**DATA SHEET**

# SKY67013-396LF: 600-1500 MHz Low-Noise, Low-Current Amplifier

## Applications

- ISM band receivers
- General purpose LNAs

## Features

- Low NF: 0.85 dB @ 900 MHz
- Gain: 14 dB @ 900 MHz
- Flexible supply voltage from 1.8 to 5.0 V
- Adjustable supply current for higher IIP3
- Improved NF and linearity compared to SiGe LNAs
- Incorporates on-die stability structures
- 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.

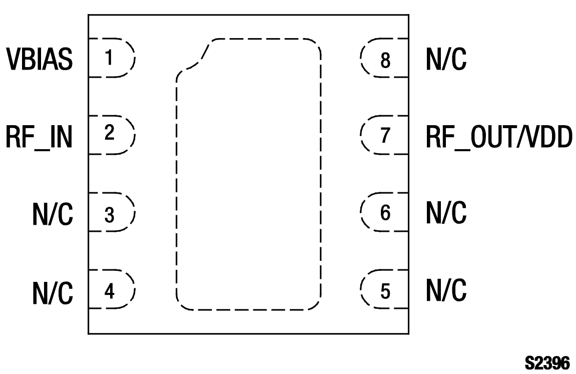



**Figure 2. SKY67013-396LF Pinout – 8-Pin DFN (Top View)**

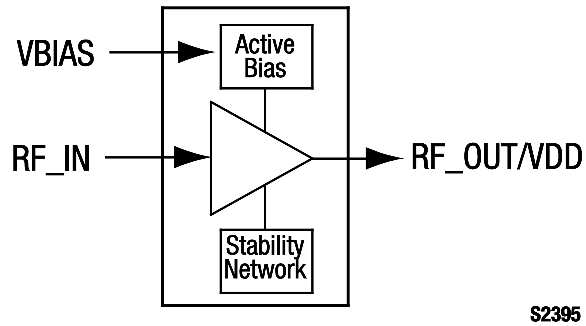



**Figure 1. SKY67013-396LF Block Diagram**

## Description

The SKY67013-396LF is a GaAs, pHEMT Low-Noise Amplifier (LNA) with an integrated active bias. The advanced GaAs pHEMT enhancement mode process provides excellent return loss, low noise, and high linearity.

The device offers the ability to externally adjust the supply current. The supply voltage is applied to the RF-OUT/VDD pin through an RF choke inductor. The VBIAS pin should be connected to the RF_OUT/VDD pin through an external resistor to control the supply current. Both RF_OUT/VDD and RF_IN pins should be DC blocked to ensure proper operation.

The SKY67013-396LF 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. SKY67013-396LF Signal Descriptions**

| Pin # | Name | Description | Pin # | Name | Description |
|---|---|---|---|---|---|
| 1 | VBIAS | Bias for first stage amplifier. External resistor sets current consumption. | 5 | N/C | No connection. May be connected to ground with no change in performance. |
| 2 | RF_IN | RF input. DC blocking capacitor required. | 6 | N/C | No connection. May be connected to ground with no change in performance. |
| 3 | N/C | No connection. May be connected to ground with no change in performance. | 7 | RF_OUT/VDD | RF output. Apply VDD through RF choke inductor. DC blocking capacitor required. |
| 4 | N/C | No connection. May be connected to ground with no change in performance. | 8 | N/C | No connection. May be connected to ground with no change in performance. |

**Table 2. SKY67013-396LF Absolute Maximum Ratings**

| Parameter | Symbol | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | | 3.3 | 5.5 | V |
| Drain current | $I_{DD}$ | | 15 | 50 | mA |
| RF input power | $P_{IN}$ | | | +10 | dBm |
| Storage temperature | $T_{STG}$ | –65 | +25 | +125 | °C |
| Operating temperature | $T_A$ | –40 | +25 | +85 | °C |
| Thermal resistance | $\Theta_{JC}$ | | 128 | | °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 SKY67013-396LF is a Human Body Model (HBM) Class 1A ESD device.*

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY67013-396LF are provided in Table 2. Electrical specifications are provided in Tables 3 (15 mA operation) and 4 (5 mA operation).

Typical performance characteristics of the SKY67013-396LF are illustrated in Figures 3 through 15 (for 15 mA quiescent current), and Figures 16 through 26 (for 5 mA quiescent current).

**Table 3. SKY67013-396LF Electrical Specifications: Supply Current = 15 mA (Note 1)**
**($V_{DD}$ = 3.3 V, $T_A$ = +25 °C, $P_{IN}$ = –20 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Tuning Optimized for 900 MHz, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| ***RF Specifications*** | | | | | | |
| Noise Figure | NF | Board and connector insertion losses not de-embedded | | 0.85 | 1.10 | dB |
| Small signal gain | $\|S_{21}\|$ | | 12.5 | 14.0 | | dB |
| Input return loss | $\|S_{11}\|$ | | | 23 | | dB |
| Output return loss | $\|S_{22}\|$ | | | 16 | | dB |
| Reverse isolation | $\|S_{12}\|$ | | | 22 | | dB |
| 3rd Order Input Intercept Point | IIP3 | Δf = 1 MHz, $P_{IN}$ = –20 dBm/tone | +9 | +12 | | dBm |
| 3rd Order Output Intercept Point | OIP3 | Δf = 1 MHz, $P_{IN}$ = –20 dBm/tone | +23 | +26 | | dBm |
| 1 dB Input Compression Point | IP1dB | | +0.5 | +2.5 | | dBm |
| 1 dB Output Compression Point | OP1dB | | +13.5 | +15.5 | | dBm |
| ***DC Specifications*** | | | | | | |
| Supply voltage | $V_{DD}$ | | | 3.3 | | V |
| Supply current | $I_{DD}$ | Set with external resistor | | 15 | | mA |

