DATA SHEET

SKY67226-11: 2.2-3.0 GHz Integrated Low-Noise Amplifier Module

Applications

- Satellite Digital Audio Radio Service (SDARS)
- LTE systems
- Cellular infrastructure
- ISM band systems

Features

- Requires only one external component
- Optimized for 2.2 to 3.0 GHz operation
- Noise Figure: 1.02 dB typical @ 2.5 GHz
- Gain: 16.6 dB typical @ 2.5 GHz
- Input return loss: 22 dB typical @ 2.5 GHz
- Operating voltage range: 3.3 to 5.0 V
- Adjustable supply current: 30 to 110 mA
- High linearity IIP3: +20.9 dBm typical @ 2.5 GHz
- MCM (16-pin, 4 x 4 mm) package (MSL3, 260 °C per JEDEC J-STD-020) package

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.

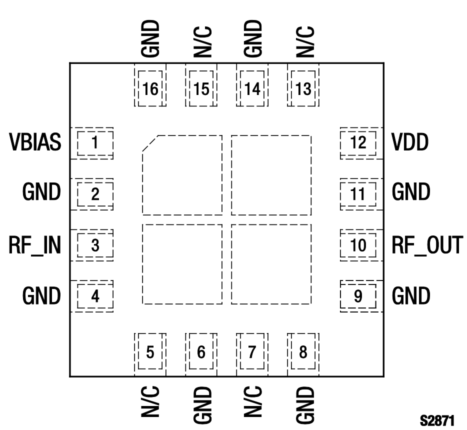


Figure 2. SKY67226-11 Pinout – 16-Pin MCM Package (Top View)

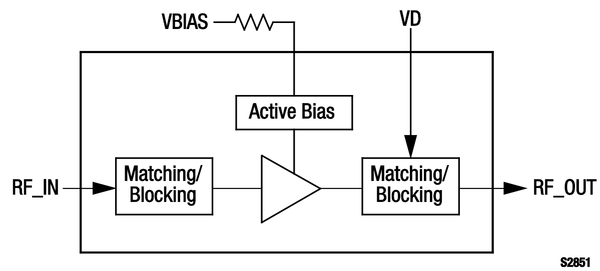


Figure 1. SKY67226-11 LNA Block Diagram

Description

The SKY67226-11 is a high performance, integrated Low-Noise Amplifier (LNA) designed for use in 2.2 to 3.0 GHz wireless infrastructure applications. The device consists of a single high linearity, LNA and all associated matching components. The only external component necessary for proper operation is an external resistor, used to set the DC current. The device is also completely DC bypassed.

The package design nearly eliminates external surface mount components, greatly reduces printed circuit board area, and offers low thermal resistance for enhanced Mean Time Between Failures (MTBFs).

For optimum performance in the following frequency ranges, refer to the following product Data Sheets (all devices are pin-to-pin compatible with the SKY67226-11):

- 0.4 GHz to 0.7 GHz: SKY67215-11 (document #201842)
- 0.7 GHz to 1.2 GHz: SKY67216-11 (document #201808)
- 1.6 GHz to 2.1 GHz: SKY67221-11 (document #201838)

The SKY67226-11 is packaged in a 16-pin, 4 x 4 mm Multi-Chip Module (MCM). A block diagram of the SKY67226-11 is shown in Figure 1. The device package and pinout are shown in Figure 2.

Electrical and Mechanical Specifications

Signal pin assignments and functional pin descriptions are described in Table 1. The absolute maximum ratings of the SKY67226-11 are provided in Table 2. Electrical specifications are provided in Table 3.

Typical performance characteristics of the SKY67226-11 are illustrated in Figures 3 through 24 (89 mA supply current).

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 SKY67226-11 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 and 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.

Table 1. SKY67226-11 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	VBIAS	Low current bias for amplifier. External resistor sets current consumption.	9	GND	Ground
2	GND	Ground	10	RF_OUT	RF output, AC coupled. No external components required.
3	RF_IN	RF input, AC coupled. No external components required.	11	GND	Ground
4	GND	Ground	12	VDD	High current amplifier bias connection. No external bypassing required.
5	N/C	No connection	13	N/C	No connection
6	GND	Ground	14	GND	Ground
7	N/C	No connection	15	N/C	No connection
8	GND	Ground	16	GND	Ground

Table 2. Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{DD}		5.5	V
RF input power	P_{IN}		+20	dBm
Channel temperature	T_{CH}		150	°C
Operating temperature	T_A	–55	+100	°C
Storage temperature	T_{STG}	–65	+150	°C
Thermal resistance	Θ_{JC}		68.8	°C/W

Note: 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.

***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. The SKY67226-11 ESD threshold level is 500 VDC using Human Body Model (HBM) testing (Class 1B), 50 VDC using Man-Machine (MM) model testing (Class A), and 1000 VDC using Charged Device Model (CDM) testing (Class IV).*

Table 3. SKY67226-11 Electrical Characteristics (Note 1) (Note 2) (Note 3)
(V_{DD} = VBIAS = 5 V Nominal, I_{DD} = 89 mA, T_A = +25 °C, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Minimum	Typical	Maximum	Units
RF Specifications						
Noise Figure (Note 4)	NF	@ 2.5 GHz		1.02	1.35	dB
Small signal gain	$\lvert S_{21} \rvert$	@ 2.5 GHz	14.6	16.6		dB
Input return loss	$\lvert S_{11} \rvert$	@ 2.5 GHz	15.0	22.0		dB
Output return loss	$\lvert S_{22} \rvert$	@ 2.5 GHz	12	16		dB
Reverse isolation	$\lvert S_{12} \rvert$	@ 2.5 GHz	28.6	30.6		dB
3rd Order Input Intercept Point	IIP3	@ 2.5 GHz, Δf = 1 MHz, P_{IN} = –20 dBm/tone	+17.9	+20.9		dBm
3rd Order Output Intercept Point	OIP3	@ 2.5 GHz, Δf = 1 MHz, P_{IN} = –20 dBm/tone	+34.5	+37.5		dBm
Input 1dB Compression Point	IP1dB	@ 2.5 GHz	+4.4	+6.4		dBm
Output 1dB Compression Point	OP1dB	@ 2.5 GHz	+20	+22		dBm
Stability (Note 3)	µ1, µ2, K, B	Up to 18 GHz, –40 °C to +85 °C		>1		–
DC Specifications						
Supply voltage	V_{DD}			5		V
Quiescent current	I_{DD}	R_{BIAS} = 6.8 kΩ		89		mA

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

Note 2: Circuit topology optimized for best compromise between NF, S_{11}, IIP3, and IP1dB.

