MAAP-011139

Power Amplifier, 4 W
28.5 - 31 GHz

Rev. V1

Features

- High Gain: 22 dB @ 30 GHz
- P1dB: 34.5 dBm
- P_{SAT}: 36 dBm
- IM3 Level: -27 dBc @ P_{OUT} 29 dBm/tone
- Power Added Efficiency: 23% @ P_{SAT}
- Lead-Free 5 mm 32-lead AQFN Plastic Package
- RoHS* Compliant

Description

The MAAP-011139 is a 4-stage, 4 W power amplifier assembled in a lead-free 5 mm 32-lead AQFN plastic package. This power amplifier operates from 28.5 to 31 GHz and provides 22 dB of linear gain, 4 W saturated output power, and 23% efficiency while biased at 6 V.

The MAAP-011139 is a power amplifier ideally suited for VSAT communications.

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

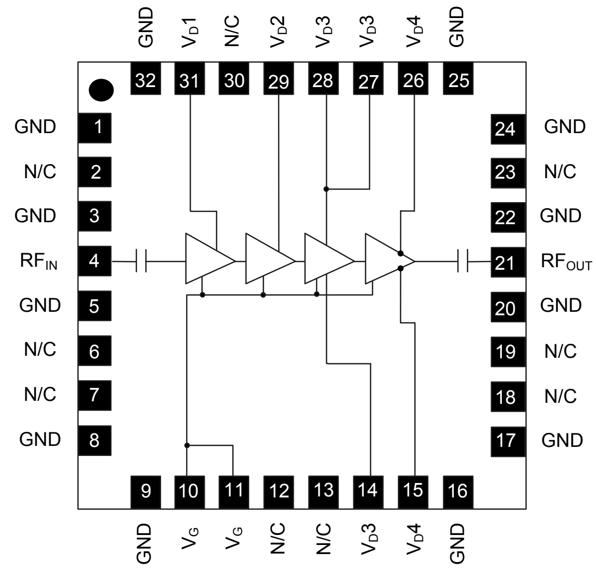
Ordering Information[1,2]

Part Number	Package
MAAP-011139-TR0500	500 piece reel
MAAP-011139-SMB	Sample Board

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

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

Functional Schematic



Pin Configuration[3]

Pin No.	Function	Pin No.	Function
1	Ground	18, 19	No Connection
2	No Connection	20	Ground
3	Ground	21	RF Output
4	RF Input	22	Ground
5	Ground	23	No Connection
6, 7	No Connection	24, 25	Ground
8, 9	Ground	26	Drain Voltage 4
10	Gate Voltage	27	Drain Voltage 3
11	Gate Voltage	28	Drain Voltage 3
12, 13	No Connection	29	Drain Voltage 2
14	Drain Voltage 3	30	No Connection
15	Drain Voltage 4	31	Drain Voltage 1
16, 17	Ground	32	Ground
		Paddle[4]	Ground

3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

Electrical Specifications: Freq. = 30 GHz, T_A = +25°C, V_D = 6 V, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	P_{IN} = 0 dBm	dB	19	22	—
P_{OUT}	P_{IN} = +17 dBm	dBm	34.5	36.0	—
IM3 Level	P_{OUT} = +29 dBm / tone	dBc	—	-27	—
Power Added Efficiency	P_{SAT} (P_{IN} = +17 dBm)	%	—	23	—
Input Return Loss	P_{IN} = -20 dBm	dB	—	10	—
Output Return Loss	P_{IN} = -20 dBm	dB	—	10	—
Quiescent Current	I_{DQ} (see bias conditions, page 5)	mA	—	2000	—
Current	P_{SAT} (P_{IN} = +17 dBm)	mA	—	2700	—

Maximum Operating Conditions

Parameter	Maximum
Input Power	+17 dBm
Junction Temperature[5,6]	+160°C
Operating Temperature	-40°C to +85°C

