GaN Amplifier 50 V, 50 W
30 - 1400 MHz

MACOM PURE CARBIDE™

MAPC-A1001
Rev. V1

Features

- *MACOM PURE CARBIDE*™ Amplifier Series
- Suitable for Linear & Saturated Applications
- CW & Pulsed Operation: 50 W Output Power
- 50 Ω Input Matched
- 260°C Reflow Compatible
- 50 V Operation
- 100% RF Tested
- RoHS* Compliant

5 x 6 mm DFN

Description

The MAPC-A1001 is a GaN on Silicon Carbide HEMT D-mode amplifier suitable for 30 - 1400 MHz frequency operation. The device supports both CW and pulsed operation with minimum output power levels of 50 W (47 dBm) in a 5 x 6 mm plastic package.

The MAPC-A1001 has a wide range of applications, including military radio communications, RADAR, avionics, digital cellular infrastructure, RF energy, and test instrumentation.

Typical Performance:

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

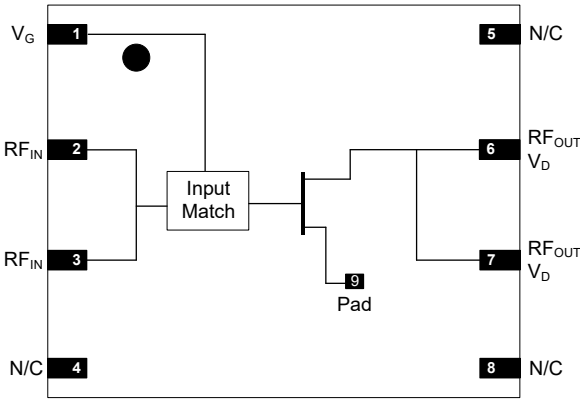
Frequency (MHz)	Output Power[1] (dBm)	Gain[2] (dB)	η_D[2] (%)
600	48.7	18.2	80.2
800	48.8	18.3	78.4
1000	48.7	17.6	77.1
1200	48.8	15.8	76.6
1400	48.6	13.5	75.6

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

Ordering Information

Part Number	Package
MAPC-A1001-AD000	Bulk Quantity
MAPC-A1001-ADTR1	Tape and Reel
MAPC-A1001-ADSB1	Sample Board

Functional Schematic



Pin Configuration

Pin #	Pin Name	Function
1	V_G	Gate
2, 3	RF_{IN}	RF Input
4, 5, 8	N/C	No Connection
6, 7	RF_{OUT} / V_D	RF Output / Drain
9	Pad[3]	Ground / Source

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

* 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], 900 MHz	G_{SS}	-	18.4	-	dB
Power Gain	Pulsed[4], 900 MHz, 2.5 dB Gain Compression	G_{SAT}	-	15.9	-	dB
Saturated Drain Efficiency	Pulsed[4], 900 MHz, 2.5 dB Gain Compression	η_{SAT}	-	61.1	-	%
Saturated Output Power	Pulsed[4], 900 MHz, 2.5 dB Gain Compression	P_{SAT}	-	46.7	-	dBm
Gain Variation (-40°C to +85°C)	Pulsed[4], 900 MHz	ΔG	-	0.018	-	dB/°C
Power Variation (-40°C to +85°C)	Pulsed[4], 900 MHz	$\Delta P2.5dB$	-	0.006	-	dBm/°C
Power Gain	Pulsed[4], 900 MHz, P_{IN} = 27.4 dBm	G_P	-	17.4	-	dB
Drain Efficiency	Pulsed[4], 900 MHz, P_{IN} = 27.4 dBm	η	-	50.4	-	%
Input Return Loss	Pulsed[4], 900 MHz, P_{IN} = 27.4 dBm	IRL	-	-12	-	dB
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 30:1, 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], 1400 MHz, 2.5 dB Gain Compression	G_{SAT}	11.8	12.4	-	dB
Saturated Drain Efficiency	Pulsed[4], 1400 MHz, 2.5 dB Gain Compression	η_{SAT}	57.5	60.5	-	%
Saturated Output Power	Pulsed[4], 1400 MHz, 2.5 dB Gain Compression	P_{SAT}	47.0	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}	-	-	7.1	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	7.1	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 7.1 mA	V_T	-	-2.9	-	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 130 mA	V_{GSQ}	-	-2.5	-	V
Maximum Drain Current	V_{DS} = 7 V, pulse width 300 µs	$I_{D, MAX}$	-	6.0	-	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	7.1 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)	4.26	°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)	3.41	°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

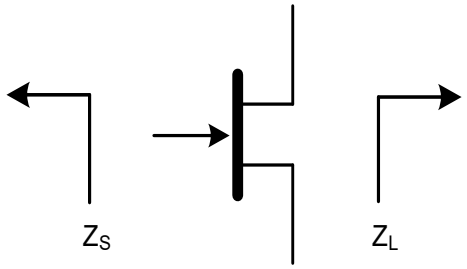
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

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

Frequency (MHz)	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 (°)
600	47.6 + j9.4	F0: 15.7 + j8.0 2F0: 20.1 + j83.2	17.5	48.7	74.1	68.9	134.5
800	38.5 + j21.4	F0: 14.8 + j6.9 2F0: 8.9 + j49.8	17.5	48.8	75.9	67.6	108.7
1000	26.5 + j17.4	F0: 14.3 + j7.0 2F0: 7.9 + j51.1	17.2	48.7	74.1	66.6	80.5
1200	22.6 + j9.3	F0: 12.6 + j6.1 2F0: 10.1 + j50.5	15.6	48.8	75.9	65.2	56.5
1400	25.0 + j3.55	F0: 12.2 + j5.7 2F0: 12.2 + j50.6	13.4	48.6	72.4	64.0	35.0

Frequency (MHz)	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 (°)
600	41.6 + j11.1	F0: 23.5 + j23.4 2F0: 20.1 + j83.2	18.2	46.6	45.7	80.2	123.1
800	35.2 + j17.4	F0: 19.7 + j20.1 2F0: 8.9 + j49.8	18.3	47.0	50.1	78.4	95.9
1000	26.8 + j12.4	F0: 17.1 + j20.1 2F0: 7.9 + j51.1	17.6	46.7	46.8	77.1	66.6
1200	25.2 + j6.0	F0: 14.7 + j17.1 2F0: 10.1 + j50.5	15.8	47.1	51.3	76.6	42.3
1400	27.5 + j2.1	F0: 11.7 + j16.6 2F0: 12.2 + j50.6	13.5	46.8	47.9	75.6	20.7

Impedance Reference

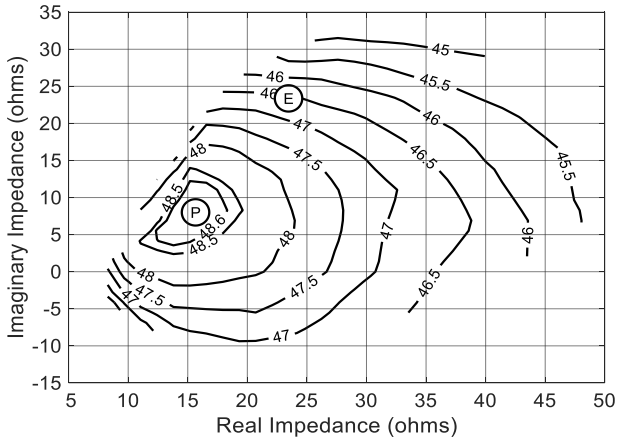


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

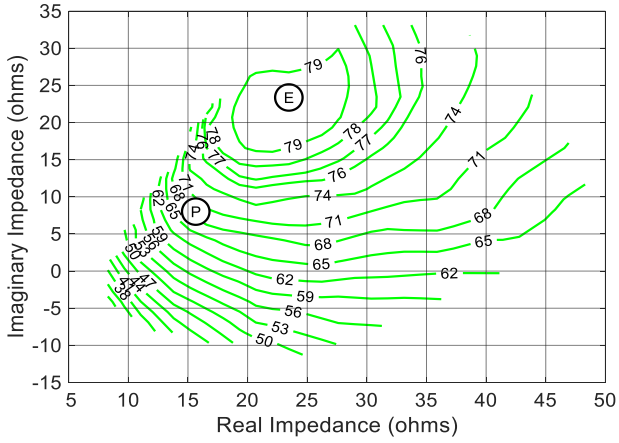
11. Load Impedance for optimum output power.
12. Load Impedance for optimum efficiency.

