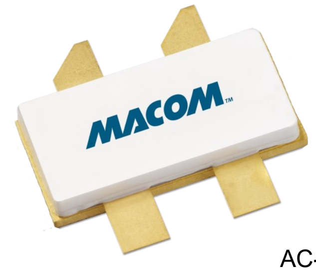
GaN Amplifier 50 V, 450 W
0.7 - 2.7 GHz

MACOM PURE CARBIDE

MAPC-A1525
Rev. V1

Features

- *MACOM PURE CARBIDE*™ Amplifier Series
- Suitable for Linear & Saturated Applications
- Pulsed Operation: 450 W Output Power
- Internally Pre-Matched
- 50 V Operation
- High Thermal Conductivity Package for Maximum Heat Transfer
- Compatible with MACOM Power Management Bias Controller/Sequencer MABC-11040B



AC-780S-4

Applications

RADAR, Datalink and Satellite Communications

Description

The MAPC-A1525 is a high power GaN on Silicon Carbide HEMT D-mode amplifier suitable for 0.7 - 2.7 GHz frequency operation. The device supports pulsed operation with output power levels of 450 W (56.5 dBm) and in an air cavity ceramic package.

Typical Performance:

Measured under evaluation board at 3 dB Compression, 100 µs pulse width, 10% duty cycle. V_{DS} = 50 V, I_{DQ} = 900 mA, T_C = 25°C

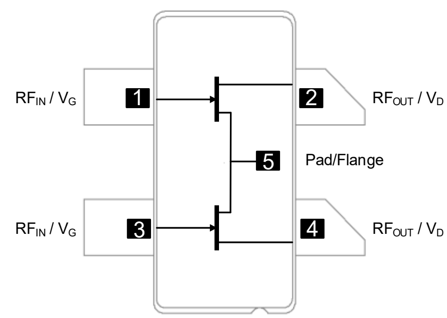
- Efficiency Tuned Board (2.5 - 2.7 GHz)

Frequency (GHz)	Output Power[1] (dBm)	Gain[2] (dB)	η_D [2] (%)
2.5	57.5	17.0	60.5
2.6	56.7	18.0	65.7
2.7	55.5	18.6	63.3

- Wideband Tuned Board (1.0 - 2.5 GHz)

Frequency (GHz)	Output Power[1] (dBm)	Gain[2] (dB)	η_D [2] (%)
1.0	56.6	14.8	57.7
1.3	55.7	13.3	60.3
1.7	55.7	14.2	52.3
2.1	55.7	13.7	45.6
2.5	56.3	13.8	53.6

Functional Schematic



Pin Configuration

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

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

Ordering Information

Part Number	Package
MAPC-A1525-AS000	Bulk Quantity
MAPC-A1525-ASTR1	Tape and Reel
MAPC-A1525-ASSB1	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} = 900 mA
Note: Performance in MACOM Efficiency Tuned Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Saturated Output Power	Pulsed[2], 2.6 GHz, 3 dB Gain Compression	P_{SAT}	-	56.4	-	dBm
Power Gain	Pulsed[2], 2.6 GHz, 3 dB Gain Compression	G_{SAT}	-	18.0	-	dB
Saturated Drain Efficiency	Pulsed[2], 2.6 GHz, 3 dB Gain Compression	η_{SAT}	-	65.2	-	%
Gain Variation (-40°C to +85°C)	Pulsed[2], 2.6 GHz, 3 dB Gain Compression	ΔG	-	-0.012	-	dB/°C
Power Variation (-40°C to +85°C)	Pulsed[2], 2.6 GHz, 3 dB Gain Compression	ΔP3.0dB	-	-0.003	-	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} = 900 mA
Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	Pulsed[2], 2.6 GHz, 3 dB Gain Compression	G_{SAT}	18.1	18.7	-	dB
Saturated Drain Efficiency	Pulsed[2], 2.6 GHz, 3 dB Gain Compression	η_{SAT}	59.3	63.9	-	%
Saturated Output Power	Pulsed[2], 2.6 GHz, 3 dB Gain Compression	P_{SAT}	55.8	56.4	-	dBm

2. 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} = 150 V	I_{DLK}	-	-	57.6	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	57.6	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 57.6 mA	V_T	-3.8	-3.0	-2.3	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 450 mA	V_{GSQ}	-	-2.7	-	V
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 μs	$I_{D, MAX}$	-	55.0	-	A

Absolute Maximum Ratings [3,4,5,6,7]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	150 V
Gate Source Voltage, V_{GS}	-8 to 2 V
Gate Current, I_G	57.6 mA
Storage Temperature Range	-65°C to +150°C
Case Operating Temperature Range	-40°C to +85°C
Channel Temperature	+275°C

3. Exceeding any one or combination of these limits may cause permanent damage to this device.
4. MACOM does not recommend sustained operation above maximum operating conditions.
5. Operating at drain source voltage $V_{DS} \leq 50$ V and $T_{CH} \leq 275$°C will ensure MTTF > 2×10^6 hours.
6. 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 = 1.537, B = -24.81, and C = 21,330.

Thermal Characteristics[7]

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)	0.69	°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)	0.55	°C/W

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

ESD Characteristics

Parameter	Class	Standard
Human Body Model (HBM)	1B	ANSI/ESDA/JEDEC JS-001

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

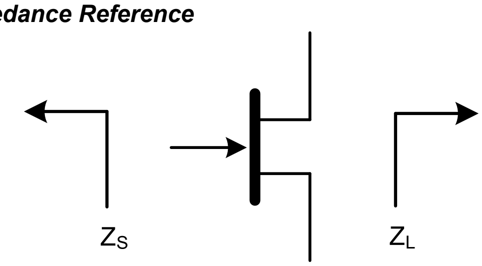
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