Note 3: Applies to typical application circuit and components shown in Figure 24.

Note 4: Loss from input SMA connector and Evaluation Board up to pin 3 of device has been de-embedded (0.08 dB @ 2.5 GHz) from the NF measurement.

Table 4. SKY67226-11 Electrical Characteristics (Note 1) (Note 2)
(V_{DD} = VBIAS = 5 V Nominal, I_{DD} = 110 mA, T_A = +25 °C, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Minimum	Typical	Maximum	Units
RF Specifications						
Noise Figure (Note 4)	NF	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		0.95 1.05 1.35		dB dB dB
Small signal gain	$\|S_{21}\|$	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		17.3 16.6 14.3		dB dB dB
Input return loss	$\|S_{11}\|$	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		14.8 23.0 14.0		dB dB dB
Output return loss	$\|S_{22}\|$	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		12.5 14.5 9.5		dB dB dB
Reverse isolation	$\|S_{12}\|$	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		31.5 31.0 31.0		dB dB dB
3rd Order Input Intercept Point	IIP3	Δf = 1 MHz, P_{IN} = –20 dBm/tone: @ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		 +19.2 +21.0 +20.1		 dBm dBm dBm
3rd Order Output Intercept Point	OIP3	Δf = 1 MHz, P_{IN} = –20 dBm/tone: @ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		 +36.5 +37.6 +34.4		 dBm dBm dBm
Input 1dB Compression Point	IP1dB	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		+3.4 +6.0 +9.0		dBm dBm dBm
Output 1dB Compression Point	OP1dB	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		+19.7 +21.6 +22.3		dBm dBm dBm
Stability (Note 3)	μ1, μ2, K, B	Up to 18 GHz, –40 °C to +85 °C		>1		–
DC Specifications						
Supply voltage	V_{DD}			5		V
Quiescent current	I_{DD}	R_{BIAS} = 5.6 kΩ		110		mA

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

Note 2: Circuit topology optimized for best compromise between NF, S_{11}, IIP3, and IP1dB.

Note 3: Applies to typical application circuit and components shown in Figure 25.

Note 4: Loss from input SMA connector and Evaluation Board up to pin 3 of device has been de-embedded from the NF measurement (0.08 dB).

Table 5. SKY67226-11 Electrical Characteristics (Note 1) (Note 2)
(V_{DD} = VBIAS = 5 V Nominal, I_{DD} = 45 mA, T_A = +25 °C, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Minimum	Typical	Maximum	Units
RF Specifications						
Noise Figure (Note 4)	NF	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		0.90 0.97 1.30		dB dB dB
Small signal gain	$\|S_{21}\|$	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		16.4 15.7 13.4		dB dB dB
Input return loss	$\|S_{11}\|$	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		12.2 19.0 12.0		dB dB dB
Output return loss	$\|S_{22}\|$	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		12.2 14.0 9.0		dB dB dB
Reverse isolation	$\|S_{12}\|$	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		31.5 31.2 31.5		dB dB dB
3rd Order Input Intercept Point	IIP3	Δf = 1 MHz, P_{IN} = –20 dBm/tone: @ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		 +16.4 +17.2 +16.4		 dBm dBm dBm
3rd Order Output Intercept Point	OIP3	Δf = 1 MHz, P_{IN} = –20 dBm/tone: @ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		 +32.8 +32.9 +29.8		 dBm dBm dBm
Input 1dB Compression Point	IP1dB	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		+3.9 +6.4 +9.1		dBm dBm dBm
Output 1dB Compression Point	OP1dB	@ 2.2 GHz @ 2.5 GHz @ 3.0 GHz		+19.3 +21.1 +21.5		dBm dBm dBm
Stability (Note 3)	µ1, µ2, K, B	Up to 18 GHz, –40 °C to +85 °C		>1		–
DC Specifications						
Supply voltage	V_{DD}			5		V
Quiescent current	I_{DD}	R_{BIAS} = 12 kΩ		45		mA

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

Note 2: Circuit topology optimized for best compromise between NF, S_{11}, IIP3, and IP1dB.

Note 3: Applies to typical application circuit and components shown in Figure 25.

Note 4: Loss from input SMA connector and Evaluation Board up to pin 3 of device has been de-embedded from the NF measurement (0.08 dB).

Typical Performance Characteristics @ I_{DD} = 89 mA

(V_{DD} = VBIAS = 5 V Nominal, T_A = +25 °C, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted)

