Wideband Distributed Amplifier
30 kHz - 44 GHz

Features
- Wide Frequency Range: 30 kHz - 44 GHz
- 16 dB Gain
- 3 - 8 V DC, 200 mA
- 22 dBm P1dB @ 22 GHz
- Integrated Power Detector with a Detector Reference Voltage Generator
- 50 Ω Input and Output Match
- RoHS* Compliant
- Die Size: 2.3 x 1.0 x 0.1 mm

Applications
- Instrumentation and Communication Systems

Description
MAAM-011286-DIE is an easy-to-use, wideband amplifier that operates from 30 kHz to 44 GHz. The amplifier provides 16 dB gain, 22 dBm output power and 5.3 dB noise figure. It is matched to 50 Ω with typical return loss better than 13 dB.

MAAM-011286-DIE is suitable for a wide range of applications in instrumentation and communication systems.

Functional Schematic

1. Image not to scale.

Pad Configuration

<table>
<thead>
<tr>
<th>Pad #</th>
<th>Pad Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,3,5,7, 14,15,16</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>RF&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>RF Input</td>
</tr>
<tr>
<td>4</td>
<td>V&lt;sub&gt;G1&lt;/sub&gt;</td>
<td>Gate Voltage 1</td>
</tr>
<tr>
<td>6</td>
<td>RF&lt;sub&gt;OUT&lt;/sub&gt;/V&lt;sub&gt;DD&lt;/sub&gt;</td>
<td>RF Output</td>
</tr>
<tr>
<td>8</td>
<td>DET&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>Output Detector</td>
</tr>
<tr>
<td>9</td>
<td>DET&lt;sub&gt;REF&lt;/sub&gt;</td>
<td>Reference Detector</td>
</tr>
<tr>
<td>10</td>
<td>DET&lt;sub&gt;BIAS&lt;/sub&gt;</td>
<td>Detector Bias</td>
</tr>
<tr>
<td>11</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt;</td>
<td>Drain Voltage</td>
</tr>
<tr>
<td>12</td>
<td>V&lt;sub&gt;DAUX&lt;/sub&gt;</td>
<td>Auxiliary Drain Voltage</td>
</tr>
<tr>
<td>13</td>
<td>V&lt;sub&gt;G2&lt;/sub&gt;</td>
<td>Gate Voltage 2</td>
</tr>
</tbody>
</table>

2. Backside of die must be connected to RF, DC and thermal ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.
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Electrical Specifications:  \( T_C = 25 \, ^\circ\text{C}, \, \text{V}_{DD} = 7 \, \text{V}, \, Z_0 = 50 \, \Omega \)

<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>1 - 44 GHz</td>
<td>dB</td>
<td>15</td>
<td>16</td>
<td>—</td>
</tr>
<tr>
<td>Gain Flatness</td>
<td>1 - 44 GHz</td>
<td>dB</td>
<td>—</td>
<td>±1.0</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>1 - 44 GHz</td>
<td>dB</td>
<td>—</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>1 - 44 GHz</td>
<td>dB</td>
<td>—</td>
<td>13</td>
<td>—</td>
</tr>
<tr>
<td>P1dB</td>
<td>22 GHz</td>
<td>dBm</td>
<td>20</td>
<td>22</td>
<td>—</td>
</tr>
<tr>
<td>P3dB</td>
<td>22 GHz</td>
<td>dBm</td>
<td>23</td>
<td>24</td>
<td>—</td>
</tr>
</tbody>
</table>
| Output IP3      | \( P_{\text{in}} = +2 \, \text{dBm} / \text{tone}, \, 22 \, \text{GHz} \)  
                  | tone spacing = 2 MHz    | dBm   | —    | 30  | —    |
| Noise Figure    | 26 GHz                  | dB    | —    | 5.3 | 6.8  |
| Drain Current\(^3\) | Quiescent bias     | mA    | —    | 200 | —    |

3. Set by adjusting \( V_{G1} \) as outlined in operating conditions on page 3.

Absolute Maximum Ratings\(^4,5\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>17 , dBm</td>
</tr>
<tr>
<td>Drain Supply Voltage</td>
<td>10 , V</td>
</tr>
<tr>
<td>( V_{G1} )</td>
<td>(-4 , V &lt; V_{G1} &lt; 0 , V )</td>
</tr>
<tr>
<td>( V_{G2} )</td>
<td>(-3.5 , V &lt; V_{G2} &lt; +4 , V )</td>
</tr>
<tr>
<td>Drain Supply Current</td>
<td>340 , mA</td>
</tr>
<tr>
<td>Junction Temperature(^6,7)</td>
<td>+150°C</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>

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Operating at nominal conditions with \( T_J \leq +150^\circ\text{C} \) will ensure \( \text{MTTF} > 1 \times 10^6 \) hours.
7. Junction Temperature \( (T_J) = T_A + \Theta_{JC} \cdot ((V \cdot I) - (P_{\text{OUT}} - P_{\text{IN}})) \)
   Typical thermal resistance \( (\Theta_{JC}) = 14.2^\circ\text{C}/\text{W} \).

Handling Procedures
Please observe the following precautions to avoid damage:

Static Sensitivity
These electronic devices 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 1A devices.
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Operating Conditions
The recommended biasing conditions are $V_{DD} = 7$ V and $I_{DSQ} = 200$ mA, with $I_{DSQ}$ set by adjusting $V_{G1}$ after correctly setting $V_{DD}$ (refer to turn on sequence). To maintain the best performance MACOM recommends using an active bias circuit for constant $I_{DD}$.

