Features
- High Gain: 25 dB @ 30 GHz
- P1dB: 34.5 dBm
- P3dB: 36.0 dBm
- IM3 Level: -27 dBc @ P_{OUT} 29 dBm/tone
- Power Added Efficiency: 27.5% @ P3dB
- Lead-Free 5 mm 32-lead AQFN Package
- RoHS* Compliant

Description
The MAAP-011233 is a 4-stage, 4 W power amplifier assembled in a lead-free 5 mm 32-lead AQFN plastic package. This power amplifier operates from 28.5 to 31.0 GHz and provides 26 dB of linear gain, 4 W saturated output power and 27.5% efficiency while biased at 6 V.

The MAAP-011233 can be used as a power amplifier ideally suited for VSAT communications.

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-011233</td>
<td>Bulk</td>
</tr>
<tr>
<td>MAAP-011233-TRP0500</td>
<td>500 Piece Reel</td>
</tr>
<tr>
<td>MAAP-011233-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.

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

[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, 4 W
28.5 - 31.0 GHz

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>22</td>
<td>25.0</td>
<td>—</td>
</tr>
<tr>
<td>P_OUT</td>
<td>P_IN = +14 dBm</td>
<td>dBm</td>
<td>34.5</td>
<td>36.0</td>
<td>—</td>
</tr>
<tr>
<td>IM3 Level</td>
<td>P_OUT = 29 dBm / tone</td>
<td>dBC</td>
<td>—</td>
<td>-27.0</td>
<td>—</td>
</tr>
<tr>
<td>Power Added Efficiency</td>
<td>P_IN = +14 dBm</td>
<td>%</td>
<td>—</td>
<td>27.5</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>10</td>
<td>—</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>I_DQ (see bias conditions, page 4)</td>
<td>mA</td>
<td>—</td>
<td>2000</td>
<td>—</td>
</tr>
<tr>
<td>Current</td>
<td>P_IN = +14 dBm</td>
<td>mA</td>
<td>—</td>
<td>2800</td>
<td>3600</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>14 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 thermal resistance (Θ_JC) = 4.4 °C/W.
   a) For T_C = +25°C,
   T_J = +82°C @ 6 V, 2.8 A, P_OUT = 36 dBm, P_IN = 14 dBm
   b) For T_C = +85°C,
   T_J = +137°C @ 6 V, 2.5 A, P_OUT = 35 dBm, P_IN = 14 dBm

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>20 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^8</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 electronics 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 - C7</td>
<td>0.01 µF</td>
<td>0402</td>
</tr>
<tr>
<td>C8 - C12</td>
<td>1 µF</td>
<td>0603</td>
</tr>
<tr>
<td>C13 - C16</td>
<td>10 µF</td>
<td>0805</td>
</tr>
<tr>
<td>R1 - R7</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
Sample Board Layout:
RF input and output port pre-matching circuit patterns are designed to compensate for packaging effects. Input and output patterns are identical.

Biasing Conditions
Recommended biasing conditions are $V_D = 6$ V, $I_DQ = 2$ A (controlled with $V_G$). The drain bias voltage range is 3 to 6 V, and the quiescent drain current biasing range is 1.5 to 2.5 A.

$V_G$ 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 14 and either pin 27 or 28 are required for current symmetry. Pins 27 and 28 are connected internally; choose either pin for layout convenience.

Both $V_{D4}$ pins 15 and 26 are required for current symmetry.

Operating the MAAP-011233

Turn-on
1. Apply $V_G$ (-1.5 V).
2. Apply $V_{D1}$, $V_{D2}$, $V_{D3}$, $V_{D4}$ (6.0 V typical).
3. Set $I_DQ$ by adjusting $V_G$ more positive (typically -0.9 to -1.0 V for $I_DQ = 2$ A).
4. Apply $RF_{IN}$ signal.

Turn-off
1. Remove $RF_{IN}$ signal.
2. Decrease $V_G$ to ~1.5 V.
3. Decrease $V_{D1}$, $V_{D2}$, $V_{D3}$, $V_{D4}$ to 0 V.

Application Information
The MAAP-011233 is designed to be easy to use yet high performance. The ultra small size and simple bias allow easy placement on system board. RF input and output ports are DC de-coupled internally.
Typical Performance Curves

Small Signal Gain vs. Frequency over Temperature

[Graph showing Small Signal Gain vs. Frequency over Temperature with curves for different temperatures.]

Small Signal Gain vs. Frequency over Bias Voltage

[Graph showing Small Signal Gain vs. Frequency over Bias Voltage with curves for different voltages.]

Input Return Loss vs. Frequency over Temperature

[Graph showing Input Return Loss vs. Frequency over Temperature with curves for different temperatures.]

Input Return Loss vs. Frequency over Bias Voltage

[Graph showing Input Return Loss vs. Frequency over Bias Voltage with curves for different voltages.]

Output Return Loss vs. Frequency over Temperature

[Graph showing Output Return Loss vs. Frequency over Temperature with curves for different temperatures.]

Output Return Loss vs. Frequency over Bias Voltage

[Graph showing Output Return Loss vs. Frequency over Bias Voltage with curves for different voltages.]
Power Amplifier, 4 W
28.5 - 31.0 GHz

Typical Performance Curves

**P3dB vs. Frequency over Temperature**

![Graph showing P3dB vs. Frequency over Temperature for different temperatures: +25°C, -40°C, +85°C.](image)

**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.](image)

**P1dB vs. Frequency over Temperature**

![Graph showing P1dB vs. Frequency over Temperature for different temperatures: +25°C, -40°C, +85°C.](image)

**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.](image)
Typical Performance Curves: $P_{\text{OUT}} = 29$ dBm / Tone

- **Output IP3 vs. Frequency over Temperature**
- **Output IP3 vs. Frequency over Bias Voltage**
- **IM3 vs. Frequency over Temperature**
- **IM3 vs. Frequency over Bias Voltage**
Power Amplifier, 4 W
28.5 - 31.0 GHz

Typical Performance Curves

**P1dB & P3dB vs. Frequency**

- **P1dB & P3dB (dBm)** vs. Frequency (GHz)
- 30 32 34 36 38 40
- 28.5 29.0 29.5 30.0 30.5 31.0

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

- **PAE (%) & Gain (dB)** vs. Frequency (GHz)
- 20 22 24 26 28 30
- 28.5 29.0 29.5 30.0 30.5 31.0

**IM3 vs. Output Power**

- **IM3 Level (dBc)** vs. Output Power / Tone (dBm)
- -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40
- 29 GHz 30 GHz 31 GHz

**Output IP3 vs. Output Power**

- **OIP3 (dBm)** vs. Output Power / Tone (dBm)
- 30 35 40 45 50
- 5 10 15 20 25 30 35
- 29 GHz 30 GHz 31 GHz
Power Amplifier, 4 W
28.5 - 31.0 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 32-Lead AQFN Package†

All dimensions shown as inches [mm].

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