GaN Amplifier 50 V, 85 W
DC - 3.3 GHz

MACOM PURE CARBIDE

MAPC-A1106
Rev. V1

Features

- *MACOM PURE CARBIDE®* Amplifier Series
- Suitable for Linear & Saturated Applications
- CW & Pulsed Operation: 85 W Output Power
- Internally Pre-Matched
- 50 V Operation
- Compatible with MACOM Power Management Bias Controller/Sequencer MABC-11040

7.0 x 6.5 mm DFN

Applications

Military Radio Communications, RADAR, Avionics, Digital Cellular Infrastructure, RF Energy, and Test Instrumentation.

Description

The MAPC-A1106 is a high power GaN on Silicon Carbide HEMT D-mode amplifier suitable for DC - 3.3 GHz frequency operation. The device supports both CW and pulsed operation with output power levels of 85 W (49.3 dBm) in an air cavity ceramic package.

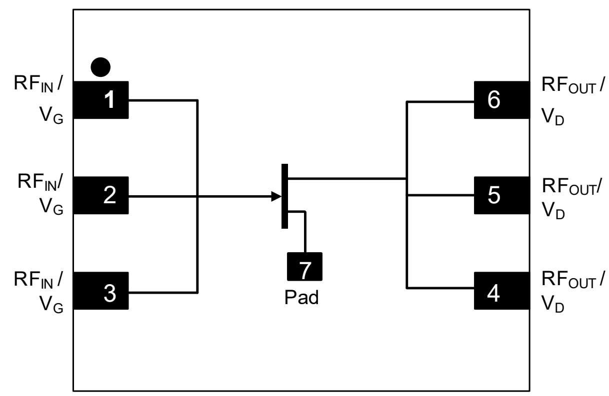
Typical Performance:

- Measured under load-pull at 2.5 dB compression, 100 µs pulse width, 10% duty cycle.
- V_{DS} = 50 V, I_{DQ} = 130mA, T_C = 25°C.

Frequency (GHz)	Output Power[1] (dBm)	Gain[2] (dB)	η_D [2] (%)
0.9	49.0	25.1	72.2
1.4	49.0	22.1	70.2
2.0	48.9	19.2	69.3
2.5	49.5	18.5	67.4
2.7	49.5	18.3	68.6
3.0	49.3	17.8	71.7
3.3	49.0	17.0	73.6

1. Load impedance tuned for maximum output power.
2. Load impedance tuned for maximum drain efficiency.

Functional Schematic



Pin Configuration

Pin #	Pin Name	Function
1,2,3	RF_{IN} / V_G	RF Input / Gate
4,5,6	RF_{OUT} / V_D	RF Output / Drain
7	Pad[3]	Ground / Source

3. The pad on the package bottom must be connected to RF, DC, and thermal ground.

Ordering Information

Part Number	Package
MAPC-A1106-AD000	Bulk Quantity
MAPC-A1106-ADTR1	Tape and Reel
MAPC-A1106-ADSB1	Sample Board

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

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 50 V, I_{DQ} = 130 mA
Note: Performance in MACOM Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed[4], 2.95 GHz	G_{SS}	-	18.9	-	dB
Power Gain	Pulsed[4], 2.95 GHz, 2.5 dB Gain Compression	G_{SAT}	-	16.4	-	dB
Saturated Drain Efficiency	Pulsed[4], 2.95 GHz, 2.5 dB Gain Compression	η_{SAT}	-	72.4	-	%
Saturated Output Power	Pulsed[4], 2.95 GHz, 2.5 dB Gain Compression	P_{SAT}	-	48.8	-	dBm
Gain Variation (-25°C to +85°C)	Pulsed[4], 2.95 GHz	ΔG	-	-0.014	-	dB/°C
Power Variation (-25°C to +85°C)	Pulsed[4], 2.95 GHz	ΔP2.5dB	-	-0.004	-	dB/°C
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 10:1, No Damage			