It is noted that any biasing arrangement used, including active biasing, must be able to source at least 10 mA into the $V_{G1}$ port. This is because the $V_{G1}$ port contains a resistive divider with a total resistance to ground of 244 $\Omega$. For the recommended $I_{DSQ}$ of 200 mA obtained at a $V_{G1}$ voltage of around 2.5 V, 10 mA of $V_{G1}$ current ($I_{G1}$) is expected. These values of $V_{G1}$ and $I_{G1}$ will vary slightly between devices.

There are two possible methods for biasing $V_{DD}$:

1. Apply $V_{DD}$ through a bias tee connected to the $RF_{OUT}/V_{DD}$ port and connect an external DC block to the $RF_{IN}$ port. This provides wide band performance of 40 MHz to 50 GHz (depending on the bandwidth of the bias tee).

2. Apply $V_{DD}$ through a wideband conical inductor connected to the $V_{DD}$ port. No external bias tee is required at the $RF_{OUT}/V_{DD}$ port; however, external DC blocks are required at both the $RF_{IN}$ and $RF_{OUT}$ ports. Using this method provides for an operational frequency of 40 MHz to 50 GHz.

$V_{G2}$ can be used for gain control in all bias configurations. If gain control is not required, $V_{G2}$ should be left open-circuited.

Regardless of bias method used, 2 bypass capacitors of 100 pF and 1 $\mu$F should be connected to $V_{DAUX}$. This provides for improved gain flatness below 2 GHz down to 30 kHz when required.

The 100 pF capacitor can be a single layer capacitor or an SMT device on the PCB. Although it should be positioned as closely to the device as practically possible, the frequency response is not particularly sensitive to this. The 1 $\mu$F capacitor can be placed further away on the PCB.

Data in this datasheet was measured using bias option 1 and 100 pF (C1) and 1 $\mu$F (C3) capacitors on $V_{DAUX}$.

Operating the MAAM-011286-DIE
Turn-on
1. Apply $V_{G1}$ (-4 V).
2. Increase $V_{DD}$ to +7 V.
3. Set $I_{DSQ}$ by adjusting $V_{G1}$ more positive.
   (typically -2.5 V for $I_{DSQ}$ = 200 mA).
4. Apply $RF_{IN}$ signal.

Turn-off
1. Remove $RF_{IN}$ signal.
2. Decrease $V_{G1}$ to -4 V.
3. Decrease $V_{DD}$ to 0 V.
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Application Schematic

All bond pads labelled GND have vias to the backside metal. Bond wires on these pads are optional.

Component List

<table>
<thead>
<tr>
<th>Part</th>
<th>Value</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>100 pF</td>
<td>Single Layer</td>
</tr>
<tr>
<td>C2</td>
<td>1000 pF</td>
<td>0402</td>
</tr>
<tr>
<td>C3, C4</td>
<td>1 µF</td>
<td>0402</td>
</tr>
</tbody>
</table>
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Typical Performance Curves: $V_{DD} = 7$ V, $I_{DSQ} = 200$ mA

**Gain**

- $S_{21} (\text{dB})$
  - $-40^\circ\text{C}$
  - $+25^\circ\text{C}$
  - $+85^\circ\text{C}$

**Reverse Isolation**

- $S_{12} (\text{dB})$
  - $-40^\circ\text{C}$
  - $+25^\circ\text{C}$
  - $+85^\circ\text{C}$

**Input Return Loss**

- $S_{11} (\text{dB})$
  - $-40^\circ\text{C}$
  - $+25^\circ\text{C}$
  - $+85^\circ\text{C}$

**Output Return Loss**

- $S_{22} (\text{dB})$
  - $-40^\circ\text{C}$
  - $+25^\circ\text{C}$
  - $+85^\circ\text{C}$
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Typical Performance Curves: $V_{DD} = 7$ V, $I_{DSQ} = 200$ mA

**Output P1dB**

![Output P1dB Chart](chart1)

**Output P3dB**

![Output P3dB Chart](chart2)

**Noise Figure @ +25°C**

![Noise Figure Chart](chart3)

**OIP3, +2 dBm / tone, tone spacing = 2 MHz**

![OIP3 Chart](chart4)
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Typical Performance Curves: $T_A = +25^\circ C$, $I_{DSQ} = 200$ mA

- **Output P1dB vs. $V_{DD}$**
- **P3dB vs. $V_{DD}$**
- **Noise Figure vs. $V_{DD}$**
- **Gain vs. $V_{DD}$**

For further information and support please visit: https://www.macom.com/support
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Die Dimensions\textsuperscript{9,10,11,12}

9. All units in μm, unless otherwise noted, with a tolerance of ± 5 μm.
10. Die thickness is 100 ± 10 μm.
11. Die size reflects un-cut dimensions. Laser kerf reduces die size by ~ 25 μm each dimension.
12. Bond Pad / Backside Metallization : Gold

<table>
<thead>
<tr>
<th>Pad</th>
<th>X (μm)</th>
<th>Y (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,3</td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>160</td>
</tr>
<tr>
<td>4,8,9,10,13,14,16</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>5,7</td>
<td>63</td>
<td>107</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>200</td>
</tr>
<tr>
<td>11,12</td>
<td>97</td>
<td>77</td>
</tr>
<tr>
<td>15</td>
<td>77</td>
<td>97</td>
</tr>
</tbody>
</table>