

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_{DD}: 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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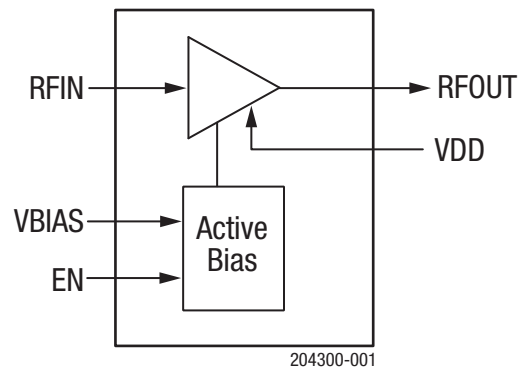


Figure 1. SKY67189-396LF Block Diagram

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.

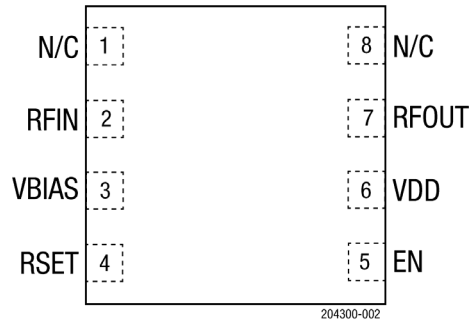


Figure 2. SKY67189-396LF Pinout (Top View)

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 Ratings¹

| Parameter | Symbol | Minimum | Maximum | Units |
|--------------------------------------|------------------|---------|---------|-------|
| Supply voltage | VDD | 0 | 5.5 | V |
| Quiescent supply current | I _{DD} | | 100 | mA |
| RF input power (C/W) | P _{IN} | | +22 | dBm |
| Storage temperature | T _{STG} | -40 | +150 | °C |
| Operating temperature | T _A | -40 | +115 | °C |
| Junction temperature | T _J | | +150 | °C |
| Electrostatic discharge: | ESD | | | |
| Charged Device Model (CDM), Class C3 | | | 1000 | V |
| Human Body Model (HBM), Class 1A | | | 250 | 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. 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 Data¹

(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, IDD = 56 mA, no RF applied | | 131 | | °C |

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

Table 5. SKY67189-396LF Electrical Specifications: 2500 to 6000 MHz Optimized Tuning¹

(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 |
|--|--------|---|-----|------------------------------|--------------------|--------------------------|
| RF Specifications | | | | | | |
| 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 |
| DC Specifications | | | | | | |
| Quiescent current | IDD | | | 52 | 60 | mA |
| Settling time 0.3 dB ² Settling time 0.1 dB ³ | ton | @ 4400 MHz | | 0.2 0.2 | 1 1 | us us |

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

² 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.