Pulsed[4] 50 V Load-Pull Performance at 600 MHz

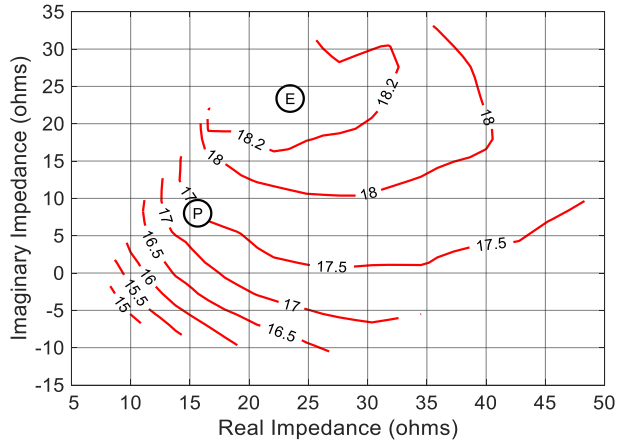
P2.5dB Loadpull Output Power Contours (dBm)



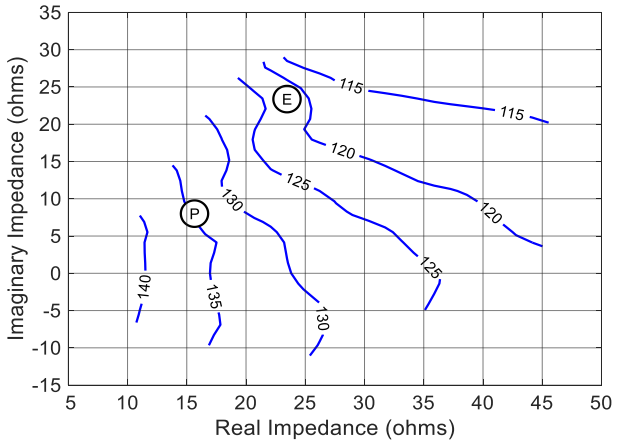
P2.5dB Loadpull Drain Efficiency Contours (%)



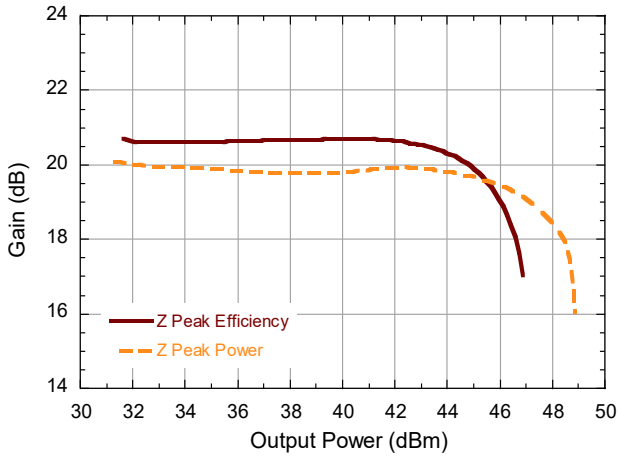
P2.5dB Loadpull Gain Contours (dB)



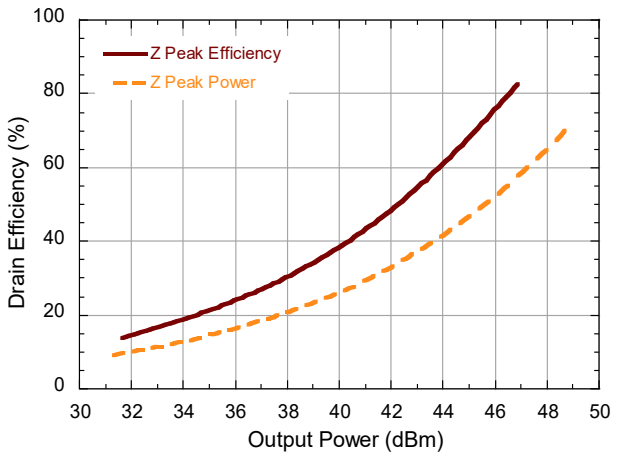
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

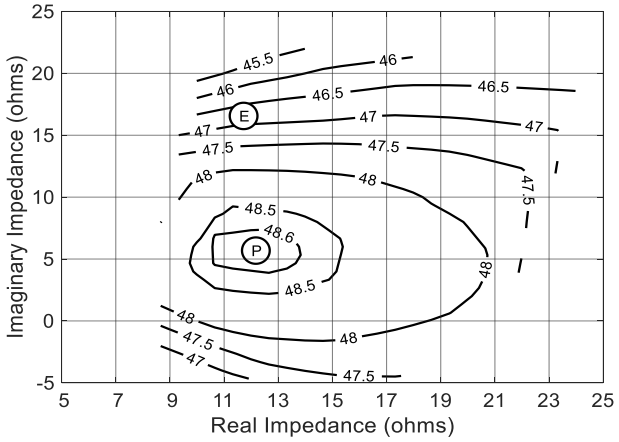


Drain Efficiency vs. Output Power

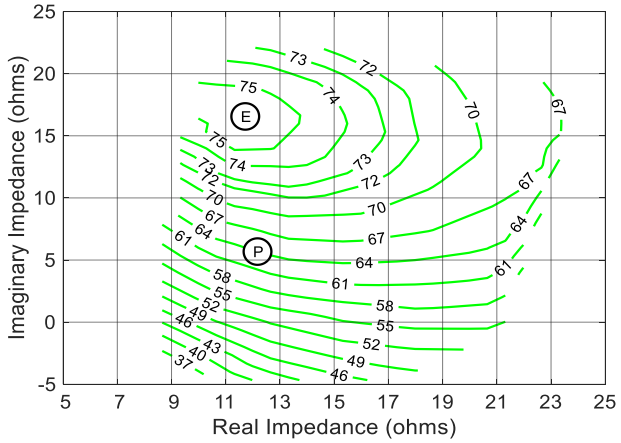


Pulsed[4] 50 V Load-Pull Performance at 1400 MHz

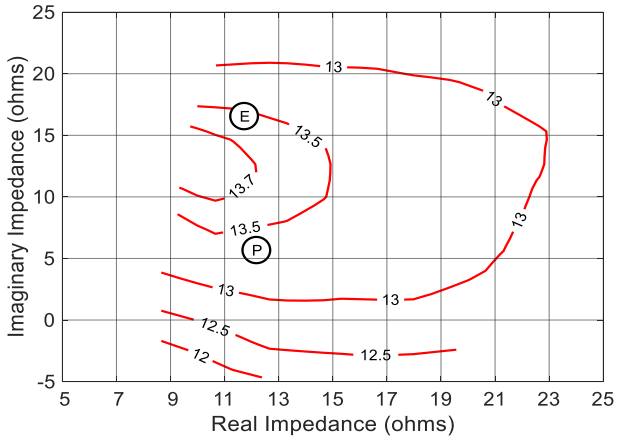
P2.5dB Loadpull Output Power Contours (dBm)



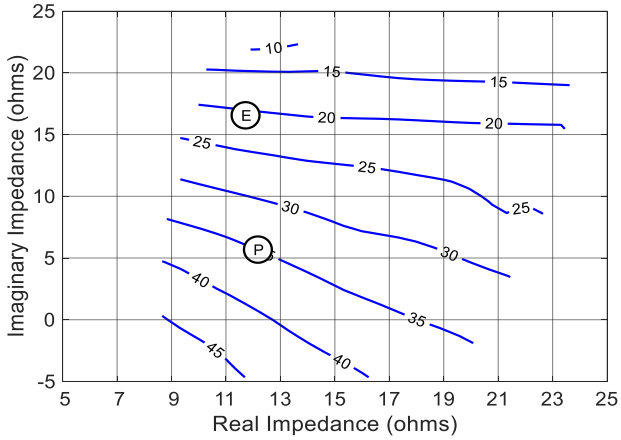
P2.5dB Loadpull Drain Efficiency Contours (%)