RF Electrical Specifications: T_A = 25°C, V_{DS} = 50 V, I_{DQ} = 130 mA
Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	Pulsed[4], 3.3 GHz, 2.5 dB Gain Compression	G_{SAT}	11.8	12.6	-	dB
Saturated Drain Efficiency	Pulsed[4], 3.3 GHz, 2.5 dB Gain Compression	η_{SAT}	58.5	63.4	-	%
Saturated Output Power	Pulsed[4], 3.3 GHz, 2.5 dB Gain Compression	P_{SAT}	46.7	47.6	-	dBm

4. Pulse details: 100 µs pulse width, 10% duty cycle.

DC Electrical Characteristics T_A = 25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 130 V	I_{DLK}	-	-	8.9	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	8.9	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 8.9 mA	V_T	-3.6	-2.8	-	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 130 mA	V_{GSQ}	-	-2.5	-	V
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 µs	$I_{D, MAX}$	-	7.6	-	A

Absolute Maximum Ratings [5,6,7,8,9]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	130 V
Gate Source Voltage, V_{GS}	-10 to 3 V
Gate Current, I_G	8.9 mA
Storage Temperature Range	-65°C to +150°C
Case Operating Temperature Range	-40°C to +85°C
Channel Operating Temperature Range, T_{CH}	-40°C to +225°C
Absolute Maximum Channel Temperature	+250°C

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation above maximum operating conditions.
7. Operating at drain source voltage V_{DS} < 55 V will ensure MTTF > 2 x 10^6 hours.
8. Operating at nominal conditions with T_{CH} ≤ 225°C will ensure MTTF > 2 x 10^6 hours.
9. MTTF may be estimated by the expression MTTF (hours) = A $e^{[B + C/(T+273)]}$ where *T* is the channel temperature in degrees Celsius, *A* = 1, B = -38.215, and C = 26,343.

Thermal Characteristics[10]

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	V_{DS} = 50 V, T_C = 85°C, T_{CH} = 225°C	R_θ(FEA)	3.0	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	V_{DS} = 50 V, T_C = 85°C, T_{CH} = 225°C	R_θ(IR)	2.2	°C/W

10. Case temperature measured using thermocouple embedded in heat-sink. Contact local applications support team for more details on this measurement.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

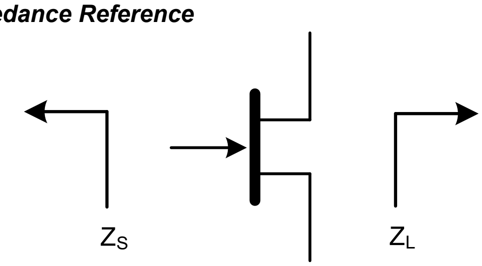
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

50 V Pulsed[4] Load-Pull Performance
Reference Plane at Device Leads

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Output Power V_{DS} = 50 V, I_{DQ} = 130 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
0.9	0.6 + j1.6	10.0 + j2.4	23.7	49.0	79.4	60.0	66.2
1.4	0.6 - j1.8	7.8 + j2.2	20.4	49.0	79.4	60.7	52.2
2.0	0.8 - j4.6	5.0 + j1.0	17.4	48.9	77.6	59.4	31.8
2.5	1.0 - j7.5	5.3 - j0.2	16.6	49.5	89.1	58.8	21.4
2.7	1.2 - j8.8	4.7 - j1.0	16.6	49.5	89.1	60.2	18.6
3.0	2.0 - j11.0	4.0 - j1.7	16.0	49.3	85.1	61.7	7.6
3.3	4.4 - j13.7	3.4 - j2.6	15.3	49.0	79.4	63.8	-17.2

