GaN Amplifier 28 V, 5 W
20 - 1500 MHz

NPA1003QA
Rev. V3

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 Ω Input / Output Matched
- Lead-Free 4 mm 16-lead QFN plastic Package
- RoHS* Compliant and 260°C Reflow Compatible

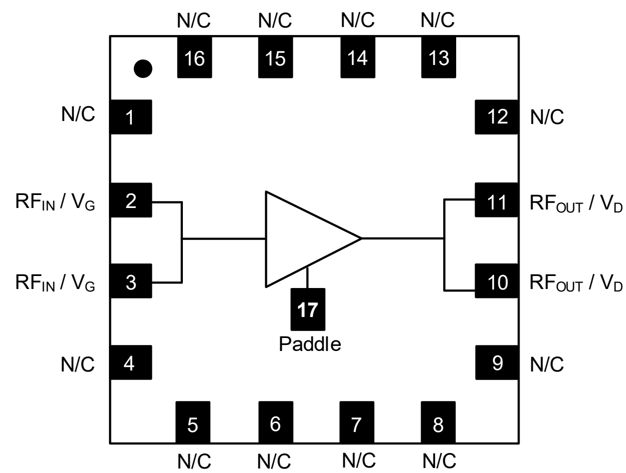
Description
The NPA1003QA is a GaN on silicon power amplifier optimized for 20 - 1500 MHz operation. This amplifier has been designed for saturated and linear operation with output levels to 5 W (37 dBm) assembled in a lead-free 4 mm 16-lead QFN plastic package.

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[1,2]

Pin #	Pin Name	Function
1	N/C	No Connection
2, 3	RF_{IN} / V_G	RF Input / Gate Voltage
4 - 9	N/C	No Connection
10, 11	RF_{OUT} / V_D	RF Output / Drain Voltage
12 - 16	N/C	No Connection
17	Paddle[2]	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.

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

RF Electrical Specifications: T_C = +25°C , V_{DS} = 28 V, I_{DQ} = 100 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	η_{SAT}	—	50	—	%
Noise Figure	CW, 1000 MHz	NF	—	2.0	—	dB
Power Gain	CW, 1000 MHz, P_{OUT} = 5 W	G_P	14	16	—	%
Power Added Efficiency	CW, 1000 MHz, P_{OUT} = 5 W	PAE	38	42	—	%
Ruggedness	All phase angles	Ψ	VSWR=10:1, No Device Damage			

DC Electrical Specifications: T_C = +25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 100 V	I_{DLK}	—	—	2	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	—	—	1	mA
Gate Threshold Voltage	V_{DS} = 28 V, I_D = 2 mA	V_T	-2.9	-2.0	-0.9	V
Gate Quiescent Voltage	V_{DS} = 28 V, I_D = 88 mA	V_{GSQ}	-2.5	-1.6	-0.7	V
On Resistance	V_{DS} = 2 V, I_D = 15 mA	R_{ON}	—	1.6	—	Ω
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 μs	$I_{D,\ MAX.}$	—	1.5	—	A

Absolute Maximum Ratings[3,4,5]

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 $T_J \leq 180°C$ will ensure MTTF > 1 x 10^6 hours.

Thermal Characteristics[6]

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance	V_{DS} = 28 V, T_J = 180 °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

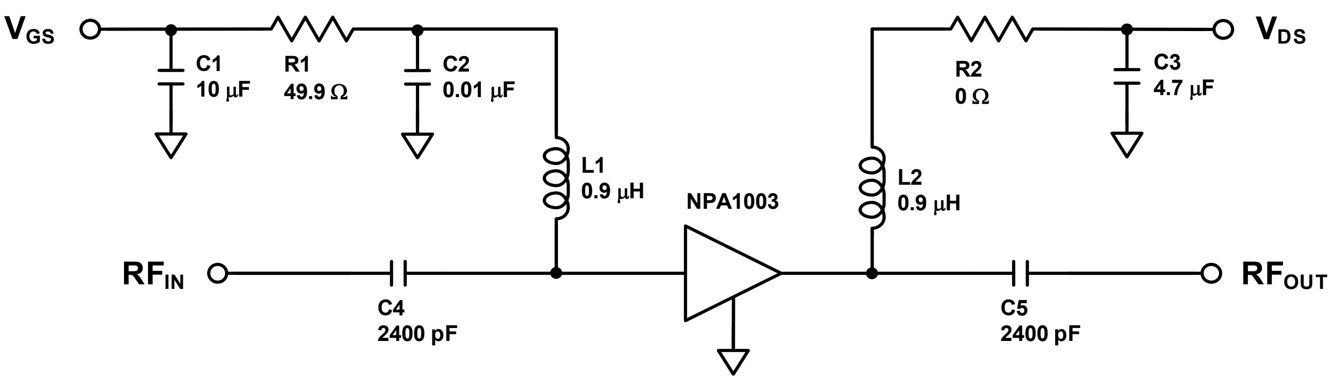
Please observe the following precautions to avoid damage:

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

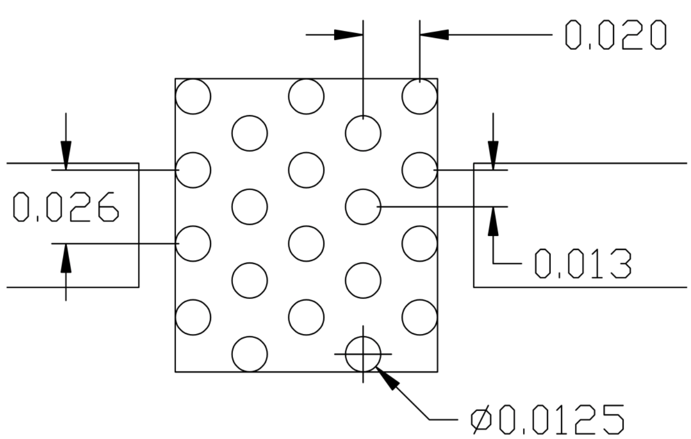
Turning the device ON

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

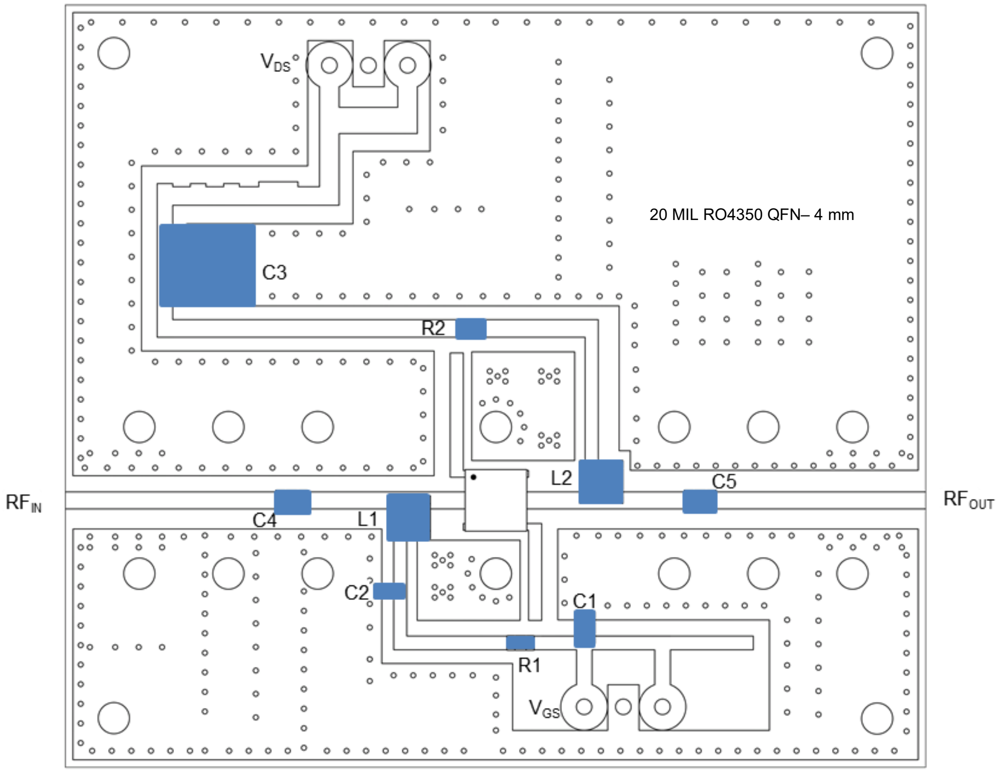
1. Turn the RF power off.
2. Decrease V_{GS} down to V_P.
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}.

