DATA SHEET

SKY12235-11: High IIP3 1.4 to 2.4 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

- 1.4 to 2.4 GHz broadband operating range
- Maximum attenuation level: 36 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)

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.

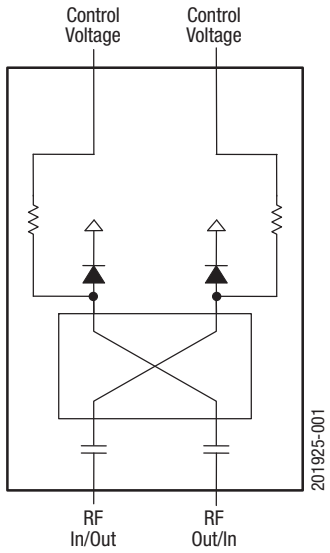

Figure 1. SKY12235-11 Block Diagram

Description

The SKY12235-11 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 1.4 to 2.4 GHz frequency band, but is specifically optimized for use as a wide dynamic range, low distortion attenuator, centered at 1.9 GHz.

The SKY12235-11 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.

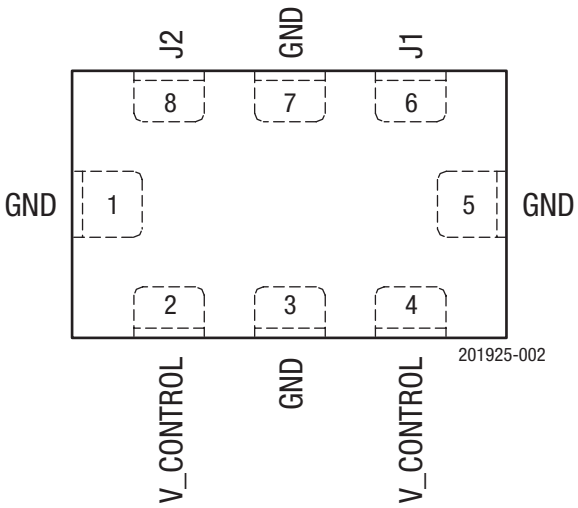

Figure 2. SKY12235-11 Pinout (Top View)

Table 1. SKY12235-11 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 SKY12235-11 is a 50 Ω matched voltage controlled variable attenuator with monotonic attenuation performance from 1.4 to 2.4 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 SKY12235-11 are provided in Table 2. Electrical specifications are provided in Table 3.

Performance characteristics for the SKY12235-11 are illustrated in Figures 3 through 8.

Table 2. SKY12235-11 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Control voltage	$V_{CONTROL}$		10	V
RF input power (CW)	P_{IN}		4	W
Control current	Icc		50	mA
Diode reverse bias voltage			50	V
Storage temperature	T_{STG}	–40	+85	°C
Operating temperature	T_{OP}	–40	+85	°C
Electrostatic discharge:	ESD			
Charged Device Model (CDM), Class 4			1000	V
Human Body Model (HBM), Class 1B			500	V
Machine Model (MM), Class A			100	V

[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.

***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. SKY12235-11 Electrical Specifications[1]
(T_{OP} = +25 °C, $V_{CONTROL}$ = 0 to 5 V, P_{IN} = 0 dBm, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Attenuation	Attn	$V_{CONTROL}$ = 5 V, f = 1.9 GHz	25	36		dB
Control current	Icc	$V_{CONTROL}$ = 5 V		1.7		mA
Insertion loss	IL	$V_{CONTROL}$ = 0 V, f = 1.4 to 2.4 GHz		1.8	2.5	dB
Return loss	RL	$V_{CONTROL}$ = 0 V, f = 1.4 to 2.4 GHz	7	18		dB
Third order input intercept point[2]	IIP3	P_{IN} = +8 dBm each tone, $V_{CONTROL}$ = 0 V, f1 = 1.900 GHz, f2 = 1.910 GHz		+61		dBm

[1] Performance is guaranteed only under the conditions listed in this table.

[2] Minimum specification is guaranteed by design and is not 100% production tested.