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency V_{DS} = 50 V, I_{DQ} = 130 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[12] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
0.9	0.5 + j1.2	14.3 + j10.9	25.1	47.4	55.0	72.2	53.4
1.4	0.5 - j2.0	7.4 + j8.3	22.1	47.5	56.2	70.2	38.9
2.0	0.7 - j4.7	3.5 + j4.4	19.2	47.3	53.7	69.3	19.1
2.5	0.9 - j7.7	3.6 + j3.0	18.5	47.9	61.7	67.4	18.5
2.7	1.1 - j8.9	3.2 + j1.6	18.3	48.1	64.6	68.6	7.5
3.0	1.8 - j11.4	2.2 + j0.7	17.8	47.3	53.7	71.7	-3.3
3.3	4.4 - j14.6	2.1 - j0.6	17.0	47.0	50.1	73.6	-34.8

Impedance Reference

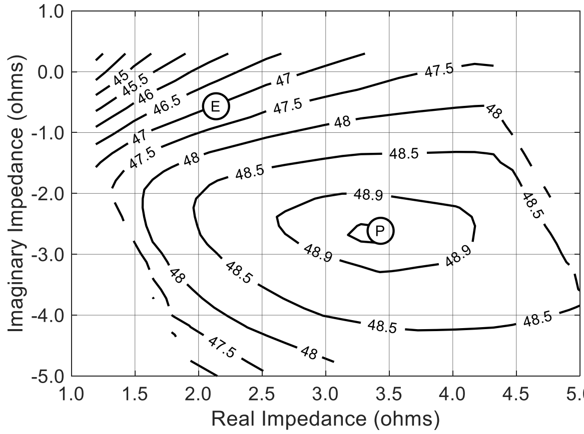


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

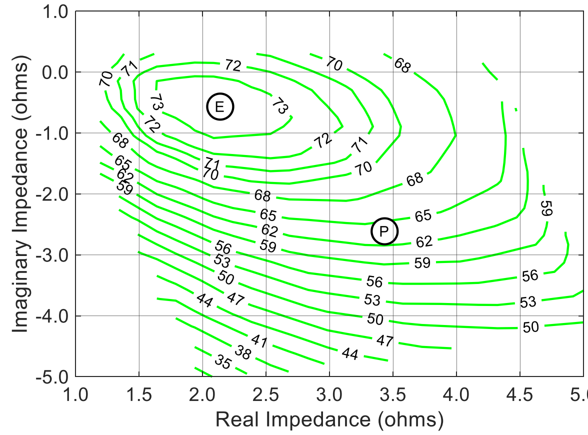
11. Load Impedance for optimum output power.
12. Load Impedance for optimum efficiency.

Pulsed[4] Load-Pull Performance @ 3.3 GHz

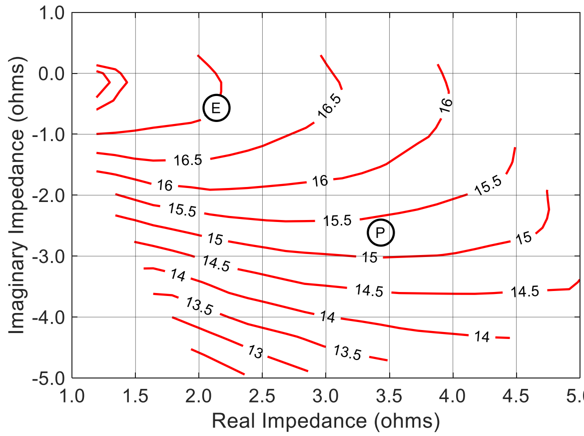
P2.5dB Loadpull Output Power Contours (dBm)



