MAAP-011298

Power Amplifier, 2.3 W
27 - 31.5 GHz

Rev. V1

Features

- High Gain: 24.5 dB
- P1dB: 32.5 dBm
- P3dB: 33.5 dBm
- IM3 Level: -17.5 dBc @ P_{OUT} = 30 dBm/tone
- Power Added Efficiency: 26% @ P3dB
- Temperature Compensated Output Power Detector
- Lead-Free 5 mm AQFN 32-lead Package
- RoHS* Compliant

Description

The MAAP-011298 is a 2.3 Watt, 4-stage power amplifier assembled in a lead-free 5 mm 32-lead AQFN plastic package. This power amplifier operates from 27 to 31.5 GHz and provides 24.5 dB of linear gain, 2.3 W saturated output power and 26% efficiency while biased at 6 V.

The MAAP-011298 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.

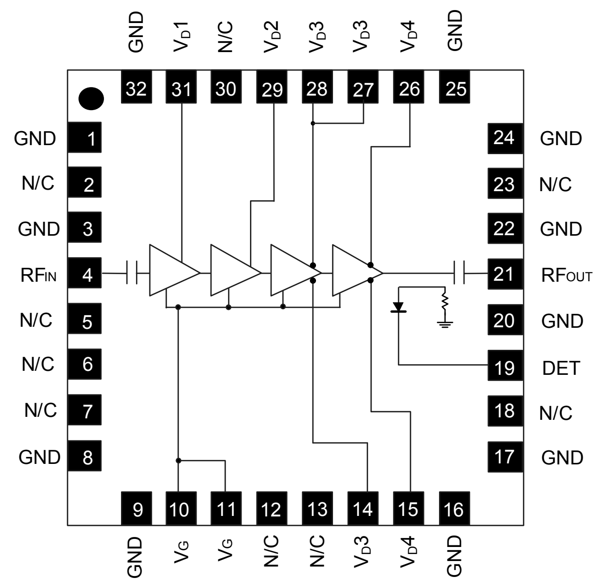
This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

Ordering Information[1,2]

Part Number	Package
MAAP-011298-TR0500	500 piece reel
MAAP-011298-SMB	sample board

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

Functional Schematic



Pin Configuration[3,4]

Pin #	Pin Name	Description
4	RF_{IN}	RF Input
10, 11	V_G	Gate Voltage
14, 27, 28	V_D3	Drain Voltage 3
15, 26	V_D4	Drain Voltage 4
19	DET	Power Detector
21	RF_{OUT}	RF Output
29	V_D2	Drain Voltage 2
31	V_D1	Drain Voltage 1
1, 3, 8, 9, 16, 20, 22, 24, 25, 32	GND	Ground
2, 5 - 7, 12, 13, 18, 23, 30	N/C	No Connection

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°C, V_D = 6 V, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	P_{IN} = -5 dBm, 27 GHz P_{IN} = -5 dBm, 29 GHz P_{IN} = -5 dBm, 31 GHz	dB	21.0 24.0 22.0	26.5 27.0 24.0	—
Output Power	P_{IN} = 9.0 dBm, 27 GHz P_{IN} = 10.5 dBm, 29 GHz P_{IN} = 12.5 dBm, 31 GHz	dBm	31.0 33.0 32.0	33.0 34.5 34.0	—
IM3 Level	P_{OUT} = 30 dBm / tone	dBc	—	-17.5	—
Power Added Efficiency	P_{IN} = 12 dBm	%	—	26	—
Input Return Loss	P_{IN} = -20 dBm	dB	—	10	—
Output Return Loss	P_{IN} = -20 dBm	dB	—	10	—
Quiescent Current	I_{DSQ} (see bias conditions, page 4)	mA	—	1000	—
Drain Current (V_{D1} + V_{D2} + V_{D3} + V_{D4})	P_{IN} = 12 dBm	mA	—	1700	—

Maximum Operating Ratings

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

5. Operating at nominal conditions with junction temperature ≤ +160°C will ensure MTTF > 1 x 10^6 hours.
6. Junction Temperature (T_J) = T_C + Θ_{JC} * ((V * I) - (P_{OUT} - P_{IN}))
   Typical thermal resistance (Θ_{JC}) = 7.4 °C/W.
   a) For T_C = +25°C, P_{IN} = 10.5 dBm
      T_J = +80°C @ 6 V, 1.7 A, P_{OUT} = 34.5 dBm
   b) For T_C = +85°C, P_{IN} = 10.5 dBm
      T_J = +140°C @ 6 V, 1.6 A, P_{OUT} = 33.3 dBm

Absolute Maximum Ratings[7,8]

Parameter	Absolute Maximum
Input Power	15 dBm
Drain Voltage	+6.5 V
Gate Voltage	-3 to 0 V
Junction Temperature[9]	+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 effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

