

**DATA SHEET**

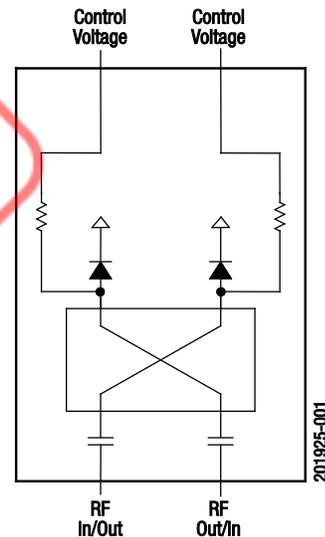
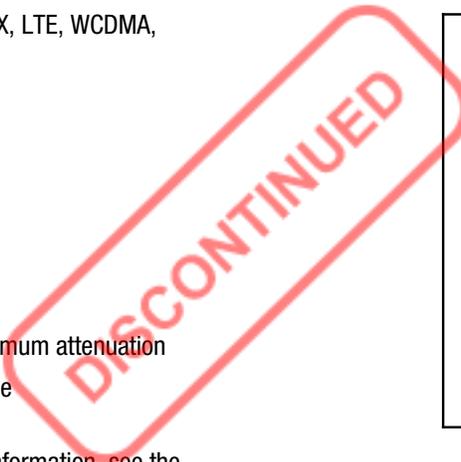
# SKY12233-11: High IIP3 2.1 to 3.1 GHz Voltage-Controlled Variable Attenuator

## Applications

- Automatic power leveling/gain control circuits in cellular base stations and point-to-point radio IF chains
- General wireless systems including WiMAX, LTE, WCDMA, VSAT, and military communications

## Features

- 2.1 to 3.1 GHz broadband operating range
- Maximum attenuation value: 34 dB
- Control voltage range: 0 to 5 V
- High IIP3: +61 dBm
- Low current consumption: <2 mA @ maximum attenuation
- Small, MCM (8-pin, 4.9 x 3.2 mm) package (MSL3, 260 °C per JEDEC J-STD-020)
- For RoHS and other product compliance information, see the [Skyworks Certificate of Conformance](#)



**Figure 1. SKY12233-11 Block Diagram**

## Description

The SKY12233-11 is a voltage-controlled variable attenuator from Skyworks series of high third order input intercept point (IIP3) components. The device has been designed to operate over the 2.1 to 3.1 GHz frequency band, but is specifically optimized for use as a wide dynamic range, low distortion attenuator, centered at 2.60 GHz.

The SKY12233-11 provides monotonic attenuation performance over its entire control voltage range. This attenuator is comprised of a pair of matched PIN diodes that terminate two ports of its internal 90-degree hybrid coupler. The diodes are biased using an external control voltage signal. The attenuator requires no external components. It operates with a control voltage range of 0 to 5 V and a 1.7 mA typical control current at maximum attenuation.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

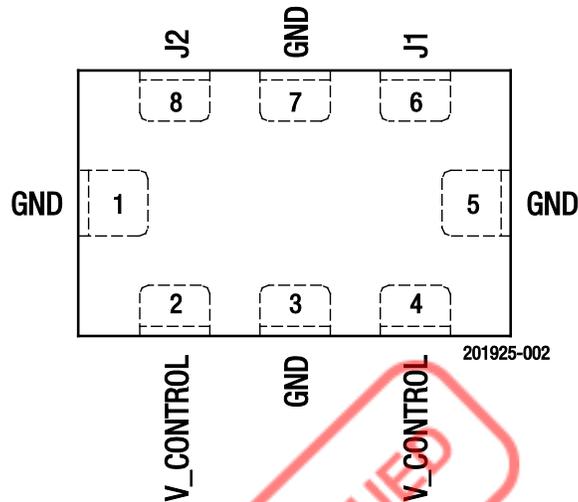


Figure 2. SKY12233-11 Pinout (Top View)

