

SKYWORKS®

## DATA SHEET

# SKY67101-396LF: 0.4 to 1.2 GHz High Linearity, Active Bias Low-Noise Amplifier

## Applications

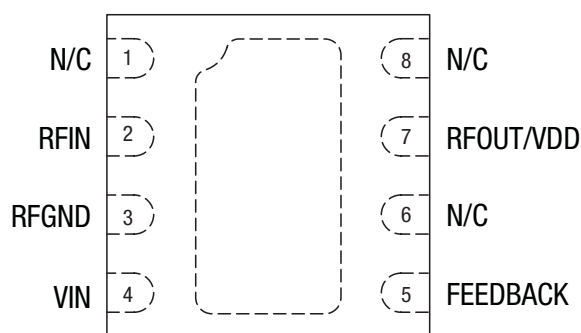
- GSM, CDMA, WCDMA, and TD-SCDMA cellular infrastructure
- Ultra low-noise systems

## Features

- Ultra-low-noise figure: 0.57 dB @ 0.9 GHz
- Input and output return loss > 18 dB @ 0.9 GHz
- High OIP3 performance: +33.8 dBm @ 0.9 GHz
- Adjustable supply current and gain
- Temperature and process-stable active bias
- Miniature DFN (8-pin, 2 x 2 mm) package (MSL1 @ 260 °C per JEDEC J-STD-020)

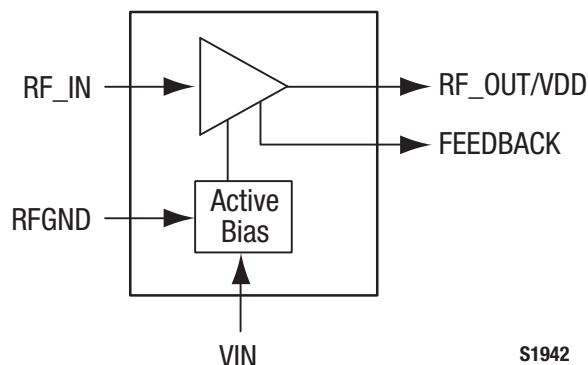


Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04-0074.



S1943

**Figure 2. SKY67101-396LF Pinout – 8-Pin DFN (Top View)**



S1942

**Figure 1. SKY67101-396LF Block Diagram**

## Description

The SKY67101-396LF is GaAs, pHEMT low-noise amplifier (LNA) with an active bias and high linearity performance. The advanced GaAs pHEMT enhancement mode process provides excellent return loss, low noise, and high linearity performance.

The internal active bias circuitry provides stable performance over temperature and process variation. The device offers the ability to externally adjust supply current and gain. Supply voltage is applied to the RFOUT/VDD pin through an RF choke inductor. Pin 4 (VIN) should be connected to RFOUT/VDD through an external resistor to control the supply current. The RFIN and RFOUT/VDD pins should be DC blocked to ensure proper operation. Pin 5 (FEEDBACK) is connected through an RC network to externally adjust the gain of the device without affecting the noise figure (NF) of the LNA.

The SKY67101-396LF operates in the frequency range of 0.4 to 1.2 GHz with proper tuning. For higher frequency operation, the pin-compatible SKY67100-396LF or SKY67102-396LF should be used.

The LNA is manufactured in a compact, 2 x 2 mm, 8-pin Dual Flat No-Lead (DFN) package. 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.

**Table 1. SKY67101-396LF Signal Descriptions**

Pin	Name	Description	Pin	Name	Description
1	N/C	No connection. May be connected to ground with no change in performance.	5	FEEDBACK	LNA external gain control. Connect to RFOUT using a series RC network.
2	RFIN	RF input. DC blocking capacitor required.	6	N/C	No connection. May be connected to ground with no change in performance.
3	RFGND	RF ground. Connect to ground through a capacitor.	7	RFOUT/VDD	RF output. Apply VDD through RF choke inductor. DC blocking capacitor required.
4	VIN	LNA supply current. Connect through series resistor to VDD.	8	N/C	No connection. May be connected to ground with no change in performance.

