

# Power Amplifier, 2 W 27.5 - 31.0 GHz



MAAP-011316

Rev. V1

## Features

- High Gain: 26.0 dB
- P1dB: 33.5 dBm
- P3dB: 34.0 dBm
- IM3 Level: -36 dBc @ P<sub>OUT</sub> = +20 dBm/tone
- Power Added Efficiency: 28% @ P3dB
- Temperature Compensated Output Power Detector
- Lead-Free 5 mm AQFN 32-lead Package
- RoHS\* Compliant

## Applications

- Point-to-Point
- VSAT

## Description

The MAAP-011316 is a 2 W, 4-stage power amplifier assembled in a lead-free 5 mm 32-lead air cavity QFN plastic package. This power amplifier operates from 27.5 to 31 GHz and provides 26 dB of linear gain, 2 W saturated output power and 28% efficiency while biased at 6 V.

The MAAP-011316 can be used as a power amplifier stage or as a driver stage in higher power applications. This device is ideally suited for VSAT and 28 GHz PTP applications.

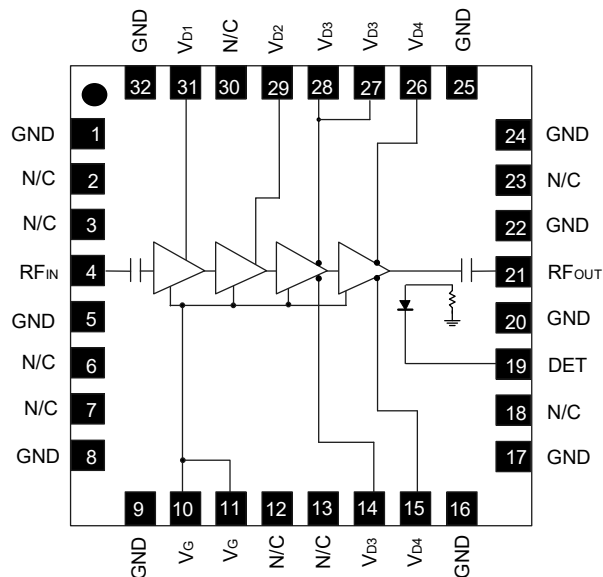
This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

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

Part Number	Package
MAAP-011316	Bulk part
MAAP-011316-TR0500	500 part reel
MAAP-011316-001SMB	Sample Board

1. Reference Application Note M513 for reel size information.
2. All sample boards include 3 loose parts.

## Functional Schematic



## Pin Configuration<sup>3,4</sup>

Pin #	Pin Name	Description
1, 5, 8, 9, 16, 17, 20, 22, 24, 25, 32	GND	Ground
2, 3, 6, 7, 12, 13, 18, 23, 30	N/C	No Connection
4	RF <sub>IN</sub>	RF Input
10, 11	V <sub>G</sub>	Gate Voltage
14, 27, 28	V <sub>D3</sub>	Drain Voltage 3
15, 26	V <sub>D4</sub>	Drain Voltage 4
19	DET	Power Detector
21	RF <sub>OUT</sub>	RF Output
29	V <sub>D2</sub>	Drain Voltage 2
31	V <sub>D1</sub>	Drain Voltage 1

3. MACOM recommends connecting all No Connection (N/C) pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

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

**Electrical Specifications:  $T_A = +25^\circ\text{C}$ ,  $V_D = 6\text{ V}$ ,  $Z_0 = 50\ \Omega$**

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	27.5 GHz 31.0 GHz	dB	23 17	26 21	—
Output Power (@ Pin = +12dBm)	27.5 GHz 31.0 GHz	dBm	32 31	33.5 33.5	—
IM3 Level	$P_{OUT} = 20\text{ dBm / tone}$	dBc	—	-36	—
Power Added Efficiency	$P_{IN} = 12\text{ dBm}$	%	—	28	—
Input Return Loss	—	dB	—	10	—
Output Return Loss	—	dB	—	15	—
Quiescent Current	$I_{DSQ}$ (see bias conditions, page 4 )	mA	—	900	—
Drain Current ( $V_{D1} + V_{D2} + V_{D3} + V_{D4}$ )	$P_{IN} = 12\text{ dBm}$	mA	—	1500	—

**Maximum Operating Conditions**

Parameter	Rating
Input Power	$P_{IN} \leq 3\text{ dB Compression}$
Junction Temperature <sup>5,6</sup>	+160°C
Operating Temperature	-40°C to +85°C

5. Operating at nominal conditions with junction temperature  $\leq +160^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.
6. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{JC} * ((V * I) - (P_{OUT} - P_{IN}))$   
Typical thermal resistance ( $\Theta_{JC}$ ) = 6.6 °C/W.
  - a) For  $T_C = +25^\circ\text{C}$   
 $T_J = +78^\circ\text{C @ } 6\text{ V, } 1.5\text{ A, } P_{OUT} = 34.0\text{ dBm, } P_{IN} = 12\text{ dBm}$
  - b) For  $T_C = +85^\circ\text{C}$   
 $T_J = 138^\circ\text{C @ } 6\text{ V, } 1.5\text{ A, } P_{OUT} = 34.0\text{ dBm, } P_{IN} = 12\text{ dBm}$

**Absolute Maximum Ratings<sup>7,8</sup>**

Parameter	Absolute Maximum
Input Power	15 dBm
Drain Voltage	+6.5 V
Gate Voltage	-3 to 0 V
Junction Temperature <sup>9</sup>	+175°C
Storage Temperature	-65°C to +125°C

7. Exceeding any one or combination of these limits may cause permanent damage to this device.
8. MACOM does not recommend sustained operation near these survivability limits.
9. Junction temperature directly affects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

