GaN Amplifier 50 V, 2 W
1 - 5 GHz

MAGX-101050-002C0P
Rev. V1

Features

- Suitable for Linear and Saturated Applications
- CW & Pulsed Operation: 2 W Output Power
- Internally Pre-Matched
- 50 V Operation
- 100% RF Tested
- RoHS* Compliant

Applications

- Military Radio Communications
- RADAR
- Avionics
- Digital Cellular Infrastructure
- RF Energy
- Test Instrumentation

Description

The MAGX-101050-002C0P is a GaN on Si HEMT D-mode amplifier designed for 2 W peak power and optimized for 1 - 5 GHz frequency operation. This device supports both CW and pulsed operation with minimum output power levels of 2 W (33 dBm) in a 4 mm plastic package.

The MAGX-101050-002C0P has a wide range of applications.

Typical Performance:

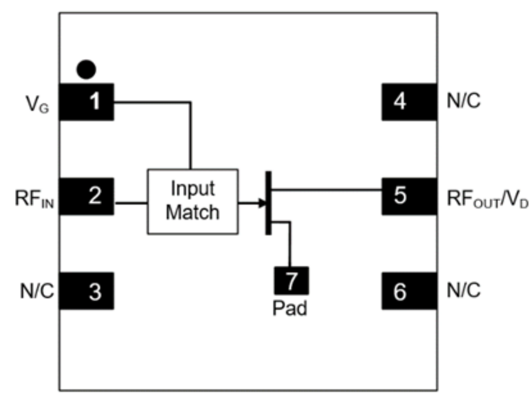
- V_{DS} = 50 V, I_{DQ} = 20 mA, T_C = 25°C. Measured under load-pull at 2.5 dB Compression, 100 µs pulse width, 10% duty cycle.

Frequency (GHz)	Output Power[1] (dBm)	Gain[2] (dB)	η_D[2] (%)
1.0	38.1	11.2	78.6
2.0	37.9	13.9	69.0
3.0	36.7	15.2	55.1
4.0	37.5	15.4	55.3
5.0	37.4	11.2	53.8

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

4 mm DFN

Functional Schematic



Pin Configuration

Pin #	Pin Name	Function
1	V_G	Gate
2	RF_{IN}	RF Input
3, 4, 6	N/C	No Connection
5	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
MAGX-101050-002C0P	Bulk Quantity
MAGX-101050-002CTP	Tape and Reel
MAGX-1A1050-002C0P	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} = 20 mA
Note: Performance in MACOM Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed[4], 4 GHz	G_{SS}	-	18.3	-	dB
Power Gain	Pulsed[4], 4 GHz, 2.5 dB Gain Compression	G_{SAT}	-	15.7	-	dB
Saturated Drain Efficiency	Pulsed[4], 4 GHz, 2.5 dB Gain Compression	η_{SAT}	-	50.2	-	%
Saturated Output Power	Pulsed[4], 4 GHz, 2.5 dB Gain Compression	P_{SAT}	-	35.7	-	dBm
Gain Variation (-40°C to +85°C)	Pulsed[4], 4 GHz	ΔG	-	0.022	-	dB/°C
Power Variation (-40°C to +85°C)	Pulsed[4], 4 GHz	ΔP2.5dB	-	0.003	-	dB/°C
Power Gain	Pulsed[4], 4 GHz, P_{IN} = 15.2 dBm	G_P	-	17.7	-	dB
Drain Efficiency	Pulsed[4], 4 GHz, P_{IN} = 15.2 dBm	η	-	39	-	%
Input Return Loss	Pulsed[4], 4 GHz, P_{IM} = 15.2 dBm	IRL	-	-17	-	dB
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} = 20 mA
Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	Pulsed[4], 4 GHz, 2.5 dB Gain Compression	G_{SAT}	11.8	13.1	-	dB
Saturated Drain Efficiency	Pulsed[4], 4 GHz, 2.5 dB Gain Compression	η_{SAT}	37.2	41.5	-	%
Saturated Output Power	Pulsed[4], 4 GHz, 2.5 dB Gain Compression	P_{SAT}	35.1	35.8	-	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}	-	-	0.72	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	0.72	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 0.72 mA	V_T	-2.6	-2.0	-	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 20 mA	V_{GSQ}	-2.0	-1.7	-1.4	V
On Resistance	V_{GS} = 2 V, I_D = 5.4 mA	R_{ON}	-	6.7	-	Ω
Maximum Drain Current	V_{DS} = 7 V, pulse width 300 μs	$I_{D, MAX}$	-	0.42	-	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	1.4 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 > 4 x 10^6 hours.
8. Operating at nominal conditions with $T_{CH} \leq 225°C$ will ensure MTTF > 4 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* = 1.76, *B* = -33.83, and *C* = 23,476.

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)	35.4	°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)	31.9	°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

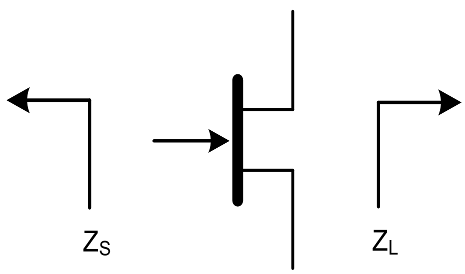
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling.

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

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Output Power V_{DS} = 50 V, I_{DQ} = 20 mA, T_C = 25°C, P2.5 dB					
		Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
1	40.3 - j9.3	111.3 + j77.2	9.8	38.1	6.5	69.7	148.9
2	10.7 + j20.6	48.6 + j74.0	13.2	37.9	6.2	63.2	80.7
3	7.4 - j10.3	28.7 + j65.4	14.7	36.7	4.7	53.9	38.1
4	46.6 - j34.0	26.4 + j46.9	14.9	37.5	5.6	52.5	-28.5
5	19.5 + j2.4	19.0 + j37.8	10.8	37.4	5.6	50.5	-129.1

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency V_{DS} = 50 V, I_{DQ} = 20 mA, T_C = 25°C, P2.5 dB					
		Z_{LOAD}[12] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
1	39.8 - j8.6	118.1 + j148.6	11.2	36.7	4.7	78.6	145.4
2	11.3 + j20.1	52.3 + j96.7	13.9	37.1	5.1	69.0	72.9
3	8.1 - j10.9	26.3 + j74.5	15.2	36.1	4.1	55.1	30.7
4	49.6 - j24.9	19.7 + j53.8	15.4	36.8	4.8	55.3	-35.9
5	18.9 + j1.8	13.3 + j41.3	11.2	36.8	4.8	53.8	-133.1

Impedance Reference

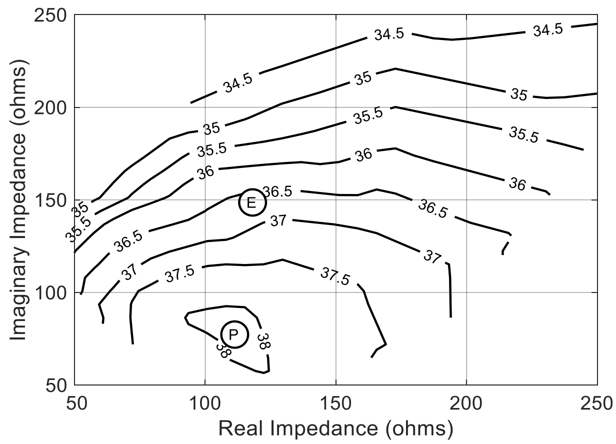


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

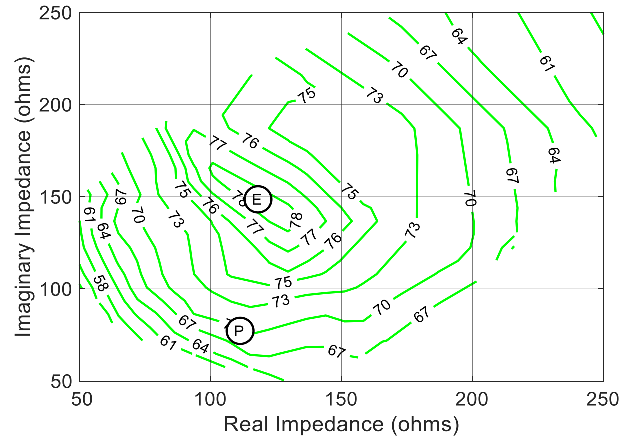
11. Load Impedance for optimum output power.
12. Load Impedance for optimum efficiency.

Pulsed[4] Load-Pull Performance 50 V, 1 GHz

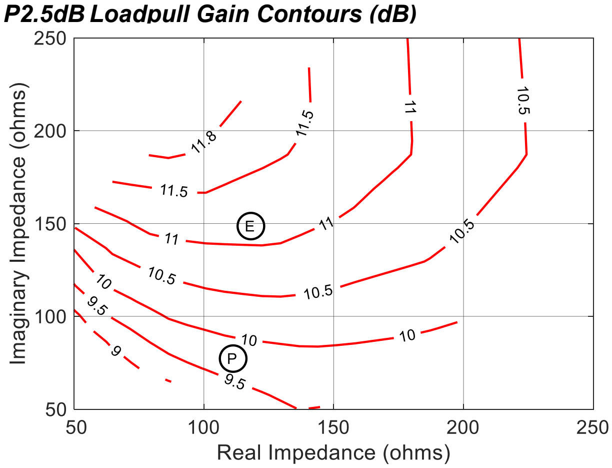
P2.5dB Loadpull Output Power Contours (dBm)



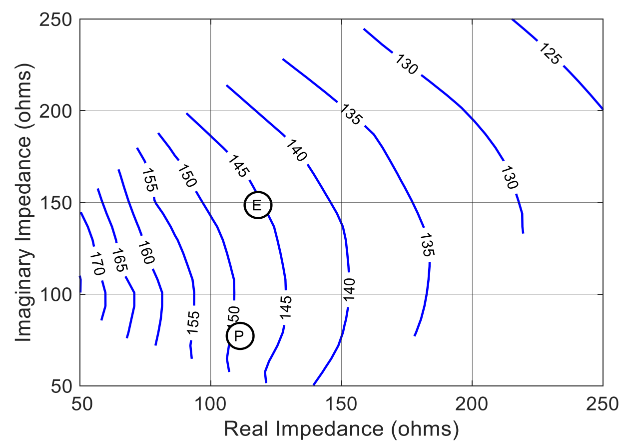
P2.5dB Loadpull Drain Efficiency Contours (%)



