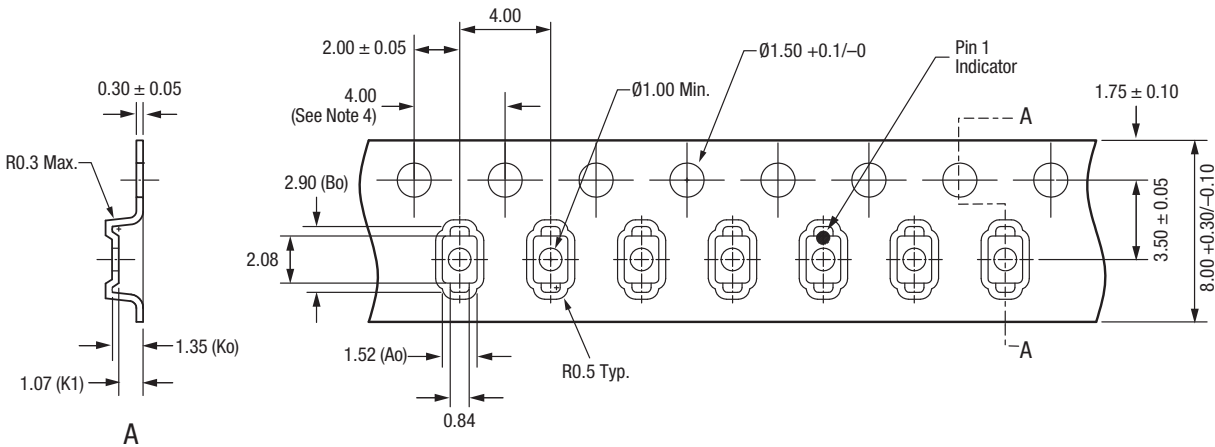




Dimensions are in inches (millimeters shown in parentheses)

S1619

Figure 10. SOD-323 Package Dimensions

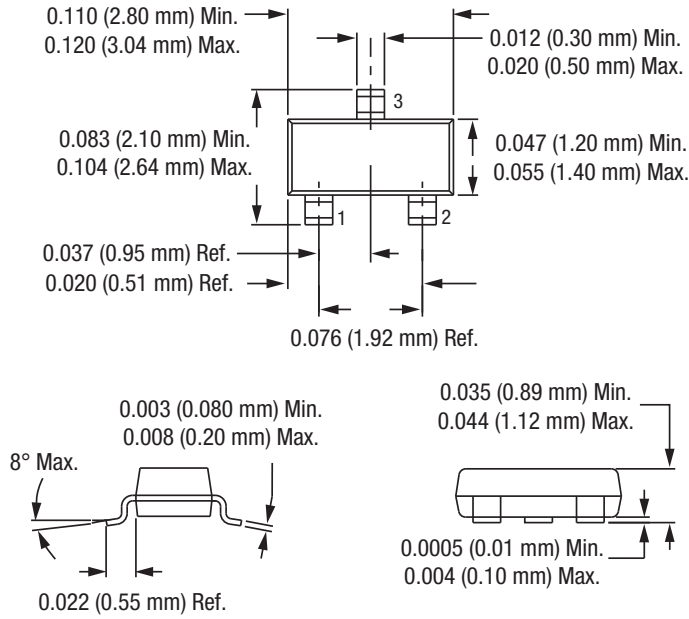


Notes:

1. Carrier tape: black conductive polystyrene.
2. Cover tape: transparent conductive PSA.
3. Cover tape size: 5.4 mm width.
4. 10 sprocket hole pitch cumulative tolerance: ±0.20 mm.
5. All measurements are in millimeters.

S2910

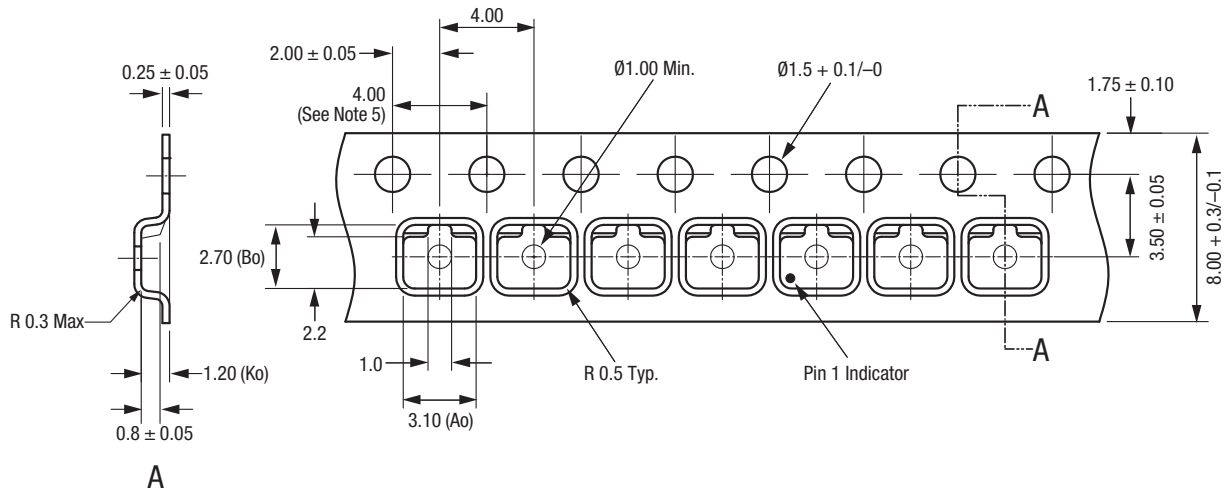
Figure 11. SOD-323 Tape and Reel Dimensions



