GaN Amplifier 50 V, 525 W
2.8 - 3.5 GHz

MACOM PURE CARBIDE

MAPC-A4015-AS
Rev. V2

Features
- Saturated Power: 525 W
- Large Signal Gain: 11 dB
- Drain Efficiency: 65%
- Internally Matched: 50 Ω
- High Temperature Operation
- RoHS* Compliant

AC-587SH-2

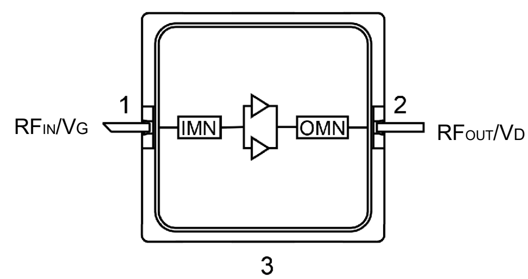
Applications
- General Amplification
- S-Band Radar

Description
The MAPC-A4015 is a Gallium Nitride (GaN) amplifier designed specifically with high efficiency and high gain for the 2.8 - 3.5 GHz S-Band radar band.

The device has been developed with long pulse capability to meet the developing trends in radar architectures. The amplifier is matched to 50 Ω on the input and 50 Ω on the output.

The MAPC-A4015 is based on the high power density 50 V, GaN on Silicon Carbide (SiC) manufacturing process. The amplifier is supplied in a ceramic/ metal flange package of type AC-587SH-2.

Functional Schematic



Typical RF Performance:
Measured in Evaluation Test Fixture @ P_{IN} = 46 dBm, 500 µs Pulse Width & 10% Duty Cycle.

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

Frequency (GHz)	Output Power (W)	Power Gain (dB)	η_D (%)
2.8	613	11.9	62
2.9	607	11.8	71
3.2	504	11.0	68
3.5	500	11.0	64

Pin Configuration

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

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

Ordering Information

Part Number	MOQ Increment
MAPC-A4015-AS000	Bulk
MAPC-A4015-ASSB1	Sample Board

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

RF Electrical Characteristics: Freq. = 2.8 - 3.5 GHz, T_C = 25°C, V_{DS} = 50 V, I_{DQ} = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%

Performance in MACOM Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Output Power	Pulsed, P_{IN} = 46 dBm	P_{OUT}	—	57.0	—	dBm
Drain Efficiency	Pulsed, P_{IN} = 46 dBm	DE	—	68	—	%
Large Signal Gain	Pulsed, P_{IN} = 46 dBm	G_P	—	11.0	—	dB
Small Signal Gain	CW, P_{IN} = -20 dBm	S21	—	14	—	dB
Input Return Loss	CW, P_{IN} = -20 dBm	S11	—	-7	—	dB
Output Return Loss	CW, P_{IN} = -20 dBm	S22	—	-6	—	dB
Output Mismatch Stress	P_{IN} = 46 dBm	ψ	VSWR = 3:1, No Device Damage			

RF Electrical Specifications[2]: P_{IN} = 46 dBm, T_A = +25°C, V_{DS} = 50 V, I_{DQ} = 500 mA, Pulse Width 500 µs, 10% Duty Cycle

Parameter	Conditions	Min.	Typ.	Max.	Units
Output Power	2.8 GHz 3.2 GHz 3.5 GHz	470 420 420	550 519 524	—	W
Power Gain	2.8 GHz 3.2 GHz 3.5 GHz	10.7 10.2 10.2	11.4 11.2 11.2	—	dB
Drain Efficiency	2.8 GHz 3.2 GHz 3.5 GHz	52 62 62	58 66 68	—	%

2. Final testing and screening for all amplifier sales is performed using the MAPC-A4015 production test fixture.

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}	—	—	11.62	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 10 V	I_{GLK}	-11.62	—	—	mA
Gate Threshold Voltage	V_{DS} = 10 V, I_D = 83.6 mA	V_T	-3.8	-3.1	-2.3	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 500 mA	V_{GSQ}	—	-2.75	—	V

Thermal Characteristics

Parameter	Symbol	Test Conditions	Units	Rating
Operating Junction Temperature	T_J	Pulse Width = 500 µs, Duty Cycle = 10 %, P_{DISS} = 430 W, T_C = 85 °C	°C	162
Thermal Resistance, Junction to Case	$R_{\theta JC}$		°C/W	0.18

Parameter	Symbol	Test Conditions	Units	Rating
Operating Junction Temperature	T_J	Pulse Width = 2000 µs, Duty Cycle = 20 %, P_{DISS} = 418 W, T_C = 85 °C	°C	202
Thermal Resistance, Junction to Case	$R_{\theta JC}$		°C/W	0.28

Absolute Maximum Ratings[3,4]

Parameter	Absolute Maximum
Pulse Width	2000 µsec
Duty Cycle	20%
Drain-Source Voltage	150 V
Gate Voltage	-10, +2 V
DC Drain Current	14 A
Gate Current	80 mA
Input Power	48 dBm
Storage Temperature	-65°C to +150°C
Mounting Temperature	+245°C for 30 seconds
Junction Temperature[5]	+225°C
Operating Temperature	-40°C to +125°C

3. Exceeding any one or combination of these limits may cause permanent damage to this device.
4. MACOM does not recommend sustained operation near these survivability limits.
5. Operating at nominal conditions with $T_J \leq$ +225 C will ensure MTTF ≥ 1 x 10^6 hours.

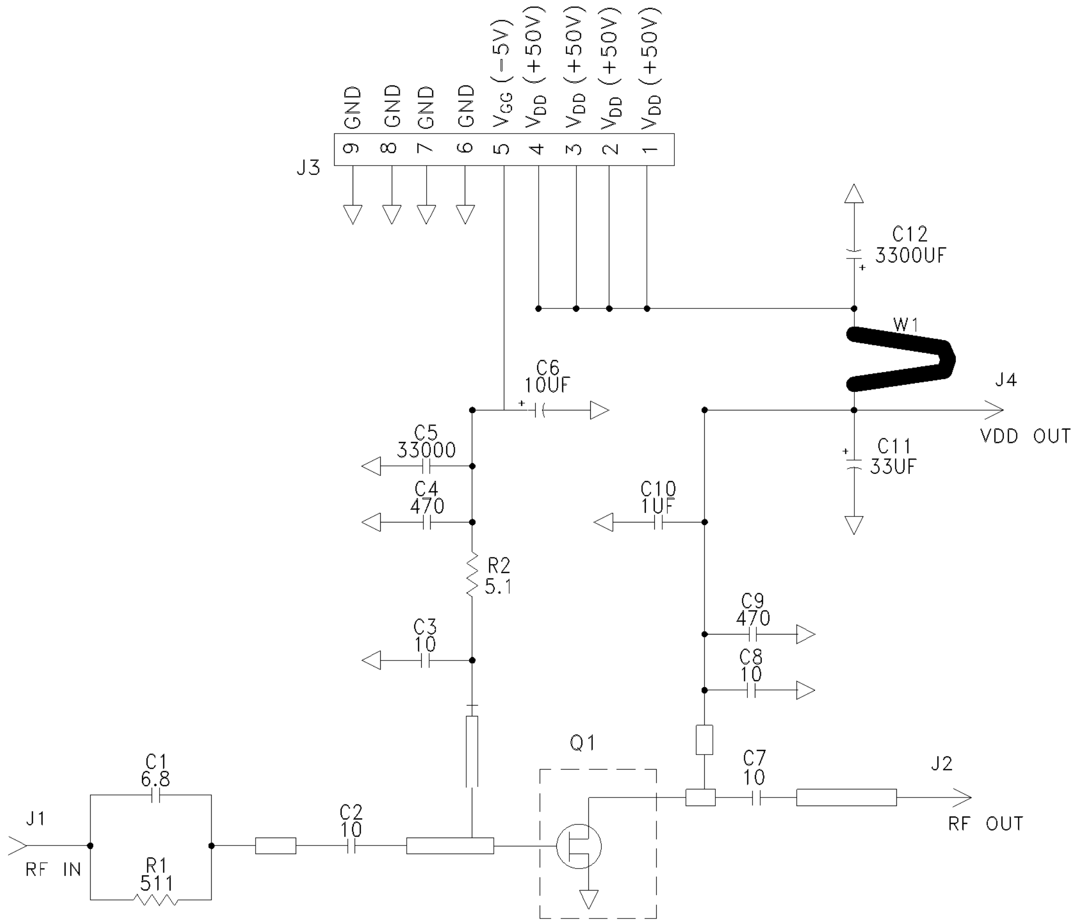
Handling Procedures

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.

Evaluation Test Fixture and Recommended Tuning Solution, 2.8 - 3.5 GHz



Description

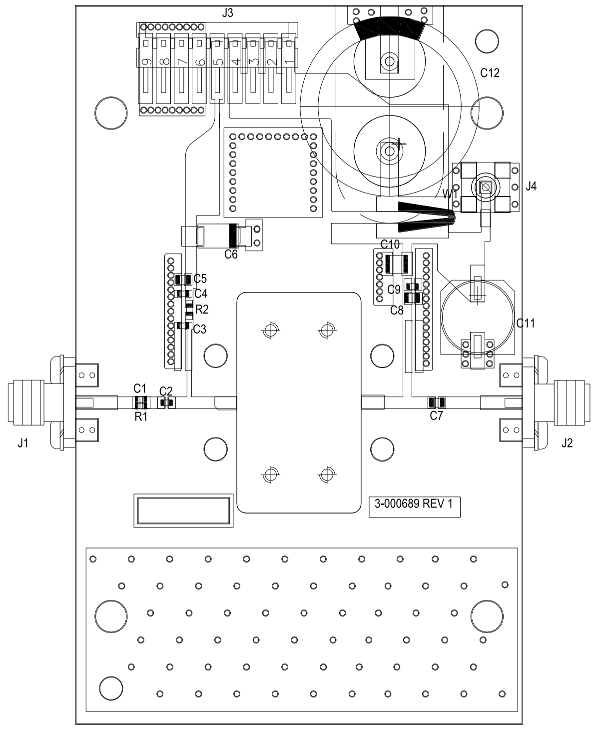
Parts measured on evaluation board (30-mil thick RO4350). Matching is provided using a combination of lumped elements and transmission lines as shown in the simplified schematic above. Recommended tuning solution component placement, transmission lines, and details are shown on the next page.

