MAAP-011246

Power Amplifier, 2 W
27.5 - 31.5 GHz

Features
- High Gain: 23 dB
- P1dB: 30 dBm
- PSAT: 33 dBm
- IM3 Level: -22 dBc @ POUT 27 dBm/tone
- Power Added Efficiency: 24% at PSAT
- 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 A0QFN 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 Information1,2

<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.

Pin Configuration3

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Function</th>
<th>Pin #</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground</td>
<td>20</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>No Connection</td>
<td>21</td>
<td>RF Output</td>
</tr>
<tr>
<td>3</td>
<td>Ground</td>
<td>22</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>RF Input</td>
<td>23</td>
<td>No Connection</td>
</tr>
<tr>
<td>5 - 7</td>
<td>No Connection</td>
<td>24, 25</td>
<td>Ground</td>
</tr>
<tr>
<td>8, 9</td>
<td>Ground</td>
<td>26</td>
<td>Drain Voltage 4</td>
</tr>
<tr>
<td>10</td>
<td>Gate Voltage</td>
<td>27, 28</td>
<td>Drain Voltage 3</td>
</tr>
<tr>
<td>11</td>
<td>Gate Voltage</td>
<td>29</td>
<td>Drain Voltage 2</td>
</tr>
<tr>
<td>12 - 14</td>
<td>No Connection</td>
<td>30</td>
<td>No Connection</td>
</tr>
<tr>
<td>15</td>
<td>Drain Voltage 4</td>
<td>31</td>
<td>Drain Voltage 1</td>
</tr>
<tr>
<td>16, 17</td>
<td>Ground</td>
<td>32</td>
<td>Ground</td>
</tr>
<tr>
<td>18, 19</td>
<td>No Connection</td>
<td></td>
<td>Ground</td>
</tr>
</tbody>
</table>

3. MACOM recommends connecting all No Connection (N/C) pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

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

For further information and support please visit: https://www.macom.com/support
Electrical Specifications:  Freq. = 30 GHz, $T_A = +25°C$, $V_D = 6$ 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>$I_{DD}$ (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>
</tbody>
</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 > $1 \times 10^6$ hours.

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

Note: Vd2 must be biased from both sides.

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
**Power Amplifier, 2 W**

**27.5 - 31.5 GHz**

**Rev. V3**

**MAAP-011246**

**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.

![Diagram](image)

Underneath of the package must be Copper filled plated through holes. D = 0.2 mm and Space = 0.43 mm. Total Via-holes = 8 x 8.

**All units are in microns**

**Recommended PCB Layout Detail:**

Recommended PCB layout details 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>
<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>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>dB</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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Typical Performance Curves over Temperature

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

- **S22 (dB)** vs. Frequency (GHz)
- **Frequency (GHz)**: 27 to 32
- **Temperature**:
  - +25°C
  - -40°C
  - +85°C

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

- **S22 (dB)** vs. Frequency (GHz)
- **Frequency (GHz)**: 27 to 32
- **Bias Voltage**:
  - 5.5 V
  - 6.0 V
  - 6.5 V

**P1dB Output Power vs. Frequency**

- **P1dB (dBm)** vs. Frequency (GHz)
- **Frequency (GHz)**: 26 to 36
- **Temperature**:
  - +25°C
  - -40°C
  - +85°C

**PSAT Output Power vs. Frequency**

- **PSAT (dBm)** vs. Frequency (GHz)
- **Frequency (GHz)**: 26 to 36
- **Temperature**:
  - +25°C
  - -40°C
  - +85°C

**OIP3 vs. Frequency (Pout = 27 dBm/tone)**

- **OIP3 (dBm)** vs. Frequency (GHz)
- **Frequency (GHz)**: 15 to 45
- **Temperature**:
  - +25°C
  - -40°C
  - +85°C

**IM3 vs. Frequency (Pout = 27 dBm/tone)**

- **IM3 (dBc)** vs. Frequency (GHz)
- **Frequency (GHz)**: -45 to 0
- **Temperature**:
  - +25°C
  - -40°C
  - +85°C
Typical Performance Curves over Bias Voltage

**P1dB Output Power vs. Frequency**

- **P1dB (dBm)** vs. **Frequency (GHz)** for bias voltages 5.5 V, 6.0 V, and 6.5 V.

**PSAT Output Power vs. Frequency**

- **PSAT (dBm)** vs. **Frequency (GHz)** for bias voltages 5.5 V, 6.0 V, and 6.5 V.

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

- **OIP3 (dBm)** vs. **Frequency (GHz)** for bias voltages 5.5 V, 6.0 V, and 6.5 V.

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

- **IM3 (dBc)** vs. **Frequency (GHz)** for bias voltages 5.5 V, 6.0 V, and 6.5 V.
Typical Performance Curves over Frequency

- **$P_{\text{OUT}}$ vs. $P_{\text{IN}}$**
  - Graph showing $P_{\text{OUT}}$ (dBm) vs. $P_{\text{IN}}$ (dBm) with frequency bands.

- **PAE vs. $P_{\text{IN}}$**
  - Graph showing PAE (%) vs. $P_{\text{IN}}$ (dBm) with frequency bands.

- **$I_{\text{DS}}$ vs. $P_{\text{IN}}$**
  - Graph showing $I_{\text{DS}}$ (mA) vs. $P_{\text{IN}}$ (dBm) with frequency bands.

- **OIP3 vs. $P_{\text{OUT}}$ (dBm/tone)**
  - Graph showing OIP3 (dBm) vs. $P_{\text{OUT}}$ (dBm) with frequency bands.

- **IM3 Level vs. $P_{\text{OUT}}$ (dBm/tone)**
  - Graph showing IM3 (dBc) vs. $P_{\text{OUT}}$ (dBm) with frequency bands.

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Power Amplifier, 2 W
27.5 - 31.5 GHz

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.

All Dimensions shown as inches [mm]
Power Amplifier, 2 W
27.5 - 31.5 GHz

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