Features
- Wide Frequency Range: 20 - 45 GHz
- High Gain: 24.5 dB @ 39 GHz
- P1dB: 23.5 dBm @ 39 GHz
- Output IP3: 30 dBm
- Integrated Power Detector
- Bare Die
- RoHS* Compliant

Applications
- ISM/MM

Description
The MAAM-011277-DIE is a 4-stage, 0.25 W power amplifier 2.5 x 1.15 mm MMIC die. This power amplifier operates from 20 to 45 GHz and provides 22 dB of linear gain, 0.25 W at P1dB compression, and 17% efficiency (P3) while biased at 5 V.

This device can be used as a driver amplifier ideally suited for various operational band in between 20 GHz and 45 GHz.

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>MAAM-011277-DIE</td>
<td>Bare Die</td>
</tr>
</tbody>
</table>

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

1. Backside of die must be connected to RF, DC and thermal ground.
Power Amplifier, 0.25 W
20 - 45 GHz

Electrical Specifications: Freq. = 20 - 45 GHz, \( T_A = +25^\circ C, V_D = 5 \text{ V}, I_{DSQ} = 0.3 \text{ A}, Z_0 = 50 \text{ \Omega} \)

<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} = -10 \text{ dBm} )</td>
<td>dB</td>
<td>21.0</td>
<td>24.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>20 GHz</td>
<td></td>
<td>18.5</td>
<td>20.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>30 GHz</td>
<td></td>
<td>21.5</td>
<td>24.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>39 GHz</td>
<td></td>
<td>—</td>
<td>18.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>45 GHz</td>
<td></td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Input Return loss</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>P1dB</td>
<td>20 GHz</td>
<td>dBm</td>
<td>21.5</td>
<td>23.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>30 GHz</td>
<td></td>
<td>21.0</td>
<td>22.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>39 GHz</td>
<td></td>
<td>22.5</td>
<td>23.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>45 GHz</td>
<td></td>
<td>—</td>
<td>22.0</td>
<td>—</td>
</tr>
<tr>
<td>P3dB</td>
<td>—</td>
<td>dBm</td>
<td>—</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>OIP3</td>
<td>( P_{OUT/Tone} = 18 \text{ dBm}, \Delta f = 10 \text{ MHz} )</td>
<td>dBm</td>
<td>—</td>
<td>30</td>
<td>—</td>
</tr>
<tr>
<td>Drain Voltage</td>
<td>—</td>
<td>V</td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Drain Current @ P1dB</td>
<td>—</td>
<td>mA</td>
<td>—</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Power Added Efficiency</td>
<td>P3dB</td>
<td>%</td>
<td>—</td>
<td>17</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</td>
<td>( P_{IN} \leq 3\text{ dB Compression} )</td>
</tr>
<tr>
<td>Junction Temperature(^{2,3})</td>
<td>(+160^\circ C)</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>(-40^\circ C \text{ to } +85^\circ C)</td>
</tr>
</tbody>
</table>

2. Operating at nominal conditions with junction temperature \(+160^\circ C\) will ensure MTTF \(>1 \times 10^6\) hours.
3. Junction Temperature \((T_J) = T_C + \Theta_{JC} \cdot (V_{DS} - I_{DSQ}) \cdot (P_{OUT} - P_{IN})\).
   Typical thermal resistance \((\Theta_{JC}) = 16.7 \text{ \degree C/W}\)
   a) For \( T_C = +25^\circ C \)
      \( T_J = 56.2^\circ C \) at 5 V, 443 mA, \( P_{OUT} = 25.4 \text{ dBm}, P_{IN} = 4 \text{ dBm} \)
   b) For \( T_C = +85^\circ C \)
      \( T_J = 117.1^\circ C \) at 5 V, 434 mA, \( P_{OUT} = 24.0 \text{ dBm}, P_{IN} = 8 \text{ dBm} \)

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 250 V 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 - C3</td>
<td>1 µF</td>
<td>0402</td>
</tr>
</tbody>
</table>

Sample Board Thru Loss

Refer to the plot on page 9 for sample board thru loss.

