



**SKYWORKS®**

DATA SHEET

## SKY12239-11: High IIP3 10 MHz to 1.5 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

- 10 MHz to 1.5 GHz broadband operating range
- Low insertion loss: 2.5 dB @ 700 MHz
- Maximum attenuation level: 40 dB @ 700 MHz
- Control voltage range: 1 V to 5 V
- High IIP3: +50 dBm
- Low current consumption:  
< 2 mA @ maximum attenuation
- Small MCM (8-pin, 3.8 x 3.8 x 1 mm) package (MSL3, 260 °C per JEDEC J-STD-020)
- For RoHS and other product compliance information, see the [Skyworks Certificate of Conformance](#).

### Description

The SKY12239-11 is a voltage-controlled variable attenuator from the Skyworks series of broadband, flat attenuation, high third order input intercept point (IIP3) components. The device is designed to operate over the 10 MHz to 1.5 GHz frequency band, and is specifically optimized for use as a wide dynamic range, low distortion attenuator.

The device provides monotonic attenuation performance over its entire control voltage range, and includes four matched PIN diodes that are biased using an external control voltage signal. The attenuator requires no external components. It operates with a control voltage range of 1 V to 5 V and a 2 mA typical control current at maximum attenuation.

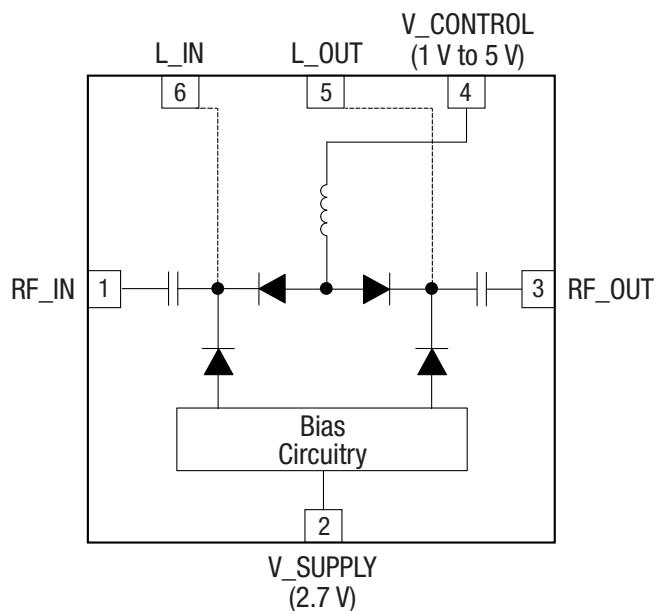


Figure 1. Functional Block Diagram

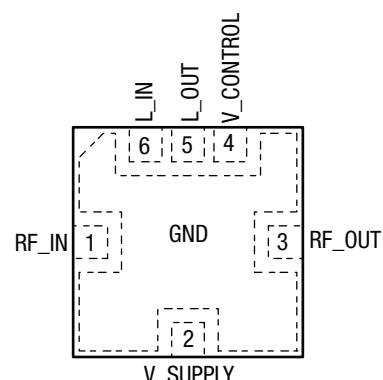


Figure 2. Pinout (Top View)

**Table 1. Signal Descriptions**

Pin	Name	Description	Pin	Name	Description
1	RF_IN	RF input, ac coupled. No external components required.	5	L_OUT	Phase compensation inductor output.
2	V_SUPPLY	Fixed reference supply, 2.7 V dc.	6	L_IN	Phase compensation inductor input.
3	RF_OUT	RF output, ac coupled. No external components required.	7	GND	Device paddle. Ground to the applications board. Provides thermal contact and RF ground.
4	V_CONTROL	Variable reference supply, 1.0 V dc to 5.0 V dc.			

## Technical Description

The SKY12239-11 is a  $50\ \Omega$  matched voltage controlled variable attenuator with monotonic attenuation performance from 10 MHz to 1.5 GHz over its entire control voltage range. The device requires no external biasing or RF matching components. Monotonic performance means that attenuation increases or decreases as applied dc voltage increases or decreases. The device consists of four matched PIN diodes that terminate two ports of an internal matching network.

