MAAM-011240

75 Ω, Differential RF Amplifier
5 - 1218 MHz

Features
- Single Stage, Differential Amplifier
- 5 V, 290 mA Operation
- 17 dB Flat Gain
- Low Noise
- Low Distortion Performance
- ESD Class 1B for HBM
- Lead-Free SOIC-8EP Plastic Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant

Description
The MAAM-011240 is high gain, high linearity and low noise differential RF amplifier assembled in a SOIC-8EP plastic package. This amplifier provides 17 dB of flat gain with very low noise figure. The differential push-pull topology provides superior 2nd order intermodulation performance.

The MAAM-011240 provides high gain, low noise and low distortion making it ideally suited for 75 Ω infrastructure applications.

The MAAM-011240 is fabricated using GaAs pHEMT technology.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAM-011240</td>
<td>Bulk Packaging</td>
</tr>
<tr>
<td>MAAM-011240-TR1000</td>
<td>1000 Part Reel</td>
</tr>
<tr>
<td>MAAM-011240-TR3000</td>
<td>3000 Part Reel</td>
</tr>
<tr>
<td>MAAM-011240-001SMB</td>
<td>Sample Board, 45 - 1218 MHz</td>
</tr>
<tr>
<td>MAAM-011240-002SMB</td>
<td>Sample Board, 5 - 300 MHz</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>Pin Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RF IN+</td>
<td>RF Input +</td>
</tr>
<tr>
<td>2</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>3</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>4</td>
<td>RF IN-</td>
<td>RF Input -</td>
</tr>
<tr>
<td>5</td>
<td>RF OUT+</td>
<td>RF Output + / V DD</td>
</tr>
<tr>
<td>6</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>7</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>8</td>
<td>RF OUT-</td>
<td>RF Output - / V DD</td>
</tr>
<tr>
<td>9</td>
<td>Pad3</td>
<td>RF and DC Ground</td>
</tr>
</tbody>
</table>

3. The exposed pad centered on package bottom must be connected to RF and DC ground.

75 Ω, Differential RF Amplifier
5 - 1218 MHz

Electrical Specifications:  \( T_A = 25°C, V_{DD} = 5 \text{ V}, Z_0 = 75 \text{ Ω} \)
Performance specified with input/output balun MABA-009210-CT1760

<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>1218 MHz</td>
<td>dB</td>
<td>16.2</td>
<td>17</td>
<td>18.5</td>
</tr>
<tr>
<td>Tilt</td>
<td>45 - 1218 MHz</td>
<td>dB</td>
<td>—</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>Reverse Isolation</td>
<td>45 - 1218 MHz</td>
<td>dB</td>
<td>—</td>
<td>21</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>45 - 1218 MHz</td>
<td>dB</td>
<td>—</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>45 - 1218 MHz</td>
<td>dB</td>
<td>—</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>45 MHz</td>
<td>dB</td>
<td>—</td>
<td>1.7</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1218 MHz</td>
<td></td>
<td></td>
<td>2.6</td>
<td>—</td>
</tr>
<tr>
<td>Output IP2</td>
<td>45 - 1218 MHz, tone spacing 6 MHz, ( P_{OUT} ) per tone = +13 dBm</td>
<td>dBm</td>
<td>—</td>
<td>63</td>
<td>—</td>
</tr>
<tr>
<td>Output IP3</td>
<td>45 - 1218 MHz, tone spacing 6 MHz, ( P_{OUT} ) per tone = +13 dBm</td>
<td>dBm</td>
<td>—</td>
<td>44</td>
<td>—</td>
</tr>
<tr>
<td>P1dB</td>
<td>45 - 1218 MHz</td>
<td>dBm</td>
<td>—</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>Composite Triple Beat, CTB</td>
<td>79 channels, 0 dB Tilt, 39 dBmV per channel output, QAM to 1000 MHz</td>
<td>dBc</td>
<td>—</td>
<td>-75</td>
<td>—</td>
</tr>
<tr>
<td>Composite Second Order, CSO</td>
<td>79 channels, 0 dB Tilt, 39 dBmV per channel output, QAM to 1000 MHz</td>
<td>dBc</td>
<td>—</td>
<td>-77</td>
<td>—</td>
</tr>
<tr>
<td>ACPR(^4)</td>
<td>62 dBmV output, Single Channel: 79 MHz 1218 MHz</td>
<td>dBc</td>
<td>—</td>
<td>-70</td>
<td>-64</td>
</tr>
<tr>
<td>( I_{DD} )</td>
<td>( V_{DD} = 5 \text{ V} )</td>
<td>mA</td>
<td>—</td>
<td>290</td>
<td>350</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Input Power</td>
<td>10 dBm</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>8 V</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>
<tr>
<td>Junction Temperature(^6)</td>
<td>+150°C</td>
</tr>
</tbody>
</table>

4. Adjacent Channel (750 kHz from channel block edge to 6 MHz from channel block edge), 256 QAM, 5.36 Msym/sec.

Absolute Maximum Ratings\(^5,6,7\)

Handling Procedures
Please observe the following precautions to avoid damage:

Static Sensitivity
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 (HBM) Class 1B devices.

