

DATA SHEET

# SKY67189-396LF: 400 to 6000 MHz Broadband Low-Noise Amplifier

## Applications

- 2G/3G/4G/5G TDD and FDD systems
- Active antenna array and massive MIMO
- Receive LNA for micro-cell, macro-cell, and small-cell base stations
- Land mobile radios and military communications
- Low-noise broadband gain block and driver amplifier

## Features

- Excellent broadband flat gain performance
- Low noise figure
- High IP3 performance over voltage
- Minimal external components
- Low current I<sub>DD</sub>: 50 mA @ 5.0 V
- Fast rise/fall time ENABLE function suitable for 5G TDD applications
- Temperature and process-stable active bias up to +115 °C
- Miniature DFN (8-pin, 2 x 2 mm) package (MSL1 @ 260 °C per JEDEC J-STD-020)



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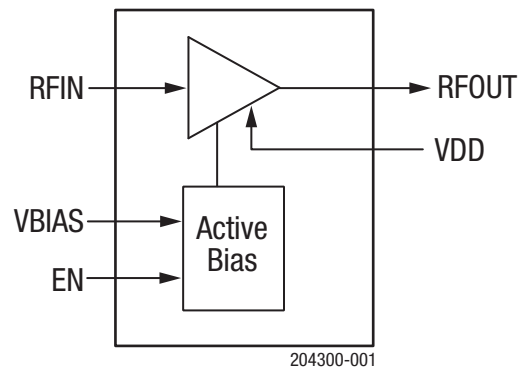


Figure 1. SKY67189-396LF Block Diagram

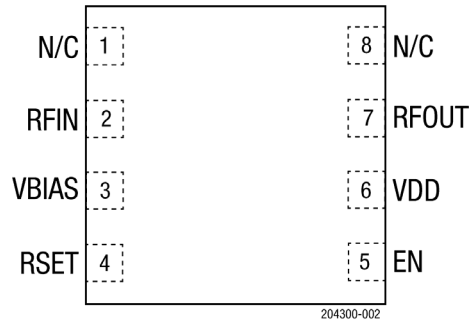
## Description

The SKY67189-396LF is a wide-band low-noise amplifier with superior gain flatness and exceptional linearity.

The compact 2 x 2 mm, 8-pin Dual Flat No Lead packaged LNA is designed for 2G/3G/4G/5G TDD and FDD infrastructure systems operating from 400 MHz to 6 GHz.

The internal active bias circuitry provides stable performance over temperature and process variation.

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. SKY67189-396LF Pinout (Top View)**

**Table 1. SKY67189-396LF Signal Descriptions**

Pin	Name	Description	Pin	Name	Description
1	N/C	No connection (may be connected to ground with no change in performance)	5	EN	Enable voltage to LNA
2	RFIN	RF input (DC blocking capacitor required)	6	VDD	VDD voltage to LNA
3	VBIAS	Bias voltage for input gate	7	RFOUT	RF output. DC blocking capacitor is required.
4	RSET	External resistor to set the bias current	8	N/C	No connection (may be connected to ground with no change in performance)

### Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY67189-396LF are provided in Table 2. Recommended operating conditions are shown in Table 3. Thermal data is shown in Table 4.

Electrical specifications are provided in Table 5. Typical performance characteristics are shown in Figures 3 through 13.

**Table 2. SKY67189-396LF Absolute Maximum Ratings<sup>1</sup>**

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	VDD	0	5.5	V
Quiescent supply current	I <sub>DQ</sub>		100	mA
RF input power (C/W)	P <sub>IN</sub>		+22	dBm
Storage temperature	T <sub>STG</sub>	-40	+150	°C
Operating temperature	T <sub>A</sub>	-40	+115	°C
Junction temperature	T <sub>J</sub>		+150	°C
Electrostatic discharge:	ESD			
Charged Device Model (CDM), Class C3			1000	V
Human Body Model (HBM), Class 1A			250	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. SKY67189-396LF Recommended Operating Conditions**

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage	VDD	3.3	5.0	5.25	V
LNA enable ON OFF	EN	1.17	0 1.8	0.63 2.4	V V

**Table 4. SKY67189-396LF Electrical Specifications: Thermal Data<sup>1</sup>**

(VDD = 5.0 V, Enable = GND, TA = +25 °C, PIN = -20 dBm, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Thermal resistance	θJC			56.9		°C/W
Channel temperature @ +115 °C reference (package heat slug)	TJ	VDD = 5.0 V, I <sub>DD</sub> = 56 mA, no RF applied		131		°C