Typical Performance Characteristics

(T_{OP} = +25 °C, $V_{CONTROL}$ = 0 to 5 V, P_{IN} = 0 dBm, Characteristic Impedance [Z_0] = 50 Ω, J1 = Input Port, J2 = Output Port, Unless Otherwise Noted)

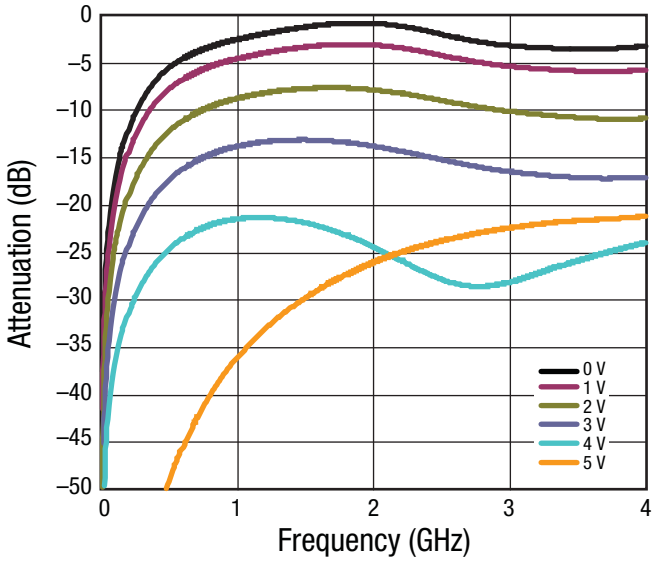

Figure 3. Attenuation vs Frequency Over Control Voltage

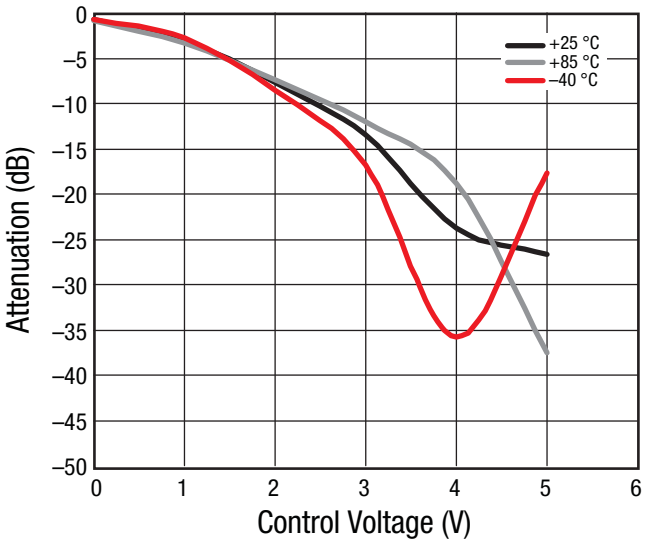

Figure 4. Attenuation vs Control Voltage Over Temperature (f = 1.90 GHz)

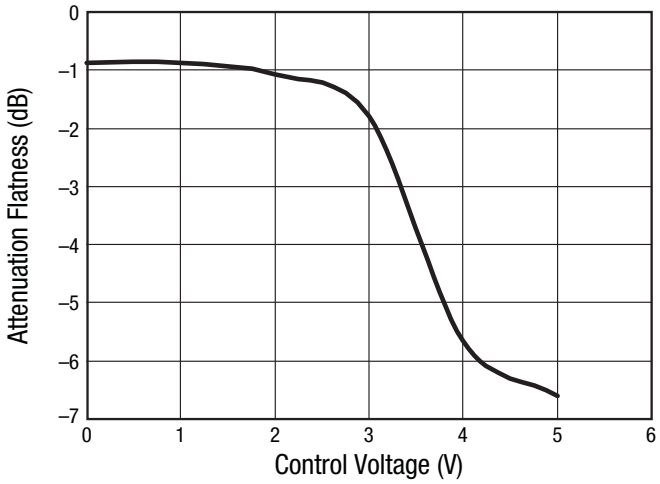

Figure 5. Attenuation Flatness vs Control Voltage (f = 1.4 to 2.4 GHz)

