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 Information1,2

<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.

Broadband Variable Gain Amplifier (VGA)

400 MHz - 20 GHz

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

<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>$V_C = \text{open @ 400 MHz}$</td>
<td>dB</td>
<td>8</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>$V_C = \text{open @ 10 GHz}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_C = \text{open @ 20 GHz}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Gain</td>
<td>$V_C = -2, V @ 400, MHz$</td>
<td>dB</td>
<td>—</td>
<td>-33</td>
<td>-23</td>
</tr>
<tr>
<td></td>
<td>$V_C = -2, V @ 10, GHz$</td>
<td></td>
<td></td>
<td>-25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_C = -2, V @ 20, GHz$</td>
<td></td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Gain Control</td>
<td>$V_C = 0\to -2, V$</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>$P_{1\text{dB}}$</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>unconditional</td>
<td></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>$V_G = +5, V$</td>
<td>mA</td>
<td>—</td>
<td>75</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>$V_G = -0.5, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Max.</th>
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</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

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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$^4$ 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 $T_J \leq 150^\circ C$ will ensure $\text{MTTF} > 1 \times 10^6$ hours.

$^7$ Junction Temperature ($T_J$) = $T_C + \Theta_{JC} \cdot ((V \cdot I) - (P_{OUT} - P_{IN}))$

Typical thermal resistance ($\Theta_{JC}$) = 67°C/W

a) For $T_C = 25^\circ C$,

$T_J = 47^\circ C \atop 5\, V, 70\, mA, P_{OUT} = 15\, \text{dBm}, P_{IN} = 6\, \text{dBm}$

b) For $T_C = 85^\circ C$,

$T_J = 107^\circ C \atop 5\, V, 70\, mA, P_{OUT} = 15\, \text{dBm}, P_{IN} = 6\, \text{dBm}$
MAAM-011100

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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\textsubscript{G} (-0.5V) and V\textsubscript{D} (+5V) pins \textit{in that order}. Adjusting V\textsubscript{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\textsubscript{C} pin. The gain reduction is almost linear with V\textsubscript{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\textsubscript{C} pin is +1 V and produces maximum gain and power. Limiting applications and zero crossing adjustment can be done by adjusting the V\textsubscript{G} and V\textsubscript{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 K\text{\textOmega} resistor can be used as a RF choke for the negative V\textsubscript{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-\textmu m) diameter vias under the device, assuming an 8-mil (200-\textmu m) thick RF layer to ground.

For further information and support please visit:
https://www.macomtech.com/content/customersupport

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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 \textmu F</td>
<td>0201</td>
</tr>
<tr>
<td>C2, C3</td>
<td>0.22 \textmu F</td>
<td>0402</td>
</tr>
<tr>
<td>FB\textsuperscript{8}</td>
<td>407 \textOmega</td>
<td>0402</td>
</tr>
<tr>
<td>R1</td>
<td>1 K\text{\textOmega}</td>
<td>0402</td>
</tr>
</tbody>
</table>

\textsuperscript{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 $P_{1\text{dB}}$

Input $I_{P3}$
Typical Performance Curves vs. Control Voltage

**Gain**

![Gain Graph](image)

**Noise Figure**

![Noise Figure Graph](image)

**Input Return Loss**

![Input Return Loss Graph](image)

**Output Return Loss**

![Output Return Loss Graph](image)

**Output P1dB**

![Output P1dB Graph](image)

**Input IP3**

![Input IP3 Graph](image)
Typical Performance Curves

**Saturated Power**

Gain @ 10 GHz

Noise Figure @ 10 GHz

Input IP3 @ 10 GHz

Current @ 10 GHz

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**Lead-Free 1.5 x 1.2 mm 6-lead TDFN**

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

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