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

**Table 5. SKY67189-396LF Electrical Specifications: 2500 to 6000 MHz Optimized Tuning<sup>1</sup>**

(VDD = 5.0 V, Enable = GND, TA = +25 °C, PIN = -20 dBm, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
<b>RF Specifications</b>						
Noise figure	NF	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz		0.75 0.65 0.65 0.75	1 0.9 1 1	dB dB dB dB
Gain	IS211	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	16	18.6 18.3 17.8 17.3		dB dB dB dB
Input return loss	IS111	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz		15 15 14 18		dB dB dB dB
Output return loss	IS221	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz		12 12 10 9		dB dB dB dB
Third order output intercept point	OIP3	PIN = -25 dBm, Δ Tone = 2 MHz @ 4400 MHz: @ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	+24	+29 +28 +27 +27		dBm dBm dBm dBm
1 dB output compression point	OP1dB	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	+15	+19 +19 +19 +19		dBm dBm dBm dBm
<b>DC Specifications</b>						
Quiescent current	I <sub>DD</sub>			52	60	mA
Settling time 0.3 dB <sup>2</sup> Settling time 0.1 dB <sup>3</sup>	t <sub>ON</sub>	@ 4400 MHz		0.2 0.2	1 1	us us

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

<sup>2</sup> Settling time 0.3 dB is measured from the time the PA enable reaches 50% of PA enable "on" level to the time at which the RF output power achieves within 0.3 dB of the average steady-state "on" level.

<sup>3</sup> Settling time 0.1 dB is measured from the time the PA enable reaches 50% of PA enable "on" level to the time at which the RF output power achieves within 0.1 dB of the average steady-state "on" level.

### Typical Performance Characteristics

2500 to 6000 MHz, VDD = 5 V, PIN = -20 dBm, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted