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

**Table 4. SKY67013-396LF Electrical Specifications: Supply Current = 5 mA (Note 1)**
**($V_{DD}$ = 3.3 V, $T_A$ = +25 °C, $P_{IN}$ = –20 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Tuning Optimized for 900 MHz, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| ***RF Specifications*** | | | | | | |
| Noise Figure | NF | Board and connector insertion losses not de-embedded | | 1.1 | | dB |
| Small signal gain | $\|S_{21}\|$ | | | 12.5 | | dB |
| Input return loss | $\|S_{11}\|$ | | | 16 | | dB |
| Output return loss | $\|S_{22}\|$ | | | 14 | | dB |
| Reverse isolation | $\|S_{12}\|$ | | | 23 | | dB |
| 3rd Order Input Intercept Point | IIP3 | Δf = 1 MHz, $P_{IN}$ = –20 dBm/tone | | +9.5 | | dBm |
| 3rd Order Output Intercept Point | OIP3 | Δf = 1 MHz, $P_{IN}$ = –20 dBm/tone | | +22 | | dBm |
| 1 dB Input Compression Point | IP1dB | | | +4 | | dBm |
| 1 dB Output Compression Point | OP1dB | | | +15.5 | | dBm |
| ***DC Specifications*** | | | | | | |
| Supply voltage | $V_{DD}$ | | | 3.3 | | V |
| Supply current | $I_{DD}$ | Set with external resistor | | 5 | | mA |

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

## Typical Performance Characteristics

**($V_{DD}$ = 3.3 V, Quiescent Current = 15 mA, $T_A$ = +25 °C, $P_{IN}$ = –20 dBm, Characteristic Impedance [$Z_O$] = 50 Ω, Tuning Optimized for 900 MHz, Unless Otherwise Noted)**

