

# GaN Amplifier 50 V, 15 W

## DC - 2.7 GHz



MAGX-100027-015S0P

Rev. V2

### Features

- Suitable for Linear and Saturated Applications
- CW and Pulsed Operation: 15 W Output Power
- 260°C Reflow Compatible
- 50 V Operation
- 100% RF Tested
- RoHS\* Compliant



6 x 3 mm DFN

### Description

The MAGX-100027-015S0P is a high power GaN on Silicon HEMT D-mode transistor suitable for DC - 2.7 GHz frequency operation. The device supports both CW and pulsed operation with peak output power levels to 15 W (41.8 dBm) in a plastic package.

The MAGX-100027-015S0P is ideally suited for a multitude of applications including military radio communications, digital cellular infrastructure, RF energy, avionics, test instrumentation and RADAR.

### Typical Performance:

- $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 60\text{ mA}$ ,  $T_C = 25^\circ\text{C}$ .  
Measured under pulsed load-pull at 2.5 dB Compression, 100  $\mu\text{s}$  pulse width, 1 ms period, 10% duty cycle.

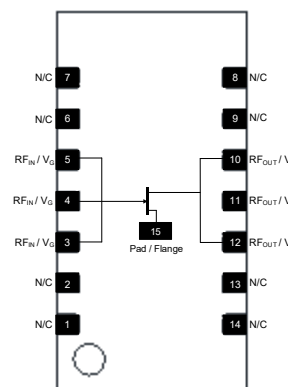
Frequency (GHz)	Output Power <sup>1</sup> (dBm)	Gain <sup>2</sup> (dB)	$\eta_D^2$ (%)
0.9	44.2	27.6	78.3
1.4	44.3	22.3	73.5
2.0	44.2	22.7	68.4
2.5	44.2	20.7	67.6
2.7	43.7	20.8	62

1. Load impedance tuned for maximum output power.
2. Load impedance tuned for maximum drain efficiency.

### Ordering Information

Part Number	Package
MAGX-100027-015S0P	Bulk Quantity
MAGX-100027-015STP	Tape and Reel
MAGX-1A0027-015S0P	Sample Board

### Functional Schematic



### Pin Configuration

Pin #	Pin Name	Function
1, 2	NC	No Connection
3 - 5	RF <sub>IN</sub> / V <sub>G</sub>	RF Input / Gate
6 - 9	NC	No Connection
10 - 12	RF <sub>OUT</sub> / V <sub>D</sub>	RF Output / Drain
13, 14	NC	No Connection
15	Pad <sup>3</sup>	Ground / Source

3. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

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

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**RF Electrical Characteristics:  $T_C = 25^\circ\text{C}$ ,  $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 60\text{ mA}$**   
**Note: Performance in MACOM Evaluation Test Fixture, 50  $\Omega$  system**

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed <sup>4</sup> , 2.5 GHz	$G_{SS}$	-	17.6	-	dB
Power Gain	Pulsed <sup>4</sup> , 2.5 GHz, 2.5 dB Gain Compression	$G_{SAT}$	-	15.3	-	dB
Saturated Drain Efficiency	Pulsed <sup>4</sup> , 2.5 GHz, 2.5 dB Gain Compression	$\eta_{SAT}$	-	60	-	%
Saturated Output Power	Pulsed <sup>4</sup> , 2.5 GHz, 2.5 dB Gain Compression	$P_{SAT}$	-	44	-	dBm
Gain Variation (-25°C to +85°C)	Pulsed <sup>4</sup> 2.5 GHz	$\Delta G$	-	0.02	-	dB/°C
Power Variation (-25°C to +85°C)	Pulsed <sup>4</sup> 2.5 GHz	$\Delta P_{2.5dB}$	-	0.012	-	dB/°C
Gain	Pulsed <sup>4</sup> , 2.5 GHz, $P_{OUT} = 42.8\text{ dBm}$	$G_P$	-	17.2	-	dB
Drain Efficiency	Pulsed <sup>4</sup> , 2.5 GHz, $P_{OUT} = 42.8\text{ dBm}$	$\eta$	-	52	-	%
Ruggedness: Output Mismatch	All phase angles	$\Psi$	VSWR = 10:1, No Device Damage			

**RF Electrical Specifications:  $T_A = 25^\circ\text{C}$ ,  $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 60\text{ mA}$**   
**Note: Performance in MACOM Production Test Fixture, 50  $\Omega$  system**