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 1 V to 5 V and a 2 mA typical control current at maximum attenuation. As control voltage increases, 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 is at maximum (control voltage of approximately 1 V dc).

## Electrical and Mechanical Specifications

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

Parameter	Symbol	Minimum	Maximum	Units
Control voltage	$V_{CTRL}$	0	5.5	V
Reference voltage	$V_{SUPPLY}$		5.5	V
RF input power (CW)	$P_{IN}$		1	W
Control current	$I_{CC}$		50	mA
Thermal impedance ( $V_{CTRL} = 5\ V$ , $V_{SUPPLY} = 2.7\ V$ , $P_{IN} = +21\ dBm$ )	$\Theta_{JC}$		+94	C/W
Storage temperature	$T_{STG}$	-55	+125	°C
Operating temperature	$T_{OP}$	-40	+105	°C
Electrostatic discharge:				
Charged Device Model (CDM), Class C3	ESD		1000	V
Human Body Model (HBM), Class 2			3000	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.

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*ESD Handling: Industry-standard ESD handling precautions must be adhered to at all times to avoid damage to this device.*

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**Table 3. Electrical Specifications <sup>1</sup>**(T<sub>OP</sub> = +25 °C, V<sub>CTRL</sub> = 1 to 5 V, V<sub>SUPPLY</sub> = 2.7 V, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>O</sub>] = 50 Ω, unless otherwise noted)

Parameter	Symbol	Test Condition	Min <sup>2</sup>	Typ	Max	Units
<b>RF Specifications</b>						
Insertion loss (V <sub>CTRL</sub> = 5 V)	S21	100 MHz		2		dB
		700 MHz		2.5	3.5	dB
		1500 MHz		3		dB
Maximum attenuation (V <sub>CTRL</sub> = 1 V)	S21	100 MHz		51		dB
		700 MHz	35	40		dB
		1500 MHz		33		dB
IRL maximum attenuation (V <sub>CTRL</sub> = 1 V)	S11	100 MHz		29		dB
		700 MHz		28		dB
		1500 MHz		22		dB
ORL maximum attenuation (V <sub>CTRL</sub> = 1 V)	S22	100 MHz		29		dB
		700 MHz		27		dB
		1500 MHz		21		dB
IRL minimum attenuation (V <sub>CTRL</sub> = 5 V)	S11	100 MHz		37		dB
		700 MHz		19		dB
		1500 MHz		13		dB
ORL minimum attenuation (V <sub>CTRL</sub> = 5 V)	S22	100 MHz		37		dB
		700 MHz		19		dB
		1500 MHz		13		dB
Third order input intercept point (V <sub>CTRL</sub> = 5 V)	IIP3	100 MHz, 1 MHz tone spacing, +22 dBm/tone		50		dBm
		700 MHz, 1 MHz tone spacing, +22 dBm/tone		50		dBm
		1500 MHz, 1 MHz tone spacing, +22 dBm/tone		50		dBm
1 dB input compression point (V <sub>CTRL</sub> = 5 V)	IP1dB	12.5% duty cycle		34		dBm
				40		dBm
				40		dBm
Phase shift @ 150 nH <sup>3</sup>	Φ	700 MHz		15		Degrees
<b>DC Specifications</b>						
Control voltage	V <sub>CTRL</sub>	1.0 to 5.0 V nominal	1	5	5.5	V
Control current	I <sub>CTL</sub>	5.0 V, V <sub>CTRL</sub> ; 2.7 V, V <sub>SUPPLY</sub>		20		mA
Supply voltage	V <sub>SUPPLY</sub>	Fixed supply		2.7		V
Supply current	I <sub>SUPPLY</sub>			2		mA
Settling time @ 700 MHz	t <sub>SETTLE</sub>	V <sub>SUPPLY</sub> = 2.7 V, V <sub>CTRL</sub> change from 5 V to 1 V, settled within 0.2 dB of respective state, 10 KHz repetitive rate, 50% duty cycle		8		μs

1. Performance is guaranteed only under the conditions listed in this table.
2. Minimum specification is assured by design and is not 100% production tested.
3. L1 is 0201 size, 150 nH inductor from TDK. Part number is MLG0603SR15J.

