

## Features

- GaN on Si HEMT D-Mode Amplifier
- Suitable for Linear & Saturated Applications
- Broadband Operation from 20 - 1500 MHz
- 28 V Operation
- 16 dB Gain @ 1 GHz
- 42% PAE @ 1 GHz
- 100% RF Tested
- 50  $\Omega$  Input / Output Matched
- Lead-Free 4 mm 16-lead QFN plastic Package
- RoHS\* Compliant and 260°C Reflow Compatible

## Description

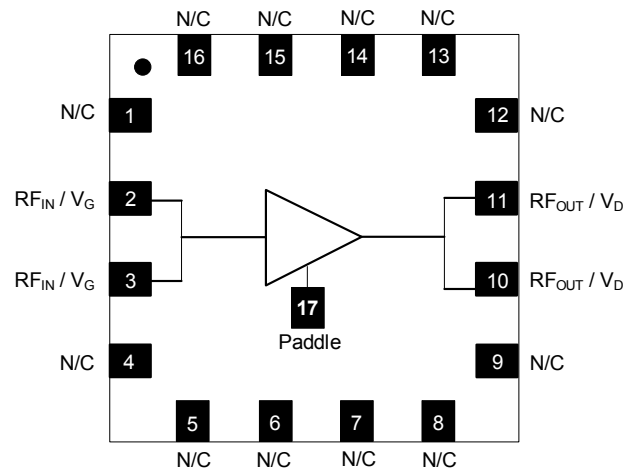
The NPA1003QA is a GaN on silicon power amplifier optimized for 20 - 1500 MHz operation. This amplifier has been designed for saturated and linear operation with output levels to 5 W (37 dBm) assembled in a lead-free 4 mm 16-lead QFN plastic package.

The NPA1003QA is ideally suited for broadband general purpose, test and measurement, defense communications, land mobile radio and wireless infrastructure.

## Ordering Information

Part Number	Package
NPA1003QA	Bulk
NPA1003QA-SMBPPR	sample

## Functional Schematic



## Pin Designations<sup>1,2</sup>

Pin #	Pin Name	Function
1	N/C	No Connection
2, 3	RF <sub>IN</sub> / V <sub>G</sub>	RF Input / Gate Voltage
4 - 9	N/C	No Connection
10, 11	RF <sub>OUT</sub> / V <sub>D</sub>	RF Output / Drain Voltage
12 - 16	N/C	No Connection
17	Paddle <sup>2</sup>	Ground

1. All no connection pins may be left floating or grounded.
2. The exposed pad centered on the package bottom must be connected to RF and DC ground. This path must also provide a low thermal resistance heat path.

**RF Electrical Specifications:  $T_C = +25^\circ\text{C}$ ,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$**

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	CW, 1000 MHz	$G_{SS}$	—	18	—	dB
Saturated Output Power	CW, 1000 MHz	$P_{SAT}$	—	38.5	—	dBm
Drain Efficiency at Saturation	CW, 1000 MHz	$\eta_{SAT}$	—	50	—	%
Noise Figure	CW, 1000 MHz	NF	—	2.0	—	dB
Power Gain	CW, 1000 MHz, $P_{OUT} = 5\text{ W}$	$G_P$	14	16	—	%
Power Added Efficiency	CW, 1000 MHz, $P_{OUT} = 5\text{ W}$	PAE	38	42	—	%
Ruggedness	All phase angles	$\Psi$	VSWR=10:1, No Device Damage			

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

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	$V_{GS} = -8\text{ V}$ , $V_{DS} = 100\text{ V}$	$I_{DLK}$	—	—	2	mA
Gate-Source Leakage Current	$V_{GS} = -8\text{ V}$ , $V_{DS} = 0\text{ V}$	$I_{GLK}$	—	—	1	mA
Gate Threshold Voltage	$V_{DS} = 28\text{ V}$ , $I_D = 2\text{ mA}$	$V_T$	-2.5	-1.5	-0.5	V
Gate Quiescent Voltage	$V_{DS} = 28\text{ V}$ , $I_D = 88\text{ mA}$	$V_{GSQ}$	-2.1	-1.2	-0.3	V
On Resistance	$V_{DS} = 2\text{ V}$ , $I_D = 15\text{ mA}$	$R_{ON}$	—	1.6	—	$\Omega$
Maximum Drain Current	$V_{DS} = 7\text{ V}$ pulsed, pulse width 300 $\mu\text{s}$	$I_{D, MAX.}$	—	1.5	—	A