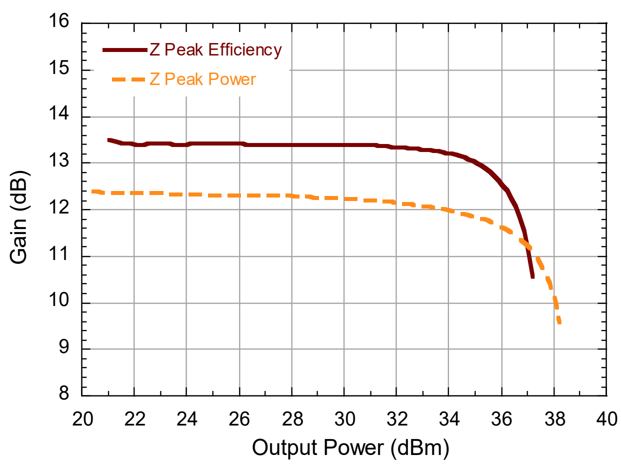
P2.5dB Loadpull Gain Contours (dB)



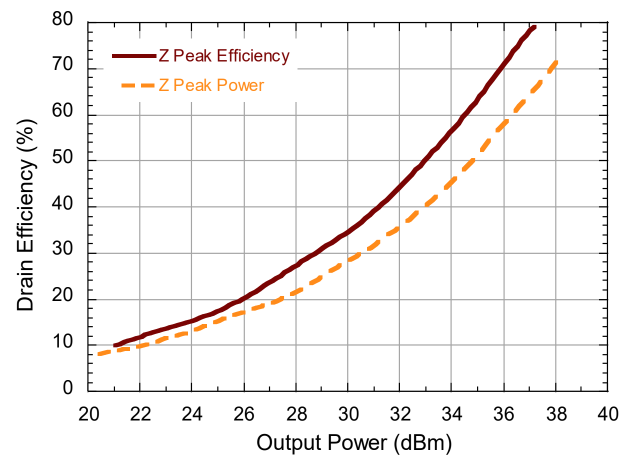
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

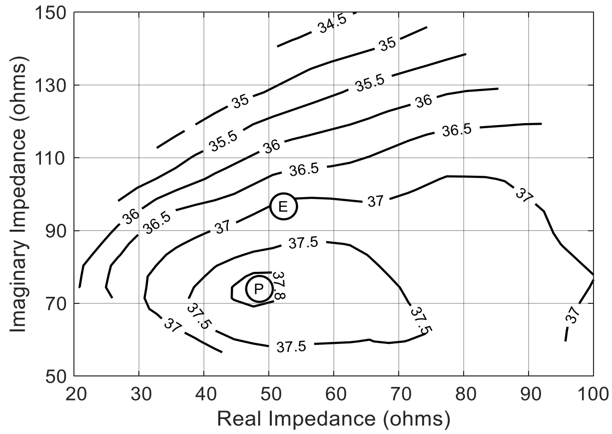


Drain Efficiency vs. Output Power

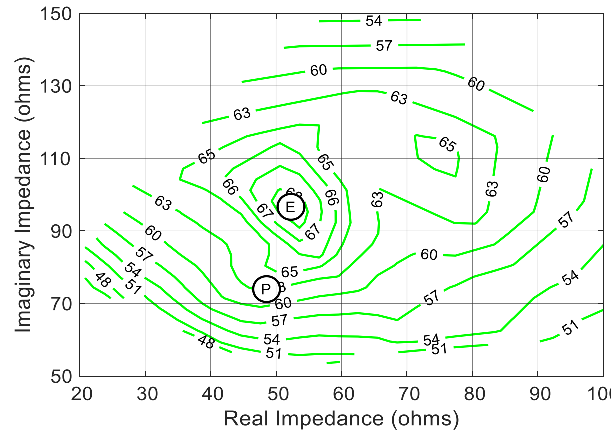


Pulsed[4] Load-Pull Performance 50 V, 2 GHz

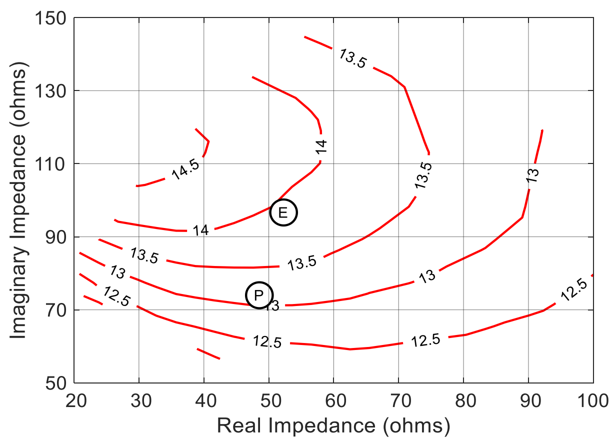
P2.5dB Loadpull Output Power Contours (dBm)



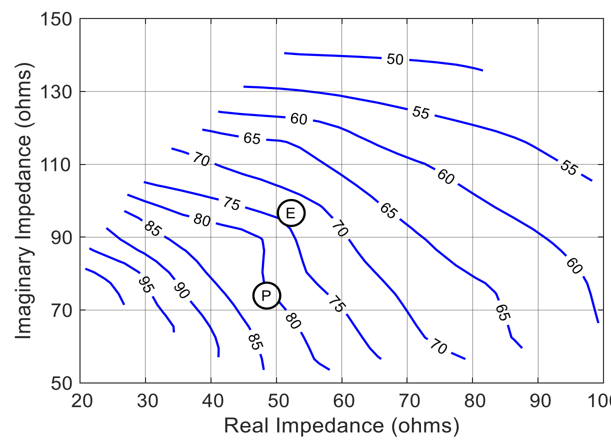
P2.5dB Loadpull Drain Efficiency Contours (%)



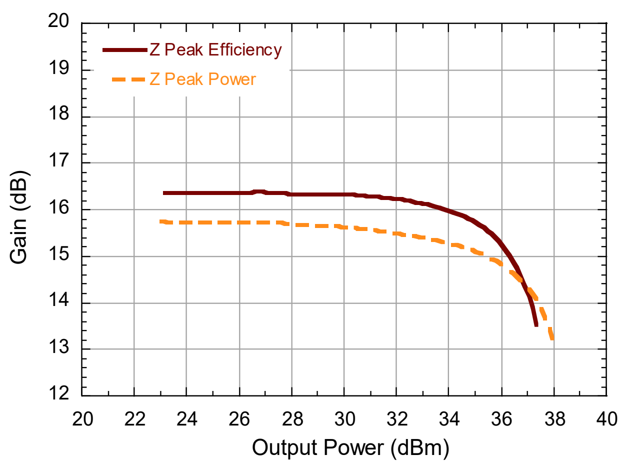
P2.5dB Loadpull Gain Contours (dB)



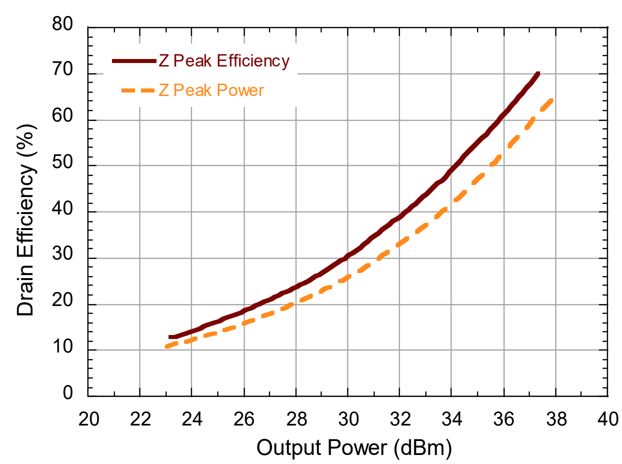
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

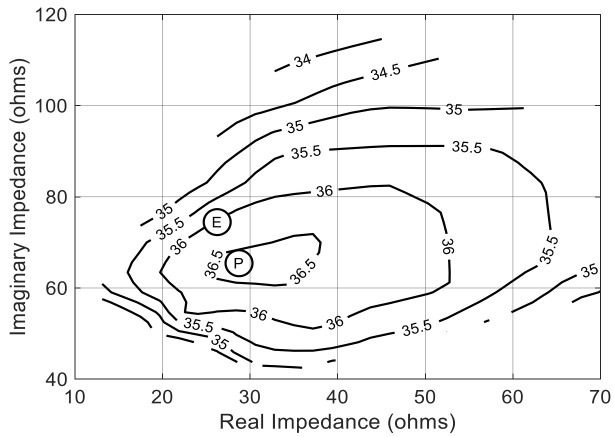


Drain Efficiency vs. Output Power

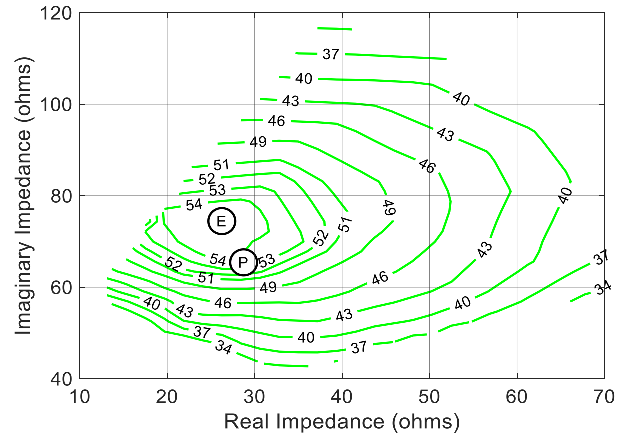


Pulsed[4] Load-Pull Performance 50 V, 3 GHz

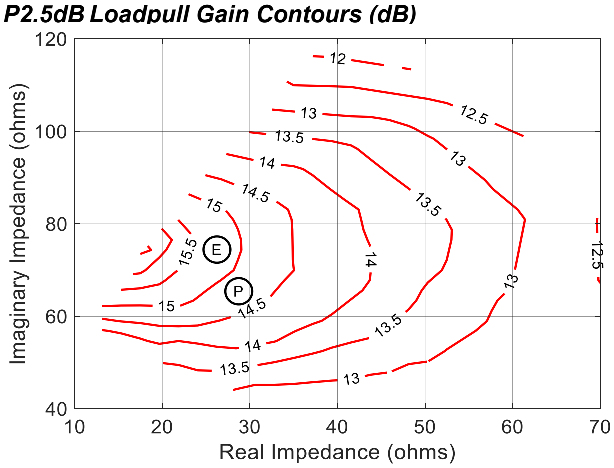
P2.5dB Loadpull Output Power Contours (dBm)



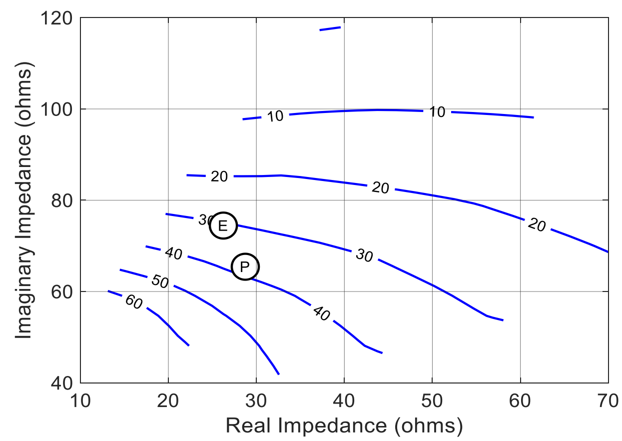
P2.5dB Loadpull Drain Efficiency Contours (%)