Table 1. SKY12233-11 Signal Descriptions

| Pin | Name      | Description  | Pin | Name | Description  |
|-----|-----------|--|-----|------|--|
| 1   | GND       | Ground. Must be connected to PCB ground using lowest possible inductance path.             | 5   | GND  | Ground. Must be connected to PCB ground using lowest possible inductance path. |
| 2   | V_CONTROL | Control voltage input (voltage applied is nominally equal to the voltage applied to pin 4) | 6   | J1   | RF input/output  |
| 3   | GND       | Ground. Must be connected to PCB ground using lowest possible inductance path.             | 7   | GND  | Ground. Must be connected to PCB ground using lowest possible inductance path. |
| 4   | V_CONTROL | Control voltage input (voltage applied is nominally equal to the voltage applied to pin 2) | 8   | J2   | RF output/input  |

### Technical Description

The SKY12233-11 is a 50 Ω matched voltage controlled variable attenuator with monotonic attenuation performance from 2.1 to 3.1 GHz over its entire control voltage range. This attenuator requires no external biasing or RF matching components.

Monotonic performance means the attenuation increases as the applied DC voltage increases. This attenuator is comprised of a pair of matched PIN diodes that terminate two ports of an internal 90-degree hybrid coupler.

The diodes are biased using an external control voltage signal that sets the bias current through a resistive network. The attenuator operates with a control voltage range of 0 to 5 V and a 1.7 mA typical control current at maximum attenuation. As the control voltage increases, the bias current through each of the PIN

diodes also increases. This increased bias current lowers the resistance of the PIN diodes. Maximum attenuation occurs when the resistance of the PIN diodes equals the characteristic impedance of the hybrid coupler ports, which they terminate. This occurs at a control voltage of approximately 5 VDC.

### Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY12233-11 are provided in Table 2. Electrical specifications are provided in Table 3.

Performance characteristics for the SKY12233-11 are illustrated in Figures 3 through 8.

**Table 2. SKY12233-11 Absolute Maximum Ratings<sup>1</sup>**

| Parameter                           | Symbol               | Minimum | Maximum | Units |
|-------------------------------------|----------------------|---------|---------|-------|
| Control voltage                     | V <sub>CONTROL</sub> |         | 10      | V     |
| RF input power (CW)                 | P <sub>IN</sub>      |         | 4       | W     |
| Control current                     | I <sub>CC</sub>      |         | 50      | mA    |
| Diode reverse bias voltage          |                      |         | 50      | V     |
| Storage temperature                 | T <sub>STG</sub>     | -40     | +85     | °C    |
| Operating temperature               | T <sub>OP</sub>      | -40     | +85     | °C    |
| Electrostatic discharge:            | ESD                  |         |         |       |
| Charged Device Model (CDM), Class 3 |                      |         | 500     | V     |
| Human Body Model (HBM), Class 1A    |                      |         | 250     | V     |
| Machine Model (MM), Class A         |                      |         | 50      | V     |

<sup>1</sup> 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.

**ESD HANDLING:** 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 when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.

**Table 3. SKY12233-11 Electrical Specifications<sup>1</sup>**

(T<sub>OP</sub> = +25 °C, V<sub>CONTROL</sub> = 0 to 5 V, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)

| Parameter                                      | Symbol          | Test Condition   | Min | Typical | Max | Units |
|--|-----------------|--|-----|---------|-----|-------|
| Attenuation                                    | Attn            | V <sub>CONTROL</sub> = 5 V, f = 2.6 GHz  | 25  | 34      |     | dB    |
| Control current                                | I <sub>CC</sub> | V <sub>CONTROL</sub> = 5 V   |     | 1.7     |     | mA    |
| Insertion loss                                 | IL              | V <sub>CONTROL</sub> = 0 V, f = 2.1 to 3.1 GHz   |     | 1.5     | 2.5 | dB    |
| Return loss                                    | RL              | V <sub>CONTROL</sub> = 0 V, f = 2.1 to 3.1 GHz   | 7   | 20      |     | dB    |
| Third order input intercept point <sup>2</sup> | IIP3            | P <sub>IN</sub> = +8 dBm each tone, V <sub>CONTROL</sub> = 0 V, f1 = 2.600 GHz, f2 = 2.610 GHz |     | +61     |     | dBm   |

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

<sup>2</sup> Minimum specification is guaranteed by design and is not 100% production tested.