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

Evaluation Test Fixture and Recommended Tuning Solution, 2.8 - 3.5 GHz



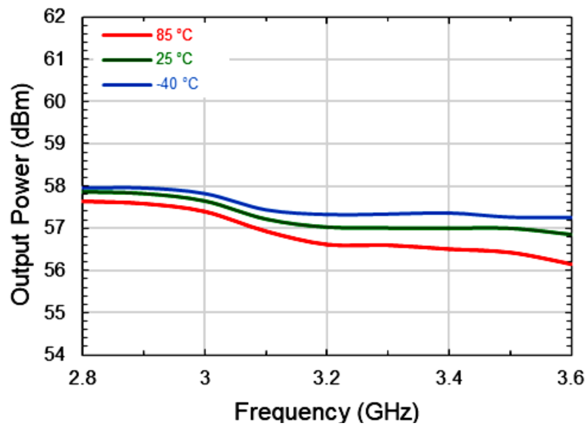
Assembly Parts List

Reference Designator	Description	Qty
R1	RES, 511, OHM, +/- 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	MAPC-A4015	1

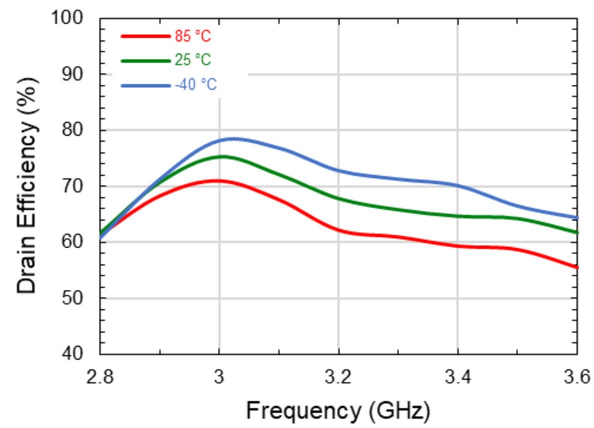
Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA

For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

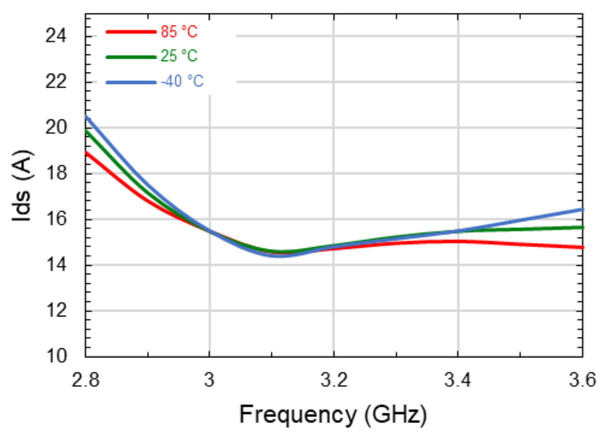
Output Power vs. Temperature and Frequency



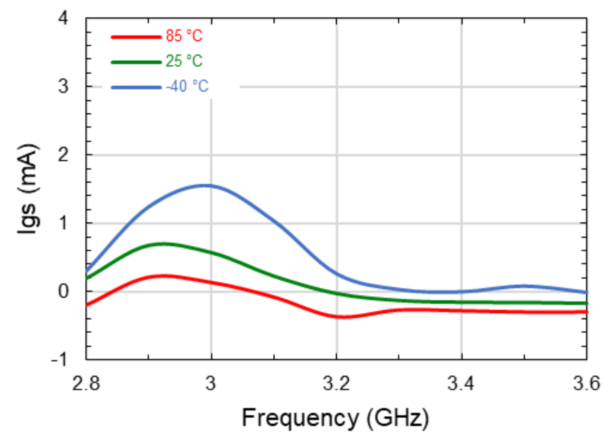
Drain Efficiency vs. Temperature and Frequency



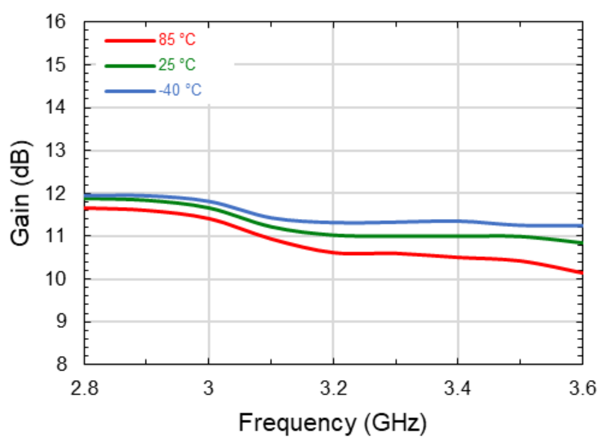
Drain Current vs. Temperature and Frequency



Gate Current vs. Temperature and Frequency



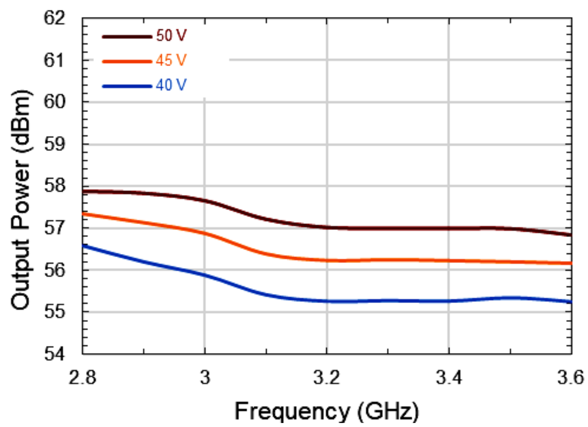
Power Gain vs. Temperature and Frequency



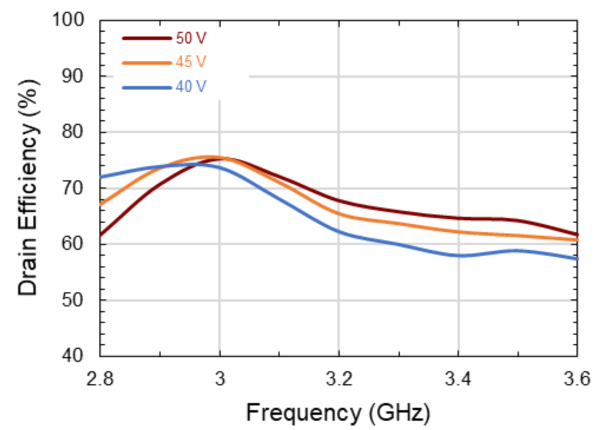
Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA

For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

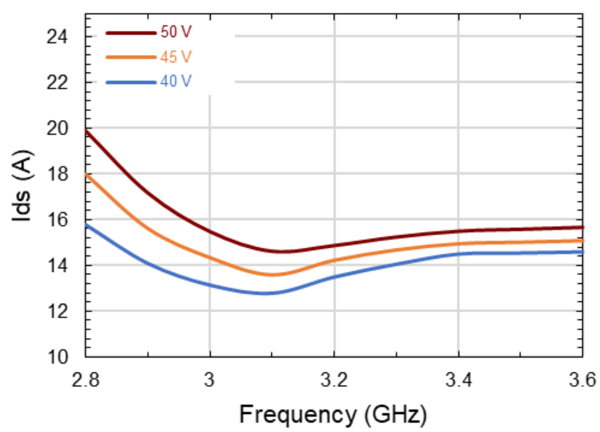
Output Power vs. V_{DS} and Frequency



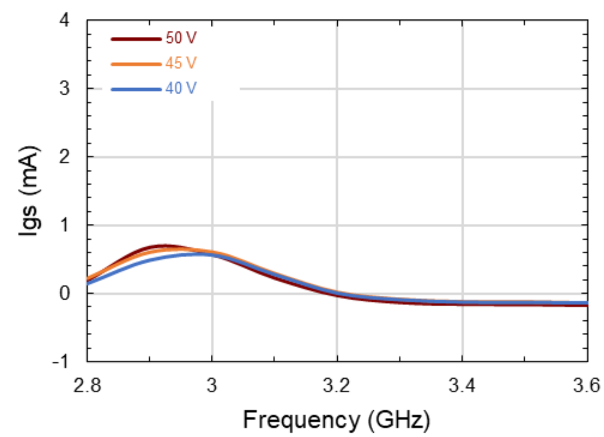
Drain Efficiency vs. V_{DS} and Frequency



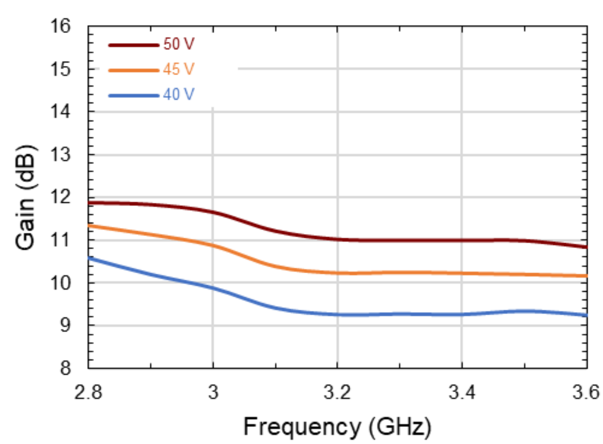
Drain Current vs. V_{DS} and Frequency



Gate Current vs. V_{DS} and Frequency

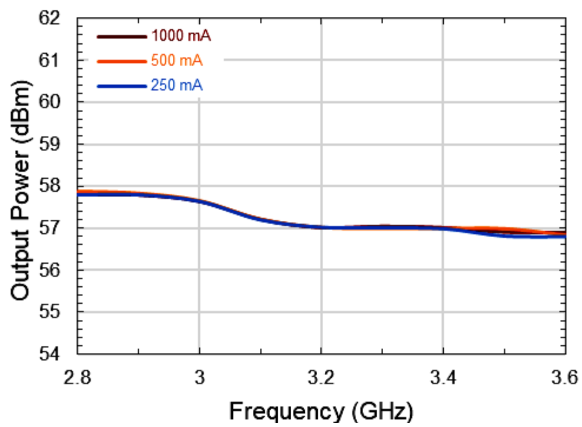


Power Gain vs. V_{DS} and Frequency

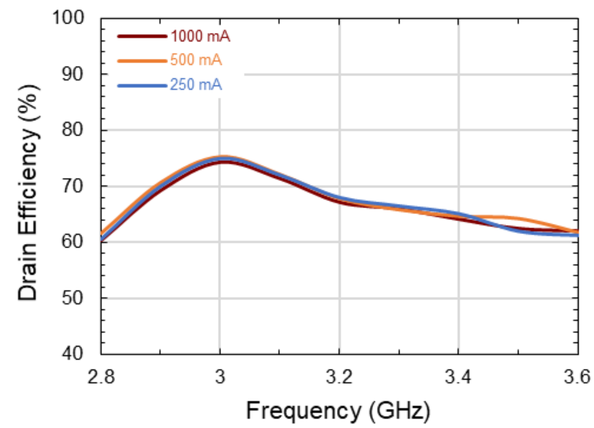


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

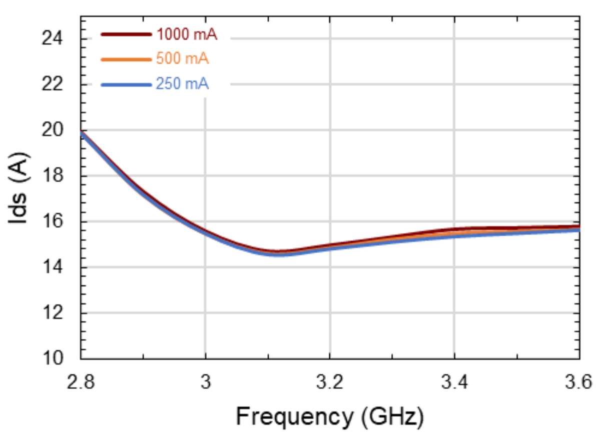
Output Power vs. I_{DQ} and Frequency



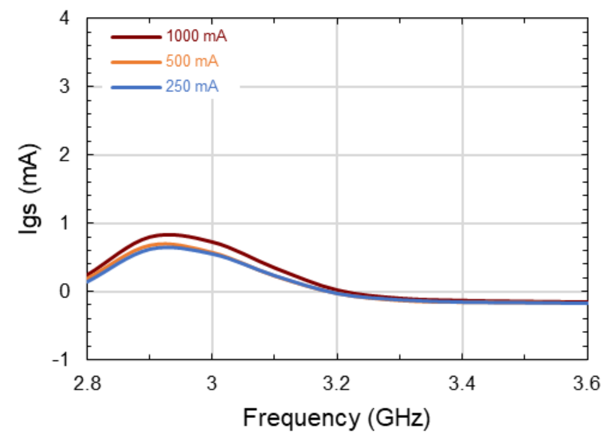
Drain Efficiency vs. I_{DQ} and Frequency