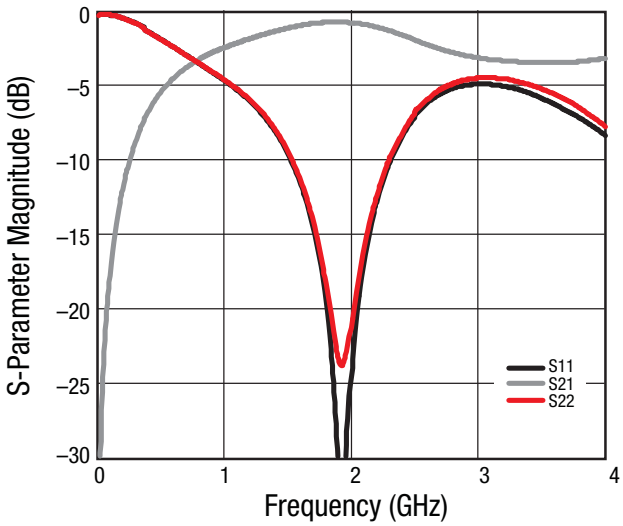

Figure 6. S-Parameter Magnitude vs Frequency

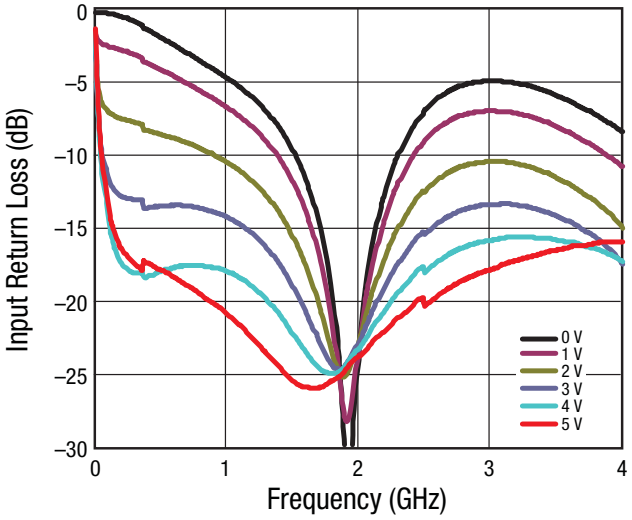

Figure 7. Input Return Loss vs Frequency Over Control Voltage

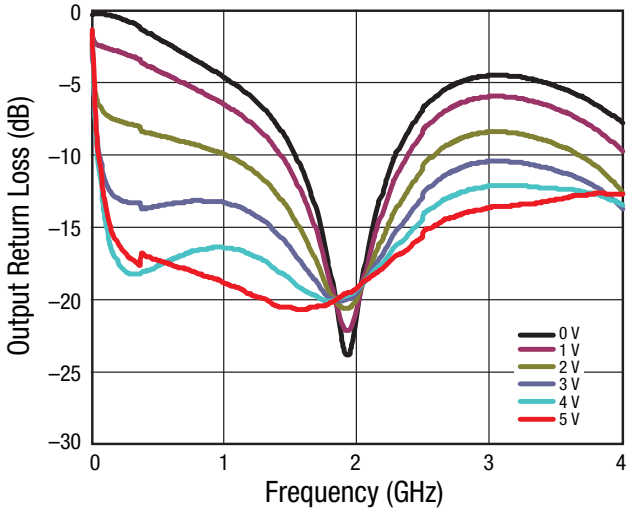

Figure 8. Output Return Loss vs Frequency Over Control Voltage

Evaluation Board Description

The SKY12235-11 Evaluation Board is used to test the performance of the SKY12235-11 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 SKY12235-11 is controlled by applying 0 to 5 V to the V_CONTROL pins.

Package Dimensions

The PCB layout footprint for the SKY12235-11 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 the 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 SKY12235-11 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.