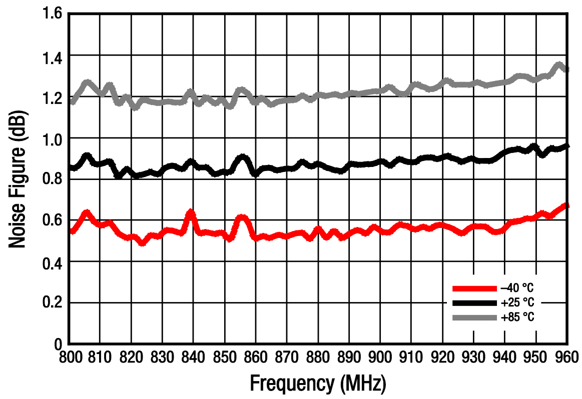



**Figure 3. Noise Figure vs Frequency and Temperature, Narrow Band (Includes EVB Insertion Losses)**

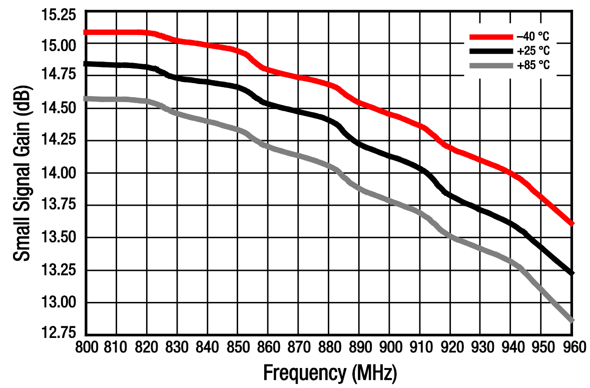



**Figure 4. Small Signal Gain (|S21|) vs Frequency and Temperature, Narrow Band**

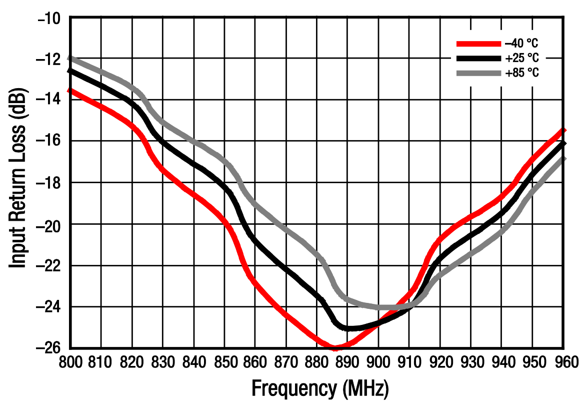



**Figure 5. Small Signal Input Return Loss (|S11|) vs Frequency and Temperature, Narrow Band**

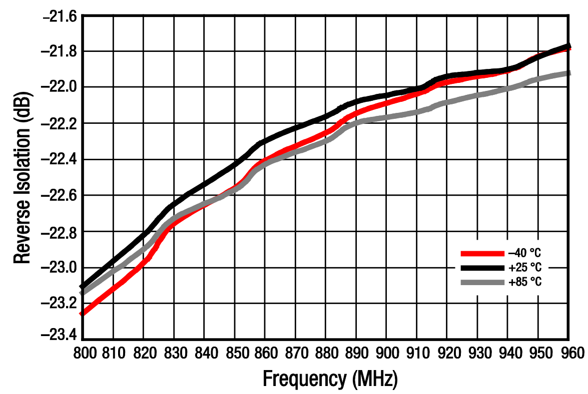



**Figure 6. Small Signal Reverse Isolation (|S12|) vs Frequency and Temperature, Narrow Band**

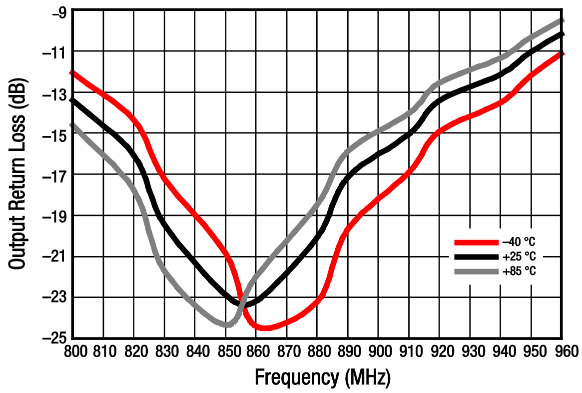



**Figure 7. Small Signal Output Return Loss (|S22|) vs Frequency and Temperature, Narrow Band**

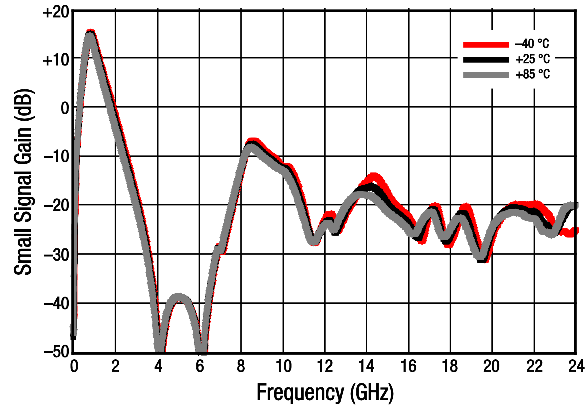



**Figure 8. Small Signal Gain (|S21|) vs Frequency and Temperature, Wide Band**

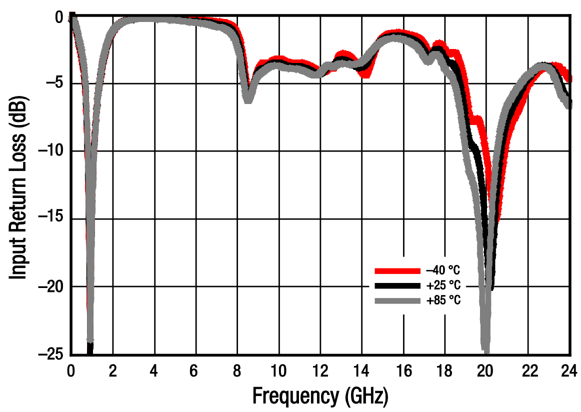