50 V Pulsed[2] Load-Pull Performance (Per Each Side of Symmetric Device)
Reference Plane at Device Leads

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Output Power V_{DS} = 50 V, I_{DQ} = 450 mA, T_C = 25°C, P3.0dB					
		Z_{LOAD}[8] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
800	2.0 - j1.2	3.9 - j0.9	24.5	54.4	276	63.9	68.5
1400	2.5 - j4.5	2.8 - j2.0	19.8	54.7	295	61.3	41.4
1800	3.0 - j6.0	3.1 - j3.2	18.5	55.6	363	63.1	29.0
2100	3.8 - j7.5	2.8 - j4.0	17.5	55.6	363	64.0	24.6
2500	5.0 - j10.0	2.8 - j5.3	17.2	55.3	339	63.4	-8.6
2700	6.0- j10.5	2.6 - j6.0	17.1	55.2	331	63.5	-43.0

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency V_{DS} = 50 V, I_{DQ} = 450 mA, T_C = 25°C, P3.0dB					
		Z_{LOAD}[9] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
800	2.0 - j1.2	5.9 + j2.6	27.2	52.4	174	74.2	40.0
1400	2.5 - j4.5	3.3 + j0.6	22.1	52.9	195	72.5	24.7
1800	3.0 - j6.0	3.1 - j1.2	20.0	54.3	269	72.5	15.7
2100	3.8 - j7.5	2.5 - j1.8	19.6	54.0	251	75.7	9.0
2500	5.0 - j10.0	2.2 - j3.1	19.5	53.4	219	75.1	-28.2
2700	6.0- j10.5	2.4 - j4.3	19.1	54.0	251	76.0	-60.1

Impedance Reference

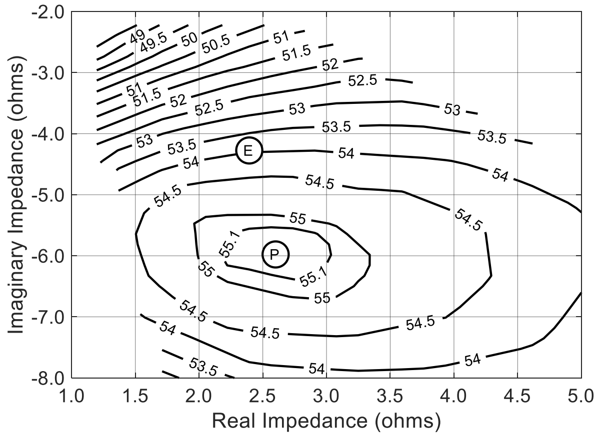


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

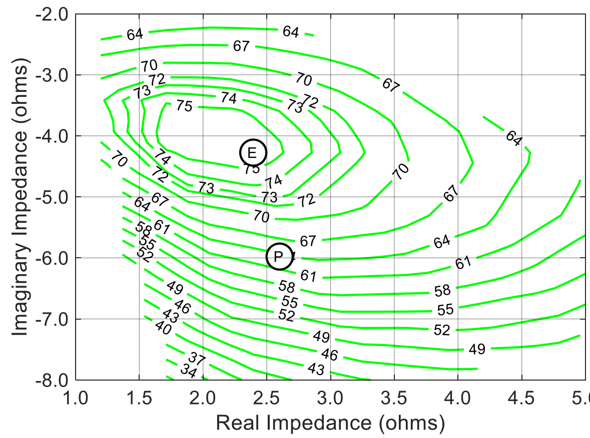
8. Load Impedance for optimum output power.
9. Load Impedance for optimum efficiency.

Pulsed[2] Load-Pull Performance (Per Each Side of Symmetric Device)
2.7 GHz

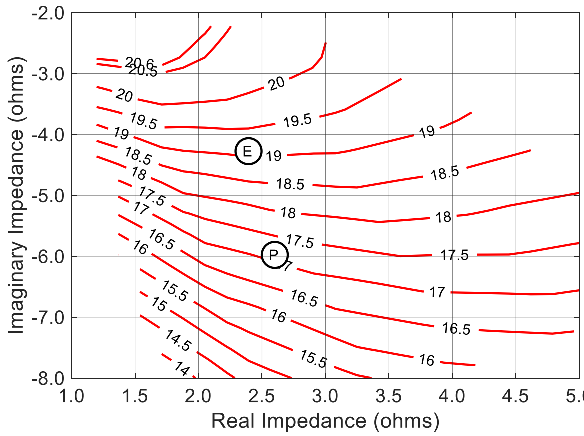
P3.0dB Loadpull Output Power Contours (dBm)



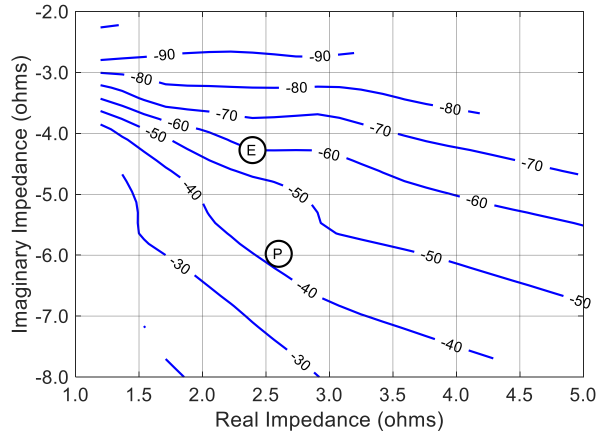
P3.0dB Loadpull Drain Efficiency Contours (%)



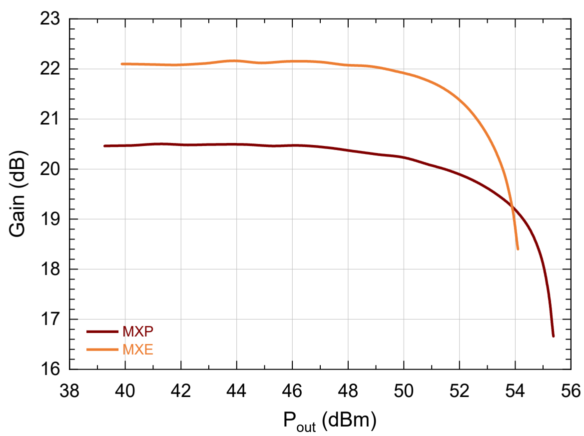
P3.0dB Loadpull Gain Contours (dB)