## Typical Performance Characteristics

(TOP = +25 °C, V<sub>CTRL</sub> = 0 to 5 V, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, J1 = Input Port, J2 = Output Port, Unless Otherwise Noted)

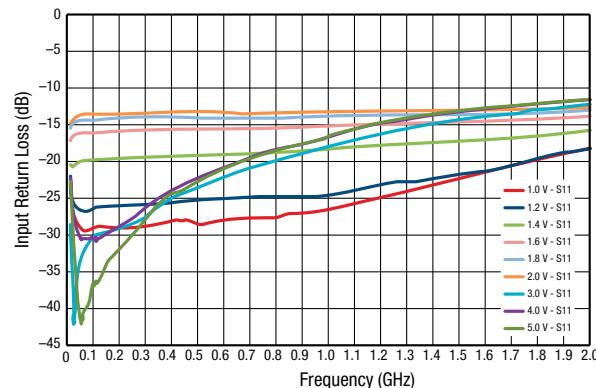


Figure 3. Input Return Loss vs. Freq. Over Control Voltage

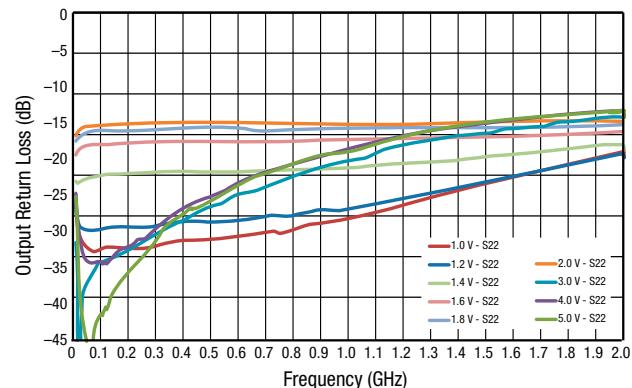


Figure 4. Output Return Loss vs. Freq. Over Control Voltage

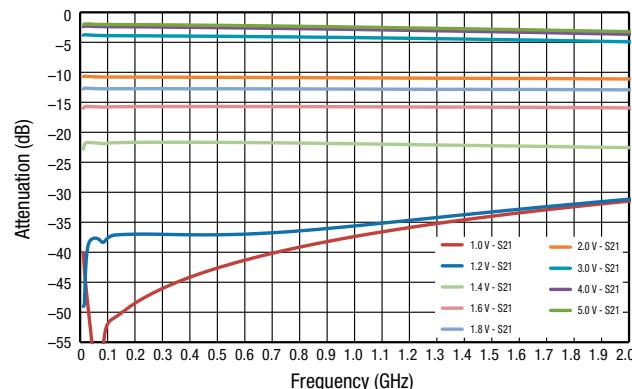
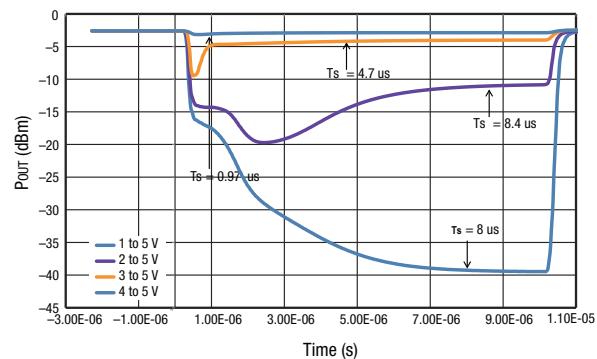


Figure 5. Attenuation vs. Frequency Over Control Voltage



Note: Settling Time = -0.2 dB from final settled value.

