

## Features

- GaN on Si HEMT D-Mode Transistor
- Suitable for linear and saturated applications
- Tunable from DC - 3.5 GHz
- 28 V Operation
- 12 dB Gain @ 2.5 GHz
- 54 % Drain Efficiency @ 2.5 GHz
- 100 % RF Tested
- Standard metal ceramic package with bolt down flange
- RoHS\* Compliant

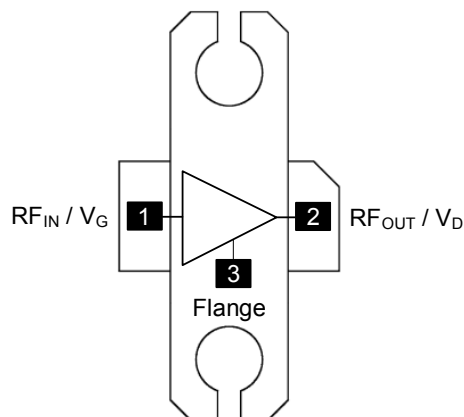
## Description

The NPT1015 GaN HEMT is a wideband transistor optimized for DC - 3.5 GHz operation. This device supports CW, pulsed, and linear operation with output power levels to 45 W (46.5 dBm) in an industry standard metal-ceramic package with bolt down flange.

The NPT1015 is ideally suited for defense communications, land mobile radio, avionics, wireless infrastructure, ISM applications and VHF/UHF/L/S-band radar.

Built using the SIGANTIC® process - a proprietary GaN-on-Silicon technology.

## Functional Schematic



## Pin Configuration

Pin No.	Pin Name	Function
1	RF <sub>IN</sub> / V <sub>G</sub>	RF Input / Gate
2	RF <sub>OUT</sub> / V <sub>D</sub>	RF Output / Drain
3	Flange <sup>1</sup>	Ground / Source

1. The Flange must be connected to RF and DC ground. This path must also provide a low thermal resistance heat path.

## Ordering Information

Part Number	Package
NPT1015B	bulk quantity
NPT1015B-SMBPPR	sample

\* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

**RF Electrical Specifications:  $T_C = 25^\circ\text{C}$ ,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$**

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	CW, 2.5 GHz	$G_{SS}$	-	13.5	-	dB
Saturated Output Power	CW, 2.5 GHz	$P_{SAT}$	-	47.3	-	dBm
Drain Efficiency at Saturation	CW, 2.5 GHz	$\eta_{SAT}$	-	57	-	%
Power Gain	2.5 GHz, $P_{OUT} = 45\text{ W}$	$G_P$	10.5	12	-	dB
Drain Efficiency	2.5 GHz, $P_{OUT} = 45\text{ W}$	$\eta$	47	54	-	%
Ruggedness: Output Mismatch	All phase angles	$\Psi$	VSWR = 15:1, No Device Damage			

**DC Electrical Characteristics:  $T_C = 25^\circ\text{C}$**

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	$V_{GS} = -8\text{ V}$ , $V_{DS} = 100\text{ V}$	$I_{DLK}$	-	-	16	mA
Gate-Source Leakage Current	$V_{GS} = -8\text{ V}$ , $V_{DS} = 0\text{ V}$	$I_{GLK}$	-	-	8	mA
Gate Threshold Voltage	$V_{DS} = 28\text{ V}$ , $I_D = 16\text{ mA}$	$V_T$	-2.3	-1.5	-0.7	V
Gate Quiescent Voltage	$V_{DS} = 28\text{ V}$ , $I_D = 400\text{ mA}$	$V_{GSQ}$	-2.1	-1.2	-0.5	V
On Resistance	$V_{DS} = 2\text{ V}$ , $I_D = 120\text{ mA}$	$R_{ON}$	-	0.22	-	$\Omega$
Maximum Drain Current	$V_{DS} = 7\text{ V}$ pulsed, pulse width 300 $\mu\text{s}$	$I_{D,MAX}$	-	9.2	-	A

## Absolute Maximum Ratings<sup>2,3,4</sup>

Parameter	Absolute Maximum
Drain Source Voltage, $V_{DS}$	100 V
Gate Source Voltage, $V_{GS}$	-10 to 3 V
Gate Current, $I_G$	32 mA
Junction Temperature, $T_J$	+200°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

2. Exceeding any one or combination of these limits may cause permanent damage to this device.
3. MACOM does not recommend sustained operation near these survivability limits.
4. Operating at nominal conditions with  $T_J \leq 200^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.

