GaN Amplifier 50 V, 700 W
900 - 930 MHz

MACOM PURE CARBIDE™

MAPC-A1508
Rev. V3

Features

- *MACOM PURE CARBIDE*™ Amplifier Series
- Suitable for CW and Pulsed Applications
- CW Operation: 700 W Output Power
- High Efficiency
- Broadband Operation: 896 - 928 MHz
- 50 V Operation
- 100% RF Tested
- RoHS* Compliant

AC-780S-2

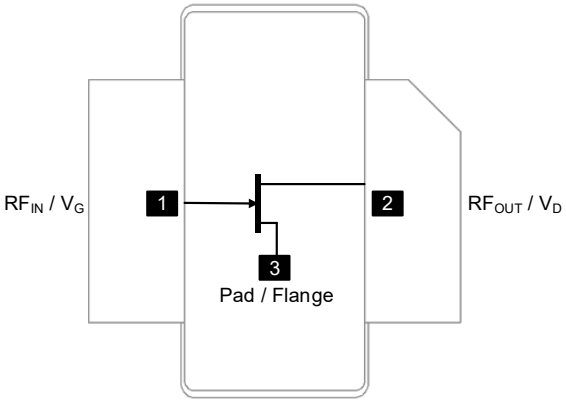
Applications

- 915 MHz Industrial Heating/Welding Systems
- Plasma Generators

Description

The MAPC-A1508 is a GaN on Silicon Carbide HEMT D-mode amplifier suitable for 900 - 930 MHz frequency operation. The device supports both pulsed and CW operation with minimum output power levels of 700 W (58.46 dBm) in an air cavity ceramic package.

Functional Schematic



Typical RF Performance:

Measured under load-pull at 2.5 dB Compression, 100 µs pulse width, 10% duty cycle.

- V_{DS} = 50 V, I_{DQ} = 550 mA, T_C = +25°C

Frequency (MHz)	Output Power[1] (dBm)	Gain[2] (dB)	η_D[2] (%)
900	59.6	19	78.1
915	59.7	19	76.2
925	60	19	78.2

- V_{DS} = 28 V, I_{DQ} = 550 mA, T_C = +25°C

Frequency (MHz)	Output Power[1] (dBm)	Gain[2] (dB)	η_D[2] (%)
900	56.2	17.9	73.5
915	56.5	17.3	71.8
925	56.3	17.2	73.5

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

Pin Configuration

Pin #	Pin Name	Function
1	RF$_{IN}$ / V$_G$	RF Input / Gate
2	RF$_{OUT}$ / V$_D$	RF Output / Drain
3	Flange[3]	Ground / Source

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

Ordering Information

Part Number	Package
MAPC-A1508-AS000	Bulk Quantity
MAPC-A1508-ASTR1	Tape and Reel
MAPC-A1508-ASSB1	Sample Board

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

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 55 V, I_{DQ} = 250 mA
Note: Performance in MACOM Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	CW, 915 MHz	G_{SS}	-	20.1	-	dB
Power Gain	CW, 915 MHz, 3.5 dB Gain Compression	G_{SAT}	-	16.6	-	dB
Saturated Drain Efficiency	CW, 915 MHz, 3.5 dB Gain Compression	η_{SAT}	-	73.2	-	%
Saturated Output Power	CW, 915 MHz, 3.5 dB Gain Compression	P_{SAT}	-	59	-	dBm
Gain Variation (-40°C to +85°C)	Pulsed[4], 915 MHz	ΔG	-	0.016	-	dB/°C
Power Variation (-40°C to +85°C)	Pulsed[4], 915 MHz	$\Delta P3.5dB$	-	0.002	-	dB/°C
Power Gain	CW, 915 MHz, P_{IN} = 39.6 dBm	G_P	-	18.8	-	dB
Drain Efficiency	CW, 915 MHz, P_{IN} = 39.6 dBm	η	-	67.1	-	%
Input Return Loss	CW, 915 MHz, P_{IN} = 39.6 dBm	IRL	-	-12	-	dB
Ruggedness: Output Mismatch	Pulsed[4], All phase angles	Ψ	VSWR = 10:1, No Damage			

RF Electrical Specifications: T_A = 25°C, V_{DS} = 50 V, I_{DQ} = 550 mA
Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	Pulsed[4], 915 MHz, 2.5 dB Gain Compression	G_{SAT}	16.4	17.6	-	dB
Saturated Drain Efficiency	Pulsed[4], 915 MHz, 2.5 dB Gain Compression	η_{SAT}	63.3	68.4	-	%
Saturated Output Power	Pulsed[4], 915 MHz, 2.5 dB Gain Compression	P_{SAT}	58.2	58.9	-	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}	-	-	107	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	107	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 107 mA	V_T	-	-3.1	-	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 550 mA	V_{GSQ}	-	-2.7	-	V
Maximum Drain Current	V_{DS} = 7 V, pulse width 300 µs	$I_{D, MAX}$	-	91	-	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	107 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)	0.40	°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)	0.32	°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

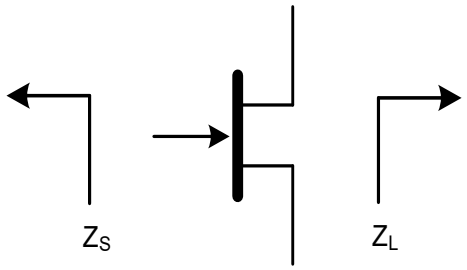
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling.