**Table 2. SKY67101-396LF Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage	V <sub>DD</sub>			5.5	V
Supply current	I <sub>DD</sub>			100	mA
RF input power	P <sub>IN</sub>			+20	dBm
Storage temperature	T <sub>STG</sub>	−65	+25	+125	°C
Operating temperature	T <sub>A</sub>	−40	+25	+85	°C
Junction temperature	T <sub>J</sub>			+150	°C
Electrostatic discharge: Human Body Model (HBM), Class 1A	ESD			300	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.

Thermal resistance = 80 °C/W @ 4 V bias.

**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.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY67101-396LF are provided in Table 2. Electrical specifications are provided in Tables 3 and 4.

Typical performance characteristics of the SKY67101-396LF are illustrated in Figures 3 through 14.

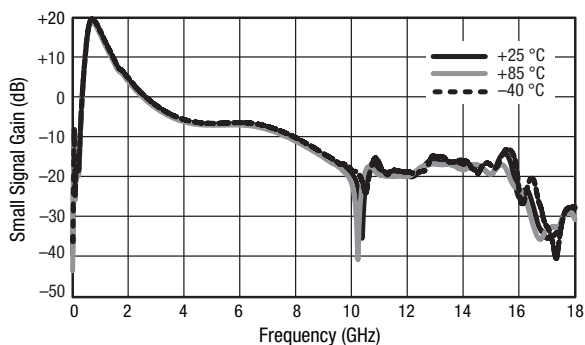
**Table 3. SKY67101-396LF Electrical Specifications (Note 1)****(V<sub>DD</sub> = 4.0 V, I<sub>DD</sub> = 56 mA, T<sub>A</sub> = +25 °C, P<sub>IN</sub> = -20 dBm, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Refer to Table 5 [4.0 V, 56 mA BOM])**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
<b>RF Specifications</b>						
Noise figure (Note 2)	NF	@ 0.80 GHz @ 0.85 GHz @ 0.90 GHz		0.63 0.59 0.57	1.00	dB dB dB
Small signal gain	IS <sub>21</sub> I	@ 0.80 GHz @ 0.85 GHz @ 0.9 GHz	17.7 17.0 16.6	18.7 18.0 17.6	19.7 19.0 18.6	dB dB dB
Input return loss	IS <sub>11</sub> I	@ 0.80 GHz @ 0.85 GHz @ 0.9 GHz		17.2 18.8 18.2		dB dB dB
Output return loss	IS <sub>22</sub> I	@ 0.80 GHz @ 0.85 GHz @ 0.9 GHz		19.8 33.0 20.0		dB dB dB
Reverse isolation	IS <sub>12</sub> I	@ 0.80 GHz @ 0.85 GHz @ 0.9 GHz		30.5 30.3 30.3		dB dB dB
3 <sup>rd</sup> Order Input Intercept Point	IIP3	@ 0.9 GHz, Δf = 5 MHz, P <sub>IN</sub> = -20 dBm/tone		+16.2		dBm
3 <sup>rd</sup> Order Output Intercept Point	OIP3	@ 0.9 GHz, Δf = 5 MHz, P <sub>IN</sub> = -20 dBm/tone	+32.5	+33.8		dBm
1 dB Input Compression Point	IP1dB	@ 0.9 GHz		+2.6		dBm
1 dB Output Compression Point	OP1dB	@ 0.9 GHz		+19.2		dBm
Stability	u1, u2	Up to 18 GHz, -40 °C to +85 °C		>1		–
<b>DC Specifications</b>						
Supply voltage	V <sub>DD</sub>			4		V
Supply current	I <sub>DD</sub>	Set with external resistor		56		mA

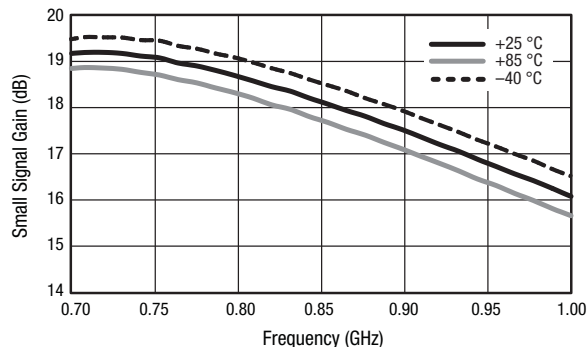
**Note 1:** Performance is guaranteed only under the conditions listed in this table.**Note 2** Loss from the input SMA connector and Evaluation Board up to component C1 has been de-embedded from the NF measurement.