Sample Board Material Specifications

- Top Layer: 1/2 oz Copper Cladding, 0.0175 mm thickness
- Dielectric Layer: Rogers RO4003C 0.203 mm thickness
- Bottom Layer: 1/2 oz Copper Cladding, 0.0175 mm thickness
- Finished overall thickness: 0.238 mm
Power Amplifier, 0.25 W
20 - 45 GHz

Recommended Bonding Diagram and PCB Details:
For optimum performance, RF input and output transmission lines require open stubs on the application board for bonding wire inductance compensation. The physical length for the 1 mil diameter gold wire is approximately 350 µm each for the two wire connection.

Use copper filled and plated over vias for the thermal, DC and RF ground vias.

Biasing Conditions
Recommended biasing conditions are \(V_D = 5\) V, \(I_{DO} = 300\) mA (controlled with \(V_G\)). The drain bias voltage range is 4 to 6 V, and the quiescent drain current biasing range is 250 to 350 mA.

\(V_G\) pins 3 and 11 are internally connected; therefore, interconnection is not required. 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 \(V_{DN}\) and \(V_{DS}\) (north and south). North \(V_D\) supplies and south \(V_D\) supplies are not connected internally.

Operating the MAAM-011277-DIE

**Turn-on**
1. Apply \(V_G\) (-1.5 V).
2. Apply \(V_D\) (5.0 V typical).
3. Set \(I_{DO}\) by adjusting \(V_G\) more positive (typically -0.9 to -1.0 V for \(I_{DO} = 300\) 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.
Power Amplifier, 0.25 W
20 - 45 GHz

Typical Performance Curves: $V_D = 5\, \text{V}$, $I_{DSQ} = 300\, \text{mA}$

**Small Signal Gain vs. Frequency**

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

**Input Return Loss vs. Frequency**

![Input Return Loss vs. Frequency](image2)

**Output Return Loss vs. Frequency**

![Output Return Loss vs. Frequency](image3)
Power Amplifier, 0.25 W
20 - 45 GHz

Typical Performance Curves: \(V_D = 5\) V

**Small Signal Gain vs. Frequency**

**Input Return Loss vs. Frequency**

**Output Return Loss vs. Frequency**

For further information and support please visit:
https://www.macom.com/support
Power Amplifier, 0.25 W
20 - 45 GHz

Typical Performance Curves: \( V_D = 5 \text{ V}, I_{DSQ} = 300 \text{ mA} \)

- **P3dB vs. Frequency**
  - Graph showing P3dB vs. Frequency for different temperatures and supply voltages.

- **P1dB vs. Frequency**
  - Graph showing P1dB vs. Frequency for different temperatures and supply voltages.

- **Ids vs. Frequency @ P3dB**
  - Graph showingIds vs. Frequency for different temperatures.

- **Igs vs. Frequency @ P3dB**
  - Graph showing Igs vs. Frequency for different temperatures.
Power Amplifier, 0.25 W
20 - 45 GHz

Typical Performance Curves: \( V_D = 5 \text{ V}, I_{DSQ} = 300 \text{ mA} \)

**Output Power vs. Input Power**

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

**Drain Current vs. Input Power**

**PAE vs. Input Power**

**Detector Voltage vs. Output Power**

**Detector Voltage vs. Output Power @ 30 GHz**
Power Amplifier, 0.25 W
20 - 45 GHz

Typical Performance Curves: $V_D = 5 \text{ V}$, $I_{DSQ} = 300 \text{ mA}$

Output IP3 vs. Frequency @ $P_{out} = 18 \text{ dBm} / \text{Tone}$

Output IP3 vs. Frequency @ $P_{out} = 18 \text{ dBm} / \text{Tone}$

Sample Board Thru Losses
Includes Two 2.4 mm Connectors
Power Amplifier, 0.25 W
20 - 45 GHz

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Die Dimensions

Units are in micro meters with a tolerance of ±5 µm, except for die exterior dimensions which are street-center-to-street-center – nominal saw or laser kerf is ~25 µm each dimension. Pads and backside metal are gold. Die thickness is 100 ± 10 µm.

Pad Dimensions (µm)

<table>
<thead>
<tr>
<th>Pad #</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 7</td>
<td>68</td>
<td>228</td>
</tr>
<tr>
<td>2, 8</td>
<td>68</td>
<td>78</td>
</tr>
<tr>
<td>3, 10, 13</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>4, 5, 11, 12</td>
<td>75</td>
<td>85</td>
</tr>
<tr>
<td>6, 9</td>
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