## Absolute Maximum Ratings<sup>3,4,5</sup>

Parameter	Absolute Maximum
Drain Source Voltage, $V_{DS}$	100 V
Gate Source Voltage, $V_{GS}$	-10 to 3 V
Gate Current, $I_G$	4 mA
Junction Temperature, $T_J$	+200°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°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  $T_J \leq 180^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.

## Thermal Characteristics<sup>6</sup>

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance	$V_{DS} = 28 \text{ V}, T_J = 180^\circ\text{C}$	$R_{\theta JC}$	12	°C/W

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

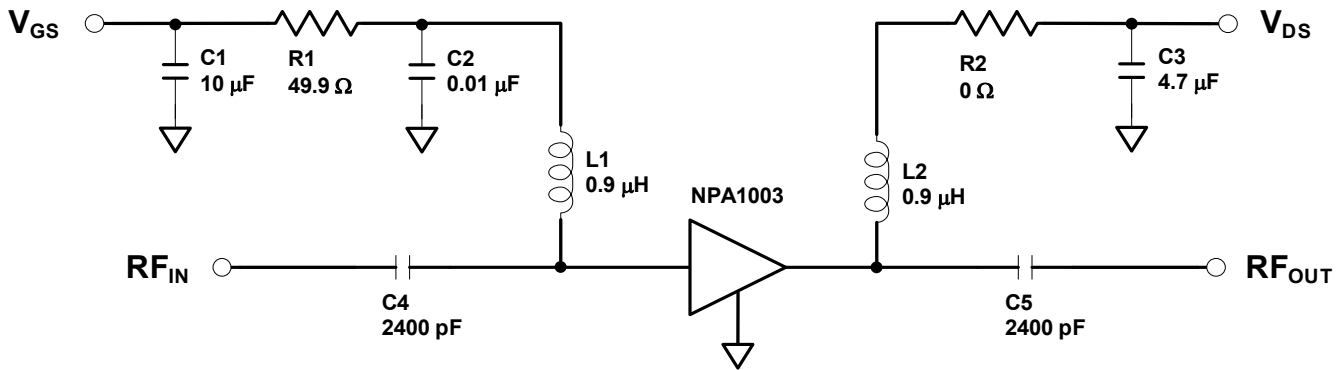
## Handling Procedures

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 1A devices.

**Evaluation Board and Recommended Tuning Solution**  
**20 - 1500 MHz Broadband Circuit**



**Description**

Parts measured on evaluation board (20-mil thick RO4350). The PCB's electrical and thermal ground is provided using a standard-plated densely packed via hole array (see recommended via pattern).

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**

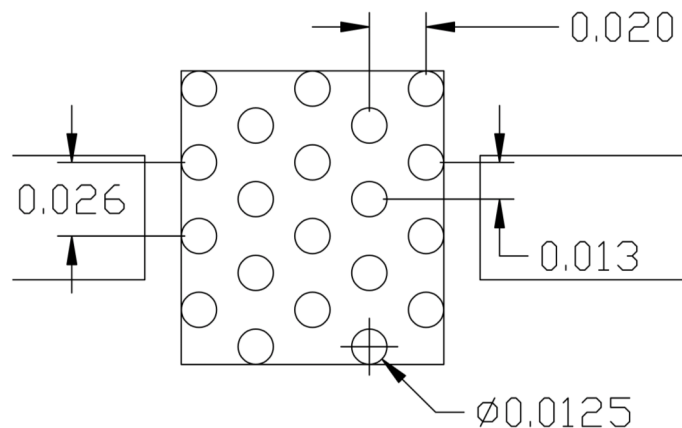
**Turning the device ON**

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.