### Typical Performance Characteristics

( $T_{TOP} = +25\text{ }^{\circ}\text{C}$ ,  $V_{CONTROL} = 0\text{ to }5\text{ V}$ ,  $P_{IN} = 0\text{ dBm}$ , Characteristic Impedance [ $Z_0$ ] =  $50\text{ }\Omega$ , J1 = Input Port, J2 = Output Port, Unless Otherwise Noted)

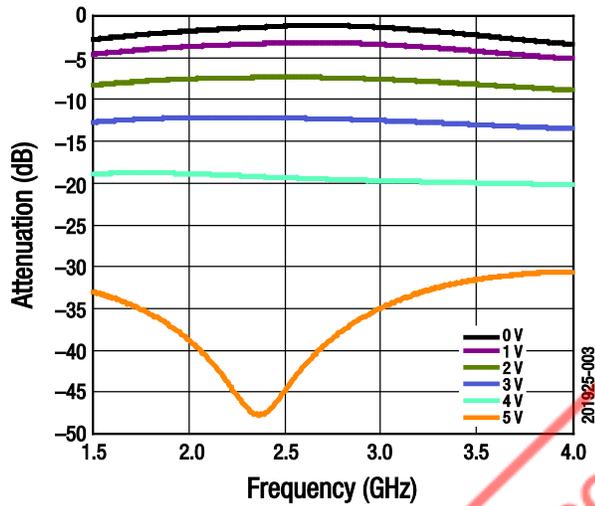


Figure 3. Attenuation vs Frequency Over Control Voltage

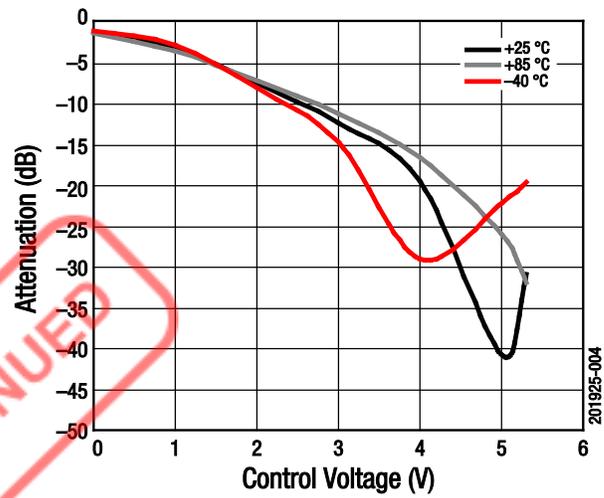


Figure 4. Attenuation vs Control Voltage Over Temperature (f = 2.6 GHz)

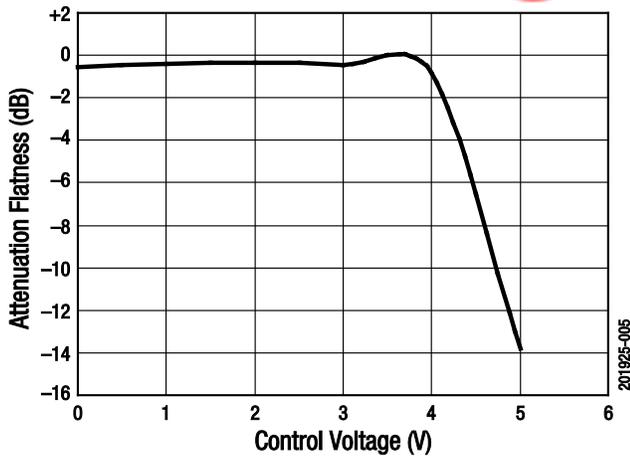


Figure 5. Attenuation Flatness vs Control Voltage (f = 2.1 to 3.1 GHz)

