

DATA SHEET

SKY67012-396LF: 300 to 600 MHz Low-Noise, Low-Current Amplifier

Applications

- ISM, CDMA, TETRA, RFID, mobile broadcast, automobile-to-home control systems, Medical Micro-Power Networks
- General purpose LNAs

Features

- Low NF: 0.85 dB @ 450 MHz
- Gain: 16.5 dB @ 450 MHz
- Flexible supply voltage from 1.8 to 5.0 V
- Adjustable supply current for higher IIP3
- Incorporates on-die stability structures
- Miniature DFN (8-pin, 2 x 2 mm) package (MSL1 @ 260 °C per JEDEC J-STD-020)



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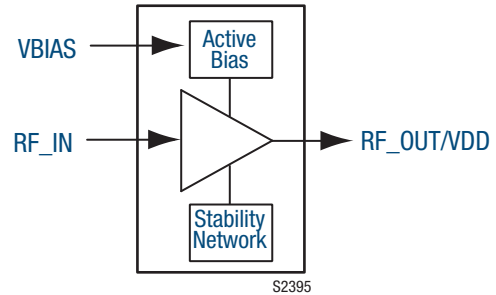


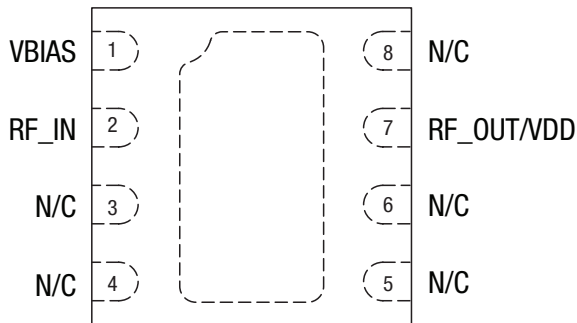
Figure 1. SKY67012-396LF Block Diagram

Description

The SKY67012-396LF 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 SKY67012-396LF 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.



S2396

Figure 2. SKY67012-396LF Pinout – 8-Pin DFN (Top View)

Table 1. SKY67012-396LF 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. |

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY67012-396LF 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 SKY67012-396LF are illustrated in Figures 3 through 26.

Table 2. SKY67012-396LF Absolute Maximum Ratings (Note 1)

| 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} | | | +18 | dBm |
| Storage temperature | T _{STG} | -65 | +25 | +125 | °C |
| Operating temperature | T _A | -40 | +25 | +85 | °C |
| Thermal resistance | Θ _{JC} | | 128 | | °C/W |
| Electrostatic discharge: Human Body Model (HBM), Class 1A | ESD | | | 500 | 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.

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.

Table 3. SKY67012-396LF Electrical Specifications: Supply Current = 15 mA (Note 1)
(V_{DD} = 3.3 V, T_A = +25 °C, P_{IN} = -20 dBm, Characteristic Impedance [Z₀] = 50 Ω, Tuning Optimized for 450 MHz, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|------------------------------------|------------------|---|------|---------|-----|-------|
| RF Specifications | | | | | | |
| Noise figure | NF | | | 0.85 | 1.1 | dB |
| Small signal gain | IS21I | | 15.0 | 16.5 | | dB |
| Input return loss | IS11I | | | 20 | | dB |
| Output return loss | IS22I | | | 12 | | dB |
| Reverse isolation | IS12I | | | 26 | | dB |
| Third Order Input Intercept Point | IIP3 | $\Delta f = 1$ MHz, P _{IN} = -20 dBm/tone | +4.5 | +7.5 | | dBm |
| Third order output intercept point | OIP3 | $\Delta f = 1$ MHz, P _{IN} = -20 dBm/tone | +21 | +24 | | dBm |
| 1 dB input compression point | IP1dB | | -3.5 | -1.5 | | dBm |
| 1 dB output compression point | OP1dB | | +12 | +14 | | dBm |
| DC Specifications | | | | | | |
| Supply voltage | V _{DD} | | | 3.3 | | V |
| Quiescent current | I _{DDQ} | Set with external resistor | 10 | 15 | | mA |

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

Table 4. SKY67012-396LF Electrical Specifications: Supply Current = 5 mA (Note 1)
(V_{DD} = 3.3 V, T_A = +25 °C, P_{IN} = -20 dBm, Characteristic Impedance [Z₀] = 50 Ω, Tuning Optimized for 450 MHz, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|------------------------------------|------------------|---|-----|---------|-----|-------|
| RF Specifications | | | | | | |
| Noise figure | NF | | | 1 | | dB |
| Small signal gain | IS21I | | | 15.5 | | dB |
| Input return loss | IS11I | | | 20 | | dB |
| Output return loss | IS22I | | | 13 | | dB |
| Reverse isolation | IS12I | | | 24 | | dB |
| Third order input intercept point | IIP3 | $\Delta f = 1$ MHz, P _{IN} = -20 dBm/tone | | +2.5 | | dBm |
| Third order output intercept point | OIP3 | $\Delta f = 1$ MHz, P _{IN} = -20 dBm/tone | | +18 | | dBm |
| 1 dB input compression point | IP1dB | | | +0.5 | | dBm |
| 1 dB output compression point | OP1dB | | | +15 | | dBm |
| DC Specifications | | | | | | |
| Supply voltage | V _{DD} | | | 3.3 | | V |
| Quiescent current | I _{DDQ} | Set with external resistor | | 5 | | mA |

