GaN Amplifier 50 V, 1250 W
400 - 460 MHz

MACOM PURE CARBIDE

MAPC-A1542
Rev. V2

Features
- *MACOM PURE CARBIDE*® Amplifier Series
- Suitable for Linear & Saturated Applications
- Pulsed Operation: 1250 W Output Power
- Internally Pre-Matched
- 260°C Reflow Compatible
- 50 V Operation
- 100% RF Tested
- RoHS* Compliant

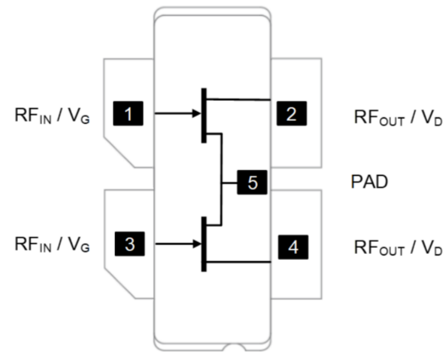
AC-1230B-4

AC-1230S-4

Applications
- UHF Radar, Public Safety Radio

Description
The MAPC-A1542 is a high power GaN on Silicon Carbide HEMT D-mode amplifier suitable for 400 - 460 MHz frequency operation. The device supports pulsed operation with output power levels of 1250 W (61 dBm) at 50 V in an air cavity ceramic package.

Functional Schematic



Typical Performance:
Measured in MACOM evaluation circuit at 3 dB compression, 15 mS pulse width, 25% duty cycle.

- V_{DS} = 50 V, I_{DQ} = 600 mA, T_C = 25°C

Frequency (MHz)	Output Power (dBm)	Gain (dB)	η_D (%)
400	61.1	14.7	82.1
410	61.2	15.7	85.1
420	61.1	16.2	86.4
430	61.0	16.2	86.3
440	61.0	15.9	86.2
450	61.1	15.2	85.2
460	61.2	14.4	83.9

Pin Configuration

Pin #	Pin Name	Function
1, 3	RF_{IN} / V_G	RF Input / Gate
2, 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-A1542-AS000	Bulk Quantity : Earless
MAPC-A1542-ASTR1	Tape and Reel : Earless
MAPC-A1542-ASSB1	Sample Board : Earless
MAPC-A1542-AB000	Bulk Quantity : Boltdown
MAPC-A1542-ABTR1	Tape and Reel : Boltdown
MAPC-A1542-ABSB1	Sample Board : Boltdown

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

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 50 V, I_{DQ} = 600 mA
Note: Performance in MACOM 400 - 460 MHz Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed[2], 430 MHz	G_{SS}	-	19.2	-	dB
Saturated Output Power	Pulsed[2], 430 MHz, 3 dB Gain Compression	P_{SAT}	-	61.0	-	dBm
Power Gain	Pulsed[2], 430 MHz, 3 dB Gain Compression	G_{SAT}	-	16.2	-	dB
Saturated Drain Efficiency	Pulsed[2], 430 MHz, 3 dB Gain Compression	η_{SAT}	-	86	-	%
Gain Variation (-40°C to +85°C)	Pulsed[2], 430 MHz	ΔG	-	0.009	-	dB/°C
Power Variation (-40°C to +85°C)	Pulsed[2], 430 MHz	ΔP3dB	-	0.004	-	dB/°C
Power Gain	Pulsed[2], 430 MHz, P_{IN} = 43.1 dBm	G_P	-	60.9	-	dB
Drain Efficiency	Pulsed[2], 430 MHz, P_{IN} = 43.1 dBm	η	-	84	-	%
Input Return Loss	Pulsed[2], 430 MHz, P_{IN} = 43.1 dBm	IRL	-	-17	-	dB
Ruggedness: Output Mismatch	Pulsed[3], All phase angles	Ψ	VSWR = 50:1, No Damage			

2. Pulse Details: 15 ms pulse width, 25% duty cycle.

RF Electrical Specifications: T_A = 25°C, V_{DS} = 50 V, I_{DQ} = 600 mA
Note: Performance in MACOM 400 MHz Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	Pulsed[3], 400 MHz, 2.5 dB Gain Compression	G_{SAT}	15.0	15.6	-	dB
Saturated Drain Efficiency	Pulsed[3], 400 MHz, 2.5 dB Gain Compression	η_{SAT}	72.2	78	-	%
Saturated Output Power	Pulsed[3], 400 MHz, 2.5 dB Gain Compression	P_{SAT}	60.4	61.2	-	dBm

3. 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}	-	-	215	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	215	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 215 mA	V_T	-	-2.9	-	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 600 mA	V_{GSQ}	-	-2.71	-	V
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 µs	$I_{D, MAX}$	-	255	-	A

Absolute Maximum Ratings[4,5,6,7,8]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	195 V
Gate Source Voltage, V_{GS}	-10 to 2 V
Gate Current, I_G	215 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	+225°C

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Operating at drain source voltage V_{DS} < 55 V will ensure MTTF > 2 x 10^6 hours.
7. Operating at nominal conditions with T_{CH} ≤ 200°C will ensure MTTF > 2 x 10^6 hours.
8. 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[9]

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)	0.19	°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)	0.152	°C/W

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

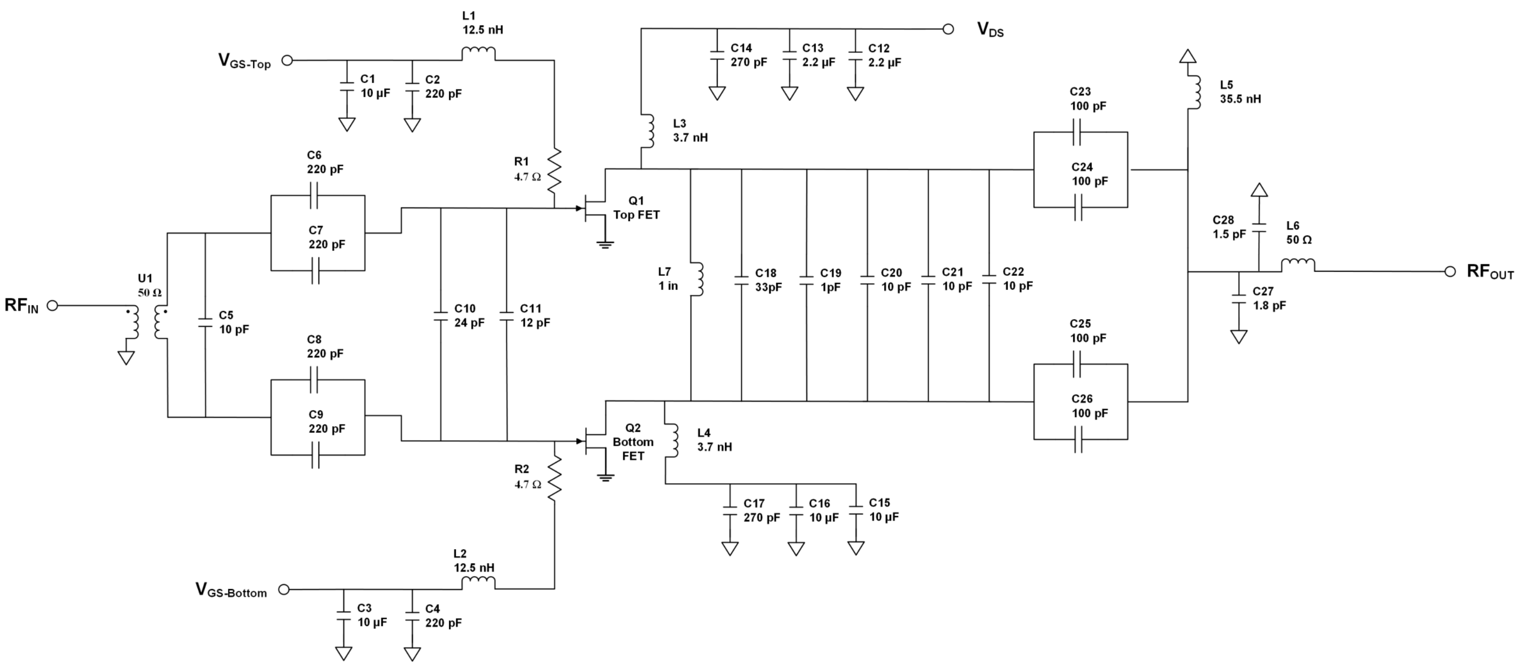
Handling Procedures

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.