## Thermal Characteristics<sup>5</sup>

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance	$V_{DS} = 28 \text{ V}, T_J = 180^\circ\text{C}$	$R_{\theta JC}$	2.1	°C/W

5. Junction temperature ( $T_J$ ) measured using IR Microscopy. Case temperature measured using thermocouple embedded in heat-sink.

## Handling Procedures

Please observe the following precautions to avoid damage:

## Static Sensitivity

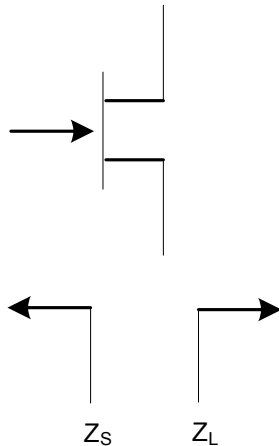
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1B devices.

**Load-Pull Performance:  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$ ,  $T_C = 25^\circ\text{C}$**

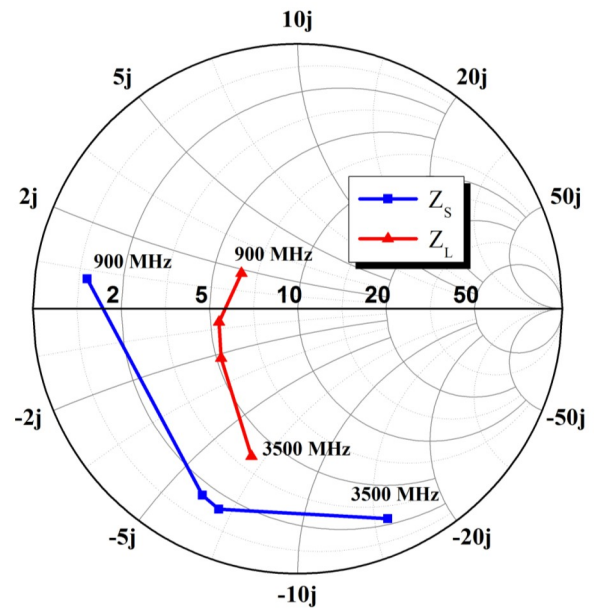
**Reference Plane at Device Leads, CW Drain Efficiency and Output Power Tradeoff Impedance**

Frequency (MHz)	$Z_S$ ( $\Omega$ )	$Z_L$ ( $\Omega$ )	$P_{SAT}$ (W)	$G_{SS}$ (dB)	Drain Efficiency @ $P_{SAT}$ (%)
900	$1.1 + j0.7$	$6.3 + j1.8$	53.7	22.5	65.1
2200	$1.6 - j6.0$	$5.4 - j0.6$	53.2	15.8	64.8
2500	$1.5 - j6.7$	$5.2 - j2.2$	50.9	60.8	
3500	$2.6 - j15$	$3.9 - j6.3$	42.0	13.9	55.4

