GaN Amplifier 50 V, 150 W
8.8 - 9.6 GHz

MACOM PURE CARBIDE™

MAPC-A4004
Rev. V1

Features

- Output Power: 150 W
- Power Gain: 11 dB
- Drain Efficiency: 44%
- 50 Ω Impedance Matched
- 50 V Operation
- RoHS* Compliant

AC-587BH-2

Applications

Marine Radar, Weather Monitoring, Air Traffic Control, Marine Vessel Traffic Control, Port Security.

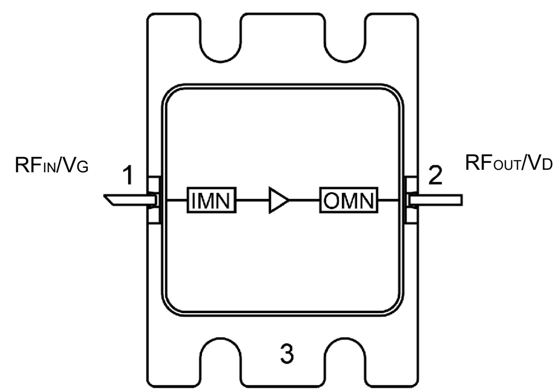
Description

The MAPC-A4004 is a 150 W packaged amplifier fully matched to 50 Ω at both input and output ports.

Utilizing the high performance, 50 V GaN on SiC production process, the MAPC-A4004 operates from 8.8 - 9.6 GHz and targets pulsed radar applications such a marine weather radar.

The MAPC-A4004 typically achieves 150 W of saturated output power with 11 dB of large signal gain and 44 % drain efficiency under pulsed operation.

Functional Schematic



Typical Performance:

Measured in Evaluation Test Fixture[1] at
P_{IN} = 41 dBm, 100 μs pulse width, 10% duty cycle.

- V_{DS} = 50 V, I_{DQ} = 630 mA, T_C = 25°C

Frequency (GHz)	Output Power[1] (dBm)	Power Gain[1] (dB)	η_D[1] (%)
8.8	51.8	10.8	46.0
9.3	52.0	11.1	43.5
9.6	52.0	11.0	42.1

1. Performance values and curves in this data sheet were measured in this fixture, de-embedded to the package lead reference planes. (Offset 0.48 dB for both input and output).

Pin Configuration

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

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

Ordering Information

Part Number	Package
MAPC-A4004-AB000	Bulk Quantity
MAPC-A4004-ABSB1	Sample Board

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

RF Electrical Characteristics: Freq. = 8.8 - 9.6 GHz, T_C = 25°C, V_{DS} = 50 V, I_{DQ} = 630 mA
Note: Performance in MACOM Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Output Power	Pulsed[3,4], P_{IN} = 41 dBm	P_{OUT}	-	52.0	-	dBm
Drain Efficiency	Pulsed[3,4], P_{IN} = 41 dBm	DE	-	44.0	-	%
Large Signal Gain	Pulsed[3,4], P_{IN} = 41 dBm	G_P	-	11.0	-	dB
Small Signal Gain	CW, P_{IN} = -20 dBm	S21	-	15.2	-	dB
Input Return Loss	CW, P_{IN} = -20 dBm	S11	-	-7	-	dB
Output Return Loss	CW, P_{IN} = -20 dBm	S22	-	-6	-	dB

RF Electrical Specifications: T_A = 25°C, V_{DS} = 50 V, I_{DQ} = 630mA
Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Output Power	Pulsed[3,4], P_{IN} = 41 dBm 8.8 GHz 9.3 GHz 9.6 GHz	P_{OUT}	51.3 50.7 50.1	52.0 51.8 51.6	—	dBm
Drain Efficiency	Pulsed[3,4], P_{IN} = 41 dBm 8.8 GHz 9.3 GHz 9.6 GHz	DE	42 38 33	46 43 40	—	%
Large Signal Gain	Pulsed[3,4], P_{IN} = 41 dBm 8.8 GHz 9.3 GHz 9.6 GHz	G_P	—	11.0 10.8 10.6	—	dB

3. Pulse Width = 100 µs, Duty Cycle = 10 %
4. Power data de-embed to Pkg lead, (Offset 0.48 dB for both Input and Output)

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} = 10 V	I_{DLK}	-	-	2.94	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 10 V	I_{GLK}	-2.94	-	-	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 21.1 mA	V_T	-3.5	-2.6	-1.9	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 630 mA	V_{GSQ}	-	-2.4	-	V

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

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	150 V
Gate Source Voltage, V_{GS}	-8 to 2 V
DC Drain Current	14 A
Gate Current, I_G	21.1 mA
Input Power, P_{IN}	44 dBm
Pulse Width	100 µsec
Duty Cycle	10 %
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 +275°C
Absolute Maximum Channel Temperature	+275°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} ≤ 275°C will ensure MTTF > 2 x 10^6 hours.

Thermal Characteristics

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	T_C = 85°C, T_{CH} = 275°C P_{DISS} = 147 W, CW	R_θ(FEA)	1.20	°C/W
Thermal Resistance using Finite Element Analysis	T_C = 85°C, T_{CH} = 275°C P_{DISS} = 211 W, 100 µs 10%	R_θ(FEA)	0.89	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	T_C = 85°C, P_{DISS} = 211 W, 100 µs 10%	R_θ(IR)	0.40	°C/W

