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.

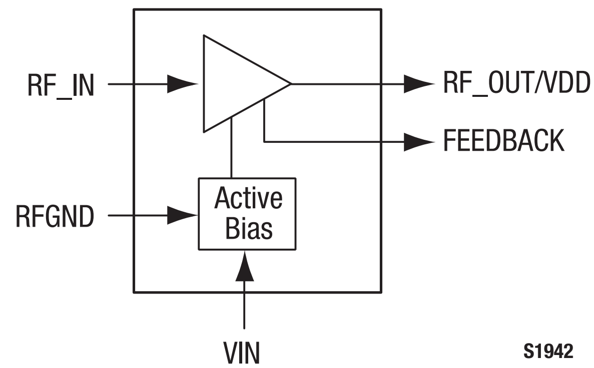


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**Figure 1. SKY67101-396LF Block Diagram**

## 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.

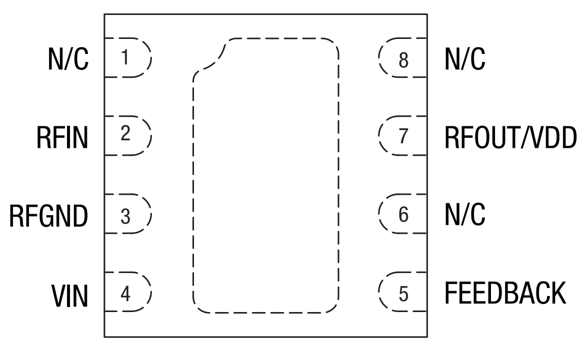


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**Figure 2. SKY67101-396LF Pinout – 8-Pin DFN (Top View)**

**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 | $V_{DD}$ | | | 5.5 | V |
| Supply current | $I_{DD}$ | | | 100 | mA |
| RF input power | $P_{IN}$ | | | +20 | dBm |
| Storage temperature | $T_{STG}$ | –65 | +25 | +125 | °C |
| Operating temperature | $T_A$ | –40 | +25 | +85 | °C |
| Junction temperature | $T_J$ | | | +150 | °C |
| Electrostatic discharge:<br>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)**
**($V_{DD}$ = 4.0 V, $I_{DD}$ = 56 mA, $T_A$ = +25 °C, $P_{IN}$ = –20 dBm, Characteristic Impedance [$Z_O$] = 50 Ω, Refer to Table 5 [4.0 V, 56 mA BOM])**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| ***RF Specifications*** | | | | | | |
| Noise figure (Note 2) | NF | @ 0.80 GHz<br>@ 0.85 GHz<br>@ 0.90 GHz | | 0.63<br>0.59<br>0.57 | <br><br>1.00 | dB<br>dB<br>dB |
| Small signal gain | $\|S_{21}\|$ | @ 0.80 GHz<br>@ 0.85 GHz<br>@ 0.9 GHz | 17.7<br>17.0<br>16.6 | 18.7<br>18.0<br>17.6 | 19.7<br>19.0<br>18.6 | dB<br>dB<br>dB |
| Input return loss | $\|S_{11}\|$ | @ 0.80 GHz<br>@ 0.85 GHz<br>@ 0.9 GHz | | 17.2<br>18.8<br>18.2 | | dB<br>dB<br>dB |
| Output return loss | $\|S_{22}\|$ | @ 0.80 GHz<br>@ 0.85 GHz<br>@ 0.9 GHz | | 19.8<br>33.0<br>20.0 | | dB<br>dB<br>dB |
| Reverse isolation | $\|S_{12}\|$ | @ 0.80 GHz<br>@ 0.85 GHz<br>@ 0.9 GHz | | 30.5<br>30.3<br>30.3 | | dB<br>dB<br>dB |
| 3rd Order Input Intercept Point | IIP3 | @ 0.9 GHz, Δf = 5 MHz,<br>$P_{IN}$ = –20 dBm/tone | | +16.2 | | dBm |
| 3rd Order Output Intercept Point | OIP3 | @ 0.9 GHz, Δf = 5 MHz,<br>$P_{IN}$ = –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,<br>–40 °C to +85 °C | | >1 | | – |
| ***DC Specifications*** | | | | | | |
| Supply voltage | $V_{DD}$ | | | 4 | | V |
| Supply current | $I_{DD}$ | 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 V, $I_{DD}$ = 56 mA, $T_A$ = +25 °C, $P_{IN}$ = –20 dBm, Characteristic Impedance [$Z_O$] = 50 Ω)**

