MAAP-011246

Power Amplifier, 2 W
27.5 - 31.5 GHz

Features
- High Gain: 23 dB
- P1dB: 30 dBm
- P\text{SAT}: 33 dBm
- IM3 Level: -22 dBc @ P\text{OUT} 27 dBm/tone
- Power Added Efficiency: 24% at P\text{SAT}
- Lead-Free 5 mm AQFN 32-lead Package
- RoHS* Compliant

Description
The MAAP-011246 is a 2 Watt, 4-stage power amplifier assembled in a lead-free 5 mm 32-lead A QFN plastic package. This power amplifier operates from 27.5 to 31.5 GHz and provides 23 dB of linear gain, 2 W saturated output power and 24% efficiency while biased at 6 V.

The MAAP-011246 can be used as a power amplifier stage or as a driver stage in higher power applications. This device is ideally suited for VSAT and 28 GHz PTP applications.

This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

Ordering Information\(^1,2\)

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAP-011246-TR0500</td>
<td>500 Piece Reel</td>
</tr>
<tr>
<td>MAAP-011246-1SMB</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 3 loose parts.

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

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For further information and support please visit:
https://www.macom.com/support
**Electrical Specifications:** Freq. = 30 GHz, $T_A = +25^\circ$C, $V_D = 6$ V, $Z_0 = 50$ Ω

<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>$P_{IN} = 0$ dBm</td>
<td>dB</td>
<td>19</td>
<td>22</td>
<td>—</td>
</tr>
<tr>
<td>$P_{OUT}$</td>
<td>$P_{IN} = 15$ dBm</td>
<td>dBm</td>
<td>31.5</td>
<td>33</td>
<td>—</td>
</tr>
<tr>
<td>IM3 Level</td>
<td>$P_{OUT} = 27$ dBm / tone</td>
<td>dBc</td>
<td>—</td>
<td>-22</td>
<td>—</td>
</tr>
<tr>
<td>Power Added Efficiency</td>
<td>$P_{SAT}$ ($P_{IN} = 15$ dBm)</td>
<td>%</td>
<td>—</td>
<td>24</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>$P_{IN} = -20$ dBm</td>
<td>dB</td>
<td>—</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>$P_{IN} = -20$ dBm</td>
<td>dB</td>
<td>—</td>
<td>14</td>
<td>—</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>$I_{DO}$ (see bias conditions, page 4 )</td>
<td>mA</td>
<td>—</td>
<td>900</td>
<td>—</td>
</tr>
<tr>
<td>Current</td>
<td>$P_{SAT}$ ($P_{IN} = 15$ dBm)</td>
<td>mA</td>
<td>—</td>
<td>1450</td>
<td>—</td>
</tr>
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</table>

**Maximum Operating Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>15 dBm</td>
</tr>
<tr>
<td>Junction Temperature$^5,6$</td>
<td>+160°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

5. Operating at nominal conditions with junction temperature ≤ +160°C will ensure MTTF > 1 x 10⁶ hours.

6. Junction Temperature ($T_J = T_C + \Theta_{JC} * ((V * I) - (P_{OUT} - P_{IN}))$)
   Typical thermal resistance ($\Theta_{JC}$) = 8°C/W.
   a) For $T_C = +25^\circ$C,
      $T_J = +79^\circ$C @ 6 V, 1.45 A, $P_{OUT} = 33.0$ dBm, $P_{IN} = 15$ dBm
   b) For $T_C = +85^\circ$C,
      $T_J = +136^\circ$C @ 6 V, 1.34 A, $P_{OUT} = 32.4$ dBm, $P_{IN} = 15$ dBm

**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.
Sample Board Layout

Application Schematic

Parts List

<table>
<thead>
<tr>
<th>Part</th>
<th>Value</th>
<th>Case Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 - C6</td>
<td>0.01 µF</td>
<td>0402</td>
</tr>
<tr>
<td>C7 - C10</td>
<td>1 µF</td>
<td>0402</td>
</tr>
<tr>
<td>C11 - C13</td>
<td>10 µF</td>
<td>0603</td>
</tr>
<tr>
<td>R1 - R6</td>
<td>10 Ω</td>
<td>0402</td>
</tr>
<tr>
<td>L1 - L3</td>
<td>600 Ω @ 100 MHz</td>
<td>0603</td>
</tr>
</tbody>
</table>

10. L1 - L3 (chip ferrite bead) supplied from Murata, part number BLM18HE601SN1D.

Sample Board Material Specifications

- **Top Layer**: 1/2 oz Copper Cladding, 0.017 mm thickness
- **Dielectric Layer**: Rogers RO4003C 0.203 mm thickness
- **Bottom Layer**: 1/2 oz Copper Cladding, 0.017 mm thickness
- **Finished overall thickness**: 0.238 mm
Recommended PCB Layout Detail:
RF input and output pre-matching circuit patterns are designed to compensate packaging effects. Transmission line dimensions apply to a PCB with 0.203 mm thick Rogers RO4003C laminate dielectric. Performance curves shown in this data sheet were measured with these circuit patterns.