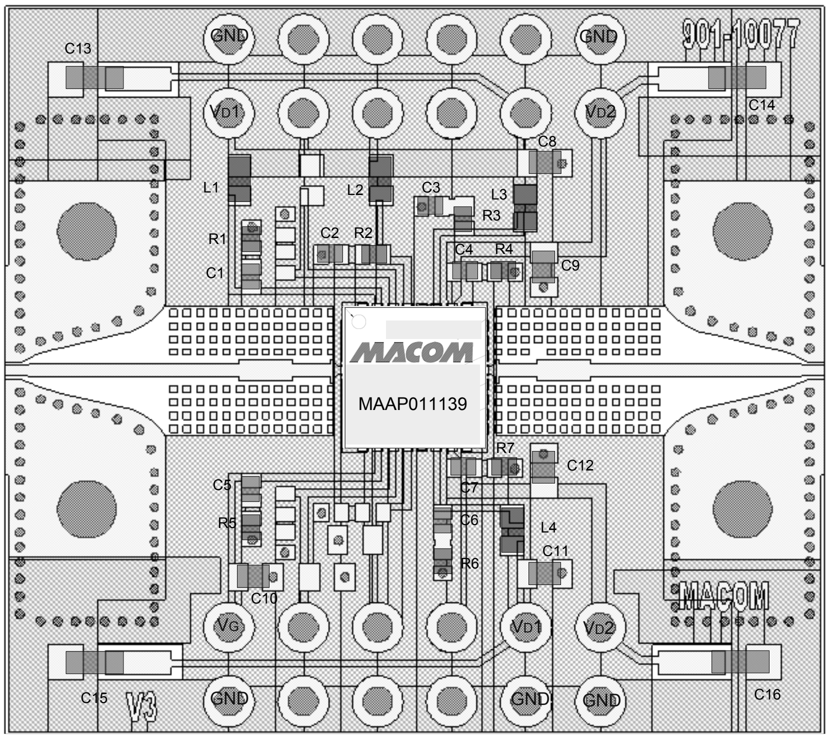
5. Operating at nominal conditions with junction temperature ≤ +160°C will ensure MTTF > 1 x 10^6 hours.
6. Junction Temperature (T_J) = T_C + Θ_{JC} * [(V * I) - (P_{OUT} - P_{IN})]. Typical thermal resistance (Θ_{JC}) = 4.4 °C/W.
   a) For T_C = +25°C,
      T_J = +79°C @ 6 V, 2.7 A, P_{OUT} = 36 dBm, P_{IN} = 17 dBm
   b) For T_C = +85°C,
      T_J = +143°C @ 6 V, 2.7 A, P_{OUT} = 35.1 dBm, P_{IN} = 17 dBm

Absolute Maximum Ratings[7,8]

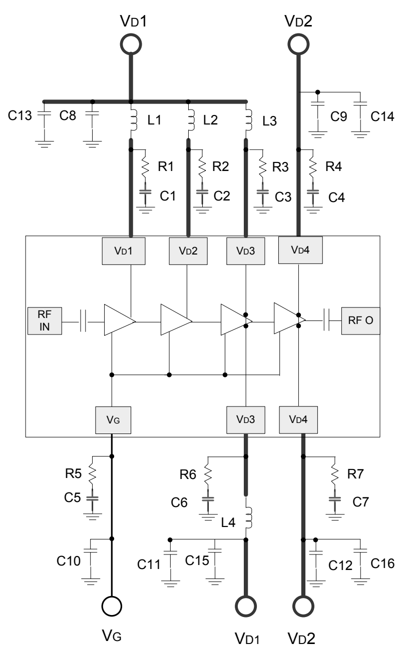
Parameter	Absolute Maximum
Input Power	+23 dBm
Drain Voltage	+6.5 V
Gate Voltage	-3 to 0 V
Junction Temperature[9]	+175°C
Storage Temperature	-65°C to +125°C

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.

