GaN Amplifier 50 V, 500 W
2.7 - 3.1 GHz

MACOM PURE CARBIDE

CGHV31500F1
Rev. V1

Features

- Saturated Power: 500 W
- Large Signal Gain: 11 dB
- Drain Efficiency: 60%
- Internally Matched: 50 Ω
- High Temperature Operation
- RoHS* Compliant
- Long Pulse Operation

Applications

- General Amplification
- RADAR

Description

The CGHV31500F1 is a packaged amplifier fully matched to 50 ohms at both input and output ports. Utilizing the high performance, 50 V, 0.4 µm GaN on SiC process. This device operates from 2.7 to 3.1 GHz and supports both defense and commercial-related S-band radar applications.

The CGHV31500F1 achieves 500 W of saturated output power with 11 dB of large signal gain and 60 % drain efficiency under long pulse operation.

Packaged in a thermally-enhanced, flange package, the CGHV31500F1 provides superior performance under long pulse operation allowing customers to improve SWaP-C benchmarks in their next-generation systems.

Typical RF Performance:

Measured in Evaluation Test Fixture[1] at P_{IN} = 46 dBm, 2 msec pulse width and 20% Duty Cycle.

- V_{DS} = 50 V, I_{DQ} = 500 mA, T_C = 25°C

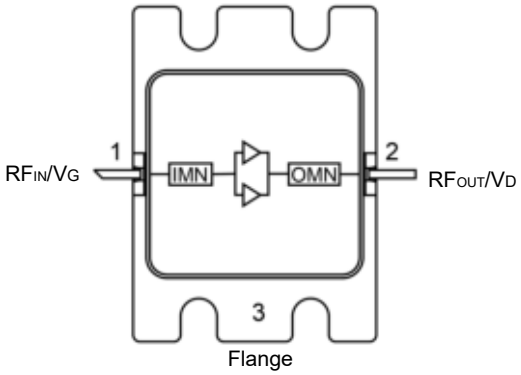
Frequency (GHz)	Output[1] Power (dBm)	Power[1] Gain (dB)	η_D[1] (%)	S_{21}[2] (dB)
2.7	57.0	11.0	65.1	16.2
2.9	57.5	11.7	60.9	15.4
3.1	56.6	10.7	57.6	12.5

1. Performance values and curves in this data sheet were measured in this fixture, de-embedded to the package lead reference planes.
2. Measured @ P_{IN} = -20 dBm.



440226

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	MOQ Increment
CGHV31500F1	Bulk
CGHV31500F1-AMP	Sample Board

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

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RF Electrical Specifications[4]: T_A = +25°C, V_{DS} = 50 V, I_{DQ} = 500 mA

Parameter	Conditions	Units	Min.	Typ.	Max.
Output Power	P_{IN} = 46 dBm Pulse Width = 2000 µs, Duty Cycle = 20% 2.7 GHz 2.9 GHz 3.1 GHz	dBm	 56.7 57.6 56.7	 57.5 58.5 57.9	—
Drain Efficiency	P_{IN} = 46 dBm Pulse Width = 2000 µs, Duty Cycle = 20% 2.7 GHz 2.9 GHz 3.1 GHz	%	 58 64 52	 66.6 72.1 63.2	—
Small Signal Gain (S21)	—	dB	10	13.4	—
Input Return Loss (S11)	—	dB	—	-10.6	-4
Output Return Loss (S22)	—	dB	—	-5.9	-3

4. Final testing and screening for all amplifier sales is performed using the CGHV31500F-AMP

Absolute Maximum Ratings[5,6]

Parameter	Absolute Maximum
Drain-Source Voltage	150 V
Gate Voltage	-10, +2 V
Drain Current	24 A
Gate Current	80 mA
Input Power	48 dBm
Storage Temperature	-55°C to +150°C
Mounting Temperature[7]	+320°C
Junction Temperature[8,9]	+225°C
Operating Temperature	-40°C to +85°C

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Mounting temperature for 30 seconds.
8. Operating at nominal conditions with $T_J \leq$ +225 °C will ensure MTTF > 1 x 10^6 hours.
9. Junction Temperature (T_J) = T_C + Θjc * (V * I)
   Typical thermal resistance (Θjc) = 0.4 °C/W for CW.
   a) For T_C = +25°C,
   T_J = 189 °C @ P_{DISS} = 409 W
   b) For T_C = +55°C,
   T_J = 224 °C @ P_{DISS} = 422 W

Handling Procedures

Please observe the following precautions to avoid damage:

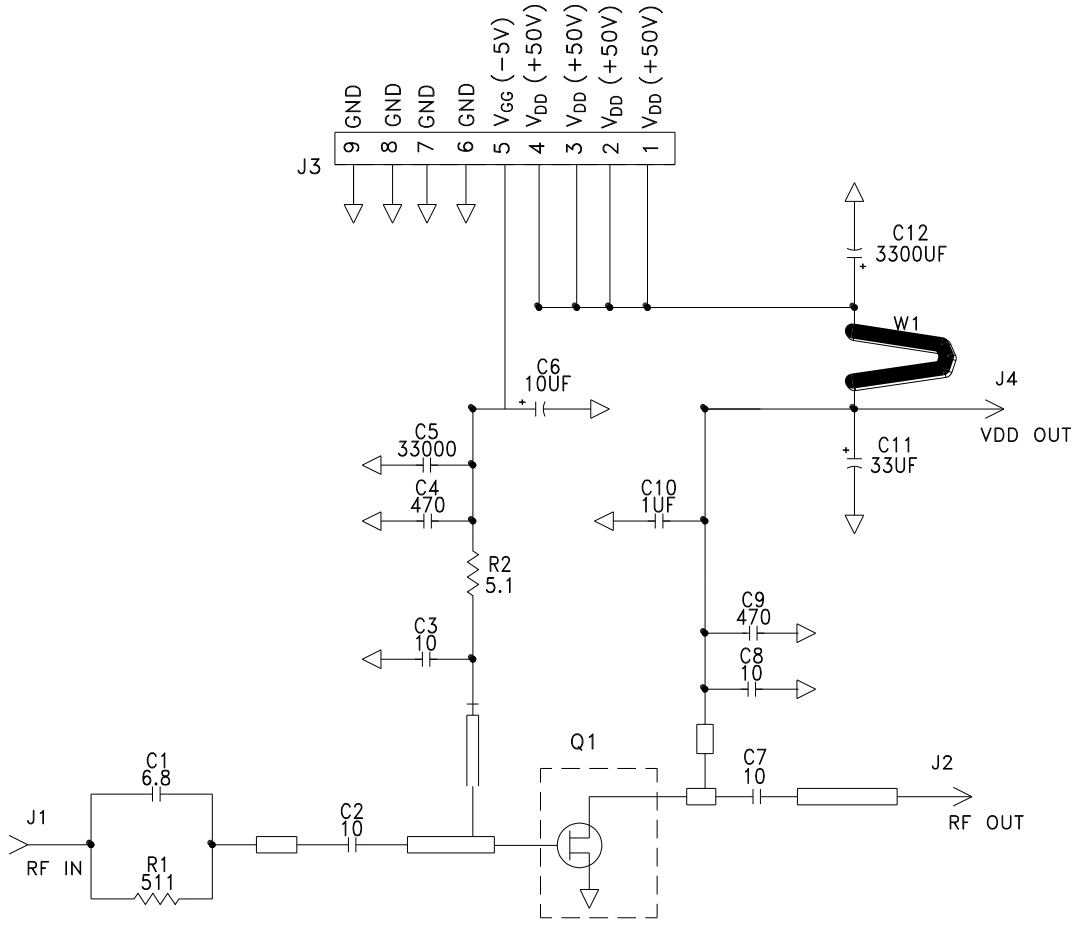
Static Sensitivity

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

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Evaluation Test Fixture and Recommended Tuning Solution, 2.7 - 3.1 GHz



Parts measured on evaluation board (30-mil thick RO4350). 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.

