Power Amplifier, 1 W
0.001 - 22 GHz

Features
- Positive Gain Slope
- High Gain: 13.5 dB @ 18 GHz
- P1dB: 28.5 dBm @ 18 GHz
- PSAT: 30.5 dBm @ 18 GHz
- Output IP3: 47 dBm @ 18 GHz
- Bias Voltage: \( V_{DD} = 10 \) V
- Bias Current: \( I_{DSQ} = 500 \) mA
- 50 Ω Matched Input / Output
- Temperature Compensated Output Power Detector
- Lead-Free 5 mm 32-lead AQFN Package
- RoHS* Compliant

Applications
- Test & Measurement, EW, ECM, and Radar

Description
The MAAP-011327 is a 1 W distributed power amplifier offered in a lead-free 5 mm 32-lead AQFN package. The power amplifier operates from 0.001 to 22 GHz and provides 13.5 dB of linear gain and 30.5 dBm of output power at saturation. The device is fully matched across the band and includes a temperature compensated output power detector.

The MAAP-011327 can be used as a power amplifier stage or as a driver stage in higher power applications. This device is ideally suited for test and measurement, EW, ECM, and radar 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-011327-TR0500</td>
<td>500 Piece Reel</td>
</tr>
<tr>
<td>MAAP-011327-TR1000</td>
<td>1000 Piece Reel</td>
</tr>
<tr>
<td>MAAP-011327-SMB</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.
### Electrical Specifications: \( T_A = +25^\circ C, \ V_{DD} = 10 \ V, \ I_{DSQ} = 500 \ mA, \ Z_0 = 50 \ \Omega \)

<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><strong>Gain</strong></td>
<td>( 2, 10, 18, 22 \ GHz )</td>
<td>dB</td>
<td>—</td>
<td>11.0</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>( 18, 22 \ GHz )</td>
<td></td>
<td>11.5</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 22 \ GHz )</td>
<td></td>
<td>12.5</td>
<td>14.5</td>
<td></td>
</tr>
<tr>
<td><strong>PSAT</strong></td>
<td>( P_{IN} = +24 \ dBm )</td>
<td>dBm</td>
<td>—</td>
<td>32.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>( 2, 10, 18, 22 \ GHz )</td>
<td></td>
<td>31.5</td>
<td>30.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 22 \ GHz )</td>
<td></td>
<td>31.0</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>P1dB</strong></td>
<td>( 2, 10, 18, 22 \ GHz )</td>
<td>dBm</td>
<td>—</td>
<td>28.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>( 10 \ GHz )</td>
<td></td>
<td>29.0</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 18 \ GHz )</td>
<td></td>
<td>28.5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 22 \ GHz )</td>
<td></td>
<td>27.5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>OIP3</strong></td>
<td>( P_{OUT} = +18 \ dBm/\text{tone} ) (10 MHz Tone Spacing)</td>
<td>dBm</td>
<td>—</td>
<td>45.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>( 2, 12, 18, 22 \ GHz )</td>
<td></td>
<td>45.0</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 12 \ GHz )</td>
<td></td>
<td>47.0</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 18 \ GHz )</td>
<td></td>
<td>39.5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>PAE</strong></td>
<td>( P_{IN} = +22 \ dBm )</td>
<td>%</td>
<td>—</td>
<td>27.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>( 2, 12, 18, 22 \ GHz )</td>
<td></td>
<td>24.5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 18 \ GHz )</td>
<td></td>
<td>19.5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 22 \ GHz )</td>
<td></td>
<td>19.5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>NF</strong></td>
<td>( 10, 18, 22 \ GHz )</td>
<td>dB</td>
<td>—</td>
<td>3.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>( 18 \ GHz )</td>
<td></td>
<td>3.5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( 22 \ GHz )</td>
<td></td>
<td>3.75</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>Input Return Loss</strong></td>
<td>( P_{IN} = -20 \ dBm )</td>
<td>dB</td>
<td>—</td>
<td>12</td>
<td>—</td>
</tr>
<tr>
<td><strong>Output Return Loss</strong></td>
<td>( P_{IN} = -20 \ dBm )</td>
<td>dB</td>
<td>—</td>
<td>12</td>
<td>—</td>
</tr>
<tr>
<td><strong>I_{DD} (with RF drive)</strong></td>
<td>( P_{IN} = +23 \ dBm )</td>
<td>mA</td>
<td>—</td>
<td>600</td>
<td>—</td>
</tr>
<tr>
<td><strong>I_{G1} (with RF drive)</strong></td>
<td>( P_{IN} = +23 \ dBm )</td>
<td>mA</td>
<td>—</td>
<td>-0.1</td>
<td>—</td>
</tr>
</tbody>
</table>
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Maximum Operating Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>24 dBm</td>
</tr>
<tr>
<td>Drain Voltage</td>
<td>+12 V</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>+150°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings\(^8,9\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>30 dBm</td>
</tr>
<tr>
<td>Drain Voltage</td>
<td>+13 V</td>
</tr>
<tr>
<td>Gate Voltage</td>
<td>-2 to 0 V</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>+175°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +125°C</td>
</tr>
</tbody>
</table>