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	Pulsed <sup>4</sup> , 2.5 GHz, 2.5 dB Gain Compression	$G_{SAT}$	10.5	13.2	-	dB
Saturated Drain Efficiency	Pulsed <sup>4</sup> , 2.5 GHz, 2.5 dB Gain Compression	$\eta_{SAT}$	53	59.6	-	%
Saturated Output Power	Pulsed <sup>4</sup> , 2.5 GHz, 2.5 dB Gain Compression	$P_{SAT}$	42.9	44.0	-	dBm
Gain	Pulsed <sup>4</sup> , 2.5 GHz, $P_{IN} = 27.5\text{ dBm}$	$G_P$	12.4	15.0	-	dB
Drain Efficiency	Pulsed <sup>4</sup> , 2.5 GHz, $P_{IN} = 27.5\text{ dBm}$	$\eta$	42.5	49.0	-	%

4. Pulse details: 100  $\mu\text{s}$  pulse width, 1 ms period, 10% Duty Cycle.

### DC Electrical Characteristics $T_A = 25^\circ\text{C}$

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	$V_{GS} = -8\text{ V}$ , $V_{DS} = 130\text{ V}$	$I_{DLK}$	-	-	3.3	mA
Gate-Source Leakage Current	$V_{GS} = -8\text{ V}$ , $V_{DS} = 0\text{ V}$	$I_{GLK}$	-	-	3.3	mA
Gate Threshold Voltage	$V_{DS} = 50\text{ V}$ , $I_D = 3.3\text{ mA}$	$V_T$	-	-2.0	-	V
Gate Quiescent Voltage	$V_{DS} = 50\text{ V}$ , $I_D = 60\text{ mA}$	$V_{GSQ}$	-2.4	-1.8	-1.4	V
On Resistance	$V_{GS} = 2\text{ V}$ , $I_D = 23.1\text{ mA}$	$R_{ON}$	-	1.5	-	$\Omega$
Maximum Drain Current	$V_{DS} = 7\text{ V}$ pulsed, pulse width 300 $\mu\text{s}$	$I_{D,MAX}$	-	1.93	-	A

**Absolute Maximum Ratings**<sup>5,6,7,8,9</sup>

Parameter	Absolute Maximum
Drain Source Voltage, $V_{DS}$	130 V
Gate Source Voltage, $V_{GS}$	-10 to 3 V
Gate Current, $I_G$	10 mA
Storage Temperature Range	-65°C to +150°C
Case Operating Temperature Range	-40°C to +85°C
Channel Operating Temperature Range, $T_{CH}$	-40°C to +225°C
Absolute Maximum Channel Temperature	+250°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  $MTTF > 1 \times 10^7$  hours.
8. Operating at nominal conditions with  $T_{CH} \leq 225^\circ\text{C}$  will ensure  $MTTF > 1 \times 10^7$  hours.
9. MTTF may be estimated by the expression  $MTTF \text{ (hours)} = A e^{[B + C/(T+273)]}$  where  $T$  is the channel temperature in degrees Celsius,  $A = 3.686$ ,  $B = -35.00$ , and  $C = 25,416$ .

**Thermal Characteristics**<sup>10</sup>

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	$V_{DS} = 50$ V, $P_D = 13$ W, $T_{CASE} = 85^\circ\text{C}$ , $T_{CH} = 225^\circ\text{C}$	$R_{\theta}(\text{FEA})$	7.7	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	$V_{DS} = 50$ V, $P_D = 13.5$ W, $T_{CASE} = 85^\circ\text{C}$ , $T_{CH} = 225^\circ\text{C}$	$R_{\theta}(\text{IR})$	8.9	°C/W

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

**Handling Procedures**

Please observe the following precautions to avoid damage:

**Static Sensitivity**

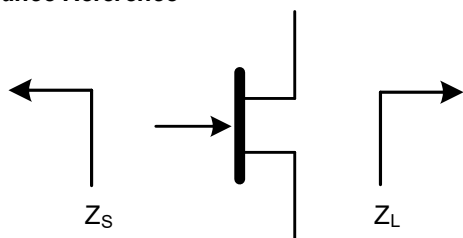
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A, CDM Class C2B devices.