Biasing Sequence

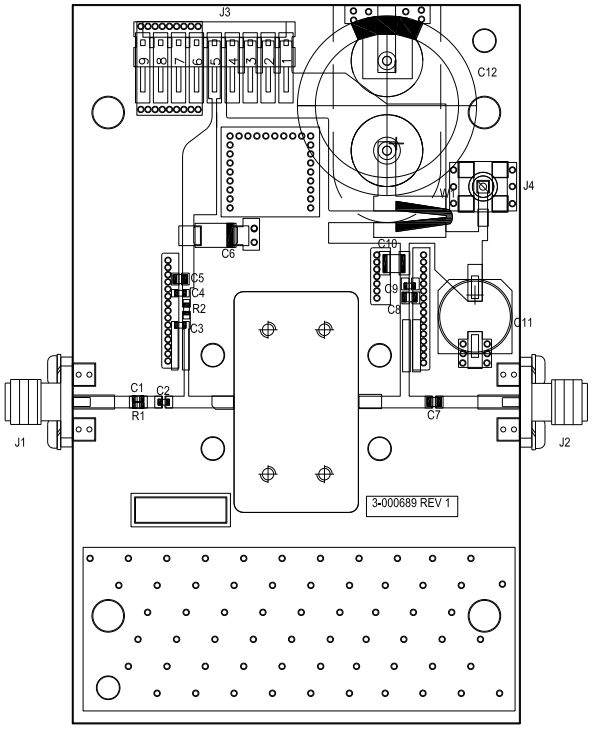
Bias ON
1. Ensure RF is turned off
2. Apply pinch-off voltage of -5 V to the gate
3. Apply nominal drain voltage
4. Bias gate to desired quiescent drain current
5. Apply RF

Bias OFF
1. Turn RF off
2. Apply pinch-off voltage of -5 V to the gate
3. Turn-off drain voltage
4. Turn-off gate voltage

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Evaluation Test Fixture and Recommended Tuning Solution, 2.7 - 3.1 GHz



Assembly Parts List

Reference Designator	Description	Qty
R1	RES, 511 Ω, +/- 1%, 1/16W, 0603	1
R2	RES, 5.1 Ω, +/- 1%, 1/16W, 0603	1
C1	CAP, 6.8 pF, +/-0.25%, 250V, 0603	1
C2, C7, C8	CAP, 10 pF, +/-1%, 250V, 0805	3
C3	CAP, 10 pF, +/-5%, 250V, 0603	1
C4, C9	CAP, 470 pF, 5%, 100V, 0603, X	2
C5	CAP, 33000 pF, 0805, 100V, X7R	1
C6	CAP, 10 µF 16V TANTALUM	1
C10	CAP, 1 µF, 100V, 10%, X7R, 1210	1
C11	CAP, 33 µF, 20%, G CASE	1
C12	CAP, 3300 µF, +/-20%, 100V, ELECTROLYTIC	1
J1, J2	CONN, SMA, PANEL MOUNT JACK, FL	2
J3	HEADER, RT>PLZ, 0.1CEN LK 9POS	1
J4	CONNECTOR; SMB, Straight, JACK, SMD	1
W1	CABLE, 18 AWG, 4.2	1
—	PCB, RO4350, 2.5 X 4.0 X 0.030	1
Q1	CGHV31500F1	1

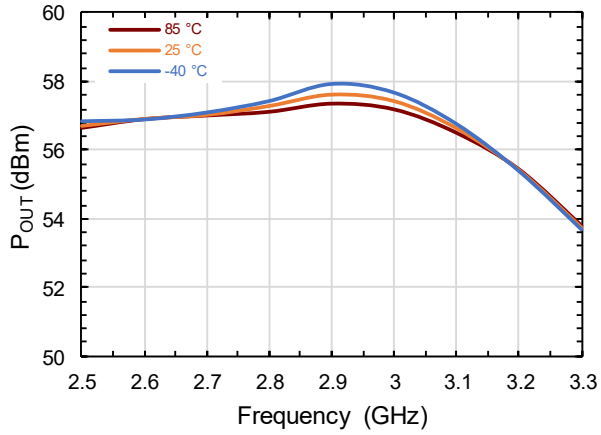
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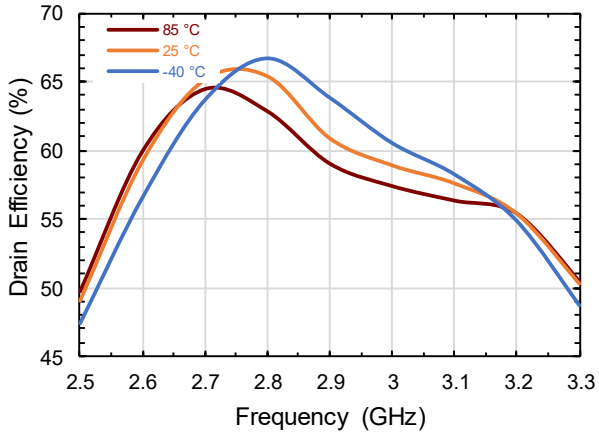
Typical Performance Curves as Measured in the 2.7– 3.1 GHz Evaluation Test Fixture

Pulsed 2000 µs 20%, P_{IN} = 46 dBm, V_{DS} = 50V, I_{DQ} = 500 mA, Frequency=2.9 GHz (Unless otherwise noted)
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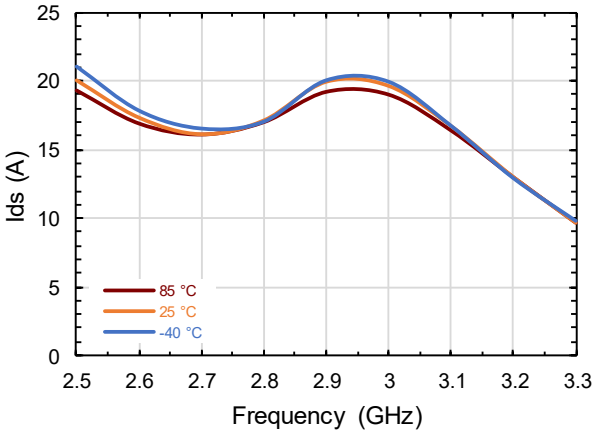
Output Power vs. Temperature and Frequency



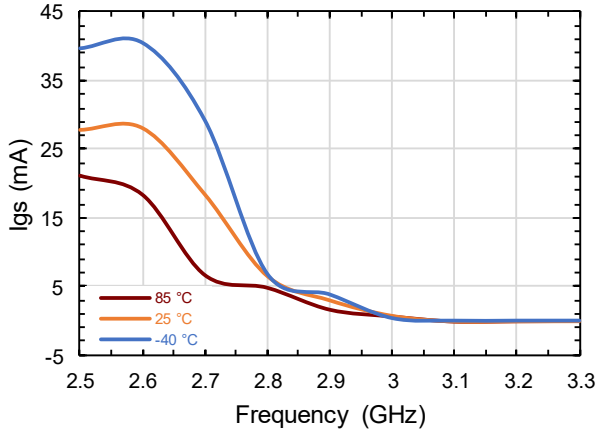
Drain Efficiency vs. Temperature and Frequency