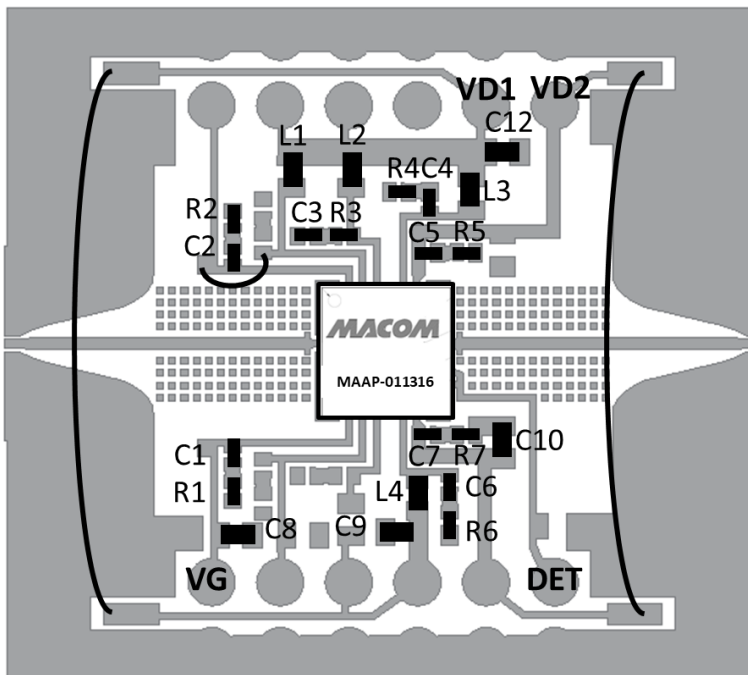
**Handling Procedures**

Please observe the following precautions to avoid damage:

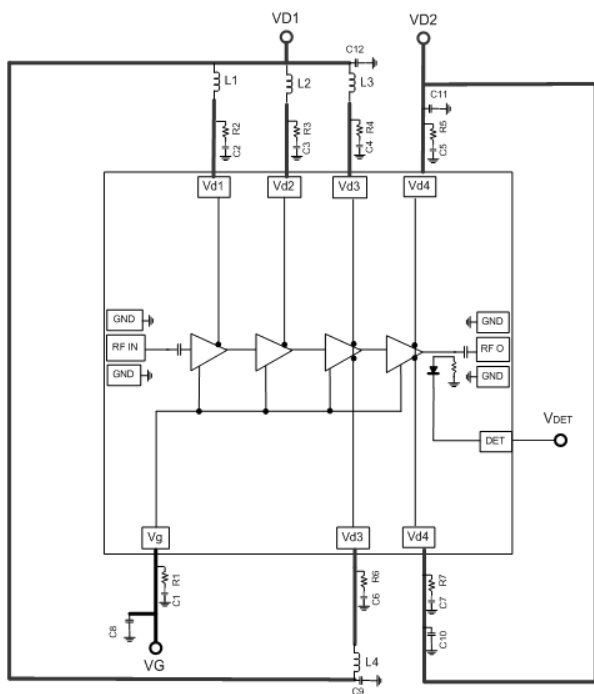
**Static Sensitivity**

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 HBM Class 1A devices.

Sample Board Layout



Application Schematic



Parts List

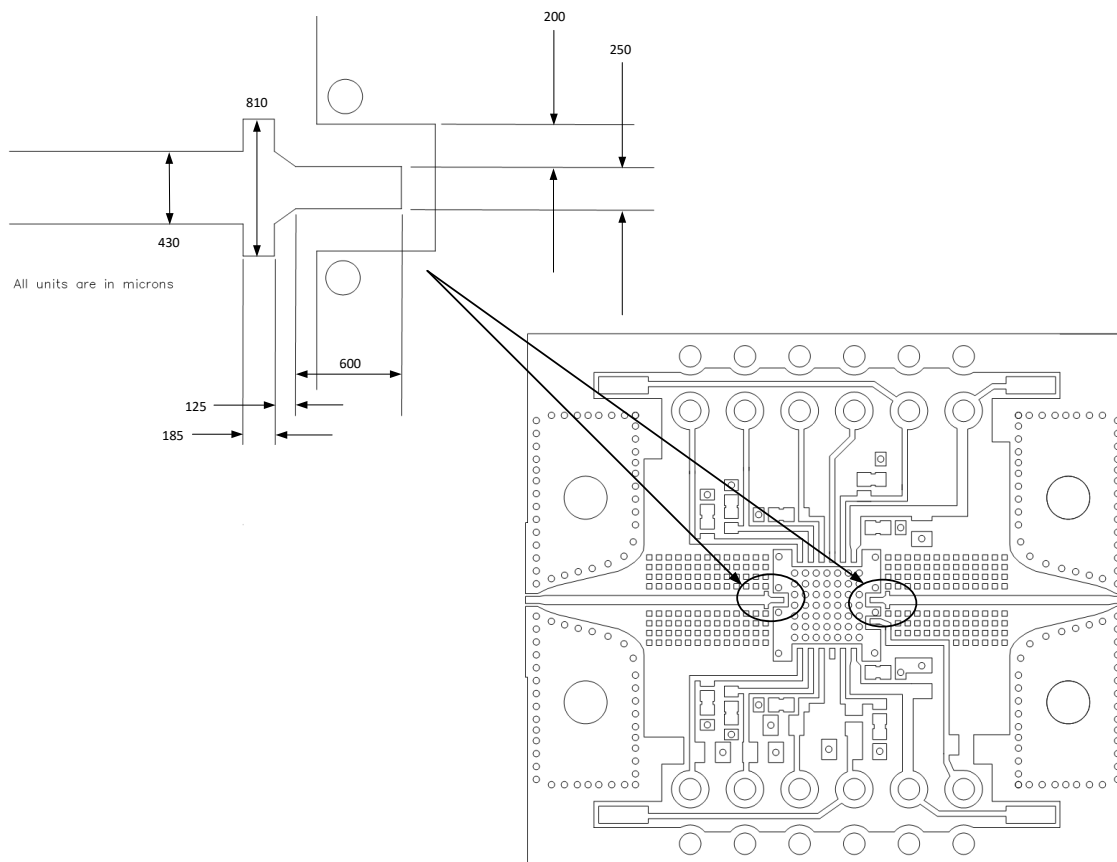
Part	Value	Case Style
C1 - C7	0.01 $\mu$ F	0402
C8 - C12	22 $\mu$ F	0603
R1 - R7	10 $\Omega$	0402
L1 - L4	Ferrite bead Murata BLM18HE601SN1D	0603