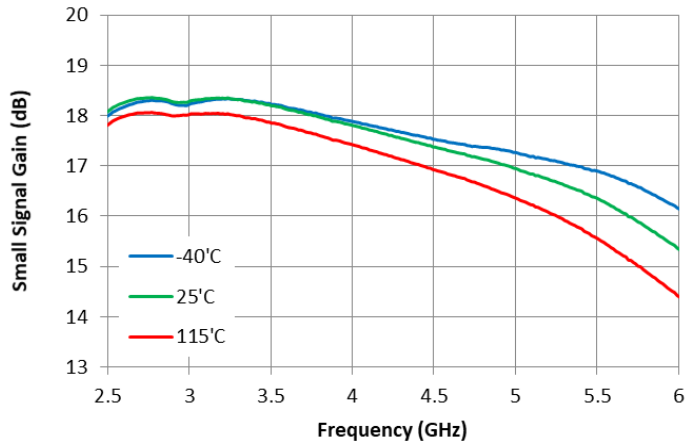


Figure 3. Small Signal Gain vs Frequency

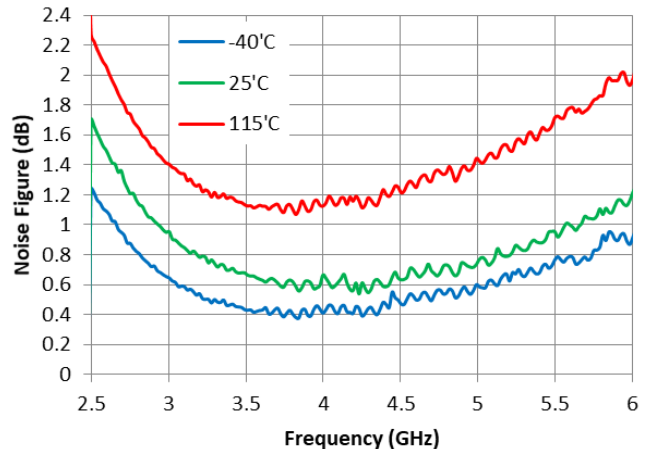


Figure 4. Noise Figure vs Frequency

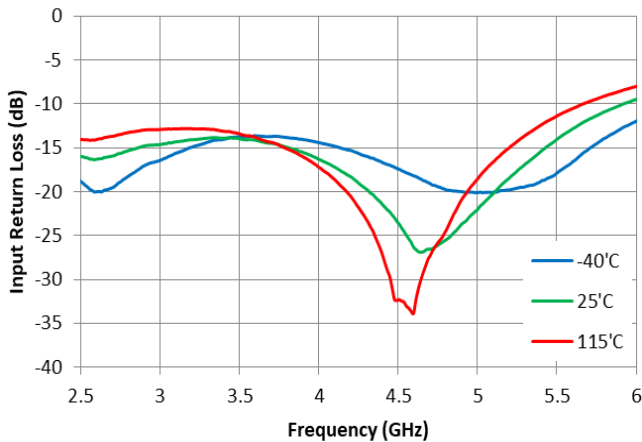


Figure 5. Input Return Loss vs Frequency

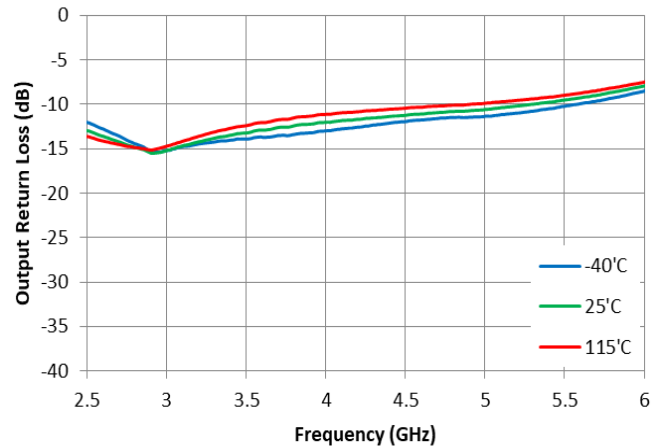


Figure 6. Output Return Loss vs Frequency

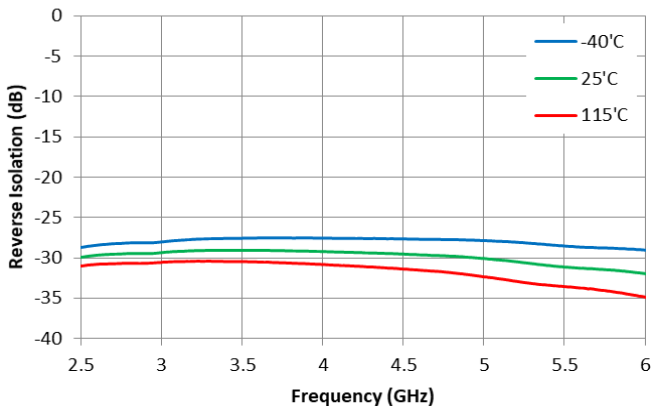
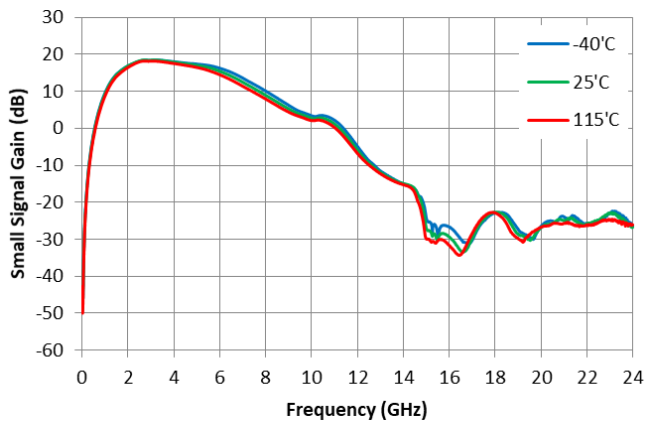


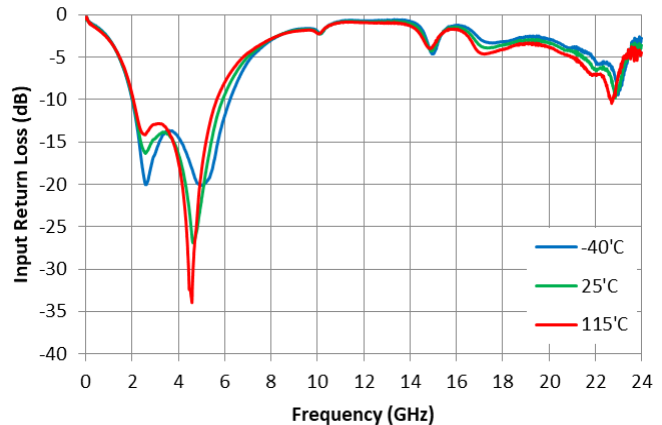
Figure 7. Reverse Isolation vs Frequency