Figure 6. Settling Time — Falling Edge  
(f = 700 MHz, Rep Rate = 50 kHz, Duty Cyle = 50%, 25 °C)

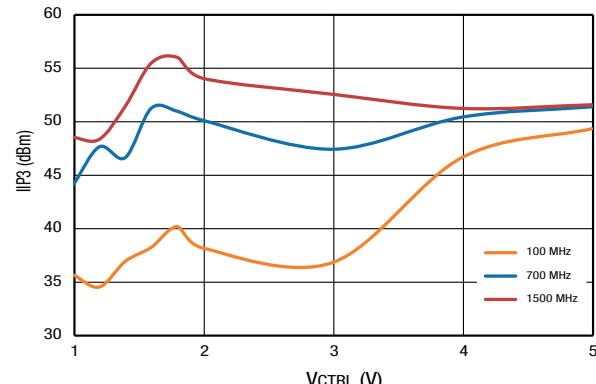


Figure 7. IIP3 vs. VCTRL over Frequency  
(1 MHz tone spacing, +22 dBm/tone)

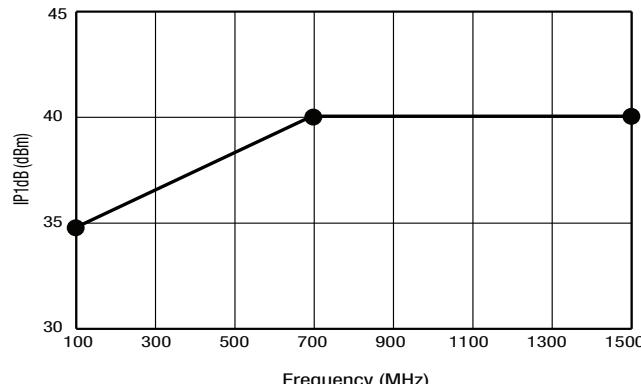


Figure 8. IP1dB vs. Frequency

## Evaluation Board Description

The evaluation board is used to test the performance of the SKY12239-11 variable attenuator. A schematic of the evaluation board is shown in Figure 9. The attenuation level of the device is controlled by applying 1 V to 5 V to the V\_CONTROL pin.

