GaN Amplifier 45 V, 250 W
8.8 - 9.6 GHz

MACOM PURE CARBIDE™

CGHV1A250F
Rev. V4

Features

- *MACOM PURE CARBIDE™* Amplifier Series
- Suitable for Linear & Saturated Applications
- Pulsed Operation: 250 W Output Power
- 45 V Operation
- 100% RF Tested
- RoHS* Compliant

440226

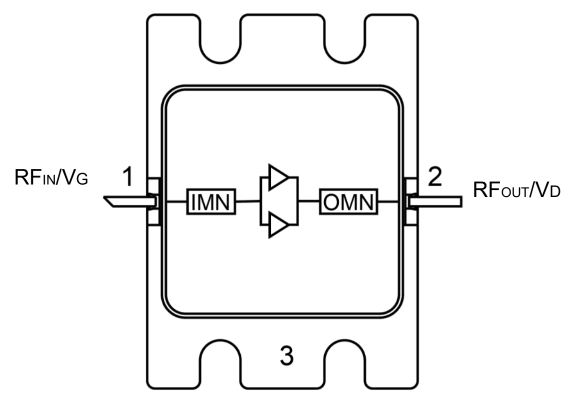
Applications

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

Description

The CGHV1A250F is a 250 W packaged amplifier fully matched to 50 Ω at both input and output ports. Utilizing the high performance, 45 V, 0.25 µm GaN on SiC production process, this device operates from 8.8 - 9.6 GHz and targets pulsed radar applications such a marine weather radar. This amplifier typically achieves 250 W of saturated output power with 12 dB of large signal gain and 41% drain efficiency under pulsed operation.

Functional Schematic



Typical Performance:

Measured in Evaluation Test Fixture[1]: P_{IN} = 43 dBm, 100 µs pulse width, 10% duty cycle.

- V_{DS} = 45 V, I_{DQ} = 1060 mA, T_C = 25°C

Frequency (GHz)	Output Power (dBm)	Gain (dB)	PAE (%)
8.8	55.0	12.0	39.0
9.3	55.0	12.0	41.0
9.6	54.5	11.5	39.0

1. Performance values and curves in this data sheet were measured in this fixture, de-embedded to the package lead reference planes.

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
CGHV1A250F	Bulk Quantity
CGHV1A250F-AMP	Sample Board

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

RF Electrical Specifications: T_A = 25°C, V_{DS} = 45 V, I_{DQ} = 1060 mA
Note: Performance in MACOM Evaluation Test Fixture[1], 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Output Power	Pulsed[3], P_{IN} = 43 dBm 8.8 GHz 9.3 GHz 9.6 GHz	P_{OUT}	—	55.0 55.0 54.5	—	dB
Power Added Efficiency	Pulsed[3], P_{IN} = 43 dBm 8.8 GHz 9.3 GHz 9.6 GHz	PAE	—	39 41 39	—	%
Large Signal Gain	Pulsed[3], P_{IN} = 43 dBm 8.8 GHz 9.3 GHz 9.6 GHz	G_P	—	12.0 12.0 11.5	—	dB
Small Signal Gain	CW, 8.8 - 9.6 GHz, P_{IN} = -20 dBm	S21	—	15.5	—	dBm
Input Reflection	CW, 8.8 - 9.6 GHz, P_{IN} = -20 dBm	S11	—	-8	—	dB
Output Reflection	CW, 8.8 - 9.6 GHz, P_{IN} = -20 dBm	S22	—	-7	—	dB
Ruggedness: Output Mismatch	Pulsed[3], All phase angles	Ψ	VSWR = 3:1, No Damage, Stable			

RF Electrical Specifications: T_A = 25°C, V_{DS} = 45 V, I_{DQ} = 1060 mA
Note: Performance in MACOM Production Test Fixture[1], 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Output Power	Pulsed[3], P_{IN} = 43 dBm 8.8 GHz 9.3 GHz 9.6 GHz	P_{OUT}	53.5 52.9 52.8	55.0 54.4 54.0	—	dB
Power Added Efficiency	Pulsed[3], P_{IN} = 43 dBm 8.8 GHz 9.3 GHz 9.6 GHz	PAE	31 33 28	44 40 34	—	%
Small Signal Gain	CW, 8.8 - 9.6 GHz, P_{IN} = -20 dBm	S21	11.8	14.0	—	dBm
Input Reflection	CW, 8.8 - 9.6 GHz, P_{IN} = -20 dBm	S11	—	-8.3	-4	dB
Output Reflection	CW, 8.8 - 9.6 GHz, P_{IN} = -20 dBm	S22	—	-7.7	-4	dB

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} = 150 V	I_{DLK}	-	-	16.9	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 10 V	I_{GLK}	-	-	5.9	mA
Gate Threshold Voltage	V_{DS} = 10 V, I_D = 42.2 mA	V_T	-3.5	-2.6	-1.9	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 1060 mA	V_{GSQ}	-	-2.4	-	V

Absolute Maximum Ratings[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	42 mA
Input Power, P_{IN}	46 dBm
DC Drain Current	14 A
Pulse Width	100 µs
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
Channel Temperature	+275°C

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation above maximum operating conditions.
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} ≤ 275°C will ensure MTTF > 2 x 10^6 hours.

Thermal Characteristics

Parameter	Test Conditions	Typical
Thermal Resistance using Finite Element Analysis ($R_θ$(FEA))	T_C = 85°C, T_{CH} = 275°C, P_{DISS} = 452 W, 100 µs 10%	0.42°C/W

Handling Procedures

Please observe the following precautions to avoid damage:

