MAAL-010200

Miniature Broadband Gain Stage
70 - 3000 MHz

Features
- Low Noise Figure
- High IP₃
- Single Supply +3 V, +5 V
- RoHS* Compliant SOT-89 Package

Description
M/A-COM Technology’s MAAL-010200 broadband gain stage is a GaAs MMIC amplifier in a lead-free SOT-89 surface mount plastic package. The MAAL-010200 employs a monolithic 1-stage self-biased design featuring a convenient 50 Ω input/output impedance that minimizes the number of external components required. Its broadband design provides usable performance from 500 to 3000 MHz. For operation below 500 MHz contact M/A-COM Technology’s application group for support.

Ordering Information ¹,²

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAL-010200 -TR3000</td>
<td>3000 piece reel</td>
</tr>
<tr>
<td>MAAL-010200-001SMB</td>
<td>Sample Test Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

Functional Block Diagram

Pin Configuration

<table>
<thead>
<tr>
<th>Pin</th>
<th>Pin Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RF In</td>
<td>RF Input</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>RF Out/V_DD</td>
<td>RF Output &amp; Voltage Bias</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings ³,⁴,⁵

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain Compression</td>
<td>6 dB</td>
</tr>
<tr>
<td>Voltage</td>
<td>5.5 volts</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40 °C to +85 °C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65 °C to +150 °C</td>
</tr>
</tbody>
</table>

3. Exceeding any one or combination of these limits may cause permanent damage to this device.
4. M/A-COM Technology does not recommend sustained operation near these survivability limits.
5. Operating at 5 volts with no drain resistor will require the RF output power to be no greater than 10 dBm.

Miniature Broadband Gain Stage
70 - 3000 MHz

Electrical Specifications: Freq. = 500 - 3000 MHz, $T_A = 25^\circ$C, $Z_0 = 50 \ \Omega$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>3 Volts</th>
<th>5 Volts</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>$F = 0.9 \ \text{GHz}$</td>
<td>dB</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$F = 1.9 \ \text{GHz}$</td>
<td></td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise Figure</td>
<td>$F = 0.9 \ \text{GHz}$</td>
<td>dB</td>
<td></td>
<td>1.3</td>
<td>1.4</td>
<td>1.4</td>
<td>1.45</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>$F = 1.9 \ \text{GHz}$</td>
<td></td>
<td></td>
<td>1.4</td>
<td>2</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>$F = 3.0 \ \text{GHz}$</td>
<td></td>
<td></td>
<td>1.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>$F = 0.9 \ \text{GHz}$</td>
<td>dB</td>
<td>7.5</td>
<td></td>
<td></td>
<td>7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$F = 1.9 \ \text{GHz}$</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$F = 3.0 \ \text{GHz}$</td>
<td></td>
<td>14</td>
<td></td>
<td></td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>$F = 0.9 \ \text{GHz}$</td>
<td>dB</td>
<td>19.5</td>
<td></td>
<td></td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$F = 1.9 \ \text{GHz}$</td>
<td></td>
<td>22</td>
<td></td>
<td></td>
<td>21.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$F = 3.0 \ \text{GHz}$</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output P1dB</td>
<td>500 – 3000 MHz</td>
<td>dBm</td>
<td>17.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output IP3</td>
<td>500 – 3000 MHz</td>
<td>dBm</td>
<td>36</td>
<td></td>
<td></td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>—</td>
<td>mA</td>
<td>50</td>
<td></td>
<td></td>
<td>77</td>
<td>100</td>
<td>90</td>
</tr>
</tbody>
</table>

Baseline Application Schematic @ 3V, 5V

Component List @ 3V, 5V

<table>
<thead>
<tr>
<th>Part</th>
<th>Value</th>
<th>Case Style</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1,C2</td>
<td>39 pF</td>
<td>0402</td>
<td>DC Block</td>
</tr>
<tr>
<td>C3</td>
<td>0.1 µF</td>
<td>0402</td>
<td>RF Bypass</td>
</tr>
<tr>
<td>L1</td>
<td>12 nH</td>
<td>0402</td>
<td>RF Choke/Tuning</td>
</tr>
</tbody>
</table>

Handling Procedures

The following precautions should be observed to avoid damage:

Static Sensitivity

Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.
Typical Performance Curves: \( V_{DD} = 3 \) V

**Gain**

- Frequency (GHz) vs. \( S_{21} \) (dB)

**Input Return Loss**

- Frequency (GHz) vs. \( S_{11} \) (dB)

**Output Return Loss**

- Frequency (GHz) vs. \( S_{22} \) (dB)

**Noise Figure**

- Frequency (GHz) vs. Noise Figure (dB)
Typical Performance Curves: $V_{DD} = 3\, V$