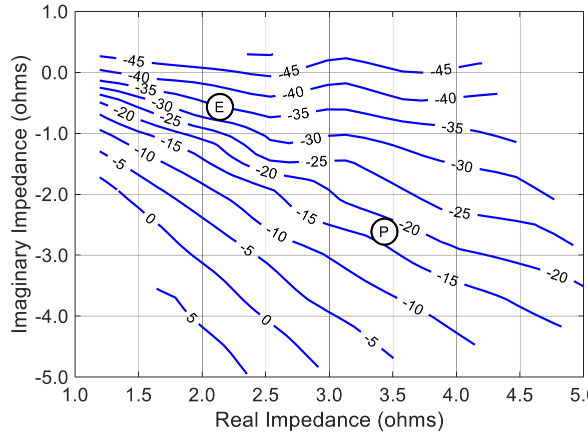
P2.5dB Loadpull Drain Efficiency Contours (%)



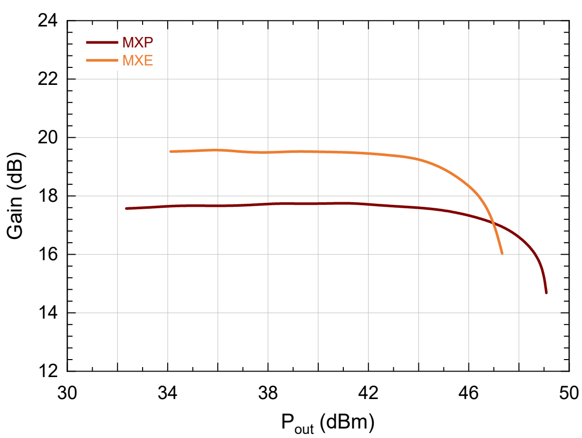
P2.5dB Loadpull Gain Contours (dB)



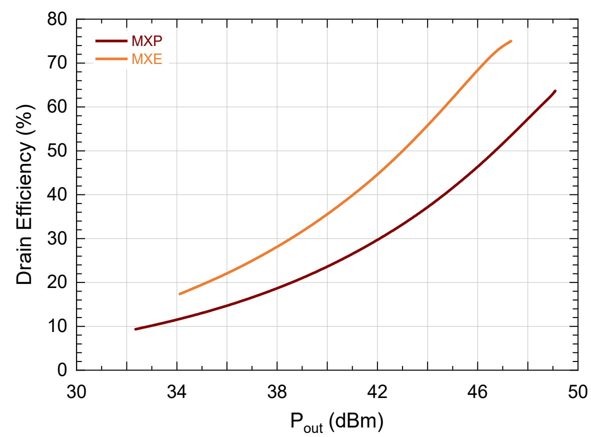
P2.5dB Loadpull AM/PM Contours (°)



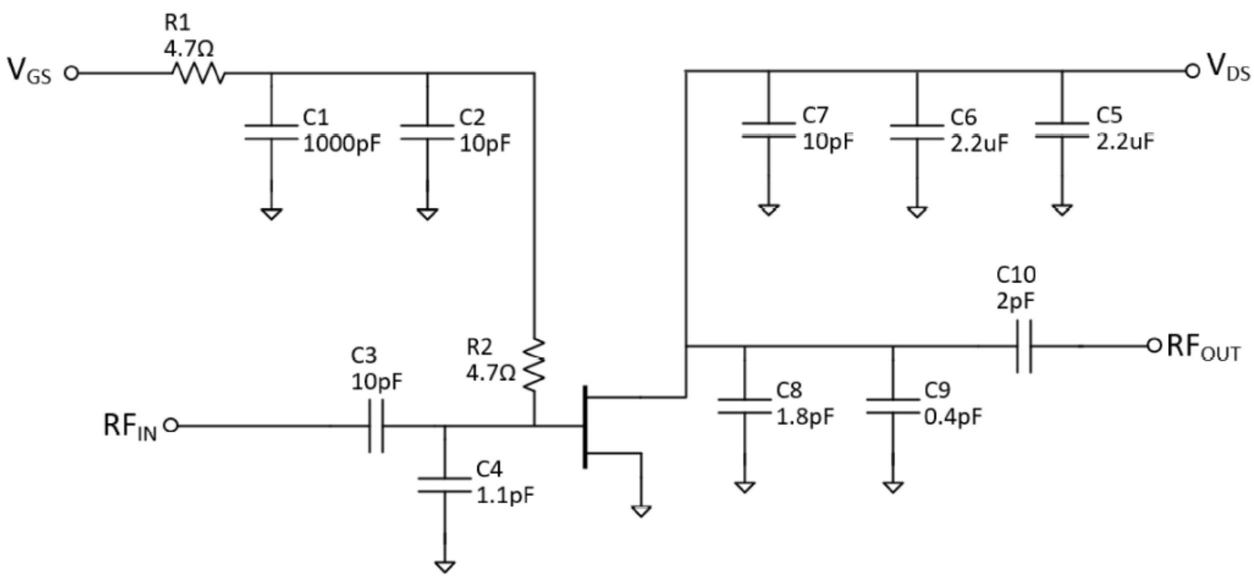
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Test Fixture and Recommended Tuning Solution 2.9 - 3.0 GHz