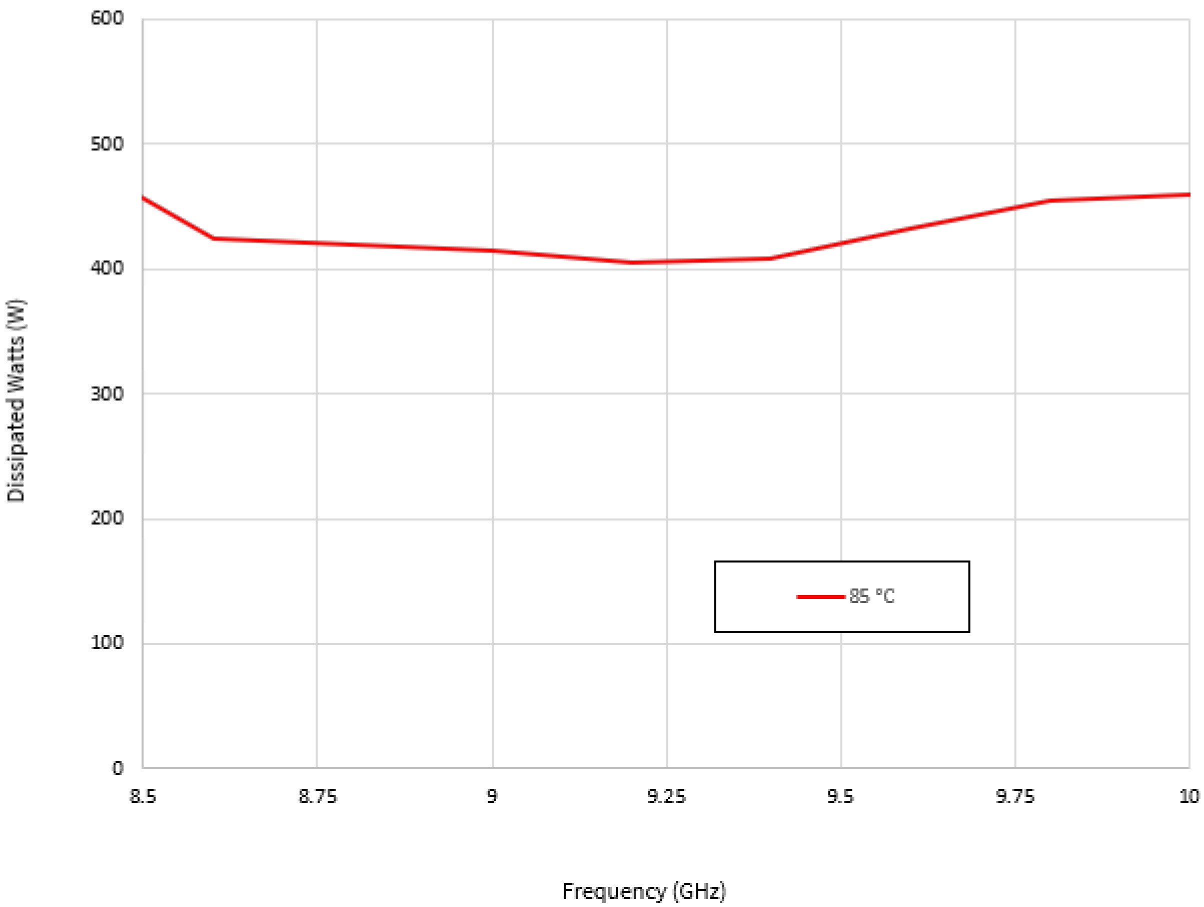
Static Sensitivity

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.

Thermal Characteristics

Parameter	Test Conditions	Typical
Operating Junction Temperature (T_J)	Freq. = 9.5 GHz, V_D = 45 V, I_{DQ} = 1060 mA, I_{DRIVE} = 14.4 A, P_{IN} = 43 dBm, P_{OUT} = 53.85 dBm, P_{DISS} = 423 W T_C = 85°C, PW = 100 µs, DC = 10%	263°C
Thermal Resistance, Junction to Case ($R_{\theta JC}$)		0.42°C/W

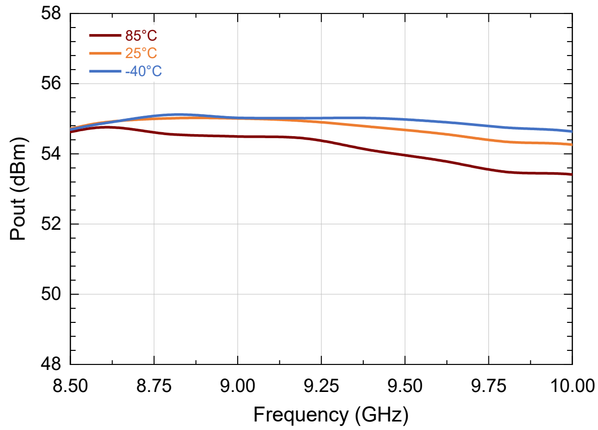
Power Dissipation v. Frequency (Tcase = 85°C)



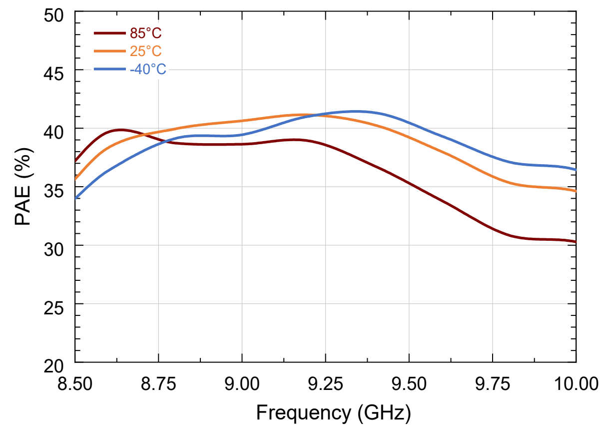
Typical Performance Curves as Measured in the Evaluation Test Fixture:

Pulsed 100 µs 10%, V_{DS} = 45 V, I_{DQ} = 1060 mA, P_{IN} = 43 dBm (Unless Otherwise Noted)
For Engineering Evaluation Only - This data does not Modify MACOM's Datasheet Limits.

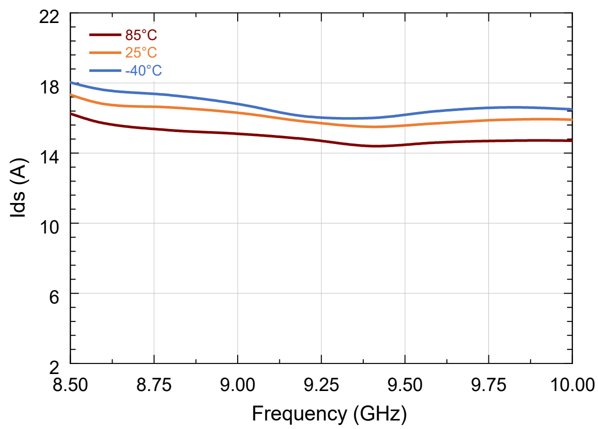
Output Power vs. Temperature and Frequency



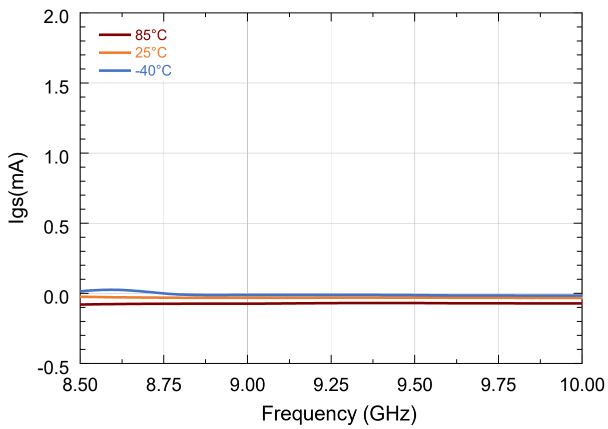
PAE vs. Temperature and Frequency



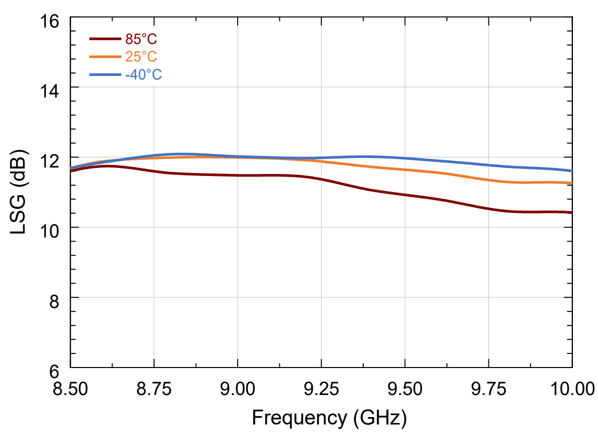
Drain Current vs. Temperature and Frequency



Gate Current vs. Temperature and Frequency



Large Signal Gain vs. Temperature and Frequency



Typical Performance Curves as Measured in the Evaluation Test Fixture:

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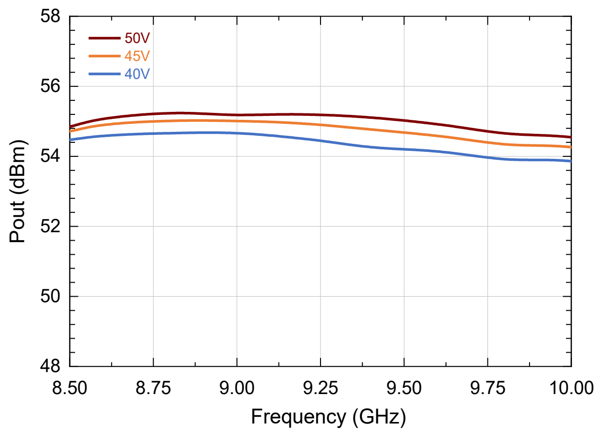
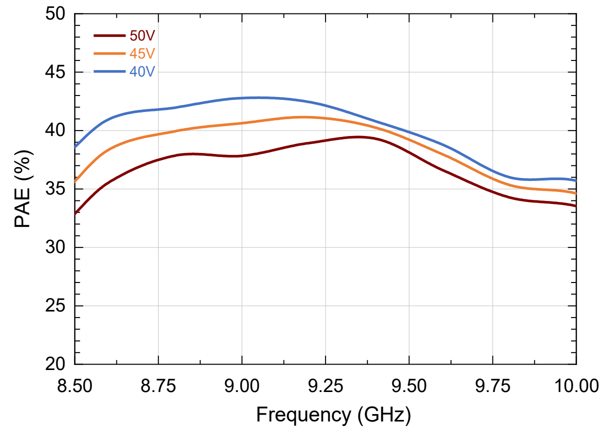
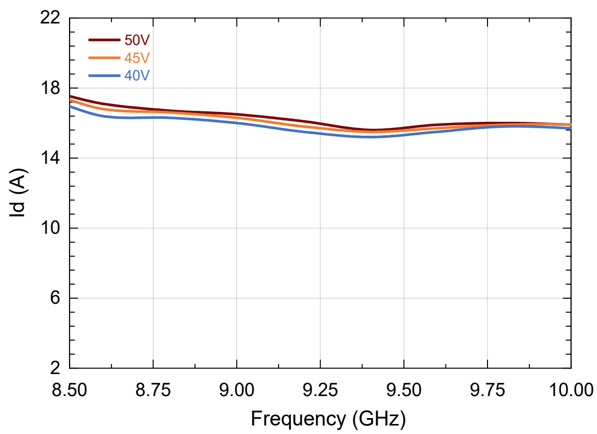
Output Power vs. V_{DS} and Frequency



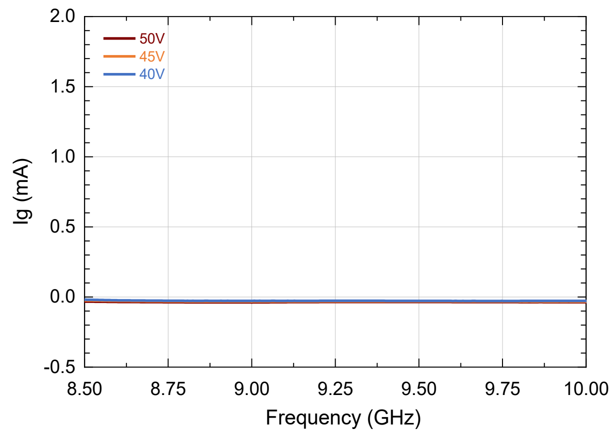
PAE vs. V_{DS} and Frequency



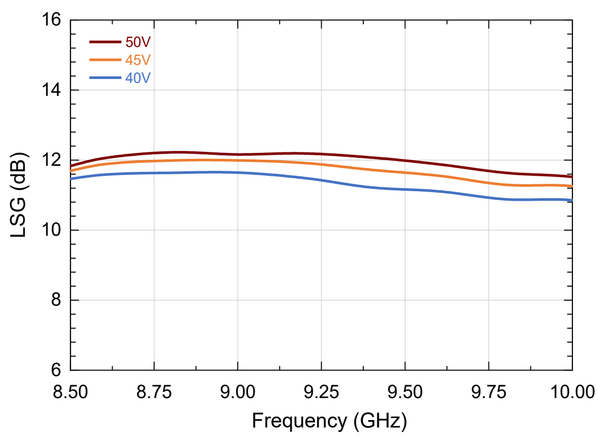
Drain Current vs. V_{DS} and Frequency



Gate Current vs. V_{DS} and Frequency



Large Signal Gain vs. V_{DS} and Frequency



Typical Performance Curves as Measured in the Evaluation Test Fixture:

Pulsed 100 µs 10%, V_{DS} = 45 V, I_{DQ} = 1060 mA, P_{IN} = 43 dBm (Unless Otherwise Noted)
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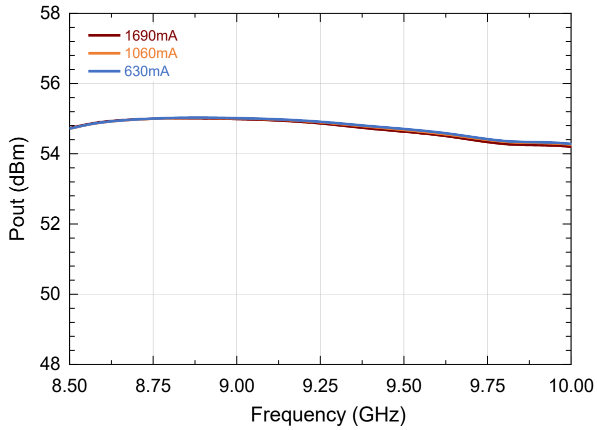
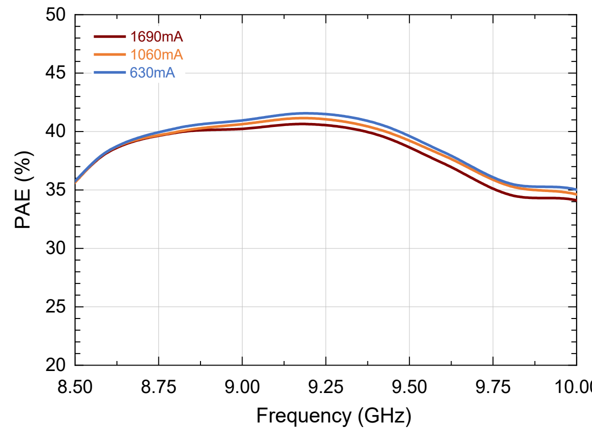
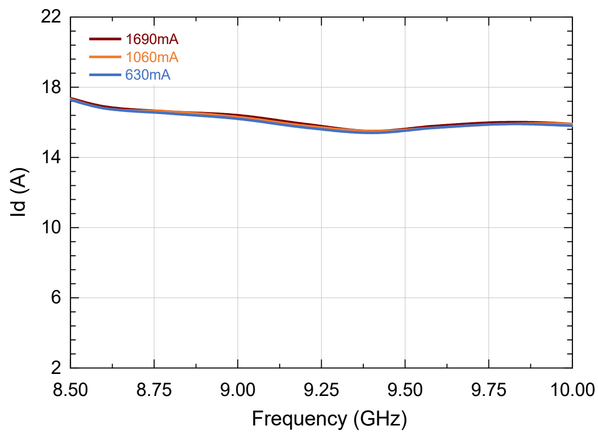
Output Power vs. I_{DQ} and Frequency