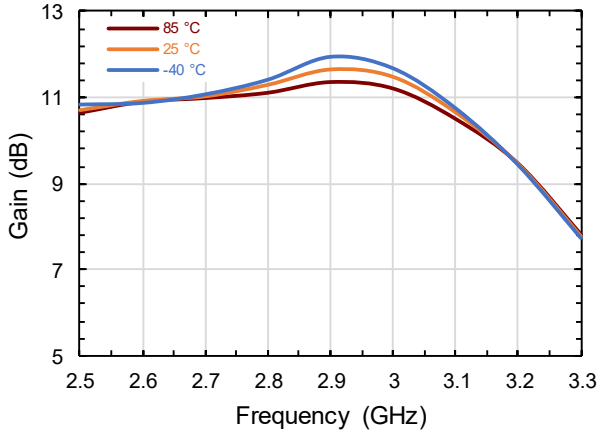
Drain Current vs. Temperature and Frequency



Gate Current vs. Temperature and Frequency



Large Signal Gain vs. Temperature and Frequency



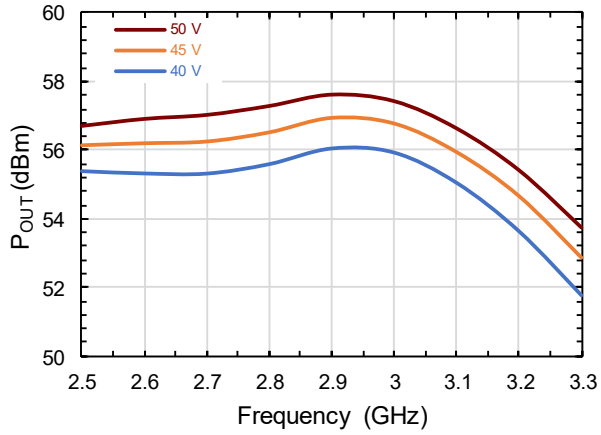
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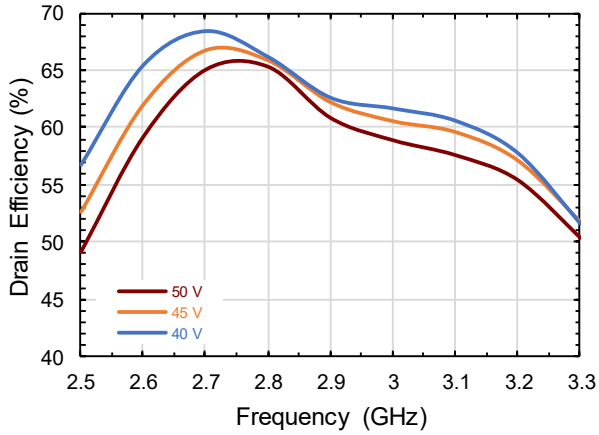
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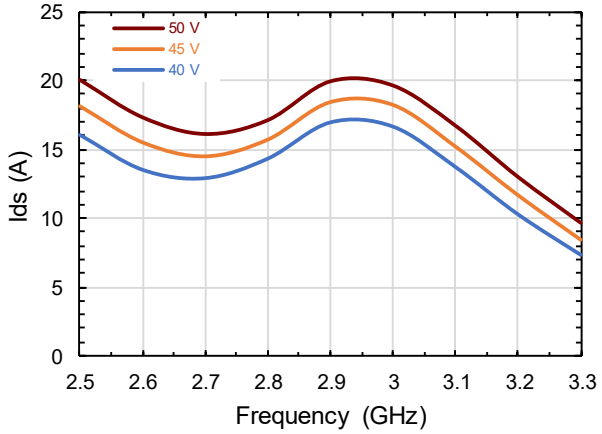
Output Power vs. V_{DS} and Frequency



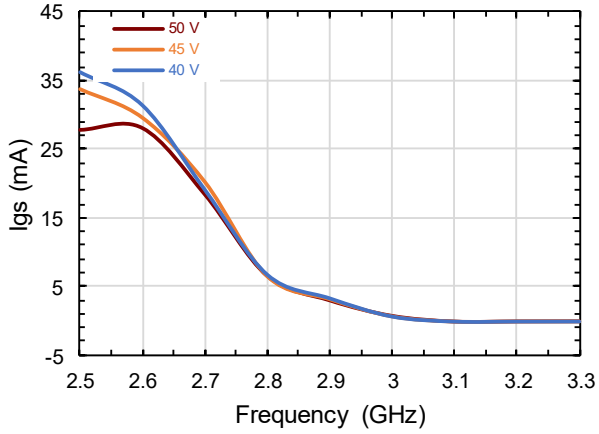
Drain Efficiency vs. V_{DS} and Frequency



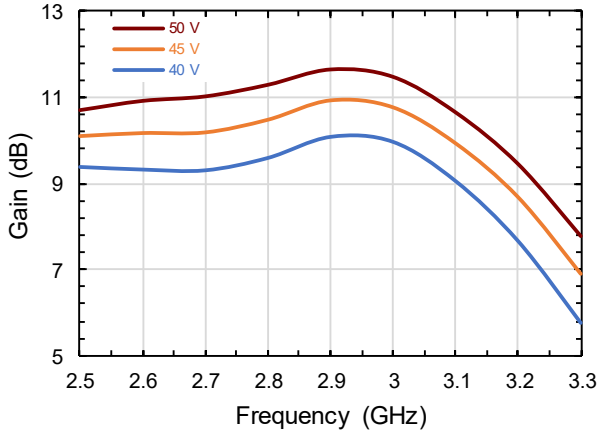
Drain Current vs. V_{DS} and Frequency



Gate Current vs. V_{DS} and Frequency



Large Signal Gain vs. V_{DS} and Frequency



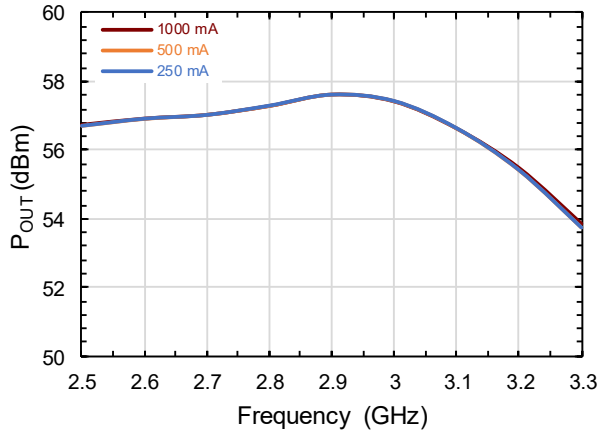
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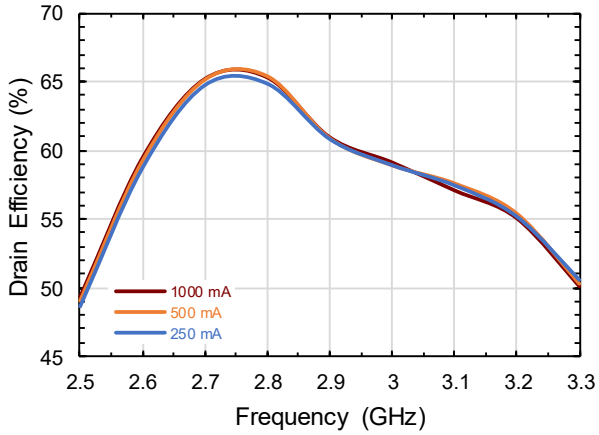
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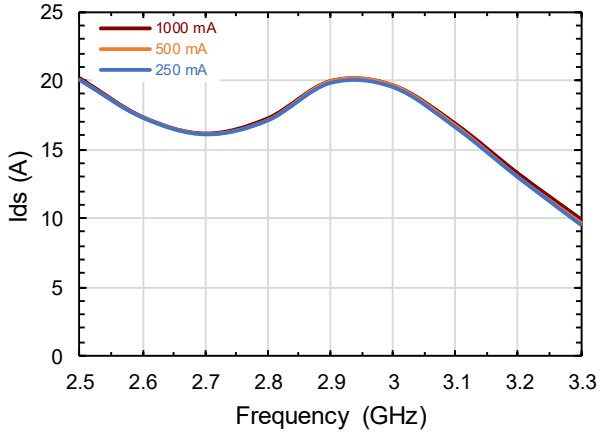
Output Power vs. I_{DQ} and Frequency



