Features

- Fully Integrated Power Amplifier
- Wide Bandwidth 10.0 - 15.35 GHz
- 27 dB Small Signal Gain
- 42 dBm Third Order Intercept Point (OIP3)
- 33.5 dBm Output P1dB
- Integrated Power Detector
- Bias 5 V, 2.2 A
- Lead-Free 7mm 48-lead QFN Package
- RoHS* Compliant

Description

The MAAP-010150 is a packaged linear power amplifier that operates over the range 10.0 - 15.35 GHz. The device typically provides 27 dB of gain and 42 dBm OIP3 with more than 33.5 dBm of Output P1dB.

This power amplifier is assembled in a lead free, fully molded 7 mm QFN package and consists of a 3 stage power amplifier with integrated, on-chip peak power detector and envelope detector. The device includes on-chip ESD protection structures to ease the implementation and volume assembly.

The device is well suited for use in the 10, 11, 13, 15 GHz cellular backhaul applications.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAP-010150</td>
<td>Bulk</td>
</tr>
<tr>
<td>MAAP-010150-TR0500</td>
<td>Tape and Reel</td>
</tr>
<tr>
<td>MAAP-010150-001SMB</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 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 - 5</td>
<td>NC</td>
<td>31</td>
<td>RF Output</td>
</tr>
<tr>
<td>6</td>
<td>RF Input</td>
<td>32</td>
<td>GND</td>
</tr>
<tr>
<td>7 - 16</td>
<td>NC</td>
<td>33, 34</td>
<td>NC</td>
</tr>
<tr>
<td>17</td>
<td>VG1</td>
<td>35</td>
<td>Pdet_Env2</td>
</tr>
<tr>
<td>18</td>
<td>VG2</td>
<td>36</td>
<td>Pdet_Peak2</td>
</tr>
<tr>
<td>19</td>
<td>VG3</td>
<td>37</td>
<td>NC</td>
</tr>
<tr>
<td>20 - 22</td>
<td>NC</td>
<td>38</td>
<td>VD3</td>
</tr>
<tr>
<td>23</td>
<td>VD3</td>
<td>39</td>
<td>NC</td>
</tr>
<tr>
<td>24, 25</td>
<td>NC</td>
<td>40</td>
<td>VD2</td>
</tr>
<tr>
<td>26</td>
<td>Pdet_Peak</td>
<td>41</td>
<td>NC</td>
</tr>
<tr>
<td>27</td>
<td>Pdet_Env</td>
<td>42</td>
<td>VD1</td>
</tr>
<tr>
<td>28, 29</td>
<td>NC</td>
<td>43 - 48</td>
<td>NC</td>
</tr>
<tr>
<td>30</td>
<td>GND</td>
<td>49</td>
<td>Paddle</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.

Power Amplifier
10.0 - 15.35 GHz

Electrical Specifications:
Freq. = 10.0 - 15.35 GHz, \( I_{DQ} = 2.2 \, A \), \( T_A = 25^\circ C \), \( V_D = 5 \, V \), \( Z_0 = 50 \, \Omega \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
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<tbody>
<tr>
<td>Gain</td>
<td>10.00 - 12.00 GHz</td>
<td>dB</td>
<td>26</td>
<td>28.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>12.00 - 13.50 GHz</td>
<td></td>
<td>26</td>
<td>27.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>13.50 - 15.35 GHz</td>
<td></td>
<td>26</td>
<td>27.5</td>
<td>—</td>
</tr>
<tr>
<td>P1dB, @ 1 dB Compression</td>
<td>10.00 - 12.00 GHz</td>
<td>dBm</td>
<td>—</td>
<td>33.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>12.00 - 13.50 GHz</td>
<td></td>
<td>—</td>
<td>33.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>13.50 - 15.35 GHz</td>
<td></td>
<td>—</td>
<td>34.0</td>
<td>—</td>
</tr>
<tr>
<td>( P_{SAT} )</td>
<td>10.00 - 12.00 GHz</td>
<td>dBm</td>
<td>33.5</td>
<td>36.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>12.00 - 13.50 GHz</td>
<td></td>
<td>33.5</td>
<td>36.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>13.50 - 15.35 GHz</td>
<td></td>
<td>33.5</td>
<td>36.0</td>
<td>—</td>
</tr>
<tr>
<td>OIP3</td>
<td>10.00 - 12.00 GHz</td>
<td>dBm</td>
<td>41</td>
<td>42</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>12.00 - 13.50 GHz</td>
<td></td>
<td>41</td>
<td>42</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>13.50 - 15.35 GHz</td>
<td></td>
<td>38.5</td>
<td>41</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>12</td>
<td>—</td>
</tr>
<tr>
<td>PAE, @ 1 dB Compression</td>
<td>—</td>
<td>%</td>
<td>—</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>—</td>
<td>mA</td>
<td>2000</td>
<td>2200</td>
<td>2400</td>
</tr>
</tbody>
</table>

**Absolute Maximum Ratings**

- Drain Voltage (\( V_D \), 1,2,3) (Under No RF Drive): 9 V
- Drain Voltage (\( V_D \), 1,2,3) (Under RF Drive): 5.5 V
- Gate Voltage (\( V_G \), 1,2,3): -3 V
- Storage Temperature: -65°C to +150°C
- Junction Temperature: +175°C

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Operating at nominal conditions with \( T_J \leq +150°C \) will ensure \( MTTF > 1 \times 10^6 \) hours.