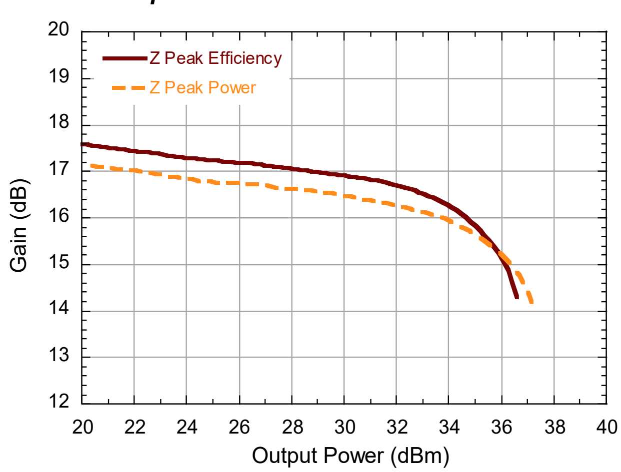
P2.5dB Loadpull Gain Contours (dB)



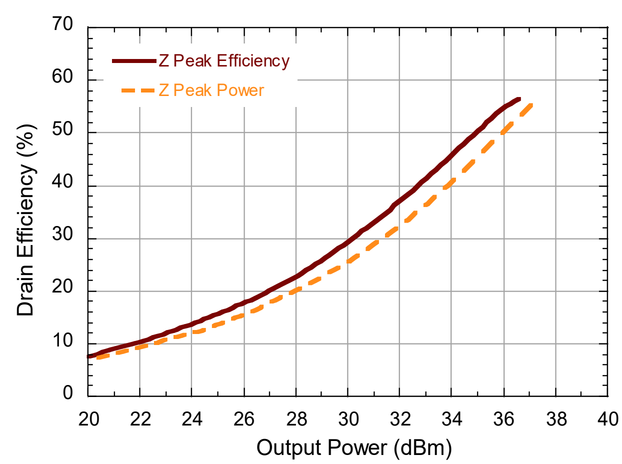
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

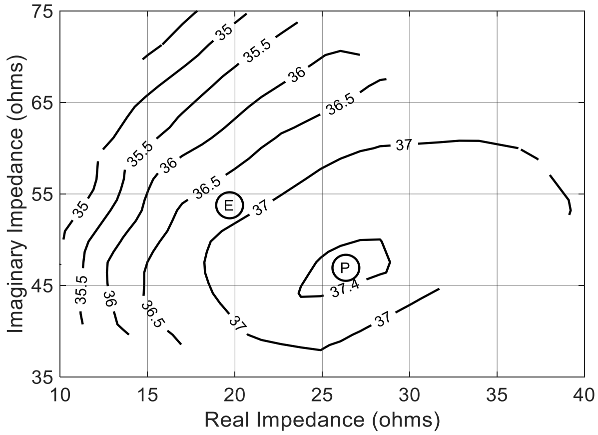


Drain Efficiency vs. Output Power

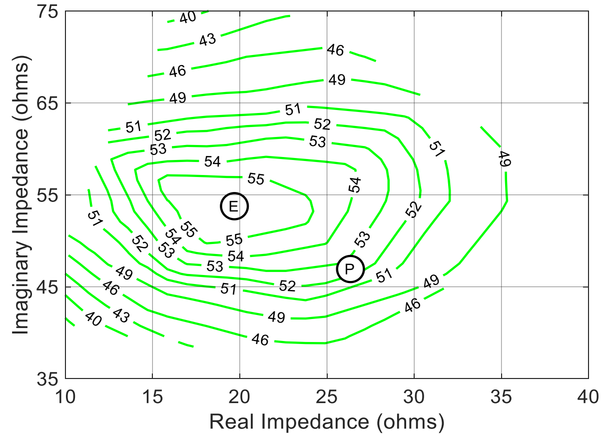


Pulsed[4] Load-Pull Performance 50 V, 4 GHz

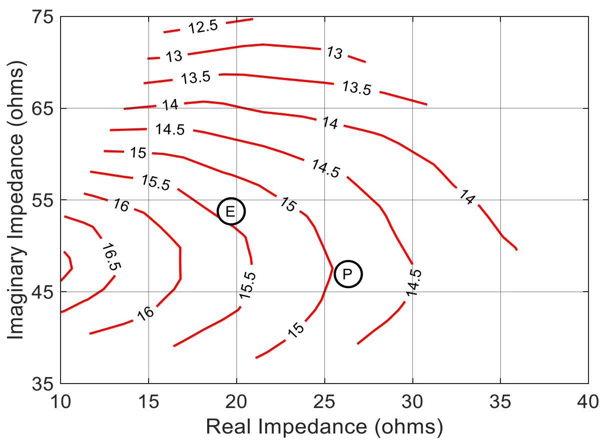
P2.5dB Loadpull Output Power Contours (dBm)



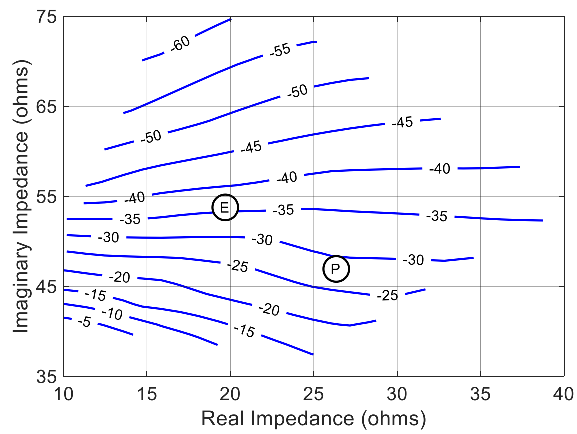
P2.5dB Loadpull Drain Efficiency Contours (%)



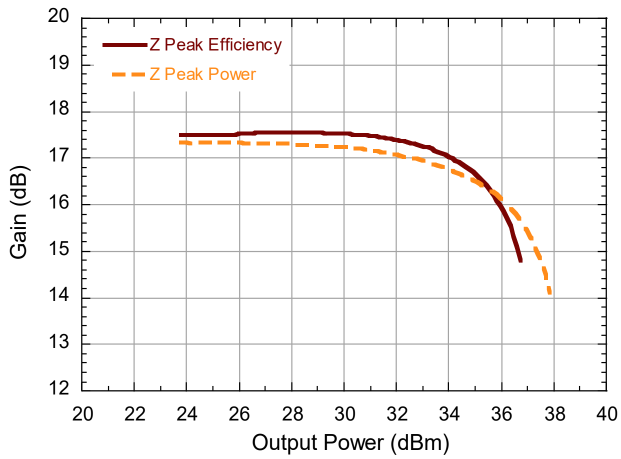
P2.5dB Loadpull Gain Contours (dB)



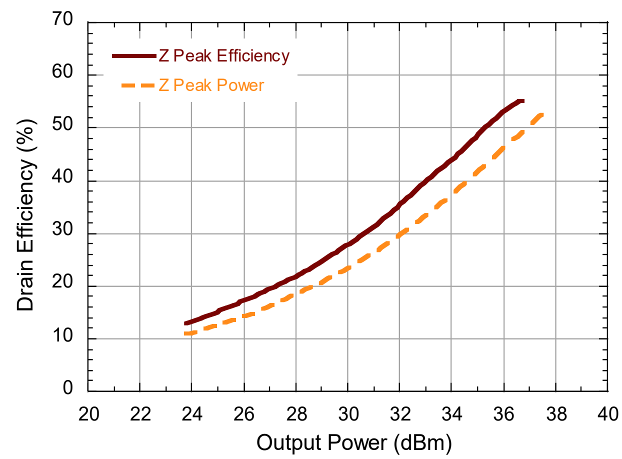
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

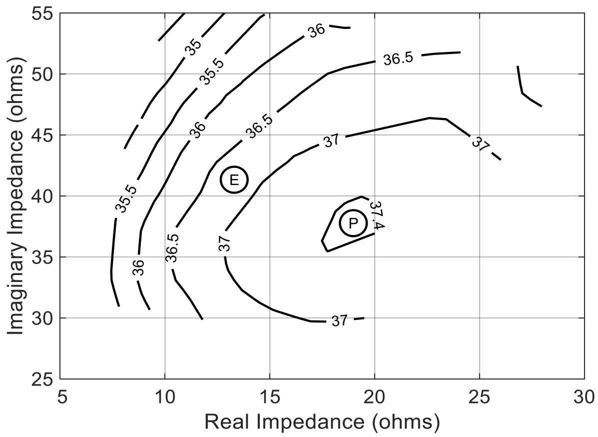


Drain Efficiency vs. Output Power

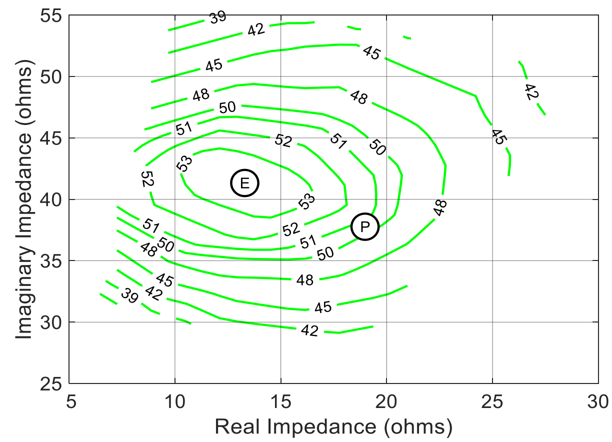


Pulsed[4] Load-Pull Performance 50 V, 5 GHz

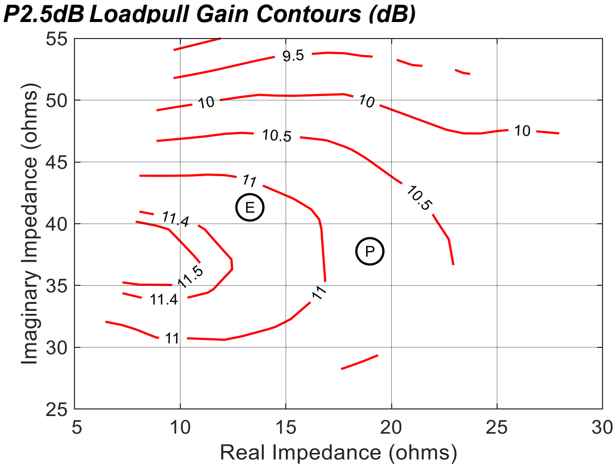
P2.5dB Loadpull Output Power Contours (dBm)