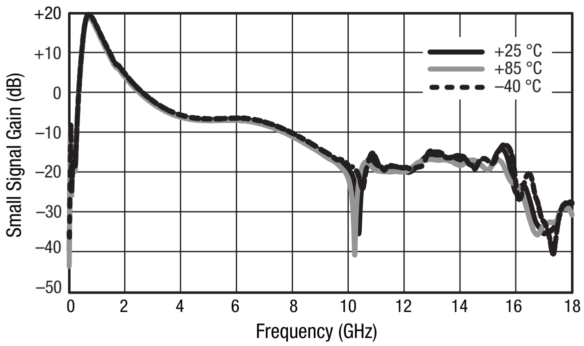



**Figure 3. Broadband Gain Response vs Frequency**

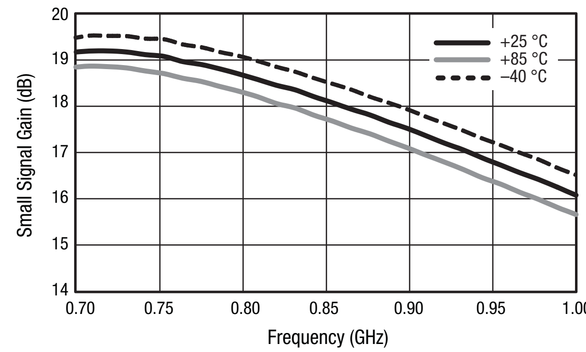



**Figure 4. Narrowband Gain Response vs Frequency**

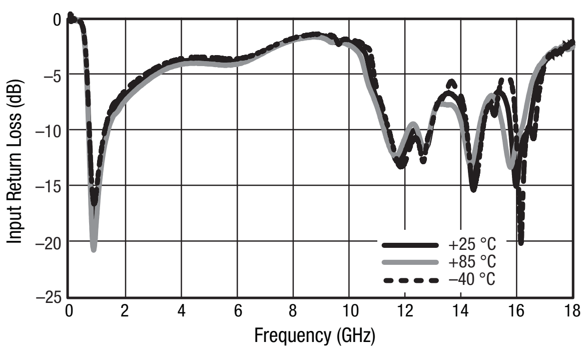



**Figure 5. Broadband Input Return Loss vs Frequency**

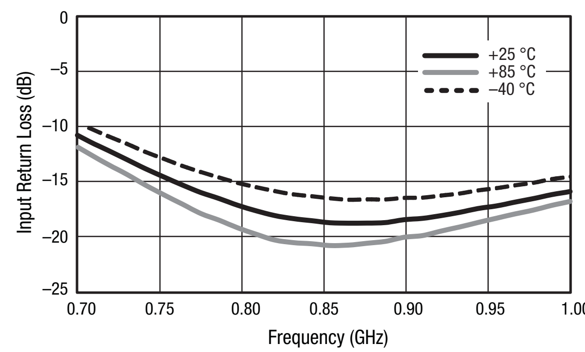



**Figure 6. Narrowband Input Return Loss vs Frequency**

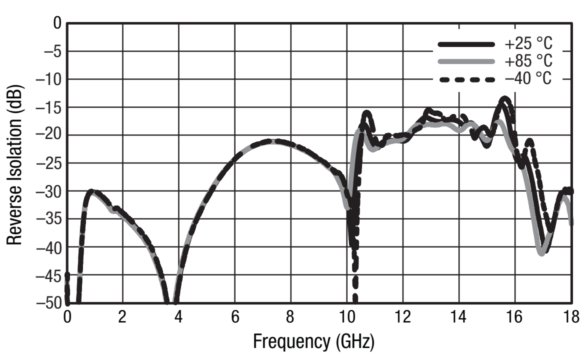



**Figure 7. Broadband Reverse Isolation vs Frequency**

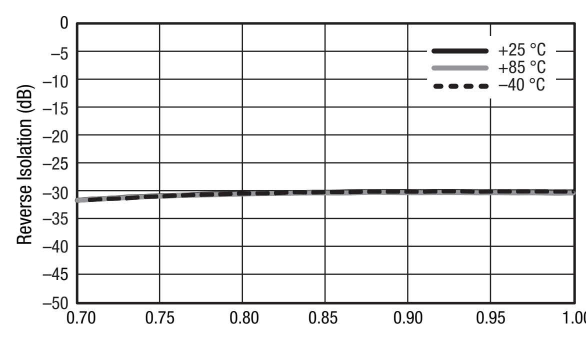



**Figure 8. Narrowband Reverse Isolation vs Frequency**

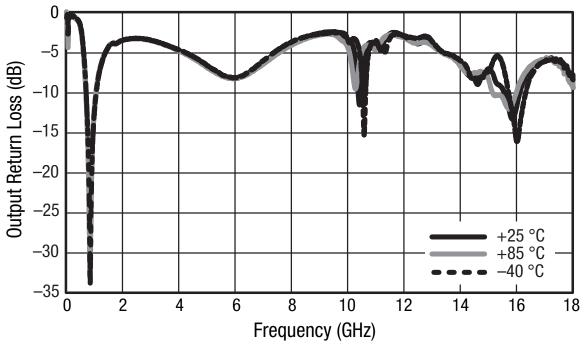



**Figure 9. Broadband Output Return Loss vs Frequency**

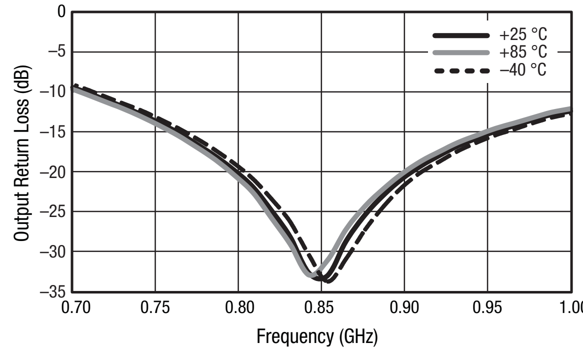