**Pulsed<sup>4</sup> Load-Pull Performance  
Reference Plane at Device Leads**

Frequency (GHz)	$Z_{SOURCE}$ ( $\Omega$ )	Maximum Output Power					
		$V_{DS} = 50\text{ V}, I_{DQ} = 60\text{ mA}, T_C = 25^\circ\text{C}, P_{2.5dB}$					
		$Z_{LOAD}^1$ ( $\Omega$ )	Gain (dB)	$P_{OUT}$ (dBm)	$P_{OUT}$ (W)	$\eta_D$ (%)	AM/PM <sup>11</sup> (°)
0.9	5 + j13.8	38.2 + j21.2	26.7	44.2	26.3	66	0.5
1.4	5 + j8.6	27.4 + j15	21.2	44.3	26.9	57.9	0.1
2.0	5 + j4.7	22.7 + j13.8	18.2	44.2	26.3	57.7	-0.5
2.5	5 + j1.5	14.1 + j13.9	19.2	44.2	26.3	58.6	1.6
2.7	5 + j0.2	13.1 + j14.5	19.1	43.7	23.4	55	1.3

Frequency (GHz)	$Z_{SOURCE}$ ( $\Omega$ )	Maximum Drain Efficiency					
		$V_{DS} = 50\text{ V}, I_{DQ} = 60\text{ mA}, T_C = 25^\circ\text{C}, P_{2.5dB}$					
		$Z_{LOAD}^2$ ( $\Omega$ )	Gain (dB)	$P_{OUT}$ (dBm)	$P_{OUT}$ (W)	$\eta_D$ (%)	AM/PM <sup>11</sup> (°)
0.9	5 + j13.8	38.4 + j50.8	27.6	42.9	19.5	78.3	1.2
1.4	5 + j8.6	14.2 + j32.7	22.3	42.2	16.6	73.5	1.3
2.0	5 + j4.7	11.6 + j23.2	22.7	42.5	17.8	68.4	2.2
2.5	5 + j1.5	8.2 + j20.4	20.7	42.7	18.6	67.6	1.0
2.7	5 + j0.2	7.5 + j18.8	20.8	42.4	17.4	62	1.3

**Impedance Reference**



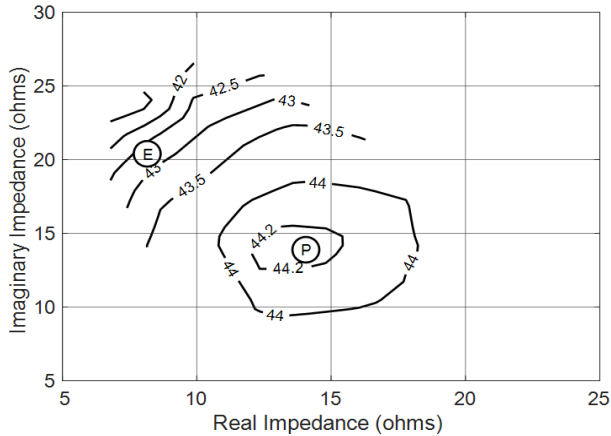
$Z_{SOURCE}$  = Measured impedance presented to the input of the device at package reference plane.

$Z_{LOAD}$  = Measured impedance presented to the output of the device at package reference plane.

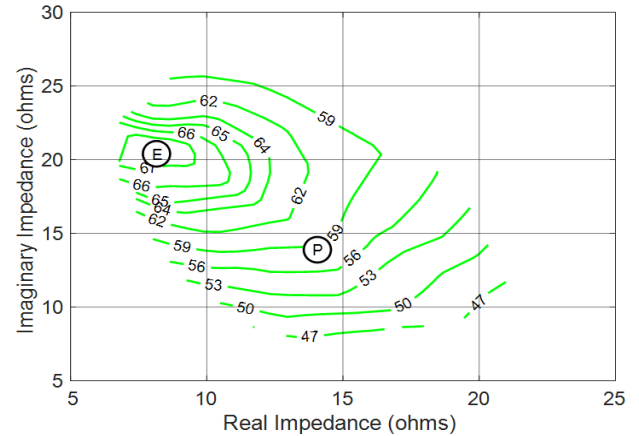
11. AM/PM listed are relative values.

**Pulsed<sup>4</sup> Load-Pull Performance  
2.5 GHz**

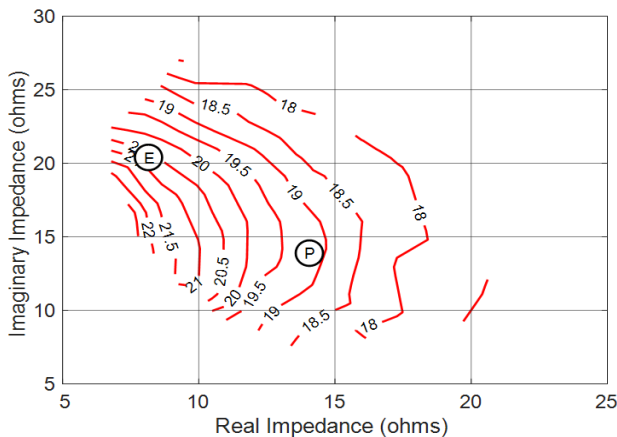
**P2.5dB Loadpull Output Power Contours (dBm)**