Sample Board Layout



Application Schematic



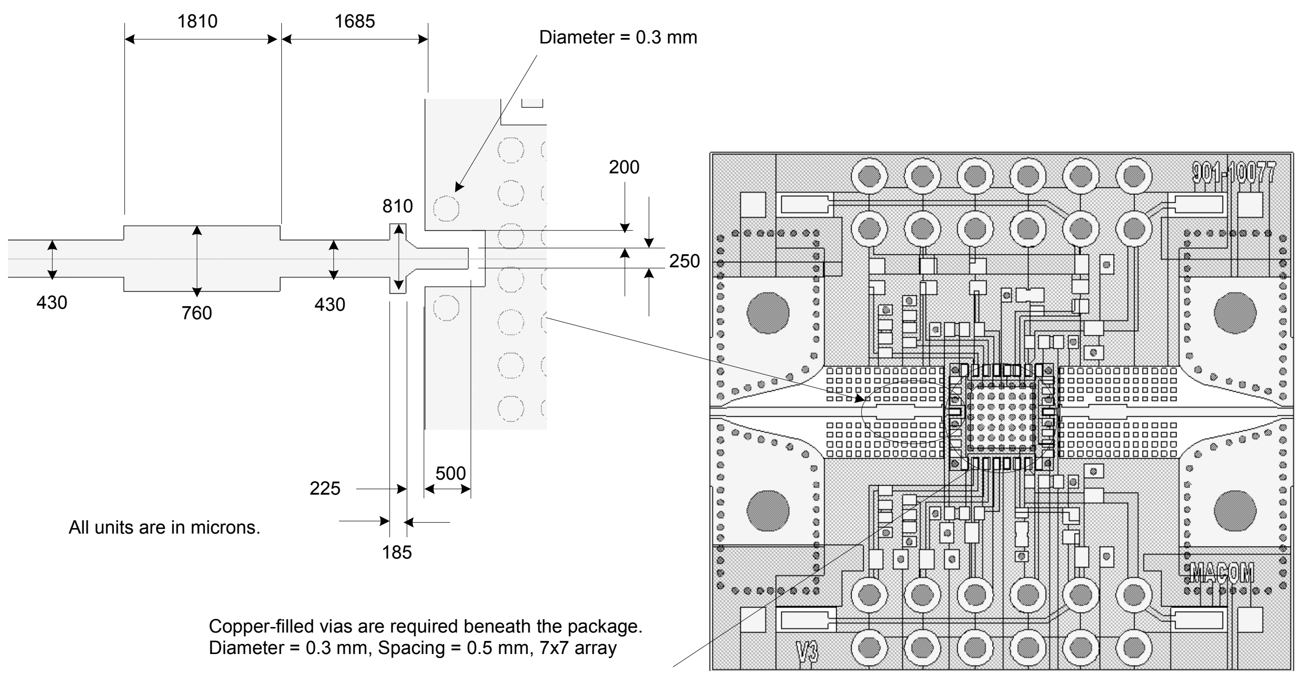
Parts List

Part	Value	Case Style
C1 - C7	0.01 µF	0402
C8 - C12	1 µF	0603
C13 - C16	10 µF	0805
R1 - R7	10 Ω	0402
L1 - L4 (Chip Ferrite Bead)	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

Sample Board Layout: RF input and output port pre-matching circuit patterns are designed to compensate for packaging effects. Input and output match patterns are identical.



Application Information

The MAAP-011139 is designed to be easy to use yet high performance. The ultra small size and simple bias allow easy placement on system board. RF input and output ports are DC de-coupled internally.

Biasing conditions

Recommended biasing conditions are V_D = 6 V, I_{DQ} = 2000 mA (controlled with V_G). The drain bias voltage range is 3 to 6 V, and the quiescent drain current biasing range is 1500 to 2500 mA.

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).

V_D bias must be applied to V_D1, V_D2, V_D3, and V_D4 pins.

V_D3 pins 14 and either pin 27 or 28 are required for current symmetry. Pins 27 and 28 are connected internally; choose either pin for layout convenience.

Both V_D4 pins 15 and 26 are required for current symmetry.

Operating the MAAP-011139

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 V_G~ -0.9 V for I_{DQ} = 2000 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.

Handling Procedures

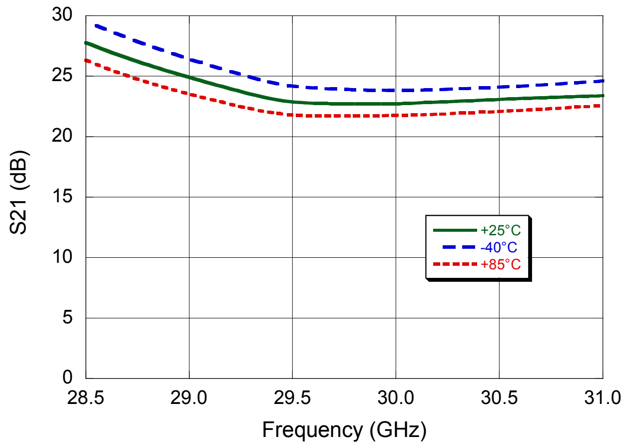
Please observe the following precautions to avoid damage:

Static Sensitivity

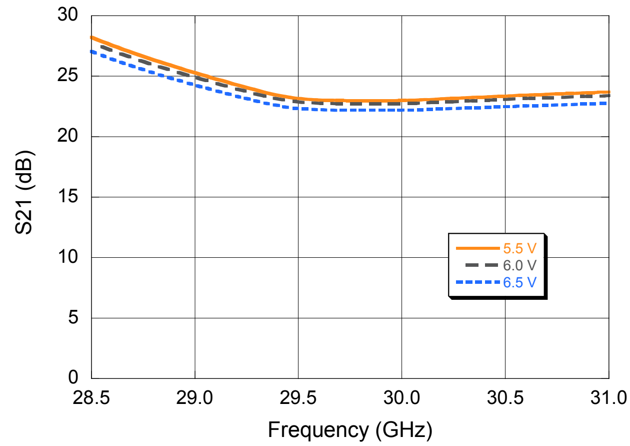
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A devices.