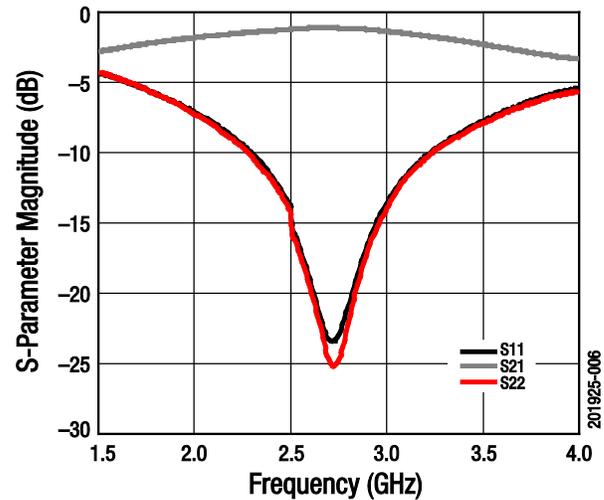
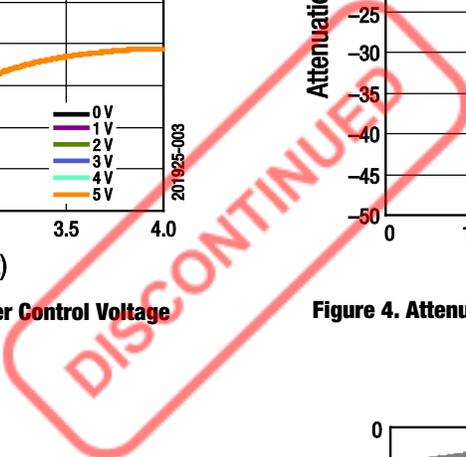