³ 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

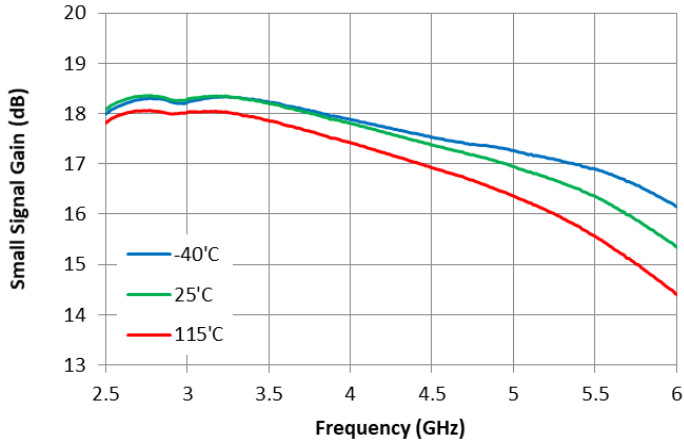


Figure 3. Small Signal Gain vs Frequency

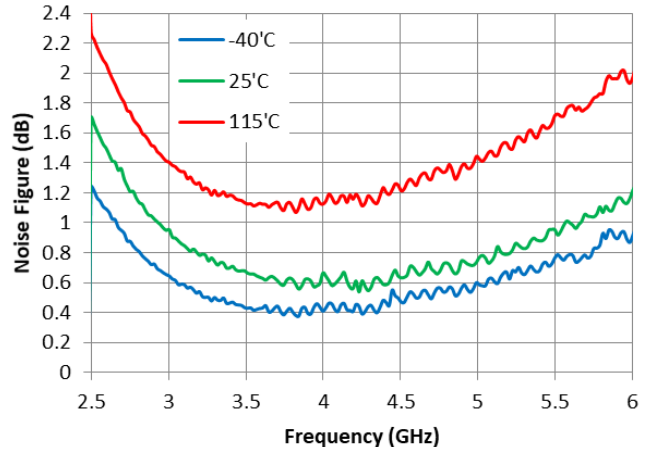


Figure 4. Noise Figure vs Frequency

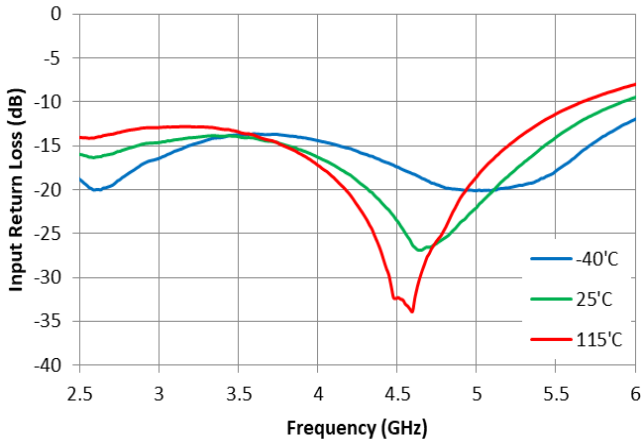


Figure 5. Input Return Loss vs Frequency

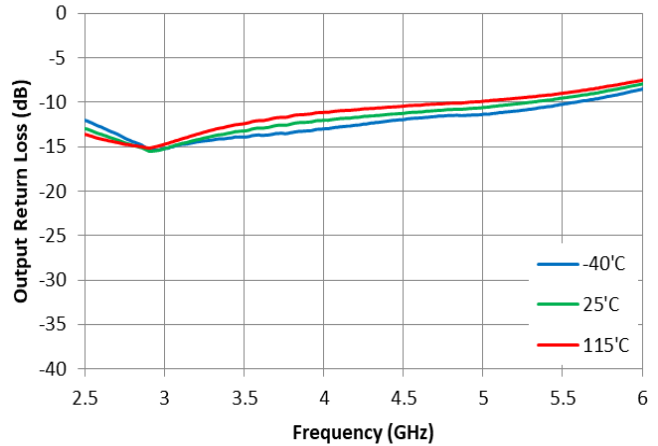


Figure 6. Output Return Loss vs Frequency