**Figure 10. Narrowband Output Return Loss vs Frequency**

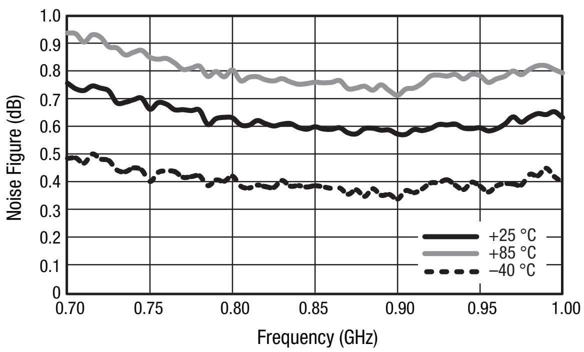



**Figure 11. Noise Figure vs Frequency**

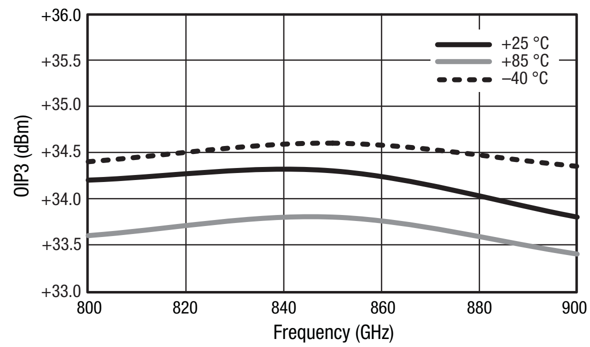



**Figure 12. OIP3 vs Frequency**
**($P_{IN}$ = –20 dBm, Spacing = 5 MHz)**

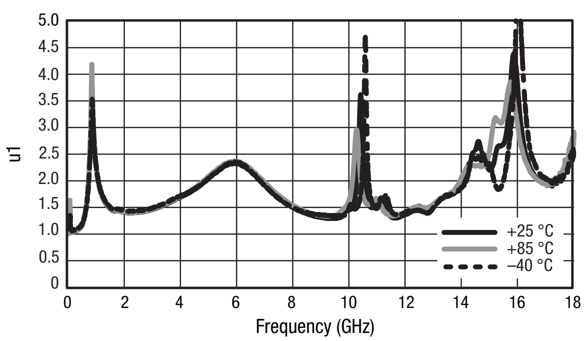



**Figure 13. u1 Stability vs Frequency**

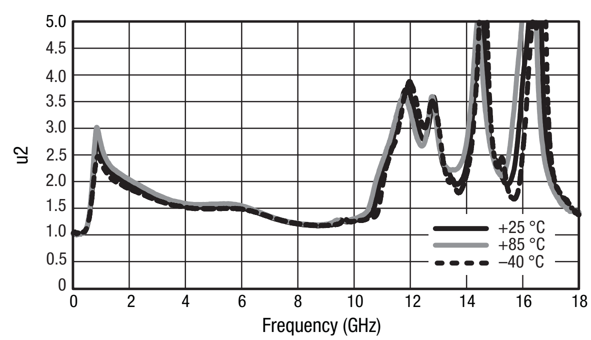



**Figure 14. u2 Stability vs Frequency**

**Table 4. SKY67101-396LF Electrical Specifications (Note 1)**
**($V_{DD}$ = 3.3 V, $I_{DD}$ = 46 mA, $T_A$ = +25 °C, $P_{IN}$ = –20 dBm, Characteristic Impedance [$Z_O$] = 50 Ω, Refer to Table 5 [3.3 V, 46 mA BOM])**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| ***RF Specifications*** | | | | | | |
| Noise figure (Note 2) | NF | @ 848 MHz | | 0.72 | | dB |
| Small signal gain | \|S21\| | @ 848 MHz | | 17.9 | | dB |
| Input return loss | \|S11\| | @ 848 MHz | | 17.0 | | dB |
| Output return loss | \|S22\| | @ 848 MHz | | 25.0 | | dB |
| Reverse isolation | \|S12\| | @ 848 MHz | | 31.0 | | dB |
| Input Third Order Intercept Point | IIP3 | ΔF=1 MHz, $P_{IN}$=-20 dBm/tone 848 MHz | | +15.6 | | dBm |
| Output Third Order Intercept Point | OIP3 | ΔF=1 MHz, $P_{IN}$=-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 | μ1, μ2, K, B | | | >1 | | - |
| ***DC Specifications*** | | | | | | |
| Supply voltage | $V_{DD}$ | | | 3.30 | | V |
| Supply current | $I_{DD}$ | | | 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 ($\varepsilon_r$) and low $\varepsilon_r$ 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.