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 \( T_J < 150°C \) will ensure \( \text{MTTF} > 1 \times 10^8 \text{ hours} \).
8. Junction Temperature (\( T_J \)) = Case Temperature (\( T_C \)) + \( \Theta_{JC}(V^*) \)
   Typical thermal resistance (\( \Theta_{JC} \)) = 29°C/W.
   a) For \( T_C = 25°C \),
      \( T_J = 67°C @ 5 \text{ V}, 290 \text{ mA} \)
   b) For \( T_C = 85°C \),
      \( T_J = 127°C @ 5 \text{ V}, 290 \text{ mA} \)
75 Ω, Differential RF Amplifier
5 - 1218 MHz

Recommended PCB Layout

Schematic Including Off-Chip Components

Parts List

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Package</th>
<th>Component</th>
<th>Value</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C4</td>
<td>270 pF</td>
<td>0402</td>
<td>L1, L2</td>
<td>33 nH</td>
<td>0402</td>
</tr>
<tr>
<td>C2, C3, C5, C6, C10</td>
<td>10 nF</td>
<td>0402</td>
<td>R1, R2</td>
<td>62 Ω</td>
<td>0402</td>
</tr>
<tr>
<td>C7</td>
<td>0.5 pF</td>
<td>0402</td>
<td>R3, R4</td>
<td>316 Ω</td>
<td>0402</td>
</tr>
<tr>
<td>C8</td>
<td>1.0 pF</td>
<td>0402</td>
<td>T1, T2</td>
<td>1:1 Balun</td>
<td>—</td>
</tr>
<tr>
<td>C9</td>
<td>Do Not Install</td>
<td>0402</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. MABA-009210-CT1760
Typical Performance Curves: $V_{DD} = 5\, V$

**Gain**

Gain vs. Frequency (GHz) graph showing $S21$ (dB) at various temperatures:
- +25°C
- -40°C
- +85°C

**Gain to 3 GHz**

Gain vs. Frequency (GHz) graph showing $S21$ (dB) at various temperatures:
- +25°C
- -40°C
- +85°C

**Input Return Loss**

Input Return Loss vs. Frequency (GHz) graph showing $S11$ (dB) at various temperatures:
- +25°C
- -40°C
- +85°C

**Output Return Loss**

Output Return Loss vs. Frequency (GHz) graph showing $S22$ (dB) at various temperatures:
- +25°C
- -40°C
- +85°C

**Reverse Isolation**

Reverse Isolation vs. Frequency (GHz) graph showing $S12$ (dB) at various temperatures:
- +25°C
- -40°C
- +85°C

**Noise Figure**

Noise Figure vs. Frequency (GHz) graph showing Noise Figure (dB) at various temperatures:
- +25°C
- -40°C
- +85°C
75 Ω, Differential RF Amplifier
5 - 1218 MHz

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

**OIP3, $P_{OUT} = +13$ dBm/tone**

**OIP2, $P_{OUT} = +13$ dBm/tone**

**P1dB**

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DC-0011769
Typical Performance Curves: $V_{DD} = 5$ V

**CSO Lower, 79 channels + QAM to 1 GHz, 0 dB tilt, 39 dBmV per channel**

**CSO Upper, 79 channels + QAM to 1 GHz, 0 dB tilt, 39 dBmV per channel**

**CTB, 79 channels + QAM to 1 GHz, 0 dB tilt, 39 dBmV per channel**
Typical Performance Curves: \( V_{DD} = 5 \text{ V}, \) Temp = +25°C

**ACPR vs. \( P_{OUT} \), Single Channel**

![ACPR vs. \( P_{OUT} \), Single Channel graph](attachment:acpr_vs_pout_single_channel.png)

**ACPR vs. \( P_{OUT} \), 4 Channels**

![ACPR vs. \( P_{OUT} \), 4 Channels graph](attachment:acpr_vs_pout_4_channels.png)

**ACPR vs. Frequency, \( P_{OUT} = +62 \text{ dBmV} \), Single Channel**

![ACPR vs. Frequency, \( P_{OUT} = +62 \text{ dBmV} \), Single Channel graph](attachment:acpr_vs_frequency_single_channel.png)
75 Ω, Differential RF Amplifier
5 - 1218 MHz

SOIC-8EP†

† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is 100% matte tin over copper.

Recommended PCB Land Pattern

70 ground vias
0.008 inch finished hole diameter
Applications Section: 5 - 300 MHz Application

The MAAM-011240 may be tuned for operation in the 5 - 300 MHz band for CATV reverse path (upstream) applications using an alternate balun and other external tuning components as identified in the table below. The recommended PCB layout and schematic are the same as identified on page 4.