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

Typical Performance Characteristics

(VDD = 3.3 V, Quiescent Current = 15 mA, TA = +25 °C, Pin = -20 dBm, Characteristic Impedance [Zo] = 50 Ω, Tuning Optimized for 450 MHz, Unless Otherwise Noted)

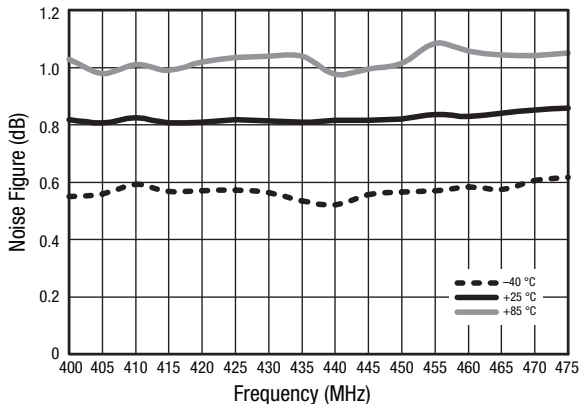


Figure 3. Noise Figure vs Frequency and Temperature, Narrow Band (Includes EVB Insertion Losses)

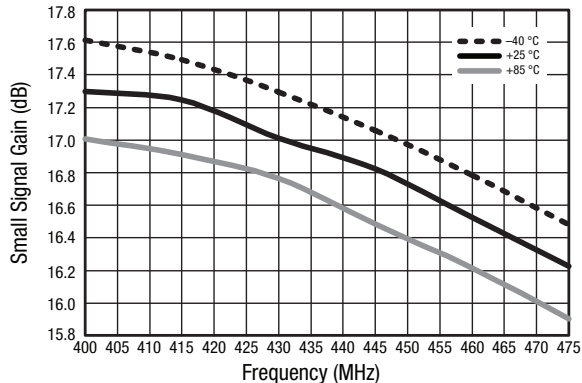


Figure 4. Small Signal Gain (IS21) vs Frequency and Temperature, Narrow Band

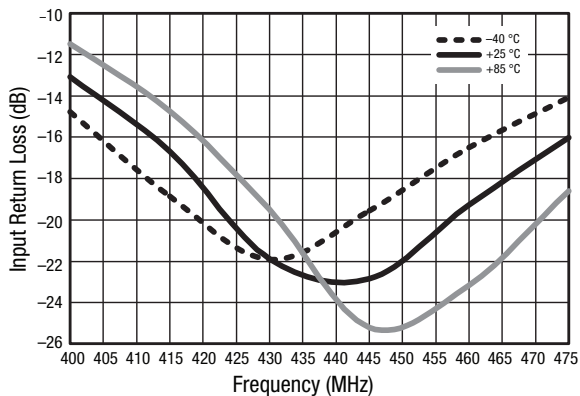


Figure 5. Small Signal Input Return Loss (IS11) vs Frequency and Temperature, Narrow Band

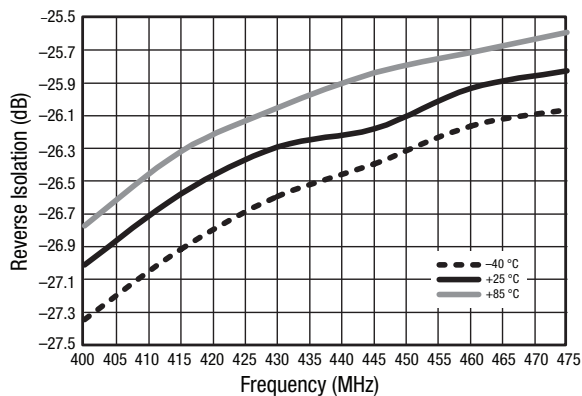


Figure 6. Small Signal Reverse Isolation (IS12) vs Frequency and Temperature, Narrow Band