**Figure 9. Small Signal Input Return Loss (|S11|) vs Frequency and Temperature, Wide Band**

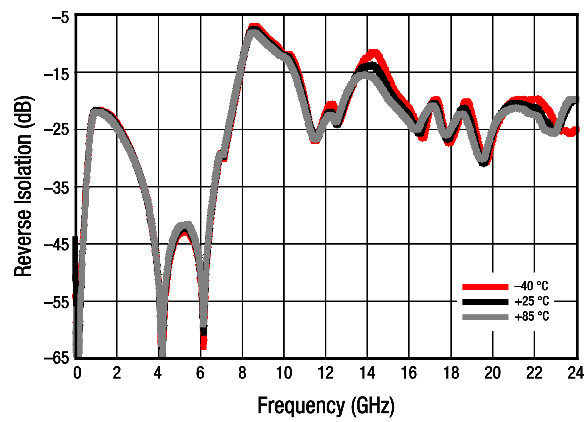



**Figure 10. Small Signal Reverse Isolation (|S12|) vs Frequency and Temperature, Wide Band**

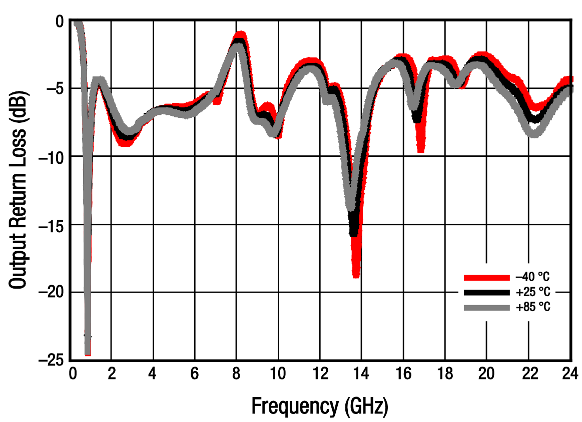



**Figure 11. Small Signal Output Return Loss (|S22|) vs Frequency and Temperature, Wide Band**

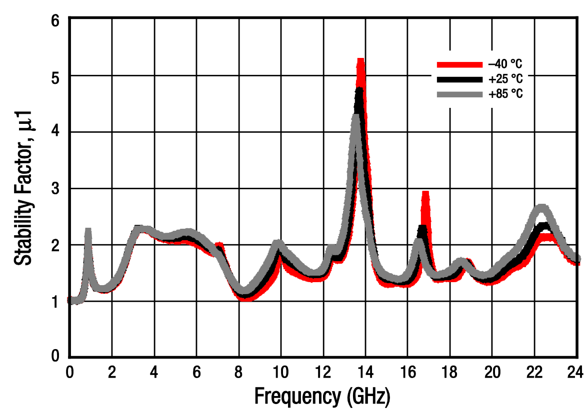



**Figure 12. Stability Factor (µ1) vs Frequency and Temperature, Wide Band**

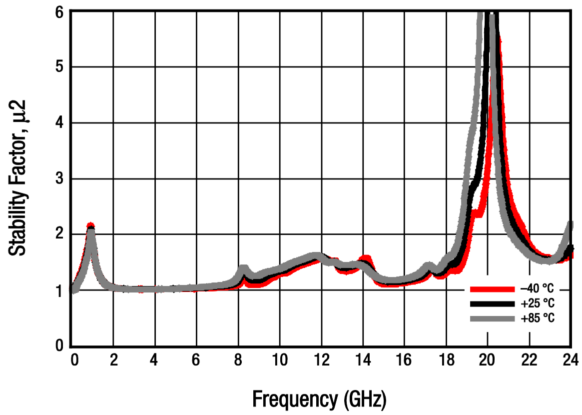



**Figure 13. Stability Factor (µ2) vs Frequency and Temperature, Wide Band**

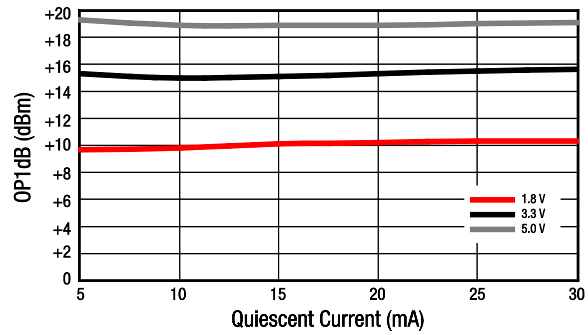



**Figure 14. OP1dB vs Quiescent Current**

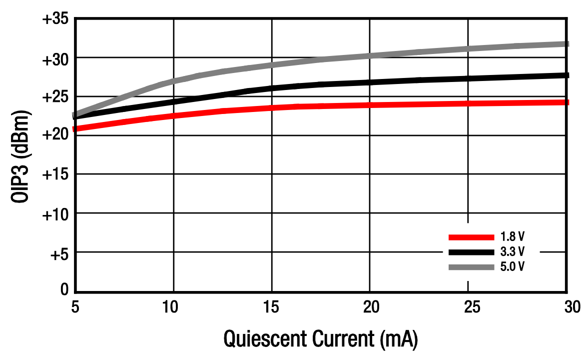



**Figure 15. OIP3 vs Quiescent Current**

## Typical Performance Characteristics

**(VDD = 3.3 V, Quiescent Current = 5 mA, TA = +25 °C, PIN = –20 dBm, Characteristic Impedance [ZO] = 50 Ω, Tuning Optimized for 900 MHz, Unless Otherwise Noted)**