### Typical Performance Characteristics

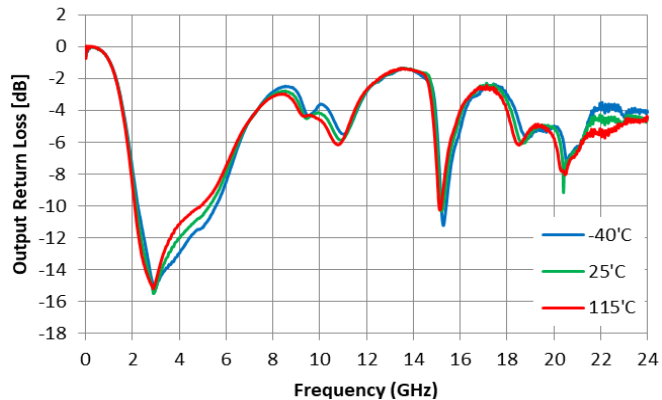
**0 to 20 GHz, VDD = 5 V, PIN = -20 dBm, Characteristic Impedance [Zo] = 50 Ω, Unless Otherwise Noted**



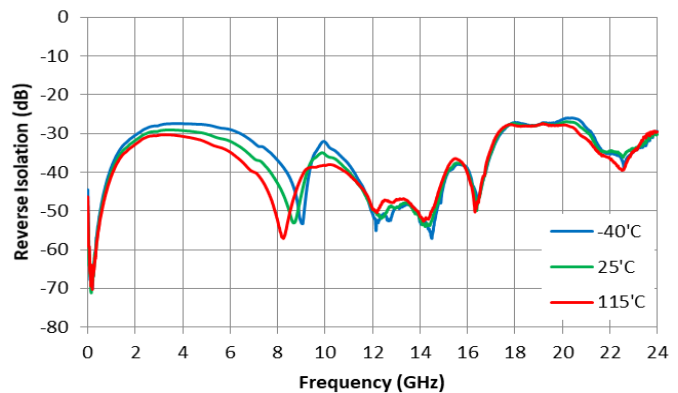
**Figure 8. Small Signal Gain vs Frequency**



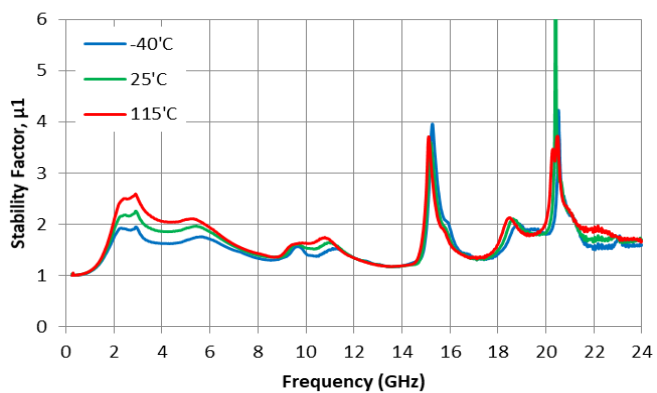
**Figure 9. Input Return Loss vs Frequency**



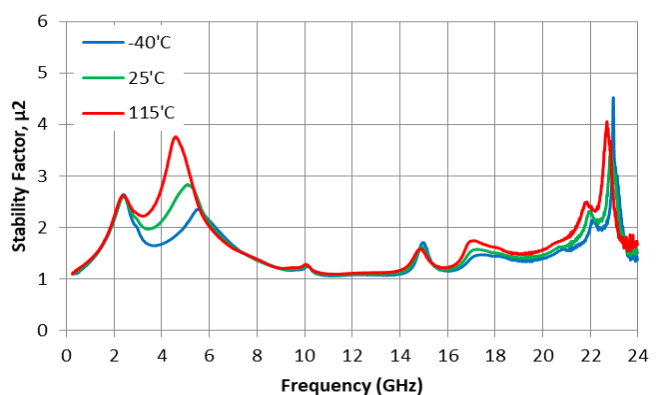
**Figure 10. Output Return Loss (dB) vs Frequency**



**Figure 11. Reverse Isolation (dB) vs Frequency**



**Figure 12. Stability Factor, μ1 vs Frequency**



**Figure 13. Stability Factor, μ2 vs Frequency**

### Evaluation Board Description

The SKY67189-396LF Evaluation Board is used to test the performance of the SKY67189-396LF LNA. An Evaluation Board schematic (optimized for 2500 to 6000 MHz tuning) diagram is provided in Figure 14.