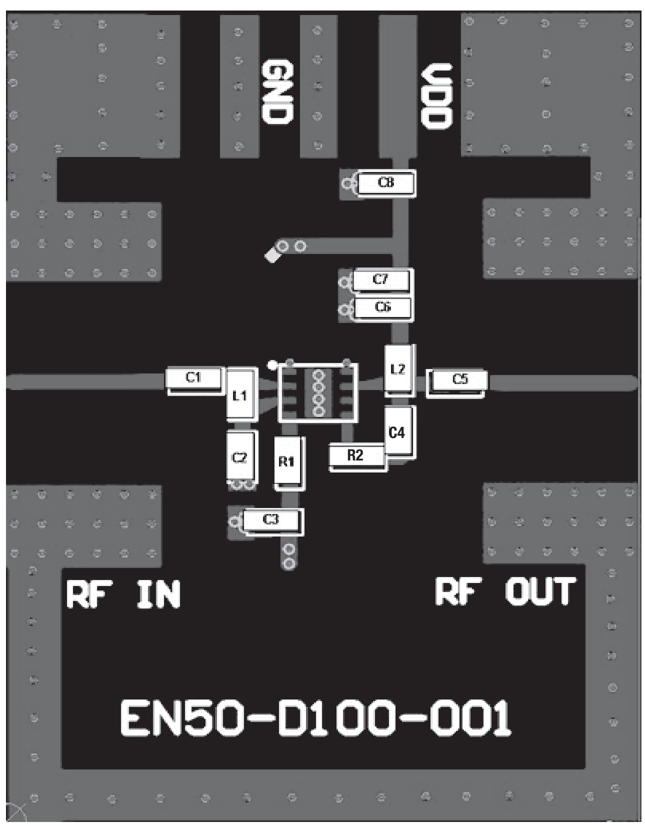



**Figure 15. SKY67101-396LF Evaluation Board Assembly Diagram**

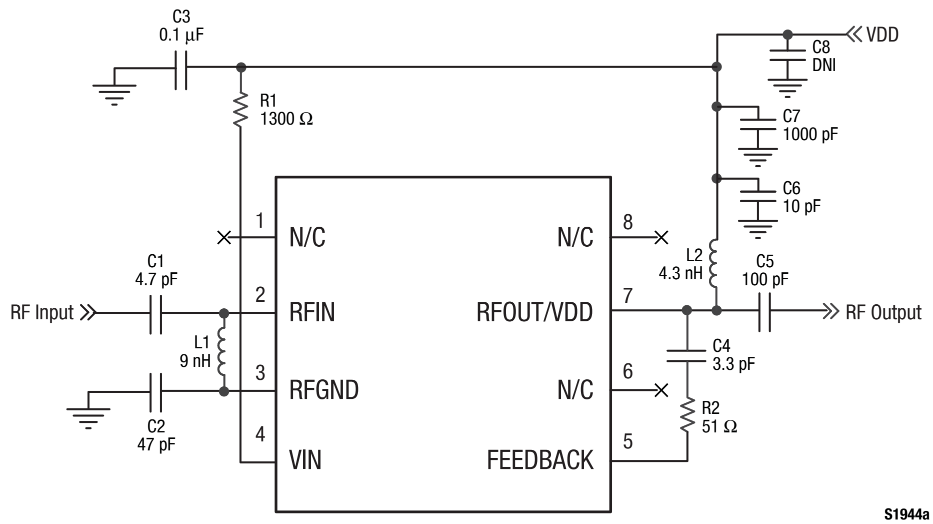



**Figure 16. SKY67101-396LF Evaluation Board Schematic**

**Table 5. SKY67101-396LF Evaluation Board Bill of Materials**
**($V_{DD}$ = 4.0 V, $I_{DD}$ = 56 mA and $V_{DD}$ = 3.3 V, $I_{DD}$ = 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 |