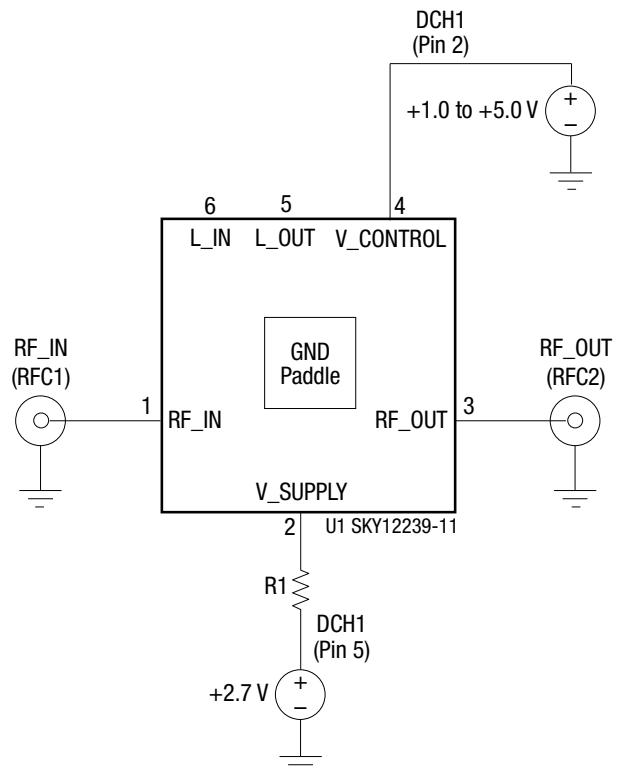


Figure 9. Evaluation Board Schematic

Table 4. Evaluation Board Bill of Materials

Component	Description	Value	Size
R1	Resistor	0 Ω	0402
L1	Inductor	DNI	0402

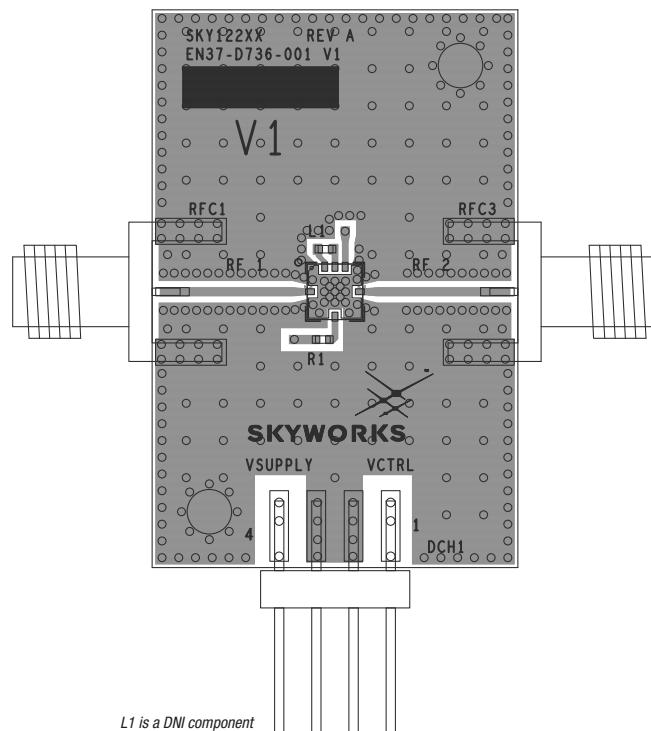


Figure 10. Evaluation Board Assembly Diagram

Cross Section	Name	Thickness (in)	Material
	Top Solder Mask		
	L1	(0.0007)	Finished Copper Thickness
	Dielectric	0.010	Rogers R04350 Core
	L2	(0.0007)	Finished Copper Thickness
	Dielectric	(Note 1)	FR4 Prepreg
	L3	(0.0007)	Finished Copper Thickness
	Bottom Solder Mask		

*Note 1: Adjust this thickness to meet total thickness goal of  $0.062 \pm 0.005$  inch.*

Figure 11. Layer Detail Physical Characteristics

## 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 SKY12239-11 is rated to Moisture Sensitivity Level 3 (MSL 3) 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. Product production quantities are shipped in a standard tape and reel format.