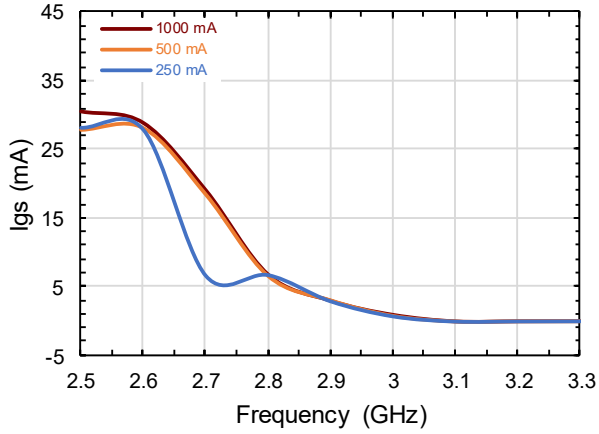
Drain Efficiency vs. I_{DQ} and Frequency



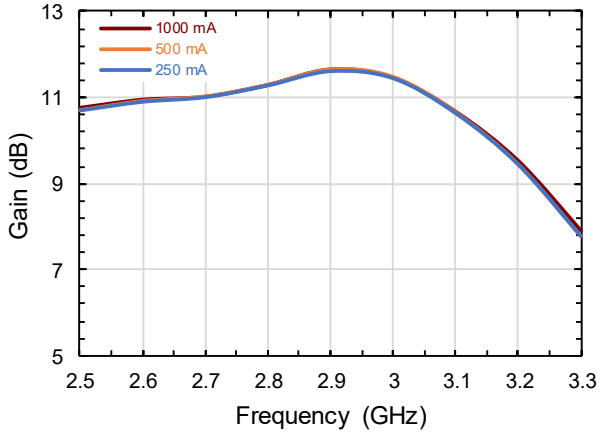
Drain Current vs. I_{DQ} and Frequency



Gate Current vs. I_{DQ} and Frequency



Large Signal Gain vs. I_{DQ} and Frequency



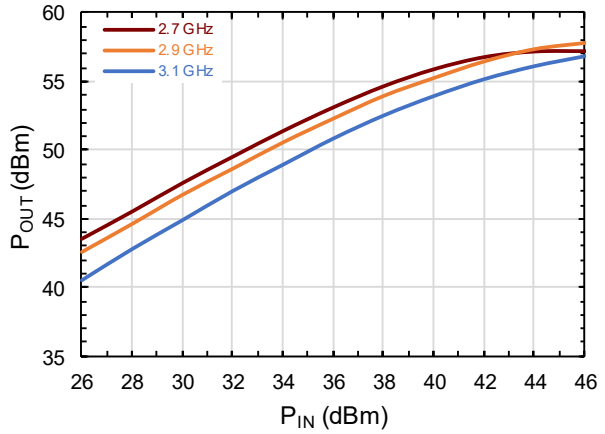
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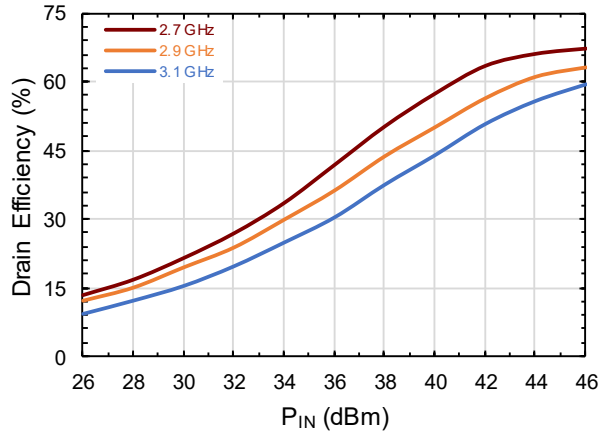
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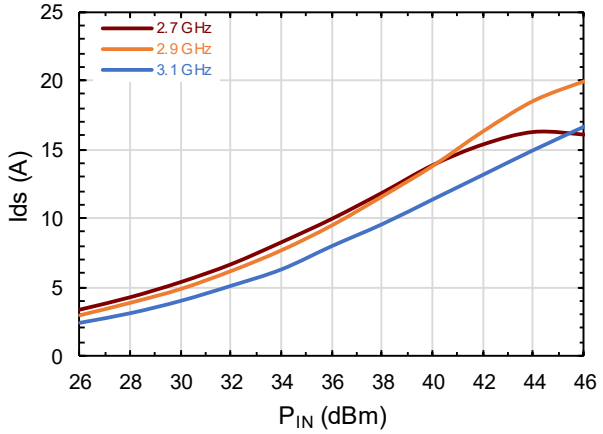
Output Power vs. Frequency and P_{IN}



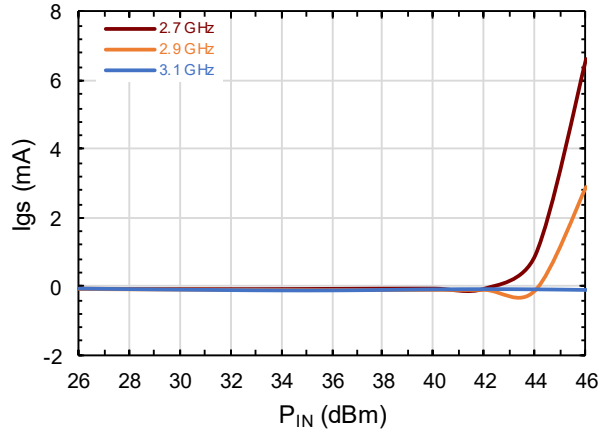
Drain Efficiency vs. Frequency and P_{IN}



