NPA1008

GaN Wideband Power Amplifier, 28 V, 5 W
20 - 2700 MHz

Rev. V3

Features

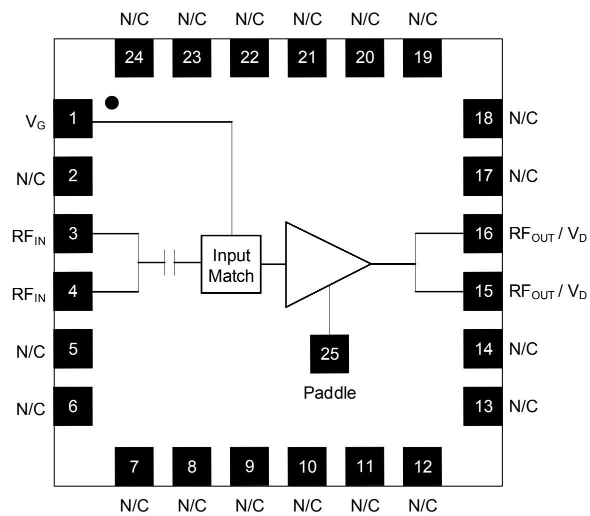
- GaN on Si HEMT D-Mode Integrated Amplifier
- Suitable for Linear and Saturated Applications
- Wideband tuned from 20 - 2700 MHz
- 50 Ω Input Matched
- 28 V Operation
- 45% Drain Efficiency
- 100% RF Tested
- Lead-Free 4 mm 24-lead PQFN Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant

Description

The NPA1008 is a wideband integrated GaN power amplifier optimized for 20 - 2700 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 x 4 mm 24-lead QFN plastic package.

The NPA1008 is ideally suited for general purpose narrowband to broadband applications in test and measurement, defense communications, land mobile radio and wireless infrastructure.

Functional Schematic



Ordering Information

Part Number	Package
NPA1008	Bulk Quantity
NPA1008-SMB	Sample Board

Pin Designations

Pin No.	Pin Name	Function
1	V_G	Gate - DC Bias
2	N/C[1]	No Connection
3,4	RF_{IN}	RF Input
5-14	N/C[1]	No Connection
15,16	RF_{OUT} / V_D	RF Output / Drain
17-24	N/C[1]	No Connection
25	Paddle[2]	Ground / Source

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, European Union Directive 2011/65/EU.

RF Electrical Specifications: T_C = 25 °C , V_{DS} = 28 V, I_{DQ} = 88 mA

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	CW, 1900 MHz	G_{SS}	-	15.6	-	dB
Gain	CW, P_{OUT} = 37 dBm, 1900 MHz	G_P	10.5	12.0	-	dB
Saturated Output Power	CW, 1900 MHz	P_{SAT}	-	38.9	-	dBm
Drain Efficiency	CW, 1900 MHz	η_{SAT}	44	47.0	-	%
Power Added Efficiency	CW, P_{OUT} = 37 dBm, 1900 MHz	PAE	-	44.7	-	%
Ruggedness	All phase angles	Ψ	VSWR = 15:1, 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}	-	4	-	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	2	-	mA
Gate Threshold Voltage	V_{DS} = 28 V, I_D = 4 mA	V_T	-2.5	-1.5	-0.5	V
Gate Quiescent Voltage	V_{DS} = 28 V, I_D = 88 mA	V_{GSQ}	-2.1	-1.2	-0.3	V
On Resistance	V_{DS} = 2 V, I_D = 45 mA	R_{ON}	-	1.2	-	Ω
Saturated Drain Current	V_{DS} = 7 V pulsed, pulse width 300 µs	$I_{D(SAT)}$	-	2.3	-	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	12 mA
Junction Temperature, T_J	+200°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
ESD Min. - Human Body Model (HBM)	+350 V

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 $T_J \leq 200°C$ will ensure MTTF > 1 x 10^6 hours.

Thermal Characteristics[6,7]

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance	V_{DS} = 28 V, T_J =200°C	Θ_{JC}	12.1	°C/W

6. Junction temperature (T_J) measured using IR Microscopy. Case temperature measured using thermocouple embedded in heat-sink.
7. The thermal resistance of the mounting configuration must be added to the device Θ_{JC} , for proper T_J calculation during operation. The recommended via pattern, shown on page 4, on a 20 mil thick, 1 oz plated copper, PCB adds an additional 4 °C/W to the typical value.