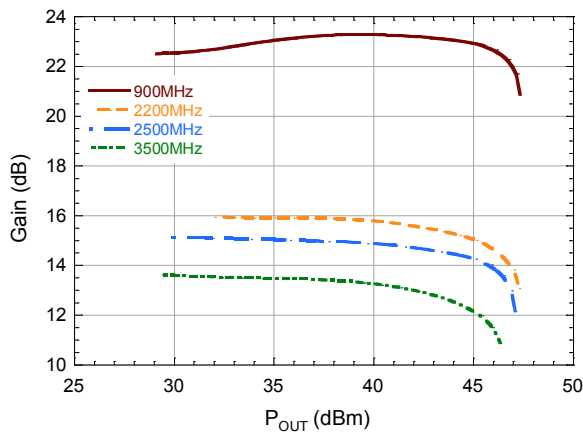
**Impedance Reference**



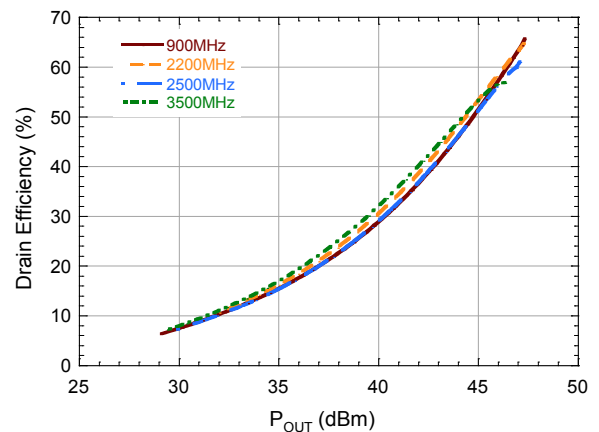
**$Z_S$  and  $Z_L$  vs. Frequency**



**Gain vs. Output Power**

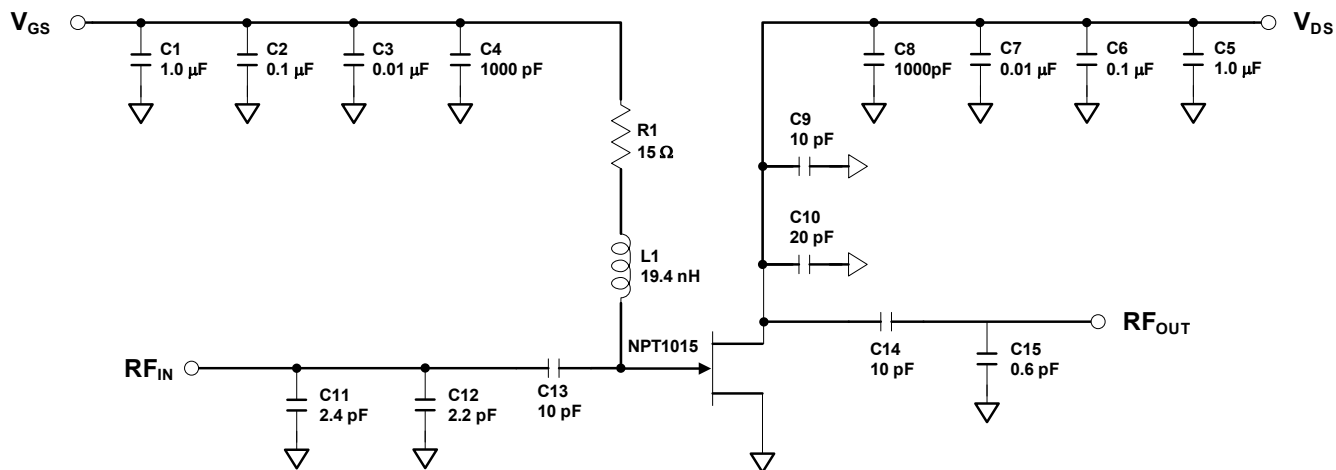


**Drain Efficiency vs. Output Power**



## Evaluation Board and Recommended Tuning Solution

### 2.5 GHz Narrowband Circuit



### 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

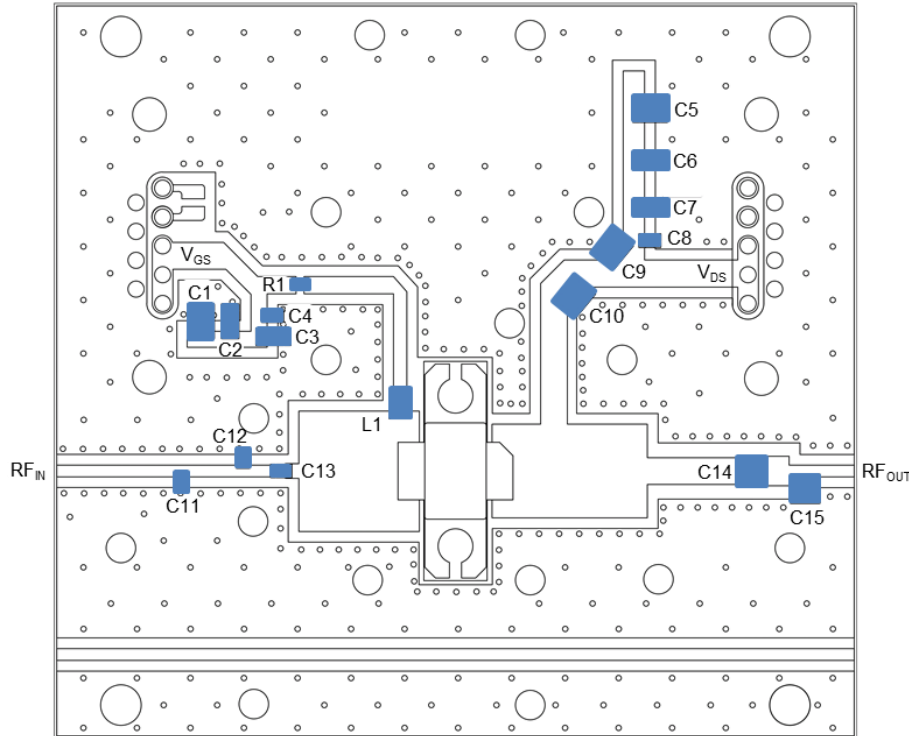
#### Turning the device ON

1. Set  $V_{GS}$  to the pinch-off ( $V_P$ ), typically -5 V.
2. Turn on  $V_{DS}$  to nominal voltage (28 V).
3. Increase  $V_{GS}$  until the  $I_{DS}$  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  $V_P$ .
3. Decrease  $V_{DS}$  down to 0 V.
4. Turn off  $V_{GS}$ .

## Evaluation Board and Recommended Tuning Solution 2.5 GHz Narrowband Circuit

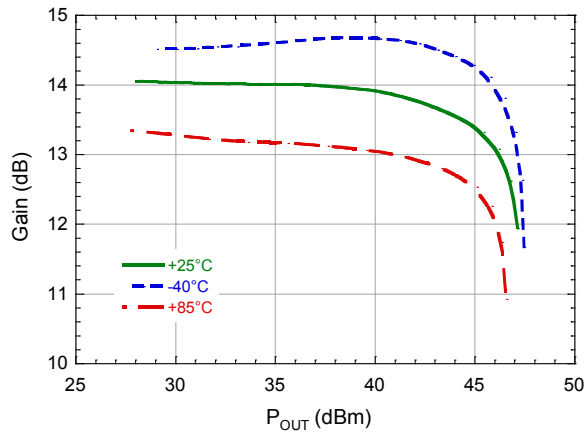


