DATA SHEET

SKY65404-31: 5 GHz Low-Noise Amplifier

Applications

- 802.11a/n/ac radios
- 5 GHz ISM radios
- Smartphones
- Notebooks, netbooks, and tablets
- Access points, routers, and gateways
- Wireless video systems

Features

- Ultra-low Noise Figure: 1.0 dB
- 4.9 GHz to 5.9 GHz operation
- Enable/disable mode
- High IIP3: +7 dBm
- High gain: 13 dB
- 2.8 to 5.0 V single-supply operation
- QFN (6-pin, 1.5 x 1.5 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

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Description

The SKY65404-31 is an ultra Low-Noise Amplifier (LNA) intended for 5 GHz wireless receiver applications. Its industry-leading Noise Figure (NF), together with high linearity, makes it ideal as a first-stage LNA in 802.11a Wireless Local Area Network (WLAN) radios.

Operating with a single supply voltage, the SKY65404-31 consumes only 10 mA of current. The device includes a shutdown mode to save power when the receiver is inactive.

The tiny package footprint of the SKY65404-31, requiring only four external components, enables the industry’s smallest PCB area needed to implement a 5 GHz LNA.

A block diagram of the SKY65404-31 is shown in Figure 1. The device package and pinout for the 6-pin Quad Flat No-Lead (QFN) are shown in Figure 2.
**Technical Description**

The SKY65404-31 is matched at the RF output port (pin 4) and requires only a shunt capacitor match at the RF input port (pin 3). The VCC signal (pin 6) requires a simple bypass circuit. An external resistor on the V_ENABLE signal (pin 1) allows a wide range of control voltages to be used. Shutdown mode is achieved by switching the V_ENABLE signal to 0 V.

**Package and Handling Information**

Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. 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 SKY65404-31 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.

**Electrical and Mechanical Specifications**

Signal pin assignments and functional pin descriptions are described in Table 1. The absolute maximum ratings of the SKY65404-31 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4. Table 5 provides the control logic for the SKY65404-31.

Performance characteristics for the SKY65404-31 are illustrated in Figures 3 through 9.

An application schematic diagram for the SKY65404-31 is shown in Figure 10. The PCB footprint drawing for the SKY65404-31 is provided in Figure 11. Typical part markings are shown in Figure 12. The package dimensions for the 6-pin QFN are shown in Figure 13, and the tape and reel dimensions are provided in Figure 14.

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**Table 1. SKY65404-31 Pin Assignments and Signal Descriptions**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V_ENABLE</td>
<td>Enable control input</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>RF_IN</td>
<td>LNA input</td>
</tr>
<tr>
<td>4</td>
<td>RF_OUT</td>
<td>LNA output</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>6</td>
<td>VCC</td>
<td>Supply voltage for LNA</td>
</tr>
</tbody>
</table>
### Table 2. Absolute Maximum Ratings (Note 1)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>0</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>DC voltage at control ports</td>
<td>V_ENABLE</td>
<td>0</td>
<td>5.0</td>
<td>V</td>
</tr>
<tr>
<td>RF input power:</td>
<td></td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>LNA enabled</td>
<td>RFIn</td>
<td>+1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LNA disabled</td>
<td></td>
<td>+10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>TA</td>
<td>−40</td>
<td>+85</td>
<td>ºC</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>TSTG</td>
<td>−40</td>
<td>+125</td>
<td>ºC</td>
</tr>
<tr>
<td>Electrostatic discharge:</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Charged Device Model (CDM), Class 3</td>
<td></td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Body Model (HBM), Class 0</td>
<td></td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine Model (MM), Class A</td>
<td></td>
<td>50</td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

**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 values. Exceeding any of the limits listed here may result in permanent damage to the device.

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**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. Recommended Operating Conditions (@ +25 ºC, VCC = 3 V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>2.8</td>
<td>3.0</td>
<td>5.0</td>
<td>V</td>
</tr>
<tr>
<td>RF frequency range</td>
<td>f</td>
<td>4900</td>
<td>5900</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>−40</td>
<td>+25</td>
<td>+85</td>
<td>ºC</td>
</tr>
<tr>
<td>DC voltage at control port:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>V_ENABLE_H</td>
<td>2.5</td>
<td>3.0</td>
<td>3.5</td>
<td>V</td>
</tr>
<tr>
<td>Low</td>
<td>V_ENABLE_L</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>V</td>
</tr>
</tbody>
</table>