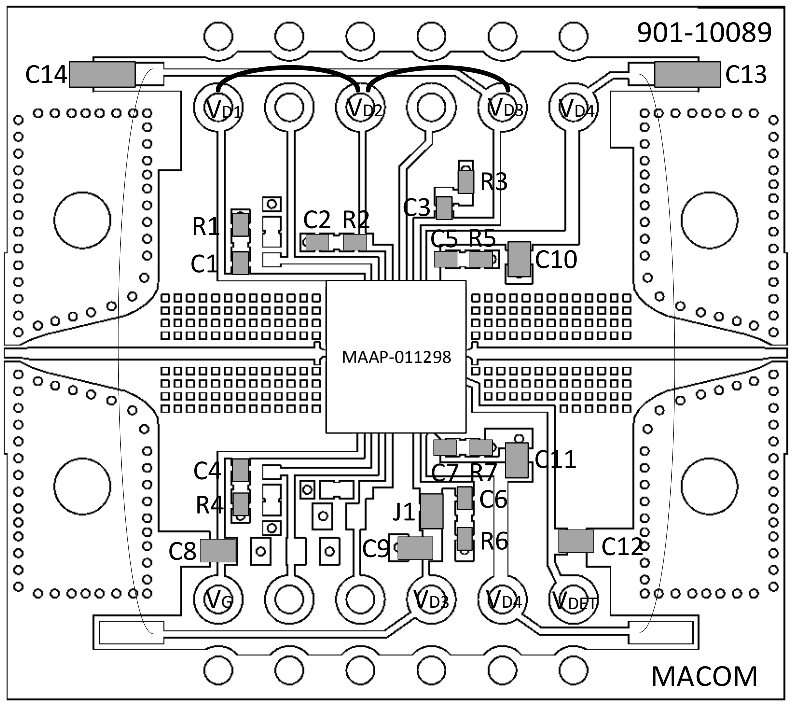
Handling Procedures

Please observe the following precautions to avoid damage:

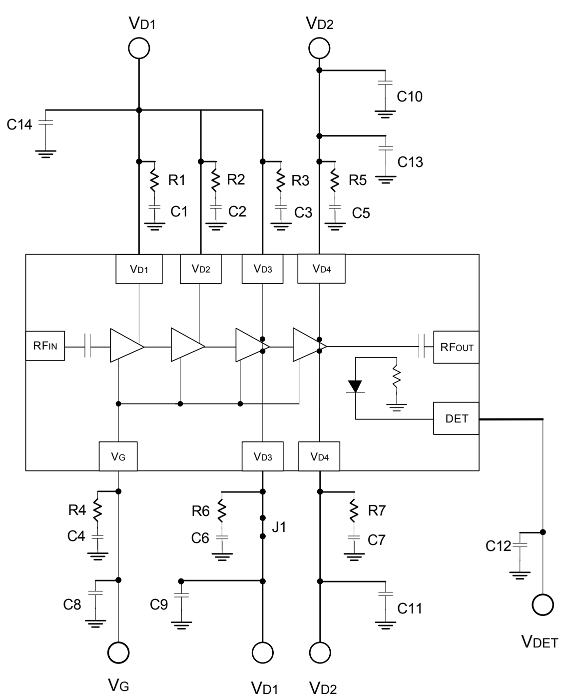
Static Sensitivity

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

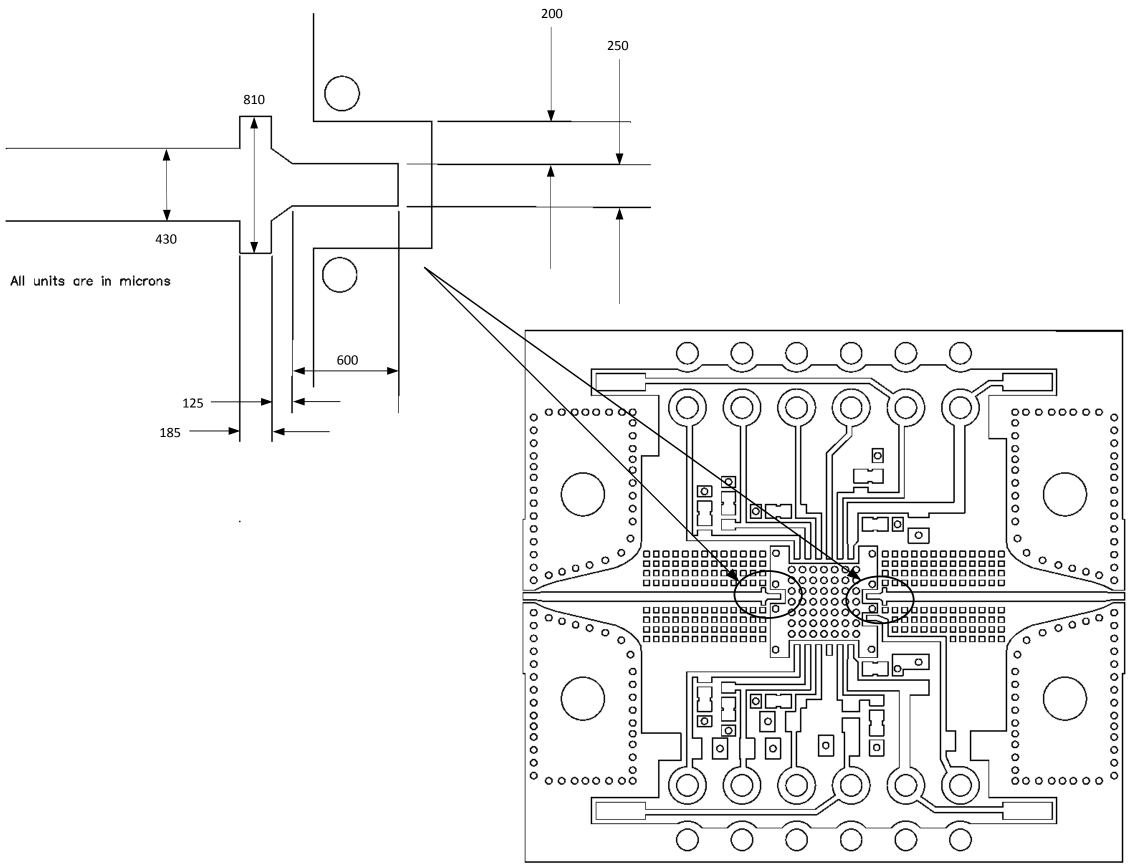
Part	Value	Case Style
C1 - C7	0.01 µF	0402
C8 - C12	1 µF	0603
C13 - C14	10 µF	0805
R1 - R7	10 Ω	0402
J1	jumper	0603

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 V, I_{DSQ} = 1000 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 V).

VD 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-011298

Turn-on

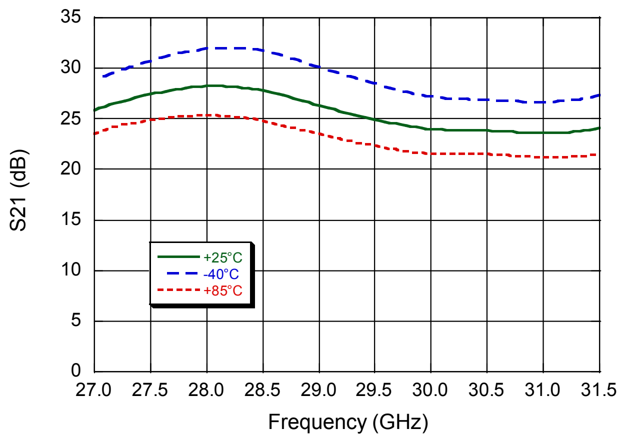
1. Apply V_G (-1.5 V).
2. Apply V_D (6.0 V typical).
3. Set I_{DQ} by adjusting V_G more positive (typically -0.9 to -1.0 V for I_{DSQ} = 1000 mA).
4. Apply RF_{IN} signal.

Turn-off

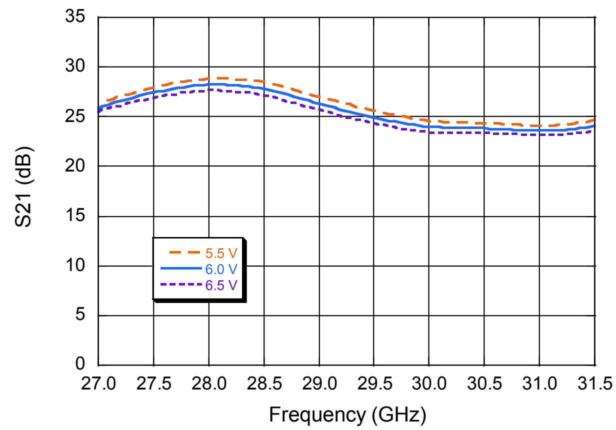
1. Remove RF_{IN} signal.
2. Decrease V_G to -1.5 V.
3. Decrease V_D to 0 V.