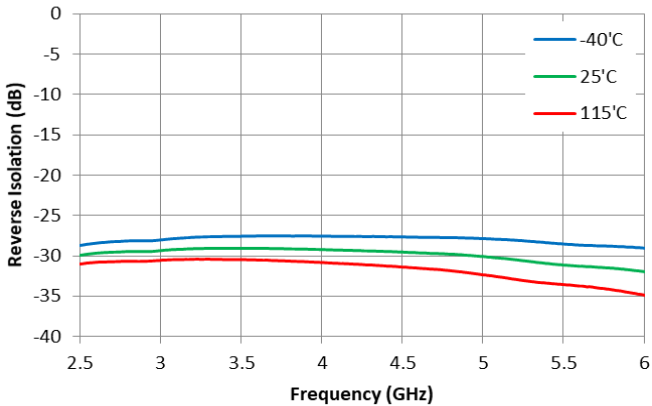


Figure 7. Reverse Isolation vs Frequency

Typical Performance Characteristics

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

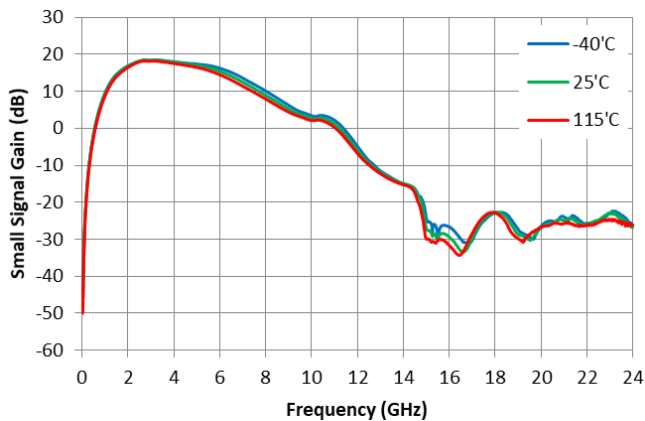


Figure 8. Small Signal Gain vs Frequency

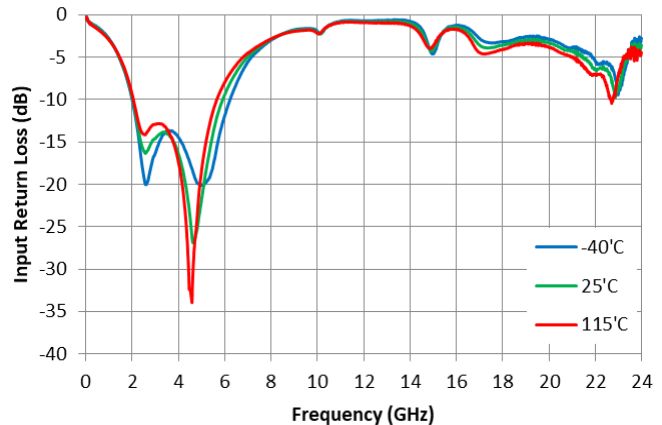


Figure 9. Input Return Loss vs Frequency

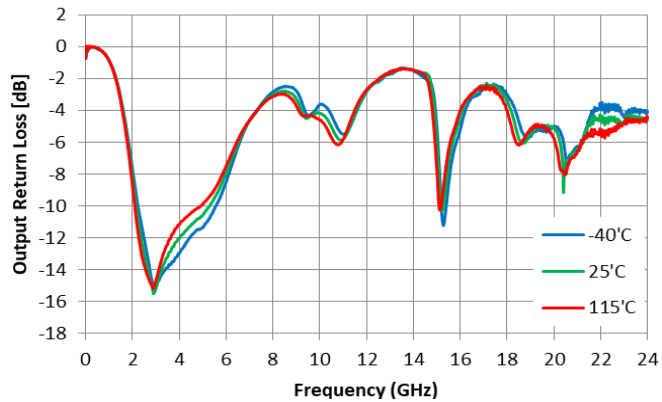