Handling Procedures

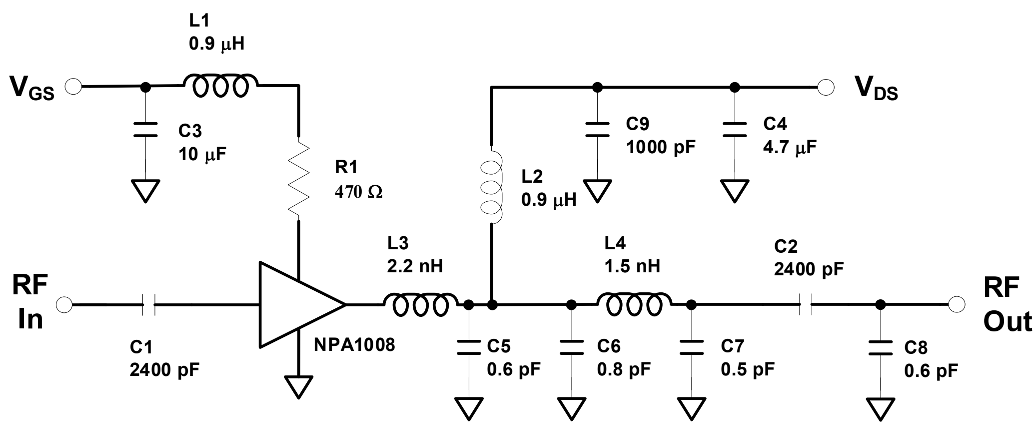
Please observe the following precautions to avoid damage:

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.

Evaluation Board and Recommended Tuning Solution

20 - 2700 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

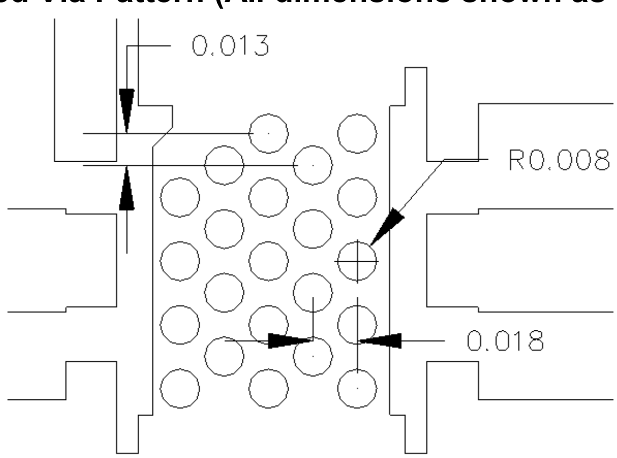
Turning the device ON

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

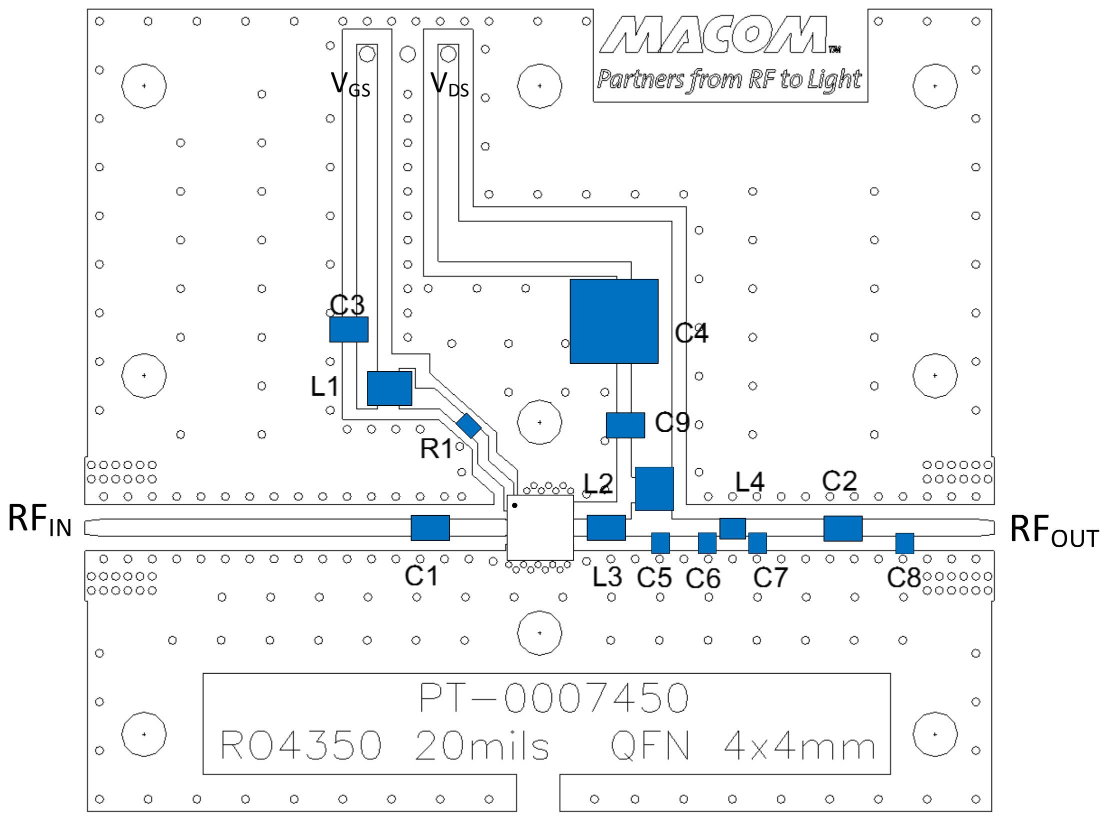
1. Turn the RF power off.
2. Decrease V_{GS} down to V_P.
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}.