Table 6 lists the Bill of Materials (BOM) for the Evaluation Board optimized for 2500 to 6000 MHz tuning. An EVB assembly diagram is shown in Figure 15. EVB layout detail information is provided in Figure 16.

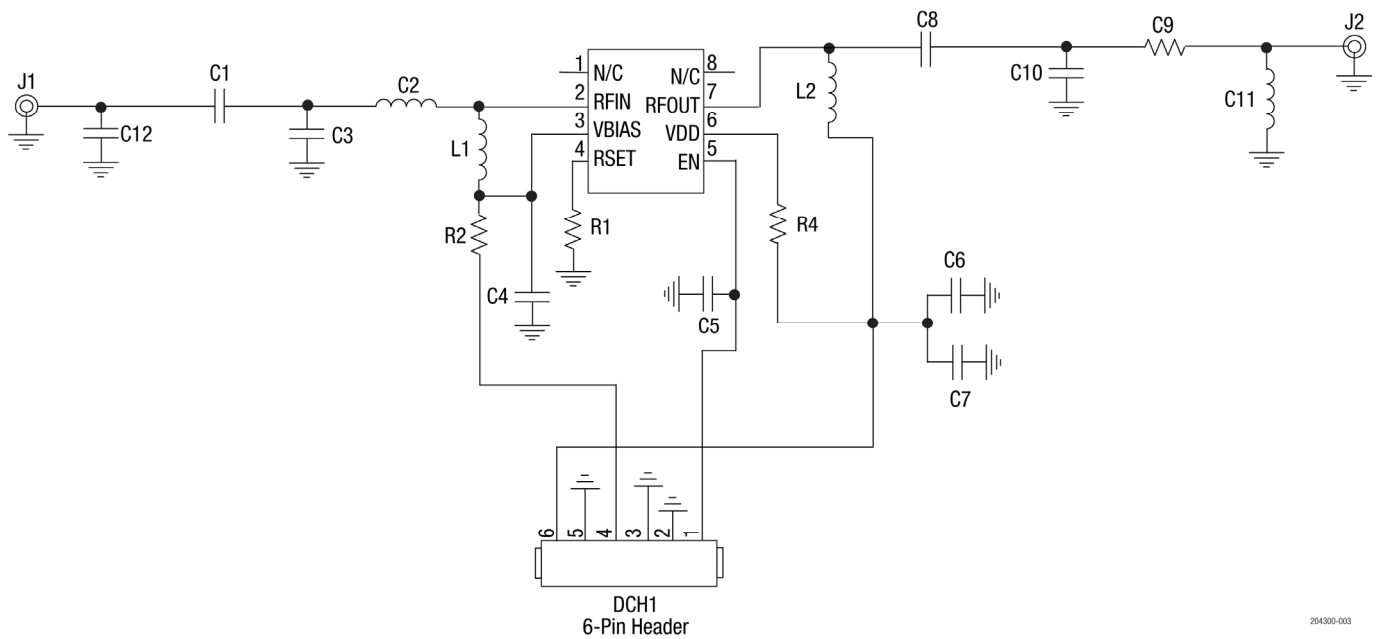
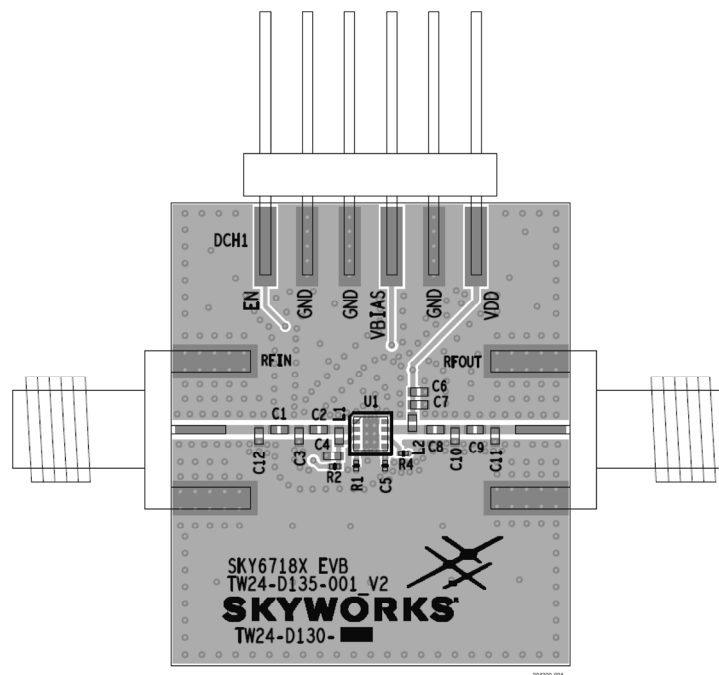


