

GaN Amplifier 50 V, 150 W

2.7 - 3.6 GHz



MACOM PURE CARBIDE

MAPC-A1521

Rev. V1

Features

- MACOM PURE CARBIDE® Amplifier Series
- Suitable for Linear & Saturated Applications
- CW & Pulsed Operation: 150 W Output Power
- Internally Pre-Matched
- 50 V Operation
- Compatible with MACOM Power Management Bias Controller/Sequencer MABC-11040



AC-360S-2

Applications

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

Description

The MAPC-A1521 is a high power GaN on Silicon Carbide HEMT D-mode amplifier suitable for 2.7 - 3.6 GHz frequency operation. The device supports both CW and pulsed operation with output power levels of at least 150 W (52.0 dBm) in an air cavity ceramic package.

Typical Performance:

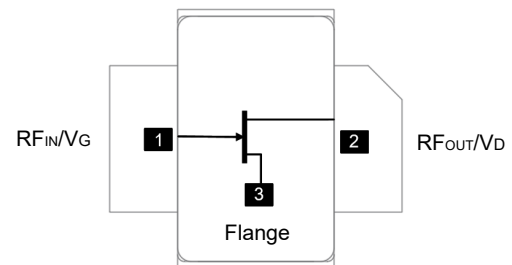
Measured under load-pull at 3 dB Compression, 100 μ s pulse width, 10% duty cycle.

- $V_{DS} = 50$ V, $I_{DQ} = 200$ mA, $T_C = 25^\circ$ C.

Frequency (GHz)	Output Power ¹ (dBm)	Gain ² (dB)	η_D ² (%)
2.7	53.3	16.0	60.0
2.9	53.4	15.7	62.1
3.1	53.3	15.4	61.5
3.3	53.2	15.4	63.5
3.5	52.8	14.5	61.4
3.6	52.7	14.6	66.1

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	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-A1521-AS000	Bulk Quantity
MAPC-A1521-ASTR1	Tape and Reel
MAPC-A1521-ASSB1	Sample Board

¹ * Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

RF Electrical Characteristics: $T_C = 25^\circ\text{C}$, $V_{DS} = 50\text{ V}$, $I_{DQ} = 200\text{ mA}$

Note: Performance in MACOM Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed ⁴ , 3.5 GHz	G_{SS}	-	15.3	-	dB
Power Gain	Pulsed ⁴ , 3.5 GHz, 2.5 dB Gain Compression	G_{SAT}	-	12.8	-	dB
Saturated Drain Efficiency	Pulsed ⁴ , 3.5 GHz, 2.5 dB Gain Compression	η_{SAT}	-	55.0	-	%
Saturated Output Power	Pulsed ⁴ , 3.5 GHz, 2.5 dB Gain Compression	P_{SAT}	-	52.7	-	dBm
Gain Variation (-25°C to +85°C)	Pulsed ⁴ , 3.5 GHz	ΔG	-	-0.03	-	dB/°C
Power Variation (-25°C to +85°C)	Pulsed ⁴ , 3.5 GHz	$\Delta P_{2.5dB}$	-	-0.01	-	dB/°C
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 10:1 No Damage			

RF Electrical Specifications: $T_A = 25^\circ\text{C}$, $V_{DS} = 50\text{ V}$, $I_{DQ} = 200\text{ mA}$

Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	Pulsed ⁴ , 3.6 GHz, 2.5 dB Gain Compression	G_{SAT}	10.0	11.2	-	dB
Saturated Drain Efficiency	Pulsed ⁴ , 3.6 GHz, 2.5 dB Gain Compression	η_{SAT}	45.0	50.0	-	%
Saturated Output Power	Pulsed ⁴ , 3.6 GHz, 2.5 dB Gain Compression	P_{SAT}	51.0	52.4	-	dBm