Recommended Via Pattern (All dimensions shown as inches)



Evaluation Board and Recommended Tuning Solution

20 - 1500 MHz Broadband Circuit

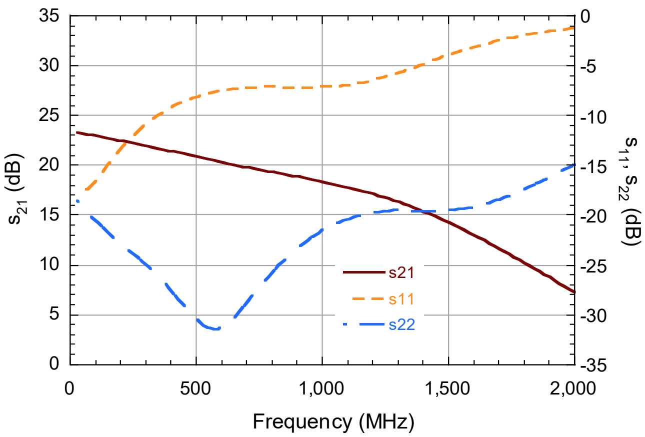


Parts list

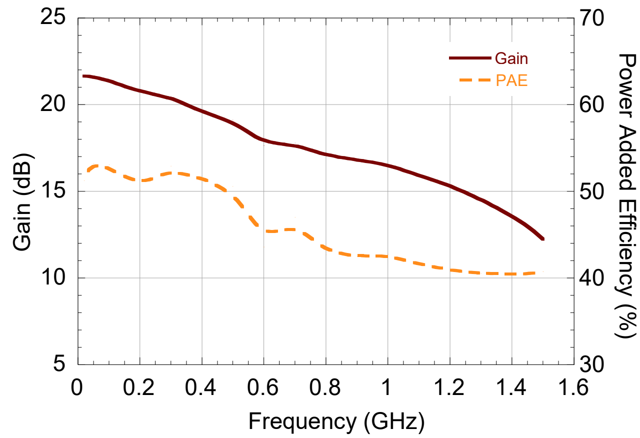
Reference	Value	Tolerance	Manufacturer	Part Number
C1	10 µF	20%	TDK	C2012X5R1C106M085AC
C2	0.01 µF	5%	AVX	06031C103JAT2A
C3	4.7 µF	10%	TDK	C5750X7R2A475K230KA
C4, C5	2400 pF	-	Dielectric Labs, Inc.	C08BL242X-5UN-X0
R1	49.9 Ω	1%	Panasonic	ERJ-6ENF49R9V
R2	0 Ω	-	Panasonic	ERJ-3GEY0R00V
L1, L2	0.9 µH	10%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