Figure 14. SKY67189-396LF Evaluation Board Schematic for 2500 to 6000 MHz Tuning

**Table 6. SKY67189-396LF Evaluation Board Bill of Materials (BOM) for 2500 to 6000 MHz Tuning**

Component	Description	Value	Size	Manufacturer	Part Number
C1	Capacitor	4.3 pF	0402	muRata	GJM series
C2	Inductor	0.4 nH	0402	TDK	MLG series
C3	Capacitor	0.4 pF	0402	muRata	GJM series
C4	DNI				
C5	DNI				
C6	Capacitor	5.6 pF	0402	muRata	GRM series
C7	Capacitor	4.7 uF	0402	muRata	GRM series
C8	Capacitor	2.2 pF	0402	muRata	GRM series
C9	Resistor	0 Ω	0402		
C10	DNI				
C11	DNI				
C12	DNI				
L1	Inductor	6.8 nH	0402	muRata	LQW series
L2	Inductor	2.4 nH	0402	TDK	MLG series
R1	Resistor	5.1 kΩ (1%)	0201		
R2	DNI				
R4	Resistor	20 Ω	0201		



**Figure 15. SKY67189-396LF EVB Assembly Diagram**

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50-OHM TRACE	50-OHM TRACE	CROSS SECTION	NAME	THICKNESS	MATERIALS
$W=0.301\text{mm}$ $S=0.100\text{mm}$	TOL: +/- 5% $W=0.508\text{mm}$ $CPW = 0.375\text{mm}$		TMASK	0.020mm	SOLDER RESIST
		L1	0.047mm	FINISHED Cu.	
$W=N/A$ $S=N/A$	$W=N/A$ $CPW = N/A$		DIELECTRIC	0.254mm	RO4350B
		L2	0.018mm	Cu-0.5oz.	
			L3	0.018mm	Cu-0.5oz.
			DIELECTRIC	0.254mm	FR4 (4.34)
			L4	0.047mm	FINISHED Cu.
			BMASK	0.020mm	SOLDER RESIST
			<b>TOTAL THICKNESS</b>	<b>1.578mm</b>	<b>TOL: +/- 10%</b>

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**Figure 16. SKY67189-396LF EVB Layer Details**



### Package Dimensions

A typical part marking for the SKY67189-396LF is shown in Figure 17. The PCB layout footprint for the SKY67189-396LF is provided in Figure 18. Package dimensions are shown in Figure 19. Tape and reel dimensions are shown 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 SKY67189-396LF 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.