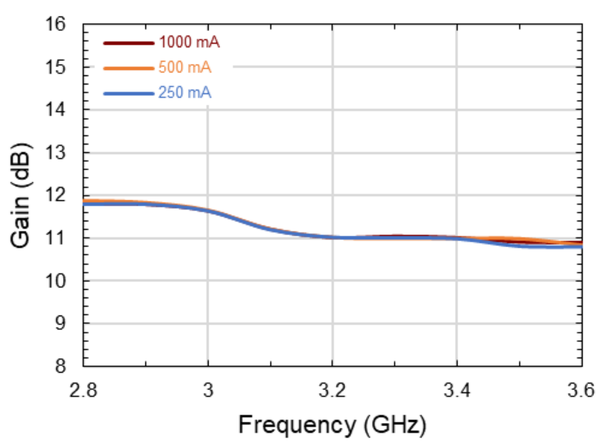
Drain Current vs. I_{DQ} and Frequency



Gate Current vs. I_{DQ} and Frequency



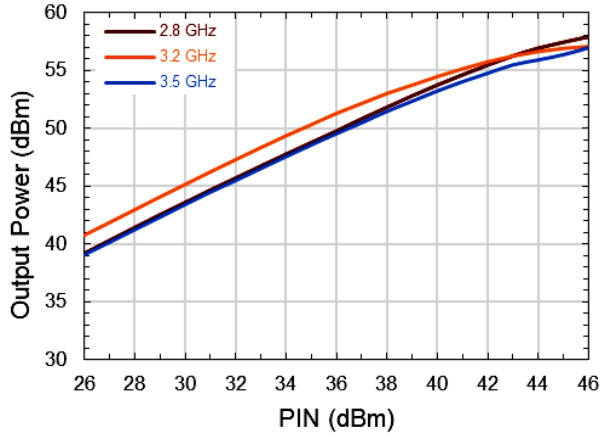
Power Gain vs. I_{DQ} and Frequency



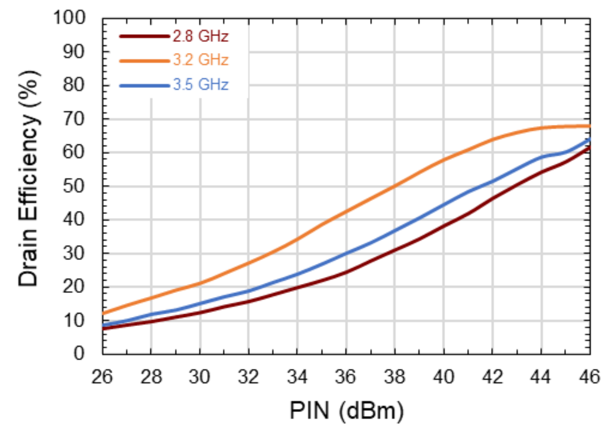
Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA

For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

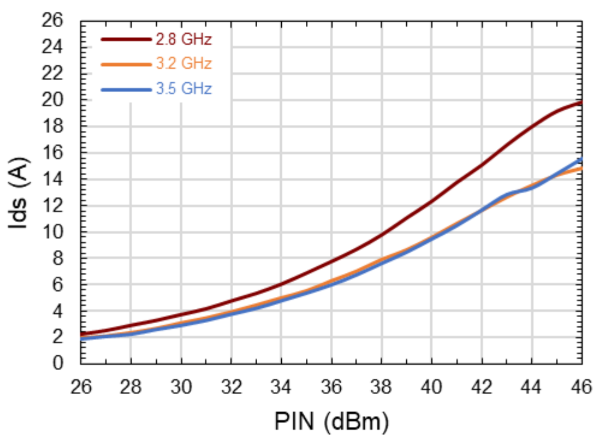
Output Power vs. Frequency and P_{IN}



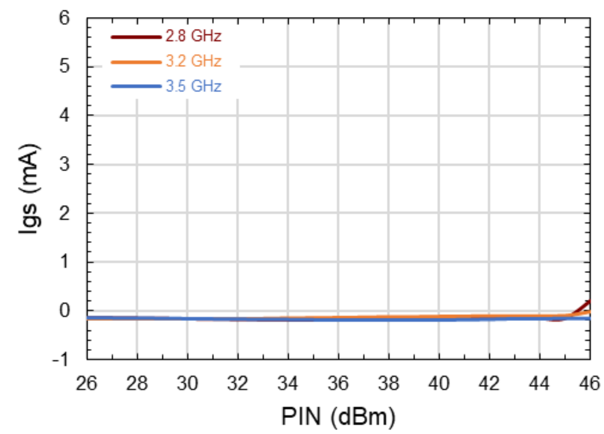
Drain Efficiency vs. Frequency and P_{IN}



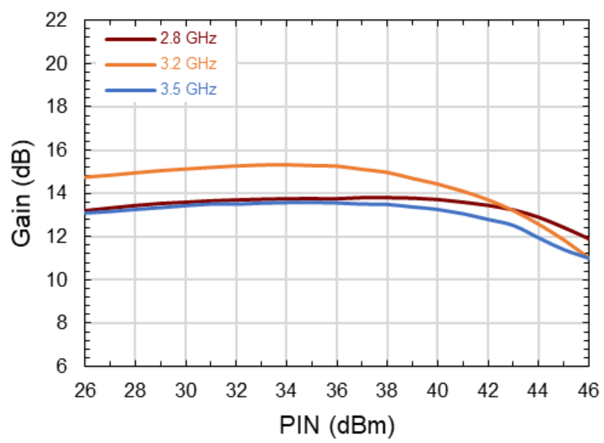
Drain Current vs. Frequency and P_{IN}



Gate Current vs. Frequency and P_{IN}

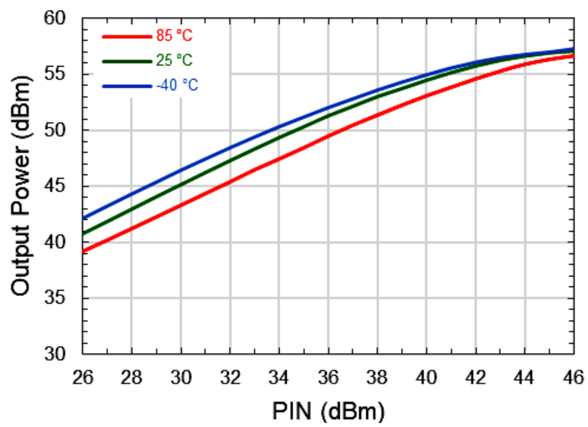


Power Gain vs. Frequency and P_{IN}

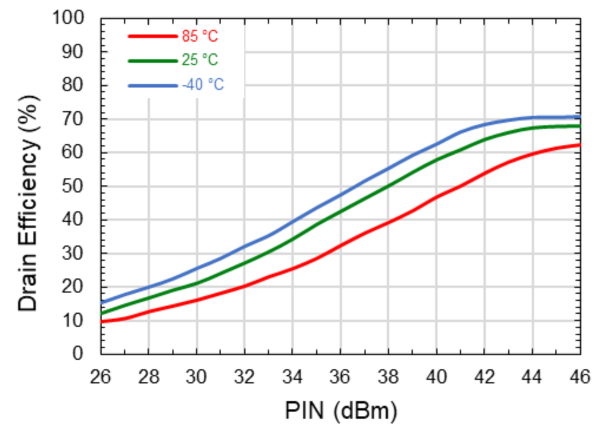


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA, Frequency = 3.2GHz
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

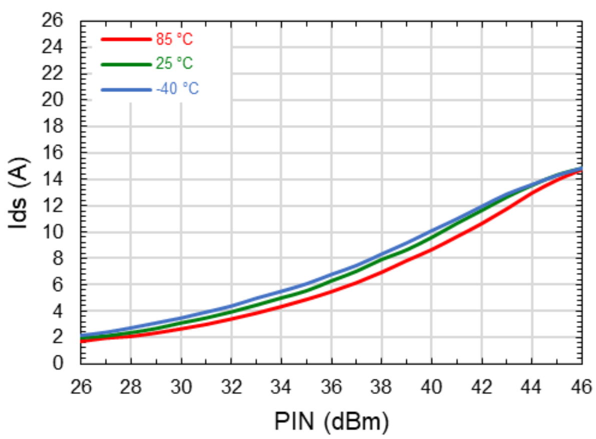
Output Power vs. Temperature and P_{IN}



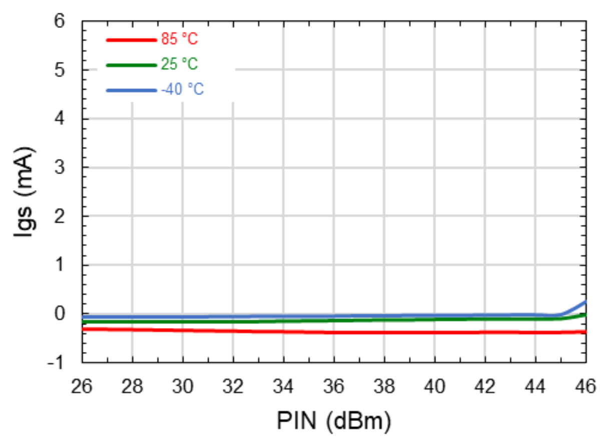
Drain Efficiency vs. Temperature and P_{IN}



