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 @ POUT 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.

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

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice. Visit www.macom.com for additional data sheets and product information.
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</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_{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</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

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.

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice. Visit www.macom.com for additional data sheets and product information.
**Application Schematic**

```
  V_D1  V_D2  V_D3  V_D4
  |     |     |     |
  C5   R1   C1   C1
  |     |     |
  V_D  V_D  V_D  V_D
  |     |     |
  C6   R2   C2   C2
```

Note:

- $V_D$ must be biased from both sides.

---

**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
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:

COPPER-FILLED VIAS
0.3 mm DIA, 0.5 mm CENTERS
7x7 ARRAY

1810
1685
1195
760
430
430
810
250
225
185
125
1150
500
700

Output Tuning:

100
185
810
200
200
250
915

Biasing Conditions
Recommended biasing conditions are $V_D = 6 \, \text{V}$, $I_{DQ} = 1500 \, \text{mA}$ (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 ($V_G = -2 \, \text{V}$).

$V_D$ bias must be applied to $V_D1$, $V_D2$, $V_D3$, and $V_D4$ pins. $V_P3$ 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 $I_{DQ} = 1500 \, \text{mA}$).
4. Apply RF$_{\text{IN}}$ signal.

Turn-off
1. Remove RF$_{\text{IN}}$ 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 over temperature at different frequencies.]

**Small Signal Gain vs. Frequency over Bias Voltage**

![Graph showing small signal gain over bias voltage at different frequencies.]

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

![Graph showing input return loss over temperature at different frequencies.]

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

![Graph showing input return loss over bias voltage at different frequencies.]

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

![Graph showing output return loss over temperature at different frequencies.]

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

![Graph showing output return loss over bias voltage at different frequencies.]

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice. Visit [www.macom.com](http://www.macom.com) for additional data sheets and product information.

For further information and support please visit: [https://www.macom.com/support](https://www.macom.com/support)
Typical Performance Curves

**P3dB vs. Frequency over Temperature**

![Graph showing P3dB vs. Frequency over Temperature for different temperatures: +25°C, -40°C, +85°C. The graph shows the P3dB level in dBm at various frequencies.]  

**P3dB vs. Frequency over Bias Voltage**

![Graph showing P3dB vs. Frequency over Bias Voltage for different bias voltages: 5.5 V, 6.0 V, 6.5 V. The graph shows the P3dB level in dBm at various frequencies.]  

**P1dB vs. Frequency over Temperature**

![Graph showing P1dB vs. Frequency over Temperature for different temperatures: +25°C, -40°C, +85°C. The graph shows the P1dB level in dBm at various frequencies.]  

**P1dB vs. Frequency over Bias Voltage**

![Graph showing P1dB vs. Frequency over Bias Voltage for different bias voltages: 5.5 V, 6.0 V, 6.5 V. The graph shows the P1dB level in dBm at various frequencies.]
Power Amplifier, 3 W
28 - 30 GHz

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**

- **P1dB & P3dB vs. Frequency**

![Graph showing P1dB and P3dB vs. Frequency across 28.0 to 30.0 GHz.]

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

- **Gain and PAE vs. Frequency**

![Graph showing Gain and PAE vs. Frequency across 28.0 to 30.0 GHz.]

**IM3 vs. Output Power**

- **IM3 vs. Output Power**

![Graph showing IM3 vs. Output Power across 8 to 34 dBm.]

**Output IP3 vs. Output Power**

- **Output IP3 vs. Output Power**

![Graph showing Output IP3 vs. Output Power across 30 to 50 dBm.]

---

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice. Visit [www.macom.com](http://www.macom.com) for additional data sheets and product information.

For further information and support please visit: [https://www.macom.com/support](https://www.macom.com/support)
Power Amplifier, 3 W
28 - 30 GHz

Typical Performance Curves

Output Power vs. Input Power

PAE vs. Input Power

Bias Current vs. Input Power

Quiescent Drain Current vs. Temperature

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.

Visit www.macom.com for additional data sheets and product information.

For further information and support please visit: https://www.macom.com/support
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.
Power Amplifier, 3 W
28 - 30 GHz

MACOM Technology Solutions Inc. All rights reserved.

Information in this document is provided in connection with MACOM Technology Solutions Inc ("MACOM") products. These materials are provided by MACOM as a service to its customers and may be used for informational purposes only. Except as provided in MACOM's Terms and Conditions of Sale for such products or in any separate agreement related to this document, MACOM assumes no liability whatsoever. MACOM assumes no responsibility for errors or omissions in these materials. MACOM may make changes to specifications and product descriptions at any time, without notice. MACOM makes no commitment to update the information and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to its specifications and product descriptions. No license, express or implied, by estoppels or otherwise, to any intellectual property rights is granted by this document.

THESE MATERIALS ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, CONSEQUENTIAL OR INCIDENTAL DAMAGES, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. MACOM FURTHER DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. MACOM SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS, WHICH MAY RESULT FROM THE USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.

For further information and support please visit:
https://www.macom.com/support