Evaluation Test Fixture and Recommended Tuning Solution 400 - 460 MHz



Description

Parts measured on evaluation board (50-mil thick RO3006). 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

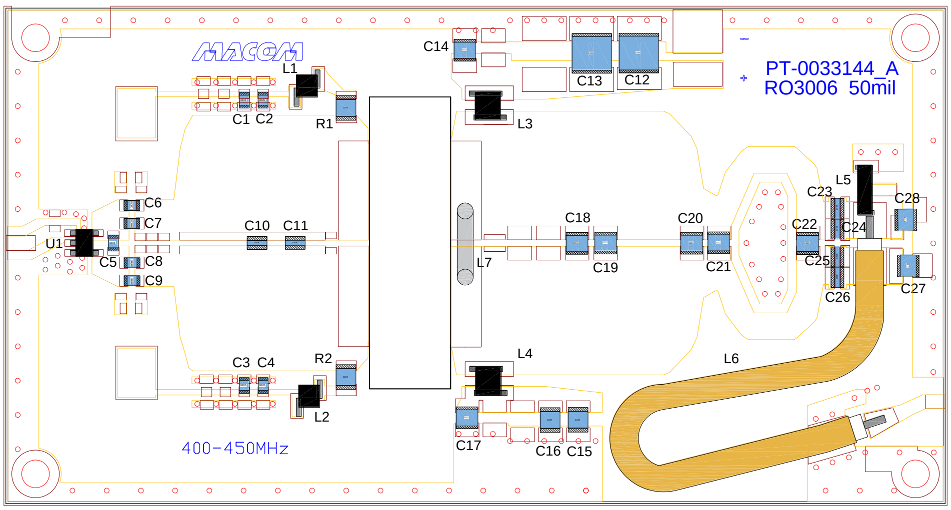
Turning the device ON

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}.

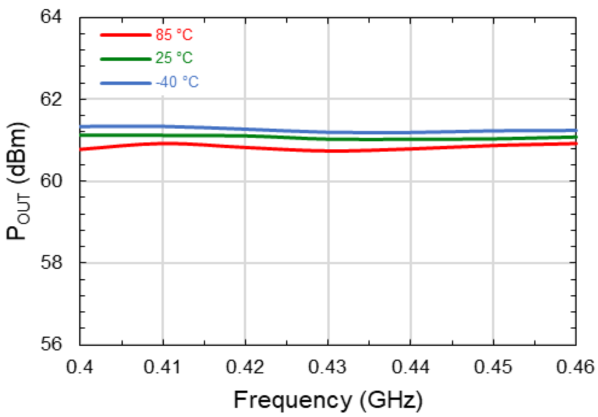
Evaluation Test Fixture and Recommended Tuning Solution 400 - 460 MHz



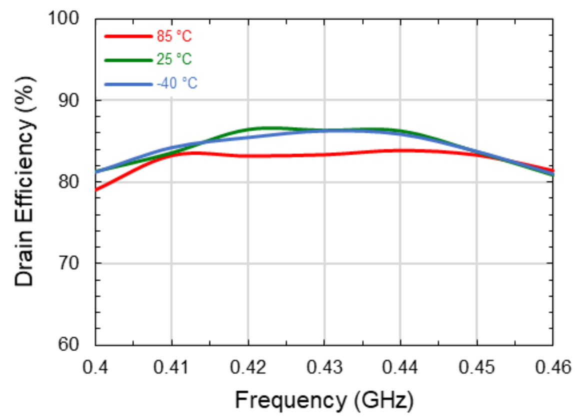
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1, C3	10 µf	+/- 10 %	Murata	GRM21BR6YA106KE43L
C2, C4. C6-C9	220 pF	+/- 5 %	PPI	0805N221JW251X
C5	10 pF	+/- 5 %	PPI	0805N100JW251X
C10	24 pF	+/- 5 %	PPI	0708N240JW501
C11	12 pF	+/- 5 %	PPI	0708N120JW501
C12, C13	2.2 µF	+/- 20 %	Murata	KRM55TR72E225MH01L
C14, C17	270 pF	+/- 5 %	PPI	1111N271JW201X
C15, C16	10 µF	+/- 10 %	Murata	GRM32EC72A106KE05L
C18	1.0 pF	+/- 0.1 pF	PPI	1111N1R0BW501X
C19	33 pF	+/- 5 %	PPI	1111N330JW501X
C20-C22	10 pF	+/- 5 %	PPI	1111N100JW501X
C23-C26	100 pF	+/- 5 %	PPI	0708N101JW501
C27	1.8 pF	+/- 0.1 pF	PPI	1111N1R8BW501X
C28	1.5 pF	+/- 0.1 pF	PPI	1111N1R5BW501X
R1, R2	4.7 Ω	+/- 5 %	KOA Speer	SG73P2ETTD4R7J
L1, L2	12.5 nH	+/- 5 %	Coilcraft	A04TJLC
L3, L4	3.7 nH	+/- 5 %	Coilcraft	GA3092-ALC
L5	35.5 nH	+/- 2 %	Coilcraft	B09TGLB
L6	50 Ω	-	AMAWAVE	UT-141C
L7	1 in	-	-	18 AWG
U1	50 Ω	-	Macom	MABA-009602-ES2922
Q1	MACOM GaN Power Amplifier			MAPC-A1542
PCB	RO3006, 50 mil, 1.0 oz. Cu, Au Finish			

Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture:
Pulsed[2] V_{DS} = 50 V, I_{DQ} = 600 mA, Pout = p3dB (Unless Otherwise Noted)

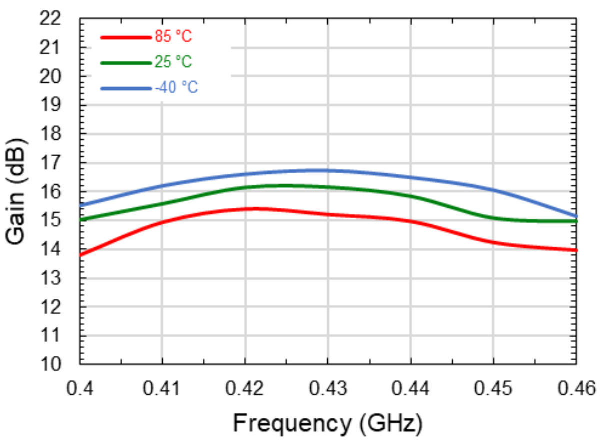
Pout (dBm) vs Frequency (GHz) vs Temp



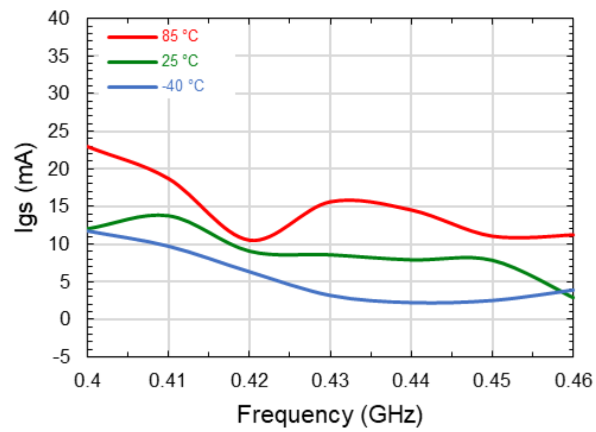
Drain Efficiency (%) vs Frequency (GHz) vs Temp