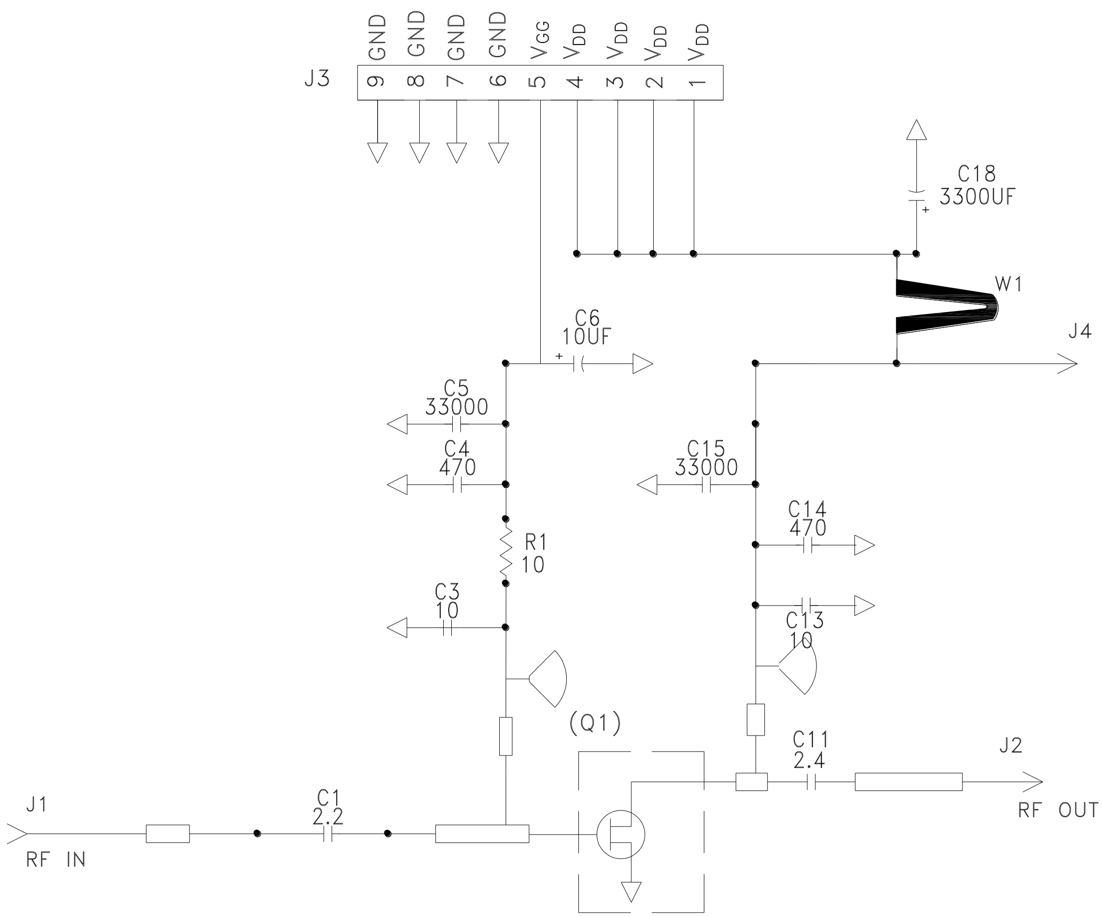
Handling Procedures

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[1] and Recommended Tuning Solution



Description

Parts measured on evaluation board (20-mil thick RO6035-HTC). 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

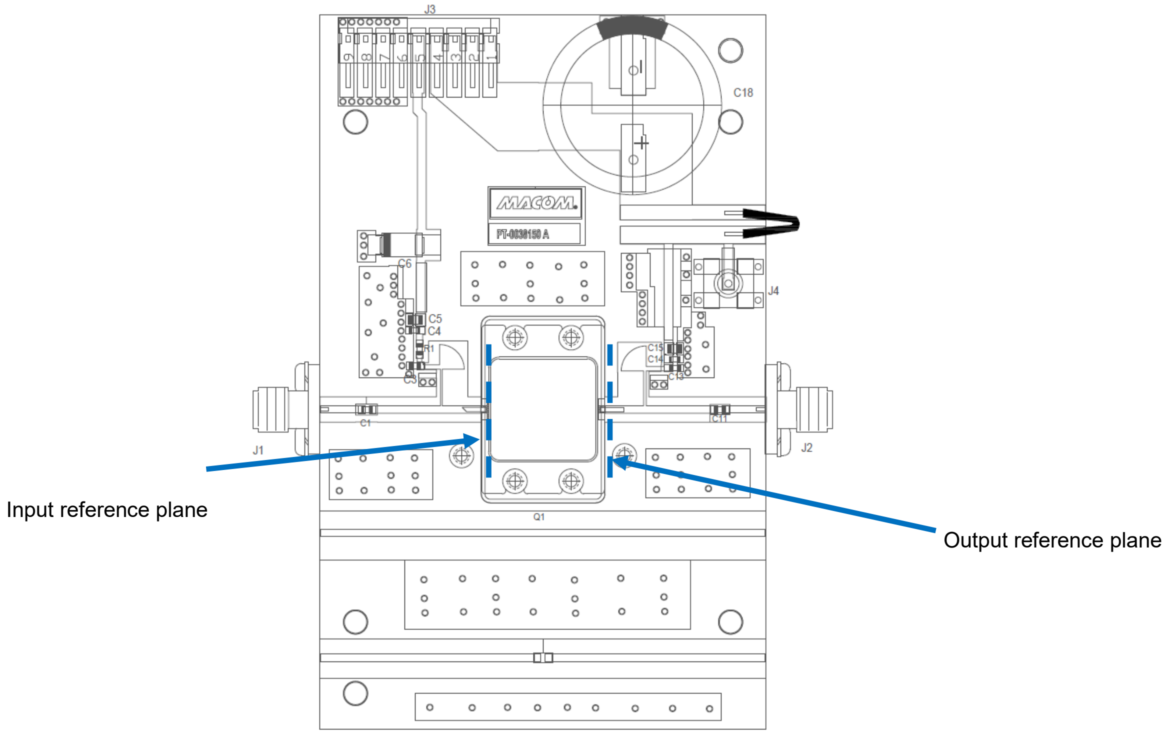
Turning the device ON

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[1] and Recommended Tuning Solution

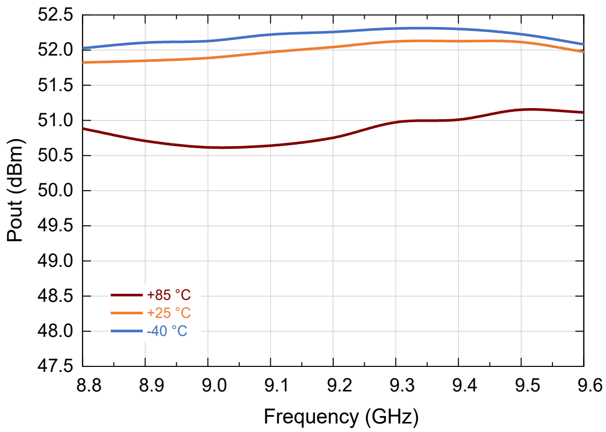


Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	2.2 pF	0.1pF	Kyocera/AVX	ATC600S2R2BW250XT
C3,C13	10 pF	0.1pF	Kyocera/AVX	ATC600S100FW250XT
C11	2.4 pF	0.1pF	Kyocera/AVX	ATC600S2R4BW250XT
C4,C14	470 pF	5%	Murata	GRM39X7R471J100AD
C5,C15	33000 pF	10%	Murata	GRM21BR72A333KA01
C6	10 µF	10%	Kemet	T496C106K016ATE2K0
C18	3300 µF	20%	Nichicon	UFW2A332MRD
R1	10 Ω	1%	Vishay/Dale	CRCW060310R0FKEA
J1,J2	-	-	Gigalane	PSF-S00-000
J3	-	-	TE Connectivity	640457-9
J4	-	-	Cinch	131-3711-201
W1	-	-	-	18 AWG Black
Q1	MACOM GaN Power Amplifier			MAPC-A4004
PCB	RO6035-HTC, 20 mil, 1 oz. Cu, Au Finish			

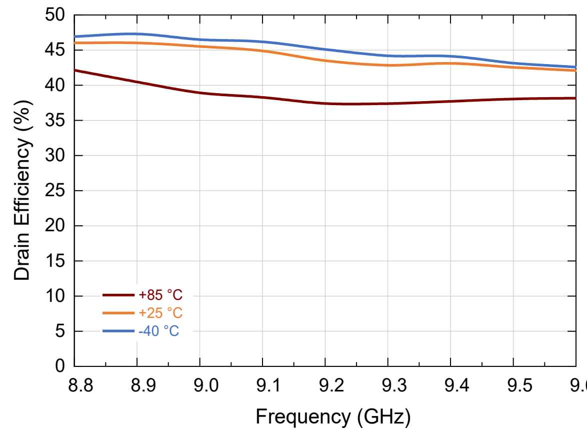
Typical Performance Curves as Measured in the Evaluation Test Fixture[1]:

Pulse Width = 100 µs, Duty Cycle = 10 %, V_{DS} = 50 V, I_{DQ} = 630 mA, P_{IN} = 41 dBm (Unless otherwise noted)
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