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

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Output Power V_{DS} = 50 V, I_{DQ} = 550 mA, T_C = 25°C, P2.5dB Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
900	0.5 - j1.5	F0: 0.5 + j0 2F0: 0.64 + j3.9	19.0	59.6	912.0	68.6	48.3
915	0.5 - j1.6	F0: 0.5 - j0 2F0: 0.8 + j3.9	18.9	59.7	933.3	66.6	45.9
925	0.6 - j1.7	F0: 0.5 + j0 2F0: 0.8 + j3.9	19.2	60.0	1000	69.5	46.4

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency V_{DS} = 50 V, I_{DQ} = 550 mA, T_C = 25°C, P2.5dB Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
900	0.9 - j1.8	F0: 0.7 + j0.8 2F0: 0.64 + j3.9	19.0	56.2	416.9	78.1	14.1
915	0.8 - j1.8	F0: 0.7 + j0.6 2F0: 0.8 + j3.9	19	56.9	489.8	76.2	15.5
925	1.0 - j1.9	F0: 0.7 + j0.6 2F0: 0.8 + j3.9	19	56.9	489.8	78.2	11.9

Impedance Reference

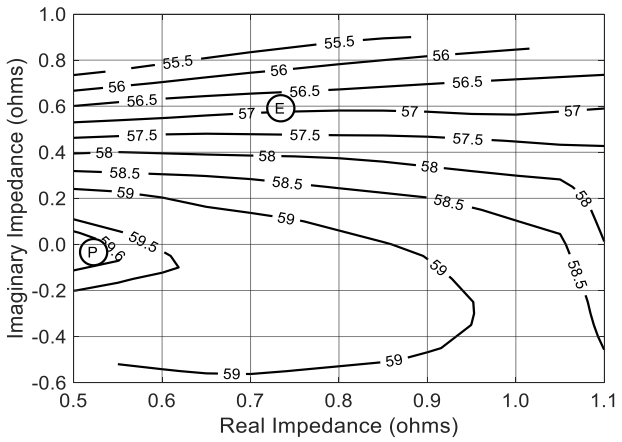


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

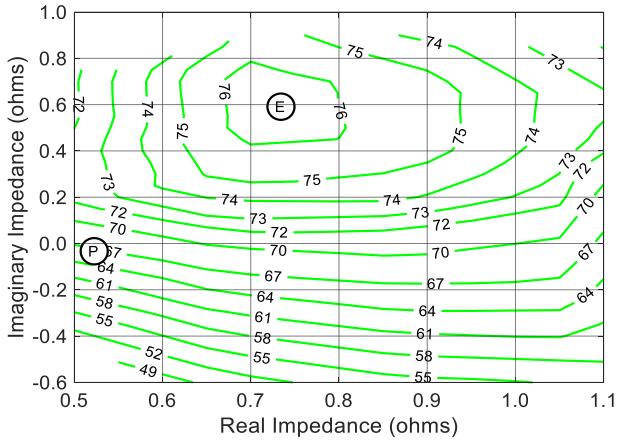
11. Load Impedance for optimum output power.
12. Load Impedance for optimum efficiency.

Pulsed[4] 50 V Load-Pull Performance @ 915 MHz

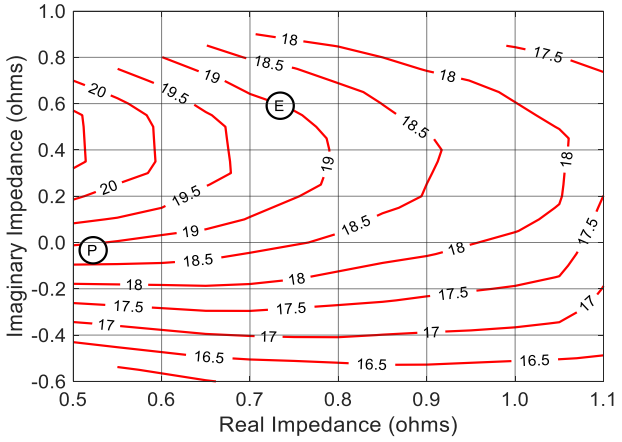
P2.5dB Loadpull Output Power Contours (dBm)



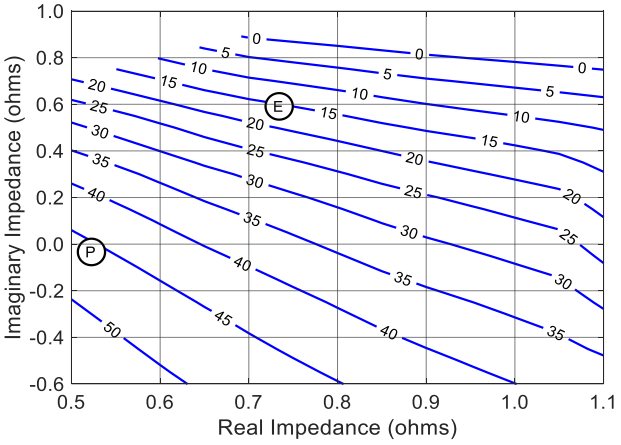
P2.5dB Loadpull Drain Efficiency Contours (%)