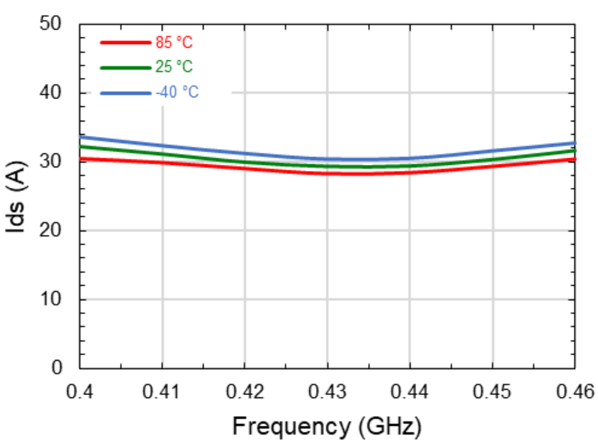
Gain (dB) vs Frequency (GHz) vs Temp



Gate Current (mA) vs Frequency (GHz) vs Temp

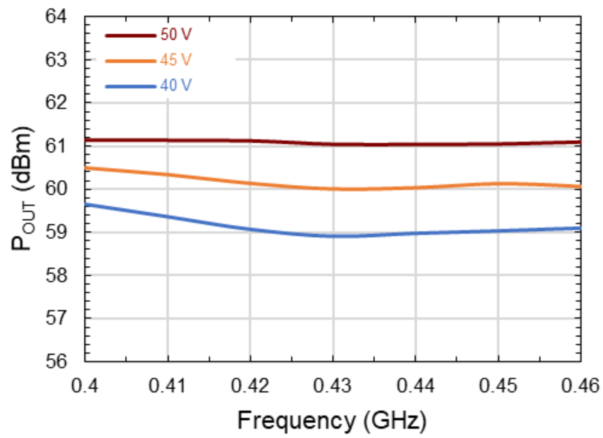


Drain Current (A) vs Frequency (GHz) vs Temp

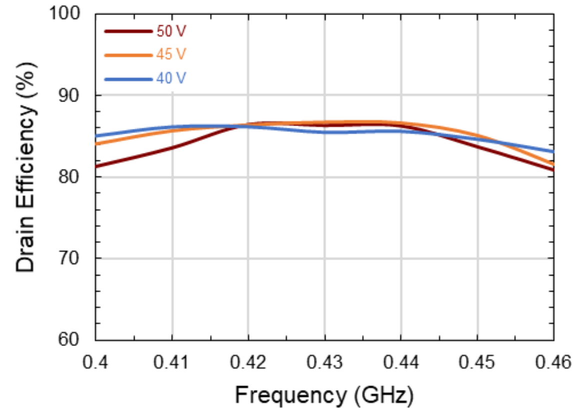


Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture: Pulsed[2] I_{DQ} = 600 mA, Pout = p3dB, T_C = 25°C (Unless Otherwise Noted)

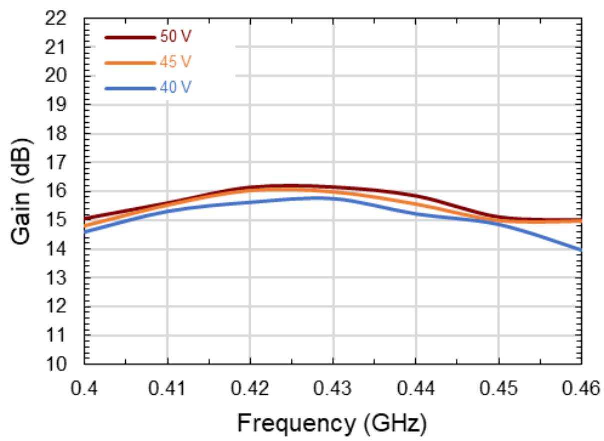
Pout (dBm) vs Frequency (GHz) vs Vds (V)



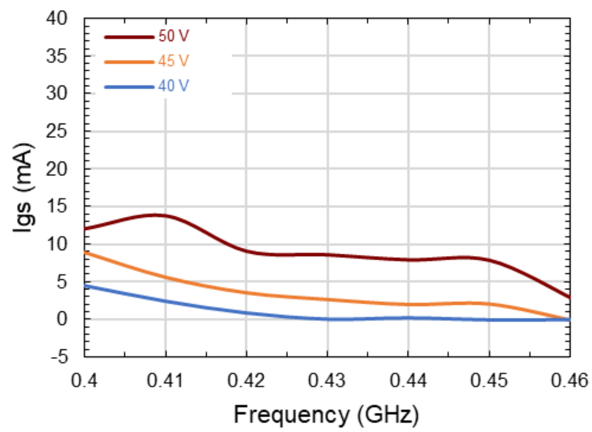
Drain Efficiency (%) vs Frequency (GHz) vs Vds (V)



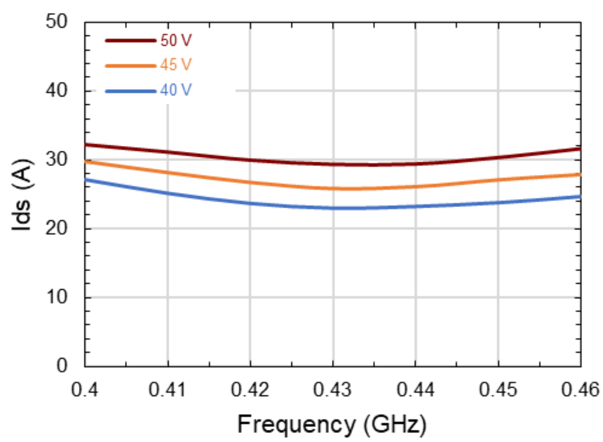
Gain (dB) vs Frequency (GHz) vs Vds (V)



Gate Current (mA) vs Frequency (GHz) vs Vds (V)

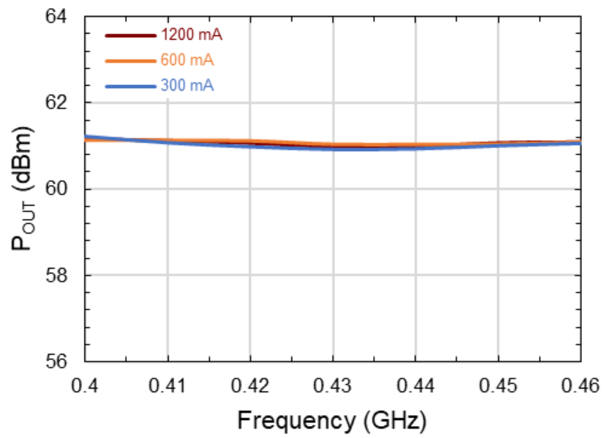


Drain Current (A) vs Frequency (GHz) vs Vds (V)