## Typical Performance Characteristics

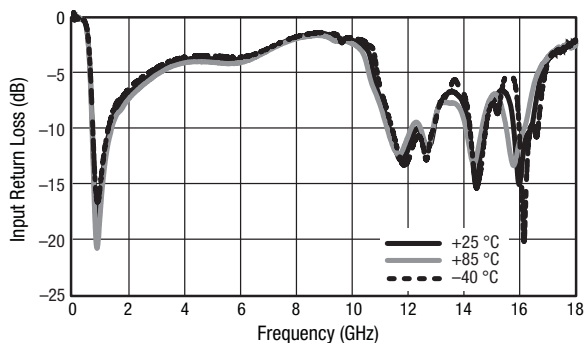
( $V_{DD} = 4.0\text{ V}$ ,  $I_{DD} = 56\text{ mA}$ ,  $T_A = +25\text{ }^{\circ}\text{C}$ ,  $P_{IN} = -20\text{ dBm}$ , Characteristic Impedance [ $Z_0$ ] =  $50\text{ }\Omega$ )



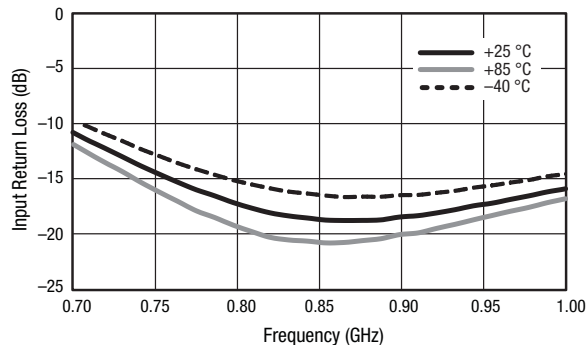
**Figure 3. Broadband Gain Response vs Frequency**



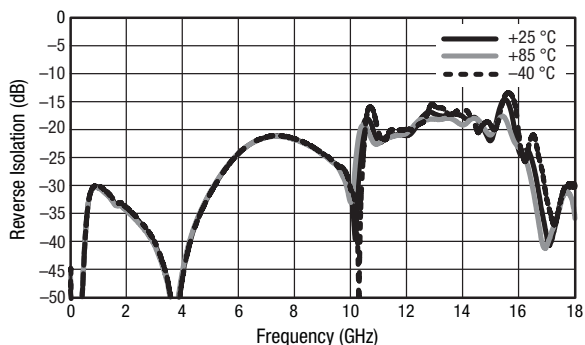
**Figure 4. Narrowband Gain Response vs Frequency**



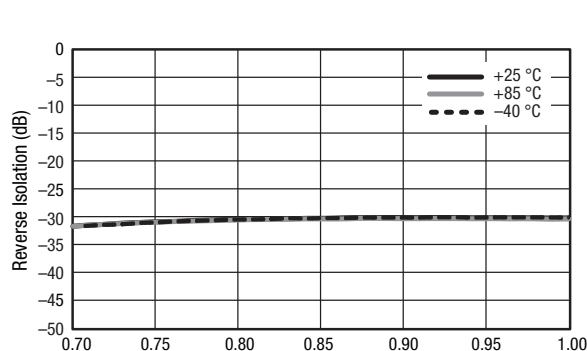
**Figure 5. Broadband Input Return Loss vs Frequency**



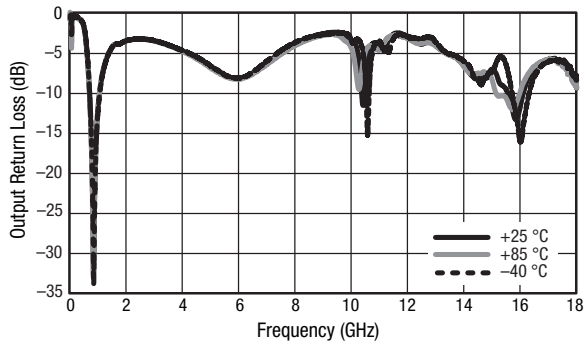
**Figure 6. Narrowband Input Return Loss vs Frequency**