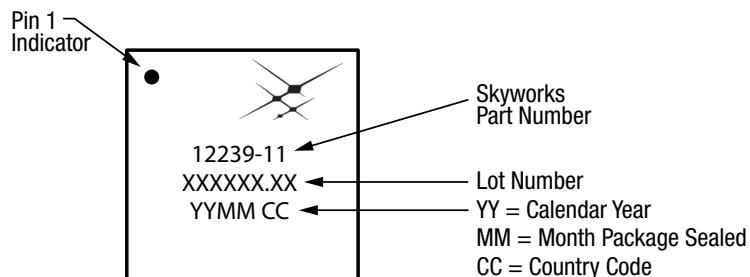


Figure 12. Typical Part Marking

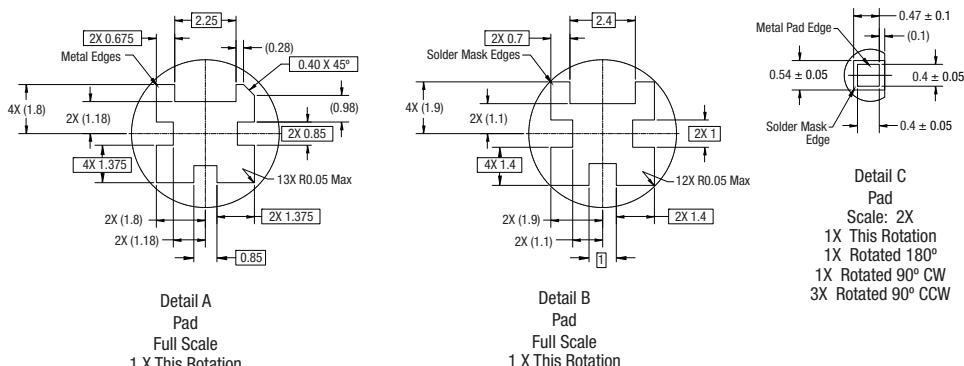
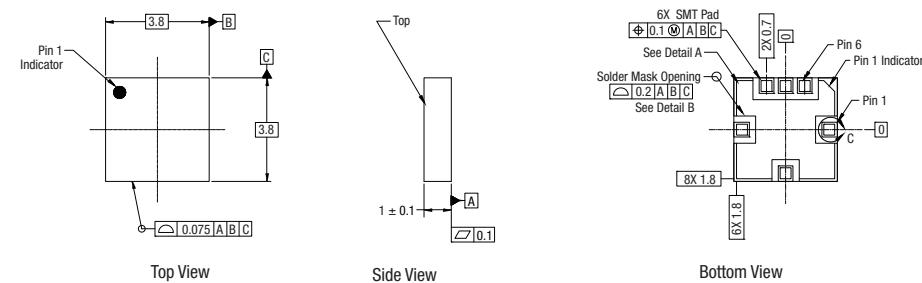
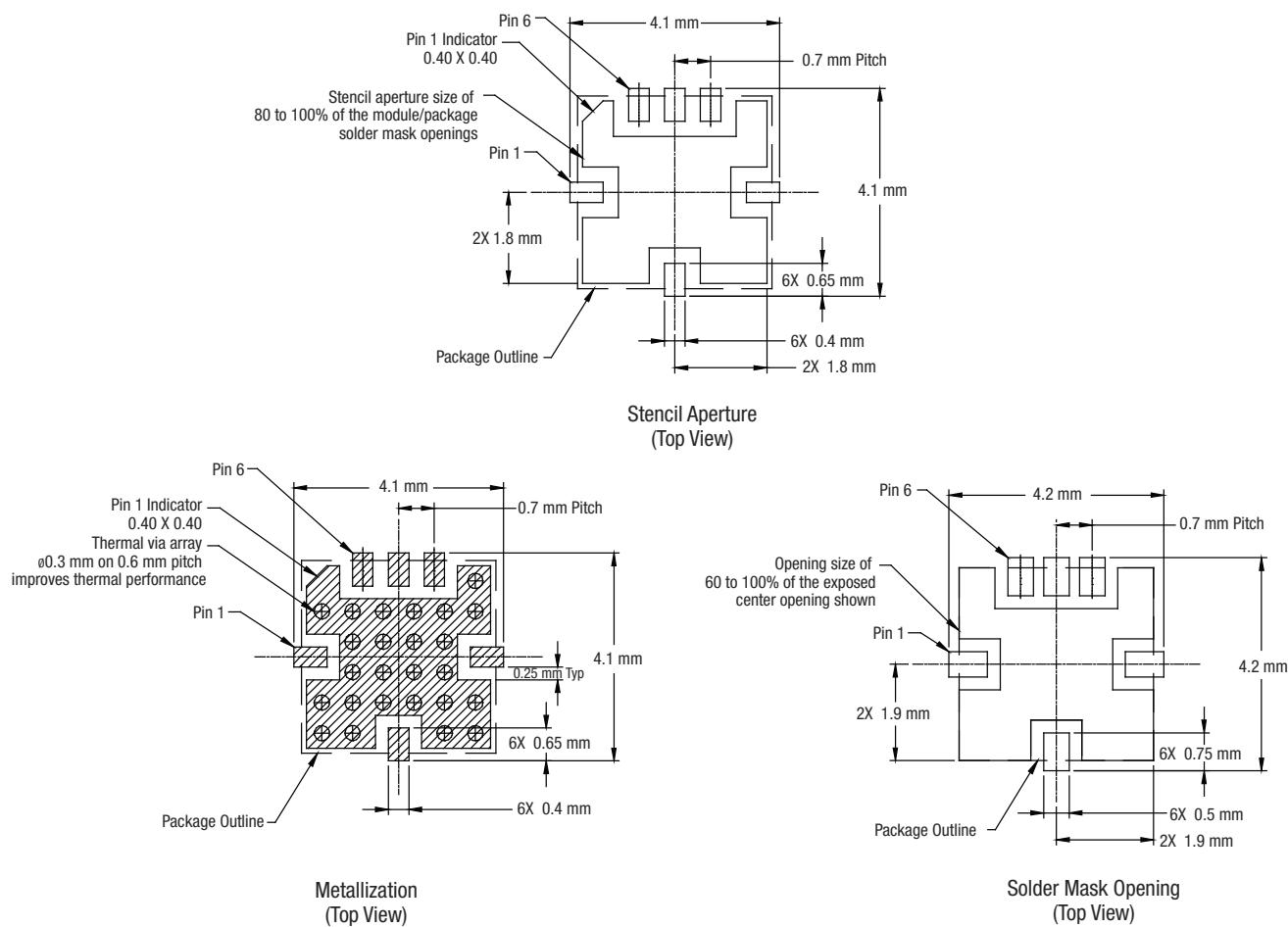


