X-Band Low Noise Amplifier
8 - 12 GHz

**Features**
- 1.6 dB Noise Figure
- Single 4 V Bias @ 60 mA
- Fully Internally Matched to 50 Ω
- Lead-Free 3 mm 16-Lead PQFN Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant

**Description**
The MAAL-010528 is a high performance X-band GaAs LNA, housed in a miniature, lead-free 3 mm PQFN surface mount plastic package. This MMIC operates from 8 to 12 GHz providing a nominal gain of 20 dB with excellent gain flatness, high OIP3 linearity of 26 dBm, and a mid-band noise figure of 1.6 dB. The part features a self-bias architecture which requires only a single, positive supply.

The device is internally matched to 50 Ω input/output and is well suited to multiple applications including VSAT, radar and microwave radios due to the part's ease of use and excellent performance parameters.

**Ordering Information**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAL-010528-TR0500</td>
<td>500 piece reel</td>
</tr>
<tr>
<td>MAAL-010528-001SMB</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

**Pin Configuration**

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Pin Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>3</td>
<td>RF&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>RF Input</td>
</tr>
<tr>
<td>4</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>5&lt;sup&gt;3,4&lt;/sup&gt;</td>
<td>V&lt;sub&gt;G1&lt;/sub&gt;</td>
<td>Gate Voltage 1</td>
</tr>
<tr>
<td>6</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>7&lt;sup&gt;3,4&lt;/sup&gt;</td>
<td>V&lt;sub&gt;G2&lt;/sub&gt;</td>
<td>Gate Voltage 2</td>
</tr>
<tr>
<td>8, 9</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>10</td>
<td>RF&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>RF Output</td>
</tr>
<tr>
<td>11, 12</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>13</td>
<td>V&lt;sub&gt;DD2&lt;/sub&gt;</td>
<td>Bias Voltage 2</td>
</tr>
<tr>
<td>14, 15</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>16</td>
<td>V&lt;sub&gt;DD1&lt;/sub&gt;</td>
<td>Bias Voltage 1</td>
</tr>
</tbody>
</table>

3. For self-bias, external components C7 through C12 are optional. No V<sub>G</sub> bias is needed. If C7 through C12 are removed, traces must also be removed.
4. For optional adjustment of self-bias, apply DC gate voltage between -1 V and +0.3 V. External components C7 through C12 are required.
5. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

X-Band Low Noise Amplifier
8 - 12 GHz

Electrical Specifications: \( T_A = 25^\circ C, V_{DD} = 4 \, V, Z_0 = 50 \, \Omega \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>8 - 12 GHz</td>
<td>dB</td>
<td>17.5</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Noise figure</td>
<td>8 GHz</td>
<td>dB</td>
<td>—</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>10 GHz</td>
<td>dB</td>
<td>—</td>
<td>1.8</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>12 GHz</td>
<td>dB</td>
<td>—</td>
<td>2.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>8 - 12 GHz</td>
<td>dB</td>
<td>—</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>8 - 12 GHz</td>
<td>dB</td>
<td>—</td>
<td>13</td>
<td>—</td>
</tr>
<tr>
<td>P1dB</td>
<td>8 - 12 GHz</td>
<td>dBm</td>
<td>—</td>
<td>14</td>
<td>—</td>
</tr>
<tr>
<td>OIP3</td>
<td>8 - 12 GHz</td>
<td>dBm</td>
<td>—</td>
<td>26</td>
<td>—</td>
</tr>
<tr>
<td>Current</td>
<td></td>
<td>mA</td>
<td>—</td>
<td>60</td>
<td>75</td>
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</tbody>
</table>

Absolute Maximum Ratings\(^6,7\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>22 dBm</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>6 V</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +150°C</td>
</tr>
</tbody>
</table>

Handling Procedures
Please observe the following precautions to avoid damage:

Static Sensitivity
Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1B devices.

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. MACOM does not recommend sustained operation near these survivability limits.

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Recommended PCB

8. For best performance, ensure proper grounding at the device. Recommended grounding is 9 vias beneath the ground paddle, each with 10-mil diameter. Contact MACOM technical support for recommended PCB layout details.