Typical Performance Curves: V_D = 6 V, I_{DSQ} = 1000 mA, V_G = -0.9 V typical

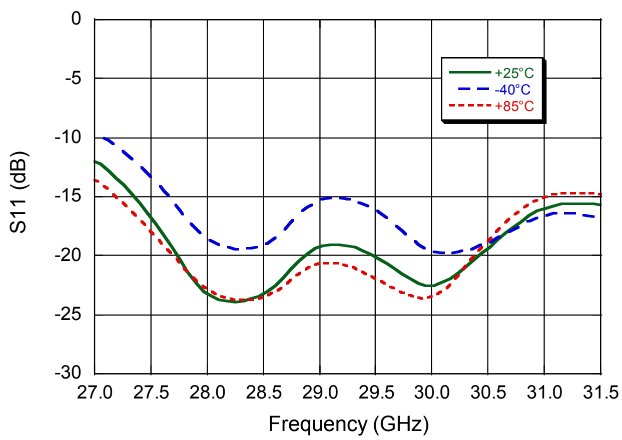
Small Signal Gain vs. Frequency over Temperature



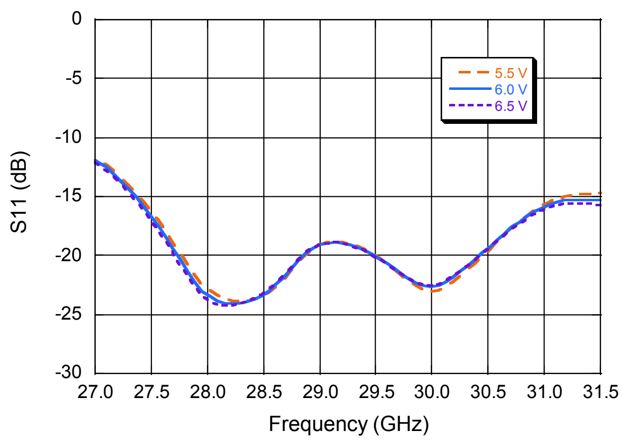
Small Signal Gain vs. Frequency over Bias Voltage



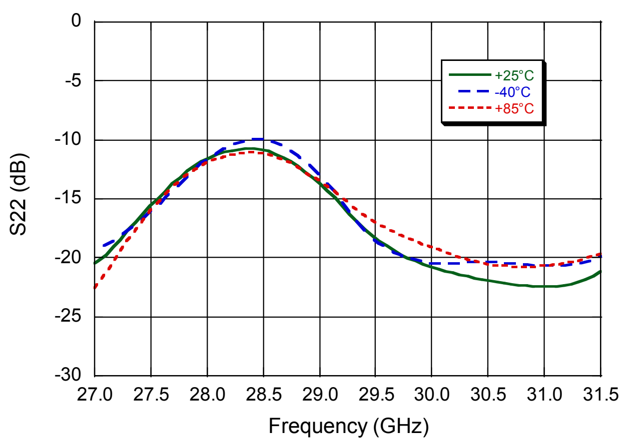
Input Return Loss vs. Frequency over Temperature



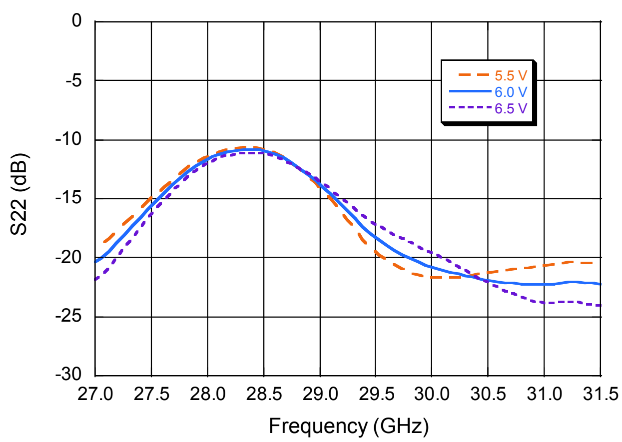
Input Return Loss vs. Frequency over Bias Voltage