Dimensions are in inches (millimeters shown in parentheses)

S1389

Figure 12. SOT-23 Package Dimensions

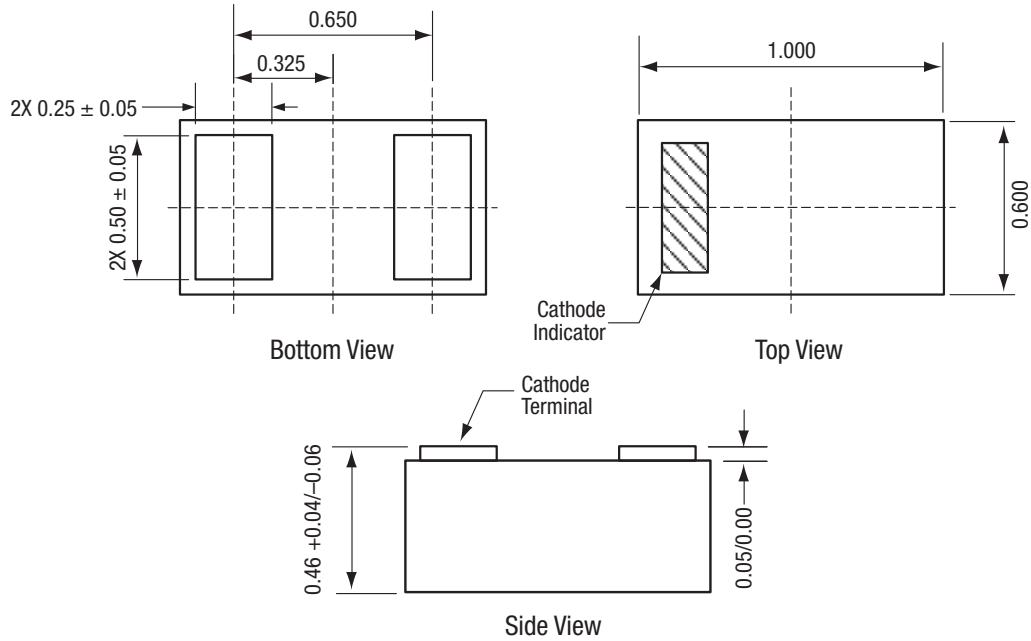


Notes:

1. Carrier tape: black conductive polycarbonate.
2. Cover tape material: transparent conductive PSA.
3. Cover tape size: 5.40 mm width.
4. Tolerance ±0.10 mm.
5. Ten sprocket hole pitch cumulative tolerance: ±0.2 mm.
6. All measurements are in millimeters.

S1684b

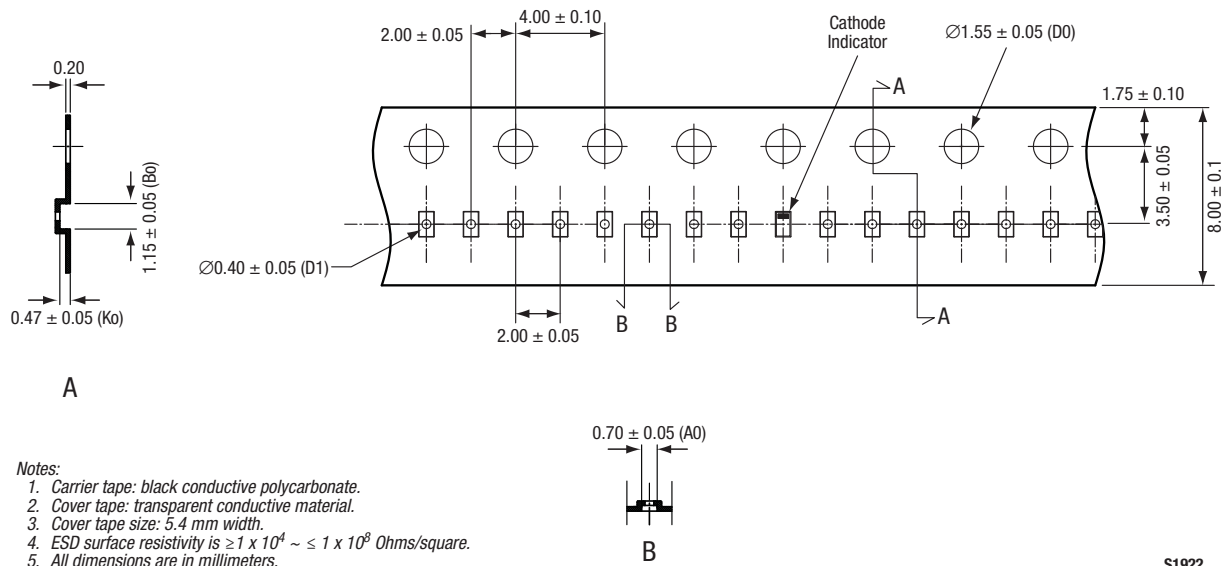
Figure 13. SOT-23 Tape and Reel Dimensions



All dimensions in millimeters

S1892

Figure 14. SOD-882 Package Dimensions



Notes:

1. Carrier tape: black conductive polycarbonate.
2. Cover tape: transparent conductive material.
3. Cover tape size: 5.4 mm width.
4. ESD surface resistivity is  $\geq 1 \times 10^4 \sim \leq 1 \times 10^8$  Ohms/square.
5. All dimensions are in millimeters.

S1922

Figure 15. SOD-882 Tape and Reel Dimensions

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