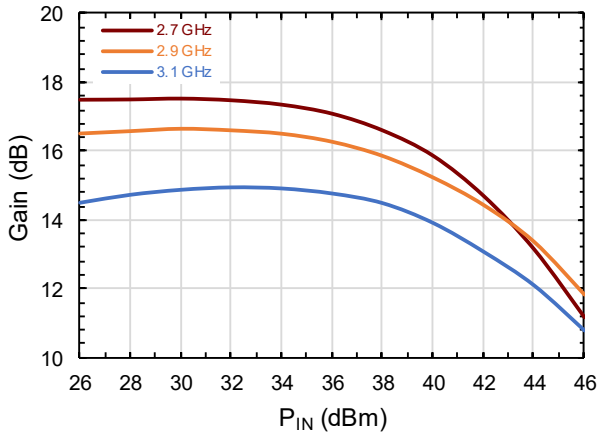
Drain Current vs. Frequency and P_{IN}



Gate Current vs. Frequency and P_{IN}



Large Signal Gain vs. Frequency and P_{IN}



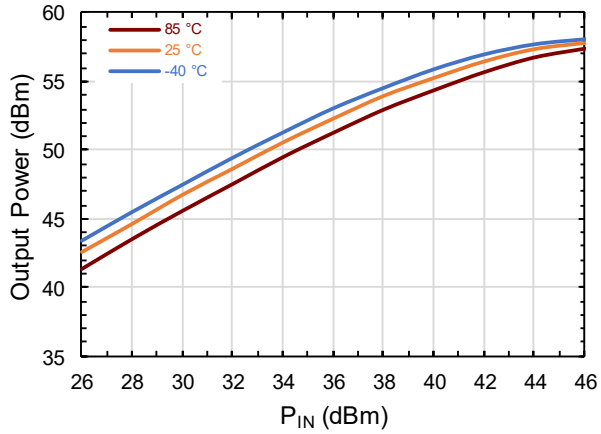
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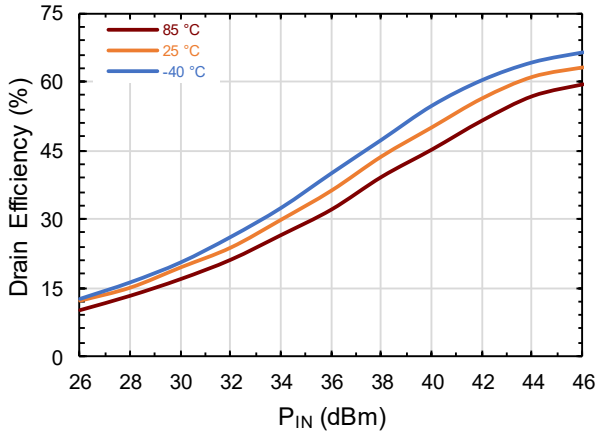
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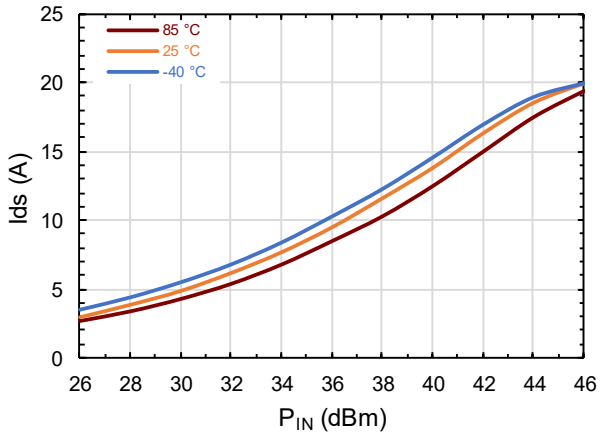
Output Power vs. Temperature and P_{IN}



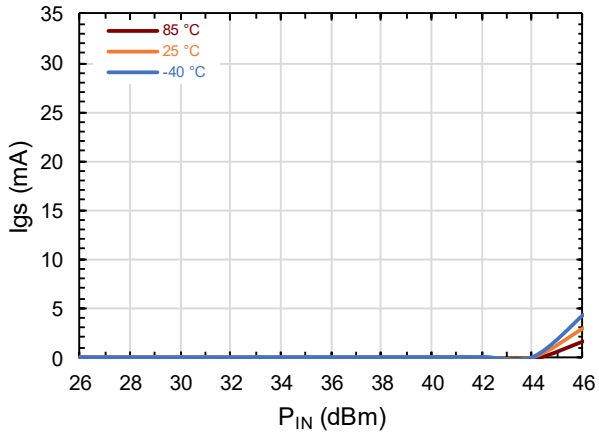
Drain Efficiency vs. Temperature and P_{IN}



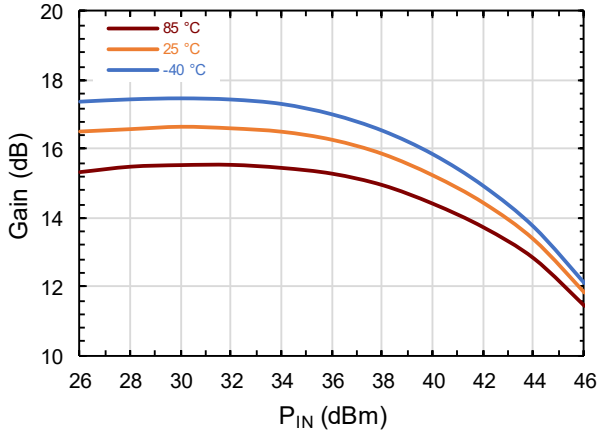
Drain Current vs. Temperature and P_{IN}



Gate Current vs. Temperature and P_{IN}



Large Signal Gain vs. Temperature and P_{IN}



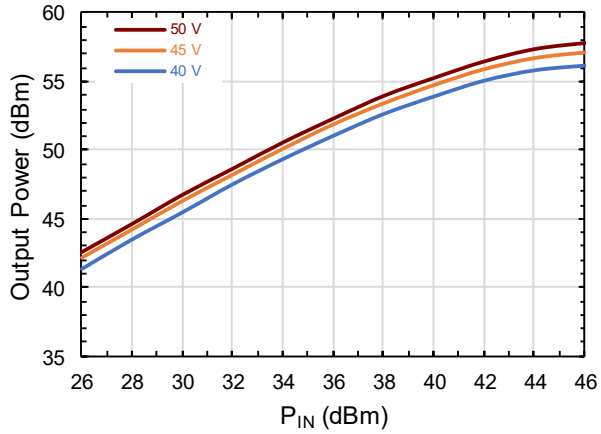
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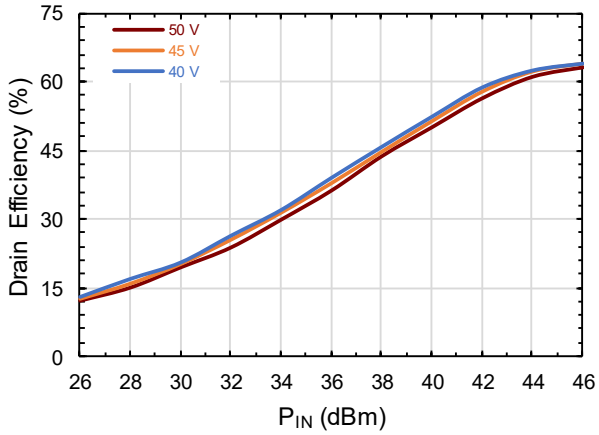
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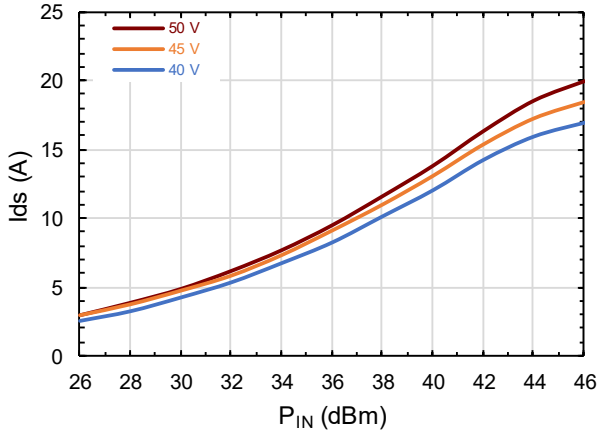
Output Power vs. V_{DS} and P_{IN}