4. Pulse details: 100 μs pulse width, 10% Duty Cycle.

DC Electrical Characteristics $T_A = 25^\circ\text{C}$

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	$V_{GS} = -8\text{ V}$, $V_{DS} = 130\text{ V}$	I_{DLK}	-	-	21.6	mA
Gate-Source Leakage Current	$V_{GS} = -8\text{ V}$, $V_{DS} = 0\text{ V}$	I_{GLK}	-	-	21.6	mA
Gate Threshold Voltage	$V_{DS} = 50\text{ V}$, $I_D = 21.6\text{ mA}$	V_T	-3.6	-3.1	-	V
Gate Quiescent Voltage	$V_{DS} = 50\text{ V}$, $I_D = 200\text{ mA}$	V_{GSQ}	-	-2.6	-	V
Maximum Drain Current	$V_{DS} = 7\text{ V}$ pulsed, pulse width 300 μs	$I_{D, MAX}$	-	18	-	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	21 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 $MTTF > 2 \times 10^6$ hours.
8. Operating at nominal conditions with $T_{CH} \leq 225^\circ\text{C}$ will ensure $MTTF > 2 \times 10^6$ hours.
9. MTTF may be estimated by the expression $MTTF \text{ (hours)} = A e^{\frac{B+C}{T+273}}$ 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, $T_C = 85^\circ\text{C}$, $T_{CH} = 225^\circ\text{C}$	$R_{\theta}(\text{FEA})$	1.31	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	$V_{DS} = 50$ V, $T_C = 85^\circ\text{C}$, $T_{CH} = 225^\circ\text{C}$	$R_{\theta}(\text{IR})$	1.00	°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

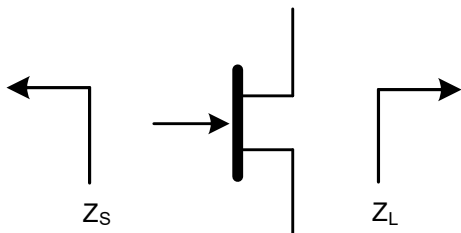
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

50 V Pulsed⁴ Load-Pull Performance
Reference Plane at Device Leads

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Output Power					
		$V_{DS} = 50 \text{ V}, I_{DQ} = 200 \text{ mA}, T_C = 25^\circ\text{C}, P_{2.5dB}$					
		Z_{LOAD}^{12} (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM ($^\circ$)
2.7	1.0 - j 5.5	2.0 - j 1.7	14.8	53.3	214	53.5	21.6
2.9	1.6 - j 6.5	1.9 - j 1.9	14.6	53.4	219	55.3	14.5
3.1	2.4 - j 7.9	1.8 - j 2.0	14.4	53.3	214	55.7	5.5
3.3	4.4 - j 9.7	1.6 - j 2.4	14.3	53.2	209	56.9	-9.2
3.5	10.6 - j 9.8	1.6 - j 2.7	13.7	52.8	191	54.0	-39.9
3.6	13.3 - j 7.3	1.4 - j 2.9	13.6	52.7	186	57.3	-57.9

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency					
		$V_{DS} = 50 \text{ V}, I_{DQ} = 200 \text{ mA}, T_C = 25^\circ\text{C}, P_{2.5dB}$					
		Z_{LOAD}^{12} (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM ($^\circ$)
2.7	1.0 - j 5.6	1.5 - j 0.8	16.0	52.5	178	60.0	11.1
2.9	1.5 - j 6.8	1.4 - j 1.0	15.7	52.6	182	62.1	2.8
3.1	2.3 - j 8.1	1.2 - j 1.4	15.4	52.5	178	61.5	-4.0
3.3	4.7 - j 10.3	1.0 - j 1.7	15.4	52.0	158	63.5	-23.1
3.5	11.6 - j 10.2	1.1 - j 2.1	14.5	52.1	162	61.4	-56.2
3.6	15.9 - j 6.0	0.8 - j 2.4	14.6	51.7	148	66.1	-78.6

Impedance Reference



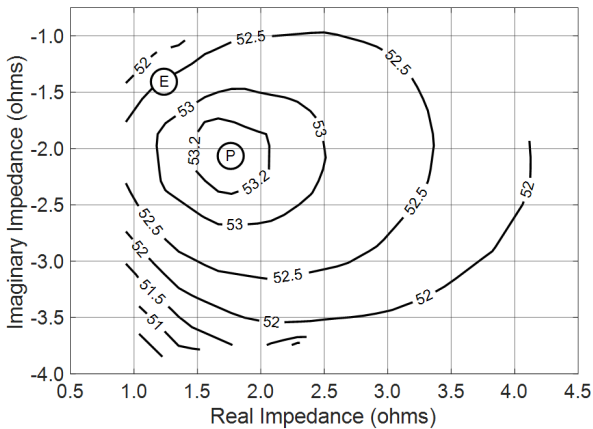
Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.