### Parts list

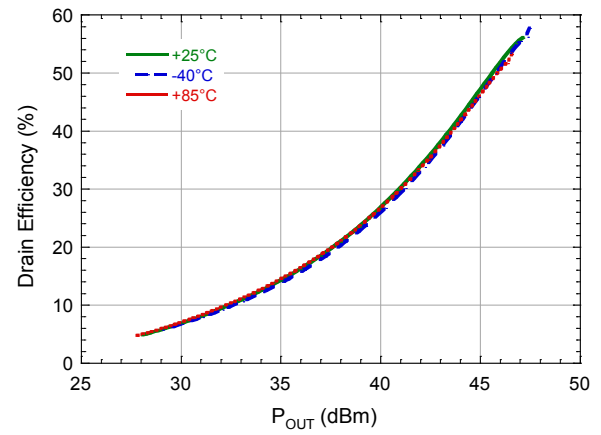
Reference	Value	Tolerance	Manufacturer	Part Number
C1, C5	1.0 $\mu$ F	10%	AVX	12101C105KAT2A
C2, C6	0.1 $\mu$ F	10%	Kemet	C1206C104K1RACTU
C3, C7	0.01 $\mu$ F	10%	AVX	1206C103KAT2A
C4, C8	1000 pF	10%	Kemet	C0805C102K1RACTU
C9, C14	10 pF	0.1 pF	ATC	ATC800B100B
C10	20 pF	0.1 pF	ATC	ATC800B200B
C11	2.4 pF	0.1 pF	ATC	ATC600F2R4B
C12	2.2 pF	0.1 pF	ATC	ATC600F2R2B
C13	10 pF	0.1 pF	ATC	ATC600F100B
C15	0.6 pF	0.1 pF	ATC	ATC600F0R6B
L1	19.4 nH	5%	CoilCraft	0806SQ-19NJL
R1	15 $\Omega$	1%	Panasonic	ERJ-2RKF15R0X
PCB	Rogers RO4350, $\epsilon_r = 3.5$ , 0.020"			

**Typical performance as measured in the 2.5 GHz evaluation board:**  
**CW,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$  (unless noted)**

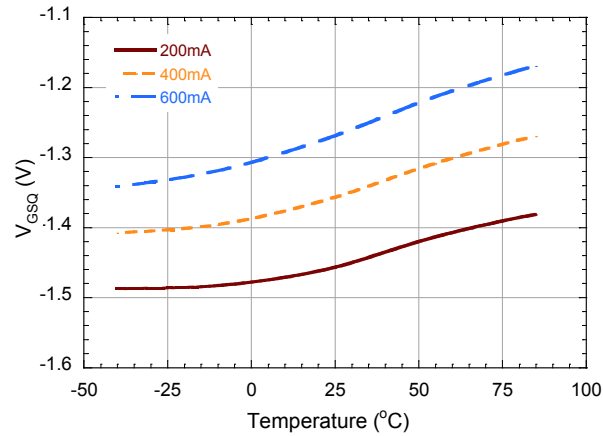
**Gain vs. Output Power over Temperature**