Description

Parts measured on evaluation board (20 mil thick RO4350B). Matching is provided using a combintion of lumped elements and transmission lines as shown in the simplified schematic above. Recommended tuning solution component placement, transmission lines, and details are shown on the next page.

Bias Sequencing*

Turning the device ON

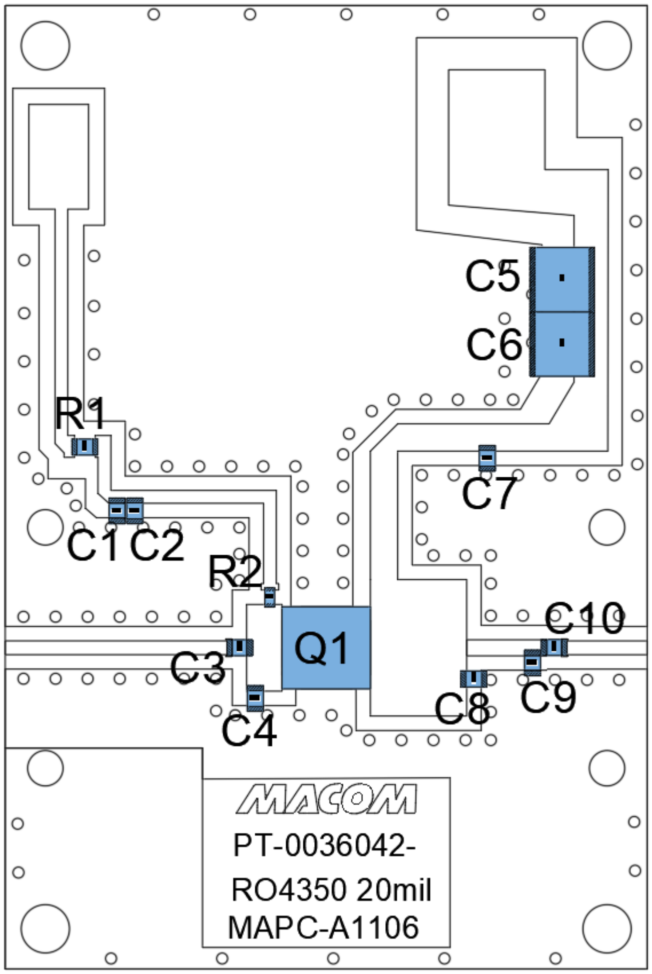
1. Set V_{GS} to pinch-off (V_P).
2. Turn on V_{DS} to nominal voltage (50 V).
3. Increase V_{GS} until I_{DS} current is reached.
4. Apply RF power to desired level.

Turning the device OFF

1. Turn the RF power OFF.
2. Decrease V_{GS} down to V_P pinch-off.
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}.

* For an integrated power management solution please contact MACOM support regarding the MABC-11040.