Figure 6. S-Parameter Magnitude vs Frequency



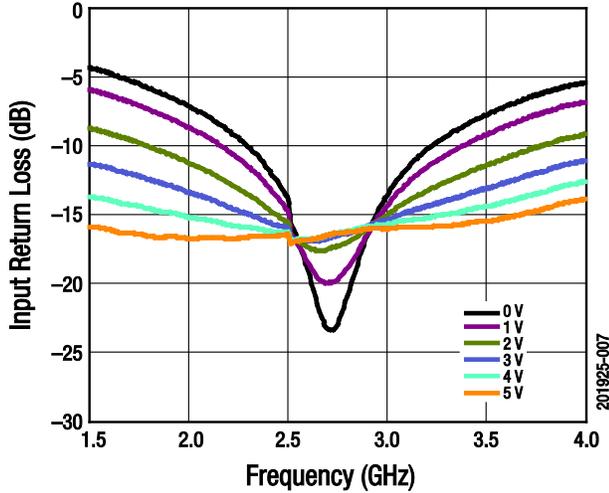


Figure 7. Input Return Loss vs Frequency Over Control Voltage

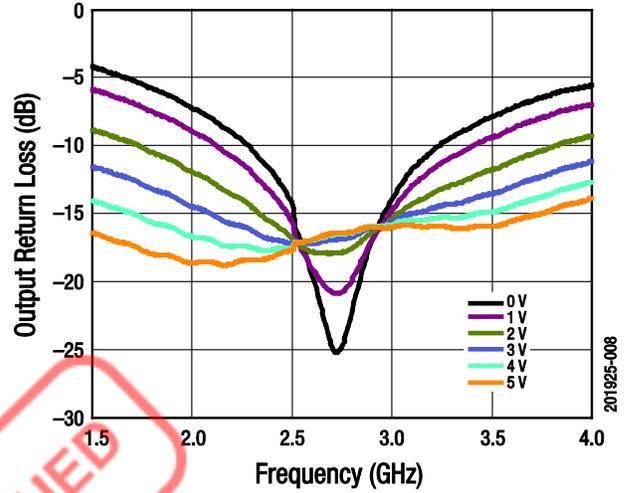


Figure 8. Output Return Loss vs Frequency Over Control Voltage

### Evaluation Board Description

The SKY12233-11 Evaluation Board is used to test the performance of the SKY12233-11 variable attenuator. An assembly drawing for the Evaluation Board is shown in Figure 9. The Evaluation Board layer detail is shown in Figure 10.

The attenuation level of the SKY12233-11 is controlled by applying 0 to 5 V to the V\_CONTROL pins.

### Package Dimensions

The PCB layout footprint for the SKY12233-11 is shown in Figure 11. Typical part markings are shown in Figure 12. Package dimensions are shown in Figure 13, and tape and reel dimensions are provided in Figure 14.

### Package and Handling Information

Since this device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. 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 SKY12233-11 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design & SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

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.

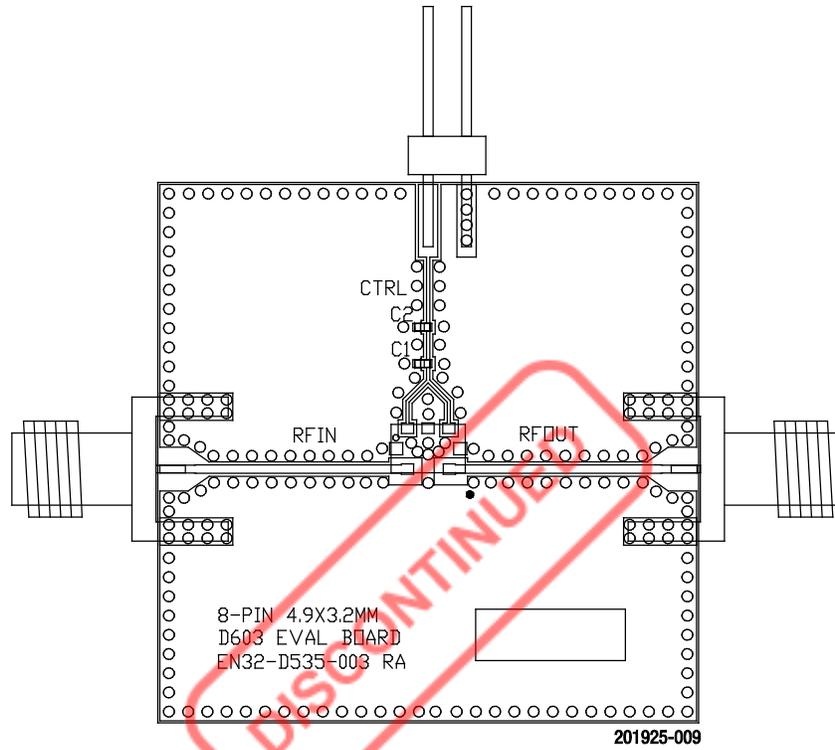


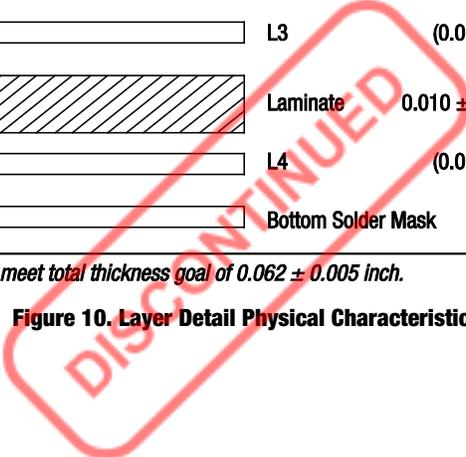
Figure 9. SKY12233-11 Evaluation Board Assembly Diagram

