MAAM-011100

Broadband Variable Gain Amplifier (VGA)
400 MHz - 20 GHz

Features

- 12 dB Gain
- 50 Ω Input / Output Match over Gain Range
- 30 dB Gain Control with 0 to -2 V Control
- +18 dBm Output Power
- +5 V, -0.5 V DC, 70 mA
- Lead-Free 1.5 x 1.2 mm 6-lead TDFN Package
- RoHS* Compliant and 260°C Reflow Compatible

Description

The MAAM-011100 is an easy-to-use, broadband, general purpose variable gain amplifier. Its over 30 dB gain range is controlled by a single control pin and 50 Ω match is maintained over all settings.

The MAAM-011100 operates from 400 MHz to 20 GHz and features flat gain control from +10 dB to -20 dB. At maximum gain setting (V_C=Open) it delivers up to +18 dBm power and under 5 dB noise figure. Both reduce proportionally as gain is reduced with V_C. The input IP3 exceeds +15 dBm at max/min gain settings. The device is typically biased with a V_D = +5 V, V_G = -0.5 V, and a control of 0 V to -2 V. Typical current is 70 mA with V_G at -0.5 V.

The MAAM-011100 is ideally suited for use as a power amplifier driver, gain trimming block, or temperature compensation in the receive or transmit mode. Typical applications include Wi-Fi, LTE, Point-to-Point, IMS, EW, and A&D systems.

This device is assembled in a leadless 1.5 X 1.2 mm package that can be handled and placed with standard pick and place assembly equipment.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAM-011100</td>
<td>bulk quantity</td>
</tr>
<tr>
<td>MAAM-011100-TR1000</td>
<td>1000 piece reel</td>
</tr>
<tr>
<td>MAAM-011100-001SMB</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.

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400 MHz - 20 GHz

Electrical Specifications (unless otherwise noted):
Freq = 10 GHz, \( T_A = +25^\circ\text{C} \), \( V_D = +5 \text{V} \), \( V_G = -0.5 \text{V} \), \( V_C = \text{Open} \), \( Z_{IN} = Z_{OUT} = 50 \Omega \)

<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>Highest Gain</td>
<td>( V_C = \text{open at 400 MHz} ) ( V_C = \text{open at 10 GHz} ) ( V_C = \text{open at 20 GHz} )</td>
<td>dB</td>
<td>8</td>
<td>12</td>
<td>—</td>
</tr>
<tr>
<td>Lowest Gain</td>
<td>( V_C = -2 \text{V at 400 MHz} ) ( V_C = -2 \text{V at 10 GHz} ) ( V_C = -2 \text{V at 20 GHz} )</td>
<td>dB</td>
<td>—</td>
<td>-33</td>
<td>-18</td>
</tr>
<tr>
<td>Gain Control</td>
<td>( V_C = 0 \text{ to } -2 \text{V} )</td>
<td>dB</td>
<td>—</td>
<td>30</td>
<td>—</td>
</tr>
<tr>
<td>Isolation</td>
<td>All States</td>
<td>dB</td>
<td>—</td>
<td>28</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>All States</td>
<td>dB</td>
<td>—</td>
<td>14</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>All States</td>
<td>dB</td>
<td>—</td>
<td>12</td>
<td>—</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>At maximum gain</td>
<td>dB</td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>( P1dB )</td>
<td>At maximum gain @ 10 GHz</td>
<td>dBm</td>
<td>—</td>
<td>+15</td>
<td>—</td>
</tr>
<tr>
<td>Input IP3</td>
<td>At maximum or minimum gain</td>
<td>dBm</td>
<td>—</td>
<td>+15</td>
<td>—</td>
</tr>
<tr>
<td>Stability</td>
<td>Any Load</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>unconditional</td>
</tr>
<tr>
<td>Voltage Supply</td>
<td>External Choke</td>
<td>V</td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Bias Current</td>
<td>( V_G = +5 \text{V} ) ( V_G = -0.5 \text{V} )</td>
<td>mA</td>
<td>—</td>
<td>75</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings\(^4,5,6\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>+15 dBm</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>+8 Volts</td>
</tr>
<tr>
<td>Operating Current</td>
<td>110 mA</td>
</tr>
<tr>
<td>Junction Temperature(^7)</td>
<td>+150°C</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>

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity
Galium 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.