6. Operating at nominal conditions with junction temperature \(\leq 150^\circ\) will ensure MTTF \(> 1 \times 10^6\) hours.
7. Junction Temperature \(T_J = T_C + \Theta_{JC} \cdot (V \cdot I - (P_{OUT} - P_{IN}))\)
   Typical thermal resistance \(\Theta_{JC} = 14.0^\circ\)C/W.
   a) For \(T_C = +85^\circ\)C and 22 GHz,
      \(T_J = +146^\circ\)C @ 10 V, 0.5 A, \(P_{OUT} = 28.5\) dBm, \(P_{IN} = 18\) dBm

Biasing Conditions
Recommended biasing conditions are \(V_{DD} = 10\) V, \(I_{DSQ} = 500\) mA (controlled with \(V_{G1}\)).

\(V_{DD}\) bias must be applied through a resonant free high inductance on the RF output line.

Bypass capacitors C1 and C2 for the auxiliary pads are required for a low frequency operation extension (below 1 GHz).

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 2 and CDM Class C3 devices.

Operating the MAAP-011327
Turn-on
1. Apply \(V_{G1}\) (-1.5 V).
2. Increase \(V_{DD}\) to 10 V.
3. Set \(I_{DSQ}\) by adjusting \(V_{G1}\) more positive (typically -0.8 V for \(I_{DSQ} = 500\) mA).
4. Apply RF\(_{IN}\) signal.

Turn-off
1. Remove RF\(_{IN}\) signal.
2. Decrease \(V_{G1}\) to -1.5 V.
3. Decrease \(V_{DD}\) to 0 V.
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MAAP-011327
Rev. V1

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 - C3</td>
<td>0.1 µF</td>
<td>0402</td>
</tr>
<tr>
<td>R1</td>
<td>0 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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Recommended PCB Layout Detail:
The RF input and output pre-matching circuit patterns are identical and 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.

Recommended PCB Information
RF input and output are 50 Ω transmission lines on single layer 8 mil Rogers RO4003C with 1/2 oz. Cu. Use copper filled vias under ground paddle. Do not use copper paste as the thermals will cause over heating.

Grounding and Thermal Vias
It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8 mil (200 μm) diameter vias under the device, assuming an 8 mil (200 μm) thick RF layer to ground. For best thermal management, use as many copper filled vias as physically possible. 0.3 mm diameter in a 9 x 9 array are shown here.
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Typical Performance Curves $V_{DD} = 10$ V, $I_{DSQ} = 500$ mA, $V_{G1} = -0.8$ V typical

**S-Parameters**

![S11, S21, S22 (dB) vs. Frequency (GHz)](chart1)

**Gain**

![S21 (dB) vs. Frequency (GHz)](chart2)

**Input Return Loss**

![S11 (dB) vs. Frequency (GHz)](chart3)

**Output Return Loss**

![S22 (dB) vs. Frequency (GHz)](chart4)

**Isolation**

![S12 (dB) vs. Frequency (GHz)](chart5)

**Gain over Voltage**

![Gain (dBm) vs. Frequency (GHz)](chart6)
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Typical Performance Curves $V_{DD} = 10 \text{ V}$, $I_{DSQ} = 500 \text{ mA}$, $V_{G1} = -0.8 \text{ V}$ typical

$P_{1dB}$ over Temperature

$P_{SAT}$ over Temperature

$P_{1dB}$ over Voltage

$P_{SAT}$ over Voltage

$P_{1dB}$ over Current

$P_{SAT}$ over Current
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Output IP3 vs. Frequency over Temperature
@Po=18dBm/tone

Output IP3 vs. Frequency over Drain Current
@Po=18dBm/tone

Output IP2 vs. Frequency @Po=18dBm/tone

2nd Harmonic level vs. Frequency over Output Power

Noise Figure vs. Frequency
Power Amplifier, 1 W
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Typical Performance Curves $V_{DD} = 10$ V, $I_{DSQ} = 500$ mA, $V_{G1} = -0.8$ V typical

Power Compression @ 2 GHz

Power Compression @ 12 GHz

Power Compression @ 22 GHz

Detector Voltage vs. Pout

Current

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Lead-Free 5 mm 32-lead AQFN Package†

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