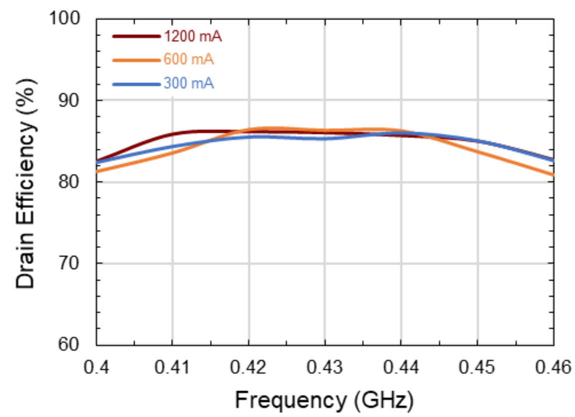


Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture: Pulsed[2] V_{DS} = 50 V, Pin = p3dB, T_C = 25°C (Unless Otherwise Noted)

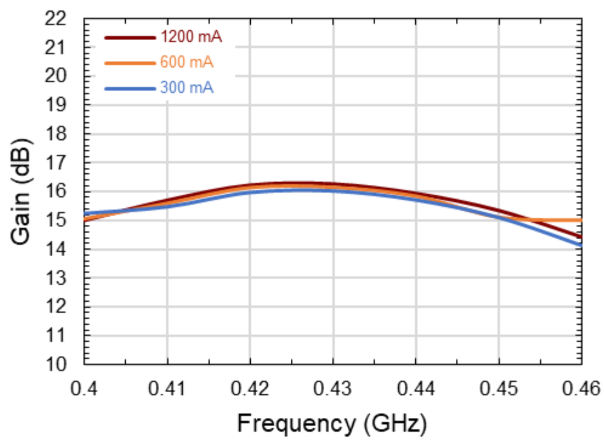
Pout (dBm) vs Frequency (GHz) vs Idq (mA)



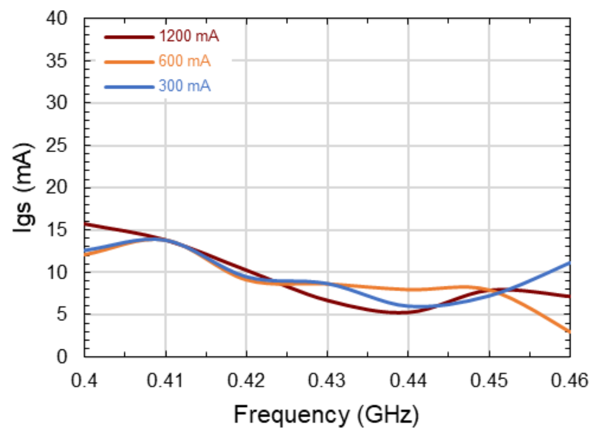
Drain Efficiency (%) vs Frequency (GHz) vs Idq (mA)



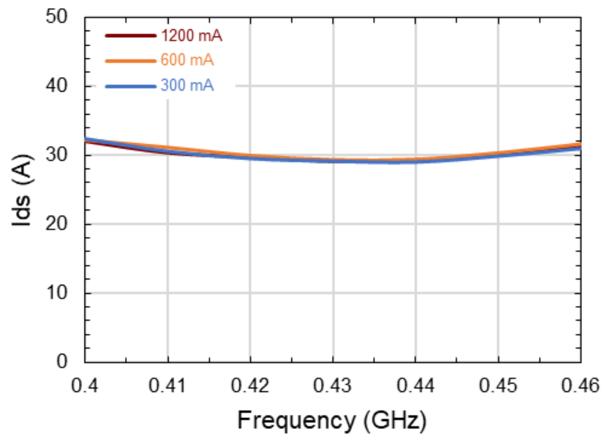
Gain (dB) vs Frequency (GHz) vs Idq (mA)



Gate Current (mA) vs Frequency (GHz) vs Idq (mA)

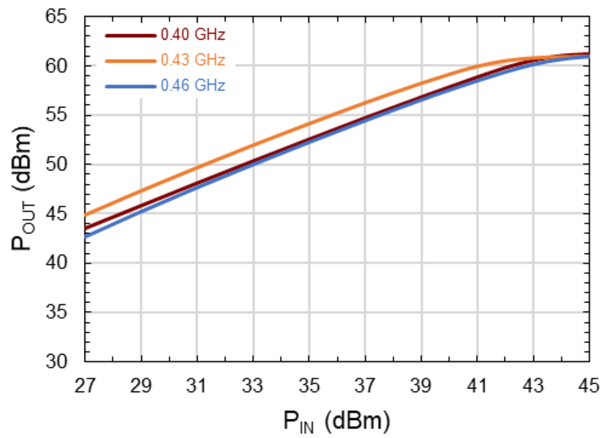


Drain Current (A) vs Frequency (GHz) vs Idq (mA)

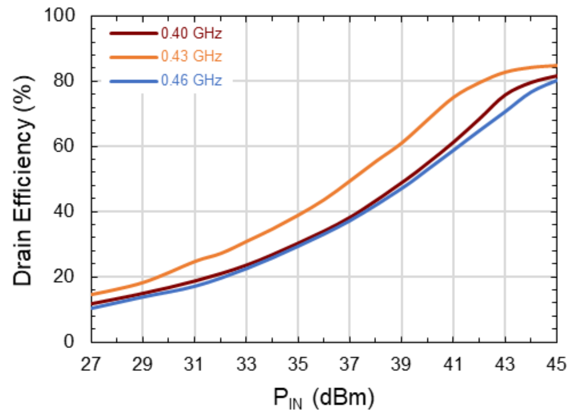


Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture:
Pulsed[2] V_{DS} = 50 V, I_{DQ} = 600 mA, T_C = 25°C (Unless Otherwise Noted)

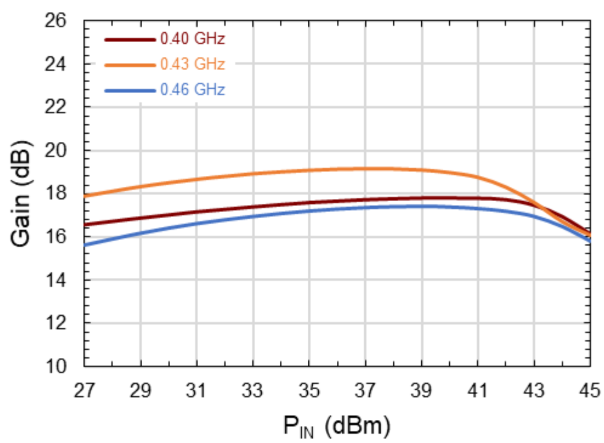
Pout (dBm) vs Pin (dBm) vs Freq (GHz)



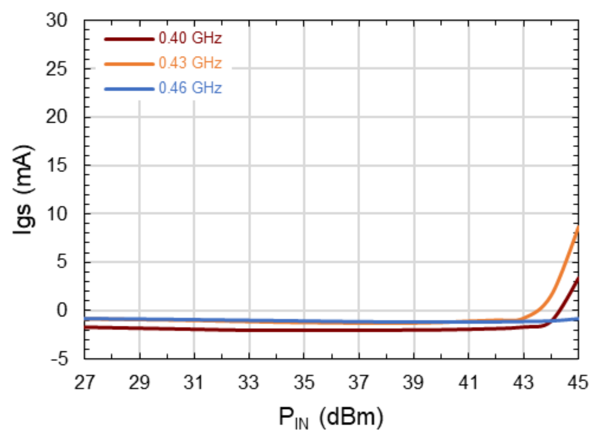
Drain Efficiency (%) vs Pin (dBm) vs Freq (GHz)