Typical Performance Curves

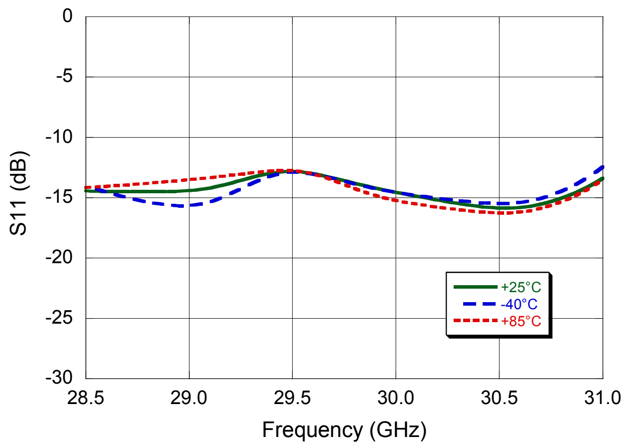
Small Signal Gain vs. Frequency over Temperature



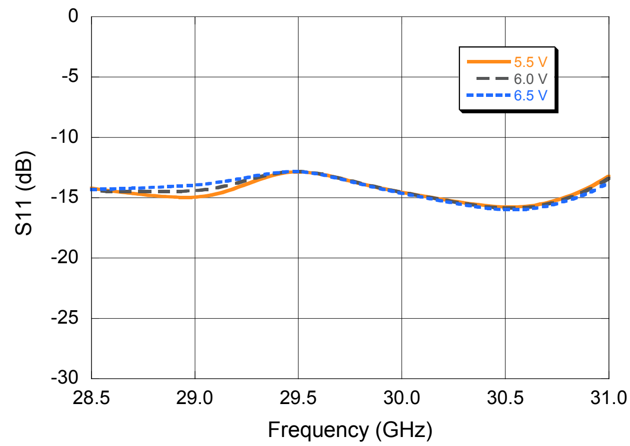
Small Signal Gain vs. Frequency over Bias Voltage



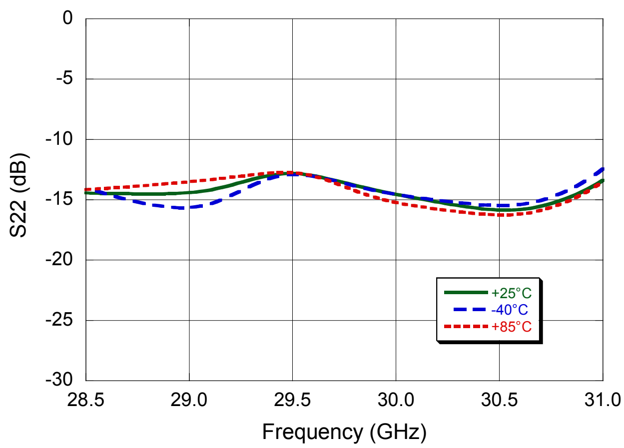
Input Return Loss vs. Frequency over Temperature



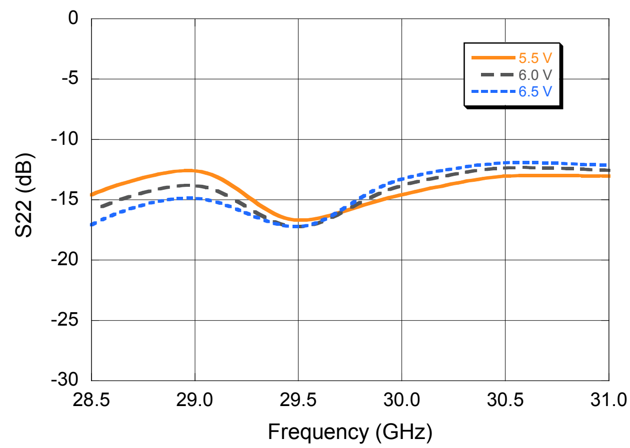
Input Return Loss vs. Frequency over Bias Voltage