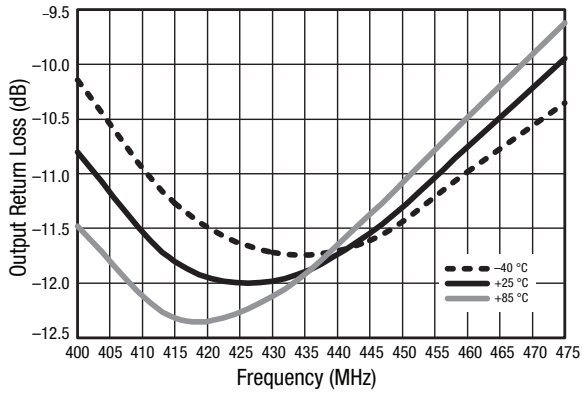


Figure 7. Small Signal Output Return Loss (IS22I) vs Frequency and Temperature, Narrow Band

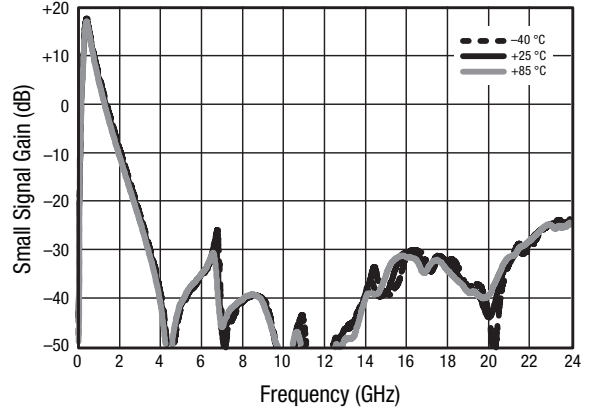


Figure 8. Small Signal Gain (IS21I) vs Frequency and Temperature, Wide Band

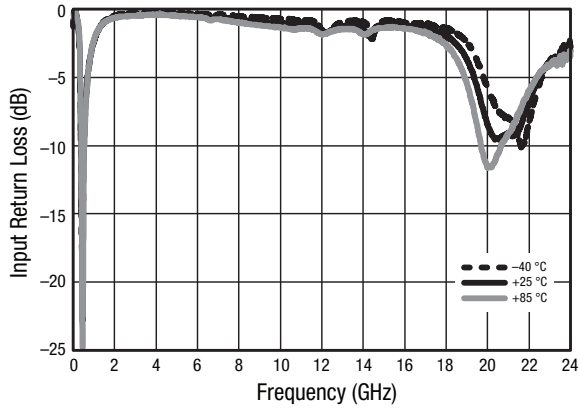


Figure 9. Small Signal Input Return Loss (IS11I) vs Frequency and Temperature, Wide Band

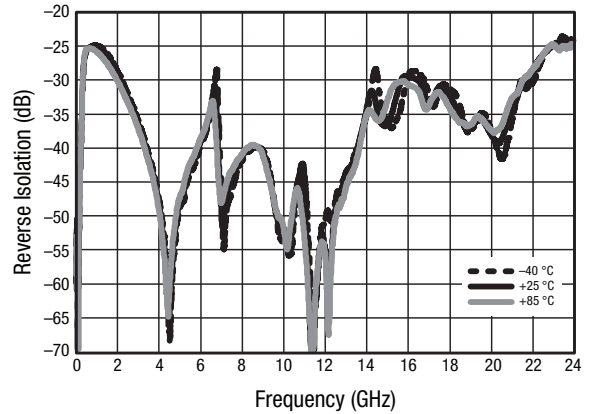


Figure 10. Small Signal Reverse Isolation (IS12I) vs Frequency and Temperature, Wide Band

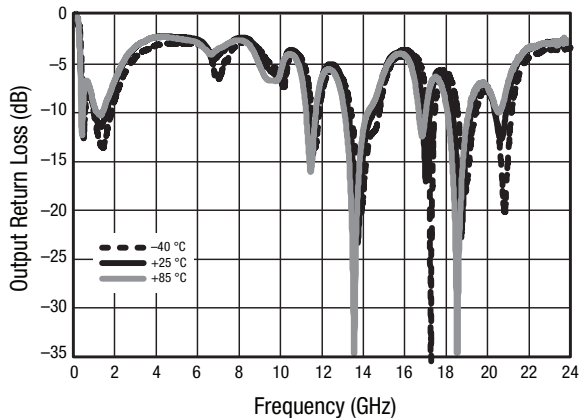


Figure 11. Small Signal Output Return Loss (S22) vs Frequency and Temperature, Wide Band