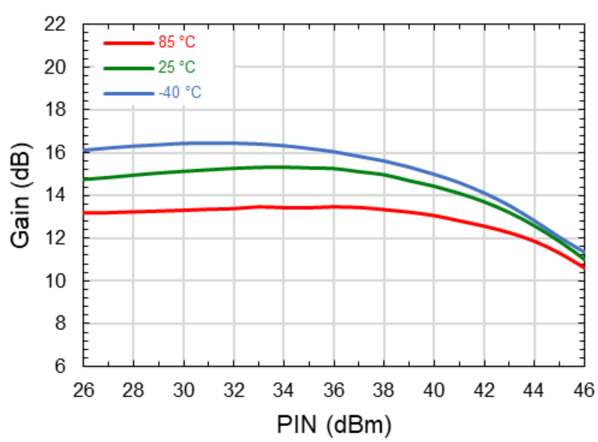
Drain Current vs. Temperature and P_{IN}



Gate Current vs. Temperature and P_{IN}

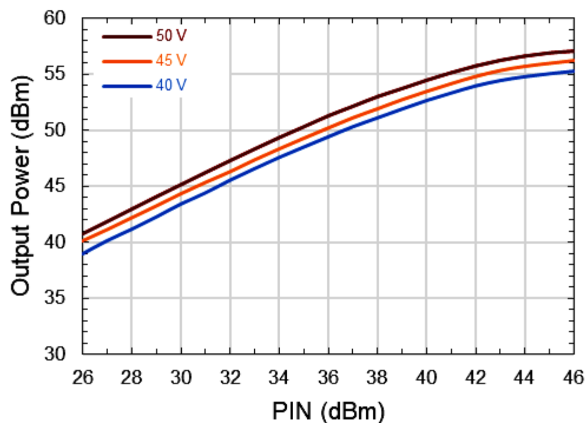


Power Gain vs. Temperature and P_{IN}

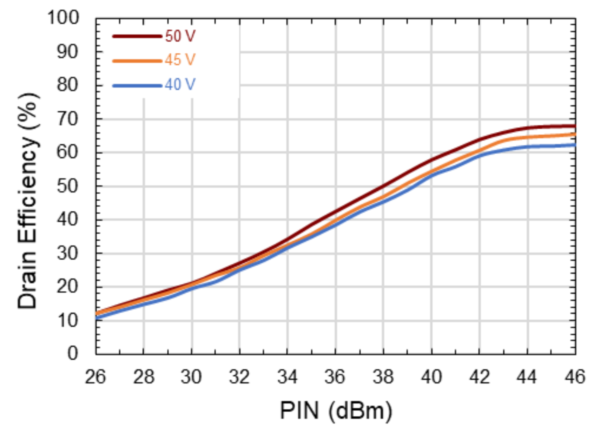


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 500 μs, Duty Cycle = 10%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA, Frequency = 3.2GHz
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

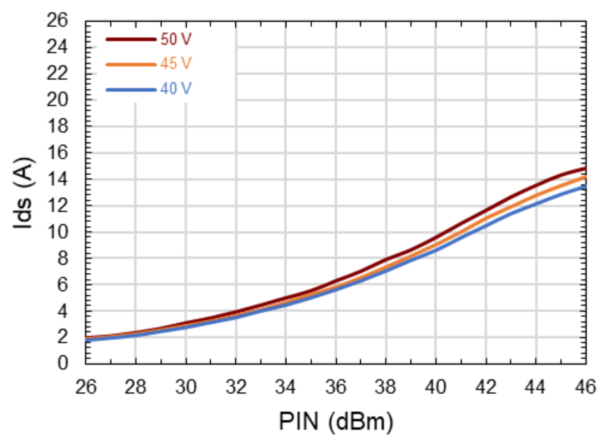
Output Power vs. V_{DS} and P_{IN}



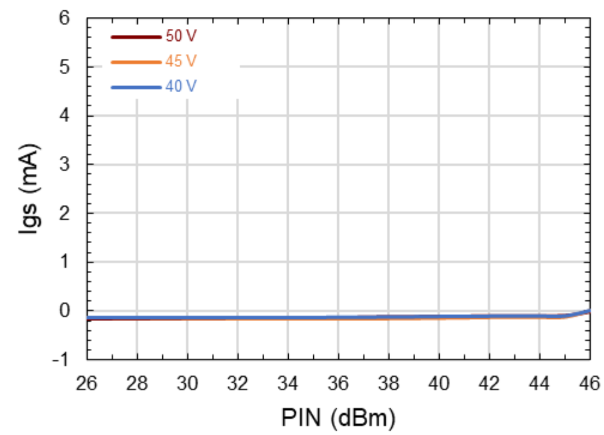
Drain Efficiency vs. V_{DS} and P_{IN}



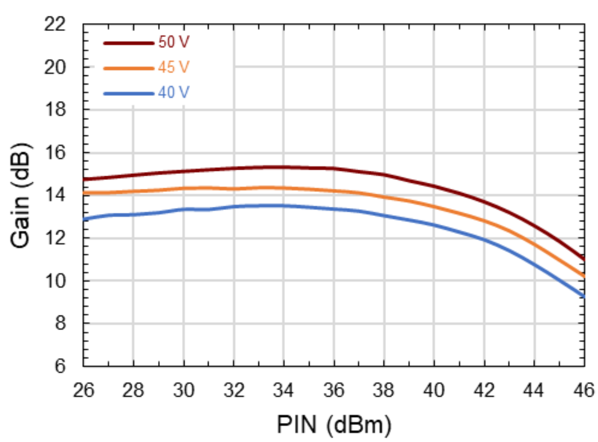
Drain Current vs. V_{DS} and P_{IN}



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

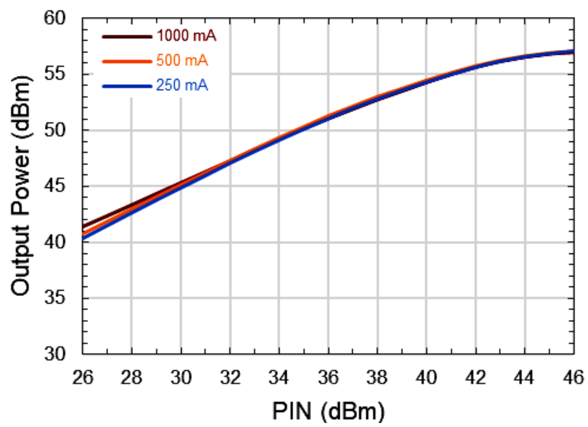


Power Gain vs. V_{DS} and P_{IN}

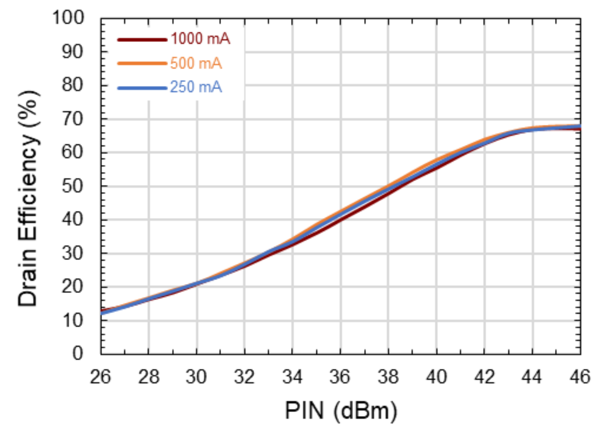


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 500 μs, Duty Cycle = 10%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA, Frequency = 3.2GHz
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

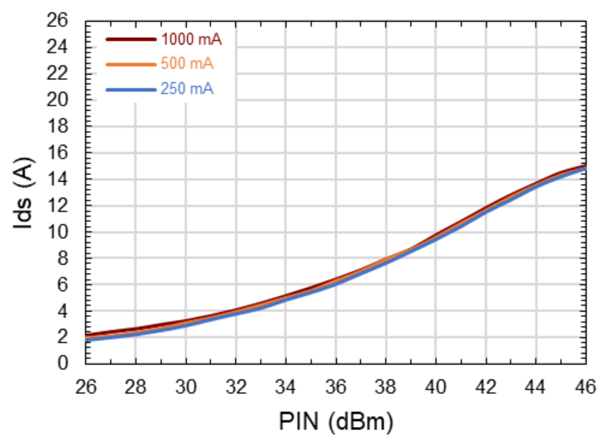
Output Power vs. I_{DQ} and P_{IN}



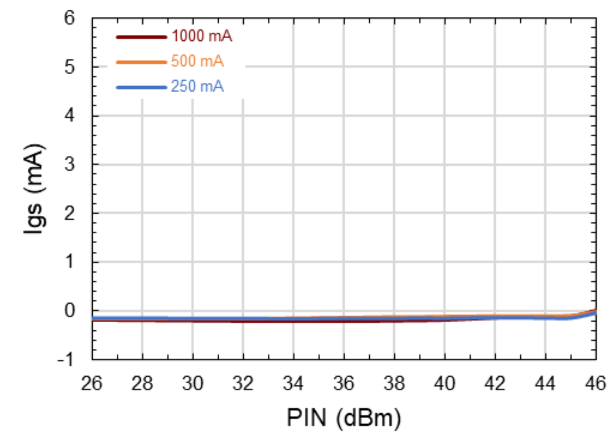
Drain Efficiency vs. I_{DQ} and P_{IN}



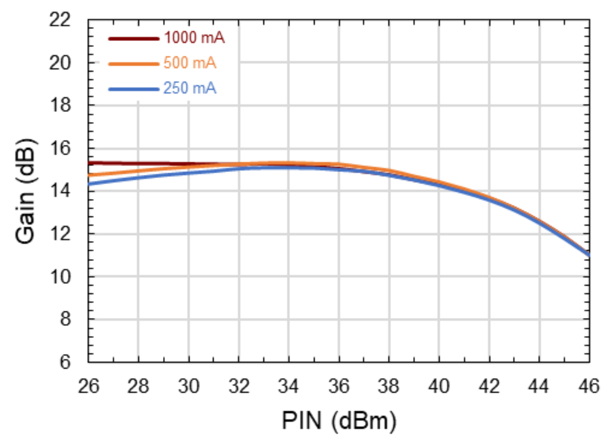
Drain Current vs. I_{DQ} and P_{IN}



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



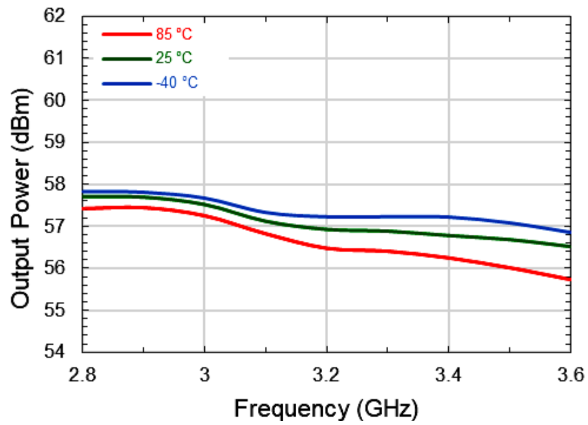
Power Gain vs. I_{DQ} and P_{IN}



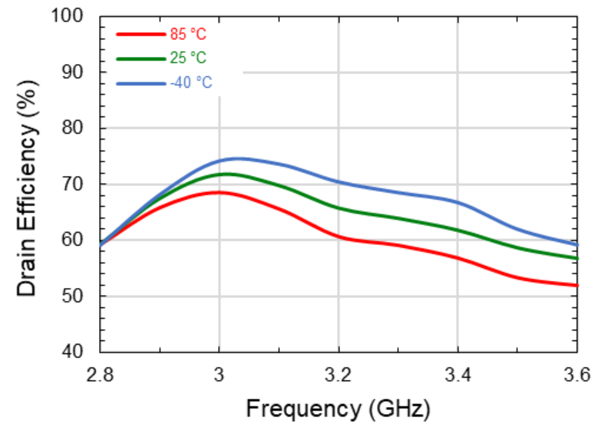
Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 2000 µs, Duty Cycle = 20%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA