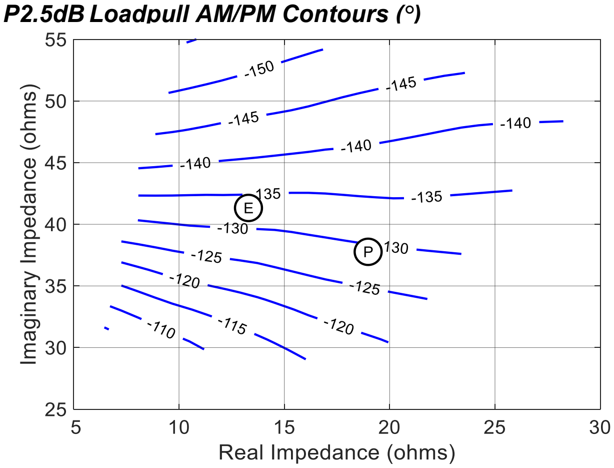
P2.5dB Loadpull Drain Efficiency Contours (%)



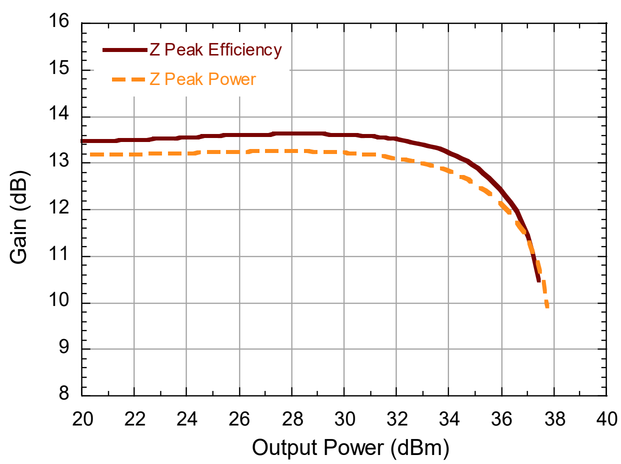
P2.5dB Loadpull Gain Contours (dB)



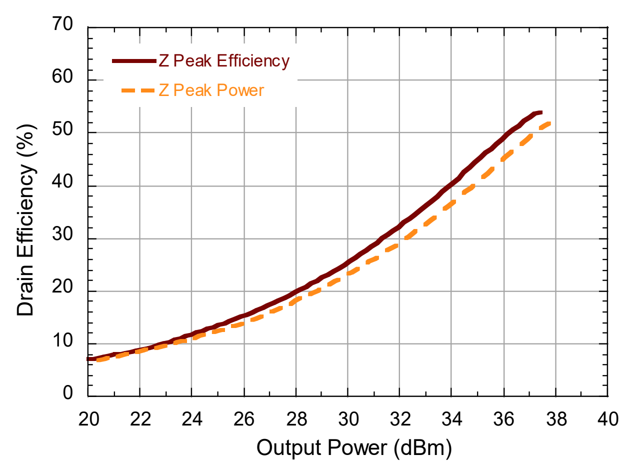
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power



Drain Efficiency vs. Output Power

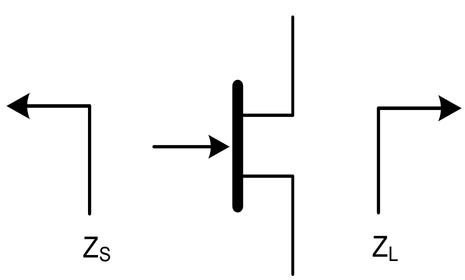


Pulsed[4] Load-Pull Performance: Reference Plane at Device Leads

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Output Power V_{DS} = 28 V, I_{DQ} = 20 mA, T_C = 25°C, P2.5 dB					
		Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
1	40.4 - j9.4	68.0 + j25.1	7.4	35.4	3.5	62.3	149.0
2	10.8 + j20.7	45.8 + j36.9	11.1	35.3	3.4	60.5	76.5
3	7.0 - j10.5	27.9 + j38.3	12.8	34.6	2.9	51.3	45.2
4	47.4 - j28.8	33.2 + j32.4	12.5	34.9	3.1	51.8	-35.2
5	18.6 + j0.9	23.4 + j24.9	9.4	34.6	2.9	48.5	-126.4

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency V_{DS} = 28 V, I_{DQ} = 20 mA, T_C = 25°C, P2.5 dB					
		Z_{LOAD}[12] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
1	39.6 - j7.0	96.9 + j109.6	9.9	32.7	1.9	74.7	144.2
2	11.6 + j18.6	46.5 + j78.0	12.8	33.4	2.2	71.4	64.9
3	7.9 - j11.8	25.8 + j53.1	14.2	33.6	2.3	57.1	33.6
4	56.7 - j15.1	21.8 + j44.6	13.1	33.9	2.5	56.7	-50.5
5	18.0 + j1.8	15.7 + j33.4	9.7	33.7	2.3	53.9	-135.1

Impedance Reference

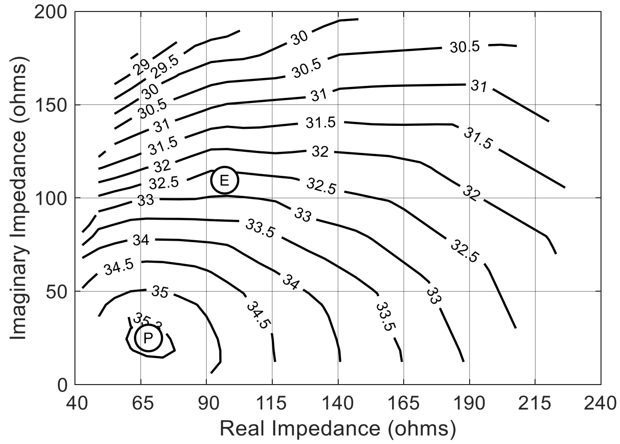


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

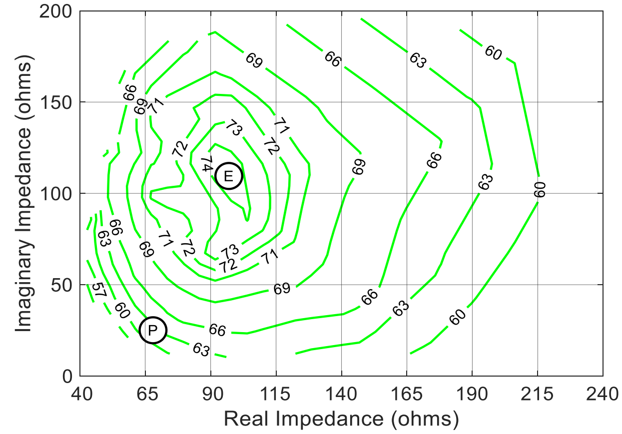
11. Load Impedance for optimum output power.
12. Load Impedance for optimum efficiency.

Pulsed[4] Load-Pull Performance 28 V, 1 GHz

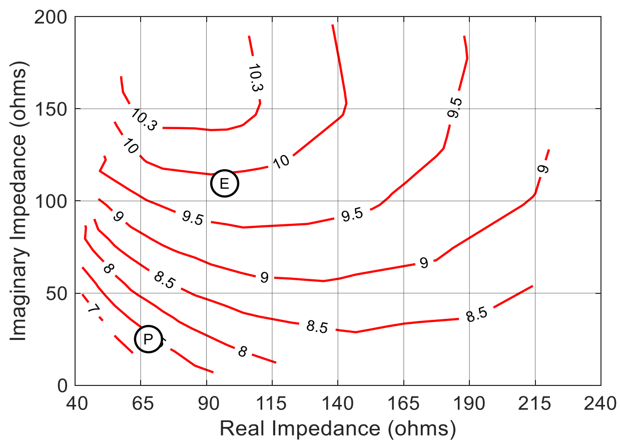
P2.5dB Loadpull Output Power Contours (dBm)



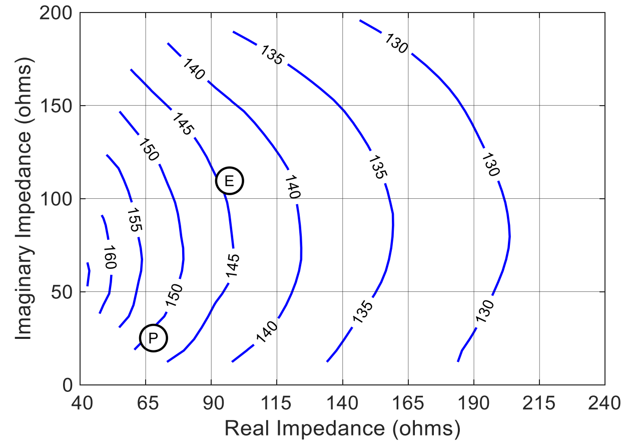
P2.5dB Loadpull Drain Efficiency Contours (%)



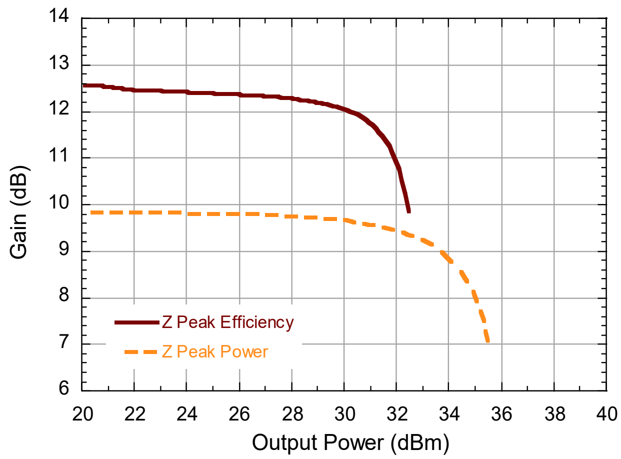
P2.5dB Loadpull Gain Contours (dB)



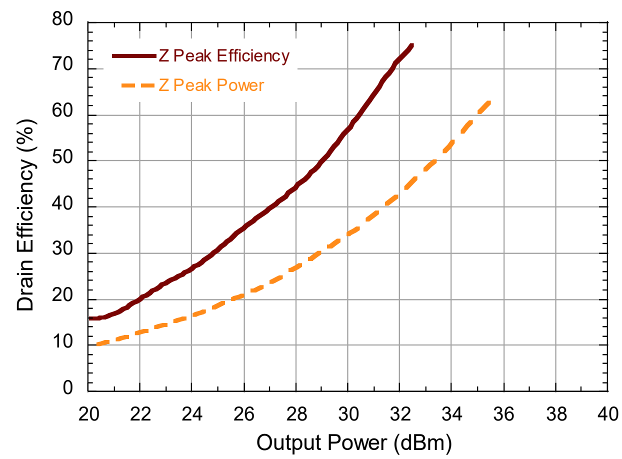
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