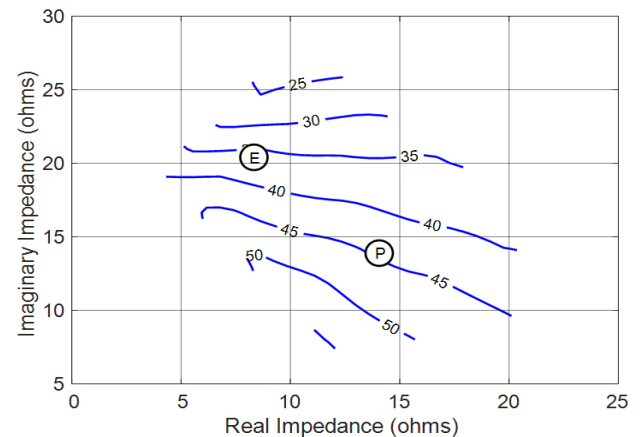
**P2.5dB Loadpull Drain Efficiency Contours (%)**



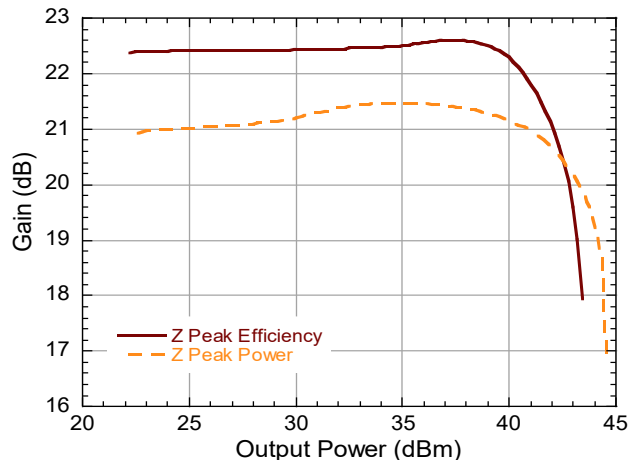
**P2.5dB Loadpull Gain Contours (dB)**



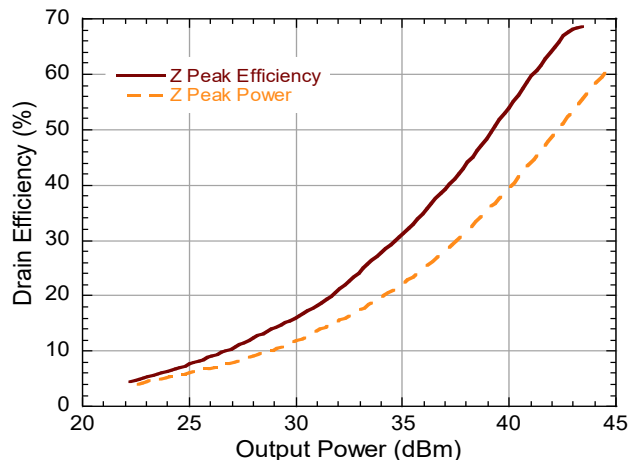
**P2.5dB Loadpull AM/PM Contours (°)**



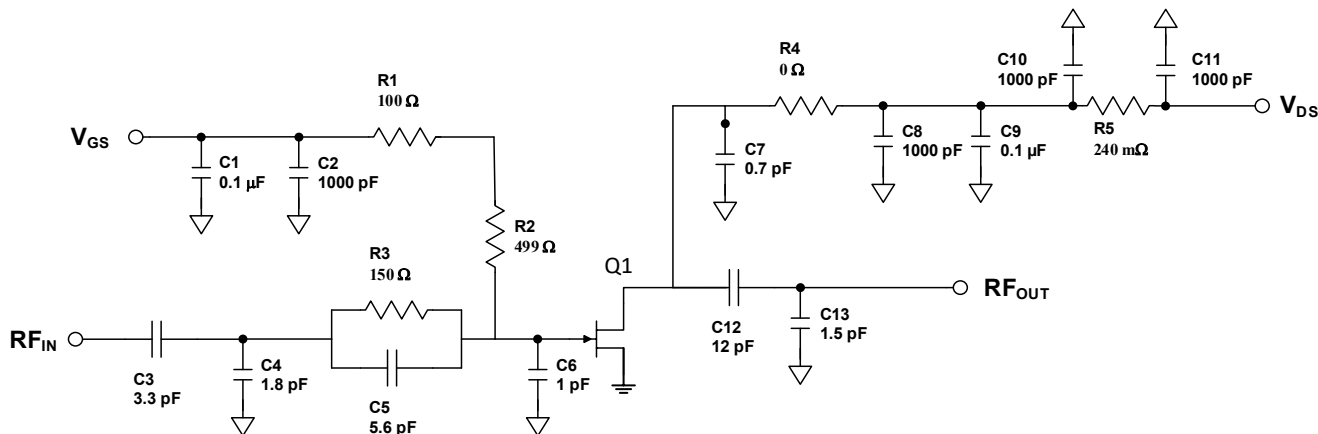
**Gain vs. Output Power**



**Drain Efficiency vs. Output Power**



Evaluation Test Fixture and Recommended Tuning Solution 2.45 - 2.55 GHz



**Description**

Parts measured on evaluation board (20-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.