Output Return Loss vs. Frequency over Temperature

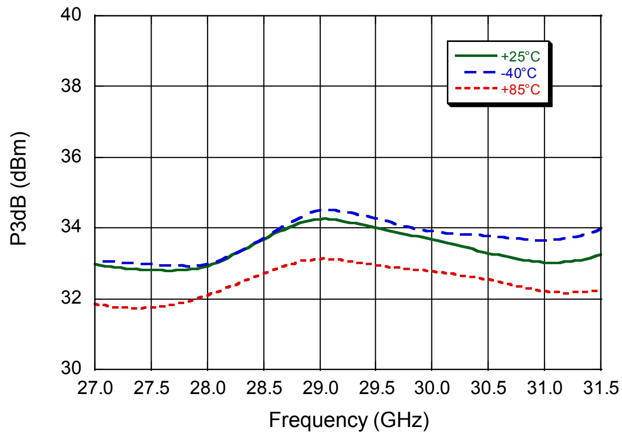


Output Return Loss vs. Frequency over Bias Voltage

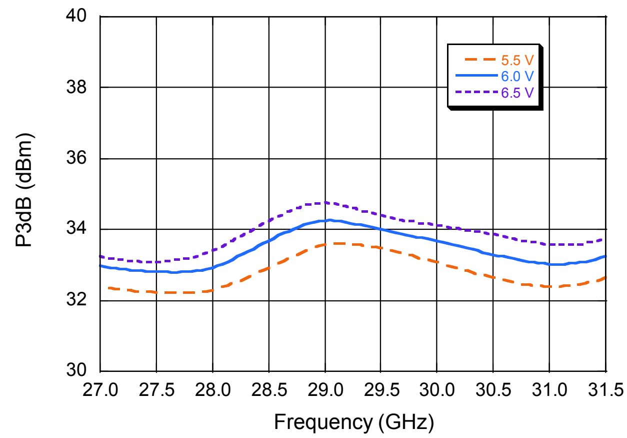


Typical Performance Curves: V_D = 6 V, I_{DSQ} = 1000 mA, V_G = -0.9 V typical

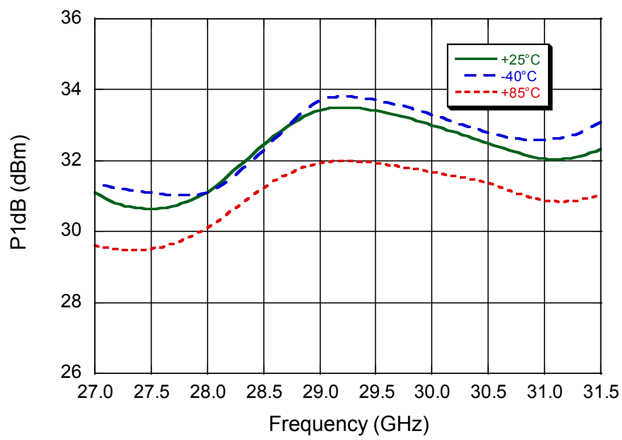
P3dB vs. Frequency over Temperature



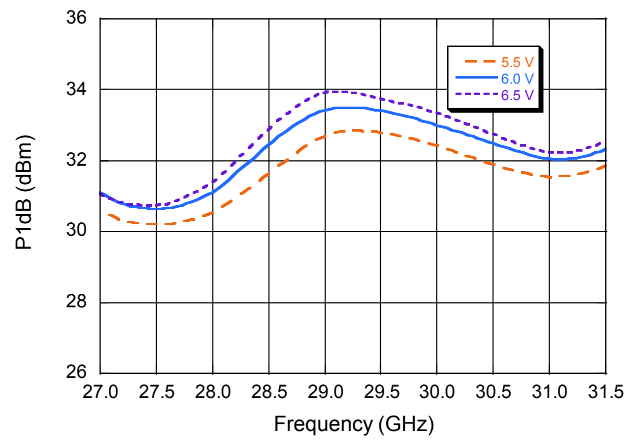
P3dB vs. Frequency over Bias Voltage



P1dB vs. Frequency over Temperature

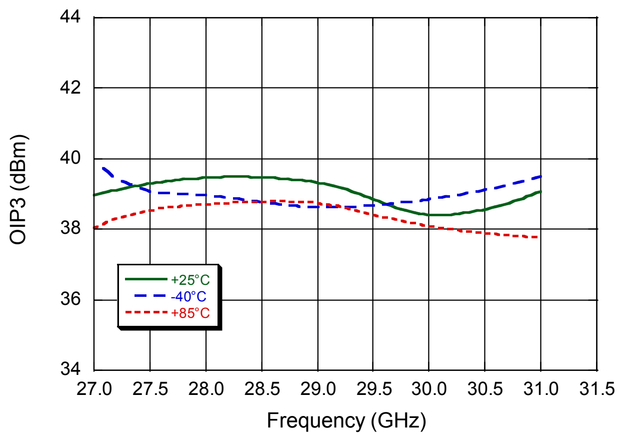