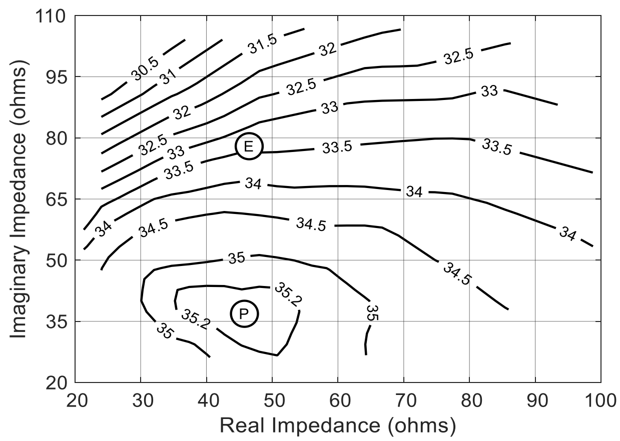


Drain Efficiency vs. Output Power

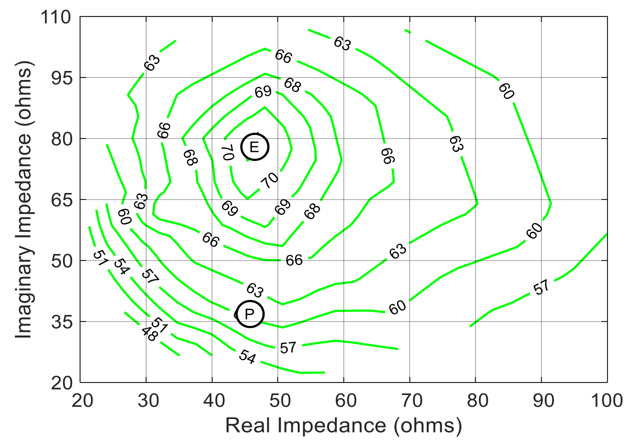


Pulsed[4] Load-Pull Performance 28 V, 2 GHz

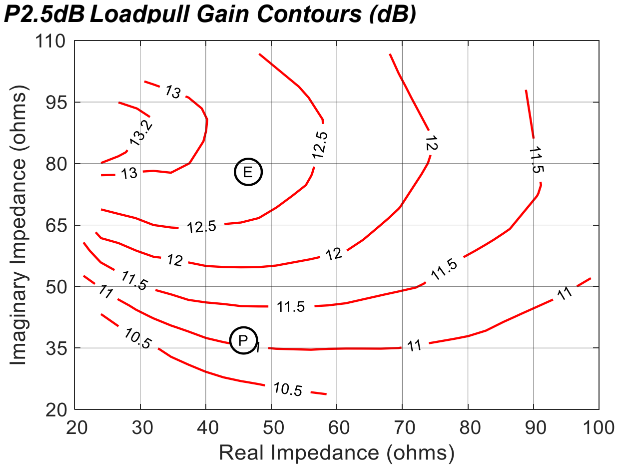
P2.5dB Loadpull Output Power Contours (dBm)



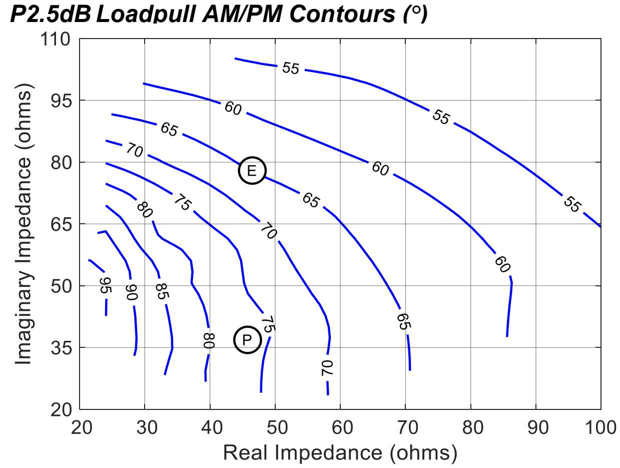
P2.5dB Loadpull Drain Efficiency Contours (%)



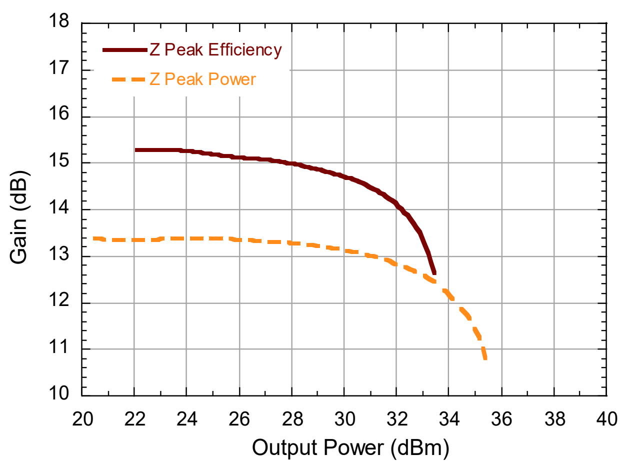
P2.5dB Loadpull Gain Contours (dB)



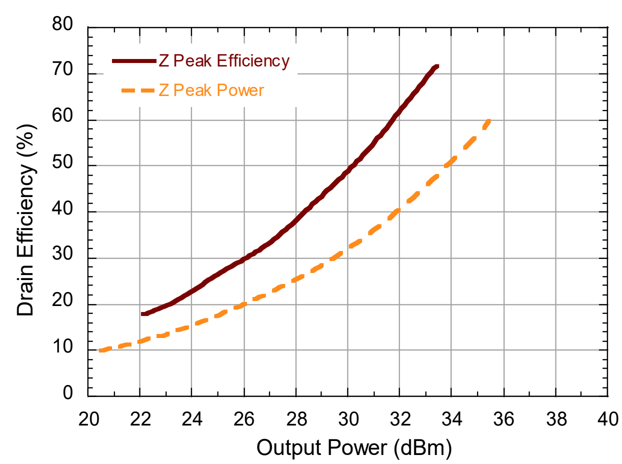
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

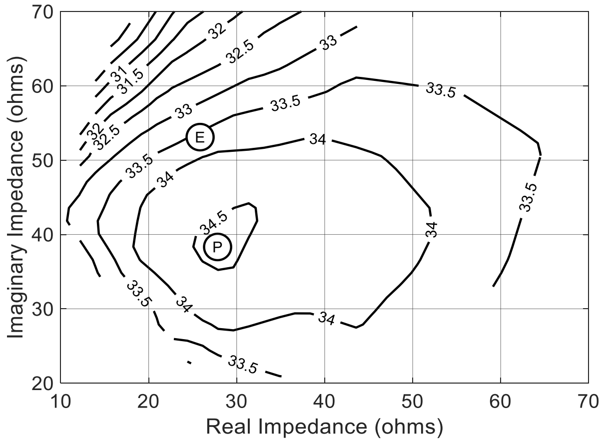


Drain Efficiency vs. Output Power

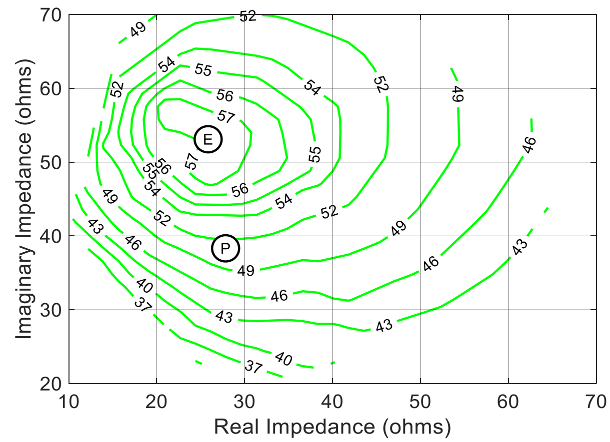


Pulsed[4] Load-Pull Performance 28 V, 3 GHz

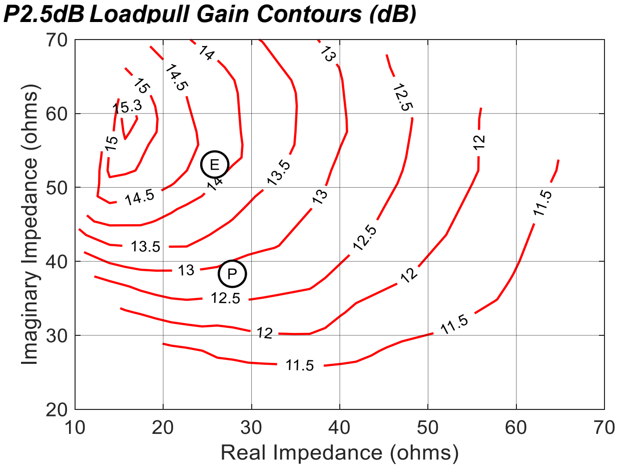
P2.5dB Loadpull Output Power Contours (dBm)



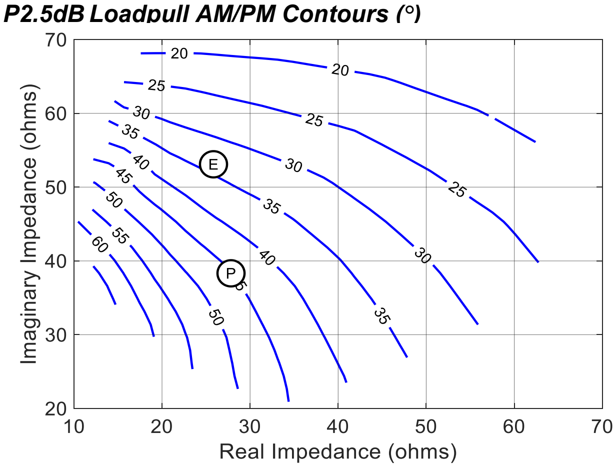
P2.5dB Loadpull Drain Efficiency Contours (%)



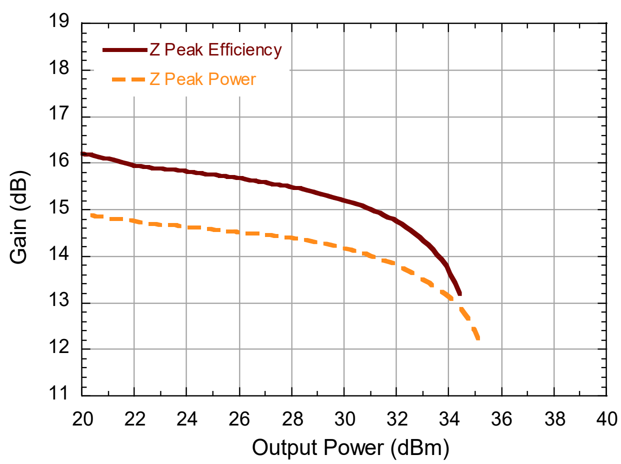
P2.5dB Loadpull Gain Contours (dB)