**Bias Sequencing**

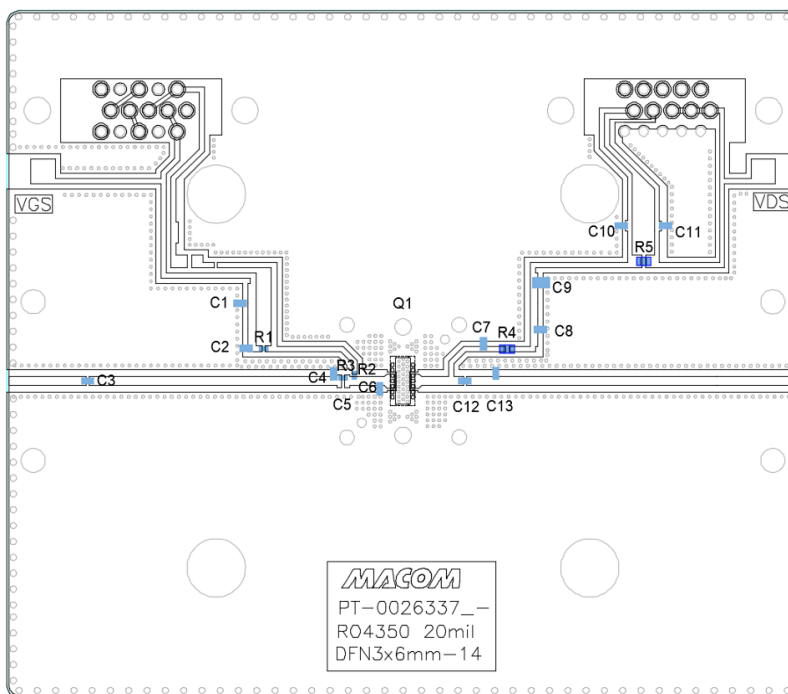
**Turning the device ON**

1. Set  $V_{GS}$  to the pinch-off ( $V_P$ ).
2. Turn on  $V_{DS}$  to nominal Voltage (50 V).
3. Increase  $V_{GS}$  until  $I_{DSQ}$  current is reached.
4. Apply RF power to desired level.

**Turning the device OFF**

1. Turn the RF power off.
2. Decrease  $V_{GS}$  down to  $V_P$  pinch-off.
3. Decrease  $V_{DS}$  down to 0 V.
4. Turn off  $V_{GS}$ .