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

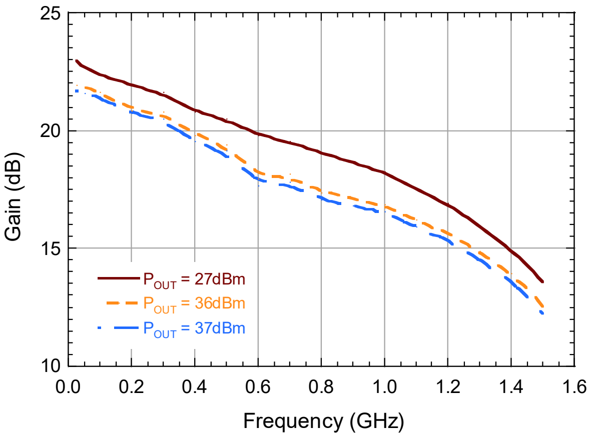
Small Signal s-Parameters vs. Frequency



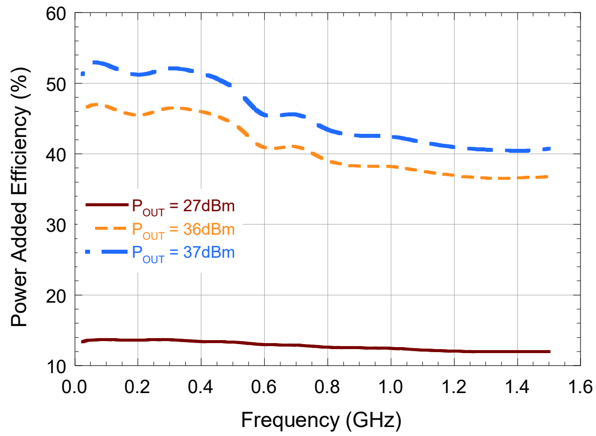
Performance vs. Frequency at P_{OUT} = 37 dBm



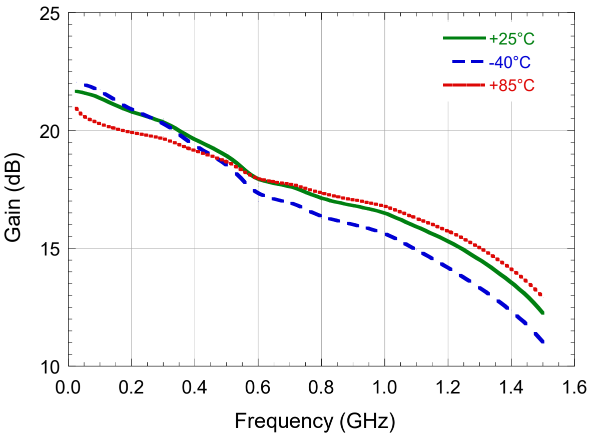
Gain vs. Frequency



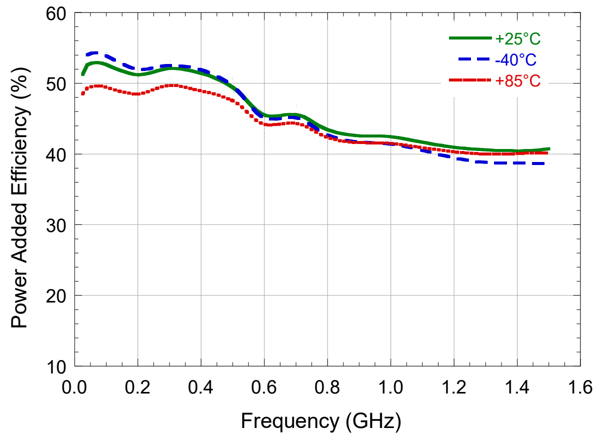
Power Added Efficiency vs. Frequency



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

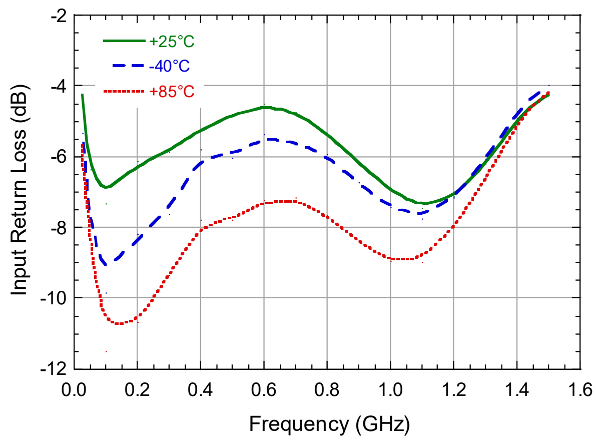


Power Added Efficiency vs. Frequency at P_{OUT} = 37 dBm

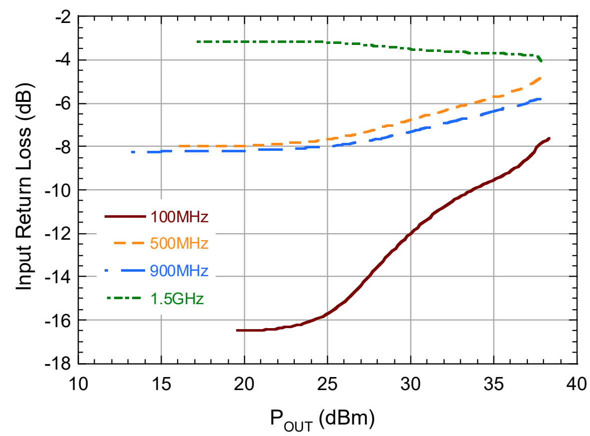


Typical Performance as measured in the broadband evaluation board: CW, V_{DS} = 28 V, I_{DQ} = 100 mA (unless noted)