Figure 10. Output Return Loss (dB) vs Frequency

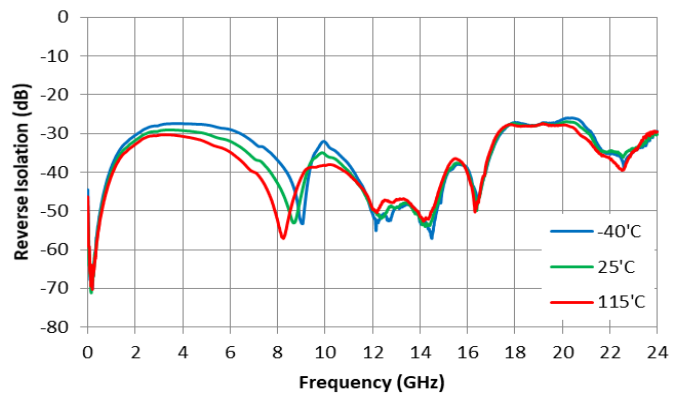


Figure 11. Reverse Isolation (dB) vs Frequency

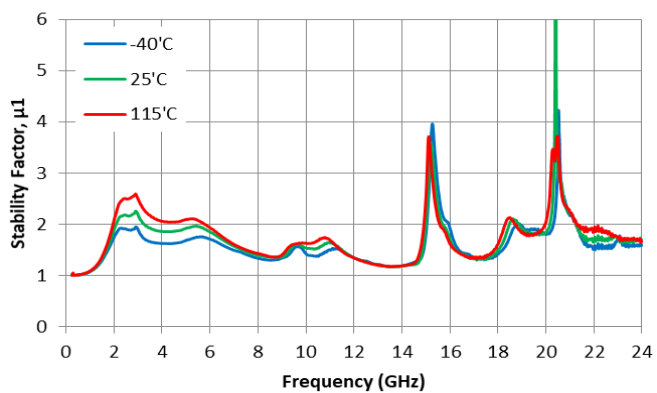


Figure 12. Stability Factor, μ1 vs Frequency

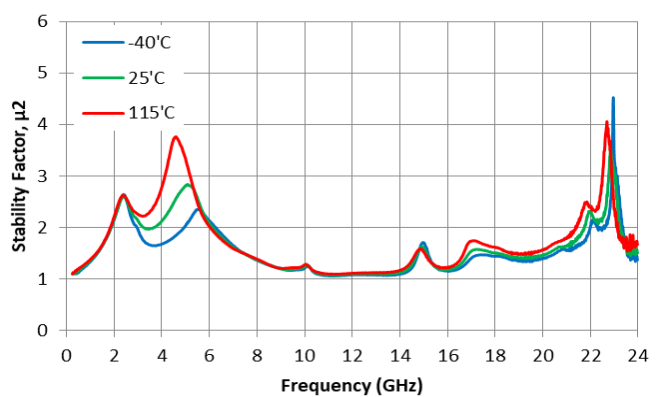


Figure 13. Stability Factor, μ2 vs Frequency

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.

