Power Amplifier, 3 W
21.15 - 23.65 GHz

Features
- 24 dB Small Signal Gain
- 41 dBm Third Order Intercept Point (OIP3)
- >2 W Output P1dB
- 35 dBm Saturated Output Power
- Integrated Power Detector
- Bias 1330 mA @ 6 V
- Lead-Free 7 mm Cavity Package
- RoHS* Compliant

Description
The MAAP-011146-STD is a power amplifier assembled in a 7 mm surface mount package with a temperature compensated integrated power detector operating from 21.15 to 23.65 GHz. The circuit provides 24 dB gain, 41 dBm OIP3, 2 W P1dB and 35 dBm saturated output power.

The device includes ESD protection and by-pass capacitors to ease the implementation and volume assembly of the packaged part.

This power amplifier is specifically designed for use in point-to-point radios for cellular backhaul applications in the 23 GHz band.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAP-011146-STD</td>
<td>Bulk Quantity</td>
</tr>
<tr>
<td>MAAP-011146-STR500</td>
<td>500 piece reel</td>
</tr>
<tr>
<td>MAAP-011146-001SMB</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.

2. All "No Connection" pins should be grounded.
3. The exposed pad centered on the package bottom must be

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

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Power Amplifier, 3 W  
21.15 - 23.65 GHz  

Electrical Specifications: \( V_{DD} = 6 \, \text{V}, \, I_{DQ}^4 = 1330 \, \text{mA}, \, T_A = +25^\circ \text{C} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Signal Gain</td>
<td>dB</td>
<td>21.7</td>
<td>24.0</td>
<td>28.3</td>
</tr>
<tr>
<td>( P_{SAT} )</td>
<td>dBm</td>
<td>34</td>
<td>35</td>
<td>—</td>
</tr>
<tr>
<td>Output IP3, +20 dBm SCL</td>
<td>dBm</td>
<td>39.25</td>
<td>41.00</td>
<td>—</td>
</tr>
<tr>
<td>Output IP3, +24 dBm SCL</td>
<td>dBm</td>
<td>37.25</td>
<td>39.00</td>
<td>—</td>
</tr>
<tr>
<td>( P_{1dB} )</td>
<td>dBm</td>
<td>—</td>
<td>34</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>dB</td>
<td>—</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>dB</td>
<td>—</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Detector ( V_{DIFF} ), ( P_{OUT} \geq +20 , \text{dBm} )</td>
<td>V</td>
<td>0.5</td>
<td>1.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>dB</td>
<td>—</td>
<td>6</td>
<td>—</td>
</tr>
<tr>
<td>Gain Ripple over frequency</td>
<td>dB</td>
<td>—</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>Gate Voltage</td>
<td>V</td>
<td>—</td>
<td>—</td>
<td>-0.60</td>
</tr>
</tbody>
</table>

4. Adjust \( V_G1, V_G2 \) and \( V_G3 \) between -1.2 and -0.6 V to achieve specified \( I_{DQ} = I_D1+I_D2+I_D3 \). \( V_G1, V_G2 \) and \( V_G3 \) are nominally the same voltage.

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>18 dBm</td>
</tr>
<tr>
<td>Drain Voltage ( (V_{D1,2,3}) )</td>
<td>7 V</td>
</tr>
<tr>
<td>Gate Voltage ( (V_{G1,2,3}) )</td>
<td>-3 V</td>
</tr>
<tr>
<td>Drain to Gate Voltage ( (V_D-V_G) )</td>
<td>10 V</td>
</tr>
<tr>
<td>Current ( (I_{DD} = I_{D1}+I_{D2}+I_{D3}) )</td>
<td>2000 mA</td>
</tr>
<tr>
<td>Detector Pin</td>
<td>6 V</td>
</tr>
<tr>
<td>Detector Reference Pin</td>
<td>6 V</td>
</tr>
<tr>
<td>Detector Pout</td>
<td>35 dBm</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>+175°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +150°C</td>
</tr>
</tbody>
</table>

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Operating at nominal conditions with \( T_J \leq +150^\circ \text{C} \) will ensure MTTF > 1 x 10^6 hours.