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

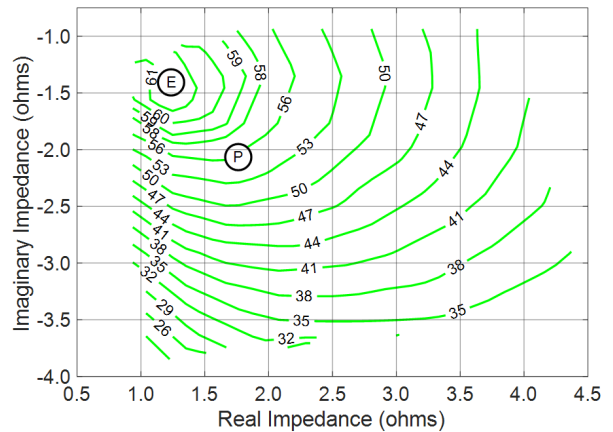
- 11. Load Impedance for optimum output power.
- 12. Load Impedance for optimum efficiency.

Pulsed⁴ Load-Pull Performance @ 3.1 GHz

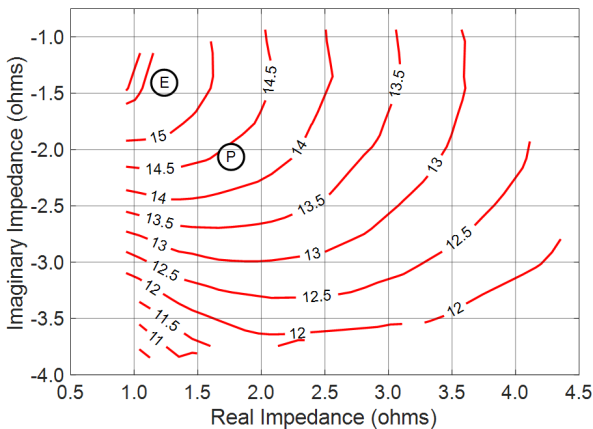
P2.5dB Loadpull Output Power Contours (dBm)



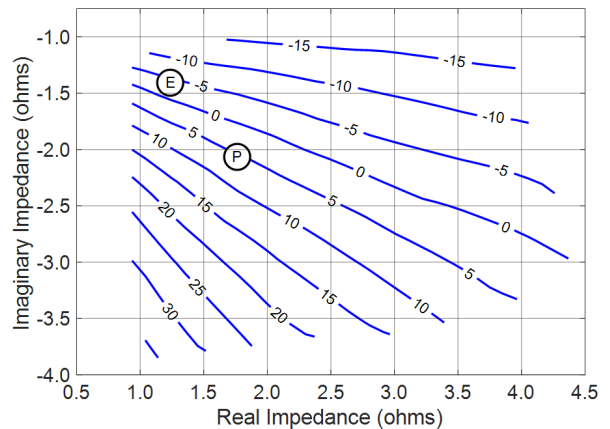
P2.5dB Loadpull Drain Efficiency Contours (%)



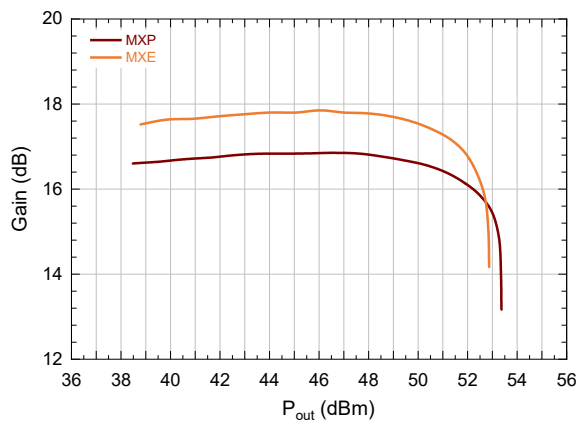
P2.5dB Loadpull Gain Contours (dB)