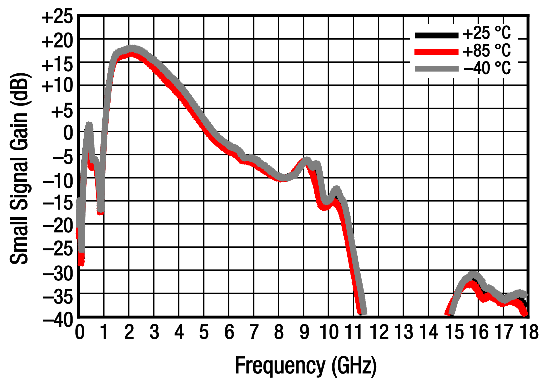


Figure 3. Broadband Gain Response vs Frequency Over Temperature

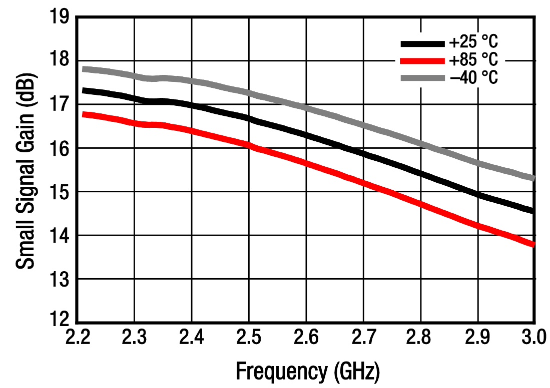


Figure 4. Narrowband Gain Response vs Frequency Over Temperature

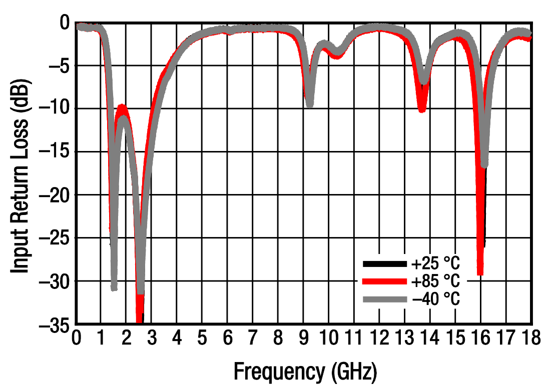


Figure 5. Broadband Input Return Loss vs Frequency Over Temperature

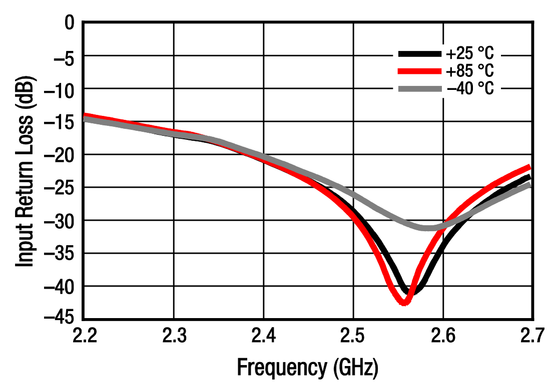


Figure 6. Narrowband Input Return Loss vs Frequency Over Temperature

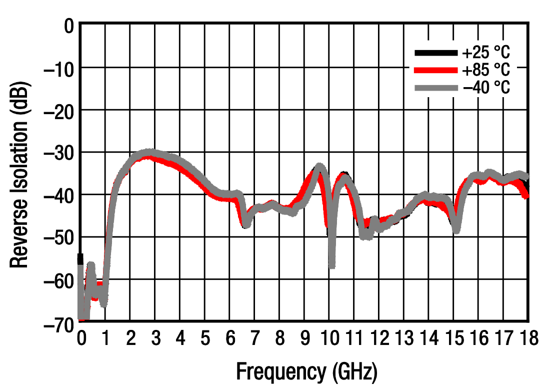


Figure 7. Broadband Reverse Isolation vs Frequency Over Temperature

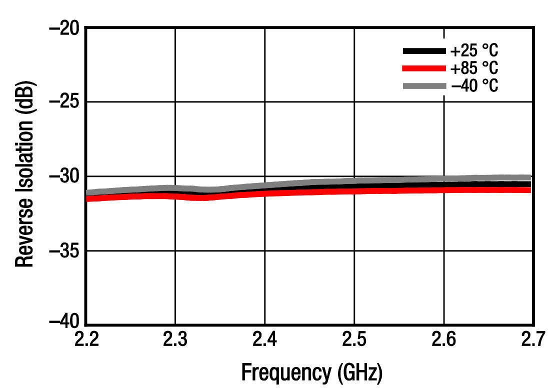


Figure 8. Narrowband Reverse Isolation vs Frequency Over Temperature

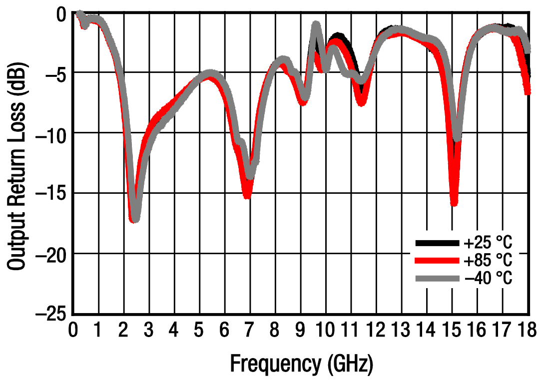


Figure 9. Broadband Output Return Loss vs Frequency Over Temperature

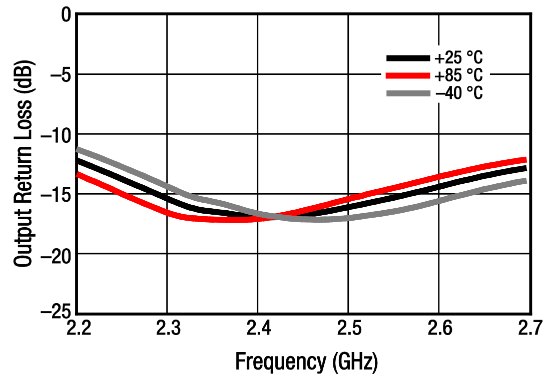


Figure 10. Narrowband Output Return Loss vs Frequency Over Temperature

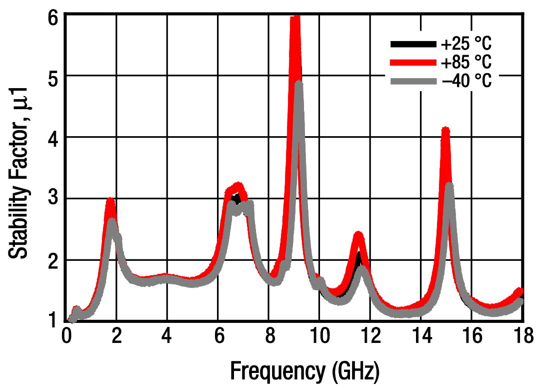


Figure 11. Stability Factor (μ1) vs Frequency Over Temperature