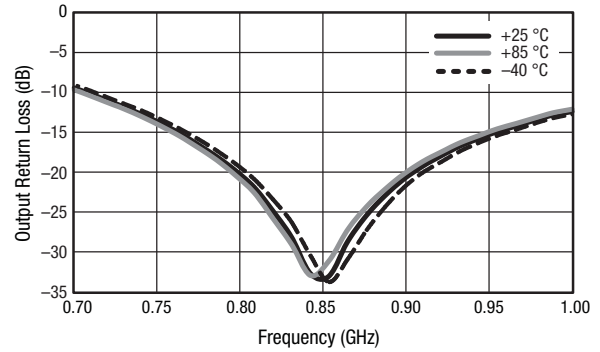
**Figure 7. Broadband Reverse Isolation vs Frequency**



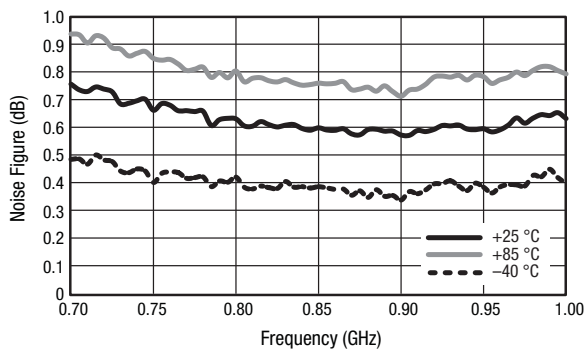
**Figure 8. Narrowband Reverse Isolation vs Frequency**



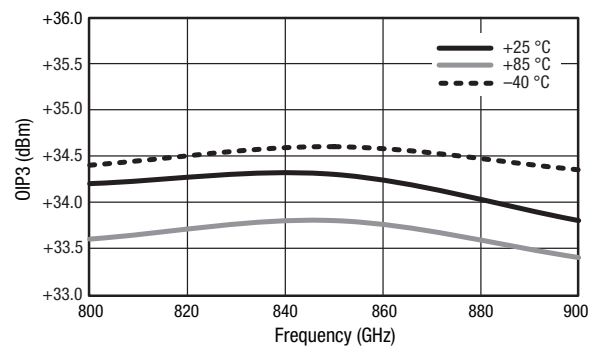
**Figure 9. Broadband Output Return Loss vs Frequency**



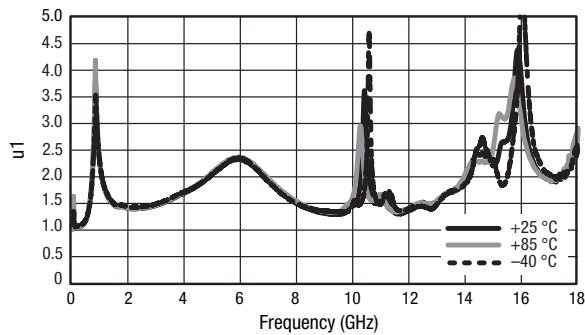
**Figure 10. Narrowband Output Return Loss vs Frequency**



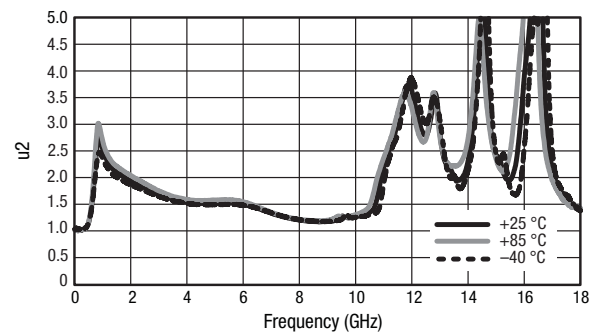
**Figure 11. Noise Figure vs Frequency**