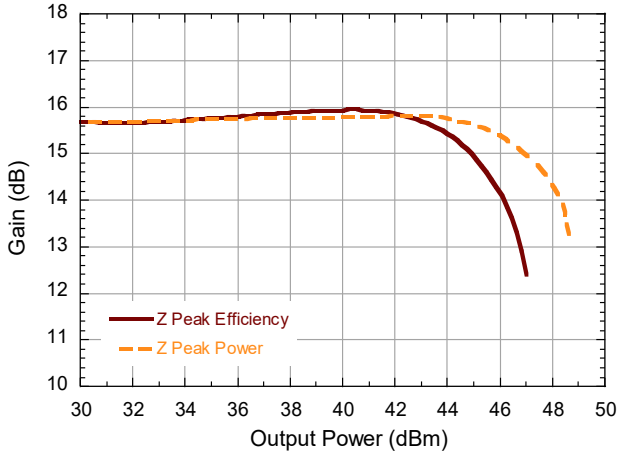
P2.5dB Loadpull Gain Contours (dB)



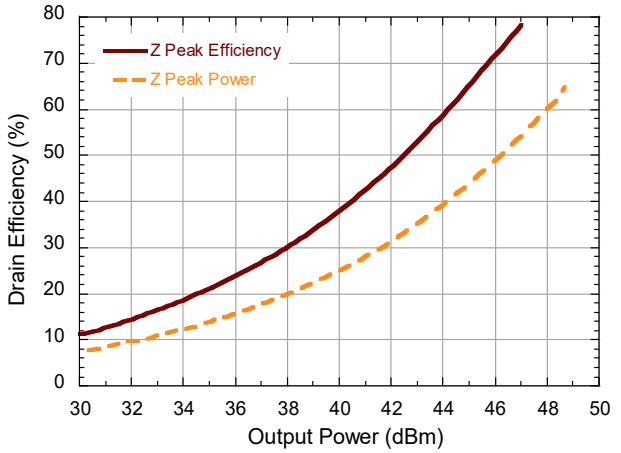
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power



Drain Efficiency vs. Output Power

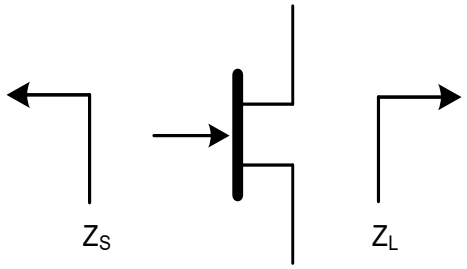


Pulsed[4] 28 V Load-Pull Performance
Reference Plane at Device Leads

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Output Power					
		V_{DS} = 28 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 (°)
600	48.7 + j13.7	F0: 8.8 + j6.7 2F0: 67.7 + j165	15.9	45.9	38.9	66.9	138.1
800	37.0 + j21.9	F0: 8.6 + j5.1 2F0: 17.4 + j87.5	16.2	45.9	38.9	65.0	111.7
1000	24.3 + j16.5	F0: 8.5 + j3.9 2F0: 8.7 + j50.7	15.8	45.9	38.9	65.3	84.3
1200	22.0 + j8.2	F0: 8.1 + j2.7 2F0: 9.2 + j50.7	14.0	46.0	39.8	64.4	59.8
1400	24.3 + j2.1	F0: 7.8 + j2.2 2F0: 10.2 + j50.0	11.7	45.8	38.0	62.5	39.5

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency					
		V_{DS} = 28 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 (°)
600	39.5 + j12.5	F0: 15.7 + j15.7 2F0: 67.7 + j165	16.6	43.4	21.9	77.6	119.3
800	32.7 + j13.2	F0: 15.0 + j14.0 2F0: 17.4 + j87.5	16.5	43.5	22.4	76.1	91.1
1000	26.6 + j9.9	F0: 12.7 + j12.5 2F0: 8.7 + j50.7	15.7	43.5	22.4	75.2	62.3
1200	25.5 + j4.5	F0: 11.2 + j10.7 2F0: 9.2 + j50.7	13.8	43.8	24.0	75.6	38.9
1400	27.7 + j1.3	F0: 9.7 + j9.7 2F0: 10.2 + j50.0	11.5	43.8	24.0	74.5	21.1

Impedance Reference

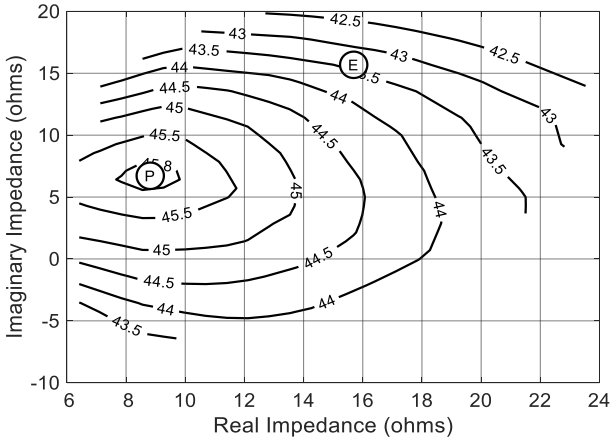


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

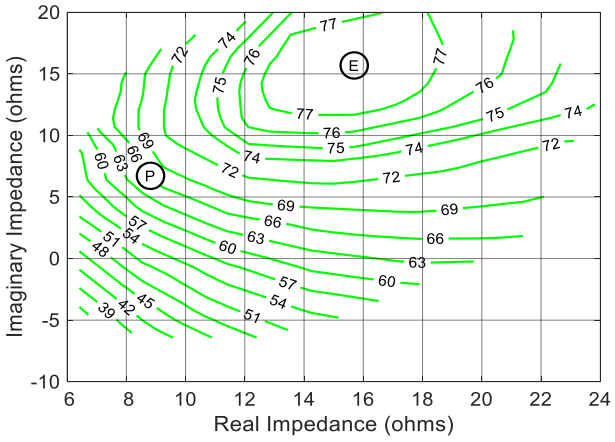
11. Load Impedance for optimum output power.
12. Load Impedance for optimum efficiency.

Pulsed[4] 28 V Load-Pull Performance at 600 MHz

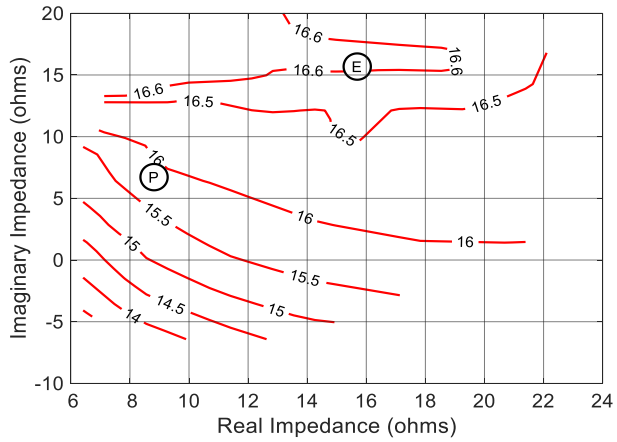
P2.5dB Loadpull Output Power Contours (dBm)



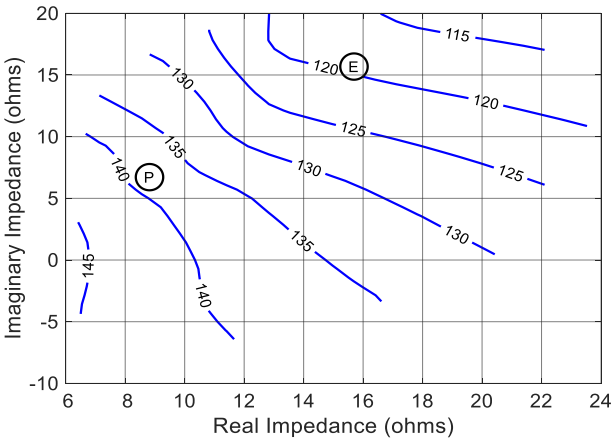
P2.5dB Loadpull Drain Efficiency Contours (%)



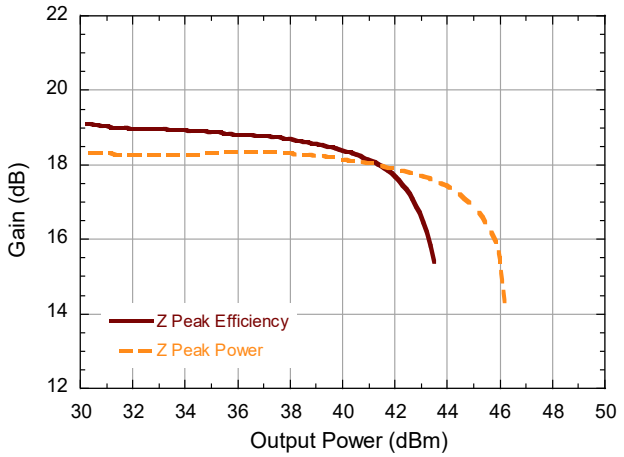
P2.5dB Loadpull Gain Contours (dB)