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Operating at nominal conditions with \( T_J \leq 150^\circ\text{C} \) will ensure MTTF > 1 x 10^6 hours.
7. Junction Temperature \( (T_J) = T_C + \Theta_{JC} * ((V * I) - (P_{OUT} - P_{IN})) \)
   Typical thermal resistance \( (\Theta_{JC}) = 67^\circ\text{C/W} \)
   a) For \( T_C = 25^\circ\text{C} \),
      \( T_J = 47^\circ\text{C @ 5 V, 70 mA, P_{OUT} = 15 dBm, P_{IN} = 6 dBm} \)
   b) For \( T_C = 85^\circ\text{C} \),
      \( T_J = 107^\circ\text{C @ 5 V, 70 mA, P_{OUT} = 15 dBm, P_{IN} = 6 dBm} \)
Evaluation Board

Recommended PCB Layout

Application Schematic

Application Information for DC & pins

For proper MAAM-011100 operation a DC voltage must be applied at the V_G (-0.5V) and V_D (+5V) pins in that order. Adjusting V_G from -0.2 V to -0.6 V will change the quiescent current which can effect power and linearity if set below or above 70 mA.

The gain of the MAAM-011100 is controlled with the V_C pin. The gain reduction is almost linear with V_C between 0 V to -2 V. Below -2 V internal ESD protection diodes will draw increasing current. The nominal open circuit voltage at the V_C pin is +1 V and produces maximum gain and power. Limiting applications and zero crossing adjustment can be done by adjusting the V_G and V_C pins together.

To bias properly, a DC voltage must be applied at the output pin. Typically this is done with a 2 element bias network that consists of a choke and a DC blocking capacitor. We recommend a ferrite bead for the main bias choke and quality capacitor for the DC block. A simple 1 KΩ resistor can be used as a RF choke for the negative V_G as applied to the input pin.

It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8-mil (200-µm) diameter vias under the device, assuming an 8-mil (200-µm) thick RF layer to ground.

Parts List

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C4</td>
<td>0.22 µF</td>
<td>0201</td>
</tr>
<tr>
<td>C2, C3</td>
<td>0.22 µF</td>
<td>0402</td>
</tr>
<tr>
<td>FB(^8)</td>
<td>407 Ω</td>
<td>0402</td>
</tr>
<tr>
<td>R1</td>
<td>1 KΩ</td>
<td>0402</td>
</tr>
</tbody>
</table>

8. MACOM recommends using Murata part BLM15GG471.
Typical Performance Curves over Temperature

**Gain, \( V_C = 0 \text{ V}, -2 \text{ V} \)**

**Return Loss**

**Reverse Isolation**

**Noise Figure**

**Output P1dB**

**Input IP3**

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Typical Performance Curves vs. Control Voltage

Gain

Noise Figure

Input Return Loss

Output Return Loss

Output P1dB

Input IP3

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Typical Performance Curves

**Saturated Power**

![Saturated Power @ 10 GHz](image1)

**Gain @ 10 GHz**

![Gain @ 10 GHz](image2)

**Noise Figure @ 10 GHz**

![Noise Figure @ 10 GHz](image3)

**Input IP3 @ 10 GHz**

![Input IP3 @ 10 GHz](image4)

**Current @ 10 GHz**

![Current @ 10 GHz](image5)
MAAM-011100

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Rev. V2

Lead-Free 1.5 x 1.2 mm 6-lead TDFN

NOTES:
1. All Dimensions are in inches/mm.
2. Reference specific product outline drawing for additional dimensional and tolerance information.

1 Reference Application Note S2083 for lead-free solder reflow recommendations.

Meets JEDEC moisture sensitivity level 1 requirements.

Plating is matte tin over Copper.