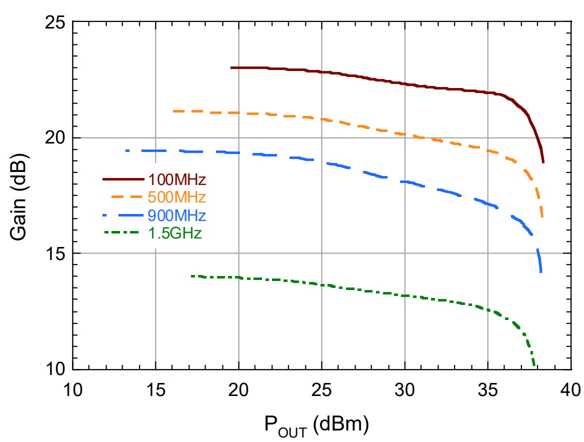
Input Return Loss vs. Frequency at P_{OUT} = 37 dBm



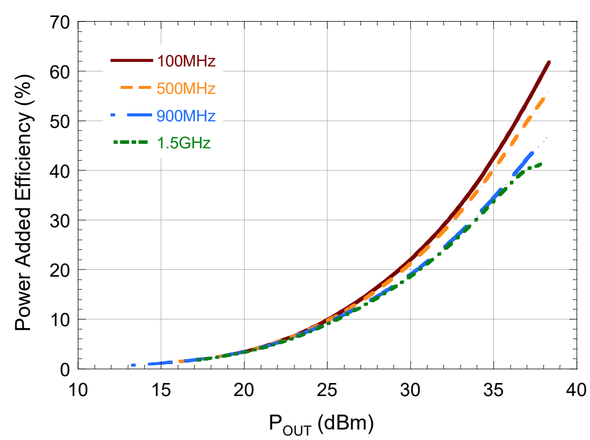
Input Return Loss vs. Output Power



Gain vs. Output Power

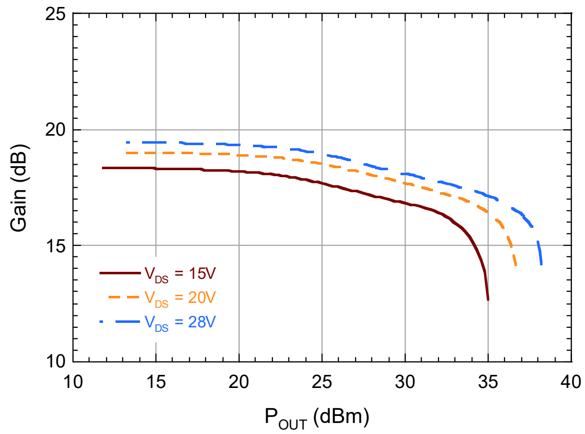


Power Added Efficiency vs. Output Power

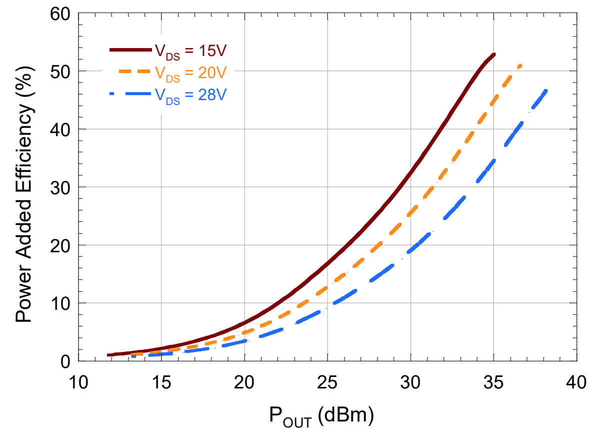


Typical Performance as measured in the broadband evaluation board: CW, V_{DS} = 28 V, I_{DQ} = 100 mA (unless noted)