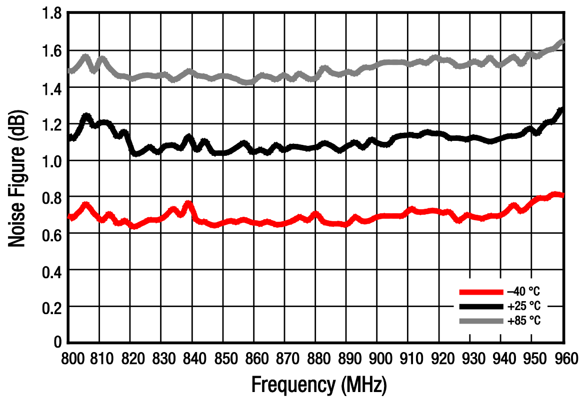



**Figure 16. Noise Figure vs Frequency and Temperature, Narrow Band (Includes EVB Insertion Losses)**

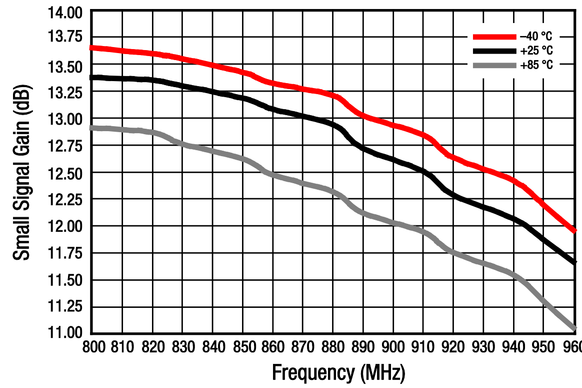



**Figure 17. Small Signal Gain (|S21|) vs Frequency and Temperature, Narrow Band**

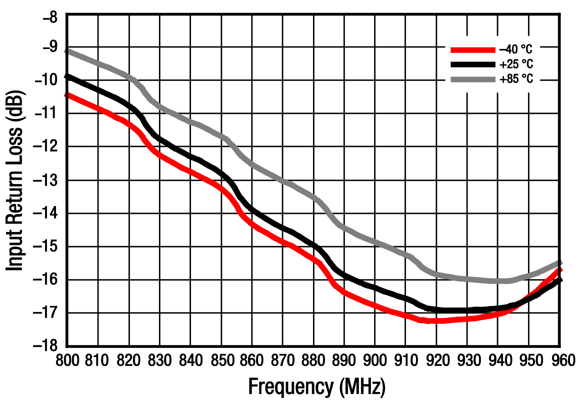



**Figure 18. Small Signal Input Return Loss (|S11|) vs Frequency and Temperature, Narrow Band**

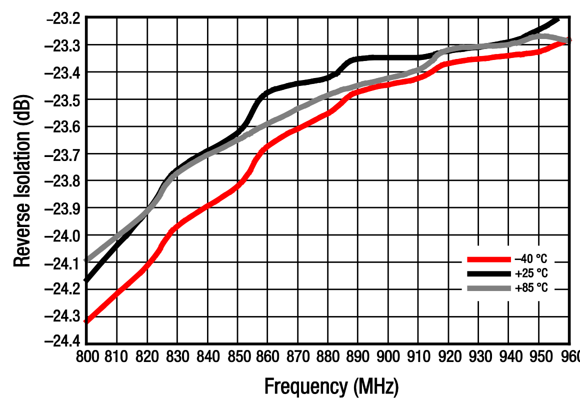



**Figure 19. Small Signal Reverse Isolation (|S12|) vs Frequency and Temperature, Narrow Band**

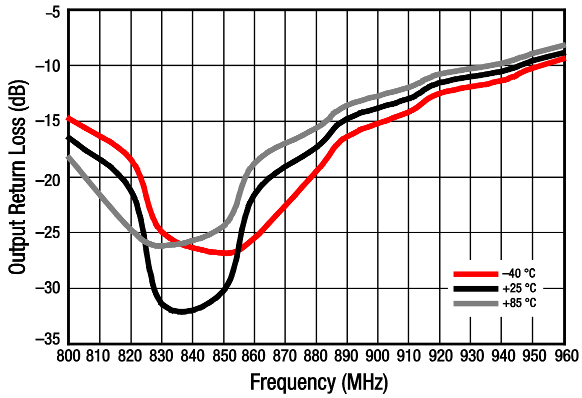



**Figure 20. Small Signal Output Return Loss (|S22|) vs Frequency and Temperature, Narrow Band**

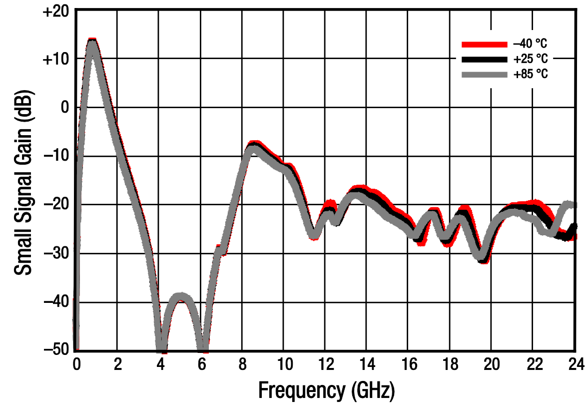



**Figure 21. Small Signal Gain (|S21|) vs Frequency and Temperature, Wide Band**

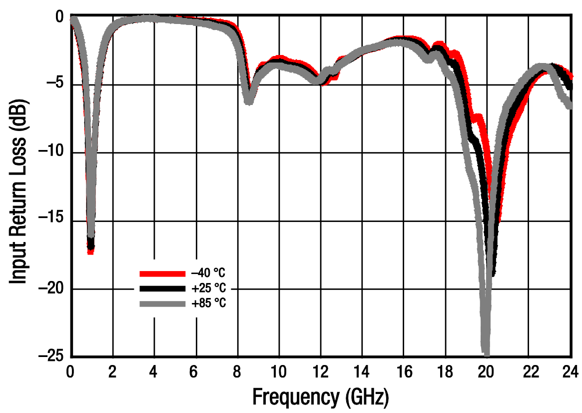



**Figure 22. Small Signal Input Return Loss (|S11|) vs Frequency and Temperature, Wide Band**

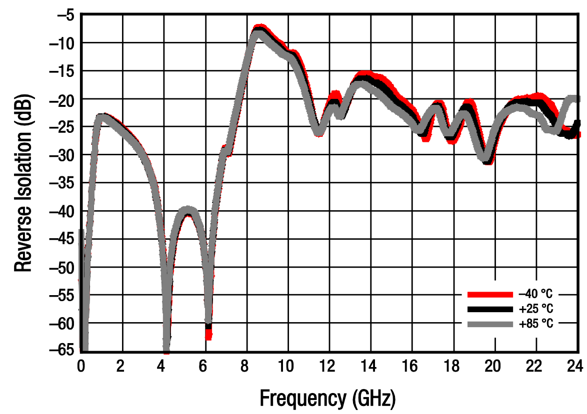



**Figure 23. Small Signal Reverse Isolation (|S12|) vs Frequency and Temperature, Wide Band**

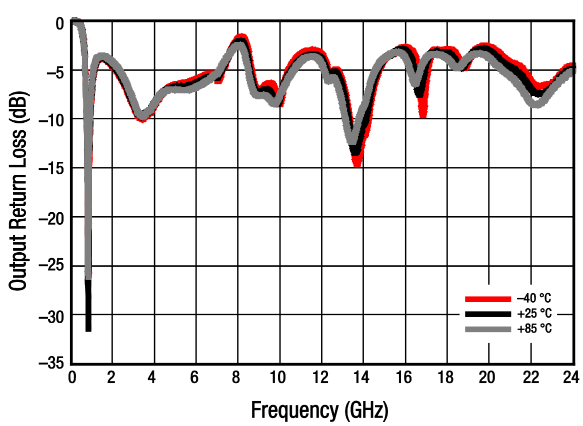