For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

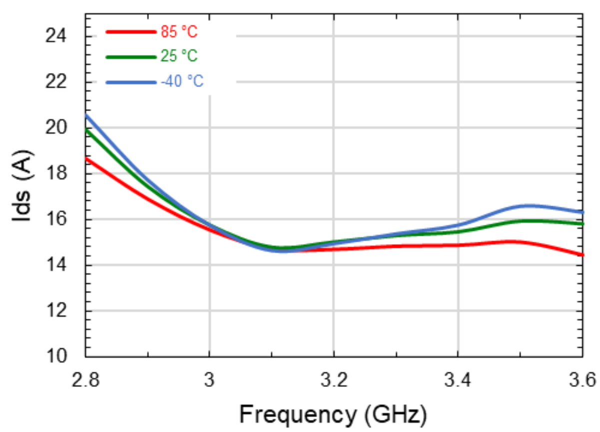
Output Power vs. Temperature and Frequency



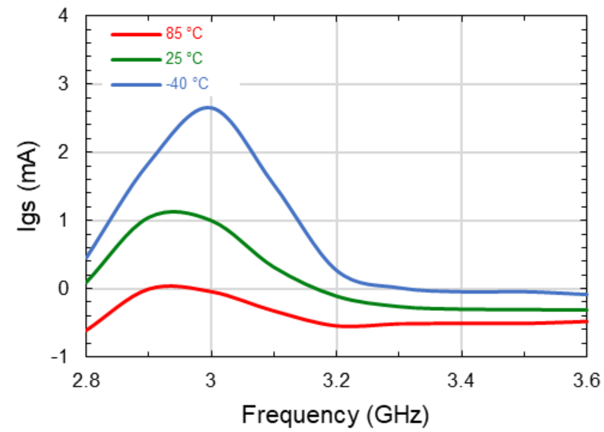
Drain Efficiency vs. Temperature and Frequency



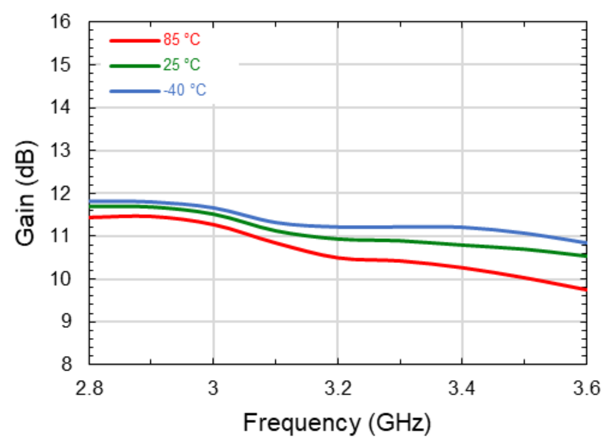
Drain Current vs. Temperature and Frequency



Gate Current vs. Temperature and Frequency

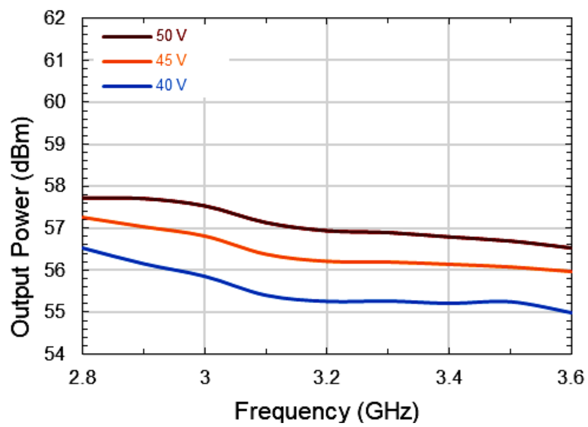


Power Gain vs. Temperature and Frequency

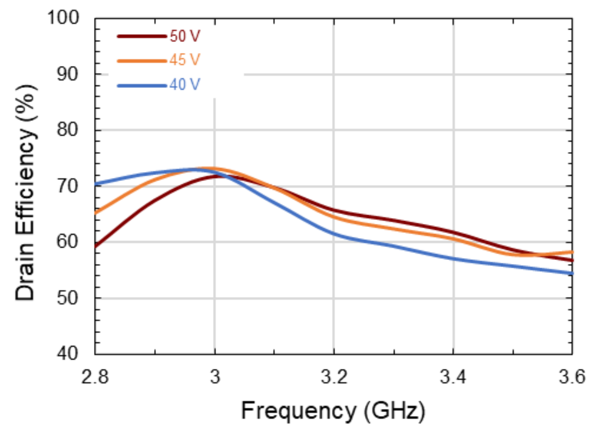


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 2000 µs, Duty Cycle = 20%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

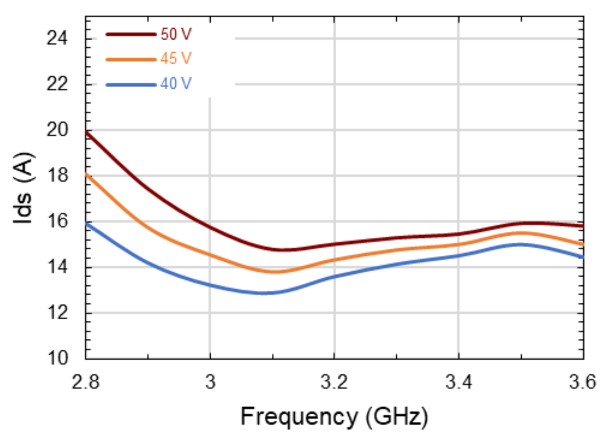
Output Power vs. V_{DS} and Frequency



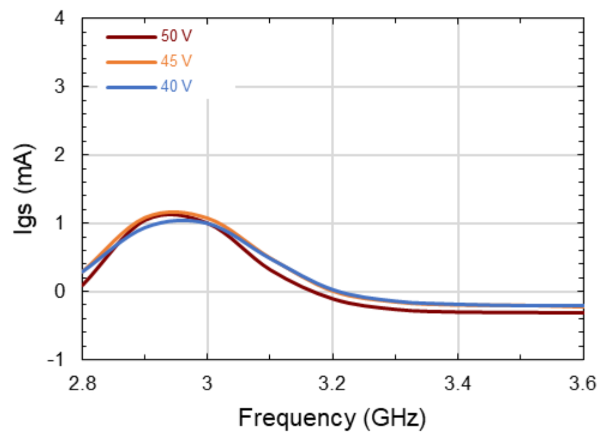
Drain Efficiency vs. V_{DS} and Frequency



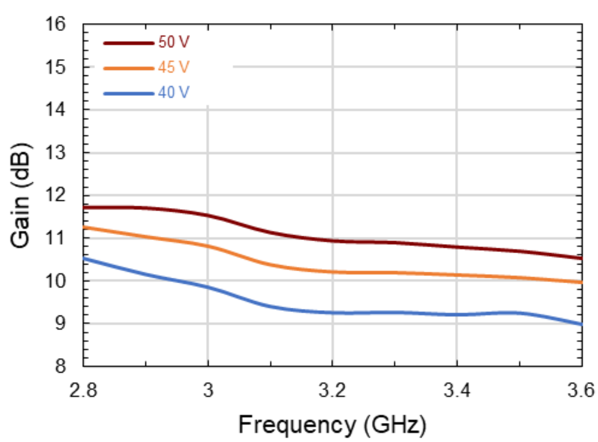
Drain Current vs. V_{DS} and Frequency



Gate Current vs. V_{DS} and Frequency



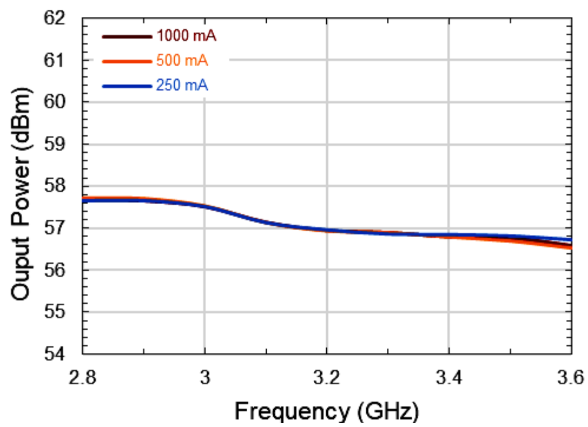
Power Gain vs. V_{DS} and Frequency



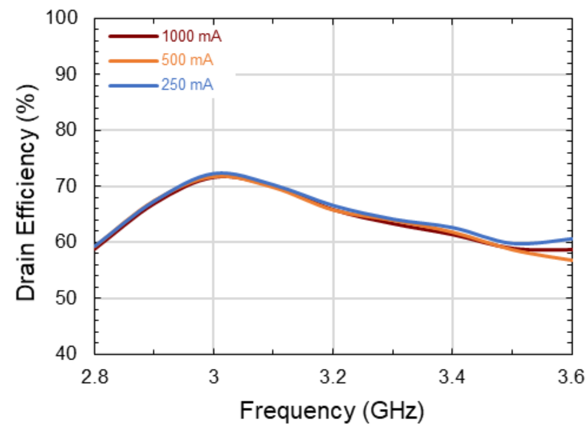
Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 2000 µs, Duty Cycle = 20%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA