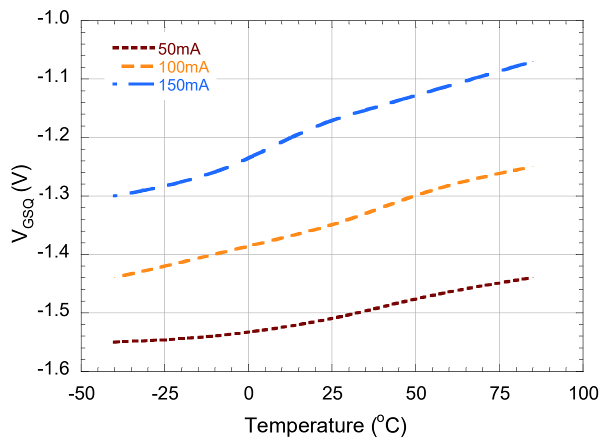
Gain vs. Output Power at freq = 900 MHz



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

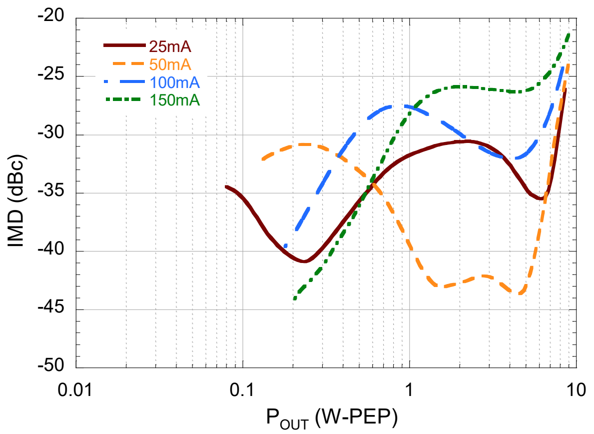


Quiescent V_{GS} vs. Temperature

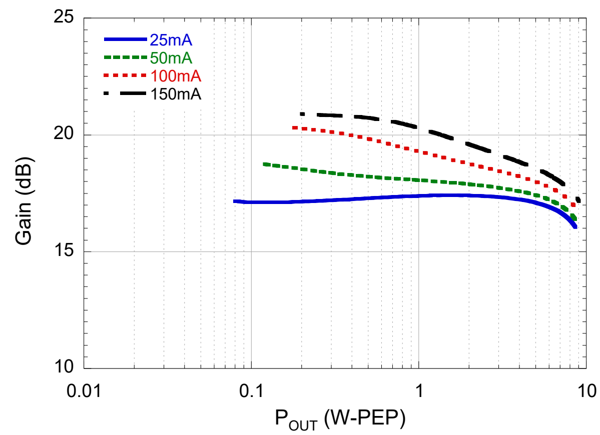


Typical 2-Tone Performance as measured in the broadband evaluation board: 1 MHz Tone Spacing, f = 500 MHz, V_{DS} = 28 V, I_{DQ} = 100 mA (unless noted)

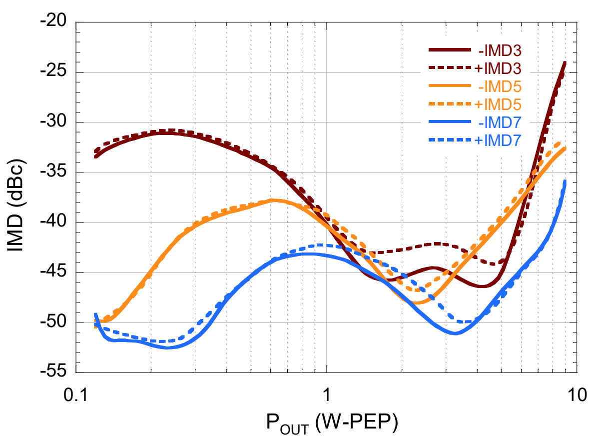
2-Tone IMD3 vs. Output Power vs. Quiescent Current