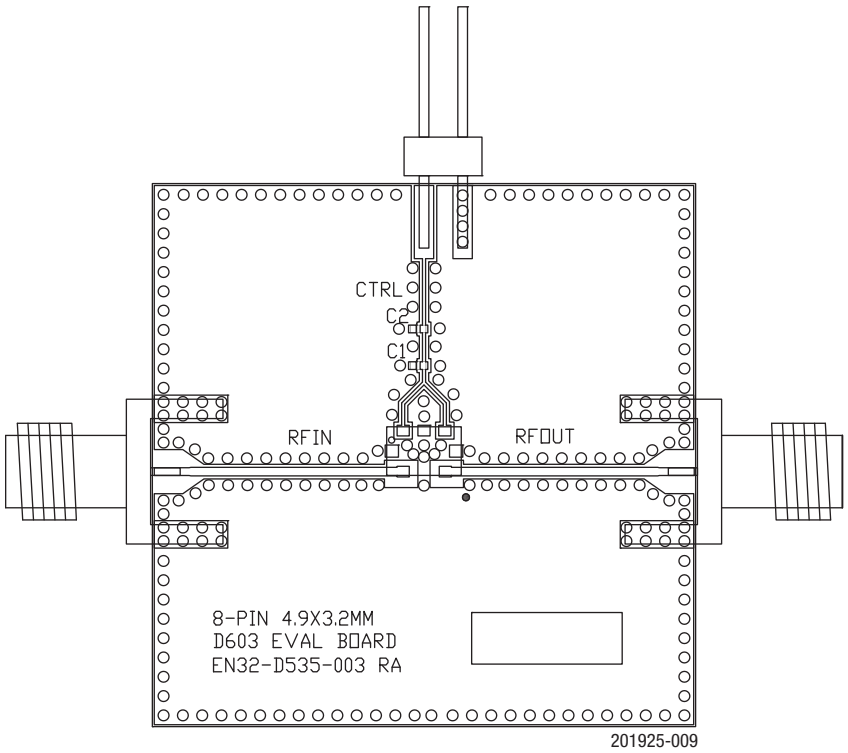

Figure 9. SKY12235-11 Evaluation Board Assembly Diagram

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.

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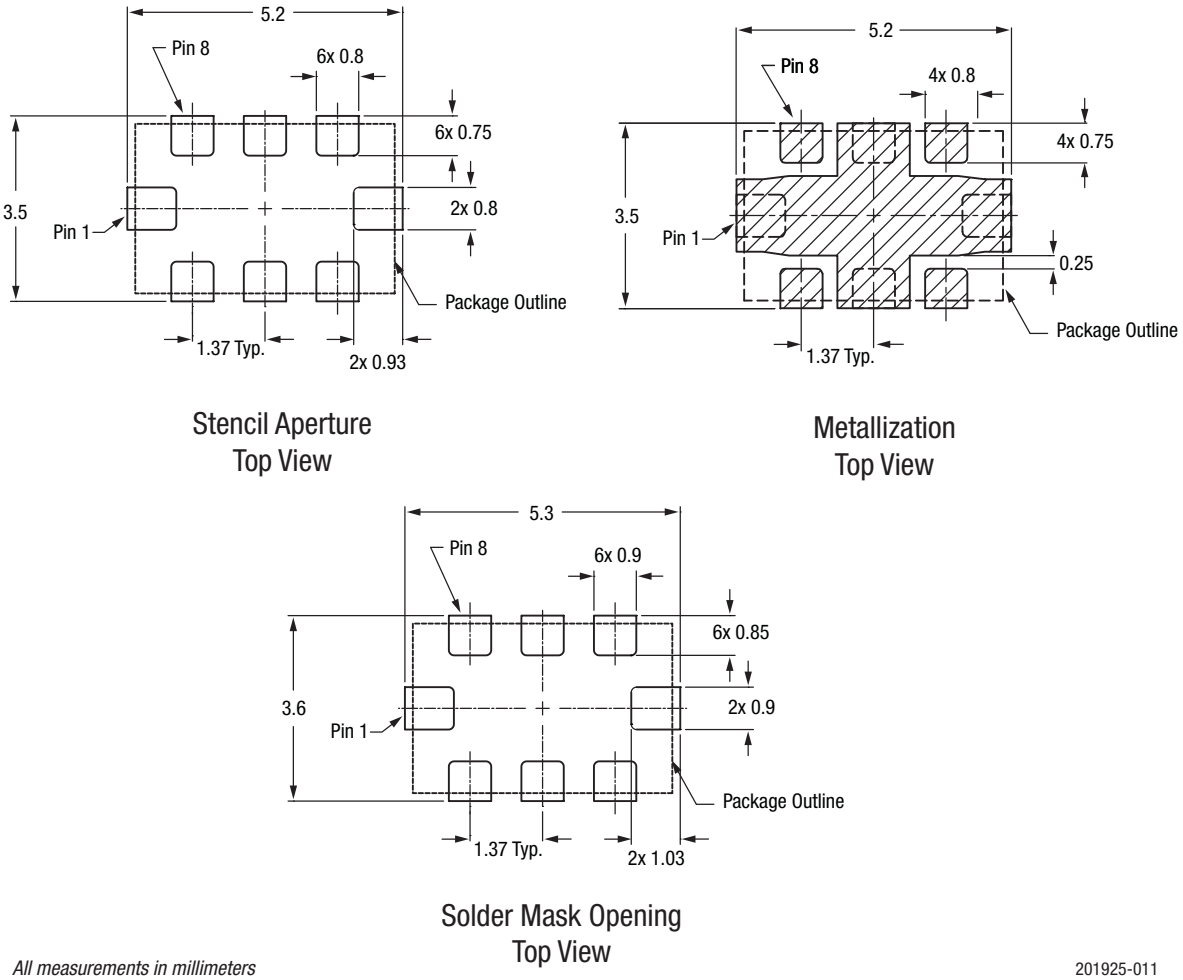
Figure 10. Layer Detail Physical Characteristics



