MAAM-011229

Broadband Low Noise Amplifier
0.05 - 4 GHz

Features
- 19 dB flat Broadband Gain to 3.25 GHz
- Low Noise Figure:
  - 1.3 dB @ 1.2 GHz
  - 1.8 dB @ 3.25 GHz
- High Linearity OIP3:
  - 36 dBm @ 1.2 GHz
  - 33 dBm @ 3.25 GHz
- Internal Matching to 50 Ω
- Single Voltage Bias: 3 - 5 V
- Integrated Active Bias Circuit
- Current Adjustable 20 - 120 mA
- Lead-Free 2 mm 8-Lead PDFN Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant
- Power Down Option

Description
The MAAM-011229 is a broadband high dynamic range, single stage MMIC LNA assembled in a lead-free 2 mm 8 Lead PDFN plastic package. The amplifier is internally matched to provide flat gain and excellent return losses to 3.25 GHz without any external matching components. Use of external matching could extend usable frequency range beyond 4 GHz.

This low noise amplifier has an integrated active bias circuit allowing direct connection to 3 V or 5 V bias and minimizing variations over temperature and process. The bias current can be adjusted with an optional external resistor, so the user can customize the power consumption to fit the application. I_{ADJ} pin can be utilized as an enable pin to power the device up and down during operation.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAM-011229-TR1000</td>
<td>1000 piece reel</td>
</tr>
<tr>
<td>MAAM-011229-TR3000</td>
<td>3000 piece reel</td>
</tr>
<tr>
<td>MAAM-011229-SMB</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.

Electrical Specifications: \( V_{DD} = 5 \text{ V}, +25^\circ\text{C}, Z_0 = 50 \Omega \), Typical Application Circuit

<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>0.05 - 3.25 GHz, 4 GHz</td>
<td>dB</td>
<td>17</td>
<td>19</td>
<td>—</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>0.05 - 1.2 GHz, 1.2 - 3.25 GHz, 4 GHz</td>
<td>dB</td>
<td>—</td>
<td>1.3</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>0.05 - 3.25 GHz</td>
<td>dB</td>
<td>—</td>
<td>16</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>0.05 - 3.25 GHz</td>
<td>dB</td>
<td>—</td>
<td>14</td>
<td>—</td>
</tr>
<tr>
<td>Output IP3</td>
<td>( P_{IN} = -15 \text{ dBm per tone, 6 MHz spacing} ) 0.05 - 1.2 GHz, 1.2 - 3.25 GHz</td>
<td>dBm</td>
<td>—</td>
<td>36</td>
<td>—</td>
</tr>
<tr>
<td>Output IP2</td>
<td>( P_{IN} = -15 \text{ dBm per tone, 6 MHz spacing} ) 0.05 - 1.2 GHz, 1.2 - 3.25 GHz</td>
<td>dBm</td>
<td>—</td>
<td>45</td>
<td>—</td>
</tr>
<tr>
<td>Output P1dB</td>
<td>0.05 - 1.2 GHz, 1.2 - 3.25 GHz</td>
<td>dBm</td>
<td>—</td>
<td>19.5</td>
<td>—</td>
</tr>
<tr>
<td>Current</td>
<td>( I_{DD} )</td>
<td>mA</td>
<td>—</td>
<td>80</td>
<td>115</td>
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</table>

Maximum Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Input Power CW</td>
<td>4 dBm</td>
</tr>
<tr>
<td>( V_{DD} )</td>
<td>7 V</td>
</tr>
<tr>
<td>Operating Temperature(^5)</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>Junction Temperature(^6)</td>
<td>+150°C</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings\(^7,8\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Input Power CW</td>
<td>30 dBm</td>
</tr>
<tr>
<td>( V_{DD} )</td>
<td>8 V</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-55°C to +150°C</td>
</tr>
<tr>
<td>Junction Temperature(^6)</td>
<td>+175°C</td>
</tr>
</tbody>
</table>

5. Operating at nominal conditions with \( T_J \leq 150^\circ\text{C} \) will ensure MTTF &gt; 1 x 10^6 hours.
6. Junction Temperature (\( T_J \)) = \( T_C + \Theta_{JC} \times ((V \times I) - (P_{OUT} - P_{IN})) \)
   Typical thermal resistance (\( \Theta_{JC} \)) = 85°C/W
   a) For \( T_C = +25^\circ\text{C} \), \( T_J = 59^\circ\text{C} @ 5 \text{ V}, 80 \text{ mA} \)
   b) For \( T_C = +85^\circ\text{C} \), \( T_J = 119^\circ\text{C} @ 5 \text{ V}, 80 \text{ mA} \)
7. Exceeding any one or combination of these limits may cause permanent damage to this device.
8. MACOM does not recommend sustained operation near these survivability limits.

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 devices.
Typical Application Circuit

Current Adjust Options
The I_{ADJ} (pin 5) of MAAM-011229 may be used to adjust the DC operating current by placing either R1 or R2 as shown the schematic below. Placing resistor R2 to ground will reduce the current from typical application level. When using R2 to reduce current do not place (DNP) R1. To increase current from typical application circuit install resistor R1 and connect to V_{DD}.

