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

Rev. V2

### Features

- 12 dB Gain
- 50  $\Omega$  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  $\Omega$  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.

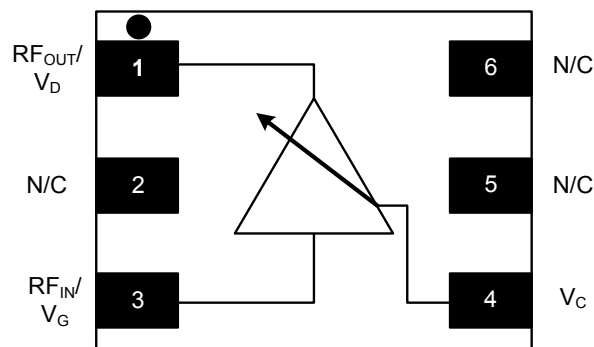
### Ordering Information<sup>1,2</sup>

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.

\* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

### Functional Schematic



### Pin Configuration

Pin No.	Pin Name	Function
1	RF <sub>OUT</sub> /V <sub>D</sub>	RF Output
2	N/C	No Connection
3	RF <sub>IN</sub> /V <sub>G</sub>	RF Input
4	V <sub>C</sub>	Voltage Control
5	N/C	No Connection
6	N/C	No Connection
7	Paddle <sup>3</sup>	Ground

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

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### Electrical Specifications (unless otherwise noted):

Freq = 10 GHz,  $T_A = +25^\circ\text{C}$ ,  $V_D = +5\text{ V}$ ,  $V_G = -0.5\text{ V}$ ,  $V_C = \text{Open}$ ,  $Z_{IN} = Z_{OUT} = 50\ \Omega$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Highest Gain	$V_C = \text{open @ 400 MHz}$ $V_C = \text{open @ 10 GHz}$ $V_C = \text{open @ 20 GHz}$	dB	8	12 10 11	—
Lowest Gain	$V_C = -2\text{ V @ 400 MHz}$ $V_C = -2\text{ V @ 10 GHz}$ $V_C = -2\text{ V @ 20 GHz}$	dB	—	-33 -23 -25	-18
Gain Control	$V_C = 0\text{ to }-2\text{ V}$	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	$V_D = +5\text{ V}$ $V_G = -0.5\text{ V}$	mA	—	75 0.01	—

### Absolute Maximum Ratings<sup>4,5,6</sup>

Parameter	Absolute Max.
Input Power	+15 dBm
Operating Voltage	+8 Volts
Operating Current	110 mA
Junction Temperature <sup>7</sup>	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

- 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.
- Operating at nominal conditions with  $T_J \leq 150^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.
- Junction Temperature ( $T_J$ ) =  $T_C + \theta_{JC} * ((V * I) - (P_{OUT} - P_{IN}))$   
Typical thermal resistance ( $\theta_{JC}$ ) = 67°C/W
  - For  $T_C = 25^\circ\text{C}$ ,  
 $T_J = 47^\circ\text{C @ 5 V, 70 mA, } P_{OUT} = 15\text{ dBm, } P_{IN} = 6\text{ dBm}$
  - For  $T_C = 85^\circ\text{C}$ ,  
 $T_J = 107^\circ\text{C @ 5 V, 70 mA, } P_{OUT} = 15\text{ dBm, } P_{IN} = 6\text{ dBm}$

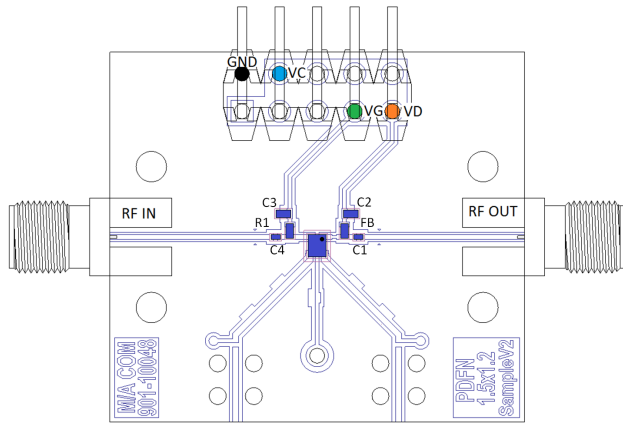
### Handling Procedures

Please observe the following precautions to avoid damage:

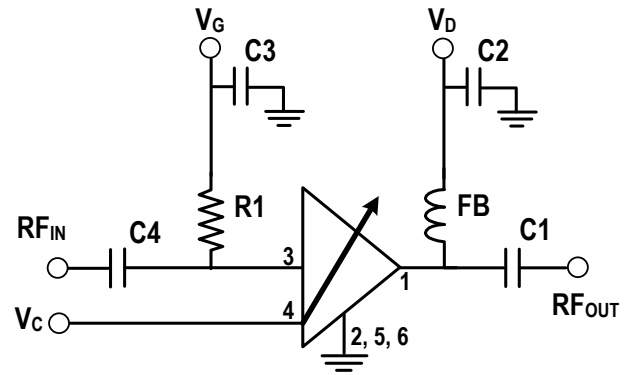
### Static Sensitivity

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.

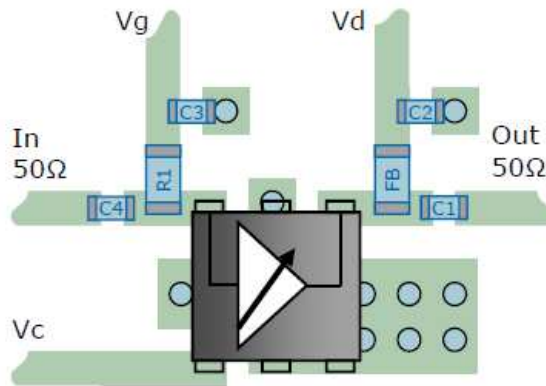
## Evaluation Board



## 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  $V_D$  (+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 K $\Omega$  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- $\mu$ m) diameter vias under the device, assuming an 8-mil (200- $\mu$ m) thick RF layer to ground

## Parts List

Component	Value	Package
C1, C4	0.22 $\mu$ F	0201
C2, C3	0.22 $\mu$ F	0402
FB <sup>8</sup>	407 $\Omega$	0402
R1	1 K $\Omega$	0402

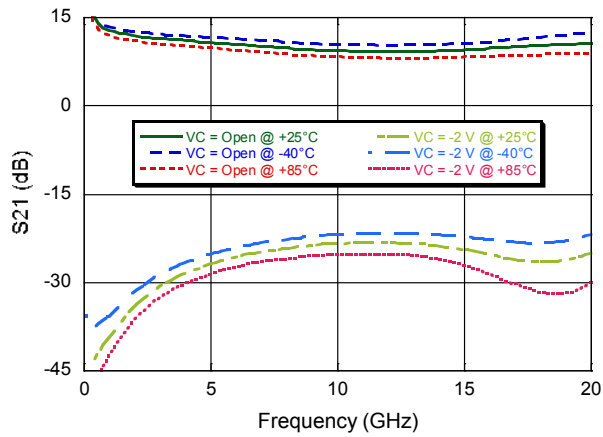
8. MACOM recommends using Murata part BLM15GG471.

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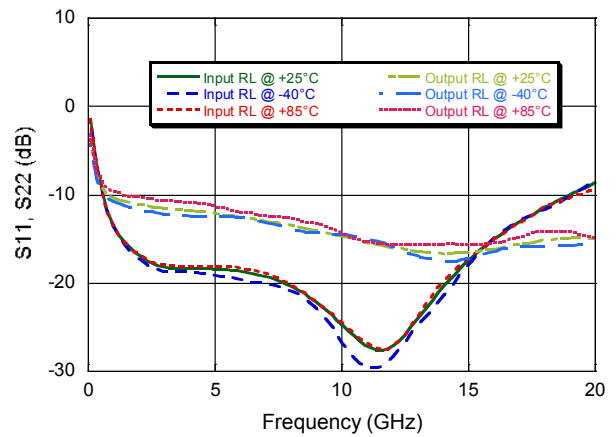
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### Typical Performance Curves over Temperature