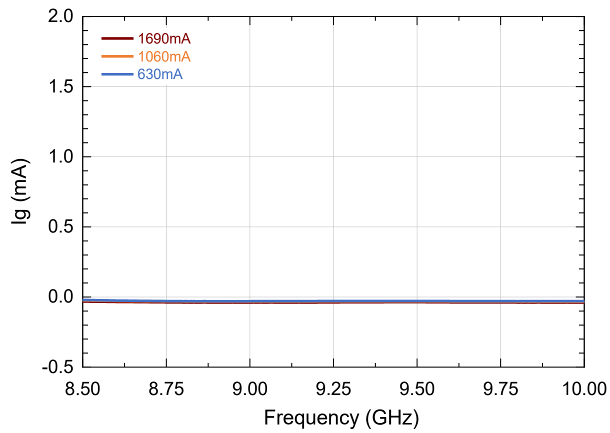
PAE vs. I_{DQ} and Frequency



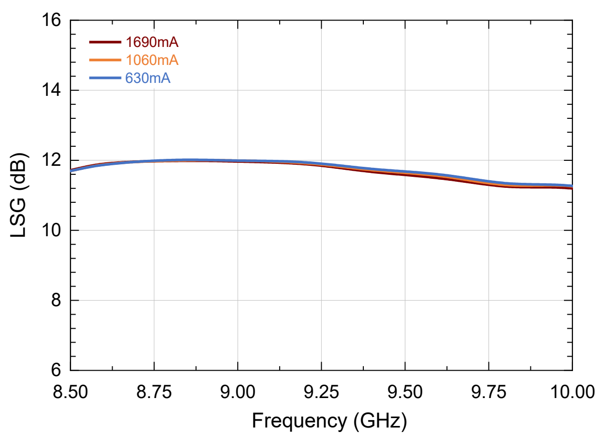
Drain Current vs. I_{DQ} and Frequency



Gate Current vs. I_{DQ} and Frequency



Large Signal Gain vs. I_{DQ} and Frequency



Typical Performance Curves as Measured in the Evaluation Test Fixture:
Pulsed 100 µs 10%, V_{DS} = 45 V, I_{DQ} = 1060 mA (Unless Otherwise Noted)
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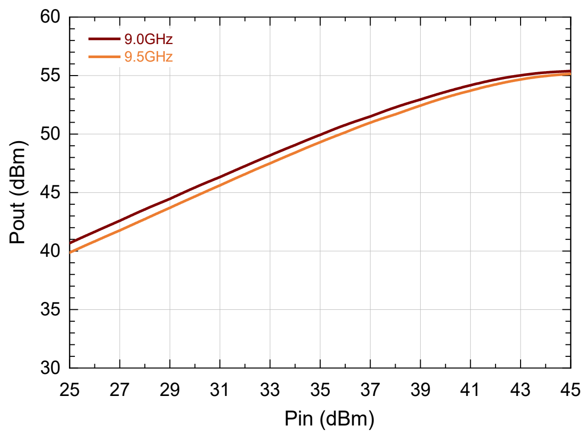
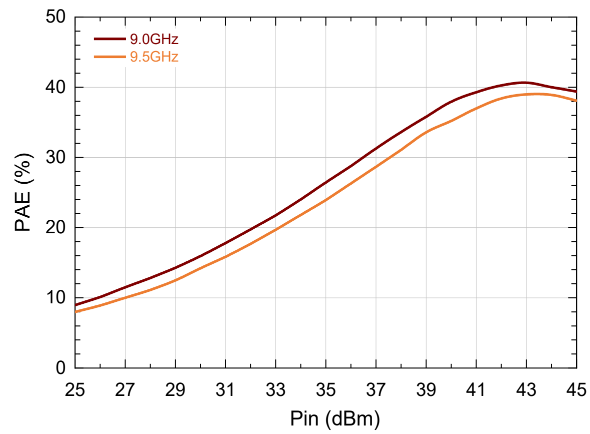
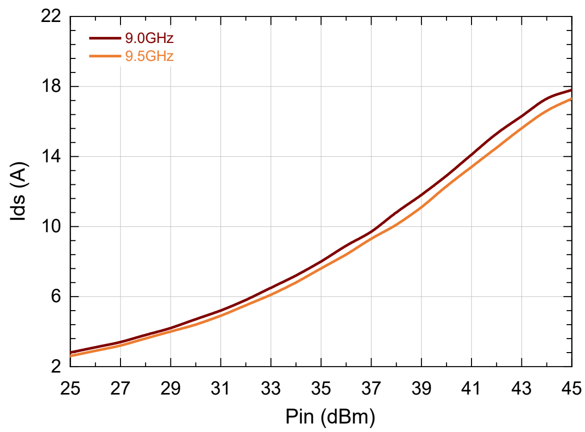
Output Power vs. Frequency and P_{IN}



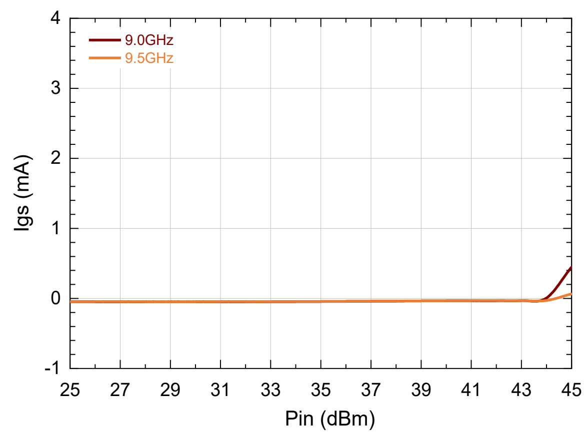
PAE vs. Frequency and P_{IN}



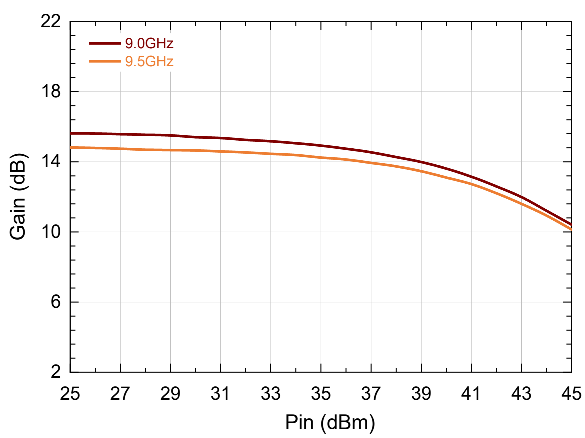
Drain Current vs. Frequency and P_{IN}



Gate Current vs. Frequency and P_{IN}



Large Signal Gain vs. Frequency and P_{IN}



Typical Performance Curves as Measured in the Evaluation Test Fixture:

Pulsed 100 µs 10%, V_{DS} = 45 V, I_{DQ} = 1060 mA, Freq. = 9.5 GHz (Unless Otherwise Noted)
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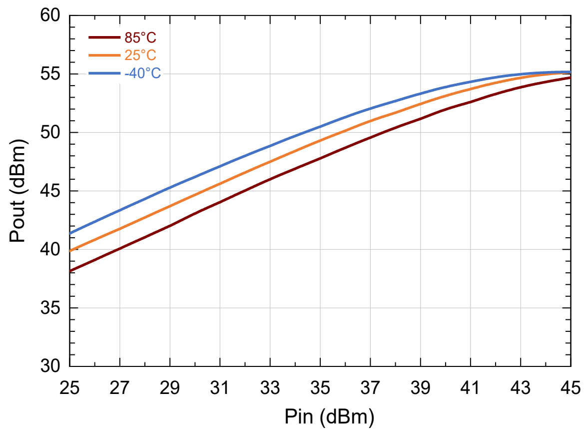
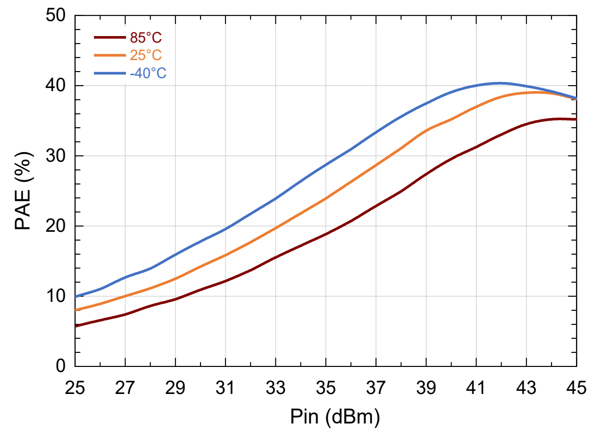
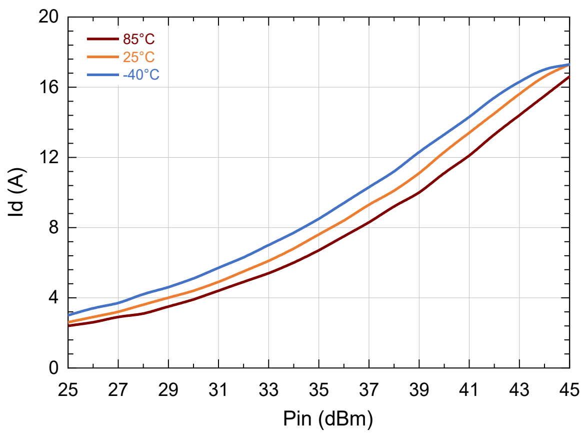
Output Power vs. Temperature and P_{IN}