Output Return Loss vs. Frequency over Temperature

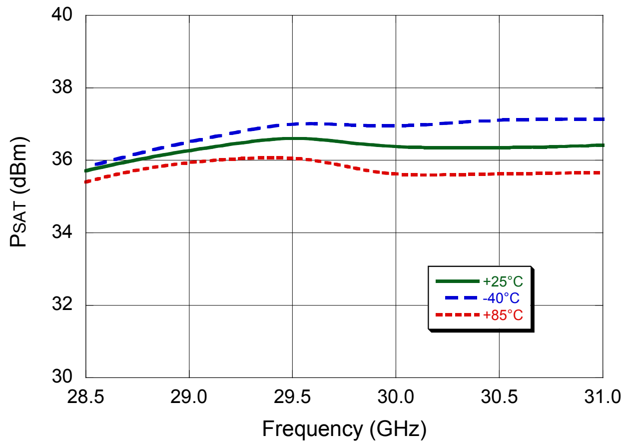


Output Return Loss vs. Frequency over Bias Voltage

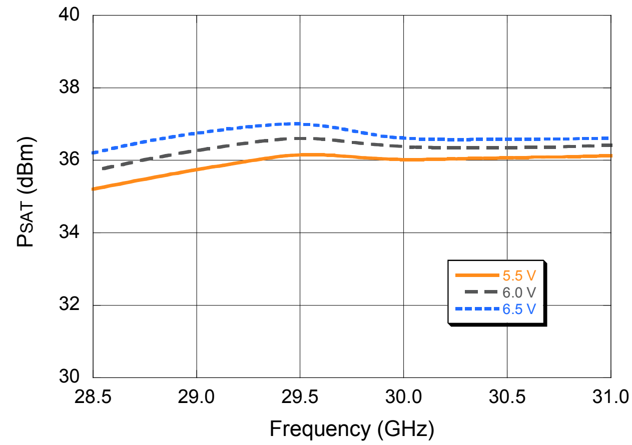


Typical Performance Curves

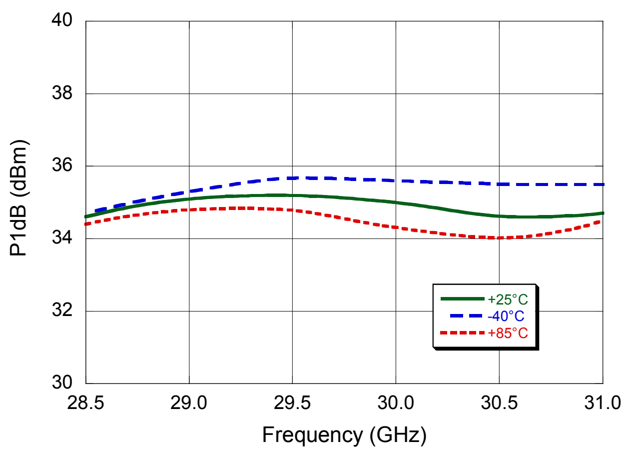
***P$_{SAT}$* vs. Frequency over Temperature**



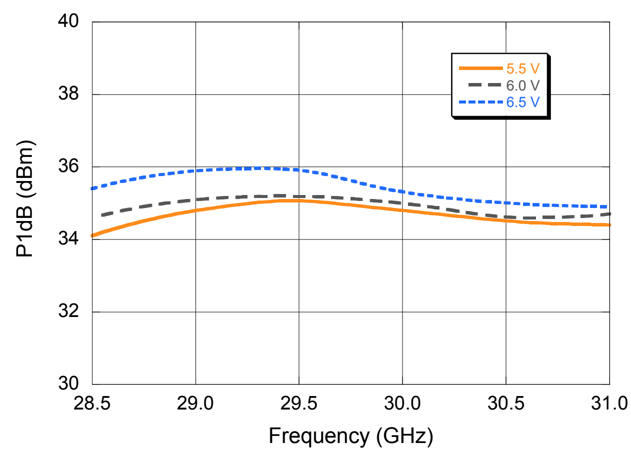
***P$_{SAT}$* vs. Frequency over Bias Voltage**