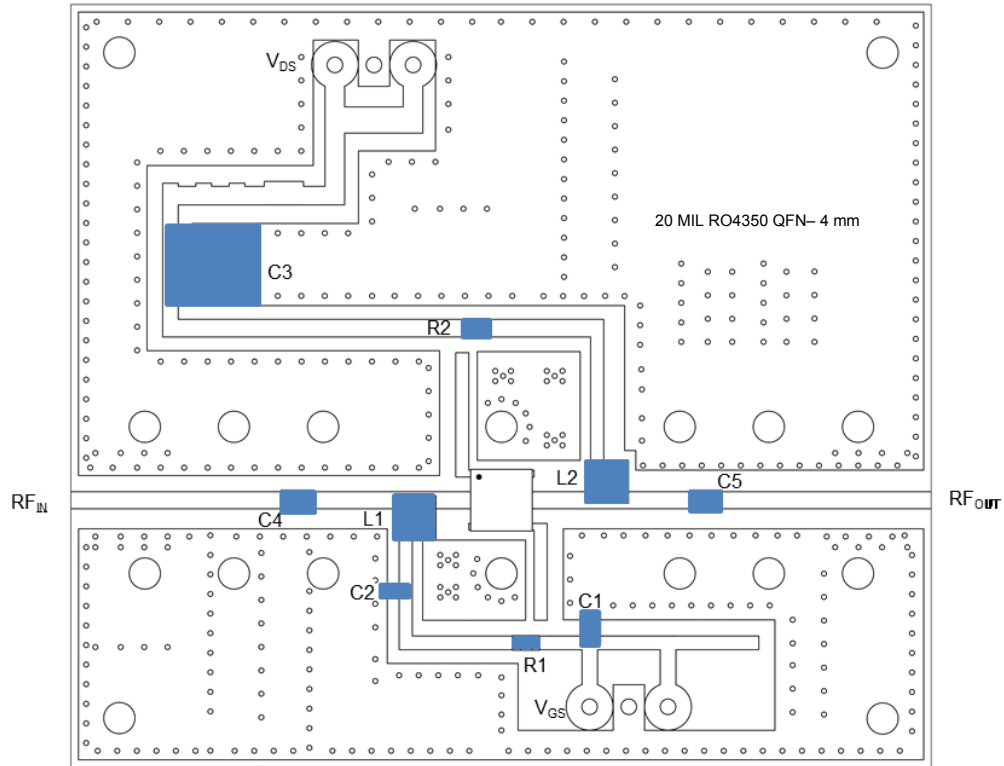
**Turning the device OFF**

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

**Recommended Via Pattern (All dimensions shown as inches)**



**Evaluation Board and Recommended Tuning Solution**  
**20 - 1500 MHz Broadband Circuit**



**Parts list**

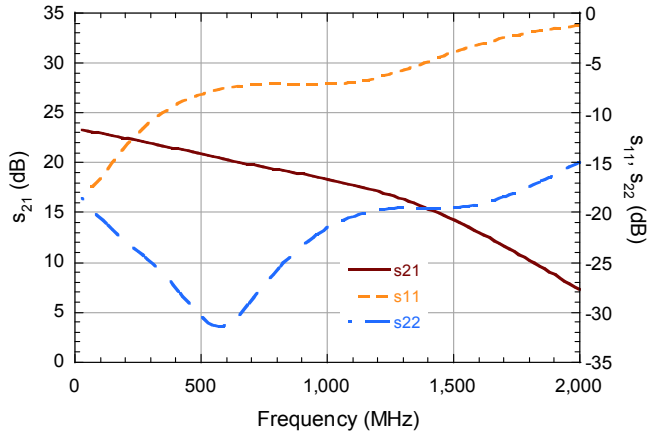
Reference	Value	Tolerance	Manufacturer	Part Number
C1	10 $\mu$ F	20%	TDK	C2012X5R1C106M085AC
C2	0.01 $\mu$ F	5%	AVX	06031C103JAT2A
C3	4.7 $\mu$ F	10%	TDK	C5750X7R2A475K230KA
C4, C5	2400 pF	-	Dielectric Labs, Inc.	C08BL242X-5UN-X0
R1	49.9 $\Omega$	1%	Panasonic	ERJ-6ENF49R9V
R2	0 $\Omega$	-	Panasonic	ERJ-3GEY0R00V
L1, L2	0.9 $\mu$ H	10%	Coilcraft	1008AF-901XJLC
PCB	Rogers RO4350, $\epsilon_r = 3.5$ , 0.020"			