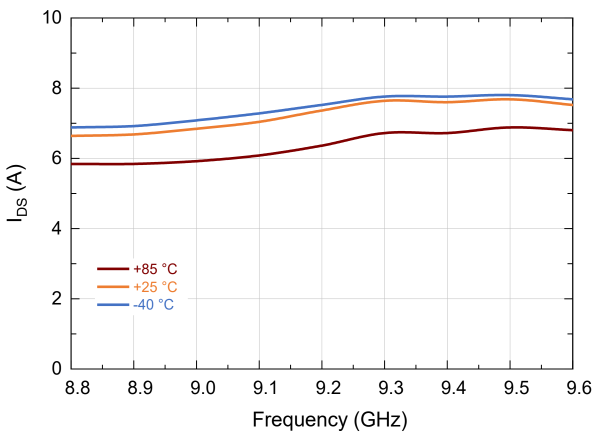
Output Power vs. Temperature and Frequency



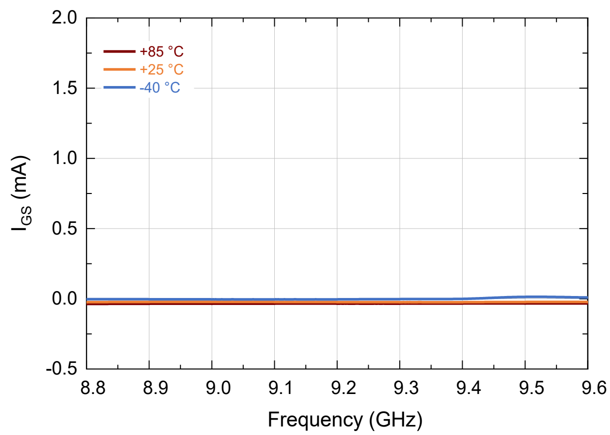
Drain Efficiency vs. Temperature and Frequency



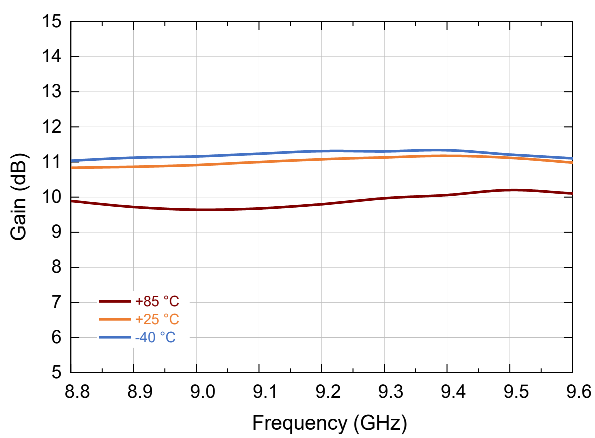
Drain Current vs. Temperature and Frequency



Gate Current vs. Temperature and Frequency



Large Signal Gain vs. Temperature and Frequency



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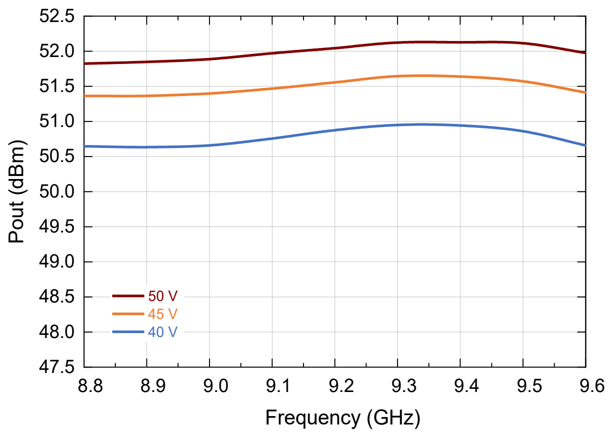
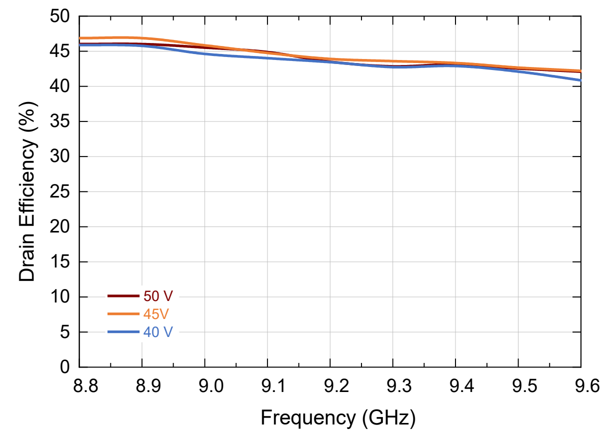
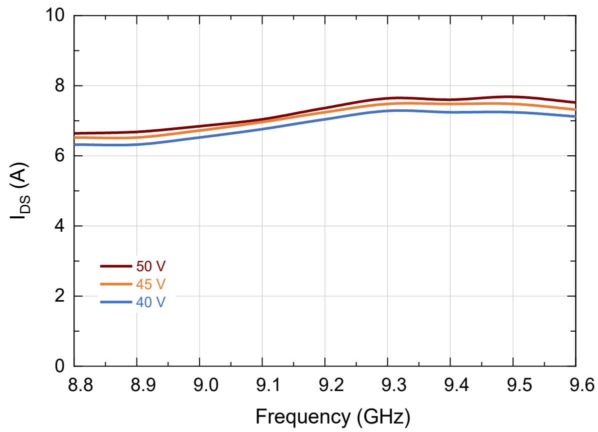
Output Power vs. V_{DS} and Frequency



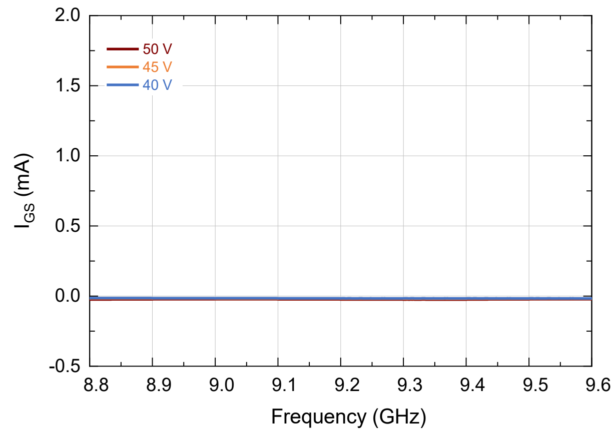
Drain Efficiency vs. V_{DS} and Frequency