**Maximum Operating Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>( PDISS )</td>
<td>11.2 W</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>+150°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

8. Channel temperature directly affects device MTTF. Channel temperature should be kept as low as possible to maximize lifetime. Thermal resistance, \( \Theta_jc \), is 5.8 °C/W.
9. For saturated performance, it is recommended that the sum of \( (2V_{DD} + \text{abs} (V_{DD})) < 15 \, \text{V} \).

**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 CDM class 2, HBM class 1B devices.
Typical Performance Curves: 8 W Quiescent Bias, $V_D = 6 \text{ V}$

- **Gain**
  - $S_{21}$ (dB)
  - Frequency (GHz)

- **Input Return Loss**
  - $S_{11}$ (dB)
  - Frequency (GHz)

- **Output Return Loss**
  - $S_{22}$ (dB)
  - Frequency (GHz)

- **$P_{1dB}$**
  - $P_{1dB}$ (dBm)
  - Frequency (GHz)

- **$P_{3dB}$**
  - $P_{3dB}$ (dBm)
  - Frequency (GHz)
Typical Performance Curves: \( V_D = 6 \) V

**Gain @ 21.2 GHz**

![Gain @ 21.2 GHz Graph](image)

**Gain @ 22.2 GHz**

![Gain @ 22.2 GHz Graph](image)

**OIP3 @ 21.2 GHz**

![OIP3 @ 21.2 GHz Graph](image)

**OIP3 @ 22.2 GHz**

![OIP3 @ 22.2 GHz Graph](image)
Typical Performance Curves: $V_D = 6\, V$

**Gain @ 22.7 GHz**

- DC Power (W) vs. Gain (dB)
- Three curves for different temperatures: +25°C, -40°C, +85°C

**OIP3 @ 22.7 GHz**

- DC Power (W) vs. OIP3 (dBm)
- Three curves for different temperatures: +25°C, -40°C, +85°C

**Gain @ 23.7 GHz**

- DC Power (W) vs. Gain (dB)
- Three curves for different temperatures: +25°C, -40°C, +85°C

**OIP3 @ 23.7 GHz**

- DC Power (W) vs. OIP3 (dBm)
- Three curves for different temperatures: +25°C, -40°C, +85°C
Typical Performance Curves: 8 W Quiescent Bias, \( V_D = 6 \, \text{V} \)

### Lower and Upper Intermodulation Tones @ 21.2 GHz

- **Output Tone Levels (dBm)**
- **Output Power per tone (dBm)**

### Lower and Upper Intermodulation Tones @ 22.2 GHz

- **Output Tone Levels (dBm)**
- **Output Power per tone (dBm)**

### Lower and Upper Intermodulation Tones @ 22.7 GHz

- **Output Tone Levels (dBm)**
- **Output Power per tone (dBm)**

### OIP3 vs. Output Power

- **OIP3 (dBm)**
- **Output Power per tone (dBm)**

### Detector Delta Voltage vs. Output Power

- **Vdelta (V)**
- **Output Power (dBm)**
Biasing -
All gates should be pinched-off ($V_G < -2$ V) before applying drain voltage ($V_D = 6$ V). Then the gate voltages can be increased until the desired quiescent drain current is reached in each stage. The recommended quiescent bias is $V_D = 6$ V, $I_{D1} = 190$ mA, $I_{D2} = 380$ mA and $I_{D3} = 762$ mA. The performance in this datasheet has been measured with fixed gate voltage and no drain current regulation under large signal operation. It is also possible to regulate the drain current dynamically, to limit the DC power dissipation under RF drive. To turn off the device, the turn on bias sequence should be followed in reverse.

Bias Arrangement -
Each DC pin ($V_D1,2,3$ and $V_G1,2,3$) needs to have bypass capacitance (120 pF and 10 nF) mounted as close to the MMIC as possible.

Power Detector -
As shown in the schematic below, the power detector is implemented by providing $+5$ V bias and measuring the difference in output voltage with standard op-amp in a differential mode configuration.

Application Schematic
Package Outline Drawing and Recommended Land Pattern†

All dimensions are in mm.

† Meets JEDEC moisture sensitivity level 3 requirements.