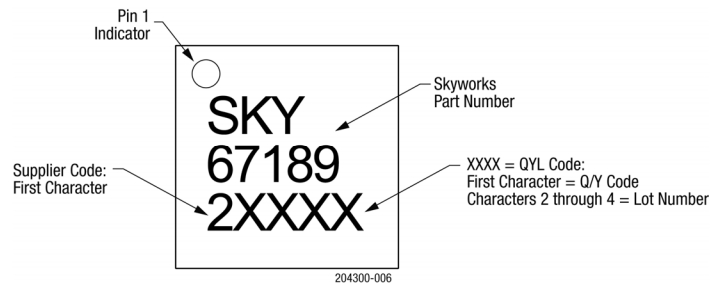


Figure 17. SKY67189-396LF Typical Part Marking

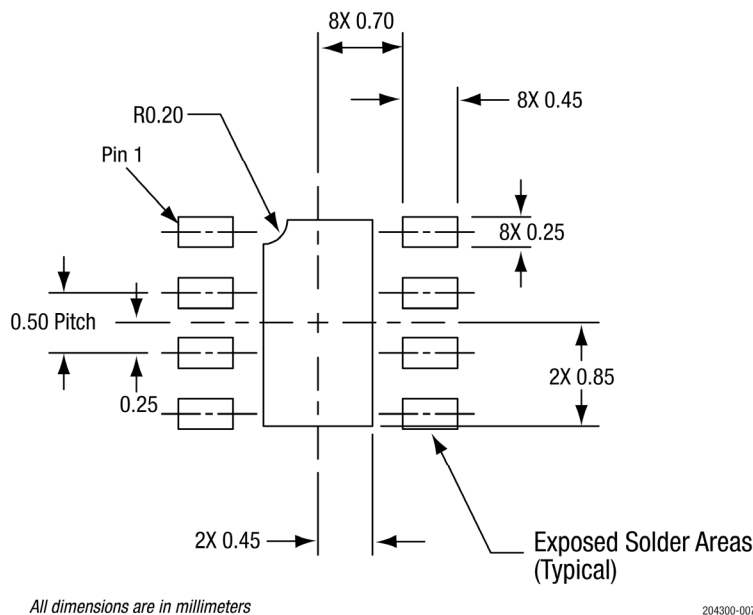
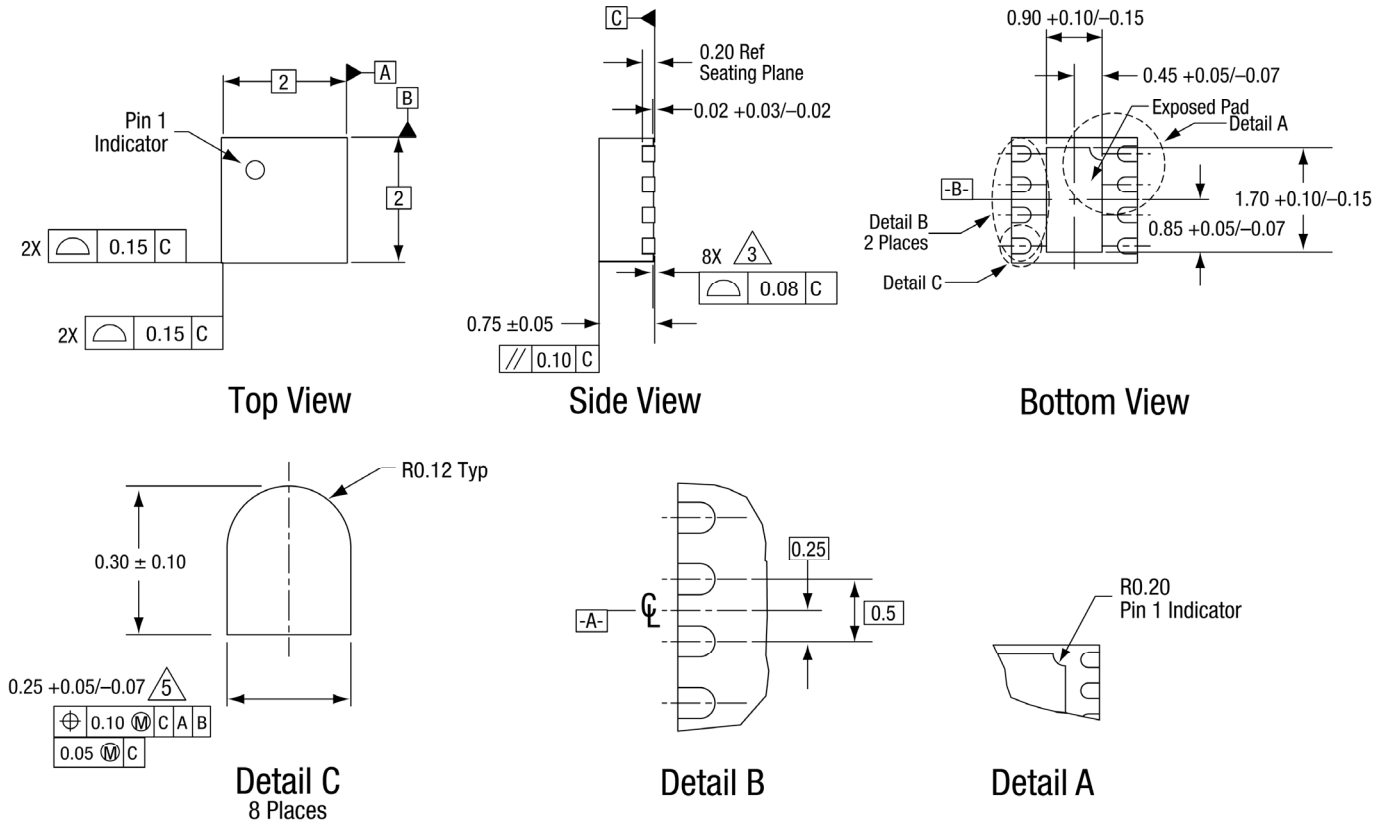