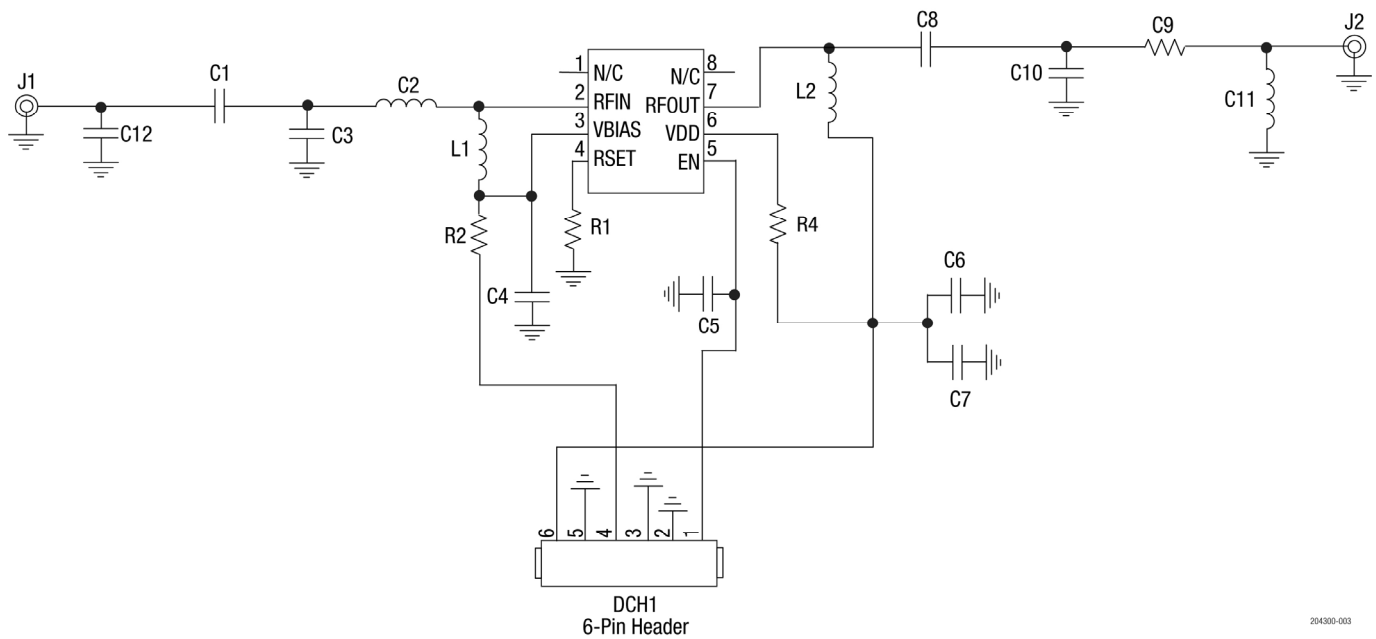


Figure 14. SKY67189-396LF Evaluation Board Schematic for 2500 to 6000 MHz Tuning

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 | | |

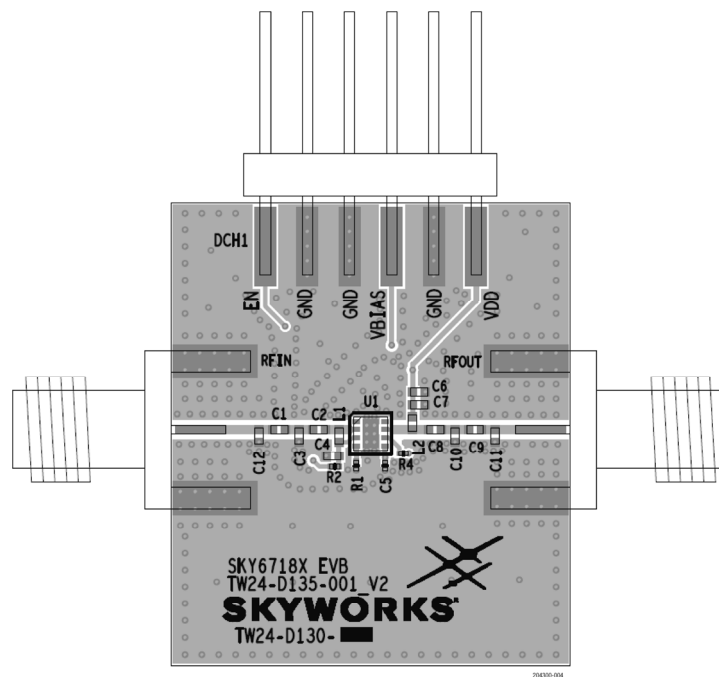
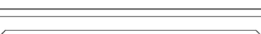

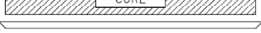


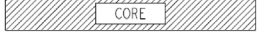





Figure 15. SKY67189-396LF EVB Assembly Diagram

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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 = 0.375mm |  | 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. |
| | |  | DIELECTRIC | 0.900mm | FR4 (4.34) |
| | |  | L3 | 0.018mm | Cu-0.5oz. |
| | |  | DIELECTRIC | 0.254mm | FR4 (4.34) |
| | |  | L4 | 0.047mm | FINISHED Cu. |
| | |  | BMASK | 0.020mm | SOLDER RESIST |
| | | | TOTAL THICKNESS | 1.578mm | TOL: +/- 10% |

204300-005

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.