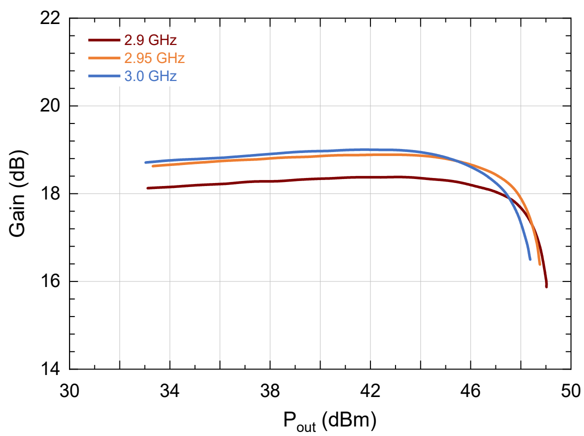
Evaluation Test Fixture and Recommended Tuning Solution 2.9 - 3.0 GHz



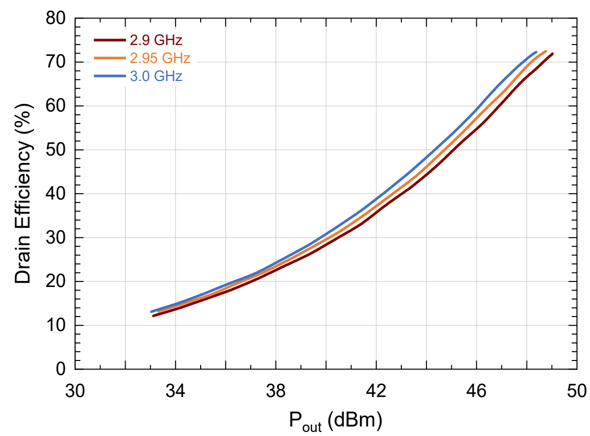
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	1000 pF	+/- 5%	Murata	GRM21A5C2E102JWA1J
C2, C3, C7	10 pF	+/-1%	Murata	GQM2195C2E100FB12D
C4	1.1 pF	+/- 0.1pF	Murata	GQM2195C2E1R1BB12D
C5, C6	2.2 µF	+/- 20%	Murata	KRM55TR72E225MH01L
C8	1.8 pF	+/- 0.1pF	Murata	GQM2195C2E1R8BB12D
C9	0.4 pF	+/- 0.1pF	Murata	GQM2195C2ER40BB12D
C10	2.0 pF	+/- 0.1pF	Murata	GQM2195C2E2R0BB12D
R1	4.7 Ω	+/- 5%	Panasonic	ERJHP6J4R7V
R2	4.7 Ω	+/- 5%	Panasonic	ERJH3GJ4R7V
Q1	MACOM GaN Power Amplifier			MAPC-A1106
PCB	RO4350B, 20 mil, 1 oz Cu, ENIG Finish			

Typical Performance Curves as Measured in the 2.9 - 3.0 GHz Evaluation Test Fixture: Pulsed[2] 2.95 GHz, V_{DS} = 50 V, I_{DQ} = 130 mA, T_C = 25°C (Unless Otherwise Noted)