Application Schematic

9. For self-bias, external components C7 through C12 are optional. No Vg bias is needed. If C7 through C12 are removed, traces must also be removed. When using self-bias, leave Vg1 and Vg2 pins open (do not ground).

10. For optional adjustment of self-bias, apply DC gate voltage between -1 V and +0.3 V. External components C7 through C12 are required.

Parts List

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C4, C7, C10</td>
<td>2.2 pF</td>
<td>0402</td>
</tr>
<tr>
<td>C2, C5, C8, C11</td>
<td>100 pF</td>
<td>0402</td>
</tr>
<tr>
<td>C3, C6, C9, C12</td>
<td>0.01 µF</td>
<td>0402</td>
</tr>
</tbody>
</table>
Typical Performance Curves

Wide-Band Gain and Return Loss

Small-Signal Gain vs. Temperature

Input Return Loss vs. Temperature

Output Return Loss vs. Temperature

Noise Figure vs. Temperature

Noise Figure vs. Supply Voltage

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Typical Performance Curves

**Small-Signal Gain vs. Supply Voltage**

- Frequency (GHz)
- Supply Voltage: 3.0V, 3.5V, 4.0V, 4.5V, 5.0V, 5.5V
- Gain (dB)
- Vdd=3.0V, Vdd=3.5V, Vdd=4.0V, Vdd=4.5V, Vdd=5.0V, Vdd=5.5V

**Input Return Loss vs. Supply Voltage**

- Frequency (GHz)
- Supply Voltage: 3.0V, 3.5V, 4.0V, 4.5V, 5.0V, 5.5V
- Return Loss (dB)
- Vdd=3.0V, Vdd=3.5V, Vdd=4.0V, Vdd=4.5V, Vdd=5.0V, Vdd=5.5V

**Output Return Loss vs. Supply Voltage**

- Frequency (GHz)
- Supply Voltage: 3.0V, 3.5V, 4.0V, 4.5V, 5.0V, 5.5V
- Return Loss (dB)
- Vdd=3.0V, Vdd=3.5V, Vdd=4.0V, Vdd=4.5V, Vdd=5.0V, Vdd=5.5V

**P1dB vs. Temperature**

- Frequency (GHz)
- Temperature: +25°C, -40°C, +85°C
- P1dB (dBm)

**Large-Signal Gain vs. Voltage @ 10 GHz**

- Output Power (dBm)
- Supply Voltage: 3.0V, 3.5V, 4.0V, 4.5V, 5.0V, 5.5V
- Gain (dB)
- Vdd=3.0V, Vdd=3.5V, Vdd=4.0V, Vdd=4.5V, Vdd=5.0V, Vdd=5.5V

**Large-Signal Gain vs. Temperature @ 10 GHz**

- Output Power (dBm)
- Temperature: +25°C, -40°C, +85°C
- Gain (dB)
- Vdd=3.0V, Vdd=3.5V, Vdd=4.0V, Vdd=4.5V, Vdd=5.0V, Vdd=5.5V
Typical Performance Curves

Output IP3 vs. Supply Voltage

Output IP3 vs. Temperature @ 10 GHz

Output IP3 vs. Temperature for $V_{DD} = 3$ V

Output IP3 vs. Temperature for $V_{DD} = 4$ V

Output IP3 vs. Temperature for $V_{DD} = 5$ V

Typical Bias Current vs. Supply Voltage

<table>
<thead>
<tr>
<th>$V_{DD1} = V_{DD2}$ (V)</th>
<th>$I_{DD1}$ (mA)</th>
<th>$I_{DD2}$ (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>14.6</td>
<td>43.4</td>
</tr>
<tr>
<td>4</td>
<td>15.2</td>
<td>44.5</td>
</tr>
<tr>
<td>5</td>
<td>15.6</td>
<td>45.0</td>
</tr>
<tr>
<td>6</td>
<td>15.8</td>
<td>45.1</td>
</tr>
</tbody>
</table>
Lead-Free 3 mm 16-Lead PQFN†

† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is 100% matte tin plating over copper.
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