Recommended Via Pattern (All dimensions shown as inches)



Evaluation Board and Recommended Tuning Solution

20 - 2700 MHz Broadband Circuit

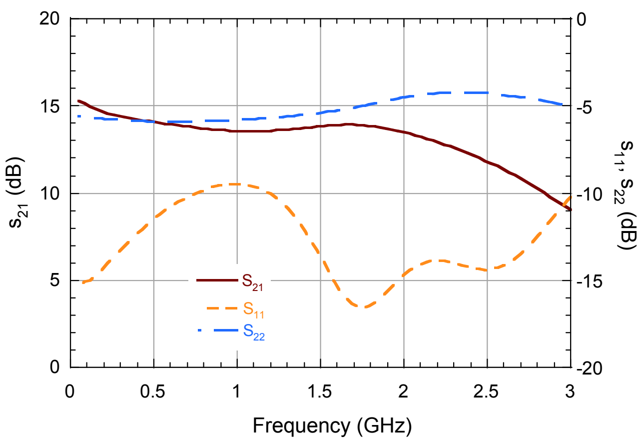


Parts list

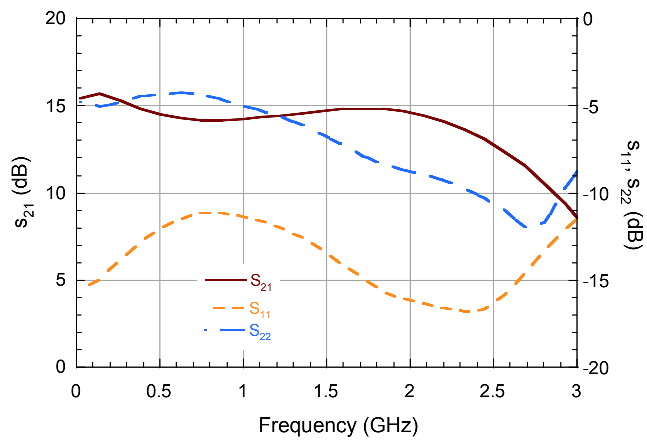
Reference	Value	Tolerance	Manufacturer	Part Number
C1, C2	2400 pF	-	Dielectric Labs, Inc.	C08BL242X-5UN-X0
C3	10 µF	10%	TDK	C2012XR1C106M085AC
C4	4.7 µF	10%	TDK	C5750X7R2A475K230KA
C5, C8	0.6 pF	0.1 pF	ATC	800A0R6BT250X
C6	0.8 pF	0.1 pF	ATC	800A0R8BT250X
C7	0.5 pF	0.1 pF	ATC	800A0R5BT250X
C9	1000 pF	10%	Kemet	C0805C102K1RACTU
R1	470 Ω	10%	Panasonic	ERJ-P03F4700V
L1, L2	0.9 µH	10%	Coilcraft	1008AF-901XJLC
L3	2.2 nH	±0.2 nH	AVX	L08052R2CEW
L4	1.5 nH	±0.2 nH	AVX	L06031R5CGS
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} = 88 mA, T_C = 25°C (unless noted)