Figure 13. Package Dimensions

**Notes:**

1. Thermal vias should be resin filled and capped in accordance with IPC-4761 type VII vias.
2. Recommended Cu thickness is 30 to 35  $\mu\text{m}$ .

**Figure 14. PCB Layout Footprint (Top View)**

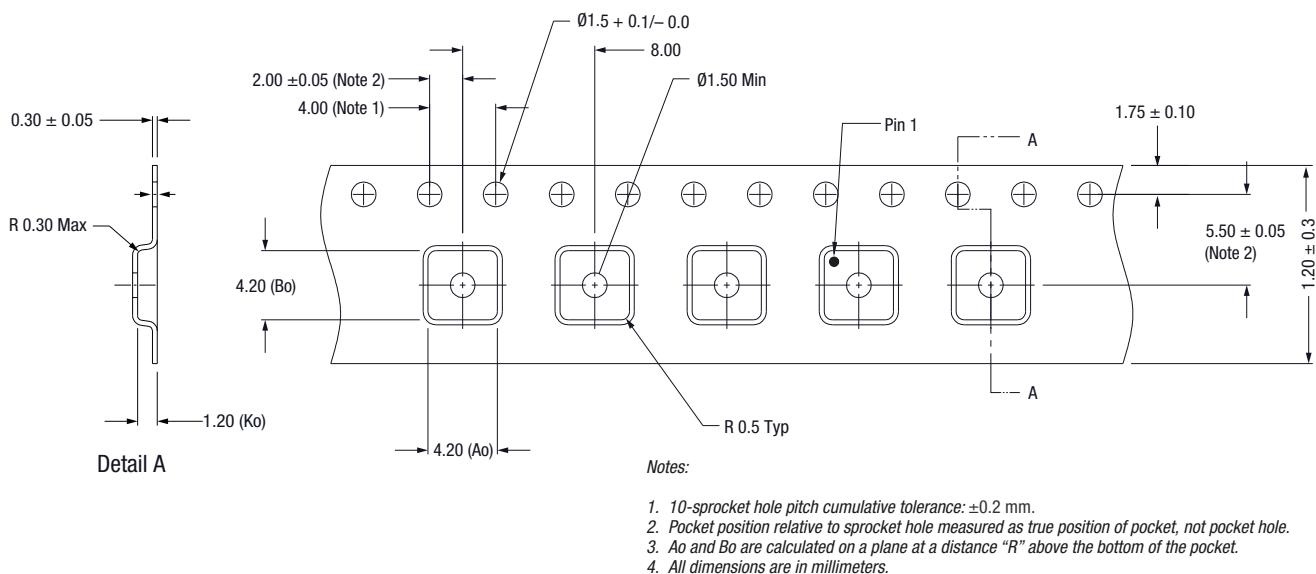


Figure 15. Tape and Reel Information

## Ordering Information

Part Number	Description	Evaluation Board Part Number
SKY12239-11	High IIP3 10 MHz to 1.5 GHz Voltage-Controlled Variable Attenuator	SKY12239-11EK1

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