P1dB vs. Frequency over Bias Voltage

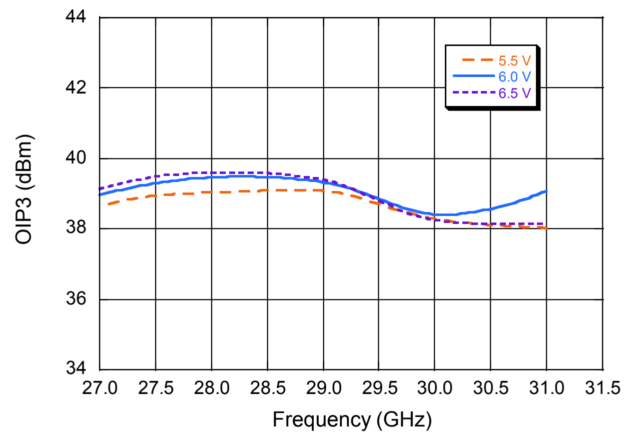


Typical Performance Curves: V_D = 6 V, I_{DSQ} = 1000 mA, V_G = -0.9 V typical

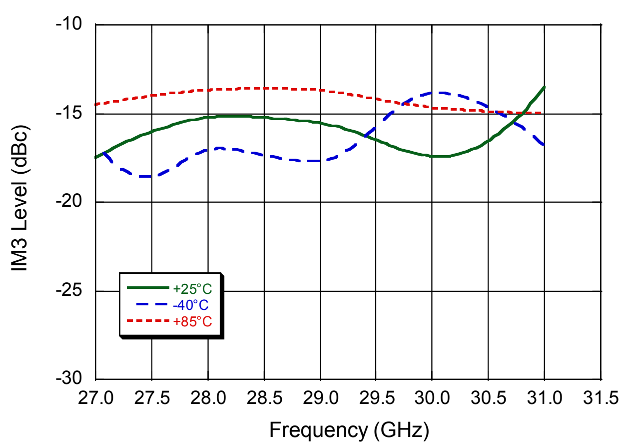
Output IP3 over Temperature (P_{OUT} = 30 dBm / Tone)



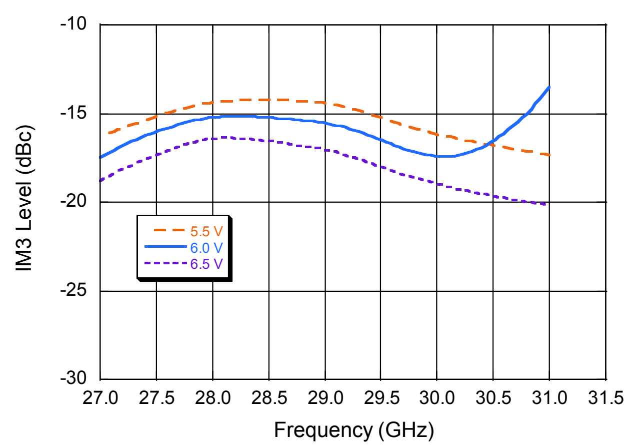
Output IP3 over Bias Voltage (P_{OUT} = 30 dBm / Tone)



IM3 over Temperature (P_{OUT} = 30 dBm / Tone)

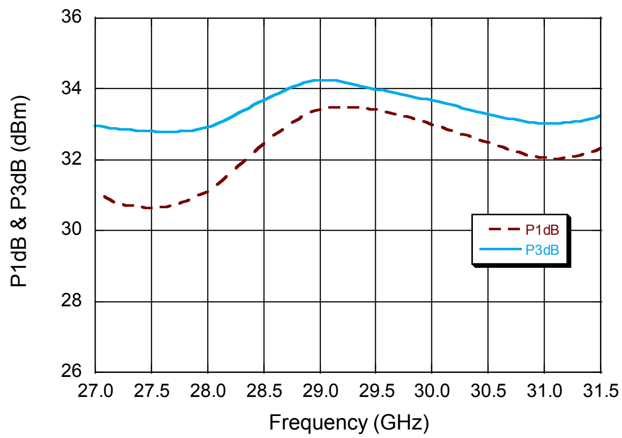


IM3 over Bias Voltage (P_{OUT} = 30 dBm / Tone)