**Maximum Operating Ratings**

- \( P_{Diss} \): 16.5 W
- Operating Temperature: -40°C to +85°C
- Junction Temperature: +150°C

8. Junction temperature directly affects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime. Thermal resistance, \( \Theta_{jc} \) is 5.45 °C/W.
9. For saturated performance, it is recommended that the sum of \( (2V_{DD} + \text{abs}(V_{GG})) < 12 \, V \).
Power Amplifier
10.0 - 15.35 GHz

PCB Layout

Parts List

<table>
<thead>
<tr>
<th>Part</th>
<th>Value</th>
<th>Case Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24</td>
<td>100 nF</td>
<td>0402</td>
</tr>
<tr>
<td></td>
<td>2.2 µF</td>
<td>0603</td>
</tr>
<tr>
<td>R1, R2, R3, R4</td>
<td>100 Ω</td>
<td>0402</td>
</tr>
<tr>
<td>R5, R6, R7, R8</td>
<td>5600 Ω</td>
<td>0402</td>
</tr>
<tr>
<td>R9, R10</td>
<td>10 KΩ</td>
<td>0402</td>
</tr>
</tbody>
</table>

Application Schematic
Biasing

All gates should be pinched-off, $V_G < -2$ V, before applying the drain voltage, $V_D = 5$ V (do not exceed maximum $V_{DG}$ value for RF drive condition). Then the gate voltages can be increased until the desired quiescent drain current is reached in each stage. The recommended quiescent bias is $V_D = 5$ V, $I_{D1} + I_{D2} + I_{D3} = 2200$ mA (total). The performance in this datasheet has been measured with a fixed gate voltage and no drain current regulation under large signal operation. It is also possible to regulate the drain current dynamically, to limit the DC power dissipation under RF drive. To turn off the device, the turn on bias sequence should be followed in reverse.

Detector Operation

MAAP-010150 includes dual power and envelope detectors. These are included on both sides of the device to ease integration onto larger radio boards. As per the application schematic, the power detector requires an external 5 V supply and the envelope detector requires -5 V. The output from the resistive voltage divider can be fed into a ADC or multimeter for the result.

Bias Arrangement

Each DC pin ($V_{D1}$, $V_{D2}$, $V_{D3}$ and $V_{G1}$, $V_{G2}$, $V_{G3}$) needs to have bypass capacitance of 100 nF mounted as close to the packaged device as possible.

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 CDM class C1, HBM Class 0A devices.
Power Amplifier
10.0 - 15.35 GHz
Rev. V2

Typical Performance Curves: $V_D = 5\, \text{V}$, $I_{DQ} = 2.2\, \text{A}$, $V_G = -1.05 \sim -0.85\, \text{V}$, $T_A = +25^\circ\text{C}$

- Broadband S-Parameters vs. Freq (GHz), $V_d = 5\, \text{V}$, $I_d = 2.2\, \text{A}$
- Gain (S21) vs. Freq (GHz), $V_d = 5\, \text{V}$, $I_d = 2.2\, \text{A}$
- Return Loss (S11/S22) vs. Freq (GHz), $V_d = 5\, \text{V}$, $I_d = 2.2\, \text{A}$
- P1dB/P3dB/Psat (dBm) vs. Freq (GHz), $V_d = 5\, \text{V}$, $I_d = 2.2\, \text{A}$
- Output IP3 (dBm) vs. SCL Output Pwr (dBm), $V_d = 5\, \text{V}$, $I_d = 2.2\, \text{A}$
- Output IP3 (dBm) vs. Freq (GHz), $V_d = 5\, \text{V}$, $I_d = 2.2\, \text{A}$

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Typical Performance Curves: $V_D = 5\,\text{V}$, $I_{DQ} = 2.2\,\text{A}$, $V_G = -1.05 \sim -0.85\,\text{V}$, $T_A = +25^\circ\text{C}$

- Output Power (dBm), Power Gain (dB) and Current (mA) vs. Input Power (dBm) @ 10.00GHz, $V_d = 5\,\text{V}$, $I_d = 2.2\,\text{A}$