Evaluation Test Fixture and Recommended Tuning Solution 2.45 - 2.55 GHz

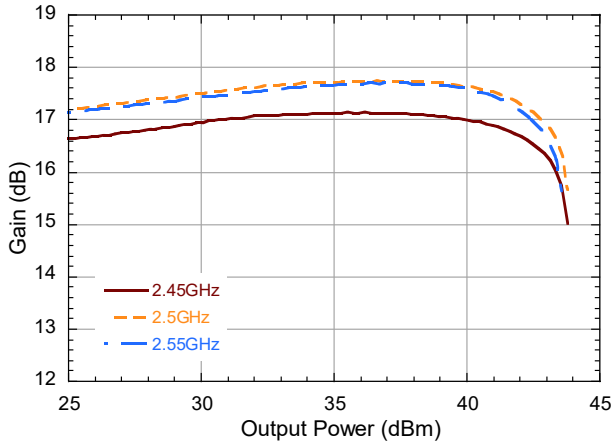


Parts List

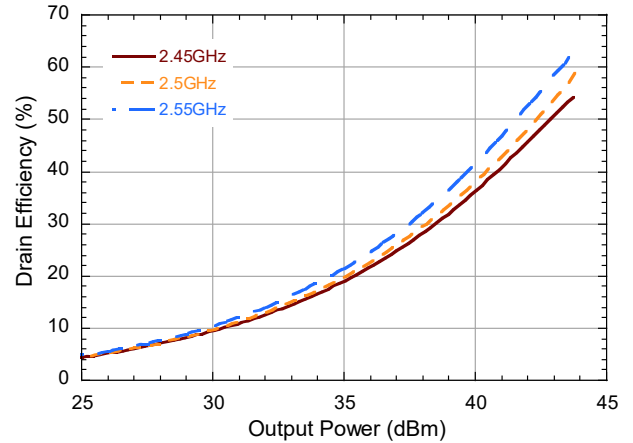
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1, C9	0.1 $\mu$ F	5 %	Murata	GCJ188R72A104KA01D
C2, C10, C11	1000 pF	+/- 0.1 pF	Murata	GCJ188R92A102KA01D
C3	3.3 pF	+/- 0.1 pF	PPI	0603N3R3BL250
C4	1.8 pF	+/- 0.1 pF	PPI	0603N1R8BL250
C5	5.6 pF	+/- 0.1 pF	PPI	0402N5R6BL250
C6	1 pF	+/- 0.1 pF	PPI	0603N1R0BL250
C7	0.7 pF	+/- 0.1 pF	PPI	0603N0R7BL250
C8	1000 pF	5 %	Murata	GRM21AR72E102KW01D
C12	12 pF	+/- 5%	PPI	0603N120BL250
C13	1.5 pF	+/- 0.1 pF	PPI	0603N1R5BL250
R1	100 $\Omega$	1%	Panasonic	ERJ-PA2F1000X
R2	499 $\Omega$	1%	Viking	CR-02FL6—499R
R3	150 $\Omega$	1%	Vishay Dale	CRCW0402150RFKEDHP
R4	0 $\Omega$	1%	Vishay Dale	CRCW06030000Z0EBC
R5	240 m $\Omega$	1%	Vishay Dale	RCWE1210R240FKEA
Q1	15 W	-	MACOM	MAGX-100027-015S0P
PCB	Rogers RO4350, 20mil, 1oz Cu, Au Finish			

**Typical Performance Curves as Measured in the 2.45 - 2.55 GHz Evaluation Test Fixture:**  
**Pulsed<sup>4</sup> 2.5 GHz,  $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 60\text{ mA}$ ,  $T_C = 25^\circ\text{C}$**   
**Unless Otherwise Noted**

