MAAP-011139

Power Amplifier, 4 W
28.5 - 31 GHz

Features
- High Gain: 22 dB @ 30 GHz
- P1dB: 34.5 dBm
- PSAT: 36 dBm
- IM3 Level: -27 dBc @ POUT 29 dBm/tone
- Power Added Efficiency: 23% @ PSAT
- Lead-Free 5 mm 32-lead AQFN Plastic Package
- RoHS* Compliant

Description
The MAAP-011139 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 GHz and provides 22 dB of linear gain, 4 W saturated output power, and 23% efficiency while biased at 6 V.

The MAAP-011139 is 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-011139-TR0500</td>
<td>500 piece reel</td>
</tr>
<tr>
<td>MAAP-011139-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.

Functional Schematic

Pin Configuration

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Function</th>
<th>Pin No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground</td>
<td>18, 19</td>
<td>No Connection</td>
</tr>
<tr>
<td>2</td>
<td>No Connection</td>
<td>20</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>Ground</td>
<td>21</td>
<td>RF Output</td>
</tr>
<tr>
<td>4</td>
<td>RF Input</td>
<td>22</td>
<td>Ground</td>
</tr>
<tr>
<td>5</td>
<td>Ground</td>
<td>23</td>
<td>No Connection</td>
</tr>
<tr>
<td>6, 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</td>
<td>Drain Voltage 3</td>
</tr>
<tr>
<td>11</td>
<td>Gate Voltage</td>
<td>28</td>
<td>Drain Voltage 3</td>
</tr>
<tr>
<td>12, 13</td>
<td>No Connection</td>
<td>29</td>
<td>Drain Voltage 2</td>
</tr>
<tr>
<td>14</td>
<td>Drain Voltage 3</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></td>
<td>Paddlestructions on Hazardous Substances, European Union Directive 2011/65/EU.</td>
<td></td>
<td>Ground</td>
</tr>
</tbody>
</table>

3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.
### Electrical Specifications: Freq. = 30 GHz, $T_A = +25°C$, $V_D = 6 V$, $Z_0 = 50 \Omega$

<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>$P_{IN} = 0 \text{ dBm}$</td>
<td>dB</td>
<td>19</td>
<td>22</td>
<td>—</td>
</tr>
<tr>
<td>$P_{OUT}$</td>
<td>$P_{IN} = +17 \text{ dBm}$</td>
<td>dBm</td>
<td>34.5</td>
<td>36.0</td>
<td>—</td>
</tr>
<tr>
<td>IM3 Level</td>
<td>$P_{OUT} = +29 \text{ dBm} \text{ / tone}$</td>
<td>dBc</td>
<td>—</td>
<td>-27</td>
<td>—</td>
</tr>
<tr>
<td>Power Added Efficiency</td>
<td>$P_{SAT} (P_{IN} = +17 \text{ dBm})$</td>
<td>%</td>
<td>—</td>
<td>23</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>$P_{IN} = -20 \text{ dBm}$</td>
<td>dB</td>
<td>—</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>$P_{IN} = -20 \text{ dBm}$</td>
<td>dB</td>
<td>—</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>$I_{DD} \text{ (see bias conditions, page 5 )}$</td>
<td>mA</td>
<td>—</td>
<td>2000</td>
<td>—</td>
</tr>
<tr>
<td>Current</td>
<td>$P_{SAT} (P_{IN} = +17 \text{ dBm})$</td>
<td>mA</td>
<td>—</td>
<td>2700</td>
<td>—</td>
</tr>
</tbody>
</table>

### Maximum Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>$+17 \text{ dBm}$</td>
</tr>
<tr>
<td>Junction Temperature$^5,6$</td>
<td>$+160°C$</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>$-40°C \text{ to } +85°C$</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 thermal resistance ($\Theta_{JC}$) = $4.4^\circ \text{C/W}$.
   a) For $T_C = +25°C$.
   $T_J = +79°C \text{ @ 6 V, 2.7 A, } P_{OUT} = 36 \text{ dBm, } P_{IN} = 17 \text{ dBm}$
   b) For $T_C = +85°C$.
   $T_J = +143°C \text{ @ 6 V, 2.7 A, } P_{OUT} = 35.1 \text{ dBm, } P_{IN} = 17 \text{ dBm}$

### Absolute Maximum Ratings$^7,8$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>$+23 \text{ dBm}$</td>
</tr>
<tr>
<td>Drain Voltage</td>
<td>$+6.5 \text{ V}$</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>$-65°C \text{ to } +125°C$</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.
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>
<tr>
<td>L1 - L4 (Chip Ferrite Bead)</td>
<td>BLM18HE601SN1D</td>
<td>0603</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

For further information and support please visit: https://www.macom.com/support
Sample Board Layout: RF input and output port pre-matching circuit patterns are designed to compensate for packaging effects. Input and output match patterns are identical.

Copper-filled vias are required beneath the package. Diameter = 0.3 mm, Spacing = 0.5 mm, 7x7 array.

All units are in microns.
Application Information
The MAAP-011139 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.

Biasing conditions
Recommended biasing conditions are V_D = 6 V, I_DQ = 2000 mA (controlled with V_G). The drain bias voltage range is 3 to 6 V, and the quiescent drain current biasing range is 1500 to 2500 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 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-011139

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 V_G ~ -0.9 V for I_DQ = 2000 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.

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.
Typical Performance Curves

**Small Signal Gain vs. Frequency over Temperature**

![Small Signal Gain vs. Frequency over Temperature graph](image1)

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

![Small Signal Gain vs. Frequency over Bias Voltage graph](image2)

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

![Input Return Loss vs. Frequency over Temperature graph](image3)

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

![Input Return Loss vs. Frequency over Bias Voltage graph](image4)

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

![Output Return Loss vs. Frequency over Temperature graph](image5)

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

![Output Return Loss vs. Frequency over Bias Voltage graph](image6)
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Typical Performance Curves

Output IP3 over Temperature (Pout=29 dBm/tone)

Output IP3 over Bias Voltage (Pout=29 dBm/Tone)

IM3 over Temperature (Pout=29 dBm/tone)

IM3 over Bias Voltage (Pout=29 dBm/tone)

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Typical Performance Curves

**P1dB, P_{SAT} vs. Frequency**

![Graph showing P1dB and PSAT vs. Frequency](image)

**PAE, Gain vs. Frequency**

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

**IM3 vs. Output Power (per tone)**

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

**Output IP3 vs. Output Power (per tone)**

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

Output Power vs. Input Power

PAE vs. Input Power

Bias Current vs. Input Power

Quiescent Drain Current vs. Temperature
Lead-Free 5 mm QFN 32-Lead†

Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is NiPdAu.
Power Amplifier, 4 W
28.5 - 31 GHz

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