**Figure 12. OIP3 vs Frequency**  
( $P_{IN} = -20$  dBm, Spacing = 5 MHz)



**Figure 13. u1 Stability vs Frequency**



**Figure 14. u2 Stability vs Frequency**

**Table 4. SKY67101-396LF Electrical Specifications (Note 1)****(V<sub>DD</sub> = 3.3 V, I<sub>DD</sub> = 46 mA, T<sub>A</sub> = +25 °C, P<sub>IN</sub> = -20 dBm, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Refer to Table 5 [3.3 V, 46 mA BOM])**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
<b>RF Specifications</b>						
Noise figure (Note 2)	NF	@ 848 MHz		0.72		dB
Small signal gain	IS21I	@ 848 MHz		17.9		dB
Input return loss	IS11I	@ 848 MHz		17.0		dB
Output return loss	IS22I	@ 848 MHz		25.0		dB
Reverse isolation	IS12I	@ 848 MHz		31.0		dB
Input Third Order Intercept Point	IIP3	$\Delta F=1$ MHz, P <sub>IN</sub> =-20 dBm/tone 848 MHz		+15.6		dBm
Output Third Order Intercept Point	OIP3	$\Delta F=1$ MHz, P <sub>IN</sub> =-20 dBm/tone 848 MHz		+33.6		dBm
Input 1 dB Compression Point	IP1dB	@ 848 MHz		+0.0		dBm
Output 1 dB Compression Point	OP1dB	@ 848 MHz		+17.6		dBm
Stability	$\mu 1, \mu 2, K, B$			>1		-
<b>DC Specifications</b>						
Supply voltage	V <sub>DD</sub>			3.30		V
Supply current	I <sub>DD</sub>			46.00		mA

**Note 1:** Performance is guaranteed only under the conditions listed in this table.**Note 2** Loss from the input SMA connector and Evaluation Board up to component C1 has been de-embedded from the NF measurement.

## Evaluation Board Description

The SKY67101-396LF Evaluation Board is used to test the performance of the SKY67101-396LF LNA. An assembly drawing for the Evaluation Board is shown in Figure 15. An Evaluation Board schematic diagram is provided in Figure 16. Table 5 provides the Bill of Materials (BOM) list for Evaluation Board components.

The test board uses a 10 mil Rogers 4350B substrate on a 50 mil FR4 supporting substrate. The Rogers 4350B material was selected for the RF circuit because of its low dielectric constant ( $\epsilon_r$ ) and low  $\epsilon_r$  variation over temperature for the best possible noise performance.

## Package Dimensions

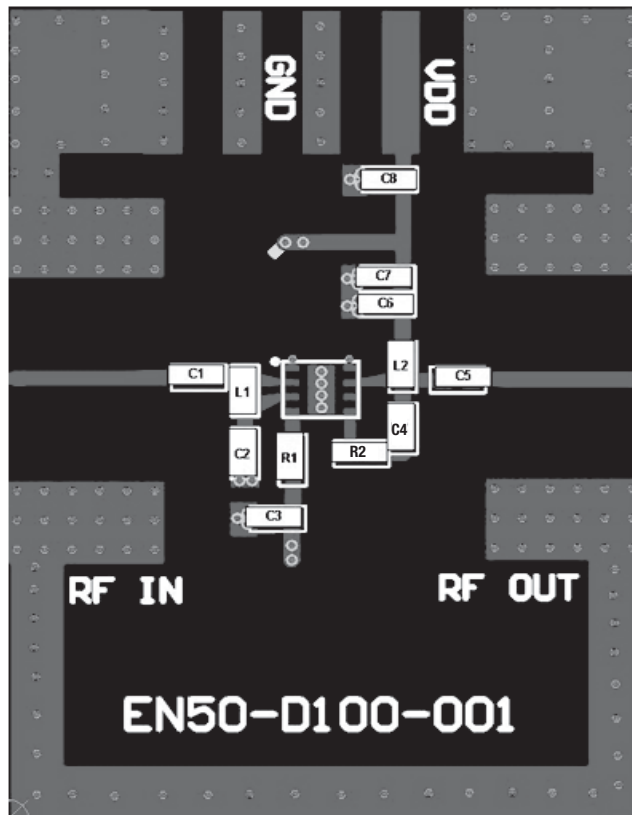
The PCB layout footprint for the SKY67101-396LF is provided in Figure 17. Typical case markings are shown in Figure 18. Package dimensions for the 8-pin DFN are shown in Figure 19, and tape and reel dimensions are provided in Figure 20.