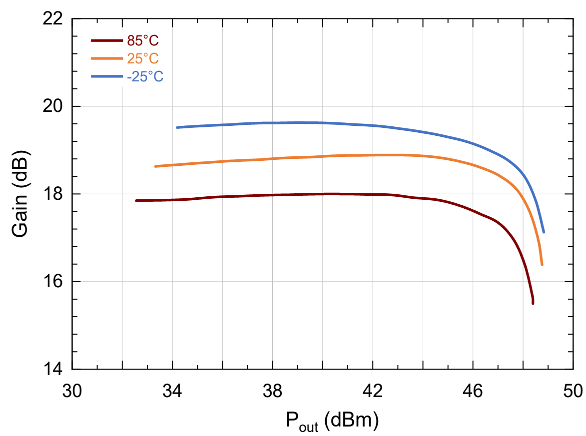
Gain vs. Output Power and Frequency



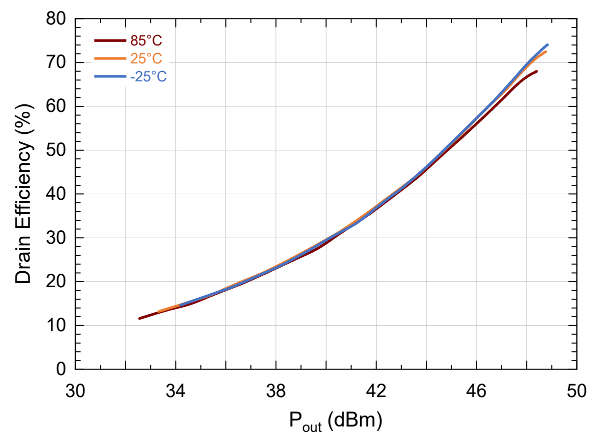
Drain Efficiency vs. Output Power and Frequency



Gain vs. Output Power and T_C

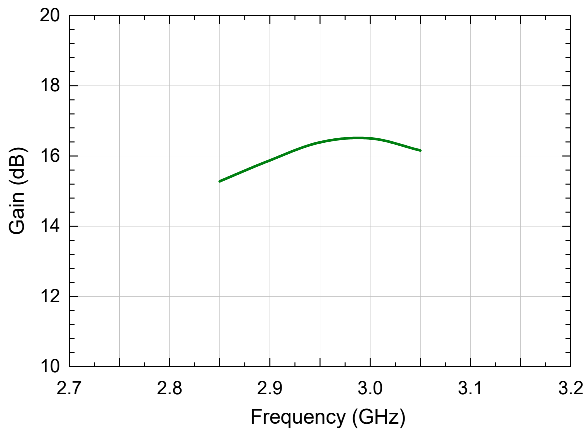


Drain Efficiency vs. Output Power and T_C

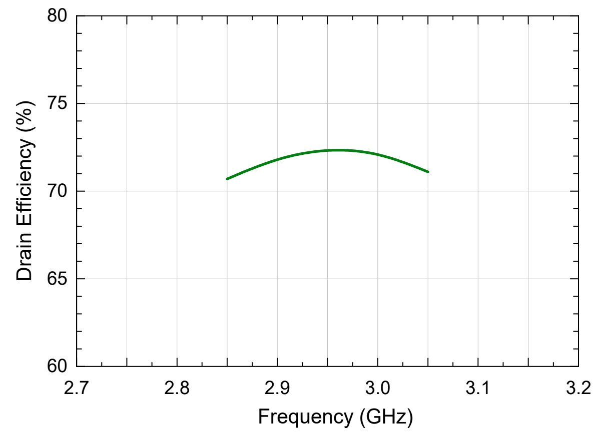


Typical Performance Curves as Measured in the 2.9 - 3.0 GHz Evaluation Test Fixture: Pulsed[2], V_{DS} = 50 V, I_{DQ} = 130 mA, T_C = 25°C (Unless Otherwise Noted)

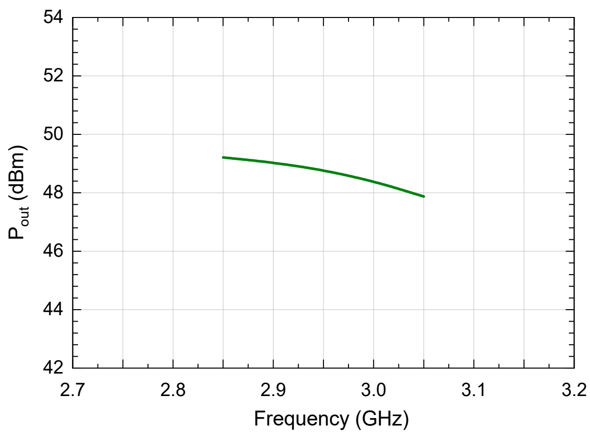
Gain vs. Frequency, 2.5dB Gain Compression