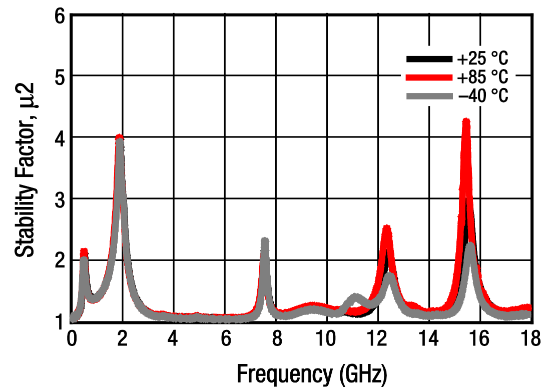


Figure 12. Stability Factor (μ2) vs Frequency Over Temperature

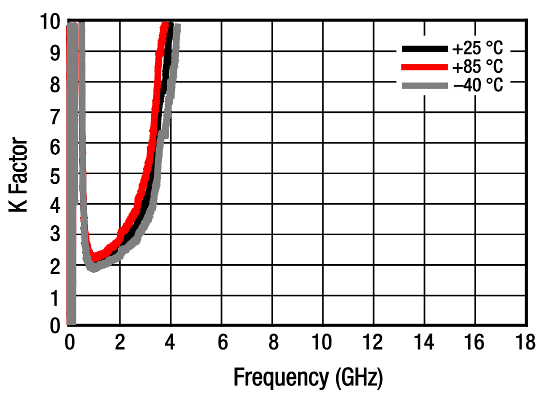


Figure 13. Stability Factor (K) vs Frequency Over Temperature

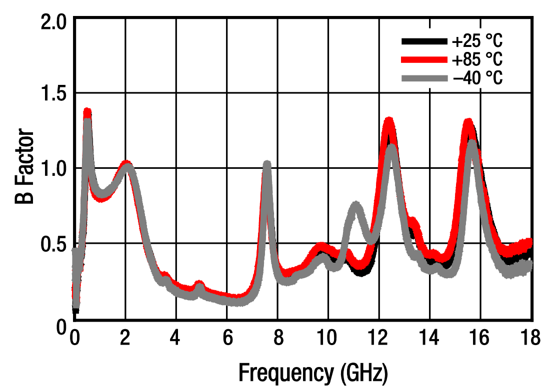


Figure 14. Stability Factor (B) vs Frequency Over Temperature

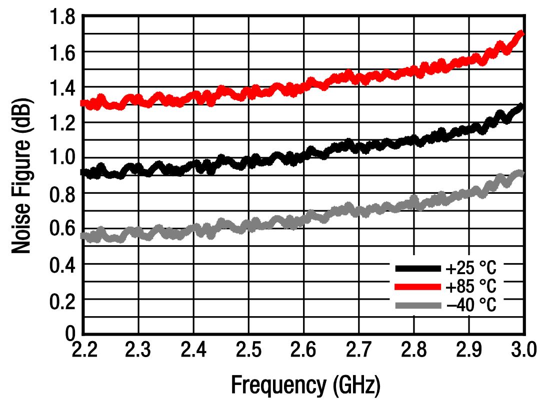


Figure 15. Noise Figure vs Frequency Over Temperature

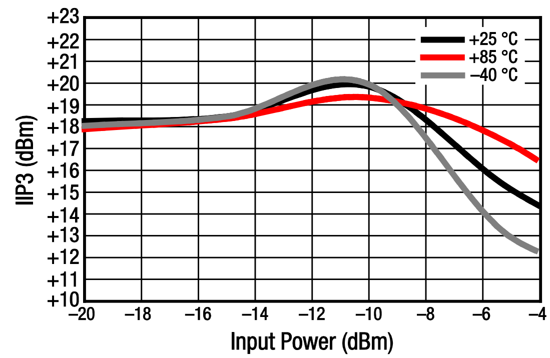


Figure 16. IIP3 vs Input Power Over Temperature @ 2300 MHz (PIN = –20 dBm, Tone Spacing = 1 MHz)

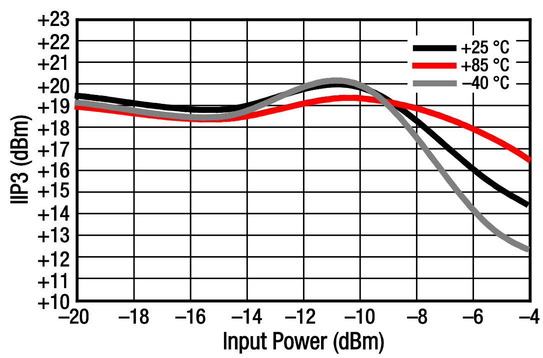


Figure 17. IIP3 vs Input Power Over Temperature @ 2500 MHz (PIN = –20 dBm, Tone Spacing = 1 MHz)

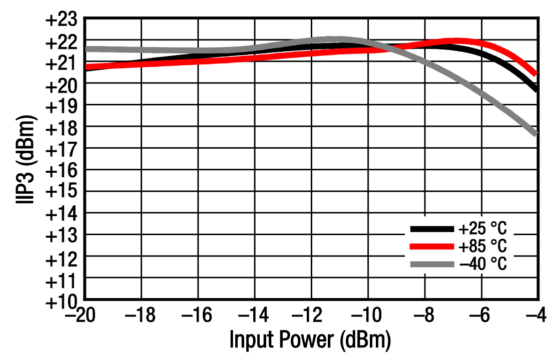


Figure 18. IIP3 vs Input Power Over Temperature @ 2700 MHz (PIN = –20 dBm, Tone Spacing = 1 MHz)

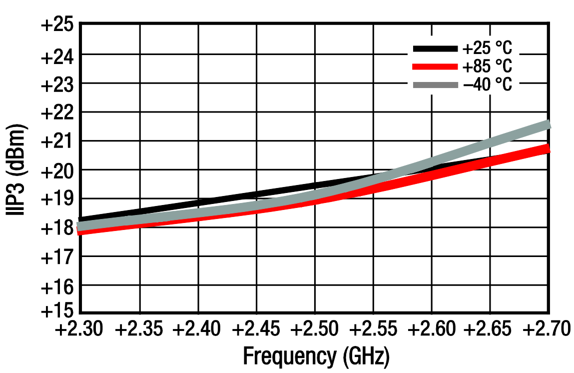


Figure 19. IIP3 vs Frequency Over Temperature (PIN = –20 dBm, Tone Spacing = 1 MHz)