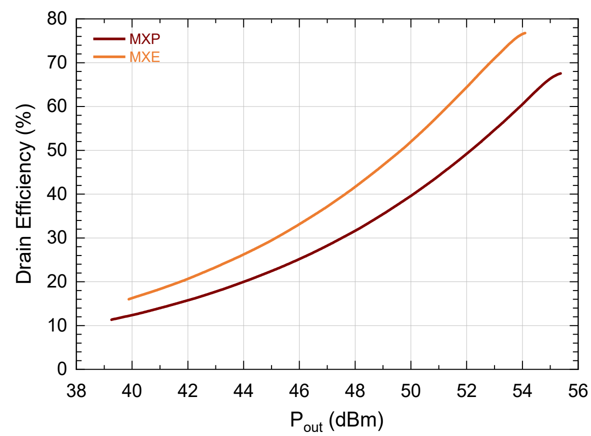
P3.0dB Loadpull AM/PM Contours (°)



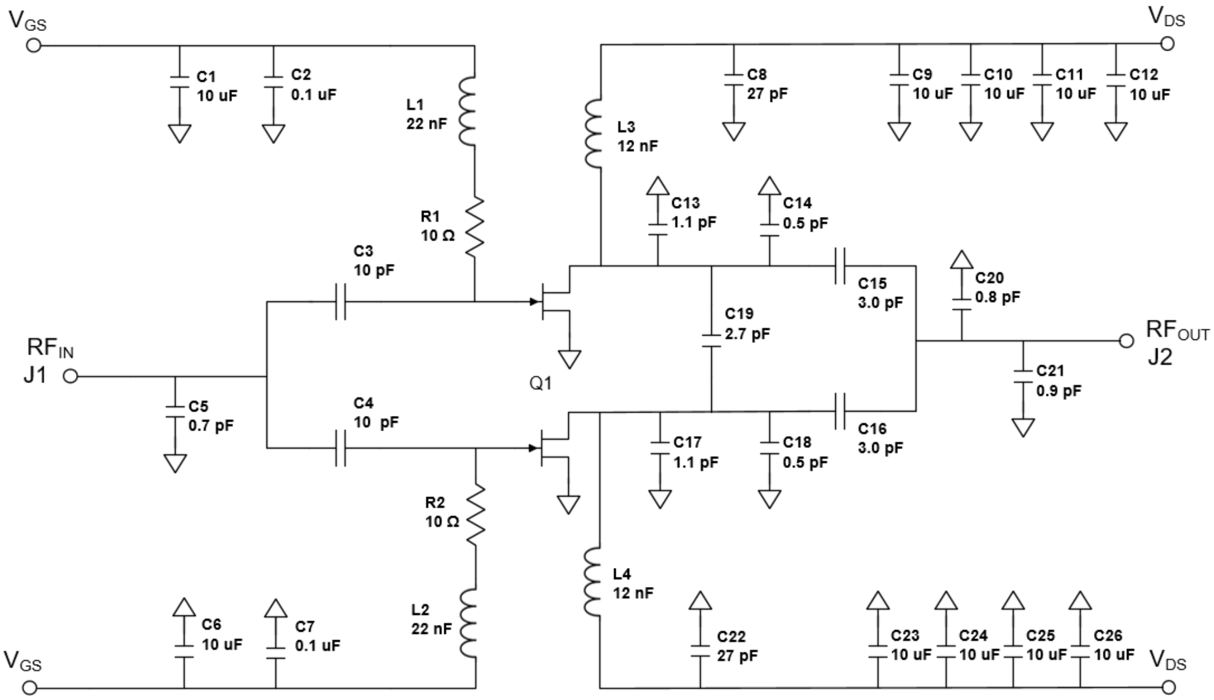
Transducer Gain vs. Output Power



Drain Efficiency vs. Output Power



Efficiency Tuned Test Fixture and Recommended Tuning Solution 2.5 - 2.7 GHz



Description

Parts measured on evaluation board (20 mil thick RO4350B). 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

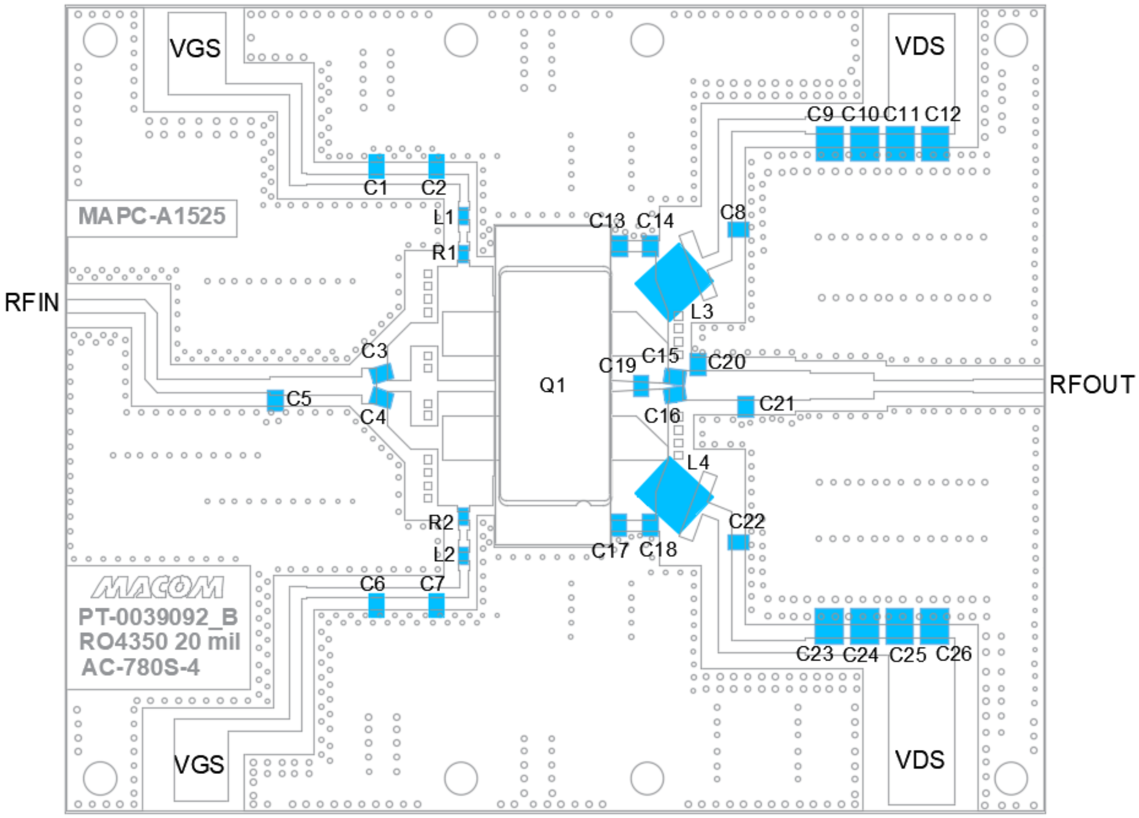
1. Set V_{GS} to pinch-off (V_P).
2. Turn on V_{DS} to nominal voltage (50 V).
3. Increase V_{GS} until I_{DS} current is reached.
4. Apply RF power to desired level.