**Drain Efficiency vs. Output Power over Temperature**

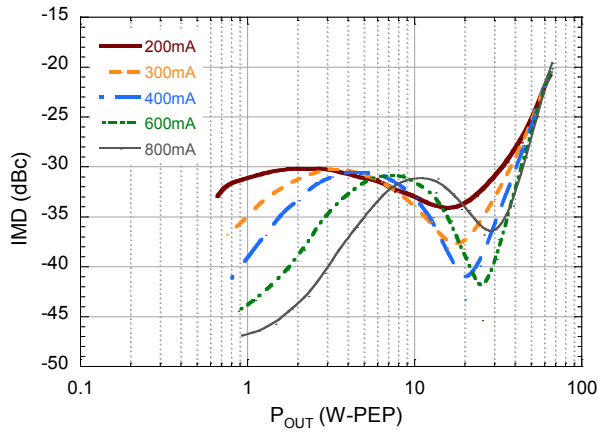


**Quiescent  $V_{GS}$  vs. Temperature**

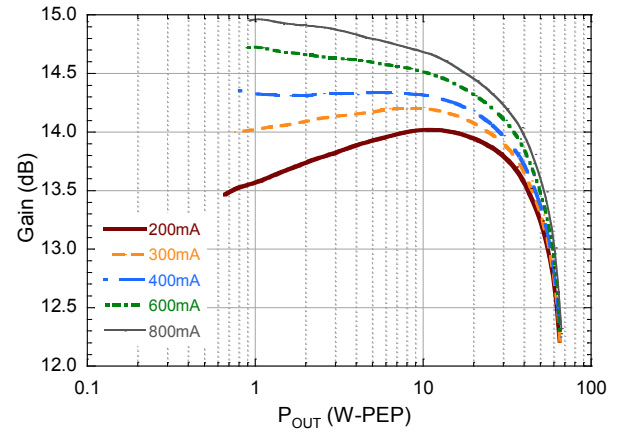


**Typical 2-Tone Performance as measured in the 2.5 GHz evaluation board:  
1 MHz Tone Spacing,  $V_{DS} = 28$  V,  $I_{DQ} = 400$  mA,  $T_C = 25^\circ\text{C}$  (unless noted)**

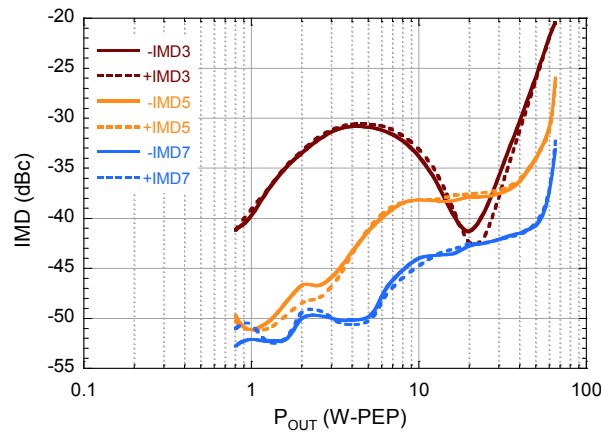
**2-Tone IMD3 vs. Output Power vs. Quiescent Current**