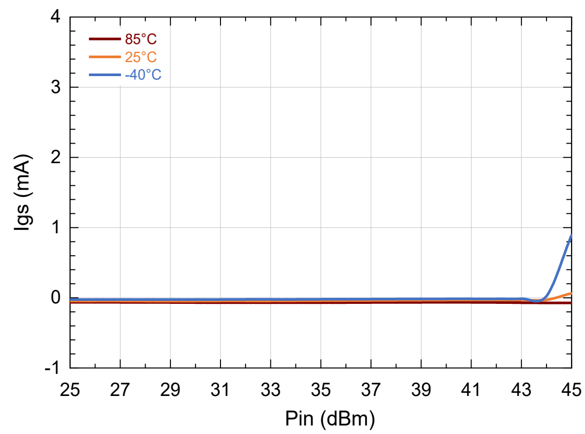
PAE vs. Temperature and P_{IN}



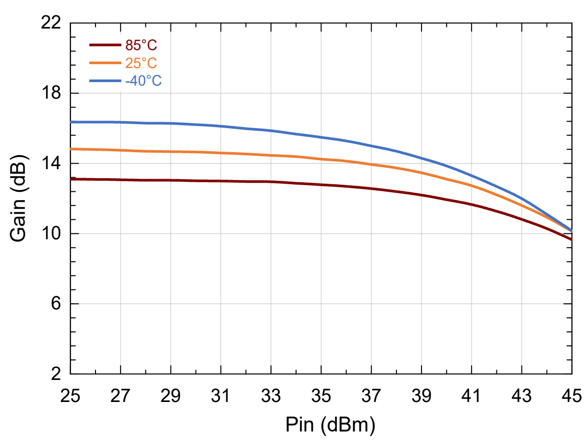
Drain Current vs. Temperature and P_{IN}



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:
Pulsed 100 µs 10%, I_{DQ} = 1060 mA, Freq. = 9.5 GHz, T_C = 25°C (Unless Otherwise Noted)
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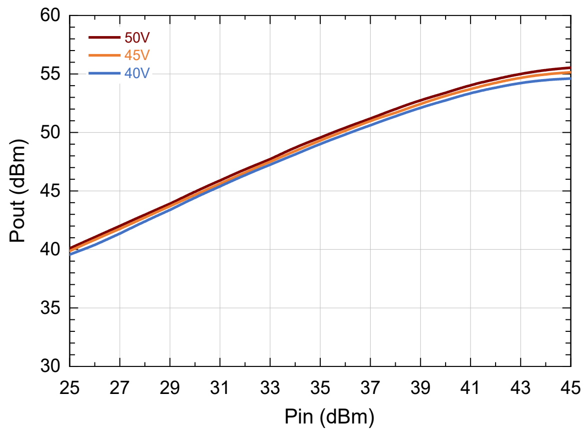
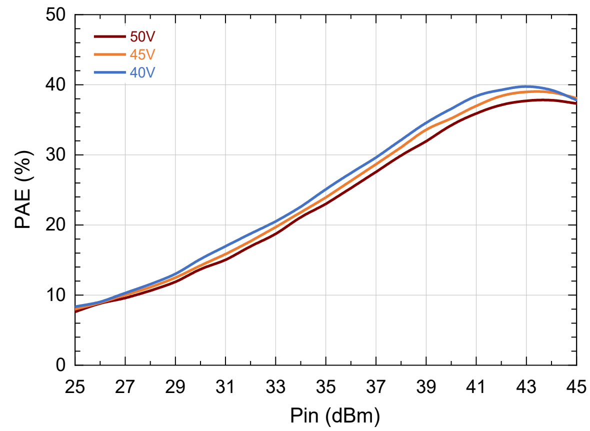
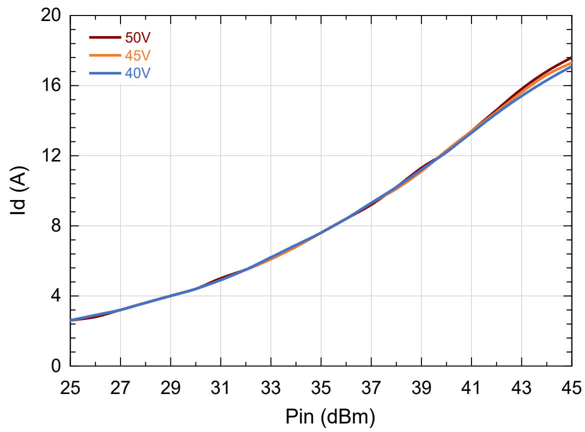
Output Power vs. V_{DS} and P_{IN}