Sample Board Material Specifications

Top Layer: 1/2 oz Copper Cladding, 0.017 mm thickness  
Dielectric Layer: Rogers RO4003C 0.203 mm thickness  
Bottom Layer: 1/2 oz Copper Cladding, 0.017 mm thickness  
Finished overall thickness: 0.238 mm

**Recommended PCB Layout Detail:**

RF input and output pre-matching circuit patterns are identical and are designed to compensate packaging effects. Transmission line dimensions apply to a PCB with 0.203 mm thick Rogers RO4003C laminate dielectric. Performance curves shown in this data sheet were measured with these circuit patterns.



**Biasing Conditions**

Recommended biasing conditions are  $V_D = 6\text{ V}$ ,  $I_{DSQ} = 900\text{ mA}$  (controlled with  $V_G$ ). The drain bias voltage range is 5.5 to 6.5 V.

$V_G$  pins 10 and 11 are connected internally; choose either pin for layout convenience. Muting can be accomplished by setting the  $V_G$  to the pinched off voltage ( $V_G = -2\text{ V}$ ).

$V_D$  bias must be applied to  $V_{D1}$ ,  $V_{D2}$ ,  $V_{D3}$ , and  $V_{D4}$  pins.  $V_{D3}$  pins 27 and 28 are connected internally: choose pin 14, 27 or 28 for layout convenience. Two  $V_{D4}$  pins 15 and 26 (not connected internally) are required for current symmetry.

**Operating the MAAP-011316**

**Turn-on**

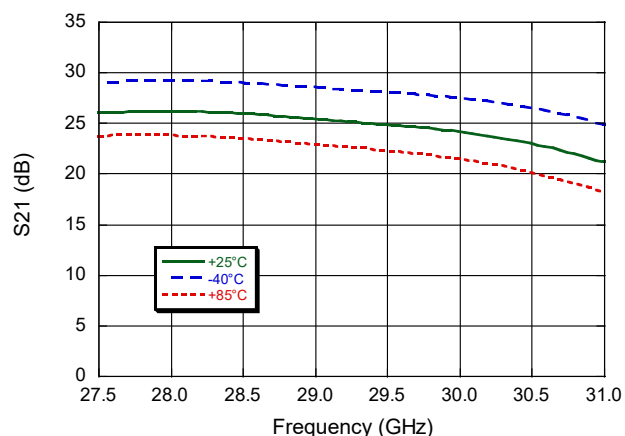
1. Apply  $V_G$  (-1.5 V).
2. Apply  $V_D$  (6.0 V typical).
3. Set  $I_{DQ}$  by adjusting  $V_G$  more positive (typically -0.9 to -1.0 V for  $I_{DSQ} = 900\text{ mA}$ ).
4. Apply  $RF_{IN}$  signal.

**Turn-off**

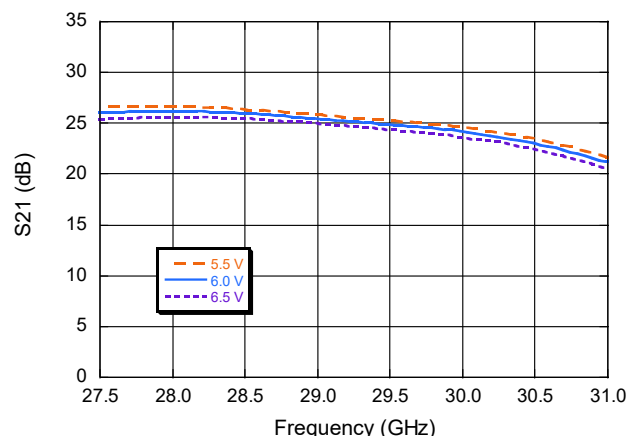
1. Remove  $RF_{IN}$  signal.
2. Decrease  $V_G$  to -1.5 V.
3. Decrease  $V_D$  to 0 V.

**Typical Performance Curves:  $V_D = 6\text{ V}$ ,  $I_{DSQ} = 900\text{ mA}$ ,  $V_G = -0.9\text{ V}$  typical**

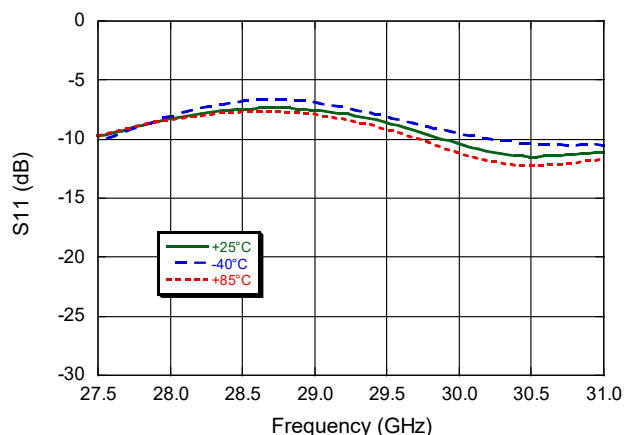
**Small Signal Gain vs. Frequency over Temperature**