For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

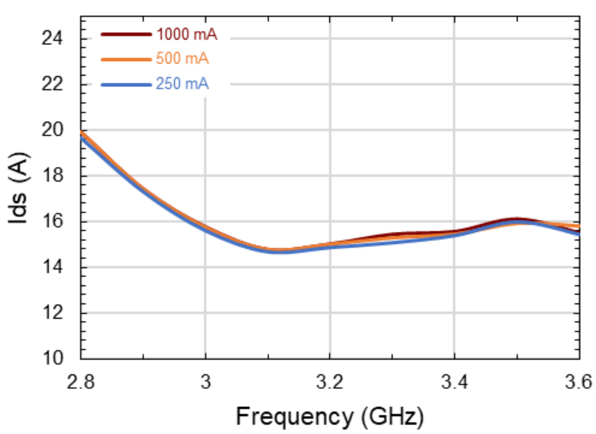
Output Power vs. I_{DQ} and Frequency



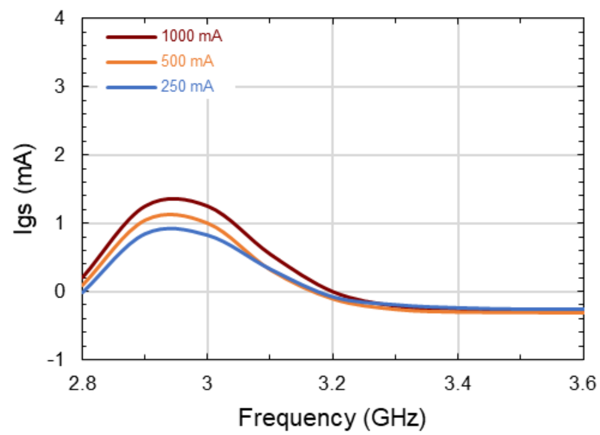
Drain Efficiency vs. I_{DQ} and Frequency



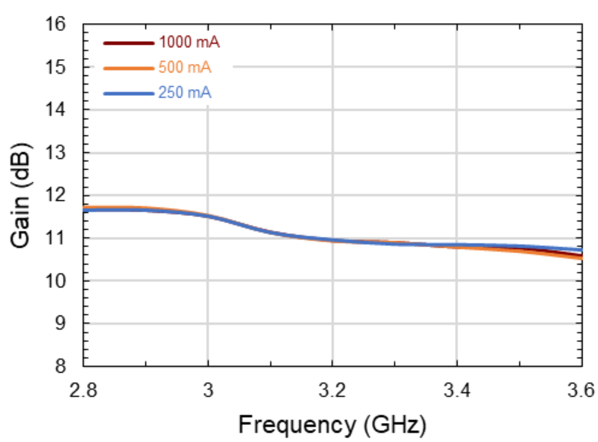
Drain Current vs. I_{DQ} and Frequency



Gate Current vs. I_{DQ} and Frequency



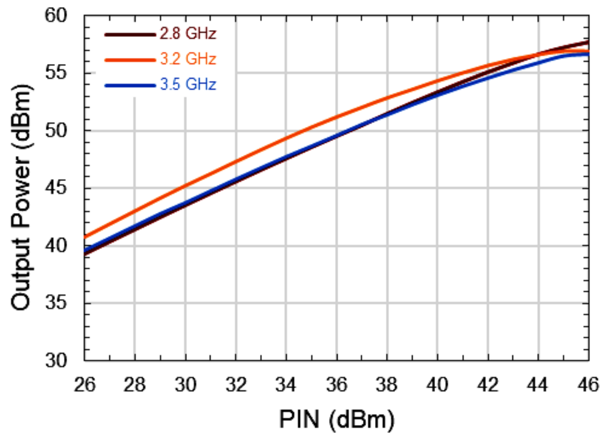
Power Gain vs. I_{DQ} and Frequency



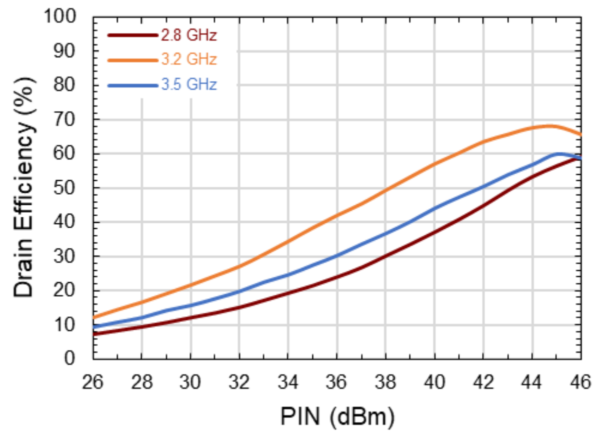
Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 2000 µs, Duty Cycle = 20%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA

For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

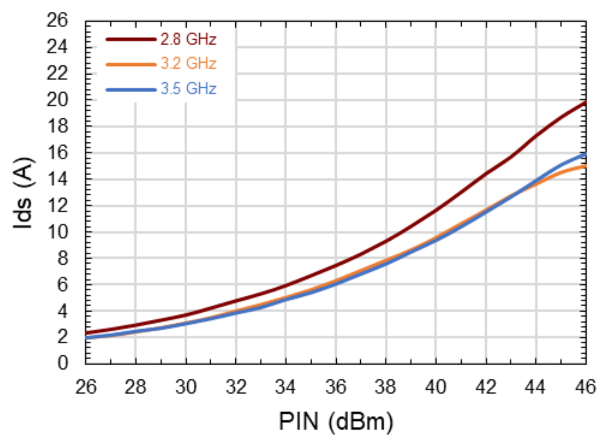
Output Power vs. Frequency and P_{IN}



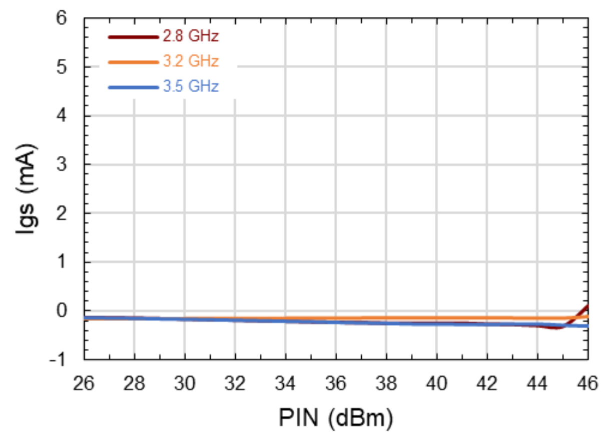
Drain Efficiency vs. Frequency and P_{IN}



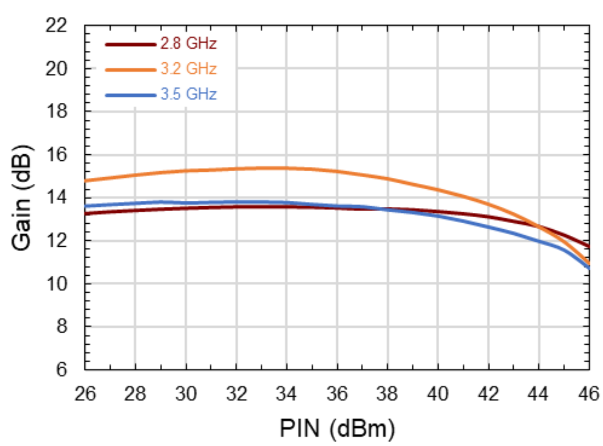
Drain Current vs. Frequency and P_{IN}



Gate Current vs. Frequency and P_{IN}

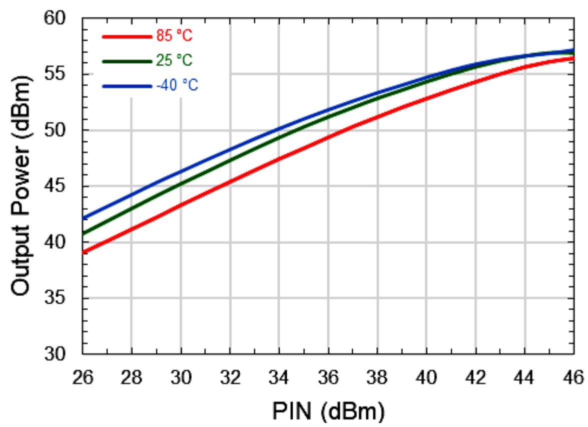


Power Gain vs. Frequency and P_{IN}

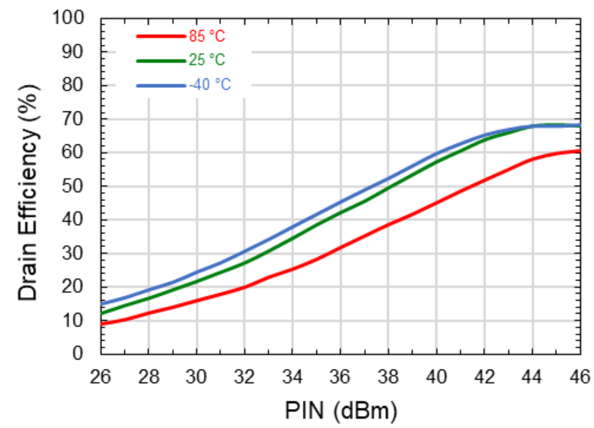


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 2000 µs, Duty Cycle = 20%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA, Frequency = 3.2GHz
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

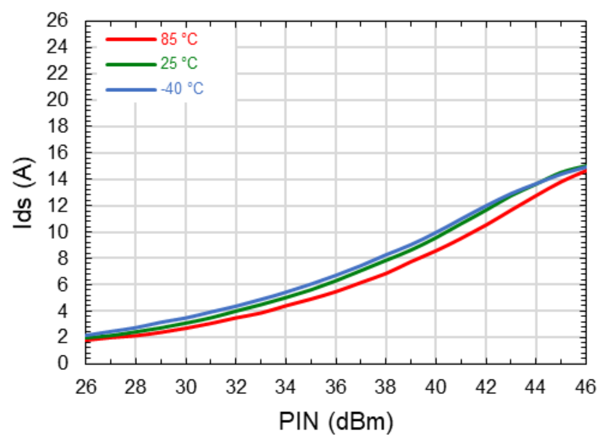
Output Power vs. Temperature and P_{IN}



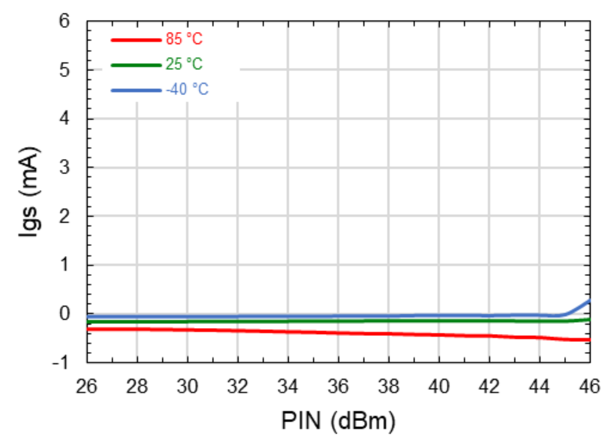
Drain Efficiency vs. Temperature and P_{IN}



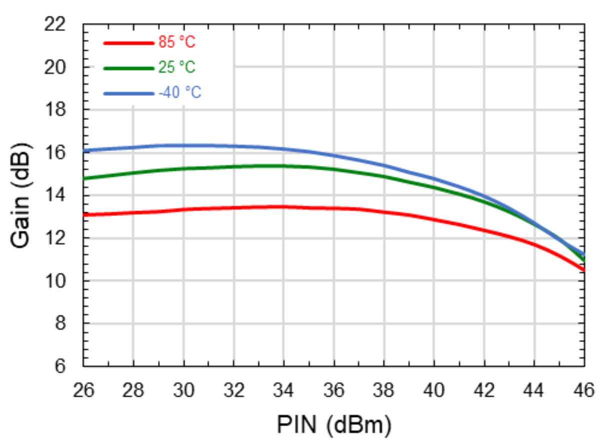
Drain Current vs. Temperature and P_{IN}