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}.

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

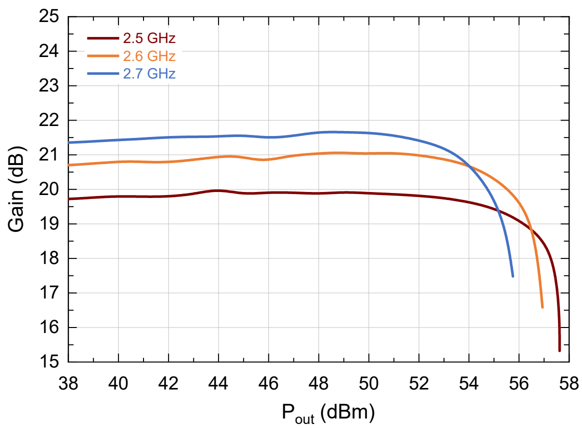
Efficiency Tuned Test Fixture and Recommended Tuning Solution 2.5 - 2.7 GHz



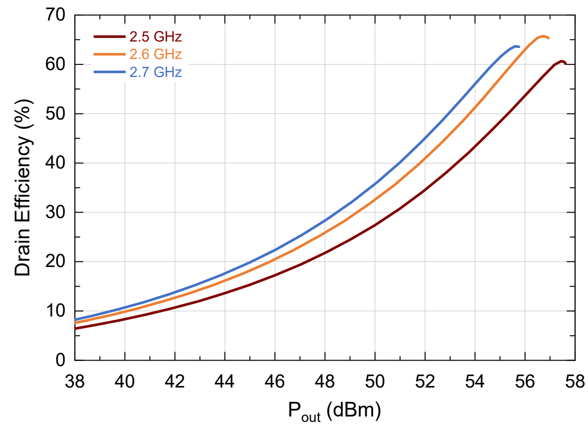
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1,C6	10 µF	+/- 10%	Murata	GRM21BR61C106KE15K
C2,C7	0.1 µF	+/- 10%	Murata	GRM219R71C104KA01D
C3,C4	10 pF	+/- 0.1 pF	ATC	ATC800A100BT250XT
C5	0.7 pF	+/- 0.1 pF	ATC	ATC800A0R7BT250XT
C8,C22	27 pF	+/- 0.1 pF	ATC	ATC800A270BT250XT
C9,C10,C11,C12,C23,C24, C25,C26	10 µF	+/- 10%	Murata	GRM32EC72A106KE05L
C13,C17	1.1 pF	+/- 0.1 pF	ATC	ATC800A1R1BT250XT
C14,C18	0.5 pF	+/- 0.1 pF	ATC	ATC800A0R5BT250XT
C15,C16	3.0 pF	+/- 0.1 pF	ATC	ATC800A3R0BT250XT
C19	2.7 pF	+/- 0.1 pF	ATC	ATC800A2R7BT250XT
C20	0.8 pF	+/- 0.1 pF	ATC	ATC800A0R8BT250XT
C21	0.9 pF	+/- 0.1 pF	ATC	ATC800A0R9BT250XT
L1,L2	22 nF	+/- 5%	AVX	LCMC0603J22NGTAR
L3,L4	12 nF	+/- 5%	Coilcraft	GA3094-ALC
R1,R2	10 Ω	+/- 1%	Vishay	RCC060310R0FKEA
Q1	MACOM GaN Power Amplifier			MAPC-A1525
PCB	RO4350B, 20 mil, 1 oz. Cu, Au Finish			

Typical Performance Curves as Measured in the 2.5 - 2.7 GHz Efficiency Tuned Test Fixture: Pulsed[2] 2.6 GHz, V_{DS} = 50 V, I_{DQ} = 900 mA, T_C = 25°C (Unless Otherwise Noted)

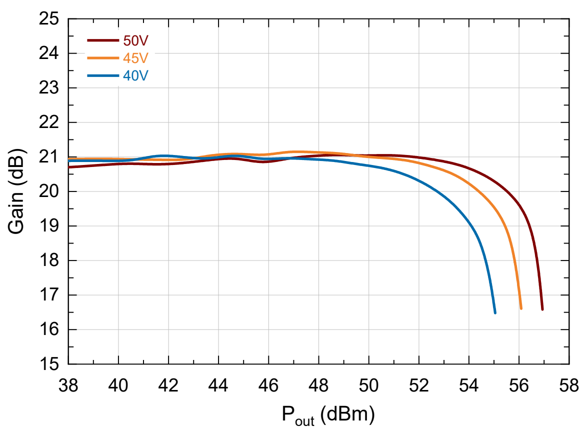
Gain vs. Output Power and Frequency



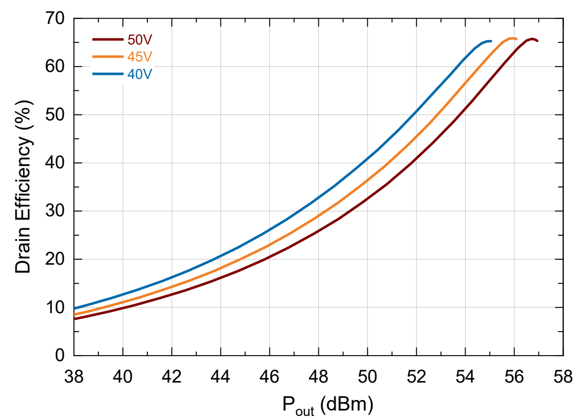
Drain Efficiency vs. Output Power and Frequency