## GaN on Silicon Power Amplifier 20 - 1500 MHz, 28 V, 5 W

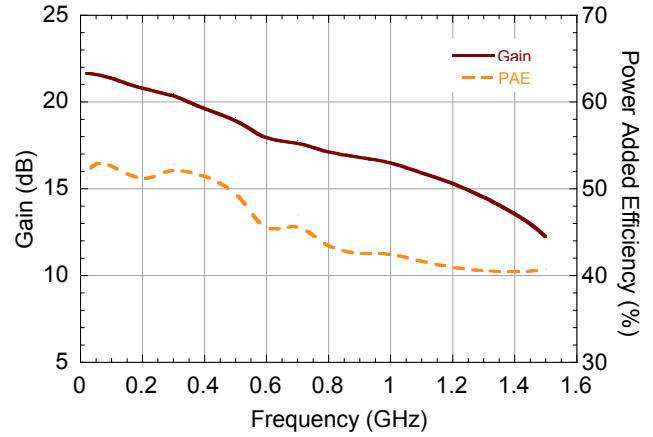
Rev. V2

Typical Performance as measured in the broadband evaluation board:  
CW,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$  (unless noted)

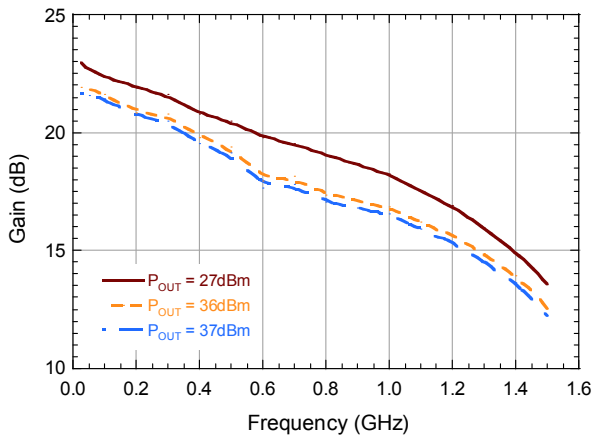
Small Signal s-Parameters vs. Frequency



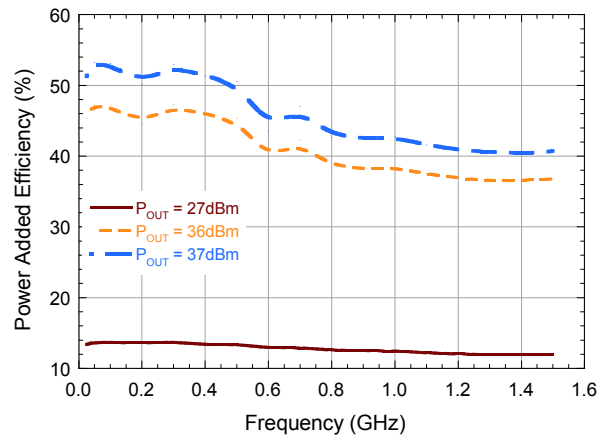
Performance vs. Frequency at  $P_{OUT} = 37\text{ dBm}$