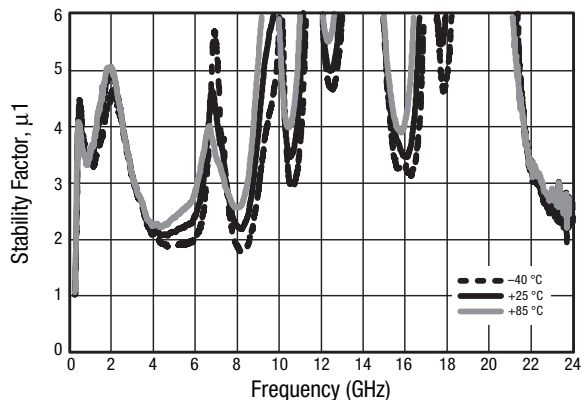


Figure 12. Stability Factor (μ_1) vs Frequency and Temperature, Wide Band

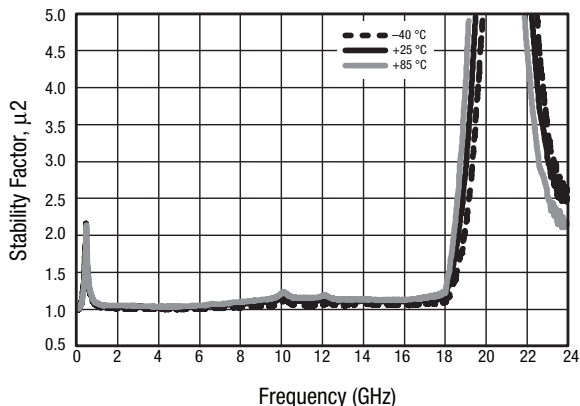


Figure 13. Stability Factor (μ_2) vs Frequency and Temperature, Wide Band

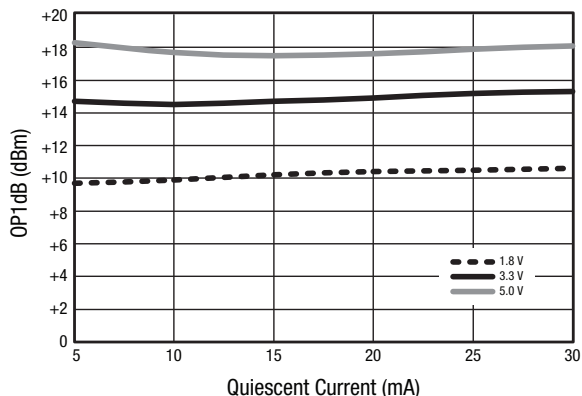


Figure 14. OP1dB vs Quiescent Current

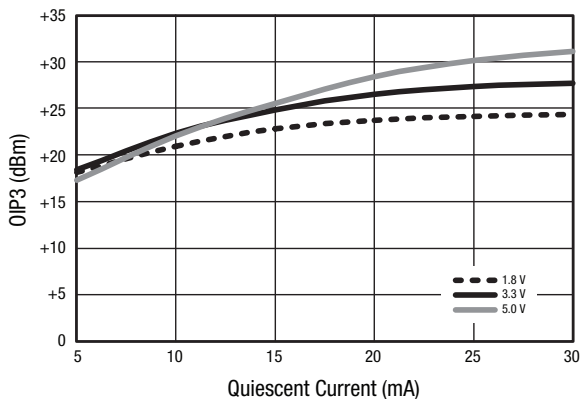


Figure 15. OIP3 vs Quiescent Current

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 450 MHz, Unless Otherwise Noted)

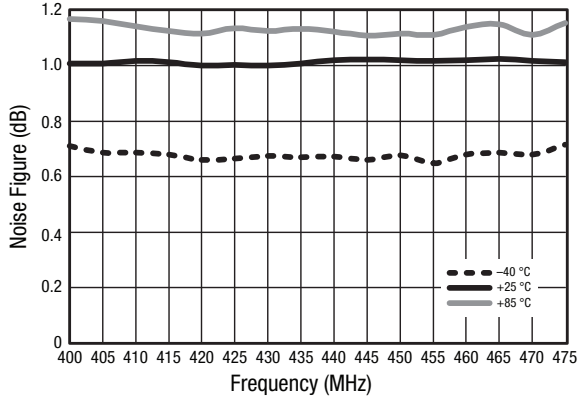


Figure 16. Noise Figure vs Frequency and Temperature, Narrow Band (Includes EVB Insertion Losses)