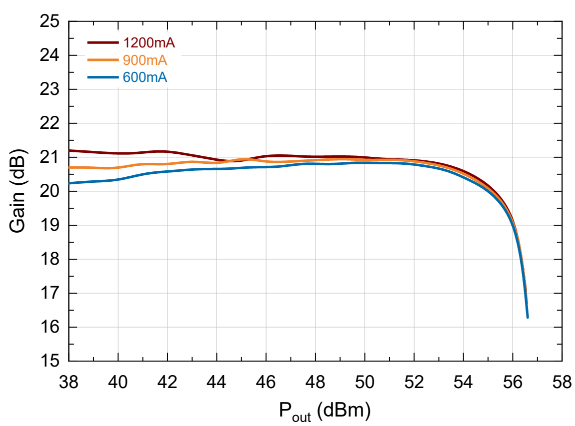
Gain vs. Output Power and V_{DS}



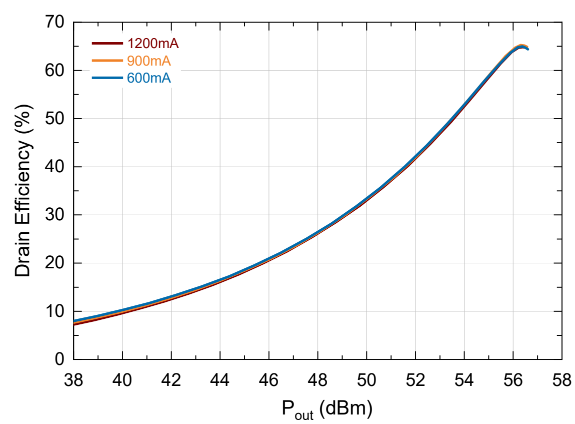
Drain Efficiency vs. Output Power and V_{DS}



Gain vs. Output Power and I_{DQ}

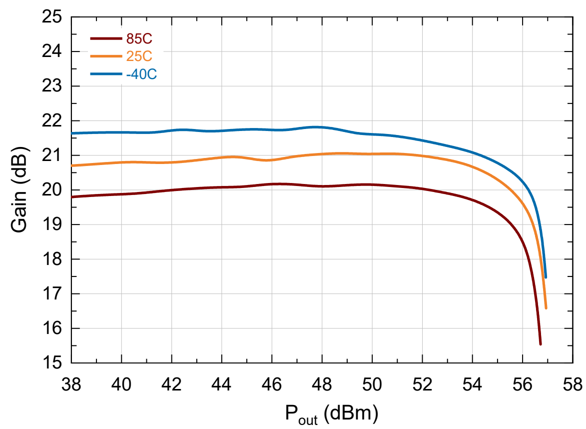


Drain Efficiency vs. Output Power and I_{DQ}

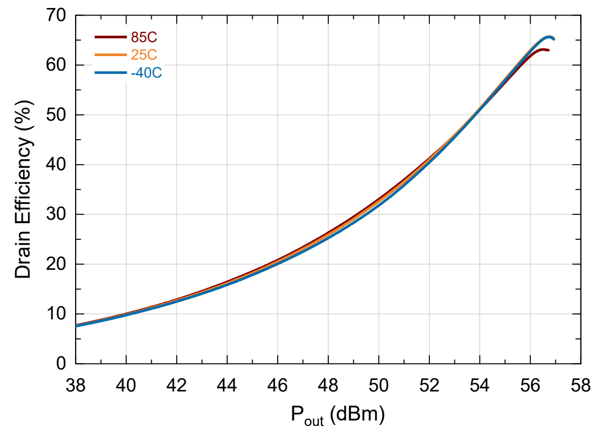


Typical Performance Curves as Measured in the 2.5 - 2.7 GHz Efficiency Tuned Test Fixture: Pulsed[2] 2.6 GHz, V_{DS} = 50 V, I_{DQ} = 900 mA, T_C = 25°C (Unless Otherwise Noted)

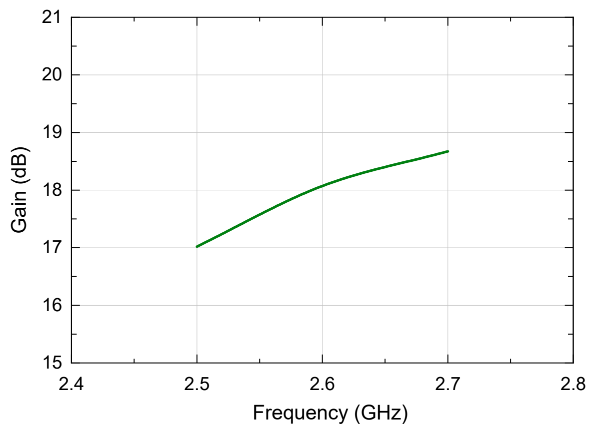
Gain vs. Output Power and T_C



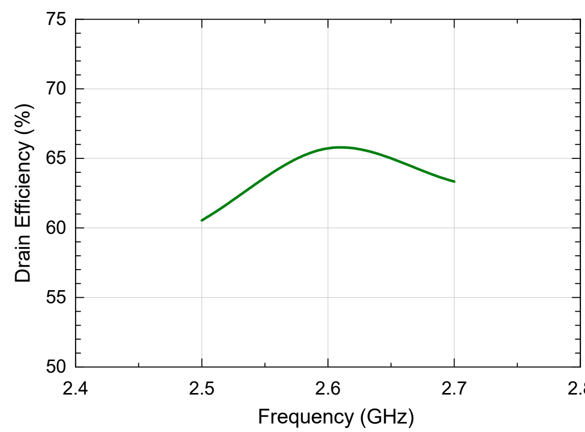
Drain Efficiency vs. Output Power and T_C



