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



MAAM-011100

Rev. V3

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

Applications

• Wi-Fi, LTE. Point-to-Point, IMS, EW, A&D

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 50Ω 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.

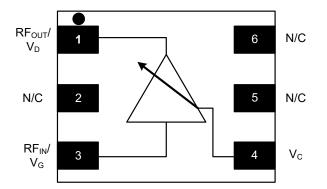
This device is assembled in a leadless 1.5 x 1.2 mm package that can be handled and placed with standard pick and place assembly equipment.

Ordering Information^{1,2}

Part Number	Package
MAAM-011100	bulk quantity
MAAM-011100-TR1000	1000 piece reel
MAAM-011100-001SMB	Sample board

- 1. Reference Application Note M513 for reel size information.
- 2. All sample boards include 5 loose parts.

Functional Schematic



Pin Configuration

Pin#	Pin Name	Function	
1	RF _{OUT} /V _D	RF Output	
2	N/C	No Connection	
3	RF _{IN} /V _G	RF Input	
4	V _C	Voltage Control	
5	N/C	No Connection	
6	N/C	No Connection	
7	Paddle ³	Ground	

^{3.} The exposed paddle centered on the package bottom must be connected to RF and DC ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

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Electrical Specifications (unless otherwise noted):

Freq = 10 GHz, T_A = +25°C, V_D = +5 V, V_G = -0.5 V, V_C = Open, Z_{IN} = Z_{OUT} = 50 Ω

Parameter	Test Conditions	Units	Min.	Тур.	Max.
Highest Gain	V_C = open @ 400 MHz V_C = open @ 10 GHz V_C = open @ 20 GHz	dB	8	12 10 11	_
Lowest Gain	V_{C} = -2 V @ 400 MHz V_{C} = -2 V @ 10 GHz V_{C} = -2 V @ 20 GHz	dB	_	-33 -23 -25	-18
Gain Control	V _C = 0 to -2 V	dB	_	30	_
Isolation	All States	dB	_	28	_
Input Return Loss	All States	dB	_	14	_
Output Return Loss	All States	dB	_	12	_
Noise Figure	At maximum gain	dB	_	5	_
P1dB	At maximum gain @ 10 GHz	dBm	_	15	_
Input IP3	At maximum or minimum gain	dBm	_	15	_
Stability	Any Load	-		unconditional	
Voltage Supply	External Choke	V	_	5	_
Bias Current ⁴	V _D = +5.0 V V _G = -0.5 V	mA	_	75 0.01	_

^{4.} See Applications Section for typical V_C current.

Absolute Maximum Ratings^{5,6,7}

Parameter	Absolute Max.	
Input Power	15 dBm	
Operating Voltage	8 Volts	
Operating Current	110 mA	
Junction Temperature ⁸	+150°C	
Operating Temperature	-40°C to +85°C	
Storage Temperature	-65°C to +150°C	

- 5. Exceeding any one or combination of these limits may cause permanent damage to this device.
- MACOM does not recommend sustained operation near these survivability limits.
- 7. Operating at nominal conditions with $T_J \le 150^{\circ}\text{C}$ will ensure MTTF > 1 x 10^6 hours.
- 8. Junction Temperature (T_J) = T_C + Θ_{JC} * ((V * I) (P_{OUT} P_{IN})) Typical thermal resistance (Θ_{JC}) = 67°C/W

a) For $T_C = 25$ °C,

 $T_J = 47^{\circ} C \ @ \ 5 \ V, \ 70 \ mA, \ P_{OUT} = 15 \ dBm, \ P_{IN} = \ 6 \ dBm$ b) For $T_C = 85^{\circ} C,$

 $T_J = 107^{\circ}C @ 5 V$, 70 mA, $P_{OUT} = 15 dBm$, $P_{IN} = 6 dBm$

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

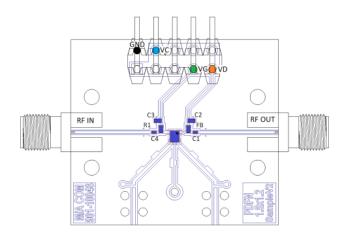
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.