**2-Tone Gain vs. Output Power vs. Quiescent Current**

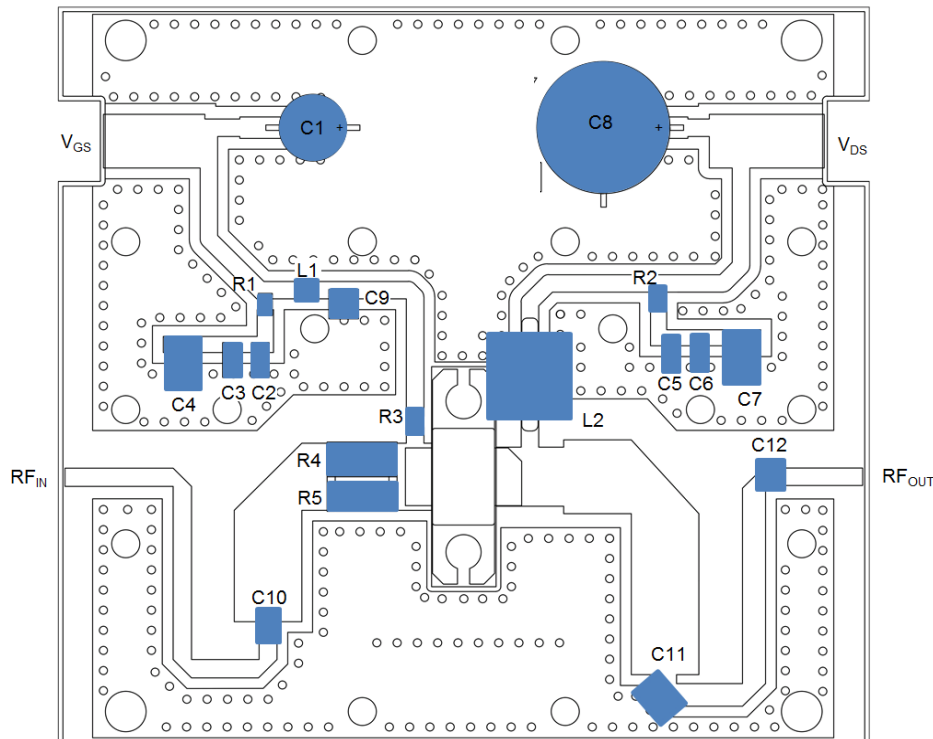


**2-Tone IMD vs. Output Power**





## Evaluation Board and Recommended Tuning Solution 600 - 1000 MHz Broadband Circuit

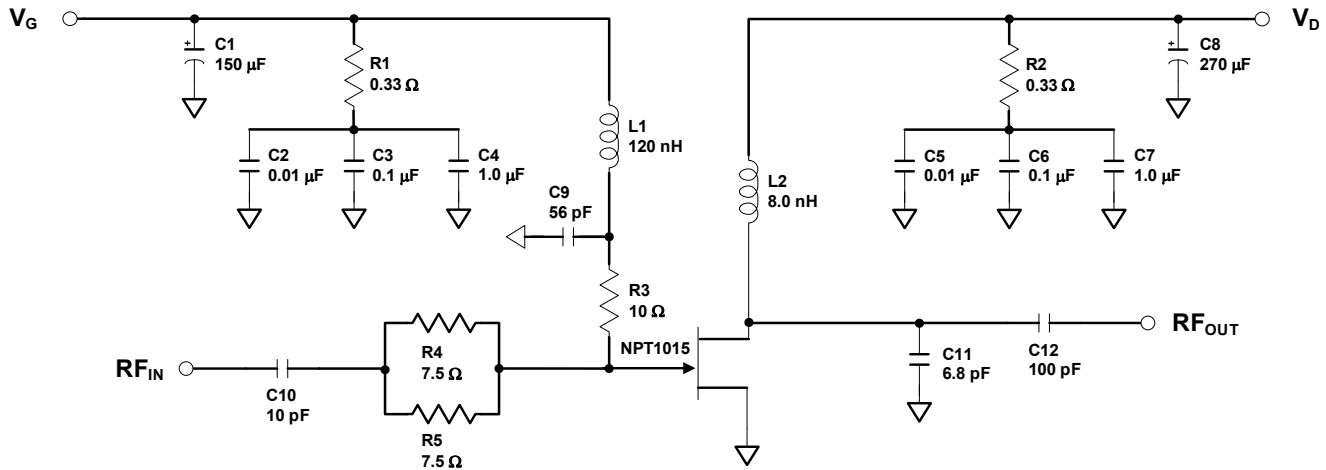


### Parts list

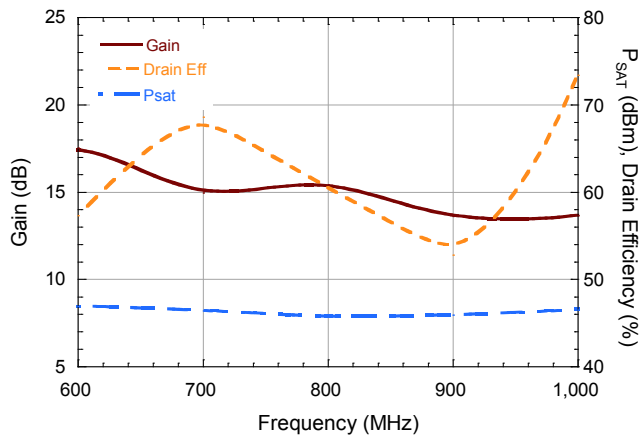
Reference	Value	Tolerance	Manufacturer	Part Number
C1	150 $\mu$ F	20%	Nichicon	UPW1C151MED
C2, C5	0.01 $\mu$ F	10%	AVX	1206C103KAT2A
C3, C6	0.1 $\mu$ F	10%	Kemet	C1206C104K1RACTU
C4, C7	1.0 $\mu$ F	10%	AVX	12101C105KAT2A
C8	270 $\mu$ F	20%	United Chemi-Con	ELXY 630ELL271MK25S
C9	56 pF	5%	ATC	ATC100B560J