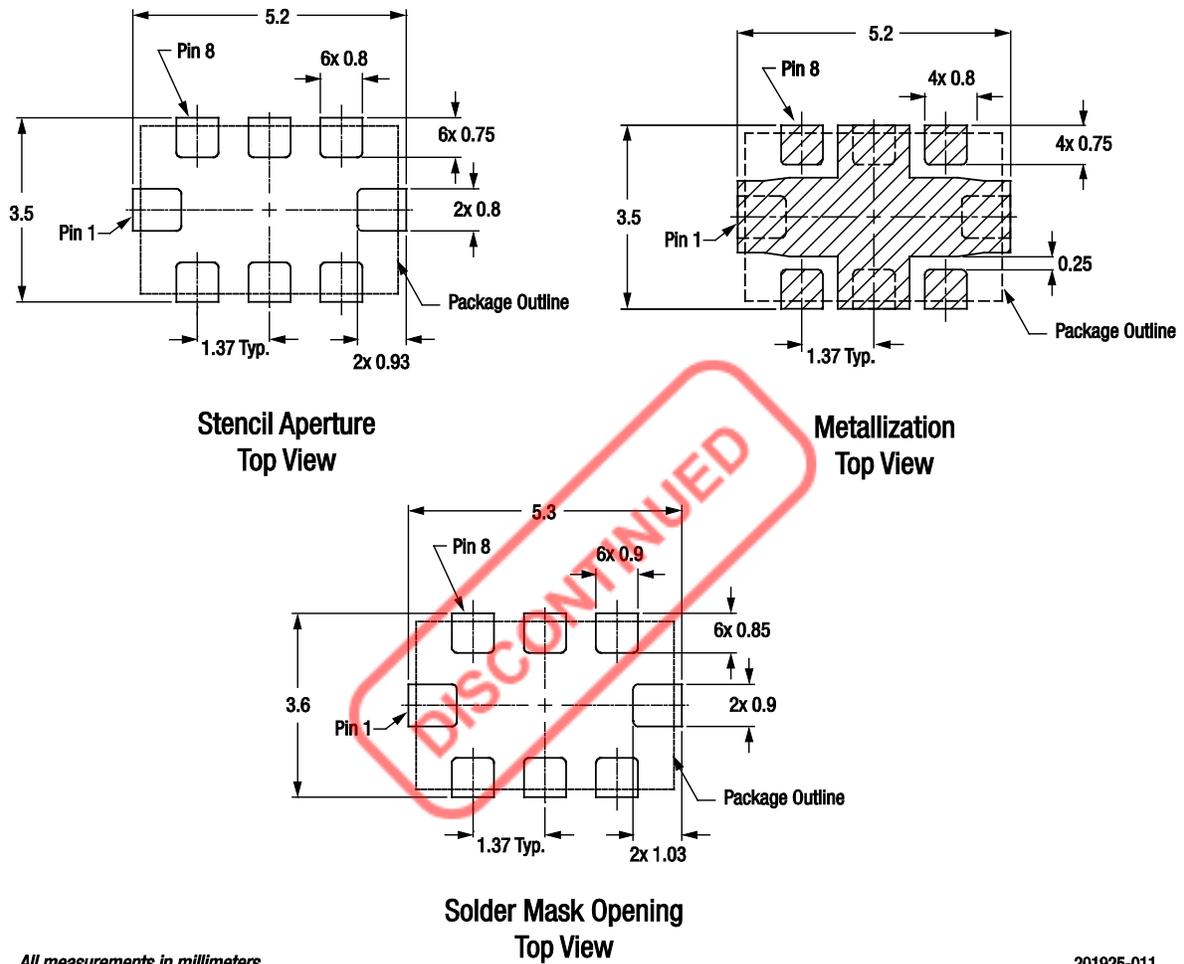
| Cross Section | Name               | Thickness (in) | Material            |
|---------------|--------------------|----------------|---------------------|
|               | Top Solder Mask    |                |                     |
|               | L1                 | (0.0028)       | Cu foil             |
|               | Laminate           | 0.012 ± 0.0006 | Rogers RO4003C Core |
|               | L2                 | (0.0014)       | Cu foil             |
|               | Laminate           | (Note 1)       | FR4 Prepreg         |
|               | L3                 | (0.0014)       | Cu foil             |
|               | Laminate           | 0.010 ± 0.0006 | FR4 Core            |
|               | L4                 | (0.0028)       | Cu foil             |
|               | Bottom Solder Mask |                |                     |