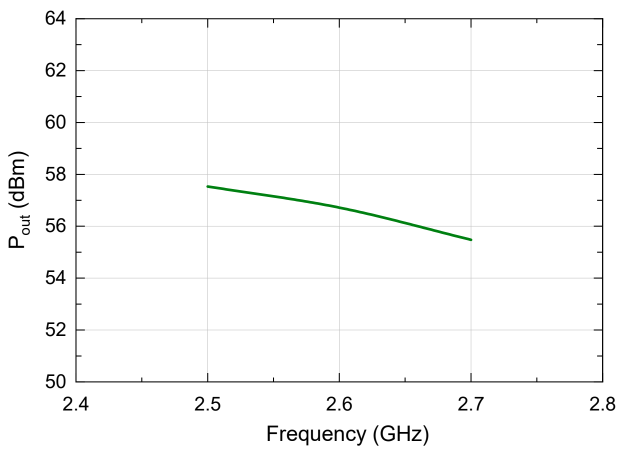
Gain vs. Frequency, 3dB Gain Compression



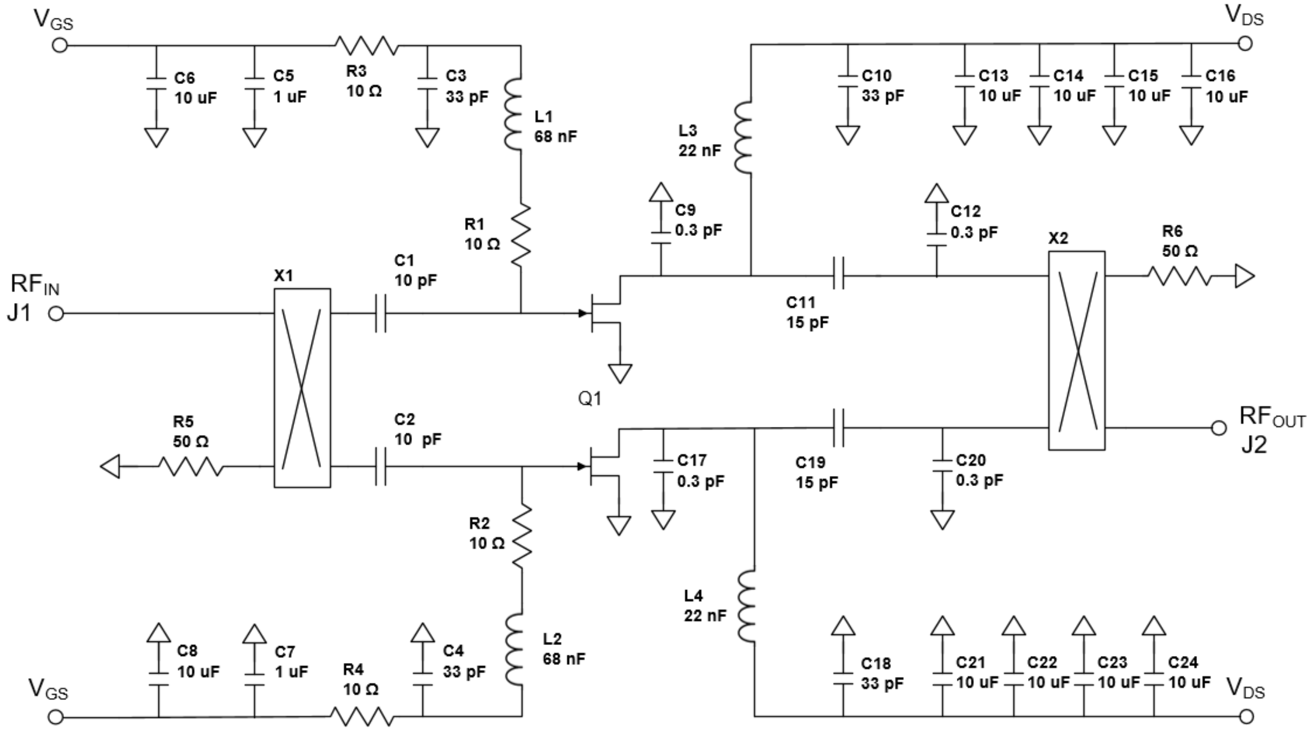
Drain Efficiency vs. Frequency, 3dB Gain Compression



Output Power vs. Frequency, 3dB Gain Compression



Wideband Tuned Test Fixture and Recommended Tuning Solution 1.0 - 2.5 GHz



Description

Parts measured on evaluation board (20 mil thick RO4350B). 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

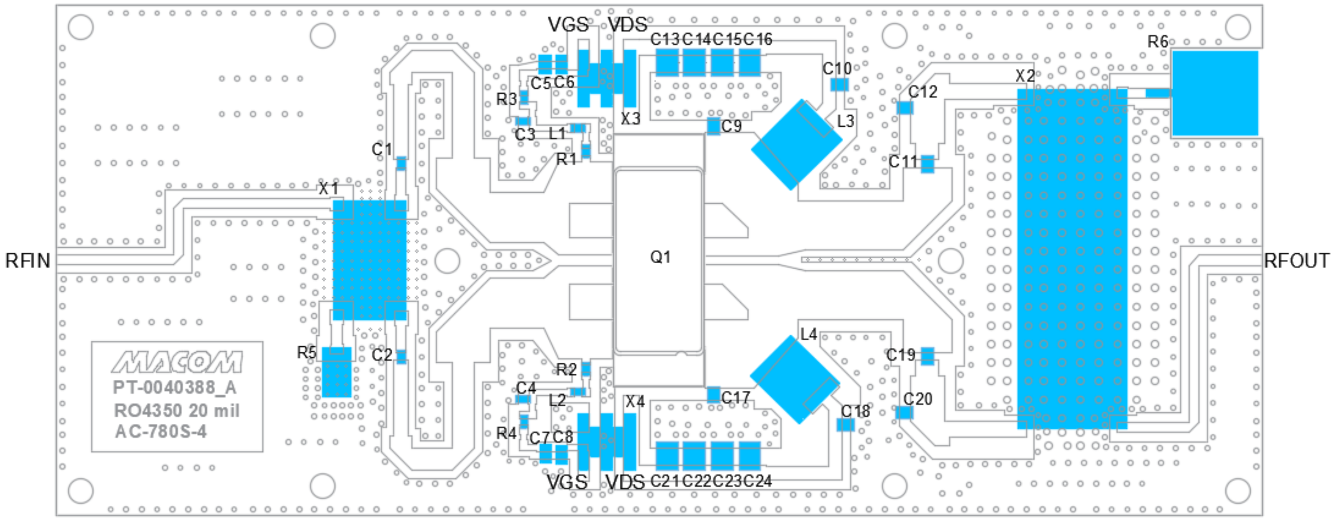
1. Set V_{GS} to pinch-off (V_P).
2. Turn on V_{DS} to nominal voltage (50 V).
3. Increase V_{GS} until I_{DS} current is reached.
4. Apply RF power to desired level.