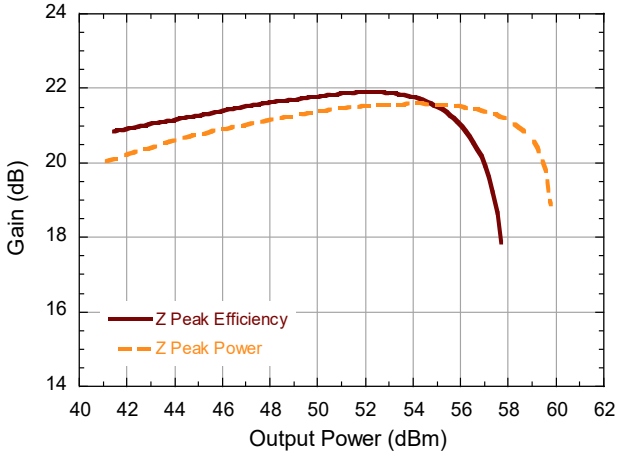
P2.5dB Loadpull Gain Contours (dB)



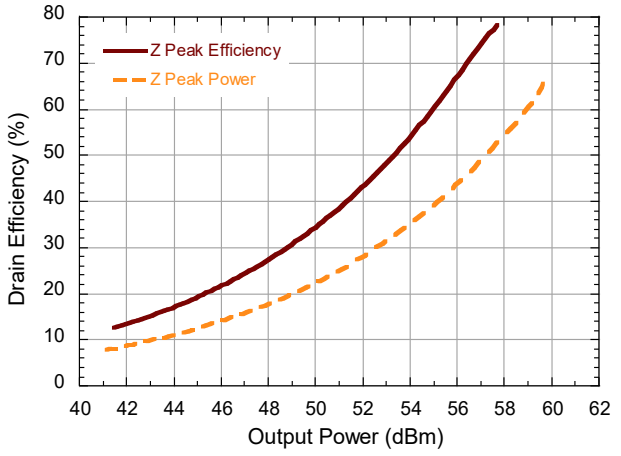
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power



Drain Efficiency vs. Output Power

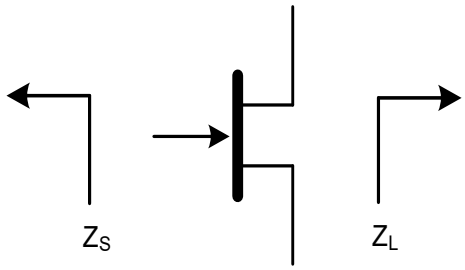


Pulsed[4] Load-Pull Performance @ 28 V (Reference Plane at Device Leads)

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Output Power V_{DS} = 28 V, I_{DQ} = 550 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
900	0.5 - j1.4	F0: 0.5 - j0.3 2F0: 0.74 + j3.9	16.4	56.2	416.9	65.4	51
915	0.6 - j1.6	F0: 0.4 - j0.3 2F0: 0.68 + j3.9	17.1	56.5	446.7	66.9	50.4
925	0.7 - j1.6	F0: 0.5 - j0.3 2F0: 0.69 + j2.6	16.4	56.3	426.6	65.5	47.3

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency V_{DS} = 28 V, I_{DQ} = 550 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
900	0.7 - j1.7	F0: 0.6 + j0.1 2F0: 0.74 + j3.9	17.9	54.2	263.0	73.5	30.7
915	0.9 - j1.9	F0: 0.6 + j0.1 2F0: 0.68 + j3.9	17.3	53.8	239.9	71.8	20.8
925	0.9 - j1.9	F0: 0.6 + j0.1 2F0: 0.69 + j2.6	17.2	53.9	245.5	73.5	16.3

Impedance Reference

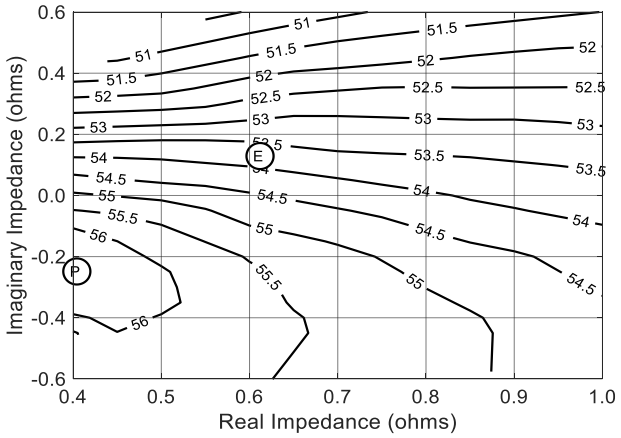


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

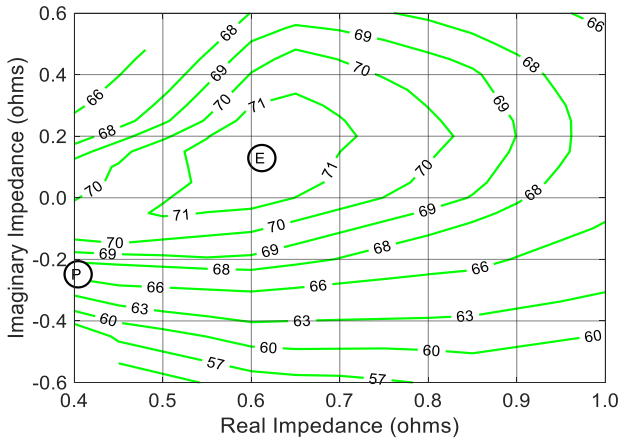
11. Load Impedance for optimum output power.
12. Load Impedance for optimum efficiency.