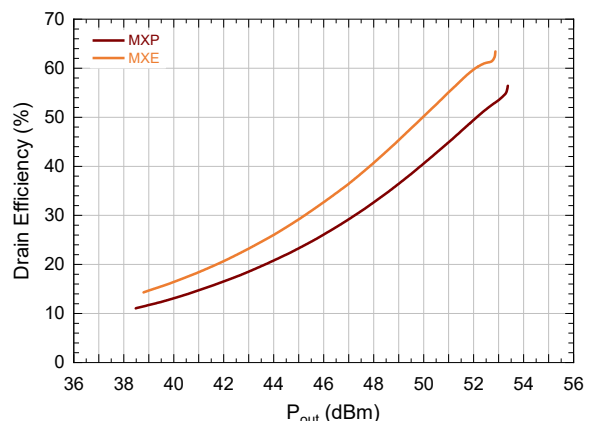
P2.5dB Loadpull AM/PM Contours (°)



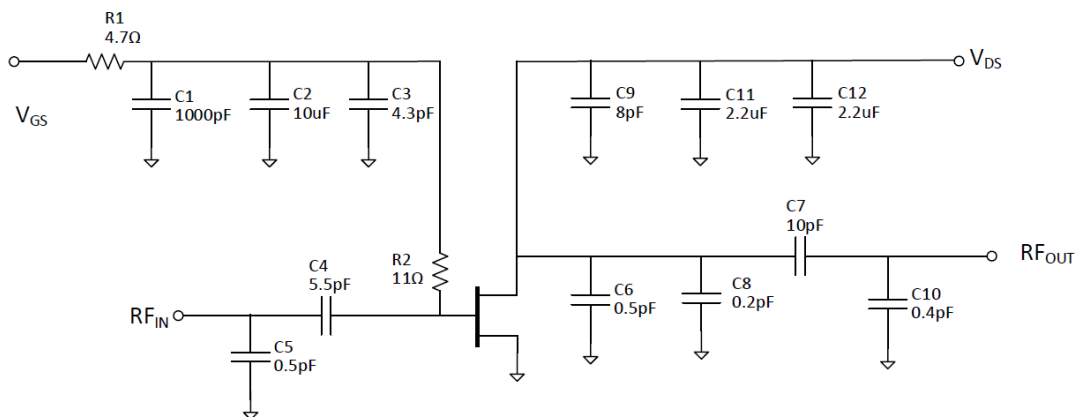
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Test Fixture and Recommended Tuning Solution 3.3 - 3.6 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

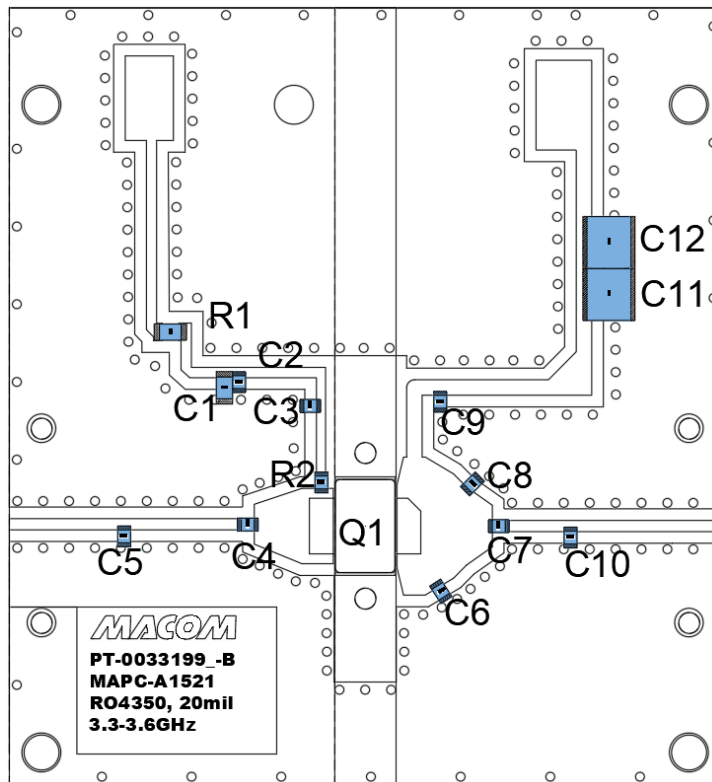
1. Set V_{GS} to pinch-off (V_P).
2. Turn on V_{DS} to nominal voltage (50 V).
3. Increase V_{GS} until I_{DS} current is reached.
4. Apply RF power to desired level.