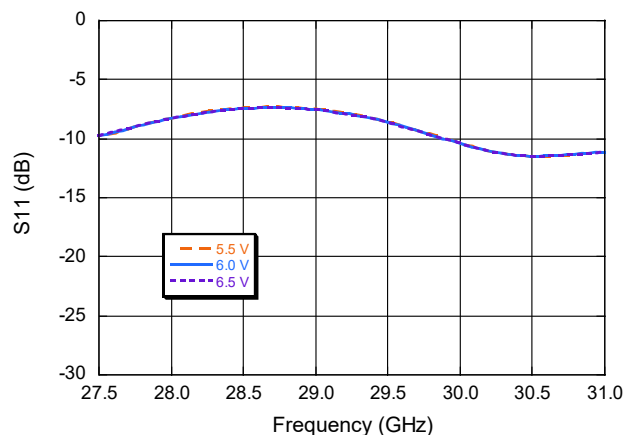
**Small Signal Gain vs. Frequency over Bias Voltage**



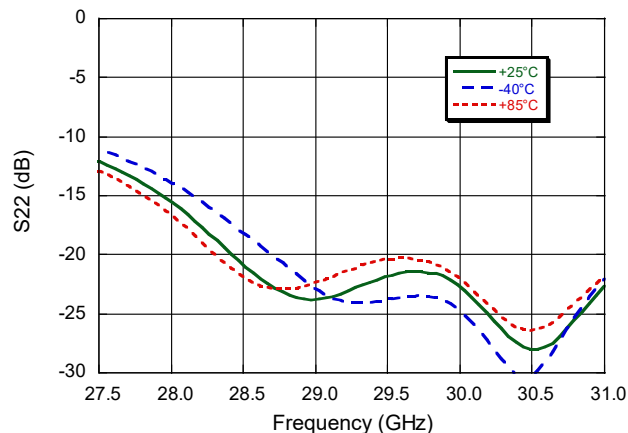
**Input Return Loss vs. Frequency over Temperature**



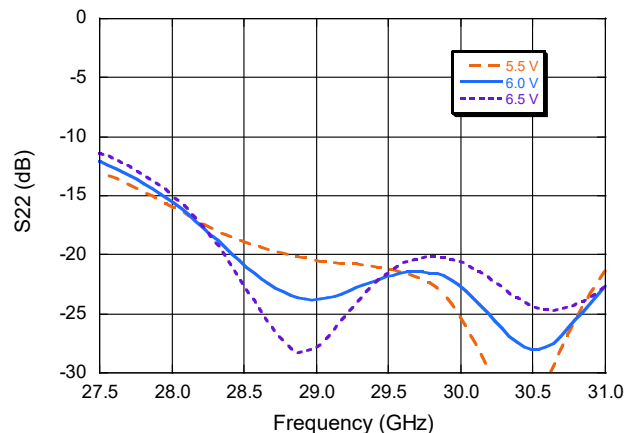
**Input Return Loss vs. Frequency over Bias Voltage**



**Output Return Loss vs. Frequency over Temperature**

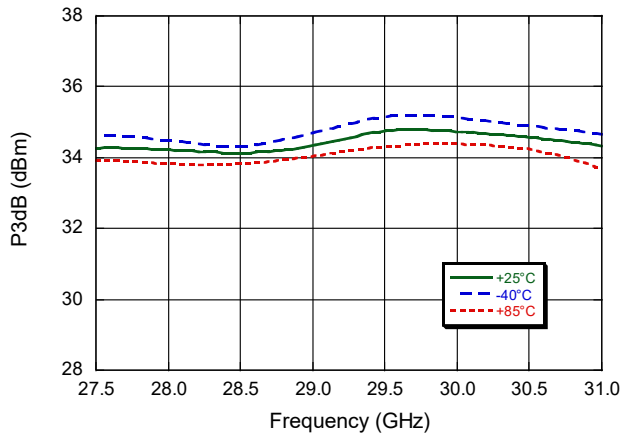


**Output Return Loss vs. Frequency over Bias Voltage**

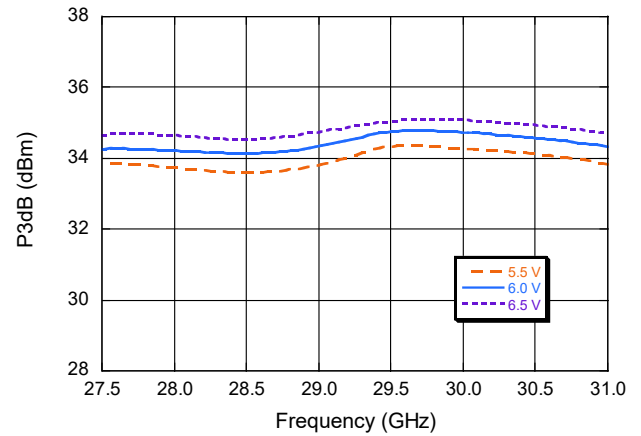


**Typical Performance Curves:  $V_D = 6\text{ V}$ ,  $I_{DSQ} = 900\text{ mA}$ ,  $V_G = -0.9\text{ V}$  typical**

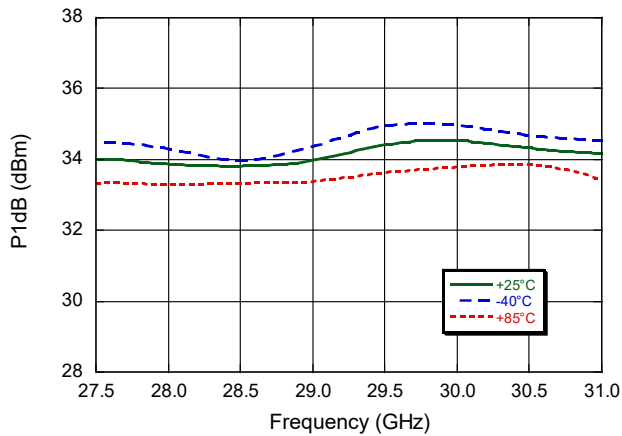
***P3dB vs. Frequency over Temperature***