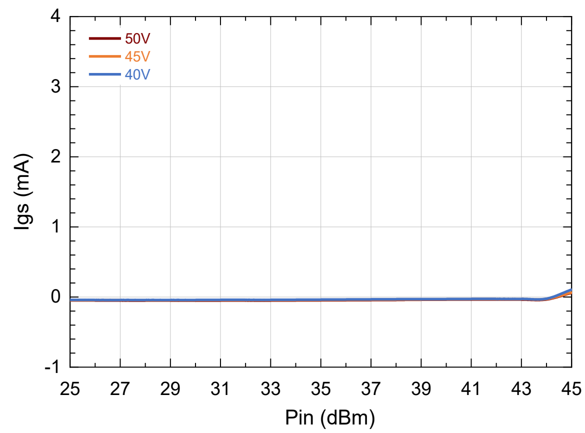
PAE vs. V_{DS} and P_{IN}



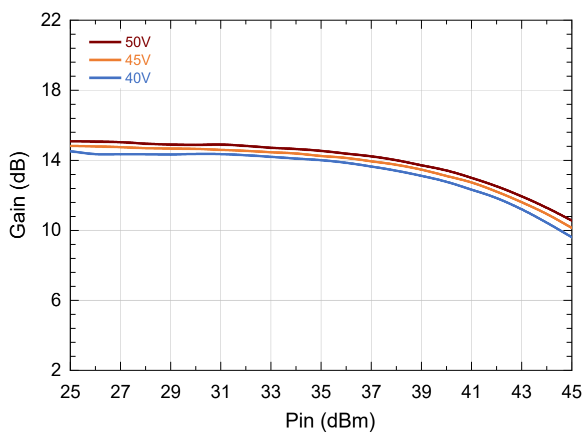
Drain Current vs. V_{DS} and P_{IN}



Gate Current vs. V_{DS} and P_{IN}



Large Signal Gain vs. V_{DS} and P_{IN}



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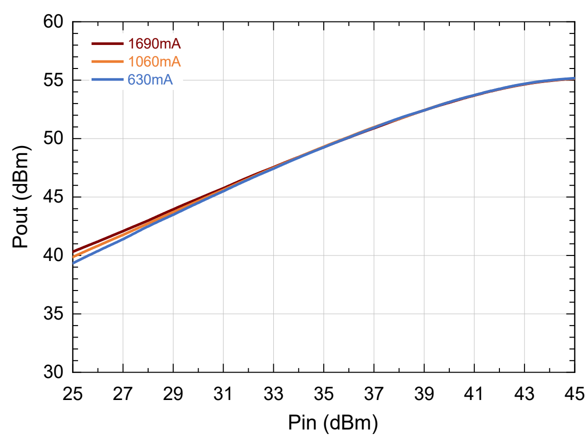
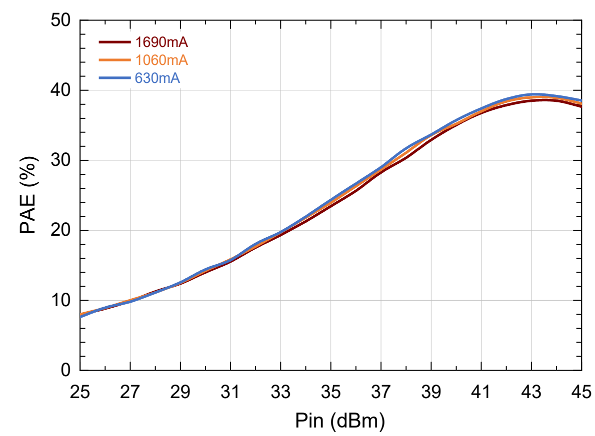
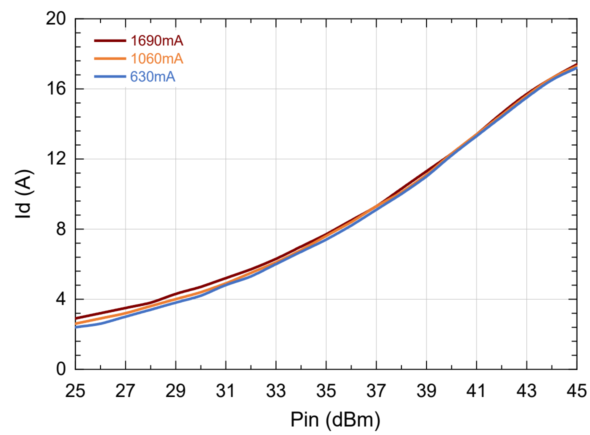
Output Power vs. I_{DQ} and P_{IN}



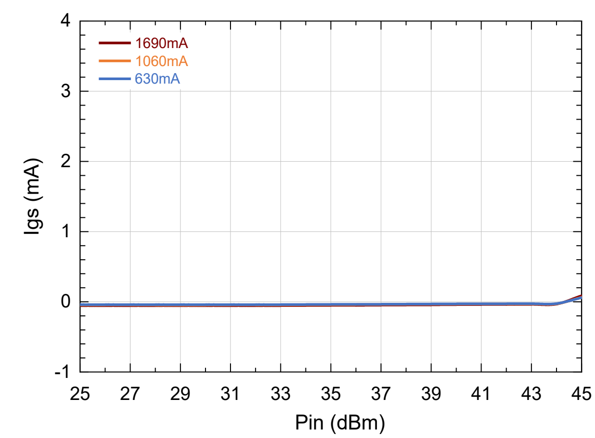
PAE vs. I_{DQ} and P_{IN}



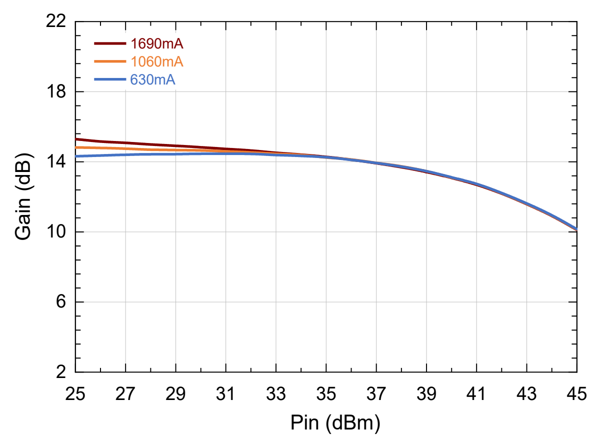
Drain Current vs. I_{DQ} and P_{IN}



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



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



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CW, V_{DS} = 45 V, I_{DQ} = 1060 mA, P_{IN} = -20 dBm (Unless Otherwise Noted)
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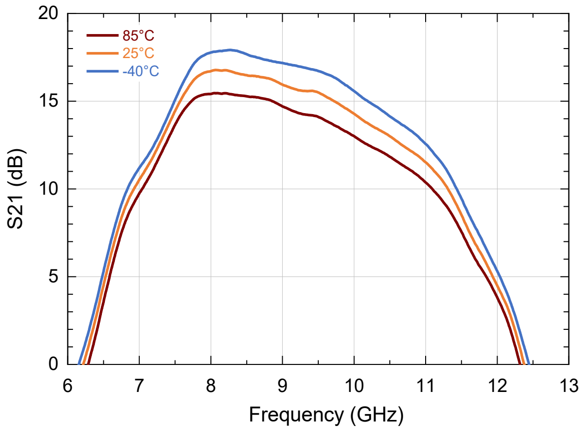
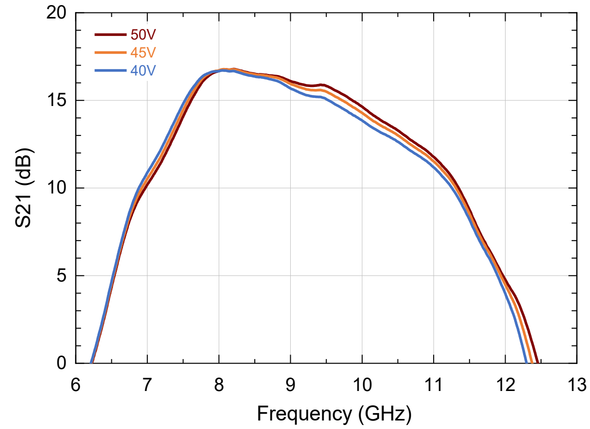
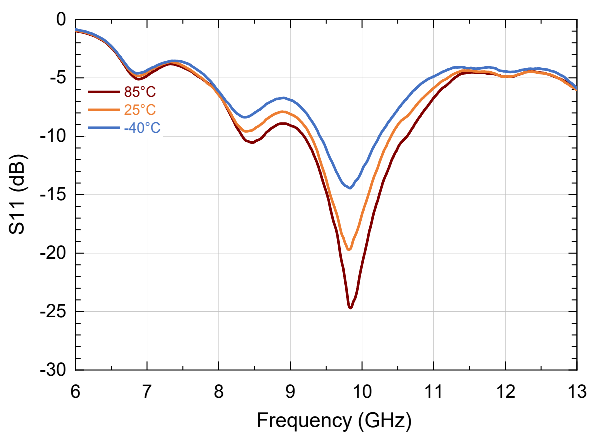
S21 vs Frequency and Temperature