**Figure 24. Small Signal Output Return Loss (|S22|) vs Frequency and Temperature, Wide Band**

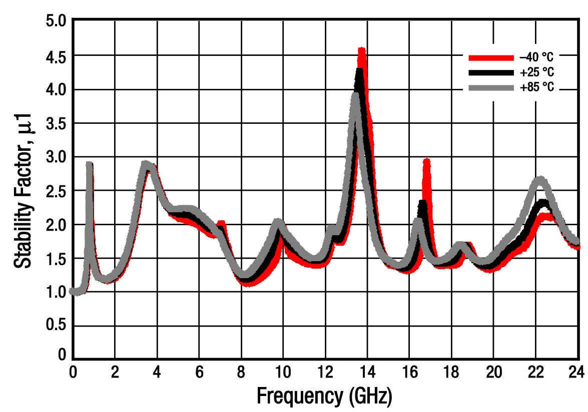



**Figure 25. Stability Factor (µ1) vs Frequency and Temperature, Wide Band**

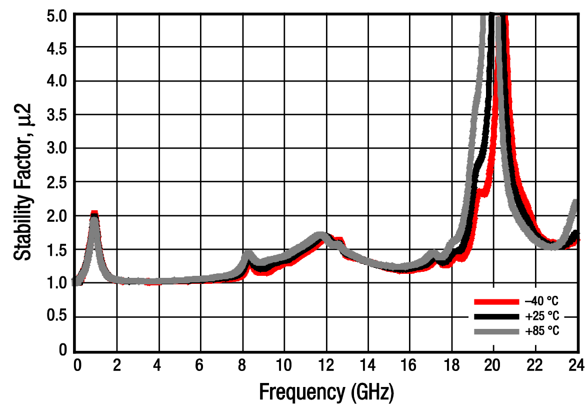



**Figure 26. Stability Factor (µ2) vs Frequency and Temperature, Wide Band**

## Evaluation Board Description

The SKY67013-396LF Evaluation Board is used to test the performance of the SKY67013-396LF LNA. An assembly drawing for the Evaluation Board is shown in Figure 27. An Evaluation Board schematic diagram is provided in Figure 28. Table 5 provides the Bill of Materials (BOM) list for Evaluation Board components.

## Package Dimensions

The PCB layout footprint for the SKY67013-396LF is provided in Figure 29. Typical case markings are shown in Figure 30. Package dimensions for the 8-pin DFN are shown in Figure 31, and tape and reel dimensions are provided in Figure 32.

## 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 SKY67013-396LF 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.