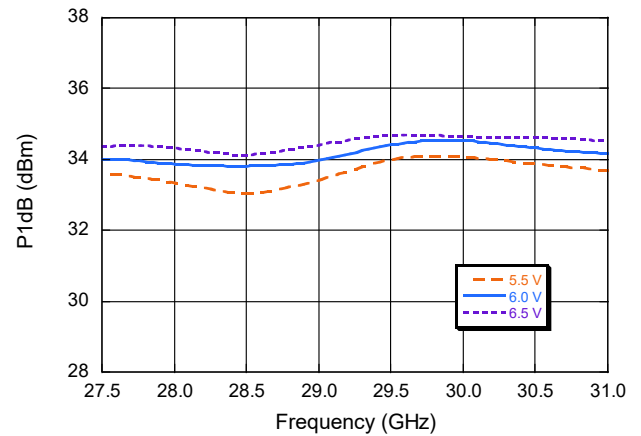
***P3dB vs. Frequency over Bias Voltage***



***P1dB vs. Frequency over Temperature***

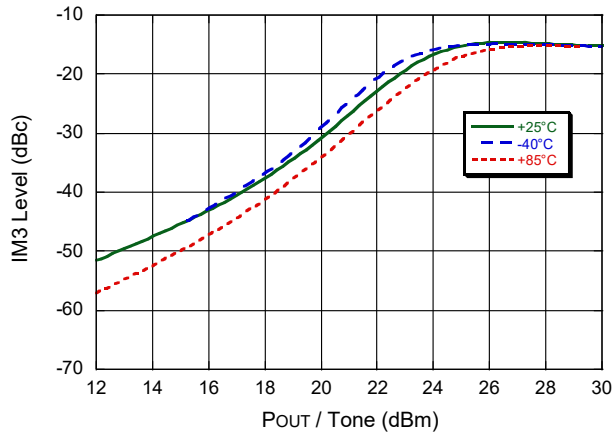


***P1dB vs. Frequency over Bias Voltage***

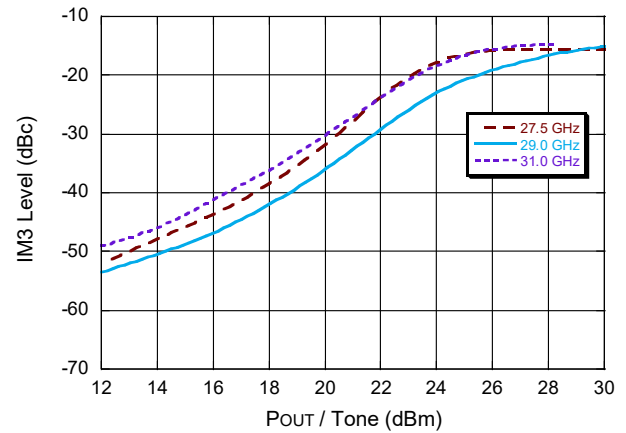


**Typical Performance Curves:  $V_D = 6\text{ V}$ ,  $I_{DSQ} = 900\text{ mA}$ ,  $V_G = -0.9\text{ V}$  typical**

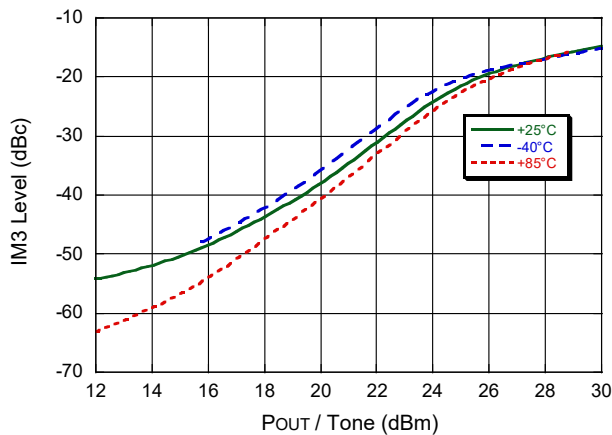
**IM3 vs. Output Power (27.5 GHz)**



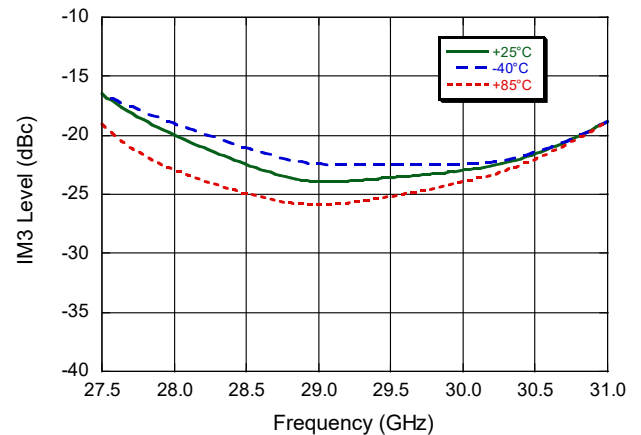
**IM3 vs. Output Power**



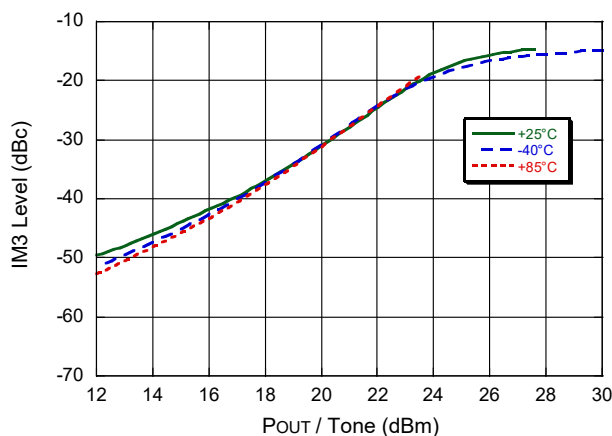