**Output IP3, Input Power @ -12 dBm**

![Graph showing Output IP3 vs. Frequency for different temperatures.](image)

**$P_{1dB}$**

![Graph showing $P_{1dB}$ vs. Frequency for different temperatures.](image)

**Current**

![Graph showing Drain Current vs. Output Power for different temperatures.](image)
Typical Performance Curves: \( V_{DD} = 5 \text{ V} \)

**Gain**

\[
\begin{align*}
\text{S21 (dB)} & \quad 20 & \quad 15 & \quad 10 & \quad 5 & \quad 0 & \quad -5 & \quad -10 & \quad -15 & \quad -20 \\
\text{Frequency (GHz)} & \quad 0.5 & \quad 1.0 & \quad 1.5 & \quad 2.0 & \quad 2.5 & \quad 3.0
\end{align*}
\]

**Input Return Loss**

\[
\begin{align*}
\text{S11 (dB)} & \quad 0 & \quad -5 & \quad -10 & \quad -15 & \quad -20 & \quad -25 & \quad -30 \\
\text{Frequency (GHz)} & \quad 0.5 & \quad 1.0 & \quad 1.5 & \quad 2.0 & \quad 2.5 & \quad 3.0
\end{align*}
\]

**Output Return Loss**

\[
\begin{align*}
\text{S22 (dB)} & \quad 0 & \quad -5 & \quad -10 & \quad -15 & \quad -20 & \quad -25 & \quad -30 \\
\text{Frequency (GHz)} & \quad 0.5 & \quad 1.0 & \quad 1.5 & \quad 2.0 & \quad 2.5 & \quad 3.0
\end{align*}
\]

**Noise Figure**

\[
\begin{align*}
\text{Noise Figure (dB)} & \quad 0 & \quad 0.5 & \quad 1.0 & \quad 1.5 & \quad 2.0 & \quad 2.5 & \quad 3.0 \\
\text{Frequency (GHz)} & \quad 0.5 & \quad 1.0 & \quad 1.5 & \quad 2.0 & \quad 2.5 & \quad 3.0
\end{align*}
\]

**Output IP3, Input Power = -12 dBm**

\[
\begin{align*}
\text{OIP3 (dBm)} & \quad 25 & \quad 30 & \quad 35 & \quad 40 & \quad 45 \\
\text{Frequency (GHz)} & \quad 0.5 & \quad 1.0 & \quad 1.5 & \quad 2.0 & \quad 2.5 & \quad 3.0
\end{align*}
\]

**Current**

\[
\begin{align*}
\text{Drain Current (mA)} & \quad 80 & \quad 85 & \quad 90 & \quad 95 & \quad 100 & \quad 105 & \quad 110 & \quad 115 & \quad 120 \\
\text{Output Power (dBm)} & \quad 0 & \quad 2 & \quad 4 & \quad 6 & \quad 8 & \quad 10 & \quad 12 & \quad 14
\end{align*}
\]

6. This device can run from a single 5 volt supply, but for 1M hour MTTF the output power must be no greater than 10 dBm unless using a series resistor on the drain. See Application note 7 on page 7.
Lead-Free SOT-89†

† Reference Application Note M538 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is 100% matte tin over copper.
5 Volt Application Section for operation above 10 dBm output power

7. The addition of a 27 Ω series resistor on the drain line allows for 5 volt operation above 10 dBm output power, but no greater than 22 dBm of output power.

Component List @ 5V

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<thead>
<tr>
<th>Part</th>
<th>Value</th>
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<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>39 pF</td>
<td>0402</td>
<td>Input DC Block</td>
</tr>
<tr>
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<td>39 pF</td>
<td>0402</td>
<td>Output DC Block</td>
</tr>
<tr>
<td>C3</td>
<td>0.1 µF</td>
<td>0402</td>
<td>RF Bypass</td>
</tr>
<tr>
<td>L1</td>
<td>12 nH</td>
<td>0805</td>
<td>RF Choke/Tuning</td>
</tr>
<tr>
<td>R1</td>
<td>27 Ω</td>
<td>0402</td>
<td>Voltage Drop</td>
</tr>
</tbody>
</table>
5 Volt Application Section for operation above 10 dBm output power

Typical Performance Curves: $V_{DD} = 5\, V$

**Gain**

**Input Return Loss**

**Output Return Loss**

**Noise Figure**
5 Volt Application Section for operation above 10 dBm output power

Typical Performance Curves: $V_{DD} = 5$ V

**Output IP3, Input Power @ -12 dBm**

![Graph](image1)

**P1dB**

![Graph](image2)

**Current**

![Graph](image3)

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