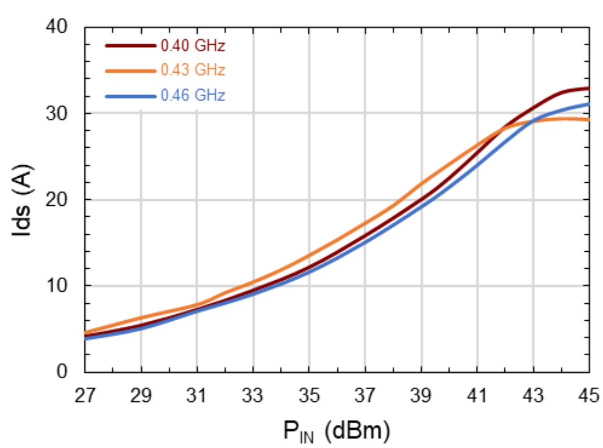
Gain (dB) vs Pin (dBm) vs Freq (GHz)



Gate Current (mA) vs Pin (dBm) vs Freq (GHz)

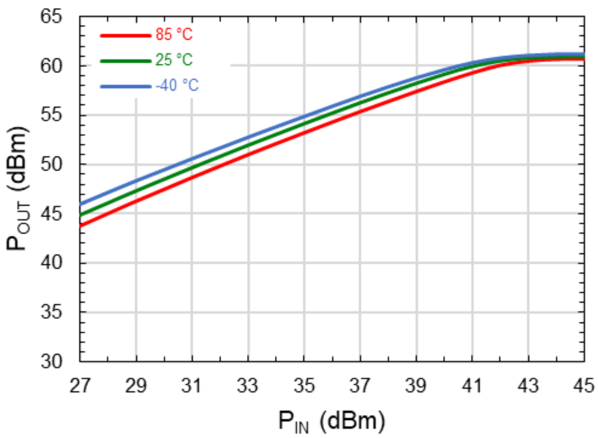


Drain Current (A) vs Pin (dBm) vs Freq (GHz)

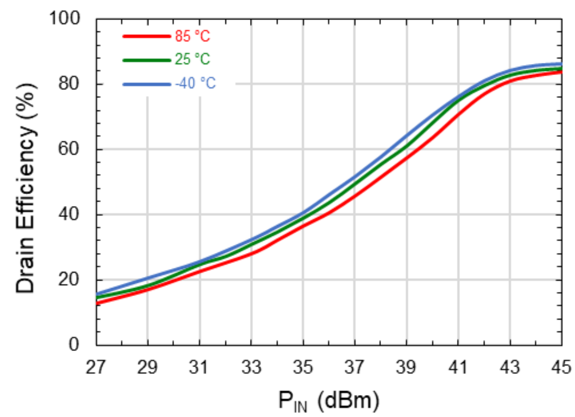


Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture: Pulsed[2] 430MHz, V_{DS} = 50 V, I_{DQ} = 600 mA (Unless Otherwise Noted)

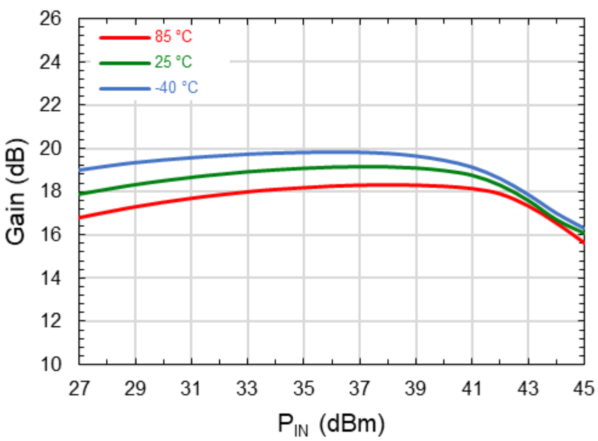
Pout (dBm) vs Pin (dBm) vs Temp



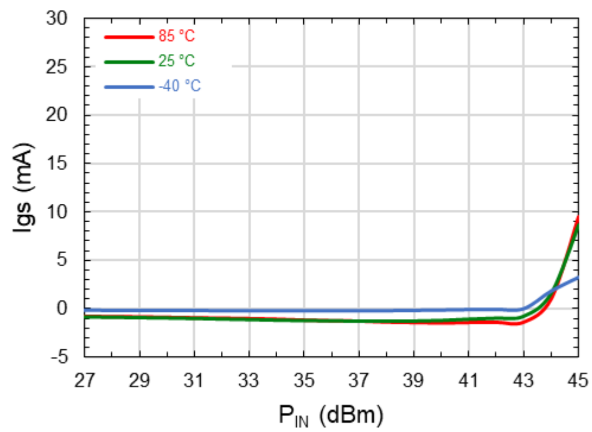
Drain Efficiency (%) vs Pin (dBm) vs Temp



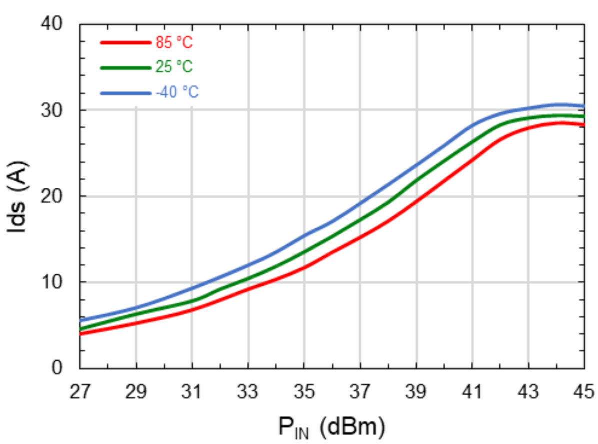
Gain (dB) vs Pin (dBm) vs Temp



Gate Current (mA) vs Pin (dBm) vs Temp

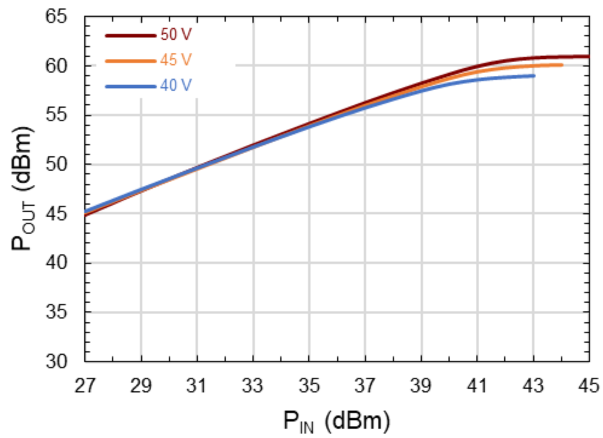


Drain Current (A) vs Pin (dBm) vs Temp

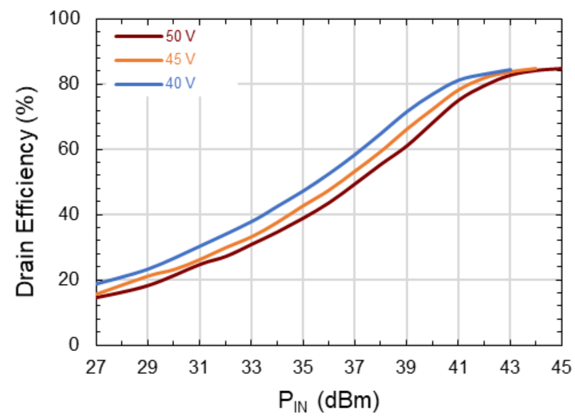


Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture: Pulsed[2] 430MHz, I_{DQ} = 600 mA, T_C = 25°C (Unless Otherwise Noted)