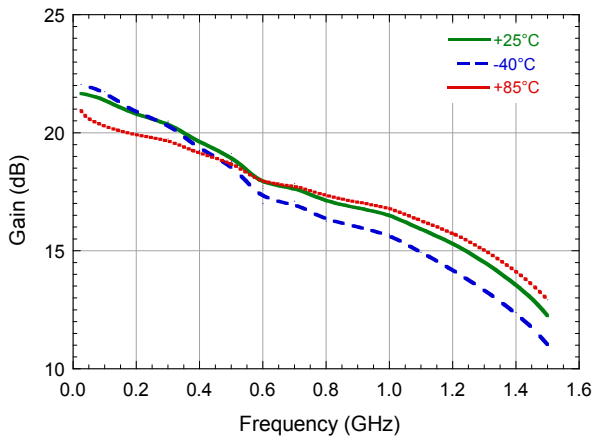
Gain vs. Frequency



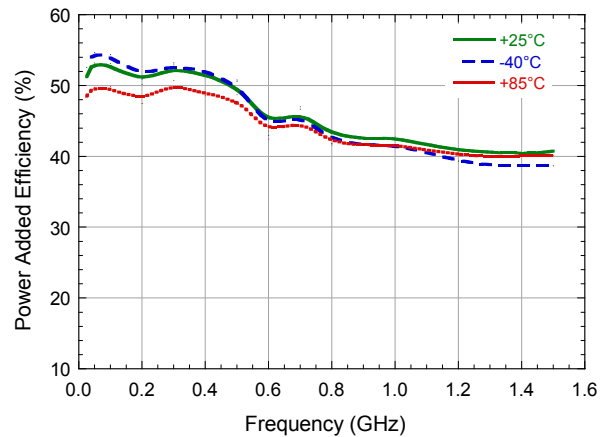
Power Added Efficiency vs. Frequency



Gain vs. Frequency  
at  $P_{OUT} = 37\text{ dBm}$

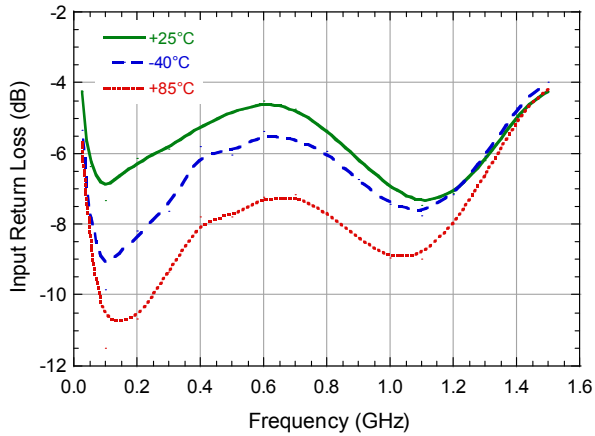


Power Added Efficiency vs. Frequency  
at  $P_{OUT} = 37\text{ dBm}$

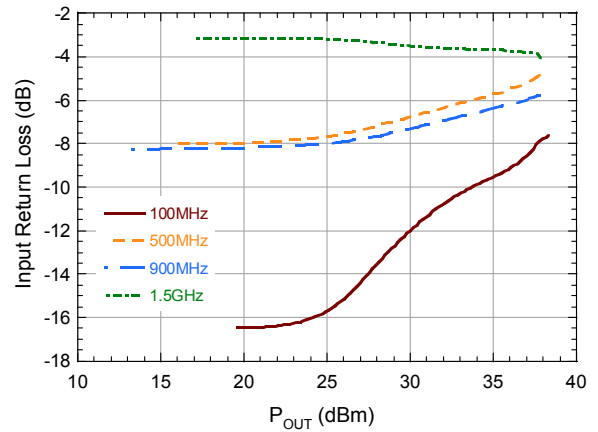


**Typical Performance as measured in the broadband evaluation board:**  
**CW,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$  (unless noted)**

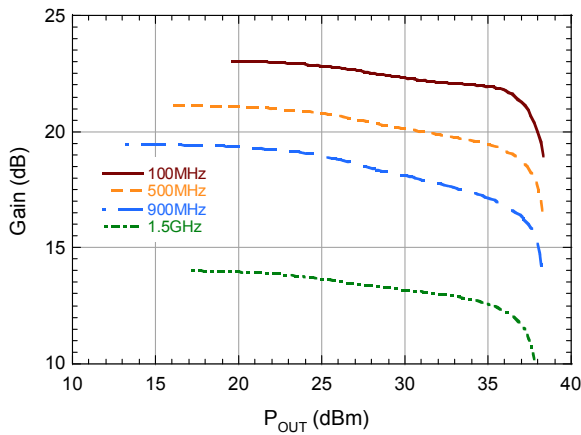
**Input Return Loss vs. Frequency at  $P_{OUT} = 37\text{ dBm}$**