Recommended PCB Layout for Upstream

![PCB Layout Image]

Parts List: 5 - 300 MHz Tune

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Package</th>
<th>Component</th>
<th>Value</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C2, C4 - C6</td>
<td>10 nF</td>
<td>0402</td>
<td>C3</td>
<td>0.1 µF</td>
<td>0402</td>
</tr>
<tr>
<td>C10</td>
<td>2200 pF</td>
<td>0402</td>
<td>R1, R2</td>
<td>150 Ω</td>
<td>0402</td>
</tr>
<tr>
<td>T1, T2</td>
<td>1:1 Balun&lt;sup&gt;10&lt;/sup&gt;</td>
<td>—</td>
<td>R3, R4</td>
<td>180 Ω</td>
<td>0402</td>
</tr>
</tbody>
</table>

10. MABA-011085

Electrical Specifications: 5 - 300 MHz Tune, $T_A = 25^\circ C$, $V_{DD} = 5$ 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>5 - 300 MHz</td>
<td>dB</td>
<td>—</td>
<td>17</td>
<td>—</td>
</tr>
<tr>
<td>Reverse Isolation</td>
<td>5 - 300 MHz</td>
<td>dB</td>
<td>—</td>
<td>21</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>5 - 300 MHz</td>
<td>dB</td>
<td>—</td>
<td>23</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>5 - 300 MHz</td>
<td>dB</td>
<td>—</td>
<td>21</td>
<td>—</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>5 - 10 MHz, 20 - 300 MHz</td>
<td>dB</td>
<td>—</td>
<td>2.3</td>
<td>2.0 -</td>
</tr>
<tr>
<td>Output IP2</td>
<td>5 - 300 MHz, tone spacing 6 MHz $P_{out}$ per tone = +13 dBm</td>
<td>dBm</td>
<td>—</td>
<td>75</td>
<td>—</td>
</tr>
<tr>
<td>Output IP3</td>
<td>5 - 300 MHz, tone spacing 6 MHz $P_{out}$ per tone = +13 dBm</td>
<td>dBm</td>
<td>—</td>
<td>45</td>
<td>—</td>
</tr>
<tr>
<td>P1dB</td>
<td>5 - 300 MHz</td>
<td>dBm</td>
<td>—</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>$I_{DD}$</td>
<td>$V_{DD} = 5$ V</td>
<td>mA</td>
<td>—</td>
<td>290</td>
<td>—</td>
</tr>
<tr>
<td>Noise Power Ratio</td>
<td>5 - 85 MHz, 41 MHz Notch, Peak NPR 5 - 204 MHz, 100 MHz Notch, Peak NPR</td>
<td>dB</td>
<td>—</td>
<td>72</td>
<td>71 —</td>
</tr>
</tbody>
</table>

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75 Ω, Differential RF Amplifier
5 - 1218 MHz

Typical Performance Curves: 5 - 300 MHz Tune, \( V_{DD} = 5 \text{ V}, +25^\circ \text{C} \)

**Gain**

- **S21 (dB)**
  - Frequency (MHz):
    - 0
    - 50
    - 100
    - 150
    - 200
    - 250
    - 300
  - Values:
    - 15
    - 16
    - 17
    - 18
    - 19
    - 20

**Noise Figure**

- **Noise Figure (dB)**
  - Frequency (MHz):
    - 0
    - 50
    - 100
    - 150
    - 200
    - 250
    - 300
  - Values:
    - 1.0
    - 1.5
    - 2.0
    - 2.5
    - 3.0
    - 3.5
    - 4.0

**Input Return Loss**

- **S11 (dB)**
  - Frequency (MHz):
    - 0
    - 50
    - 100
    - 150
    - 200
    - 250
    - 300
  - Values:
    - -30
    - -25
    - -20
    - -15
    - -10
    - -5
    - 0

**Output Return Loss**

- **S22 (dB)**
  - Frequency (MHz):
    - 0
    - 50
    - 100
    - 150
    - 200
    - 250
    - 300
  - Values:
    - -30
    - -25
    - -20
    - -15
    - -10
    - -5
    - 0

**OIP3**

- **OIP3 (dBm)**
  - Frequency (MHz):
    - 0
    - 50
    - 100
    - 150
    - 200
    - 250
    - 300
  - Values:
    - 30
    - 35
    - 40
    - 45
    - 50
    - 55

**NPR**

- **NPR (dB)**
  - Output Power (dBm):
    - -35
    - -25
    - -15
    - -5
    - 5
    - 15
    - 25
  - Values:
    - 0
    - 10
    - 20
    - 30
    - 40
    - 50
    - 60
    - 70
    - 80

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