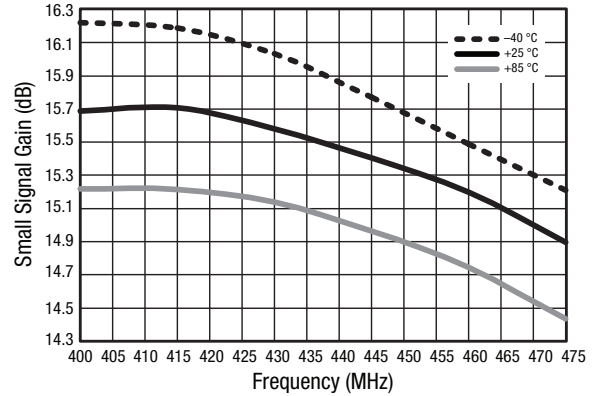


Figure 17. Small Signal Gain (IS21) vs Frequency and Temperature, Narrow Band

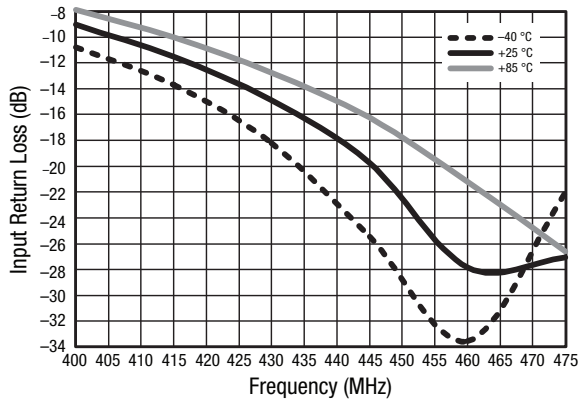


Figure 18. Small Signal Input Return Loss (IS11) vs Frequency and Temperature, Narrow Band

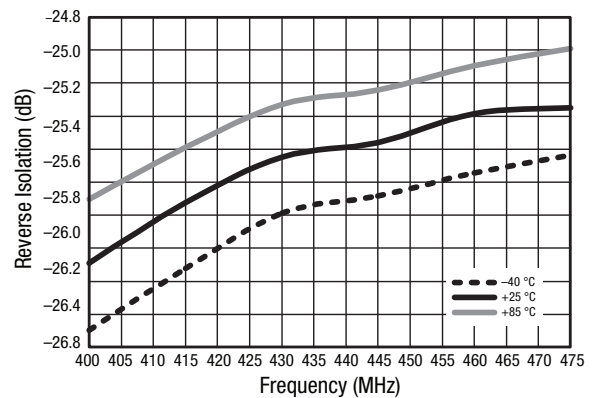


Figure 19. Small Signal Reverse Isolation (IS12) vs Frequency and Temperature, Narrow Band

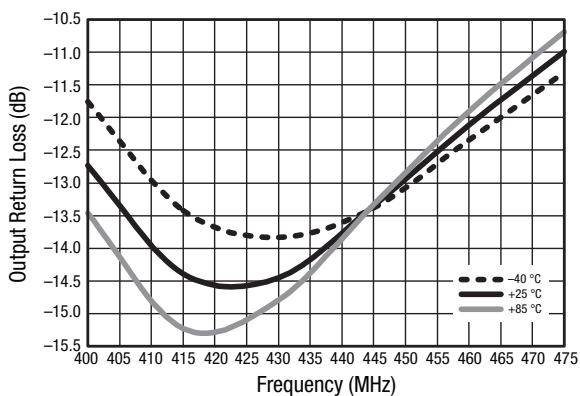


Figure 20. Small Signal Output Return Loss (IS22I) vs Frequency and Temperature, Narrow Band

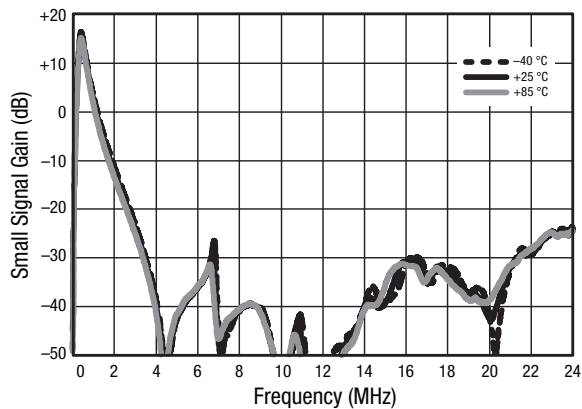


Figure 21. Small Signal Gain (IS21I) vs Frequency and Temperature, Wide Band

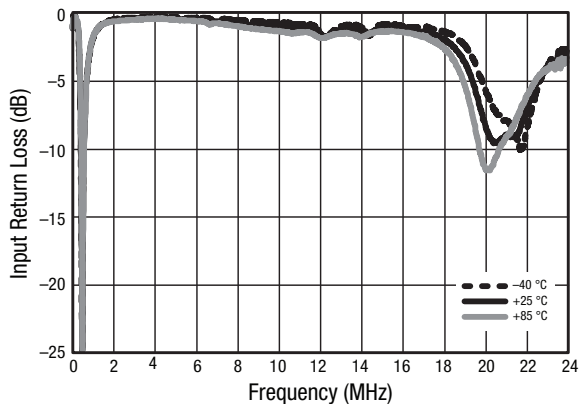


Figure 22. Small Signal Input Return Loss (IS11I) vs Frequency and Temperature, Wide Band

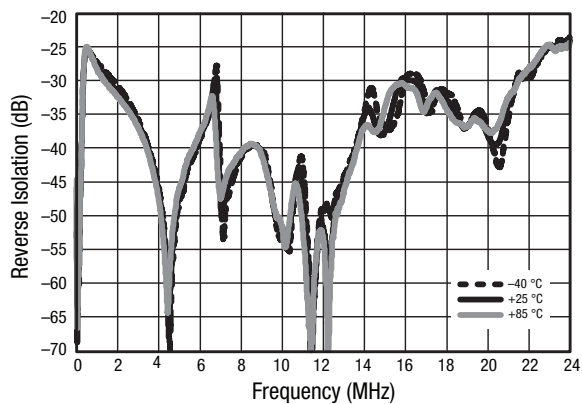


Figure 23. Small Signal Reverse Isolation (IS12I) vs Frequency and Temperature, Wide Band