Pulsed[4] 28 V Load-Pull Performance @ 915 MHz

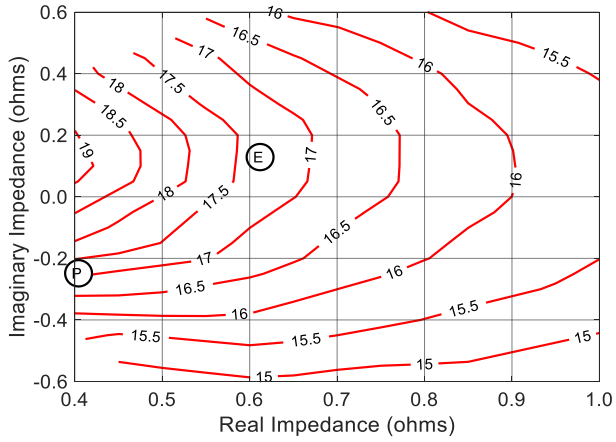
P2.5dB Loadpull Output Power Contours (dBm)



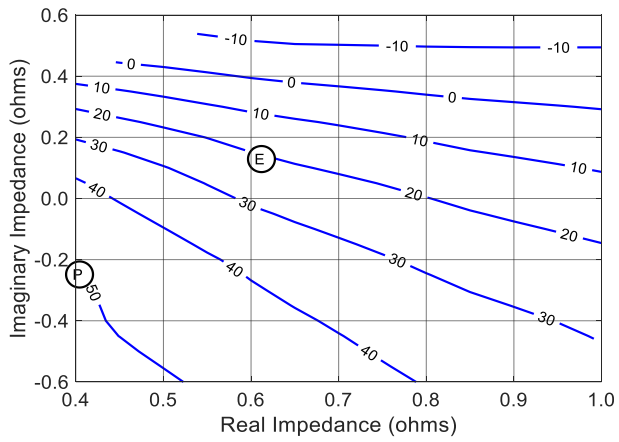
P2.5dB Loadpull Drain Efficiency Contours (%)



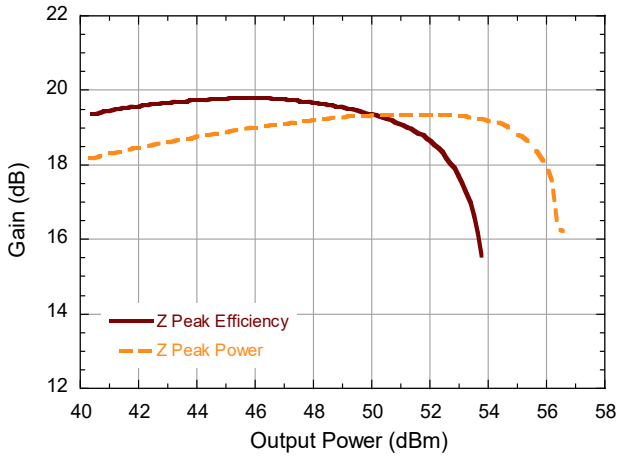
P2.5dB Loadpull Gain Contours (dB)



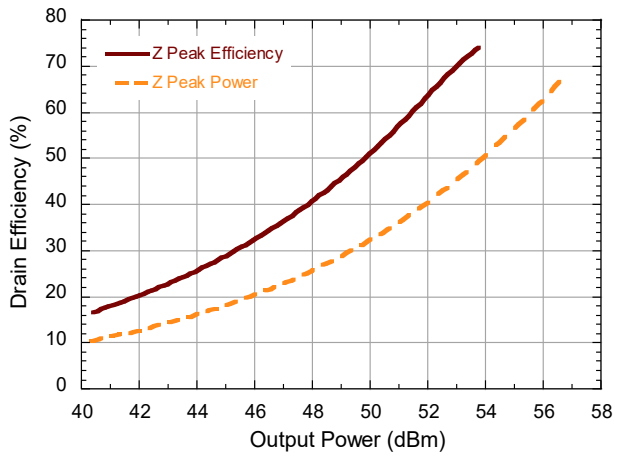
P2.5dB Loadpull AM/PM Contours (°)



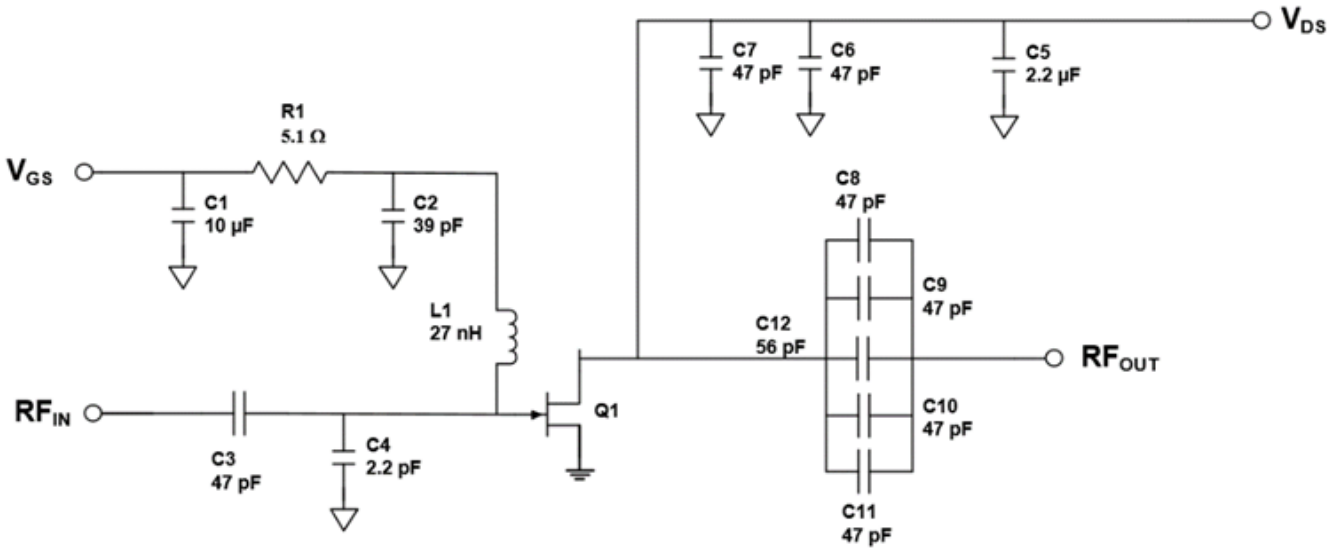
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Test Fixture and Recommended Tuning Solution 900 - 930 MHz