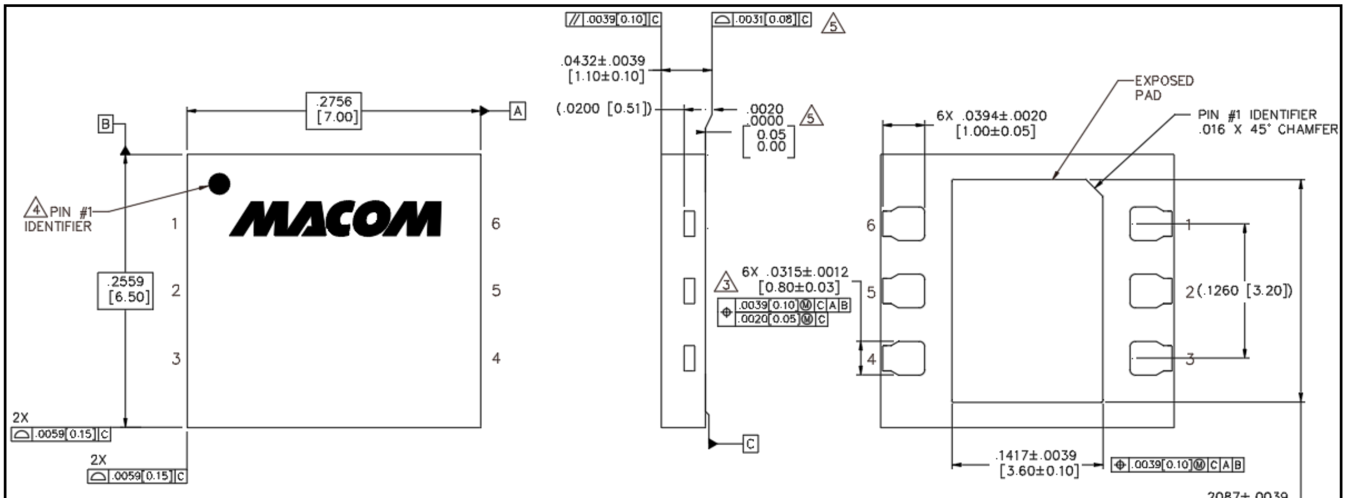
Drain Efficiency vs. Frequency, 2.5dB Gain Compression



Output Power vs. Frequency, 2.5dB Gain Compression



Lead-Free 7.0 x 6.5 mm 6-Lead Package Dimensions†



NOTES:

1. ALL DIMENSIONS AND TOLERANCES ARE BASED ON JEDEC MO-220, VAR WITH SAW SINGULATION. ALL DIMENSIONS SHOWN AS in[mm]. CONTROLLING DIMENSIONS ARE IN mm AND CONVERTED in DIMENSIONS ARE NOT NECESSARILY EXACT.
2. ELECTROSTATIC DISCHARGE CONTROL PROGRAM FOR THE PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES AND EQUIPMENT SHALL BE IN ACCORANCE WITH ANSI/ESD 20.20.
3. INDICATED DIMENSIONS/TOLERANCES APPLY TO THE PLATED LEAD AND IS MEASURED BETWEEN .0059[0.15] AND .0118[0.30] FROM THE LEAD END. LEAD NECK DOWN FEATURE IS OPTIONAL.
4. EXACT SIZE AND SHAPE OF THIS FEATURE IS OPTIONAL.
5. INDICATED DIMENSIONS/TOLERANCES APPLY TO LEADS AND EXPOSED PAD.
6. ALL MATERIALS DESCRIBED IN THIS DOCUMENT/DRAWING SHALL BE IN COMPLIANCE WITH AND CONTAIN NO SUBSTANCES RESTRICTED OR REQUIRING SPECIAL RECLAMATION UNDER THE LATEST ROHS, WEEE OR ELV DIRECTIVES.

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