Biasing Conditions
Recommended biasing conditions are \( V_D = 6 \text{ V} \), \( I_{DQ} = 900 \text{ mA} \) (controlled with \( V_G \)). The drain bias voltage range is 3 to 6 V, and the quiescent drain current biasing range is 600 to 1200 mA.

\( V_G \) pins 10 and 11 are connected internally; choose either pin for layout convenience. Muting can be accomplished by setting the \( V_G \) to the pinched off voltage (\( V_G = -2 \text{ V} \)).

\( V_D \) bias must be applied to \( V_{D1} \), \( V_{D2} \), \( V_{D3} \), and \( V_{D4} \) pins. \( V_{D3} \) pins 27 and 28 are connected internally: choose either pin for layout convenience. Two \( V_{D4} \) pins 15 and 26 (not connected internally) are required for current symmetry.

Operating the MAAP-011246

Turn-on
1. Apply \( V_G \) (-1.5 V).
2. Apply \( V_D \) (6.0 V typical).
3. Set \( I_{DQ} \) by adjusting \( V_G \) more positive (typically -0.9 to -1.0 V for \( I_{DQ} = 900 \text{ mA} \)).
4. Apply \( RF_{IN} \) signal.

Turn-off
1. Remove \( RF_{IN} \) signal.
2. Decrease \( V_S \) to -1.5 V.
3. Decrease \( V_D \) to 0 V.
Power Amplifier, 2 W
27.5 - 31.5 GHz

Electrical Specifications with the Recommended PCB Layout and bias conditions:
Freq. = 27.5 - 29.5 GHz, T_A = +25°C, V_D = 6 V, Z_0 = 50 Ω

<table>
<thead>
<tr>
<th>Parameter</th>
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<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>P_IN = 0 dBm</td>
<td>dB</td>
<td>19</td>
<td>27</td>
<td>30.5</td>
</tr>
<tr>
<td>P_SAT</td>
<td></td>
<td>dBm</td>
<td>31.5</td>
<td>33.5</td>
<td>—</td>
</tr>
<tr>
<td>IM3 Level</td>
<td>P_OUT = 27 dBm / tone</td>
<td>dBc</td>
<td>—</td>
<td>-20</td>
<td>—</td>
</tr>
<tr>
<td>Power Added Efficiency</td>
<td>P_SAT</td>
<td>%</td>
<td>—</td>
<td>24</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>P_IN = -20 dBm</td>
<td>dB</td>
<td>—</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>P_IN = -20 dBm</td>
<td></td>
<td>—</td>
<td>13</td>
<td>—</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>I_DQ (see bias conditions, page 4)</td>
<td>mA</td>
<td>—</td>
<td>900</td>
<td>—</td>
</tr>
<tr>
<td>Current</td>
<td>P_SAT</td>
<td>mA</td>
<td>—</td>
<td>1600</td>
<td>—</td>
</tr>
</tbody>
</table>

Typical Performance Curves

Gain vs. Frequency over Temperature

Gain vs. Frequency over Bias Voltage

Input Return Loss vs. Frequency over Temperature

Input Return Loss vs. Frequency over Bias Voltage

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DC-0009231
Typical Performance Curves over Temperature

**Output Return Loss vs. Frequency over Temperature**

![Graph showing Output Return Loss vs. Frequency over Temperature](image1)

**Output Return Loss vs. Frequency over Bias Voltage**

![Graph showing Output Return Loss vs. Frequency over Bias Voltage](image2)

**P1dB Output Power vs. Frequency**

![Graph showing P1dB Output Power vs. Frequency](image3)

**P_{SAT} Output Power vs. Frequency**

![Graph showing P_{SAT} Output Power vs. Frequency](image4)

**OIP3 vs. Frequency (P_{OUT} = 27 dBm/tone)**

![Graph showing OIP3 vs. Frequency](image5)

**IM3 vs. Frequency (P_{OUT} = 27 dBm/tone)**

![Graph showing IM3 vs. Frequency](image6)
Typical Performance Curves over Bias Voltage

**P1dB Output Power vs. Frequency**

![P1dB Output Power vs. Frequency graph]

**P_{SAT} Output Power vs. Frequency**

![P_{SAT} Output Power vs. Frequency graph]

**OIP3 vs. Frequency (P_{OUT} = 27 dBm/tone)**

![OIP3 vs. Frequency graph]

**IM3 vs. Frequency (P_{OUT} = 27 dBm/tone)**

![IM3 vs. Frequency graph]
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27.5 - 31.5 GHz

Typical Performance Curves over Frequency

**$P_{OUT}$ vs. $P_{IN}$**

**PAE vs. $P_{IN}$**

**$I_{DS}$ vs. $P_{IN}$**

**OIP3 vs. $P_{OUT}$ (dBm/-tone)**

**IM3 Level vs. $P_{OUT}$ (dBm/tone)**
Lead-Free 5 mm AQFN 32-Lead†

† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is NiPdAu.
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