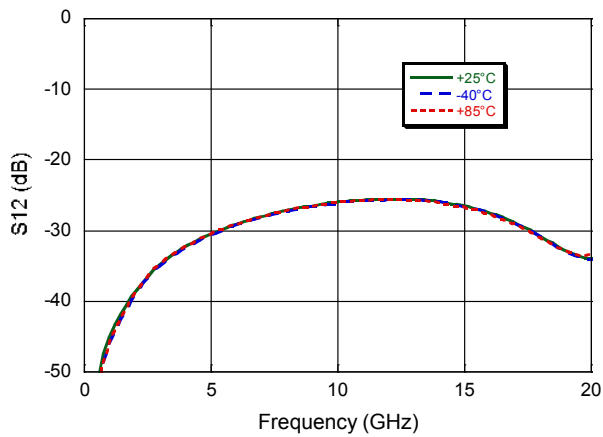
Gain,  $V_C = 0\text{ V}, -2\text{ V}$



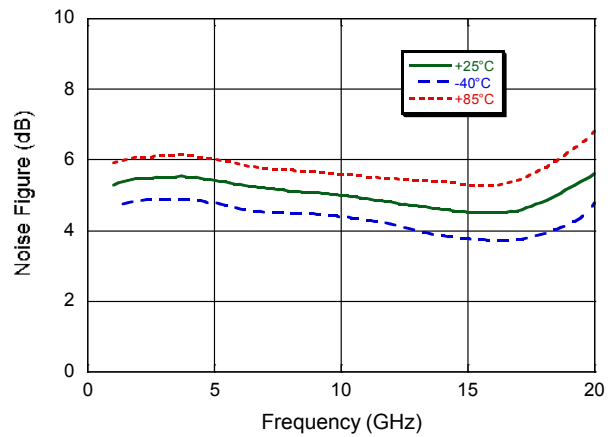
Return Loss



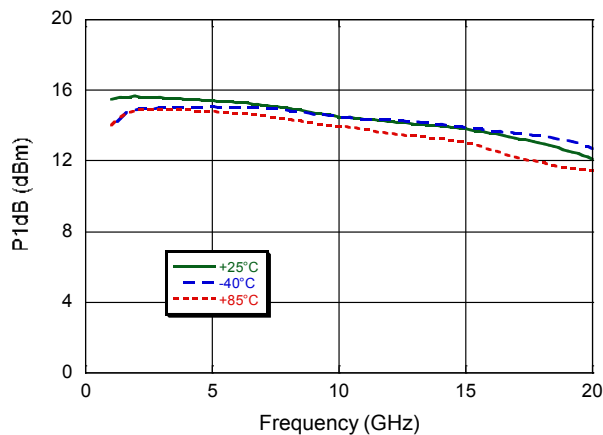
Reverse Isolation



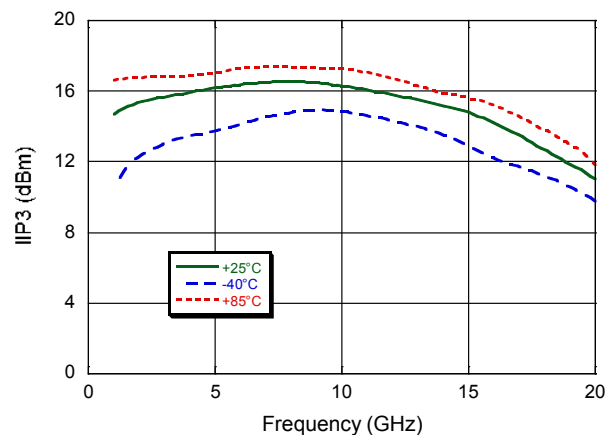
Noise Figure



Output P1dB

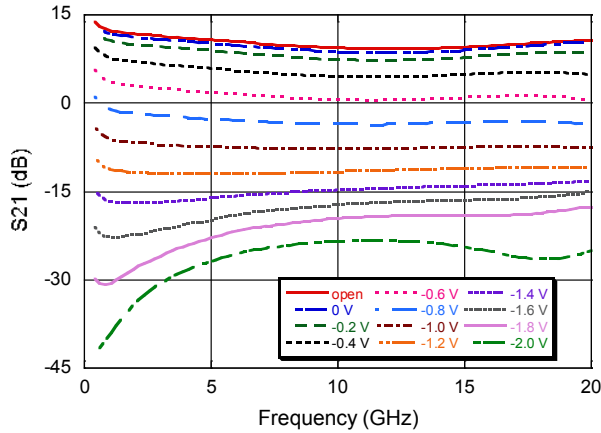