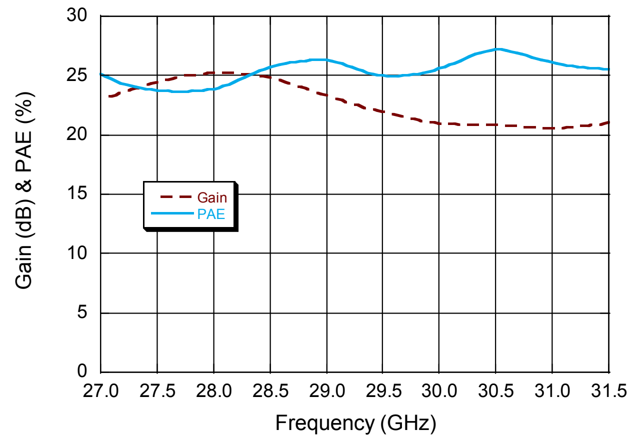


Typical Performance Curves: V_D = 6 V, I_{DSQ} = 1000 mA, V_G = -0.9 V typical

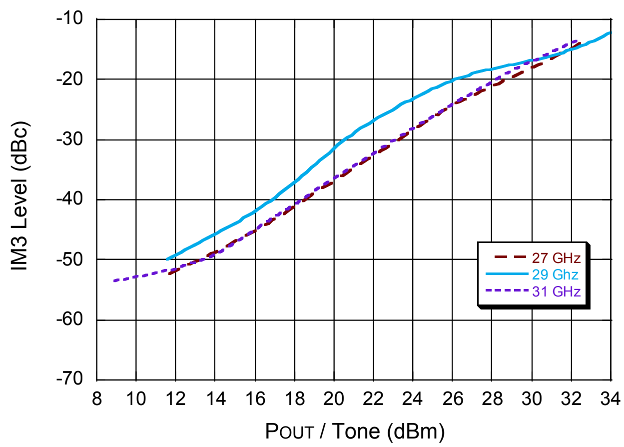
P1dB, P3dB vs. Frequency



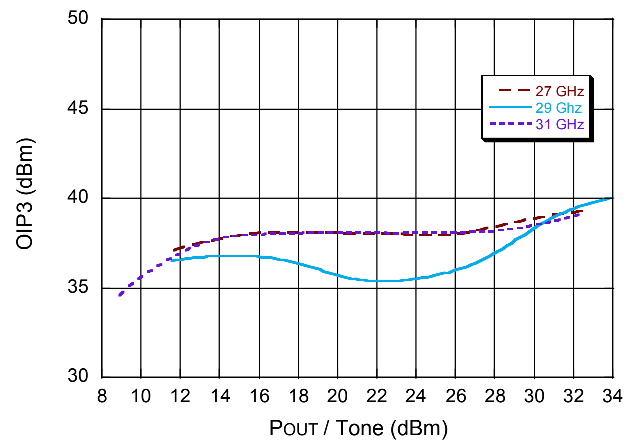
Gain and PAE @ P3dB vs. Frequency



IM3 vs. Output Power

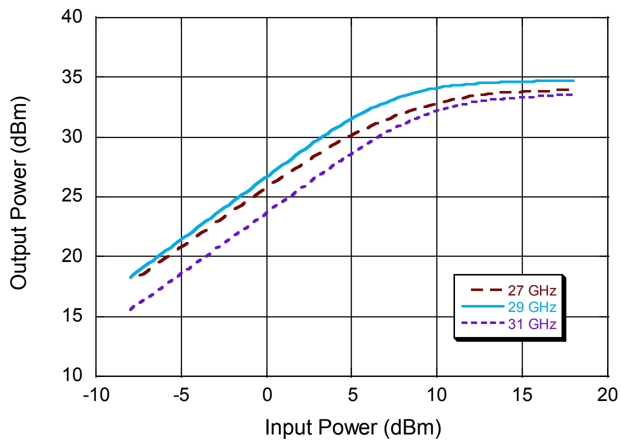


Output IP3 vs. Output Power

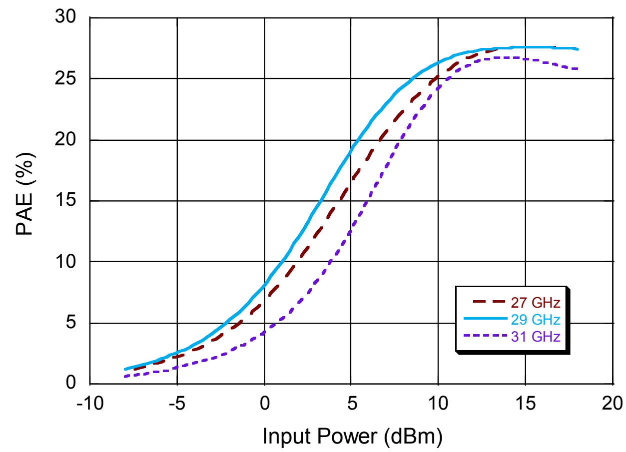


Typical Performance Curves: V_D = 6 V, I_{DSQ} = 1000 mA, V_G = -0.9 V typical