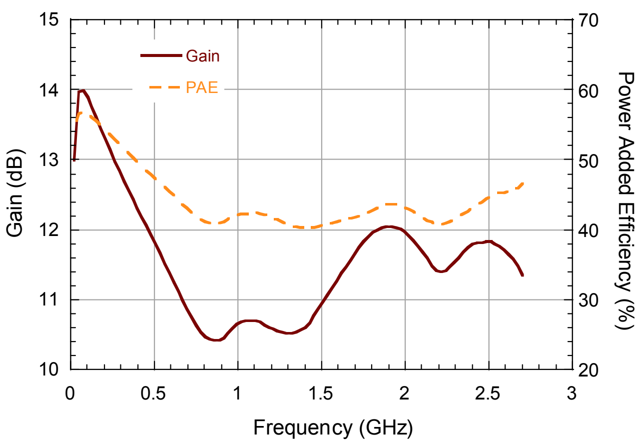
Device s-parameters (Deembedded)



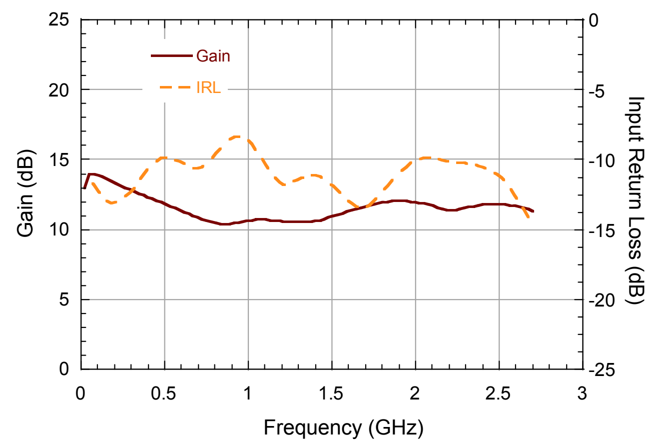
Broadband Circuit s-Parameters



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

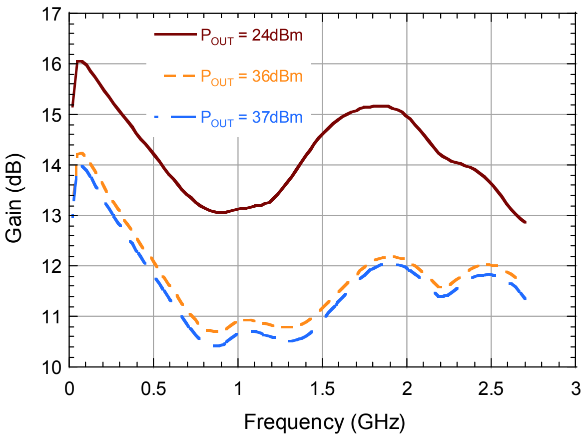


Performance vs. Input Return Loss at P_{OUT} = 37 dBm

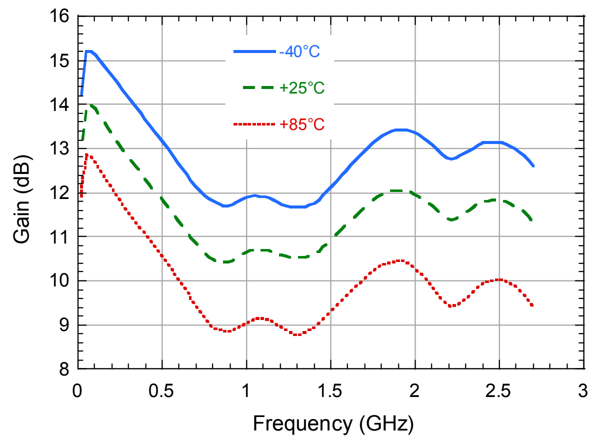


Typical Performance as measured in the Broadband Evaluation Board: CW, V_{DS} = 28 V, I_{DQ} = 88 mA, T_C = 25°C (unless noted)