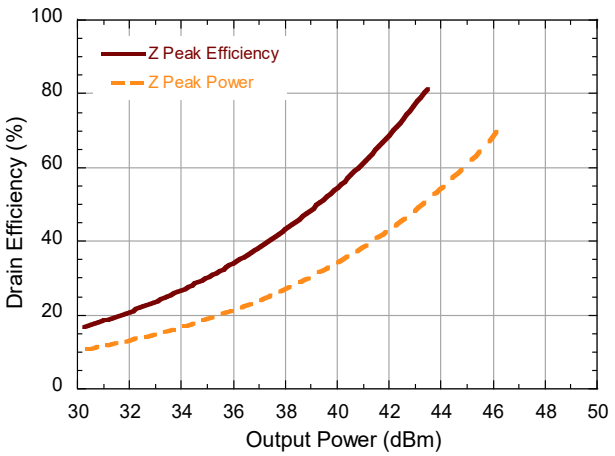
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

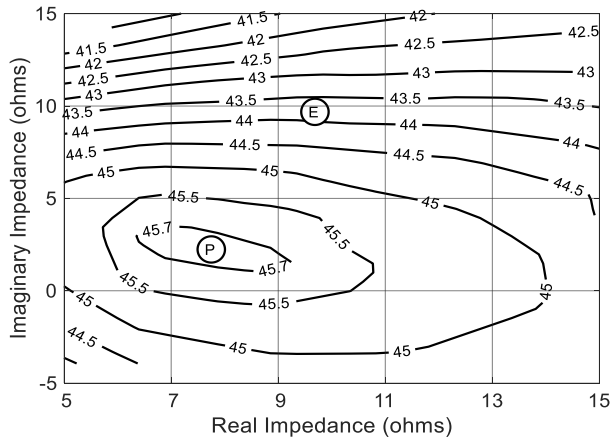


Drain Efficiency vs. Output Power

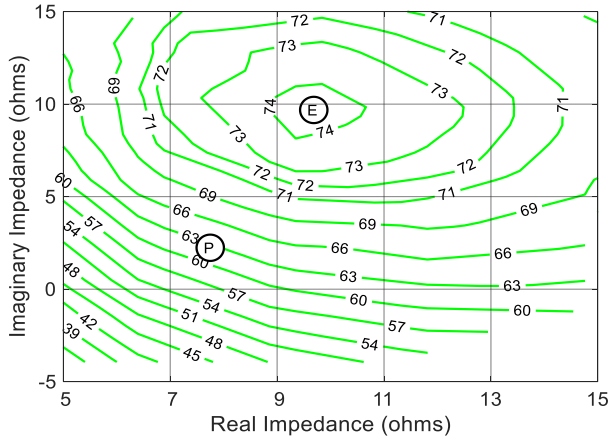


Pulsed[4] 28 V Load-Pull Performance at 1400 MHz

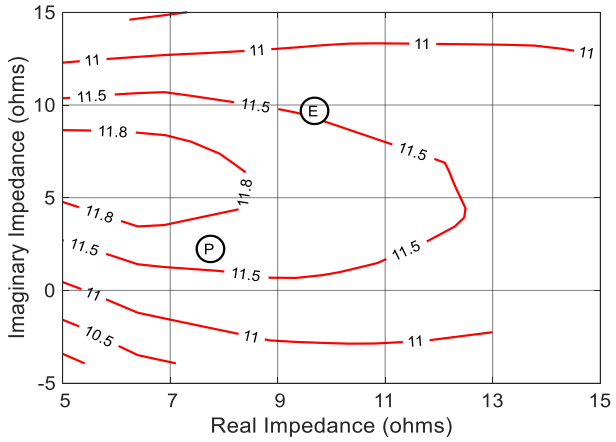
P2.5dB Loadpull Output Power Contours (dBm)



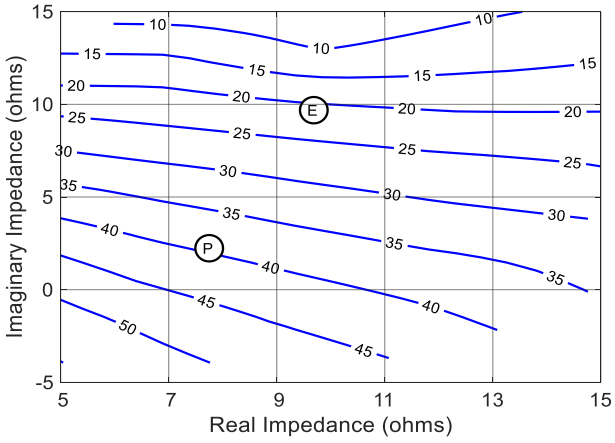
P2.5dB Loadpull Drain Efficiency Contours (%)



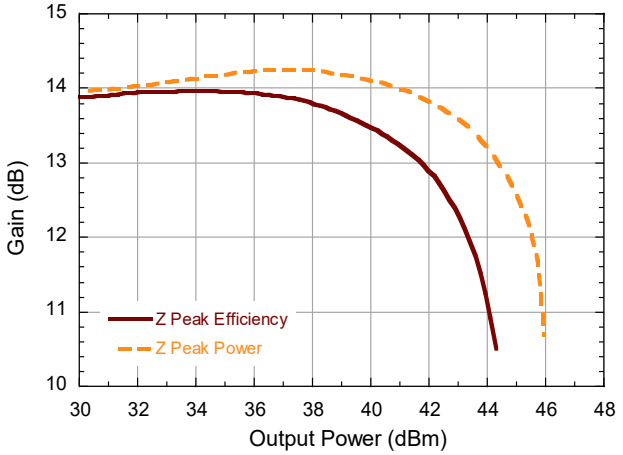
P2.5dB Loadpull Gain Contours (dB)



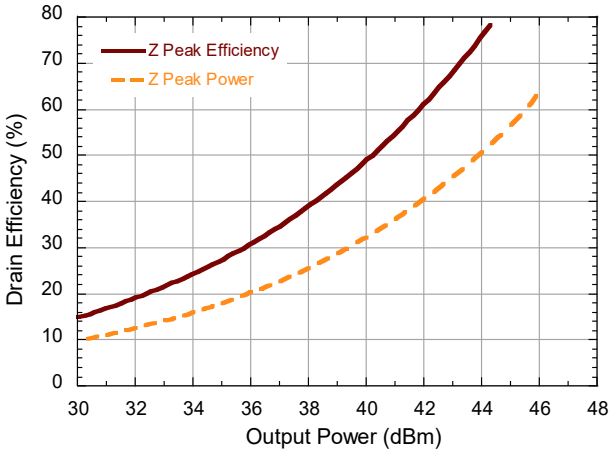
P2.5dB Loadpull AM/PM Contours (°)



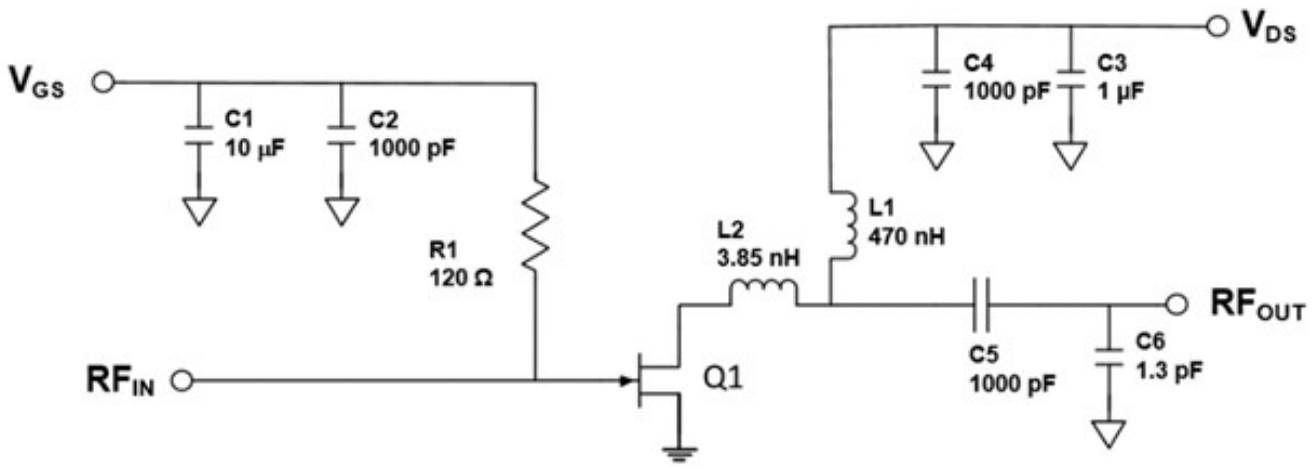
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Test Fixture and Recommended Tuning Solution 30 - 1400 MHz