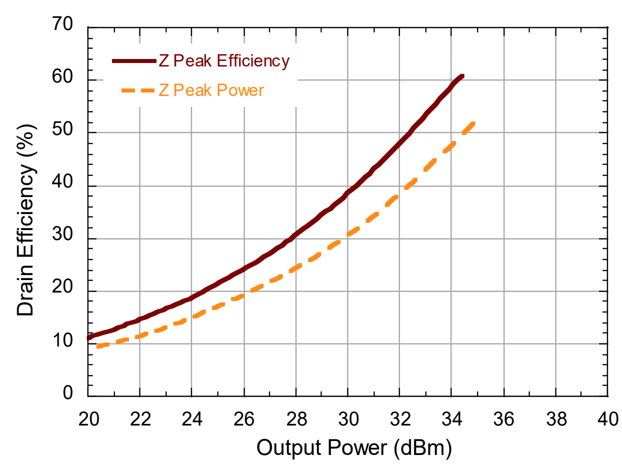
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

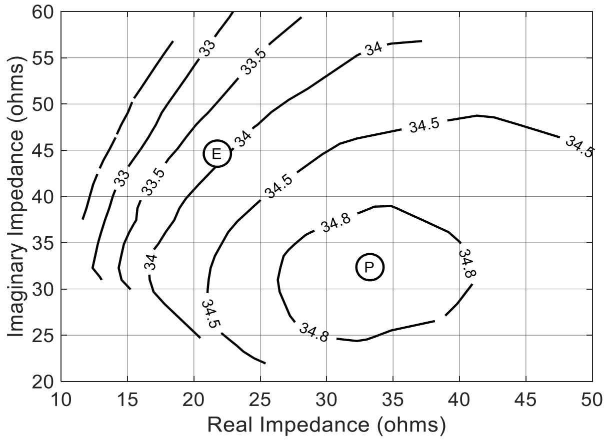


Drain Efficiency vs. Output Power

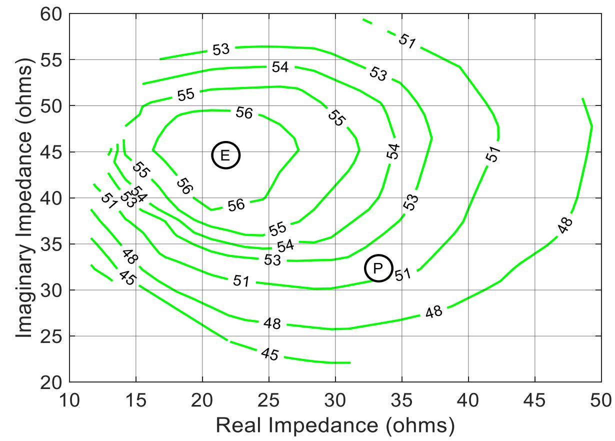


Pulsed[4] Load-Pull Performance 28 V, 4 GHz

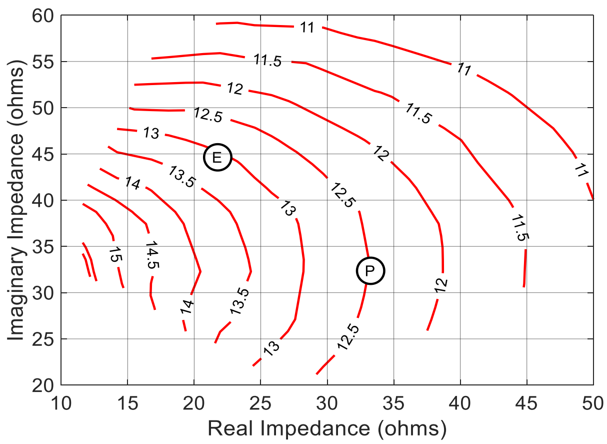
P2.5dB Loadpull Output Power Contours (dBm)



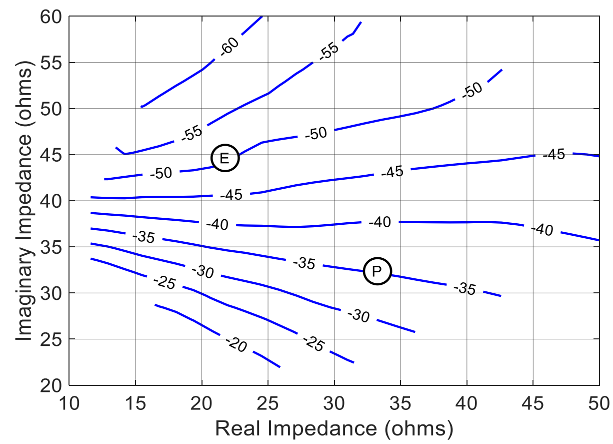
P2.5dB Loadpull Drain Efficiency Contours (%)



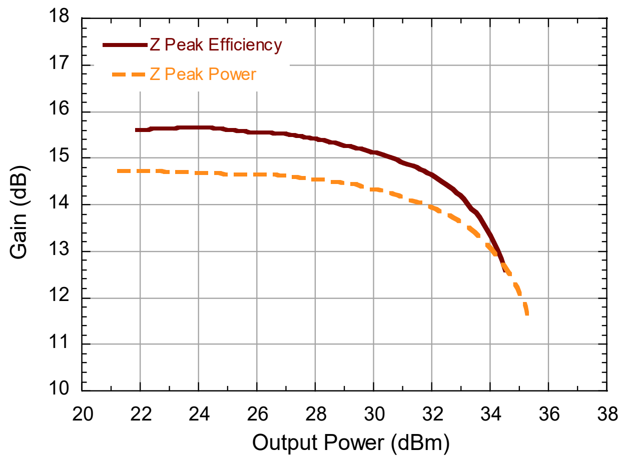
P2.5dB Loadpull Gain Contours (dB)



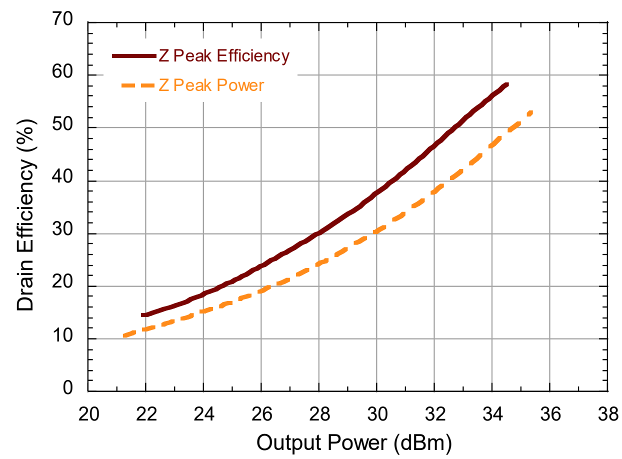
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

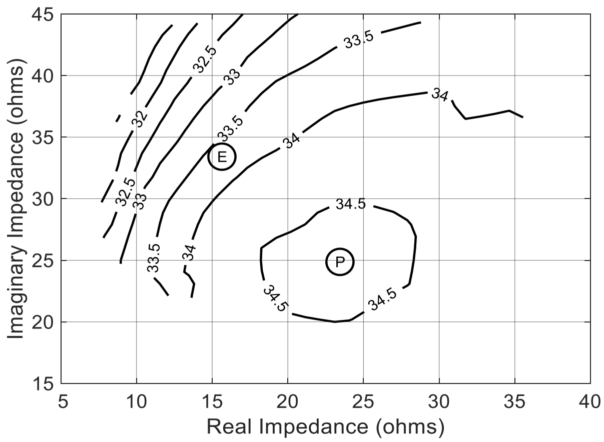


Drain Efficiency vs. Output Power

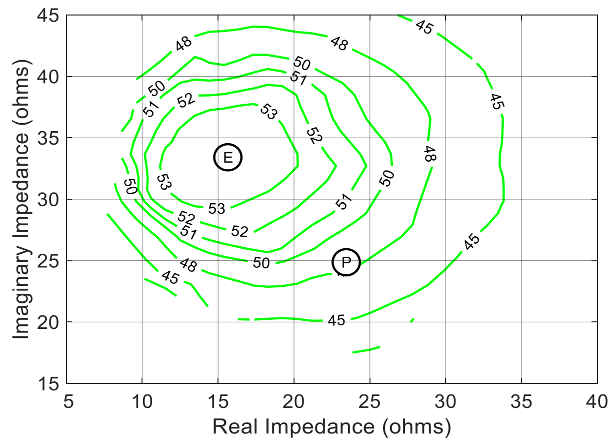


Pulsed[4] Load-Pull Performance 28 V, 5 GHz

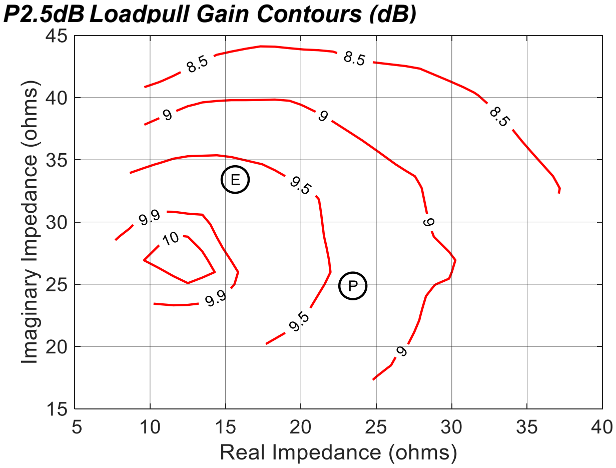
P2.5dB Loadpull Output Power Contours (dBm)



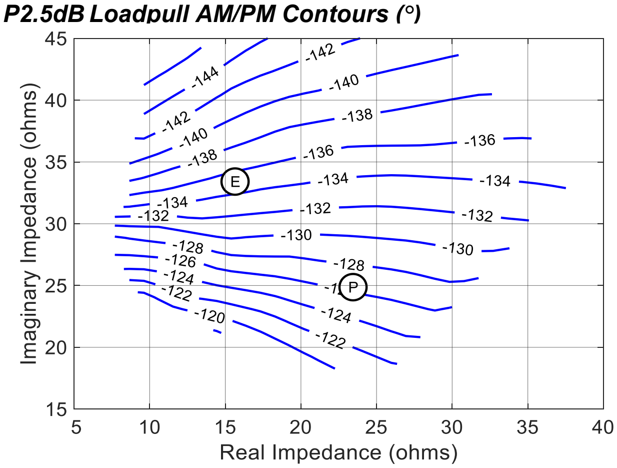
P2.5dB Loadpull Drain Efficiency Contours (%)



