CATV Return Path Amplifier
5 - 300 MHz

Features
- 21 dB Adjustable Gain
- 2.25 dB Noise Figure
- +5 V, 95 mA Adjustable Bias
- Low Distortion
- Wide Bandwidth for DOCSIS 3.1
- Lead-Free MSOP8-EP Package
- RoHS* Compliant and 260°C Reflow Compatible

Description
The MAAM-011184 is a 75 Ω single ended GaAs MMIC amplifier assembled in a lead-free MSOP8-EP package. This device provides high gain, low noise, and excellent linearity from 5 - 300 MHz.

This amplifier is ideally suited for use in CATV return path applications, including DOCSIS 3.1 systems: it typically provides 2.25 dB noise figure, 64 dBm OIP2 and 43 dBm OIP3 while drawing 95 mA DC current at 5 V bias.

Functional Schematic

Pin Configuration

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BIAS1</td>
<td>VCC Bias</td>
</tr>
<tr>
<td>2</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>3</td>
<td>RF_IN</td>
<td>RF Input</td>
</tr>
<tr>
<td>4</td>
<td>FB</td>
<td>Feedback</td>
</tr>
<tr>
<td>5</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>6</td>
<td>RF_OUT</td>
<td>RF Output (DC Bias)</td>
</tr>
<tr>
<td>7</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>8</td>
<td>BIAS2</td>
<td>Active Bias</td>
</tr>
<tr>
<td>9</td>
<td>Pad3</td>
<td>RF and DC Ground</td>
</tr>
</tbody>
</table>

1. All sample boards include 5 loose parts.
2. All pins listed as ‘No Connection’ should be grounded.
3. The exposed pad centered on the package bottom must be connected to RF and DC ground.

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5 - 300 MHz

Electrical Specifications\(^4\): \(T_A = 25^\circ C, V_{CC} = 5\) V, \(Z_0 = 75\) Ω

<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} = -21) dBm, 5 - 300 MHz (P_{IN} = -21) dBm, 205 MHz</td>
<td>dB</td>
<td>—</td>
<td>21</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>(P_{IN} = -21) dBm, 5 - 300 MHz</td>
<td>dB</td>
<td>—</td>
<td>26</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>(P_{IN} = -21) dBm, 5 - 300 MHz</td>
<td>dB</td>
<td>—</td>
<td>23</td>
<td>—</td>
</tr>
<tr>
<td>Reverse Isolation</td>
<td>(P_{IN} = -21) dBm, 5 - 300 MHz</td>
<td>dB</td>
<td>—</td>
<td>23</td>
<td>—</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>5 - 205 MHz (205 - 300) MHz</td>
<td>dB</td>
<td>—</td>
<td>2.25</td>
<td>2.5</td>
</tr>
<tr>
<td>P1dB</td>
<td>(5 - 300) MHz</td>
<td>dBm</td>
<td>—</td>
<td>21.7</td>
<td>—</td>
</tr>
<tr>
<td>OIP3(^5)</td>
<td>(P_{IN} = -21) dBm per tone, 3 MHz spacing, (f_1 = 5 - 205) MHz (P_{IN} = -21) dBm per tone, 3 MHz spacing, (f_1 = 205) MHz</td>
<td>dBm</td>
<td>—</td>
<td>43</td>
<td>—</td>
</tr>
<tr>
<td>OIP2(^5)</td>
<td>(P_{IN} = -21) dBm per tone, 3 MHz spacing, (f_1 = 5 - 205) MHz</td>
<td>dBm</td>
<td>—</td>
<td>41</td>
<td>—</td>
</tr>
<tr>
<td>Output Power</td>
<td>16 Channels, 5 - 205 MHz</td>
<td>dBm/Channel</td>
<td>—</td>
<td>51</td>
<td>—</td>
</tr>
<tr>
<td>at 30 dB MER(^6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICC(^7)</td>
<td>(V_{CC} = 5) V</td>
<td>mA</td>
<td>—</td>
<td>95</td>
<td>115</td>
</tr>
</tbody>
</table>

4. Data corresponds to the typical application circuit shown on page 3 of this datasheet. See pages 4 and 5 for typical performance using this application circuit.
5. \(f_1\) is the frequency of the lower of the two input tones. Higher tone \(f_2 = f_1 + 3\) MHz. OIP2 is measured at intermodulation frequency \(f_1 + f_2\).
6. Modulation Error Ratio, 64 QAM 5.12 MS/s.
7. ICC is the total DC current draw from the \(V_{CC}\) supply. As shown on page 3 of this datasheet, it is distributed to device pins 1, 6, and 8.