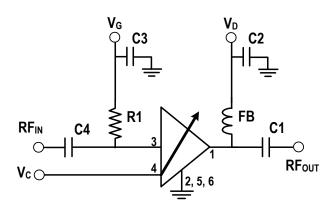
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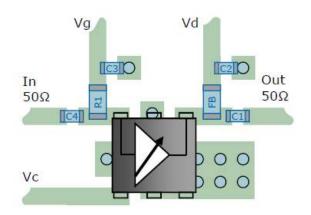
Evaluation Board



Application Schematic



Recommended PCB Layout



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 (+5 V) 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 $V_{\rm C}$ pin. The gain reduction is almost linear with $V_{\rm C}$ between 0 V to -2 V. Below -2 V internal ESD protection diodes will draw increasing current. The nominal open circuit voltage at the $V_{\rm C}$ pin is +1 V and produces maximum gain and power. Limiting applications and zero crossing adjustment can be done by adjusting the $V_{\rm G}$ and $V_{\rm C}$ 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 $K\Omega$ resistor can be used as a RF choke for the negative $V_{\rm G}$ 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 μ m) diameter vias under the device, assuming an 8-mil (200 μ m) thick RF layer to ground

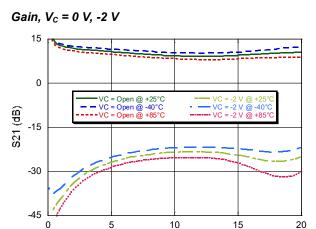
Parts List

Component	Value	Package
C1, C4	0.22 μF	0201
C2, C3	0.22 μF	0402
FB ⁹	407 Ω	0402
R1	1 ΚΩ	0402

9. MACOM recommends using Murata part BLM15GG471.

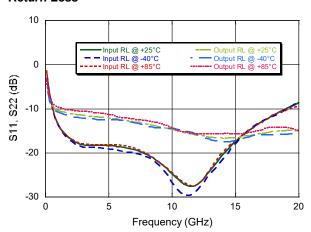


Typical Performance Curves over Temperature

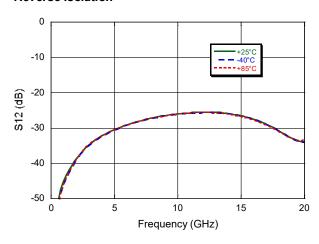


Frequency (GHz)

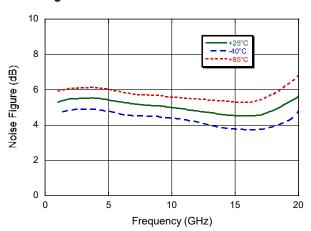
Return Loss



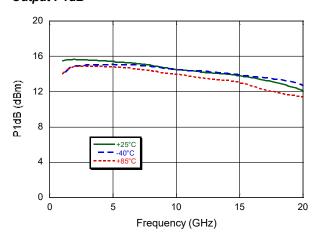
Reverse Isolation



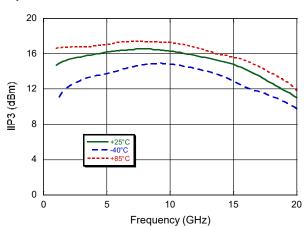
Noise Figure



Output P1dB



Input IP3



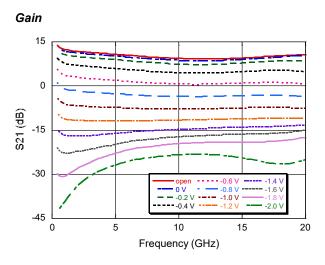
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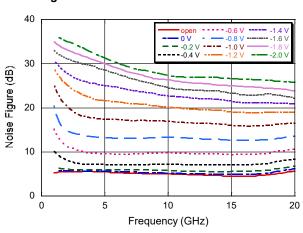
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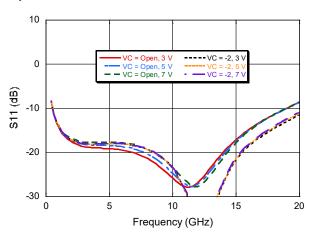
Typical Performance Curves vs. Control Voltage