The table below shows values of R1 and R2 for a range of operating currents for V_{DD} = 5 V and 3 V.
Typical Performance Curves @ 5 V / 80 mA, \(Z_0 = 50 \, \Omega\)

**Gain to 4 GHz**

**Gain to 8 GHz**

**Input Return Loss**

**Output Return Loss**

**Noise Figure**

**Reverse Isolation**
Typical Performance Curves @ 5 V / 80 mA , Z_0 = 50 Ω

- **OIP3**
  - Frequency (GHz)
  - OIP3 (dBm)
  - Temperatures: +25°C, -40°C

- **OIP2**
  - Frequency (GHz)
  - OIP2 (dBm)
  - Temperatures: +25°C, -25°C, -40°C

- **P1dB**
  - Frequency (GHz)
  - P1dB (dBm)

- **P1dB vs. Current, +25°C**
  - Idd (mA)
  - Frequencies: 70 MHz, 1 GHz, 2 GHz, 3 GHz, 3.25 GHz

- **Noise Figure vs. Current, +25°C**
  - Idd (mA)

- **OIP3 vs. Current, +25°C**
  - Idd (mA)
  - Frequencies: 70 MHz, 1 GHz, 2 GHz, 3.25 GHz
# Electrical Specifications: \( V_{\text{DD}} = 3 \, \text{V}, \, +25^\circ \text{C}, \, Z_0 = 50 \, \Omega \), Typical Application Circuit

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<tr>
<td>Gain</td>
<td>0.05 - 3.25 GHz 4 GHz</td>
<td>dB</td>
<td>—</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>0.05 - 1.2 GHz 1.2 - 3.25 GHz 4 GHz</td>
<td>dB</td>
<td>—</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>0.05 - 1.2 GHz 1.2 - 3.25 GHz 4 GHz</td>
<td>dB</td>
<td>—</td>
<td>1.3</td>
<td>1.6</td>
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<td>Input Return Loss</td>
<td>0.05 - 3.25 GHz</td>
<td>dB</td>
<td>—</td>
<td>16</td>
<td>—</td>
</tr>
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<td>Output IP3</td>
<td>( P_{\text{IN}} = -15 , \text{dBm per tone, 6 MHz spacing} ) 0.05 - 1.2 GHz 1.2 - 3.25 GHz</td>
<td>dBm</td>
<td>—</td>
<td>33</td>
<td>40</td>
</tr>
<tr>
<td>Output IP2</td>
<td>( P_{\text{IN}} = -15 , \text{dBm per tone, 6 MHz spacing} ) 0.05 - 1.2 GHz 1.2 - 3.25 GHz</td>
<td>dBm</td>
<td>—</td>
<td>43</td>
<td>37</td>
</tr>
<tr>
<td>Output P1dB</td>
<td>0.05 - 1.2 GHz 1.2 - 3.25 GHz</td>
<td>dBm</td>
<td>—</td>
<td>17.0</td>
<td>15.5</td>
</tr>
<tr>
<td>Current</td>
<td>( I_{\text{DD}} )</td>
<td>mA</td>
<td>—</td>
<td>60</td>
<td>—</td>
</tr>
</tbody>
</table>
Typical Performance Curves @ 3 V / 60 mA, Z₀ = 50 Ω

**Gain to 4 GHz**

![Gain to 4 GHz Graph]

**Gain to 8 GHz**

![Gain to 8 GHz Graph]

**Input Return Loss**

![Input Return Loss Graph]

**Output Return Loss**

![Output Return Loss Graph]

**Noise Figure**

![Noise Figure Graph]

**Reverse Isolation**

![Reverse Isolation Graph]
Typical Performance Curves @ 3 V / 60 mA, $Z_0 = 50 \, \Omega$

**OIP3**

![OIP3 graph]

**OIP2**

![OIP2 graph]

**P1dB vs. Frequency**

![P1dB vs. Frequency graph]

**P1dB vs. Current, +25°C**

![P1dB vs. Current graph]

**Noise Figure vs. Current, +25°C**

![Noise Figure vs. Current graph]

**OIP3 vs Current, +25°C**

![OIP3 vs Current graph]
The recommended PCB layout includes placeholders for additional components that are not necessary for typical applications but may be useful for extending performance to higher frequencies or optimizing a particular performance parameter at different bias conditions.

Component | Value | Package
--- | --- | ---
C1 - C3, C6 | 1000 pF | 0402
C4 | 0.1 µF | 0402
C5 | 47 pF | 0402
C7, C8 | DNP | 0402
R3, R4 | 0 Ω | 0402
R1, R2 | DNP | 0402
R3, R4 | 0 Ω | 0402
L1 | Ferrite Bead | 0402

10. Murata, part number BLM15HD182SN.
Applications Section: Power Down Option

The I_{ADJ} (pin 5) of MAAM-011229 may be used to power down and turn on the amplifier. The critical characteristics of the power down circuit are that it presents a low impedance to DC ground in the off mode and that it presents a high impedance (much greater than 5 kΩ) in the on mode. The single very low cost MMBT3904 NPN switching transistor (available from many suppliers) may be added externally along with a 1 kΩ resistor to provide this function. As shown in plots below, the time from when voltage on the I_{ADJ} pin (V_{ADJ}) goes HIGH to the time RF reaches 90% of final amplitude is 444 ns. The total turn-on time, however, from change of power down signal is 1.18 µs (736 ns of this time is consumed in time for MMBT3904 to transition). Alternate choice for switching transistor could reduce total turn-on time. Total turn off time is 392 ns.

V_{Power Down} = 0 V (on) / 1.8 V (off)

1 kΩ

Q_{1} MMBT3904

Turn ON Time

Turn OFF Time
**Lead-Free 2 mm 8-Lead PDFN†**

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