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}.

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

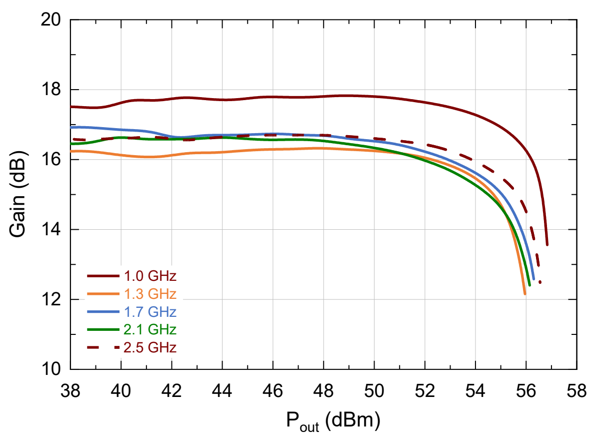
Wideband Tuned Test Fixture and Recommended Tuning Solution 1.0 - 2.5 GHz



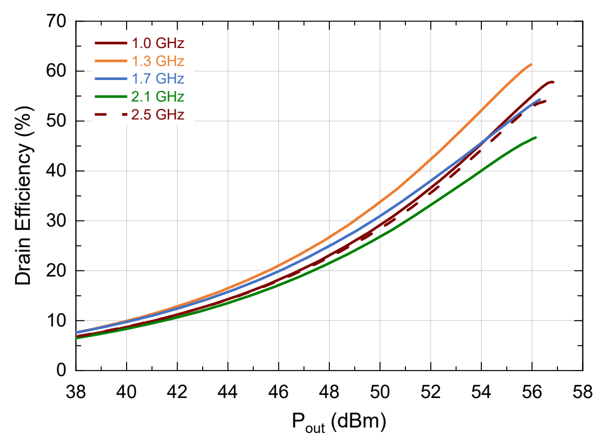
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1,C2	10 pF	+/- 1%	PPI	0603N100FW251
C3,C4	33 pF	+/- 2%	PPI	0603N330GW251
C5,C7	1 µF	+/- 10 %	TDK	CGA4J2X7R1C105K125AA
C6,C8	10 µF	+/- 10 %	TDK	C2012X6S1C106K085AC
C9,C12,C17,C20	0.3 pF	+/- 0.1 pF	ATC	ATC800A0R3BT250XT
C10,C18	33 pF	+/- 0.1 pF	ATC	ATC800A330BT250XT
C11,C19	15 pF	+/- 0.1 pF	ATC	ATC800A150BT250XT
C13,C14,C15,C16,C21,C22,C23,C24	10 µF	+/- 10%	Murata	GRM32EC72A106KE05L
L1,L2	68 nF	+/- 5%	AVX	LCCI0603J68NGTAR
L3,L4	22 nF	+/- 5%	Coilcraft	WA3096-ALC
R1,R2,R3,R4	10 Ω	+/- 1%	Vishay	RCC060310R0FKEA
R5	50 Ω Termination		Anaren	C45N50Z4
R6	50 Ω Termination		Anaren	E250N50X4B
X1	50 Ω Hybrid Coupler		Anaren	X3C17A1-03WS
X2	25/50 Ω Hybrid Coupler		IPP	IPP-7105IT
X3,X4	Connector Header 6 Pins		Samtec	HW-03-09-F-D-450-SM
J1, J2	Radiall 9114-1113-000-SMA Connector			PT-0022540
Q1	MACOM GaN Power Amplifier			MAPC-A1525
PCB	RO4350, 20 mil, 1 oz. Cu, Au Finish			

Typical Performance Curves as Measured in the 1.0 - 2.5 GHz Wideband Tuned Test Fixture: Pulsed[2], V_{DS} = 50 V, I_{DQ} = 900 mA, T_C = 25°C (Unless Otherwise Noted)

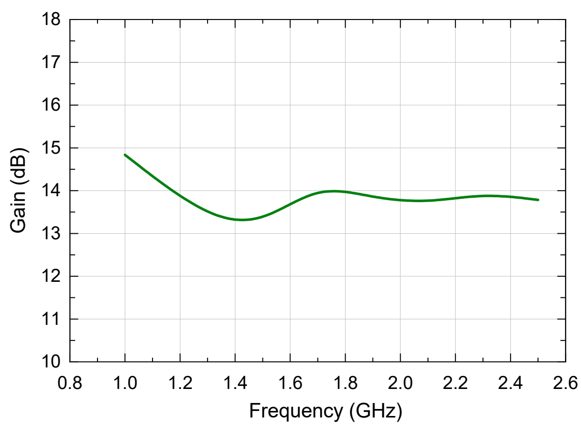
Gain vs. Output Power and T_C



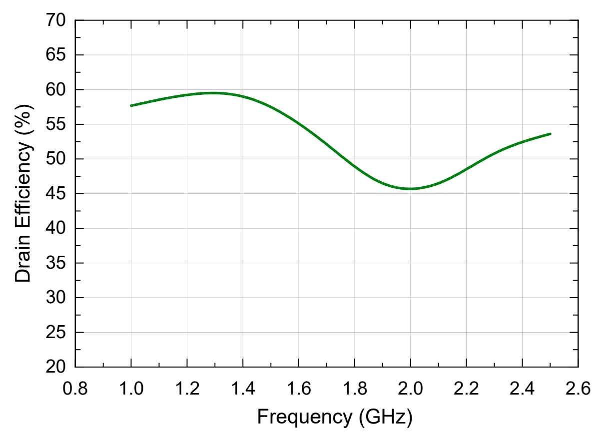
Drain Efficiency vs. Output Power and T_C