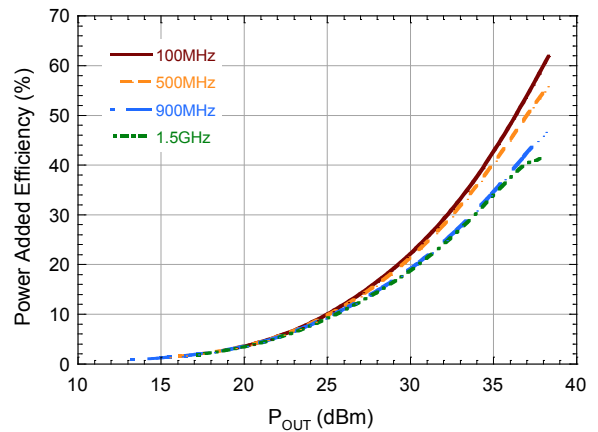
**Input Return Loss vs. Output Power**



**Gain vs. Output Power**



**Power Added Efficiency vs. Output Power**

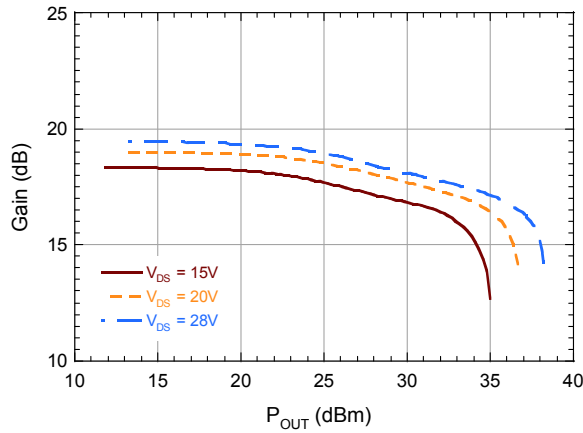


## GaN on Silicon Power Amplifier 20 - 1500 MHz, 28 V, 5 W

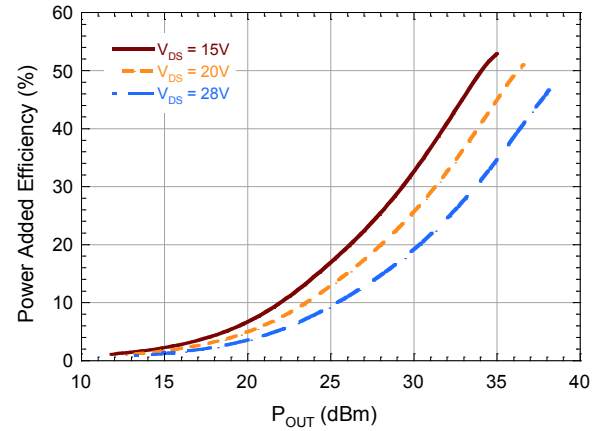
Rev. V2

Typical Performance as measured in the broadband evaluation board:  
CW,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$  (unless noted)

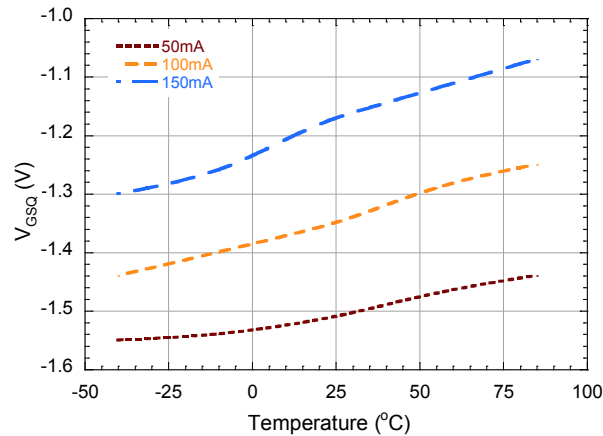
**Gain vs. Output Power**  
at freq = 900 MHz