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-11040.

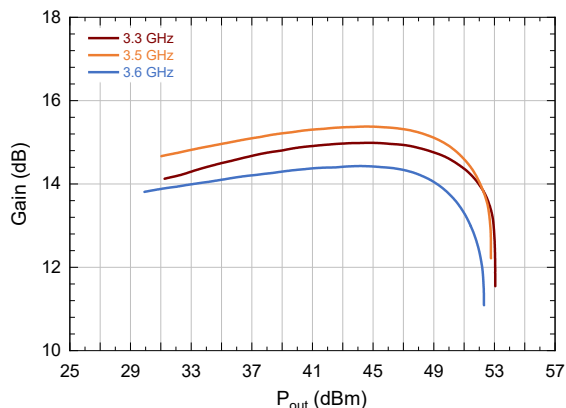
Evaluation Test Fixture and Recommended Tuning Solution 3.3 - 3.6 GHz



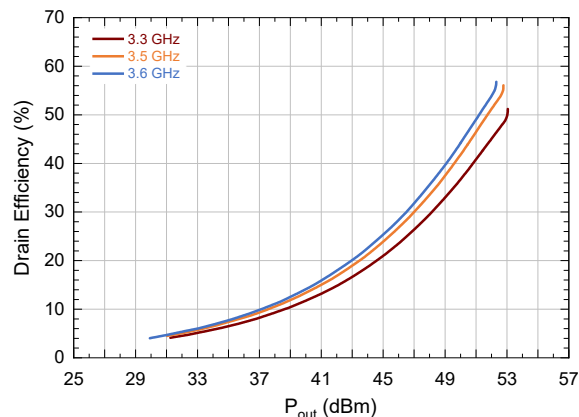
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C2	10 μ F	+/- 20%	TDK	C2012X5R1C106M085AC
C1	1000 pF	+/- 5%	Murata	GRM1555C1H102JA01J
C3	4.3 pF	+/- 0.1 pF	Murata	GQM2195C2E4R3BB12D
C4	5.5 pF	+/- 0.1 pF	Murata	GQM2195C2E5R5BB12D
C5, C6	0.5 pF	+/- 0.1 pF	Murata	GQM2195C2ER50BB15D
C7	10 pF	+/-1%	Murata	GQM2195G2H100GB12D
C8	0.2 pF	+/- 0.1 pF	Murata	GQM2195C2ER20BB15D
C9	8 pF	+/- 0.1 pF	Murata	GQM2195C2E8R0BB12D
C10	0.4 pF	+/- 0.1 pF	Murata	GQM2195C2ER40BB15D
C11,C12	2.2 μ F	+/- 20%	Murata	KRM55TR72E225MH01L
R1	4.7 Ω	+/- 5%	Yageo	RC1206JR-074R7L
R2	11 Ω	+/- 5%	Viking Tech	TAR05ATNP11R0
Q1	MACOM GaN Power Amplifier		MAPC-A1521	
PCB	RO4350B, 20 mil, 1oz Cu, ENIG Finish			

Typical Performance Curves as Measured in the 3.3 - 3.6 GHz Evaluation Test Fixture:
Pulsed⁴ 3.5 GHz, $V_{DS} = 50$ V, $I_{DQ} = 200$ mA, $T_C = 25^\circ\text{C}$ (Unless Otherwise Noted)