Input IP3

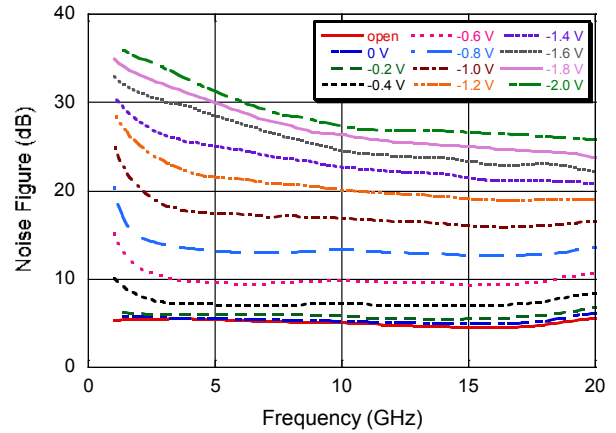


## Typical Performance Curves vs. Control Voltage

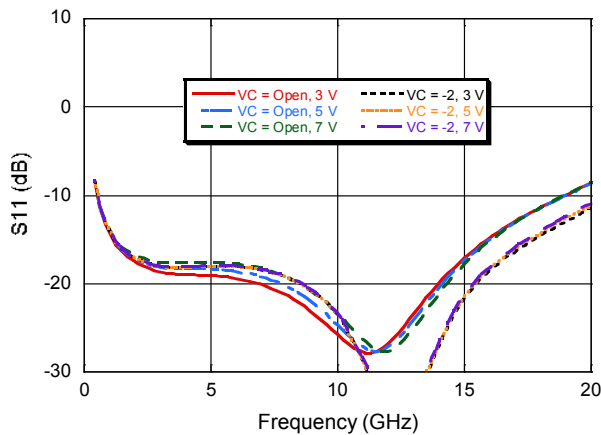
**Gain**



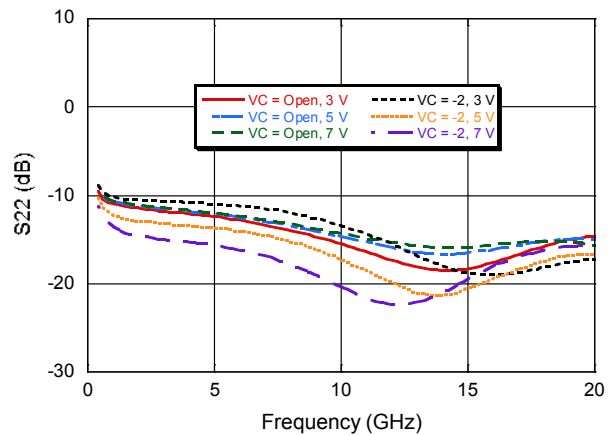
**Noise Figure**



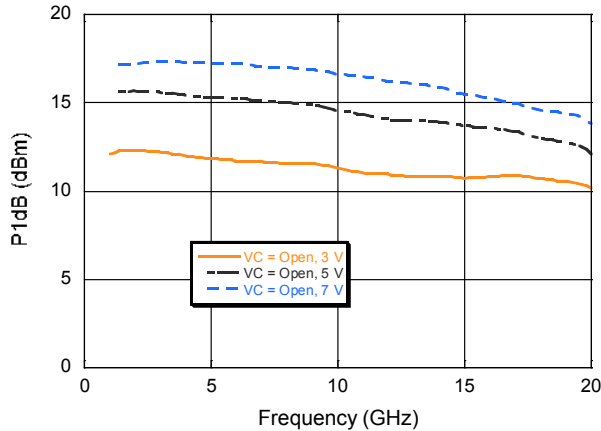
**Input Return Loss**



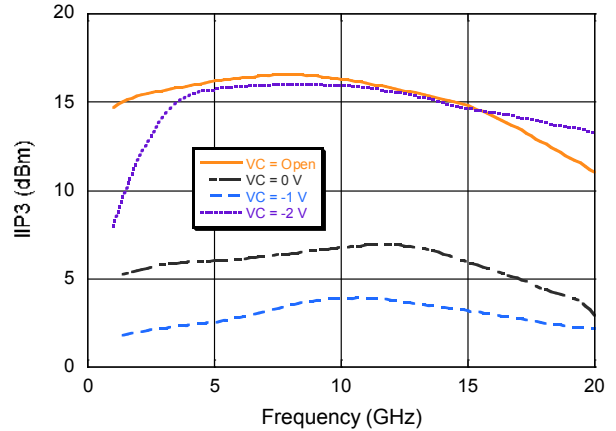