- Power Gain (dB) and Power Added Efficiency (%) vs. Output Power (dBm) @ 10.00GHz, $V_d = 5\,\text{V}$, $I_d = 2.2\,\text{A}$

- Output Power (dBm), Power Gain (dB) and Current (mA) vs. Input Power (dBm) @ 10.30GHz, $V_d = 5\,\text{V}$, $I_d = 2.2\,\text{A}$

- Power Gain (dB) and Power Added Efficiency (%) vs. Output Power (dBm) @ 10.30GHz, $V_d = 5\,\text{V}$, $I_d = 2.2\,\text{A}$

- Output Power (dBm), Power Gain (dB) and Current (mA) vs. Input Power (dBm) @ 10.70GHz, $V_d = 5\,\text{V}$, $I_d = 2.2\,\text{A}$

- Power Gain (dB) and Power Added Efficiency (%) vs. Output Power (dBm) @ 10.70GHz, $V_d = 5\,\text{V}$, $I_d = 2.2\,\text{A}$
**Power Amplifier**

**10.0 - 15.35 GHz**

**Rev. V2**

**Typical Performance Curves:** $V_D = 5 \text{ V}$, $I_{DQ} = 2.2 \text{ A}$, $V_G = -1.05 \sim -0.85 \text{ V}$, $T_A = +25^\circ\text{C}$

![Graph 1: Output Power (dBm), Power Gain (dB) and Current (mA) vs. Input Power (dBm) at 11.70GHz, $V_d = 5\text{ V}, I_d = 2.2\text{ A}$](#)

![Graph 2: Power Gain (dB) and Power Added Efficiency (%) vs. Output Power (dBm) at 11.70GHz, $V_d = 5\text{ V}, I_d = 2.2\text{ A}$](#)

![Graph 3: Output Power (dBm), Power Gain (dB) and Current (mA) vs. Input Power (dBm) at 12.75GHz, $V_d = 5\text{ V}, I_d = 2.2\text{ A}$](#)

![Graph 4: Power Gain (dB) and Power Added Efficiency (%) vs. Output Power (dBm) at 12.75GHz, $V_d = 5\text{ V}, I_d = 2.2\text{ A}$](#)

![Graph 5: Output Power (dBm), Power Gain (dB) and Current (mA) vs. Input Power (dBm) at 13.25GHz, $V_d = 5\text{ V}, I_d = 2.2\text{ A}$](#)

![Graph 6: Power Gain (dB) and Power Added Efficiency (%) vs. Output Power (dBm) at 13.25GHz, $V_d = 5\text{ V}, I_d = 2.2\text{ A}$](#)

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DC-0009793
Typical Performance Curves: \( V_D = 5 \) V, \( I_{DQ} = 2.2 \) A, \( V_G = -1.05 \sim -0.85 \) V, \( T_A = +25^\circ C \)
Power Amplifier
10.0 - 15.35 GHz

Rev. V2

Typical Performance Curves: $V_D = 5\, \text{V}, \quad I_{DQ} = 2.2\, \text{A}, \quad V_G = -1.05 \sim -0.85\, \text{V}, \quad T_A = +25^\circ\text{C}$

- **Output IMD3 (dBc) vs. SCL Output Pwr (dBm)**
  
  - $V_D = 5\, \text{V}, \quad I_{DQ} = 2.2\, \text{A}$

- **Peak Detected Voltage (V) vs. Output Power (dBm)**
  
  - $V_D = 5\, \text{V}, \quad I_{DQ} = 2.2\, \text{A}$

- **Env Detected Voltage (V) vs. Output Power (dBm)**
  
  - $V_D = 5\, \text{V}, \quad I_{DQ} = 2.2\, \text{A}$
Typical Performance Curves: $V_D = 5\, V$, $I_{DQ} = 2.2\, A$, $V_G = -1.05 \sim -0.85\, V$, $T_A = -40^\circ C \sim +85^\circ C$
Typical Performance Curves: \( V_D = 5 \text{ V}, \ I_{DQ} = \text{Various}, \ V_G = -0.85 \sim -1.65 \text{ V}, \ T_A = +25^\circ\text{C} \)

- **Gain (S21) vs. Freq (GHz), Various Bias Points**
- **Input Return Loss (S11) vs. Freq (GHz), Various Bias Points**
- **Output Return Loss (S22) vs. Freq (GHz), Various Bias Points**
- **Gain (dB) vs. Drain Current (mA), \( V_d = 5 \text{ V}, \ I_d = \text{Various} \)**
- **Output IP3 (dBm) vs. Drain Current (mA), \( V_d = 5 \text{ V}, \ I_d = \text{Various} \)**
- **Output IP3 (dBm) vs. Gain (dB), \( V_d = 5 \text{ V}, \ I_d = \text{Various} \)**
Lead-Free 7 mm 48-Lead PQFN†

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