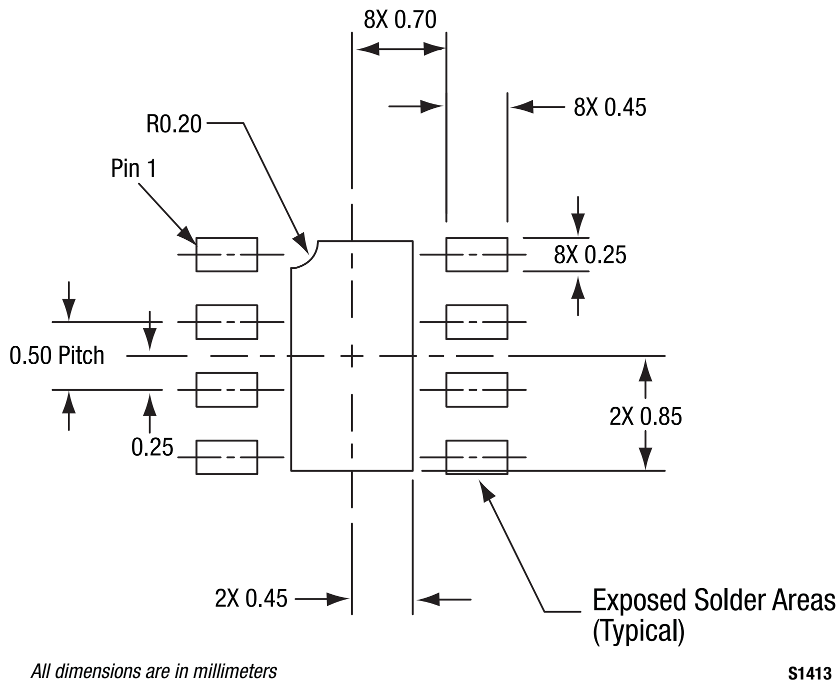



**Figure 17. SKY67101-396LF PCB Layout Footprint (Top View)**

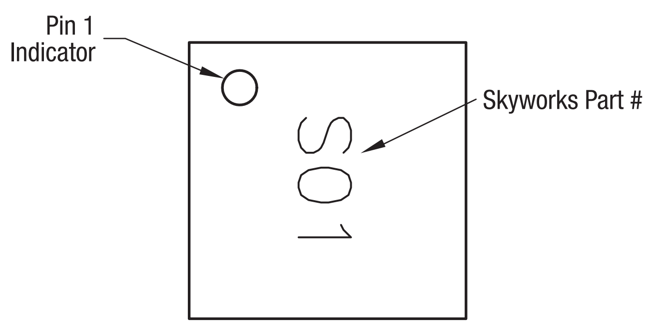
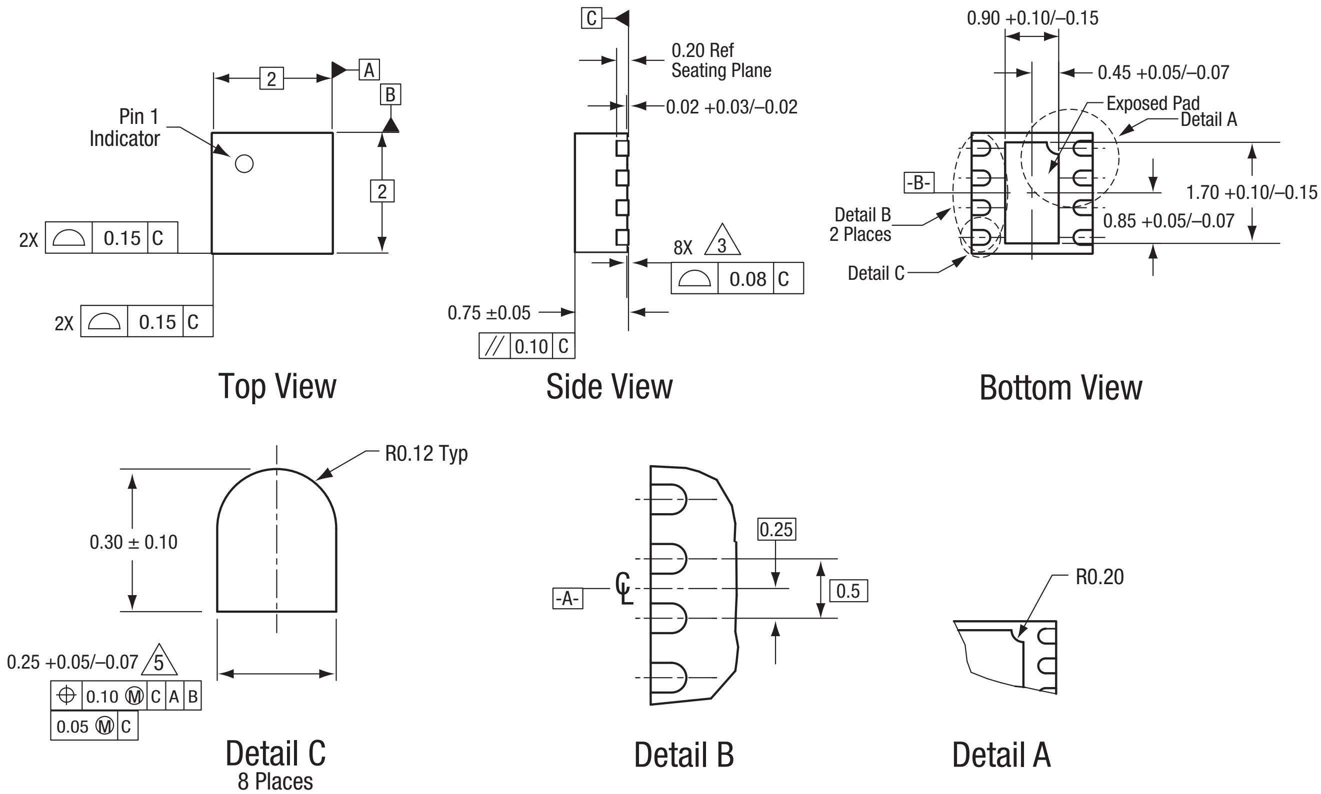