**IM3 vs. Output Power (29 GHz)**



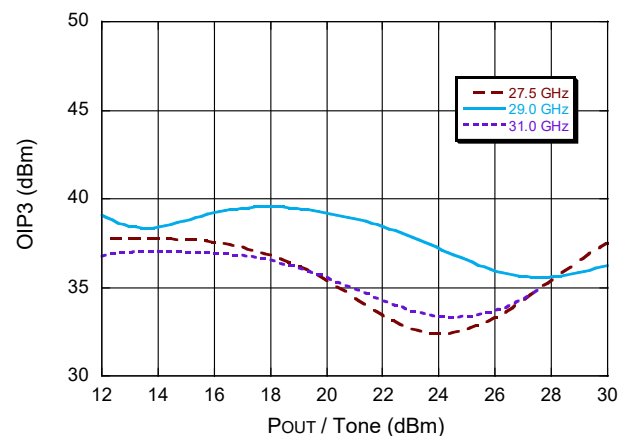
**IM3 vs. Frequency @ Output Power = 24 dBm/tone**



**IM3 vs. Output Power (31 GHz)**

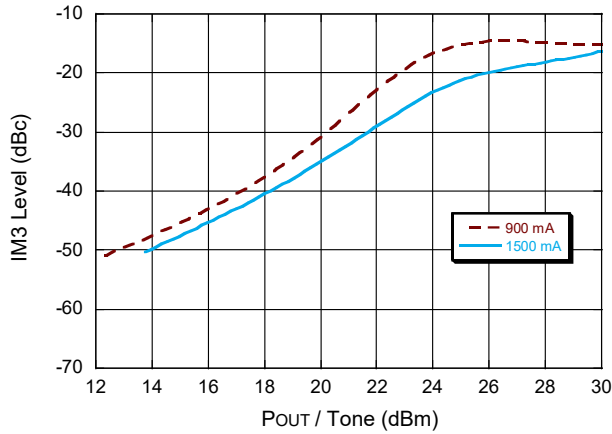


**Output IP3 vs. Output Power**

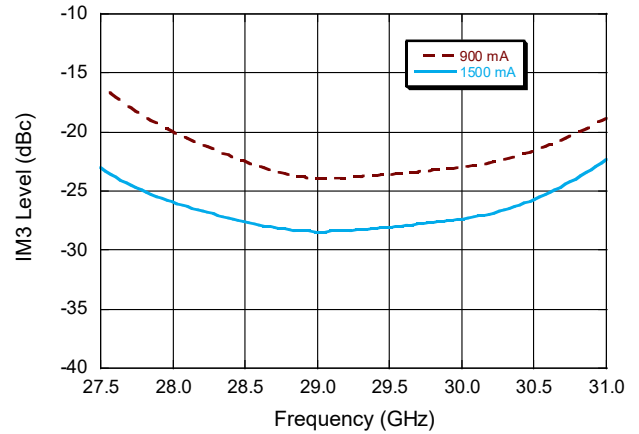


**Typical Performance Curves:  $V_D = 6\text{ V}$ ,  $25^\circ\text{C}$**

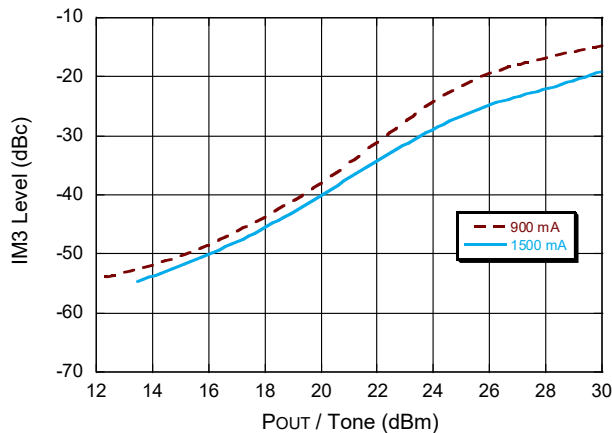
**IM3 vs. Output Power by Drain Current @ 27.5 GHz**



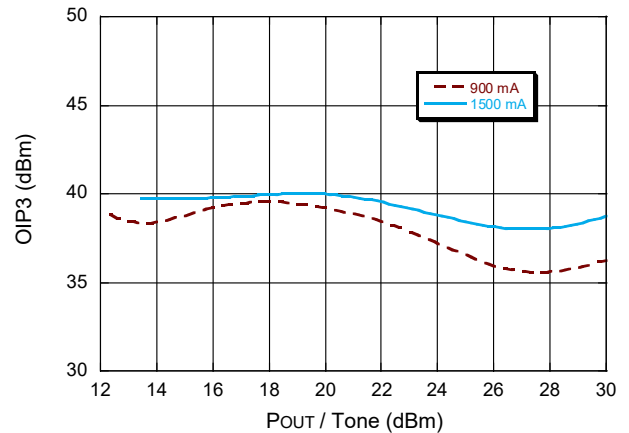
**IM3 vs. Frequency by Drain Current @  $P_{out} = 24\text{ dBm/tone}$**



