Features
- Low Noise Figure
- High $I_{P3}$
- Single Supply $+3\,\text{V}, +5\,\text{V}$
- RoHS* Compliant SC70-6LD Package

Description
M/A-COM Technology’s MAAL-009120 broadband gain stage is a GaAs MMIC amplifier in a lead-free SC70-6LD (SOT-363) surface mount plastic package. The MAAL-009120 employs a monolithic 1-stage self-biased design featuring a convenient $50\,\Omega$ 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 Tech’s application group for support.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAL-009120 -TR1000</td>
<td>1000 piece reel</td>
</tr>
<tr>
<td>MAAL-009120 -TR3000</td>
<td>3000 piece reel</td>
</tr>
<tr>
<td>MAAL-009120 -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.

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain Compression</td>
<td>$6,\text{dB}$</td>
</tr>
<tr>
<td>Voltage</td>
<td>$5.5,\text{V}$</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>$-40,\degree\text{C}$ to $+85,\degree\text{C}$</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>$-65,\degree\text{C}$ to $+150,\degree\text{C}$</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 $10\,\text{dBm}$.

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>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>( F = 0.9 , \text{GHz} )</td>
<td>dB</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>( F = 1.9 , \text{GHz} )</td>
<td></td>
<td>10.4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>( F = 3.0 , \text{GHz} )</td>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Noise Figure</td>
<td>( F = 0.9 , \text{GHz} )</td>
<td>dB</td>
<td></td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>( F = 1.9 , \text{GHz} )</td>
<td></td>
<td>1.4</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>( F = 3.0 , \text{GHz} )</td>
<td></td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>( F = 0.9 , \text{GHz} )</td>
<td>dB</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>( F = 1.9 , \text{GHz} )</td>
<td></td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( F = 3.0 , \text{GHz} )</td>
<td></td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>( F = 0.9 , \text{GHz} )</td>
<td>dB</td>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>( F = 1.9 , \text{GHz} )</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( F = 3.0 , \text{GHz} )</td>
<td></td>
<td>15.5</td>
<td></td>
</tr>
<tr>
<td>Output P1dB</td>
<td>500 – 3000 MHz</td>
<td>dBm</td>
<td></td>
<td>18.5</td>
</tr>
<tr>
<td>Output IP3</td>
<td>500 – 3000 MHz</td>
<td>dBm</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>Current</td>
<td></td>
<td>mA</td>
<td></td>
<td>60</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</td>
<td>39 pF</td>
<td>0402</td>
<td>Input DC Block</td>
</tr>
<tr>
<td>C2</td>
<td>39 pF</td>
<td>0402</td>
<td>Output DC Block</td>
</tr>
<tr>
<td>C3</td>
<td>470 pF</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>
</tbody>
</table>

Recommended PCB Configuration @ 3V, 5V

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.
Miniature Broadband Gain Stage
70 - 3000 MHz

Typical Performance Curves: $V_{DD} = 3 \text{ V}$

**Gain**

![Gain Graph]

**Input Return Loss**

![Input Return Loss Graph]

**Output Return Loss**

![Output Return Loss Graph]

**Noise Figure**

![Noise Figure Graph]
Typical Performance Curves: \( V_{DD} = 3 \, \text{V} \)

- **Output IP3, Input Power @ -12 dBm**
- **Current**
- **P1dB**

Figure showing performance curves for various temperatures and frequency ranges.
Typical Performance Curves: \( V_{DD} = 5 \) V

**Gain**

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

**Input Return Loss**

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

**Output Return Loss**

\[
\begin{align*}
\begin{array}{c}
\text{Frequency (GHz)} \\
0.5 & 1.0 & 1.5 & 2.0 & 2.5 & 3.0 \\
\text{S22 (dB)} \\
-10 & -15 & -20
\end{array}
\end{align*}
\]

**Noise Figure**

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

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

\[
\begin{align*}
\begin{array}{c}
\text{Frequency (GHz)} \\
0.5 & 1.0 & 1.5 & 2.0 & 2.5 & 3.0 \\
\text{OIP3 (dBm)} \\
25 & 30 & 35 & 40 & 45 & 50
\end{array}
\end{align*}
\]

**Current**

\[
\begin{align*}
\begin{array}{c}
\text{Output Power (dBm)} \\
0 & 2 & 4 & 6 & 8 & 10 & 12 & 14 \\
\text{Drain Current (mA)} \\
85 & 90 & 95 & 100 & 105 & 110 & 115 & 120 & 125 & 130
\end{array}
\end{align*}
\]

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 SC70-6LD (SOT-363)†

† 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

6. The addition of a 24.9 \( \Omega \) 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**

<table>
<thead>
<tr>
<th>Part</th>
<th>Value</th>
<th>Case Style</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>39 pF</td>
<td>0402</td>
<td>Input DC Block</td>
</tr>
<tr>
<td>C2</td>
<td>39 pF</td>
<td>0402</td>
<td>Output DC Block</td>
</tr>
<tr>
<td>C3</td>
<td>470 pF</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>24.9 ( \Omega )</td>
<td>0402</td>
<td>Voltage Drop</td>
</tr>
</tbody>
</table>
Miniature Broadband Gain Stage
70 - 3000 MHz

5 Volt Application Section for operation above 10 dBm output power

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

![Gain](image1)

![Input Return Loss](image2)

![Output Return Loss](image3)

![Noise Figure](image4)
5 Volt Application Section for operation above 10 dBm output power

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

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

**P1dB**

**Current**

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### MINIATURE BROADBAND GAIN STAGE

**70 - 3000 MHz**

**Rev. V1**

**MAAL-009120**

**3 Volt Application Section @ 70 MHz**

**Application Layout Schematic @ 3V**

**Typical Performance Curves: V_{DD} = 3 V**

**S-Parameter Response @ 3 Volts**

**Component List @ 3V**

<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>L1</td>
<td>80 nH</td>
<td>0805</td>
</tr>
<tr>
<td>L2</td>
<td>220 nH</td>
<td>0603</td>
</tr>
<tr>
<td>R1</td>
<td>3 Ω</td>
<td>0402</td>
</tr>
</tbody>
</table>

**Noise Figure**

**P1dB**

**Gain (dB)**

**Frequency (GHz)**

**Output Power (dBm)**

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