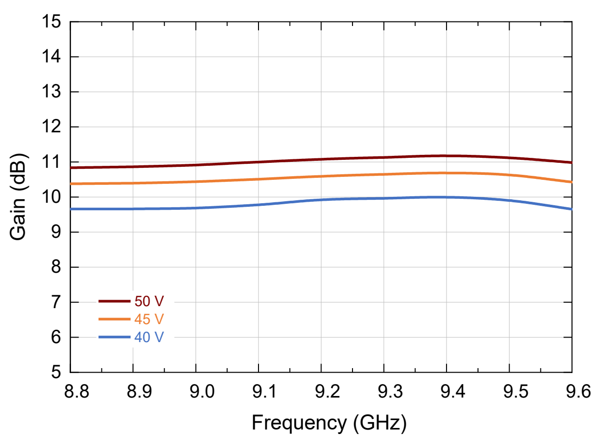
Drain Current vs. V_{DS} and Frequency



Gate Current vs. V_{DS} and Frequency



Large Signal Gain vs. V_{DS} and Frequency



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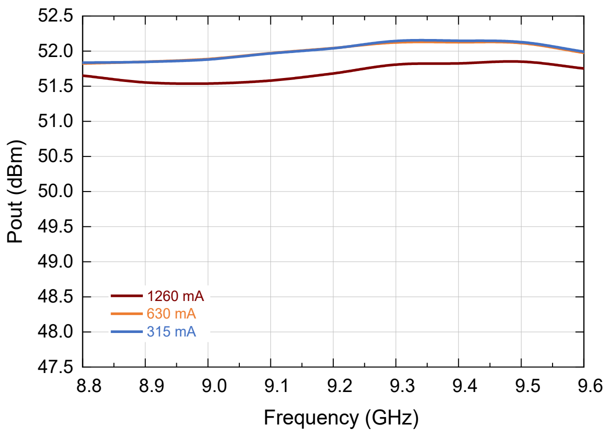
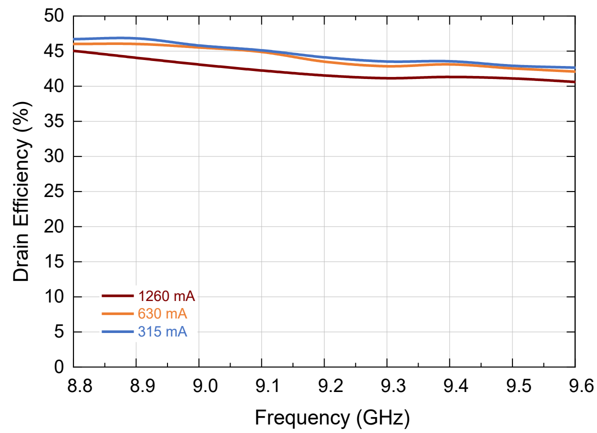
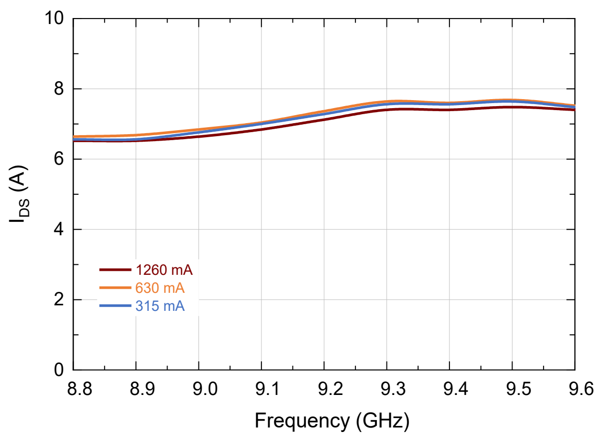
Output Power vs. I_{DS} and Frequency



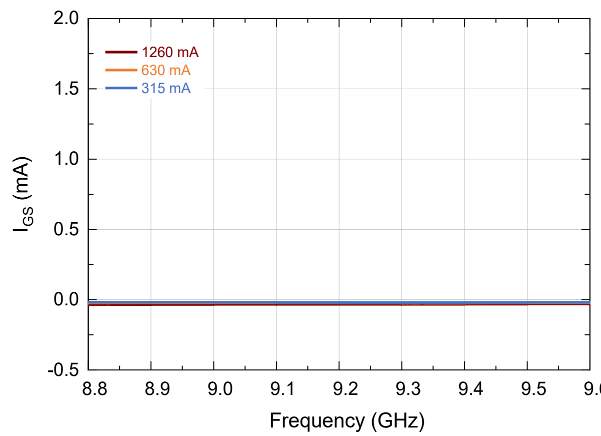
Drain Efficiency vs. I_{DS} and Frequency



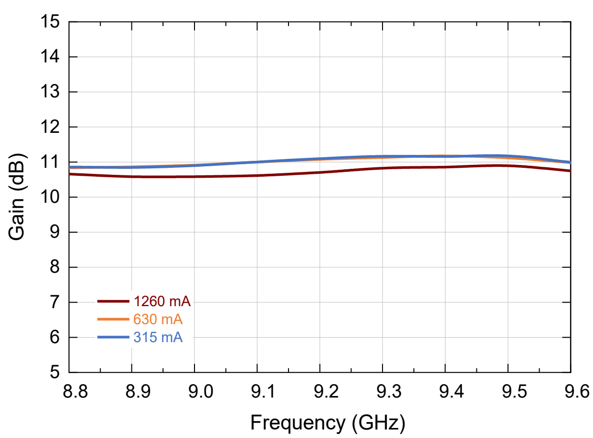
Drain Current vs. I_{DS} and Frequency



Gate Current vs. I_{DS} and Frequency



Large Signal Gain vs. I_{DS} and Frequency



Typical Performance Curves as Measured in the Evaluation Test Fixture[1]:

Pulse Width = 100 µs, Duty Cycle = 10 %, V_{DS} = 50 V, I_{DQ} = 630 mA, Freq = 9.2 GHz (Unless otherwise noted)
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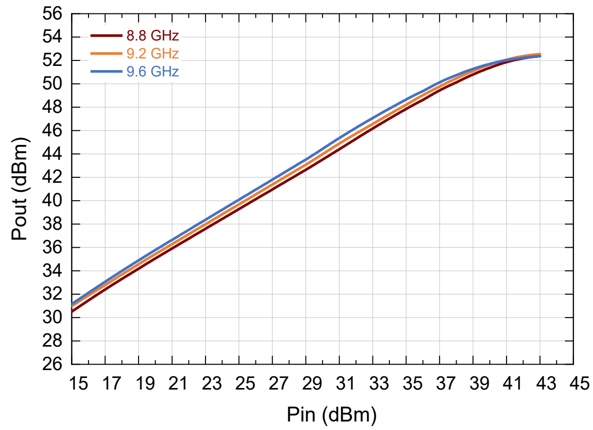
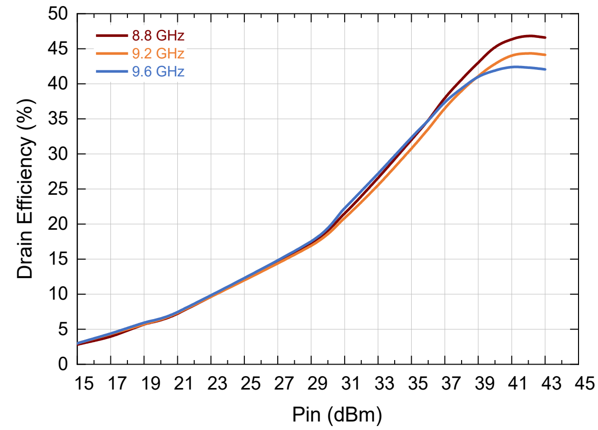
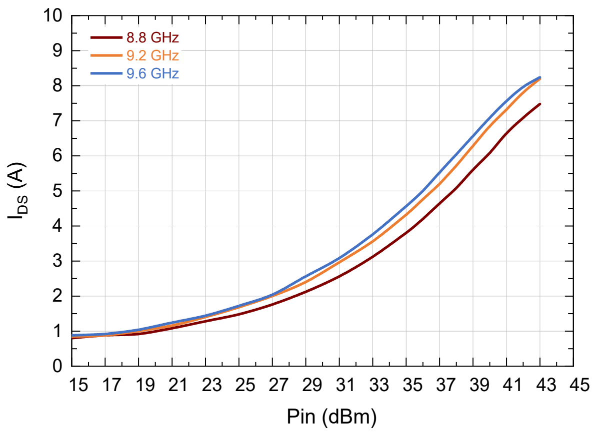
Pout vs. Frequencies and Pin