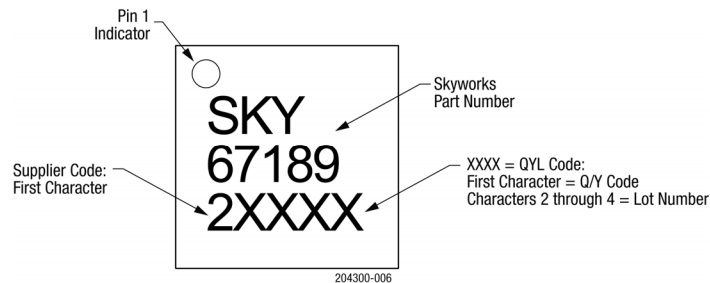


Figure 17. SKY67189-396LF Typical Part Marking

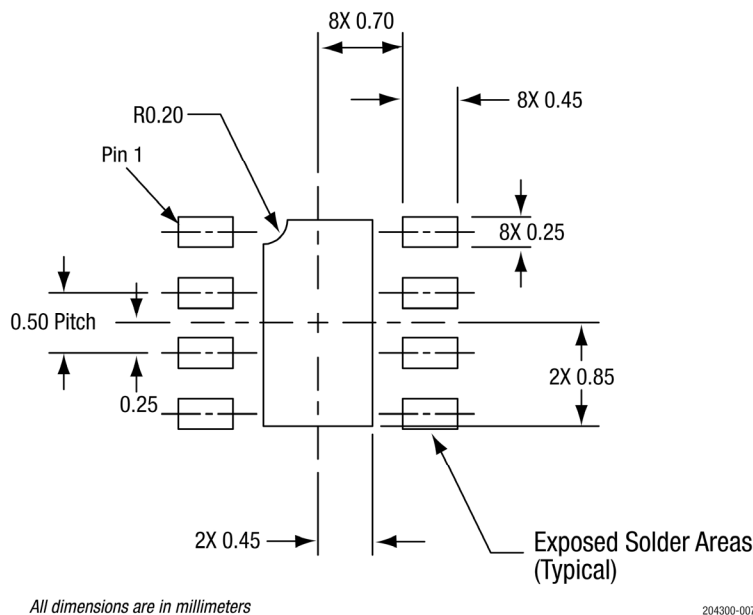
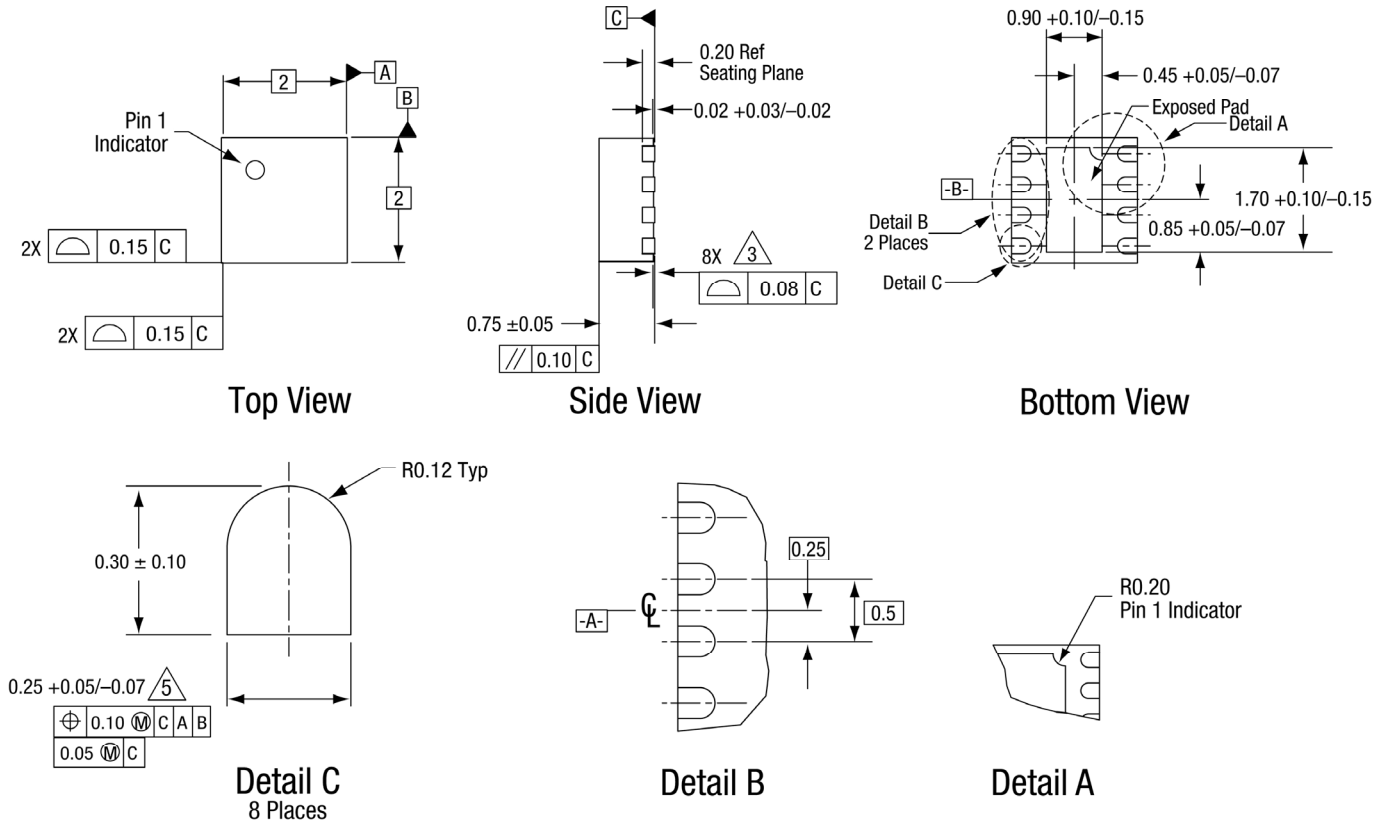