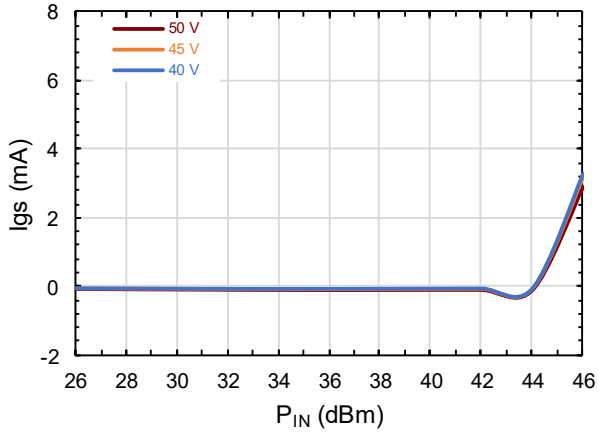
Drain Efficiency vs. V_{DS} and P_{IN}



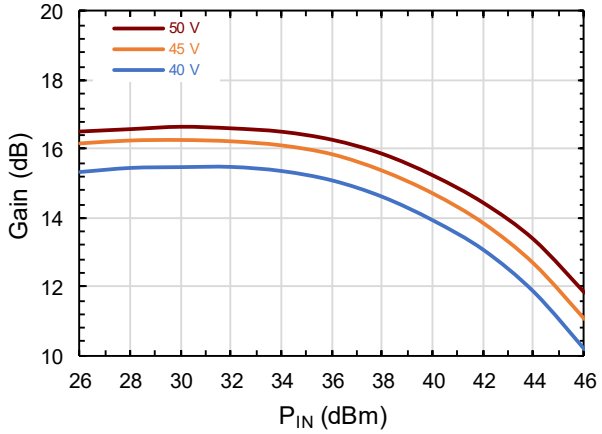
Drain Current vs. V_{DS} and P_{IN}



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



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



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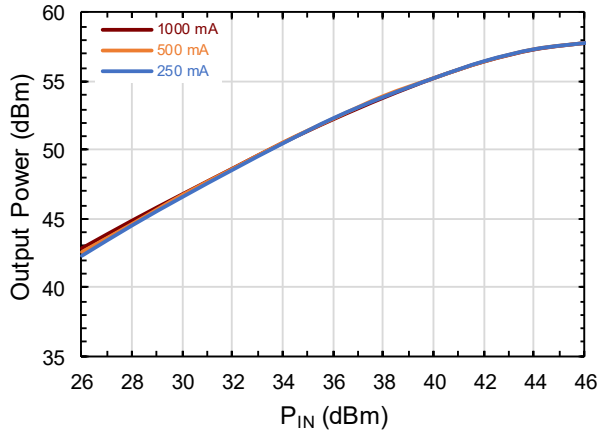
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Typical Performance Curves as Measured in the 2.7– 3.1 GHz Evaluation Test Fixture

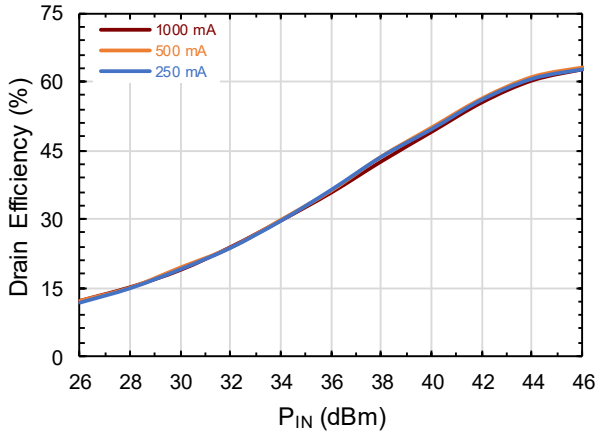
Pulsed 2000 µs 20%, P_{IN} = 46 dBm, V_{DS} = 50V, I_{DQ} = 500 mA, Frequency=2.9 GHz (Unless otherwise noted)

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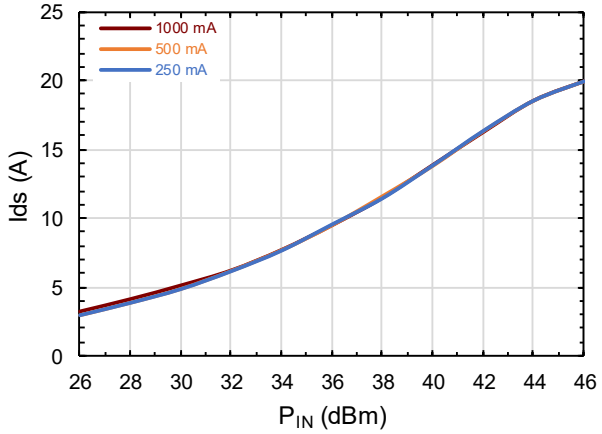
Output Power vs. I_{DQ} and P_{IN}



