MAAP-011289

Power Amplifier, 3 W
28 - 30 GHz

Rev. V2

Features
- High Gain: 24 dB
- P1dB: 34 dBm
- P3dB: 35 dBm
- IM3 Level: -18 dBc @ P_OUT 30 dBm/tone
- Power Added Efficiency: 23% @ P3dB
- Lead-Free 5 mm AQFN 32-lead Package
- RoHS* Compliant

Description
The MAAP-011289 is a 3 Watt, 4-stage power amplifier assembled in a lead-free 5 mm 32-lead AQFN plastic package. This power amplifier operates from 28 to 30 GHz and provides 24 dB of linear gain, 3 W saturated output power and 23% efficiency while biased at 6 V.

The MAAP-011289 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

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAP-011289-TR0500</td>
<td>500 piece reel</td>
</tr>
<tr>
<td>MAAP-011289-SMB</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.

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DC-0012700

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.
Power Amplifier, 3 W
28 - 30 GHz

Electrical Specifications: Freq. = 28 & 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>$P_{IN} = -5$ dBm, 28 GHz</td>
<td>dB</td>
<td>22</td>
<td>26</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>$P_{IN} = -5$ dBm, 30 GHz</td>
<td></td>
<td>21</td>
<td>24</td>
<td>—</td>
</tr>
<tr>
<td>$P_{OUT}$</td>
<td>$P_{IN} = 11$ dBm, 28 GHz</td>
<td>dBm</td>
<td>33</td>
<td>34.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>$P_{IN} = 13$ dBm, 30 GHz</td>
<td></td>
<td>33</td>
<td>34.5</td>
<td>—</td>
</tr>
<tr>
<td>IM3 Level</td>
<td>$P_{OUT} = 30$ dBm / tone</td>
<td>dBc</td>
<td>—</td>
<td>-18</td>
<td>—</td>
</tr>
<tr>
<td>Power Added Efficiency</td>
<td>$P_{IN} = 11$ &amp; 13 dBm</td>
<td>%</td>
<td>—</td>
<td>23</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>$P_{IN} = -20$ dBm</td>
<td>dB</td>
<td>—</td>
<td>14</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>$I_{DQ}$ (see bias conditions, page 4)</td>
<td>mA</td>
<td>—</td>
<td>1500</td>
<td>—</td>
</tr>
<tr>
<td>Current</td>
<td>$P_{IN} = 11$ &amp; 13 dBm</td>
<td>mA</td>
<td>—</td>
<td>2300</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, Pulsed</td>
<td>16 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 ($T_J$) = $T_C + \Theta_{JC} \times (V \times I) - (P_{OUT} - P_{IN})$
   Typical CW thermal resistance ($\Theta_{JC}$) = 4.8 °C/W.
   a) For $T_C = +25°C$
      $T_J = +75°C$ @ 6 V, 2.3 A, $P_{OUT} = 35.2$ dBm, $P_{IN} = 13$ dBm
   b) For $T_C = +85°C$
      $T_J = 132°C$ @ 6 V, 2 A, $P_{OUT} = 33.6$ dBm, $P_{IN} = 13$ 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.

Absolute Maximum Ratings$^{7,8}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power, CW</td>
<td>18 dBm</td>
</tr>
<tr>
<td>Drain Voltage</td>
<td>+6.5 V</td>
</tr>
<tr>
<td>Gate Voltage</td>
<td>-3 to 0 V</td>
</tr>
<tr>
<td>Junction Temperature$^9$</td>
<td>+175°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +125°C</td>
</tr>
</tbody>
</table>

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.
9. Junction temperature directly affects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.
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 - C4</td>
<td>0.01 µF</td>
<td>0402</td>
</tr>
<tr>
<td>C5 - C8</td>
<td>1 µF</td>
<td>0603</td>
</tr>
<tr>
<td>R1 - R4</td>
<td>10 Ω</td>
<td>0402</td>
</tr>
</tbody>
</table>

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
Recommending 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.

Input Tuning:

Output Tuning:

Biasing Conditions
Recommended biasing conditions are $V_D = 6$ V, $I_{DQ} = 1500$ mA (controlled with $V_G$). The drain bias voltage range is 3 to 6 V, and the quiescent drain current biasing range is 1300 to 1700 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 ($V_G = -2$ 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-011289

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 $I_{DQ} = 1500$ mA).
4. Apply $RF_{IN}$ signal.

Turn-off
1. Remove $RF_{IN}$ signal.
2. Decrease $V_G$ to -1.5 V.
3. Decrease $V_D$ to 0 V.
Typical Performance Curves

Small Signal Gain vs. Frequency over Temperature

![Graph showing Small Signal Gain vs. Frequency over Temperature](image)

Small Signal Gain vs. Frequency over Bias Voltage

![Graph showing Small Signal Gain vs. Frequency over Bias Voltage](image)

Input Return Loss vs. Frequency over Temperature

![Graph showing Input Return Loss vs. Frequency over Temperature](image)

Input Return Loss vs. Frequency over Bias Voltage

![Graph showing Input Return Loss vs. Frequency over Bias Voltage](image)

Output Return Loss vs. Frequency over Temperature

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

Output Return Loss vs. Frequency over Bias Voltage

![Graph showing Output Return Loss vs. Frequency over Bias Voltage](image)
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Typical Performance Curves

**P3dB vs. Frequency over Temperature**

![Typical Performance Curves](P3dB_Freq_Temp.png)

**P3dB vs. Frequency over Bias Voltage**

![Typical Performance Curves](P3dB_Freq_Bias.png)

**P1dB vs. Frequency over Temperature**

![Typical Performance Curves](P1dB_Freq_Temp.png)

**P1dB vs. Frequency over Bias Voltage**

![Typical Performance Curves](P1dB_Freq_Bias.png)
Typical Performance Curves

**Output IP3 over Temperature** ($P_{OUT} = 30$ dBm / Tone)

![Output IP3 over Temperature Graph]

**Output IP3 over Bias Voltage** ($P_{OUT} = 30$ dBm / Tone)

![Output IP3 over Bias Voltage Graph]

**IM3 over Temperature** ($P_{OUT} = 30$ dBm / Tone)

![IM3 over Temperature Graph]

**IM3 over Bias Voltage** ($P_{OUT} = 30$ dBm / Tone)

![IM3 over Bias Voltage Graph]
Typical Performance Curves

**P1dB, P3dB vs. Frequency**

![Graph showing P1dB, P3dB vs. Frequency](image)

**Gain and PAE @ P3dB vs. Frequency**

![Graph showing Gain and PAE @ P3dB vs. Frequency](image)

**IM3 vs. Output Power**

![Graph showing IM3 vs. Output Power](image)

**Output IP3 vs. Output Power**

![Graph showing Output IP3 vs. Output Power](image)
Typical Performance Curves

**Output Power vs. Input Power**

- 28.0 GHz
- 28.5 GHz
- 29.0 GHz
- 29.5 GHz
- 30.0 GHz

**PAE vs. Input Power**

- 28.0 GHz
- 28.5 GHz
- 29.0 GHz
- 29.5 GHz
- 30.0 GHz

**Bias Current vs. Input Power**

- 28.0 GHz
- 28.5 GHz
- 29.0 GHz
- 29.5 GHz
- 30.0 GHz

**Quiescent Drain Current vs. Temperature**

- IDS (mA) at 25°C
- IDS (mA) at 85°C
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].