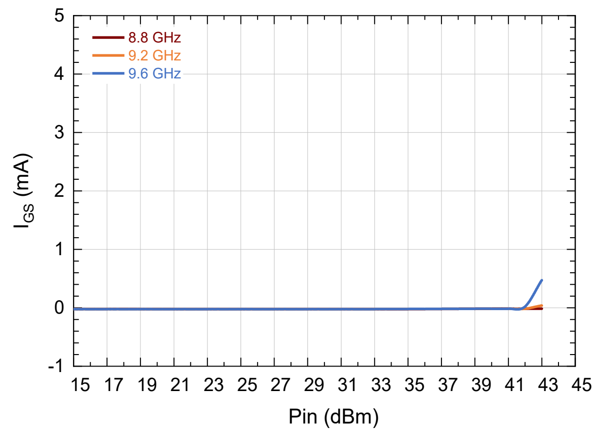
Drain Efficiency vs. Frequencies and Pin



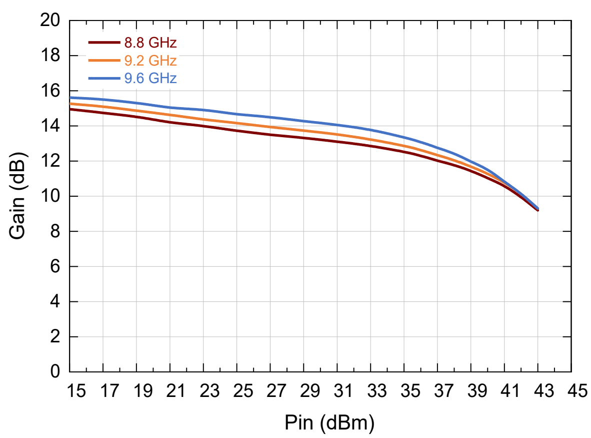
Drain Current vs. Frequency and P_{IN}



Gate Current vs. Frequency and P_{IN}



Large Signal Gain vs. Frequency and P_{IN}



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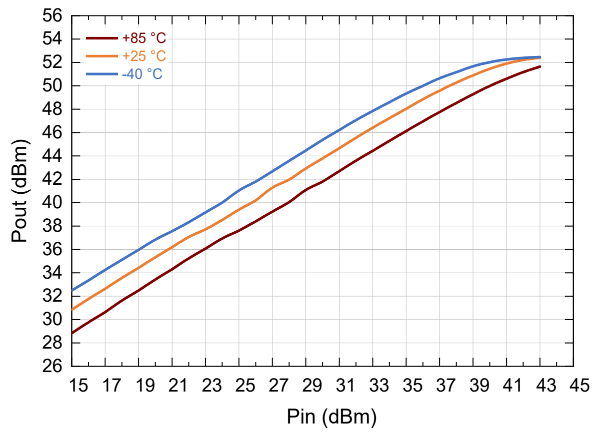
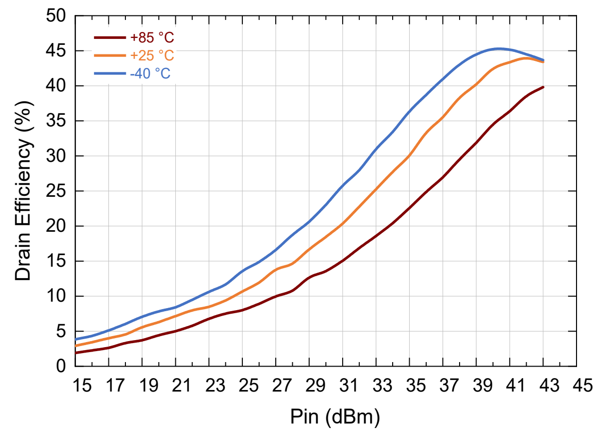
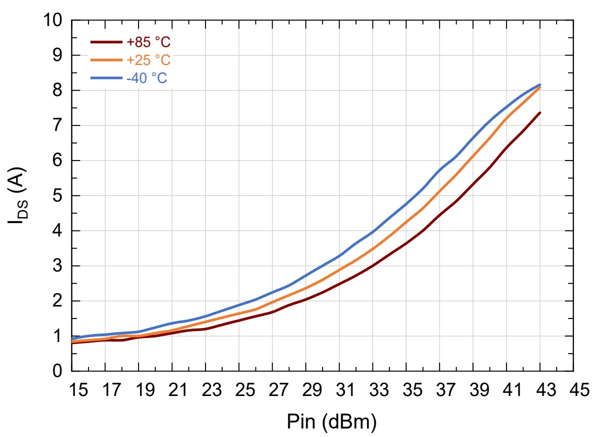
Output Power vs. Temperature and P_{IN}



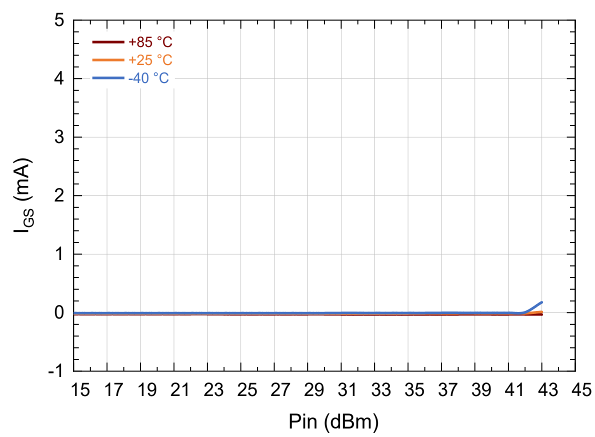
Drain Efficiency vs. Temperature and Pin



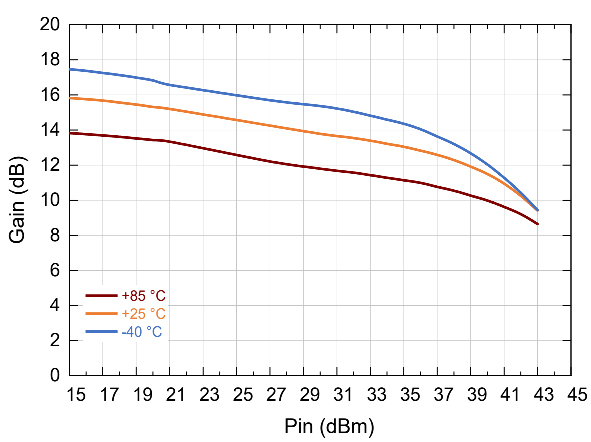
Drain Current vs. Temperature and P_{IN}



Gate Current vs. Temperature and P_{IN}



Large Signal Gain vs. Temperature and P_{IN}



Typical Performance Curves as Measured in the Evaluation Test Fixture[1]:

Pulse Width = 100 µs, Duty Cycle = 10 %, V_{DS} = 50 V, I_{DQ} = 630 mA, Freq = 9.2 GHz (Unless otherwise noted)
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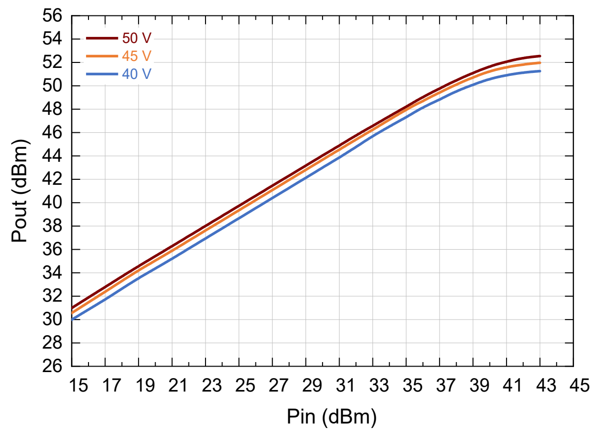
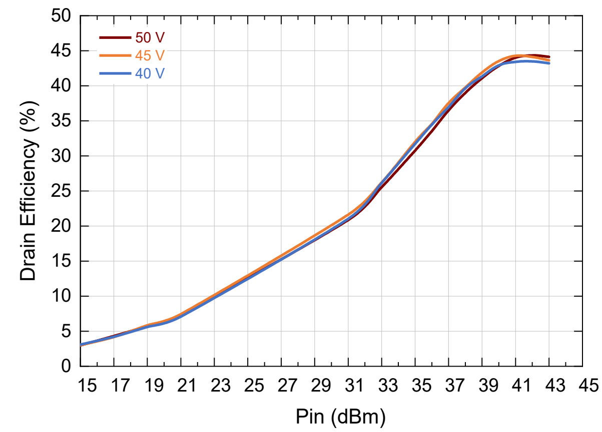
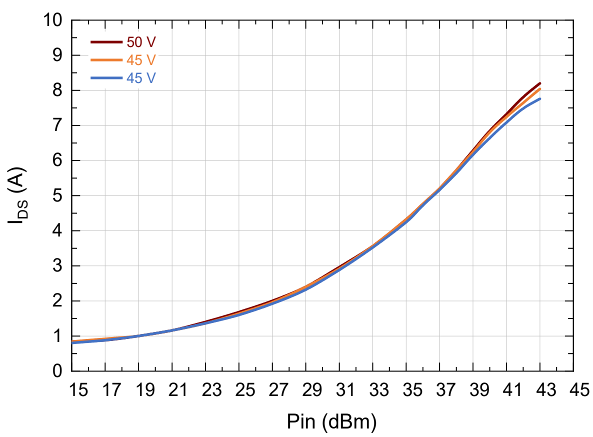
Output Power vs. V_D and P_{IN}



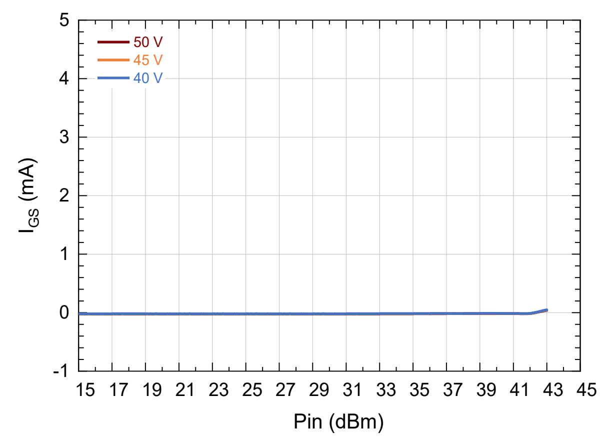
Drain Efficiency vs. V_D and Pin



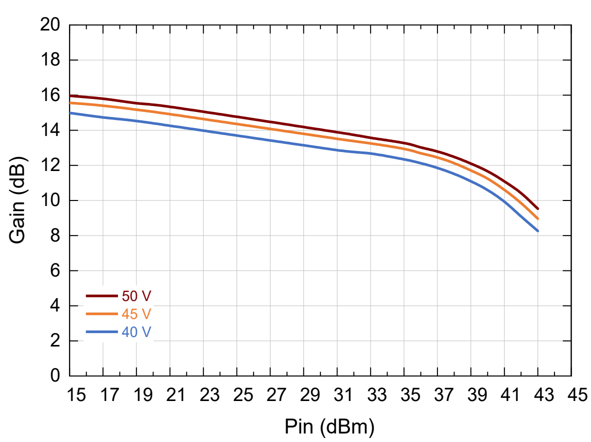
Drain Current vs. V_D and P_{IN}



Gate Current vs. V_D and P_{IN}



Large Signal Gain vs. V_D and P_{IN}



Typical Performance Curves as Measured in the Evaluation Test Fixture[1]:

Pulse Width = 100 µs, Duty Cycle = 10 %, V_{DS} = 50 V, I_{DQ} = 630 mA, Freq = 9.2 GHz (Unless otherwise noted)
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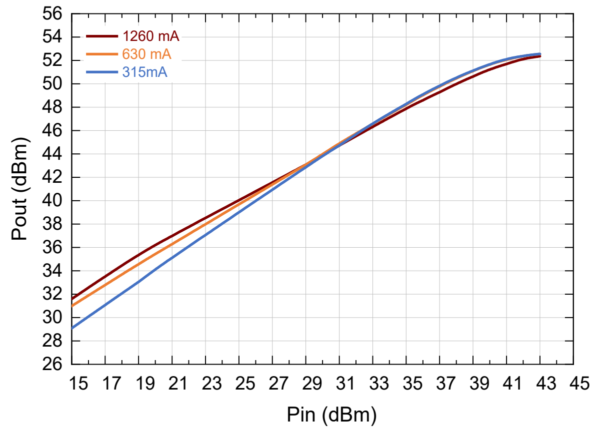
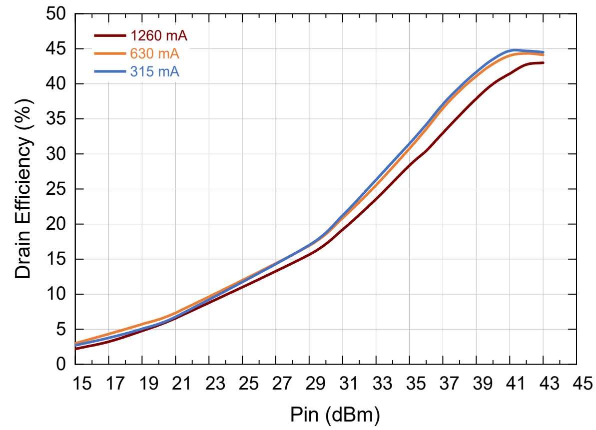
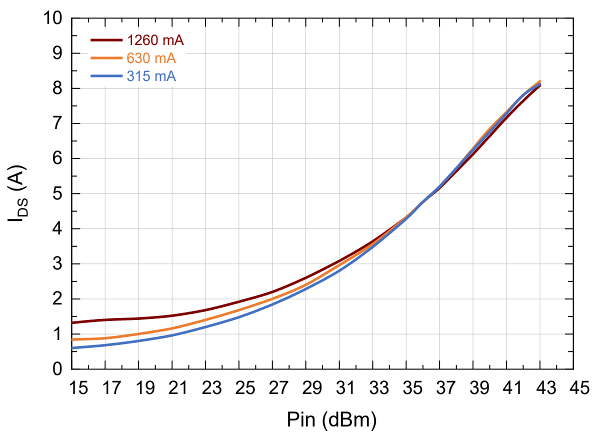
Output Power vs. I_{DQ} and P_{IN}