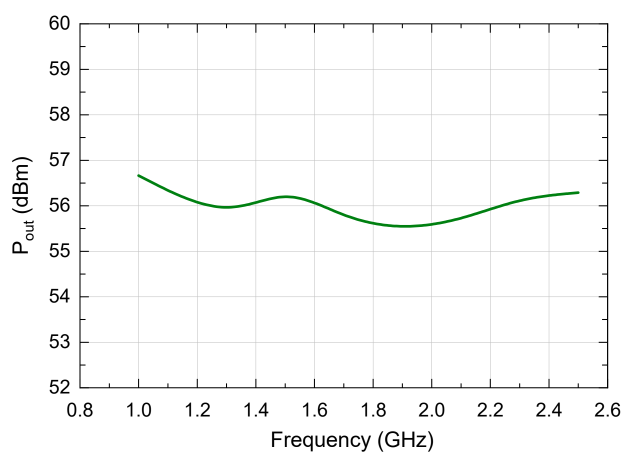
Gain vs. Frequency, 3dB Gain Compression



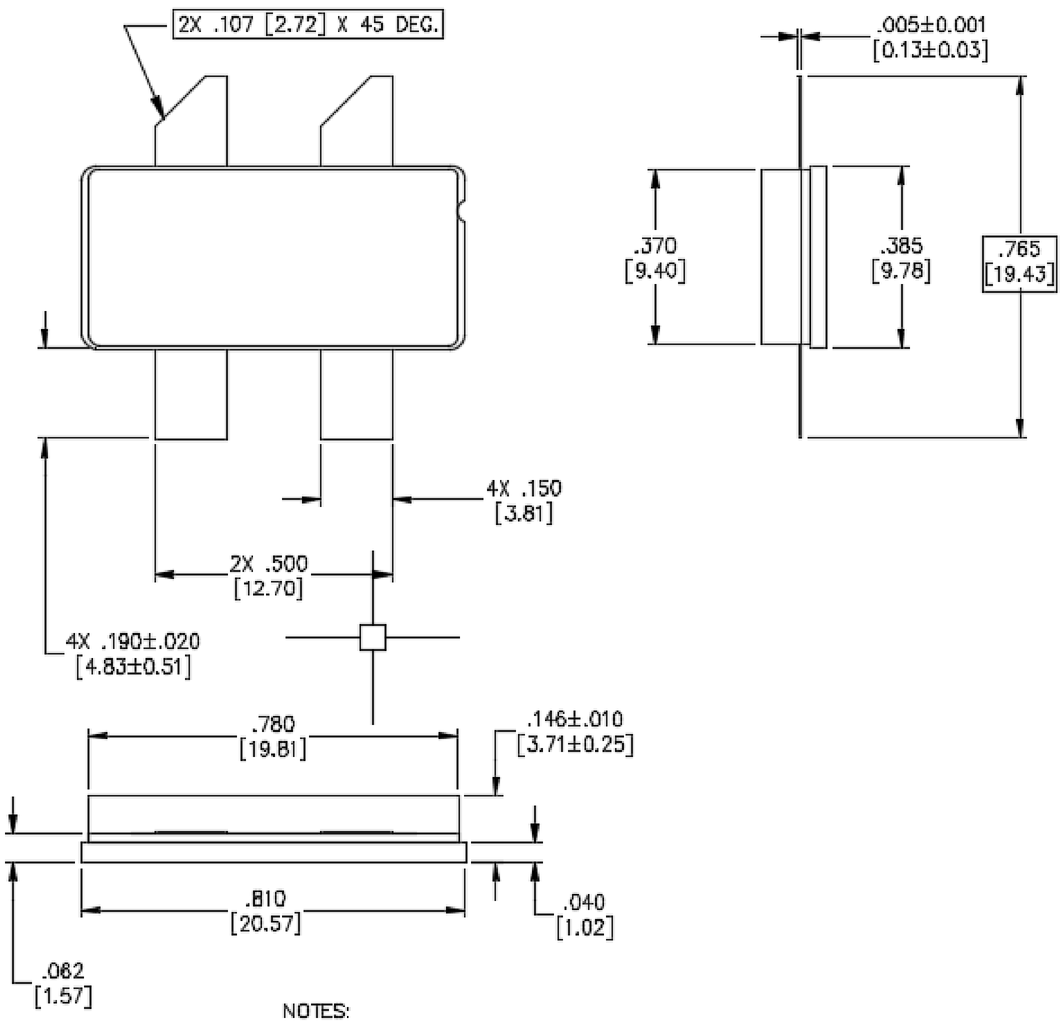
Drain Efficiency vs. Frequency, 3dB Gain Compression



Output Power vs. Frequency, 3dB Gain Compression



Lead-Free AC-780S-4 Package Dimensions†



NOTES:
1. ALL DIMENSIONS SHOWN AS in[mm]. CONTROLLING DIMENSIONS ARE IN in AND CONVERTED mm DIMENSIONS ARE NOT NECESSARILY EXACT.
2. ALL TOLERANCES ARE ±.005 [0.13] UNLESS OTHERWISE NOTED
3. LEAD FINISH: AU
   FLANGE FINISH: AU
4. LID SEAL EPOXY MAY FLOW OUT A MAXIMUM OF .020 [0.51] FROM EDGE OF LID
5. LID MAY BE MIS-ALIGNED UP TO .010 [0.25] FROM PACKAGE IN ANY DIRECTION

† Reference Application Note AN0004363 for lead-free solder reflow recommendations.
Moisture Sensitivity Level: Not Specified
Plating is Au.