## Package and Handling Information

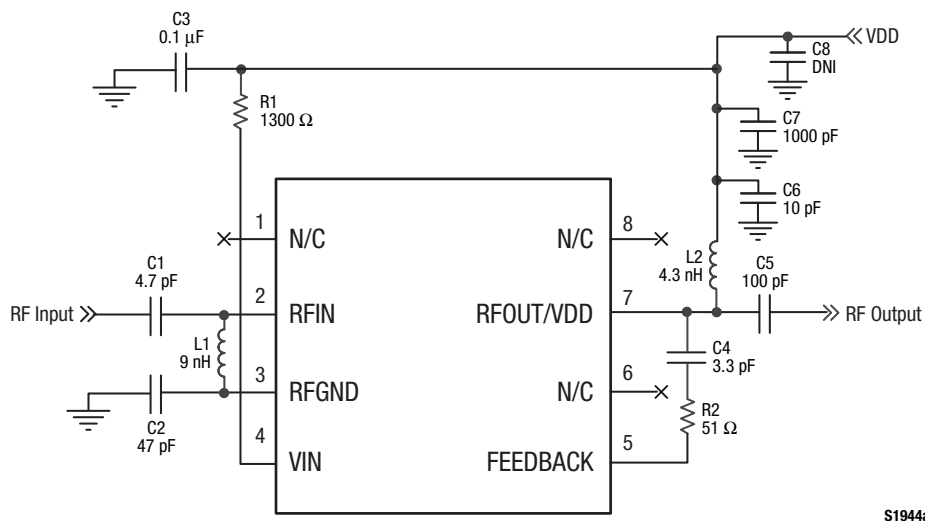
Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY67101-396LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It 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.



**Figure 15. SKY67101-396LF Evaluation Board Assembly Diagram**



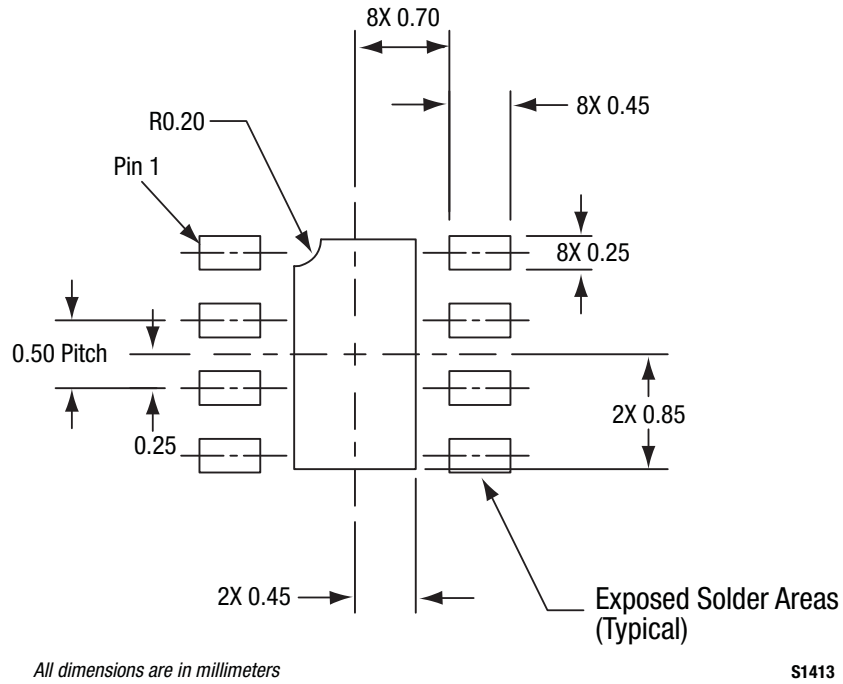
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Figure 16. SKY67101-396LF Evaluation Board Schematic

**Table 5. SKY67101-396LF Evaluation Board Bill of Materials**  
**(VDD = 4.0 V, IDD = 56 mA and VDD = 3.3 V, IDD = 46 mA)**