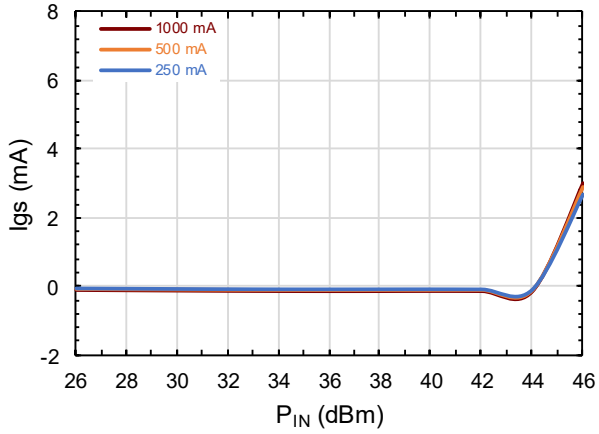
Drain Efficiency vs. I_{DQ} and P_{IN}



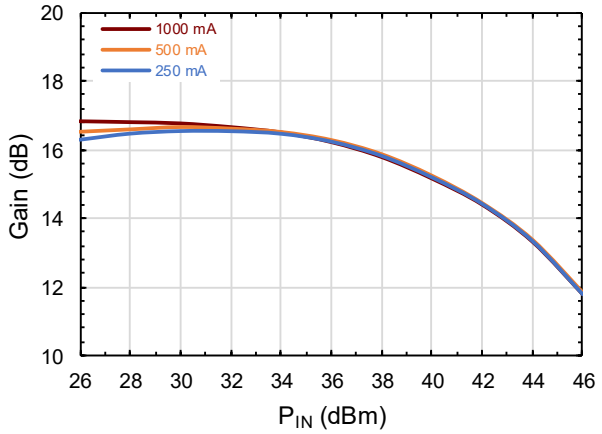
Drain Current vs. I_{DQ} and P_{IN}



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



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



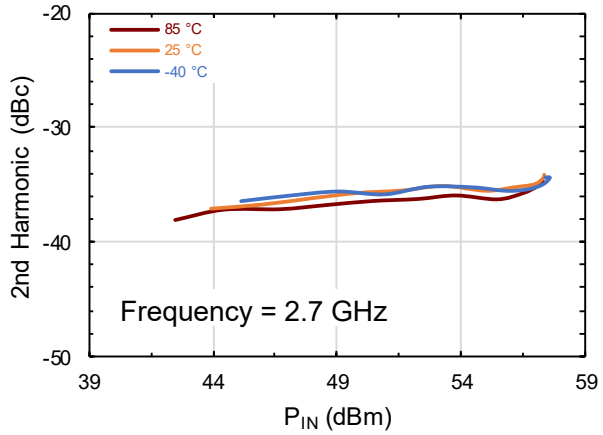
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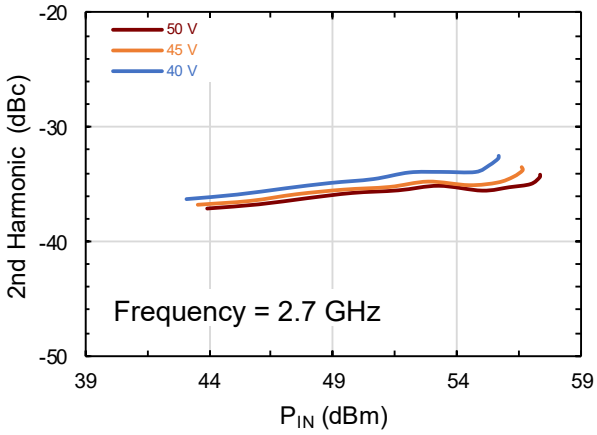
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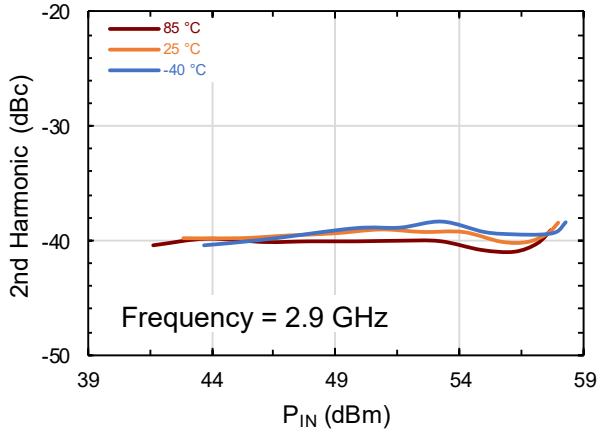
2nd Harmonic vs. Temperature and P_{IN}



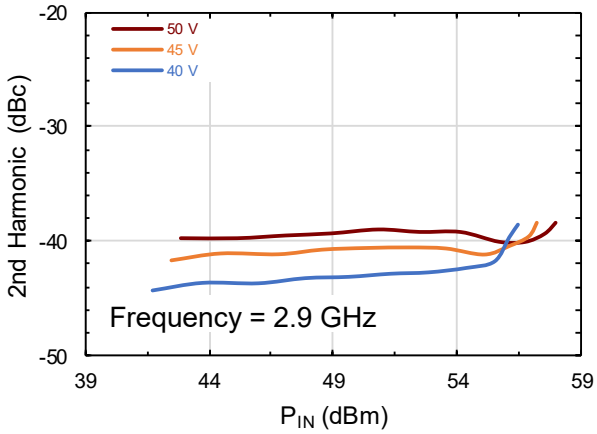
2nd Harmonic vs. V_{DS} and P_{IN}



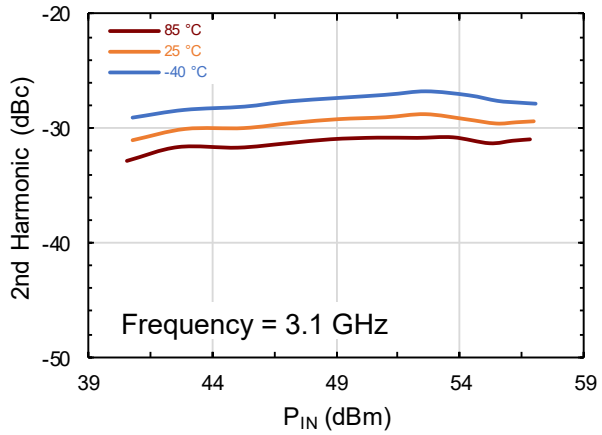
2nd Harmonic vs. Temperature and P_{IN}



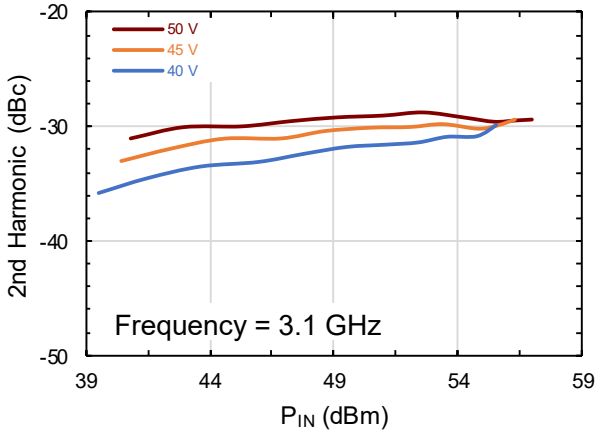
2nd Harmonic vs. V_{DS} and P_{IN}



2nd Harmonic vs. Temperature and P_{IN}



2nd Harmonic vs. V_{DS} and P_{IN}



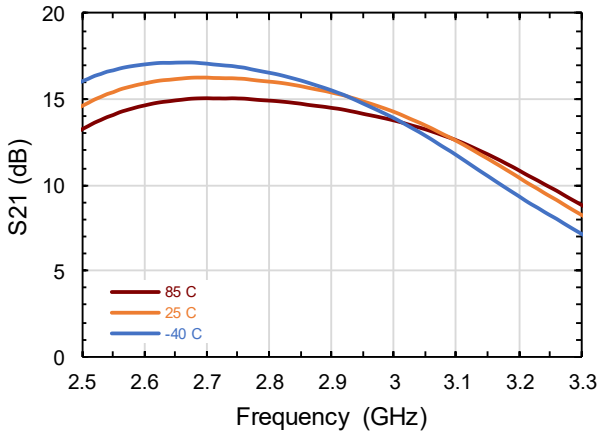
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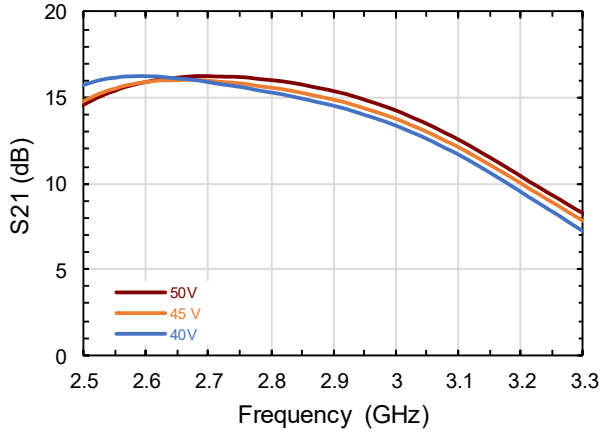
Typical Performance Curves as Measured in the 2.7– 3.1 GHz Evaluation Test Fixture:

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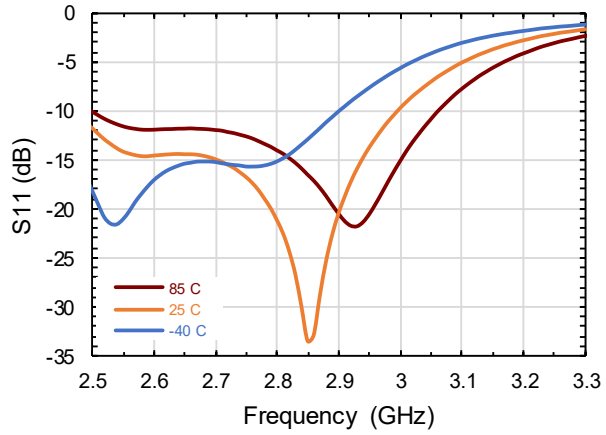
S21 vs Frequency and Temperature