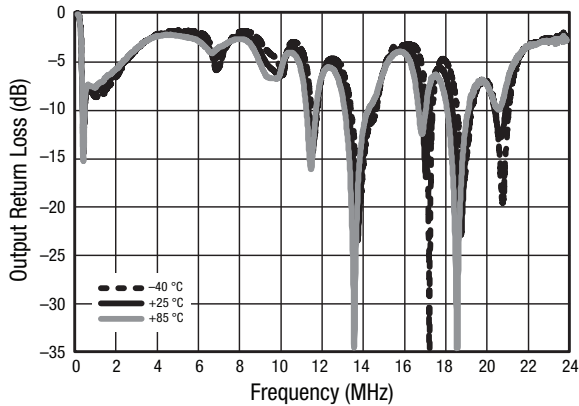


Figure 24. Small Signal Output Return Loss (S22) vs Frequency and Temperature, Wide Band

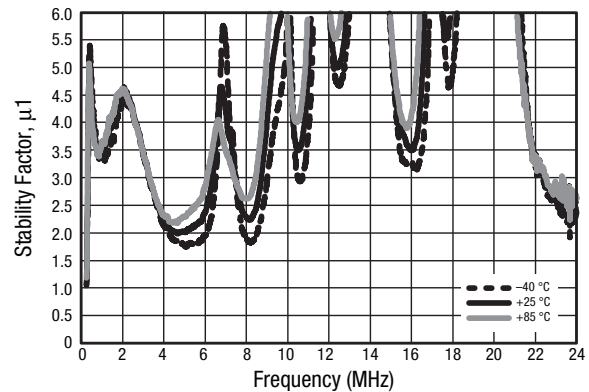


Figure 25. Stability Factor (μ_1) vs Frequency and Temperature, Wide Band

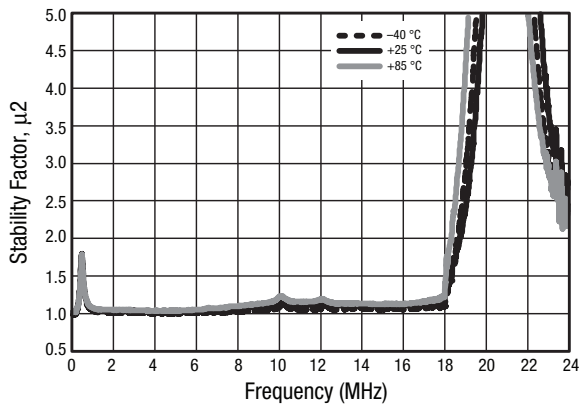


Figure 26. Stability Factor (μ_2) vs Frequency and Temperature, Wide Band

Evaluation Board Description

The SKY67012-396LF Evaluation Board is used to test the performance of the SKY67012-396LF 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

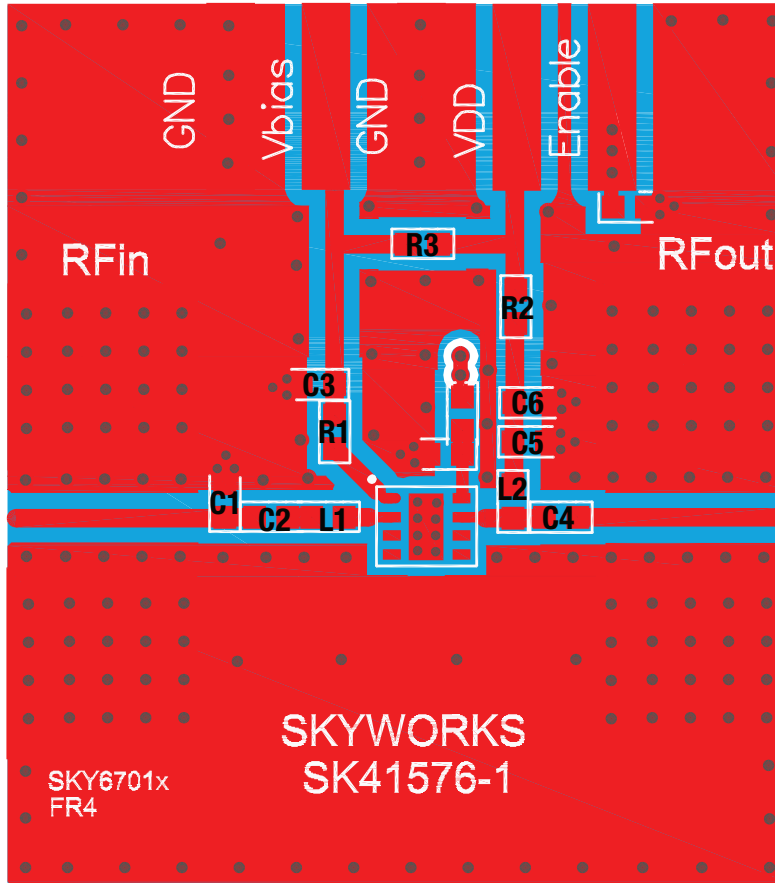
The PCB layout footprint for the SKY67012-396LF is provided in Figure 29. Typical part markings are shown in Figure 30. Package dimensions for the 8-pin DFN are shown in Figure 31, and tape and reel dimensions are provided in Figure 32.