Absolute Maximum Ratings\(^8,9\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>11 dBm</td>
</tr>
<tr>
<td>(V_{CC})</td>
<td>6 V</td>
</tr>
<tr>
<td>Junction Temperature(^10,11)</td>
<td>(+150^\circ C)</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>(-40^\circ C to +85^\circ C)</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>(-65^\circ C to +125^\circ C)</td>
</tr>
</tbody>
</table>

8. Exceeding any one or a combination of these limits may cause permanent damage to this device.
9. MACOM does not recommend sustained operation near these survivability limits.
10. Operating at nominal conditions with \(T_J \leq 150^\circ C\) will ensure \(MTTF > 1 \times 10^6\) hours.
11. Junction Temperature (\(T_J\)) = \(T_C + \Theta_{jc} \times (V \times I)\) 
    Typical thermal resistance (\(\Theta_{jc}\)) = 44° C/W.
    a) For \(T_C = +25^\circ C\), 
       \(T_J = 46^\circ C @ 5\) V, 95 mA
    b) For \(T_C = +85^\circ C\), 
       \(T_J = 106^\circ C @ 5\) V, 95 mA

Handling Procedures
Please observe the following precautions 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.

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Typical Application Circuit: Schematic

Typical Application Circuit: Component Values

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 - C6</td>
<td>100 nF</td>
</tr>
<tr>
<td>C7</td>
<td>0.5 pF</td>
</tr>
<tr>
<td>R1</td>
<td>330 Ω</td>
</tr>
<tr>
<td>R2</td>
<td>SHORT - 0 Ω</td>
</tr>
<tr>
<td>L1</td>
<td>22 µH</td>
</tr>
<tr>
<td>L2</td>
<td>27 nH</td>
</tr>
<tr>
<td>L3</td>
<td>10 nH</td>
</tr>
</tbody>
</table>

12. Designers may decrease resistor R1 to reduce the gain of the amplifier by approximately 1 dB per 164 Ohms. Below 19.8 dB gain, typical input and output return losses fall below 20 dB. Resistor R2 may be increased in order to reduce bias current $I_{CC}$ (at the cost of large-signal performance) by approximately 1 mA per 42 Ohms.

13. Low-ESR inductor LQH2MCN220K02 from Murata.

Typical Application Circuit: Sample Board Layout
Typical Performance Curves: Small-Signal

**Gain**

- **S21 (dB)**
  - Frequency (MHz)
  - S21 (dB) values for different temperatures:
    - +25°C
    - -40°C
    - +85°C

**Reverse Isolation**

- **S12 (dB)**
  - Frequency (MHz)
  - S12 (dB) values for different temperatures:
    - +25°C
    - -40°C
    - +85°C

**Input Return Loss**

- **S11 (dB)**
  - Frequency (MHz)
  - S11 (dB) values for different temperatures:
    - +25°C
    - -40°C
    - +85°C

**Output Return Loss**

- **S22 (dB)**
  - Frequency (MHz)
  - S22 (dB) values for different temperatures:
    - +25°C
    - -40°C
    - +85°C

**Noise Figure**

- **NF (dB)**
  - Frequency (MHz)
  - NF (dB) values for different temperatures:
    - +25°C
    - -40°C
    - +85°C
Typical Performance Curves: Large-Signal

**P1dB**

![P1dB Graph]

**OIP2**

![OIP2 Graph]

**OIP3**

![OIP3 Graph]

**MER, 16 Channels 64-QAM**

![MER Graph]
MAAM-011184

CATV Return Path Amplifier
5 - 300 MHz

Rev. V2

Lead-Free MSOP8-EP Package†

†Dimensions shown as inches over millimeters [in/mm].
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is 100% matte tin over copper.