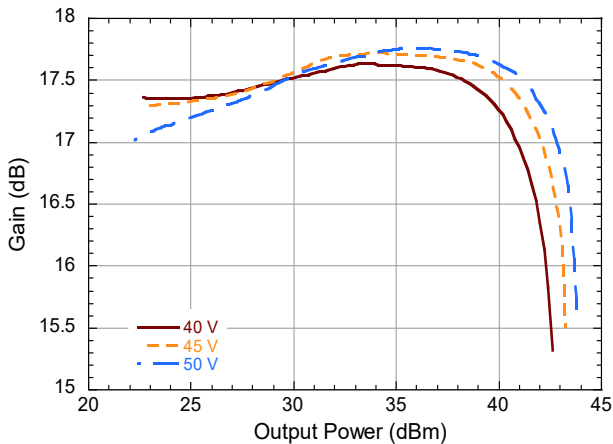
**Gain vs. Output Power**



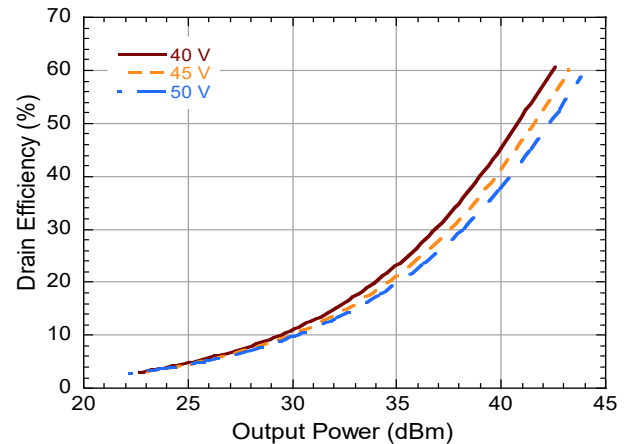
**Drain Efficiency vs. Output Power**



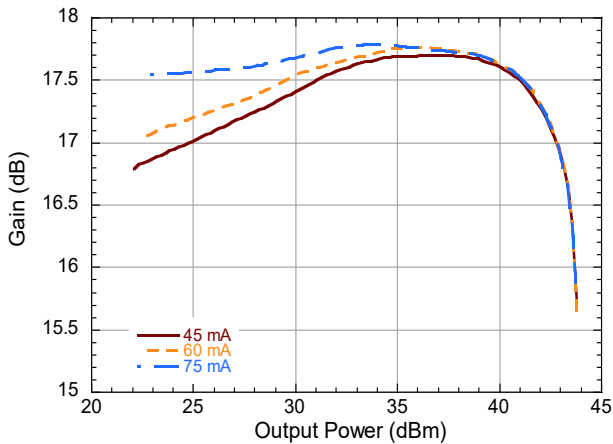
**Gain vs. Output Power and  $V_{DS}$**



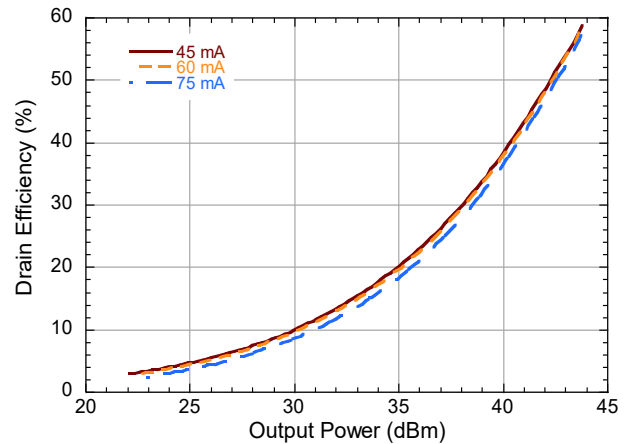
**Drain Efficiency vs. Output Power and  $V_{DS}$**



**Gain vs. Output Power and  $I_{DQ}$**



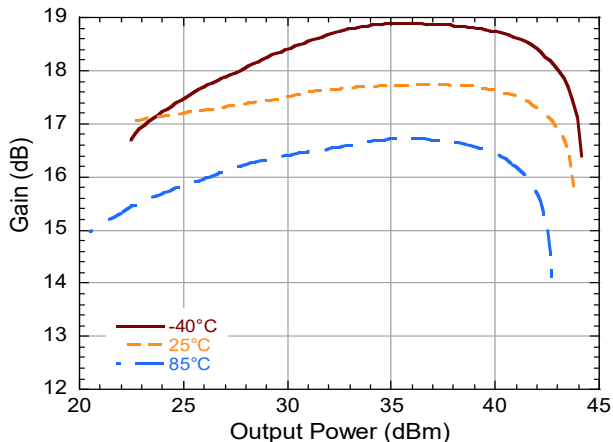
**Drain Efficiency vs. Output Power and  $I_{DQ}$**



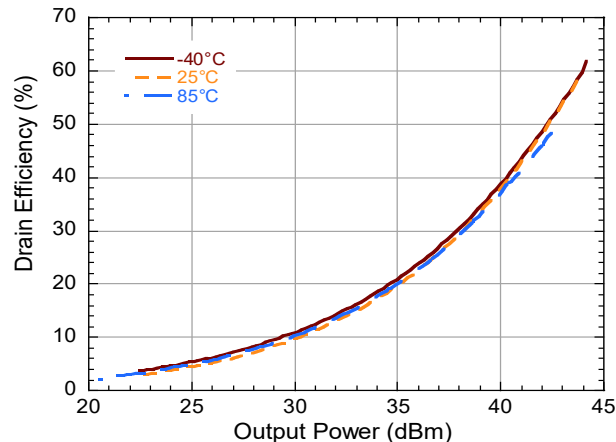


**Typical Performance Curves as Measured in the 2.45 - 2.55 GHz Evaluation Test Fixture:  
Pulsed<sup>4</sup> 2.5 GHz,  $V_{DS} = 50$  V,  $I_{DQ} = 60$  mA,  $T_C = 25^\circ\text{C}$   
Unless Otherwise Noted**