Description

Parts measured on evaluation board (20-mil thick RO4350). Matching is provided using a combination 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

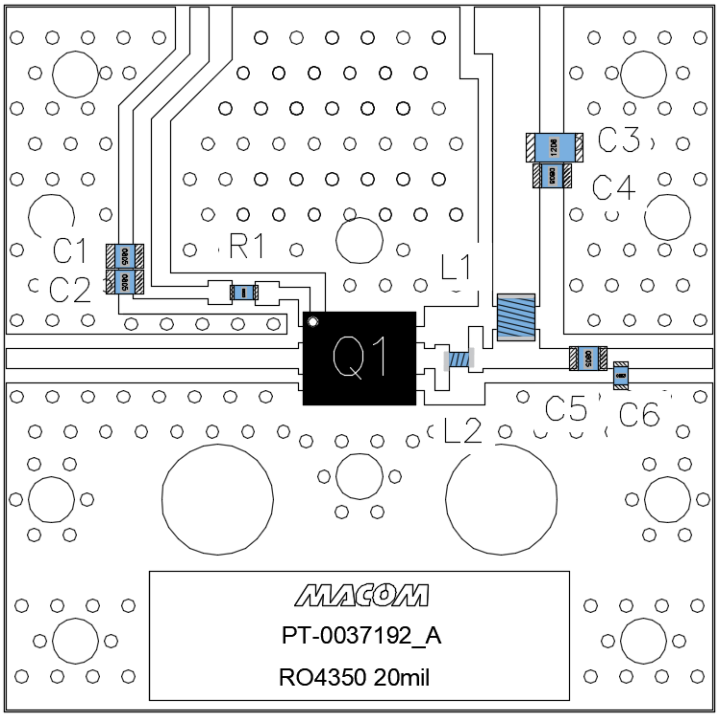
Turning the device ON

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}.

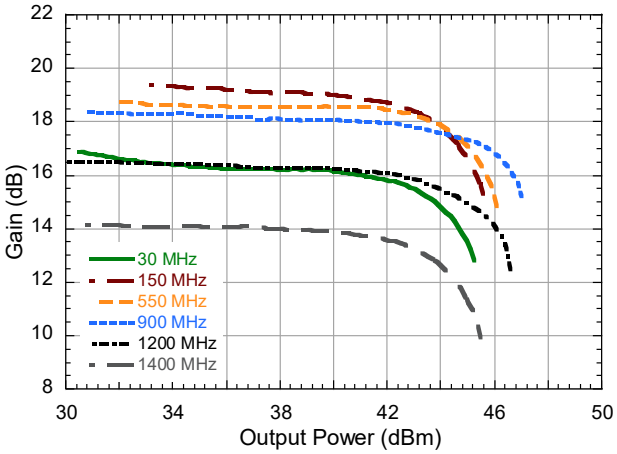
Evaluation Test Fixture and Recommended Tuning Solution 30 - 1400 MHz



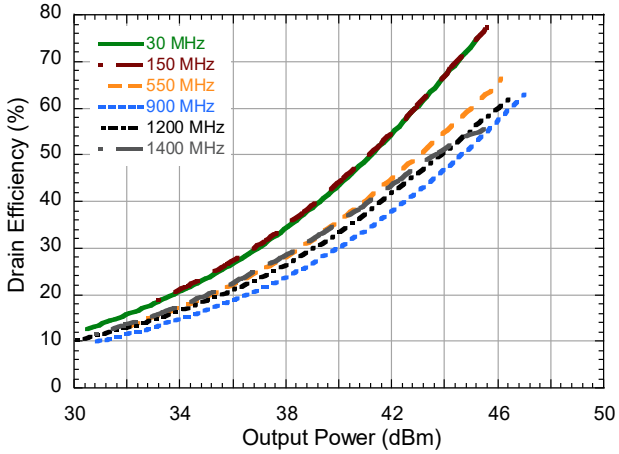
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	10 µF	+/- 10 %	Murata	GRM21BC71E106KE11L
C2, C4, C5	1000 pF	+/- 5 %	Murata	GRM219R72A102JA01D
C3	1 µF	+/- 10 %	Murata	GRM32CR72A105KA35L
C6	1.3 pF	+/- 0.1 pF	Johanson	251R14S1R3BV4T
R1	120 Ω	+/- 25 %	Fair-Rite	2506031217Y0
L1	470 nH	+/- 5 %	CoilCraft	1008CS-471XJRC
L2	3.85 nH	+/- 5 %	CoilCraft	0906-4JLC
Q1	MACOM GaN Power Amplifier			MAPC-A1001
PCB	RO4350, 20 mil, 0.5 oz. Cu, Au Finish			

Typical Performance Curves as Measured in the 30 - 1400 MHz Evaluation Test Fixture: Pulsed[4] 900 MHz, V_{DS} = 50 V, I_{DQ} = 130 mA, T_C = 25°C Unless Otherwise Noted

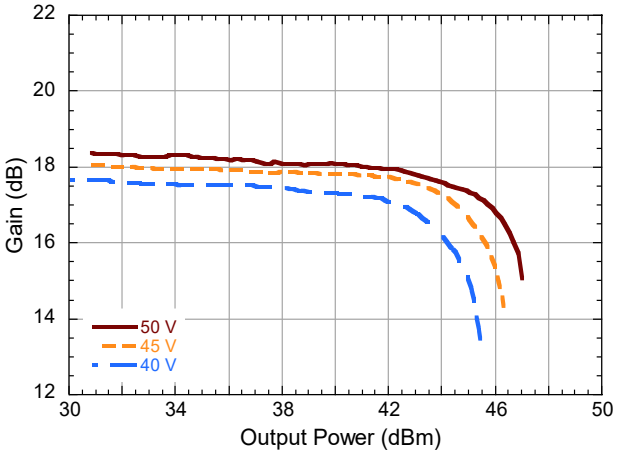
Gain vs. Output Power and Frequency



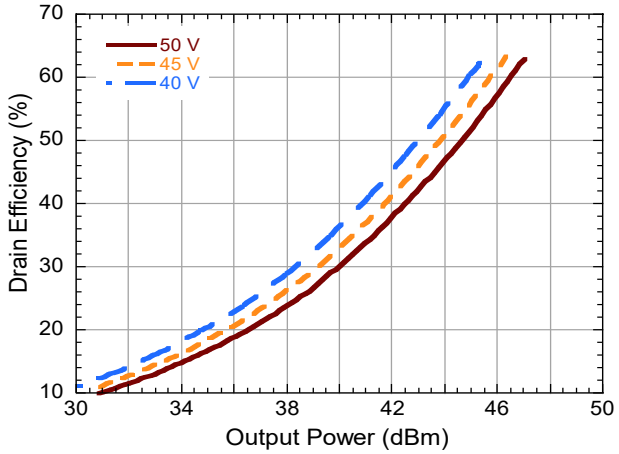
Drain Efficiency vs. Output Power and Frequency