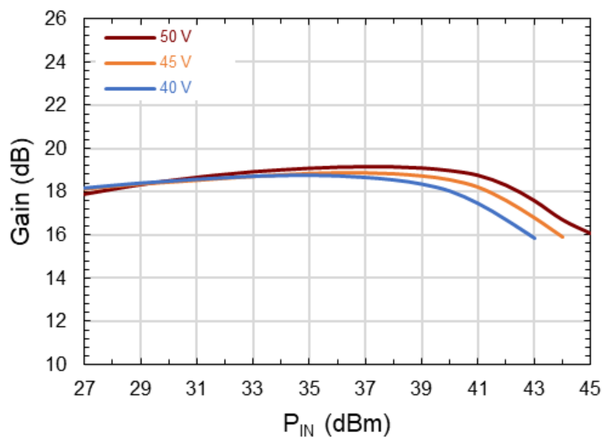
Pout (dBm) vs Pin (dBm) vs Vds (V)



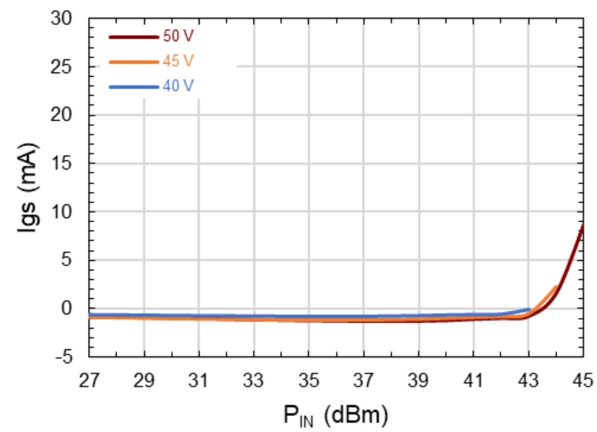
Drain Efficiency (%) vs Pin (dBm) vs Vds (V)



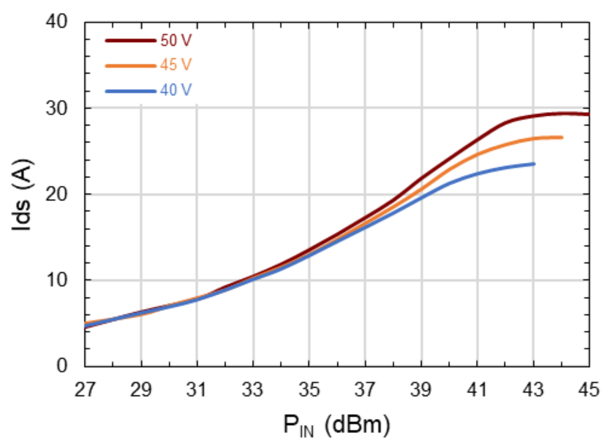
Gain (dB) vs Pin (dBm) vs Vds (V)



Gate Current (mA) vs Pin (dBm) vs Vds (V)



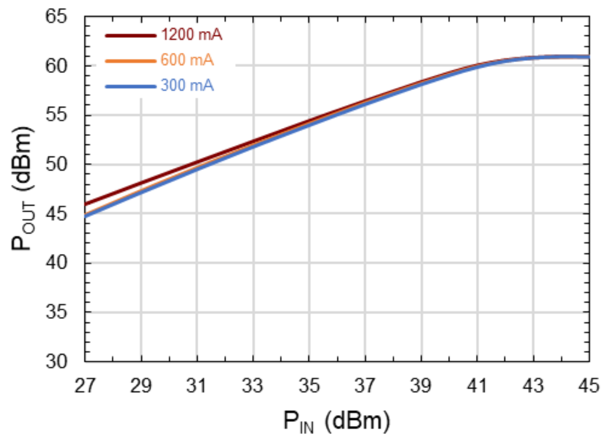
Drain Current (A) vs Pin (dBm) vs Vds (V)



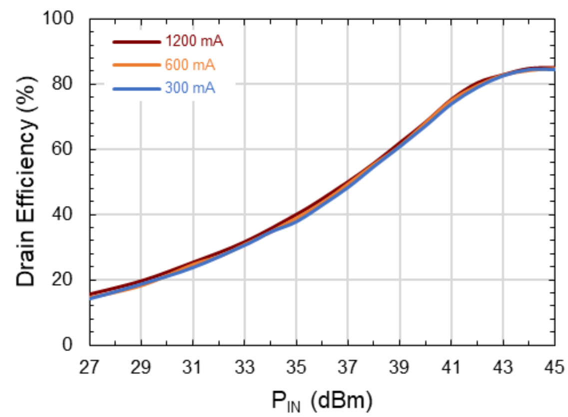
Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture:

Pulsed[2] 430MHz, V_{DS} = 50 V, T_C = 25°C (Unless Otherwise Noted)

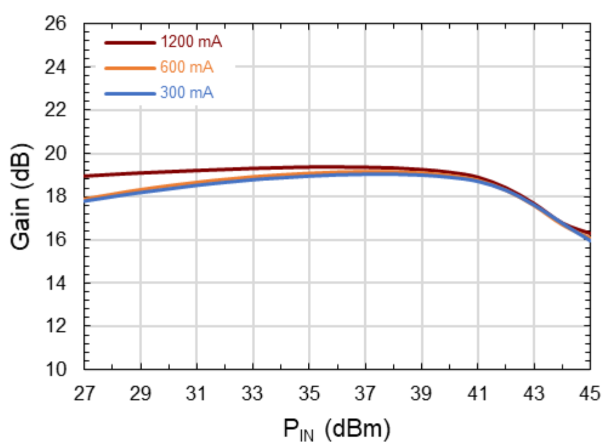
Pout (dBm) vs Pin (dBm) vs Idq (mA)



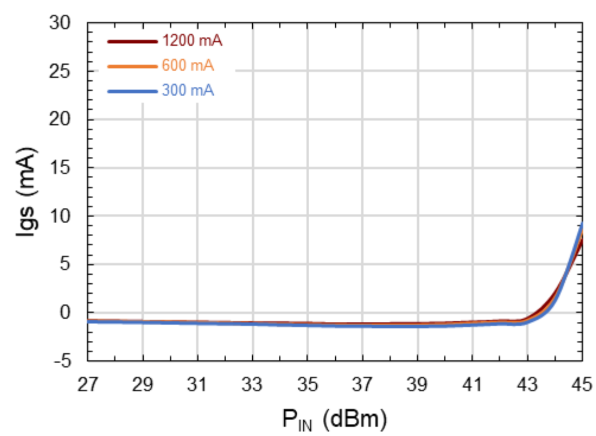
Drain Efficiency (%) vs Pin (dBm) vs Idq (mA)



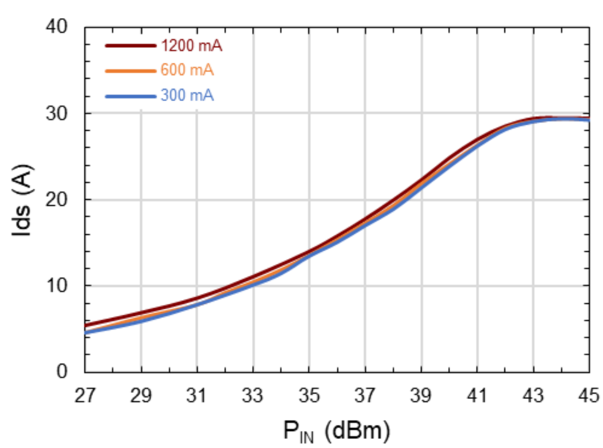
Gain (dB) vs Pin (dBm) vs Idq (mA)