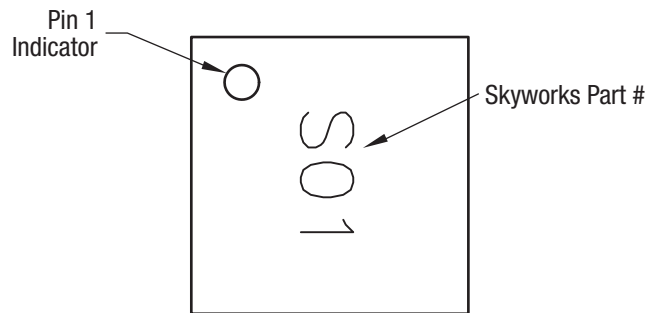
Component	Description	Value	Size	Manufacturer	Mfr Part Number
C1	Capacitor	4.7 pF	0402	Murata GJM	GJM1555C1H4R7CB01
C2	Capacitor	47 pF	0402	Murata GRM	GRM1555C1H470JZ01
C3	Capacitor	0.1 μF	0402	Murata GRM	GRM155R71H104KA01
C4	Capacitor	3.3 pF	0402	Murata GRM	GRM1555C1H3R3JZ01
C5	Capacitor	100 pF	0402	Murata GRM	GRM1555C1H101JZ01
C6	Capacitor	10 pF	0402	Murata GRM	GRM1555C1H100JZ01
C7	Capacitor	1000 pF	0402	Murata GRM	GRM155R71H102KA01
C8		DNI			
L1	Inductor	9.0 nH	0402	Coilcraft HP	0402HP-9N0XJL
L2	Inductor	4.3 nH	0402	TDK	MLG1005S4N3S
R1	Resistor	1.3 K Ω	0402	Panasonic	ERJ2GEJ132X
R2	Resistor	51 Ω	0402	Panasonic	ERJ2GEJ510X