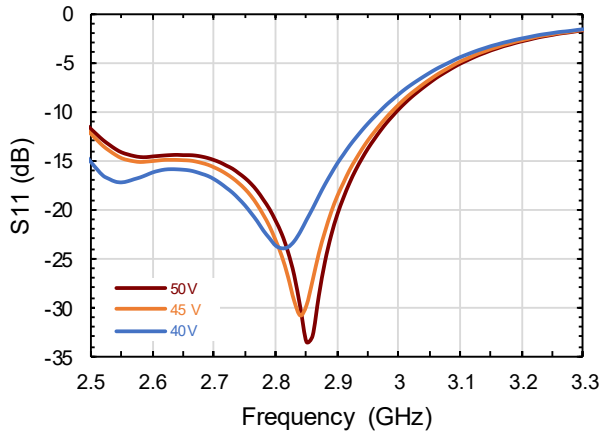
S21 vs Frequency and V_{DS}



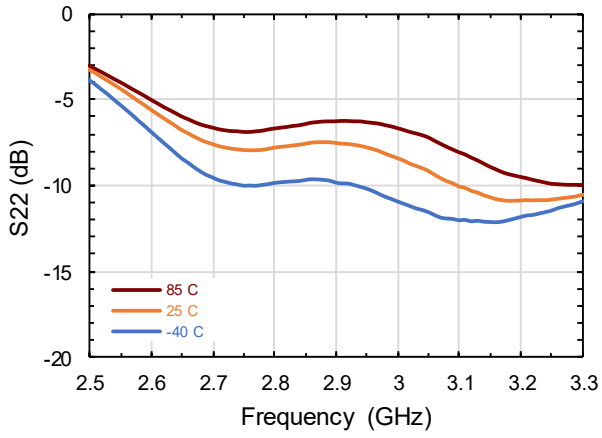
S11 vs Frequency and Temperature



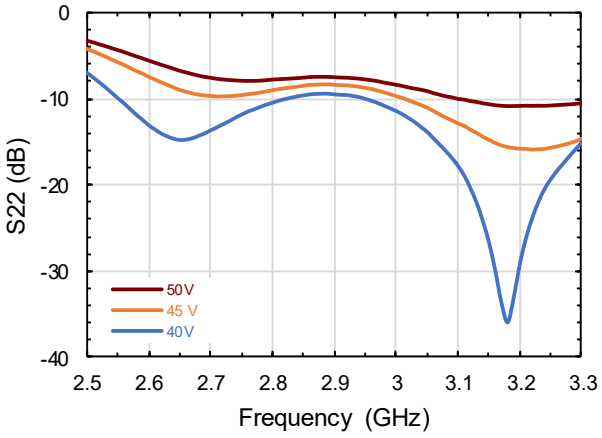
S11 vs Frequency and V_{DS}



S22 vs Frequency and Temperature



S22 vs Frequency and V_{DS}



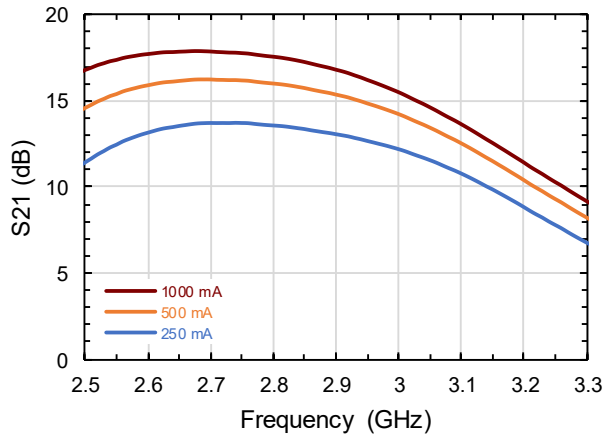
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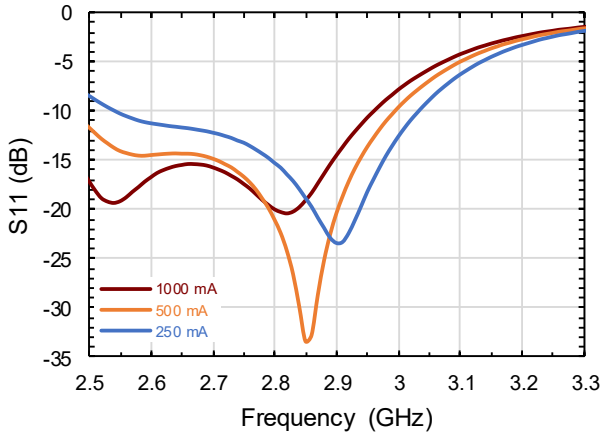
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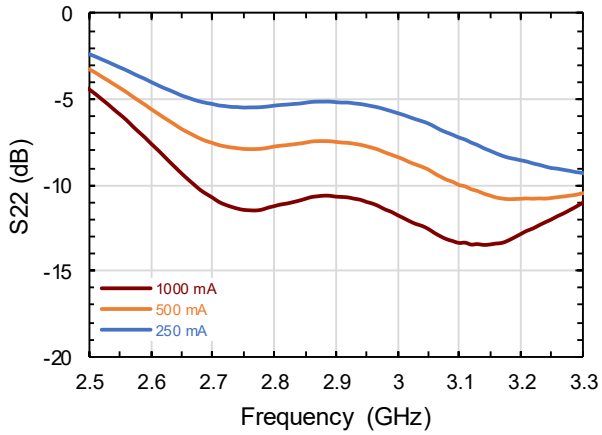
S21 vs Frequency and I_{DQ}



S11 vs Frequency and I_{DQ}



S22 vs Frequency and I_{DQ}

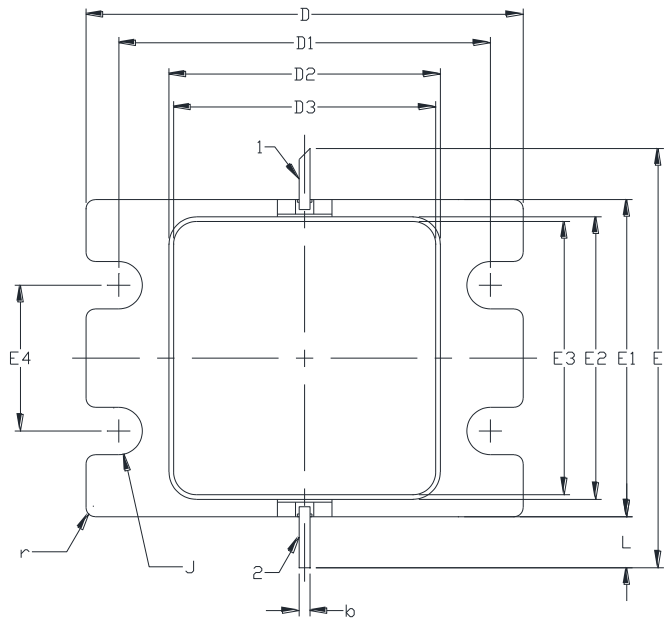


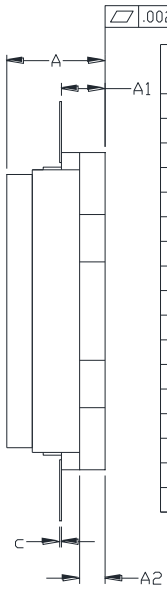
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Lead-free 440226 Package Dimensions

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. INTERPRET DRAWING IN ACCORDANCE WITH ANSI Y14.5M-2009
2. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF .020 BEYOND EDGE OF LID
3. LID MAY BE MISALIGNED TO THE BODY OF PACKAGE BY A MAXIMUM OF .008 IN ANY DIRECTION
4. ALL PLATED SURFACES ARE GOLD OVER NICKEL





1. GATE
2. DRAIN

DIM	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.205	0.221	5.21	5.61	
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	0.565	0.571	14.35	14.50	
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	0.588	0.594	14.93	15.09	
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

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