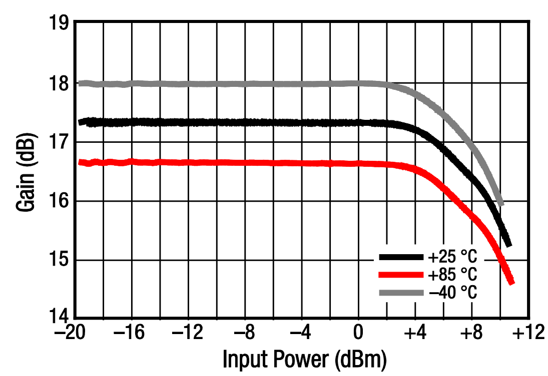


Figure 20. Gain vs Input Power Over Temperature @ 2300 MHz

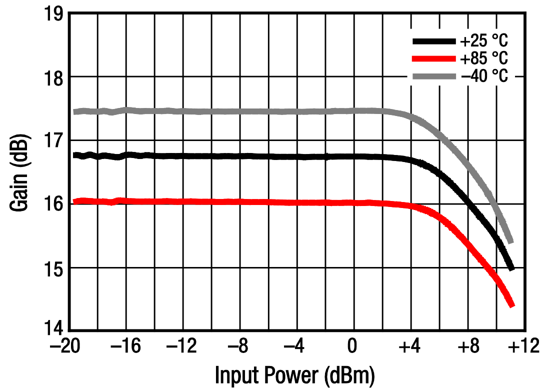


Figure 21. Gain vs Input Power Over Temperature @ 2500 MHz

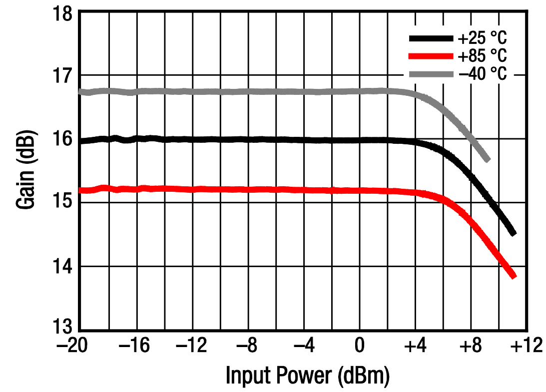


Figure 22. Gain vs Input Power Over Temperature @ 2700 MHz

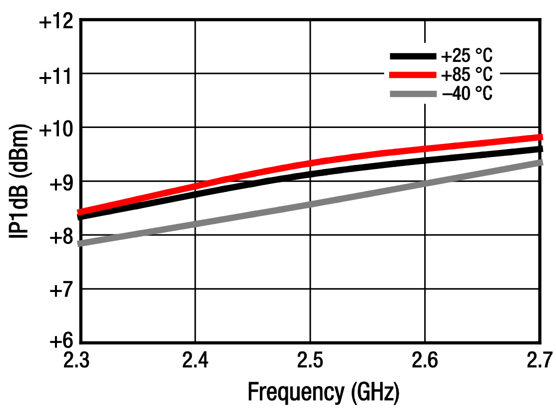


Figure 23. Gain vs Input Power Over Frequency and Temperature

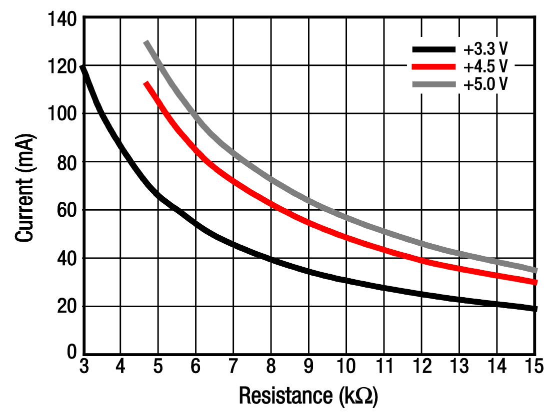


Figure 24. Resistor R1 vs Current Over Voltage

Evaluation Board Description

The SKY67226-11 Evaluation Board is used to test the performance of the SKY67226-11 LNA. The Evaluation Board schematic diagram is shown in Figure 25. An assembly drawing for the Evaluation Board is shown in Figure 26. The layer detail physical characteristics are noted in Figure 27. Table 6 provides the Bill of Materials (BOM) list for Evaluation Board components.

Package Dimensions

The PCB layout footprint for the SKY67226-11 is shown in Figure 28. Typical case markings are shown in Figure 29. Package dimensions for the 16-pin MCM are shown in Figure 30, and tape and reel dimensions are provided in Figure 31.