Gate Current vs. Temperature and P_{IN}

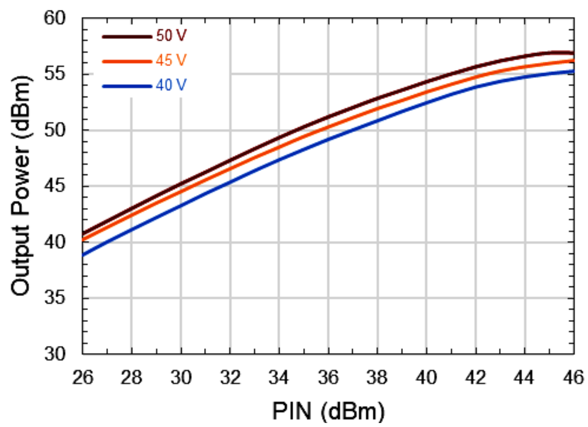


Power Gain vs. Temperature and P_{IN}

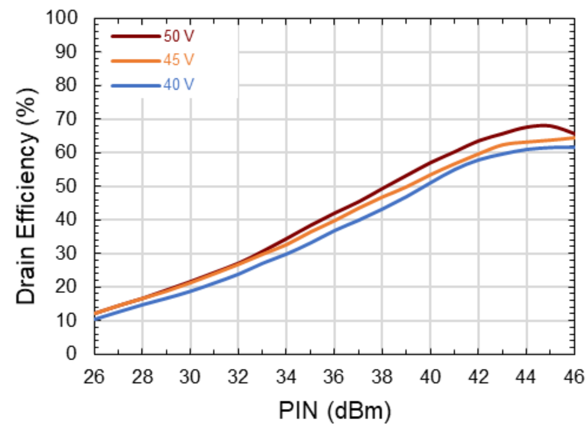


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 2000 µs, Duty Cycle = 20%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA, Frequency = 3.2GHz
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

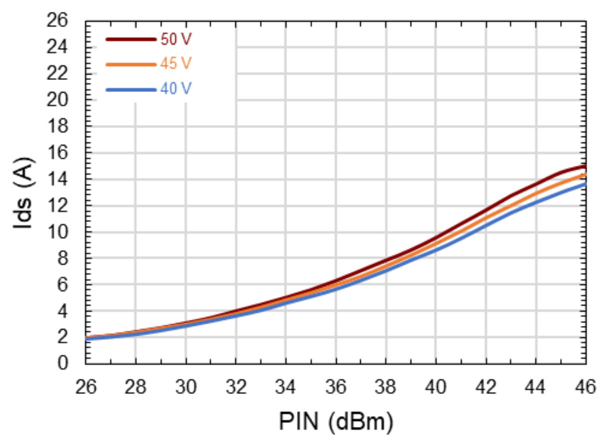
Output Power vs. V_{DS} and P_{IN}



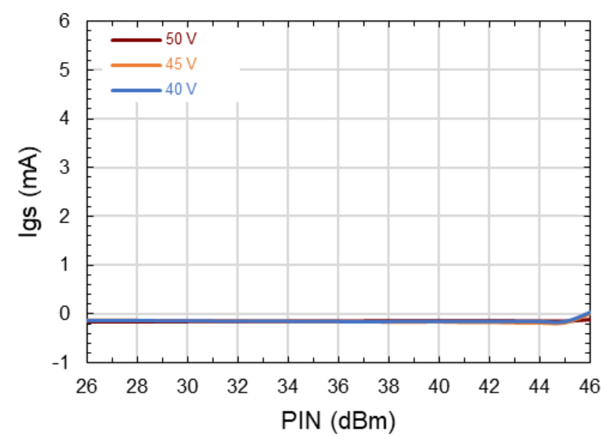
Drain Efficiency vs. V_{DS} and P_{IN}



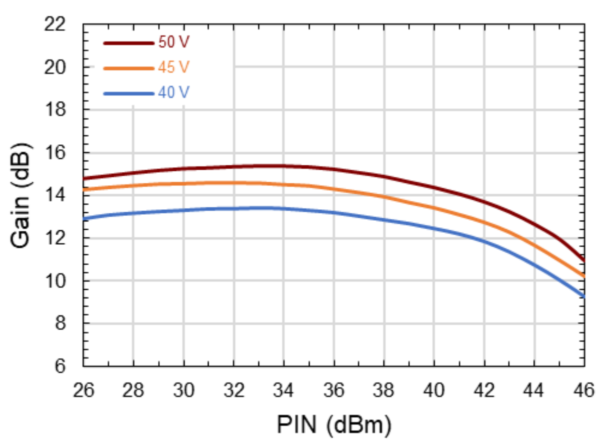
Drain Current vs. V_{DS} and P_{IN}



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

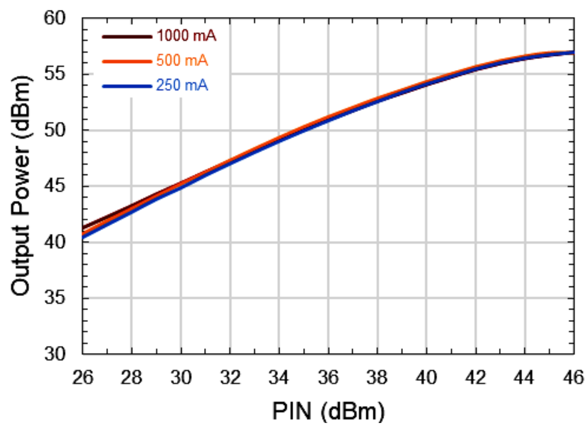


Power Gain vs. V_{DS} and P_{IN}

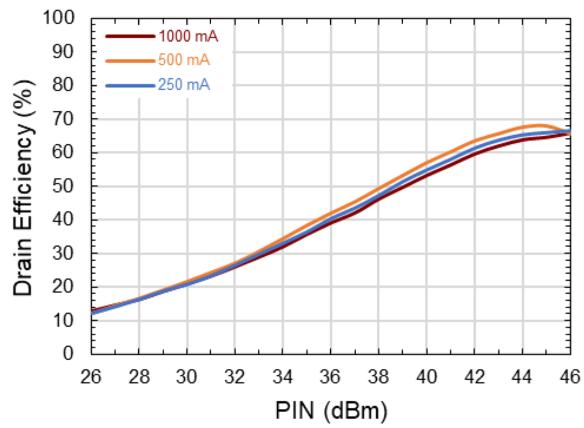


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse Width = 2000 μs, Duty Cycle = 20%, P_{IN} = 46 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA, Frequency = 3.2GHz
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

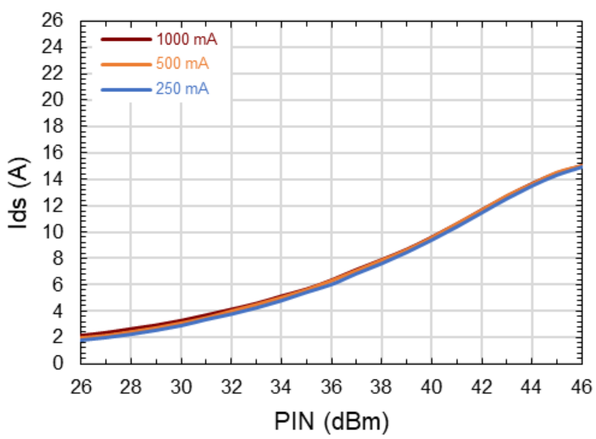
Output Power vs. I_{DQ} and P_{IN}



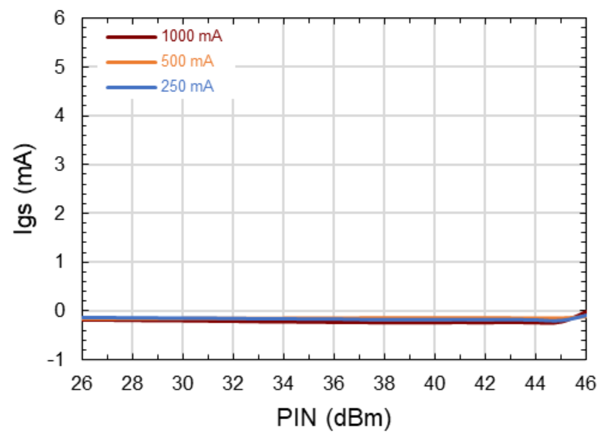
Drain Efficiency vs. I_{DQ} and P_{IN}



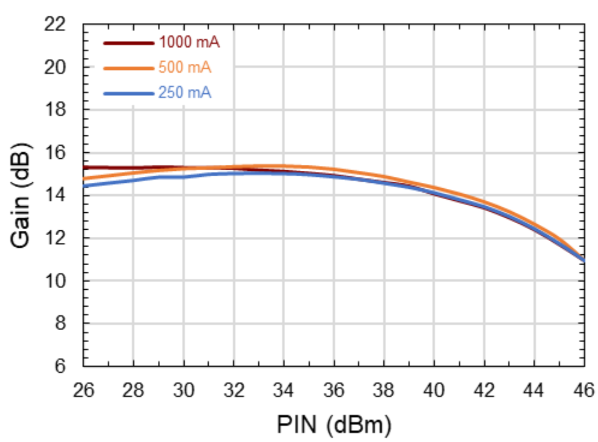
Drain Current vs. I_{DQ} and P_{IN}



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

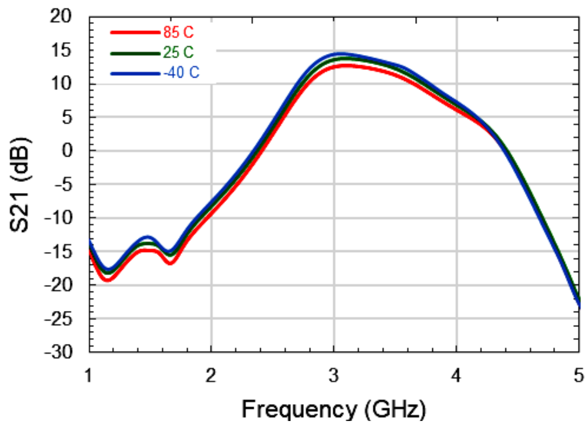


Power Gain vs. I_{DQ} and P_{IN}

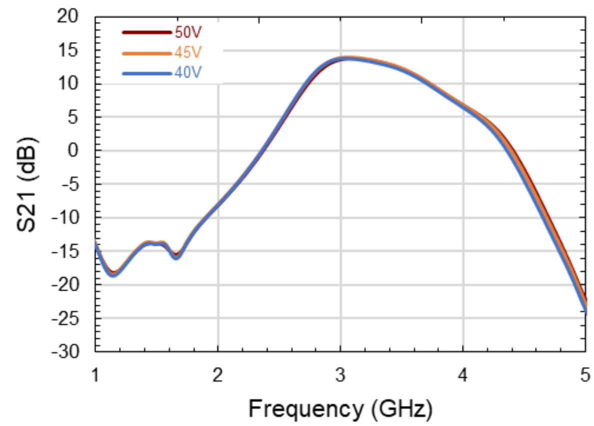


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse CW, P_{IN} = -20 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