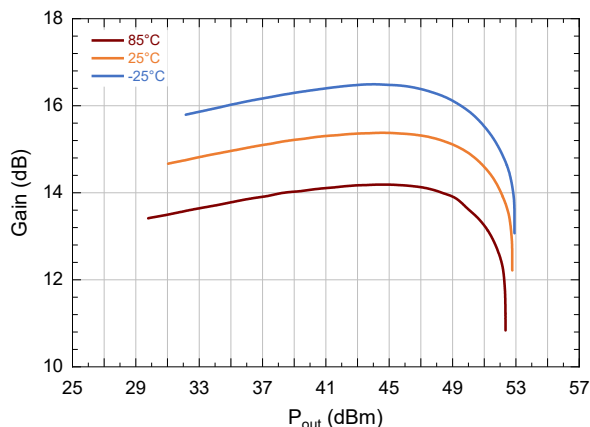
Gain vs. Output Power and Frequency



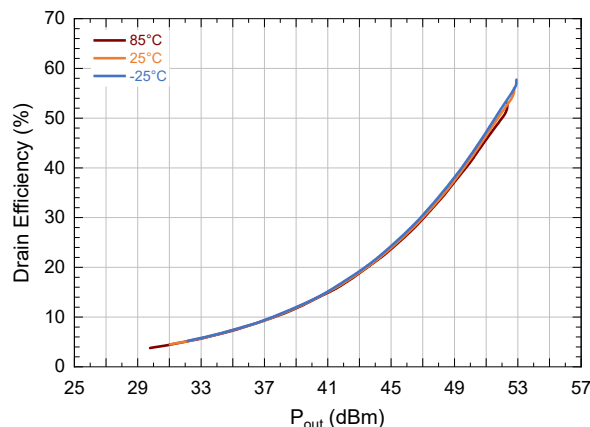
Drain Efficiency vs. Output Power and Frequency



Gain vs. Output Power and T_C

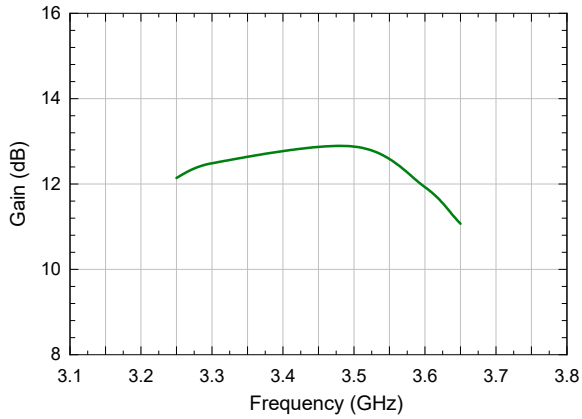


Drain Efficiency vs. Output Power and T_C

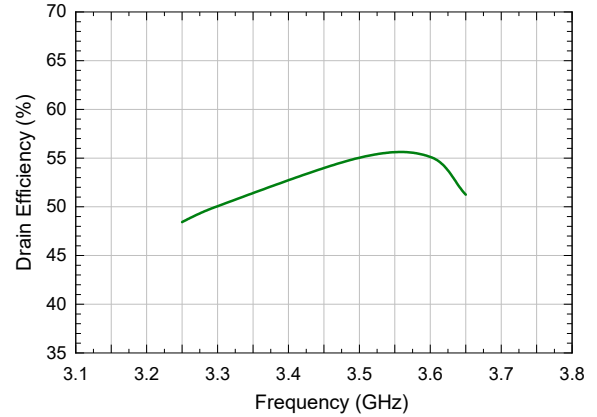


Typical Performance Curves as Measured in the 3.3 - 3.6 GHz Evaluation Test Fixture:
Pulsed⁴ 3.5 GHz, $V_{DS} = 50$ V, $I_{DQ} = 200$ mA, $T_C = 25^\circ\text{C}$ (Unless Otherwise Noted)

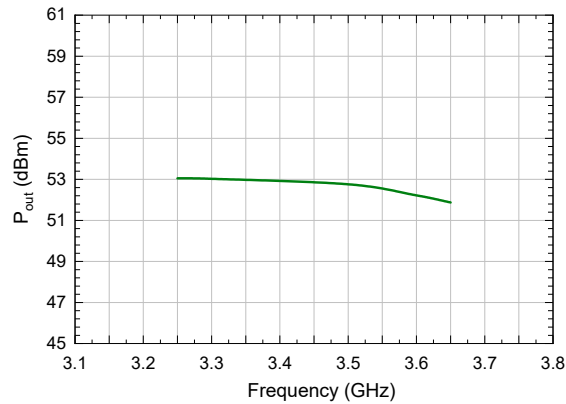
Gain vs. Frequency, 2.5dB Gain Compression