Description

Parts measured on evaluation board (20-mil thick RT6035HTC). 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

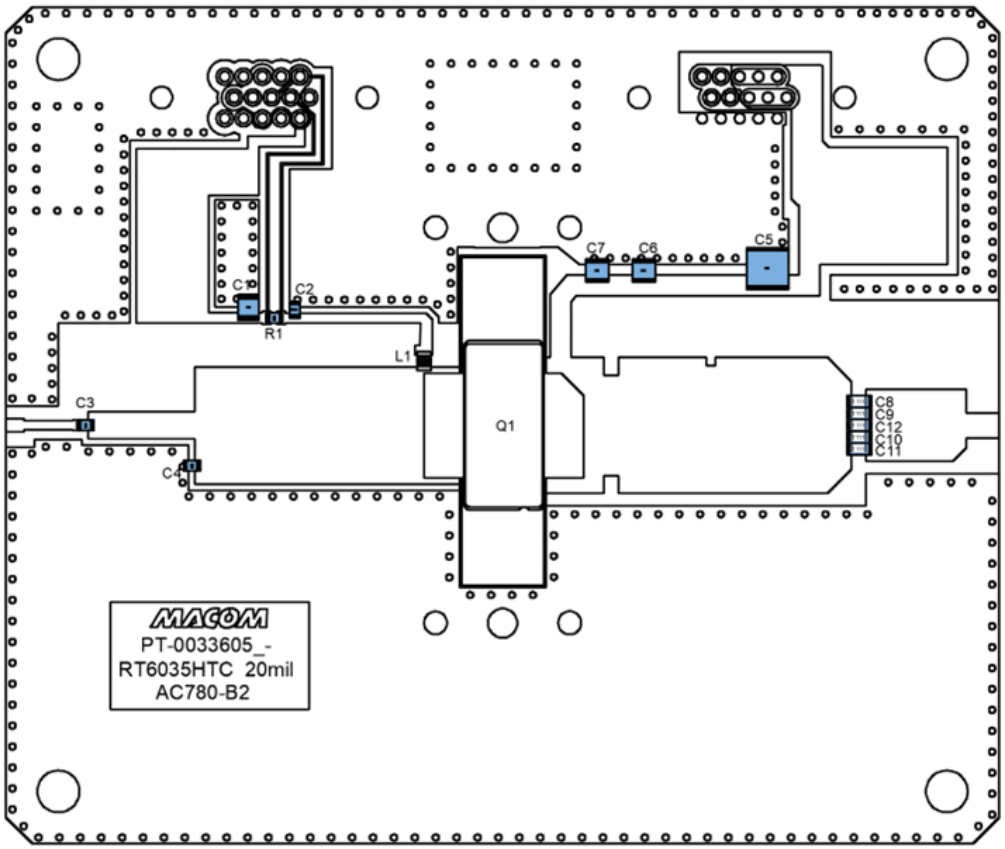
Turning the device ON

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}.

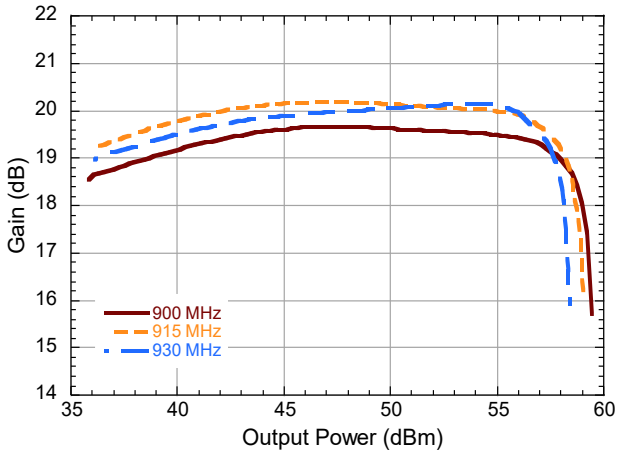
Evaluation Test Fixture and Recommended Tuning Solution 900 - 930 MHz