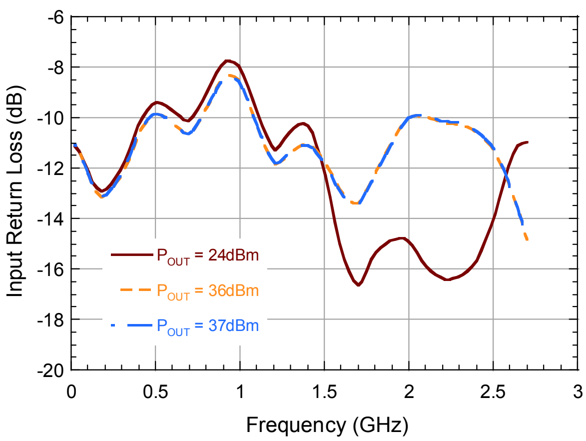
Gain vs. Frequency



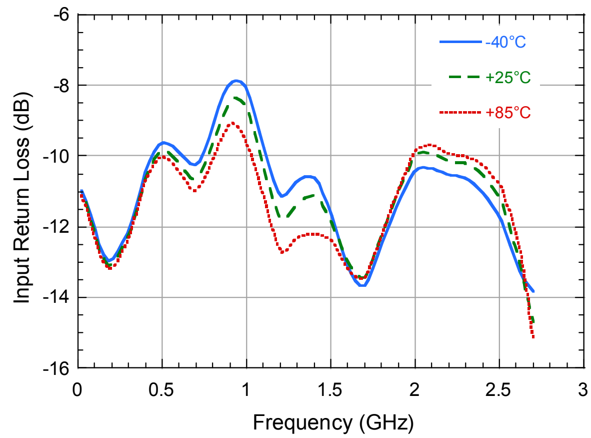
Gain vs. Frequency at P_{OUT} = 37 dBm



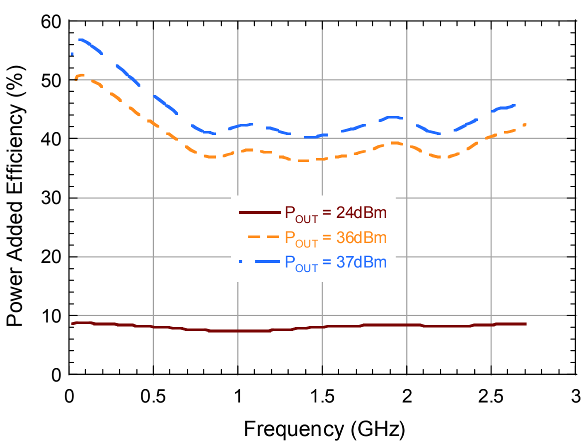
Input Return Loss vs. Frequency



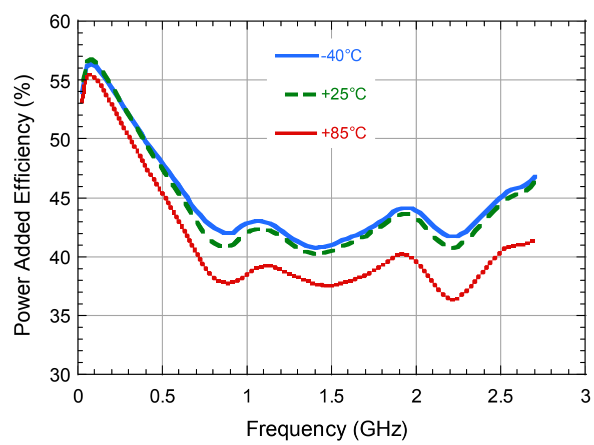
Input Return Loss at P_{OUT} = 37 dBm vs. Frequency



Power Added Efficiency vs. Frequency

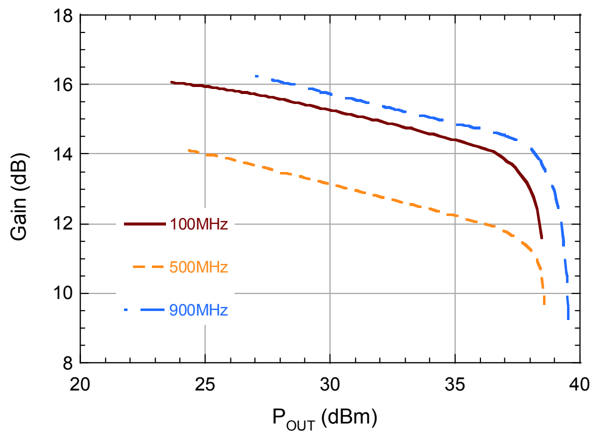


Power Added Efficiency at P_{OUT} = 37 dBm vs. Frequency

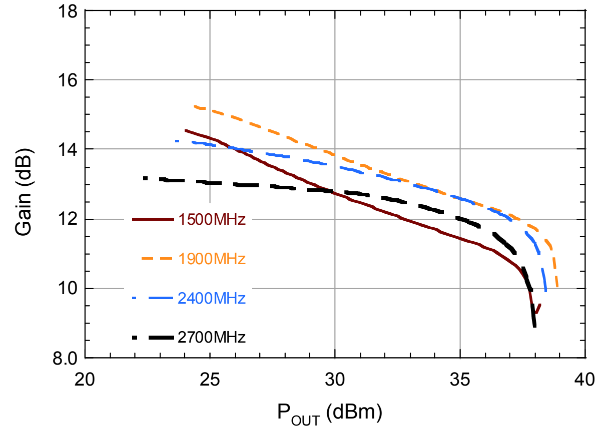


Typical Performance as measured in the Broadband Evaluation Board: CW, V_{DS} = 28 V, I_{DQ} = 88 mA, T_C = 25°C (unless noted)