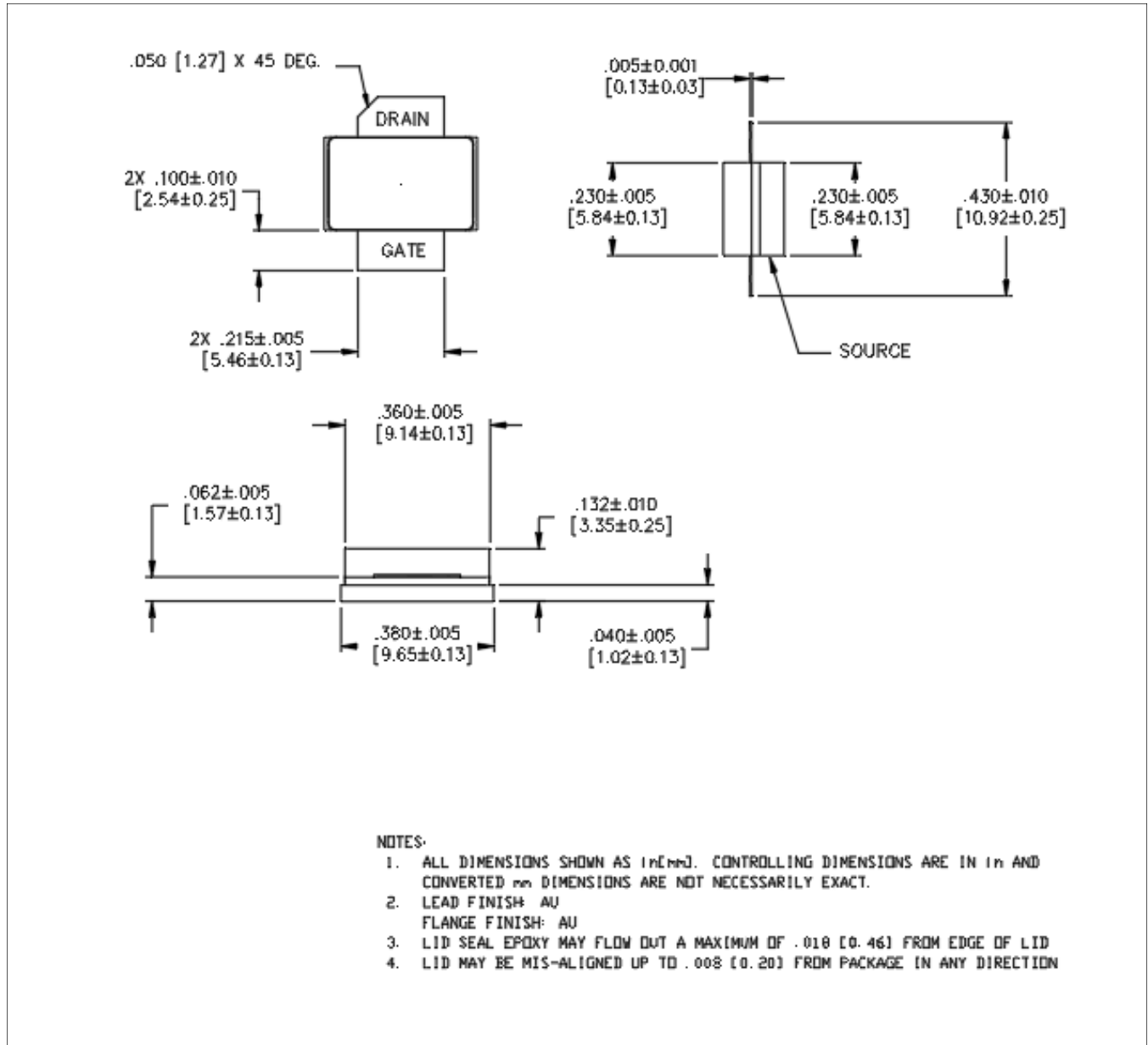
Drain Efficiency vs. Frequency, 2.5dB Gain Compression



Output Power vs. Frequency, 2.5dB Gain Compression



Lead-Free AC-360S-2 Package Dimensions[†]



[†] Reference Application Note AN0004363 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Au.

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