Figure 18. SKY67189-396LF PCB Layout Footprint

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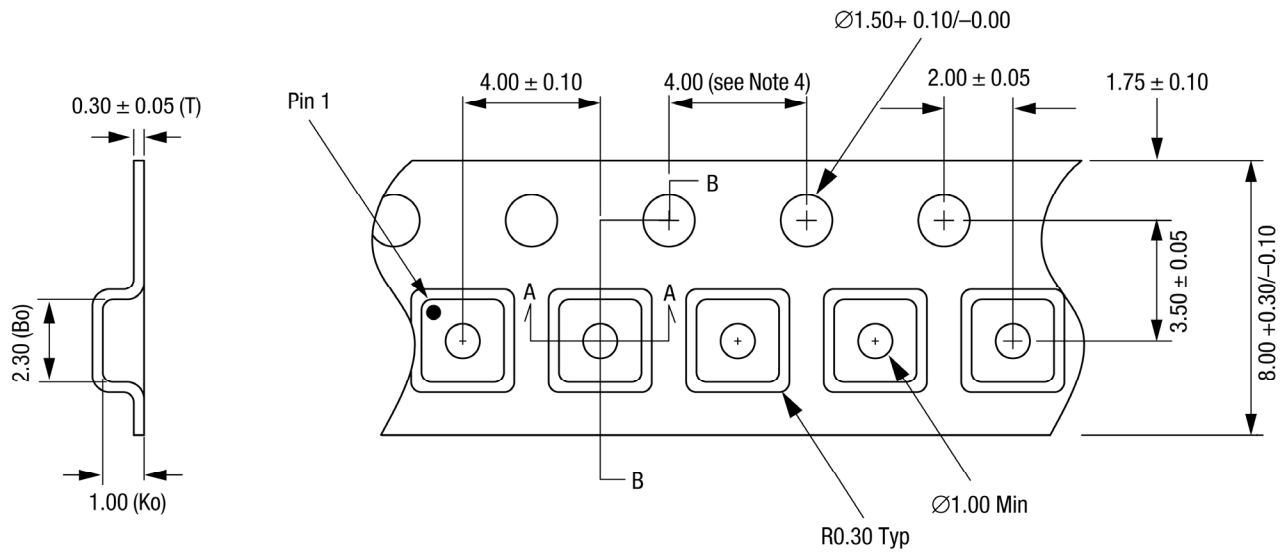


Notes:

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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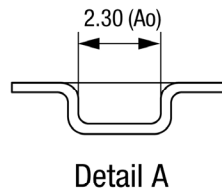
Figure 19. SKY67189-396LF Package Dimensions



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 = ± 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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