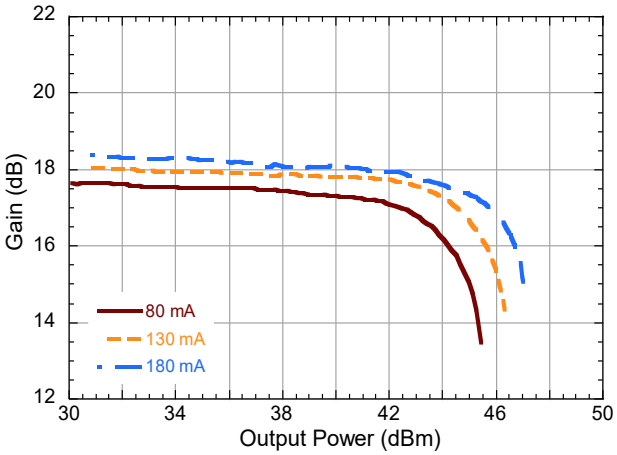
Gain vs. Output Power and V_{DS}



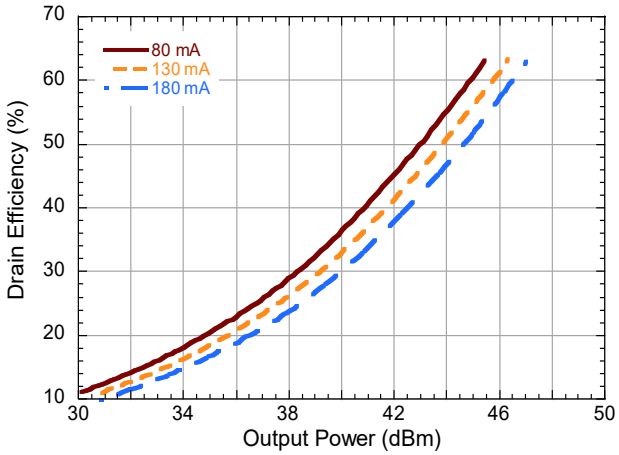
Drain Efficiency vs. Output Power and V_{DS}



Gain vs. Output Power and I_{DQ}

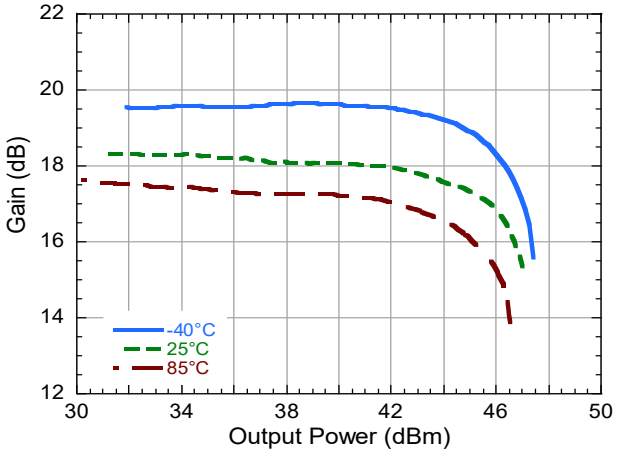


Drain Efficiency vs. Output Power and I_{DQ}

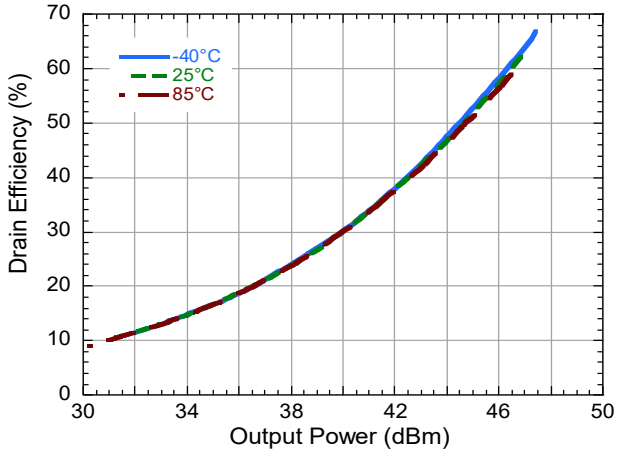


Typical Performance Curves as Measured in the 30 - 1400 MHz Evaluation Test Fixture:
Pulsed[4] 900 MHz, V_{DS} = 50 V, I_{DQ} = 130 mA, T_C = 25°C
Unless Otherwise Noted

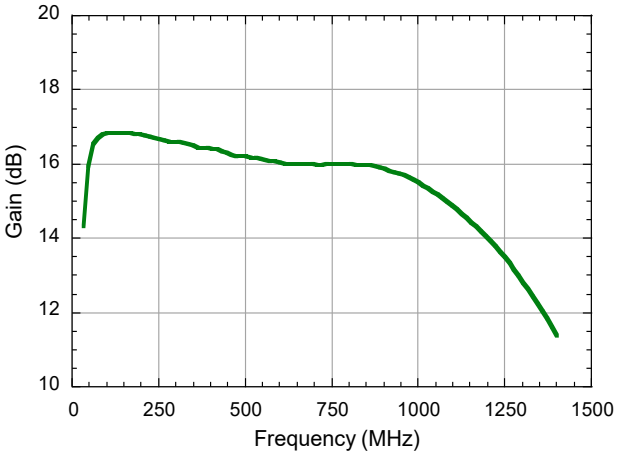
Gain vs. Output Power and T_C



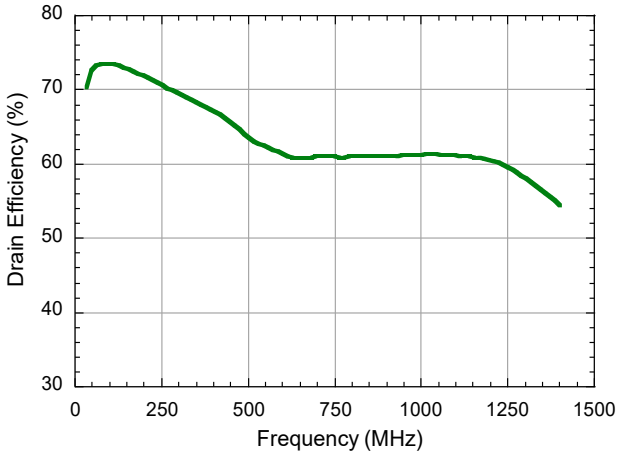
Drain Efficiency vs. Output Power and T_C



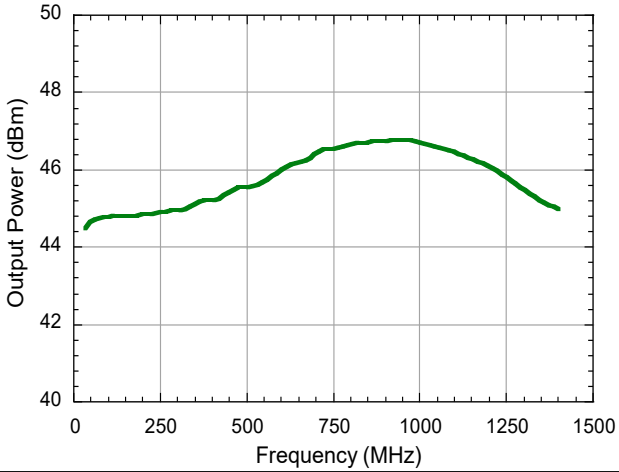
Gain vs. Frequency, 2.5dB Compression



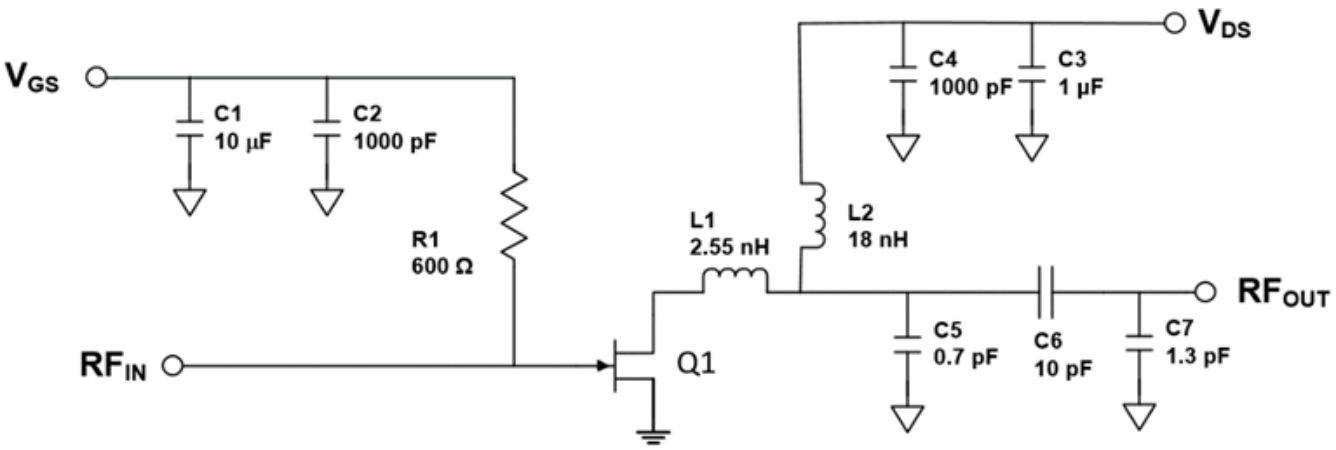
Drain Efficiency vs. Frequency, 2.5dB Compression