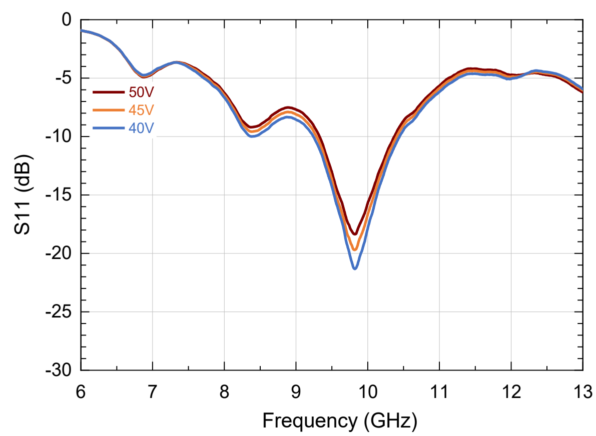
S21 vs Frequency and V_{DS}



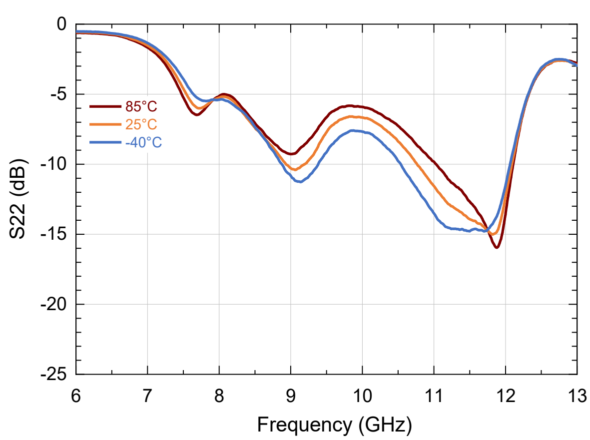
S11 vs Frequency and Temperature



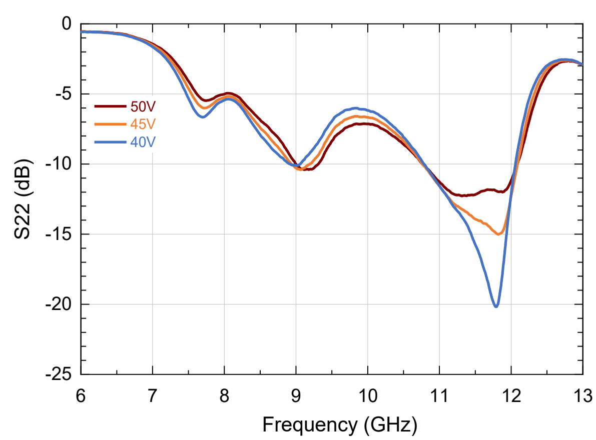
S11 vs Frequency and V_{DS}



S22 vs Frequency and Temperature



S22 vs Frequency and V_{DS}



Typical Performance Curves as Measured in the Evaluation Test Fixture:
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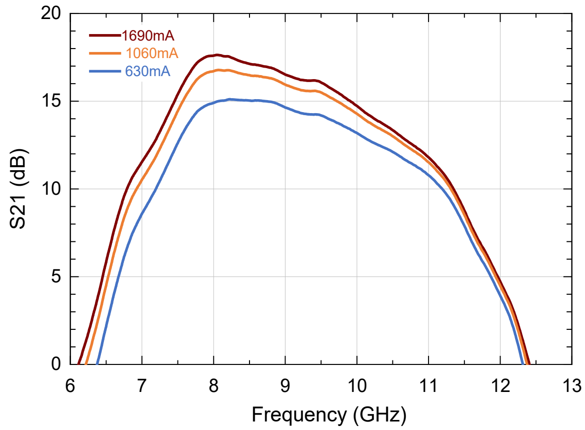
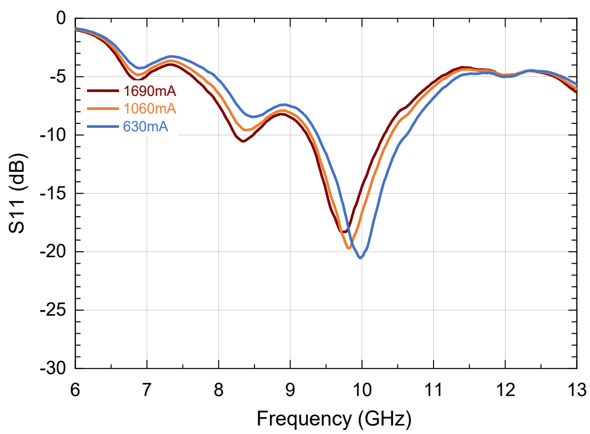
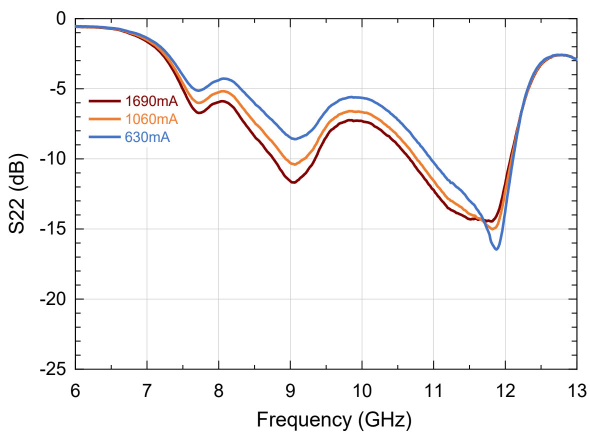
S21 vs Frequency and I_{DQ}