All measurements in millimeters

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Figure 11. SKY12235-11 PCB Layout Footprint

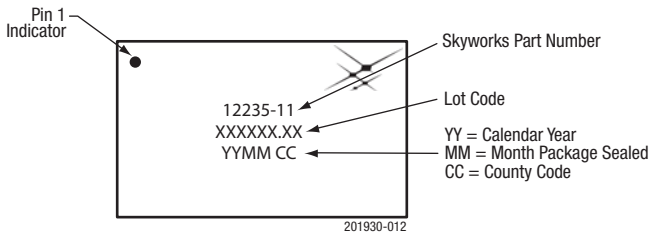
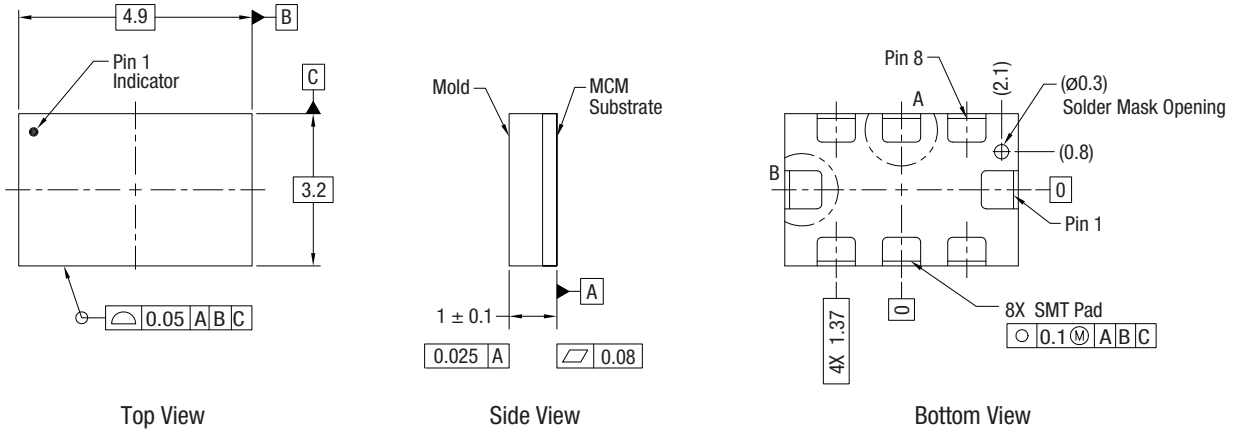
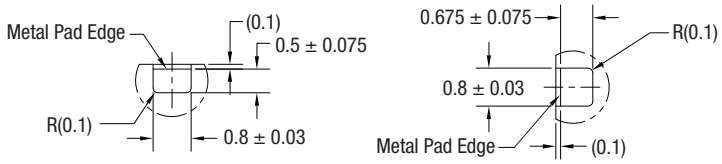