P1dB vs. Frequency over Temperature

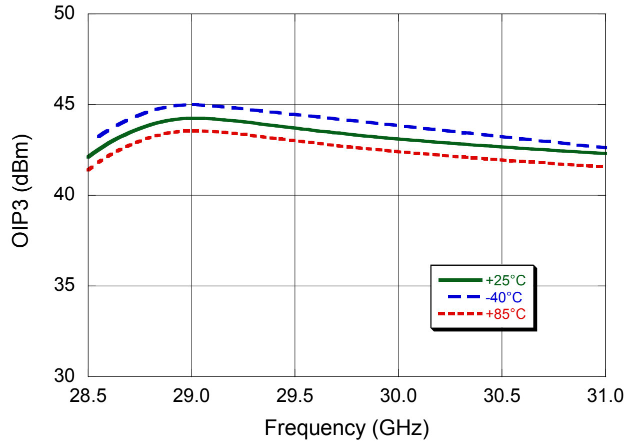


P1dB vs. Frequency over Bias Voltage

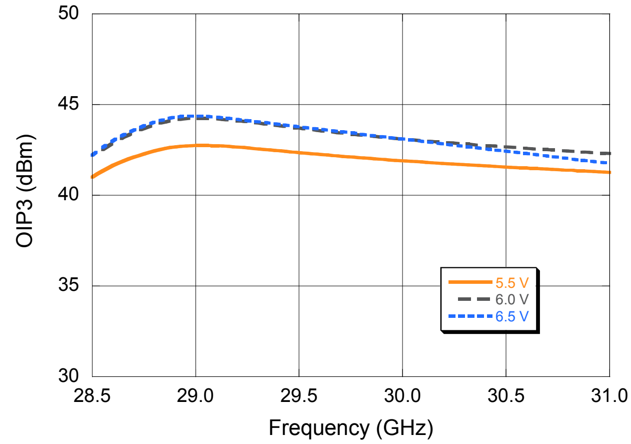


Typical Performance Curves

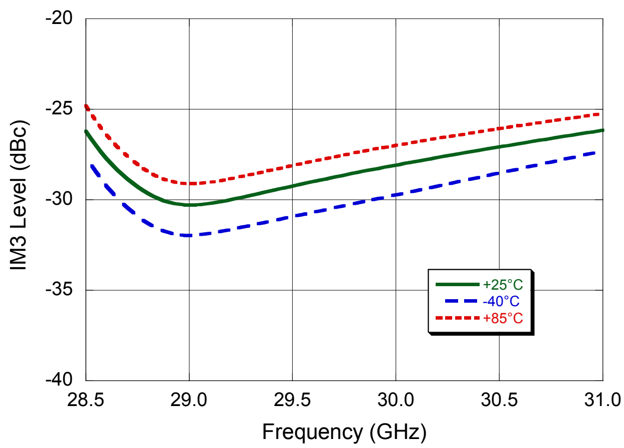
Output IP3 over Temperature (Pout=29 dBm/tone)



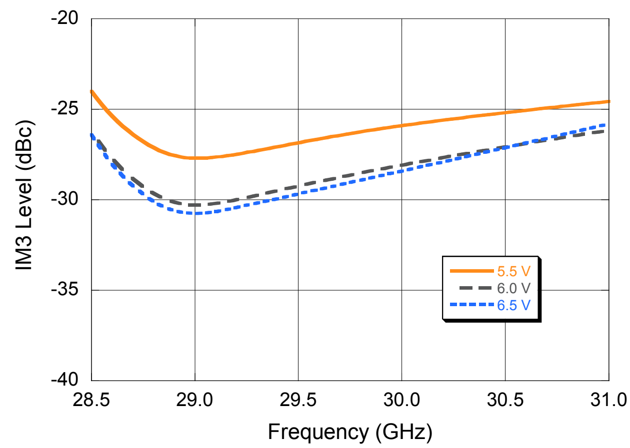
Output IP3 over Bias Voltage (Pout=29 dBm/Tone)



IM3 over Temperature (Pout=29 dBm/tone)

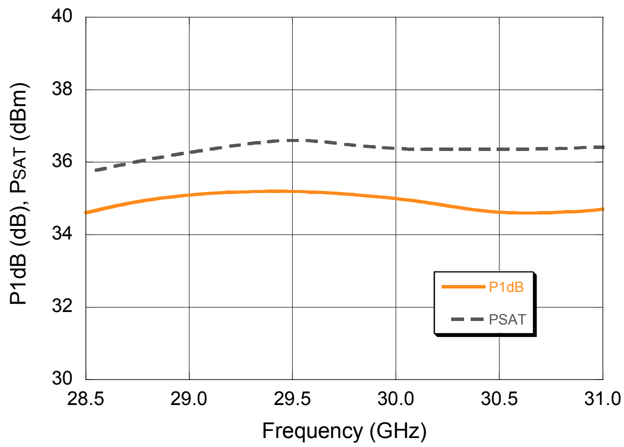


IM3 over Bias Voltage (Pout=29 dBm/tone)