Output Power vs. Frequency, 2.5dB Compression



Evaluation Test Fixture and Recommended Tuning Solution 1200 - 1400 MHz



Description

Parts measured on evaluation board (20-mil thick RO4350). Matching is provided using a combination 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

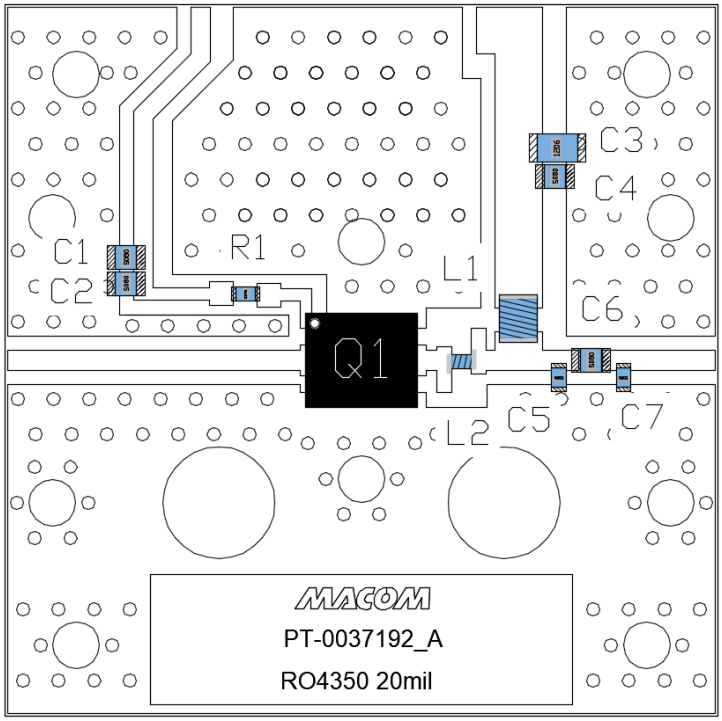
Turning the device ON

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}.

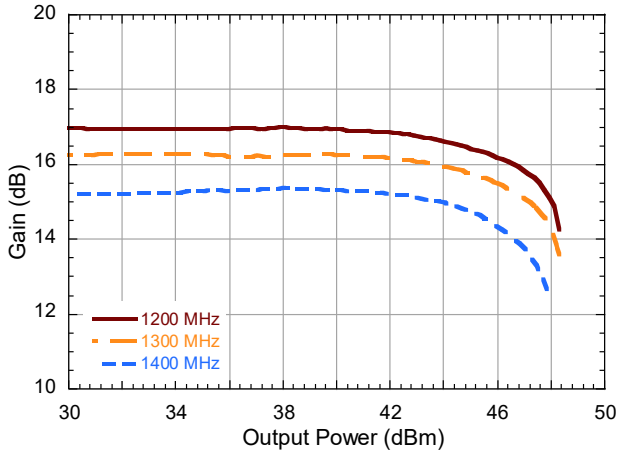
Evaluation Test Fixture and Recommended Tuning Solution 1200 - 1400 MHz



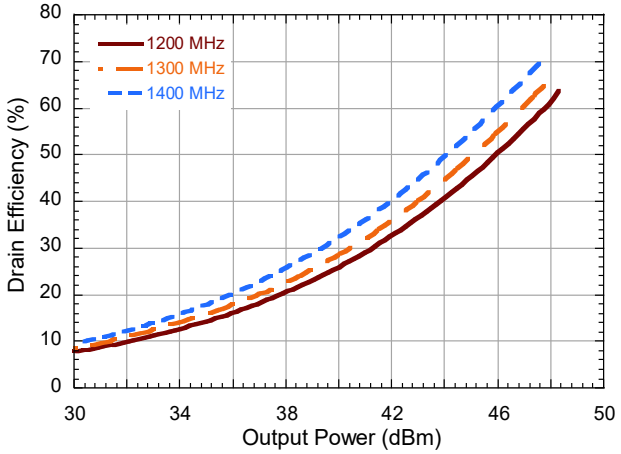
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	10 µF	+/- 10 %	Murata	GRM21BC71E106KE11L
C2, C4,	1000 pF	+/- 5 %	Murata	GRM219R72A102JA01D
C3	1 µF	+/- 10 %	Murata	GRM32CR72A105KA35L
C5	0.7 pF	+/- 0.1 pF	Johanson	251R14S0R7BV4T
C6	8.2 pF	+/- 0.1 pF	Johanson	251R15S8R2CV4E
C7	1.3 pF	+/- 0.1 pF	Johanson	251R14S1R3BV4T
R1	600 Ω	+/- 25 %	Fair-Rite	2506036017Y0
L1	18 nH	+/- 5 %	CoilCraft	1008CS-180XJRC
L2	2.55 nH	+/- 5 %	CoilCraft	0906-3JLC
Q1	MACOM GaN Power Amplifier			MAPC-A1001
PCB	RO4350, 20 mil, 0.5 oz. Cu, Au Finish			

Typical Performance Curves as Measured in the 1200 - 1400 MHz Evaluation Test Fixture: Pulsed[4] 1300 MHz, V_{DS} = 50 V, I_{DQ} = 130 mA, T_C = 25°C Unless Otherwise Noted

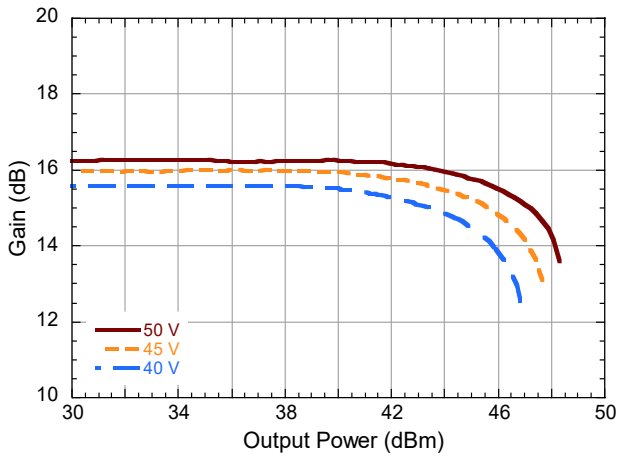
Gain vs. Output Power and Frequency



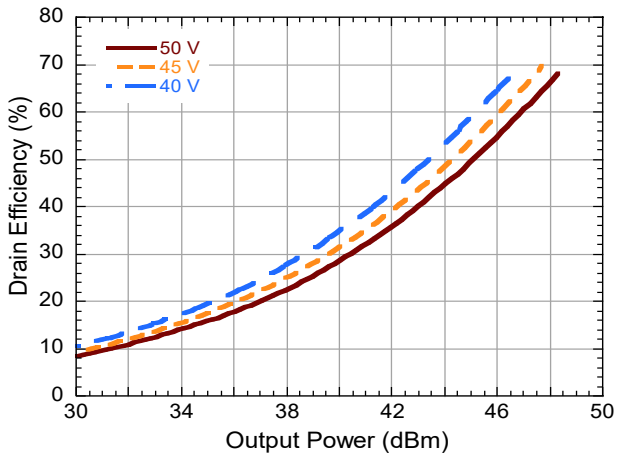
Drain Efficiency vs. Output Power and Frequency