Figure 18. SKY67189-396LF PCB Layout Footprint

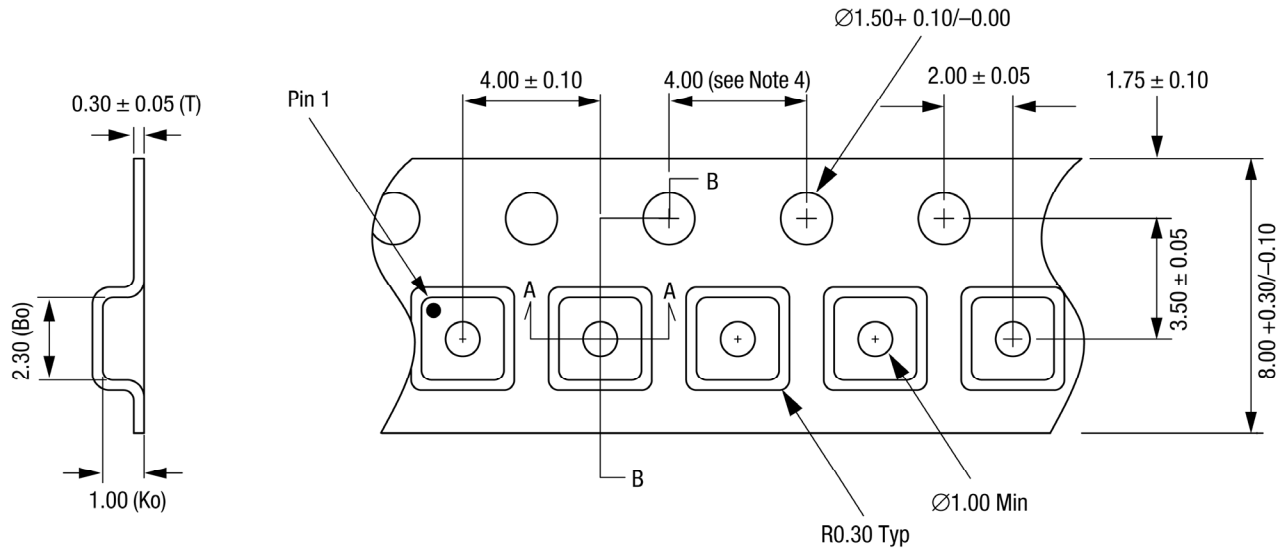


Notes:

1. All measurements are in millimeters.
2. Dimensions and tolerances according to ASME Y14.5M-1994.
3. Coplanarity applies to the exposed heat sink ground pad as well as the terminals.
4. Plating requirement per source control drawing (SCD) 2504.
5. Dimension applies to metallized terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.

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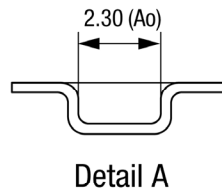
Figure 19. SKY67189-396LF Package Dimensions



Detail B

Notes:

1. Carrier tape: black conductive polystyrene.
2. Cover tape material: transparent conductive HSA.
3. Cover tape size: 5.40 mm width.
4. Ten sprocket hole pitch cumulative tolerance =  $\pm 0.20$  mm.
5. ESD surface resistivity is  $\leq 1 \times 10^9$  Ohms/square per EIA, JEDEC tape and reel specification.
6. Ao and Bo measurement point to be 0.30 mm from bottom pocket.
7. All measurements are in millimeters.



204300-009

Figure 20. SKY67189-396LF Tape and Reel Dimensions

## Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY67189-396LF	400 to 6000 MHz Broadband LNA	SKY67189-396EK1 (2.5 to 6.0 GHz Tuning)

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