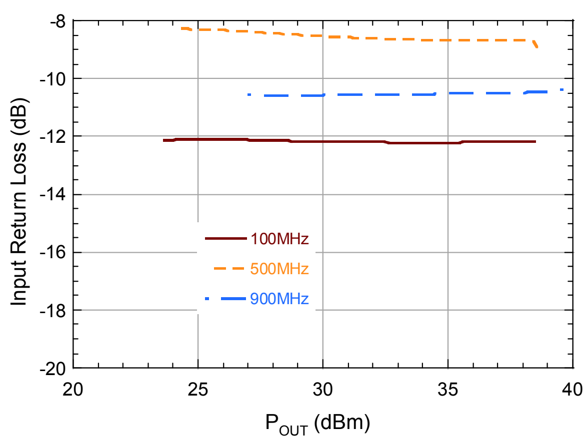
Gain vs. P_{OUT}



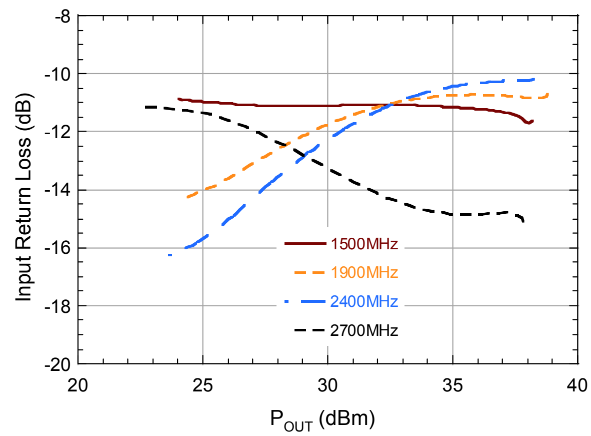
Gain vs. P_{OUT}



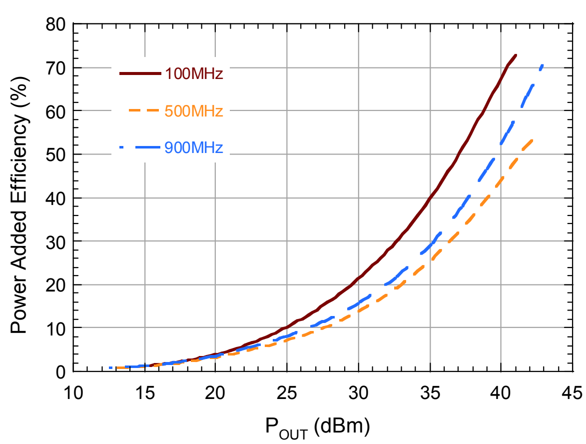
Input Return Loss vs. P_{OUT}



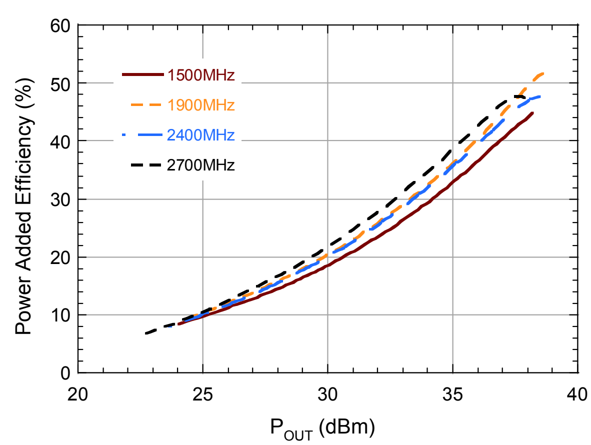
Input Return Loss vs. P_{OUT}



Power Added Efficiency vs. P_{OUT}

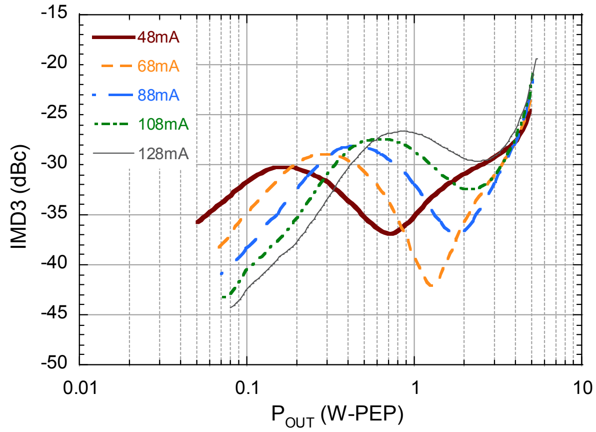


Power Added Efficiency vs. P_{OUT}

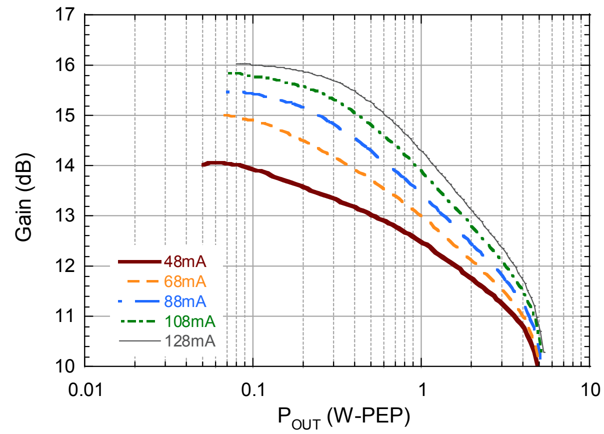


Typical 2-Tone Performance as measured in the Broadband Evaluation Board
1 MHz Tone Spacing, Freq = 1900 MHz, V_{DS} = 28 V, I_{DQ} = 88 mA, T_C = 25°C (unless noted)