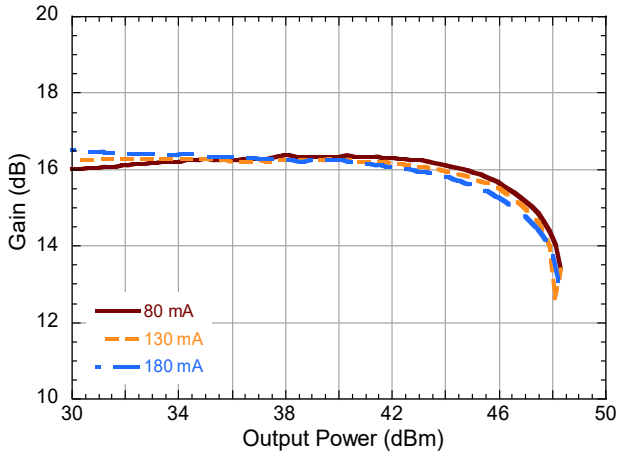
Gain vs. Output Power and V_{DS}



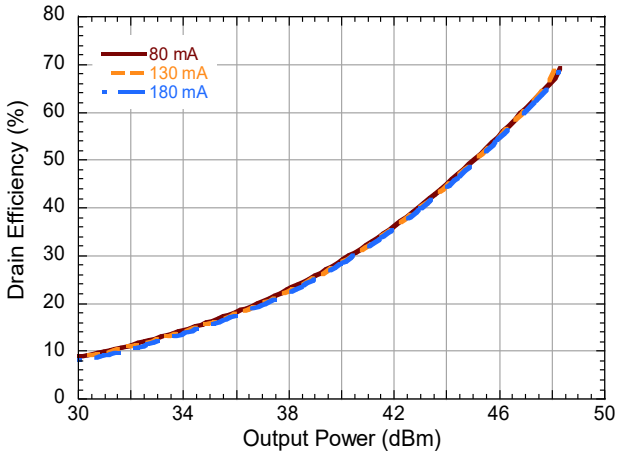
Drain Efficiency vs. Output Power and V_{DS}



Gain vs. Output Power and I_{DQ}

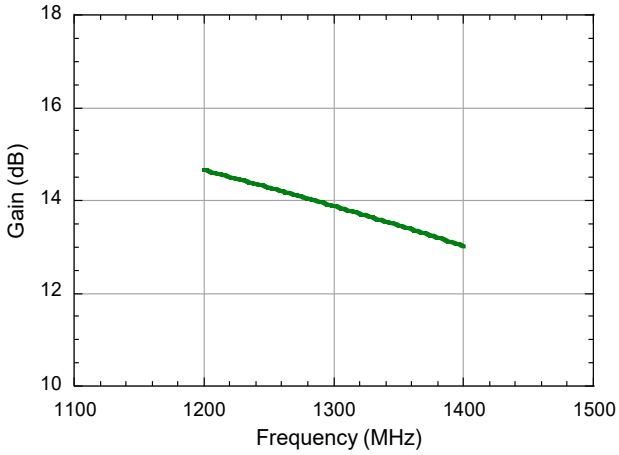


Drain Efficiency vs. Output Power and I_{DQ}

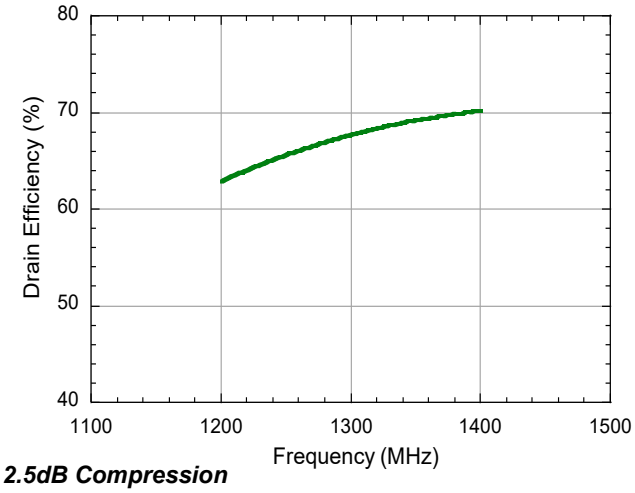


Typical Performance Curves as Measured in the 1200 - 1400 MHz Evaluation Test Fixture:
Pulsed[4] 1300 MHz, V_{DS} = 50 V, I_{DQ} = 130 mA, T_C = 25°C
Unless Otherwise Noted

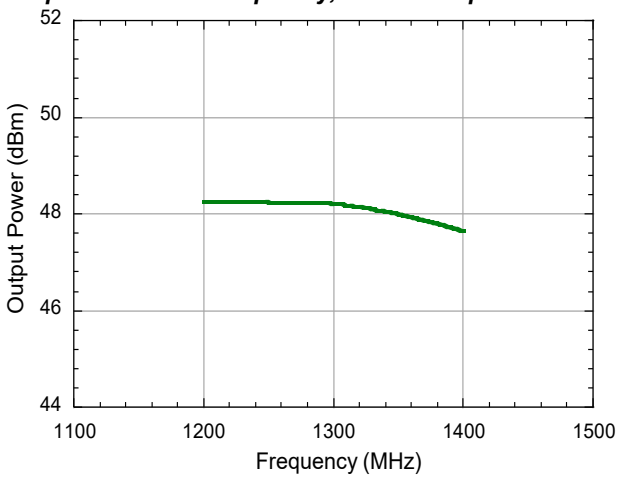
Gain vs. Frequency, 2.5dB Compression



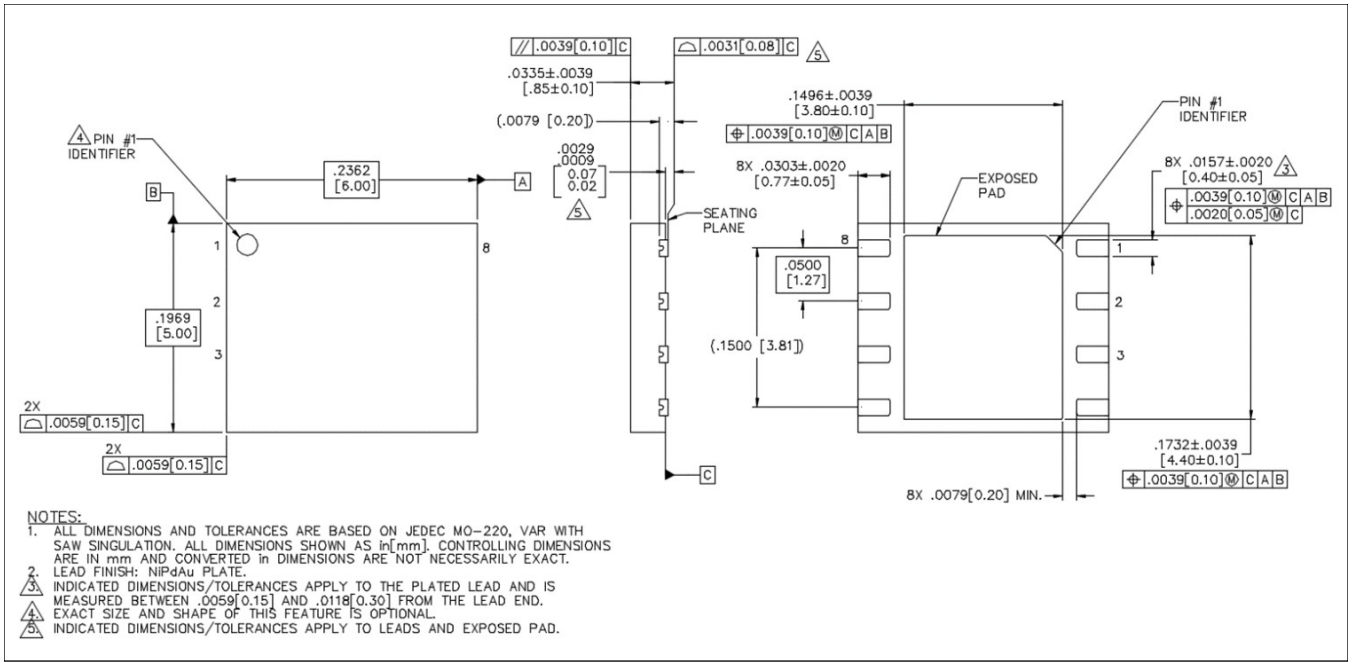
Drain Efficiency vs. Frequency, 2.5dB Compression



Output Power vs. Frequency, 2.5dB Compression



Lead-Free 5 x 6 mm 8-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. LEAD FINISH: NiPdAu PLATE.
3. INDICATED DIMENSIONS/TOLERANCES APPLY TO THE PLATED LEAD AND IS MEASURED BETWEEN .0059[0.15] AND .0118[0.30] FROM THE LEAD END.
4. EXACT SIZE AND SHAPE OF THIS FEATURE IS OPTIONAL.
5. INDICATED DIMENSIONS/TOLERANCES APPLY TO LEADS AND EXPOSED PAD.

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