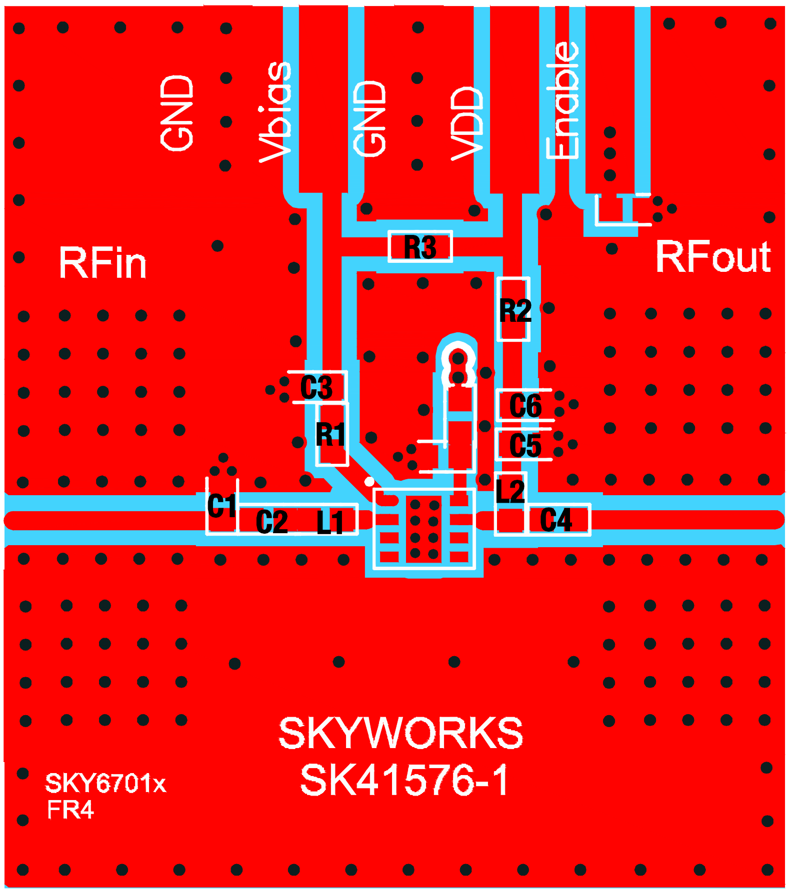



**Figure 27. SKY67013-396LF Evaluation Board Assembly Diagram**

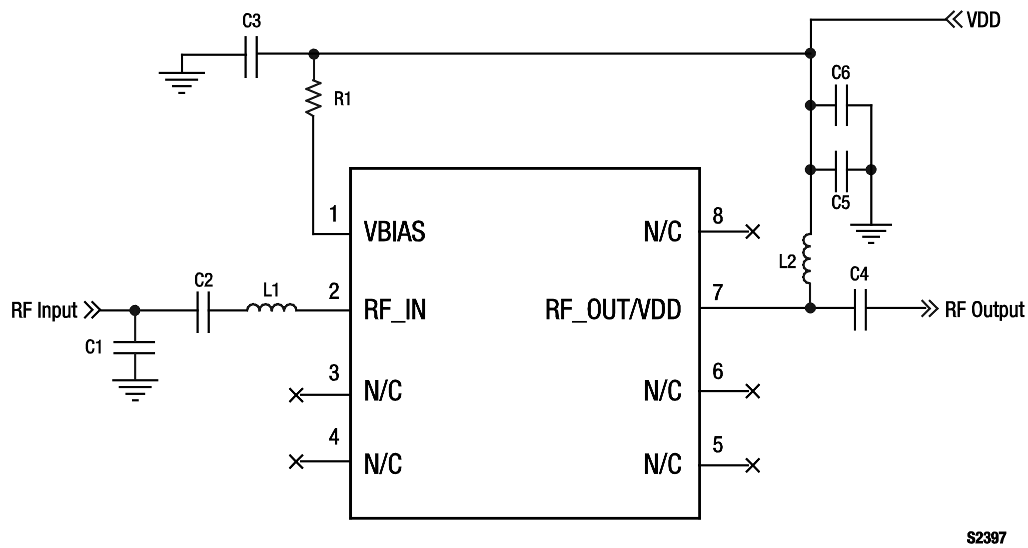



**Figure 28. SKY67013-396LF Evaluation Board Schematic**

**Table 5. SKY67013-396LF Evaluation Board Bill of Materials**

| Component | Value | Size | Manufacturer |
|---|---|---|---|
| C1 | 1.8 pF | 0402 | Murata GJM |
| C2 | 20 pF | 0402 | Murata GJM |
| C3 | 10 pF | 0402 | Murata GRM |
| C4 | 2.4 pF | 0402 | Murata GRM |
| C5 | 10000 pF | 0402 | Murata GRM |
| C6 | 0.5 pF | 0402 | Murata GRM |
| L1 | 10 nH | 0402 | Murata LQW |
| L2 | 8.2 nH | 0402 | Murata LQG |
| R1 (Note 1) | 6.2 kΩ | 0402 | Panasonic |
| R2 | 0 Ω | 0402 | Panasonic |
| R3 | 0 Ω | 0402 | Panasonic |