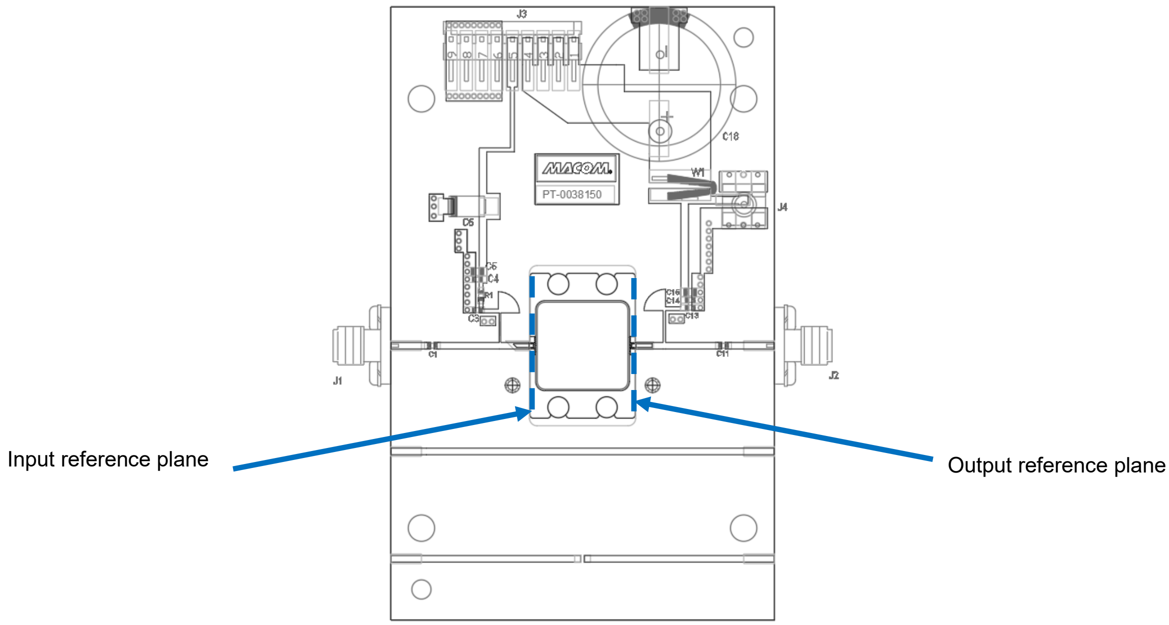
S11 vs Frequency and I_{DQ}



S22 vs Frequency and I_{DQ}

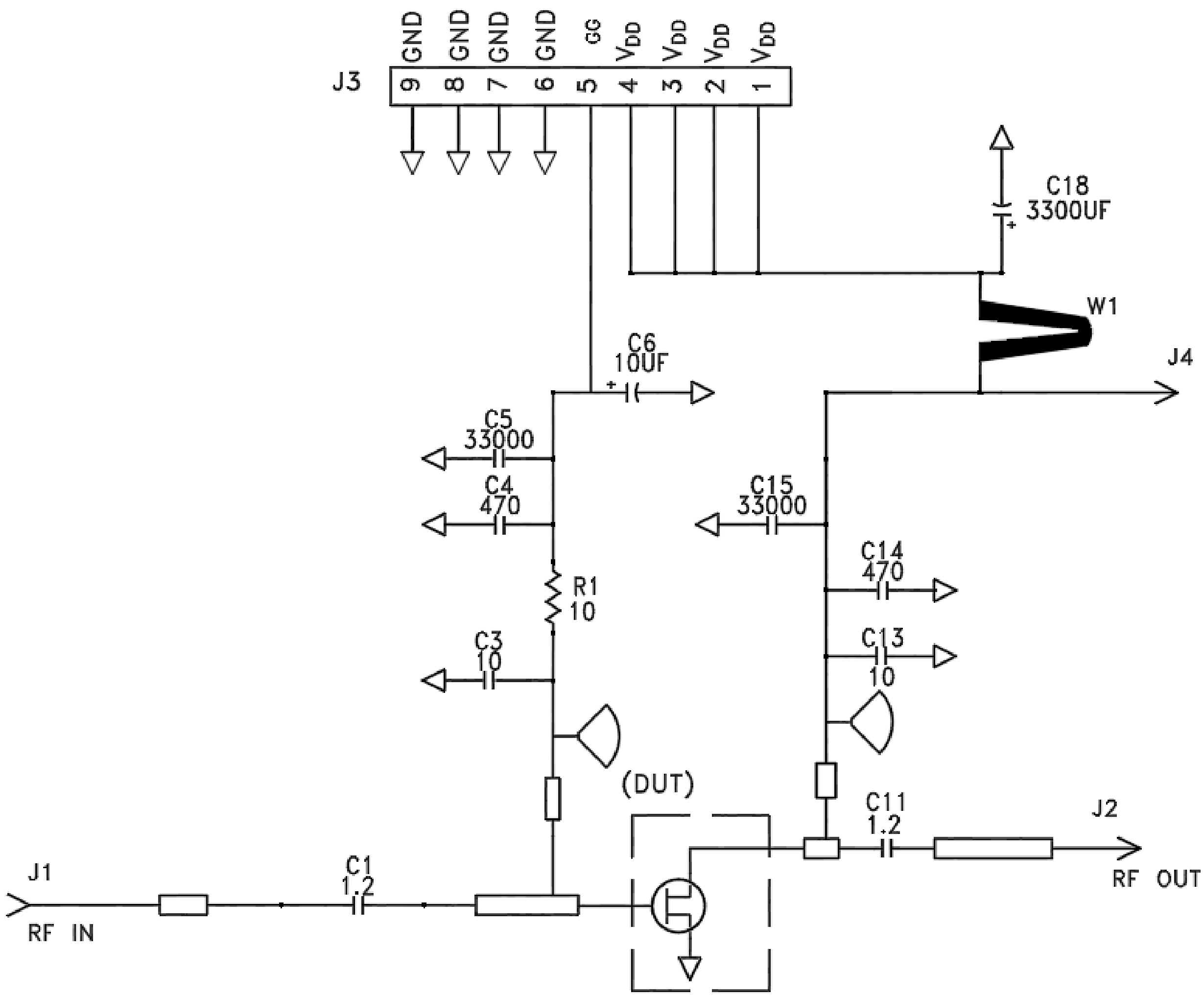


Evaluation Test Fixture[1] and Recommended Tuning Solution



Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	1.2 pF	0.1pF	Kyocera/AVX	ATC600S1R2BW250XT
C3,C13	10 pF	0.1pF	Kyocera/AVX	ATC600S100FW250XT
C11	1.2 pF	0.1pF	Kyocera/AVX	ATC600S1R2BW250XT
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			CGHV1A250F
PCB	RO6035-HTC, 20 mil, 1 oz. Cu, Au Finish			

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 previous page.

Bias Sequencing

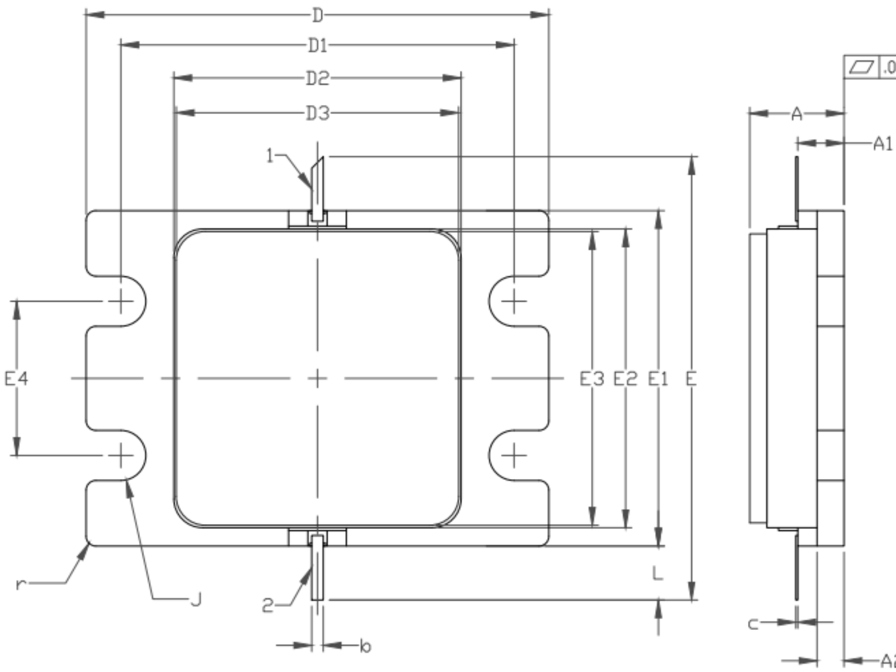
Turning the device ON

1. Set V_{GS} to pinch-off (V_P, typ. -5 V).
2. Turn on V_{DS} to nominal voltage (45 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 (typ. -5 V).
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}.

Lead-Free 440226 Package Dimensions†



DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	NOTES
A	0.185	0.201	4.70	5.11	
A1	0.088	0.100	2.24	2.54	2x
A2	0.049	0.061	1.24	1.55	
b	0.022	0.026	0.56	0.66	2x
c	0.003	0.006	0.08	0.15	
D	0.935	0.955	23.75	24.26	
D1	0.797	0.809	20.24	20.55	2x
D2	0.581	0.593	14.76	15.06	
D3	0.575	0.581	14.61	14.76	
E	0.906		23.01		REF
E1	0.679	0.691	17.25	17.55	
E2	0.604	0.616	15.34	15.65	
E3	0.598	0.604	15.19	15.34	
E4	0.309	0.321	7.85	8.15	2x
J	ø0.097	ø0.107	ø2.46	ø2.72	4x
L	0.090	0.130	2.29	3.30	2x
r	0.02 TYP		0.51 TYP		12x

† Reference Application Note AN-0004363 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Au.