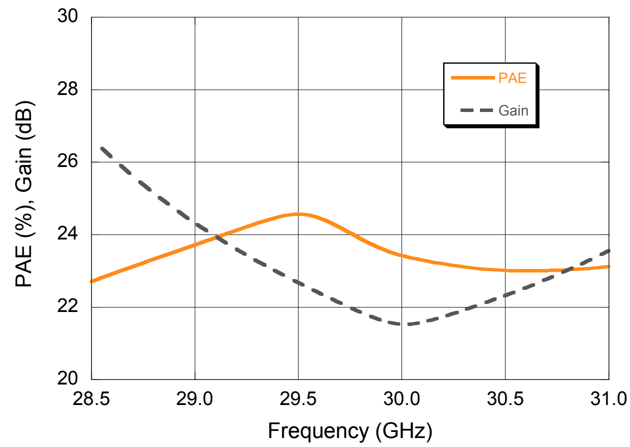


Typical Performance Curves

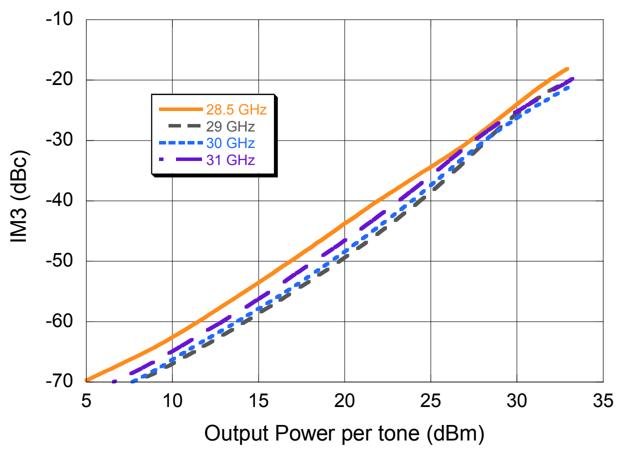
P1dB, P_{SAT} vs. Frequency



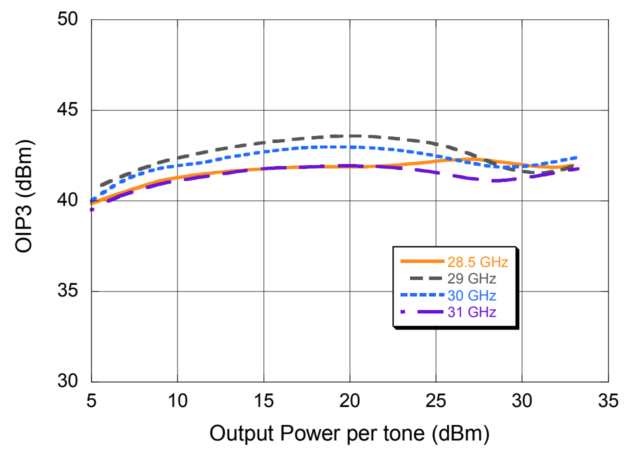
PAE, Gain vs. Frequency



IM3 vs. Output Power (per tone)

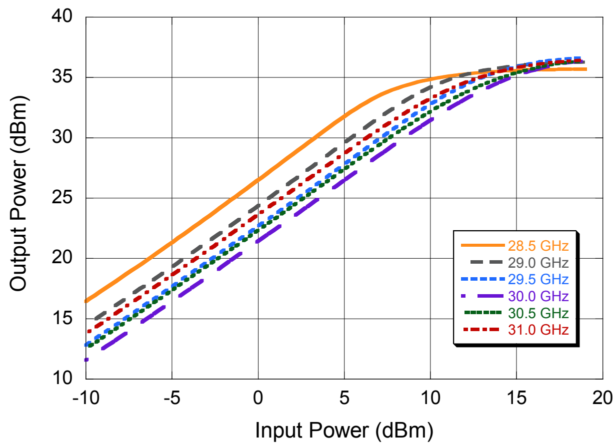


Output IP3 vs. Output Power (per tone)