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.

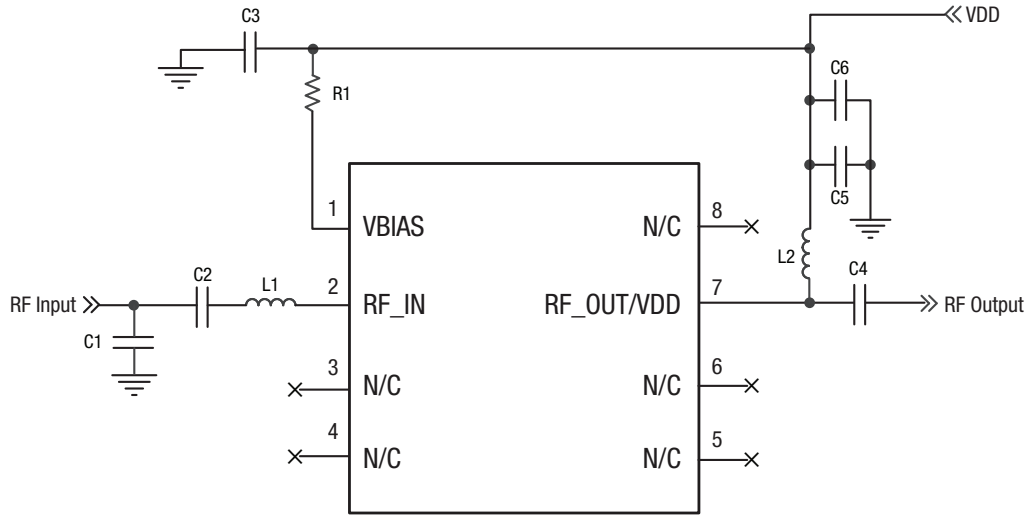
The SKY67012-396LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

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.