Note 1: Adjust this thickness to meet total thickness goal of 0.062 ± 0.005 inch.

201925-010

Figure 10. Layer Detail Physical Characteristics

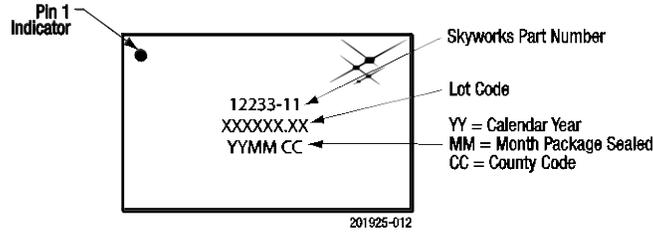




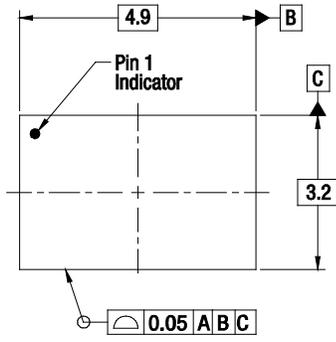
All measurements in millimeters

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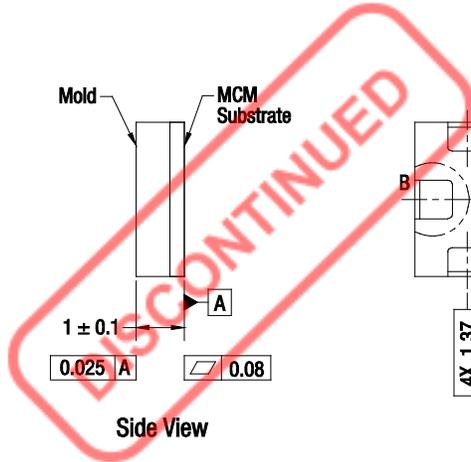
Figure 11. SKY12233-11 PCB Layout Footprint



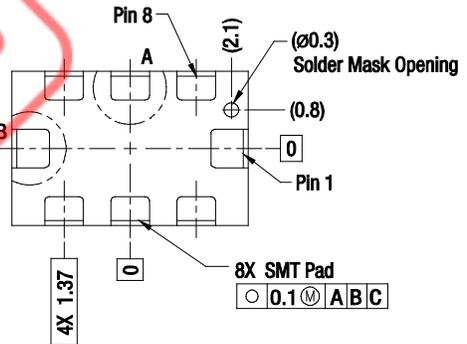
**Figure 12. Typical Part Markings (Top View)**