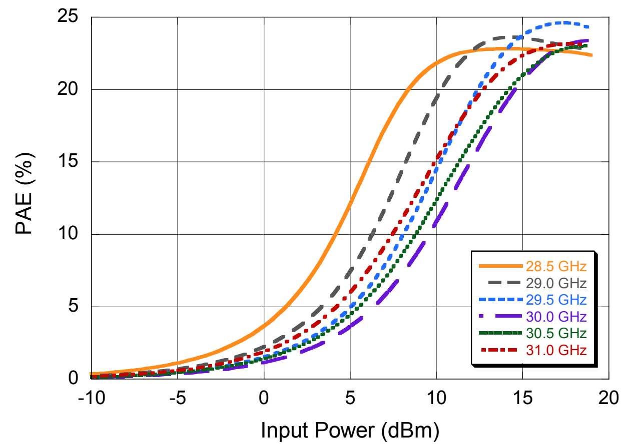


Typical Performance Curves

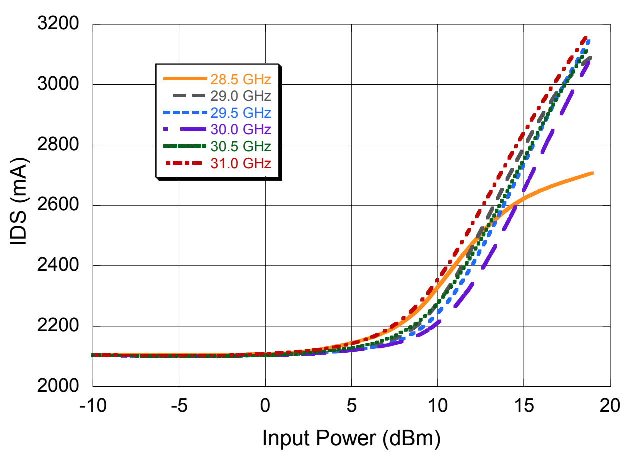
Output Power vs. Input Power



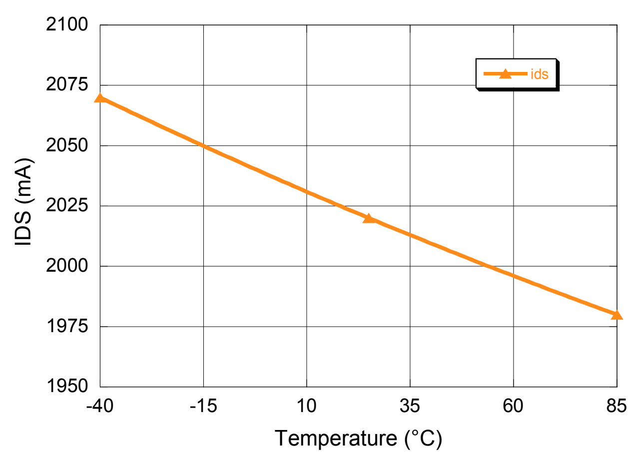
PAE vs. Input Power



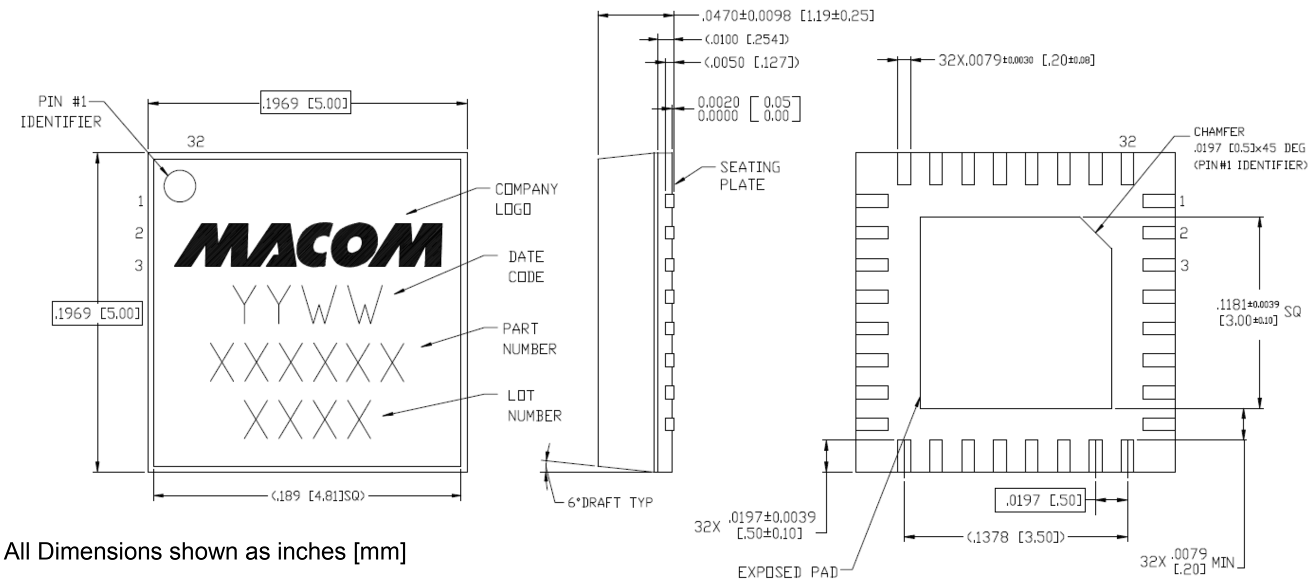
Bias Current vs. Input Power



Quiescent Drain Current vs. Temperature



Lead-Free 5 mm QFN 32-Lead†



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.