**Power Added Efficiency vs. Output Power**  
at freq = 900 MHz



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



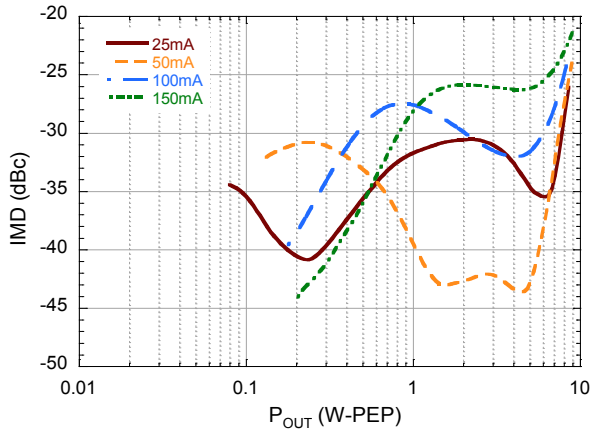


## GaN on Silicon Power Amplifier 20 - 1500 MHz, 28 V, 5 W

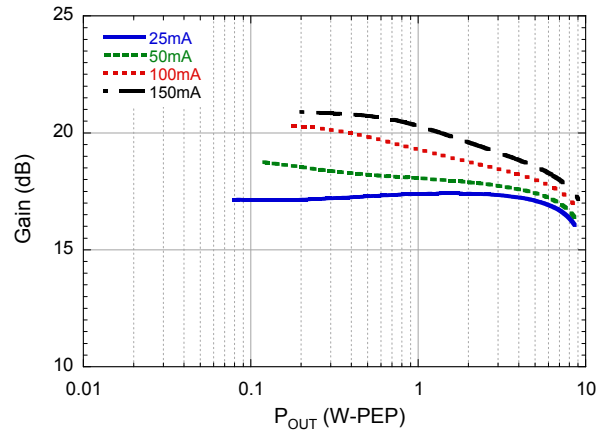
Rev. V2

Typical 2-Tone Performance as measured in the broadband evaluation board:  
1 MHz Tone Spacing,  $f = 500$  MHz,  $V_{DS} = 28$  V,  $I_{DQ} = 100$  mA (unless noted)

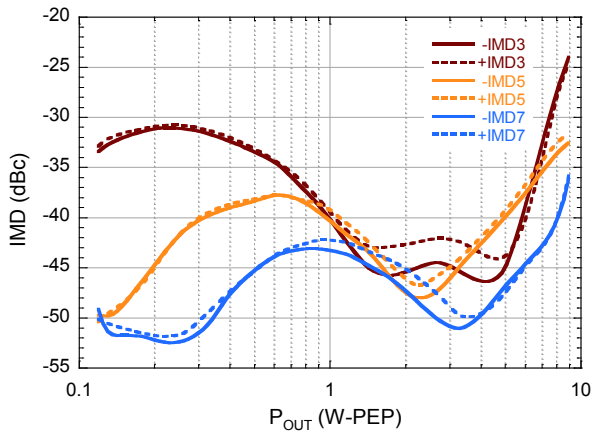
2-Tone IMD3 vs. Output Power vs. Quiescent Current



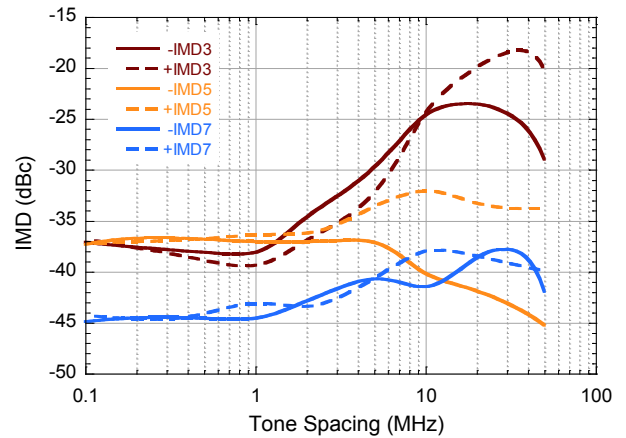
2-Tone Gain vs. Output Power vs. Quiescent Current