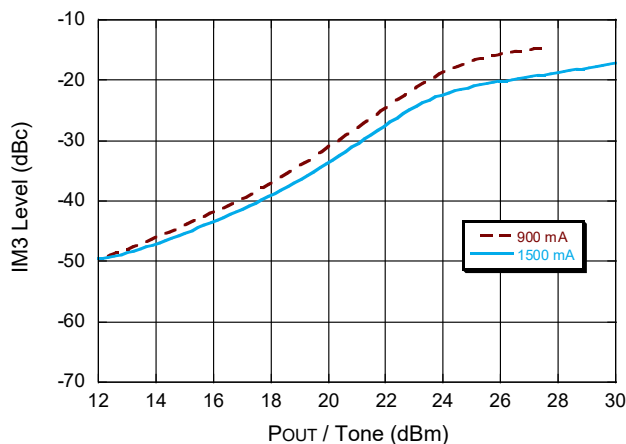
**IM3 vs. Output Power by Drain Current @ 29 GHz**



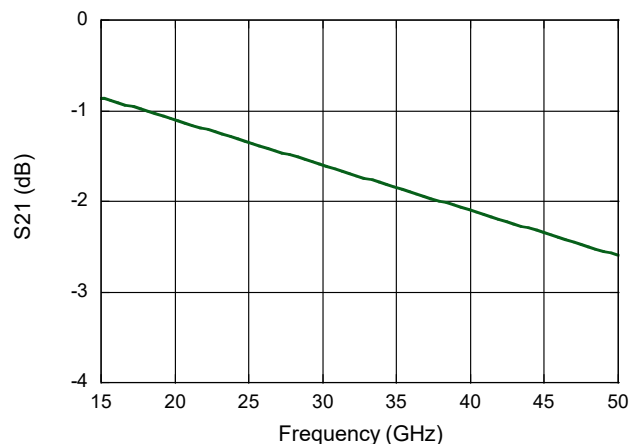
**Output IP3 vs. Output Power @ 29 GHz**



**IM3 vs. Output Power by Drain Current @ 31 GHz**



**Sample Board Thru Loss**





# Power Amplifier, 2 W 27.5 - 31.0 GHz

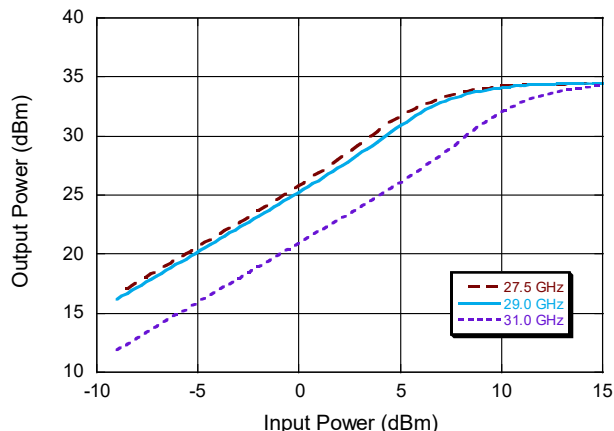


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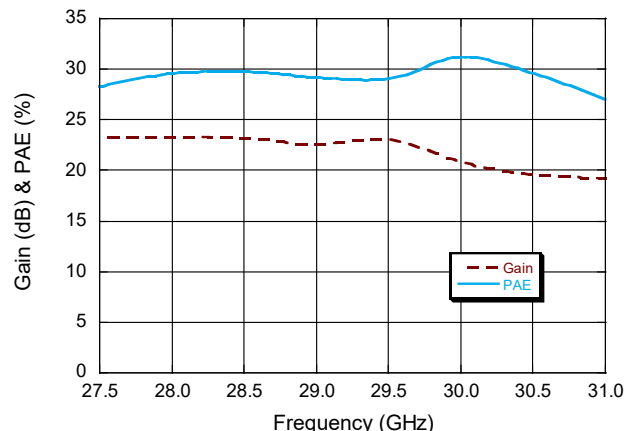
Rev. V1

Typical Performance Curves:  $V_D = 6\text{ V}$ ,  $I_{DSQ} = 900\text{ mA}$ ,  $V_G = -0.9\text{ V}$  typical,  $+25^\circ\text{C}$