Gate Current (mA) vs Pin (dBm) vs Idq (mA)

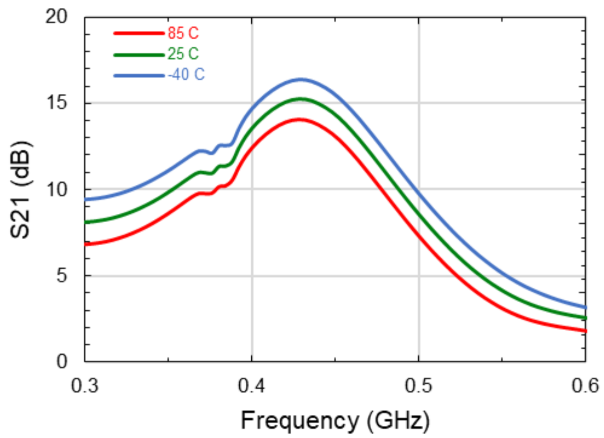


Drain Current (A) vs Pin (dBm) vs Idq (mA)

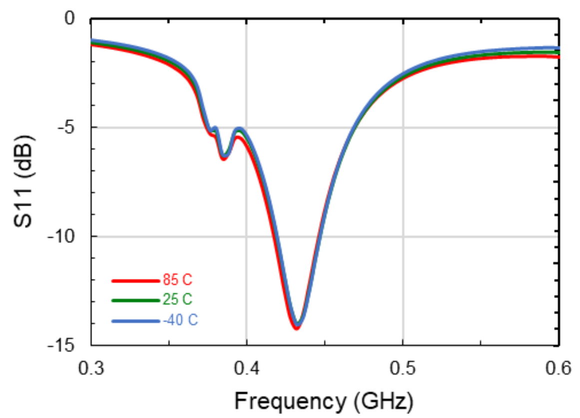


Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture:
Pulsed[2] V_{DS} = 50 V, I_{DQ} = 600 mA, Pin = -20dBm (Unless Otherwise Noted)

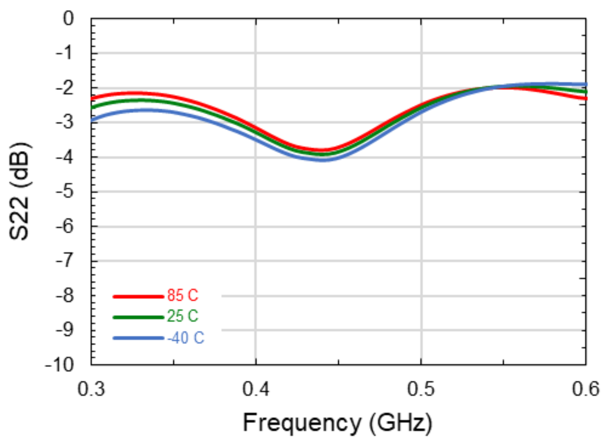
S21 (dB) vs Freq (GHz) vs Temp



S11 (dB) vs Freq (GHz) vs Temp

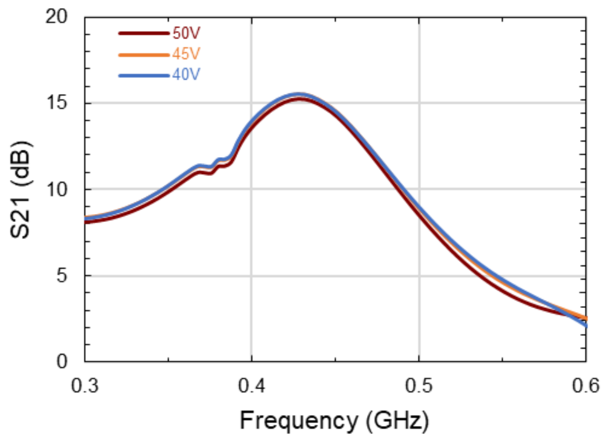


S22 (dB) vs Freq (GHz) vs Temp

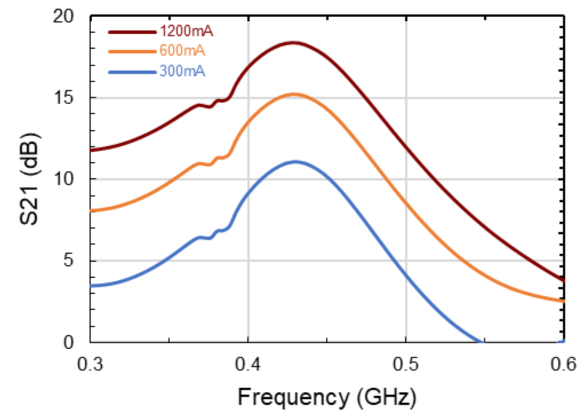


Typical Performance Curves as Measured in the 400 - 460 MHz Evaluation Test Fixture:
Pulsed[2] V_{DS} = 50 V, I_{DQ} = 600 mA, Pin = -20dBm, T_C = 25°C (Unless Otherwise Noted)

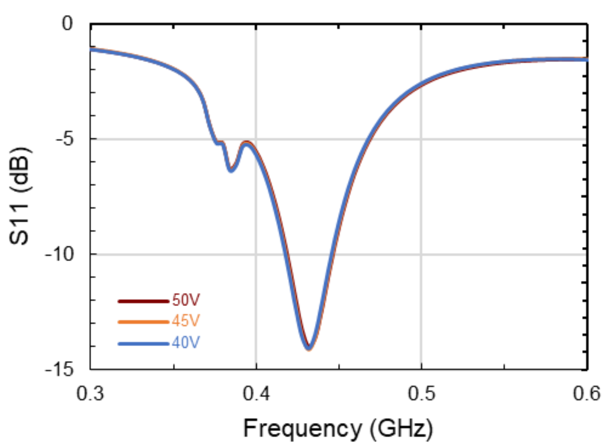
S21 (dB) vs Freq (GHz) vs Vds (V)



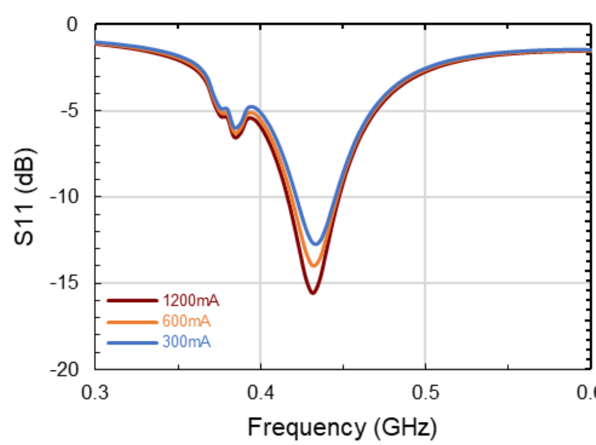
S21 (dB) vs Freq (GHz) vs Idq (mA)



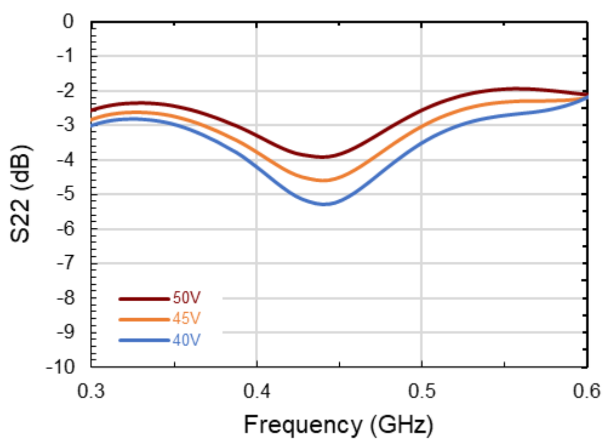
S11 (dB) vs Freq (GHz) vs Vds (V)