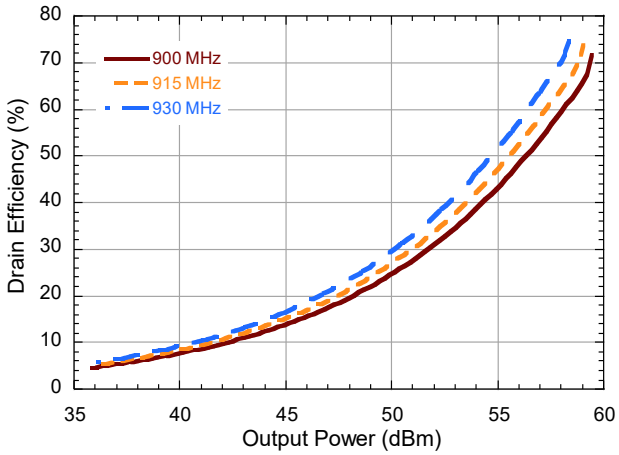
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	10 µF	+/- 10 %	TDK Corporation	GRM32EC72A106KE05L
C2	39 pF	+/- 5 %	PPI	0805N390JW251X
C3	47 pF	+/- 5 %	PPI	0805N470JW251X
C4	2.2 pF	+/- 0.1 pF	PPI	0805N2R2BW251X
C5	2.2 µF	+/- 20 %	Murata	KRM55TR72E225MH01L
C6,C7, C8, C9, C10, C11	47 pF	+/- 5 %	Vishay	VJ1111D470JXEQJHT
C12	56 pF	+/- 2 %	Vishay	VJ1111D560GXLQJ
R1	5.1 Ω	+/- 5 %	YAGEO	RC0603JR-075R1L
L1	27 nH	+/- 5 %	CoilCraft	1008CS-270XJLC
Q1	MACOM GaN Power Amplifier			MAPC-A1508
PCB	RT6035HTC, 20 mil, 1.0 oz. Cu, Au Finish			

Typical Performance Curves as Measured in the 900 - 930 MHz Evaluation Test Fixture:
CW 915 MHz, V_{DS} = 55 V, I_{DQ} = 250 mA, T_C = 25°C (Unless Otherwise Noted)

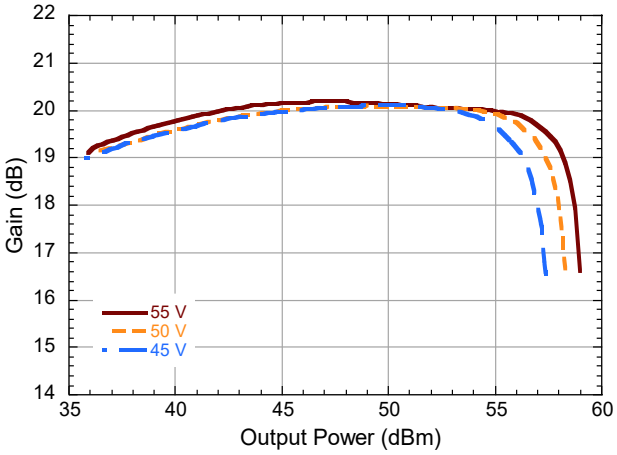
Gain vs. Output Power and Frequency



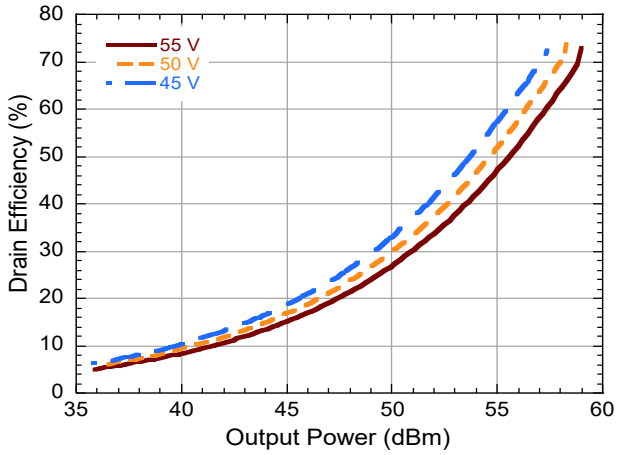
Drain Efficiency vs. Output Power and Frequency



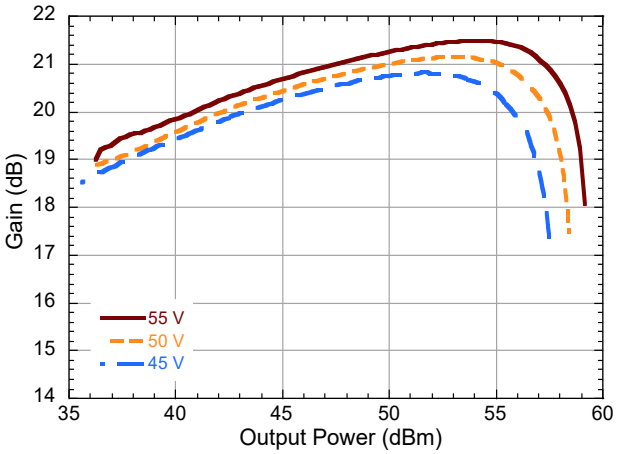
Gain vs. Output Power and V_{DS}



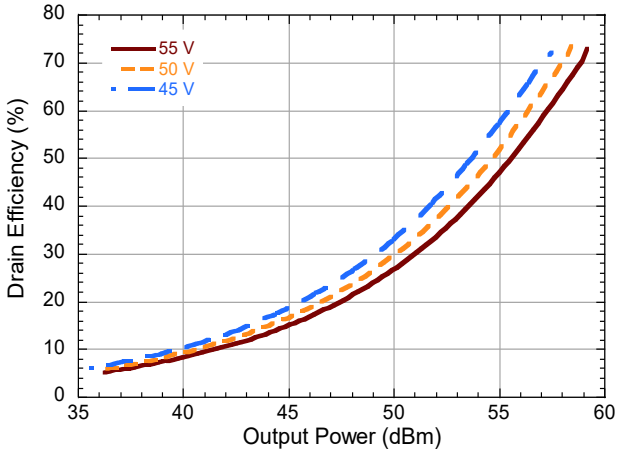
Drain Efficiency vs. Output Power and V_{DS}