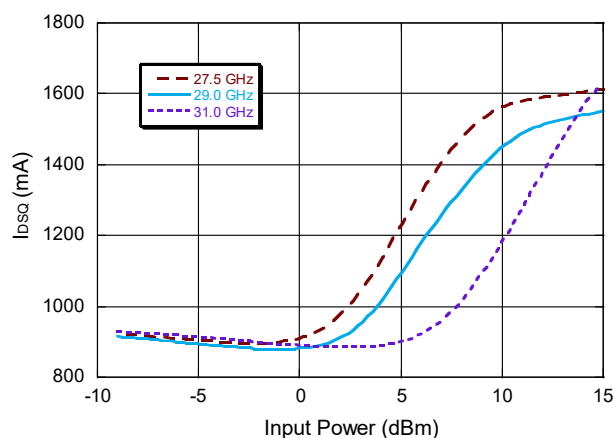
Output Power vs. Input Power



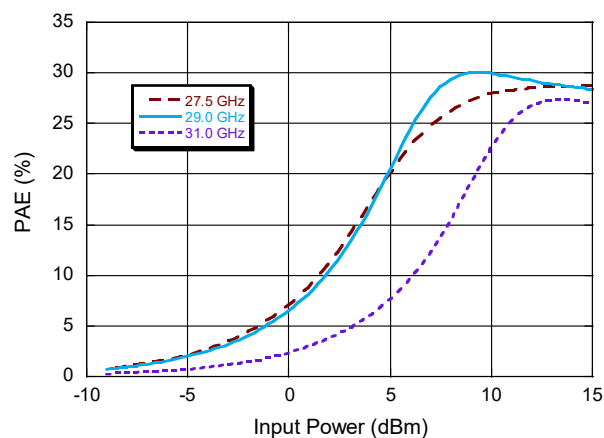
Gain and PAE @ P3dB vs. Frequency



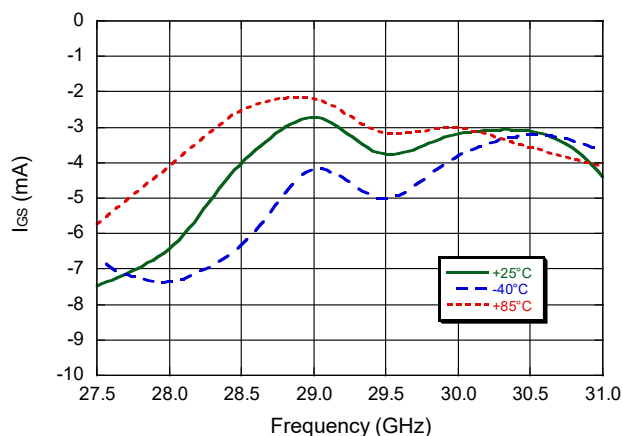
Bias Current vs. Input Power



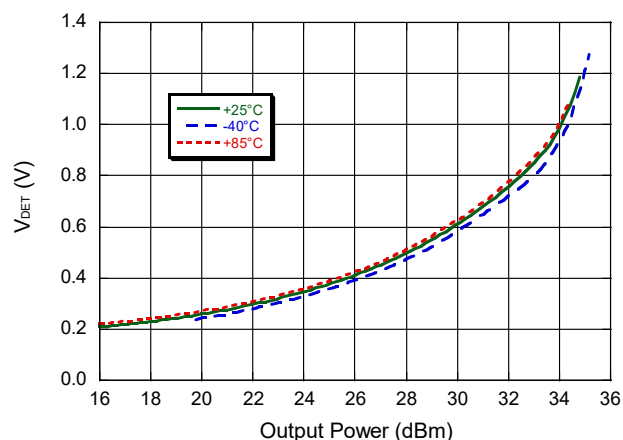
PAE vs. Input Power



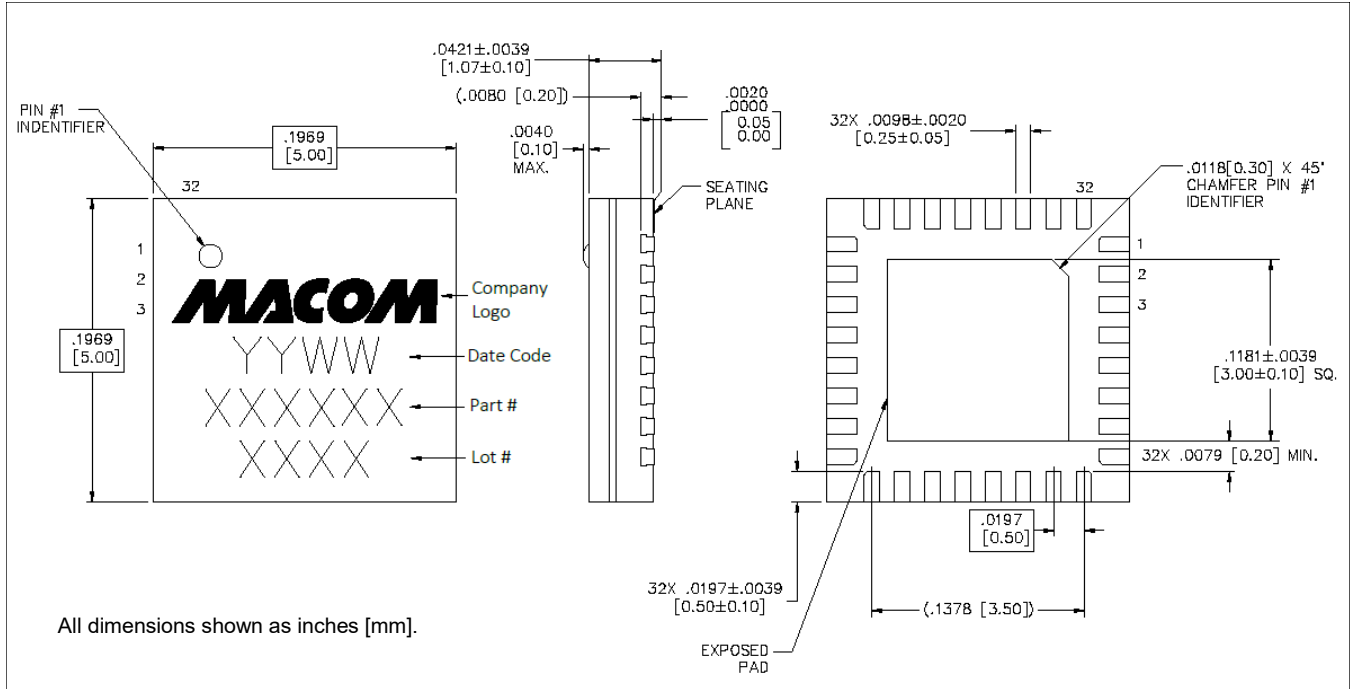
Gate Current @ P3dB



Detector Voltage vs. Output Power @ 30 GHz



**Lead-Free 5 mm 32-Lead AQFN Package<sup>†</sup>**



<sup>†</sup> Reference Application Note S2083 for lead-free solder reflow recommendations.  
 Meets JEDEC moisture sensitivity level 3 requirements.  
 Plating is NiPdAu.

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