Figure 12. Typical Part Markings (Top View)





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).*

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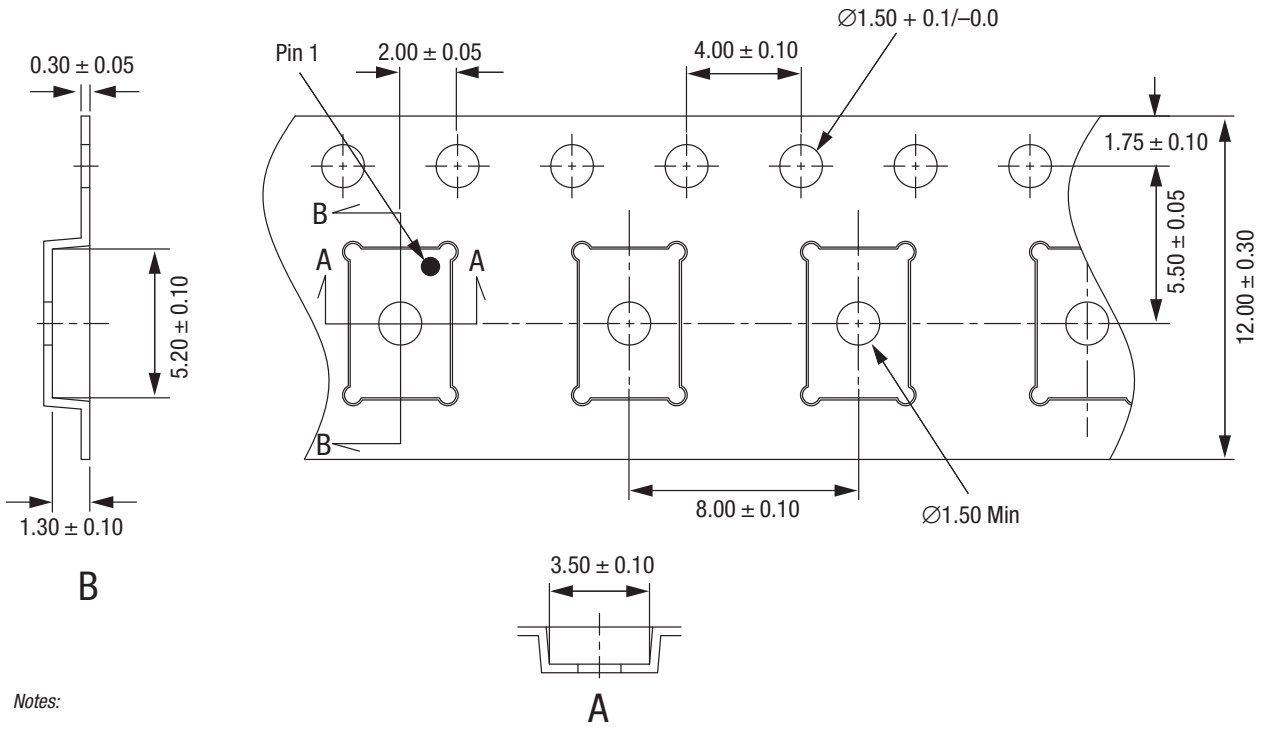
Figure 13. SKY12235-11 Package Dimensions



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.

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Figure 14. SKY12235-11 Tape and Reel Dimensions