Pulsed[4] Gain vs. Output Power and V_{DS}

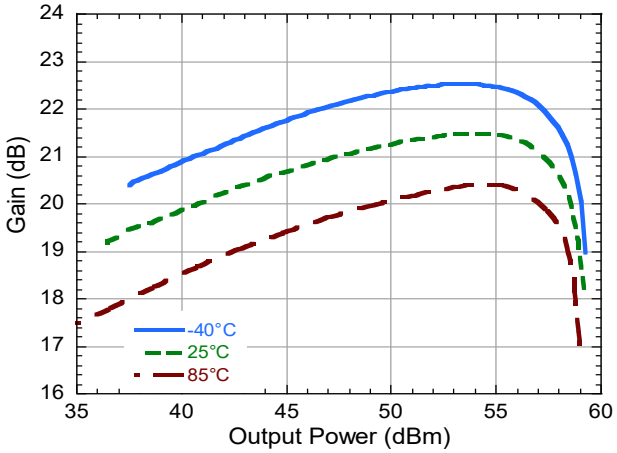


Pulsed[4] Drain Efficiency vs. Output Power and V_{DS}

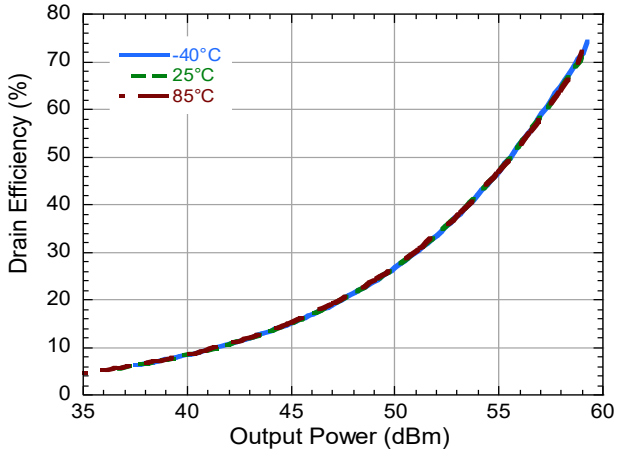


Typical Performance Curves as Measured in the 900 - 930 MHz Evaluation Test Fixture:
Pulsed[4] 915 MHz, V_{DS} = 55 V, I_{DQ} = 250 mA, T_C = 25°C (Unless Otherwise Noted)

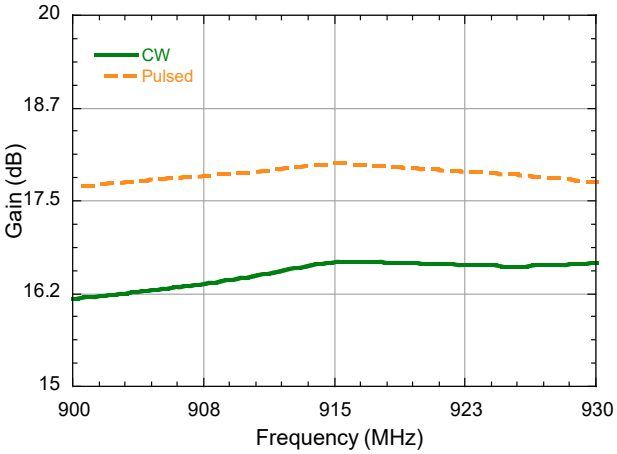
Gain vs. Output Power and T_C



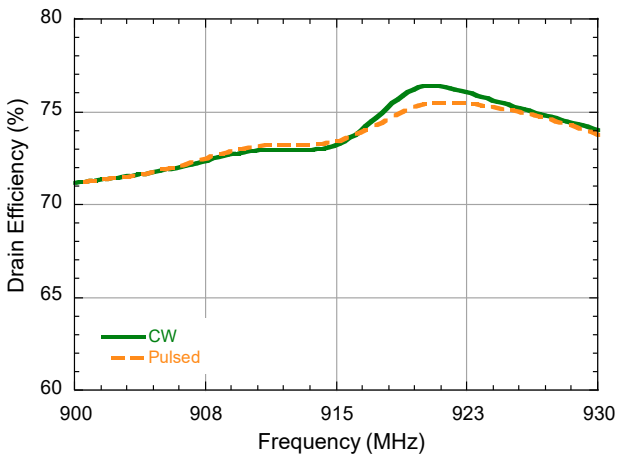
Drain Efficiency vs. Output Power and T_C