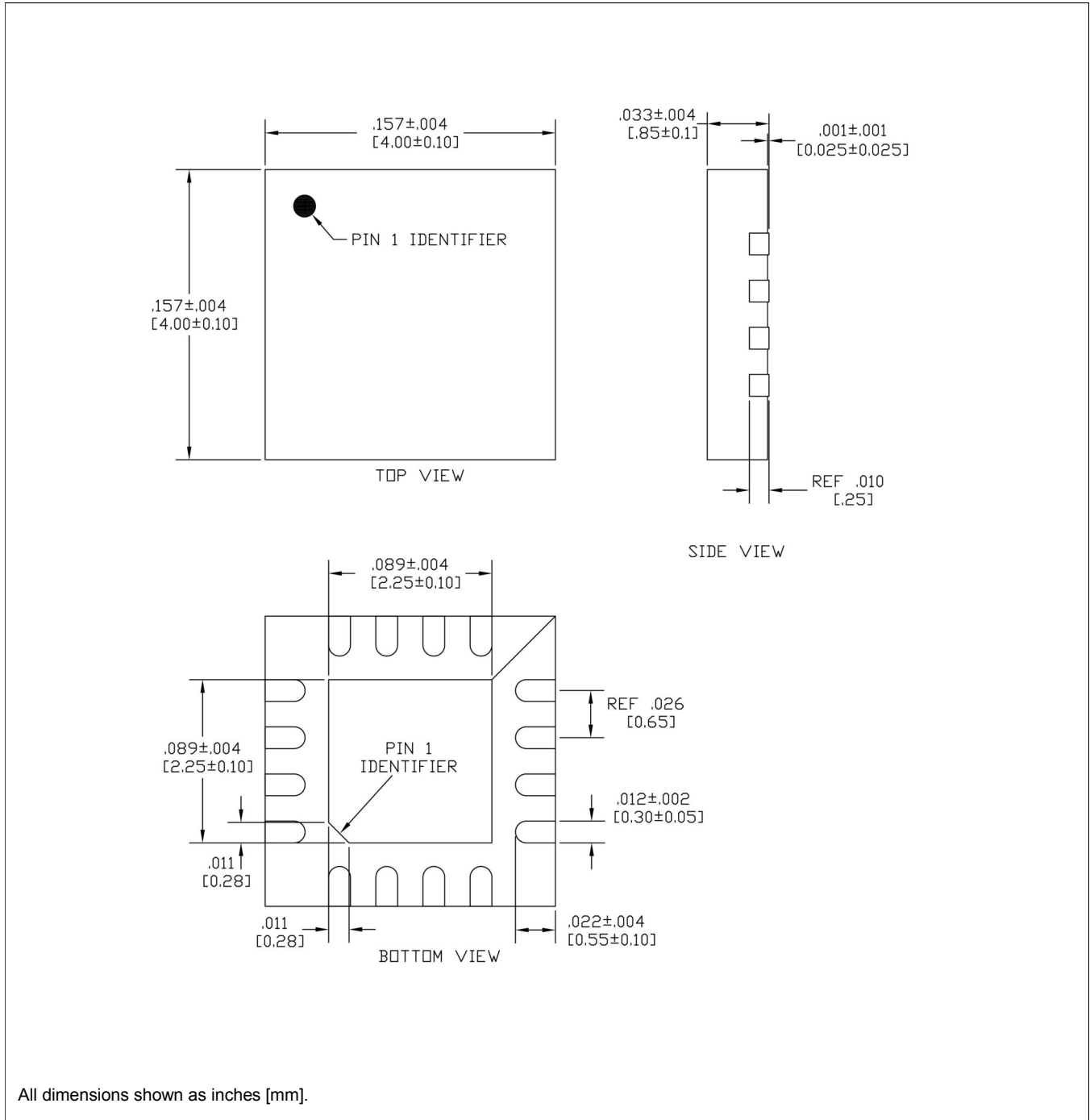
2-Tone IMD vs. Output Power



2-Tone IMD vs. Tone Spacing  
at  $P_{OUT} = 6$  W-PEP,  $I_{DQ} = 6$  mA



**Lead-Free 4 mm QFN 16-lead plastic package**



† Meets JEDEC moisture sensitivity level 3 requirements.  
 Plating is 100% matte tin over copper.

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