**Output Return Loss**



**Output P1dB**

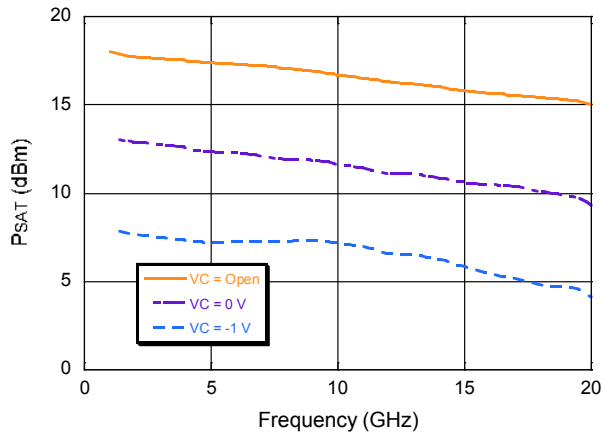


**Input IP3**

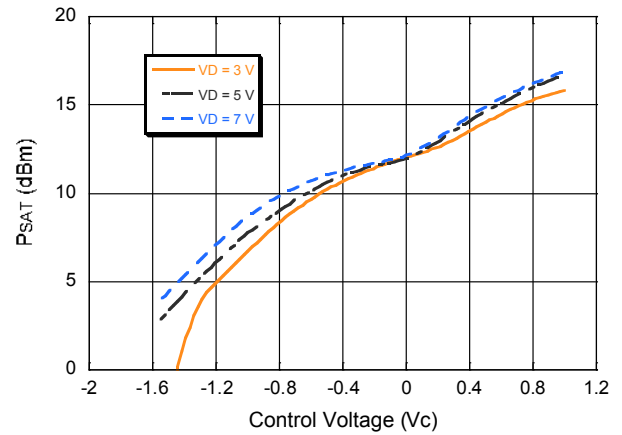


### Typical Performance Curves

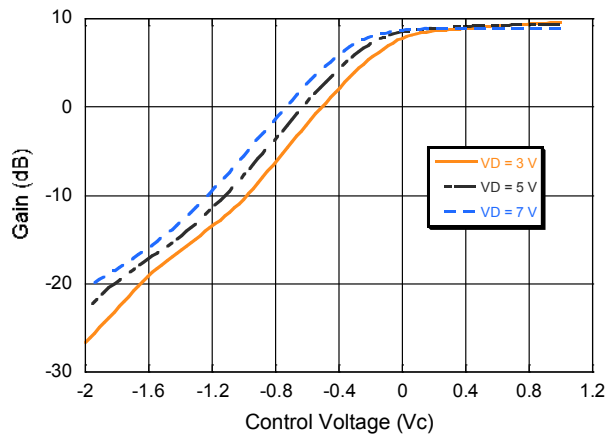
**Saturated Power**



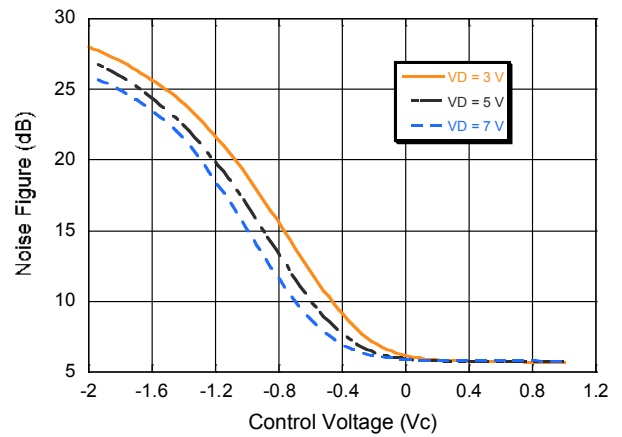