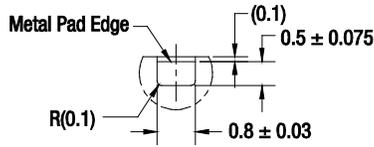
**Top View**



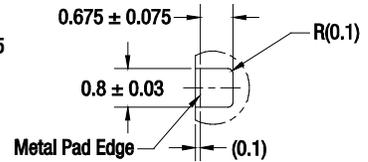
**Side View**



**Bottom View**



**Detail A**  
SMT Pad  
Scale 2X  
3X This Rotation  
3X Rotated 180°



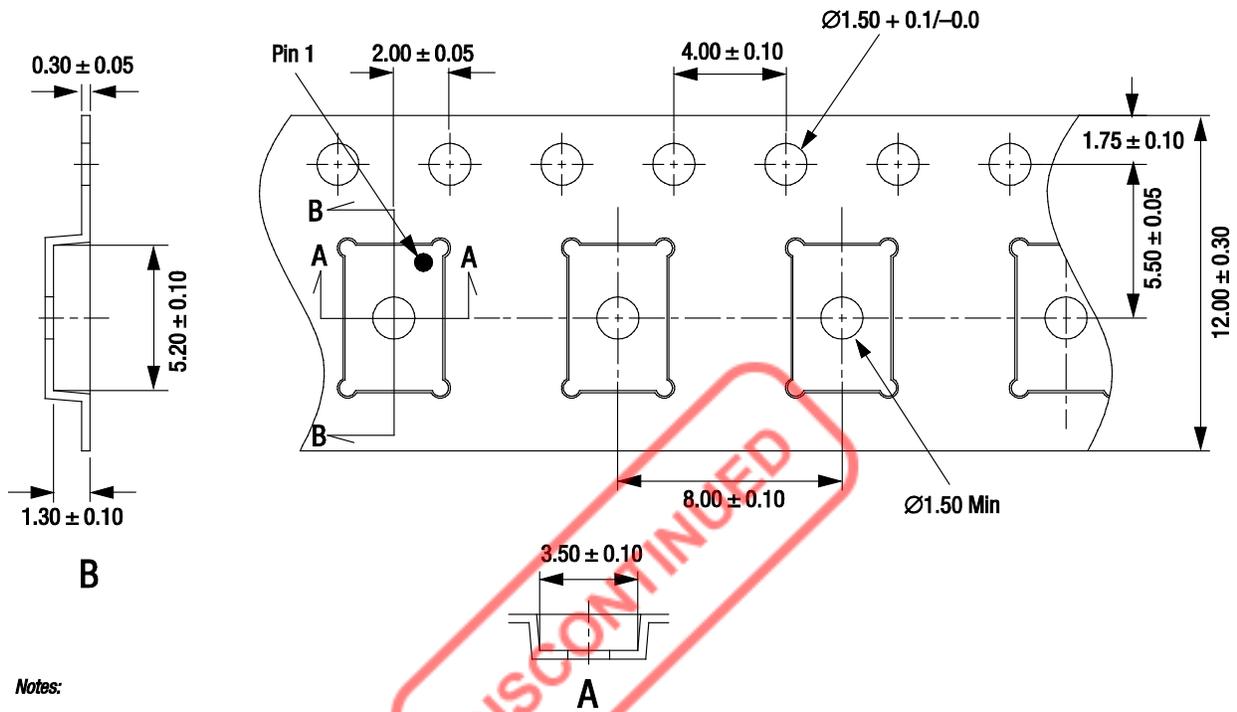
**Detail B**  
SMT Pad  
Scale 2X  
1X This Rotation  
1X Rotated 180°

**Notes:**

1. All measurements are in millimeters.
2. Dimensions and tolerances according to ASME Y14.5M-1994.
3. See applicable bonding diagram and device assembly drawing for die and component placement.
4. Pad definitions per details on drawing.
5. PCB Type 4L PPG TEV MCM (100).

201925-013

**Figure 13. SKY12233-11 Package Dimensions**



**Notes:**

1. Carrier tape: black conductive polycarbonate or polystyrene.
2. Cover tape material: transparent conductive PSA.
3. Cover tape size: 9.30 mm width.
4. Sprocket hole (10) pitch cumulative tolerance: ±0.20 mm.
5. All measurements are in millimeters.

201925-014

**Figure 14. SKY12233-11 Tape and Reel Dimensions**

**Ordering Information**

| Model Name  | Manufacturing Part Number | Evaluation Board Part Number |
|---|---------------------------|------------------------------|
| SKY12233-11: Voltage-Controlled Variable Attenuator | SKY12233-11               | SKY12233-11-EVB              |



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