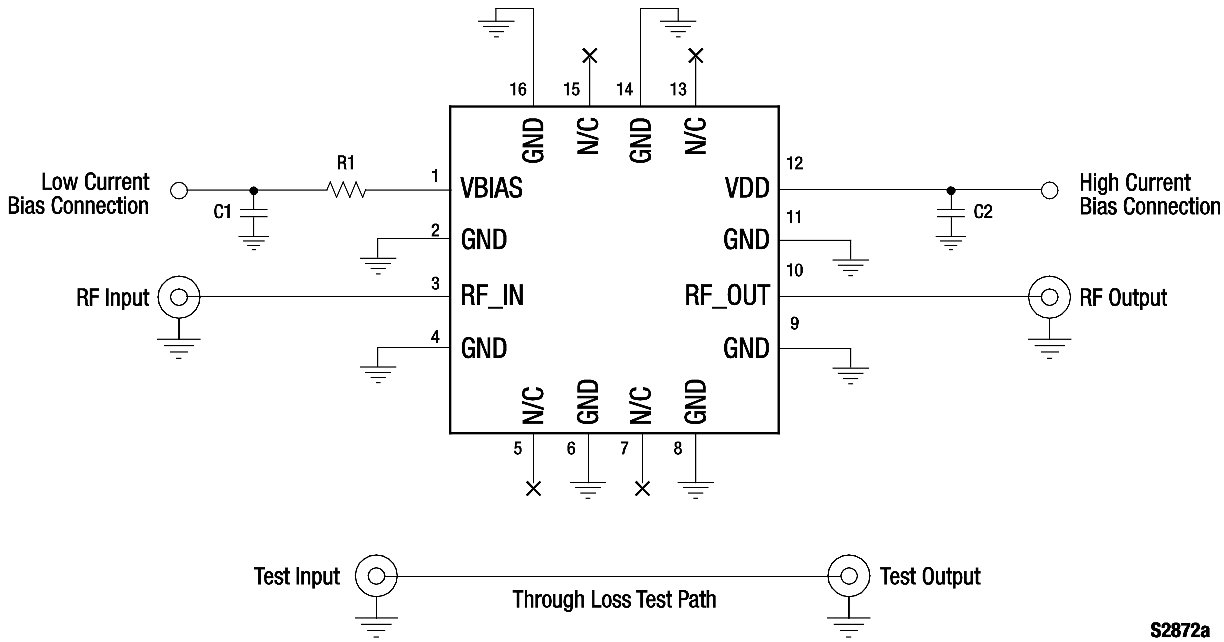


Figure 25. SKY67226-11 Schematic Diagram

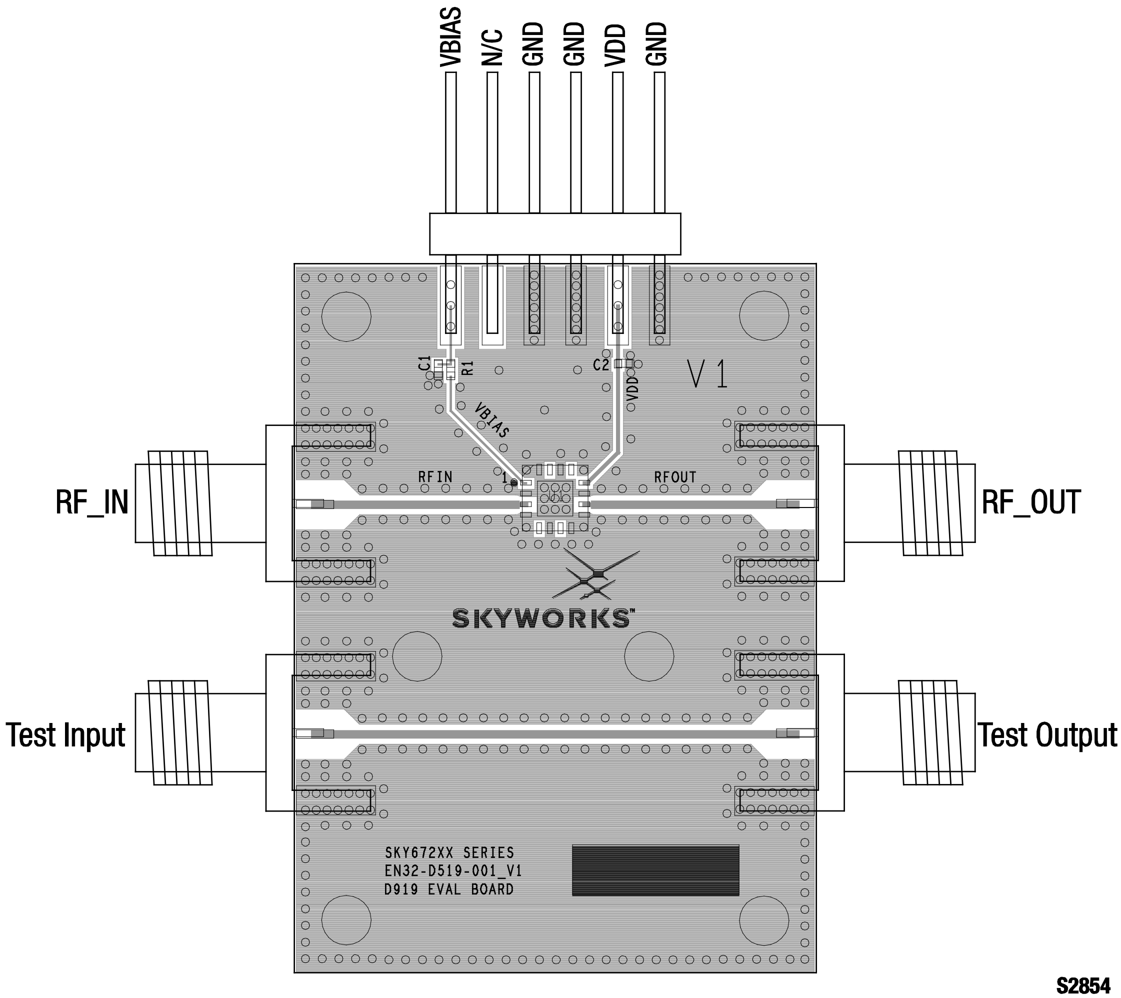


Figure 26. SKY67226-11 Evaluation Board Assembly Drawing

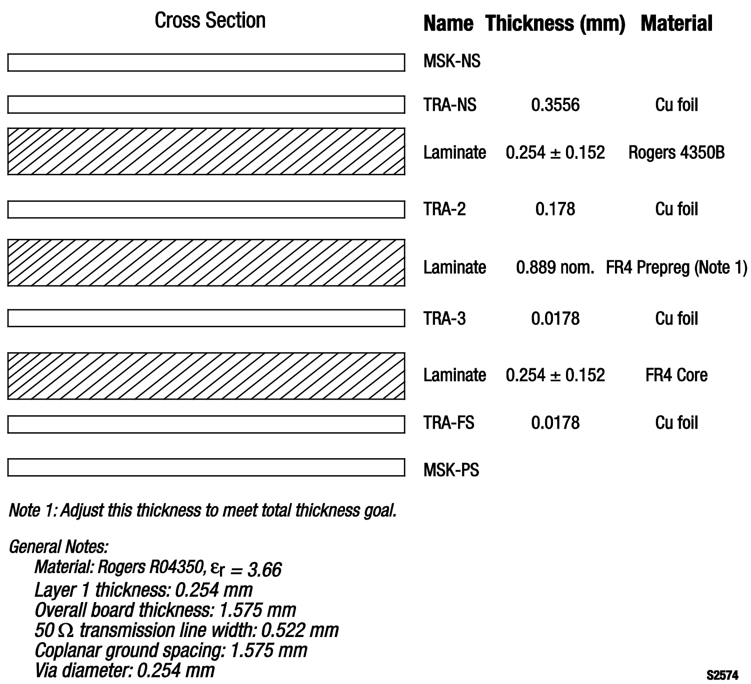


Figure 27. Layer Detail Physical Characteristics

Table 6. SKY67226-11 Evaluation Board Bill of Materials

Component	Size	Value	Vendor	Part Number
C1		DNI		
C2		DNI		
R1 for 89 mA operation (Note 1)	0402	6800 Ω	Panasonic	

Note 1: Placement in relation to component package is not critical.