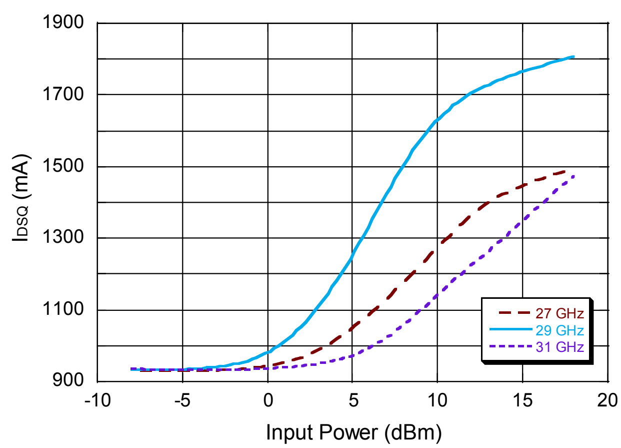
Output Power vs. Input Power



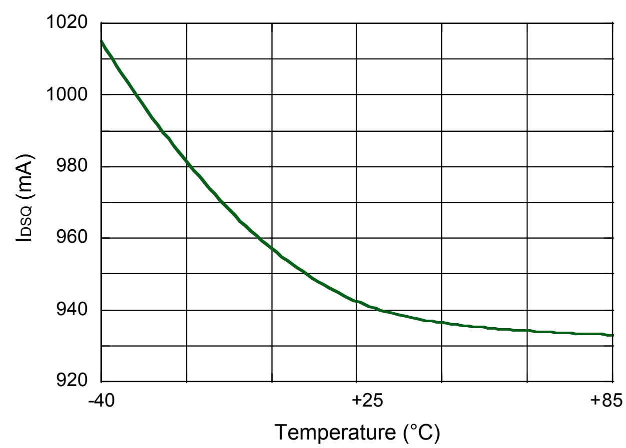
PAE vs. Input Power



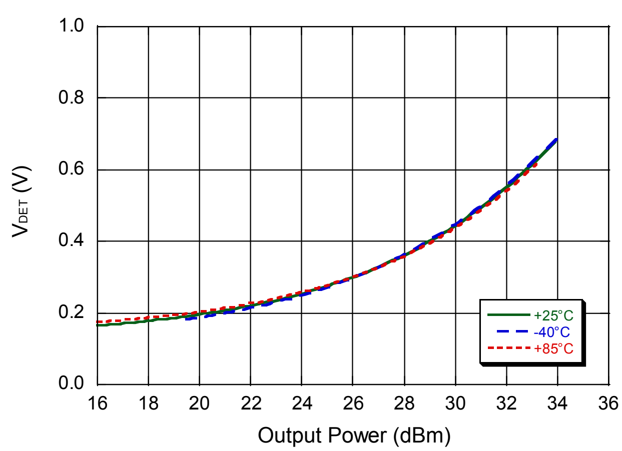
Bias Current vs. Input Power



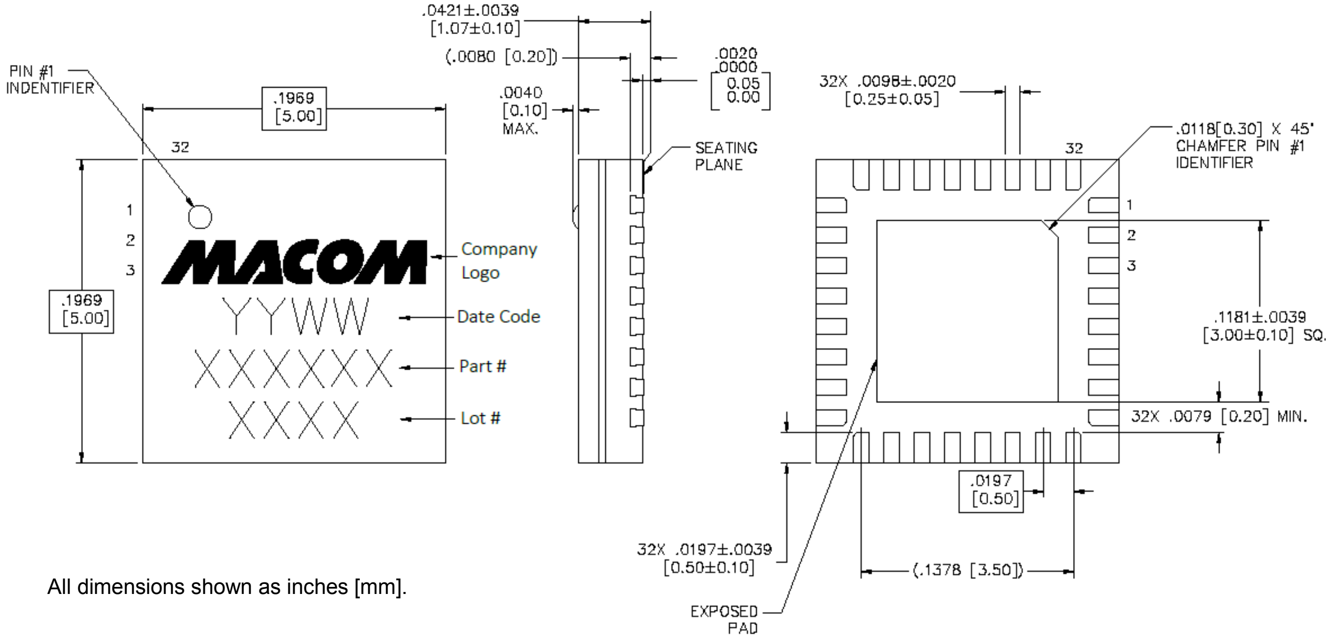
Quiescent Drain Current vs. Temperature



Detector Voltage vs. Output Power @ 30 GHz



Lead-Free 5 mm 32-Lead AQFN Package†



All dimensions shown as inches [mm].

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