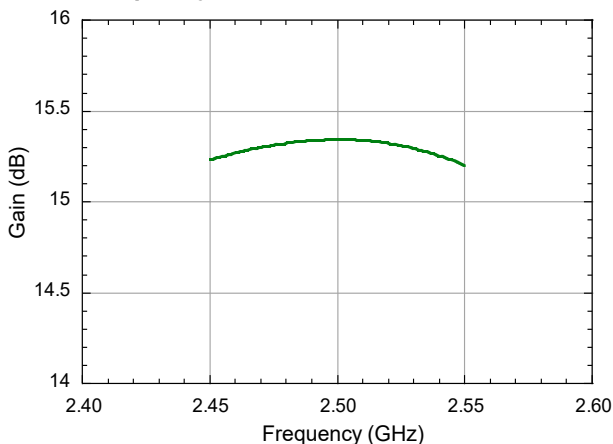
**Gain vs. Output Power and  $T_c$**



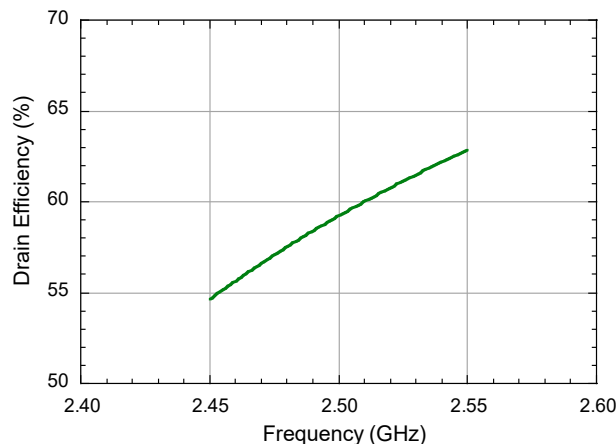
**Drain Efficiency vs. Output Power and  $T_c$**



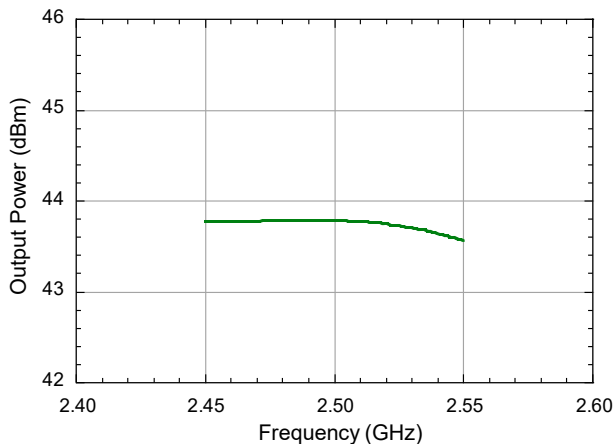
**Gain vs. Frequency, 2.5 dB Gain Compression**



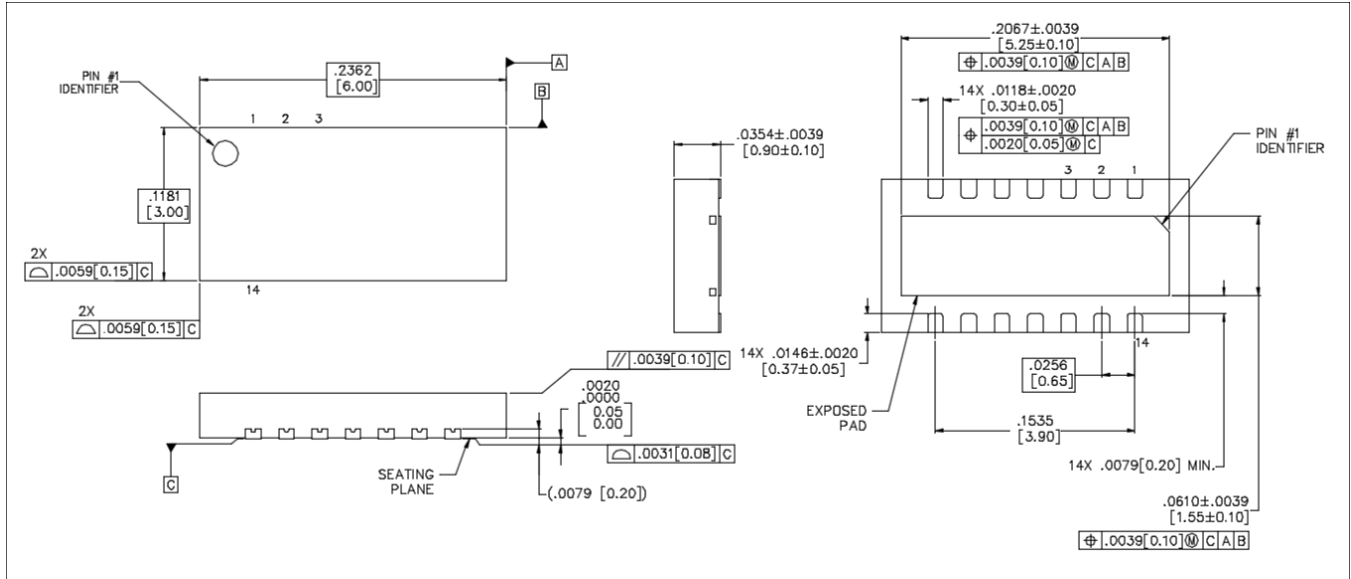
**Drain Efficiency vs. Frequency, 2.5 dB Gain Compression**



**Output Power vs. Frequency, 2.5 dB Gain Compression**



Lead-Free 6 x 3 mm DFN Package Dimensions†



† Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity level (MSL) 3 requirements.  
Plating is NiPdAu.

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