C10, C12	100 pF	5%	ATC	ATC100B101J
C11	6.8 pF	5%	ATC	ATC100B6R8J
R1, R2	0.33 $\Omega$	1%	Panasonic	ERJ-6RQFR33V
R3	10 $\Omega$	1%	Panasonic	ERJ-6ENF10R0V
R4, R5	7.5 $\Omega$	1%	Stackpole	RHC2512FT7R50
L1	120 nH	5%	Coilcraft	0805CS-121XJB
L2	~50 nH	-	16 AWG Cu Wire	5 turn, 0.2"ID
PCB	Rogers LM6010, $\epsilon_r = 10.2$ , 0.025"			

## Evaluation Board and Recommended Tuning Solution

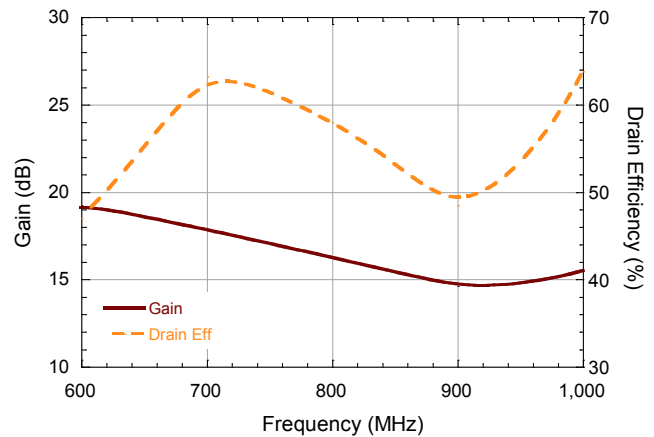
### 600 - 1000 MHz Broadband Circuit



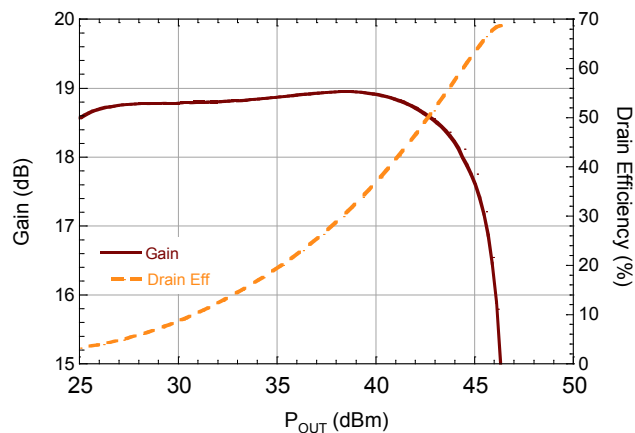
**Performance vs. Frequency at  $P_{OUT} = P_{SAT}$**



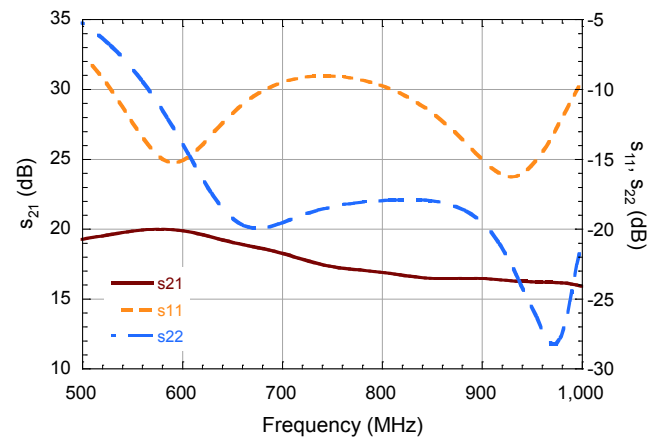
**Performance vs. Frequency at  $P_{OUT} = 45$  dBm**