### Table 4. Electrical Characteristics (4900-5900 MHz) (1 of 2) (Note 1)

*(VCC = 3 V, TA = +25 ºC, V_ENABLE = 3 V, Unless Otherwise Noted)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable Mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>S21</td>
<td></td>
<td>11</td>
<td>13</td>
<td>16</td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>NF</td>
<td></td>
<td>0.8</td>
<td>1.0</td>
<td>1.5</td>
<td>dB</td>
</tr>
<tr>
<td>3rd Order Input Intercept Point</td>
<td>IIP3</td>
<td></td>
<td>+5</td>
<td>+7</td>
<td>+9</td>
<td>dBm</td>
</tr>
<tr>
<td>In-band 1 dB compression point at input</td>
<td>IP1dB</td>
<td></td>
<td>−5</td>
<td>−4</td>
<td>−2</td>
<td>dBm</td>
</tr>
<tr>
<td>Out-of-band (2.45 GHz injected signal) 1 dB compression point at input</td>
<td>IP1dB</td>
<td></td>
<td>−7</td>
<td>−3</td>
<td>−2</td>
<td>dBm</td>
</tr>
<tr>
<td>Input/output return loss</td>
<td>S11, S22</td>
<td>Zin = 50 Ω</td>
<td>−10</td>
<td>−6</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Reverse isolation</td>
<td>S12</td>
<td></td>
<td>−26</td>
<td>−20</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Drain current</td>
<td></td>
<td>V_ENABLE = 3 V</td>
<td>10</td>
<td>11</td>
<td>15</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_ENABLE = 0 V</td>
<td>0</td>
<td>&lt;1</td>
<td>5</td>
<td>µA</td>
</tr>
<tr>
<td>V_ENABLE current</td>
<td>bEN, hEN</td>
<td>V_ENABLE = 3 V</td>
<td>2.3</td>
<td>3.0</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Rise time</td>
<td>bRise</td>
<td></td>
<td>125</td>
<td>155</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>Fall time</td>
<td>bFall</td>
<td></td>
<td>60</td>
<td>90</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>
Table 4. Electrical Characteristics (4900-5900 MHz) (2 of 2) (Note 1)
(VCC = 3 V, TA = +25 °C, V_ENABLE = 3 V, Unless Otherwise Noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable Mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>S21</td>
<td></td>
<td>−25</td>
<td>−15</td>
<td>−10</td>
<td>dB</td>
</tr>
<tr>
<td>Input return loss</td>
<td>S11</td>
<td></td>
<td>−2</td>
<td>−1</td>
<td>0</td>
<td>dB</td>
</tr>
<tr>
<td>Output return loss</td>
<td>S22</td>
<td></td>
<td>−15</td>
<td>−12</td>
<td>−8</td>
<td>dB</td>
</tr>
<tr>
<td>V_ENABLE current</td>
<td>IEN_LOW</td>
<td>V_ENABLE = 0 V to 0.2 V</td>
<td>1.7</td>
<td>1.9</td>
<td></td>
<td>μA</td>
</tr>
</tbody>
</table>

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

Table 5. Mode Control Logic

<table>
<thead>
<tr>
<th>V_ENABLE Voltage (V)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>LNA is enabled</td>
</tr>
<tr>
<td>0</td>
<td>LNA is disabled</td>
</tr>
</tbody>
</table>

Figure 3. S-Parameter Data

Figure 4. Noise Figure vs Frequency
Figure 5. IIP3 vs Frequency

Figure 6. P1dB vs Temperature

Figure 7. Gain vs Temperature
Figure 8. Noise Figure vs Temperature

Figure 9. IIP3 vs Temperature

Figure 10. SKY65404-31 Schematic Diagram
Figure 11. SKY65404-31 PCB Layout Footprint
(Top View)

Figure 12. Typical Part 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.

Figure 13. SKY65404-31 6-Pin LGA Package Dimensions
Notes:
1. Carrier tape: black conductive polycarbonate or polystyrene.
2. Cover tape material: transparent conductive PSA.
3. Cover tape size: 5.4 mm width.
4. All measurements are in millimeters.

Figure 14. SKY65404-31 Tape and Reel Dimensions
### Ordering Information

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Manufacturing Part Number</th>
<th>Evaluation Board Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKY65404-31 LNA</td>
<td>SKY65404-31</td>
<td>EN31-D985-001</td>
</tr>
</tbody>
</table>