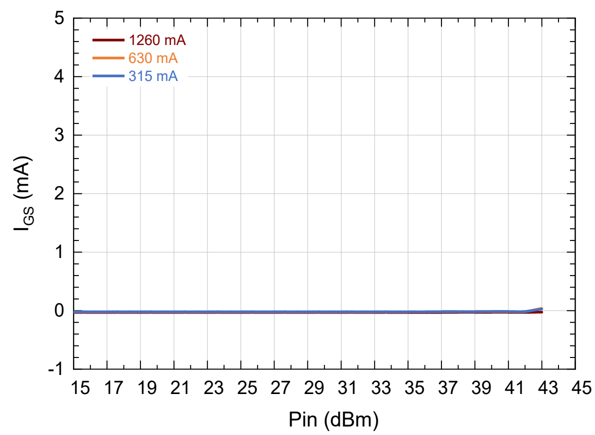
Drain Efficiency vs. I_{DQ} and Pin



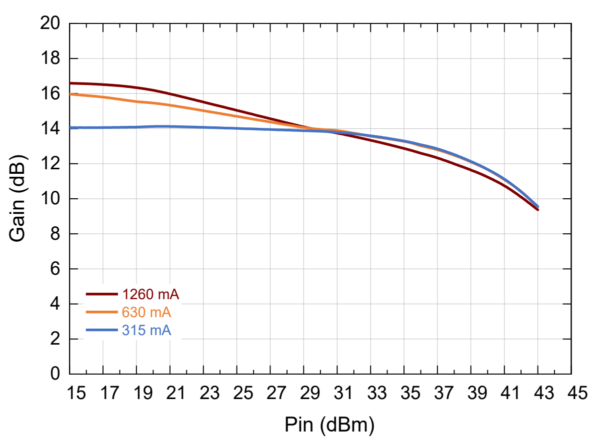
Drain Current vs. I_{DQ} and P_{IN}



Gate Current vs. I_{DQ} and P_{IN}



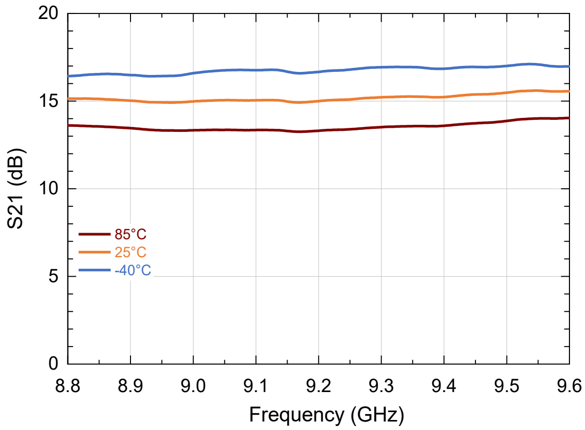
Large Signal Gain vs. I_{DQ} and P_{IN}



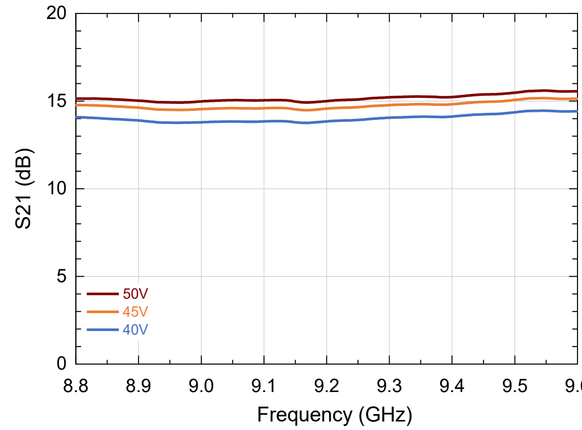
Typical Performance Curves as Measured in the Evaluation Test Fixture:

CW, V_{DS} = 50 V, I_{DQ} = 630 mA, P_{IN} = -20 dBm (Unless Otherwise Noted)