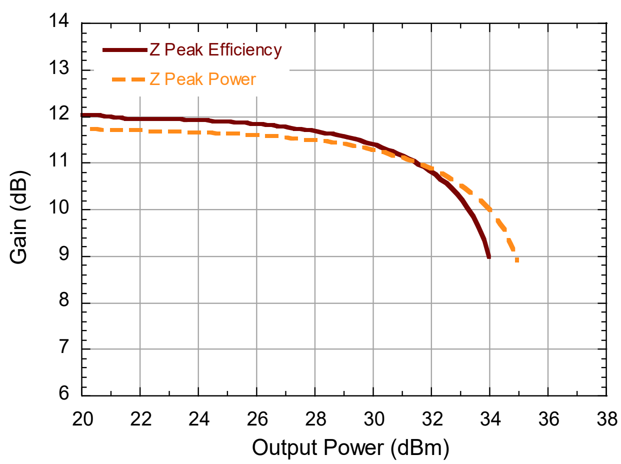
P2.5dB Loadpull Gain Contours (dB)



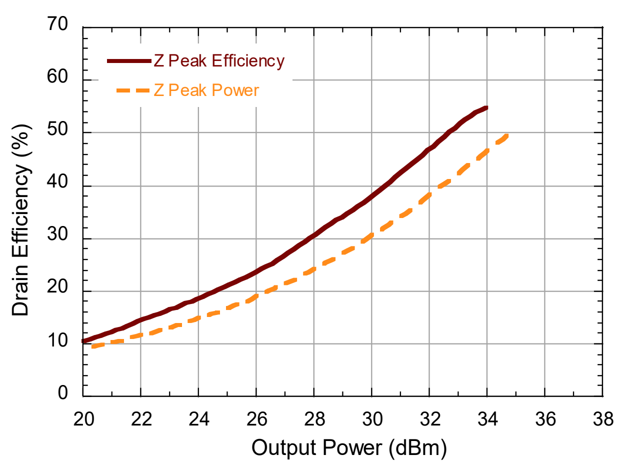
P2.5dB Loadpull AM/PM Contours (°)



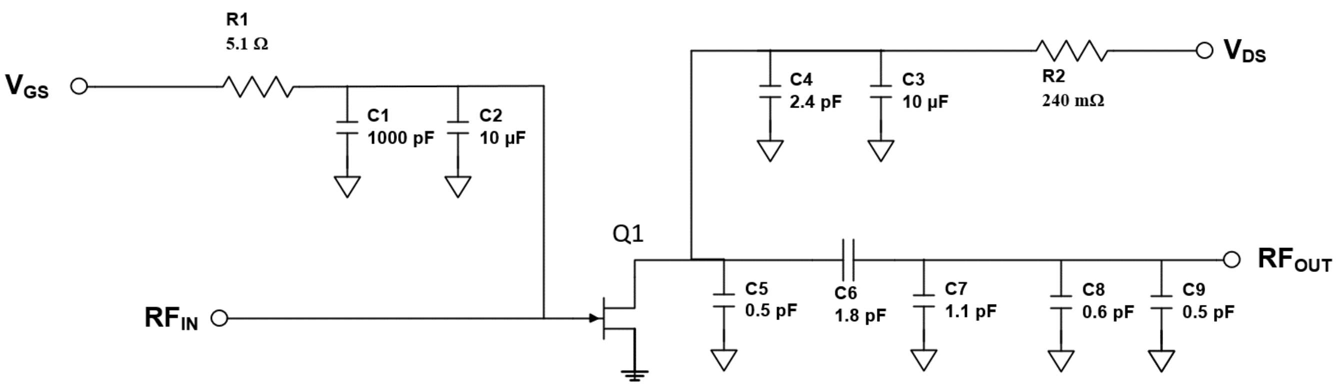
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Test Fixture and Recommended Tuning Solution 3.95 - 4.05 GHz



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

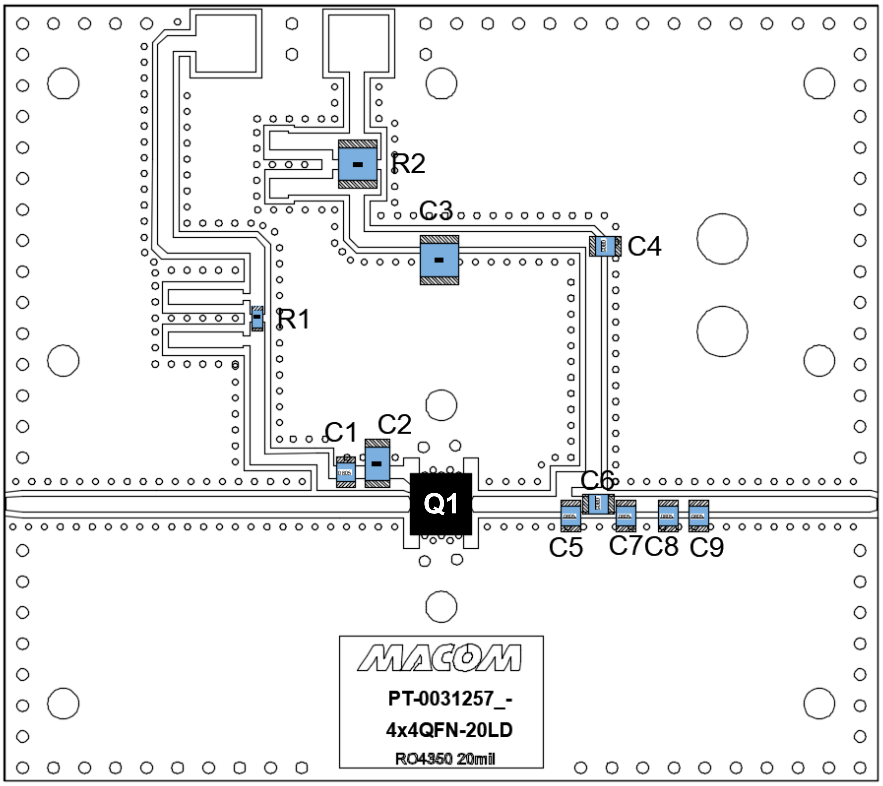
Turning the device ON

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}.

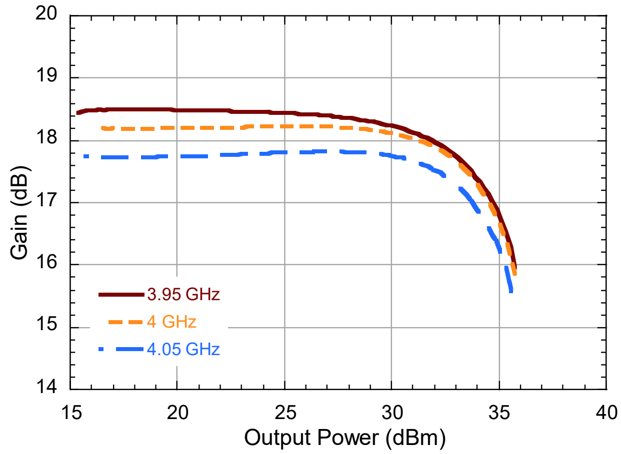
Evaluation Test Fixture and Recommended Tuning Solution 3.95 - 4.05 GHz



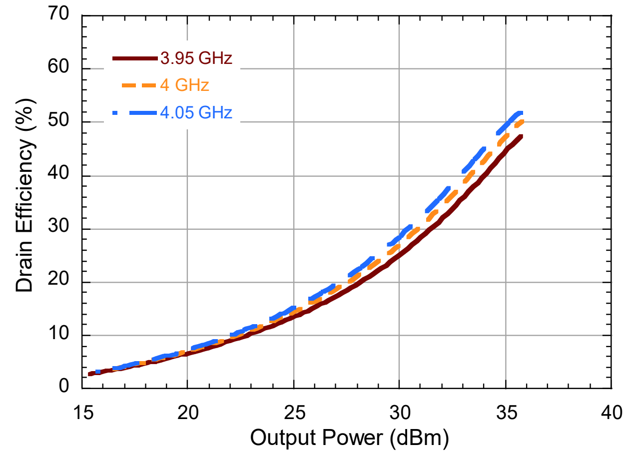
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	1000 pF	+/- 5 %	Murata	GRM219R72A102JA01D
C2	10 µF	+/- 5 %	Murata	GRM219R72A102JA01D
C3	10 µF	+/- 10 %	Murata	GRM32EC72A106KE05L
C4	2.4 pF	+/- 0.1 pF	Murata	GQM2195C2E2R4BB12D
C5, C9	0.5 pF	+/- 0.1 pF	Murata	GQM2195C2ER50BB12D
C6	1.8 pF	+/- 0.1 pF	Murata	GQM2195C2E1R8BB12D
C7	1.1 pF	+/- 0.1 pF	Murata	GQM2195C2E1R1BB12D
C8	0.6 pF	+/- 0.1 pF	Murata	GQM2195C2ER60BB12D
R1	5.1 Ω	+/- 1 %	Vishay Dale	CRCW06035R10FKEA
R2	240 mΩ	+/- 1%	Vishay Dale	RCWE1210R240FKEA
Q1	MACOM GaN Power Amplifier			MAGX-101050-002C0P
PCB	RO4350, 20 mil, 0.5 oz. Cu, SnPb Finish			

Typical Performance Curves as Measured in the 3.95 - 4.05 GHz Evaluation Test Fixture: Pulsed[4] 4 GHz, V_{DS} = 50 V, I_{DQ} = 20 mA, T_C = 25°C (Unless Otherwise Noted)

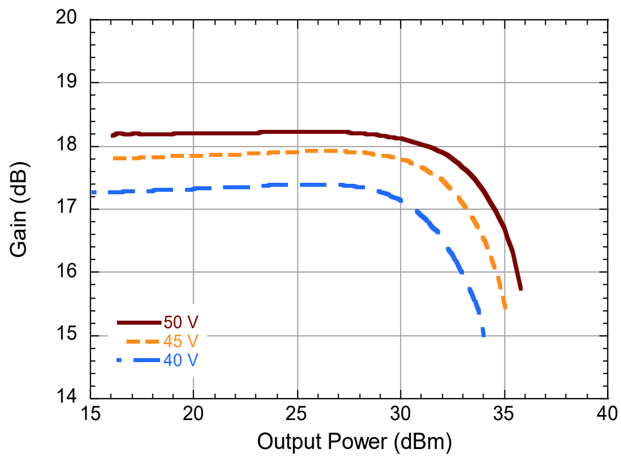
Gain vs. Output Power and Frequency



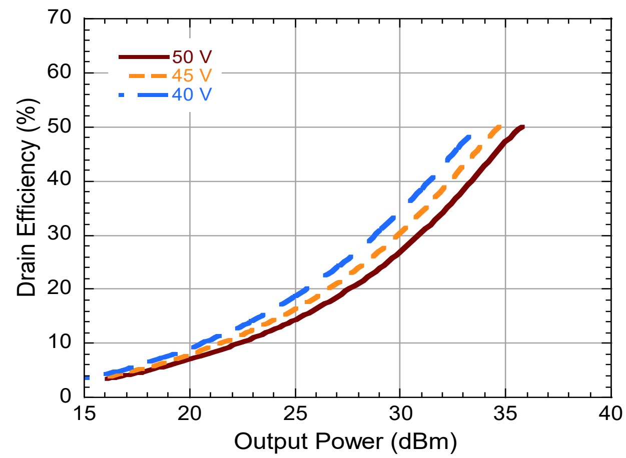
Drain Efficiency vs. Output Power and Frequency



