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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Power Amplifier, 3 W
28 - 30 GHz

Electrical Specifications: Freq. = 28 & 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 = -5 dBm, 28 GHz P_IN = -5 dBm, 30 GHz</td>
<td>dB</td>
<td>22</td>
<td>26</td>
<td>—</td>
</tr>
<tr>
<td>P_OUT</td>
<td>P_IN = 11 dBm, 28 GHz P_IN = 13 dBm, 30 GHz</td>
<td>dBm</td>
<td>33</td>
<td>34.0</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_DD (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 x 10^6 hours.
6. Junction Temperature (T_J) = T_C + Θ_JC * ((V * I) - (P_OUT - P_IN))
   Typical CW thermal resistance (Θ_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

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 effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

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 - 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

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MAAP-011289

Power Amplifier, 3 W
28 - 30 GHz

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.

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

Input Return Loss vs. Frequency over Temperature

Output Return Loss vs. Frequency over Temperature

Small Signal Gain vs. Frequency over Bias Voltage

Input Return Loss vs. Frequency over Bias Voltage

Output Return Loss vs. Frequency over Bias Voltage
Typical Performance Curves

**P3dB vs. Frequency over Temperature**

-25°C (green), 40°C (blue), 85°C (red)

**P3dB vs. Frequency over Bias Voltage**

5.5 V (orange), 6.0 V (blue), 6.5 V (red)

**P1dB vs. Frequency over Temperature**

-25°C (green), 40°C (blue), 85°C (red)

**P1dB vs. Frequency over Bias Voltage**

5.5 V (orange), 6.0 V (blue), 6.5 V (red)
Typical Performance Curves

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

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

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

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

P1dB, P3dB vs. Frequency

Gain and PAE @ P3dB vs. Frequency

IM3 vs. Output Power

Output IP3 vs. Output Power
**Typical Performance Curves**

**Output Power vs. Input Power**

- **Output Power (dBm)** vs. **Input Power (dBm)**
- Curves for different frequencies: 28.0 GHz, 28.5 GHz, 29.0 GHz, 29.5 GHz, and 30.0 GHz

**PAE vs. Input Power**

- **PAE (%)** vs. **Input Power (dBm)**
- Curves for different frequencies: 28.0 GHz, 28.5 GHz, 29.0 GHz, 29.5 GHz, and 30.0 GHz

**Bias Current vs. Input Power**

- **IDS (mA)** vs. **Input Power (dBm)**
- Curves for different frequencies: 28.0 GHz, 28.5 GHz, 29.0 GHz, 29.5 GHz, and 30.0 GHz

**Quiescent Drain Current vs. Temperature**

- **IDSQ (mA)** vs. **Temperature (°C)**
- Curves for different frequencies: 28.0 GHz, 28.5 GHz, 29.0 GHz, 29.5 GHz, and 30.0 GHz

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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.