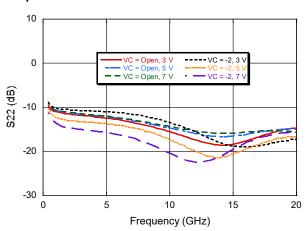
Noise Figure



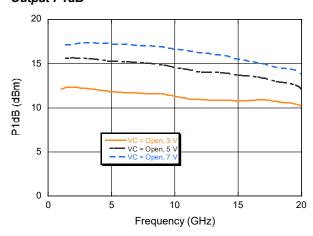
Input Return Loss



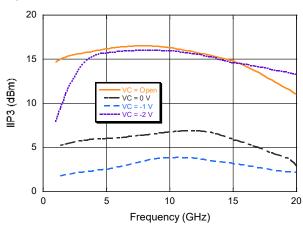
Output Return Loss



Output P1dB



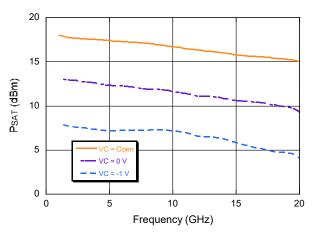
Input IP3



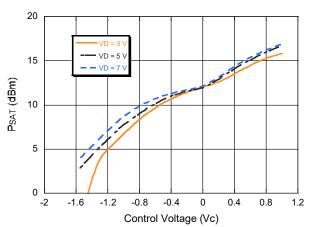


Typical Performance Curves

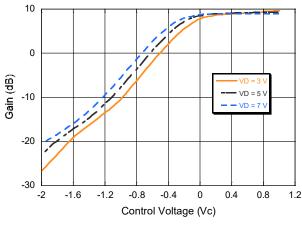
Saturated Power



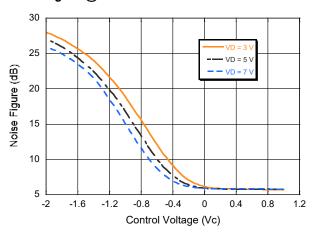
Saturated Power @ 10 GHz



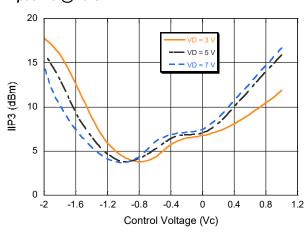
Gain @ 10 GHz



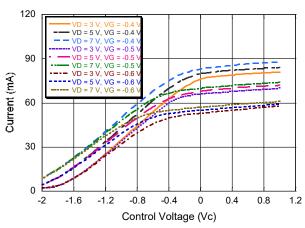
Noise Figure @ 10 GHz



Input IP3 @ 10 GHz



Current @ 10 GHz

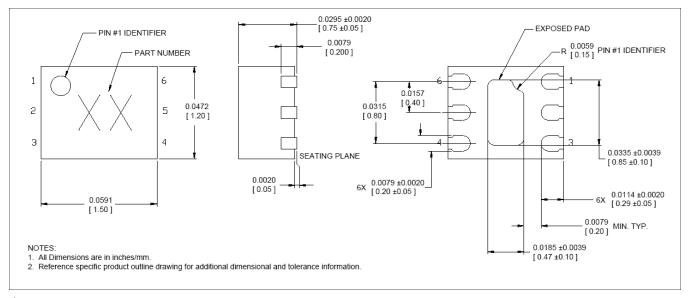


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Lead-Free 1.5 x 1.2 mm 6-lead TDFN



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

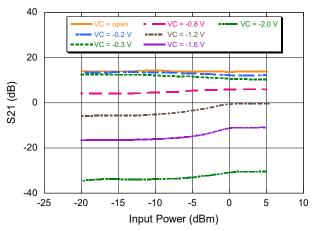


Applications Section: Swept Power Across V_C

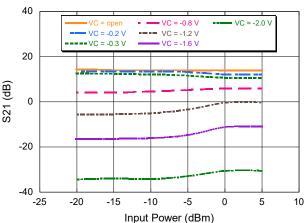
Typical Performance Curves:

Measured on Sample Board - Data includes Board/Connector Loss

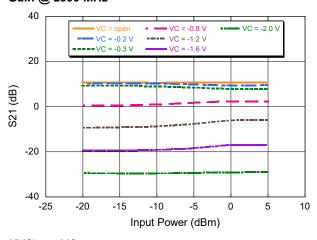
Gain @ 208 MHz



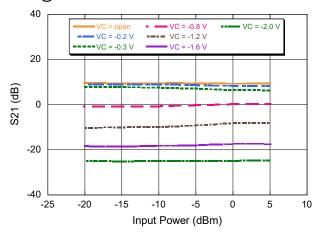
Gain @ 408 MHz



Gain @ 2500 MHz

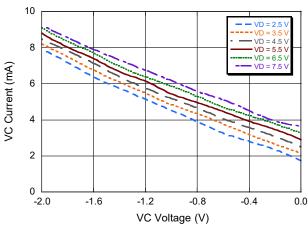


Gain @ 5500 MHz



I(VC) vs. VC

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