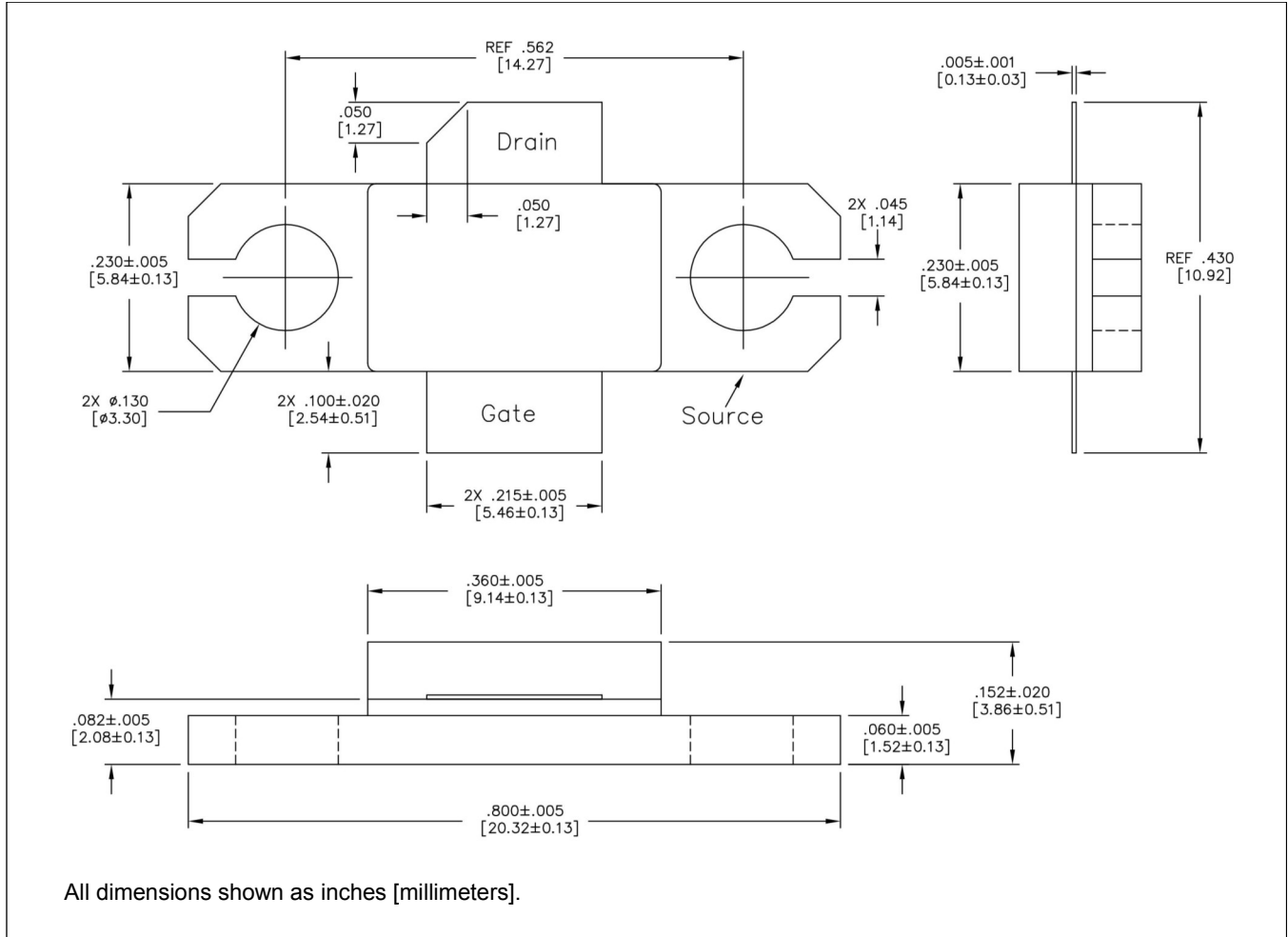
**Performance vs. Output Power ( $f = 700$  MHz)**



**Small Signal s-parameters vs. Frequency**



## AC360B-2 Metal Ceramic Package<sup>†</sup>



<sup>†</sup> Plating is Ni / Au.

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