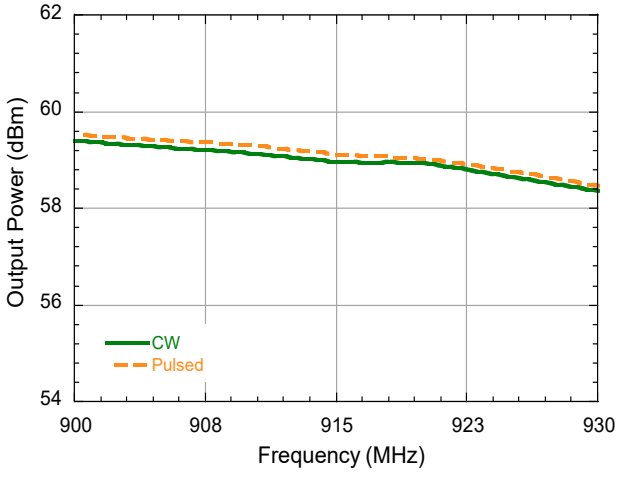
Gain vs. Frequency, 3.5dB Compression



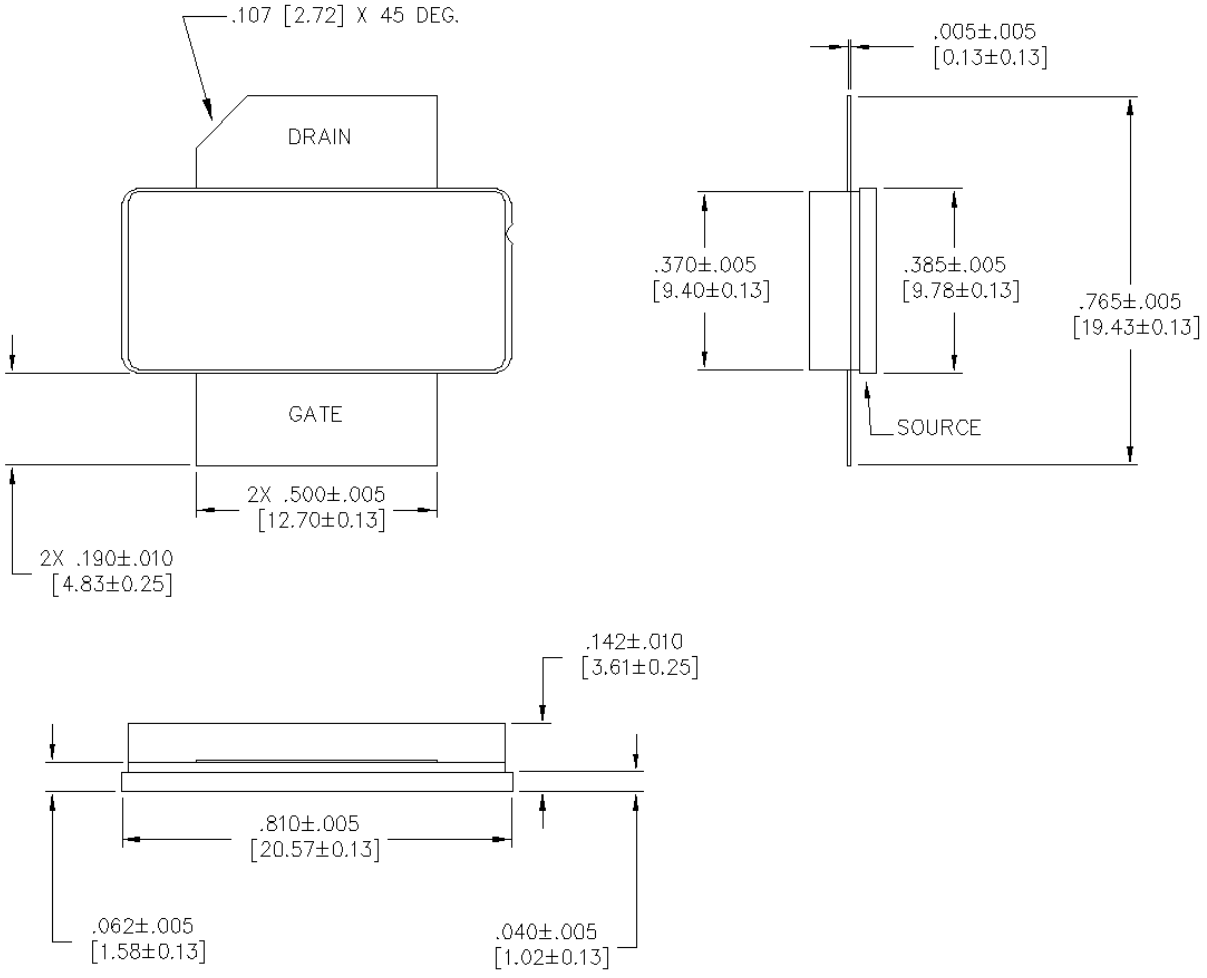
Drain Efficiency vs. Frequency, 3.5dB Compression



Output Power vs. Frequency, 3.5dB Compression



Lead-Free AC-780S-2 Ceramic Package Dimensions†



NOTES:

1. ALL DIMENSIONS SHOWN AS in[mm]. CONTROLLING DIMENSIONS ARE IN in AND CONVERTED mm DIMENSIONS ARE NOT NECESSARILY EXACT.
2. LEAD FINISH: AU
   FLANGE FINISH: AU
3. LID SEAL EPOXY MAY FLOW OUT A MAXIMUM OF .018 [0.46] FROM EDGE OF LID
4. LID MAY BE MIS-ALIGNED UP TO .008 [0.20] FROM PACKAGE IN ANY DIRECTION

† Reference Application Note AN0004363 for mounting recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Au plating on flange and leads.