**Note 1**: Use 20 kΩ for R1 to achieve 5 mA of quiescent current with 3.3 $V_{DD}$.

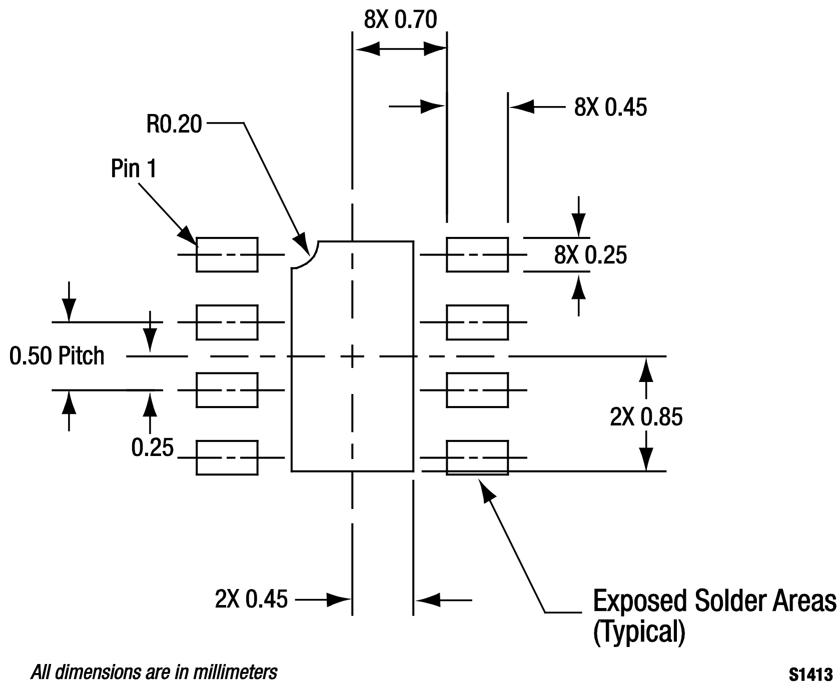



**Figure 29. SKY67013-396LF PCB Layout Footprint (Top View)**

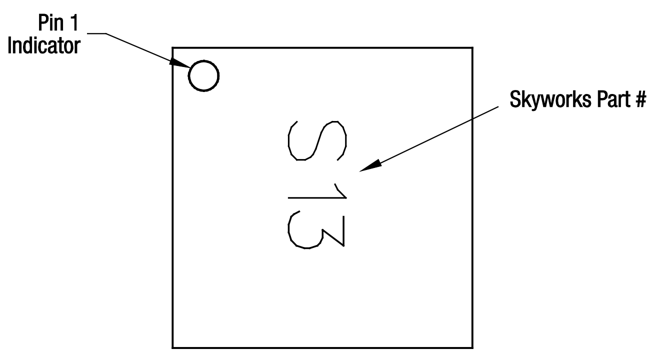
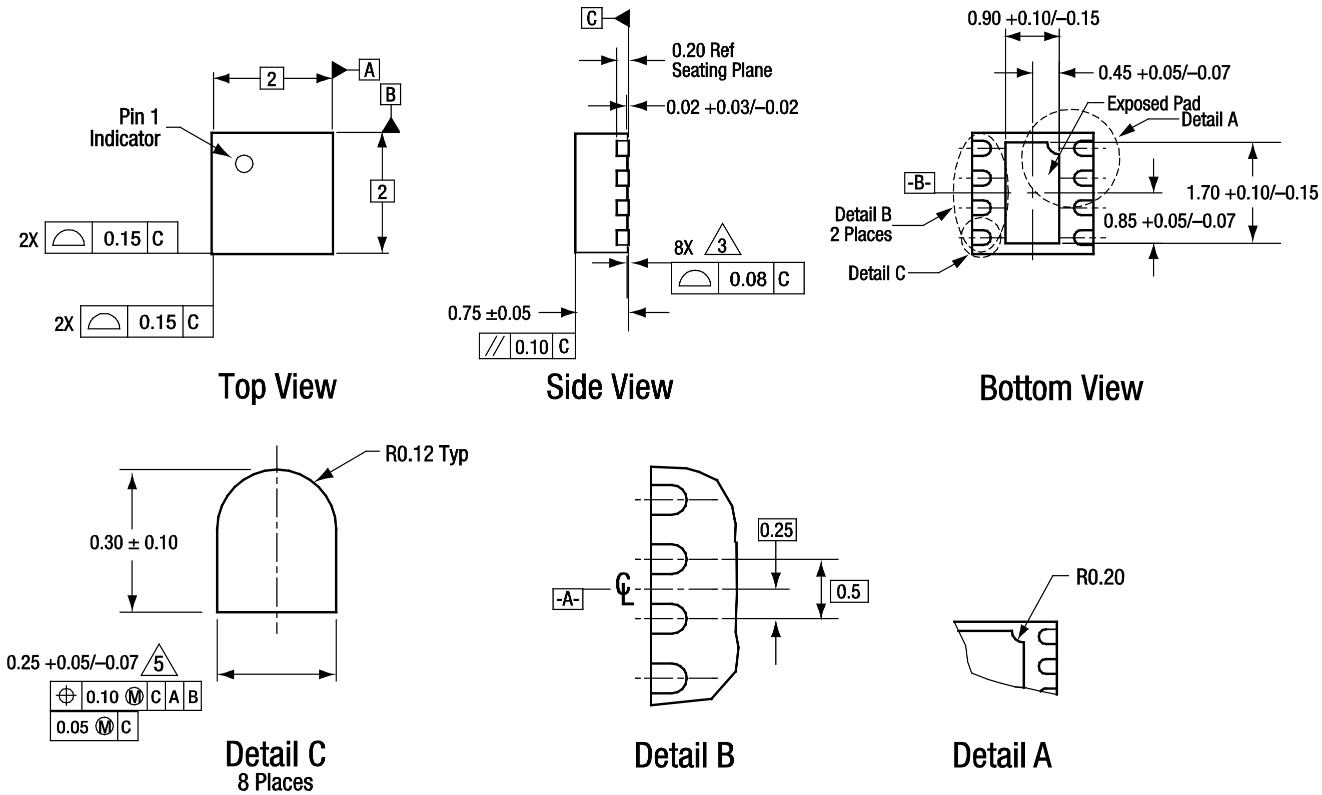



**Figure 30. Typical Case Markings (Top View)**




*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.*

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**Figure 31. SKY67013-396LF 8-Pin DFN Package Dimensions**

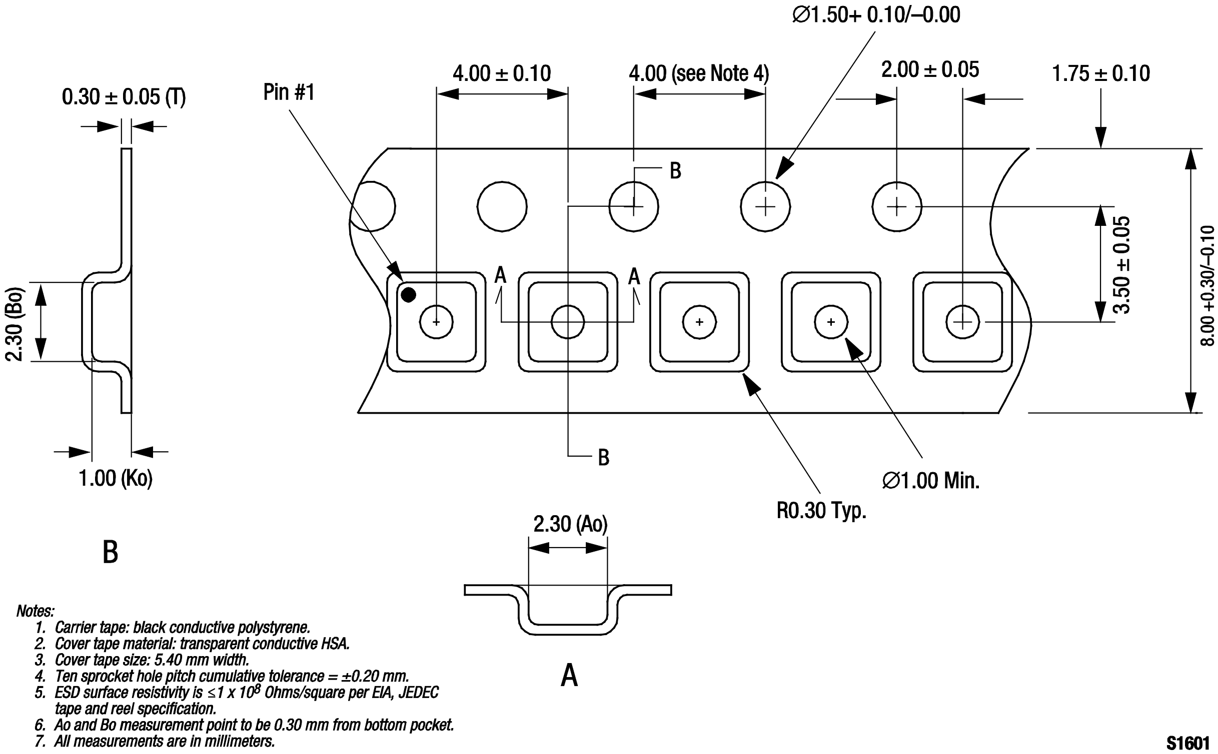


**Figure 32. SKY67013-396LF Tape and Reel Dimensions**

## Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|---|---|---|
| SKY67013-396LF Low-Noise, Low-Current Amplifier | SKY67013-396LF | SKY67013-396LF-EVB |