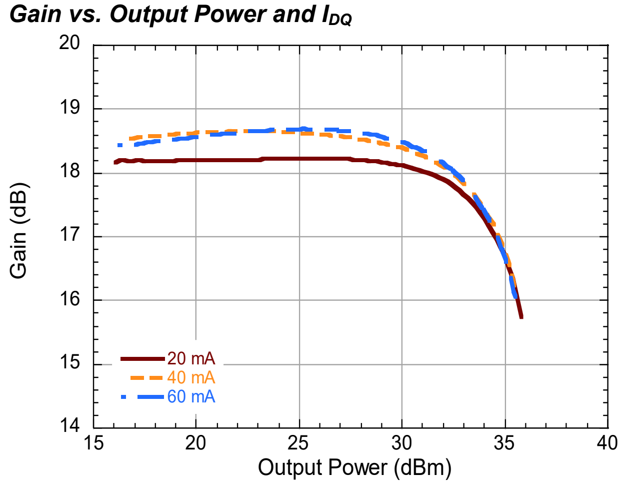
Gain vs. Output Power and V_{DS}



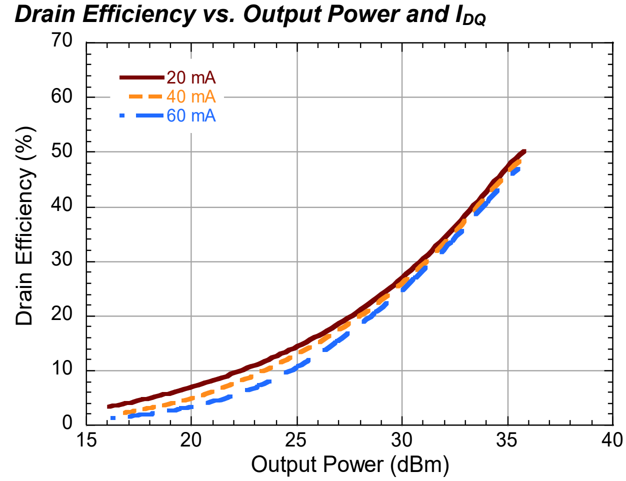
Drain Efficiency vs. Output Power and V_{DS}



Gain vs. Output Power and I_{DQ}

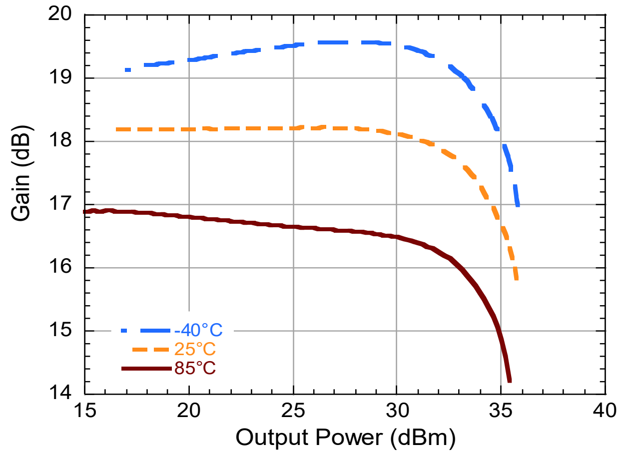


Drain Efficiency vs. Output Power and I_{DQ}

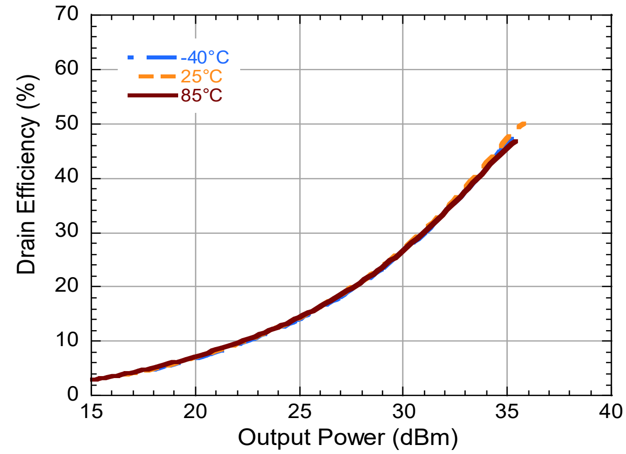


Typical Performance Curves as Measured in the 3.95 - 4.05 GHz Evaluation Test Fixture:
Pulsed[4] 4 GHz, V_{DS} = 50 V, I_{DQ} = 20 mA, T_C = 25°C (Unless Otherwise Noted)

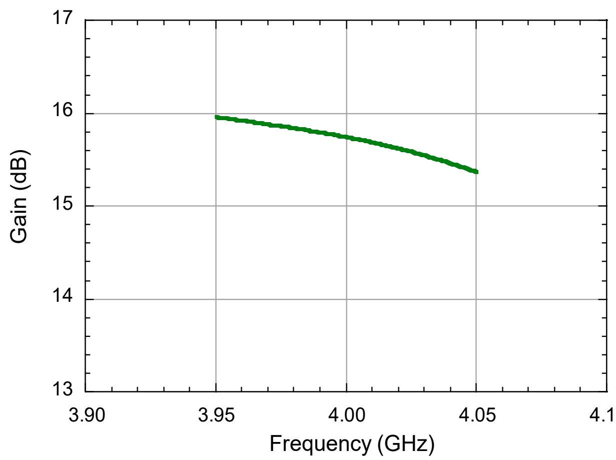
Gain vs. Output Power and T_C



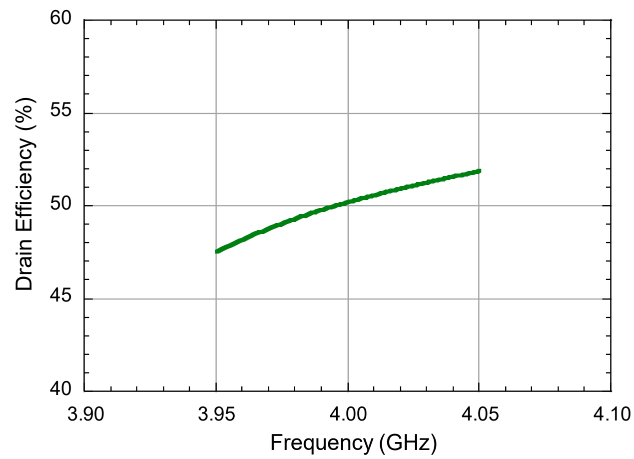
Drain Efficiency vs. Output Power and T_C



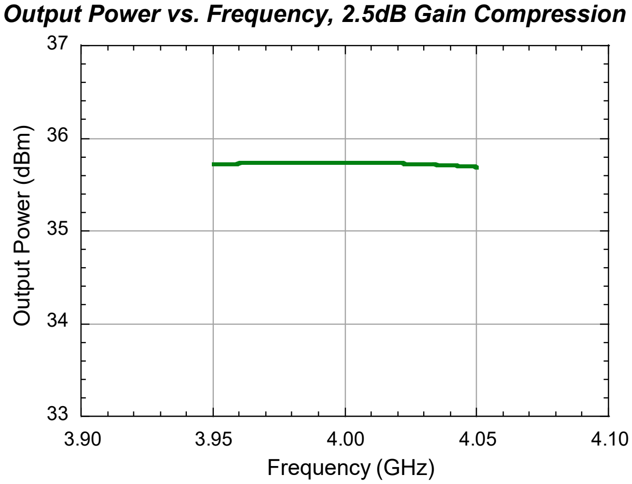
Gain vs. Frequency, 2.5dB Gain Compression



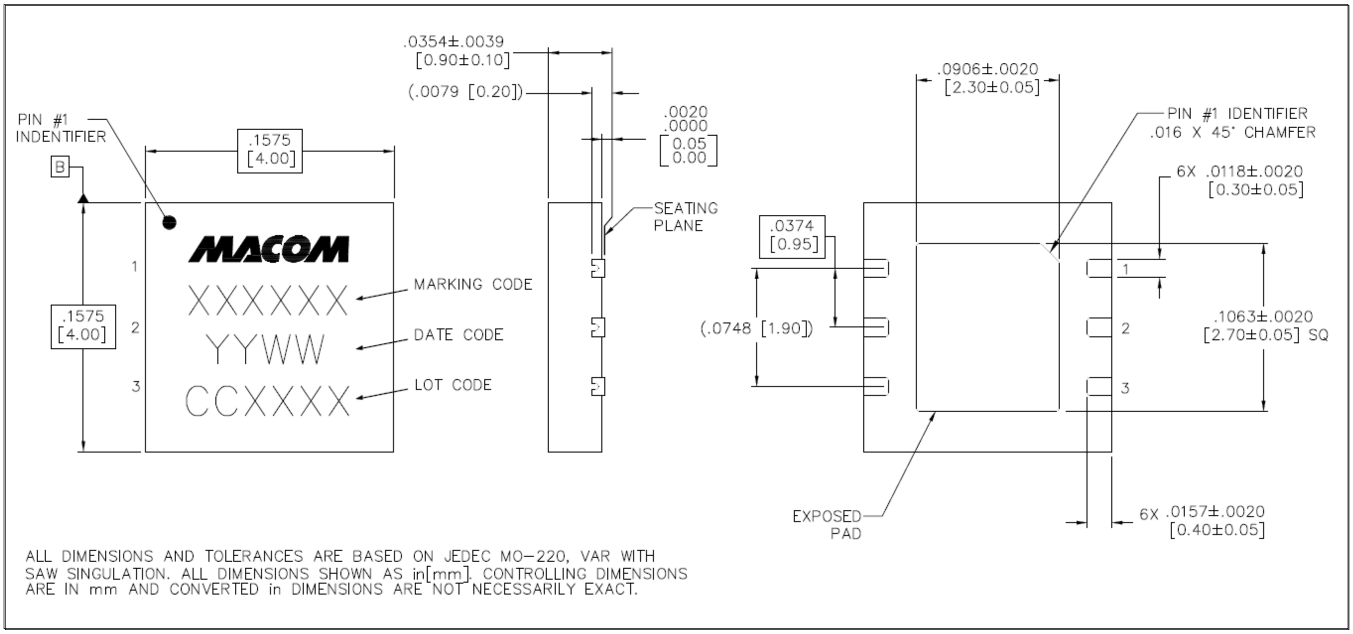
Drain Efficiency vs. Frequency, 2.5dB Gain Compression



Output Power vs. Frequency, 2.5dB Gain Compression



Lead-Free 4 mm 6-Lead Package Dimensions†



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