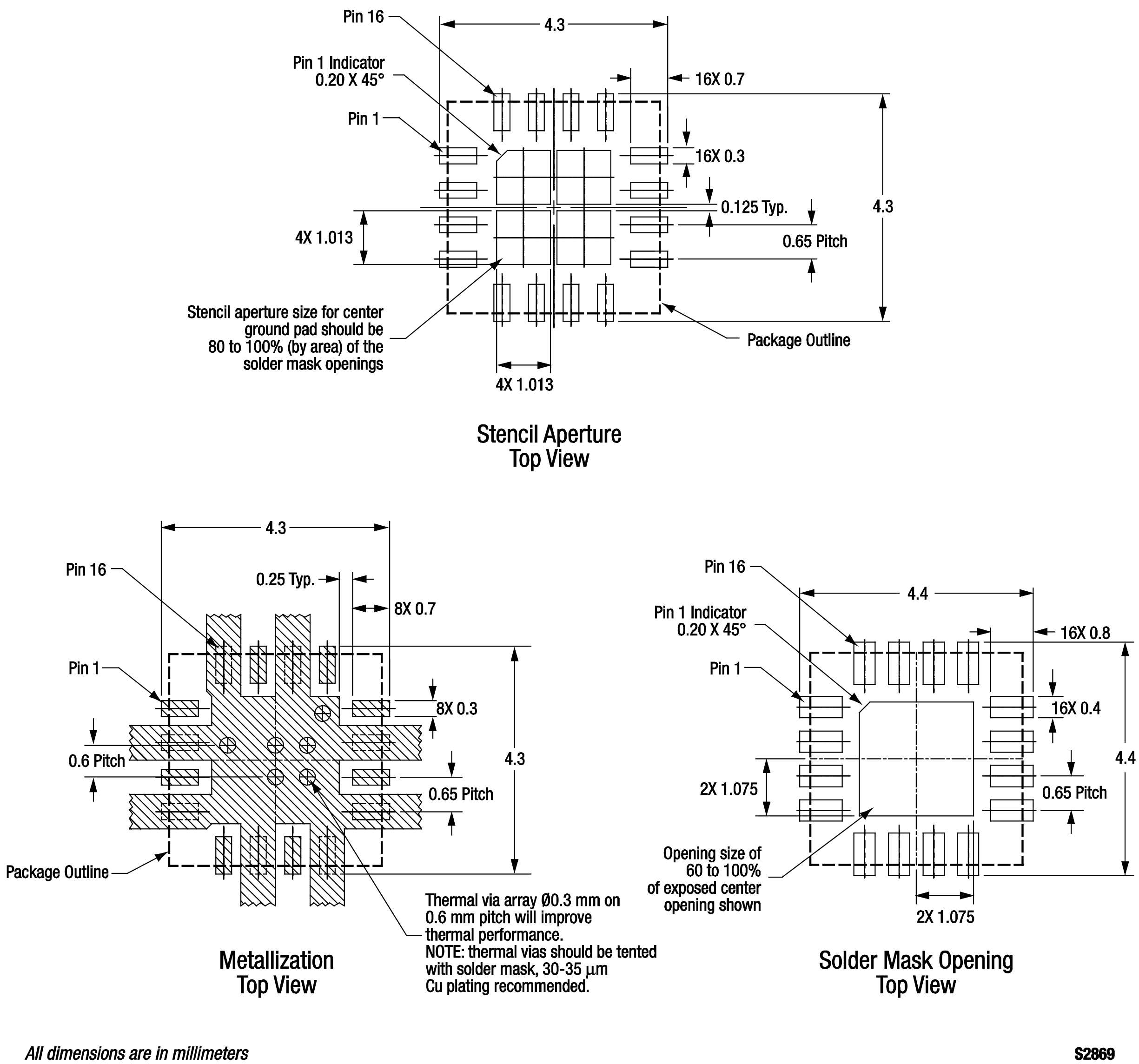


Figure 28. SKY67226-11 PCB Layout Footprint

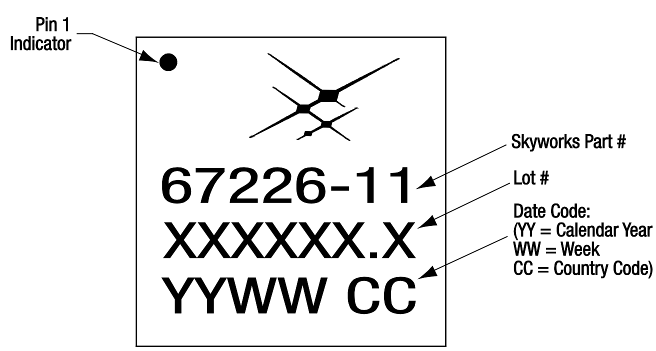
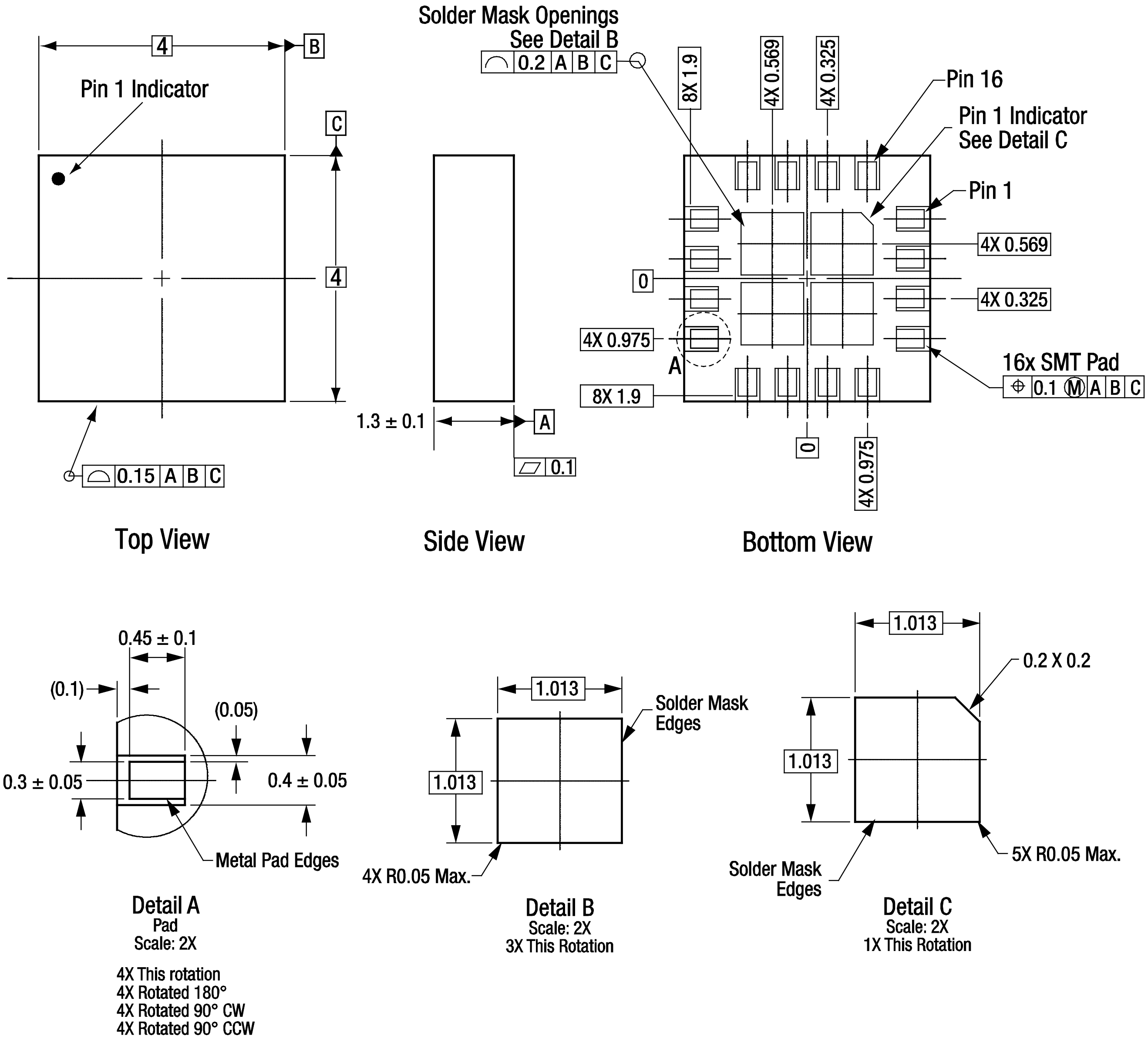


Figure 29. Typical Part Markings (Top View)

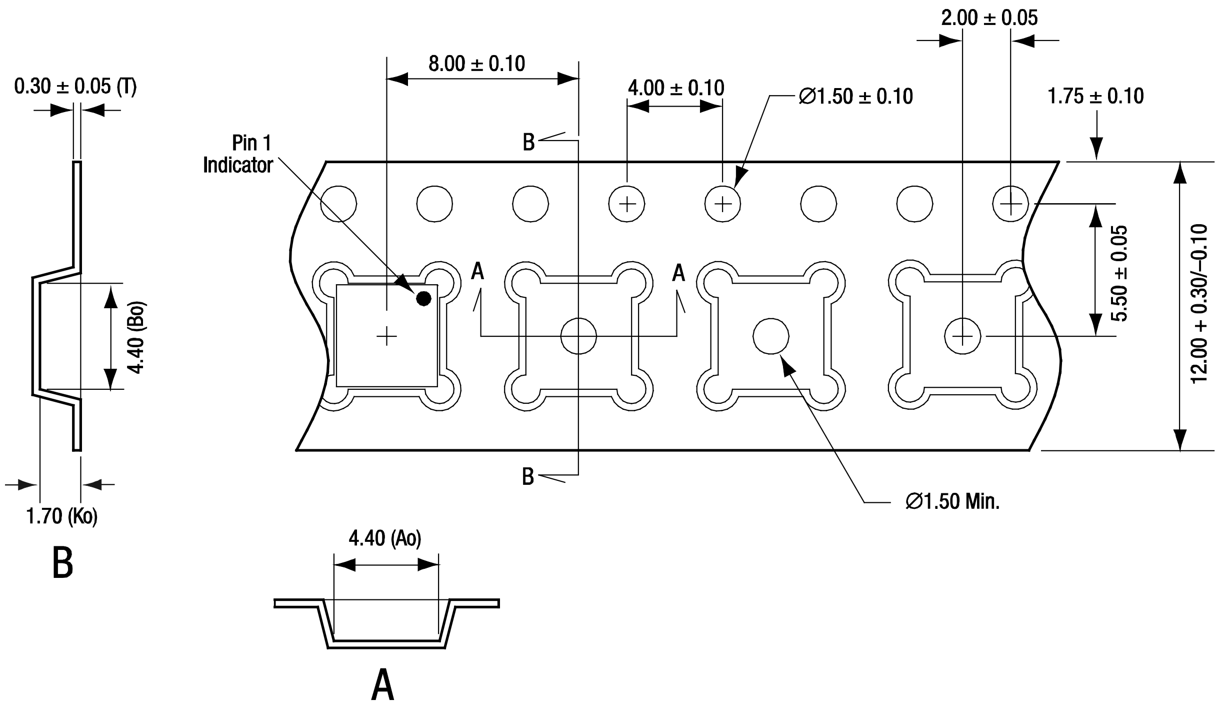


All measurements are in millimeters

Dimensioning and tolerancing according to ASME Y14.5M-1994

S2870

Figure 30. SKY67226-11 16-Pin MCM Package Dimensions



Notes:
1. *Carrier tape material: black conductive polycarbonate or polystyrene.*
2. *Cover tape material: transparent conductive PSA.*
3. *Cover tape size: 9.3 mm width.*
4. *Ten sprocket hole pitch cumulative tolerance: ±0.20 mm.*
5. *Ao and Bo measured on plane 0.30 mm above the bottom of the pocket.*
6. *Typical ESD surface resistivity is ≤1 x 10^{10} Ohms/square per EIA, JEDEC tape and reel specification.*
7. *All measurements are in millimeters*

S2031

Figure 31. SKY67226-11 Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY67226-11 2.2-3.0 GHz Integrated LNA Module	SKY67226-11	SKY67226-11-EVB