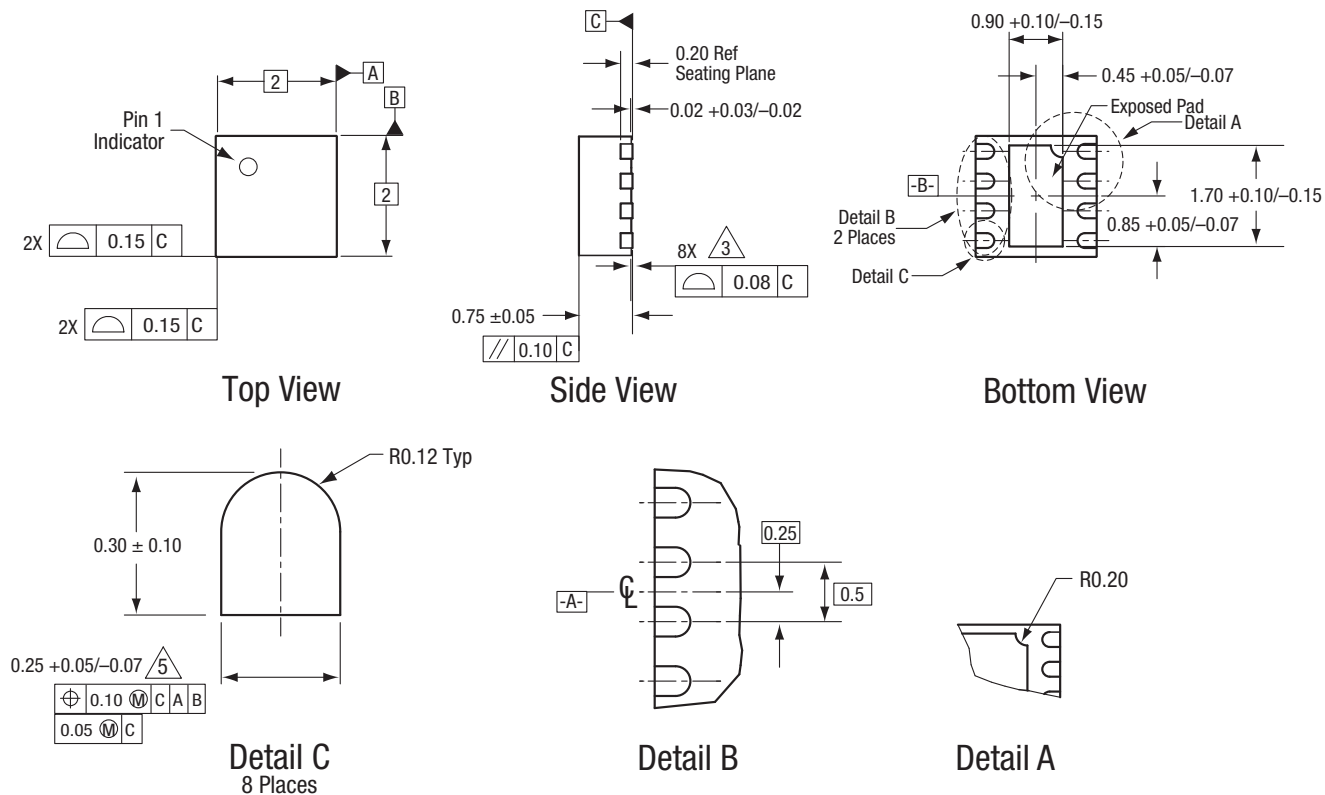


S1413

**Figure 17. SKY67101-396LF PCB Layout Footprint (Top View)**



**Figure 18. Typical Case Markings (Top View)**



All measurements are in millimeters.

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

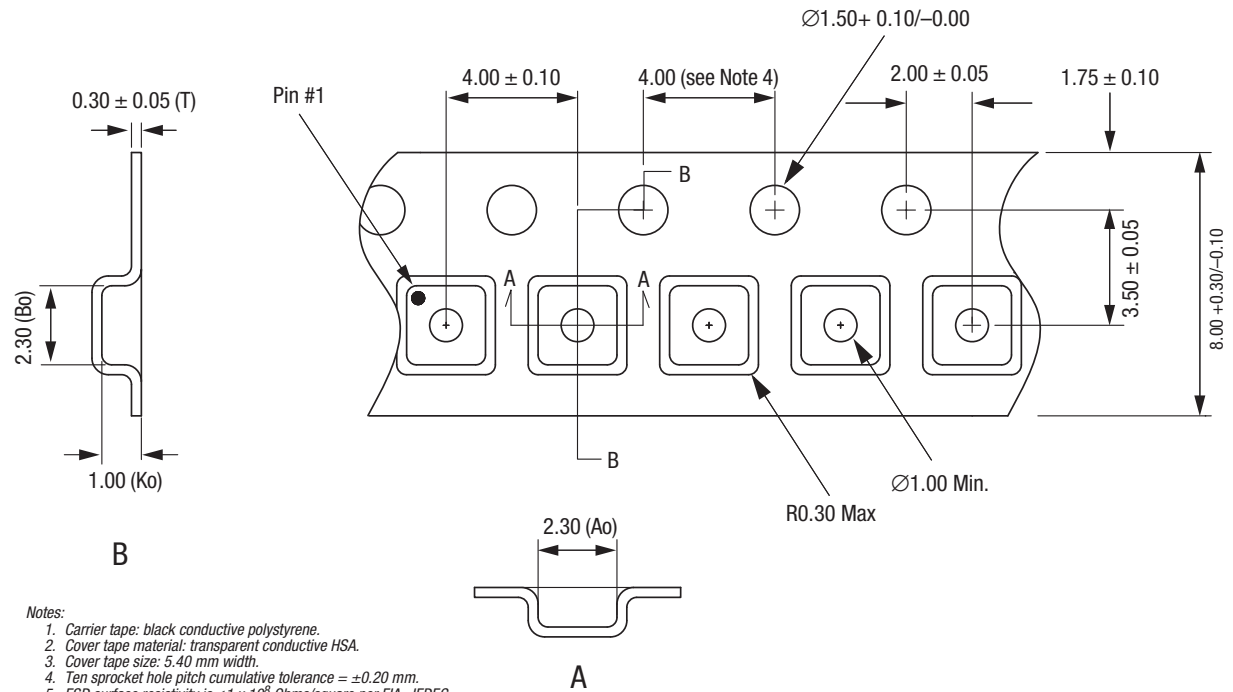
Coplanarity applies to the exposed heat sink slug as well as the terminals..

Plating requirement per source control drawing (SCD) 2504.

Dimension applies to metalized terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.

S1945

**Figure 19. SKY67101-396LF 8-Pin DFN Package Dimensions**



**S1601**

### Figure 20. SKY67101-396LF Tape and Reel Dimensions

## Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY67101-396LF LNA	SKY67101-396LF	SKY67101-396LF-EVB

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