S2394

Figure 27. SKY67012-396LF Evaluation Board Assembly Diagram



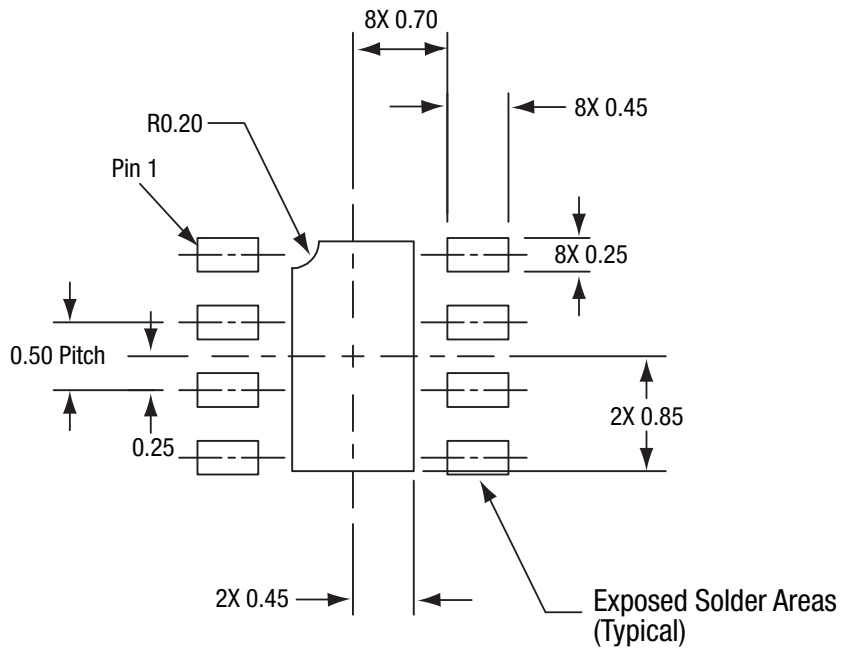
S2397

Figure 28. SKY67012-396LF Evaluation Board Schematic

Table 5. SKY67012-396LF Evaluation Board Bill of Materials

| Component | Value | Size | Manufacturer |
|-------------|----------------|------|--------------|
| C1 | 0.5 pF | 0402 | Murata GJM |
| C2 | 10 pF | 0402 | Murata GJM |
| C3 | 10 pF | 0402 | Murata GRM |
| C4 | 4.7 pF | 0402 | Murata GRM |
| C5 | 10000 pF | 0402 | Murata GRM |
| C6 | 0.5 pF | 0402 | Murata GRM |
| L1 | 33 nH | 0402 | Murata LQW |
| L2 | 22 nH | 0402 | Murata LQG |
| R1 (Note 1) | 4.7 k Ω | 0402 | Panasonic |
| R2 | 0 Ω | 0402 | Panasonic |
| R3 | 0 Ω | 0402 | Panasonic |

Note 1: Use 18 k Ω for R1 to achieve 5 mA of quiescent current with 3.3 V VDD.



All dimensions are in millimeters

S1413

Figure 29. SKY67012-396LF PCB Layout Footprint (Top View)

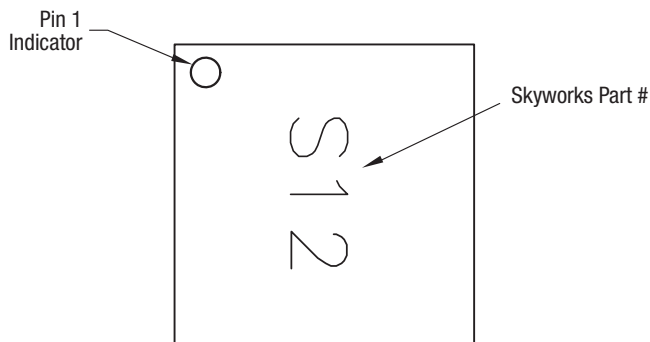
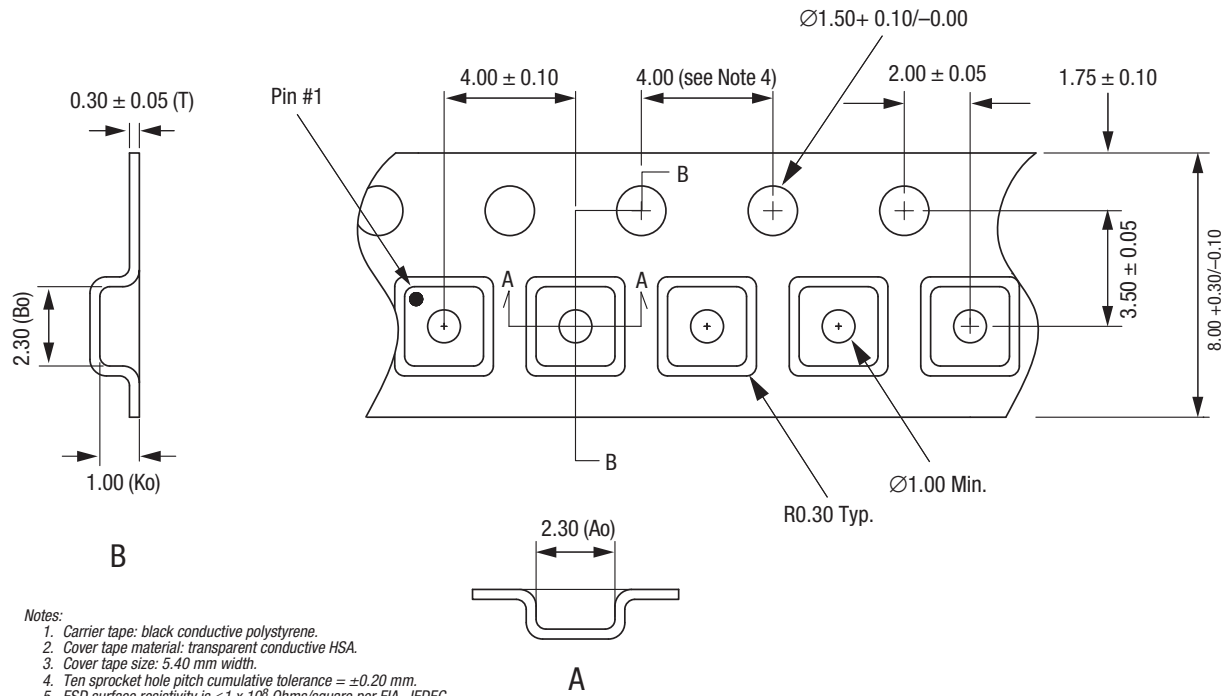


Figure 30. Typical Part Markings (Top View)



- 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.

S1601

Figure 32. SKY67012-396LF Tape and Reel Dimensions

Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|--|---------------------------|------------------------------|
| SKY67012-396LF: Low-Noise, Low-Current Amplifier | SKY67012-396LF | SKY67012-396LF-EVB |

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