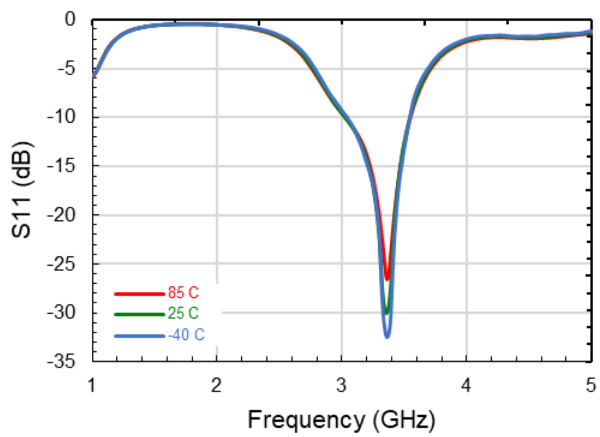
Small Signal Gain vs. Temperature and Frequency



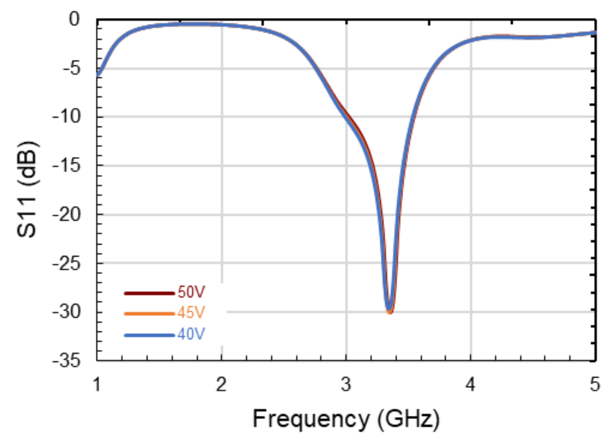
Small Signal Gain vs. V_{DS} and Frequency



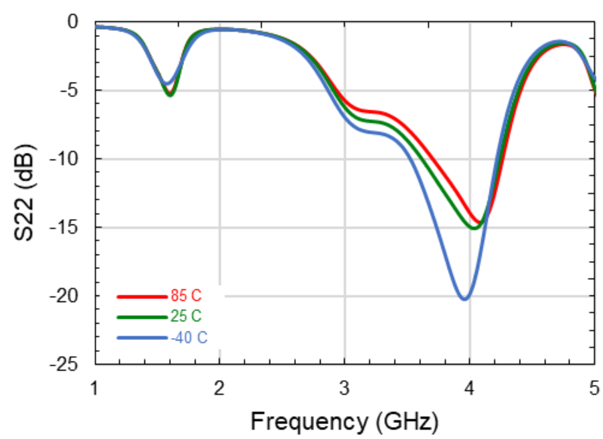
IRL vs. Temperature and Frequency



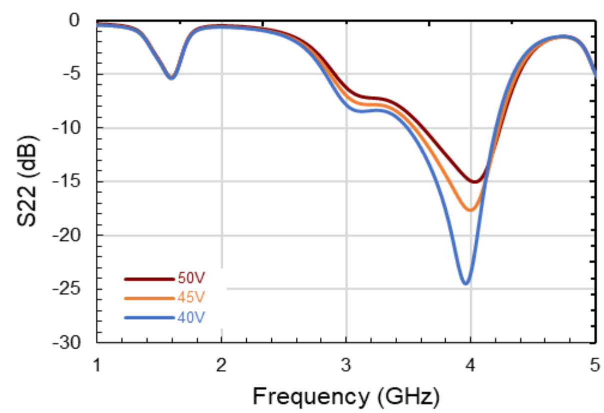
IRL vs. V_{DS} and Frequency



ORL vs. Temperature and Frequency

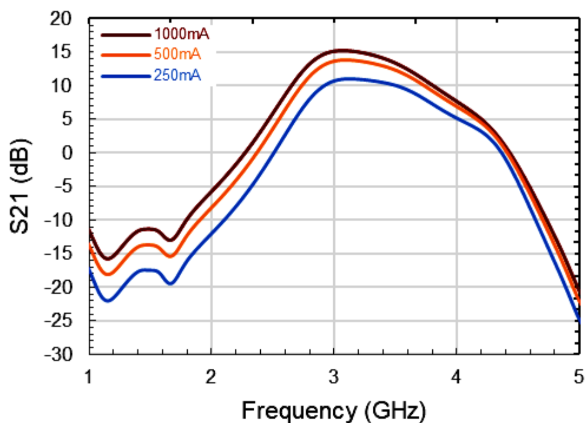


ORL vs. V_{DS} and Frequency

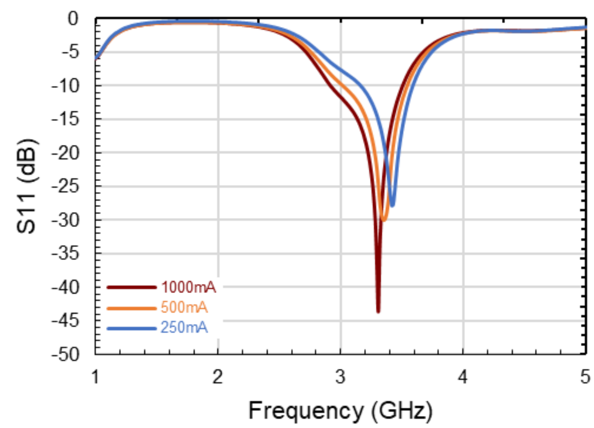


Typical Performance Curves as Measured in the 2.8 - 3.5 GHz Evaluation Test Fixture
Pulse CW, P_{IN} = -20 dBm, V_{DS} = 50 V, I_{DQ} = 500 mA
For Engineering Evaluation Only – This data does not Modify MACOM's Datasheet Limits.

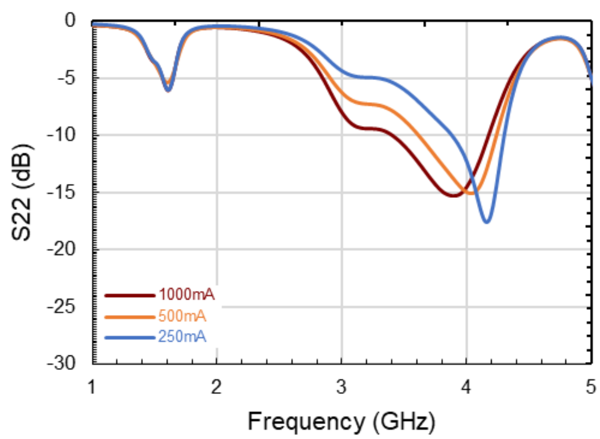
Small Signal Gain vs. I_{DQ} and Frequency



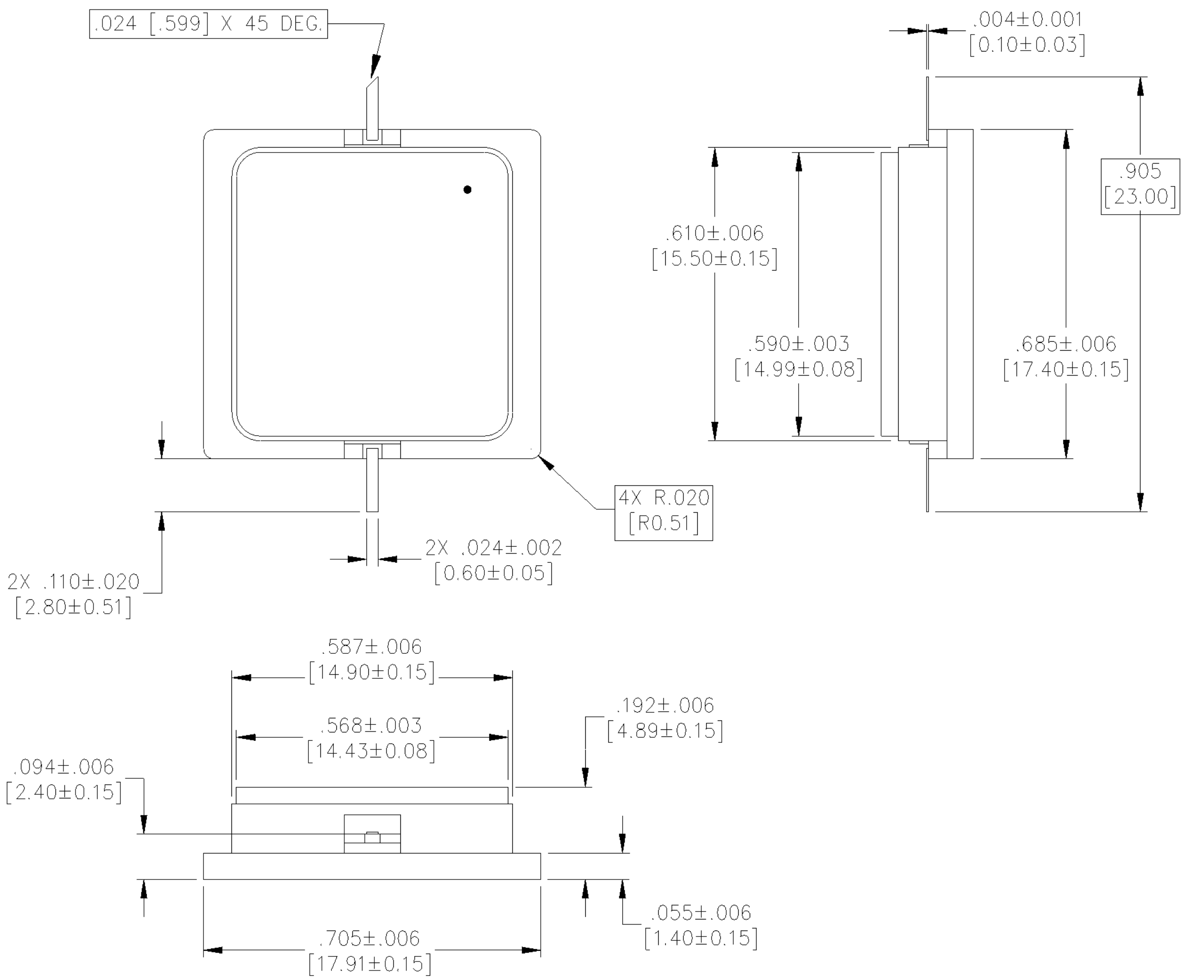
IRL vs. I_{DQ} and Frequency



ORL vs. I_{DQ} and Frequency



Lead-free AC-587SH-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