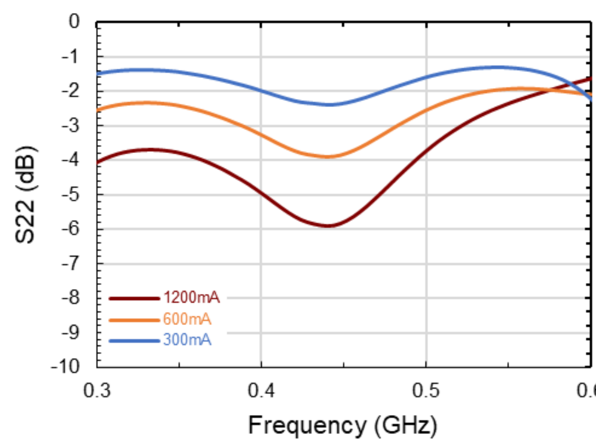
S11 (dB) vs Freq (GHz) vs Idq (mA)



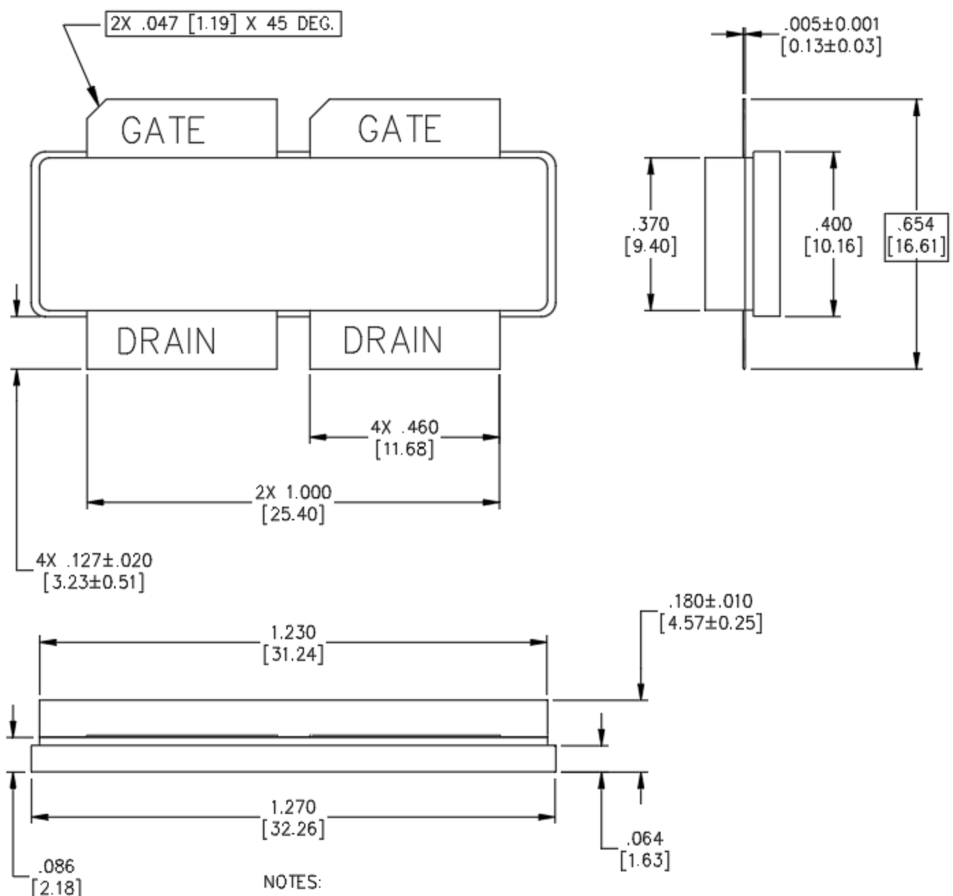
S22 (dB) vs Freq (GHz) vs Vds (V)



S22 (dB) vs Freq (GHz) vs Idq (mA)



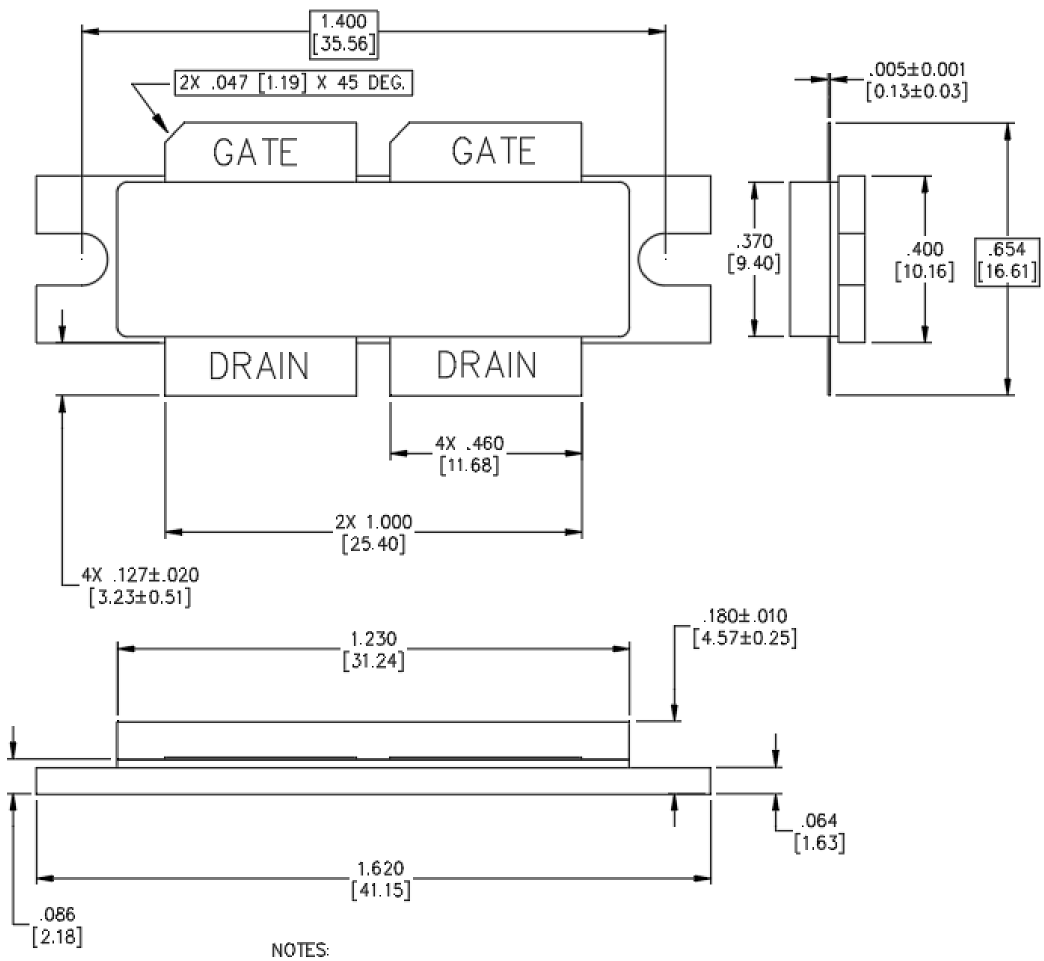
Lead-Free AC-1230S-4 Package Dimensions†



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.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Au.

Lead-Free AC-1230B-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.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Au.