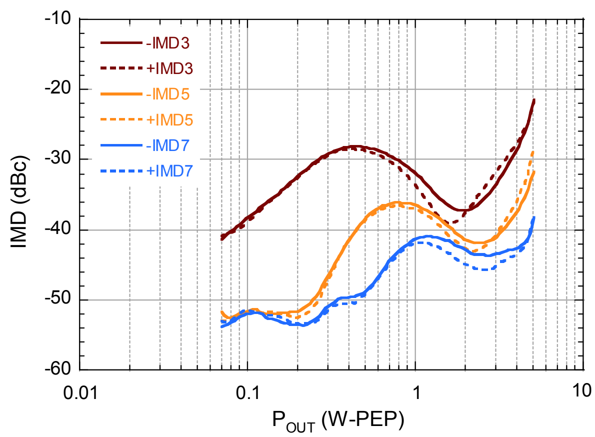
2-Tone IMD vs. Output Power vs. I_{DQ}



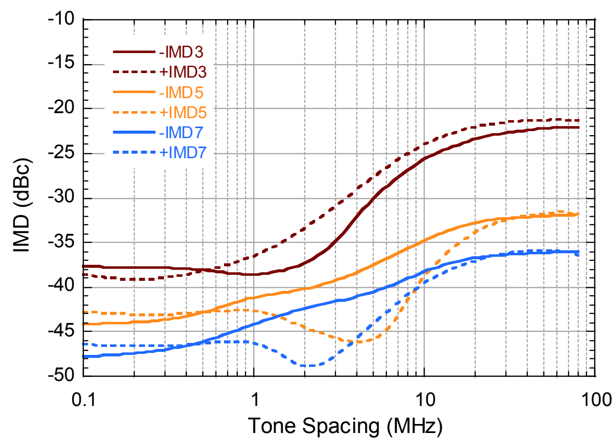
2-Tone Gain vs. Output Power vs. I_{DQ}



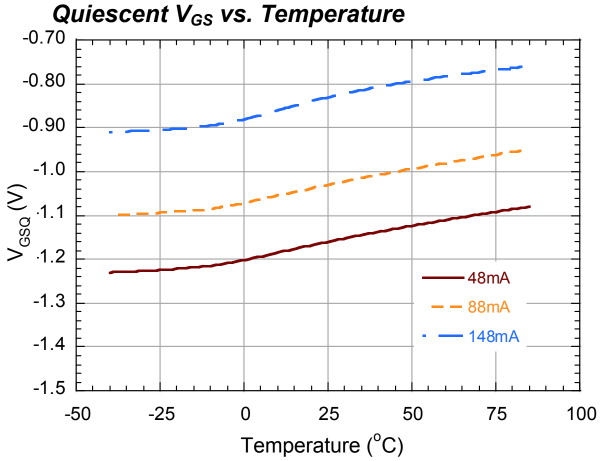
2-Tone IMD vs. Output Power



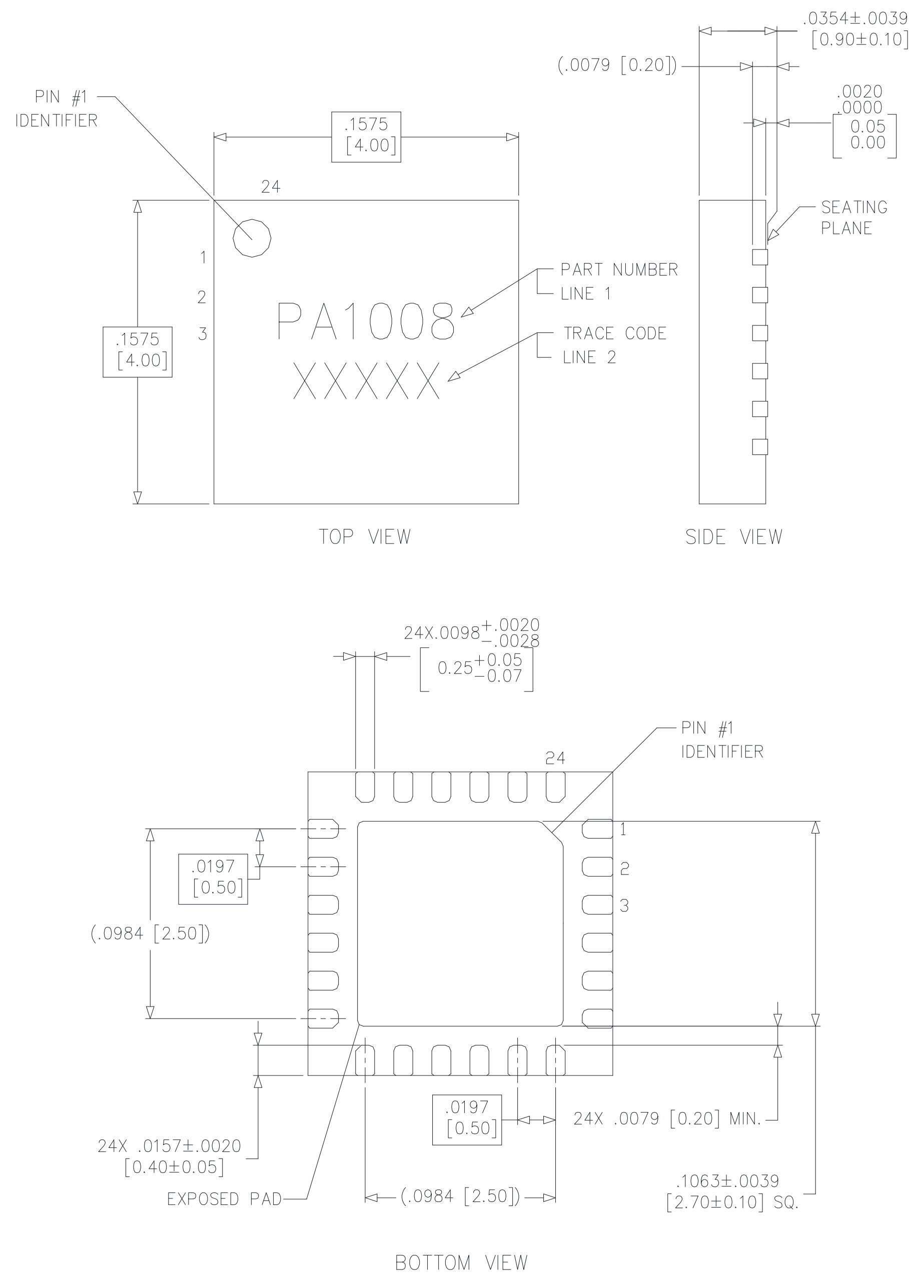
2-Tone IMD vs. Tone Spacing (P_{OUT} = 37 dBm-PEP)



Quiescent V_{GS} vs. Temperature



Lead-Free 4 mm 24-Lead QFN Plastic Package†



All dimensions shown as inches [millimeters]

† Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Matte Tin