**Figure 18. Typical Case Markings (Top View)**




*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.*

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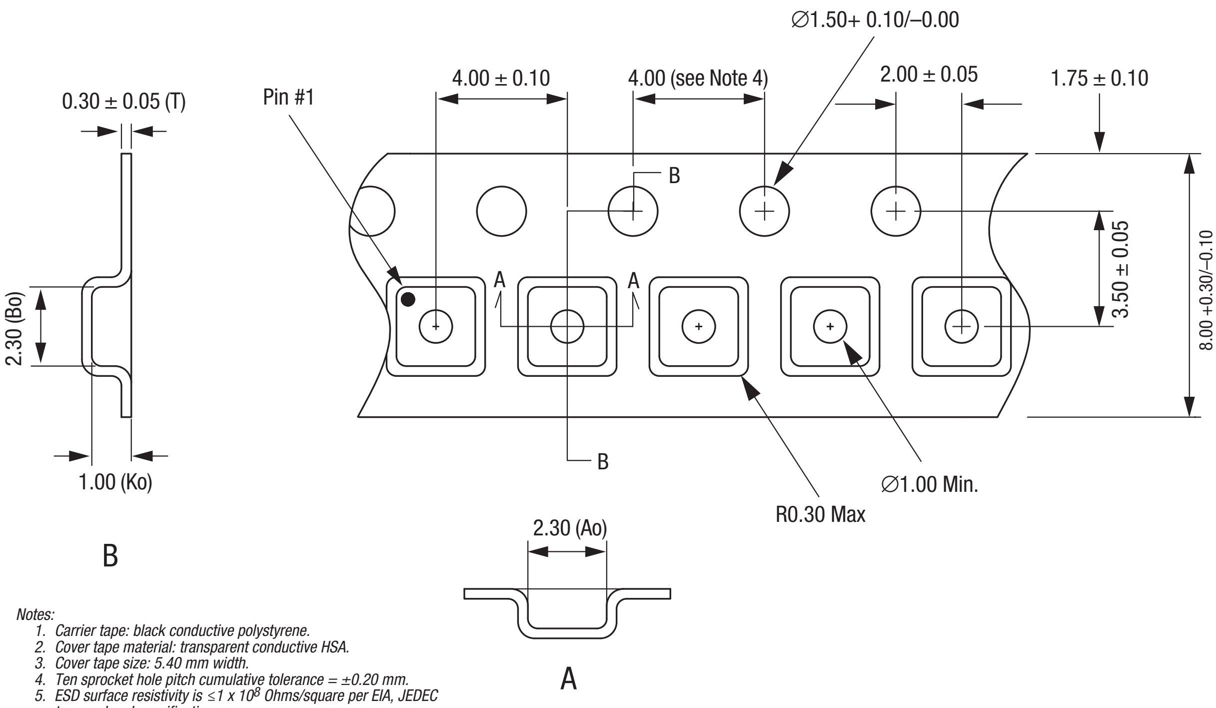
**Figure 19. SKY67101-396LF 8-Pin DFN Package Dimensions**




*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 ≤1 x $10^8$ 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.*

**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 |