**Saturated Power @ 10 GHz**



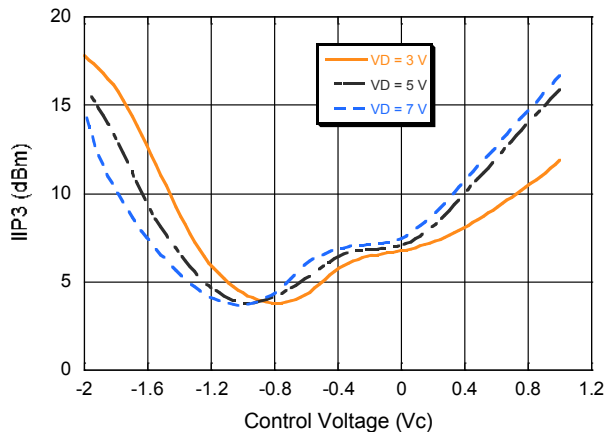
**Gain @ 10 GHz**



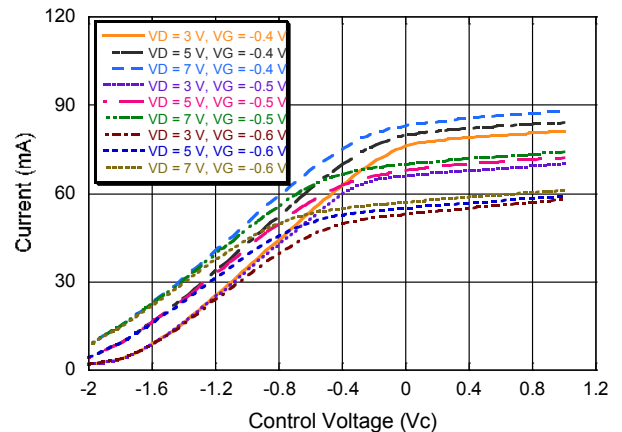
**Noise Figure @ 10 GHz**



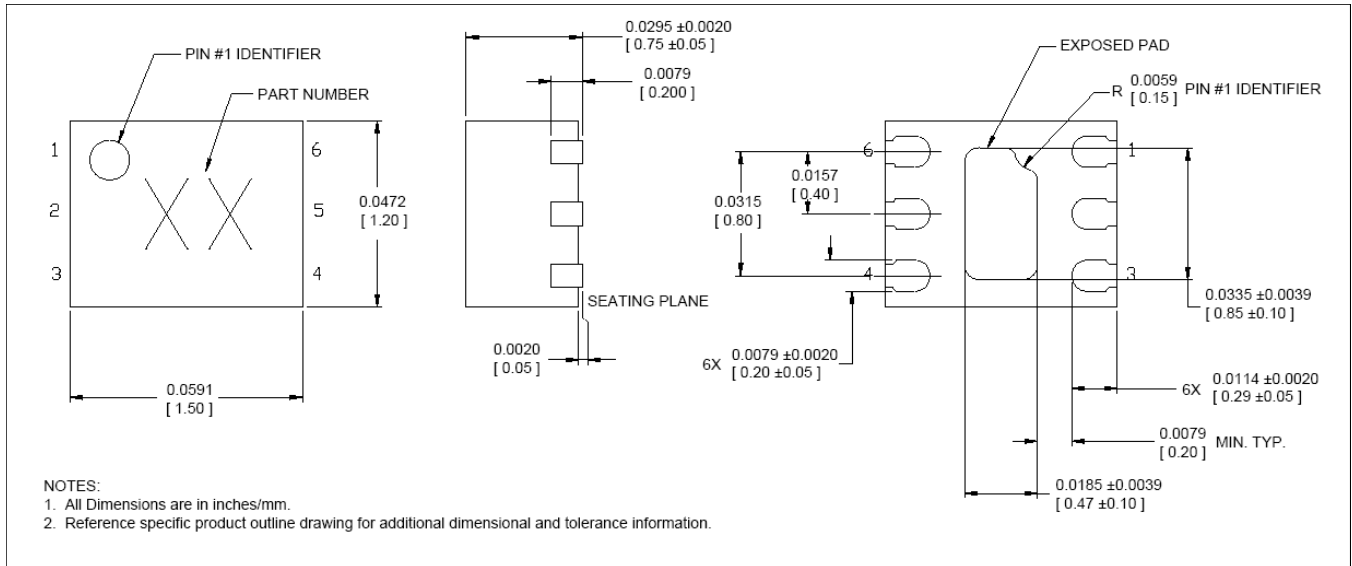
**Input IP3 @ 10 GHz**



**Current @ 10 GHz**



**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.