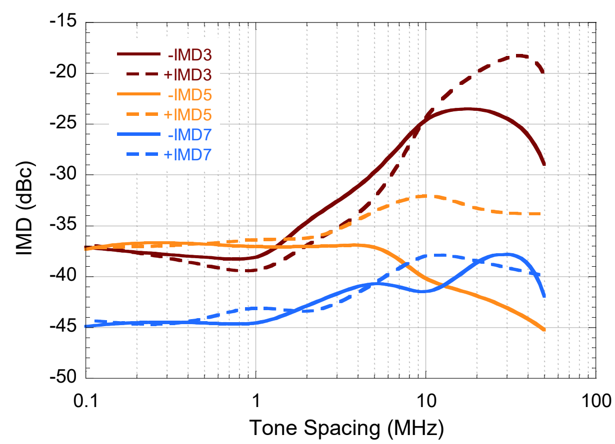
2-Tone Gain vs. Output Power vs. Quiescent Current



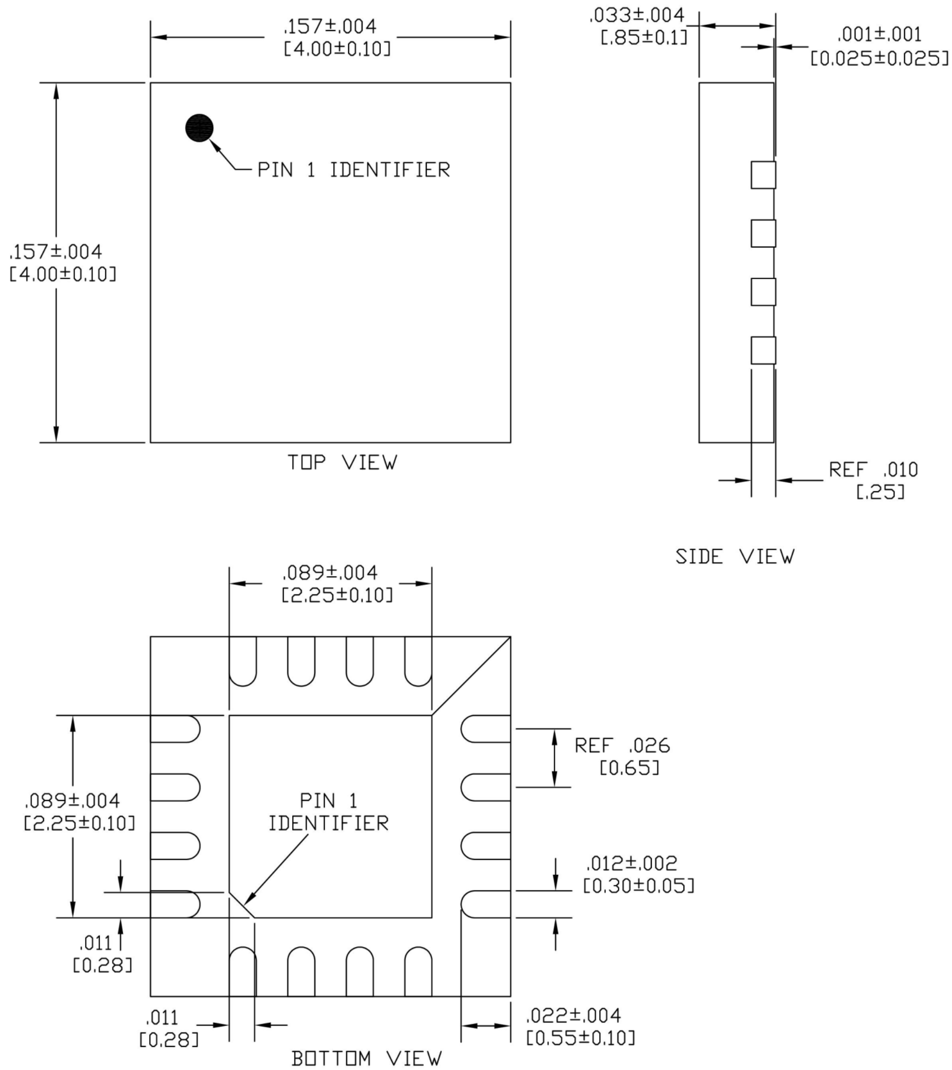
2-Tone IMD vs. Output Power



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



All dimensions shown as inches [mm].

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