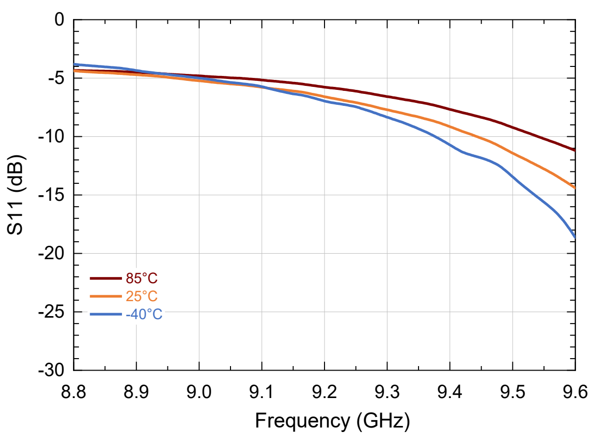
S21 vs Frequency and Temperature



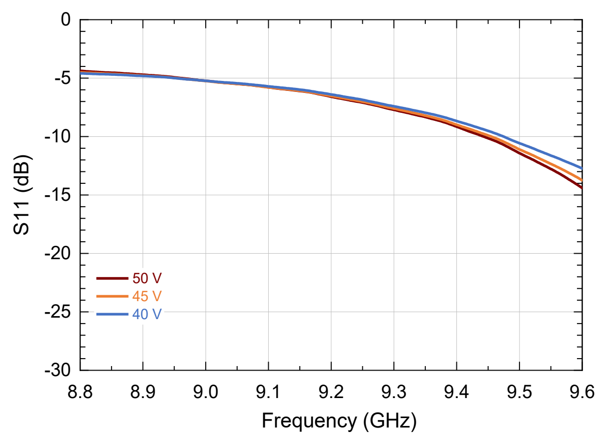
S21 vs Frequency and V_{DS}



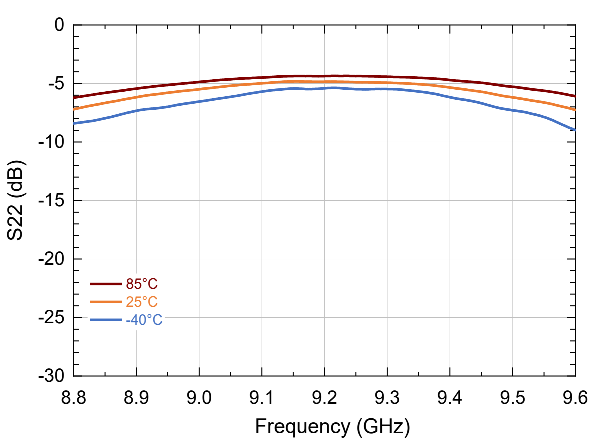
S11 vs Frequency and Temperature



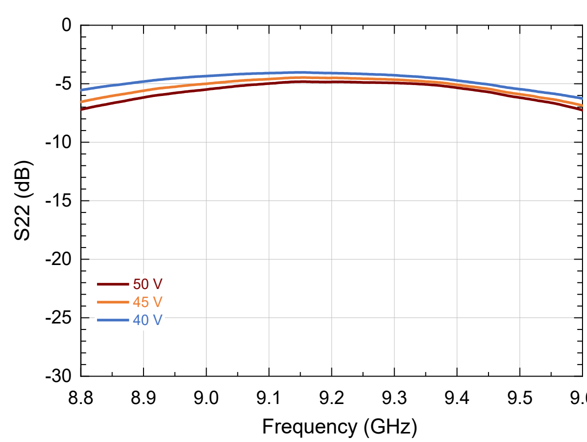
S11 vs Frequency and V_{DS}



S22 vs Frequency and Temperature

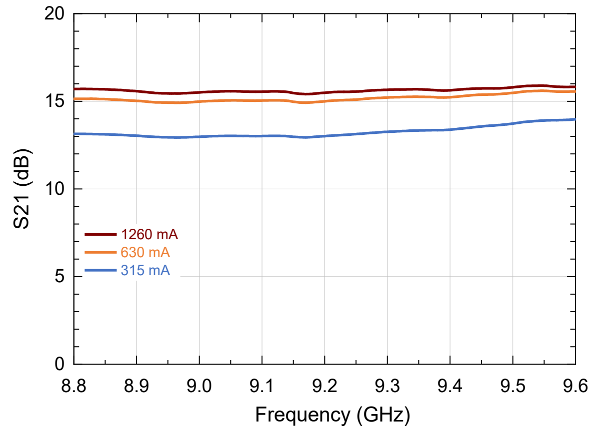


S22 vs Frequency and V_{DS}

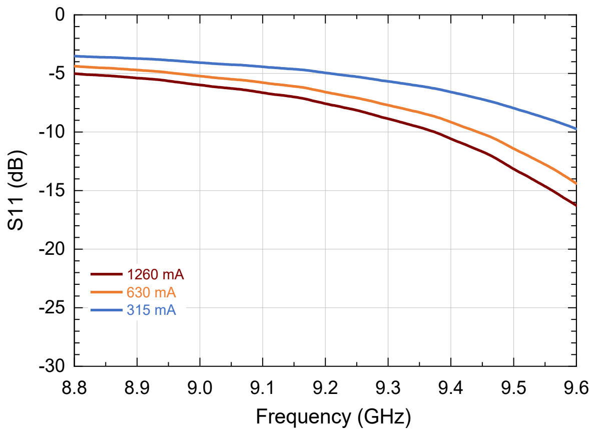


Typical Performance Curves as Measured in the Evaluation Test Fixture:
CW, V_{DS} = 50 V, I_{DQ} = 630 mA, P_{IN} = -20 dBm (Unless Otherwise Noted)

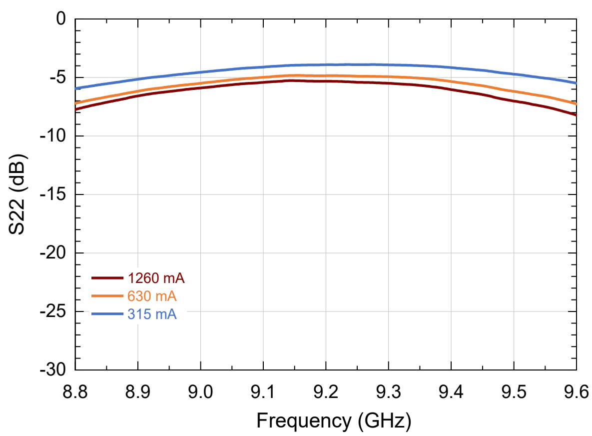
S21 vs Frequency and I_{DQ}



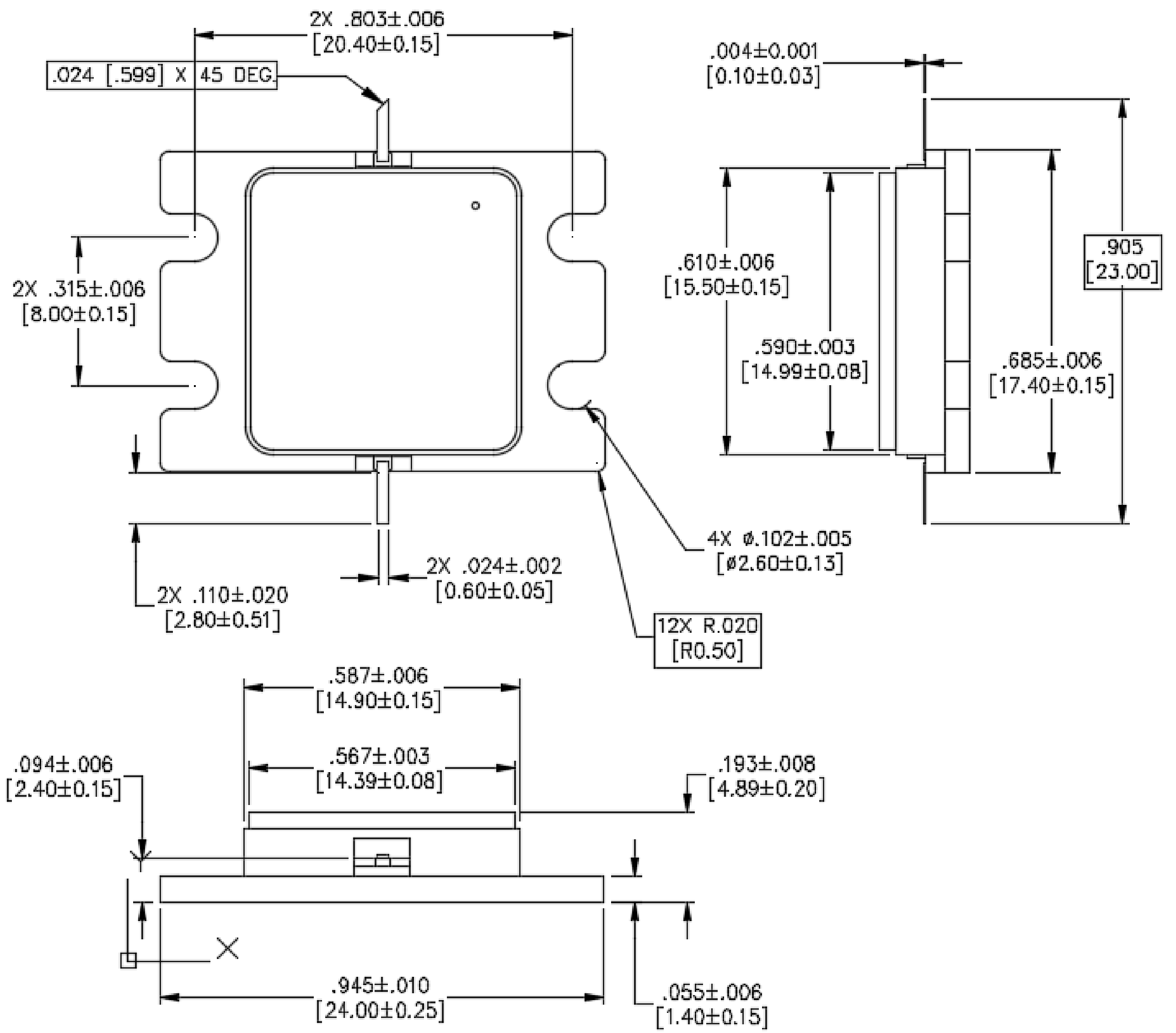
S11 vs Frequency and I_{DQ}



S22 vs Frequency and I_{DQ}



AC-587BH-2 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 AN-0004363 for lead-free solder reflow recommendations.
Moisture Sensitivity Level: Not Specified